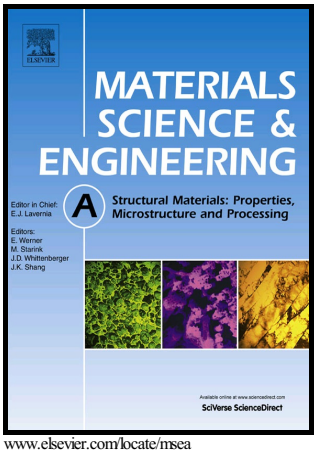

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Contrasting mechanical behavior in precipitation hardenable $Al_XCoCrFeNi$ high entropy alloy microstructures: single phase *FCC* vs. dual phase *FCC-BCC*

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Abstract:

$Al_xCoCrFeNi$ is a prominent high entropy alloy system with varying crystal structure from *FCC* to *BCC* depending on aluminum content. The mechanical behavior of $Al_{0.7}CoCrFeNi$ with dual phase *FCC+BCC* microstructure has been compared with that of single phase *FCC* $Al_{0.3}CoCrFeNi$. Both quasi-static and dynamic strain rate regimes were investigated. Hypo-eutectic $Al_{0.7}CoCrFeNi$ showed much higher strength due to fine lamellar microstructure with a large number of *FCC-BCC* interphase boundaries. But this also lead to lower strain rate sensitivity due to the long range nature of these interfaces, overcoming them is indifferent with temperature elevation to assist slip, thus making them athermal barriers. Both these precipitation hardenable alloys were aged to induce precipitation of ordered $L1_2$ in the *FCC* phase. This coherent nano-scale $L1_2$ precipitate caused a significant increase in the yield strength of both single phase and dual phase structures, while reducing the strain rate sensitivity (SRS) only slightly. $L1_2$ precipitation in *FCC* matrix greatly enhanced twinning during dynamic deformation. Large-scale deformation twins were observed in coarse $Al_{0.3}CoCrFeNi$ *FCC* and *FCC+L1*$_2$ microstructures. The scale of deformation twins were much smaller in the dual phase $Al_{0.7}CoCrFeNi$ whose refined lamellae width retarded twinning. The lamellar structures, nevertheless, had higher work hardening due to their higher dislocation density storage capability.

Keywords: strain rate sensitivity; work hardening; deformation twinning; dual phase vs. single phase high entropy alloy; $Al_XCoCrFeNi$; precipitation effect.

Introduction:

High-entropy alloys (HEAs) are a new paradigm-shift in metallic alloy development consisting multiple principal elements. Significant multi-element effects as compared with conventional alloys have been proposed and investigated in HEAs, including high entropy, sluggish diffusion, lattice distortion, and cocktail effects [1-4]. They offer extraordinary tunability in microstructural design [5-6] for enhanced strength, along with good ductility from simple crystal structures. $Al_xCoCrFeNi$ is prominent among several alloy systems identified on this alloy-design strategy. It changes from *FCC* to *BCC* structure with increasing aluminum content, x = 0 to 2, and displays a wide spectrum of mechanical behavior [7-9]. At intermediate aluminum levels ~ x =

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