Application of Scanning Kelvin Probe Force Microscopy and AFM Scratching for Studies of Corrosion

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The development of techniques linked to the atomic force microscope (AFM) has enabled the evaluation of physical and chemical properties of sub-micron structures. Scanning Kelvin Probe Microscopy (SKPFM) and in-situ AFM scratching are particularly useful for studying corrosion phenomena. SKPFM generates a map of the potential distribution across a sample with a resolution of at least 100 nm. Furthermore, the open circuit potential of various pure metals in solution is linearly related to the Volta potential value measured in air immediately after exposure. SKPFM is a useful tool to assess the practical nobility of a surface. This technique has been successfully applied to the heterogeneous microstructure of AA2024-T3 and provided clear evidence regarding the shape, position, compositional inhomogeneities and local practical nobility of copper-rich intermetallic particles. Correlation between the measured potential distribution and the reactivity of these particles has been shown. AFM scratching is a controlled method for local disruption of the protective oxide film on a metal surface in solution. As with other approaches that utilize in situ scratching, the stability of the passive film and the tendency for stabilization of localized corrosion can be monitored. However, the lateral imaging capabilities of the AFM provides an approach to study the role of different microstructural features in the process of localized corrosion stabilization. Finally, AFM scratching can be used to open up small windows in a protective organic coating to reveal selected microstructural features. This enables the study of the corrosion behavior of these features in isolation from the rest of the microstructure or to study the interaction of different selected microstructural features. This approach is useful for understanding the interaction between different types of intermetallic particles in AA2024-T3.

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