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Hydrogen-assisted Cracking Behavior of a Fine-grained Equiatomic CoCrFeNi High-entropy Alloy

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To design hydrogen-resistant alloys, the face-centered cubic (FCC) structure alloys must be obtained. In this regard, remarkable resistance to hydrogen embrittlement after hydrogen gas charging at 120 MPa has been reported in an equiatomic CoCrFeNi high-entropy alloy (HEA) [1, 2]. More specifically, a grain-refined equiatomic CoCrFeNi HEA shows over 800 MP with an elongation of 50% [2]. In this study, the hydrogen embrittlement resistance of the HEA was comparatively evaluated by tensile testing under electrochemical hydrogen charging and tensile testing after hydrogen gas charging at 120 MPa. Then, the associated cracks and microstructures were characterized by electron backscatter diffraction measurements. The tensile tests were conducted at ambient temperature with the initial strain rate of 10^{-4} s^{-1}.

The hydrogen-assisted intergranular, which was observed in coarse-grained HEAs, was suppressed by the grain refinement, irrespective of hydrogen charging condition. More specifically, the crack growth resistance was significantly improved by the grain refinement. Most of subcracks, which were observed in hydrogen-charged fractured specimens, showed blunting of their tips. This indicates that the HEA has significant plasticity even after the elongation enabling crack initiation. Therefore, the plasticity-induced crack blunting behavior is key to understanding the superior resistance to hydrogen embrittlement. In this context, the grain refinement plays two roles. First, the crack initiation size was decreased, which can stop the crack propagation with a small degree of crack tip blunting. Second, the crack tip can early meet grains that are resistant to hydrogen-assisted crack propagation, because the grain boundary character often changes with crack length. Further details will be discussed in the presentation.

References:

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