PROCESSING GUIDE

APTIV™ Films

VICTREX™ PEEK Film Technology

Heat Sealing
Welding
Laminating

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Heat Sealing, Welding, Laminating APTIV™ Films

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About This Guide

This guide is provided to our customers as a reference tool for the heat sealing, welding and laminating processes that can be used for APTIV™ film. The following notes may be applied to any of the commonly used techniques. Many variables such as part design, process equipment and film thickness will influence the process. Victrex works with supply chain partners who have specialist skills in these areas & can be used for development of such applications.

Introduction to VICTREX™ PEEK Polymer and Flim

VICTREX PEEK polymer is a high-temperature, semi-crystalline thermoplastic, which provides a unique combination of properties to Engineers, Designers & OEM's. As a thermoplastic polymer PEEK can be extruded or injection moulded into a variety of shapes and forms, one important form is cast film.

PEEK polymer has a glass transition temperature (Tg) of 143 °C (290°F) and a crystalline melting point (Tm) of 343 °C (650°F).

Heat Sealing Applications

Two layers of APTIV film may need to be heat sealed for the production of a bag, or for the encapsulation of electronic devices, for example. As VICTREX PEEK is a thermoplastic material, heat sealing can be accomplished easily by heating the film to the melt point, and applying pressure to bring the molten polymer into intimate contact.

Typical Process Parameters

A typical process temperature of about 340 – 370°C (645-700°F) can be used, depending on equipment. A time of a few seconds is required to allow the two melt surfaces to contact & intimately bond. The applied pressure will vary according to thickness of the film & equipment. If excessive flow & thinning of the heat sealed section occurs then it is likely that too much pressure has been applied. To avoid the molten film sticking to the sealer jaws, PTFE coated glass cloth should be used. The sealed film should be cooled while still under pressure in the sealer jaws, so that the sealed area is not damaged when the piece is removed from the equipment.

A typical cycle for 25 micron APTIV film would be heat to 340-350°C (645-660°F), seal at a pressure of 4bar for 2.5 sec, and cool whilst still under pressure to below Tg.

Heat Impulse Welder Unit
(Courtesy of JOKE GmbH)

Ultrasonic and Laser Welding

APTIV film can be joined by ultrasonic and laser welding. As VICTREX PEEK is a thermoplastic material, the welding is accomplished by heating the film to the melting point and applying an appropriate level of pressure to bring the molten polymer surfaces into intimate contact.

1) Ultrasonic welding

Ultrasonic welding uses high frequency sound energy to raise the temperature of the APTIV film so that it melts. The surfaces to be joined are brought together under pressure and exposed to ultrasonic vibrations which allow the polymer surfaces to intimately contact in the melt phase. The sound energy is transmitted to the film to be welded by a horn or sonotrode. The design of this horn is important and needs to be suitable for welding film. APTIV film has been welded using frequencies from 10–40 kHz, and cycle times of <1 second. This technique is suitable for use on production lines. Continuous joints, or spot welds, can be produced. This technique can also be used for simultaneously cutting and sealing. No raised bead is produced when film is cut, which can happen with laser welding.

The use of ultrasonic equipment is a specialised field, but samples of APTIV film have been successfully welding using an ultrasonic method, particularly with thicker films >100 microns. Specialist providers of this service will be required to select the appropriate frequency and design of tool to achieve the weld required.

Ultrasonic and Laser Welding

2) Laser welding

Laser welding works by producing an intense beam of electromagnetic radiation, usually located in the infra-red region of the spectrum, which causes molecules in the film to resonate. This results in localized heating of the material, which causes melting, and fusion, to form a bond. This can be achieved by using CO2, YAG or diode lasers. Clear film may not absorb enough energy to produce a bond so is often filled, for example with carbon black or other pigments, to increase absorption. A clear film is clamped on top of a carbon filled film so that the laser energy is transmitted through the top layer to the carbon filled material, which heats up and transfers heat to the upper layer. Thus, the mating surfaces of both layers are melted, and a bond is formed. Another way of increasing absorbance is to use a clear infra-red absorbing liquid, which is applied to one surface of the joint. This produces a strong transparent joint. Laser welding is not suitable for thick opaque films.

The use of lasers for welding is a specialised field, but samples of APTIV film have been successfully welding using a laser method. Specialist providers of this service will be required to select the appropriate type of laser and design of equipment to achieve the weld required.

Laser Welding unit
(Courtesy of Leister USA)

Lamination to other Polymer Films

The general principle for laminating APTIV film to another thermoplastic or non-thermoplastic film is to ensure that one component is above the melt point. For example, with polyetherimide film, lamination can be accomplished at 330°C (625°F), whereas for polyimide film, a non thermoplastic, the PEEK has to be melted, so a higher temperature, e.g. 360°C (680°F) has to be used.

Composites and Laminates

Composites can be produced by laminating APTIV film to both sides of various other webs. These might include glass cloth, carbon fibre cloth or aramid tissues. The PEEK is taken above the melting point and enough pressure applied to impregnate the weave or fibres of the other web. The aim is to produce a material which does not delaminate, and has a good thickness profile.

Lamination to Metals Using a Press

Metal Surface Preparation

A roughened metal surface provides better bond strength, and may be required for aluminum, which can be more difficult to laminate to than, for example, copper or steel. A surface roughness (Ra) of approximately 1 micron should suffice. This can be achieved by conventional grit blasting using # 320 aluminum oxide. The metal should be degreased using normal degreasing techniques to remove all traces of grease and surface impurities.

Pressing Conditions

Clean APTIV film should be placed on the metal substrate, and care taken to avoid any contamination of the work. At PEEK processing temperatures, any organic contamination will carbonise, and become electrically conductive, which could give rise to failures of electronic devices, for example.

The film should be covered with a release layer to prevent it sticking to the press platens. This could be polyimide, glass filled PTFE, or treated aluminum. A suitable treatment found to prevent sticking is the application of a mould release agent, e.g. Frekote 55-NC from Henkel Loctite. This can be applied to polyimide film, enabling it to be used more than once. However, mould release agents may contaminate the PEEK surface, which may not be acceptable for all applications. It is not possible to give exact pressing conditions as these will depend on the equipment used, but certain guidelines should be followed. As a starting point a temperature of 350 – 360°C (660-680°F) should be used. The assembly should be allowed to come to temperature as pressure is applied. Sufficient pressure should be applied to force the PEEK into intimate contact with the substrate, but not to squeeze it so much that a poor thickness profile results.

Pressure should be maintained during the heating and cooling cycle. It has been found that cooling under pressure to ca. 200oC (390oF) or below, can improve adhesion and appearance.
A starting point for bonding 50 micron APTIV film to grit blasted aluminium might be to apply a pressure of 2bar, heat from room temperature to 360oC (680oF) over a period of 30 min, holding at temperature for 10 min, then cooling to room temperature under pressure for 40 min. If a vacuum press is available, vacuum should be applied throughout the cycle. This can reduce degradation in samples that react with oxygen.

Lamination to Metals Using a Press

Electrically Heated Hydraulic Vacuum Press for Lamination (Victrex)

Roll to Roll Lamination

It is possible for a continuous roll to roll metal lamination to be used with APTIV film. We do recommend that users determine their process window on a batch process first, and then scale up to a continuous roll to roll process. The general principles for pressing will still apply, but residence time at both temperature and pressure in the nip roll will be much shorter. This is probably the key factor to consider in the scale up. Specialist processors should be consulted for more detailed advice.

About Victrex

Victrex is an innovative world leader in high performance polymer solutions, focused on the strategic markets of automotive, aerospace, energy (including manufacturing & engineering), electronics and medical. Every day, millions of people use products and applications, which contain our materials – from smart phones, aeroplanes and cars to oil and gas operations and medical devices. With over 40 years' experience, we develop world leading solutions in PEEK and PAEK-based polymers, semi-finished and finished parts which shape future performance for our customers and our markets, and drive value for our shareholders. Find out more at www.victrex.com

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