Polymerization threshold at high scanning speeds for microstructures using 2-Photon Polymerization in 1, 2 and 3-dimensional conditions

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Two-Photon Polymerization (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. Originally this high resolution and low scanning speeds used to be a bottleneck in 2PP resulting in a time-consuming fabrication process and limited structure sizes. However, recent advances in 2PP technology have made it possible to use higher scanning speeds and lower processing times. With this progress 2PP becomes interesting for a larger field of application such as producing upscaled structures for biomedical applications [1] or batch production of microscaffolds for cell seeding [2]. Using higher scanning speeds creates new challenges and a thorough understanding of the material performance at this new processing window is essential.

Determining the minimal required laser power (P_{th}) needed to induce polymerization has become an approved method to evaluate a material's sensitivity for a given set of structuring parameters. A closer examination of P_{th} for fabrication speeds up to 600 mms^{-1} using a 63x and a 10x objective was carried out. From the results, it was concluded that for these fabrication speeds, P_{th} was significantly lower than predicted by the established model [3]. Initial simulation results point to higher ordered effects, which are not considered by current polymerization models such as diffusion assisted processes. At higher scan speeds and as a consequence thereof shorter exposure times, these higher ordered processes seem to significantly affect the polymerization threshold, requiring a lower energy for polymerization than predicted by the established model.

References:

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