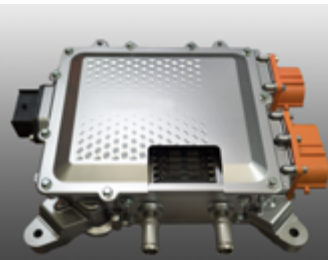


Power Electronics

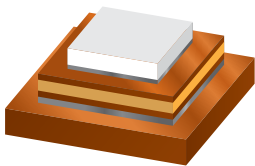
Sintering Process Solutions with ALPHA® Argomax®
For Superior Power Cycling Endurance



Engineered sinter materials and unique processes to address all possible design implementations for power electronics.

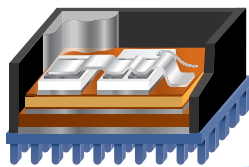
The portfolio of Argomax products enables:

- Low Pressure Sintering Enabled by Proprietary Nano Particle Technology
- Package Attach Sintering with Flat Dispense
- Unique Film Format for Die, Clip & Foil Lamination
- Wafer Level Sintering Die Attach Film
- Sintering Preforms for Custom Bondlines
- Sintering to Bare Copper Substrates



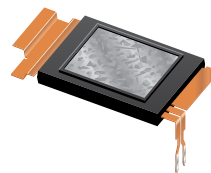
DAS Die Attach Sinter

- Die level lamination for precision die placement
- High throughput sinter from diced laminated wafer
- Sintering paste for dispensing and printing



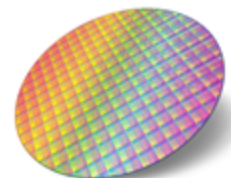
TAS Top Attach Sinter

- Film laminated "ready-to-sinter" clips
- Inline clip lamination using sinter film sheets
- Film for copper foil lamination



PAS Package Attach Sinter

- Sintering from small package to large area modules
- High throughput flat dispensing / printing paste and preforms
- Low pressure sintering compatible with molded packages



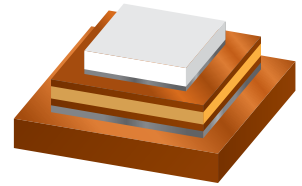
WAS Wafer Lamination Attach Sinter

- Sinter film lamination for high throughput die attach
- Standard wafer dicing of laminated wafers
- Minimal die spacing with laminated die

⚡ DAS - Die Attach Sinter

WHY Sinter die attach enables a number of critical advantages for high power switching applications, such as traction inverters. It has been demonstrated that replacing solder with Argomax sinter material extends power cycling endurance by factors of 15-30X. Argomax can also enable +50% increase in switching current with the same die temperature rise by creating a highly efficient thermal path.

The transition to wide band gap devices also has presented a challenge for developers. During power cycling, silicon dies will exhibit some flexure, which results in less total strain on the die attach material. By comparison, SiC is very stiff, resulting in nearly all the strain from large rises in die temperature being directly placed on the die attach layer.



Sintered Die Attach

		Si	SiC-4H
CTE	ppm/K	3	4.3
Youngs Modulus	GPa	162	501

As shown on the chart to the left, the stiffness (modulus) of silicon carbide is about 3X that of silicon.

HOW Argomax is offered in both sinter paste and sinter film to support high volume die attach processes. Our die attach film enables heated dies to be laminated with film, which then can be directly placed and sintered onto a DBC substrate or copper leadframe.

Argomax paste is available for both stencil printing and flat dispense processes, supporting die attach. The die is placed in the wet paste, eliminating the need for a tack agent. After drying, many modules or substrates can be sintered in parallel.

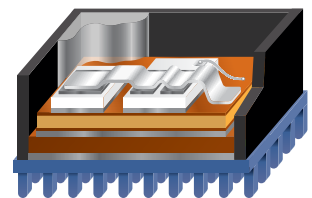
The significantly higher power cycling endurance demonstrated by Argomax makes this material critical to enable the promise of higher current density and lower switching losses possible with SiC.

⚡ TAS - Top Attach Sinter

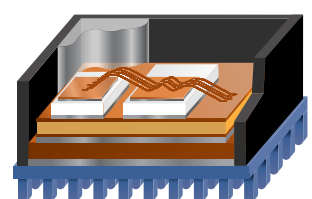
WHY The reliability testing on previous generation power devices demonstrated that the two main causes of failure are die attach solder fatigue and wirebond lift off, both the result of the strain caused by material CTE differences and the temperature excursions during switching.

The implementation of sinter material die attach addresses the solder fatigue issue, but the true ability of sintering to extend product endurance is only realized when traditional aluminum wirebond failures are eliminated.

HOW In the new generation of devices, the topside attachment to the die uses sintered clips or sintered copper foils. Clips are typically constructed of silver plated copper or pure silver, laminated and sintered to the die topside. Alternatively, a copper foil can be laminated, then sintered to the die topside, supporting the increased reliability and current density of copper wirebonds. Clips and foils, laminated with Argomax film, enable an assembly ready interconnect for a fully sintered solution.



Sintered Clip Top Attach

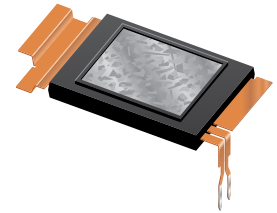


Sintered Copper Foils

⚡ PAS - Package Attach Sinter

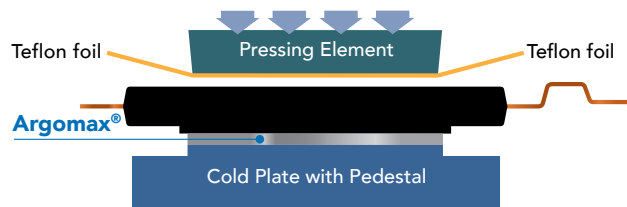
WHY The most significant contributors to the overall thermal resistance (R_{TH}), from die to heat sink are the interconnect materials, including the thermal interface material (TIM). These interconnect materials can account for >50% of the total. By replacing the TIM or solder with a thinner, highly conductive pressure sinter layer, the R_{TH} decreases by 10-15%. This change also improves reliability by managing the stress and warpage between the package and heat sink.

HOW A sintering solution with flat nozzle dispense enables the application of Argomax paste for an entire inverter in <20 seconds. The paste ensures intimate contact between the package and the heat-sink, accommodates warpage, and sinters with low pressure without cracking the molded package. Argomax, based on proprietary nano-particle technology, is the only viable sintering solution for package to heat-sink attach.



Sinter Capable Power Package

The successful sintering of molded power packages is possible due to the lower pressure, lower temperature, and faster sinter times enabled by ALPHA Argomax.

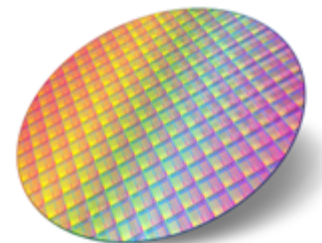


Package Sinter Process

⚡ WAS – Wafer Lamination Attach Sinter

WHY High manufacturing throughput can be realized by lamination of an entire wafer with Argomax film. Standard wafer dicing equipment can then be utilized to efficiently integrate sinter die attach materials into existing discrete packaging processes. Large area Argomax film lamination is also used for thyristor attach and wafer-to-wafer bonding.

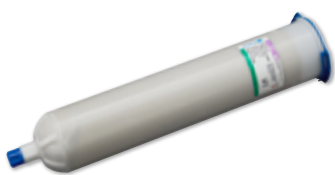
HOW Argomax precut film is compatible with wafers up to 12" in diameter. The film is laminated onto the wafer with heat and pressure on automated wafer handling equipment. After film lamination, the wafers are diced into individual dies. These dies, pre-laminated with Argomax film, can then be assembled onto the substrate by different process and equipment options – hot tacking, cold tacking, and direct sintering.



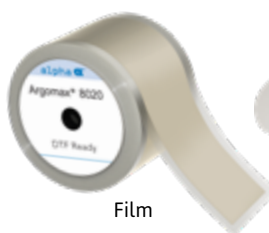
Semiconductor Wafer



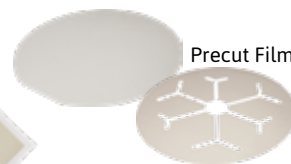
Print Paste



High-capacity, 3000 grams
Dispense Paste Cartridge



Film



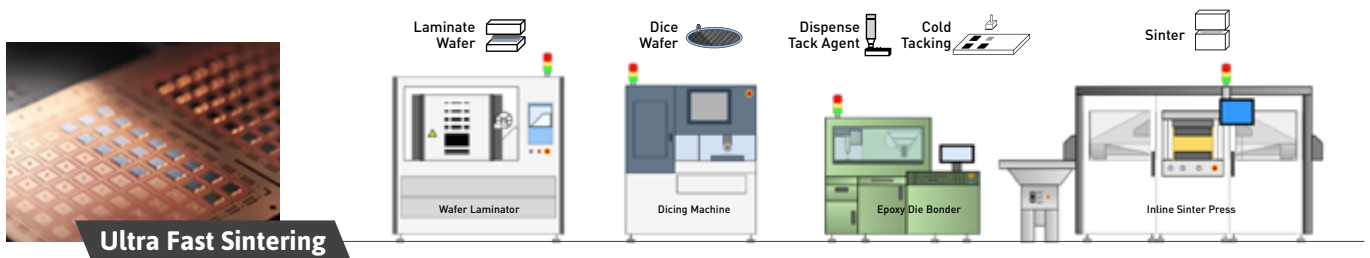
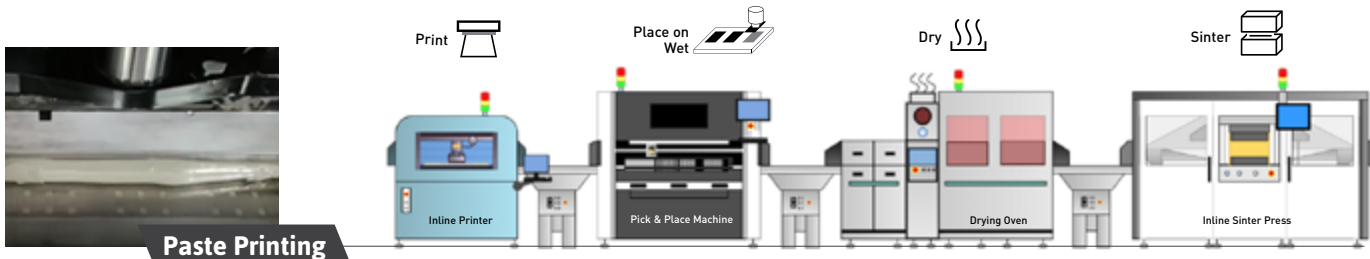
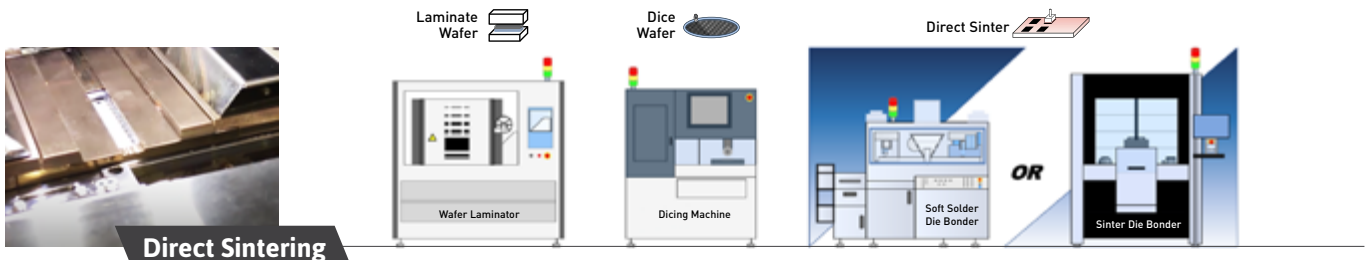
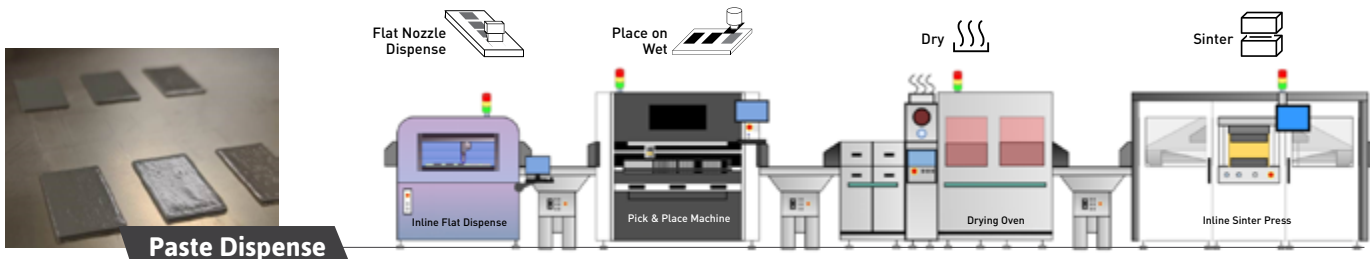
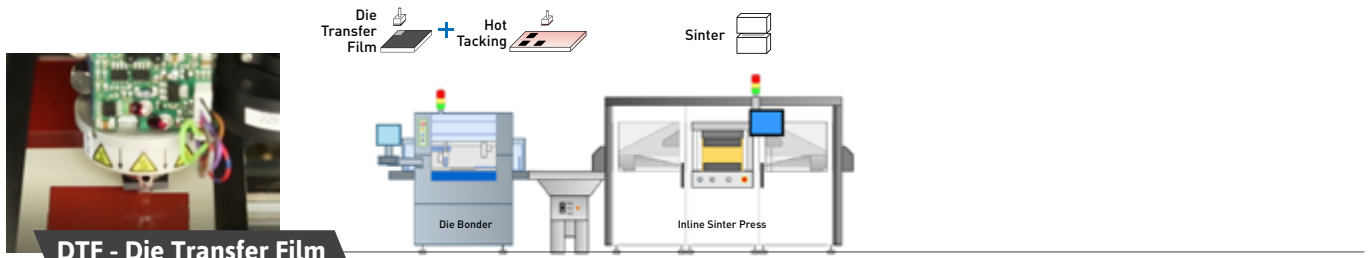
Precut Film



Preforms

Power Electronics

Process Flexibility Enabled by ALPHA® Argomax®



techinfo@macdermidalpha.com

macdermidalpha.com

MacDermid Enthone is a product brand of MacDermid Alpha Electronics Solutions. © 2023. MacDermid, Inc. and its group of companies. All rights reserved. "(R)" and "TM" are registered trademarks or trademarks of MacDermid, Inc. and its group of companies in the United States and/or other countries.