ABSTRACT

The aim of this study was to investigate the effect of chemical modification and method of preparation of nanocrystalline TiNi and Ti_2Ni alloys, on their structure, morphology, corrosion resistance, electrochemical and hydrogen sorption properties. These materials were produced by mechanical alloying combined with heat treatment. Mechanical alloying method allows the production of nanocrystalline materials, and is an alternative to conventional methods of preparation of microcrystalline materials. The chemical modification of Ti-Ni alloys was based on partial replacement of titanium by zirconium and/or additive of palladium and/or silver and/or multi-wall carbon nanotubes (MWCNTs). The general chemical formula of studied materials was $Ti_{1-x}Zr_xNi$+A and $Ti_{2-x}Zr_xNi$+A, where A is a Pd and/or Ag and/or MWCNTs.

In the past, most studies concerned Ti-Ni type materials prepared by conventional methods (materials with micrometric size of grains), that did not comply the electrochemical and hydrogen sorption hopes pinned on them. For example the Ti_2Ni alloy has a high theoretical capacity above 500 mAh/g, but due to the formation of the irreversible hydride phase and subsequent oxidation, experimental maximum capacity was less than 200 mAh/g. Moreover, they also couldn't desorb hydrogen in room temperature.

A combination of production method and chemical modification used in this work, significantly improves the electrochemical and hydrogen sorption properties of studied materials. The most important achievements of the doctoral thesis include the development of energy-saving technology of chemically modified Ti-Ni nanomaterials production. Moreover, one of the obtained materials was nanocomposite which included Ti_2Ni alloy modified by Pd and MWCNTs, which was characterized by high discharge capacity (301 mAh / g) in 6M KOH – one of the highest among all known Ti_2Ni materials. Furthermore, Ti_2Ni alloy modified by palladium has a high hydrogen storage capacity (2.1 wt.%), which has not been achieved by any other research group. Properties improvements result from changes in the chemical composition, particle size reduction, microstructure modification, better anti-corrosion properties, created new clean surfaces and channels for transporting of hydrogen.

The work results showed that the use of mechanical alloying as the production method of chemically modified Ti-Ni alloys, allows to obtain new materials with potential application in Ni-MH_x rechargeable batteries and hydrogen storage systems.