

**3398**  
**Silver Aluminum Conductor**

**Description:** Ferro Corporation offers a full range of thick film inks for contacting the back surface of silicon solar cells. A common class of materials for bus bar and grid applications is an aluminum doped silver formulation. The purpose of the aluminum is to reduce the ohmic contact resistance between the thick film material and the p-doped silicon surface. The other classes of back surface metallizations offered are pure aluminum inks. These inks, which come in fritted and unfritted versions, are used to form a p+ back surface field layer. A

variety of configurations and process sequences, including sequential or cofired processing methods can be accommodated by combinations of our product offerings.

3398 contains a modest content of aluminum to ensure excellent ohmic contact to the backside of mono and poly-crystalline silicon solar cells. Solderability is good, and the product works well in full area coverage and gridded configurations.

**Typical Properties**

	<b>3398</b>
Viscosity (Pa·s) <sup>1</sup> :	90–110
Solids Content:	78.5–81.5%
Fineness of Grind:	< 21/20 μm
Dried Thickness:	20–25μm
Fired Thickness:	10–14 μm
Resistivity <sup>2</sup> (milliohms/square):	< 3.0
Drying Profile <sup>3</sup> :	250–300°C, < 60 seconds
Firing <sup>3</sup>	810–940°C, < 1–3 seconds
Recommended Thinner	0800

All properties are target values and are not meant to represent product specifications

Notes:

<sup>1</sup>Viscosity as measured on Brookfield model HBT cone/plate viscometer; 9.6 reciprocal seconds, 1.565” cone, 25°C.

<sup>2</sup>Milliohms/sq. at 25μm.

<sup>3</sup> Recommended set points °C in infrared firing furnace.

**Product Advantages:**

- RoHS-compliant<sup>4</sup>
- Cadmium Free<sup>5</sup>
- Reduced ohmic contact resistance with p-doped silicon wafer surface
- Excellent adhesion on mono and poly-crystalline silicon solar cells
- Good solderability
- Works well in full area coverage and gridded configurations

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## Processing Recommendations

**Printing:** It is recommended that the paste temperature be between 20–25°C prior to printing, and it is advisable to control the ambient room temperature within  $\pm 2^\circ$  to insure consistent printing results. The printing area should be clean and well-ventilated.

**Screen:** 200–325 mesh screen with a 20–25  $\mu\text{m}$  emulsion thickness is recommended.

**Drying:** The ink can be dried in an Infrared or conventional dryer under a wide range of conditions. Inks are typically dried in an IR dryer with set points of 250–300°C in less than 60 seconds.

**Soldering:** Recommended soldering conditions (ribbons) are 290°C for 96.5Sn/3.5Ag; and 220°C for 62Sn/36Pb/2Ag.

**Firing:** An Infrared fast process furnace with three or more firing zones and belt speeds of > 200 inches per minute is highly recommended, although the product may be fired in a variety of furnaces with belt speeds > 120 inches per minute. Optimum firing conditions must be established by the customer based on the cell configuration, thickness, and manufacturing process. Peak set point temperatures between 810–940°C with a dwell time above 700°C ranging from > 1 to 3 seconds is typical.

**Compatibility:** Ferro has tested this material according to the recommended processing conditions described here, however, it is imperative that customers evaluate the material in their manufacturing process and conditions to insure suitability for their intended use. Ferro technical personnel can help facilitate testing, and can assist with integration into customer manufacturing processes.

**Thinning:** Thinning is not recommended, since the paste is supplied at the correct viscosity for application. Contact your local Ferro Representative for appropriate solvent details, should thinning become necessary to replace solvent lost through evaporation.

**Paste Storage & Shelf Life:** The paste should be stored in tightly capped containers in a cool (5–30°C) dry place away from direct sunlight. When properly stored, unopened material will have a shelf life of up to 6 months.

### Notes:

<sup>4</sup>Complies with EU Directives on Restriction of the use of Hazardous Substances (RoHS; 2002/95/EC) and Waste from Electrical and Electronic Equipment (WEEE; 2002/96/EC). Current exemptions allow lead contained in the glass system of thick film materials used in electronic components. In anticipation of future amendments and more stringent environmental regulations, Ferro continues to expand its range of Lead Free<sup>5</sup> materials.

<sup>5</sup>Initial product composition was certified by SGS laboratories to be below the detection level for cadmium. This conductor paste is not routinely analyzed for cadmium content and is not the basis for product specification or warranty.

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