Ultrasonic welding process:

When bonding material through ultrasonic welding, the energy required comes in the form of mechanical vibrations. The welding tool (sonotrode) couples to the part to be welded and moves it in longitudinal direction. The part to be welded on remains static. Now the parts to be bonded are simultaneously pressed together. The simultaneous action of static and dynamic forces causes a fusion of the parts without having to use additional material. This procedure is used on an industrial scale for linking both plastics and metals (figure 1).

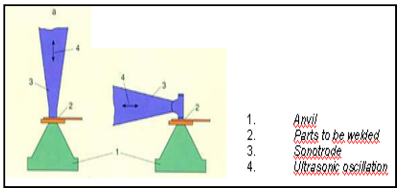


Figure 1: Differences in the process for welding plastics and metals with ultrasonics

Ultrasonic welding of plastics

When welding thermoplastics, the thermal rise in the bonding area is produced by the absorption of mechanical vibrations, the reflection of the vibrations in the connecting area, and the friction of the surfaces of the parts. The ultrasonic vibrations are introduced vertically and are usually subjected at a frequency of 20, 30 or 40kHz.In the contraction area, frictional heat is produced so that material plasticizes locally, forging an insoluble connection between both parts within a very short period of time.

The prerequisite is that both working pieces have a near equivalent melting point. The joint quality is very uniform because the energy transfer and the released internal heat remains constant and is limited to the joining area. In order to obtain an optimum result, the joining areas are prepared to make them suitable for ultrasonic bonding. Besides plastics welding, ultrasonics can also be used to rivet working parts or embed metal parts into plastic.

Phases of the ultrasonic welding process:

In the solid friction phase, heat is generated as a result of the friction energy between the two surfaces and the internal frictional in the parts. This causes the polymer material to heat up until the melting point is reached. The heat generated is dependent on the applied frequency, amplitude and pressure.

In the second phase, a thin molten polymer layer is formed which grows in thickness as a result of the continuous heat generation. In this stage heat is generated by viscous dissipation. At first only a thin

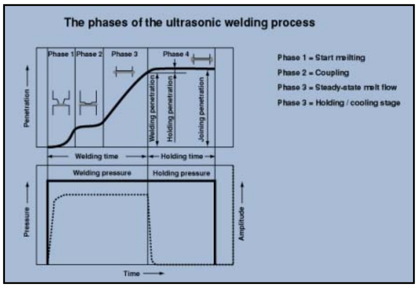
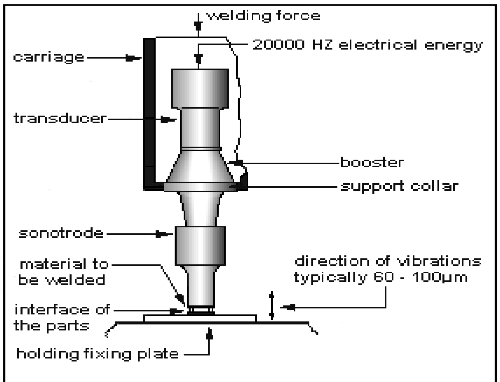


Figure 2: Phases of the ultrasonic welding process

Equipment:



An ultrasonic welding system for joining thermoplastics

Figure 3: An ultrasonic welding system for

An ultrasonic welding machine consists of four main components: a power supply, a converter, an amplitude modifying device (commonly called a Booster) and an acoustic tool known as the horn (or sonotrode). The power supply changes mains electricity at a frequency of 50-60Hz, into a high frequency electrical supply operating at 20, 30 or 40kHz. This electrical energy is supplied to the converter. Within the converter, discs of piezoelectric material are sandwiched between two metal sections. The converter changes the electrical energy into mechanical vibratory energy at ultrasonic frequencies.

The vibratory energy is then transmitted through the booster, which increases the amplitude of the sound wave. The sound waves are then transmitted to the horn. The horn is an acoustic tool that transfers the vibratory energy directly to the parts being assembled, and it also applies a welding pressure. The vibrations are transmitted through the workpiece to the joint area. Here the vibratory energy is converted to heat through friction - this then softens or melts the thermoplastic, and joins the parts together.

Benefits of the process include: energy efficiency, high productivity with low costs and ease of automated assembly line production. The main limitation of the process is that the maximum component length that can be welded by a single horn is approximately 250 mm. This is due to limitations in the power output capability of a single transducer, the inability of the horns to transmit very high power, and amplitude control difficulties due to the fact that joints of this length are comparable to the wavelength of the ultrasound.

Typical applications:

Ultrasonic assembly is the method of choice for many applications in the automotive, appliance, medical, textile, packaging, toy and electronics markets, among others. The basic advantages of ultrasonic assembly - fast, strong, clean and reliable welds - are common to all markets. However, each market has specialised needs that they rely on ultrasonic assembly to meet.

Appliance	In this high-volume market, hermeticity, strength and also cosmetic appearance are important. Applications include: steam iron, pump housing, vacuum cleaner wand, and dishwasher spray arm.
Automotive	Hermetic seals in applications such as lenses, filters and valves. Other applications include: glove box door, instrument cluster, air diverter and mass airflow sensor.
Business	"Clean" assemblies with reduced particulate matter are produced on information storage discs. Other applications include the assembly for ribbon cartridges, and audio and video cassettes.
Consumer	Precision welding, staking and forming operations are used in the manufacture of the Swatch®.
Electrical	Multiple staking and inserting applications are often automated for high-volume production requirements with consistent reliability. Applications include: terminal blocks, connectors, switches (e.g. toggle, dip, rotary quick and diaphragm), and bobbin assemblies.
Medical	Non-contamination and the ability to be operated in a clean room are as important as the strength of the weld. Reliable, repeatable assemblies for critical life-support devices are produced with new capabilities in process control. Applications include: arterial filter, cardiometry reservoir, blood/gas filter, face mask and IV spike/filter.