Release and Transport of Chemical Species Within and From Functional Coatings

W. Gan, C. Lin, R. G. Kelly
Center for Electrochemical Science and Engineering
Department of Materials Science and Engineering
University of Virginia
Charlottesville, VA 22904

Advances within the materials and chemical sciences have created a unique opportunity for the identification of a new multi-functional and environmentally compliant aerospace coating for military hardware. A new multi-functional coating system for military aircraft will be developed by implementing advances in molecular-and nano-engineering.

Many of the approaches for achieving a functional coating (*e.g.*, inhibitor release from encapsulants, polychromism, sensing) require the controlled release of chemical species. Quantitatively characterizing the pathways, mechanisms, and controlling parameters of the retention and release of the functional species is required to develop long-lived but rapidly responsive functional coatings.

The objectives of this research are to:

(1) quantitatively understand the parameters that control the release and transport of active corrosion inhibitors from organic and inorganic matrices to areas of active corrosion,
(2) assist efforts in optimal design of loading and release mechanisms for long-lived but rapidly responsive functional coatings.

Experimentally, the solution concentration of chemical species leached from proposed coatings systems (both organic and inorganic) will be measured in the leachate as a function of time, pH, ionic strength, electrochemical potential on both inert and Al alloy substrates. This will also be performed for the encapsulation systems proposed as both isolated capsules and also when incorporated within various resin systems. It is the latter condition that will ultimately determine the inhibitor delivery rate, but which is impossible to predict based upon unknown capsule/matrix interactions. Measurements will be made with a combination of capillary electrophoresis, confocal laser scanning microscopy, and various electrochemical probes.

Computationally, it is desired to extend the mass transport modeling currently done at UVa on occluded region corrosion to functional coatings. In addition, it is desired to determine the "throwing power" of such active inhibitors as a function of the coating formulation parameters that affect the release and transport kinetics. This work will assist design and development of functional coatings by calculating the effects of coating/cladding parameters on release kinetics and transport through films.