Wire bonding is a technique widely used to provide electrical interconnection between semiconductor chips and relative metal pads on substrates or lead frames.

The most commonly used method in the field of power electronics is ultrasonic bonding. During the process, a metal wire is bonded between chips and a metal pad using ultrasonic energy and pressure to break the interface of different layers and form the bonding.

This process can be done with aluminum, copper, copper/aluminum clad and gold wires or ribbons. The low cost and high efficiency enable wire bonding to be the basic technology in the assembly of power modules.

**Definition:**
- A process which uses force, time and ultrasonic energy on the bonding surface at room temperature to make two metal materials bonded
- The process needs a bonding machine, bonding wire and bonding tool

**Key Material Properties:**
- Normally used wire: Al, Cu, Al/Cu clad material, Au
- Wire Diameter: Thin wire 25–100μm, Heavy wire 100–500μm
- Normally bonded surface: bare Cu, Ni/Au, Al

**Advantages:**
- Inexpensive and fast process enable the high cost-effective technology
- Common and flexible way to make complex interconnection, especially for fine pitch design
- Mature processability and stability after half century development

**Key Parameters for reliable Wire Bonding**

<table>
<thead>
<tr>
<th>Substrate</th>
<th>metallization, plating, roughness, copper grain configuration, contamination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bonding</td>
<td>downward pressure, downward speed, ultrasonic energy</td>
</tr>
<tr>
<td>Bonding type</td>
<td>Wedge Bonding (e.g. Al wire on chip and pad)</td>
</tr>
<tr>
<td>Bonding order</td>
<td>first on chip, then on pad</td>
</tr>
</tbody>
</table>
curamik® SUBSTRATES for Wire Bonding  tech note

Process Flow

<table>
<thead>
<tr>
<th>Bonder structure</th>
<th>First bonding</th>
<th>Wire looping</th>
<th>Second bonding</th>
<th>Wire termination</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bond Tool:</strong></td>
<td>The bonder is accurately approaching the target pad, then moving downwards, meanwhile the foot deforms the wire with ultrasonic vibrations and pressure to enable the metallic connection (welding) between wire and pad.</td>
<td>After the 1st bond is finished, the opening of the wire clamp allows the wire to slide through. While the bonder rises above the pad with the designed route, the bond tool moves towards the position of the second bond.</td>
<td>The bonder now descends towards the second bond pad, pressing the wire against the pad with the foot. The same as the first bond, both force and ultrasonic energy are applied to create the second bond.</td>
<td>The wire clamps keep closing after all bonds are finished, the Cutter blade will make a pre-cut on the wire tail, then the bonder will pull the wire and causing it to break at its pre-cut (weakest) point, wire bonding is terminated.</td>
</tr>
<tr>
<td><strong>Wire Guide:</strong></td>
<td>to provide channel feeding wire</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Wire Clamp:</strong></td>
<td>used to hold wire to avoid sliding during bonding and terminating</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cutter Blade:</strong></td>
<td>used to pre-cut wire after bonding</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Cutter Blade

Wire Clamp

Wire Guide

Bonder structure

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curamik® Solution

// All curamik products in any ceramic grade (Al₂O₃, HPS, AlN, Si₃N₄) and any material combination, according to design rules, are suitable for wedge wire bonding.

// Depending on the wire bonding process parameters, bare copper, Ni and flash Au surface with curamik standard roughness is suitable to achieve the best adhesion between heavy Al wire and DBC.

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