FIRST INTERNATIONAL CONFERENCE ON ELECTRON MICROSCOPY OF NANOSTRUCTURES

ELMINA 2018

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• **PO2.19**

Electrochemical Deposition of Ni in the Liquid Cell: Groundwork Experimental Approach Prior to LC TEM Experiments

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• **PO2.20**

Characterization Of Composite Polymer Membranes Modified By Electrospinning Method

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• **PO2.21**

Morphology of Poly(urethane-siloxane)/Montmorillonite Nanocomposites

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• **PO2.22**

Morphology, Biocompatibility and Antimicrobial Activity of Hydroxyapatite Simultaneously Doped with Silver and Strontium Ions

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• **PO2.23**

Nanocomposite Hydrogels Based on Poly(vinyl alcohol) and Chitosan with Silver Nanoparticles and Graphene Aimed for Wound Dressing Applications

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Biomaterials based on hydroxyapatite (HAp) due to its approved biocompatibility, possibility for chemical bonding with the hard tissue and also its evident osteogenic potential, are irreplaceable part of dental and orthopedic practice [1,2]. Various cations are usually incorporated in HAp structure instead of calcium and have an important role in a large number of physiological processes in human body. Strontium, as an ion with a dual role in bone metabolism, improves osteoblast differentiation, proliferation and activity and on the other hand simultaneously inhibits osteoclast proliferation, can also affect the changes of the lattice dimensions, particle size, crystallinity and solubility of the synthesized HAp powders. The substitution of optimal amount of calcium ions with strontium is of great interest for development of novel bioceramic materials [3,4]. On the other hand, the incorporation of silver ions in bioceramic structures as an antimicrobial agent could inhibit the bacteria adhesion on the implant surface after incorporation into the body [5]. The aim of this study was to optimize the antimicrobial activity and biocompatibility of silver and strontium doped HAp based bioceramic materials.

HAp powders doped with various amounts of strontium and silver ions related to calcium were synthesized by modified hydrothermal method at 160 ºC for 3 h. For all experiments (Ca+Ag+Sr)/P molar ratio was kept at a constant value of 1.67. After deposition of a thin gold/palladium layer on the powder surface, a TESCAN MIRA 3 XMU field emission scanning electron microscope, operated at

20 keV, was used to analyze the morphology of the obtained powders. Spherically agglomerated nanosized HAp powder (Fig. 1.) doped with 0.4 mol % of Ag and 0.5-5.0 mol % of Sr ions in relation to calcium were successfully synthesized. Energy dispersive spectroscopy (EDS), tip Oxford Inca 3.2, coupled with the scanning electron microscope Jeol JSM 5800, operated at 20 keV, confirmed the presence of Sr and Ag in synthesized powders. Incorporated strontium ions affected the size of primary rod-like particles, and furthermore had the effect on the density, hardness and fracture toughness of sintered samples.

On the basis of the antimicrobial properties against *Staphylococcus aureus* and *Escherichia coli* it can be concluded that strontium could enhance the antimicrobial effect of silver doped bioceramic materials. The *in vitro* cellular biocompatibility tests on MRC-5 human fibroblasts showed that obtained Sr- and Ag-doped HAP materials exhibited no cytotoxic effects and that the cytotoxicity decreased with the prolongation of the incubation time. Biocompatibility tests also revealed that the powder doped with 5.0 mol% Sr and 0.4 mol% Ag had highest stimulatory effect on the growth of the MRC-5 cells and that stimulated cellular proliferation more effectively compared to pure HAp and Ag-doped HAP. The attachment, material/cell interface and the shape of MRC-5 human cells during intimate contact with sintered bioceramic samples was observed by using the JEOL-JSM 6460LV microscope. The shape of the cell in Fig. 2. indicates their excellent spreading over the Ag- and Sr-doped HAp bioceramic material and the position of their cytoplasm extensions indicates good proliferation and adequate metabolic activity.

Based on the powder morphology, examined sinetrability, biocompatibility and antimicrobial activity it could be concluded that simultaneously doped HAp powders with Sr and Ag could be a good basis for processing dense, control porous and scaffold bioceramics as well as bioactive, biocompatible and antimicrobial active ceramic fillers for different composite biodegradable forms.

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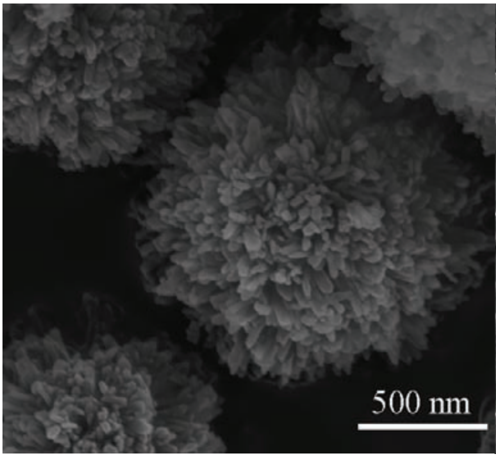

Figure 1. SEM micrograph of HAp powder doped with 3.0 mol% Sr and 0.4 mol% Ag.

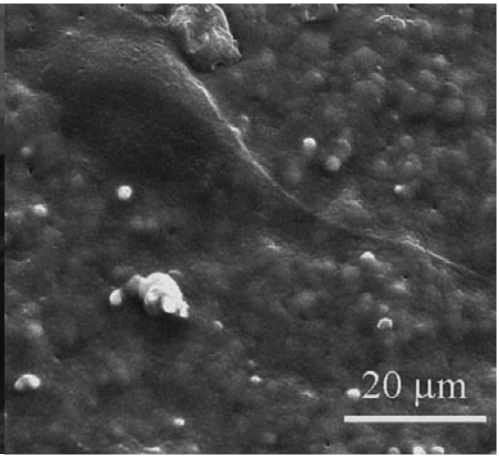

Figure 2. SEM micrograph of MRC-5 cell coupled with sintered HAp bioceramic doped with 5.0 mol% Sr and 0.4 mol% Ag.

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