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Title : MICROSTRUCTURAL EVALUATION AND CORROSION BEHAVIOUR OF Fe-Cr-Ni-Mn-Co AND Al0.5-Fe-Cr-Ni-Mn-Co HIGHENTROPY ALLOYS (HEA) WITH ELEMENTAL ADDITIONS

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Equiatomic or near-equiatomic multicomponent alloys, often termed as high-entropy alloys (HEAs), are an emerging class of metallic materials that are being investigated for a wide range of technical applications. Most studies have been focused on optimizing microstructures or mechanical properties of HEAs and relatively few have designed an alloy for investigating corrosion behavior of HEAs. This study describes the microstructural and corrosion behaviour together with mechanical properties of six HEAs that were designed with the intent to provide high corrosion resistance whilst offering the possibility for high temperature applications. The basic components of the alloys are composed of five elements that are commonly utilized in high temperature alloys, Fe, Cr, Ni, Mn and Co. A sixth element, Al, was also added. Another elements that had been selected as the alloying elements, particularly due to their remarkable properties were Zr, Ta and Sc. Detailed microstructural and chemical analysis have confirmed the presence of the expected BCC and FCC solid solution phases, however, the minority phases in all of the alloys were found to be ordered intermetallics. The hardness investigation demonstrated that the hardness values increased gradually for all alloys due to the formation of the intermetallic compounds. The FeCrNiMnCo alloy density reached up to 8.056 g/cm3 meanwhile the introduction of Al to the alloy apparently reduced the density to 7.533 g/cm3. The enhancement of Ta to the high-entropy alloys has improved the densification of the systems caused by the higher density of Ta atom amongst other constituent elements. FeCrNiMnCoTa0.6 alloy reached the highest density up to 9.455 g/cm3. The increase of Zr and Ta content has lowered the thermal stability of the systems whereas Sc alloying has showed vice versa. Electrochemical study revealed that all elemental additions significantly increased the corrosion resistance. The comprehensive atomic radius δ, the mixing enthalpy ΔH_{mix} and the mixing entropy ΔS_{mix} of alloys were also calculated according to relevant equations using the phase selection rules. Collectively, these results have confirmed that complex multicomponent HEAs can be designed and processed using the existing phase selection rules. These results also reiterated the need for refinement of the phase selection rules for HEA formation and improved thermodynamic databases to facilitate the design of better HEAs.