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Thermal stability and high temperature deformation behavior of microstructurally graded nickel

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Nanocrystalline (NC) materials have gained significant importance in scientific research owing to their improved strength. However, there exists strength-ductility trade-off to occur for homogenous NC materials. Recently, NC materials with gradient microstructures have proven to be an effective way to address the limitations of homogeneous NC materials. A recent study corroborated that grain size gradient (GSG) Ni synthesized using direct current electrodeposition by varying current density had better structural homogeneity [1], but there exists limited literature on deformation behaviour of GSG at elevated temperatures. In the present study, free standing foils of NC nickel with GSG are synthesized using pulsed reverse current electrodeposition. The aim of the study is to examine the microstructural stability and also to evaluate the deformation behaviour of GSG Ni as a function of temperature. The microstructures of as-deposited and post-deformed GSG Ni samples were examined in-detail using electron microscopy. Nanoindentation measurements and tensile studies were conducted as a function of the deformation temperature in the range of 300 K-873 K. . The results indicate that the GSG Ni displayed improved thermal stability, higher overall hardness and unusual hot tensile behaviour as compared to the monolithic Ni foils. The observed deformation behaviour of GSG Ni is correlated with the evolved microstructures along with the activation energy and the strain rate sensitivity measurements.

Keywords: Nanocrystalline Ni; Gradient microstructure; Electrodeposition; Nanoindentation; High temperature deformation.

References:

[1] Haitao Ni et al., Fabrication and Characterization of Nanocrystalline Nickel with a Grain Size Gradient by Direct Current Electrodeposition, Int. J. Electrochem. Sci., 14 (2019) 8429 – 8438