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Vacuum Plasma Spray Deposition of Refractory Hafnium Materials

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Next generation aerospace applications require materials, which can allow higher temperatures upto 2800⁰C be attained for improved performance. Group IV (hafnium and zirconium) based refractory ceramics are potential coating/structural materials with a significantly high ablation and erosion resistance due to their resistance and stability against complex gaseous and thermal environments. Refractory ceramics such as hafnium diboride (HfB₂), hafnium carbide (HfC) and hafnium nitride (HfN) are candidate materials because of their high melting points, relatively low coefficient of thermal expansion, high erosion and oxidation resistance. Conventionally, processing of these ceramics has been very difficult and expensive due to their intrinsic brittle nature. Near net shape forming of these ceramics using vacuum plasma spray (VPS) technique offers a cost effective method to fabricate structural components. The VPS technique involves spraying material onto a mandrel of the desired shape and subsequently removing the mandrel. A primary advantage of VPS forming over other powder metallurgy techniques is that near-net-shape spray forming of components significantly simplifies and reduces the cost. In the present investigation, it has been demonstrated that HfB₂, HfC and HfN can be spray formed to near net shapes. Microstructural characterization for density and phase distribution has been performed using scanning electron microscope (SEM). Phase identification and chemical characterization have been carried out using x-ray diffraction (XRD) and energy dispersive spectroscopy (EDS).