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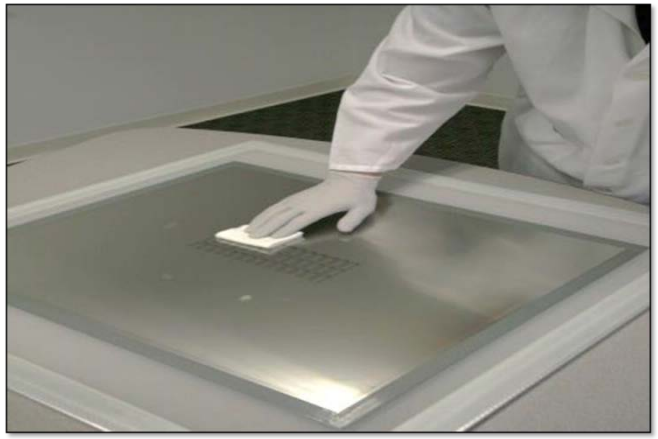
Stencil Nanocoatings are Not Just for Fine Pitch Anymore



Presenters

Mario Gattuso

- Senior Business Development Manager at Aculon,

Join Us! PCB WEST 2018 – Next Week

Santa Clara CA

September 12, 2018

Booth # 603

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Agenda

Today's Presentation

- Introduction
- Nanocoating Benefits
- Cost and Payback Calculator – Case Study
- Documented Performance Improvements
- Key Questions
  - Aperture Side Wall Coating
  - Spray on Coatings vs NanoClear
  - Best Practices in Cleaning and Durability
- Case Study on NanoClear Implementation
- Questions & Answers

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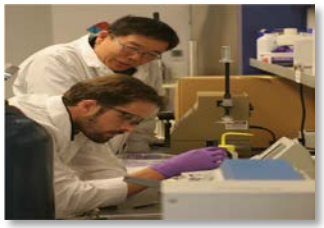
OVERVIEW

Aculon is a leading provider of surface modification technologies

- **Surface Solution Experts** – develop & produce technologies to modify a broad variety of surfaces (metals, glass, polymers).
- **Treatments include** - create hydrophobic, oleophobic, hydrophilic, adhesion promoting treatments.
- **Treatments are very thin**, easy to apply and need minimal equipment.
- **3 Focuses -** Electronics, Oil & Gas, Specialty
- **Business Model:** produce chemistry
- **Location:** San Diego California USA, worldwide distribution



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WORLDWIDE DISTRIBUTION PARTNERS

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What are Stencil Nanocoatings?

Extremely thin flux-repellent films that are applied to the bottom side and aperture walls of stencils to:

- **Improve Quality**
  - Higher yields
  - Better transfer effectiveness
- **Boost Productivity**
  - Less underwiping
  - Less downtime for paper changes
- **Reduce Costs**
  - Less rework
  - Lower paper and solvent consumption

Nanoclear is a SAMP Coating
(Self-Assembling Monolayer Phosphonate)

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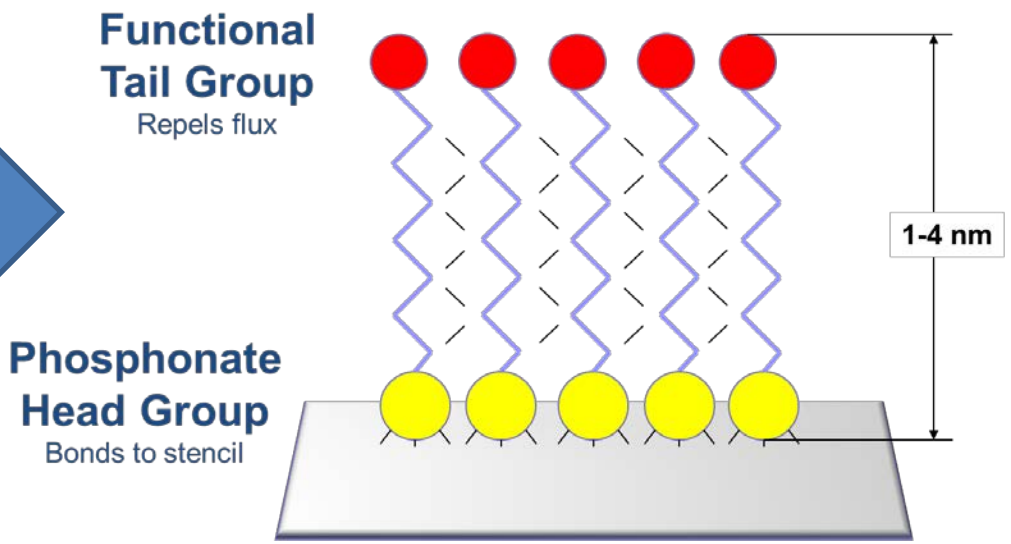
Stencil Printing and Cleaning Improvement - NanoClear

Purpose:

- Increase yields and output on SMT assembly lines
- Improve print quality and reduce variation
- Decrease under stencil wipe frequency

NanoClear's SAMP Molecule
(Self-Assembling Monolayer Phosphonate)



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Enabling Technologies in Printing

Early Technology	Improvements
• Chemically etched apertures • Generic, mill-grade stainless steel • Chemically etched single steps	• Laser cut apertures • Specialty alloys • Machined or welded multi-level steps

All these technologies commanded a premium price when introduced to the market. SAMP nanocoatings have always been extremely affordable.

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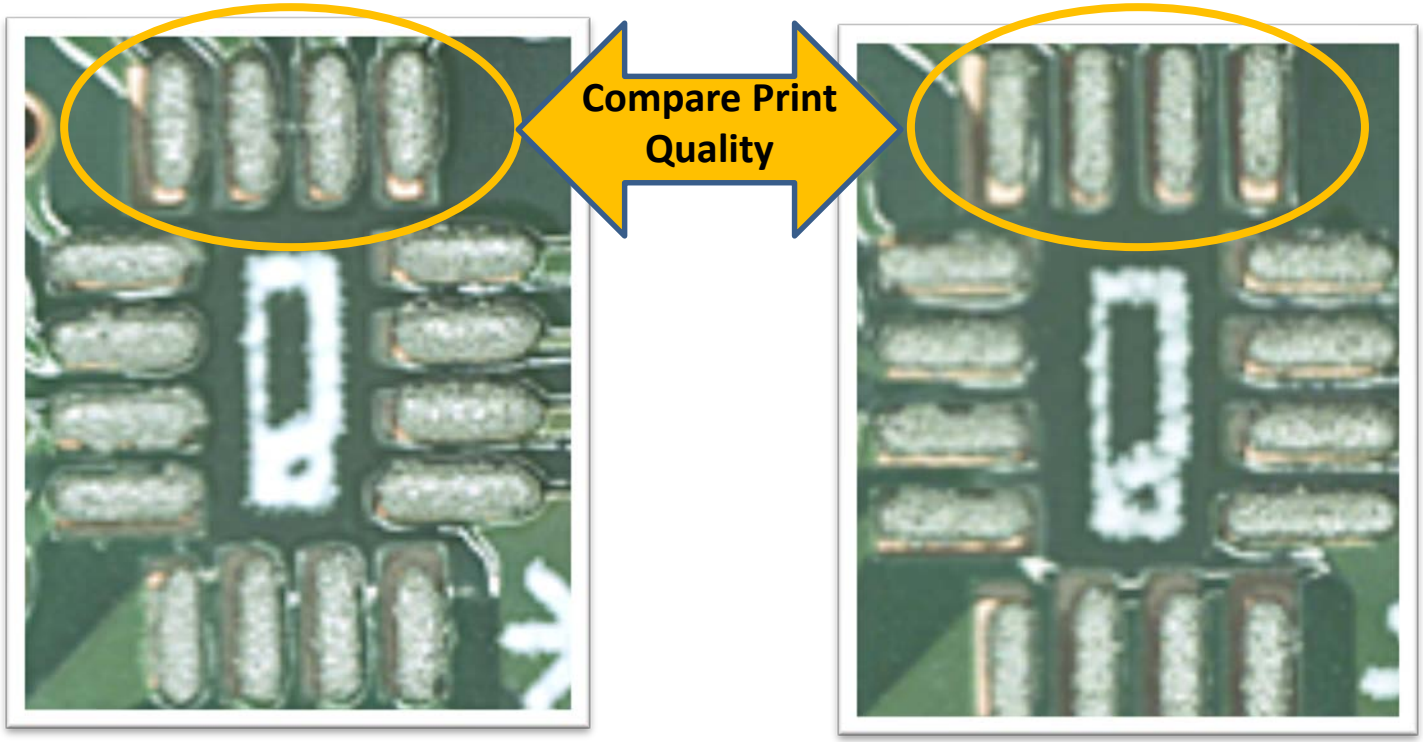
Print Performance Improvements

0.4mm QFN in production (100µm stencil)

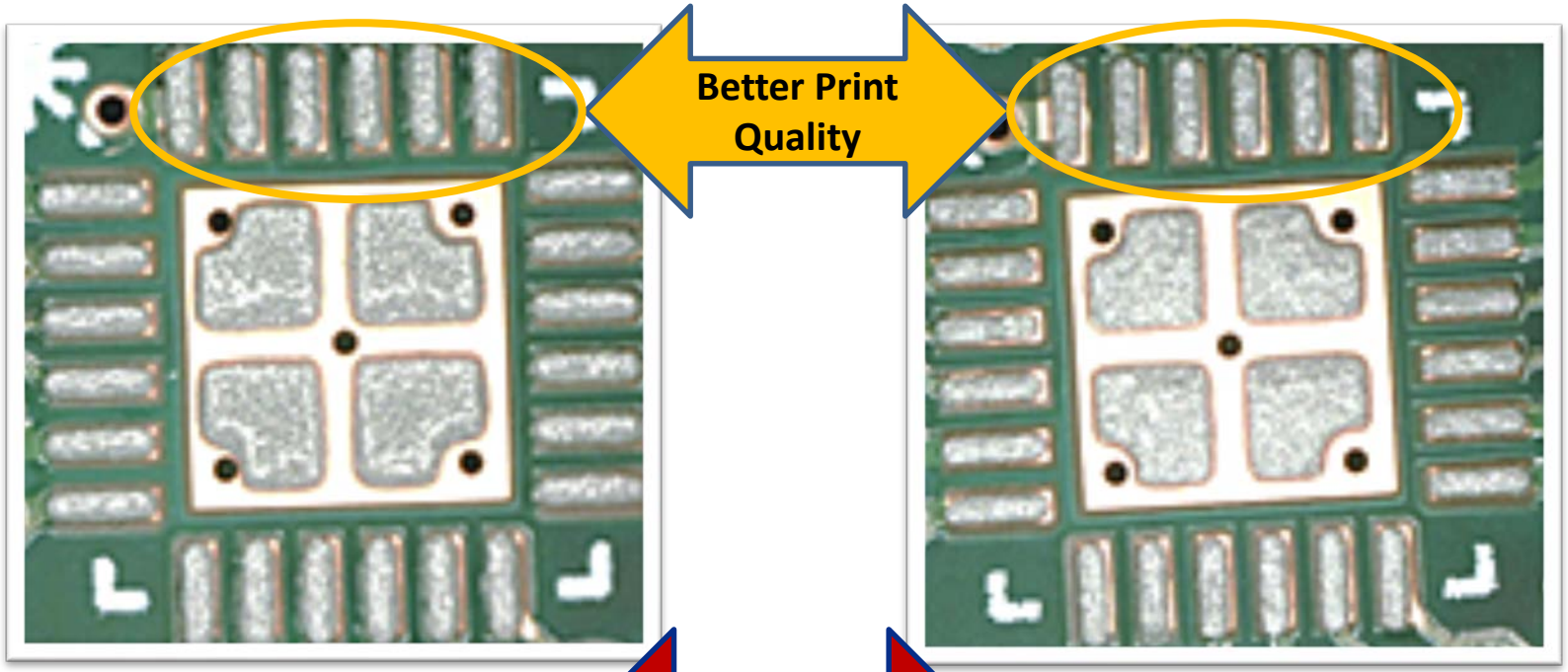


Without Nanoclear

With Nanoclear

Print Performance Improvements

0.5mm QFN in production (120µm stencil)

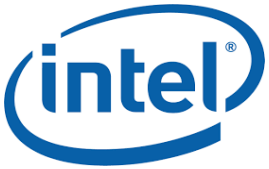


Without Nanoclear
Wet/Dry wipe: 3 prints
Wet/Dry/Vac wipe: 6 prints

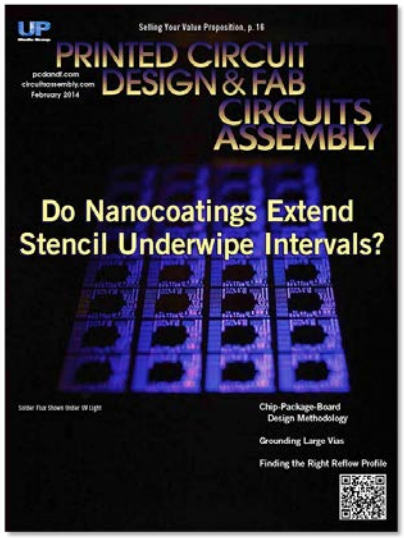
Fewer Wipes

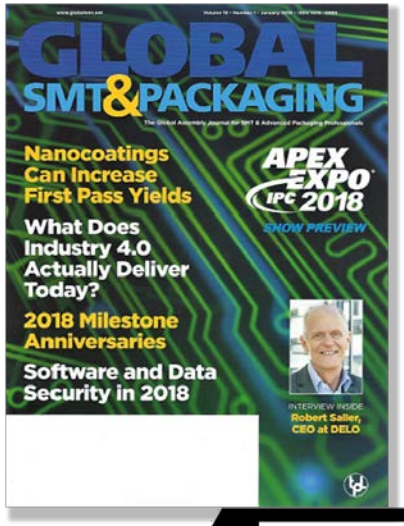
With Nanoclear
Wet/Dry wipe: 5 prints
Wet/Dry/Vac wipe: 10 prints

Users Include



Well Respected





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Benefits of NanoClear Stencil Treatment

PCB Assembly Characteristics	Quality		Productivity		Cost Reduction	
	Higher Yields	Better Transfer Effectiveness	Reduced Under Wiping	Less Downtime for Paper Change	Lower Paper and Solvent Usage	Less Rework

✓ - measurable improvement, ✓✓ - substantial improvement

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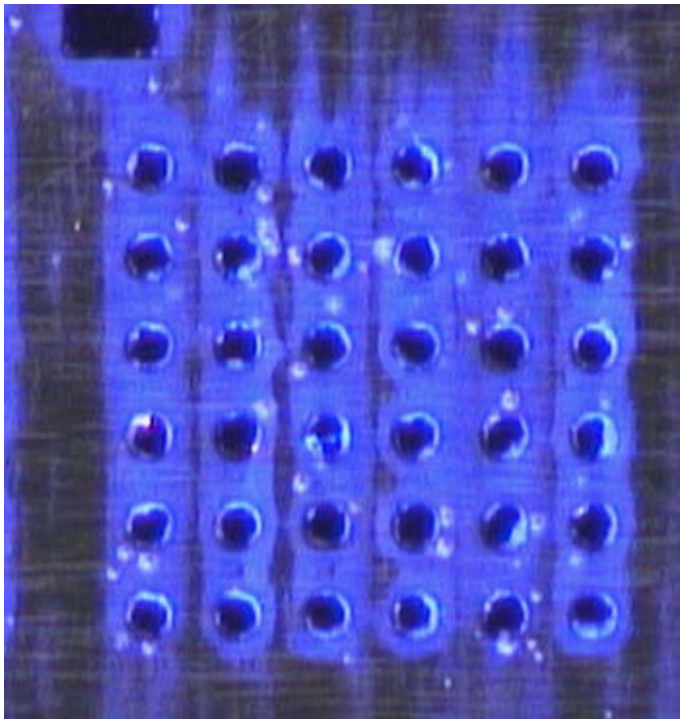
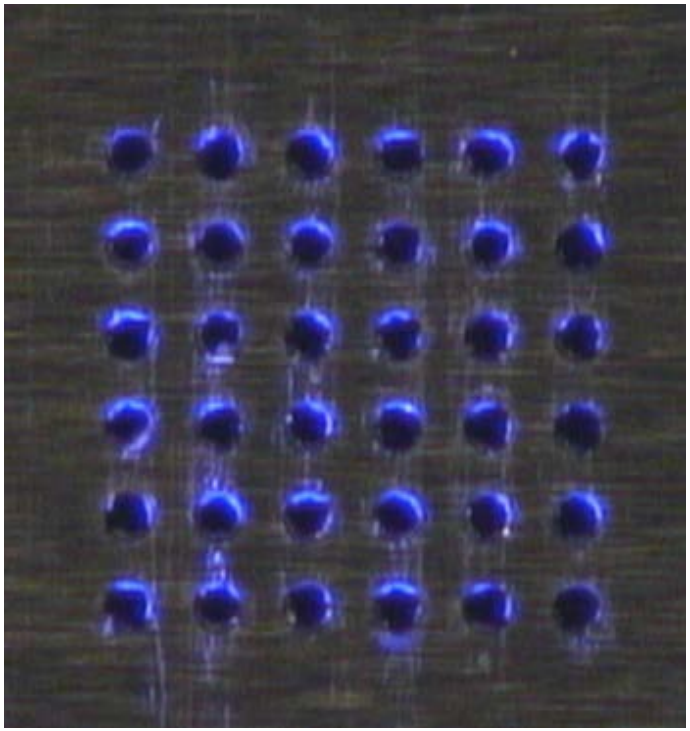
Dry Wipe - 0.5mm BGA

10 prints with 1 wipe (vac-dry-vac)



Untreated



Nanocoated

Flux treated with UV tracer dye and photographed under black light

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Cost and Savings Payback Calculator

- Simple
- Customizable, no locked cells
- Works with any currency
- All calculations transparent
- Returns payback in # of prints PLUS extra uptime per year
- Available at www.aculon.com

Live Demo: Open Excel Workbook named “NanoClear Cost Savings Estimator”

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Actual Business Case – Operating Cost Savings

Cost of Simple Rework	
Time required, min`	15
Labor rate, per hour	28
Benefit rate, %	25
Overhead Rate, %	25
Cost of Simple Rework	$ 10.50

Cost of Wiper Paper	
Cost per roll	20
Length of roll, m	10
Advance per wiper pass, mm	5
# of wiper passes in cycle	3
Cost of Paper per Wipe Cycle	$ 0.03

Cost of Complex Rework	
Time required, min`	60
Labor rate, per hour	16
Benefit rate, %	25
Overhead Rate, %	25
Cost of Complex Rework	$ 24.00

Cost of Wiper Solvent	
Cost of solvent container	30
Capacity of solvent container, liter	4
Volume of solvent used on each wipe, ml	2
# of solvent passes in wipe cycle	1
Cost of Solvent per Wipe Cycle	$ 0.02

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Actual Business Case – Operating Cost Savings

Quality	
Current First Pass Yield, %	80
Projected First Pass Yield, %	99
% Improvement	19%
% of defects requiring simple rework	90
% of defects requiring complex rework	10

Savings in Yield Improvement, per print $ 1.05

Productivity	
Current Wipe Frequency	5
Projected Wipe Frequency	24
% Reduction	79%

Savings in under wipe consumables, per print $ 0.007

Cost Reduction	
Cost of simple rework	$ 2.30
Cost of complex rework	$ 34.50
Cost of wiper paper, per wipe cycle	$ 0.03
Cost of solvent, per wipe cycle	$ 0.02

Modify cost information on the "Cost Calculator" tab

Payback Period	
Savings per print	$ 1.06
Cost of Nanoclear	$ 25.00
Cost of Application	$ 20.00
Payback - # of Prints	43

Annual Savings per SMT Line	
# of prints per hour	90
# of production hours per week	80
# of paper roll changes per week	12
Time to change wiper roll, minutes	5
Annual Cost Reduction	$ 395,338

>>> PLUS <<<

Additional Prodution Uptime, hours per year	52
Additional PCBs assembled per year	4680

Note: Annual cost reduction based on 4 lines and all stencils coated with NanoClear at a total investment of under $5000.

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Documented CEM Performance Improvements

- **SPI Yields boosted from 60% to 75%**
- 0.4mm QFN - 100µ stencil
  - **Average height reduced from ~120% of stencil thickness to ~97% of stencil thickness** – *more in control*
  - **Average transfer efficiency reduced from 150% to 125%** - *more in control*
- 0.5mm QFN - 120µ stencil, less wiping
  - **Average height reduced from ~134% of stencil thickness to ~120% of stencil thickness**– *more in control*
  - **Average transfer efficiency reduced from 138% to 125%** - *more in control*
- **All min-max ranges improved also**

Improvements due to cleaner stencil bottom and apertures

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Does it Coat the Inside of the Apertures?

Yes!

- Because it is so thin it is difficult to see
- Transmission Electron Microscopy is required

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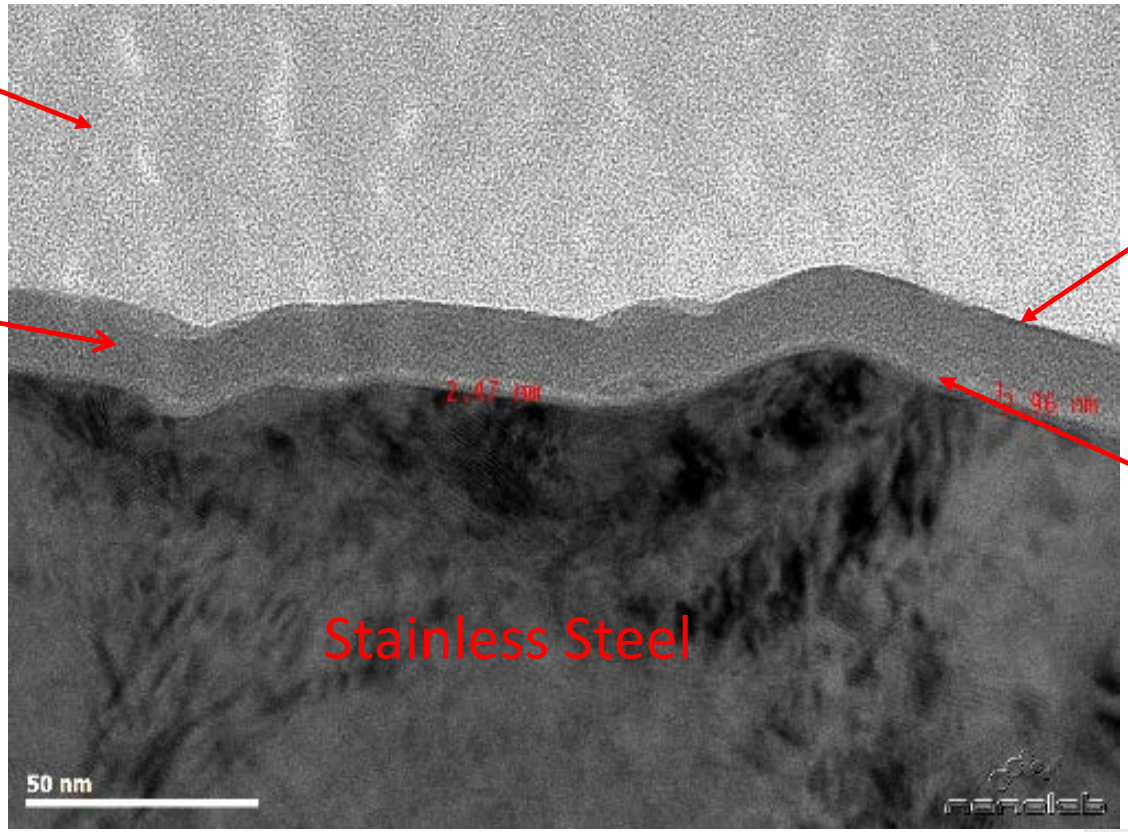
TEM Analysis - New Stencil

Pt layer

Cr layer, distinguishes between nanocoat and Pt layer

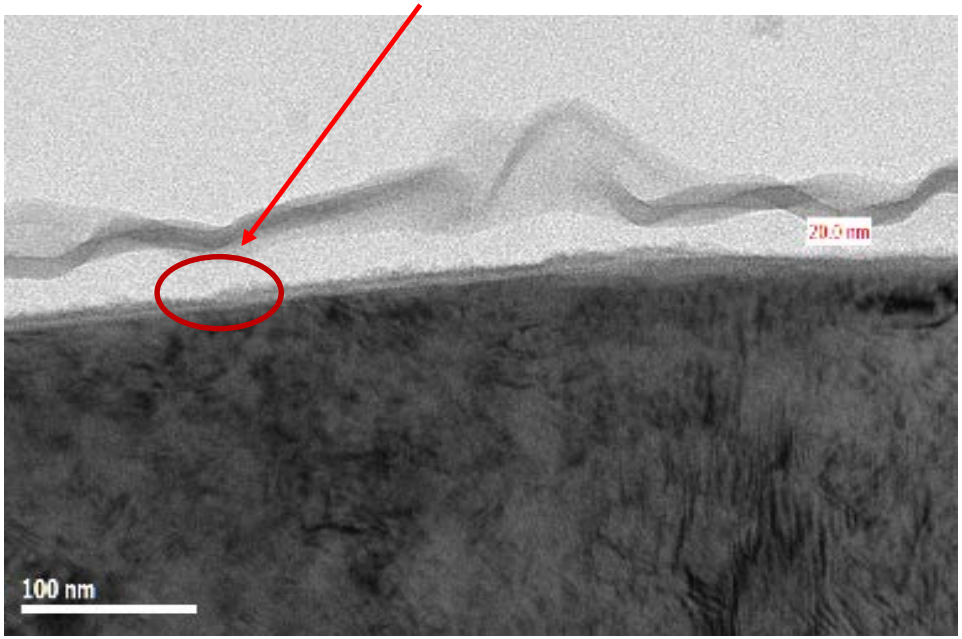


Carbon Layer

NanoCoat

TEM Analysis – 15,000 Prints

NanoCoat Present



Sidewall – coated & 15k prints

Spray On or NanoClear?

Attribute	Spray	NanoClear
Application	Spray and thermal cure	Wipe on
Applied by	Stencil supplier	Supplier or self
Thickness	2-4 µm	1-2 nm
Hydro- and oleophobic	✓	✓
Abrasion resistance	✓	✓
Chemical resistance	✓	✓
Visible	✓	
Accessibility	Selected suppliers	Stencil suppliers & Aculon
Reworkable if worn off		✓
Reduces frequency of underside cleaning	✓	✓
Solder paste volume	15 – 25% increase in TE	Slight decrease < 5%
Aperture Redesign?	yes	No
Lead Time	Days	5 Minutes
Minimum Area Ratio	0.10 lower than foil	Same as foil
Cost	>$100 supplier dependent	$20-50

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Spray On Issues

After a few years in the field issues with spray on coatings becoming well known. Numerous customer reports of spray on coatings cracking/chipping/flaking:

- Spray on Coatings crack & flake off!
  - Stencil with flaked coated is unusable and must be discarded.
  - Contaminated paste!
  - No QC method in place to check for cracking coatings!
- Stencil often redesigned to accommodate thick coating in aperture
- Spray Process is inherently difficult to control thickness. Leads to poor control of aperture size and inconsistent result.
- Reports of Spray coatings ceasing to function after multiple prints even when coating is still “visible”. A visible coating is not a good proxy for function

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Spray On Vs NanoClear

- NanoClear is a monolayer. It will NEVER crack, flake, or chip as can be expected with spray coatings.
  - Paste will never be contaminated
  - Stencils never needs to be discarded due to NanoClear, simply recoat if function is diminished
- NanoClear never requires a stencil redesign.
- NanoClear is a self controlled application. Always 2-4nm thick monolayer ensuring a high quality coating everytime.
- NanoClear can easily be tested for function with a NanoClear test pen. No gimmicks. If function has diminished simply reapply.

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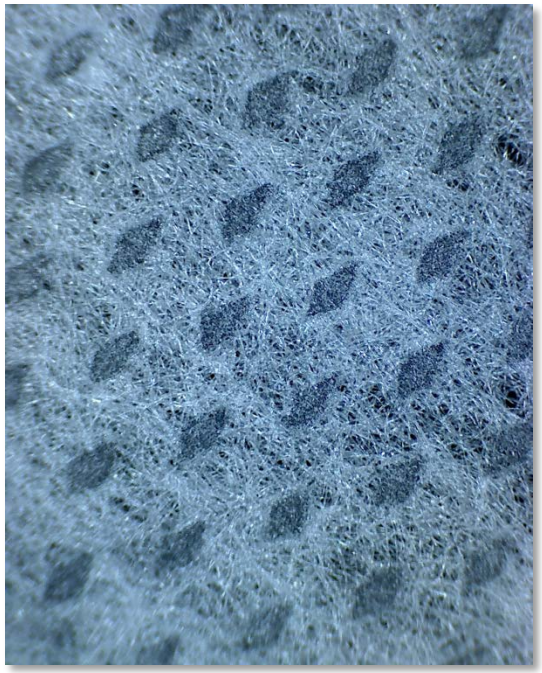
Best Practices for Durability

Based on 5 years of production and multiple research projects:

1. Use soft, non-abrasive Understencil Wiper Paper such as Eco Roll SC-ER360 or Hyperclean PP4200
2. Utilize a Solvent Wipe Rather than a Dry Wipe – engineered solvents are best for lead-free no-clean pastes
3. Utilize pH Neutral Cleaners
4. Reduce Understencil Wipe Frequency



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Rauland Case Study

Case Study : “How nanocoating helped reduce SMT related defects by over 50% and increase throughput by over 20%”

Stencil Printing Improvement Program

Three Pronged Approach:

1. Applied NanoClear to existing stencils
   - ➢ No need for new stencils
2. Changed Solvent Cleaner from IPA to Zestron Vigon UC160
3. Changed to use MicroCare Stencil Wipe

Implementing NanoClear, MicroWipe & Zestron Solvent

Assumptions:

Wipe every 5 cycles	to	Wipe every 25 cycles
Average Paste Application		27 Seconds
Average Under-wipe and Cleaning		54 Seconds
Bottle Neck Rate on Line 3		18 Seconds
Bottle Neck Rate on Line 4		22 Seconds
Bottle Neck Rate On Lines 1		40 Seconds
Bottle Neck Rate On Lines 2		40 Seconds

Began implementing this in April 2016 and had it complete by the end of July 2016 on All 4 Lines

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Projected Throughput Improvement

Effective Cycle Time (current)

- (5 * 27 second) + 54 seconds = 189 Seconds/ 5 Boards

OR

37 seconds/board

Effective Cycle Time (future, with fewer wipes)

(25 * 27 seconds) + 54 seconds = 729 seconds/25 Boards

OR

29 seconds/board

*Expect to see **22 Percent** Improvement In Throughput*

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Business Case –
Actual Throughput Improvement

From SMT OEE Calculator						
	May-16			Aug-16		
	Boards	Minutes	Bds/Min	Boards	Minutes	Bds/Min
Day 1	2462	1780	1.38	8182	1740	4.70
Day 2	3092	2260	1.37	5766	1748	3.30
Day 3	4979	1916	2.60	11822	2225	5.31
Day 4	7845	1793	4.38	6538	1833	3.57
Day 5	3317	1838	1.80	9148	2314	3.95
Day 6	3422	1799	1.90	4910	1986	2.47
Day 7	4715	1681	2.80	7466	1920	3.89
Day 8	2625	1896	1.38	7195	2122	3.39
Day 9	3159	800	3.95	6823	2077	3.29
Day 10	6333	2052	3.09	6068	2951	2.06
Day 11	5407	2284	2.37	8412	2499	3.37
Day 12	2723	1471	1.85	6934	1863	3.72
Day 13	4996	1691	2.95	10146	1716	5.91
Day 14	6027	1617	3.73	11295	1506	7.50
Day 15	6161	2218	2.78	6435	1596	4.03
Day 16	5279	1750	3.02	6124	2185	2.80
Day 17	3913	2513	1.56	5695	2425	2.35
Day 18	6819	1748	3.90	4430	2357	1.88
Day 19	5291	1525	3.47	6046	1624	3.72
Day 20	2373	1825	1.30	5016	2614	1.92
Day 21	6782	1823	3.72	6202	2230	2.78
Day 22	6741	1998	3.37	6585	2234	2.95
Day 23	5102	1738	2.94	9580	2107	4.55
Day 24	3753	1682	2.23	5987	1642	3.65
Day 25	3981	1609	2.47	4838	2223	2.18

Average Boards per Minute May 2016	2.7	3.6
Percent Increase In Board Production Rate		35%

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Throughput is Up!

What about Quality?

It is really possible to make it faster, cheaper AND better?

Let's see…

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Business Case – Actual Quality Improvement

Between May 2016 and August 2016:

SMT defects **down 52%**

ATE defects **down 42%**

	Defects in SMT (OQR Report)					Defects in ATE (OQR Report)				
	Defects	# Bds	Defects/Bd			Defects	# Bds	Defects/Bd		
May	804	90000	0.89%			1503	49842	3.0%		
Aug	763	179772	0.42%			1753	100866	1.7%		

Reduction In Defects SMT	**52.49%**	**Reduction In Defects ATE**	**42.4%**

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Actual Business Case – Operating Cost Savings

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Summary

NanoClear® The #1 NanoCoating Globally

- Not just for fine pitch stencils
- Easy to calculate benefits:
  - Improved Quality
  - Boost productivity
  - Reduced Costs
- Coats the aperture walls
- Techniques to enhance durability – Soft wipes & clean better!
- Continue to innovate to meet customer demand
- Available locally in Europe via Caplinq

NanoClear enables a higher quality, more cost-effective stencil print process

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For More Information

Presentation

- Will be emailed to all attendees

Videos

- Introduction & Instruction Videos

To download Cost Calculator Workbook

- NanoClear Cost of Ownership Calculator

For NanoClear orders, quotes

- orders@aculon.com

For questions and volume quotes for NanoClear

- Contact Mario Gattuso **gattuso@aculon.com**

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