Study on Exceptional Hydrogen Storage in High Entropy Alloys

Heo, Jihye (School: Seoul International School)

As one of the major clean energy sources in the future, demand for hydrogen energy is rapidly increasing due to its various advantages. However, the hydrogen storage density per unit volume is too low in its gaseous state, making commercialization difficult due to economic and stability issues. In particular, considering the high risk of explosion, a safe method of storing hydrogen is the most imperative aspect in order to expand utilization of hydrogen energy. This research produced a High Entropy Alloy (HEA), an alloy consisting of more than 5 elements mixed in relatively equal ratios, to alleviate these issues. The severe lattice distortion that occurs in HEAs provides significant interstitial voids for hydrogen occupancy. Cost-effective and common metals Aluminum (Al), Nickel (Ni), Iron (Fe), Titanium (Ti), Cobalt (Co), and Molybdenum (Mo) were used and the fabrication procedure involved High energy ball milling and spark plasma sintering to produce a HEA cylindrical pellet. XRD analysis confirmed the HEA was successfully formed with the desired phase, and the microstructure was also analyzed through SEM analysis. In addition, the TG-DTA analysis further showed that hydrogen was effectively absorbed in the lattice's interstitial sites. This study confirmed that a cost-effective and efficient hydrogen storage of the HEA is possible by applying mechanical alloying using a novel combination of metal elements that excludes rare earth metals. Furthermore, this study can be seen as an invaluable stepping stone for the commercialization of hydrogen energy by eliminating many of the obstacles that stand against it today.

Awards Won: