

Chemical Heterogeneities in AA2024: Dioxygen Reduction as a Probe of Removal of Cu-Rich Inclusions via Chemical Etching

Guoying Chen, Jesse Seegmiller and Daniel A. Buttry*
Department of Chemistry, University of Wyoming,
Laramie (WY), 82071-3838, USA

Several aluminum alloys contain intermetallic compounds that influence their corrosion behavior. In particular, AA 2024-T3 alloys have intermetallic inclusions that variously contain Al, Cu, Fe, Mn or Mg [1]. These cause corrosion of AA 2024 by virtue of galvanic cells that arise because of compositional variations across the surface [2]. One particular type of inclusion, Al₂CuMg (the S phase), has been suggested to be a source of Cu-rich regions that can act as cathodes in local galvanic cells [1]. This type of behavior is thought to drive the severe susceptibility of these alloys toward corrosion. Thus, there is significant motivation to find mild conditions under which such intermetallic inclusions can be selectively removed from the surface, both to be able to study corrosion at surfaces depleted of one or more inclusion types, and as a possible way to control corrosion in these alloys.

Previously, we described the use of chemical etching baths to remove intermetallic inclusions from the surface of AA 2024-T3 alloys. These baths contain mixtures of oxidants and ligands, with the combination chosen based on the desire to oxidatively complex one or more metals from the inclusions so as to remove them from the surface and prevent their redeposition at other locations. The goal of this work is to inhibit reduction of dioxygen at these inclusions. Thus, a question that arises in such studies is whether or not these chemical etching treatments actually result in inhibition of dioxygen reduction at AA2024 surfaces. In this contribution, we report on the use of purposeful potentiostatic reduction of dioxygen at AA2024 cathodes as a means of assaying the removal of Cu from the surface.

AA2024-T3 samples were cleaned and polished using standard procedures, except that polishing was done in aprotic solvents to inhibit corrosion during the polishing. The samples were etched for various times in solutions containing persulfate (oxidant) and ligands such as ethylene diamine tetraacetate, ethylene diamine, diethylene triamine or triethylene tetraamine. They were then placed in a flow cell that allowed an AA2024 sample to be used as a working electrode in a three electrode potentiostatic configuration with a Pt counter electrode and a SCE reference electrode. This flow cell allows the controlled delivery of solutions that were saturated with respect to either dinitrogen or dioxygen. By switching between these two solutions at an applied potential of -1.0 V, the current due to reduction of dioxygen could be observed at the various samples. This current was measured as a function of the etching time. These data are plotted at right, and show that longer etching times lead to significantly reduced reduction of dioxygen at these samples. We interpret these data as suggesting that the removal of Cu from the Cu-rich inclusions decreases the catalytic efficiency of the surface toward dioxygen reduction. These results and other details of these measurements will be discussed in this presentation.

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REFERENCES

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