17.5: Refining of Copper

Unrefined or "blister" copper is about 99 percent pure when obtained from the ore, but it is desirable to increase this to 99.95 percent if the copper is to be used in electrical wiring. Even small concentrations of impurities noticeably lower copper's electrical conductivity. Such a high degree of purity can be obtained by *electrolytic refining* in a cell similar to that shown in Figure $17.5.1$.

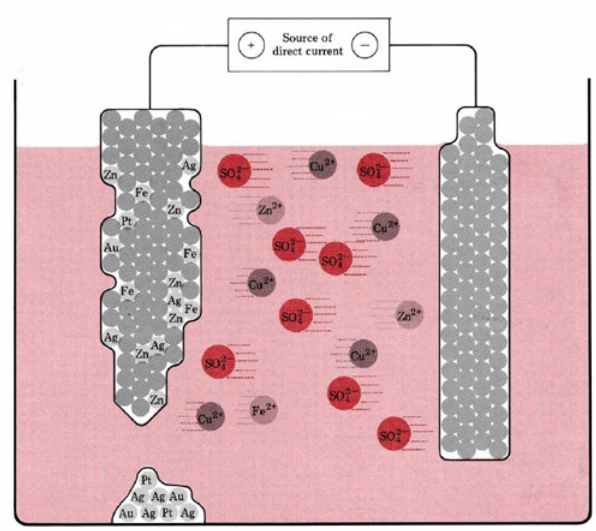

Figure 17.5.1: The electrolytic purification of copper.

In such a cell a thin sheet of high-purity Cu serves as the cathode, and the anode is the impure Cu which is to be refined. The electrolyte is a solution of copper(II) sulfate. Some of the impurities are metals such as Fe and Zn which are more easily oxidized than Cu. When current passes through the cell, these impurities go into solution from the anode, along with Cu:

$$\mathrm{Cu}(s) \rightarrow \mathrm{Cu}^{2+}(aq) + 2e^{-}$$

$$\mathrm{Fe}(s) \rightarrow \mathrm{Fe}^{2+}(aq) + 2e^{-}$$

$$\mathrm{Zn}(s) \rightarrow \mathrm{Zn}^{2+}(aq) + 2e^{-}$$

These ions all migrate toward the cathode, but Cu^{2+}(*aq*) is more readily reduced than Fe^{2+}(*aq*) or Zn^{2+}(*aq*) and so it is the only one that plates out. The impurity ions remain in solution. Other impurities, such as Ag, Au, and Pt, are less easily oxidized than Cu. These remain in metallic form and fall to the bottom of the cell, forming "anode sludge" from which they can later be recovered. The great value of Ag, Au, and Pt helps to offset the cost of refining.