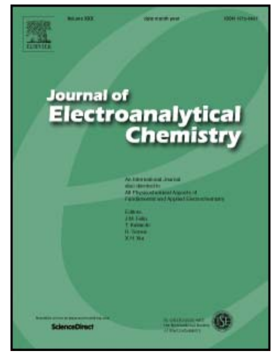

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A model for impedance of a PEM fuel cell cathode with poor electron conductivity

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Abstract

A model for impedance of the cathode catalyst layer (CCL) with poor electronic conductivity σ_e is developed. In the case of small cell current, an analytical expression for the CCL impedance is derived. At small currents, finite σ_e increases the static cell resistivity by the value $1/(3\sigma_e)$. In addition, the CCL exhibits a pure ohmic resistivity, which is equivalent to proton and electronic resistivities connected in parallel. Finite σ_e distorts the shape of the Nyquist spectrum in the HF domain; the CCL proton conductivity σ_p can no longer be determined simply as a projection of the straight HF line onto the real axis. However, σ_p and σ_e can be found by fitting the model equations to the experimental spectra.

Keywords: PEM fuel cell impedance; modeling; cathode catalyst layer; poor electron conductivity

1. Introduction

A key component of polymer electrolyte fuel cell is a cathode catalyst layer (CCL), where oxygen meets electrons and protons to produce water. The CCL is a composite structure of interpenetrating clusters of proton–conducting ionomer and electron–conducting Pt/C particles. The proton σ_p and electron σ_e conductivities of this structure are functions of both the Nafion and Pt/C content. Finite thickness raises a problem of proton and electron transport through the CCL depth.

The literature data on σ_e have recently been summarized by Morris et. al. [1]; in a well–designed CCL, σ_e is one to two orders of magnitude larger, than σ_p. This explains large interest in measurements and modeling of σ_p, which under

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