

An Electrochemical Impedance Investigation of the Effect of New Corrosion Inhibitors in epoxy Coatings on AA2024-T3 Substrates

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Introduction

Cr(VI) compounds, mainly chromates, are widely applied as corrosion inhibitors in aqueous media. Their high efficiency/cost ratio has made them standard corrosion inhibitors for organic coatings. However, in recent years, more ecological benign alternatives have been investigated to replace chromates in their different fields of applications [1]. One class of molecules that is of interest is represented by the coordination compounds, as they may have several advantages compared to inorganic salts. First, ligands, such as molecules with extended π -delocalized orbitals, may facilitate the electron exchange between the central cations and the environment as well as the stabilization of intermediate oxidation states. Second, organic coatings, offer the possibility of distributing metal cations homogeneously into an organic coating, preventing distribution and release into the environment. Furthermore, mobility and diffusion of a coordination compound may be significant and release of inhibitor under demand might be an important feature of metal complexes. Moreover, coordination compounds are often colored and their color change as a function of both the oxidation state of the central cation and the nature of the ligands. Therefore, corrosion may be easily detected by local changes in the color of the structures undergoing failure.

Experimental Methods

Coordination compounds of vanadium, niobium, molybdenum and other transition metals were dissolved into an epoxy coating. Both global and Local Electrochemical Impedance Spectroscopy (LEIS) (Fig 1) [2], [3] were used to monitor the electrochemical behavior of artificial coating defects such as osmotic blisters, pin-holes, scribe-lines in 0.5M sodium chloride. Mapping experiments are usually collected using an AC frequency of 3000 Hz and 15 mV amplitude voltage of the excitation signal.

Results

Figure 2 is a preliminary result showing the admittance of two artificial blisters on an AA2024 electrode. The blister located at X about 17000 microns was produced by depositing a small droplet of solution containing 5.0E-3M NaCl and 3.1E-4M $(\text{BuNH}_3)_6\text{V}_{10}\text{O}_{28}$, while the blister located at X = 5000 microns did not contain the vanadium compound. The admittance mapping clearly shows that corrosion takes place in both blisters at the same rate indicating that the vanadium compound used did not provide significant corrosion protection at the concentration employed.

A detailed series of experiments conducted with different inhibitors both in the coatings and directly deposited onto the electrode surface at different concentrations are in progress and will be presented.

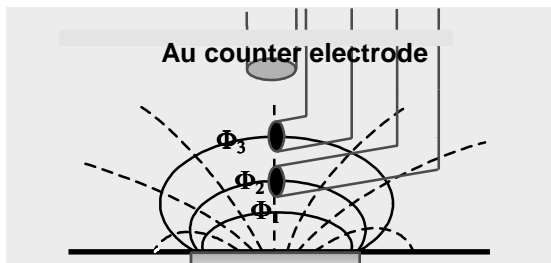


Figure 1 Schematic of five electrode configuration to acquire LEIS data. Distance between ϕ_2 and ϕ_3 is about 250 μm .

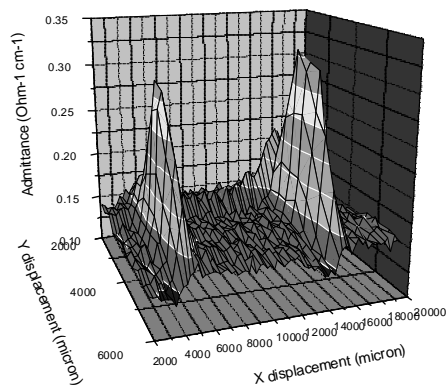


Figure 2 Admittance mapping of two artificial blisters on AA2024 exposed to 0.5M NaCl for 31 hours.

References

- [1] M. Bethencourt, F.J. Botana, J.J. Calvino, M. Marcos, M. A. Rodriguez-Chacon *Corrosion Science* **40** (11) 1803-1819 1998.
- [2] M.W. Wittmann, R. B. Leggat, S.R. Taylor, *Journal of the Electrochemical Society*, **146** (11) 4071-4075 1999.
- [3] S.R. Taylor, *Progress in Organic Coatings* **43** 141-148 2001.