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Effect of Aluminium Content on Oxidation Behavior of Arc Melted $Al_xCoCrFeNi$ (x=0, 0.3, 0.6, 1 mole) High Entropy Alloys

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ABSTRACT

One of the most anticipated properties of high entropy alloys (HEA) is excellent oxidation resistance. $Al_xCoCrFeNi$ (x=0,0.3,0.6,1 mole) HEAs were synthesized by arc melting route, followed by 4 remelting operations to ensure compositional homogenization. Alloys with x = 0 and 0.3 show single phase FCC structure and x = 1 have intricate BCC+B2 structure, whereas x = 0.6 have dual phases – FCC and BCC. Subjected to oxidation in air at 1000 °C and 1150 °C for 24 hours, CoCrFeNi (x = 0) developed a continuous Cr_2O_3 layer, while for $Al_{0.3}CoCrFeNi$, a Cr_2O_3 surface layer and internal Al_2O_3 was observed. Under the same test conditions, AlCoCrFeNi exhibited a continuous protective Al_2O_3 surface layer. $Al_{0.6}CoCrFeNi$ having dual phase structure develops Cr_2O_3 surface and internal Al_2O_3 over FCC dendritic regions and single Al_2O_3 surface oxide layer over the BCC interdendritic region. Oxidation resistance increases with increase in Al content. AlCoCrFeNi shows the best oxidation resistance, with a 5 micron thick, adherent, continuous and protective Al_2O_3 surface layer even at $0.89T_m$(1150°C) when exposed for 24h. The oxidation resistance of $Al_{0.6}CoCrFeNi$ and AlCoCrFeNi synthesized by arc melting is far superior to that of Inconel 718 and Inconel 600 superalloys, in terms of oxide layer thickness, adherence, stability and protective behavior. This is due to their higher Al content, which remains dissolved in the alloy phases, owing to configurational entropy stabilization.

Keywords: High entropy alloys; oxidation resistance; arc melting; configurational entropy stabilization.

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