Enhancing Microstructure of Siliconized Silicon Carbide Fabricated Using Binder Jetting: Influence of Printing and Infiltration Variations

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Understanding the process-structure relations of Siliconized Silicon Carbide (SiSiC) is crucial in unraveling their role in subsequent properties. This research aims to enhance microstructural homogeneity in additively manufactured SiSiC, which is essential when isotropic properties are intended. In this regard, samples were fabricated via Binder Jetting (BJ) and densified using Liquid Silicon Infiltration (LSI) (where capillary infiltration of Silicon melt produces secondary SiC once in contact with the available carbon). Attempts were made to minimize printing and layering marks while diminishing porosity levels, which were assessed by examining final siliconized samples.

Binder jetting variables were selected to be layer thickness (35 and 70 µm) and printing strategy (normal and shell). In normal printing strategy, the binder bonds particles in the whole geometry whereas in shell printing only the walls with a specified thickness are exposed to the printing binder, leaving loose powder entrapped in the core. For LSI, two initiation sides were selected on the sample according to the build-up direction.

The findings reveal notable differences in the green density of samples correlated with the employed printing variables. Specifically, lower layer thickness contributes to increased green density, regardless of the printing strategy. Moreover, shell printed samples lead to lower density compared to their normally printed counterparts.

Furthermore, this study investigates the directionality of siliconizing process in debinded and carbonized samples. The latter includes an additional step of phenolic resin impregnation and pyrolysis for the green part to embed extra carbon within the structure. The results indicate that siliconizing carbonized shell printed samples produce a significantly more uniform microstructure, compared to normally printed ones. In addition, this phenomenon is augmented when the LSI is conducted opposite to the build-up direction. On the other hand, debinded shell printed samples deny complete access of silicon melt to the non-bonded powder core.