Ultradźwiękowe techniki pokrywania polimerowych rusztowań dla zastosowań biomedycznych

Ultrasound Coating Technique for Polymer Scaffolds in Bio-applications

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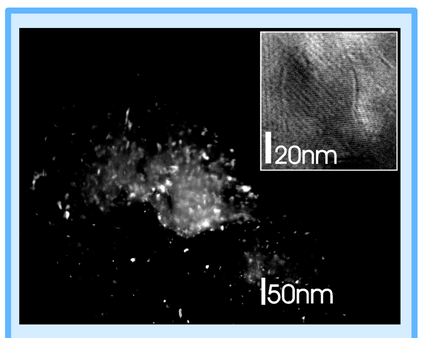
GOAL: Coatings made from bioresorbable hydroxyapatite nanopowder obtained with ultrasound technique which will promote bone regrowth process.

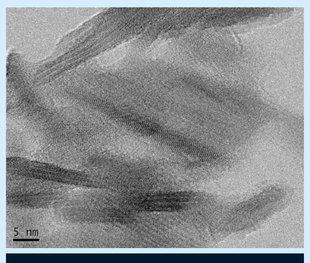
MICROWAVE SOLVOTHERMAL SYNTHESIS

Scheme of hydroxyapatite nanopowder production route. The process is conducted in a microwave reactor with a 2,45 GHz frequency, current density 5 W/ml and less than 2 minutes synthesis time. The obtained nanopowder (GoHAp) is characterize by **high purity** and **homogeneity**.

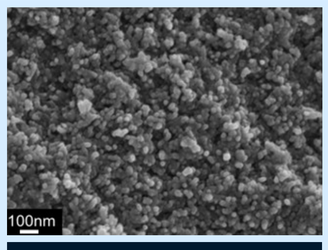
CHEMICAL and PHYSICAL PROPERTIES of HYDROXYAPATITE

Specific surface area of GoHAp nanopowder (BET method) is **236 ± 5 m²/g**. Material density is **2,93 g/cm³**. Ca/P ratio is **1.57**, determined by inductively coupled plasma optical emission spectrometry (ICP-OES). XRD measurements indicate that the nanopowder is pure, with thigh crystalline hexagonal hydroxyapatite integrity.

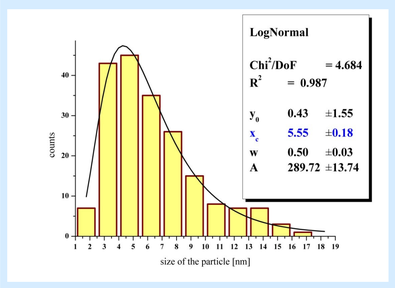




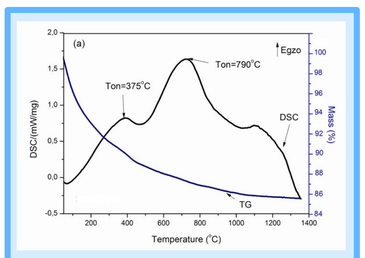
GoHAp nanopowder – TEM microscopy. Platelet like morphology with **aspect ratio 2 – 5**.



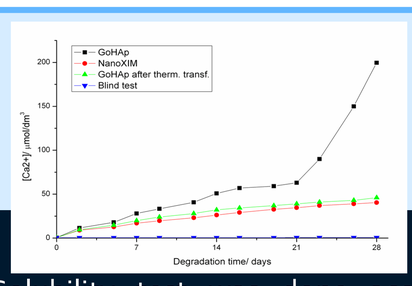
Nanopowder GoHAp – SEM microscopy. Agglomerates with average size of 20 nm can be seen.

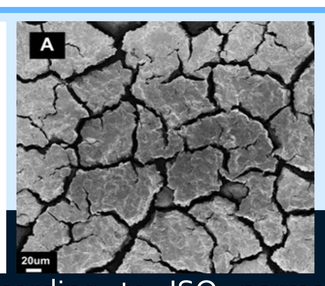


Hydroxyapatite grain size from analysis of the TEM microphotograph varied **from 2 to 17 nm**.



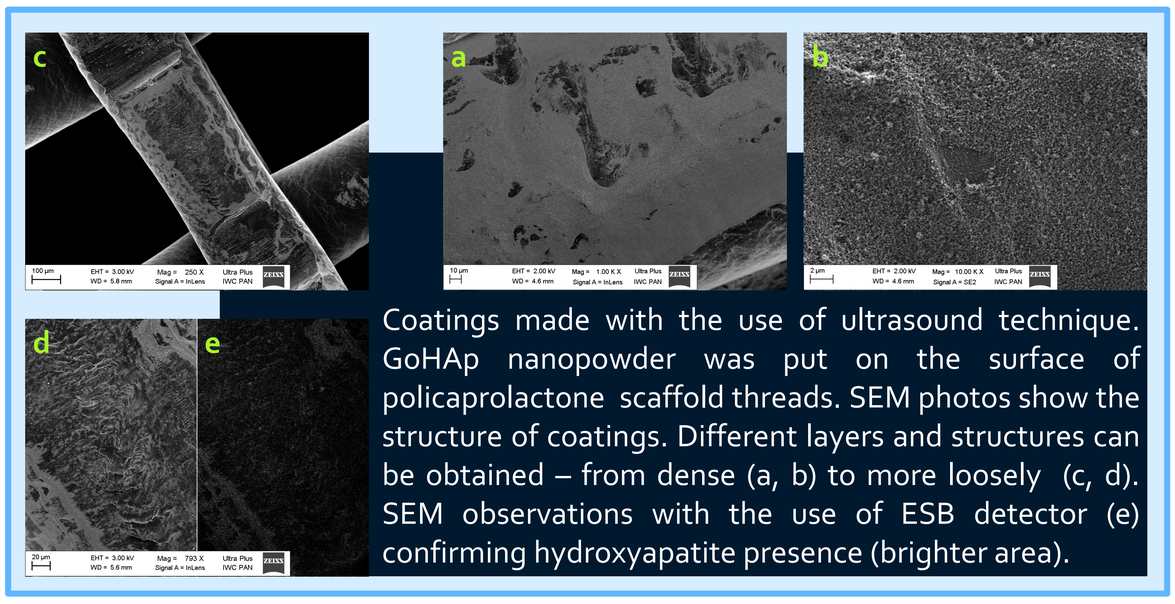
Analysis DSC/TG mesurments show two phase transition: I – max at 375°C, II – max at 790°C.



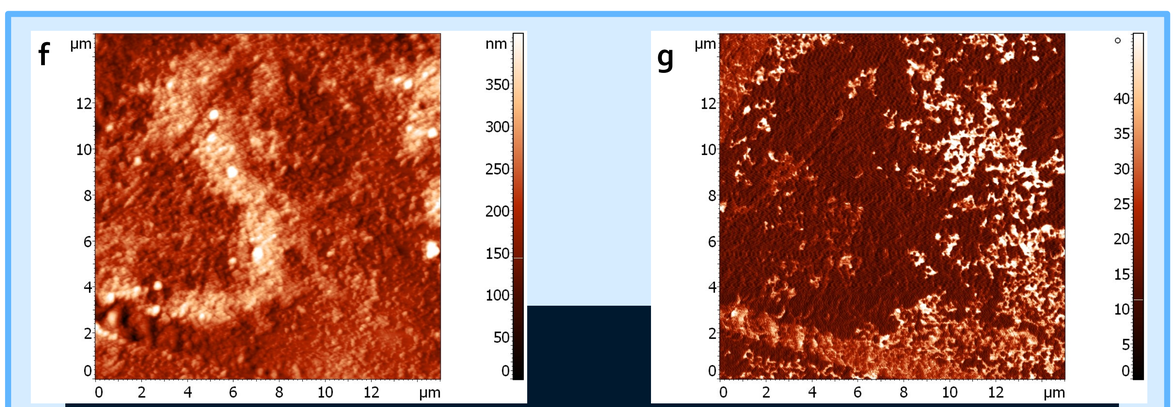


Solubility test was done according to ISO norms 10993-14. GoHAp nanopowder (black colour) is characterize by high solubility (20 mg/dm³ after 28 day) when compared to commercial nanopowder (NanoXIM, red colour). On the SEM photograph, the surface of GoHAp pellet was observed after the test. Slots appeared by reason of the solubility process.

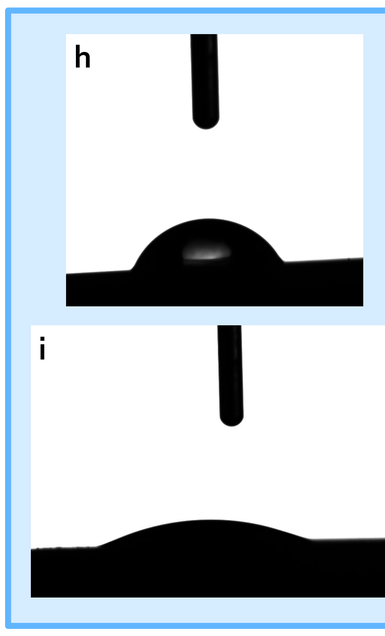
HYDROXYAPATITE COATINGS on a POLYMER SCAFFOLD



Coatings made with the use of ultrasound technique. GoHAp nanopowder was put on the surface of policaprolactone scaffold threads. SEM photos show the structure of coatings. Different layers and structures can be obtained – from dense (a, b) to more loosely (c, d). SEM observations with the use of ESB detector (e) confirming hydroxyapatite presence (brighter area).



Atomic Force Microscopy (AFM) is a excellent tool to study the topography of obtained coating. Thickness of hydroxyapatite layer varied from few to 350 nm (f, brighter colour, higher point from polycaprolactone surface). Phase contrast (g) overlap with the topography image, dark areas show the hydroxyapatite layer, bright areas show the polymer surface. The coating is not continuous – polymer areas free of hydroxyapatite can be still observed.



Wetting angle for water was measured for pure polycaprolactone surface (h) and for polycaprolactone with hydroxyapatite coating (i). Difference is immediately visible. The hydroxyapatite is more hydrophilic material than the polycaprolactone, due to many hydroxyl groups present in the hydroxyapatite structure, especially with nanosize crystallites. Average **wetting angle** for pure polycaprolactone was 65° and for **hydroxyapatite coating, 34°**. For biological application , especially bone regrowth , low wetting angle is required.

CONCLUSIONS

Coatings made from bioresorbable hydroxyapatite nanopowder are a promising tool to enhance bone regrowth process. There is a need to test which type of topography for the coating surface will be best for this application.

ACNOWLEGMENTS

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