BIOACTIVE COMPOSITES FOR BONE TISSUE ENGINEERING

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Introduction: Bone replacement materials are required to be both biocompatible and mechanically compatible with the bone they are replacing. However in addition bioactivity or osteoinduction is advantageous to improve the biological response. For bone tissue engineering additional requirements are for the material to degrade in parallel with the increase in properties of the regenerating tisssue. Thus bioactive biodegradable materials are required. Polylactic acid (PLA) is commonly used in such applications however its mechanical properties, even when reinforced with calcium phosphates, are too low for application in significant load bearing areas of the body. However, drawing polymers leads to higher stiffness and strength fibres which can be used for reinforcement, increasing the stiffness and strength.

Materials and Methods: The PLA based materials were processed by producing pre-impregnated (pre-preg) sheets of drawn PLLA fibres in a PLDLA reinforced with HA or TCP matrix followed by compression moulding the pre-preg into specimens. The sheets were produced by drawing the fibres through a solution of PLDLA and one of a range of calcium phosphate, including spray dried hydroxyapatite, sintered hydroxyapatite, nanoscale hydroxyapatite and tricalcium phosphate in acetone, spooled onto a rotating drum and then allowing the resultant pre-preg to dry. The resultant pre-preg was laid up and compression moulded to produce a range of specimens or devices.

The specimens have been soaked for various times upto 52 weeks in simulated body fluid (SBF-K9) [1]. Before and after soaking the specimens were weighed to follow the fluid uptake, and after soaking and drying were subjected to four point bend testing to meaasure stiffness and strength.

After various soaking times the specimens were re-sterilised and then an osteoblast cell line was cultured on the surface. The cell activity was followed using AlamarBlue and the morphology investigated using scanning electron microscopy.

Results: Materials have been produced successfully. Water uptake was limited over the first 10 weeks thereafter for the unfilled material there was water absorption and subsequent mass loss, while the filled materials only showing change in mass after about 24 weeks (Figure 1).

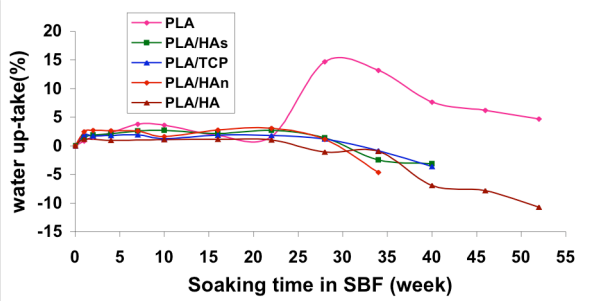

Figure 1 Water uptake with soaking time in SBF at 37˚C

The change in flexural strength occured more quickly while the changes in flexural modulus occurred in parallel with the water uptake behaviour.

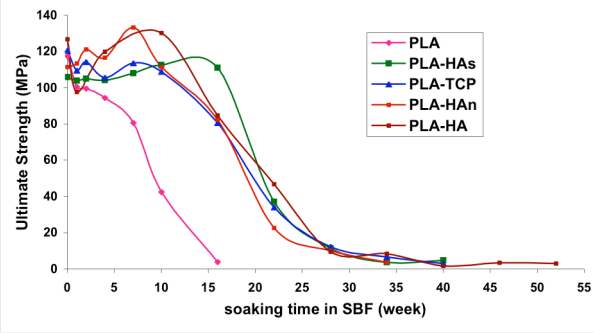

Figure 2 Flexural strength soaking time in SBF at 37˚C

Cell culture showed all materials to be well accepted by the body. There was attachment of the osteoblast filopodia onto the individual calcium phosphate particles.

Discussion: The use of degradable polymer fibres has lead to improved mechanical properties. Furthermore the addition of calcium phosphates increases the bioactivity.

Conclusions: We have produced anisotropic composites with fibre reinforcement, that have shown appropriate degradation times and bioactivity.

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References

1. Kukobo (1990) *J. Non-Crystalline Solids*, **120**, 138.

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