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Prof. Ayşe BAYRAKÇEKEN YURTCAN
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UNESCO-UNISA Africa Chair in Nanosciences-Nanotechnology, Muchleuneuck, College of Graduate Studies, PO Box 392
Nanosciences African Network (NANOAFNET), iThemba LABS-National Research Foundation, Somerset West, Western Cape Province

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Department of Applied Chemistry, Faculty of Chemistry,
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Graduate School of Natural and Applied Sciences, Nanoscience and Nanoengineering Department,
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Solar Energy Research Institute, Universiti Kebangsaan Malaysia, 43600, Bangi, Selangor, Malaysia
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Department of Materials, University of Manchester, Manchester M13 9PL, Lancs. United Kingdoom

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Department of Physical Science and Engineering, Nagoya Institute of Technology, 466-8555, Gokiso-cho, Showa-ku, Nagoya, Japan
Department of Physics, Faculty of Science, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia
Department of Materials, Faculty of Mechanical Engineering, Universiti Teknologi Malaysia, 81310 Skudai, Johor, Malaysia
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Atatürk University, Vocational College of Technical Sciences, Department of Chemistry and Chemical Processing Technologies, Erzurum, Turkey, 25240
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LVOBEEN laboratory, MEEM & DD Group, Hassan II University of Casablanca, FSTM BP Mohammedia, Morocco
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Department of Electricity and Energy, Vocational College of Technical Sciences, Ataturk University, 25240 Erzurum, Turkey
Materials Science Unit / DERS / CNESTEN National Centre for Energy, Sciences and Nuclear Techniques), Rabat, Morocco
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Fakulti Kejuruteraan Elektronik & Kejuruteraan Komputer, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia
bInstitute of Advanced Technology, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia
Engineering Faculty, Ataturk University, 25250 Erzurum, Turkey
Faculty of Sciences, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia
Fakulti Kejuruteraan Elektrik, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia

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Atatürk University, Technical Science Vocational College, Department of Automotive Technologies, Erzurum-TÜRKİYE
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Atatürk University, Faculty of Engineering, Department of Mechanical Engineering, Erzurum-TÜRKİYE
Atatürk University, Technical Science Vocational College, Department of Machine Technologies, Erzurum-TÜRKİYE

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Atatürk University, Technical Science Vocational College, Department of Automotive Technologies, Erzurum-TÜRKİYE
Atatürk University, Faculty of Engineering, Department of Mechanical Engineering, Erzurum-TÜRKİYE
Atatürk University, Department of Nanoscience and Nano Engineering, Erzurum-TÜRKİYE
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Nanotechnology Engineering Department, Faculty of Engineering, Sivas Cumhuriyet University, 58140, Sivas, Turkey
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Department of Nanoscience and Nanoengineering, Atatürk University, Erzurum 25240, Turkey
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Department of Physics, Canakkale Onsekiz Mart University, 17100, Canakkale, Turkey
Department of Electrical and Electronics Engineering, Atilim University, 06836, Ankara, Turkey
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Department of Nano-Science and Nano-Engineering, Institute of Science, Ataturk University, 25240 Erzurum, Turkey
Department of Electrical and Electronic Engineering, Faculty of Engineering, Ataturk University, 25240 Erzurum,Turkey
Department of Food Technology, Vocational College of Technical Sciences, Ataturk University, 25240 Erzurum,Turkey
Department of Nursing, Faculty of Health Sciences, Sakarya University of Applied Sciences, 54187 Sakarya,Turkey
Department of Electrical and Electronic Engineering, Faculty of Engineering, Ataturk University, 25240 Erzurum,Turkey

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Department of Food Technology, Vocational College of Technical Sciences, Ataturk University, 25240 Erzurum,Turkey
Department of Electrical and Electronic Engineering, Faculty of Engineering, Ataturk University, 25240 Erzurum,Turkey
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Department of Chemistry Education, Mathematics and Science Education, Kazim Karabekir Faculty of Education, Atatürk University, Erzurum, Turkey
Department of Veterinary Pharmacology and Toxicology, Faculty of Veterinary Medicine, Atatürk University, Erzurum, Turkey
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Department of Nursing, Faculty of Health Sciences, Sakarya University of Applied Sciences, 54187 Sakarya,Turkey
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Department of Horticulture, Faculty of Agriculture, Sakarya University of Applied Sciences, 54580 Sakarya, Turkey
Department of Nursing, Faculty of Health Sciences, Sakarya University of Applied Sciences, 54187 Sakarya,Turkey
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Grupo de Biología Estructural y Biotecnología (GBEyB), IMBICE (CONICET CCT-La Plata), Buenos Aires 1906, Argentina.
Instituto de Investigaciones Fisicoquímicas Teóricas y Aplicadas (INIFTA), Facultad de Ciencias Exactas, UNLP-CONICET, CC16 Suc 4 (1900), La Plata, Buenos Aires, Argentina.
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Functional Device Laboratory, Institute of Advanced Technology, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia
Department of Electric and Electronics, Faculty of Engineering, Ataturk University, 25240 Erzurum, Turkey
Department of Computer and Communication Systems, Faculty of Engineering, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor
Department Physics, Faculty of Science, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia
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Functional Device Laboratory, Institute of Advanced Technology, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia
Department of Electric and Electronics, Facilty of Engineering, Ataturk University, 25240 Erzurum, Turkey
Department of Computer and Communication Systems, Faculty of Engineering, Universiti Putra Malaysia, 43400 UPM Serdang
Department of Electrical and Electronic, Faculty of Engineering, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia
Department Physics, Faculty of Science, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia
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Department of Chemical Engineering, Ataturk University, 25240 Erzurum, Turkey
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Department of Chemical Engineering, Ataturk University, 25240 Erzurum, Turkey
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Department of Nano-Science and Nano-Engineering, Institute of Science, Ataturk University, 25240 Erzurum, Turkey
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Department of Molecular Biology and Genetics, Erzurum Technical University, 25050 Erzurum, Turkey.
Department of plant nutrition and soil science, Faculty of Agriculture, Ataturk University, 25240 Erzurum, Turkey
Department of Food Technology, Vocational College of Technical Sciences, Ataturk University, 25240 Erzurum, Turkey
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Zonguldak Bulent Ecevit University, Department of Chemistry, 67100 Zonguldak, Turkey
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Department of Electrical and Electronic Engineering, Faculty of Engineering, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia.
Malaysian-Japan International Institute of Technology, Universiti Teknologi Malaysia, 57000 Kuala Lumpur, Malaysia.
Graduate School of Life Science and System Engineering, Kyushu Institute of Technology, 2-4 Hibikino, Wakamatsu, Kitakyushu, Fukuoka 808-0196, Japan.
Department of Chemical Engineering, Faculty of Engineering, Universiti Malaysia Pahang, 26000 Gambang, Pahang, Malaysia.
School of Electronic Science and Engineering, Southeast University, Sipailou, JinLing Yuan 109, Nanjing 210096, China.

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Department of Animal Science, Faculty of Agriculture, Unuiversity of Tabriz, Tabriz, Iran
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Department of Animal Production and Health, Federal University of Technology, P.M.B. 704, Akure, Nigeria
Facultad de Medicina Veterinaria y Zootecnia, Universidad Autónoma del Estado México, Toluca, Estado de México, Mexico
Veterinary Assistant Surgeon, Veterinary Dispensary, Taticherla, Andhra Pradesh, India
Department of Animal Science, Agricultural Faculty, Ataturk University, 25240, Erzurum, Turkey

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Department of Microbiology, Sadguru Gadage Maharaj College, Karad. 415124. Maharashtra. India.
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PREFACE

Dear Keynote and Plenary Speakers, Colleagues and Distinguished Participants,

The World Congress on Applied Nanotechnology was held as a virtual event between 24th and 26th November 2021 with high participation and a great attraction. I, hereby, thank you all for your informative presentations, exchange of ideas, and your active participation all through the course of the Congress, in every session.

For these 3 days, 70 oral presentations were made in 22 sessions held on 12 topics from 20 different countries (Argentina, Azerbaijan, Belgium, Brazil, Germany, India, Iran, Japan, Malaysia, Mexica, Morocco, Netherland, Nigeria, Portugal, Russia, South Africa, South Korea, UEA, UK, USA and Turkey). In this regard, I would like to thank my colleagues and distinguished scientists, who participated in the congress with their valuable studies, especially to the plenary and keynote speakers, and to those who made presentations.

W-CAN 2021 was planned to be a well-organized international conference that contributes to the development of nanoscience and nanotechnology by providing a platform for future scientists. I believe that the conference has been beneficial in terms of emphasizing the awareness of the importance of nanoscience.

Within this framework, the first World Congress on Applied Nanotechnology 2021 congress allowed scientific exchange including the latest developments in the field, and will also enable the emergence of new collaborations. It is certain that the congress was very beneficial as we are aware of the latest developments in this subject and we had the chance to listen to the latest developments from the mouths of distinguished scientists.

The congress was organized by joint cooperation with the Graduate School of Natural and Applied Sciences, Nanoscience and Nanoengineering Department and Nanoscience and Nanoengineering Research and Application Center, aiming to follow and share the latest developments in the field. As the head of the Research Center and the Institutional Department, I carry the pride, but as you all know for sure, there is a great team behind and the burden of this success was mainly on their shoulders. With your permission, I would like to express my thanks and gratitude to the team.

In witness of all these, the first W-CAN congress has been successfully held, and I believe it provided an important platform for international researchers and technologists to communicate valuable research results, that will recur in the following years. I believe you agree with us in that the WCAN congress provided useful information to all participants and gave them different perspectives in the field.

First, I want to thank the Honorary Chair of WCAN, Prof. Ömer Çomaklı and Vice-Chancellor Prof. Ayşe Bayrakçeken Yurtcan for their firm support both before the congress and during all the organizing stages. I also would like to thank the members of the coordinating committee, organizing committee, scientific committee and technical committee.

As nanoscience is a rapidly growing multidisciplinary scientific field that attracts great attention in many fields, and scientists conduct an enormous amount of research and development, I am eager to see what comes next in the following W-CAN events.

I am looking forward to seeing you at the next World Congress on Applied Nanotechnology,

My most sincere greetings and respects,

Thank you for your attention.

Prof. Hayrunnisa NADAROGLU

Congress Chair

PLENARY SPEAKERS

Recent Advances in Nanomaterials for PEMFC Electrocatalysts

Ayşe Bayrakçeken Yurtcan[a,b]

Department of Chemical Engineering[a], Department of Nanoscience and Nanoengineering[b],

Atatürk University, 25240 Erzurum, Turkey

abayrakceken@atauni.edu.tr

Abstract

Energy demand of humankind is increasing tremendously parallel to the increasing population and technological developments. Alternative and environmentally friendly energy sources, storage and conversion devices seem to be the keys for the uninterrupted electrified daily lives. Proton exchange membrane fuel cells (PEMFCs) have a special place in the alternative energy systems due to their outstanding properties that provide the needs for portable and mobile applications. Oxygen reduction reaction (ORR) slowness is the major obstacle for better performing PEMFC electrocatalysts. PEMFC electrocatalysts are mainly based on platinum (Pt) group metal (PGM) based catalysts which suffer from high cost and limited reserves and Pt doesn't look like to give the first place seat to another catalyst any time soon due to its higher ORR activity. The goal of this study is to give a brief summary about the recent advances in nanomaterials for PEMFC electrocatalysts from the literature and also carried out in our laboratory. This study will also cover the durability changes of the nanomaterials depending on different electrocatalysts used.

***Keywords*: PEM fuel cell, ORR, nanomaterial, electrocatalyst**

Introduction

Among the other fuel cell types due to low operating temperature and high power density proton exchange membrane fuel cells (PEMFCs) seems to be the key for the heavy vehicles, maritime and train applications which can be compete with the battery based ones (1). Most of the research and development studies are devoted to the PEMFC components in order to get better performing fuel cells with higher performance and lower cost as shown in Figure 1 (2).

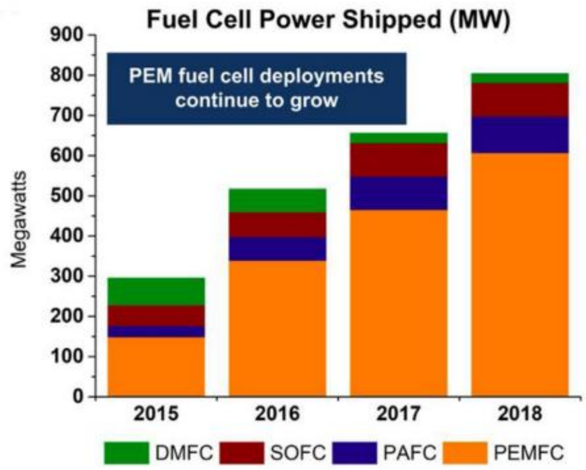

Figure 1. Fuel cell power shipped in the U.S. department of energy (DOE) report (2)

The main components in a PEMFC are the electrocatalysts where the half cell reactions occur which affect the fuel cell perfromance significantly. Sluggish oxygen reduction reaction (ORR) is the major obstacle for better performing PEMFC electrocatalysts. PEMFC electrocatalysts are mainly based on platinum (Pt) group metal (PGM) based catalysts which suffer from high cost and limited reserves and Pt doesn't look like to give the first place seat to another catalyst any time soon due to its higher ORR activity. As can be seen from Figure 2, the cost of the catalyst and its application is increasing with mass production (3). In this respect, the main approaches are including the decrease of PGM amount in the electrocatalyst via alloying, shape tuning, and Pt rich surfaces of created nanoparticles strategies or utilization of non-PGM materials as electrocatalysts for cost effective and efficient ORR electrocatalysts.

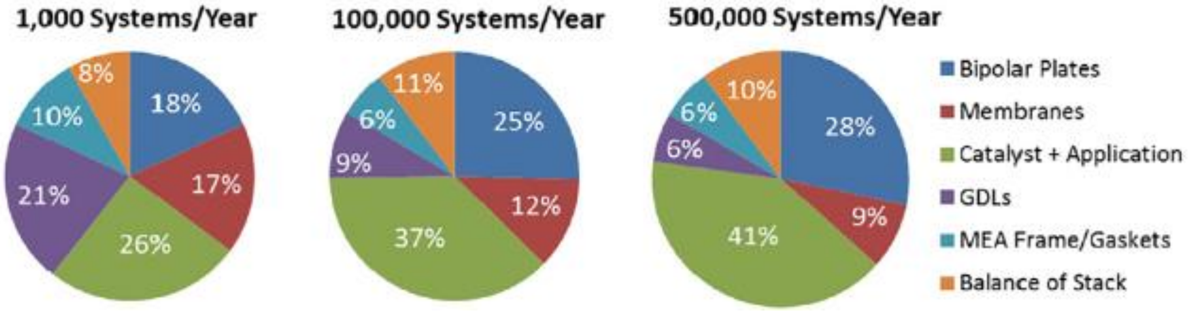

Figure 2. Fuel cell cost breakdown (3)

Results and Discussion

The main approaches in order to decrease the cost and also the activity of the electrocatalyst are including the decrease of PGM amount in the electrocatalyst via alloying, shape tuning, and Pt rich surfaces of created nanoparticles strategies or utilization of non-PGM materials as electrocatalysts for cost effective and efficient ORR electrocatalysts (4) (Figure 3).

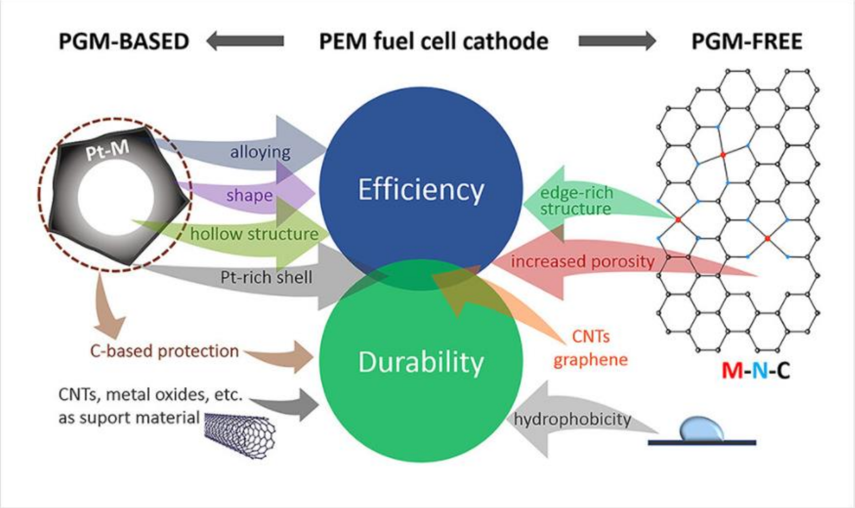

Figure 3. ORR catalyst activity and durability improvement strategies (4)

In PtM alloys, the electronic structure of Pt is modified by transition metals in order to adjust ORR activity (5). DFT calculations and experimental studies showed that ORR activity of PtM (M=Co and Ni) is much better than any other PtM or Pt catalysts (6). Simultaneously (7) and sequentially (8) deposition of PtNi nanoparticles over graphene prepared in supercritical carbon dioxide medium gave better performance as PEM fuel cell catalysts. Nanomaterials at different shapes were also used in order to increase the catalytic activity. It was found that cube-shaped platinum nanocrystals give 4 times higher performance than other shapes (9). FePPy/C (10) and N-doped graphene (11) were used as PGM-free catalysts. Nitrogen doping will create some new active sites for further catalytic activity improvement. Nitrogen doping can be handled with in situ and post treatment methods.

Most important cost of PEM fuel cell stack comes from the electrocatalysts. Widespread utilization of PEM fuel cells depend on lower cost and highly active electrocatalysts. The main approach is to reduce the best performing PGM catalyst amounts in PEM fuel cells. These approaches have to provide higher activity with high durability. There are plenty of ways to achieve higher activity; including electrocatalyst preparation methods, new support materials, different combinations of nanoparticles, different treatment methods etc. So there still a long way to go for the best performing and durable catalysts.

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An Application Of Nanotechnology For Transmission Power Lines: Ultraconductors

Mehmet Ertugrul

Department of Electrical and Electronics Engineering, Engineering Faculty,

Ataturk University, 25240 Erzurum, Turkey

ertugrul@atauni.edu.tr

Energy-saving and increasing the efficiency of power transmission lines, electrical machines and transformers are important as much as diversity and renewability of energy resources. Considering the increasing power need it would be impossible to transmit dozens of GW power using the existing transmission lines due to the current carrying limitation of the metals used in transmission lines. Hence, it is a must to develop new materials for power transmission lines. The studies on energy-efficient materials, which can be alternative to superconductors and normal conductors, especially for applications of daily life are continued due to these disadvantages. It is known that new generation electrical materials on which the studies have been heavily performed in recent years have demonstrated close or better performances than superconductors in certain aspects even though they are not superconductors. One potential approach for decreasing metals electrical resistivity is the incorporation of carbon nanotubes into metal. In present work, we developed a unique method to obtain metal-CNT composite to get ultraconductive wire.

Introduction:

Nowadays, the dependence on electricity gradually increases, and the production and use of vehicles such as electrically operated automobiles and other electronic devices are increasing rapidly. For this reason, decreasing the amount of energy lost while carrying the electricity or producing new generation conductors due to the fact that cheaper conductive materials and the copper resources are limited gradually gain importance. Nowadays, studies are being carried out to produce new generation electrical cables from the nanotube-polymer composite structures [1]. As a matter of fact, it has also been reported that the conductivity of the composite structures containing carbon nanotube is higher than that of metals [2]. The studies to be carried out on decreasing the energy loss have always taken an important place in the science world. For example, various studies have been carried out on superconductors. Since the conductivity and current-carrying capacity of copper wires have the potential to be enhanced more by placing carbon nanotubes (CNT) into copper wires, these new composite structures produced are called ultra-conductors. Despite the fact that there has been a deep interest in this topic in a recent couple of years, there is a limited number of studies in the literature [3-5]. However, various studies conducted in cooperation of many developed universities and laboratories have been encountered. Although there are some studies indicating that the electrical conductivity of composite copper wires decorated with CNT remains almost the same [3], there are also studies indicating that their electrical conductivity improves [3,4, 6-8]. However, in all of the studies carried out on this topic, it is indicated that the maximum current-carrying capacity of the composite copper wires decorated with CNT will increase at least ten times more. It is observed that the electrical conductivity and the maximum current-carrying capacity of the copper wires covered with CNT increase to a considerable extent with the CNT modification [5].

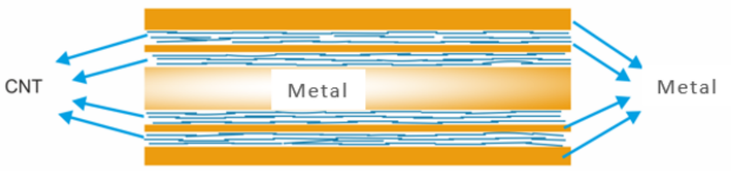

Figure 1. Schematic representation of aligned and welded CNTs and Metal thin films covered on them

Material-Methods:

After the carbon nanotubes were coated on the metal surface, CNT’s welted to get electrical contact. Then, metal-CNT structure was obtained by metal coating processes (Figure 1).

Surface morphology (Figure 2), structural, mechanical and electrical measurements are made after each of the above-mentioned steps to determine composite ultra-conductive structures.

Results:
SEM images shown that CNT-metal (Al and Cu) layered structures formed to get composite CNT-metal wires. Electrical measurements shown that current carrying capacity of the composite wires were obtained a few times higher than pure metal wires.

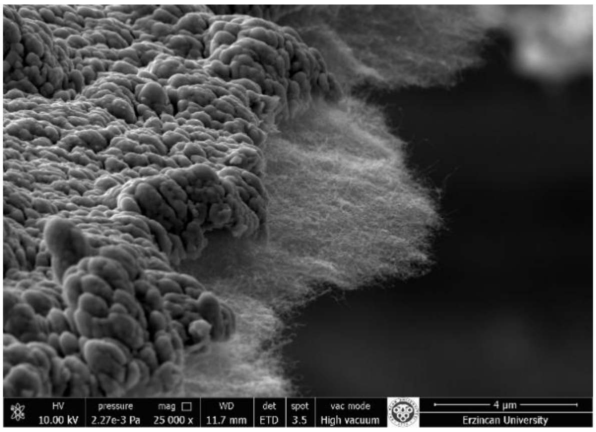

Figure 2. Layered Metal-CNT structures

Conclusion:

In the coming years, it is a necessity to replace the wires in the transmission lines with the high current carrying capacity and low resistance wires. In this study, current carrying capacity and electrical conductivity improved metal wires are developed. These wires are thought to be an alternative to superconducting wires.

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KEYNOTE SPEAKERS

Energy On Fingertips: Microfluidic Water Electrolyser For Hydrogen And Oxygen Generation In Tandem Opertaion With Microlfuidic Fuel Cell

Suddhastawa Basu

CSIR-Institute of Minerals & Materials Technology, Bhubaneswar and Professsor (on lien) Indian Institute of Technology Delhi, India

sbasu@chemical.iitd.ernet.in

Membrane-less microfluidic reactors for water electrolysis can serve as a disruptive technology for the sustainable production of hydrogen utilizing excess electricity from intermittent renewable energy sources. Membrane-less electrolyzer facilitates flexible pH operation of electrolyzer using liquid electrolytes, which have higher ionic conductivity than solid membranes. Herein, we demonstrate a microfluidic electrolyzer driven by electrochemical neutralization energy in which an asymmetric electrolyte configuration (acidic catholyte and alkaline anolyte) was used for the first time to reduce the voltage requirement of water electrolysis drastically. The potential recorded for water electrolysis in this device was 1.3 V for an asymmetric electrolyte, 1.96 V for an acidic electrolyte, and 1.94 V for an alkaline electrolyte. The product gas separation was attained by balancing inertial and viscous forces acting on a fluid induced by the flow of electrolyte. The flow in microchannel was characterized by a low Reynolds number (43.94) and high Peclet number (7.29 ×103 and 1.75 ×104 for H2 and O2 respectively), which implies highly viscous flow and negligible diffusion of gas products across the electrodes. The charge transfer resistance for water electrolysis with an asymmetric electrolyte was less (47.2 Ω cm2) as compared to acidic (272.94 Ω cm2) and alkaline electrolytes (292.92 Ω cm2). The reactor exhibits 4 hours stability with no perturbation in current density at 1.4 ml min-1 electrolyte flow rate. Product crossover analyzed by gas chromatography was less than 5% with H2 and O2 volumetric collection efficiencies of 93.14% and 91.43%, respectively. The device has a performance efficiency of 96.5% based on a 150 µm interelectrode distance. Finally the electrolyser is tested with a tandem fuel cell and compared with a typical photovoltaic cell to ascertain commercial viability.

Measuring Temperature At The Nanoscale Through Light Emission

Luís António Dias Carlos

University of Aveiro, Portugal

lcarlos@ua.pt

The emergence of luminescent nanothermometry during the last decade opened up the possibility of measure thermal flows at spatial scales below 10 µm, unreachable by conventional electrical methods. Diverse phosphors capable of providing a contactless thermal reading through their light emission properties have been examined, e.g., polymers, DNA or protein conjugated systems, organic dyes, quantum dots, and trivalent lanthanide (Ln3+) ions incorporated in organic-inorganic hybrids, multifunctional heater-thermometer nanoplatforms, upconverting, downconverting and downshifting nanoparticles.

The lecture will give a general perspective of the work done on luminescence nanothermometry since the explosion of the field one decade ago, illustrating the potential of the technology with recent examples on thermal bioimaging and the unveiling of properties of the thermometers themselves and their local surroundings.

Terahertz Kirigami Metamaterials And Chiral Phonons

Wonjin Choi[a,b]

[a]*Department of Chemical Engineering,*[b]*Biointerfaces Institute, University of Michigan, Ann Arbor, USA*

wonjchoi@umich.edu

Kirigami, the art of paper cutting, presents a powerful tool to create complex and tunable 3D geometries from pre-designed 2D cut patterns. In principle, kirigami can be scaled across many orders of magnitude to yield macro- to nanoscale structures. The ability to achieve out-of-plane deformations and designed 3D shapes, the robustness of the patterns under cyclic reconfiguration and the manufacturing simplicity of kirigami structures together promise untapped possibilities for the efficient modulation of optical beams. Here, I present that kirigami optics affords real-time modulation of beams at terahertz (THz) frequencies with polarization rotation and ellipticity angles as large as 80° and 40° over thousands of cycles, respectively. Several biomaterials, exemplified by an elytron of the beetle and petal of dandelion, revealed distinct THz circular dichroism fingerprints associated with the helical substructure in the biocomposite. Analogous kirigami modulators will also enable other applications in optics, such as polarization-based imaging, line-of-sight telecommunication and space exploration.

Engineered Nanomaterials In Nanomedicine And Diagnosis

Mustafa Culha

Sabanci University Nanotechnology Research and Application Center (SUNUM),
Istanbul, Turkey

mustafa.culha@sabanciuniv.edu

There is an enormous effort to utilize nanomaterials and nanostructures for disease diagnosis and treatment. In this presentation, first I will discuss our research effort for label-free cancer diagnosis and microorganism identification using surface-enhanced Raman scattering, a very sensitive vibrational spectroscopic technique, where gold and silver nanostructures are used as substrates. Then, I will summarize our effort to utilize DNA-origami based nanostructures, gold nanoparticles, BNNTs and hBNs as drug and antisense oligonucleotide carriers.

Electrochemical Reduced Graphene Oxide Nanocomposites Decorated With Metal/Metal Oxides Nanostructures For Energy And Sensor Applications

Umit Demir

Department of Chemistry , Faculty of Science, Gebze Technical University, Turkey

demiru@gtu.edu.tr

Graphene (G) and reduced graphene oxide (rGO)-based nanocomposites show great potential in photocatalysis, photoelectrochemical cells, dye and quantum dot sensitized solar cells, energy storage and sensors applications. Especially, the hybrid composites that are formed by the anchoring of metal (M) or metal oxide (MO) with G or rGO have been the most studied research topic in the recent years due to the enhanced electrical and electronic properties and the synergistic effect between G and M or MO.

Our research area focuses on to the developing one-pot electrochemical strategy to fabricate electrochemically reduced graphene oxide (ERGO)-M/MO nanocomposites by simultaneous electrochemical reduction of GO and M ions from the same solution. Unlike existing approaches, this approach is simple and allows us to fabricate M or MO decorated ERGO hierarchical structures with novel and enhanced properties directly onto substrates, which are highly desirable for many applications. By using this technique, we fabricated highly efficient Ni or NiO decorated ERGO nanocomposite for energy storage and sensor applications, ERGO/TiO2 and ERGO/ZnO nanocomposites for photocatalytic applications and compound semiconducting (CdS, PbS, CdTe etc.,) quantum dot decorated ERGO/TiO2 or ERGO/ZnO nanocomposites for quantum dot sensitized solar cells.

The Role of Metal–Organic Frameworks in the Fabrication of Biosensors

Ali A. Ensafi

Department of Chemistry, Isfahan University of Technology, Isfahan, Iran

ensafi@iut.ac.ir, aensafi@uark.edu, aaensafi@gmail.com

The assembly of metal ions with organic ligands through the formation of coordination bonds gives crystalline framework materials, known as metal–organic frameworks (MOFs), which recently emerged as a new class of porous materials [1]. MOFs are a new class of porous coordination compounds, which their remarkable properties, such as large surface area, adjustable structure, and tunable pore sizes, MOFs have emerged as one kind of important porous solid and attracted intensive interests in different subject area.

MOF composites can be divided into four parts according to their dimension, including MOF/zero dimension (0D), MOF/one-dimension (1D), MOF/two dimension (2D) and MOF/three-dimension (3D) [2], each of them has special properties. Subsequently, many types of MOFs were reported with designed structural, magnetic, electrical, optical, and catalytic properties by choosing appropriate metal ions and organic ligands [3-6]. Due to the unsaturated coordination metal sites and active functional groups, the interaction between certain analyte and active site results in the high selectivity to fabricate optical and electrochemical sensors and biosensors because of their excellent new properties and multifunctional capabilities. Although yet to be systematically exploited, the exceptional tunability of MOF structures and properties should constitute an important advantage over other candidate classes of chemo-sensory materials [7]. For example, MOFs with luminescent properties have been used as excellent platforms for designing luminescent sensors and biosensors [8]. On the other hand their chemically tailorable framework with specific host-guest interactions and modifications plays an important role in the selectively sensing metal ions, small organic molecules and biomolecules with electrochemical detection. Here, I am going to short discuss about the applicability of MOFs in sensors technology to have higher selective with lower detection limit.

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Combination of Photonics and Acoustic Tools with Nanostructured Particles for Biomedical Applications

Dmitry Gorin

Biophotonics group, Center of Photonics & Quantum Materials (CPQM)

Skolkovo Institute of Science and Technology, Moscow, Russia

D.Gorin@skoltech.ru

The photonic tools as well as acoustic tools can be used for in vivo navigation, visualization and activation of new type of multifunctional nanostructured particles. These particles will combine ability to deploy drug in controllable manner with physical triggering, multimodal detection and visualization as well as sensing of important biological markers. It was required to apply a new bottom-up method as layer by layer assembly and freezing induced loading and their combination. It can be allowed us to vary of the volume fraction of components and its chemical composition led to the control the physicochemical and mechanical properties of multifunctional carriers. Physical targeting of carriers was realized by gradient of magnetic field, optical tweezers approach. Acoustics has a good perspective for same purpose. The carrier sensitivity to external influences as laser irradiation, ultrasound treatment can be changed by variation of volume fraction and chemical composition of inorganic nanoparticles and/or organic dyes in the carrier shells. Same approach is applied for drug delivery carriers imaging by MRI, OCT and optoacoustics using inorganic nanoparticles and/or organic dyes as contrast or functional agents. Combination of photonic tools as well as acoustic tools with multifunctional carriers has a good perspective for application in biomedicine for diagnostic and therapy.

Gas Sensor Technology With Nano

Mohd Nizar Hamidon[a,b]

[a]*Department of Electrical and Electronic Engineering, Faculty of Engineering,*
[b]*Institute of Advanced Technology, Universiti Putra Malaysia, Malaysia*

mnh@upm.edu.my

In the last three decades along with growing industries and development of cities, many pollutants have entered into the environment cycle and some resultants of these can be felt as air pollution. Due to this, the 17 Sustainable Development Goals or Global Goals been designed by the United Nations General Assembly in 2015 with several of the goals are to tackled and solved this issue by the year 2030. To do that we are not only need to employed smart gas sensors in industrial settings, but also in every aspect of human life, where they are telling something about their environment by bridging them with the electronic world. The sensors are used to gather a wealth of information from the process that can improve operational efficiency of the industry and quality of life which involving a mass of data that need to be analysis especially with the merging of the Internet of Things. Leading edge research in gas sensors has been propelled by the advancements made in fabrication, signal processing and material technology in the last decade especially nanotechnology. With these the scientific world is now on the verge of delivering gas sensors with radically new capabilities for the human societies. This talk deals with the nanotechnology together the interfacing and signal processing of gas sensor.

Toxicological Relevance Of Nanoparticle Agglomerates And Aggregates (AA): A Step Towards A Toxicologically Relevant Definition Of Nanomaterials

Peter Hoet

KU Leuven University, Environment and Health Unit, Department of Public Health and Primary Care, Belgium

peter.hoet@kuleuven.be

To verify the toxicological relevance of agglomerates and aggregates (AA), the general nanotoxicity paradigm “smaller AA of nanoparticles (NPs) induce stronger toxicity/biological responses compared to their largely agglomerated/aggregated counterparts” was tested throughout our study. We have systemically prepared suspensions of agglomerates and aggregates with different size distributions using TiO2 and silica nanomaterials (NMs), respectively, and studied their toxicity using in vitro (both TiO2 and silica) and in vivo (only TiO2) models.

Multifunctional Magnetic Nanoparticles For MRI And Hyperthermia

Bashar Issa[a,b]

[a]*Department of Medical Diagnostic Imaging, College of Health Sciences*

[b]*Institute of Medical and Health Sciences*

University of Sharjah, Sharjah, UAE

bissa@sharjah.ac.ae

Magnetic Nanoparticles (MNP) have a wide range of applications in biomedicine such as Drug Delivery, Cell Tracking, Magnetic Hyperthermia (MH) of cancer, and Magnetic Resonance Imaging (MRI).

The characteristics of MNPs have to be tailored for the specific application. These include particle size and size distribution, magnetization, shape, and surface functionalization. For multifunctional MNP, such as simultaneously serving as MRI Contrast Agents (CA) and MH CA, optimization of conflicting objectives is important. For example, increasing MNP size in order to improve the efficacy MH will reduce Signal-to-Noise ratio in MRI because of T2* effects.

We discuss a model for the calculation of T2/T2* enhancement due to the spread in particle size and magnetization values in MNP that are used as MRI CA. We use Monte Carlo simulations to justify the model.

Imaging With Nanoprobes: Strengths And Limitations

Fabian Kiessling

RWTH Aachen University, Germany

fkiessling@ukaachen.de

In this talk, applications for diagnostic nanoprobes will be highlighted and limitations discussed. These comprise, iron oxide nanoparticles to image the reticuloendothelial system, to label cells and tissue engineered vascular grants, and to assess vascular leakiness in tumors. Another focus will be theranostic nanomedicines. Here, examples will be provided for optical, photoacoustic as well as ultrasound responsive drug delivery systems. Furthermore, microbubble-based ultrasound imaging applications will be introduced. These will range from superresolution imaging of tissue vascularization in animals and patients, molecular imaging of angiogenesis and inflammation, and hybrid imaging with MRI. Thus, although nanoprobes do not fulfill the pharmacokinetic prerequisites for most molecular imaging applications, they can be highly valuable for the ex vivo labelling of cells and implants, to compose activatable probes, to act as companion diagnostics for nano-based drug delivery systems, and to characterize tissue microvascularization.

Nanotechnologies Towards Sdgs' Attainment

Malik Maaza[a,b,]

[a]*UNESCO-UNISA Africa Chair in Nanosciences-Nanotechnology, Muchleuneuck, College of Graduate Studies, PO Box 392*

[b]*Nanosciences African Network (NANOAFNET), iThemba LABS-National Research Foundation, Somerset West, Western Cape Province*

University of South Africa, PO Box 722, Pretoria-South Africa

maaza@tlabs.ac.za

Notwithstanding their specific characteristics in general, nanomaterials have ushered a broad applications in a variety of fields, especially biophotonics & nanomedecine. Among the specific fingerprints of the nano-scaled materials are; size effects, electrons or phonons confinement, the breaking of the 3-D symmetry as well as the elevated surface to volume ratio.

Up to recently, the various nanomaterials were synthesized via 2 major methodologies: Physical or chemical. While the physical methodologies are energy intensive, the chemical ones are waste exhaustive. Lately, green nano-bio/nanosynthesis, based on the usage of natural extracts as effective chelating agents is gaining momentum. This fast growing topic, obeying the 12 commandements of green chemistry, cements further the fields of Phytochemistry, biosciences & drug design. This contribution reports on a series of functional nanomaterials bio-engineered using natural extracts of various indigenous plants such as Hoodia gordonii (Khoisan hoodia), Agathosma betulina (Buggu) or aspalathus linearis(Rooibois) or Calistemon viminalis (bottlebrush)or Moringa. Likewise, we report on their efficiency as anti-microbial & anti-viral, anti-cancer & cosmetics responses.

While the above are in line with SDG12 (Reponsible Consumption & Production), several nanotechnologies are potential bridges to address several SDGs. Recent advanced multifunctional nanomaterials will be presented including nanofluids as new generation of coolants, intelligent coatings for solar Heat regulation for smart windows as well as new generation of nanofertilizers.

Materials, The Activators And Accelerators Of Our Global Prosperity

Rodrigo Martins[a,b,c]

[a] *NOVA School Of Scıence And Technology | FCT NOVA*

[b] *CEMOP | UNINOVA - Centre of Excellence in Microelectronics and Optoelectronics Processes of Uninova*

[c] *CENIMAT|i3N – Materials Research Centre, Portugal*

rfpm@fct.unl.pt

Today science is essential to enable comfort and welfare, as well as prosperity to regions and countries. This implies fostering the creativity of scientists and consequent innovations to support the current societal challenges. In this respect, advanced materials offer a variety of solutions that are based on the idea that “Materials are everywhere even in our body!”. Within these solutions, it is vital to consider the reuse of residues, recycling and circularity to serve a Green Agenda and bring an eco-sustainable environment, as we do not have a planet B as alternative solution!

In this regard, the future of our planet will have advanced materials at the heart of our progress and cannot be thought of as an isolated cluster. In fact, the role of advanced materials is to foster several economic sectors, by exploiting materials on their multiple latitudes to provide outstanding structural and functional applications of materials, particularly by understanding the nanoscale, as this is the scale by which the digital, bio and physical worlds can communicate and interact. Those are the key issues to be addressed in this presentation, where the metro concept as far materials exploitation are concerned will be addressed.

Photocatalysis with the Nanocomposites Comprising Non-metallic 2D Semiconductors and Metal Nanoparticles

Önder Metin[a,b]

[a]*Department of Chemistry, College of Sciences, Koç University, 34450 Sarıyer, İstanbul, Türkiye*
[b]*Koç University Surface Science and Technology Center, 34450 Sarıyer, İstanbul, Türkiye*
ometin@ku.edu.tr

After the isolation of monolayer graphene in 2004 and Nobel Prize in Physics in 2010 was given to the scientists who did this invention (Novoselov and Geim) [1], the interest in graphene-like single atomic layer two-dimensional (2D) materials has increased every day. 2D materials exhibit unprecedented optical, electrical, and thermal properties owing to the ability of their electrons to move freely in only two dimensions. However, although graphene exhibits unique electronic, optical and thermal properties, it is a superconductor due to its zero band gap and does not exhibit photocatalytic activity upon interaction with sunlight [2]. However, the interest in semiconductor 2D materials other than graphene has recently increased to realize sunlight-induced chemical reactions for sustainable chemistry. Among the semiconductor 2D materials have been developed to date, graphitic carbon nitride (g-CN), which is a metal-free semiconductor polymer consisting of only C, N, and H atoms, has received great attention in the photocatalysis because it can be activated under visible light and synthesized easily on a large scale from commercially inexpensive raw materials [4]. However, g-CN suffers from some disadvantages such as photo-excited charge recombination, low visible light utilization, and low surface area leading to low photocatalytic activity. The electronic and optical disadvantages of g-CN can be developed by forming g-CN composites with other suitable semiconductors or metal nanoparticles. In this context, black phosphorus (BP), another non-metallic semiconductor 2D material, possesses a tunable band gap (from 0.3 eV to 2.0 eV) depending on its layer thickness, light absorption ability in a wide range from visible region to near infrared, high charge mobility [5]. BP is the thermodynamically most stable allotrope of phosphorus. These properties make BP a very promising material for applications in catalysis, particularly photocatalysis. Optical and electronic properties of SF, as in g-CN, can be improved by combining other semiconductor materials. Establishing heterojunctions between different semiconductors and/or metal nanoparticles (NPs) seems to be a promising strategy to increase photocatalyst efficiency by reducing the tendency of charge carriers to recombine. In this presentation, a brief summary of our studies showing that photocatalytic activities can be increased in specific reactions studied by the design and synthesis of heterojunction photocatalysts formed by g-CN, BP and metal nanoparticles will be presented.

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Emerging Nano-Biomaterials To Combat Antimicrobial Resistance (AMR)

Saravanan Muthupandian
AMR and Nanomedicine Lab, Department of Pharmacology, Saveetha Dental College, Saveetha Institute of Medical and Technical Sciences (SIMATS), 600077 Chennai, India
bioinfosaran@gmail.com

Nanoscience and nanotechnology represent an expanding research area such as pharmacy, chemistry, biology and medicine. Nanomaterials with unique physicochemical properties offer great opportunities and challenges for researchers in biomedical areas. Nanotechnology approaches have earned lots in nanomedicine and proved to be the best alternative antimicrobial materials. Antimicrobial Microbial infections cause dangerous, life-threatening invasive infections and are found to be resistant to a wide range of anticancer drugs and antibiotics, respectively. Multidrug-resistant bacteria have a significant role in public health by destroying the potency of the existing antibiotics. Hence, novel strategies are required to combat antimicrobial resistance. Meanwhile, nanomedicine plays a significant role in developing alternative and more effective treatment strategies microbial infections in the current scenario.

Nanomaterials For Enzyme Immobilization And Biocatalysis For Clean Energy And Green Environment

Ashok Kumar Nadda

Department of Biotechnology and Bioinformatics, Jaypee University of Information Technology, Waknaghat, Solan, 173 234, Himachal Pradesh - India

ashok.nadda09@gmail.com

The current demands of sustainable green methodologies have increased the use of highly efficient enzymes in industrial processes. The use of enzyme as immobilized biocatalysts offers the benefits of mild reaction conditions, biodegradability and catalytic efficiency. The harsh conditions of industrial processes, however, increase propensity of enzyme destabilization, shortening their industrial lifespan. Nanobiocatalysis has been an emrging area of research that integrate the advanced nanotechnology with biological molecules such as enzymes. The coenzyme regeneration system using some nanomaterials such as TiO2 composites offers a great advantage of maintaining the continuous supply of NADH in the catalytic reactions. Consequently, the technology of enzyme immobilization provides an effective means to circumvent these concerns by enhancing enzyme catalytic properties and also simplify downstream processing and improve operational stability. The nanomaterials with tuned surface properties and internal morphology can be synthyesized as per the need of biocatalytic reactions. Hence, it is mandatory to obtain information about the molecular weight, size and structure of the enzyme protein following interaction with the support surface as well as interactions of the enzymes with other reaction ingradients. Characterization technologies at the nanoscale level to study enzymes immobilized on surfaces are crucial to obtain valuable qualitative and quantitative information, including morphological visualization of the immobilized enzymes. These technologies are pertinent to assess efficacy of an immobilization technique and development of future enzyme immobilization strategies.

Nanocomposite Hydrogels; Promising Materials For Agricultural And Biomedical Applications

Ali Olad[a,b,c,d]

[a]Department of Applied Chemistry, Faculty of Chemistry, [b]Engineering Faculty, [c]Nanoscience and Nanoengineering Research and Application Center, [d]Graduate School of Natural and Applied Sciences, Nanoscience and Nanoengineering Department,

University of Tabriz, Tabriz, Iran

a.olad@yahoo.com

Hydrogels are 3D networks of polymers having high hydrophilic properties. Various synthetic and natural based polymers are used to design and synthesis of hydrogels. The hydrogel systems and especially natural based hydrogels have gained considerable attention in agricultural and biomedical applications due to their suitable biocompatibility and physicochemical properties. However they suffer from poor mechanical properties. The application of nanotechnology by the preparation of nanocomposite hydrogels, not only improves the mechanical properties of hydrogels, but also causes to more tailoring of their functionality, efficiency, biological activities and physicochemical properties. So, the nanocomposite hydrogels, as promising materials with superior physicochemical, mechanical and biological properties, can be developed through the nanostructural engineering by using of various carbon based, silica based, metal based or polymeric nanoadditive systems.

In this study, the preparation, structure and properties of nanocomposite hydrogels are reviewed. The various polymer matrices, nature and structure of various nanoadditives and the different preparation technologies, used in the preparation of nanocomposite hydrogels, and their effect on the structure and properties of prepared hydrogels are discussed. The applications of nanocomposite hydrogels in agricultural and biomedical fields such as slow release fertilizers and micronutrients, sustainable irrigation of plants, drug delivery, scaffolds, tissue engineering and wound healing are focused. Polymer-additives interactions, reinforcement mechanisms and structural/properties improvements are illustrated. The nanocomposite hydrogels synthesized in our laboratory, with the aim of using in agricultural and biomedical applications, will be introduced and discussed. Finally the future, predictions and important points in designing and preparation of new, more efficient and green hydrogel systems will be concluded.

Prospects of nanofluid utilization in solar energy technologies

Kamaruzzaman Sopian[a], Ali H. A. Al-Waeli[a], Hussein A. Kazem[a,b], Miqdam T. Chaichan[c]
[a]*Solar Energy Research Institute, Universiti Kebangsaan Malaysia, 43600, Bangi, Selangor, Malaysia*
[b]*Sohar University, PO Box 44, PCI 311, Sohar, Oman*
[c]*Energy and Renewable Energies Technology Research Center, University of Technology-Iraq*
E-mail ksopian@ukm.edu.my

Abstract

Nanofluid incorporation in solar energy technologies to effectively enhance its processes is an area of research that has generated much attention. The ability to engineer these fluids makes to obtain the desired thermophysical properties makes them excellent replacements with water or other refrigerants as heat transfer fluids. However, given that this field of research is recent, there is an immense need to understand and attain standards and procedures to deal with nanofluids in this context. An overview of the recent and state-of-the-art nanofluid and nanofluid-based solar energy technologies. The review is divided into two section, the first deals with nanofluids and recent developments in their processes and preparation. The second part of the paper focuses on their utilization in different direct solar energy systems. Thus, the main pillars of the second part are: (i) photovoltaic (PV) modules, (ii) solar thermal collector and (iii) photovoltaic thermal (PVT). Nanofluid stability and price are found to be the main issues when integrated into solar energy technologies, along with other issues such as the increase in density and pumping power losses.

Keywords*: *Nanofluids, heat transfer fluids, solar thermal collector, photovoltaic module

Introduction

Many research investigations have been carried out in the last decade on using nanomaterial and nanofluids in solar energy technologies. The use of nanomaterial is desirable because of the improvement that can be achieved to the thermophysical properties of the base fluid they are added to. Those properties include thermal conductivity, viscosity, density and specific heat capacity. Although enhancement is observed when using nanofluids as heat transfer fluids, there are other issues and challenges that needs to be tackled such as the stability of the nanofluids and the added costs to the system when incorporating nanofluids.

Although many research studies are produced on this topic, it remains to be absent from the industry. For such technology to penetrate the market, it is important to establish international standards for preparation, production, testing, and performance evaluation. In order to produce such standards, it is important to provide an overview of the various innovative nanofluid-based solar energy collectors, thus this paper intends to review the recent discoveries and state of the art research on this topic. The protocol of this research is a standard review with an expert's insight.

Results and Discussion

Solar thermal and photovoltaic thermal (PVT) collectors can both incorporate nanofluids for improved heat transfer. The solar thermal collector produces thermal energy only, while the PVT collector produces both thermal and electrical energies(1). However, some of the challenges may hinder the integration of nanofluids into the existing solar energy sector. Among these issues are the high cost of nanofluids, the long-term stability of these nanofluids and the increase in pressure drop(2). The increase in the pressure drop leads to an increase in pumping power which might be an issue when comparing the overall pumping power needed by a solar collector using water with one using nanofluids. Moreover, many difficulties arise when trying to produce nanofluids and ongoing research aims to discover the optimal preparation methods by investigation parameters such as sonication time, surfactant type and pH adjustment to improve the nanofluid's stability. Other aspects to take into consideration are related to safety and the end-user.

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Capturing Charge-Dynamics of Ionic-Liquid Electrolytes within Energy Storage Devices by Operando X-Ray Photoelectron Spectroscopy

Erdinc Oz,[a] Mustafa Basaran,[b] Burak Ulgut,[a] Askin Kocabas,[b] Coskun Kocabas[c] and Sefik Suzer[a]

[a]*Department of Chemistry, Bilkent University, 06800 Ankara, Turkey*
[b]*Department of Physics, Koc University, 34450 Istanbul, Turkey*
. [c]Department of Materials, University of Manchester, Manchester M13 9PL, Lancs. United Kingdoom.
E-mail suzer@fen.bilkent.edu.tr

Energy Supply and Storage Systems play pivotal role in scientific and technological activities, and batteries are still on top of the list. However, batteries are slow, since they involve sluggish chemical reactions. Electrical-Double Layer Capacitors, or Super-Capacitors have recently been proposed as alternative, since they involve movement of ions only through liquid/solid interfaces.[1] Transport of the ions also controlls performance of these devices and need to be investigated during their operation. XPS is one of the most informative surface analyses techniques, which can deliver chemical as well as electrical properties of systems, when used in-Operando (o-XPS). Unfortunately, the technique requires Ultra-High-Vacuum environment, not very suitable for volatile liquids like water, but there are also several non-volatile liquids, like ionic liquids, which are also excellent electrolytes for battery and super-capacitor applications. Emergence of Ionic Liquids with several promising properties, including their low volatility, has rekindled the use of XPS.[2] Our recent efforts have also concentrated on ionic-liquids and their interfaces under **dc** and **ac** bias, and extended to monitoring electrochemical reactions, as well.[3-5] The common theme in our studies is the use of the bias dependent shifts in the positions of the core-levels as reflection of the electrical potentials, recorded in a non-invasive and chemically resolved fashion. We use both **the magnitude** and **the frequency** dependence of such potentials to extract pertinent information related to static, as well as dynamic chemical and/or electrochemical properties of the materials and their interfaces, configured as devices,[6-8] with particular emphases on the ionic liquids' certain chemical/physical parameters, like steric effects, ion size, diffusivity, etc.[8] Examples using ionic liquids, liquid poly-ethylene-glycol (PEG) and salts, as well as their mixtures, as electrolytes, with special emphases on energy storage systems, will be presented and discussed.

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Low-Temperature Synthesis And Practical Applications Of Carbon-Based Nanocomposites

~From Nanoworld To Real World~

Subash Sharma[a], Lin Wei Ming[a], Shinsuke Ozeki[a], Takumi Yoshida[a], Yazid Yaakob[b], Mohd Zamri Mohd Yusop[c], Mohamad Saufi Rosmi[d], Masaki Tanemura[a]

[a]*Department of Physical Science and Engineering, Nagoya Institute of Technology, 466-8555, Gokiso-cho, Showa-ku, Nagoya, Japan*

[b]*Department of Physics, Faculty of Science, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia*

[c]*Department of Materials, Faculty of Mechanical Engineering, Universiti Teknologi Malaysia, 81310 Skudai, Johor, Malaysia*

[d]*Department of Chemistry, Faculty of Science and Mathematics, Universiti Pendidikan Sultan Idris, 35900 Tanjong Malim, Perak, Malaysia*

tanemura.masaki@nitech.ac.jp

Nano-sized materials, such as graphitized nanocarbon like carbon nanotubes (CNTs) and graphene, are currently one of the hottest materials in nanotechnology and nanomaterials science. Huge effort has been devoted to their controllable growth in quality, size, position and temperature for their practical applications. In general, they are synthesized at elevated temperatures. So, their synthesis is the high-temperature process. However, for the eco-friendly (environmentally friendly) synthesis and also for the practical applications, the lower-temperature process, ideally room-temperature process, is preferable. In this talk, I will deal with a challenge to the lower-temperature synthesis of carbon-based nanocomposites using an ion-beam technique, together with their crystallinity control based on the in-situ transmission electron microscopy (TEM) observations of their graphitization process. In the talk, their energy-related application, the nano-soldering of CNTs towards the interconnection application, and the highly sensitive detection of COVID-19 virus using ion-induced nanostructures will be also demonstrated.

Keywords: Carbon nanocomposites, Carbon nanofiber, graphene, TEM, Ion beam

Using Of Monte Carlo Simulations For Designing Of Nano-Particle Added Shielding Materials: A Closer Look On Nano-WO3 And Nano-Bi2O3 Reinforced Shielding Concretes

Huseyin Ozan Tekin
University of Sharjah, UAE
tekin765@gmail.com

Monte Carlo simulations are increasingly being used in nuclear shielding investigations. As researchers have increased their use of nanomaterials, there has been a growing interest in enhancing the qualities of ordinary concrete. The primary objective of this work is to discuss the effect of WO3 and Bi2O3 additions on the radiation shielding characteristics of ordinary and hematite serpentine concrete (HSC) at the micro and nanoscales. In this study, MCNPX Monte Carlo code, technical details on nano-particle studies and its abilities will be discussed. Moreover, some of the recent investigations will be presented along with their outcomes.

Unraveling The Schottky Barrier Mystery

Raymond T. Tung[a]* and Leeor Kronik[b]
[a]*Dept. of Physics, Brooklyn College, CUNY, NY 11210, Brooklyn; and Physics Ph.D. Program, Graduate Center, CUNY, NY 10016, New York, USA*
[b]*Department of Materials and Interfaces, Weizmann Institute of Science,*
76100, Rehovoth, Israel
** rtung@brooklyn.cuny.edu*

Metal-semiconductor (MS) interfaces have been ubiquitous in microelectronic and optoelectronic devices. The Schottky barrier height (SBH) controls the electrical characteristics and is crucial for the successful operation of these devices, as well as other, e.g. nanodevices. A cloud of mystery hung over the formation mechanism of the SBH for many decades. The experimental discovery of an insensitivity of the SBH of polycrystalline MS interfaces to the metal work function (WF), known as “Fermi-level pinning (FLP),” prompted the proposal of many empirical interface states models, which long dominated the theoretical scenes of SBH research. The reliance on empiricism in this field is curious because, being a direct consequence of charge distribution at MS interfaces, the magnitude of the SBH should be predictable from principles that govern charge distribution in general, i.e., chemistry. With experimental work on epitaxial NiSi2/Si interfaces more than three decades ago that showed a sharp dependence of the SBH on atomic structure, the shroud covering the FLP mystery began to lift. Subsequently, SBHs of polycrystalline MS interfaces were widely recognized to be inhomogeneous, showing that the FL was never “pinned” after all. Even though theoretical calculation was able to numerically reproduce SBHs for specific interfaces, it has not been possible to quantitatively predict/explain the SBH from chemical principles, until very recently. Density functional theory (DFT) calculations demonstrated that SBH could be quantitatively predicted from basic chemical principles, provided that the traditional analysis method, based on the Schottky–Mott approach, was abandoned and a newly proposed neutral polyhedra theory was adopted. Through the same study, the cause for the FLP effect and the apparent experimental “pinning level” were also identified. It appears that the SBH mystery is finally over.

Plasmon-Induced Super-Semiconducting In Nanostructured Bimetallic Arrays

Bingqing Wei
Department of Mechanical Engineering, University of Delaware, DE 19716, Newark, USA
weib@udel.edu

Solid state materials can be categorized as conductors, semiconductors, and insulators based on their electrical conductivity. For conductors, breakthrough discoveries, such as superconductors (FeSe, YBCO, etc.) and topological insulators (HgTe, Bi2Te3, etc.), have led the limit of conductivity falling by orders of magnitude or even to zero when certain extreme conditions, such as an ultra-low temperature or an ultra-high pressure, are met. Electrons can move freely through a superconductor without resistance when it becomes colder than a "critical temperature", which is far below room temperature. For semiconductors (Si, GaAs, etc.), both negative charge carriers (electrons) and positive charge carriers (holes) contribute to semiconductors' conductance, the foundation of modern electric devices and integrated circuits, but with a much higher resistance than metallic conductors. Conventional wisdom holds that electrons are the dominant charge carriers of metallic conductors (Al, Cu, etc.), and holes do not contribute to metals' excellent conductance because there are infinite free electrons in them. In this presentation, I will discuss, for the first time, a transition from metallic conductors to super-semiconductors (SSCs, their resistivity is lower than the metallic conductors) at near room temperature in nanostructured bimetallic arrays where the internal electrons can no longer be regarded as infinitely numerous. Hall effect revealed that the dominant carriers have changed from electrons (the n-type charge carriers) to holes (the p-type charge carriers) along with the transition from metallic conductors to SSCs. The cause of the SSC transition and p-type metal formation (the metal with p-type semiconductor behavior) is attributed to the hot electrons and holes induced by metal plasmonic resonance in the infrared wavelength range. These results reveal nanostructured metals and alloys' unusual and unexplored properties with limited free electrons that would have tremendous applications on metal-based ultra-low-power devices, such as diodes, transistors, and integrated circuits.

Multi-Scale Chirality Of Inorganic Materials

Jihyeon Yeom[a,b]
[a]*Engineering Faculty,* [b]*Nanoscience and Nanoengineering Research and Application Center*
South Korea
jhyeom@kaist.ac.kr

Inorganic materials possess many practical properties – e.g. optical, magnetic, and mechanical – due to the dense electron clouds, strong dipole moments, crystal structures, etc. Providing chirality to such inorganic materials in multiscale brings numerous unique properties. For example, when transition metal elements are incorporated in atomic chirality, due to the strong magnetic transition dipole moments, the optical activity of the system is amplified 1000 times and optical modulation is enabled in a very mild condition. By designing the chirality of ceramic materials from atomic- to micro-level, the optical activity from UV to NIR can be obtained. The biological properties of nanomedicine also can be controlled by their chirality. The precise synthesis and analysis of such multiscale chiral inorganic materials are challenging. However, we can achieve it by controlling over chirality transfer from enantiomers to materials or from circularly polarized photons to matter. This talk will cover strategies of synthesis, analysis, and applications of atomic-, nano-, and micro- chiral inorganic materials.

2D Graphene-Like Materials

Harold J.W. Zandvliet
Faculty of Science and Technology & MESA+ Research Institute for Nanotechnology, University of Twente, PO Box 217, 7500AE Enschede, Netherlands
h.j.w.zandvliet@utwente.nl

The impressive rise of graphene has spurred many scientists to look for alternative two-dimensional materials. The most obvious alternatives for graphene are the group IV elements. In this talk I will give an update on the germanium analogue of graphene, also referred to as germanene. Germanene does not occur in Nature and therefore this material has to be synthesized. Germanene is in many aspects very similar to graphene, but in contrast to the planar graphene lattice, the germanene honeycomb lattice is buckled and composed of two vertically displaced sub-lattices. Despite the buckling germanene hosts Dirac fermions. The spin-orbit gap of germanene is substantially larger than that of graphene making this material an ideal candidate to exhibit the quantum spin Hall effect. In the second part of my talk I will elaborate on the physical properties of small angle (< 1o) twisted bilayer graphene. The application of an transversal electric field results in the formation of a two-dimensional hexagonal network of topologically protected one-dimensional channels that run along the boundaries of the AB/BA domains. Using Fourier transforms of atomically resolved scanning tunneling microscopy images, I will show that the electronic transport in the counter-propagating one-dimensional states is valley protected.

ORAL PRESENTATIONS

Optical Band Gaps of Mixed-phase Copper-oxide Thin Films on Silicon Substrates

Mustafa Tolga Yurtcan[ab], Gökhan Uygur[a]

[a]*Department of Nanoscience and Nanoengineering, Graduate School of Natural and Applied Sciences, Atatürk University, Erzurum, Turkey*

[b]*Department of Mathematics & Science Education, Kazim Karabekir Education Faculty, Atatürk University, Erzurum, Turkey*

yurtcan@atauni.edu.tr

Abstract

Copper oxides are commonly used as electronic components or sensors in electronics. For this reason, thin films of copper oxides are important. We have deposited copper oxide thin films on silicon substrates at different pressures (50 – 200 mTorr) and temperatures (300 – 500 °C) using a cupric oxide target with the Pulsed Laser Deposition technique. Although copper oxides have two main phases as Copper(I)oxide (Cu_2O - Cuprous oxide) and Copper(II)oxide (CuO - Cupric oxide), we found that some samples have peaks of an intermediate phase called Paramelaconite (Cu_3O_4) and none of the samples have a single copper phase in the given range. The optical band gap of the thin films deposited under different conditions was calculated using UV-VIS characterization and presented in this study.

***Keywords*: PLD, Cu_2O, CuO, Cu_4O_3**

Introduction

Copper oxide is a low-cost non-toxic semiconductor (1). Copper oxides are mostly used in sensors (2) and other electronics (1,3,4). Copper oxides have two main phases Cupric oxide (CuO) and cuprous oxide (Cu_2O). In addition, there is an interphase called Paramelaconite (Cu_4O_3) (5). Copper(II)Oxide is black semiconductor with monoclinic structure, Copper(I)Oxide is a red semiconductor with a cubic structure and Paramelaconite Cu_4O_3 has a tetragonal (6) structure.

Usually copper oxides are p–type semiconductors (7), but some cases it exhibits n-type semi conductivity (8,9). Band gap of Copper(II)Oxide varies between 1.2-1.9 eV, and Copper(I)oxide vary as 1.8-2.5 eV (7).

Results and Discussion

12.5 grams of Alfa-Aesar 200 mesh Copper(I)oxide powder (Cuprous Oxide) used for pellet preparation. Then Pellet sintered in a muffle furnace for 10 hours at 900 °C (10). Silicon substrates cleaned with RCA process and placed inside the vacuum chamber. Copper-oxide thin films deposited on silicon substrates by Pulsed Laser Deposition (PLD) technique with a Neocera Complete P180 PLD System (11). Deposition parameters given in table 1.

Table 1

Target-Substrate Distance	5cm
Base Pressure	9×10^{-6} mTorr
Deposition Temperature	300-400-500 °C
Deposition Pressure	50-100-150-200 mTorr O_2
Laser Energy Density	1.5 J/cm^2

All growths were poly-crystal not single-crystal. Higher deposition temperature in same deposition pressure results increase in Copper(I)oxide and Paramelaconite peaks. For the given parameters 100 mTorr and 300 °C growth is recommended (12).

In UV-VIS analysis optical band gaps calculated by Tauc Method. For 300 ℃ samples band gaps varied between 3,90 - 4,04 eV, for 400 ℃ samples band gaps varied between 3,82 - 4,52 eV and for 500 ℃ samples band gaps varied between 3,56 - 4, 93 eV. The bandgaps for mixed phase copper-oxide thin films are not encouraging. Rising the deposition pressure results increase in the optical band gaps for the same deposition temperature.

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Fluorometric Fe^{3+} Ion Detection with Green Synthesis Carbon Dot Structures

Ayse Merve Senol[a], Ebru Bozkurt[b]

[a]*Medical Laboratory Techniques Program, Hamidiye Health Services Vocational School, Health Sciences University, İstanbul, Turkey*
[b]*Program of Occupational Health and Safety, Vocational College of Technical Sciences, Ataturk University, Erzurum, Turkey*
ebrubozkurt@atauni.edu.tr

We synthesized new carbon dots (CDs) from a natural resource, Seville orange (Citrus aurantium), using the hydrothermal method and investigated the ion sensor potential of this new carbon dot. Prepared CDs were structurally and morphologically characterized by TEM, FTIR, XRD and XPS measurements. As a result of these measurements, it was determined that the average particle size of CDs was 4.8 nm and the its structure contained carbon, oxygen and nitrogen atoms and groups such as hydroxyl and carboxyl. It was observed in studies with 16 different metal ions (K^+, Li^+, Ag^+, Ba^{2+}, Ca^{2+}, Mg^{2+}, Cd^{2+}, Co^{2+}, Fe^{2+}, Cu^{2+}, Hg^{2+}, Mn^{2+}, Zn^{2+}, Fe^{3+}, Al^{3+}, and Cr^{3+}) that these new CDs were only selective towards Fe^{3+} ions without interference other ions. Limit of detection of Fe^{3+} ions was quite low compared to other Fe^{3+} sensor in the literature and was calculated as 0.53 µM (1, 2). Real sample tests were conducted on tap and ground water samples to understand the practical usability of the new CDs. The results obtained from the study exhibited that the newly synthesized CDs were a fluorometrically selective and sensitive sensor for Fe^{3+} ions.

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Electro-oxidation of Methanol on Cu_2O-Graphene Nanocomposite Electrode

Bingül Kurt Urhan[a], Hülya Öztürk Doğan[a,b]

a. Atatürk University, Nanomaterials Sciences, Department of Nanoscience and Nanoengineering, Erzurum, Turkey, 25240

b. Atatürk University, Vocational College of Technical Sciences, Department of Chemistry and Chemical Processing Technologies, Erzurum, Turkey, 25240

bingulkurt@gmail.com

Abstract Graphene-based composite materials have demonstrated great advances in science, which can be used together with graphene oxide (GO) and metal oxide particle catalysts for application in electrocatalysts for fuel cells, biosensors, supercapacitors, and reducing oxygen, among other applications. The aim of this study is the design of highly active Cu_2O-graphene electrocatalysts for methanol electrooxidation in alkaline media. Here we reported that the homogeneously distributed Cu_2O nanostructures anchored to graphene were synthesized via a simple one-step electrochemical deposition process, in which metal ions and graphene oxide were simultaneously electro-reduced on the gold electrode. The characteristic properties of the graphene-based nanocomposites were investigated via X-ray diffraction (XRD), X-ray photoelectron spectroscopy (XPS), and scanning electron microscopy (SEM) measurements. Experimental results on the electrocatalytic activity of methanol electro-oxidation demonstrate that Cu_2O-graphene nanocomposites exhibit higher methanol electro-oxidation activity (with low oxidation potential and high current density) compared to individual electrodes.

***Keywords*: Copper (I) oxide, graphene, methanol electro-oxidation.**

Introduction

Graphene and graphene-based nanocomposites have attracted numerous interests in recent years in many fields, such as a catalyst for fuel cells, capacitors, supercapacitors, and batteries. Among them, direct methanol fuel cells (DMFCs) have been regarded as a potential candidate for power generation in electric vehicles (1). While platinum is commonly employed as the anode material for DMFCs, graphene-based nanocomposites are the best alternatives to Pt electrodes. In literature, numerous studies deal with the electro-oxidation of methanol on graphene electrodes mainly to develop DMFCs (2). Here, we reported that electrooxidation of methanol on Cu_2O-graphene (Cu_2O-G) electrodes was investigated in alkaline solutions.

Results and Discussion

The one-step electrochemical synthesis of Cu_2O-G composite was occurred in a solution containing Cu^{2+} and GO on a polycrystalline gold electrode under an O_2 atmosphere. The preparation of Cu_2O-G composite and experimental procedure were shown in Fig.1. X-ray diffraction (XRD) analysis (Fig. 2) demonstrates that the Cu_2O-G composite consists of cubic Cu_2O (JCPDS: 78-2076) and graphene.

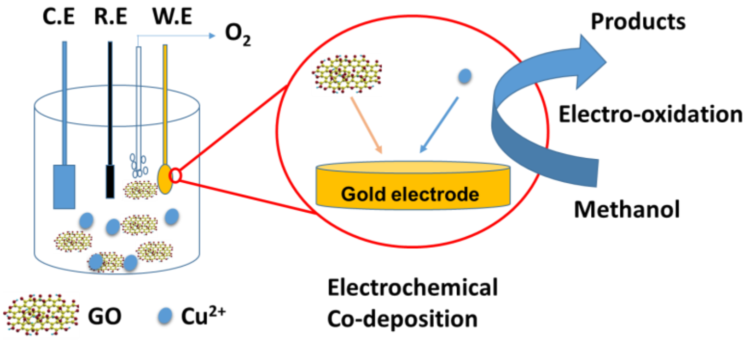

Figure 1. The electrochemical preparation of Cu_2O-G nanocomposite.

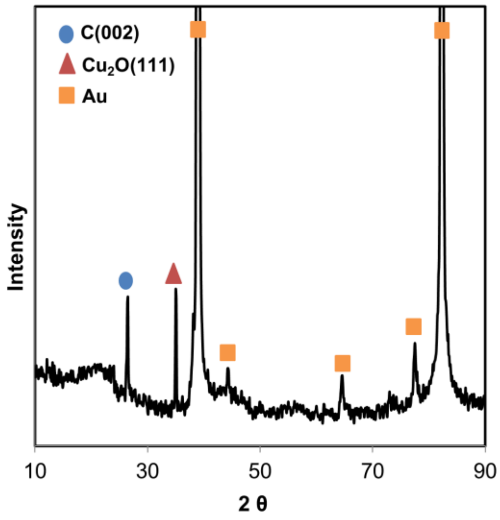

Figure 2. XRD spectra of Cu_2O-G nanocomposite.

The electrocatalytic activities of various electrodes for methanol electro-oxidation were examined using cyclic voltammetry. The cyclic voltammograms (CVs) of bare Au, Cu_2O, and Cu_2O-G electrodes were compared in 1 M methanol/0.5 M NaOH solution (Fig.3).

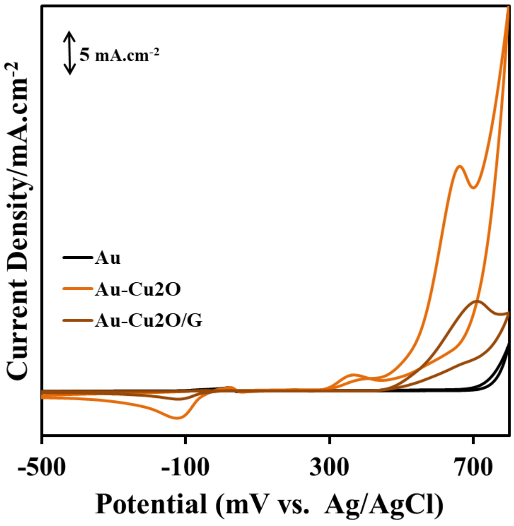

Figure 3. CVs of bare Au, Cu_2O, and Cu_2O-G electrodes in methanol solution.

The Cu_2O-G electrode for methanol electrooxidation was exhibited low oxidation potential and high current density. This result shows that the Cu_2O-G electrode can be used for DMFCs applications.

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Electrochemical Synthesis of Various Metal Nanoparticles-Decorated Cr_2O_3 Nanostructures

Ahmet Recep Korkmaz[a], Emir Çepni[a,b], Hülya Öztürk Doğan[a,c], Tuba Öznülüer Özer[a,d]

a. *Atatürk University, Nanomaterials Sciences, Department of Nanoscience and Nanoengineering, Erzurum, Turkey, 25240*

b. *Atatürk University, Faculty of Engineering, Department of Electrical and Electronics Engineering, Erzurum, Turkey, 25240*

c. *Atatürk University, Vocational College of Technical Sciences, Department of Chemistry and Chemical Processing Technologies, Erzurum, Turkey, 25240*

d. *Atatürk University, Faculty of Science, Department of Chemistry, Erzurum, Turkey, 25240*

emircepni@atauni.edu.tr

Abstract In this study, firstly, chromium (III) oxide (Cr_2O_3) nanostructures were prepared on fluorine-doped tin oxide (FTO) electrodes by electrochemical deposition. Then, the surface of Cr_2O_3 nanostructures was decorated by nickel or palladium nanoparticles using a constant potential deposition. Structural and morphological characterizations of metal nanoparticles-decorated Cr_2O_3 nanostructures were performed using XRD, XPS, SEM, and EDS techniques. Based on the characterization results, metal nanoparticle-decorated Cr_2O_3 nanostructures could be successfully and directly synthesized on the electrode material using electrochemical techniques.

***Keywords*: Chromium (III) oxide, nickel, palladium, nanoparticles.**

Introduction

Chromium oxide (Cr_2O_3), which is known that one of the principal oxides of chromium, is an important material regarding their industrial applications such as gas sensors, lithium-ion batteries, and supercapacitors. Among various chromium oxides (such as Cr_2O_3, CrO_2, CrO_3, Cr_2O_5, etc.), Cr_2O_3 is most chemically stable under ambient conditions (1). It has been already known that nanostructures of Cr_2O_3 electrocatalysts exhibit improved performance and stability comparable to noble metal electrocatalysts in electrochemical applications (2). The Cr_2O_3 nanostructures could be deposited using various techniques, including thermal decomposition, chemical vapor deposition, electrochemical deposition, sputtering, and chemical spray pyrolysis. In this study, the electrochemical synthesis and characterization of nickel or palladium metal nanoparticles-decorated Cr_2O_3 nanostructures were investigated.

Results and Discussion

The cyclic voltammogram of FTO in Cr^{3+} solution was shown in Fig.1a. The scanning electron microscopy (SEM) image and energy dispersive spectroscopy (EDS) spectra of electrochemical fabricated Cr_2O_3 nanostructures were given in Fig.1.b and c. The EDS spectra of Cr_2O_3 contain Cr and O elements.

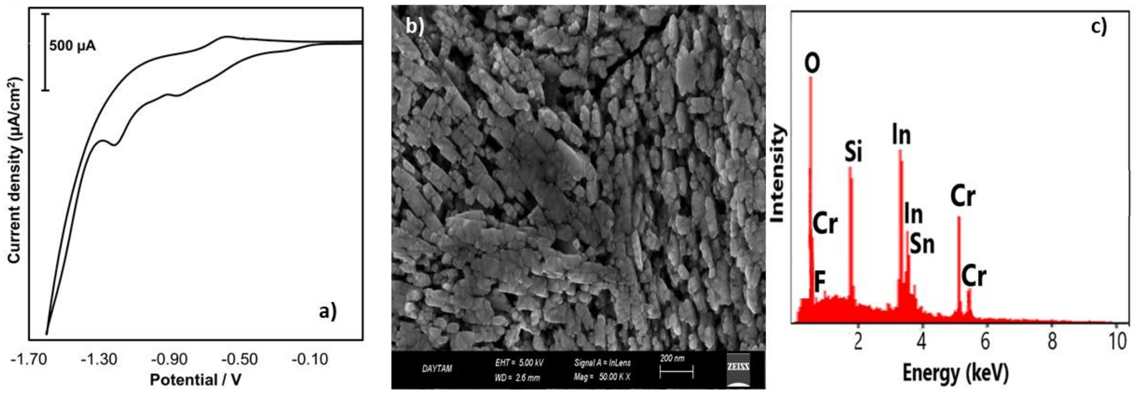

Figure 1. a) The cyclic voltammogram of FTO electrode in Cr^{3+} solution. The SEM image (b) and EDS spectra (c) of Cr_2O_3 nanostructures.

The Cr_2O_3 nanostructures were decorated with Ni nanoparticles by electrochemical deposition at a constant potential. The XRD spectrums of the FTO electrode and prepared Ni nanoparticles decorated-Cr_2O_3 were shown in Fig.2.

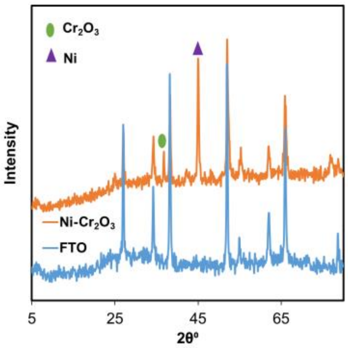

Figure 2. The XRD spectrums of Ni nanoparticles decorated-Cr_2O_3 nanostructures and FTO electrode.

The SEM and EDS are known as excellent instruments to give information about surface morphology and composition on a different surface. Ni or Pd metal decorated-Cr_2O_3 nanostructures were characterized using SEM and EDS techniques. Fig. 3a shows a typical surface morphology of the prepared Pd metal nanoparticles decorated-Cr_2O_3 electrode. The surface of FTO was fully coated with nanoscale Pd and Cr_2O_3 structures. EDS analysis confirmed that the surface composition included Cr, O, and Pd elements (Fig. 3b).

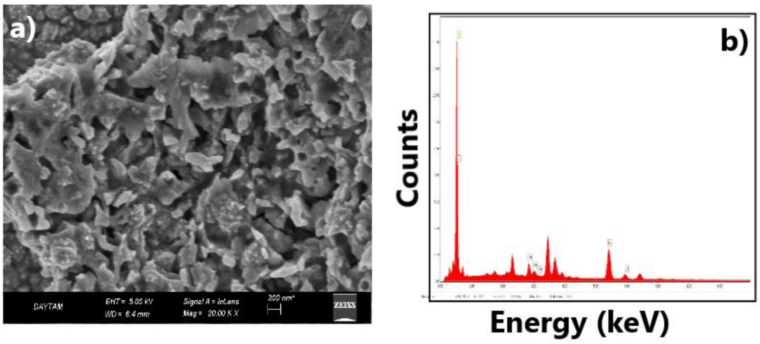

Figure 3. The SEM image (a) and EDS spectra (b) of Pd metal nanoparticles decorated-Cr_2O_3 electrode.

Cr_2O_3 and metal nanoparticles decorated-Cr_2O_3 nanostructures were prepared and deposited onto the FTO substrate by using the electrochemical deposition technique. The analytical and morphological results show also that the surface of the FTO electrode was covered with both Cr_2O_3 and metal nanoparticles decorated-Cr_2O_3 nanostructures.

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Efficiency of ZnO doped pyrite for COD removal from mixed dye solutions by heterogeneous Fenton process

Yuksel AKINAY[a], Dilara OZTURK[b], Ayse OZGUVEN[b]

[a]*Department of Mining Engineering, Faculty of Engineering, Van Yuzuncu Yil University, Van, Turkey*

[b]*Department of Environmental Engineering, Faculty of Engineering, Van Yuzuncu Yil University, Van, Turkey*

E-mail (yukselakinay@yyu.edu.tr)

Abstract In this study, it was aimed to investigate the efficiency of ZnO doped pyrite as a heterogeneous Fenton catalyst for COD removal from solution prepared from a mixture of methyl orange and reactive orange 16 dyes. Used pyrite ore was purchased commercially, which has origin in Spain. The effect of major parameters such as pH (3-7), catalyst dosage (0.5-3 g/L), and H_2O_2 concentration (0.5-2 g/L) were investigated under fixed agitation speed of 150 rpm, reaction time of 60 min., reaction temperature of 20 °C in a batch system. Scanning Electron Microscope (SEM), Energy Dispersive X-ray Spectroscopy (EDX), X-ray diffractometer (XRD) method, and Fourier Transform Infrared Spectroscopy (FTIR) analyses were performed to characterize the ZnO doped pyrite. Optimum values were determined as, H2O2 concentration of 1 g/L, pH of 5.05 (natural pH of mixed dye solution), and 2 g/L of catalyst dosage. Under these optimum conditions, the COD removal efficiency was calculated as 80.04%. The EDX analysis of ZnO doped pyrite showed that the extra Zn peaks were observed with 10.46 wt% compared to undoped pyrite. The characteristic reflections such as Fe-O, Fe-S are observed by FTIR spectrum. Moreover, the peak that appeared around 700-600 cm^{-1} can be attributed to ZnO vibrations. Finally, it can be said that ZnO doped pyrite showed good performance and can be used to remove COD from mixed dye solutions.

Keywords: ZnO doped pyrite; anionic; dye; COD; heterogeneous Fenton

Introduction The textile wastewater must be treated appropriately before being discharged into receiving environments. In this study, the performance of FeS_2/ZnO as a catalyst in the removal of methyl orange and reactive orange 16 dyes from wastewater with the HF process were investigated. The characterization of the FeS_2/ZnO was determined by SEM-EDX, XRD, and FTIR analysis.

2. Material and Method

2.2. Synthesis and Characterization of ZnO/Pyrite particles

Pyrite ore was purchased commercially from suppliers(originated:Spain). All chemicals were obtained from Sigma(USA).3 gr pyrite was mixed in 50 ml pure water for 1 h stirring. The 0.2M $ZnCl_2.7H_2O$ was dissolved in 50 ml pure water. This solution was poured into the pyrite solution. The pH was adjusted to 8-9 with NaOH with stirring 1 h. Then it was washed and dried at 70 ^oC. FESEM, EDX, FTIR and XRD analyses were carried out for pyrite and ZnO/Pyrite particles.

2.3. Heterogeneous Fenton process

Batch HF experiments started by adding desired amounts of H_2O_2 and catalyst into 150 mL dye solution (750 mg/L) with stirring (Daihan MSH-20D) at room temperature. COD and H2O2 anaylyzed with the methods in literature [1,2]. Removal efficiency was calculated with Eq. (1).

$$COD_{removal} = \frac{1 - COD_t}{COD_0}\, x\, 100 \qquad (1)$$

3. Results and discussion

3.1.Characterization

The SEM and EDX images of untreated pyrite and ZnO/pyrite particles are given in Fig.1. The untreated pyrite has roughness surface with small protrusions(Fig.1a). The size of pyrite particles is not uniform(3-15 µm). Almost the whole surface of raw pyrite is coated by ZnO flakes(Fig 1(b)). The EDX spectra of both particles are acquired from selected surfaces (yellow squares) (Fig. 1a,b). The Fe and S are present in untreated pyrite with the rate of 13.84 wt% and 49.95 wt%. The Zn peak appears after ZnO coating with the rate of 10.46 wt%. The XRD peaks of untreated pyrite and ZnO/pyrite are given in Fig. 2a. The diffraction patterns of untreated pyrite appeared at 33.4°, 41.02°, 47.56°, 56.34°, 58.7°, 62°, 64.3°, 76.8°, and 79.24° are indexed to cubic (FeS_2) planes of 200, 101, 211, 220, 311, 222, 023, 321, 311, 420, respectively. The peak of ZnO observed at 37.34^o is assigned to 101 crystal plane. The FT-IR spectra of untreated pyrite and ZnO/pyrite particles are given in Fig.2b. In the case of untreated pyrite an obvious peak appeared at 1040 cm^{-1} is attributed to stretching vibrations of C-O-C and C=O in FeS and FeO. The ZnO/pyrite shows typical ZnO vibrations. Herein, the broad peaks that appeared at 3460 cm^{-1} and 2870 cm^{-1} are attributed to O-H vibration and absorption peak of ZnO. The vibration of H-O-H is observed at 1590-1620 cm^{-1}, while the O-H vibration of H2O in ZnO appeared at 1060 $cm^{-1.}$

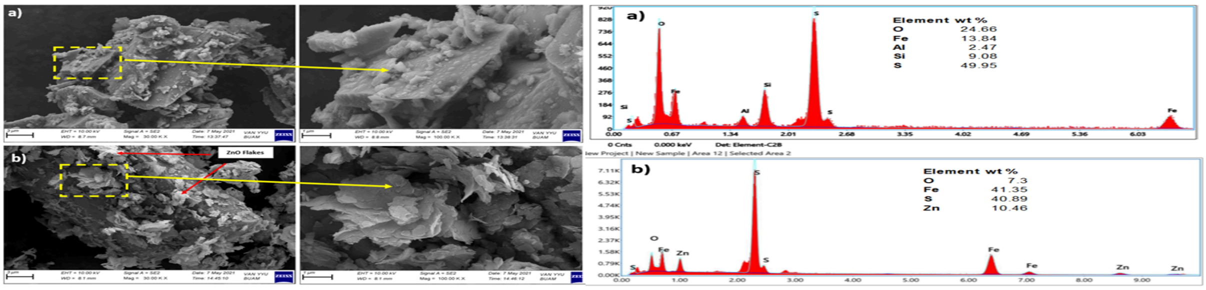

Fig.1 (left) The SEM images and **(right)** EDX spectra of **(a)** untreated pyrite and **(b)** ZnO coated pyrite

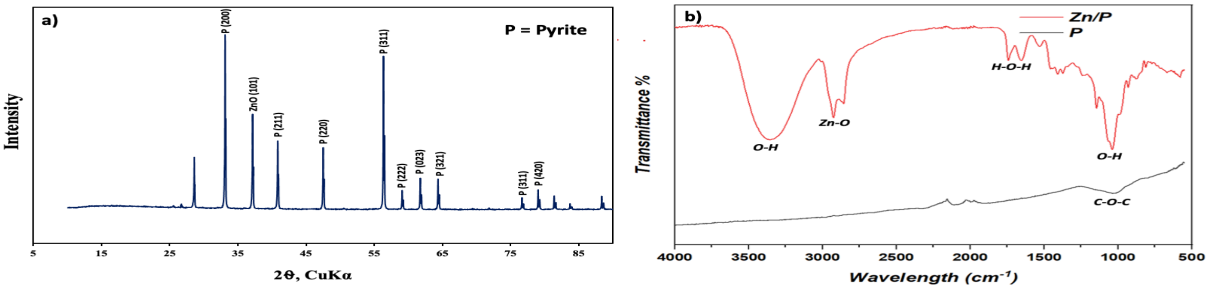

Fig. 2. XRD patterns (a) and FT-IR spectra (b) of untreated pyrite and ZnO coated pyrite

3.2. Effect of operational parameters on COD removal

In the presence of oxygen, FeS_2 can react to produce Fe^{2+} in solution and produce protons that cause the pH to drop (Eq. 2). Then, Fe^{2+} reacts with H_2O_2 to form HO· and turns into Fe^{3+} (Eq. (3)) [3]. Therefore, in the heterogeneous Fenton system, the production of both Fe^{2+} (Eq. (2)) and HO· (Eq. (3)) is the main rate-limiting factor for COD removal.

$2FeS_2 + 7O_2 + 2H_2O \longrightarrow 2Fe^{2+} + 4SO_4^{2-} + 4H^+$ (2) $Fe^{2+} + H_2O_2 \longrightarrow Fe^{3+} + OH^{\bullet} + OH^-$ (3)

The effect of pH was investigated at; pH values of 3.0, 5.05, and 7.0, 1 g/L FeS_2/ZnO, 1g/L H_2O_2, 60 min, and 150 rpm and max. COD removal (72%) was observed at pH 5.05. Since more •OH are produced at acidic pHs, the removal efficiency is high. The effect of H_2O_2 conc. and catalyst dosage was investigated (Fig.3). Max. removal was observed 72% at 1g/L H_2O_2 (Eq.4-5). At 2 g/L catalyst dosage, 80% COD removal was obtained. Above 2 g/L,the scavenging effect of Fe^{2+} ions occurred, and the removal decreased (Eq. (6)) [3].

$Fe^{2+} + H_2O_2 + H^+ \longrightarrow Fe^{3+} + H_2O + OH^\bullet$ (4) $H_2O_2 + OH^\bullet \longrightarrow Fe^{3+} + OH^-$ (5)

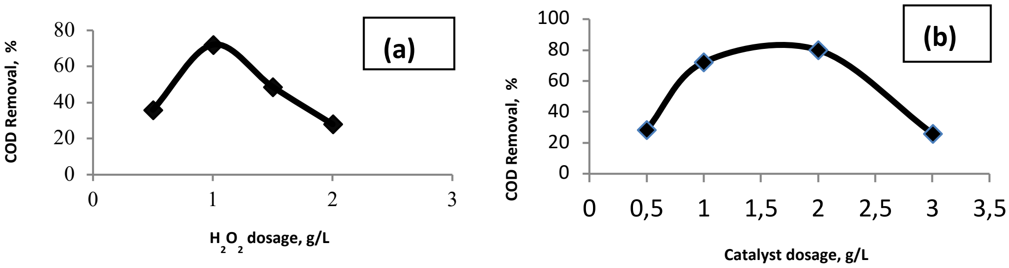

Fig. 3. The effect of **(a)** H_2O_2 concentration (pH=5.05; FeS_2/ZnO = 1 g/L; T = 25°C) and (**b**) catalyst dosage (pH=5.05; H_2O_2 = 1 g/L; T = 25°C) on COD removal

$Fe^{3+} + H_2O_2 \longrightarrow H_2O + HO_2^\bullet$ (6)

Conclusion The efficiency of dye removal from the aqueous solution containing methyl orange and reactive orange 16 by the HF process was investigated. Optimum conditions were determined as 2 g/L FeS_2/ZnO, 1g/L H_2O_2, 60 min, and pH 5.05. The max.removal efficiency was found to be 80%.The major elements of untreated pyrite and FeS_2/ZnO were confirmed by SEM, and EDX. The FeS_2/ZnO seems suitable for the degradation of methyl orange and reactive orange 16 dyes.

Acknowledgement: The authors would like to thank the Van Yuzuncu Yil University Science Research and Application Center and its staffs for their support in material characterization.

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Effect on Heat Transfer of Al_2O_3/water Nanofluid in a Trapezoidal Channel with Baffles

Selma Akcay[a]

[a] *Cankiri Karatekin University, Department of Mechanical Engineering, Cankiri, Turkey,*
selma.352@hotmail.com

Abstract: In this study, the effects on heat transfer and friction factor of Al_2O_3-water nanofluid in a trapezoidal channel with baffles were numerically investigated. Iterations are solved with SIMPLE algorithm. In the study, Reynolds number ($200 \leq Re \leq 1200$), and nanoparticle volume ratio ($0.01 \leq \phi \leq 0.03$) were changed, and other parameters kept constant. The lower trapezoidal walls of the channel were kept at constant temperature. The upper wall is considered straight and adiabatic. There are the baffles to the upper wall of channel. The Nusselt number (Nu) and the skin friction coefficient along the channel were calculated. The contours of velocity and temperature in the channel were obtained. The numerical results show that the nanofluids contribute significantly to the heat transfer improvement. The increasing particle volume fractions at high Reynolds numbers significantly improve the heat transfer, while the friction factor increases slightly.

Keywords: Nanofluid, Trapezoidal channel, Baffle, Heat transfer

Introduction: In engineering applications, passive heat transfer improvement methods are widely used. This methods are economical and reliable as they have no moving parts and does not require any external energy. One of the passive methods is the use of the different corrugated channels. The other is the addition of nano-sized solid particles with high thermal conductivity to the base fluid. Some researchers have used nanofluids together with the passive techniques. [1-7]. Manca et al. [8] examined the heat transfer of Al_2O_3-water nanofluid for 0% to 4% particle volume ratios in a channel with different rib heights. Heshmati et al. [9] studied the heat transfer for different geometries with the baffles at varying particle volume ratios of different nanofluids. Ajeel et al. [10] studied the heat transfer of ZnO-water nanofluid for turbulent flow in a corrugated channel with baffles. Menni et al. [11] examined the dynamic and thermal behaviors of nanofluids for turbulent flow in a channel with the baffles. There are some studies in the literature examining the combined effects of passive heat transfer applications. However, the high number of parameters used has increased the efforts to find the optimum parameters and new studies are needed on this subject. Therefore, in this study, the effects on heat transfer and friction factor of Al_2O_3-water nanofluid for a trapezoidal channel with baffles was numerically investigated.

Results and Discussion: In Figure 1, the geometry of the channel used in this study is given. The dimensions of the trapezoidal channel are considered as L_1 = 0.2 m (unheated), L_2 = 0.336 (heated), H = 19 mm, s =1.5H and t=b=H/3.

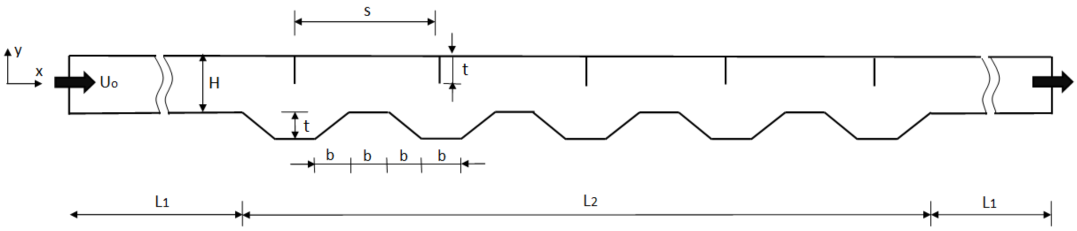


Figure 1. The geometry of the numerical model

Al_2O_3-water was considered as the nanofluid, and three different particle volume fractions (ϕ = 1%, 2% and 3%) were used. Simulations are applied for 200 ≤ Re ≤ 1200. Computational Fluid Dynamics (CFD) based Fluent 15.0 program was used for numerical solution. In study was preferred 220200 grid cell number. The temperature at the channel inlet is T_o = 300 K. At the entrance, "velocity inlet" and at the outlet, "outflow" boundary conditions are defined. The lower trapezoidal surfaces are preserved at an constant temperature of T_w = 330 K. The numerical study is validated with Ref [12].

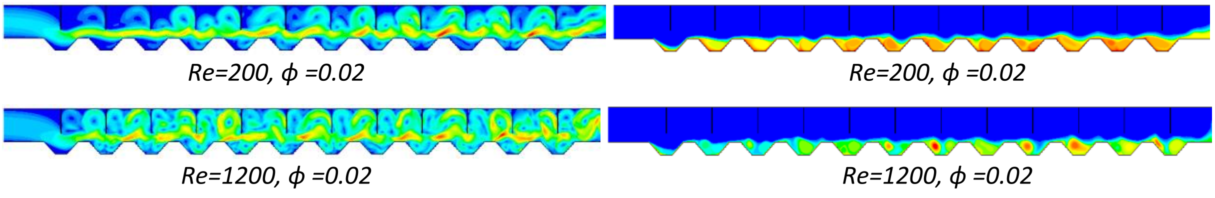
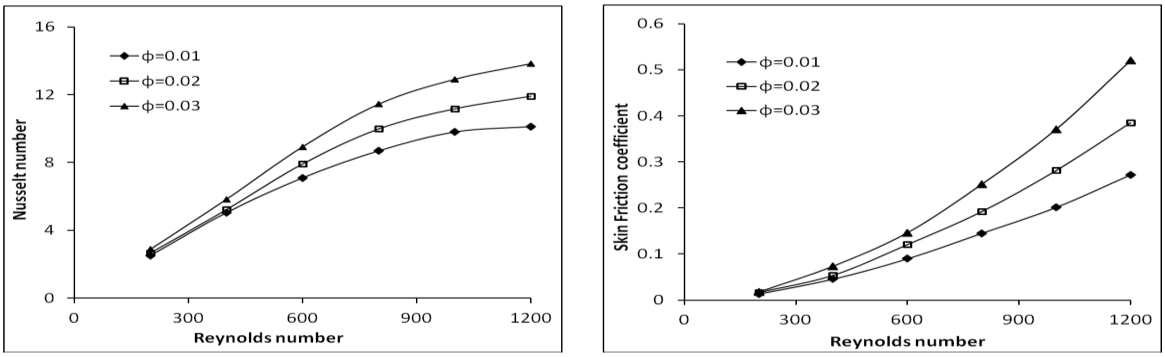


Figure 2. a-The velocity contours, **b-** The temperature contours (Re=200 and Re= 1200)

In Figure 3, the velocity and temperature structures are given at different Re for ϕ =2%. The channel structure and baffles affected the flow and temperature fields depending on Re. It has been observed that the baffles cause seconder flow structures in the channel and the heat transfer enhanced. The local and average Nu are defined by Equations (1,2).

$$Nu_x = \frac{q'' D_h}{k(T_{w,x} - T_{b\,x}} \tag{1}$$

$$Nu = \frac{1}{L}\int_0^L Nu_x dx \tag{2}$$



a **b**

Figure 3. a-The Nusselt number, b**-** The skin friction coefficient with Re and ϕ

In Figure 3a, the Nusselt number and in Figure 3b the skin friction coefficient (f) are given. The Nu and f increase with the increase of ϕ and Re. The highest heat transfer was obtained as 13.82 at Re = 1200 and ϕ = 0.03. The highest friction factor was obtained as 0.52 at same parameters. The nanofluid and the baffles in the trapezoidal channel provided significant improvement on heat transfer, while an acceptable increase in friction factor was observed.

In this study, the effects of particle volume fraction and Re on flow and heat transfer in the trapezoidal channel were analyzed. The results show that the heat transfer performance increases significantly with the increase of Re and particle volume fraction. Nanofluids have an important role for heat transfer improvement.

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Facile Elaboration Of Tio2 -Zno Based Low-Cost H2 Gas Sensors

A. Faddouli[1], B. Hartiti[1], Y. Doubi[1,5], M. Ertugrul[2], H. K. Sağlam[2,3], M. Masat[2], Ö. Çoban[2], H. Labrim[4], S. Fadili[1] , M. Siadat [5]

[1] LVOBEEN laboratory, MEEM & DD Group, Hassan II University of Casablanca, FSTM BP Mohammedia, Morocco

[2] Department of Electrical and Electronics Engineering Faculty, Ataturk University, 25240 Erzurum, Turkey

[3] Department of Electricity and Energy, Vocational College of Technical Sciences, Ataturk University,

25240 Erzurum, Turkey

[4] Materials Science Unit / DERS / CNESTEN National Centre for Energy, Sciences and Nuclear Techniques), Rabat, Morocco

[5] LCOMS, University of Lorraine, Metz, France

alifaddouli@hotmail.com

The high demand for semiconductor gas sensors that work at low operating temperatures of up to 100 _C has led to the production of a gas sensor based on TiO2 nanoparticles. A gas sensor film was made by mixing the detection material, TiO2 and zinc oxide. The sensor film was tempered at 300 ° C. in 30 minutes. The gas sensor has been exposed to hydrogen at a concentration of 100 to 1000 ppm and tested at various operating temperatures, which are 100_C, 200_C, and 300_C to find optimal performance. Temperature to achieve the highest sensitivity. The gas sensor exhibited p-type conductivity based on the decrease in current when exposed to hydrogen.The gas sensor demonstrated the ability to detect low levels of hydrogen down to 100 ppm at 100_C.

Keywords: gas sensor; TiO2-ZnO; hydrogen; nanoparticles; p-type TiO2

Hydrogen sensitivity of TiO_2 Gas Sensor based on different firing temperatures for bottom interdigitated electrode

Siti Amaniah Mohd Chachuli[a], Mohd Nizar Hamidon[b], Mehmet Ertugrul[c], Md. Shuhazlly Mamat[d], Omer Coban[c], M. Idzdihar Idris[a], and N.H. Shamsudin[e]

[a] Fakulti Kejuruteraan Elektronik & Kejuruteraan Komputer, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia
[b]Institute of Advanced Technology, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia
[c]Engineering Faculty, Ataturk University, 25250 Erzurum, Turkey
[d]Faculty of Sciences, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia
[e]Fakulti Kejuruteraan Elektrik, Universiti Teknikal Malaysia Melaka, Hang Tuah Jaya, 76100 Durian Tunggal, Melaka, Malaysia

sitiamaniah@utem.edu.my

Abstract

This paper presents the sensitivity of the TiO2 gas sensor to hydrogen with silver diffusion at elevated operating temperatures for the bottom interdigitated electrode. The silver acted as an interdigitated electrode of the thick film gas sensor and deposited using a screen-printing technique on the bottom of the sensing film. Two different firing temperatures were carried out for the silver: 150℃ and 500℃ for 30 minutes under ambient air to study the effect of silver on the hydrogen response. The results revealed that E1(B-500) gas sensor showed better sensitivity than the E1(B-150) gas sensor to the hydrogen (100 – 1000 ppm). The sensitivity values for the E1(B-500) gas sensor were approximately 3.74, 13.16, 23.69, 32.80 and 43.60 for 100, 300, 500, 700, and 1000 ppm of hydrogen at the operating temperature of 200℃.

Keywords*: *silver diffusion; interdigitated electrode; thick film gas sensor; screen-printing

Introduction

Titanium dioxide (TiO_2) is an n-type semiconductor and consists of three phases: anatase, rutile, and brookite. Besides, TiO_2 also chemically stable, non-toxic, biocompatible, and inexpensive [1]. In gas sensing applications, the anatase phase and rutile phase are the most phases used in TiO2 in detecting the hydrogen [2]–[5]. TiO_2 nanostructures such as nanorods [3], nanotubes [1], [6] nanoparticles [4], [7], and nanocrystalline [8] have been widely used in detecting hydrogen. Reported that, TiO_2 can sense a low concentration of hydrogen as low as 1 ppm and working at room operating temperature [3]. Due to the enormous advantages of

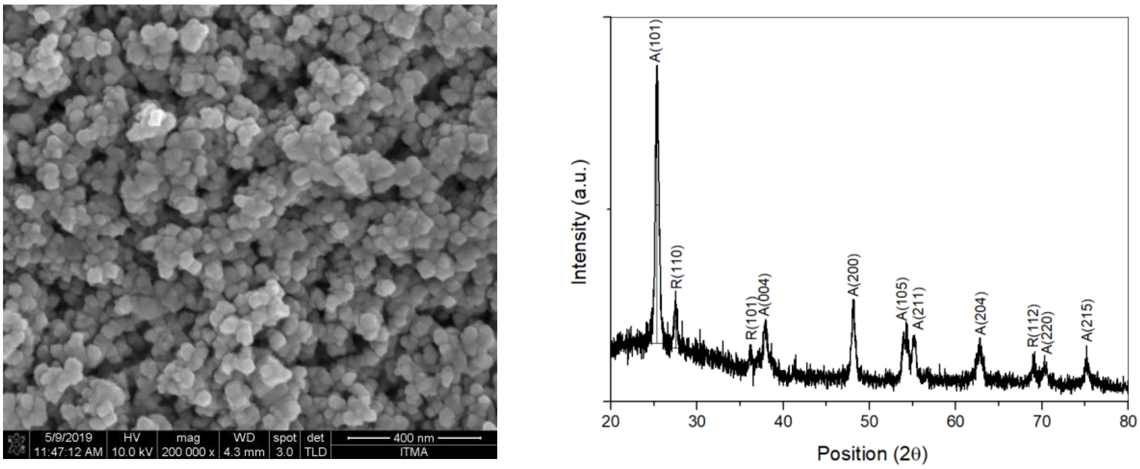
TiO_2 and the ability to sense a low concentration of hydrogen at low operating temperature, TiO_2 was chosen as a sensing material for the thick film gas sensor in this work.

In previous work, as presented in Ref. [2], the TiO_2 gas sensor has shown a good response to 100 – 1000 ppm of hydrogen at different operating temperatures, and optimum operating temperature has occurred at 200℃. In this work, the TiO_2 thick film gas sensors were fabricated using screen-printing technology, and the IDE of the gas sensor was firing at different firing temperatures. Both gas sensors were exposed to 100 – 1000 ppm of hydrogen at operating temperatures of 200℃.

Results and Discussion

The preparation of TiO_2 paste can be referred to in previous work in Ref. [9]. Two gas sensors were prepared with different firing temperatures on IDE: 150℃ and 500℃. Initially, the IDE will be printed and followed by a firing process under ambient air for 30 minutes. Then, the TiO_2 paste was deposited on the IDE as a second layer of the gas sensor and followed by the annealing treatment at 500℃ under ambient air. The thick film gas sensors were labeled as E1(B-150) and E1(B-500) for IDE that firing at the temperature of 150℃ and 500℃, respectively.

Fig. 1 shows the morphology and XRD spectra of TiO_2 thick film after annealing treatment at 500℃. It can be seen that the TiO_2 structures were in sphere shapes, and the diameter of the particles in the ranges of 30 – 70 nm. This morphology verified that the structure on the surface of the gas sensor was TiO_2 nanoparticles. It was also observed that the anatase and rutile phases were detected on the surface of the sensing film and sharp and high peaks in the XRD spectra. This result indicated the crystallinity of TiO_2 after the annealing treatment.



(a) (b)

Fig. 1. Characterization of TiO_2 thick film after annealing treatment at 500°C (a) FESEM morphology and (b) XRD spectra

Response and sensitivity of E1(B-150) and E1(B-500) to 100 – 1000 ppm of hydrogen at the operating temperature of 200°C is displayed in Fig. 2. Both gas sensors showed a stable response, in which saturated current was easily reached less than 150s and able to recover well after exposure to hydrogen and showed a significant difference for each hydrogen concentration. In terms of linearity graph, both gas sensors produced good linearity at the operating temperature of 200°C, which this result verfified the optimum operating temperature for these gas sensors occurred at 200°C. Besides that, significant differences of response for each hydrogen concentration were observed at this temperature.

E1(B-150) and E1(B-500) gas sensors were successfully fabricated using screen-printing technology. Two different firing temperatures were applied on the IDE gas sensor, and the result revealed that IDE that fired at 500°C had achieved a metallic silver. The sensitivity for E1(B-500) gas sensor at the operating temperature of 200°C were approximately 3.74, 13.16, 23.69, 32.80 and 43.60 for 100, 300, 500, 700, and 1000 ppm of hydrogen.

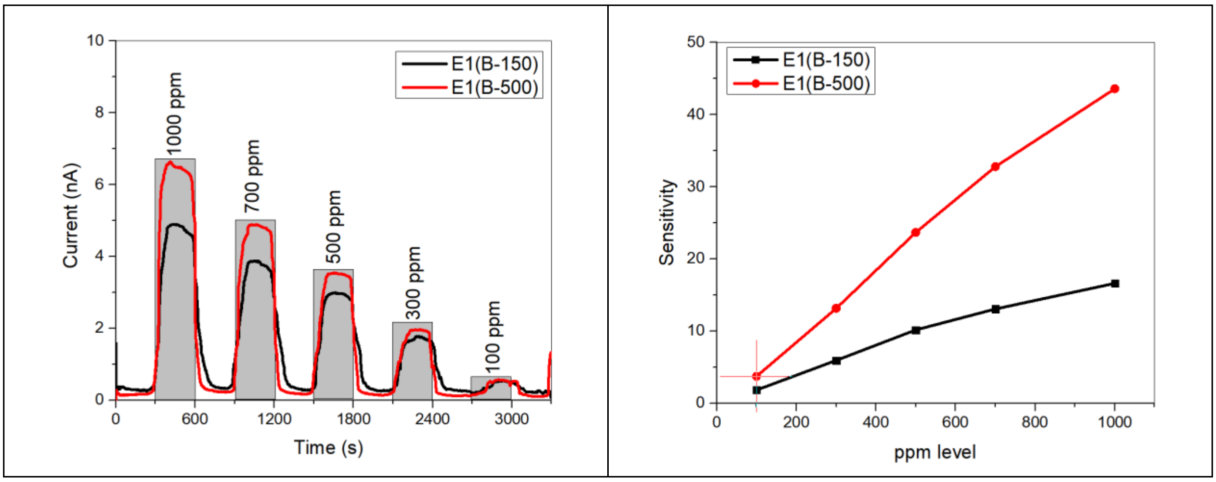


Fig. 2. Response and sensitivity of E1(B-150) and E1(B-500) gas sensors to 100 – 1000 ppm of hydrogen at the operating temperature of 200℃

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Investigation of the Effects of Nano-Clay Addition at Different Ratios on Thermal Properties of the Hybrid Composite Glass / Carbon / Glass (Withdrawn)

İlhan Volkan ÖNER[a], Gülşah ALAR ÖNER[b]

ivoner@atauni.edu.tr

galar@atauni.edu.tr

This abstract was withdrawn on November 2, 2021 at the request of the corresponding author.

Preparation of Ce_2O_3 NPs and SrO NPs nanoparticle doped epoxy nanocomposites synthesized by green synthesis method and investigation of their bending strength

Gülşah (ALAR) ÖNER[a], Hayrunnisa NADAROĞLU[b], Volkan ACAR[c], Soner GÖK[d]

[a]Atatürk University, Technical Science Vocational College, Department of Automotive Technologies, Erzurum-TÜRKİYE
[b]Atatürk University, Department of Nanoscience and Nano Engineering, Erzurum-TÜRKİYE
[c]Atatürk University, Faculty of Engineering, Department of Mechanical Engineering, Erzurum-TÜRKİYE
[d]Atatürk University, Technical Science Vocational College, Department of Machine Technologies, Erzurum-TÜRKİYE

galar@atauni.edu.tr

The improvement of the strength of modified epoxy composites by means of nanoparticles could pave the way for obtaining new materials with superior properties that can be used in the industrial field. Preparation of epoxy composites by adding Cerium (III) oxide (Ce_2O_3) and Strontium oxide (SrO) nanoparticles, produced by green synthesis method, at ratios of 0.3 wt%, 0.6 wt% and 1 wt%, and determination of their strength properties were aimed in this study. The chemical and structural compositions of the composites prepared with the addition of Ce_2O_3 NPs and SrO NPs nanoparticles were analyzed using Scanning Electron Microscope (SEM). In addition, the thermal stability of the nanocomposites was also determined using thermo-gravimetric analysis (TGA) and Differential Scanning Calorimetry (DSC). Mechanical strength tests of all samples were made in three-point bending testing machine. The thermal and mechanical properties were found to have improved with the addition of nanoparticles at different ratios, compared to the plain samples.

Keywords: Flexural strength, Flexural modulus, Modified Epoxy Composite, Ce_2O_3 NPs, SrO NPs.

Production of Bi_2O_3 NPs and NiO NPs nanoparticle doped epoxy nanocomposites synthesized by green synthesis method and investigation of their bending strength

Gülşah (ALAR) ÖNER[a], Volkan ACAR[b], Hayrunnisa NADAROĞLU[c], Soner GÖK[d]

[a]*Atatürk University, Technical Science Vocational College, Department of Automotive Technologies, Erzurum-TÜRKİYE*
[b]*Atatürk University, Faculty of Engineering, Department of Mechanical Engineering, Erzurum-TÜRKİYE*
[c]*Atatürk University, Department of Nanoscience and Nano Engineering, Erzurum-TÜRKİYE*
[d]*Atatürk University, Technical Science Vocational College, Department of Machine Technologies, Erzurum-TÜRKİYE*

galar@atauni.edu.tr

In this study, the mechanical properties of epoxy composites containing Bi_2O_3 NPs and NiO NPs nanoparticles, at weight percentages of 0.3 wt%, 0.6 wt% and 1wt% were examined. The chemical and structural composition of composites reinforced with Bi_2O_3 NPs and NiO NPs nanoparticles were determined by using scanning electron microscopy (SEM). In addition, the thermal stabilities of prepared nano-composites were examined with thermo-gravimetric analysis (TGA) and Differential Scanning Calorimetry (DSC) tests. Mechanical strength tests of all samples were made in three-point bending testing machine. The thermal and mechanical properties were found to have improved with the addition of nanoparticles at different ratios, compared to the control samples.

Keywords: Flexural strength, Epoxy Composite, Nanoparticle, Flexural modulus.

Development of Keratin-based Viscosupplement Alternatives Extracted From Bubalus *Bubalis* (Buffalo) Horn

Dilşad TAYDAŞ [a], Levent Cenk KUMRUOĞLU [b]

[a]*Nanotechnology Engineering Department, Faculty of Engineering, Sivas Cumhuriyet University, 58140, Sivas, Turkey*

[b]*Metallurgical and Materials Engineering Department, Faculty of Engineering and Natural Sciences, İskenderun Technical University, 31200, İskenderun/ Hatay, Turkey*

dilsadtaydas@gmail.com

Abstract

Osteoarthritis (OA) is the most common degenerative joint disease with severe joint pain due to the breakdown of articular cartilage. The knee is the joint most affected by this disease. Every joint has a natural lubricating fluid called synovial fluid. Synovial fluid is a naturally produced lubricant consisting of proteins, lipids, and hyaluronic acid. The rheological properties of synovial fluid play an important role in joint lubrication. Damage to the articular cartilage, together with insufficient synovial fluid, affects the joint, causing pain, sensitivity when touched, stiffness and inflammation. Current treatments for OA are about reducing pain and maintaining joint function. Viscosupplementation involves injecting a bio-compatible fluid that is shear thinning and viscoelastic directly to the intra-articular joint cavity to improve joint lubrication and shock absorption. In this work, keratin was extracted from horn for viscosupplement. The keratin protein from horn was extracted, which was observed to be pure were determined using FTIR. Viscosupplement alternative was synthesized by adding extracted keratins into sodium hyaluronate dissolved in physiological saline. Prepared solutions were measured by rheometer for viscosity. As a result of the measurements, it was seen that the amount of added keratin affected the viscosity positively. It has been observed that the synthesized viscosupplements have better shear stress values with keratin, show similar rheological properties with the viscosupplements available in the market, and show non-Newtonian fluidity.

Keywords: ***Osteoarthritis, Viscosupplement, Hyaluronic acid, Keratin.***

Introduction

Osteoarthritis (OA) is a serious joint disease that reduces quality of life. Osteoarthritis (OA), popularly known as "joint calcification" or "joint wear", is a slowly progressive chronic musculoskeletal disease that starts with damage to the hyaline articular cartilage, although it is mostly associated with old age. OA can occur in any joint but is most often seen in the knee joints. A synovial or diarthrodial joint is a freely movable joint which is characterized by a synovial cavity filled with the lubricating substance known as synovial fluid. The articular surface of a synovial joint is covered completely by a layer of articular cartilage [1]. Synovial fluid is an ultra-filtered blood plasma composed of blood plasma, hyaluronan, librucin, and proteins from interstitial fluid. Normal synovial fluid contains HA (hyaluronic acid) at a concentration ranging from 3-4 mg/ml, which is the main contributor to the viscoelastic properties of the synovial fluid [2]. Viscoelasticity shows that HA acts as a viscous fluid at low shear rates and as an elastic material at high shear rates. This property reduces friction between the articular cartilages. Damage to the articular cartilage may result in deficient rheological properties of the synovial fluid and eventually will influence the performance of the joint. However, in a diseased joint, the composition of the synovial fluid is changed resulting in deterioration of rheological properties. Synovial fluid becomes less viscous and therefore less effective in lubrication.

The goals for treatment of OA are to minimize pain and maintain joint mobility. Intraarticular injections of hyaluronic acid known as viscosupplementation is a non-operative treatment for OA. In this study, it is aimed to produce an alternative viscosupplement by using HA together with keratin. Most biological materials are neither purely elastic nor purely viscous in mechanical behaviour; instead, they show a combination of both and are hence termed viscoelastic [3]. The viscoelasticity is of primary importance for keratinous tissues not only to provide mechanical support and sustain impact but also to absorb energy and dampen load fluctuations [4]. In this study, the rheological properties of viscosupplements obtained by adding keratins extracted from Bubalus bubalis (Buffalo) horn into HA were compared.

Results and Discussion

Extraction of keratin

The first step of extraction is defatting. Defatting is a critical process because of removal of fats from the raw material. Soxhlet's apparatus was used to carry out defatting of pulverized horn sample for about 72 h. Mixture of hexane and dichloromethane (1:1, v/v) was used for refluxing. Ten gram of defatted horn sample was mixed with 7 M urea, 6 g SDS and 15 ml of 2-mercaptoethanol (1M) in a 300 mL roundbottom flask and kept in orbital shaker at 50°C for 24 h to extract keratin at pH 7. After the reaction, solution was centrifuged for 15 mins at 6000 rpm and the supernatant was dialyzed against degassed water 3 days. Extracted keratin was kept in a deep freezer at -80oC overnight and lyophilized to make it into powder.

Preparation of Viscosupplements

250 mg of keratin was completely dissolved in 0.1 mol/L sodium hydroxide and diluted to 25 mL with distilled water. This way, keratin solution at a concentration of 10.0 mg/mL was obtained. 250 mg of HA was dissolved in distilled water and diluted to 25 mL to obtain a HA solution at a concentration of 10.0 mg/mL. The keratin solution and HA solution were mixed at a 1:1 mass ratio and the pH was adjusted to 7 with 2M HCl. The mixture was then

magnetically stirred for 60 min. In the same way, the keratin solution at a concentration of 8.5 mg/mL was prepared.

Results

After the dialysis, it was observed that the urea was removed with the appearance of the characteristic absorbance peak of keratin in the UV-VIS measurements (Fig. 1a). Fig. 1b shows the FTIR spectra of keratin. The peak at 3272 cm-1 could be ascribed to the stretching vibration absorption peak of the N-H bond of the amino group. The peak at 1633 cm-1 corresponded to the characteristic peak of the amide absorption band I and could be ascribed to the C=O stretching vibration of the polypeptide backbone after hydrogen bonding, i.e. the most representative peak band of protein secondary structure [5]. The peak at 1538 cm-1 could be ascribed to the amino absorption band II, causing a bending vibration of N-H. The peak at 1234 cm-1 corresponded to the stretching vibration absorption peak of the C-N (amide absorption band III) group [6].

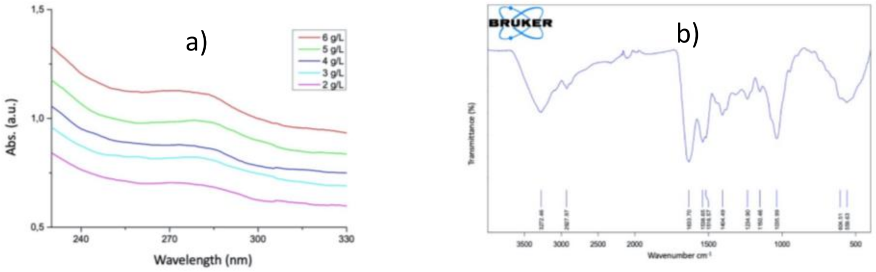

Fig. 1. (a) UV-VIS spectra of keratin, (b) FTIR spectra of keratin

The shear viscosity is plotted as a function of shear rate for all samples at 25 and 37 ^{o}C.

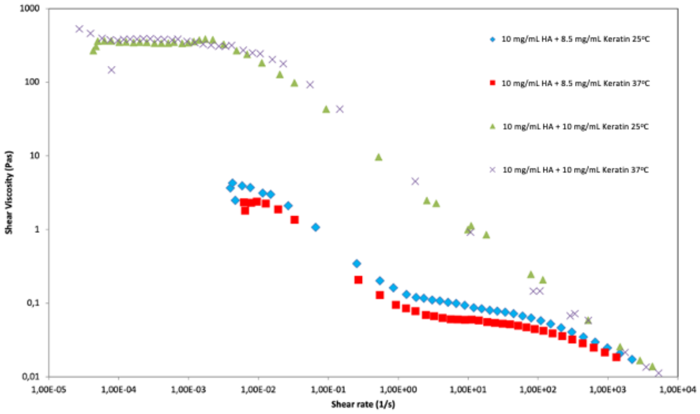

Fig. 2. Shear viscosity as a function of shear rate for all samples at 25 ^{o}C and 37 ^{o}C.

The samples exhibited non-Newtonian shear thinning behavior; that is viscosity decreases with increasing shear rate. For the 10 mg/mL HA + 10 mg/mL keratin sample, a plateau at low shear rates was also observed. It has been concluded that the amount of keratin affected the viscosity positively.

Conclusions

In this work, we show that pure keratin can be extracted from Bubalus Bubalis (Buffalo) Horn. In addition, rheological characterizations of viscosupplement alternatives with keratin were performed. Apparent differences in rheological properties of different viscosupplements were observed. The results suggested that the addition of keratin to viscosupplement led to the increase in viscosity.

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Preparation of Novel Double Molecular Imprinted Nanoparticles for Investigation to Adsorption of Salmeterol Xinafoate and Fluticasone Propionate

Esra FEYZİOĞLU DEMİR[a,*], Sinan AKGÖL[b]

[a]. *Vocational School of Health Services, Department of Medical Laboratory Techniques, Izmir University of Economics, Izmir, Turkey*
b. Faculty of Science, Department of Biochemistry, Ege University, Izmir, Turkey
**E-mail: esraa.feyzioglu@gmail.com*

Nanoparticles, especially polymeric nanoparticles, have generated great interest in recent years because of their properties [1]. Nanoparticles can be formed in different methods and molecular imprinted method is one of these alternative methods for synthesis of nanoparticles [2]. Molecular imprinted technology is the process of synthesizing polymers containing binding sites that recognize target molecules specifically. Recently, different imprinting strategies have been used and one of these strategies is the multi-template imprinting strategy (double imprinting). In this method, polymer has multiple types of recognition sites, because there are several target molecules as templates. This technique also allows different classes of species to be extracted, separated, detected, and analysed with one polymeric material [3].

In this study, salmeterol xinafoate (SAM; β2 adrenergic receptors agonists) and fluticasone propionate (FLU; corticosteroids) were chosen as a model drugs because of combination of these are used in the treatment of respiratory diseases such as asthma and chronic obstructive pulmonary disease (COPD). The novel double molecular imprinted nanoparticles (DMIP nanoparticles) containing SAM and FLU drugs were prepared and their usability in adsorption of these drugs was investigated. For this purpose, SAM and FLU imprinted poly(2-hydroxyethyl methacrylate-N-methacryloyl-(L)-alanine-N-methacryloyl-(L)-histidine) [p(HEMA-MAAL-MAH)] nanoparticles were synthesized by surfactant-free emulsion polymerization method. After the synthesis, SEM, FTIR, SPM, Zeta size analysis were performed, and specific surface areas were calculated. Adsorption conditions were optimized, and the adsorption kinetics parameters were also calculated. The maximum adsorption values of SAM and FLU on the DMIP nanoparticles having a surface area of 1055.00 m^2/g at a mean size of 231.8 nm were found as 537.64 mg/g and 393.32 mg/g respectively. In the selectivity experiments, budesonide (BS) and formoterol fumarate (FF) drugs were used as competitive drugs. According to these results, these novel development DMIP nanoparticles have the potential for use in many different areas, for purposes such as drug release, separation, and purification.

Keywords: Double molecular imprinted nanoparticles, salmeterol xinafoate, fluticasone propionate, adsorption study.

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The Effect of Oxygen Pulsing Duration on Target Poisoning for Memristor Applications

Melik Gul[a], **Hasan Efeoglu**[a,b]

[a]Department of Nanoscience and Nanoengineering, Atatürk University, Erzurum 25240, Turkey
[b]Department of Electrical & Electronics Engineering, Atatürk University, Erzurum 25240, Turkey

Reactive sputter has an application for metal oxide thin film growth, which used mainly in electronics. One of the emerging application is the use of metal oxide layer as an active material for memristor device development. DC and RF power sources used for metal and metal oxide targets. In both of the application one of the limitation is the target poisoning which lower down the film growth rate well below 0.01 A/sec. The reason of that is the sputter rate limited by the target oxidation rate. One of the solution is the use high power impulse magnetron (HiPIMS) source. Experiments show that, even HiPIMS do not solve the problem. Functionality of a memristor require non stokiyometric inter layer. This is might be achieved by oxygen pulsing by choosing oxygen pulse duration and pulse period. In this study real time integrated plasma emission lines for argon at 809-813 nm, for oxygen at 775,9-778 nm and for titanium at 515,4-523 nm ranges used for plasma behaviour during the oxygen pulsing. Purging oxygen into the chamber modulated which as we found modulation and frequency and pulse duration significantly effects the growth rates of TiO_2 thin films. In addition, plasma intensity belongs to each element have a strong dependence to partial pressure change of oxygen. As period of oxygen increased from 2 sec to 9 sec, ionised Ti intensity increases which indication of target poising gets much less effective. Because of that, TiO_2 growth rate increased up to 0.7 A/sec.

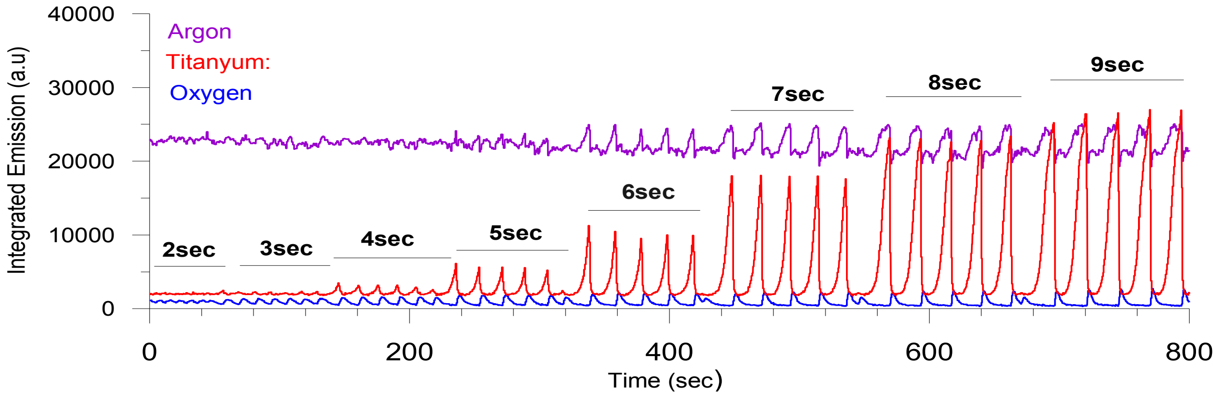

Fig.1 Certain emission line intensities of argon, titanium and oxygen as a function of oxygen pulse period. Five pulse sampled for each period.

Keywords: Memristor, TiO_2, Oxygen pulse, HiPIMS

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The Effect of Target Pulse Count on The Wear Properties of Copper Oxide Doped Hydroxyapatite Thin Film Layer Formed By Pulsed Laser Deposition

Yenal Vangolu

Atatürk University, Faculty of Engineering, Department of Metallurgical and Materials Engineering, Erzurum-TURKEY

yvangolu@atauni.edu.tr

Abstract

Although austenitic 316L stainless steel has good corrosion resistance due to its Cr, Ni, Mo and Mn content, it often tends to corrode in the aggressive environment in the body during long-term and even in short-term implantations. As a result, the implant becomes unfunctional and secondary operations are needed. In addition, 316L is bioinert which means it does not have tissue-implant interaction. Considering all these factors a surface modification is important to achieve the above-mentioned properties and to improve the antibacterial properties. Scientists have been working for many years to improve osseointegration and reduce bacterial growth on the surfaces of biomaterials. Copper oxide doped hydroxyapatite coating is among those promising methods. In this method, as copper oxide adds antibacterial properties to the surface, hydroxyapatite is used to ensure the increase in osseointegration. In this study, a copper oxide-containing hydroxyapatite (HA/CuO) thin film layer was formed on the surface of 316L stainless steel material by using the pulsed laser deposition (PLD) method. The pulse count of HA was set to a constant value (1000), where the pulse count of CuO was variant (100-1000). Sliding wear behaviours of untreated and coated samples were comparatively investigated to find the effect of the target pulse count. The coated samples were named C-100 and C-1000 according to the pulse count they were subjected to. Structural characterizations were examined by scanning electron microscope (SEM), X-ray diffraction (XRD) and profilometer. As a result, a thin and dense CuO containing HA layer with high adhesion was successfully formed on the 316L base material on both C-100 and C-1000. The hardness of the untreated sample, which was 168 HV0.1, increased to 182 HV0.1 on C-100 and 195 HV0.1 on C-1000 after coating. The wear properties were enhanced on both coated samples compared to untreated 316L. The average friction coefficient of C-100 and C-1000 were 0.194±0.1 and 0.149±0.12 respectively, while that of the untreated sample was 0.735±0.016. The wear rate ($4.0821x10^{-4}$) has decreased by 2.4 times on C-100 ($1.7270x10^{-4}$) and 8.7 times on C-1000 ($4.7101x10^{-5}$) and a much more resistant surface has been obtained. The best wear resistance was obtained from the samples deposited with 1000 pulse counts (C-1000). It is thought that this method could be a good alternative for enhancing bioactivity and anti-bacterial properties. Thus, it is considered that *in vivo* studies should be done in terms of investigating the use of this method and coating in biomaterials.

PREPARATION OF BITUMINOUS CALCAREOUS AGGREGATE HOT MIXES (HMA) CONTAINING ORGANO-CLAY USING AN INNOVATIVE GRADATION DESIGN

A.Gürses and T.B.Barın

Atatürk University, K.K. Education Faculty, Department of Chemistry, 25240 Erzurum Turkey

ahmetgu@yahoo.com

This study aims to prepare organo-clay-containing bituminous calcareous aggregate hot mixes (HMA) using a new gradation design. For this, firstly, dispersion of long-chain hydrocarbon material was prepared using a cationic surfactant, Cetyl trimethyl ammonium bromide, CTAB, and by adding Na-Montmorillonite (MMT) to this dispersion, organo-clay (OMM) was prepared by the solution-intercalation method. The prepared organoclay was characterized by XRD diffractogram and HRTEM images. Bituminous hot mixes were prepared in a special gradation taking into account the organo-clay, OMM, contribution, and their stability and various volumetric parameters were investigated as a function of different bitumen ratios. From the HRTEM images of HMAs prepared in three different bitumen ratios, it was determined that the organo-clay layers were exfoliated in the bitumen matrix, and the best dispersion appeared in the sample of 6.0%.

The mechanical properties and volumetric parameters of bituminous mixtures containing organoclay prepared with the original gradation design were compared with conventional hot asphalt mixture (HMA) and stone mastic asphalt (SMA). It has been determined that the bituminous calcareous hot mixtures prepared with a gradation design in which organo-clay is used instead of traditional fillers exhibit quite superior properties.

Preparation of Long-Tailed CTA$^+$ Ions Modified Montmorillonite-Polystyrene Nanocomposites (MMPS) and Investigation of Their Thermal and Mechanical Properties

Ahmet Gürses[a] and Kübra Güneş[a]

[a] *Ataturk University, K.K. Education Faculty, Department of Chemistry Education, Erzurum, Turkey*

kgunes@atauni.edu.tr

Polymer nanocomposites have significantly taken lots of attention over the last decade. The reason of this attention is thanks to the substantial improvements in thermal and mechanical properties of these composites which is obtained even with a small addition of clay, compared to conventional composites [1]. As the clay platelets are exfoliated and randomly dispersed in the polymer matrix, the enhancements of the properties such as higher modulus, increased thermal stability and flame retardancy, and more efficient gas barrier are maximized [2]. Polystyrene (PS) is a commodity polymer that is used in a number of commercial products microns [3]. It is a very appropriate and functional manufacturing material and, a strong plastic which can be easily injected, blow molded or extruded. Polystyrene -clay nanocomposites have been produced in different ways: direct melt intercalation [4], in-situ polymerization [5] and solution blending method [6].

This study aims to prepare nanocomposites of organo clay and polystyrene by melt intercalation method and to investigate their mechanical and thermal properties. Organo-clay was synthesized by solution intercalation method using aqueous dispersions of a long-chain hydrocarbon dispersed in aqueous medium by cetyltrimethylammonium bromide (CTAB) as a surfactant, with montmorillonite clay. The structural, thermal and mechanical properties of the nanocomposites were also investigated as a function of the content of organo-clay. The organo-clay and the PCNs synthesized were characterized via XRD, HRTEM, FTIR and DSC techniques. The XRD patterns and HRTEM images show that in the both cases, the organo-clay platelets have predominantly dispersed as tactoids (stacks of parallel clay platelets at about 100 nm separation) and also partialy exfoliated into polymer matrix. It was also found that the mechanical and thermal properties of the nanocomposites were significantly improved compared with pure polymer. The presence of the infrared bands of CTAB-montmorillonite in the PS/montmorillonite nanocomposite indicates that the clay tactoids was transformed into fine particles and dispersed homogeneously in the PS matrix. DSC results also show that glass transition temperature and the thermal stability of the synthesized composites are higher than those of the pure polymer and other composites.

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Synthesis, Characterization and Electrochemical Performance of ZnO Coated on Nanostructured Copper Foam for Rechargeable Zn-Ni Battery

Taşkın Çamurcu[a], Duygu Akyüz[a], Erhan Demirbas[a*]

[a]*Gebze Technical University, Department of Chemistry, Gebze, Kocaeli 41400, Turkey*

tcamurcu2018@gtu.edu.tr

Zn-based rechargeable batteries are considered as a good alternative to widely used li-ion batteries due to their unique features such as low cost, eco-friendly and high theoretical capacity (820 mA h g^{-1} or 5854 mA h cm^{-3}) (1). However, Zn-based rechargeable batteries are limited due to the low operating voltage and instability of the cathode materials, and the four main problems (dendrite growth, corrosion, passivation and deformation) occurring on the Zn anode electrode. In this study, it is aimed to reduce the above problems that affect the battery life and operating performance of Zn anode electrode. For this purpose, 3-dimensional (3D) copper current collector foam (CuF) with nano-structure was synthesized by the dynamic hydrogen bubble template (DHBT) method (2). Then, ZnO film synthesis was carried out on produced foam by electrochemical technique to obtain CuF/ZnO electrode. The 3D porous structure of CuF increased the electrically active area and minimized the local current density, thus preventing the formation of zinc dendrite (3). During the battery charge-discharge, Zn material could be well controlled and confined within the 3D foam hole, which prevented deformation of the anode electrode surface. CuF and CuF/ZnO electrodes were characterized by BET, XRD, SEM and XPS. In addition, CV, LSV, TAFEL and EIS analyses were used to examine their electrochemical properties. Battery performance tests such as charge-discharge cycle capacity measurement were carried out in a battery cell formed by NiOOH cathode and CuF/ZnO anode. According to battery performance measurements, CuF/ZnO anode has the potential to be used as anode in Zn-Ni battery.

Keywords: Zn-Ni batteries; Copper foam; Nanostructure; Anode

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The Electrical Analysis Of n-ZnSe/p-SiNW Devices Depending On Different Nanowire Length

Emre Coskun[a], Cansu. Emir[b] and Mehmet Parlak[c,d]

a Department of Physics, Canakkale Onsekiz Mart University, 17100, Canakkale, Turkey

b Department of Electrical and Electronics Engineering, Atilim University, 06836, Ankara, Turkey

c Department of Physics, Middle East Technical University (METU), Ankara, 06800, Turkey

d Center for Solar Energy Research and Applications (GUNAM), METU, Ankara, 06800, Turkey

ecoskun@comu.edu.tr

The semiconductor nanowire (NW) technology is raised attention considering one-dimensional geometry as a solution of lattice mismatch in the fabricated heterostructures. In this study, the length effect of the nanowires on device properties of n-ZnSe/p-SiNW heterojunction was investigated, and the result was shown. SiNWs substrates were produced by the metal-assisted etching method using silver nitrate (AgNO3, 99.5%) and hydrofluoric acid (HF, 38-40%) at the molar ratio of 4.6M: 0.02M, in-room temperature for 15, 30, and 45 minutes. ZnSe film was deposited on SiNWs substrates by thermal evaporation of elemental sources. The optical bandgap of the deposited ZnSe film is 2.7 eV, in good agreement with the literature [1]. The diode parameter results indicate that when the nanowire length increases, the diode parameter results in less valuable. The optimum size for SiNW could select for more beneficial optoelectronic devices.

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Development of Nanosensor by Electrochemical Method Using Sodium Doped Iron Oxide Films

Sümeyra GÜNDÜZ[a], Harun GÜNEY[b], Hayrunnisa NADAROGLU[a,c], Azize ALAYLI[d], Omer COBAN[e]

[a]Department of Nano-Science and Nano-Engineering, Institute of Science, Ataturk University, 25240 Erzurum, Turkey

[b]Department of Electrical and Electronic Engineering, Faculty of Engineering, Ataturk University, 25240 Erzurum,Turkey

[c]Department of Food Technology, Vocational College of Technical Sciences, Ataturk University, 25240 Erzurum,Turkey

[d]Department of Nursing, Faculty of Health Sciences, Sakarya University of Applied Sciences, 54187 Sakarya,Turkey

[e]Department of Electrical and Electronic Engineering, Faculty of Engineering, Ataturk University, 25240 Erzurum,Turkey

(E-mail: sumeyra_gunduz@outlook.com)

In recent years, sensors have been extensively researched, and developments in microelectronics and the discovery of the extraordinary sensitive response capacity of biological molecules have led to the rapid development of sensor technologies (1). In sensor applications, the use of electrochemical sensors based on nano-structured metal oxides (NMOs) offers numerous potential benefits and significantly increases the sensitivity of the system (2).

In this study, the synthesis of undoped and Na-doped nano-structured $FeCl_2$ nano-composite thin films produced by SILAR (sequential ionic layer adsorption and reaction) technique was investigated. Then, X-ray diffraction (XRD), scanning electron microscopy (SEM), EDAX, UV-Vis spectrophotometer and current-time (I-T) measurements were performed for sensor characterization and optimization. For both undoped and doped $FeCl_2$ nanoparticles, the pH in the range of pH: 9.5-11.5, detailed research was carried out and the pH with the best conductivity was selected. Experiments will be made in different voltage ranges in current-time measurement and the current with the best result was preferred. It was investigated whether the structural properties of $FeCl_2$ films are affected by doping, and in which direction doping with alkali metals such as sodium affects the conductivity and sensitivity of the sensors. In the study, detailed research was carried out on weight measurement, crystal structure and conductivity. The use of the sensor as a detector, which was synthesized by looking at the resistance change of different samples with the electrochemical amphoremetric method, was investigated. The simultaneous use of the advantages of nanostructures and electrochemical techniques may lead to the emergence of nanosensors with high sensitivity and separation power, and the detector thus obtained will have qualities that can be used in many areas for environmental protection and analysis.

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Determination of Trypan Blue Azo Dyestuff by Developing Nanosensor with Electrochemical Method in Different Samples

Sümeyra GUNDUZ[a], Hayrunnisa NADAROGLU[a,b], Mehmet ERTUGRUL[c], Azize ALAYLI[d], Hilal Kübra SAGLAM[e]

[a]*Department of Nano-Science and Nano-Engineering, Institute of Science, Ataturk University, 25240 Erzurum, Turkey*
[b]*Department of Food Technology, Vocational College of Technical Sciences, Ataturk University, 25240 Erzurum,Turkey*
[c]*Department of Electrical and Electronic Engineering, Faculty of Engineering, Ataturk University, 25240 Erzurum,Turkey*
[d]*Department of Nursing, Faculty of Health Sciences, Sakarya University of Applied Sciences, 54187 Sakarya, Turkey*
[e]*Department of Electricity and Energy, Vocational College of Technical Sciences, Ataturk University, 25240 Erzurum, Turkey*

(E-mail: sumeyra_gunduz@outlook.com)

Trypan blue, one of the azo dyestuffs, is used in the food and textile industry. The use of chemicals is inevitable to give the product the desired properties. The use of azo dyes, which is a chemical substance, also necessitates the determination of limit values that will not harm human health. The toxins of azo dyes attract worldwide attention due to their serious threats to food safety and human health. Therefore, it is extremely necessary and urgent to develop a low-cost and suitable method to detect these azo dye-containing toxins. With the rapid progress in nanosensor processes, electrochemical sensors are developed and new approaches are offered to address this issue. In addition to their low cost, portability, ease of use, high efficiency and high bioactivity, electrochemical sensors have great potential to realize rapid in situ detection of trypan blue azo dye(1,2). In this study, $FeCl_2$ nano-composite thin films produced by sequential ionic layer adsorption and reaction technique (SILAR) were synthesized and a new nano-sensor was developed for rapid detection of Trypan blue dye by electrochemical amperometric method. In the study, parameters related to weight measurement, crystal structure and conductivity were investigated. The use of the sensor as a detector, which was synthesized by looking at the change in resistance of the trypan blue azo dye with the electrochemical amphoremetric method, was investigated. The use of nano-materials together with the recent developments in sensor technology, nano-sensors applied for rapid detection in the field expects to play an important role for food safety and textile industry in the near future. Finally, the suitability of the nanosensor developed for the trypan blue azo dye will be discussed.

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Synthesis and Characterization of Graphene-derived Graphene Aerogel

Meryem Samancı [a], Ayşe Bayrakçeken Yurtcan [a,b]

[a] *Atatürk University, Faculty of Engineering, Department of Chemical Engineering, Erzurum, 25240, Turkey*

[b] *Atatürk University, Department of Nanoscience and Nanoengineering, Erzurum, 25240, Turkey*

meryemsamanci@gmail.com

Abstract Graphene and graphene-derived aerogels are used in many applications in energy materials due to their unique electrochemical and physicochemical properties. In this study, three-dimensional (3D) graphene aerogel synthesis was carried out by sol-gel method by using commercial two-dimensional (2D) graphene. It is intended to be used as electrode support material in PEM fuel cells. In addition, Pt nanoparticles were formed over this support material via supercritical deposition technique.

Keywords*: *Graphene, Graphene Aerogel, Sol-gel Method, Supercritical deposition

Introduction Due to their unique electrochemical and physicochemical properties, graphene and graphene aerogels have the desired functionality as electrode support material in most fuel cells types, especially in PEM fuel cells. In this study, three different 3D graphene aerogels were synthesized by sol-gel method (1) by using commercial 2D graphene. Structural comparison of these synthesized aerogels with commercial graphene and graphene-free carbon aerogels was made. Then, Pt catalyst synthesis was performed on these electrode support materials via supercritical carbo dioxide deposition technique (2) by using platinum(II) acetylacetonate as Pt source. At the same time, it is aimed to control the loading amount of platinum, which is a precious metal and used as catalyst, on the support material surface in a less and homogeneous way. In this way, it is aimed to reduce the catalyst cost and increase its mechanical strength.

Results and Discussion For the synthesis of carbon and graphene aerogel, purified water, resorcinol (99%, $C_6H_4(OH)_2$), formaldehyde (34.5%, CH_2O), sodium carbonate (99%, Na_2CO_3) and commercial graphene (XG Sciences) were mixed in the amounts specified in Table 1. In carbon aerogel synthesis, the sol solution was placed in a glass tube and kept at room temperature for 24 h, kept at 50 ^{0}C for 24 h and at 90 ^{0}C for 72 h. In the synthesis of graphene aerogel, the commercial graphene was put in the sol solution with the weight percentages given in the Table 1 mixed at 35 ^{0}C for 6 h before putting it into the glass tube. Then, both aerogels were kept in an oven at 50 ^{0}C for 24 h and at 90 ^{0}C for 72 h. The aerogels were removed from the tube and placed in acetone. It was kept in acetone for 48 h. In order to obtain RF aerogel, the samples placed in the high pressure reactor were extracted with supercritical carbon dioxide ($SCCO_2$) at a temperature of 50 ^{0}C and a pressure of 2000 psi in the reactor. Carbon and graphene aerogels were synthesized by pyrolysis of RF aerogels in a pyrolysis furnace at 1000 ^{0}C in nitrogen (N_2) environment and 15 °C/min heating rate for 4 h.

Tablo 1. Concentrations of reactants used in aerogel synthesis

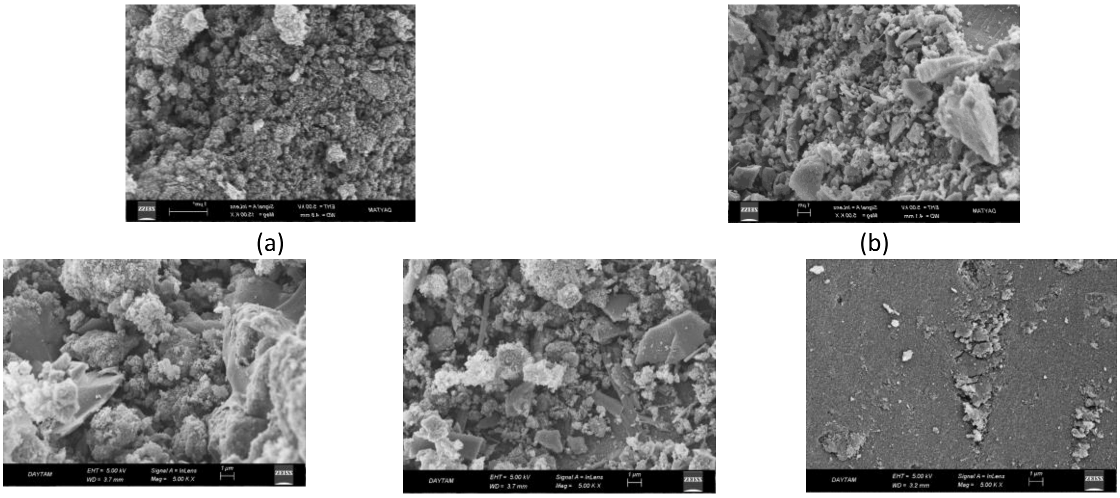
Label	**Material**	**Resorcinol / Formaldehyde molar ratio (R/F)**	**Resorcinol / Water molar ratio (R/W)**	**Resorcinol / Catalyst molar ratio (R/C)**	**Graphene weight percentages (%)**
CA	Carbon aerogel	0,5	0,02	100	0
G	Commercial graphene	-	-	-	100
GA1	Graphene aerogel 1	0,5	0,02	100	0,25
GA2	Graphene aerogel 2	0,5	0,02	100	0,5
GA3	Graphene aerogel 3	0,5	0,02	100	1

The Pt reduction process on the support material was carried out using the supercritical carbon dioxide deposition method. Reduction of Pt on the support material was carried out using platinum (II) acetylacetonate (97%, $Pt(acac)_2$) as platinum source. The catalyst synthesis consists of two steps firstly adsorption of Pt source and then thermal reduction of Pt source to metallic Pt. First of all, the support material and Pt precursor are mixed at a ratio of 1:1 and placed in the reactor. It was kept in $SCCO_2$ medium for 24 h at 50 ^{0}C and 3500 psi. After the adsorption process, thermal reduction was carried out in N_2 environment at 500 ^{0}C for 2 h. Thus, Pt was converted to the metallic form.

Table 2. BET results for synthesized materials

Material	**BET surface area (m^2/g)**	**Average pore diameter (nm)**	**Langmuir surface area (m^2/g)**	**t-Plot Micro pore area (m^2/g)**	**Average particle size (nm)**	**BJH surface area (m^2/g)**	**D-H surface area (m^2/g)**	**BJH pore volume (cm^3/g)**	**D-H pore volume (cm^3/g)**
CA	202,86	2,91	427,43	115,72	29,58	90,78	87,97	0,108	0,106
GR	710,34	5,63	2161,67	113,57	8,45	552,1	534,96	1,189	1,176
GA 1	172,16	4,38	419,41	94,83	34,85	64,51	63,21	0,193	0,191
GA 2	185,43	3,91	448,17	118,09	32,36	63,39	61,49	0,158	0,156
GA 3	471,88	4,46	1210,53	250,09	12,72	223,54	221,09	0,44	0,435

Micromeritics 3Flex 3-port BET device was used to examine the morphological structures of the support materials. Scanning electron microscope (SEM-Zeiss Sigma 300) was used to obtain information about topography. Inductively Coupled Plasma-Mass Spectrometer (ICP-MS (Agilent 7800) was used to determine the amount of Pt in the synthesized Pt catalysts.



(a) (b)

(c) (d) (e)

Figure 1. SEM images of synthesized support materials, a) graphene, b) carbon aerogel, c) GA1, d) GA2, e) GA3

The BET surface area results of the synthesized materials are given in Table 2. Looking at the results, it was observed that the surface area increased, respectively, as the amount of graphene added into the carbon aerogel structure increased. Among the graphene aerogels, the highest surface area belongs to GA3 with 471.88 m^2/g.

SEM images of the synthesized support materials are given in Figure 1. When we look at the SEM images, the formation of three-dimensional (3D) particles was observed in the graphene aerogel structures.

ICP-MS results of Pt catalysts prepared using supercritical deposition technique are given in the Table 3. Among the graphene aerogels, the highest Pt loading belongs to GA2.

Table 3. ICP-MS results of Pt catalysts

Catalyst	**ICM-MS (w/w) %Pt**
Pt / G	30.1
Pt / CA	16.8
Pt / GA1	16.1
Pt / GA2	22.9
Pt / GA3	6.3

The synthesized catalysts will be used as cathode electrodes in PEM fuel cells. The effect of structural changes on fuel cell performance will be examined.

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Effect of Ramelteon Bioconjugated CdS Quantum Dots on Cancer Lines: An In Vitro Study

Özge Balpınar[a], Hayrunnisa Nadaroğlu[b], Ahmet Hacımüftüoğlu[c]
[a] Ondokuz Mayıs University, Faculty of Medicine, Departmant of Medical Pharmacology, 55200, Samsun, Turkey
[b] Department of Food Technology, Erzurum Vocational College, Ataturk University, 25240 Erzurum, Turkey
[c] Ataturk University, Faculty of Medicine, Department of Medical Pharmacology, 25240 Erzurum, Turkey
ozge.balpinar@omu.edu.tr

Melatonin has a role in many physiological processes, especially in the regulation of circadian rhythm. Quantum dots, which are frequently encountered in previous studies, have been shown to be much more effective both in vitro and in vivo when used with drugs targeting cancer cells. In this study, it was aimed to bioconjugate the active ingredient of melatonin agonist ramelteon to quantum dots, thereby increasing the effectiveness of the drug on cancer lines. It was determined that the synthesized quantum dots and bioconjugated nanostructures were synthesized correctly by SEM, TEM, FTIR and XRD analyzes. As a result of SEM and TEM analyzes, it was observed that cadmium sulfide quantum dots and bioconjugates exhibited a spherical shape and circular character. XRD crystallography revealed that cadmium sulfide quantum dots and bioconjugates are in hexagonal crystal structure. Findings obtained by FT-IR spectroscopy indicate that the synthesized materials are targeted nanostructures.

The anticancer effect of melatonin has been proven by many epidemiological studies. Quantum dots, on the other hand, are particles that are generally smaller than 10 nm and have a low toxic effect. The aim of this study is to test the melatonin hormone and agonist on cancer lines by combining them with quantum dots, which have the ability to increase their effectiveness.

Cadmium sulfide quantum dots were synthesized with Punica granatum extract using the green synthesis method as in the previous study. The synthesized quantum dots and bioconjugates were characterized by advanced spectrophotometric methods. SEM, TEM, XRD, FTIR analyzes were performed for the characterization of nanomaterials. At the same time, the effect of related quantum dots and bioconjugated materials on cancer cell viability was also tested with the MTT cytotoxicity test. In SEM and TEM images, it has been determined that quantum dots are structures within nanotechnological boundaries in terms of shape, size and formation. Images of CdS quantum dots similar to those obtained by different researchers in the literature were obtained. Spectra at wavelengths of 3350, 2950, 1590, 1400, 1090 and 970 cm^{-1} were seen in the FTIR spectrum of CdS quantum dots. The obtained peaks, the frequency fluctuations observed in the spectrum and the functional groups indicated by these spectra reveal that a product containing pure CdS quantum dot is obtained [1]. In the study, X-ray crystallography (XRD) was used to determine the crystal forms of quantum dots. Considering the plane data exhibited by the obtained CdS quantum dot, it is understood that the CdS quantum dots have a hexagonal crystal structure [2]. According to MTT results, it was determined that CdS quantum dots showed more effective results in reducing the viability of colon cancer cells.

Acknowledgement: This study was supported by Atatürk University BAP Project numbered 7401.

Keywords: *Quantum dots, cancer, green synthesis*

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Ag Dopant Effect On CuO Thin Films Grown By Spray Pyrolysis Method

Demet İSKENDEROĞLU[a], Harun GÜNEY[b], Sibel Morkoç KARADENİZ[c], Muhammed Emin GÜLDÜREN[d]

[a]*Kazım Karabekir Education Faculty, Department of Science Education, Atatürk University, Erzurum, Turkey*

[b]*Hınıs Vocational School, Department of Medical Services and Techniques, Atatürk University, Erzurum, Turkey*

[c]*Department of Physics, Art & Science Faculty, Erzincan Binali Yıldırım University, Erzincan, Turkey*

[d]*Vocational School, Department of Electric and Energy, Ağrı İbrahim Çeçen University, Ağrı, Turkey*

demettatar@atauni.edu.tr

In this study, Ag dopant effect on CuO thin films was carried out by spray pyrolysis method on glass substrate. The structural, morphological and optical effects of Ag dopant on CuO samples grown by spray pyrolysis method were investigated. The structural properties of the samples were examined by X-ray diffraction (XRD), morphological properties by scanning electron microscopy (SEM) and optical properties by UV–Vis spectroscopy.

XRD measurements show that the peaks of the samples shifted, and their intensities changed with the Ag dopant. SEM photographs of the samples show that CuO surfaces changed with the Ag dopant. Absorption measurements show that the band gaps of the samples changed with the doping of Ag.

Growth And Characterization Of FeO Thin Films Grawn By Spray Pyrolysis Method

Demet İSKENDEROĞLU[a], Harun GÜNEY[b], Sibel Morkoç KARADENİZ[c], Muhammed Emin GÜLDÜREN[d]

[a]Kazım Karabekir Education Faculty, Department of Science Education, Atatürk University, Erzurum, Turkey

[b]Hınıs Vocational School, Department of Medical Services and Techniques, Atatürk University, Erzurum, Turkey

[c]Department of Physics, Art & Science Faculty, Erzincan Binali Yıldırım University, Erzincan, Turkey

[d]Vocational School, Department of Electric and Energy, Ağrı İbrahim Çeçen University, Ağrı, Turkey

demettatar@atauni.edu.tr

FeO thin films was carried out by spray pyrolysis method on glass substrate. The growth of the samples was investigated by changing the base temperature at grown, these temperatures how affected the structural, morphological, and optical effects of FeO thin films. The structural properties of the samples were examined by X-ray diffraction (XRD), morphological properties by scanning electron microscopy (SEM) and optical properties by UV–Vis spectroscopy.

It was observed that XRD peaks with the effect of temperature on the samples. It was observed from the SEM photographs that there were changes on the surfaces of the samples with the effect of temperature. The absorption measurements showed that the temperature also affects the optical properties and affects the variation of the band gaps of the samples.

The Effect of Nb/ Zr Target Voltage on Mechanical Properties TiBCN Based Films Deposited by CFUBMS- HiPIMS

Ihsan EFEOGLU[a], Nuriye AKSAKALLI[a], Berkay GUMUS[b], Evren TAN[b]

[a]*Atatürk University, Faculty of Engineering, Erzurum, Turkey*
[b] *ASELSAN A.Ş., Ankara, Turkey*

nuriye.aksakalli12@ogr.atauni.edu.tr

Abstract

The surface properties of machine elements such as gears, bearings and shafts that are in contact with each other, move relative to each other and operate in different conditions can be made functional. Carbonitride based coatings; Due to their high hardness, adhesion, wear, oxidation and corrosion resistance, they can improve the surface properties in order to increase the performance and life of the machine elements. In this study, Zr and Nb transition element doped TiBCN-based coatings were synthesized on 4140 tool steel by using CFUBMS-HiPIMS as hybrid PVD technology to develop thin film coatings suitable for operating and environmental conditions especially for defense system sub-elements. With the hybrid use of pulsed-dc and HiPIMS power supplies, coatings with dense microstructure and high adhesion were obtained. Cr, Ti, TiB_2, Nb, Zr targets and Ar_2, N_2, C_2H_2 gases were used in the coating. While SEM, XRD and XPS were used to determine the microstructural properties of TiBCN based coatings, Microhardness and Scratch test devices were used to determine the mechanical properties. In the coatings synthesized with the Taguchi experimental design, the hardness and adhesion values of the TiBCN based coatings, which were grown by adding Zr and Nb, respectively, on the Cr:CrN graded coating as the transition layer, changed according to the applied target voltage. With the increase of the applied target voltage, an increase in adhesion values and a decrease in hardness values were observed.

Keywords: *TiBCN:Zr/Nb, Adhesion, Microhardness, CFUBMS-HiPIMS*

Introduction

Nanostructured thin film coatings containing nitrides, carbides and borides of transition metals provide functional properties with high adhesion and hardness values with amorphous matrix (1). The hybrid use of HiPIMS (High Power Impulse Magnetron Sputtering) power supplies with a target current density of 1000 mA/cm^2 with the closed field unbalanced magnetic field sputtering (CFUBMS) coating technique, which is one of the Physical Vapor Deposition (PVD) techniques, has revealed significant technological advantages (2). Within the scope of this research, the mechanical properties were investigated by adding Nb and Zr transition elements to TiBCN based coatings whose process parameters were determined by Taguchi experimental design. TiBCN-Nb/Zr graded nanocomposite thin film coatings were synthesized using CFUBMS:HiPIMS+Pulsed-dc on 4140 steel (6GPa) and silicon substrate.

Results and Discussion

Process Teer Coating Ltd. CFUBMS produced by HiPIMS (IONAUTICS-Hipster 6) was used to synthesize the coatings. Cr, Ti, TiB_2, Nb and Zr targets were used to as target materials. Thin film coatings were synthesized by applying HiPIMS power supply to TiB_2 and Nb/Zr targets and Pulsed -dc to the other two Ti and Cr targets. In addition, Ar, N_2, and C_2H_2 gases were used in the coating process. In the synthesis of TiBCN-Nb/ Zr coatings, Nb / Zr Target voltage is -600V, -700V, -800V, TiB_2 target voltage -800V, base voltage -70V, N_2 amount 3sccm, frequency 500 Hz, duty time 90 µs, working pressure 0.33 Pa values are used (3). While the Cr layer was synthesized by applying 3A current to the Cr target for 10 minutes, the CrN layer was formed by adding 14sccm N_2 flux for 10 minutes. On the top layer, TiCN-Nb/Zr and TiBN-Nb/Zr were applied for a total of 120 minutes (C_2H_2:4sccm used) with the optimum parameters determined by the Taguchi experimental design (3). EI Quanta FEG-450 SEM was used to determine the thickness and microstructural properties of thin films. The crystalline phase and densities of the coatings were determined by the Rigaku DMax-2200 system with an XRD (Cu-Kα: 1.5405 Å) radiation source. The chemical composition and bond structures of the coatings were determined by the electron binding energy (eV) determined by Specs-Flex XPS. Buehler Micromet 2001 (Knoop indenter, 10gf load, 15sec) was used to characterize the microhardness properties of coatings, while Anton Parr (formerly CSM Instrument) Revetest tester (using a Rockwell-C diamond insert with a tip radius of 200µ with a loading speed of 100 N/min and a sliding speed of 10 mm/s) was used to determine the adhesion between the substrate and the coating. All of the TiBCN based Nb and Zr doped nanocomposite thin film coatings coated with the same coating parameters have a very dense and uniform microstructure (see **Fig.1**). When the SEM image is examined, the Cr:CrN layer is clearly seen.

This layer, which is ~200 nm thick, improves the adhesion between the substrate and the coating (4). The thicknesses of TiBCN-Nb coatings (0.521µm, 0.538µm, 0.664µm) were found to be lower than TiBCN-Zr coatings (1.010µm, 1.038µm, 1.228µm). The reason for this can be noted that the sputtering rate of the Nb (80Å/sec) is lower than that of the Zr (85Å/sec). When the XRD graphs were examined TiN, hBN, TiCN phases were formed in both coating types. While the NbN phase is formed in Nb added coatings, the density of the NbN phase increases with the increase in voltage applied to the Nb target. Similarly, while Zr and ZrN phases are formed in coatings with Zr addition, the density of these phases increases with the increase of the voltage applied to the Zr target (5). N1s, B1s and C1s peaks of the coatings were analyzed in XPS plots. When XPS graphs were examined, ZrN, BN, TiN and NbN peaks corresponded to 397.6 eV, 398.1 eV, 397.86 eV, 397.03 eV, respectively. When the N 1s graphs of nanocomposite thin film coatings were examined, Ti (C-N) and BN peaks were obtained at 396.8 eV and 398.1 eV, respectively (6). In addition, NbN peak at 397.4 eV and ZrN peak at 397.6 eV were observed in the N1s graph (7). When the C1s XPS graph of TiBCN-Nb/Zr coatings was examined, Ti (C-N), CN peaks were observed at 284.9 eV and 285.8 eV, respectively (6,8). Approximately 190.5 eV hBN phase was obtained in B 1s XPS plots. (9). From the scratch test results, at the highest voltage values (-800V), the highest critical load value was obtained as 58N in Nb added coatings, and 110N in Zr added coatings. In both coating types, adhesion values increased with increasing voltage applied to Nb and Zr targets. When the TiBCN-Nb/Zr coatings were examined with a microscope, no adhesive, chevron, edge damage and fragmentation were observed (see **Fig.2**). In the literature review, it was seen that the addition of Nb and Zr to the structure increased the adhesion of the coatings, which was in harmony with the results obtained. The increase in adhesion was greater with the addition of Zr than with the addition of Nb (1,10). When the test results were examined, differences in the adhesion values were observed with the change of the voltage values applied to the targets (-600V, -700V, -800V) (see **Fig 3**). At the highest target voltage (-800V) applied to Nb and Zr targets in coatings, the highest adhesion value in TiBCN-Nb coatings is 58N (the lowest hardness is 14GPa), and in TiBCN-Zr coatings it is 110N (the lowest hardness is 12, 5GPa) was obtained at -70 V base voltage applied with a 4.5% duty cycle.

Acknowledgements

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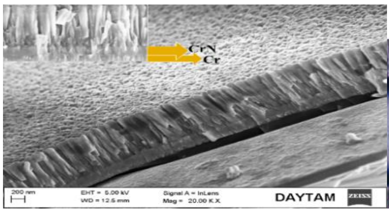

Figure 1. SEM image (3)

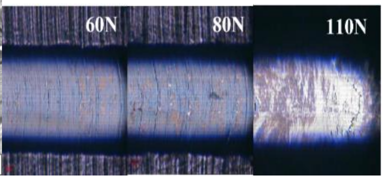

Figure 2. Scratch İmages (3)

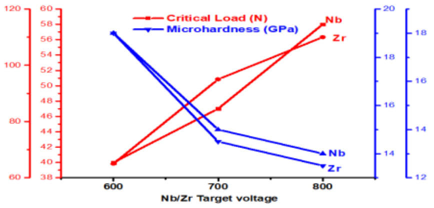

Figure 3. Voltage-dependent results

Alternating Magnetic Field Mediated Heat Inducible Gene Expression System

Melek Acar[a], Kübra Solak[b], Şeyda Yıldız[a], Yağmur Ünver[a], Ahmet Mavi[b,c]

[a]Department of Molecular Biology and Genetics, Faculty of Science, Atatürk University, Erzurum, Turkey
[b]Department of Nanoscience and Nanoengineering, Institute of Science, Atatürk University, Erzurum, Turkey
[c]Department of Chemistry Education, Kazım Karabekir Faculty of Education, Atatürk University, Erzurum, Turkey

melek.acar12@ogr.atauni.edu.tr

Delivering therapeutic proteins to diseased cells through gene transfer and the ability to produce proteins only in the target cell when desired thanks to induction increases the efficacy of the treatment as well as decreasing the undesirable side effects. For this purpose, gene carrier systems that can be induced by pH, light, or temperature are developed. In this study, cloning of a recombinant plasmid containing the promoter region of heat-shock protein (HSP) that can initiate the expression of the gene inserted in its downstream region when the ambient temperature increases, the delivery of this plasmid to mammalian cells via magnetic nanoparticles (MNPs) and induction of the HSP promoter with magnetic hyperthermia were performed.

Green fluorescent protein (GFP) was used as a reporter gene for easy tracking of gene transfer. For this, the CMV promoter in the pCMV-GFP plasmid was replaced with the HSP promoter and pHSP-GFP was obtained. Then, magnetofectins (100 µg/mL MNPs; 5 µg DNA and N:P=2) prepared with pHSP-GFP were applied to MCF-10A cells using a magnet. After overnight incubation, cells were exposed to alternating magnetic field (AMF) for 40 min at 41 °C. As a control group, pCMV-GFP was applied to cells with commercial transfection agent (LyoVec). After 12 or 36 hours of incubation, cells were fixed and GFP expression intensity was examined with a fluorescence microscope.

As a result, it was determined that the heat released from MNPs in cells exposed to AMF induced the heat-inducible promoter to produce GFP. It was observed that 12 hours of incubation was not sufficient for GFP expression after MHT application while GFP expression was increased in cells incubated for 36 hours. Thus, in this study, an alternating magnetic field mediated heat inducible gene expression system was successfully achieved.

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Suggestion a Magnetic Nanoparticle-Mediated Cancer Vaccine for Immunotherapy

Kübra SOLAK[a], Ahmet MAVI[a, b], Ali TAGHIZADEHGHALEHJOUGHI[a, c], Serkan YILDIRIM[d], and Ahmet HACIMÜFTÜOĞLU[e]

a: Department of Nanoscience and Nanoengineering, Institute of Science and Technology, Atatürk University, Erzurum, Turkey

b: Department of Chemistry Education, Mathematics and Science Education, Kazim Karabekir Faculty of Education, Atatürk University, Erzurum, Turkey

c: Department of Veterinary Pharmacology and Toxicology, Faculty of Veterinary Medicine, Atatürk University, Erzurum, Turkey

d: Department of Veterinary Pathology, Faculty of Veterinary Medicine, Atatürk University, Erzurum, Turkey

e: Department of Medical Pharmacology, Karabekir Faculty of Medical School, Atatürk University, Erzurum, Turkey

kubra.solak@ogr.atauni.edu.tr, https://orcid.org/0000-0001-6643-3368

Mammalian cells have sensor systems that detect foreign molecules to create an immune response when the infections reach the cells. These sensor proteins might use to effectively fight cancer. So, the aim of our work is to deliver short DNA into human cells by nanoparticles that may provide the treatment of cancer via sensing pathways in cells.

In this study, Fe_3O_4 magnetic nanoparticles (MNPs) were produced and modified with silica and polyethyleneimine. Short and double-stranded DNA (dsDNA) was combined with MNPs and the construct was sent to cells (MCF-7, MDA-MB-231, and MCF-10A cell lines) by magnetofection for rapid transfection to generate a strong inflammatory signal. The cancer-targeting of this system was achieved by folic acid modification. The cytotoxicity of the suggested MNP-mediated dsDNA vaccine was determined by MTS and apoptosis tests. The amount of interferon in culture media belongs to treated cells was collected to determine by the ELISA.

Eventually, increased cytotoxicity on cancer cells was achieved through the application of DNA vaccine by magnetofection, which is a more effective and rapid delivery method.

Acknowledgement: The authors kindly acknowledge BAP (The Scientific Research Projects Coordination Unit of Atatürk University, FCD-2019-6846) for the financial supports and DAYTAM (Atatürk University, Erzurum, Turkey) for the equipment support. K.S. is also thankful for The Council of Higher Education (CoHE, 100/2000) PhD Scholarship Program, Turkey.

Synthesis of Iron Oxide Nanoparticle with the Green Synthesis Method and Using It as Nano-Fertilizer Content in Growing the Plant

Neslihan BABALI[a], **Azize ALAYLI**[b], **Hayrunnisa NADAROGLU**[c,d], **Taki DEMİR**[a]

[a]*Department of Horticulture, Faculty of Agriculture, Sakarya University of Applied Sciences,* 54580 *Sakarya, Turkey*
[b]*Department of Nursing, Faculty of Health Sciences, Sakarya University of Applied Sciences, 54187 Sakarya,Turkey*
[c]*Department of Food Technology, Vocational College of Technical Sciences, Ataturk University, 25240 Erzurum,Turkey*
[d]*Department of Nano -Science and Nano -Engineering, Institute of Science, Ataturk University, 25240 Erzurum, Turkey*
(E-mail: neslihanb@subu.edu.tr)

Crop farming is a very important research field today. Today, 78% of the plants produced are ornamental plants (1). Faced with famine and environmental problems day by day, the world population has begun to research the rational use of arable land. It is very important to minimize soil pollution caused by excessive fertilization used in this area. In the examinations, it has been seen that the use of nano-fertilizer has many positive properties in terms of crop yield, environmental protection and plant resistance. Chinese Fringe Flower (*Loropetalum chinense*) is an attractive outdoor ornamental plant in the landscape with its tiered branches in spring, drooping and numerous bright pink flowers throughout the year. It grows fast and is highly tolerant of diseases and pests (2,3). In addition, the leaves, flowers and roots of Loropetalum chinense have been proven to have hemostatic, detoxifying, bacteriostatic, anti-inflammatory and antioxidant effects in traditional and modern medicine. In the research to be done, pomegranate fruit extract will be used as the reducing medium of the green synthesis method. After characterizing the nanoiron produced under optimized conditions, its effects on plants will be examined. In order to examine the effects of nanoiron on plant growth, experimental randomized plots will be set up with Chinese Fringe Flower (*Loropetalum chinense*) plant grown under sterile and homogeneous conditions. If the results are positive, it is thought that domestic nano-fertilizer formulation additives with added value for our country can be created and used in the production of different plants, with minimum damage to the environment, to increase agricultural productivity. This research was carried out with the support of the scientific research project (SUBU-BAP: 2021-06-03-044) of Sakarya University of Applied Sciences.

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Effect of 2-(pyren-1-ylmethylene) malononitrile on preparation of copper structures by electrochemical deposition

Fatma Bayrakçeken Nişancı

Faculty of Science, Department of Chemistry, Ataturk University, 25240, Erzurum, Turkey

E-mail fbayrakceken@atauni.edu.tr

Abstract

2-(pyren-1-ylmethylene) malononitrile was synthesized via a condensation reaction. The films that are prepared by the potentiodynamic polymerization of 2-(pyren-1-ylmethylene) malononitrile on indium tin oxide (ITO) exhibits a well-defined reproducible redox behavior in tetrabutylammonium hexafluorophosphate ($TBAPF_6$) in CH_2Cl_2 electrolyte. Copper (Cu) structures were then deposited on the patterns of poly(2-(pyren-1-ylmethylene) malononitrile)/ITO electrochemically with a constant potential and time using a combined electrochemical technique. The electrochemical properties of the obtained polymer films are studied by cyclic voltammetry. Characterizations of the resulting poly(2-(pyren-1-ylmethylene) malononitrile) and poly(2-(pyren-1-ylmethylene) malononitrile)-Cu were performed by atomic force microscopy and scanning electron microscopy. The results show that the shape and density of the Cu deposits on poly(2-(pyrene-1-ylmethylene) malononitrile)-ITO can be controlled depending on electrodeposition time of Cu and the presence of poly(2-(pyrene-1-ylmethylene) malononitrile) used as a template created by electropolymerization on ITO. These controllable nanostructured thin films have an attractive potential for practical applications in nanotechnology.

Keywords**: *Electrochemical polymerization, Molecular imprinting, Pyrene***

Using Iron Nanoparticles as Nano-Fertilizer in Cultivation of Christmas Bery Trees

Neslihan BABALI[a], **Azize ALAYLI**[b], **Taki DEMİR**[a], **Hayrunnisa NADAROGLU**[c,d]

[a]*Department of Horticulture, Faculty of Agriculture, Sakarya University of Applied Sciences,* 54580 *Sakarya, Turkey*
[b]*Department of Nursing, Faculty of Health Sciences, Sakarya University of Applied Sciences, 54187 Sakarya, Turkey*
[c]*Department of Food Technology, Vocational College of Technical Sciences, Ataturk University, 25240 Erzurum, Turkey*
[d]*Department of Nano-Science and Nano-Engineering, Institute of Science, Ataturk University, 25240 Erzurum, Turkey*

(E-mail: neslihanb@subu.edu.tr)

Today, many plant species are cultivated and grown as ornamental plants. Especially the ornamental plants sector has been one of the rapidly developing sectors in recent years. The lands on which crop production is made are being lost day by day due to factors such as erosion, environmental pollution, excessive fertilization and unconscious irrigation. Considering the yield and environmental factors, the use of nano fertilizers in plant cultivation is a very important research topic. Christmas Bery Trees (*Photinia frasserii*) is an evergreen woody ornamental plant that can grow up to 3-5 meters. It is highly preferred in seedlings with its leaf shape, colors and rapid growth feature. It is among the most remarkable ornamental plants thanks to its long, straight and shiny, cold weather resistant and intense red leaves. The economic and environmental value of the species is increasing day by day with its impressive leaves and resistance to adverse environmental conditions (1,2).

In the research to be done, using the green synthesis method, iron nanoparticles will be biologically synthesized using green synthesis method and plant extract with an efficient and one-step environmental method(3). Afterwards, flame trees grown with normal fertilizer will be compared with those grown in tissue culture using nano iron in a controlled manner. In order to examine the effects of nanoparticles on plant growth, experimental plots will be established with Christmas Bery Trees (*Photinia frasserii*) plant grown under aseptic conditions. In line with the results obtained, it is thought that it will be a study that guides and forms the basis for the use of nano-fertilizer in plant growth and reproduction, especially in ornamental plants. This research was carried out with the support of the scientific research project (SUBU-BAP: 2021-06-03-044) of Sakarya University of Applied Sciences.

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Development of Multifunctional Polymer Nanocomposite Scaffolds by 3D Printing for Biomedical Applications

İlknur Kökcü [a], Meltem Eryıldız [b], Sedat Odabaş[c], Mirigül Altan [a]

[a] *Yildiz Technical University, Department of Mechanical Engineering, Istanbul, Turkey*

[b] *Beykent University, Department of Mechanical Engineering, Istanbul, Turkey*

[c] *Ankara University, Department of Chemistry, Ankara, Turkey*

ilknur8941@hotmail.com

Abstract

In recent years, three-dimensional (3d) printers have gained great importance in biomedical applications. Fused deposition modeling (FDM) is one of the 3d printing methods for fabrication hard tissues such as bone or cartilage. However, the lack of biological and mechanical properties of the commercial filaments used in FDM, has brought the demand of new materials. In this study, it was aimed to develop polymer nanocomposite scaffolds by FDM. In this regard, PLA (polylactic acid) and HNT (Halloysite Nanotube) were compounded on a twin screw extruder by melt mixing method within the HNT loadings of 1, 3, 5 wt% and filaments in Φ 1.75 mm were obtained. Additionally, metformin (MET) was loaded to HNT particles via electrostatic interactions. MET in different ratios (500-1000 µg/ml) were incubated with different amount of HNT particles (2-4 mg/ml) for about 18 to 24 hours and optimal amount was determined. PLA and MET loaded HNT filaments were also obtained with the same procedure. Then, polymer nanocomposite scaffolds were obtained by FDM from the fabricated filaments. Compression test was applied to specify the mechanical property of the scaffolds. Finally, it has been seen that compression behavior and drug release performance of the scaffolds were improved.

Keywords: *3d printing, scaffold, halloysite nanotube, drug loading*

Introduction

There are many studies on the production of biodegradable structures from PLA by FDM method for tissue engineering. In the majority of these studies, it has been seen that polymer is reinforced with nano materials (glass sphere, hydroxyapatite, silicate) to increase the mechanical and biological properties of PLA filament [1-7]. Additionally, HNT which can be dispersed very homogeneously in a polymer matrix, is used as reinforcement material with PLA. In addition, due to the tube-shaped structure of HNT and its drug-carrying feature, it also provides targeted drug release in tissue engineering in the repair of traumatic tissues and accelerates the healing process of the patient [8-10]. Regarding HNT in literature, Weisman et al. [11] produced catheters by FDM 3D-printing with antibiotic and chemotherapeutic loaded HNT- PLA filaments. Morever, it is performed by Luo et al. [12] PLA-halloysite nanotubes (HNT) loaded with zinc nanoparticles (PLA + HNT + Zn). In the study of Buffa et al. [13], halloysite nanotube reinforced biocompatible polymer films based on PHVB were developed and used to heal damaged bones. Bugatti et al. [14] PLA reinforcement, and these biocomposites they developed were used for regeneration of damaged human bone. When examining the previous literature, compared to other nano materials, studies on the usage of halloysite nanotubes are quite a few via FDM method. The aim of this study is to produce multi-functional biodegradable polymer composite filament for the fabrication of PLA-HNT hard tissue scaffolds by FDM method.

Materials and Methods

Polylactic acid (PLA) (3001D, Resinex, NatureWorks) based composite filaments were reinforced with halloysite nanotube (HNT) (Sigma-Aldrich). Metformin (MET) was used as a type of drug for loading to HNT particles. MET loaded HNT particles via electrostatic interactions. MET in different ratio (500-1000 µg/ml) were incubated with various amount of HNT particles (2-4 mg/ml) for about 18 to 24 hrs. PLA/HNT composite filament fabrication was carried out in a twin screw extruder (Rondol, UK, L/D:10) Diameter of filament was constant as Φ 1.75 mm throughout the entire filament. Filaments were obtained with HNT loadings of 1, 3, 5 wt%. Scaffolds were fabricated on 3D FDM printer (Prusa i3) as shown in Figure 1 within 50% infill. The dimensions of the compression test samples in Figure 1 (a) are Φ 12 mm in diameter and 24 mm in height. The dimensions of the drug release test samples are Φ 15.6 mm in diameter and 0.5 cm in height in Figure 1 (b).

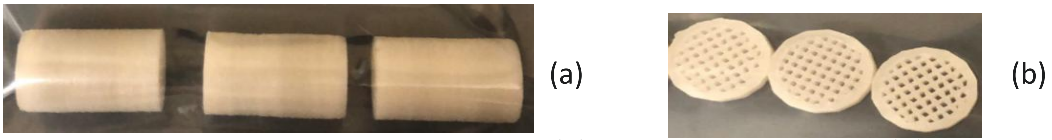


Figure 1. Photograph of fabricated scaffolds (a) compression test and (b) drug release test

Results and Discussion

Scaffolds were produced with PLA/HNT doped filaments. When the compressive strength was examined, maximum compressive stress was obtained respectively 22.5 MPa, 33.1 MPa, 55.2 MPa, 41 MPa for neat PLA, PLA-HNT%1, PLA-HNT%3, PLA-HNT%5 as shown in Figure 2.

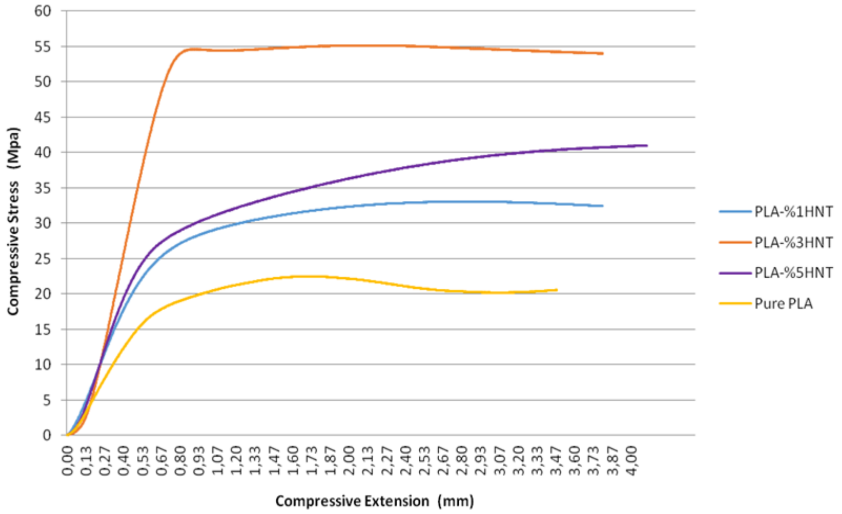
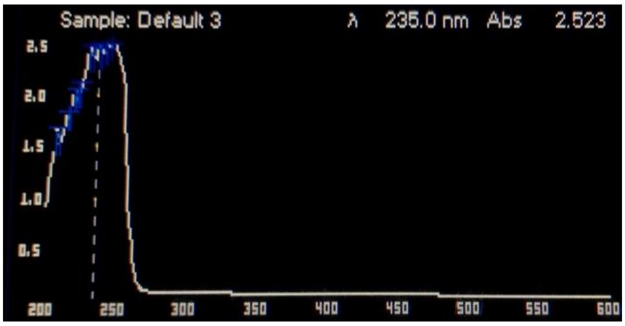


Figure 2. Compression test graphic of fabricated scaffolds

As a result of MET release from scaffold, the amount of released MET at certain time intervals was determined using a UV-vis spectrophotometer at 235 nm based on calibration curve in Figure 3. According to the drug release results at pH 7.4, over 50% of the drug was released by the end of 5 days by weight as shown in Figure 4.



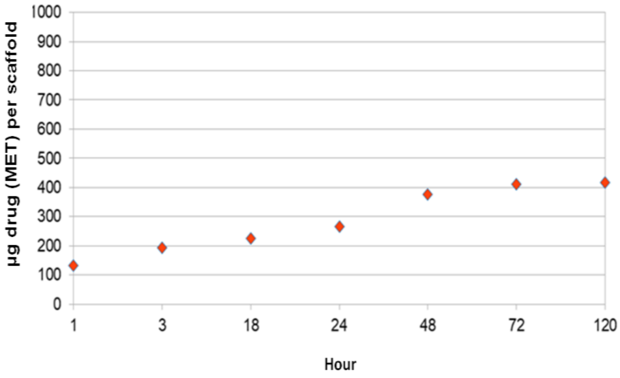


Figure 3. Spectrum scan of MET

Figure 4. Cumulative MET release in scaffold

Conclusion

Compression test revealed that HNT (3%wt) increased 145% of compressive strength when compared to the neat PLA scaffolds. MET loaded HNT particles of the optimization studies depicted that the maximum loading efficacy (>70%) were achieved in the interaction of 4mg/ml HNT with 500 µg/ml MET at pH 7.5 for 24hrs.

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Development and Characterization of Repaglinide-Loaded PLGA-Zein Nanoparticles

Afife Busra Ugur Kaplan, Meltem Cetin

Atatürk University, Faculty of Pharmacy, Department of Pharmaceutical Technology, Erzurum

busra.ugur@atauni.edu.tr

Abstract

Repaglinide (RPG) is an FDA-approved antidiabetic agent listed in BCS Class II. RPG, which is practically insoluble in water, has poor oral bioavailability due to extensive first-pass metabolism in the liver, and its half-life in the systemic circulation is approximately 1 hour. Therefore, nano-sized delivery systems are being prepared to solve the solubility problem of RPG, to improve its low oral bioavailability and to provide modified release. The aim of this study was to develop and *in vitro* characterize RPG-loaded PLGA-Zein nanoparticles (RPG-PLGA-Z-NPs). The mean particle size and zeta potential (ZP) values of RPG-PLGA-Z-NPs were 224.50±5.672 nm and -22.633±0.887 mV, respectively. Besides, the encapsulation efficiency (EE%) and drug loading capacity (DL%) of RPG-PLGA-Z-NPs were found 36.54±2.87% and 5.36±0.34%, respectively. The characteristics of RPG-PLGA-Z-NPs can be modified by changing the PLGA:Zein ratio and the stabilizer used. RPG-PLGA-Z-NPs may be a useful candidate for improving the oral bioavailability of RPG.

Keywords: *Nanoparticle, PLGA, repaglinide, zein.*

Introduction

Type 2 Diabetes Mellitus (T2-DM) is a metabolic disease and it is characterized by chronic hyperglycemia, relative insulin deficiency in the body, and insulin resistance. According to the International Diabetes Federation, the number of patients with DM is estimated to increase to 592 million by 2035. The available antidiabetic agents are not sufficiently successful in the chronic treatment of T2-DM due to serious side effects, failure in drug delivery and low patient compliance. [1]

Today, the use of nanotechnology plays an important role in the diagnosis and treatment of diabetes.[2] RPG is a member of the meglitinide class and approved by FDA as an antidiabetic agent. It stimulates the release of insulin from pancreatic beta cells and reduces the glucose concentration. Repaglinide (RPG) is an FDA-approved antidiabetic agent listed in BCS Class II. RPG, which is practically insoluble in water, has poor oral bioavailability due to extensive first-pass metabolism in the liver, and its half-life in the systemic circulation is approximately 1 hour. Therefore, nano-sized delivery systems are being prepared to solve the solubility problem of RPG, to improve its low oral bioavailability and to provide modified drug release.[3,4] . The aim of this study was to develop RPG-PLGA-Z-NPs for T2-DM treatment and *in vitro* characterize the NPs.

Materials and Methods

Materials

RPG was generous gifts from İlko Ilaç San. ve Ticaret A.S. (Ankara, Turkey), PLGA (50:50, Resomer RG 502 H, Ave. Mw 7000-17000 Da) and zein were purchased from Sigma-Aldrich (USA). All other reagents and chemicals used were of analytical grade.

Preparation of NPs

Briefly, PLGA and RPG were dissolved in dichloromethane (DCM), and then the solution was added to ethanol containing Zein. The obtained organic phase was added dropwise into the aqueous solution of PVA (3%, w/v) stirred using a T10 Ultraturrax (IKA, Germany) at 25000 rpm for 5 min and then ultrasonicated with 60% power for 5 min (“Sonoplus HD 2070”; Bandelin Electronics, Germany). The evaporation of the organic phase was carried out under reduced pressure. After centrifugation, nanoparticles were re-suspended with 5% mannitol. Then, the NPs were lyophilized for 24 h at 0.021 mbar and -55 °C (Martin Christ, Alpha 1-2 LD Plus, Germany). Blank nanoparticles (B-PLGA-Z-NPs) were prepared according to the above procedure without using RPG.

Morphological Properties of NPs

The images of lyophilized RPG-PLGA-Z-NPs were obtained by “scanning electron microscope” (SEM, Zeiss Sigma 300, Germany).

Particle Size, Polydispersity Index (PDI), and Zeta Potential Values of NPs

The mean particle size, polydispersity index (PDI), and ZP values of the NPs were determined before lyophilization using “Zetasizer Nano ZSP” (Malvern Ins. Ltd, UK).

Drug Content of RPG-PLGA-Z-NPs

DCM was added onto the lyophilized RPG-PLGA-Z-NPs, and this mixture was mixed at 500 rpm for 15 min. After adding ethanol to this mixture, the resulting dispersion was held in the ultrasonic bath for 15 min and then stirred at 750 rpm for 30 min. The dispersion was passed through a 0.45 µm membrane filter, and the content of RPG in the solution was analyzed by a validated HPLC method at 242 nm. DL% and EE% were then calculated for the RPG-PLGA-Z-NPs.

Results and Discussion

Morphological Properties of NPs

RPG-PLGA-Z-NPs were prepared using solvent evaporation method. The SEM image of the lyophilized RPG-PLGA-Z-NPs is shown in Figure 1. SEM images of RPG-PLGA-Z-NPs revealed that almost spherical NPs were obtained, but there was also partial aggregation after lyophilization.

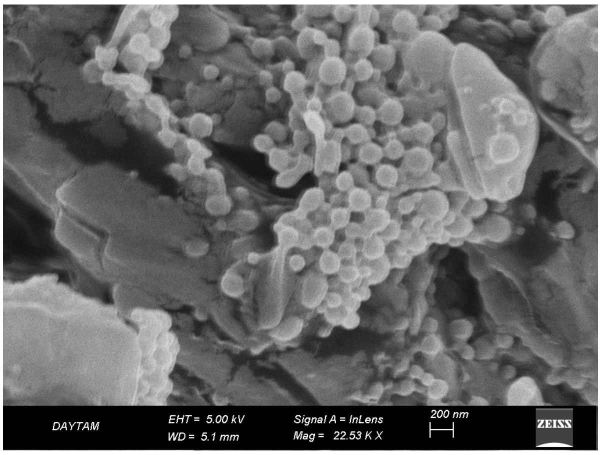

Figure 1. SEM image of RPG-PLGA-Z-NPs.

Particle Size and Zeta Potential Values of NPs

The mean particle size, PDI, and ZP values of NPs are given in Table 1. While differences between the particle size and PDI values of B-PLGA-Z-NPs and RPG-PLGA-Z-NPs were not statistically significant ($p>0.05$), the difference between their ZP were significant ($p<0.05$). The particle size and PDI are very critical factors for the physical stability of colloidal dispersions. PDI values were less than 0.3 and it indicated the monodispersity for colloidal dispersions.[5] Also, ZP is an essential parameter for the physical stability of colloidal dispersions. In the presence of negative zeta potential and non-ionic surfactants, about ±20 mV for the zeta potential of dispersed systems may be sufficient for acceptable stability.[6]

Table 1. The mean particle size, PDI, and ZP values of NPs (Mean±SD; n=6)

	Particle Size (nm)	PDI	Zeta Potential (mV)
B-PLGA-Z-NPs	226.52±10.746	0.237±0.040	-20.72±0.960
RPG-PLGA-Z-NPs	224.50±5.672	0.209±0.016	-22.633±0.887

The EE% and DL% values of RPG-PLGA-Z-NPs

The EE% and DL% values of RPG-PLGA-Z-NPs were found to be 36.54±2.87% and 5.36±0.34%, respectively. (Mean±SD; n=6)

Conclusion

In this study, RPG-PLGA-Z-NPs were prepared and *in vitro* characterized. The characteristics of RPG-PLGA-Z-NPs can be modified by changing the PLGA:Zein ratio and the stabilizer used. RPG-PLGA-Z-NPs may be a useful candidate for improving the oral bioavailability of RPG.

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Production of Zinc Selenide Nanoparticles (ZnSe-NPs) via Microbial Green Synthesis and Their Antibacterial Activities

Sumeyra Gurkok, Murat Ozdal

Department of Biology, Atatürk University, 25240 Erzurum, Turkey

sumeyrag@gmail.com

Abstract

Researchers have recently focused on using microbes as "nanofactories" for the manufacture of metal nanoparticles. Bacterial synthesis of nanoparticles (NPs) is a green chemistry approach that interconnects nanotechnology and microbial biotechnology. The use of bacteria for production nanoparticles provides a low cost, simple and eco-friendly method because the synthesis occurs under ambient conditions without the use of toxic reducing agents. The resistance of pathogenic bacteria to antibiotics has become a serious problem. Therefore, the development of novel and potent bactericidal agents is of great importance. In the present study, zinc selenide nanoparticles (Zn:Se-NPs) have been synthesized by *Pseudomonas aeruginosa* strain OG1 in Nutrient Broth (NB) medium containing sodium selenite and zinc sulfate under dark conditions. The antibacterial activities of nanoparticles at different concentrations (50-250 µg/mL) against both Gram-negative (*Escherichia coli* and *Acinetobacter baumannii*) and Gram-positive bacteria (*Bacillus cereus* and *Staphylococcus aureus*) were tested in NB medium. After 24 h treatment, nanoparticles inhibited the growth of both bacterial groups in a concentration-dependent manner. The growth curves of bacterial cells treated with nanoparticles indicated that nanoparticles could inhibit the reproduction of bacterial cells. This study indicates that Zn:Se-NPs can be used as effective antibacterial agents against various microorganisms which can endanger human beings.

Keywords: *Zn:Se nanoparticles; green synthesis; antibacterial activity; Pseudomonas aeruginosa*

Introduction

Recently, various methods such as physical, chemical and biological have been carried out for the synthesis of ZnSe nanoparticles (1-3). Among these methods, the microbial green synthesis method is known to be simple, inexpensive and environmentally friendly (3). Studies have focused on the optical properties (4), biosensors and photocatalytic activity of

ZnSe NPs (2). Bacterial infections are among the most important health problems. There is a need for new alternative antimicrobial agents to combat antibiotic resistance that occurs as a result of incorrect and unnecessary use of antibiotics. The aim of this study is to demonstrate the efficacy of the antimicrobial activity of ZnSe NPs as a new therapeutic agent against bacteria.

Experimental

Production and characterization of ZnSe nanoparticles

Pseudomonas aeruginosa OG1 was cultured in the Nutrient Broth (NB) for 24 h at 150 rpm and 30 °C. The cell suspension (100 µl, OD_{600} 1) was inoculated into the Luria Bertani Broth medium (50 mL) containing 1 mM Na_2SeO_3 and 0.5 mM $ZnSO_4$. Nanoparticles biosynthesis was conducted at 30 °C for a period of 72 h on rotating shaker (150 rpm) at dark conditions. After 72 h, the culture solutions were observed to have distinctly color change at tubes. Nanoparticles were recovered from the bacterial growth medium by centrifugation and washing with various organic solvents. The ZnSe NPs were then characterized by transmission electron microscopy (TEM).

Bacterial strains

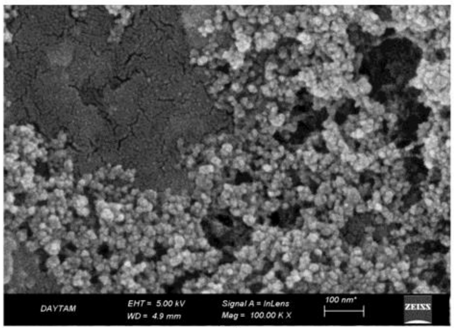
The synthesized nanoparticles were tested for antibacterial activity against Gram-positive (*Bacillus cereus* BC6830, *Staphylococcus aureus* BC7231) and Gram-negative bacterial strains (*Escherichia coli* BC1402 and *Acinetobacter baumannii* ATCC BA1609). All bacterial cultures were incubated at 37 °C unless otherwise stated. Growth rates for bacterial cultures were determined spectrophotometrically (OD_{600} nm).

Determining the growth curves of bacterial cells exposed to different concentrations of NPs

To examine the growth curves of bacterial cells exposed to nanoparticles, NB with different concentrations of ZnSe NPs (50-200 µg/mL) was used, and the bacterial cell concentration was adjusted to 10^6 CFU/mL. Each culture was incubated in a shaking incubator at 37 °C for 24 h. Growth curves of bacterial cell cultures were attained through repeated measures of the optical density (OD) at 600 nm. The antibacterial ratio was calculated as following formula: Antibacterial activity ratio: $[(OD_{control}-OD_{sample})/ OD_{control}] \times 100$

Results and Discussion

In Figure 1, it can clearly see a uniform dispersion of ZnSe nanoparticles with an average particle size of about 10–25 nm. These results coincide with the literature (3).



(a)

Figure 1. TEM image of ZnSe nanoparticles

Antibacterial effects of ZnSe nanoparticles

The antibacterial activities of nanoparticles were evaluated at different concentrations (50-200 µg/mL) against both Gram-negative and Gram-positive bacteria. After 24 h treatment, nanoparticles inhibited the growth of both groups of bacteria in a concentration-dependent manner (Figure 2). The growth curves of bacterial cells treated with nanoparticles indicated that nanoparticles could inhibit the reproduction of bacterial cells. The harmful effect of nanoparticles also depends on the test organisms used. It was determined that ZnSe NPs had higher activity against Gram-negative bacteria than Gram-positive ones. This is due to the membrane structure between both groups. Damage to the cytoplasmic membrane, degradation of nucleic acids and enzymes, emergence of reactive oxygen species are the main causes of bacterial cell death due to exposure to NPs (5).

In conclusion, the biosynthesized ZnSe NPs were determined to have antimicrobial activity against both Gram-positive and Gram negative bacterial strains.

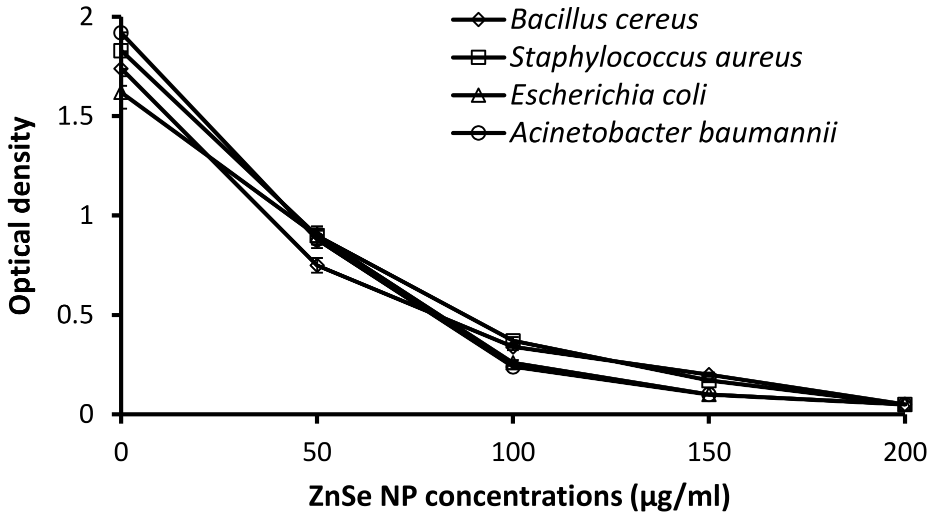


Figure 2. Growth inhibition curve of bacteria in the presence of different concentrations of ZnSe NPs

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The effects of different surfactant and organic solvent concentrations on famotidine nanosuspensions particle size and zeta potential

Rukiye Sevinç Özakar, Emrah Özakar

Atatürk University, Faculty of Pharmacy, Department of Pharmaceutical Technology, Erzurum, Turkey

rukiyeso@atauni.edu.tr

Nanotechnology term is generally used to describe the products, processes, and properties at the nanoscale/microscale. Nanomedicine is applying the nanotechnology to medicine that diagnoses, treats, or prevents diseases and improves human health by using nanosized/microsized drugs or products. Nanosuspensions (NSs) are formulations that have attracted a lot of attention in nanomedicine studies in recent years. NSs are formed of the pure poorly water/lipid-soluble drug without any matrix material (such a polymer) and stabilized via surfactants. NSs are a promising alternative for Famotidine (FM). FM is a potent H_2 receptor antagonist than ranitidine and cimetidine, used for the treatment of gastric/duodenal ulcers, Zollinger-Ellison syndrome, and gastroesophageal reflux disease. FM is classified as a Biopharmaceutics Classification System (BCS) Class IV drug with low solubility and permeability. The aim of this study was to evaluate the effects of different surfactant and organic solvent concentrations on FM NSs particle size and zeta potential. In this study, 8 different FM NSs were prepared by the nanoprecipitation method (n=3). In formulations, polyvinyl alcohol (PVA, low MW 60000 and high MW 130000, 0.1-2% in water), dimethylsulphoxide (DMSO, 100-250 µL) and Tween® 20 were used as a surfactant, organic solvent and co-surfactant, respectively. Particle size, zeta potential, and polydispersity index values were determined by using the Zetasizer (Malvern Zetasizer Nano ZSP) (n=3). The nanostructures of the FM NSs were evaluated by using a SEM (Zeiss Sigma 300). FT-IR analysis was performed to examine the interactions of the formulation components with FM and to understand whether there was any incompatibility between them by using the FT-IR spectrometer (Bruker VERTEX 70v). As a result, FM NSs were successfully prepared and characterized. The average yields of the FM NSs were in the range of 92.01%±3.66-95.49%±0.60. The average particle size and zeta potential values were in the range of 296.8±46.05-886.2±23.04 nm and (-)14.2±0.7-(-)23.9±1.74 mV, respectively. It was determined from the images of all FM NSs that their structures were square-like. In the FT-IR analysis, it was determined by the presence of characteristic peaks that the formulation components and FM did not interact, and there was no deterioration in the chemical structure of FM. In this study, it has been shown that the nanoprecipitation method is suitable for the nanosizing of poorly water-soluble FM. Optimum organic solvent and surfactant concentration were determined by characterization studies. It can be said that the increase in surfactant concentration in formulations causes the size growth of NSs.

Keywords: Famotidine, nanosuspension, nanotechnology.

Introduction

Nanotechnology term is generally used to describe the products, processes, and properties at the nanoscale/microscale that have resulted from the combination of the physical, chemical, and life sciences. Nanomedicine is applying the nanotechnology to medicine that diagnoses, treats, or prevents diseases and improves human health by using nanosized/microsized drugs or products (1). NSs are an alternative and promising universal formulation approach that increases drug efficacy and pharmacoeconomics for most drugs. NSs are formulations that have attracted a lot of attention in nanomedicine studies in recent years. NSs are formed of the pure poorly water/lipid-soluble drug without any matrix material (such a polymer) and stabilized via surfactants. NSs solve the solubility and bioavailability problems and thus improve drug safety and efficacy (2). NSs are also called nanocrystals. NSs are a promising alternative for famotidine (FM). FM is a potent H2 receptor antagonist than ranitidine and cimetidine, used for the treatment of gastric/duodenal ulcers, Zollinger-Ellison syndrome, and gastroesophageal reflux disease. FM is classified as a BCS Class IV drug with low solubility and permeability (3). The aim of this study was to evaluate the effects of different surfactant and organic solvent concentrations on FM NSs particle size and zeta potential.

Results and Discussion

Preparation of Famotidine Nanocrystals

In this study, 8 different FM NSs were prepared by the nanoprecipitation method with sonication (4) (Table 1). The prepared formulations were precipitated by ultracentrifugation and then lyophilized for 24 h.

Table 1. Formulation components and amounts.

Formulation code / Component	F1	F2	F3	F4	F5	F6	F7	F8
FM (mg)	40	40	40	40	40	40	40	40
DMSO (mL)	0.25	0.25	0.1	0.1	0.25	0.25	0.1	0.1
Tween 20 (mg)	150	150	150	150	150	150	150	150
PVA (Low MW) (mg)	-	0.1	-	0.1	-	0.05	-	0.05
PVA (High MW) (mg)	0.1	-	0.1	-	0.05	-	0.05	-

Yield, Zeta Potential (ZP), Polydispersity Index (PDI) and Particle Sizes of Famotidine Nanocrystals

The amounts of all lyophilized formulations were evaluated with proportioning the amounts of components added and their yields were calculated (mean±SD). ZP, PDI and particle size are essential characterization parameters for NSs physical stability. PDI gives a degree of the particle size distribution of NSs. The higher value of PDI indicates broad particle distribution and, the lower value of PDI indicates narrow particle distribution. In NSs, stabilizers should interact effectively with the crystal surface to provide physical stability by preventing agglomeration via steric or ionic barriers. PVA provides electrosteric stabilization. For physically stable NSs stabilized only by electrostatic repulsion, a minimum ZP of ±30mV is required. However, in electrosteric stabilization, a ZP of ±20mV is sufficient (4). When the first four formulations were examined, both the low amount of DMSO and low molecular weight PVA provided smaller sizes and greater zeta potential value. However, when the last four formulations are examined, contrary to the first results, it is seen that the particle size and zeta potential increases when the amount of DMSO is increased and low molecular weight PVA is used. It is seen that the amount of PVA is important in obtaining small or large sizes. Very low amounts of PVA were insufficient to achieve a small size. Obtained results are given below in the Table 2.

Table 2. Yield, zeta potential, polydispersity index and particle size results.

Formulation code	**F1**	**F2**	**F3**	**F4**	**F5**	**F6**	**F7**	**F8**
Yield (%)	92,01±3.66	92,71±1.04	92,36±2.62	94,10±1.59	94,44±1.59	93,06±5.14	93,75±3.61	95,49±0.60
Zeta Potential (mV)	-21.7±4.14	-20.0±1.53	-18.0±1.47	-22.6±2.02	-14.2±0.7	-19.1±1.5	-20±0.79	-23.9±1.74
Polydispersity Index	0.79±0.23	0.42±0.02	0.64±0.20	0.49±0.16	0.57±0.06	0.61±0.02	0.74±0.02	0.79±0.05
Particle size (nm)	634.9±30.1	357.7±18.4	426.9±13.8	296.8±46.1	472.7±16.9	568.0±25.2	748.7±34.7	886.2±23.0

FT-IR Analysis of Famotidine Nanocrystals

FT-IR spectrums of pure FM and formulations are given below in Figure 1. In the FT-IR analysis, it was determined by the presence of characteristic peaks that the formulation components and FM did not interact, and there was no deterioration in the chemical structure of FM. Specific bands of FM are also found in the spectra of the formulations. So, FM in NSs form is chemically stable.

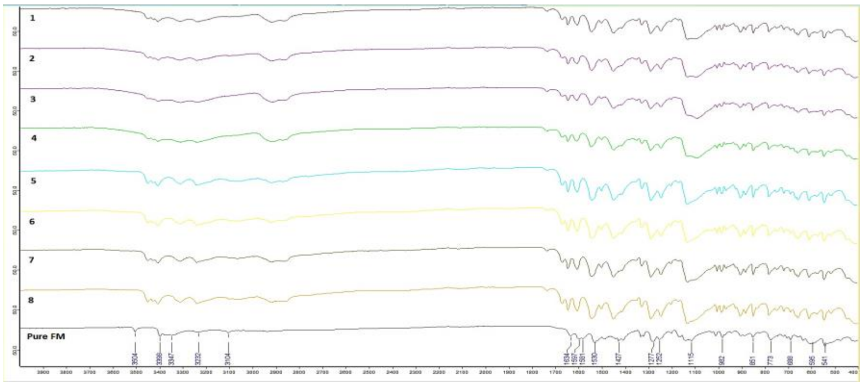

Figure 1. Spectrums of pure FM and formulations.

SEM Analysis of Famotidine Nanocrystals

It has been demonstrated using SEM that FM forms square-like nanostructures. SEM images of pure FM and FM NSs (F8) are given below in Figure 2.

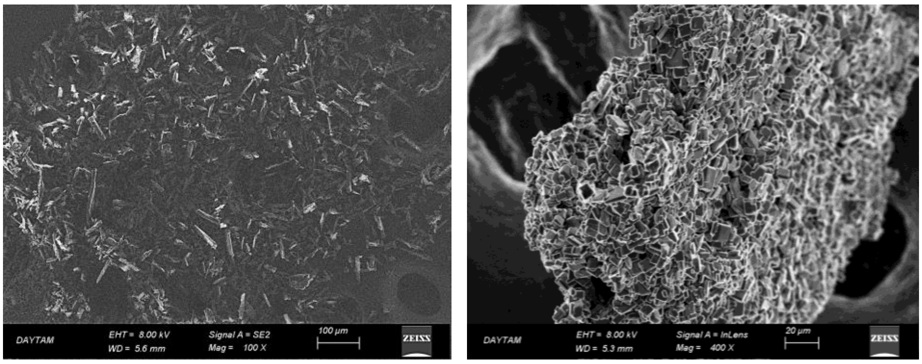

Figure 2. SEM images of pure FM (left) and F8 (right).

Conclusion

In this study, it has been shown that the nanoprecipitation method is suitable for the nanosizing of poorly water-soluble FM. Optimum organic solvent and surfactant concentration were determined by characterization studies. It can be said that the increase in surfactant concentration in formulations causes the size of NSs to decrease when used in sufficient amount for stabilization. However, these results need to be elaborated with further studies.

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Topical Nanomedicines For Leishmaniasis And Skin Cancer Based on Photodynamic And Photothermal Therapies

Daniela Maza Vega[a,b], Cristian Lillo[c], Martín Lemos[d], Taís Aguayo Frías[a,b], Laura Astorga[d], Fernando Alvira[a,b], Silvia del Valle Alonso[a,b], María Natalia Calienni[a,b,d], Jorge Montanari[a,b,d].

(a) Universidad Nacional de Quilmes, Departamento de Ciencia y Tecnología, Laboratorio de Bio-Nanotecnología, Bernal, Buenos Aires 1876, Argentina.
(b) Grupo de Biología Estructural y Biotecnología (GBEyB), IMBICE (CONICET CCT-La Plata), Buenos Aires 1906, Argentina.
(c) Instituto de Investigaciones Fisicoquímicas Teóricas y Aplicadas (INIFTA), Facultad de Ciencias Exactas, UNLP-CONICET, CC16 Suc 4 (1900), La Plata, Buenos Aires, Argentina.
(d) Universidad Nacional de Hurlingham (UNAHUR), Hurlingham, Buenos Aires 1688, Argentina.

dmazavega@gmail.com

Tegumentary leishmaniasis and skin cancer are skin diseases that require new approaches for the improvement of current treatments. Our group focuses on combining lipid matrices for trespassing the stratum corneum impermeable barrier, with photochemistry-based therapies for toxicity or hyperthermia to kill cells in a very narrow area.

For leishmaniasis, intending to reach the parasite nests into skin macrophages, we work on one hand with carbon quantum dots (CQD), obtained from the most popular infusion in Argentina, named yerba mate (*Ilex paraguariensis*), and from the most popular infusion in Turkey, named çay (*Camellia sinensis*). CQD are produced from the vegetable residues from infusion by a top-down method (1). We analyzed their fluorescence and absorbance spectra, for choosing the best excitation and emission windows to generate a photodynamic effect, in which reactive oxygen species (superoxide anion and singlet oxygen) that are toxic for parasites, are produced after exposure to visible radiation. We show our results on the detection of both species. Other physicochemical characterization parameters of our CQD (size by dynamic light scattering, TEM, Zeta potential) are also presented. We include the CQD on ultradeformable ethosomes, that transiently break the barrier function of the stratum corneum, allowing the photodynamic effectors to enter the skin towards the viable epidermis and dermis. We use fluorescent labels to follow the ethosomes on their path through the skin (2). On the other hand, another strategy intended for leishmaniasis treatment is the use of ultradeformable ethosomes as a transport system for the dye methylene blue (3), also for generating reactive species of oxygen after irradiation with visible light. In both strategies, we plan to test the photodynamic action in vitro on leishmania parasite cultures.

For skin cancer, we started working on other kinds of CQD, also from vegetable sources —i.e., fruit juices (4)—, aiming to produce an increment of local temperature after irradiation to a level that diminishes cell viability, which is known as photothermal therapy. In this case, after obtaining the CQD, a folate moiety is added to the nano-entities for specific tumor targeting (5), and then also loaded into ultradeformable ethosomes for skin application.

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Effect of Electrical Properties on Silver and Graphite Interdigitated Electrode for TiO2/MWCNT Thick Film at Difference Temperature Operating

Azlinda Abu Bakar[a], Mohd Nizar Hamidon[a], Mehmet Ertugrul[b], Mohd Hanif Yaacob[c], Suriati Paiman[d], Haslina Jaafar[e], Wan Nurshiela Wan Jusoh[f], Farah Nabilah Shafiee[a], Nor Hapishah Abdullah[a]

[a]*Functional Device Laboratory, Institute of Advanced Technology, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia*
[b]*Department of Electric and Electronics, Faculty of Engineering, Ataturk University, 25240 Erzurum, Turkey*
[c]*Department of Computer and Communication Systems, Faculty of Engineering, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor*
[d]*Department Physics, Faculty of Science, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia*
[e]*Department of Electrical and Electronic, Faculty of Engineering, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia*
[f]*Malaysians Institute of Aviation Technology, Universiti Kuala Lumpur, 43000 Dengkil, Selangor, Malaysia*
azlinda@unikl.edu.my

The Interdigitated Electrode (IDE) is an important components for sensing operation, whereas the electrical signal generated by the sensing material have been detect and haverst via IDE[1]. This work compare the electrical properties performance of silver and graphite IDE on titanium dioxide multiwall carbon nanotube (TiO2/MWCNT) sensing materials. Screen printing technique are used to deposite silver and graphite conductive paste as IDE layer on kapton substrate firering at 1500C and 2000C respectively. Followed by TiO2/MWCNT paste mixing with organic binder as material sensing layer of thick film at 3500C for two hours. The electrical properties analysis in this work was characterized by IV characteristics measurement at -10Volt to +10Volt. The results shows silver and graphite IDE observed produced Ohmic contact behaviour. It verify and show that silver and graphite IDE with TiO2/MWCNT as sensing film can exposed to the target gas and suitable to develop as gas sensor.

Keywords
Interdigitate electrode, electrical properties, TiO2/MWCNT, thick film, screen printing

Preparation And Characterization Of Lanthanum Oxide (La_2O_3) Nanoparticles By Sonication Method

Mehmet Semih BİNGÖL[1]

[1]*East Anatolia High Technology Application and Research Center (DAYTAM), Ataturk University, 25240 Erzurum, Turkey*

semih.bingol@atauni.edu.tr

ABSTRACT

Nano technology allows many applications thanks to the desired shape and dimensions of nano particles. In addition, the limited number of synthesis and characterization of nanoparticles of rare earth elements attracts more attention to study these elements. In this study, One of these elements is Lanthanum. Lanthanum Oxide (La_2O_3) nanostate of lanthanum is widely used not only in water treatment, but also in solid oxide fuel cells, catalytic exhaust gas converters, high dielectric materials. s. This nanoparticle prepared by sonication method was analyzed with SEM and Zetasizer devices. In the SEM analyzes, it was observed that the particles were fragmented and separated from each other after the La_2O_3 treatment in bulk form. In the subsequent Zetasizer device, it was observed that La_2O_3 in bulk was approximately 4600 nm in the average size analysis, and the sample examined after the process decreased by approximately 700 nm. This shows that SEM and Zetasizer analyzes confirm each other.

Keywords: Lantanum Oxide, nanoparticle, sonication, Zetasizer, earth rare elements

Theoretical study of a new smart hybrid solar water heater

Abderrahim Habchi[a], Bouchaib Hartiti[a], Hicham Labrim[b], Salah Fadili[a], Mehmet Ertuğrul[b]

[a]*ERDyS laboratory, MEEM & DD Group, Hassan II University of Casablanca, FSTM BP 146 Mohammedia 20650, Morocco*

[b]*Materials Science Unit / DERS / CNESTEN National Centre for Energy, Sciences and Nuclear Techniques, Rabat, Morocco*

[c]*Engineering Faculty, Ataturk University, 25240 Erzurum, Turkey*

isohb2015@gmail.com

Abstract

This paper presents the modeling of a new solar water heater, which uses a mini hydro turbine to generate more electrical power from cold water motion. The smart system is based on integrating two tubular thermoelectric generators within four absorber tubes in order to generate electrical power. A turbine is attached between the outlet of the absorber tube and inlet of water tank in order to generate more electrical power from the outlet cooling water. Our theoretical analysis shows that the smart system is suitable to produce a maximum electrical power of 348.073 W via both tubular thermoelectric generators, corresponding to 2.72% of the maximum electrical efficiency. Also, for a concentration of 30 suns, the maximum thermal efficiency reached to 86.09% with a total quantity of hot water up to 1548.57 L/day. The portion of the mini-hydro turbine electrical power is about 89.467W.

Keywords: *Smart solar water heater, Tubular thermoelectric generator, Mini-hydro turbine, electrical power.*

Introduction

Solar water heater systems mainly use to convert a large amount of sun irradiation into thermal power via absorber layer. Last year, the maximum amount of thermal power produced by these systems reached 479 gigawatts [1]. Also, the solar water heater (SWH) systems are equipped with a glass cover and insulation layer to reduce the convective and radiative heat losses around the absorber layer, but a good part of thermal power is totally transformed into waste energy, which will affect negatively in their thermal performances. To this effect, C. Lertsatitthanakorn et al [2] proposed an experimental model for a new hybrid solar water heater, integrated with a heat pump and many planar thermoelectric modules. They found that the electrical efficiency and power output of the thermoelectric modules were reached to 2.03% and 7.5 W, respectively, and 1300 L/day of hot water at 40°C. As well, an additional combination method was developed to integrate solar water heater systems with PV cells (PV/T) in order to minimize heat losses and improve hot water storage and electrical power [3]. Based on these literature reviews, the electrical power generated by each system was highly unstable, which complicates the prediction of their electrical behavior. Also, the instability of electrical power will create overvoltage problem, which will damage the system's pumps or electronic components energized by these hybrid solar systems. On the other hand, the storage process is based on a single hot water outlet, meaning that it is necessary to store the hot water at a specific temperature without any other storage source. Moreover, there is no proposed study on the SWH systems performance, integrated with a mini-hydro turbine. Therefore, in this paper, a new smart solar water heater system is mainly proposed to solve the mentioned problems and generate a large electrical power using the waste energy.

Results and Discussion

System description

Figure 1a presents the overall configuration of the SHSWH system, which consists of a flat plate made of 4 copper tubes with an outer and inner diameter of 0.12m and 0.115 m, respectively. The flat plate is wound by an absorbent layer of copper coated with a black chrome selective surface with a pitch of 0.0127 m between each pipe. A tubular thermoelectric generator 1 of the module TEC1-12706 placed inside 4 copper tubes where 0.01 m is the gap distance between the inner surface of copper tube and outer side of TTEG1. Another tubular thermoelectric generator 2 is also positioned inside absorbent tubes. 1298-TEM1 modules are used in the present smart system. A set of 874 TEM2 are used to build the second thermoelectric generator (TTEG2). The selected tubular thermoelectric generators have the same length of flat plate, which has 1.9m long and 0.92m wide. In order to minimize the heat losses by convection and radiation between the absorber layer and ambient, an insulation layer is attached at the backside of the absorber plate where the used isolation layer is made of rock wool which has very low thermal conductivity. For the same reason, the patterned low-iron material used for the glass cover of the absorber plate with a low thickness of 0.0038 m in order to reduce thermal resistances and to guarantee the greenhouse effect between the inner side of glass cover and upper surface of absorber plate. As shown in Fig.1a, the hot water 1 is connected to a pump with low consumption in order to adjust the mass flow rate to keep the hot water 1 temperature at 95°C for a long time. Similarly, the hot water 2 is linked to a second pump with low consumption to control the mass flow rate to keep the hot water 2 temperature at 60°C for a long period. Both pumps are equipped by a flow meter in order to measure the flow rate at each instant. Lastly, a water tank is proposed for cooling process, which has three holes. The first hole is where the cold water flows through the mini-hydro turbine towards the first inlet of main tank (First hole). The second hole is where the cold water flows from the water tank to the inlet of absorber tubes using a pump 3 passing by a flow meter 3 while the last hole is connected directly with the external water source.

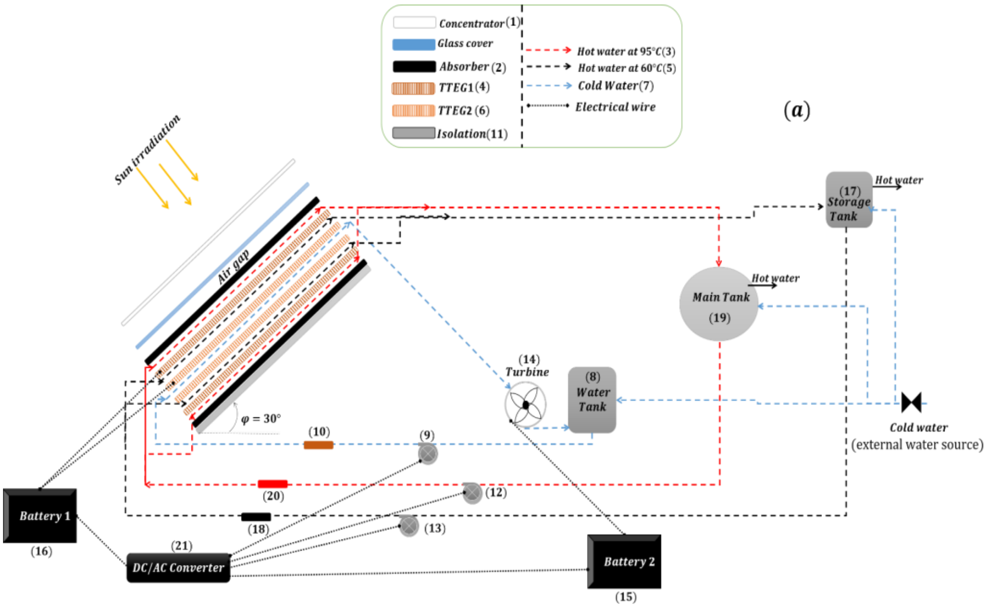

Fig.1 Schematic diagram of the SHSWH system.

Hot water 1 and 2 storage and power output results

The use of optical concentrator leads to accelerate the hot water 1 and 2 heating process, which affects positively in the hot waters storage. Thus, the storage of the hot water 1 increases with increasing solar concentration ratio. Also, the hot water 2 storage increases slightly when solar concentration ratio increases. Therefore, the maximum hot water 1 storage for a concentration of 30 suns is 1411.18 Liter/day of hot water at 95°C, while that of hot water 2 is about 137.39 Liter/day at 60°C (Fig.2a). Meanwhile, the maximum thermal efficiency of new smart system reached 86.09% (Fig.2b), where the electrical power generated by the smart system reached to 193.79 W as shown in Fig.2c.

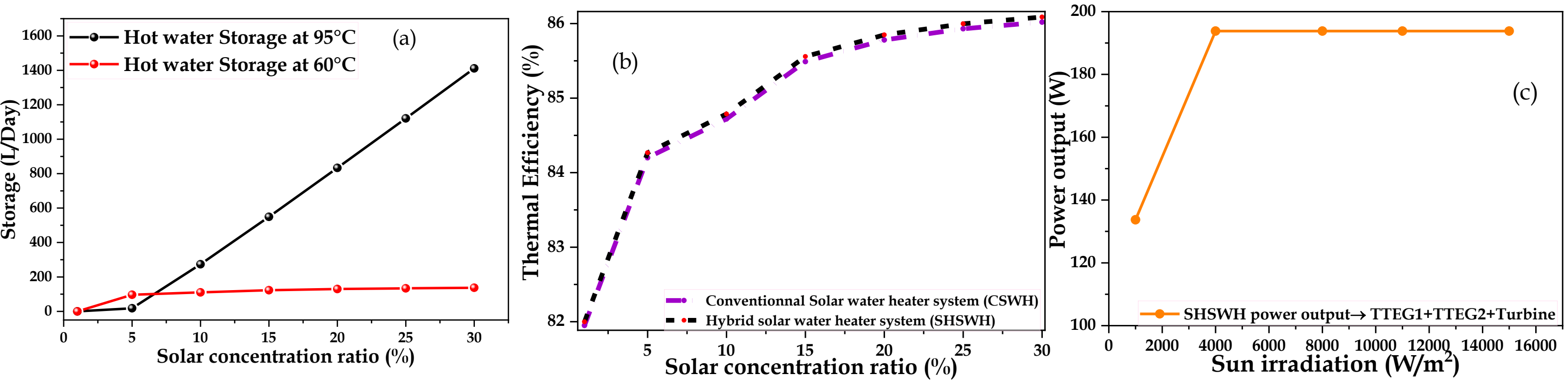

Fig.2. Solar concentration ratio effect on the: storage of hot water at 95°C and 60°C (a) and thermal efficiency (b). Sun irradiation effect on the electrical power ouput of the new system (c).

Conclusions

The maximum hot water 1 storage for a concentration of 30 suns is about 1411.18 Liter/day of hot water at 95°C, while that of hot water 2 is about 137.39 Liter/day at 60°C. In addition, the maximum thermal efficiency increases from 81.99% without the presence of optical concentrator to 86.087% for a solar concentration ratio of 30 suns. Also, the maximum electrical power generated by the smart system reached to 193.79 W.

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Synthesis, Optimization and Electrochemical Sensor Application of Copper Ferrite Nanoparticles

Vildan Şanko[a], Ahmet Şenocak[a], Süreyya Oğuz Tümay[a], Taşkın Çamurcu[a], Erhan Demirbas*[a]

[a]*Gebze Technical University, Department of Chemistry, Gebze, Kocaeli 41400, Turkey*

vildansanko@gtu.edu.tr

Bisphenol A (BPA) known as an endocrine disruptor is structurally similar to endocrine steroidal hormones with its two hydroxyphenol content. This chemical structure is used together with polycarbonates in the inner surface coating of food packages, apart from the production of food containers. It has been stated that BPA is detected in the products of the food packaging, depending on the type of food and storage conditions. Exposure to people can cause diseases related to obesity, early puberty, thyroid disorders, cardiovascular diseases, diabetes and neurotoxicity in connection with the endocrine system (1). For these reasons, the development of a sensitive and effective biosensor has gained importance. Ferrites are metal oxides with the general formula AB_2O_4 and contain two different crystallographic domains (tetrahedral and octahedral) regions. Cation types and their distribution in tetrahedral and octahedral regions have a very important effect on the physical and chemical properties of ferrite nanoparticles (2). Biopolymers are biocompatible, non-toxic and suitable platforms for immobilization of biorecognition elements (3).

In the present study, Ferrite nanoparticles are preferred for the composite system to be used in the production of the biosensor due to their electrocatalytic properties and biocompatibility. Ferrite nanoparticles were obtained by co-precipitation method and optimized at three different calcination temperatures. Then, their surface functionalized with organo silanes were modified with biopolymer, which was biocompatible, non-toxic structure and suitable for the immobilization of biorecognition elements. The obtained modified and unmodified ferrite nanoparticles were characterized by FTIR, XRD, TGA, SEM, EDS, TEM and particle size analysis. Cyclic (CV) and differential pulse voltammetry (DPV) methods are used to examine their electroanalytical properties. In addition, limit of detection, linear measuring range, selectivity, repeatability, reusability and real sample analyzes were performed to evaluate for the performance of the new biosensor. The biosensor offered a low detection limit, good repeatability and sensitivity for the detection of BPA analyte.

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Comparison between Silver and Graphite Interdigitated Electrode (IDE) in TiO_2/MWCNT Thick Film on Electrical Properties

Azlinda Abu Bakar[1,6,*], Mohd Nizar Hamidon[1,4], Mehmet Ertugrul[2], Mohd Hanif Yaacob[3], Suriati Paiman[5], Haslina Jaafar[4], Wan Nurshiela Wan Jusoh[6], Farah Nabilah Shafiee[1], Nor Hapishah Abdullah[1]

[1] Functional Device Laboratory, Institute of Advanced Technology, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia
[2] Department of Electric and Electronics, Facilty of Engineering, Ataturk University, 25240 Erzurum, Turkey
[3] Department of Computer and Communication Systems, Faculty of Engineering, Universiti Putra Malaysia, 43400 UPM Serdang
[4]Department of Electrical and Electronic, Faculty of Engineering, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia
[5] Department Physics, Faculty of Science, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia
[6] Malaysians Institute of Aviation Technology, Universiti Kuala Lumpur, 43000 Dengkil, Selangor, Malaysia
*Corresponding Author's Email: mnh@upm.edu.my

Abstract: The comparison on electrical properties performance of silver and graphite IDE with titanium dioxide multiwall carbon nanotube (TiO2/MWCNT) as sensing materials is presented in this research work. Screen printing technique has been selected to deposit silver and graphite conductive paste as IDE layer on kapton substrate continued by firing at 1500C and 2000C respectively. TiO2/MWCNT paste were then printed as a sensing layer followed by firing at 3500C. The electrical properties analysis has been characterized by I-V characteristics measurement from 2V to 12V. The results have shown that silver and graphite IDE produced an ohmic contact behaviour convincing the suitability to be developed as sensor with TiO2/MWCNT sensing film. The resistance values of both silver and graphite IDE were found from the ohmic contact behaviour, showed a decreasing trend in different range values whereas the values were decreased after the layer of TiO2/MWCNT were deposited. It showed the improvement of resistance value on IDE graphite and TiO2/MWCNT, however silver are proven in good conditions.

Keywords: interdigitated electrode, graphite, thick film, resistance

1.0 Introduction

Interdigitated electrodes are one of the important components in sensor construction. It is an important component for sensing fabrication, whereas the electrical signal generated will be detected by the sensing material hence allowing electron harvesting via IDE. The latest IDE construction also provides a substitute for small sized electronic products in device sensors. IDE was constructed from two separate interlocking electrode combs; with the repetition of the configuration constitute a mature IDE structure. This IDE is very convenient because it provides simplicity and usability on various device suitability with only small changes in electrode configuration such as width, length and distance between electrodes [1].

Technical depositions are made by various methods such as photolithography, screen printing, inkjet printing and other methods [3]. The screen printing fabrication process is a simple, low cost and time saving method. The electrode material adopted is also an important part as it will increase the sensitivity and reliability of the sensor. Metals commonly used as electrodes are such as silver, gold and platinum [2]. Among these materials, the most popular material is silver because it is the cheapest and most stable in air. However, under high humidity, it differently moves to the surface of the resistor. The purpose of this research work is to see the capability of graphite as the material of choice in the design of the sensor platform itself.

2.0 Materials and Methods

2.1 Preparation and Fabrication

This research work will compare the I-V characteristics for two different interdigitated electrode materials by using screen printing technique. Silver conductive paste (DGP80 TESM8020) provided by Sigma-Aldrich (Steinheim am Albuch, Germany) and graphite conductive paste (Serdang Paste Technology) are used as interdigitated electrode materials. As for sensing material, TiO_2 (Aeroxide P25) and MWCNT were provided by Sigma-Aldrich and Materials-A2Z prepared by mixing ratio of 30:70 with an organic binder. The proposed organic binder was prepared by mixing the linseed oil (85 wt.%) and m-xylene (12.5 wt.%) for 250 rpm in 3 hours at 40^0C, then the solution mix again with α-terpineol (2.5 wt.%) using magnetic stirrer for 250 rpm in 2 hours at 40^0C to obtain homogeneous binder. Screen printing fabrications method is used in paste deposition technique to get thick film as shown in Figure 1(a). Thick film used in this work consist of two film layers, first layer was the IDE silver conductive paste or Graphite (Alfa Aesar) and sensing materials TiO_2/MWCNT as shown in Figure 1(b). Sample was left about 15 min before proceeding to drying process at 150^0C and firing 350^0C for 2 hours respectively.

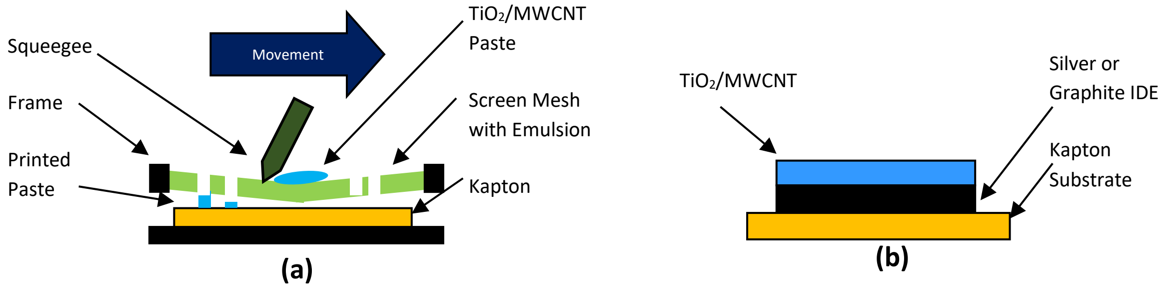

Figure 2.1: Thick film fabrications (a) screen printing technique to deposit interdigitated electrode film and sensing film, (b) sample layer after screen printing process.

2.2 Experimental and Measuring

The characteristics of interdigitated electrode were studied by using a two point probes measurement and conducted by LabView software for all samples measurement as Figure 2.2(a). Copper wires are attached to both ends of the interdigitated electrode. This is called the two point probes technique, since two probes are attached to the material as shown in Figure 2.2(b). A voltage source applies a voltage, V across the sample, causing a current, I to flow through the sample. A current source through the voltage 10V flow across the sample supply by Keithley 2400 SourceMeter. The amount of current, I that flows through the sample is measured by the Lab View software, which is connected in series with the sample and voltage source. The resistance, R of the sample is given by Equation 1. Where R equal to resistance in Ω, V is voltage in volts and I is Current in Amps.

$$V = IR \qquad (1)$$

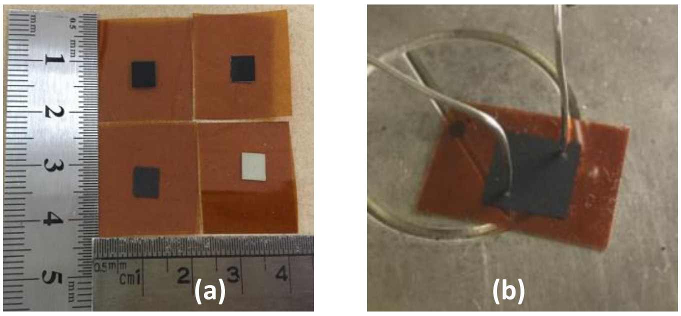

Figure 2.2: Interdigitated electrode testing (a) IDE for silver and graphite (b) two point probe measurement process on graphite interdigitated electrode

3.0 Results and Discussion

The resistance value of each interdigitated electrode as mentioned in Table 3.1 were measured by using two point probe. Silver IDE showed a lower value of resistance with higher conductivity compared to graphite interdigitated electrode. The range difference between IDE silver and graphite are 99.5 %, showing that the silver are highly conductor for electron mobility. After combining IDE graphite with TiO_2/MWCNT sensing layer, the resistance value was observed to be decreased. The resistance value of silver IDE showed an increasing trend after the deposition of TiO_2/MWCNT sensing layer. The comparisons of the value of resistance of all samples are shown in Figure 3.1(a) and (b). Although the resistance value of IDE graphite with TiO_2/MWCNT increased, it is still higher than that of IDE silver value.

Table 3.1: Resistance value for various interdigitated electrode.

Interdigitated Electrode	Resistance, Ω
Silver	100.00
Graphite	9780.20
Silver_TiO2/MWCNT	7097.74
Graphite_TiO2/MWCNT	17027.82

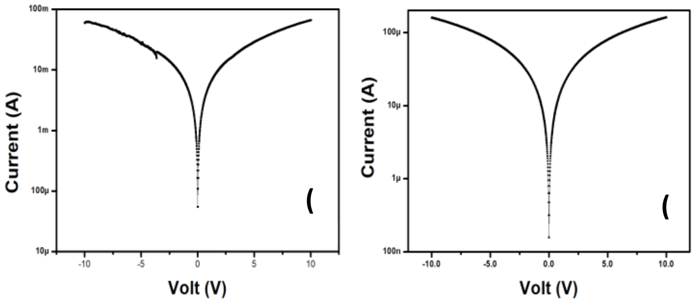

Figure 3.1: Comparison two point probes measurement process (a) graphite and (b) silver interdigitated electrode

The effect of current-voltage characteristics between silver IDE and graphite IDE on TiO_2/MWCNT material using two point probes system can be represented by log asymmetry taken from LabView as shown in Figure 3.2. The results could demonstrate the performance of interdigitated electrode for silver and graphite with TiO_2/MWCNT sensing layer. IDE graphite shows a lower range of current value from 100mA to 100μA as compared to that of IDE silver (100μA to 100nA).

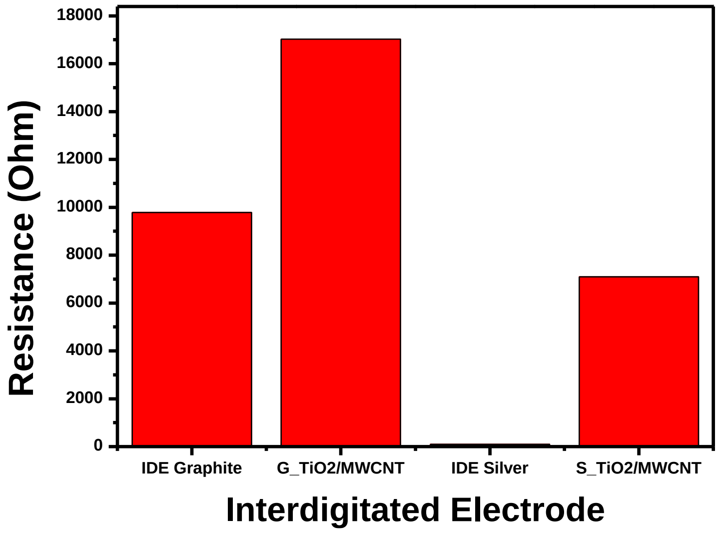

Figure 3.2: I-V Characteristic as log asymmetry curve for 10V supply, I-V for IDE graphite, IDE Graphite TiO_2/MWCNT, IDE silver and IDE Silver TiO_2/MWCNT

4.0 Conclusions

I-V characteristic measurements technique has been able to determine the resistance and the current flow of the sample in the presented IDE. The measurement has shown that the resistance value has a current flow through the sample and carries a good response when IDE graphite and sensing layer were measured. The effect of TiO_2/MWCNT causes an increase and decrease in the resistance and current value of IDE as supported by experimental.

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Poly(L-DOPA)-mediated silver nanoparticle-decorated titanium dioxide nanowires with high SERS and, photocatalytic activity

Hayrunnisa Mazlumoglu[a] and Mehmet Yilmaz[a,b]

aDepartment of Chemical Engineering, Ataturk University, 25240 Erzurum, Turkey
bDepartment of Nanoscience and Nanoengineering, Ataturk University, 25240 Erzurum, Turkey

h.mazlumoglu@atauni.edu.tr

Abstract

Silver nanoparticle decorated-titanium dioxide (TiO_2) nanocomposite systems represent unique performances in various applications such as surface-enhanced Raman spectroscopy (SERS), and photocatalysis. These nanocomposites can be fabricated through many strategies including electrodeposition, sol-gel method, electrospinning, ultraviolet (UV) irradiation reduction, and hydrothermal methods. However, novel, easy-to-tune, low-cost, simple, effective, reducing, and stabilizing agent-free methods are highly required for the fabrication of these nanocomposites. Herein, we propose the fabrication of silver nanostructure decorated TiO_2 nanowires (NWs) by employing a conformal thin polymer layer of 3,4-dihydroxyphenyl-L-alanine (PLDOPA).

Keywords: *L-DOPA, SERS, titanium dioxide nanowires, clean water and sanitation*

Introduction

TiO_2 nanostructures are semiconductor materials with unique advantages [1]. TiO_2 nanomaterials have attracted great interest in many applications due to these advantages. [2]. However, the wide bandgap of TiO_2 is one of its drawbacks. This band gap determines the absorption of only UV light, which covers about 4% of the solar spectrum [3]. Another disadvantage is the recombination of photoelectron-holes. This situation limits the use of TiO_2 nanomaterials especially in photocatalysis applications [4]. Many strategies have been developed to overcome these disadvantages [5]. For example, the presence of silver nanoparticles (NPs) with low cost and impressive conductivity on TiO_2 nanosystems enhances the transfer of photogenerated carriers and improves electron-hole pair separation [6]. Moreover, the surface plasmon resonance (SPR) nature of silver nanoparticles contributes to the light response of TiO_2 nanomaterials. Thus, it leads to an increase in light conversion in the visible range [7]. The difficulty of controlling the size and morphology on the incorporation of silver nanostructures on TiO_2 remains an important limitation of these nanosystems [8]. In addition, the accumulated amount of silver causes the overgrowth of the TiO_2 substrate, the formation of aggregated structures, and a consequent decrease in photocatalytic activity. Therefore, it is clear that low-cost, simple and flexible strategies are highly demanded to produce nanocomposites of TiO_2 and silver in a well-controlled manner. In this study, we propose, for the first time, the fabrication of silver nanostructure decorated TiO_2 NWs via a thin polymer layer of PLDOPA. After the TiO_2 NWs were produced by the hydrothermal method, a thin layer of compatible PLDOPA was deposited on the TiO_2 NWs (TiO_2@PLDOPA). By varying the amount of silver ions, the size, morphology and interparticle spacing of silver nanostructures on the TiO_2@PLDOPA@ Ag NP systems were changed.

Results and Discussion

The morphologies of TiO_2@PLDOPA@Ag NP systems were investigated by TEM analysis (Fig. 1). With a 2-hour oxidative polymerization of L-DOPA formed a discernible conformal PLDOPA layer on TiO_2 NWs. In the case of the TiO_2@PLDOPA@Ag1 NP system, we detected silver nanostructures with mostly spherical morphology (Fig. 1a). The relatively low NP size distribution on this system shows that the silver nanostructures are well separated and the interparticle distance between them is higher than the average particle sizes. When the amount of supplied silver ions was increased, the size and density of silver nanostructures increased compared to the previous case. Interparticle distance decreased due to higher deposition (Fig. 1b). With the increase of deposited silver, the formation of larger and mostly non-spherical silver nanostructures was observed (Fig. 1c). The overgrowth of silver nanostructures can be attributed to the presence of more nanostructures in the medium and the assembly of these small nanostructures. From TEM images and EDX data showing the distribution of silver nanostructures (Figs 1 a3, b3 and c3), it can be seen that the NP systems were efficiently synthesized through the bioinspired PLDOPA film. We employed the TiO_2@PLDOPA NP system decorated with silver nanostructures as a SERS platform in the detection of MB as a Raman reporter molecule (Fig. 2). From the Raman spectra it can be seen that for TiO_2 NWs and TiO_2@PLDOPA NP systems, relatively low Raman signals for MB are obtained. Silver nanostructures significantly improved the Raman signal intensity of TiO_2@PLDOPA NP systems (Fig. 2). Relatively higher SERS performances were achieved with the increase in the amount of deposited silver nanostructures. However, further increase in deposited silver nanostructures (TiO_2@PLDOPA@Ag3) provided relatively weak SERS activity. This can be attributed to the overgrowth of plasmonic nanostructures due to the excessive amount of silver ions.

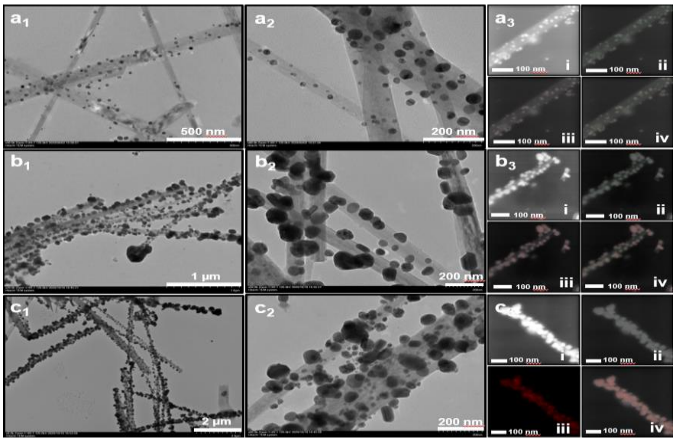

Fig.1. Representative TEM images of TiO_2@PLDOPA@Ag NP systems at different magnifications and relevant mapping images. (a) TiO_2@PLDOPA@Ag1, (b) TiO_2@PLDOPA@Ag2 and (c) TiO_2@PLDOPA@Ag3. (i) STEM image, (ii) Ti, (iii) Ag and (iv) overlapped images [9].

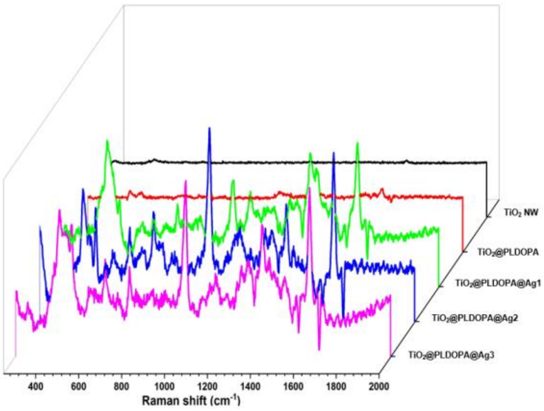

Fig.2. Representative normalized SERS spectra for different NP systems [9].

The photocatalytic activities of TiO_2@PLDOPA@Ag NP systems with the degradation of MB under visible light irradiation were investigated. When using TiO_2@PLDOPA@Ag1 or TiO_2@PLDOPA@Ag3 complete degradation of MB occurred after 7 hours of irradiation (Figs. 3a and c), whereas in the case of the TiO_2@PLDOPA@Ag2 NP system it was achieved within 5 hours (Fig. 3b). The high catalytic activity of TiO_2@PLDOPA@Ag2 NPs can be attributed to the appropriate size, distribution and morphology of the silver nanostructures. Photocatalytic testing of TiO_2@PLDOPA@Ag NP systems has shown that silver nanostructures provide remarkable performance under visible light irradiation.

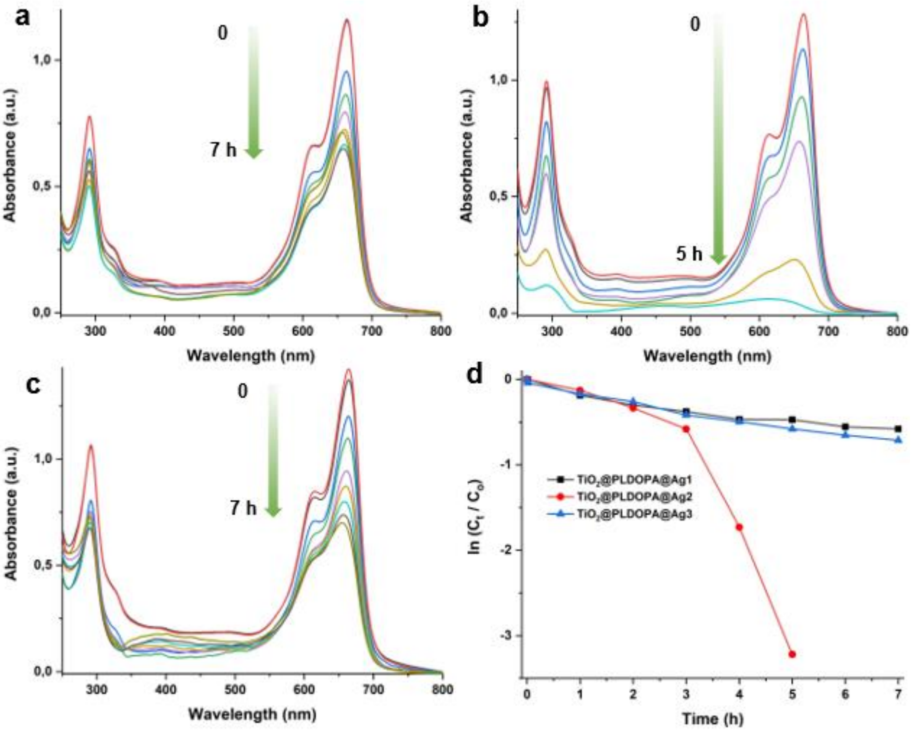

Fig. 3 Time evolution of the UV-vis spectra indicating the conversion of MB for TiO_2@PLDOPA@Ag1 (a), TiO_2@PLDOPA@Ag2 (b), and (c) TiO_2@PLDOPA@Ag3 NP systems and the kinetic trace of concentration (d) for the different relevant systems for comparison [9].

Conclusions

In conclusion, we have obtained TiO_2 NW nanocomposite systems decorated with silver nanostructure through a thin layer of PLDOPA with a simple but very effective approach. TiO_2@PLDOPA@Ag nanocomposite systems showed unique properties in SERS and photocatalytic activity tests. It was observed that the size, morphology and interparticle distance of silver nanostructures have a certain effect on SERS and catalytic performances.

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Gold nanoparticle-decorated polystyrene hybrid nanosystems as SERS platform, and catalyst

Mehmet Yilmaz[a,b]

[a]Department of Chemical Engineering, Ataturk University, 25240 Erzurum, Turkey
[b]Department of Nanoscience and Nanoengineering, Ataturk University, 25240 Erzurum, Turkey

nano.yilmaz@gmail.com

Noble metallic nanoparticle decorated-polymer hybrid systems show certain advantages in terms of simplicity, stability, and flexibility. With these unique advantages, these nanosystems provide extraordinary performances in many applications such as surface-enhanced Raman spectroscopy (SERS), catalysis, and biosensing. However, despite the recent progress in the fabrication methods, low-cost, simple, novel, easy-to-follow, well-controlled, and reducing agent-free approaches are still highly demanded to prepare these efficient nanosystems.

In this study, we propose an alternative method to fabricate the gold nanoparticle decorated polystyrene (PS) nanospheres (NSs) by employing a thin polymer layer of 3,4-dihydroxyphenyl-L-alanine (PLDOPA). For this, firstly, a conformal thin film of PLDOPA was deposited onto the PS NSs through oxidative polymerization LDOPA (PS@PLDOPA). Herein, PLDOPA with its numerous functional groups including catechol and amine served in the reduction of gold ions and stabilization of the resultant gold nanoparticles (AuNPs). It must be noted that during the procedure no surfactant, reducing agent, and seed material was employed. The size, morphology, and interparticle distance of the AuNP decorated PS@PLDOPA composite system (PS@PLDOPA@Au NP) was controlled by simply manipulating the amount of the gold ions. We utilized the PS@PLDOPA@Au NP systems in SERS and catalytic activity tests. The optimized PS@PLDOPA@Au NP hybrid system provided high SERS activity with an enhancement factor of 4.3×10^5. Also, this platform performed the total catalytic conversion of 4-nitrophenol within 5 min. We envision that with the biocompatible PLDOPA layer, this low-cost simple, novel, and easy-to-tune metallic nanoparticle/polymer hybrid system will find potential biomedical applications including therapy, bioimaging and, biosensing.

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Engineered CaO, CuO, ZnO Nanoparticles Enhanced, Callus Formation Maintain of *Alfalfa* (*Medicago sativa* L.) Under *In Vitro* Salt Stress

Ismail Bezirganoglu[a,*], Merve Simsek Geyik[a], Busra Yazicilar[a], Fatma Boke[a], Hayrunisa Nadaroglu[b,c], Azize Alayli[c,d]

[a]*Department of Molecular Biology and Genetics, Erzurum Technical University, 25050 Erzurum, Turkey.*

[b]*Department of Food Technology, Vocational College of Technical Sciences, Ataturk University, 25240 Erzurum, Turkey*

[c]*Department of Nano-Science and Nano-Engineering, Institute of Science, Ataturk University, 25240 Erzurum, Turkey*

[d]*Department of Nursing, Faculty of Health Sciences, Sakarya University of Applied Sciences, 54187,*

Sakarya, Turkey

ismail.bezirganoglu@erzurum.edu.tr

Abstract

Nanoparticules plays an important role in plant adaptation to abiotic stress, especially in response to salt stress. In this study, two *alfalfa* lines (*Erzurum*, and *Muş)* were used as the material for the response NaCl to CuO, ZnO and CaO nanoparticules (NPs). CaO is evident to be higher effective than CuO, ZnO in callus induction from leaf explants. The antioxidant enzyme activities were also determined in the callus cultures. The maximum activity in MDA analysis was observed from callus treated of 50 mM NaCl with 0.8 ppm CuO NPs. The callus induction stage without salt treatments indicated a best result in 0.8 ppm CaO NPs for H_2O_2 value compared to the other NPs. The callus induction stage without salt treatments indicated a best result in 0.8 ppm CaO NPs for POD value compared to the other NPs for POD activity.

The best response in protein rate was obtained from callus induction stage and callus formation stage after 50 mM treatment NaCl with 0.8 ppm CuO. LSCM analysis evident that the NPs could migitate the negative effects of NaCl stress by the elimination of stress severity in callus cells. SEM analysis was supported the results obtained by LSCM analysis. Our findings suggest that CuO, CaO and ZnO NPs can offer a simple and effective method to protect *alfalfa* callus from NaCl stress severity.

Key words: Callus, *alfalfa*, nanoparticle, confocal laser scanning analysis, *in vitro* assay

Production of Novel Carbon Nanostructures by Electrochemical Reduction of Polychlorinated Organic Rings under Mild Conditions for Supercapacitors

Duygu Ekinci[a], Züleyha Kudaş[a], Emir Çepni[a], Emre Gür[b]

[a]*Atatürk University Faculty of Sciences Department of Chemistry*

[b]*Atatürk University Faculty of Sciences Department of Physics*

dekin@atauni.edu.tr

Here, new carbon-based nanostructures were prepared via a one-step electrochemical method using hexagonal and pentagonal polychlorinated organic rings as the carbon source (1,2). The electrochemical growth of carbon nanostructures on substrates was accomplished via electrochemical reduction of organic halides in nonaqueous electrolyte solutions containing hexachlorobenzene (HCB), hexachlorocyclopentadiene (HCCP) and mixtures of HCB and HCCP with molar ratios of 2/2, 2/1.2 and 2/0.6. The effect of HCB/HCCP molar ratio, deposition time and temperature on the morphological and structural properties of the carbon coatings was investigated using spectroscopic and microscopic methods. The performance of the carbon nanostructures as supercapacitors was also studied using cyclic voltammetry, galvanostatic charge–discharge and electrochemical impedance spectroscopy in aqueous $\mathrm{Na2SO_4}$ solutions. The structural and chemical properties of the carbon nanostructures was found to depend strongly on the nature and relative molar ratios of the precursors used in the electrochemical reduction process. In the case of a 2/2 molar ratio of HCB to HCCP, mushroom-like carbon nanostructures are obtained, whereas, higher molar ratios of HCB to HCCP (2/1.2 and 2/0.6) result in carbon nanoflowers with graphitic features. Furthermore, the capacitance measurements show that these novel carbon structures are potential candidates for supercapacitor-based energy storage systems because they offer high specific capacitances (332–73 F g^{-1} at 0.5 A g^{-1}), good cycling stabilities and a maximum energy density of 16 W h kg^{-1} at a power density of 250 W kg^{-1}.

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Role of ABA and CaO in *triticum monococcum* callus gluten amounts decreased

Ismail Bezirganoglu[a,] Sinan Ata[b], Büşra Yazıcılar[a], Merve Simsek Geyik[a], Hayrunisa Nadaroglu[c,d]

[a]Department of Molecular Biology and Genetics, Erzurum Technical University, 25050 Erzurum, Turkey.

[b]Department of plant nutrition and soil science, Faculty of Agriculture, Ataturk University, 25240 Erzurum, Turkey

[c]Department of Food Technology, Vocational College of Technical Sciences, Ataturk University, 25240 Erzurum, Turkey

[d]Department of Nano-Science and Nano-Engineering, Institute of Science, Ataturk University, 25240 Erzurum, Turkey

ismail.bezirganoglu@erzurum.edu.tr

Abstract

Einkorn (*Triticum monococcum* L. ssp. *monococcum*) is a diploid ($2n = 2x = 14$) primitive wheat and a close relative of durum (*Triticum turgidum* ssp. *durum*) and bread (*Triticum aestivum* ssp. *aestivum*) wheats. In this study, two ecotype (*İncedere* and *Kürekdere)* were used as the material for the response to CaO nanoparticule and ABA applications. The mature seeds were sterilized with 1% NaOCl for 5 min, washed several times with sterile distilled water and rinsed with several changes of sterile distilled water overnight at 4 °C. Coytledons or leaves were explanted to in vitro medium from two weeks old plants onto hormone-free MS medium (Murashige and Skoog 1962). The cotyledon and leaf explants were incubated in total darkness at 25 ± 1 °C temperature for one month. After one months, callus formation was assessed and used for *Cuprac*, TOS, DPPH, PPO activity studies and gluten amounts as well. The two tested Einkorn *Triticum monococcum* ecotypes varied in their CaO and ABA in response to first and second week. Incedere ecotype were observed for better gluten amount in presence of 10 mM ABA; similarly, the Kurekdere ecotype responded with better gluten amount in the 10 mM ABA+0.5 ppm CaO in vitro media. In terms of *Cuprac*, TOS, DPPH, PPO activities, it was found that the CaO+ABA treatment was significant, and it showed a high correlation with the resistance degrees of ecotypes. The activity of *Cuprac* was strongly linked to 10-50 ml CaO concentrations.

Key words: Einkorn, CaO+ABA, nanoparticule, gluten amount, *in vitro* assay

The Synthesis and Characterizations of Silver@Carbon core-shell structure for potential application of oxygen evaluation reaction

Soner ÇAKAR[a,b],

[a]*Zonguldak Bulent Ecevit University, Department of Chemistry, 67100 Zonguldak, Turkey*

[b]*Sakarya University, Biomaterials, Energy, Photocatalysis, Enzyme Technology, Nano & Advanced Materials, Additive Manufacturing, Environmental Applications and Sustainability Research & Development Group (BIOENAMS R & D Group), 54187 Sakarya, Turkey*

E-mail : cakarsoner@gmail.com

Despite the developing world and increasing population, the rapid depletion of clean water resources and the increasing need for energy are the main problems of today. Electrolysis of water to oxygen and hydrogen is a cornerstone in the transformation of our petrochemical based society toward a future based on sustainable chemicals and fuels. Oxygen evaluation reaction (OER) is a reaction that causes molecular oxygen production through chemical reaction. OER can occur in ways such as the oxidation of water during photosynthesis with oxygen, electrolysis of water to oxygen and hydrogen, and electrocatalytic oxygen production from oxides and oxoacids [1]. Catalyst development for OER, one of the most important steps in renewable energy technologies, has found an intensive field of work in recent years. Although the noble metal oxides (especially Ru and Ir oxides) have shown the best OER activities, studies on the OER capacities of low-cost and chemically stable metal oxides have accelerated in recent years due to the fact that these metal oxides are expensive and rare [2]. In this study, the coating of the carbon structure synthesized from glucose around the Ag core, the core shell catalysis structure was synthesized. Then, XRD and TEM characterizations of these synthesized samples were carried out. These synthesized samples were coated on ITO glass and OER capacities were determined under light in OER experimental setup. I-V curves and Tafel curves were used to determine the OER capacities.

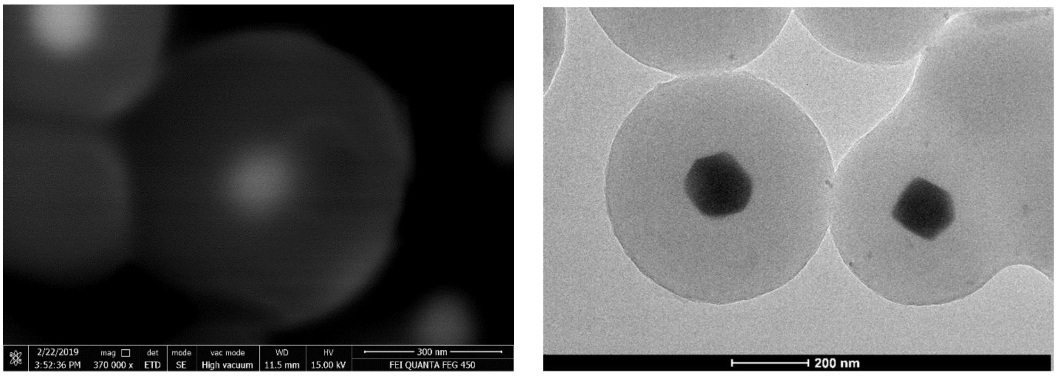

Fig. 1. FE-SEM (A) and TEM (B) images of Ag@C core shell.

Acknowledgement: This study was supported by the Zonguldak Bülent Ecevit University (BAP), (Project Number: 2019-72118496-06).

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Electrochemical properties and solar cell assembly of highly efficient 4-ferrosenilfenoksi ftalonitril substituted Zn-phthalocyanines

Şeyma Nur YILDIRIR[1], Nuray ARSLAN[1], Yiğitcan DEMİRCİ[2,3], Soner ÇAKAR[3,4,*], Altuğ Mert SEVİM[1], Mahmut ÖZACAR[2,3], Ahmet GÜL[1]

[1]Istanbul Technical University, Department of Chemistry, 34469 Maslak, Istanbul, Turkey

[2]Sakarya University, Faculty of Science & Arts, Department of Chemistry, 54187 Sakarya, Turkey

[3]Sakarya University, Biomaterials, Energy, Photocatalysis, Enzyme Technology, Nano & Advanced Materials, Additive Manufacturing, Environmental Applications and Sustainability Research & Development Group (BIOENAMS R & D Group), 54187 Sakarya, Turkey

[4]Zonguldak Bulent Ecevit University, Department of Chemistry, 67100 Zonguldak, Turkey

E-mail : cakarsoner@gmail.com

While population and the need for energy is increasing in the world on the one hand, the demand for renewable energy is increasing day by day due to the depletion of natural resources on the other hand While both population and the need for energy in the world increases, the demand for renewable energy is increasing day by day due to the depletion of natural resources [1]. Solar energy is remarkable as it is an endless energy source among renewable energy sources. Solar cells are device that convert the energy they receive from the sun into electrical energy Solar cells are devices that generate electrical energy by the energy they receive from the sun [2]. The use of non-toxic materials and abundant in the world, in solar cells has been very interesting recently. Dye sensitive solar cells (DSSCs) are third generation solar cells, and it has an intense works area due to advantages such as low cost and easy manufacturing. Ruthenium-based complex dyes, TiO_2 semiconductor materials and I^-/I_3^- electrolyte systems are frequently used in DSSCs [3]. In this study, starting from related novel dinitrile precursors, synthesis and total characterization of new Pc dyes with Zn(II) center atom symmetrically substituted with 4-(ferrosenilfenoksi)ftalonitril were performed and their applications in DSSCs were investigated. The cyclic voltammetry (CV) and square wave voltammetry (SWV) techniques were used for the electrochemical characterization of synthesized Pc dyes. TiO_2 coated FTO substrate (photoanode), synthesized Pc dyes (sensitizers), I-/I3- redox couple (electrolyte) and Pt coated FTO substrate (counter electrode) were used in DSSCs studies. Characterization of the prepared DSSCs was performed by current density-voltage (J-V), electrochemical impedance spectroscopy (EIS) and incident photon to converted electron efficiency (IPCE) measurements.

Acknowledgement: This study was supported by the Turkish Research Council in Turkey (TUBITAK) (Project Number:119Z082), and AG and MO thank Turkish Academy of Science (TUBA) for their partial support.

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Design and Simulation of Microstrip Patch Antenna using ProsopisAfricana Carbon based Nanomaterial for X-Band Application

Auwalu Aminu Abubakar Zainab Yunusa[1,2] Sulaiman Aliyu Babale

[1]Department of Electrical Engineering, Bayero University Kano, Nigeria
[2]Department of Electrical Engineering, University of Hafr Al Battin Saudi Arabia
aaabubakar.ele@buk.edu.ng

Abstract This work presents the design and simulation of microstrip patch antenna using prosopis Africana carbon based nanomaterial. The characterization of prosopis carbon based nanomaterial was conducted in which Electrical conductivity test, thermal conductivity test, SEM and EDX test were carried out. The characterized prosopis Africana carbon nanomaterial was placed on the FR-4 substrate material before the copper patch material. The design of microstrip patch antenna using copper and FR-4 material was achieved and then compare with the design of sandwiched microstrip patch antenna using prosopis carbon nanomaterial. The CST software was used in both the simulation of the proposed design. The first model that is using copper and FR-4 material was resonates at (9.96 GHz). While the second model using prosopis Africana carbon based nanomaterial was resonates at 9.89GHz. The results obtained in this proposed design show that the design using prosopis Africana, copper and FR-4 material has the wider bandwidth compare with the design using copper material and FR-4 only. However Bandwidth, Gain and VSWR were all presented.

***Keywords*:** Patch Antenna, Microstrip Line, Prosopis Africana, Carbon material

Introduction

In wireless communication technology, the need for light weight, compact size, cost and low profile antenna has increased significantly [1]. Microstrip antennas have the advantages of being compact in size, low cost and conformal. The major draw backs of microstrip antennas are low gain and narrow bandwidth which limit them from many wireless communication system [1]. Different types of material have been used as radiating patch, or substrate material to overcome the limitations of microstrip patch antenna these includes: conducting polymer , silver nano particle ink, metal-organic conductive ink , Graphene and carbon nano tube (CNT) etc as radiating patch instead of pure metals [2]. Dielectric substrates materials mainly comprises of ceramic, semiconductor, ferromagnetic, synthetic, composite and foams. There has been growing need to explore green materials as potential replacement of metals. It therefore becomes interesting to investigate the potential application of using carbon charcoal from (prosopis Africana tree). The physical and engineering properties showed that, the seed of prosopis Africana contains a steel material which can be used for machine design and therefore has some good electrical and thermal conductivity.

In the present work the prosopis Africana carbon-based nanomaterial will be explored for potential application in as conductive patch material in microstrip patch antenna. The prosopis carbon charcoal is a cheaper, green and readily available free material.

METHODOLOGY

The antenna was designed using antenna design equations adopted by [1] and then simulated in CST as shown in Figure 1(a) and (b).

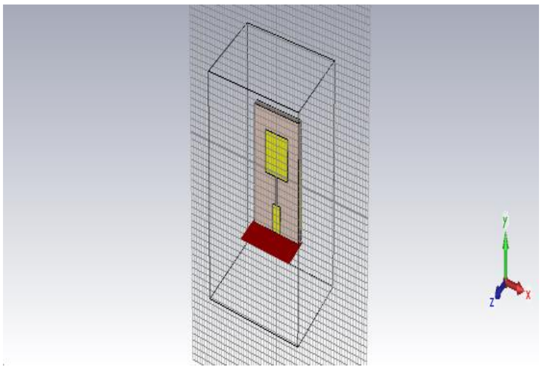


Fig. 1a. Design using Copper and FR-4

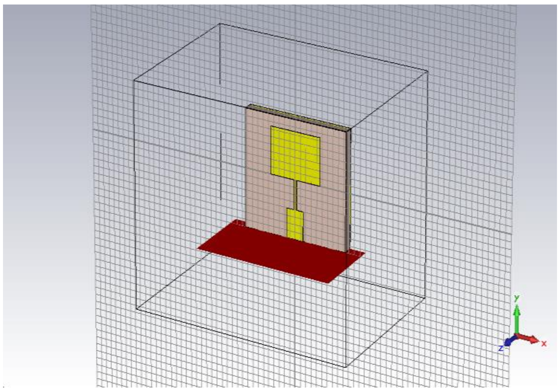
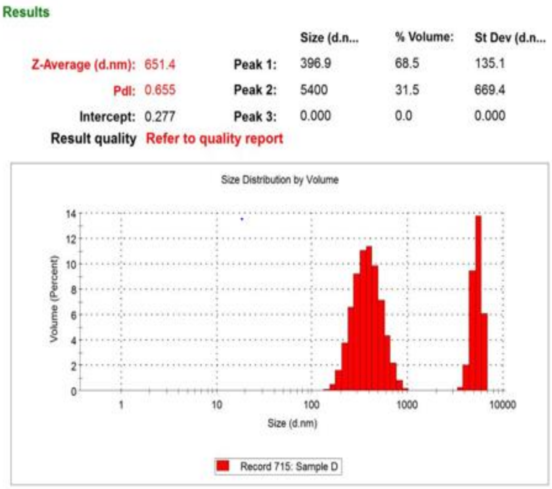


Fig. 1b. Design using Carbon Charcoal and Copper Material

RESULTS

The milled charcoal was characterized using nanosizer and then Scanning Electron Microscope which is shown in Figure 2 and 3 respectively.



Results

			Size (d.n...	% Volume:	St Dev (d.n...
Z-Average (d.nm):	651.4	Peak 1:	396.9	68.5	135.1
PdI:	0.655	Peak 2:	5400	31.5	669.4
Intercept:	0.277	Peak 3:	0.000	0.0	0.000
Result quality	Refer to quality report				

Fig. 2 Nanosize Result

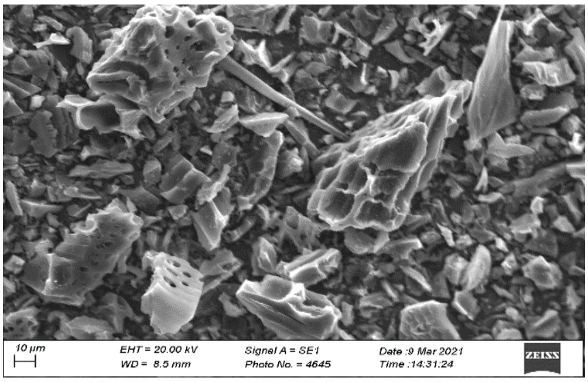


Fig. 3 SEM micrograph showing particle size from 100 nm

The simulation results of the proposed antenna, consisting the return losses, VSWR, bandwidths and gains of the MPA were summarized and presented in Table 1.

The S11 result shows that the design of MPA using copper material resonates at 9.96 GHz and -29.96db while MPA design using characterized carbon material resonates at 9.89 GHz and -16.55dB. The bandwidth obtained showed that model 1 has 502 MHz while model 2 has 614 MHz respectively. The effect of the gain is very minimal as compared with models 1 and 2. The results showed that when compared with the work of , the present model has an improvement on the bandwidth of the antenna only when compared with the gain.

Table 1. Summary and Comparison of Results

Models	Resonant Frequency	Bandwidth	Gain	VSWR	S_{11}
Model 1 (using copper & FR-4)	9.96GHz	502 MHz	2.6 dB	1.06	-29.96 dB
Model 2 (using prosopisafricana carbon, copper & FR-4)	9.89 GHz	614 MHz	2.5 dB	1.35	-16.55 dB
Benchmark work A.F Salami et al. (2017)	10GHz	500 MHz	4.6 dB	1.05	-31 dB

Conclusion

In this work the results obtained showed that, proposed model design using copper and FR-4 material is 502MHz while the design using carbon of prosopis and copper is 614MHz. This indicated that the model design using copper and charcoal material has a wider bandwidth compared with the design using copper only. And all the VSWR of the two model designs are within the standard value which is less than 2.

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Bacterial synthesis of complex GO: Ag nanoparticles and their use as a thin film on p-Si

Tuba Çakıcı [a], Murat Özdal [b] and Fevkani Yıldız[c]

*[*a] Department of Electrical and Energy, Ispir Hamza Polat Vocational School of Higher Education,
Ataturk University, 25250, Erzurum, Turkey*
[b] Department of Biology, Atatürk University, 25500, Erzurum, Turkey
[c] Department of Physycs, Atatürk University, 25500, Erzurum, Turkey

**tuba.cakici@atauni.edu.tr*

Abstract A novel approach to bacterial biosynthesis of complex nanoparticles is simple, eco-friendly, and economical. In this research, complex silver dropped graphene nanoparticles metals (GO: Ag) were reduced together via a particular type of bacteria in the Luria-Brentani medium under dark conditions for the first time. The synthesized GO: Ag nanoparticles in solution were dropped on glass and p-Si substrates and then dried to form a thin-film structure at 350oC temperature. UV-Vis has investigated the optical properties of the GO: Ag thin film. Spectrophotometer method. The indirect band gap of GO: Ag thin film was obtained as 0.75 eV. Structural characterization of the thin film was investigated by X-ray diffraction (XRD), Micro Raman, and Transmission electron microscopy (TEM) techniques. GO: Ag thin film had good nano-crystalline nature.

Keywords*: Nanoparticles, Bacterial Synthesis, *GO: Ag Nanoparticles, TEM

Introduction Researchers use many different methods (chemical, physical, and biological) to synthesize nanoparticles of the required composition, shape, and size because these factors significantly affect the material's properties. It is advantageous over chemical and physical methods as it is safe, simple, eco-friendly, cheap, reproducible, and often results in more stable materials [1-2]. Various metal nanomaterials (such as magnesium, gold, graphene, selenium, copper, zinc, silver, iron, titanium, cadmium) are being produced for electronic, textile, energy, computer, and medical food, optic, and space industries. Bacterial synthesis method, some special ones are unique to tolerate high chemical concentration. [1-3].

The bacterial synthesis method has been shown that nanoparticles and thin films can be grown on desired substrates without consuming any energy and without using expensive elements such as vacuum elements. This method allows us to obtain thin films more easily, eco-friendly, and economically without using expensive thin-film production methods.

This study first reports eco-friendly and accessible microbial biosynthesized complex GO: Ag nanoparticles. Also, we fabricated directly high-quality GO: Ag compounds thin films using these methods based on the homogeneous nucleation and growth mechanism. GO: Ag nanoparticles, synthesized as composite nanoparticles via the microbial synthesized method, sintered as a nano-thin film on glass and p-Si substrates.

Results and Discussion

To produce GO-Ag NPs in a solution, *Pseudomonas aeruginosa* OG1 strain was used. *Pseudomonas aeruginosa* OG1 strain was grown in Luria-Brentani (LB) medium at 30 °C for 24 h with shaking at 150 rpm. The cell suspension (100 µl, OD600 1) was inoculated into the Tryptic soy broth (TSB) medium (50 mL) containing 1 mM AgNO3+ 1 mM graphene oxide. They were kept under a shaking incubator at 150 rpm at 30 ℃ for 72 h. Control experiments without $AgNO_3$ and Graphene oxide were performed simultaneously. After 72 h, the culture solutions were observed to have distinctly color change at tubes.

Fig. 1. Pseudomonas aeruginosa gram-negative bacterium

After completing the fabrication of the GO: Ag Np, they sintered on glass and p-Si substrates at 300 ℃ temperature. Then GO: Ag thin films were obtained. The obtained thin films have performed the characterization of the thin film samples. We determined the optical properties and crystal structures of GO: Ag thin films by using UV-VIS spectrometer (Perkin-Elmer Lambda 2S UV-Visible spectrometer), X-rays diffractometer (XRD Bruker D2, Kα, λ=1.54 A, Scanning angle 70^o), Atomic Force Microscopy (AFM), Micro Raman Technique, Transmission electron microscopy (TEM) Technique.

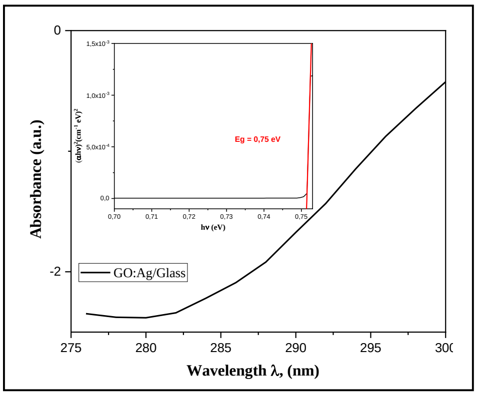

Fig. 2. $(ahυ)^2$ versus hυ and variation of optical absorbance versus the wave-length of incident photons of the as-deposited GO: Ag thin film at room temperature.

Fig. 2 shows GO: Ag thin film's optical absorption spectra measured between 200 and 1100 nm. The Eg value is calculated using $ahυ=A\ (hυ-E_g)^n$ plot by extrapolation of the linear region of the curve. As shown in Fig. 3, the value of band gap energy Eg of GO: Ag thin film is 0.75 eV.

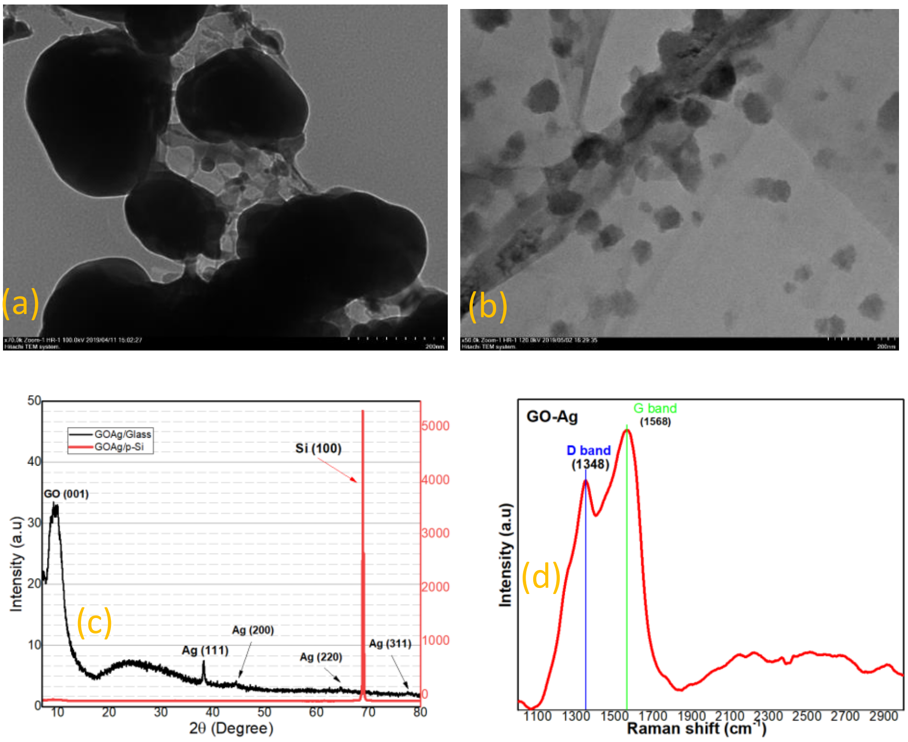

Fig. 3. Structural analysis of GO: Ag nanoparticles and nano-thin film (a) TEM image of Ag nanoparticles at 200 nm (b) TEM image of GO: Ag nanoparticles at 200 nm (c) XRD patens of the GO: Ag thin film is grown on glass and p-Si substrates (d) Micro Raman shift result of GO: Ag thin film

Table 1: The structural parameters of GO:Ag thin film evaluated on glass substrate

(hkl)	FWHM	FWHM (rad)	Intensity (a.u.)	2q (observed)	d- values (A)	Crystal size (D) (nm)	Crystal
(001)GO	2,71682	0,047417	32,45833	9,92847	8,901715296	2,935123	Hexagonal
(111)Ag	0,55367	0,009663	7,4375	38,19067	2,354642472	15,183905	Cubic
(200)Ag	0,41185	0,007188	3,53125	44,38114	2,039511949	20,832266	Cubic
(220)Ag	0,51917	0,009061	3,01042	64,60547	1,441449339	18,103698	Cubic
(311)Ag	0,57497	0,010035	2,19792	77,60219	1,22929621	17,729263	Cubic

Fig 3 (a) shows GO: Ag complex nanoparticles are synthesized via bacteria for the first time, and they have been characterized by the TEM analysis method. GO: Ag complex nanoparticles size has determined of 45-50 nm range. Fig. 3 (b) shows the XRD pattern of GO: Ag thin film deposited on the glass substrate. The five XRD peaks located at 2Θ angles, shown in Table 1, are identified and match well with the JCPDS 00-021-1016 pattern corresponding to a hexagonal phase of GO thin film. It can be seen that the GO: Ag thin film is found to have polycrystalline nature, and Ag thin film is grown in the cubic crystal structure with nano-crystalline nature. Fig 3 (d) indicates that the new graphite areas formed by Ag doping to GO are higher but smaller. According to the literature, the D peak of GO is around 1350 cm^{-1}, and the G peak is about 1580 cm^{-1} and 1600 cm^{-1} [4]. In this study, the intensity of the G peak (I_G) is greater than the intensity of the D peak (I_D). In this case, we can state that the regular structure is preserved due to the operation performed on the sample.

Conclusion GO: Ag nanoparticles were synthesized via the green biosynthesis method and used as interfacial thin films. GO: Ag thin film obtained on glass and p-Si substrates. Thin-film properties were investigated UV-Vis. Spectrophotometer method, TEM, XRD, and Raman Analysis showed that GO: Ag thin films were obtained successfully. XRD graph indicates that GO: Ag thin films have polycrystalline nature. TEM images revealed that the Ag and GO: Ag nanoparticles have nanoscale sheeted and spherical structures. Raman Analysis shows that GO: Ag's D peak of GO is around 1350 cm-1, and the G peak is around 1580 cm-1 and 1600 cm^{-1}. (I_D/I_G=0.85). The literature confirms this result

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Using of Nanotechnology for Photovoltaic Solar Energy Cells

Hüseyin GÜLLÜCE

Address: Department of Machine and Metal, Vocational College of Technical Sciences,
Ataturk University, 25240, Erzurum, Turkey

E-mail: hgulluce@atauni.edu.tr

Abstract

It is very important to obtain energy from renewable energy sources at this time when energy consumption is increasing rapidly and environmental pollution has reached significant dimensions. Solar energy is one of these sources. Recently used photovoltaic systems are very important in the supply of electrical energy.

The low efficiency of photovoltaic panels used to generate electricity is one of the most important disadvantages of these systems. The efficiency of photovoltaic cells is greatly affected by both the materials used to convert the incoming solar energy into electrical energy and the surface pollution. The use of nanomaterials has recently increased considerably to increase efficiency. Studies are carried out on self-cleaning materials in order to reduce the reflection of incoming rays and to ensure that the energy is selectively absorbed by the surface and to prevent surface pollution. Nanotechnology makes very important contributions to the design and production of thin-film PV cells. PV cells developed using nanomaterials will continue to reduce the cost of commercial solar cells using cheaper raw materials. Nanomaterials have some desirable properties such as high catalytic activity, better stability in aqueous media, relatively easier preparation techniques, and material economy.

In this study, information is given about nanomaterials used in photovoltaic cells and efficiency-enhancing studies in PV technology.

Keywords: solar nanotechnology, solar energy, photovoltaic, increased efficiency

Introduction

The rapid increase in the world population and the rapid development of the industry are increasing the need for energy. The consumption of fossil fuels used to meet the world's energy needs both causes the depletion of these limited resources and increases environmental pollution due to harmful gas emissions to the environment. Due to the rapid increase in the world's atmospheric temperature, the Paris Agreement, which was accepted at the United Nations Framework Convention on Climate Change in December 2015 and to which our country is a party, guides the whole world in the transition to renewable energy on a global scale (1). Renewable energy sources, whose investment costs are significantly reduced in order to limit fossil fuel consumption, are the most important alternative energy sources. Photovoltaic panels are the most commonly used product for converting solar energy into electricity. For this reason, a wide range of studies are carried out in the world to increase the efficiency of PV panels. For this purpose, one of the most studied subjects is nanomaterials.

Nanotechnology used in PV cells

Nanoparticles typically consist of solid particles with dimensions ranging from 1 to 100 nm. They have advanced thermo-physical properties such as viscosity, thermal conductivity, convective heat transfer coefficients and optical properties. Nanofluids are the process of obtaining a new heat transfer fluid by adding nanoparticles to heat transfer fluids. In Table 1, the thermal values of the widely used nanoparticles are given. Types of nanoparticles (2) are; Metals: Al, Ag, Fe, Cu, Zn,Au; Metal oxides: MgO, ZnO, CaO, CuO, CuO_2, Al_2O_3, Fe_3O_4, TiO_2, SiO_2, Fe_2O_3; Carbon based: Graphene, Fulleneres, Carbon nanotubes (SWCNT,MWCNT); Nanocomposites: Polymer matrix (polymer/CNT, Polyster/TiO_2), Ceramic matrix (Al_2O_3/SiC, Al_2O_3/TiO_2, Al_2O_3/CNT, Al_2O_3/SiO_2), Metal matrix (Ag-MgO, FeMgO, CoCr).

Table 1- *Thermal values of commonly used nanoparticles*

Solids	$k_{c(p)}$(W/mK)	Liquids	$k_{c(f)}$(W/mK)
Silver	427	**Water**	0.613
Copper	395	**Ethylene glycol**	0.253
Aluminum	237	**Engine oil**	0.145
Carbon nanotubes	3200-3500	**Alcohol**	0.115
Brass	120	**Glycerol**	0.285
Nickel	91		
Alumina	39		

Use of Nanoparticles in PV Cells

Conventional solar cells have two main disadvantages. First, low efficiency is almost inevitable in silicon cells. This is because incoming photons or light must have the right energy, called band gap energy, to hit an electron. If the photon has less energy than the band gap energy, then it will pass. If it has more energy than the band gap, this extra energy will be wasted as heat. These two effects alone constitute the loss of approximately 70 percent of the radiation energy incident in the cell. The second is the high production cost. Most of the nanoparticle atoms are usually on the surface. This means that the surface interactions nanoparticle property dominates the material behavior and they often have different properties from the same material. Nanostructured layers have three important advantages. First, due to multiple reflections, the effective optical path for absorption is much larger than the actual film thickness. Second, it allows electrons and holes produced by light to be transmitted via a much shorter path, thereby greatly reducing recombination losses. The absorber layer thickness in nanostructured solar cells can be as thin as 150 nm. Third, by varying the size of the nanoparticles, the energy band gap of the various layers can be made to the desired design value. Being able to use thin films requires much less material and reduces costs. (3).

In conventional solar cells, ultraviolet light is filtered or absorbed by silicon, converted into heat, not electricity. Integrating silicon nanoparticles in 1-nanometer size directly into silicon solar cells increased power performance by 60 percent in the ultraviolet range of the spectrum. Efficiency can be increased by increasing the amount of absorption according to the wavelength of the incoming light with various forms of nanoparticles.

Nanofluid Applications in PV Cells

In addition to the low efficiency of the PV system, the high ambient temperature also reduces the efficiency. Different nanofluids are used as refrigerants in order to increase the efficiency more and to increase the amount of electrical energy to be produced. In hybrid systems used to cool the panels with fluid, both electricity is produced and the heat obtained is used according to the need. In general, it is to increase efficiency thanks to the cooling process made with pipes placed under the PV panels. Various researches are carried out by changing the shape, diameter, material, type and amount of nanofluid passing through the cooling pipes. Different design shapes and usage are shown in Figure 1.

Self-cleaning and anti-reflective nano coatings

One of the most important factors affecting the efficiency of PV cells is rainy weather and sedimentary deposits on the surface of solar cells (4). Advances in technology and the creation of nanometer layers with self-cleaning and anti-reflective properties are crucial. Titanium oxide nanoparticles, which can trap organic compounds such as hydrocarbons by blocking the ultraviolet wavelengths of sunlight, can keep solar cell surfaces clean by reducing fossil fuel emissions and preventing their pollution.

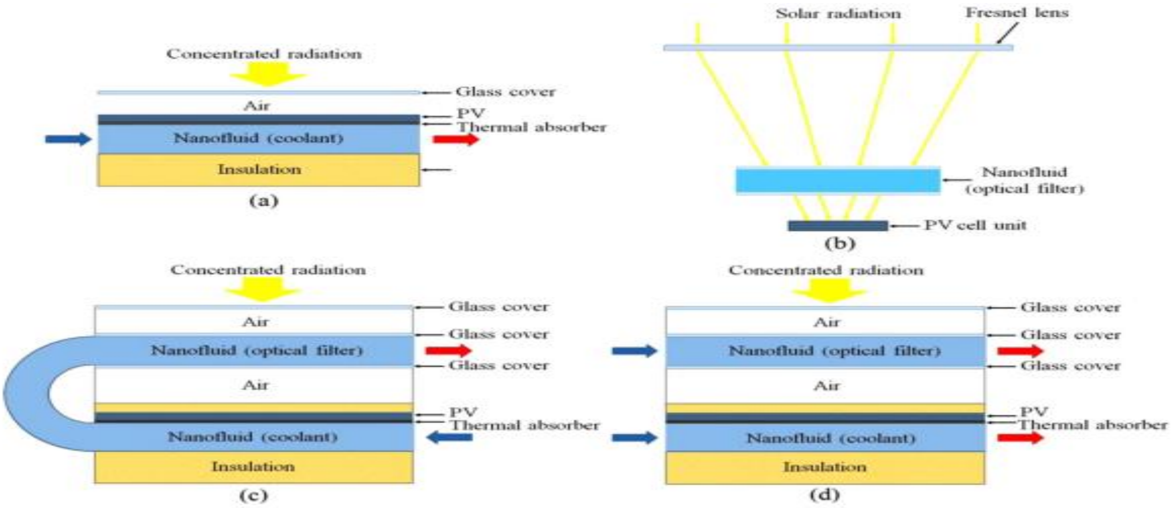

Figure 1- *Schematic diagram, cooling of PV cell with nanofluid, using nanofluid as an optical filter, using* nanofluid *as both optical filter and cooler, using nanofluid as both optical filter and cooler with separate channels (5).*

Results and Discussion

In our country and the world, which has very important values in terms of sunbathing time, the low efficiency of photovoltaic panels used to generate electricity from the sun causes the energy unit cost to increase and the recovery times of the investments made to be long. Studies show that nanomaterials will cause both increased material efficiency and reduced production costs. Therefore, in order to produce different green, cheap and commercially usable materials and systems, studies should be increased and continued.

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Design and Simulation of multi-slot graphene-based microstrip patch antenna for X-band Application

Zainab Yunusa[1,2] Aminu Atiku Shehu[1], ,Sani Aliyu Babale[1]

[1]Department of Electrical Engineering, Bayero University Kano,
Kano, Nigeria, [2]University of Hafr Al Batin, Saudi Arabia

E-mail: aashehu@gmail.com / zee2yunusa@gmail.com

Abstract

Microstrip patch antennas may be made from a variety of materials with varying dielectric constants. In this article, a modified multi-slot patch multiband antenna simulated using CST. Graphene material is used and studied at X and Ku band frequencies . Due to high conductivity of graphene, it becomes interesting to use it as a conductive patch material so as to replace copper and other metal conductors and also to enhance the antenna's bandwidth and radiation efficiency. Different sizes of slot cuts were created on the patch. The antenna is made of Duroid RT5880 (lossy) material with a dielectric constant of 2.2 that is sandwiched between a graphene patch and a ground plane. The effects of the different slots sizes were studied as well as defected ground structure and the results obtained showed that the 1mm by 4mm slot gave the highest bandwidth of 1114 MHz and a gain of 6.98 dB. The antenna resonated at 11.22 GHz which showed that it has potential application at the X band frequency.

Keywords: Graphene, X-Band, Ku-Band, Slots

Introduction

The microstrip antenna (MPA) has been said to be the most innovative area in the antenna engineering. The idea of microstrip antenna was first presented in year 1950s but it only got serious attention in the 1970s [1,2]. The positive features that made the microstrip antenna prominent are relatively easy to build, inexpensive, lightweight and extremely thin protrusion from the surface. These MPAs have a popular frequencies range of above 100 MHz. The patch antenna is made on a dielectric substrate [3].

Nanotechnology symbolizes a revolutionary path of technological development that concerns the management of material at the nanoscale (1 billion size smaller than a meter) [4]. It factually means technology on the nanoscale that has numerous applications in the real world. Nanotechnology literally encompasses the fabrication and application of chemical, physical and biological systems at a scale ranging from single molecules or atoms to submicron levels and integrating these resulting nanomaterials into a larger system [5]. Nanomaterials are materials of nanosized thickness, i.e., less than 100nm in thickness. Materials with any external dimension in the nanoscale or having internal structure or surface structure in nanoscale. Nanomaterials often fall into different dimensional categories, be it 2D, 1D or 0D such as graphene [6].

Graphene is rapidly becoming an exceptionally interesting choice for vast variety of electronic components, circuits, systems and devices such as frequency multipliers, metamaterials, organic electronics, high frequency field effect transistors (FET), wireless nano-sensors, modulators, transparent solar cells and devices operating in terahertz band. [7]. It has an outstanding performance with much less power consumption, and option of fabrication process using a technology like the advanced silicon device (CMOS) fabrication [1, 2].

Bandwidth enhancement is a major requirement for the practical application of microstrip patch antennas [8]. Exploiting a material with a lower dielectric constant, partial grounding, creating and/or enlarging the antenna's inset gap, and using the defective ground structure (DGS) are all examples of bandwidth enhancement techniques [7,9]. In this paper, adjacent slots were introduced to the patch which significantly enhances the antenna bandwidth. The frequency ranges as defined in 2002 by IEE Standard is the X-Band range varies from 8 to 12 GHz . This frequency range is widely used in applications such as radar applications, air traffic control, military satellite, weather forecasting and monitoring, radio-determination purposes, defense and tracking vehicle speed for law enforcement [10].

Results and Discussion

The results are presented and summarized in Table 1. Seven different models were designed and simulated as seen from the Table. Results obtained were presented based on the different antenna performance parameters which includes S11, VSWR, Gain, Directivity, Bandwidth and the Resonance frequency. It could be observed from the Table that model 2 has the highest bandwidth of 1114 MHz and a gain of 6.98 dB Whereas model 6 had the lowest bandwidth of 702 MHz. Similarly, model 3 had the lowest gain of 5.86 dB.

Table 1 Summary of Results for X band

No.	Model	S11	VSWR	Rf (GHz)	Gain (Db)	Directivity (Dbi)	BW (MHz)
1	Conventional	-25.4	1.04	11.22	6.75	7.07	770
2	1mm by 4mm slot	-24.54	1.13	11.46	6.98	7.32	1114
3	2*1mm by 4mm slots	-35.56	1.03	11.69	5.86	6.17	896
4	3*1mm by 4mm slots	-16.72	1.34	11.64	6.54	6.87	814
5	DGS	-13.94	1.50	11.54	6.96	7.37	736
6	DGS + Partial Ground	-13.52	1.53	11.57	6.94	7.36	702
7	Partial Ground	-16.20	1.37	11.66	6.44	6.78	789

Conclusion

The Microstrip antenna with multiple slots on the patch and defect in the ground plane is designed and analyzed. Thus, designed antenna shows good results in terms of bandwidth and operates in two bands X and Ku, hence a multiband MPA. The simulation results produced a bandwidth of 1114MHz with corresponding peak gain of 6.98 dB when RT5880 was used as the substrate. In addition, the VSWR is 1.03 which is less than 2.0. This suggests a good matching between transmission line and the patch element. The results obtained for all the seven models suggests that the MPA is suitable for X-band applications.

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Synthesis of Nano-clays-based Drugs, Progression of the Pharmaceutical Industry

Shahriyar Karimdoust[a]*, Ekrem Kalkan[b], Yousef Vasigh[c], Beheshteh Gharibi[d]

[a] Payame Noor University, Department of geology, Ardebil, Iran
[b]Ataturk University, Engineering Faculty, Department of Geological Engineering, Erzurum, Turkey
[c]Islamic Azad University, Department of Geography, Ardabil Branch, Ardabil, Iran
[d]University of Medical Sciences and Health Services, Central Laboratory, Ardabil, Iran
E-mail: karimdoust_sh@yahoo.com

Abstract

Nanotechnology has grown significantly in recent years, especially in the medical field. This new and valuable technology, with the synthesis and introduction of a new drug system, has taken a huge change and a fundamental step in the discussion of treatment and health. The preparation and production of drugs based on natural and mineral compounds and the drug delivery system to specific organs of the body is an example of the fruit of this technology in the field of pharmacy. Mineral drugs (unlike chemical drugs) do not have any negative or destructive effects on various organs of the body. Nano-clays - with their unique properties - are an example of such mineral drugs, which today play a very important role in the pharmaceutical industry and are one of the most basic nanotechnology tools in the modern pharmaceutical industry. Pharmacists hope to mass-produce this drug to achieve promising results in the treatment of specific and incurable diseases such as cancer. The result is that with extensive research on mineral drugs, a new step can be taken in the preparation and production of new organic therapies.

Keywords: Nanotechnology, Nano-clays, Pharmaceutical Industry, Bentonite

Introduction

Nanotechnology has grown significantly in recent years, especially in the medical field. This new and valuable technology, with the synthesis and introduction of a new drug system, has taken a huge change and a fundamental step in the discussion of treatment and health. The preparation and production of drugs based on natural and mineral compounds and the drug delivery system to specific organs of the body is an example of the fruit of this technology in the field of pharmacy that has transformed the world of the pharmaceutical industry (Fig. 1).

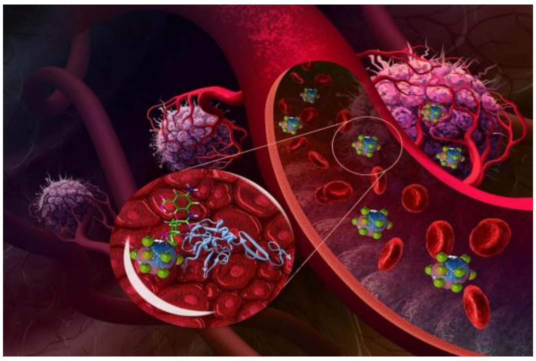

Fig. 1. Nanotechnology for Drug Delivery Applications

The new drug system has no adverse effects on other organs of the body and is compatible with the body's biological environment. Clay minerals are among the most important natural materials used in the preparation and synthesis of drugs of modern pharmaceutical technology. Clay minerals are a group of phyllosilicates or sheet silicates minerals that are very important in the pharmaceutical and nanotechnology industries for various reasons such as abundance, low cost, excellent adsorption properties, etc (Fig. 2).

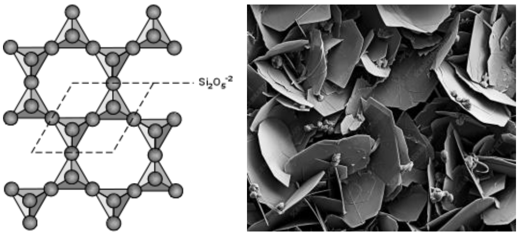

Fig. 2. The mineral structure of phyllosilicate

Pharmacists hope to mass-produce this drug to achieve promising results in the treatment of specific and incurable diseases such as cancer (Carretro and Gomes, 2006; Murray, 2007; Savjami et al., 2012). Nano-clays are a group of minerals that are at least one nanometer in size. This group of minerals has attracted the attention of nanotechnology scientists due to its unique properties (Fig. 3). By purifying, modifying and optimizing nano-clays, valuable medicinal composites can be obtained that play an important role in health. Extensive production of mineral therapists using nanotechnology, which not only has no side effects but also provides minerals needed by various organs of the body, will be an essential step in ensuring human health.

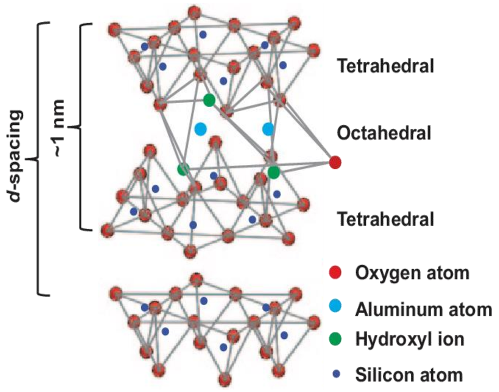

Fig. 3. Structure of nano-clay (Montmorillonite)

Results and Discussion

Nano-clays are a group of minerals that are at least one nanometer in size. This group of natural materials has been considered by many nanotechnology scientists due to its special structural properties, cheapness and expansion and abundance. The advent of nanotechnology, despite its infancy, has been accompanied by major changes in medicine and health. Modification of various properties of materials by changing ions, impregnation with metal elements and treatment with acids in this technology, has provided natural drugs without side effects to the pharmaceutical industry. Preparation and production of drugs based on natural and mineral compounds and drug delivery system to specific organs of the body is an example of the fruit of this technology in the field of pharmacy that has changed the world of pharmaceutical industry and has eliminated the damage caused. Unlike chemical drugs, these mineral drugs do not have any adverse effects on other organs of the body. Addition of effective drugs between cavities and structural spaces of clay mineral layers after refining and modification processes as well as strengthening structural cavities by various physical and chemical methods and finally preparation of mineral therapeutic nano-fibers is main method of synthesis of these drugs (Savjami et al., 2012; Kaur and Datta, 2014) (Fig. 4). The basic properties of drug carriers (such as nano-clays) are that they protect the drug against degradation, increase its absorption efficiency by facilitating its distribution through the intestinal membrane, and modulate tissue distribution by modulating body functionThe result is that by conducting extensive research on mineral drugs, a fundamental step can be taken in the preparation and production of new organic therapies.

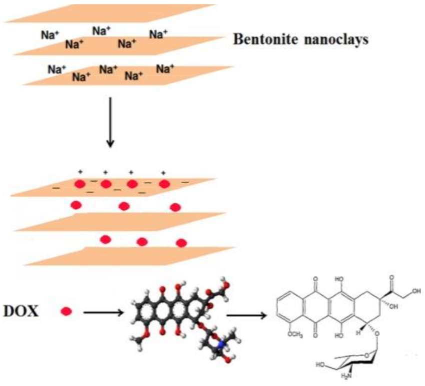

Fig. 4. Addition of effective drugs between cavities and structural spaces of clay mineral layers (bentonite)

Conclusion

Preparation and production of drugs based on natural and mineral compounds and drug delivery system to specific organs of the body is a product of this technology in the field of pharmacy that has changed the world of pharmaceutical industry and has eliminated the damage caused. The result is that with extensive research on mineral drugs, a new step can be taken in the preparation and production of new organic therapies.

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The Effect of Nano-clay on Human Gastrointestinal Health

Shahriyar Karimdoust[a]*, Ekrem Kalkan[b], Yousef Vasigh[c], Yavar Nourmohammadi Ziba[d]

[a]*Payame Noor University, Department of geology, Ardebil, Iran*
[b]*Ataturk University, Engineering Faculty, Department of Civil Engineering, Erzurum, Turkey*
[c]*Islamic Azad University, Department of Geography, Ardabil Branch, Ardabil, Iran*
[d]*Islamic Azad University, Department of Chemistry, Ardabil Branch, Ardabil, Iran*
E-mail: karimdoust_sh@yahoo.com

Abstract

Nano-clays are a group of minerals that are at least one nanometer in size. This group of minerals due to their unique properties has attracted of nanotechnology scientists. The various pathogens and toxins that infect body cells in the mucous membranes of the intestine and stomach are bioelectrical positively charged and strongly absorbed by the negative structural charge of nano-clay, thus preventing the accumulation of pathogens. By purifying, modifying and optimizing nano-clays, valuable pharmaceutical composites can be obtained that play an important role in gastrointestinal health. Extensive production of mineral therapists using nanotechnology, which not only has no side effects but also provides the minerals needed by various organs of the body, will be an essential step in ensuring the health of the gastrointestinal tract.

Keywords: Nano-clays, Gastrointestinal Diseases, Nanotechnology

Introduction

Nano-clays are a group of minerals that are at least one nanometer in size. This group of natural materials has attracted the attention of many nanotechnology scientists due to its special structural properties, cheapness and expansion and abundance (Fig. 1). The advent of nanotechnology, despite its infancy, has been accompanied by major changes in medicine and health. Modification of various properties of materials by changing ions, impregnation with metal elements and treatment with acids in this technology, has provided natural drugs without side effects to the pharmaceutical industry (Awasthi et al., 2019).

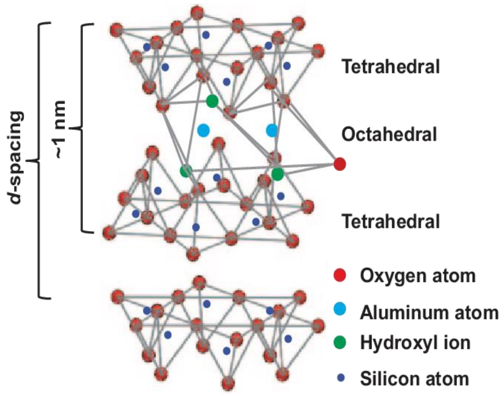

Fig. 1. Structure of nano-clay (Montmorillonite)

Nano-clays are a group of these natural and uncomplicated therapists who, due to their very high specific surface area and excellent absorption properties, can take a very serious and effective step in protecting the tissues and mucosa of the human gastrointestinal tract. Accumulation of bacteria, pathogens and various toxins that infect the body's cells in the mucous membranes of the intestine and stomach is an important factor in causing gastrointestinal diseases and even cancer (Fig. 2).

Absorption and repulsion of these disease agents by modified nano-clay is the main goal of researchers in the field of medical nanotechnology. Purification, modification and optimization of clay minerals are among the processes performed for the preparation and synthesis of nano-clays (del Hoyo et al., 1996; Carretero et al., 2006).

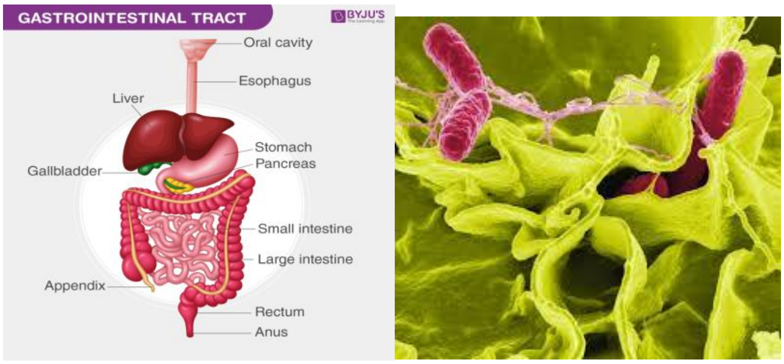

Fig. 2. Accumulation of bacteria in the mucosal tissue of the gastrointestinal tract.

Results and Discussion

Bacteria and pathogens are bioelectrical positive and strongly absorbed by the negative structural charge of nano-clay, thus preventing the accumulation of pathogens. Pure and modified nano-clay with high specific surface area and strong adsorption property by creating a coating of natural and uncomplicated materials on the gastrointestinal mucosa on the one hand by absorbing and dispersing pathogens in the gastrointestinal mucosa and on the other hand, by providing the minerals needed by the body has a very valuable role in ensuring the health and function of the gastrointestinal tract (Fig. 3).

Preparation of nano-particles absorbing pathogens from the gastrointestinal tract begins with the processes of mechanical crushing and pulverization and then continues with the extraction and purification of clay minerals by chemical processes. Increasing the distance between the layers of pure clay minerals is the most important step in the preparation of nano-clay. By performing the mentioned steps, the absorption power is increased and the mucosa of the gastrointestinal tract is cleansed with optimal efficiency.

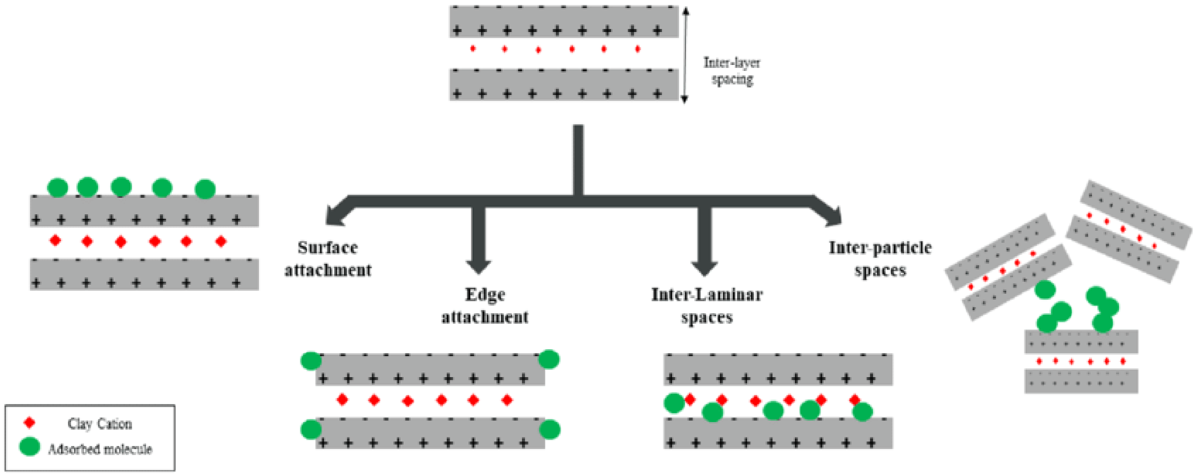

Fig. 3. Schematic diagram of adsorption by nano-clay adapted from Awasthi et al., 2019

Conclusion

Nano-clays are a group of minerals that are at least one nanometer in size. This group of minerals due to their unique properties has attracted of nanotechnology scientists. Pure and modified nano-clay with high specific surface area and strong adsorption property by creating a coating of natural and uncomplicated materials on the gastrointestinal mucosa on the one hand by absorbing and dispersing pathogens in the gastrointestinal mucosa and on the other hand, by providing the minerals needed by the body has a very valuable role in ensuring the health and function of the gastrointestinal tract. Extensive production of mineral therapists using nanotechnology, which not only has no side effects but also provides the minerals needed by various organs of the body, will be an essential step in ensuring the health of the gastrointestinal tract.

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Use of Nano-clays to Isolate Municipal Landfills

Parisa Nami[a*], Günay Kaya[b], Shahriyar Karimdoust[c]

[a]*Payame Noor University, Department of geography and urban planning, Maragheh, Iran.*
[b]*Atatürk University, Department of geography, Erzurum, Turkey.*
[c]*Payame Noor University, Department of geology, Ardebil, Iran*
E-mail: parisanamii@gmail.com

Abstract

Nanoclays are natural minerals that have at least one nanometer in size. With the advent of new nanotechnology, these minerals, with their unique properties, have taken a very important place in this new technology. By making changes in ions, impregnation with metal elements, treatment with acid, valuable mineral minerals and composites can be obtained. High specific surface area, excellent adsorption capacity, unique geological properties, no harmful side effects are among the positive points of these minerals that have put them in the spotlight of various industries. Recently, environmental pollution caused by human societies, and the problems caused by them, have been discussed in scientific circles of countries. The most important type of this pollution is solid waste pollution. One of the most important applications of nanoclay is to use the properties of these natural and valuable nanostructures in solving environmental problems caused by urban waste and isolating landfills in urban communities. In most cities, landfills and solid wastes do not have specific environmental standards, and therefore leachate from this waste has caused acute environmental problems by leaking and infiltrating the network of underground waterways and adjacent soils. The use of a natural barrier and a cheap and affordable nanostructured barrier is of great scientific importance. Bentonite is a type of clay that is composed mostly of the mineral montmorillonite, a mineral with unique properties that can act as a natural, mineral blocker to prevent leachate from leaking into municipal landfills. Sodium or swollen bentonite, with a property of more than 20 times its volume, is the most environmentally friendly nanostructure. By performing purification and modification, it is possible to create environmentally friendly mineral dams from sodium bentonites, which have been very resistant and effective against leakage and infiltration of leachate from municipal landfills.

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Nanoclays; Valuable Mineral Compounds in the Medical and Pharmaceutical Industries

Parisa Nami*[a], Günay Kaya [b], Shahriyar Karimdoust[c], Beheshteh Gharibid [d]

[a]*Payame Noor University, Department of geography and urban planning, Maragheh, Iran.*
[b]*Ataturk University, Department of geography, Erzurum, Turkey.*
[c]*Payame Noor University, Department of geology, Ardebil, Iran.*
[d]*University of Medical Sciences and Health Services, Central Laboratory, Ardabil, Iran.*

E-mail: parisanamii@gmail.com

Abstract

Clay minerals are aqueous alumino-silicate that are the product of previous weathering and decomposition processes. From ancient times, they have had a special place in various industries and in traditional medicine. The application of clay depends on its internal structure and chemical composition, and these materials are composed of layers of oxygen ions and oh, which by placing different actions such as a, b, c and d in the interlayer structure, a network Form a regular atom, the result of which is the placement of negative charges on the surface of their crystal structure. Bioelectric research has shown that toxins and pathogens accumulate as a positive charge in various tissues of the body. Due to the negative effects on the structural surface of clays, with high adsorption power and high specific surface area, they can be used as an organic adsorbent and natural purifier for purification and cleansing of body organs. Nano-clay, provided it is pure, has no side effects on various organs due to its organic nature. Humans with internal and external use of these mineral compounds, in addition to absorbing and purifying cellular toxins, also benefit from the supply of actions needed by the body. But pure nanoclay is not only a natural healer and has no side effects, but it is the most important and rich supplier of actions and essential and vital elements of various organs of the body. As a result, by substituting mineral drugs instead of chemical treatments, a fundamental step can be taken in human health.

Keywords: ***Nanoclays, Nanotechnology, Medical and Pharmaceutical Industries.***

Introduction

Nanotechnology has grown significantly in recent years, especially in the field of medicine. This new and valuable technology, with the synthesis and introduction of a new drug system, has taken a huge change and a fundamental step in the discussion of treatment and health. Preparation and production of drugs based on natural and mineral compounds and drug delivery system to specific organs of the body is an example of the fruit of this technology (Fig1).

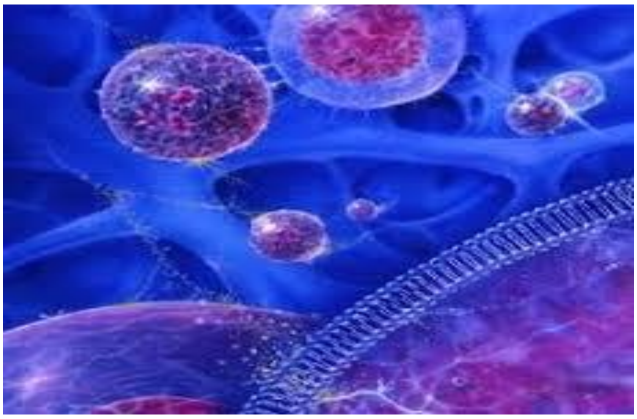

Fig1: Intelligent drug delivery system by nanotechnology.

Nanoclays are natural minerals that have at least one nanometer in size. With the advent of new nanotechnology, these minerals, with their unique properties, have taken a very important place in this new technology (Fig2). Modification of various properties of materials by changing ions, impregnation with metal elements and treatment with acids in this technology has provided natural drugs without side effects to the pharmaceutical industry

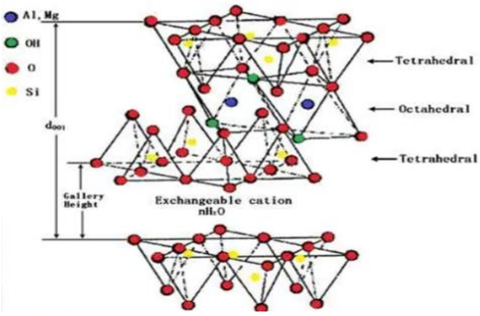

Fig2: Atomic structure of nanoclay.

Addition of effective drugs between cavities and structural spaces of clay mineral layers after refining and modification processes as well as strengthening structural cavities with various physical and chemical methods and finally preparation of mineral nano-fiber therapy is the main method of synthesis of these drugs (Fig3).

Purification of clay minerals, increasing the distance between layers, modification and optimization are the processes that are performed on them in order to increase the productivity and efficiency of nanoclays.

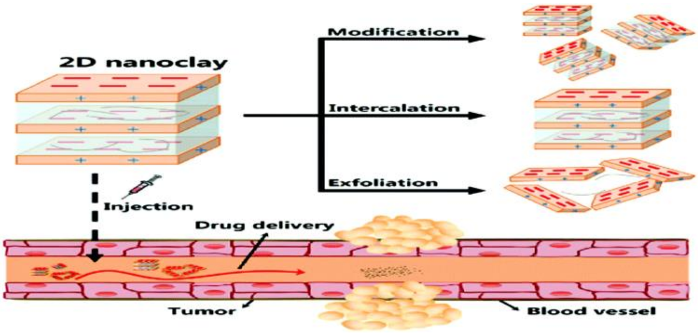

Fig3: Structural process and drug delivery performance in nanoclay.

Results and Discussion

The result is that with extensive research on mineral drugs, a new step can be taken in the preparation and production of new organic therapies.

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Antiglycating potential of zinc oxide nanoparticle and its interaction with BSA

Dinesh Kumar, Ahmad Ali

Department of Life Sciences, University of Mumbai, Mumbai 400098, Maharashtra, INDIA

ahmadali@mu.ac.in

Abstract:

Nanoparticles have become a great potential tool as biosensors, therapeutic agents, and drug delivery vehicles. In this study, the chemically synthesized zinc oxide nanoparticles (ZnO NPs) have been characterized with UV-spectrophotometer, FTIR, XRD, TEM and DLS. These ZnO NPs were investigated with respect to their binding interaction with serum albumin and thermodynamic parameters of these interactions at different temperatures. Glycation process was checked in the presence of ZnO NPs by measuring fructosamine and carbonyl content for glycated end products and aggregation by Congo red assay. The intrinsic activities of bovine serum albumin (BSA) like esterase and cysteine reactivity were also evaluated in the presence of ZnO NPs. The results indicate that the ZnO NPs showed static as well as dynamic binding interaction with BSA, reduced the content of glycation products and prevented the glycation induced aggregation and antioxidant properties. Therefore, these findings suggest that ZnO NPs may be used for drug delivery agents and antiglycating as well as an antioxidant agent.

Acknowledgement: The study was funded by the Research Society for the Study of Diabetes in India (RSSDI/HQ/Grants/2017/342).

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Porous Alginate Prepared Through O/W Emulsification (High Internal Phase Emulsions) And Gelation with Calcium Chloride ($CaCl_2$) Nanoparticles

Ghasem Rezanejade Bardajee[a], Parinaz Pargolghasemi[a], Mir Saleh Hoseininezhad-Namin[b], Shahriyar Karimdoust[a]

[a] Department of Chemistry, Payame Noor University (PNU), Tehran, Iran , [b] Pharmaceutical Analysis Research Center and Faculty of Pharmacy, Tabriz University of Medical Sciences, Tabriz, Iran

E-mail : pargolghasemi2015@gmail.com

Abstract: Alginate is a renewable, nontoxic, inexpensive biopolymer with numerous applications in adsorbent materials of water pollutants and scaffolds for tissue engineering and drug delivery. In such kinds of applications, the most convenient physical form of alginate-based materials is porous matrices. Many polymers, generally known as poly HIPEs have been synthesized using high internal phase emulsions (HIPEs) as templates for the porous structure. A well-known example of HIPE is mayonnaise. HIPEs formed by mixing two immiscible liquids in the presence of an emulsifier, usually a surfactant. This paper aims to describe a simple method for preparing porous alginate with calcium chloride nanoparticles and the use of high internal Phase emulsions. Different percentages of sodium alginate and toluene contain calcium chloride nanoparticles were used to prepare oil-in-water emulsions stabilized by surfactant. The resulting was characterized using Fourier transform infrared spectroscopy (FT-IR), Field emission scanning electron microscope (FESEM).

Keywords*: *Calcium Chloride nanoparticles, High internal phase emulsions, porous alginate, O/W.

Introduction: Alginate is a linear biocopolymer with homopolymeric blocks of (1→4)-linked β-D-mannuronate (M) and α-L-guluronate (G) residues that obtain from brown marine alge. In some kinds of applications, the most convenient physical form of alginate-based materials is porous matrices. Many polymers, generally known as poly HIPEs have been synthesized using high internal phase emulsions (HIPEs) as templates for the porous structure. A well-known example of HIPE is mayonnaise. HIPEs formed by mixing two immiscible liquids in the presence of an emulsifier, usually a surfactant. One of the liquids is an aqueous solution and the other is usually hydrophobic. (HIPE): internal phase contents of over 74%, (MIPE): internal phase volume fraction of 30-74%, (LIPE): internal phase volume fraction of less 30%. HIPE focused on W/O for hydrophobic synthesis, O/W, supercritical Co2 in water, Oil in oil O/O, ionic liquid in oil and oil in deep eutectic solvent.

Synthesis of nanoparticles calcium chloride in toluene with tween 80 surfactant:

1. Aqueous phase: 0.058 gr $CaCl_2$ + 4 ml Ethanol
2. Organic phase: 1.5 gr tween 80 + 24 ml Toluene
3. phase1 + phase2 :10 min ultrasonic
4. Heat 75 C°, alcohol was evaporated.
5. Formation of nano-$CaCl_2$

Alginate PolyHIPE Synthesis:

Aqueous phase : Sodium alginate 3% , 1 cc + Triton x 100 0.2 cc , then 5 min mix +
Organic phase: 3 cc Nano Ca in toluene drop by drop added, 400 rpm
after 24 h, complete polymerization, soxhlet extraction with ethanol for 4 h, dried convection oven 60 °C for 24 h . (Fig-1)

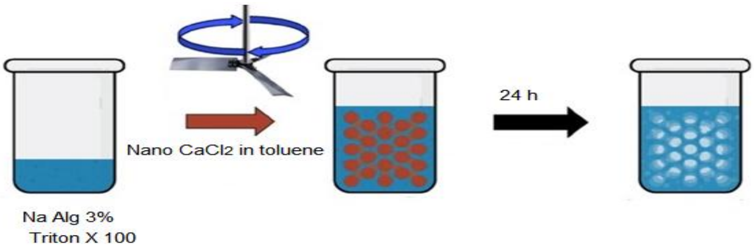

Fig-1

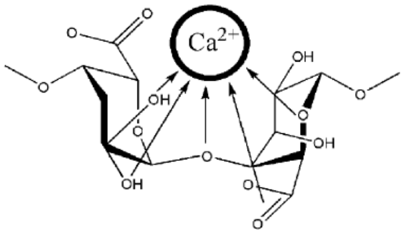

Fig-2

Divalent cations such as Calcium, can quickly form so-called egg-box complex with G block to create alginate hydrogel through gelation phenomenon. (Fig2)

Alginate hydrogel synthesis: Sodium alginate 3%, 1 cc + $CaCl_2$ (0.0165 M), 400 rpm, after 24h , complete polymerization and washed with ethanol, dried convection oven 60 °C for 24 h.

Results and discussion :

The hydrogel was characterized using (FE-SEM): Fig-3

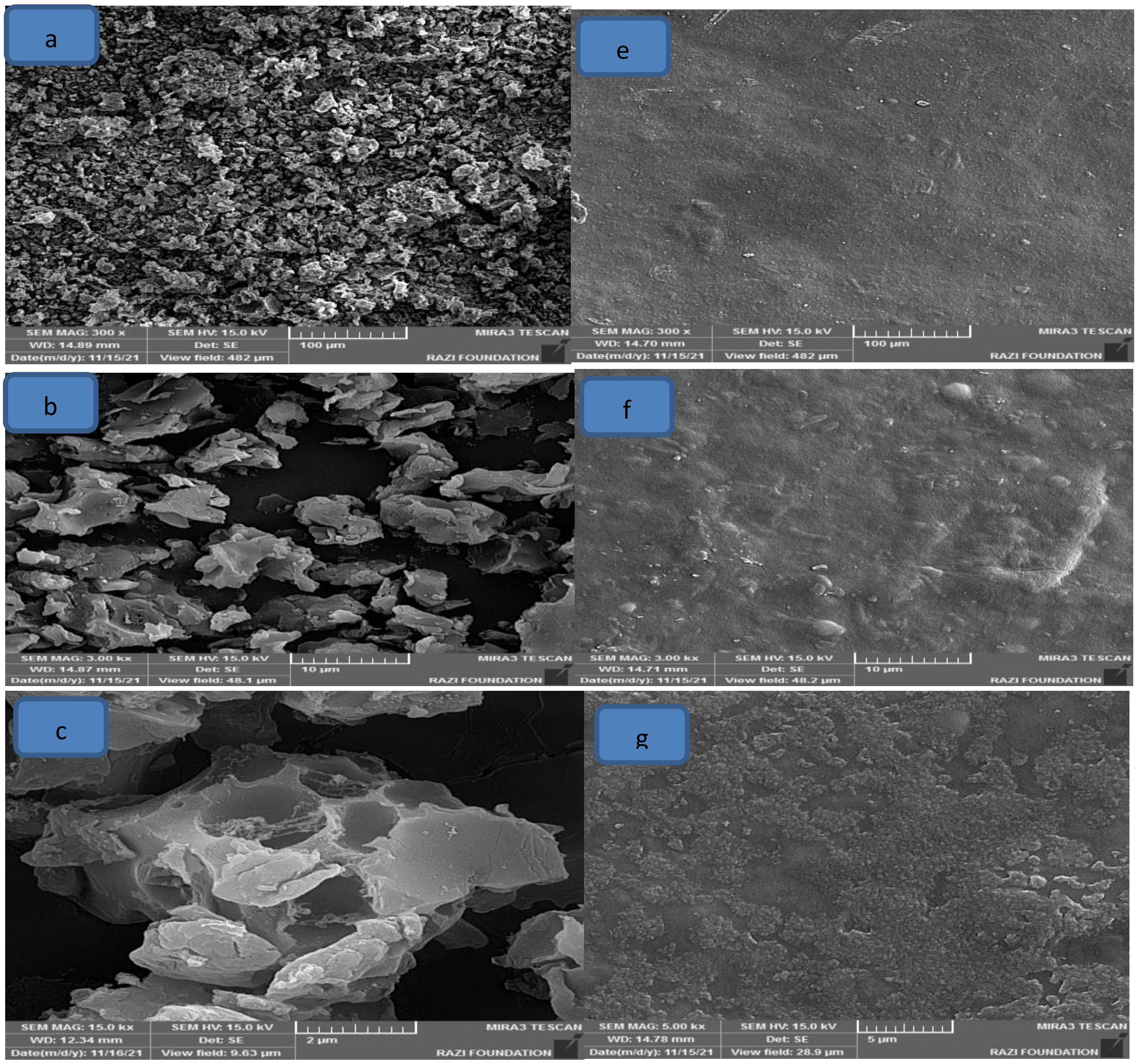

Fig-3: Comparison of porous alginate prepared by Poly HIPE method (a, b, c) ,with alginate hydrogel without HIPE (e, f, g).

The product was characterized using (FT-IR): Fig-4

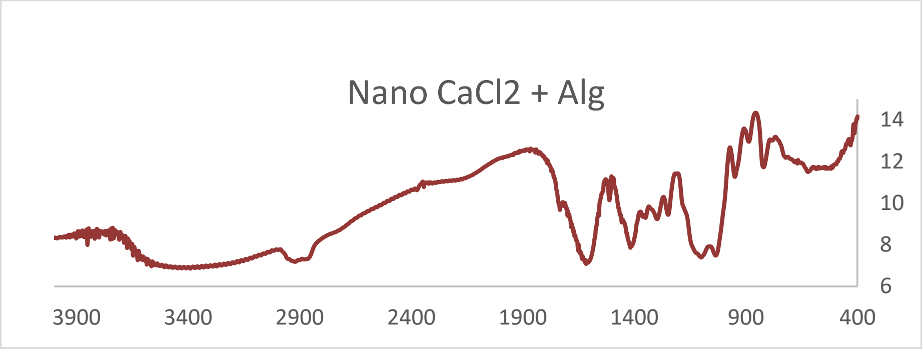

Fig-4: two bands at 1594 and 1407 cm^{-1} corresponded to COO$^-$ group, one peak at 1024 cm^{-1} were responsible for C-O vibration, major peak at about 3435 cm^{-1} absorption of stretching of the –OH groups, 2924 cm^{-1} corresponding to the C-H stretching of the CH_2 groups.

Conclusions:

Calcium chloride nanoparticles were prepared by reverse microemulsion technique. Porous structure of alginate was prepared by high internal phase emulsion method. Preferred candidate for drug delivery, nanomedicine, removal of heavy metals, agricultural applications and etc.

Acknowledgement: This research was supported by Grants from PNU.

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Multiferroic Bismuth Iron Oxide/Epoxy Resin Composite as High Efficiency Microwave Absorbing Material at High GHz Frequency

Khamirul Amin Matori, Siti Nor Ain Rusly, Ismayadi Ismail

Materials Synthesis and Characterization Laboratory, Institute of Advanced Technology, Universiti, Putra Malaysia, 43400 UPM Serdang Selangor, Malaysia.
Department of Physics, Faculty of Science, Universiti Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia
khamirul@upm.edu.my

This report presents a development of high efficiency microwave absorbing materials with a single thin layer and simple coating structure. From a previous study, a single layer absorber with minimum thickness usually cannot accomplish the requirements to achieve high absorption with low reflection within broad band working frequency. Hence, it is necessary to explore a new potential absorber consisting of a single material that can simultaneously contribute both magnetic losses and dielectric losses to enhance the microwave absorption ability in a broad working frequency. BiFeO3 (BFO) is an interesting multiferroic material. It exhibits intrinsic magnetolectric coupling by simultaneously having a canted G-type antiferromagnetic and ferroelectric order in a single phase. This fascinating behavior gives high potential to magnetoelectric devices, including microwaves absorbers. This research revealed BFO/epoxy resin composite performances as potential coating materials for microwave absorption. The narrow bandwidth at -10 dB for BFO absorber was reported previously; hence, this study mainly aimed to explore the possibility of improving the microwave absorption ability of BFO composite in broader working frequency. In general, three types BFO based materials were prepared; BFO/epoxy resin composite, rare-earths doped BFO/epoxy resin composite, and CNT-BFO/epoxy resin composite. The BFO is prepared by mechanical activation high energy ball milling (HEBM) technique within 6 hours milling time using a SPEX8000D mechanical alloying machine. BFO/epoxy resin composite has been modified to improve microwave absorption performance in broad working frequency. Thus, the microwave absorption properties for all synthesized samples were characterized by a network analyzer in 8 -18 GHz frequency ranges.

Study of silicon-carbon nanocomposite structural and electrical properties for potential anode materials in lithium-ion batteries

Y Yaakob[1,2,*], M. S. Rosmi[1,3], S. Sharma[1] and M. Tanemura[1]

[1]*Dept. of Physical Science and Engineering, Nagoya Inst.of Tech., Nagoya 466-8555, Japan*
[2]*Dept. of Physics, Faculty of Science, Univ. Putra Malaysia, 43400 UPM Serdang, Selangor, Malaysia*
[3]*Dept. of Chemistry, Faculty of Sci. and Maths., Univ. Pendidikan Sultan Idris, 35900 Tanjung Malim, Perak, Malaysia*
yazidakob@upm.edu.my

In this research, we have demonstrated structural transformation of Si/C nanocomposite via joule heating generated through current flow using in situ TEM facilities, respectively. Sample were fabricated on the edge of 100 µm thick graphite foil by co-sputtering it with Si plate as shown in Fig.1. The ion irradiation process were conducted at room temperature using Ne+ ion. The basal and working pressures of the chamber were 1 × 10^{-5} Pa and 5 × 10^{2} Pa, respectively. For in situ I-V measurement, sample and tungsten (W) nanoprobe were mounted on a special piezo-driven TEM holder. The I-V measurements were carried out while observing the structural transformation of the Si/C nanocomposite by transmission electron microscopy. From the observation, initial structure of Si/C nanofiber which composed of Si and C in amorphous structures. After the current flow, the nanocomposite has change significantly to graphitic structure. The I-V measurement correspond the observation shows significant increase on current indicating improvement in conductivity of the composite after structural transformation. The finding has demonstrated one step synthesis of Si/C nanocomposites and in situ experiments to improve our understanding of Si/C nanocomposites structural and electrical properties, which is expected to mimic charge/discharge process of electrochemical process in Lithium Ion Batteries (LIB) for our future work.

Keywords
Si-C composites, Carbon nanostructures, In situ transmission electron microscopy, graphitic structure

Superconducting properties of Eu_2O_3 nanoparticles substitution in Bi(Pb)-2223 ceramics

Nurbaisyatul Ermiza Suhaimi[a], Azhan Hashim[b], Siti Fatimah Saipuddin[a,b]

[a]Faculty of Applied Sciences, Universiti Teknologi MARA Shah Alam, 40450 Shah Alam, Selangor, Malaysia

[b]Faculty of Applied Sciences, Universiti Teknologi MARA Pahang, 26400 Bandar Tun Abdul Razak Jengka, Pahang, Malaysia

dazhan@uitm.edu.my

Abstract

This research reports on the effect of Eu_2O_3 nanoparticles on structural and superconducting properties of Bi(Pb)-2223 superconductor. Samples were produced through solid state reaction method. The prepared samples have been analyzed through critical temperature (T_C), critical current density (J_C), X-ray diffraction (XRD), Field Emission Scanning Electron Microscopy (FESEM) and Alternating Current Susceptibility (ACS). Both Bi-2212 and Bi-2223 phases have been detected for all prepared samples with different ratios. The microstructure for all samples shows randomly distributed plate-like grains. The crystallite size was estimated from XRD while the critical temperature (T_C) has been determined from resistivity measurements in the range of 30 – 300 K. The maximum calculated J_C was obtained at the sample with $x = 0.0025$ Eu_2O_3 nanoparticles substitution. The best amount of doping was found at $x = 0.0025$ which improved the superconducting properties of this system.

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Flux pinning mechanisms of $YBa_2Cu_3O_{7-\delta}$ thick films by $BaZrO_3$ nano inclusions

M. M. Awang Kechik[a], N.A. Che Dzul-Kifli[a], P. Mikheenko[b], J.S. Abell[b], I. A. Crisan[b], P. Paturi[c], H. Huhtinen[c], S.K. Chen[a],
S.A. Halim[a] and K.P. Lim[a]

[a]*Deparment of Physics, Faculty of Science, Universiti Putra Malaysia,*
43400 UPM Serdang, Selangor, Malaysia

[b]*School of Metallurgy and Materials, University of Birmingham, Edgbaston, Birmingham B15 2TT, UK*

[c]*Wihuri Physical Laboratory, Department of Physics and Astronomy, University of Turku, FI-20014, Finland*

mmak@upm.edu.my

A high critical current density J_c is crucial for the application of High Temperature Superconductor $YBa_2Cu_3O_{7-\delta}$ (YBCO) in the fabrication of energy efficient power devices and wires. We have investigated the possibility of enhancing the flux pinning in $YBa_2Cu_3O_{7-\delta}$ thick films by using $BaZrO_3$ nano inclusions. YBCO films were deposited on $SrTiO_3$ single crystal substrates by PLD using a scanning laser beam from a composite target having the composition $YBa_2Cu_3O_{7-\delta}$ + 2 wt.% $BaZrO_3$ nano inclusions. The J_c and the pinning force F_p, determined by DC magnetization measurements at temperatures of 65 K and 77.3 K and in applied field up to 4.0 T, showed impressive increases in comparison with reference YBCO samples. The Dew-Hughes pinning analysis shows that normal point and normal surface pinning contribute for the thinnest $YBa_2Cu_3O_{7-\delta}$ +BZO film. The normal point pinning becomes the dominant mechanism to enhance flux pinning in the $YBa_2Cu_3O_{7-\delta}$ +BZO films and seems to mainly arise from the defects introduced due to BZO addition. These normal point defects are thought to develop from the non-superconducting state caused by $BaZrO_3$ doping to the YBCO superconducting layer. The improvement of the pinning force, F_p, is seen for $YBa_2Cu_3O_{7-\delta}$ +BZO and presumably caused by multi-elementary pinning mechanism.

Keywords: *Flux pinning mechanism, YBCO, thick films*

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How TELSAM Protein Polymer Improves the Success Rate and Speed of Protein Crystallization

Sara Soleimani[a], James D. Moody[a]

Department of Chemistry and Biochemistry, Brigham Young University, Provo, UT 84602, USA

E-mail: Sara@chem.byu.edu

The development of novel crystallization approaches that require less time, effort, and expense can significantly increase the success rate of target proteins crystallization and accelerate structure determination of many biotechnology and disease-relevant proteins. Specifically, improved crystallization methods will accelerate study of the molecular mechanisms of disease. The long-term goal of this research is to develop crystallization methods that could lead to diffraction-quality crystals from greater than 70% of targeted proteins of interest[1]. Polymer forming crystallization chaperones (PFCCs) are a potentially better type of crystallization chaperone. One potential PFCC is the sterile alpha motif domain (SAM) of the human Translocation ETS Leukemia protein. In this study, the effectiveness of TELSAM protein polymers to reliably form well-diffracting crystals of Capillary Morphogenesis Gene 2 (CMG2) is investigated[2]. CMG2 is involved in cancer, where its overexpression is associated with increased tumor grade and poor patient survival. We generated CMG2 alone, 1TEL-flex-CMG2, 1TEL-flex-CMG2+PGM, 1TEL-flex-DARPin and we crystalized them. TELSAM accelerates the rate of crystal formation by as much as 27-fold versus the target protein alone, likely by using avidity to stabilize weak crystal contacts made by the target protein. In addition, TELSAM-target protein fusions can form well-ordered, diffracting crystals using flexible TELSAM-target linkers. The TELSAM polymers themselves need not directly touch one another in the crystal lattice to form well order crystals. We conclude that TELSAM is a powerful crystallization chaperone warranting future investigation.

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Zinc Oxide Nanosheets Supported on 3D Graphene Foam as Photoelectrode for PEC Water Splitting

Rozan Mohamad Yunus and Nur Rabiatul Adawiyah Mohd Shah

Fuel Cell Institute, Universiti Kebangsaan Malaysia, 43600 UKM Bangi, Selangor, Malaysia

rozanyunus@ukm.edu.my

One of the major challenges in designing an efficient photoelectrode is the understanding of the charge transfer behaviour. Currently, in photoelectrochemical (PEC) water splitting, the wide band gap of photoelectrodes, such as zinc oxide (ZnO) led to higher photogenerated electrons and holes recombination resulting in low photocatalytic performance (1). To alleviate this limitation, the introduction of three-dimensional (3D) graphene foam (GF) as support is considered to be a promising approach to enhance the photocatalytic activity of ZnO due to its excellent intrinsic properties that can promote charge transfer as well as high surface area (2). This research focus on the synthesis of graphene on nickel foam as a template via chemical vapor deposition (CVD) method. The nickel foam was etched to obtained the 3D structure of GF, followed by hydrothermal method with various temperatures (150 -200 °C) to synthesize ZnO nanosheets supported on 3D GF. The FESEM image analysis and Raman spectroscopy confirmed the growth of 3D structure GF while ZnO nanosheets have successfully synthesized on 3D GF as confirmed by XRD analysis. EDX analysis revealed the composition of ZnO on the GF surface. The ZnO/3D graphene porous structure significantly improved the current density, higher compared to bare ZnO which attributed to positive roles combination of ZnO nanosheets and 3D GF in electron-hole separation and transportation. Hence, ZnO nanosheets supported on 3D GF provides new insight into efficient semiconductor photoelectrode in the field of PEC water splitting.

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Application of nanotechnology in animal nutrition

Anna Sheikhalipour [a] *, Akbar Taghizadeh* [a*] *, Ali Hosseinkhani* [a] *and Valiollah Palangi* [b]

[a.] *Department of Animal Science, Faculty of Agriculture, University of Tabriz, Tabriz, Iran*
[b.] *Department of Animal Science, Agricultural Faculty, Ataturk University, 25240, Erzurum, Turkey*

** Corresponding Author's Email: a_tagizadeh@tabrizu.ac.ir*

Abstract

IN recent years, nanotechnology has gained much attention within the scientific community in many countries. Nano mechanism is no longer a connotation or notion for the modern scientist only, but it has overturned into a recent enabling technique over the years, with a huge possibility to transfer. The field of cultivation and domestic animal, so evolved in these fields can be conveyed to avian and animals offspring systems to increase production efficiency and meet human needs of quality poultry and animal products. As a result of the small size of nanoparticles, their passage is very fast through the walls of the gastrointestinal tract, creating many important effects in various body systems, which provides the opportunity for researchers to deal with nanomaterials by studying many veterinary fields, including production, reproduction, disease control, dealing with biological materials such as the study of DNA and cellular molecules. Objective: This review article aims to gather the materials and research that has been done to clarify the potential effects of nanotechnology on animal nutrition and its potential benefits and risks.

Keywords: Nanotechnology, Nanoparticle performance, Rumen fermentation, Livestock Nutrition.

Introduction

Nano means "dwarf" in Greek, which is a size of about 9-10 meters, which is one-billionth of a meter. Everything around us is made of atoms, and in fact, the atom is the smallest building block of matter. From the Stone Age to the later ages and the present age, which is the age of silicones, human beings have always realized how and by what laws billions of atoms are placed next to each other and at the same time a shape and a model. They create something special and create macroscopic properties. So each atom and molecule, on its own, has certain physical properties that can be actualized and used to build new devices with extraordinary properties. The science that does this is nanotechnology. The simplest definition of nanotechnology is the technology that provides the power of structure and organization at the atomic and molecular level that has occupied mankind in the 21st century and will revolutionize human societies over the next few decades. As a new science, Nanotechnology has been able to improve the performance of food molecules to increase the efficiency and production of animals by manipulating and modifying a material at the nanoscale. Nanotechnology can improve food evaluation and act as a new tool for delivering nutrients to target tissues and a tool for explaining the metabolism and physiology of nutrients. The mineral particle size acts as food additives in the form of nanoparticles from the intestinal wall and enters the body cells faster than normal materials with a larger size, thus improving bioavailability. There are also challenges to the emergence of nano-nutrients, including changes in the metabolism, toxicity, and environmental effects of nanoscale mutants compared to micronutrients, and so many consequences must be considered. Therefore, nanotechnology can be used in animal nutrition to improve the bioavailability of nutrients, production performance, and safety status of livestock.

The physiological role of nanoparticles

In this section, we will briefly describe how nanoparticles function in the body:
.It increases the surface area of the compounds, allowing the opportunity for biological reactions
.Increased persistence in the gastrointestinal tract
. Minimize the effects of intestinal secretory mechanism
. Due to their small particles, they penetrate deeply into the tissues through the tiny capillaries
.Crossing organs with epithelial tissue (e.g., liver)
. Enabling better absorption in cells brightens up
. Efficient transfer of active ingredients to the desired sites in body tissues

Nanotechnology intervention in animal feed

Nanotechnology has four possible applications in animal nutrition. These four uses are:
. Prescribing medicine, nutrients, probiotics, etc
. Diagnosis and treatment of diseases with nanoparticles allow identifying and eliminating the cause of this disease without the need for surgery.
. An identity register that allows you to track the history of animal products
. Reproductive management with hormonal immunosensors

Nanoparticles can also be used as additives to improve livestock production. Nanocapsules are also used as carriers of essential oils, flavors, antioxidants, vitamins and minerals, and phytochemicals for bioavailability.

Digestion and absorption

Nanoparticles can enter the gastrointestinal tract in a variety of ways, including eating water and food and using it as a nanopharmaceutical (swallowing pathway), as well as nanoparticles that enter through the respiratory tract. They also enter the gastrointestinal tract after purification in the respiratory tract (airway). The gastrointestinal tract is through the mucosa. Therefore, the smaller the particle size, the faster its release from the gastrointestinal mucosa occurs and ultimately causes faster absorption through the gastrointestinal tract into the blood.

The role of nanoparticles in ruminal fermentation

The rumen is a complex ecosystem in which the consumed nutrients are digested anaerobically by microorganisms such as bacteria and fungi, and the final product of food fermentation is VFAs, which are used by the host ruminants. The relation between the beneficial bacteria and the host animal results in an equivalent relevance that permits ruminants to digest fiber- affluent and minimal-protein materials. The fermentation process in the rumen is highly inefficient because it produces some final compounds like methane and ammonia. To improve the efficiency of microbial digestion, many food systems have been followed to change the path of microbial digestion in a way that serves the efficiency of the digestive process without affecting the health and productivity of the animal; to achieve this goal, the employed of minerals in the diet of animals has been directed towards, including nanoscale minerals because of their importance in improving the digestion process. As a result, its tiny particles along with the provision of a with its availability. Hassan et al. (2019) indicate that the addition of nano zinc at dose 20 mg/kg feed led to reduced methane production and improved antioxidants. This positive effect of nanoparticles by reducing the level of methane gas can be attributed to reducing the numbers of bacteria producing it or re-directing the hydrogen flow to bind to the receptors for producing propionate. The positive effect of these minerals also lies in their improvement of some digestive enzymes in the alimentary channel.

Potential risks associated with the use of nanotechnology in animal feed

What is needed is to assess the risk of nanotechnology in food and its impact on animals and humans. There is also a need for further research on nanoparticles' toxicological impact and potential hazards for the animal, environmental and human health. Potential hazards associated with nanoparticle nutrition include:(1) greater access to nanoparticles compared to larger forms of the same food, (2) the prominent role of ROS-induced nanoparticles in gastrointestinal inflammatory diseases (3) the potential effects of nanoparticles on the stability and function of proteins and enzymes that may be metabolic processes Disrupt or alter the bioavailability of nutrients, (4) Potential effects of storage, heating, and aging on the biomass complexes of nanoparticle molecules in feed (FSAI, 2008).

Conclusion

In short, nanotechnology is a science that can be used in livestock diets to improve the bioavailability of nutrients, production performance, and the safety and health status of livestock. However, much research is needed in Relate to the usefulness and efficiency of nanotechnology and whether it is harmful or less harmful to the environment and humans.

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Usability of nano-capsulation technology in animal nutrition

Masoumeh Niazifar[a*], Akbar Taghizadeh[a] and Valiollah Palangi[b]

[a]Department of Animal Science, Faculty of Agriculture, University of Tabriz, Tabriz, Iran
[b]Department of Animal Science, Agricultural Faculty, Ataturk University, 25240, Erzurum, Turkey
** Corresponding Author's Email: M.niaz2@yahoo.com*

Abstract

Nanotechnology as new science has attracted the attention of researchers around the world, so that today this technology is one of the most powerful branches of science. After introducing nano and recognizing its skills in various fields of agriculture, veterinary medicine, mining, minerals, the textile industry carried out many activities for its development. The advent of nanotechnology led to a great revolution in science and technology. According to the present and future conditions, paying attention to this science and specializing in sciences with this technology will maximize productivity to the minimum of time and energy. On the other hand, the small size of nanoparticles reduces pollution, thus reducing the amount of toxicity and their lightweight, making this technology efficient. In addition, these materials have a long half-life, and their mass production will lead to high economic efficiency in production. Nanoparticles can be used as additives to improve livestock production. The nanoparticles' minimal size and extensive surface area make them more effective than the macrostructure. New types of membranes such as nano and micro can be used in food processing. Nanoparticles can also improve feed quality. Manipulation and modification of materials at the nano-level allows enhancing the performance of food molecules. Nanotechnology is the study of phenomena and manipulation of materials at the nano-scale in which properties of materials differ from those of larger scales. Manipulation and modification of a substance at the nano-scale have improved the performance of food molecules for the benefit, efficiency, and production of livestock. Enriching staple foods with healthy bioactive compounds using nano-delivery systems is an excellent strategy for communities to take steps to improve nutrition quality. Given this necessity, many efforts have been made to design severe nano-structured delivery systems to protect Bioavailable foods from adverse conditions, modify their distribution, control release rates, and ultimately improve their Bioavailable foods. Therefore, new nano-conduction methods have been proposed to overcome these problems. Bioavailable compounds coated in capsules with a size of less than 100 to 500 nm are called nano-capsules, and the process of preparing them is called nano-encapsulation. Today, one of the scientific challenges is using alternative food additives that do not produce antibiotic-resistant microbial species and increase resistance to stress and growth. The advantage of nano-additives is better bioavailability due to their small size and stable interaction with other components. Because they are used in low doses, they can replace growth-promoting antibiotics and eliminate residual antibiotics in livestock products, reduce environmental pollution, and produce pollution-free livestock products. Tiny micelles (nano-capsules) are carriers for plant's essential oils, extracts, antioxidants, vitamins, minerals, and phytochemicals with high bioavailability. By encapsulating nanoparticles of active ingredients (polyphenols, minerals, and micronutrients), oxidative reactions in the body are prevented. In this article, we try to study the structures of nanotechnology in animal husbandry and the function of nano-capsules in animal nutrition.

Keywords: Bioavailable, Bioactive, encapsulating, Nanotechnology, encapsulation

Introduction

Encapsulation is described as encapsulating material or combination in capsules through covering it by some other material or some other practice and, to be expressed as a combination of firm, fluid, or volatile ingredients, cells, various meanings, enzymes, and microorganisms with a film substance primarily based totally on proteids or carbs. Encapsulation of the nutrients and delivery of the properly targeted tissue enhance the flavoring characteristics and stimulate the organoleptic properties of the food product. Currently, encapsulation technology is utilized in several states such as pharmaceutics, chemistry, arts, Veterinary medicine, biotechnology, and feed; the product used sponsors a series of opportunities to enhance the functional attributes. Micro-substances are in capsule form, having a diameter of 3 to 800µm (2). Capsules are in vesicular structures, formed by encapsulation in which small core, bioactive substances are packed within the cavity, and walls of the pit are constructed with biopolymer elements. In the encapsulation methods utilized to produce various profitable characteristics to capsules, primarily firm and fluid oils, aromatic ingredients, inorganics force ingredients, vitamins, antioxidants, and enzymes are encapsulated with a protecting substance, thus producing various elements these nanocapsule substances can slow and control release nearby the aim point and enhance bioavailability. These nanocapsule materials can slow and maintain clearance near the target point and improve bioavailability (3). In food, these nanocarriers are used as flavoring agents, stabilizing agents, and controlling food pathogens. Food flavors are most volatile, and their aromatic compounds are changed with oxidation and chemical interactions, and heating changes. Encapsulation prevents the volatilization of the aromatic compounds and entraps their flavors (2).

Nano-Encapsulation

Encapsulation is a process of covering bioactive composites around a core, making it safe from environmental stresses and hazards; when this process is done at the nano level, it is called nano-encapsulation (1). Two materials are involved in the process of nano-encapsulation. The first one is a bioactive compound that has to be encapsulated and called an active substance. This bioactive material is also called core material, nucleus, and internal phase, the substance that covers the active ingredient is termed carrier substance. The carrier substance that provides bioactive components could be starch, pectin, protein, guar gum, chitosan, cellulose, and alginates (2). Some selection considerations and characteristics of carrier substances can be summarizing as being resistant to pH changes. Carrier substances must be inert and inexpensive and reach high temperatures and enzymatic activity and bear mechanical stress. The most crucial property of carrier material is regarded as safe from the food certification bodies and to be food grade. There are many benefits of nano-encapsulation technology; some of the significant benefits are that it protects the bioactive compounds from environmental hazards, enhances the nutritional value of food, provides more balanced foods within a limiting time frame, and releases nutrients slowly. The Nano encapsulates act on a particular action site, increasing bioactive compounds' shelf and storage life, and Nano-encapsulate improves food quality includes organoleptic and functional properties (3).

Encapsulation of Film Materials

Encapsulation practices are among the first and various essential starts in determining the appropriate film substance for the encapsulated material according to the actual ingredient and the coveted characteristics the substance election creates for the final product. The need to be careful of several material characteristics to be encapsulated should the selected features. The economic costs of the substances covered in the process include the features such as the physicochemical formation of biocompatible ingredients, the expected time for the substance to encapsulate the encapsulated product's storage conditions, and the size and density of the substances covered in the process concordant with one another (3). According to the issue mentioned above, the encapsulation procedure can be arrived at by determining the coverage method with the coating substance and considering compliance with the legal organizations. The structure of the film material is the essential component that defines the functional features of the capsules. The ideal cladding substance should have are; Must be a stable emulsifying property by active ingredient (1). To be encapsulated, it must not react with the material during both the process and long-term storage. It must cover active substances and have the capacity of impermeability under processing and long-term storage provisions. At high concentrations, the time-dependent deformation' resistance should be affordable underneath any load. It ought to maintain a high level of active substance against environmental conditions and be in food purity. It must be soluble within the desired solvents for the food and food crafts. Should not enter chemical reactions with the active substances. Its supply must be accessible and economical, must have the capacity to dissolve the active substance in the capsule dissolution properties under the desired release situations, and is challenging for a private covering substance to have the features detailed above (3). So, using successions of various film substances is recommended. It ıs better in terms of the physical and mechanical characteristics of the film substances modified prepared. In current years, substances such as sugars, resins, proteins, original and modified polysaccharides, oils or synthetic polymers, gelatin, pectin, carbohydrate, agar, whey can create coating have been used as most favored coating substances (4).

Methods of the encapsulation

The determination of the bioactive substance to be encapsulated with the suitable film substance can vary pertinent on these substances' corporeal and chemical features and the state of practice of the concerned micro-encapsulates (1). During choosing a suitable microencapsulation process, the corporal and biochemical features of the essence and covering substance and the area of the feed element to be covered have meaningful effects (1). For the kernel statement to be appropriately checked, it is essential to analyze the communications within the encapsulation and prepared core substances. In addition, various effects so as mutability in ph standardized influence temperature enzymatic actuality time and an osmotic power could be utilized to check the encapsulated element and improve the controlled liberation peculiarity (2).

Encapsulated products used in animal nutrition

Encapsulation is described as encapsulating a substance or combination in capsules through coating it with some other substance or some other system and, to expressed as a package of solid, liquid, or gaseous components, enzymes, cells, various meanings, and microorganisms with a coating substance primarily based totally on proteins or carbohydrates. Encapsulation of the nutrients and delivery of the properly targeted tissue enhance the flavoring characteristics and stimulate the organoleptic properties of the food product. Currently, encapsulation technology utilizes in many areas such as pharmacology, chemistry, faces, veterinary, biotechnology, and feed; the product used sponsors a series of opportunities to enhance the functional attributes. Micro-substances are in capsule form, having a diameter of 3 to 800µm (2). Capsules are in vesicular structures, formed by encapsulation in which small core, bioactive substances are packed within the cavity, and walls of the pit construct with biopolymer elements. In the encapsulation processes utilized to produce many profitable characteristics to capsules, primarily solid and liquid oils, aromatic ingredients, vitamins, minerals color ingredients, fatty acids, antioxidants, and enzymes are encapsulated with a protecting substance, thus providing various elements these nanocapsule substances can slow and control release nearby the aim point and enhance bioavailability. These nanocapsule materials can slow and maintain clearance near the target point and improve bioavailability (3). In food, these nanocarriers are used as flavoring agents, stabilizing agents, and controlling food pathogens. Food flavors are most volatile, and their aromatic compounds change with oxidation and chemical interactions and heating changes. Encapsulation prevents the volatilization of the aromatic compounds and entraps their flavors (2).

Conclusion

Nanotechnology is an important technique to make food nutritious. Core material protects the bioactive compound and makes it available in the body to perform essential body functions. Emulsification, coacervation, nano-precipitation, and emulsification-solvent evaporation techniques are much necessary to achieve nano-encapsulation.

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Utilization of selenium nanoparticle technology as bioavailable supplement alternatives in animal nutrition

Masoumeh Niazifar[a], Akbar Taghizadeh[a], Adem Kaya [b]*
[a]Department of Animal Science, Faculty of Agriculture, University of Tabriz, Tabriz, Iran
[b]Department of Animal Science, Agricultural Faculty, Ataturk University, 25240, Erzurum, Turkey
* Corresponding Author's Email: M.niaz2@yahoo.com

Abstract

Nano-science is the study of the properties of nanomaterials, their production, and their use in improving the properties and properties of materials. Because many properties of matter in nanometer dimensions are different from properties in macroscopic dimensions, with the help of nanotechnology, can be made changes in atoms by controlling the properties. Nanotechnology as a new and powerful tool can play an essential role in increasing the efficiency of livestock activities. The application of food and drug delivery systems to the target tissue, the creation of new tools for the study of biology and molecular and the reduction of waste from the production process in agricultural systems, and thus the efficiency of the production process are among the applications of nanotechnology in various fields of life sciences. Like any other new phenomenon, efficient nanotechnology requires accurate knowledge of its various aspects and consideration of potential risks. To date, most research has been done on trace element nanoparticles, the most important of which are chromium and selenium nanoparticles. The metabolic function of selenium in preventing oxidative damage to body tissues is a well-known process. Selenium deficiency is evident in pastures and forage feeds, and therefore the use of selenium supplementation by ruminants seems necessary. Many studies have shown that a new source of selenium, called nano-selenium, is more effective than selenite (the mineral form of selenium), seleno-methionine, and methyl seleno-cysteine (the organic structure of selenium) in mice and rats and also shows less toxicity. The addition of nano-selenium supplements to sheep feed increased the concentration of volatile fatty acids in the rumen. It led to an increase in the fermentation of propionate (relative to acetate). Urinary excretion of purine derivatives and digestibility increased fourfold. The best dose of nano selenium in this experiment is estimated to be about 3 kg / g of dietary dry matter. In this article, we try to study nanotechnology applications in animal husbandry and the function of nano-selenium in animal nutrition as a subset of agricultural activities and animal sciences.

Keywords: Bioavailable, mineral, Nanoparticle, Nano-science, Selenium

Introduction

Selenium (Se) is an essential micronutrient of great importance in animal nutrition, health, and production. Se plays a vital role in metabolism by participating in a large number of selenoproteins. Se also plays an essential role in preventing the harmful effects of oxidative and environmental stresses in livestock due to its presence in the activity of antioxidants such as thioredoxin reductase and glutathione peroxidase (1). Due to Se's metabolic and antioxidant effects, a deficiency of this mineral in the animal's body reduces production and causes diseases such as white muscle, while its increase causes severe poisoning and death. Therefore, due to the variable amount of Se in Iranian rangelands and its low absorption rate, Se supplements, especially its organic type such as selenium-methionine and selenium-yeast, to the diet improves the health and production of livestock. The solution to optimizing livestock composition and the conceptive position is to restore the metabolism of nutrition and eliminate or decrease stress conditions by applying metabolic enhancers (5). Metabolic enhancers such as anabolic steroids, minerals, vitamins, and beta-agonists are fed to hypertrophic levels, increase growth rate, further meat production, improve feed achievement, decrease body fat and enhance reproductive performance. Se can be used as an essential micronutrient for the animal body as a metabolic enhancer among the various elements. Se is one of the elements with a wide range of functions due to its antioxidant role and entry into essential compounds such as various selenoproteins. Organic forms of Se such as yeast-selenium, selenium-methionine, and selenocysteine have a higher absorption rate in the gastrointestinal tract than mineral forms such as sodium selenite and Na_2SeO_4 (3). Nano-science is the study of the properties of nanomaterials, their production, and their use in improving the properties and properties of materials. Because many properties of matter in nanometer dimensions are different from properties in macroscopic dimensions, with the help of nanotechnology, can be made changes in atoms by controlling the properties (1). Nanotechnology as a new and powerful tool can play an essential role in increasing the efficiency of livestock activities. Nanotechnology applications in animal nutrition include various pharmaceuticals, complements, probiotics, nutrition, and other materials. Food additives such as trace minerals in the form of nanoparticles (NPs) can meet the mineral needs of livestock and poultry. In this paper, we study applied models of Se in animal nutrition and the performance of nano-selenium (Se NPs) in ruminants as a subset of agricultural and animal science activities (6).

The biological importance of selenium

Before 1957, selenium was a toxic element until researchers showed that liver necrosis in rats could be treated with Se supplements (2). Although its toxicity first demonstrated the biological importance of Se to livestock, Se deficiency is a much more common problem. The nutritional necessity of Se was first shown by its role in preventing diseases such as liver necrosis in rats, hepatosis in pigs, white muscle in ruminants, and reproductive disorders in various species. Se protects biological membranes from oxidation by hydrogen peroxide and other oxidizing agents such as superoxide free radicals and organic hydroperoxides (1). Se is needed for growth and reproduction and prevents diseases like nutritional muscular dystrophy or white muscle disease. Se deficiency causes multiple clinical symptoms such as decreased production, increased susceptibility to infectious diseases and reproductive disorders, while high Se intake causes alkaline disease with reduced production, stagnation and diarrhea, and eventually death (4).

Selenium absorption and metabolism

The various dietary forms of Se in the diet include sodium selenite (Na2SeO3) and sodium selenate (Na2SeO4). In ruminants, mineral forms are converted to insoluble forms with low absorption capacity due to metabolism by the rumen microbial population. The most commonly used organic form of selenium in research is selenomethionine and selenium-yeast (3). Selenium amino acid supplements include selenomethionine, selenocysteine, and selenocysteine. The bioavailability of selenomethionine is three times that of its mineral forms. The higher bioavailability of organic forms of selenium can be attributed to their uptake through the active amino acid uptake mechanism. Selenomethionine and selenium in selenium-yeast, often in the form of selenomethionine, are absorbed by the amino acid carriers, while the mineral forms Na_2SeO_3 and Na_2SeO_4 is absorbed as passive transport (4). The nutrition of organic selenium increases the concentration of selenium in muscle tissue, blood, and milk compared to its mineral forms in sheep. Since discovering selenium as part of the cellular glutathione peroxidase enzyme, significant advances have been made in understanding the molecular and biochemical function (5).

Selenium Nanoparticles

Selenium Nanoparticles with spherical shape and high specific surface area, and antioxidant properties increase the body's resistance to diseases. Because the body needs very little selenium, this element is usually overlooked (6). Selenium is an essential micronutrient for livestock. Se's most prominent biological role is its presence as a functional component structure in splenocytes; with the development of nanotechnology, the element Se NPs showed a new and different feature than other sources of Se (2). Newly, Se NPs have absorbed much regard Because of their huge bioavailability and down noxious.

Because nano-meter particles have new properties such as exceptional surface, increased activity level, countless active surface centers, vast catalytic performance, little toxicity, and sturdy adsorption capability, in ruminants, Se is converting to insoluble form by rumen microorganism, during which consumption of Se throughout that gastrointestinal expanse is modified. Polymer nanoparticle systems have been proposed, To prevent these adverse effects. Na_2SeO_3, NPs design, and appraisement in ruminative to enhance Se uptake in vitro by Romeropers et al. (2010) showed that Se emission from NPs was huge at acidic pH provided better availability provides minerals in the intestine-small (3). The National Research Association stated in 1985 that sheep needed Se at 8.3 mg/kg of feed, up from 2 mg/kg in 2007. Aside from species differences in hepatic accumulation or excretion of Se NPs, the NRC (2007), in estimating the nutrient requirements for dairy cows, stated that the required amount of this element is about 0.3 ppm the animal uses the need without any poisoning. Shi et al. (7) reported the influence of Na_2SeO_4, Se yeasty, and Se NPs in the billy goat on development achievement, selenium condensation, and antioxidant condition in maturity. There were other groups.

Nano-selenium (Se NPs) supplements can be used more effectively than organic or inorganic Se. On the other hand, Se is essential for maintaining the fertility of male animals. In poultry, Se NPs supplementation in chickens' diets effectively increased feed conversion ratio, growth yield, tissue selenium content, and meat quality (4).

Conclusion

Nanotechnology applications in animal feeding require special attention in risk catalysis, regulatory policy, and oversight; hence accurate decomposition of these applications' social, potential, technological and political, influence is growing. New methods Nanotechnology provides to enhance the growth and generation of livestock with recovery diet constituents, food security, supplements, and quality control. Although the technology is succeeding in constant development with varied applications, studies are limited. However, extensive research is needed to patronage biosafety and performance, avoiding harming animals, individuals, and the environment. Nanogoods in agriculture, animal feed, or food are permitted in countries all over the world. Selenium supplements in livestock diets are important due to their essential roles in metabolism and the antioxidant system. Selenium deficiency reduces the production and incidence of disease, and its excess nutrition leads to poisoning and death of livestock.

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The role of nano-vaccines in animal nutrition and health

Masoumeh Niazifar[a], Akbar Taghizadeh[a*] and Valiollah Palangi [b]

[a]*Department of Animal Science, Faculty of Agriculture, University of Tabriz, Tabriz, Iran*
[b]*Department of Animal Science, Agricultural Faculty, Ataturk University, 25240, Erzurum, Turkey*
** Corresponding Author's Email: a_tagizadeh@tabrizu.ac.ir*

Abstract

Nutrition is a process that expresses the knowledge of biochemistry and physiology about a living organism. It involves the flow in which cells of the animal body interact with the external environment to meet their needs for maintenance, growth, work, and production. In agriculture, the fundamental processes and basis of life have been discovered through research at the cellular and molecular levels; nanotechnology will allow us to advance in agricultural science in areas such as disease prevention and treatment of animal diseases. Nanotechnology has become a global competitor. Even countries that lagged decreased industrialized countries in some regions have once again had the opportunity to compete with developing countries in a new course. Due to the increasing growth of nanotechnology, researchers in various fields and fields have tried to use it. The applications of technology in animal health have been an important issue and have potentially devised solutions. Nanotechnology offers a vast horizon for drug prescribing, disease diagnosis and treatment, and reproduction.

Nanometer devices will diagnose and treat infection, nutritional deficiencies, or other health-related problems before symptoms appear clinically. Intelligent medication prescribing systems have features such as remote control, self-regulation, time control, and pre-scheduling. The disease's diagnosis and treatment will be possible by injecting nanometer particles into the animal and then destroying the tumor cells by activating the tumor killers by shining light on the animal's body. Nano-vaccines have emerged as a new method in vaccination and are much more effective than conventional vaccines. Nano-vaccines elicit both blood and cellular immune responses, and they prevent the spread of infection by killing infectious agents by controlling the immune system.

Advances have been reported in developing DNA-based vaccines for several diseases and their comparison with conventional therapies. These DNA vaccines will be used to treat animals with cancer by encoding the reverse transcriptase enzyme telomerase. Nanovaccines produced in Iran can be made into nano vaccines against leishmaniasis. In this type of vaccine, chitosan was used as the Adjuvant nanoparticle delivery system for the SODBI vaccine. Chitosan is a dictated form of catechin whose polysaccharide in crustacean shells and the cationic nature of chitosan make it suitable for drug delivery systems. In addition, chitosan is a stimulant of antigens that stimulate the immune system.

Keywords: Bioavailable, DNA vaccines, Nanotechnology, Nano-vaccines , Nutrition

Introduction

For uncountable years, nature has been affording "Nanotechnological achievements" services. Nano applied science is an impressive and speedily advancing technology permitting us to operate, typically atom by atom, to make and control tools, elements, and operative compositions with nanometer

dimensions. By connecting atoms and molecules, biological methods combine wet chemistry and electrochemistry into a private living system. It is utilized within cellule in the body to diagnose and treat illnesses; it will considerably impact the treatment of animals and the investigation. There are various indicative uses that diagnostic bio-sensors love; nano-chips imaging for captivating vibration imaging discriminators with unrivaled size-affiliate nanoparticles' (NPS) attributes. Multi-operative nano-elements utilizing, Nanotechnology can generate to image a particular limb, reach broad molecular purposes, target tissue, and deliver the medicine in a checked statement. Significant improvements have been constructing Nano biochip elements; Nanotechnology mistreatment multi-functional nano-materials are often developing to image a selected limb, target tissue, acquire deep molecular targets, and provide the medicine at controlled deliverance. Nanotechnology may be a swiftly developing applicant by LED to the event of the several new NPs with mediocre dimensions beginning from 1 to one hundred nm, which defined backward to 1974. Since 10-9 meters (m) matches one nm, the title nano originates from the Latin word "nanus," which means "very small." Currently, nanotechnology is applying in several departments, farming, transmittal rein, and bio-medication.
The significant process is building Nano-microchip substances, Nano-scale biomimetic materials, Nano motors, Nano- multiplex substances, jointing bio-elements, and Nano biosensors with considerable prospects in Animal Science medicament utilization. NPs have various physiological and morphological properties, increased reflexive characteristics, an outsized facade space, bioaccessibility, a substantial volume-to-size relation, persistence, bio-actuality, regulated particle length, controlled delivery of medications, site-specific targeting, and managed pharmaceutical liberation. In addition, NPs can penetrate the cell, muscle, and limb, creating a practical tool for medicine performance. Various drugs may further be glued to the facade of the NPs. Many countries' economies depend on the animal industry, and the advent of several viruses illnesses necessarily requires new illness prevention also control systems. Nanotechnology must be shown impossible potential for improving the offering of drugs and vaccines in veterinary medicine. Increasing the growth of the nanoparticle range will reach novel therapies to treat virus or bacterial conditions and strengthen the healing of deep wounds. In addition, these recently outstretch NPs might achievement deliver drugs to completely various cellule to remedy disorders. Moreover, this synthesis affords an excellent chance to enhance and style these factors that alter remedial delivery and delivery and recognition afore and through therapy. One in every concrete and promising nanotechnology part is nano pharmaceutical reproduction, with several veterinary medication advantages.

Disease Recognition

Today, nonmaterial plays a crucial function in imaging and supervises and away more immediate exposure of infection. Stabler investigation should have a real influence on the value of animal wellness trouble. Nanotechnology is the potential to produce faster, more affordable, and more accurate diagnostic servants. Bio nanomaterial-based analysis has appeared as a novel, impressive range, DNA, and peptides and RNA are contemplated substantial bionanomaterials to significant improvement in behavioral sciences. Nano-materials such as Nano-shells, quantum points, and C nano-pipes can manufacture and functionalized, coupled by image authorizations, and accompanying the particle, including ultrasound, MRI, and X-ray technologies to diagnose the target organ efficiently. Nanosensors and Nanochips can detect diagnosis on a molecular level and a single cell; this helps diagnose, informant, and treat infections.

Safety system

Farm animals have various inherent and adaptive safety features percentage with individuals, rodents, and different bestial; so, the immune system factors are tremendously maintaining amongst mammalian varieties. Although specific parts of the bovine safety system are individual and can be acknowledged in infectious diseases and vaccine improvement, essential ingredients of the safe approach in cows may be regarded for vaccine advancement and appraising the efficiency of nano-vaccine platforms.

Nanovaccines

NPs have essential safety moderator proficiency to increase safe answers, improve peptide cross-presentation, and actuate/moderate antibody presenting cells; accordingly, they are increasingly utilized in vaccine production and more significantly develop while adjuvants to slow discharge antigen improves the vaccine effectiveness. The antigen-loaded NPs might further immediately target the lymphatic tissues; this will enhance vaccine efficiency.

There are various milestones in the evolution of multiple forms of veterinary nano-vaccines, such as:

1. Nano-emulsion vaccines, e.g., recombinant Bacillus anthracis based-spore vaccine, improve mucosa safety following intranasal management, 2. PLGA NPs, e.g., Helicobacters vaccine, Tetanus toxoid, and cows influenza class 3 vaccine developed both IgG and IgA safe acknowledgment developing their vocal treatment, 3. The NPs Chitosan can be given S/C and intranasal or consumptive.

Other nano vaccines were more advanced for veterinary persistence against FMD (gold-based NPs vaccine), Newcastle virus (nano-capsule to be particular orally), influenza virus, or herpes simplex virus 2 (on calcium phosphate NPs), and empty capsid and nucleus similar particle vaccines of African horse ailment bacillus can be generated utilizing baculovirus-mediated co synthesis of African horse sickness virus-like particles (VLPs) of the VP3, VP7, VP2, and VP5. As a result, vaccine yields little immune response, so that improvements in vaccine design are essential.

Conclusion

The fast improvement withinside the designing and manipulating nano substances approved the advancement from countless variations of the NPs. Here service allows for the personify of the pharmaceutical interventions. Nanotechnology rendered unprecedented progress in all branches of animal nutrition includes analysis, medication, vaccination, animal composition and generation, feeding, and health.

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Electrical Conductivity of Carbon Nanotubes Cotton as Counter Electrode for Dye-Sensitized Solar Cells

Yusnita Yusuf[a], Suhaidi Shafie[a, b], Ismayadi Ismail[a], Fauzan Ahmad[c], Mohd Nizar Hamidon[a, b], Shyam S. Pandey[d], Nur Farra Ilyana[e], Lei Wei[f]

[a]*Institute of Nanoscience and Nanotechnology, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia.*

[b]*Department of Electrical and Electronic Engineering, Faculty of Engineering, Universiti Putra Malaysia, 43400 Serdang, Selangor, Malaysia.*

[c]*Malaysian-Japan International Institute of Technology, Universiti Teknologi Malaysia, 57000 Kuala Lumpur, Malaysia.*

[d]*Graduate School of Life Science and System Engineering, Kyushu Institute of Technology, 2-4 Hibikino, Wakamatsu, Kitakyushu, Fukuoka 808-0196, Japan.*

[e]*Department of Chemical Engineering, Faculty of Engineering, Universiti Malaysia Pahang, 26000 Gambang, Pahang, Malaysia.*

[f]*School of Electronic Science and Engineering, Southeast University, Sipailou, JinLing Yuan 109, Nanjing 210096, China.*

E-mail (yusnita5890@gmail.com)

Abstract

In this study, we reported the electrical properties of carbon nanotubes cotton (CNTC) on which is intended to replace the conventional platinum (Pt) as an electrocatalyst for triiodide reduction in dye-sensitized solar cells (DSSC). The analysis such as Hall effect, and I-V measurements, exposed the electrical properties and I-V characteristics, respectively. These analyses are explained in detail in the paper. The highest photovoltaic conversion energy of using CNTC as electrocatalyst was obtained by single layer is 2.56 % compared to reference platinum which is 2.91%.

Keywords**: *Carbon-nanotubes cotton, counter electrode, carbon-based, dye-sensitized solar cells.***

Introduction

The DSSC demonstrated by Brian O'Regan and Micheal Grätzel in 1991 as a promising alternative to silicon solar cells with the potential of high conversion efficiency [1]. The basic DSSC structure consists of wide band-gap semiconductor photoanode, sensitizer dye, electrolyte, catalyst and counter electrode (CE). The CE with catalyst is used for improving the iodide/triiodide reaction, serves to bring the electrons from the external loads connected to the cell and catalyzed the triiodide/iodide reaction in the electrolyte. The typical CE catalyst is platinum (Pt) which is the most popular catalyst due to its excellent catalytic activity, and conductivity [2]. Despite that Pt-based catalysts are still the effective catalyst for a redox reaction, their expensive in price makes them less cost-effective. Several studies have reported the potential materials to substitute platinum such as carbon-based materials. Recently, our group has reported on the synthesis of CNTC through the one-step process by floating-catalyst chemical vapor deposition (FCCVD) [3]. The report demonstrated the growth of CNT cotton with waste cooking oil as a carbon source and studied the effect of thiophene concentration on CNT cotton formation. To the best of our knowledge, there is relatively less attention about the utilization of CNTC grown by the FCCVD method utilizing waste cooking oil as a carbon source for catalyst in DSSC application. Therefore, this work analyzed the synthesized CNTC in term of the electrical properties at different layer thickness, which is essential to enhance the DSSC performance.

Experimental details

This work is divided into 2-part, the CNTC synthesis and DSSC fabrication. In the first part, CNTC was grown using the FCCVD method with carbon source from waste cooking oil. The grown CNTC was made to slurry paste and then deposited on the FTO substrate. Subsequently, the deposited electrode was annealed at 500 °C. The deposited CNTC was measured using hall-effect for electrical characteristics measurements. Then, in the second part, DSSC has been fabricated with the photoanode composed of TiO_2 and N719 dye. The photoanode and counter electrode was assembled using a 60 μm spacer. Lastly, the electrolyte was injected into the cells and immediately tested with the solar simulator for I-V measurement.

Results and Discussion

Electrical analysis

Electrical properties of CNTC of each layer determined from Hall effect measurement are given in Table I. The CNTC 3 layer shows better performance compared to others. This is because, the higher the thickness value, the lower the sheet resistance due to less resistance barrier for the electron to flow. It causes the electron to flow smoothly without any obstacle and result in a higher conductivity value with the higher mobility value. As the mobility increases, the CNTC 3 layer be more conductive since it can carry much more electrons.

Table I. Electrical properties of CNTC

Sample	Thickness (µm)	Sheet resistance (Ω/□)	Resistivity (Ω.cm)	Conductivity (S/cm)	Mobility (cm^2/Vs)
CNTC 1 layer	30.05	72.481	0.181	5.519	1.562
CNTC 2 layer	60.57	58.747	0.206	4.864	1.548
CNTC 3 layer	83.40	50.232	0.2255	4.434	1.922

I-V measurement

The I-V measurement of DSSC with CNTC and Platinum catalyst was presented in Fig. 1 and Table II. The efficiency obtained for DSSC with 1 layer, 2 layers and 3 layers CNTC are 2.56%, 2.10% and 2.33%, respectively. It shows that DSSC with 1 layer CNTC has a higher efficiency compared to the others. For the comparison, the corresponding efficiency of Platinum is 2.91%. Therefore, the efficiency of DSSC utilizing 1 layer CNTC catalyst is comparable with DSSC with Platinum catalyst. Although the overall efficiency of DSSC utilizing 1 layer CNTC catalyst is slightly lower, it shows a higher current density. This characteristic attracted of our interest for future study.

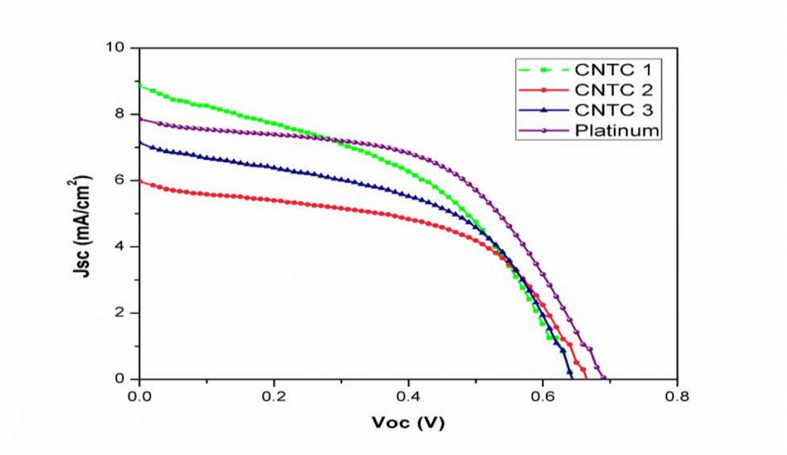

Fig. 1 I-V measurement of CNTC at different layers and platinum electrode.

Table II. I-V characteristics

Sample	V_{oc} (V)	J_{SC} (mA/cm^2)	FF	Efficiency (%)
Pt	0.69	7.85	0.54	2.91
CNTC 1 layer	0.64	8.85	0.45	2.56
CNTC 2 layer	0.66	5.97	0.53	2.10
CNTC 3 layer	0.64	7.14	0.51	2.33

Conclusions

The thickness variation of the CNTC results in different electrical characteristics particularly the sheet resistance, resistivity, conductivity, and mobility. The 3 layers CNTC is the most conductive among the others. The I-V performance shows that DSSC utilizing 1 layer CNTC catalyst is comparable to DSSC with Platinum catalyst, hence the CNTC can be the material of choice to replace conventional Platinum as catalyst for DSSC.

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Application of nanotechnology in the stabilization of enzymes

Shabnam Delir[a*], Akbar Taghizadeh[a], Valiollah Palangi[b]

[a]Department of Animal Science, Faculty of Agriculture, University of Tabriz, Tabriz, Iran
[b]Department of Animal Science, Agricultural Faculty, Ataturk University, 25240, Erzurum, Turkey
** Corresponding Author's Email:* shabnam.delir@gmail.com

Abstract

Recent advances in nanotechnology and the fabrication of various nanostructures have provided new applications in nanotechnology-based biotechnology. One of the most important nanostructures areas in biotechnology is their use in the stabilization of enzymes. Despite the many functionalities of enzymes, their widespread use is very limited due to their short lifespan, thermal instability, and instability in the organic environment. This paper reviews recent research on enzyme stabilization using various nanostructures such as nanoparticles, nanofibers, porous materials, and single-enzyme nanoparticles. Finally, the most important applications of enzymatic nanostructures, such as biosensors, anti-adhesion agents of biomolecules, and biofuel cells, are briefly reviewed.

Keywords: Nanotechnology, Enzyme, Stabilization, Nanomaterial

Introduction

Enzymes are nanometer-sized biocatalysts catalysts that have many well-known functionalities. In the past, enzymes were commonly used in industry, especially in the detergent production process. Currently, enzymes are widely used in new fields such as pure chemical synthesis, pharmacy, biosensor, biodegradation of biological contaminants, bioassay, PCR process, protein digestion in proteomic analysis, and biofuel cells (1, 2). The specificity of the enzymes has made them very useful, but for now, the short lifespan of the enzymes has limited their use. Improving the stability of the enzyme can increase its practical applications. The use of nanostructured materials for enzyme stabilization increases the stability of the enzyme activity and enhances its other special properties as a bio-catalytic nano-catalyst system. These properties include high enzyme loading, high enzyme activity, the possibility of magnetic separation, and increased electron transfer rate (2, 3).

Nanomaterials performance as enzymes

Natural enzymes are mostly proteins made from amino acid sequences and have different structures. However, most Nanomaterials have different sizes or structures (1). Although proteins are considered soft materials, the nanomaterial is hard with a porphyritic nucleus (2). Notably, they share a certain likeness, such as overall size, shape, and surface charge, which enable nanomaterials to mimic enzymes (3). In this part, we will look at different nanomaterials that can mimic natural enzymes as the basis of texture similarity and flexibility.

Use of nanoparticles in enzyme stabilization

Due to the ratio of surface to volume of nanoparticles, the amount of enzyme load on nanoparticles is very high and efficient. Ideally, the use of nanoparticles in enzyme stabilization, such as the minimum restriction on the penetration of the substrate into the enzyme surface and the maximum surface area and high enzyme load, provide optimal conditions for enzyme stabilization (6). For example, the covalent attachment of a lipase enzyme to γ-Fe_2O_3 nanoparticles (a magnetic field can be used to separate the enzyme from the reaction environment) is an example of an enzyme stabilization method using magnetic nanoparticles (5).

Use of nanofibers

Dispersion of nanoparticles in the reaction solution and their recovery for reuse is one of the challenges of using nanoparticles in enzyme stabilization. It seems that the use of nanofibers can solve this problem to some extent. For example, electrospun nanofibers provide a very large surface area for binding or trapping enzymes. Porous nanofibers can also reduce the penetration of the substrate from the reaction environment to the enzyme's active sites. Electrospun nanofibers are durable, easily detached from the environment, and can also produce porous forms (4, 6). To increase the load, a coating of enzymes clotted on the fiber can be formed by crosslinking the enzymes. Of course, this method can also be applied to other types of nanomaterials, such as nanoparticles or carbon nanotubes (2).

Single enzyme nanoparticles (SENs)

A new way for enzyme stabilization, first introduced in 2003, is the synthesis of single-enzyme nanoparticles. Each enzyme molecule is surrounded by a porous organic/mineral composite network. The production of monoenzyme nanoparticles offers a new method of enzyme stabilization that differs from other methods (e.g., enzyme stabilization in porous materials or encapsulation in cell-gels, polymers, or composite mass structures). The conversion of free enzymes to SENs results in the extraordinary stability of the catalytic activity of the enzymes. However, there are not many restrictions on substrate mass transfer to the enzyme surface (2). As shown in the previous figure, in this method, the surface of the enzyme is modified with covalent bonds (for example, vinyl groups); then is polymerized each of them and in the next step, cross-links are established between these strands and eventually are formed single-enzyme nanoparticles (6).

Bio fuel cells

An enzyme-based biofuel cell is a system that generates electricity using biofuels such as glucose, fructose, ethanol, and oil. Enzymatic biofuel cells can be used as an energy source for low-power sensors, communication devices, and medical implants. However, the practical application of these cells is limited due to their short lifespan due to poor enzyme stability and low cell power density. Conventional fuel cells, such as methanol direct fuel cells, use expensive metal catalysts. While in biofuel cells are used from enzymes that have specific properties. In the anode of a biofuel cell, various enzymes can be used, such as glucose oxidase, alcohol hydrogenase, and aldehyde dehydrogenase to oxidation fuels, which produce protons and electrons. At the cathode, lactase or bilirubin oxidase is used to catalyze the reaction of an oxidant (usually oxygen) with these electrons and proteins and form water (2). An important advantage of using the enzyme is the possibility of removing the proton exchange membrane, which is due to the specificity of the enzymes to the substrate and can lead to the reduction of the biofuel cell. In a conventional biofuel cell, membrane removal leads to useless oxidation of the fuel without generating electricity because metal catalysts do not have the specificity of enzymes (2, 3). Enzyme stabilization can be very effective in extending the life span of biofuel cells. It is also predicted that power density will increase with increasing enzyme loading using nanotechnology in enzyme stabilization. The use of conductive nanomaterials such as carbon nanotubes and gold nanoparticles can also increase the power density (2).

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Aplication of Nanotechnology in Biotechnology

Shabnam Delir[a*], Akbar Taghizadeh[a] and Adem Kaya[b]

[a]Department of Animal Science, Faculty of Agriculture, University of Tabriz, Tabriz, Iran
[b]Department of Animal Science, Agricultural Faculty, Ataturk University, 25240, Erzurum, Turkey
** Corresponding Author's Email:* shabnam.delir@gmail.com

Abstract

Nanotechnology cause revolutionized the new era. Nanoparticles are small synthetic particles that differ from natural particles in physical and chemical properties. Nanoenzymes are a type of nanomaterial that is synthetically produced and mimics the function of natural enzymes. This technology has received more attention in recent years due to its low cost, better and faster performance, high stability, and high reproducibility. Nanozymes have shown a wide range of applications in vitro; we see practical progress in this area. These applications include medicine, chemistry, aerospace, genetic engineering, and agriculture. In this article, we give a brief overview of the applications of nanotechnology and enzymes in biotechnology (medicine, medicine, genetic engineering, food safety, environment, and agriculture).

Keywords: Nanoenzyme, Biotechnology, Application

Application of nanoenzymes in medicine

Nanozymes are widely used to diagnose and treat various diseases, including cancer, in the pharmaceutical industry and even toxicology. Studies on nanoenzymes in the field of biomedicine are advancing rapidly. In addition to mimicking the activity of superoxides, these nanoparticles can also affect biological pathways. These nanoparticles include cerium oxide-based nanomaterials (1), Fe2O3 (2), cobalt oxide as catalase and peroxidase, manganese dioxide as oxidase, and gold nanoparticles as oxidase (3).

Application of nanoenzymes in pharmacy

Treatments for diseases are usually through surgery, radiation therapy, medication, or a combination of these methods. Medications play an important role in the treatment of various diseases. Therefore, drugs must be careful in transmitting and targeting the target tissue. These properties are made possible by the use of nanoparticles in drugs. Due to their small size, nanoparticles can easily pass through the body, spread in the target tissue, and affect the body. In using nanoparticles in drug delivery, several characteristics must be observed, such as bioavailability, drug envelopment with biomolecules, and non-toxicity (4). Today, nanoparticles of microbial origin are also used in the treatment of diseases, especially cancer. Table 1 lists the nanomaterials produced by microorganisms.

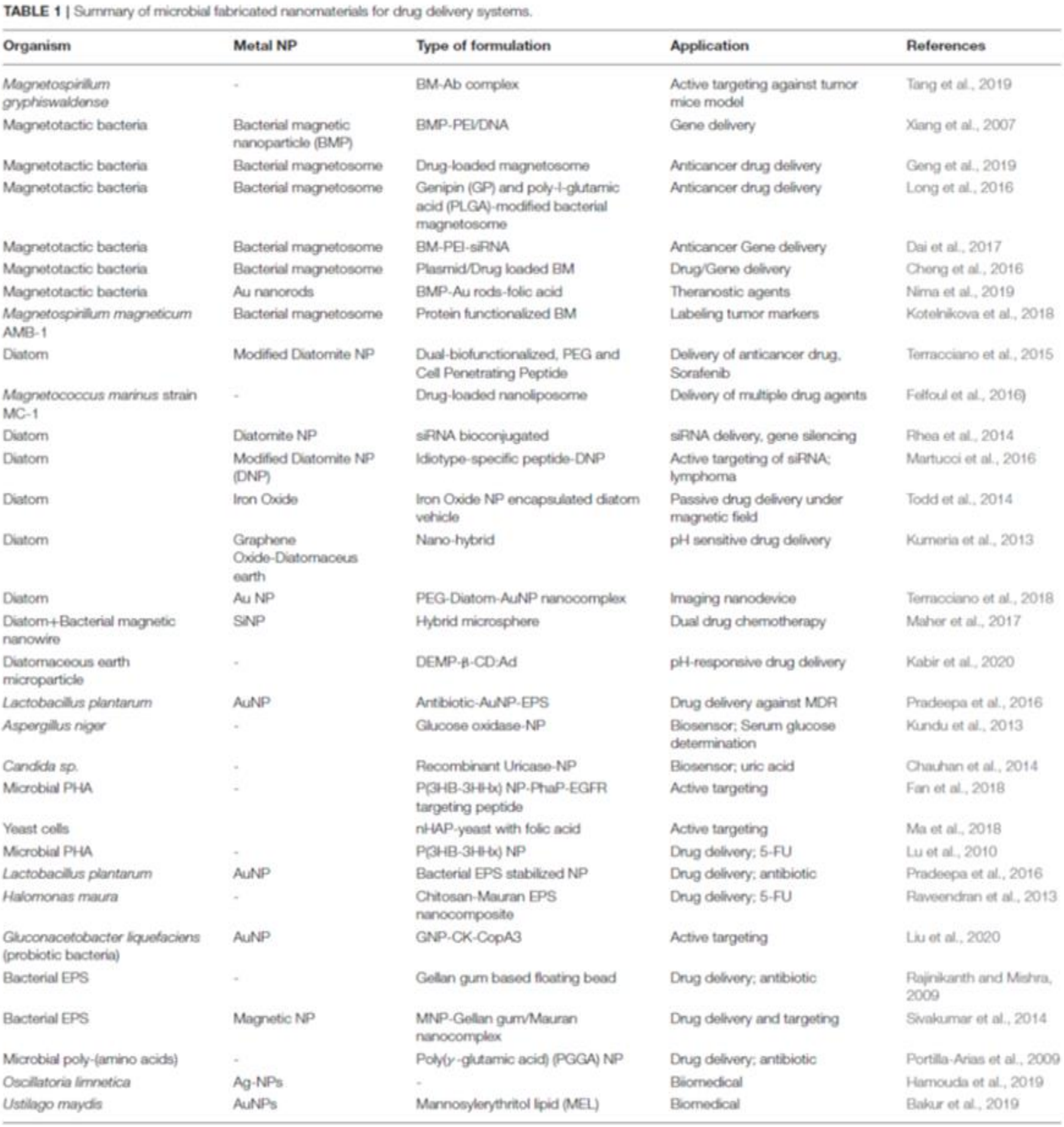

TABLE 1 | Summary of microbial fabricated nanomaterials for drug delivery systems.

Organism	Metal NP	Type of formulation	Application	References
Magnetospirillum gryphiswaldense	-	BM-Ab complex	Active targeting against tumor mice model	Tang et al., 2019
Magnetotactic bacteria	Bacterial magnetic nanoparticle (BMP)	BMP-PEI/DNA	Gene delivery	Xiang et al., 2007
Magnetotactic bacteria	Bacterial magnetosome	Drug-loaded magnetosome	Anticancer drug delivery	Geng et al., 2019
Magnetotactic bacteria	Bacterial magnetosome	Genipin (GP) and poly-l-glutamic acid (PLGA)-modified bacterial magnetosome	Anticancer drug delivery	Long et al., 2016
Magnetotactic bacteria	Bacterial magnetosome	BM-PEI-siRNA	Anticancer Gene delivery	Dai et al., 2017
Magnetotactic bacteria	Bacterial magnetosome	Plasmid/Drug loaded BM	Drug/Gene delivery	Cheng et al., 2016
Magnetotactic bacteria	Au nanorods	BMP-Au rods-folic acid	Theranostic agents	Nima et al., 2019
Magnetospirillum magneticum AMB-1	Bacterial magnetosome	Protein functionalized BM	Labeling tumor markers	Kotelnikova et al., 2018
Diatom	Modified Diatomite NP	Dual-biofunctionalized, PEG and Cell Penetrating Peptide	Delivery of anticancer drug, Sorafenib	Terracciano et al., 2015
Magnetococcus marinus strain MC-1	-	Drug-loaded nanoliposome	Delivery of multiple drug agents	Felfoul et al., 2016)
Diatom	Diatomite NP	siRNA bioconjugated	siRNA delivery, gene silencing	Rhea et al., 2014
Diatom	Modified Diatomite NP (DNP)	Idiotype-specific peptide-DNP	Active targeting of siRNA; lymphoma	Martucci et al., 2016
Diatom	Iron Oxide	Iron Oxide NP encapsulated diatom vehicle	Passive drug delivery under magnetic field	Todd et al., 2014
Diatom	Graphene Oxide-Diatomaceus earth	Nano-hybrid	pH sensitive drug delivery	Kumeria et al., 2013
Diatom	Au NP	PEG-Diatom-AuNP nanocomplex	Imaging nanodevice	Terracciano et al., 2018
Diatom+Bacterial magnetic nanowire	SiNP	Hybrid microsphere	Dual drug chemotherapy	Maher et al., 2017
Diatomaceous earth microparticle	-	DEMP-β-CD:Ad	pH-responsive drug delivery	Kabir et al., 2020
Lactobacillus plantarum	AuNP	Antibiotic-AuNP-EPS	Drug delivery against MDR	Pradeepa et al., 2016
Aspergillus niger	-	Glucose oxidase-NP	Biosensor; Serum glucose determination	Kundu et al., 2013
Candida sp.	-	Recombinant Uricase-NP	Biosensor; uric acid	Chauhan et al., 2014
Microbial PHA	-	P(3HB-3HHx) NP-PhaP-EGFR targeting peptide	Active targeting	Fan et al., 2018
Yeast cells		nHAP-yeast with folic acid	Active targeting	Ma et al., 2018
Microbial PHA	-	P(3HB-3HHx) NP	Drug delivery; 5-FU	Lu et al., 2010
Lactobacillus plantarum	AuNP	Bacterial EPS stabilized NP	Drug delivery; antibiotic	Pradeepa et al., 2016
Halomonas maura	-	Chitosan-Mauran EPS nanocomposite	Drug delivery; 5-FU	Raveendran et al., 2013
Gluconacetobacter liquefaciens (probiotic bacteria)	AuNP	GNP-CK-CopA3	Active targeting	Liu et al., 2020
Bacterial EPS	-	Gellan gum based floating bead	Drug delivery; antibiotic	Rajinikanth and Mishra, 2009
Bacterial EPS	Magnetic NP	MNP-Gellan gum/Mauran nanocomplex	Drug delivery and targeting	Sivakumar et al., 2014
Microbial poly-(amino acids)	-	Poly(γ-glutamic acid) (PGGA) NP	Drug delivery; antibiotic	Portilla-Arias et al., 2009
Oscillatoria limnetica	Ag-NPs	-	Biomedical	Hamouda et al., 2019
Ustilago maydis	AuNPs	Mannosylerythritol lipid (MEL)	Biomedical	Bakur et al., 2019

Application of nanoenzymes in food safety

Toxins produced by various fungi (Aspergillus and Penicillium, etc.) can endanger human health and cause poisoning (5). These fungi multiply in various foods and animal feeds, and the mycotoxins that are produced cause food contamination. Therefore, it is necessary to be careful in keeping food healthy and also to detect these contaminants. Rapid detection of food contaminants can be a new way to reduce the harm caused by contaminants and ensure human health. With the advancement in the nanotechnology industry, several methods have been identified that, due to new and efficient capabilities, prevent the old diagnostic and analytical methods that cause high costs and waste of time.

Figure1: Methods for the identify of food toxins

Application of nanoenzymes in preventing environmental pollution

Despite the welfare of society, human industrial activities have caused problems in the environment. Factory wastes, the release of plastics into the environment, the use of pesticides in the agricultural industry, and many other things are the causes of pollution in the environment. In addition to destroying nature and polluting rivers and seas, environmental pollution also endangers human life by toxins released into the environment. Today, many efforts have been made to control this pollution to overcome these problems, and various methods are used. These methods include membrane filtration, adsorption, distillation, oxidation, biocatalytic and photocatalytic degradation (6 and 7). Biocatalytic degradation can be one of the most appropriate methods to prevent environmental pollution. This method is useful because 1- Nanoenzymes (peroxidase and oxidase) act as catalysts faster and save time and money. 2- We can control them in natural environments. 3- Also, enzymes and microbes are recycled into harmless compounds in the environment and prevent further pollution of the environment.

Application of nanoenzymes in agriculture

Agricultural products have always been one of the main sources of human food. Today, with population growth, the need for agricultural products has also increased, and man has always been looking for a way to make the most profit in the shortest time with the least cost. Hence, many studies in this field have been done by experts, and today, nanobiotechnology methods (nano-pesticides and nano-fertilizers) in this field are welcomed because of the many benefits such as no environmental degradation and preservation of soil nutrients. Other applications of nanotechnology in agriculture are related to genetic engineering. Genetic engineering is a nascent method that transfers desirable genes to produce more transgenic plants, higher nutritional value, and resistance to disease and pesticides. Of course, genetic engineering and transgenic products have always been associated with opposing and agreeing on views. In this method, gene transfer is usually done by bacteria. But despite the advantages mentioned, genetic engineering alone is low efficiency, costly, and requires a lot of time to achieve the desired goal, which is not economically viable. For this reason, the use of nanoparticles in genetic engineering has been proposed. Gene transfer using nanoparticles is more efficient than conventional genetic engineering methods. The passage of nanoparticles through the plant cell wall should be facilitated. Nanoparticles protect the genetic charge against enzymatic degradation (nucleases) (8). Different types of nanomaterials are used in genetic engineering, including carbon-based nanoparticles, silicon-based nanoparticles, metal-based nanoparticles, and polymer-based nanoparticles, each of which have a different genetic charge (8). Cation-based nanoparticles are more suitable than other nanoparticles because they have a high ability to bind to the plant cell wall (8) and gene transfer.

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Nanotechnology in Animal Sciences: Methods of Manufacturing, Improving the Quality of Animal Products and Its Current and Future Prospects in Animal Nutrition

Mehri Montazer Harzand[a], Hamid Paya[a]*, Adem Kaya[b] and Akbar Taghizadeh[a]

[a] *Department of Animal Science, Faculty of Agriculture, Unuiversity of Tabriz, Tabriz, Iran*

[b] *Department of Animal Science, Agricultural Faculty, Ataturk University, Erzurum, Turkey*

**hamid.paya@tabrizu.ac.ir*

Abstract

Nanotechnology is one of the most advanced technologies used in various fields such as agriculture, medicine, and the food industry. Due to the special properties of nanomaterials and their dimensions - approximately 1 to 100 nanometers - they are constantly developing and expanding. Nanomaterials can contribute to the sustainability of the ruminant nutrition sector by improving the quantity and quality of products and producing safe, healthy, and functional products. Many methods have been developed to enhance the composition and quality of food. However, one of the cheapest and most effective is the use of feed additives. Many studies have shown that micro and macro elements in the form of nanoparticles can be better absorbed by animals, which improves the quality of the products obtained from them. Previously, these minerals were synthesized chemically, which led to their release into the environment. Recently, the production of nanoparticles from plant sources - called green synthesis - has become important. This process includes plant extracts that contain sugars, polyphenols, terpenoids, proteins, and more. The waste products of these phytochemicals are highly biodegradable and therefore have no adverse effects on the environment.

Due to reports of an increase in the number of antibiotic-resistant bacteria, many countries are updating laws and regulations to end antibiotics in the livestock industry. Many reports suggest that nanoparticles could be a good candidate in this field. There is currently a lack of valid and cost-effective diagnostic tests to detect diseases in breeding animals. Biosensor technologies can solve these problems by developing innovative diagnostic tools to quickly detect important health threats in the livestock and agricultural sectors. Also, creating new foods or supplements by encapsulation or nanoemulsion, achieving the slow release of some compounds, or obtaining healthier foods by improving the product's organoleptic properties will lead to more product innovation. Although nanotechnology offers many advantages, like other innovations, there are disadvantages and risks associated with its use. Risk assessment should be considered because the biokinetic and toxicity characteristics of the target tissues may vary depending on the type of nanomaterials used.

Main Text

Nanotechnology is a multidisciplinary science and combines chemical engineering, materials engineering, biotechnology, and industrial processing technology. As a general definition, nanotechnology is described as "the design, identification, production, and application of structures, methods, and systems by controlling shape and size at the nanometer scale" (Ranjan et al., 2014). In recent years, many studies have been conducted on the possibility of improving the composition and quality of livestock products using nanomaterials in animal nutrition. Many methods have been developed to improve the composition and quality of food; however, one of the cheapest and most effective methods is feed additives. Many studies have shown that micro and macro elements in the form of nanoparticles can be better absorbed by animals, which improves the quality of the products obtained from them. The inclusion of nanomaterials in animal feed or water can be beneficial for the quality of the product obtained and the production cycle (Konkol and Wojnarowski, 2018). In the study of adding chromium nanoparticles to poultry feed and a positive effect on the amount of protein in the muscles of the chest and thighs, it reduced cholesterol and increased feed efficiency and average daily gain. Nanotechnology can also help ensure milk quality through new techniques for detecting food pathogens. The researchers produced nanocomposites containing S. aureus antibodies, gold nanoparticles, and magnetic nanoparticles and detected the presence of S. aureus in milk with a 40-minute colorimetric experiment. Also, using polyclonal antibodies and immunochromatographic strips of gold nanoparticles, they were able to detect the carcinogenic aflatoxin M1 within 10 minutes of detection of toxins in milk (Wang et al., 2011).

Converting molecules to nanoscale - nanotechnology - is done by various chemical, physical, biological methods (microorganisms and plants) or combined methods. The main idea in these approaches is to make changes in the chemical and physical nature of the main material. Although chemical and physical methods for the synthesis of nanoparticles are widespread, the use of low doses of these substances is often toxic. They may also be in an unstable state, and the chemical may enter the environment. Therefore, due to avoiding limitations related to conventional synthesis methods, and environmentally friendly method - green synthesis - has been developed to fabricate nanoparticles (Singh and Prasad 2017). The term green synthesis indicates that the preparation of a nanomaterial is done using nanotechnology and plant biotechnology. Plant extracts contain various compounds such as sugar, alkaloids, polyphenols, proteins, etc., that play an important role in reducing metal ions' particle size and stability. The synthesis of nanoparticles with this process has two significant advantages over the conventional synthesis method. First, these nanoparticles are more permeable and, as a result, play an important role in targeted drug delivery. Second, biodegradable materials are used in this process, which eliminates the possibility of accumulation and environmental pollution caused by chemicals (Marappan et al., 2017).

Manufacturers are now using antibiotics as feed additives to achieve the ideal slaughter weight and maximize profitability quickly. While useful from a production point of view, this universal method leads to an increase in drug-resistant bacteria, which can cause disease in livestock and meat contamination. This has led to several countries passing legislation restricting the use of antibiotics. Nanoparticles not only have the potential to fill the gap created by these limitations but can do so without creating antibiotic resistance in microbes. Despite the increased resistance of antibiotics in bacteria, antibiotics have not yet been completely ineffective against them. Their delivery and efficacy can be increased with nanoparticle carriers and potentially reduce the dose of antibiotics required for treatment (Hill and Li, 2017).

In the modern world, new diseases that can threaten the health of animals are frequently emerging. There is currently a lack of valid and cost-effective diagnostic tests to detect diseases in breeding animals. Biosensor technologies can address these problems by developing innovative diagnostic tools to quickly detect significant health and health threats in the livestock and feed sectors. Diagnosis of diseases in the early stages requires time-consuming, expensive tests and diagnostic tools that can predict the likelihood of an accident and its possible effects on a specific population (both humans and animals) and diagnosis and treatment options. Nano biosensor applications reduce the current costs of reagents, sample review, analysis time, and transportation costs and help implement and promote sustainable farming techniques and ethical treatment of livestock. The future of biosensors depends on the extensive use of knowledge of physiology, genetics, environmental sciences, and animal nutrition, and the integration of this knowledge in a meaningful way can effectively transform commercial and social benefits. Biosensors should be used to develop approaches such as quickly and accurately identifying food inputs and final products (meat, eggs, milk) in terms of nutrient content (total and bioavailability) and anti-nutritional agents and bioactive components. As well as chemical and microbiological contaminants to use this technology at the feed mill level commercially or animal products processing plant. On the other hand, they can assist in the decision-making process of changing the composition of animal feed if animal products are found to be unhealthy from the expected nutritional status (Abdel-Megeed 2020).

As nanotechnology is evolving and gaining more attention, its livestock industry applications are also developed. This progress is important for human health in many ways, including the production of healthy food, the diagnosis and treatment of diseases, and the delivery of medicine. Regular use of nano-supplements to enrich animal feed will probably be possible soon. In addition, consumer demand and awareness have increased as consumers seek healthy, high-quality foods with beneficial health benefits and longevity. However, it takes longer for nanoparticles to completely replace antibiotics in the diet, as many biocidal candidates must be tested in vivo before clinical trials and food safety tests. In general, in vivo studies are needed to confirm the performance of nanoparticles observed in in vitro research.

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Nano-minerals: Benefits and risks in ruminant nutrition

Mehri Montazer Harzand[a], Hamid Paya[a]*, Akbar Taghizadeh[a], Valiollah Palangi[b]

[a] *Department of Animal Science, Faculty of Agriculture, Unuiversity of Tabriz, Tabriz, Iran*

[b] *Department of Animal Science, Agricultural Faculty, Ataturk University, Erzurum, Turkey*

******hamid.paya@tabrizu.ac.ir*

Abstract

The bioavailability of minerals from inorganic sources is very low, so these minerals are added to the diet 20 to 30 times more than animals' natural needs, which can lead to excessive excretion of these minerals in the feces and thus environmental pollution. In addition, it may affect the balance of other minerals. Interaction between two or more minerals can reduce bioavailability. Therefore, alternative sources such as organic minerals are studied, with much higher bioavailability than inorganic mineral resources. However, organic mineral resources are much more expensive than conventional inorganic sources. Recently, minerals in the nanoscale have been shown to have new and different properties than naturally occurring particles. Due to their high bioavailability in biological systems, nanomaterials have a high potential as mineral supplements due to their increased surface area, surface activity, and catalytic efficiency, even at much lower doses than conventional sources.

Minerals in the form of nanoparticles reduce the intestinal mineral antagonism and thus mitigate the excretion and pollution of the environment. It also increases antioxidant activity and improves growth performance, reproduction, immune response, intestinal health, and nutritional value of livestock products. Nano minerals are useful for improving the results of assisted reproductive technologies (ART) by enriching environments with antioxidant nano minerals to preserve the freezing of sperm, ovule, and embryos. Despite the positive and promising effects of mineral nanomaterials on animal performance (growth, feed intake, nutrient bioavailability, antioxidant status, and immune response), various challenges, including metabolism and their fate in the animal body, are related to there are mineral nanomaterials. Although nanotechnology is one of the main innovations used in ruminant nutrition and other fields, it is still in its early stages of development and may interfere with the environment, animal, and human health. Therefore, extensive assessments and research should be conducted to support efficiency and biosafety and prevent damage to livestock, humans, and the environment. This study covers the benefits of using nano minerals in ruminant diets by focusing on animal function, physiological effects, and potential toxicity and their impact on human health.

Main Text

Nanotechnology is a new science that has been widely used in many areas of life, including medicine, nutrition, disease diagnosis, the chemical industry, and biological research. In recent years, nano-supplements have attracted much attention, especially in the animal products and veterinary sciences industry. Mineral nanoparticles are particles with a particle size in the range of 1-100 nanometers (Bertero et al., 2019). Even at lower doses than their usual sources, Nano minerals show significant and higher effects and potential than conventional sources, thus reducing the required amount. Recent studies have shown that mineral nanoparticles have higher bioavailability due to properties such as higher specific surface area, higher surface activity, high catalytic efficiency, and strong adsorption capacity. The remarkable properties of nano minerals are mainly determined by their shape, size, crystal structure, composition, morphology, and structure. The particle size strongly influences particle size and functional activities (catalytic, chemical, or biological effects) of mineral nanomaterials. Inorganic nanomaterials have large levels that allow better interconnection with other organic and inorganic components (Rosi et al., 2020).

Minerals can be useful in ruminants to improve health and safety, gastrointestinal function, microbial homeostasis, metabolism, and reproductive function. Recently, zinc nanoparticles have received more attention in lamb nutrition to meet nutritional needs and improve animal growth. The addition of zinc nanoparticles to the diets of growing lambs has increased the digestibility and nutritional value of the diet through high feed efficiency. In one study, male goats receiving 0.03 mg/kg of selenium nanoparticles showed a higher body weight and daily weight gain than those receiving sodium or selenium-yeast selenite (Shi et al., 2011). The positive effects on ruminal fermentation, nutrient digestibility, and growth can be attributed to increased surface-to-volume ratio, nanoscale size, rapid and specific motion, and catalytic effect. These help to improve the bioavailability of nano-minerals in the GIT.

Minerals with high antioxidant capacity, such as selenium and zinc, are important trace elements in maintaining the reproductive physiology of animals. These minerals play an important role in spermatogenesis, sperm viability, sperm cell membrane integrity, and the maintenance of the chromatin structure of the sperm nucleus. In addition, semen purification and maintenance processes have been developed using nanomaterials and various methods to obtain high-quality semen (Hashem and Gonzales, 2020). Improving semen diluent with antioxidant agents, such as antioxidant minerals, enhances the quality characteristics of semen cells in the cooling state, mainly if nano-shaped. During the freezing/cooling process, the sperm is stored in a synthetic diluent that must be controlled and adjusted to maintain quality semen characteristics. Accordingly, mineral nanomaterials are used to modulate the diluting properties of semen to achieve antioxidant and antibacterial effects. Supplementation of semen diluent with zinc nanoparticles during freezing to reduce lipid peroxidation, increase mitochondrial activity, and dose-dependent plasma membrane function of sperm has been identified without any detrimental effect on motor parameters (Jahanbin et al., 2015).

Nano minerals may increase antioxidant activity by inhibiting the production of free radicals due to increased levels, leading to an increase in the number of active sites to eliminate more free radicals. In one study, sheep fed a basal diet containing zinc nanoparticles showed better antioxidant levels. In one study, supplementation of 50 ppm nano-copper in pigs significantly improved IgG, γ-globulin, and total globulin protein levels (Gonzales et al., 2009). Selenium nanoparticles show excellent bioavailability due to their high catalytic efficiency, low toxicity, and adsorption capacity. Due to the antibacterial activity of nano-minerals with antioxidant properties, some nano-minerals such as ZnONPs can be useful in the prevention and treatment of some bacterial diseases such as subclinical mastitis in cattle (Rajendran et al., 2013).

The nano-form of supplements can increase absorption by increasing the surface area, resulting in better use of minerals and reduced use of dietary supplements, reduced feed costs, and greater stability. However, the rise of nanotechnology and the widespread use of nanoparticles in everyday life have raised concerns about the potential impact of their hazards on living organisms and human health. The adverse effects of nanoparticles on many cellular and molecular changes have been well considered; however, the potential toxicity in laboratory animal studies requires further investigation. The study of the toxicity of nano minerals will help producers and researchers in livestock and poultry production to make safer decisions in the use of nanotechnology and increase public awareness of nanotechnology-based applications in livestock production systems (Attia et al., 2019).

The animal breeding industry is facing the constant pressure of rising raw material prices, including the price of minerals, which necessitates the use of potential mineral resources with high bioavailability and efficiency and less antagonism. The use of nano minerals in animal nutrition shows promising results in increasing yield, nutrient bioavailability, and animals' safety and reproductive status. However, a balance between safety and effectiveness and risk and benefit, which are among the considerations of nanoparticle accumulation in the environment, is necessary. Further research is needed to confirm nanomaterials' effectiveness, efficiency, and safety to prevent adverse effects on livestock, environment and human requirements.

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Controlling of Absorption threshold of transparent SrF2-Ge ceramic glass film

Mojtaba FARHANGMEHR*[1], Mehmet ERTUGRUL[2]

[1] Nanoscience and Nanoengineering Department of Tesla Tajhiz Nano Company, Tabriz, Iran

2 Engineering Faculty and Department of Electric-Electronics, Ataturk University, Erzurum, Turkey

mfarhangm@gmail.com

Abstract

Crystallization of alkaline earth fluorides or rare earths of nano size has many optical applications. In this study, the nano crystal of SrF2-Ge was grown on quartz substrate. An RF sputtering magnetron system was used to obtain SrF2-Ge crystallization. 12.3SrO/3.7Al2O3/8.0Na2O/5.3K2O/10.4SrF2/60.3SiO2 and Ge (3%, 5% and 10%) targets were prepared in different % ratios, and SrF2-Ge nano crystal thin films was obtained for 6, 8, 10, 12, 14 and 16 hour growth periods. The samples were then heat treated in air for 3 hours at temperatures between 570 and 610 ° C. The results of XRD analysis showed good crystallization in the samples (having a thickness of 500 nm) grown for 16 hours. Optical absorption and transmission analyzes showed that the light scattering increased with increasing coating time and that the absorption threshold changed with increasing germanium percentage. SEM analyzes showed that the sizes of nano crystals were varied between 50 to 100 nm.

Keywords: SrF2-Ge, XRD, SEM, Absorption & Transmittance analyses

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Plant Derived Nanoparticles In Livestock Farming

Moyosore Adegbeye[a], Mona M.M.Y. Elghandour [b], Abdelfattah. Z. Salem [b*], P. Ravi Kanth Reddy[c], Valiollah Palangi [d], Olalekan Balogun[e]

[a] Department of Animal Production and Health, Federal University of Technology, P.M.B. 704, Akure, Nigeria

[b]*Facultad de Medicina Veterinaria y Zootecnia, Universidad Autónoma del Estado México, Toluca, Estado de México, Mexico*

[c]Veterinary Assistant Surgeon, Veterinary Dispensary, Taticherla, Andhra Pradesh, India

[d]*Department of Animal Science, Agricultural Faculty, Ataturk University, 25240, Erzurum, Turkey*

[e]Department of Microbiology, College of Agriculture and Natural Sciences, Joseph Ayo Babalola University, Ikeji-Arakeji, P.M.B 5006 Ilesha, Nigeria

**E-mail : salem@uaemex.mx; asalem70@yahoo.com)*

Abstract

Plant synthesized nanoparticles have the potentials to be more effective against ecto- and endoparasites such as helminths, ticks, hematophagous parasites, etc., promoting the healing of burned wounds and multidrug-resistant pathogens in poultry and ruminants even at a lower concentration. Plant-derived nanoparticles could enhance survival, growth, and production in livestock and aquaculture. Green Synthesized Gold Nanoparticles increased motility, liveability, and membrane integrity post-equilibration and improved goat semen during cryopreservation. For biosecurity control against disease-spreading insects such as Musca domestica, green synthesized Ag NPs were effective as a potential eco-friendly control sanitary pest and could be an alternative to synthetic insecticides. Green synthesized nanoparticles are an effective material that could be applied in livestock production for control of pests, ecto- and endoparasites, multidrug-resistant pathogens, productive performance, biosecurity control, and mycotoxin alleviation in feed.

***Keywords*: Plant synthesized nanoparticles, livestock, pest control, performance**

Introduction

Nanoparticles application in diverse fields is unfolding. Recent demand for a deviation from the use of synthetics to natural sources is encouraging. Despite the positive impact of nanoparticles in animal nutrition, there is an increasing call for green synthesis of these nanoparticles due to the concerns about hazardous by-products, expensive, low yield, and labor-intensive. The green synthesis approach is an interesting area because of its economic, biocompatible, and eco-friendly benefits, enhancing sustainable livestock management over chemical methods. Several options have been explored, especially on the use of materials of phytogenic origins for animal health. Several sources of green synthesized nanoparticles such as honey, glucose, microorganism, and plants based. Nanoparticles could be synthesized from eco-friendly resources like plant extracts such as Cleome viscose, Alfalfa sprouts, *Azadirachta indica*, *Ziziphus Jujuba*, *Eucalyptus globulus leaves*, *Ocimum canum*, *Ananas comosus*, *Manilkara zapota*, *Prunus dulcis* (Almond Gum), Aloe vera, olive leaves, and bamboo, peels, or leaves. This green synthesized nanoparticle from the plant can be useful in aquaculture, ruminant and monogastric production, biosecurity, and animal health (Adegbeye et al., 2019, Ravi Kanth Reddy et al., 2020). The purpose of this article is to highlight the importance of plant synthesized nanoparticles.

Performance

In aquaculture, Ananas comosus (L.) peel extract synthesized manganese-oxide nanoparticles with 3–18 mg Mn-oxide NPs/kg, improved the growth performance (survival rate; length gain; weight gain; specific growth rate; feed conversion ratio), digestive enzyme activities (protease, amylase and lipase}}) and muscle biochemical compositions (amino acid, carbohydrate, lipid, total protein) of freshwater M. rosenbergii than the control (Asaikkutti et al. 2016). Dietary inclusion of 50 and 100 mg/kg curcumin nanoparticles (CurNPs) on broiler chicken improved body weight gain, feed conversion ratio, and reduced feed consumption. It also had Hypocholesterolaemia impacts, reduced lipid peroxidation, enhanced glutathione peroxidase, and superoxide dismutase activities, and exhibited immunomodulatory effects (elevated serum antibody titer against SRBCs, IgG, and IgM) compared to the control (Badran et al. 2020). This suggests that curcumin nanoparticles can be used to improve the productive and immunomodulatory functions of broiler chickens. Similarly, supplementing rabbits with 2.5 mg curcumin nanoparticles per kg diet improved the weight gain, Final BW, feed conversion ratio, viability, immunoglobulins, total antioxidants capacity compared to the control of heat-stressed growing rabbits (El-Rate et al. 2020). Mycotoxins are present in several doses in feed ingredients, and their presence affects the production performance of both ruminant and non-ruminants. Importantly, the mycotoxins residue is also transferred to the animals' products, passed to the consumers (Adegbeye et al. 2020). Asghar et al. (2018) study showed that iron (Fe), copper (Cu), and silver (Ag) nanoparticles (NPs) synthesized from green tea and black tea leaves extracts had antifungal activity and adsorption capacity of 110-139 ng/mg against mycotoxins of Aspergillus flavus and Aspergillus parasiticus origins. Similarly, Al-zubaidi et al. (2021) showed that silver nanoparticles synthesized from Curcuma plant extract (Curcuma longa L.) added to broiler feed at 590.33 ppm showed no evidence of aflatoxin B1. When fed to broilers, they had optimal hepatocyte function (AST and ALT) and no liver damage, as evidenced by the histopathological evidence. This suggests that green-derived metal NPs may be useful as aflatoxins adsorbent in livestock feed. The mammalian sperm cells contain a high ratio of polyunsaturated fatty acids, and they are highly susceptible to the cryopreservation process. There are various challenges during semen cryopreservation used for artificial insemination; oxidative stress is considered the major factor. Adding Nettle-leaved Goosefoot synthesized gold nanoparticles 10ppm/mL to Tris-extender increased sperm motility, liveability, membrane integrity post-equilibration, acrosome integrity post-thawing, decreased necrotic sperm, and enhanced total antioxidant capacity and catalase activity in goat semen during cryopreservation (Ismail et al. 2020).

Antiparasitic/antimicrobial

Ecto and endoparasite are major challenges in livestock management systems. They cause higher mortality and morbidity rates and ultimately decrease the flock's production performance. There is increasing resistance to established drugs due to prolonged use or excessive use. Tomar and Preet (2017) and Avinash et al. (2017a) have shown that neem-mediated nanoparticle is more effective, lethal than the individual neem or albendazole drug against helminth at over 97% lower doses against causing 15%–85% motility of adult H. contortus. Similarly, Preet and Tomar (2017) that Ziziphus jujuba leaf extract bio fabricated AgNp had 91% egg hatch inhibition had an adulticidal effect on Haemonchus contortus worms by altering the nutrition status (glycogen, lipid, and protein depletion) of Haemonchus contortus worms by 5.69%–21.81% at an LC50 was 98.37% lower than the individual leaf extract in raw form. Ticks are very common in extensive animals or animals in the intensive system but on a pasture-based system. Neem-coated silver nanoparticles (Avinash et al., 2017b), Ocimum canum leaf extract silver nanoparticles (Jayaseelan and Rahuman 2012), Musa paradisiaca peel, synthesized silver nanoparticles (Jayaseelan et al. 2012), and Catharanthus roseus leaf extract-mediated titanium dioxide nanoparticles (Velayutham et al. 2012) were reported to be toxic to both adult and larvae of ticks and sheep-biting louse. Currently, there is an increasing call for the use of plant additives instead of synthetic drugs as a means of promoting healthy livestock production and reducing drug resistance. But can this herbal medicine be efficient in commercial livestock production, where a single infection can destroy large financial investments and cause epidermic outbreaks and short-term animal protein shortage. Avian colibacillosis caused by the zoonotic pathogen Escherichia coli is a common bacterial infection that causes major losses in the poultry sector. Masood et al. (2021)'s study showed that green synthesis of zinc oxide nanoparticles (ZnO-NPs) from Eucalyptus globulus leaves had an 88% inhibition rate compared to 58% from Eucalyptus globulus leaves. The low concentration required by herbal conjugated AgNp suggests the importance of silver nanoparticles in potentiating the lethal effects of herbal extracts against pathogens and the development of "nano herbal medicines.

Biosecurity

Housefly (Musca domestica) are good and bad insect. They could be a source of animal protein for aquaculture and poultry production and as well as vectors. Hence their usefulness depends on the intention of the farm owner. In this case, Housefly as viewed as vectors and there is need for their control using eco-friendly biopesticides. *Moringa oleifera* Synthesized Silver and Zinc Nanoparticles, and Manilkara zapota synthesised silver nanoparticles decreased the fecundity of the female and the hatchability of their eggs by reducing the total protein content, acetylcholine esterase, and glutathione S-transferase enzymes compared to control (Abdel-Gawad 2018, Kamaraj et al 2012). This suggest that plant synthesized nanoparticles could be a cheap control tool for immature stages of Musca domestica. This paper shows that plant mediated nanoparticles has great potentials and could be useful in livestock industry. They could aid wound healing, antimicrobial functions, cryopreservation and importantly, animal productive performances, and mycotoxin alleviation in feed. The importance of plant derived nanoparticles in animal health could lead to the development of "nanoherbal medicines".

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Catalytic Decolourization and Degradation of Methyl Violet Using Biosynthesized Colloidal Gold Nanoparticles and $NaBH_4$

Nilofar Nadaf[ab], Shivangi Kanase[b]

[a]Department of Microbiology, Sadguru Gadage Maharaj College, Karad. 415124. Maharashtra. India.

[b]Department of Microbiology, Yashvantrao Chavan Institute of Science, Satara. 415001. Maharashtra.

E-mail : nilofariiitp@gmail.com

Abstract

The effluent release of dye industries is a serious cause of concern. Many textile dyes are toxic, resistant to conventional degradation, and pose a threat to environment and also affects the aesthetic beauty of aquatic environment. The treatment and removal of organic dyes from textile effluent are one of the challenging tasks faced by the environmentalists and industries. The treatment of dyes in the presence of biocompatible, ecofriendly nanocatalyst is the straight forward route which does not include the use of organic solvents. Here we report for the first time, catalytic degradation of methyl violet by biologically synthesized gold nanoparticles in presence of $NaBH_4$. The gold nanoparticles were found to show catalytic decolorization and degradation of methyl violet within four seconds in presence of $NaBH_4$. It was confirmed by recording the UV-visible spectra of the reaction mixture. The degraded products were identified by gas chromatography-mass spectroscopy (GC-MS) after the degradation of methyl violet. These results suggest *B. marisflavi* mediated synthesized gold nanoparticles as a promising nano-catalyst in the degradation of methyl violet.

Keywords

Green synthesis; Bacillus marisflavi ; Gold nanoparticles; Catalysis; Methyl violet degradation

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TELSAM Accelerates Crystallization Of Fused Target Proteins By Stabilizing Weak Crystal Contacts

Supeshala Nawarathnage[a], James D. Moody[a]

Department of Chemistry and Biochemistry, Brigham Young University, Provo, UT 84602, USA

E-mail: dilru@byu.edu

X-ray crystallography is required for atomic-level structure determination of proteins too small for cryo-electron microscopy. Sterile Alpha motif (SAM) domain of human Translocation ETS Leukemia (TEL) protein is a chaperone that is engineered to polymerize at low pH (Kim et al., 2001). Investigation into covalent protein crystallization chaperones to facilitate the crystallization of novel protein targets is important as it increases the success rate of protein crystallization. The chaperone-target protein fusion polymerization lends avidity to strengthen subsequent weak crystal contacts made by the target protein. As the chaperone provides many of the crystal contacts, chaperones should enable protein crystallization with the minimal screening of crystallization conditions, significantly reducing the time and resources required to determine protein structure. The TELSAM monomers that polymerize when the pH is lowered are fused to target protein DARPin to test their ability to form diffraction-quality crystals. The 3TEL-DARPin structure showed that it forms a crystal lattice where polymers do not touch in 1 dimension and stabilize extremely weak inter-DARPin contacts between sheets of polymers. We then crystallized the human TNK1 UBA domain as a fusion to TELSAM. The UBA homology model that was used for the molecular replacement did not fit the electron density data. But the TELSAM polymer allowed the solution of the X-ray phases to build the UBA domain one helix at a time. With all these data we understand that the TELSAM helps to crystallize the target proteins 27 times faster. With the 1TEL-Flex-UBA structure, we learned that TELSAM polymers do not touch each other, and TELSAM crystallizes UBA with a lack of TELSAM polymers 1TEL-Rigid-UBA. In the future, pH-dependent TELSAM can be used as a protein crystallization tool that speeds the crystallization of target proteins with diffraction quality crystals.

POSTER PRESENTATIONS

Calcium nanoparticles and their applications

Ozlem BARIS[a]

[a] *Department of Nanoscience and Nanoengineering, Institute of Naturel and Applied Sciences, Atatürk University, Postal Code 25240, Erzurum, Turkey.*

baris@atauni.edu.tr

Calcium is the fifth most abundant element on earth and can form compounds of different content and nature.[1] The nanoparticle samples of these compounds are very important and their activities in various composites are also important. Examples of usable compounds of calcium; can be sorted as calcium oxide (CaO), calcium carbonate ($CaCO_3$), calcium phosphate ($[Ca_x(PO_4)_y{\cdot}zH_2O]$), apatite ($[Ca_5(PO_4)_3F]$), hydroxyapatite $Ca_5(PO_4)_3OH$ (often abbreviated as HAP or HA), gypsum ($CaSO_4{\cdot}2H_2O$), anhydrite ($CaSO_4$), and fluorite (CaF_2). Calcium compounds are one of the important components in living systems as well as being widely found in nature.[1-3] They are considered as ideal carrier systems with their porous structures and biocompatibility.[1] In vaccine technologies (carrier material), drug delivery systems (toxicity-reducing and protection from stomach acids in oral use), composite formation (toxicity-reducing etc.), paper industry (non-flammable paper technology), agricultural production (nanofertilizer), graft, filler and implant in addition to being used in processes (bone component, nanocement), it can also be used in studies related to energy storage technologies (high redox potential).[2-6] Synthesis techniques of calcium nanoparticles, like other nanoparticles, are very important.[2,5] Since biological processes are important in the formation of calcium minerals, biosynthesized calcium nanoparticles are of greater importance. One of the most important features of calcium nanoparticles, which has no biocompatibility problem, is that it can mask toxic materials in addition to its low toxicity.[4] Composites of calcium nanoparticles may be preferred due to their low toxic properties. Calcium nanoparticles have a very rich potential for use with their properties that can also be used in the design of biodegradable materials.

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A comparison on the performance of NiO and Spiro-OmeTAD as an HTL in perovskite solar cells through numerical GPVDM simulation

Subathra Muniandy[a], Muhammad Idzdihar Bin Idris[a], Saranyah Palani[a], Zul Atfyi Fauzan Bin Mohammed Napiah[a], Siti Amaniah Mohd Chachuli[a], Marzaini Rashid[b] and Luke Bradley[c]

[a]*Fakulti Kejuruteraan Elektronik dan Kejuruteraan Komputer (FKEKK), Universiti Teknikal Malaysia Melaka (UTeM), Hang Tuah Jaya, 76100, Durian Tunggal, Melaka, Malaysia.*
[b]*School of Physics, Universiti Sains Malaysia (USM) Penang, Malaysia.*
[c]*School of Engineering, Newcastle University*

m022020016@student.utem.edu.my

Abstract— Perovskite solar cells (PSCs) are the most current type of solar cell and have already distinguished themselves as one of the most appealing thin-film PV technologies. The hole transporting layer (HTL), one of the crucial layers for PCSs, is typically 2,2′,7,7′-tetrakis(*N*, *N*-di-*p*-methoxyphenylamine)-9,9′-spirobifluorene (Spiro-OMeTAD) due to its high hole mobility and its ability to lower series resistance and interlayer recombination losses. Despite the benefits of Spiro-OMeTAD, it is expensive in comparison to other HTLs and time-consuming to synthesise. Recent work has shown that adding additives to enhance the conductivity of Spiro-OMeTAD can lead to deterioration and physical damage of the internal contact layers. An inorganic substance known as Nickel Oxide (NiO) has been mooted as a potential alternative to Spiro-OMeTAD and will be the main focus of this study. In this paper, we examine the effects of different film thickness, and a wide range of charge mobilities restrictions in a perovskite solar cell based on the framework of the PSCs FTO/ZnO/Perovskite/Spiro-OMeTAD/Al and FTO/ZnO/Perovskite/NiO/Al using GPVDM (General-purpose Photovoltaic Device Model) to determine if NiO is a superior alternative to Spiro-OMeTAD for PSCs. From the simulation results, the optimised parameters obtained for PCSs incorporating NiO were 21.67%, 0.86 a.u., 1.06 V and -2.36e+02 A/m^2. On the other hand, the optimized parameters obtained for PCSs incorporating Spiro-OMeTAD were 18.65%, 0.87 a.u., 1.06 V, and -2.04e+02 A/m^2. The results from each simulation for both PSCs were iteratively optimized following each simulation to achieve the optimal parameters. The results from the GPVDM simulations show that NiO is a suitable replacement for Spiro-OMETAD as the HTL in PSCs.

Keywords— Perovskite Solar Cell, Spiro-OMeTAD, Nickel Oxide, GPVDM software.

Introduction

Solar photovoltaic cells transform energy into electricity from incident radiation[1]. Among other third-generation solar cells, perovskite solar cells (PSCs) are one of the most appealing due to rapid advancement in efficiency[2]. The excellent performance of PSC is based on the optoelectronic properties such as high absorption rate, long diffusion lengths, and tuneable bandgaps. PSC also has the ability to deposit quality crystalline, especially in uniform thin layers[3]. HTM has a strong influence on the connectivity of PSCs. The most often used HTM is Spiro-OMeTAD because it can efficiently deliver holes for the counter electrode, and assisting to enhance the fill factor (FF) and the open-circuit voltage (V_{OC})[4]. Unfortunately, it is very expensive and has become a significant impediment to PSC marketing, given the lengthy and poor synthesis process. Ionic compounds include bis(trifluoromethane), lithium salt (Li-TFSI), 4 tert-butylpyridine (TBP) and co-doping can enhance the properties of Spiro-OMeTAD[5] but raises the expenses for synthesis Spiro-OMeTAD consisting of PSCs. Researchers refer to the concept that inorganic materials like NiO, CuSCN, CuI, $CsSnI_3$, and so on are used to overcome these drawbacks. Owing to the impactful capability of perovskites, enabling a kind of p-type high bandwidth material such as NiO is beneficial. However, it is necessary to build comprehensive working systems as they examine NiO HTM deeper[6–8]. NiO is a comparably cheap, good strength chemical and thermal treating material that enhances the endurance of PSC over several different inorganic holes transporters[10,11] like Cu_2O, CuI, Cu_2O, CuO, and MoO_2. Therefore, in this work, GPVDM program modelling is used to investigate the influence of photovoltaic on the structure for both NiO and Spiro-OMeTAD by drawing comparisons with HTM of different restrictions such as changing electron and hole mobility, and the layer thickness of perovskite and HTM.

Results and Discussion

The electron mobility at the beginning simulation has been kept at $2x10^{-3}$ (cm^2/Vs)[1,2] in both configurations (NiO and Spiro-OMeTAD). The mobility of the hole were varied from $2x10^{-1}$ to $2x10^{-4}$ (cm^2/Vs) to get the optimum outcome. For NiO, a maximal power conversion efficiency (PCE) of 17.25% was recorded for NiO and 12.12% for Spiro-OMeTAD. Both structures produced consistent PCE even at different values of hole mobility. This is might be due to the highest occupied molecular orbital (HOMO) level of NiO calculated from ($HOMO = \chi + Eg$) indicate that good bands alignment compare to Spiro-OMeTAD. The electron mobility were also varied using the best value of the hole mobility obtained from the previous simulation. Nevertheless, NiO attained a high PCE of 17.67% in comparison to the Spiro-OMeTAD of about 13.05%, at $2x10^{-4}$ (cm^2/Vs) electron mobility. A decreased of PCE and fill factor (FF) were noticed as the mobility of electrons rose. This trend ought to be countered by the realisation that tremendous electron mobility certainly improves the device's performance. The thickness of the perovskite layer as well as the HTM layer also varied in a range from 50 to 500nm[13,14] to study the influence of thickness on the efficiency of PSC. It can be seen that the thickness of the perovskite layer steadily increased in two modelling approaches by achieved its PCE peak value at 400 nm that because of the thicker perovskite absorb more photons with a longer wavelength, promoting the generation of electron-hole pairs. The simulation results show that the best optimum efficiency of 20.94% and 18.65% were obtained for NiO and Spiro-OMeTAD respectively. A sudden drop of FF were found as the perovskite layer gets thicker which might be due to the high recombination rate as the perovskite layer increased. The efficiency of NiO as HTM increased to 21.67% and achieved the optimal thickness at 400nm. However, the Spiro-OMeTAD as HTM attained an optimal thickness of 50nm. As the layer thickness increases, Spiro-OMeTAD shows a substantial decline in PCE and FF from 18.65% to 0.77% and 0.87 to 0.07 (a.u.) respectively. From these results, it can be concluded that NiO is a suitable material to replace Spiro-OMeTAD as a HTM for PSCs.

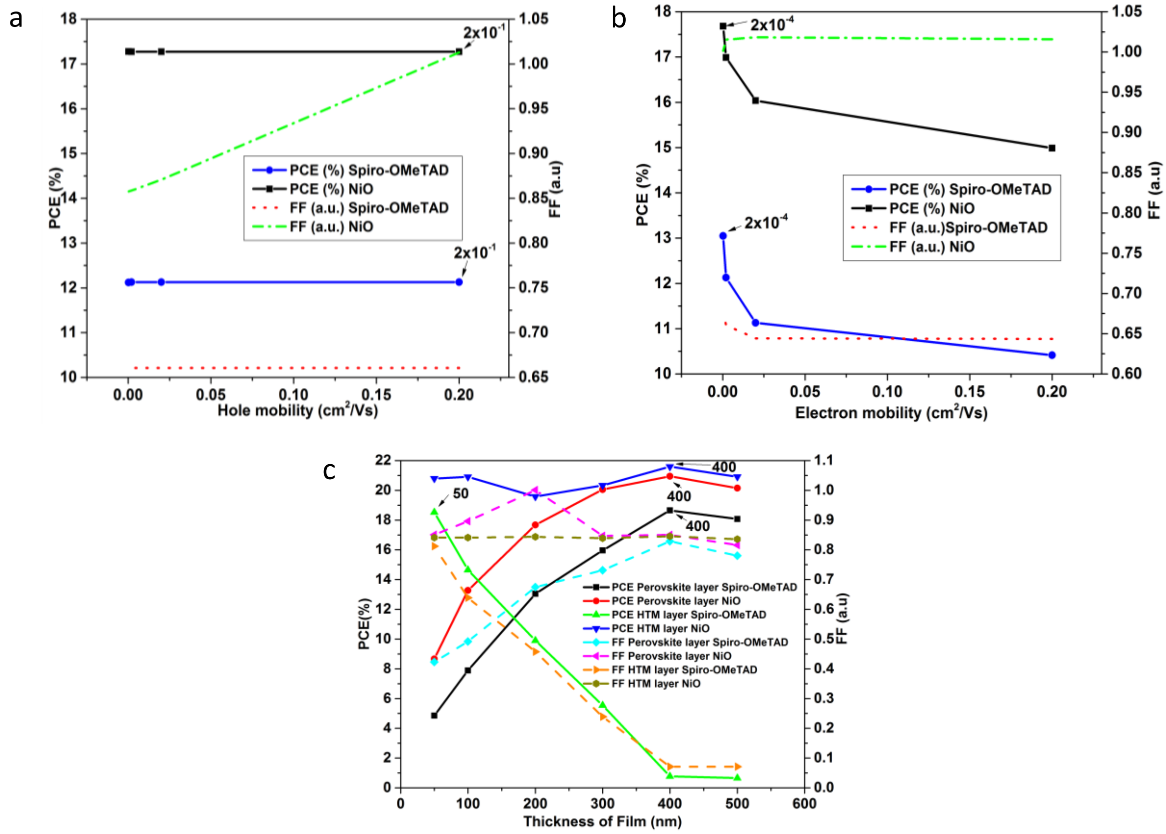

Figure 1: The optimised outcome generated by the GPVDM program focusing on the comparison of NiO and Spiro-OMeTAD as (a) hole mobility at 2 x10^{-1} (cm^2/Vs), (b) electron mobility at 2 x10^{-4} (cm^2/Vs), and (c)perovskite thickness at 400nm, HTM thickness of NiO at 400nm while Spiro-OMeTAD at 50nm.

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Synthesis and Characterization of Nanoparticle Embedded p(HEMA) Based Membran Systems For Removal of Reactive Green 19 Textile Dye

Nevra ÖZTÜRK ATAY [a], Sinan AKGÖL[b]

[a]*Ege University Apllication and Research Center For Testing And Analysis(EGE-MATAL), İzmir, TURKEY*

b Ege University, Faculty of Science, Department of Biochemistry, İzmir, TURKEY

nevraozturkatay@gmail.com

Membrane systems, the use of which has been increasing in recent years, are polymeric adsorbents that can adsorb various chemicals with their functional groups and can trap aqueous solutions up to hundreds of times their own weight [1]. Although there are many studies with membrane systems in the literature, studies with nanoparticle embedded membrane systems are few. Because of their nanosize, nanoparticles can achieve higher binding capacities by creating a larger surface area [2]. In this study, p(HEMA)-APTES and p(HEMA)-APTES-Cu nanoparticles embedded membrane systems were synthesized by UV-polymerization technique and studies for the removal of reactive green 19 textile dye from aqueous medium were carried out. Within the scope of characterization studies of nanoparticle embedded membranes, Fourier Transfrom Infrared Spectrometer (FTIR), Scanning Electron Microscopy (SEM-EDS), elemental analysis, contact angle analysis and swelling experiments were performed. Adsorption studies of the p(HEMA)-APTES embedded membranes and p(HEMA)-APTES-Cu embedded membranes were investigated under different parameters such as initial dye concentration, contact time and pH. While the optimum dye bonding time to nanoparticle embedded membranes occurred within 120 min, the optimum pH was found to be 4.0 and the maximum adsorption capacity was determined as 873 mg/g and 648 mg/g at about 15000 ppm initial dye concentration for p(HEMA)-APTES nanoparticles embedded membranes and for p(HEMA)-APTES-Cu nanoparticles embedded membranes respectively. Reactive green 19 dye was determined using a UV/Vis Spectrophotometer at a wavelength of 630 nm. Reusability of p(HEMA)-APTES nanoparticles embedded membranes and p(HEMA)-APTES-Cu nanoparticles embedded membranes were also shown for five adsorption-desorption cycles without considerable decrease in its adsorption capacity. Finally, the results showed that the nanoparticle embedded membranes were effective adsorbent systems for removal of reactive green 19 textile wastewater.

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