Invision® Enhanced Polyolefin Resin

Welding Guidelines

Invision® resins are based on enhanced polyolefin compositions that have been specifically designed to provide high performance for sheet extrusion and thermoforming applications. *Invision* resins can be categorized within the thermoplastic olefin family of polymers. Due to the thermoplastic nature of *Invision* materials, welding can be used in order to join parts during the assembly process. Some advantages of the welding process compared to adhesive bonding is the bond is fully cohesive and typically as strong or stronger than the substrate material. Also, adhesion promoters and solvents are not required and a working bond is achieved quickly. Disadvantages can be a need for capital investment in equipment, limitations in the part design to enable a welded bond, the appearance of the weld for aesthetic parts, and in many cases the inability to bond dissimilar materials ie., plastic to metal.

The type of welding process to be used can depend on a variety of factors. Part size, shape, volume, intended use, aesthetic requirements, and equipment availability are examples of various factors that need to be considered when selecting a welding process. Additionally, it is well established within the welding community that the highest quality welds are formed when the mated parts are fabricated from chemically similar or identical materials. For welding processes that require a welding rod, it is recommended to use welding rods manufactured from the same *Invision* resin that was used to fabricate the part.

All of the welding techniques discussed below can be used with *Invision* resins. Due to the large number of welding options and the variations of the different options, it is not practical to discuss specific procedures within the context of this data sheet. Each are briefly discussed as an educational guide to provide consideration of the options that are available. Detailed information of each welding technique can be obtained from the appropriate suppliers provided within this guide. Laboratory test data of *Invision* resins evaluated in some of these methods is available by contacting your A. Schulman Inc representative. It is recommended that the welding method being considered be fully evaluated in the intended application.

Extrusion Welding

Extrusion welding involves continuously extruding molten thermoplastic into an area of the finished part which is referred to as a joint. With this type of process a thermoplastic rod is fed into the rear of the extrusion barrel and is heated as it is drawn through the barrel by the rotating screw. The molten material then exits the barrel through a shoe attachment which is used to control the shape of the weld profile. As the weld is formed, a heater mounted at the end of the barrel, simultaneously preheats the substrate along the joint. Preheating of the substrate ensures the formation of a strong weld. Extrusion welding is typically used when joining parts with a butt or lap type joint.

Electromagnetic Welding (EMA)

Electromagnetic welding involves the use of high frequency energy is focused at the bonding location in conjunction with a ferrous metallic and polymeric blended bonding agent. The bonding agent is placed within the joint of the mating parts. After the bonding agent and the parts are positioned, the bonding agent is melted with electromagnetic energy which in turn heats and melts the adjoining surfaces. EMA welding is normally used in cases where the weld needs to be hidden for aesthetic purposes and/or when the joining seam has a complex geometry. EMA can be used to weld materials that are chemically similar in nature as well as certain dissimilar materials.

Electric Socket Welding

Electric Socket welding utilizes a plastic socket or sleeve for pipe fabrication. The sleeve contains a copper wire which heats up when an electric current is applied. As the copper wire heats up, the surrounding surfaces melt and expand causing the sleeve and pipe to fuse together. This method is typically only used for pipe manufacturing.

Ultrasonic Welding

Ultrasonic welding uses high frequency sound energy to generate the heat that is necessary in order to create a weld. The high frequency sound causes the plastic molecules to vibrate which in turn creates the frictional heat that is needed in order to form a melt. When the ultrasonic sound energy is discontinued, the molten material solidifies and forms a weld. This type of joining technique is classified as a "spot weld" because the sound energy is directed to a specific area which is normally limited in size. High Frequency Welding (HFW) is a variation of Ultrasonic welding. In this case, however, HFW is a continuous welding process that is used to weld thin materials.

Hot Plate Welding

Hot Plate welding is a process in which direct or radiant heat is focused at the joint of the mating parts to form a melt on the joint surface. After the melt is formed, the heat source is removed and the parts are joined together under pressure. As cooling takes place, pressure is maintained in order to ensure a strong weld. This type of welding is typically used for joining large parts that have the same shape.

Spin Welding

Spin welding is used to join round parts such as piping and rods. During this process, one part is held stationary as the other part

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is spinning. Once the spinning part reaches the set revolutions per minute (rpm), it is pressed against the stationary side in order to generate heat. This is continued until enough frictional heat is generated in order to melt and fuse the two parts together. Once an adequate weld forms, the stationary part is released and allowed to spin freely under axial pressure while cooling. As the joined parts spin, pressure is maintained in the axial direction until the weld solidifies. Vibration Welding is essentially the same process as spin welding except that the frictional heat needed for melting is generated in a "back-in-forth" linear motion. Spin welding is limited to round shapes whereas vibration welding can be used on parts with various profiles.

Hot Gas Welding

A heat gun is used in the Hot Gas welding method in order to produce a continuous flow of hot gas. The heat gun may also incorporate a filler rod feed unit. The hot gas is simultaneously directed to the surface of the mating parts and a filler rod. As melting occurs, the part surfaces fuse together with the filler rod to form the welded joint. The filler rod must of similar material to the materials being joined.

Laser Welding

Laser welding can also be used during part fabrication but there are certain guidelines that need to be followed in order for this type of process to be effective. When welding a lap type joint, the laser beam penetrates the upper layer and is absorbed by the bottom layer. As the bottom layer absorbs the energy from the laser, it begins to melt. The heat generated from the bottom layer is then conducted to the top layer which also melts. When the laser is discontinued, the two melt faces fuse together during cooling and form a weld. In order for laser welding to work, the top layer of the joint must be transmissive to the laser beam while the bottom layer must be able to absorb the laser beam. If this criteria can not be achieved, the quality of the weld will be compromised. Laser welding also requires precise distances to be maintained between the head and part surface, so robotics are typically used. It is normally limited to high volume applications due to capital equipment costs, but can be very useful in joining parts in complex aesthetic applications.

Injection Welding

Injection welding is similar to extrusion welding. In this case, however, the molten welding rod is injected via pressure into the joint. As the molten rod exits the injection cylinder, a heat tip simultaneously melts the surface of the mating parts. Injecting the molten rod into a molten joint allows for the formation of a strong weld

Welding Equipment and Welding Rod Suppliers:

- Plastic Welding Technologies (extrusion welding): (800) 635-6693, www.pwtworld.com
- Leister Process Technologies (extrusion welding, hot gas welding): +41 41 662 74 74, www.leister.com/en/contact-usa.html
- Wegener Welding (extrusion welding, hot plate welding, electric socket welding, hot air/gas welding): (630) 789-0990, www.wegenerwelding.com
- Emabond (electromagnetic welding): (201) 767-7400, www.emabond.com
- Asahi/America (electric socket welding): (800) 343-3618, www.asahi-america.com
- Sonics & Materials (ultrasonic welding, hot plate welding, spin welding, vibration welding): (800) 745-1105, www.ultrasonicwelding.com
- Branson Ultrasonics, Ultrasonic welding, Vibration welding, laser IRAM welding, hot plate welding, spin welding, sealing, thermal welding: (203) 796-0400, www.branson-plasticsjoin.com
- Dukane, Ultrasonic welding, Vibration welding, laser IRAM welding, hot plate welding, spin welding, sealing, thermal welding: (630) 797-4900, www.dukcorp.com
- Sonobond Ultrasonics (ultrasonic welding): (800) 323-1269, www.sonobondultrasonic.com
- LPKF Laser & Electronics AG, laser welding: 1-800-345-LPKF, 1-503-454-4200 www.lpkfusa.com
- Drader Injectiweld (injection welding): (800) 661-4122, www.drader.com
- Village Plastics (welding rod manufacturer): (330) 753-0100, www.villageplastics.com