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ID-9-IN-5790 Characterization of advanced biomaterials and tissue engineered constructs using 3D and 4D X-ray tomography

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X-ray tomography becomes a widely applied tool in science and industry, with a particularly strong position in the biomedical fields. The tomography techniques show high potential in study of advanced biomaterials, both synthetic and natural. Micro and nano tomography can be used to complement existing 2D characterization methods to image specimens at the micro/nano scale, nondestructively in 3D. With such tool, it is possible to characterize newly developed biomaterial, degradation process of biodegradable materials, tissue growth into biomaterial and in situ mechanical behavior of biomaterial. The aim this study was to show how 3D and 4D imaging techniques combined with advanced image analysis could be used to characterize novel biomaterials and scaffolds for tissue regeneration. 3D imaging technique which combines X-ray absorption microtomography (uCT) and X-ray diffraction microtomography (XRD-CT) was used to examine the in vitro degradation process of polycaprolactone–based composites. The complementary information on phase distribution, changes in crystallinity and morphology during degradation process was obtained by means of image analysis of combined uCT/XRD-CT scans. The conventional uCT method was applied to examine the in vitro tissue ingrowth into biodegradable scaffolds at varying resolutions (Fig.1). Imaging of the scaffold/tissue composite at a scale of 5 mm and resolution of 5 um allows characterization of the complex ingrowth of tissue into the biomaterial. Further imaging at 1 um resolution allows for quantitative analysis of cell-tissue fine structure. These results illustrate the benefits of tomography over traditional 2D imaging techniques for the description of tissue morphology and interconnectivity. The combination of microfocus X-ray computed tomography and in-situ mechanical loading allowed us to quantify the scaffolds morphology prior and during loading, to verify the mechanical properties, to analyze fracture behavior, and to estimate the internal local deformation distributions.

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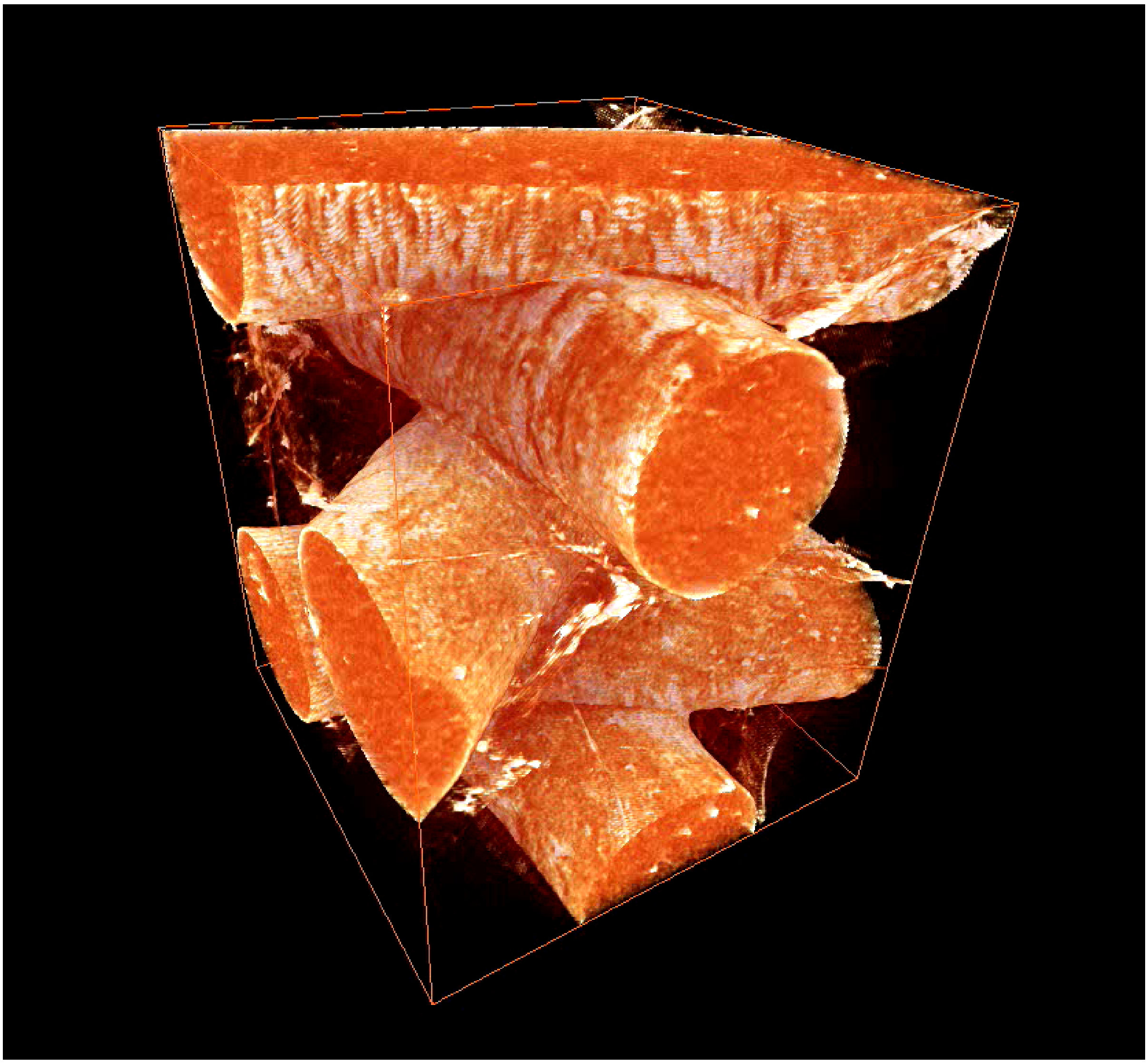

Fig. 1: Polymeric scaffold seeded with Mesenchymal Stem Cells