World Academy of Science, Engineering and Technology
International Journal of Materials and Metallurgical Engineering
Vol:16, No:10, 2022

Structural Characterization of the 3D Printed Silicon Carbon/Carbon Fibers Nanocomposites

Authors : Saja M. Nabat Al-Ajrash, Charles Browning, Rose Eckerle, Li Cao

Abstract : A process that utilizes a combination of additive manufacturing (AM), a preceramic polymer, and a chopped carbon fiber precursorto fabricate Silicon Carbon/ Carbon fibers (SiC/C) composites have been developed. The study has shown a promising, cost-effective, and efficient route to fabricate complex SiC/C composites using additive manufacturing. A key part of this effort was the mapping of the material's microstructure through the thickness of the composite. Microstructural features in the pyrolyzed composites through the successive AM layers, such as defects, crystal size and their distribution, interatomic spacing, chemical bonds, were investigated using high-resolution scanning and transmission electron microscopy. As a result, the microstructure developed in SiC/C composites after printing, cure, and pyrolysis has been successfully mapped through the thickness of the derived composites. Dense and nearly defect-free parts after polymer to ceramic conversion were observed. The ceramic matrix composite displayed three coexisting phases, including silicon carbide, silicon oxycarbide, and turbostratic carbon. Lattice fringes imaging and X-Ray Diffraction analysis showed well-defined SiC and turbostratic carbon features. The cross-sectional mapping of the printed-then-pyrolyzed structures has confirmed consistent structural and chemical features within the internal layers of the AM parts. Noteworthy, however, is that a crust-like area with high crystallinity has been observed in the first and last external layers. Not only do these crust-like regions have structural characteristics distinct from the internal layers, but they also have elemental distributions different than the internal layers.

Keywords : SiC, preceramic polymer, additive manufacturing, ceramic
Conference Title : ICCET 2022 : International Conference on Ceramic Engineering and Technology
Conference Location : Rome, Italy
Conference Dates : October 13-14, 2022