

Surlyn® Fastening Guide

Technical Information

DuPont™ Surlyn®

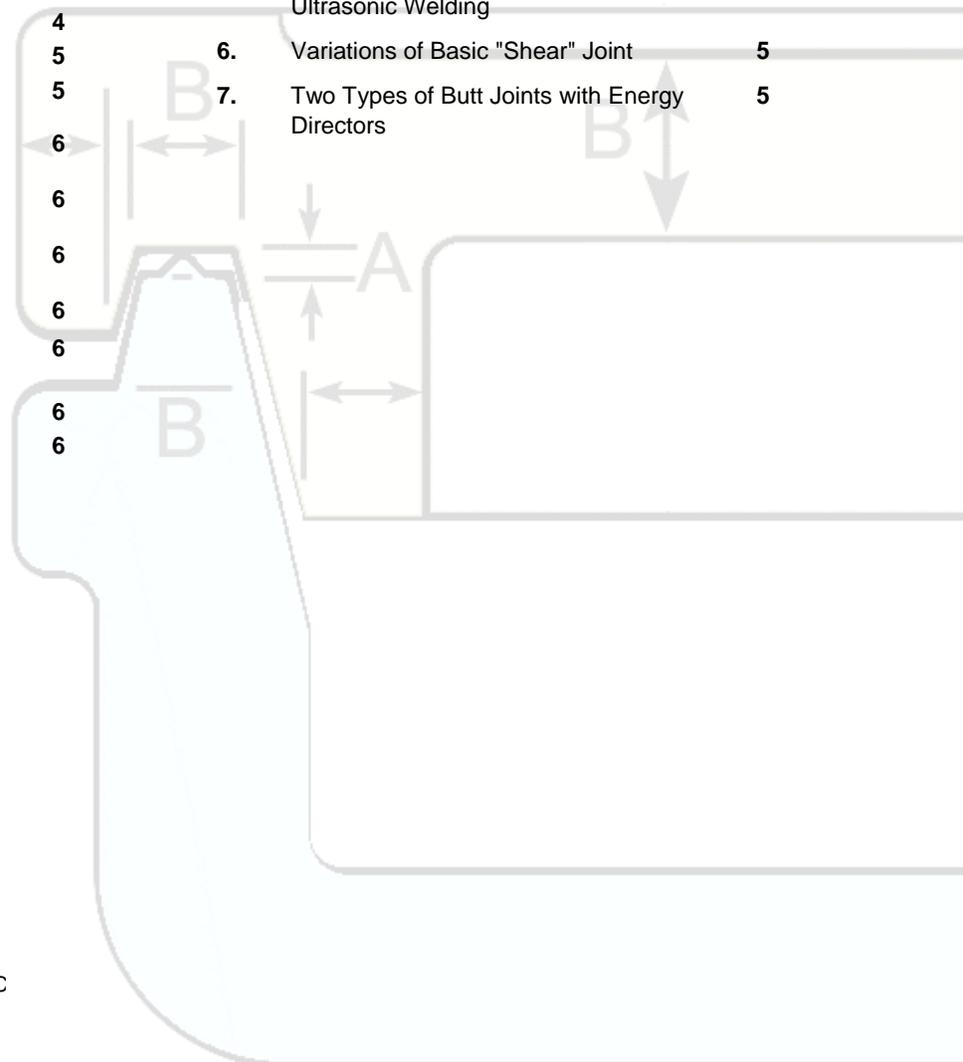


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I. INTRODUCTION

A variety of methods are available to join thermoplastics. Included are welding, where melting of the material at the interface produces a bond, bonding with adhesives, and mechanical fastening.

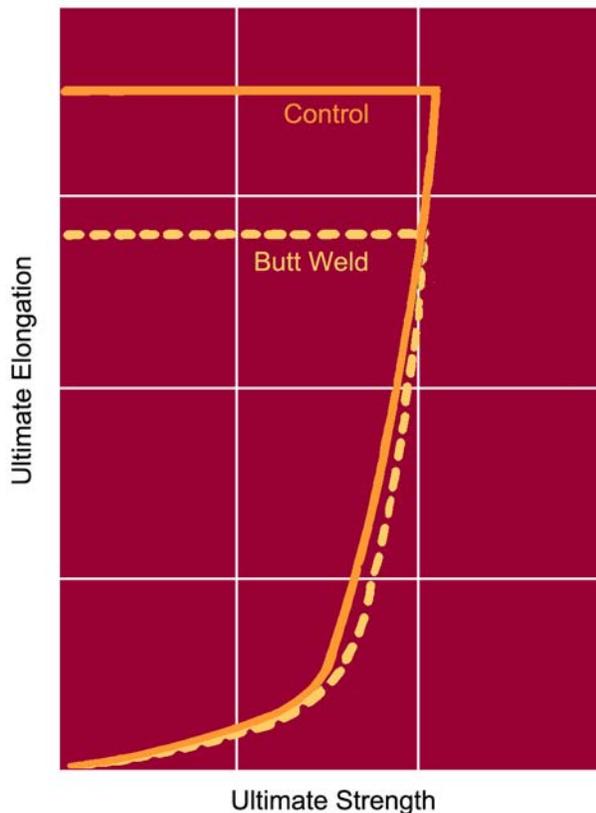
This bulletin reviews techniques that can be used to assemble two parts of Surlyn® ionomer resin or a part of Surlyn® to one of another material.

II. WELDING

A. Hot Plate

The two surfaces to be joined are held against a heated surface to form a film of melted polymer. A thermostat equipped hot plate with a nonstick, fluorocarbon surface is often used. For most ionomer resins a surface temperature between 260-288°C (500-550°F) is desirable. After 3 to 6 seconds, depending on the melt flow of the resin, the melt will form and the two pieces are brought together and held until the joint has solidified. The strength of the welds can approach the strength of the original part. See Figure 1.

Figure 1 — Weld Strength vs Original Part



B. Hot Gas

Hot gas welding is primarily used for joining thick sections. Equipment needed includes a hot gas (nitrogen) welding gun, a pressure regulator, filler rods and appropriate holding fixtures. Nitrogen is recommended to minimize oxidation of the resin which yields weak joints. Filler rods should be of the same material as that to be welded. Recommended temperatures for gas welding are 230-288°C.

Surlyn® can be notch-sensitive and, therefore, it is recommended that the weld bead be smoothed.

C. Spin

Spin welding is used to join thermoplastic parts having circular cross-sections. Frictional heat is generated at the interface of two parts as they rotate relative to each other. When a uniform molten film forms, the relative motion is stopped and the bond is allowed to cool under pressure.

Typically, weld strengths for Surlyn® are 80 to 95% of like parent material strengths. When joining different grades of Surlyn®, the bond strengths may be slightly lower.

For low volume production, or samples, a hand-operated drill press fitted with a driving tool and holding fixture will suffice. In production, more sophisticated equipment fitted with pneumatic drive, clutch and timers can operate at cycles of 1 second per part. See Figure 2.

Figure 2 — Basic Equipment Requirements for Spin Welding

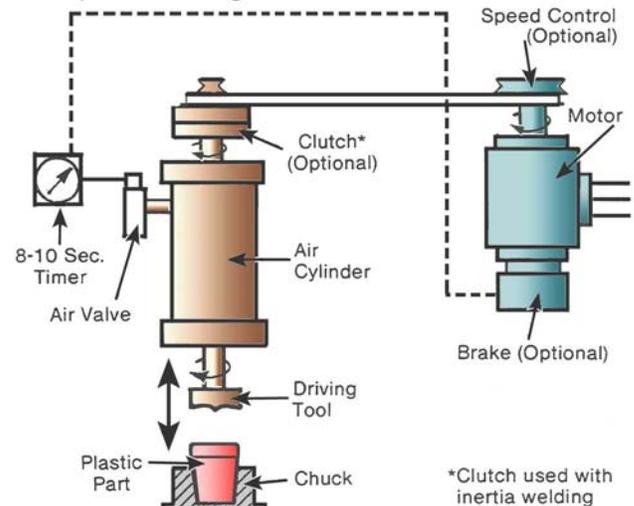
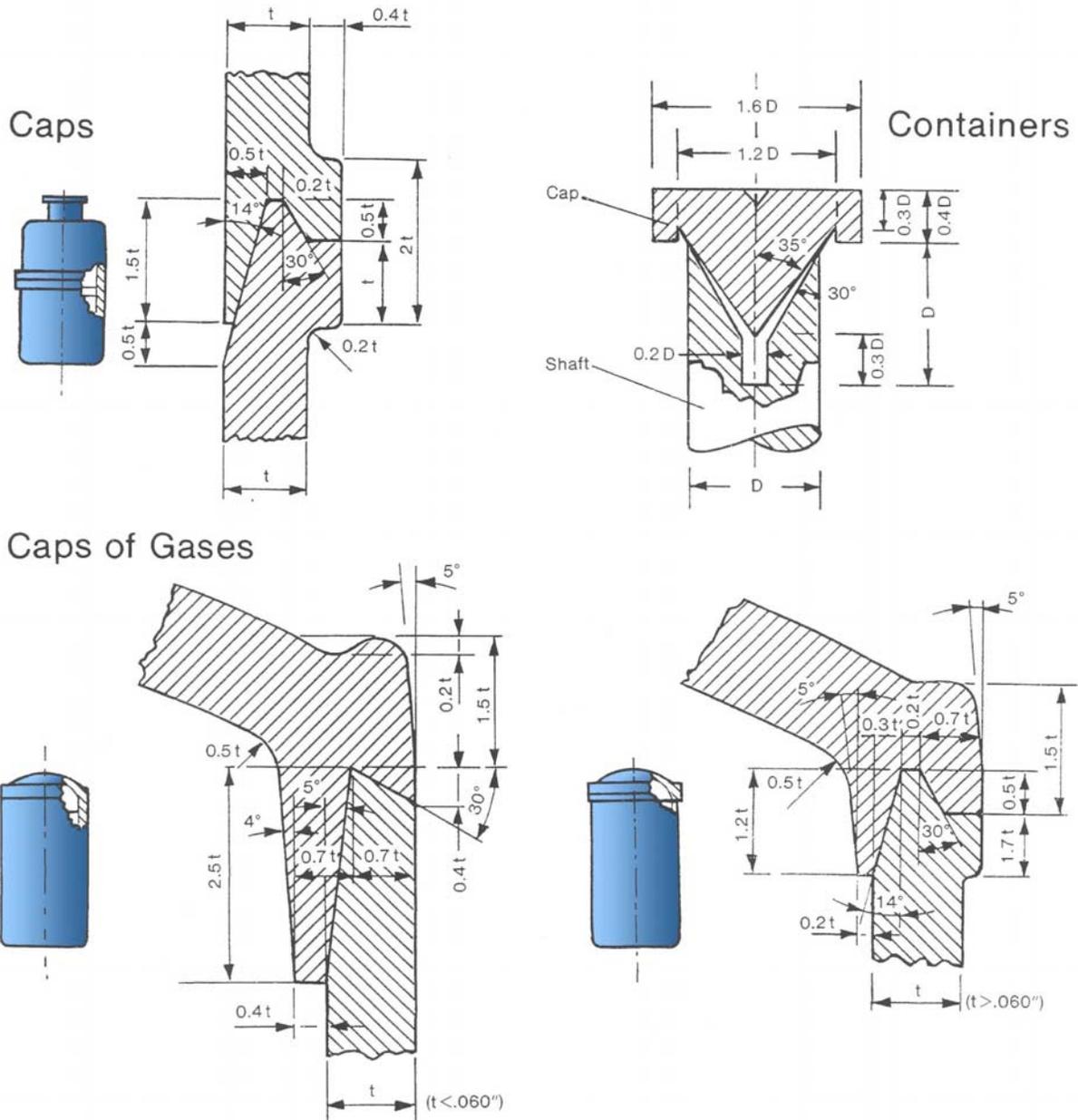


Figure 3 — Typical Joint Designs for Spin Welding



All equipment must be able to:

- Spin the piece fast enough - 2,000-3,000 rpm - to generate sufficient frictional heat to melt the polymer at the interface.
- Stop quickly to avoid shearing the joint before it has solidified.
- Maintain pressure - 1.7-7 MPa - on the joint while it is solidifying.
- Spin time should be 0.25 to 0.50 seconds.

Joint geometry is the most important influence on quality welds. See Figure 3. Therefore, these features of joint design should be taken into account:

- Maximum weld area, consistent with part design
- Self-alignment to broaden molding and welding tolerances
- Progressive contact from the center to the lip of the joint to prevent trapping air
- Rigidity to prevent bulging under maximum pressure
- Symmetry, for uniform melting and melt distribution
- No points of stress concentration

D. Vibrational

Linear or angular vibrational welding offers the advantage of frictional bonding of non-circular parts. Heat is generated by pressing the surfaces of two parts together and vibrating the parts through a small relative displacement. Whatever the configuration, when vibrations cease at the end of the welding cycle, parts are in the desired position relative to one another.

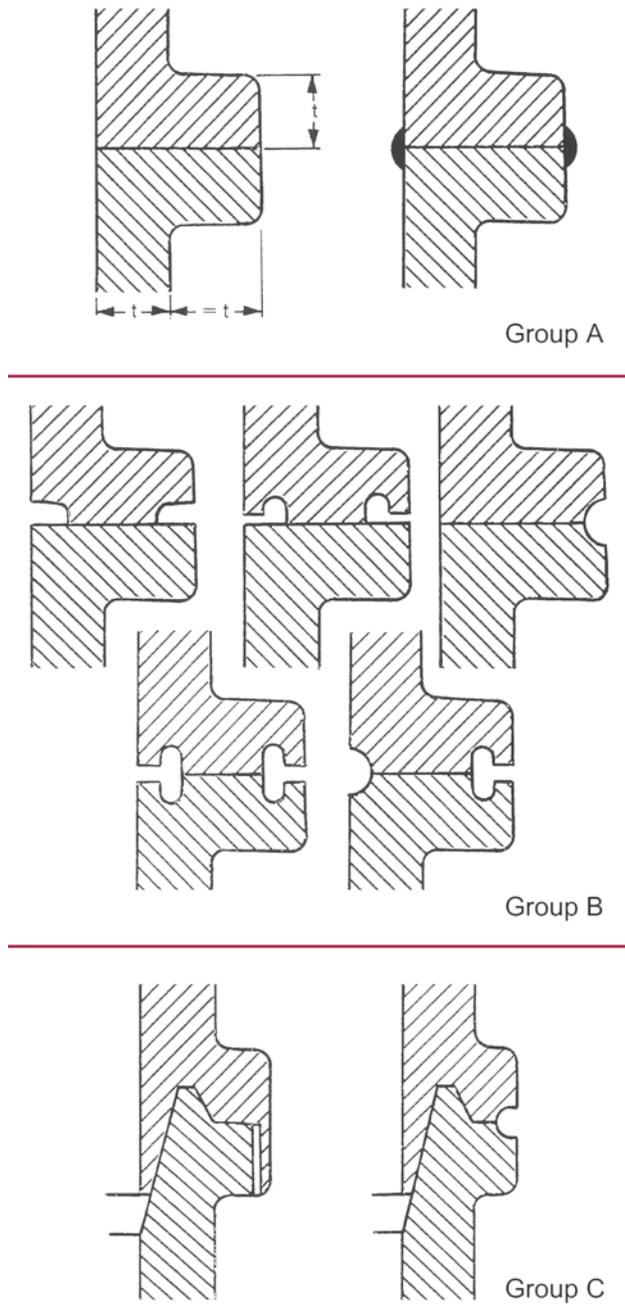
With a displacement amplitude from 3 mm (0.120 in.) to 6 mm (0.240 in.), joint pressure should be in the range of 1.4-1.8 MPa (200 to 250 psi). Weld time will generally be

between 2 to 3 seconds plus approximately 2 seconds hold time.

Joint designs are shown in Figure 4. The basic joint is a butt joint as shown before and after welding in Group A. Unless parts have thick walls, a flange is generally required to provide rigidity and an adequate welding surface. As in any melt bonding technique, there is some displacement of meltout of the joint. Various types of melt traps have been developed and are shown in Group B. For circular parts, angular welding with tongue-in-groove joints as shown in Group C (with traps) produces the best results.

Typical applications on which vibration welding techniques have been evaluated include automobile emission.

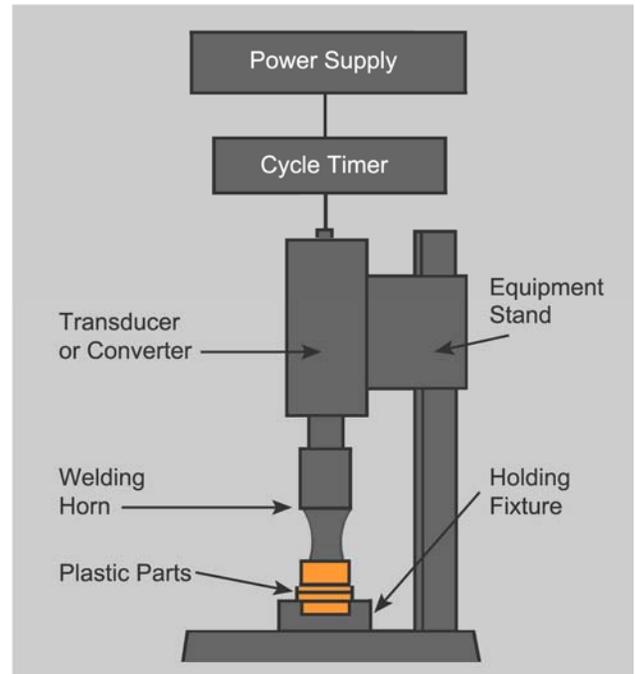
Figure 4 — Joint Designs



E. Ultrasonic

This technique produces a strong, homogeneous bond with strength approaching that of the original material. High frequency vibration and pressure are used to generate heat, which melts resin at the interface of the parts to be joined. After the vibrations cease, the pressure is maintained until the joint solidifies. Typical weld times are around 0.8 second and the equipment lends itself to automation.

Figure 5 — Basic Equipment Requirements for Ultrasonic Welding



As shown in Figure 5, the equipment for ultrasonic welding consists of:

- a power supply which converts low frequency electricity of 60 Hz (cycles per second) to 20 kHz
- a cycle timer
- a transducer which converts the electrical energy into mechanical energy in the form of vibrations
- a "horn" which transmits the mechanical vibrations to the parts and applies pressure for proper solidification of the melted Surlyn®.

It is also necessary to have a base fixture to hold and properly locate the parts under the horn.

Ultrasonic welding of Surlyn® resins is easier when stiffer, higher modulus resins are utilized. When ultrasonic welding high or low modulus Surlyn® resins, it is recommended that the part be chilled for 1-2 hours at -20°C (-4°F), and welded immediately after removal from the cold atmosphere. Chilling the parts reverses the ability of Surlyn® to absorb energy and instead lets it transmit the energy. Typical ultrasonic welding conditions for Surlyn® are:

- Weld time approx. 8 seconds
- Hold time approx. 2 seconds
- Pressure 0.08 MPa

There are many variables involved in joining Surlyn® by ultrasonic welding. Joint design is critical. There are two basic designs for joints, the shear joint, developed by DuPont, and the butt joint. Typical shear joints are shown in Figure 6, butt joints in Figure 7.

Figure 6 — Variations of Basic "Shear" Joint

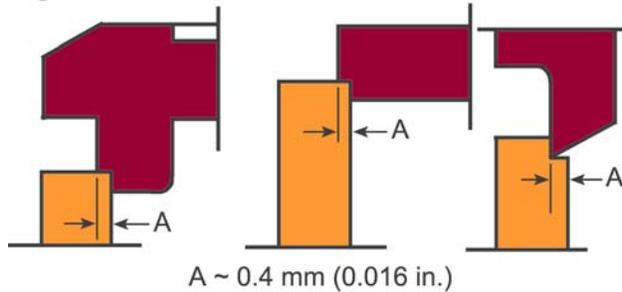
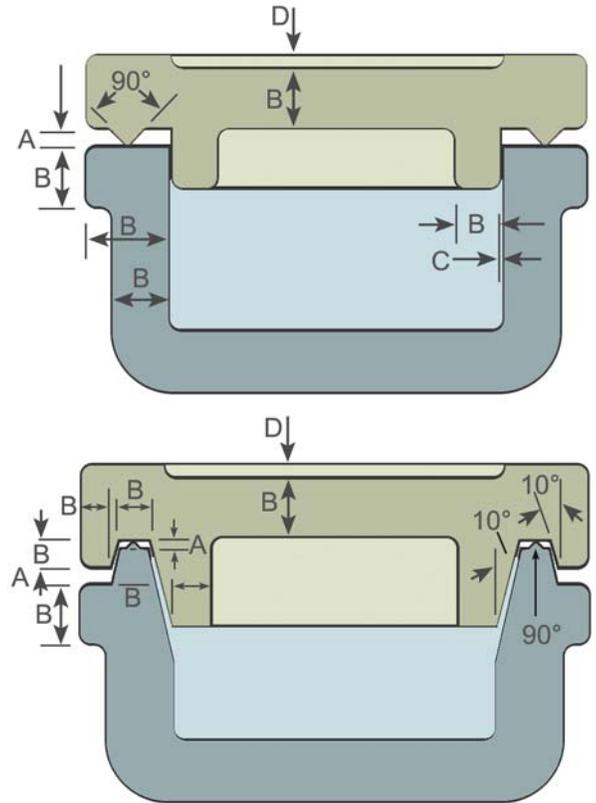


Figure 7 — Two Types of Butt Joints with Energy Directors



- Dimension A: 0.4 mm (0.016 in.), for B dimensions from 1.5-3.2 mm (0.060 to 0.125 in.) and proportionately larger or smaller for other wall thicknesses.
- Dimension B: General wall thickness.
- Dimension C: Clearance per side, 0.05-0.1 mm (0.002 to 0.005 in.).
- Dimension D: Optional recess to ensure good contact with welding horn.

F. Induction

Parts of Surlyn® may be welded by placing a high frequency coil in the joint and applying an alternating electromagnetic field to the assembly. After the Surlyn® in the joint area melts, slight pressure is maintained on the parts as the magnetic field is turned off and the part solidifies. A strong bond between the materials should be obtained within 2-10 seconds, depending on the size and geometry of the joined area.

G. Resistance Wire

A voltage is applied to a wire that has been clamped between the two pieces to be joined. The current in the wire generates enough heat to yield melted resin at the joint. When the joint is properly designed, no flash is formed and complex shapes can be accommodated.

III. HOT FLARING

Hot flaring or heat staking in its simplest form, may be accomplished by heating the end of a metal rod to a temperature slightly below the melting point of Surlyn®. For most grades of ionomer, pressing the rod against a protrusion with sufficient force causes flaring. The heated tool should not remain in contact any longer than is required.

Modifications of this basic process can be made to produce specified configurations. For instance, a soldering iron with proper temperature control and a shaped tip could be used for hot flaring. Experimentation with temperature, pressure, contact times, and tool profile will best serve to define these parameters for a specific application.

IV. LAMINATION

Surlyn® resins are excellent adhesives and laminate well to numerous surfaces. Surlyn® actually forms chemical bonds with several materials. It bonds to metals such as steel, aluminum, and copper; glass and porous substrates, paper, wood, leather and fabrics. An interface temperature of 265°C (509°F) is needed and it is recognized that interface bonds improve with time or post heat. Zinc ionomers are preferred for lamination as they are affected less by swelling and shrinkage stemming from moisture in other materials.

Backprinted films of Tedlar® coated with Surlyn® and Tedlar®/metallized Mylar® laminates coated with Surlyn® can be easily adhered with heat and pressure to parts of Surlyn®. This film can be held on the surface of the mold cavity so that molding the part and decorating become a single operation.

V. ADHESIVES

There are no room temperature solvents for Surlyn®, therefore typical solvent adhesive methods are not suitable. However, because of the chemical reactivity of the polymer, we have found that epoxy, neoprene and acrylic based adhesives work well.

VI. MECHANICAL FASTENING

A. Integral Injection Molded Fasteners

The resiliency of Surlyn® permits the design of parts that can be snap fitted into more rigid materials. It is recommended in designing snap fits that all overlaps and undercuts be specified as three times those normally needed for nylon. Surlyn® has a lower dimensional strength than engineering plastics like nylon or acetals. Typical designs are "arrowheads" (circular or rectangular), and "Christmas trees."

B. Molded-in Fasteners

The unusually high melt strength of the ionomer allows molded-in fasteners. Hex head bolts, angled bolts, and stamped plates used as inserts exhibit high torque values ([54-61 N-m (40-45 lb-ft)] and retention strength [45-57 kg (100-125 lb.)]).

Molded-in cleats in athletic shoe soles of Surlyn® also exhibit high retention values.

C. Stitching

Surlyn® can be stitched easily on standard machines. Round needles should be used to avoid notches or sharp corners.

The technical data contained herein are guides to the use of DuPont resins. The advice contained herein is based upon tests and information believed to be reliable, but users should not rely upon it absolutely for specific applications because performance properties will vary with processing conditions. It is given and accepted at user's risk and confirmation of its validity and suitability in particular cases should be obtained independently. The DuPont Company makes no guarantees of results and assumes no obligations or liability in connection with its advice. This publication is not to be taken as a license to operate under, or recommendation to infringe, any patents.

CAUTION: Do not use in medical applications involving permanent implantation in the human body. For other medical applications, see DuPont Medical Caution Statement, H-50102.

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