INVESTIGATION OF GRAIN-BOUNDARY EFFECT ON HYDROGEN BEHAVIORS IN SINGLE- AND POLY-CRYSTALLINE MEDIUM-ENTROPY CRCONI ALLOY

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In order to achieve ‘carbon neutrality’, the utilization of hydrogen energy is attracting attention. Structural materials with superior hydrogen embrittlement (HE) resistance to ensure stability for the production, storage, and transportation of hydrogen are required to use highly efficient hydrogen energy. CrCoNi alloy, a representative medium-entropy alloy, has excellent HE resistance with face-centered cubic (FCC) single-phase solid-solution as well as high strength and ductility. HE resistance of CrCoNi alloy is determined by competition between hydrogen diffusion and trapping in lattice and grain boundaries. However, earlier works primarily focused on the effect of grain boundaries on hydrogen behavior by controlling the grain size of polycrystalline alloys. The purpose of this research is to analyze the interaction between hydrogen and grain boundaries compared with single crystal and polycrystalline CrCoNi alloys. Two polycrystalline CrCoNi alloys with average grain size of 3 μm and 70 μm, respectively, and two single crystal CrCoNi alloys with orientation of {100} and {110} respectively were fabricated. The HE resistance of each alloy was investigated by the electrochemical cathodic charging under 0.1M H_2SO_4 solution at a current density of 5 mA/cm^2. Subsequently, slow strain rate test (SSRT), thermal desorption analysis (TDA), and electrochemical permeation (EP) test were performed to investigate hydrogen behaviors such as penetration depth, hydrogen content and diffusivity. Furthermore, we discussed hydrogen trapping sites and binding energy for the purpose of understanding the competitive effects between hydrogen trapping and diffusion behaviors depending on the existence and fraction of grain boundaries during hydrogen migration.