Molecular Plasma:

A sustainable revolution in single-step, roll-to-roll surface functionalisation



Marcelo Milani BU Director Roll Goods

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- A new technology that enables surface functionalisation of even the most inert (Teflon) or highly sensitive substrates (Cellulose).
- Using atmospheric plasma as a vector to graft sensitive organic chemistry onto any surface
- Resulting in a permanent surface modification





MANY WAYS TO ADD VALUE WITH PLASMA COATING





Substrate

• Textile

- Film
- Nonwoven
- Paper
- Microporous
- Yarns
- Filaments



Materials

• PET

- Polyolefins
- Cellulosic, cotton
- Fluorinated (ETFE, PVDF)
- Aramids
- PA, PEEK, etc.



Function

- Adhesion
- Hydrophilic
- Antimicrobial
- Hydrophobic
- Anti-fouling
- Priming
- Bio-active



Chemistries

- Monomers
- Biomolecules
- Fluorochemicals
- Sustainable alternatives
- Pure active ingredients



Markets

- Automotive
- Medical
- Defence
- Construction
- Electronics
- Fashion

Endless possibilities with MPG technology

AN EXAMPLE: ACRYLIC ADHESIVE TAPE TEST



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EXAMPLE: ARAMID TEXTILE TO ELASTOMER

Target: direct adhesion of elastomer on aramid woven textiles

Challenge: improving adhesion

Precursor-dependent!



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Plasma Coated Polypropylene Nonwovens

"MPG plasma treatment of non woven fabric (Polypropylene, PP) with Citric Acid decreased SARS-CoV-2 by at least 98.6% at the lowest concentration and by at least 99.4% at the highest concentration. The experiments have reached the limit of detection of the log reduction, indicating that the reduction is likely higher than the reported due to the limited sensitivity of the experiment."

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The virucidal ingredient is available where it's needed: on the surface.

ANTIMICROBIAL COATINGS

Wide range of chemistries tested: Pure liquid chemicals Solutions of natural compounds or biomolecules **Commercial biocidal formulations** Drugs/Therapeutic agents





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Focus on citric acid

- Excellent virucidal efficacy and non-irritant due to efficiency of plasma coating •
- In the Annex 1 list of European Chemicals Agency for simplified market authorization •
- It is an allowed food additive by the FDA and in Europe (E330) •

LUXEMBOURG INSTITUTE OF SCIENCE AND TECHNOLOGY

- Not an active pharmaceutical ingredient •
- Surgical facemasks with MPG's citric acid coating are CE certified as medical devices •

EXAMPLE – ADHESION

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- Poor adhesion between EPDM and adhesive tape
- Solution: Plasma deposition of acrylic precursors



Untreated EPDM foam

Without plasma treatment Adhesive failure

Treated EPDM foam

With PlasmaLine® pretreatment Cohesive failure

HOW DOES IT WORK?

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Click <u>here</u> to watch the video on YouTube



PLASMALINE - INDUSTRIAL SOLUTION





BETTER PLASMA COATING:

- Atmospheric Pressure for continuous process
- Indirect DBD plasma for energy control
- Separate flows: **no fouling** of electrodes
- Ambient Temperature for sensitive chemistry
- Adaptable for fibre treatment, contours, etc.

R2R PRODUCTION PLATFORM: PLASMALINE

T ****

 $\checkmark\,$ Plug and Produce

✓ Safe

✓ Easy to use

✓ Fast changeover

✓ Adaptable 1-2 sides

mpg

✓ Versatile chemistry



npg

SPECIFICATIONS

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

R2R production platform – 1600 mm

ne-step

Instant drying



Video: New MPG PlasmaLine 1600 variable width



from 1600 mm to 1000mm

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Coating of tows, yarns, cables, etc.

R&D FibreNozzle

- ✓ No O₂ present
- \checkmark High efficiency
- ✓ Multiple tows possible



IN-LINE PROCESS CONTROL

How to assess the quality of plasma coating?

✓ Addition of a tracer molecule

 \checkmark UV cameras detect the intensity

✓ Correlate to thickness and quality



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Plasma coating with incorporated UV tracer

OUR SOLUTION IS SUSTAINABLE



Environment – intrinsically lean



ENGAGE WITH US: DISCOVERY DAY CONCEPT

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Full Package that includes



WELCOME TO MPG

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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 (19 patents)

THANK YOU!



Questions or info required?

Please visit: www.molecularplasmagroup.com

Forward your questions to: marcelo.milani@molecularplasmagroup.com Book a Discovery day

Find out how our technology can bring value to you

Or call + 352 621 666 745

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A FEW REFERENCES

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Testimonial by Guy Larnac (ArianeGroup)

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

EXAMPLES OF PROVEN FUNCTIONS AND PRECURSORS



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