TOP TEN DESIGN TIPS

By Jürgen Hasenauer, Dieter Küper, Jost E. Laumeyer and Ian Welsh

1. Comparison of materials
2. Material selection
3. Wall thickness
4. Ribbing
5. Gate positioning
6. Cost-saving designs
7. General assembly technology
8. **Welding technology**
9. Tolerances
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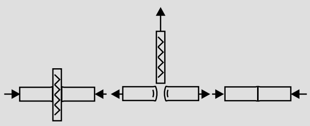
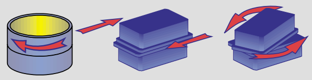
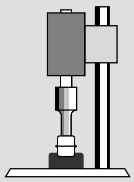
8. Welding technology

The Best Assembly Techniques – Part II

Welding technology – In addition to the assembly techniques described in article 7 of this series, many different welding methods can be used to join plastic parts. To ensure low-cost, functionally efficient designs, it is necessary to select a suitable welding method and give careful thought to the required joint geometry at an early stage in the design process.

	Hot-tool	Vibration/Spin	Ultrasonic
Principle			
Welding cycle times	10-20 s	0,2-10 s	0,1-2 s
Advantages	– unevennesses in the joint zone (e.g. distortion) are melted away – good reproducibility of welding results – best weld quality – high degree of automation possible	– suitable for welding medium-sized to large parts – suitable for welding plastics sensitive to oxidation	– different variations possible (riveting, flanging, insertion) – shortest cycle times – method can be readily automated and integrated
Limitations	– oxidation-sensitive plastics – more flash	– position of the parts to be welded relative to each other – minimum rigidity required (material/part geometry) – defined relative movement required	– suitable only for welding small to medium-sized parts – near-field/far-field an additional influencing factor
Examples			

Comparison of different welding methods

Fig. 1

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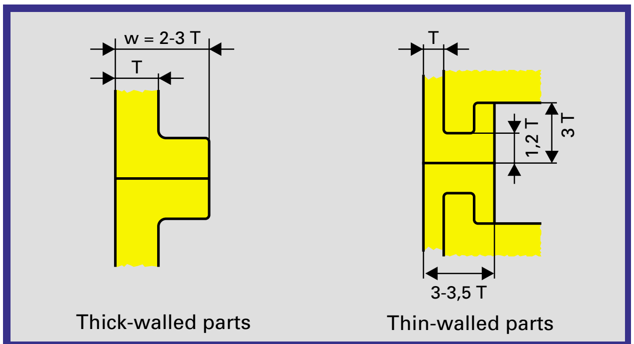
Welded joints are assemblies for permanently connecting plastics parts without additional assembly elements. The choice of welding method depends on several criteria: the geometry of the moulded part and on the materials used, on cost-effectiveness, suitability for integration into the overall production cycle and the mechanical and aesthetic quality requirements for the assembly zone.

Different welding methods

There are many different, cost-effective welding methods suitable for industrial mass production. The methods most frequently used for plastics engineering components are (Fig. 1):
– hot-tool welding
– spin welding
– vibration welding
– ultrasonic welding.

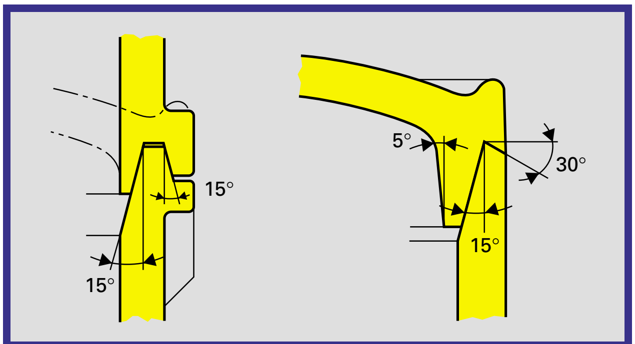
Other methods worth mentioning include:
– high-frequency welding
– induction welding
– hot-gas welding.

New methods are also being developed (e.g. laser welding), but these are not yet widely used in industry.
In all these methods, the assembly operation is carried out by applying heat (melting the surfaces to be joined) and pressure. Heat can be generated directly by contact or radiation, or indirectly by internal or external friction, or by electrical effects.



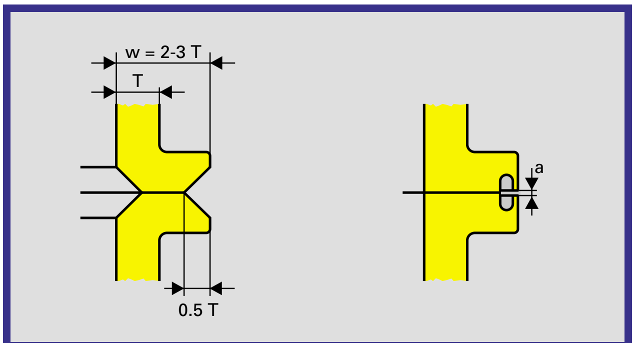
Weld design for vibration welding/hot-tool welding

Fig. 2



Weld design for spin welding

Fig. 3



Examples of recesses for absorbing flash

Fig. 4

Choosing the right method

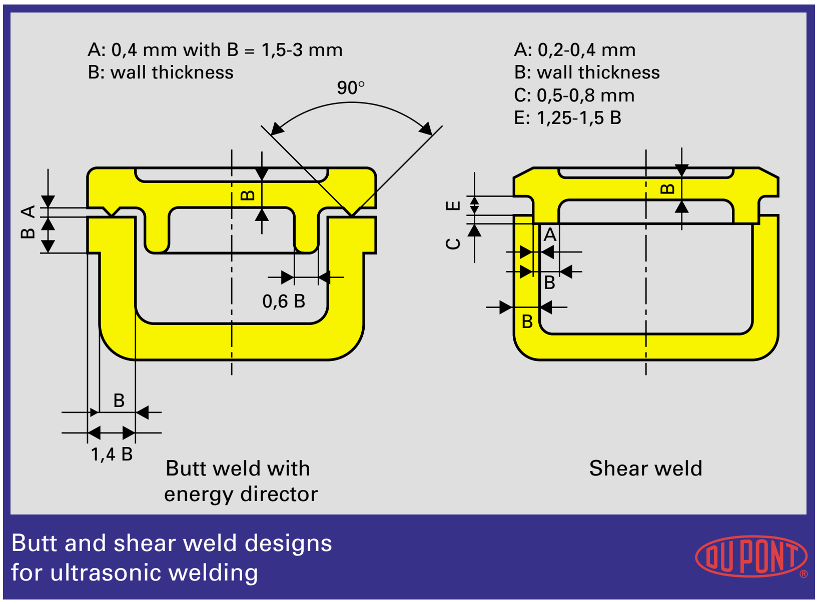
To achieve good, reproducible weld quality, it is necessary to choose a suitable welding method, optimize welding parameters and ensure that the parts to be assembled are correctly designed for the welding method being used. Welding machinery manufacturers supply not only standard equipment but also various special welding units to cater for a wide variety of welding tasks. Before deciding on a welding method, it is advisable to consult the machinery manufacturers or resin suppliers.

Different welding properties

Theoretically, all thermoplastics are weldable, but the welding behaviour of plastics differs considerably in some cases. Amorphous and semi-crystalline polymers cannot be welded together. Plastics that absorb water (e.g. nylon) need to be pre-dried, since moisture leads to poor-quality welds. For best results, nylon parts should either be welded immediately after injection-moulding or kept in a dry state before welding. Resin additives such as glass fibres and stabilizers can also influence welding results. Welded assemblies of unreinforced plastics can attain weld factors close to the strength of the parent material, given suitable process parameters and part design. With glass-fibre-reinforced plastics, loss of strength due to fibre separation or reorientation in the welding zone must be taken into account.

Correct weld design

An essential requirement for high-quality welds is suitable design of the weld profile. The profiles shown in Figures 2 and 3 have proved successful basic designs. If the weld zone additionally has to meet high aesthetic specifications, then special geometry is needed. The diagrams show possible ways of hiding flash by providing recesses to absorb the excess material (Fig. 4). Thin-walled parts need to be designed with a guided fit into each other, so that the necessary welding pressure can be applied without the walls moving out of alignment.

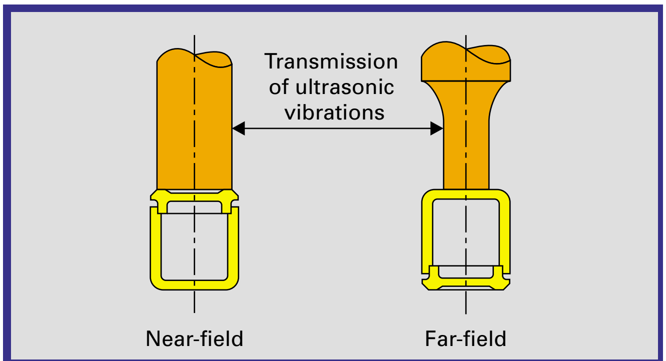


Butt and shear weld designs for ultrasonic welding

Fig. 5

Special features of ultrasonic welding

Semi-crystalline polymers have a sharply defined melting point, i.e. on application of heat they pass abruptly from the solid to the liquid phase. For ultrasonic welding of semi-crystalline plastics, it is therefore preferable to use shear welds (Fig. 5). For welding amorphous plastics, which have a softening range, the weld design is less critical. Fig. 6 shows diagrams of the near-field and far-field welding methods. These differ in the distance between the contact point where the ultrasonic horn transmits vibrations into the workpiece and the faces to be joined. Generally speaking, near-field welding produces the best results with all plastics but it is essential to use the near-field method for plastics with a low elastic modulus.



Near-field and far-field welding methods

Fig. 6

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