INTERNATIONAL MATERIALS TECHNOLOGIES AND METALLURGY CONFERENCE 2017

in honor of

Prof. Dr. Erdem Demirkesen

OCTOBER 26-27, 2017

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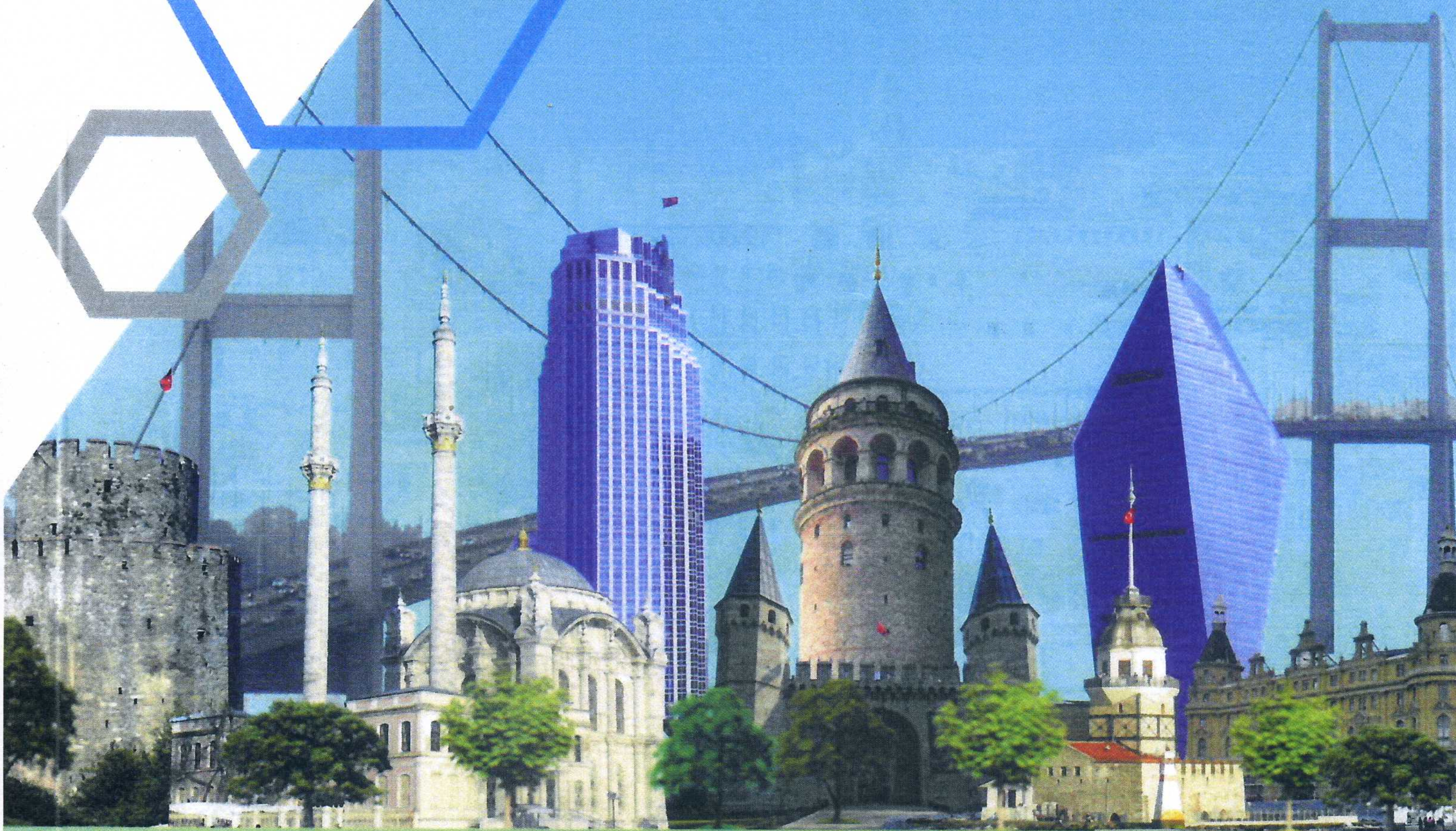

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PROCEEDINGS BOOK

INVITED SPEAKERS

Dr. Csaba Balázsi - *Centre for Energy Research Hungarian Academy of Sciences*

Dr. Csaba Balázsi (MSc-1993, PhD-2000, DSc-2014) is a Scientific Advisor in Centre for Energy Research of Hungarian Academy of Sciences. Earlier, he was head of the Ceramics and Nanocomposite Department, Institute for Technical Physics and Materials Science, Hungarian Academy of Sciences for 7 years. He acted as director of Materials Science and Technology Institute (BAY-ATI) between 2013 July - 2015 January and head of Advanced Materials Department, Engineering Divison (BAY Zoltán Nonprofit Ltd) until October 2015. He is metallurgical engineer with 20+ years of practice in various physical and chemical technologies of nanocomposite manufacturing, including ceramic processing, nano-milling, hydrothermal, powder metallurgy, sintering, electrospinning. His research area is covering R&D of high performance materials for medical, sensor and high temperature applications. He was involved in the development of nanoporous hexagonal tungsten oxide materials for gas sensorics, carbon nanotube, graphene nano-platelet added silicon nitride ceramic composites for tribological applications and severa other nanocomposites, including nano-ceramic dispersion strengthened steels for nuclear/HT application and polymer based biocompatible composites for orthopedics. He is co-author in 170 publications (100 in ISI journals), has 9 patents, 1300 independent citations, H index 22. He is principal investigator or co-PI in several national (OTKA, NKTH, TéT, Eötvös, Bolyai) and international (FP7, NATO, NSF, ESA, H2020, EI KIC RAW) research grants. He is a member of scientific societies as American Ceramic Society (ACERS Scientific Society of Silicate Industry - President of Fine Ceramics section (SZTE), European Ceramic Societ - Member of Council Board (ECERS), Young Researchers Board - Hungarian Academy of Sciences, Bolya Advisory Board Member - HAS, Member American Nano Society, Hungarian Society of Materials Scienc - Board Member and Executive Committee Member of Federation of European Materials Societies (FEMS)

Prof. Dr. Simona Cavalu - *University of Oradea*

Simona Cavalu graduated from Babes-Bolyai University in 1989 and she is awarde a scholarship of TEMPUS Program at University of Rouen, France. Prof. Cava completed her PhD degree at Department Physics/Biophysics Department of Babe Bolyai University. Prof. Cavalu published more than 100 papers in SCI journal ar proceedings, 5 books and she is also manager of National and International Resear Projects (6), international reviewer (Elsevier, Springer, Sage, Wiley), UEFISCDI (Executi Agency for Higher Education, Research, Development and Innovation) research evaluator, visiting profess at Istanbul Technical University, Debrecen University, invited lecturer at international conferences (10). T field of interests of Prof. Cavalu are Acrylic cements for orthopaedic and dental applications, bioceram (alumina/zirconia, alumina-silicate, hydroxyapatite), tissue regeneration, natural polymeric composi for drug release, nanoparticles production and characterization, nanomedicine, animal model (in vi biocompatibility tests), in vitro tests (cells culture, cytotoxicity, proliferation), atioxidative agents. Now, she a Medical Biophysics Professor at University of Oradea and head of Cells Culture Laboratory.

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SELENIUM AND GOLD NANOPARTICLES: NOVEL BIOLOGICAL AND MEDICAL APPLICATIONS

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Keywords: Nanoparticles, selenium, gold, biomedical applications

Abstract

Our work is aimed to review some chemical and biological synthesis methods for selenium and gold nanoparticle fabrication. Physico-chemical characterization of nanoparticles was performed by electron microscopy (TEM/SEM), FTIR spectroscopy, X-rays diffraction pattern (XRD), Dynamic Light Scattering (DLS) and Zeta potential techniques. Recent results referring to biological and medical applications of selenium and gold nanoparticles are referring to: 1) Developing polymeric microparticles for controlled nano-selenium delivery; 2) Developing functional food based on nano-selenium annihilating the toxic effects induced by heavy metals; 3) Nanoselenium coating on titanium mesh for cranioplasty; 4) Biosensor based on gold nanoparticles and graphene for routine clinical analysis.

1. Introduction

It is widely accepted that selenium, an essential trace element, is necessary to correct and improve organism's functions, being a constituent of one of the main antioxidative enzymes- glutathione peroxidase. Moreover, one of the most important applications of selenium nanoparticles is its chemo-preventive property, by immunological stimulation [1,2]. Biosynthesis of Se-nanoparticles can be performed using various biomaterials like bacteria, fungus, algae, and plants, by eco-friendly and potentially economically viable 'green' synthesis route towards synthesis of red elemental selenium [1]. Synthesis of elemental nano-selenium employs the reduction of a selenium salt with a reducing agent, usually in the presence of a stabilizing agent to prevent the clusters of selenium atoms from growing and to obtain stabilized nanoparticles in colloidal suspension. On the other hand, gold nanoparticles (AuNPs) are intensively used tools for the electrochemical biosensors design due to their advantageous properties such as: immobilization of biomolecules preserving their biological activity and efficient conducting interfaces with electrocatalytic ability [3]. Gold nanoparticles (AuNPs) are obtained by electrochemical reduction of $HAuCl_4$ and then attached to graphene surfaces, due to their excellent conductivity, in order to improve the bioelement immobilization by specific reaction with thiol (-SH) groups.

2. Experimental Procedure

Selenium nanoparticles were produced by different approaches:

1. Chemical synthesis, using $NaHSeO_3$ and different biological reducing agents such as lactose, glucose, fructose, amidon.
2. Biological synthesis using *Lactobacilus Casei* in a fermentation procedure.

Gold nanoparticles (AuNPs) were obtained by electrochemical reduction of $HAuCl_4$ and then electrochemically attached to graphene surfaces, in order to establish a nanoplatform for biomolecules immobilization. Physico-chemical and morphological characterization of nanoparticles was performed using (TEM/SEM), FTIR spectroscopy, X-rays diffraction pattern (XRD), Dynamic Light Scattering (DLS) and Zeta potential techniques.

3. Results and Discussion

Different formulations were prepared, based on alginate and alginate/chitosan as controlled delivery matrices for nano-selenium and their delivery efficiency was evaluated in simulated gastrointestinal fluids. Our results demonstrated that nano-Se release depends upon the nature of the polymer matrix as well as pH of the media, alginate/chitosan being a convenient matrix to be used for selenium delivery in duodenum, caecum, and colon.

Another application was related to selenium nanoparticles uptake by vegetables (Broccoli sprouts) in order to improve nutritional properties (biofortification). The effective uptake of nanoparticles was further demonstrated by FTIR spectroscopy and Hyperspectral Microscopy.

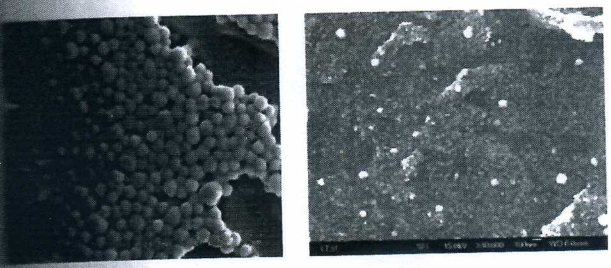

Figure 1 a) SEM image of SeNps produced by biological synthesis using *Lactobacilus Casei* in a fermentation procedure (left). b) Gold nanoparticles attached to graphene structures (right).

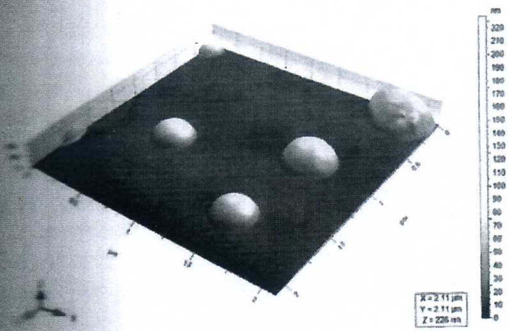

Figure 2. AFM 3D image of SeNPs obtained by chemical synthesis.

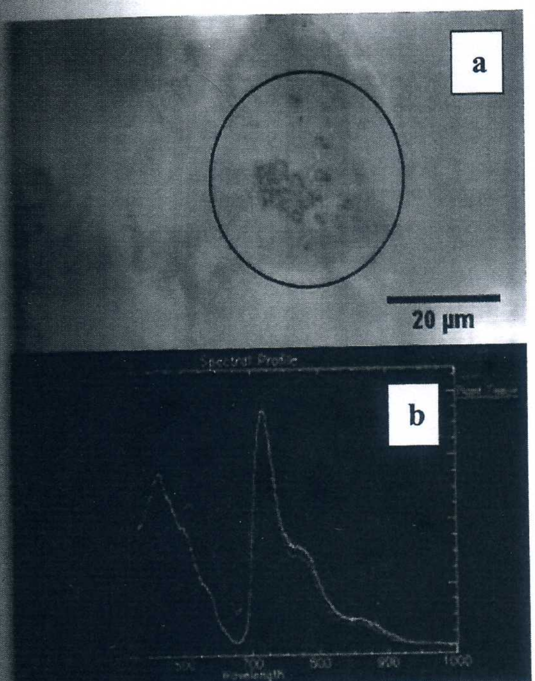

Figure 3. Hyperspectral microscopy image of SeNps in the leaf of broccoli sprouts (a) and characteristic spectrum of selenium particles (red) and vegetal tissue (green).

Nano selenium coating was also performed on the surface of titanium mesh, in order to improve healthy bone cells adhesion, in cranioplasty. Three different synthesis route were investigated, in an optimization procedure, using different reducing agents: fructose, glucose, amidon.

On the other hand, the judicious choice of the nanomaterials modifiers is an important step for the improvement of any sensor sensitivity especial by enhancing the electrochemical surface area. The graphene oxide synthesis, followed by its reduction, and then AuNps immobilization on the surface, are the main steps in production of novel biosensor designed to rapid detection of some molecules in biological fluids.

3. Conclusion

By presenting our recent results, we pointed out some of the novel applications of selenium and gold nanoparticles in the field of biology, biomaterials, and biosensors. Further investigations are planned related to production of nanocarriers for cancer-targeted drug delivery, and miniaturization of biosensors for rapid detection of molecules in blood.

Acknowledgment

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