

Metals and Alloys

Found in such items as jewelry, vessels, and weapons

Identification and General Information

Everybody knows what metal is; it is found in thousands of items that surround us every day.

When you begin to conserve some of these metal items, however, you find that the substance is more complicated than it seems. Most things we call metals today are more accurately called alloys. True metals are pure elements, while alloys are blends of two or more metals that have been melted together. Metals and alloys are easy to distinguish from nonmetals because they are usually shinier, heavier, and harder than most materials, and they are excellent conductors of heat and electricity. Even so, visually distinguishing various metals, and especially alloys, from one another can be difficult. If you need to identify a metal exactly, contact someone who is skilled in identifying metals, such as a conservator, a jeweler, or a metallurgist. This section will refer to metal in the larger sense of the word, meaning both true metals and alloys.

On the most basic level, conservators describe metals that appear white as *white metal*. Some examples of white metals are silver, tin, nickel, iron, and lead. The most commonly used term for metals that are not white metal is *copper alloy*. One of the most common alloys of copper is *brass*. Brass is a blend of copper and zinc and usually has a very shiny golden appearance when polished.

Identifying metal items is also made difficult when they are plated, since a thin layer of one metal covers another. Common examples of plating include tin cans, which are made of steel plated with tin; silver-plated spoons, which are usually made of a cheap base metal covered with the more expensive silver; eyeglass frames, also made with cheaper metals plated with gold. Identifying the base metal helps you decide how to preserve a plated item. For example, if an

item looks like it is made of gold, you might assume that it will not corrode. However, if you observe green corrosion on it, you would suspect that it was gold-plated copper alloy, which requires a dryer environment than gold alone.

Many metals will often have a *patina*, or protective finish. A patina is a coating on the outside of a metal object that usually acts as a protective layer and also is intended to make the item more beautiful. A patina can be intentionally applied using chemicals or coatings, or it forms naturally when the metal slowly accumulates a thin film of stable corrosion on the outside. Intentionally applied metal patinas are usually composed of various chemicals, oils, resins, or waxes. Copper and its alloys are the most common metals to have patinas. Items made of silver often have a natural patina of dark tarnished silver in the recesses, while the smooth parts of the metal are brightly polished. This patina makes any engraved areas stand out better, and it often improves the overall appearance of a silver item.

A *stable patina* is simply a very thin layer that is usually darker than the polished metal. In copper alloys, the color may range from tan to brown or black and is usually smooth textured. An *unstable patina* on a metal is usually uncontrolled corrosion. On copper alloys, this patina is usually a powdery or greasy green corrosion product that is typically bumpy or uneven. A significant amount of thought and consultation should take place before any patina, tarnish, or corrosion is removed. A stable patina is highly valued by some people and can form a protective layer over the metal. Stable patinas may take many decades to form, and removing them may damage the item, harm its appearance, or decrease its value.

Basic Care and Storage

Metals have no sensitivity to light and no biological pests. The primary concerns are tarnish and corrosion. Corrosion cannot occur without moisture. For this reason, it is advisable to store

metals in dry conditions. One of the best ways to accomplish this is to place the metal item in an enclosed space, such as a re-sealable polyethylene or polypropylene plastic container intended for food storage, with a drying material such as silica gel. Silica gel can absorb large quantities of moisture and can remove almost all of the moisture in a plastic container. Every few years, the silica gel will need to be dried in an oven to remove all of the accumulated moisture that has penetrated the plastic container from the outside environment. *It is important that the metal not touch the silica gel directly.* Place the silica gel inside a separate open container, such as a cup, in the larger plastic container to avoid contact with the metal. An alternative is to place the metal item in a re-sealable polyethylene bag, such as a Ziploc, and put the silica gel around it in the plastic container.

Metals are not significantly harmed by everyday variations in temperature unless the melting point is approached. All chemical reactions, however, including corrosion, are accelerated by heat, so metals are best stored at cool temperatures. Note that metals stored in a cool environment should be allowed to slowly adjust to the warmer environment before their storage box is opened. This is because bringing cold metals into a warmer environment will cause water to condense on their surface, which can quickly lead to corrosion.

Many items that contain metal are composite items. Examples are leather garment with metal buttons or decorations, guns with wooden stocks, and medals with cloth ribbons. In items such as these, metals can interact with other materials and cause corrosion. These items are particularly difficult to preserve because the different materials from which they are made can have conflicting storage and display needs. For example, the metal buttons and decorations on a leather garment need a very dry environment, preferably at or below 30 percent relative humidity, while the leather can become dry, inflexible, and even brittle in these conditions. On

the other hand, the leather will be more flexible at higher humidity, but the metal buttons and decorations will be more likely to corrode. In these cases, it is sometimes advisable to coat the metal parts of a composite item so that these parts can better withstand higher humidity. If you think specific items need this type of care, consult a conservator. Another alternative is to choose a relative humidity halfway between the extremes.

Eventually all coatings on metals will get scratched, peel off, or otherwise break down and lose their value. At this point they should be removed so that another coating can be applied. Varnishes or lacquers are difficult to apply correctly, so if you need this done, you should contact a conservator. A thin coating of wax, however, is easier to apply to most metals and is less difficult to remove than varnish or lacquer.

Special Pest Concerns

Metals have no natural biological pests. Residues left by insects, however, such as flyspecks, can permanently etch and corrode metals.

Routine Handling

Metals should always be handled with clean gloves made of cotton, nitrile, or latex. Metals that are roughly corroded or that have small details that could easily catch on cotton threads are better handled with nitrile or latex gloves. Also, do not use cotton gloves that have plastic dots on the palms and fingers, because these dots can be made of polyvinyl chloride, a substance that quickly corrodes metal. Do not touch metals with your bare hands because moisture and oils from the skin can corrode, etch, and permanently mark metals.

Display Issues

Compared to nonmetallic materials, metals can be displayed with fewer concerns since they are impervious to low humidity, pests, and light damage. They, however, must be displayed in an environment that is not chemically damaging to metal. Ideally, this environment should have a low level of humidity and be free of pollutants. Display materials that release damaging vapors can corrode metals and should be avoided. Be aware that any silver kept in a display cabinet with items made of rubber, wool, or any other material containing sulfur can rapidly turn black, because the sulfur reacts with the silver to form silver sulfide.

Since metals have no sensitivity to light, they can be exhibited at high light levels. Materials attached to the metal, however, such as textiles, skins, or stones, may be more sensitive. For example, stones inset in metal jewelry can fade in light.

Mounts and Supports

Even though metals are often stronger than other materials, they must still be supported. Thin metal sheets or heavily corroded metals can be very weak and require significant support. Materials that will release acidic vapors, such as wood and wood products, should be avoided for mounts and supports as they can corrode metal. The stable plastics mentioned in *Storage Containers, Supports, and Mounts* are often the best materials to use with metals.

Cleaning and Minor Repairs

If an item is composed of only metal, it can usually be cleaned and repaired more easily than if it is a composite. When a composite item needs to be cleaned, it is better to remove the metal parts before cleaning, if this is possible, and then to reattach or reassemble them after cleaning. You should clean different materials separately because many of the compounds used to clean one

material will harm other materials.

Carefully study a metal item before cleaning. Examine the stability of the patina. If the patina is stable, the best option usually is to simply leave the item as it is. Items with stable patinas have been preserved adequately up to now, and they will probably remain stable if conditions do not change significantly. If, however, the metal is undergoing active corrosion and has an unstable patina, then you should change the environment. Corrosion cannot occur without moisture, so make the environment as dry as possible. Only after the environment has been improved should you consider cleaning. This is because cleaning may cause metal in a poor environment to corrode even faster.

Degreasing metal is the most basic cleaning procedure. Degreasing refers to using a solvent to remove oils and other soil that can cause corrosion. Because solvents are a health hazard, careful precautions must be taken to avoid exposing yourself or others to the solvent and its vapors. Acetone is one of the best solvents for degreasing metals. It is, however, highly flammable and can irritate the eyes and skin. When using acetone, follow the precautions provided by the manufacturer or supplier. Alcohol can be used to degrease metals, but it has drawbacks. It usually contains a significant amount of water, which can cause metal to corrode. Acetone, in fact, can also contain water and often will cause water condensation on metal artifacts as it evaporates. To prevent this condensation, thoroughly dry a metal artifact with a soft cloth or tissue after it is degreased to completely dry it. Setting the item in a sunny space for a few minutes will also help to remove any remaining moisture. Some other solvents, such as mineral spirits, are not very pure and may leave oils or other contaminants behind after evaporation.

Since metals become oily and soiled from handling without gloves, be sure to handle a

metal item with gloves during and after degreasing. Apply the solvent with cotton swabs or a clean paintbrush, and allow the item to dry in a warm place, as described above. Since the metal is now very clean, it may actually corrode faster if it encounters moisture. To keep a clean item from corroding again, you can coat it with a protective wax finish. Conservators use a paste wax composed of carnauba wax or microcrystalline wax to protect metal. These waxes can be purchased from conservation suppliers and at furniture shops. Two common brands are Butcher's carnauba wax and Renaissance microcrystalline wax. These paste waxes are applied with a soft cloth, allowed to dry for a few minutes, and then buffed with a clean dry cloth. The wax provides a nearly invisible coating that resists moisture but is not so durable that it is difficult to remove should this be necessary.

Like cleaning, repair of metals should not be done without careful thought. If the item is in pieces, but the pieces are stable while in storage and on display, the best option may be to do nothing at all. Consult a conservator for advice if you have an item that you think needs repair.

With metal items that are severely corroded, such as items that are weathered from being outdoors, carefully consider all options before removing any thick layers of corrosion. The layers of corrosion often conceal the original surface layer of the metal item. This surface can be destroyed by cleaning, causing the original shape of the item to be lost forever. Sometimes severely weathered metal items will preserve the image and texture of a piece of textile or other perishable material that was next to the metal as it corroded. When the corrosion products contain images or textures, or the original layer of the metal is at risk, it is better not to remove the corrosion.