

## Task 2.2; Task 2:

### **Title:** *Analysis of Relative Importance of Surface Environment Components and Dynamics*

**Objective:** The overarching objective of this task is the quantitative assessment of the roles of relevant chemical species on the corrosivity of natural atmospheres including the species identified in Task 1.

**Technical Approach:** The levels of species measured in Task 1 will be used to guide the design of experiments matrix to assess the relative importance of the many species. Laboratory studies will use electrochemical measurements to characterize the effects of the species on active (steel) and passive (aluminum) alloys as well as the films that develop on silver. The concept and standard approaches to measurement of TOW will be assessed. There are a number of different approaches to measure TOW, but their relation to the corrosivity of the surface environment requires clarification. The dynamic nature of surface environments will also be studied in the laboratory to assess the role of variations in temperature/RH cycles on the corrosion behavior of both active and passive metals. Two-dimensional microelectrochemical cells will be used to measure the responses of metallic surfaces *in-situ* during dynamic changes in temperature and RH. The effects of UV light on the corrosion electrochemistry and behavior of steel, aluminum, and silver will be evaluated in laboratory studies. Specific milestones are as follows:

- *Quantitatively determine the relative contributions of the species identified in Task 1 on the corrosion type and rate of attack on steel, an aluminum alloy, and silver.* A design of experiments (DOE) approach will be used to develop a fractional factorial design of solution chemistries to be used. Electrochemical polarization data will be generated for each material in each environment. The polarization data will be analyzed in terms of corrosion rate, corrosion potential, pitting and repassivation potentials (as required), and these data will be analyzed in statistical software to determine which species and combinations have the most important effects.
- *Develop a robust definition and method for determination of the TOW that is broadly applicable and is directly relevant to the chemical and electrochemical reaction kinetics occurring in the surface environment.* The dynamic nature of surface environments will also be studied in the laboratory to assess the role of variations in temperature/RH cycles on the corrosion behavior of both active and passive metals. The scanning Kelvin probe will be used to measure the responses of metallic surfaces *in-situ* during dynamic changes in temperature and RH.
- *Quantify the effects of UV exposure on the chemistry and electrochemistry of metallic surfaces in terms of corrosion with a specific focus on silver.* The scanning Kelvin probe will be used to measure the responses of metallic surfaces *in-situ* during the exposure to UV light in the presence and absence of salt on the surface and ozone.

**Student Development Approach:** A combination of graduate research assistants, post-doc and undergraduate research assistants will be used to accomplish the work. Either an M.S. or Ph.D. degree will be obtained. Student participation at the Tri-service Conference and other forums will be expected.

**Suggested Collaborator Role:** Collaboration with USM will involve coordination of analyses of the effects of corrodent species including those that result from polymer degradation. The work on silver will be coordinated with the work in Task 1 and related work at OSU.

**DOD Payoff:** This proposed OUSD program will leverage and capitalize on the foundation established at UVa in identification of corrosion test environments based on service exposures. In addition, it provides a natural extension of the current OUSD program on naturally occurring reactive halogens. The work represents a critical step in the establishment of improved accelerated testing. The data resulting from this work will be provided to OUSD for enhancement and validation of their current corrosion rate model as developed by Battelle.