CABLE MANUFACTURING & ASSEMBLY CO. INC.

WHEN AND WHERE TO USE TINNING

Improving Wire's Performance

Electrical wiring serves one purpose — it conducts an electrical current from one point to another. The wire's ability to conduct electricity is affected by several factors, including the primary material of the wire, the operating temperature in which the wire will be used, and how much mechanical stress (twisting, stripping, soldering, etc.) the wire will be required to endure.

Wire performance can be improved with the application of a wire coating, the most popular of which is tinning. How do you determine whether or not to specify tinned wire for your application? Let's take a closer look at when and where to use tinning.

Choose Wire Type

Wire is chosen based on the properties required for the application for which and the environment in which it will be used. Common uncoated electrical wire types and some of their properties are compared in the following table.

Properties of Uncoated Wire by Type

Material	Relative conductivity (where 1 – highest)	Mechanical strength	Operating temperature range	Corrosion resistance	Cost	Solderability
Copper	1	Medium	To 100°C	Medium (poor oxidation resistance)	Low	Medium
Copper-covered Steel	3	Medium	To 200°C	Medium	Medium	Medium
High-strength Alloys	2	High	To 200°C	Low	High	High
Stainless Steel	4	High	To 870°C	High	High	Low

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Why Coat Wire?

Similarly, wire coatings are chosen based on the properties they impart to the base wire.

Tinning provides an improvement in the operating temperature range, water resistance, and mechanical strength of bare copper wire. In addition, tinning is considered a soldering aid. Note that solderability and conductivity do degrade over time and/or rise in temperature because of the migration of tin and copper and tin oxidation. Crimp terminability is initially quite good, but contact resistance increases with time.

Despite its shortcomings, tinning is an extremely affordable coating that, if worked shortly after coating and allowed to age without changes, is an extremely affordable solution for the improvements it imparts to bare wire.

Nickel coating's primary purpose is to extend the operating temperature range of affordable bare wire, taking it to 450°C or higher, depending on coating thickness. It remains stable over time or with small changes in operating temperature. Like tinning, nickel coating's crimp terminability is initially good, but contact resistance deteriorates with time.

Unfortunately, nickel coating has only 25% of copper's electrical conductivity and, in most cases, reduces a wire's overall conductivity. In addition, unlike other coatings, nickel coating requires active flux during solder.

Silver coating can greatly improve the conductivity of wire materials other than copper and also improves the operating temperature range of bare wire. Its conductivity remains stable and its solderability is good over the life of the wire. Contact resistance stays low, and silver-coated wire has exceptional solder properties.

Unfortunately, these desirable properties come at a price. Silver coating can be extremely expensive due to the raw material costs and to the electroplating and drawing process required to coat the wire.

Why Choose Tinning?

As discussed, tinning copper wire imparts desirable characteristics to bare copper wire:

- Soldering improvement
- Operating temperature range improvement
- Water and general corrosion resistance
- Good crimp terminability
- Affordability

Historically, tinning was used to protect bare wire from the corrosion caused by the

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make-up of the wire itself — copper chemically reacted with the freed sulfur ions released from wiring insulation. Modern chemistry has since created more stable wiring insulation, and tinning is usually not required just to prevent corrosion from within. However, while not as commonly used, sulfur-bearing power-cable insulations or chlorosulfonated polyethylene (CPSE) still require tinning to protect copper wire from sulfur-caused (i.e., copper sulfide) corrosion.

Tinning, today, is considered one of the best choices for wire that will be exposed to corrosive or harsh environments, including marine environments or industrial environments such as water or pulp treatment operations. In fact, tinned conductors can extend wire life by ten times compared to bare wire. Its affordability makes it extremely cost effective in nearly any application for which corrosion resistance and higher operating temperatures are required.

Choose Tinning Type

When specifying tinning, it is just as important to specify tinning type. Consider the requirements of tinned copper for your particular application. The most common tinning types, their makeup, and characteristics are described in the following table.

Tinning Types

Type	Fabrication	Characteristics
Basic	Individual strands of wire are coated with tin	Least expensive, meets almost all recognized standards, used in nearly any application across most industries
Heavy	Individual strands of wire are coated with a heavier coat of tin for use in high-frequency induction heaters	Allows bonding on stripped areas without degrading remaining cable flexibility
Pre-bonded	Heavy-tinned wire strands are twisted and fused	Behaves as a solid conductor but is less likely to break or harden, is not accepted under all standards
Over-coated	Individually tinned and twisted strands are then coated with an additional layer	Behaves as a solid conductor but is less likely to break or harden, is not accepted under all standards
Top-coated	Bare twisted strands are coated	Is not accepted under all standards

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Questions: Contact CMA

If you have questions or are interested in speaking with us about a custom cable assembly, we are happy to help. Please contact us by email or phone.

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