Chapter 59

Polyphenylene Sulfide

Ultrasonic Welding

LNP Engineering Plastics: OF1006 (material composition 30% glass fiber)

Polyphenylene sulphide, being a semicrystalline thermoplastic, is not ideally suited to ultrasonic welding. In a semicrystalline plastic the amorphous portions soften at a low temperature with a corresponding increase in mechanical loss factor, which results in more energy being needed to melt the crystalline portions. This phenomenon is reflected in the results of the weldability trials.

The results of the weldability study suggest that oints can be formed so long as sufficient power is applied to the joint, i.e. it is necessary to employ a high vibration amplitude and to contact the welding horn as close as possible to the joint. A projection joint has proved to be the most successful joint design. Far field welding is not feasible for this material.

The ultrasonic welding of 30% short glass fiber filled PPS was studied using a 1500 W commercial ultrasonic welding machine. Projection and shear joints were used for weldability trials. The effect of the base fixturing material was investigated by comparing aluminium, Devcon and PTFE.

- 30% short glass fibre PPS (grade LNP OF-1006) can be welded by ultrasonics in the near field. A high vibration amplitude, 80 μm and low weld force, 275N, is required to ensure that sufficient heat is generated at the joint. Poor tolerance to variations in welding parameters means that critical optimization of welding procedures is required.

- If ultrasonic welding is required, the quality of the injection molded component is of great importance. Defects in the molding, such as internal weld lines, affect ultrasonic energy transmission and can act as energy absorbers within the component. This results in damage to the specimen, either cracking or overheating, and poor joint quality as a result of insufficient energy availability at the weld line.

- The fixturing material affects the weld quality. In the present trials, a PTFE fixture gave a wider tolerance to welding parameters and less scatter than aluminum, but did not improve the maximum joint strength achieved.

Reference: Taylor, N., *The Ultrasonic Welding of Short Glass Fibre Reinforced Thermoplastics,* ANTEC 1991, conference proceedings - Society of Plastics Engineers, 1991.

Infrared Welding

Bayer: Tedur 9611 (material compostion: 45% glass fiber reinforcement)

Due to the orinetation of the glass fibers, the bulk material specimen (3 mm thick plates) showed a strength of 120 MPa parallel to the welded line and 80 MPa normal to it. In tests showing the actual weld strength of IR welded polyphenylene sulfide (PPS) plates as a function of weld layer thickness, PPS does not show a minimum in the course of strength. At the same time, the range of melt layer thicknesses resulting in optimal strengths is comparable to that in heated tool butt welding. The obtained strengths of PPS welded seams exceeded a range of 45 MPa. This corresponds to a welding factor of approximately 0.6 at a base material strength of 80 MPa.

Reference: Potente, H., Michel, P., Heil, M., *Infrared Radiation Welding: A Method for Welding High Temperature Resistant Thermoplastics,* ANTEC 1991, conference proceedings - Society of Plastics Engineers, 1991.

Adhesive Bonding

GE Plastics: Supec

A study was conducted to test for bond strength on a representative matrix of commonly used plastics and the adhesives best suited to them. For many of the plastics evaluated, the effect of polymer composition on bond strength was evaluated by compounding plastic formulations with each of the most commonly used additives and fillers for that plastic; common grades were used for the remaining resins. The effect of each additive and filler was determined by comparing the bond strength achieved with the specially compounded formulations to that of the neat plastic. In addition, the effect of surface roughening and chemical treatment of the plastic surface on bond strength was examined.

The block-shear (ASTM D 4501) test was chosen as the test method because it places the load on a thicker section of the test specimen that can withstand higher loads before experiencing substrate failure. In addition, the geometry of the test specimens and the block-shear fixture helps minimize peel and cleavage forces in the joint. How well the block-shear test method reflects the stresses that an adhesively bonded joint will experience in real world applications should be considered. Also, limitations on the data due to the variety of additives and fillers used by different companies should not be ignored.

Loctite 3105, a light curing acrylic adhesive, achieved the highest bond strengths on the grades of PPS evaluated. Prism 401 and Super Bonder 414, both cyanoacrylate adhesives, achieved the second highest bond strengths. The lowest bond strengths were achieved by Depend 330, a two-part no-mix acrylic adhesive, and Black Max 380, a rubber toughened cyanoacrylate adhesive. Typically, Depend 330 achieved slightly higher bond strengths than Black Max 380.

Surface Treatments
Surface roughening caused a statistically significant increase in the bond strengths achieved by all the adhesives evaluated, with the exception of Loctite 3105, which experienced no statistically significant change. The use of Prism Primer 770, in conjunction with Prism 401, did not produce any statistically significant change in the bondability of PPS.

Other Information
PPS is compatible with all Loctite adhesives, sealants, primers, activators, and accelerators. Recommended surface cleaners are isopropyl alcohol and Loctite ODC Free Cleaner 7070.

Table 59.1: Shear strengths of polyphenylene sulfide (PPS) to PPS adhesive bonds made using adhesives available from Loctite Corporation. Values are given in psi and (MPa).[a,b]

Plastic Material Composition (GE Plastics Supec)		Loctite Adhesive					
		Black Max 380 rubber toughened cyanoacrylate (200 cP)	**Prism 401** surface insensitive ethyl cyanoacrylate (100 cP)	**Prism 401/ Prism Primer 770** polyolefin primer for cyanoacrylate	**Super Bonder 414** general purpose cyanoacrylate (110 cP)	**Depend 330** two-part no-mix acrylic	**Loctite 3105** light cure acrylic (300 cP)
Supec grade W331	30% glass reinforced PTFE filled 9 rms	100 (0.7)	150 (1.0)	400 (2.8)	250 (1.7)	150 (1.0)	550 (3.8)
Grade W331 roughened	24 rms	150 (1.0)	500 (3.5)	400 (2.8)	400 (2.8)	350 (2.4)	550 (3.8)
Grade G301T	30% glass reinforced	200 (1.4)	400 (2.8)	150 (1.0)	350 (2.4)	250 (1.7)	1200 (8.3)
Grade G401	40% glass reinforced	200 (1.4)	300 (2.1)	300 (2.1)	300 (2.1)	450 (3.1)	1100 (7.6)
Grade G323	65% glass/mineral filled	250 (1.7)	400 (2.8)	900 (6.2)	600 (4.1)	300 (2.1)	2050 (14.1)
Grade CTX530	30% glass reinforced PPS/PEI blend	150 (1.0)	250 (1.7)	400 (2.8)	400 (2.8)	200 (1.4)	900 (6.2)

[a] All testing was done according to the block shear method (ASTM D4501).
[b] For more information on data presented in this table, contact Loctite Corporation at 800-562-8483 (1-800-LOCTITE). Request the "Design Guide for Bonding Plastics."

Reference: *The Loctite Design Guide for Bonding Plastics*, supplier design guide (LT-2197) - Loctite Corporation.