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Effect of Molybdenum on Phases, Microstructure and Mechanical Properties of $Al_{0.5}CoCrFeMo_xNi$ High Entropy Alloys

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Abstract

Effect of molybdenum on phases, microstructure and mechanical properties of $Al_{0.5}CoCrFeMo_xNi$ (x=0-0.5 mol) high entropy alloys has been investigated in this paper. The microstructure, phase constituents and mechanical properties of the alloys have been studied using scanning electron microscopy, X-ray diffraction, transmission electron microscopy, compressive and hardness tests. The possible equilibrium phases existing in the alloys have also been evaluated using the Thermo-Calc program. The as-cast $Al_{0.5}CoCrFeMo_xNi$ alloys have typical dendrite microstructure. The alloys with x=0 and 0.1 consist of FCC and (Ni,Al)-rich ordered BCC phase, while the other four alloys are composed of FCC, (Ni,Al)-rich ordered BCC phase and (Cr,Mo)-rich σ phase. The thermodynamic calculation shows that Mo changes the phase formation order, mole fraction and composition of the equilibrium phases in the $Al_{0.5}CoCrFeMo_xNi$ alloys. The addition of Mo enhances formation of σ phase in the $Al_{0.5}CoCrFeMo_xNi$ alloys, improves the hardness and compressive strength of as-cast alloys, and reduces the ductility of the alloys. The $Al_{0.5}CoCrFeMo_{0.3}Ni$ and $Al_{0.5}CoCrFeMo_{0.4}Ni$ alloys have balanced properties of compressive strength and ductility. $Al_{0.5}CoCrFeMo_{0.3}Ni$ alloy has a $\sigma_{0.2}$ of 814 MPa, an ultimate strength of 2101 MPa, and a fracture strain of 31%, while $Al_{0.5}CoCrFeMo_{0.4}Ni$ alloy has a $\sigma_{0.2}$ of 1091 MPa, an ultimate strength of 2117 MPa, and a fracture strain of 18%.

Key words: high entropy alloy; microstructure; phases; mechanical properties; thermodynamic calculation.