



Surfaces are Key to Product Quality

Applying Water Contact Angle with Brighton Science



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Hosts: The Product Quality Cleaning Workshop Team



Barbara and Ed Kanegsberg - "The Cleaning Lady and the Rocket Scientist"

- BFK Solutions - Consultants in Critical Cleaning
- Authors and Editors of the two-volume CRC Handbook for Critical Cleaning
- Independent evaluations and recommendations
- Co-chairs of the Product Quality Cleaning Workshops
- barbara@bfksolutions.com and ed@bfksolutions.com



Darren Williams - "The Professor"

- Professor of Physical Chemistry at Sam Houston State University
- Leader of the Cleaning Research Group
- Co-chair of the Product Quality Cleaning Workshops
- Performs cleaning trials and formulates cleaning chemistries
- williams@shsu.edu



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Our Speakers




Lucas Dillingham - Applications Team Leader

- Leads the Brighton Science Applications team delivering Surface Intelligence to manufacturing organizations around the world.
- 12+ years of materials science experience
- Creates specifications and workflows
- Gives expert advice on surface preparation techniques
- Helps clients discover those non-obvious variables that reduce lost time, wasted material, and undue warranty cost.

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Applying Water Contact Angle: Increasing Manufacturing Excellence Along the Product Lifecycle

December 5, 2023

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What Are We Talking About Today?

- **Surfaces are more important to modern manufacturing than ever**
- **Supply Chains are shifting**
- **Consumers demand more quality and less waste**
- **Leaders in Mfg have the opportunity to leverage new data tools to**
 - Build competitive advantage
 - Organizational Competency
 - Build better product, for less cost, and less risk

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Agenda

- **About Brighton Science**
- **Introducing the Problem**
 - Surfaces affect the entire product lifecycle
 - They cost your company time and money without you realizing
- **How do we talk about surfaces?**
 - What is the common language we should be using?
- **Three Applications of new technology**

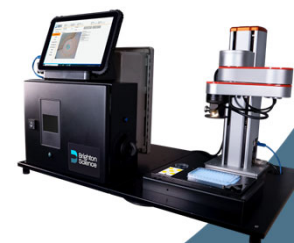
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About Brighton Science?

- Materials Science Company with 30 years of experience solving Surface Critical challenges in MFG
 - Cincinnati, OH and Minneapolis, MN
- Our patented technology was developed in conjunction with the Air Force Research Lab and Lockheed Martin to measure surface conditions in producing the F35 fighter jet and supporting the fighter wherever it is surface, air depot to Air Force carrier
 - Software, Hardware, Consulting
 - Full Surface Analysis laboratory (XPS, FTIR, LIBS, XRF, UTC, Surface treatment)
- Our PhD materials scientists work with customers to apply the data to their specific challenge



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About Brighton Science

- **Roots in the aerospace industry**
- **Our scientists & engineers developed a tool to take Water Contact Angle readings in the field**
- **Patented the technology that works in the real world**
 - Wide range of materials
 - Wide range of environments
- **Deployed in support of F35 ten years ago**
- **Now used by over 450 of the worlds leading manufacturers**

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For more than 20 years, we have been using our knowledge, experience, and technology to help some of the most successful brands in the world

90% of our customers' issues related to adhesion, cleaning, and coating were driven from not having critical surface readiness information in their processes ... *until now.*



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Over the past 10 years, we have learned something that gives our customers an advantage in cost, quality and speed:

Our Unique Position:

With a mobile measurement tool, and advanced technical knowledge, over the past 10 years Brighton has worked closely with hundreds of customers on thousands of problems.

We Have Learned:

That complex *environmental circumstances* and *human choices* regularly compromise optimal design and manufacturing of products that involve chemical bonding, coating and sealing throughout the product lifecycle.

Our Solution Is:

A technology that provides visibility to surface readiness by bringing a detection to the point of preparation. Unlike systems that are limited to the lab, our solution collects and shares that data across functions, processes and companies.

So That:

The community of designers, scientists and engineers may accelerate the growth of their knowledge of effective surface control and improve their ability to coordinate and cooperate in applying that creativity to bring greater innovation and productivity for the world.

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Brighton Science Strategy is to Focus on Helping Customers Leverage *Surface Intelligence*

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Surface Analyst Product Line

BConnect	5001	7001-DS	7001-AC	7001-Kit


The Brighton Science progression of inspection products: manual to 100% inspection



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The Scope of the Problem

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Surface Critical Failure Happens Everyday



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....And It Reaches The Market

Tesla told to recall 12,300 Model X SUVs over trim adhesive

The request comes from Germany's KBA, which is the equivalent of NHTSA in the US.

Andrew Ross | 14h 15, 2023 6:44 AM PT



These pieces that fly off in transit could cause big issues for other vehicles. The reason is because...

Nissan Is Recalling Nearly 400,000 Vehicles Over Potential Fire Hazard

November 10, 2023 4:40 PM ET

PAUL D'AGOSTA



Manufacturers in North America are often criticized for not doing enough to protect consumers from safety risks. Nissan is...

The Ford Bronco roof problem is getting worse. Some production was delayed

November 10, 2023

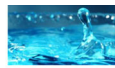
PAUL D'AGOSTA



Siemens Energy tumbles after warning of wind turbine component failures

Published: 08:32 23 Jun 2023

Analysts said they expect the manufacturers' warranty obligations will cover any issues for wind farm owners



Forward Water Technologies seeks to turn wastewater into clean

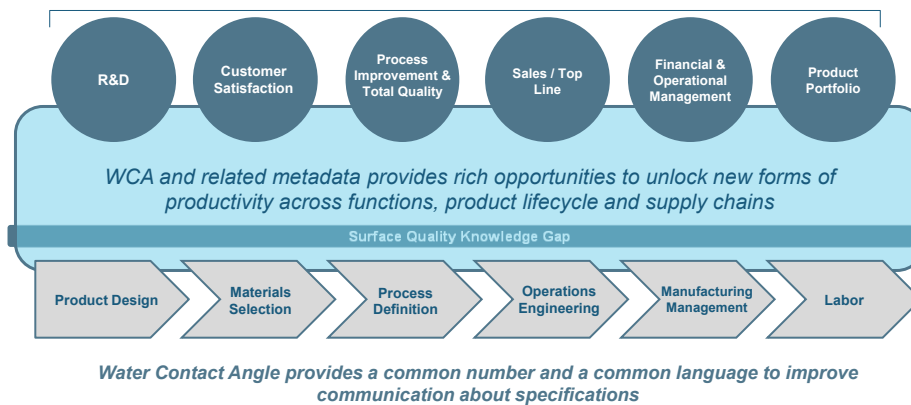
Air Taxis Keep Crashing, Bursting Into Flames in Testing Phase

Little-noticed accidents have struck leading companies. The industry says it's driving and that failure is necessary.



July 10, 2023 10:00 AM EDT. Source: July Aviation Inc.

The Surface Quality Knowledge Gap





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Surface energy: chemical reactivity of a surface

(energy/bond) x (# bonds/unit area) = energy/unit area: **Surface Energy**

Newly created
~1 J/m²

Seconds later
~0.1 J/m²

Minutes to hours later
~0.05 J/m²

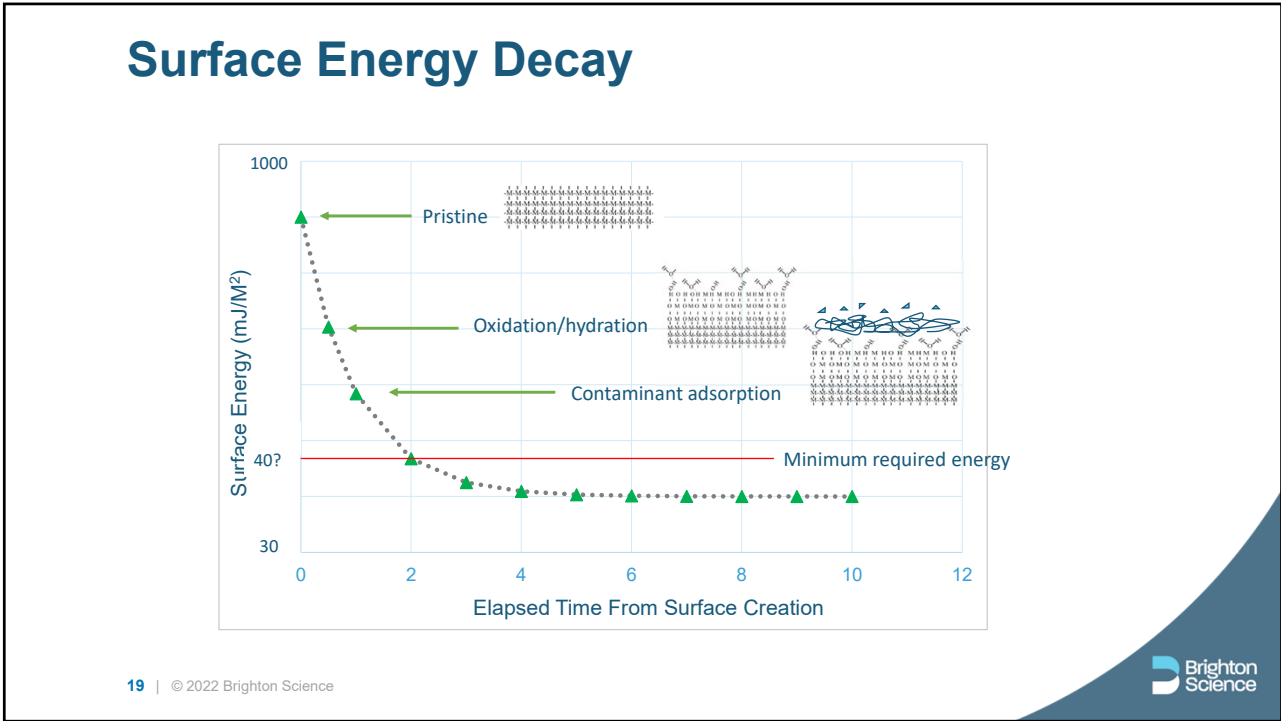
Hard material:
Metal, ceramic, glass

- **Surface created by fracture or chemical treatment is not in equilibrium**
 - Radicals (unpaired electrons); strained bonds
- **Extremely reactive:**
Reactivity = chemical potential = *surface energy*
- **Adhesion: interaction of adhesives, inks, coatings with these reactive sites through primary (covalent) or secondary (van der Waals) bonds**

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Brighton Science

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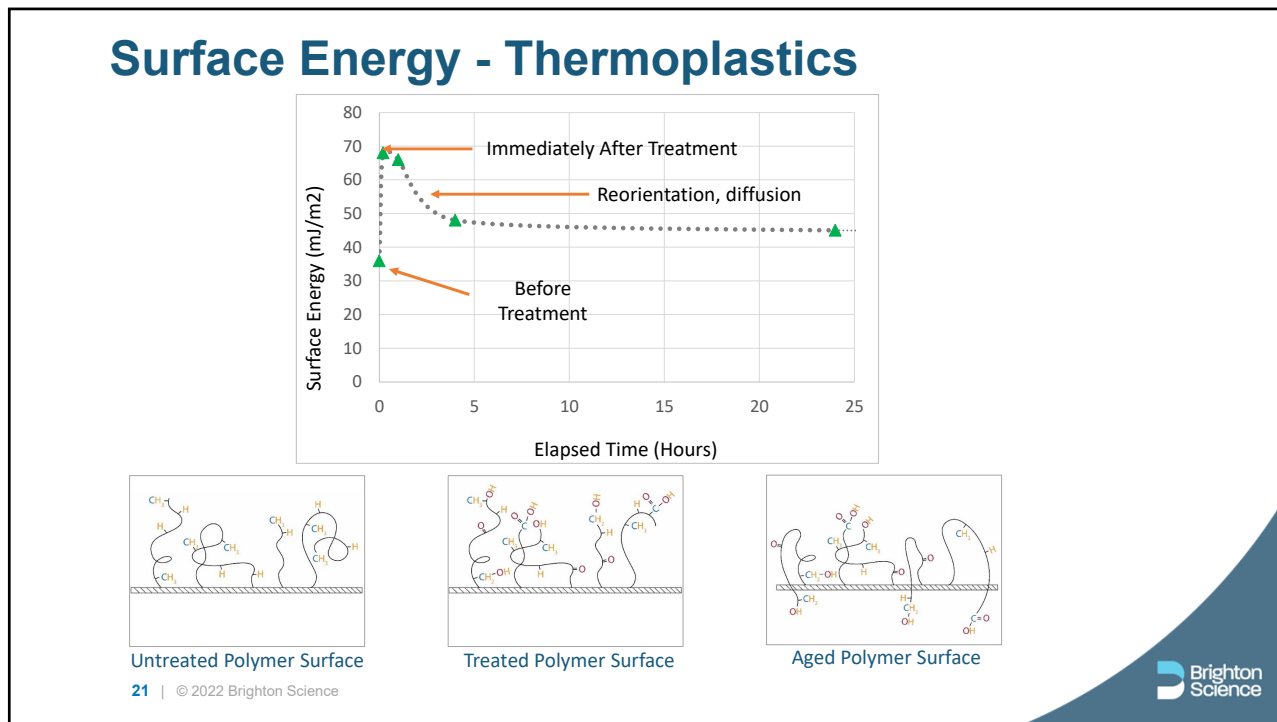
Surface Energy - Thermoplastics

Viscoelastic (polymeric, soft) materials:

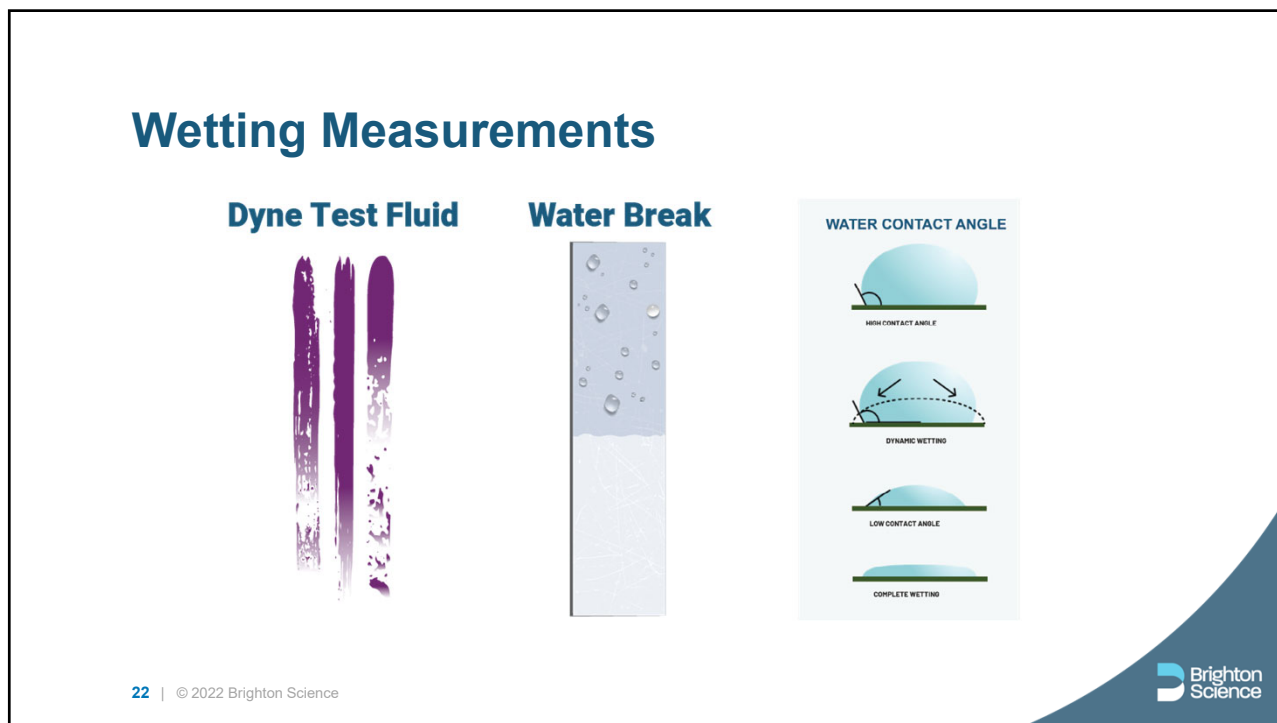
- Fewer broken bonds: low chemical potential (surface energy)
 - Slow or no reaction with environment: stable
 - Frequently require surface treatment for adhesion of paints, adhesives
- High molecular mobility; high free volume
 - Substances can diffuse from bulk to surface (intrinsic contamination)
 - Substances can diffuse from surface to bulk
 - Treatments tend to decay over time

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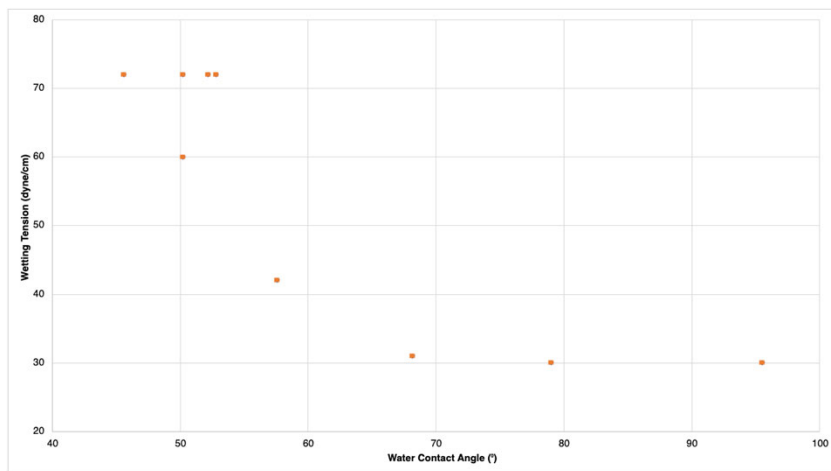


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Why change? Dyne Inks are not sensitive enough

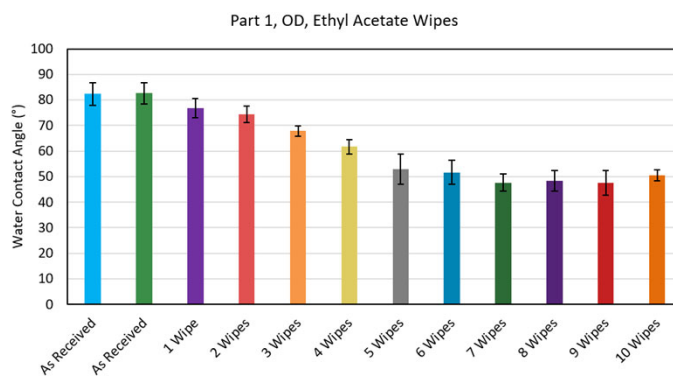


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WCA Correlates To Fundamental Methods



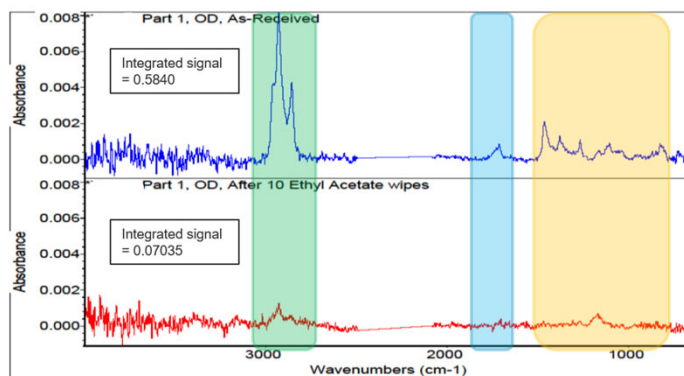
- "As Received" contact angles were very high (ca. 82°)
- CA consistently reduces with each additional wipe, eventually plateauing after 7 wipses
- 7 cycles of wiping were needed to remove the contaminant, with a contact angle of ca. 50° represents a cleaned part
- This is common behavior for parts that have hydrocarbons "adhered" to the surface
- A well designed ultrasonic cleaning and etching process should be able to replicate these contact angles

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Solvent Cleaning Metals: Brighton Science WCA vs FTIR

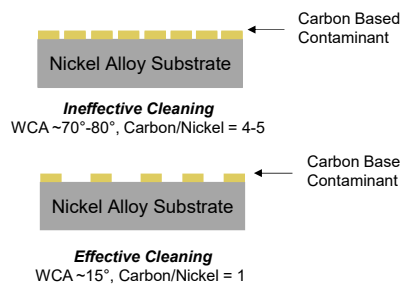
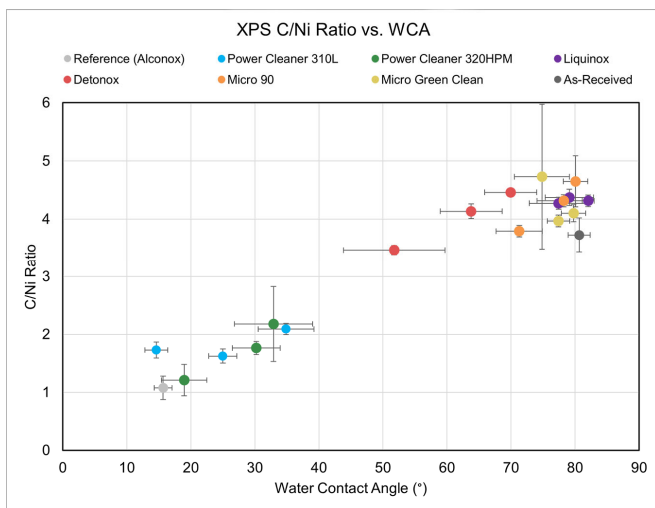


- The peaks in GREEN (ca. 3000 cm⁻¹) indicate hydrocarbons (contamination-need to learn more about your or manufacturers process)
- The peaks in BLUE (ca. 1730 cm⁻¹) indicate carbonyls (polar compounds)
- The peaks in ORANGE (ca. 1450-800 cm⁻¹) are a potential match for silicone (nonpolar compounds)
- Integration of the GREEN region indicates a reduction of hydrocarbons by 88%
- The BLUE and ORANGE regions are effectively removed upon wiping.
- Together, these observations suggest that hydrocarbon (e.g. an oil) remains after wiping, while the polar species and possible silicone were removed. This remaining signal is a very small amount that is typical on a well-cleaned part exposed to the atmosphere



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Water Contact Angle Correlates Directly to Surface Chemical Composition (Chemical Cleanliness)



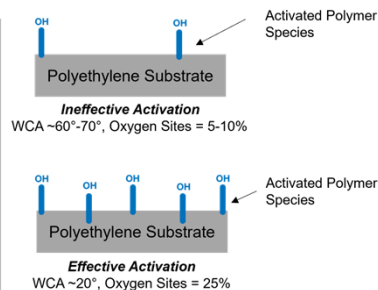
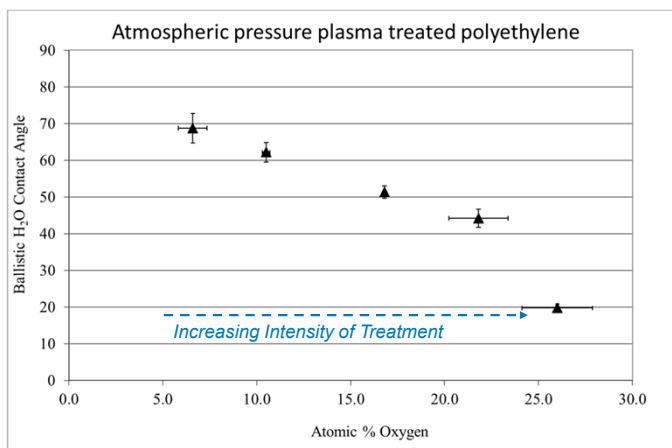
Real Time, Objective, Technical Cleanliness Data in the Hands of:

- Designers
- Managers
- Operators of Adhesion Processes



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Water Contact Angle Correlates Directly to Surface Chemical Composition (*Treatment level*)



Real Time, Objective, Surface Chemistry Data in the Hands of:

- Designers
- Managers
- Operators of Paint Processes

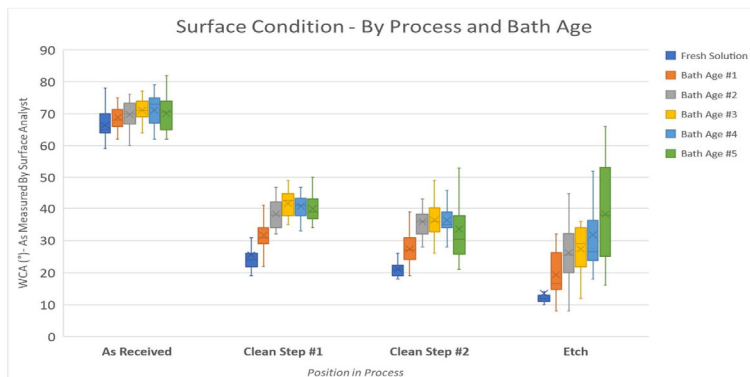
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Surface Variability – Pre-Treatment Process

- Comments on Process
 - Both soak and electro-cleaning processes contribute positively towards technical cleanliness
 - The etch process further drives the WCA value lower, but variance was observed
- Bath Degradation
 - Soak and electro-cleaning become less effective with time
 - Final etch process shows the most variance with degradation



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Three Applications

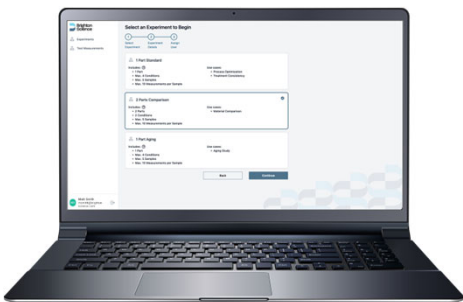


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BConnectSM

Combining Expertise, Experience, Equipment For You




Create

Design an experiment linked to your Brighton ID on your desktop.



Perform


Access your experiment and perform the required measurements.



Analyze, Share, Collaborate & Publish

...all through the cloud-based BConnect platform.

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SURFACE INTELLIGENCE IN ACTION CASE STUDY:

Enabling a process development team to overachieve deadlines

Client: Automotive Manufacturer

The Challenge

- As part of a new program and process for development of an electric vehicle, the client team had only four months in which to select a cleaning process for wire bonding of the battery module.

The Brighton Science Approach

- Using BConnect, the team was able to quickly select methods, test, develop a specification, and provide bond test results to correlate to a plasma cleaning step.

The Solution

- In half the allocated time, the client's development team was able to successfully provide a specification for the manufacturing engineering team. This was then written into the specification for production.

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SURFACE INTELLIGENCE IN ACTION CASE STUDY:

Maintaining Quality in Production through WCA as KPI

Client: Aerospace Manufacturer

The Opportunity

- Reduce scrap, Improve Yield, Improve Quality

The Brighton Science Approach

- Institute a quality check after cleaning the aircraft before bonding.

The Solution

- The certification process was updated to include validation with surface cleanliness data. Further, training and measurement immediately after cleaning, fixed the discrepancy between operators, eliminating employee-induced spikes in scrap. By using real data to mitigate risk and change behavior, scrap rates were immediately reduced by multiple percentage points.

"We finally took the organic out of the mechanic!" Senior M&P Lead

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SURFACE INTELLIGENCE IN ACTION CASE STUDY:

Unlocking New Opportunities Along A Supply Chain

Client: Manufacturer/Vendor of “Smart Mirrors”

The Opportunity – mitigating risk and preventing failure

- Large-scale failure was occurring where the pc/abs backing plate was delaminating from the glass during thermal shock testing. This issue was straining the relationship with the OEM, delaying acceptance, incurring major personnel time, and amping up costs.

The Brighton Science Approach

- After parts were scanned, the presence of a contaminant was immediately detected. Exploration of the supply chain uncovered that the supplier of the backing plate had begun using WD40 on the injection molded tooling surface to prevent rust.

The Solution

- The specification and contract were amended to include QC checks at the supplier before shipping to the OEM. Failures ceased.

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What did we talk about today?

- **Introducing the Problem – surfaces affect more than you think!**
 - Surfaces affect the entire product lifecycle
 - They cost your company time and money without you realizing
- **How do we talk about surfaces? Chemistry Matters!**
 - What is the common language we should be using - WCA

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What did we talk about today?

- **Surfaces are more important to modern manufacturing than ever**
- **Supply Chains are shifting**
- **Consumers demand more quality and less waste**
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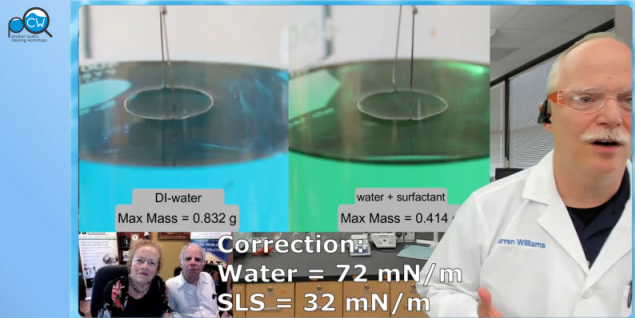


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PQCW - Workshops for Terrific Products


- “While I would prefer to have been at in-person laboratories so I could have hands-on experiences with cleaning processes, **I really liked the two-week virtual PQCW.**”
- “People with different functions within our company, including Strategic **Sourcing**, Project **Management**, and **Manufacturing Engineering**, attended.”
- “We learned a lot; and we have made changes. We are **refining our own cleaning** requirements and putting together training programs.”
- “For example, we used the workshop to develop **black light testing and fixtures**; and we have already set up a one-hour “**Parts Washing 101**” training course.”
- “The section about **EPA amended TSCA had useful, timely information.**”
 - Christian Johnson, Engineer, Yaskawa, participant, PQCW21




Demo: Surface Tension Measurement



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PQCW On-Demand Workshop on Aqueous Cleaning



- Half day on-line program
- Includes 30 minutes individualized live consulting with a PQCW Instructor
- Convenient training modules
- Continuing education credit / certificate
- The Product Quality Cleaning Workshop Team
 - Barbara Kanegsberg, BFK Solutions
 - Ed Kanegsberg, PhD, BFK Solutions
 - Professor Darren Williams, Sam Houston State U.

Go to www.shsu.edu/pqcw to sign up for the course!

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Thank you for attending

We welcome your questions



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