

The intensification of the use of new sources and the increase in energy prices resulted in the development of works on the methods of its storage. The largest share in energy storage is played by electrochemical power sources – batteries. The most commonly used are lithium-ion cells, which have the highest capacity and power, although there is no Li-ion system that would be characterized by the highest capacity and the highest power at the same time. Lithium-ion cells, which are the most powerful, have energy capacity comparable to hydride batteries. Moreover, the cost of a unit of energy stored in a lithium-ion cell is several times higher than that of other cells, such as lead-acid or hydride cells.

The most interesting seems to be energy storage in the form of metallic hydrides, formed by hydrogen and metals – transition group metal alloys. The energy carrier is the hydrogen absorbed in the anode, which oxidizes to hydrogen ions during the discharge of the cell. Transition metal alloy hydrides are widely used primarily in nickel metal hydride (Ni-MH) batteries. This system is characterized by a much higher energy capacity (60–120 Wh / kg) than the recently withdrawn from the European market due to the toxic cadmium content of nickel-cadmium cells (30–50 Wh / kg) or traditional lead-acid batteries (25– 40 Wh / kg). The great advantage of Ni-MH cells is their relatively low internal resistance, which allows to obtain high discharge currents and lifetime of thousands of cycles. In a nickel-metal hydride battery, the negative electrode (anode during discharge) is metal hydride of the  $A_xB_y$  type, and the positive electrode (cathode) is nickel oxyhydroxide (NiOOH). In the current solutions, the electrolyte is usually 6 M KOH.  $A_xB_y$  consists of transition metals such as La, Mm, Ni, Al, Mn, Co. During the operation, as a result of the reaction with  $KOH_{aq}$ , the cell alloy is covered with a layer of metal oxides and hydroxides, making it difficult to diffuse hydrogen ions from the solution to / from the alloy during the cell charging / discharging processes. In order to eliminate this phenomenon, in the proposed project we want to replace the aqueous electrolyte with non-aqueous protonated ionic liquids. Moreover, in order to bring the operating parameters of this cell closer to the so-called high-power lithium-ion batteries, in our project we intend to introduce into the system an asymmetric electrochemical capacitor operating at the same voltages as the hydride cell thanks to the same anode reaction which is the oxidation of the absorbed hydrogen. In order to accelerate the diffusion of hydrogen, the anode alloy will be covered ("decorated") with nanoparticles from alloys of palladium with other platinum metals, through which the process of hydrogen sorption / desorption will be significantly accelerated. Our research has shown that the Pd-Ru alloy (1%) has an absorption capacity of hydrogen increased by 20% compared to palladium, and platinum is the best catalyst for its oxidation. The electrochemical capacitor will be made by electroplating palladium or its alloy on a conductive porous carbon (CPC) developed by our group. The positive electrode (cathode during the discharge process) in this cell will be a redox system based on organic compounds. The processes taking place in the Pd (alloy) / CPC electrochemical capacitor and in the Ni-MH hydride cell rely on the same electrosorption and hydrogen desorption reactions in / from the metal that take place in the hydride cell, but processes in palladium and its alloys run much faster than in less noble materials that are components of the alloy of hydrogen absorbing cell.

The project is a pioneering approach to research into how energy is converted and stored. A new type of non-aqueous hydride cell with an electrolyte based on protic ionic liquids, unknown so far in the literature, will be developed, in which the negative electrode, acting as an anode during discharge, will be a hybrid system of  $A_xB_y$  alloy "decorated" with palladium-platinum metals alloy and an electrochemical capacitor – conductive porous carbon covered with thin layer of palladium. The  $A_xB_y$ -Pd (Rh, Ru, Pt) / CPC system will be optimized in terms of obtaining maximum current power from the oxidation of absorbed hydrogen during discharge. The concept of a non-aqueous hybrid hydride cell presented in the project can be applied in the form of new nickel-hydride hybrid batteries.