STABLE HIGH SURFACE ENERGY

Most polymeric materials possess low surface energy. This limits their use in a large range of applications such as printing, laminating, gluing... Specific surface treatments are required to improve the surface energy of polymers and allow their use for such applications. Commonly used treatments are corona, flame or chemical treatment of the surface.

We present results of high speed treatment of polymeric films by CPI's breakthrough atmospheric pressure plasma technology.

CPI offers two kinds of treatment for improved wettability: **grafting or coating.**

For grafting the substrate is exposed to the highly reactive species of the plasma gas. The interactions between the substrate and those species will modify the surface chemistry. New chemical functions will be grafted on the material surface. The nature of the grafted functionalities can be adjusted by carefully controlling the gas composition.

For coating, vapors of a specific molecule are added to the plasma gas. Those vapors are activated by the energetic species in the plasma and will react on the surface to create a coating. This process is called AP-PECVD (Atmospheric Pressure Plasma Enhanced Chemical Vapor Deposition). Depending on the nature of the precursor, coating with very specific properties can be deposited.

GRAFTING

This first example shows the results of a grafting treatment on Polypropylene (PP) film done at 200 m/min. The process gas was nitrogen. The energetic species of the plasma have modified the chemical composition of the surface, nitrogen and oxygen functionalities have been grafted onto the PP. *(Tab. 1)*

The nitrogen and oxygen containing species grafted on the surface have increased the surface energy and therefore the wettability of the PP film. *(Fig. 1)*

Ageing and hydrophobic recovery are common issues when working with polymeric films treated by plasma or Corona.

CPI's innovative process shows very little ageing of the grafted surface. Obviously, the stability of the treatment will depend on the substrate characteristics*. However, in most cases the treatment effects are very long lasting, especially when compared to traditional Corona treatment. *(Fig.2)*

*Additives used during the manufacturing of polymeric film can significantly change the chemistry of the film. They have to be taken into consideration when selecting the treatment parameters.

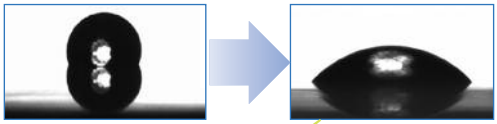
Tab. 1

Composition of PP after plasma treatment. Determined by XPS (ESCA) analysis

	% C	%O	%N
Untreated	100.0	0.0	0.0
Plasma treated	92.6	2.3	5.1

Fig. 1

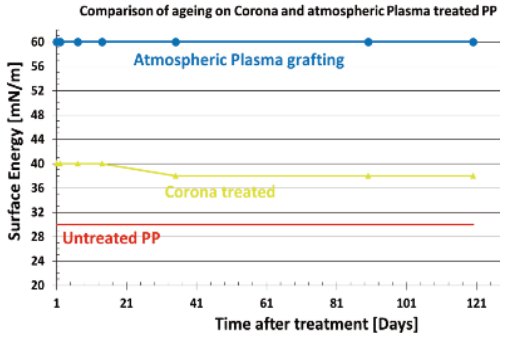
Water droplets deposited on BOPET before and after grafting by atmospheric pressure plasma



Untreated: Θ=106° — **After grafting: Θ=50°**

Fig. 2

Comparison of PP surface stability after treatment by Corona (air plasma) or grafting by CPI atmospheric pressure plasma system.



(continue) STABLE HIGH SURFACE ENERGY

The good stability of CPI atmospheric pressure plasma treatment has been evidenced on a wide range of polymeric films. **Table 2** shows stability studies results on some of the materials already treated by CPI atmospheric plasma.

Tab. 2

Surface energy measurements (calibrated inks method) of polymeric films treated by atmospheric pressure plasma

Samples	Surface energy [mN/m]		
HDPE	Before treatment	Day 0	Day 734
	32	60	60
LDPE	Before treatment	Day 0	Day 30
	32	60	60
PET	Before treatment	Day 0	Day 227
	46	60	60
CPO	Before treatment	Day 0	Day 30
	32	62	60
PA	Before treatment	Day 0	Day 90
	46	60	58
PTFE	Before treatment	Day 0	Day 55
	<30	60	60
ETFE	Before treatment	Day 0	Day 55
	<30	60	60
ECTFE	Before treatment	Day 0	Day 790
	30	60	60

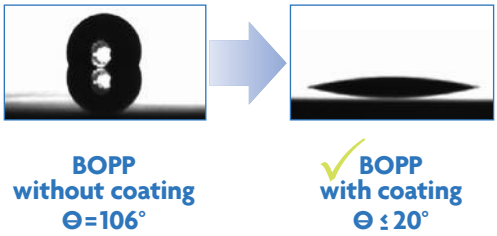
COATING

This example shows the results of a silica coating deposition on BOPP *(Fig.3)*

The surface properties are now the one of the coating, highly hydrophilic in this case, while the bulk properties of the materials are unaffected. This treatment offers more possibilities than simple grafting as there is a large amount of available precursor depending on the desired properties of the coating. In the case of coatings there is no ageing issue as the surface is completely covered by the coating. Hydrophobic, release or barrier properties can be obtained by the same process. (see other case studies for such examples).

Fig. 3

Water droplets deposited on BOPP before and after coating by atmospheric pressure plasma



BOPP without coating Θ=106°

✓BOPP with coating Θ ≤ 20°