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Materials processing for the manufacture of musculoskeletal Medical devices at the point of need

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INTRODUCTION:

Osteochondral defects result in severe pain and disability for millions of people worldwide and massive healthcare costs. There is a recognized and urgent need for developing novel treatments based in bone tissue engineering and three dimensional scaffolds design. The use of Additive Manufacturing (AM) has been growing in recent years due to its ability to directly print 3D porous scaffolds with pre-designed shape and patient customized, solvent-free, controlled pore size and interconnected porosity [1]. This paper reports the results of an initial scoping study on the development of new processes to support the in-clinic manufacture and configuration of hybrid bioactive devices for large defects which are load bearing, functionally gradient, and biologically enhanced.

METHODS:

As a starting point the aim was to develop a modular composite of a porous polylactic acid (PLA) block and wollastonite (A-W) cylinders. The overall aim is to have anatomical geometries derived from patient data. A Fused Filament Fabrication (FFF) 3D printer was selected to fabricate the PLA rectangular part with a 0º/90º laydown pattern and the AW cylinders were produced by a Z310 Plus 3D printer (Z-Corp, USA) using prepared AW and Maltodextrin powder. Afterwards the A-W green specimens were sintered at 1150ºC for 2 hours. Measurements were performed before and after sintering and all specimens were observed with a stereo microscope (Nikon SMZ1500).

RESULTS:

The specimens were successfully manufactured as presented in Fig.1.A-C and the modular composite was assembled (Fig.1.D). The PLA block presents an interconnected porous structure characterized by approximately 300 µm pore size (Fig.1.C) which was defined by the CAD model geometry and the laydown pattern. Moreover the walls are also porous and interconnected with the surrounding porous structure (Fig1.B), which is crucial for achieving an interconnected porosity throughout the hybrid device. Shrinkage of 15% and 18% for both diameter and length was observed after sintering of the AW cylinders.

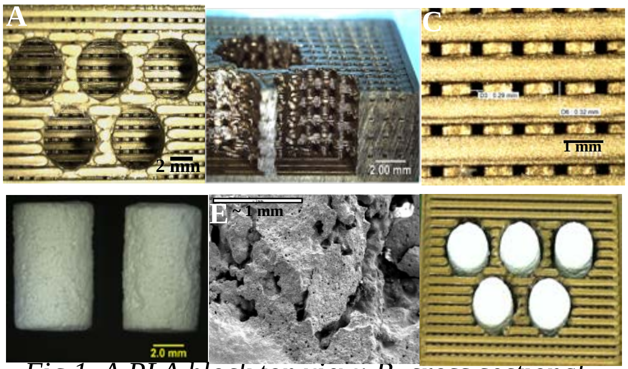

Fig.1. A.PLA block top view; B. cross sectional view; C. porous structure; D. AW cylinders after sintering; E. SEM of porous AW structure; and F. hybrid composite.

DISCUSSION & CONCLUSIONS:

The composite was successfully assembled and it is characterized by an interconnecting porous structure which is crucial for a good osteointegration. Additionally the pore size and geometry can be controlled during the design step.

REFERENCES:

1. Bose, S. et al. Materials Today, 2013. **16**(12): p. 496-504.

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