

Imaging of Mass Transport Process for Localized Corrosion of Stainless Steel

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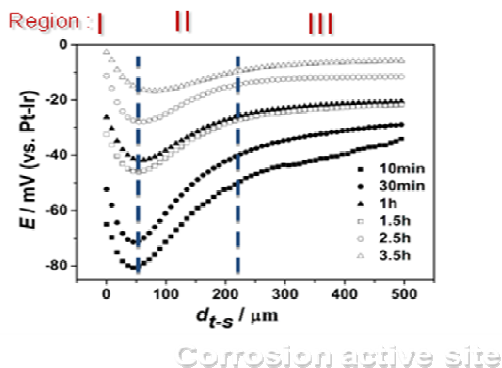
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Localized corrosion is one of the most crucial and subjects in corrosion science, and various research methods have been developed for studying localized corrosion. Unfortunately, traditional electrochemical techniques, such as polarization curve, electrochemical impedance spectroscopy (EIS), and etc. are usually only able to provide general and average information for a localized corrosion system]. Especially, it is difficult to distinguish the contribution of mass transport and charge transfer for a process of localized corrosion.

In the past decades, several scanning probe techniques have been developed and employed for *in situ* corrosion studies. Among these methods, the Scanning Reference Electrode Technique (SRET) is a powerful tool to detect the active sites and monitor their development by continuously measuring the potential distribution on the metal surface without interrupting the process during localized corrosion. However, it is difficult to control the distance between tip-substrate (d_{t-s}) exactly and there were few studies aiming at the vertical information over active and passive sites during localized corrosion.

In this work, a home-built SRET/STM system was developed to image the vertical potential in the thin layer of solution near the metal surface. There are two prominent advantages of this method: (1) probe approaching in STM mode is able to bring the probe tip very close to the surface precisely and reproducibly; (2) Potential mapping helps to position the probe tip accurately to a region where localized corrosion occurs. A distinct difference of the vertical potential profiles over the corroded and passive sites of stainless steel in FeCl₃ solution was observed for the first time and the reason for the difference was discussed for further understanding localized corrosion.

The vertical potential profiles in the thin layer of solution near the metal surface at corrosion active sites were different from those at passive area. At corrosion active sites, the vertical potential profile exhibits a V-shape dependence on d_{t-s} . In contrast, the potential decreases monotonously with decreasing d_{t-s} at the passive area. This distinct difference of the vertical potential profile was mainly originated from the combination of electric field of charge transfer and Fe²⁺/Fe³⁺ species distribution in the solution over the active pitting corrosion.



The variations of vertical potential distribution at location of a pitting with time for 18-8 stainless steel immersing in 10% FeCl₃ solution during pitting corrosion development