Development of a methodology to characterize the electrodeposition of Ni-W alloys using EIS and IMPS techniques

Anh Phong Tran

Department of Chemical Engineering
Northeastern University
Boston, MA 02115
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Electrochemical Impedance Spectroscopy (EIS) is a technique used to assess the governing processes at an electrode/electrolyte interface and it is applied here to Ni-W alloy electrodeposition. By oscillating either the current or the potential and measuring the other variable, the impedance of a system can be determined. The simplest and most frequently used application of the EIS is to measure the ohmic drop indicating the potential drop across two electrodes due to the electrolyte conductivity. This value has a vital importance in electrochemical measurements as a correction factor. In recent years, the use of this technique has been extended to determine the reaction mechanisms in corrosion and deposition systems[1].

Sun and Podlaha[2] have previously demonstrated the detection of intermediates that occur in Ni-W for the first time by Intensity Modulated Photocurrent Spectroscopy (IMPS). It is believed that the nickel and tungstate ions form an absorbed photoactive complex for which the photocurrent impedance is at least dependent on the applied potential and the concentration of the concerned ions. It was previously thought that only semiconductors were photoactive. This finding thus opens the door to possibilities never explored before.

In our study, we would like to use both techniques to characterize the electrodeposition of alloy systems for which the reaction mechanisms are currently not well understood. To determine the reaction order of the species of interest, we will use optimal designs with respect to the concentration levels. An analysis of variance (ANOVA) will then be used to eliminate the unlikely mechanisms, and select the most appropriate one. Once a sound mechanism is selected, we will then approach the impedance data to determine the relationship between the manipulated variables and the measured ones.

* This work is supervised by Professor Podlaha-Murphy, Northeastern, Boston, MA, USA.

[1] Orazem, Mark E., and Bernard Tribollet. *Electrochemical impedance spectroscopy*. Vol. 48. John Wiley & Sons, 2011.

[2] Sun, S., T. Bairachna, and E. J. Podlaha. "Induced Codeposition Behavior of Electrodeposited NiMoW Alloys." *Journal of The Electrochemical Society*160.10 (2013): D434-D440.