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Technical Tidbits

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IN THIS ISSUE

Hi Ho Silver! This issue of Technical Tidbits is an overview on the use of silver as an electrical contact material.

- Fine Silver
- Sterling Silver
- Coin Silver
- Electrical Arcing
- Contact Welding

Silver as a Contact Material

Fine silver has the highest electrical conductivity (over 100% IACS) of all the electrical contact materials. Silver does not readily oxidize, although it does have a tendency to form sulfide and chloride films. Its hardness and wear resistance may be improved by alloying with other contact metals such as copper, palladium, or platinum. Silver based composite materials such as silver nickel and silver metal oxides offer significantly improved resistance to arc erosion, as compared to fine silver.

Silver can most often be found in the form of contact buttons staked or welded to the blades of electrical switching contacts. Often, a high performance base metal such as C17200 or C17460 are used in the blades to provide and reliably maintain the appropriate contact force. Meanwhile the silver or silver-based contact button provides a high condutivity, arcing-resistant, wear-resistant interface.

Silver has the highest electrical and thermal conductivities of all the contact materials. This makes it ideal for handling high electrical currents. **Fine silver** is silver with greater than 99.9% purity. It has only moderate wear resistance, with a hardness of only 75-200 HV, similar to soft gold. Despite this lack of durability, silver contacts should be mated with a wiping action. This will disrupt the sulfide and chloride films which tend to form on the surface.

Silver-copper alloys with a minimum of 92.5% silver are known as **sterling silver**. **Coin silver** is 90% silver, 10% copper. These alloys are harder and less electrically conductive than fine silver, in proportion to the copper content. Their corrosion resistance is similar to fine silver, hence the use of sterling silver in eating utensils. However, these alloys still will readily form sulfide and chloride films. Additionally, the copper component can make them susceptible to oxidation. (The tendency to oxidize increases in proportion to the copper content.)

Binary Silver Alloys

Name	Composition	Annealed Hardness	Elec. Cond. % IACS
Fine Silver	99.9 Ag	30 HR 15T	104
Sterling Silver	92.5 Ag 7.5 Cu	65 HR 15T	88
Coin Silver	90 Ag 10 Cu	70 HR 15T	85
	72 Ag 28 Cu	79 HR 15T	84
	97 Ag 3 Pt	45 HR 15T	45
	97 Ag 3 Pd	45 HR 15T	58
	90 Ag 10 Pd	63 HR 15T	27
	40 Ag 60 Pd	65 HR 15T	8
	90 Ag 10 Au	57 HR 15T	40
	25 Ag 75 Au	50 HR 15T	17

Table 1. Properties of Silver Alloy Contact Materials (ASM Handbook Volume 2, pages 844-847)

The next issue of Technical Tidbits will discuss arcing electrical contacts.

Platinum, palladium, and gold are also commonly added to silver to improve its corrosion resistance and increase its hardness. These alloys, however, will show lower conductivity than fine silver. Very small amounts of nickel also may be added to these alloys to improve the hardness without appreciably decreasing the conductivity. Table 1 shows how these alloying elements affect the hardness and conductivity of silver (data taken from ASM Handbook Volume 2). These are just a few of the silver alloys available, but this table shows in a general way how the alloying elements affect silver's hardness and conductivity.

Silver composites are usually produced through powder metallurgy processes, since the constituents are not mutually soluble and cannot be alloyed. These include silver metal oxides (silver cadmium oxide, silver tin oxide, silver indium oxide), silver graphite, silver molybdenum, and silver nickel. (Silver nickels are not to be confused with nickel silvers, a family of copper-nickel-zinc alloys which, interestingly enough, contain no silver.) Table 2 shows how the hardness and conductivity of these composites vary with the amount of silver present. (Data taken from the ASM Handbook Volume 2.)

Silver composite materials are used in make and break contacts operating under high current and/or voltage. These materials are more resistant to damage from **electrical arcing** and **contact welding**, which may occur under these loading characteristics. These subjects will be discussed in upcoming editions of Technical Tidbits.

Silver Composites

Composition	Annealed Hardness	Elec. Cond. % IACS
90 Ag 10 Mo	37 HRB	67
60 Ag 40 Mo	59 HRB	59
35 Ag 65 Mo	87 HRB	43
99.75 Ag 0.25 C	39 HRF	99
97 Ag 3 C	20 HRF	59
90 Ag 10 C	13 HRF	48
99.7 Ag 0.3 Ni	53 HR 15T	100
85 Ag 15 Ni	40 HRF	73
60 Ag 40 Ni	40 HR 30T	46

Silver Metal Oxides

Composition	Annealed Hardness	Elec. Cond. % IACS
97.5 Ag 2.5 CdO	22 HRF	85
90 Ag 10 CdO	42 HRF	79
80 Ag 20 CdO	70 HRF	68
92 Ag 8 SnO_2	58 HV	88
90 Ag 10 SnO_2	64 HV	82
88 Ag 12 SnO_2	72 HV	72
92 Ag 8 ZnO_2	63 HV	77

Table 2. Properties of Silver Composite Contact Materials (ASM Handbook Volume 2, pages 851-852)

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