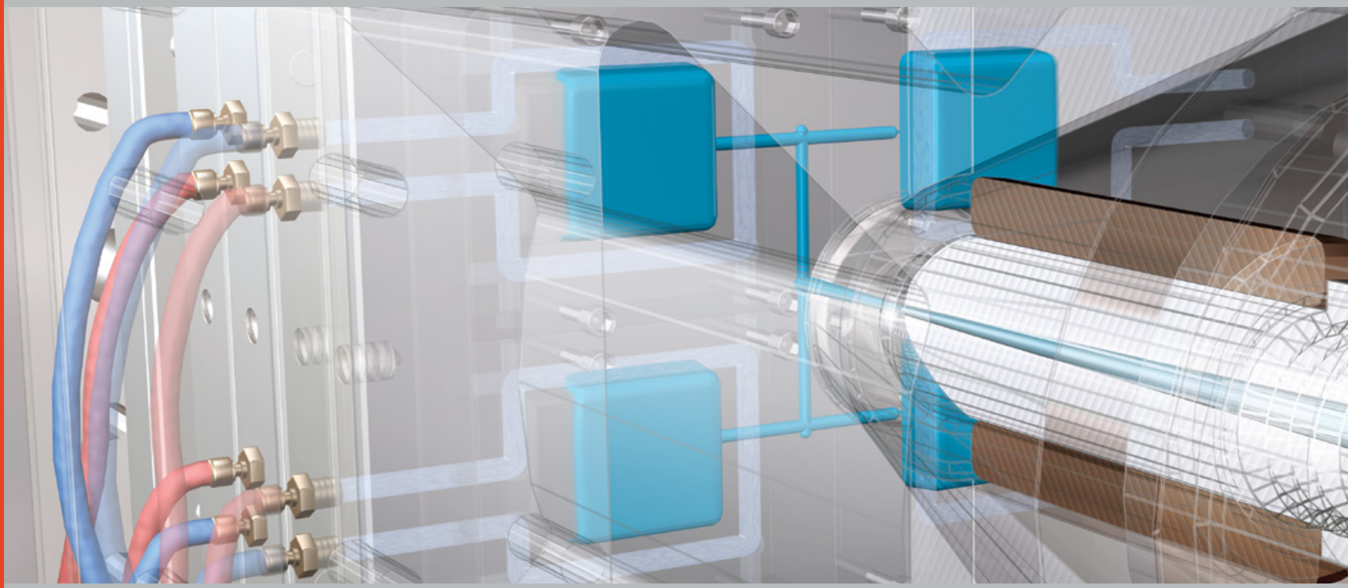
REFERENCE SERIES: DESIGN

Ultrasonic Welding Concerns for Plastic Parts



nexeo plastics

Created exclusively for **Nexeo Plastics** by Routsis Training, this free guide contains excerpts from Routsis's ***Mold & Part Design Courses***.

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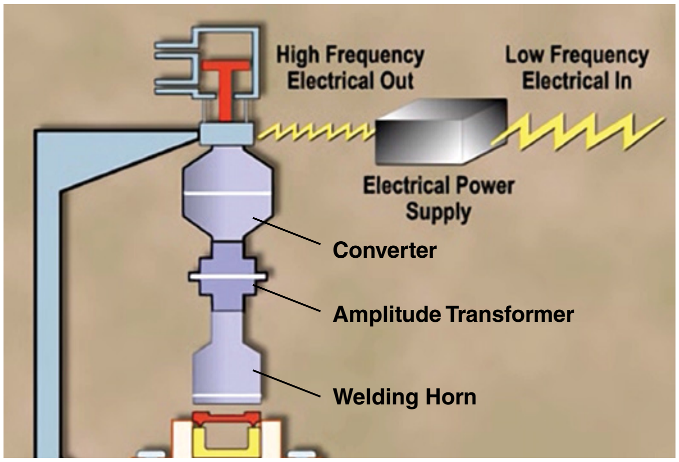
ULTRASONIC WELDING

Ultrasonic Welding is the most common Welding technique. This technique uses Ultrasonic Vibrational Energy to generate the Intermolecular Friction, Heating, and Diffusion between the two mating surfaces.

This is a diagram of an **Ultrasonic Welding Machine**:



One of the two parts to be joined is placed into a stationary fixture. The top part is placed either on top of the lower part, or is placed into the **Welding Horn** above.

A low-frequency electrical signal is passed through the **Electrical Power Supply**, and converted to a high-frequency signal. The **Converter** then converts this high-frequency electrical signal into a high-frequency mechanical vibration. This signal passes through the **Amplitude Transformer**, or Booster Horn, where the amplitude of the axial vibration is increased.

An aluminum or titanium **Welding Horn** is specifically designed for the part. The Ultrasonic vibrational energy is transferred to the part through the horn.

An **Energy Director** is usually designed on the part to concentrate the vibrational energy and begin the ultrasonic weld.

During and after ultrasonic vibration, a **Pneumatic Cylinder** is used to apply pressure to the welding apparatus and the assembly. The Weld Time, Horn Position, and Weld Pressure can be manipulated to increase the quality of the weld.

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Ultrasonic Welding Considerations

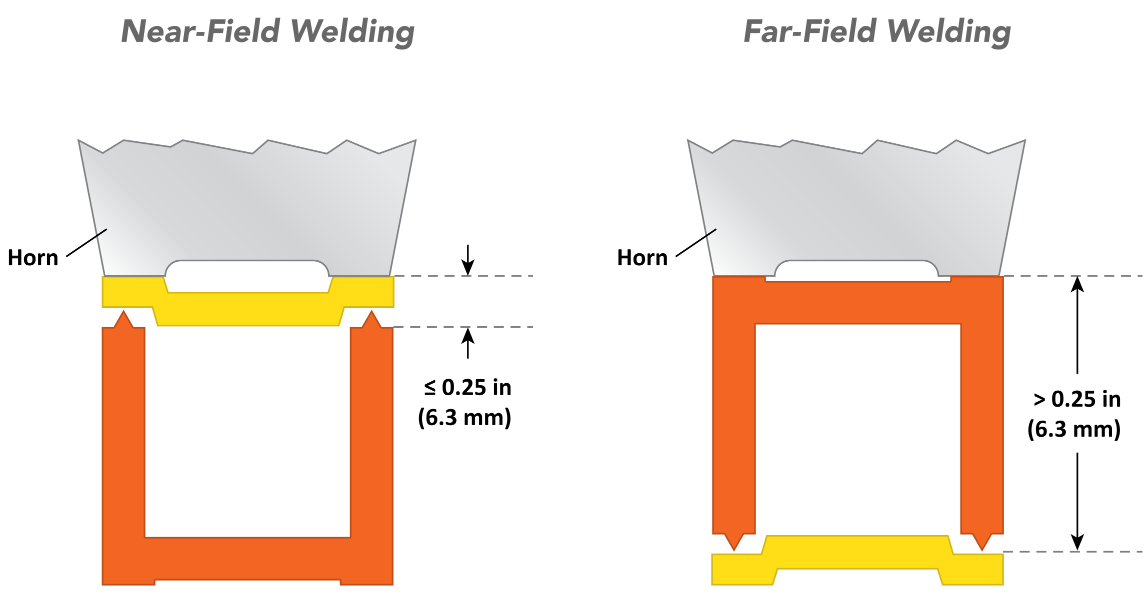
There are many aspects to consider when designing parts for Ultrasonic Welding.

Near Field Welding vs. Far Field Welding

The first concern is whether the part is being **Near Field Welded** or **Far Field Welded**. "Near" and "Far" refer to the horn's distance from the weld site.

In Near Field Welding, the horn is less than 1/4" from the weld.

In Far Field Welding, the horn is more than 1/4" from the weld. This is less effective than Near Field Welding, due to the increased distance between the vibration source and the weld location. Design features, such as steps, can be added to the part to improve the weld.



Material Properties

Material Properties must also be taken into consideration. The **Morphology** of the polymer is very important: Amorphous Polymers ultrasonically weld better than Semi-Crystalline Polymers.

Whenever possible, use the same material for both pieces to be welded.

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If the parts to be welded are made of different materials, the materials must be compatible. If the materials have different Glass Transition Temperatures, or $\mathbf{T_g}$, the polymers may not be compatible. Polystyrene, for example, welds poorly to Polycarbonate. This is because the Glass Transition of Polycarbonate is much higher than that of Polystyrene. Therefore, the Polystyrene half melts before the Polycarbonate softens.

The **Hygroscopicity** of the material is also important. If the parts absorb water, the weld may not hold. Such parts may have to be placed into a Dryer or Desiccator to remove the moisture pior to Welding. Be careful when drying the parts, as they may warp when heated.

Additives also affect the weldability of the polymer. Fillers and reinforcements can interfere with the polymer flow at the weld Interface. Other additives, such as colorants and lubricants can migrate to the part surface and interfere with the weld.

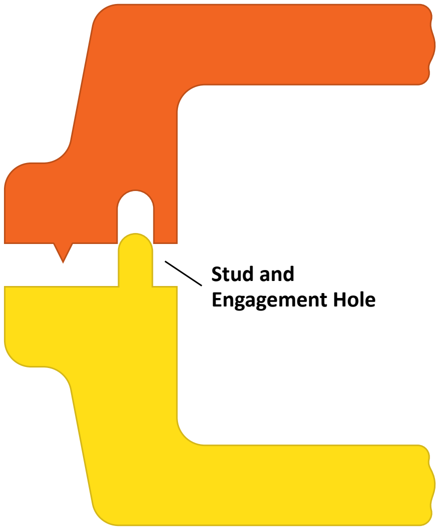
Alignment

Proper alignment of the two parts is critical to Ultrasonic Welding processes.

Aligning the weld through part design is more effective than aligning the weld with a **Welding Fixture**, as fixtures can scrape and damage the outside of the part.

Joint Design can be extremely important to processes such as Ultrasonic Welding, and can help facilitate proper part registration.

Studs with engagement holes can also be used to align the parts during welding.



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Ultrasonic Staking

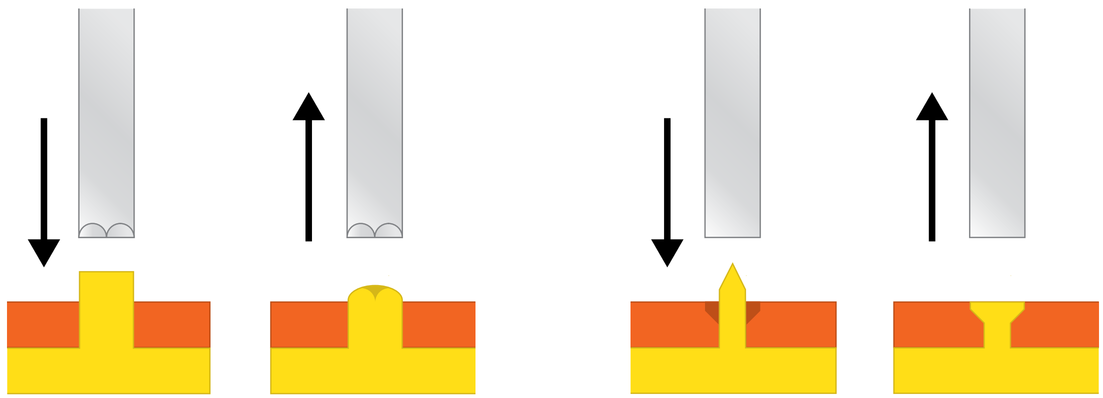
Ultrasonic Staking is similar to Ultrasonic Welding. In staking, one of the adjoining parts is molded with holes, and the other with posts. An ultrasonic welding horn forms the post over the other part. This creates a weld and a mechanical joint between the pieces.

For thin posts, Standard Domed Stakes are usually used. These are the simplest and most common types of stakes.

A Hollow Stake can be used for parts with large posts. Hollow Stakes allow the use of large posts; without resulting in a Sink mark on the wall opposite the post. Lastly, a Flush Stake can be used. These stakes can provide better surface finishes and weld appearances, but they are more difficult to implement and design.

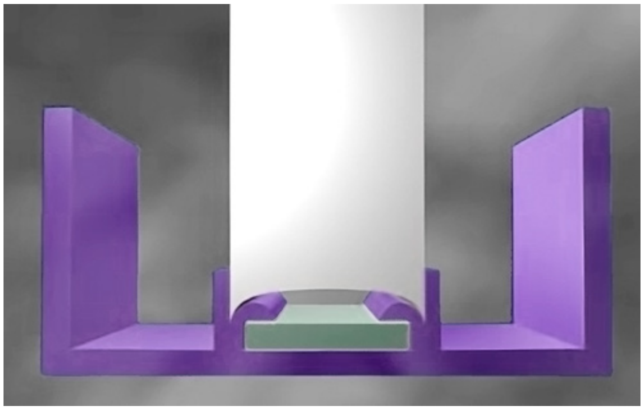
Standard Domed Stake

Flush Stake



Ultrasonic Swaging

Swaging is similar to staking and is used in cases where one part is placed into the other. In Swaging, an Ultrasonic Horn is used to cut the material surrounding the part — and create a dome-shaped seal to hold the part down.



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