Title:

Hydrogen induced ductility-loss accompanied with intergranular fracture in pure Ni and Cu–Ni binary alloy

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Abstract:

It has been desired to enlarge the selection of hydrogen-compatible materials to increase a safety, reliability and cost efficiency of hydrogen-related equipment. To achieve this, hydrogen embrittlement (HE) behavior and its mechanism is needed to be extensively studied. Of various metallic materials, we target Cu–Ni binary alloy system including pure Ni and Cu, where Cu is negligibly embrittled and Ni is severely embrittled by hydrogen. Although most previous studies drew a common conclusion, i.e. pure Ni and Cu–Ni alloys are embrittled via hydrogen-induced intergranular (IG) cracking, underlying mechanism has not yet been revealed completely. Therefore, the present study aims to reveal the mechanism to cause the hydrogen-induced IG fracture via slow strain rate tensile (SSRT) test as well as detailed analyses of fracture surface, fracture path and hydrogen trapping.

As a result, it was revealed that hydrogen-induced IG cracking was suppressed at cryogenic temperature (77 K) in Cu–55 Ni alloy, whereas it was promoted even at 77 K in pure Ni. In addition, hydrogen atoms were trapped at grain boundaries (GBs) in pure Ni, while they were not in Cu–Ni alloy. These findings indicate that key mechanism to cause hydrogen-induced IG cracking is different even though HE is commonly caused through IG cracking in these metals. Namely, although hydrogen initially trapped at GBs can solely trigger IG cracking in pure Ni, trapped hydrogen is not enough to trigger it in Cu–Ni alloy. In such a case, additional hydrogen supply such as hydrogen transport along moving dislocation might be necessary to cause IG fracture. In the presentation, detailed discussion of hydrogen trapping and transport as well as further study on the effect of Ni fraction on HE behavior will take place.