

Nanowires – Many Materials Many Applications



NanoScience Exchange
March 2003

Charles Ostman

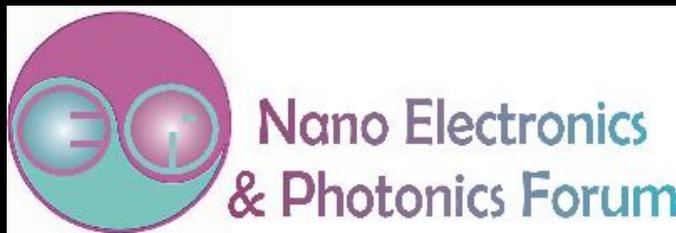
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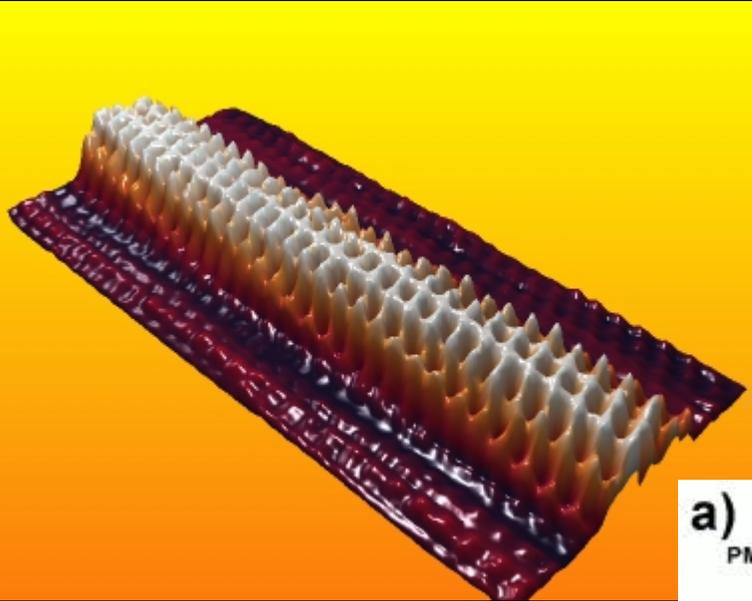
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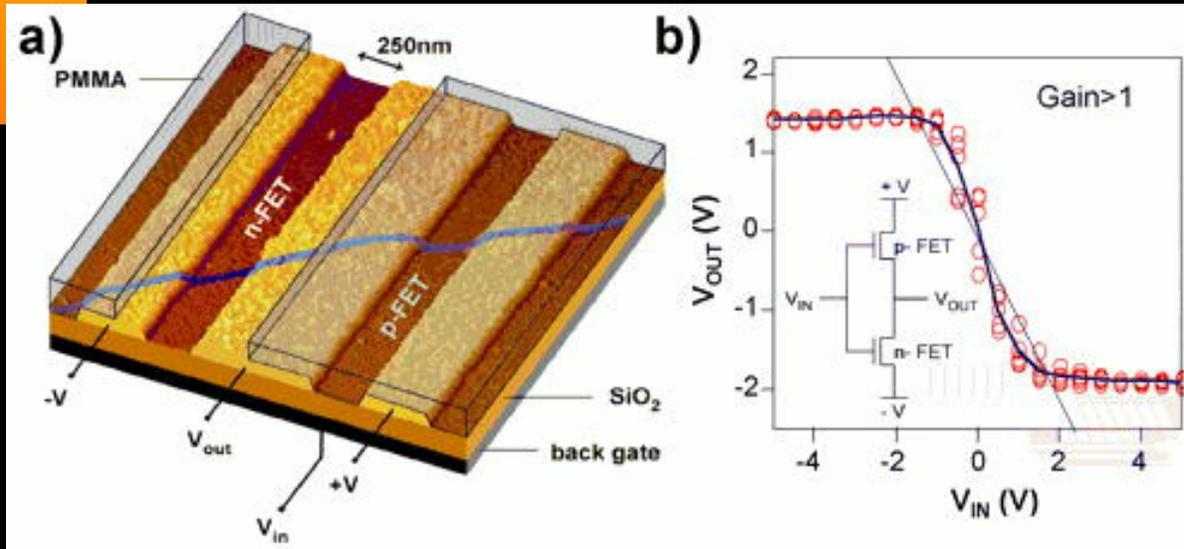
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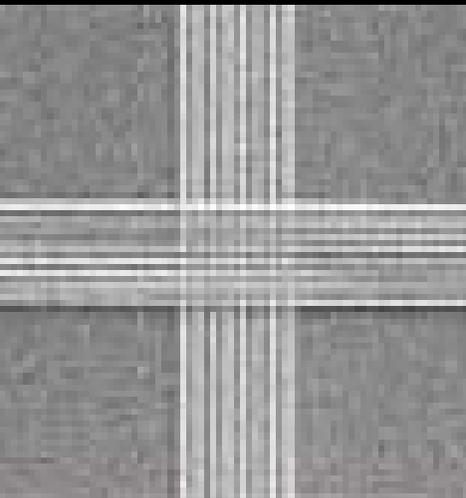
Nanowires in Nanoelectronics / Molectronics



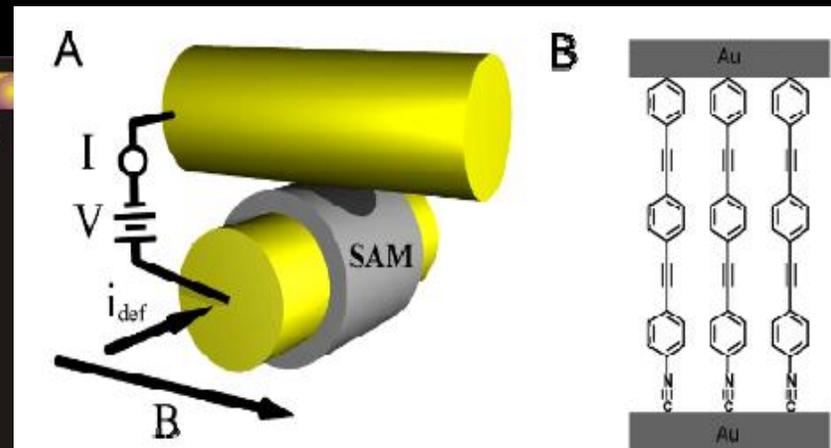
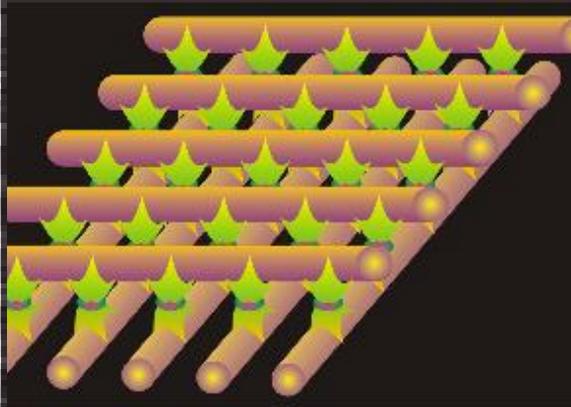
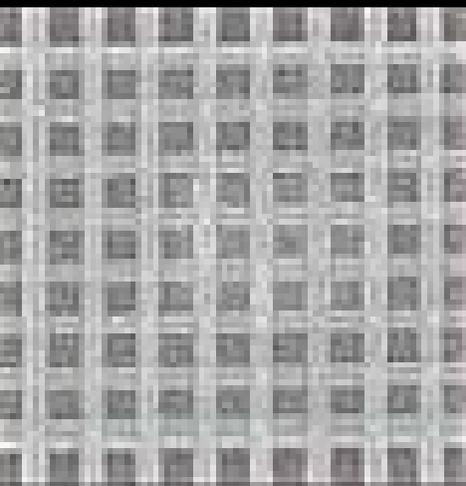
- Interconnections
- Dynamic Devices



Nanoelectronics / Molelectronics

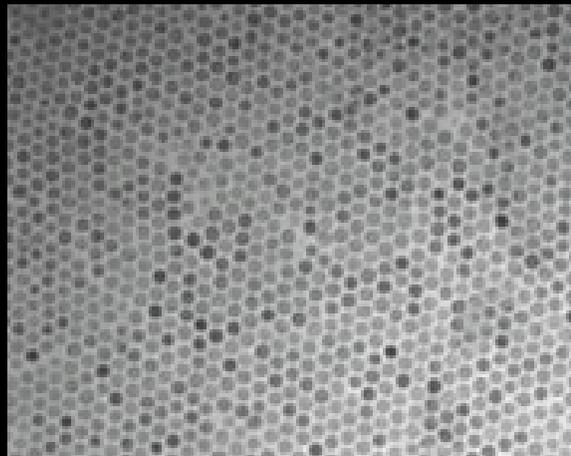
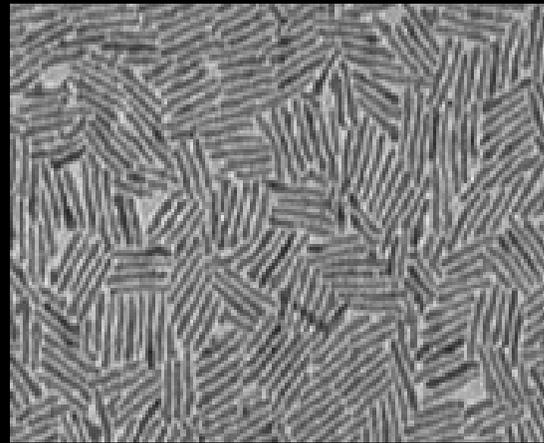
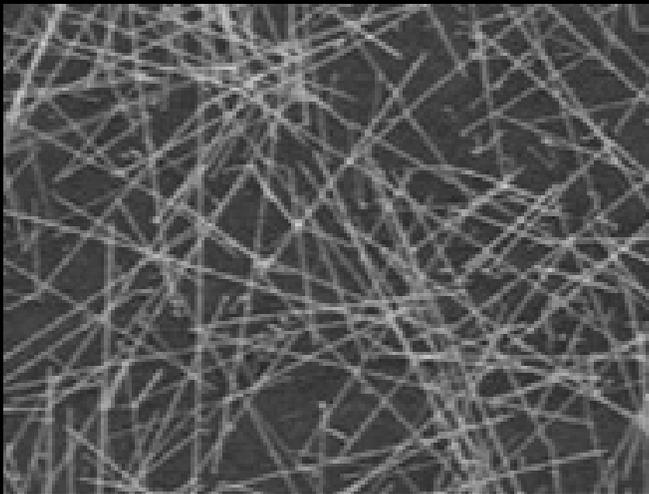


- Interconnects for memory, FPGA (reconfigurable logic) array fabrics
- Interconnection between the nano / micro / meso domains

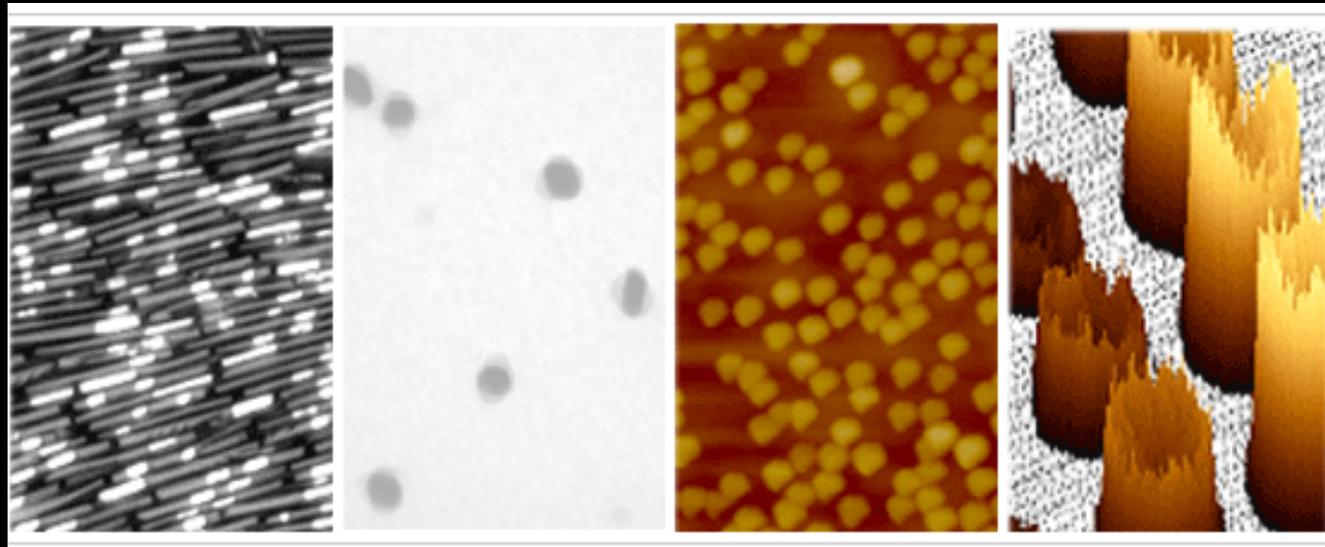
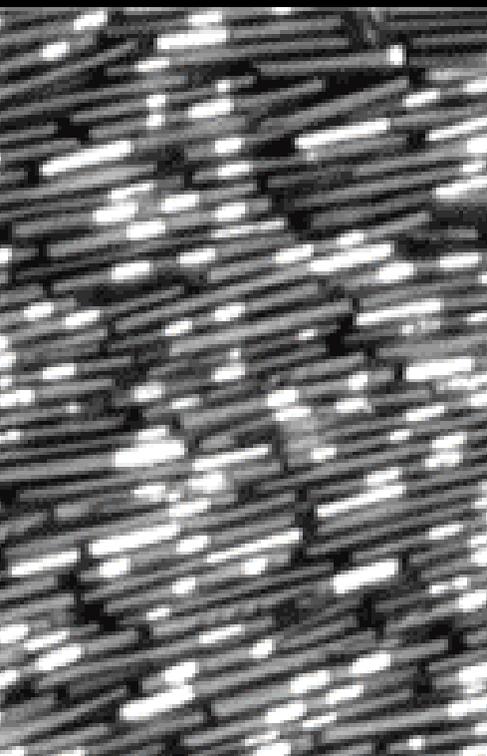


Nanostructured Materials – Wires, Rods, Dots . . .

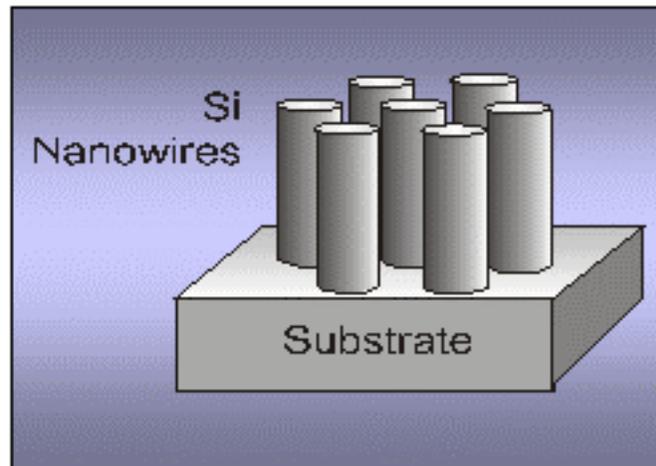
- Foundry processes / fabrication techniques enabling mass production of nanoparticles
- Broad range of functionality



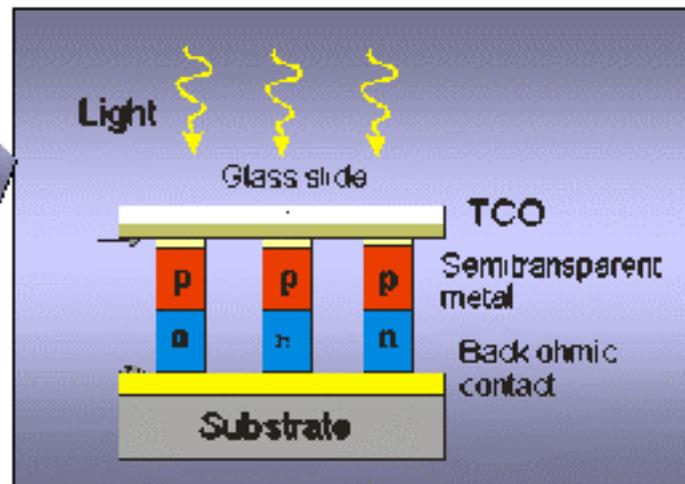
Periodic Nanostructured Materials



Some of the potential applications of periodic nanostructures are:



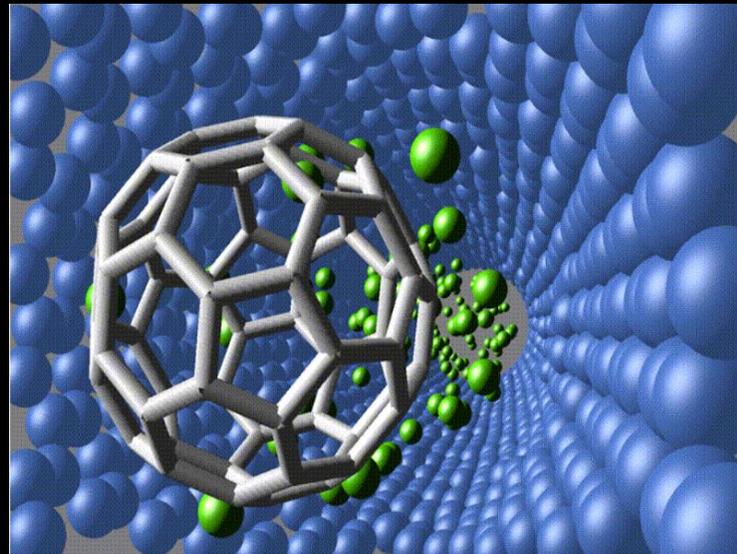
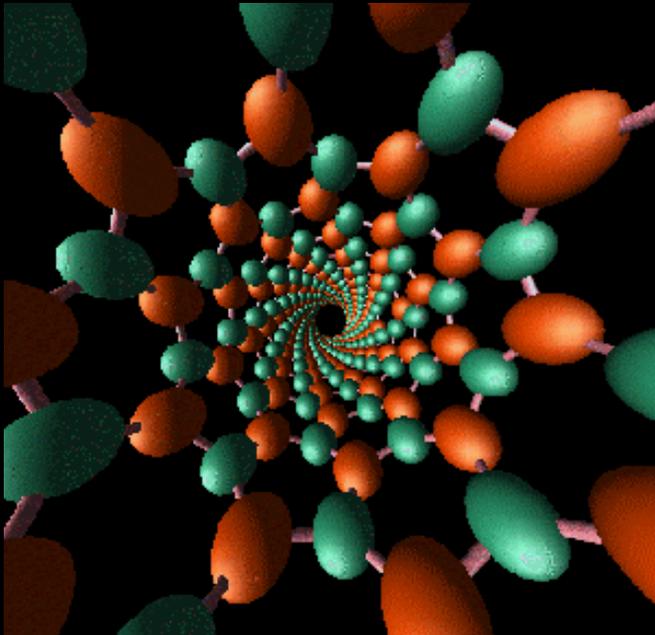
- Quantum effect dots
- Resonant tunneling diodes
- Single-domain/bit magnetic storage media
- Single electron transistors (SETs)
- Light-emitting diodes (LEDs)
- Photodetectors
- Quantum well optoelectronic devices
- Quantum cellular automata
- High-density memory



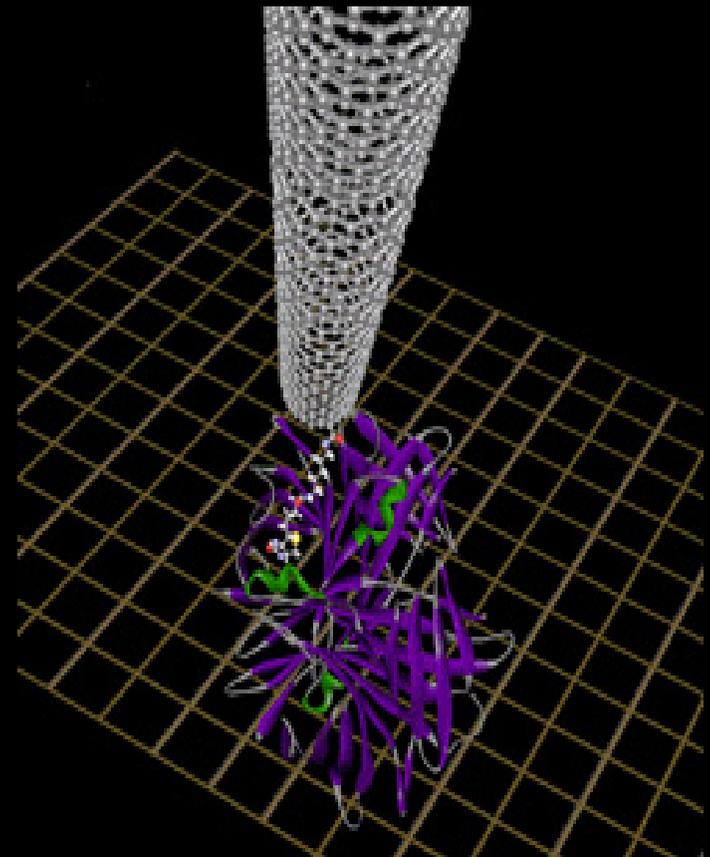
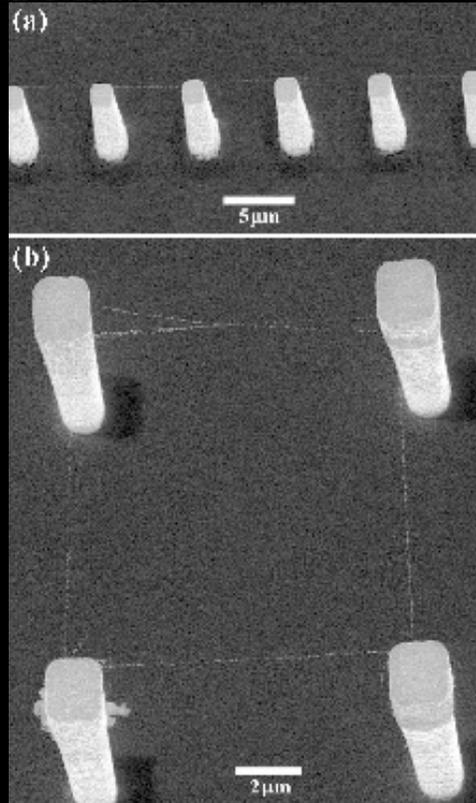
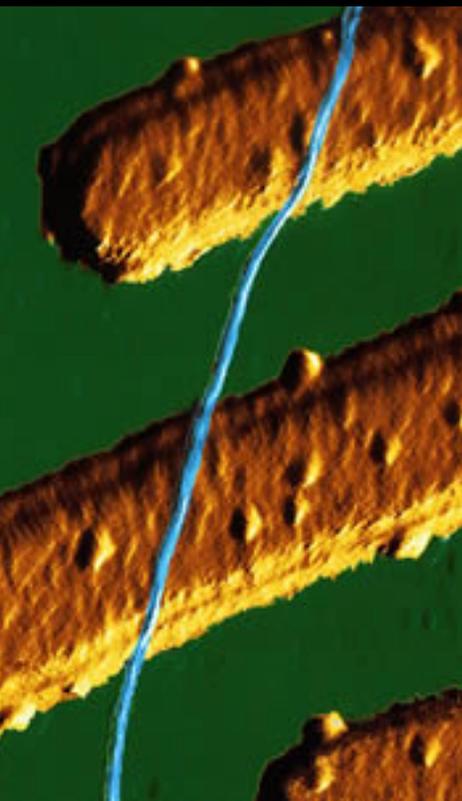
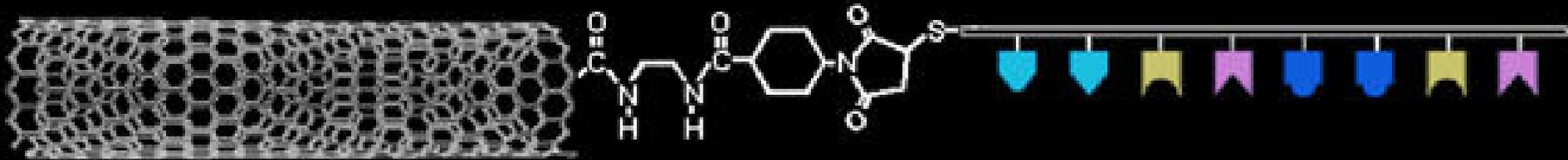
Schematic of a Si photodetector array fabricated on periodic Si nanowires

Carbon Nanotubes and Nanostructures

- Electrically conductive
- Receptive to wide variety of chemical / metallic dopants
- Excellent mechanical properties

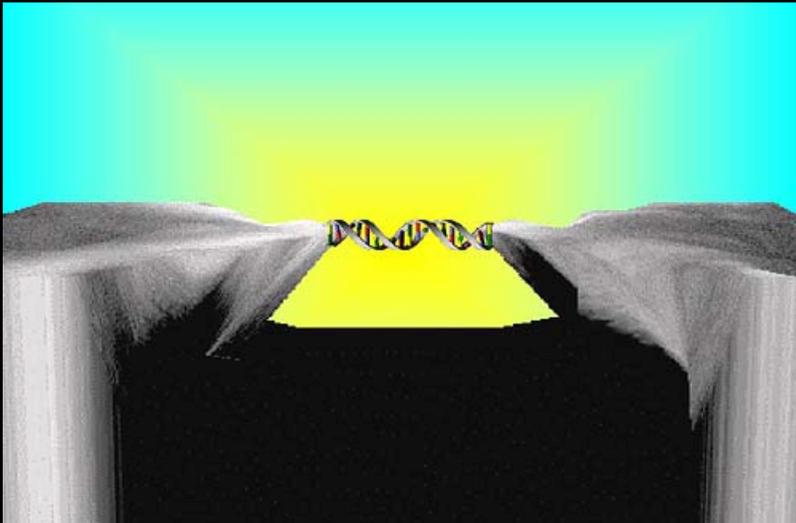
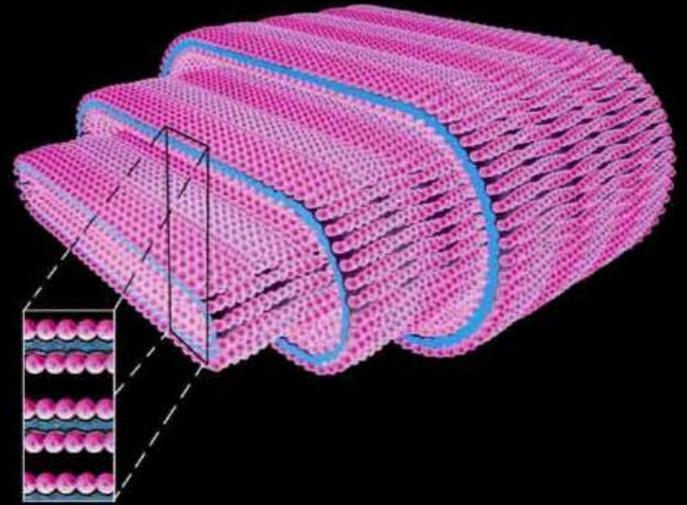


Carbon Nanotubes Integrated with Organic Molecules / Biological Materials

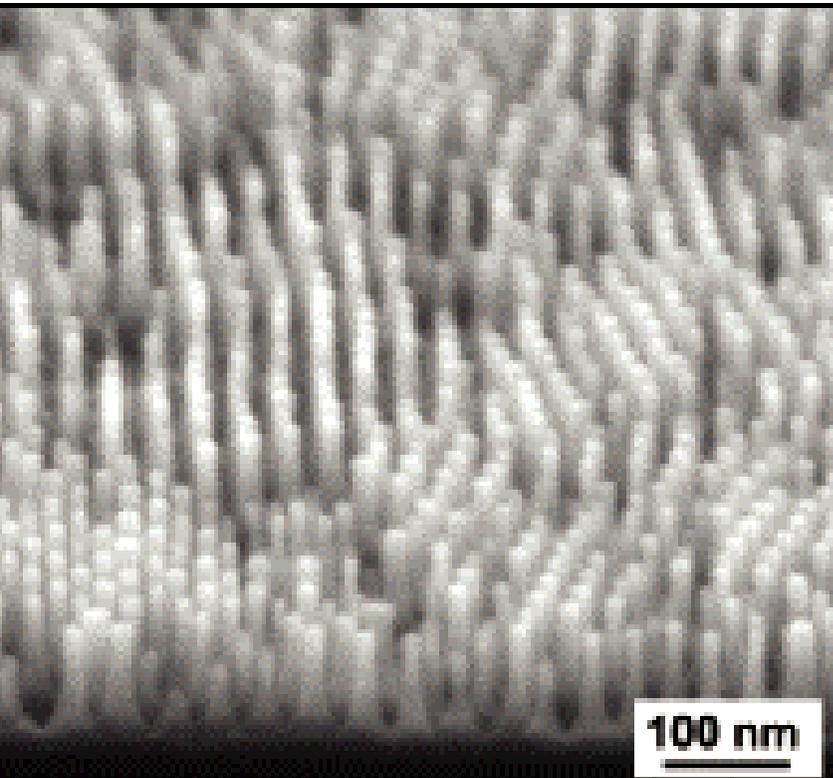


Define Nanowires . . .

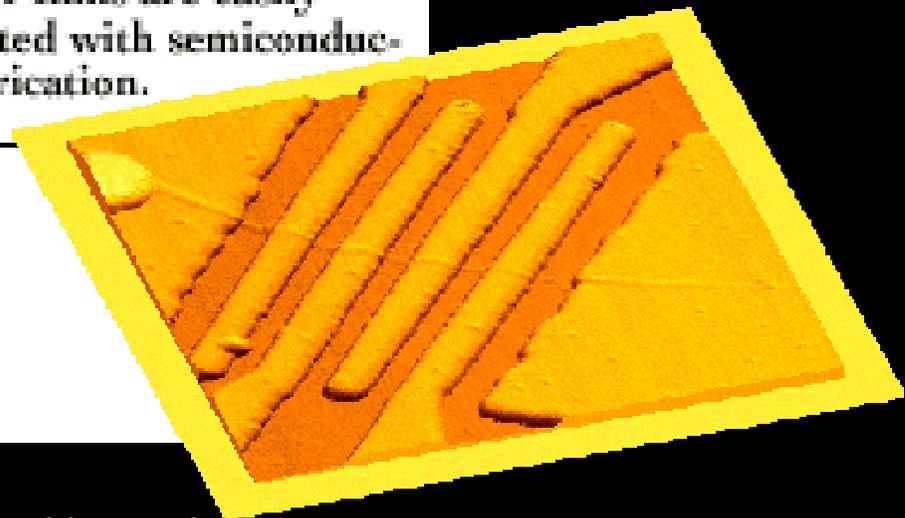
- Electronic, Photonic, Structural Properties
- Carbon, Polymers, Proteomics, Metallics
- Integrated / Periodic Nanostructures
- Integrated Devices, Circuitry, Sensors



Define Nanowires . . .



IBM combined diblock copolymer thin films with conventional silicon processing to form these 20-nm-diameter self-assembled silicon pillar arrays. The polymer films are easily integrated with semiconductor fabrication.

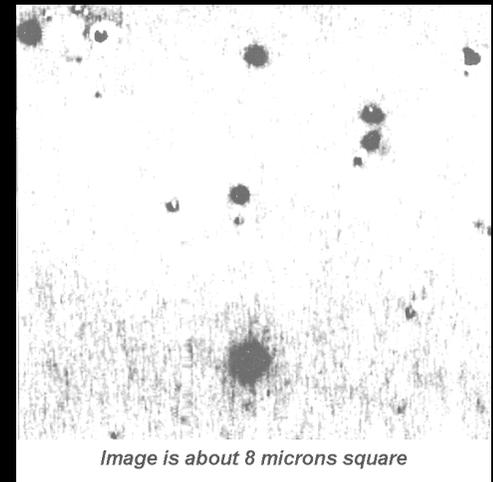
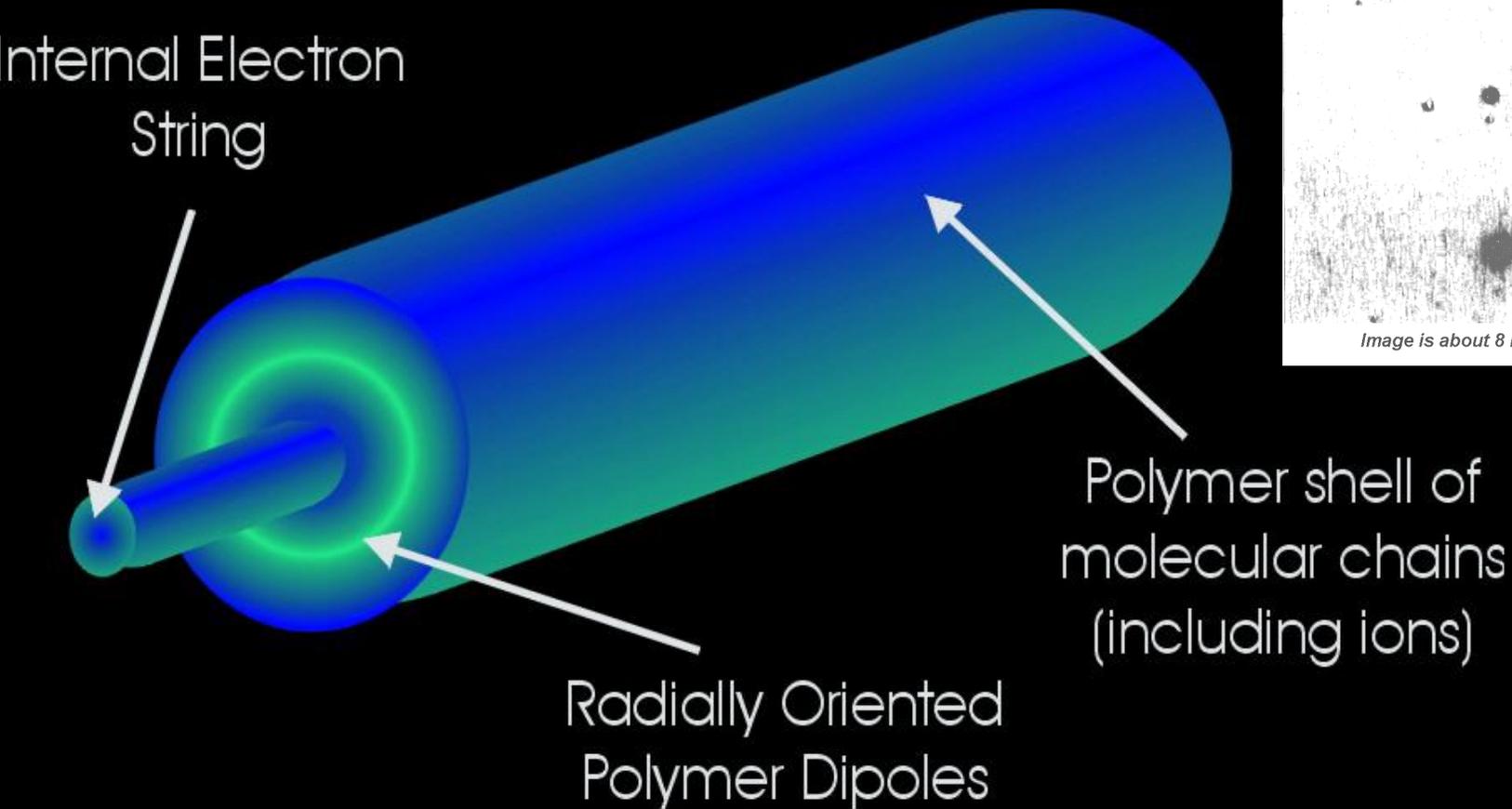


- Many Materials, Many Applications

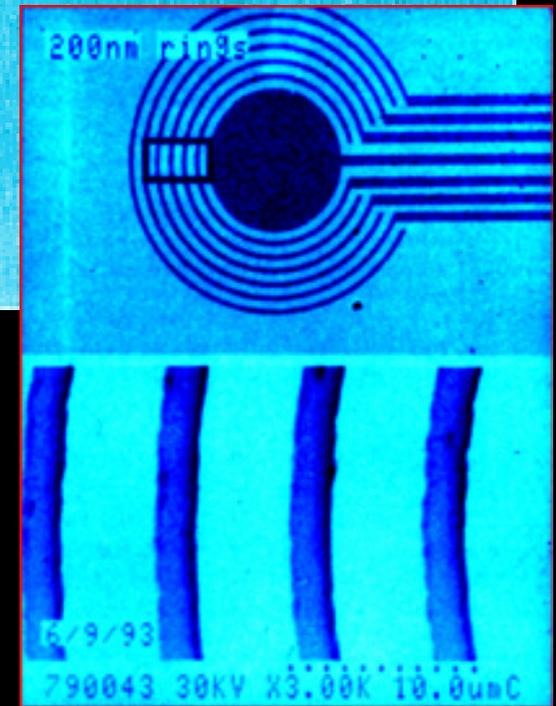
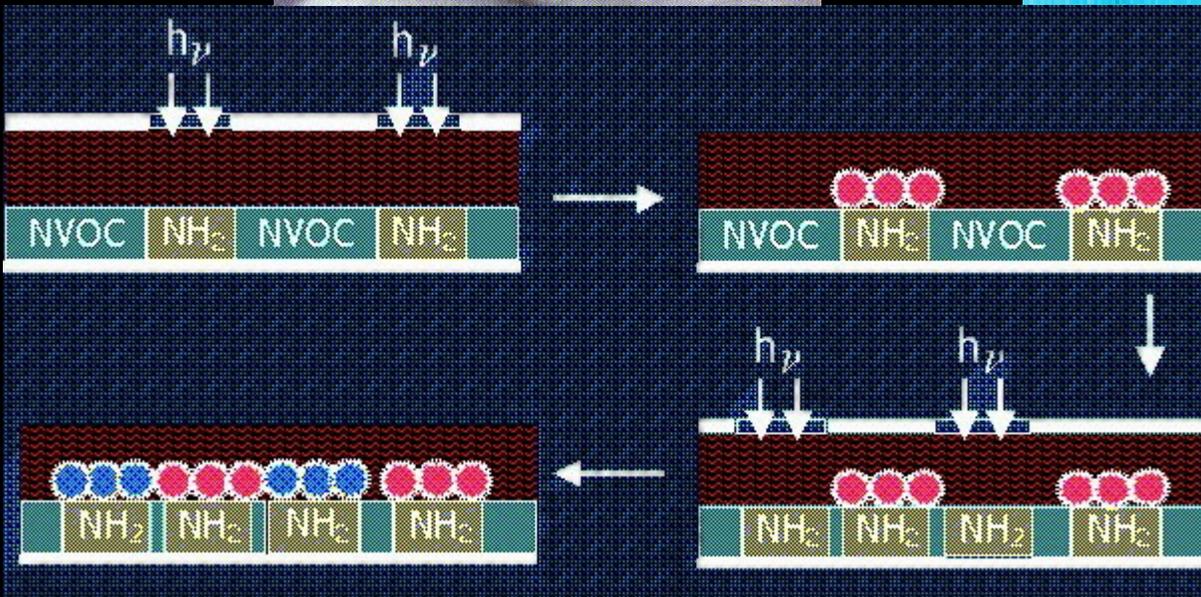
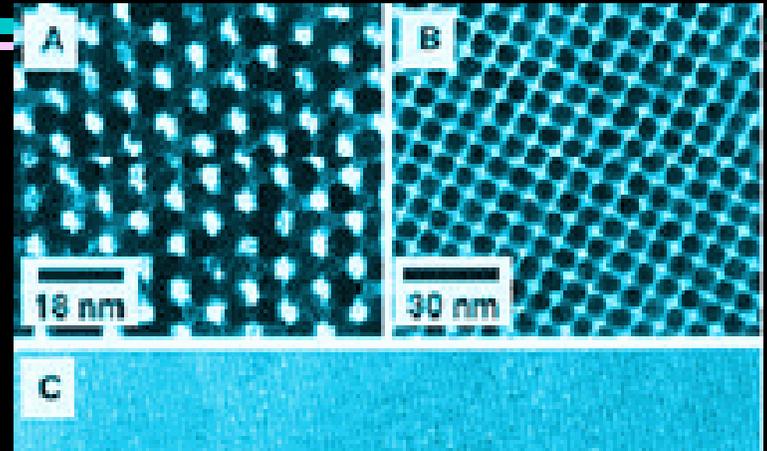
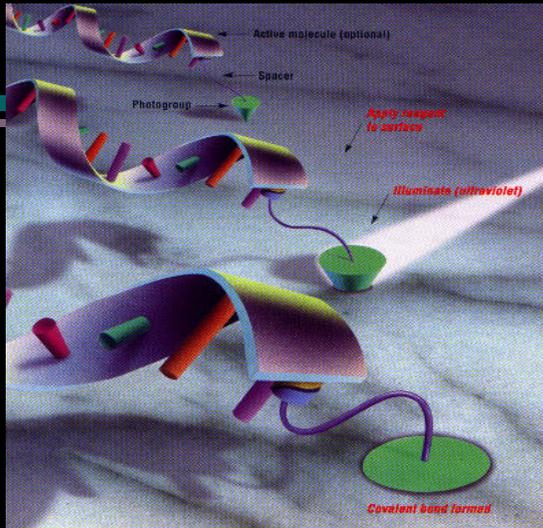
1 μm

Nanomaterials with Novel Properties

- Vertically oriented ultra-conductive self polymer assembled “nanowires” in an insulating thin film



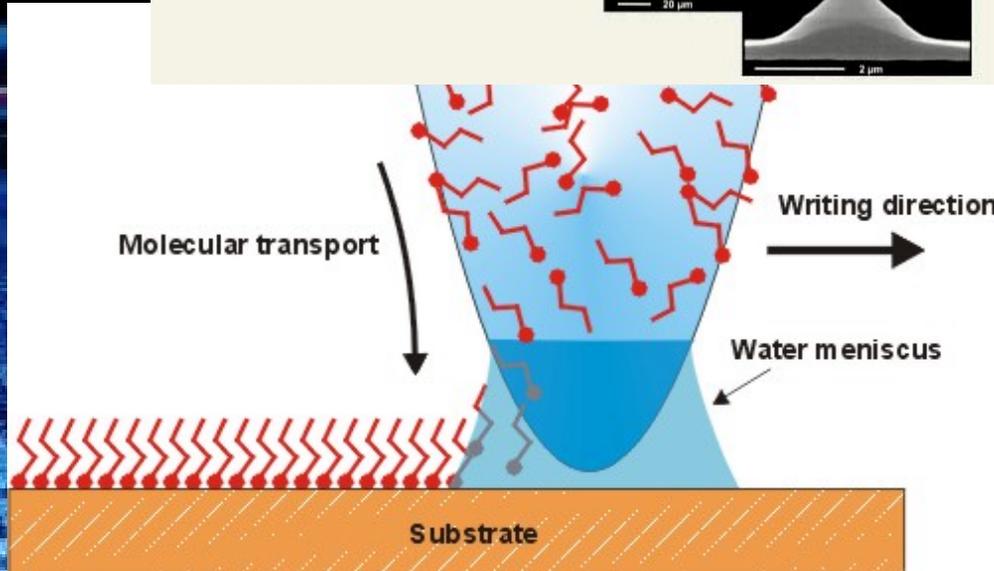
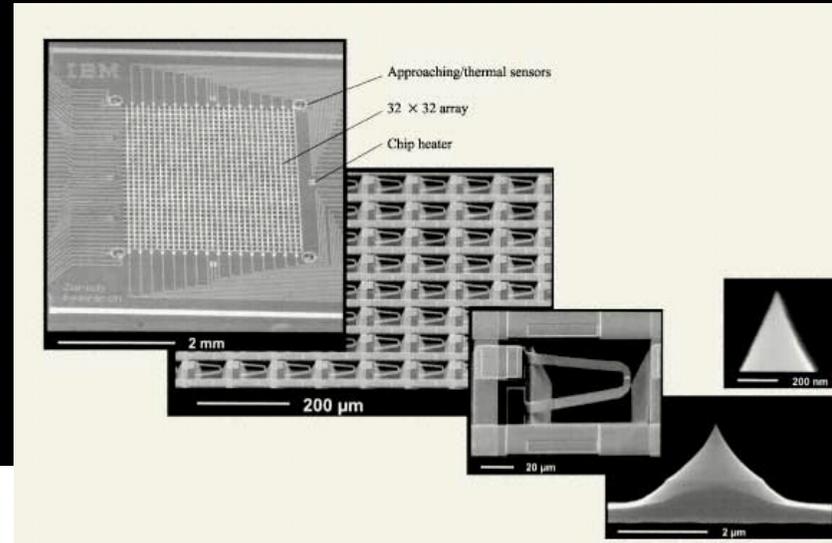
Biolithography – Directed Biochemical Assembly



Value Proposition is in Synergistic Opportunity

Example - AFM arrays

- Enabling platform for data storage
- Massively parallel molecular deposition

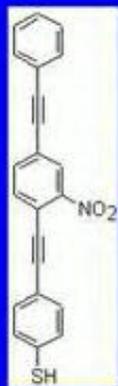


Key Nanowire / Nanodevice Development Indicators

- Self Assembly Reaching Into Applications

Advantages of Molecular Electronics over Silicon:
Bottom-up vs. Top-Down

Molecular Electronics Uses Self-Assembly!



Synthesis

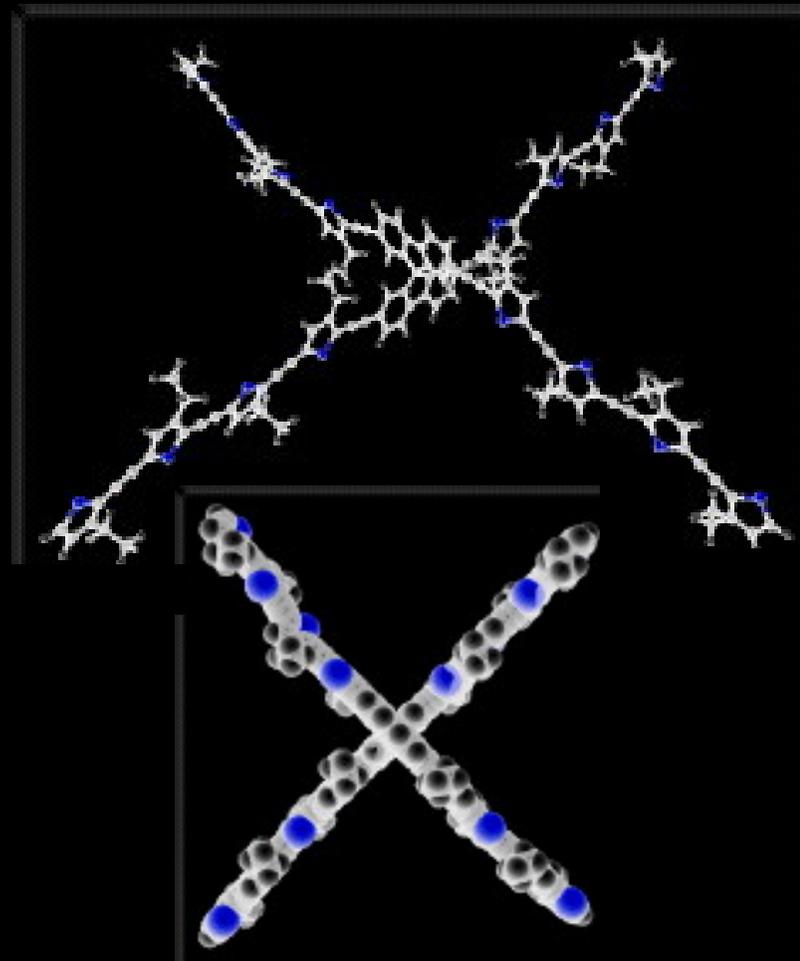


Solution



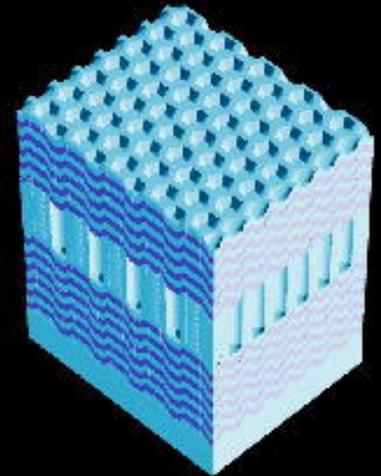
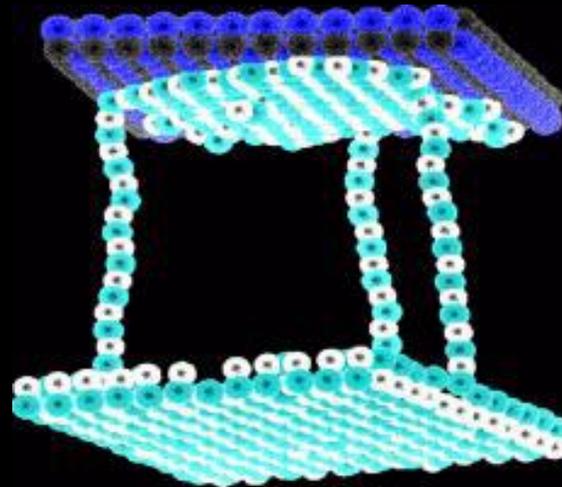
Assembly

Copyright 2001 Molecular Electronics Corp.

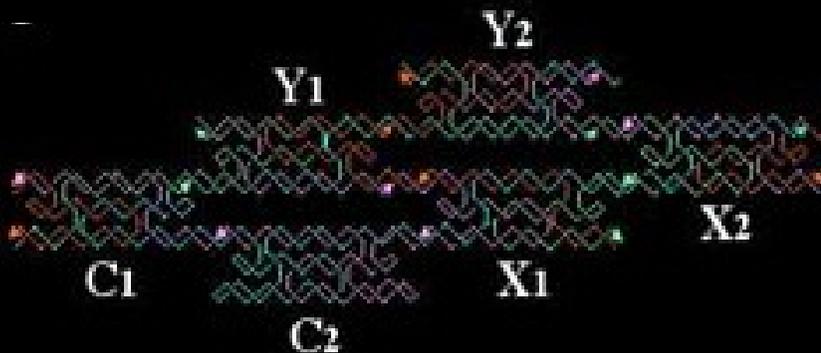
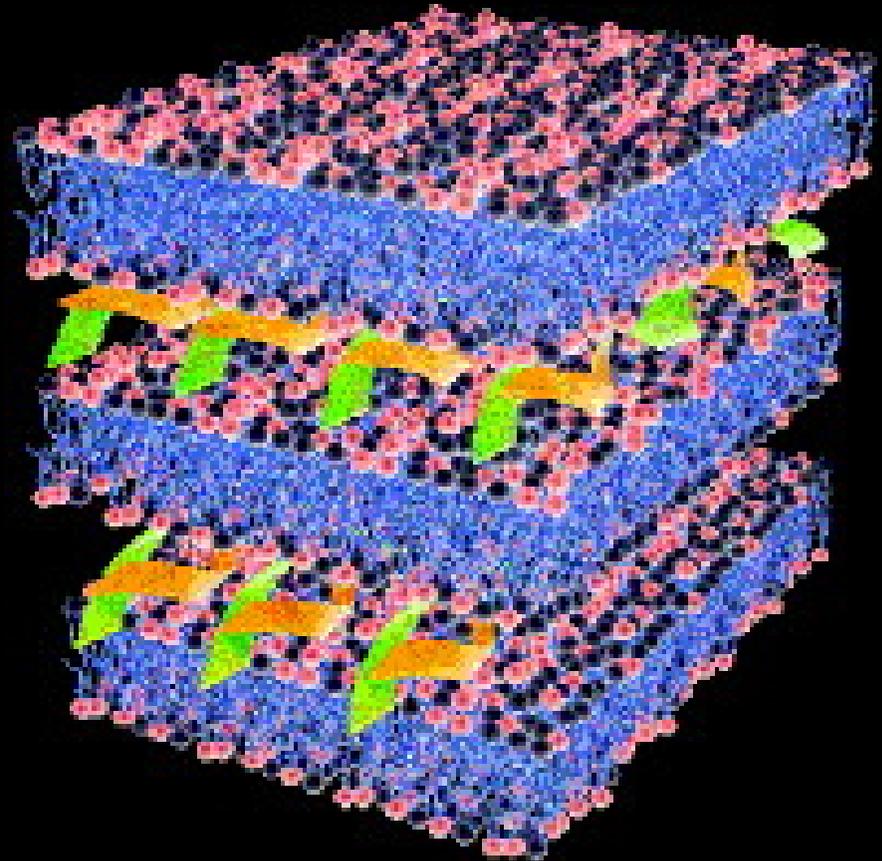


Complimentary Chemistries in Molecular Components

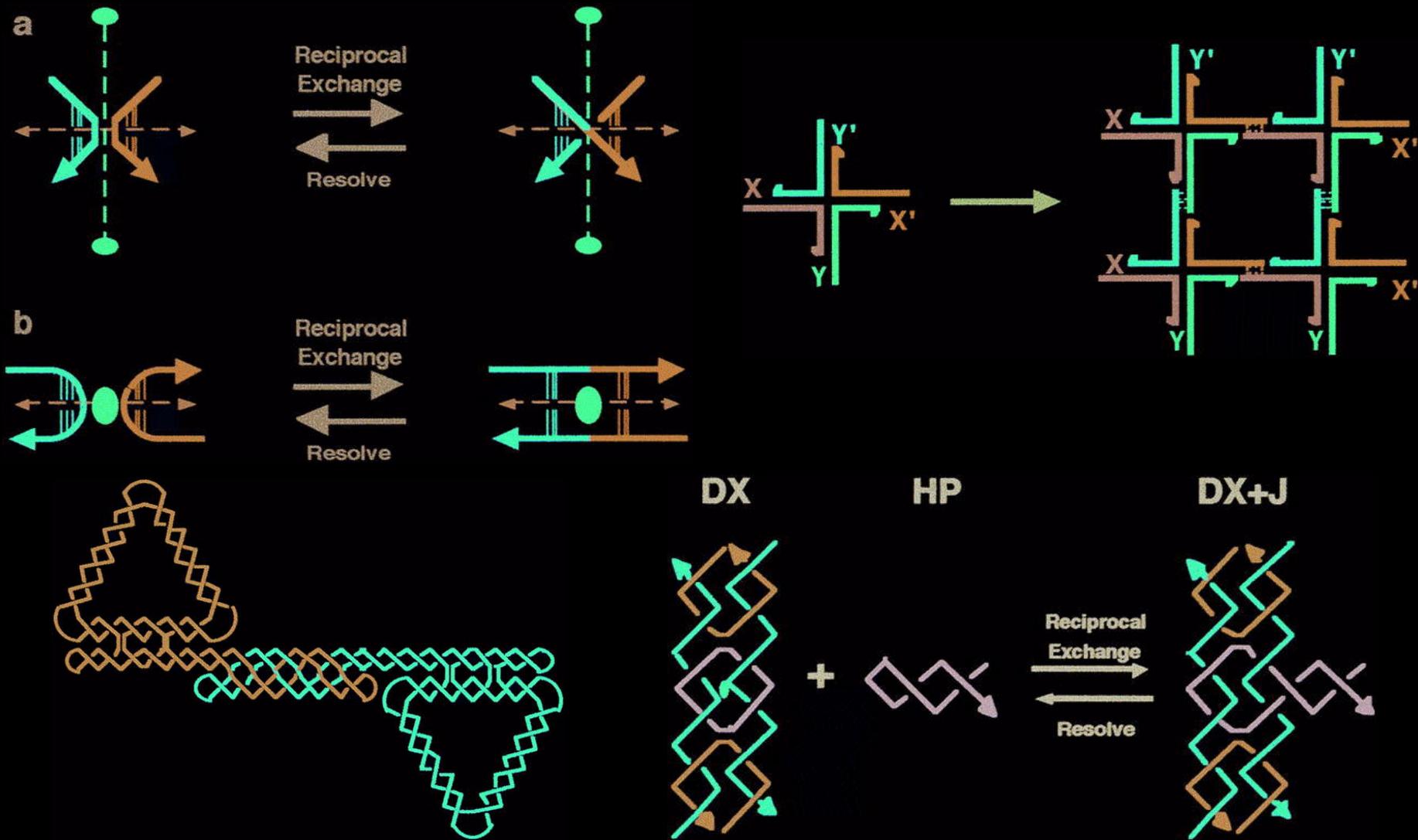
- Integration of organic and in-organic dopants with carbon nanotubes, dendrimers, various molecular structures



Structural Proteomics - Proteomic Assembly

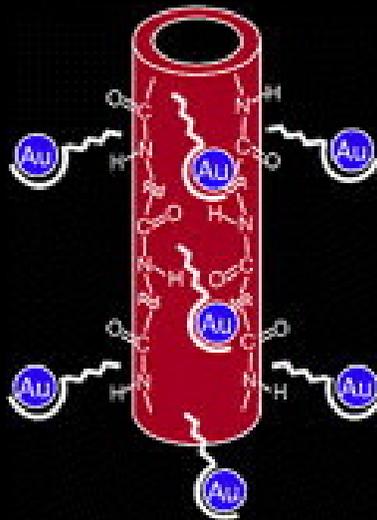
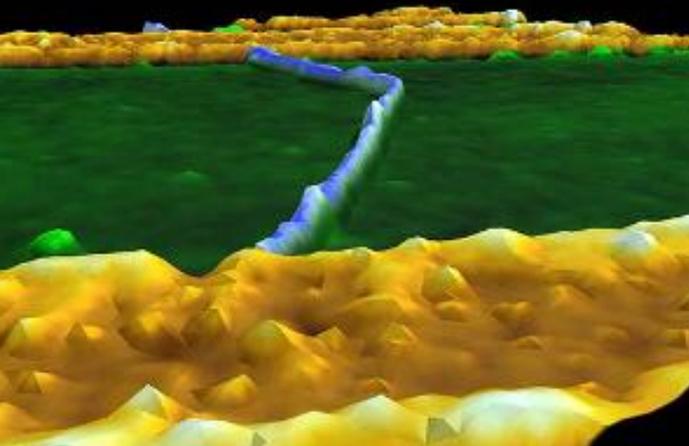


Structural Proteomics - Proteomic Assembly



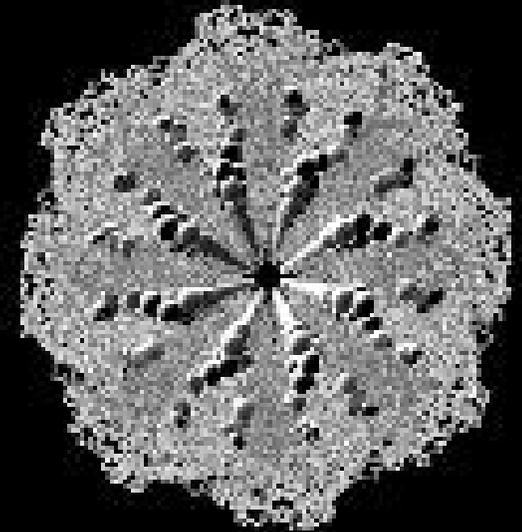
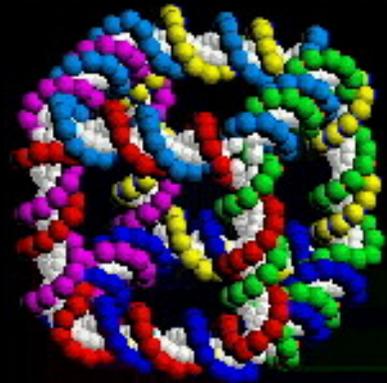
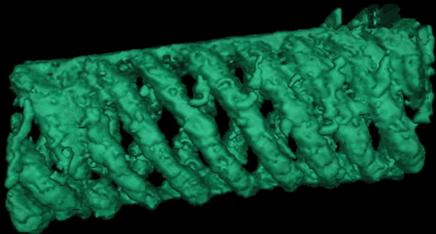
Define Nanowire – Value Proposition

- Self Assembling / Self Organizing Molecular Systems
- Systems Approach to Supramolecular Synthesis / Integration



Molecules as Tools – Not Just Endproducts

- Nanotubes - carbon, polymer, protein, etc.
- Structural proteomics
- Dendrimers
- Organometallics



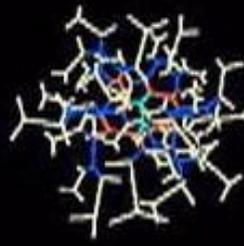
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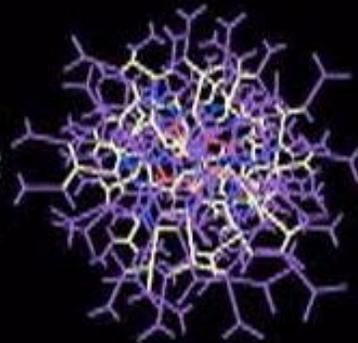
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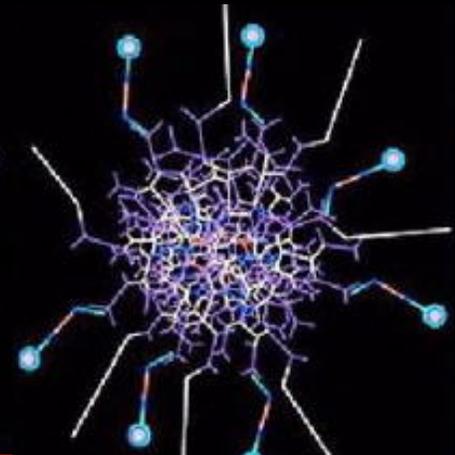
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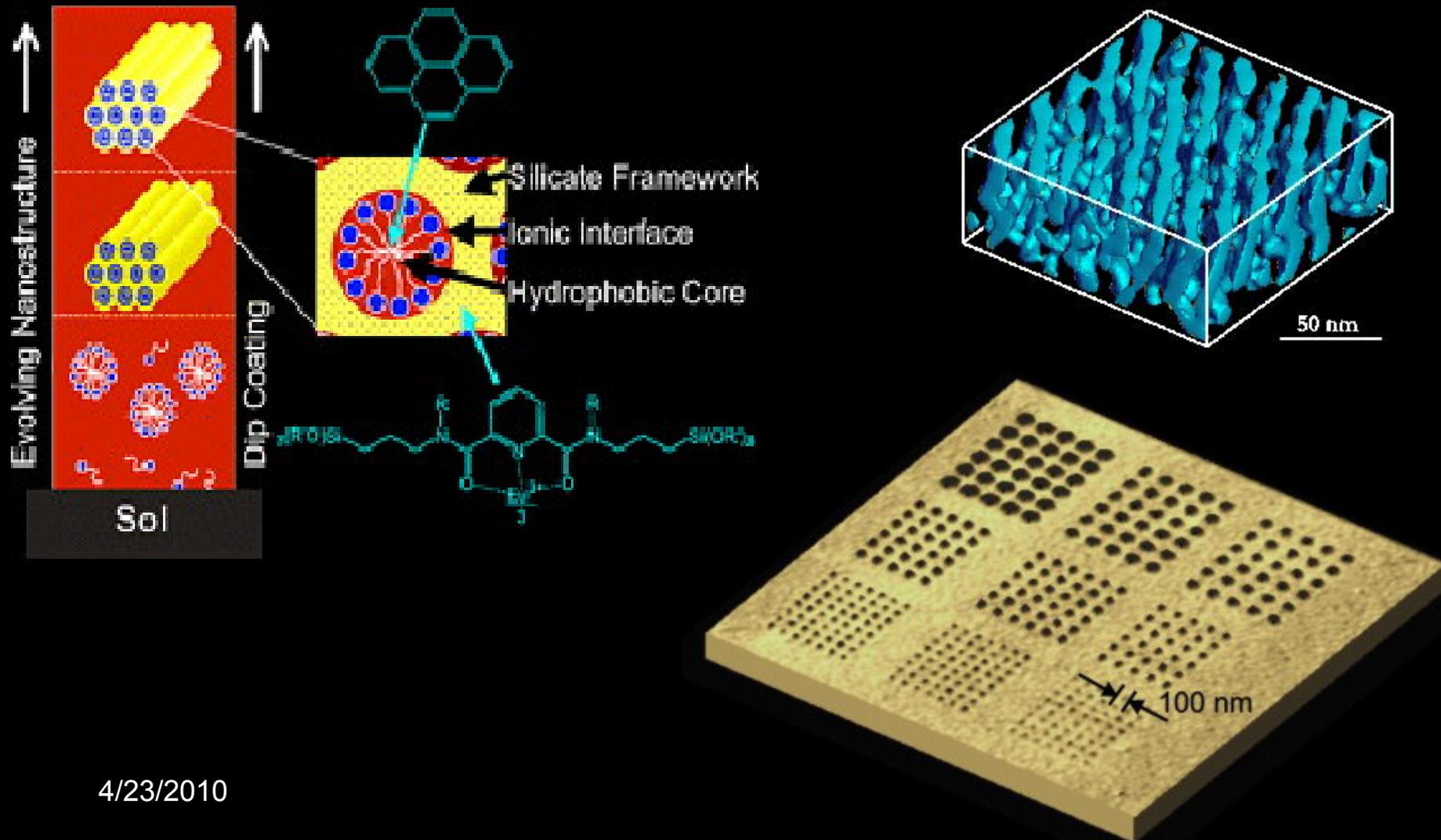
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4 layer

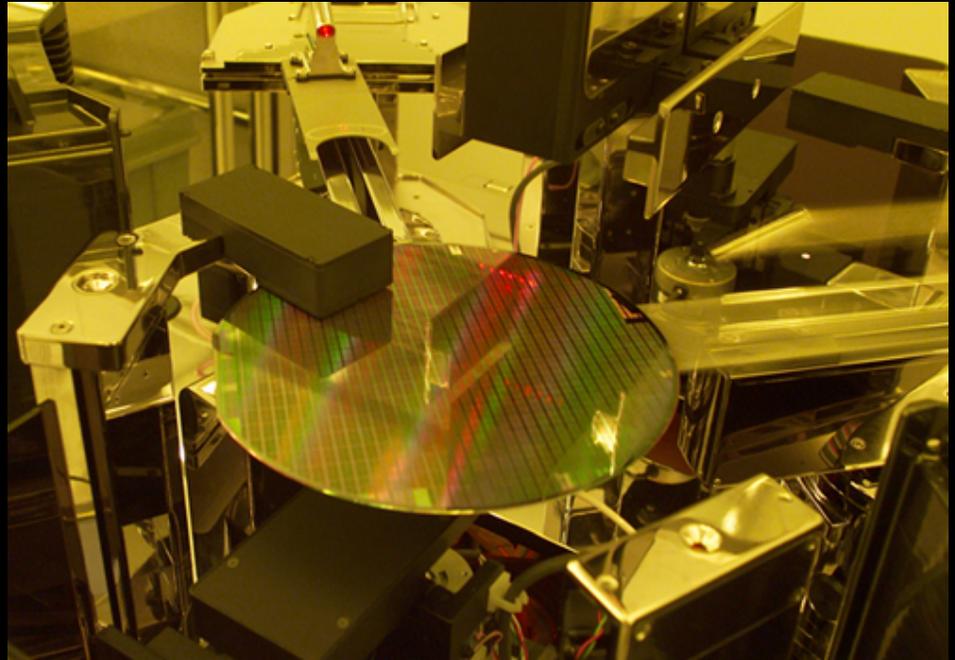


Diversity of Molecular Integration



Define Foundry - Current

- Monolithic, Centralized
- Volume Dependant Amortization
- Rigid Fabrication Parameters
- Highly confined range of materials



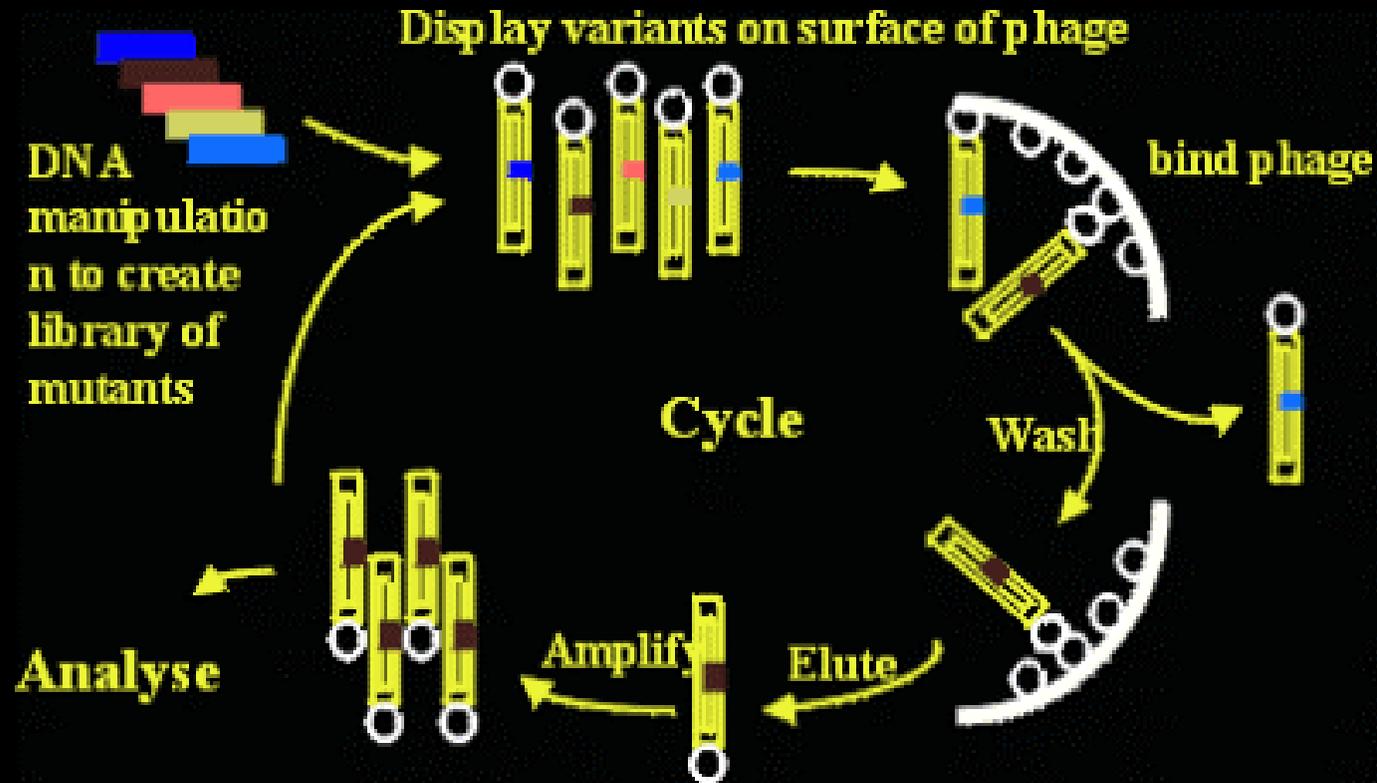
Define Foundry - Future

- Extremely diverse range of materials
- Highly adaptive, polymorphic
- Just as Needed Fabrication



Define Foundry

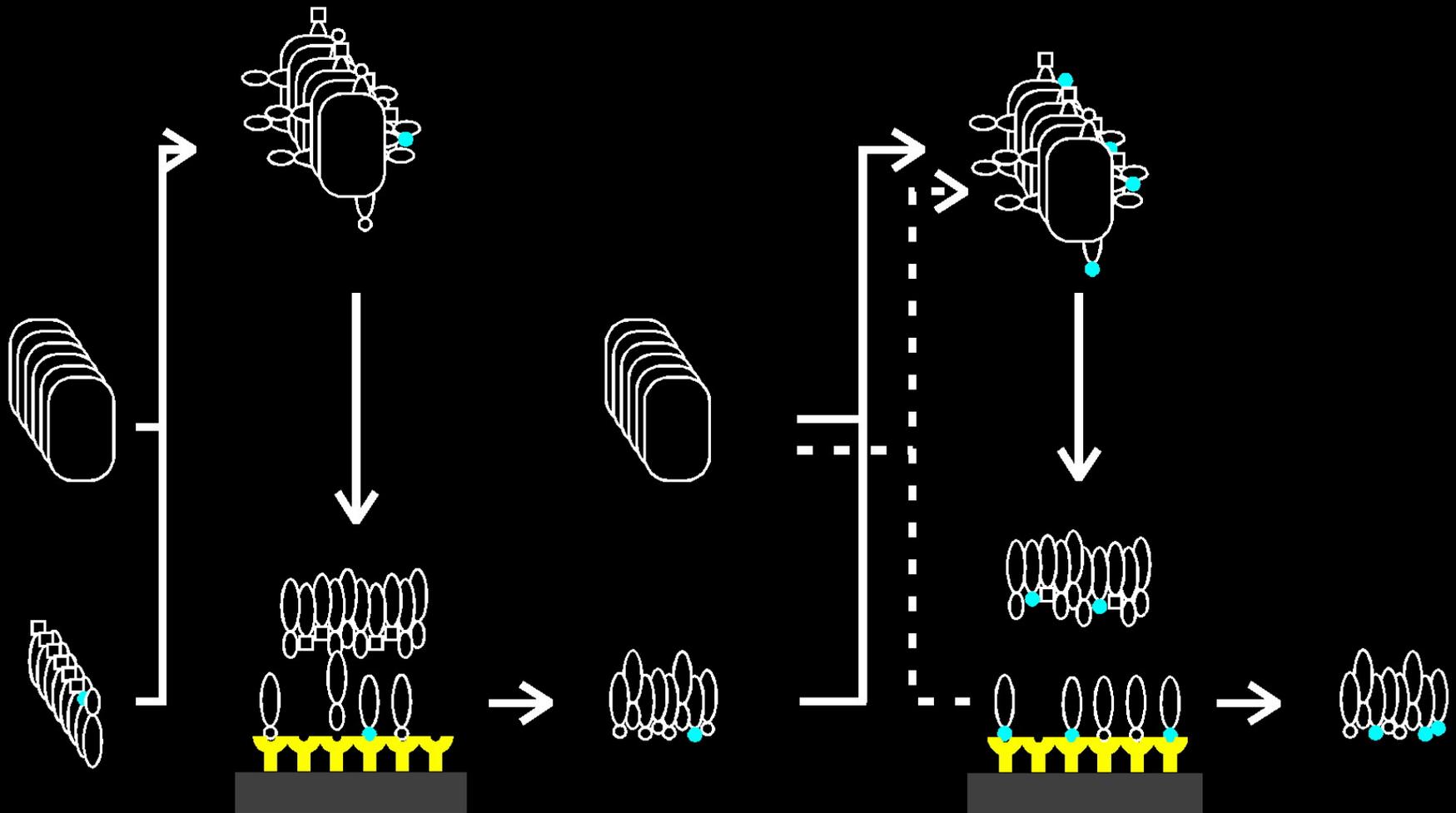
Living Systems as BioFoundries



Phage Display Methods (A. Bradbury et al, LANL, *Nature Biotech.* 18 (2000) 75; *J. Immunol. Methods* 253 (2001) 233.)

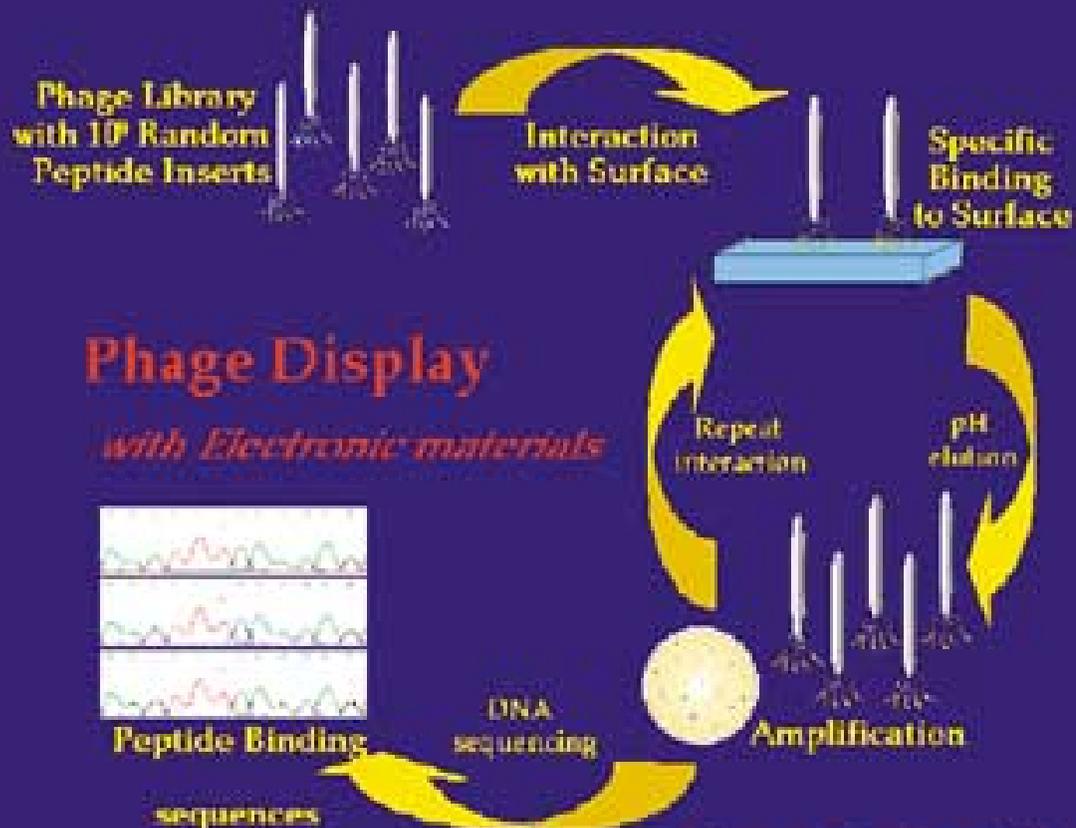
Define Foundry

Living Systems as BioFoundries

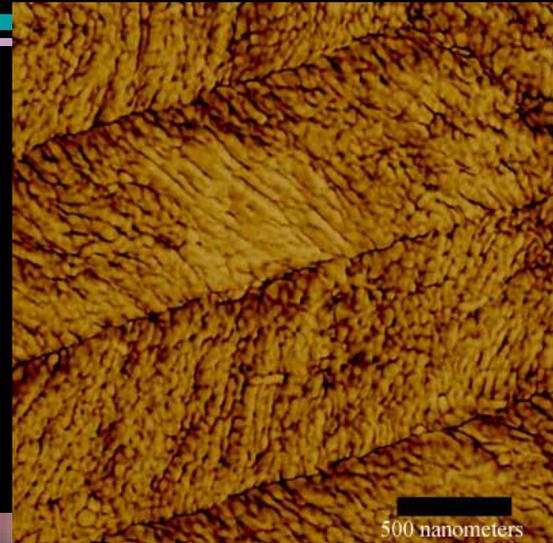


Define Foundry

Living Systems as BioFoundries

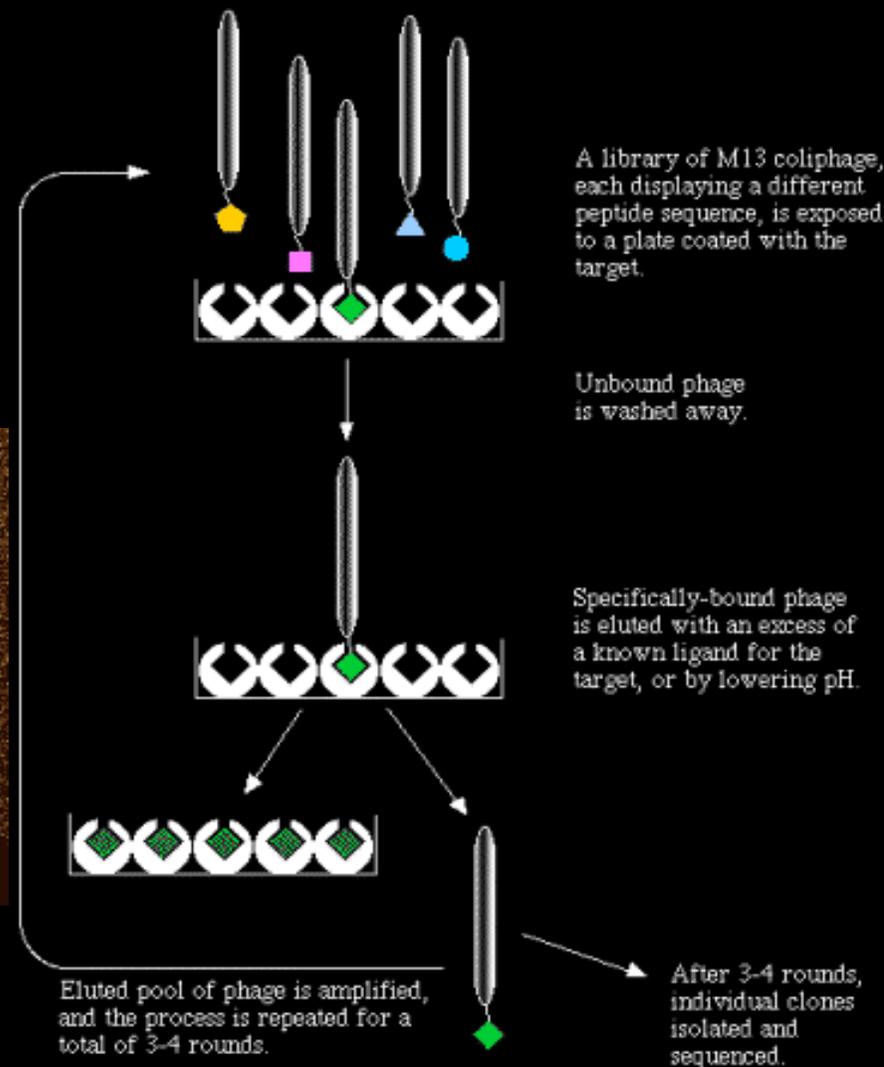
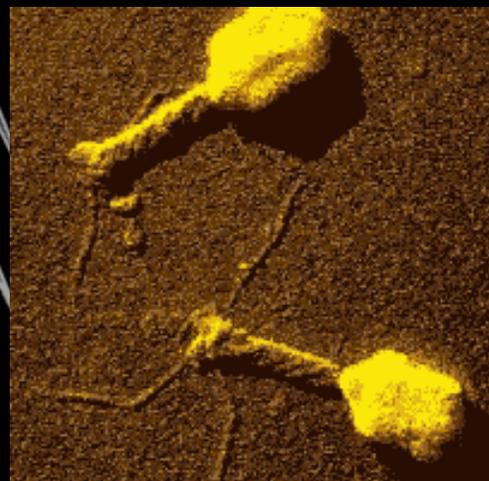
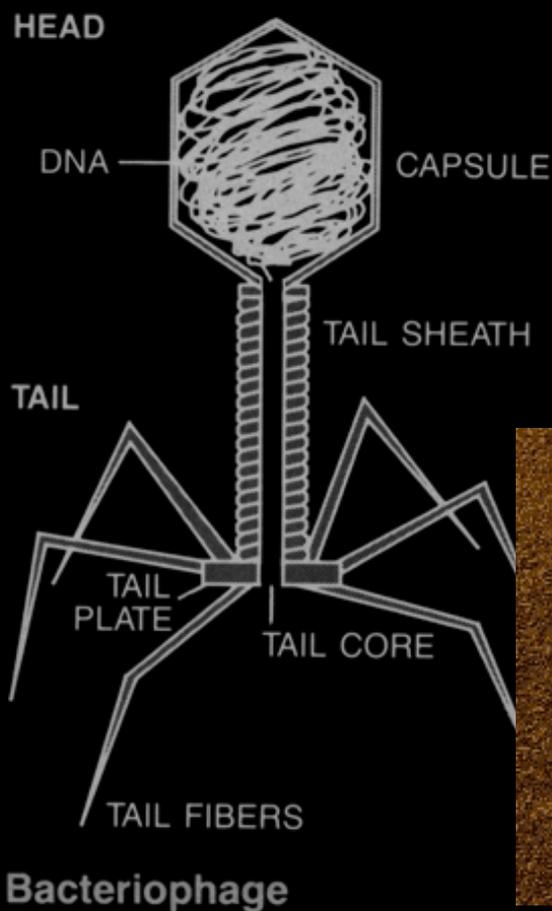


Soldner group, The University of Texas at Austin, 2008



Define Foundry

Living Systems as BioFoundries

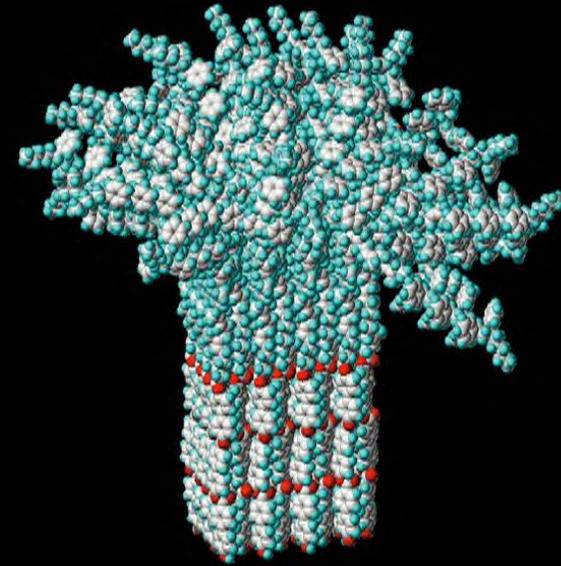


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