Case Study

Pitting corrosion – looking into industrial processes using time-resolved *in situ* studies

The Problem

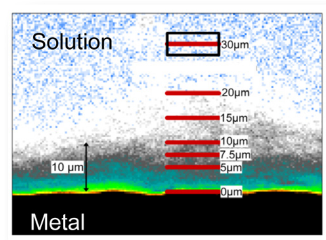
"Corrosion resistant" metals are used in challenging environments and where safety is critical, such as in pipelines, aircraft and nuclear waste storage vessels. But it is precisely these materials that are vulnerable to a form of corrosion known as pitting. Understanding of the mechanisms by which these pits form and propagate may allow engineers to build more accurate models of corrosion to predict the lifetime of components and plan when they need inspecting or replacing.

The Challenge

Corrosion pits can occur in metals such as stainless steel, and nickel, penetrating beneath the surface of the otherwise passive metal. Inside these pits a highly concentrated acidic metal chloride solution develops, from which a layer of salt crystals can precipitate, affecting the corrosion rate. However, the structure and chemistry of these layers is very difficult to study as they are present only on dynamically-dissolving metal surfaces.

The Solution

Scientists from the University of Birmingham used Diamond's beamline I18 to carry out *in situ* X-ray diffraction and X-ray absorption spectroscopy studies on salt layers and solutions in one-dimensional artificial corrosion pits designed to be characteristic of real pits. I18's micro-focused X-ray beam revealed that the phases present in salt films on dissolving iron, nickel and stainless steel surfaces can vary through their thickness and showed that the metal ions have different chemical coordination environments depending on their proximity to the dissolving metal surface.



The Benefits

This work has demonstrated that it is possible to observe the mechanisms of pitting corrosion with high spatial resolution, identifying the chemical species present. The nature of the salt layers and the chemical species in the solution affect the rate of pit growth by changing the transport of species out of the pit. This information can now be used to develop and validate models that predict the long-term growth of corrosion pits.

"Our research is providing the underpinning knowledge of corrosion come mechanisms and rates: the results can be used to validate corrosion prediction models over short periods of time and assess the level of confidence in longer term predictions."

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