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Towards new strategies for development of bone tissue engineering composite scaffolds

3D printing techniques become attractive to produce scaffolds for bone tissue engineering (BTE) with high complexity, anisotropy and reproducibility, different shapes and geometries etc. Poly(3-hydroxybutyrate) (PHB) is a microbial and biodegradable polyester, which has been studied as raw material to produce scaffolds for BTE. PHB is biocompatible and has no toxicity to several mammalian cells lines. Addition of a calcium phosphate phase into PHB materials should potentially have the dual effect of improving both the bioactivity and mechanical properties. The aim of this work was to evaluate a join strategy to develop a scaffold for BTE applications: one related to raw materials and other related to manufacturing technique. PHB/beta-tricalcium phosphate (b-TCP) composite scaffolds were directly fabricated by 3D mini-screw extrusion printing. This 3D printing technique uses a simple device, which allows the direct use of a powder mix, without the need for prior preparation of solution or filaments. Compositions containing 0-30 wt.% of b-TCP were used. Scaffolds with physical integrity, internal pore structure of $0^o/90^o$ pattern and compressive modulus like that of human trabecular bone were produced. No cytotoxicity was observed for any scaffold. In vitro release of cytokines and growth factors was monitored for 24 h. Higher concentration of growth factors released was observed for composite scaffolds. A release of pro- and anti-inflammatory cytokines was also detected. The use of scaffolds in critical-size bone defects did not alter any thermal sensitivity and motor performance of male Wister rats. Physical and biological tests results showed that PHB scaffolds containing 20 wt.% of b-TCP has greater potential for bone tissue engineering application than those of pure PHB. Moreover, the employed 3D printing technique opens up the opportunity for the use of a wider range of materials and thus, is a viable alternative manufacturing process for composite scaffold materials.

Speaker Biography

Rossana Mara da Silva Moreira Thire received her D.Sc. degree in materials and metallurgical engineering (2003) from Federal University of Rio de Janeiro (UFRJ), Brazil. She is currently a full-time professor at Program of Metallurgical and Materials Engineering (PEMM), UFRJ, Brazil, conducting teaching activities to graduate and undergraduate students and developing researches focused on polymers for biomedical and technological applications. Her main research interests are polymeric and composite biomaterials for bone and skin tissue engineering, drug-loaded biomaterials, additive manufacturing, electrospinning and biodegradable plastics. She is the head of Biomaterial area of PEMM/COPPE/UFRJ, leader of the "Technology in Biomaterials" Research Group, board member of Latin American Society of Biomaterials and Artificial Organs (SLABO) and a member of the Brazilian Committee for Special Study of Additive Manufacturing (ABNT/CEE-261) related to ISO/TC 261Technical Committee. Her work has been recognized with two important Brazilian sponsorships: CNPq Researcher of Productivity and FAPERJ Scientist of our State.

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