

Recognizing Active Corrosion

Introduction

Metal corrosion can be active or inactive. Some objects may be corroded but stable, and therefore inactive; others may be actively corroding. An important part of preventive maintenance of metals is to recognize the early stages of destructive, active corrosion. Very few shiny metal artifacts will remain in that condition. Only metals such as gold and platinum will retain a fully metallic or polished surface for a long time.

Inactive corrosion occurs as a stable oxide layer — a tarnish or colour change that slowly forms on metal artifacts and protects the underlying surface. The oxide layer is often considered to be a desirable patina, particularly if it has a pleasing appearance. Artificial patinas are often applied to the surface of a metal object to protect it and change its appearance. Artificially patinated surfaces on artifacts are found mostly on sculptures, medals, weapons, and tools.

By contrast, *active corrosion* causes a continuing loss of material from the object. Action must be taken to slow down or prevent further deterioration.

Examining a collection to identify corroding metal artifacts can reveal problems with environmental conditions. High relative humidity (RH) or pollutants can initiate many of the corrosion reactions.

Environmental factors that could contribute to active corrosion are discussed under each metal.

Only the metals most commonly found in museum collections are considered in this Note: iron, copper, copper alloys (such as brass and bronze), lead, silver, pewter, and plated metals.

Identification

Active corrosion can be identified by a rapid expansion in volume as the metal alters to form a corrosion product. Flaking or powdering of the surface

may occur. **Any metal artifact surrounded by flakes or by loose powder can be considered actively corroding** (see Figure 1). Common signs of active corrosion in specific metals are noted below.

Iron

Stable surfaces on iron are compact, adherent, and vary in colour between blue-black and red-brown.

One form of *active corrosion* is commonly found between the metal core of the artifact and its outer corrosion layer. Clear indications of active iron corrosion include fragments surrounding an object, depressions on the metal surface, and orange spots in the centres of these depressions (see Figure 2).

Another form of particularly active corrosion of iron is recognized by “sweating” or “weeping”— yellow, brown, or orange droplets on the metal surface (see Figure 3). Sweating or weeping occurs where the RH of the environment in which the iron is housed is high (i.e. 55% and above). At lower levels, around 50% RH, the weeping areas will desiccate to produce orange or brown blisters (see Figure 4). (For more information on the care and storage

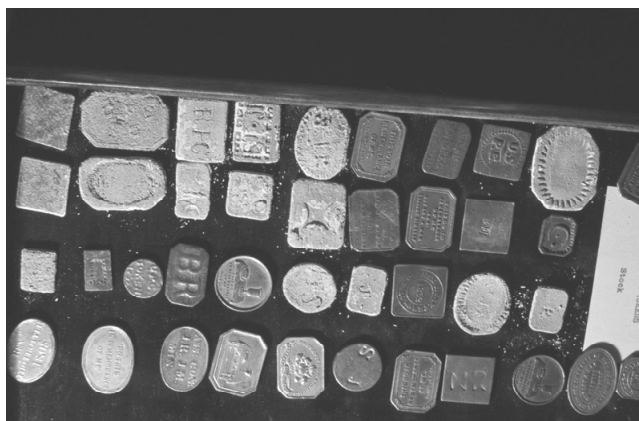


Figure 1. The lead tokens covered with white corrosion and surrounded by white particles are suffering from active corrosion; the other tokens are not.

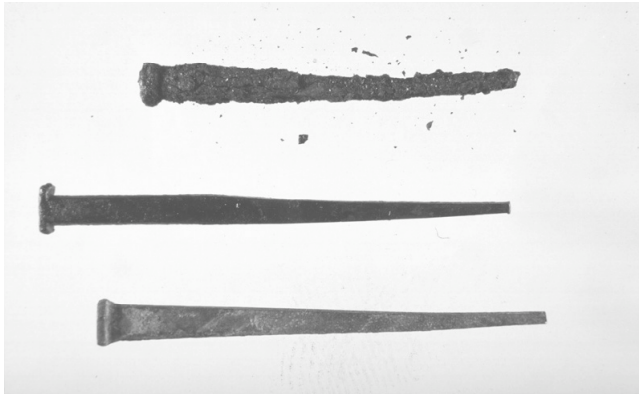


Figure 2. The corrosion products surrounding the top nail provide evidence that this nail is unstable and is suffering from active corrosion. The two lower nails are stable.

of iron, and on composite objects with iron parts, see CCI Notes 9/6 *Care and Cleaning of Iron*. For more information on active iron corrosion, see Turgoose 1982.)

Copper and Copper Alloys: Brass and Bronze

Stable surfaces on copper and copper alloy artifacts are characterized by a wide variety of natural and artificial patinas. Stable patinas on these metals are generally coherent, adherent, and smooth. Stable patinas vary in colour from red, brown, black, and blue to shades of green. Stable corrosion layers, which develop on archaeological copper artifacts, may appear rough and uneven.

Active corrosion of copper and copper alloys is characterized by the rapid development of a light green powder erupting in spots over the surface. This powder may surround an undisturbed object. This type of corrosion is most common on archaeological copper alloys and is known as "bronze disease." As with sweating and weeping, bronze disease occurs where the RH is high (i.e. 55% and above). The corrosion reaction is progressive and may rapidly cause extensive damage. (For more information on bronze disease, see Scott 1990.)

Active corrosion on copper and copper alloys may also appear as a loosely adherent, powdery layer over the surface, rather than as spots. These corrosion layers may be induced by atmospheric pollutants, most commonly airborne chloride particles (particularly in coastal areas) and acetic acid. Both pollutants produce a green surface layer. Ammonia, as a gaseous pollutant often found in window cleaning compounds, produces a bluer corrosion layer.

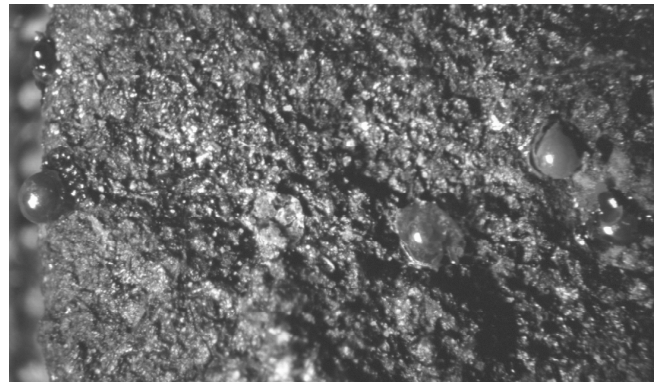


Figure 3. Spherical drops of liquid on the surface of archaeological iron are characteristic of weeping iron and active corrosion caused by chloride ion contamination. Magnification approximately $\times 6$.

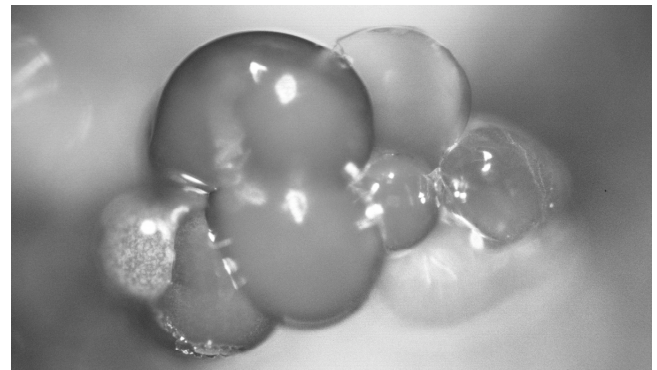


Figure 4. Detail of hollow shells characteristic of weeping iron on archaeological iron. Magnification about $\times 25$.

Lead and Pewter

Stable patina on lead is a darker grey than the stable patina of pewter. The colour may vary depending on the composition of the alloy, the object's past history, and its present storage conditions.

Active corrosion on lead and pewter is characterized by the formation of loosely adherent white powder. The powder may form evenly over the surface, but is often concentrated in pinpoint spots. Powder surrounding an undisturbed object is a clear indication of active corrosion. This white powder is basic lead carbonate (better known as lead white), and is most commonly induced by the vapours of weak organic acids. The most common sources of these acid vapours are wooden storage or display units (especially those made of oak), deteriorated cardboard and poor quality paper, and acetic acid from vinegar used in cleaning.

Silver

Silver in museum collections is generally expected to have a white metallic appearance. The black surface tarnish characteristic of silver corrosion is not usually considered to be a patina.

Tarnish forms as a dense, compact, and adherent layer when silver reacts with sulphide gases. These atmospheric pollutants are found in industrial areas, particularly those close to pulp mills, and are easily detected by their characteristic “rotten egg” smell. The corrosion reaction requires both sulphide gases and atmospheric humidity to begin. Most damage to silver from tarnishing is the result of the abrasion and polishing required to remove tarnish and repolish the silver.

Frequent polishing of plated objects can rapidly remove the silver plating (see CCI Notes 9/7 *Silver — Care and Tarnish Removal*).

Plated Metals

Common combinations of plated metals are:

- copper and silver
- copper and gold
- copper and nickel
- copper and tin
- iron and tin
- iron and zinc (“galvanized” iron)
- iron and chromium (usually with copper and/or nickel in between)
- iron and nickel (usually with a copper “flash” in between, hence the green corrosion in the pit)
- cupronickel and silver

Metal platings present special problems and are particularly prone to corrosion. Two dissimilar metals in contact require only an electrolyte (i.e. a salt and atmospheric moisture) to start a corrosive reaction. When examining plated metal objects, it is often difficult to identify either the metal plating or the underlying metal.

Stable surfaces, particularly gold, silver, nickel, and chromium, often retain their original bright metallic appearance when kept under appropriate

environmental conditions, although the shine may be obscured by dust or dirt (see CCI Notes 9/3 *The Cleaning, Polishing, and Protective Waxing of Brass and Copper*).

Active corrosion on plated metals manifests itself in various ways. It is most often found in areas where the object has been damaged or has defective plating. The plating usually lifts as the corrosion products of the underlying metal expand. This lifting can be seen, for instance, on the blistered chrome parts of automobiles. Corrosion products from the underlying metal may also occur on top of the plating — often in the form of a compact corrosion layer.

Pitting also occurs on plated objects when the plating is perforated and corrosion products grow in the underlying metal.

All active corrosion on plated metals is accompanied by an expansion in volume, which leads to loose powder around the object, or to blisters of more coherent corrosion products on the surface.

Routine Inspection

Regularly inspecting objects is a vital part of their care. Because many corrosion reactions occur quickly, metal artifacts should be inspected monthly. Deterioration can then be noted at an early stage and preventive measures taken before damage becomes severe.

Bibliography

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