Microbial Fouling and Corrosion

A wide range of environmental microbes thrives on the surface of metals and in industrial water systems. Their metabolic activities can significantly affect the metal surfaces as well as other surfaces in contact with water. Potential negative effects include corrosion, pitting, fouling, plugging and loss of heat transfer capabilities. These effects are observed in a range of infrastructure settings, e.g., power plants, roads, bridges, piping, metal, containers and storage pool liners.

INL biological systems and materials scientists and engineers have conducted studies to better understand and control these effects. Techniques and tools to define these naturally occurring microbes and their associated biofilms include scanning electrochemical microscopy, environmental scanning electron microscopy (ESEM), atomic force microscopy, and molecular biology techniques to characterize the organisms and their metabolic products.

Progress

INL scientists have researched biocorrosion issues such as nuclear fuel storage pools, geothermal power plants, concrete bridge and piping systems, and industrial sheet metal infrastructure items. Concerns driving the research range from deterioration of critical structures, to poor energy transfer, to environmental release of toxic materials.

Microbial growth in geothermal power plants is a common problem. Microbes and the associated biofilm interfere with energy transfer, and if untreated, lead to biocorrosion of the metal surfaces in these plants. Microbial monitoring and characterization is the first step in controlling the negative impacts associated with fouling and corrosion.

The biocorrosion phenomenon has been put to beneficial use on the surfaces of radioactively contaminated concrete. Selected microbes are deployed on the concrete, where they produce an acid that gradually loosens the surface over a few weeks or months. This "biodecontamination" technique minimizes human exposure to ionizing radiation and reduces the cost of decontamination.

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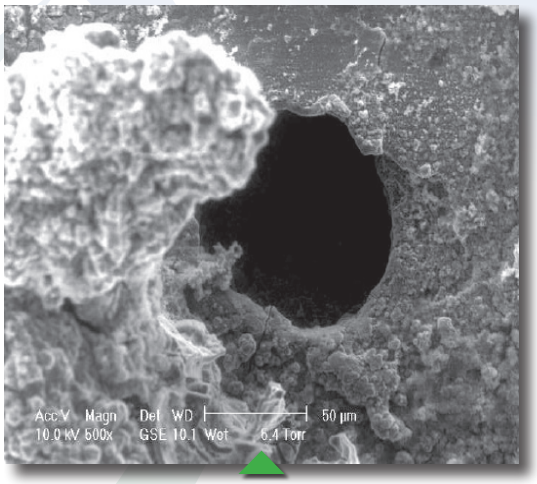
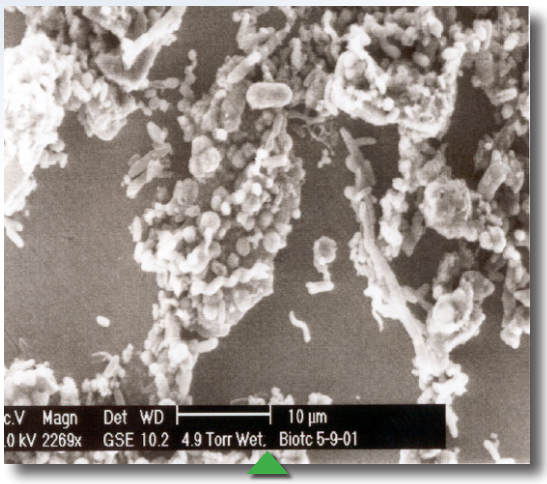


Biocorrosion pit ESEM



Microbes on metal surface ESEM

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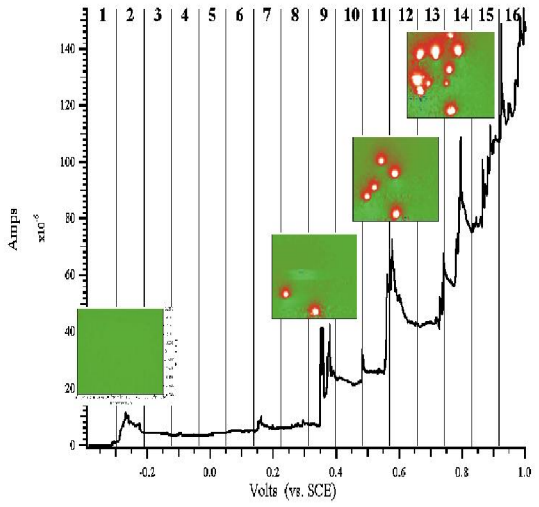
Sample SRET Scan of Al6061-T6 in Sterile Conditions



Measuring and visualizing metal surface biocorrosion process.

Selected Publications/Presentations

Bruhn, D.F., S.M. Frank, F.F. Roberto, P.J. Pinhero, S.G. Johnson. 2009. Microbial Biofilm Growth on Irradiated, Spent Nuclear Fuel Cladding. Journal of Nuclear Materials. 384: 140-145.

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P. A. Pryfogle, "Evaluation of Biological Measurement Methods Used at The Geysers," *Geothermal Resources Council Transactions,* Vol. 24, September 2000, pp. 24–27.

M. A. Hamilton, R. D. Rogers, L. O. Nelson, R. G. Holmes, T. N. Milner, "Biodecontamination: Cost-Benefit Analysis of A Novel Approach for Decontamination of Massive Concrete Structures," *Proceedings of Institution of Mechanical Engineers, National Meeting, Nuclear Decommissioning 98,* London, December 1998.

M. A. Hamilton, R. D. Rogers, R. H. Veeh, M. Zolynski, "Evaluation of Microbially-Influenced Degradation of Massive Concrete Structures," *Materials Research Society Symposium Proceedings 412, 1996,* pp. 469-474.

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