Advanced IC Packaging using Silicon Interconnect Fabric

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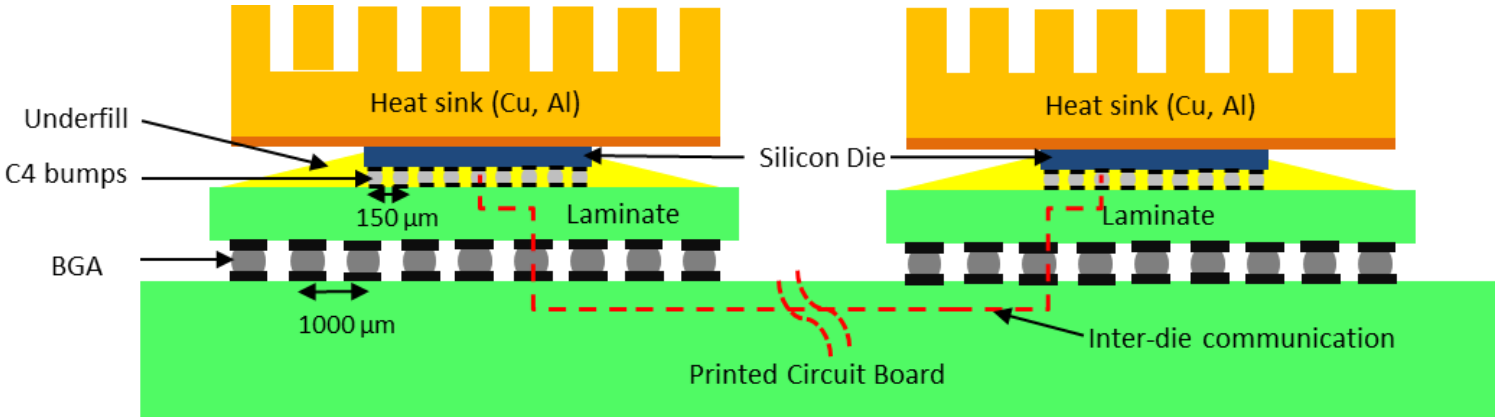
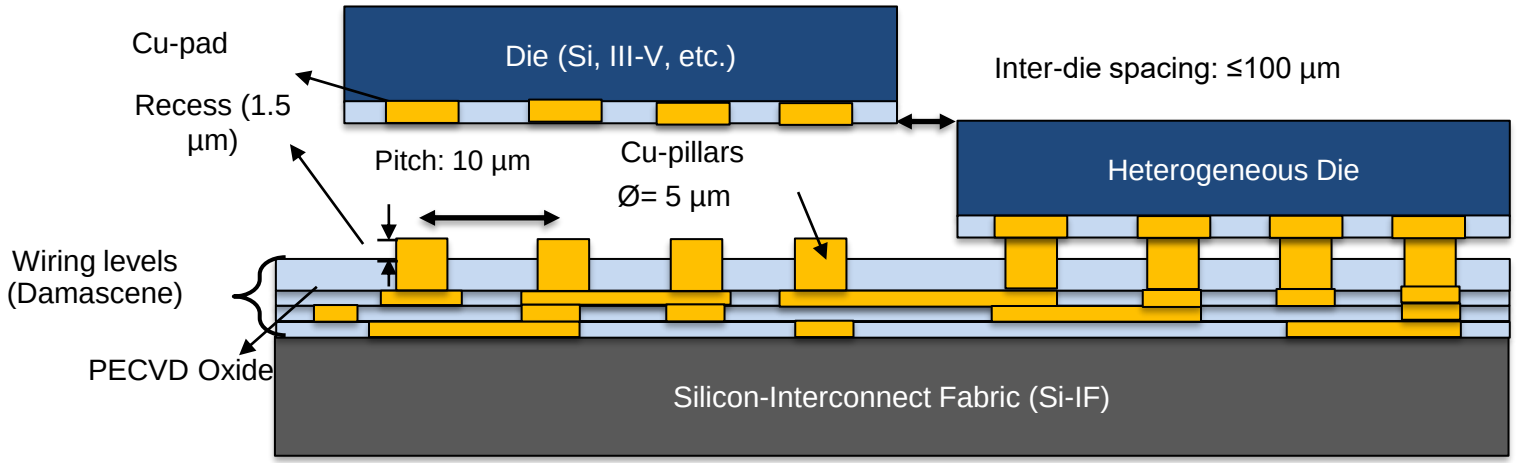
Silicon Interconnect Fabric

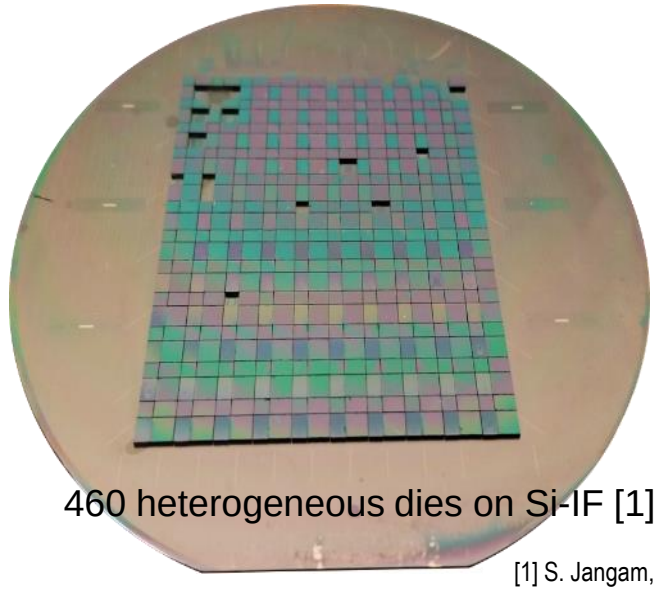


Conventional Assembly



Silicon Interconnect Fabric (Si-IF)

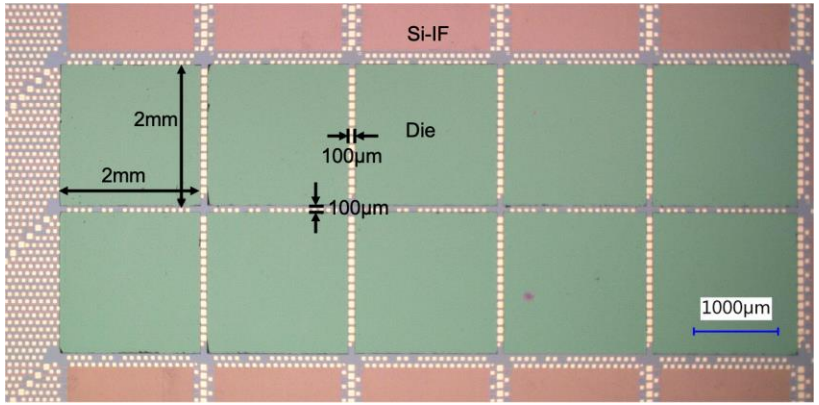
- Conventional Assemblies limited by Si vs package dimensions
  - –Large packages, long links, high loss
- Silicon Interconnect Fabric (Si-IF)
  - –Fine pitch interconnects: <10 µm
  - –Packages-less (die spacing <100µm)
  - –High bandwidth, low latency & power



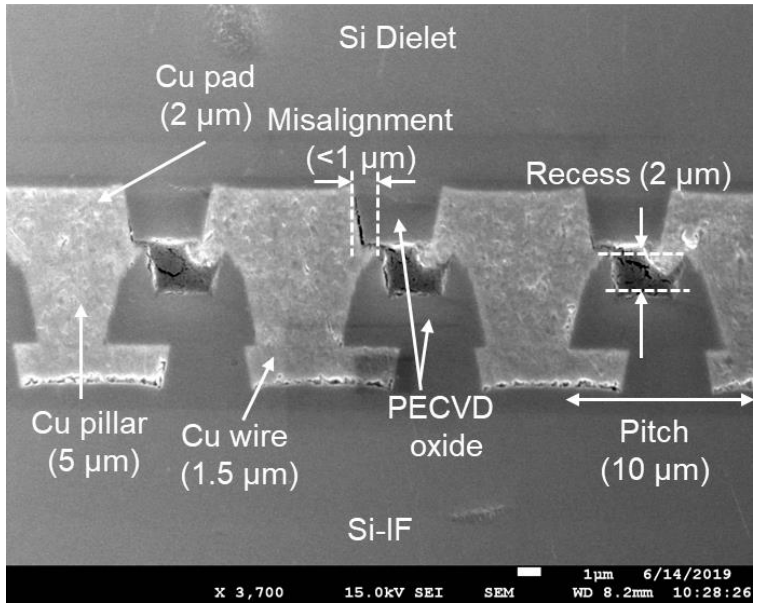
460 heterogeneous dies on Si-IF [1]

[1] S. Jangam, et al, T-CPMT, 2021

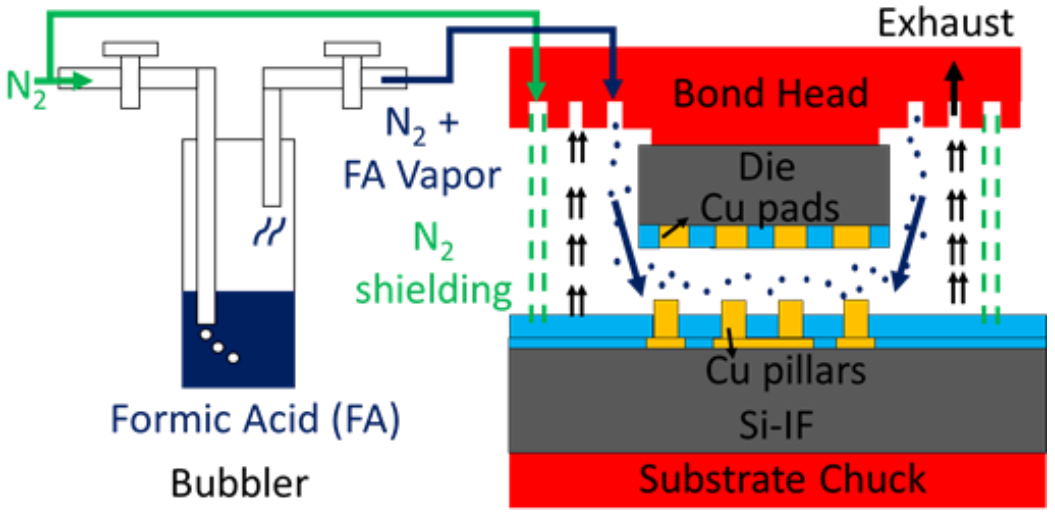
Fine Pitch Assembly



Dies assembled at 100µm spacing on Si-IF [1]



10µm pitch bonded interconnects [2]

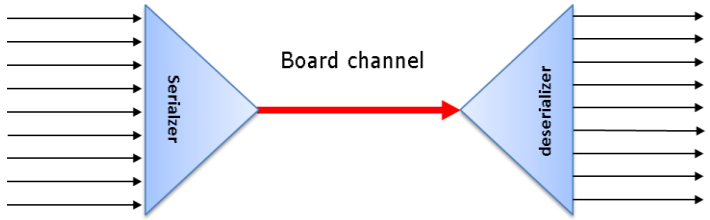


In-situ formic acid treatment setup (In collaboration with K&S) [2]

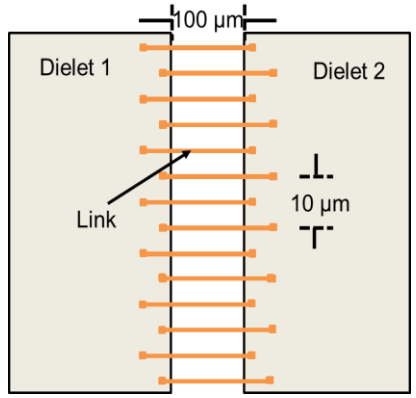
- Demonstrated sub-10µm fine-pitch interconnects
- Solder-less metal-metal thermal compression bonding (TCB)
  - Temperature & pressure on planar, pristine bonding surfaces
- In-situ formic acid treatment for direct Cu-Cu bonding
  - Local reducing environment under bond-head

[1] S. Jangam, et al, T-CPMT, 2021 [2] S. Jangam, et al, ECTC, 2019

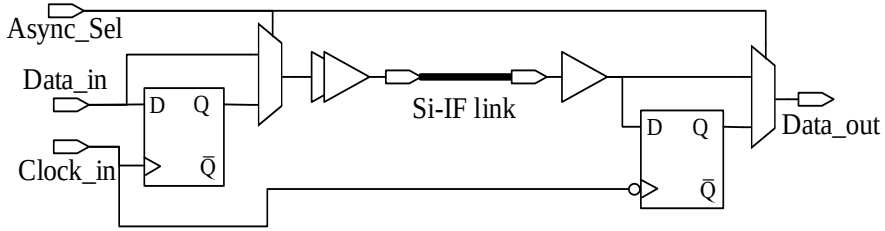
Simple Universal Parallel intERface for chips (SuperCHIPS)



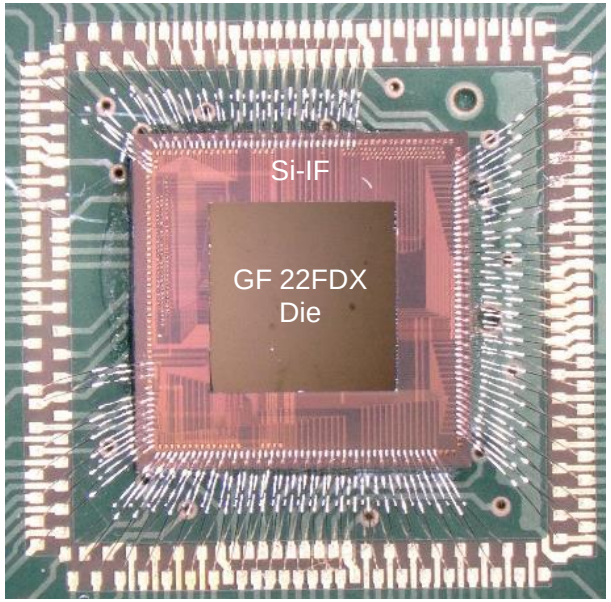
SERDES on PCBs



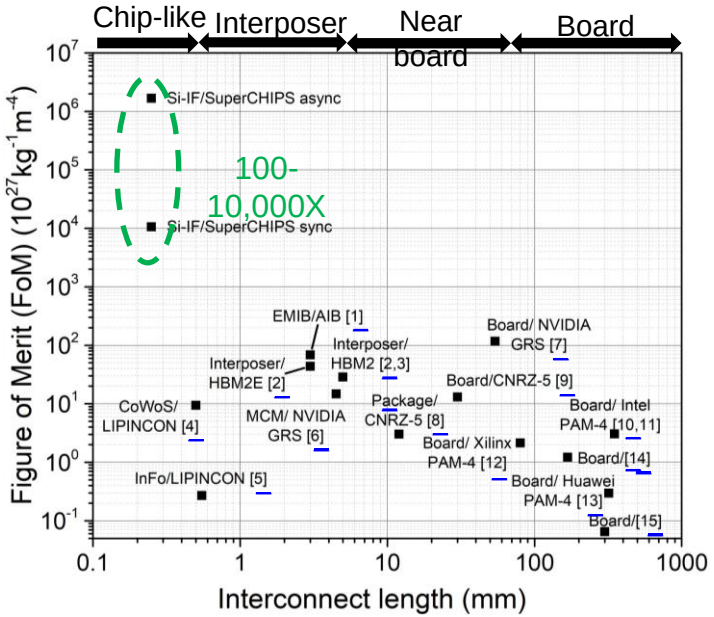
SuperCHIPS on Si-IF



SuperCHIPS I/O [16]



TV on Si-IF Test Assembly [16]



FoM Comparison [17]

- High bandwidth & low power using large number of parallel short links
  - Simple inverter based drivers
- Demonstrated SuperCHIPS performance on functional TV
  - Latency: <30 ps (3-65X ↓)
  - Energy/bit: <0.03 pJ/b (5-40X ↓)
  - Data-Bandwidth: up to 8 Tbps/mm (4-23X ↑)

[1] AIB interface [2] HBM JESD235C, 2020. [3] M. O'Connor , MICRO, 2017. [4] M. Lin, JSSC, 2020. [5] M. Lin, et al, HCS, 2016. [6] J. W. Poulton, et al, JSSC, 2013. [7] J. W. Poulton, JSSC, 2019. [8] A. Shokrollahi, ISSCC, 2016. [9] A. Tajalli,, JSSC, 2020. [10] Y. Krupnik I, JSSC, 2020. [11] J. Kim et al, JSSC 2019. [12] M. Erett, ISSCC 2018.[13] M. LaCroix et al, ISSC 2019. [14] E. Depaoli, JSSC, 2019. [15] R. Navid, JSSC, 2019. [16] S. Jangam et al, ECTC, 2020. [17] S. Jangam et al, T-CPMT, 2020

Thank You!

See you at my poster