Int. J. Electrochem. Sci., 15 **(2020)** 9779 – 9795

International Journal of ELECTROCHEMICAL SCIENCE
www.electrochemsci.org

Effect of Process Parameters on the Electrodeposition of Zinc on 1010 Steel: Central Composite Design Optimization

Mehmet Kul[1], Kürşad Oğuz Oskay[2], Fuat Erden[1,], Erdem Akça[2], Ramazan Katırcı[3], Erkan Köksal[2], Evindar Akıncı[2]*

[1] Sivas University of Science and Technology, Department of Aeronautical Engineering, 58050, Sivas, Turkey
[2] Cumhuriyet University, Department of Metallurgical and Materials Engineering, 58140, Sivas, Turkey
[3] Sivas University of Science and Technology, Department of Metallurgical and Materials Engineering, 58050, Sivas, Turkey
[*]E-mail: fuaterden@sivas.edu.tr

doi: 10.20964/2020.10.19

Received: 7 May 2020 / *Accepted:* 17 July 2020 / *Published:* 31 August 2020

In the present work, we studied the effect of critical electrogalvanizing parameters on the quality of electrodeposited Zn films. The current density, electrodeposition time, and $ZnCl_2$ concentration of electrolyte were optimized to maximize current efficiency and brightness, and also, to minimize the surface roughness. Importantly, regression models of the response variables were developed. These models could help industrial applications by providing definitive process conditions to obtain Zn coatings at a desired thickness, roughness and brightness with a high current efficiency. First, preliminary studies were conducted to determine the initial levels of the designated factors. Then, the optimization was conducted through the Central Composite Design by Design-Expert (trial version). Upon completion of the optimization, analysis of variance was also performed. The optimum values of current density, coating duration and $ZnCl_2$ concentration were determined as 3.7 A/dm^2, 4.4 minutes, and 50 g/L, respectively, at a thickness of 6 μm. Finally, a set of Zn films were deposited at this optimum conditions. The characterization of these films showed that the experimental results were in good accordance with model predictions, providing a bright (L*=83.69) and smooth (Ra=0.75 μm) coating with excellent adhesion to steel substrate (pull-off strength > 29.4 MPa) at a current efficiency of 98.7%.

Keywords: Electrogalvanizing, Central composite design, Zinc coating, Electrodeposition

FULL TEXT