Structure and thermodynamics of Mg-Ti-H films deposited by microwave plasma-assisted co-sputtering

Daniel Fruchart
Neel Institute – CNRS, France

Introduction: Hydrogen storage ennobles renewable and intermittent energy objectives thanks to electrolysis from wind-mill and PV. MgH_2 is performing since Mg abundance, low cost, 7.6 w% H-storage capacities. However, sorption kinetics remain slow, unless adding specific additives in dedicated nanostructures. Early transition metals, not forming stable compounds with Mg can act as efficient catalyst. Thin films deposited by co-sputtering Mg and Ti were hydrogenated/dehydrogenated revealing original nanostructures, mechanisms of reaction, but some metastability of h-Mg-Ti alloy.

Methods: We operate direct combinations of Mg, Ti and H in a single-step process, using the microwave reactive plasma-assisted co-sputtering technique. Mg-Ti-H films with Ti contents $0 \leq$ at. %Ti < 20 were investigated by XRD, SEM, TEM-EDX for morphology, crystal structure, composition and distribution of elements. Ti-poor films (at. %Ti≤0.45) exhibit the β–MgH2 phase mainly, with a dense microstructure and discontinuous columnar grains. Films with intermediate Ti-contents (2.7≤at. %Ti≤6.6) exhibit β–MgH_2, metastable γ–MgH_2 and h-Mg-Ti phases in different proportions, with well-developed columnar grains. Films with Ti-contents >10 at. % form fine grain amorphous/Nano-crystalline structures.

Results: Ti content reveals critical in tuning the functional properties of magnesium hydride. The structure and morphology of different films were investigated after dehydrogenation comparison made with initial hydrogenated states using XRD and SEM. The thermal stability was studied by TGA and DTA coupled with mass spectrometry.

Conclusion: In comparison with monohydrides MgH_2- and TiH_2-films, lowest desorption temperatures of Mg-Ti-H films were observed for ~4.8 at. %Ti. The as-deposited h-Mg-Ti phase appears stable upon hydrogenation/dehydrogenation delivering comprehensive approaches on easier Mg $\leftrightarrow MgH_2$ reactions.

Biography

Daniel Fruchart has completed his MSc in mathematics at Lille University and; completed hab.D physics from Joseph Fourier University, Grenoble. He has worked as the Director 1 at CNRS from the year 1995-2009 and he took the responsibility of research group at Institute Neel (1982-2009) for 8-12 Staffs, 2 post docs, 10 PhD students, 1 Engineer. He is the founder and Research manager to MCMF department at Neel Institute since 2008 to 2013. He has published more than 820 reviewed papers and has 16 book contributions with H factor 42, RS citations more than 8800.His interests include magnetic materials, metal-hydrides, synthesis/metallurgy, thin films, neutron scattering, x-ray spectroscopy and group theory.

daniel.fruchart@neel.cnrs.fr

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