

Screen Printing on Solar Cells

EN# 208

Revision: 0107.1

Screen Printing and Solar Cell Production

- Screen printing provides the fastest and most cost effective means of metallizing solar cells.
- Thick film material is screen printed in the familiar grid pattern seen on the top of most solar cells.
- The majority of solar cells are based on the photovoltaic (PV) process to generate electricity.
- The entire wafer is capable of producing electricity. However, the area covered by the grid is unable to generate electrons (shadowing). Thus, optimization of the printed area is essential.
- Cost and product throughput are of prime importance.

The primary goal of screen printing on solar cells is to achieve a high aspect ratio of the finger lines. The printing parameters must be suitable for high volume operations.

Challenges to achieving a high aspect ratio:

- Paste Rheology
- Screen Selection
- Printing Parameters

What is Aspect Ratio?

- Fine line resolution: decreases shadowing caused by the printed area.
- Maximum line height: provides adequate pathways for current density.

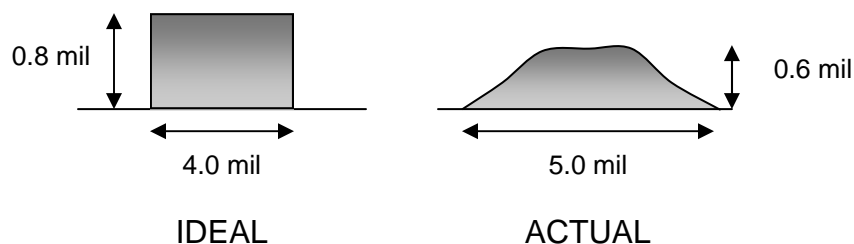


Figure 1. Cross section of printed finger lines

- When reducing line width from 5 mils to 4 mils, the printed area is decreased by 20% leading to a possible 1% increase in cell efficiency. This is a major increase in efficiency by optimizing the printing process.

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Paste Rheology

- A paste with a *pseudoplastic* rheology is best suited for printing solar cell fingers. The paste viscosity will decrease as it passes through the screen. It will then recover to near resting viscosity as the screen is peeled away from the substrate. The paste should have minimal slumping for optimal fine line resolution, and it should retain its intended printed height.

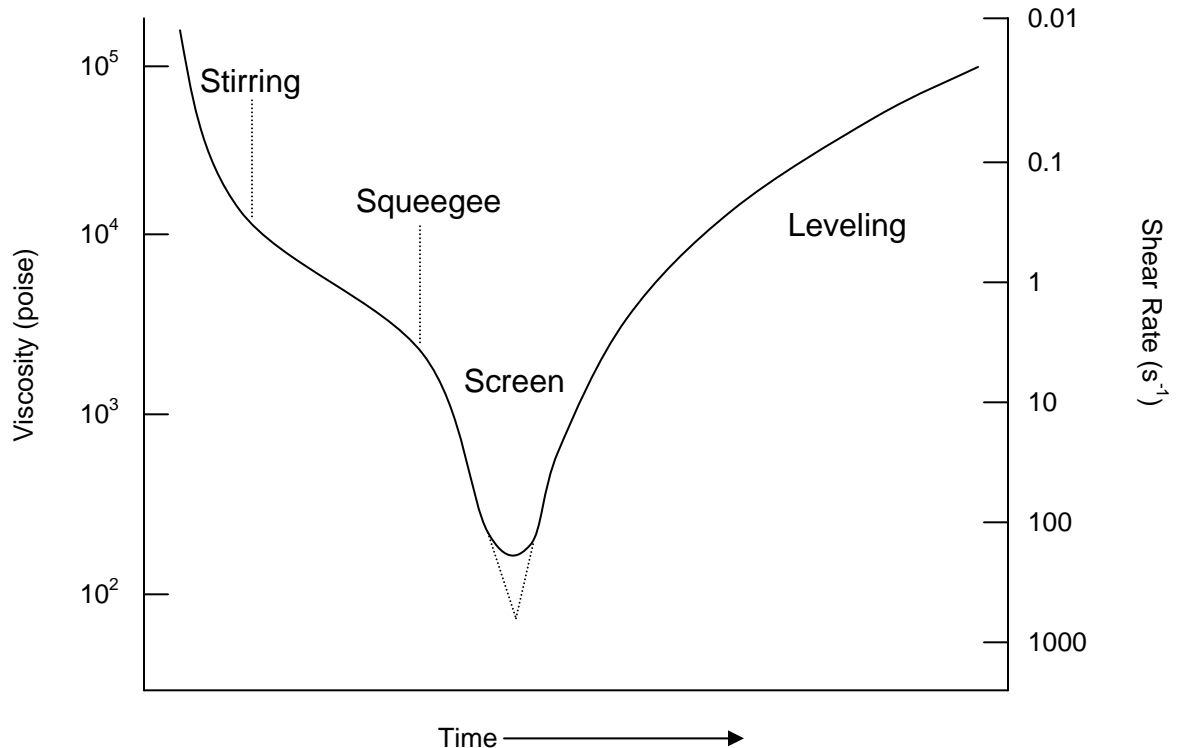


Figure 2. Pseudoplastic Rheology Curve

Choosing a Screen

- Screen mesh has the most influence on the aspect ratio.
- An inherent problem with screen mesh is wire thickness vs. wire strength. The screens become more expensive as the wires get thinner and stronger.
- Even with extra thin wires, the areas where the two wires cross create printing defects. These "knuckles" may be at the edges of the pattern or create very small openings to print through.
- Emulsion thickness also effects print quality. The optimal thickness is 0.6-1.0 mils (15-25 μm). The paste will not release well from the screen when the emulsion is too thick, and line height will suffer from too little emulsion.

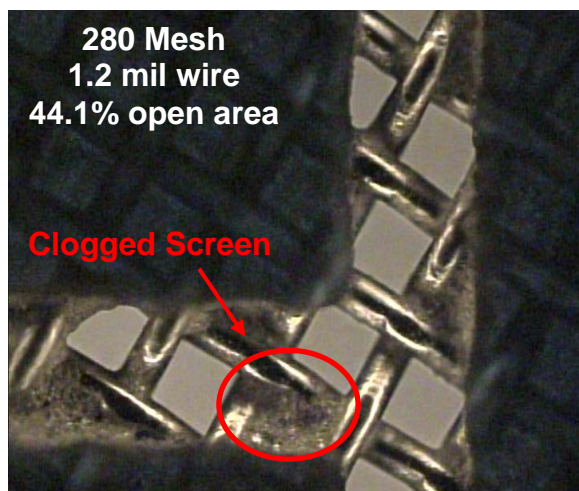
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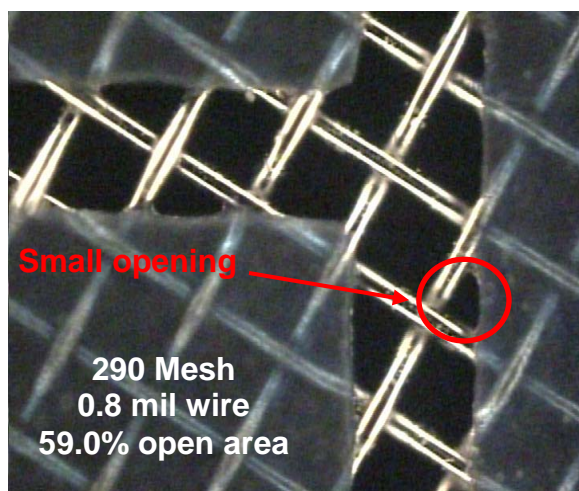
Technical Information



Properties: 4 mil line width

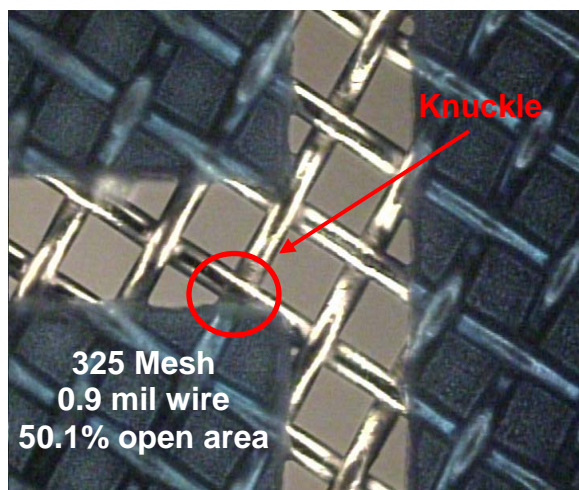
280 mesh:

- least expensive solution
- thickest theoretical print
- poor fine line resolution



290 mesh:

- very expensive, thin wire screen
- excellent fine line resolution
- adequate line height
- cost is the main issue with this screen



325 mesh:

- most cost-effective for properties
- sufficient fine line resolution
- good line height

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Printing Parameters

Table 1. Printing Parameters for High Volume Production

Printing Parameters		
	<i>English</i>	<i>Metric</i>
Squeegee Durometer	70-80	70-80
Squeegee Speed	8-10 ips	200-250 mm/sec
Squeegee Pressure	2-4 lbs/in	3.5-7 N/cm
Off-Contact Distance	45-55 mils	1.2-1.4 mm

Squeegee Durometer:

A harder durometer squeegee will print finer lines, but line height will be higher with a softer squeegee.

Squeegee Speed:

Faster speed will produce thicker lines, but print quality may suffer.

Squeegee Pressure:

Lowest pressure is best for line resolution and height, but print quality may suffer. Increased pressure will reduce the life of the screen.

Off-Contact Distance:

Higher distance will create better screen peel (print quality), but screen life will be decreased along with possible distortion of the pattern. Increased pressure and slower print speed may be required for good print quality with higher off-contact distance.

Conclusion

The optimization of the printing process is essential to getting the maximum electrical output from the solar cell. The proper paste rheology, screen selection, and printing parameters can be chosen in a cost effective manner.