Synthesis and characterization of high surface area carbide derived carbon for electrochemical capacitors

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Carbon is the material of choice in electric double layer capacitors (EDLC) because of the extremely high surface area up to 2000 m^2/g that can be achieved. The challenge is to produce a quality carbon that combines high surface area with a low resistivity. Although surface area is important, it is not the overriding criterion for high capacitance: pore size distribution and particle size need to be optimized as well. Carbide derived carbon (CDC) [1,2] is a promising material to be used in electrochemical capacitors [3].

We synthesized high surface area carbon materials by selective etching of silicon carbide with chlorine containing gases.

Powder of β-SiC (surface area 17.8 m^2/g) was treated in the chlorine and hydrogen chloride gases as well as in their mixtures of various compositions in the temperature range 600 - 1200°C. Surface area, pore size and conductivity of CDC can be controlled by temperature and gas composition.

The resultant carbon and carbon-silicon carbide composite powders were characterized by Raman spectroscopy and X-ray diffraction. To determine a conversion degree of silicon carbide, the samples were annealed in open air at 600°C thereby carbon component of the carbon/silicon carbide composite was completely oxidized.

Specific surface area and pore volume analyses were conducted using measurement of the isotherm of adsorption/desorption of nitrogen at -195.8°C. The surface areas were calculated by application of the BET (Brunauer, Emmet, Teller) equation. The results for the samples treated during 3 hours in the chlorine gas are presented in the Fig. 1. It shows that the specific surface area increases with increase in temperature of treatment from 600°C to 1100°C. The highest surface area (1985 m^2/g) was obtained for the sample chlorinated at 1100°C. Increasing reaction temperature to 1200°C resulted in a somewhat lower specific surface area of the product due to increased graphitization of carbon.

Pore volume calculations were performed using the BJH (Barret, Joyner, Halenda) method. It was found that our materials are microporous and characterized by a very narrow pore size distribution.

The CDC obtained exhibit very promising properties allowing us to discuss their possible application in supercapacitors.

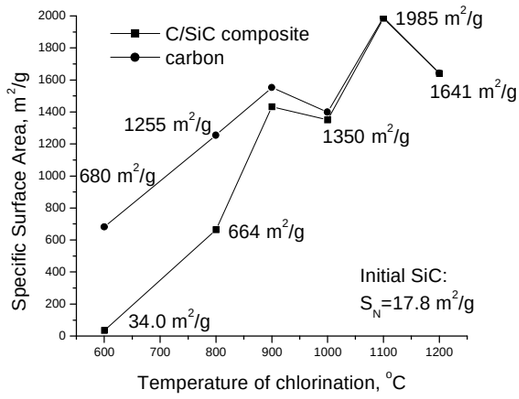

Fig.1. Dependence of the specific surface area on the chlorination temperature. The powder was treated in Cl_2 for 3 hours.

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References:

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