ABSTRACT – Student Speech Contest

Colloidal Stability, Rheology, and Printability of SiSiC Slurries for Slurry-based Laser Powder Bed Fusion

Mira Sinée, Additive Manufacturing Research Group, Department of Mechanical Engineering, KU Leuven, Belgium

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Silicon carbide (SiC) is a refractory ceramic valued for its hardness, thermal conductivity and thermal shock resistance, but its strong covalent bonding makes it difficult to densify. Silicon infiltrated SiC (SiSiC), also called reaction bonded SiC, avoids high temperature sintering by infiltrating a porous preform with molten silicon, which gives near net shape parts. Laser powder bed fusion (LPBF) of a dry Si and SiC powder blend has been combined with this route to shape the preform without a binder [1]. Dry spreading, however, depends on powder flowability, which restricts the use of fine and angular powders and thereby the refinement of the microstructure. Spreading the powder as a slurry removes this restriction. Layerwise slurry deposition (LSD) has been applied to SiSiC in binder jetting [2], but its use in LPBF has not been reported, and the literature on SiSiC slurry formulation is scarce. Slurry-based LPBF of SiSiC requires a suspension that is colloidally stable and suited to nozzle deposition and blade recoating. In this work, an aqueous SiSiC slurry was developed by studying dispersion, rheology and deposition behaviour. Zeta potential measurements across a wide pH range were used to compare polyethylenimine (PEI) and polyacrylic acid (PAA) as cationic and anionic dispersants. Rheological measurements as a function of pH and dispersant concentration identified formulations with low viscosity in the processing window, where the deposition nozzle was used as a capillary rheometer to reach shear rates above the rheometer range. Sedimentation tests, quantified deposition experiments and printability tests were then used to establish a stable slurry with the maximum usable solids loading. Additionally, the effect of the SiC to Si ratio on stability, flow behaviour and printability was examined. Together, these steps establish a reliable framework for developing slurries for slurry-based LPBF.
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References

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