Printing Practices for 01005 Components

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Outline/Agenda

- Introduction
- 01005 Components-Size, Shape and usage
- Stencil Design
- Transfer Efficiencies
- Q & A

Introduction

01005 components are a challenge due to their size

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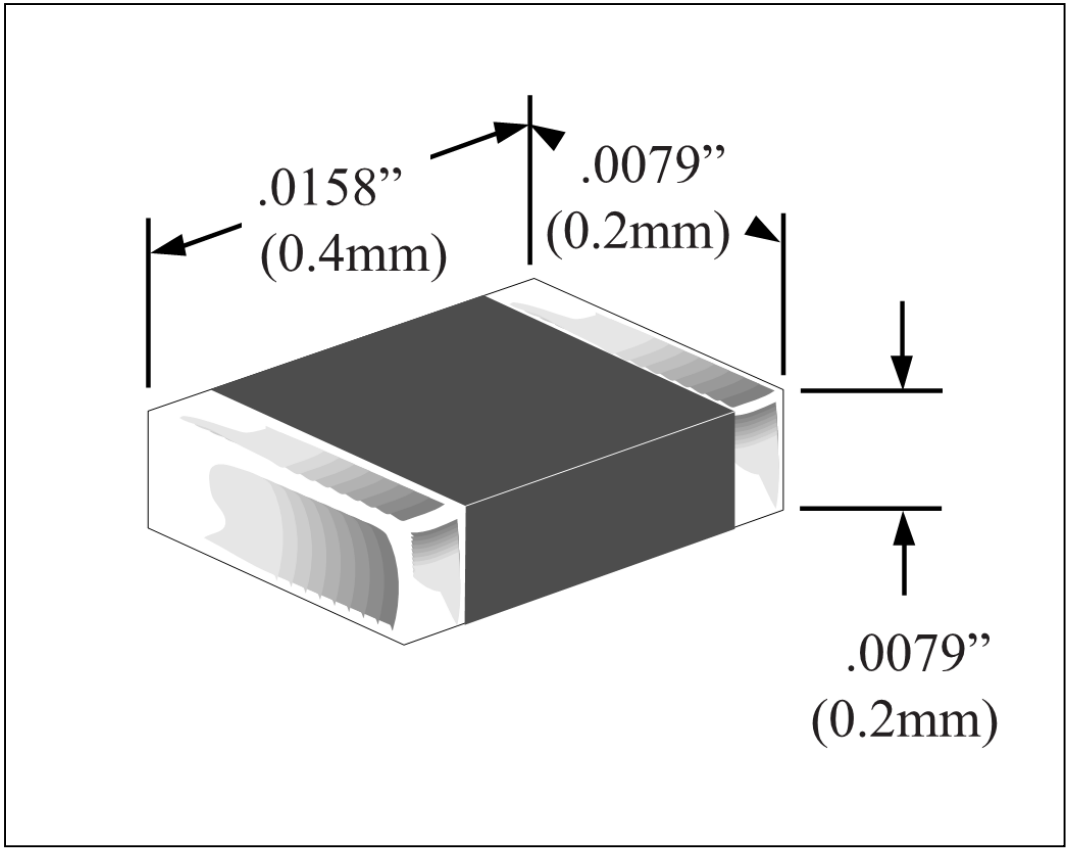
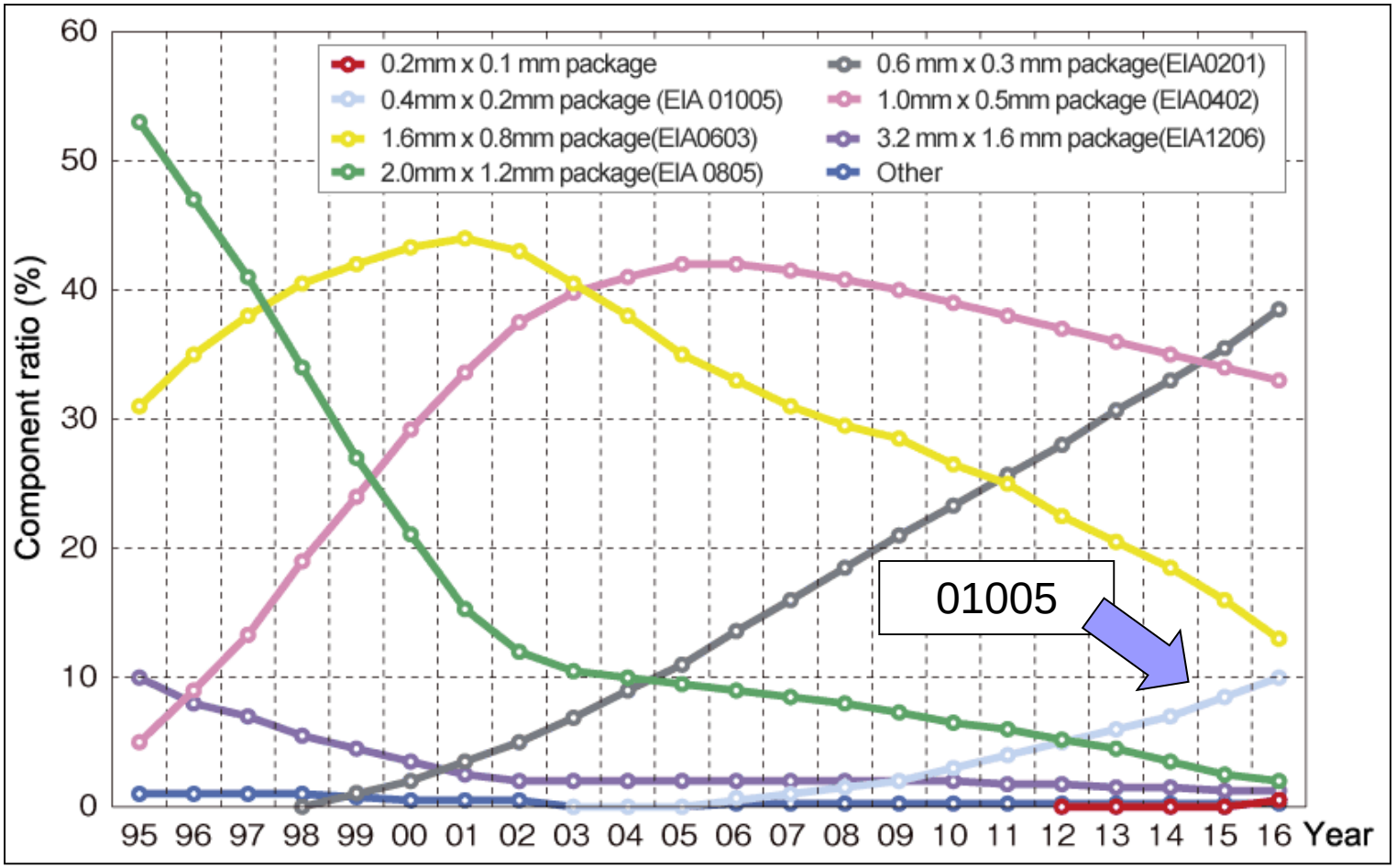


Introduction

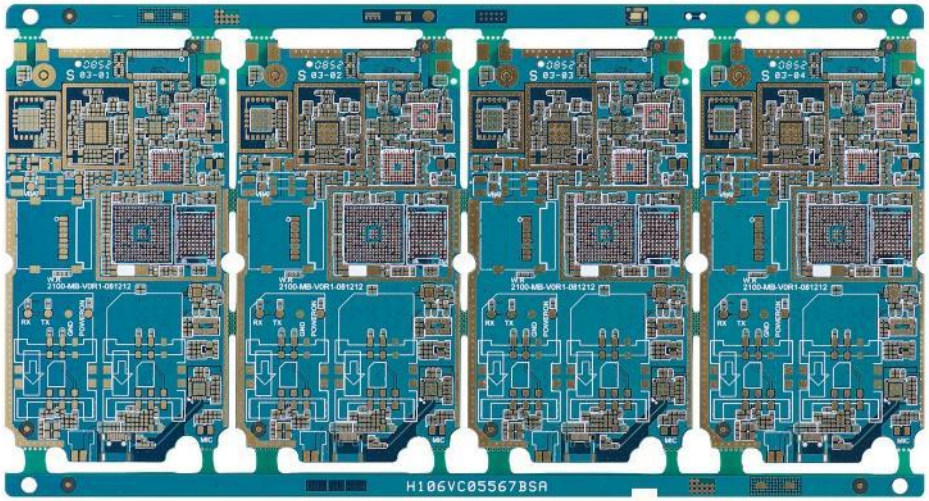


**Murata Manufacturing Company

http://www.murata.com/products/article/pp09e1/3.html

Why Use 01005 Components?

- Small size allows for use in high density circuit boards.
- Cell phones, Bluetooth applications, wireless LAN and wearable technology



Why Use 01005 Components?

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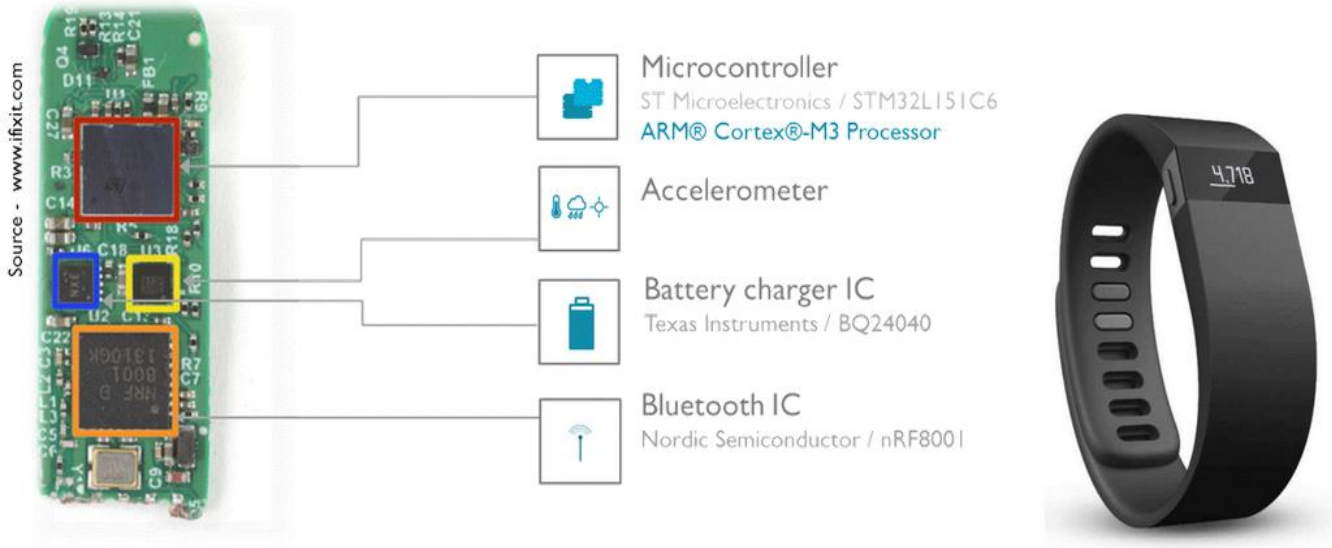


Printing Challenges

Proper paste printing requires:

- **Optimized Stencil design**
- **Best Stencil Material**
- **Best Coating Technology**
- **Proper Solderpaste Type**

Stencil Design

Table 3-2 General Aperture Design Guideline Examples for Selective Surface-Mount Devices (Tin Lead Solder Paste)

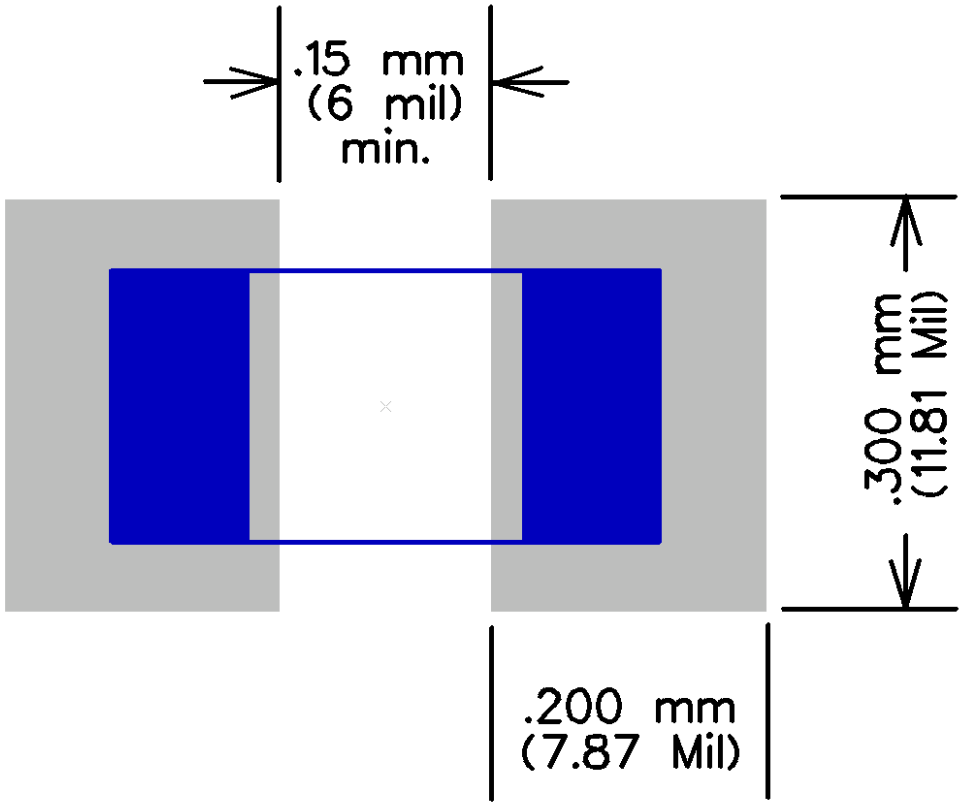
Part Type	Pitch	Land Footprint Width	Land Footprint Length	Aperture Width	Aperture Length	Stencil Thickness Range	Aspect Ratio Range	Area Ratio Range	Solder Paste Type
PLCC	1.25 mm [49.2 mil]	0.65 mm [25.6 mil]	2.00 mm [78.7 mil]	0.60 mm [23.6 mil]	1.95 mm [76.8 mil]	0.15 - 0.25 mm [5.91 - 9.84 mil]	2.4 - 4.0	0.92 - 1.53	Type 3
QFP	0.65 mm [25.6 mil]	0.35 mm [13.8 mil]	1.50 mm [59.1 mil]	0.30 mm [11.8 mil]	1.45 mm [57.1 mil]	0.15 - 0.175 mm [5.91 - 6.89 mil]	1.7 - 2.0	0.71 - 0.83	Type 3
QFP	0.50 mm [19.7 mil]	0.30 mm [11.8 mil]	1.25 mm [49.2 mil]	0.25 mm [9.84 mil]	[1.20 mm] 47.2 mil	0.125 - 0.15 mm [4.92 - 5.91 mil]	1.7 - 2.0	0.69 - 0.83	Type 3
QFP	0.40 mm [15.7 mil]	0.25 mm [9.84 mil]	1.25 mm [49.2 mil]	0.20 mm [7.87 mil]	[1.20 mm] 47.2 mil	0.10 - 0.125 mm [3.94 - 4.92 mil]	1.6 - 2.0	0.69 - 0.86	Type 3
QFP	0.30 mm [11.8 mil]	0.20 mm [7.87 mil]	1.00 mm [39.4 mil]	0.15 mm [5.91 mil]	0.95 mm [37.4 mil]	0.075 - 0.125 mm [2.95 - 4.92 mil]	1.2 - 2.0	0.52 - 0.86	Type 3
0402	N/A	0.60 mm [19.7 mil]	0.65 mm [25.6 mil]	0.45 mm [17.7 mil]	0.60 mm [23.6 mil]	0.125 - 0.15 mm [4.92 - 5.91 mil]	N/A	0.86-1.03	Type 3
0201	N/A	0.4 mm [9.84 mil]	0.45 mm [15.7 mil]	0.23 mm [9.06 mil]	0.35 mm [13.8 mil]	0.075 - 0.125 mm [2.95 - 4.92 mil]	N/A	0.56 - 0.93	Type 3
01005	N/A	0.200 mm [7.87 mil]	0.300 mm [11.81 mil]	0.175 mm [6.89 mil]	0.250 mm [9.87 mil]	0.063 - 0.089 mm [2.5 - 3.5 mil]	N/A	0.58 - 0.81	Type 4
BGA	1.25 mm [49.2 mil]	CIR 0.55 mm [21.6 mil]		CIR 0.52 mm [20.45 mil]		0.15 - 0.20 mm [5.91 - 7.87 mil]	N/A	0.65 - 0.86	Type 3
Fine-pitch BGA	1.00 mm [39.4 mil]	CIR 0.45 mm [15.7 mil]		SQ 0.42 mm [13.8 mil]		0.115 - 0.135 mm [4.53 - 5.31 mil]	N/A	0.65 - 0.76	Type 3
Fine-pitch BGA	0.50 mm [19.7 mil]	CIR 0.25 mm [9.84 mil]		SQ Overprint 0.28 mm [11.0 mil]		0.075 - 0.125 mm [2.95 - 4.92 mil]	N/A	0.56 - 0.93	Type 3
Fine-pitch BGA	0.40 mm [15.7 mil]	CIR 0.20 mm [7.87 mil]		SQ Overprint 0.23 mm [9 mil]		0.075 - 0.100 mm [2.95 - 4 mil]	N/A	0.56 - 0.75	Type 4

Note 1: It is assumed that the fine-pitch BGA lands are not solder mask defined.
Note 2: N/A implies that only the area ratio should be considered.

IPC-7525B 2011-October. Stencil Design Guidelines

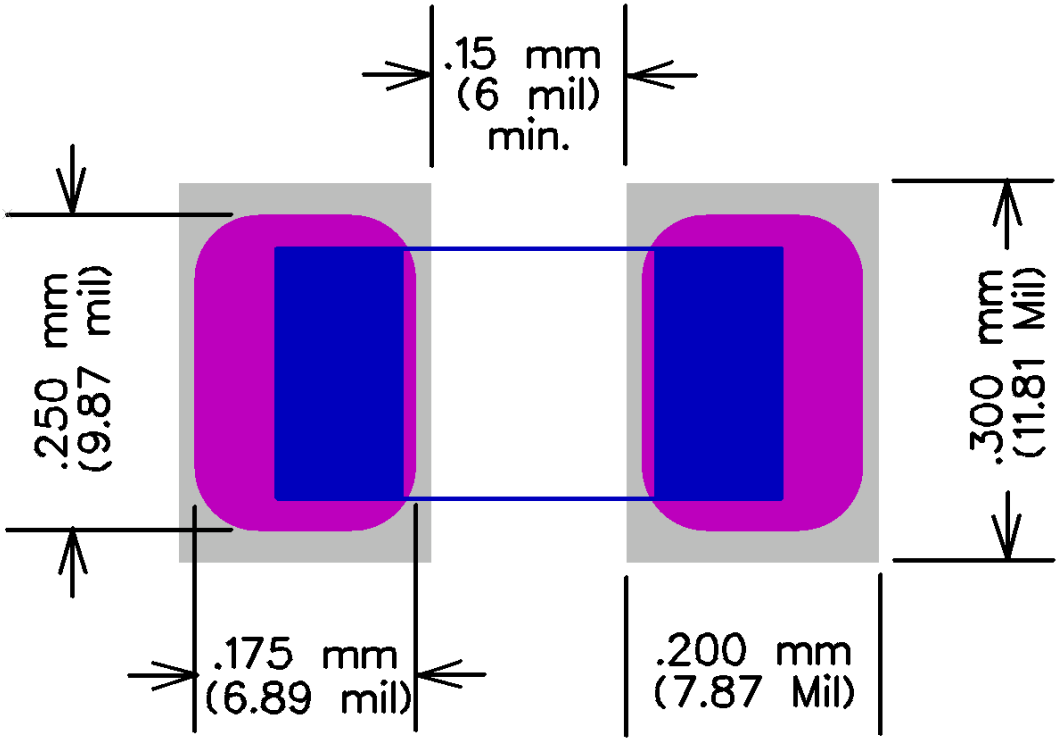
Stencil Design

01005 IPC Recommended Land Size



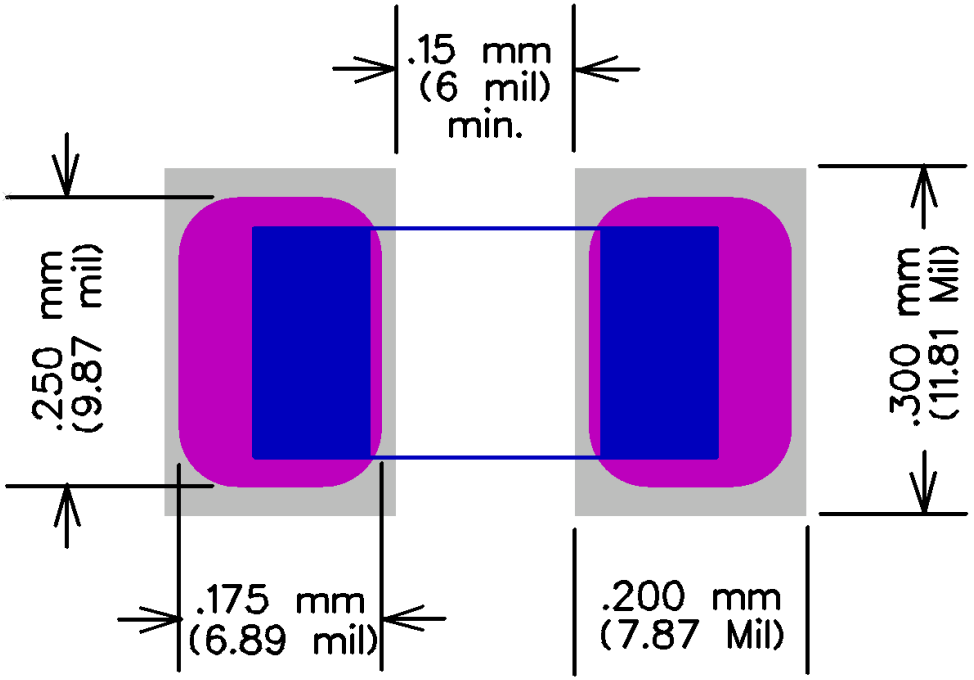
Stencil Design

01005 IPC Recommended Aperture Size



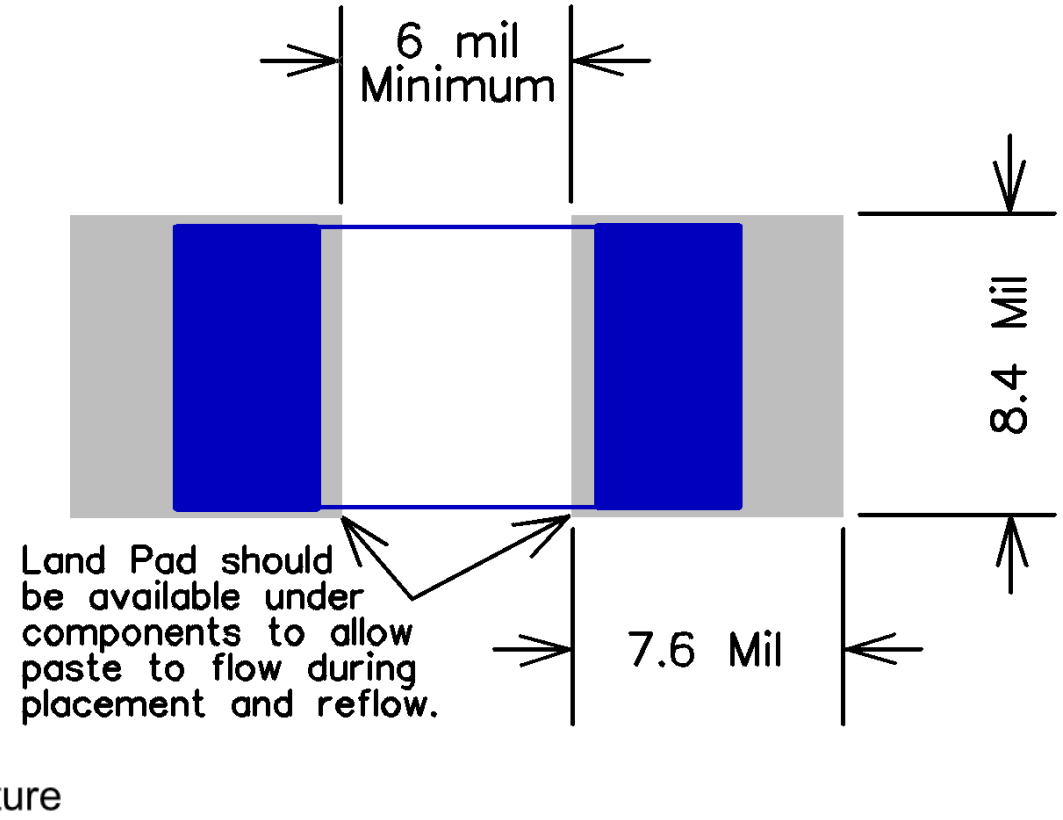
Stencil Design

The IPC aperture design produces an Area Ratio of:
5 mil=.41 4 mil=.51 3 mil=.68



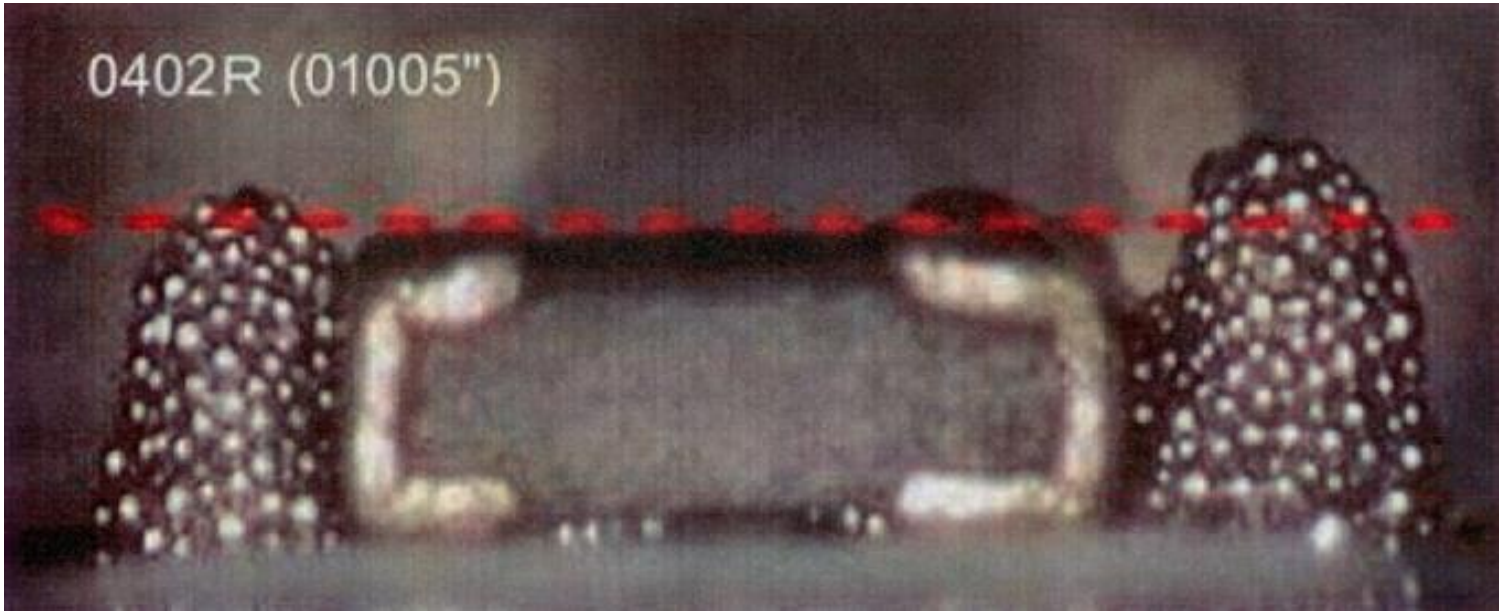
Stencil Design

01005 Land Designs in Manufacturing Environments: Approx. 30% smaller than IPC



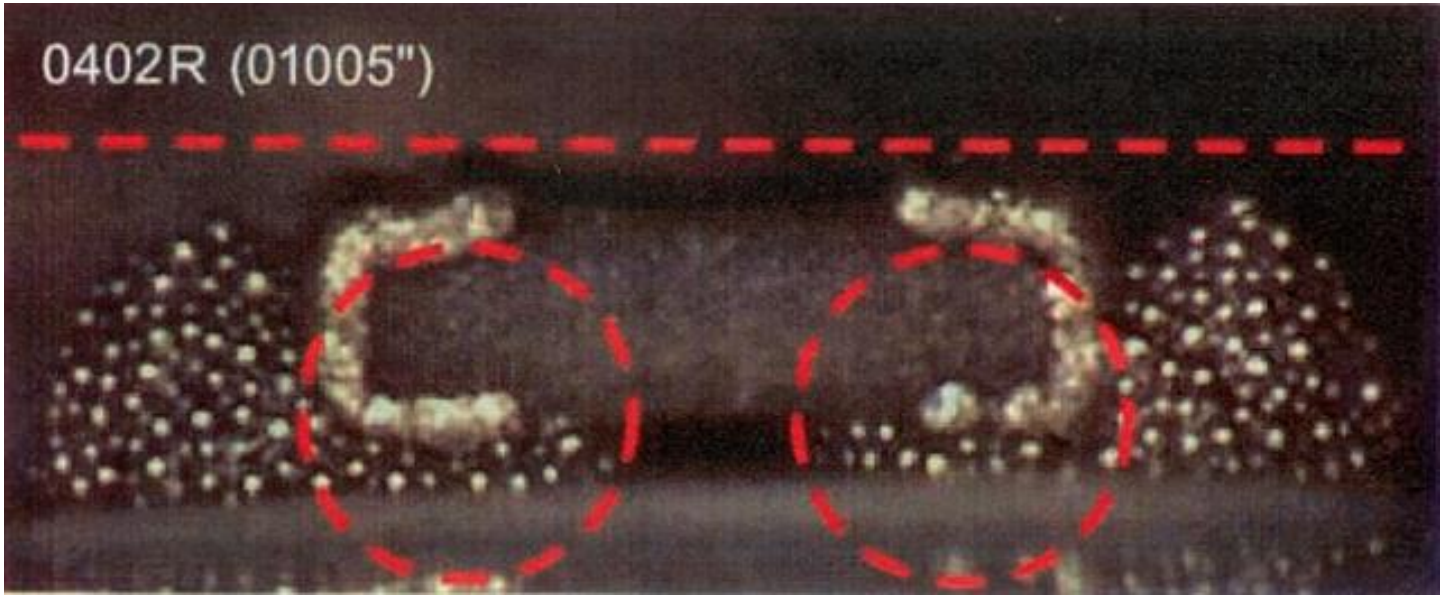
Stencil Design

01005 Land Designs in Manufacturing Environments: Must Balance Volume and Placement Pressure



Stencil Design

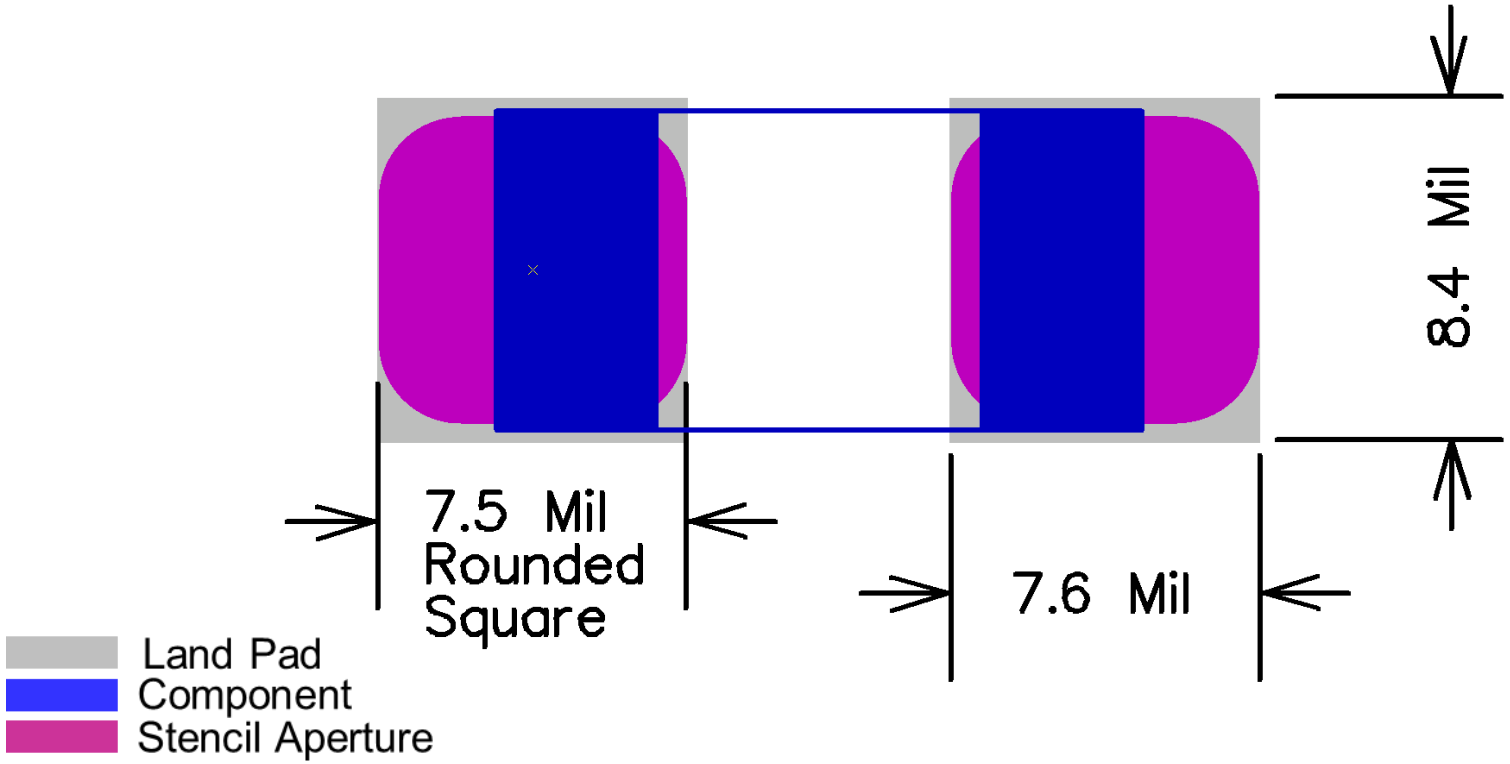
01005 Land Designs in Manufacturing Environments: Reduced Volume/Less Pressure-Optimized Reflow



Stencil Design

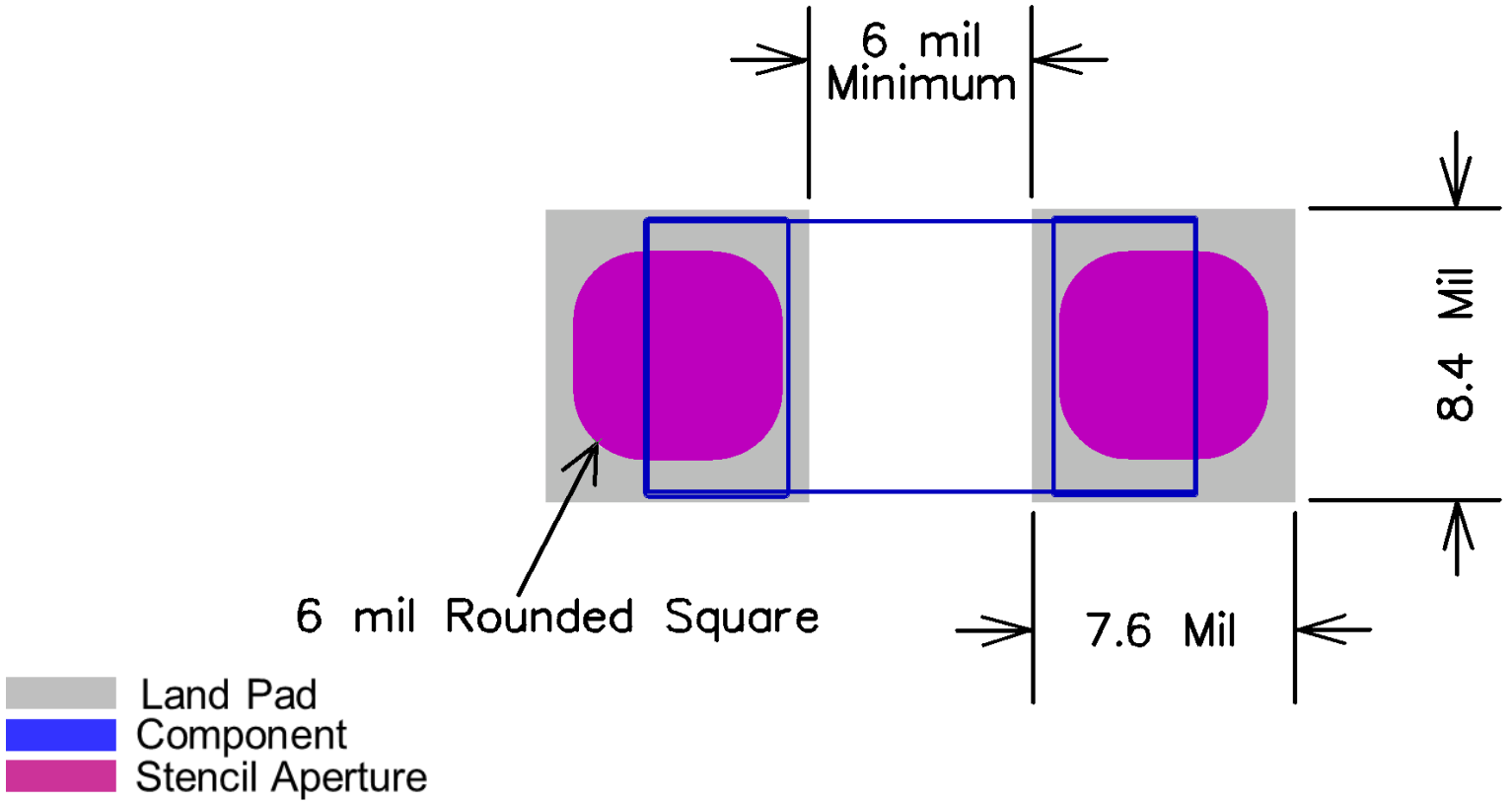
01005 Land Designs in Manufacturing Environments

- ❑ Minimize overprint, float and skew by reducing Land Size
- ❑ Print 7.5 mil aperture, radius corners 2 mils to improve release



Stencil Design

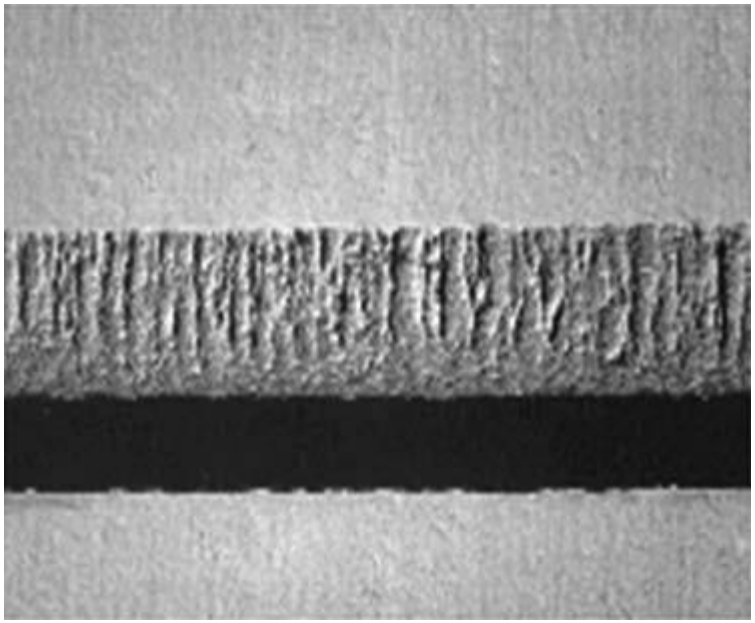
01005 Land Designs in Manufacturing Environments



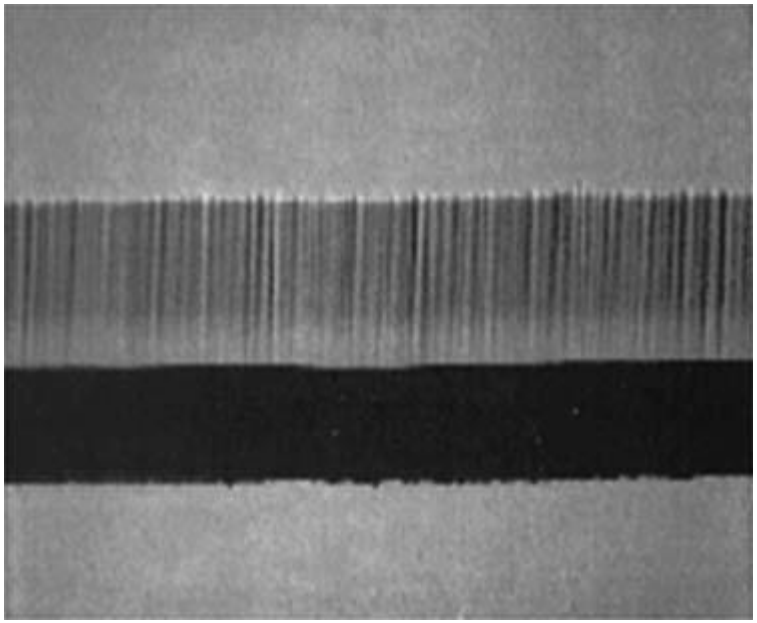
Material Types:

Fine grain steel gives smoother side walls

Improves Paste Transfer Efficiency



Mill grade steel (500X)
25-30 µm

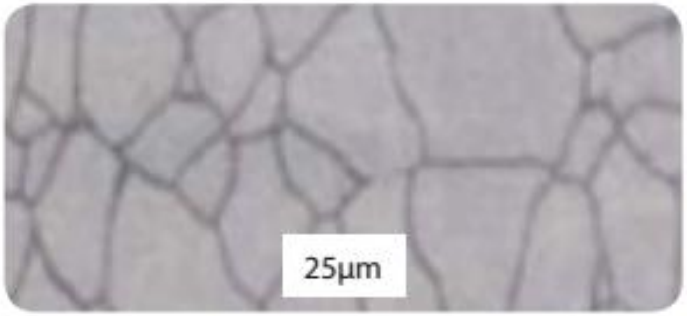


Fine grain steel (500X)
8-9 µm

Material Types:

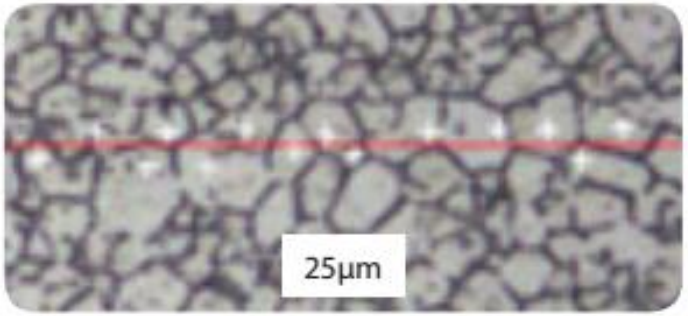
Fine grain steel gives smoother side walls

Improves Paste Transfer Efficiency



Standard SS Microstructure

Grain Size: 15-30µm

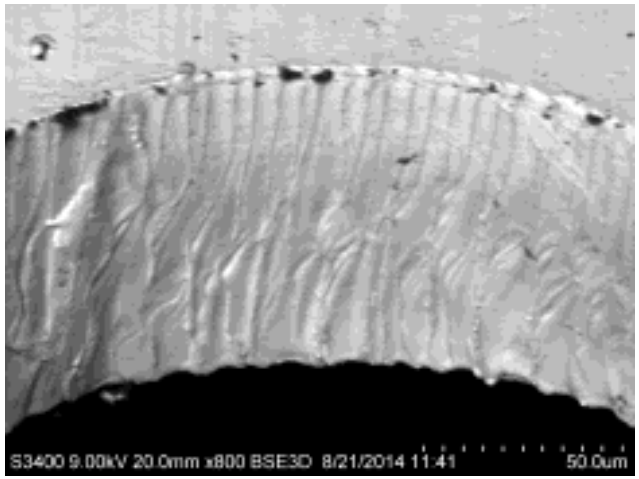


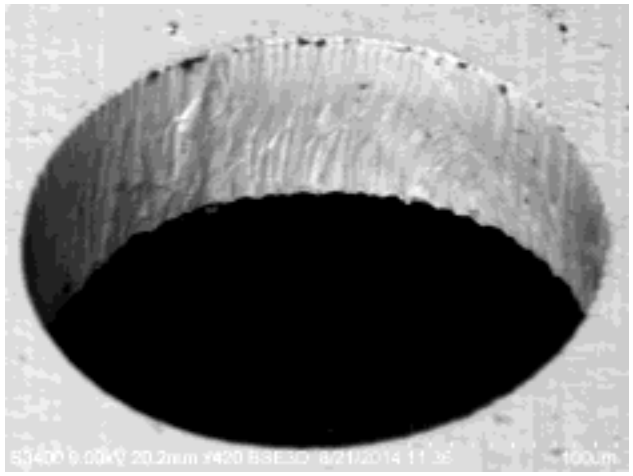
Datum PhD Microstructure

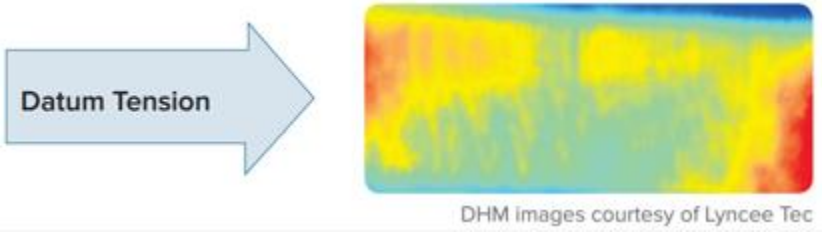
Grain Size: 7-11µm

Material Types:
Fine Grain or Finer Grain?

Fine grain steel gives smoother side walls



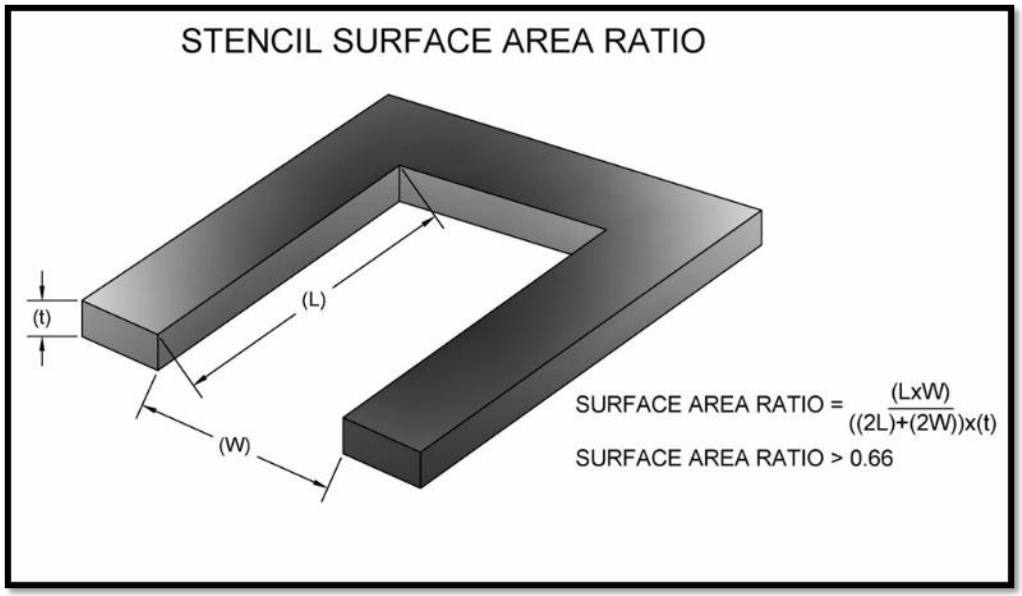




Datum FG/Tension Foil is Now down to the 2-3 micron Grain Size and is the best Performing material available.

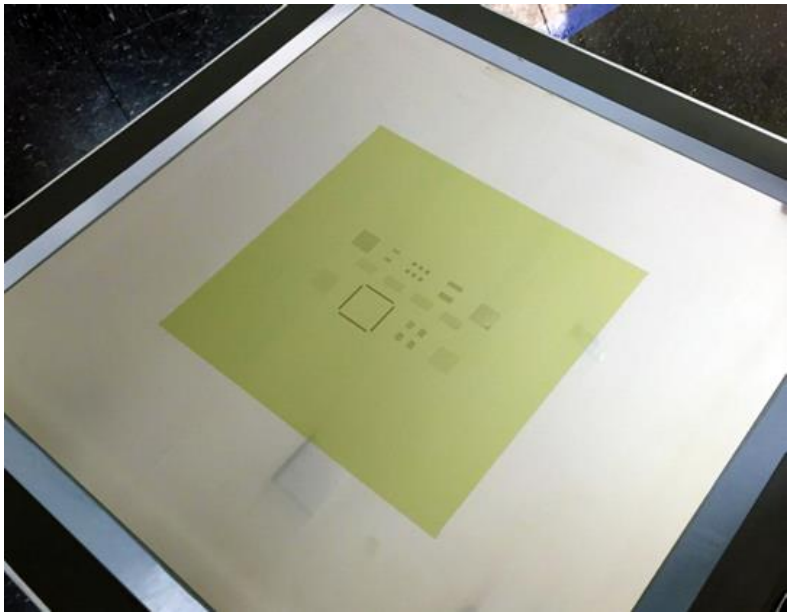
Fine Grain Stencils

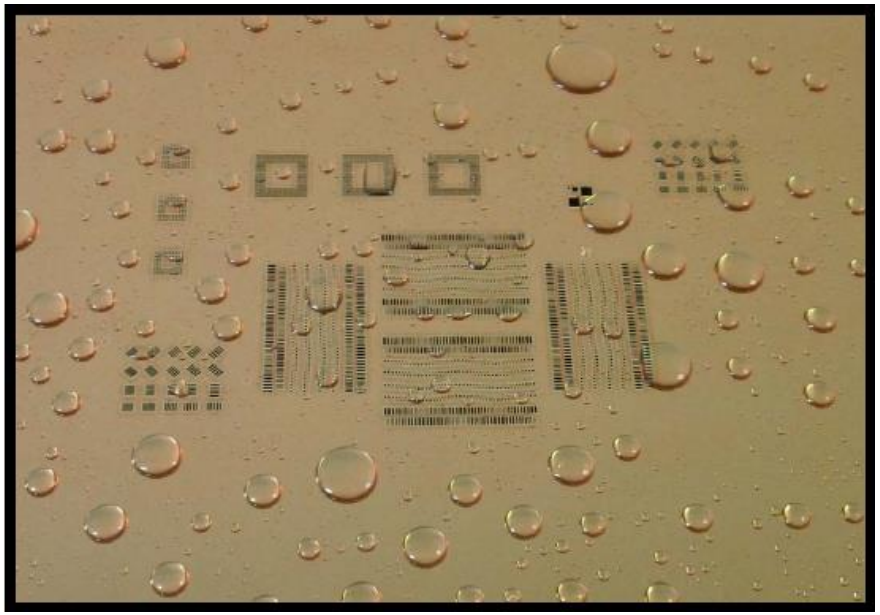
- Fine grain steel reduces the min. area ratio
- Minimum area ratios
  - Mill grade steel = 0.66 (industry standard)
  - Fine grain steel = 0.55 (with no coating)



Nano Coatings

- Polymer Nano Coatings can reduce min area ratios and maintain acceptable TE%
- Minimum area ratios
  - Fine grain steel = 0.55
  - Fine grain steel + Nano Coating = 0.45

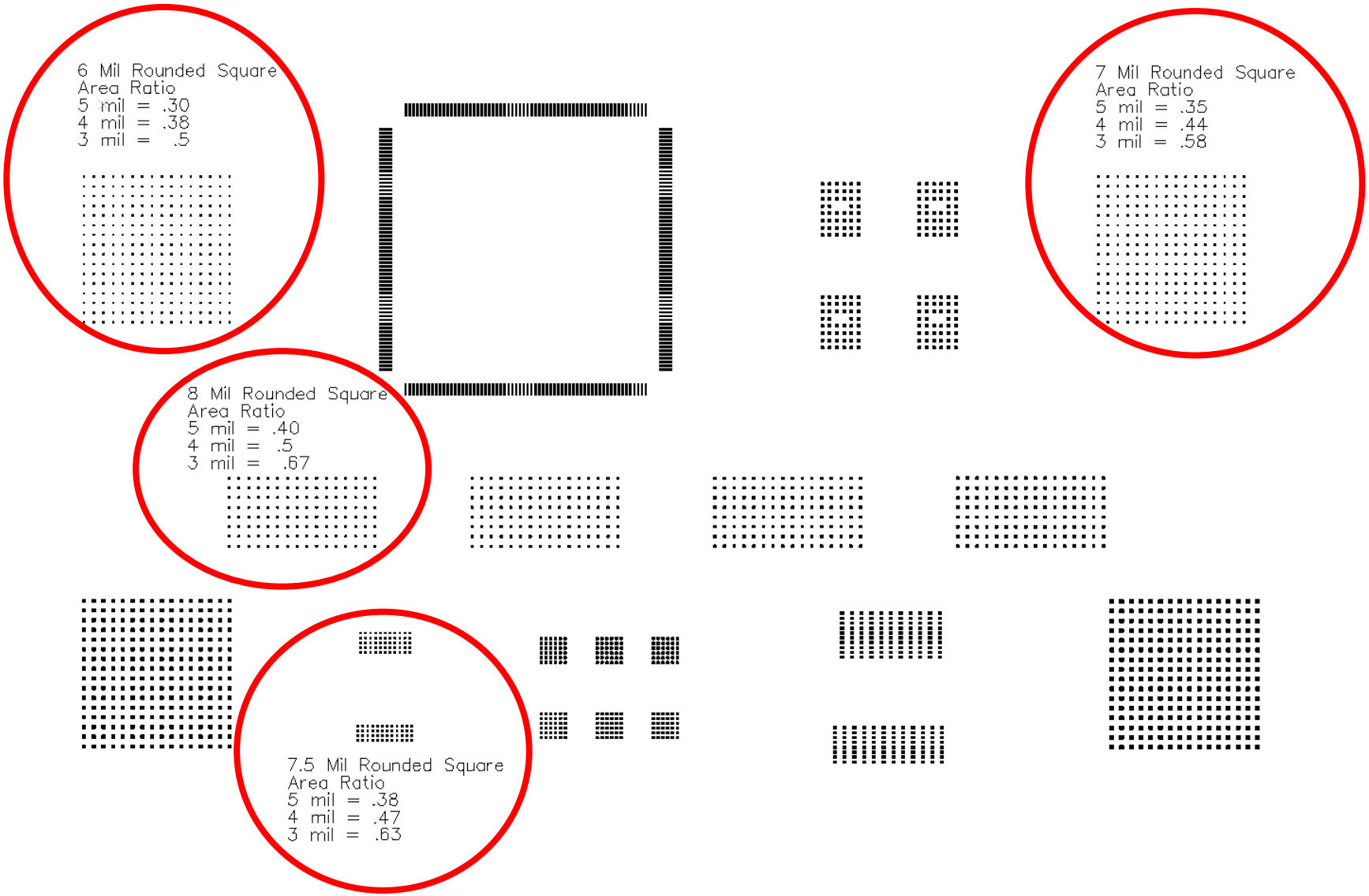




Transfer Efficiency Experiment Equipment and Materials

- **Essemtec printer**
  - 20 mm/sec, 0.18 Kg/cm, 1.5 mm/sec
- **ASC International SPI**
  - AP212 with VM150 sensor
- **Solder paste**
  - No clean, lead free, SAC305
- **Stencils**
  - Datum PhD
- **Copper Clad Board**

SAR Test Design



SAR Test Design

Size (mils)	Shape	Pitch (mm)	Volume (mil3)	Area Ratio
5 mil stencil				
6	RSQ	1	180	0.300
7	RSQ	1	245	0.350
7.5	RSQ	0.5	281	0.380
8	RSQ	1	320	0.400
4 mil stencil				
6	RSQ	1	144	0.380
7	RSQ	1	196	0.440
7.5	RSQ	0.5	225	0.470
8	RSQ	1	256	0.500
3 mil stencil				
6	RSQ	1	108	0.500
7	RSQ	1	147	0.580
7.5	RSQ	0.5	169	0.630
8	RSQ	1	192	0.670

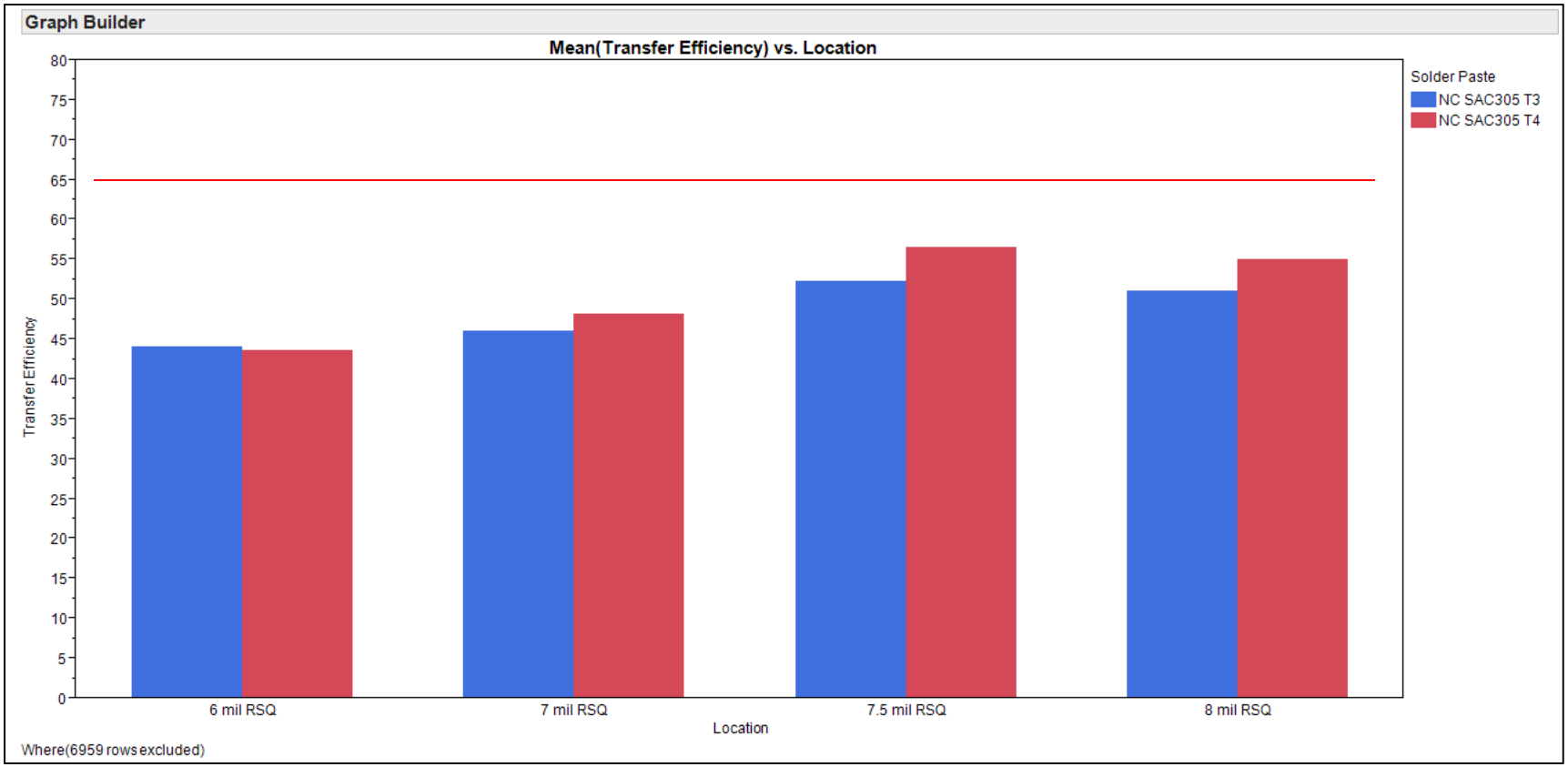
1st Experiment

- Compare TE of 3 mil, 4 mil and 5 mil Foil, Uncoated
- Compare TE of Type 3 vs Type 4 paste
- Draw Conclusions

Solder Paste & TE

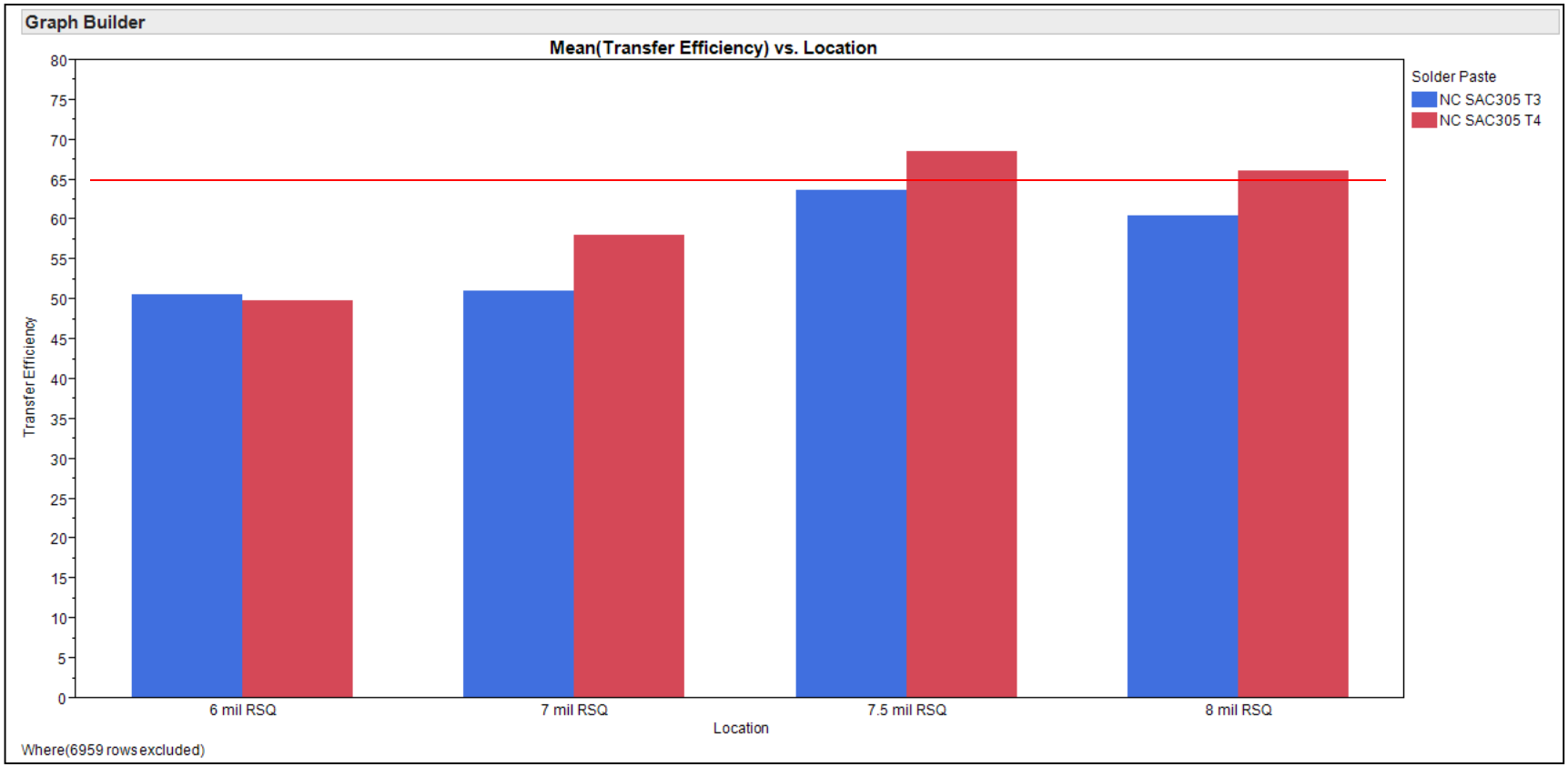
0.005” thick stencil, Uncoated

Solder Paste & TE



0.004” thick stencil, Uncoated

Solder Paste & TE



0.003” thick stencil, Uncoated

Stencil Thickness Summary

- Type 4 solder paste gives higher TE than Type 3
- 5 mil thick stencil does not work for 01005s
- 4 mil thick stencil and Type 4 paste acceptable
- 3 mil thick stencil is the best option
- 3 mil thick stencils works with Type 3 & 4 pastes

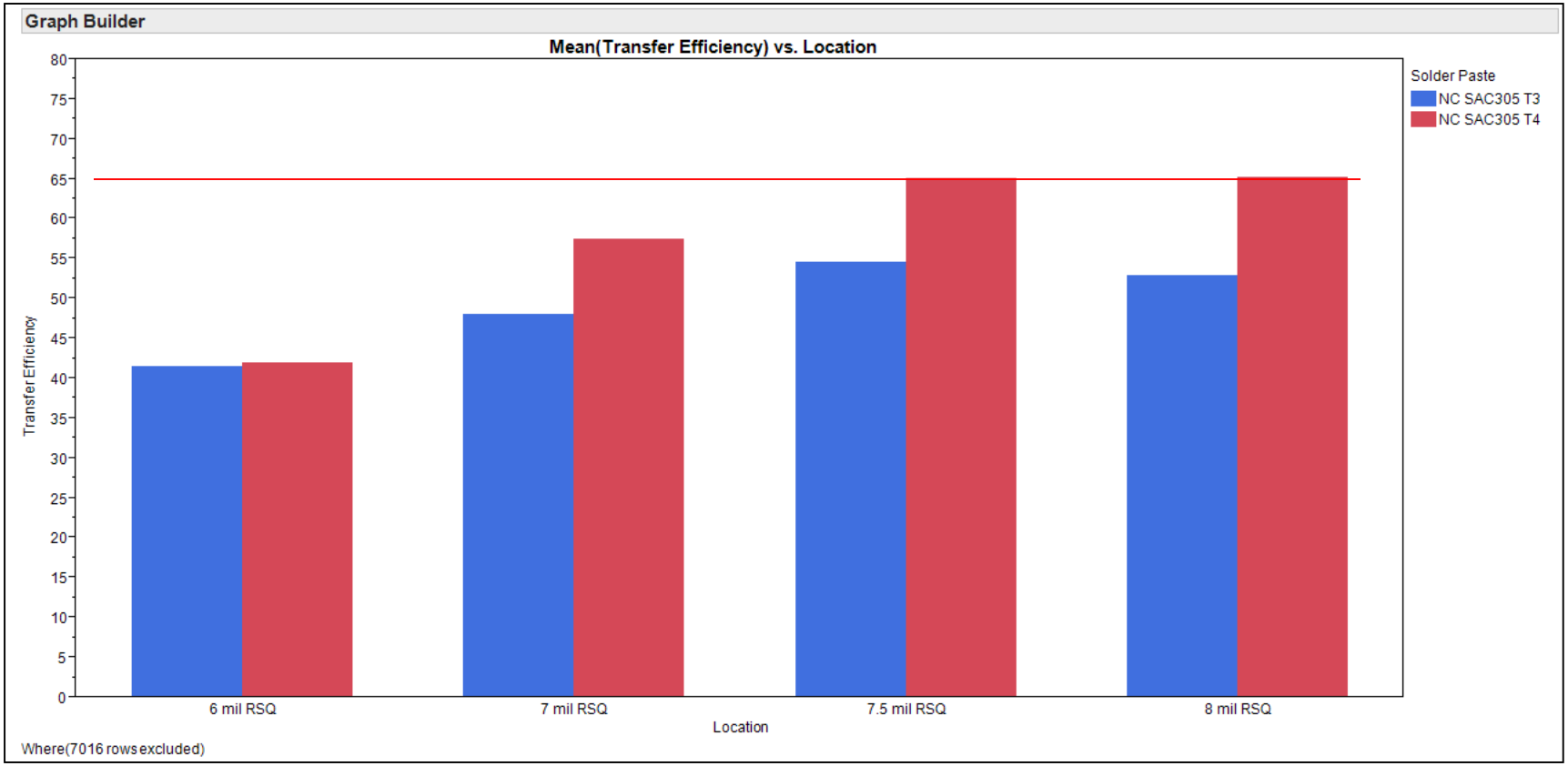
2nd Experiment

- Compare TE of 3 mil, 4 mil and 5 mil Foil, With Nanocoated Polymer
- Compare TE of Type 3 vs Type 4 paste
- Draw Conclusions

Solder Paste & TE

0.005” thick stencil, Nano Coat Polymer

Solder Paste & TE



0.004” thick stencil, Nano Coat Polymer

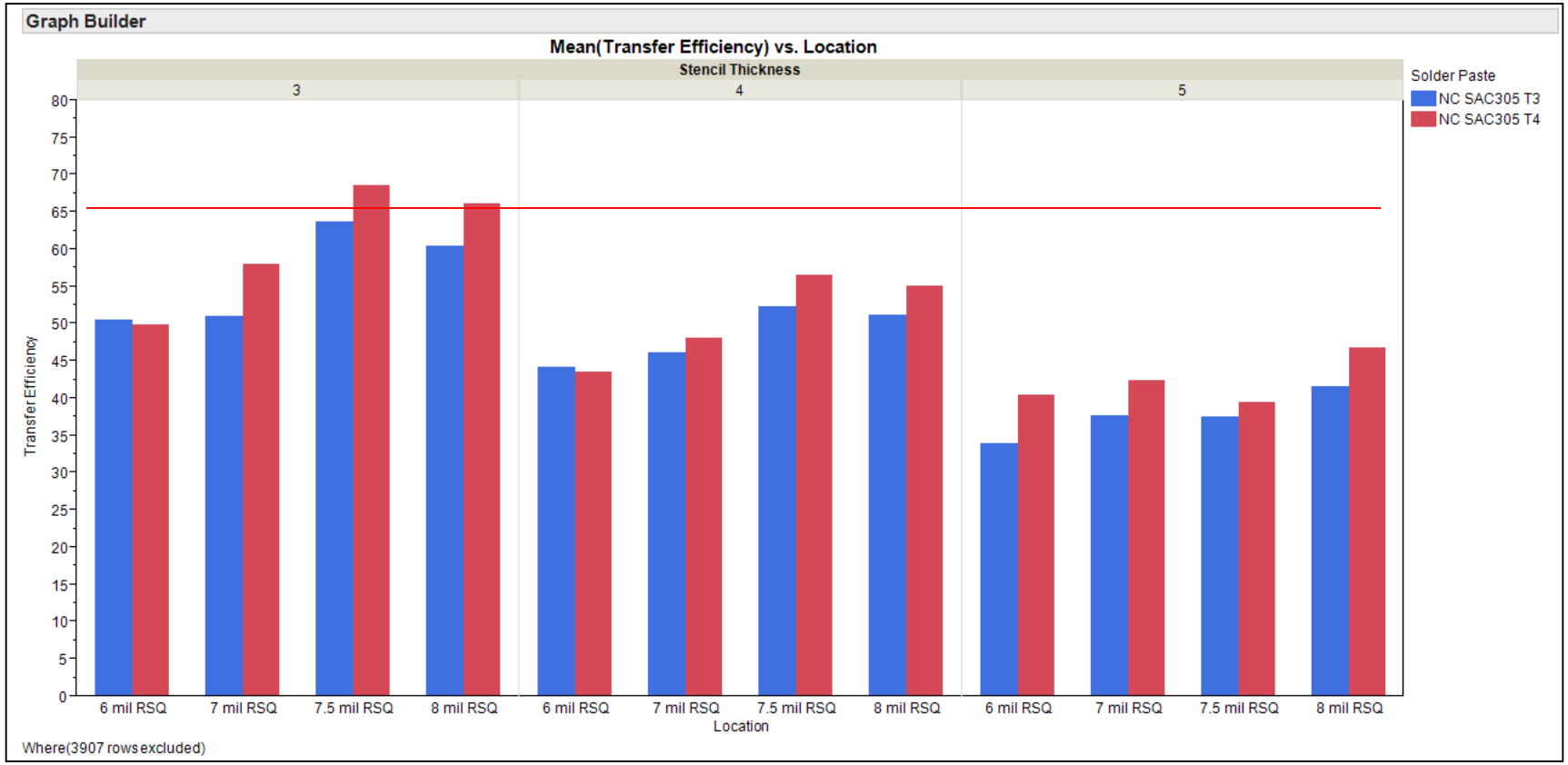
Solder Paste & TE

0.003” thick stencil, Nano Coat Polymer

Nano Coating Polymer Summary

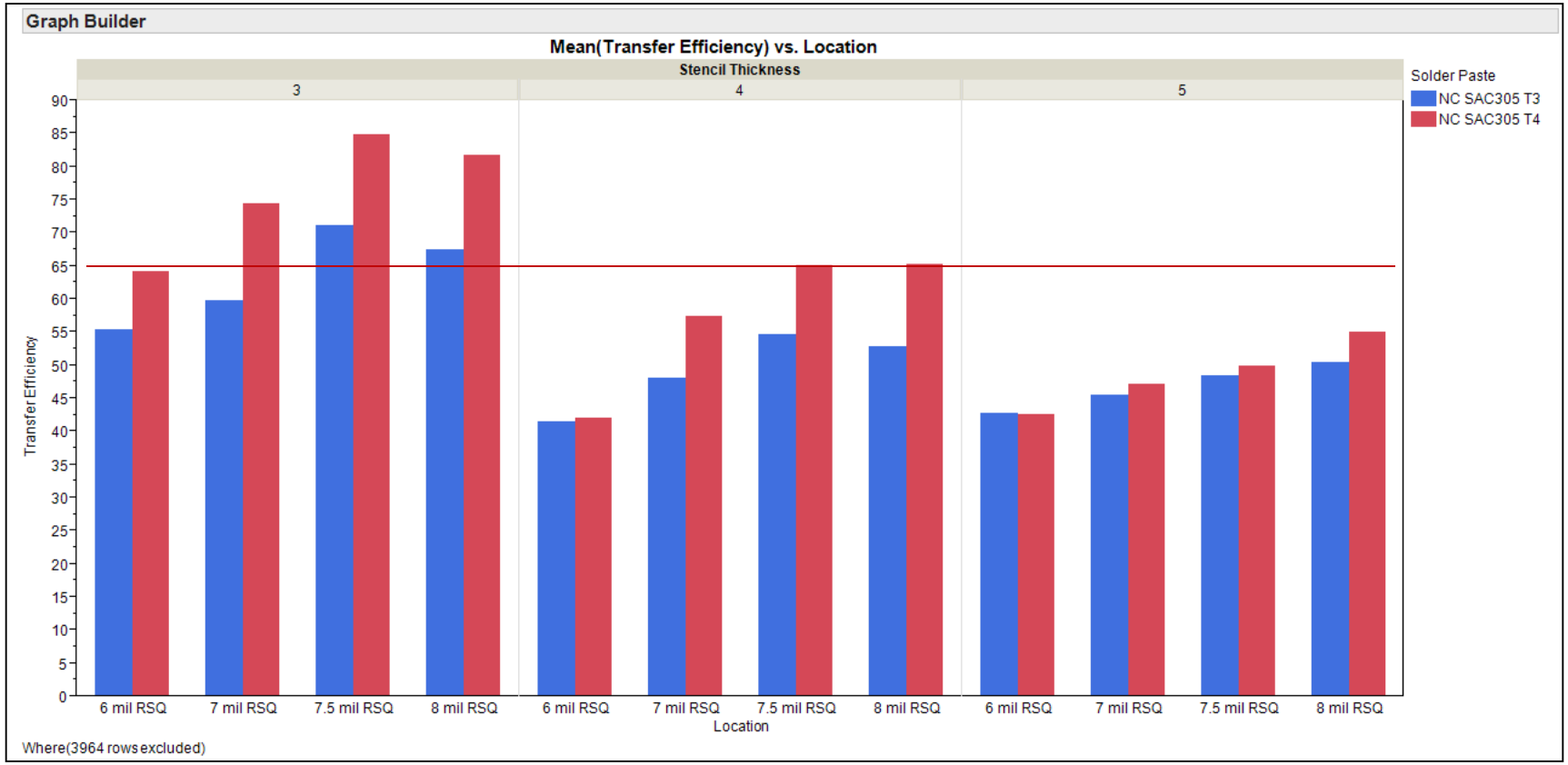
- 5 mil Nano coated stencil still low TE
- 4 mil Nano coated stencil and Type 4 paste works well
- 3 mil Nano coated stencil gave exceptional TE

Summary: Uncoated Stencils



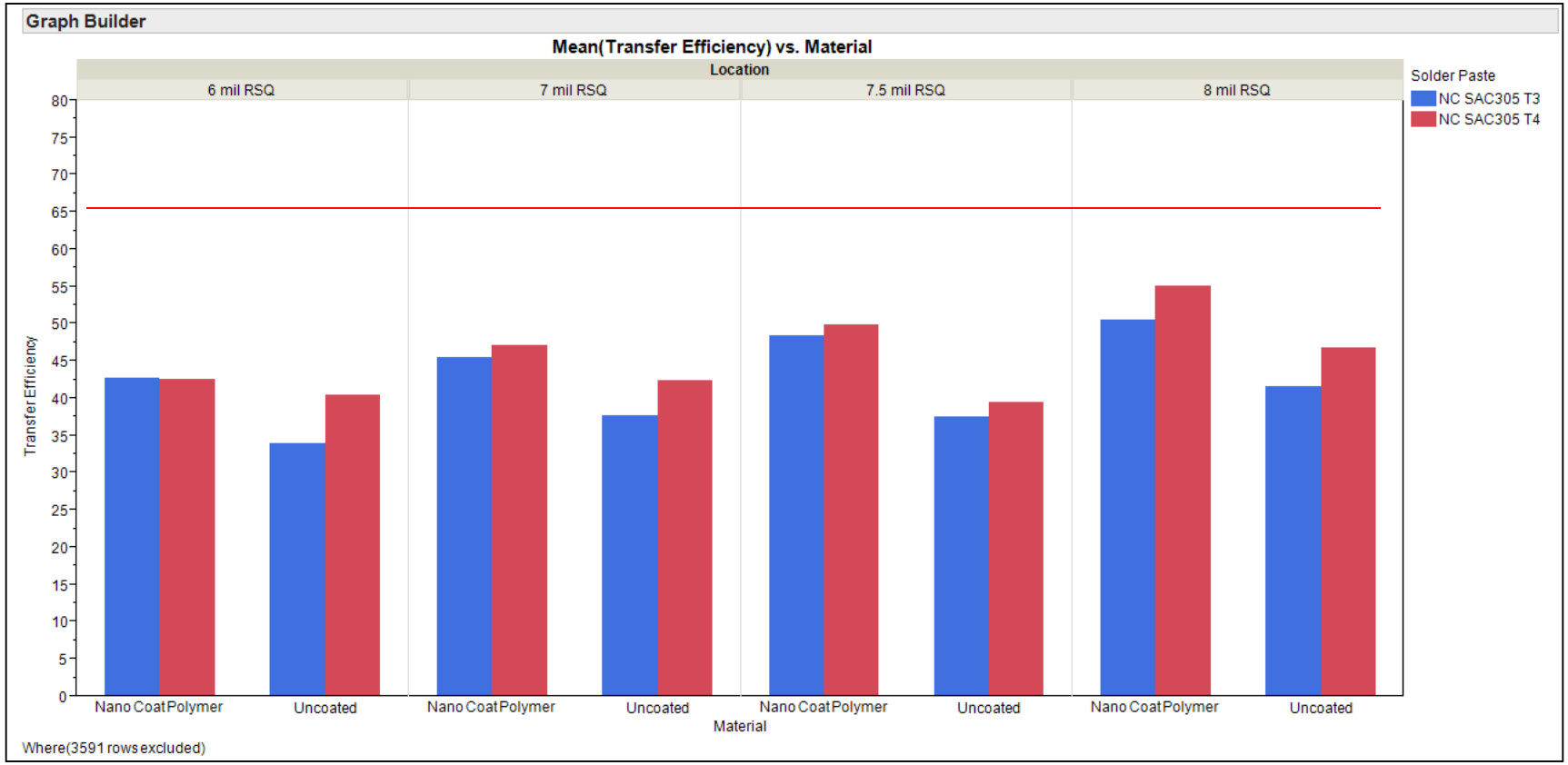
3 mil uncoated stencil & Type 4 paste near 70% TE

Summary: Nano Coated Polymer Stencils



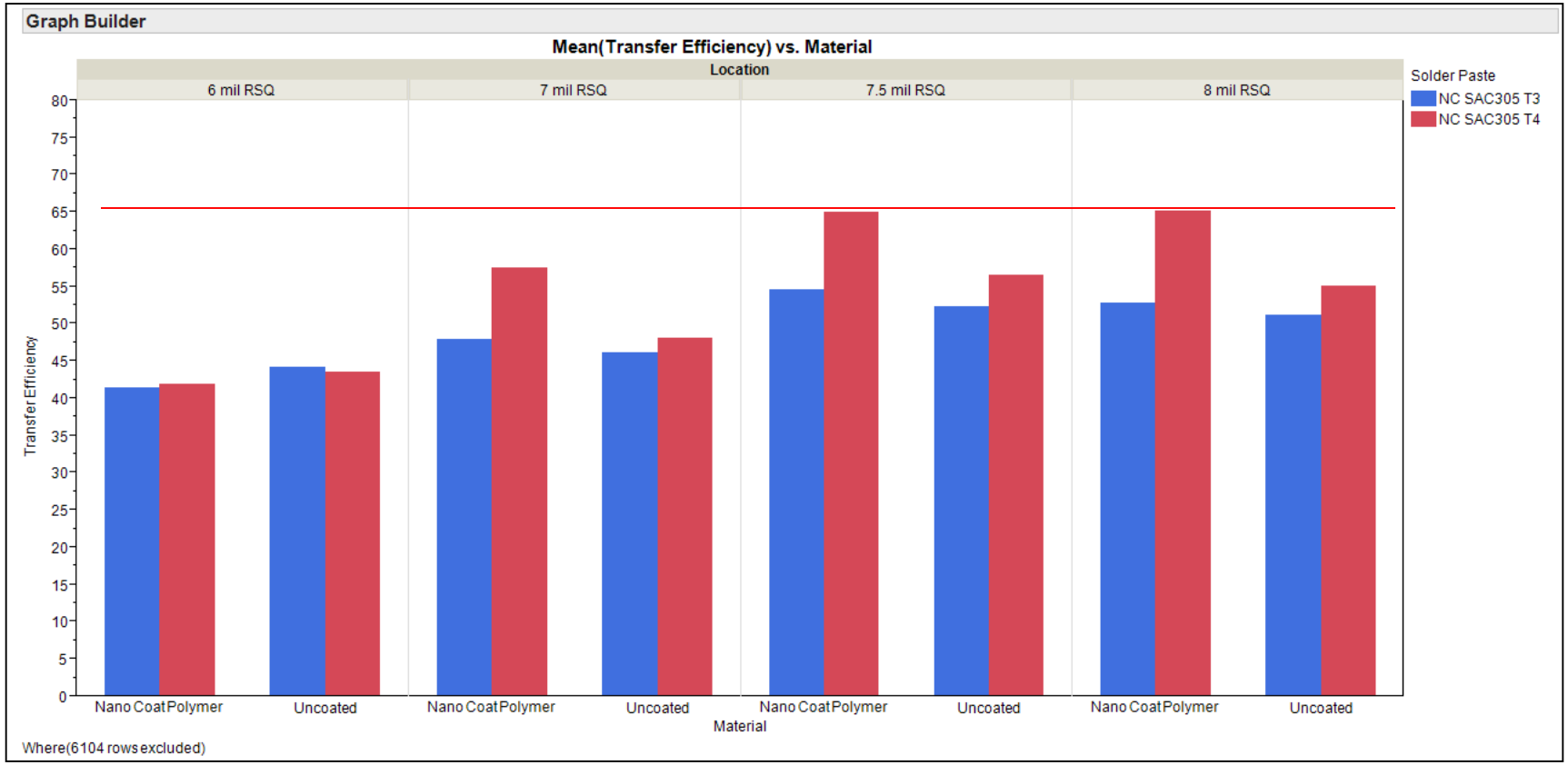
3 and 4 mil Nano coated stencils gave > 70% TE

5 mil Stencil Summary



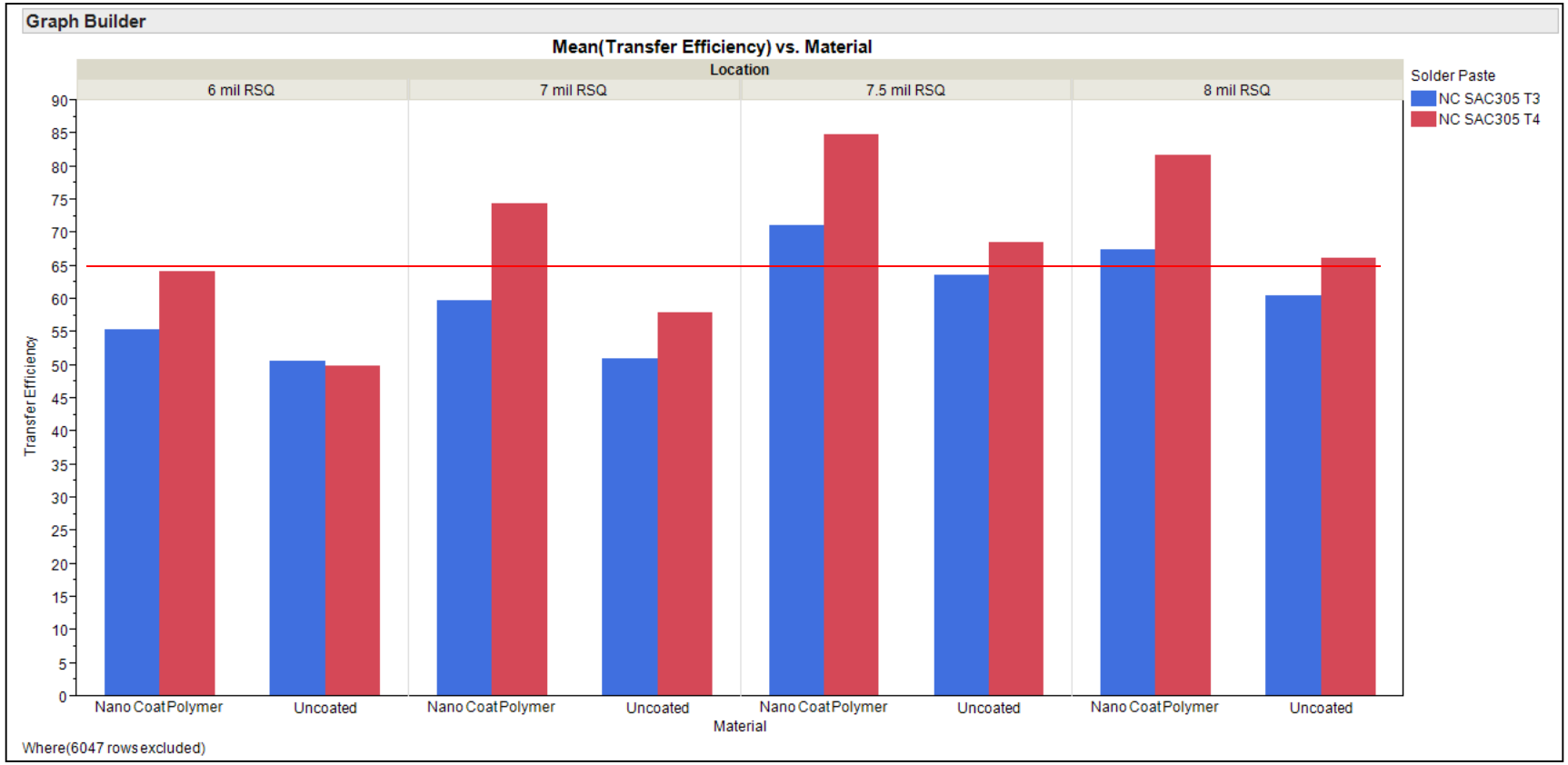
5 mil Stencils, Coated and Uncoated

4 mil Stencil Summary



4 mil Stencils, Coated and Uncoated

3 mil Stencil Summary



3 mil Stencils, Coated and Uncoated

Transfer Efficiency Summary

- Adequate TE% can be achieved
  - 4 mil Nano coated stencil with Type 4 paste
  - 3 mil uncoated stencil with Type 4 paste
  - 3 mil Nano coated stencil with Type 3 paste
- 5 mil stencil too thick – area ratios too low

Conclusion

- **Recommended Stencil Design**
  - **4 mil Stencil, Standard Phd material**
  - **7.5 mil Square Aperture, 2 mil Radius Corners**
  - **Nano coated polymer coating**

Notes For Further Study

- **“Fine Grain/Tension” Foil needs to be examined to determine the effect of TE with and without Polymer Nanocoatings on different foil thicknesses.**
- **Type 5 Solderpaste needs to be examined to determine the effect on TE with different foil types and thicknesses.**

Any Questions?

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