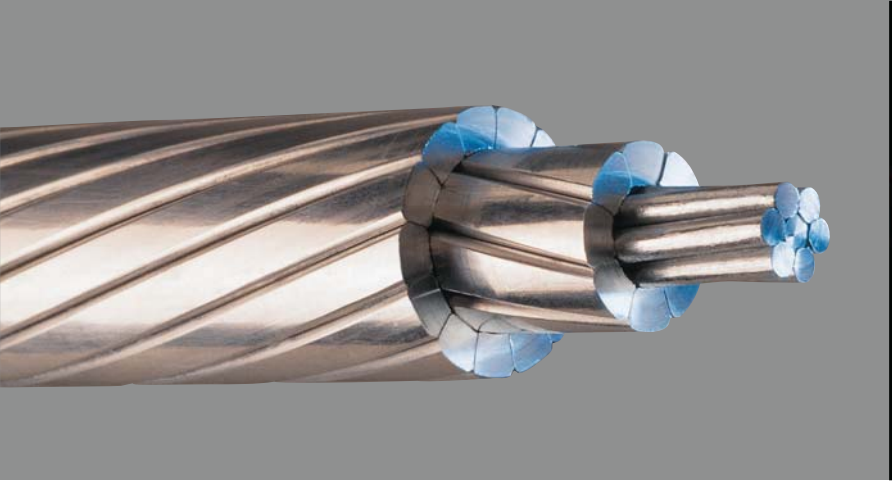

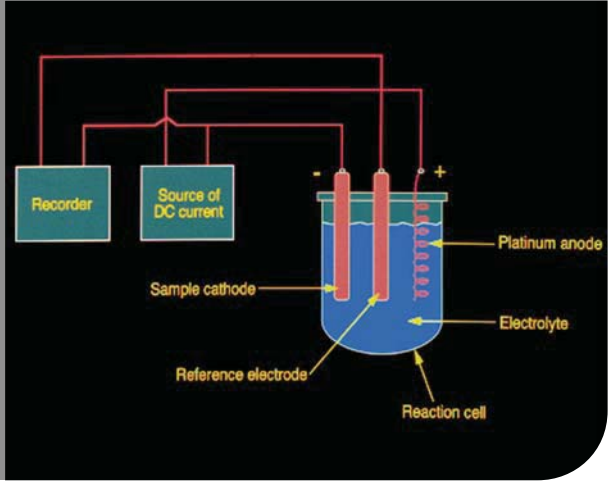

Electrical Conductor Wires

Electrical conductors are almost always produced from commercially pure non ferrous metals such as aluminum and copper because they have excellent electrical and thermal conductivities. If limited space is an important factor, such as in small sealed motors, copper is the preferred choice. Its extremely low resistivity enables it to be quite volume efficient. On the other hand, aluminum is often used if light weight is a major consideration, but this metal will require larger cross-sections in order to carry the same current. Silver actually has the highest conductivity of all metals, but its high cost eliminates its use for large scale applications. Industrial wire and cable applications are usually restricted to pure metals because all alloying elements lower the electrical and thermal conductivities of the matrix. Although copper is used for many purposes such as tube, sheet, alloys, chemicals, and powders, more than half of its commercial application is associated with electrically conductive wires. Major markets for these wires are power cable, telecommunication, building construction, and electrical / electronic products such as magnet wire.

All impurities lower the electrical conductivity of copper and aluminum and this adverse effect occurs mostly when the elements are dissolved in solid solution. Oxygen renders the majority of impurities less harmful in copper by tying them up as metal oxides. Most conductors are fabricated from electrolytic tough pitch (ETP) copper rather than from oxygen free (OF) copper or other materials. Commercial ETP copper is produced by adding a controlled amount of oxygen (~ 125 to 525 ppm) to high purity 4-9's copper (99.99%) in its molten state. At lower values of oxygen, hot cracking problems may occur during casting and hot-rolling due to hydrogen embrittlement. On the other hand, the propensity for brittle wire breaks, such as cups and cones, may increase at higher oxygen contents.

By analogy, boron is frequently added to aluminum in order to improve conductivity. It performs this function by reacting with harmful impurities such as Titanium and Zirconium, and tying them up as intermetallic compounds.

Because of its excellent formability, copper can be easily drawn from rod to fine wire without the use of intermediate process anneals. Albeit intermittent anneals are not necessary to restore ductility, nevertheless they are employed in the magnet wire industry. Magnet wire is oftentimes referred to as winding wire, and is used to convert electrical energy into mechanical work. It has the most demanding quality requirements of all types of coppers. Intermediate anneals are employed to improve final wire performance such as maximum conductivity, low springback, and good windability, i.e., the ability to hold its shape during coil winding operations. To achieve this characteristic, which is oftentimes referred to as "conformability", the amount of reduction in area prior to annealing is oftentimes restricted to about 90%. It should be noted that impurities also have an adverse effect upon elastic springback and conformability. Once again, oxygen in ETP copper plays an important role as a scavenger to improve such wire properties as conformability and annealing kinetics.

by Horace Pops