Abstract #1726, 224th ECS Meeting, © 2013 The Electrochemical Society

Multidimensional Simulation of Corrosion at Coating Defects

J. N. Harb‡*and C. Lueth†

‡*Department of Chemical Engineering*
Brigham Young University, Provo, Utah 84602

†*CD-adapco Seattle*
13810 SE Eastgate Way, Sunset Corporate Campus,
Bellevue, WA, 98005, United States

**Corresponding Author: john_harb@byu.edu*

Mechanistic models of corrosion systems facilitate quantitative insight into the physical processes that control the rate and extent of corrosion, and identification of key factors that may be effective in mitigating corrosion damage. Such models, and the increased understanding derived therefrom, will also enable more effective use of accelerated testing to predict behavior under realistic conditions.

Corrosion at defects in organic coatings, particularly underpaint corrosion, is of great interest to the automotive and other industries. Such coatings, which protect surfaces from corrosion, inevitably experience defects where the integrity of the coating is breeched. Corrosion not only attacks the metal exposed at the defect, but also damages the area under the adjacent coating. The oxygen permeability of the coating is an important factor that influences the corrosion behavior and coating delamination at the defect.

Stratmann *et al.* published a series of papers documenting an experimental study of coating delamination due to corrosion at defects [1−6]. Their work, which was done on a well-defined experimental system with *in situ* diagnostics using a simple, transparent polymer coating, provides an excellent basis for model development and validation. A one-dimensional model, which used an empirical relationship between the coating porosity and the local pH in describing ion transport, was developed by Allahar *et al.* to predict delamination [7]. This model was followed more recently by a two-dimensional model [8], which incorporated many of the same assumptions as Allahar [7], and made some significant simplifications when defining the 2D computational domain.

The present modeling study builds upon previous experimental and modeling work to provide a multidimensional description of corrosion at coating defects. The data of Stratmann *et al.* are used for model development and validation [1−6]. The resulting model is used to evaluate the impact of a number of variables on the corrosion behavior at defects, including the amount of liquid in the defect, the thickness and morphology of the polymer coating, the permeability of oxygen through the coating, and the impact of defect geometry in two and three dimensions. Other factors, such as the implications of sequential wet and dry periods on the corrosion behavior, are also considered.

References

1. A. Leng, H. Streckel, M. Stratmann, *Corrosion Science*, 41 (1999) 547–578.
2. A. Leng, H. Streckel, M. Stratmann, *Corrosion Science*, 41 (1999) 579–597.
3. A. Leng, H. Streckel, K. Hofmann, M. Stratmann, *Corrosion Science*, 41 (1999) 599–620.
4. W. Furbeth, M. Stratmann, *Corrosion Science*, 43 (2001) 207–227.
5. W. Furbeth, M. Stratmann, *Corrosion Science*, 43 (2001) 229–241.
6. W. Furbeth, M. Stratmann, *Corrosion Science*, 43 (2001) 243–254.
7. K.N. Allahar, M.E. Orazem, K. Ogle, *Corrosion Science*, 49 (2007) 3638.
8. T.M. Amorim, C. Allély, Proceedings of the COMSOL Users Conference, Grenoble (2007).