EFFECTS OF C AND AL ON HYDROGEN EMBRITTLEMENT MECHANISM IN MEDIUM MN-NI STEELS

Min Young Sung, Department of Materials Science and Engineering, Korea University, Republic of korea
sminho02@korea.ac.kr
Sang Yoon Song, Department of Materials Science and Engineering, Korea University,Republic of korea
Young-Kyun Kim, Department of Special Alloys, Korea Institute of Materials Science, Republic of Korea
Young-Sang Na, Department of Special Alloys, Korea Institute of Materials Science, Republic of Korea
Seok Su Sohn, Department of Materials Science and Engineering, Korea University, Republic of korea

Key Words: medium Mn-Ni steel, Hydrogen embrittlement, TRIP

As the world declares carbon net zero by 2050, the importance of hydrogen energy among eco-friendly energies has increased, and hydrogen storage and transportation technologies are necessary for the efficient use of hydrogen energy. Although metallic materials for this purpose have been widely used, many studies have shown that hydrogen embrittlement (HE) critically deteriorates the mechanical properties and promotes premature fracture. Therefore, austenitic stainless steels or high-Mn steels have been extensively studied to improve hydrogen embrittlement resistance. However, due to high Ni cost and other technical issues (e.g., hot-dip galvanizing, welding, etc.) from the high Mn content in conventional alloys, it is necessary to study hydrogen embrittlement in medium-Mn and medium-Ni steels which could overcome the limitation of conventional alloys. In particular, effects of Al and C in medium-Mn and medium-Ni steels on hydrogen embrittlement, which stabilizes the FCC phase while forms other phases such as κ-carbide or ferrite in the Fe-Mn-Ni-C-Al alloy system, have rarely been reported. In this study, four model alloys are designed to reveal the effects of C and Al contents on hydrogen embrittlement in medium Mn and medium Ni steel. Four alloys are all composed of a single face-centered cubic (FCC) γ-austenite phase due to medium-Ni as a FCC stabilizer. HE susceptibility is evaluated by slow strain rate tests (SSRTs) for the H pre-charged specimen via electrochemical cathodic methods under NaCl solution for 24 h at 90°C. The resistance of HE is quantified by hydrogen-embrittlement index (HEI). As a result, the alloys with low C content have different hydrogen embrittlement resistance depending on the Al content compared to the alloys with high carbon content. In the low-C alloys, the HE resistance decreases with increasing Al content. By contrast, the HE resistance of the high-C alloys increases with increasing Al content. As the Al content increases, the depth of the embrittlement region in the low-C alloys increases, while the depth in the high-C alloys decreases, similar to the HEI trend. These four alloys showing different HE susceptibility are subjected to detailed analysis of hydrogen diffusion, trap behavior, hydrogen-affected brittle zone, and hydrogen-induced cracking.