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SYNTEZA, WODOROWANIE I WŁAŚCIWOŚCI CIENKICH WARSTW METALICZNYCH NA BAZIE MAGNEZU

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ABSTRACT

The growing interest in the study of thin films reversibly absorbing hydrogen is mainly due to their potential use as hydrogen sensors in a variety of hydrogen powered devices or switchable mirrors (smart windows) in electronics. From an economic point of view, magnesium would be the most suitable material for this type of application. Contrary to bulk magnesium, thin Mg layers coated with a palladium layer can absorb hydrogen at room temperature at pressures up to 1 bar. One of the important experimental problems still to be solved is the improvement of the too slow absorption kinetics.

This work presents the results of research leading to a significant improvement in the kinetics of hydrogen absorption by applying an ultra-thin Ni layer (Al or C) between the top Pd catalytic layer and the main Mg layer. A significant improvement in the absorption kinetics was also obtained by replacing pure Mg with Mg_2Ni alloy. In addition, the atomic mixing effect in the interface area was studied in detail using X-ray photoelectron spectroscopy to determine the mechanisms responsible for improving the absorption kinetics. The obtained results confirmed the significant role of the Ni interlayer in improving the kinetics of hydrogen absorption in Pd/Ni/Mg trilayers and Pd/Mg_2Ni bilayers. In the latter case, the Ni interlayer is formed spontaneously as a result of segregation of Mg atoms to the surface. In the case of Al and C interlayers, the absorption kinetics are improved due to the spontaneous formation of small islands at the interfaces containing Al and magnesium carbides, respectively. Such islands can form heterogeneous nucleation centers, which greatly improves the hydrogenation kinetics. The optimal thicknesses of the Ni, Al and C layers are 3, 0.5 and 1.4 nm, respectively.

The work is of a cognitive nature and its main assumption is to broaden the knowledge of the hydrogenation mechanisms in metallic materials. On the other hand, the obtained results can be used to obtain new thin-film metallic nanomaterials with better functional properties at room temperature.