Corrosion, the degradation of materials, has a massive economic impact. The estimated annual cost of corrosion to the U.S. economy is on the order of $200 billion. Our current work focuses on moving the field of corrosion science and engineering from one of simply explaining phenomena under controlled laboratory conditions to one of predicting corrosion damage modes and rates for conditions relevant to actual engineering structures. Applications include life prediction of naval structures using advanced aluminum alloys, long-term storage of nuclear waste, compressor blades for jet engines, and high-strength aluminum alloys for aerospace structures. In all cases, we combine experimental measurements using state-of-the-art probes with modeling across a wide range of time and length scales. Collaborations are critical to the success of the work, and our group has close interactions with faculty from Chemical Engineering, Systems Engineering, and Environmental Engineering, as well as others in Materials Science and Engineering.
Improved Accelerated Corrosion Tests
One of the most challenging aspects of corrosion engineering is need to accelerate the
damage in laboratory tests in order to predict damage under less aggressive conditions in
the field. Unfortunately, many accelerated corrosion tests lack a strong science basis and
are thus not sufficient for life prediction. By combining recent advances in atmospheric
science on the chemistry of aerosols with improved means of measuring corrosion under
atmospheric conditions, we are developing improved accelerated tests that increase the
fidelity of the corrosion morphology while increasing the rate of attack by over 400,
allowing tests of 1 week to accurately predict damage that would take nearly 8 years to
occur in service. Materials of interest include carbon steel, the most widely used metallic
material, as well as advanced aluminum alloys, and stainless steels. Collaborations are
ongoing with Prof. Keene in the UVa Department Environmental Science, as well as with
colleagues at Ohio State University, University of Hawai‘i-Manoa and CSIRO (Australia).

Life Prediction of Naval Al-Mg Alloys
Naval ship structures are increasingly being constructed from Al-Mg alloys in efforts to
increase speed and range. Our work involves developing an integrated suite scientific and
engineering models to predict the damage evolution for such structures. The damage
results from the development of a metallurgical condition known as sensitization, and the
subsequent damage due to combination of intergranular corrosion, stress-corrosion
cracking, and fatigue. The model so developed predicts the statistical distribution of the
time-to-failure for ship components, which allows for more accurate service life prediction
as well as design of maintenance and repair schedules. Collaborations with Profs. Scully,
Gangloff and Burns in Materials Science are coupled with ongoing work with the
University of Utah.

Localized Corrosion: Measurement & Modeling
Localized corrosion is very common, but understanding and predicting continues to be a
challenge. Our recent evaluation of the literature on long-term atmospheric exposures of
stainless steels has provided support for the idea that there exists a maximum bound on the
size a pit can achieve under these conditions. Understanding the origins and controlling
factors behind such a bound would have a profound impact on the ability to assess the
likelihood of corrosion failure of these materials. Our current work combines advanced
measurements and modeling of localized corrosion in stainless steels and aluminum alloys
to develop and validate a means to predict the maximum amount of pitting or intergranular
corrosion damage that can occur on a surface of corrosion resistant alloys exposed to
atmospheric conditions. Collaborations are ongoing with colleagues at Rolls Royce and
Alcoa.

RECENT RESEARCH DEVELOPMENTS
• Developed a computational model for the inhibitor release and transport within and
from a hydrotalcite coating system to assist in the design of the multifunctional coating
systems with encapsulated inhibitors.
• Developed improved accelerated salt spray laboratory corrosion test.

RECENT GRANTS
High-Performance Alloys that Affect Air and Land Vehicle Structural Integrity
• ONR – Mechanistic Studies if Intergranular Corrosion and Stress Corrosion Cracking
Under Atmospheric Exposure Conditions
• OUSD – Investigation of Selected Atmospheric Corrosion Processes on
Modern High-Performance Ferrous Alloys that Affect Structural Integrity: Development
of Predictive Capabilities and Test Methods
• ONR – Understanding and modeling the inhibitor-based mitigation of atmospherically
induced structural degradation of galvanically coupled airframe components

SEAS Research Information
Pamela M. Norris, Associate Dean
University of Virginia
Box 400242
Charlottesville, VA 22903
pamela@virginia.edu
434.243.7683