MODELING PITTING CORROSION INDUCED BY CLUSTERS OF PARTICLES

D.G. Harlow
Mechanical Engineering and Mechanics
Lehigh University
19 Memorial Drive West
Bethlehem, PA 18015-3085, USA
dgh0@lehigh.edu

Pitting corrosion is a primary degradation mechanism that affects the durability and integrity of structures, especially those made with aluminum alloys. Consequently, it is a major concern for commercial transport and military aircraft that have been in service well beyond their original design service objectives. Corrosion pits have been shown to initiate at constituent particles in an alloy and to evolve into severe pits by growth through clusters of these particles. These severe pits then serve as nucleation sites for subsequent corrosion fatigue cracking. Thus, the role of clusters of constituent particles is critical to the quality of aluminum alloys subjected to deleterious environments. To formulate a stochastic model of corrosion, as a part of the methodology for structural reliability analysis, it is essential to have quantitative descriptions of the spatial statistics of the particles and particle clusters, including their location, size, density and chemical composition. A simple scientifically based probability model incorporating the role of clustered particles on the growth of corrosion pits is presented and discussed. The proposed model includes the effect of randomness in the number and sizes of the clusters. The applicability of the model is considered in terms of experimental data from 2024-T3 and 7075-T6 aluminum alloy specimens that had been exposed to a 0.5 M NaCl solution which is approximately the composition of salt water.

Keywords: constituent particles, clusters, pitting corrosion, probability modeling, spatial statistics