

## AL 53-112, -113, -114 Aluminum Conductor Lead Free

**Description:** AL 53-110 series aluminum conductor pastes are designed to form a p<sup>+</sup> doped layer when fired on p-doped silicon photovoltaic devices 160–200 microns thick. This series accommodates variations in wafer surface texturizations and other surface treatments to promote low distortion and a smooth surface. When properly processed on 150 mm x 150 mm wafers at 180 micron thickness, the material exhibits <1.5 mm

distortion. The material has been optimized to eliminate Al bead formation during the firing process. The product is lightly fritted using an environmentally friendly lead free glass composition and can be fired over a broad range of conditions including co-fire process techniques with front contact silver inks. Combinations of our product offerings can accommodate a variety of configurations and process sequences.

### Typical Properties

	AL 53-112, -113, -114
Viscosity (Pa·s) <sup>1</sup> :	17.5–37.5
Fineness of Grind:	< 50 μm
Dried Thickness:	30–40 μm
Fired Thickness:	20–30 μm
Wet Deposition (mg/square cm):	5–8
Bowing (180 micron wafer):	< 1.5 mm
Back Surface Field Thickness:	6–8 μm
Resistivity <sup>2</sup> (milliohms/square):	< 10
Drying Profile <sup>3</sup> :	250–300°C, < 60 seconds
Firing <sup>3</sup> :	810–940°C, < 1–3 seconds
Recommended Thinner:	0804

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>
- Lead and Cadmium free<sup>5</sup>
- Exhibits <1.5 mm camber on 150 mm x 150 mm wafers at 180 microns thickness
- Uniform BSF yields high electrical efficiency

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**Lead Free**

**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:** 200–250 mesh screen with a 10–25  $\mu\text{m}$  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.

**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>3</sup>Initial product composition was certified by SGS laboratories to contain less than 25 ppm of lead; less than the RoHS allowable level of 1000 ppm in electronic equipment. The cadmium content is below the detection level. This conductor paste is not routinely analyzed for lead and cadmium content and is not the basis for product specification or warranty.

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