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PII: S0264-1275(16)30086-7
DOI: doi: 10.1016/j.matdes.2016.01.089
Reference: JMADE 1290

To appear in:

Received date: 28 October 2015
Revised date: 6 January 2016
Accepted date: 20 January 2016

Please cite this article as: Mary Lyn C. Lim, Robert Matthews, Michael Oja, Robert Tryon, Robert G. Kelly, John R. Scully, Model to predict intergranular corrosion propagation in three dimensions in AA5083-H131, (2016), doi: 10.1016/j.matdes.2016.01.089

Model to Predict Intergranular Corrosion Propagation in Three Dimensions in AA5083-H131

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Abstract
A three-dimensional (3-D) granular model that has the capability of predicting time-dependent intergranular corrosion (IGC) damage propagation depths in AA5083-H131 exposed to 0.6 M NaCl solution under potential control is presented. The geometry of grains and degree of sensitization (DoS) of grain boundaries were utilized as inputs, organized in a database, which informed the model to produce IGC depth distributions. The dependencies of IGC depth with exposure time, DoS, and orientation of propagation, both in terms of propagation kinetics and damage morphology, are outputs from the model. The model was calibrated by comparing outputted damage depths to IGC depth data from experiments. Model validation was achieved by comparing the predicted to experimental IGC depths based on image analyses of metallographic cross-section of AA5083-H131 exposed under the same conditions. The relevance and limitations of the current version of the model are discussed.

Keywords: Al-Mg alloy, sensitization, intergranular corrosion, 3-D model, statistical model

Introduction

Due to their characteristic high strength-to-weight ratio, general corrosion resistance, and weldability, aluminum alloys are widely used in aerospace, automotive, and marine industries.[1–7] This combination of material properties makes such alloys the material of choice in applications involving corrosive environments. However, depending on its metallurgical state, these alloys can become vulnerable to localized corrosion and associated corrosion cracking and fatigue due to their heterogeneous microstructure.[7–13] One such alloy is the AA5XXX Al-Mg class of alloys, which are increasingly used as lightweight substitute for steel in marine environments.[1,4,6,14,15] Although these alloys are designated as marine grade aluminum alloys, during service these alloys can become susceptible to intergranular corrosion (IGC) and intergranular stress corrosion cracking (IGSCC) in