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Kinetics of Double-Layer Charging/Discharging of Porous Activated Carbon-Fiber Cloth Electrode : Effects of Pore Length Distribution and Solution Resistance

활성탄소섬유의 이중층 충/방전에 관한 속도론적 연구 : 기공길이분포와 용액저항의 영향

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The effects of pore length distribution (PLD) and solution resistance on the kinetics of double-layer charging/discharging of an activated carbon-fiber cloth electrode were investigated in a 30 wt.% H_2SO_4 solution using scanning electron microscopy, nitrogen gas adsorption, ac-impedance spectroscopy, current transient technique, and cyclic voltammetry (CV). In order to remove the surface acidic functional groups on the commercially as-activated carbon-fiber cloth specimen, it was heat-treated at 1000 ℃ for 0.5 h in an atmosphere of an Ar/H_2 gas mixture. SEM micrograph revealed that the pores comprising the carbon specimen were cylindrical in shape. From the result of nitrogen gas adsorption, it was found that the pore size was uniformly distributed. For these reasons, the PLD was considered as an origin of the deviation from ideal capacitive behaviour in the impedance spectra. The experimentally measured impedance spectra, cathodic current transients and CVs for the carbon electrode specimen with a certain PLD accorded well in shape and value with those theoretically calculated based upon the modified transmission line model in view of the PLD under the effect of the solution resistance. In addition, the cathodic current transients and CVs for the carbon electrode specimens with various PLDs were theoretically calculated based upon the modified transmission line model as a function of the solution resistance. The kinetics of double layer charging/discharging were discussed for the carbon electrode specimen with various PLDs in terms of the penetration depth and the rate capability as a function of the solution resistance.

Reference

1. C.-H. Kim, S.-I. Pyun and H.-C. Shin, J. Electrochem. Soc. 149 (2001) A93.