Hydrogen occupation, diffusion, and trapping in high entropy alloy

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Abstract

Hydrogen embrittlement is a serious issue in metal, especially when a metal displays high strength. The mechanism of hydrogen embrittlement was proposed about 100 years ago and used for a very long time. It is believed hydrogen molecules will decompose into hydrogen atoms and diffuse into a metal, the interaction between hydrogen atoms (H^+) and stress field will speed up the fracture of a metal. The theory of hydrogen embrittlement is completed, while, the experimental evidence of hydrogen molecules or atoms is rare actually. Maybe it is because of the deficiency of analytical tools to detect hydrogen. In this study, we would like to explore the diffusion path and the type of hydrogen in a high entropic alloy. Due to the high spatial resolution of synchrotron x-ray diffraction, the hydrogen diffusion path can be deduced as hydrogen shoving the structure. The variation in the lattice strain clearly indicates hydrogen diffusion into the alloy will cause the expansion of highly-asymmetric plane FCC (111). That means hydrogen diffusion into the alloy along FCC (111) plane. To distinguish the type of hydrogen, we use inelastic neutron scattering technique to prove the vibration mode of hydrogen. Inelastic neutron scattering spectra clearly indicate the existence of hydrogen molecules in a high entropy alloy. The result is opposite to the mechanism used for more than 100 years, the mechanism based on the existence of hydrogen atoms in metals. That means the mechanism of hydrogen embrittlement should be modified, the method to prevent hydrogen embrittlement should also be re-organized.

Keywords– hydrogen embrittlement, spatial resolution, synchrotron x-ray, inelastic neutron scattering, high-entropy alloy