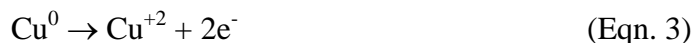
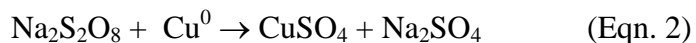
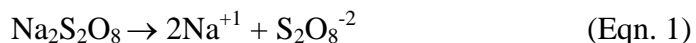


Copper Etching Reactions

The circuit board etching step takes the solid copper metal from the PCB into solution as copper ions Cu^{+2} . The chemical reaction causing the metal to dissolve is a corrosion reaction involving the persulfate ion and the copper atoms on the board. The sodium persulfate crystals ($\text{Na}_2(\text{SO}_4)_2$ or $\text{Na}_2\text{S}_2\text{O}_8$) are a stable salt of persulfuric acid ($\text{H}_2\text{S}_2\text{O}_8$)¹. When the sodium persulfate salt is dissolved in water, the sodium is present as Na^{+1} ions and the persulfate ion is present as $\text{S}_2\text{O}_8^{-2}$ ions as shown in Equation 1. The persulfate ion is a powerful oxidant that oxidizes the metallic copper on the circuit board and converts it to copper ions in solution as shown in Equation 2. If the water in the solution is allowed to evaporate, the copper will precipitate as CuSO_4 as shown in the products of Equation 2. The persulfate ion can also hydrolyze into peroxy monosulfate ion (HSO_5^{-1}) which then converts to hydrogen peroxide (H_2O_2) and oxygen (O_2) byproducts. These subsequent reactions cause the etchant bath to deteriorate over time. It is important, therefore, to store the etchant in its stable salt form and mix up fresh etchant solution as needed.



Equation 3 shows the copper metal dissolving off of the circuit board and into solution as the copper atom loses two electrons to become a copper ion. A loss of electrons is an oxidation reaction and making the copper an anode that supplies electrons². A gain of electrons is a reduction reaction and a cathode receives electrons. Two electrons are required to make one copper ion and the persulfate ion has two extra electrons. In Equation 2, one mole of sodium persulfate etchant can dissolve one mole of copper, however, the deterioration of the solution discussed above makes the practical etching capacity lower.

The sodium persulfate etching solution described in the Etching handout is mixed at ½ pound per gallon and heated to 40-70°C.

¹ C.F. Coombs, Jr., Printed Circuits Handbook, McGraw-Hill, New York, 1996.

² A mnemonic for remembering oxidation and reduction is: Leo the lion says Gerrr. LEO = Loss of Electrons is Oxidation. GER = Gain of Electrons is Reduction.