AN INVESTIGATION INTO THE DURABILITY OF STENCIL COATING TECHNOLOGIES

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Outline

Introduction

Methodology

- Chemical Damage to Nano-Coatings
- Mechanical Damage to Nano-Coatings

Results and Discussion

- Wet Chemical Scrub Testing Data
- Chemical Attack Testing
- Mechanical Damage Testing

Recommendations to Extend the Life of Nano-Coatings

Conclusions

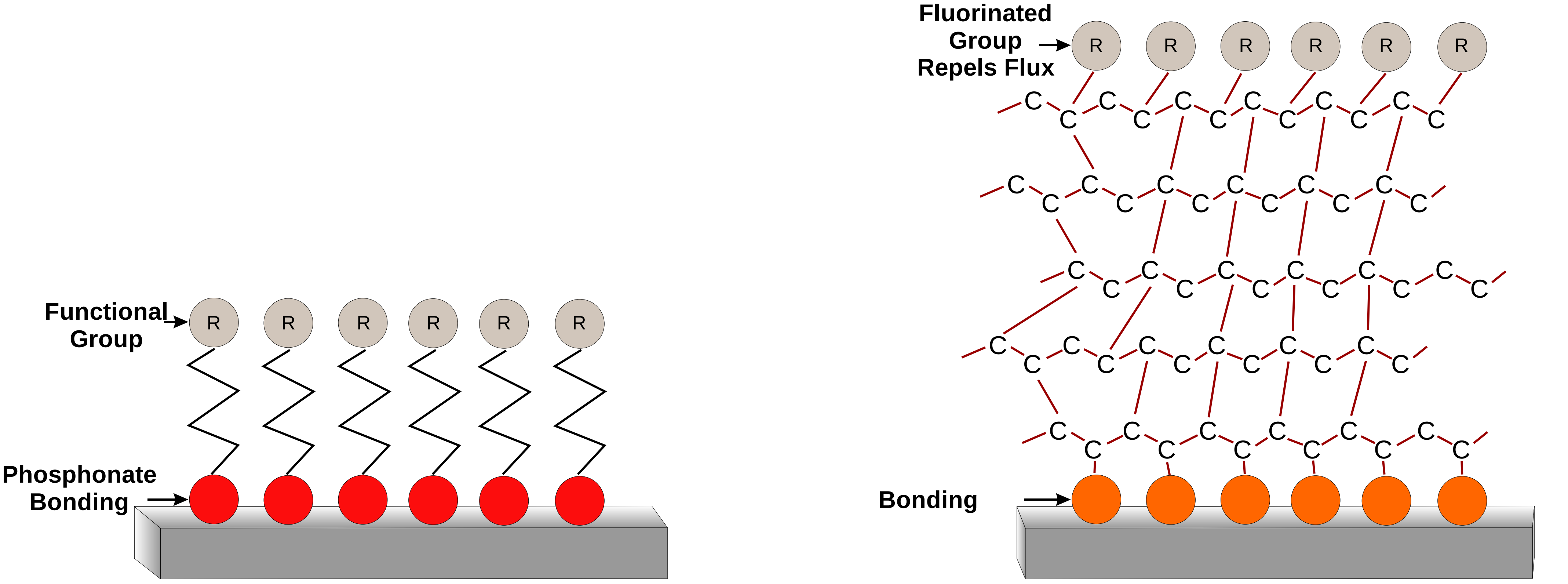
Introduction

Fluoro-Polymer Coating

Phosphonate Coating

Nano coatings are used to improve the print process. The ongoing question is, "How long do they last?"

Description of Nano Coating Types



Phosphonate Coating
2-4 nm Thick, Clear

Flouro Polymer Nano Coating-Cross Linked
2-4 Microns Thick, Color, Some Fluoresce

Properties of FPN and Phosphonate Nano-Coatings

Attributes	Fluoro-Polymer Coating	Phosphonate
Application	Spray and thermal cure	Wipe on
Thickness	2-4 microns	2-4 nm
Visible on stencil?	Yes	No
Hydro and oleophobic	✓	✓
Reduces frequency of underside cleaning	✓	✓
Abrasion resistant	✓	Wears off
Chemical resistant	✓	Wears off
Re-coating possible?	No	✓
Solder paste volume	15 – 25% increase in TE	Slight decrease < 5%
Minimum Area Ratio	0.10 lower than foil	Same as foil

Three coatings tested

- FPN
- Phos-1 and Phos-2

Chemical Damage to Nano-Coatings

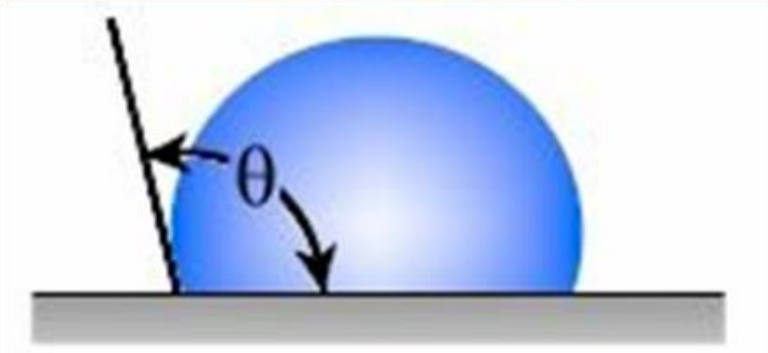
ASTM D2486 Wet Scrub Tester

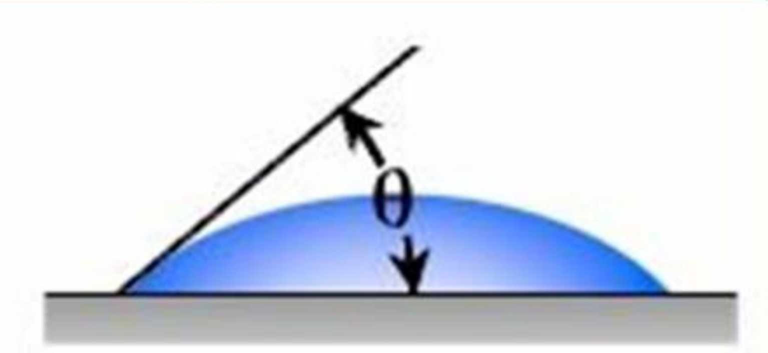
- 2000 scrub cycles
- Dry and wet chemical scrub

Measured contact angle change

Chemical Damage to Nano-Coatings

Hydrophobic Surface		Hydrophilic Surface
High	**Contact Angle**	Low
Poor	**Adhesiveness**	Good
Poor	**Wettability**	Good
Low	**Surface Free Energy**	High





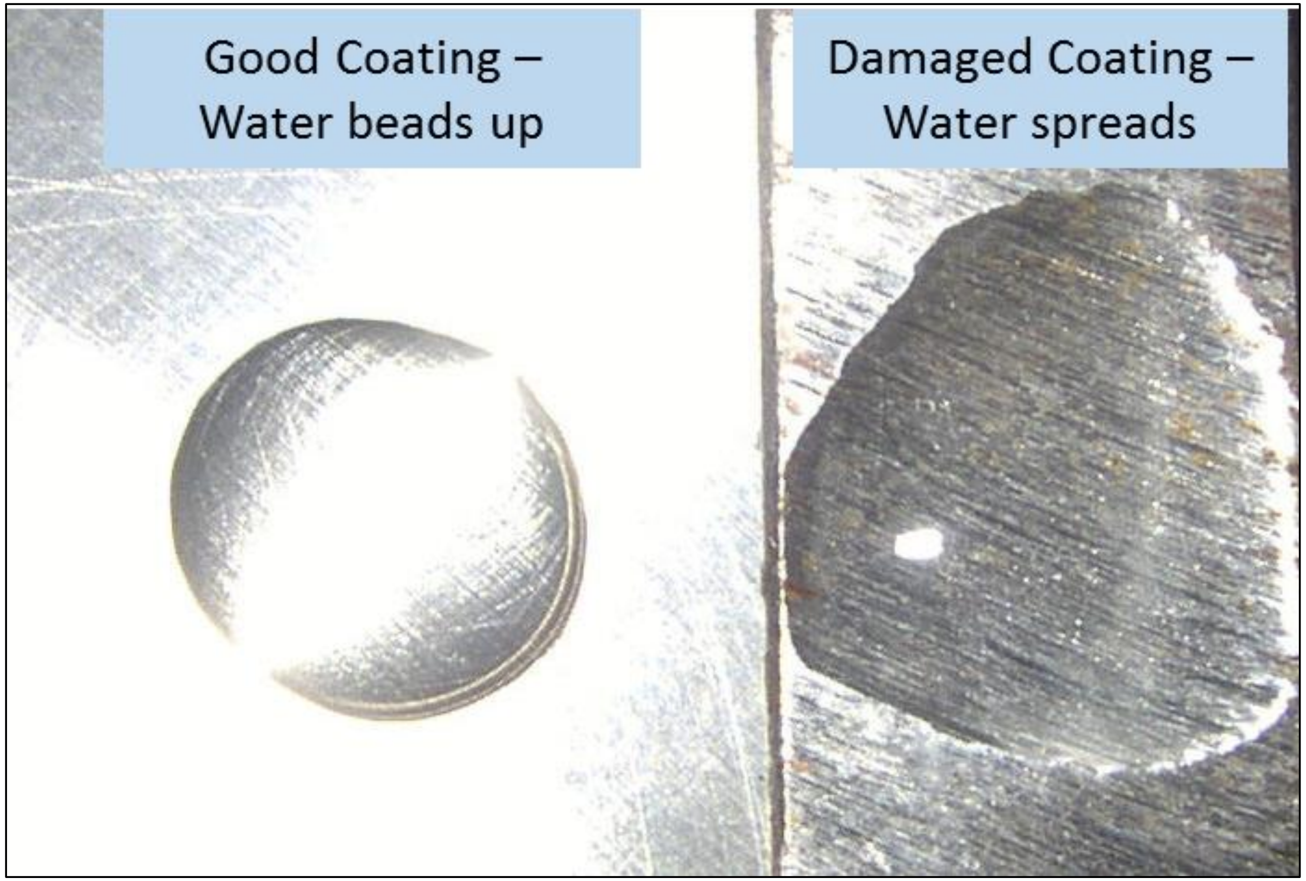
Chemical Damage to Nano-Coatings

Immersion 48 hours at Room Temp

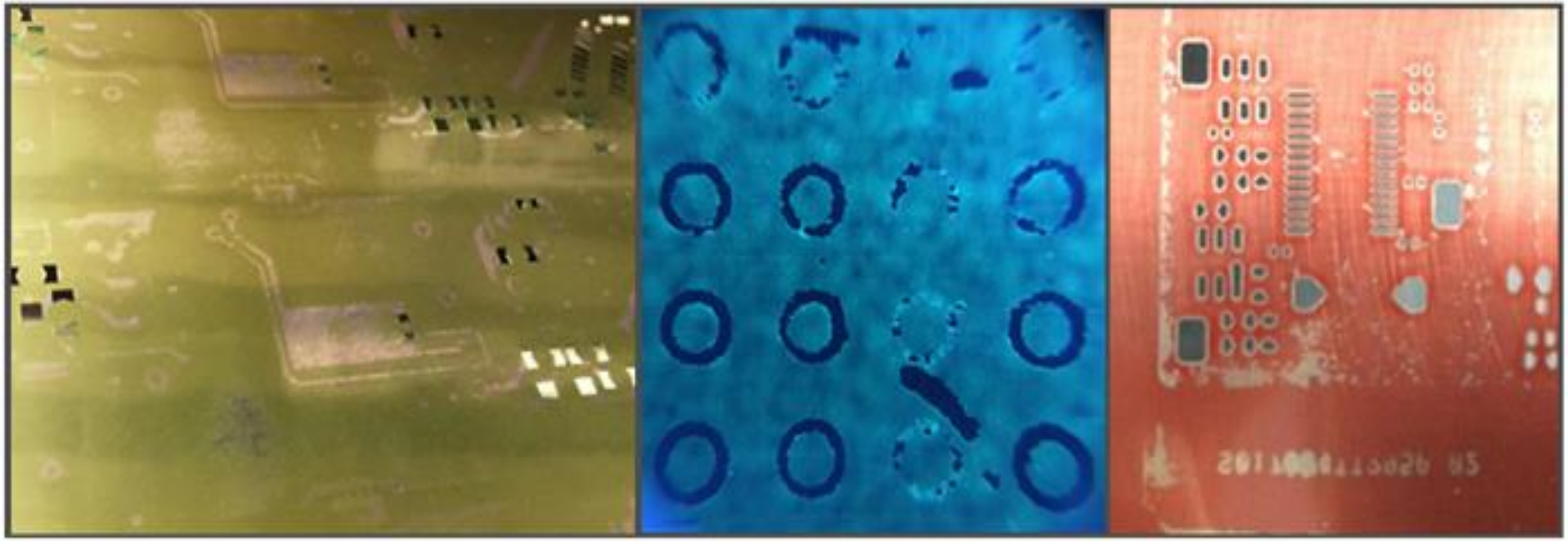
- 192 cleaning cycles

Rinsed and dried

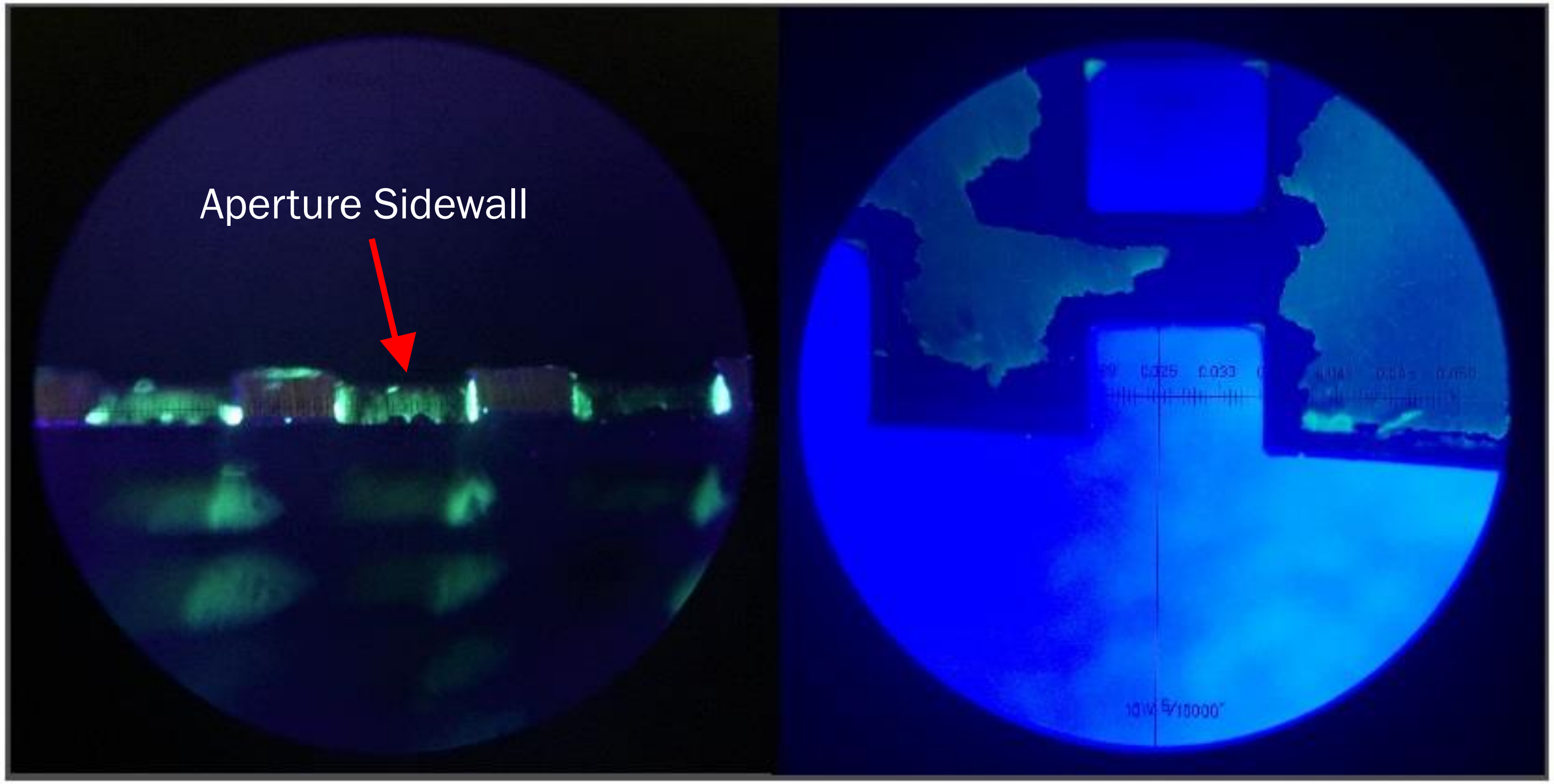
Evaluated for DI water spread



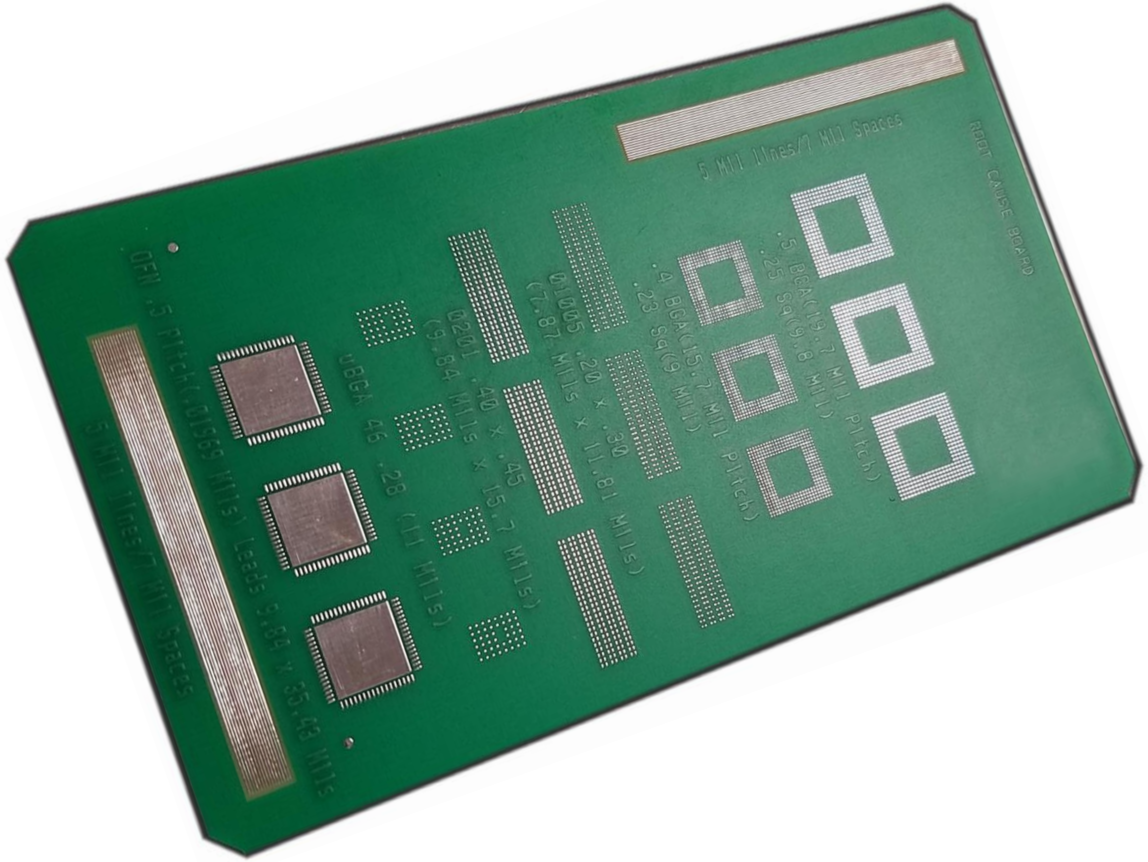
Mechanical Damage to Nano-Coatings



Mechanical Damage to Nano-Coatings
Retired Stencil with > 10,000 Print Cycles



Mechanical Damage to Nano-Coatings Methodology



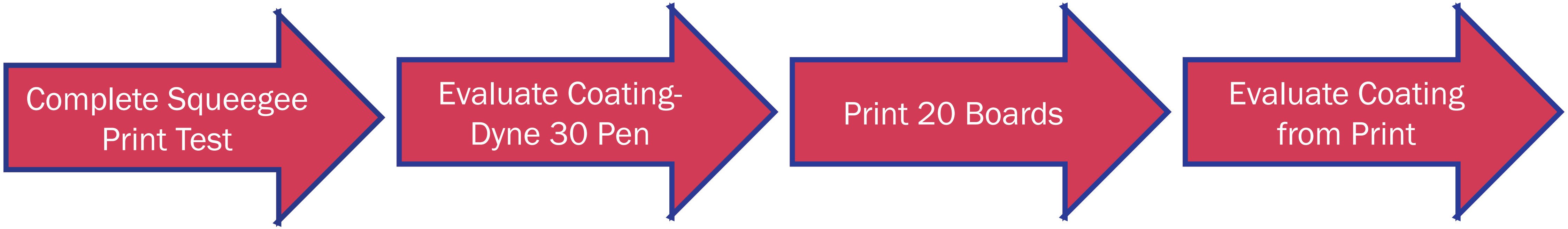
Mechanical Damage to Nano-Coatings Methodology

	Underside Wipe Test	Squeegee Print Test	50 Cycle Print Test
Coating	PHOS-2 and FPN	FPN	Hybrid(FPN/PHOS-2)
Variable Tested	1000 Dry Wipe Cycles	1000 Dry Squeegee Cycles	50 Print Cycles
Solder Paste	None	None	No Clean, SAC 305, Type 4
Squeegee Length	300 mm	300 mm	300 mm
Squeegee Wipe Material	Mid-Grade Stencil Wipe Material	No Underside Wipe	No Underside Wipe
Squeegee Pressure	1 Kg	12 Kg	12 Kg
Squeegee Speed	50 mm/sec	50 mm/sec	50 mm/sec

Mechanical Damage to Nano-Coatings
Underside Wipe Test

Complete Underside Wipe Test → Evaluate Coating- Dyne 30 Pen → Print 10 Boards → Evaluate Coating from Print

Mechanical Damage to Nano-Coatings
Squeegee Print Test



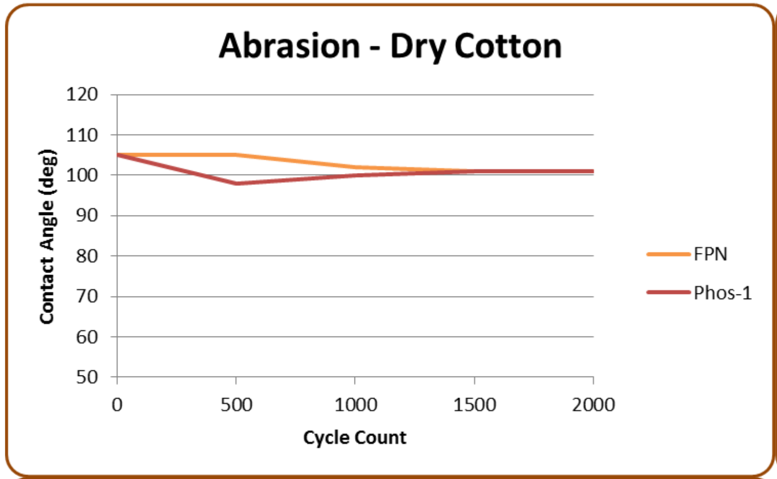
2 Oz. Cu, HASL Test Vehicle

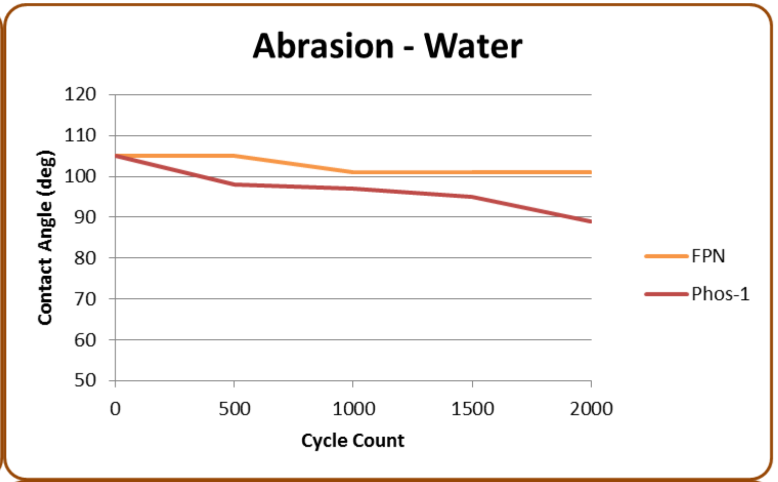
Mechanical Damage to Nano-Coatings
50 Cycle Print Test-Hybrid Technology

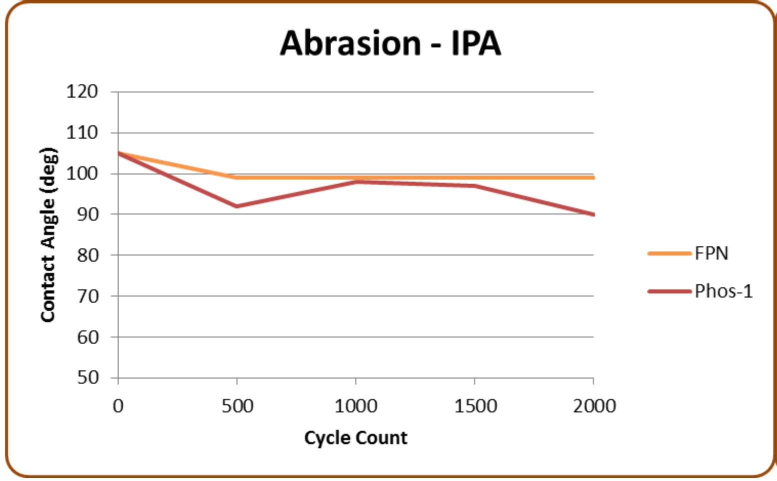
Complete 50 Cycle Print Test → Evaluate Coating from Print → Capture Image-Underside of Stencil

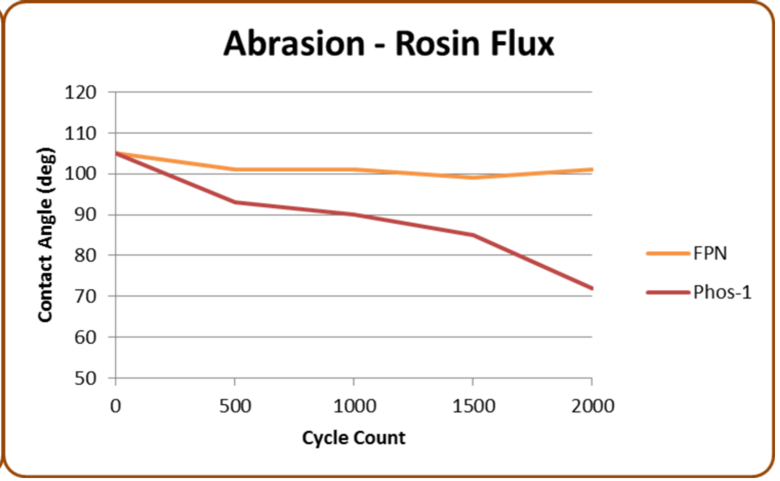
2 Oz. Cu, HASL Test Vehicle

Chemical Damage to Nano-Coatings
Scrub Test Results



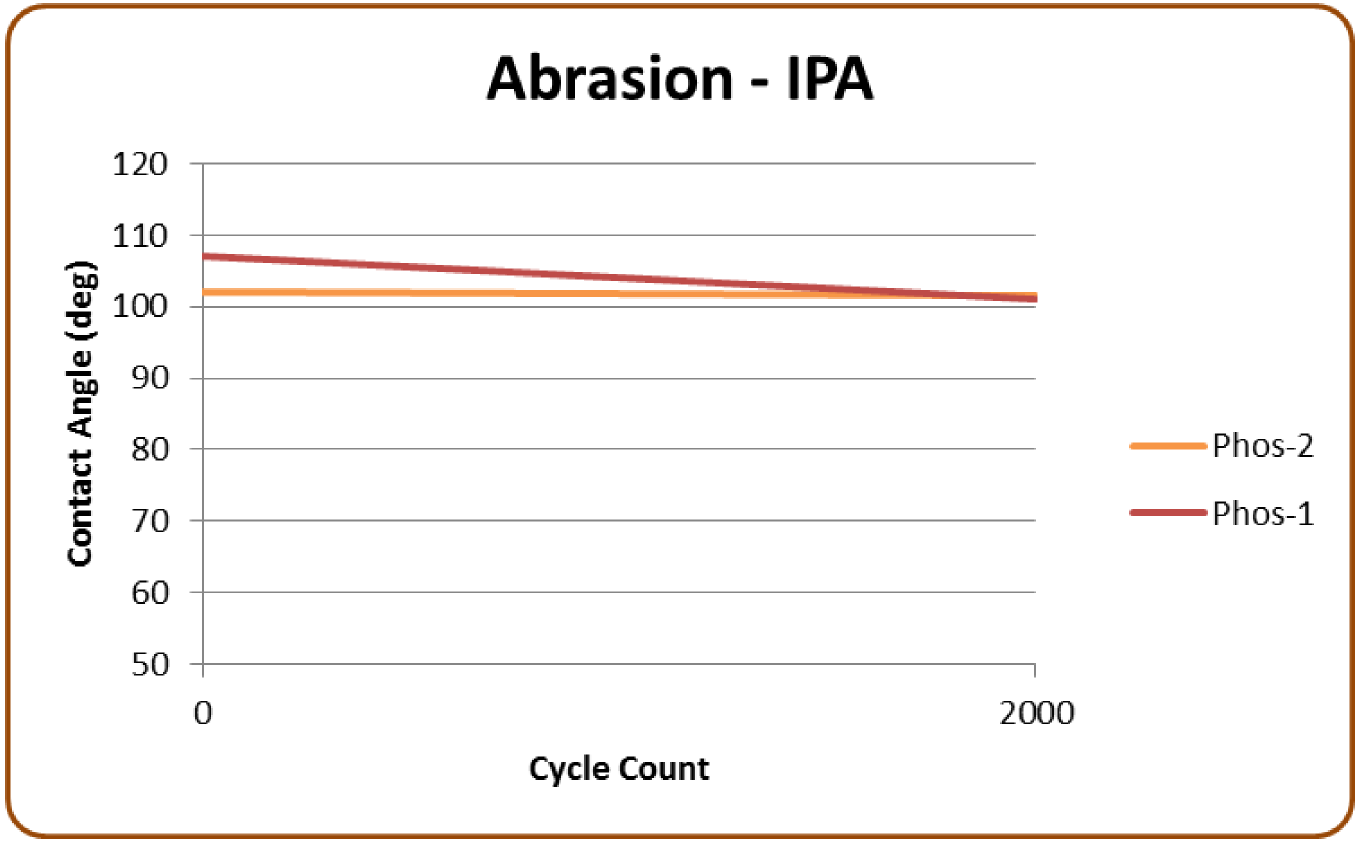






Contact angle decrease indicates loss of hydrophobicity

Chemical Damage to Nano-Coatings
Scrub Test Results



Contact angle decrease indicates loss of hydrophobicity

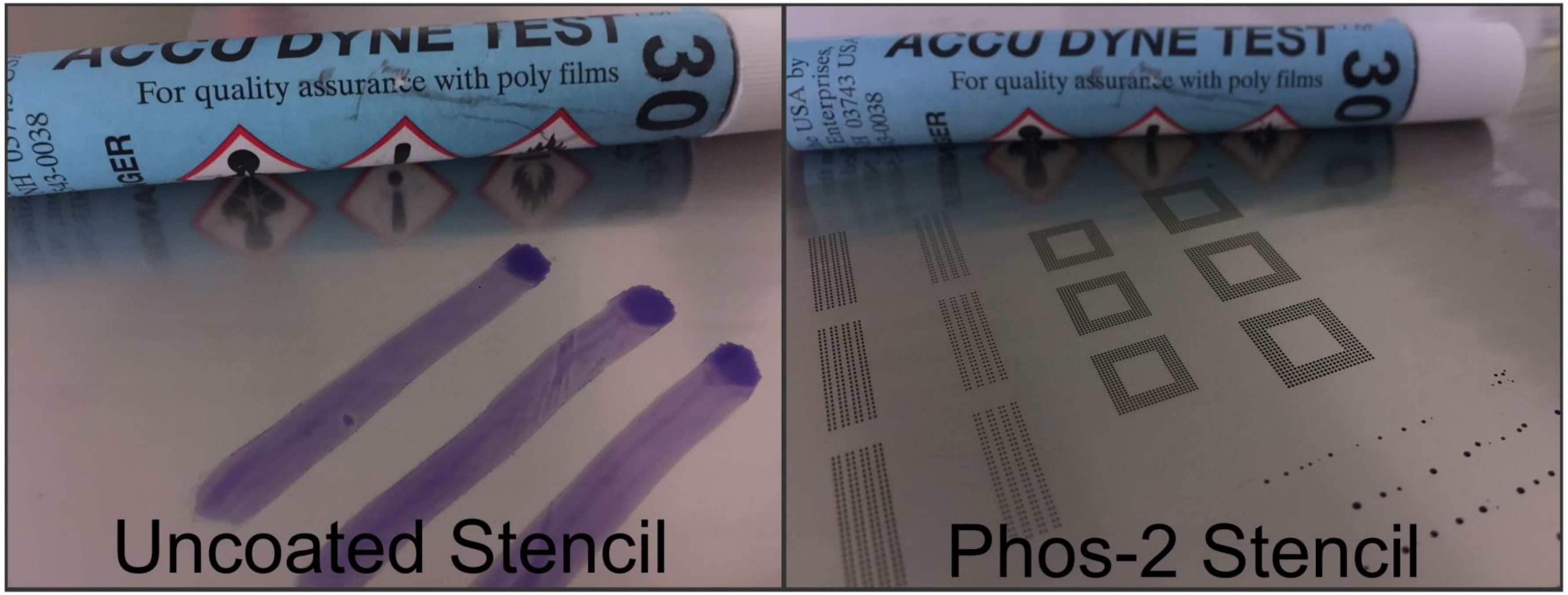
Chemical Damage to Nano-Coatings
Chemical Immersion Test Results

Chemicals	Chemical Type	Phos-1	Phos-2	FPN
Isopropyl alcohol	Solvent	Damaged		
n-butyl alcohol	Solvent	Damaged		
Hexylene glycol	Solvent			
Propylene glycol	Solvent			
Dipropylene glycol	Solvent	Damaged	Damaged	
Dimethyl esters (Dibasic ester)	Solvent	Damaged		
Ethylene glycol monobutyl ether	Solvent	Damaged		
Diethylene glycol monobutyl ether	Solvent	Damaged		
Triethylene glycol monobutyl ether	Solvent	Damaged		
Diethylene glycol monohexyl ether	Solvent	Damaged	Damaged	
Propylene glycol methyl ether (1-methoxy-2-propanol)	Solvent			
Tripropylene glycol n-butyl ether	Solvent			
D-Limonene (orange oil)	Solvent	Stripped	Stripped	
Non-ionic block copolymer surfactant 50 g/L	Surfactant			
Octylphenol ethoxylate surfactant 50 g/L	Surfactant			
Monoethanolamine (100 g/L pH 11.60)	Mild base			
Potassium carbonate (100 g/L pH 11.50)	Mild base			
Tetrapotassium pyrophosphate (100 g/L pH 10.40)	Mild base	Damaged		

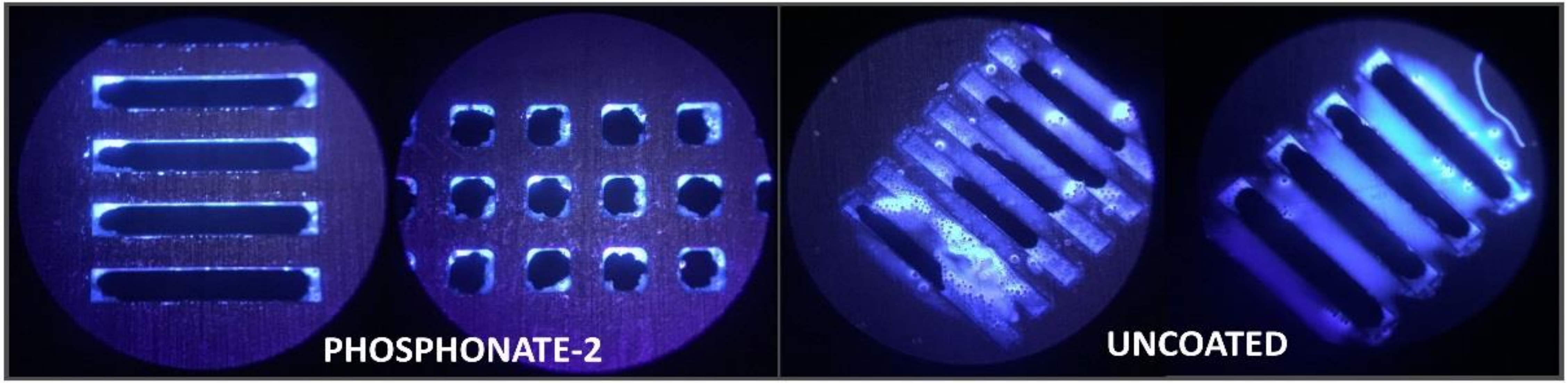
Damaged indicates loss of hydrophobicity

Stripped indicates complete removal

Mechanical Damage Testing
Underside Wipe Test Results

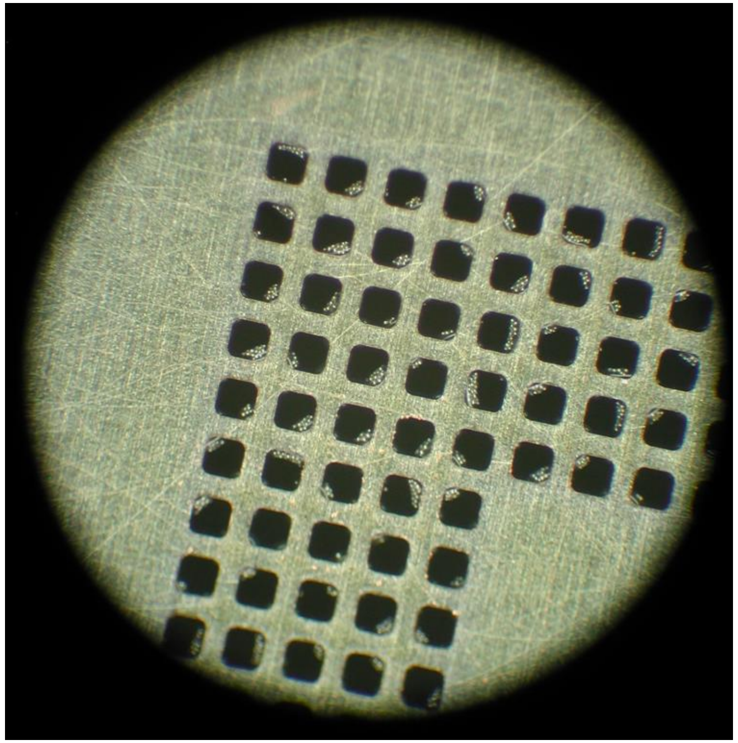


Mechanical Damage Testing
Underside Wipe Test Results



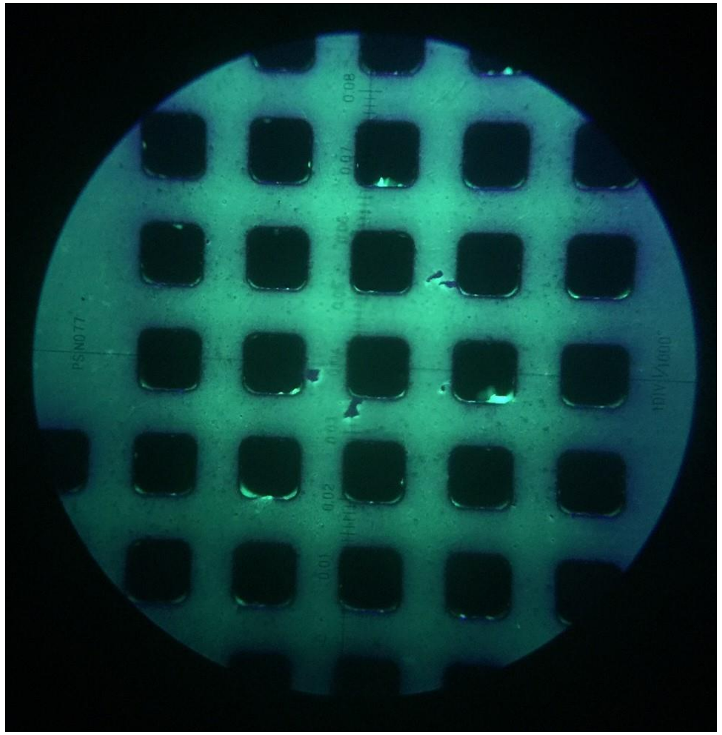
10 Prints, No Under Side Wipe

Mechanical Damage Testing
Underside Wipe Test Results



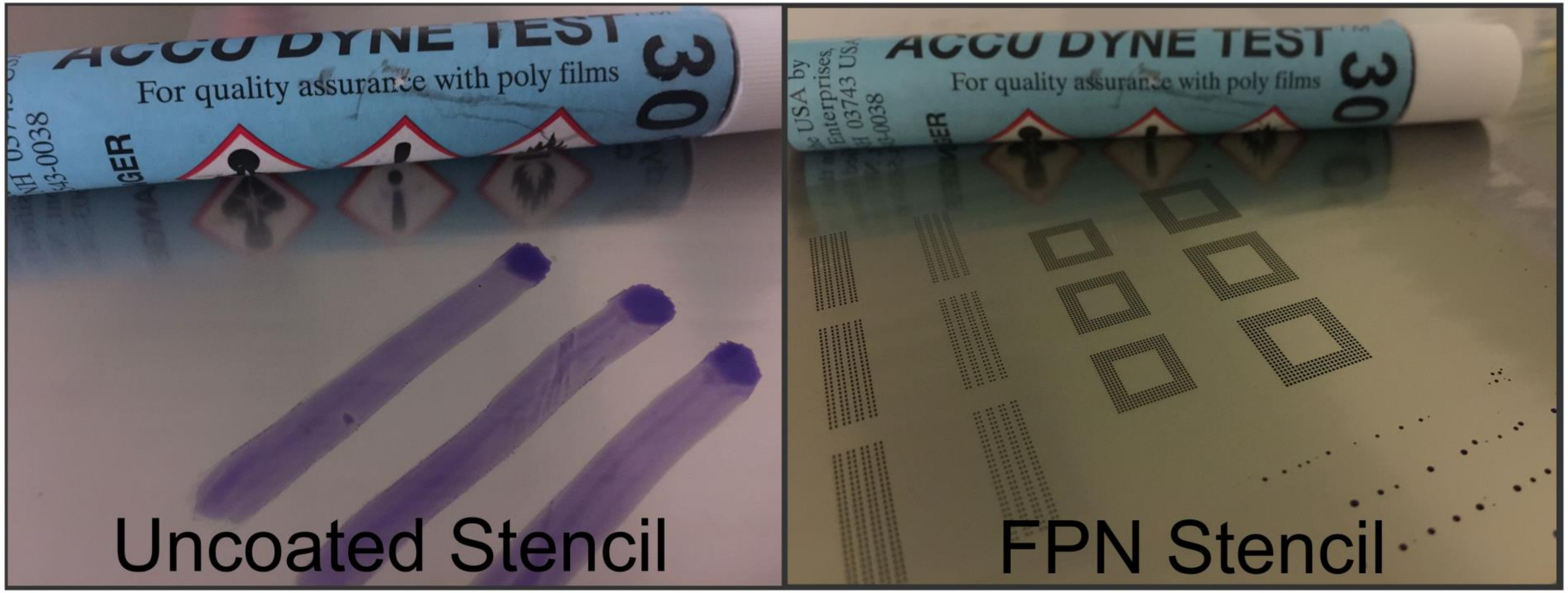
20 Prints, No Under Side Wipe

Mechanical Damage Testing
Underside Wipe Test Results

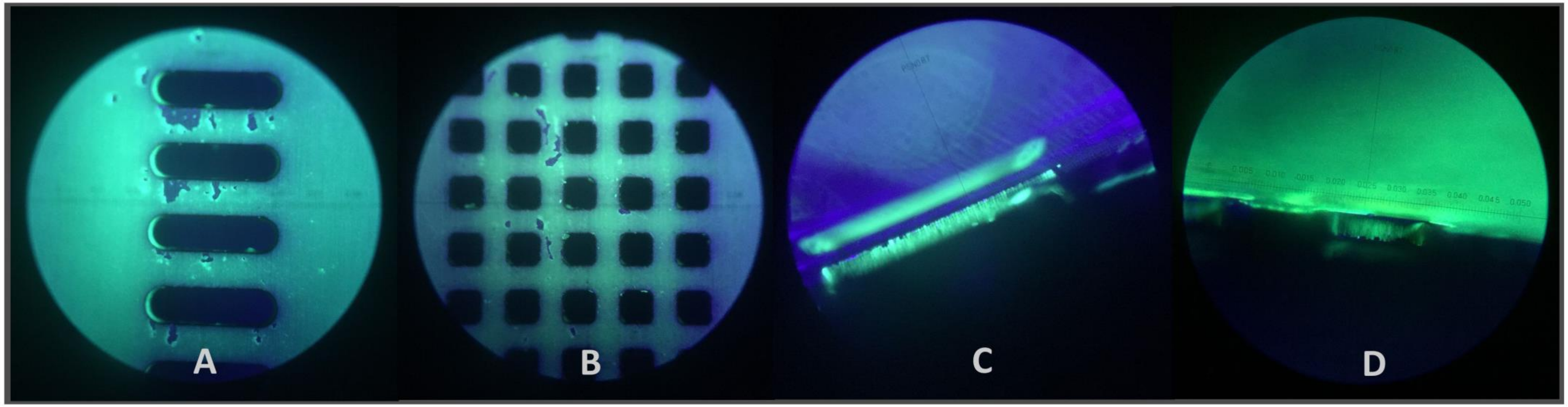


Mechanical Wear after 1000 Underside Wipes

Mechanical Damage Testing
Squeegee Print Test Results

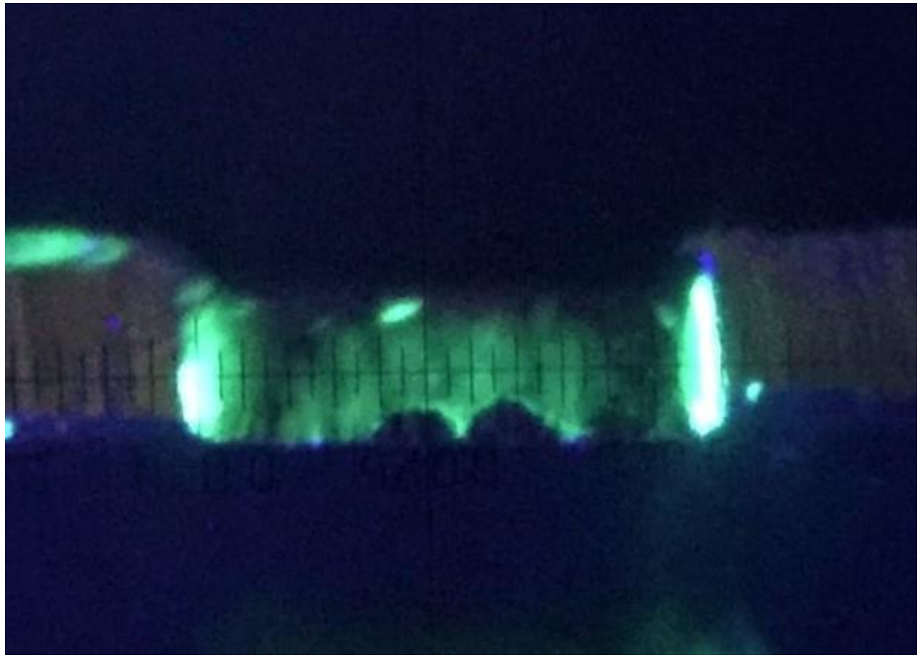


Mechanical Damage Testing
Squeegee Print Test Results



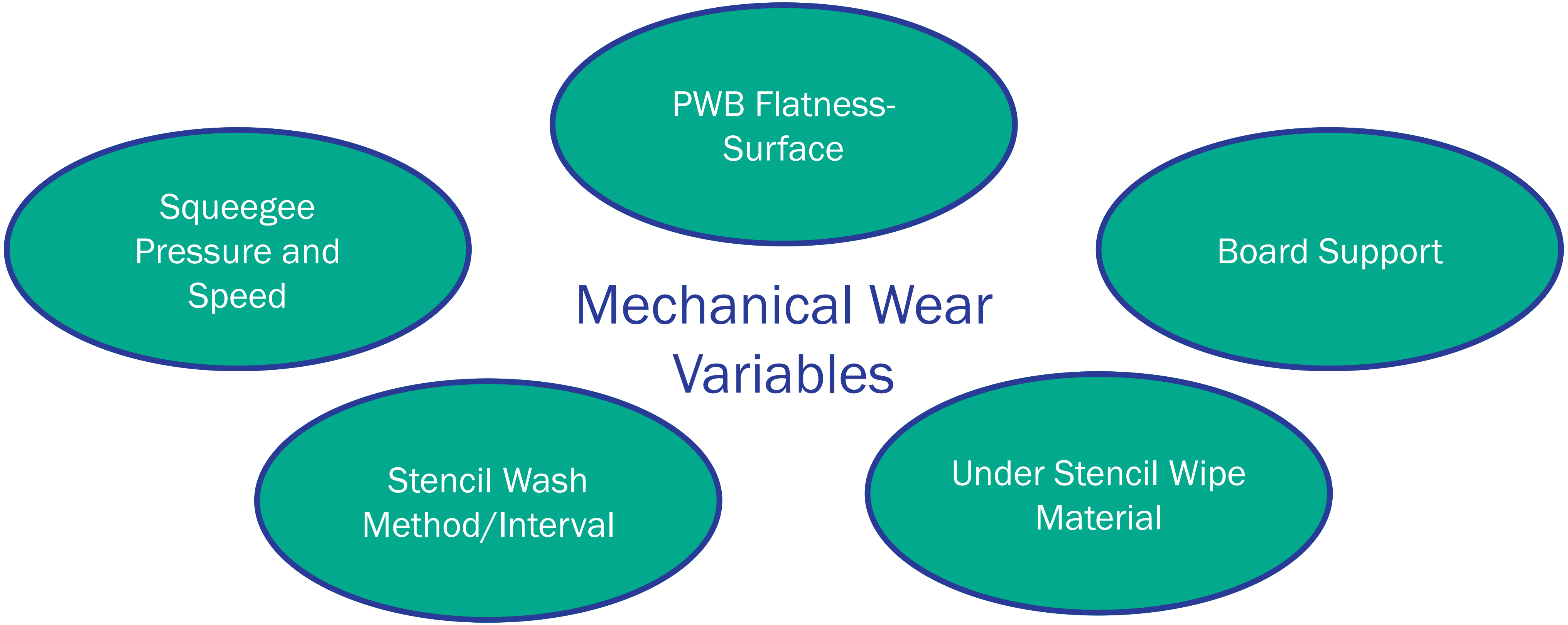
Mechanical Damage after 1000 Dry Squeegee Prints

Mechanical Damage Testing
Squeegee Print Test Results

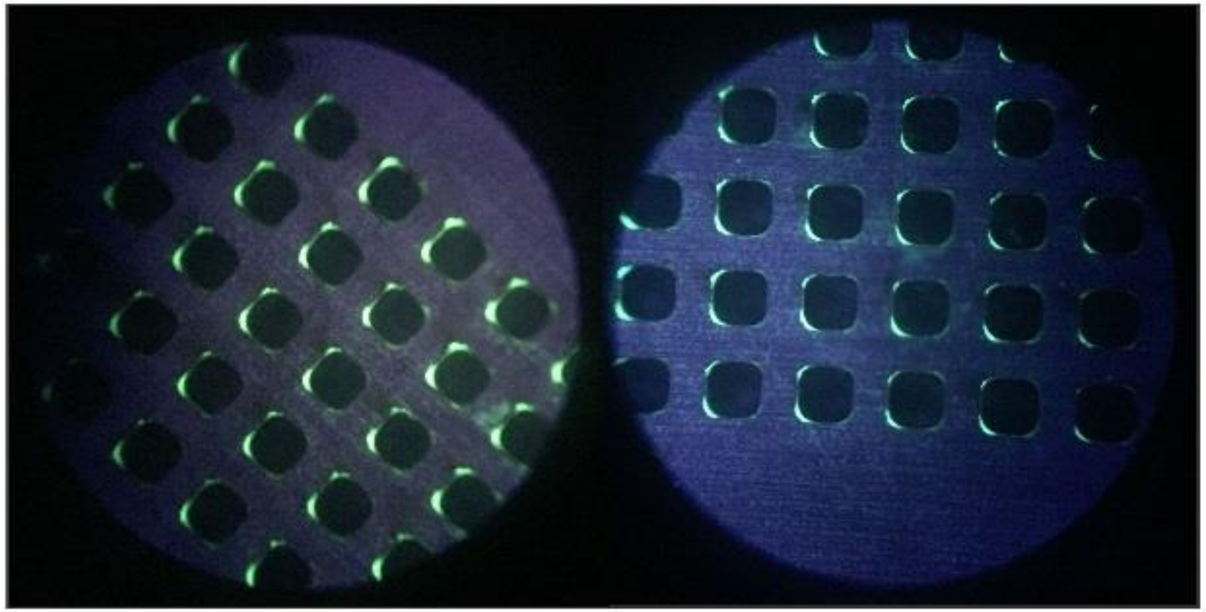


Mechanical Damage in Aperture Wall

Mechanical Damage Testing

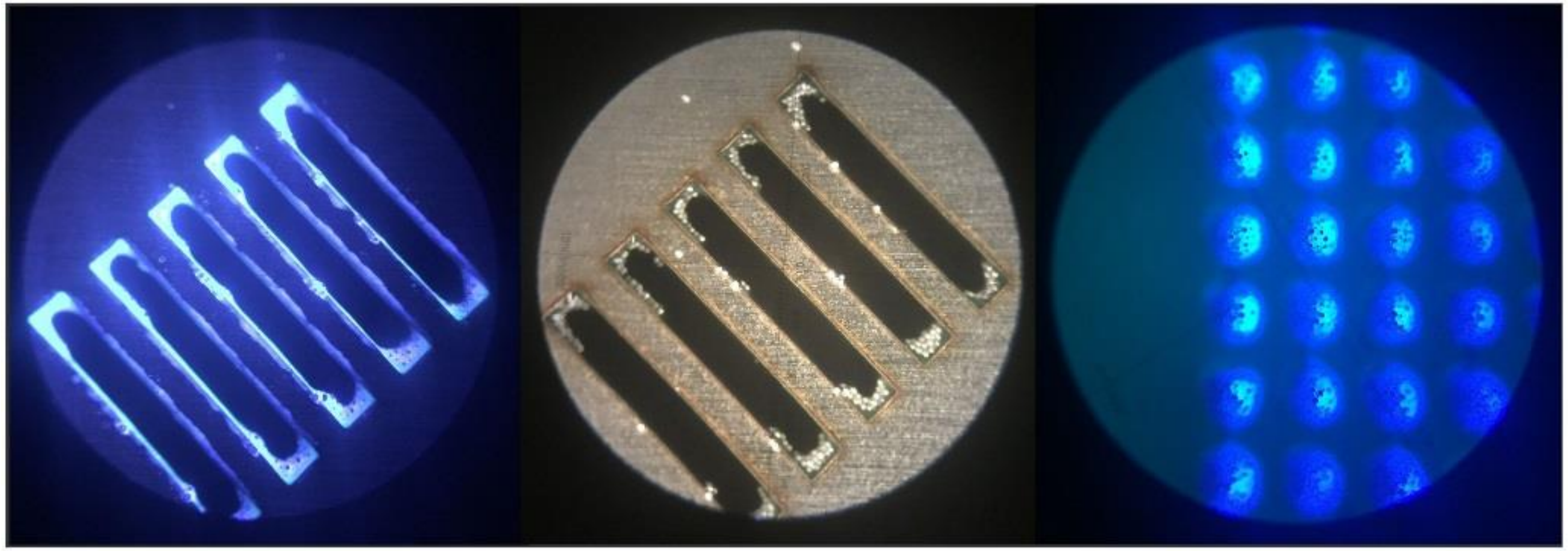


Mechanical Damage Testing
50 Cycle Print Test-Hybrid Results



R & D Hybrid Stencil

Mechanical Damage Testing
50 Cycle Print Test-Hybrid Results



R & D Hybrid Stencil

Conclusions

- ✓ Nano-coatings provide printing benefits, but these benefits only last as long as the coating is functional
- ✓ Mechanical and Chemical damage occur to the nano-coatings during use
- ✓ Nano-coatings are nano-meters to microns thick and will not last forever
- ✓ Nano-coating life can be extended

Guidelines to Extend the Life of Nano-Coatings

1. Use solder pastes and stencil cleaners that are chemically compatible with the nano-coating
2. Reduce the frequency of underside cleaning to minimize abrasive and chemical damage
3. Minimize squeegee pressure and use proper board support to minimize mechanical damage
4. Use nano-coatings that are more resistant to damage
5. Re-coat phosphonate based nano-coatings as needed to maintain functionality