

PROPERTIES AND TECHNICAL NOTES



SPI Supplies Silver Paint

Typical Properties

Sheet Resistivity (25 um [0.001"] film thickness):

Specification: <100 milli Ω /square

Typical: 12 milli Ω /square

Adhesion Strength:

Tensile:

Specification: >700 N/cm² (1000 lb/in²)

Typical: 1000 N/cm² (1500 lb/in²)

Lap Shear: ~1400 N/cm² (2000 lb/in²)

Bulk Resistivity: 3×10^{-5} Ω -cm

Specific Heat: 0.30 J/g°C (0.07 cal/g°C)

Thermal Conductivity: 0.04J/cm-s°C (0.01 cal/cm-s°C)

Coefficient of Expansion: 3×10^{-5} m/m/°C

Modulus of Elasticity (tensile): $4 \times 10^{+10}$ Pa (6x10⁶ lb/in²)

Poisson's Ratio: 0.35

VOC %: 21

VOC (g/L): 570

Specific Gravity

Range (g/ml): 1.8 - 2.0

The properties of the most interest are density and resistivity, and both of these are highly dependent on application technique. All of the properties given here are "typical", but we offer no guarantee that you will obtain similar results in your application. You will have to do your own testing to be sure.

SPI Conductive Silver Paint



General Information

The [SPI #5001-AB and #5002-AB Silver Paint](#) Product (the same product in two different size bottles) is a highly concentrated suspension (43% \pm 3% silver solids) of specially prepared and tightly controlled high purity silver powder combined with a highly effective organic suspending and binder system.



The product is formulated to produce electrically conductive paths, patterns or films over nonconductive surfaces. The product is also designed for strictly room temperature air drying applications since for the most part, samples being mounted for SEM cannot tolerate higher temperatures. The product is sufficiently versatile that it can be dried at elevated temperatures as well, especially for those using the product in UHV (e.g. ultra high vacuum) systems. More often than not, the substrate composition dictates the limit to the possibilities for drying (curing) temperatures.

We are often times asked about drying "rate". Of course the real question being ask is how long does one have to wait before inserting their specimen into the column and vacuum system of their SEM. And, like with so many other things, there is no unambiguous answer. Drying time is a function of the solvent system, the method of application (dictated by viscosity), and the binder to solvent ratio.

We are also asked about the suitability of this product for application to various types of surfaces. It can be applied to various types of organic as well as inorganic substrates, mainly for the purpose of "painting on" a silver conductor line that serves as a surface electrode. It furthermore is formulated for brush or automatic bonding applications or it can be thinned for spray application. Some typical applications outside of the SEM laboratory include printed circuit board repair, shielding paint, plating base and capacitor electrode formation.

The thinner SPI #5004-AB has been formulated to give optimum results for use with the two SPI silver paint products. Only this recommended thinner should be used for optimum results.



Other potentially useful information about the SPI Silver Paint products:

| | |
|------------------------|----------------|
| %Silver Solids | 43% ±3% |
| Viscosity ¹ | 280-400 cps |
| Cure temperatures | 1 hour at 60°C |

Typical Cured Properties²:

| | |
|--------------------------------|--------------------|
| Sheet resistivity ³ | |
| Resistivity: | < 60 mohms/sq./mil |

¹ As measured by Brookfield LVT, Spindle #2, at 30 rpm, 25 °C ± 1 °C

² Dried at 80 °C for 10 minutes then cured at 100 °C for 15 minutes

³ The value given is for "sheet" resistivity, which is a way of measuring the ability of a layer of material, such as a layer of a paint coating, to conduct charge away, or dissipate it, on a surface. The term is widely used in the specification of materials for ESD protection, and we are using it for the rather specialized use of charge dissipation in scanning electron microscopy. The "per square" term is really "per square centimeter per square centimeter" or "per square inch per square inch", and the units cancel each other out, but convention is to use the unit "per square" to remind us that area is an important consideration. Since the larger the area of the layer of coating being measured, the larger the cross sectional area through which the charge is being dissipated, the "per square" term really does make sense. The best parallel is that thermal expansion is measured in "dimensionless" units like "centimeters per centimeter", and eventually we get used to the idea that you can plug in any length and temperature change and get the dimensional change in the same units in which you entered the length.

In this case, the resistivity of a layer of silver paint one mil (0.001"/25µm) thick is less than 60 milliohms, whatever the area of the measurement.

Processing Procedures

Mixing: This product has excellent resistance to "hard pack settling" and is relatively easy to redisperse after long term storage. The preferred method of remixing is by slow rolling on a jar rolling machine for several hours before use. The material may also be shaken in a high speed paint shaker machine for 5-10 minutes, but must be allowed to stand for some time in order for entrapped air bubbles to escape. These two approaches are primarily for customers of bulk silver suspension and would be overkill for the small bottle 0.5 and 1.0 troy oz products. For the resuspension of the product in the small bottles, a simple laboratory ultrasonic shaker can be used for a few minutes to return the suspension to its "ready to use" state.

Painting: The paint is ready to use as received for brush application. It may need slight thinning after prolonged storage due to solvent evaporation. Do not over-thin the paint. Use small portions of the SPI recommended thinner until the desired viscosity is obtained.

Drying: The paint was formulated to be air dried to a tack-free state within 30 minutes. Adequate conductivity and adhesion are achieved after 24 hours in air at 25 °C. Adhesion may be improved if necessary and the cure accelerated by force drying at 100-150 °C for 15-30 minutes.

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VACUUM & MATERIALS

Storage: The SPI Supplies Silver Paint should be stored in sealed containers away from heat or flames. Product in the small glass containers, with the special brush applicator tops and which the heat seal is applied, have an expected storage life of five years or more. For the pint and one gallon sizes, due to the large volumes and the difficulty of adequately dispersing settled silver content, it is suggested that these products be used within several months of receipt. All SPI Supplies Silver paint is recommended to be stored at a temperature of 25 °C.

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