Bioactive Glass Fiber Reinforced Composite

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INTRODUCTION: For bone regeneration and repair, combinations of different materials are often needed. In many applications it is useful to combine biodegradable polymers with osteoconductive materials. Bioactive glass (BaG) is one such material. A related issue is to improve the mechanical properties of polymer matrix by reinforcing it with BaG fiber. Thus, the aim of this work was to develop a BaG fiber reinforced starch-polycaprolactone (SPCL) composite.

METHODS: The composite was produced by extruding thick sheets from SPCL (30/70 wt%) blend. Sheets were cut and heat-pressed in layers with BaG fiber mats to form composite structures, with the following different combinations: 6xSPCL+5xBaG, 3xSPCL+6xBaG, 3xSPCL+4xBaG, 3xSPCL+2xBaG. 3xSPCL and 6xSPCL were used as non-reinforced controls. Thermal, mechanical, and degradation properties of the composite were studied. In addition, the actual amount of BaG in the composites was determined using simple burning tests.

RESULTS: A strong endothermic peak indicating melting at about 56^{o}C was observed by DSC analysis. TGA showed that thermal degradation of SPCL started at 300^{o}C with the degradation of starch and continued at 380^{o}C with the degradation of polycaprolactone (PCL). Mechanical properties of the reinforced composites were considerably better than the properties of the non-reinforced composites. Reinforcing increased shear strength by 50%, tensile strength by 52%, and bending strength by 67%. However, the mechanical properties of the composites after two weeks of hydrolysis were comparable to the properties of the non-reinforced samples. The degradation time of SPCL, as expected, was long; during the 6 weeks hydrolysis the mass only decreased by about 5%. The decrease of mass will of course occur faster at a later stage. The amount of glass in the composites remained the same for the 6 weeks period of hydrolysis.

DISCUSSION & CONCLUSION: It is possible to enhance initial mechanical properties of SPCL by reinforcing it with BaG fibers. However, mechanical properties need to be further improved for allowing long-lasting bone applications.

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