

TUESDAY, AUGUST 23, 2005, A.M.

SESSION 12B: INTERNATIONAL SYMPOSIUM ON FUEL CELL AND HYDROGEN TECHNOLOGIES

HYDROGEN STORAGE

Sponsor(s): Materials Science and Engineering Section, The Metallurgical Society of CIM

Room: Imperial Ballroom 7

Chairmen: B.R. DAVIS, Kingston Process Metallurgy Inc., Canada and
G. XU, McMaster University, Canada

PAPER 12B.1 — 10:20

CHEMICAL HYDROGEN STORAGE FOR AUTOMOTIVE APPLICATIONS.

B.R. DAVIS, Kingston Process Metallurgy Inc., Canada

There are a number of hydrogen storage systems proposed for automotive applications. However, all of the current suggestions fall short of the DOE targets for storage density and volumetric density. The DOE has suggested that only through radically new ideas will a practical solution to hydrogen storage for automotive applications be realized. This paper provides some background in chemical hydrogen storage and reports on advances in a number of areas in hydrogen storage that are being undertaken at the Fuel Cell Research Centre at Queen's University.

PAPER 12B.2 — 10:40

XRD STUDY OF STRESS STATE IN NANO-ALUMINUM AND METAL-HYDROGEN SYSTEMS PRODUCED BY HIGH-ENERGY MILLING OF POWDERS.

G. ROY, Z. WRONSKI, J. NEIMA, CANMET, Natural Resources Canada, Canada and
R. A. VARIN, University of Waterloo, Canada

Interest in metal-hydrogen systems can be manifold. Small amounts of hydrogen absorbed by elemental metals and alloys usually result in strong changes in the physical and mechanical properties of engineering materials. Overwhelmingly, these changes, viz. hydrogen embrittlement, are considered deleterious with respect to structural performance of engineering materials. However, the changes, often studied by metallurgists and metal physicists, can present new possibilities and applications. A prominent example is the recent interest in safe, solid-state hydrogen storage in metallic lattices. A study has been initiated to investigate the effect of elasto-plastic deformation on hydrogen sorption in light metals and hydrides. It is anticipated that high-rate impacting and subsequent grain refinement in the mill will have an effect on hydrogen storage capacity in lightweight magnesium and aluminum alloys. First examination of the state-of-stress by X-ray diffraction in high-rate milled, nanostructured pure aluminum, aluminum milled with a solid surfactant, and aluminum or magnesium alloy milled with hydride will be presented.

PAPER 12B.3 — 11:00

SYNTHESIS AND HYDROGEN STORING PROPERTIES OF NANOSTRUCTURED MG-BASED COMPOUNDS.

X. LI, H. SHAO, Y. WANG and Y. LI, Peking University, China

In order to avoid impurity problem and enhance absorption/desorption kinetics of Mg-based compounds, nanostructured Mg-based compounds were synthesized from Mg, Ni and other elemental ultrafine particles produced by hydrogen plasma-metal reaction. XRD and TEM results demonstrate that homogeneous nanostructured Mg-based compounds with less impurity were successfully synthesized by this method. DSC in hydrogen atmosphere, pressure-composition isotherm and the kinetics of hydrogen adsorption/desorption were investigated at different temperatures. The results show that the nanostructured Mg-based compounds can absorb hydrogen in a high speed at a low temperature without any activation. The detailed results and mechanism will be reported and discussed.

PAPER 12B.4 — 11:20

MAGNESIUM DERIVED FOAMS FOR HYDROGEN STORAGE.

J.O.G. POSADA and P.J. HALL, University of Strathclyde, United Kingdom

Magnesium derived foams were prepared by using the so-called baking of powder blended precursor material method. This method comprises mixing magnesium powder with a small fraction of blowing agent (ZrH_2 , Cs_2CO_3 and CaH_2) and Ni like catalyst, compacting this mix and creating a foam by heat treatment above the magnesium melting temperature. The resulting samples were characterised by microscopy, gas adsorption (BET method) and by small angle neutron scattering. Several mathematical models were used in order to determine particle size distribution, fractal dimension and total pore volume fractions.

PAPER 12B.5 — 11:40

STUDIES OF PROTON EXCHANGE MEMBRANE FUEL CELLS AND HYDROGEN STORAGE MATERIALS.

G. XU, McMaster University, Canada

We report the studies of Proton-Exchange Membrane Fuel Cells (PEM FC) and hydrogen storage materials at McMaster University for the last 14 years. In addition to the discovery of suppressed ionic conduction in Electrode-Membrane Assembly (EMA) and novel hydrocarbon PEMs based on micro-emulsion, the first evidence of hydrogen adsorption saturation by carbon nanotubes is emphasized, which has been the bottleneck for the application of PEM FC. Prior to our study, a number of controversial publications have claimed the hydrogen capacity of these materials to be between 0.1 to 10.0 wt.%, and none demonstrated a plateau of adsorption with pressure that is consistent with monolayer saturation. Others suggested that the tube bundle structure is opened under high pressure to enable higher adsorption on newly uncovered surfaces, but received no confirmation. Using our home made high-pressure instrument with in-situ electrical probes, we found that a plateau is nearly achieved at about 300 atm in the room temperature isotherm, and that nanotube bundles actually compress with pressure instead of splitting, using in-situ electrical measurements.