Biogas-slurry Derived Mesoporous Carbon for Supercapacitor Applications

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Abstract

This study reports on the transformation of biogas slurry into mesoporous carbon for supercapacitor electrodes. Pore structures have been modified by altering activation time, temperature and KOH/carbon mass ratio. The mesoporous carbons are successively developed as evidenced by type IV isotherms obtained in nitrogen sorption studies. BET, micropore and mesopore surface area of 515, 350, and 165 m^2 g^{-1}, respectively as well as a narrow pore width distribution of 3-4.5 nm are obtained. X-ray photoelectron results have confirmed the presence of functional groups of oxygen and nitrogen in the samples which facilitates the pseudocapacitance. The electrochemical measurements in 6 M KOH using a three electrode cell with Ag/AgCl as reference electrode and platinum as counter electrode has been performed. The materials activated at 700 ºC, 3:1 KOH to carbon mass ratio, and for 120 min exhibit high specific capacitance of 289 F g^{-1} at a scan rate of 5 mV s^{-1}. Shortening activation time to 30 and 60 min reduces specific capacitance to 163 and 182 F g^{-1}, in that order. Additionally, at 3:1 KOH to carbon mass ratio and 60 min activation time, specific capacitances of 170 and 210 F g^{-1} at 600 and 800 ºC, respectively are obtained. Moreover, specific capacitance increases with increasing the KOH to carbon mass ratio from 148 F g^{-1} for 1:1 to 163 F g^{-1} for 3:1 at 700 ºC. Electrochemical impedance spectroscopy studies demonstrate that material has high conductivity. In addition; capacity retention of 96% after 20,000 cycles is shown at scan rate of 30 mV s^{-1}. The study shows that high performance electrodes can be designed from biogas slurry derived porous carbon.

Key words: Biogas-slurry; Activated carbon; Mesopores; Supercapacitor; Specific Capacitance.