International Journal of Hydrogen Energy

Volume 41, Issue 21, 8 June 2016, Pages 9100–9107

Hydrogen behavior in Al— Cr alloys: Synchrotron-based photoelectron microscopy of the rapidly solidified structure

Iya I. Tashlykova-Bushkevich[a], Matteo Amati[b], Belén Alemán[c], Hikmet Sezen[b], Luca Gregoratti[b], Maya Kiskinova[b]

[a] Belarusian State University of Informatics and Radioelectronics, Minsk 220013, Belarus

[b] Elettra – Sincrotrone Trieste SCpA, SS14-km 163.5 in Area Science Park, Basovizza 34012, Trieste, Italy

[c] IMDEA Materials Institute, c/Eric Kandel 2, Getafe, 28960 Madrid, Spain

Received 25 December 2015, Revised 28 March 2016, Accepted 29 March 2016, Available online 18 April 2016

Highlights

- High-purity Al and Al—Cr alloy were rapidly solidified.
- TDA and SPEM provide complementary information on hydrogen desorption behavior.
- Aluminum oxide inclusions are regarded to be irreversible hydrogen traps.
- Cr-rich and Cr-depleted surface regions exhibit Cr segregation beneath foil surface.
- The effect of reversible and irreversible traps on hydrogen desorption is discussed.

http://dx.doi.org/10.1016/j.ijhydene.2016.03.193

Abstract

This work reports recent advances in characterization of the composition at submicron length scales of Al-based rapidly solidified alloys, which are correlated to their interactions with hydrogen. The hydrogen desorption kinetics and the evolution of the surface and subsurface structure and chemical state of high-purity Al and Al-3.0 at.% Cr alloy have been studied by thermal desorption analysis and scanning photoelectron microscopy. The alloy foil structure consisted of Cr-rich and Cr-depleted surface regions exhibits Cr segregation beneath the surface. The obtained results reveal how inclusions of aluminum oxide species can become very strong hydrogen traps at the highest temperatures of 600–630 °C, representing irreversible trapping in Al and its alloy. The effect of strong reversible and irreversible hydrogen traps on hydrogen desorption from aluminum alloys is discussed, suggesting that their direct identification in the microstructure provides further insights into hydrogen embrittlement mechanisms for aluminum materials in energy technologies.