

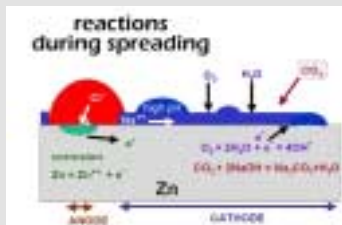
# Synchrotron Investigations

## 8.6 Case study 5: Corrosion

Articles can be found at:

- <http://www.sciencedirect.com> (type corrosion in the search facility)
- <http://www.nsls.bnl.gov/about/everyday/corrosion.html>

## Corrosion



A diagram that shows some of the reactions that occur as corrosion spreads.



Corroding sites on aluminum form under a disk of agar gel containing salt (NaCl) and a pH indicator.

### Fast Facts

- One of the most commonly known forms of corrosion is rust
- Rust is a layer of iron oxide on the surface of the metal
- When corrosion forms very thin layers of oxides, it helps metals keep their shape
- Corrosion costs the USA and Europe in excess of 3% of GNP (Gross National Product).
- A common way to slow corrosion is to add a layer of paint to block contact with the atmosphere.

### What is corrosion?

If you ever had to replace rusted bike gears, or throw out old discolored silverware, you have encountered corrosion. Chemically corrosion is a reaction where oxygen bonds to metal atoms forming an oxide coat. This means that the metal combines with the oxygen in the air and becomes a different material, one that no longer possess the characteristics that you want in gears or forks.

### Are there any good forms of corrosion?

Although the most commonly know forms of corrosion, such as rust, are bad, one form of corrosion is very useful. It is the thin oxide layer that forms as a result of corrosion and prevents bad types of corrosion that changes the shape of the metal.

### What speeds up corrosion?

There are many factors that can cause corrosion, and the type of metal plays a big role in the rate at which corrosion occurs. For example chromium corrodes much slower than iron; valuable metals like sterling silver, platinum and gold hardly corrode at all. The environment also plays a role in corrosion. Metals corrode faster in hot humid climates and slower in cold dry ones. Other chemicals, such as chloride, which is commonly found in seawater and on roads in winter, can drastically increase the rates at which things corrode.



### Can we stop corrosion?

Although we can't stop corrosion all together, there are ways we can slow it down. Stainless steel is a mixture of chromium and steel. The outer layer forms a chromium oxide because it corrodes much slower than the iron. Also if

we can keep oxygen away from the metal we can slow corrosion. Although we can't keep everything in a vacuum we can add a coat of paint or plastic to the metal, protecting it from the atmosphere.

### What is BNL doing to understand corrosion?

Researchers at BNL are trying to determine exactly how chromate helps to protect metal from corrosion. It is suspected that chromium (VI) is reduced to chromium (III) and forms the very thin protective form of oxide.



### How is synchrotron light used?

At the NSLS, X-rays are used to look at the oxidation state of chromium to determine if it is forming a solution or remaining on the surface of the sample.

### How will this research help prevent corrosion in the future?

By understanding how chromium prevents corrosion, researcher hope to develop better chromate conversion coatings to protect metals from corrosion.

### For more information, you can contact:

Dr. Hugh Isaacs  
Division of Material and Chemical Sciences  
Building 480  
Brookhaven National Laboratory  
Upton, NY 11973  
Phone: (631) 344-4516  
Email: isaacs@bnl.gov