Chapter 70

Rigid Thermoplastic Urethane

Ultrasonic Welding

Dow Chemical: Dow XU72523.01 (features: high heat grade, transparent); **Isoplast 101** (features: impact modified); **Isoplast 301** (features: transparent, low impact)

This study was designed to identify which resins could be effectively ultrasonically welded to themselves and other resins, and to identify the maximum bond integrity. Besides looking at the weld strength of various thermoplastic resins, this study explores the effects of gamma radiation and ethylene oxide (EtO) sterilization on the strength of these welds. A wide variety of resins used in the healthcare industry were evaluated including: ABS, polycarbonate (PC), polycarbonate/ ABS blends (PC/ABS), styrene acrylonitrile (SAN), thermoplastic polyurethanes (TPU), rigid TPU's (RTPU), high impact polystyrene (HIPS), and general purpose polystyrene (GPPS).

The strength of customized "I" beam test pieces was tested in the tensile mode to determine the original strength of each resin in the solid, nonbonded test piece configuration. Data from this base line testing was used to determine the percent of original strength that was maintained after welding. Only amorphous resins were used in this study. The most commonly used energy director for amorphus resins, a 90° butt joint, was used as the welding architecture.

Every attempt was made to make this a "real world" study. The aim during the welding process was to create a strong weld while maintaining the aesthetics of the part. One of the most important factors in determining whether or not a good weld had been achieved was the amount of flash, or overrun noticed along both sides of the joint. Another characteristic of a good weld was a complete wetting of the cross sectional weld area. The problem here, however, was that only clear polymers used as the top piece, allowed the whole weld to be seen.

Almost all resins involved in the study could be welded together with some degree of success (except for thermoplastic urethanes which didn't bond to the polystyrenes). Overall, it apppeared that resin compatibility and the ability to transfer vibrational energy through a part, and not similar glass transition temperatures, were the overriding characteristics that lead to the best welds. Although not shown in this study, it should be noted that the ability of a resin to be welded is also a function of the architecture of the ultrasonic weld. Some resins which welded well in the architecture used for this study may not weld well with other architectures.

As a group the RTPU's did not ultrasonically bond well with the polystyrenes or the polycarbonates. The high heat RTPU didn't bond very well with any of the resins in the study although some degree of bonding was achieved with every resin. The impact modified and clear RTPU's bonded very well with the ABS resins and to a lesser degree with the RTPU's and SAN resins. Sterilization by both EtO and gamma did not significantly affect the bonds in this short term study.

Reference: Kingsbury, R.T., *Ultrasonic Weldability of a Broad Range of Medical Plastics*, ANTEC 1991, conference proceedings - Society of Plastics Engineers, 1991.

Adhesive and Solvent Bonding

Dow Chemical: Isoplast 301 (features: transparent)

In tests conducted to evaluate the solvent bondability/compatibility of plasticized PVC tubing to rigid, transparent thermoplastics, no evidence of post-assembly crazing could be found with luers made of RTPU. The ease of insertion was superb in every case except when acetone was the solvent. Satisfactory bonds could only be obtained with THF, which gave a very strong bond, and with certain specific blends of MEK or methylene chloride in cyclohexanone -- particularly those mixtures with 30-50% MEK. Besides THF, a preferred solvent blend which provides maximum bond integrity is a 30:70 cocktail of MEK in cyclohexanone.

Reference: Haskell, A., *Bondabilitly/Compatibility of Plasticized PVC to Rigid, Transparent Thermoplastics*, ANTEC 1989, conference proceedings - Society of Plastics Engineers, 1989.