The growing demand for electricity requires the exploration of electrical devices, which could meet the increasing needs of modern society. The supercapacitors are group of devices with promising opportunities for storage of large amounts of energy. Accordingly, there are requested the new innovative materials which would exceed the electrochemical properties of currently used activated carbons. Among the intensively studied groups of compounds are conducting polymers and transition metal oxides, and their composites with carbon materials. Recently, the large scientific interest is focused on the synthesis of metal sulfides. The electrochemical capacitance of metal sulfides as electrode material are much higher than the capacitance of metal oxides.

The aim of these project is synthesis of metal sulfides/carbon nanostructure composites as an electrode material for supercapacitors.

The project will consist of several steps, including synthesis of metal sulfides under various conditions, its physical and chemical characterization, and evaluation of their capacitance properties in supercapacitor working in aqueous electrolyte. Then, the most electrochemically promising metal sulfides will be used for the preparation of metal sulfide/carbon nanostructure composites with different ratio of compounds. Three carbon nanostructures will be tested: carbon nanofibers, activated carbon and graphene/reduced graphene oxide. The compounds ratio in the composite will be verified by the electrochemical measurements. Finally, the chosen composite will be tested in asymmetric system using aqueous solution as an electrolyte, where at least one electrode will be built of metal sulfide/carbon nanomaterial composite.

Scanning electron microscopy and transmission electron microscopy will be used in order to determine the morphology and macroscopic form of resultant metal sulfides and metal sulfides/CNF, AC and graphene composites. The structural parameters will be measured by X-Ray diffraction. Nitrogen sorption at 77 K will be applied for the determination of the porous texture of resultant metal sulfides and metal sulfides/CNF, AC and graphene composites. The oxidation state of metal in resultant composites will be identified based on X-Ray photoelectron spectroscopy. Two and three-electrode capacitors will be assembled. The measurements will be performed by cyclic voltammetry, galvanostatic cycling and electrochemical impedance spectroscopy.

The findings may contribute to a better understanding of the mechanisms, occurring in the pseudocapacitive electrodes. Materials received as the project may contribute to setting new trends in the development of innovative energy storage devices.