A CONCEPT OF DOUBLE LAYER CAPACITANCE MOTIVATED BY NANOTECHNOLOGY

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Determination of heterogeneous rate constants of redox reactions or charge transfer resistances always involves ambiguities due to participation in double layer (DL) capacitances and solution resistances. The rate constants determined by the steady-state voltammograms at ultra-microelectrodes are inconsistent with time-dependent voltammograms, implying participation of the DL impedance. We examine controlling variables of DLs by paying attention to frequency-dependence of the capacitance on the basis of definition of the current and the capacitance. The capacitance is obeyed by the power law of the frequency. It is controlled by orientation of limited amount of solvent dipoles, independent of salts. Redox species, of which dipoles are oriented oppositely to the solvent dipoles, decrease the DL capacitance and make the value negative at high concentration of the specie. The decrease in the capacitance increases the real impedance, as predicted from the phase angle, yielding a extra resistance. This may be a ghost charge transfer resistance. However, there are a number of actually well-defined charge transfer resistances, which are observed as transferring rates through films on electrodes. This logic will be explained step-by-step by tracing the six sections: difference in heterogeneous rate constants by steady-state and fast voltammetry; frequency-dependent double layer impedance; variables of determining DL impedance; origin of the frequency dependence; DL impedance complicated by diffusion-controlled current of redox reactions; redox reaction of unanticipatedly adsorbed redox species

Biography

Jingyuan Chen has completed her PhD from University of Fukui, supervised by Prof Koichi Aoki. Then she worked as a Senior Researcher at MAEDAKOSEN Company Limited; as a Full-Time Lecturer at Faculty of Science in Kanazawa University; as a Visiting Scholar at Henry White's laboratory in University of Utah. In 2001, she moved to University of Fukui and worked as an Associate Professor and was appointed as a Full Professor at Department of Applied Physics in 2017. She has set the life aiming to solving fundamental subjects of basic electrochemistry and defined the work focus into physics of interfacial phenomena. During her career, over the past 17 years, she has supervised more than 30 PhD students. She has published more than 90 papers in reputed journals.

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