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Programme and Abstracts
Th-A3, 10:00

Oscillating behavior of physical and mechanical properties of alloys at hydrogenation

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This work provides an overview of experimental results revealing unique phenomenon — as stochastic changes of local composition and transition metal elements ordering within the alloys. A necessary and sufficient condition for the manifestation of this phenomenon is the presence of hydrogen in the structure of the materials. Interestingly the stochastic changes are observed at room temperature after a rather long rest time from the initial insertion of hydrogen. Changing positions and environments of the metal elements yield changing the phase compositions. As a result, specific properties e.g. the mechanical ones, are pointed out. Reproducibility the same effect in a given alloy as well as its occurrence in various states of the matter e.g. in amorphous and crystallized alloys leads question the fundamental basis of the phenomenon.

The present analysis aims underline the difference between the stochastic oscillating behavior and the well-known “hydrogen inducted atomic rearrangements” (HIA) that could go along hydrogenation of alloys. The steady occurrence of the phenomenon was investigated using various experimental techniques such as XRD, UPS, AES.

In terms of applications, the phenomenon can lead to critical changes e.g. in the structure of low-temperature electrodes used to deliver high purity hydrogen made of platinum group as well as of type alloys.

Th-A4, 10:15

Transition metal induced bcc phase magnesium as issue for fast hydrogen sorption kinetics and low stability of MgH₂

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Among many metals and alloys reacting with hydrogen magnesium, due to its high hydrogen storage capacity and low cost, appears as one of the most promising metal for practical hydrogen storage systems. However, rather high MgH₂ enthalpy of hydrogen desorption, slow hydrogen absorption and desorption kinetics, and noticeable reactivity toward oxygen essentially limit its applications. Numerous studies have established that hydrogen sorption kinetics of magnesium can be improved by different processes, e.g. by ball-milling magnesium or magnesium hydride with small amount of transition metals (TM) or their oxides and fluorides. However, up to now the impact of TM additives on hydrogen sorption kinetics of magnesium is not completely understood. Experimental studies of Mg/Nb thin films and micro-sized particles revealed that Nb act not as a true catalyst but as a gateway for hydrogen transportation¹. As it was shown first theoretically² and then confirmed experimentally³ Nb interfacings Mg layers can stabilize the bcc structure of magnesium. Recent studies have revealed that upon hydrogenation hcp Mg-Ti thin films, a cubic fluorite Mg₁₋ₓTiₓHₓ phase promotes favorable hydrogen sorption kinetics⁴. Furthermore, Mg-Ti nanoparticles of 10-20 nm size demonstrate essentially lower hydride formation enthalpy⁵.

Here we review on the most recent studies of Mg-TM systems for hydrogen storage focusing on the role of TM additives in formation of bcc Mg and fluorite MgH₂ structures. In our opinion this acts as a driving force significantly improving the hydrogen sorption kinetics and modify the thermodynamics stability of MgH₂.