NANO DESIGN OF BIPHASIC CALCIUMPHOSPHATE/POLY-DL-LACTIDE-CO-GLYCOLIDE, AS COMPOSITE BIOMATERIALS FOR HARD TISSUE RECONSTRUCTION

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Introduction

Composite biomaterials have enormous potential for natural bone tissue reparation, filling and augmentation. Composite biomaterials used today are available in the form of blocks, thin layers, paste, gels, powder, etc. The powder or injectable paste, which may play different roles when applied in an organism, have been used for fixing various damage in maxillofacial surgery, but also for filling up cavities in hard and soft tissues [1-3].

The aim of the study

This paper investigates possibilities of synthesizing calciumphosphate/poly-DL-lactide-co-glycolide (BCP/DLPLG) composite biomaterial formed as powder suitable for preparing injectable gels or pastes. BCP/DLPLG composite biomaterial was produced in form of spherical nanogranules of nanosized BCP covered by a DLPLG layer.

Materials and methods

A calcium phosphate gel was produced by precipitation [1, 2]. Gels of calcium phosphate were added into completely dissolved polymer [3]. Composite biomaterials were characterized by wide-angle X-ray structural analysis WAXS (*Enraf Nonius FR590*), differential scanning calorimetry DSC (DSC-50 SHIMADZU), atomic force microscopy AFM (*Thermo Microscopes, Autoprobe CP Research*) and FT-IR spectroscopy (Avatar 370 FTIR Thermo Nicolet).

Results and discussion

As evident from Fig. 1, the obtained calcium phosphate powder is highly crystalline. The most intense peaks at $2\theta = 31.8$, 32.9, 25.9 and 46.7 ^{o} originate from calcium hydroxyapatite (HAp) and those at $2\theta = 31$, 34.3 and 27.8^o from calcium phosphate (β-TCP). Based on earlier described methodology, mass contents of HAp and β-TCP of 80% and 20%, respectively, were calculated. According to DSC analysis (Fig 2.), all transformations occurring in the temperature range from 20 to 130 ^{o}C are connected with DLPLG. The only transformation is characterized by a peak at the glass transition temperature of 57 ^{o}C. These results indicate that DLPLG is completely amorphous polymer.

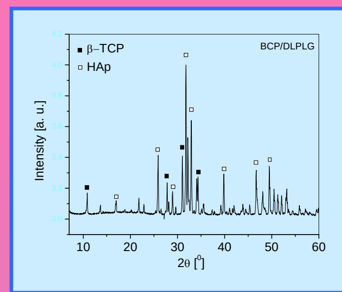


Fig. 1. XRD patterns of BCP/DLPLG composite biomaterial

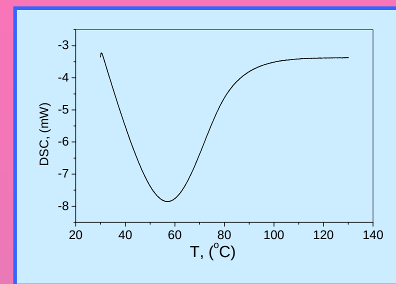
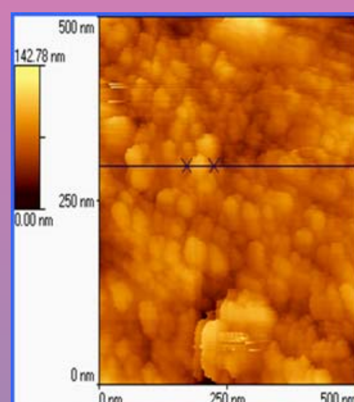


Fig 2. DSC of BCP/DLPLG composite biomaterial

Figure 3 shows the topology of the surface of BCP/DLPLG composite biomaterial. Each nanoparticle of BCP was coated with DLPLG and the average particle diameter was between 40 and 60 nm. The nanospherical form of BCP/DLPLG enabled synthesis of an injectable paste, which can be successfully used in reconstruction of small bone damages. Nanoparticles may have advantages at adhesion, adsorption and interaction with cells.



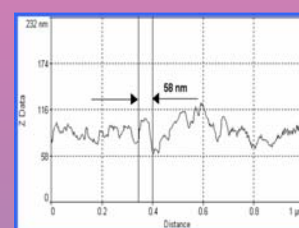
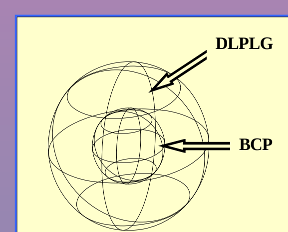
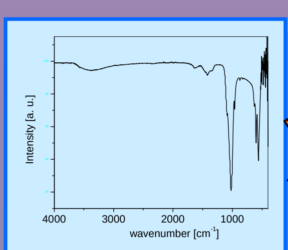


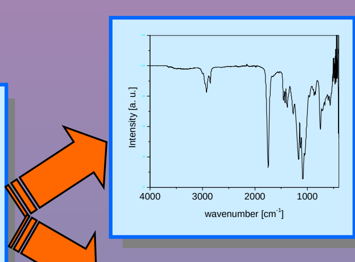
Fig. 3. AFM topology of the surface of BCP/DLPLG composite biomaterial



Conclusion

BCP/DLPLG composite biomaterial was synthesized in nanospherical form. Nanospherical particles were 40-60 nm in diameter, and each BCP particle was coated with amorphous DLPLG polymer. Calcium phosphate present in the composite was in the form of biphasic calcium phosphate consisting of 80% calcium hydroxyapatite and 20% tricalciumphosphate.





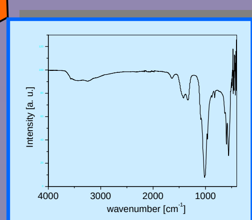


Figure 4. FT-IR spectrum of BCP/DLPLG composite biomaterial.

After dissociating BCPDLPLG, we obtained two phases: spectrum of DLPLG and spectrum of BCP.

References

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3. Ignjatovic, N., Ajdukovic, Z. & Uskokovic, D., New biocomposite calcium phosphate/poly-DL-lactide-co-glicolide/biostimulatite agens filler, Journal of Materials Sciences: Materials in Medicine, 2005, 16, 621-626.