LITHOGRAPHY-BASED ADDITIVE MANUFACTURING OF HIGH PERFORMANCE CERAMICS

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In the last years multiple developments in lithography-based additive manufacturing technology (L-AMT) enabled the processing of ceramic materials, resulting in new opportunities for ceramic part production. In this work different L-AMT processes, containing dynamic masks as well as laser-scanning based approaches, are studied to improve material properties of high performance ceramics for applications in engineering and biomedical engineering. In this study samples made of alumina (Al_2O_3) and zirconia (ZrO_2) were investigated.

Using layer by layer manufacturing of filled photosensitive monomer slurries, solid loadings of more than 50vol% of ceramic powders were achieved. Rheometric measurements were conducted to determine the influence of the slurry viscosity on the building process. The slurry formulations used in this study allowed for the fabrication of detailed ceramic structures with pore sizes down to 100µm. An overall building resolution of 25x25x25µm³ during green part structuring was possible. The 3D printing of green parts was subsequently followed by thermal debinding and sintering to achieve ceramic parts with high density. Mechanical properties and fracture behaviour were investigated using biaxial bending tests and SEM. Mechanical test results confirm early density measurements by showing excellent biaxial strength for Al_2O_3 (520MPa) and ZrO_2 (1000MPa).

There is high evidence that ceramic stereolithography promises to be a highly competitive manufacturing alternative for small series or single pieces of high performance ceramic products. This is especially true for parts with complex shapes or small parts containing fine geometric details.