Test Methods for Measuring the Volume Resistivity and Contact Resistance of LTTF-7888 Solar Metallization Paste

APPLICATION NOTE

There currently are no industry standards for solar metallization paste. The following are test methods that have been adopted by many thin film photovoltaic solar cell manufacturers and are used by Indium Corporation to test volume resistivity and contact resistance, two major physical properties of metallization paste.

Volume Resistivity

A line of the metallization paste 2mm wide x 4.5cm long was printed through a stencil 0.1 mm thick on a glass substrate and cured at 165°C for 20 minutes. Normal curing time is 10 minutes, but due to larger volume a longer curing time was needed. The bulk resistance was measured for 2cm length of the line with a four wire Micro-Ohm meter (Biddle Instruments, Blue Bell, PA) as follows:

- Connect the two alligator clips from the meter at the ends of the line at points A and D. The distance between B and C on the figure below is exactly 2cm.
- Place the two probes from the meter at B and C to measure the bulk resistance.

A B C D

- The line width and the line height are measured after curing the paste.

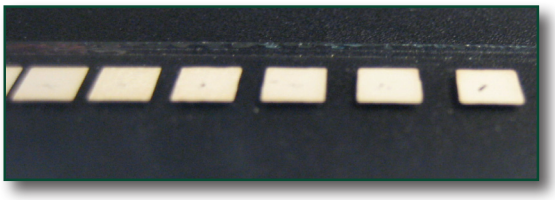
Volume resistivity was calculated by the following equation:

Volume resistivity (μΩ·cm) = [measured bulk resistance (μΩ) x line width (0.2cm) x line height (cm)] / line length (2cm).

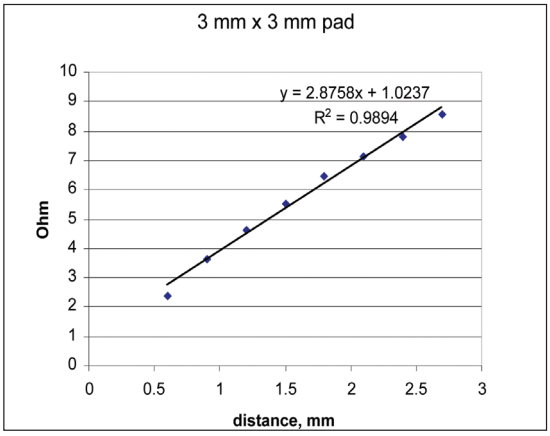
Contact Resistance/ Resistivity

Contact resistance was measured using the transmission line method. Two types of patterns are usually used. The paste is printed through a stencil 25 micron thick on ITO- or AZO-coated glass and cured at 165°C for 10 minutes.

1) Larger pads: 3mm x 3mm paste pads with the distance of 0.6, 1.2, 1.5, 1.8, 2.1, 2.4, 2.7mm.



When the resistance (Ohm) is plotted with distance, a line is obtained. The intercept of the line to the y-axis is the theoretical resistance without a gap (without the sheet resistance factor of TCO).



Contact resistance is calculated by multiplying the intercept (1.0237 Ohm) by the pad area (0.3cm x 0.3cm) divided by 2 (the number of pads).

Contact resistance (contact resistivity) = 1.0237 Ohm x 0.3cm x 0.3cm / 2 = 0.046Ωcm^2 (46mΩcm^2)

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Form No. 98551 (A4) R0

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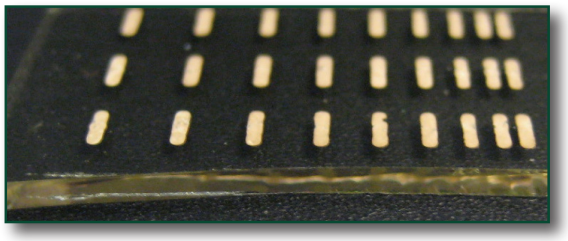
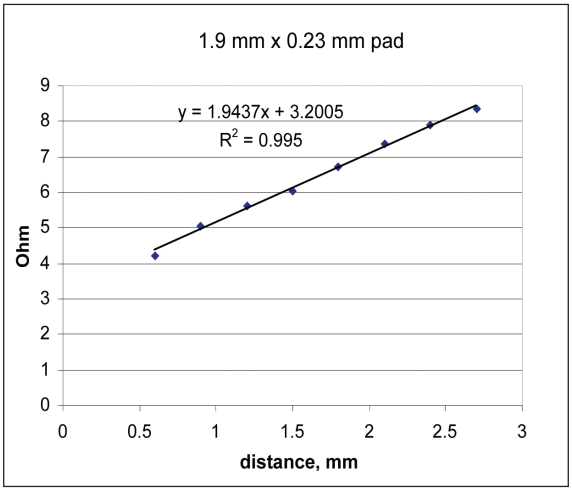
2) Smaller pads: 1.9mm x 0.23mm paste pads with the distance of 0.6, 1.2, 1.5, 1.8, 2.1, 2.4, 2.7 mm.





Contact resistance (contact resistivity) = 3.2005 Ohm x 0.19cm x 0.023cm / 2 = 0.007Ωcm^2 (7mΩcm^2).

Note: As there are no industry standards for measuring contact resistance, data comparison should only be made using matching test conditions. This is especially true when comparing metallization pastes from different suppliers. The smaller pad method always gives a lower contact resistance than the large pad method. Although both methods are used, more thin film photovoltaic companies are adapting the small pad method.

APPLICATION NOTE

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