What is ultrasonic welding?

Ultrasonic welding is a kind of joining method applying oscillation in ultra-frequency (normally 15~70KHz) to generate high temperature at the contacting (welding) area to melt material for joining to achieve parts assembly. During ultrasonic welding, the supplied electrical energy is in 50/60Hz is converted into mechanical oscillation energy in ultra frequency and working on work-pieces under pressure which case fast temperate rising to melt material, then stop ultrasonic oscillation and keep pressure forced on workpieces until cooling done to resolidify and form joining.

Read more about ULTRSONIC>>

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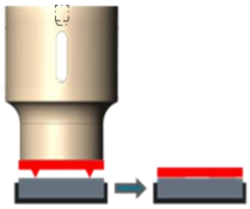
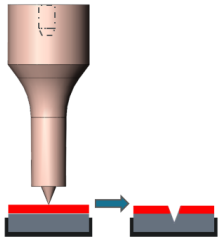
What is the application of ultrasonic welding principle in process to non-metal material?

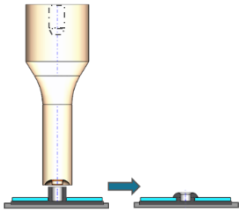
Ultrasonic welding principle is applied over than joining, the most application as below:



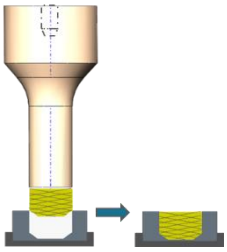
1. Energy ultrasonic welding: two plastic parts overlay together under pressure between which there is energy director (called welding rib) designed to melt as replacement to form joining.



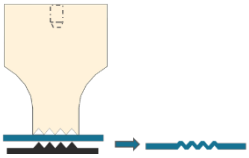
2. Ultrasonic Spot Welding：Two work-pieces overlay together at welding area, ultrasonic energy transmits to teeth or needles designed on ultrasonic tooling and melt the material of the upper layer and work-through it, then reach to the lower layer and work it to melt material to form material joining.



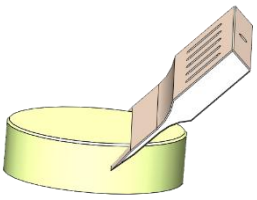
3. Ultrasonic Staking (Riveting): ultrasonic energy work on plastic boss (stud) of work-pieces with ultrasonic tooling to melt material and re-form shape under pressure to fix two-work pieces together, by which it achieves assembly of work-pieces.



4. Ultrasonic inserting (embedding): press metal pieces into the hole of plastic parts and form embedding with ultrasonic tooling, during which ultrasonic tooling works on metal parts, such as metal nuts, transmitting ultrasonic oscillation energy to metal parts which case temperature rising in short time to melt plastic material contacting metal parts under pressure, as the same time press metal parts into plastic part hole, stop ultrasonic oscillation when metal parts has been pressed into target depth and keep pressure forced on metal parts, until thermoplastic material cool down to resolidify and hold metal parts firmly.

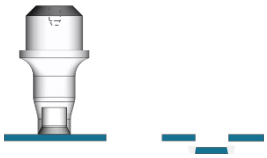


5. Ultrasonic Forming: Applies ultrasonic oscillation energy to melt thermoplastic material with ultrasonic tooling under pressure to re-form material in target shape.

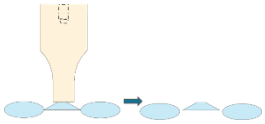


6. Ultrasonic Cutting : Ultrasonic tooling designed with blade, oscillation energy transmitted on material to achieve clean & neat with lower force than normal cutting. [ultrasonic Cutting>>]

by which ultrasonic blade works on cutting in efficiency [Read more about]



7. Ultrasonic Punching: a kind of ultrasonic cutting process, by which ultrasonic punching tooling made of hard material works on thermoplastic material with oscillation energy under pressure to cut through material gaining clean and net punching result.

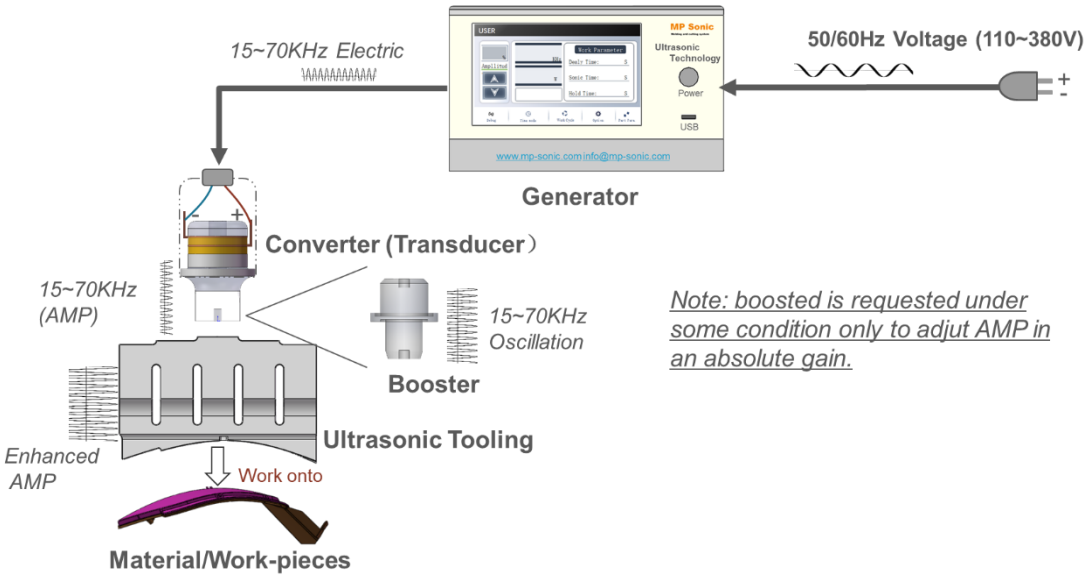


8. Ultrasonic de-gating: ultrasonic oscillation is transmitted to injection molded parts and focuses at the injection gate points of parts, by which cases neat crack at the gate to separate work-pieces from waste material.

What is the advantage of ultrasonic welding?

1. Very short cycle time, Efficient operation;
2. No consumption of material, low production cost;
3. Ensure high assembly strength;
4. Can achieve aright joining.

What contents in ultrasonic system?



1. Ultrasonic Generator: Power supplier of ultrasonic system which transforms supplied

voltage frequency into ultrasonic frequency and supplies to transducer.

2. Ultrasonic Converter: the transducer converts electric in ultrasonic frequency into mechanical oscillation called amplitude.
3. Ultrasonic Booster: to adjust amplitude in a designed gain;
4. Ultrasonic Horn: adjust amplitude and work onto material or work-pieces.

Read Details>>

What is critical to ultrasonic welding?

a. Ultrasonic frequency: frequency of ultrasonic is not adjustable. Normally, ultrasonic frequency bandwidth (eg. 35±0.3KHz) exists fitting for frequency tolerance of ultrasonic tooling (ultrasonic transducers, boosters & horns). Ultrasonic tooling intime frequency must be in the ultrasonic frequency range for co-work.
b. AMP of ultrasonic wave: wave length of ultrasonic oscillation.
c. Pressure of melting: the pressure forced on workpieces by ultrasonic tooling when ultrasonic oscillate.
d. Ultrasonic energy output: ultrasonic energy working on workpieces, the normal calculation form as blow:

   E: Energy; P: Power: Ultrasonic Power; Time: Ultrasonic Time

   E=P*T

   F: Clamp Force; A: Amplitude; f: Ultrasonic Frequency

   E=P*F*A*f*T

   Integral form:

   E = \int \mu P v \, dt, which indicates that the energy is the integral over time of the product of the friction coefficient, pressure, and velocity.

   Energy density:

   E = K_1 P^{n_1}, where the energy density (E) is related to the welding pressure (P) by a power function.

   Energy distribution:

   E_0 = E_t + E_w, where the total energy equals the sum of frictional heat generation (E_t) and heat generated by plastic deformation (E_w).
e. Ultrasonic welding volume control: normally means welding depth.
f. Hold Time: the time for material cooling down under pressure to resolidify and form joining.
g. Cooling pressure: the clamp force for cooling down to avoid loose after ultrasonic stop.

Moreover, it is very important that have suitable construction designed for ultrasonic welding according to parts material, geometric shape and welding result standard.

The types of ultrasonic welding machine

a. Handheld (portable) type ultrasonic welder: small size and light weight for easy carrying and storage;
b. Pneumatic ultrasonic welder: machine in table-top or ground-standing construction design, control ultrasonic head motion and force welding by pneumatic cylinder, economical equipment cost;
c. Servo ultrasonic welder: machine in table-top or ground-standing construction design,

control ultrasonic head motion and force welding by servo motor system for high precision welding control, meeting high requirement of welding.

How to control the work of ultrasonic?

When start ultrasonic?

A. Delay time: a length of delay time present in system, machine head descend once start machine cycle, at the same time, timing start. When timing ends, ultrasonic starts working.
B. Depth Control: a position in height is preset, machine head descends once machine cycle start us, after which ultrasonic starts when machine head descends to a preset position.
C. Force pressure trigger: a clamping force is preset, machine head descends once machine cycle start us to clamp workpieces, ultrasonic starts when pressure forcing to workpieces reach to preset value.

When stop ultrasonic output?

A. Time mode: a length of timing is present in ultrasonic system during which ultrasonic will keep outputting, ultrasonic stops working once time's up;
B. Energy mode: a value of energy preset in ultrasonic system, ultrasonic stops working once ultrasonic energy output reached to target value;
C. Dynamic force pressure trigger mode: a clamping force value preset in machine system. During ultrasonic melting, the material will become soft the clamping force will drop, and after melting to the designed position (eg. the bottom of welding rib), the clamping force will increase fast, when reach to the preset clamping force value, ultrasonic will stop work.
D. Depth mode:
there are two types: a. ultrasonic stops work when machine head descends to the position in height preset; b. ultrasonic stops work when machine heads descends in a moving distance preset in system.

What kind of thermoplastic material can be welded by ultrasonic?

Different material different welding result by ultrasonic, the welding compacity between two similar or two dissimilar material is different.

Ultrasonic Welding Performance Analysis for Thermoplastic Materials

Material Combination	Welding Compatibility	Welding Difficulty	Weld Strength (vs. Base Material)	Welding Appearance
ABS + ABS	Excellent	Very Low	85% - 95%	Smooth, No Flash
PC + PC	Excellent	Very Low	90% - 100%	Transparent, Glossy
PS + PS	Excellent	Very Low	80% - 90%	Smooth, Minimal Flash
PMMA + PMMA	Good	Low	75% - 85%	Transparent, No Cracks
PVC + PVC	Good	Low	70% - 80%	Smooth, Chemical Resistance Retained
PP + PP	Good	Medium	65% - 75%	Slightly Rough, Visible Weld Line

PE + PE	Good	Medium	60% - 70%	Slightly Rough, High Toughness
PA66 + PA66	Good	Medium-High	60% - 70%	Rough, Visible Weld Seam
PET + PET	Fair	High	50% - 60%	Brittle, Easy to Crack
ABS + PC	Excellent	Low	80% - 90%	Smooth, Good Adhesion
ABS + PS	Good	Low	75% - 85%	Smooth, Minimal Flash
PC + PMMA	Good	Medium	70% - 80%	Transparent, Good Clarity
ABS + PVC	Fair	Medium	60% - 70%	Smooth, Moderate Adhesion
ABS + PP	Poor	High	30% - 40%	Uneven, Easy to Delaminate
PC + PP	Poor	High	25% - 35%	Brittle, Easy to Crack
PS + PP	Poor	High	20% - 30%	Uneven, Low Strength
PA66 + PP	Very Poor	Very High	<20%	No Effective Weld
PET + PE	Very Poor	Very High	<15%	No Effective Weld

Read more about ultrasonic welding performance analysis for thermoplastic material>>