Abstract

Along with the progress of civilization and a significant increase in the standard of living, combined with the dissemination of electrical devices, the demand for energy increases. It is therefore justified to develop new materials for energy storages that can be used for building new batteries or for storing hydrogen. Modern manufacturing methods such as mechanochemical synthesis and advanced structure analysis techniques allow to obtain the desired material properties with directed properties. Promising materials in the field of energy storage are, among others magnet, lithium and multi-wall carbon nanotubes.

This doctoral dissertation presents an overview of the research on lithium and magnesium and, on its basis, the preparation of multicomponent alloys with rare earth transition metals and elements p or s electron and the creation of hybrid materials, i.e. a combination of magnesium structures with multi-walled carbon nanotubes. The paper describes the parameters of the synthesis process, which was used to produce energy storage materials. Structure studies were carried out using the powder diffraction (XRD) method, as well as using the scanning electron microscope (SEM), transmission electron microscopy (TEM), X-ray photoelectron spectroscopy (XPS), Raman spectroscopy, differential scanning calorimeter (DSC). The electrochemical tests included the determination of EPC curves (electrochemical hydrogen absorption / desorption curves), discharge capacity and current characteristics during electrode charging and discharging. Additionally, the corrosion resistance of selected samples was tested. On the other hand, PCT isotherms made it possible to determine the ability of materials to physically absorb hydrogen.

Chemical methods were used to obtain brominated multi-wall carbon nanotubes. Covalently bonded bromine can provide the chemical activity of nanotubes to join organic residues through substitution reactions. The structures of the resulting systems were examined and the chemical and electrochemical properties of a selected system of carbon nanotubes functionalized with O-methyl-O-2-naphthyl L-N-methylephedrinium thiophosphate were examined.

The following metal phases were obtained:

- $Y_{5-x}Pr_xSb_{3-y}M_y$ (M = Sn, Pb)
- Li-Mg-Si-Al
- $Li_{12+x}Mg_{3-x}Si_{4-y}Sn_y$ (x = y = 0,48) and modifying it with com Li_xZnO / La_2O_3-CNT
- $Mg_{1,52}Li_{0,24}Al_{0,24}C_{0,86}$

As a result of the conducted research of the structural, sorption and electrochemical properties, it was found that the production of energy storage materials and their modification with rare earth transition metals and the elements p or s with electrons and the addition of multi-wall carbon nanotubes. Each of the above-mentioned modifications improves the energy storage capacity - hydrogen absorption / desorption kinetics and electrochemical properties. Hybrid materials (metal alloys combined with MWCNT) showed that they had most of the corrosion resistance to the unmodified alloy.

New energy storage materials based on lithium, magnesium or magnesium systems with rare earth metals or multi-wall carbon nanotubes as safe energy stores, will contribute to the development of alternative energy sources for transport, e.g. magnesium alloys are light and ultra-light metal alloys, as well as multi-walled carbon nanotubes are also characterized by low weight as well as interesting physicochemical properties. These types of materials can also improve the energetic safety and independence. At the same time, they will allow to eliminate the basic problems that constitute a barrier to the widespread use of technologies, i.e. storage, transport and production.

10.06 2022