The stability criteria for localized corrosion of AA7075-T6 and its application in galvanic interaction with noble materials

Yijing Shi, R. G. Kelly
Department of Materials and Science Engineering
University of Virginia
395 McCormick Rd, Charlottesville, VA 22904

Localized corrosion of Al alloys can be exacerbated by galvanic coupling to more noble materials when the couple is in a conductive, corrosive environment. Modern aerospace structures are increasingly using such couples as a part of designs aimed at weight reduction and for other increased functionality. Quantitative identification of the stability criteria that control the propagation of the localized corrosion of Al alloys and the factors that affect its galvanic corrosion behavior thus are very important.

The present research work specifically addresses the galvanically-induced localized corrosion of AA7075-T6 in contact with several noble materials including silver, nickel, bis-maleimides (BMI)/carbon fiber composites, under both full immersion and atmospheric conditions. The overall study is composed of two parts. First, a quantitative understanding of the stability criteria that control the propagation of localized corrosion of AA7075-T6 is sought using electrochemical testing with both bulk samples and artificial pit samples [1]. The repassivation potential, E_{rp}, known as a critical stability criterion, was measured in a range of chloride solutions relevant to atmospheric exposure in order to determine the minimum potential to maintain localized corrosion propagation. The accuracy of this potential in predicting a go/no-go condition for localized corrosion was tested with both current decay measurements and long-term potentiostatic exposure testing under full immersion. The other pit stability criterion, Galvele's stability product [2], was determined by the potentiodynamic scanning measurements on artificial pit electrodes of 25 micron diameter in order to ensure that the entire artificial pit surface is corroding [3-4]. Alloying effects on these criteria can be determined by comparing the results to those for pure Al. This understanding is then applied to galvanically-induced localized corrosion of AA7075-T6 under atmospheric conditions. The Scanning Kelvin Probe was used to measure the potential profile away from the coupling interface as a function of the noble metal, the nominal area ratio, the salt loading and the RH. After 100 h exposure, the spatial distribution of the damage was also determined via cross-sectional metallography. The SKP results were then compared with the damage morphology to validate the correlation between E_{rp} and the limit of damage evolution. In addition, the finite element analysis (FEA) method was used in order to rationalize the scenarios under which localized corrosion can be stabilized.

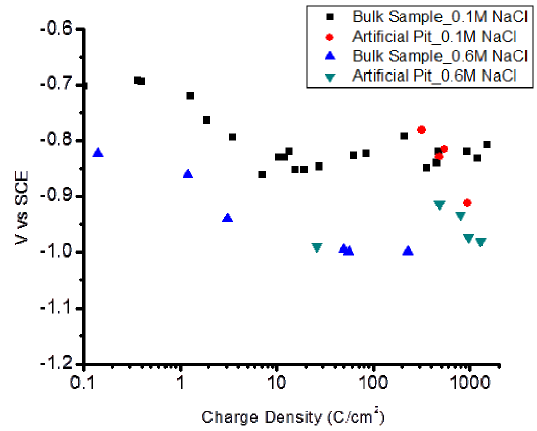

Figure 1: *E_{rp} measurement of AA7075 as a function of charge density with different solution concentration for both bulk and artificial samples*

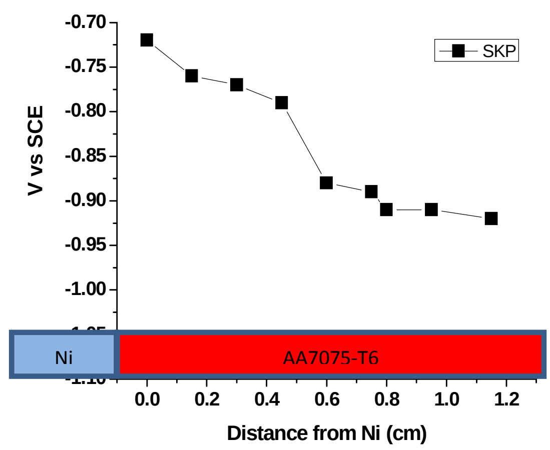

Figure 2: *Potential Distribution away from the coupling interface (Ni-AA7075-T6) measured by scanning kelvin probe after 100hours atmospheric exposure with 98%RH.*

References

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