VIBRATIONAL SPECTROSCOPY INVESTIGATION OF MONTMORILLONITE – CHITOSANE NANOCOMPOSITE MATERIALS

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Abstract

Biomaterials basing on natural polysaccharides, i.e. hiauronic acid, alginate, chitosane are an alternative for already applied bioresorbable synthetic materials basing on synthetic polyhydroxyacids. Their main advantages are good accessibility, low cost, easy forming and high biocompatibility. Additionally, they are a perfect matrix for bioactive nanoparticles i.e. hydroxyapatite (HAp), tricalcium phosphate (TCP) and silica (SiO_2).

The work presents results of research on nanocomposite consisting of chitosane matrix (CS) modified with a nanofiller, which was natural montmorillonite (MMT). Nanocomposite foils were produced by the casting method. In order to induce better biocompatibility, the surface of the CS/MMT composite was neutralized (bath in NaOH solution). The nanocomposite foils were subjected to a bioactivity test by incubation in SBF at 37°C for 7 days. It was observed that the CS/MMT material surface showed a local supersaturation, which was a result of apatite nucleation. The CS/MMT nanocomposites were investigated using FT-IR (Fourier Transform Infrared Spectroscopy) and Fourier Raman Spectroscopy.

FTIR measurements of the samples were carried out on the transmission and reflection modes. The FTIR microscopy spectra were collected using Bio-Rad Excalibur with ATR attachment as well as microscope UMA500 equipped with MCT detector. Spectra were measured at 4 cm^{-1} resolution in the region from 4000 cm^{-1} to 600 cm^{-1}. FT-Raman spectra were obtained using a FTS6000 Bio-Rad spectrometer with Ge detector. The samples were excited with a Nd-YAG laser (1064nm). Additional all materials in all steps experiments were observed under Scanning Electron Microscopy (Nova NanoSEM).

Vibrational spectroscopy methods (FT Raman and FTIR) can be used for investigation of nanocomposite foils basing on biopolymers. High sensitivity the applied spectroscopy techniques show that in the result of the neutralization of CS/MMT foil (via incubation in NaOH solution) the biopolymer chain breaks. This phenomena is visible by intensity ratio between COC/COH bands. Increase of reactivity of chitosane chain lead to entrapment of PO_4^{3-}, which is the origin of the apatite forms nucleation process.

Chemical treatment of the nanocomposite foils, i.e. NaOH washes influences their chemical structure and microstructure. Neutralisation of the foils is the first processing stage which precedes the potential use of CS/MMT foils in biomedical applications. The materials show a tendency to apatite crystallisation which may support regeneration of damaged bone tissue. The applied spectroscopic methods allowed to observe changes in the whole volume of the sample.

Individual ATR measurements taken at various spectral ranges and penetration depths allow to observe subtle changes in the polymer matrix caused by chemical treatment (NaOH and SBF incubation). Results of the investigations indicate that in the CS/MMT systems new chemical bonds and related to them vibrations appear. Quantity and quality of the interactions is related to characteristics of the nanoparticle and the presence of forming apatite structures.

[Engineering of Biomaterials, 109-111, (2011), 44]

Acknowledgements

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TRIBOLOGICAL INVESTIGATIONS OF MATERIALS USED FOR SPINE DISC IMPLANTS

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Abstract

Ailments linked to back pain is a serious problem not only medical but also social. Not only elder people but also people in working age suffers from problems related to spine pain. The most common disorders of the spine are pain syndromes of the lumbar part where center of gravity of the human body is located and where major forces are acting on the vertebrae and intervertebral discs. The market currently offers a variety of spinal implant solutions (FIG. 1).

In the Metal Forming Institute there is realized research Project entitled Investigations and spine im-

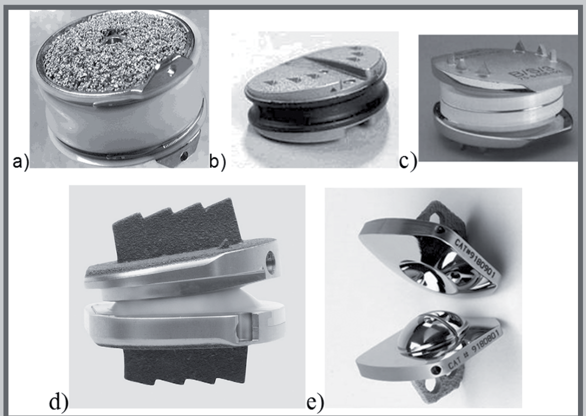

FIG. 1. Examples of artificial discs: a) Bryan's disc, Acroflex implant, c) Charite disc, ProDiscII prosthesis, e) ProDisc prosthesis.

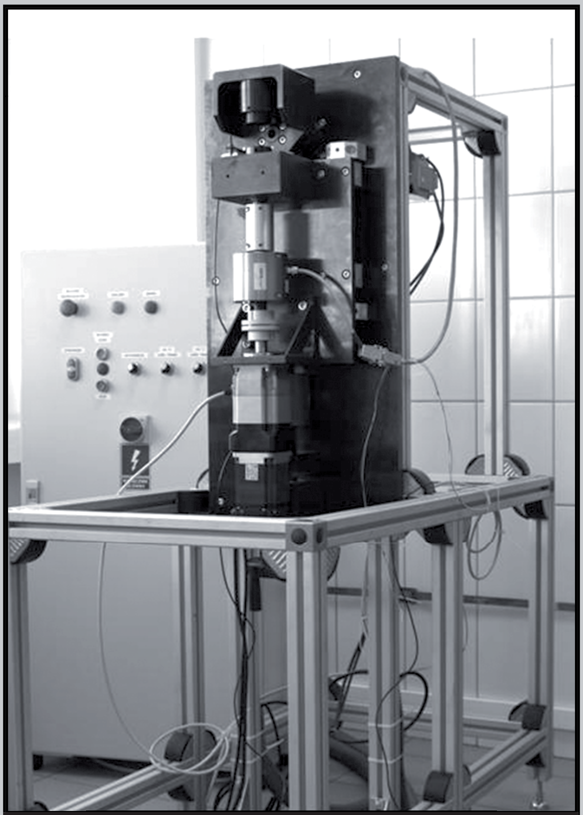

FIG. 2. Simulator for intervetebral spine disc investigations.

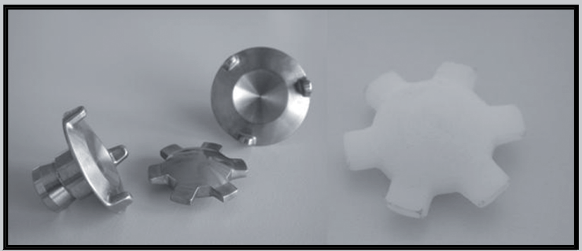

FIG. 3. Proposed solutions of spine implant linner.

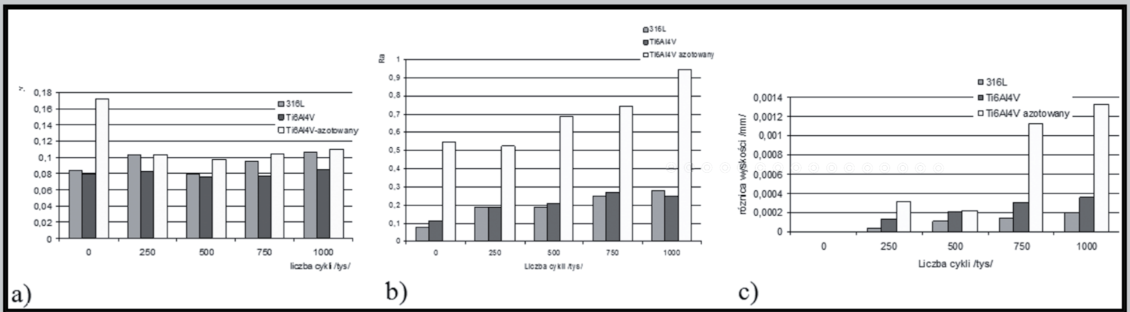

FIG. 4. Influence of number of cycles on friction coefficient (a), surface roughness (b), and polyethylene liner thickness (c).

plants functionality evaluation in material and tribological aspects.

In the frame of the Project it was designed and manufactured special simulator adapted for intervetebral spine discs implants investigations. Simulator scheme is presented on FIG.2.

Main goals of the realized Project are:

- *Investigation of friction-mechanical processes during implant usage.*
- *Evaluation of wear intensity of various types of intervertebral discs and investigations of appearing wear products.*
- *Selection of optimal material and surface machining method providing minimal wear of intervertebral disc elements wear.*

For experiments there was implant designed by K. Skalski and J. Skoworodko selected [1], which consists of 3 elements: upper liner, lower liner and nucleus pulpous (FIG.3). Actually there are 3 types of friction couple materials tested: 316L steel - polyethylene UHMWPE – 316L steel, titanium alloy Ti6Al4V – polyethylene UHMWPE and nitrided Ti6Al4V titanium alloy – polyethylene UHMWPE.

Influence of number of cycles on friction coefficient, surface roughness and poliethylene linner thickness change illustrates FIG.4. As it results from performed investigations, too high hardness level of metal elements (upper and lower clasps) provides to accelerated wear of the polyethylene part. New challenge is application of "metal-metal" friction couple.

[Engineering of Biomaterials, 109-111, (2011), 44-45]

Acknowledgements

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References

[1] J. Skworodko: Metodyka projektowania implantu międzykręgowego kręgosłupa lędźwiowego. Rozprawa doktorska, Warszawa 2008.

[2] J. Skworodko, K. Skalski, Z. Kędzior, P. Borkowski: Implant krążka międzykręgowego kręgosłupa lędźwiowego. Przegląd lekarski 2004/61. Kraków str. 147-150.