Design Requirement for 2nd Generation Fourier Transform Electrochemical Impedance Spectroscopy (FT-EIS): Rise time and Applied Potential

Changsuk Yun, Seongpil Hwang*

Department of Advanced Materials Chemistry, Korea University, Sejong 30019, Korea

*E-mail: sphwang@korea.ac.kr

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The effect of the rise time on a second generation Fourier transform Electrochemical Impedance Spectroscopy (2G FT-EIS) system was investigated using a COMSOL simulation and a numerical analysis. Chronoamperometry with either a non-ideal or an ideal step function was simulated by manipulating the rise time (transition zone in COMSOL). First, EIS data were obtained from (1) the differentiation of both step function and the current response, after which (2) the subsequent fast Fourier transform (FFT) of the derivatives in reversible electrode system. A longer rise time (ms order) caused more noise in the high frequency region compared to a shorter rise time (μ s order). Second, the noise in a slower charge transfer system was analyzed with different rise times. The noise level, however, is tolerable over the practical frequency range with a long rise time. Third, 2G FT-EIS behavior upon an unconventionally large potential amplitude on a quasi-reversible system was simulated. With an overpotential increase, the 2G FT-EIS system deviated from linear approximation due to a change in the charge transfer resistance, indicating that the decision to allow the maximum stimulating potential should depend on electrode kinetics. These simulation results here suggest the proper design requirements for the 2G FT-EIS instrument.

Keywords: Chronoamperometry, Electrochemical Impedance Spectroscopy, Fourier Transform, Electrochemical Simulation, Nyquist plot

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