J Astrophys Aerospace Technol 2017, 5:2 (Suppl)
DOI: 10.4172/2329-6542-C1-009

Atomic characterization of hydrogen within microstructure by atom probe tomography

Yi-Sheng Chen
University of Oxford, UK

Hydrogen embrittlement, where metals' ductility is significantly reduced with the presence of hydrogen, is one of the main causes of industrial material failure such as PWR in nuclear application. In addition to hydrogen's ubiquity, what makes the hydrogen-embrittlement mitigation being challenging is primarily the high mobility of hydrogen within microstructure. Hydrogen solute can near-freely diffuse within metal, aggregate at susceptible regions, and then weaken the local structure. One of conceptual approach against the diffusion of detrimental hydrogen is the introduction of microstructural traps, particularly nano-scaled carbide in steel. However, the concept requires experimental evidence to validate, and this demands solid techniques to characterize the hydrogen within engineered microstructure. Since 2010, atom probe tomography (APT) has been emerging in the field of hydrogen characterization. With the use of isotopic hydrogen as a substitute of background hydrogen in vacuum, APT is able to unambiguously analyze the microstructural hydrogen in an unsurpassable spatial resolution. Another work demonstrates the incorporation of electrolytic hydrogen charging is able to minimize the experimental requirement of hydrogen detection in APT. On the top of these, our work additionally utilizes a cryogenic sample-transfer chain to largely retain the diffusive hydrogen and present a unprecedented signal of microstructural hydrogen which enables a quantitative analysis giving a clear message for the optimization of microstructural design. Herein, we are going to present the evolution and state-of-the-art of APT technique in hydrogen characterization. In addition to a thorough overview, some practical aspects of the technique will also be given for interest.

yi-sheng.chen@materials.ox.ac.uk