Press Release

Hennigsdorf, [Veröffentlichungsdatum]

Pressure-assisted sintering in power electronics

Power modules are used for green energy conversion and e-mobility applications. The key to cost-reduction of power modules is the assembly and connection technology. As a specialist for DIE bonding, Tresky GmbH has developed an innovative technology around sintering with silver and copper sintering paste in cooperation with Bond Pulse GmbH, a consulting company focused on packaging technology.

"Silver sintering has established itself, especially in automotive applications, for the connection of power semiconductors to circuit carriers and for the connection of substrates to heat sinks. However, newly developed and significantly cheaper copper sintering pastes are now available that offer identical performance. Since the ratio of performance to euros per component is typically decisive, this is a crucial aspect," explains Dr. Aaron Hutzler, CEO of Bond Pulse GmbH. Meanwhile, sintering requires a specific technology mix, whereby the following aspects must be taken into account when using the various processes: the total material and assembly costs, the thermal performance taking into account cooling requirements and efficiency, thermomechanical properties such as service life and reliability, and finally electrical properties such as the operating temperature and integration density. From this, various possibilities can be derived to reduce costs. For example, a lower thermal resistance, a maximum acceptable increased temperature with high reliability and a higher power per chip can have a positive effect on the overall cost calculation. "All measures can be implemented taking into account the assembly and connection technology and with pressure-assisted sintering," Hutzler continues. "The increasing demand for green energy and e-mobility applications make it necessary to think about how to reduce costs. If this is not done, these technologies will neither be suitable for mass production nor will they be able to meet ecological requirements," adds Daniel Schultze, managing director and owner of Tresky GmbH.

Schultze and his team have therefore focused more on the process steps before the actual sintering in a press. These pre-sintering steps, in which the sintering paste is applied and the semiconductor or substrate is set, are crucial for the quality and reliability of the sintered connection. "Pressure sintering of power semiconductors on substrates, base plates and heat sinks offers an enormous performance gain compared to soft soldering. For example, copper sintering paste can be used to achieve excellent reliability with a 20-fold improvement in power cycling capability, compared to SAC solder," explains Schultze. The slit nozzle developed by Tresky also allows even faster and more precise application of large-area deposits, in dimensions >10x10 mm. The sintering paste can thus be dispensed onto the substrate in defined quantities.

Furthermore, the sintering pastes are characterized by advantages such as lower CTE mismatch, lower creep fatigue and a lower thermal resistance and coefficient of expansion compared to solders. Another plus point is the creep resistance. In addition, the yield strength of joints made using silver sintering paste is also much higher compared to soft solders, at 30 MPa for SAC solders and 120 MPa for sintering silver pastes. As a result, up to 20 times longer service life can be achieved in temperature cycling tests.

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Since both silver and copper sintering pastes offer a higher thermal conductivity, combined with a thinner layer thickness (bondline thickness BLT), the results are a much lower thermal resistance of the application with simultaneously higher application temperatures of the semiconductors. This can also be illustrated by the higher melting point of the sintering pastes, which is 961 °C instead of 220 °C as with the SAC solder. Because the thermal conductivity as well as the electrical conductivity of silver and copper sintering pastes is three and four times higher compared to soft solders, an excellent electrical performance is given.

"The material costs for silver sintering are 10 to 20 times higher compared to soft solder. Furthermore, the costs for SiC to Si semiconductors are also high. In sintering, the production output is therefore a decisive factor," Hutzler emphasizes. He and Schultze expect an increasing demand for the cost-reduced, copper-based sintering paste. At the same time, they point out the pre-processes required for the actual sintering process, as the liquid phase is missing in this procedure. In contrast to the soldering process, the sintering layer retains the inconsistency and deviations that occur during the placement of components or the dispensing of the sintering paste. After all, metal does not melt during the actual sintering process. Rather, the sintering process is based on reduction of surface energy. "However, the liquid phase of soldering can be beneficial in some cases for self-alignment and compensating for tolerances. Since this is not the case with sintering, the pre-processes are extremely important," says Schultze.

Another increasingly important process is picking up and placing the components. For example, in applications with sintered semiconductors, hot tacking takes place. The aim of this is to prevent any movement of the components during transport from the pick & place machine to the sintering press. In this way, the process, also called hot pick & place, differs from the standard sintering process with pre-dried and thus no longer sticky sintering paste. "If a semiconductor is placed on the dried paste, it can move during transport from the pick&place machine to the sintering machine, especially if the semiconductor has been covered with a protective Teflon protection-film," Schultze explains. Furthermore, a contact pressure of up to 1 MPa is required for the hot mounting of semiconductors. For a 15x15 mm chip size, a placement force of 22 kg is required, whereby Tresky is currently the only supplier that can also apply forces of up to 35 kg. In addition, both the substrate and the die must be heated to ~130 °C. For this purpose, Tresky offers a tool-bond heater that can achieve temperatures of up to 400°C. The substrate can also be heated up to 450°C by means of a heating plate.

But Hutzler points out that while the hot pick-and-place process is a common method of placing semiconductors for sintering, unfortunately oxidation can occur on the bare copper surface of the device when the substrate is heated. These oxidations can be avoided by performing the placement at room temperature. In this case, it is then necessary to fix the component in the sintering paste to ensure accurate positioning on the transport route to the next machining process. Therefore, the chips are usually provided with a tacking agent. The tacking agent ensures fixation until the substrates are preheated in the sintering press. At approx. 150 °C, the bonding agent evaporates without leaving any residue. "Adhesion promoters make it possible to avoid the pressing and heating of the chips required to fix the semiconductors before sintering in the assembly process. For component fixation, four dispensing points are set before the chip is placed, which take over the fixation. This has a beneficial effect on the time to

market, as it allows both development and series production to be implemented quickly and reliably," Schultze concludes.

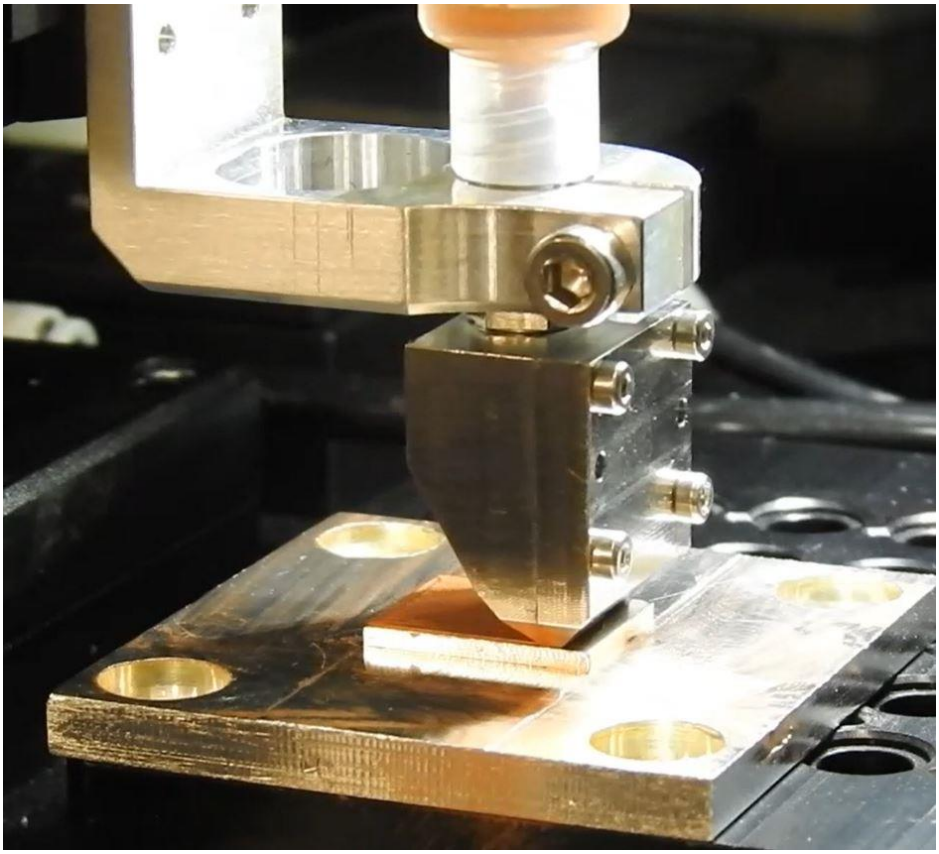
About Tresky

Since 1980 the name TRESKY stands for the highest quality, unmatched flexibility with maximum reliability. Tresky GmbH is one of the world's leading machine manufacturers for placement systems in the high-precision sector offering more than 40 years of experience in the semiconductor industry. The company is headquartered in Hennigsdorf near Berlin, in the middle of a technology park that is home to numerous highly specialized companies from the automation, electrical engineering, communications technology and life science sectors. Quality "Made in Germany" - Tresky develops, produces and sells Die Bonders from its headquarters in Hennigsdorf.

About Bond Pulse

Bond Pulse, founded by Dr.-Ing. Aaron Hutzler, supports electronics manufacturing customers in the development and assurance of manufacturing processes and product quality. In addition, Bond Pulse offers education and training on vacuum brazing, metallic sintering and the reliability and durability design of power electronics.

Pictures:



Picture captions:

Slit Nozzle from Tresky during the application of copper sinter paste

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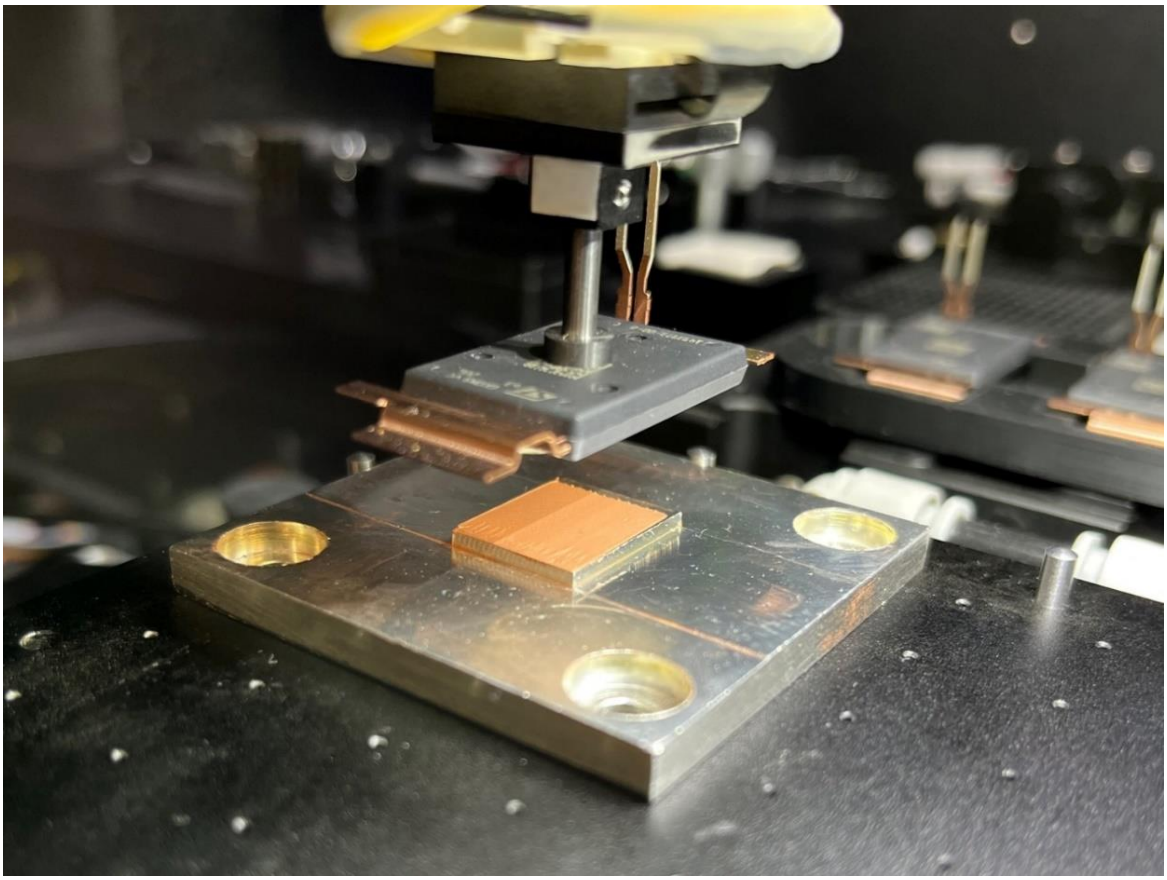

Picture captions:

Bonding of a T-Pak using copper sinter paste

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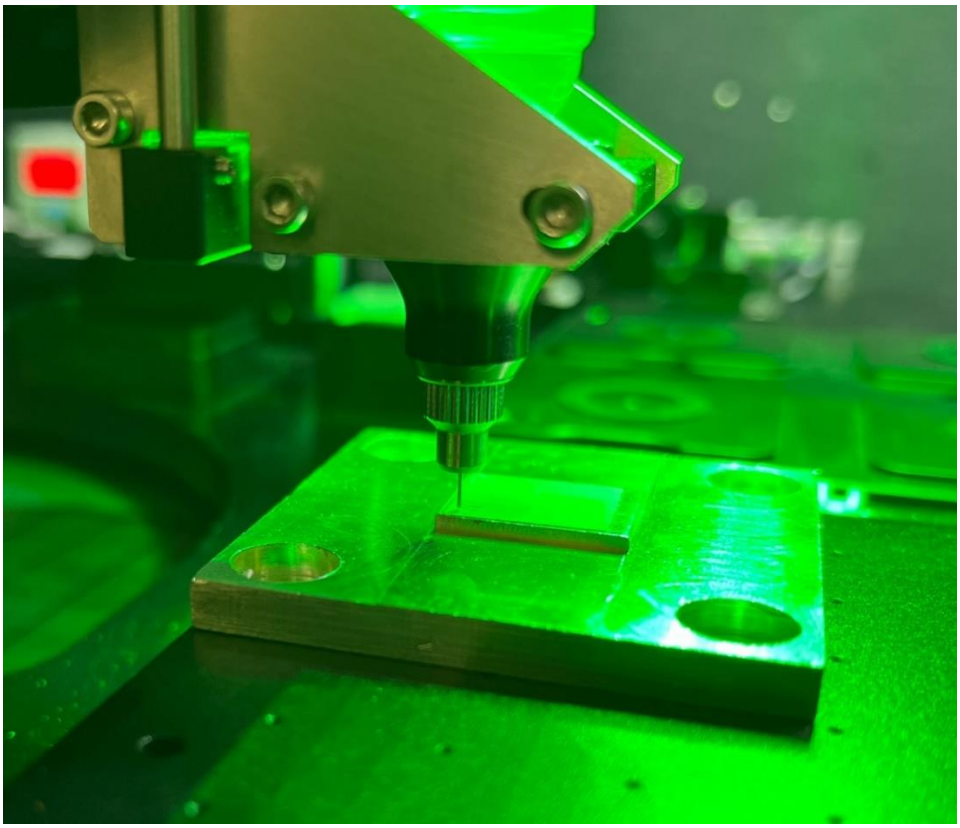

Picture captions:

Dispensing the tacking agent onto sintering paste

Deeplinks:

https://www.tresky.de/wp-content/uploads/2023/03/Tresky_Sinter-Bonding_A4_small.pdf

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