SUMMARY

This work presents the preparation of new materials with high specific surface area, large pore volume, high chemical and mechanical resistance and other characteristics that allow them to be used as a building materials for the electrodes or hydrogen storage. In the thesis the methods of the preparation of novel molecular structures were developed and investigated regarding electrochemical properties and suitability for storage of hydrogen.

The first stage of this work was mainly related to the strategy of the core/shell type carbon materials synthesis. Those were mesoporous carbon spheres, which showed very good properties as a building material of electrodes in supercapacitors. In the experimental route, a surfactant trimetoksy (octadecyl) silicate (C18TMS) was used, which allowed to obtain the structure of disordered shell. Simultaneously, a method of obtaining of the hollow carbon spheres with different wall thicknesses was developed. The material was tested regarding suitability for the construction of electrodes in supercapacitors. It was shown that the hollow carbon spheres with a disordered mesoporous structure synthesized at a temperature of 700°C exhibited the best properties allowing to reach capacity of 120 F/g.

In the next step a different kind of carbon spheres were investigated. Those were fully mesoporous including shell and core. The spheres were obtained by the template method, where mesoporous silica spheres with a core/shell structure was used a template. The received material was subjected to the electrochemical tests. Potentiometric curves at different speeds scan showed a rectangular shape, which demonstrates a good conductivity of the material and a rapid propagation of cargo. The capacity of the mesoporous carbon spheres was 59 F/g.

Silica spheres with disordered shell are not the only material which could be used for the mesporous spheres synthesis. Ordered structures can also be used as a matrix. Therefore, in a further step a cetyltrimethylammonium bromide (CTAB) was used to build a mesoporous silica layer on the solid silica sphere. The carbon hollow spheres synthesized by this method was characterized by favorable properties both when used in supercapacitors and lithium-ion batteries.

Using the template method, a spherical form of core/shell carbon was synthesized with a mesoporous carbon core and non-porous carbon shell. This new method of producing spheres of core/shell used SnO_2 as a template. The material was investigated to assess the capacity by using a multi-channel generators in a wide current density range. For comparison an activated carbon (APhR) was used as a reference material. All the materials had a similar surface area. In the first charging cycle the capacity increased ~ 60% in case of the electrode obtained from the carbon spheres in respect to the activated carbon.

Additional investigations were carried out where mesoporous carbon spheres were used for hydrogen storage. The ordered mesoporous carbon spheres were decorated with different sizes of palladium nanoparticles. The measurement of the hydrogen sorption showed that mesoporous carbon spheres with a shell of ordered pores have very good sorption properties. Additionally, a decoration of the larger diameter palladium nanoparticles increases the

sorption almost two times. There were also carried out measurements using carbon nanotubes, which were also decorated with a different size of palladium nanoparticles. The obtained particles had diameters from 3 to 12 nanometers and very good properties of hydrogen storage were showed by carbon nanotubes decorated with 3 nm diameter palladium nanoparticles. In comparison with a pure carbon, their sorption was significantly greater was 0,88 wt.%.

Karolina Wenelska