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Material Characteriation of Up-Scaled 2PP Structures

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Two-Photon Polymerisation (2PP) is a versatile tool within additive manufacturing that allows to create 3-dimensional structures with complex designs showing feature sizes down to <100 nm. 2PP utilizes nonlinear absorption of femtosecond laser pulses to induce cross-linking in photo-polymers with a high temporal and spatial control. Due to the high spatial resolution the fabrication process has always been very time consuming and hence typical overall part sizes have been within the micro-scale. However, recent advances in 2PP technology have enabled the fabrication of up-scaled objects reaching the meso- and even macro-scale while maintaining feasible processing times. As a result, 2PP now bridges the unfilled gap between micro-stereolithography (µ-SLA) and nanofabrication technologies such as photolithography. Hence, reliable and standardized characterization methods for 2PP processed materials are highly demanded now. Until now the materials characterisation of 2PP printed structures was only possible on the micro and nano-scale with non-standardized methods such as nanoindentation or atomic force microscopy, that are not capable of providing a full picture of the material properties. Up-scaled 2PP processing enables to create macro-sized test-structures that can be characterized with standardized and well-established methods (e.g., tensile tests, 3-point bending tests, …). Furthermore, by down-scaling the used test procedures it is possible to also characterize meso-sized structures. With these methods, new information on a broad spectrum of material properties can be acquired allowing it to compare 2PP processed materials with other classes of materials or differently processed materials on the meso-scale.