3D printing of zirconia-alumina composites via Digital Light Processing: optimization of the slurry and the debinding process

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Among additive manufacturing technologies, Digital Light Processing (DLP) is regarded as one of the most promising techniques for its high forming precision, excellent surface quality, and fast printing speed. However, the precise composition of the slurry and the optimization of the debinding process, are still challenges that need to be addressed. Zirconia-based ceramics present excellent hardness and abrasive resistance, as well as high aging and chemical stability, which make them suitable for many different applications, ranging from the aerospace to biomedical fields. The present work investigates the printability of zirconia-alumina composites through a stereolithography process. Commercially available 10 mol% CeO_2 and 12 mol% CeO_2-stabilized zirconia were mechanically mixed with alumina, to provide 11 mol% CeO_2-stabilized ZrO_2 / 16 vol% Al_2O_3 composite material. These powders were mixed under wet ball-milling conditions, in order to achieve a mean particle size of 0.3 μm. Photosensitive suspensions with optimized rheological properties in terms of high solid loading and low viscosity were then developed. Different drying processes and debinding profiles were also studied and compared to find the optimal conditions for the preparation of the sintered body. The sintering temperature was optimized by dilatometry studies and showed a homogeneous sintering shrinkage of about 22% in all directions. As a result, it was possible to manufacture a > 99 % dense defect-free zirconia-alumina composite with a bending strength of ~450 MPa. FE-SEM observations showed highly homogeneous microstructures (Fig 1), free from the typical 3D printing flaws, such as delamination between layers and cracks due to the organic matter decomposition. Further works are in progress to improve the mechanical strength, to print more complex geometries, and to expand the characterization of the material produced from the mechanical point of view.