Controlling PTFE surface chemistry with gas plasma technology

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PTFE is used in a broad spectrum of applications that exploit its unique combination of bulk properties. Often however, the application of PTFE in device manufacture encounters problems related to its surface properties. Poor surface wettability leads to bonding problems, not just for adhesives, but also for inks, coatings and bio-materials.

A permanent marker is used on untreated (left) and plasma treated (right) PTFE coupons. After plasma, the ink cannot be removed by finger rubbing.

Gas plasma surface modification has solved many of the compromises between bulk and surface properties of fluoropolymers and PVA TePla America's new plasma activation processes provides PTFE with increased wettability and bonadibility to adhesives, inks, and selective biomaterials with remarkable improvements in stability and treatment lifetime. Better control of specific chemical functionality on PTFE has also been attained, adding flexibility to its use in biological media by enabling the conjugation of bioactive molecules to its surface.

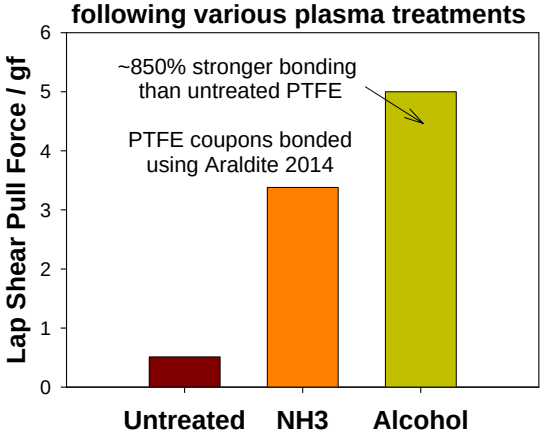
What is plasma?

Plasma is a state of matter just as a solid, liquid or gas. Add enough energy to a gas and it becomes ionized into the plasma state. Chemically it is a highly reactive environment that is used to change the properties of surfaces without affecting the bulk material. Gas plasma processing is a powerful tool in solving surface preparation problems. It provides a reliable, consistent, and environmentally friendly method of nano-scale cleaning, activation for increased surface wettability, chemical grafting, and coating deposition.

Adhesion promotion.

The role of plasma surface modification of PTFE is to provide reactive chemical functionalities that promotes the binding of adhesives, inks, and the conjugation of molecules that encourages biocompatibility. Adhesion properties of PTFE are improved more than 8 times by the plasma induced copolymerization of alcohol to the surface. This process shows significant improvements over ammonia plasma treatments.

PTFE adhesive bond strength improvement following various plasma treatments

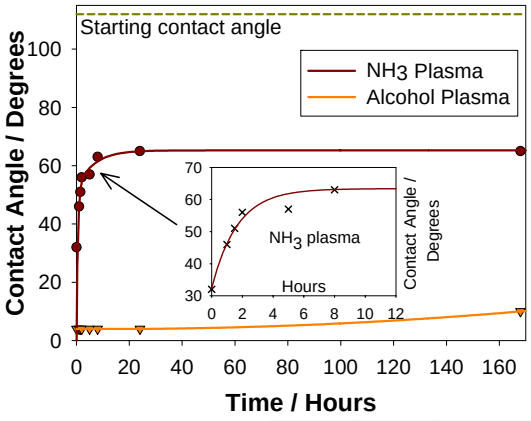


PTFE bonding strength has a direct relationship to surface energy, quite independent of the drivers causing the surface energy change (defluorination and surface polarization). This has interesting implications for *in vivo* applications that require the preservation of low surface energies while at the same time grafting specific chemical functionalities to PTFE.

Treatment lifetime

Plasma induced alcohol copolymerization of PTFE has also extended surface activation lifetimes well beyond those previously attained using ammonia plasma. The confinement to a six hour window for downstream processing and staging time has now been extended to beyond two weeks, adding greater flexibility to manufacturing environments.

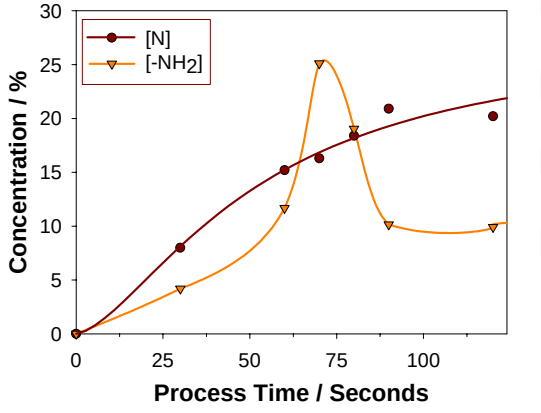
Contact angle lifetime comparison following plasma treatment of PTFE



Chemical grafting

The concept of plasma induced copolymerization opens new and exciting methods of chemically engineering surface properties of PTFE. The ability to selectively functionalize this surface with primary amines, hydroxyls, carboxylic acids, *etc.* means that engineers can now broaden their use of this material, particularly in the field of medicine. Gas plasma technology is fast gaining recognition for its ability to assist in the improvement of biomimetic and biocompatible properties of PTFE. Plasma surface modification is a highly effective technology that facilitates manufacturing and is already considered a stepping stone to future technologies.

Surface concentrations of [N], and [-NH_2] as a function of organic amine copolymerization



How are processes validated?

X-ray photoelectron spectroscopy (XPS) and surface derivatization techniques are used to quantify the percentage of the surface that has been treated with the desired coating and functionality. For example, when defluorinating materials are treated to improve hydrophilicity, the extent of defluorination at the surface can be directly measured using XPS.

ESCA surface analysis tool

What does PVA TePla America offer?

At PVA TePla America we offer a full line of vacuum and atmospheric gas plasma systems. Our reliable, easy-to-operate products deliver some of the most advanced and innovative solutions for a wide variety of industrial applications.

Additionally, we offer free proof of processing as an incentive to evaluate our plasma technology. We also offer clean area contract processing services with ISO 9001:2000 certification. This allows you to access gas plasma technology without up front capital expenditure on equipment, labor and/or facilities.

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