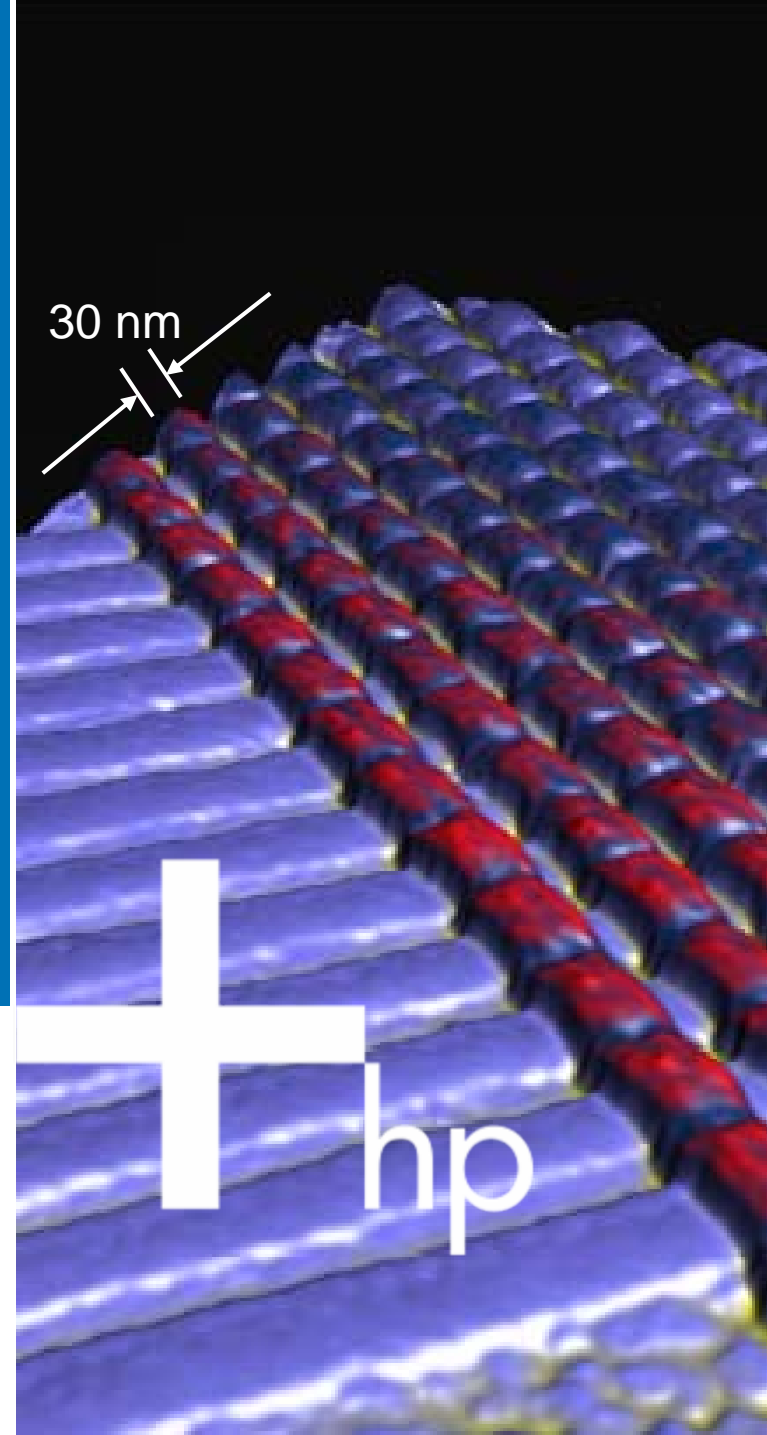




SiNW for chem/biosensing

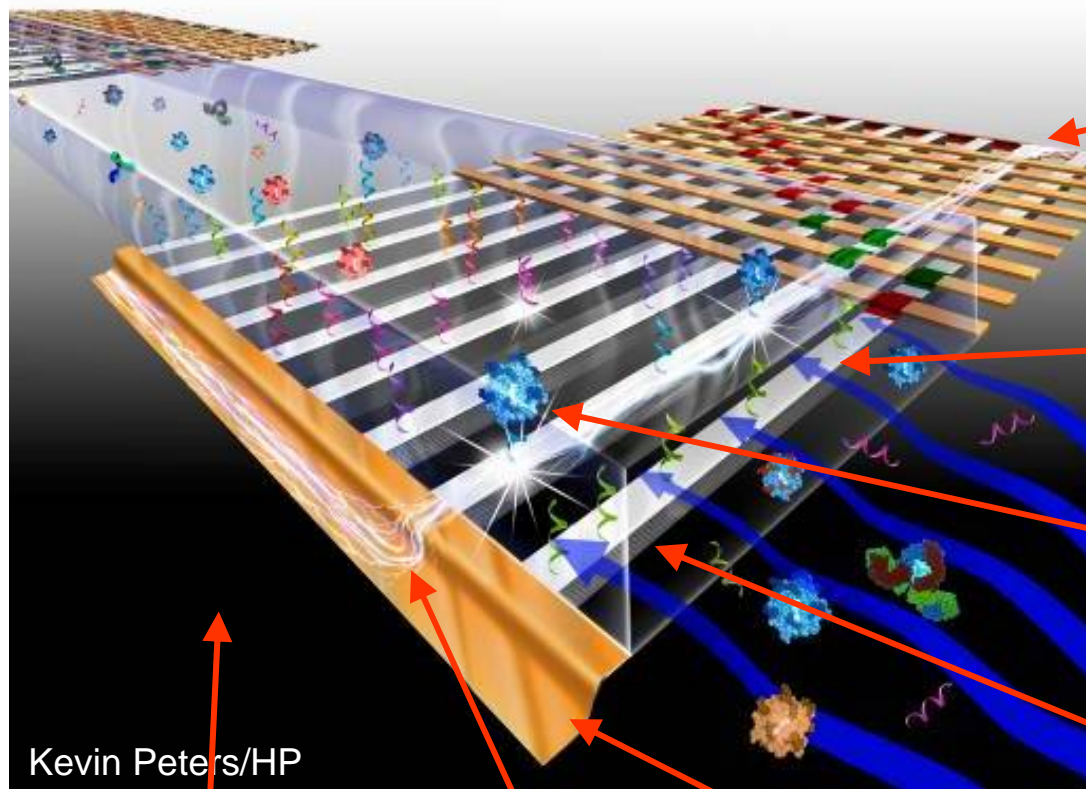
Zhiyong Li
HP Lab
Palo Alto, CA



Outline

- Si NW sensor concept and technical challenges
- Si NW sensor in micro-needle format for intracellular sensing
- Local heating for selective functionalization
- Circuitry at nanoscale

Si NW sensor concept/challenges



Circuitry at nanoscale

Selective surface functionalization

Specificity and sensitivity

Bio-compatibility

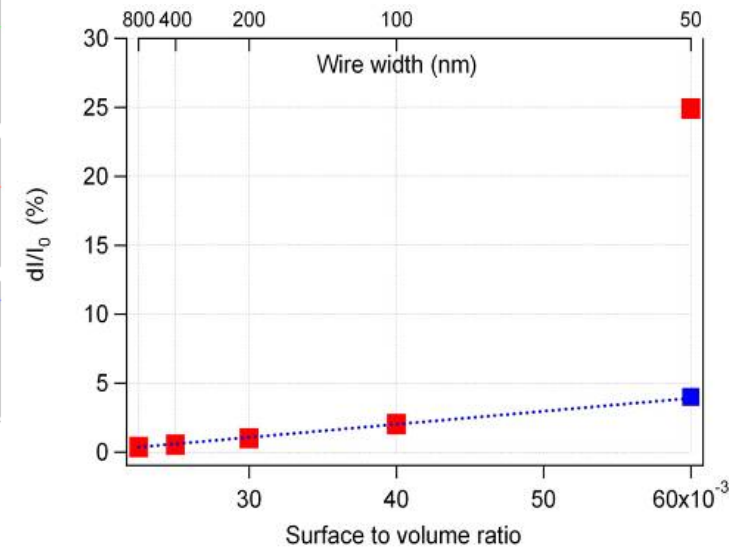
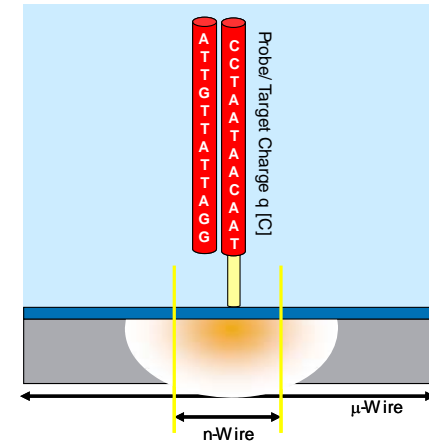
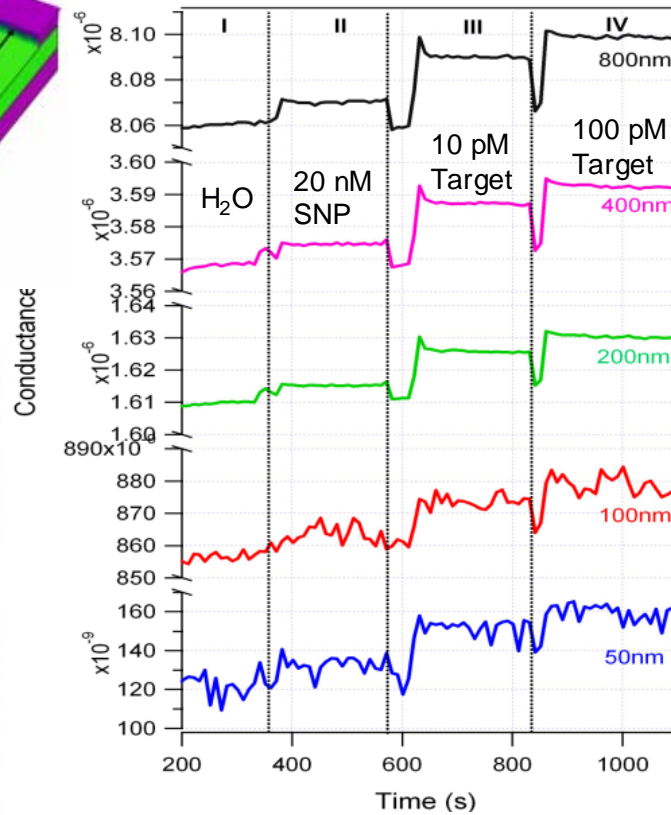
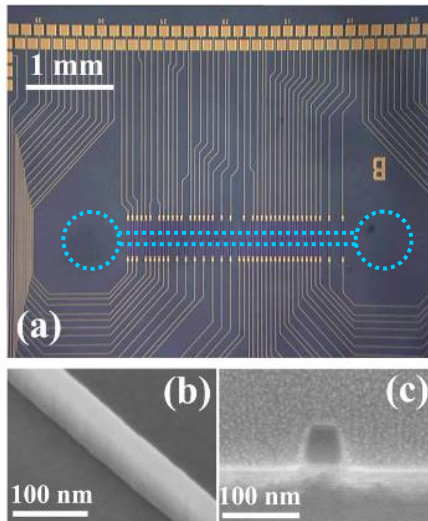
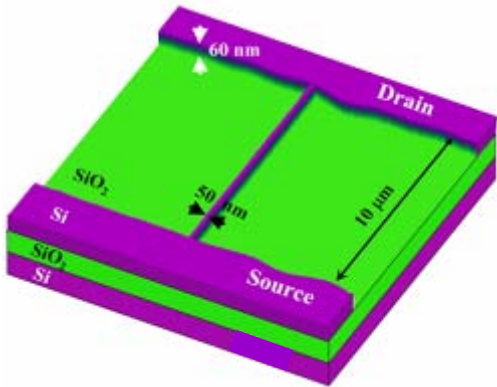
Kevin Peters/HP

I/O interfacing

Power

Stability & reliability

SiNW DNA sensor

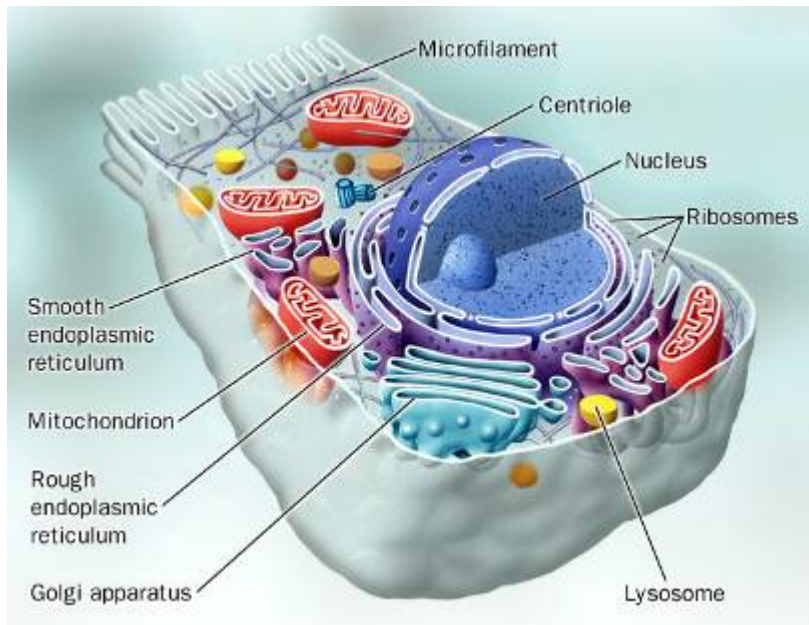


Z. Li, et al, *Nanoletter*, **2004**, 4, 245
 Z. Li, et al., *Appl. Phys. A* **2005**, 80, 1257-63.

Intra & Extra- Cellular Protein Detection

Intracellular Protein Trafficking

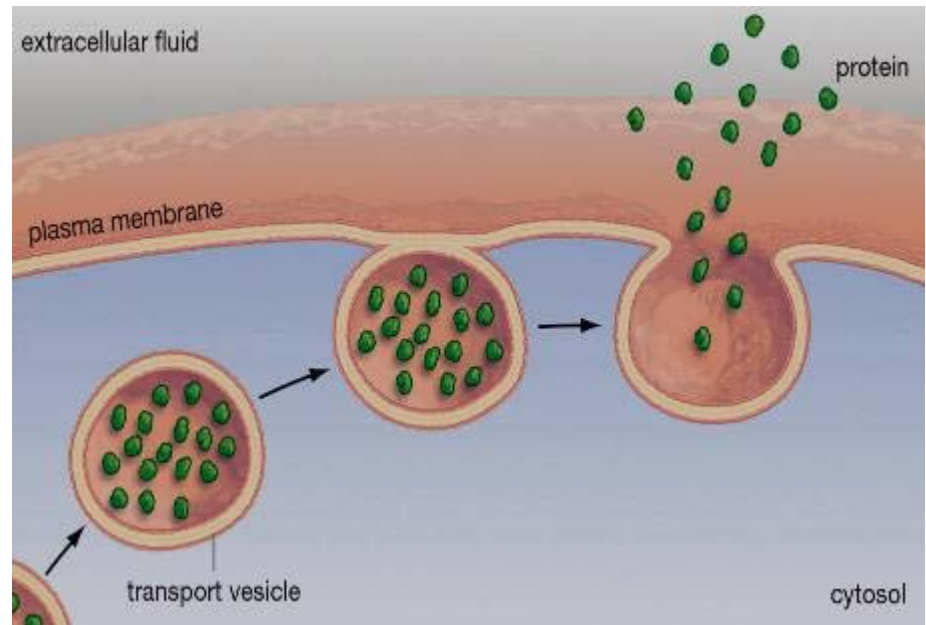
Distribution of synthesized proteins to useful locations



Courtesy of Exccentrix

Extracellular Protein Secretion

Secretion of hormones or neurotransmitters to cell exterior

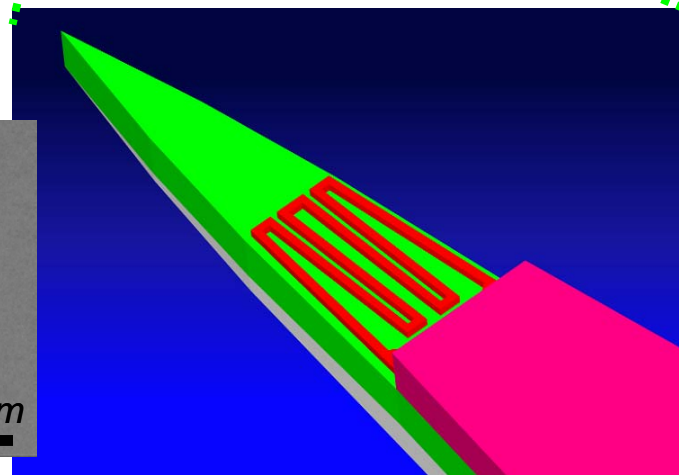
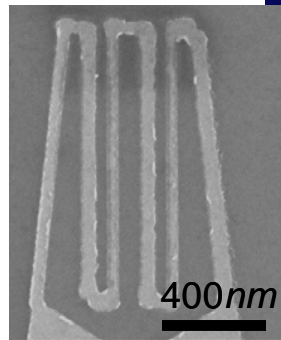
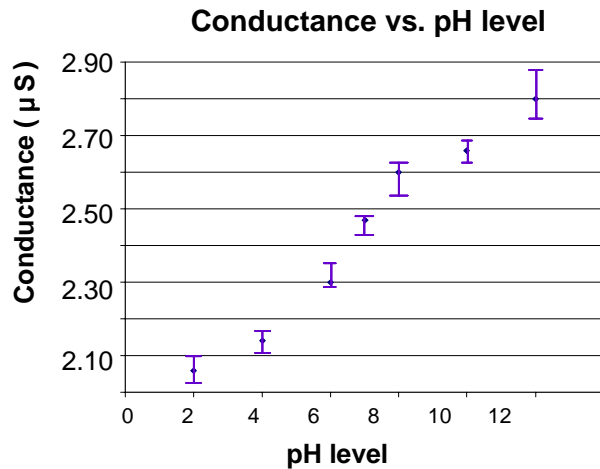
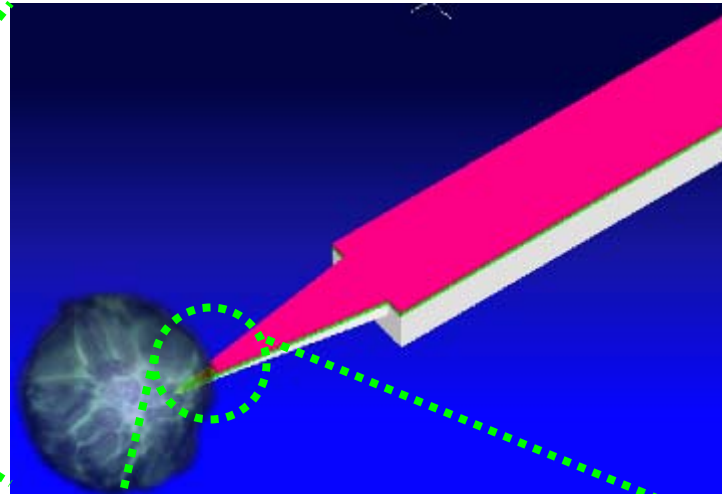
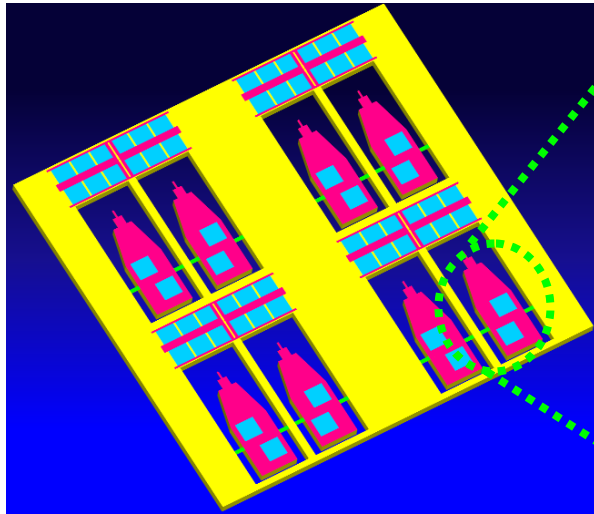


Courtesy of CSUS

Detection of **localized protein activities** is vital for

- Molecular / cell biology (ex. protein trafficking, extracellular protein secretion)
- Drug discovery (ex. drug influence on the protein synthesis and metabolism)
- Biomedical science (ex. abnormal protein secretion from neurodegenerative cells)

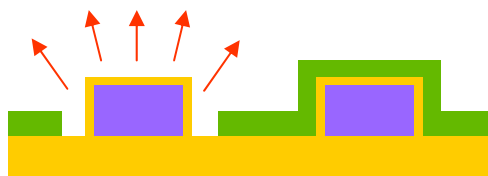
Microneedle sensor integrated with *silicon nanowire* for *single-cell / in-vitro / localized* detection of biochemical activities



Selective functionalization based on localized Joule-heating



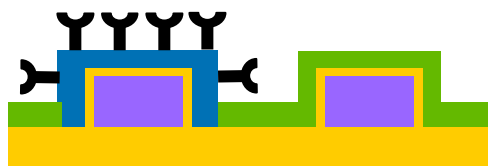
1. Uniform coating of hydrophobic protection layer



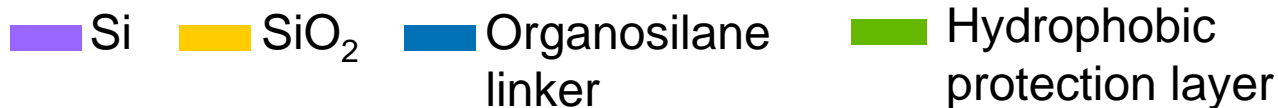
2. Joule heating of silicon micro/nanowire for localized ablation



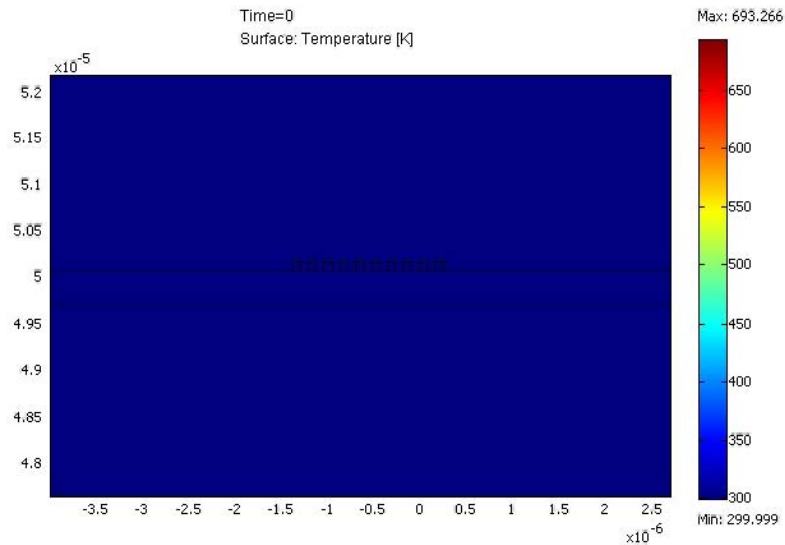
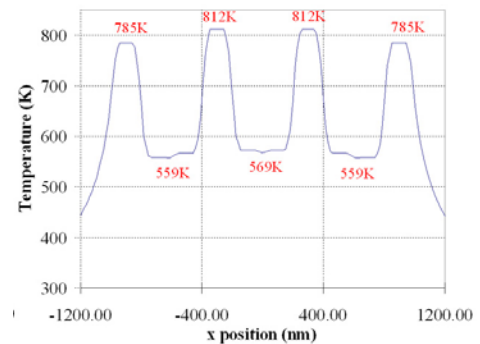
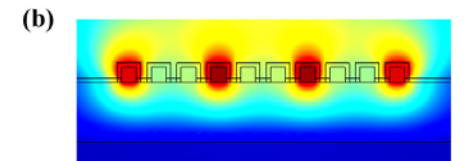
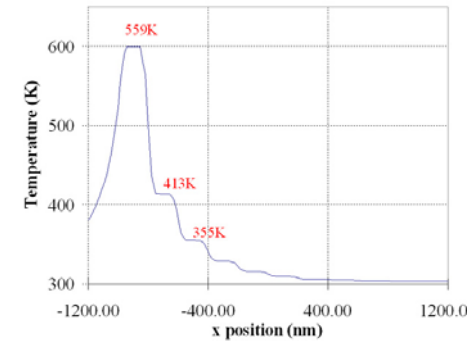
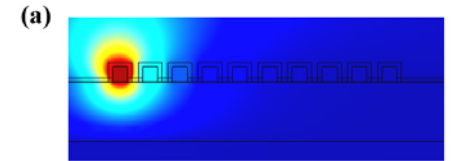
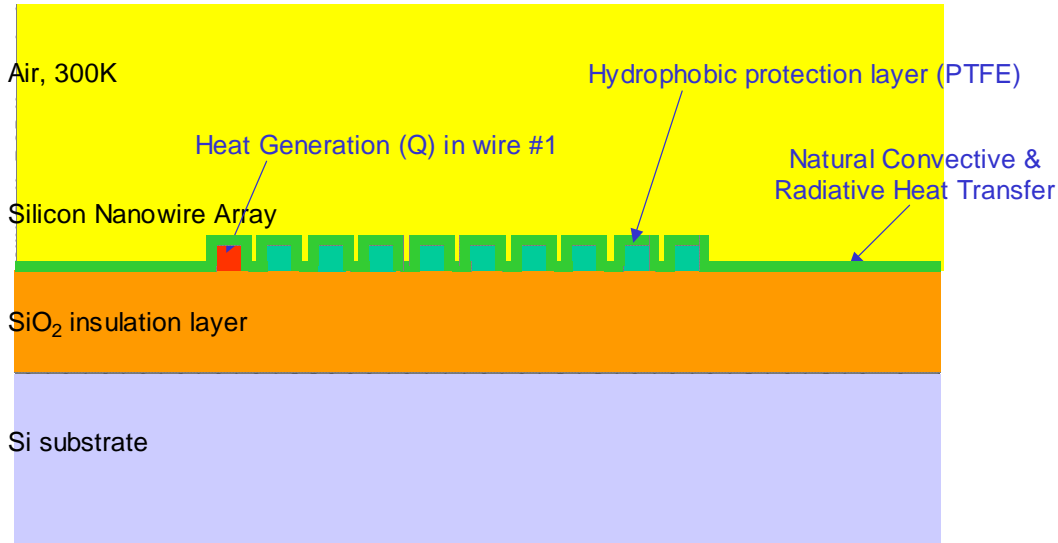
3. Surface modification with organosilane linker



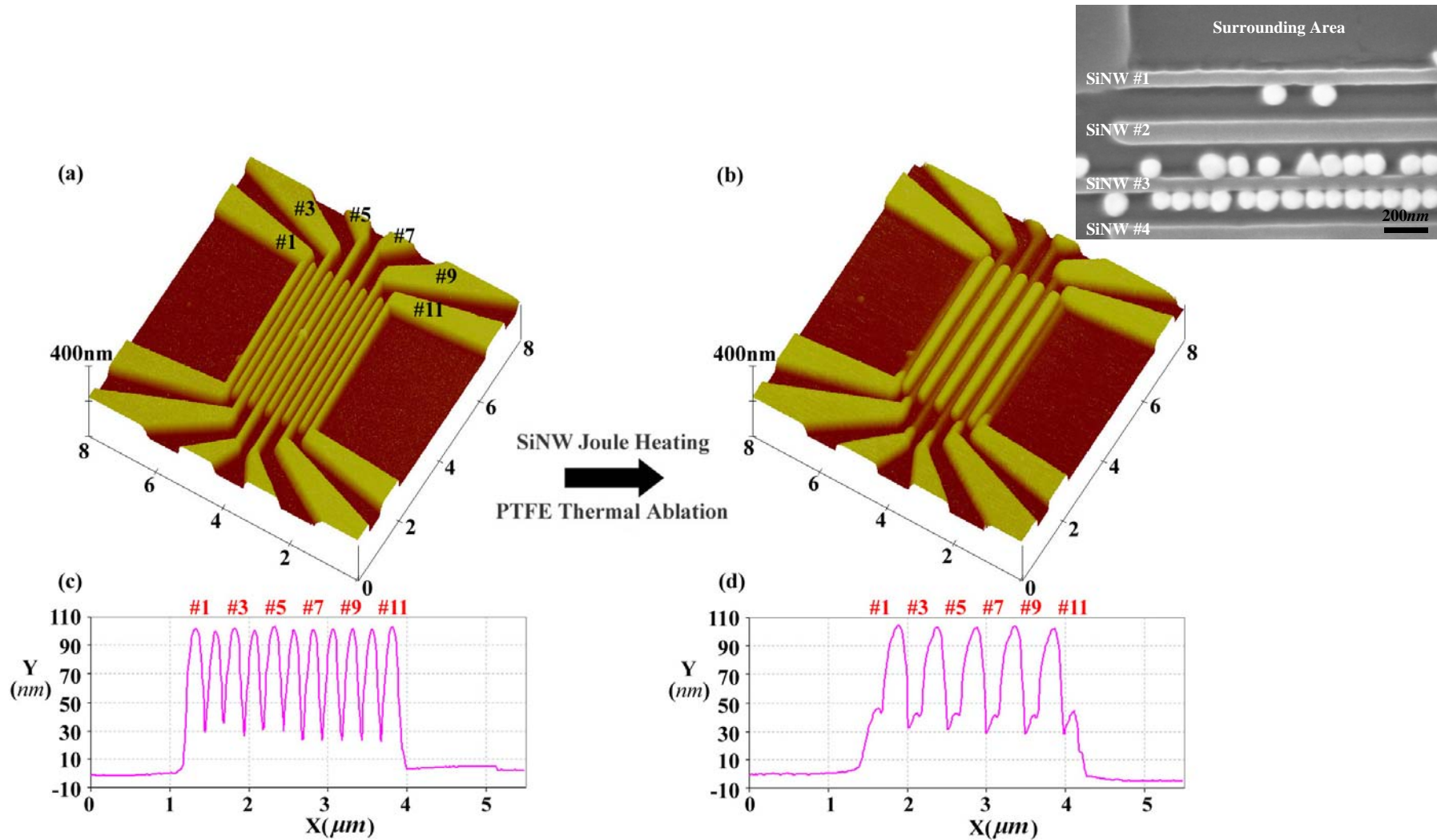
4. Localized functionalization with probe molecules



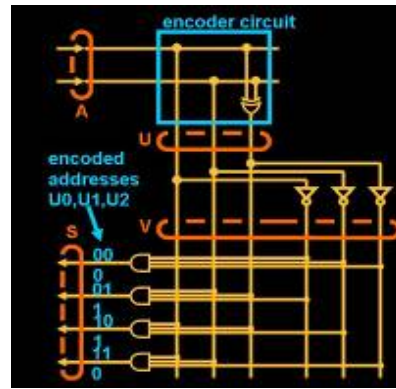
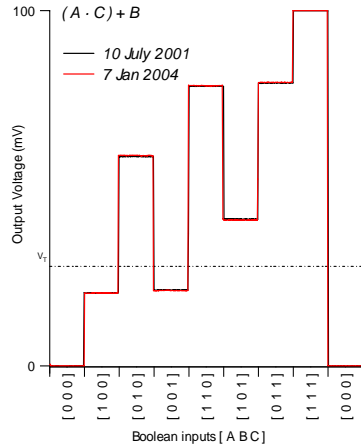
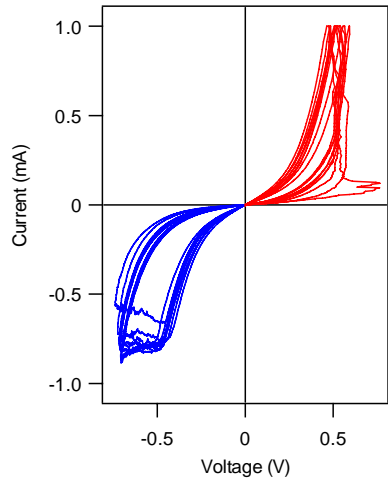
Transient Heat Transfer Simulation



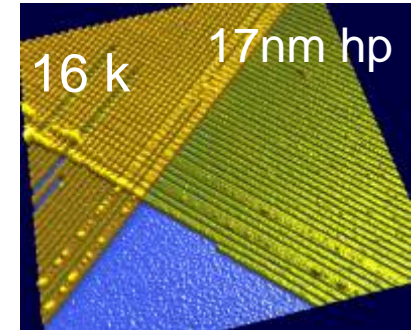
Localized joule heating for selective functionalization in a SiNW array



Nano circuitry

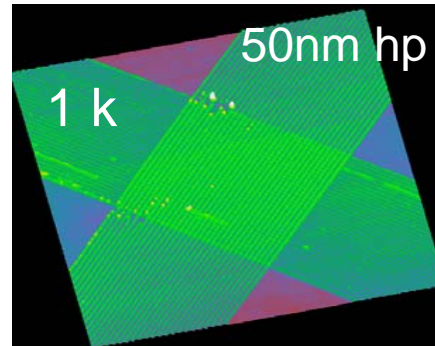


defect tolerant hardware circuits

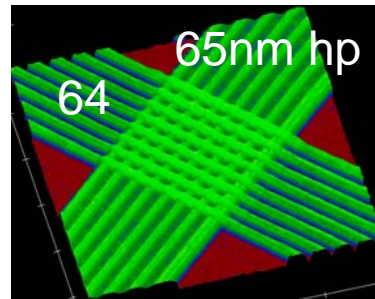


2006

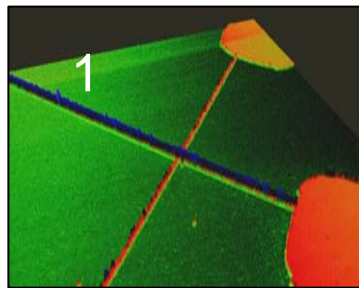
(ITRS 2018)



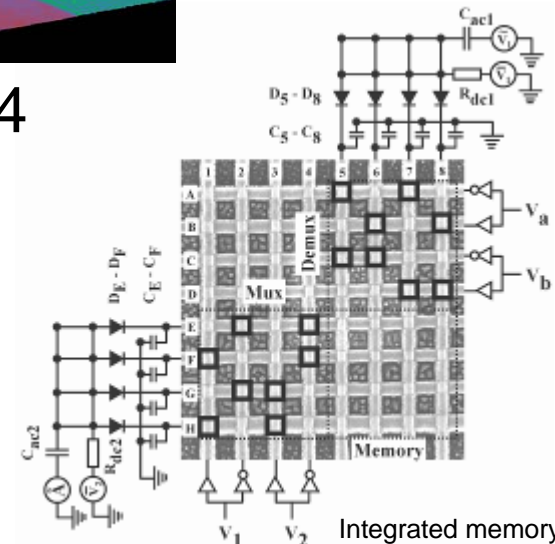
2004



2003

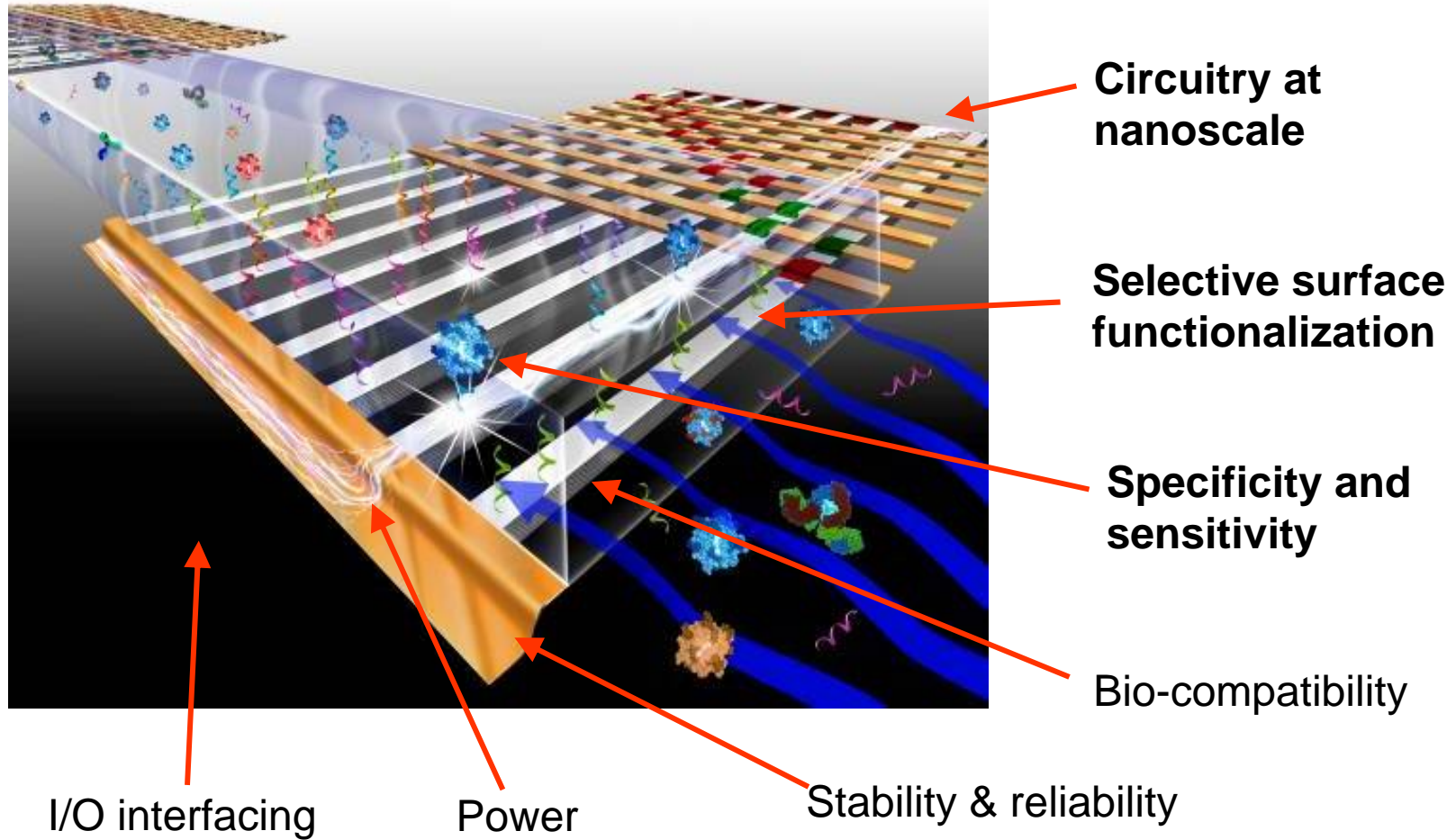


2002



Integrated memory & logic

Si NW sensor concept/challenges





i n v e n t