3rd Global Conference on Research in Chemistry and Chemical Engineering

Prague, Czech Republic 18 – 20 September 2025

Capacitance-Charge Analysis in Investigation of Oxygen Electrochemistry on Platinum in Alkaline Environments

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ABSTRACT

The oxygen reduction reaction (ORR) is crucial for development of fuel cells, which are one of the most promising sources of electricity. However, despite many years of research, mechanism of the reaction, as well as the rate-determining step (RDS) remains unclear, even at platinum electrode which is the most efficient catalyst for this reaction so far. The ORR process is also affected by formation of platinum oxides, which reduce ORR efficiency by blocking the catalyst surface. Developed capacitance-charge analysis is based on Dynamic Electrochemical Impedance Spectroscopy (DEIS) technique, which allows obtaining instantaneous impedance spectra during cyclic electrode polarization. Implementation of capacitance-charge analysis provides differential capacitance spectra and, for the first time, charge spectra during electrode polarization. Capacitance spectra provide a distinction between the electrical double layer (EDL) capacitance and the pseudocapacitance generated during ORR, formation and reduction of platinum oxides. The charge spectra allow analogous distinction of the charges associated with the EDL capacitance and pseudocapacitance. Thus, the capacitance-charge analysis can determine contribution of the EDL capacitance and pseudocapacitance to the total capacitance, and analogously determine contribution of the charges associated with these capacitances to the total generated charge. Furthermore, shape of the capacitance and charge spectra allows identification of the step controlling rate of the overall process. The presentation will reveal results of oxygen electrochemistry studies on a platinum electrode in alkaline environments during cyclic polarization of the electrode in potential ranges covering formation and reduction of platinum oxides and ORR.

Keywords: capacitance spectra; charge spectra; DEIS; ORR; platinum oxides