Galvanic Corrosion Behavior of Zinc/Steel couple under Thin Electrolyte Layer

Lei Wen, Ying Jin✉, Jie Cheng

National Center for Materials Service Safety, University of Science and Technology Beijing

30 Xueyuan Road, Haidian District, Beijing 100083, China

Galvanic corrosion between zinc and steel exists widely in atmospheric environment. In this study, coplanar zinc/steel galvanic corrosion behavior has been investigated by electrochemical methods under thin electrolyte layer (TEL), which simulating the atmospheric corrosion environment.

In our research, an experimental setup has been designed to assure an even and stable electrolyte layers formed on the surface of zinc/steel couple electrode. The initial thickness of the electrolyte was measured by micrometer, and the accuracy control of electrolyte thickness was achieved by using pipette to inject or inhale a certain volume which has been converted from the depth in the electrochemical cell. The relationship between solution volume and TEL thickness is shown in Fig. 1, and a good linear relationship can be observed. By the experimental setup, the electrolyte thicknesses of 50, 100, 200, 400, 800 and 1600 μm have been obtained on the surface of electrodes.

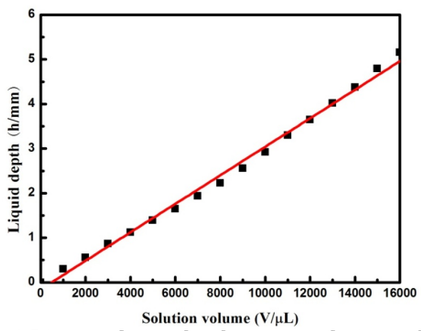

Fig. 1 Linear relationship between solution volume and TEL thickness

The galvanic current between zinc and steel under different TEL thicknesses is shown in Fig. 2. It can be observed that the galvanic current increased with the decrease of electrolyte thickness. When the thickness of the electrolyte layer is greater than 800 μm, the oxygen galvanic current is close to that of the bulk solution

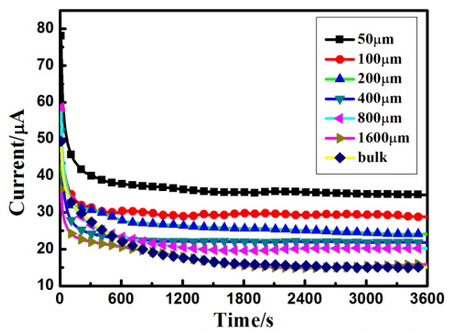

Fig. 2 Galvanic current between zinc and steel under different TEL thicknesses

Based on the EIS results shown in Fig. 3, it can be found that the radius of capacitive arc increases with the increasing electrolyte thickness, while the electrolyte resistance decreases.

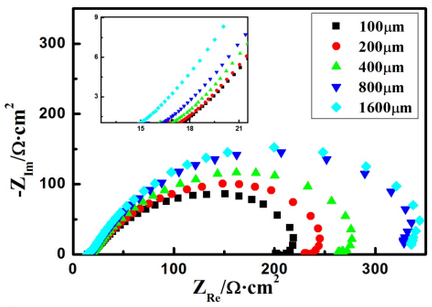

Fig. 3 Galvanic current with different area ratio between cathodes and anodes

EIS plots of steel electrodes were measured under OCP and galvanic potentials of zinc/steel, respectively, and the results are shown in Fig. 4. Compared with Fig. 4 a) and b), it can be found that steel can be well protected under galvanic potentials.

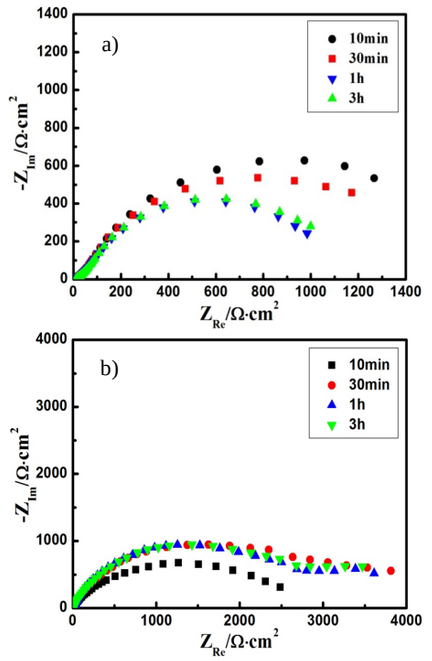

Fig. 4 EIS Nyquist plots of steel electrodes under a) OCP and b) galvanic potential with an increasing immersion time

Besides the results shown above, the polarization results under different electrolyte thicknesses, galvanic current and potential with different anode/cathode area ratio have also been studied, and these results will be shown in the presentation and the full manuscript.