Plating

Copper and copper alloys for conductors are often electroplated with pure metal coatings such as tin, silver and nickel. In special cases, alloy coatings such as tin/lead (solder coat) or composite coatings such as silver over nickel, etc., plated in multiple layers can be applied. Coatings are applied to improve the performance of the conductor.

Tin Plating

Tin applied as a pure metal coating is generally recognized to increase the operating temperature of copper conductors to 150 ^{o}C and improve its solderability. Tin plating is relatively inexpensive for the performance increases it yields. Tin plating is primarily utilized for its temperature and solderability characteristics. Parameters for tin plated copper are specified in ASTM B 33.

Due to tin's relatively low melting temperature, tin plating is used only on base materials that are not exposed to high temperature processing after the tin is applied. Some of the high strength copper alloys and other base materials require a heat treatment or anneal during processing that would melt the tin coating.

Tin plated copper conductors also have a limited shelf life for solderability. Over a period of time, and at a rate determined by temperature, tin and copper interact to form an intermetallic alloy. This reaction even occurs at room temperature and cannot be prevented by protective packaging. When all the tin has been consumed from the surface (alloyed with the base copper), the conductor loses its solderability. Surface oxidation also degrades solderability; therefore, the conductor should be protected from exposure to air and moisture with packaging. Shelf life can be maximized by proper packaging and storage in a temperature controlled environment.

Silver Plating

Silver plating is generally recognized to increase the operating temperature of copper or copper alloy conductors to 200 ^{o}C. The silver coating also gives the conductor excellent solderability characteristics. Silver will retain its solderability if standard packaging techniques are used to protect the surface from oxidation. Its solderability will not diminish over time due to diffusion.

Pure silver has the highest electrical conductivity of any pure metal. Plating a conductor with silver also improves the high frequency transmission characteristics of that wire. High frequency electrical signals travel along the surface of a conductor, known as the "skin effect", and using silver for that pathway increases the conductor's performance.

Silver is a relatively soft metal, its oxide is electrically conductive and it has a low contact resistance. Therefore, silver plated conductors have many advantages over other plating materials for crimp terminations.

Standard silver plated conductors have a minimum plating thickness of 40 micro-inches (0.000040 inches) (equivalent to 1 micron) as specified in ASTM B 298. Variations on thickness are acceptable depending on application.

Fisk Alloy Conductors, Inc. • P.O. Box 26 • 10 Thomas Road • Hawthorne, NJ 07507 • U.S.A.
Phone (973) 427-7550 • Fax (973) 427-4585 • E-mail: sales@fiskalloy.com

Nickel Plating

Nickel plating is generally recognized to increase the operating temperature of copper or copper alloy conductors to 260 °C and nickel has a fairly high resistance to corrosive environments. However, nickel requires an activated flux for soldering and due to its hardness, nickel plated conductors may exhibit slightly more variability in crimp termination reliability than other plating materials.

Standard nickel plated conductors have a minimum plating thickness of 50 micro-inches (1.25 microns) as specified in ASTM B 355.

There is a special class of nickel plate designated as Class 27 in ASTM B 355. This class of conductor contains a minimum of 27% (by weight) nickel plating. These specialized conductors are usually required in extremely high temperature conditions.

Multiple Plating

Sequential plating of different metals over the base metal provides a barrier layer between the surface and the base metal. This can reduce intermetallic interaction between the surface and the base metal while maintaining the favorable properties of the surface plating.

Thickness Measuring Techniques

The standard method of measuring plating thickness of conductor strands is by electrochemical means. ASTM (B 33, B 298, and B 355) recognizes an electronic thickness tester that employs an electrochemical de-plating technique (commonly referred to as the "Kocour" method -- which is one equipment manufacturer). This coulometric technique uses a controlled "de-plating" current rate, the time required to remove the plating material and the diameter and length of the sample area to determine the plating thickness.

Plating Integrity

Plating integrity can be characterized in terms of continuity and adherence of the plate over the base metal.

Continuity of Coating

Requirements specify that the plating material must completely cover the surface of the wire. Exposure of base metal, prior to stranding, when examined with the unaided eye is unacceptable. To facilitate this examination samples are subjected to a sodium polysulfide solution (ASTM B 33, B 298, and B 355) that blackens any exposed copper areas.

Plating Adherence

The plated layer must adhere to the base metal. Adherence tests first apply stress to the plating interface. Twisting a pair of conductor lengths or wrapping a length of conductor around its own diameter places sufficient stress such that any areas of poor adherence will appear as lifting or cracking in the plated layer. The specimens are then subjected to a sodium polysulfide test. Blackened exposed copper evidences poor adherence.

Fisk Alloy Conductors, Inc. • P.O. Box 26 • 10 Thomas Road • Hawthorne, NJ 07507 • U.S.A.
Phone (973) 427-7550 • Fax (973) 427-4585 • E-mail: sales@fiskalloy.com