Nano- versus Micron-sized Bioactive Glass Reinforcement of P(3HB) – Are Nano-fillers the Way Forward?

D. Mohn[1], S.K.Misra[2], T.J. Brunner[1], A.R. Boccaccini[2], W.J. Stark[1]

[1]*Institute of Chemical and Bioengineering, Department of Chemistry and Applied Biosciences, ETH Zurich, 8093 Zurich, Switzerland*

[2]*Department of Materials, Imperial College London, London SW7 2BP, UK*

INTRODUCTION: Composites of biodegradable polymers and bioactive ceramics in the form of biocompatible scaffolds have been proposed and used in the field of tissue engineering with emphasis towards hard tissue regeneration [1, 2]. Calcium phosphate-based ceramics or glasses can be incorporated into the polymer matrix in order to reinforce the polymer and add bioactive properties. A popular polymer within the family of polyhydroxyalkanoates is poly(3hydroxybutyrate), known as P(3HB). In order to investigate the effect of particle size of the fillers we have introduced micron- or nano-sized bioactive glass particles [3] in different concentrations within the P(3HB) matrix and compared their mechanical and thermal properties, topography, protein adsorption, *in vitro* degradation behaviour and cell proliferation [4].

METHODS: Composite films of P(3HB) with 10, 20, or 30% micron-sized, conventional (m-BG) or nano-sized bioactive glass (n-BG) were prepared by solvent casting. The topography of the resulting materials was investigated using SEM and the thermal as well as the mechanical properties using DSC and tensile strength tests respectively. Further investigations included protein adsorption with foetal bovine serum, an *in vitro* bioactivity study in SBF and cell proliferation of MG-63 osteoblast-like cells.

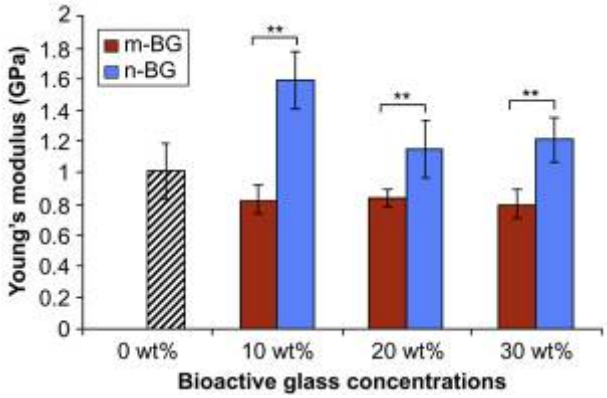

Fig. 1:Mechanical properties in dependence of the filler concentration and m- vs. n-BG.

RESULTS: The addition of n-BG particles induced a nano-structured topography on the surface of the composites not visible on m-BG containing composites. This surface effect observed for n-BG composites considerably increased the protein adsorption. Most interestingly, n-BG particles caused a significant stiffening of the composite (Fig. 1) but had no effect on the thermal properties. Immersion in SBF revealed a high level of *in vitro* bioactivity for P(3HB)/n-BG composites. Proliferation of MG-63 osteoblast-like cells on the various composites demonstrated a good biocompatibility of all composite materials.

DISCUSSION & CONCLUSIONS: The results of this study have confirmed that the addition of nanoparticulate bioactive glass has a more significant reinforcing effect on the mechanical and structural properties of a composite system than the corresponding micron-sized particles. Therefore such nanoparticles are a most interesting bioactive filler material for biodegradable polymers in order to prepare advanced composites for tissue engineering.

REFERENCES: [1] Rezwan, K. et al, *Biomaterials*, **27**, 3413-31, 2006. [2] Loher S. et al, *Nanotechnology*, **17**, 2054-61, 2006. [3] Brunner, T.J. et al, *Chem. Commun.*, **13**, 1384-6, 2006. [4] Misra, S.K., et al, *Biomaterials*, **29**, 1750-61, 2008.

ACKNOWLEDGEMENTS: Financial support by the Overseas Research Scholarship UK, IDEA league research grant and Gebert Rüf Foundation (grant nr. GRS-048/04) is kindly acknowledged.