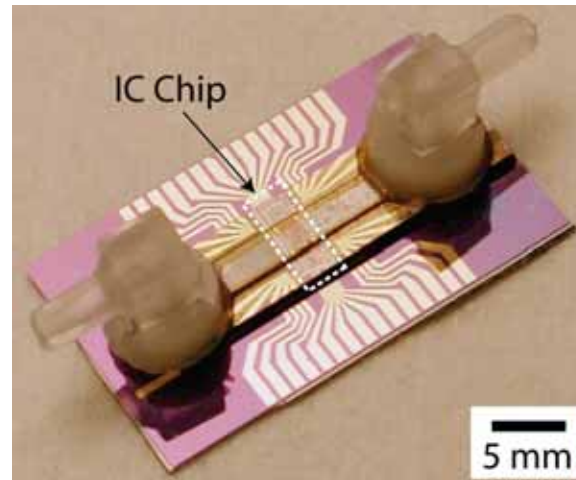


CMOS Biotechnology

Donhee Ham

Harvard University

CMOS Magnetic Manipulator for Biological Cells

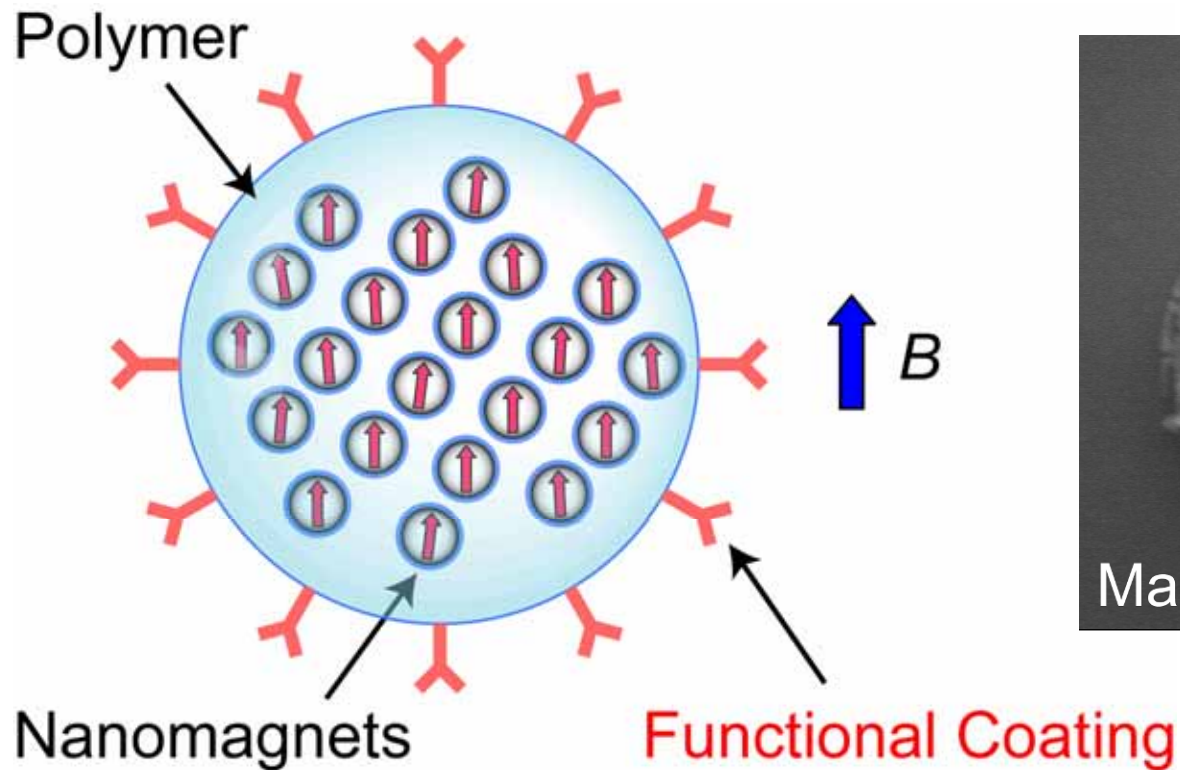


**Yong Liu, Hakho Lee
Robert M. Westervelt, & Donhee Ham**

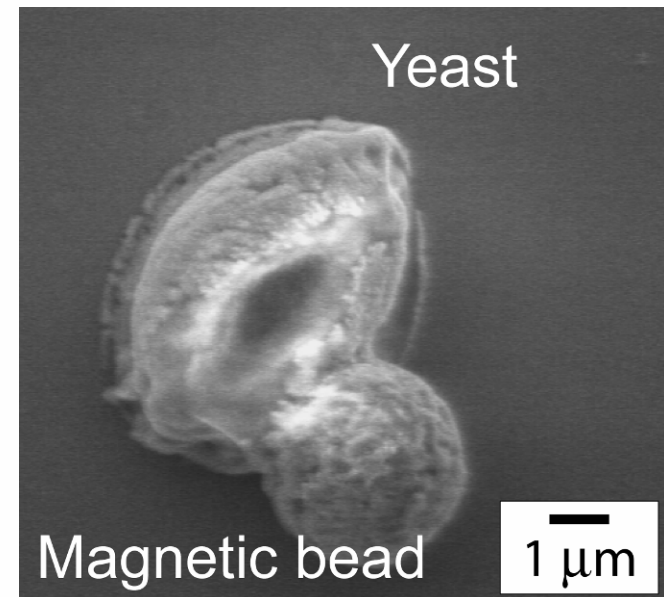
- Original articles: *IEEE ISSCC 2005, IEEE JSSC 2006, Lab-on-a-Chip 2007*
- Invited articles: *IEEE BCTM 2005, A-SSCC 2006, IEEE SSCS Newsletter 2007*
- Book: *CMOS Biotechnology, Springer 2007*

CMOS Bio Interface via Magnetics

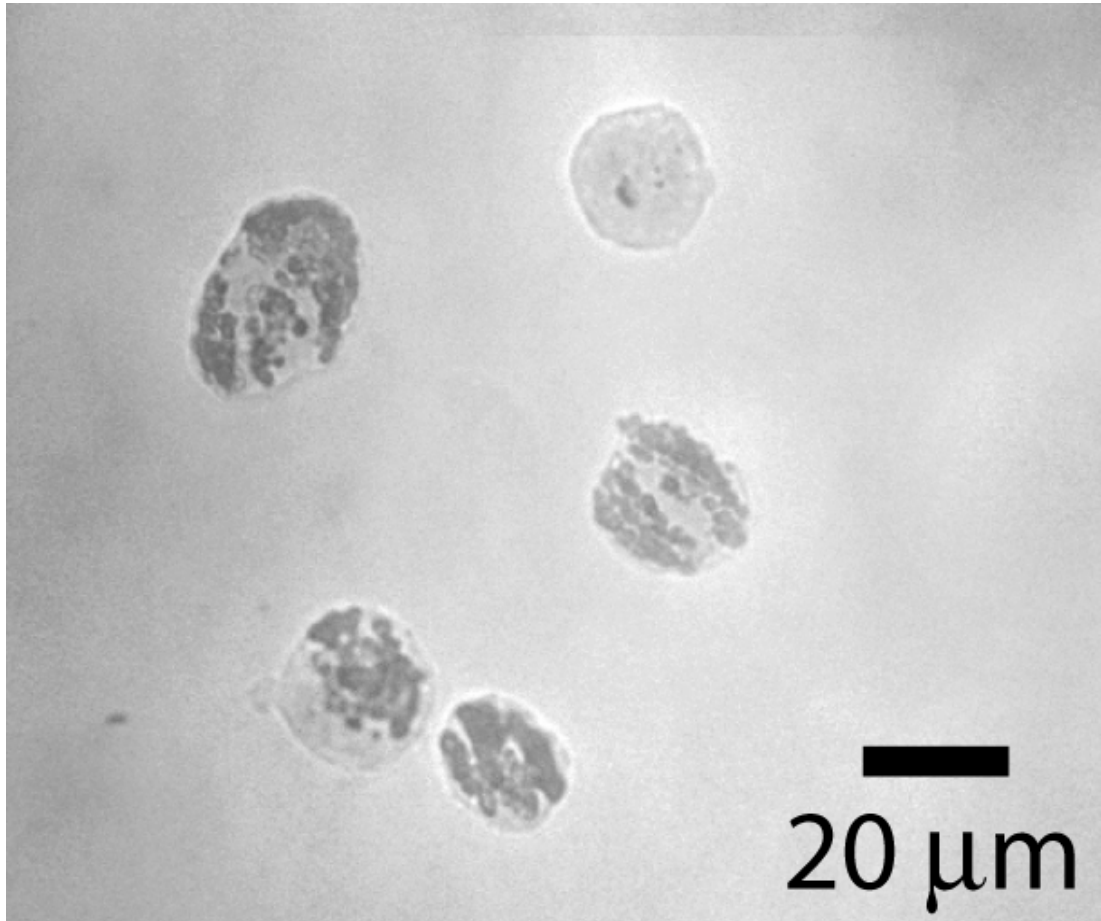
Magnetic bead



Bead-bound cell

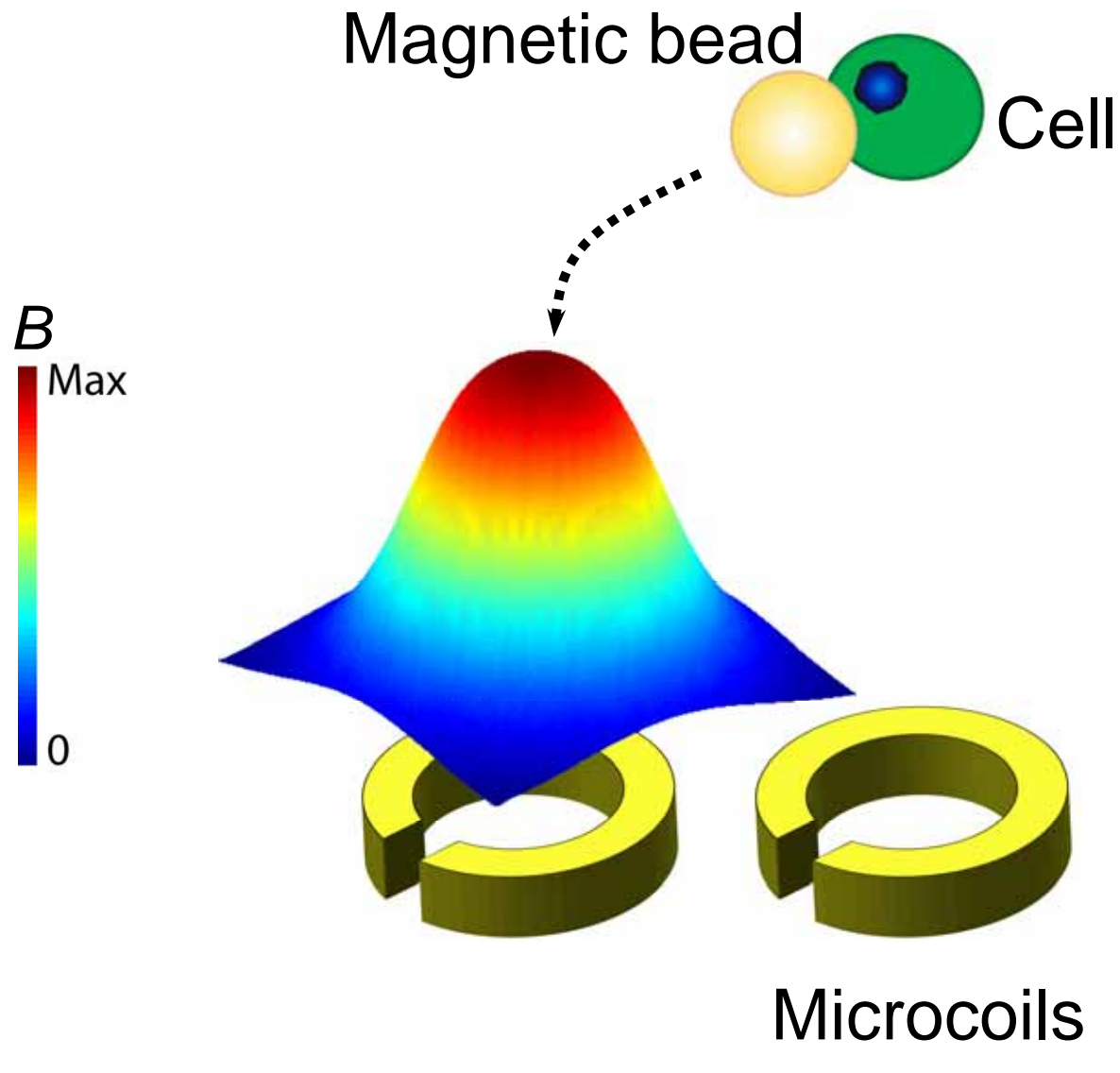


CMOS Bio Interface via Magnetics

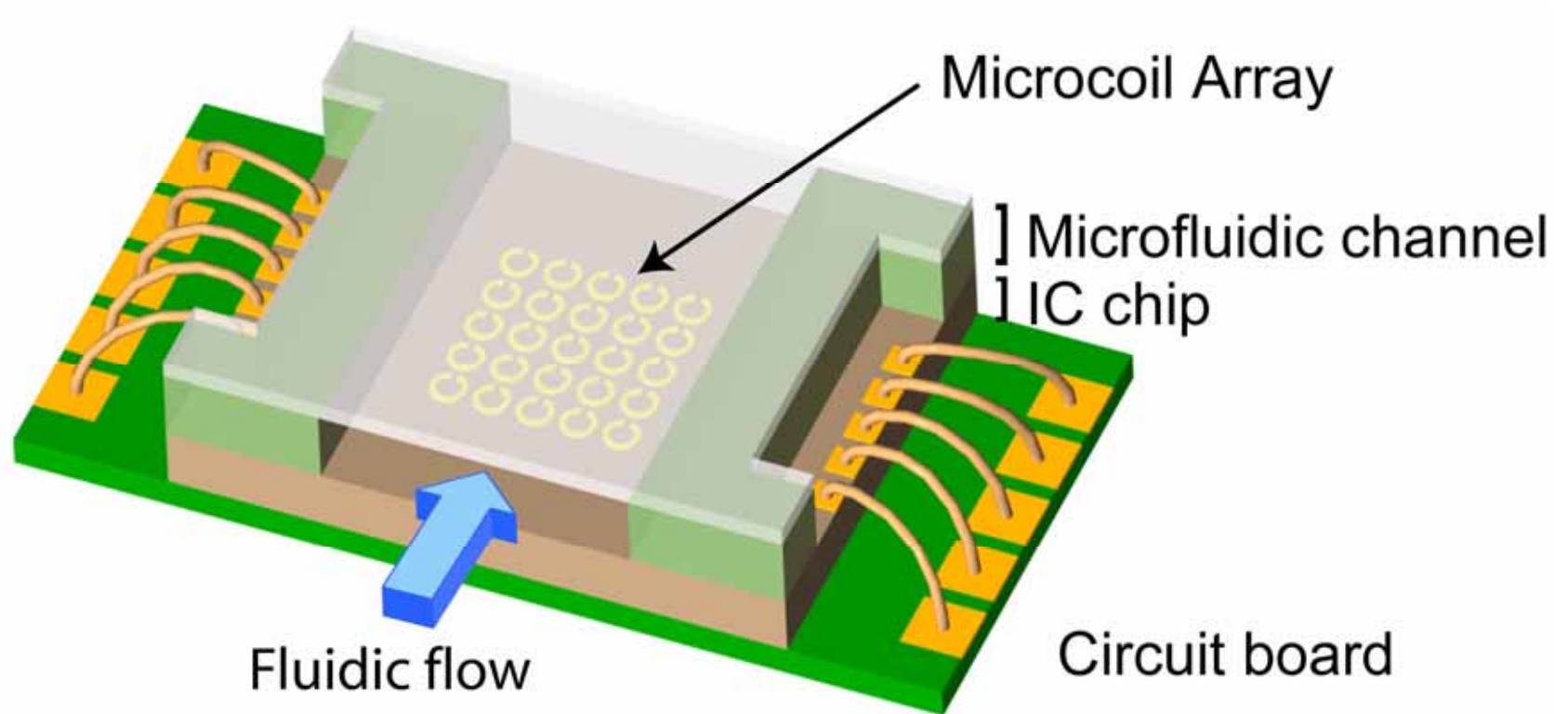


Bovine capillary endothelial cells with engulfed magnetic beads.

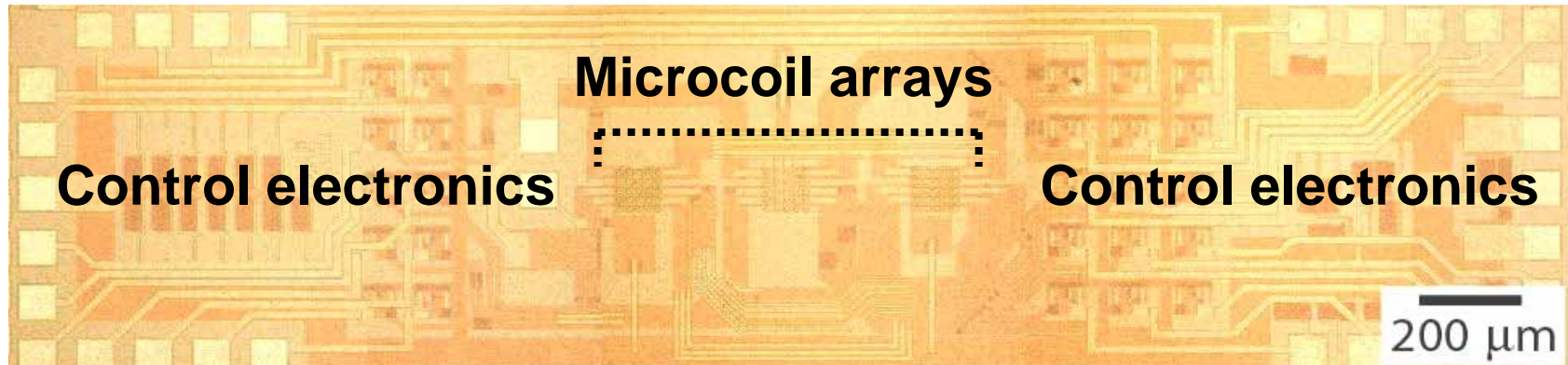
Magnetic Manipulation



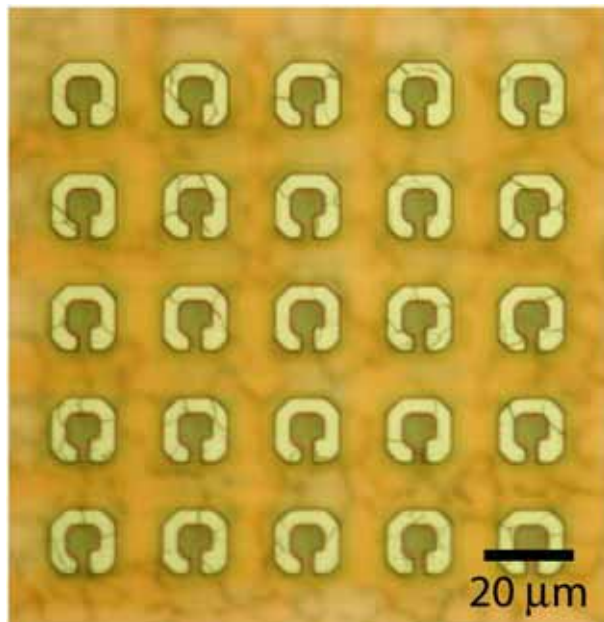
CMOS + Microfluidics



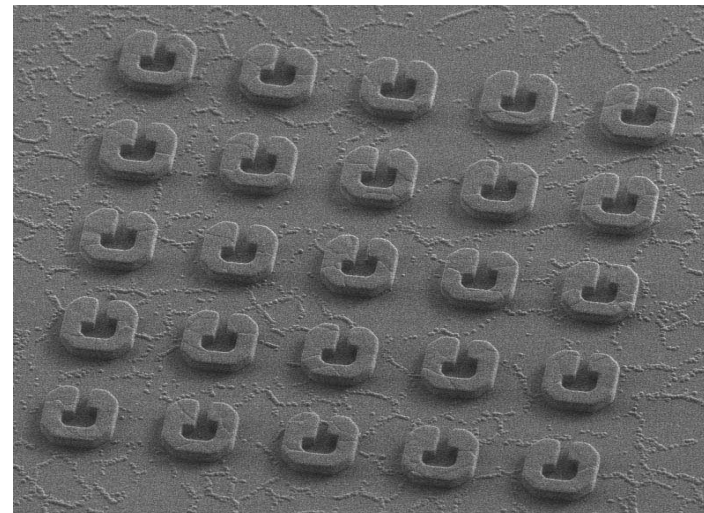
1st Prototype --- SiGe IC



Chip size 1 mm × 4 mm



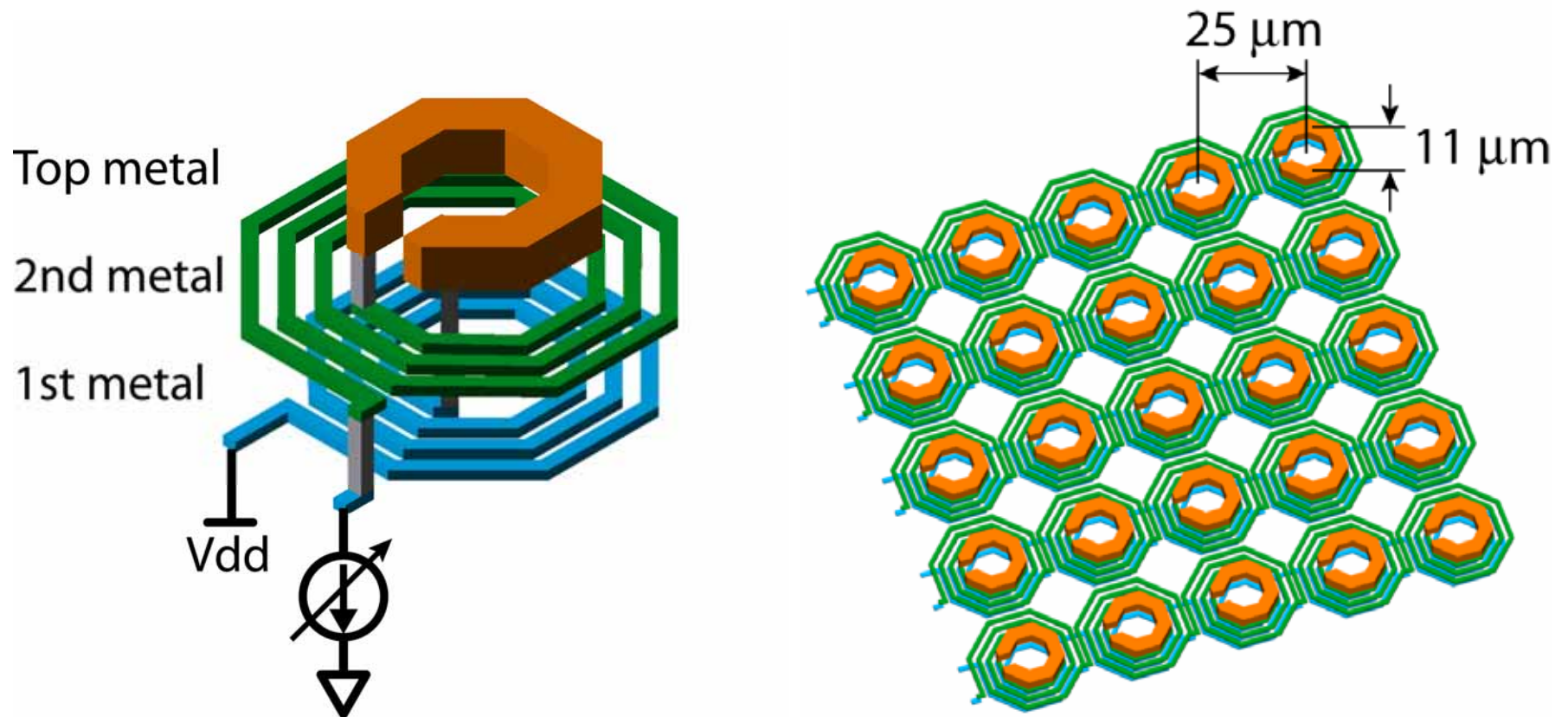
Microcoil array

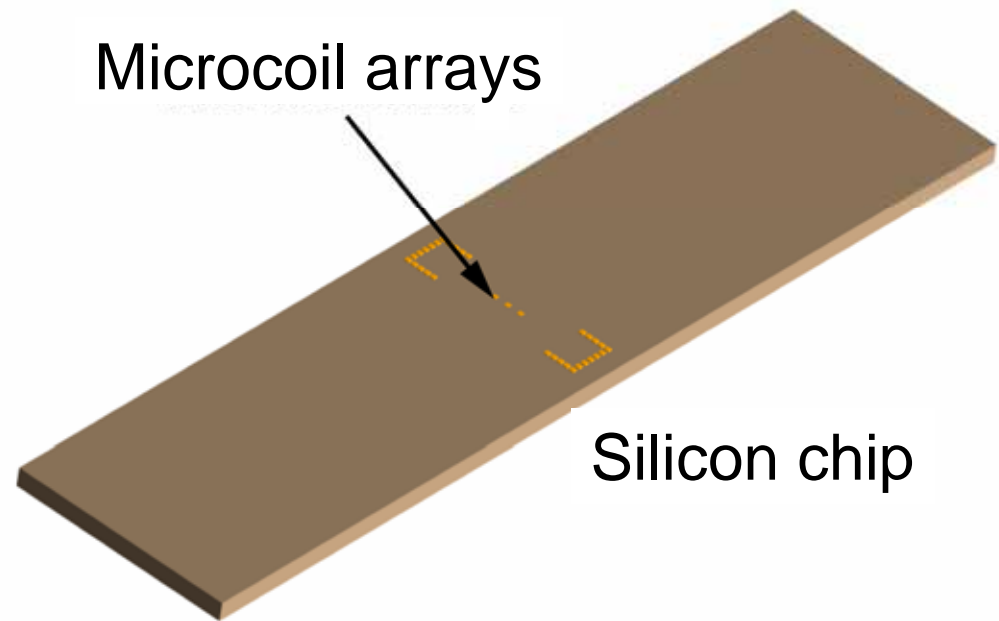


Array surface (SEM)

IEEE ISSCC 2005

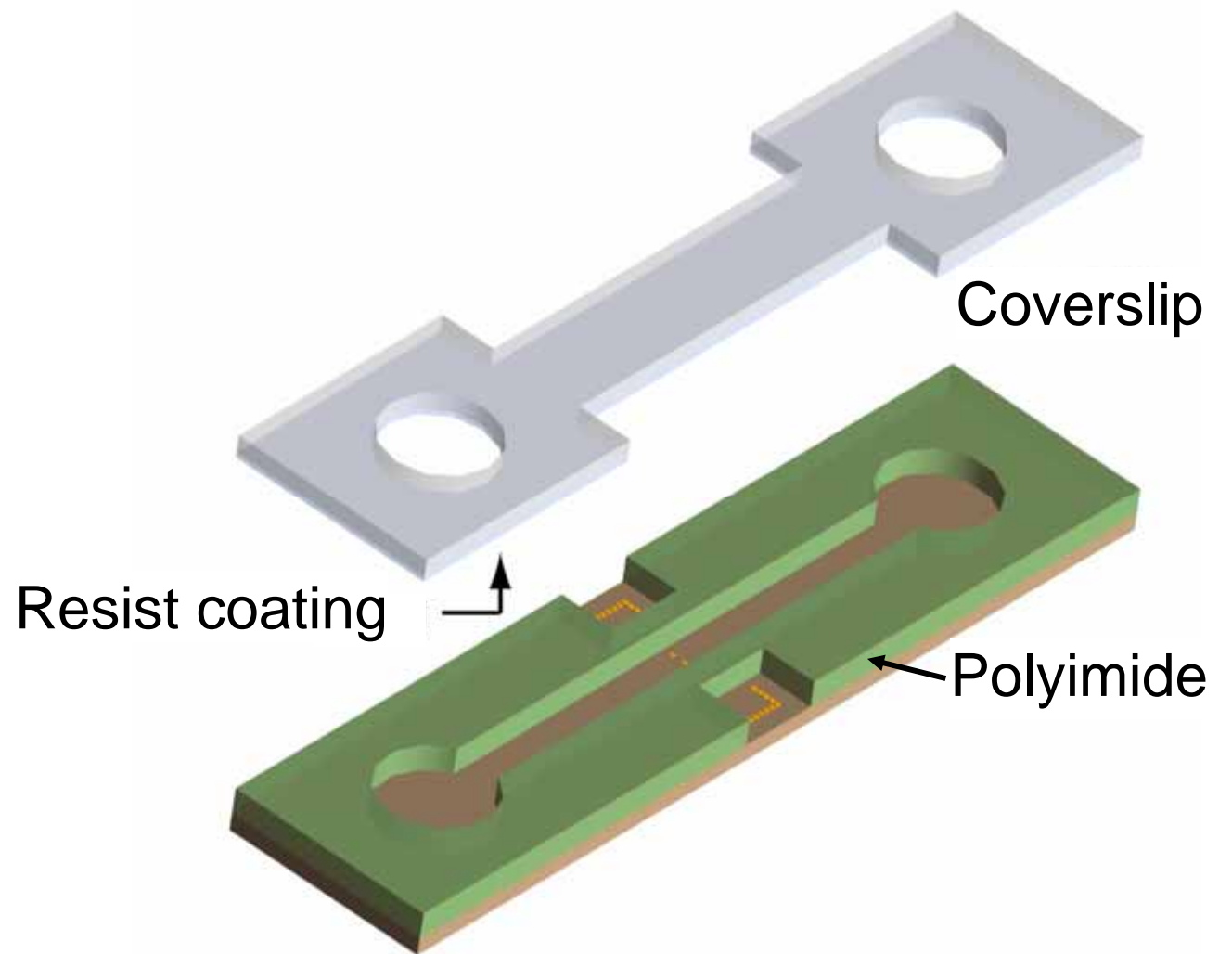
1st Prototype --- Microcoil Array



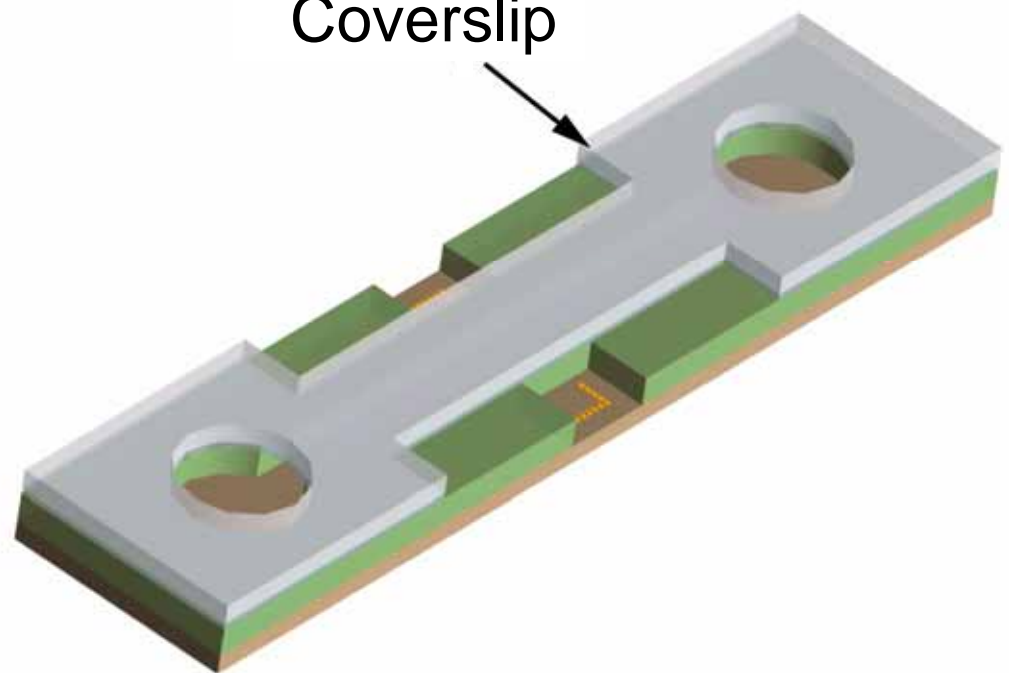


Microcoil arrays

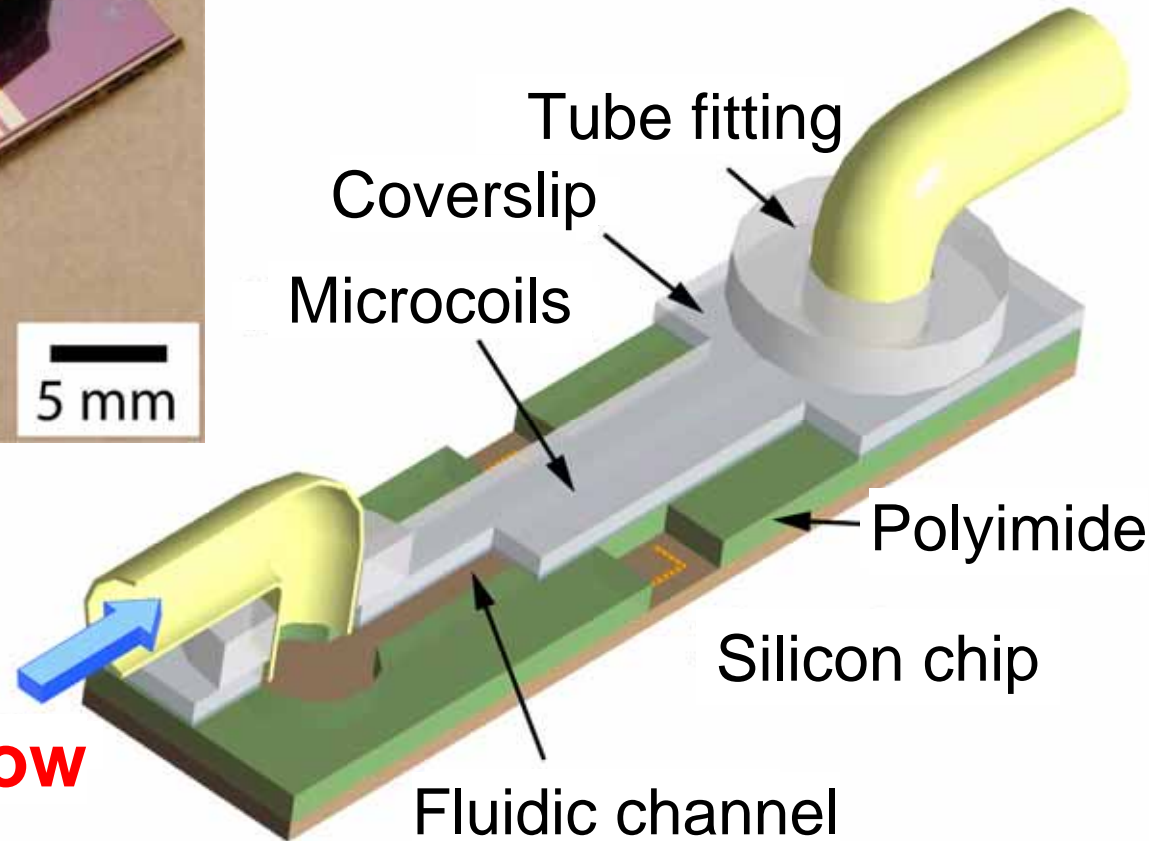
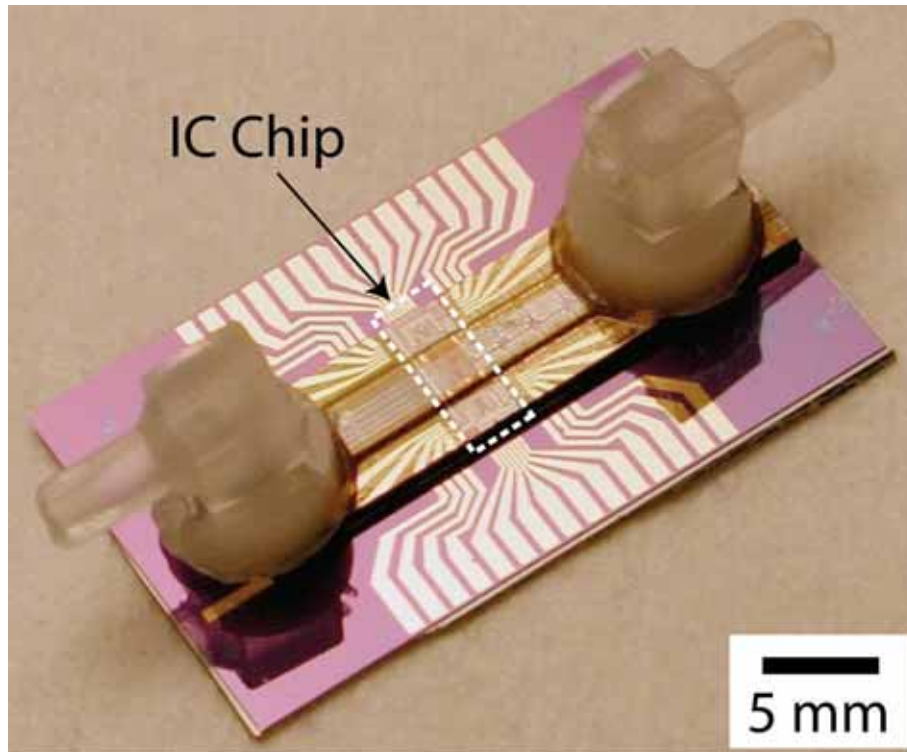
Silicon chip



Coverslip

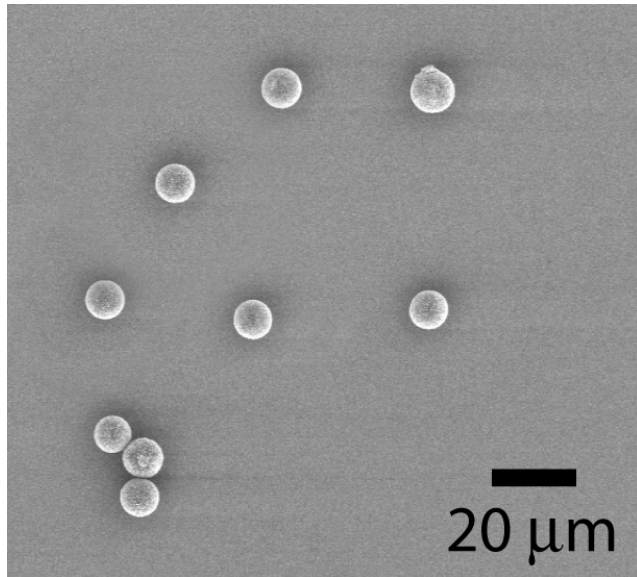


1st (SiGe / μ fluidic) Hybrid Prototype

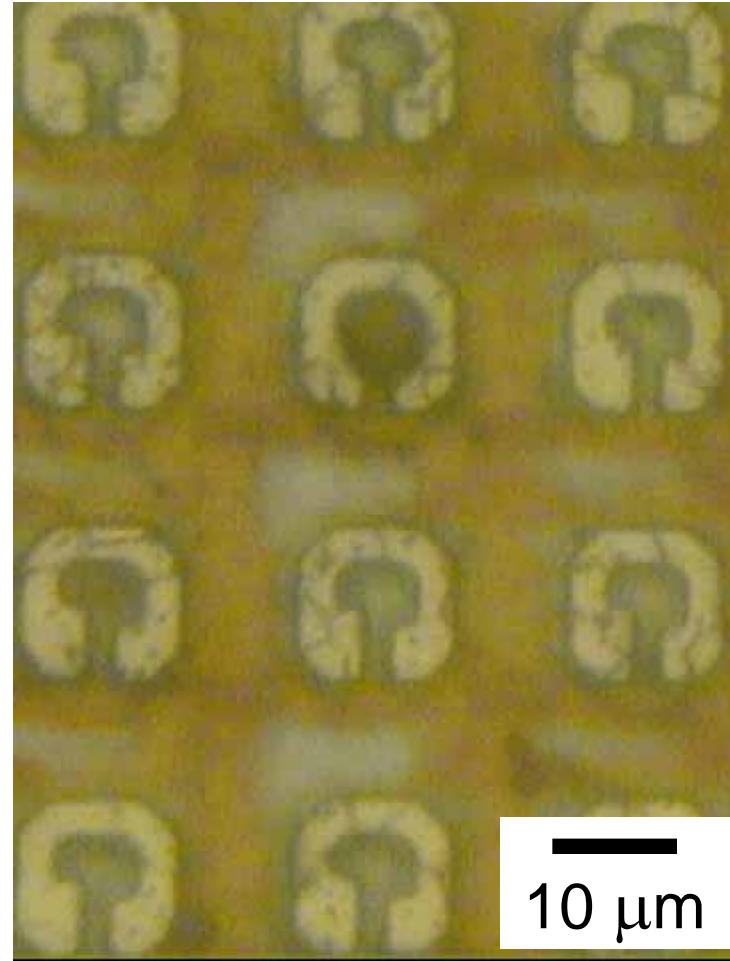


Fluidic flow

Magnetic Bead Manipulation

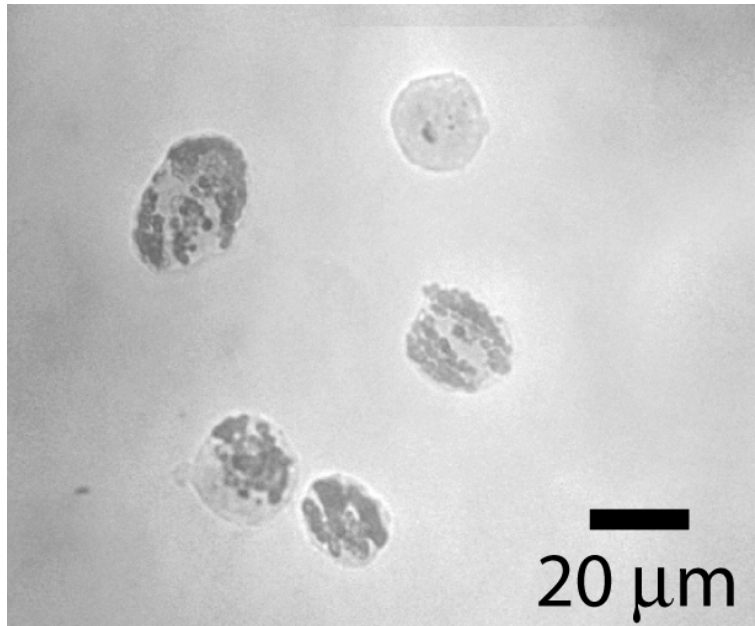


Magnetic beads

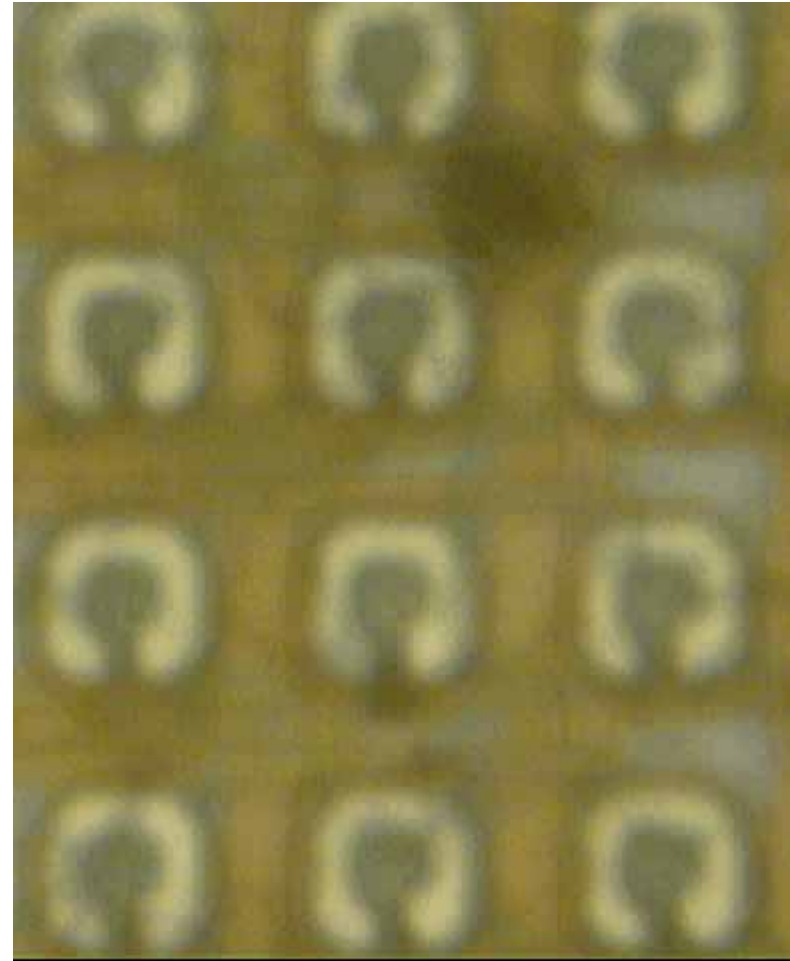


Movie 1

Biological Cell Manipulation

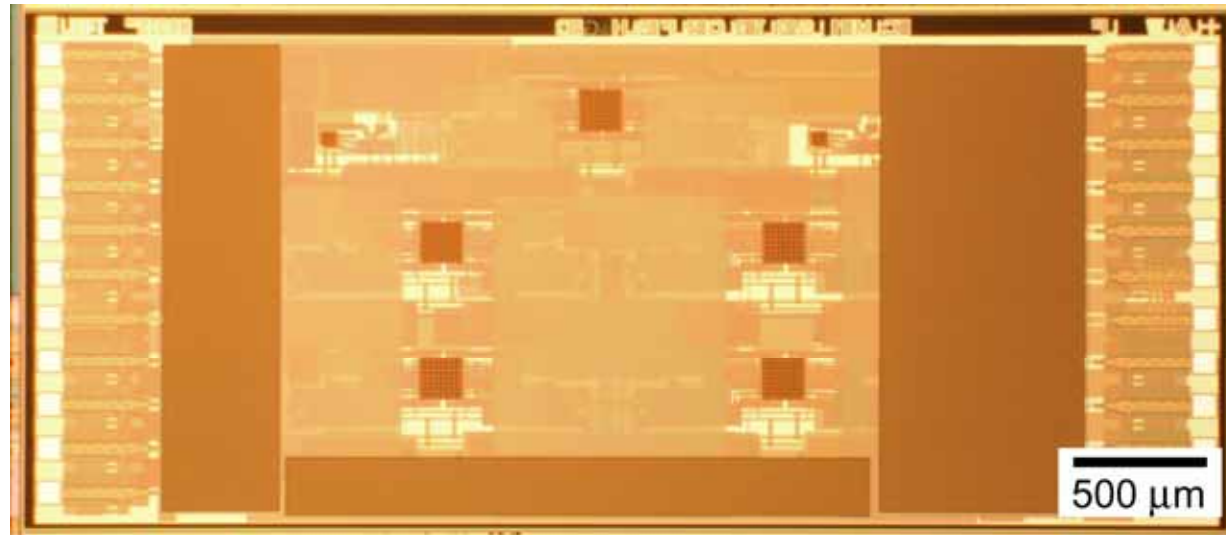


Bovine capillary endothelial cells with engulfed beads.



Movie 2

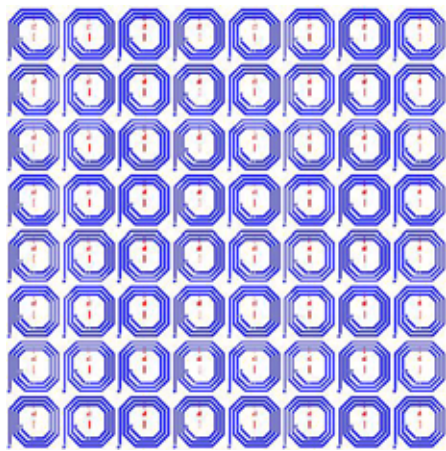
2nd Prototype --- CMOS IC



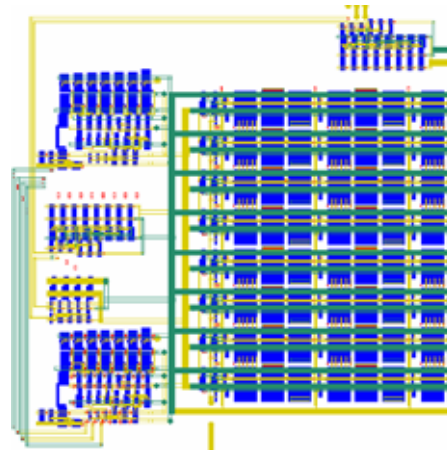
JSSC 2006

TSMC
0.18 μm

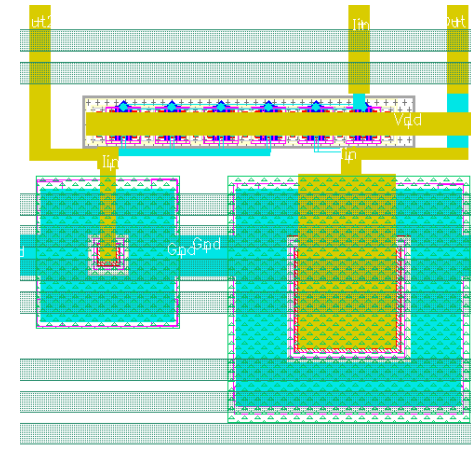
2 mm × 5 mm



Large array of coils

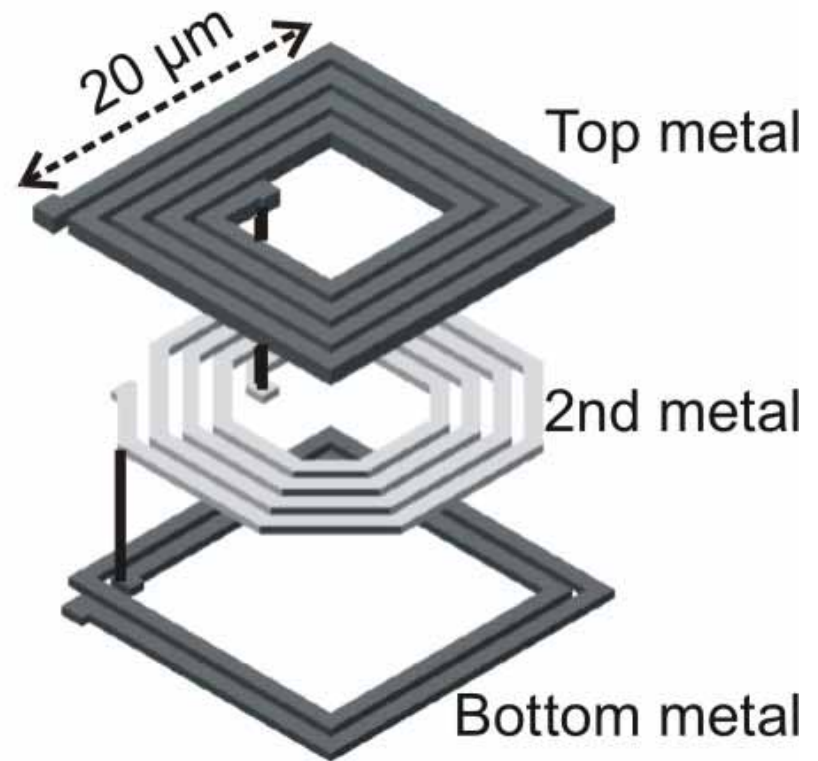
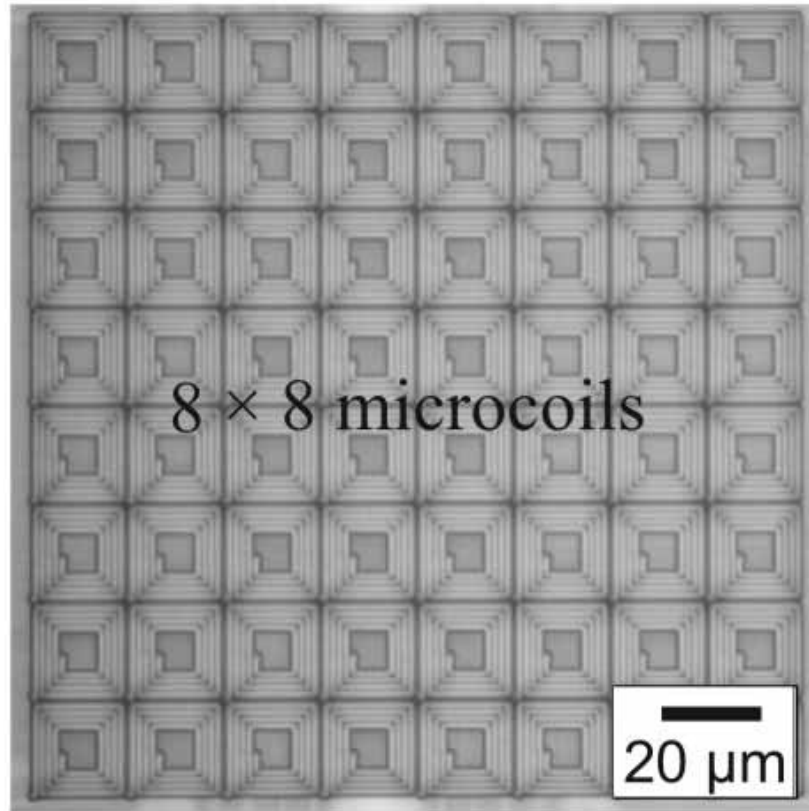


Logic/timing circuits

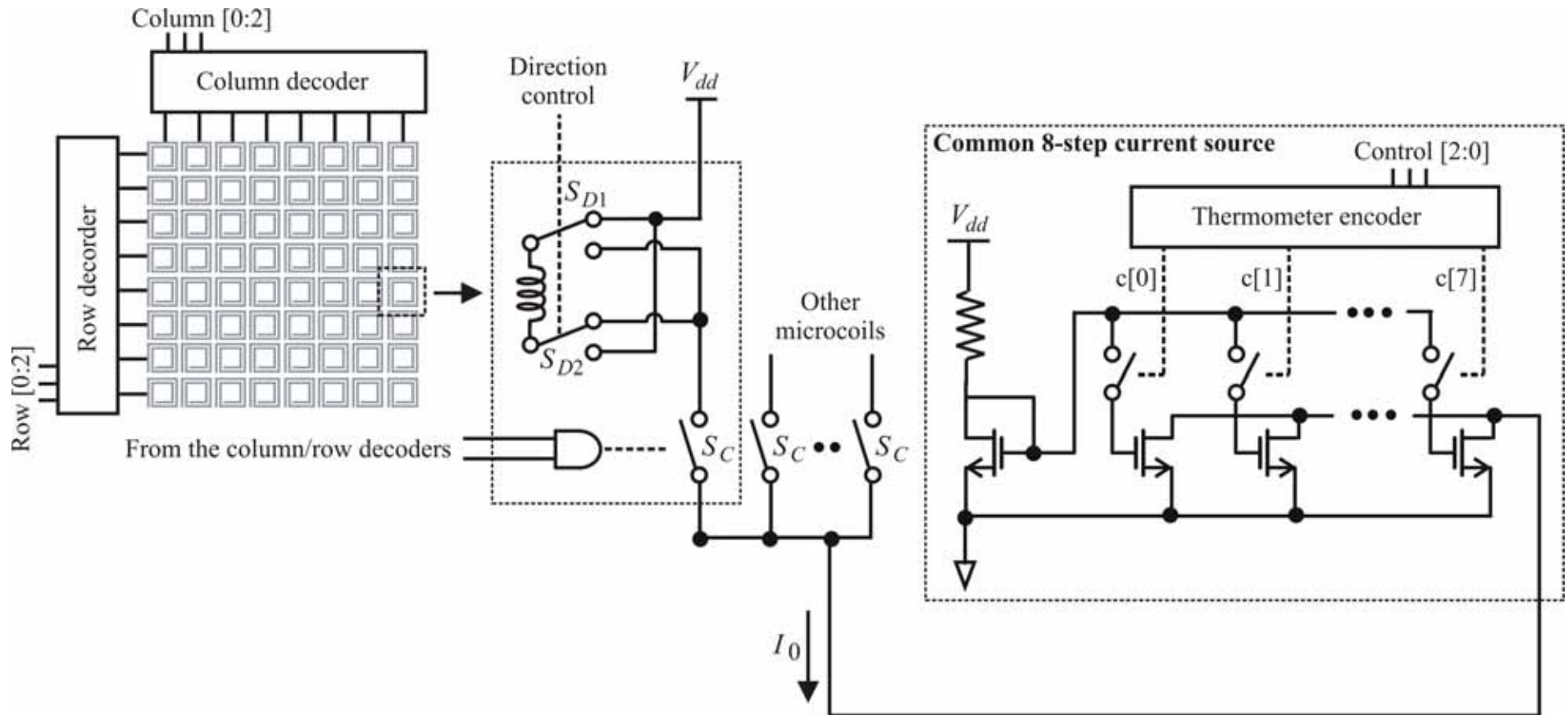


Temperature sensors

2nd Prototype --- Microcoil Array

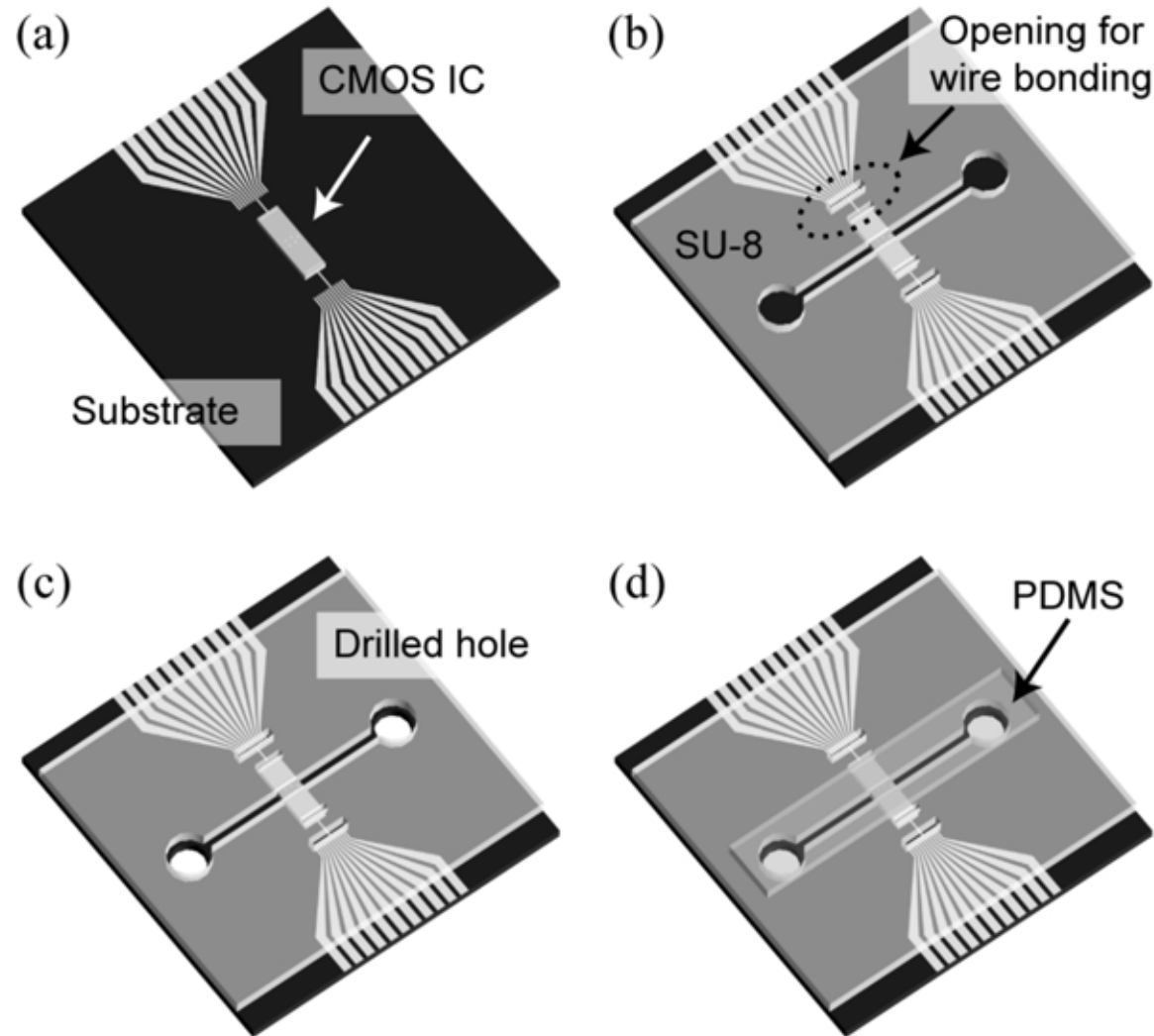


Overall Architecture

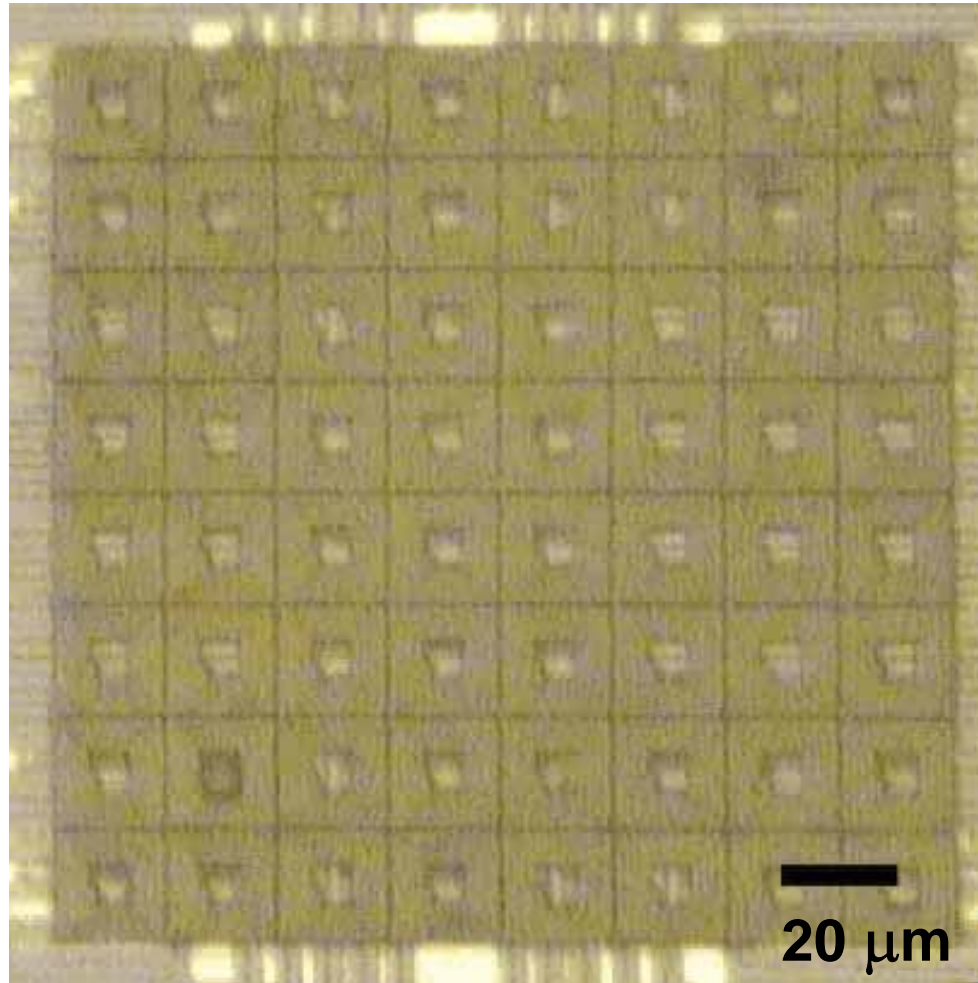


2nd Prototype

- μ fluidic Channel Fabrication -

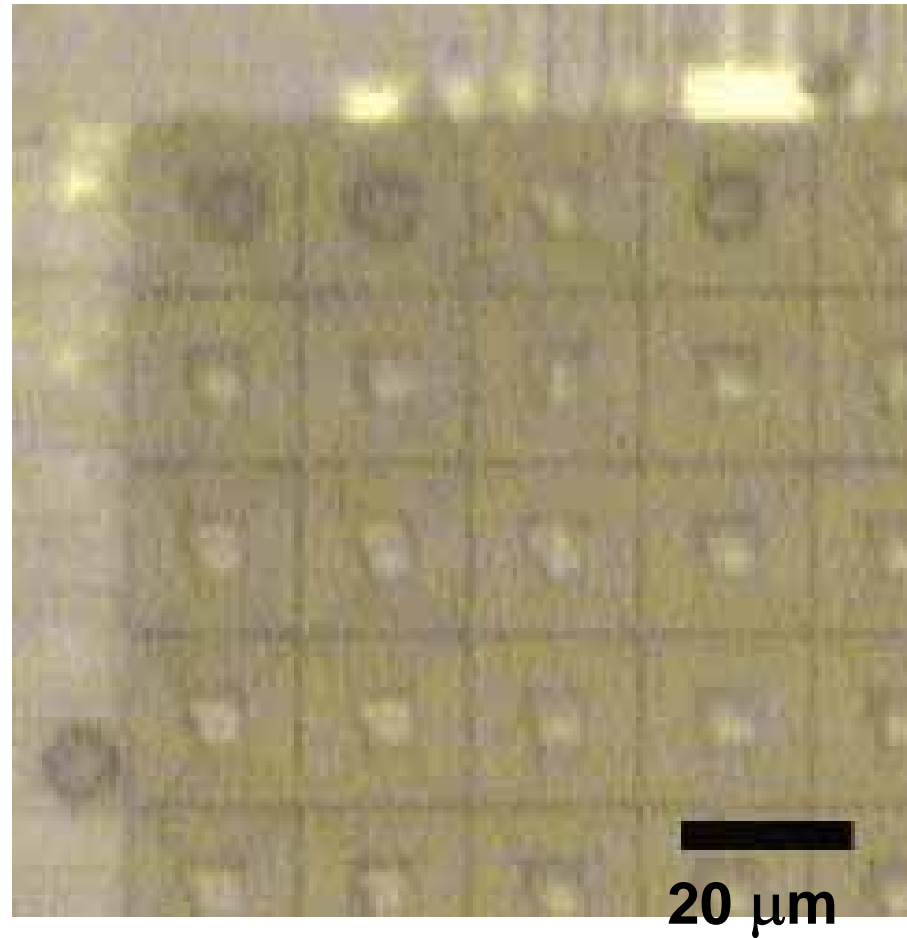


Single Bead Manipulation



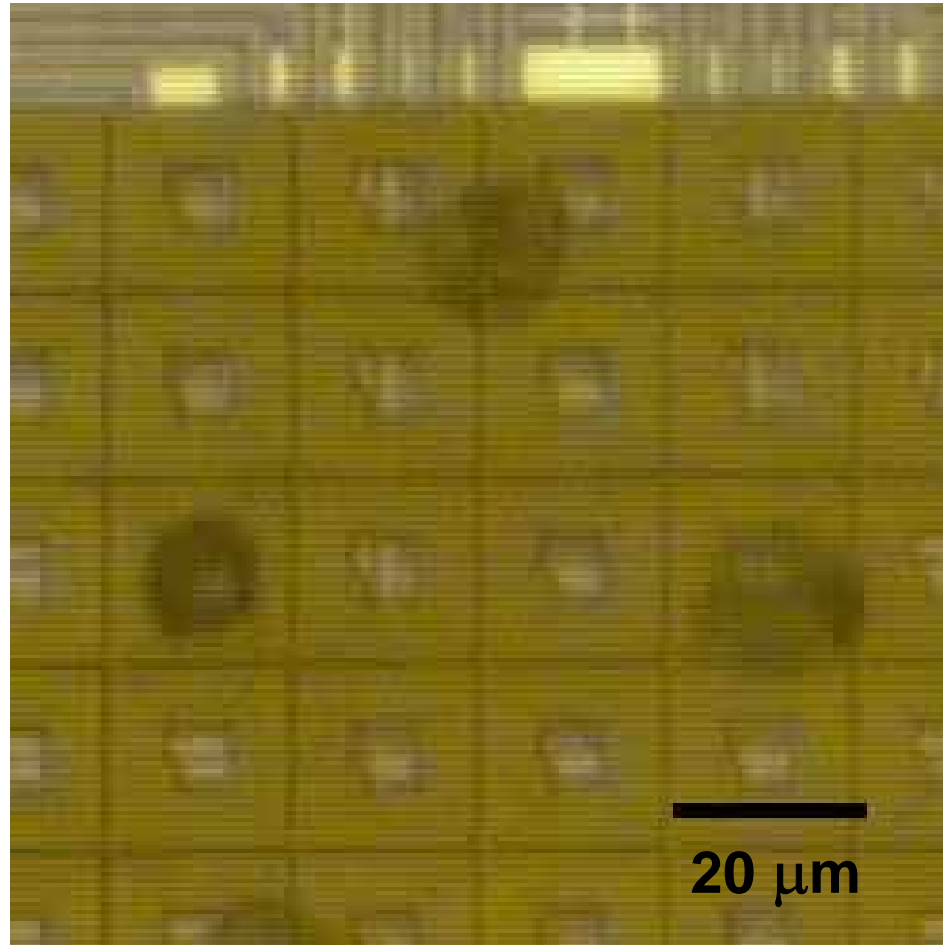
Movie 3

Manipulation of Multiple Beads



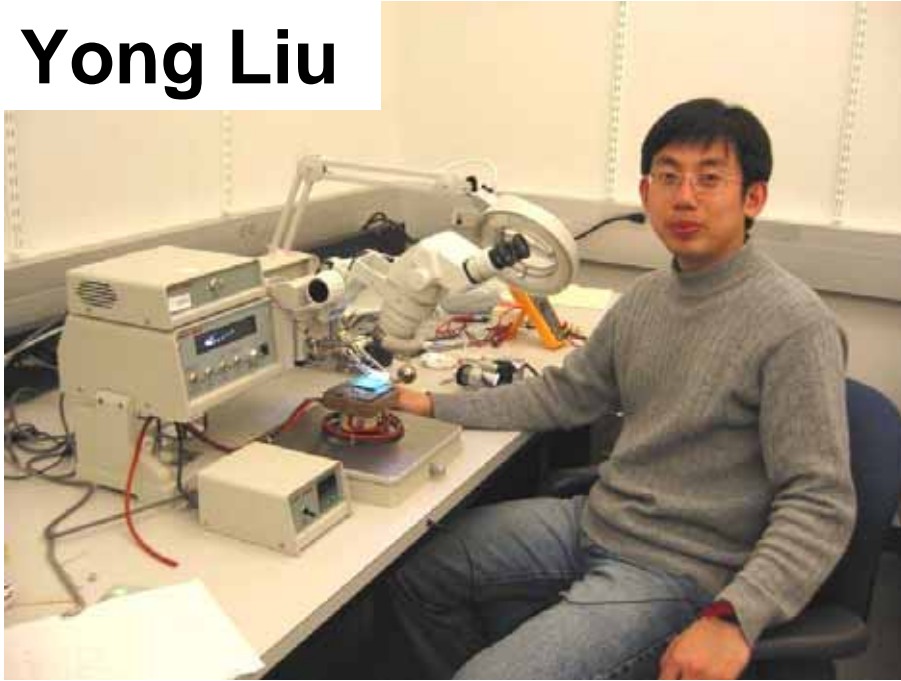
Movie 4

Manipulation of Multiple Cells

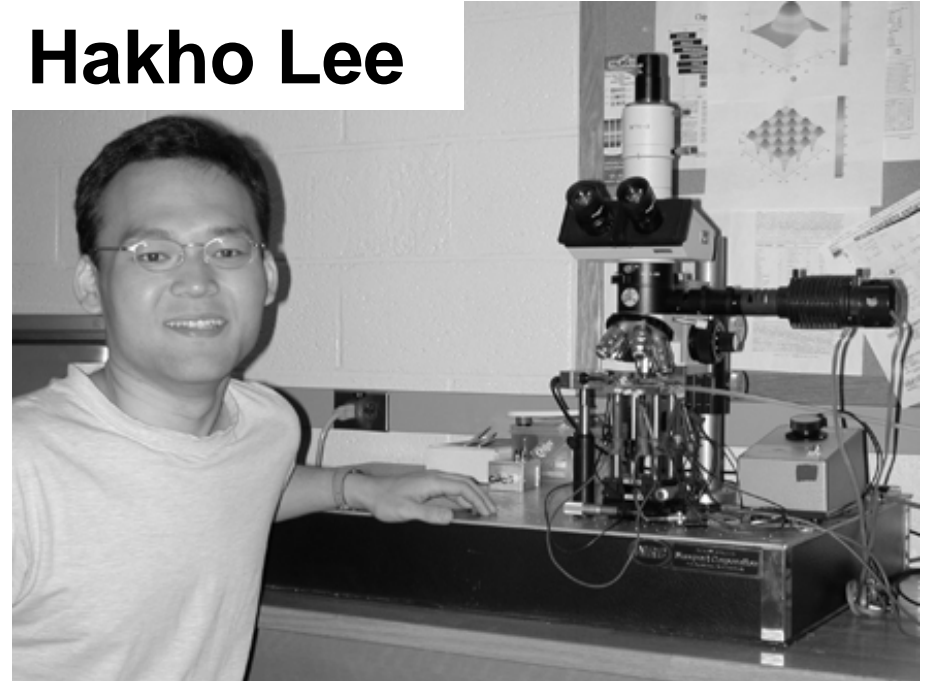


Movie 5

Yong Liu



Hakho Lee



**Robert M.
Westervelt**



Donhee Ham

Thank you