## The effect of microstructure and chemical composition on gaseous and electrochemical hydrogen storage properties of Ti-V-type materials

The world wide population and economic growth are increasing the energy demand at a dramatic pace. Nowadays, combustion of fossil fuels provides 86% of the world's energy. Drawbacks to fossil fuel utilization include limited supply, pollution and carbon dioxide emissions. These drawbacks argue for the replacement of fossil fuels with a less-polluting energy carriers. For this reasons, hydrogen is an ideal energy carrier which is considered for future transport, such as automotive applications. In this context storage of hydrogen is one of the key challenges in developing hydrogen economy.

There are three ways of storing hydrogen: as a high-pressure compressed gas, as a cryogenic liquid or as a solid. Metal hydrides (on of solid material example) have been for a long time in focus as one of several alternatives to store hydrogen in a hydrogen-based economy. These materials which reversibly absorb and desorb hydrogen at ambient temperature and pressure, are regarded as important materials for solving energy and environmental issues.

Apart from the above, development of novel rechargeable metal-hydride (MHx) batteries, in order to improve materials for electrodes, is another extremely important path for green technology. The Ni-MHx-type battery offers the safest and most rugged rechargeable battery. The advantages is in total cost and life time expectancy. The principle of energy storage in such rechargeable batteries is also based on hydrogen absorption.

Among the hydrogen absorbing materials are vanadium-based alloys, which shown in last years good weight capacities compared to rare earth based storage materials because of the relatively low atomic mass of vanadium. Conventional metal hydrides have weight capacities less than 1.8 wt% whereas Ti-V based solid solutions exhibit a total capacity close to 4 wt%. Moreover, because magnesium-based alloys suffer from an undesirable, extremely high working temperature, vanadium based solid solution alloys seem to be the most promising candidates for hydrogen energy systems. However, the use of Ti-V-base alloys is limited due some factors like: high cost of vanadium and complicated hydrogen desorption procedure.

One way to cope with the limitations of Ti-V alloys is the use of chemical modification of these alloys. This method consists of a partial substitution of some element atoms by another element atoms. Partial substitution of vanadium atoms by other elements can not only reduce the cost of material but also improve the sorption properties.

Improvement of the properties of Ti-V-based alloys may also result from the use of other unconventional production methods. One of such methods is mechanical alloying. This process consists of repeated fracturing, mixing and cold welding of a fine blend of elemental powders, resulting in size reduction and chemical reactions. This method is commonly considered to be highly effective and cheap. However, this method has not been widely used to obtain the Ti-V-based alloys.

The aim of the project is to develop a new generation of hydrogen-absorbing materials based on Ti-V alloys. These materials are produced by mechanical alloying. The chemical composition of alloys will be modified with other chemical elements. The combination of a new method of preparation of the materials and the chemical modification impact on obtaining new materials, which will be characterized by improved properties of absorption of hydrogen. These materials may have potential use in storage and production of energy.

Basic research of this research project are related to production of new, chemically modified Ti-V-based materials which will be produced by mechanical alloying method. Obtained materials will be studied in order to obtain information on their structure (tests using X-rays), microstructure (microscopic observations) and on the ability to absorb hydrogen. The results will be published in international scientific journals.

Planned studies, of Ti-V-type nanomaterials provide answers to the cognitive nature problems, linking issues of knowledge about materials and technology. The results obtained may be used to solve problems in the design of technological processes in a modern electrode materials.