World Academy of Science, Engineering and Technology
International Journal of Materials and Metallurgical Engineering
Vol:14, No:05, 2020

Preceramic Polymers Formulations for Potential Additive Manufacturing

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

Abstract : Three preceramic polymer formulations for potential use in 3D printing technologies were investigated. The polymeric precursors include an allyl hydrido polycarbosilane (SMP-10), SMP-10/1,6-dexanediol diacrylate (HDDA) mixture, and polydimethylsiloxane (PDMS). The rheological property of the polymeric precursors, including the viscosity within a wide shear rate range was compared to determine the applicability in additive manufacturing technology. The structural properties of the polymeric solutions and their photocureability were investigated using Fourier transform infrared spectroscopy (FTIR) and differential scanning calorimetry (DSC). Moreover, thermogravimetric analysis (TGA) and X-ray diffraction (XRD) were utilized to study polymeric to ceramic conversion for versatile precursors. The prepared precursor resin proved to have outstanding photo-curing properties and the ability to transform to the silicon carbide phase at temperatures as low as 850 °C. The obtained ceramic was fully dense with nearly linear shrinkage and a shiny, smooth surface after pyrolysis. Furthermore, after pyrolysis to 1350 °C and TGA analysis, PDMS polymer showed the highest onset decomposition temperature and the lowest retained weight (52 wt%), while SMP.10/HDDA showed the lowest onset temperature and ceramic yield (71.7 wt%). In terms of crystallography, the ceramic matrix composite appeared to have three coexisting phases, including silicon carbide, and silicon oxycarbide. The results are very promising to fabricate ceramic materials working at high temperatures with complex geometries.

Keywords : preceramic polymer, silicon carbide, photocuring, allyl hydrido polycarbosilane, SMP-10
Conference Title : ICACC 2020 : International Conference on Advanced Ceramics and Composites
Conference Location : Vancouver, Canada
Conference Dates : May 21-22, 2020