”Working from Home”
Webinar Series:
Surface Modification Overview
“Why Surfaces Matter!”

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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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THANK YOU FOR JOINING US

- Hope everyone is well and safe
- Pandemic – scope, speed, stakes
- Ability to adapt –”WFH”
- Essential company
- Be there for you when we come out of this

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
- Applications
  - Electronics
  - Oil & Gas
  - Specialty
- Lab Services
- Q&A

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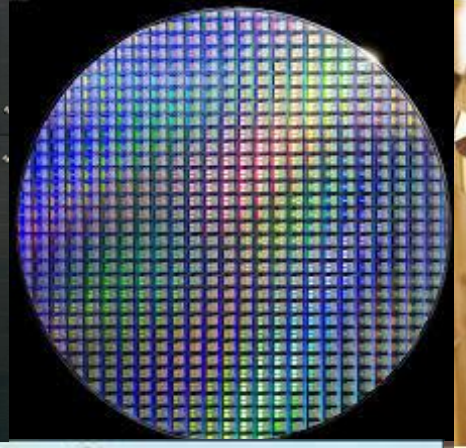

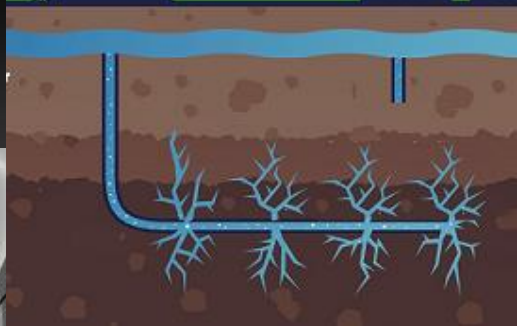

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ACULON OVERVIEW

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 35 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 SURFACES MATTER?

Interaction with surfaces can create problems.
Surface modification technologies can be used to address a wide variety of problems. Ten 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 or oil 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. Adhesion between substrate and adhesive is poor
9. Exposure to water results in electronics failure
10. Physical barrier to prevent liquid flow is not possible

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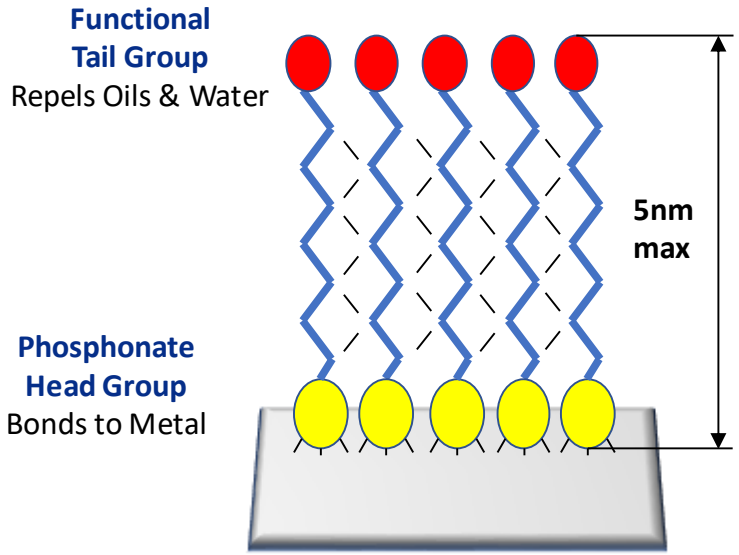
ORIGINAL TECHNOLOGY

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



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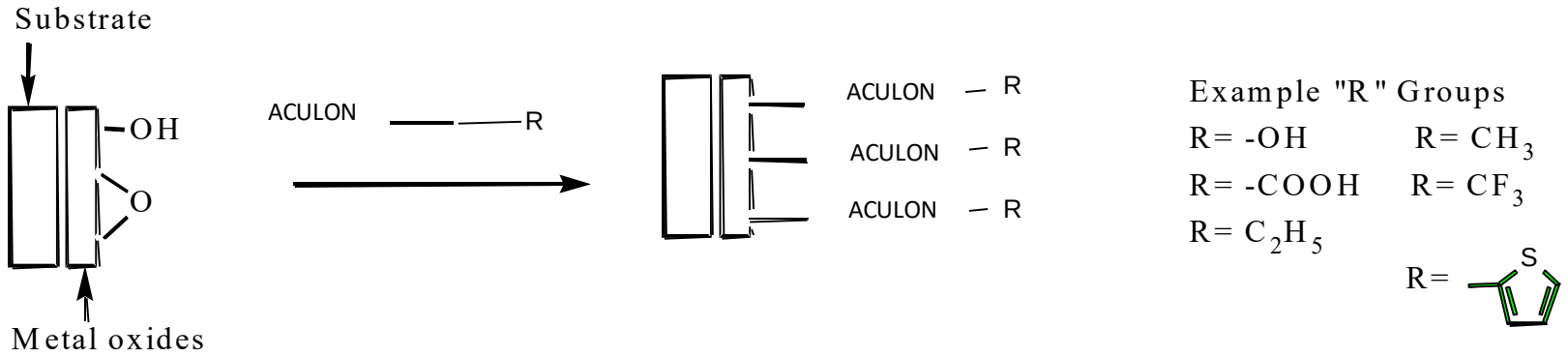
VERSATILE TECHNOLOGY



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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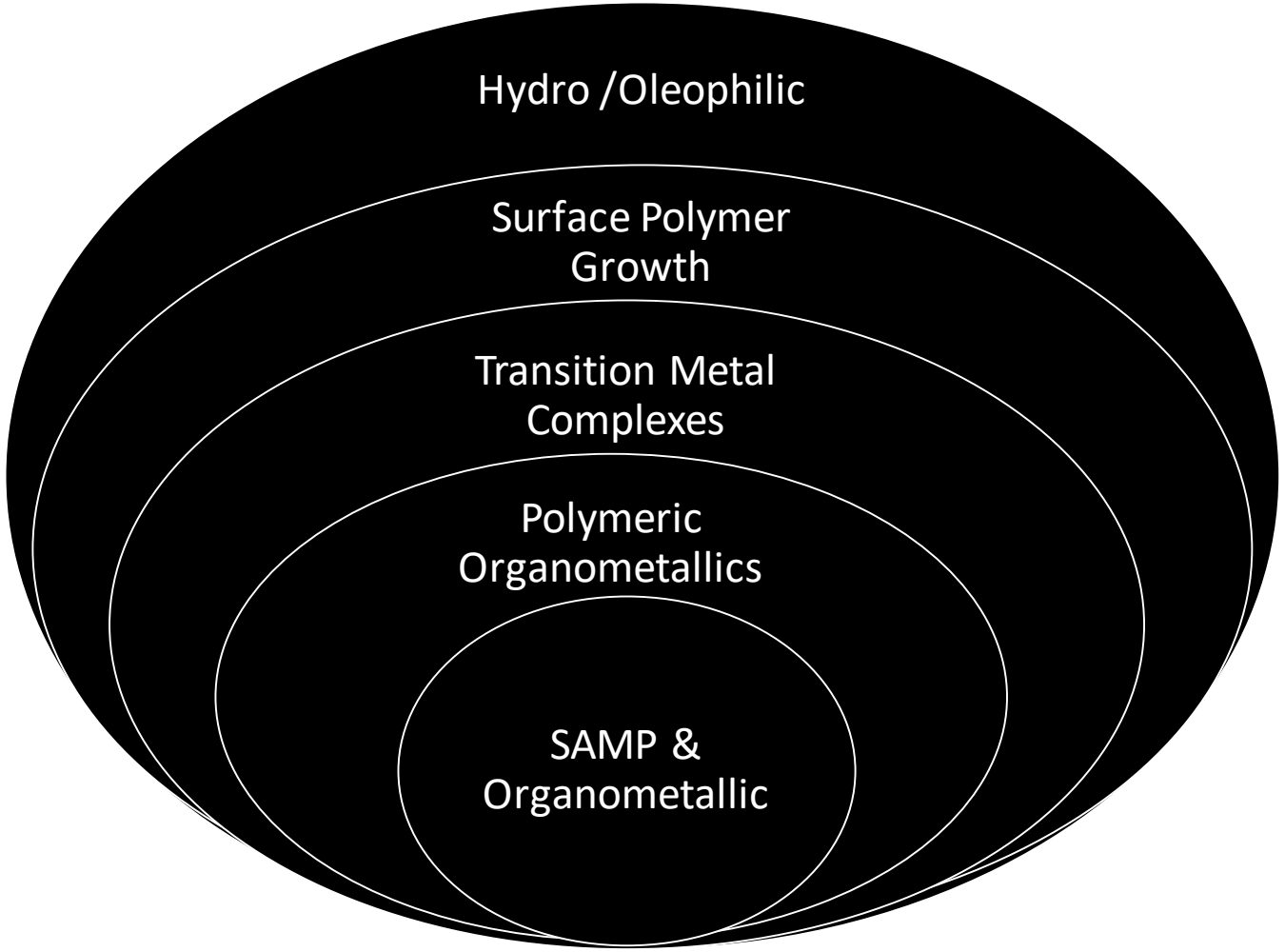
MANY SURFACE MODIFICATION PLATFORMS



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SUBSTRATE & CHEMISTRY MATCHING

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

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

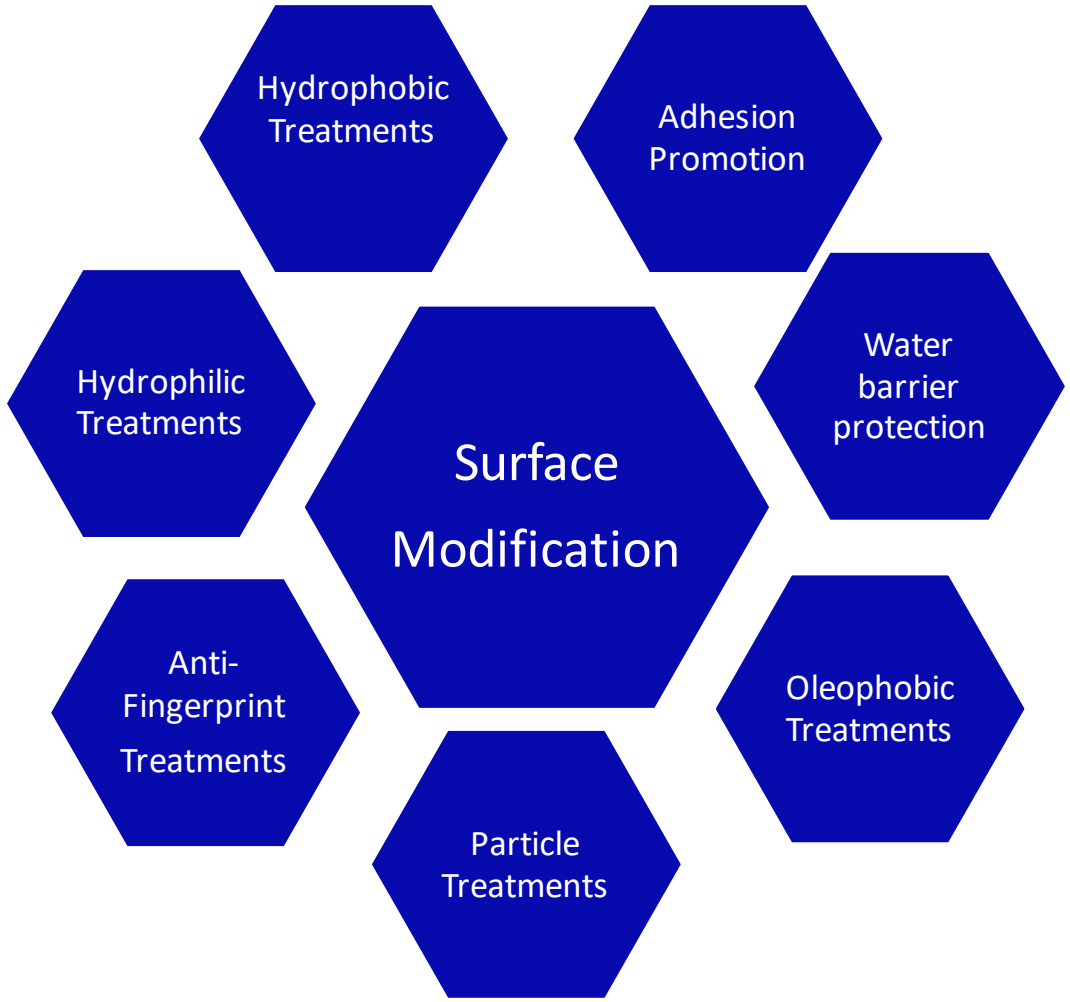
- Repellency
  - SAMPs
  - TMCs
  - Surface Growth Polymers
  - Polymeric Organometallics
- Adhesion
  - SAMPs
- Hydrophilic
  - Surface Growth Polymers
  - Hardcoats

Polymeric (non-oxide) Surfaces

- Repellency
  - TMCs
  - Polymeric Organometallics
- Adhesion
  - Not Available
- Hydrophilic
  - Hardcoats

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

EXPERTISE AND PLATFORMS



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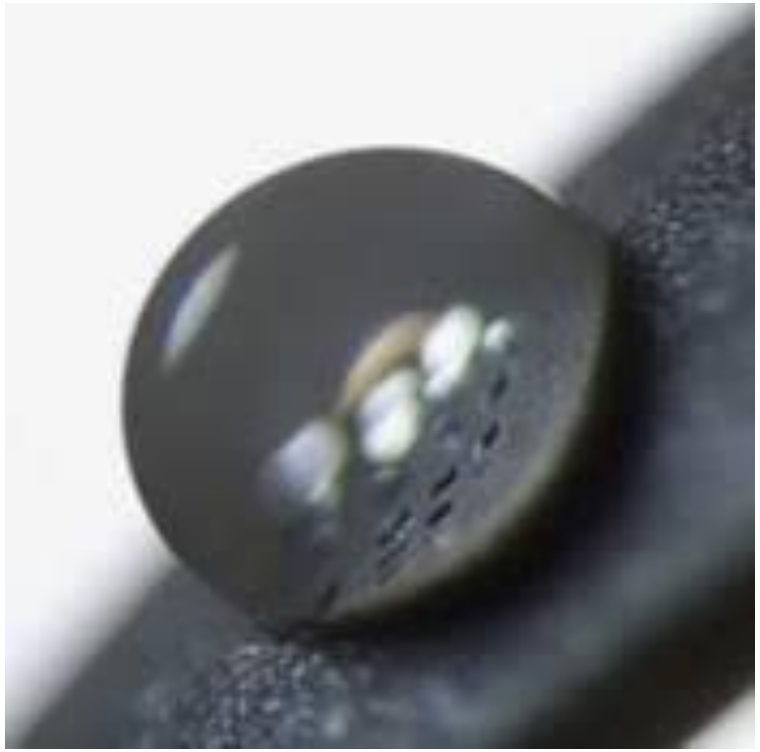
HYDROPHOBIC TREATMENTS

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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OLEOPHOBIC TREATMENTS

Variety of surface modification technologies impart oleophobic properties on surfaces:

- **Repel nearly any liquid**
  - Reduce contamination, repel oils & water, surfaces easier to clean
  - Oleophobic >60°
- **Optically Clear**
  - Ultra thin and optically clear coatings leave surface appearance and feel intact
- **Broad Application Base**
  - Broad variety of applications/industries benefit from oil repelling surfaces

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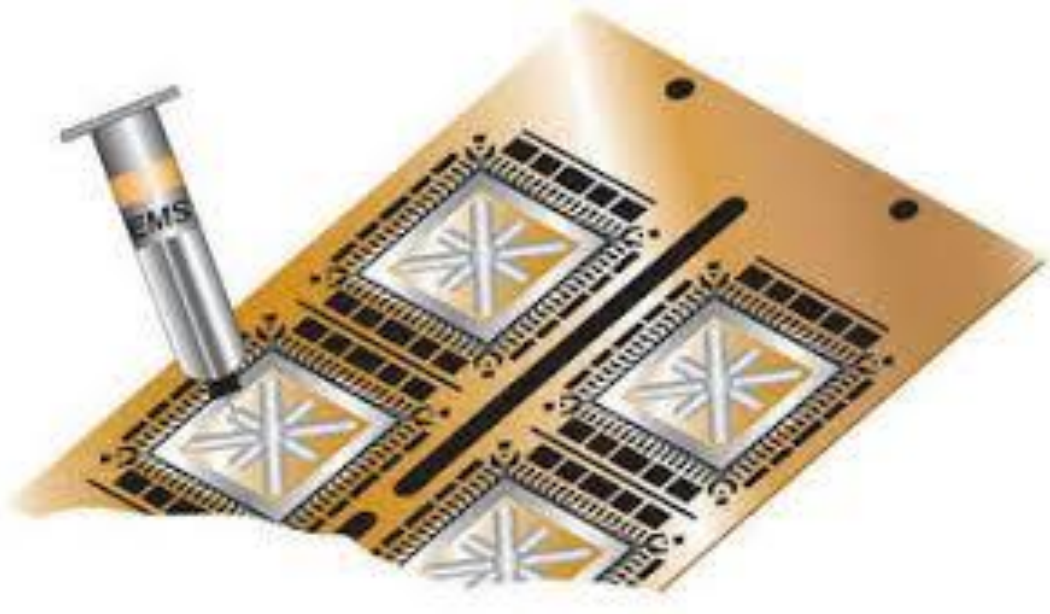
Adhesion Promotion

Improve adhesive and bonding characteristics of oxide containing substrates:

- **Functionalize Surfaces Directly**
  - By directly functionalizing the substrate surface, delamination and adhesive failure are reduced
- **Reduce Thickness**
  - Traditional roughening for adhesion can be eliminated
- **Flexible**
  - Compatible with numerous oxide containing substrates & variety of functional adhesives



HYDROPHILIC TREATMENTS

Functionalize variety of surfaces to increase surface energy and improve water wetting (hydrophilic) characteristics:

- **WCA <10°**
  - Water wets and spreads uniformly across functionalized surface
- **Optically Clear**
  - Ultra thin treatments are optically clear and do not impact surface appearance or feel
- **Durable**
  - Depends on the application

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PARTICLE TREATMENTS

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

- **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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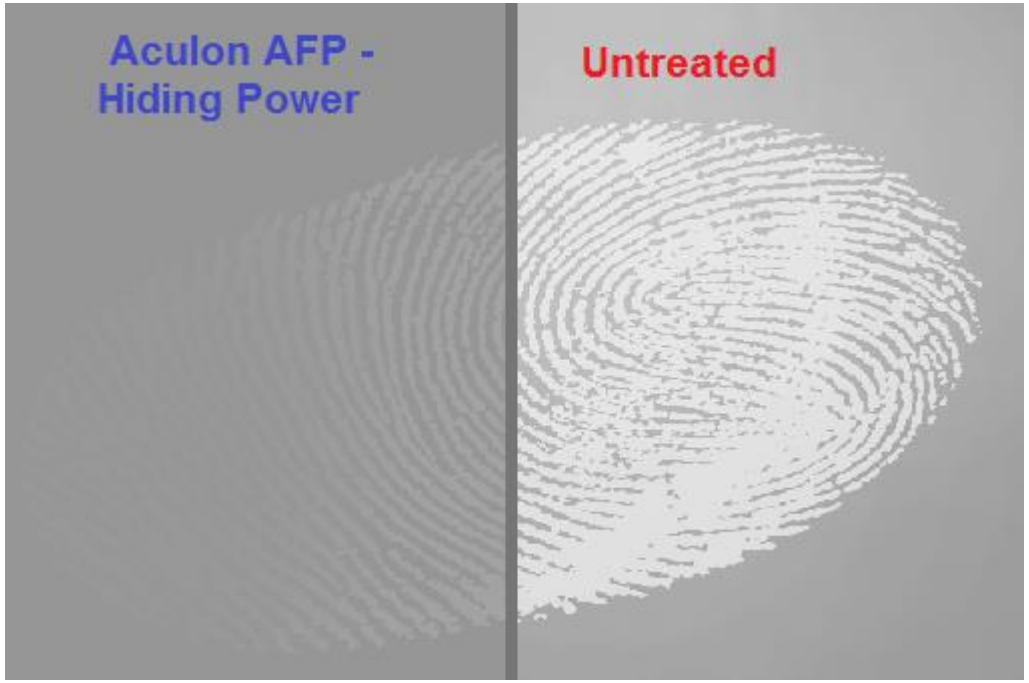
AFP COATINGS – HIDING POWER

Extremely thin optically clear AFP – Hiding Power treatments are applied to the surface which:

- **Hide the oil of the fingerprint**
  - Allow light to pass, significantly reducing its appearance
- **Durable**
  - Robust coatings offer ongoing AFP performance after normal handling



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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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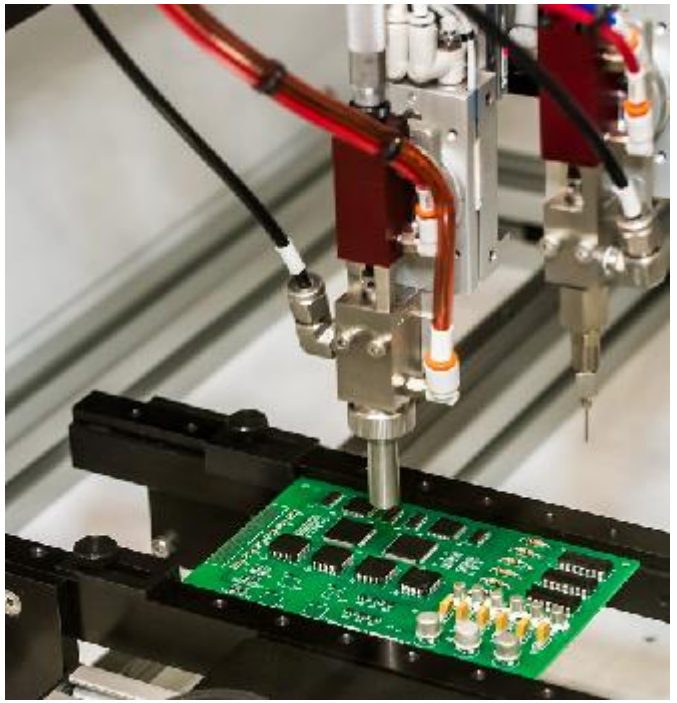
TECHNOLOGY APPLICATION

The application process depends on the application but can include:

- Dip Applied
- Spray Applied
- Wipe Applied
- Roll to Roll



Parameters:

- Concentrations
- Solvent
- Coverage
- Temperature

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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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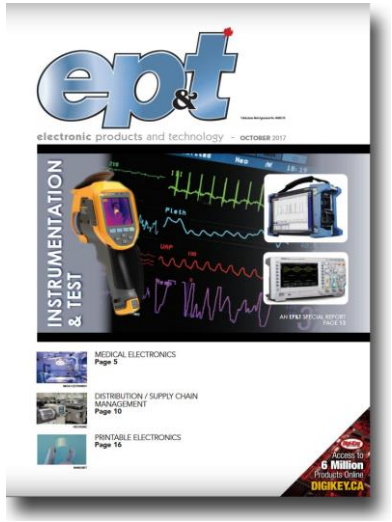
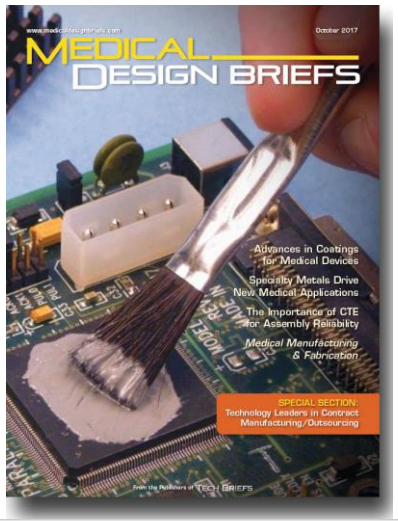
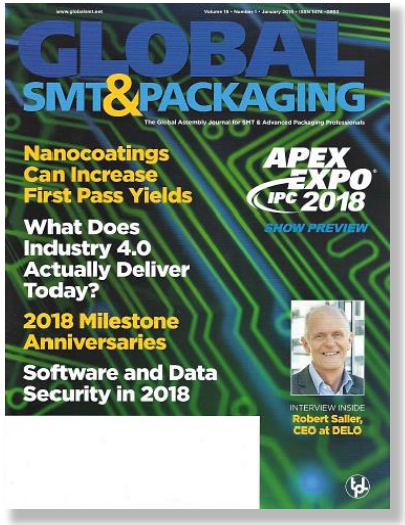
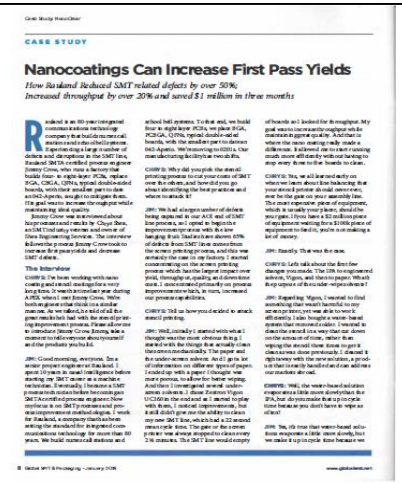
NANOCLEAR MEDIA COVERAGE








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

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Feature Interview by Stephen Las Marias

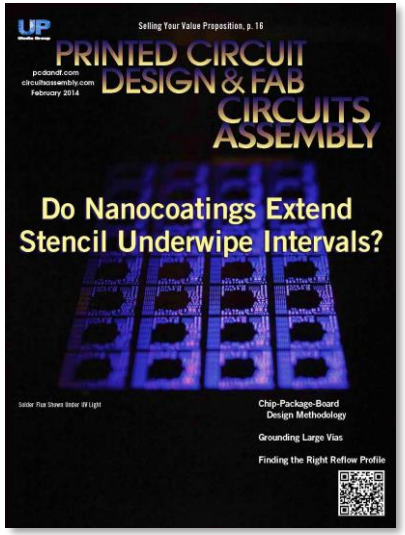
Aculon Inc. commercializes unique surface coatings leveraging nanotechnology and other surface modification techniques. The company's original focus was the optical industry, developing treatments of prescription eyewear, sunglasses and other optics. In 2010, the company launched its electronics business, 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.

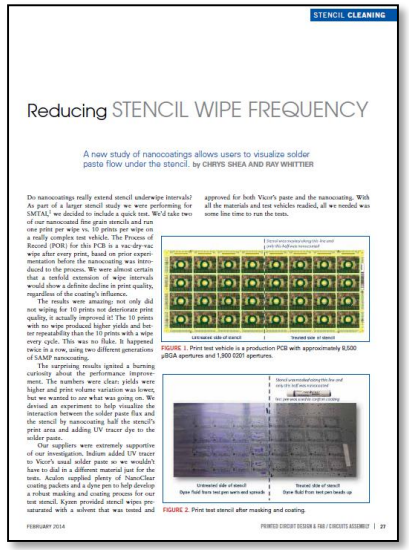
In an interview with *SMTOO7 Magazine*, Aculon Chairman and CEO Edward Hughes speaks about addressing their customers' challenges and ensuring customer satisfaction.

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 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.

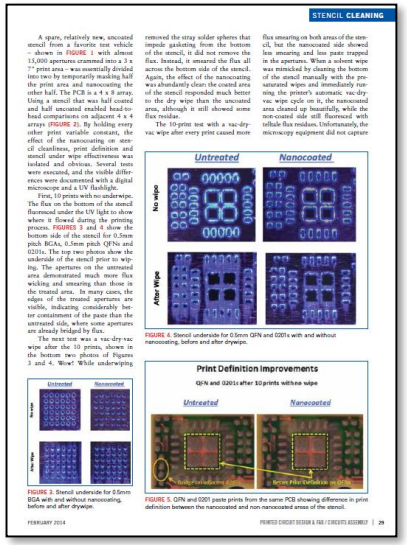
For NanoClear, we added repellency functionality to stencils that paybacks in hard savings in generally less than 200 prints. As a result, our customers enjoy dramatic improvements in first pass yield and lower consumables costs for an investment of less than $50 per stencil. For NanoProof, we are providing 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.




STENCIL CLEANING

Reducing STENCIL WIPE FREQUENCY

A new study of nanocoatings allows users to visualize solder paste flow under the stencil. by CHRYS SHEA AND RAY WHITTIER


STENCIL CLEANING

A spare, relatively new, uncoated stencil from a favorite test vehicle is shown in FIGURE 1 with almost 15,000 apertures crammed into a 3 x 7" print area – was essentially divided into two by temporarily masking half the print area and nanocoating the other half. The PCB is a 4 x 8 array. Using a stencil that was half coated and half uncoated enabled head-to-head comparisons on adjacent 4 x 4 arrays (FIGURE 2). By holding every other print variable constant, the effect of the nanocoating on stencil cleanliness, print definition and stencil under wipe effectiveness was isolated and obvious. Several tests were executed, and the visible differences were documented with a digital microscope and a UV flashlight.

First, 10 prints with no underwipe. The flux on the bottom of the stencil fluoresced under the UV light to show where it flowed during the printing process. FIGURES 3 and 4 show the bottom side of the stencil for 0.5mm pitch BGAs, 0.5mm pitch QFNs and 0201s. The top two photos show the underside of the stencil prior to wiping. The apertures on the untreated area demonstrated much more flux wicking and smearing than those in the treated area. In many cases, the edges of the treated apertures are visible, indicating considerably better containment of the paste than the untreated side, where some apertures are already bridged by flux.

The next test was a vac-dry-vac wipe after the 10 prints, shown in the bottom two photos of Figures 3 and 4. Wow! While underwiping removed the stray solder spheres that impede gasketing from the bottom of the stencil, it did not remove the flux. Instead, it smeared the flux all across the bottom side of the stencil. Again, the effect of the nanocoating was abundantly clear: the coated area of the stencil responded much better to the dry wipe than the uncoated area, although it still showed some flux residue.

The 10-print test with a vac-dry-vac wipe after every print caused more flux smearing on both areas of the stencil, but the nanocoated side showed less smearing and less paste trapped in the apertures. When a solvent wipe was introduced by cleaning the bottom of the stencil manually with the pre-saturated wipes and immediately running the printer's automatic vac-dry-vac wipe cycle on it, the nanocoated area cleaned up beautifully, while the non-coated side still fluoresced with telltale flux residues. Unfortunately, the microscopy equipment did not capture

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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

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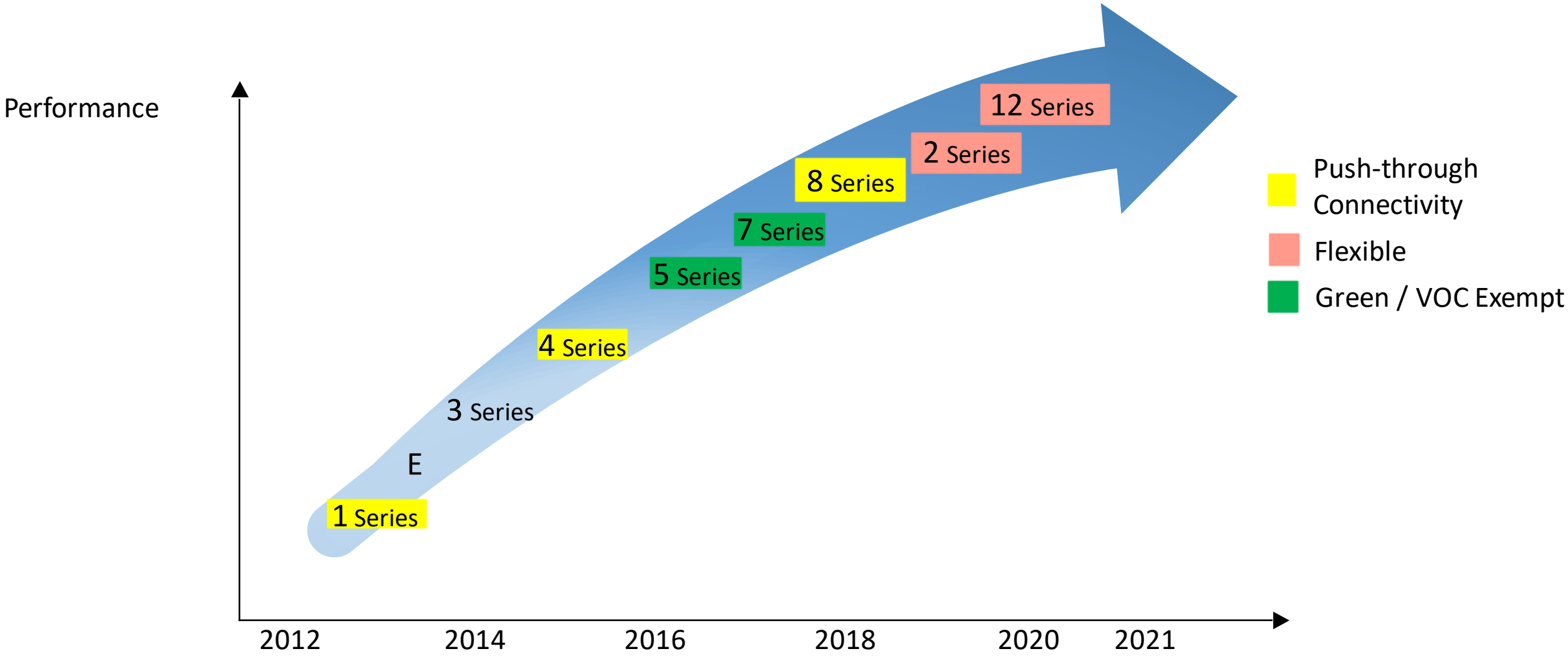
NANOPROOF® SERIES

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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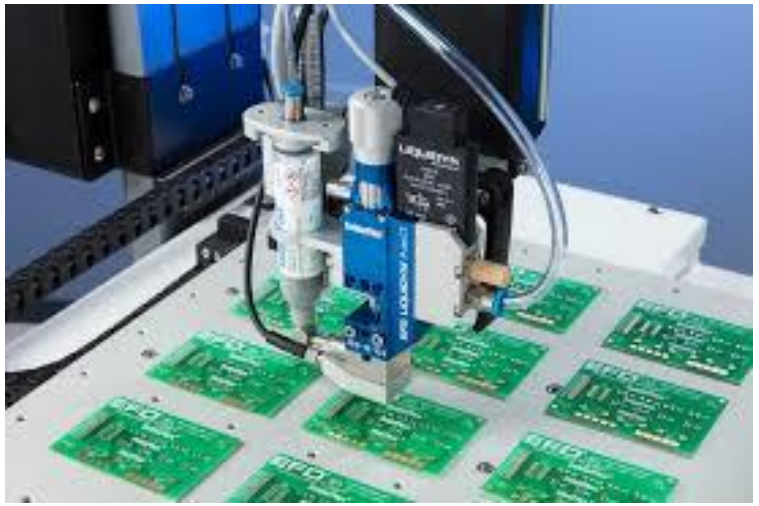
NANOPROOF® TECHNOLOGY APPLICATION

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

Spray



Jet or Dispense

Dip

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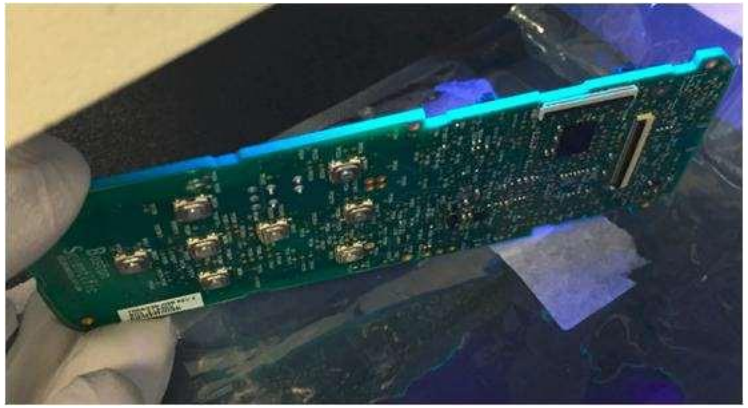
EASY VISUAL INSPECTION

NanoProof material can be inspected by automated or handheld UV inspection system



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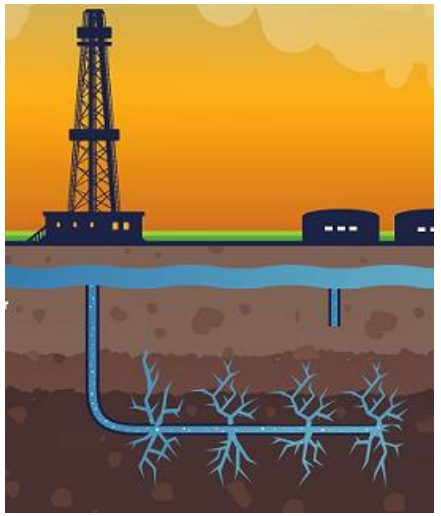
OIL & GAS

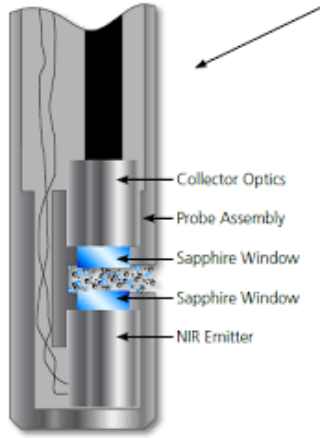
APPLICATIONS



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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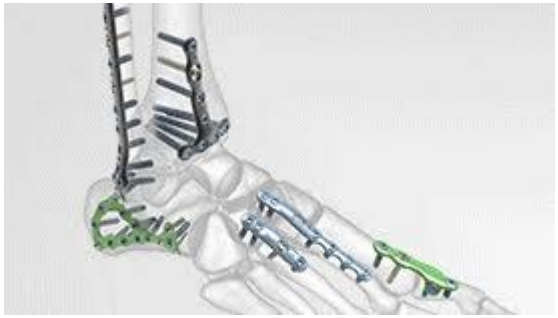
SPECIALTY EXAMPLES

OAKLEY

ALCOA

DURA-BRIGHT®

EVO WHEELS



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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

PERFORMANCE. SURFACE. SOLUTIONS

THANK YOU

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