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Structure and Properties of Detonation Gun Sprayed Coatings from the Synthesized FeAlSi/Al₂O₃ Powder

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Abstract

Structure and properties of detonation gun sprayed (DS) coatings from the synthesized FeAlSi/Al₂O₃ powder have been investigated. The powder was manufactured through a mechanically assisted self-propagating high-temperature synthesis route. A small addition of nanosized SiO₂ particles to the reaction mixture for the synthesis of FeAl-FeAl₂ eutectoid refines the thickness of B2-FeAl lamellar grains in the synthesized powder. Silicon arisen from the aluminothermic reduction of SiO₂ 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 FeAl₂O₄, FeAl₂, A2-Fe-based solid-solution, Al₂O₃, and probably complex Fe_{2.95}Si_{0.05}O₄ 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/Al₂O₃ powder than that of the basic Fe-Al eutectoid composition. As-sprayed coatings from the synthesized FeAlSi/Al₂O₃ 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 Fe₂O₃ content in the oxide scale

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