Extraction and Purification of Metals

BSc Part II,Chem (Gen), Paper-III

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Mineral: Compound of a metal from which it can be extracted. There may many minerals of a particular metal

Ore: Ores are among those minerals from which the metal can be extracted in a cheaper, easier and faster way.

Metals	Ores
Ni	Garnierite $\{(Ni,Mg)_6Si_4O_{10}(OH)_8\}$, Pentlandite $\{(Ni,Fe)_9S_8\}$
Li	Spodumene $\{LiAl(SiO_3)\}$, Lepidolite $\{LiF, LiOH, Al_2(SiO_3)_3\}$
Cr	Chromite ($FeCr_2O_4$), Crocoite ($PbCrO_4$), Chrome Ochre (Cr_2O_3)
Sn	Cassiterite or tin stone (SnO_2),
Au	Alluvial gold, placer gold, calaverite ($AuTe_2$), sylvanite $\{(Ag, Au)Te_2\}$

Galvanization

Galvanization is one of the most widely used to methods for protecting metal from corrosion. It involves applying a thin coating of zinc to a thicker base metal, helping to shield it from the surrounding environment.

There are several different processes for galvanizing metal:

Hot-Dip Galvanizing

As the name implies, this method involves dipping the base metal into a molten pool of zinc. First, the base metal must be cleaned either mechanically, chemically, or both to assure a quality bond can be made between the base metal and the zinc coating. Once cleaned, the base metal is then fluxed to rid it of any residual oxides that might remain after the cleaning process. The base metal is then dipped into a liquid bath of heated zinc and a metallurgical bond is formed.

The advantages of this method are that it is economical; it can be performed quickly and to complex shapes. However, the final coating can be inconsistent relative to other galvanizing processes.

Pre-galvanizing

This method is very similar to hot-dip galvanizing but is performed at the steel mill, usually on materials that already have a specific shape. Pre-galvanizing involves rolling metal sheet through a similar cleaning process to that of the hot-dip galvanizing process. The metal is then passed through a pool of hot, liquid zinc and then recoiled.

An advantage of this method is that large coils of steel sheet can be rapidly galvanized with a more uniform coating compared to hot-dip galvanizing. A disadvantage is that once fabrication of the pre-galvanized metal begins, exposed, uncoated areas will become present. This means that when a long coil of sheet is cut into smaller sizes, the edges where the metal is cut are left exposed.

Electrogalvanizing

Unlike the previous processes, electrogralvanizing does not use a molten bath of zinc. Instead, this process utilizes an electrical current in an electrolyte solution to transfer zinc ions onto the base metal. This involves electrically reducing positively charged zinc ions to zinc metal which are then deposited on the positively charged material. Grain refiners can also be added which helps to ensure a smooth zinc coating on the steel. Similar to the pre-galvanizing process, electrogalvanizing is typically applied continuously to a roll of sheet metal.

Some advantages of this process are a uniform coating and precise coating thickness. However, the coating is typically thinner than the coating of zinc achieved by the hot-dip galvanizing method which can result in reduced corrosion protection.

Electroplating

Electroplating is a process that uses an electric current to reduce dissolved metal cations so that they form a thin coherent metal coating on an electrode.

How does electroplating work?

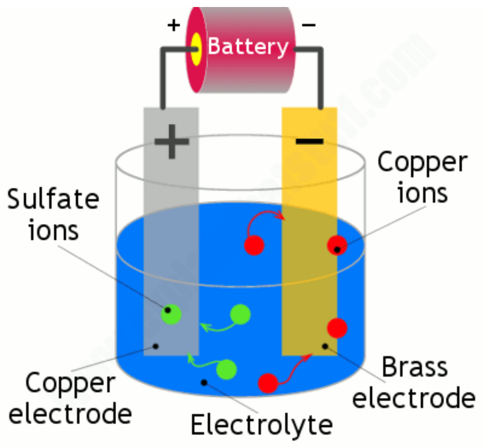
First, you have to choose the right electrodes and electrolyte by figuring out the chemical reaction or reactions you want to happen when the electric current is switched on. The metal atoms that plate your object come from out of the electrolyte, so if you want to copper plate something you need an electrolyte made from a solution of a copper salt, while for gold plating you need a gold-based electrolyte—and so on.

Next, you have to ensure the electrode you want to plate is completely clean. Otherwise, when metal atoms from the electrolyte are deposited onto it, they won't form a good bond and they may simply rub off again. Generally, cleaning is done by dipping the electrode into a strong acid or alkaline solution or by (briefly) connecting the electroplating circuit in reverse. If the electrode is really clean, atoms from the plating metal bond to it effectively by joining very strongly onto the outside edges of its crystalline structure.

Now we're ready for the main part of electroplating. We need two electrodes made from different conducting materials, an electrolyte, and an electricity supply. Generally, one of the electrodes is made from the metal we're trying to plate and the electrolyte is a solution of a salt of the same metal. So, for example, if we're copper plating some brass, we need a copper electrode, a brass electrode, and a solution of a copper-based compound such as copper sulfate solution. Metals such as gold and silver don't easily dissolve so have to be made into solutions using strong and dangerously unpleasant cyanide-based chemicals. The electrode that will be plated is generally made from a cheaper metal or a nonmetal coated with a conducting material such as graphite. Either way, it has to conduct electricity or no electric current will flow and no plating will occur.

We dip the two electrodes into the solution and connect them up into a circuit so the copper becomes the positive electrode (or anode) and the brass becomes the negative electrode (or cathode). When we switch on the power, the copper sulfate solution splits into ions (atoms with too few or too many electrons). Copper ions (which are positively charged) are attracted to the negatively charged brass electrode and slowly deposit on it—producing a thin later of copper plate. Meanwhile, sulfate ions (which are negatively charged) arrive at the positively charged copper anode, releasing electrons that move through the battery toward the negative, brass electrode.

It takes time for electroplated atoms to build up on the surface of the negative electrode. How long exactly depends on the strength of the electric current you use and the concentration of the electrolyte. Increasing either of these increases the speed at which ions and electrons move through the circuit and the speed of the plating process. As long as ions and electrons keep moving, current keeps flowing and the plating process continues.



Uses

Electroplating is generally done for two quite different reasons. Metals such as gold and silver are plated for decoration: it's cheaper to have gold- or silver-plated jewelry than solid items made from these heavy, expensive, precious substances. Metals such as tin and zinc (which aren't especially attractive to look at) are plated to give them a protective outer later. For example, food containers are often tin plated to make them resistant to corrosion, while many everyday items made from iron are plated with zinc (in a process called galvanization) for the same reason. Some forms of electroplating are both protective and decorative. Car fenders and "trim," for example, were once widely made from tough steel plated with chromium to make them both attractively shiny and rust-resistant (inexpensive and naturally rustproof plastics are now more likely to be used on cars instead). Alloys such as brass and bronze can be plated too, by arranging for the electrolyte to contain salts of all the metals that need to be present in the alloy. Electroplating is also used for making duplicates of printing plates in a process called electrotyping and for electroforming (an alternative to casting objects from molten metals).

Anodizing

Anodizing is an electrolytic passivation process used to increase the thickness of the natural oxide layer on the surface of metal parts. The process is called anodizing because the part to be treated forms the anode electrode of an electrolytic cell.