# Introducing MolecularGRIP™

# Sustainable Surface Functionalization for Adhesive Bonding

# and more…

molecular plasma group

Marc Jacobs, CEO

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# ETFE AND ACRYLIC FOAM TEST TAPE

Click here to watch the video on YouTube


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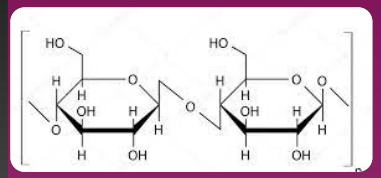
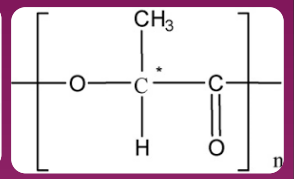
# MAJOR INDUSTRY CHALLENGES

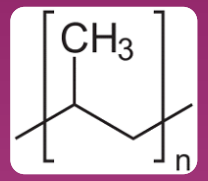
## INERT & SENSITIVE NATURAL MATERIALS



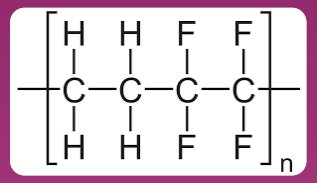
CELLULOSE



PLA



PP



ETFE

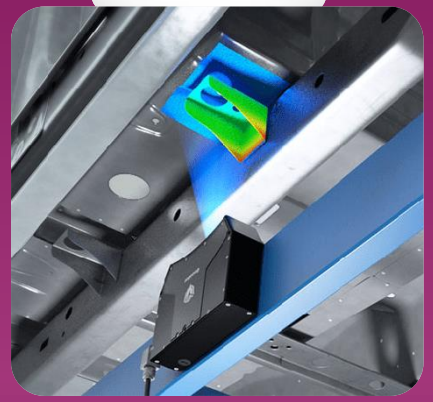
## EHS CONCERNS


SOLVENT- BASED PRIMERS

## LIMITED OPEN TIME

PROCESS CONSTRAINTS

## INLINE PROCESS CONTROL



SCRAP & RISK REDUCTION

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# WELCOME TO MPG

## Locations

- Foetz, Luxembourg
  Plasma Lab &
  Manufacturing
- Leuven, Belgium
  Plasma Lab &
  Training center
- Sales office in UK

## Foetz, Luxembourg


Plasma Lab &
Manufacturing

## Leuven, Belgium


Plasma Lab &
Training center

- **Full service provider: from application development to industrial solutions**
- **Proprietary, well protected technology**

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# SOME OF OUR REFERENCES

**Testimonial by Guy Larnac (ArianeGroup)**

***"We are collaborating efficiently with MPG and are supporting the dissemination of this innovative technology."***

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# 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 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
    - ...

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# What makes us different?

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

Click here to watch the video on YouTube


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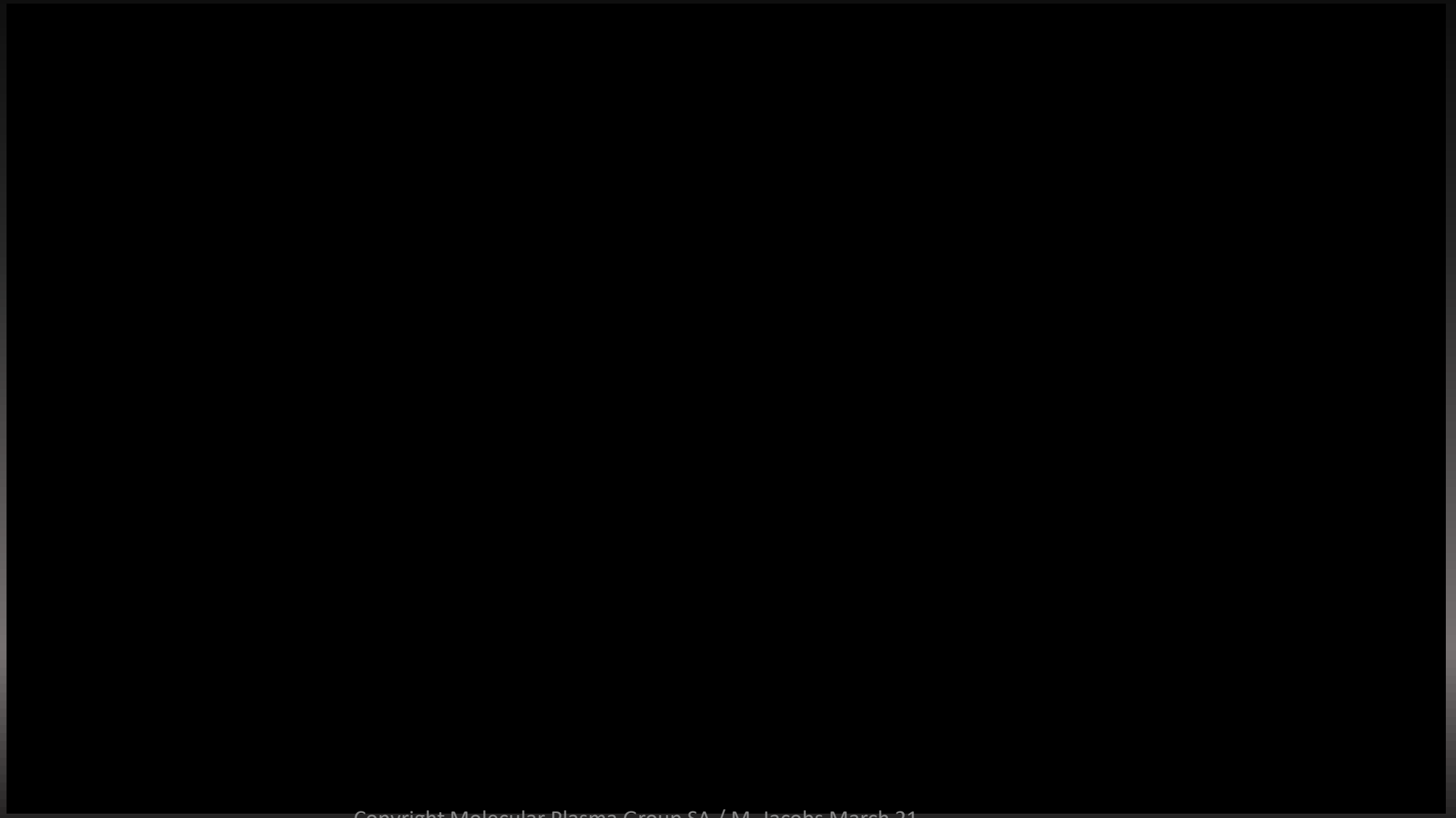
# WHAT MAKES US DIFFERENT?

Click here to watch the video on YouTube



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# The "Molecules" in Molecular Plasma

## What type of molecules can graft on the surface?

- There is **no restriction** on the type of **organic** chemistry

  *Pure liquids, mixtures, emulsions, suspensions of nanoparticles, or polymer solutions*

| | | |
|---|---|---|
| ✓ | **Adhesion improvement** | e.g. hydrophilic, reactive functional groups (amine, epoxy, acrylic, …) |
| ✓ | **Release coatings** | e.g. fluorinated & non-fluorinated molecules |
| ✓ | **Biomolecule immobilization** | e.g. antibodies, peptides, proteins, DNA,… |
| ✓ | **Anti-biofouling coatings** | e.g. PEG-like, … |
| ✓ | **Virucidal coatings** | e.g. citric acid, ... |
| ✓ | **Antimicrobial coatings** | e.g. antimicrobial peptides, quaternary ammonium |

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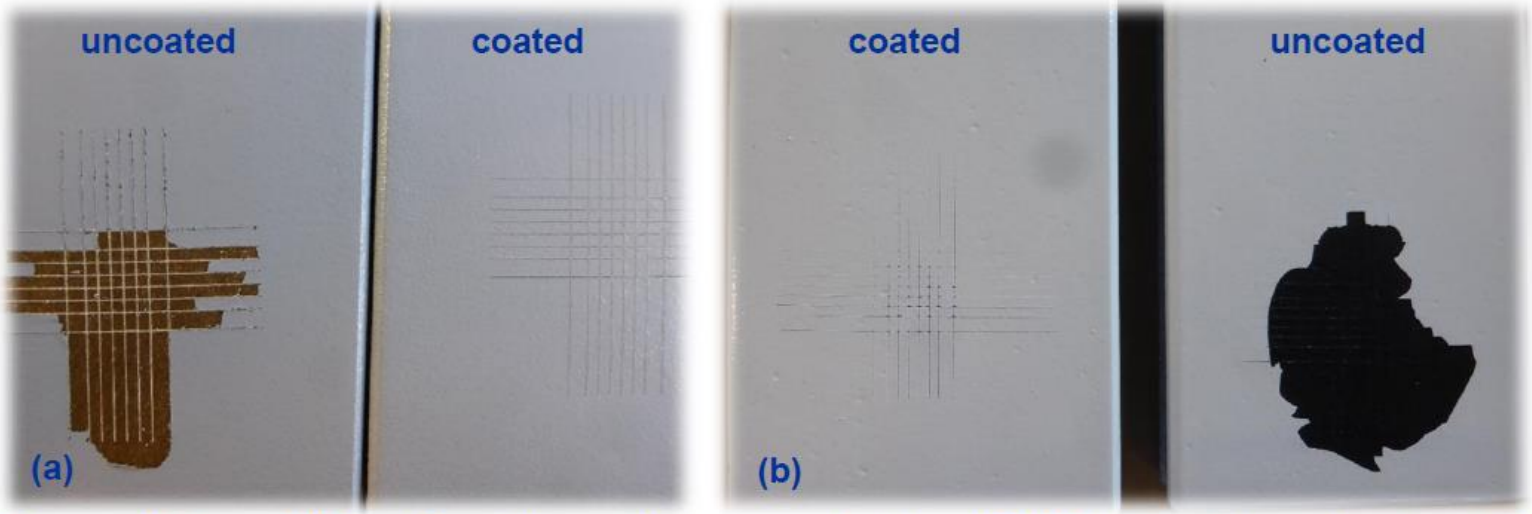
# Case study #1 – Wood Plastic Composite (WPC)

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

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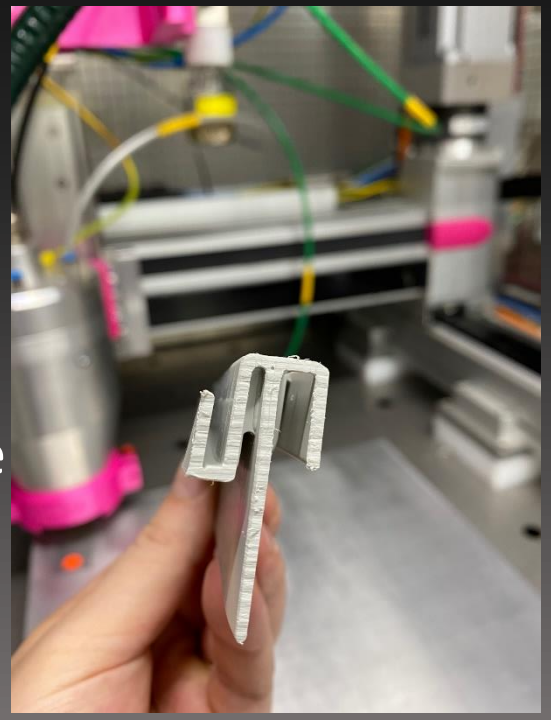
# Case Study 2: PP consumer goods

**Target:** gluing of polypropylene (PP) plates to PP frames using 1K/2K hybrid glues

**Challenges:**

- Adhesive failure between glue and PP
- Open time is too short

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# CASE STUDY 2: PP CONSUMER GOODS

**Target:** gluing of polypropylene (PP) plates to PP frames using 1K/2K hybrid glues

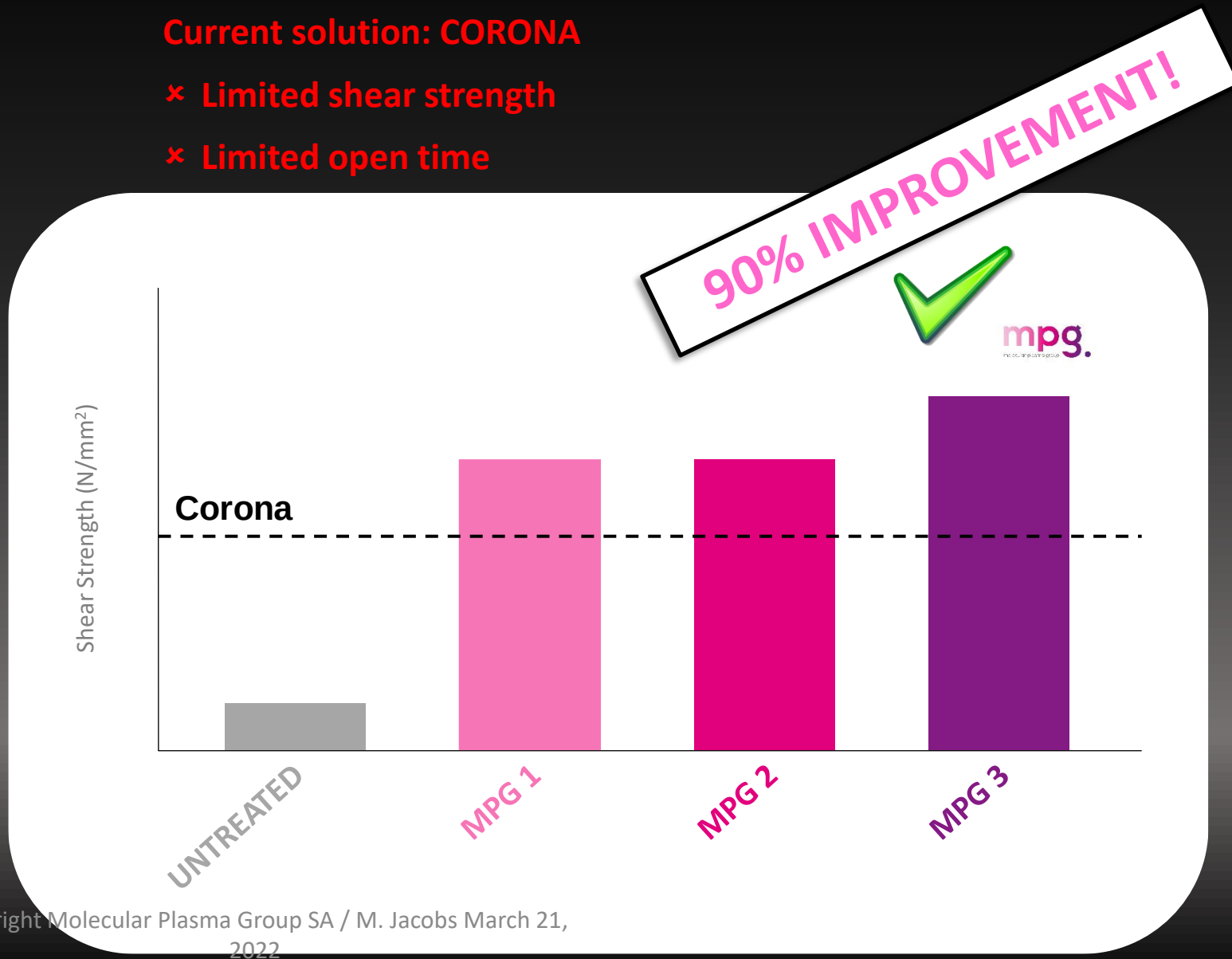
**Challenges:**

- Adhesive failure between glue and PP
- Open time is too short

**Current solution: CORONA**

× Limited shear strength

× Limited open time

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# CASE STUDY 2: PP CONSUMER GOODS

**Target:** gluing of polypropylene (PP) plates to PP frames using 1K/2K hybrid glues

**Challenges:**

- Adhesive failure between glue and PP
- Open time is too short

**OPEN TIME**

**CORONA: a few hours**

**100 X improvement**

**MPG: weeks/months**

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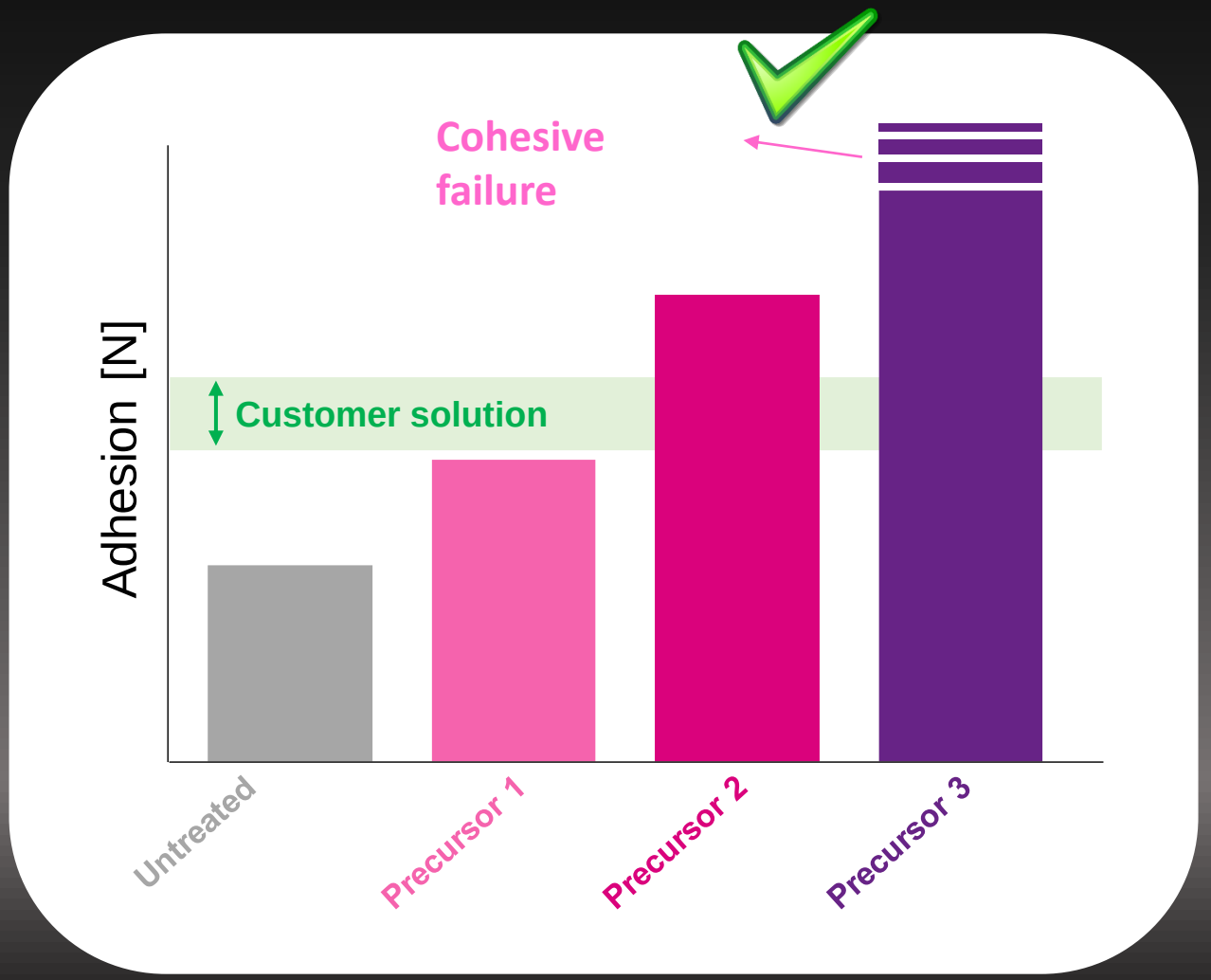
# Case Study 3: Aramid textile to elastomer

**Target:** direct adhesion of elastomer on aramid woven textiles

**Challenge:** improving adhesion

Precursor-dependent!

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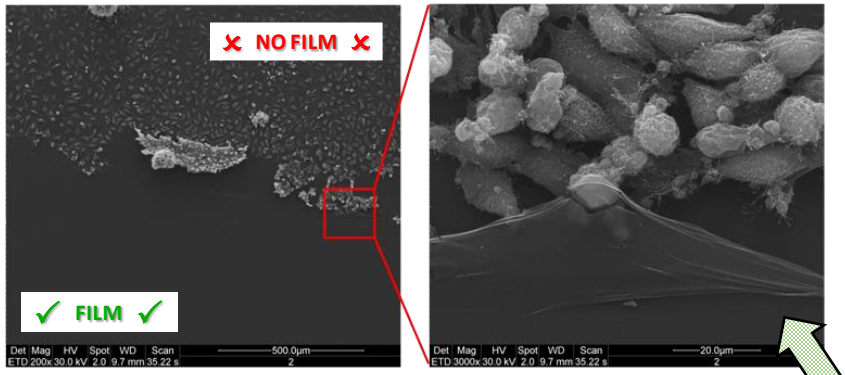
# CASE STUDY 4: BIOMEDICAL COATINGS

## BIOSENSORS, MICROFLUIDICS

### ANTI-BIOFOULING COATINGS

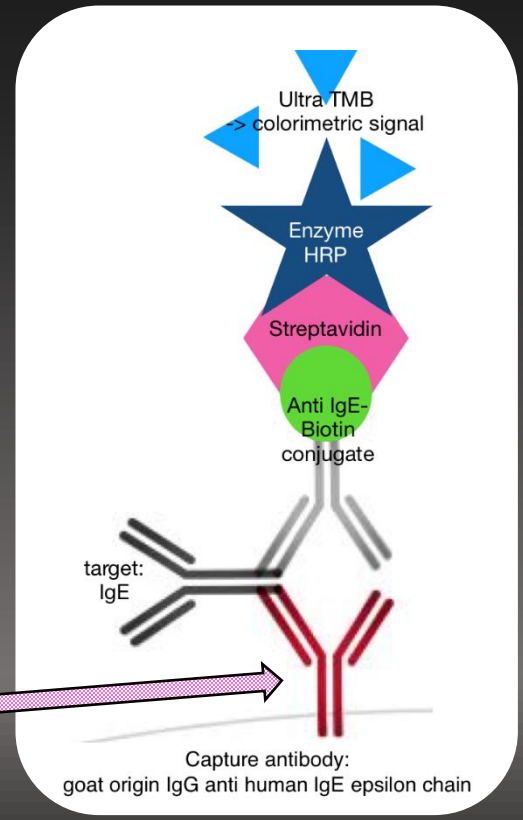
**Protein- and cell-repellent surfaces**




B. Nisol ***et al.*** *Surf. Coat. Technol.* **2014,** *252,* 126.

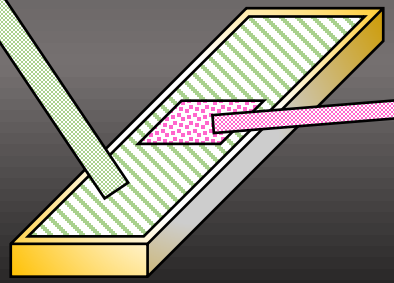
### COMPLEX BIOMOLECULES

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




### MEDICAL DEVICE

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



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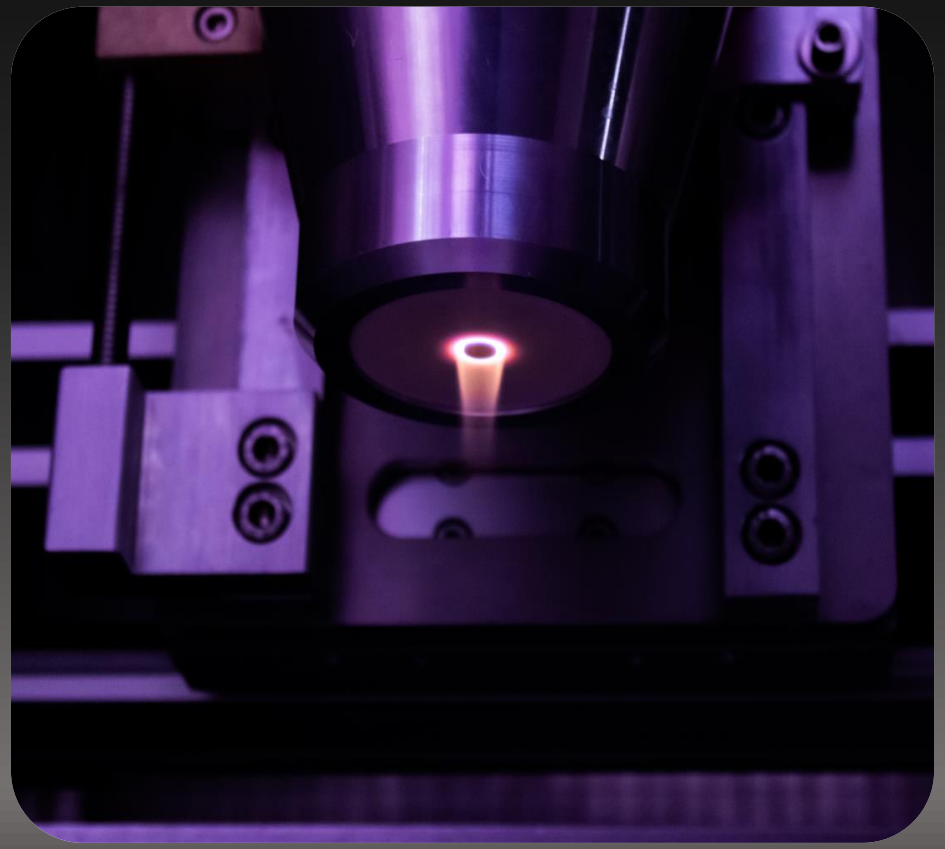
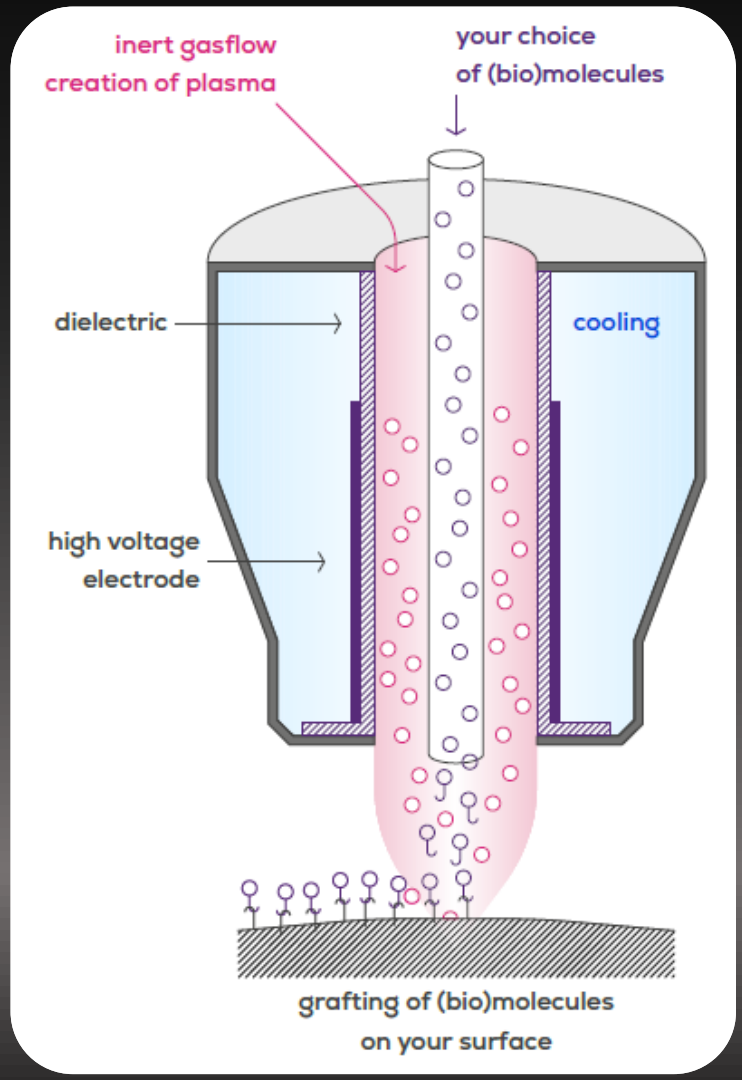
# PLASMASPOT® - OUR R&D SYSTEM

## INTO THE CORE

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



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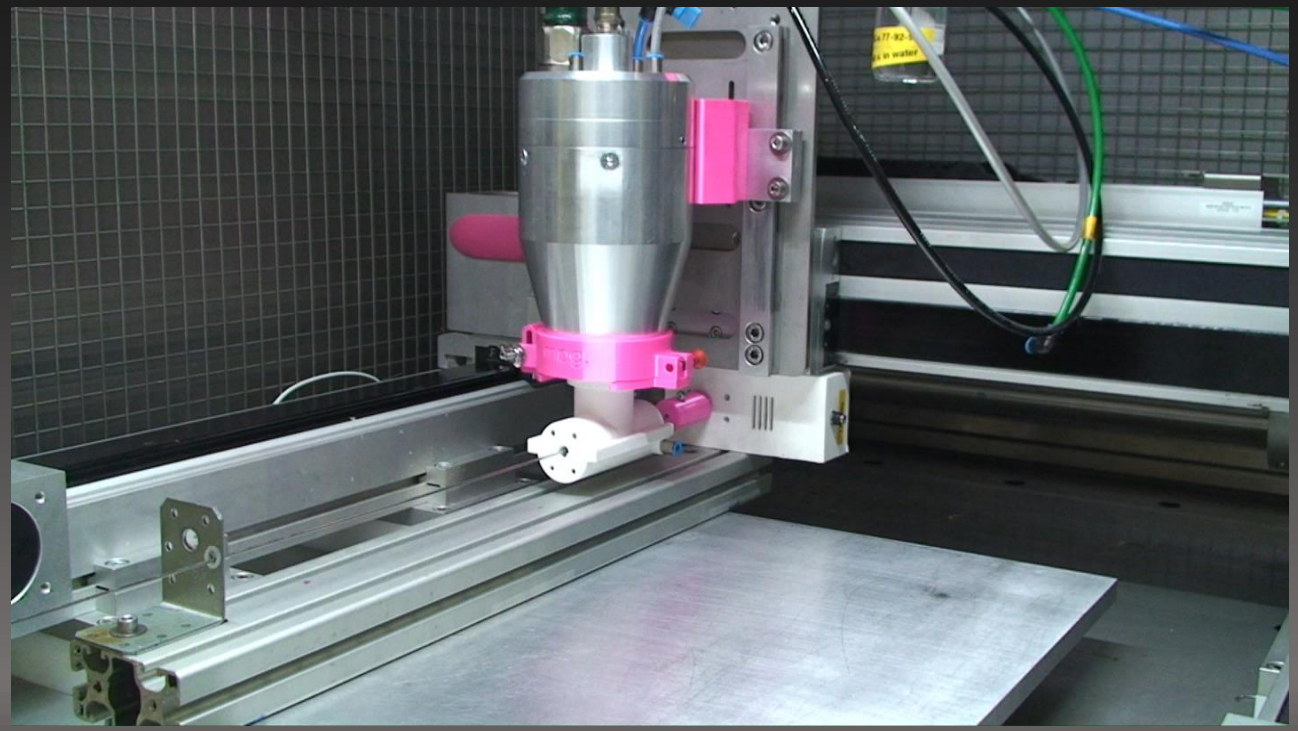
# R&D FIBRE SET-UP

## How can we treat fibres?

### R&D FibreNozzle

- ✓ No $O_2$ present
- ✓ High efficiency



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# ROLL-TO-ROLL FIBRE & TOW SET-UP

Click here to watch the video on YouTube


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# PLASMASPOT® VERSIONS

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

## ROBOT


## MINI

## MAXI

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# PLASMAPOWDER - OUR SYSTEM TO TREAT POWDERS

PartiX
FUNCTIONALISATION AND ENCAPSULATION OF PARTICLES

- ✓ Plug and play
- ✓ Safe
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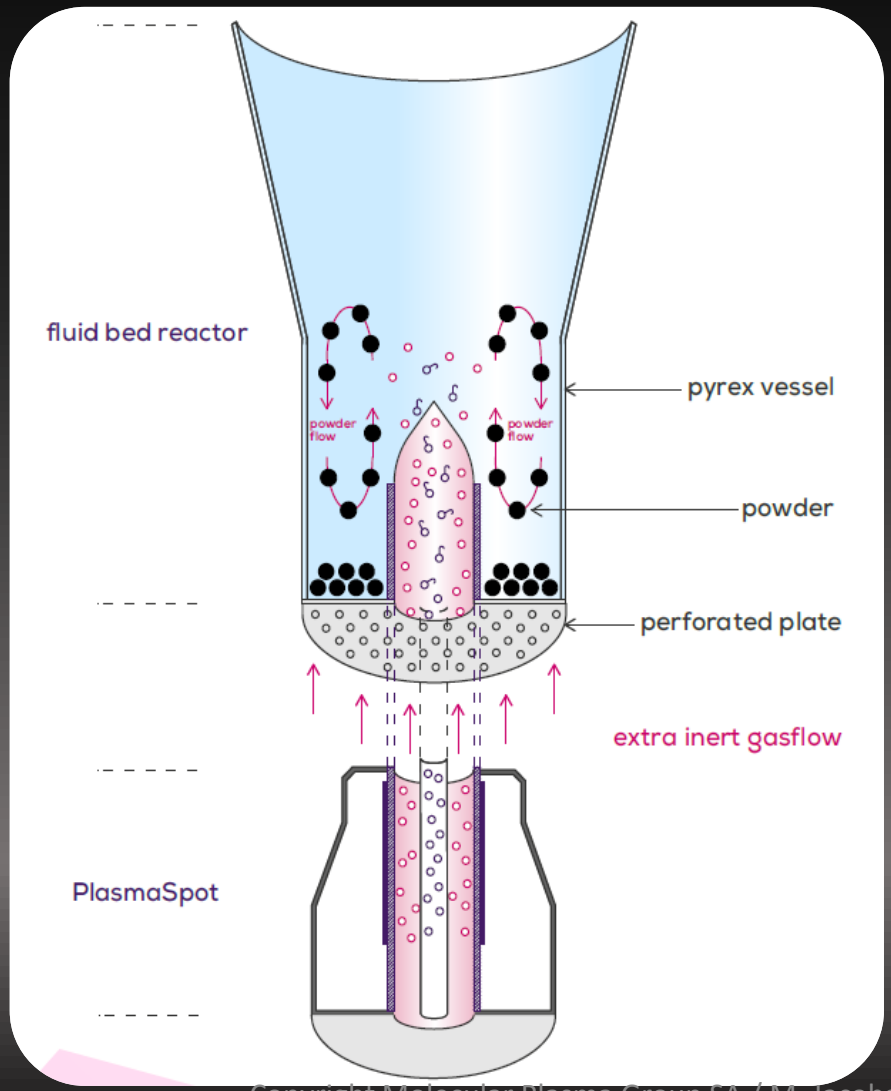
- ✓ Fast changeover
- ✓ Adaptable
- ✓ Versatile




## 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:
  $N_2$, Ar, He, air, $CO_2$
  mixtures and more

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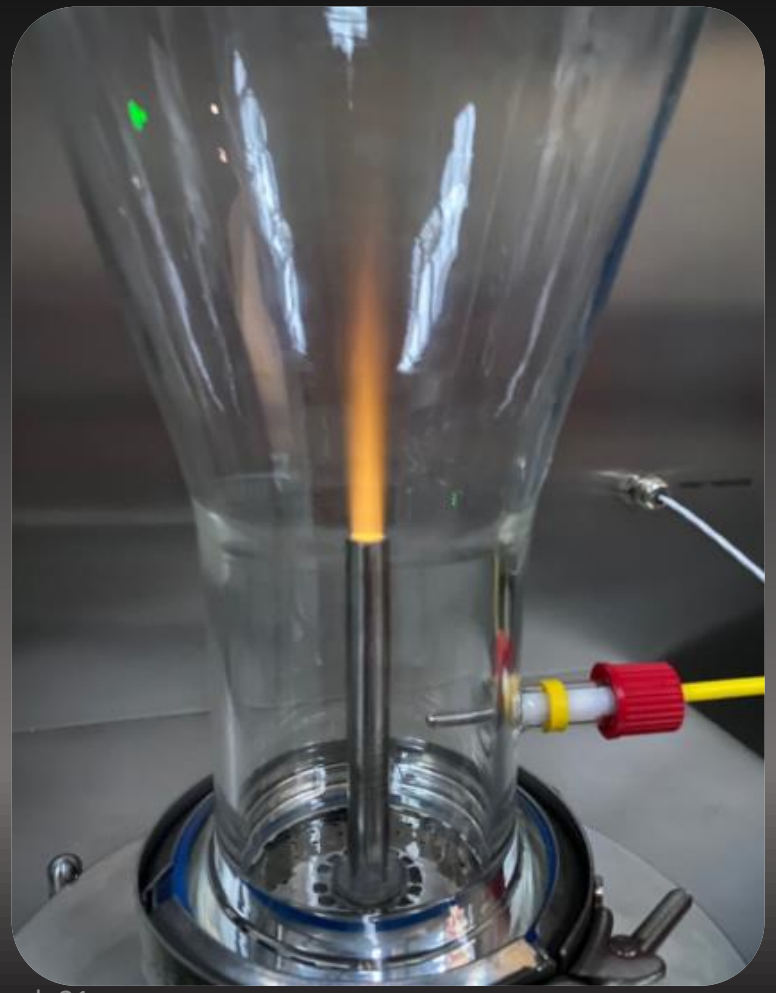

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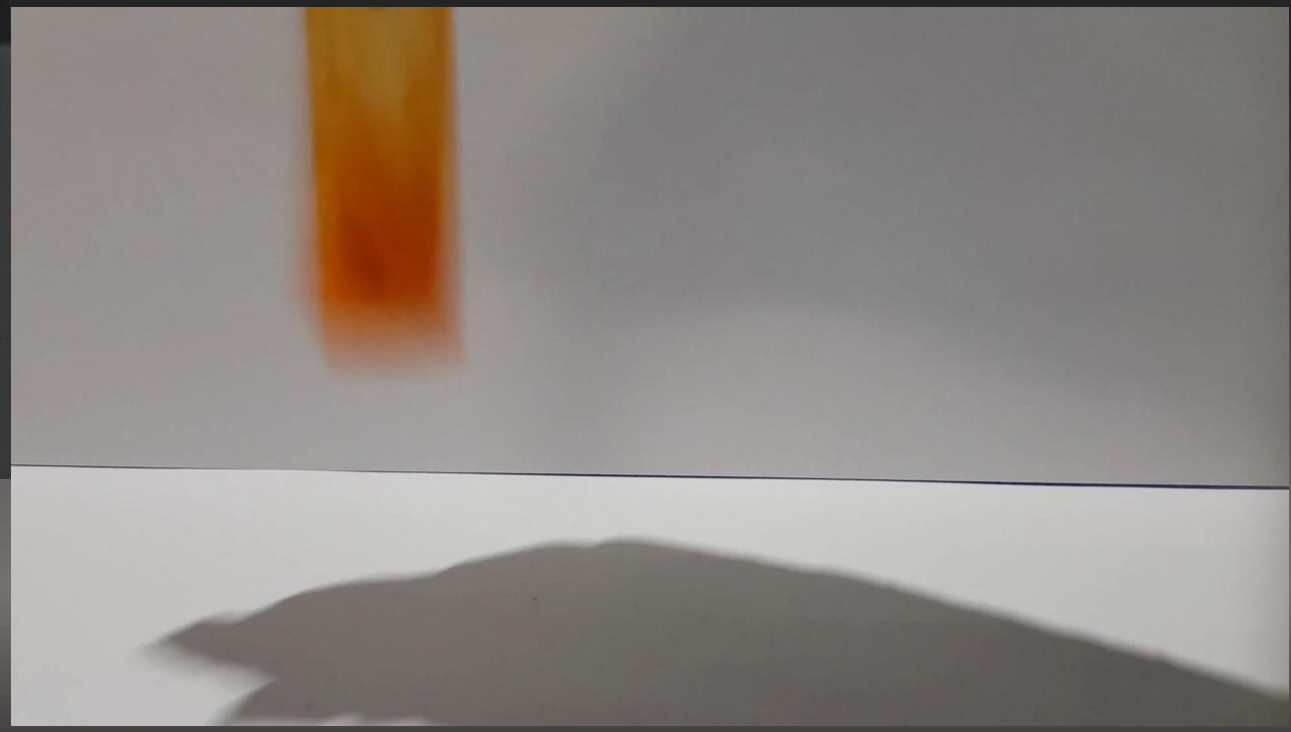
# PARTICLE ENGINEERING

PartiX
FUNCTIONALISATION AND ENCAPSULATION OF PARTICLES

Hydrophobic treatment of sugar beads


150 micron PE bead functionalization with amino groups
Orange Dye Test



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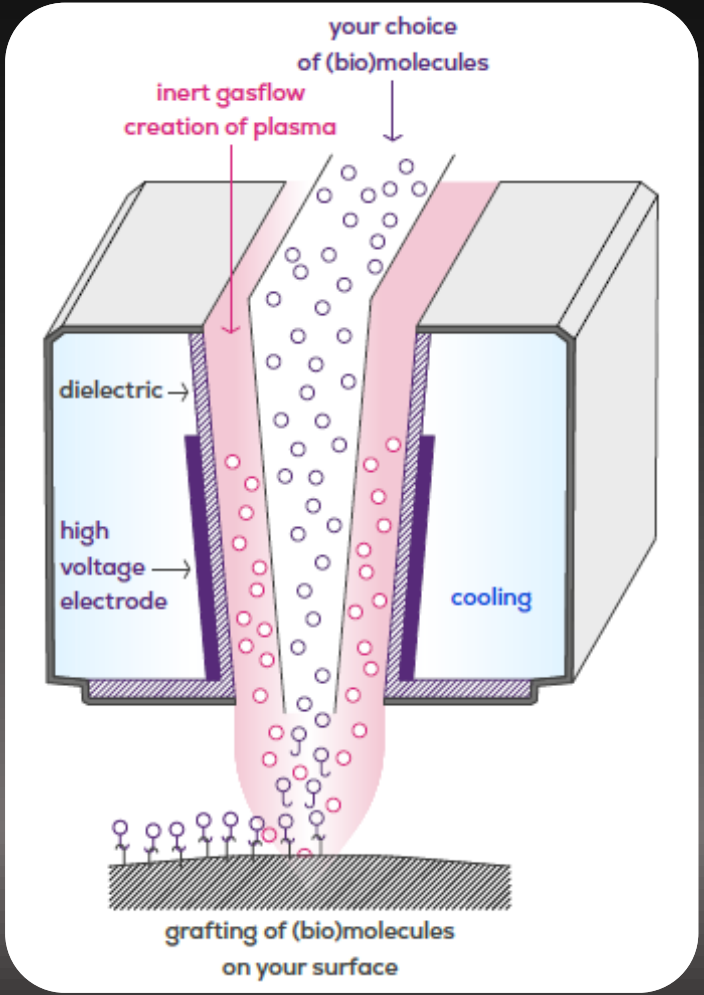
# PLASMALINE® - FROM PROTOTYPE TO INDUSTRIAL SOLUTION

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




## INTO THE CORE

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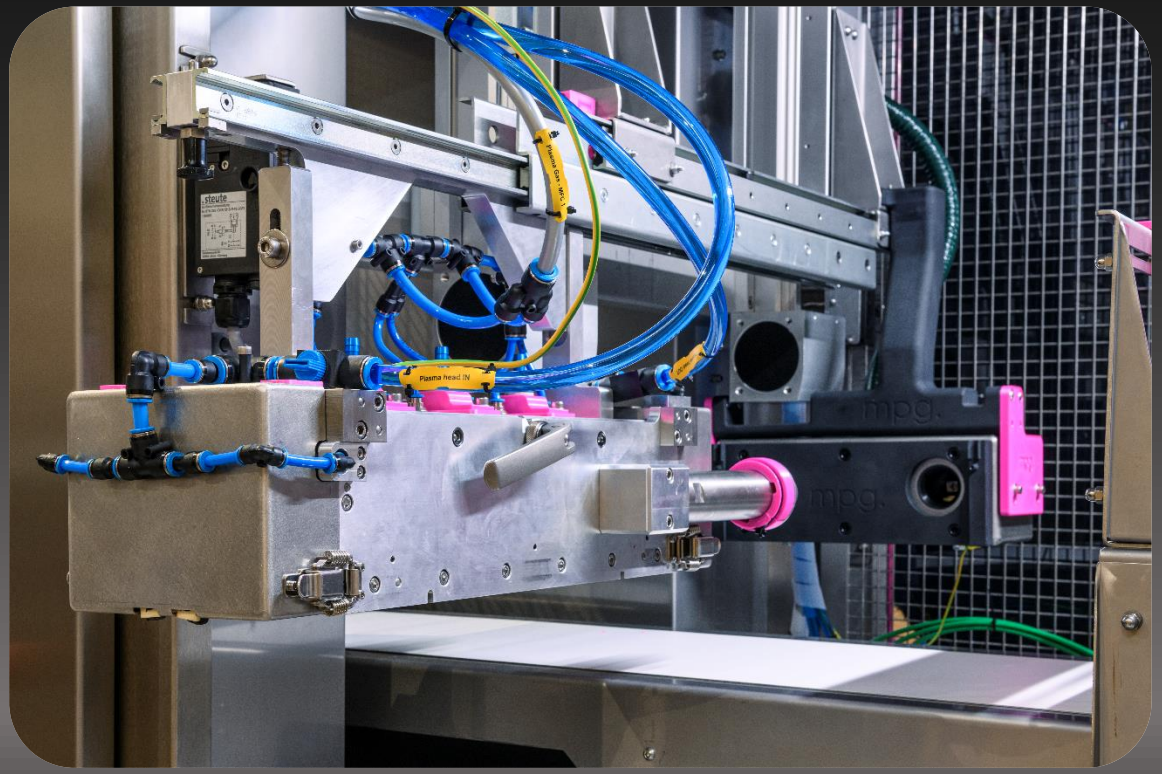


## SPECIFICATIONS

- Line width: 40 cm up to 1.6 m
- Data tracking & collection
- Remote diagnostics
- Plasma gas types:
  $N_2$, Ar, air, $CO_2$
  mixtures and more

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# R2R PRODUCTION PLATFORM – VIRUCIDAL APPLICATION


5.000 m² per shift

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# R2R PRODUCTION PLATFORM 1000 – 1600 MM

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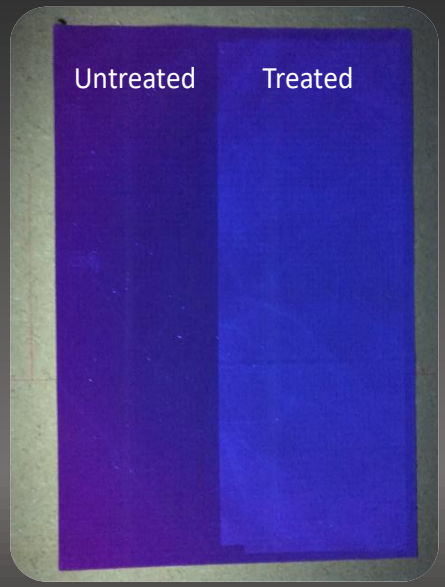
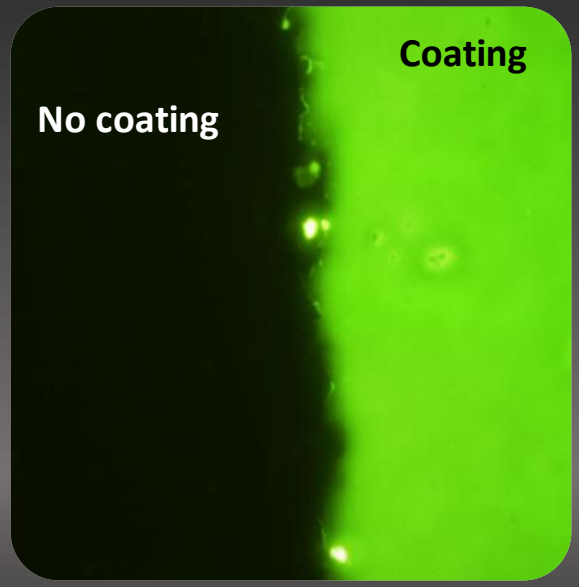
# INLINE PROCESS CONTROL

**How do we assess the quality of our plasma coating?**

- ✓ Addition of a **tracer molecule**
- ✓ UV cameras detect the intensity
- ✓ Correlate to thickness and quality




***plasma coating with incorporated UV tracer***

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# REVERSIBLE ADHESION: THE FUTURE OF COMPOSITES

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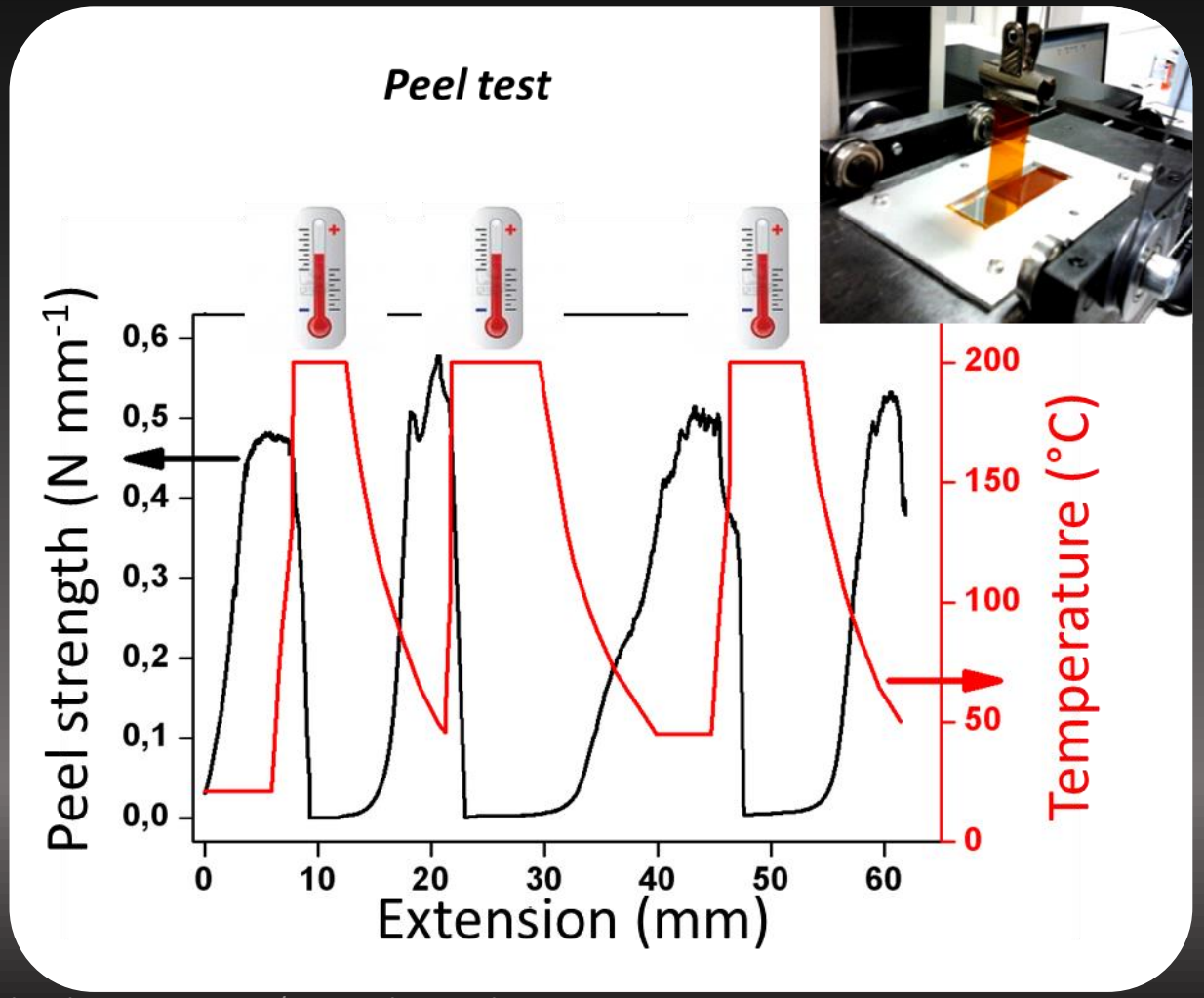
## In collaboration

LUXEMBOURG INSTITUTE OF SCIENCE AND TECHNOLOGY | LIST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# OUR SOLUTION IS GREEN

## Environment – intrinsically GREEN

**MolecularGRIP™** is a near zero emissions process

Low energy | No solvents | Less chemicals | = Same effect

**WET DEPOSITION/PRIMER:**
**5 ml / m²**

**100 X reduction**

**MPG:**
**0,05 ml / m²**

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# Engage with us: Discovery Day Concept

## Full Package that includes

**Initial Discussions**
- Function desired
- Material to be treated
- Tests requirements
- Pain Point

**Chemistry Analysis**
- Literature Studies
- Experience digging
- Precursor Injectability testing

**Test Day preparation**
- Design of Experiment
- Equipment Configuration (Nozzles, etc…)
- Parts handling

**Test Day**
- Run the experiments
- Up to 50 parameters
- Adaptation following results
- Early results indication

**Samples testing**
- Usually done by Customer
- Can be done under MPG supervision using outsourcing to LIST for example.

**Test Results review**
- Results analysis
- Critical parameters identification
- Definition of Next Steps

| Understanding of the requirements | Precursor List Quotation | Design of experiment | Samples Report Initial results | Report Results | Improvements Next steps |
|---|---|---|---|---|---|



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# VERSATILITY IS KEY!

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## 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.

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# THANK YOU!

## Questions or info required?

Please visit:
www.molecularplasmagroup.com

Forward your questions to:
marc.jacobs@molecularplasmagroup.com

Or call + 352 621 132 154


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LET'S MAKE IT HAPPEN

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