A Critical Look at Interpretation of Impedance Spectra of Coated Aluminum Alloys

Mikhail Zheludkevich, Kiryl A. Yasakau, Maxim Starykevich, Mario G.S. Ferreira
Department of Materials and Ceramic Engineering, CICECO, University of Aveiro, 3810-193 Aveiro, Portugal
e-mail: mzheludkevich@ua.pt

Introduction

Electrochemical Impedance Spectroscopy (EIS) is used as one of the main experimental techniques for characterization of corrosion resistance of aluminum alloys. Recently this method was also demonstrated to be a powerful tool for investigation of self-healing ability of active protective coatings applied on Al-based substrates.

The extensive use of EIS led to the fact that many different equivalent circuits were proposed to fit the experimental spectra. However in many cases the suggested circuits are not supported with convincing physical models leading to speculative interpretation of impedance data.

In the present work a critical analysis of equivalent circuits employed by different authors is performed. The analysis is supported with a systematic EIS study of the aluminum coated by different protective layers.

Experimental

Pure aluminum and AA2024 were used in the present work as substrates. The aluminum surface was anodized in several cases using borate-based electrolyte in order to obtain oxide films with different thickness. Hybrid sol-gel films as well as commercial epoxy-based coatings were applied as model protective layers with different barrier properties.

Results and Discussion

The measurements are performed in different electrolytes and at different immersion stages in order to assign the observed time constants to the physico-chemical processes occurring on the coated Al surface. Additional measurements with thin dense anodic layers on the metal surface help to understand role of the native oxide present on aluminum. The systematic EIS results are complemented with microscopic measurements supporting the proposed interpretations.