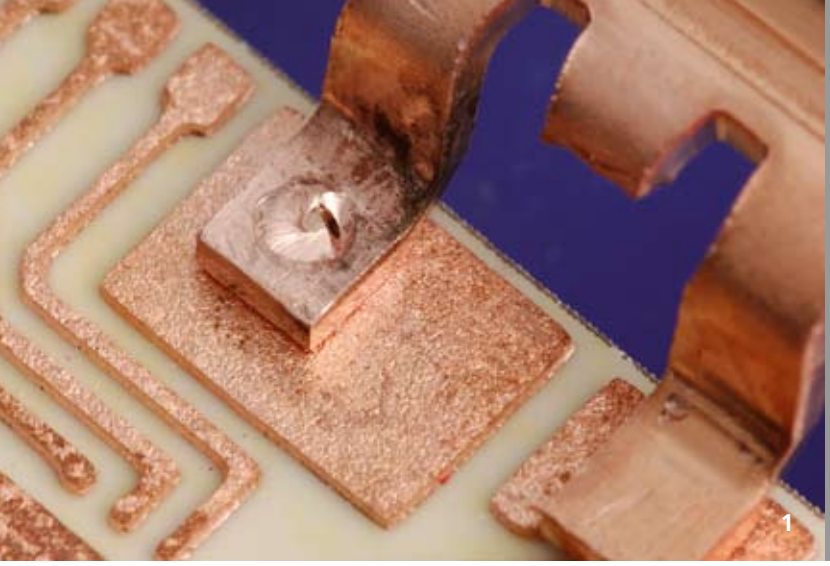

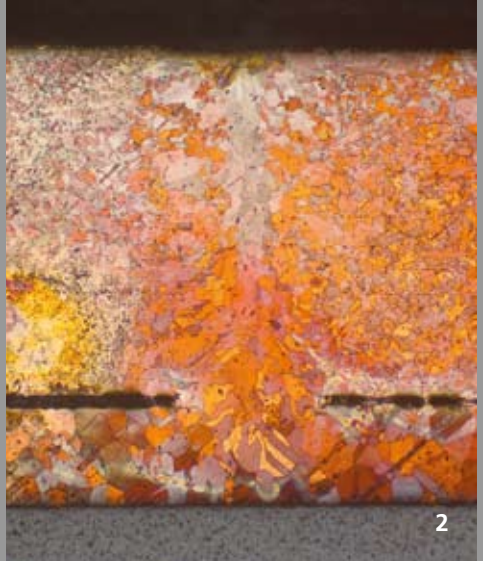

LASER BEAM WELDING OF DCB SUBSTRATES WITH SINGLE MODE LASERS

Task

In power electronics, the use of direct copper bonded substrates is becoming more and more important. In this process, the high power semi-conductor element is mounted directly onto a special ceramic substrate (aluminum oxide ceramic or aluminum nitride), which is coated with copper. In the joining process currently used for electrical contact on metal sheets with thicknesses of only a few hundred microns, there is the danger of fractures and microcracks in the ceramic substrate.

For a long-term stable bond of the DCB substrates with high-power diverters, a bonding technology is sought, which firstly enables a high bonding stability, secondly a minimal influence upon the substrate, and thirdly a connection with large terminal cross-sections.

Method

To make such joining connections possible, a new laser welding process was investigated, one which generates welding seams with constant welding penetration depth. In addition to the variation of steel diameter, steel specification and feed rate, a quick, local power modulation was used. For this, the feed movement is overlapped by a circular oscillating movement. The local power modulation positively influences the melt pool geometry and the temperature gradients in the melt pool and, thus, leads to a significant increase in process stability.

Result

Through the use of local power modulation in the range of a few hundred hertz, the melt pool dynamics of the welding seam can be inspected and a nearly even welding depth reached, for a Cu-ETP thickness of 1 mm on DCB with a thickness of 0.25 mm in overlap joints. By reducing the laser power and increasing the feed speed at the seam end, the heat congestion is reduced and the damage to the ceramic plate prevented.

Applications

The new joining technology is currently used in the high power packaging in power electronics with large terminal cross-sections. The high laser intensities used make it possible to weld difficult to weld working materials, such as copper or aluminum, which should especially have a positive effect in power electronics or battery technology.

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1 DCB substrate with electrical contact in a lap joint.
2 Cross-section through electrical terminal, copper layer and ceramic substrate.

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