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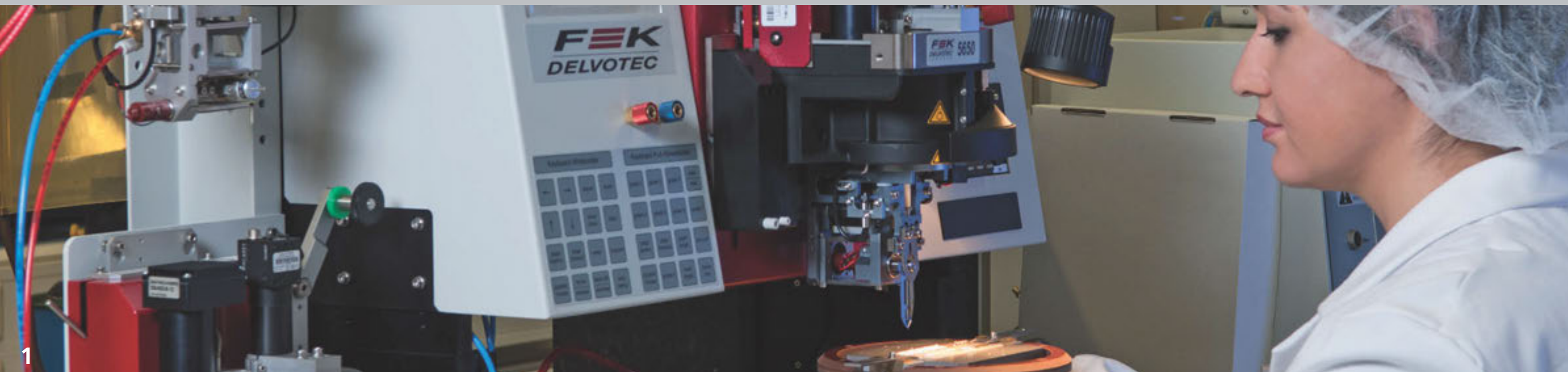
FRAUNHOFER INSTITUTE FOR INTEGRATED SYSTEMS AND DEVICE TECHNOLOGY



1 *Automatic wire bonding of power electronic modules*

(Heavy) Wire Bonding

Topside connection for semiconductors through wires

Research fields

- New materials for bond wires like copper, composites or alloys
- Improvement of application's lifetime by bonding parameters, geometry, material and others
- Metalization and surface optimization of semiconductors for best bondability
- Cleaning process to achieve a reliable bond connection
- In combination with power cycling tests a correlation between bonding parameters to lifetime

Our services

- Aluminum and copper wedge-wedge-bonding with diameters from 100 µm to 500 µm possible
- Ribbond bonding
- Gold ball-wedge bonding with diameters from 25 µm to 75 µm possible
- Heatable work holder for bond process under temperature for up to 200°C
- Quality assurance through pull and shear tests
- Control of reliability and lifetime by active power cycling test, passive temperature cycling and vibration tests
- Design of experiments to find best suited bonding parameters

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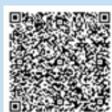
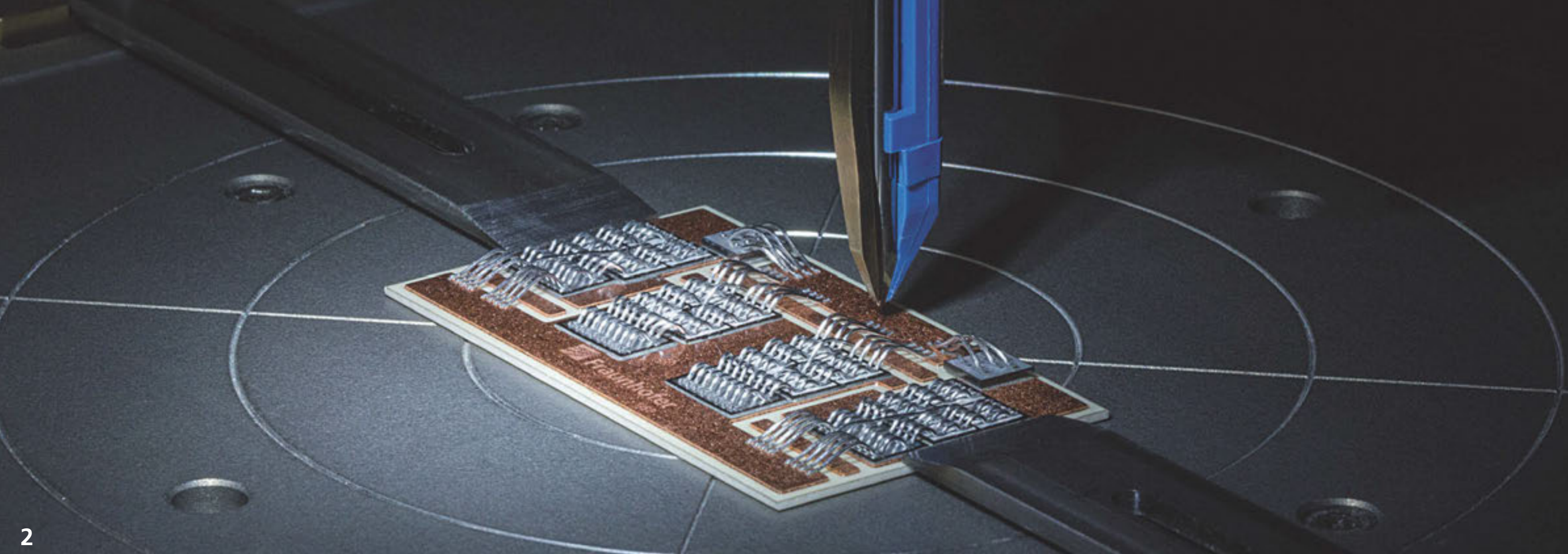




Functional principle

- Ultrasonic bonding works with high-frequency acoustic vibrations under pressure and create a solid-state welding
- For aluminum wedge-wedge-wire bonding ultrasonic energy is applied to the wire for a specific duration while being held down by a bond force
- Thermosonic gold bonding includes heat treatment and can be used to form solid-state bonds below the melting point of the mating metals
- For ball- wedge- bonding, a gold ball is formed before the bonding process by melting the end of the wire via high voltage

Devices and packaging

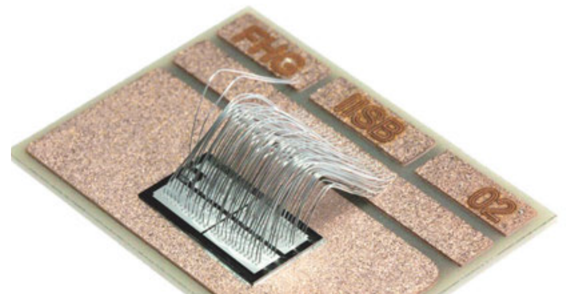
- Power electronic modules
- Single semiconductors
- Si, SiC and GaN devices
- Surfaces providing best weld solutions: Aluminum, copper, gold and silver
- Material combinations of wires and surfaces can be seen the table (below)

Bonding machine features

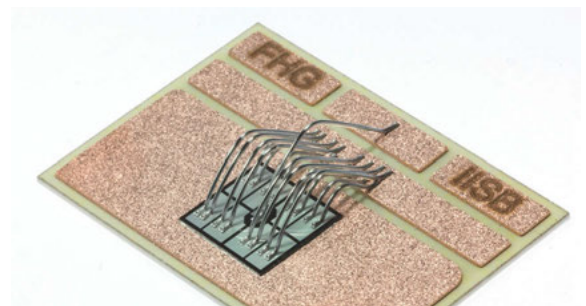
- Semi-automatic bonding process
- Programmable bond layouts
- Deformation limit control
- Image recognition of semiconductors and substrates
- Large area modules as well as small micro electronic devices bondable
- Fast switching of bond heads and pull/ shear heads

Wires				Surfaces			
Materials	Al	Cu	Au	Ni	Pd	Ag	Sn
Aluminum	✓	✓	✓	✓	✓	✓	✓
Copper	✓	✓	✓	✓	X	✓	X
Nickel	✓	X	✓	✓	X	✓	X
Palladium	✓	X	X	X	X	✓	X
Silver	✓	✓	✓	✓	✓	✓	X
Tin	✓	X	X	X	X	X	✓

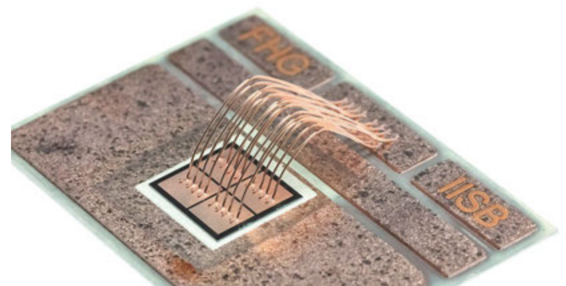
2 *Aluminum wire bonded IGBT power module*



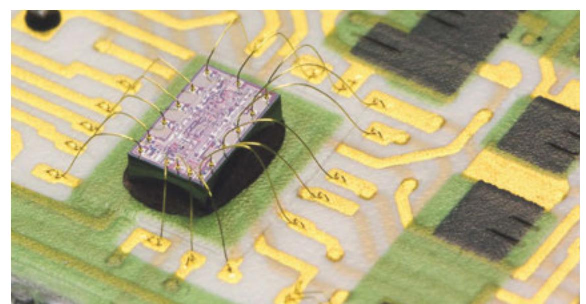
Aluminum wire (125 µm)



Aluminum wire (375 µm)



Copper wire (250 µm)



Gold wire (25 µm)