

ION ADSORPTION STUDIES ON ALUMINUM

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The corrosion resistance of aluminum continues to be of interest due to the wide range of industrial applications of aluminum alloys. We are interested in ion adsorption on aluminum because it plays an important role in corrosion initiation and inhibition. It is well known that the adsorption of ions on a metal affects the corrosion resistance of that metal. The adsorption/incorporation of aggressive ions can lead to localized corrosion in the form of pitting or crevice corrosion. Conversely, the adsorption of inhibiting ions can provide a protective film that is not penetrated by aggressive ions. An increased knowledge of ion adsorption ultimately contributes to a better understanding of the processes of corrosion and inhibition, making it easier to identify and create new inhibitors that may work better, or equally well but are safer for the environment, than those currently employed, *i.e.* chromates.

Ion adsorption/incorporation has been studied by various methods including surface analytical techniques [1] and radioactive labeling [2]. In this study our approach was to combine electrochemistry with an *in situ* radioactive labeling technique to monitor ion accumulation as it occurs. Previous adsorption studies performed by this lab (chloride [3], sulfate [3-5], and phosphate [6], and more recently chromate [7] and pertechnetate [8]) have contributed to the current understanding of the interaction of aggressive and inhibiting ions with aluminum and aluminum alloys.

The adsorption behavior of pertechnetate is markedly different from that observed for other ions previously studied. While phosphate has been shown to deposit by forming insoluble aluminum compounds via aluminum dissolution [6], the adsorption of pertechnetate species does not follow the same pattern. It appears to be an electrochemical reaction whereby the pertechnetate ion is reduced, probably to Tc(4+) [8, 9].

The effectiveness of pertechnetate as a corrosion inhibitor is expected to be highly dependent on the presence of competing ions [9]. In this study, the effect of competing ions in the pertechnetate solution was investigated to gain a better understanding of the relative strength and type of adsorption that occurs. However, because technetium has no stable isotope, typical mobility experiments could not be performed. Instead, this data was collected by a series of experiments in which the effect of competing ions present before, during, or after exposure to 0.5 mM pertechnetate solution was investigated.

In the present study the open circuit potential and ion adsorption are monitored simultaneously. It can be seen in Figure 1 that the presence of equal concentrations of nitrate or sulfate in the pertechnetate solution enhances the deposition of the Tc-containing species. Likewise, in the presence of chloride (not shown), the deposition of Tc-species is increased. However, the presence of chromate or phosphate results in a drastic reduction in the amount of Tc-species deposited. The combined

radiochemical and electrochemical data suggests that the chromate and phosphate films neutralize the active sites and block much of the surface, preventing the pertechnetate ions from adsorbing and being reduced at the surface. The effect of other anions is dependent on the concentration of the competing ion.

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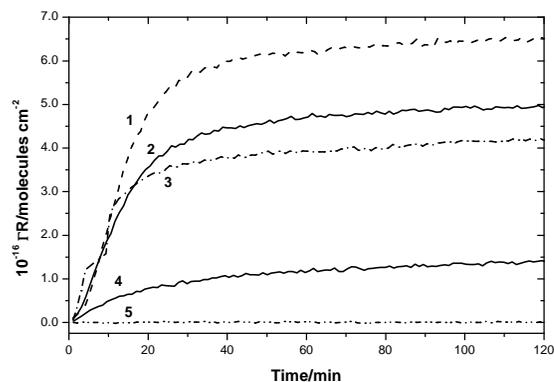


Figure 1: Time dependence of Tc-species adsorption on Al 1100 alloy in the presence of a competing anion. Solution is 0.5 mM in NH_4TcO_4 + 0.5 mM (1) sulfate, (2) nitrate, (3) none, (4) phosphate, or (5) chromate. Solution pH is 4.