3D printing of lunar regolith based ceramics via the DLP method

Ceramic parts generally have poor machinability due to their high hardness and high brittleness. Researchers and industries have overcome the difficulty of machining ceramics and have manufactured parts with intricate geometry by using pre-ceramic polymers in stereolithography (SLA) 3D printing and using slurries based on ceramic powder and photopolymer resin in digital light processing (DLP) 3D printing, among other methods. This presentation will discuss the processes involved in the 3D printing of ceramic and ceramic composite parts via the DLP technique. A vital step in ceramic 3D printing is to optimize the printing parameters for a specific slurry formulation in hand. A systematic methodology to accomplish that step has been developed and can be adopted to 3D print any ceramic slurry. During the printing process in a DLP printer, the slurry solidifies into a 3D part layer by layer using UV light to cause photopolymerization in the resin, which hardens the resin and makes it function as glue holding ceramic particles in place. After printing and additional curing, parts are heat treated to remove the polymer present within them and to fuse the ceramic particles together. The key results include the printing of cubes with side length of 10 mm having complex features using a lunar regolith simulant named greenland anorthosite with and without graphene nanoplatelets as a reinforcement and the printing of one mold for dog bone samples using just greenland anorthosite having a length of 80mm, width of 23mm, and thickness of about 8 mm. In conclusion, complex ceramic parts and ceramic composites have been 3D printed applying the slurry optimization technique mentioned above. The positive implication of this work is that more ceramic materials can be made available for applications demanding intricate shapes. A challenge for the future is to study the deformation experienced by 3D printed ceramics during sintering and to determine how to take that deformation into account in a part’s geometry so those parts can have desired dimensions after sintering.