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Deformation mechanisms and sensitivity to grain size in CrCoNi medium entropy alloy during tensile deformation at room and cryogenic temperatures

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Abstract

High/Medium entropy alloys (HEAs/MEAs) have attracted increasing research interests due to their excellent mechanical properties at a wide range of temperatures, attributing to the activation of a rich variety of deformation mechanisms. One derivative of Cantor alloy, the CrCoNi MEA exhibits exceptional mechanical properties thanks to the activation of dislocation, stacking fault, twinning and transformation synergistically during deformation. However, knowledge of its grain-scale deformation mechanism is lacking, especially the time-dependent deformation at room temperature down to cryogenic temperatures. Grain size is known to be an intriguing factor that influences the deformation mechanism and thus the mechanical behaviors of alloys. This is because grain boundaries act as pinning points that impeded the dislocation slip according to the Hall-Petch relationship. Little attention has been paid to the effect of grain size on the activation of stacking faults and twinning. Moreover, the relationship between grain size and critical stress required to active stacking faults and twinning in HEAs/MEAs remains ambiguous. In this work, the deformation mechanism and grain size effect will be investigated using in-situ neutron diffraction and high-resolution digital image correction (HR-DIC) under tensile loadings. Slip

transfer and blocking across grain boundaries will be examined through the slip trace analysis to assess the slip transfer criteria. Twinning behavior will be investigated relating to microstructures with different grain sizes and deformation induced substructures. The in-situ neutron diffraction measurements will help to determine the specific stages at which each deformation mode emerges. Electron channeling contrast imaging (ECCI) and transmission electron microscope (TEM) will be used to characterize deformation substructures. The results will not only deepen our understanding of the competing deformation mechanisms of HEAs/MEAs but also enhance our capability to develop advanced metallic alloys.

Keywords:

Medium entropy alloy CrCoNi Deformation mechanism Grain size Neutron diffraction HR-DIC