INVESTIGATIONS OF THE INFLUENCE OF DIFFERENT ADDITIVES TO THE LANTHANUM RICH MISCHMETAL

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Introduction

Researches related to new energy sources, energy storage, transport, usage – has to be as cheep and easy as possible - these are requirements for successful economics. In order for hydrogen to become fully integrated in the society, the production of hydrogen must become feasible in competition with the fossil fuels that dominate the energy economy today.

Currently hydrogen can be produced by electrolysis, by various chemical processes involving fossil fuels and natural gas, and by biological processes of plants and animals. There are basically five main methods for hydrogen storage that have attracted the common interest: compression, liquefaction, physisorption, metal hydrides, and complex hydrides. In metal hydrides, hydrogen can be stored indefinitely and released whenever needed. The AB_5 type material is the material of choice in many cases and generally has a storage capacity of about 1.5 wt% at room temperature [1]. To increase the hydrogen storage capacity one can find new materials or modify the existing materials. This paper reports electrochemical and gravimetrical studies of kinetics and thermodynamics of hydrogen evolution on Lanthanum mischmetal (LaMm) with different additives.

Results and discussion

Thermogravimetric determinations of the sorption characteristics of the La mischmetal in comparison to the same metalhydride with different additives were carried out in hydrogen. It was performed in the Risø National Laboratory, Denmark. Samples have been prepared from AB_5 mixing with tungsten oxide, SiO_2, B_2O_3 or carbon. The assumption is that according to the spill-over effect of hydrogen on the oxide surface the uniform forming of the hydrogen bronze (H_xWO_3) will take place. WO_3 is changing colour at the presence of hydrogen atoms from yellow to dark blue and that could be useful indicator that system is absorbing the gas. In the case of the glass phase (SiO_2, B_2O_3) the spill-over effect on the glass surface will increase the efficiency of the metal hydride forming. In the Figure 1 absolute changes of weight per sample are shown as a function of hydrogen loading time. In the case of glass additives slow kinetic was observed during the first 10-15 minutes of exposure to hydrogen. Samples containing B_2O_3 glass and SiO_2 glass absorbed less hydrogen as compared to the LaMm. In the case of carbon and WO_3 additives, an improved performance was observed after 10 minutes long exposure. Linear increase of the amount of absorbed hydrogen is observed.

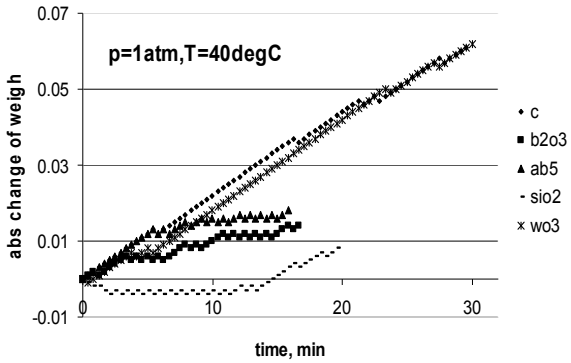

Figure 1: Abs changes of weight vs time.

Electrochemical Impedance Spectroscopy (EIS) and cyclic voltammetry was used for electrochemical measurements. The impedance and electrochemical parameters were measured using AutoLab PGSTAT 30 (Ecochemie) in the South African Institute of Advanced Material Chemistry of University of Western Cape, South Africa. Different binders were investigated in order to prevent the pulverization of the AB_5 within hydrogenation process. PVA (poly-vinyl-alcohol) and PTFE (poly-tetra-fluoro-ethylene) have been chosen, because they are widely used as binders for metal hydrides. Zeolites are low price and high stability additives and zeolite CVB-400 was

selected for our research purposes. It was assumed, that zeolites might be suitable both for hydrogen absorption and as a binder. In Figures 2-4, the electrochemical impedance data are shown as a function of applied potential (1 = -0.35V, 2 = -0.50V and 3 = -0.75V). The diameter of the large semicircle depends on applied potential and was associated with the charge transfer resistance. Equivalent circuit method was used in order to calculate the charge transfer resistances according to [2].

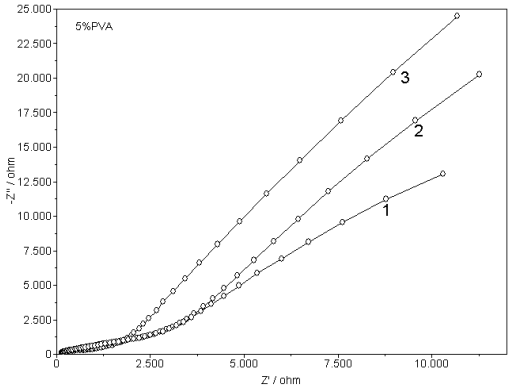

Figure 2: EIS of LaMm + 5% PVA

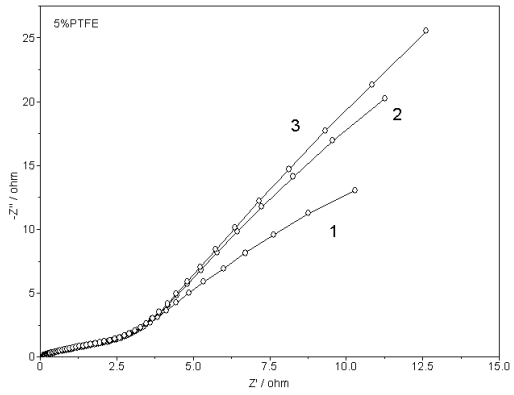

Figure 3: EIS of LaMm + 5% PTFE

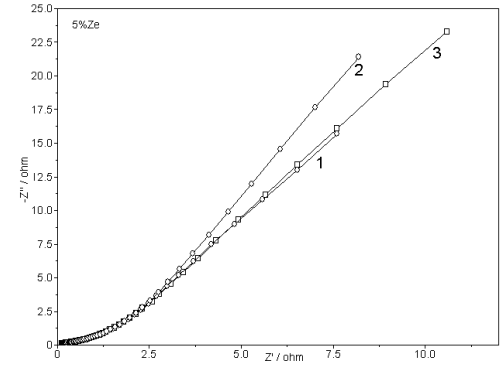

Figure 4: EIS of LaMm + 5% Zeolite

Conclusions

Thermogravimetric studies of LaMm powder with different additives at the temperature 40 ^{0}C and atmospheric pressure shows low impact of the glass phase on the absorption kinetics and an absorbed amount of hydrogen (Fig.1). WO_3 and carbon are the most promising additives so far. The impact of WO_3 can be explained in terms of spill-over effect and forming of bronze.

All applied binders provided pellets with sufficient mechanical stability and similar values of the charge transfer resistance (as calculated from EIS and cyclic voltammetry).

For future work it is planned to study charge/discharge characteristics and the influence of different binders on hydrogen sorption properties.

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References

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