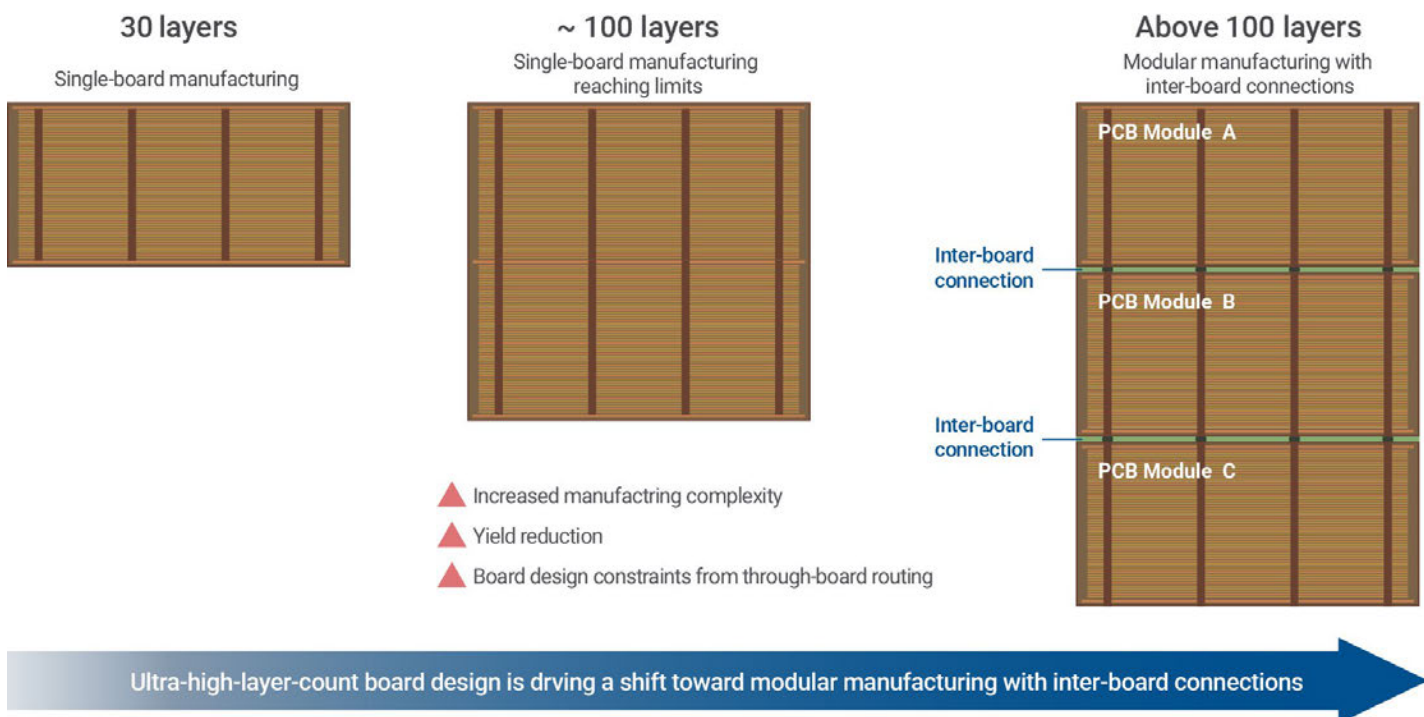


Elephantech Has Developed SAPHIRE™ B: A Low-Resistance Copper Nanopaste for Inter-Board Connections in High-Layer-Count PCBs

Achieves High Reliability Through Low-Temperature Sintering in Ambient Atmosphere

Elephantech Inc. announced SAPHIRE™ B, a copper nanopaste designed for inter-board connections in advanced multilayer PCBs. As the latest addition to the company's SAPHIRE™ portfolio, SAPHIRE™ B delivers reliable, low-resistance vertical electrical interconnects, supporting next-generation AI servers and high-speed communication systems.

Inter-Board Connection Demands in the AI Era



The rise of generative AI is driving demand for high-performance computing systems capable of transmitting massive volumes of data at high-speed while providing large, stable power supply. As a result, PCB designs for AI infrastructure, semiconductor inspection equipment, and probe cards are incorporating increasingly high layer counts to enable greater signal densities and power delivery requirements.

As the number of layers in advanced multilayer PCBs continue to grow, single-board manufacturing becomes more challenging, accelerating a pivot toward modular approaches (e.g., N-layer + N-layer and N-layer + M-layer architectures), in which relatively lower-layer-count modules are fabricated separately and then connected form an ultra-high-layer-count assembly.

Existing technologies and challenges

Both inter-board and inter-layer connections in ultra-high-layer-count PCBs are conventionally formed with conductive filler pastes consisting of metal particles dispersed in a resin matrix. Despite their long-lasting track record in electronics manufacturing, these materials are limited in demanding applications due to their relatively high resistance of their composite.

To address the intensifying performance requirements of advanced multilayer PCBs, low-resistance interconnect materials have attracted growing interest, including Transient Liquid Phase Sintering (TLPS) materials, silver sintering materials, and copper sintering materials. Among these, copper sintering materials are regarded as the most promising solution with resistance levels comparable to silver alternatives and lower than TLPS materials, while providing dramatically lower material costs than silver. However, copper sintering materials also present great technical challenge in realizing practical low-temperature sintering.

Item	TLPS Materials	Ag Sintering Materials	Cu Sintering Materials
Volume Resistivity	△ 20 – 50 $\mu\Omega\cdot\text{cm}$	○ 5 – 20 $\mu\Omega\cdot\text{cm}$	○ 5 – 20 $\mu\Omega\cdot\text{cm}$
Cost	○ Acceptable	✗ High silver cost	○ Cost-effective
Technical Maturity	○ Extensive track record	△ Limited track record in inter-board applications	✗ Challenging for inter-board connection requiring low-temperature sintering

SAPHIRE™ B Overview

Elephantech has developed SAPHIRE™ B, a copper sintering material for inter-board connections based on the self-assembling copper nanoparticle technology platform behind the SAPHIRE™ product family. The material expands the series' application beyond die-attach and TGV into advanced PCB interconnects.

Through hot-press processing at 220°C and 1 MPa in ambient atmosphere, SAPHIRE™ B achieves a volume resistivity of 15 $\mu\Omega\cdot\text{cm}$.

	Item	Measured Value
Paste Properties	Viscosity	Standard: 40 Pa·s Customizable: 1 – 100 Pa·s
	Thixotropic Index (TI) (100 s ⁻¹ /500 s ⁻¹)	Standard: 4
	Metal Content	Screen Printing etc.
	Metal Content	Copper Only
	Metal Content	> 90 %
Post-Sintering Properties	Volume Resistivity	15 $\mu\Omega\cdot\text{cm}$
	Voids / Cracks	No Significant Voids or Cracks Detected by X-ray CT
Thermal Cycling Reliability	Resistance Change (-55 °C / 125 °C × 1,000 cycles)	< 1 % (Before 71.6 mΩ, After 72.1 mΩ)

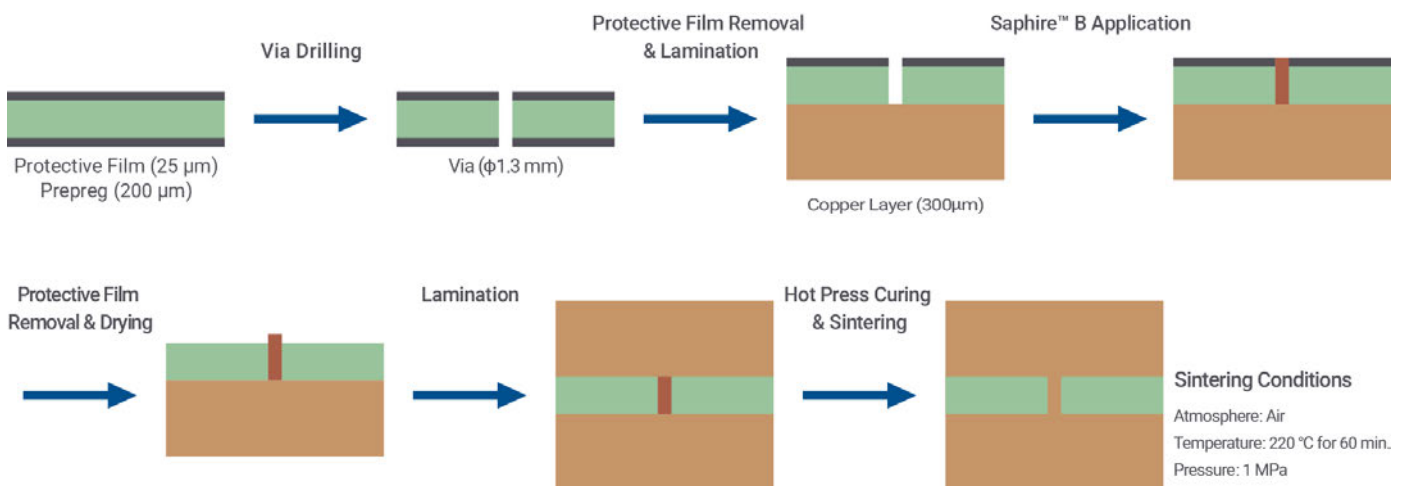
Reliability Testing

SAPHIRE™ B has maintained stable electrical performance throughout testing of 1,000 thermal cycles.

Specifically, a 36-via daisy-chain sample was subjected to thermal cycling between -55°C and 125°C for 1,000 cycles, with resistance variation remaining below 1%.

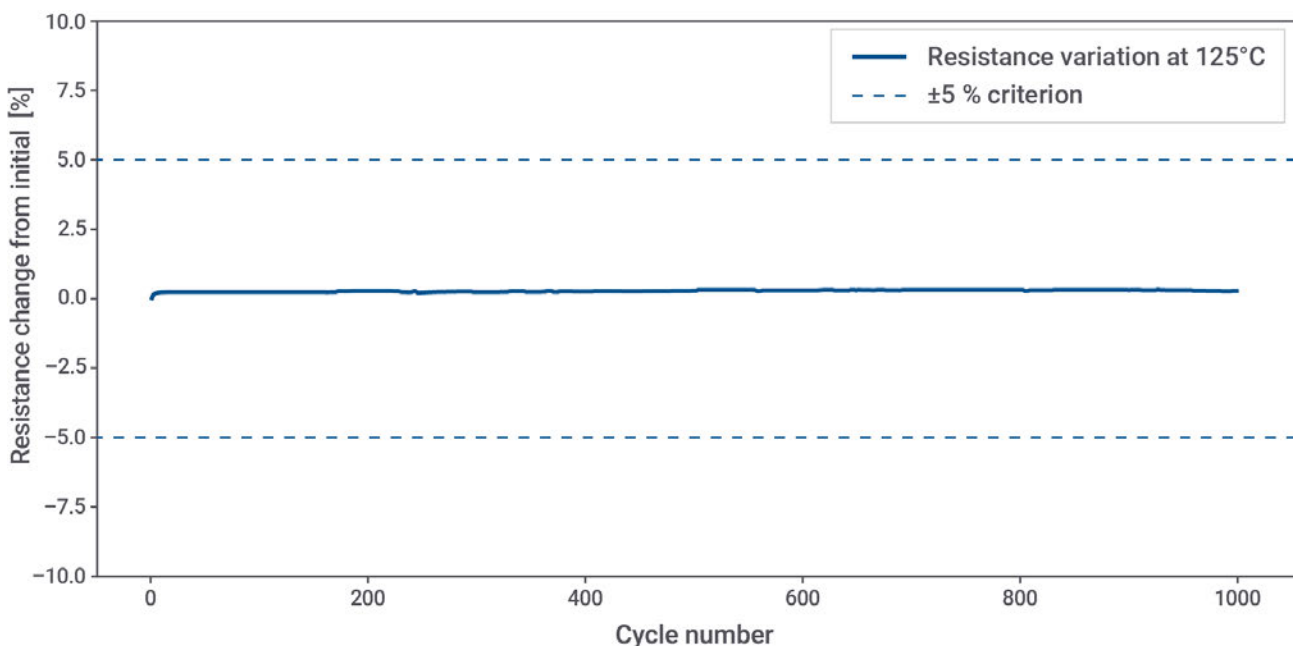
Samples for reliability testing were fabricated in the process shown below: SAPHire™ B was applied to vias formed in prepreg layers, then during hot pressing, the material sinters simultaneously with prepreg curing, forming electrical interconnects between PCB modules in a single integrated process.

Inter-Board Connect Process Using SAPHire™ B



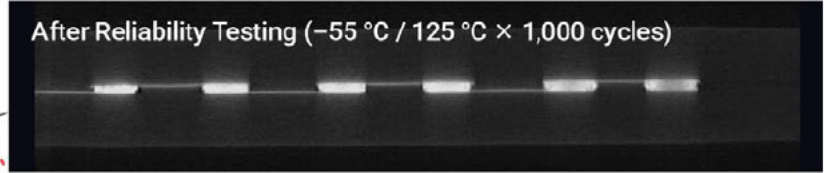
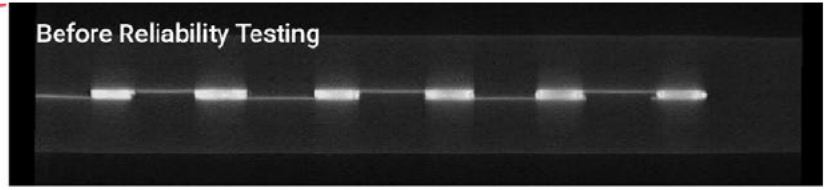
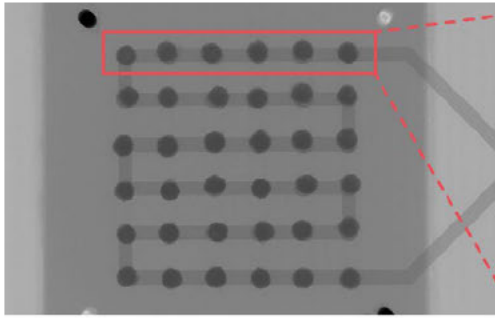
The sample was subjected to thermal shock testing between -55°C and 125°C using a two-chamber thermal shock tester. Results are as below: resistance variation remained minimal throughout 1,000 cycles. In addition, X-ray CT inspection confirmed the absence of significant void formation.

Resistance Variation at 125°C During Thermal Shock Testing.





Interconnect integrity maintained after reliability testing



No significant disconnection or delamination observed in bonding areas after 1,000 cycles

CT Imaging Conditions: 130 kV, 61 μ A, FOV 30 mm, Pixel size 10.50 μ m, Scan time 17 min

CTE mismatch among base materials, copper wiring, and interconnect materials is a commonly recognized reliability challenge in high-layer-count PCBs and package substrates. SAPHIRE™ B has demonstrated superior thermal stability under severe thermal cycling conditions, highlighting its suitability for demanding reliability-critical applications.

Outlook

SAPHIRE™ B is now available for evaluation with PCB manufacturers in Japan and overseas. Elephantech will work closely with customers to optimize implementation methods to meet specific requirements for PCB layouts, materials, and manufacturing requirements.

Going forward, the company will continue to expand reliability testing data and validate consistency for mass production. Elephantech aims to address the growing needs for low-resistance, reliable interconnects in high-layer-count and high-density PCBs, remaining committed to advancing semiconductor packaging in the AI era through its proprietary nanomaterials technologies.

Inquiries

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Company Overview

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