The Future of AI and HPC Substrates: A Breakthrough Interconnect Technology

Rozalia Beica – Chief Commercial Officer

Build-Up Substrate Symposium | May 2-3, 2024
Presentation Agenda

Industry Trends
- Semiconductor Industry
- Information Age / AI & HPC

Current Challenges
- Increased Complexity
- High Density Interconnects

LQDX Introduction
- Introduction
- Technology

Our Solutions
- High Density Interconnects
- The Road to 1um
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The semiconductor industry has never seen anything like this at any time in its history!

- In the past, there was always One Key Technology driving the roadmap: e.g. PC -> Mobile -> Smartphone -> Information Age
- Now there are multiple growth technologies ramping at the same time: AI, 5G, Datacenter, VR/AR, IIoT, Autonomous Driving, etc.
- AI & HPC are driving an unprecedented market inflection, and many processes and materials are needed to satisfy the demand
- All of this also being catalyzed by government investments worldwide
AI And HPC: The Next Growth Engine For Semiconductors

Semiconductor Market By Applications

- **02%** - IOT / Edge Compute
- **04%** - Autonomous Driving
- **14%** - Mobile Advertising
- **22%** - Network / Datacenter
- **25%** - Consumer / AVR / VR
- **33%** - HPC / AI

Source: Semiconductor End-Market Driver Breakdown By End Application, McKinsey 2023

HPC / AI – ALREADY THE DOMINANT APPLICATION DRIVING THE GROWTH OF OUR INDUSTRY
AI: Catalyzing The Next Growth Wave Of Semiconductors

Wide Range Of Applications
- Deep Learning
- Machine Learning
- Simulation / Modeling
- Natural Language Processing
- Image Analytics
- Graph Analytics
- Robotics / Automation
- Autonomous Vehicles
- Healthcare
- IoT
- ...

Generative AI: similar impact to that of the steam engine, electricity & the internet

Source: Gartner

Projected Global Sales of AI Chips

CAGR = 35%

$ BILLIONS, SOURCE: INSIGHT PARTNERS

2018 2019 2020 2021 2022 2023 2024 2025 2026 2027
5.7 7.6 10.1 13.6 18.4 24.8 33.5 45.4 61.4 83.3

10X Higher Growth Rate for AI Chips vs Non-AI

Source: Gartner
Can The Industry Keep Up With The Growth Of Generative AI?

Logic
- 2030 (non-AI) demand: 15M wafers
- 2030 fab planning / supply: 15M wafers
- 2030 gen. AI demand: + 1.2 – 3.6M wafers
- Supply Gap due to Gen. AI: 1-4M wafers

Memory
- Memory capacity & bandwidth bottlenecks
- The growth in memory capacity is not straightforward, posing challenges to hardware and software design
- New memories being tested for near-compute memory – high cost limits adoption

Global Logic & Memory Wafer Demand and Supply in 2030

<table>
<thead>
<tr>
<th>Logic ≤ 7nm</th>
<th>Current Supply</th>
<th>Traditional Demand</th>
<th>Conservative</th>
<th>Base</th>
<th>Ambitious</th>
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<tr>
<td>Logic ≤ 7nm</td>
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<td>DRAM DDR &amp; HBM</td>
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To Close the Gap, 3-9 New Logic Fabs will be needed by 2030
AI Will Drive, Like Never Before, Computing & Memory Needs, Customization

Integration of AI is Creating New Processor Structures

- Processor customization
- More powerful, efficient chips with higher bandwidth
- High degree of parallelism with multiple complex processing elements
- Higher adoption of AI Accelerators

Will Drive the Growth of Chiplets & Heterogeneous Integration

- Increased integration and multi-die packaging, heterogeneous integration
- Larger packages and more advanced substrates

AI models in data centers are becoming more complex, driving the evolution of chip architecture
The Rise Of Chiplet Is Driving Advancements In Advanced Packaging

AI / HPC is Driving a Transformative Era in Chiplet Technology & Packaging

- **Chiplets**: a modular approach to system design that is performance driven and cost-effective, customizable and scalable to different computing applications.

- The true potential of chiplets is unlocked through advanced packaging solutions and heterogeneous integration.

- The economics of chiplet adoption are linked with the cost and maturity of the interconnect & packaging solutions.

Chiplets Reshaping the Landscape of Advanced Packaging, Driving the Growth of Heterogeneous Integration.
High Performance Processors Need High Performance IC Substrates

AI / HPC Driving the Trend Towards Significantly Bigger and More Complex Substrates

- Increased substrate size
- Increased layer count
- More advanced interconnects
- Embedding technologies
- Multi-core substrates
- Glass substrates

Chip I/O increasing is driving the need for finer pitches and denser interconnects in IC substrates, strongly pushing IC Substrate makers to reduce L/S interconnects and microvias

Computing Growing Exponentially, Faster than Interconnect Improvement & Developments
AI & HPC Driving The Need For More Advanced Interconnects

Substrate Interconnect Scale Roadmap

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Source: IEEE, Georgia Tech, SEMI, 2022

OUR STRATEGIC FOCUS: ULTRA HIGH END INTERCONNECTS
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The Future Of Interconnect Is Fluid.
A Silicon Valley Nanomaterials Company Focused On Interconnect Technologies for Advanced Packaging & Substrates

Incubated At Stanford Research Institute.

Engineered At Averatek / LQDX Santa Clara.

Patented Nano-Inks for AI & HPC Driven Advanced Semiconductor Interconnect
Our Patented Liquid Metal Ink (LMIx™) – Proven Technology That Meets Today The Needs Of Next Generation IC Substrates

- **Unique Atomic Seed Metallization** chemistry suite, enabling very uniform deposition of palladium, gold, copper and other semiconductor metals.

- **Palladium seed metal is the bedrock of every printed circuit made**, including the most advanced substrates, and **the roadmap demands feature sizes of <5um**.

- Our proven seed-metallization chemistries are a critical tool in the new Heterogeneous Integration toolbox. **LMIx® has been proven on custom projects**: our focus is now scaling it into the IC substrates, organic interposer and TSVs.
Nano Conformal Deposition Of Atomic Palladium

- Atomic Pd: very thin, nano-layers of conformal Pd deposition (≤ 5nm)
- Atoms will follow the contour very well
- Conformal – difficult to do with PVD

LMI Has a Molecular and Compositional Architecture that Enables Atomic Pd Deposition on the Nano Contours of Substrates
Enabling Advanced Circuits on the Largest Range of Substrates

- **Ultra Thin**: a few nanometers thick (≤ 5nm Pd vs 100nm PVD)
- **Ultra Dense**: fully packed nano film enabling uniform initiation of e-less copper (80nm Cu vs 200-300nm PVD)
- **Ultra Conformal**: complex surfaces at nanometer scale, high AR (20:1) features (TSVs)
- **Ultra Compatible**: adheres to advanced substrates and wide range of materials (Build-up Film, PID, LCP, BT, PTFE, Ceramics, FR4, Flex)
- **Ultra Flexible**: works with pure metals & alloys

Lowest Cost of Adoption And Easy Adoption & Integration into Existing Wet Processing Lines
Driven By Our Passion For Innovation & Engineering, We Are Pushing The Boundaries In Interconnect Technologies

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OUR STRATEGIC FOCUS: Enabling The Roadmap to ≤1um L/S using Wet Processing
Building Integrated Process for Advanced Interconnects using Wet Process Seed Deposition

Integration of Process Steps & Materials & Characterization

- 1-5um L/S
- 5-20um microvias
- Via formation: using various technologies
- Patterning: stepper vs laser direct imaging
- Photoresist: dry and liquid films
- Electrical characterization & reliability testing

ABF laminated wafers & seeded with 2nm Pd & 100nm E-less Cu 45nm roughness
Proven Solution in HVM and With Strong Partnership Engagements

Meet Some of our Partners

We are fully equipped to get your design prototyped and into production for testing
Summary

Industry Trends

- Exciting times in the semiconductor industry with multiple growth technologies ramping up
- AI & HPC are driving an unprecedented market inflection, and driving innovation at a rate of change the world has never seen before
- New materials and process tools are urgently needed in the industry toolbox to address the needs of AI and enable its growth
- While packaging technologies are available to address the needs of chiplets integration, they have high cost and are complex (2.5D)
- Increased adoption of chiplets & heterogeneous integration driving the need for larger, more complex and advanced substrates, finer interconnect solutions
- PDV adoption is being considered => higher cost, footprint and has its own challenges: less conformal, cannot address high-aspect-ratio features, thicker films
- LQDX has developed a suite of cutting edge technologies and processes and can bring a disruptive leap in interconnect technology.

Current Challenges

LQDX Introduction

Our Solutions

Discover the Liquid-X Process that is Right For You
The Future Of AI and HPC Substrates: A Breakthrough Interconnect Technology

THANK YOU!

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