European Cells and Materials Vol. 13. Suppl. 3, 2007 (page 8) ISSN 1473-2262

# Fabrication and study of mechanical properties of Poly-L-lactic / nanoHydroxyapatite dense composites for bone tissue engineering

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**INTRODUCTION:** The number of high skeletal defects found in a wide variety of clinical situations keeps increasing. Current clinical therapies do not satisfy the existent needs; there is a real demand for alternative bone substitutes and improved wound healing therapies. Nanocomposite materials mimicking the microstructure of bone would probably have a good chance to achieve expected properties for bone substitutes. Poly-L-Lactic (PLLA) matrix dense composites reinforced with nanosized hydroxyapatite particles (nHA) with three particle concentrations (0, 25 and 50%wt HA) were prepared and characterized in order to estimate the intrinsic mechanical properties of the material. The effect of an annealing post-treatment was also analysed.

**METHODS:** Solvent casting-hot pressing method was used to prepare test samples. Commercial hydroxyapatite was deagglomerated by attrition-milling. Incorporation of nHA particles into the polymer was facilitated by a solvent exchange process, substituting the initial aqueous medium by chloroform. After chloroform evaporation at room temperature, dense cylindrical composite test samples were made by hot-pressing at 190°C (relative density > 97%). Mechanical properties were estimated by uni-axial compression and Brazilian tests (indirect tensile test).

Thermal, microstructural and physical properties of the composites were also measured (DSC, EDX, FTIR, TEM, X-ray diffraction, contact angles), but will be presented in detail elsewhere.

**RESULTS:** The mechanical properties of the samples changed markedly depending on their nHA content. The applied annealing treatment had no effect on the properties, and did not modify the cristallinity of the polymer matrix. Ultimate stresses obtained in both tests were analysed by the Mohr's circle approach [1], in order to estimate the intrinsic characteristic properties of the composites (*Table 1*). Neat PLLA is not shown because it could not be represented by the Mohr's approach due to its excessive ductility.

Young's compression modulus was calculated from the slope of the linear region of the stress-strain curve by least-square regression. *Figure 1* presents the Young's compression modulus in function of nHA content. Young's modulus increases linearly with ceramic content.

*Table 1. Intrinsic characteristic normal strength ($\sigma_0$) and shear strength ($\tau_0$) of composites compared to cortical bone.*

| | $\sigma_0$ [MPa] | $\tau_0$ [MPa] |
|---|---|---|
| Cortical bone [2] | 145-235 | 50-80 |
| PLLA/25%nHA | 57 | 34 |
| PLLA/50%nHA | 80 | 40 |

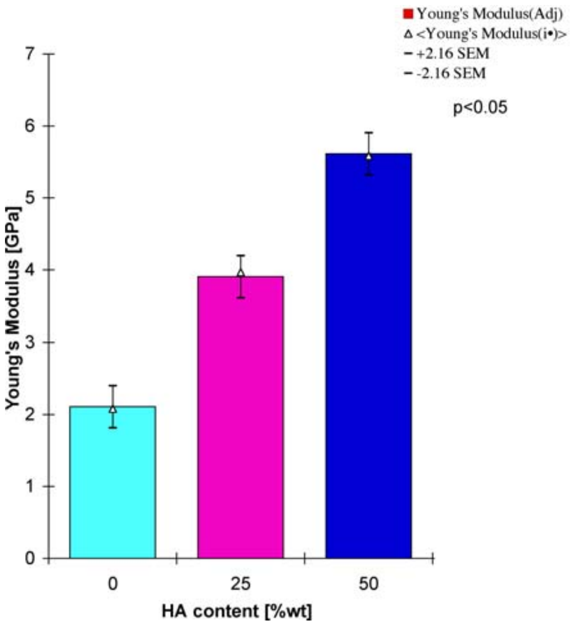


*Figure 1: Young's compression modulus* vs *nHA content of nHA/PLLA dense composites.*

**DISCUSSION & CONCLUSIONS:** Dense PLLA/nHA composites containing up to 50%wt nHA were successfully prepared by solvent casting/hot pressing method.

Mechanical performance of PLLA/nHA composite was enhanced by increasing nHA content, leading to mechanical properties commensurate to those of human cortical bone.

**REFERENCES:** [1] C. Pittet, J. Lemaître (2000) *J Biomed Mater Res* **53**:769-780. [2]A. Ravaglioli and A. Krajewski, (2003) *Bioceramics. Materials Properties Applications*, Chapman & Hall.

**ACKNOWLEDGEMENTS:** This work is part of the NANOBIOCOM project supported by the $6^{th}$ Framework European R&D Program (Project n° NMP3-CT-2005-516943).