



Getting Started with Atmospheric Plasma Surface Treatment



THANK YOU FOR DOWNLOADING

Getting Started with Atmospheric Plasma Surface Treatment

One of the most important requirements for adhesion is the condition of the surface prior to **bonding with inks, coatings & adhesives**.

In-line atmospheric plasma treating systems are proven to **improve adhesion** properties on a wide variety of surfaces.

Benefits of in-line surface treatment include **stronger bonds**, faster line speeds, and improved product quality.

This eBook covers the basics of **plasma surface treatment** and the technologies available for specific applications.

Thank you for your trust.

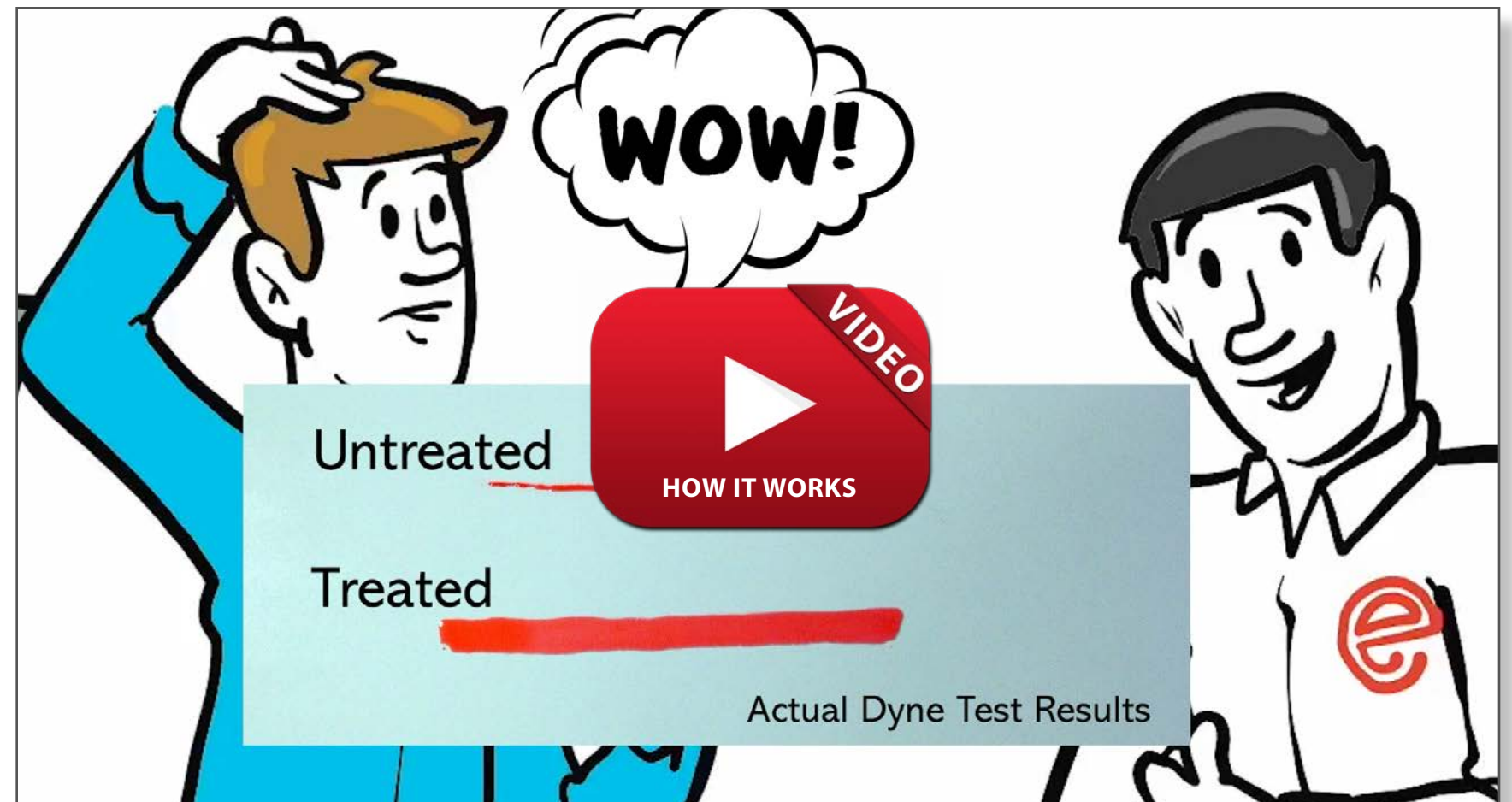


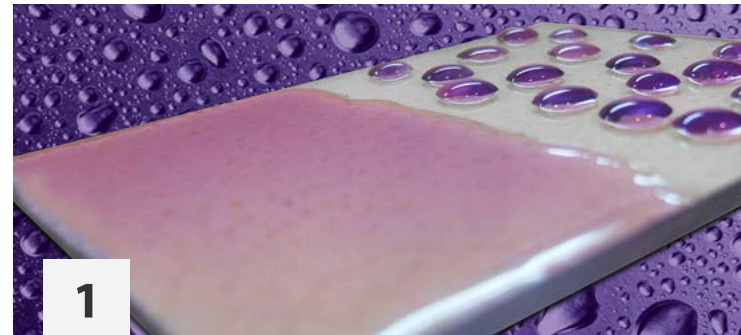
How Plasma & Flame Surface Treating Works – Explainer Video

Sam is a Quality Engineer at Stick-It Inc. and he is having trouble with the adhesive bonding and printing of his manufactured parts. The adhesives won't stick and the ink rubs off! He needs to find a solution quick and decides to call Enercon for help.

**FOLLOW SAM THROUGH HIS
JOURNEY OF DISCOVERING HOW
PLASMA TREATING WORKS**

CLICK TO WATCH NOW!

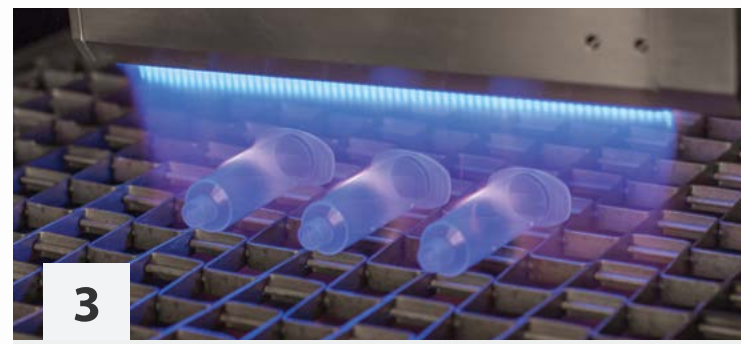


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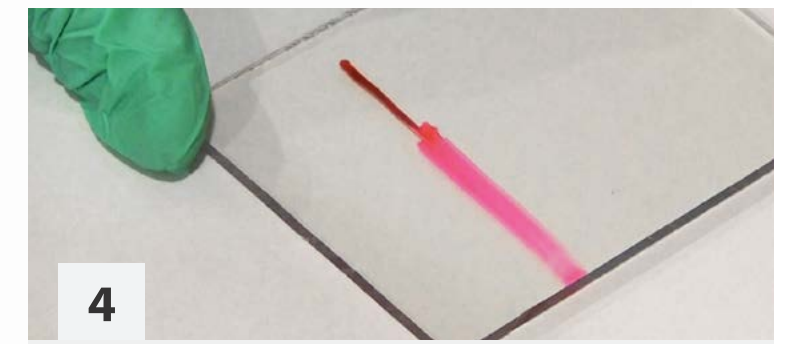
Why inks, coatings & adhesives need help bonding to surfaces



How does surface treatment promote adhesion?



What types of surfaces can be treated? >



How can I determine if surface treatment is successful?

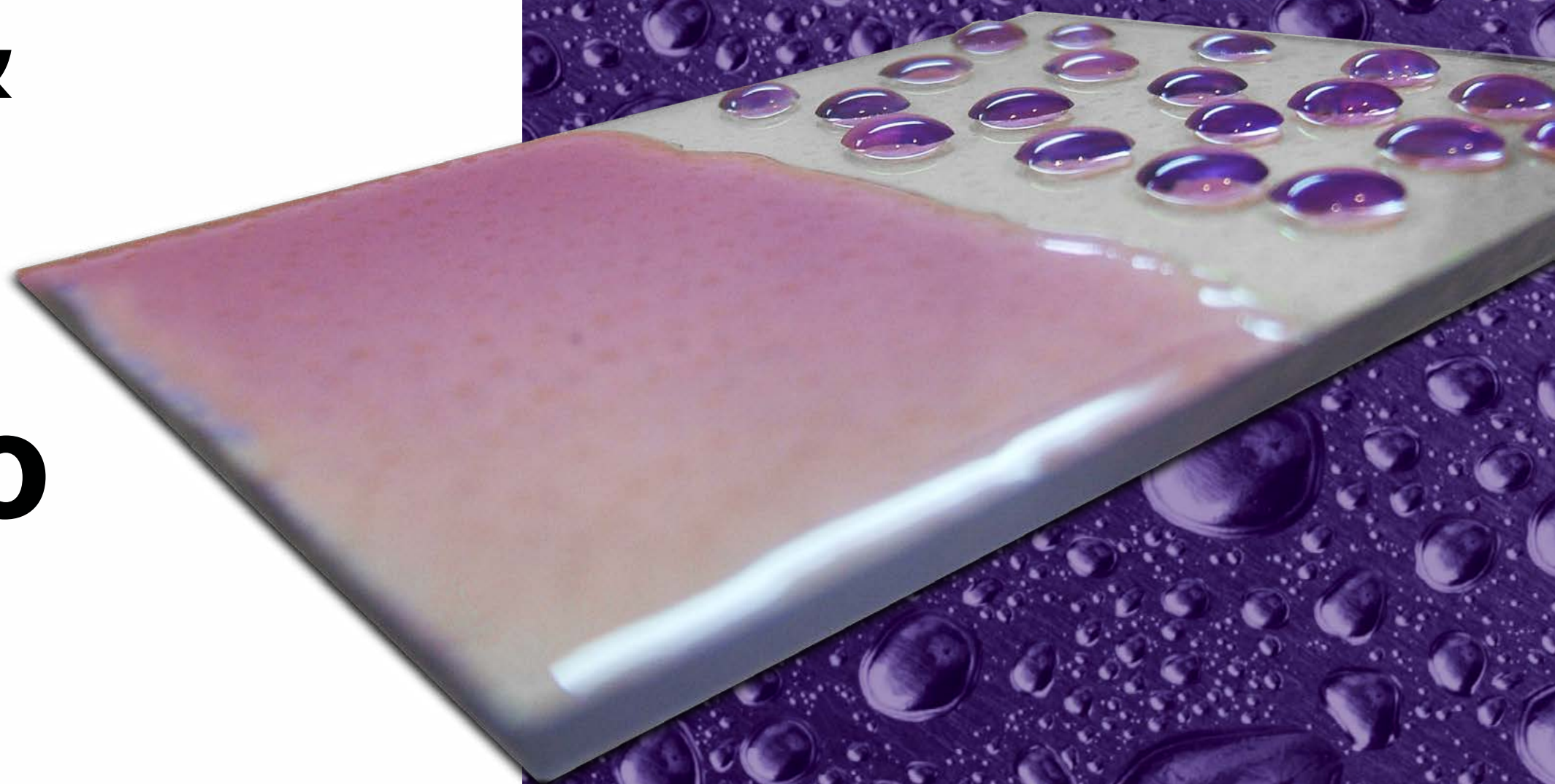


Plasma Technology Comparison



Next Steps : Review, Integration Options, Free Lab Trials

WHY INKS, COATINGS & ADHESIVES NEED HELP BONDING TO SURFACES



**Controlling surface variables is
key for successful adhesion**



Factors Affecting Adhesion Dynamics

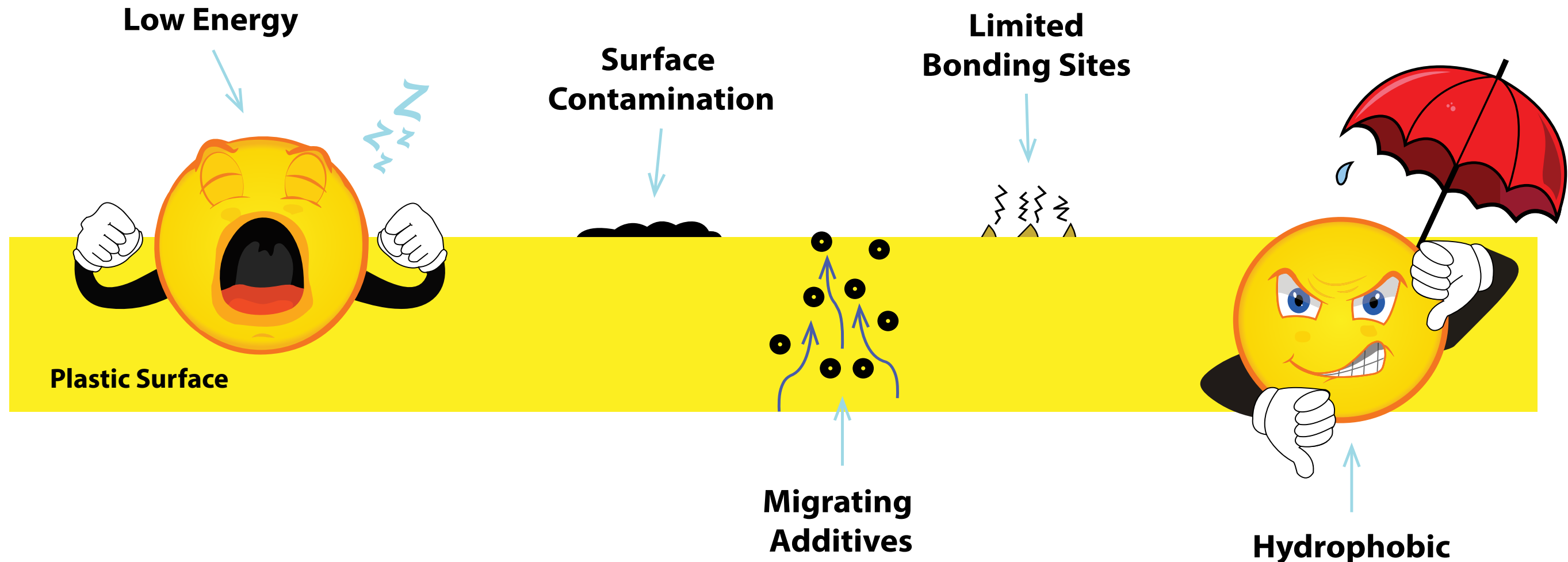
Material type
Performance-aiding additive load
Adhesive chemistry
Bond stress
Surface contaminants
Surface roughness
Surface chemistry

"I was very pleased with my experience, process and results of the Enercon lab trial. The lab gave me the option of doing a preliminary proof of concept to see if my idea would even work before jumping in too far."

Jeff Ignatowski *President*
CHAMPION PLASTICS



Common Adhesion Impediments Found on Plastic Surfaces



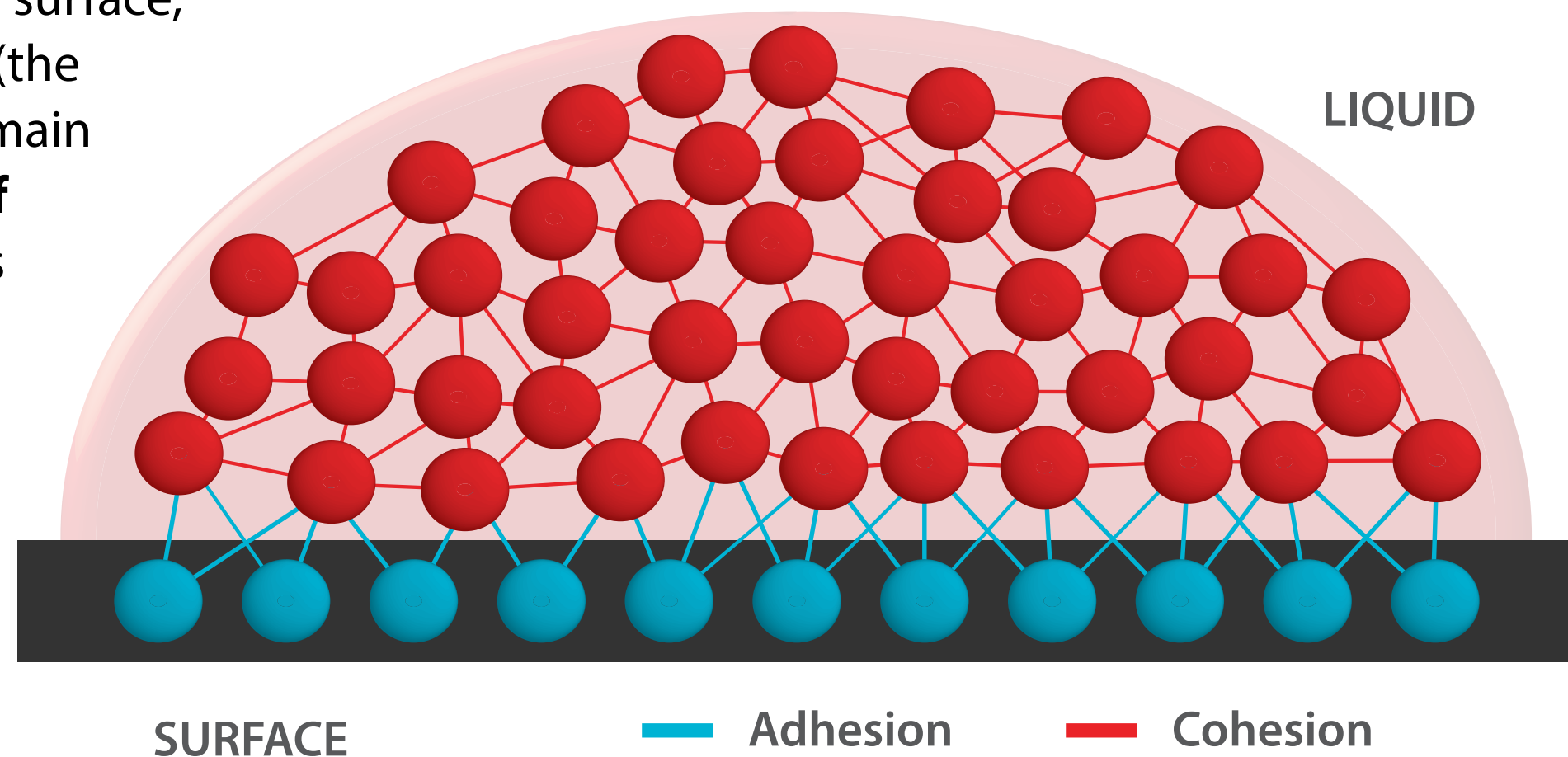
Plastics are generally composed of non polar, long-chain molecules, non porous, hydrophobic, & offer only a small amount of free energy. As such, plastics have few available bonding sites due to low levels of charged ions on the surface. Any type of surface contamination will have a negative effect on adhesion. This includes material additives & release agents which can migrate to the surface.

How the Forces of Cohesion & Adhesion Affect Wetting Out

Low energy, lack of bonding sites, and surface contamination have a negative impact on molecular attraction, causing liquids to fail to wet the surface.

In simple terms:

When you observe a liquid beading up on a surface, you are witnessing **the forces of cohesion** (the property of the liquid's like molecules to remain attracted) being stronger than the **forces of adhesion** (the property of unlike molecules to attract.)



Examples of Poor Adhesion

Poor adhesion resulting from surface issues appear in a variety of ways:

- Inconsistent ink adhesion
- Label adhesive failures
- Failure of coatings to wet out
- Bond strength failures

“Enercon has always offered us tremendous support and reliable technology. They have a great lab, knowledgeable people, and the equipment is built right here in the USA. It’s really been a great partnership for over 30 years.”

John Beck *Senior Research Scientist*
SAUDER MANUFACTURING



Plasma Treating is Used in Many Industries & Applications

Click on the industries below to access application stories, technical papers, webinars, video and more!

ADHESIVES & BONDING



[CLICK HERE TO LEARN MORE >](#)

Get insights on plasma and flame for improving adhesive bonding.

AUTOMOTIVE



[CLICK HERE TO LEARN MORE >](#)

See how automotive manufacturers use plasma & flame treatment.

BATTERY



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Learn how plasma promotes bonding in battery manufacturing.

CONSUMER GOODS



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Learn how increasing surface energy promotes the adhesion of inks.

ELECTRONICS



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Find out how pretreatment improves adhesion for electrical potting.

MEDICAL



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Learn how surface treating is an integral part of the manufacturing of medical devices.

PRINTING



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Discover better ink adhesion with plasma & flame treaters.

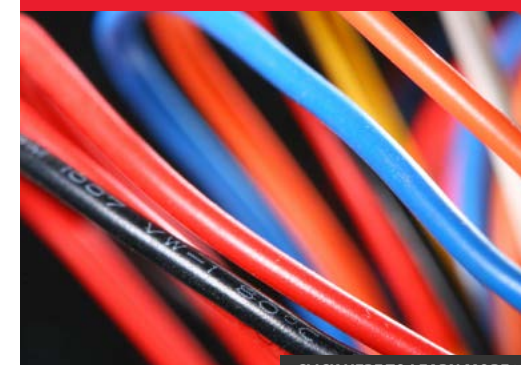
WINDOWS & DOORS



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Get insights Plasma & flame for assembly, painting & decorating.

WIRES, CABLES & PIPES



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Learn how plasma is enabling ink jet printing on wires, cables & pipes.

HOW ATMOSPHERIC PLASMA TREATMENT IMPROVES ADHESION

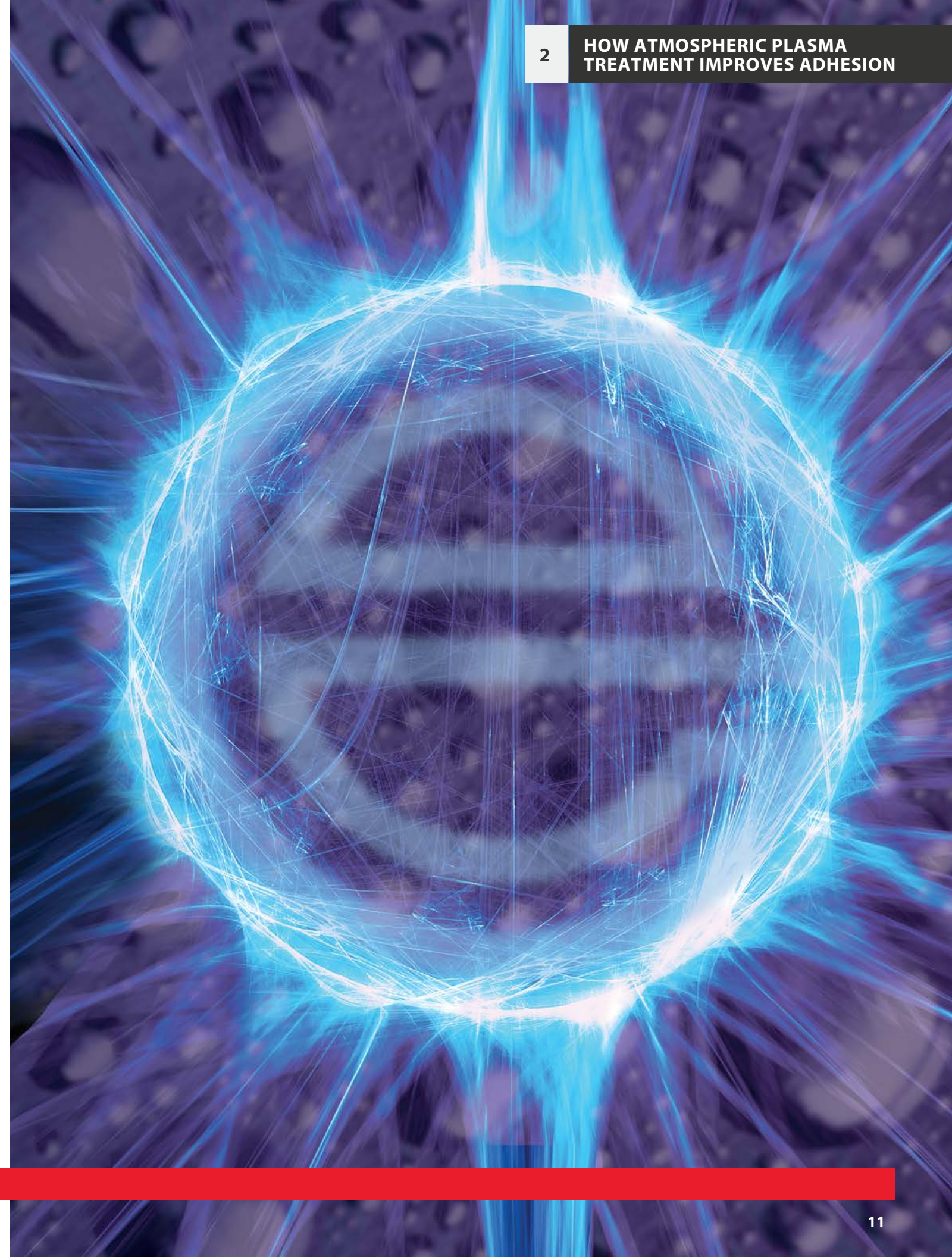
Atmospheric plasma discharges clean, etch and functionalize surfaces to improve adhesion.

What is atmospheric plasma?

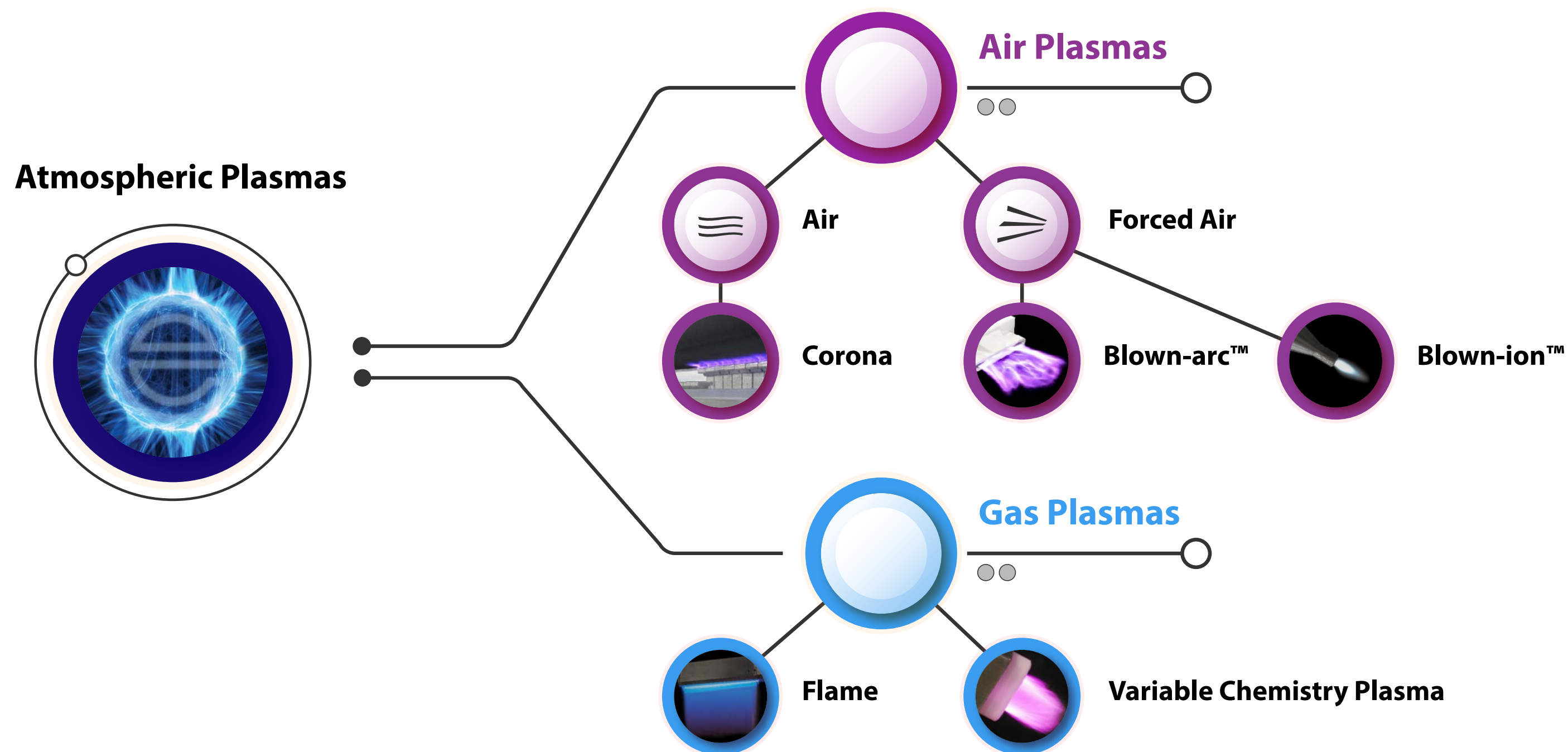
plasma : n; “Fourth state of matter”
(Solid, Liquid, Gas, Plasma.)

Mixture of charged ions & energetic electrons
generally in equilibrium.

Atmospheric plasma surface treaters generate
plasma to impart adhesion promotion onto a wide
range of surfaces.



Classifying Atmospheric Plasmas





Adhesion Promoting Surface Effects

Atmospheric plasma is highly effective at **cleaning, etching & functionalizing** a variety of surfaces.

The following pages will provide insights into how atmospheric plasma achieves these effects and how they help promote adhesion.

“With the plasma treater we know that each and every part is receiving the same treatment. We’re eliminating surface energy as a production variable and that in turn leads to greater efficiencies and consistent adhesion results. We’ve increased throughput by two and half times. This eliminated the need for us to add an additional printing line.”

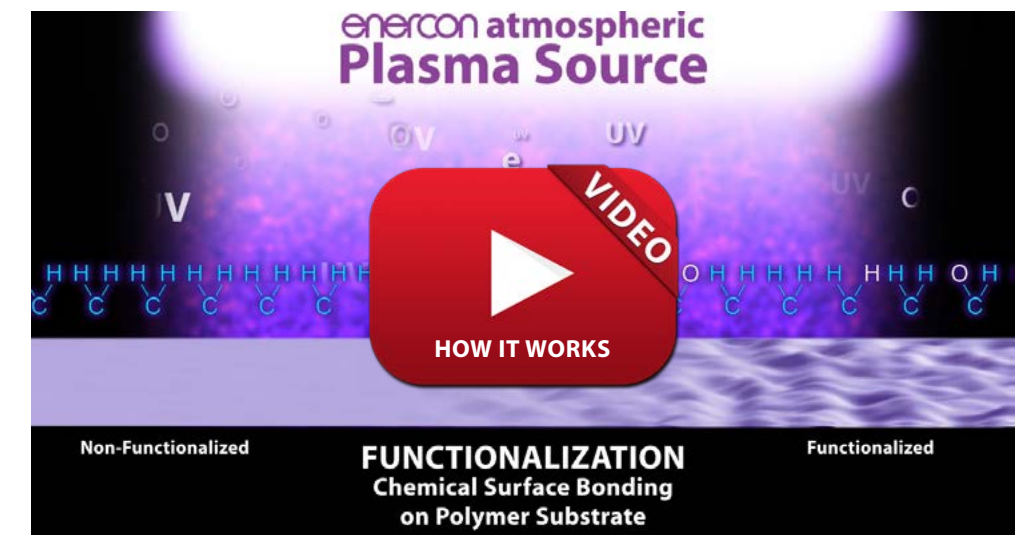
Jerry Jordan *Manufacturing Manager*
WAGO



What does Plasma Actually do to a Surface to Improve Adhesion?

Atmospheric plasma treatment cleans, etches, and functionalizes surfaces to improve surface energy and adhesion.

In this video, discover how plasma & flame surface treatment is being used by leading manufacturers to improve adhesion consistency & productivity.



Plasma Cleaning

Plasma treatment removes organic and inorganic impurities & contaminants from the surface.

Plasma species react with the surface and decompose, volatilize & vaporize low molecular weight contaminants to expose a clean, fresh surface to promote adhesion.

Plasma Etching

Micro etching of a polymer surface is accomplished as charged ions, neutral atoms and radicals, in both the plasma forming gas and the reactive process gas, bombard the surface.

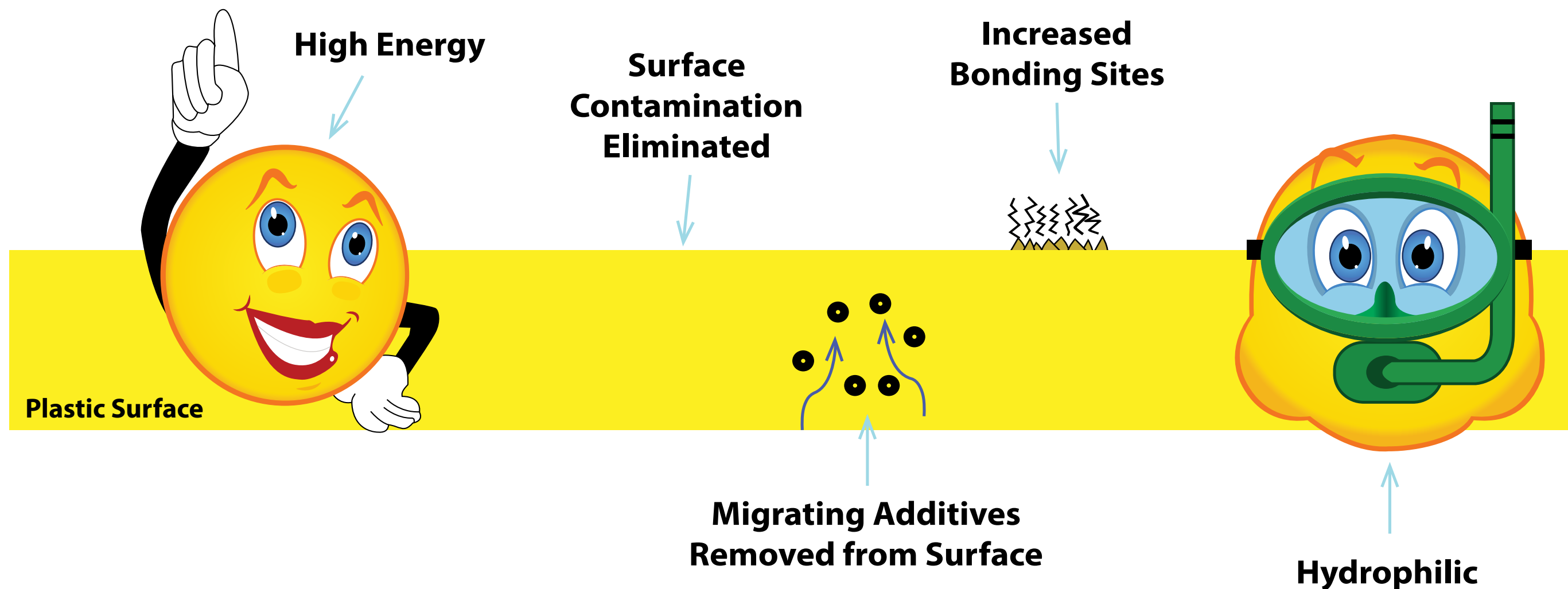
Increasing surface area creates more bonding sites which promotes adhesion success.

Plasma Functionalizing

Plasma activation or functionalization is the concurrent process of using radicals & small amounts of UV radiation to break up surface polymer bands to create cross linking of surface molecules.

This process **increases polar groups** which directly contributes to the surface's adhesion properties.

The Transformation of a Surface Prepared for Adhesion



WHAT TYPE OF SURFACES CAN BE TREATED?



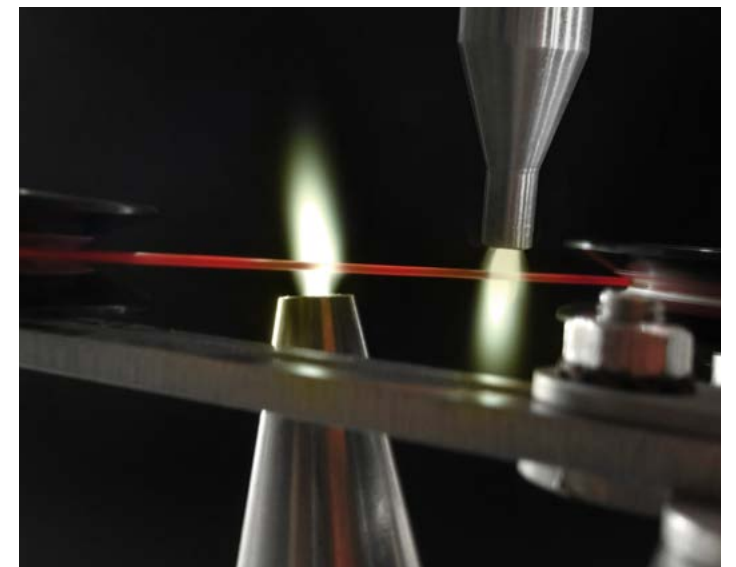
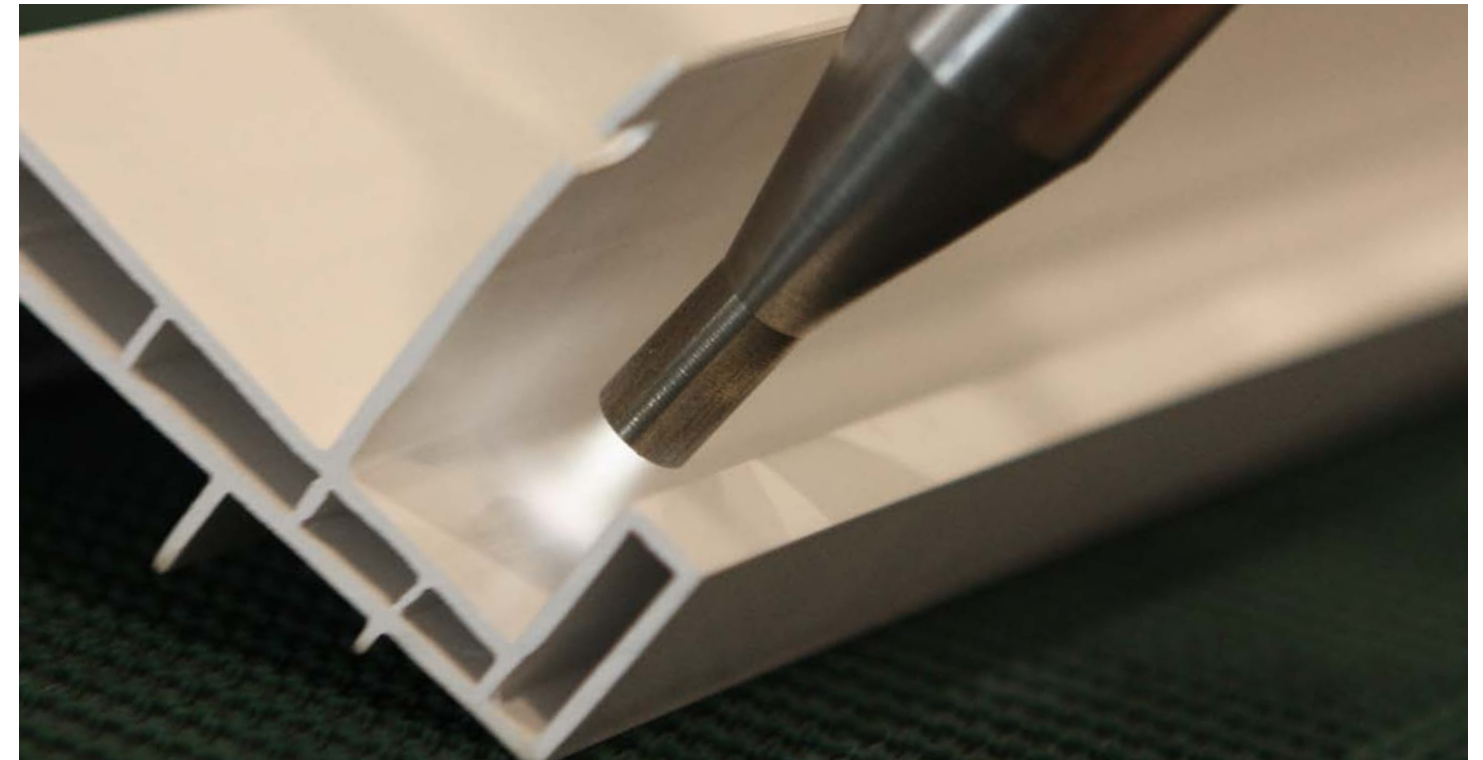
Atmospheric plasma treatment effectively treats glass, plastics and metals.

Surface Treatment Plastics

Atmospheric plasma surface treatment is effective at treating a wide variety of plastics and polymers.

Some of the more common plastics requiring treatment include:

ABS, ASA, EPOM, EVA, HOPE, LOPE, PC, PE, PET, PMMA, PP, PS, PU, PVC, PBT, TPU



Surface Treatment Metals

Atmospheric plasma surface treatment is effective at treating metals for **cleaning and removing oils**.

For large areas, flame treatment is often used to treat metals as well.

(Note: Not all atmospheric plasma treaters are suitable for treating metal. Please consult with your treater supplier to verify the capabilities of your system.)



Surface Treatment Glass

Atmospheric plasma surface treatment is effective at **treating glass for the purposes of cleaning and sterilization.**

In some cases, flame treatment may be used to treat glass as well.

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HOW CAN I TELL IF SURFACE TREATMENT CHANGED THE SURFACE?

4

There are a number of methods to determine the effectiveness of surface treatment.

Determining the Effects of Surface Treatment

In most cases, a surface that has been plasma treated will show no change to the human eye.

We'll review a number of different test methods designed to determine the effectiveness of surface treatment.

Its important to remember **the most important test is the success or failure of your ultimate bonding process**, whether that be printing, painting, coating or bonding.



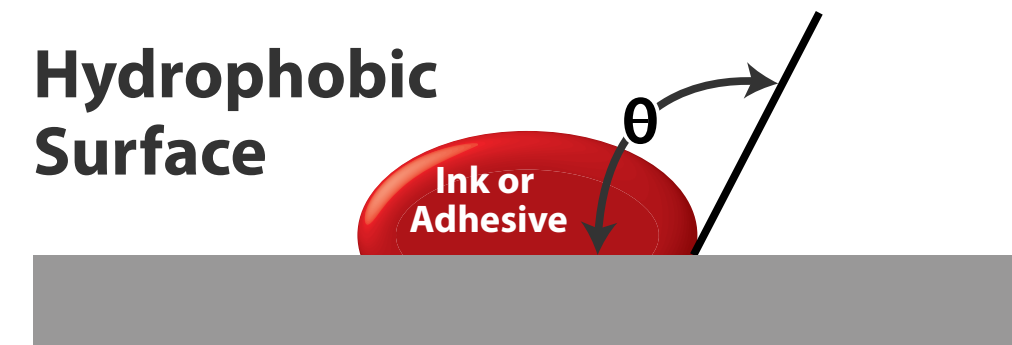
Visually Seeing Results of Plasma Surface Treatment

Instant examples of improved adhesion from surface treating can be observed by watching an ink or adhesive droplet wet out on a surface as shown in the examples to the right.

The liquid on the untreated surfaces fails to wet out whereas the treated surface enables wetting out.

“This treater solved our problem and much more. In addition to using it on untreated containers, we also tried it on containers that were treated by the container supplier. We found that treating the container in line actually improved the clarity of the lot codes we were printing.”

Dwayne Chrest *Production Manager*
BEST FORMULATIONS



High Contact Angle
Poor Adhesion



Low Contact Angle
Good Adhesion

Measuring Surface Energy in Dynes

A popular way of determining the effect of surface treatment is to **measure its change in surface energy with dyne solutions.**

Dyne solutions are calibrated liquids that measure surface energy. They are available in bottles and pens.

Often your ink or adhesive supplier will recommend a specific minimum surface dyne level for adhesion success.

[**CLICK HERE FOR MORE
INFORMATION ON
DYNE TESTING**](#)



Surface Treatment Plastics

Typical Starting Dynes

Several factors can impact initial and post treatment dyne level readings. The chart to the right is provided as a general guideline of typical results.



MATERIAL	INITIAL DYNE LEVEL	POST TREATMENT DYNE LEVEL
ABS	31-35	44-72
ETFE	30 >	50
ETFE	30 >	50
Flexible PVC	33-36	40-56
PEEK	30	> 72
PET	35	44-60
Polycarbonate	37	56-72
Polyethylene	32-34	42-60 +
Polypropylene	30-34	45-60
Polystyrene	36	52-70
PTFE	30 >	50
Rigid PVC	33-36	42-60 +
TPU	34	48

Considerations Regarding Dyne Levels

Dyne level readings are subjective

+ 2 dynes is a safe margin of error.

Higher dyne levels and adhesion

In general, higher dyne levels are better for adhesion, but once the dyne level threshold for successful adhesion is reached, there are not significant benefits to striving for even higher levels.

Dyne levels do not guarantee adhesion

Dyne level is one of many factors that contribute to adhesion, therefore it is only an indicator of your chances of success.

42 Dyne Pen



38 Dyne Pen



The solid line created by the 38 dyne pen indicates a surface energy of at least 38 dynes. The 42 dyne pen's ink did not wet out indicating a dyne level less than 42 dynes.

Considerations Regarding Dyne Levels

Dyne level decay rate vary based on environmental and material factors.

Treatment life may vary from hours to several months.

Special care should be taken when handling any surface after it has been treated to not contaminate the surface.

Since dyne levels decay over time, it is a best practice to print, coat, paint, laminate or bond to a surface as soon as possible after treatment.

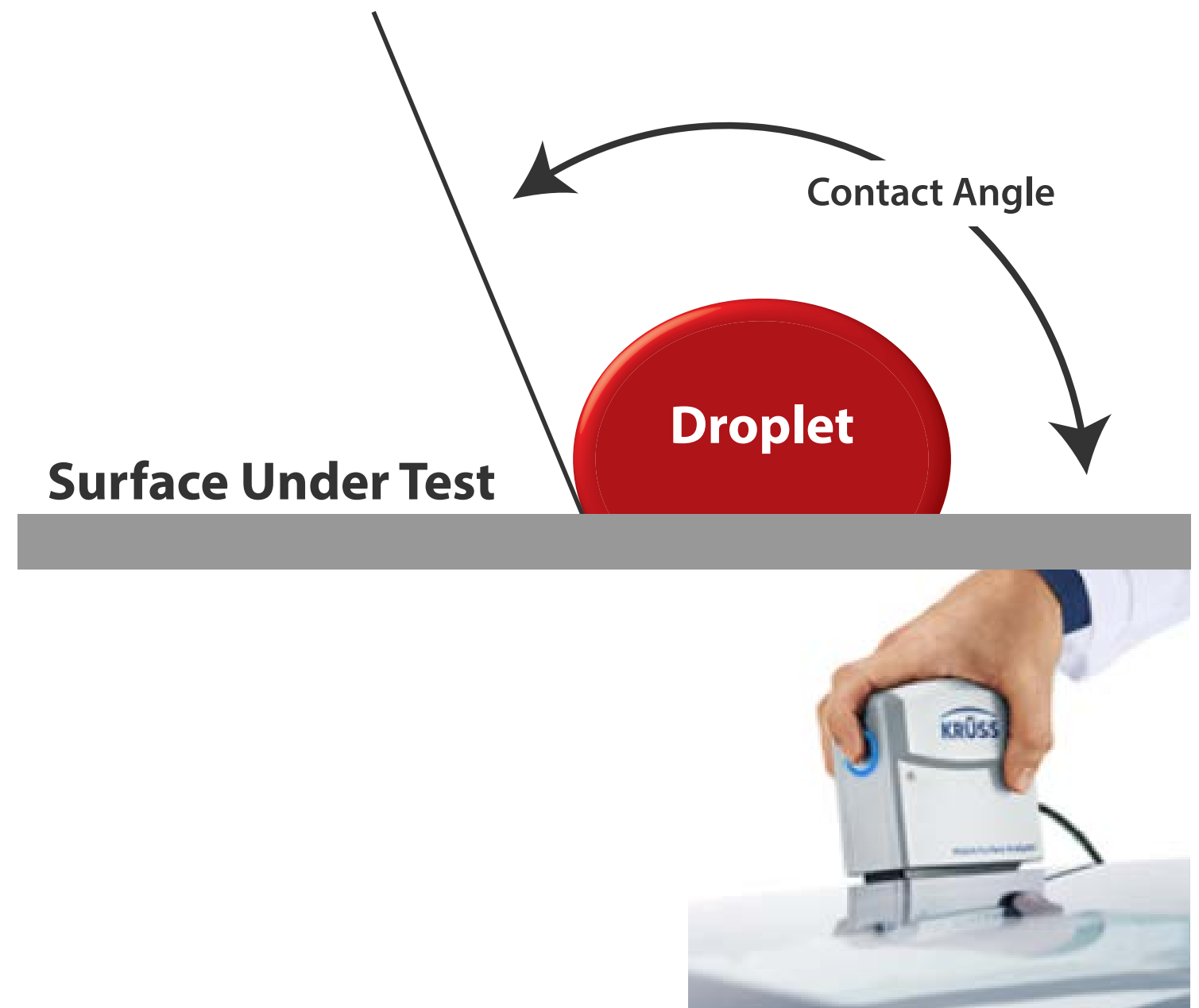


Contact Angle Measurement

Contact angle measures the interaction of a liquid with a solid.

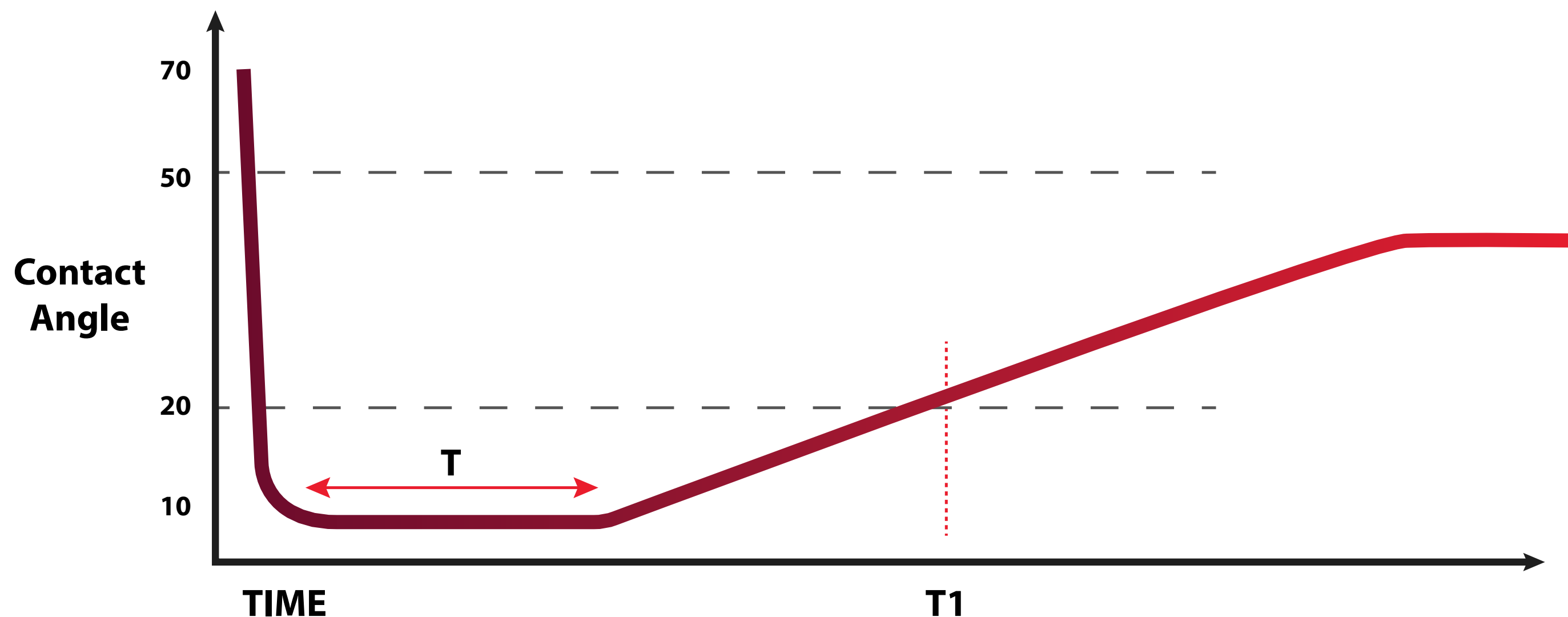
In general, a water droplet which “runs” to the base of the incline surface at a low incline angle indicates that the material has a low surface tension.

Water droplets which do not run at low angles indicate the material has a high surface energy.



How Most Surfaces React Over Time

Treatment causes the contact angle to lower which enables adhesion



“T” represents the time that the contact angle remains stable after treatment (varies based on material)

“T1” represents the time it takes until the contact angle exceeds the value needed for proper adhesion

Advanced Analysis of Surface Treatment

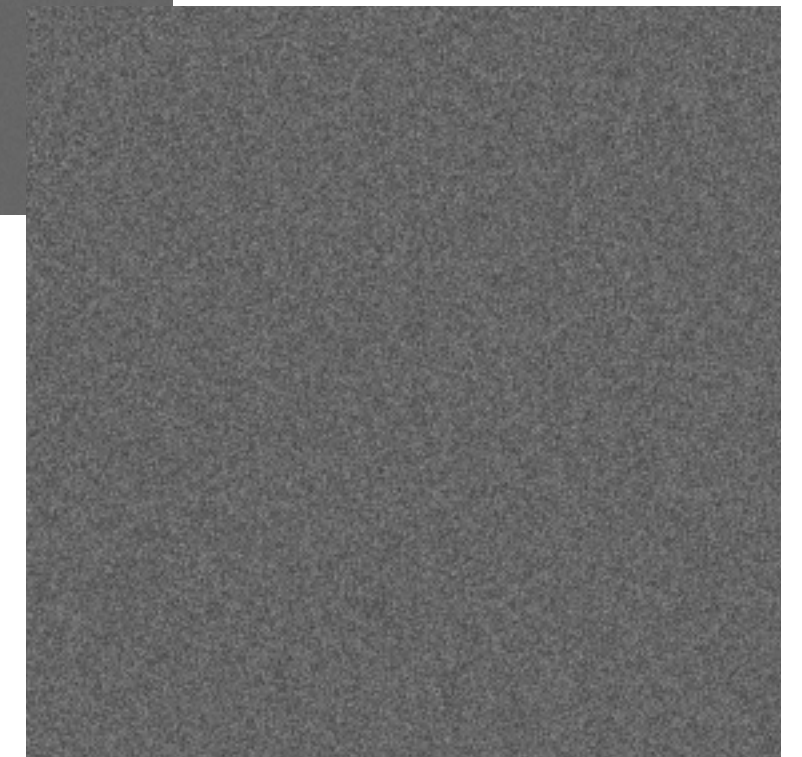
Another example of how plasma treatment can affect a surface is shown to the right.

The images are of a Polyethylene film captured by a Scanning Electron Microscope (SEM) at 30,000 magnification.

The plasma treated surface has an increase in surface area & bonding sites which promotes adhesion.

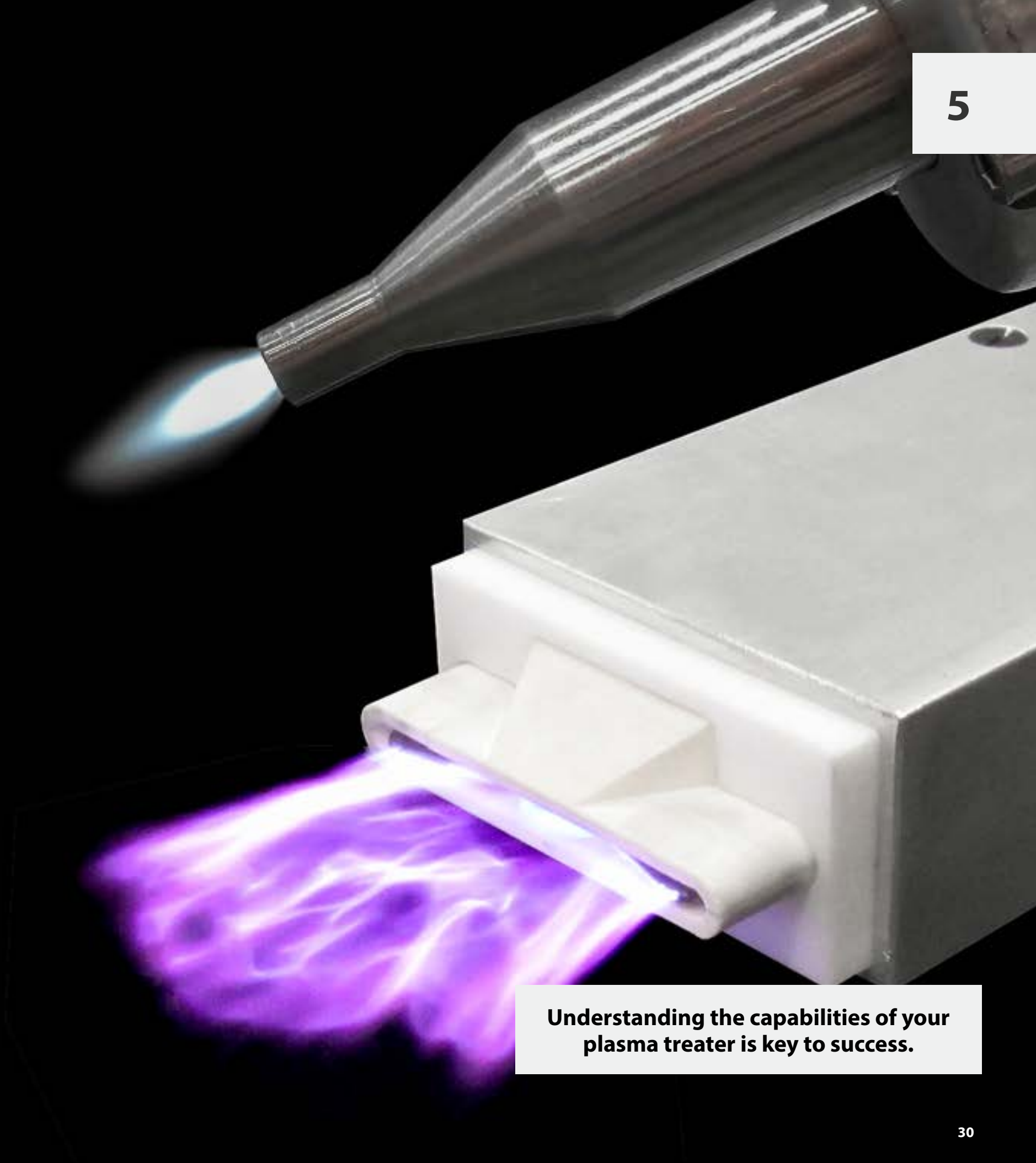


Original Film



Treated Film

ATMOSPHERIC PLASMA TREATER TECHNOLOGY COMPARISON



Understanding the capabilities of your
plasma treater is key to success.

Plasma Treating Models

Click on each treater to learn more.



BLOWN-ION™

For Conductive and Non-Conductive Surfaces

High speed plasma discharge of ions to clean, etch and functionalize surfaces

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BLOWN-ION™ 500

For Conductive and Non-Conductive Surfaces

Up to 2" wide plasma treatment of conductive and non-conductive surfaces

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BLOWN-ARC™

Treatment for Non-Conductive Surfaces

High speed plasma discharge of ions to clean, etch and functionalize surfaces

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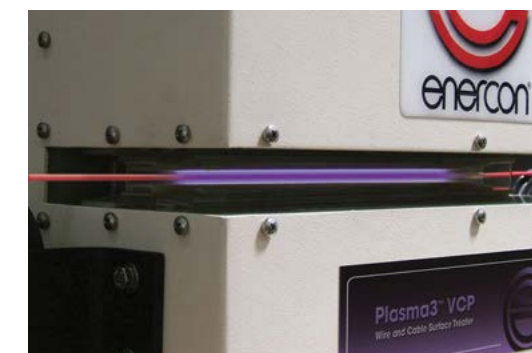


FLAME SERIES™

Powerful Flame Treatment with Precise Control

Safe and reliable flame surface treatment for any flat or dimensional shaped object

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PLASMA3™ VCP

Powerful Yet Gentle Treatment

Long lasting variable chemistry plasma treatment for materials that would be otherwise unresponsive

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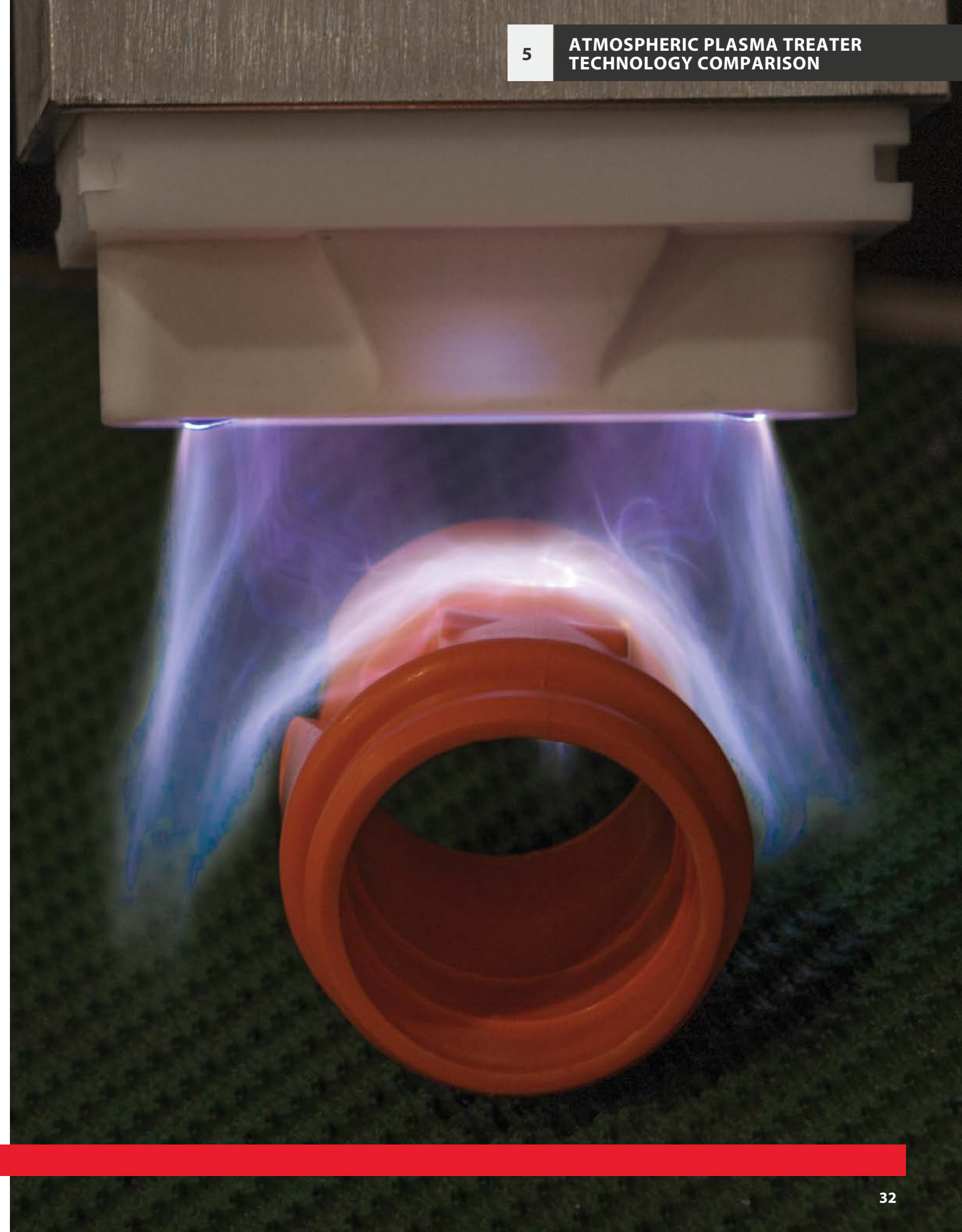
Blown-arc™ Air Plasma Characteristics

Ideal for a wide range of applications

Treats extruded, molded and formed materials

Treats non-conductive materials

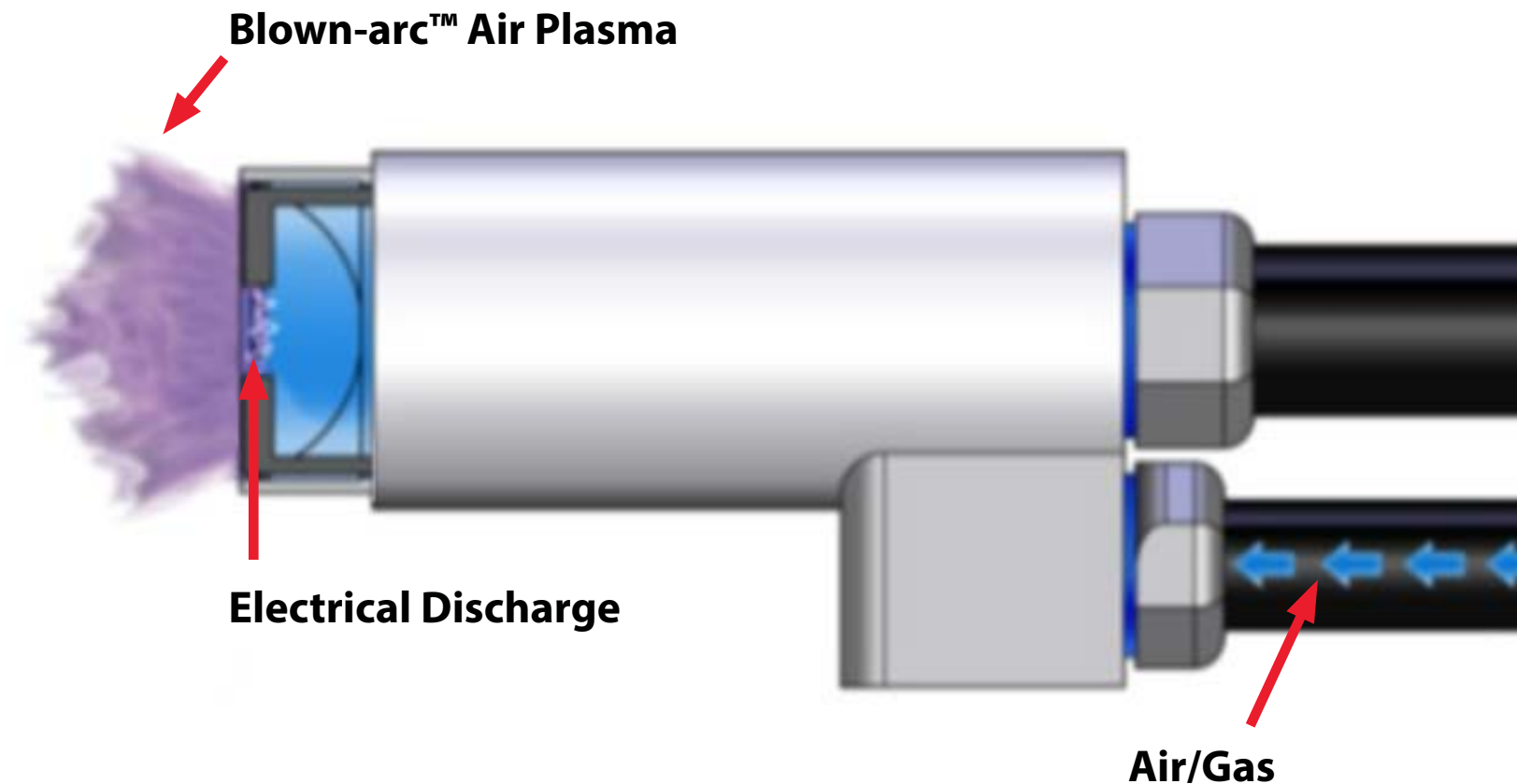
Wide Treatment Pattern - 2" or 3.5"



How Blown-arc™ Air Plasma Treatment Works

Blown arc air plasma is formed by blowing air past two high voltage power electrodes and is sometimes referred to as corona treatment.

The electrical discharge positively charges the ion particles surrounding it. Through direct contact, these **particles positively charge the treated area** making the surface more receptive to any applied substance.



**BLOWN-ARC
PLASMA ANIMATION**

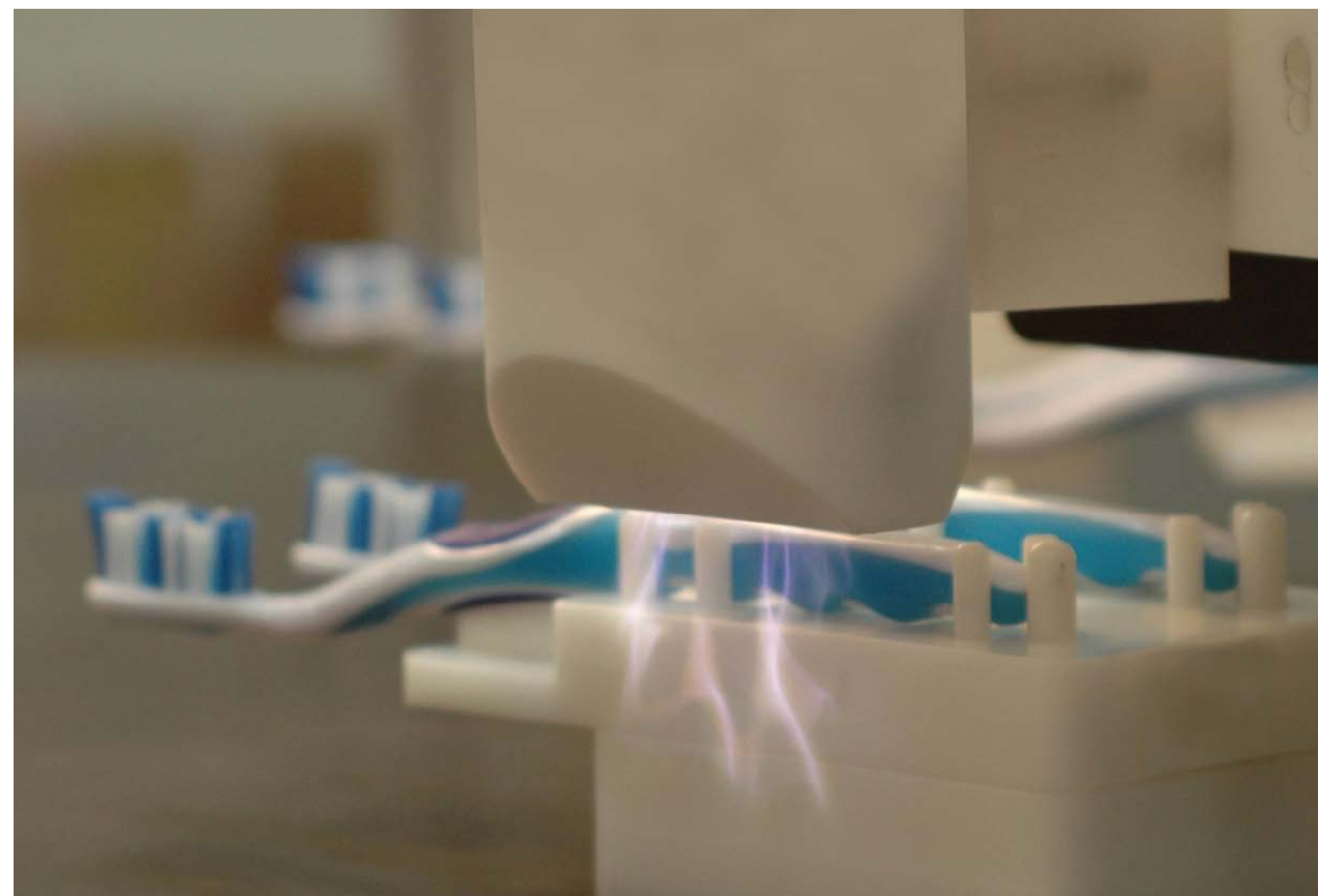
[CLICK TO WATCH NOW!](#)



Blown-arc™ Plasma Treatment in Action

The video to the right shows a lab trial of a blown arc plasma treater treating toothbrushes prior to pad printing.

The resulting increase in surface energy enabled successful printing.



**SEE THE BLOWN-ARC
PLASMA TREATER
IN ACTION**

CLICK TO WATCH NOW!



Blown-ion™ Air Plasma Characteristics

Treats Conductive & non conductive materials

Focused treatment coverage: 3/8" - 2"

Precise pattern or spot treatment

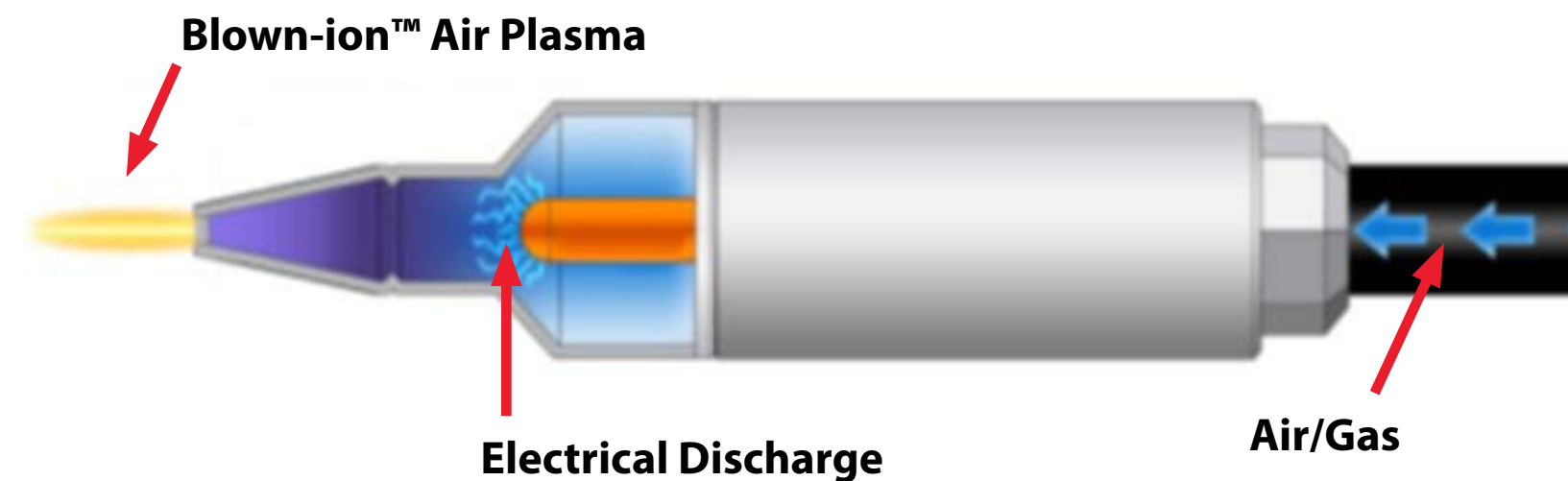
Requires minimum dwell time (enables high speed in-line treatment)



Blown-ion™ Plasma Treatment

Blown ion air plasma pushes pressurized air past a single electrode which discharges inside the treater head. The electrode creates positively charged ions in the surrounding air particles.

The air pressure then forces the air particles to accelerate of the tip of the head as **a high velocity stream of charged ions directed toward the object's surface.**



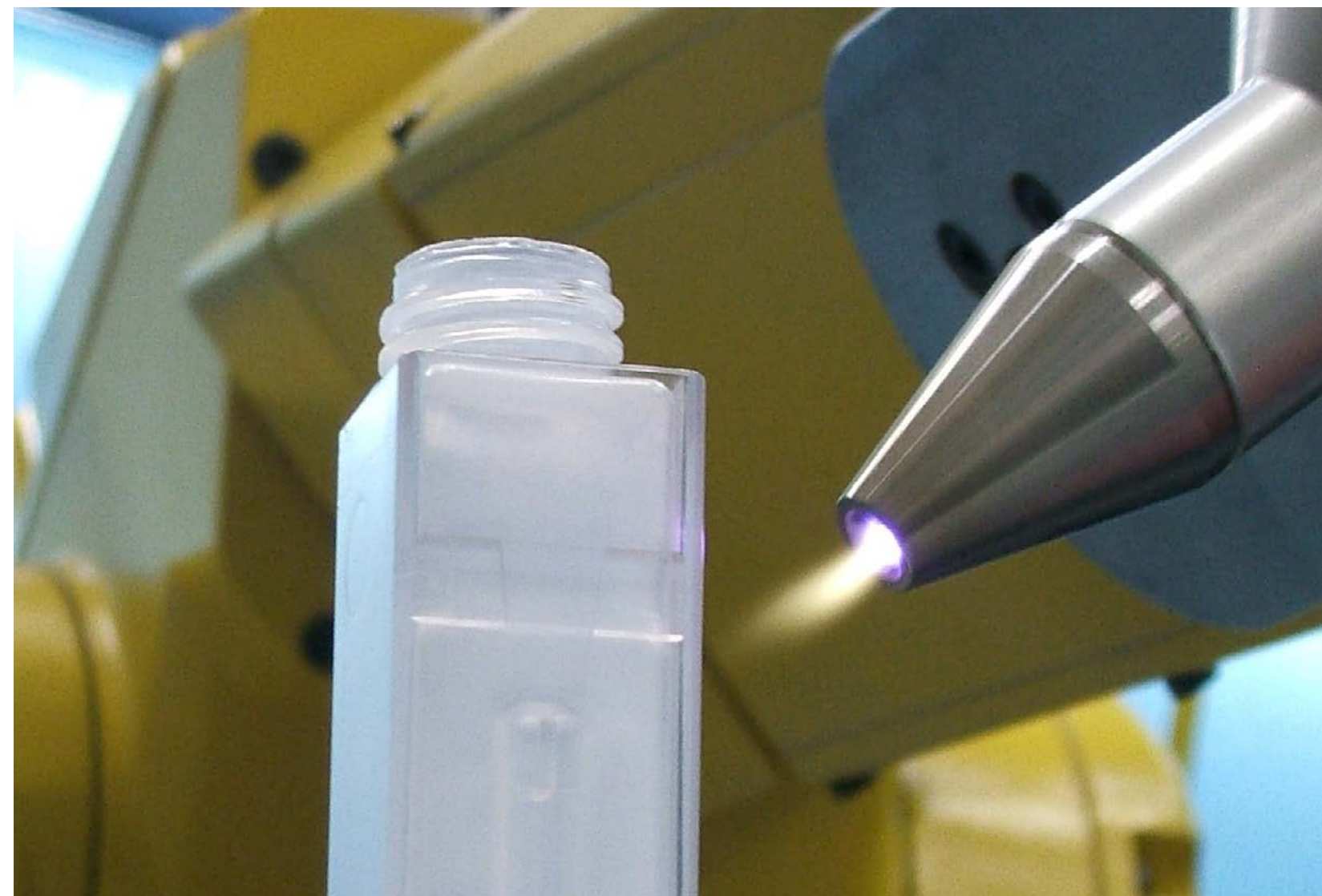
**BLOWN-ION
PLASMA ANIMATION**

[CLICK TO WATCH NOW!](#)



Blown-ion™ Plasma Treatment in Action

This video demonstrates a Blown-ion **plasma treater integrated with an articulating robotic arm** for precise treatment patterns.



**SEE THE BLOWN-ION
PLASMA TREATER
IN ACTION**

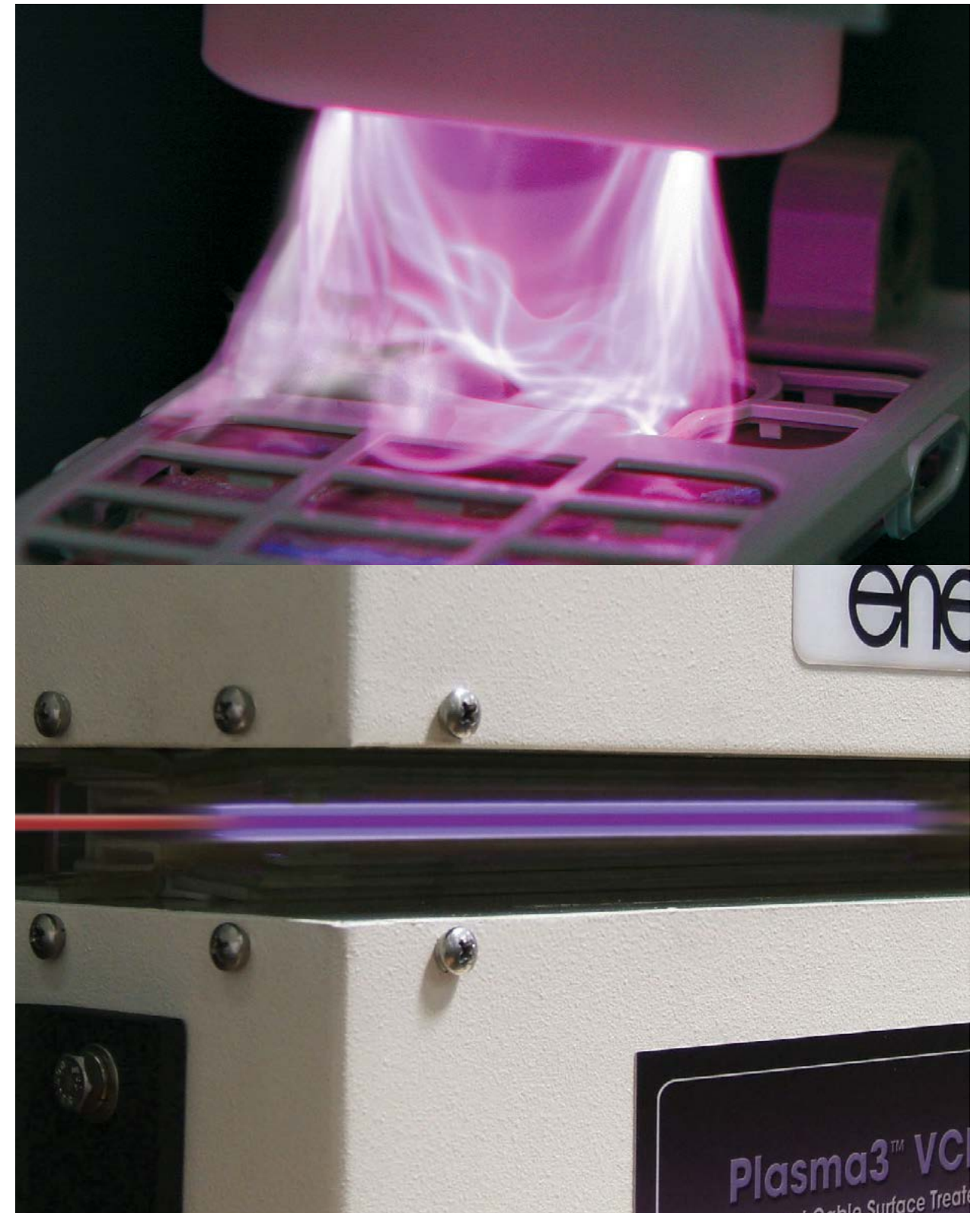
CLICK TO WATCH NOW!



Variable Chemistry Air Plasma Characteristics

Variable gas chemistry plasma are available in a variety of discharge configurations and are **suitable for films, sheets and dimensional objects**.

By using specific gas chemistries, these plasma treaters can generate treatment results on difficult to treat surfaces such as fluoropolymers.



New Plasma & Flame Treater Head Designs Improve Treatment Coverage, Integration and Efficiency

They can be integrated with robotics, indexing systems, and conveyor systems to provide precise treatment that cleans, etches, and functionalizes surfaces. And, they are very effective at reaching crevices and small areas.



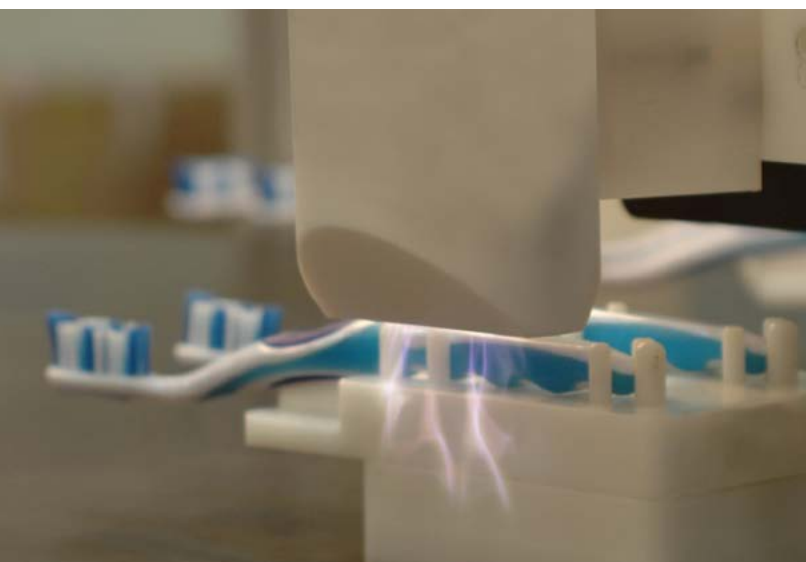
INTEGRATION

Putting your application to the test is the best way to find the optimal surface treating solution.

Integrating Atmospheric Plasma Treaters Into your Process

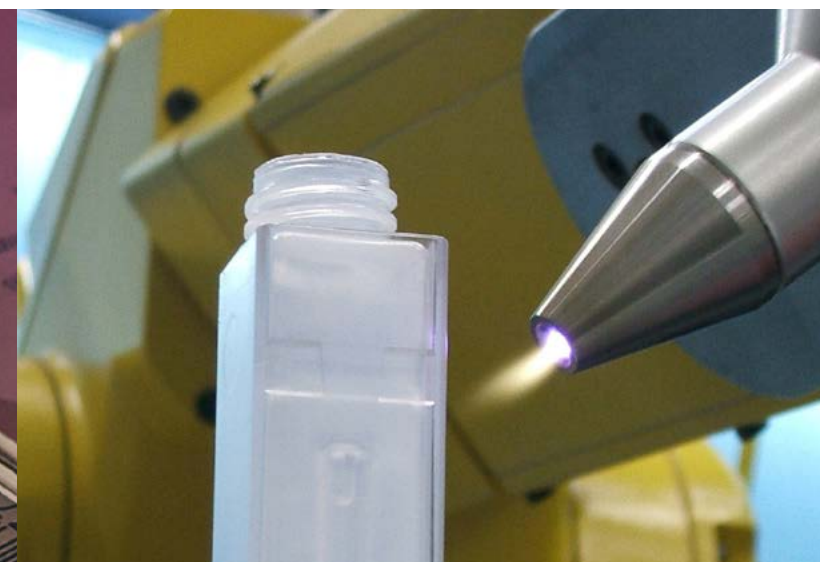
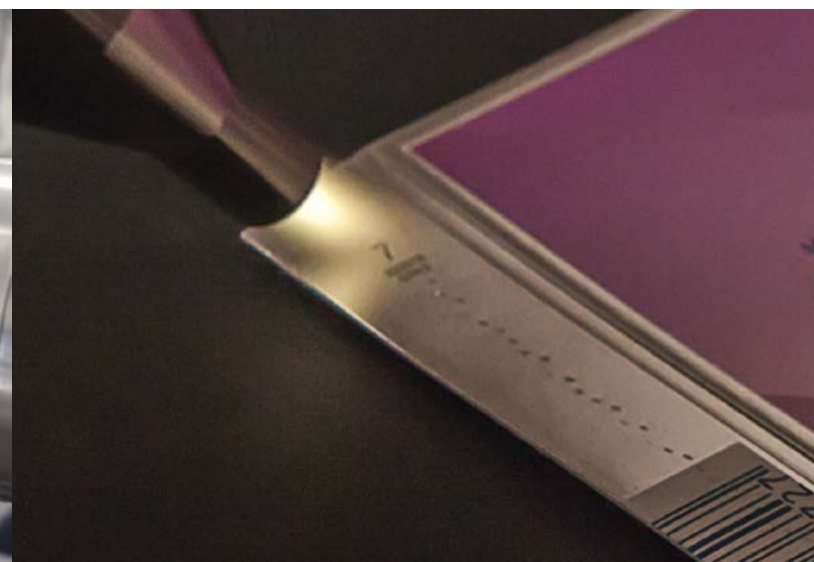
Fixed Location Treatment Head

Parts are conveyed, indexed or otherwise presented to the treatment head.



Moving Treatment Head

Head can be indexed or robotically controlled to follow precise treatment patterns.



Integration Options & Considerations

Existing line or new line?

How will the product be presented for treatment?

Work cell or continuous throughput?

Budget?



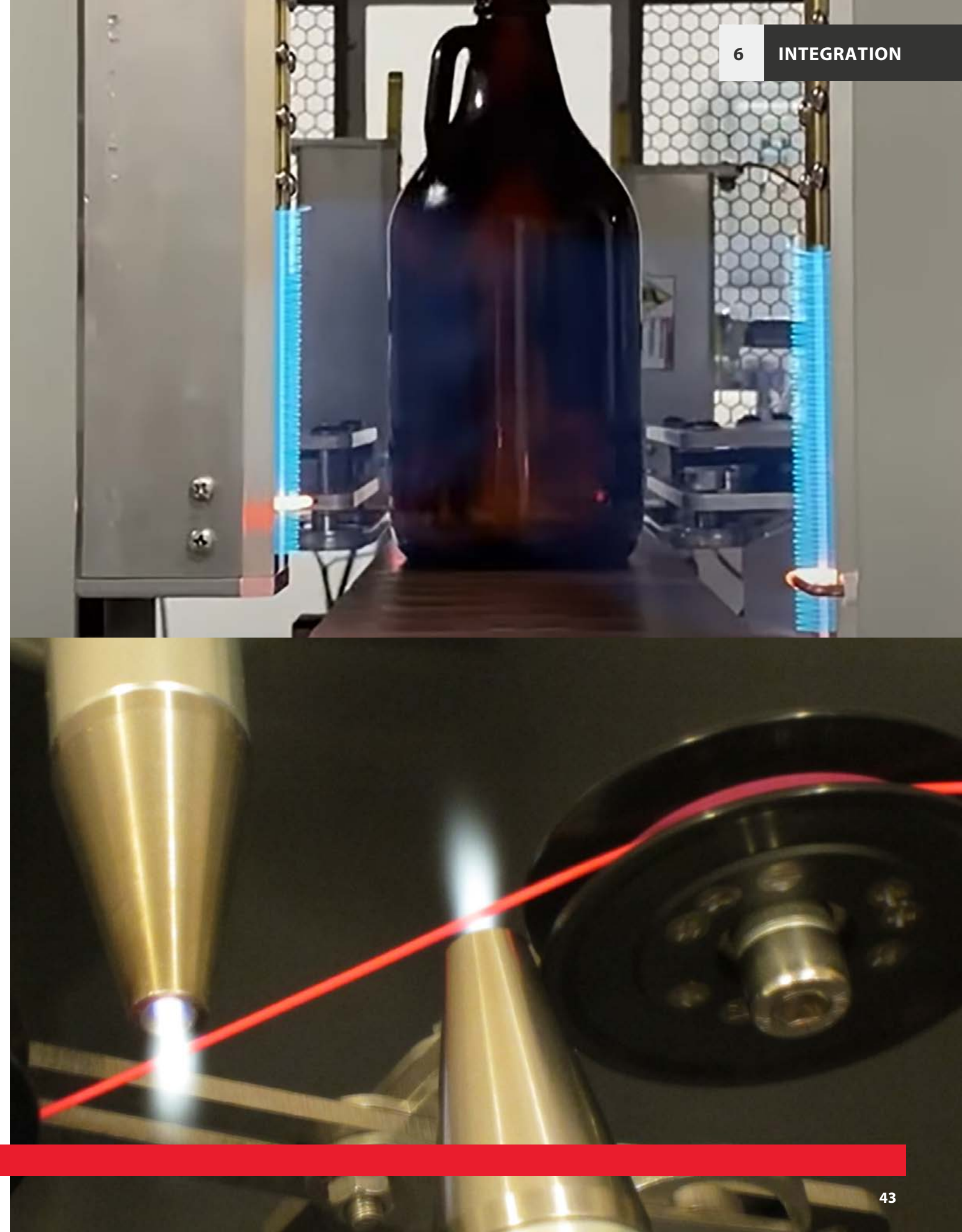
Integration Options & Considerations

Simplest Set-up

Conveyed parts with fixed treatment head(s)

In-line continuous operation

Ideal for flat and/or continuous treatment areas



Integration Options & Considerations

Indexing Parts

Parts presented to treatment head

Treatment head fixed or moving



Integration Options & Considerations

Moving the Treatment Head

X, X-Y, and X-Y-Z Gantry

Robotics

- Limitless programming capabilities
- Ideal for parts with complex shapes
- Multi-processes possible
 - E.g. treating & adhesive application
 - E.g. treating, dispensing, UV-curing
- Tool changeover possible



Putting your Application to the Test

Enercon offers free laboratory trials with blown-ion, blown-arc and flame surface treating technologies.

Simply send us your parts and our application experts will conduct tests to see which technology is best for your application. You'll receive a comprehensive report on the results of the lab trial. And if requested, we can ship the treated parts back to you for further testing at your facility.

Trials may also be conducted at your facility.



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Global Perspective and Local Support from a World Leader

Since 1974, Enercon has brought innovative and cost-effective solutions to manufacturers.

Our team is committed to your success & will provide you the finest application expertise & product support.

We invite you to consult with us on your next project.

Enercon's global operations are supported by an international network of equipment and application experts who provide you with global perspective and local support.

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