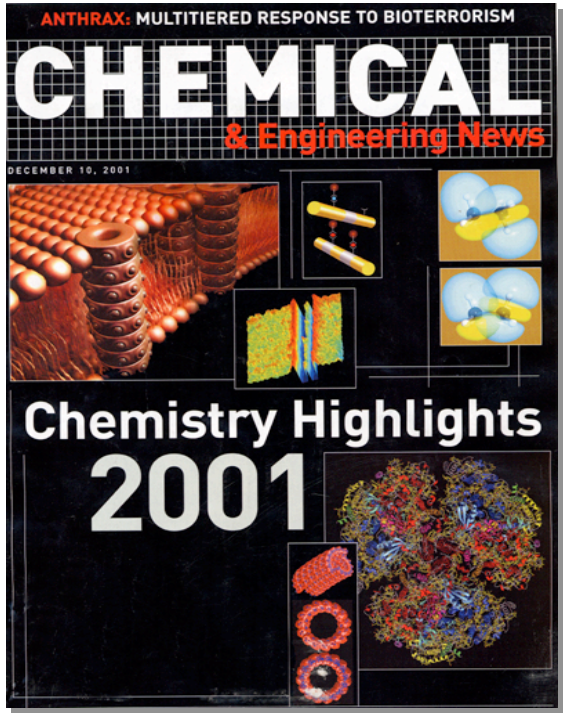
nanosys

"The Next Small Thing"



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Safe Harbour Clause

The following presentation may contain forward looking statements. Actual results may vary from projections.

Safe Harbour Clause

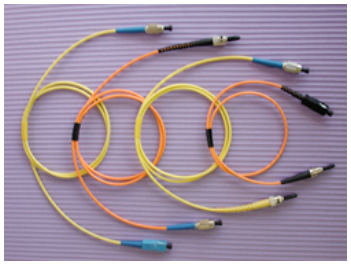
The following presentation ~~may~~ **will** contain forward looking statements. Actual results ~~may~~ **Will definitely** vary from projections.

Technology Revolution

Entertainment

Electronics

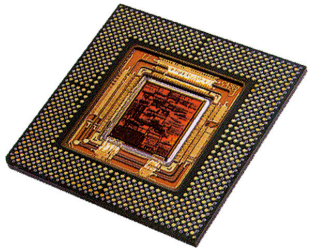
Plastics



Communications

Food

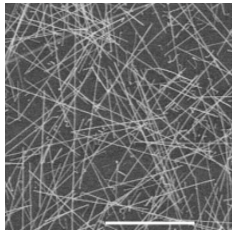
Technology Revolution



Computing

Life Science

Communications

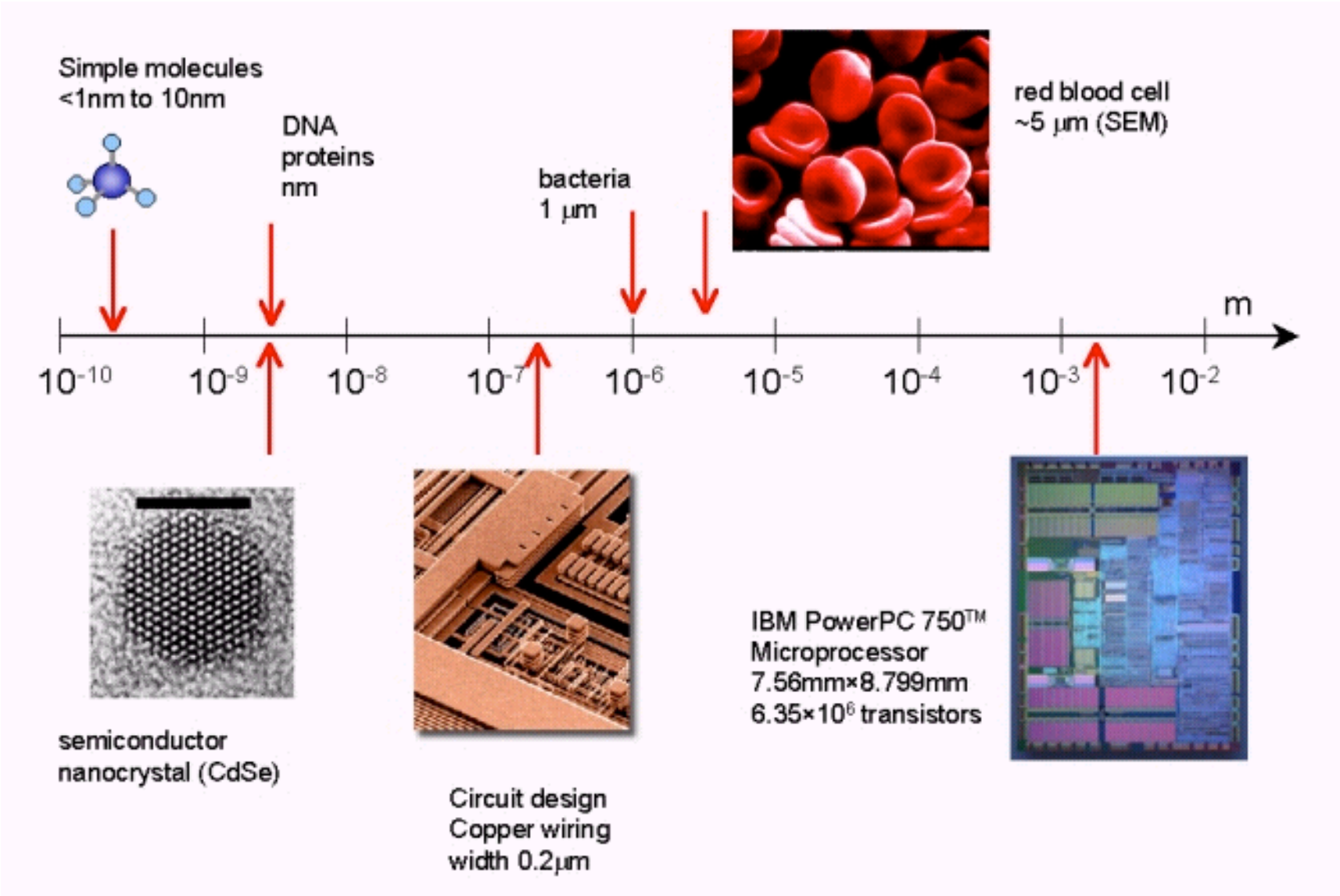


Nanomaterials

Optoelectronics

Energy

The Size Scale of Nanotechnology



NANO is Not Simply A Miniturization Play”

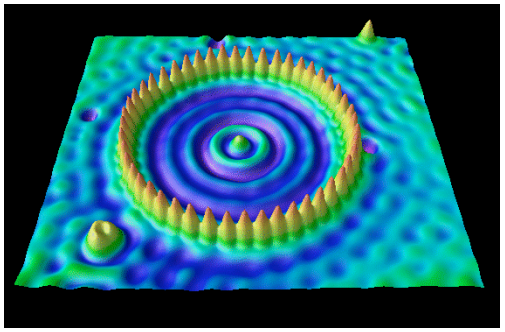
NANO is Not Simply A Miniturization Play

Not just *smaller* . . . .

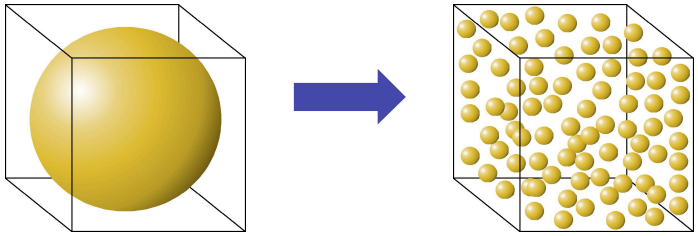
. . . *different* because it's smaller

What is Nanotechnology ?

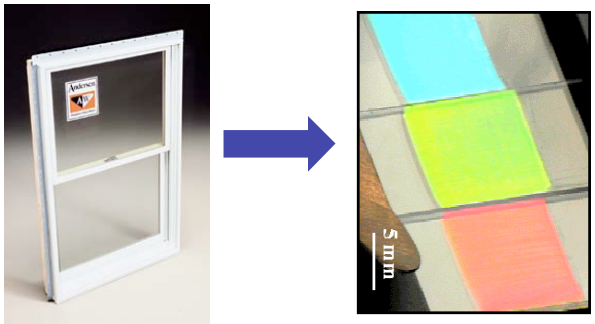
Nanomaterials will display or use new phenomena



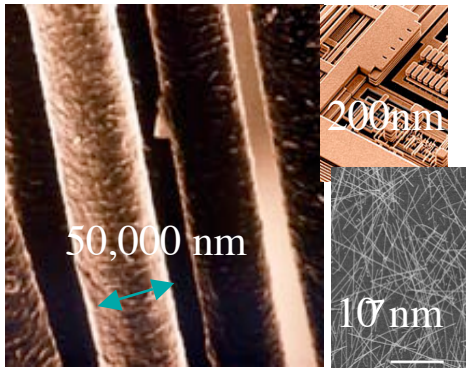
Quantum effects



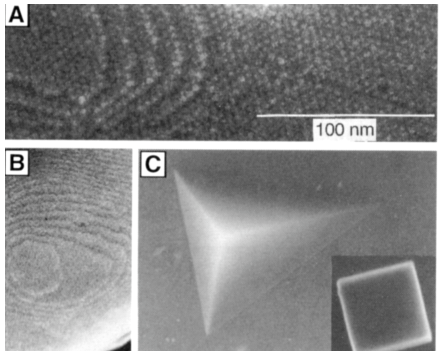
Interfacial properties – Surface Area : Volume



Molecular, aggregate, and structural properties



Massive Integration



Self-Assembly

“Nanotechnology” vs. “Nanoscience”

“Nanoscience” is the fabrication, characterization, manipulation, modeling, and precision placement of nanometer-sized materials.

This is different than *Nanotechnology*

What is "Nanotechnology"

- "Nano" is not really a technology on it's own, it is simply a type of materials science

- "Nano" becomes a technology when it is combined with other science or technology
    - Electronics
    - Optics
    - Data storage
    - Biology . . . .

"Nanotechnology" is technology (in a wide range of disciplines) enabled by the *unique* properties of nanometer-sized materials

Transition From Nanoscience to Nanotechnology

- Nanoscience has been around a long time . . .
- So have *some* areas of nanotechnology
  - e.g. quantum well lasers
- Why “nanotechnology” now?

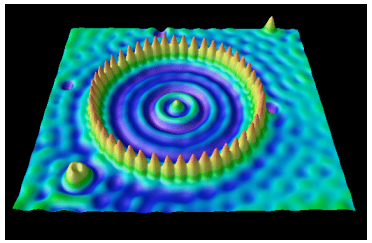
Advances in Materials Science of Nanotechnology

Synthetic capabilities have advanced

- High-quality materials
- Controlled physical parameters
  - Material
  - Size
  - Shape
  - Crystallinity
- Controlled surface chemistry
- Controlled incorporation into other materials

Nano-applications are enabled by the availability of high-quality nanomaterials

Confluence Of Events

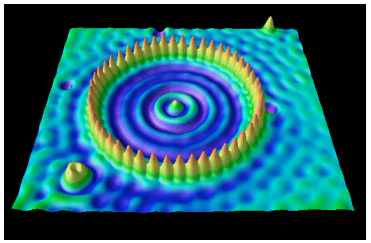


Scientific

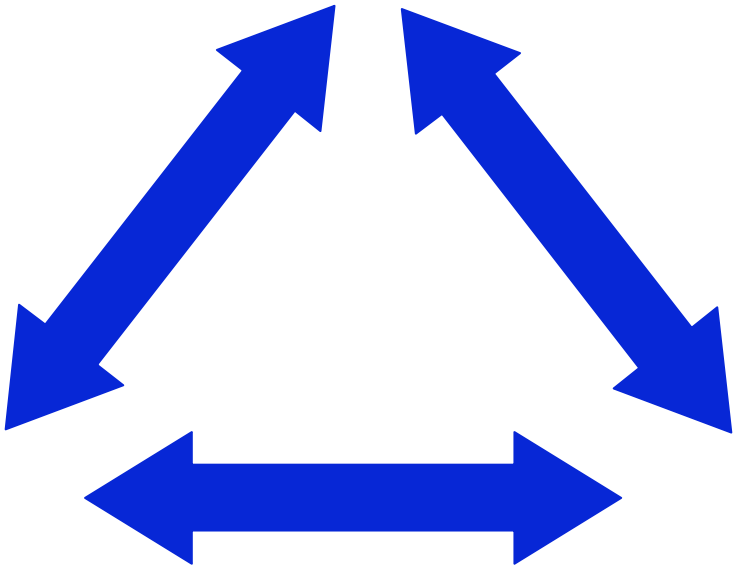
Economic

Government

Confluence Of Events

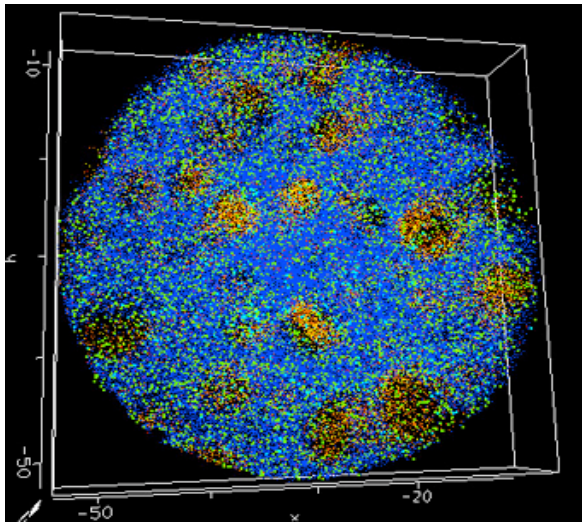


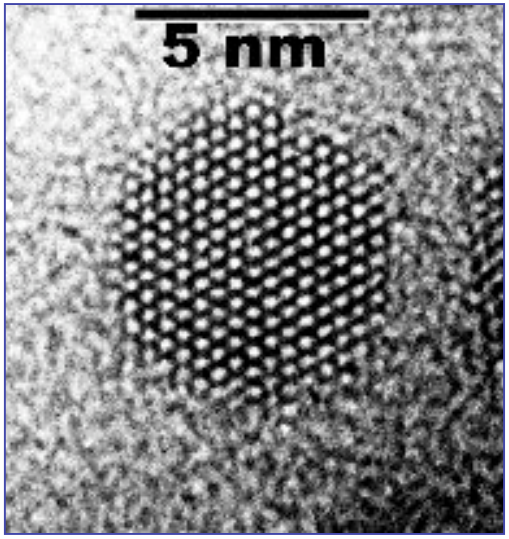
Scientific

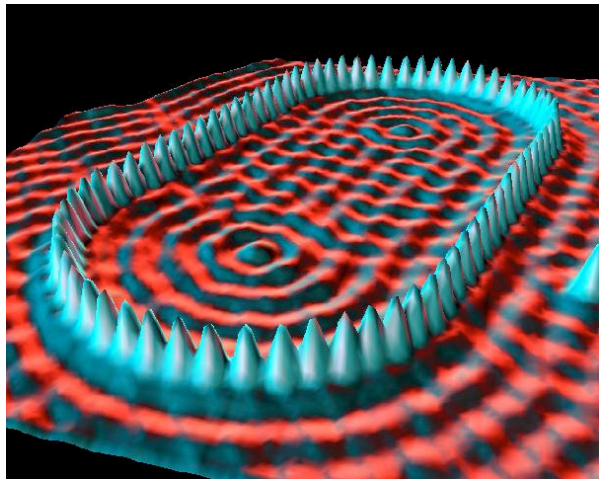


Economic **Government**

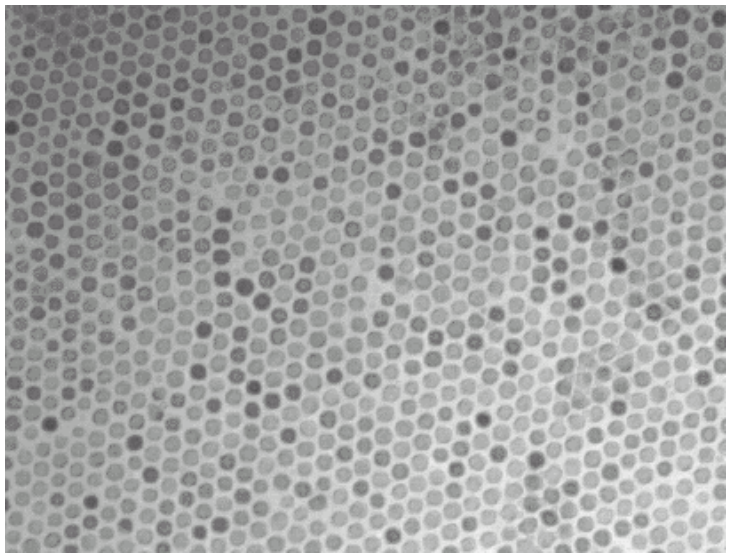
Characterization Tools Are Available

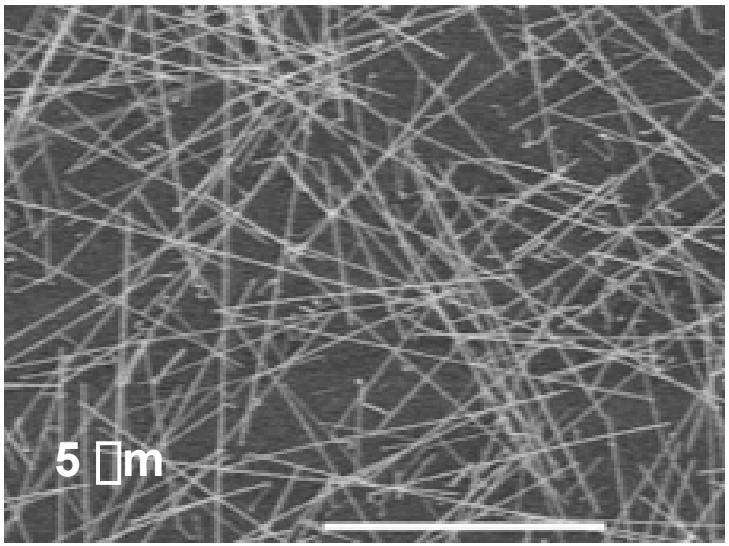


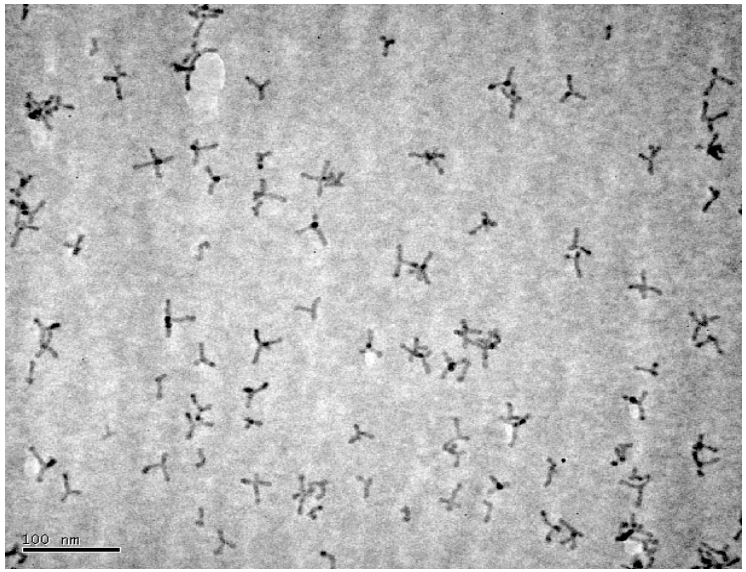




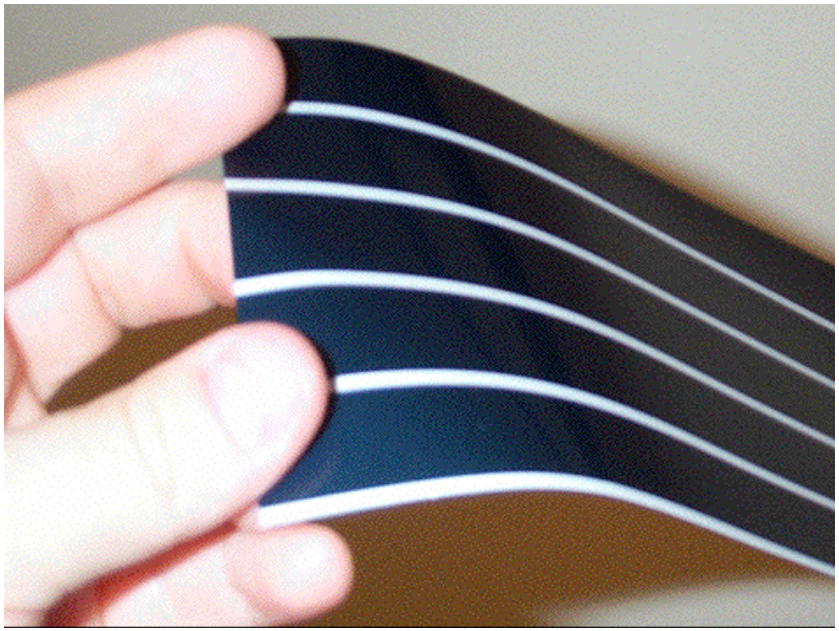
Rational Design

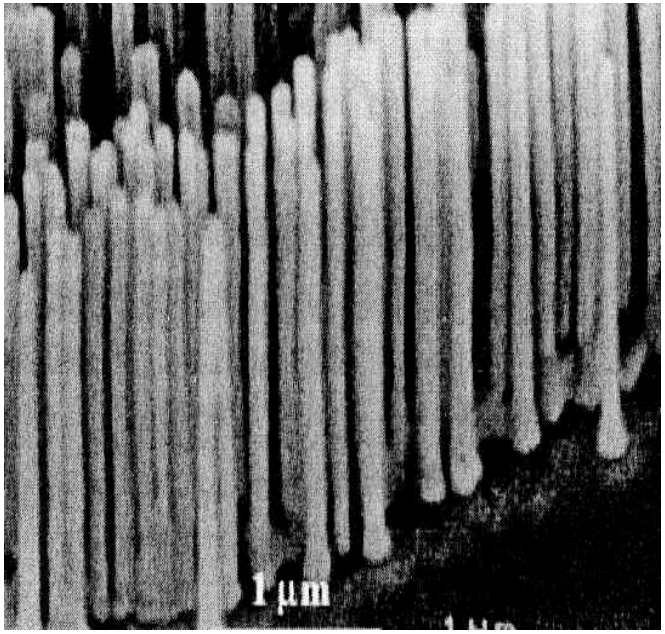


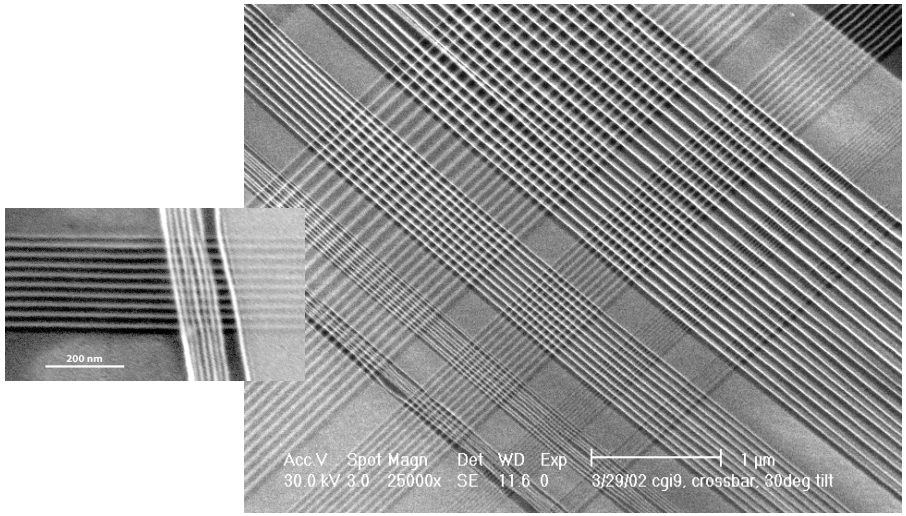




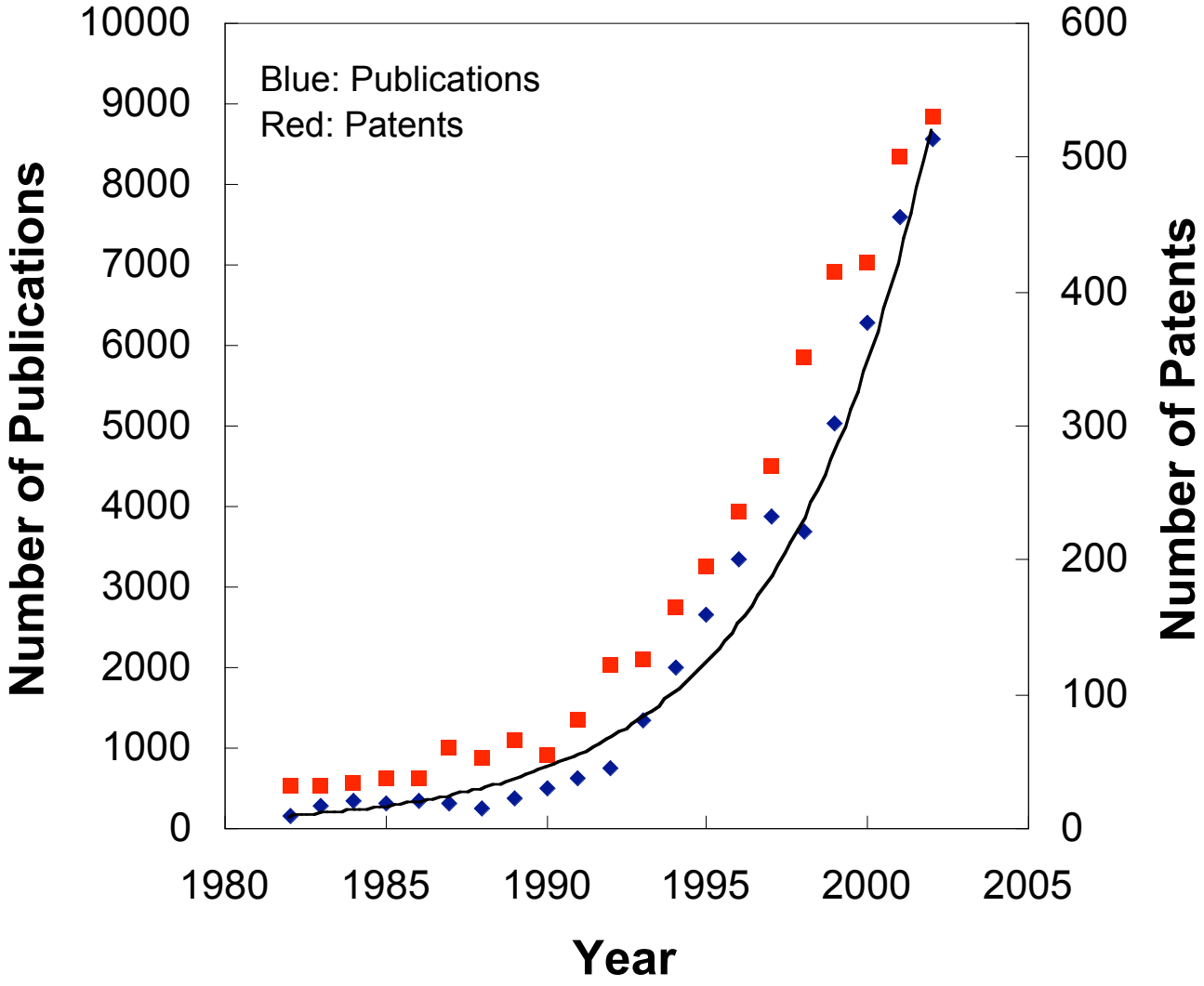
Flexible Assembly



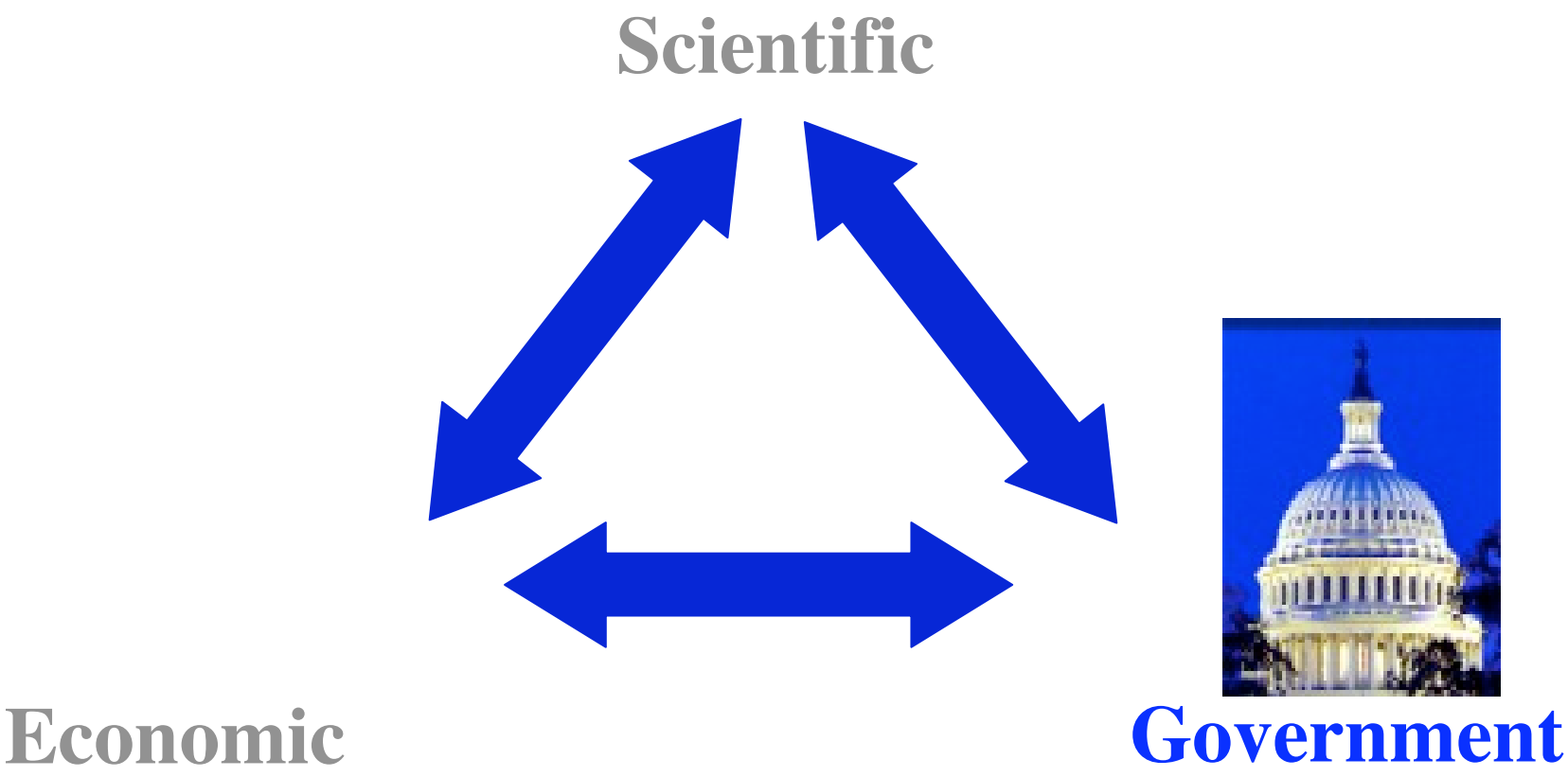




Expoenential Increase In Publications and Patents

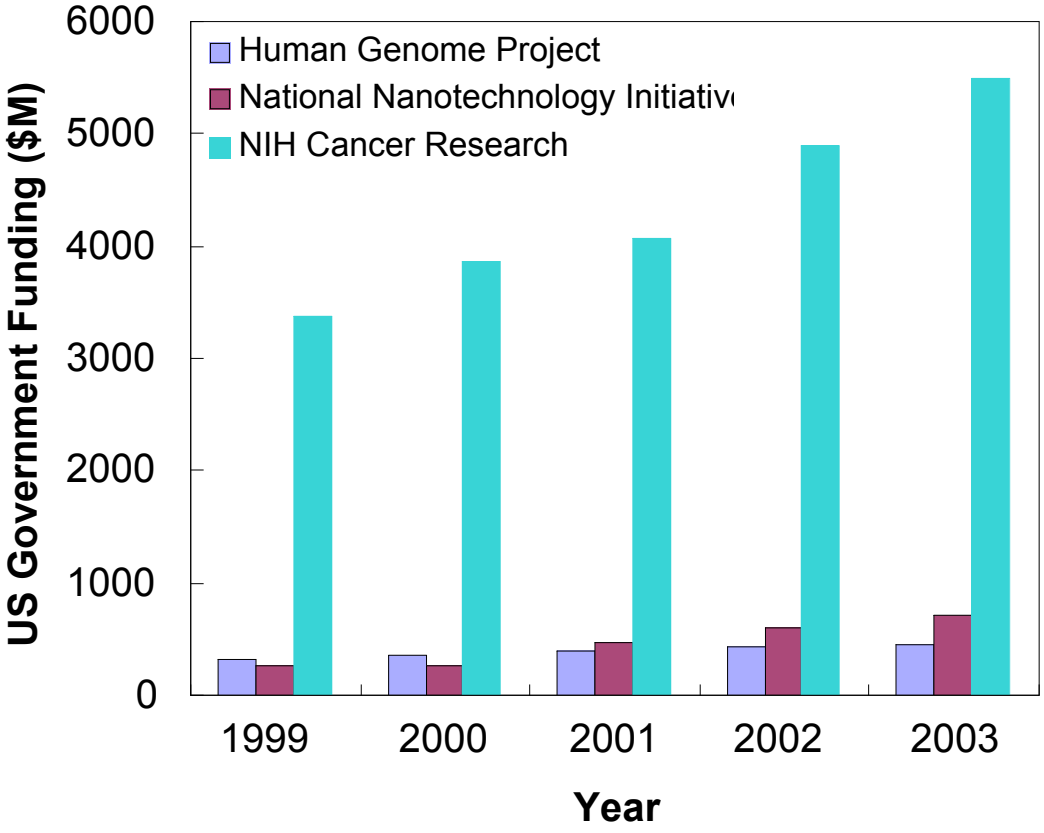


Confluence Of Events



National Nanotechnology Initiative

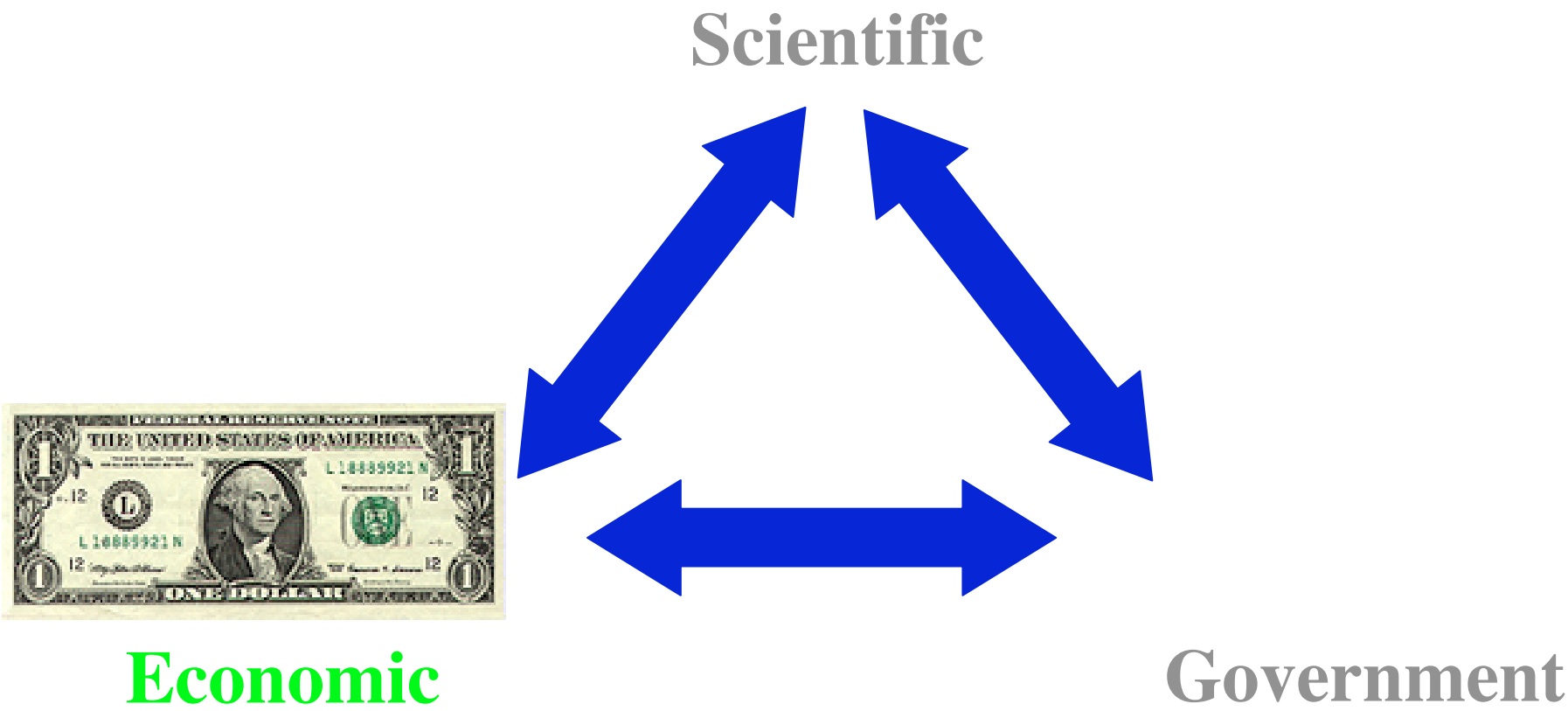
National
Nanotechnology
Initiative



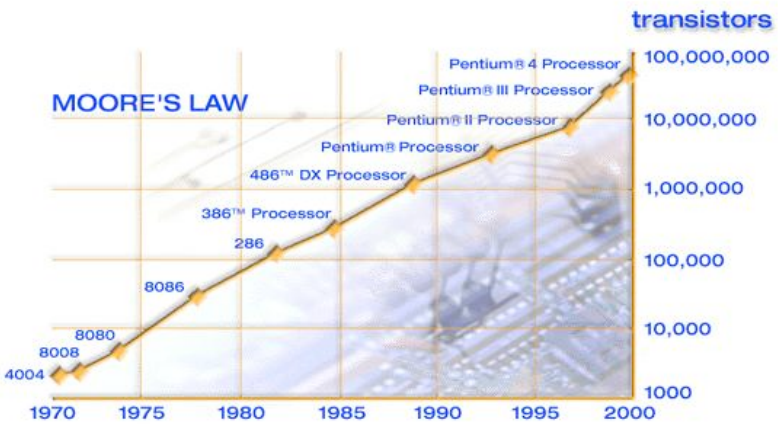
Revolution In Military Affairs

Homeland Defense

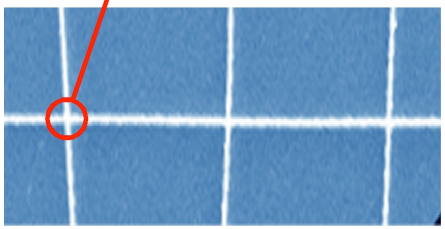
Confluence Of Events



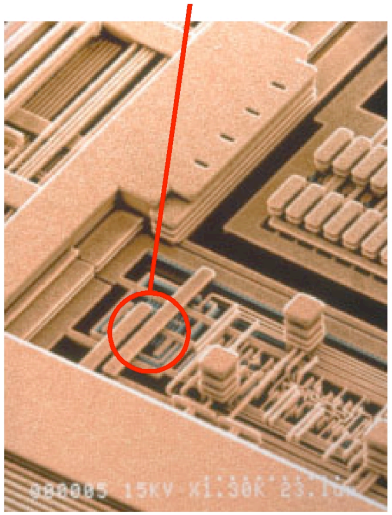
Economic

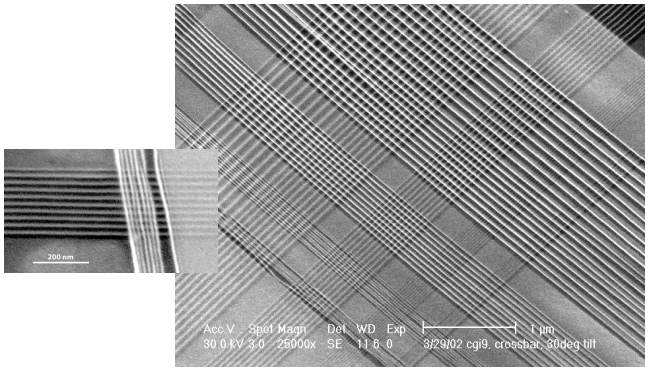


Nanowire Junction: 25 nm^2



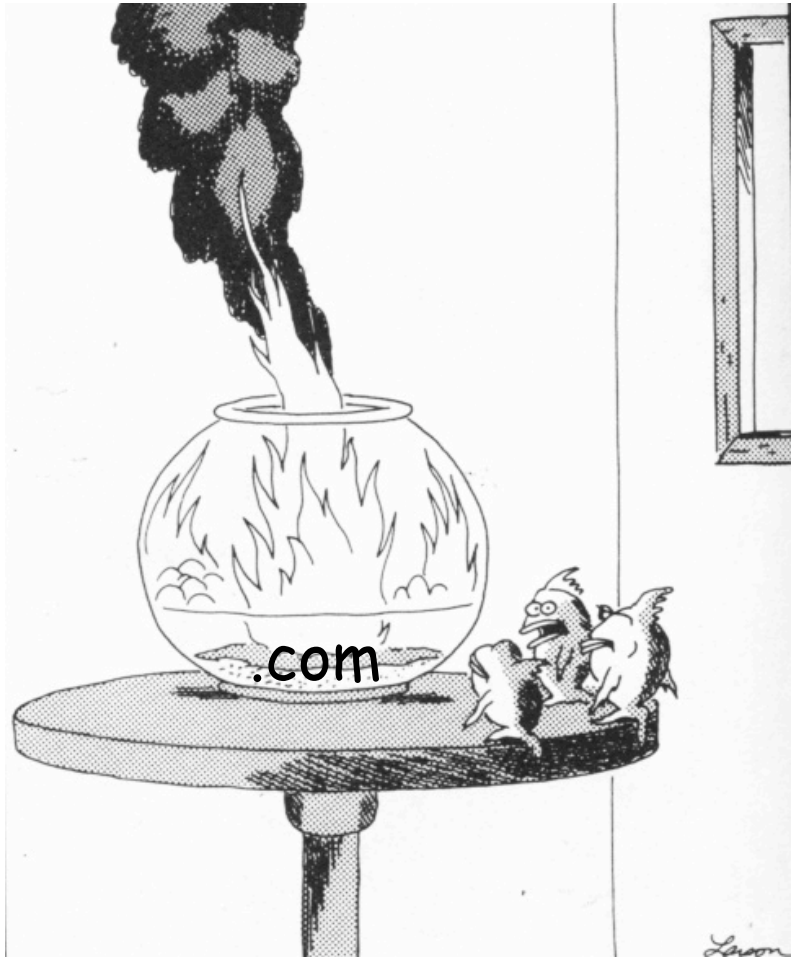
DRAM Cell: 250,000 nm^2



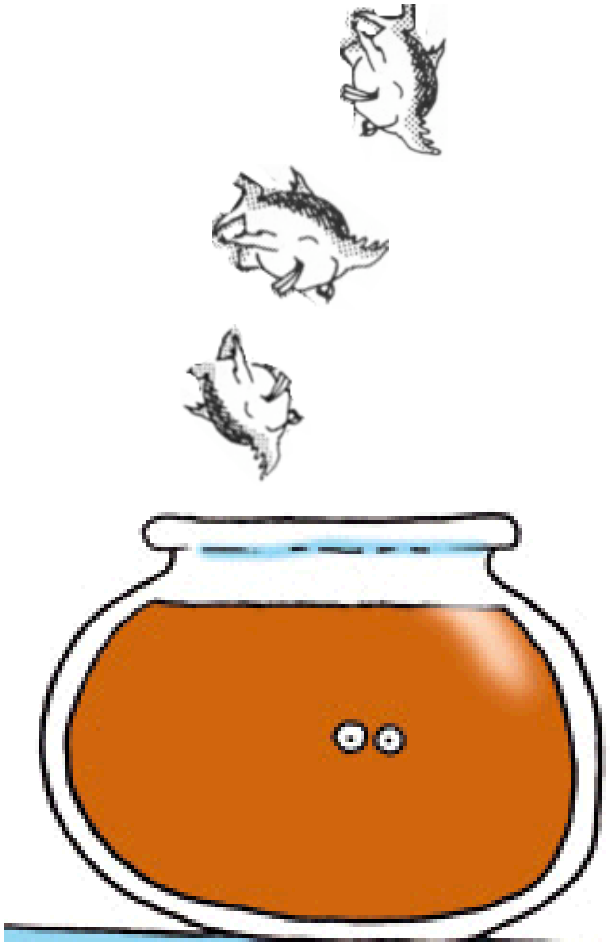


Rock's Law ***"The Cost of Capital Equipment To Build Semiconductors Will Double Every Four Years"***

Economic



"Well, thank God we all made it out in time….'Course, now we're equally screwed"



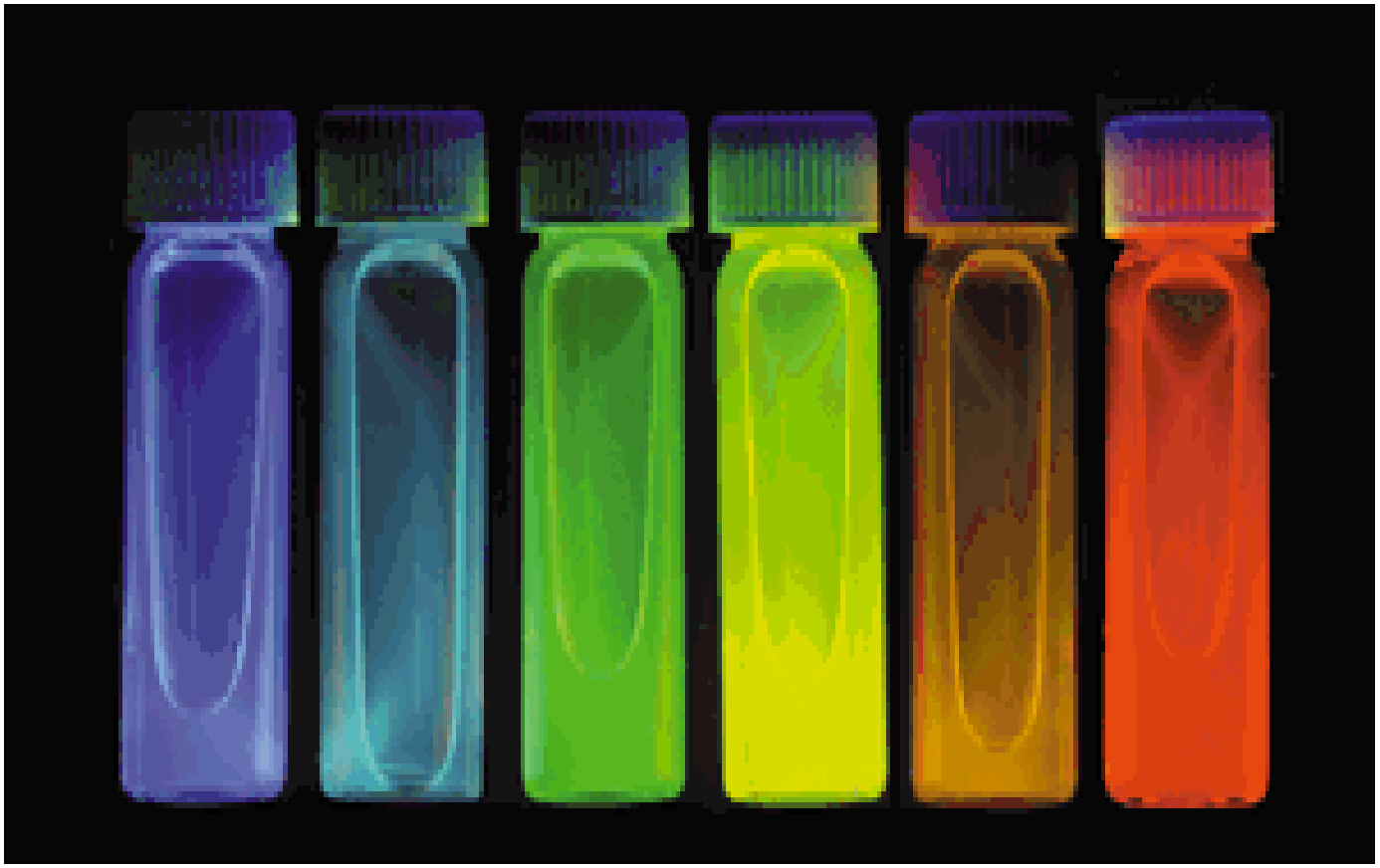
Nanotech to the rescue

…….

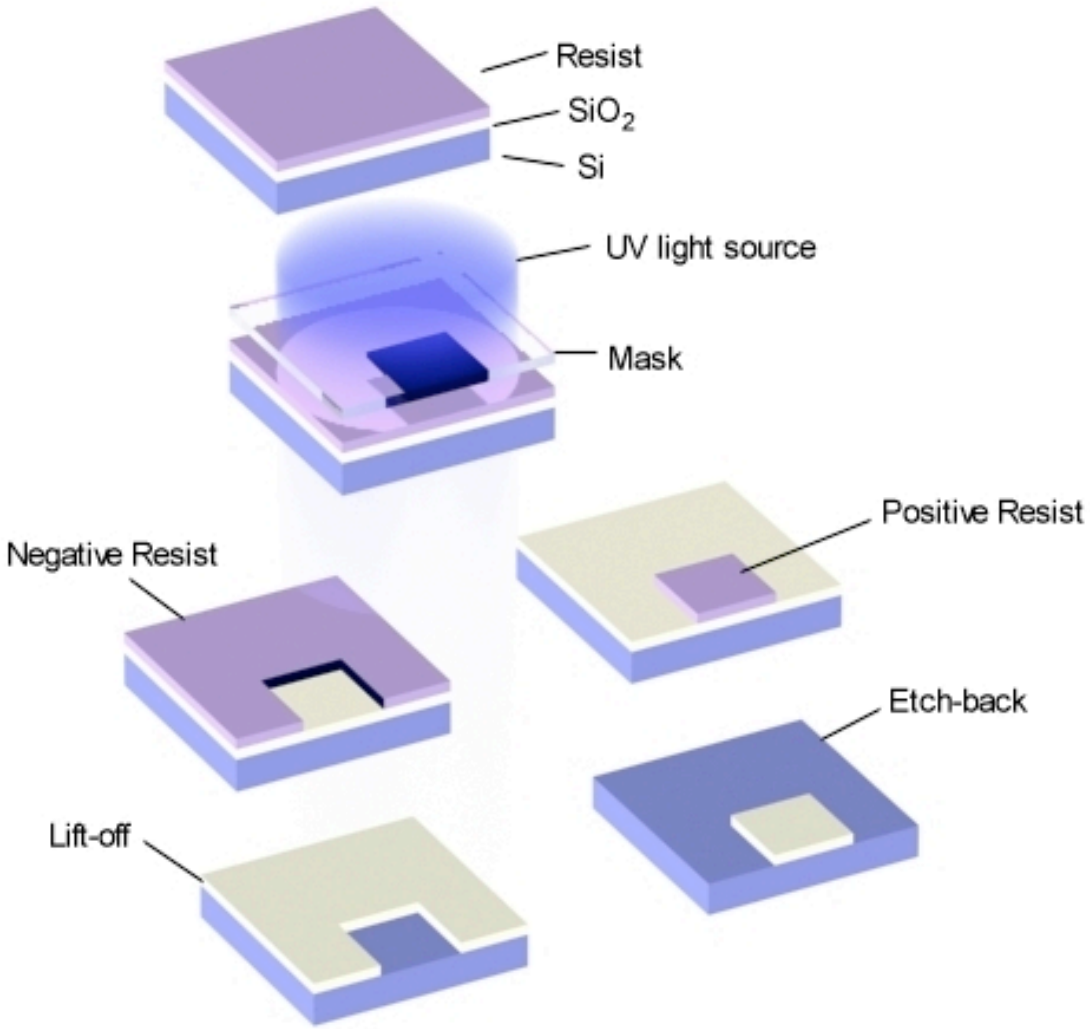
Venture Capital Perspective

Some of the Big Ideas

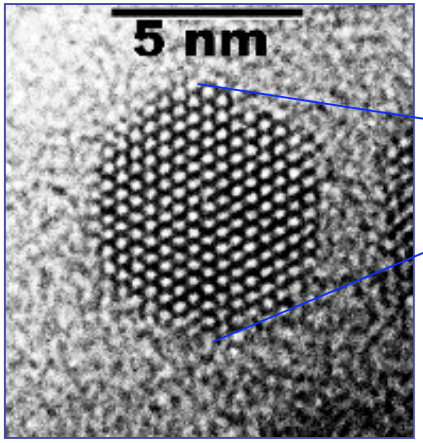
Independent Control of Fundamental vs. Processing Properties

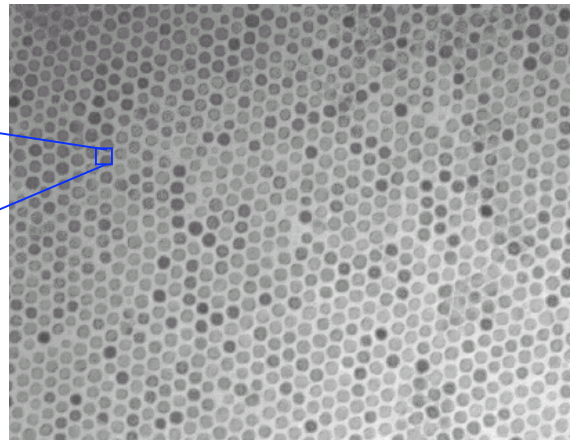


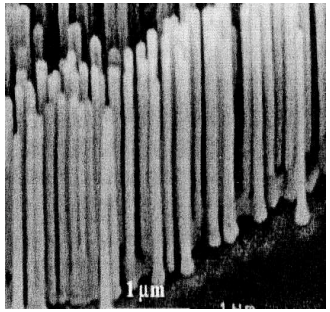
Bottom Up vs. Top Down

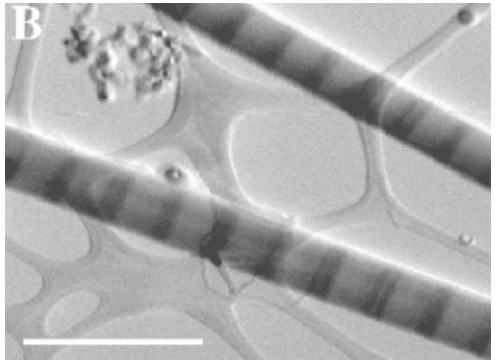


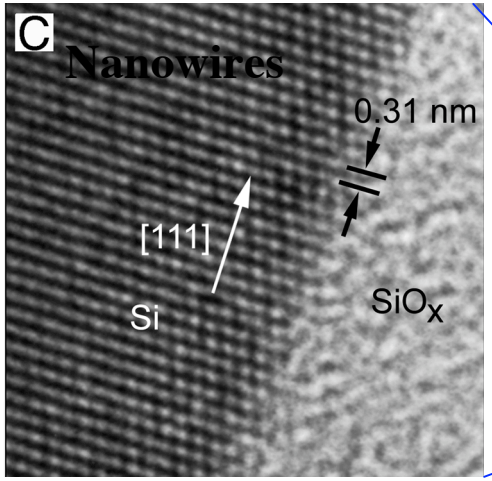
Bottom Up vs. Top Down

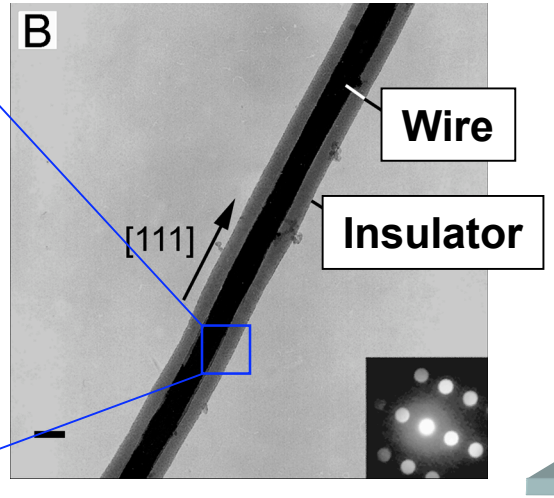


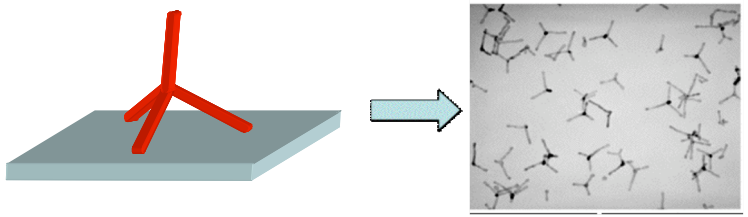




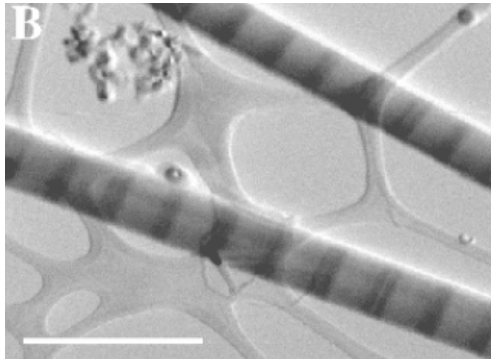


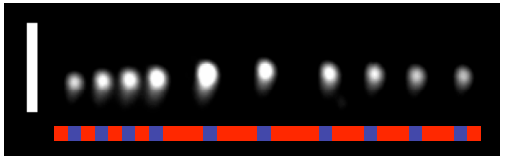




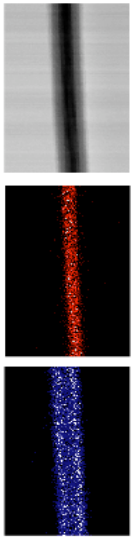


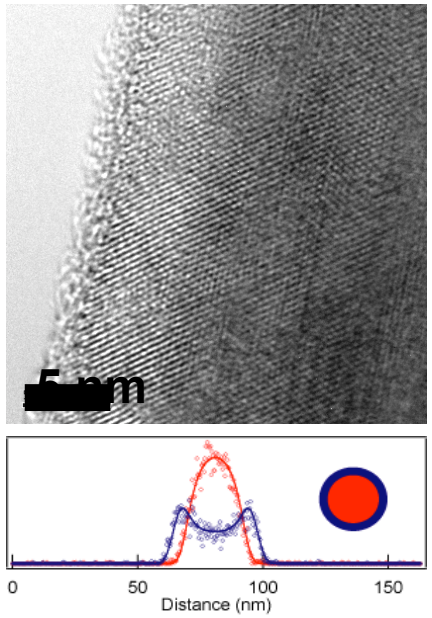
Engineer Device Complexity Directly Into Material

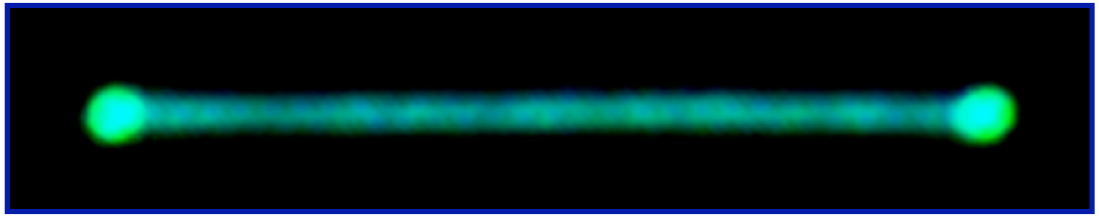


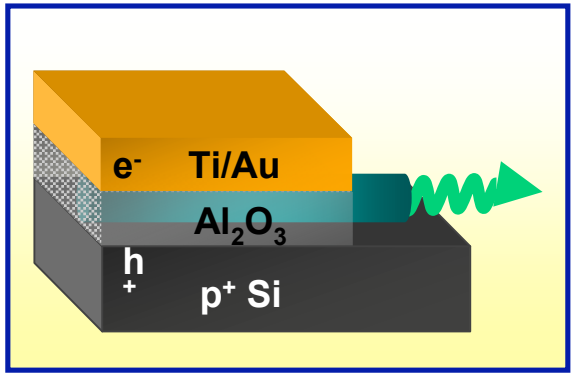


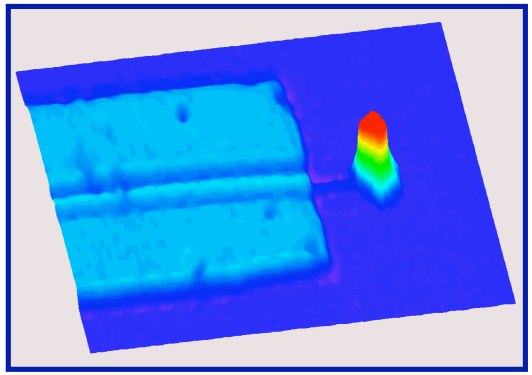
Nano-barcodes

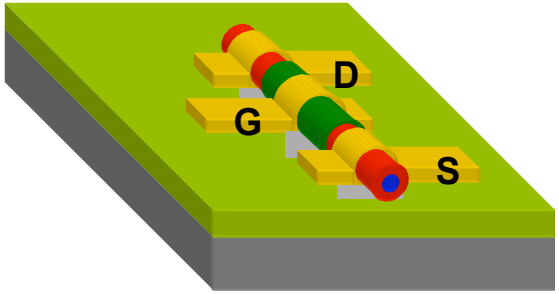




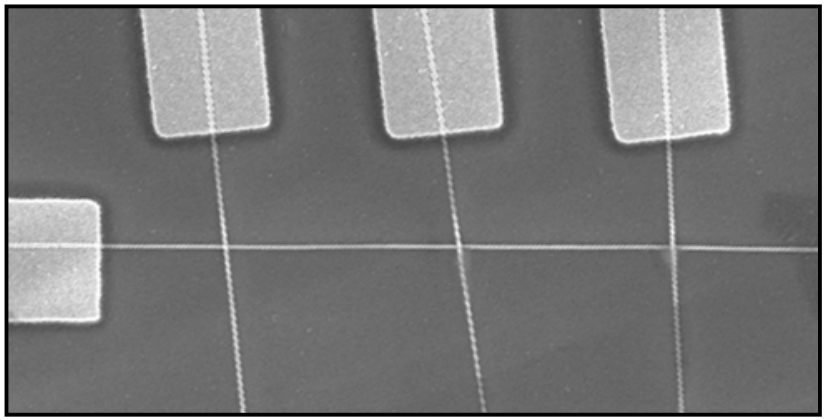


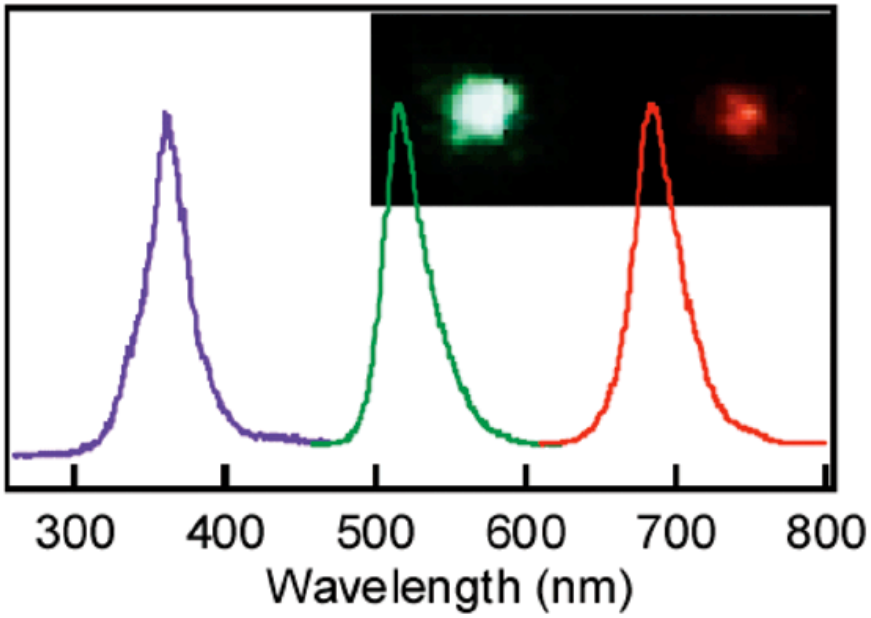






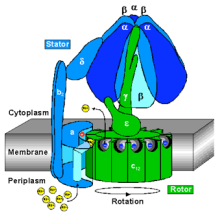
Using Combinatorics In Microelectronics



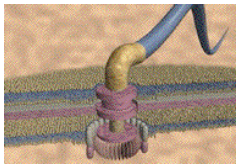


Cues From Biology

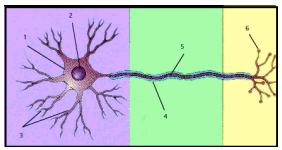
Spider silk is 100 times stronger than steel per unit weight.



ATPase is a nanoscale protein motor. Scaled to the size of a person, it would be able to spin a telephone pole 2 kilometers long at 60 rpm

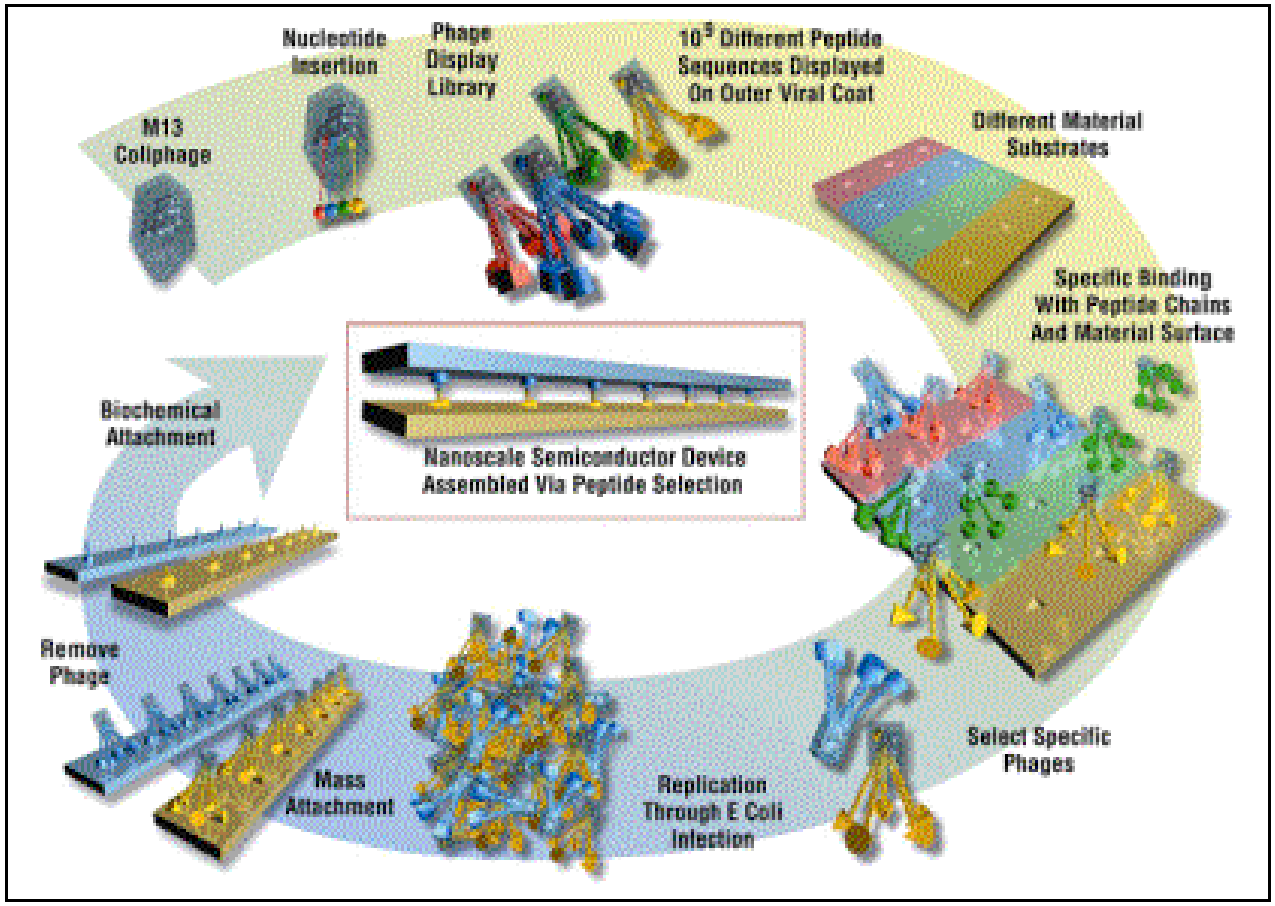


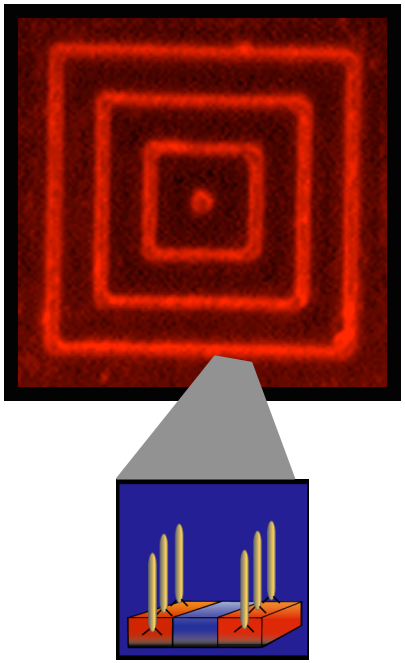
Bacterial flagellar motors convert energy with near 100% efficiency. The typical auto engine is ~30% efficient.



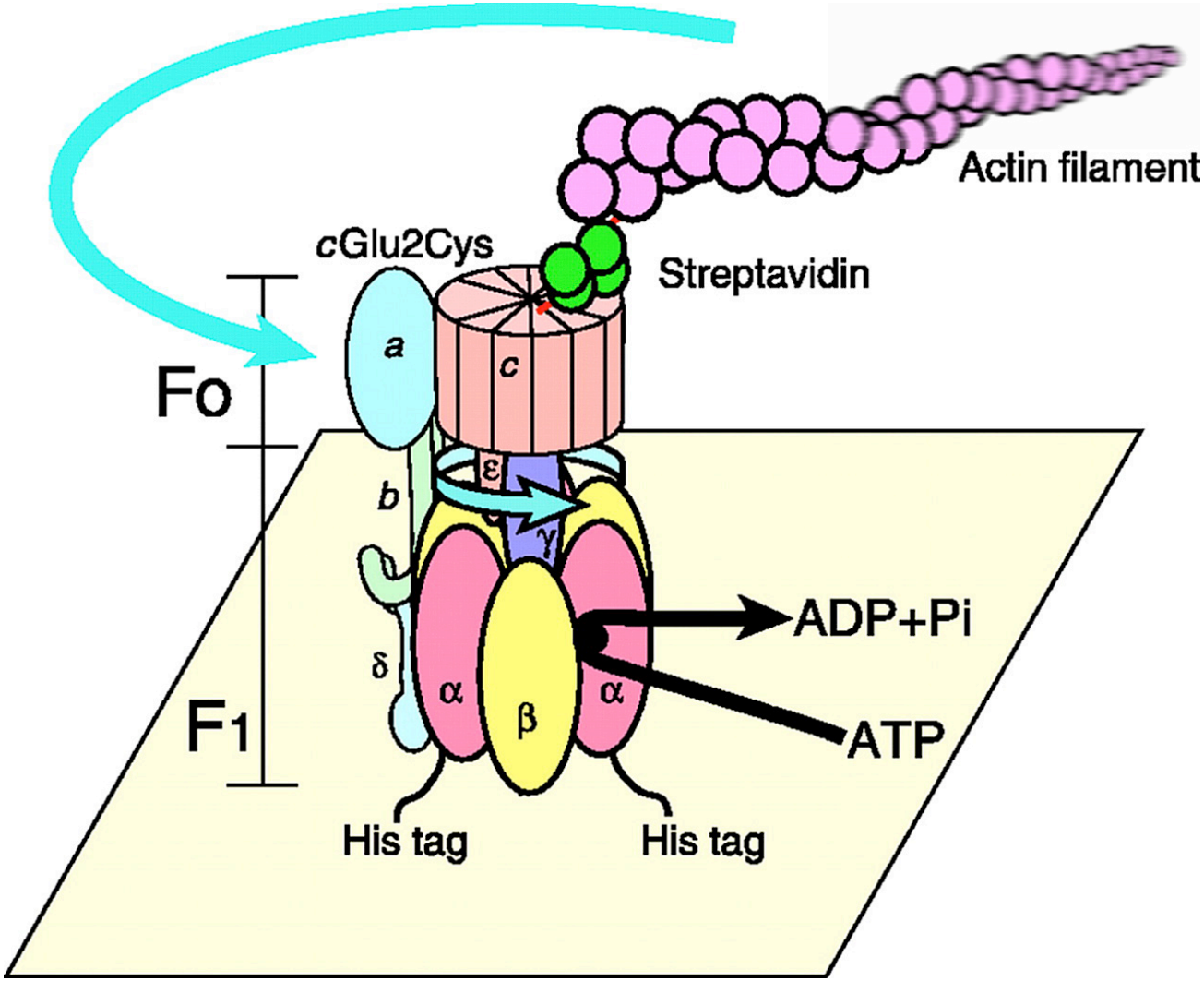
In the human brain, a trillion neurons self-assemble to form 10^{16} precise contacts, 10 orders of magnitude greater contact density than on a Pentium chip.

Use Biology To Manufacture Nano

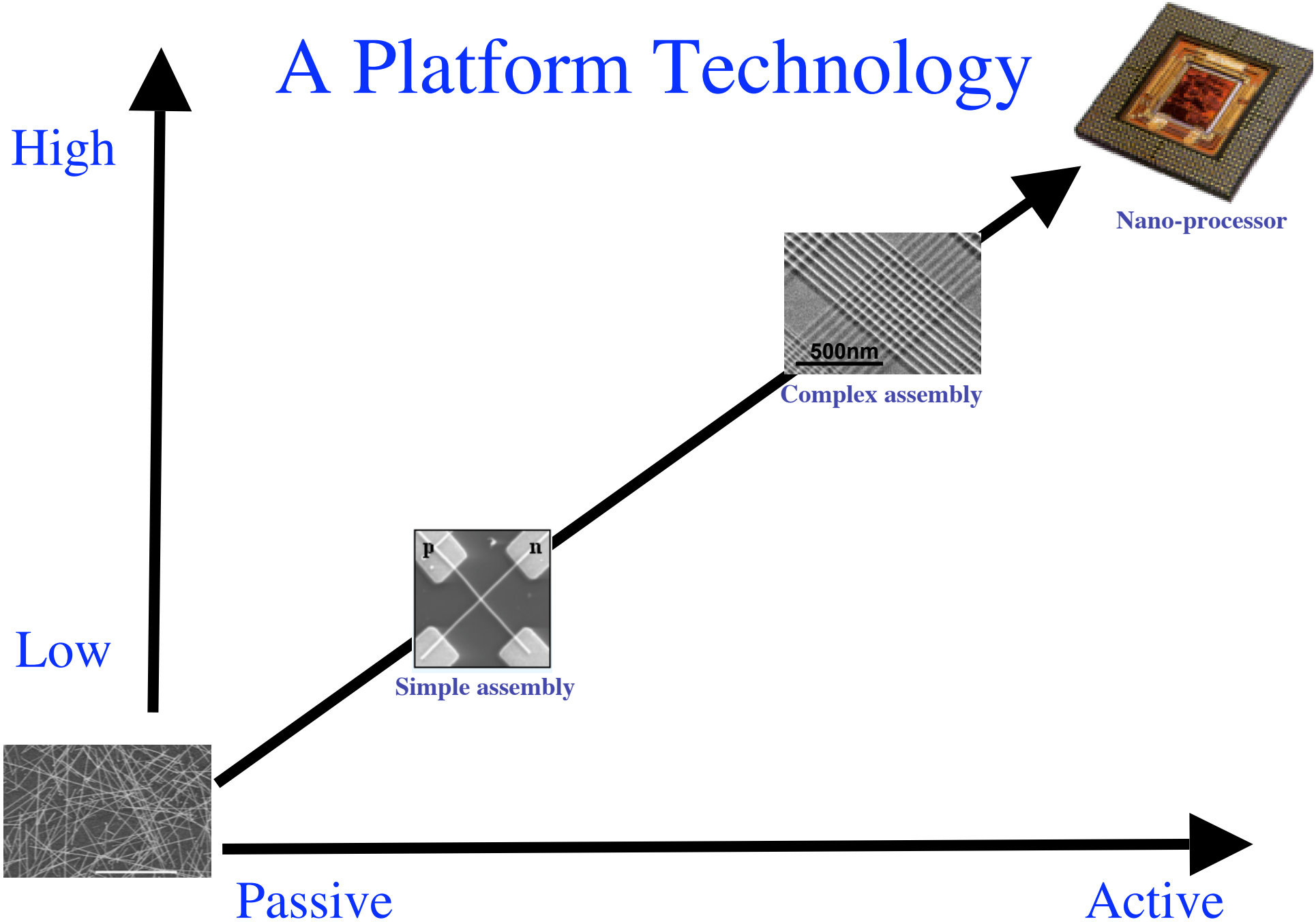




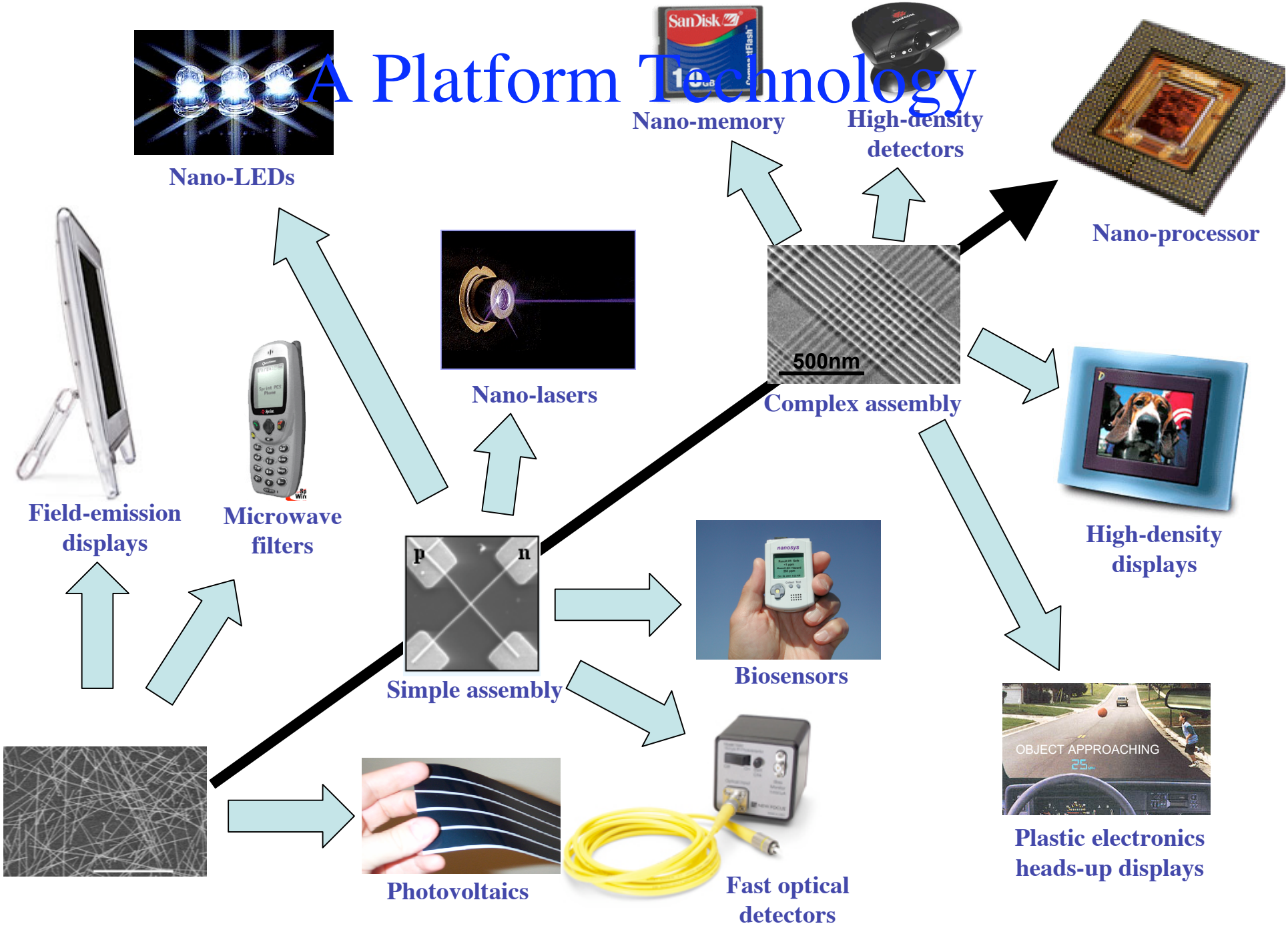
Use Biology To Manufacture Nano



A Platform Technology



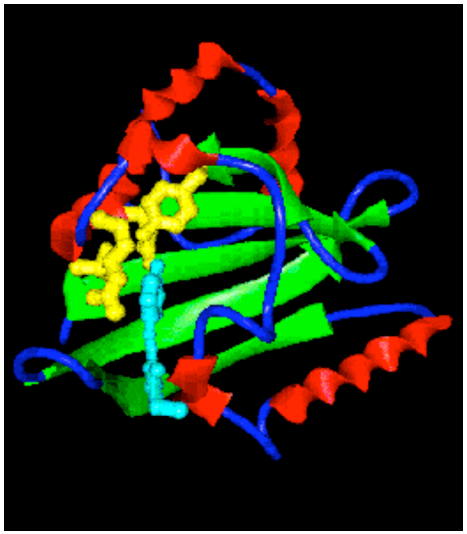
A Platform Technology



Creativity Vs. Scale of Operations

Success is Based on
Scale of Operations

Success is Based on
Cleverness of the Scientist



Creativity Vs. Scale of Operations

Success is Based on
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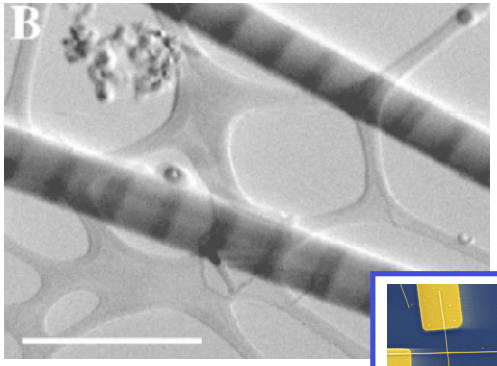
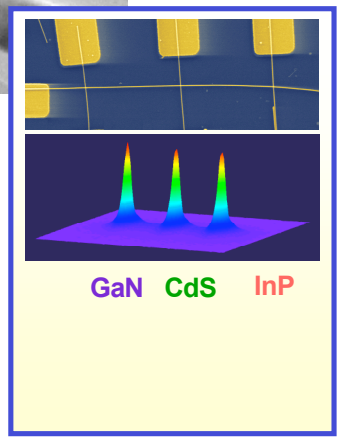
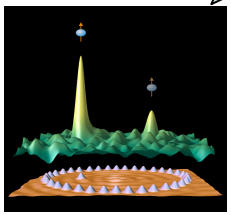
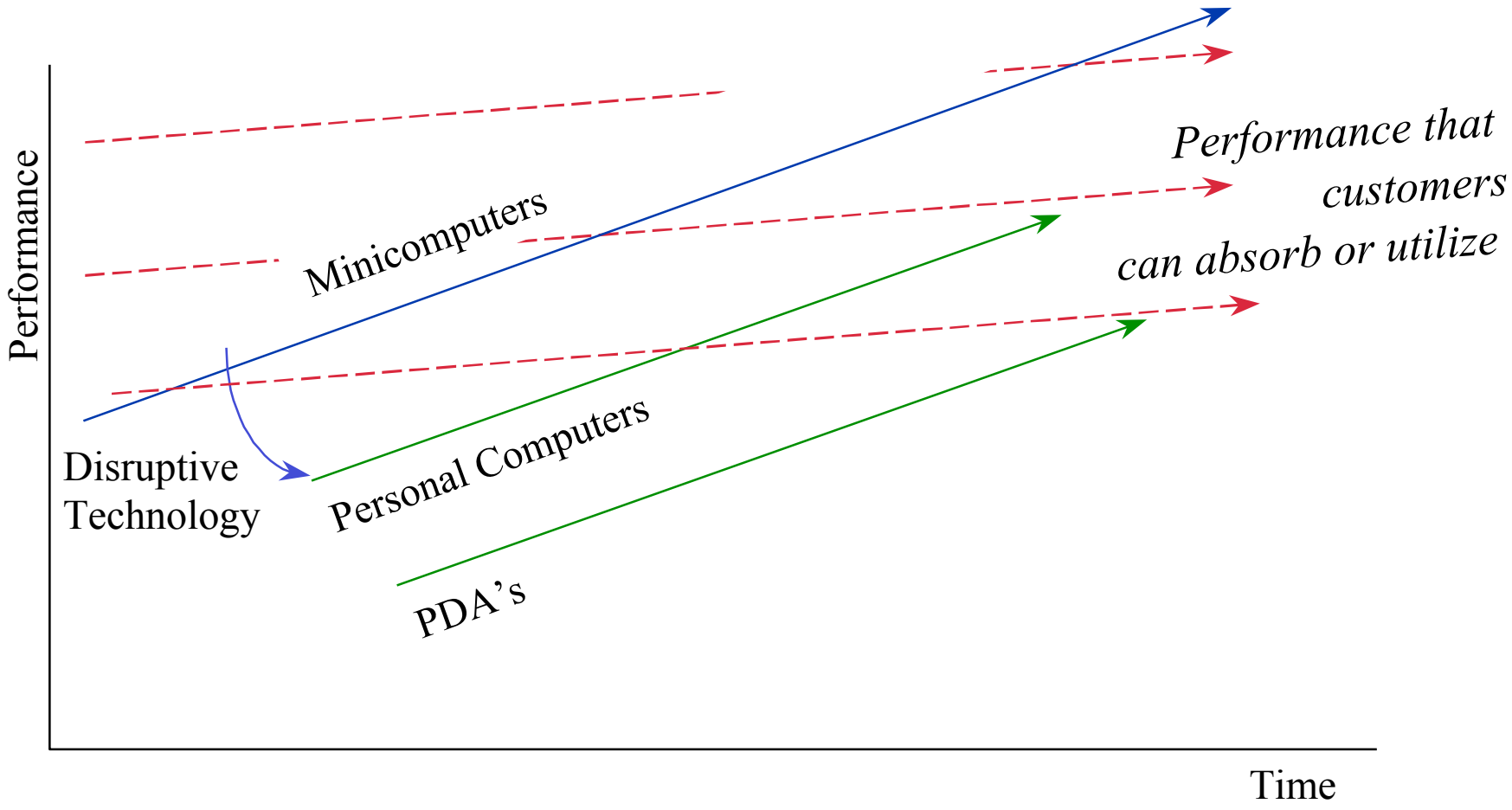






Success is Based on
Cleverness of the Scientist

A Disruptive Technology

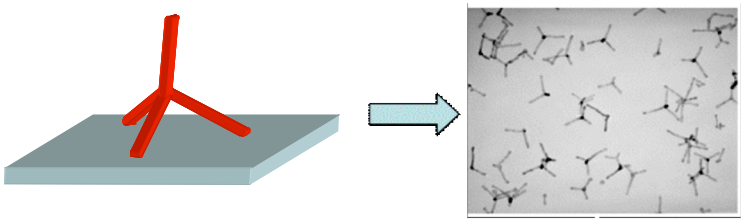


Venture Capital Perspective

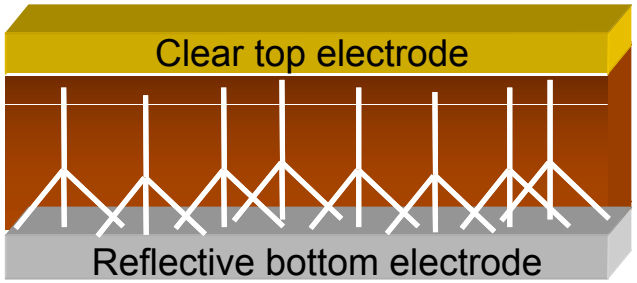
Some Representative Companies

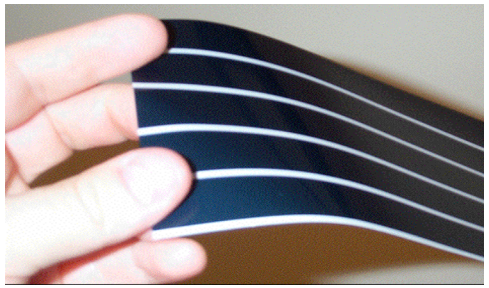
Low Cost Light Weight High Efficiency Photovoltaics

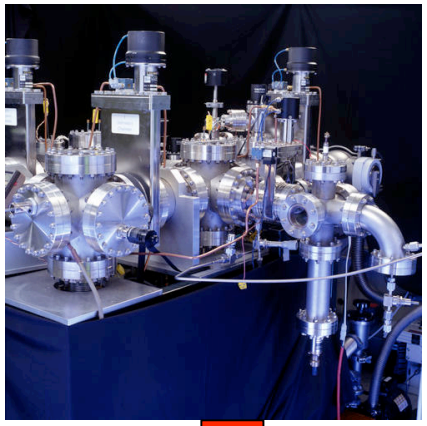
NanoTetrapods

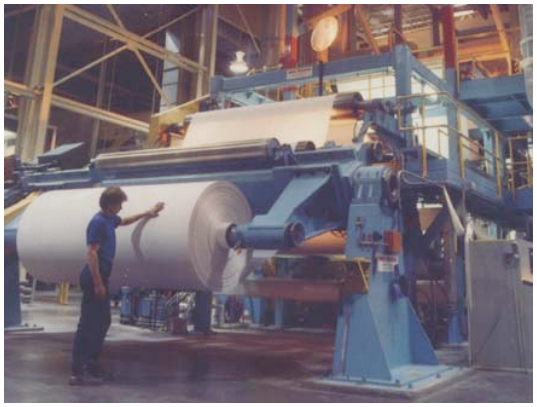


NanoTetrapod composites are self-aligning to span the active region









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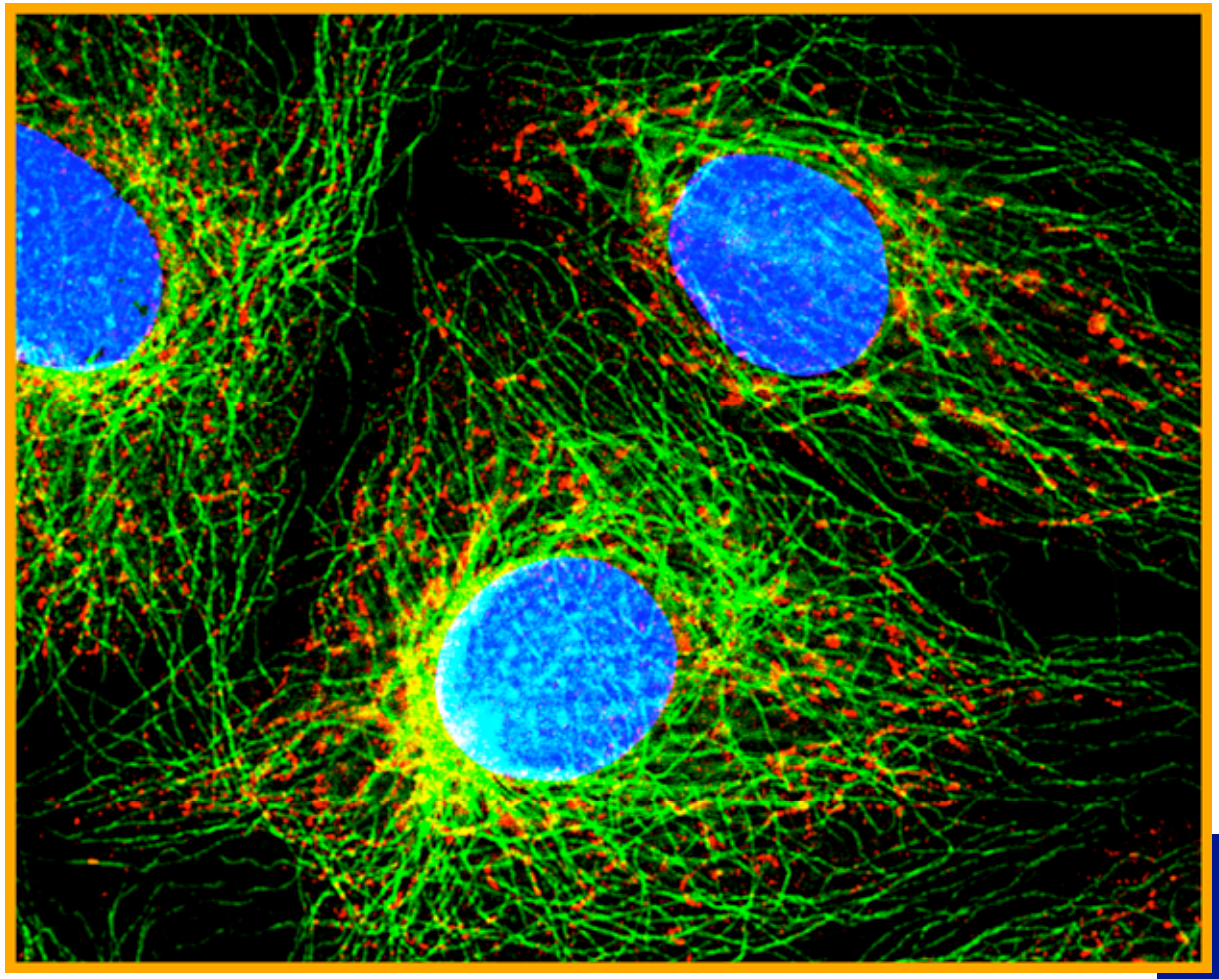
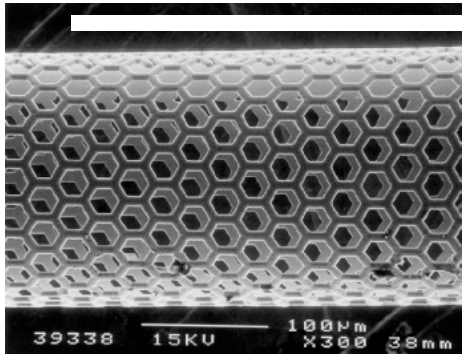
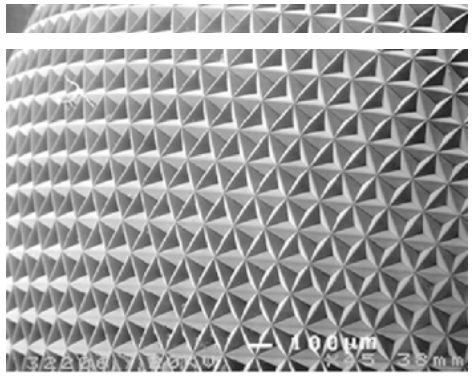
Real Time Color Movie of Gene Expression

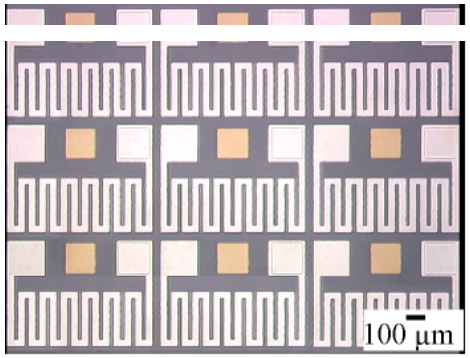


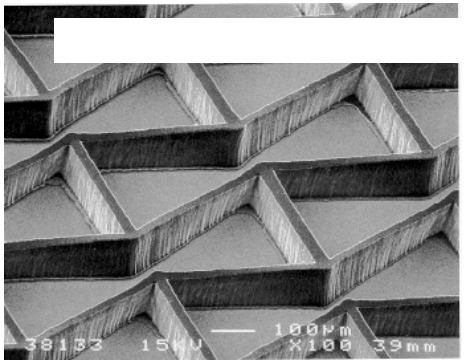
QuantumDot

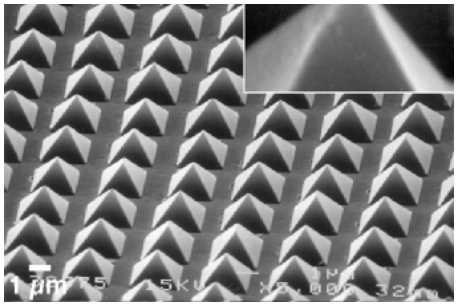
Extremely Low Cost Nanofabrication

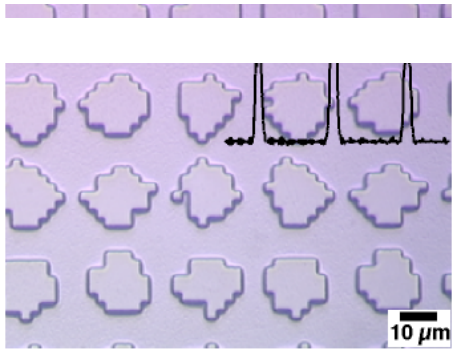


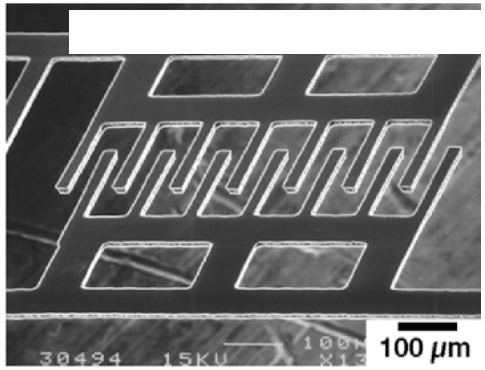


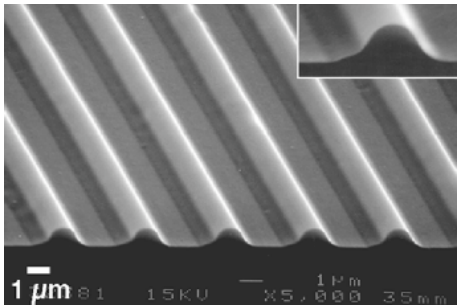


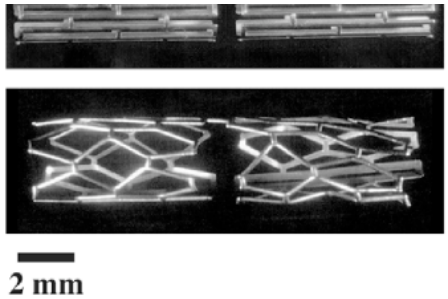






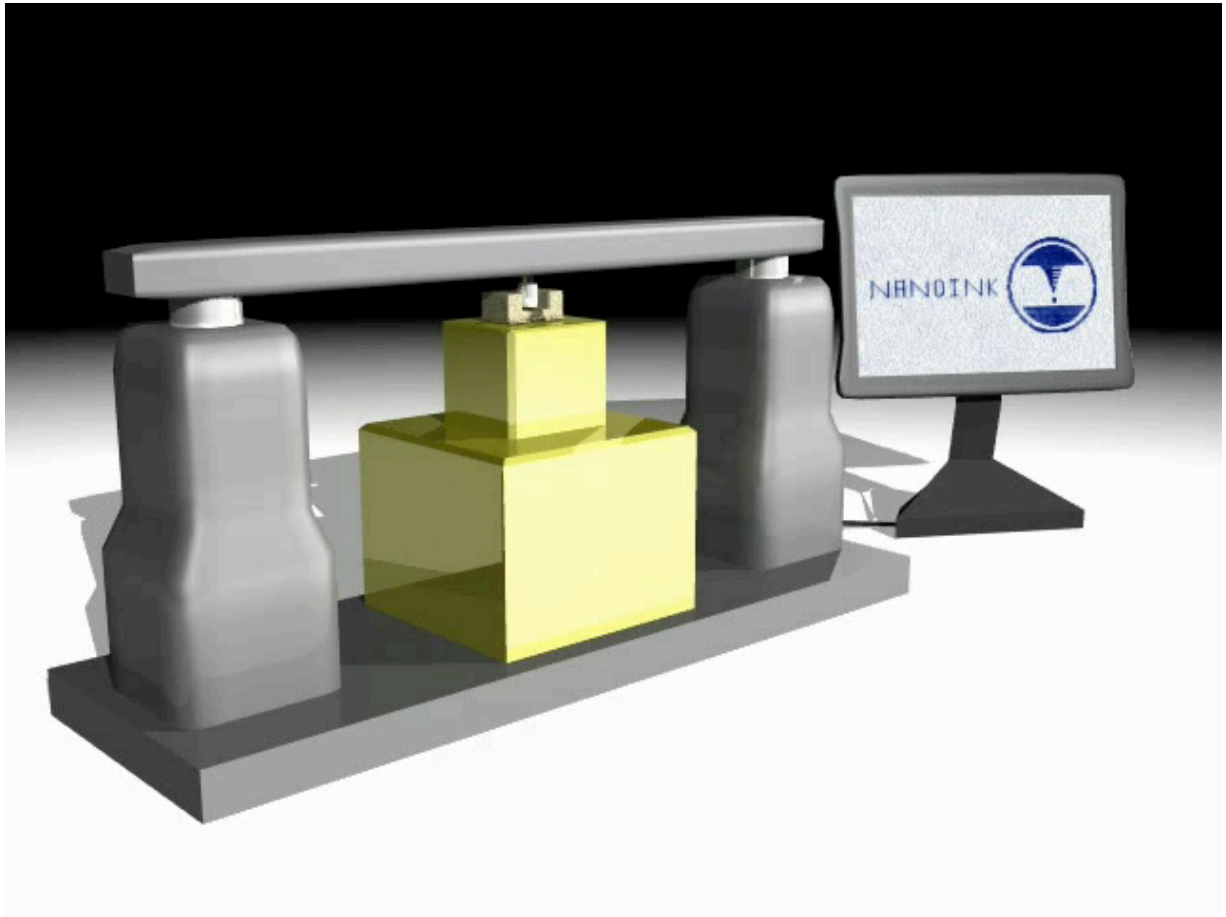






Surface Logix

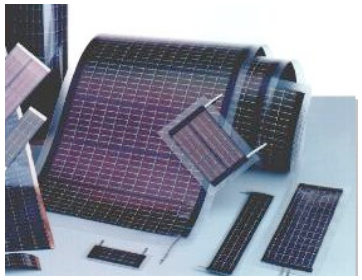
Writing One Molecule At A Time



Large Area Macroelectronics

Applications

Electronically 'steerable' antennas



Displays

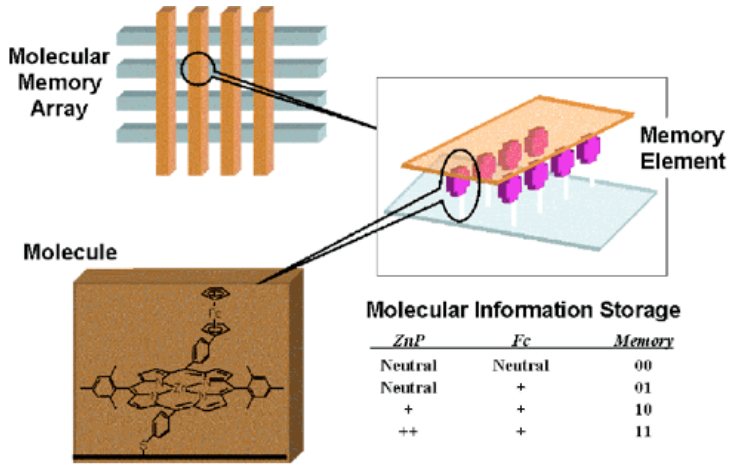
Smart cards

RF-ID tags

Wearable Electronics and Communications

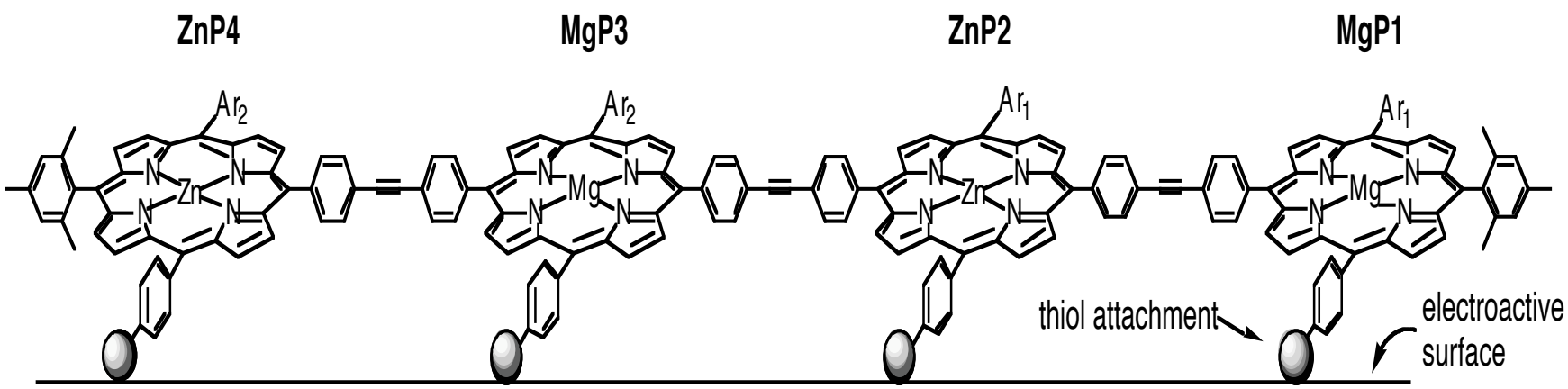
nanosys

Taking Cues From Biology For High Density Non Volatile Memory

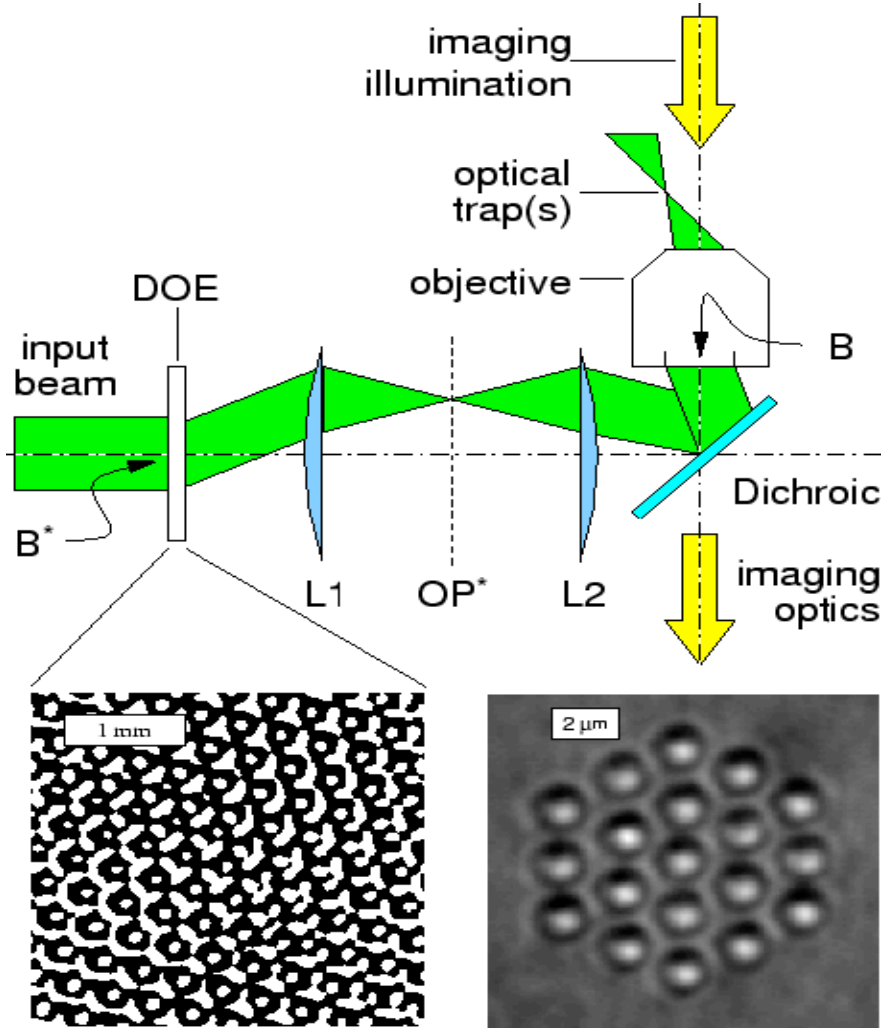


ZnP	Fc	Memory
Neutral	Neutral	00
Neutral	+	01
+	+	10
++	+	11

ZETTACORE



NanoLithography At The Atomic Scale



Arryx

Issues For Venture Capitalists

Why There Isn’t A Gold Rush

Technology Chasm

Academic
Research

Development

Technology Chasm

Academic
Research

Development

Technology Chasm

Academic Research

Applied Research

Development

“There’s A Pony In There Somewhere”

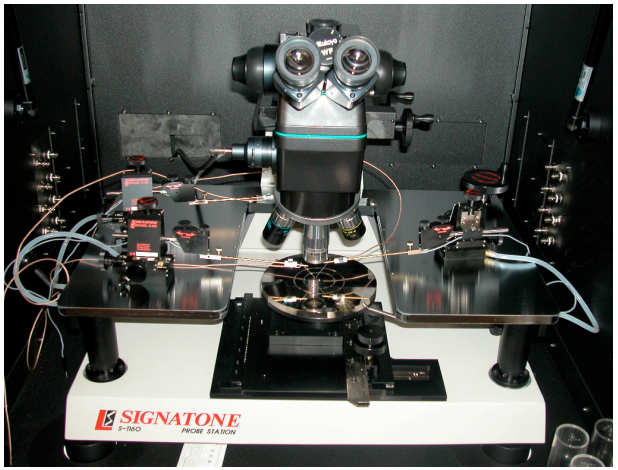
The Big Hurts

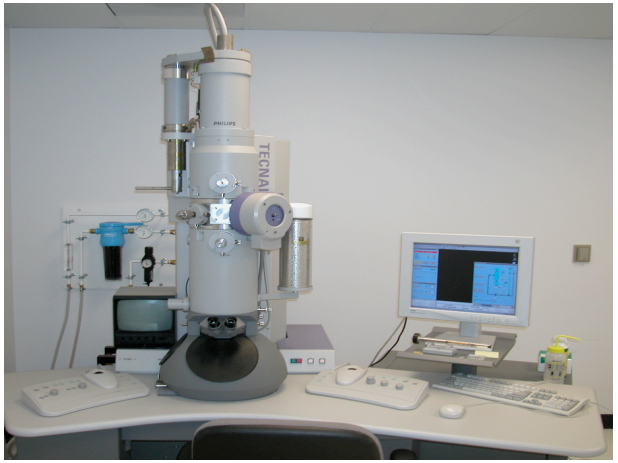
No Trained Workforce

Venture Capital Dictum

"Invest In People That Have Done It Successfully Before With Someone Else's Money"

Highly Capital Intensive Upfront



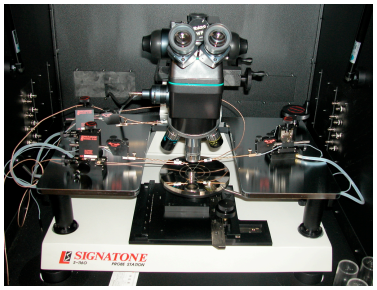


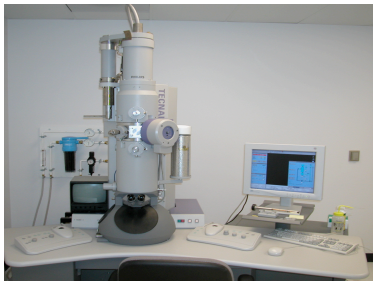
Not A Garage Shop Opportunity -- $5M To Open the Door

Issues For Government

How Do You Keep The Momentum Going

Highly Capital Intensive Upfront



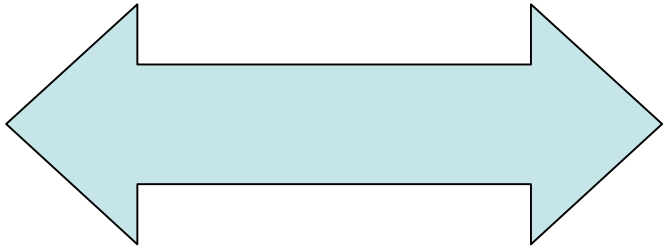


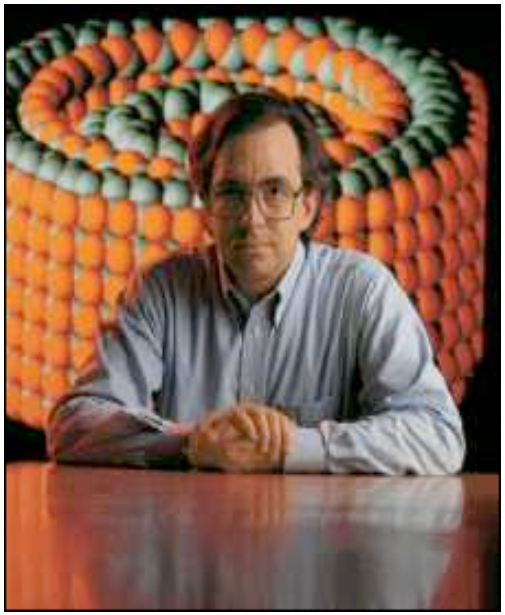
Fear Of Over Regulation

Government Grants

- **To Little**
- **To Slow**
- **To Complex**

Uneducated Public

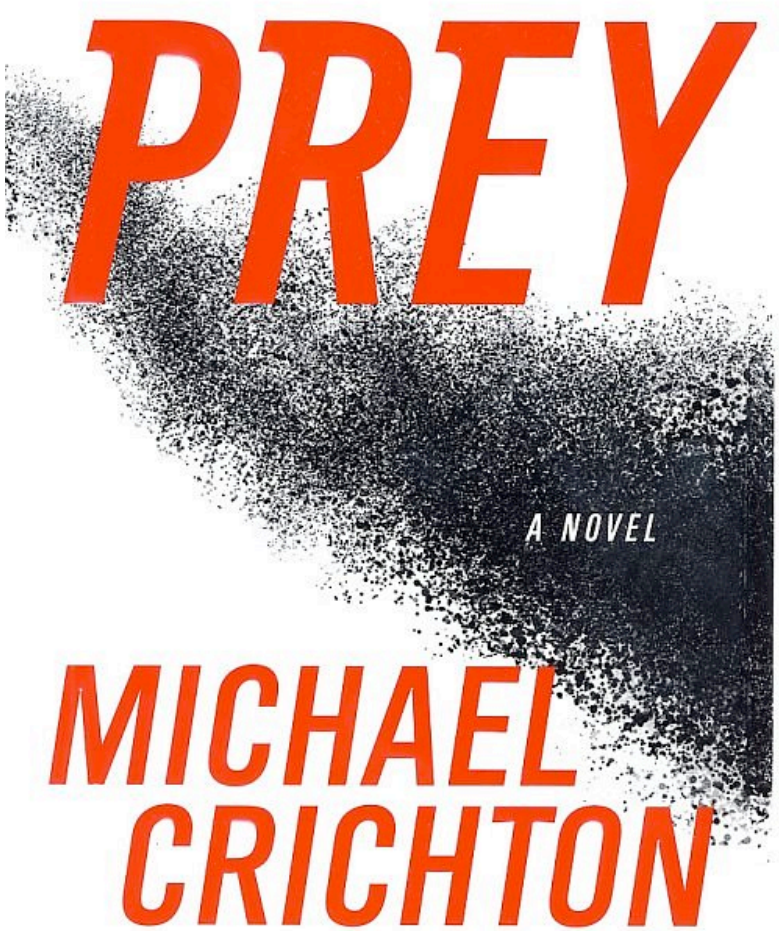




Doomsday

Utopia

Media Hype



Foreign Interest

Taiwan

Lu pledges Taiwan's commitment to nanotechnology

Veeco sets up China Nanotechnology Center
4 September 2002

Korea budgets $1.56 billion for nano R&D

South Korea to invest $150 Million in nanotechnology

JAPAN SEES NANOTECH AS KEY TO REBUILDING ITS ECONOMY

U.S. COMPANY OPENS NANOTECHNOLOGY MEDICAL RESEARCH CENTER IN SINGAPORE

Nanotechnology

"If I were asked for an area of science and engineering that will most likely produce the breakthroughs of tomorrow, I would point to nanoscale science and engineering"

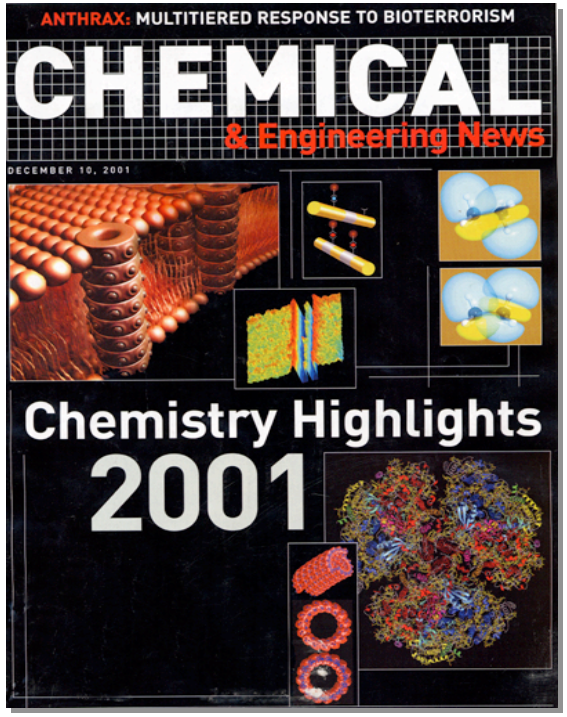
Neal Lane

Assistant to the President

For Science and Technology

nanosys

"The Next Small Thing"



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