Improvement in mechanical properties of ternary MEA by interrupted annealing and thermal cycling

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Medium Entropy Alloys (MEAs), being a subclass of Complex Concentrated Alloys (CCAs), have been fascinating researchers in the materials science community for the past few decades [1,2]. Many CCAs with FCC structure have demonstrated very high strength owing to their concentrated compositional profile and synchroneity of multiple strengthening mechanisms [3]. An equiatomic ternary MEA of Fe-Mn-Ni was pre-processed by 90% cold rolling, prior to recrystallization annealing at different temperatures above $0.5T_m \approx 773$ K. The microstructural evolution following these isochronal treatments was captured using electron microscopy and electron backscattered diffraction examinations. The multimodality in grain size distributions (GSD) of partially recovered and recrystallized microstructures *vis-à-vis* fully recrystallized microstructures was captured by the microstructure entropy parameter (MEP). Using MEP, the recrystallized microstructure was engineered by modulating the nucleation and growth kinetics, via repeated cycles of intermittent annealing treatments, called as thermal cycling. This processing technique using interrupted annealing and normalizing cycles results in overall decrease in grain size, by impeding the dynamic grain growth phase following recrystallization, which in turn manifests into higher grain boundary strengthening. Monte Carlo simulations coupled with cellular automata have been utilized to model and simulate the phenomena of nucleation and growth of nuclei in the deformed microstructure. A comparative analysis of isochronal recrystallization annealing treatments against corresponding thermally cycled treatments has been made by a thorough systematic microstructural characterization as well as investigation of the mechanical properties. The presented work will shed light on the effect of recrystallization kinetics on the plastic deformation and strain hardening behaviour in a low stacking fault energy CCA, and thereby establish microstructure-processing-property paradigm.

Keywords:

Complex Concentrated Alloys; Medium Entropy Alloy; Grain size distribution, Thermal cycling, Microstructure Entropy Parameter

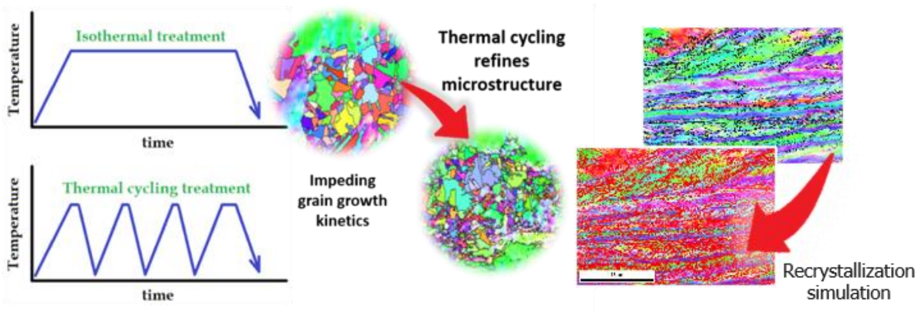

Fig.1 Grain boundary strengthening aspects from thermal cycling of FeMnNi MEA

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