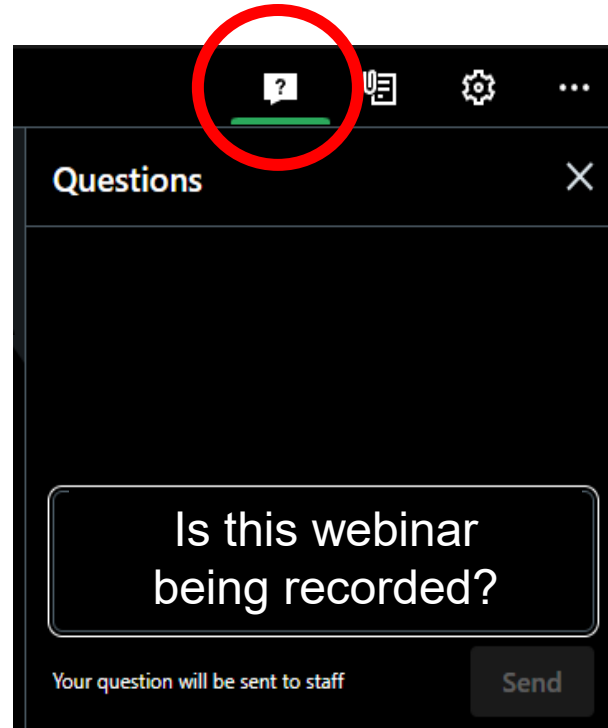


How to Optimize Direct-to-Product Printing for Consumer Goods



Optimize Direct-to-Product Printing for Consumer Goods

**Have a Question?
Use the Question Tool Bar.**



**Yes, this webinar is
being recorded.**



Optimize Direct-to-Product Printing for Consumer Goods

Today's Presenters



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Optimize Direct-to-Product Printing for Consumer Goods

Overview

- Why direct-to-product digital printing is rapidly growing
- The science of surface energy, wettability & adhesion
- What plasma & flame surface treating does to a surface
- Simple date, lot & product ID code printing
- Complex direct-to-product printing case studies
- Selecting the right inks for your application
- How to engineer adhesion for process consistency
- Questions/Answers



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Why Direct-to-Product Printing is Growing

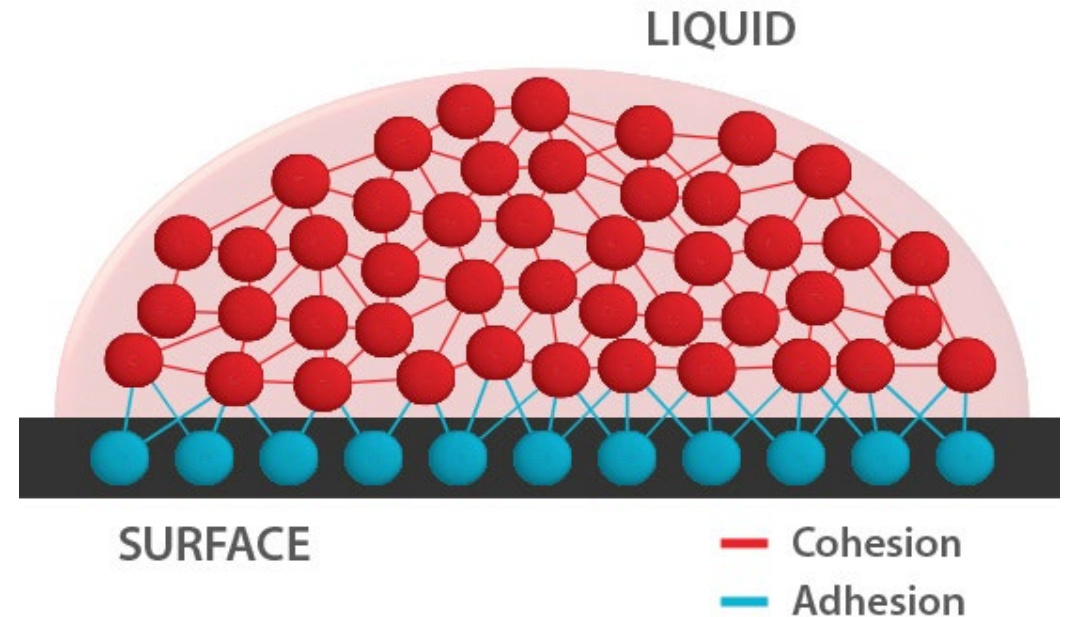
- Shelf Differentiation
 - Customization
- Manufacturing Flexibility
 - SKU Proliferation
 - Shorter Production Runs
- Sustainability Initiatives
- Lower Total Packaging Cost
- Improved Technology



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Surface Preparation & Adhesion Dynamics

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.)

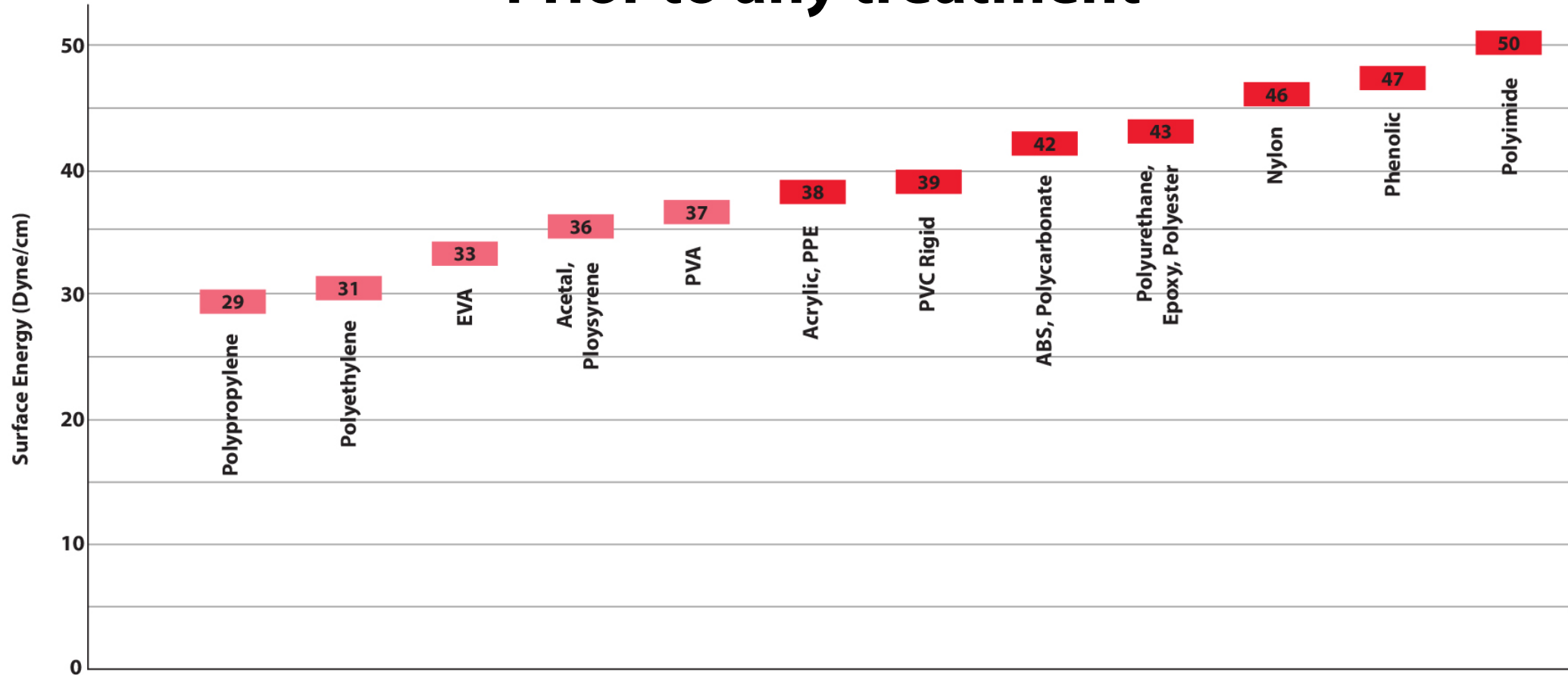


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Typical Inherent Surface Energies

Prior to any treatment

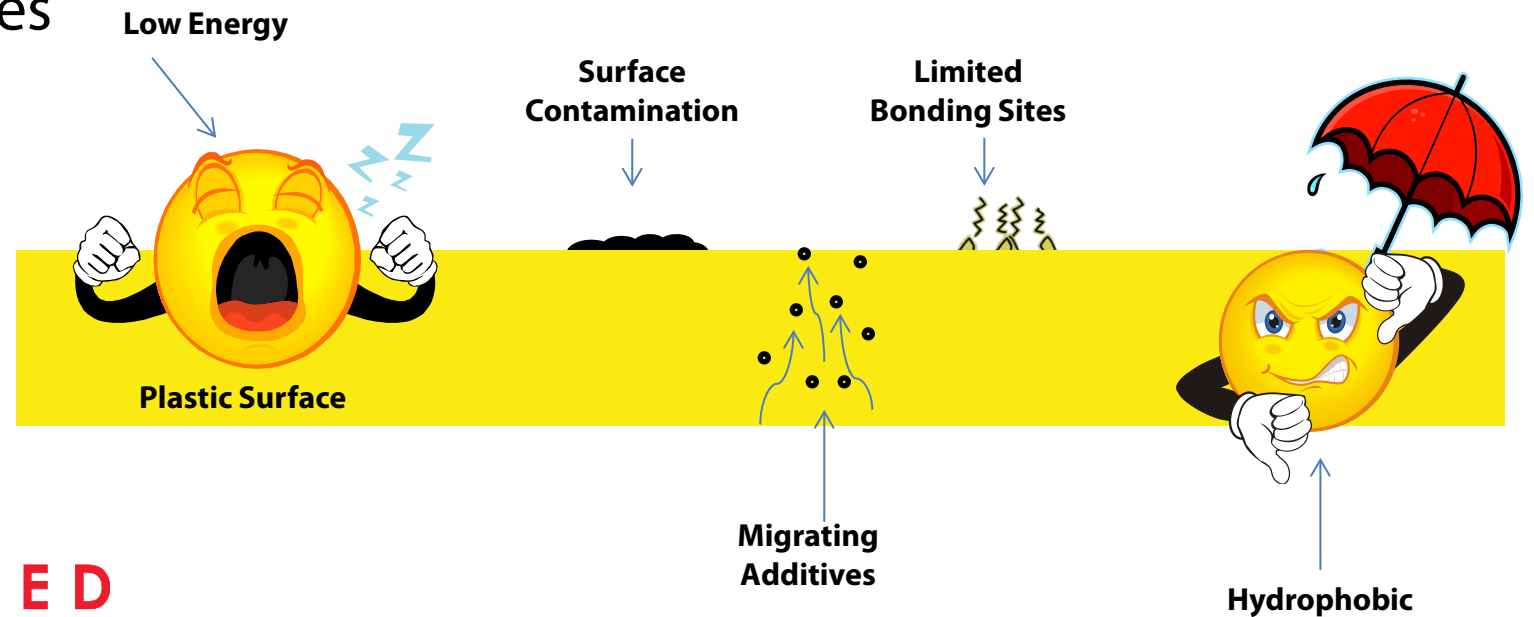


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Adhesion Impediments

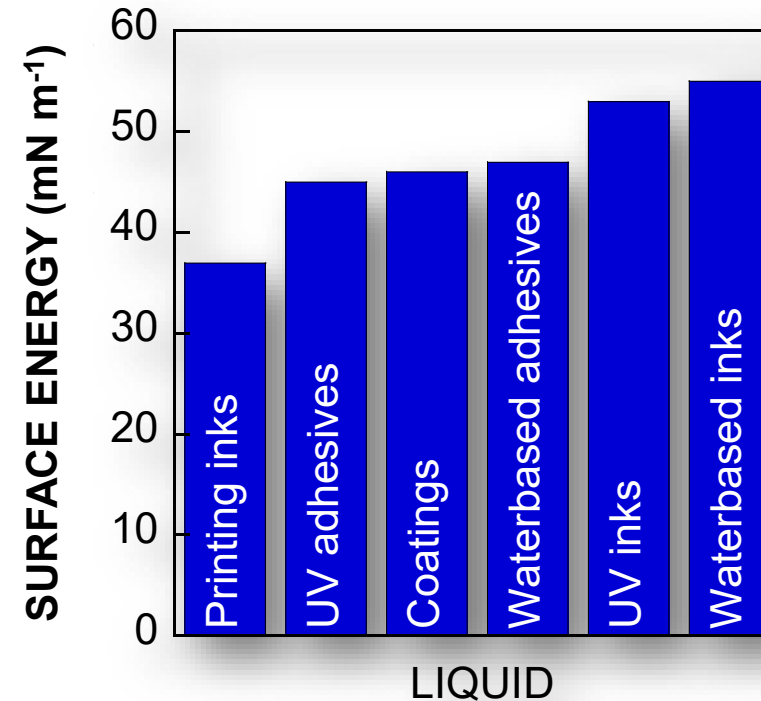
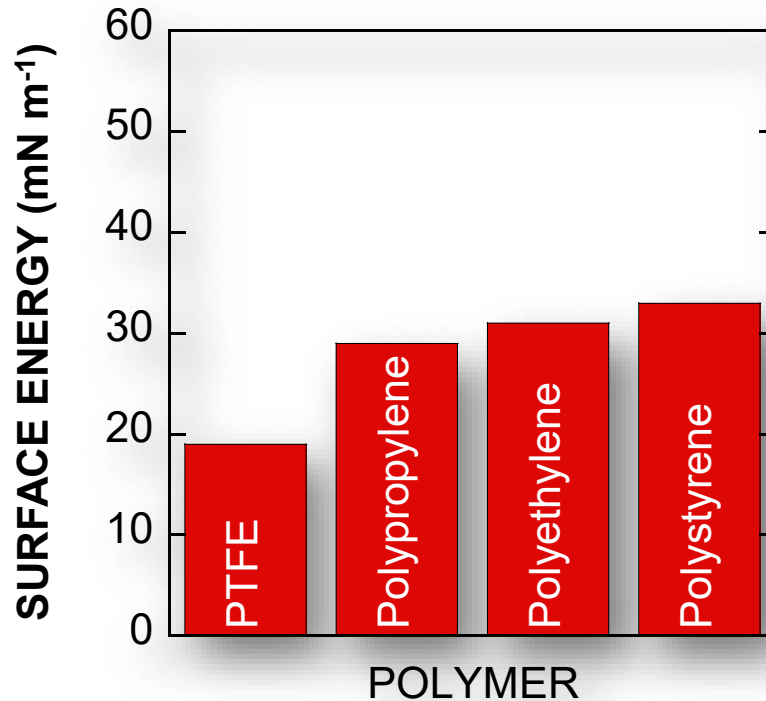
- Low surface tension
- Migration of formulation components
- Mold release agents
- Low temperature
- Design and fabrication issues
- UV light
- Mechanical stresses



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Higher Surface Energy Enables Adhesion

- Most polymers, having low surface energy, are hydrophobic.
- For good adhesion and wettability, the surface energy of the polymer should exceed the interface by $\approx 10 \text{ mN/m}$.



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Surface Treatment Results



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Surface Preparation Options

- **Liquid Primers**

Cost, hazardous, clean-up, consumable

- **Mechanical Preparations**

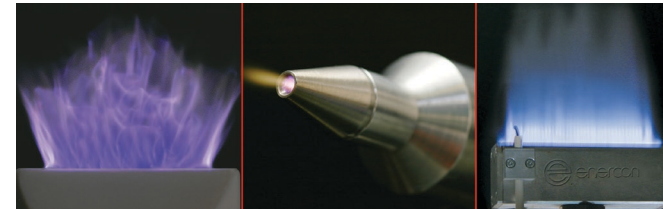
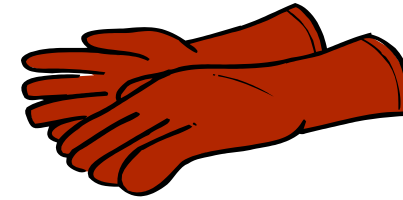
Cost, time, wear parts, clean-up

- **Vacuum Plasmas**

Capital & consumable cost, time, batch process

- **Atmospheric Plasma & Flame**

In-line, continuous, economic



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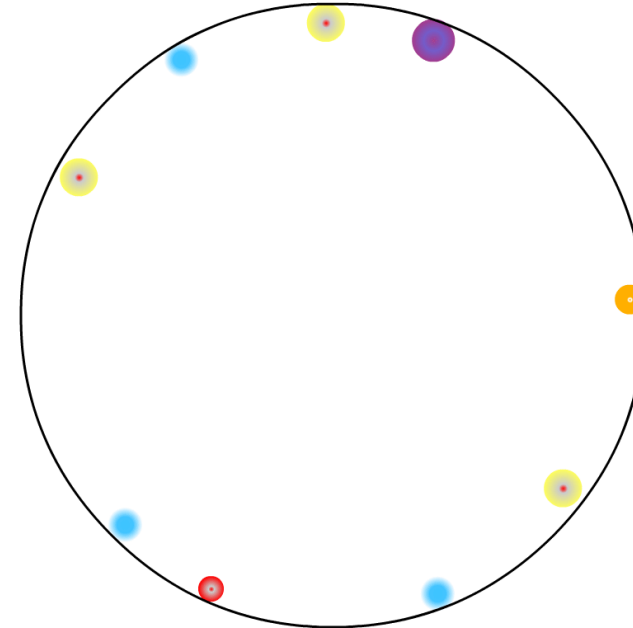
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What is Plasma

plasma : n ; “Fourth state of matter”, (Solid, Liquid, Gas, Plasma.)
Mixture of charged ions & energetic electrons generally in equilibrium.



-  Free Radical
-  Negative Ions
-  Ultraviolet Light Photon
-  Positive Ions
-  Electron



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Plasma & Flame Treating Technologies



Blown-arc™



Blown-ion™



Flame Plasma



Blown-ion™ 500



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What does plasma treatment do?

CLEAN

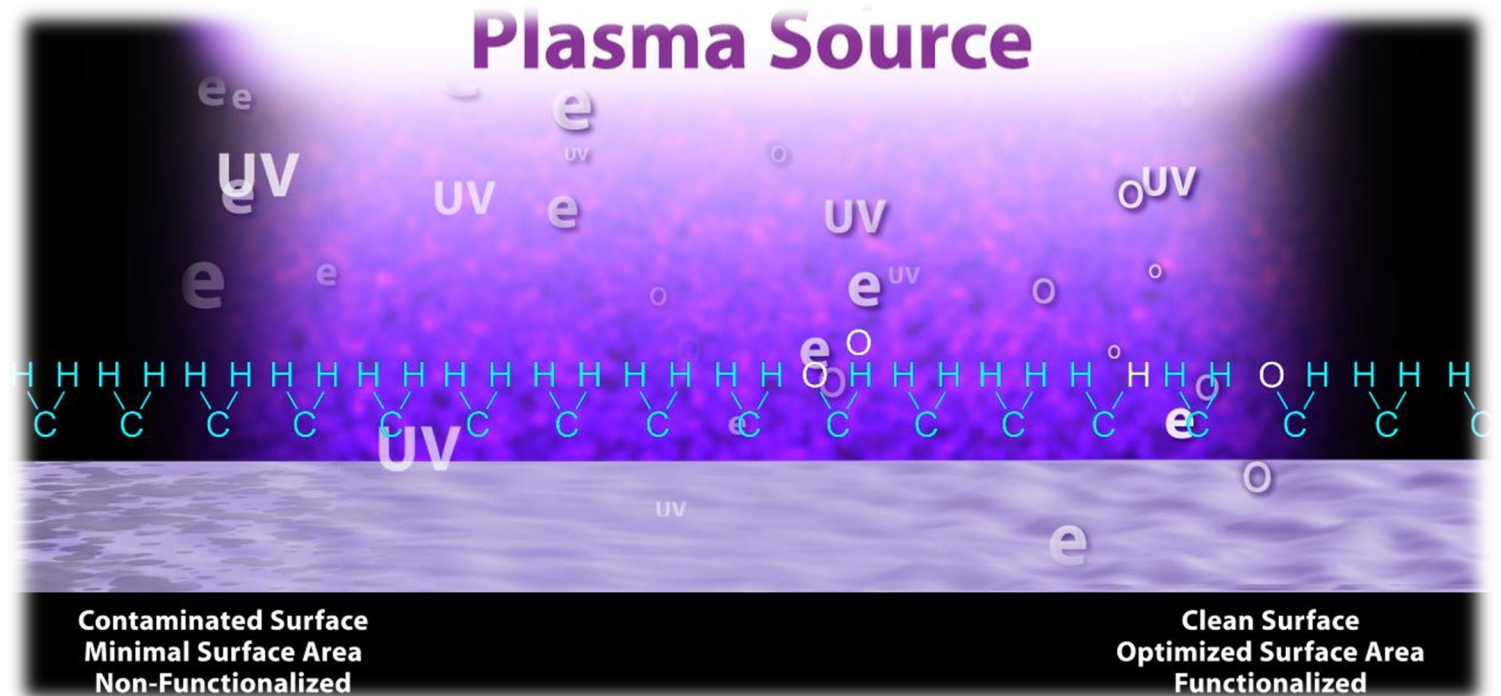
Plasma treatment removes organic and inorganic impurities & contaminants from the surface.

MICROETCH

Increases surface area creating more bonding sites, which promotes adhesion.

FUNCTIONALIZE

Increases polar groups, which directly contributes to the surface's adhesion properties.



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Lab Trial Results

	Untreated				Blown-ion				Flame			
	Dyne	Ca	Polarity	Sfe	Dyne	Ca	Polarity	Sfe	Dyne	Ca	Polarity	Sfe
PP	>30	94.35	1.55	29.62	58	47.83	20.6	57.6	70	38.59	9.5	44.64
PE	>30	114.9	0.28	28.69	60	45.28	21.41	59.9	56	52.22	16.94	56.34
PS	31	91.5	0.62	41.37	70	24.75	32.37	70.48	48	69.08	7.69	47.87
PA6	34	74.21	6.92	41.66	66	41.81	21.89	63.5	54	55.45	15.75	53.54
PA66	36	67.63	8.08	49.24	70	35.79	27.67	64.57	70	31.7	17.78	55.95
PET	>30	114.9	0.28	28.69	70	38.17	27.65	62.26	44	80.99	5.15	35.91



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Simple Digital Printing Application Examples

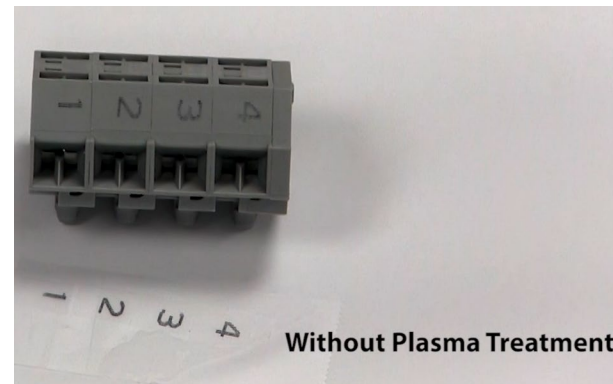
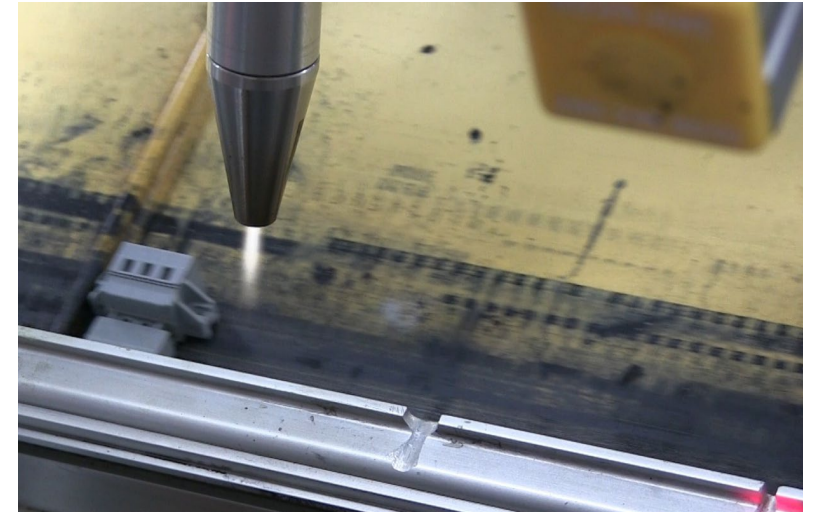


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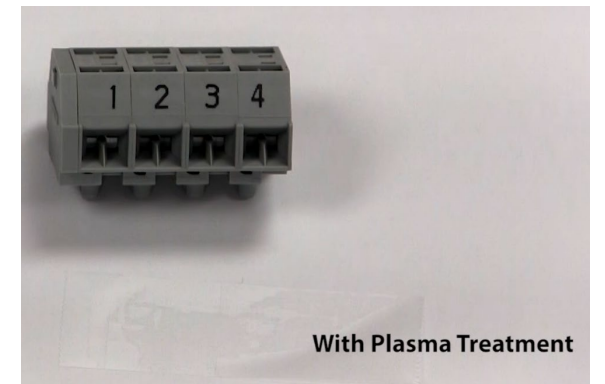
Optimize Direct-to-Product Printing for Consumer Goods

Inkjet Printing Terminal Blocks

- Promote ink adhesion on Nylon 66
- Eliminate manual surface preparation
- Replaced primer with automated solution
 - Blown-ion™ plasma treater
- Reassigned employee to higher value assignment
- Yielded a 2.5X increase in throughput



Without Plasma Treatment



With Plasma Treatment

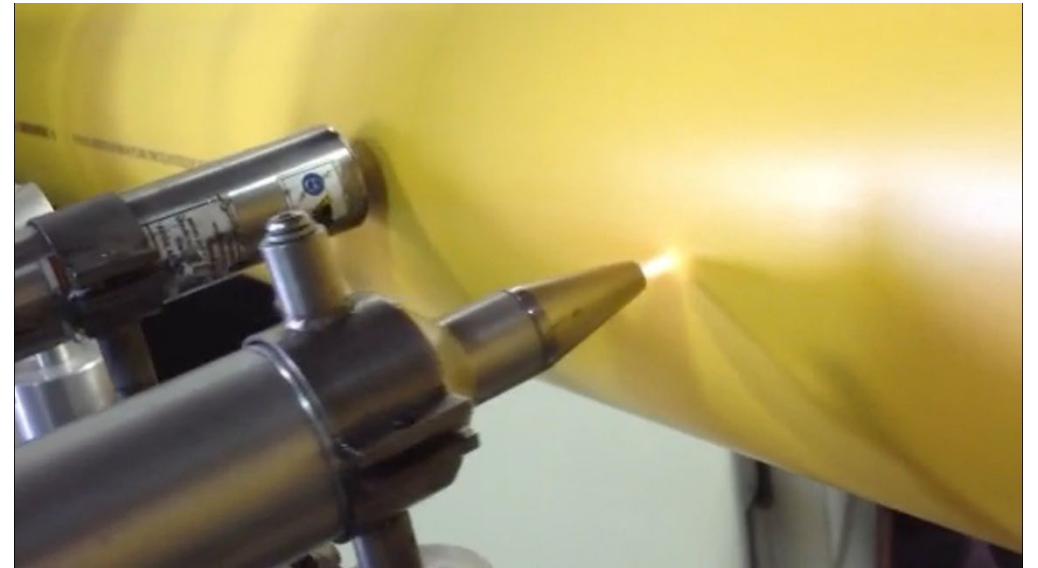
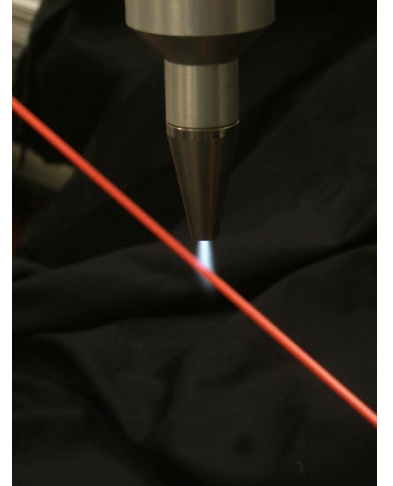


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Printing on Wire, Cable & Pipes

- Inkjet printing on wide variety of plastics
- Wire application produced 567% increase in ink durability

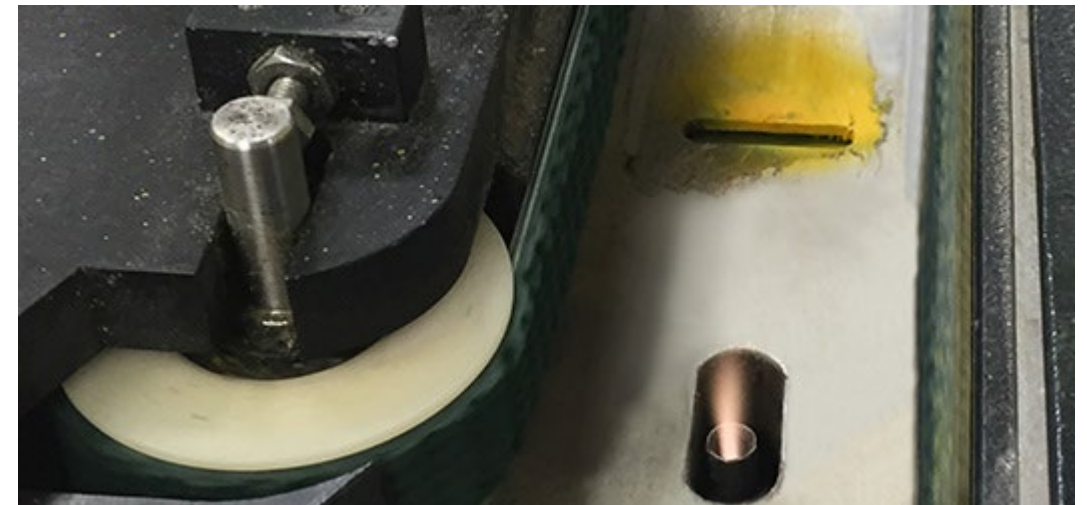


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Date & Lot Code Printing

- Inkjet printing on HDPE & PET bottles
- Enabled printing on some containers
- Improved print clarity on others



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Primary Product Digital Printing Application Examples



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EPS – 40 years of Direct-to-Product Printing

Founded 1985 • 4,000+ Systems Installed • Medical • Packaging • Industrial • Promo

Pad Printing

Analog

3,500+ installed



Multi-Pass Inkjet

Entry Level Digital

400+ installed



Single-Pass Inkjet

Production Digital

100+ installed



1985

Analog

- Tooling Needed
- Manual Setup

2010+

Entry Level

- No Setup
- Low Volume Production

2020+

Production Digital

- No Setup
- Fully Automated
- Production Volumes



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Single-Pass Speed Raises the Stakes

True Production Speed Means One Pass — and One Chance — per Part

MULTI-PASS | entry-level digital



- Printhead scans the part — seconds to minutes each
- Slower, multiple pass production is forgiving of marginal wetting
- A miss costs one reprint, not a production run
- Pre-treatment can be offline, batch or even handheld

SINGLE-PASS | production digital



- Parts pass fixed heads once — 200–2,000+ per minute
- Milliseconds from treat → jet → pin → cure
- Marginal wetting shows instantly — pinholes, weak rub
- Treatment inline, automated, dosed to line speed

From our first 100 single-pass installs: **pre-treatment is non-negotiable — it is 50% of application success.**



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How do you choose the right technology?

Three criteria to evaluate before you commit to a decorating technology



MATERIAL

What are you printing on?

- Surface energy & wettability
- Flat, cylindrical or conical
- Coatings, texture, recycle



APPLICATION

What does the job demand?

- Throughput / parts per hour
- Detail, color, variable data
- Job changeover frequency



ENVIRONMENT

Where does it have to run?

- Floor space & line integration
- Operator skill and staffing
- EHS, solvents, cure, ventilation

No single technology wins — the right one satisfies all three criteria.



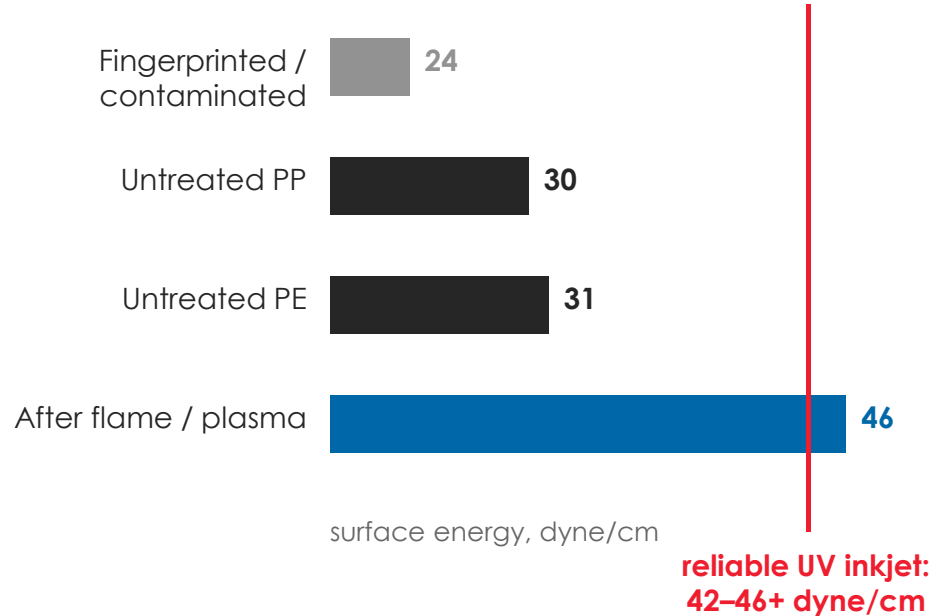
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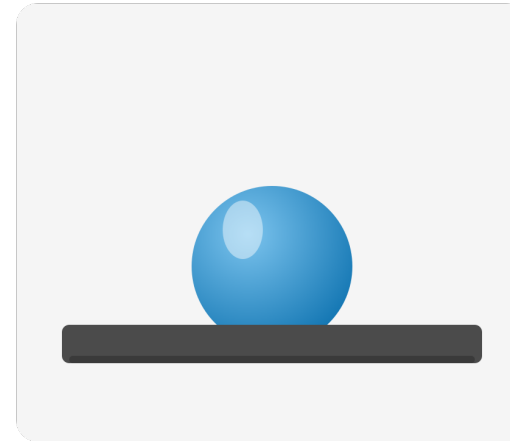
Why Ink Won't Stick - When is pretreatment needed?

Low Surface Energy + Real-World Contamination = Adhesion Failure

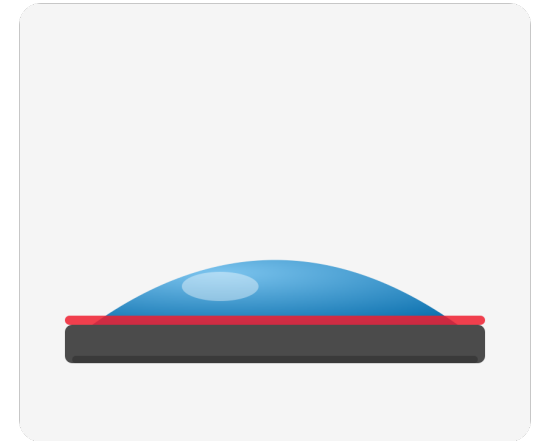
THE DYNE GAP



WETTING IN ACTION



UNTREATED
ink beads up, rubs off



TREATED — 44+ DYNE
ink wets out & bonds



Fingerprints & handling oils



Mold release & slip agents



Dust & static attraction



Lot-to-lot resin variability

If the drop can't wet the surface, no printhead, ink or cure can fix it.



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Case Study – Dental Floss Containers

Small PP Parts, Curved Faces — Precision Spot Plasma

XD-108 SERIES

	Industry	Personal care packaging
	Replaces	Dry offset, pad & pressure-sensitive labels
	Pre-Treat	Blown-ion plasma spot-treats only the decorated face
	Product Volume	High-volume continuous feed
	Advantages	Variable data, multi-SKU runs, no label inventory



Focused treatment = no wasted energy, no over-treated sidewalls



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Case Study – 4" PP Lids at 400 per Minute

Inline Flame Treatment Ahead of a Single-Pass XD-108

XD-108 SERIES



Industry

Food & consumer packaging



Replaces

Dry offset printing



Pre-Treat

Inline flame — full print-face treatment at line speed (~30 → 44+ dyne)



Product Volume

4" lids: 400 ppm



Advantages

Zero setup between jobs, 100% inspection/rejection, no changeover



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Case Study – Caps & Closures at 700–2,000 PPM

Flame Dose Synced to the Conveyor — No Margin for Error

XD-108 SERIES

	Industry	Beverage & CPG packaging
	Replaces	Dry offset & pad printing
	Pre-Treat	Flame dosed to conveyor speed — stable dyne even at 2,000 ppm
	Product Volume	Caps: 700–2,000 ppm
	Advantages	SKU-level versioning, zero changeover, 100% inspection



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Case Study – PET Bottles



XD-70 SERIES

	Industry	Food & consumer packaging
	Replaces	Screen
	Pre-Treat	Inline Plasma
	Product Volume	PET Bottles: 30–100 ppm
	Advantages	Zero setup between jobs, 100% inspection/rejection, no changeover

BEFORE — Untreated



AFTER — Inline Plasma



Plasma pre-treatment sharpens edge definition and eliminates ink pull-back on PET.



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What Inks Work Best on Specific Materials

Start with the substrate, then layer on the application and regional requirements

Substrate	Typical products	Ink chemistry that works	Pre-treatment
PET / PETG	Bottles, blister packs	UV LED, low-migration UV	Plasma
HDPE / PP	Caps, closures, drums	UV LED + adhesion promoter	Plasma or Flame
Glass	Jars, cosmetics	UV, hybrid organic	Flame or Plasma

ALSO IN THE DECISION

- Regional regulations
- Low-migration inks
- Design for recycling
- Cure: UV, LED, thermal
- Weathering / outdoor
- Flexibility, deep draw

Application determines the ink chemistry — pre-treatment is the enabler.



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Key Takeaways

Adhesion is Engineered, Not Hoped For



One Pass, One Chance

- Single-pass gives no second passes to hide behind
- Treatment must be inline and synced to line speed



Automate the Treatment

- Flame or plasma integrated into the production cell
- Loading, treating, printing, inspection — one system



Know Your Substrate

- Resin, additives and recycled content change everything
- Establish adhesion requirements upfront



Pre-Treatment is Non-Negotiable

- Nearly 100% of plastic DTO applications need it
- Pre-treatment + ink = 50% of application success



Test Ink + Treat Together

- Adhesion is a system property, not an ink spec
- Joint EPS + Enercon trials with your parts and speeds



Built for 24/7 Production

- Dyne stability, monitoring and uptime matter
- If treatment drifts, the whole line is down



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Summary

- Direct-to-product digital printing is rapidly growing
 - Provides brand owners with unique shelf appeal
 - Provides manufacturers with production flexibility
- Surface preparation is key for process consistency
 - Plasma, flame & corona are all viable technologies
- Single-pass printing technology enables high speed production
- Tips for selecting the right inks for your application
- Adhesion is engineered!



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Thank you



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