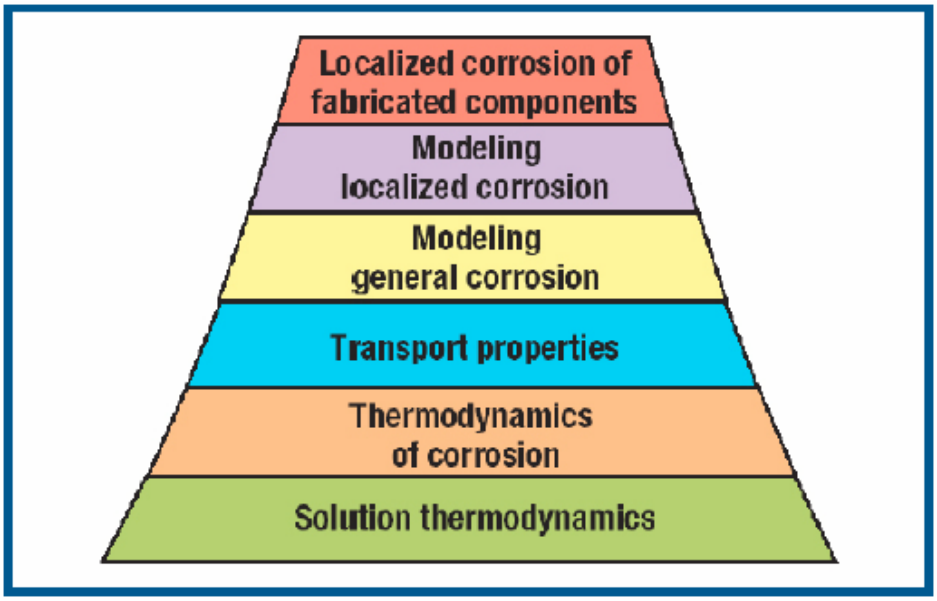
Prediction of Corrosion of Advanced Materials and Fabricated Components

New Corrosion Prediction Tool Facilitates Selection and Development of Corrosion-Resistant Alloys, Identification of Fabrication Process Conditions, and Prediction of Remaining Life

Corrosion issues occur across various industries. Modeling of the various aspects of the corrosion behavior of materials is in its early stages. Models to predict the general corrosion of certain alloys exposed to aqueous/organic environments exist. However, in many cases, localized corrosion dominates the performance characteristics of various components. Thus, there has been a need for the development of models to predict localized corrosion and pitting damage accumulation that occurs in various alloys used in corrosive environments. This project developed a computational tool that predicts the corrosion performance of fabricated components in industrial corrosive environments using minimal experimental data.

At the heart of the approach was the development of correlations between local compositional changes in the alloys arising from fabrication and the fundamental parameters that dictate the occurrence of localized corrosion. These correlations were used to predict the occurrence of localized corrosion and damage in base materials, welds, and weld overlays in selected industrially relevant alloys.



Conceptual structure of corrosion simulation technology

Benefits for Our Nation and Our Industry

The innovative technology for better prediction and management of localized corrosion resulted in benefits due to improvement in component life and productivity, reduction in waste and environmental damage, and improved risk management. Energy efficiencies resulted from reduced process losses, reduced unscheduled downtimes, less heat transfer losses attributable to corrosion and corrosion by-products, and improved thermal efficiencies due to more optimum design of components.

Applications in Our Nation's Industry

The corrosion modeling tool has found applications in industries where fabricated components are exposed to corrosive environments, including chemicals, forest products, and petroleum industries.

Project Description

The goal of the project was to develop a simulation methodology to predict the susceptibility of fabricated components to localized corrosion as a function of alloy composition, fabrication procedures, and external environmental conditions.

Barriers

Barriers addressed:

- The need to account for the effect of significant microstructural and compositional variations that occur with changes in process parameters;
- Lack of a universal parameter for correlating weld or coating characteristics with localized corrosion potential; and
- The necessity for incorporating local alloy chemistry effects in the corrosion potential, repassivation potential, and damage functions.

Pathways

The objectives of the project were achieved through (1) selecting critical alloys, treatment methods, and representative process environments; (2) developing an experimental database of alloy microchemistry in relation to fabrication process parameters; (3) obtaining electrochemical parameters that govern localized corrosion and damage growth and distribution, (4) extending the existing methodology for predicting the occurrence and propagation of localized corrosion to handle fabricated components as well as base metals; and (5) encapsulation of the models in engineering software.

Results

- Selected list of alloy compositions and process parameters of interest to the industry
- Developed database containing correlation of fabrication process parameters with alloy microchemistry
- Correlated alloy microchemistry with repassivation and corrosion potentials for selected environments
- Developed correlation of damage growth and distribution with electrochemistry, and microchemistry
- Developed correlations between alloy chemistry and the general corrosion potential model
- Developed a comprehensive model for relating the repassivation potential to alloy chemistry
- Extended and verified damage function model to include welds and other heat treatments
- Implemented models in OLI Systems' existing software, CorrosionAnalyzer, and test in industrial trials

Commercialization

This project was conducted by technology leaders under the oversight of industry experts, thus ensuring the industrial relevance of results. OLI Systems had substantial expertise in the development of computational tools and had already developed a commercial corrosion modeling product. OLI utilized its existing customer base and its distribution and marketing partners to promote the new product, as well as to offer short term leases and providing a consultation service. The models developed in this project were incorporated into existing OLI Systems products and have now been made commercially available in a package called CorrosionAnalyzer.

Project Partners

OLI Systems
Morris Plains, NJ
(Andre Anderko:
aanderko@olisystems.com)

Chevron Texaco Exploration and Production Technology Company
San Ramon, CA

DuPont Engineering Technology
Wilmington, DE

Haynes International Inc.
Kokomo, IN

Mitsubishi Chemical Corporation
Okayama, Japan

Shell Global Solutions (US) Inc.
Houston, TX

Southwest Research Institute
San Antonio, TX

Toyo Engineering Corporation
Chiba, Japan

A Strong Energy Portfolio for a Strong America

Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.

U.S. Department of Energy
Energy Efficiency and Renewable Energy
Bringing you a prosperous future where energy is clean, abundant, reliable, and affordable

Ending FY07
September 2007