Additive manufacturing of ceramics from precursors

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Additive manufacturing of ceramics is somewhat limited by their high melting temperatures and the processing issues related to handling of feedstocks containing a large volume of particles. Processing slurry-based feedstocks, in fact, poses several challenges: a high amount of powder is required to promote densification and results in high viscosity, scattering and sedimentation phenomena in vat photopolymerization processes, as well as clogging problems at the nozzle for extrusion-based processes.
Some of these issues can be solved or mitigated when using all liquid, precursor-based feedstocks. Our research activities have therefore focused on the use of preceramic polymers as well as sol-gel solutions as feedstock for the production of ceramic components by additive manufacturing. Despite the many advantages related to their liquid nature, there are also some challenges related to the reactivity of sol-gel systems and to the high amount of solvent usually present, while preceramic polymers are limited in the range of compositions available.
Additive manufacturing of geopolymer solutions or powders has also been investigated, as precursors for different components of interest for absorption, catalysis or high temperature applications.
In this talk, our strategies for producing high quality ceramic components using a variety of precursor feedstocks will be presented. Different additive manufacturing techniques were used to fabricate components ranging in size from the sub-micron to the tens of centimeters, including direct ink writing, digital light processing, two photon polymerization, robotic arm manufacturing and volumetric additive manufacturing.