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Nanoscale serration and creep characteristics of $Al_{0.5}CoCrCuFeNi$ high-entropy alloys

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Abstract

Nanoindentation tests were performed to investigate the nano-scale plastic deformation in the $Al_{0.5}CoCrCuFeNi$ high entropy alloys at room temperature (RT) and 200 ℃, respectively. Serrated plastic flow, manifested as discrete bursts of plasticity on the load-displacement curve, was observed for both temperatures during the loading period, and its behavior and dependence on the temperature was analyzed from both the experimental and theoretical perspectives. The application of a mean-field theory indicated that the displacement bursts exhibited a temperature-dependent power-law distribution, and the universal exponents, κ and λ, were computed to be 1.5 and 0.04, respectively. With the use of the computed universal exponents, a critical annealing temperature for the slip-avalanche size distribution was estimated to be 1,120 ℃. Creep occurred during the nanoindentation holding period and exhibited very large stress exponent, implying that the dislocation glide-climb is the dominant mechanism. The creep simulations with a two-layer viscoplastic model further revealed that the deformation at a higher temperature (e.g., 200 ℃) featured a greater and faster-growing plastic zone underneath the indenter, implying more pronounced dislocation activities.

Keyword: Serrated flow; Nanoindentation; Creep mechanism; Finite element modeling; Serration statistics

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