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Advances in Near Net Shape Forming and Coating of Erosion Resistant Ultra High Temperature Materials

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To meet the increasing demands and performance level of rocket engines, tactical missiles and space applications, it is essential to develop zero-erosion, thermal protection materials for rocket and missile nozzles, leading edges, and control surfaces. Ultrahigh temperature metals and ceramics such as tungsten (W), rhenium (Re), molybdenum (Mo), niobium (Nb) and Group IV ceramics i.e. (Ti, Hf, Zr) borides and carbides are potential structural/coating materials for such applications. However, fabrication of refractory and ceramic materials into useful bulk shapes is a complex problem as they are susceptible to thermal stresses and cracking. Hence, they must be used as thin, non-eroding liners or thermal protection coatings. Near net shape forming using the vacuum plasma spray technique provides a low cost manufacturing process viable to fabricate refractory metal and ceramic based zero-erosion nozzle throat liners/inserts, tubes and other hot gas components. In the present investigation, W, Re, W/Re nozzles and Mo, Nb, HfC structures have been vacuum spray formed. These structures have been evaluated for their metallurgical properties such as density, phase distribution, composition and hardness. An innovative technique for fabrication and joining of high temperature materials to low temperature structural materials in a thermal fatigue structure has also been developed. A brief introduction of other activities related to spray forming of Ultra High Temperature Ceramics (UHTCs) at Plasma Processes Inc. (PPI) is also summarized.