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Structure and Properties of Detonation Gun Sprayed Coatings from the Synthesized FeAlSi/Al_2O_3 Powder

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Abstract

Structure and properties of detonation gun sprayed (DS) coatings from the synthesized FeAlSi/Al_2O_3 powder have been investigated. The powder was manufactured through a mechanically assisted self-propagating high-temperature synthesis route. A small addition of nanosized SiO_2 particles to the reaction mixture for the synthesis of FeAl-$FeAl_2$ eutectoid refines the thickness of B2-FeAl lamellar grains in the synthesized powder. Silicon arisen from the aluminothermic reduction of SiO_2 during the synthesis is preferentially located in the B2-phase. High-quality coatings with porosity less than 1 vol. % and nanocomposite structure have been obtained from the synthesized powder using a computer-aided 'Perun-S' detonation gun complex. Phase composition of the coatings includes B2-FeAl, hercinite $FeAl_2O_4$, $FeAl_2$, A2-Fe-based solid-solution, Al_2O_3**,** and probably complex $Fe_{2.95}Si_{0.05}O_4$ oxide. It is formation of nanocomposite structure with the mean crystallite size of main components in the range of ≈9-15 nm that seems to be responsible for the lower microhardness of the coatings from the FeAlSi/Al_2O_3 powder than that of the basic Fe-Al eutectoid composition. As-sprayed coatings from the synthesized FeAlSi/Al_2O_3 powder demonstrate good room and elevated temperature erosion behavior. Oxide dominated erosion with mixed brittle-ductile wear behavior is thought to occur in the coatings at 550 °C. The proposed powder modification is found to be beneficial for the oxidation resistance of DS coatings in air at 950 °C. Promoting of alumina formation during oxidation and the corresponding decline in Fe_2O_3 content in the oxide scale