



Packaging Trends Part 1

Why is there so much buzz about Microelectronics Packaging?

BUILDING RESILIENT SUPPLY CHAINS, REVITALIZING AMERICAN MANUFACTURING, AND FOSTERING BROAD-BASED GROWTH

100-Day Reviews under
Executive Order 14017

June 2021

A Report by
The White House

Including Reviews by
Department of Commerce
Department of Energy
Department of Defense
Department of Health and Human Services



Semiconductor manufacturing and advanced packaging: Semiconductors are an essential component of electronic devices. The packaging, which may contain one or more semiconductors, provides an alternative avenue for innovation in density and size of products. Semiconductors have become ubiquitous in today's world. They enable telecommunications and grid infrastructure, run critical business and government systems, and are prevalent across a vast array of products from fridges to fighter jets. A new car, for example, may require more than 100 semiconductors for touch screens, engine controls, driver assistance cameras, and other

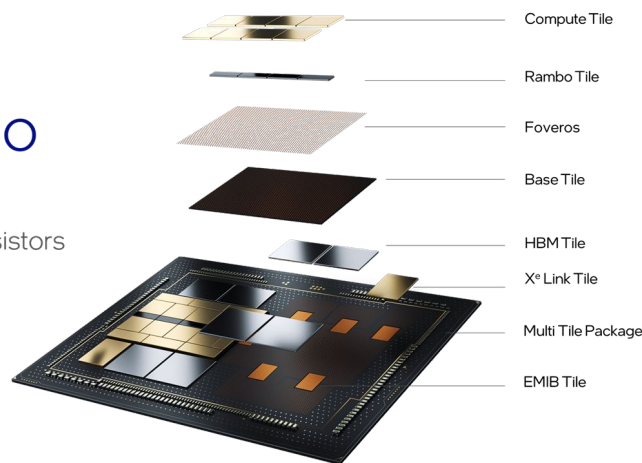
"BUILDING RESILIENT SUPPLY CHAINS, REVITALIZING AMERICAN MANUFACTURING, AND FOSTERING BROAD-BASED GROWTH". A report by the White House, June 2021.

Ponte Vecchio soc

>100 Billion Transistors

47 Active Tiles

5 Process Nodes



5

Leadership Products, Process and Packaging
Technology and Scale Capacity

Influential revolutions in the past

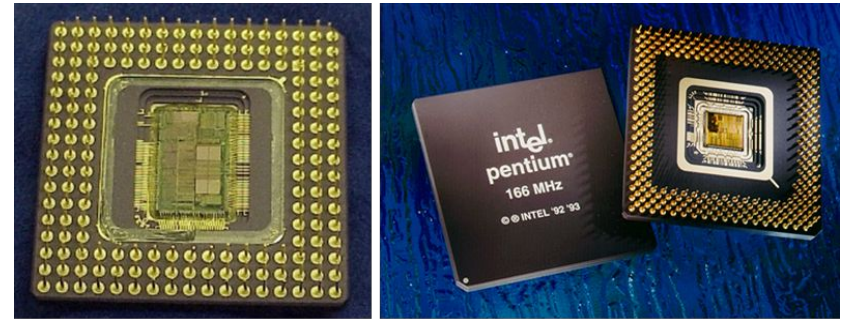


Image: Artist Kazuhito Takadoi, courtesy of jaggedart London.

Major Changes in Packaging Technologies

1990s :

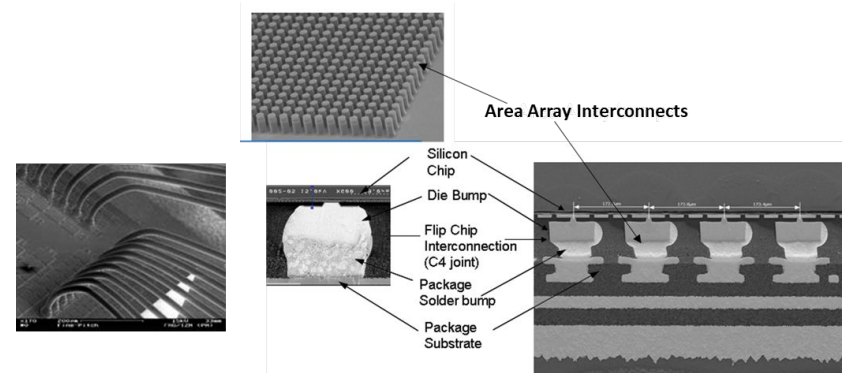
Packaging revolutionized by launch of the **first flip-chip organic substrate**; A New Package Industry is born



Ceramic Packaging → Organic Packaging

2000s :

Copper Pillar Bumps on die are introduced as an extension on Cu backend; Intel leads the industry by deploying **fully lead & halogen free packages**; High Pin Count Land Grid Sockets Become Mainstream; Drive to greater adoption of Ball Grid Arrays enables “Small and Thin”



Wire-Bond → Organic Flip-Chip

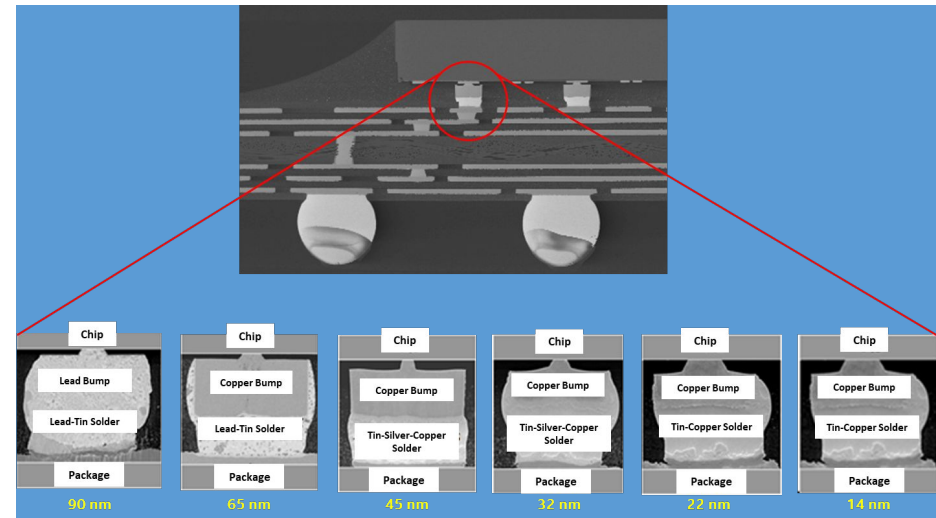
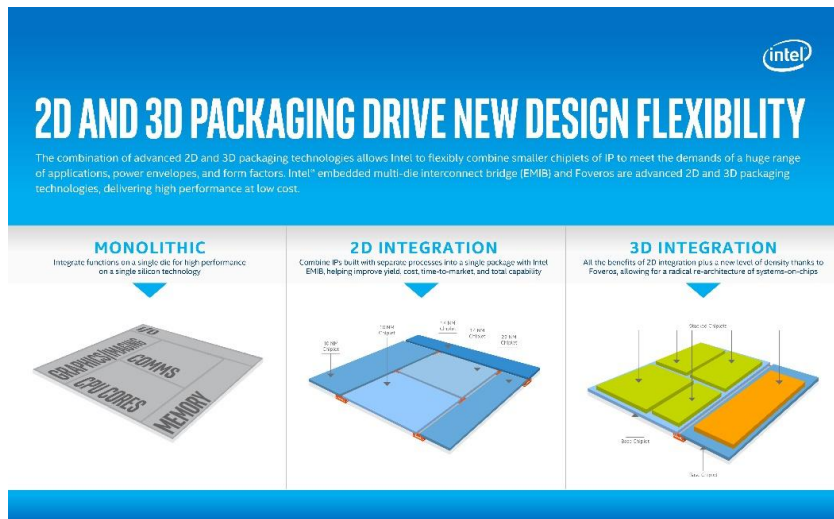
Major Changes in Packaging Technologies

2010s :

Thermo-Compression Bonding Tools enable Fine Pitch Flip-Chip; Multiple Breakthrough 2D Multi-Chip Packaging Technologies (CoWOS, EMIB, FOCOS) Introduced : HBM, Foveros, SOIC open up the 3rd Dimension

Thermo-compression Bonding for Fine-pitch Copper-pillar Flip-chip Interconnect – Tool Features as Enablers of Unique Technology

Anram Eitan; Kin-Yik Hung
Intel Corporation; ASM Pacific Technology Ltd.
5000 W. Chandler Blvd., AZ, USA; 16-22 Kung Yip Street, Kwai Chung, Hong Kong
Anram.eitan@intel.com; kyhung@asmpt.com



Not a New Idea

Moore's Law, 40 years and Counting

Future Directions of Silicon and Packaging

Bill Holt

General Manager
Technology and Manufacturing Group
Intel Corporation

InterPACK '05
2005 Heat Transfer Conference

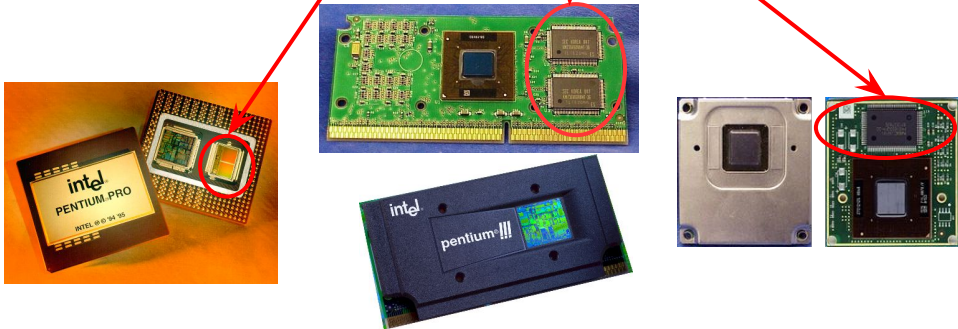
Key Messages

- Systems/platform focus drives increased requirements for silicon and packaging
- Making the right choice between on-chip and in/on package integration is critical to cost effective solutions
- Moore's Law is the engine for continued growth
- Silicon is ideal for homogenous integration
- Packaging is ideal for heterogeneous integration

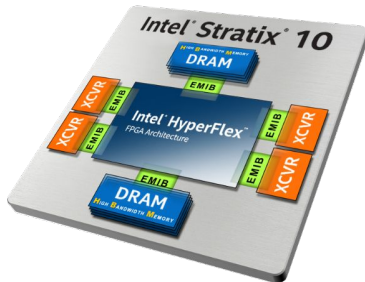
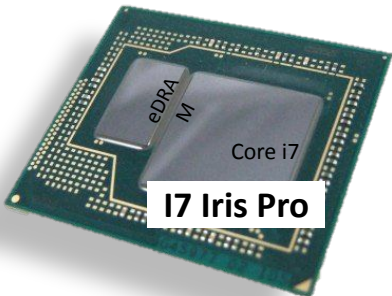
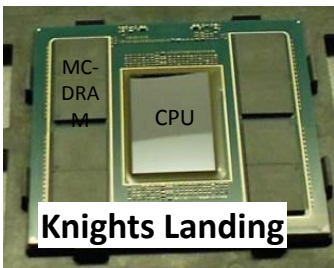
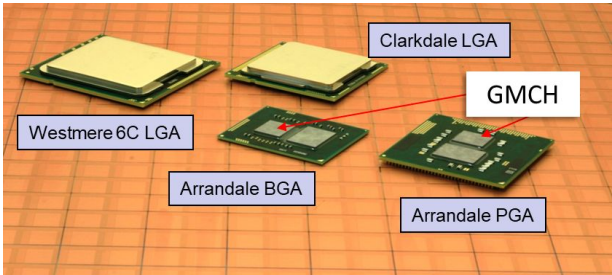
Heterogeneous Integration is the integration of separately manufactured & tested components into a higher level assembly (SiP aka MCP) that, in the aggregate, provides enhanced functionality and improved operating characteristics (Ack: Bill Chen, Bill Bottoms)

Long history of using HI for Time to Market (TTM) & Performance

SRAM Integration



(G)MCH Integration



DRAM Integration

Summary



- Packaging has historically enabled better products using HI
- Over the past 3+ decades, packaging has steadily improved interconnects, thermals

Disclaimer



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