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Recent advances in the determination of electronic properties of passive films by electrochemical impedance spectroscopy

Benoit Ter-Ovanessian, Sabrina Marcelin and **Bernard Normand**
University of Lyon, France

Semi-conductive properties of passive film represent discriminant parameters in many applications in photo-electrochemistry such as photoanodes or photoelectrochemical cells, or in electrochemistry such as sensors, bio-electrochemical cells and corrosion. For this reason, the accurate determination of these properties is of great interest. Considering passive films as thin highly disordered semiconductor, the electronic properties of passive films are generally investigated by photo-electrochemistry or differential capacitance measurement of the Mott-Schottky (MS) theory. In the MS approach, electrochemical impedance spectroscopy (EIS) is a widely used technique to determine the capacitance of the passive films. However, different limitations are known to alter the final results. For example, the electronic properties obtained by conventional MS experiments are known to be frequency dependent. Furthermore, as constant-phase-element (CPE) behavior is commonly observed on the impedance diagrams recorded with passive materials, the method to extract the effective capacitance from the high frequency time-constant dispersions has to be carefully chosen. In the present work, the recent advances in experimental procedure and interpretations of EIS spectra during MS experiments, which allow to accurately determine the electronics properties of passive film, are described for passive films grown on pure chromium and nickel-chromium alloys. The relevance of multi-frequency MS experiments that limits the frequency dependency of the capacitance measurements is firstly discussed. Secondly, the pertinence of the power-law model or the Cole-Cole representation of the complex capacitance to assess the passive film capacitance from EIS diagrams during MS experiments is then debated for different systems.

Biography

Benoît Ter-Ovanessian is an Associate Professor in the Material Science and Engineering department at INSA de Lyon in France in 2013. He has joined the Corrosion Science and Surface Engineering group of the MATEIS Laboratory and integrated the research project of the CNRS International Associated Laboratory, ELyT Lab, which promotes collaborations between Lyon University and Tohoku University. His research activities are mainly focused on the understanding of the passivation features, the interactions between mechanical loading and interfacial reactivity; and consequently the managing of the reliability of metallic components.

benoit.ter-ovanessian@insa-lyon.fr

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