NanoCT with in situ mechanical testing as a tool for the characterization of 3D additive manufactured mechanical metamaterials

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With an intermediate resolution between light and electron microscopes, the commercial lab-based X-ray microscope (Xradia Ultra 810) with mechanical in situ testing, here referred to as nanoCT, is a versatile new tool for structural characterization of complex 3D samples down to 50 nm resolution with and without loading. It allows for the observation of microstructural changes as a function of time and mechanical load. With its low energy X-ray source (Cr source, 5.4 keV) and Zernike phase contrast, the setup is ideal for analyzing low-density samples, such as polymers and soft tissues.

Tetrahedral microlattices manufactured using 3D direct laser writing method and different laser parameters were characterized using the nanoCT (Figure 1) with and without loading. Through phase and absorption contrasts and a voxel size of $(128\ nm)^3$, differences in the structures, volume density and mechanical responses, as well as defects and pores within the different polymeric samples, could be identified.

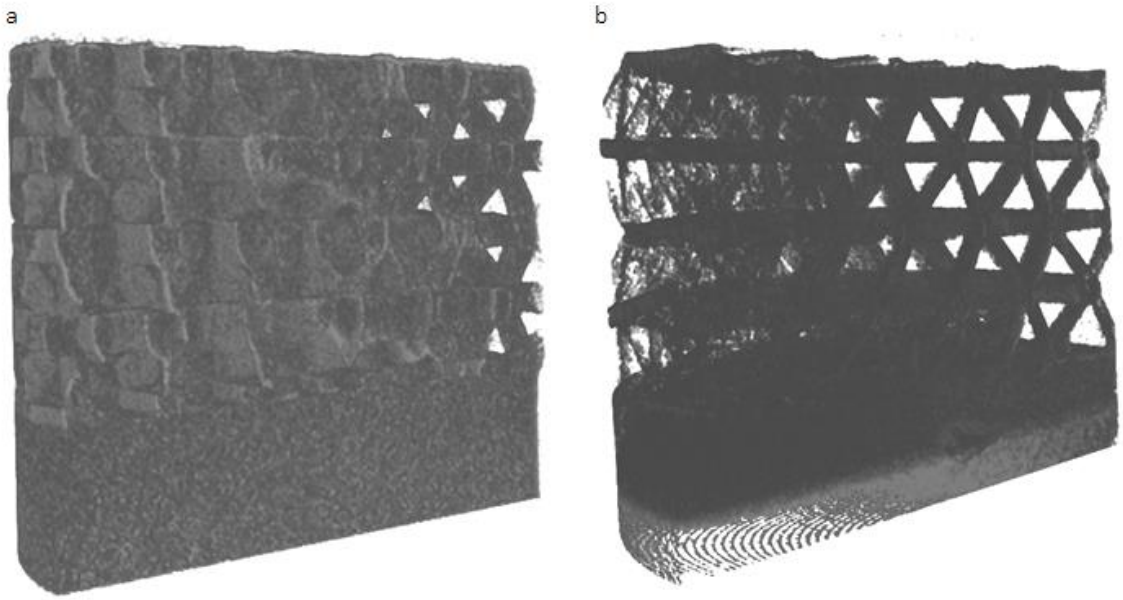

Figure 1: Volumetric reconstruction of tetrahedral metamaterial showing the structural differences depending on the fabrication parameters. Samples diameter: 60 µm. Samples manufactured with laser power [%] a) 40, b) 25.