Chiplet Microassembly Printer & Microsprings

Open Compute Project
June 10 2019

PARC
a Xerox Company

The Business of Breakthroughs®

founded 1970

laser printing
PC workstation
Ethernet
WYSIWYG, GUI

multi-beam
laser diodes
ubiquitous
computing
collaborative
filtering
AI/ model-based
systems

corporate
ethnography

incorporated 2002

UVLEDs
cleantech
printed & flexible
electronics
content-centric
networking

PARC seeks outside investors and partners
Nanotech Everywhere. Many Small Things To Assemble.

- Heterogeneous integration needs assembly
- High throughput, deterministic microassembly not available
- Directed electrostatic fluidic assembly scalable

**LED displays, lighting, signage**

10^{16} pixels in world?
1-500um

**IC Chiplets**

IP reuse, heterogeneous, modular

**Integrated Circuits**

$10^{-9}$ /transistor
IP blocks 10-100um not heterogeneous, inflexible.

**Laser Printers**

~10^8 particles (1-5um),
~300msec,
>cm/sec
< $0.01/page
Heterogeneous (multi-color)
No orientation control
Not precise
Goal – New Tool for Integrating Devices

- High throughput & low cost (like xerography)
- Digital - customize each pixel (1-1000um), sort chips, rapid prototyping
- Orientation & Heterogeneous
Process Steps

1. Nanofabrication. Test & mark bad chips.
2. Singulate (solution)
3. Assemble with programmable electrostatics. Sort out bad chips.
4. Transfer to final substrate. Non contact transfer or stamp. Interconnect.
Chip Assembly

Parallel, Deterministic, Heterogeneous

50µm x 100µm die
4µm, 1° reg

10µm x 15µm die
<2µm reg

200-250µm die
75µm spacing

Si chiplet (30x50µm)
Si chiplet (30x20µm)
Si chiplet (10x10µm)

200µm die array

250µm LED

Close-packed
Transfer

Electrostatic Non-contact

Continuous Feed Assembly & Transfer “printout”
(162 chips, 150x250um, on pdms, 1mm pitch)

Continuous Feed

Stamp Transfer
10um beads, 1um reg, on final glass substrate

Printed LEDs
(inkjet interconnects)

Stamp Transfer
10um beads, metal and dielectric
1um reg, on final glass substrate

Continuous Feed or Stamp
Interconnect

200um Si Chip
lithographic
40um metal lines
Applications. Large area & chip scale.

Rapid, custom circuits
IP Chiplet Library
- processor
- memory
- SerDes
- security
- comm
- FPGA

Assemble & Interconnect
Chiplet ASIC

Heterogeneous Chip Scale Systems
Emulators?

Metamaterials
- 3D orientation
- aperiodic

Large area, sparse, system sheets
LED, solar, active antennas..

Sift for Good Devices
Low Yield
- 2d flakes

Sort & Assemble

High Yield, Functional, Deterministic
Quantum systems, photonics
PARC Microsprings

- Thin film lithographic defined pressure contact
- Reworkable flip chip interconnects
- Integrated test & package for lower cost known good module

Organic substrate
(180x180um pitch, >2500 contacts, processors with Sun Microsystems)

Silicon TSV (180x180um pitch)

6um pitch linear array
(LED VCSEL bar)

20um pitch linear arrays
(LCD driver array, 800 contacts)

3D Coils on IC
MicroSprings Enable Rematatability

At-speed test and rework of multi-chip module
Replace single die after module testing.
Use as test socket or in final module
Lower cost known good module if
  • High chip count
  • Low yield die
  • Expensive KGD
Can replace chip in the field
  Security app – upgradable hardware
    • High bandwidth chip socket

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Chip 1 yield vs. module cost

- Flip chip module
- Springs on all chips module
- Springs on substrate module
- Springs on chip 1 module

Metal spring

dielectric  metal  dielectric

TSV  IC
Conclusion

  • Close packing, small chiplets

• Microsprings – integrated test and rework

• Seek feedback, partners, application ideas.

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