

33-452
Silver Conductor
TiO₂ ARC Solar Cells

Description: For many years, Ferro has been the leading supplier of thick film silver inks designed for making contact to the n-doped silicon front face of photovoltaic devices. Achieving good adhesion with an excellent ohmic contact to this shallow junction is critical in the production of high efficiency cells. Ferro Electronic Materials has produced a number of different formulations for this application. It has been our experience that each cell type has variations in junction depth, dopant concentration and silicon orientation. For this reason, we suggest that a manufacturer new to our product test variations of these formulations, in order to capture the sometimes subtle advantages that one of them may offer for a particular cell type. For similar reasons, our

recommended firing profile is meant to be taken as a starting point only and it is absolutely essential that a matrix of profiles be tested to achieve optimum output.

33-452 is a specially designed silver paste for contacting for p/n⁺ type silicon solar cells processed with TiO₂ ARC's. When fired, these screen printable inks yield very low bulk and contact resistivity which results in high a Fill Factor and energy conversion efficiency.

The fired film can easily penetrate through TiO₂ film and shows a very good adhesion to silicon with excellent solderability.

Typical Properties	
	33-452
Viscosity (poise) ¹ :	1100 – 1400
Solids Content:	80.0 – 83.0%
Fineness of Grind:	< 14 / 11 μm
Dried Thickness:	20 – 30 μm
Fired Thickness:	12 – 18 μm
Resistivity ² (milliohms/square):	< 1.5
Drying Profile:	250 – 300°C, < 20 seconds
Peak Firing Temp:	720 – 750°C
Time at Peak:	1 second
Recommended Thinner	0800

Notes:

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

²Milliohms/sq. at 25μm.

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Processing Recommendations

Printing: 250 – 325 mesh screen with a 20 μm – 25 μm emulsion thickness is recommended.

Drying: The ink can be dried in an Infrared or conventional dryer under wide range of conditions. Inks are typically dried in a IR dryer with set points of 250°C – 300°C in less than 20 seconds.

Firing: An Infrared furnace with belt speeds up to 120 IPM (inches per minute) is highly recommended. The front contact paste may be co-fired with the back contacts. The following furnace settings are suggested as a starting point:

Furnace:	Infrared
Heated Zone:	30 inches
Set Points:	Zone 1: 780 °C
	Zone 2: 830 °
	Zone 3: 930 °C
Belt Speed	120 IPM

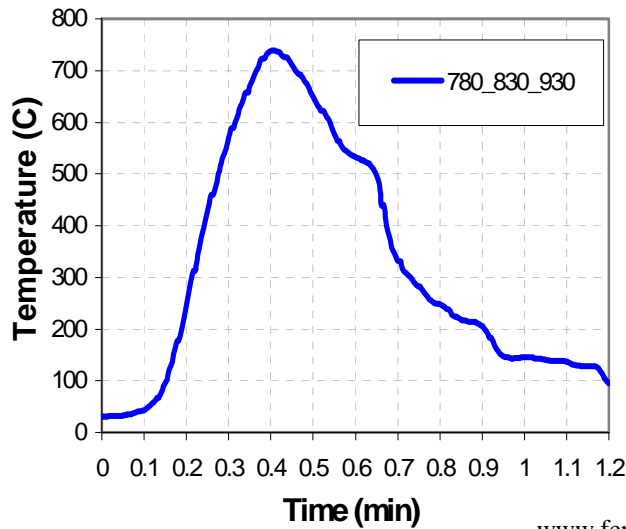
Since the furnace configurations, furnace loading and the lamp power vary; the above furnace settings may be used as a starting point. It is highly recommended that a matrix of profiles be tried to optimize cell output and efficiency

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, dry place away from direct sunlight. Properly stored material will have a shelf life in excess of 6 months.

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These parameters yield the following profile as measured using a thermocouple:



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