

Surface Treatment and Adhesion of APTIV® Film

Introduction

Untreated Victrex APTIV® films, made with VICTREX® PEEK polymer, have a low Surface Free Energy, as with most polymer surfaces. The untreated film surface may therefore exhibit low bond strength with adhesives, printing inks etc. Surface treatment increases the surface energy of the non-polar PEEK surface. The optimum adhesion is obtained when the surface energy of the solid is greater than the surface tension of the liquid (adhesive/ink etc.) to enable the surface energy of the substrate to overcome the surface tension of the liquid in contact with it to enable good 'wetting' onto the substrate.

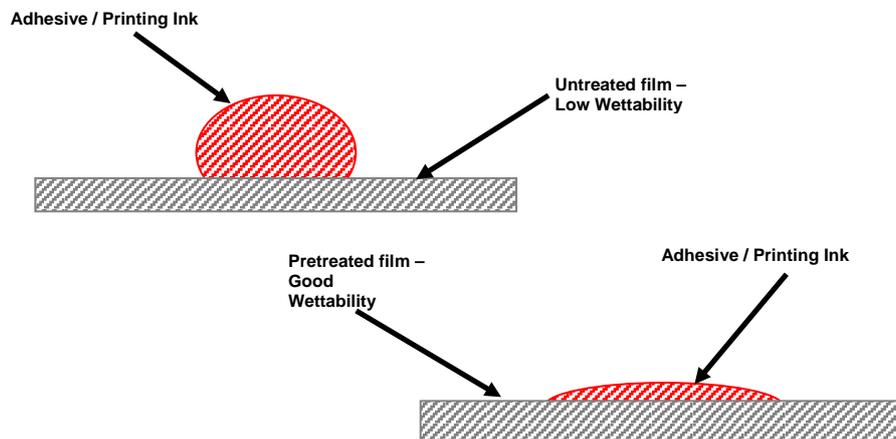


Figure 1 - Shows the Wettability of APTIV Film Surface.

The surface energy of untreated PEEK lies between 34- 38 Dynes/cm² (mN/m), with surface treatments (plasma corona etc.), this can be increased to ~60 Dynes/cm. The surface energy required on the film surface should be the highest for adhesive bonding, with laminating and printing requiring lower activation levels. A surface energy of 55 dynes/cm should be high enough for all finishing processes encountered. APTIV film supplied by Victrex can be treated with Atmospheric Plasma in a Helium/Oxygen gas mixture to greater than 55 dynes/cm.

Verification of the presence of an activated surface can be made using the ink test to ISO 8296 / DIN 53364 / ASTM D-2578 or contact angle measurement. The ink method of determining surface tension is the most widely used, especially for production control and is simply applied. It has the advantage that the full width of a web can be tested in one application. The surface to be examined is wetted with liquids of graduated surface tensions. The surface tension of the liquid that just adequately wets the film surface (uniformly distributed, not retracting into individual droplets) corresponds to the surface tension of the film. This method of surface tension determination should not be considered as a method for defining the (dispersive and polar functions of) energy of the surface and only gives the total. It is also possible to use the contact angle method to measure the surface tension, and has the advantage that it can be resolved into dispersive and polar components of the total surface energy.



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Surface Treatment Methods:

Plasma, corona, flame and chemical etching methods work by implanting reactive species into the surface of the polymer film. Mechanical etching would appear to work by purely providing a mechanical key, however one theory suggests that part of the mechanism is due to the removal of weak boundary layers.

Victrex offers the option of Atmospheric Plasma Treatment on its APTIV film which offers the following advantages over more common corona treatment:

- Higher treatment (surface energy) levels
- No reverse side treatment
- No pin holing in thin films
- Longer lasting treatment (see Figure 2 below). A plasma treated film was tested by Victrex over 120 days. Polar Component of the treated film surface (Contact angle determination) is shown in Figure 2 below

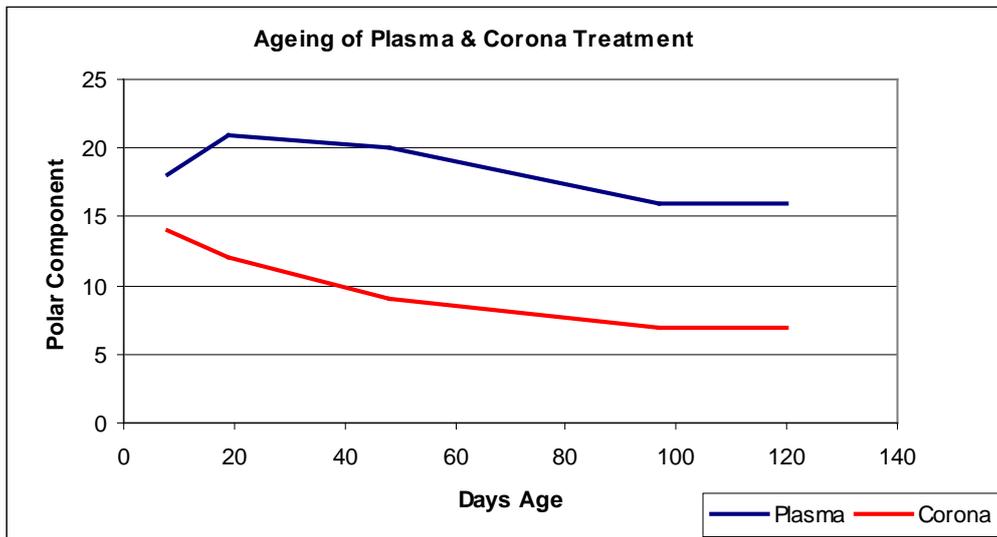


Figure 2 – Polar Component (mJ m⁻²) Ageing Over 120 Day Time Period

Considerations for the use of plasma treated APTIV film:

- Optimum storage conditions are in a cool, dry environment away from strong light sources
- Do not handle with bare hands – moisture and oils/greases can compromise the treatment
- Victrex advises discarding the first few layers of film from the roll since additives from packaging materials can leech onto the film surface and compromise the treatment.
- Victrex place a shelf life of 6 months for plasma treated APTIV film but could be used beyond this, especially if stored in the recommended conditions. If using plasma treated film beyond the shelf life it is advisable to check the surface energy level by contact angle or dyne pen/ink methods.



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Adhesives and Their General Properties

Listed in the table below are the most common classes of adhesives and their general advantages and disadvantages. Victrex is actively developing more knowledge on appropriate adhesive systems for APTIV film. It should be stated however that applications for APTIV film are varied and diverse; hence any adhesive application should be qualified by the customer for the unique conditions required by that application.

Adhesive Type	Advantages	Disadvantages
Epoxy	High bond strengths. Good chemical resistance and thermal stability.	Poor oxidative stability, limited maximum operating temperatures, speciality grades can be comparatively expensive
Acrylics	Good flexibility at ambient and elevated temperatures. Good impact, peel and shear strength.	Become brittle at low temperatures. Strength decreases rapidly at elevated temperatures.
Cyanoacrylates	Fast curing. High bond strengths. Suitable for a wide range of materials.	Limited temperature performance. Brittle. Limited chemical and moisture resistance
Urethanes	Excellent adhesion and elasticity. Fast curing. Good low temperature properties.	Limited temperature resistance. Sensitive to environmental conditions especially moisture. Application conditions critical. Primers may be necessary.
Silicones	Solvent free. Highly flexible. Excellent moisture resistance. Good temperature resistance. Suitable for a wide range of materials.	Low cohesive strength. Can swell when exposed to non-polar solvents. Primers may be necessary for some substrates.
Anaerobics	Fast curing. High bond strengths for some substrates. Good chemical resistance. Available in a wide range of viscosities.	Brittle. Cure rate surface dependant. Can stress crack some thermoplastics. Can be expensive.
UV Curing	Solvent free. Able to bond dissimilar substrates. Fast curing. Good bond strengths. Less waste produced compared to solvent based systems.	APTIV film absorbs light in the UVB & UVC regions, but partially absorbs UVA & UV(Vis) light. Matching the adhesive to the curing light source is vital for achieving good bonding. Excessive UV energy can degrade APTIV film.

Primers:

Primers are generally proprietary formulations designed to match the adhesive being used and are applied to the substrate prior to application of an adhesive for any one or more of the following:

- Protection of the surface following treatment (extends the time between surface preparation and bonding)
- Raising the surface energy of the substrate to allow better wetting/bonding of the adhesive
- Dissolving low levels of organic contamination that would otherwise remain as a weak boundary layer at the adhesive/substrate interface
- Promoting chemical bonding between adhesive and substrate
- Inhibiting corrosion of the substrate during service
- Serving as an intermediate layer to enhance the physical properties of the joint and to improve bond strength.

Please note that the application of a primer is an additional step in the bonding process and as such comes with additional cost, safety and quality requirements. Therefore, careful consideration must be taken to justify its use.



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It is important to note that there is no all purpose adhesive available so choosing an adhesive will strongly depend on its application. For example, if high strength is required one generally would choose an epoxy, however it has the disadvantage of lower flexibility. It is worth mentioning that some applications require adhesives which meet various specifications for military, automotive, aeronautical and medical applications. Choosing the proper adhesive requires precisely listing all requirements for the adhesive joint and then sourcing an adhesive and supplier who can meet these requirements.

About Victrex

Victrex is the world's leading manufacturer of VICTREX PEEK. The company is headquartered in the UK with dedicated sales, market development and technical specialists located around the world. These teams work hand-in-hand with processors and end users to provide assistance in new application development and prototyping together with product performance data and processing support.

Engineers and designers time and time again select VICTREX PEEK, and the Victrex team, to reduce system costs, improve part performance, exploit greater design freedom, and create a differentiated application.

By selecting VICTREX PEEK, customers gain not just one performance benefit, but a unique combination of chemical, wear, electrical, hydrolysis and high temperature resistance, as well as its excellent dimensional stability, fatigue, high purity, fire, smoke and toxicity performance. Victrex works with end users and processors in a variety of markets such as aerospace, automotive, electronics, food processing, industrial, defense, medical, and semiconductor.

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