MODYFICATION OF ELECTRIC PROPERTIES OF HYDROXYAPATITE WITH MAGNETITE - PRELIMINARY RESEARCH

KAROL GRYŃ*, MARIA GRZEGORCZYK

DEPARTMENT OF BIOMATERIALS AND COMPOSITES,
FACULTY OF MATERIALS SCIENCE AND CERAMICS,
AGH UNIVERSITY OF SCIENCE AND TECHNOLOGY,
KRAKOW, POLAND
*E-MAIL: KGRYN@AGH.EDU.PL

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Introduction

Hydroxyapatite has been widely used clinically for bone defects treatment. Its chemical composition and mechanical properties are similar to a natural bone tissue. Besides surface and structural modifications improving healing processes, characteristics of HAp can be tailored by a composite preparation. Depending on needs, mechanical, chemical, biological or electric properties can be altered with different additives. It is well known fact that a bone for growing is stimulated by external forces. Moreover, it has the ability of generating electrical charge when stressed. It is said that these two factors are the most important for controlling the configuration of a bone structure in accordance with the Wolff's law.

The aim of this study was to investigate the influence of magnetite nanoparticles (MGT) addition on hydroxyapatite electrical properties under compression.

Materials and Methods

For raw material composite HAp nanopowder (Chema Elektromet) with magnetite nanopowder (Sigma Aldrich) was combined and homogenized by shaking. Three compositions were prepared: A) HAp + 0,5 vol% MGT; B) HAp + 1,0 vol% MGT e; C) HAp + 1,5 vol% MGT. Cylindrical-shape samples (d = 12mm, h = 16,5mm) were made by isostatic pressing (5 MPa) in room temperature. Raw samples were sintered in 1000°C. Microscopic observations were made (optical x20 – x100 KEYENCE VHX5000 and SEM x70 – x500 000 FEI NOVA NANO SEM 200). Mechanical properties were described in uniaxial compression test Zwick-1435, V = 0,2 mm/min. For electrical changes specially designed and fabricated circuit consisted of two copper plates wired with 9V DC battery and digital multimeter (UNI-T UT33C) was fabricated. Copper plates were attached to the top and bottom surface of sample, then placed between pressure pads of testing machine and compressed. The voltage was measured and recorded.

Results and Discussion

Microstructure analyzes show that the grade of homogeneity is not satisfying. There are aggregates of bulk HAp surrounded probably with HAp-MGT composite – pinkish in colour (FIG. 1a), however in SEM pictures magnetite nanoparticles were barely visible (Fig.1b). For all types of samples – different vol% of MGT (A, B and C) similar effect was observed. Mechanical testing revealed that addition of 1,0 vol% of MGT significantly improved compressive strength (FIG. 2) and electrical conductivity (pure HAp: R_c = 18 MPa, V = 4,5-5V; HAp + 1,0 vol% MGT: R_c = 28 MPa, V = 8-9V). For all types of composites no piezoelectric effect was detected.

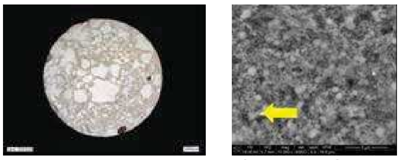

FIG. 1. Structural observations of HAp-MGT composite. a) x20; b) x10 000 (arrow – magnetite).

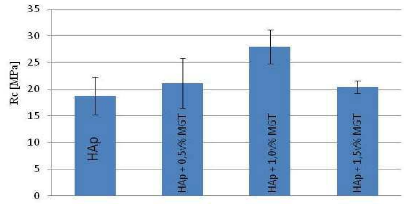

FIG. 2. Compressive strength of tested materials.

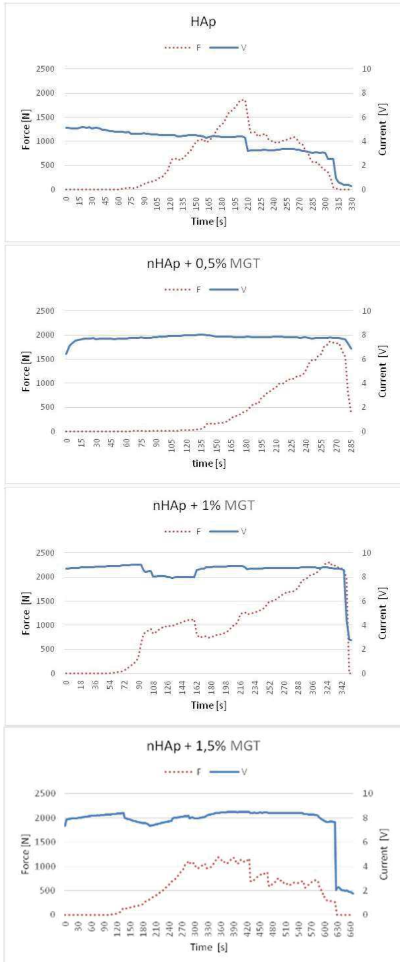

FIG. 3. Changes in electrical conductivity of different composites under compression.

Conclusions

Magnetite nanopowder can be used as a HAp properties modifier. Depending on the quantity both mechanical and electrical characteristics can be tailored in wide range. Surprisingly, the presence of HAp agglomerates didn't decrease compression strength.

References

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