MarketScreener

Applied Materials : The Fourth Era of Computing Needs More than Advanced Logic and Memory Chips – September 8, 2021

Applied Materials today held its third Master Class of the year, focusing on two important and fast-growing areas of the semiconductor industry: ICAPS and advanced packaging. ICAPS stands for IoT, Communications, Automotive, Power and Sensors. ICAPS encompasses all but the three most advanced nodes in foundry-logic. Advanced packaging is about heterogeneous design, which is increasingly being adopted by semiconductor and systems companies to drive their power, performance, area/cost and time-to-market (PPACt™) roadmaps as classic Moore's Law 2D scaling slows.

Why we're featuring these topics in the same event may not seem obvious. What ICAPS and advanced packaging have in common, however, is a highly enabling role in the fourth era of computing-which is now upon us and driving unprecedented demand for silicon and equipment. Allow me to explain.

Into the Fourth Era of Computing

In 2018, machines generated more data than humans for the first time. We believe this milestone marks the beginning of the fourth era of computing whereby the Internet of Things (IoT), Big Data and AI are creating a new wave of growth for the semiconductor industry, complementing the markets for PCs and smartphones which defined the second and third computing eras (see Figure 1). By 2025, we expect machines to generate 99 percent of the data created each year.

Most of this data will come from the billions of IoT products on the network edge, in applications ranging from farming to factory automation-and from healthcare to home security. ICAPS devices such as CMOS image sensors, MEMS devices, RF chips, power devices and analog-to-digital converters define how these IoT products function and interact with the physical world. Using a biological metaphor described in an earlier blog by my colleague, Dr. Mike Chudzik, ICAPS provides computers with eyes, ears-even noses and skin-so they can sense the world, generate information and communicate over the airwaves. Per the same analogy, cloud data centers are like the brains of this distributed system. And who is to say the brains are more important? After all, around 70 percent of a smartphone's semiconductor content is ICAPS chips, and without them the device is hardly more useful than a calculator. Without ICAPS, there can be no autonomous vehicles.

Bringing Technology Solutions to Vertical Markets

Another thing that may not seem obvious is why ICAPS and advanced packaging are nested within the same business unit at Applied Materials. The reason is that the end markets-such as high-performance computing, wireless communications, automotive, power distribution and digital imaging-are unique and highly specialized, both from a market perspective and from a materials engineering perspective. Applied's ICAPS and packaging teams include device experts who can relate to the customers and their unique roadmap challenges. They have the ability to cut across Applied's broad and deep portfolio of materials engineering technologies, including co-optimized and integrated solutions, to enable vertical market breakthroughs.

IMS for CIS

One example Mike shared in the Master Class is using co-optimization and Integrated Materials Solutions (IMS™) to improve CMOS image sensors (see Figure 2). Our dedicated CIS engineering team has designed an integrated platform solution that is in qualification at customer sites to improve next-generation digital cameras in the areas of resolution, light sensitivity and dynamic range.

Materials Engineering for Power Devices

Silicon carbide (SiC) is the 'silicon superhero' powering today's most advanced electric vehicles, giving them unprecedented torque and range. Scaling silicon carbide from 150mm wafers to 200mm wafers will help grow the market by reducing cost and boosting output. A key challenge is that SiC is harder than silicon but also susceptible to crystal lattice damage that degrades device performance, wastes power and generates heat.

Device experts from our ICAPS team have partnered with our equipment businesses to create unique systems that are highly optimized to the needs of leading chipmakers. Today we introduced a new SiC-optimized CMP system that perfectly planarizes raw silicon wafers to enable defect-free epi layers to be formed. We also launched a 'hot implant' technology that allows ions to be precisely implanted and diffused into the silicon carbide crystal while preserving the integrity of the lattice (see Figure 3).

These are just two of dozens of programs that will bring the breadth and depth of Applied Materials to highly specialized ICAPS devices and markets.

ICAPS and Advanced Packaging: Enabling a Virtuous Cycle

In the fourth era of computing, billions of new ICAPS devices at the edge are driving exponential growth in data generation which needs to be processed in the cloud.

At the same time, as another of my colleagues Dr. Nirmalya Maity explained in a recent blog, the slowing of classic Moore's Law 2D scaling is making it harder for chipmakers to place all of the transistors they need for high-performance computing, machine learning and inferencing on a single die. This is why heterogeneous design and integration are becoming so important to the world's leading chip and systems companies: it gives them the flexibility to disaggregate designs for area/cost savings while integrating them on advanced packages to optimize power and performance. This newfound flexibility-along with the opportunity for silicon IP reuse-also promises faster time to market. In short, heterogeneous design and advanced packaging enables PPACt.

In keeping with our goal to be the PPACt enablement company for our customers, Applied today made several advanced packaging announcements.

Die-to-Wafer Hybrid Bonding: Today, we are building on our collaboration with BE Semiconductor Industries N.V. (Besi) to provide customers with a proven, co-optimized equipment solution for die-based hybrid bonding. In addition, we're helping our customers by offering advanced software modeling and simulation capabilities for hybrid bonding, along with the ability to produce test vehicles. All of this capability is available under one roof, at our Advanced Packaging Development Center in Singapore, where we are already collaborating with customers.

Wafer-to-Wafer Hybrid Bonding: Today we announced another joint development agreement, with EV Group (EVG), aimed at providing co-optimized manufacturing solutions for wafer-to-wafer hybrid bonding. The collaboration brings together Applied's expertise in deposition, planarization, implant, metrology and inspection with EVG's leadership in wafer bonding, wafer pre-treatment and activation, as well as alignment and bond overlay metrology.

Larger Advanced Substrates: Today we also announced the recent acquisition of Tango Systems and our plans to enable customers to go far beyond the area constraints of 300mm silicon wafer substrates. Customers will be able to design larger advanced packages manufactured on rectangular substrates of up to 600mm x 600mm with fine-pitch interconnects (see Figure 4). Applied is also enabling its customers to use technologies from its display business such as eBeam review.

In summary, the AI Era is fueling growth from the edge to the cloud. To enable this growth era, the industry needs simultaneous innovation across leading edge, ICAPS and advanced packaging technologies. The end result is a virtuous cycle of data generation and AI processing that will unlock trillions of dollars in economic value.

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