



Applied Materials Advances Heterogeneous Chip Integration with New Technologies for Hybrid Bonding and Through-Silicon Vias

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- *New materials and systems enable chipmakers to increase the performance and reliability of hybrid bonding, the industry's most advanced interconnect technology*
- *New deposition systems improve the density, performance, quality and cost of chips stacked using TSV technology*

SANTA CLARA, Calif., July 10, 2023 (GLOBE NEWSWIRE) -- Applied Materials, Inc. today introduced materials, technologies and systems that help chipmakers integrate chiplets into advanced 2.5D and 3D packages using hybrid bonding and through-silicon vias (TSVs). The new solutions extend Applied's industry-leading breadth of technologies for heterogeneous integration (HI).

HI helps semiconductor companies combine chiplets based on a variety of functions, technology nodes and sizes in advanced packages, enabling the combination to perform as a single product. HI helps solve industry challenges created in part because the need for transistors in applications like high-performance computing and artificial intelligence continues to increase at an exponential rate, while the ability to shrink transistors with classic 2D scaling is slowing and becoming more expensive. HI is a core component of a new playbook that enables chipmakers to improve chip performance, power, area-cost and time to market (PPACT) in new ways.

Applied is the largest supplier of technologies for HI with optimized chipmaking systems spanning etch, physical vapor deposition (PVD), chemical vapor deposition (CVD), electroplating, chemical mechanical polishing (CMP), annealing and surface treatments.

"Heterogeneous integration is growing rapidly because it helps chip and systems companies overcome the limits of classic 2D scaling, which no longer delivers simultaneous improvements in performance, power and cost," said Dr. Sundar Ramamurthy, Group Vice President and General Manager of HI, ICAPS and Epitaxy, Semiconductor Products Group at Applied Materials. "Our latest HI solutions advance the industry's newest ways to pack more transistors and wiring in 2.5D and 3D configurations to increase system performance, reduce power consumption, minimize size and speed time to market."

Making Hybrid Bonds Stronger and Better

Chip-to-wafer and wafer-to-wafer hybrid bonding can be used to connect chips using direct, copper-to-copper bonds that enable the combined elements to perform as one. Hybrid bonding is the industry's most advanced HI technology in production today, improving throughput and power by packing more wiring into smaller spaces and reducing the distances signals need to travel.

Introduced today:

- The **Insepra™ SiCN** deposition system expands Applied's industry-leading hybrid bonding product portfolio. The system uses a new silicon carbon nitride (SiCN) material that delivers the highest dielectric bonding strength in the industry and offers superior copper diffusion barrier properties. The stronger dielectric bonds give designers the structural stability needed to integrate far more copper-to-copper interconnects in a given area, which lowers power consumption and increases device performance.
- The **Catalyst™ CMP** solution helps customers control the amount of "dishing," the intentional recessing of copper material on two surfaces that will be bonded in a subsequent high-temperature annealing step. CMP dishing can create unwanted metal loss at the top surfaces of the copper pads, which can cause air gaps that decrease the fidelity and strength of the copper-to-copper bonds. Applied's Catalyst solution is a dynamic temperature control technique that reduces dishing and increases throughput.

Bringing Through-Silicon Vias to New Heights

Used in high-volume manufacturing for more than a decade, TSVs are vertical wires used to precisely connect stacked chips. They are formed by etching trenches into silicon and then filling them with insulating liners and metal wires. As designers continue to integrate more logic, memory and specialty chips into advanced 2.5D and 3D packages, the number of TSV interconnects has expanded from a few hundred per package to thousands. To integrate more interconnects and accommodate taller stacks of chips, designers need the vias to become increasingly narrow and tall, which results in deposition uniformity variations that degrade performance and increase resistance and power consumption.

Applied today introduced new technologies for both dielectric and metal deposition that enable higher-aspect-ratio TSVs and help chipmakers achieve their integration, performance and power goals:

- The **Producer® InVia® 2 CVD System** is a new CVD process that makes dielectric liners uniform and electrically robust at

the extreme aspect ratios needed by logic and memory customers in a growing variety of TSV applications. The InVia 2 system uses a propriety in-situ deposition process which enables excellent conformality for high-aspect-ratio TSVs. The system also offers higher throughput than ALD technologies, thereby reducing the per-wafer cost of TSV to help further expand its adoption.

- The **Endura® Ventura® 2 PVD System** extends its widely adopted predecessor to TSV applications with aspect ratios of up to 20:1. The Ventura 2 system increases the control of metal TSV wire deposition to ensure a complete fill that delivers high electrical performance and reliability. The new TSV PVD process has been co-optimized for use with the Producer® InVia® 2 CVD process, giving customers a ready solution to their most challenging TSV designs. The Ventura 2 system is being deployed by all advanced foundry/logic chipmakers and all major DRAM producers.
- The latest generation of Applied's **Producer® Avila® PECVD System** is designed for TSV "reveal" applications. In the TSV process flow, wafers are bonded to temporary glass or silicon carriers and then thinned using CMP and etching to make the TSVs accessible. Following the TSV reveal steps, plasma-enhanced CVD technology is used to deposit a thin dielectric layer that electrically isolates the TSVs from each other. If the PECVD process generates heat above approximately 200° C, the delicate temporary bonding adhesive can be damaged, resulting in costly wafer yield loss. Applied's Producer Avila PECVD system creates high-quality dielectric films at ultra-low temperatures and at high speed, meeting the low thermal budgets and high productivity required for TSV quality and cost.

Forward-Looking Statements

This press release contains forward-looking statements, including those regarding anticipated benefits of our new products and technologies; expected growth and trends in our businesses and markets, industry outlooks and demand drivers, technology transitions, and other statements that are not historical facts. These statements and their underlying assumptions are subject to risks and uncertainties and are not guarantees of future performance. Factors that could cause actual results to differ materially from those expressed or implied by such statements include, without limitation: failure to realize anticipated benefits of our new products and technologies; the demand for semiconductors; customers' technology and capacity requirements; the introduction of new and innovative technologies, and the timing of technology transitions; market acceptance of existing and newly developed products; the ability to obtain and protect intellectual property rights in technologies; our ability to ensure compliance with applicable environmental and other law, rules and regulations; and other risks and uncertainties described in our SEC filings, including our recent Forms 10-Q and 8-K. All forward-looking statements are based on management's current estimates, projections and assumptions, and we assume no obligation to update them.

About Applied Materials

Applied Materials, Inc. (Nasdaq: AMAT) is the leader in materials engineering solutions used to produce virtually every new chip and advanced display in the world. Our expertise in modifying materials at atomic levels and on an industrial scale enables customers to transform possibilities into reality. At Applied Materials, our innovations make possible a better future. Learn more at www.appliedmaterials.com.

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These photos are also available at Newscom, www.newscom.com, and via AP PhotoExpress.



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Source: Applied Materials, Inc.