Abstract

Metallic nanomaterials reversibly absorbing hydrogen constitute a group which has attracted vast attention of scientific community all over the world. It is a result of increasing interest in hydrogen as an energy carrier, especially because of the limited resources of fossil fuels and negative effects of their combustion. Hydrogen is an element that delivers about three times the value of a combustion energy of currently used gasoline or fuels of other kind. Hydrogen, taken up from the safe storage system, e.g. metallic nanomaterial and transported to hydrogen combustion engine or fuel cell, can power up automotives and small power plants. This method is clean and safe, because the only by-product is water.

Metallic nanomaterials for reversible hydrogen storage have also been used in other kinds of applications, such as negative electrodes in ecological Ni-MH batteries, thermal energy storage or as sensors and smart windows based on yttrium hydride. Recently, commercially used systems for hydrogen storage in a form of containers with metallic nanocomposite based on magnesium hydride have become very popular. As the research on metal hydrides, which has been motivated by the increase of the gravimetric and volumetric density of stored hydrogen, goes on, novel applications and more advanced technologies appear.

The main aim of presented PhD thesis is to broaden the actual knowledge on metallic nanomaterials for reversible hydrogen storage by studying physical properties of selected intermetallic compounds of both transition metals and lanthanides. The thesis delivers new results in electronic and magnetic properties research of thin reversibly absorbing hydrogen films. Moreover, it gives a new insight into the structure's influence on mentioned properties of materials for potential hydrogen storage [1]. In the search for substitute, efficient energy sources and substances for energy storage, metallic hydrides constitute interesting and promising group of materials.

The PhD thesis is devoted to the studies of correlation between structure and valence band width of metallic thin film nanomaterials which exhibit reversible hydrogen absorption. La-Co, La-Ni, $LaNi_4M$ (M = Al, Co), as well as Fe-Ni-Ti and $ZrPd_2$ alloy thin films have been studied to obtain more data on their electronic properties according to semi-empirical hydrogenation model [2] and their potential application for hydrogen storage, reported recently for bulk $LaNi_5$-type alloys [3], and as hydrogen separation membranes [177].

Moreover, thin Fe/V/Fe trilayers have been thoroughly studied and compared with recently obtained V/Fe superlattice model systems, where the modification of their interlayer exchange coupling (IEC) by hydrogenation has been reported [4,5,VII]. Therefore, the determination of hydrogenation influence onto magnetic interlayer exchange coupling in Fe/V/Fe trilayers has also been studied.

Nano- and polycrystalline thin films have been prepared using magnetron co-sputtering method. The structural characterization have been carried out using X-ray diffraction (XRD), X-ray reflectivity (XRR) and atomic forces microscopy (AFM). The surface cleanness, composition, core-level and valence band electronic structure, as well as the study of growth of thin films have been carried out using X-ray photoelectron spectroscopy (XPS). Magnetic measurements have been performed using vibrating sample magnetometer (VSM).

Presented results can be helpful for obtaining new metallic nanomaterials with increased hydrogenation properties.