

KINETICS OF THE THIN YTTRIUM FILM HYDROGENATION IN THE 1M NaOH SOLUTION WITH AND WITHOUT PROTECTION of the yttrium BY THE OVERLAYED PALLADIUM FILM, E.Matveeva, V.Parkhutik, Technical University of Valencia, Materials Dept., Cami de Vera s/n, 46071 Valencia, SPAIN, email: eumat@mcm.upv.es

Objectives: Recent discovery of the optical switching in Yttrium and other rare earth metal/alloy hydrides is in focus of the numerous studies that could be of interest for developing of optical switchable electrochemical devices [1-3]. Reactivity of the active Y layer toward water based electrolytes is a big obstacle because of active material dissolution and transformation to oxide [4]. A protective cap Pd layer was proposed and employed to overcome this uncontrollable and irreversible Yttrium oxidation. In our previous works we have demonstrated that Pd layer is not stable under the cyclic hydrogenation/ dehydrogenation treatment and with time and cycling this layer is peeled off the thin Y film [5, 6]. Surprisingly, the hydrogenated Y active layer after a Pd protection detachment is not deteriorated, nor lost its optical switching behaviour. Analysis of the electrochemical behaviour of the Y thin film covered or not with the Pd layer in 1M NaOH is reported in the present work.

Results: All experiments with electrodes covered or not by protective Pd layer were done on the same initially Y/Pd electrode. After several cyclic experiments the Pd layer was detached from the Y surface and could be removed with the help of filter paper. We have not observed any immediate irreversible oxidation of the Yttrium electrode after it has got a contact with water based electrolyte. This electrode might be reversibly charged/ discharged with hydrogen and showed an optical switching very similar to the former protected electrode.

Both electrochemical processes, hydrogen loading as well as releasing were affected by the presence of a protection on the Yttrium surface. Presence of a Palladium protective layer allowed hydrogenation at less negative potentials. As well, an anodic process was developed at less positive potentials. From the practical point of view it means that less potential might be applied to the optical device to switch it between transparent and reflective forms. Nevertheless, decrease of the overpotential due to application of a protective Pd layer is not so big, approximately 200-300 mV, and could be neglected in case if more simple technology might be applied to obtain active electrodes.

We have analysed the chemical composition of the surface after the Pd layer was peeled off from the electrode. Most of the elements in analysis were the components of the glass substrate (Na, Mg, Si, K and Ca) and their quantities were practically equal for two analysed areas (one for Pd protection still presented on the surface and another after its detachment). The same behaviour showed Yttrium. Some elements, like carbon C, oxygen O and palladium Pd, yielded quite different concentrations in both cases. Two of them, C and Pd, decreased their concentrations and O, in contrast, increased it. The last could be very logically connected with a surface Y oxidation in the electrolyte after the protective Pd layer was peeled off (making the metal concentration decreasing), though we have not observed a

direct anodization of the electrode. The presence of a residual palladium in area where this layer had been peeled off allows us to confirm a conclusion done in [7] about an alloys formation on the surface of the electrode during metal deposition.

Conclusions: We have studied behaviour of the Y/Pd electrode in 1M NaOH solution toward the electrochemical hydrogen loading and releasing and compared them with electrochemical behaviour of the same electrode after a protective layer was removed. We have discussed possibility of Yttrium oxidation in case it has got a direct contact with electrolyte in a hydrogenated state and possible composition of an alloyed layer between Y and Pd from the point of view of hydrogen permeation. Although in presence of Pd protection the potential applied to optical device for its switching is less, many advantages could be exploited in case if no additional thin layer deposition is required to fabricate an active electrode.

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