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Fabrication

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Fabrication

There is a wide variety of fabrication techniques available for working with thermoplastic sheet materials.

7.1 Machining

Most thermoplastic materials can be easily machined, i.e. punched, sawed, drilled, milled etc., by conventional tools used in metalworking and woodworking. High speed, fine pitched blades will minimise chipping and notching, particularly for crystal polystyrene sheet. Impact resistant materials such as the high-impact polystyrenes and ABS will splinter less and can be more easily machined.

For straight line cutting, score breaking is a method that yields satisfactory results. Metal type guillotines can also be used up to 3.0 mm. Commercial fabricators use sophisticated CNC routers, laser and high pressure water jets.

Owing to the poor thermal conductivity and the comparatively low softening temperatures of most thermoplastics, the cut surfaces are usually cooled with water or a current of air, which considerably improves cutter performance.

7.2 Assembly

Typical assembly techniques used are: mechanical, frictional welding, ultrasonic welding, bonding with adhesives or solvent bonding.

Welding

Excellent bond properties can be obtained with welding processes. Polystyrene and ABS materials can be welded together using a variety of different techniques: hot plate welding, frictional (or spin) welding and ultrasonic welding. Preliminary trials are often essential, because the bond strength and the appearance of the weld depend considerably on the machine parameters as well as on the nature of the materials to be bonded. Ultrasonic welding allows bonds to be effected between related thermoplastics.

Adhesive Bonding

To obtain maximum bond strength it is necessary to apply only a thin layer of adhesive. Over-application of adhesive will usually lead to a weak joint resulting from the reduction in volume as the adhesive dries out. The surfaces to be joined should be lightly abraded with fine emery paper before application of the adhesive to optimise the bond strength.

Due to the variety of different adhesives in the marketplace the selection of the 'right' adhesive can be a formidable task. It is recommended that all questions on bonding be referred to a competent adhesives manufacturer who will be able to reduce the number of trials considerably.

Solvent Bonding

Many thermoplastics can easily be bonded to themselves by solvent bonding. It is a technique suitable only for amorphous plastics such as polystyrene and acrylic. It cannot be used for polyolefin materials (i.e. PP, HDPE, LDPE).

With solvent bonding structural bonds of up to 100% of the strength of the parent material are possible. Typically solvent cementing involves softening the bonding area with a solvent or a solvent containing small quantities of the parent material, referred to as *dope* or *bodied cement*, generally containing less than 15% resin. The solvent, or solution, is then coated onto one or both surfaces to be joined and after allowing a short period for most of the solvent to evaporate, the two pieces are brought together under firm pressure to form an instant bond.

ABS and polystyrene materials can be bonded with the aid of solvents such as MEK, toluene or dichloromethane, but this applies only to articles produced from the same material. Table 7.1 below lists suitable solvents for use with ABS and polystyrene materials.

ABS	Methyl ethyl ketone (MEK), methyl isobutyl ketone, tetrahydrofuran, methylene chloride.
Polystyrene	Methylene chloride, ethylene ketone, ethylene dichloride, trichloroethylene, toluene, xylene.

Table 7.1: **Solvents for cementing of polystyrene and ABS materials***

A key to the selection of solvents is how fast they evaporate: a fast-evaporating product may not last long enough for some assemblies; too-slow evaporation can hold up production. Careful selection of the solvent is important as some of the more volatile compounds can lead to stress cracking due to solvent attack.

*Check with suppliers about the safety aspects such as extraction equipment etc.

Mechanical Bonding

Riveting is the most common method used for mechanical bonding. In order not to apply excessive force to the plastic part, the holes should be somewhat larger and only low strength rivets used (tubular rivets or aluminium pop-rivets). To deter failure due to environmental attacks, silicone sealants are sometimes applied to the holes prior to riveting. To prevent localised overloading, the distance between rivets should not be excessive.

7.3 Line Bending

Line bending is a simple technique to shape thermoplastic sheet using a localised heat source and a cooling jig. The cooling jig simply 'sets' the angle of the bend within the required tolerances by contacting unheated areas only (Fig. 7.1 below). Numerous types of heating elements will provide a line of heat, examples include basic silica glass or quartz encased spiral elements. Provided that the line of heat is sufficiently local a uniform, blemish free bend can be produced.

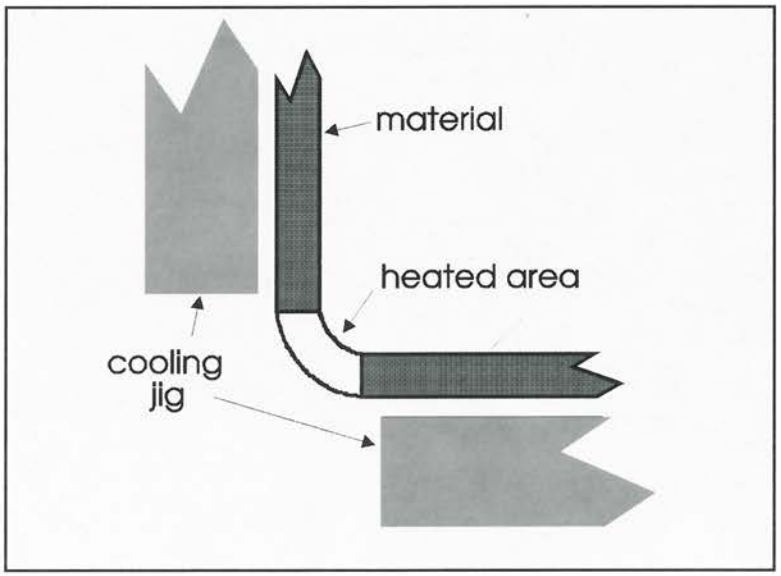

Fig. 7.1: **Local Line Bending**