“Working from Home” Webinar Series: Hydrophobic Surface Treatments

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THANK YOU FOR JOINING US

Presenters

- Edward Hughes CEO
- Mario Gattuso Sr. Business Development Mgr.

Logistical

- Recorded
- Ask questions via GoToMeeting question tab

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OUR GOAL

Aculon enables customers to make better products

by being an innovative, responsive and fast

developer and producer

of best in class

surface modification technologies.

Together we create winning products!

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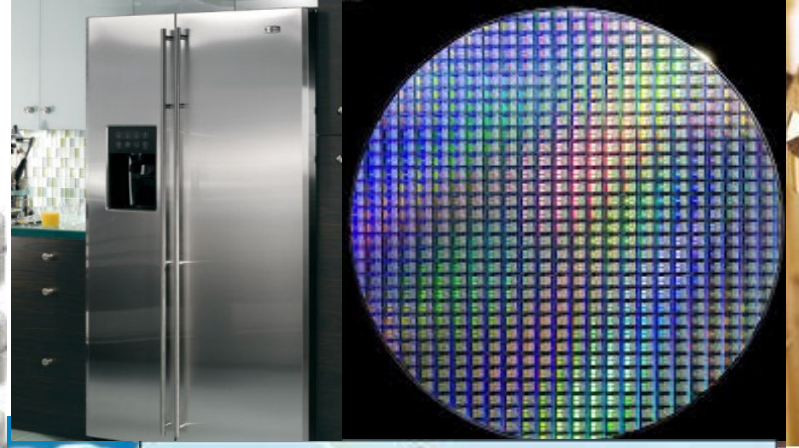
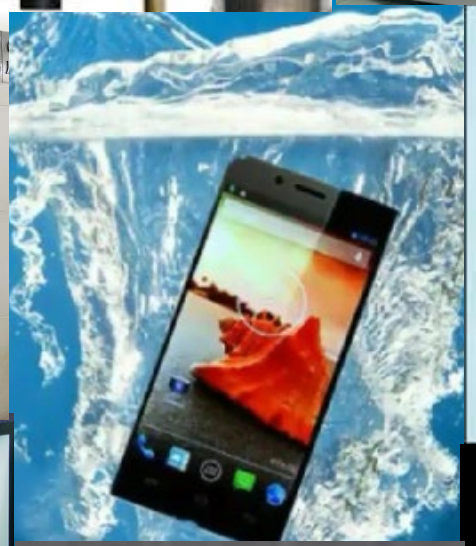
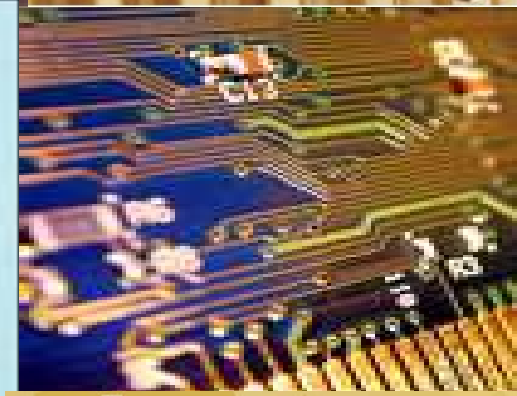
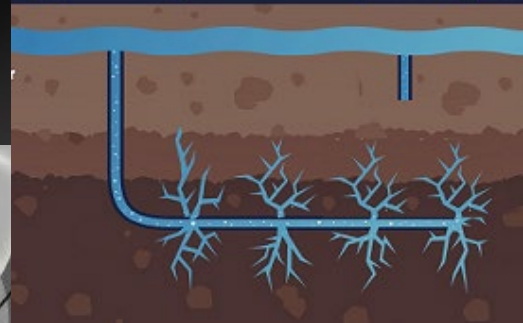
AGENDA

- Aculon Overview
- Technology Platforms
- Surface Modification Options
- Hydrophobic Applications
  - Electronics
  - Oil & Gas
  - Specialty
- Lab Services
- Q&A





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ACULON OVERVIEW

Founded 2004

- **Expertise** Develop & produce surface solutions to modify a broad variety of surfaces (metals, glass, polymers).
- **Functionality** Hydrophobic, superhydrophobic, oleophobic, hydrophilic, anti-fingerprinting, adhesion promotion
- **Treatments** Thin, easy to apply (no vacuum chambers), often no cure, safe, non-toxic and offer green options.
- **Differentiation** Create proprietary innovative treatments & willingness to work with customer to solve problems.
- **Focus areas** Electronics, Oil & Gas, Specialty (Medical +other)
- **Business Model** Produce chemistry & treat parts
- **IP** Over 38 Patents granted. Worked with 1000's applications, invested 100,000's hours
- **Products:** > 100
- **People:** Smart (numerous Chemists with PhD's & Masters Degrees, Electrical & Mechanical Engineers)
- **Global** Locations San Diego (HQ, Lab & Manufacturing) Shanghai, Singapore, Dallas, Amsterdam,
  Distributors > 12 in Asia

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WHY HYDROPHOBIC SURFACES MATTER?

Interaction with surfaces can create problems.
Hydrophobic technologies can be used to address a wide variety of problems.
Examples include:

1. Functional issue due to liquid behavior on surface
2. Cleaning a surface is time consuming & expensive, even impossible
3. Surface contamination (fingerprints) degrades a products aesthetic behavior
4. Water droplets/contamination impede optical performance
5. Adhesive materials stick to surface
6. Surface is not lubricous enough
7. Wettability of a surface or powder is not ideal
8. Exposure to water results in electronics failure
9. Physical barrier to prevent liquid flow is not possible

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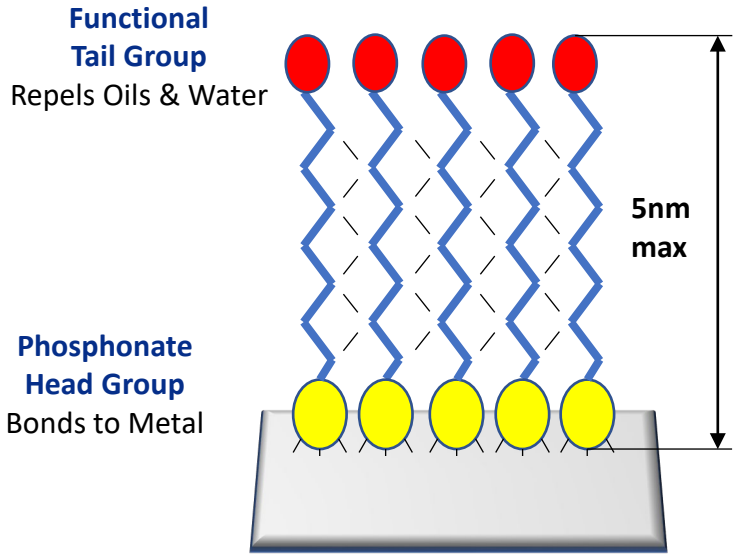
ORIGINAL TECHNOLOGY

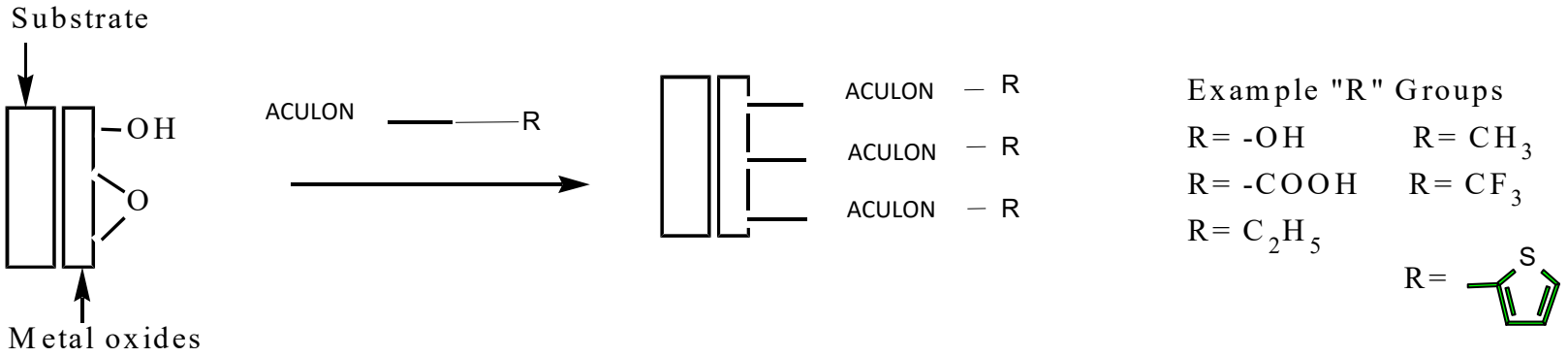
Aculon's proprietary "Self Assembled Monolayer of Phosphonates" (SAMP) can treat surfaces to impart repellency.

The SAMP monoloayer is comprised of a phosphonic acid and a repellent, carbon-based molecule:

1. Phosphonic acid reacts with the surface and creates a covalent bond at the substrate: phosphonic acid interface
2. The carbon group connected to the phosphonic acid is the functional mono layer
3. The monolayer is less than 5 nanometers thick



VERSATILE TECHNOLOGY



TAILOR THE "R" GROUP STRATEGY

"Hook"

- Strong Chemical Bonds – Resistant to Abrasion
- Chemically Resistant – Stable as the Underlying Substrate
- Thermally-Stable – up to 175-250˚C in ambient air.

"Tail"

- Surface Functionality – Lubricity, Cleanability, Surface Energy
- Interfacial Functionality – Reactivity, Adhesion of Polymers

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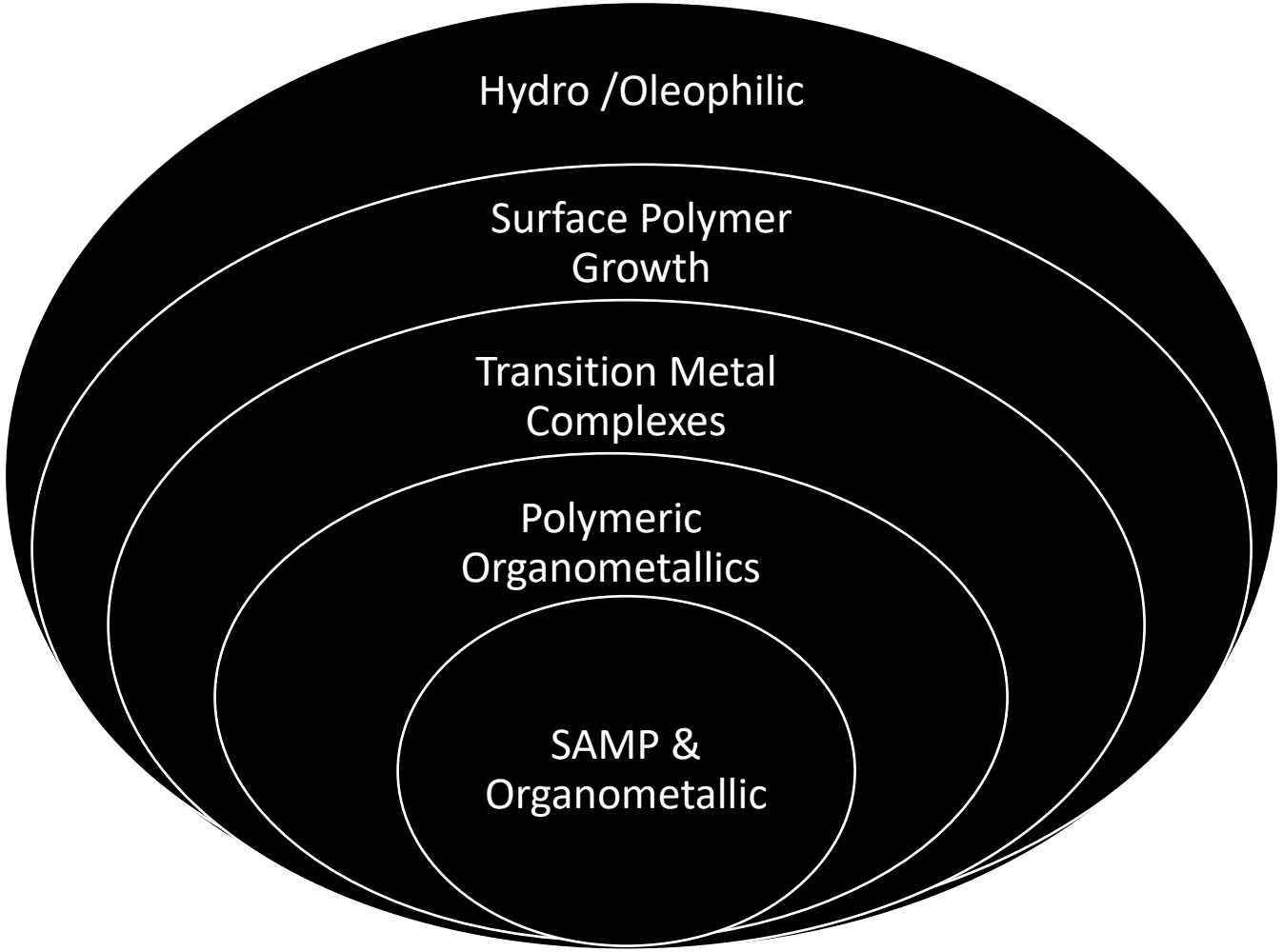
MANY SURFACE MODIFICATION PLATFORMS



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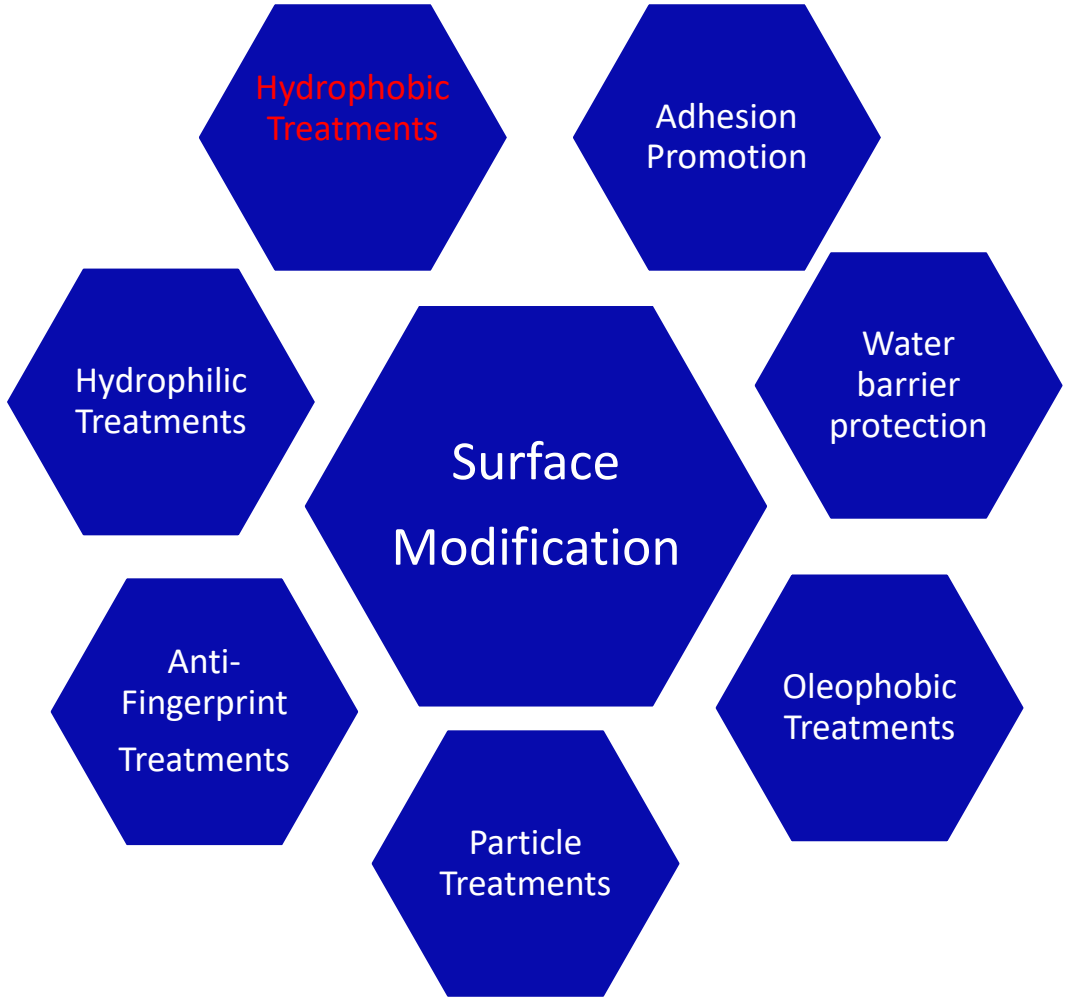
EXPERTISE AND PLATFORMS



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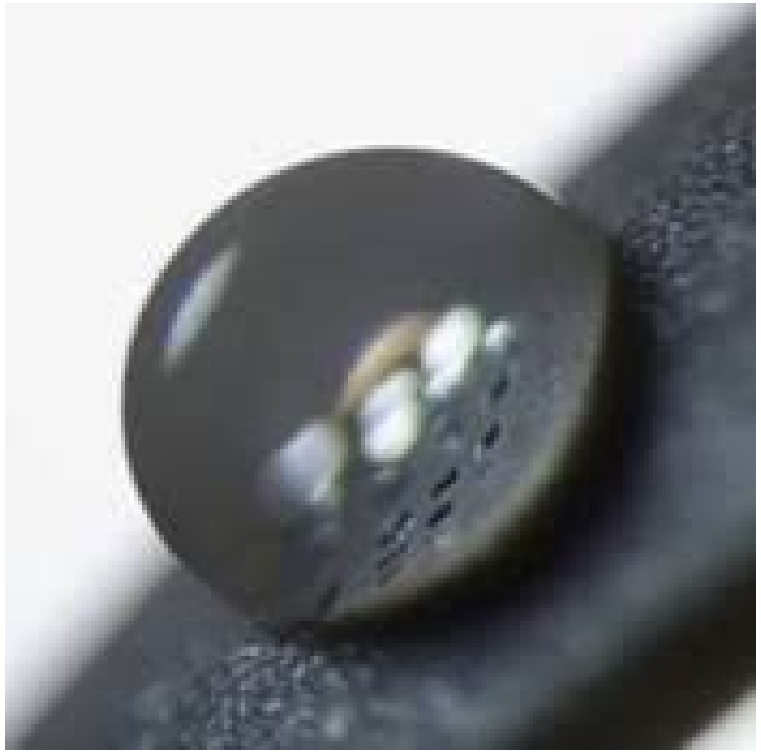
HYDROPHOBIC SURFACE TREATMENTS

Variety of surface modification technologies capable of functionalizing numerous substrate types to be hydrophobic:

- **Repel Water**
  - Reduction of surface energy repels water and most liquids
  - Hydrophobic >100°, Superhydrophobic > 120°
- **Optically Clear**
  - Ultra thin and optically clear coatings leave surface appearance and feel intact
- **Flexible**
  - Coat nearly any substrate type: metal, glass, ceramics, polymers, etc.



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SUBSTRATE & CHEMISTRY MATCHING

The substrate in question needing hydrophobic modification will drive the options available:

Metals & Oxide Containing Surfaces (Ceramics/Semiconductors/Glass)

- SAMPs
- TMCs
- Surface Growth Polymers
- Polymeric Organometallics

Polymeric (non-oxide) Surfaces

- TMCs
- Polymeric Organometallics

*Certain polymeric substrates can be functionalized to behave as an oxide containing surface

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HYDROPHOBIC DURABILITY

Treatments are chemically robust with options that can withstand most any environment or exposure condition:

- **Thermal Stability**
  - Thermally stable in ambient air
  - 200-300°C depending on technology type
- **Abrasion Resistance (Treatment Dependent)**
  - Strong covalent bonding
  - “As strong as the underlying substrate”
  - If your substrate will survive the environment undamaged, our coatings will too.
- **Chemical Stability**
  - Resistant to nearly any chemical depending on substrate and technology type
  - pH 10+ can be problematic
- **UV**
  - Poor resistance & bad fit

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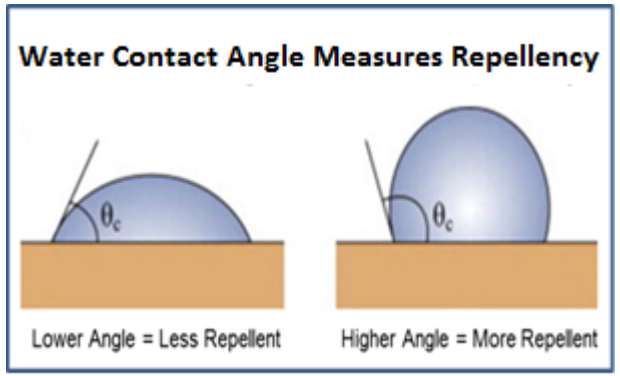
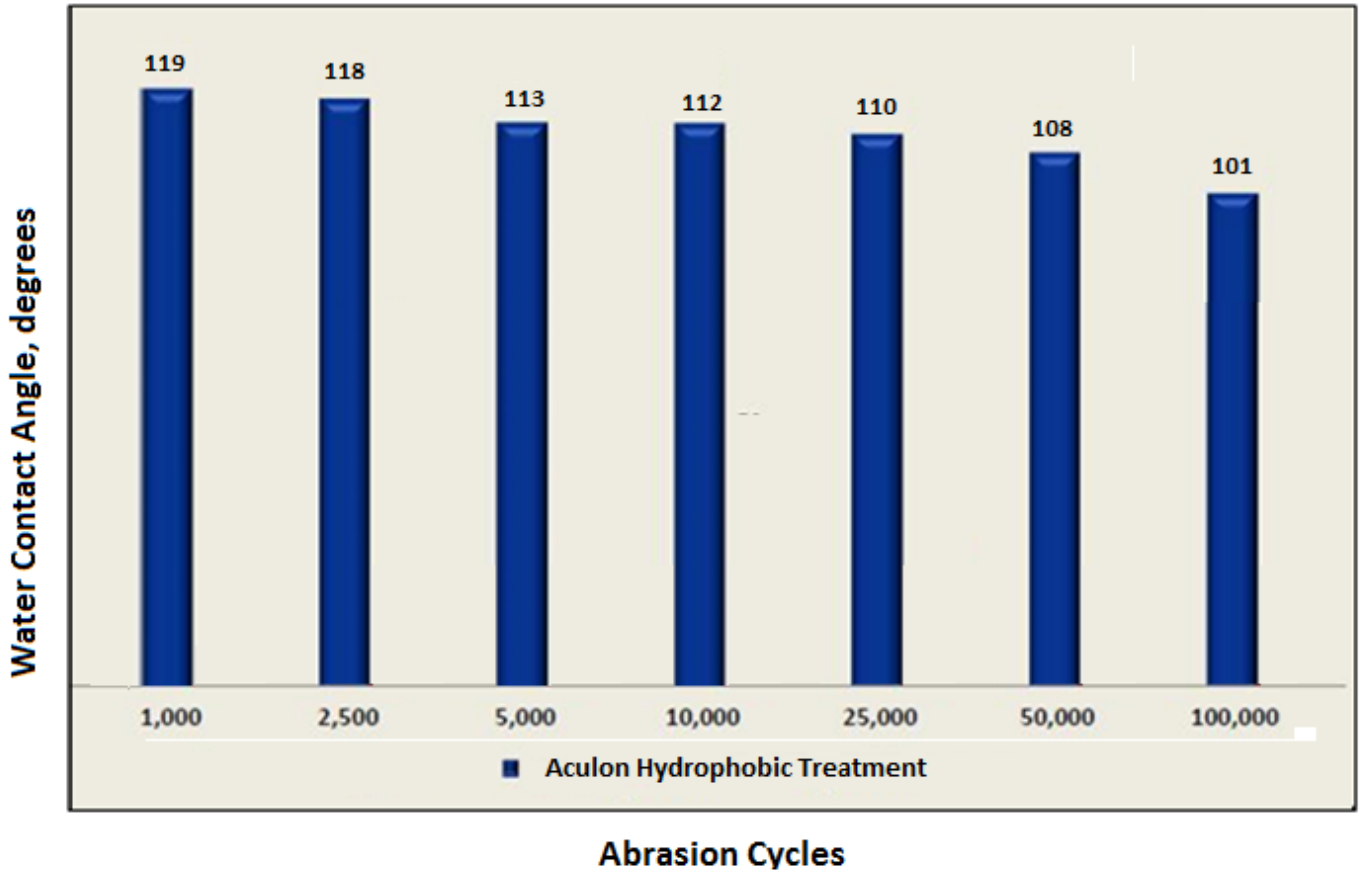
HYDROPHOBIC PERFORMANCE

CONTACT ANGLE



Hydrophobic Treatment on Stainless Steel - Durability testing done utilizing a dry wipe on a linear taber abrader as a proxy for real world abrasion treated parts will experience during usage.

ABRASION RESISTANCE



Conclusion: "Aculon's hydrophobic treatment results in water contact angles that are high and consistent, remaining hydrophobic even after 100,000 abrasion cycles"

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APPLICATION PROCESS

Hydrophobic treatments are robust and scalable for high volume commercial applications. Treatments are all applied via wet chemical processes, meaning no deposition equipment, chambers, or batch processing, ever! application process depends on the application but can include:

- Dip Applied
- Spray Applied
- Wipe Applied
- Dispense/Jet

Parameters:

- Concentrations
- Solvent
- Coverage
- Temperature

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IN HOUSE CAPABILITY

Aculon has a wide variety of manual and automated/programmable application equipment at their disposal for process optimization.

Automated Production Spray Equipment

Precision Nordson Asymtek Spray/Dispense/Jet

Automated SCS Dipping

ACULON FOCUSES

1. Electronics

2. Oil & Gas

3. Specialty

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ELECTRONICS

Applications include:

- **NanoClear®** #1 Global Stencil Coating
- **NanoProof®** Award Winning PCB protection, Moisture Barrier, Silver Migration prevention, underfill dam, connector coating
- **Anti-Fingerprinting** Laptop / tablets, Appliances, Packaging
- **Epoxy Control** Semiconductor wafer packages, leadframe mold flash
- **Acustamp** Semiconductor test pins & fixtures

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1 GLOBAL STENCIL NANOCOATING

Extremely thin flux-repellent film applied to stencil underside & aperture walls

1. Improve Quality

Higher yields

Better transfer effectiveness

2. Boost Productivity

Less underwiping

Less downtime for paper changes

3. Reduce Costs

Less rework

Lower paper and solvent consumption

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

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NANOCLEAR AWARDS

Winner Circuits Assembly
New Product Introduction Award

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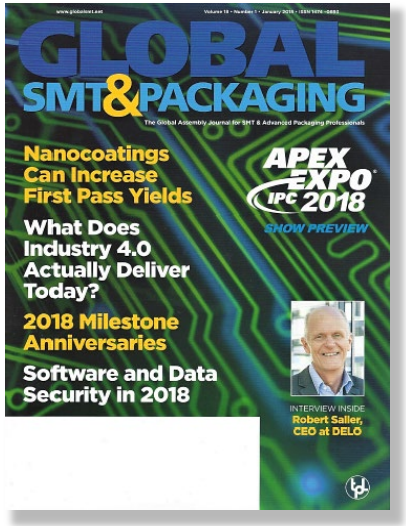
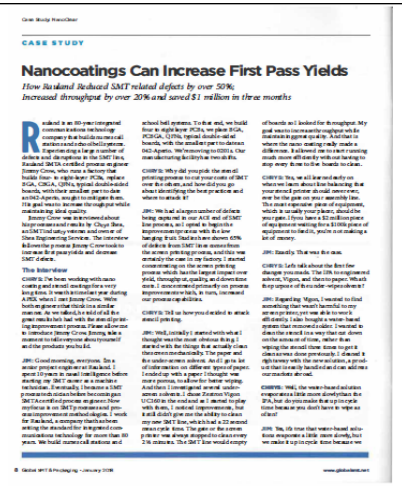
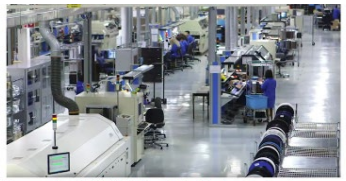
NANOCLEAR MEDIA COVERAGE




CASE STUDY

Nanocoatings Can Increase First Pass Yields

How Rauland Reduced SMT related defects by over 50%;
Increased throughput by over 20% and saved $1 million in three months



Improving SMT Yield and Reducing Defects: A Rauland Case Study

Article by Edward Hughes
ACULON

Ever-increasing demand for more complex boards that have higher densities of components means more challenges for SMT assembly operations and yields. Smaller component sizes and more densely packed PCBs lead to more powerful designs in much smaller products packages. These advancements have spurred a new set of challenges in building smaller and more complex assemblies.

Even though SMT products have been manufactured in high volume for decades, SMT line issues continue to be prevalent and new demands continue to pose new challenges. While the SMT prim process is not complicated, controlling the outcome is complex. Having an underperforming SMT process results in lots of rework, lower throughput and added product costs as well as product reliability issues.

Rauland, a division of AMSTEK Inc., is an 80-year Integrated communications technology company that builds nurses call stations and school bell systems. The company responds to market needs globally with two distinct communication system product lines: Responder, designed for the healthcare industry, and Telecenter systems, which serve the educational market.

SMTA-certified Process Engineer Jimmy Crow works at Rauland's highly sophisticated, FDA-compliant manufacturing facility that has state-of-the-art SMT equipment. At Rauland they build four- to eight-layer PCBs, place BGA, PCBGA, QFNs, typical double-sided boards, with its smallest part to date an 042 Aperio.

Disciplined and quality conscious, Crow was not happy with the performance of his SMT line. There were too many defect and too much line downtime. Rework levels were also too high. His goal was to reduce SMT related defects and increase throughput while maintaining quality.

Studies have shown that 65% of defects from SMT lines comes from the screen-printi-

Feature Interview by Stephen Las Marias
I-CONNECT 007

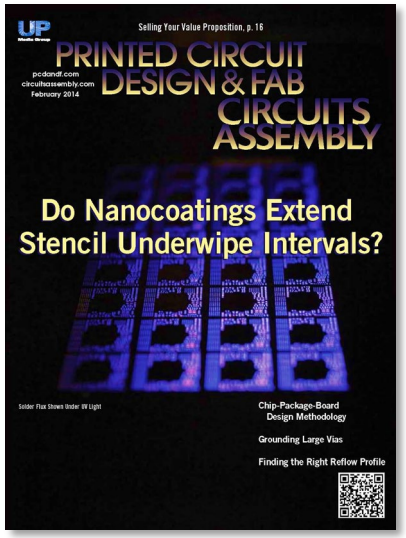
Aculon Inc. commercializes unique surface coatings leveraging nanotechnology and other surface modification techniques. The company's original focus was the optical industry, developing treatments of prescription eyewear, sunglasses and other optics. In 2010, the company launched its electronics business, and since then has been one of the leading providers of nanocoating for stencils. Since 2012, Aculon has been a supplier of nanocoating to protect printed circuits from waterproofing. In 2015, the company launched its own series of Aculon branded products called NanoProof.

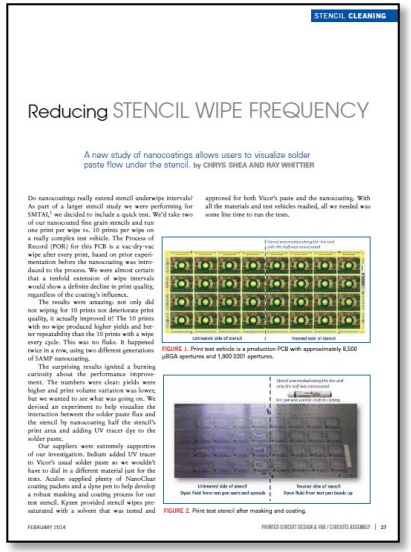
In an interview with *SMTXXP* Magazine, Aculon Chairman and CEO Edward Hughes speaks about addressing their customers' challenges and ensuring customer satisfaction.

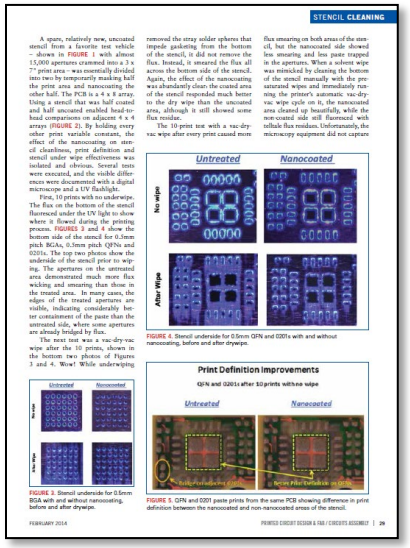
Stephen Las Marias: What challenges are your customers facing?

Edward Hughes: In electronics, we have two core products—NanoClear for stencils and NanoProof for PCB waterproofing. The challenges for stencil producers are both in cost and complexity. There is tremendous cost pressure to reduce stencil costs at the same time as complexity increases as apertures become smaller due to miniaturization. For PCBs, waterproofing is a huge issue not just for mobile phones but also other premium electronics. NanoProof allows customers to waterproof their device in a cost effective, easy to apply manner without costly vacuum equipment.

For NanoClear, we added repellency functionality to stencils that paybacks in hard savings in generally less than 200 prints. As a result, our customers enjoy dramatic improvements in first pass yield and lower consumables costs for an investment of less than $50 per stencil. For NanoProof, we are providing a more effective waterproofing solution up to and including IPX-7 that is both cost effective and easier to apply than alternative conformal coatings or vacuum deposition processes.







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NANOCLEAR SUMMARY

#1 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 on a global basis

Nanoclear enables higher quality, more cost-effective stencil print process

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ANTI-FINGERPRINT (AFP) TECHNOLOGIES

Aculon offers several easy clean and Anti-Fingerprint (AFP) treatments for electronics and other applications

AFP COATINGS – EASY CLEAN

Extremely thin optically clear easy clean treatments are applied to the surface which:

- **Increase functionality**
  - Significantly improves the ease of cleaning fingerprint contaminated surfaces
- **Allow for cleaning with no solvents**
  - Remove fingerprints with dry cloth wipe
- **Durable**
  - Robust coatings offer ongoing AFP performance after normal handling

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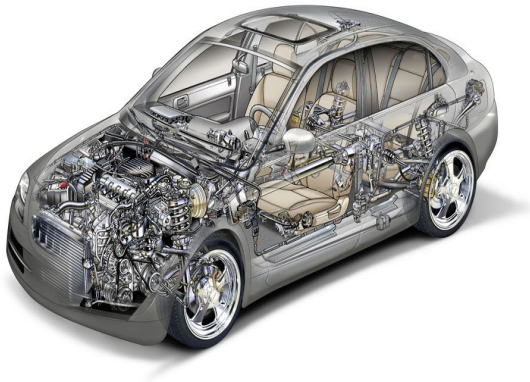
WATERPROOFING TREATMENTS

In real life, electronic devices are often damaged

- Device dropped in pool or even toilet
- Unit exposed to outdoor environment – rain, humidity
- Household appliances exposed water during operations
- Equipment (industrial and medical) exposed to wet working environment



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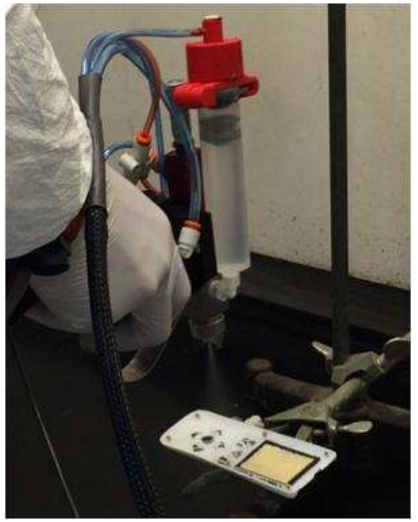
NANOPROOF® SERIES

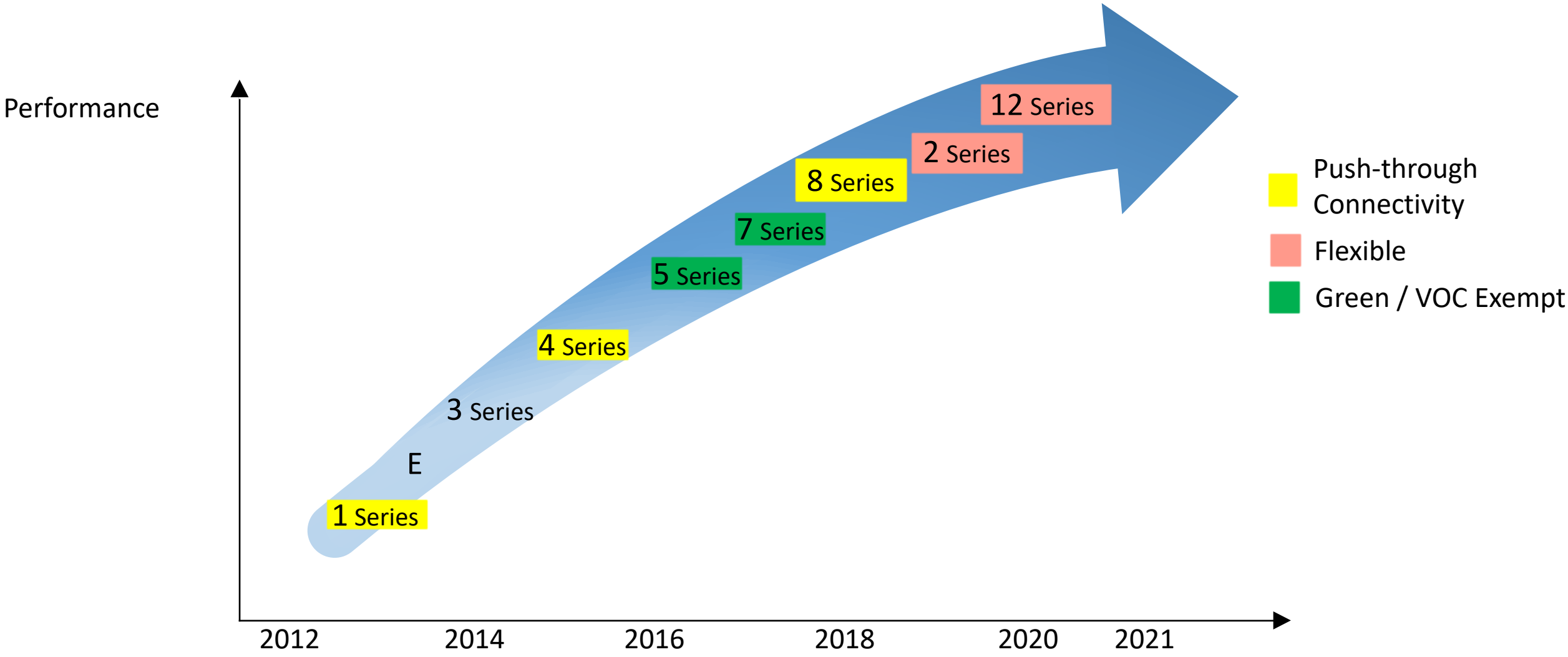
Aculon NanoProof® Series provides water protection from humidity to full water immersion

- Utilize proprietary technology
- Application equipment affordable and readily available
- Range of treatments available to meet performance, thickness, application and economic needs. From IPX3 to IPX8



Winner 2016 and 2019 Circuits Assembly New Product Introduction Award

WATERPROOFING TECHNOLOGY ROAD MAP



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NANOPROOF BENEFITS

NanoProof	IPX	In-Line	Non-Toxic	Push Through	Flexible	Green/VOC Exempt
1	3	✓	✓	✓	✓	✗
3	4	✓	✓	✓	✓	✗
6	4	✓	✓	✓	✓	✗
5	5	✓	✓	✓	✗	✓
7	7	✓	✓	✗	✗	✓
8	8	✓	✓	✓	✓	✗
12	8	✓	✓	✗	✓	✓
2	8	✓	✓	✓	✓	✗

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BENEFITS

1. Reduce Product returns due to water damage
2. Improve yields as rework is possible after coating
3. No or minimal masking required
4. Coatings are safe, non-toxic and can be used in factory environment
5. Affordable

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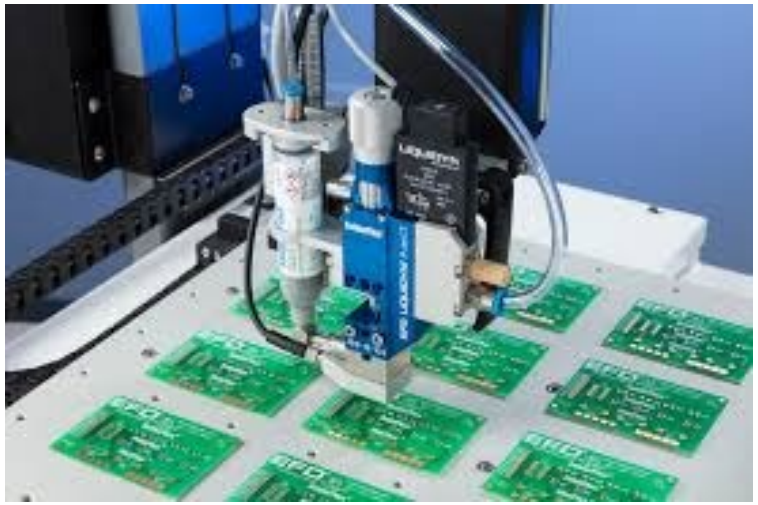
NANOPROOF® TECHNOLOGY APPLICATION

The coating process depends on the treatment selected but could include:

Spray



Jet or Dispense

Dip

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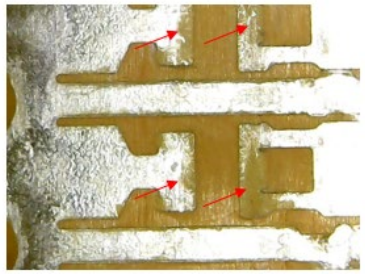
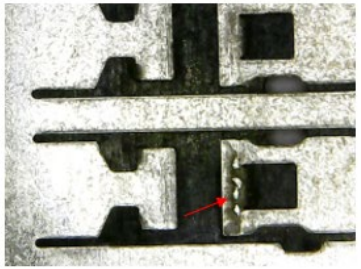
EPOXY/RESIN CONTROL

GOAL: To eliminate epoxy residue from sticking to bond pads on capacitors.

Aculon Hydrophobic Treatment Applied to repel epoxy & resin

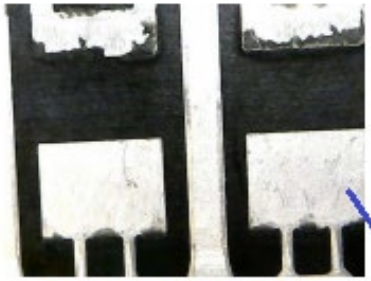


Epoxy on Bond Pads



Epoxy on Bond Pad after SandBlasting

No Aculon EC



Before Sandblast

After Sandblast

Contamination eliminated!

With Aculon EC

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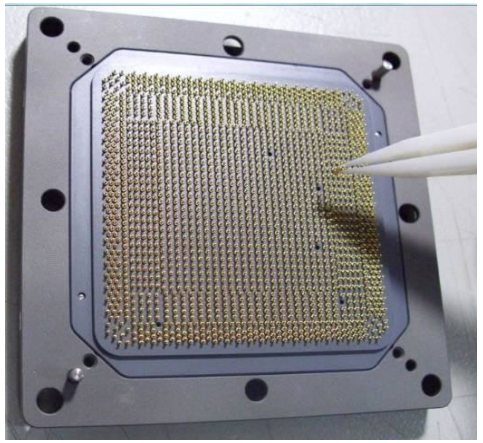
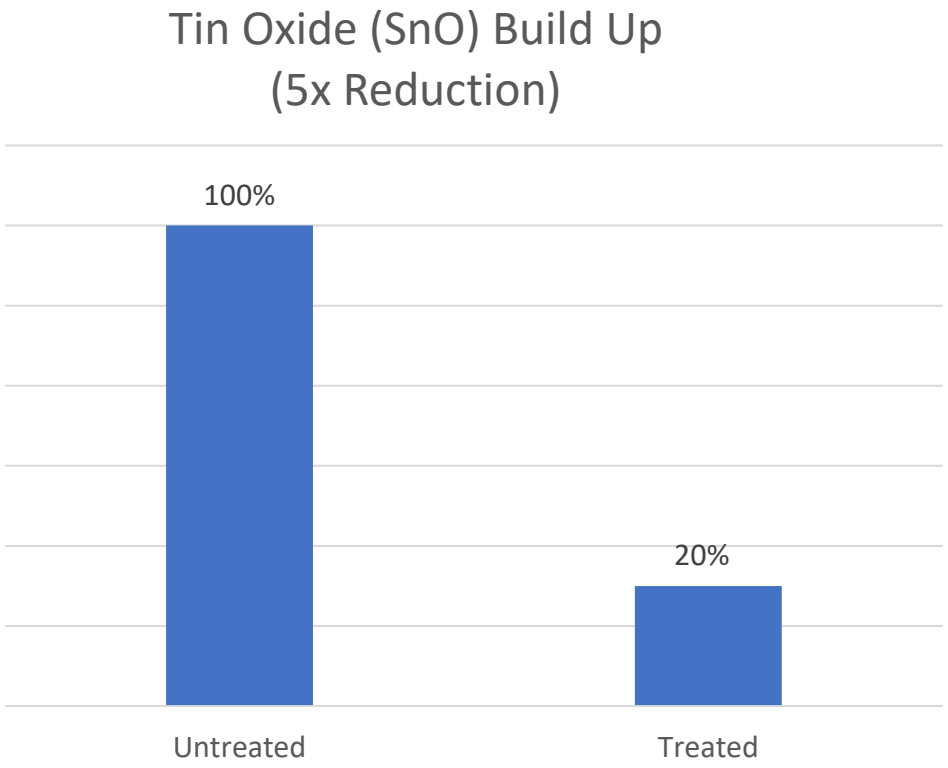
SEMICONDUCTOR TEST PINS

GOAL: Reduce contamination, tin-oxide, & downtime of semiconductor test pins

Aculon Hydrophobic Treatment Applied to POGO test pins. Treats all metals including gold, nickel, copper, & stainless steel.





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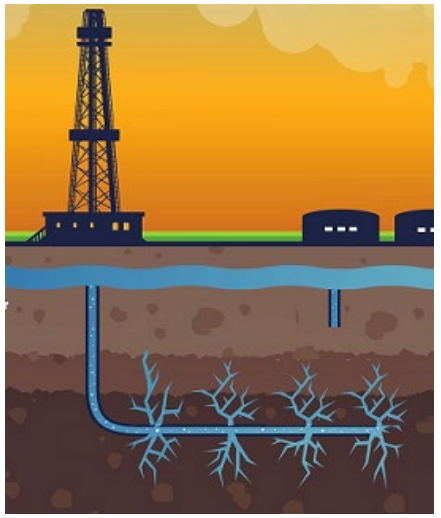
OIL & GAS

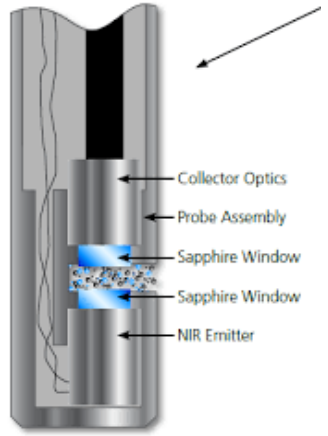
APPLICATIONS



Enhanced Oil Recovery:
Treat rock formation down well reduce water blockages and enhance oil flow for new well completions and remediations.

Anti Fouling:

- Storage tanks and stainless pipes to prevent paraffin and asphaltene build up due to contact with crude oil
- Oil spill containment booms & equipment
- Treat sapphire to prevent oil wetting on surface impacting optics



SPECIALTY

Applications include

- Medical Devices
- Sapphire Optics
- Cutting tools
- Wheel Weight adhesion
- Particles
- Watches
- Guitar Strings
- Movie Screens
- Optical / Sunglasses

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MEDICAL DEVICES

Applications:

- **Needles & Syringes**
  - Functionalize needles and syringes to have more consistent behavior
- **Electronic devices**
  - Improve easy clean and anti smudge characteristics
  - Eliminate failure due to water exposure
- **Stents & other similar devices**
  - Alter device surface behavior
- **Mesh/Screens**
  - Alter surface behavior by imparting hydrophobic functionality

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SAPPHIRE OPTICS

Functionalizing sapphire optics to be hydrophobic can significantly improve performance:

- **Increase Service Life**
  - Reduce cleaning frequency of sapphire viewports in extremely difficult to access environments (downwell, industrial, manufacturing)
- **Repels all liquids**
  - Prevent fouling of both water & oil based fouling materials
- **Durable**
  - Extremely robust coatings survive the most aggressive environments

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PARTICLE TREATMENTS

Ability to change functionality of broad variety of particles & powders for specific behavior via hydrophobic functionalization:

- **Surface Energy**
  - Options available for increasing or reducing surface energies of particles for desired performance
- **Easy Application**
  - Liquid based treatment options make bulk treatment of particles easy & scalable
- **Applications**
  - Functionalized particles and powders add value in performance in wide variety of applications

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LAB SERVICES

Understand Customer Requirements → Aculon Lab Services → Analyze & Characterize → Customer Testing & Feedback → Optimize → Selection & Recommendation → Customer Plant Trial

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INTELLECTUAL PROPERTY & EXPERTISE

Strong combination of hard and soft IP:

- Granted over 35 Patents
- Developed many trade secrets
- Treated and tested thousands of applications
- UCSD Partnership gives access to millions of dollars of equipment
- Spent hundreds of thousands of hours solving surface problems
- Invested millions of dollars in building capabilities & expertise

SUSTAINABILITY

Aculon is committed to offering a range of environmentally friendly products and follow good sustainable business practices. We help our customers support their sustainability goals and help protect the environment.

VOC-Exempt Options

PFOA-Free Products

Eco-Packaging & Waste Reduction

- Nearly all Aculon packaging (shippers, pails, bottles) is reusable or recyclable
- Green alternatives are utilized wherever possible
- From paper to pens, reusable or recyclable office supplies are used throughout our business operations

Reduced Transportation-Related Emissions

- Reduced material used → reduced transportation of material & wastes
- Localization with suppliers & distributors in Europe & Asia
- Utilize carbon-neutral shipping options when using UPS

Sustainable Energy & Increased Efficiency

- Retrofitted LED Lighting Throughout our HQ (>800 LEDs) & Utilize Extensive Natural Light
- Switched to Energy Efficient Equipment

CONCLUSION

- Platform technology company that make customers products better!
- Surface solution experts
- Strong history of working with customers to solve problems
- Broad portfolio of products, including more sustainable options
- Strong IP, testing capabilities and in-house expertise

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PERFORMANCE. SURFACE. SOLUTIONS

THANK YOU

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