

WEAR PROPERTIES OF MULTI-PRINCIPAL ELEMENT ALLOYS

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ABSTRACT

Wear is a significant issue in various fields of engineering. An efficient remedy in some cases is the development of new materials by comprehending the factors affecting the wear protective mechanisms. Over the last twenty years, Multi principal element alloys (MPEAs) have attracted significant interest due to their promise as high-performance alloys for structural and mechanical engineering applications. Some MPEAs have demonstrated good ability to resist wear, such as AlCrFeCoNiTi0.5 [1], Al0.2Co1.5CrFeNi1.5Ti0.5Si_x [2] and TiZrV0.5Nb0.5Si_x [3]. The work reported here aims to investigate the wear properties of MPEAs and understand the factors that provide wear resistance in MPEAs.

Four series of AlFeCrCoMnNi, AlSiFeCrCoNi, AlSiFeCrNi and AlSiFeCoNi alloys were produced with high-purity (99.9 wt.%) Fe, Cr, Co, Mn and Ni elements and a eutectic Al-Si alloy. The samples were manufactured by arc melting, then homogenization heat treated in an argon-filled furnace at a temperature of 1055°C for a duration of 12 hours. Phases and crystal structures of the heat-treated samples were examined by XRD, and mechanical response by micro-Vickers hardness.

The wear properties of these MPEAs were investigated by a dry sliding ball-on-disk system (Bruker UMT triboLAB) at room temperature. The samples were subjected to a sliding test against an Al₂O₃ ball of 4 mm diameter. The sliding covered a total distance of 100 m with a sliding velocity of 0.1 m/s (reciprocation) for a duration of 1000 seconds. Additionally, a normal force of 1 N was applied. The wear tracks produced were examined by a stylus profilometer, and the profiles were used to calculate the wear rate of the MPEAs. The morphologies of worn surfaces and their chemical compositions were investigated by SEM and EDS, respectively.

Figure 1 displays the wear rate of some of these MPEAs. The AlFeCrCoMnNi sample demonstrates a lower wear rate compared to the alloys with a reduced aluminium content of 0.5 molar. Al and its content affected the microstructure, which influenced the hardness and wear resistance of the alloys. The

structure of AlFeCrCoMnNi was two phase (BCC and sigma phase) as shown in figure 2. These hard phases effectively prevented plastic deformation resulting from abrasion, leading to a reduction in the wear rate. When reducing the Al amount to 0.5 molar, the observed phases were the BCC and FCC phases, resulting in an increase in the wear loss of the samples through enhanced plasticity.

Consideration of the performance and characteristics of all of the alloys allows an appreciation of the influence of the microstructures on the properties, and indicates how alloys combining beneficial properties, such as increases wear and corrosion resistance, can be designed.

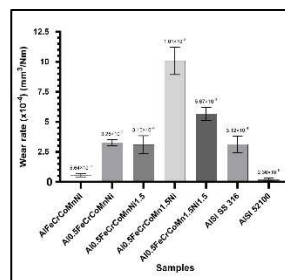


Figure 1 Wear rate of some different MPEAs

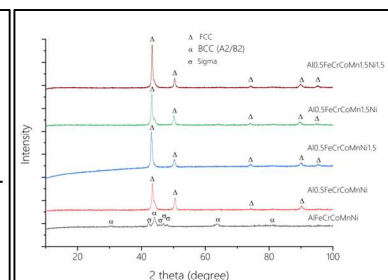


Figure 2 Pattern of X-ray diffraction obtained for the AlFeCrCoMnNi alloys

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