Conductor Facts / Solderability

Solderability is defined as the ability of a metal to be wetted by molten solder. Measurements of solderability can be performed in several ways. A Wetting Balance measures and records the wetting force as a function of time. While this is a quantitative test, it presents complications when relating the results to actual soldering practice. Additionally, it requires an expensive piece of laboratory equipment. A frequently employed qualitative test is the solder bath dip and look test. This test employs a solder pot, a low power microscope, and may include steam aging of the test samples. The procedures for using this test for the solderability of wire are well defined in American National Standards ANSI/J-STD-002 and MIL-STD-202 Method 208. NEMA Standard WC65 describes solderability issues and recommendations associated with silver, nickel and tin-coated conductors.

Definitions

- Wetting
- The formation of relatively uniform, unbroken and adherent film of solder to a base metal.
- Dewetting
- Molten solder coats a surface and then recedes to leave irregularly-shaped mounds of solder separated by areas covered with a thin film of solder and not exposing the base metal.
- Non-wetting
- The partial adherence of molten solder to a surface leaving the base metal exposed.
- Pin Holes
- Imperfections in the wetted surface appearing as small holes that penetrate through to the base metal.
- Shelf-life
- The period of time, usually measured in months and commencing with the plating date of the wire, that will pass a solderability test.

The solder bath dip and look test is a general indicator of surface cleanliness and the presence of surface oxidation. It is also a good indicator of the solderability of the conductor when in service. The general acceptance criterion for the dip and look test is a minimum 95% wetting coverage.

There are some limitations to MIL-STD-202/208. The method allows only one test procedure for all types of conductors. It does not provide for the different material properties of the various coating materials. The method employs a visual acceptance criterion that is very subjective, and the procedure can fail to provide consistent results for correlation of solderability and shelf-life.

Conductor Solderability

A material exhibits good solderability when its surface is able to form a bond with the molten solder. Most pure metals and alloys can readily bond with solder, however, surface oxidation, impurities and the formation of intermetallic compounds can inhibit this bond. Over time, as oxide layers thicken and intermetallic formation increases, solderability decreases.

The thickness and adherence of the oxide layer is dependent on the metal or alloy. Solder fluxes, containing reducing agents, are employed to break down the oxide layer to allow soldering. Thicker and more stable oxides require more active fluxes to allow solderability. Intermetallics have very stable oxides and therefore require the most active fluxes to obtain good solderability. Noble metals such as silver and gold can be readily soldered without the use of fluxes.

Custom constructions are available, please contact the sales department

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Fisk Alloy Wire, Inc. • P.O. Box 26 • 10 Thomas Road • Hawthorne, NJ 07507 U.S.A.
Phone: 855-4-PERCON (855-473-7266) • Fax (973) 427-4585 • E-mail: sales@fiskalloy.com

Solderability and Shelf-life

Solderability after storage is important for many applications. As aging decreases solderability, methods were developed to predict solderability after extended storage. MIL-STD-202 Method 208 was originally developed for terminals, lugs and component leads. This method has been modified to include insulated conductors and includes steam aging of plated samples. Steam aging is used as an artificial environment to simulate and accelerate the natural aging process. However, due to the combined effects of the variables of the different conductor coatings, alloy base metals, underplates, and storage environments, it is not possible to accurately predict the maximum storage life of any plated conductor.

Tin Plating

ASTM B 33 defines the parameters for tin plated conductors. Tin coated copper oxides readily form at normal storage conditions (50 – 100ºF). Copper-tin intermetallic compounds also form at room temperature, are very brittle and inhibit solderability. These two phenomena contribute to tin-coated copper's degradation of solderability over time. Increasing the tin thickness above that required by ASTM B 33 has been proposed as a solution to increase shelf-life. This may be acceptable for solid lead wire, but it is not desirable for stranded conductor. A thicker tin coating results in higher electrical resistance and may lead to bonding of the conductor strands.

Nickel Plating

ASTM B 355 defines the parameters for nickel plated conductors. In the past, nickel plated conductors were rarely used in applications requiring soldered terminations, however, with nickel's excellent corrosion resistance, they are increasingly being specified in more general applications. Nickel forms a very tenacious oxide which requires a very active flux for soldering.

Silver Plating

ASTM B 298 defines the parameters for silver plated conductors. There is usually no need for flux when soldering silver plated copper conductors. Unlike tin, silver does not form intermetallic compounds with copper, and shelf-life is excellent with standard sulfur-free protective wrapping and storage environments. Silver gives the best solderability and shelf-life performance of any of the standard plating materials.

To maximize solderability of any plated conductor, store the conductor or wire in appropriate wrapping to minimize air infiltration, preferably in a climate-controlled environment. When and where solderability is required, plated wire should be rechecked for solderability after extended storage.

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