



Introducing Molecular Plasma Technology

Sustainable Surface Functionalization for Adhesive Bonding & more



ETFE AND ACRYLIC FOAM TEST TAPE

SOLVENT-FREE

ATMOSPHERIC

***Adhesion of acrylic
foam test tape on
ETFE film***

Click [here](#) to
watch the
video on
the

NEAR ZERO EMISSIONS

ROOM TEMPERATURE

WHAT IS MOLECULAR PLASMA?

- A technology that enables surface functionalisation of even the most **inert** (Teflon, carbon fibre, ...) or highly **sensitive** substrates (natural fibres, ...).
- Using atmospheric plasma at **room temperature** as a vector to graft sensitive **organic chemistry** onto any surface
- Resulting in a **permanent** surface modification
 - **MolecularGRIP™ technology**
 - Hydrophobicity & hydrophilicity
 - Virucidal functionality
 - Complex biomolecule deposition
 - ...



WHAT MAKES US DIFFERENT?

Comparison of a traditional Corona torch to our **PlasmaSpot®**

Click [here](#) to watch the video on YouTube



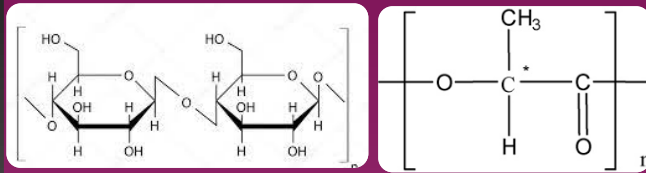
WHAT MAKES US DIFFERENT?

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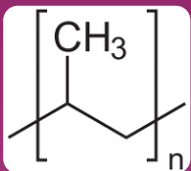
MAJOR INDUSTRY CHALLENGES

INERT & SENSITIVE NATURAL MATERIALS

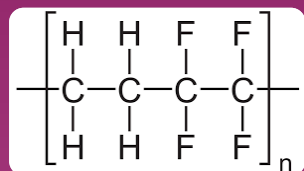


CELLULOSE

PLA



PP



ETFE

EHS CONCERNS



SOLVENT- BASED
PRIMERS

LIMITED OPEN TIME



PROCESS
CONSTRAINTS

INLINE PROCESS CONTROL



SCRAP & RISK
REDUCTION

EXAMPLES OF PROVEN FUNCTIONS AND PRECURSORS

Adhesion promotion	Permanent Hydrophilic	Permanent Hydrophobic	Surface Compatibilization
Amines, hydroxyls, carboxyls, epoxy, isocyanates with vinyls, siloxanes, acrylates, thiols, ...	Acrylates + siloxanes + vinyl containing precursors with amino, hydroxyl, carboxyl and epoxy functionalities	Siloxanes Fluorinated Long chain hydrocarbons	Polyolefin-like, amines, epoxies
Linker Layers	Virucidal / Biocidal	Biomolecules	Anti-biofouling
Amines, carboxylic acids	Citric acid, quaternary ammonium	Proteins, antibodies	PEG-derivatives
(Semi)conductive	Protective (corrosion, polymer swelling)	Scents / Oils	Release
Conductive polymers	Siloxanes, Hydrocarbons Fluorinated compounds	Essential oils Menthols	Fluorinated compounds Non-fluorinated compounds (siloxanes and acrylates)

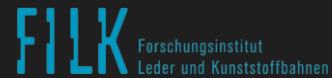
There is **no restriction** on the type of **organic** chemistry: *Pure liquids, mixtures, emulsions, suspensions of nanoparticles, or polymer solutions*



About the “Solar Impulse Efficient Solution” Label

One of the first labels for positive impact businesses bringing together protection of the environment and financial viability, the “Solar Impulse Efficient Solution” Label is attributed following an assessment performed by external independent experts. In collaboration with renowned institutions, solutions applying for the label must go through a neutral methodology based on verified standards. This label serves as an award for clean and profitable solutions.

SOME OF OUR REFERENCES



“MPG’s technology is the next ‘ECO’-logical step in surface functionalisation”

Alan Taylor (Technology Fellow at The Welding Institute)

“Unlike all the other plasma treatment people, MPG can really change the surface rationally to get proper adhesion, at commercially relevant speeds ”

Prof. Steven Abbott (ex. ICI & McDermid)

“We are collaborating efficiently with MPG and are supporting the dissemination of this innovative technology.”

Guy Larnac (ArianeGroup)

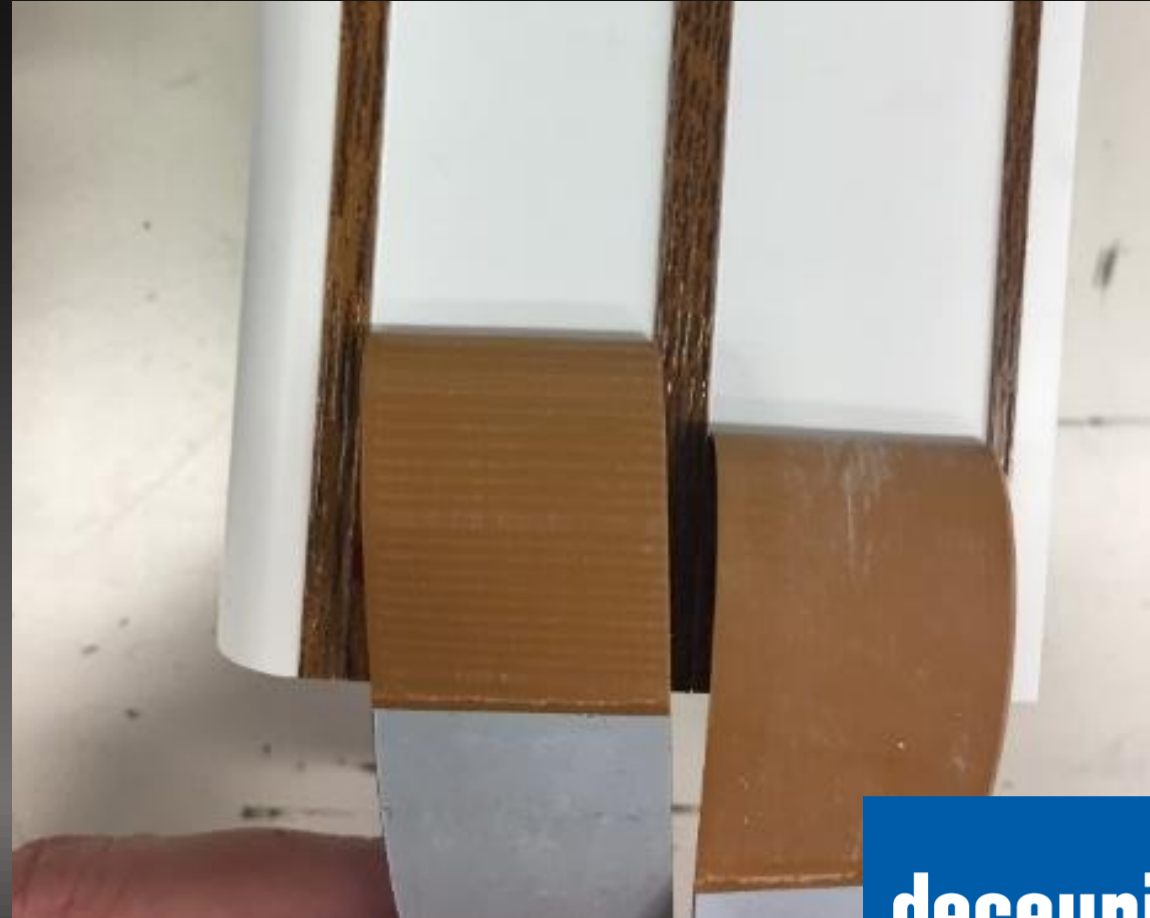


CASE STUDY 1: PVC-TO-FOILING

Target: **replacement of PRIMER** for the adhesion of decorative foiling onto PVC frames

Challenges:

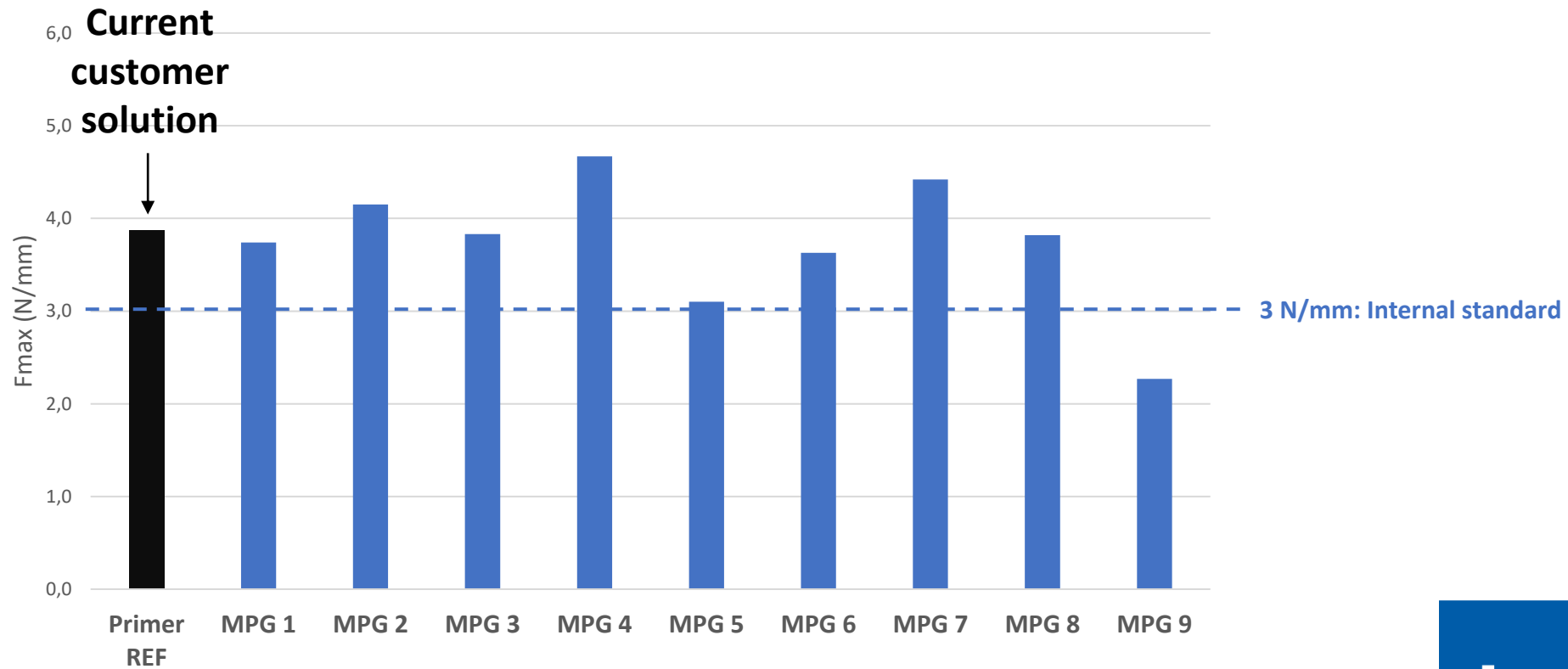
- Must be compatible with currently-used adhesion system
- Plasma coating **must pass all ageing tests**



deceuninck

CASE STUDY 1: PVC-TO-FOILING

Before ageing test: fine tuning of plasma process condition to optimize initial adhesion. **Adhesion values overtake customer target and primer performance.**

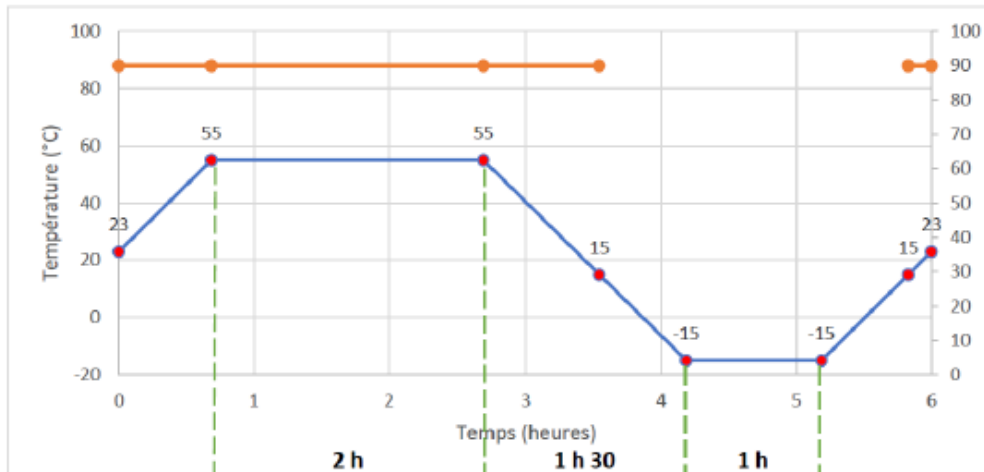


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CASE STUDY 1: PVC-TO-FOILING

Two-stage ageing tests:

Cyclic climate chamber test (CSTB)



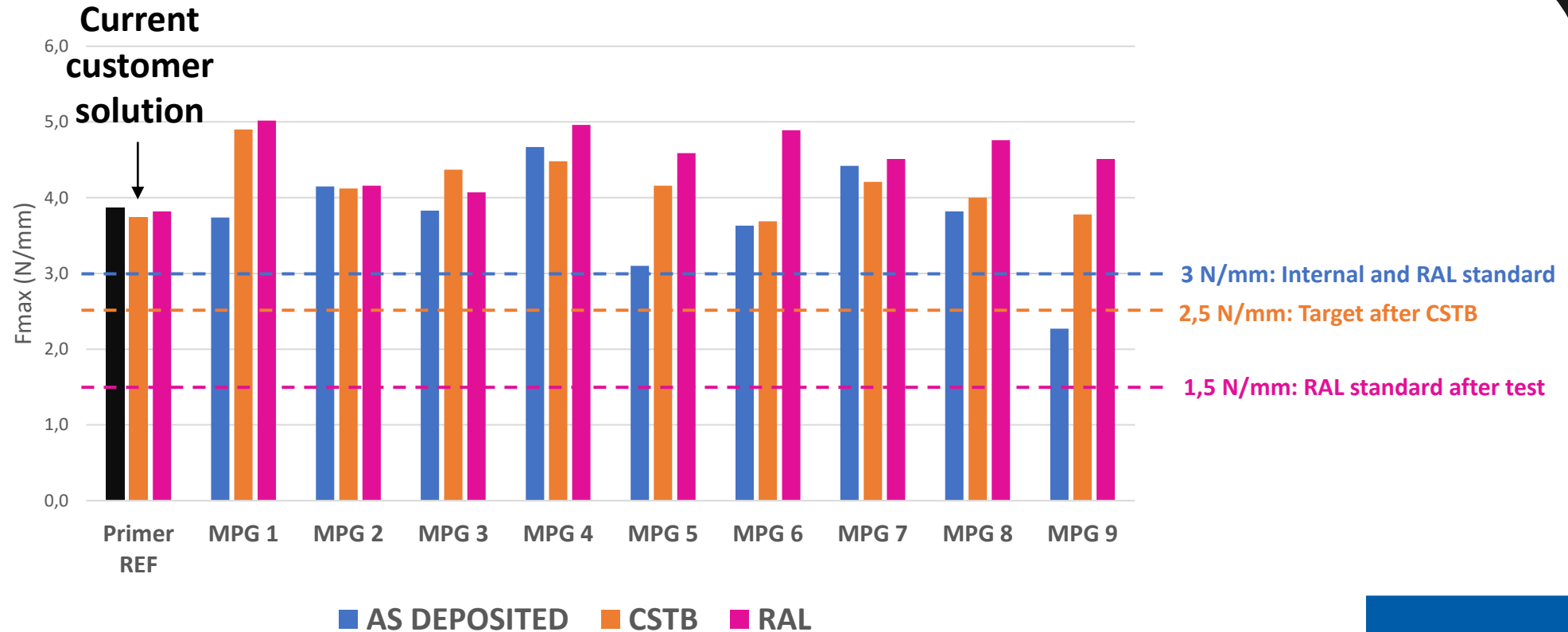
- 14 days
- 56 cycles
 - Temp variation: -15 -> 55 °C
 - RH > 90% (at temperatures > 15°C)

Accelerated aging test (RAL)

- 42 days
- 70°C
- 98 % RH
- Harsher conditions compared to CSTB
- Thermolysis/hydrolysis attempt
- Equivalent to 10 year-ageing

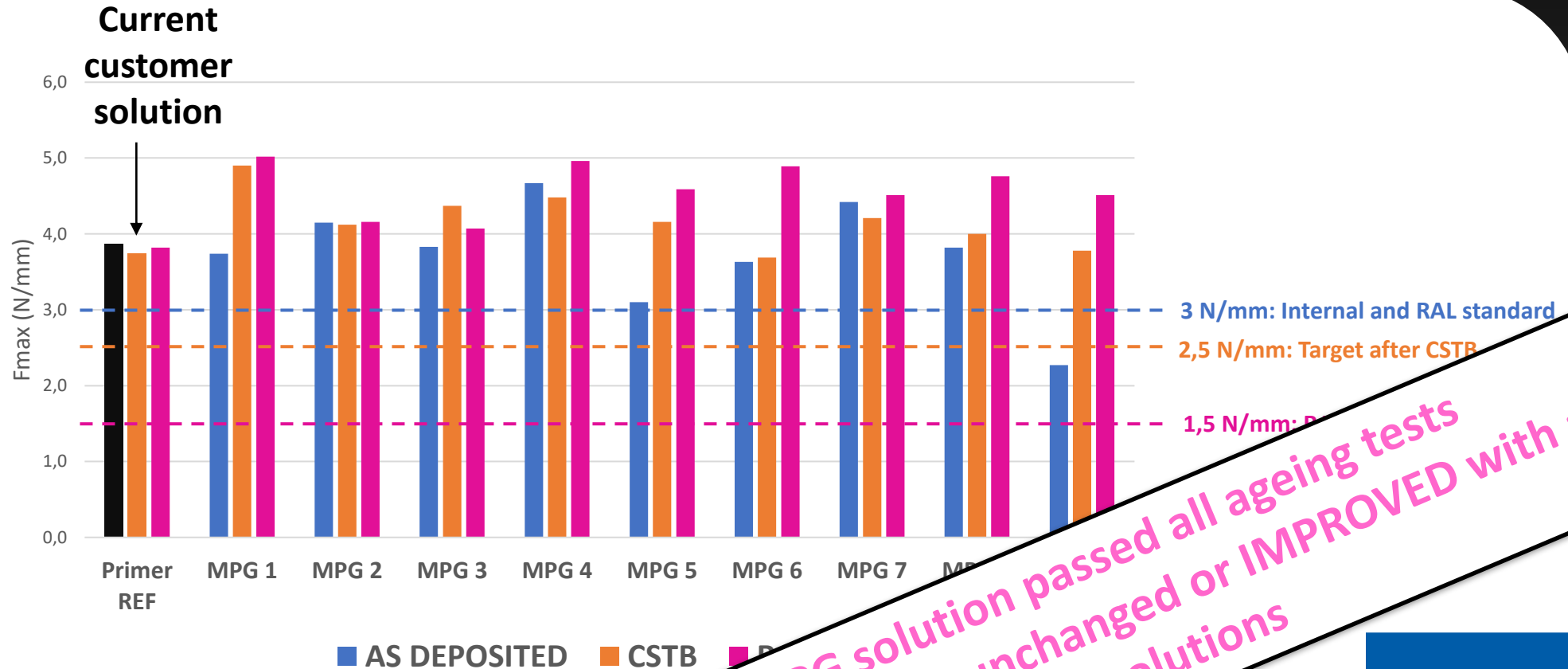
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CASE STUDY 1: PVC-TO-FOILING



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CASE STUDY 1: PVC-TO-FOILING



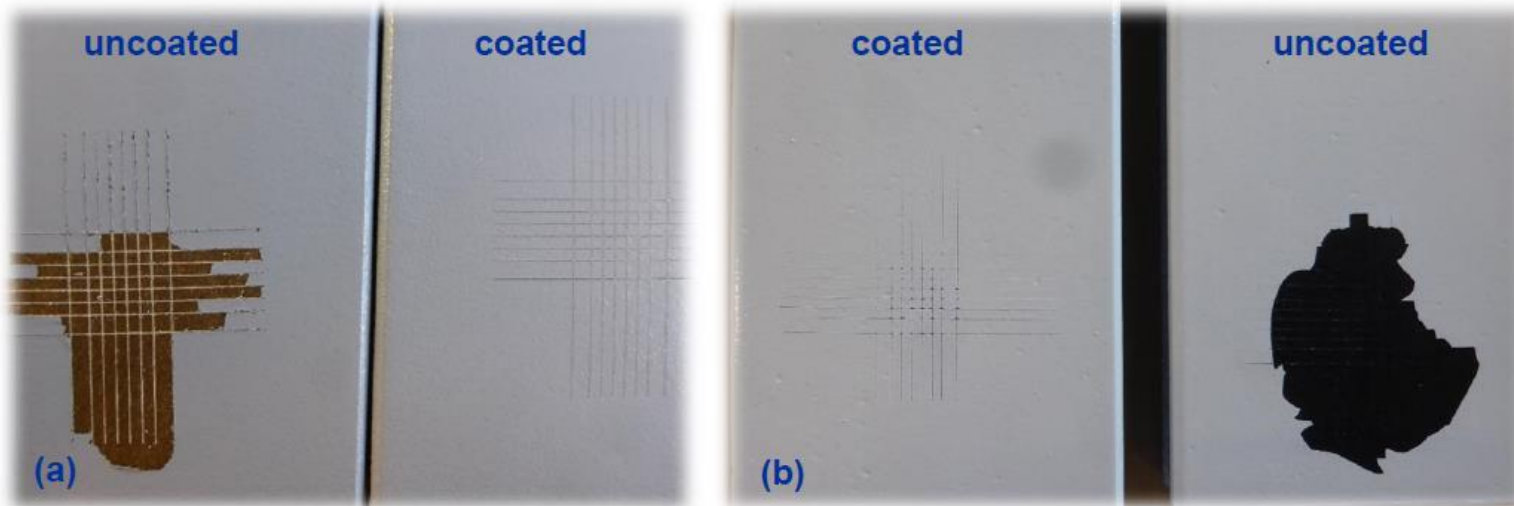
✓ MPG solution passed all ageing tests
✓ Adhesion unchanged or IMPROVED with ageing!
✓ Multiple robust solutions



CASE STUDY 2: WOOD PLASTIC COMPOSITE (WPC)

WPC profiles with the adhesion promoter layer (GLYMA) were coated using an acrylic powder coating system and an acrylic wet paint. Afterwards, cross cut tests were performed.

Results: Very good adhesion between WPC and both acrylic topcoats



Cross cut tests on WPC profiles with an adhesion promoter layer (GLYMA) using (a) a wet acrylic paint and (b) an acrylic based powder coating

Functional coatings on wood-based materials using PVD and atmospheric plasma

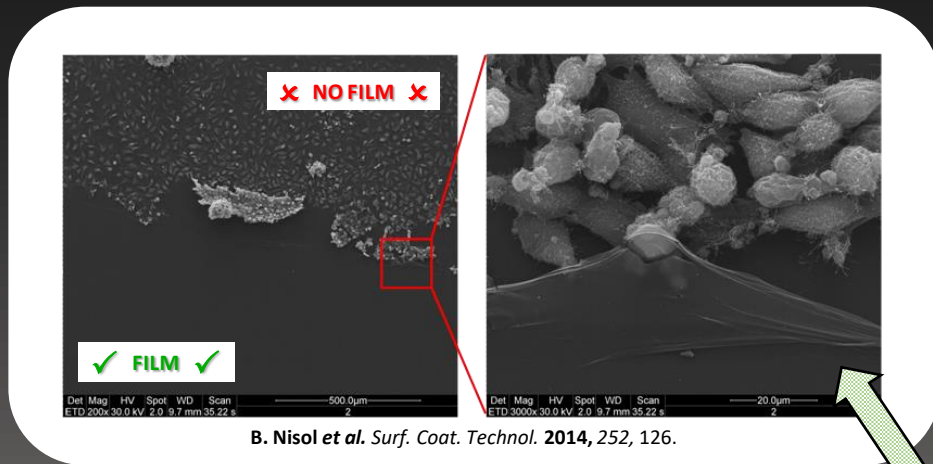


CASE STUDY 4: BIOMOLECULE DEPOSITION

BIOSENSORS, MICROFLUIDICS

ANTI-BIOFOULING COATINGS

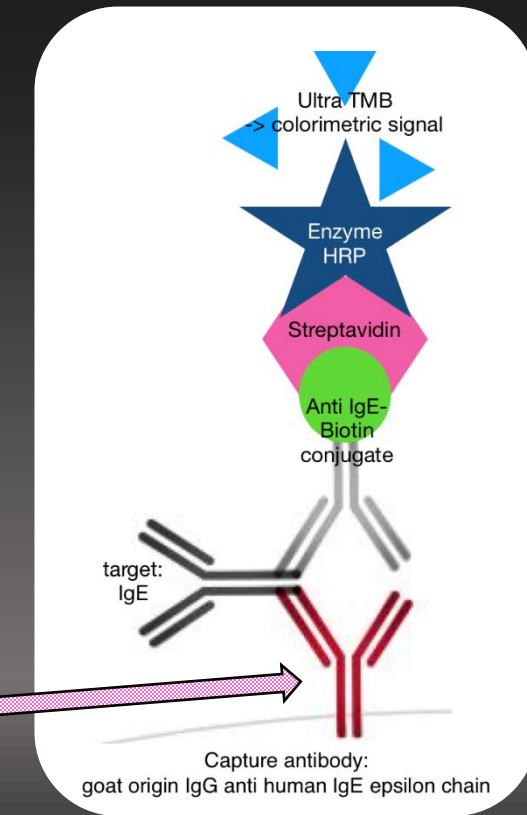
Protein- and cell-repellent surfaces



MEDICAL DEVICE
Gold, Glass, C-Si wafer, Polymers (PMMA, PC, COC, PTFE...)

COMPLEX BIOMOLECULES

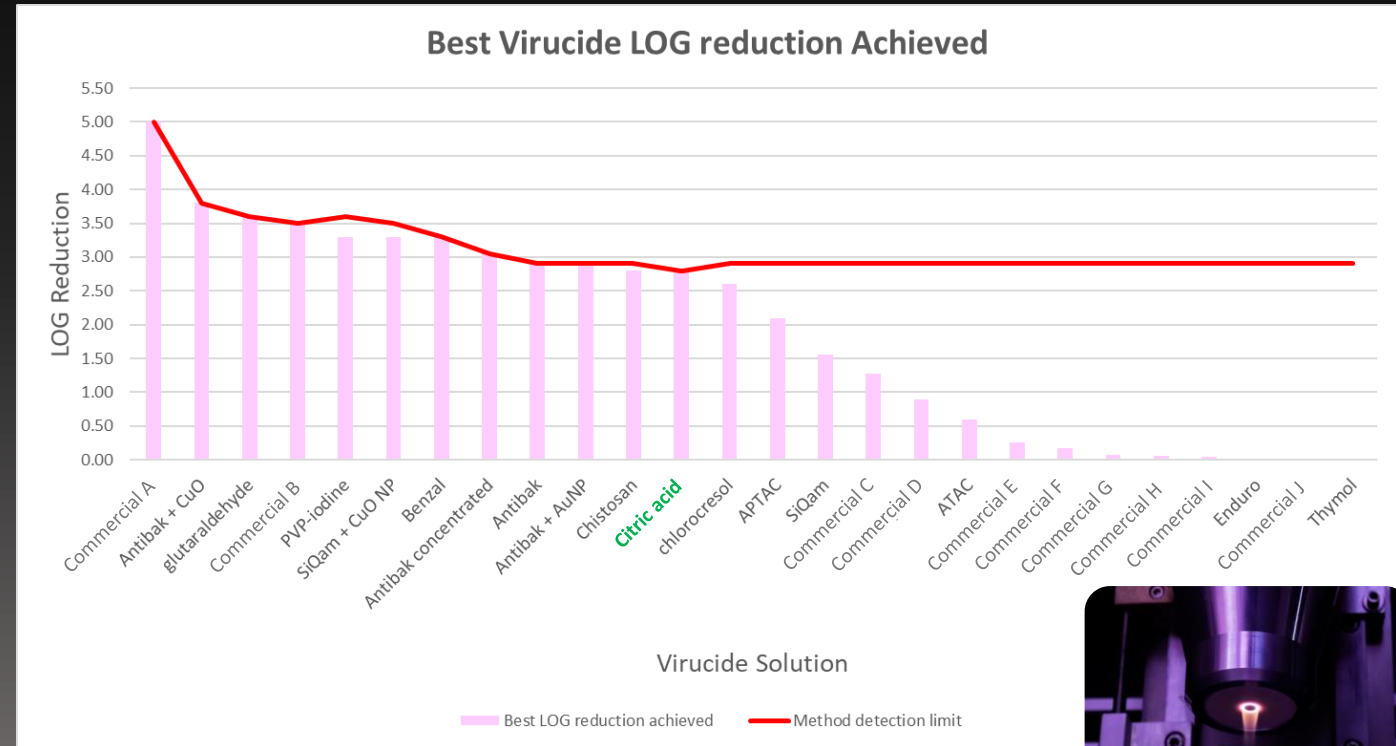
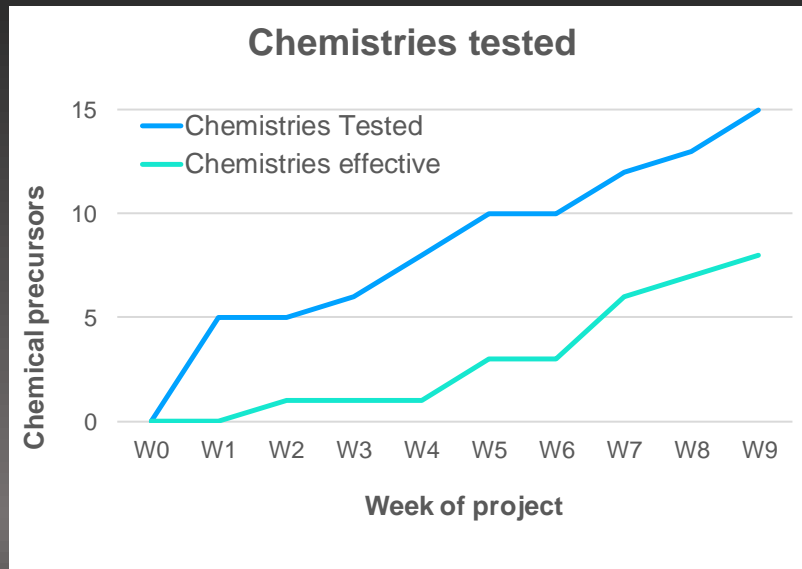
Direct deposition of antibodies, peptides, proteins, DNA, ...



CASE STUDY 5: VIRUCIDAL COATINGS

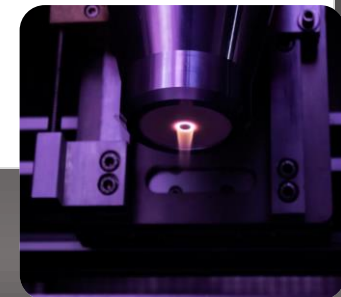
Wide range of chemistries tested:

- Pure liquid chemicals
- Solutions of natural compounds or biomolecules
- Commercial biocidal formulations
- Drugs/Therapeutic agents



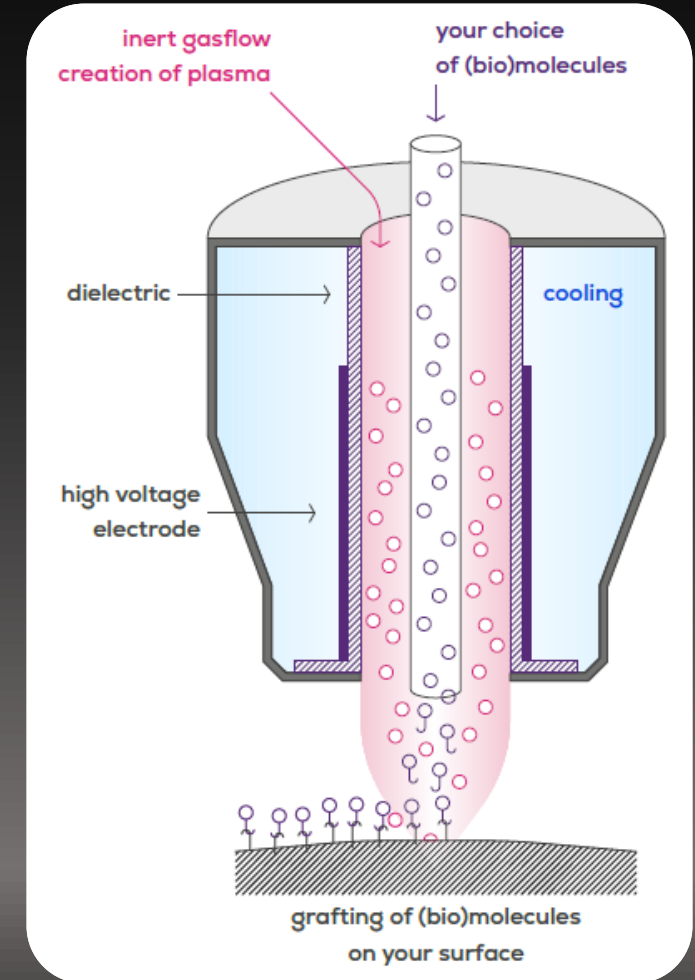
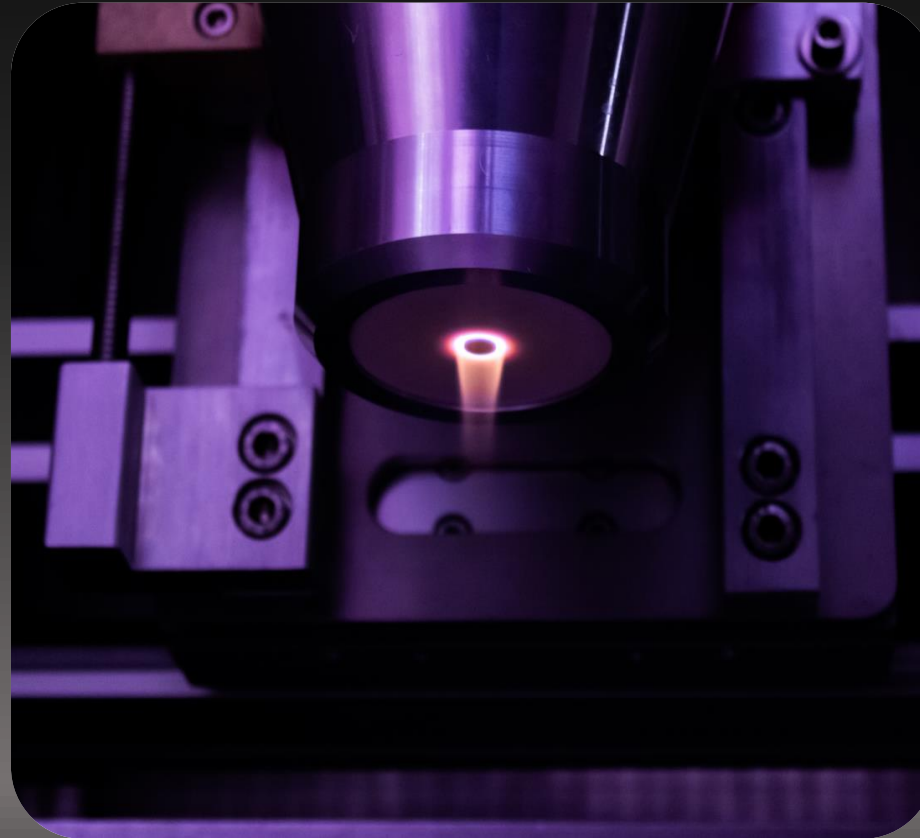
Focus on citric acid

- Excellent virucidal efficacy
- The opinion provided by the Biocidal Products Committee of the European Chemicals Agency ECHA/BPC/088/2016 from 16/02/2016 concluding that: "The use of citric acid in anti-viral facial tissues does not pose an unacceptable risk to the human health or to the environment."
- It is an allowed food additive by the FDA
- CA is an allowed monomer for plastics and material to be in contact with food
- CA is an allowed food additive in Europe (E330)
- The French National Agency of Medicine and Health Products Safety on CA from 14/08/2017 highlighting its common use



INTO THE CORE

- ✓ Indirect DBD plasma
- ✓ No arcing
- ✓ No fouling of electrodes
- ✓ Ambient T and P
- ✓ Adaptable for fibre and powder treatment



PLASMASPOT® VERSIONS

ROBOT



- ✓ Plug and play
- ✓ Safe
- ✓ Easy to use
- ✓ Fast changeover
- ✓ Adaptable
- ✓ Versatile

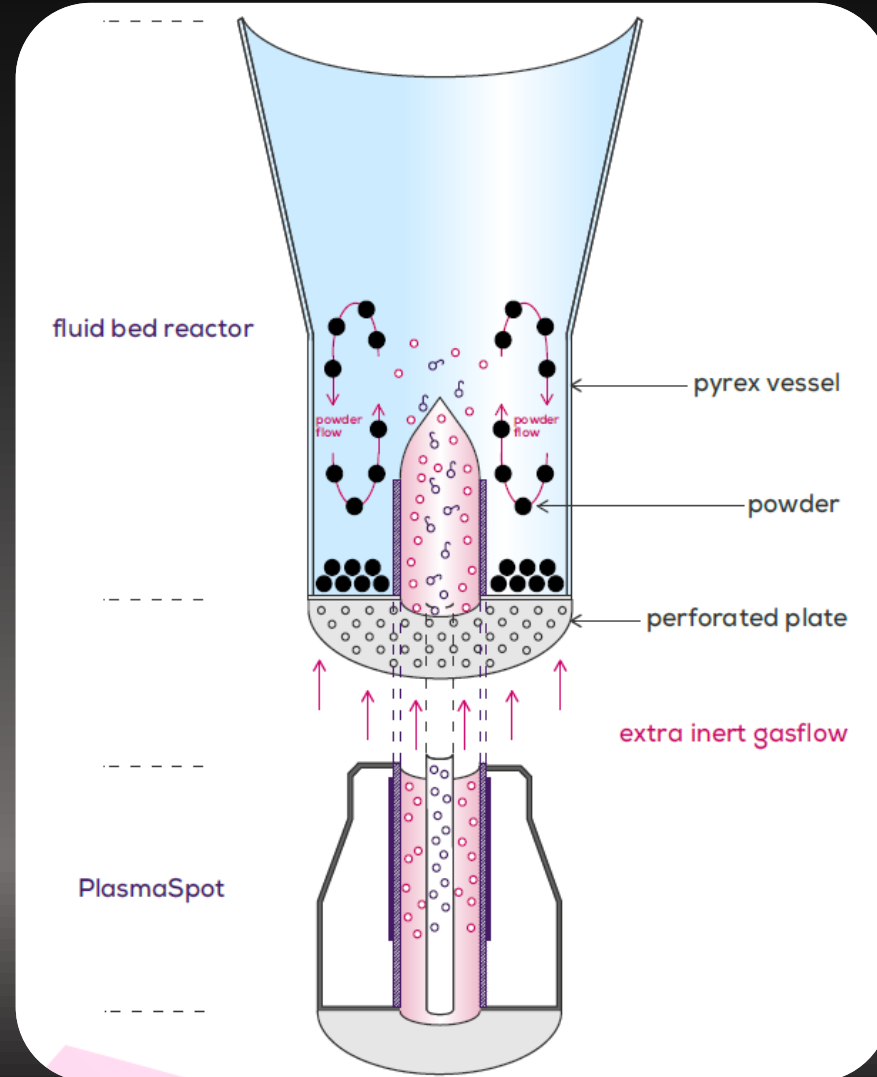
MINI



MAXI



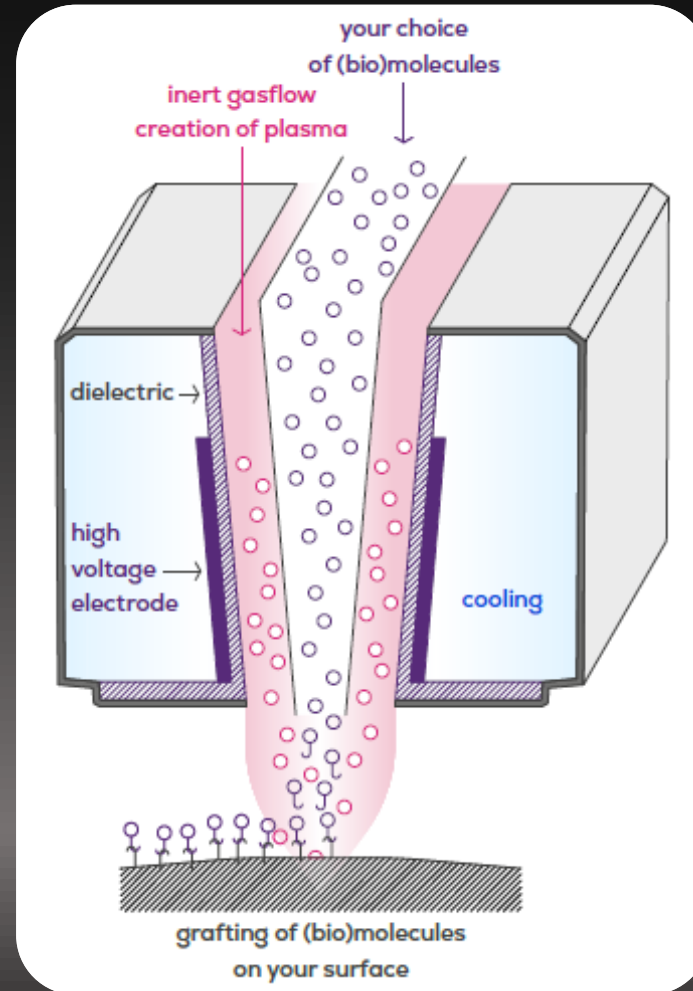
- ✓ Plug and play
- ✓ Safe
- ✓ Easy to use
- ✓ Fast changeover
- ✓ Adaptable
- ✓ Versatile



SPECIFICATIONS

- Batch treatment of powder
- Powder quantities:
 - 1 L vessel: 50 to 200 g
 - 4 L vessel: 200 to 1 kg
- Particle size: 50 micron to 3 mm
(Based on density of 0.5 kg/l)
- Plasma gas types:
 - N₂, Ar, He, air, CO₂
 - mixtures and more

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- ✓ Easy to use
- ✓ Fast changeover
- ✓ Adaptable
- ✓ Versatile

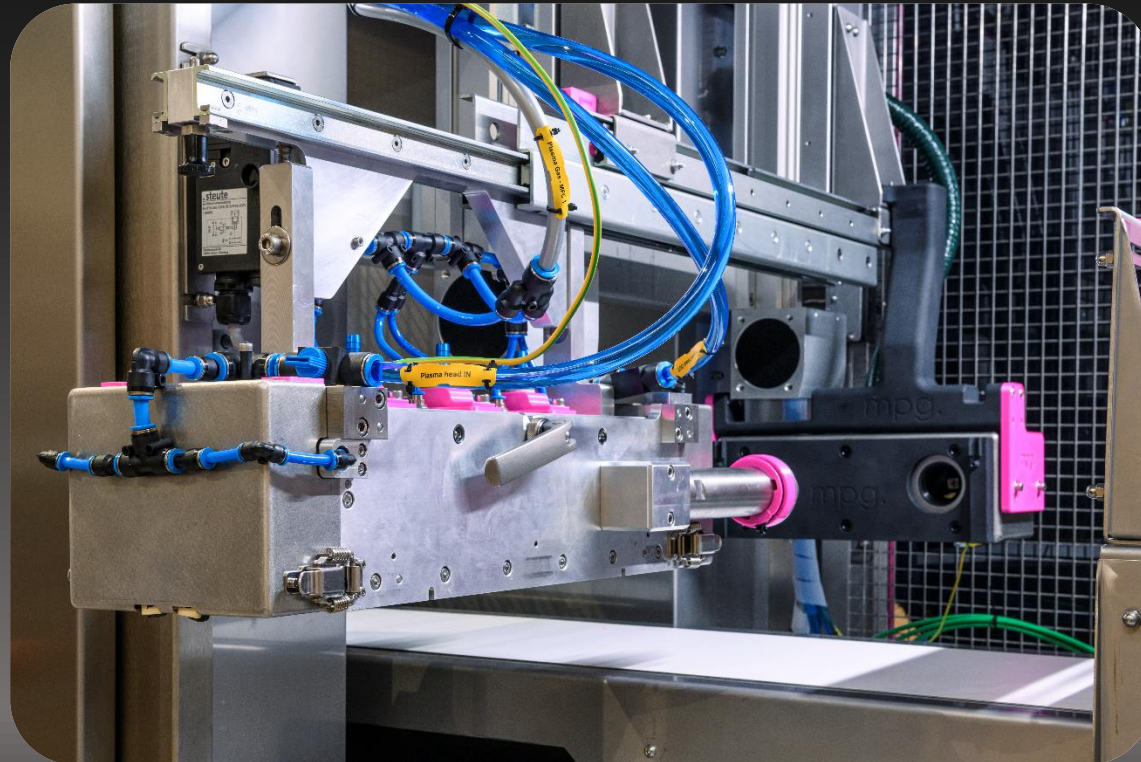


SPECIFICATIONS

- Line width: 40 cm up to 1.6 m
- Data tracking & collection
- Remote diagnostics
- Plasma gas types:
N₂, Ar, air, CO₂
mixtures and more

PLASMALINE[®] - FROM PROTOTYPE TO INDUSTRIAL SOLUTION

- ✓ Plug and play
- ✓ Safe
- ✓ Easy to use
- ✓ Fast changeover
- ✓ Adaptable
- ✓ Versatile



SPECIFICATIONS

- Line width: 40 cm up to 1.6 m
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R2R PRODUCTION PLATFORM 1000 – 1600 MM

Click [here](#) to watch the video on YouTube



sustainable technology for surface functionalization

OUR SOLUTION IS GREEN

Environment – intrinsically GREEN



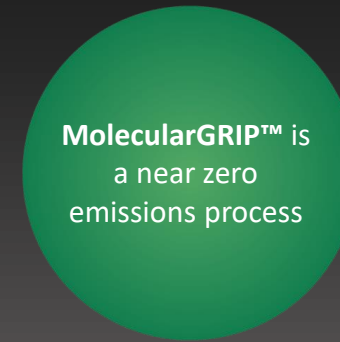
Low energy



No solvents



Less chemicals



= Same effect

WET DEPOSITION/PRIMER:

5 – 50 ml / m²

100 to 1000 X reduction

MPG:
0,05 ml / m²

OUR SOLUTION IS GREEN

Calculation of chemistry savings per production line

Example 1: Roll-to-roll film priming for adhesion/lamination

Roll width	1,6 m
Line speed	40 m/min
Annual production time	8000 hours
Annual production quantity per line	30.720.000 m ²
Quantity of chemistry used in wet chemical process	5 ml/m ²
Quantity of chemistry used in MPG process	0,05 ml/m ²
Annual quantity of chemistry used in wet chemical process	153.600 liter
Annual quantity of chemistry used in MPG process	1.536 liter
Chemistry usage reduction factor	100 times
Annual chemistry savings for 1 production line	152.064 liter





Date : April 23, 2022

Prepared by: Marc Jacobs

Calculation of chemistry savings per production line

Example 2: Automotive Direct Glazing

Treatment length	3,5	m
Treatment width (circumference of glass)	0,02	m
Parts per year per line	100.000	parts
Surface treated per year	7.000	m ²
Quantity of chemistry used in wet chemical process	50	ml/m ²
Quantity of chemistry used in MPG process	0,05	ml/m ²
Annual quantity of chemistry used in wet chemical process	350,00	liter
Annual quantity of chemistry used in MPG process	0,35	liter
Chemistry usage reduction factor	1000	times
Annual chemistry savings for 1 production line	349,65	liter

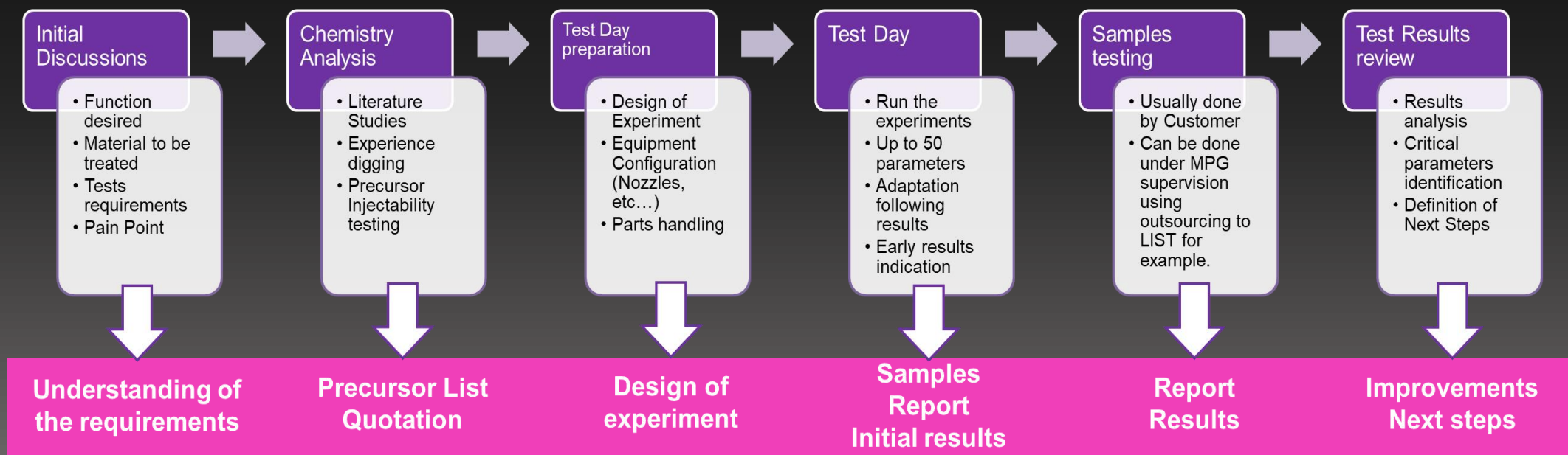


What type, shape and size of substrates can we treat?

- We can treat anything ranging from:
 - The most **inert** surfaces
(Fluorinated polymers, Glass, Polyolefins, Carbon fibres ,...)
 - The most **sensitive** materials
(paper, biodegradable polymers,...)
- We can treat from powders and fibres, to flat surfaces & 3D parts, using a spot size of 0.5 mm up to a full working width of 1.6 m.

ENGAGE WITH US: DISCOVERY DAY CONCEPT

Full Package that includes



THANK YOU!

Questions or info required?

Please visit:

www.molecularplasmagroup.com

Forward your questions to:

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Or call + 352 621 132 154



LU  **EMBOURG**

LET'S MAKE IT HAPPEN