



curamik® SUBSTRATES for Ultrasonic Welding

tech note

Ultrasonic welding is becoming more and more popular for joining copper terminals to the copper of DBC substrates. In former days, soldering or wire bonding was the technology of choice for this connection, especially for the terminals on high power packages a bonding method with increased reliability is needed. Packages cause thermal stress on the solder layers when the modules are in operation due to different CTE (Coefficient of Thermal Expansion) of copper and solder layer. The degradation of the solder becomes an increasing concern of IGBT modules. Direct ultrasonic welding between copper terminals and the copper of DBC-substrates is expected to bring high reliability because the bonding region has uniform CTE.

Definition:

// Ultrasonic welding is the use of high frequency vibration to produce a solid state weld between two components held in close contact.

Advantages:

- // High reliability due to no intermetallic phase / no CTE mismatch
- // High ampacity compared to wire bonding
- // “Cold process” – no heating of the full module necessary
- // Short process time
- // Comparable low energy process

Comparison soldering vs. ultrasonic welding

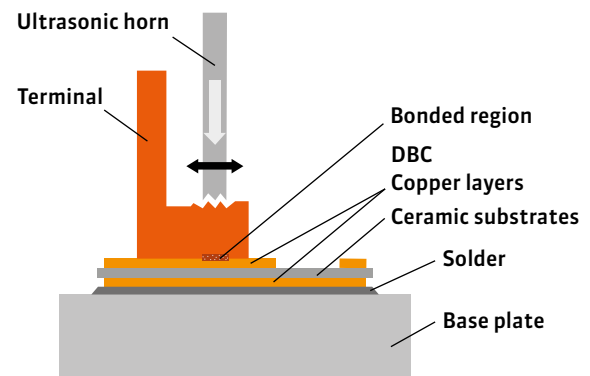
Soft soldering	stencil printing solder paste	place terminals	soldering process > 250°C	cooling	cleaning
Equipment	stencil printing machine	pick and place machine	soldering furnace	soldering furnace	chemical cleaner
Ultrasonic welding		place terminals	US-welding		
Equipment		pick and place machine	US-welding machine		

Process flow

Process	Pre-Positioning	Positioning	Pressing	US-Welding	Remove
Operation	US-Horn fast moving above the welding object	US-Horn moving down slow onto the welding object	Preset contact pressure is applied	Longitudinal ultrasonic vibration and vertical pressure; breaking surface oxide layers	Fast moving up of US-Horn after welding is completed
Result	no contact of US-Horn and welding object	contact of US-Horn to welding object		generation of a solid state bonding between the two surfaces	welding operation finished

Key Parameters for Reliable US-welding

Substrate	metallization thickness/ mechanical stability of ceramic, surface contaminations (grease, oil, etc.)
Terminal	terminal thickness, surface contamination (grease, oil, etc.), material hardness
Fixture	mechanical support of welded areas, clearance/ resonance of substrate during welding process
Welding parameters	pressure/ amplitude/ frequency/ time/ energy/ welding depth



curamik® Solution

- // All curamik products in any ceramic grade (Al_2O_3 , HPS, AlN, Si_3N_4) and any material combination, according to design rules, are suitable for connecting terminals by ultrasonic welding.
- // Depending on welding parameters substrates using ceramic grades with higher mechanical stability (HPS, Si_3N_4) may improve both ability and reliability of ultrasonic welding.
- // Depending on welding parameters, substrates using thicker copper (recommendation $\geq 0,3$ mm) may improve ability of ultrasonic welding.
- // Distance of welding area to edges of copper pads $> 0,5$ mm is recommended to avoid damage to the substrate during welding operation.