

Chiplet Microassembly Printer & Microsprings

Open Compute Project

June 10 2019

PARC

a Xerox Company

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The Business of Breakthroughs®

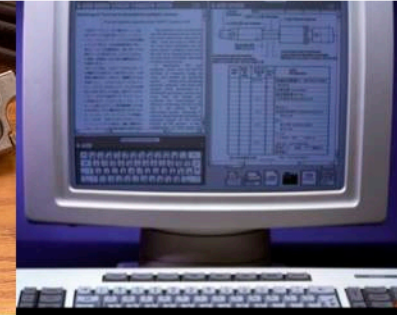
founded 1970

laser printing

PC workstation
Alto

Ethernet

WYSIWYG, GUI



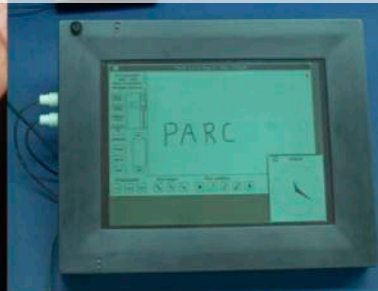
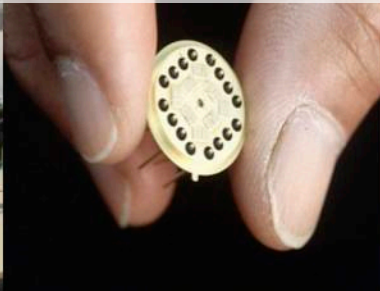
corporate
ethnography

multi-beam
laser diodes

ubiquitous
computing

collaborative
filtering

AI/ model-based
systems



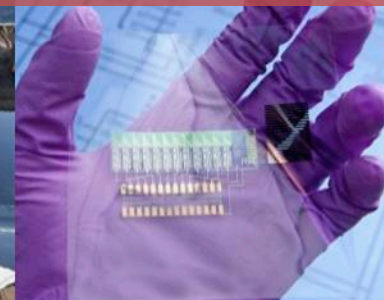
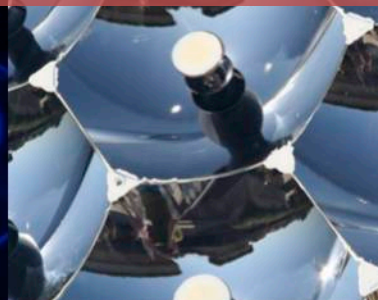
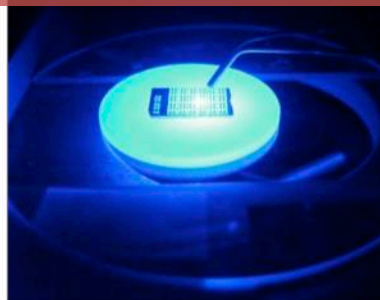
incorporated 2002

UVLEDs

cleantech

printed & flexible
electronics

content-centric
networking

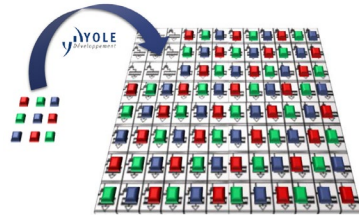


PARC seeks outside investors and partners

Nanotech Everywhere. Many Small Things To Assemble.

LED displays, lighting, signage

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



performance, sensing

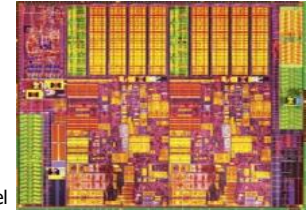
IC Chipllets



Ref: DARPA
CHIPS

IP reuse,
heterogeneous,
modular

Integrated Circuits

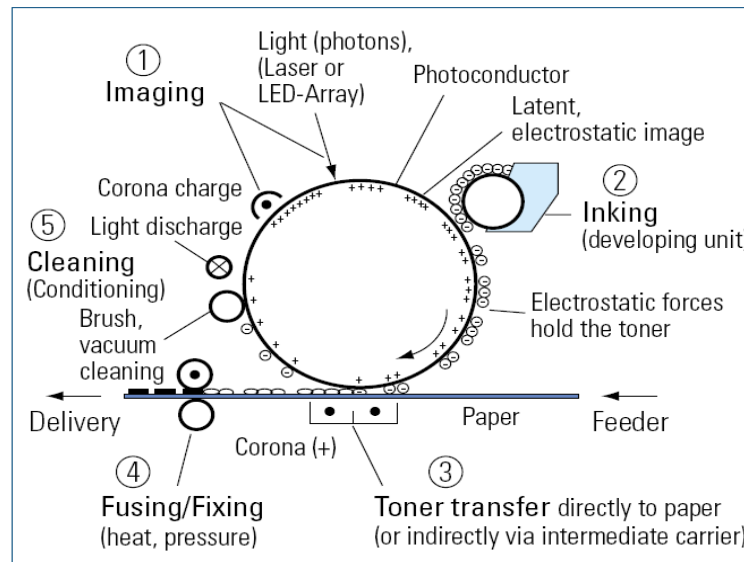


Ref: Intel

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

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

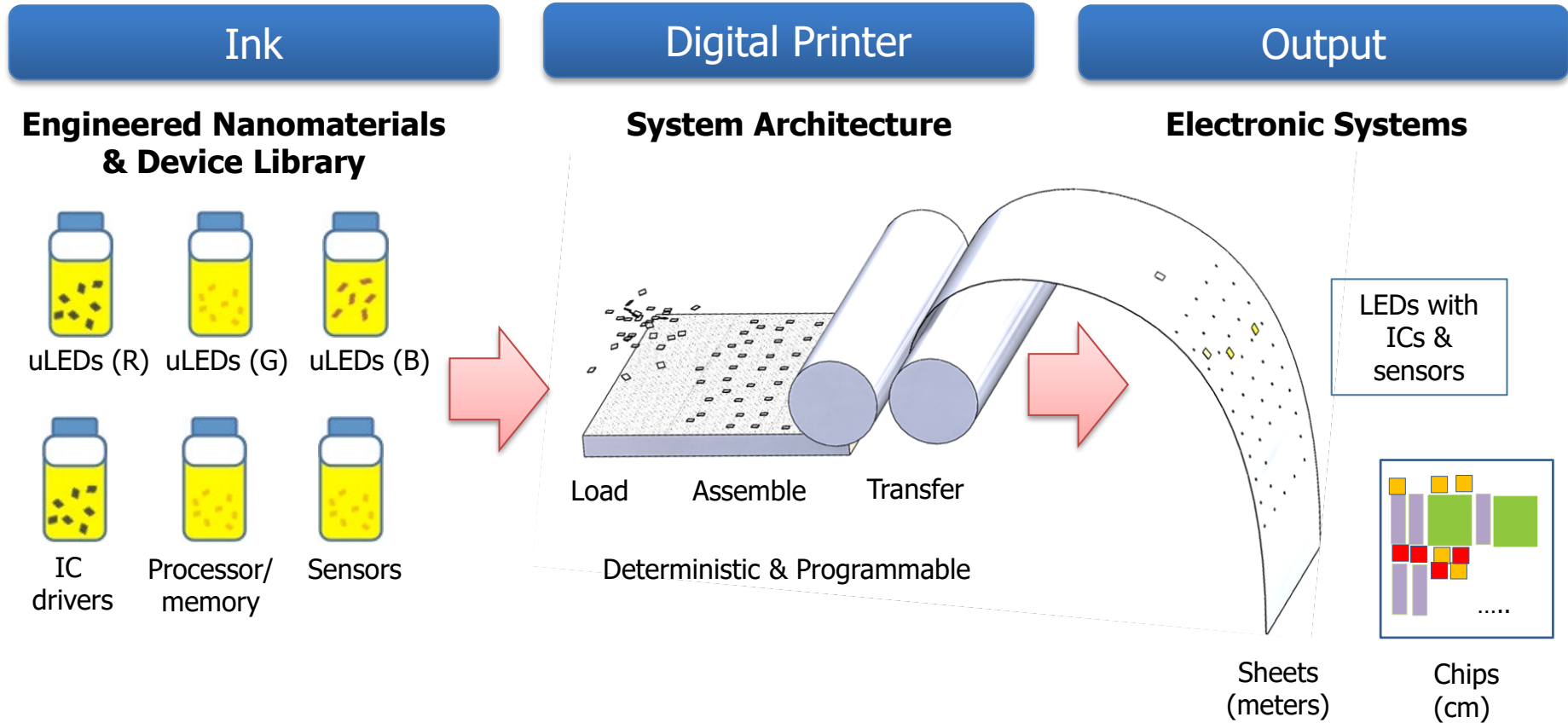
Laser Printers



Ref: Handbook of
Print Media Tech

$\sim 10^8$ particles (1-5um),
 ~ 300 msec,
 $> \text{cm/sec}$
 $< \$0.01/\text{page}$
Heterogeneous (multi-color)
No orientation control
Not precise

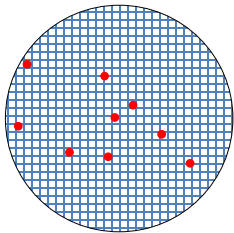
Goal – New Tool for Integrating Devices



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

Process Steps

1



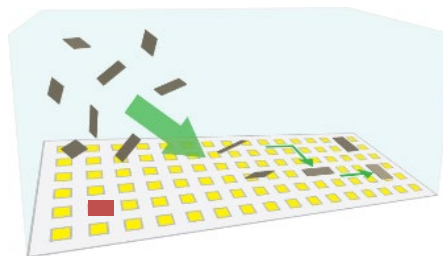
Nanofabrication.
Test & mark bad chips.

2



Singulate
(solution)

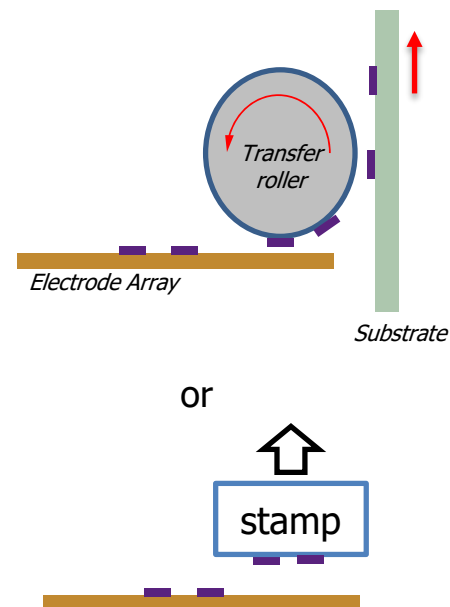
3



Active matrix electrode array

Assemble with
programmable electrostatics.
Sort out bad chips.

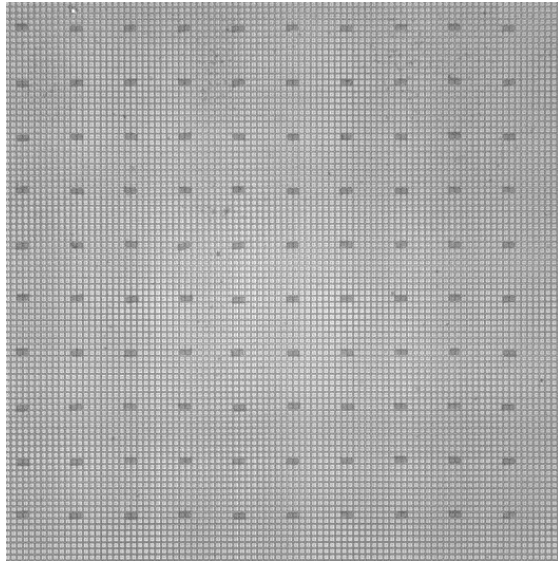
4



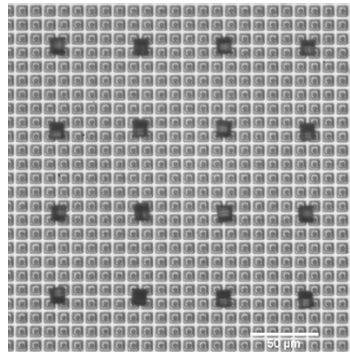
Transfer to final substrate.
Non contact transfer or stamp.
Interconnect.

Generalized Assembly

Chip Assembly

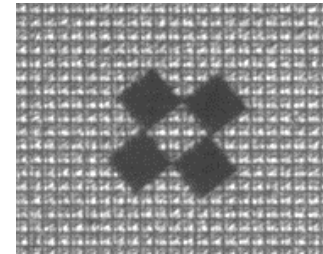


50um x 100um die
4um, 1° reg

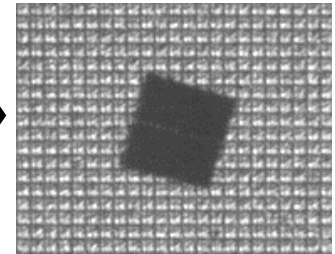


10um x 15um die
<2um reg

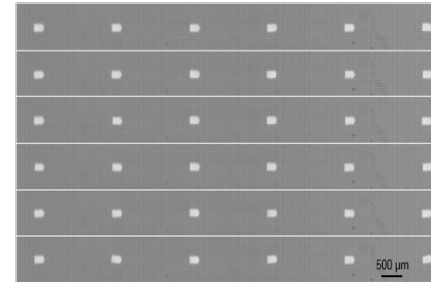
Parallel,
Deterministic,
Heterogeneous



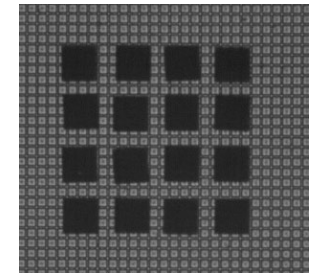
250um LED



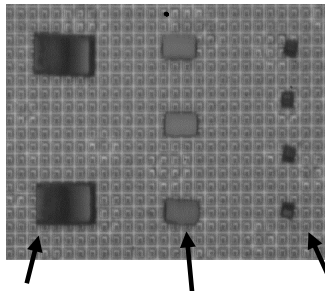
Close-packed



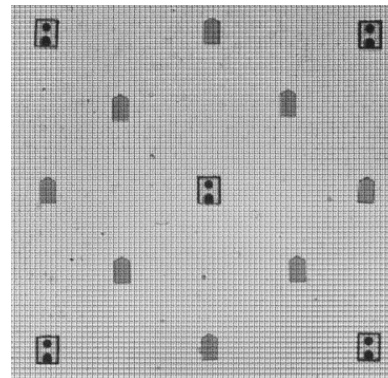
200um die array



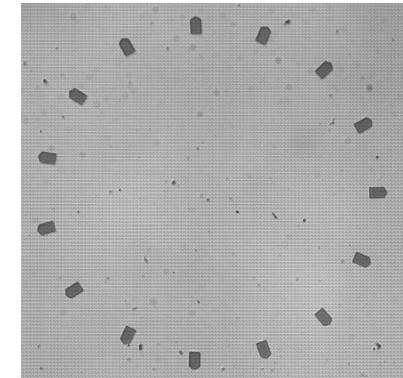
175um die
75um spacing



Si chiplet (30x50um) Si chiplet (30x20um) Si chiplet (10x10um)

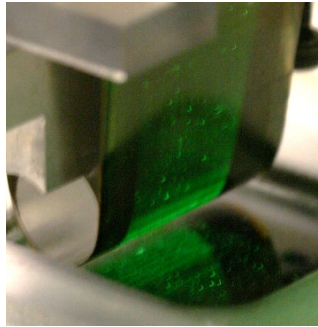


200-250um
LEDs Si

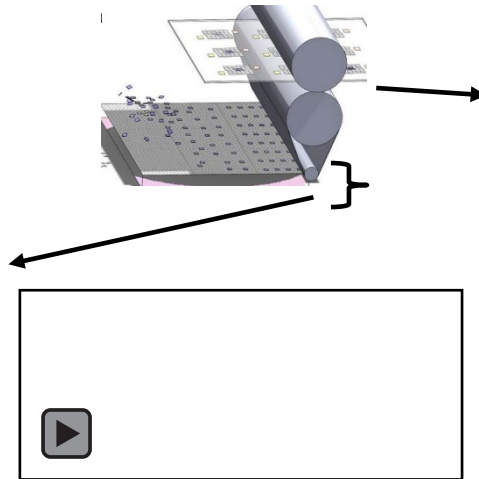


200um x 300um die
radial

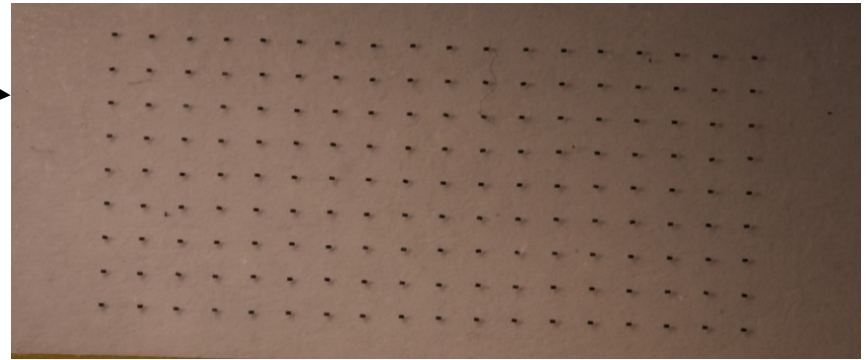
Transfer



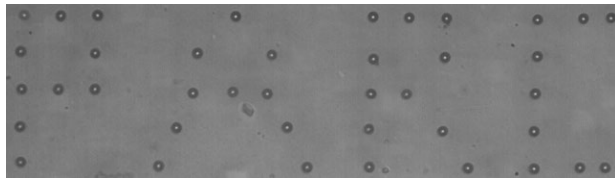
Electrostatic
Non-contact



Continuous Feed

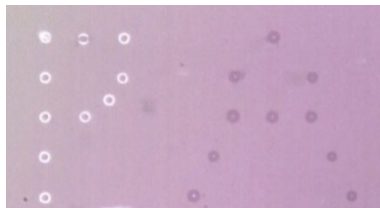


Continuous Feed Assembly & Transfer "printout"
(162 chips, 150x250um, on pdms, 1mm pitch)



Stamp Transfer

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



Stamp Transfer

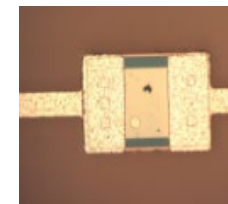
10um beads, metal and dielectric
1um reg, on final glass substrate

Continuous Feed
or
Stamp

Interconnect

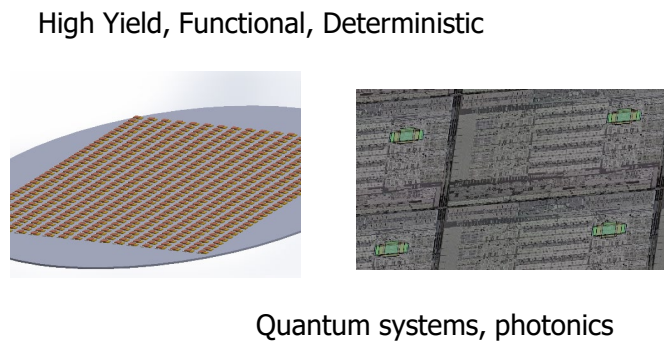
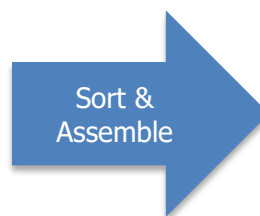
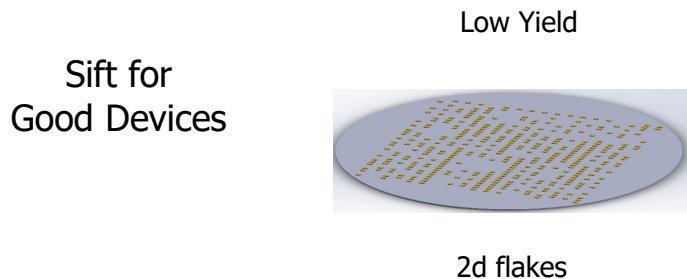
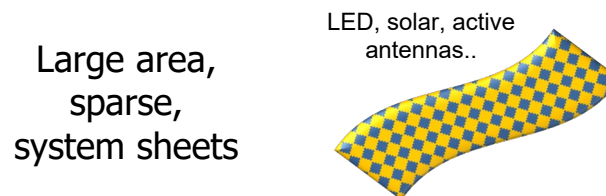
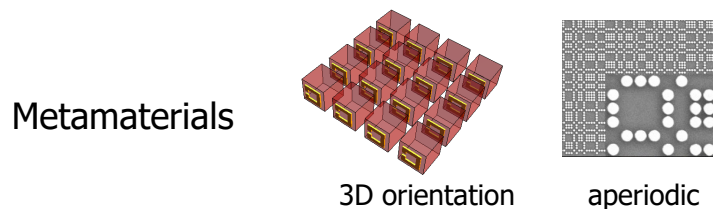
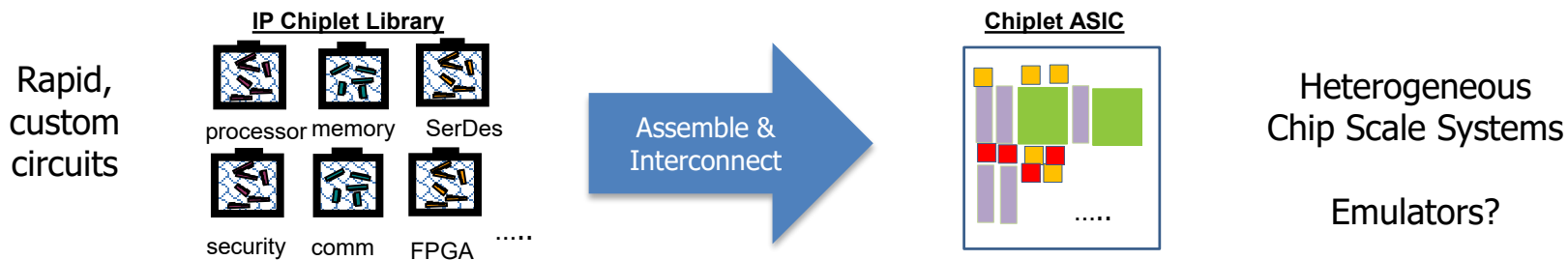


Printed LEDs
(inkjet interconnects)



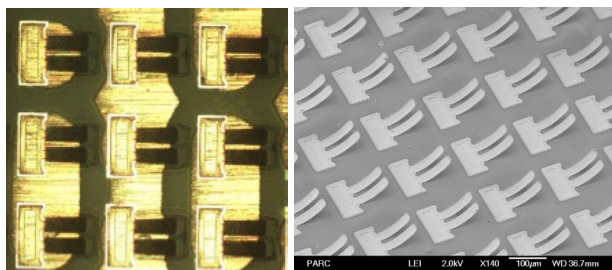
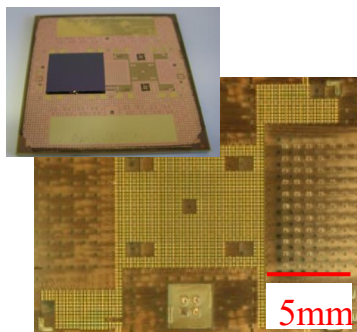
200um Si Chip
lithographic
40um metal lines

Applications. Large area & chip scale.

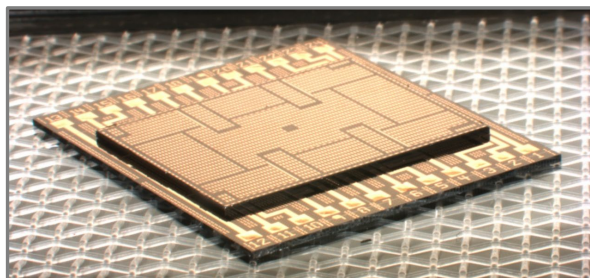


PARC Microsprings

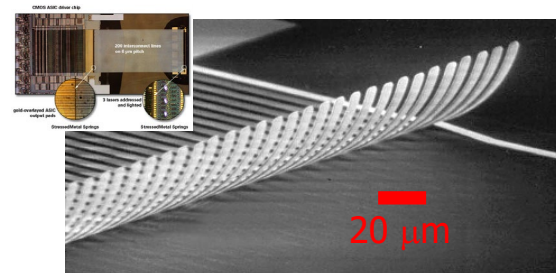
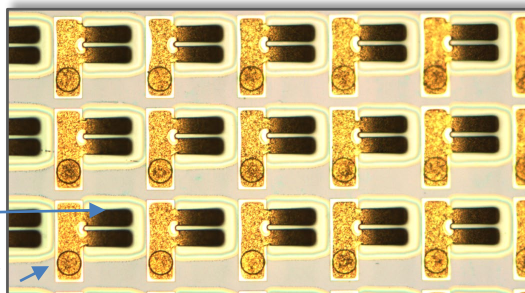
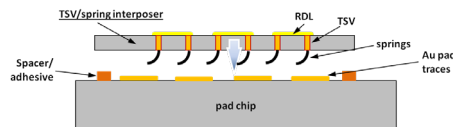
- Thin film lithographic defined pressure contact
- Reworkable flip chip interconnects
- Integrated test & package for lower cost known good module



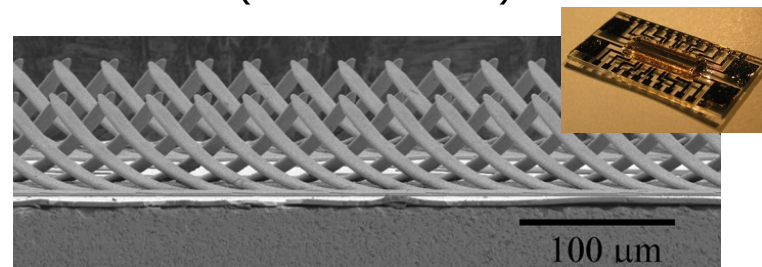
Organic substrate
(180x180µm pitch, >2500 contacts, processors with Sun Microsystems)



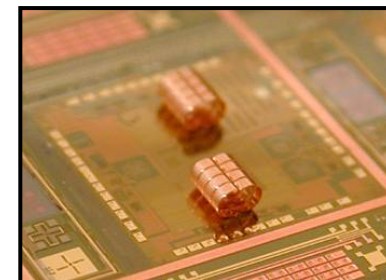
Silicon TSV (180x180µm pitch)



6µm pitch linear array
(LED VCSEL bar)



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



3D Coils on IC

MicroSprings Enable Rematability

At-speed test and rework of multi-chip module

Replace single die after module testing.

Use as test socket or in final module

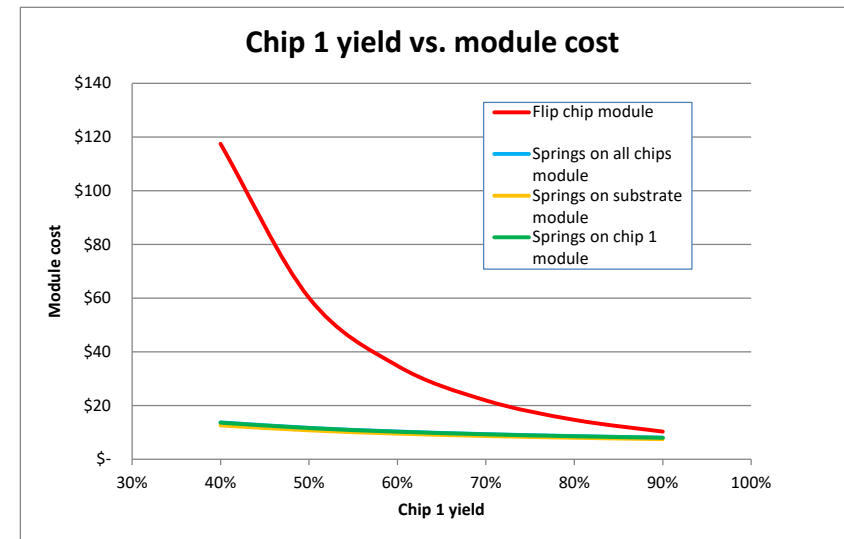
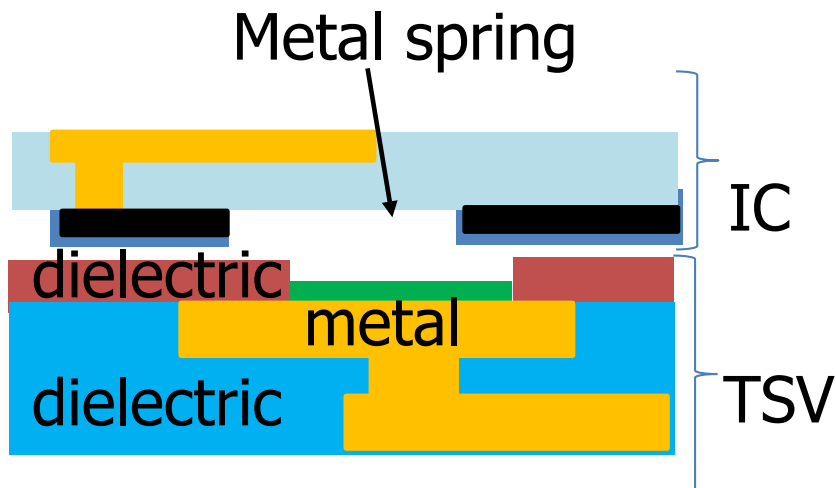
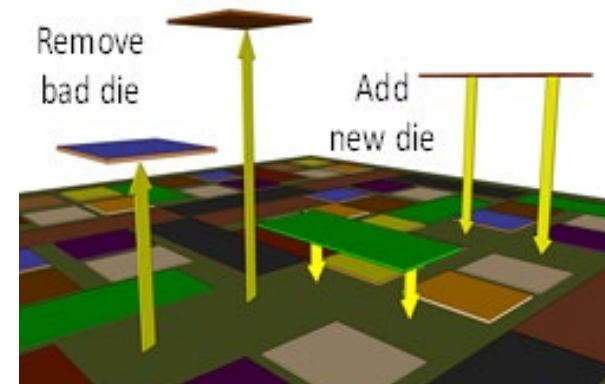
Lower cost known good module if

- High chip count
- Low yield die
- Expensive KGD

Can replace chip in the field

Security app – upgradable hardware

- High bandwidth chip socket



- Microassembly & transfer process for electronics integration. General. Heterogeneous. High throughput.
 - Close packing, small chiplets
- Microsprings – integrated test and rework
- Seek feedback, partners, application ideas.
- Acknowledgements
 - DARPA, NSF, DOE, PARC, Xerox
- Contact – Eugene.Chow@parc.com