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ETM-O-03

Non-linear frequency response analysis of the kinetics of electrochemical reactions: a case study – ferrocyanide oxidation kinetics

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In general, electrochemical (EC) systems are non-linear, which means they respond non-linearly to a frequency-dependent periodic input perturbation of high amplitude imposed around a steady-state. In addition, the kinetics of EC reactions are quite complex and different rivalling model presentations can be formulated for certain EC reaction. While standard electrochemical methods (steady-state and electrochemical impedance spectroscopy) showed low sensitivity towards the model discrimination, non-linear frequency response analysis (NLFRA) of EC kinetics can appear advantageous for this purpose. In this work, NLFRA is applied in experimental and theoretical study of ferrocyanide oxidation as a model EC reaction.

ETM-O-04

Frequency response of the electrochemical interface close to dynamic instabilities: Experimental investigation of the oscillatory electrodissolution of copper in trifluoroacetic acid

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The frequency response of neural membranes is known to determine the communication properties of neural networks via band-pass (resonance) or high-pass (integration) filtering of incoming electric signals. In the present work it is shown experimentally that the electrochemical interface is also capable of acting as a band-pass filter, as far as the steady state is a stable focus, and thus mimic neural resonators. In order to realize electrochemical resonance, the electrodissolution of copper in trifluoroacetic acid is explored close to a Hopf bifurcation where the steady state is a stable focus. Electrochemical impedance spectroscopy indicates that the impedance of the system exhibits a characteristic minimum at a specific frequency where the oscillatory current attains maximum amplitude. The existence of resonance is also supported by perturbation experiments of variable frequency in the time domain (impedance amplitude method, ZAP). It is concluded that the electrochemical interface can act as a resonator and thus mimic a primitive information processing ability of neural cells.