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M1Po2C-05: Serration Deformation Behavior of Stainless Steel and Medium Entropy Alloy at Ultra-Cryogenic Temperature

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This study investigated serration deformation (SD) behaviors of direct-energy-deposited (DED) and wrought CoCrNi medium entropy alloy as well as DED stainless steel 316L (SS316L) at ultra-cryogenic temperature of 15K. In-situ neutron diffraction was employed to examine tensile mechanical properties, localized microstructures and SD behaviors at 15K. Enhanced peierls stresses and severe dislocations pile-up at 15K resulted in an exceptional strength-ductility combination for both alloys. Higher initial dislocation density of DED alloys induced superior yield strength and delayed the onset of SD, as compared to wrought alloy. A stress drop occurring to the SD exhibited a significant increment after ultimate tensile strength (UTS), which finally led to an unexpected fracture. DED SS316L exhibited higher stress drop at the same stress level of strains than CoCrNi alloys, which is associated with martensitic transformation. The different {hkl} orientations exhibited a different behavior in terms of a magnitude in stress drop as well as subsequent linear stress-strain response after the SD. The current study reveals that the SD behavior is highly influenced by dislocation structure and microstructure features.

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