Estimation of Diffusion Coefficient of Lithium in Carbon Using AC Impedance Technique

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ABSTRACT

The validity of estimating the solid phase diffusion coefficient D_s of a lithium intercalation electrode from impedance measurements by a modified EIS method is studied. A macroscopic porous electrode model and concentrated electrolyte theory are used to simulate the synthetic impedance data. The modified EIS method is applied for estimating D_s. The influence of parameters such as the exchange current density, radius of active material particle, solid phase conductivity, porosity, volume fraction of inert material and thickness of the porous carbon intercalation electrode, the solution phase diffusion coefficient and transference number, on the validity of D_s estimation is evaluated. A simple dimensionless group is developed to correlate all the results. It shows that the accurate estimation of D_s requires large particle size, small electrode thickness, large solution diffusion coefficient and low active material loading. Finally, a "Full Model" method is developed for the cases where the modified EIS method doesn't work well.

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