Ultrasonic Welding (UW)

UW is a method of bonding plastic parts without involving adhesives or mechanical bonding methods. The combination of vibration and pressure allow for the plastic materials to soften and fuse. The designer must take into consideration the material(s) of the parts to be joined and the part design necessary to allow for a strong ultrasonic weld.

For UW to be performed properly the plastic parts must be held in a proper position, the mating interface must soften (or melt) and pressure must be applied to join the softened materials. UW utilizes insulated metal fixtures to support and align the materials. The vibratory energy is created through the conversion of electrical energy into mechanical vibratory energy at ultrasonic frequencies. The vibratory energy is converted to heat by friction that melts the thermoplastic. The heat, along with friction and applied force, approaches the melting point of the plastic. Force is maintained after the vibratory energy stops and a weld is produced.

Since UW is a thermal process, the material properties will determine how efficiently it can be used in UW. Thermoplastic materials are generally categorized as amorphous or semi-crystalline (referring to the order of their molecular structure). Amorphous polymers, due to their broad softening temperatures, flow easily without premature solidification of the melt. Whereas semi-crystalline polymers have a more definite melt temperature and tend to absorb high frequency vibrations (due to its crystalline structure). These properties of semi-crystalline plastics require higher energy input and a closer tolerance between the fixtured parts.

The most critical detail of an injected molded part for UW is the joint design. In general, the part design should have a small and uniform initial contact self-alignment area to concentrate the ultrasonic energy. There are two basic types of joint designs; shear joint for semi-crystalline plastics and the energy director for amorphous plastics.

<<image of shear joint>>

Part Thickness "T"	Interface "A"
≤0.5 in	0.008 - 0.012 in
0.75 - 1.50 in	0.012 - 0.016 in
≥1.50 in	0.016 - 0.020 in

Lead-in "B" = 0.016 - 0.024
Weld depth "C" = (1.25-1.50)T

<<image of energy director joint>>

References:
Campo, E. Alfredo, *The Complete Part Design Handbook*, Hanser, 2006.
Strong, A. Brent, *Plastics: Materials and Processing*, Prentice Hall, 2000.
Kalpakjian, Serope, *Manufacturing Engineering and Technology*, Addison-Wesley, 1989.