Stencil Nano-Coatings-Do They Improve Repeatability and Uniformity in The Print Process?

Greg Smith

BlueRing Stencils

Lumberton, NJ USA

This Presentation "Stencil Nano-Coatings-Do They Improve Repeatability and Uniformity in The Print Process?" was first presented at the 2018 IPC Apex Expo Technical Conference and published in the 2018 Technical Conference Proceedings.

Outline

- Introduction
- Experimental Methodology
- Results
  - *SPI Print Volume*
  - *Print Height*
  - *Print Area*
- Conclusions

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Introduction

Benefits of Nano-Coatings

- *Hydrophobic-repel water based chemistry (flux)*
- *Oleophobic-repel oil based chemistry (flux)*
- *Improved Transfer Efficiency (Ceramic)*
- *Reduced Underside Cleaning Frequency(Ceramic and Self-Assembled Monolayer)*
- *Reduced Bridging after print (Ceramic and Self-Assembled Monolayer)*

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Introduction

Types of Nano-Coatings

Self Assembled Monolayer

Ceramic-Spray Coat and Cure

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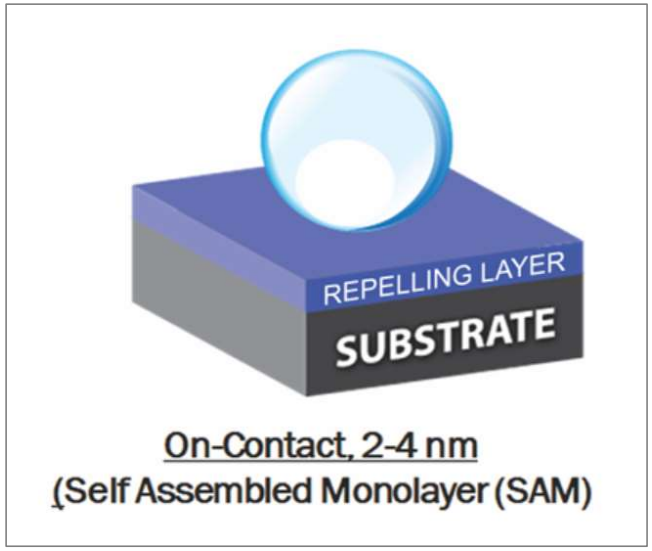
Introduction

Types of Nano-Coatings

- Self Assembled Monolayer
  - *Manually applied to the board side of stencil*
  - *Thickness is 2-4 nano meters*
  - *Clear-no color*
  - *Validation done by testing surface energy*
  - *Can be reapplied*
  - *Primary benefits are reduced underside cleaning and reduced bridging*



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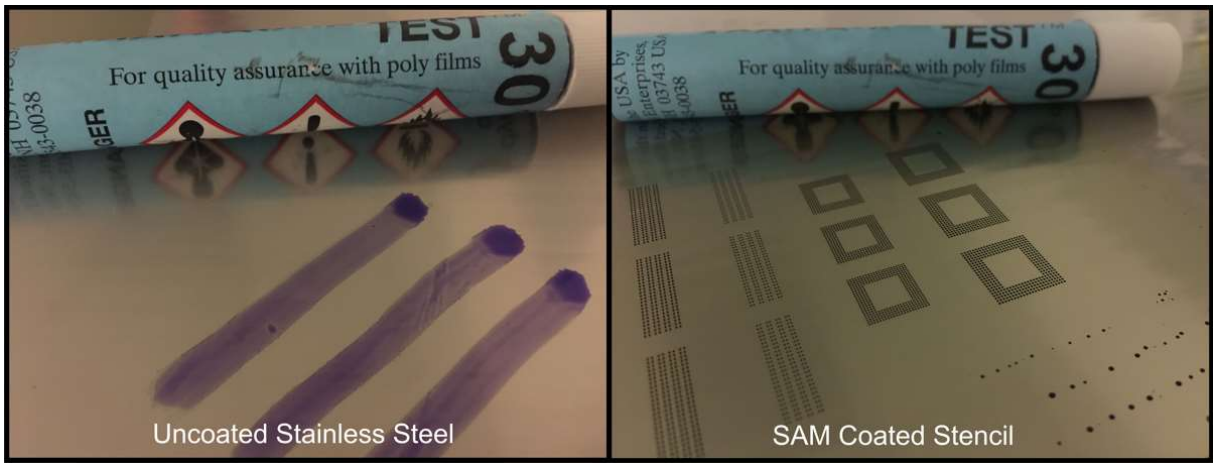
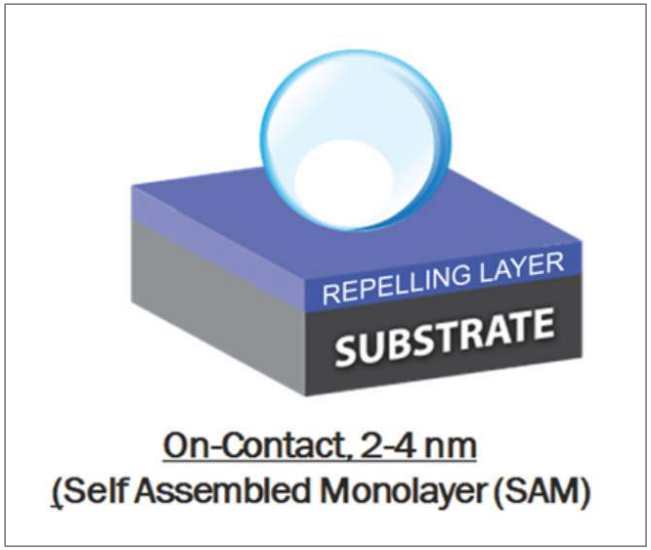
Introduction

Types of Nano-Coatings

- Self Assembled Monolayer-Testing Surface Energy





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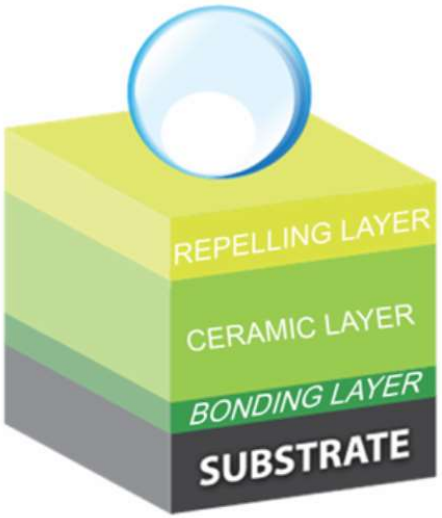
Introduction

Types of Nano-Coatings

- Ceramic
  - *Applied with custom, precision spray equipment*
  - *Thickness is 2-4 microns*
  - *Color and UV dye*
  - *Cured after coating to create a hard, durable coating*
  - *Lower Coefficient of Variation in Print Process*
  - *Primary benefits are reduced underside cleaning, reduced bridging, and increased transfer efficiency on small aperture printing*



Spray coat and cure (Ceramic)
2-4 Microns

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Introduction

Purpose of this study

- *Over the past several years, most papers on stencil coatings focus on*
  - Volume or transfer efficiency
  - Reduced underside cleaning
  - Reduced bridging
- *This presentation adds height and area data in addition to volume data to determine if nano-coatings are beneficial across a wide range of components.*

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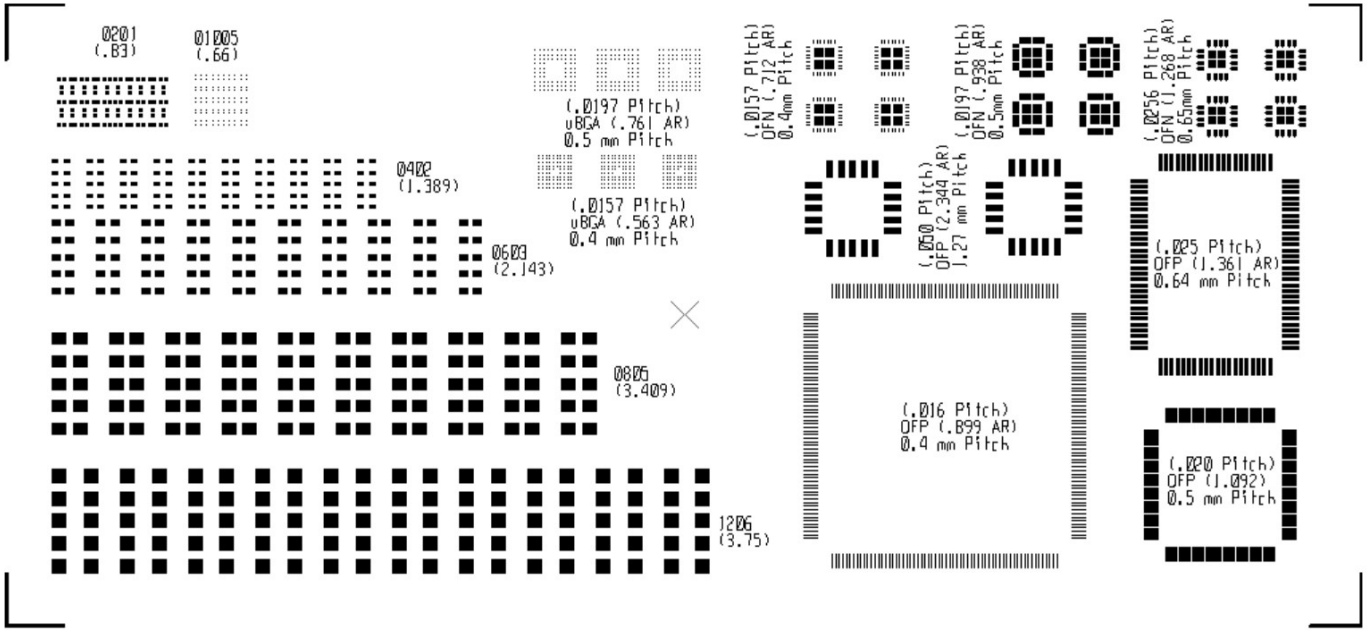
Experimental Methodology

Test Vehicle

Three stencils, one with SAM coating, one with Ceramic coating and one is uncoated



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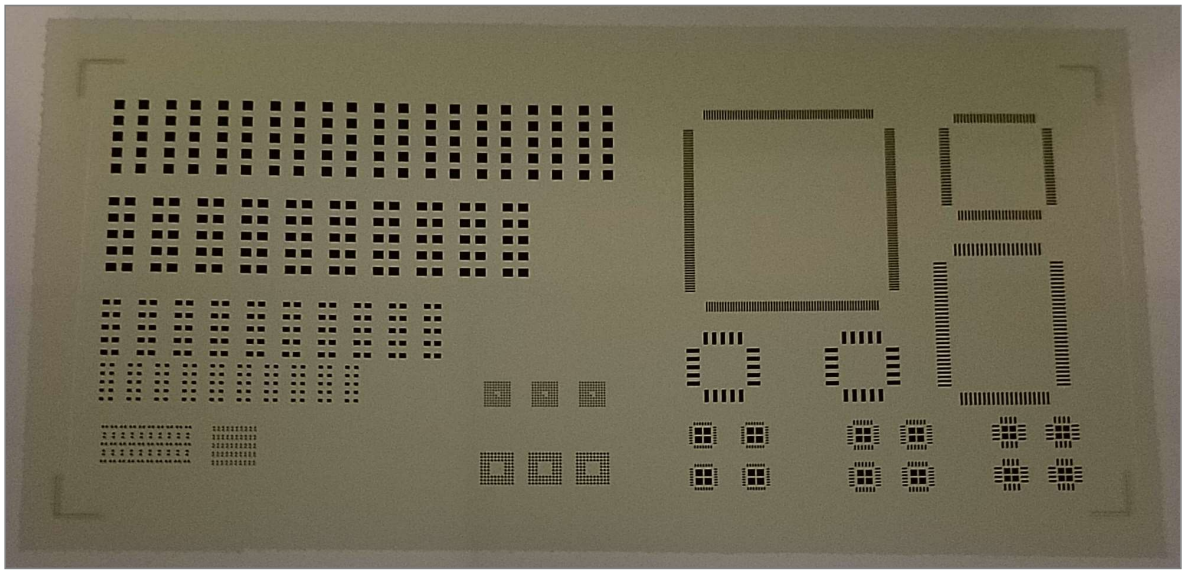

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Experimental Methodology

Print Parameters

Parameter	Value
Squeegee Length	300 mm
Squeegee Pressure	5 Kg
Squeegee Speed	30 mm/sec
Squeegee Angle	60 degrees
Separation Speed	3.0 mm/sec
Cleaning Solvent	IPA
Cleaning Cycle	2 Prints (W, V, V)
Solder Paste	NC SAC305 T4

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Experimental Methodology

Print Parameters

- 50 Boards Printed
- Boards 1, 10, 20, 30, 40 and 50 were measured with a 3D solder paste inspection system (SPI)
- Volume, Height and Area data were collected

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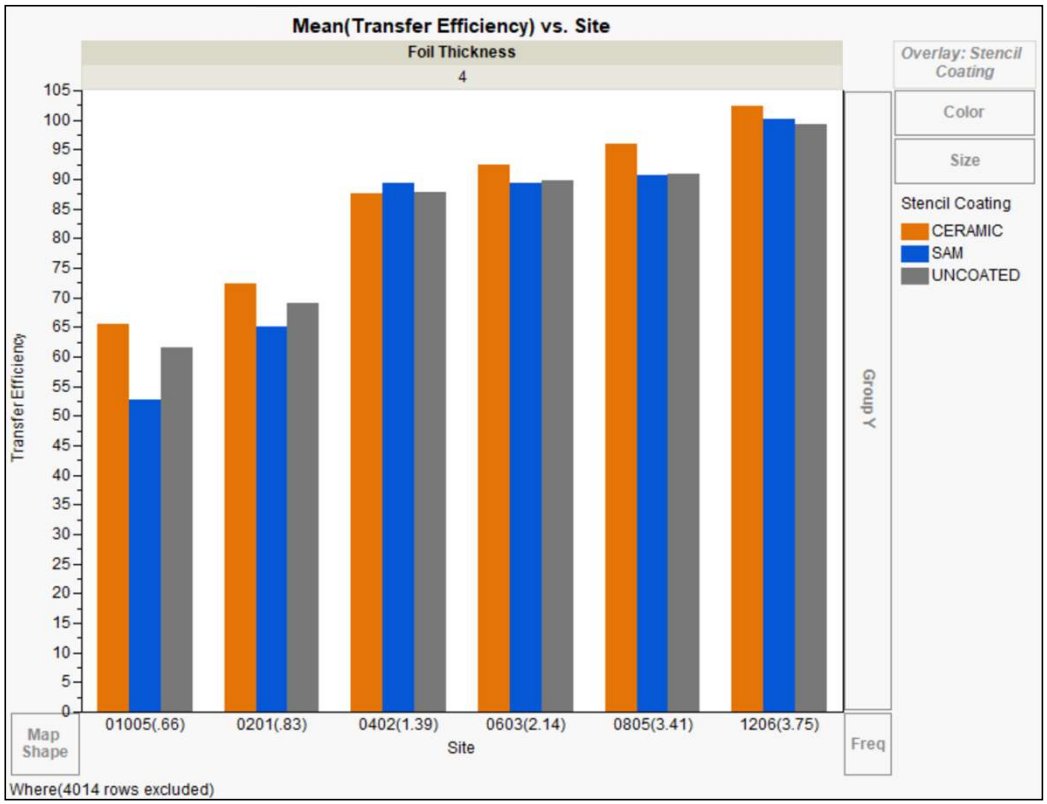
Results

Printed Solder Paste Transfer Efficiency

- Chip components 01005-1206
- Small components
  - *Ceramic coating improves volume*
  - *SAM coating decreases volume*
- Large components
  - *Ceramic and SAM coating show slight to no volume improvement*



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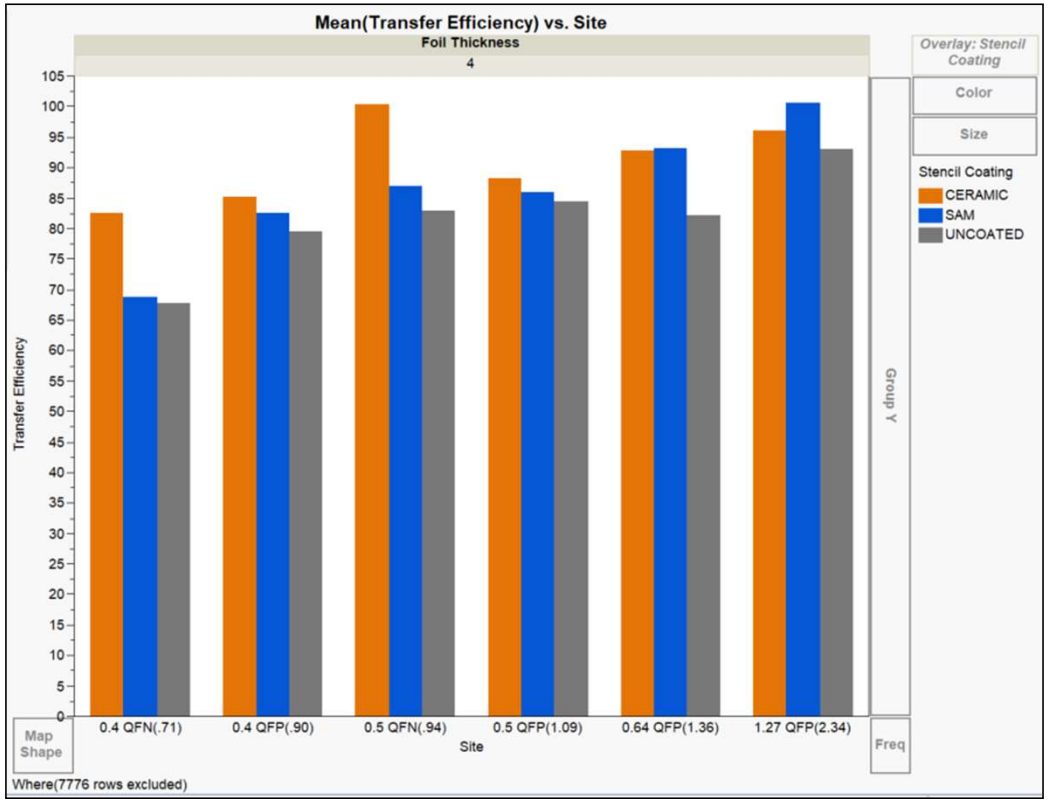
Results

Printed Solder Paste Transfer Efficiency

- QFN and QFP Components
  - *Ceramic coating improves volume up to 0.5 QFN*
  - *QFN's show greater improvement with Ceramic coating than QFP Components*
  - *SAM coating improves volume on these larger component apertures as compared to uncoated stencils*



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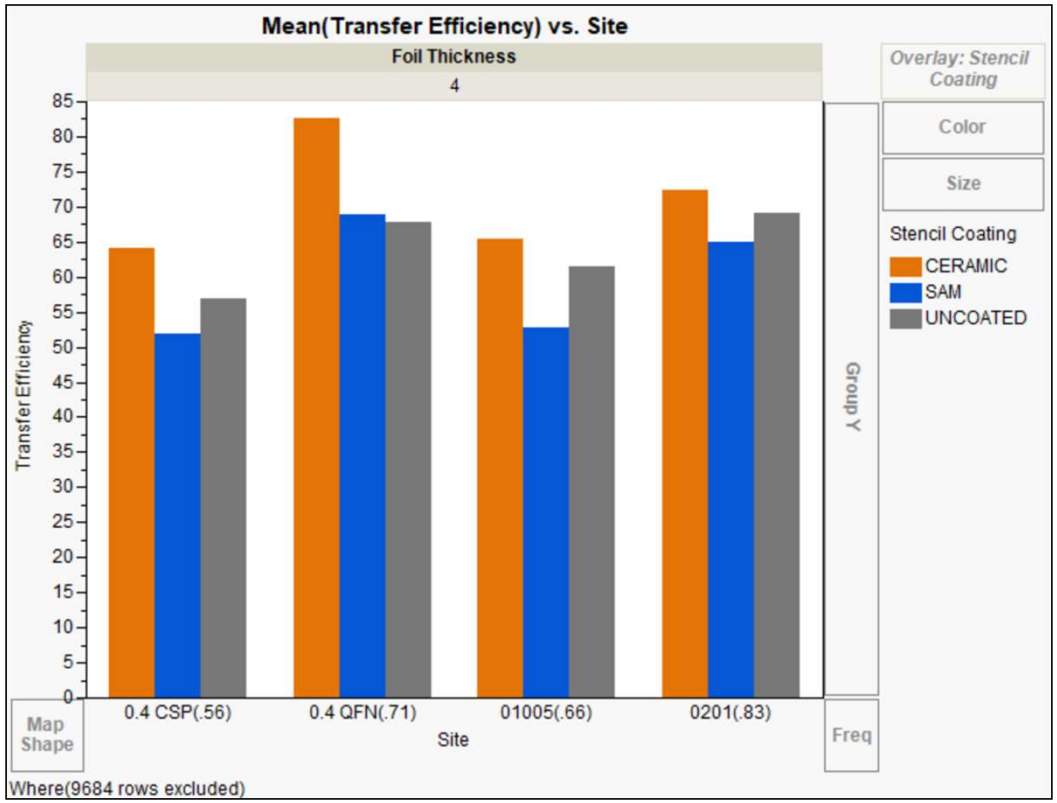
Results

Printed Solder Paste Transfer Efficiency

- **Smallest AR Components**
  - ***Ceramic coating improves volume***
  - ***SAM coating decreases volume***



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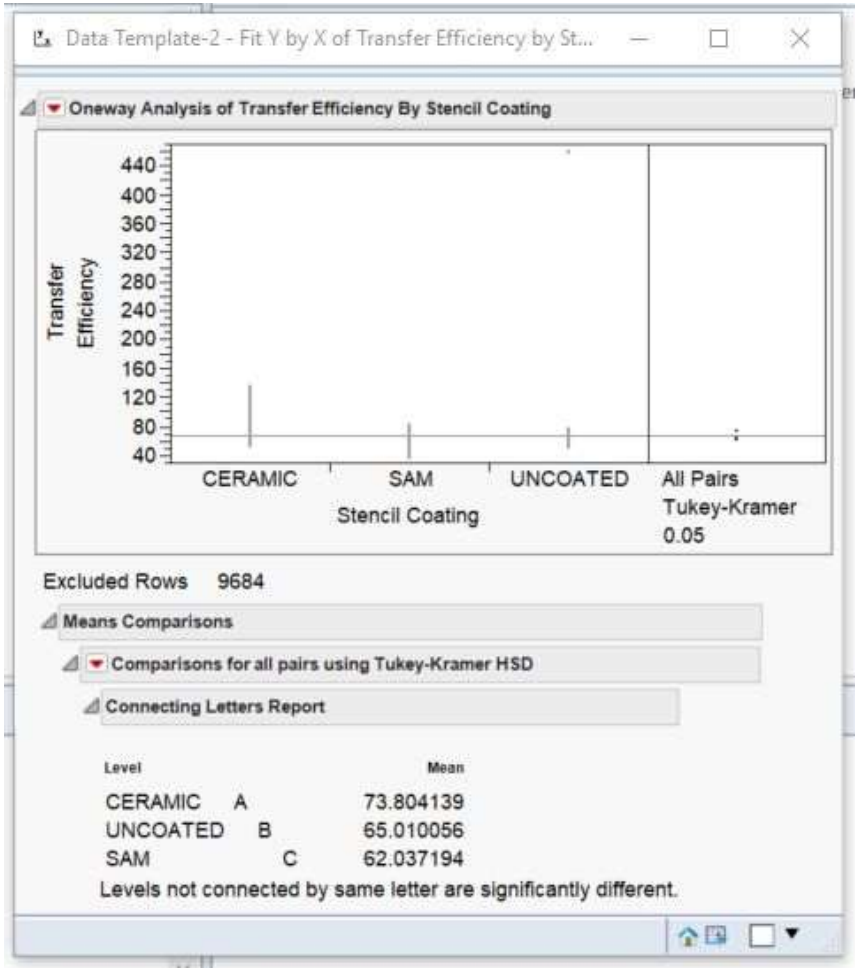
Results

Printed Solder Paste Transfer Efficiency

- Tukey-Kramer HSD Analysis on Small Area Ratio components
- Evaluates data to determine if it is significantly different
  - *Ceramic coating mean TE is highest*
  - *SAM coating mean TE is lower than the uncoated stencil*



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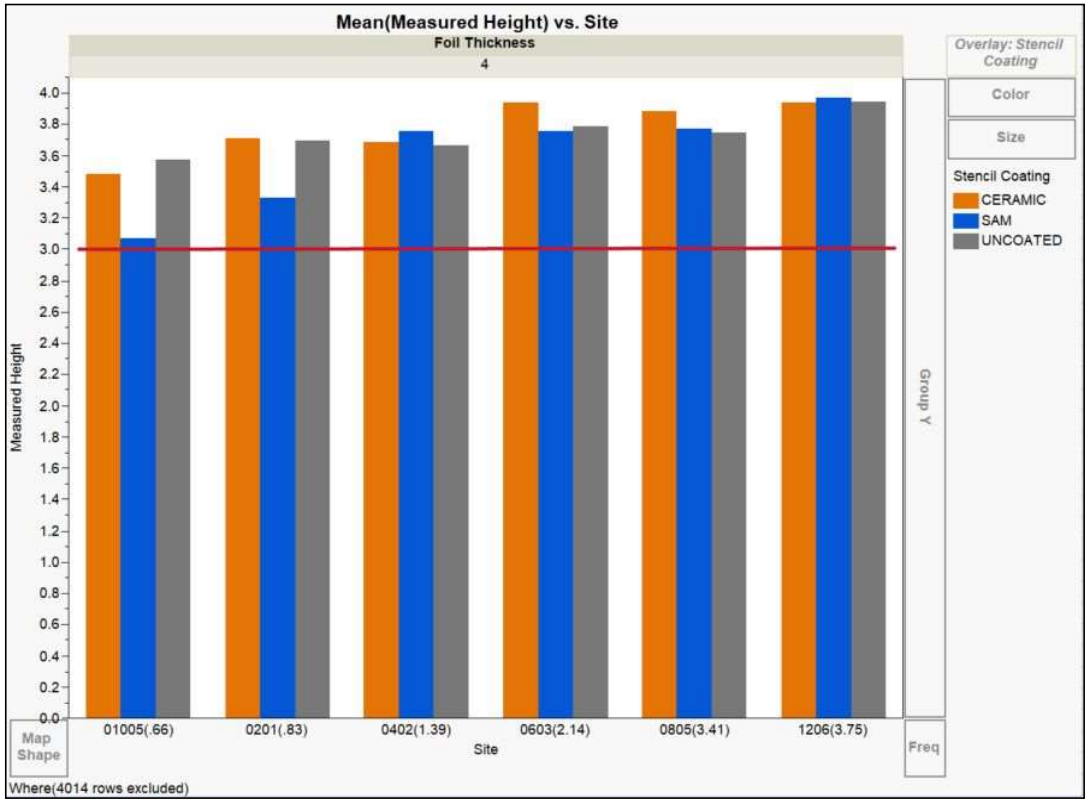
Results

Printed Solder Paste Height

- Chip Components
  - *01005 and 0201 components show SAM print height less than uncoated and Ceramic coated stencil*
  - *0402 thru 1206 components show no significant difference in mean print height for the coatings as compared to the uncoated stencil.*



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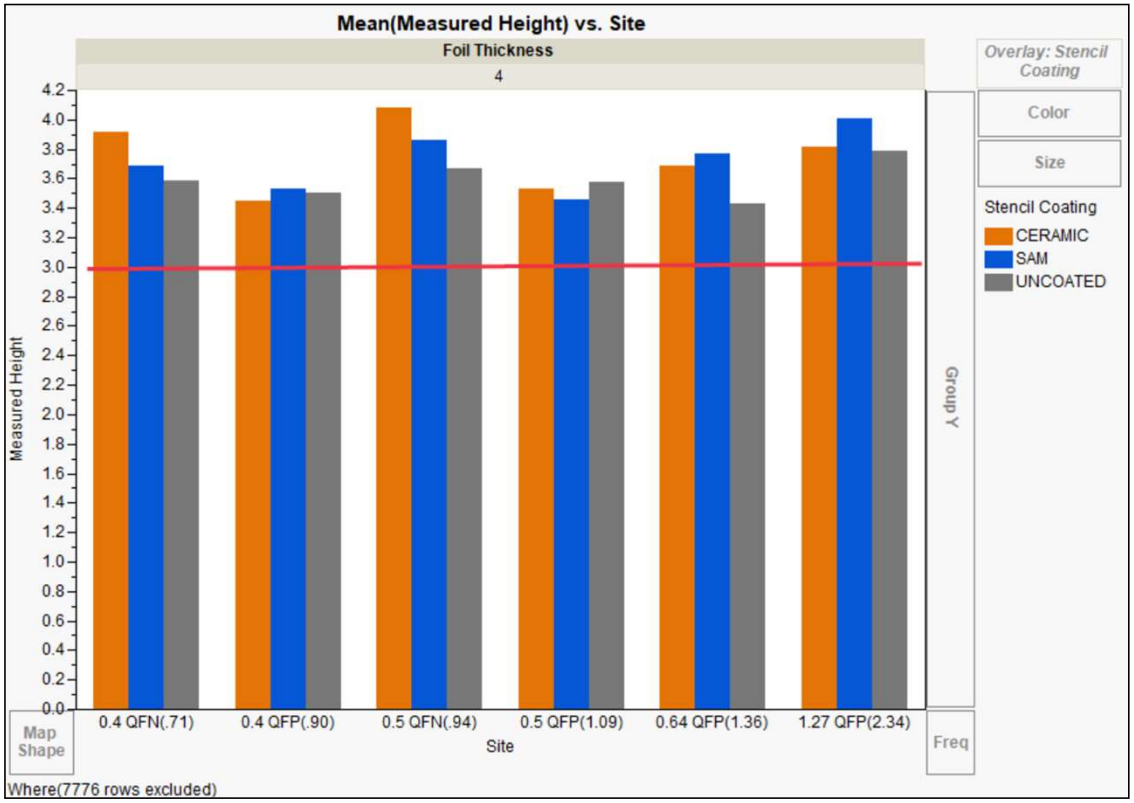
Results

Printed Solder Paste Height

- QFN and QFP Components
  - *All components printed well over 3-mil minimum threshold*
  - *Overall, both coatings show little or no improvement of mean height measurement as compared to the uncoated stencil*



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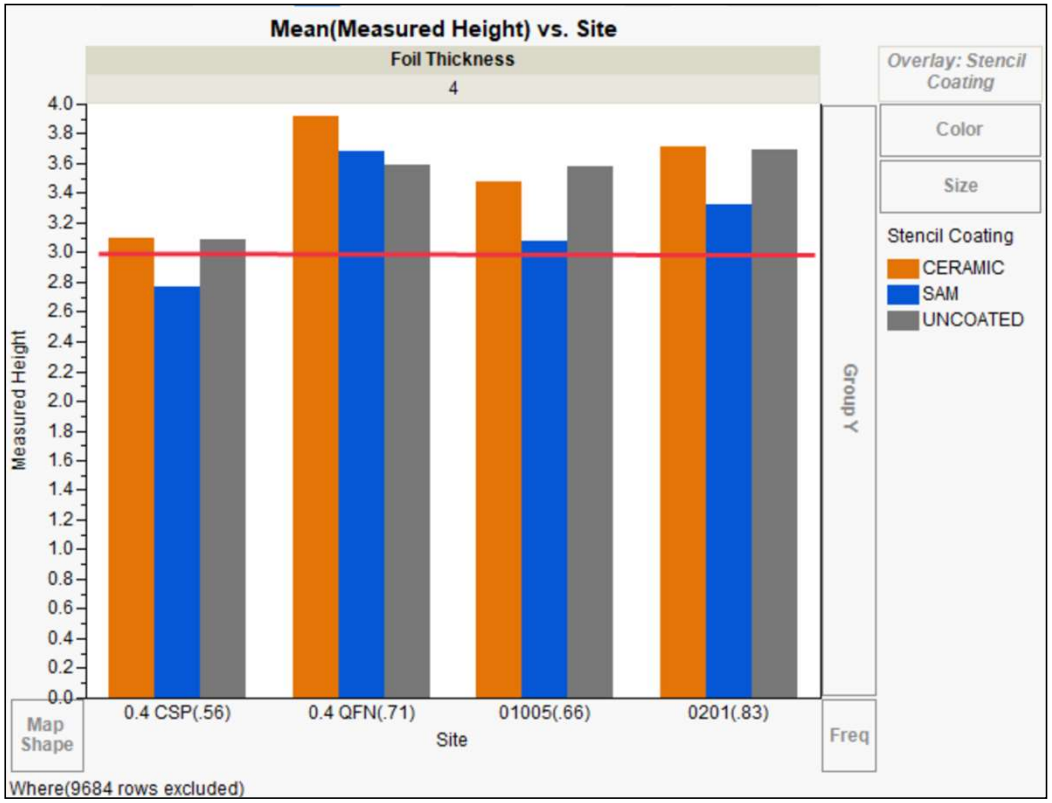
Results

Printed Solder Paste Height

- **Smallest AR Components**
  - ***Ceramic coating exhibits slight to no improvement in mean print height***
  - ***SAM coating decreases height on 0.4 CSP and 01005 components below or just at the 3-mil minimum threshold***



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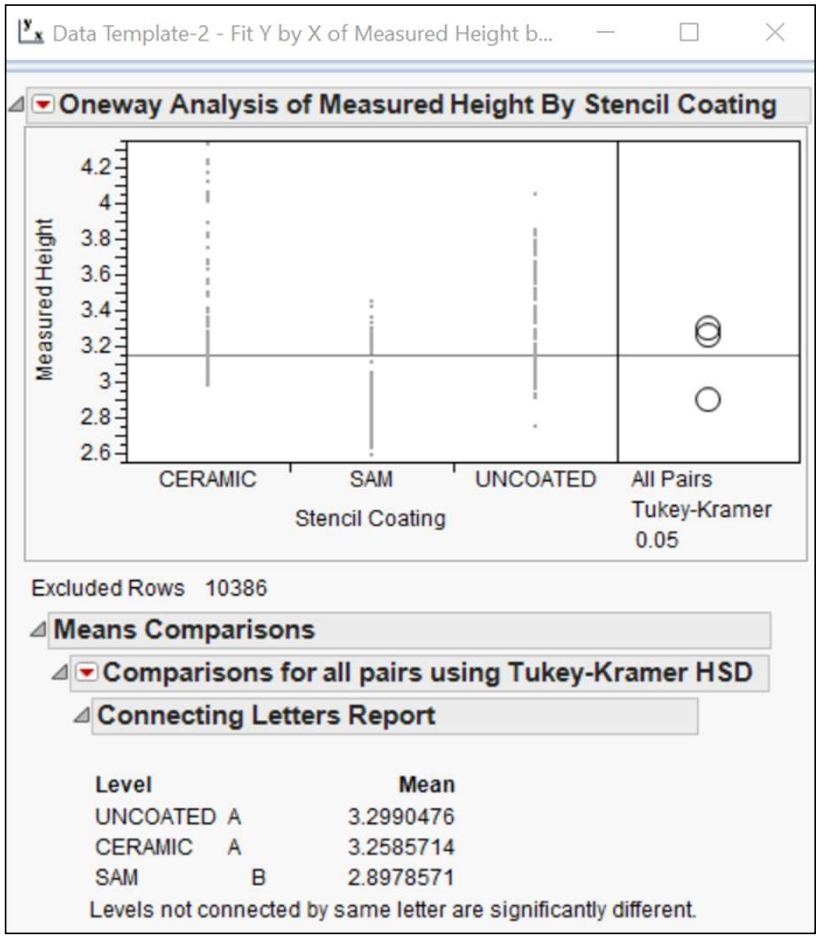
Results

Printed Solder Paste Height

- **Tukey-Kramer HSD Analysis**
  - ***0.4 CSP and 01005 component mean print height***
  - ***SAM coating shows significantly different (lower) print height results when compared to the uncoated and Ceramic coated stencil.***
  - ***Ceramic coating mean height results are not significantly different than the uncoated stencil.***



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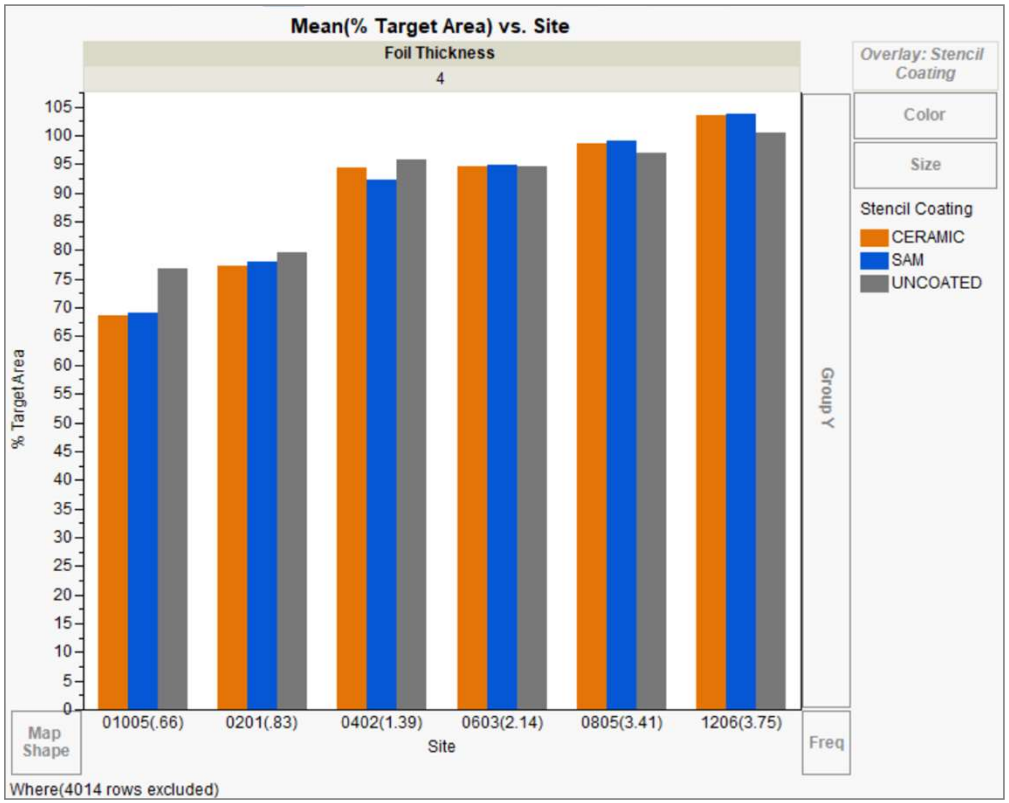
Results

Printed Solder Paste Area

- **Chip Components**
  - ***01005 component has greater area percentage on uncoated stencil than coated stencils***
  - ***Other components show no difference in printed area for coated and uncoated stencils***



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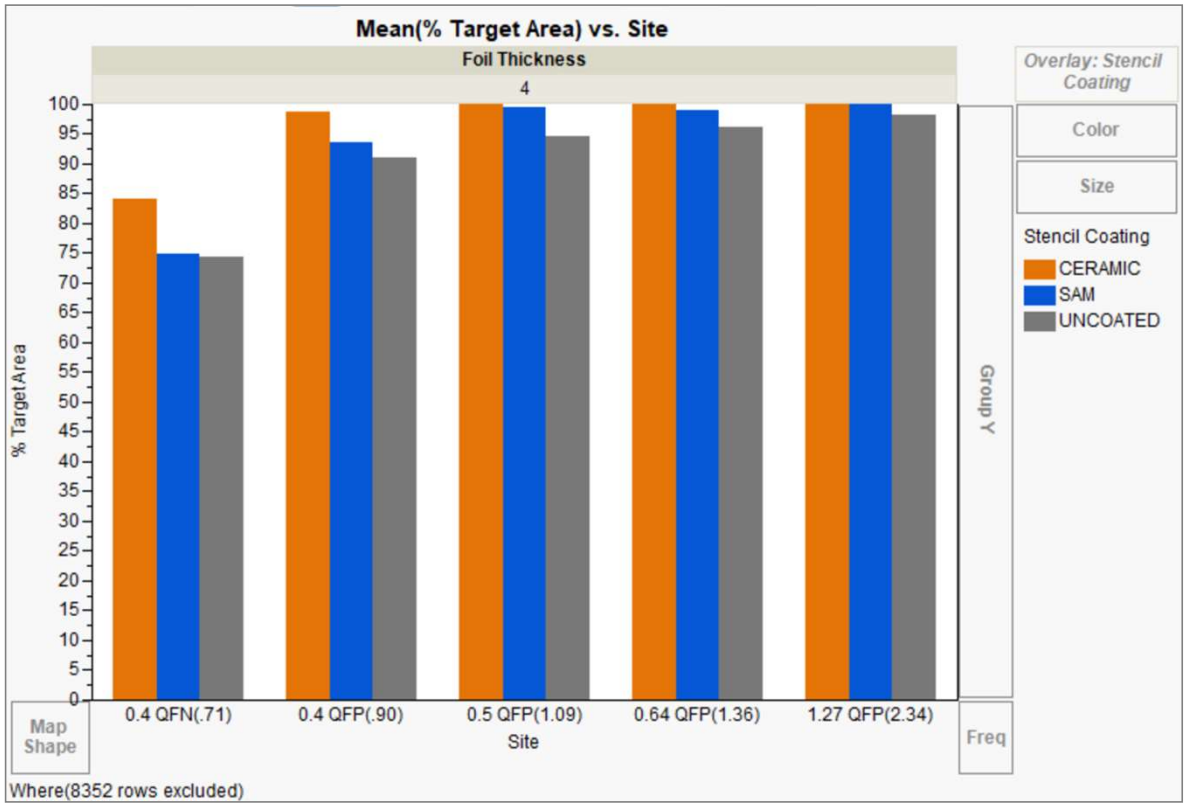
Results

Printed Solder Paste Area

- QFN and QFP Components
  - *0.4 QFN and QFP components exhibit higher printed area for ceramic coated stencil than SAM and uncoated*
  - *0.5 and higher QFP components show slightly higher printed area than the uncoated stencil for both nano-coatings*



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Results

Printed Solder Paste Area

- **Smallest AR Components**
  - ***0.4 CSP and 0.4 QFN components exhibit higher printed area for ceramic coated stencil than SAM and uncoated***

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Conclusions

- There are 2 types of nano-coatings currently being used.
  - *Self-Assembled Monolayer (SAM)*
  - *Ceramic*
- When looking at printed paste volume, Ceramic nano-coatings improve transfer efficiency for 0.66 area ratio apertures and smaller (0.4 CSP and 01005) and SAM nano-coatings decrease printed paste volume when compared to uncoated stencils.
- When area ratios are larger than 0.66, adding SAM nano-coating and Ceramic nano-coating can result in slight increases in printed paste volume when compared to uncoated stencils.
- When area ratios are less than 0.66 (0.4 CSP and 01005), SAM nano-coating decreases the printed height when compared to uncoated stencils. Both Ceramic and uncoated stencil printed height are similar.

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Conclusions

- For components larger than 01005, SAM and Ceramic nano-coatings produced printed paste height slightly higher than the uncoated stencil.
- Printed paste area was higher for the 01005 component on the uncoated stencil.
- Printed paste area was higher for the ceramic nano-coated stencil on the 0.4 CSP, 0.4 QFN and 0.4 QFP components than both the SAM nano-coated stencil and the uncoated stencil.
- When area ratios are less than 0.66 (0.4 CSP and 01005), it is recommended that Ceramic nano-coatings are used to improve repeatability and uniformity in the print process.
- When area ratios are more than 0.66, it is recommended that either Ceramic or SAM nano-coatings are used to improve repeatability and uniformity in the print process.

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Thank You for Your Attention!
Any questions?

Greg Smith
BlueRing Stencils
gsmith@blueringstencils.com

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