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Fabrication of Metal Matrix Composites via PEP Printing and Vacuum Pressure Infiltration

Abstract: This study successfully employed the “Powder Extrusion Printing (PEP) + Vacuum Infiltration” technique to fabricate aluminum matrix composites reinforced with a three-dimensional network structured silicon carbide (SiC) ceramic. Firstly, a SiC porous ceramic preform with a three-dimensional interconnected pore structure was formed via PEP technology. Subsequently, molten aluminum was infiltrated into the preform using a vacuum infiltration process, ultimately obtaining an aluminum/silicon carbide (Al/SiC) dual-continuous phase composite. The microstructure, interfacial bonding, and the sintering neck structure of the SiC preform were analyzed using optical microscopy and scanning electron microscopy (SEM). The results indicate that PEP technology can produce SiC ceramic preforms with complex shapes, interconnected pores, and distinct sintering necks, providing channels and anchoring points for the smooth infiltration of molten aluminum. After vacuum infiltration, the aluminum matrix and the SiC ceramic skeleton were well-bonded, achieving uniform compounding of the two phases. This method provides a new and effective technical pathway for preparing metal matrix composites with complex structures and high performance.

Keywords: Metal matrix composites; Powder extrusion printing; Vacuum infiltration; Silicon carbide preform; Microstructure