Bioactive Glass Fiber Reinforced Starch-Polycaprolactone Composites

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Introduction

For bone regeneration and repair in many cases combinations of different materials are needed. In many applications it is useful to combine biodegradable polymers with osteoconductive materials, as for instances, bioactive glass. One other aim is to try to improve mechanical properties of polymer matrix by means of its reinforcing. Thus, the aim of this work was to develop a bioactive glass fiber reinforced starch-polycaprolactone composite.

Materials & Methods

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

Results and Discussion

A strong endothermic peak indicating melting at about 56^{o}C was observed from DSC analysis. TGA showed that thermal degradation of SPCL started in 300^{o}C with degradation of starch and continued in 380^{o}C with degradation of PCL. Mechanical properties of reinforced composites were considerably better than the properties of non-reinforced composites. Reinforcing increased shear strength by 50%, tensile strength by 52%, and bending strength by 67%. However, mechanical properties of the composites dropped during two weeks in hydrolysis to the same level of non-reinforced controls. The degradation time of SPCL, as expected, was long; during the 6 weeks hydrolysis the mass decreased only about 5%. Degradation 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.

Conclusions

It is possible to enhance initial mechanical properties of starch-polycaprolactone by reinforcing it with bioactive glass fibers. However, mechanical properties need to be further improved for allowing long-lasting bone applications.

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