

High-Temperature Oxidation of Al_xCoCrFeNi High-Entropy Alloy Bond Coats Deposited using High-Speed Laser Cladding for Thermal Barrier Coatings

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Abstract : High entropy alloys (HEAs) are being explored as prospective substitutes for high temperature structural components. These HEAs are typically fabricated using conventional techniques like arc melting, mechanical alloying etc., while these routes exhibit a wide range of limitations. The coating surface prepared by ultra-high-speed laser cladding was well formed with dense internal structure, low defects, high bonding strength with the matrix, excellent mechanical properties and corrosion resistance. Al_xCoCrFeNi (x=0, 0.3, 0.5, 0.7, 1) high-entropy alloys (HEAs) with good high-temperature oxidation resistance were deposited as bond coats by high-speed laser cladding for thermal barrier coatings. The microstructure of the Al_xCoCrFeNi bond coats exhibited the columnar-to-equiaxed grain transition with increasing Al content. In the subsequent isothermal oxidation process, the diffusion between the bonding layer and the substrate was controlled at a low level, and the new Al_xCoCrFeNi bond coat exhibited excellent oxidation and diffusion resistance. All bond coats generated a uniform and dense aluminum oxide layer and exhibited a low thermally grown oxide (TGO) growth rate after 100 h of oxidation at 1100°C. FCC and FCC + BCC structures formed for Al_{0.3}CoCrFeNi and Al_{0.7}CoCrFeNi alloys with corresponding hardness of 180HV and 380HV. During oxidation, the mass gain for HEA Al_{0.3}CoCrFeNi was greater than for Al_{0.7}CoCrFeNi. Each oxidized HEAs formed an external Cr₂O₃ scale with Al₂O₃ subscale formed beneath. While, the thickness and continuity of oxide layers varied according to Al content. Al enhanced the oxidation resistance of the Al_xCoCrFeNi HEAs.

Keywords: high-entropy alloy; high-speed laser cladding; oxidation behavior

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