In the era of shrinking fossil fuel resources and rapid development of renewable sources of energy, there is an urgent need to search for new technologies for efficient energy conversion and storage. In recent years, the molecular hydrogen has been recognized as a promising clean energy vector for the future, due to its high energy density per unit mass and the possibility of its facile production from the electrolysis of the renewable feedstock - water. Hydrogen produced this way is very pure, therefore it can be directly applied as an energy source in the hydrogen fuel cell. Nowadays we can also experience a development of the ubiquitous electronic devices, which must meet the demand of multifunctionality, wirelessness and flexibility. Their rapid evolution, connected with raised electricity consumption, should go in hand with the development of new energy storage systems, which often become their functionality limiting factors. The promising family of the portable energy sources are the zinc-air (Zn-air) batteries. Their half-open structure, which enables using the oxygen from the air as the oxidant, allows achieving the capacities higher than those of the popular lithium-ion batteries. Furthermore, the application of solid-state electrolyte in their construction can enable production of flexible Zn-air batteries, which can be applied, for instance, in the rollable displays.

What is the common feature of the hydrogen production in the alkaline electrolysers and charging of the Zn-air battery? Both processes involve the same oxygen evolution reaction (OER), which is characterized with sluggish kinetics impeding the large-scale application of the aforementioned technologies. The effectivity of this reaction can be increased with aid of electrocatalysts, i.e. materials which mediate the electron transfer between electrode and reagents during the electrochemical reactions. Nowadays, the best OER electrocatalysts are based on the noble metals. Nonetheless, their price and scarcity largely limits the practical use. Due to this fact, their cheaper counterparts are currently being investigated. The attractive candidates for this purpose are metal-free carbonaceous materials, because of their low cost, ease of modification, high surface area and electrical conductivity. Generally, most of currently developed electrocatalysts are obtained in the powder form. For practical use they must be attached to the electrode surface, usually applying the polymer binders, which may increase the resistance of the entire system and diminish the surface area active for electrocatalytic reactions. The alternative approach is to obtain the electrocatalysts in the free-standing form, by the direct modification of the electrode surface without the use of binder. The interesting material, which can serve as the carbonaceous electrode is carbon cloth with its advantages: of high electric conductivity, low density, mechanical strength and flexibility.

The electrocatalytic activity of the carbonaceous materials can be boosted by oxidation of their surfaces, introduction of the atomic dopants, generation of structural defects or development of their electrochemically active surface areas. Nonetheless, those modifications usually increase resistance of the material, which has a negative impact of the effectiveness of the performance of the entire electrode. Because of that, the aim of the project is to optimize of the parameters of the thermal treatment of the carbon cloth samples in order to obtain metal-free, self-supported electrode with high electrocatalytic activity towards OER and high electrical conductivity. The objective of the project is also to indicate the parameters of the obtained materials, which have the highest impact on the electrocatalytic activity. It is expected that the project will provide new, simple pathways to fabricate high-performance and cheap OER electrodes and will help to better understand the basis of the electrocatalytic activity of those materials.