Manufacturing of silicon oxycarbide parts by stereolithography using cost-reduced Polymer-Derived Ceramics

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One method to build complex shape and high performance materials is the use of additive manufacturing technique such as Stereolithography (SLA) because of its high accuracy. With SLA techniques, a material with photo-reactive components is exposed to a UV source that induces photopolymerization of cross-sectional patterns in stacked layers in order to get a 3D part, starting from a CAD file.

Today, the strategy to get high performance ceramics by SLA is to include particles into a photopolymerizable resin. Due to their absorbance, silicon carbide are difficult to obtain. To go around the problem, Polymer-Derived Ceramics (PDCs) route seems to be a convenient way to obtain SiC-based printed parts because it deals with a polymer instead of a loaded paste. The PDCs present the advantages to be custom tailored in liquid state and do not absorb in the UV zone enabling their photopolymerization. These inorganic polymers combine the properties of a polymer feedstock and the possibility to convert them into non-oxide ceramic materials such as carbides or nitrides by a thermal treatment. Nonetheless, these materials are still quite expensive.

Thanks to an R&D program granted by the Nouvelle Aquitaine Region, CCTC, specialist of ceramics and their processing, and RESCOLL, specialist in polymer formulation are collaborating since 2017 to develop effective and cheap printable PDCs for SLA.

This presentation will present the results of this fruitfull collaboration on the synthesis of PDCs and their processing by SLA. The presentation will focus on the PDC synthesis formulation in order to achieve the right processability (stability, rheology and reactivity). Then, it will deal with the definition of printing parameters, photopolymerization and optimal shaping resolution. In the end, the importance of thermal treatments to get a good ceramic conversion and good mechanical behaviour will be assessed.

Key words: Stereolithography, Polymer Derived Ceramic, Silicon oxycarbide, Additive manufacturing