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Mesoporous Carbon Electrode: Synthesis, Characterization and Electrical Properties

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Abstract –The ordered mesoporous Carbon has been synthesized by vapor infiltration method. Pores with a diameter of 3.8nm can be seen on the surface and the BET specific surface areas are calculated to be 1000 m^2g^{-1} (Fig. 1,2). The electrodes have been prepared with the mesoporouse carbon. Their better electrochemical performances were confirmed by the experiment of charge / discharge and CV analysis (Fig. 3,4).

Mesoporous carbon (MC) has been synthesized by vapor infiltration method [1, 2]. This method is easy for controlling the experamental conditions owing to the self-assembly of resorcinol and surfactants. The mixture of resorcinol, an amphiphilic block copolymer (Pluronic F127), sodium hydroxide, and ethanol was stirred for 12 h so that it became a homogeneous precursor solution. The solution was formed on the glass by dip coating. The coated glass was positioned in a closed vessel with formalin solution for 4 h at various temperatures. The structured resin were then heated at 800 ºC in an inert atmosphere to remove the block copolymer and to carbonize the resins.

MC prepared was observed with a transmission electron microscope (TEM) technique. There were ordered mesoporous carbon with channle structure as shown in Figure 1. The pore size is about 3.8 nm. And the structure was confirmed further by nitrogen adsorption desorption isotherm as shown in Figure 2. Nitrogen absorption in the isolated and extracted MC sample presents typical IV isotherms, according to the IUPAC classification, with clear H1 hysteresis loops in the relative pressure range of 0.4～0.95. Furthermore, the mesoporous carbon sample show the BET specific surface areas of over 1000 m²/g and the pore size centered at 3.87nm.

As an electrode material for supercapacitor, the MC synthesized by vapor infiltration method was firmed well by electrochemical experiments including cyclic voltammetry and constant charge / discharge cycling. The cyclic voltammetry curve reveals typical electrical double-layer capacitor (EDLC) property. After 200 cycles, the CV curves almost can be overlapped as shown in Figure 3，which indicated the excellent cycling stability. From the constant charge discharge cycling, the specific capacitance of MC is 114.5 F cm^{-2} in 1.0 M KNO_3 electrolyte media at a scan rate of 1 mV s^{-1}. It decays with increasing current density as shown in Figure 4. The charge discharge efficiency is also decayed with increasing current density.

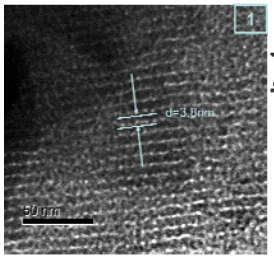

Figure 1: TEM image of the mesoporous carbon

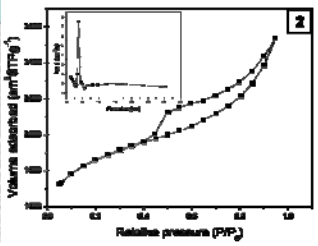

Figure 2: Nitrogen adsorption - desorption isotherm for the mesoporous carbon. Inset: Pore size distribution (PSD) profile of the corresponding sample

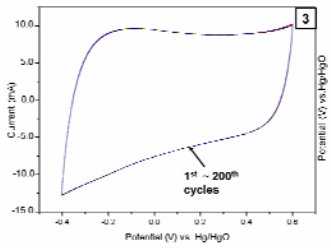

Figure 3: Cyclic voltammetry of the mesoporous carbon in 1.0M KNO_3 with 200 cycles at a scan rate of 20mV/s.

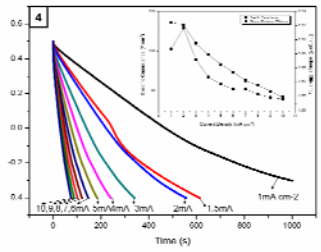

Figure 4: Discharge curves of MC at different current densities. Inset: Specific capacitance versus current density and Charge - discharge efficiency versus current density.

References

[1] Sho Kataoka, Takuji Yamamoto, Yuki Inagi, Akira Endo, Masaru Nakaiwa and Takao Ohmori, Carbon 46 (2008) 1358-1367
[2] Brinker CJ, Lu YF, Sellinger A, Fan HY. Evaporation–induced self–assembly: nanostructures made easy. Adv Mater 1999;11(7):579-85.