SAND2005-7596P

Welcome to the Nanotechnology Future!

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Albuquerque Tricentential Event
November 7, 2005

Sandia is a Multiprogram Laboratory Operated by Sandia Corporation,
a Lockheed Martin Company, for the United States Department of Energy
Under Contract DE-ACO4-94AL85000.

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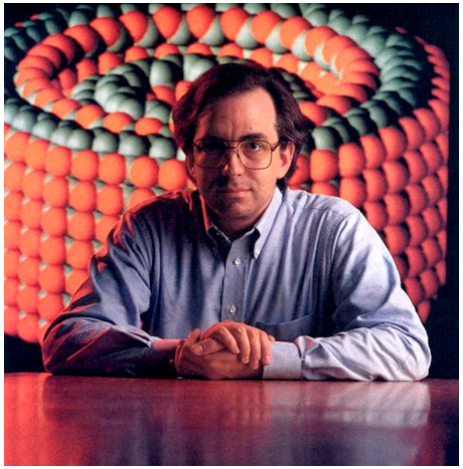
The Scary Future!

*"Nanotechnology will alleviate world hunger, clean the environment, cure cancer, guarantee biblical life spans or concoct super weapons of untold horrors."**

Nano-aliens fight human warfare



Nano-assemblers that will be able to copy and duplicate themselves, self-assemble into anything, including human body parts, in seconds. These nano-assemblers may take control of human race.

Trains and airplanes powered by nano-machines

* Scientific American, Sept., 2001.

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Nanotechnology is showing up in unexpected places

"Nanotech takes new fabric past drip-dry into drip-free"

**USA Today Wednesday, January 10, 2001*

By Kevin Maney

By this summer, you'll be able to have nanotechnology in your pants. Oh, baby.

Really – you'll walk into a store and see pants tagged with the brand name Nano-Dry or Nano-Care, each made with nanotechnology created by Nano-Tex, a 14-person company that's 51% owned by fabric giant Burlington Industries. This might be the first time that nanotech shows up in a mass-market consumer product – a landmark of sorts. You could even say these will be the first true smarty-pants…

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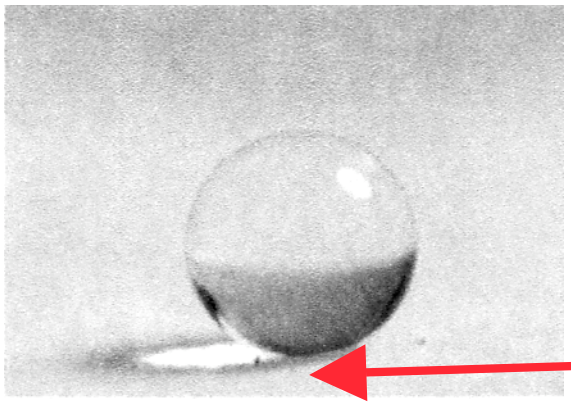
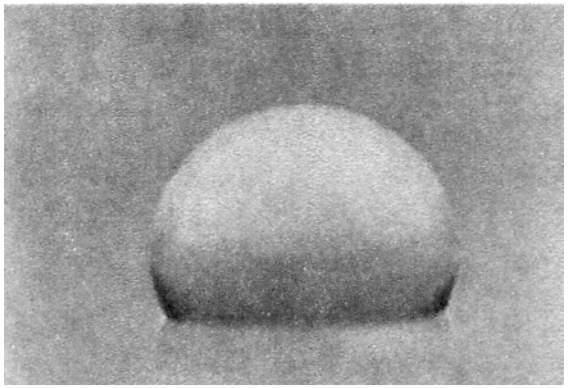
Nice pants thanks to nanoscience

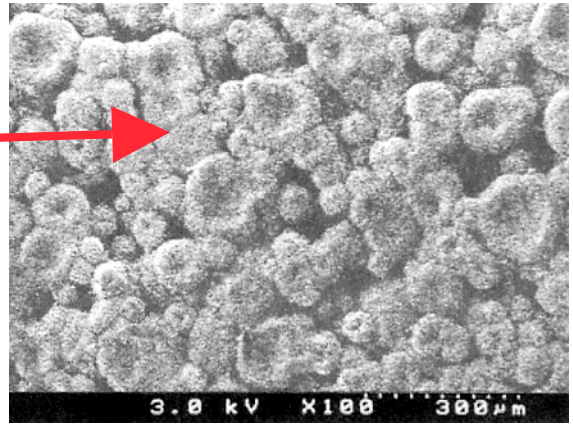
Water Drop on Fractal Surface





Water Drop on Smooth Surface

Nano-Roughness Minimizes Contact



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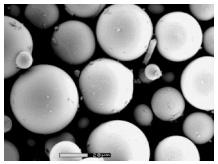
The scale of things Natural…

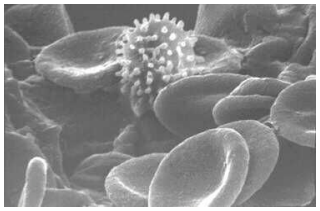
Ant
~ 5 mm

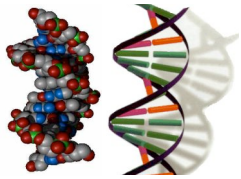
Human hair
~ 10-50 μm wide



Fly ash
~ 10-20 μm

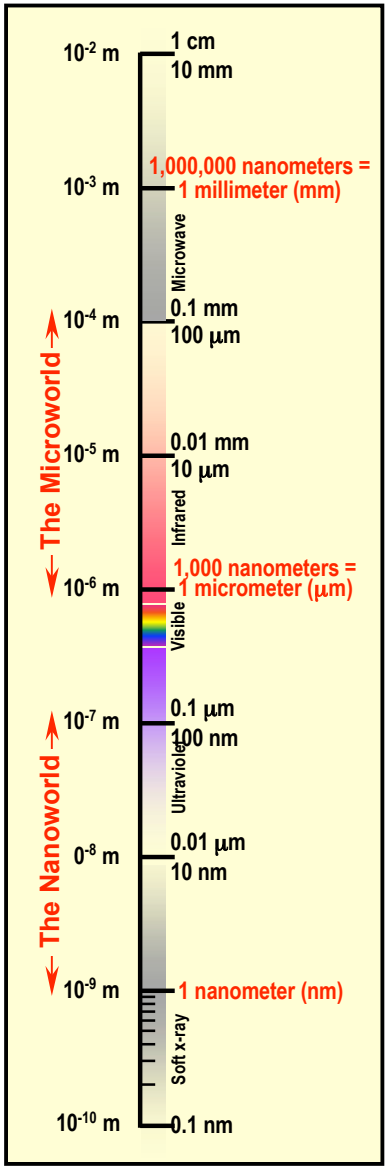
Red blood cells with white cell
~ 2-5 μm





DNA
~2-1/2 nm diameter

Atoms of silicon
spacing ~tenths of nm



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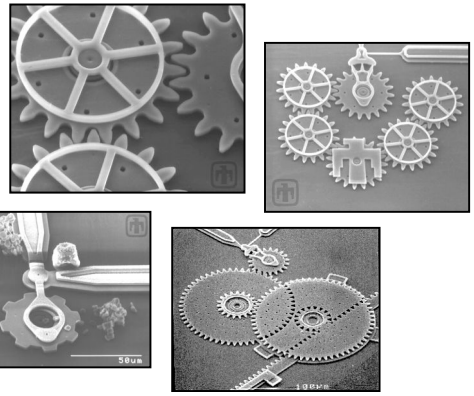
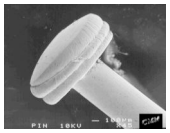
The scale of things Man-made…

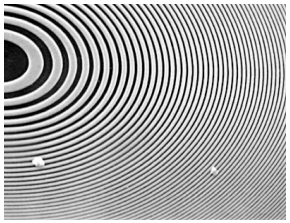
Micro-Machines
10 -100 μm wide

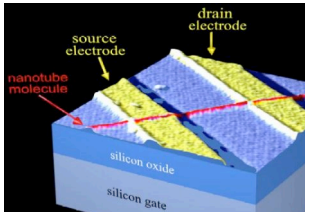




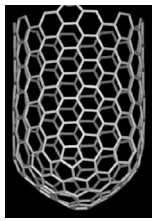
Head of a pin
1-2 mm

X-ray "lens"
Outermost ring spacing ~35 nm

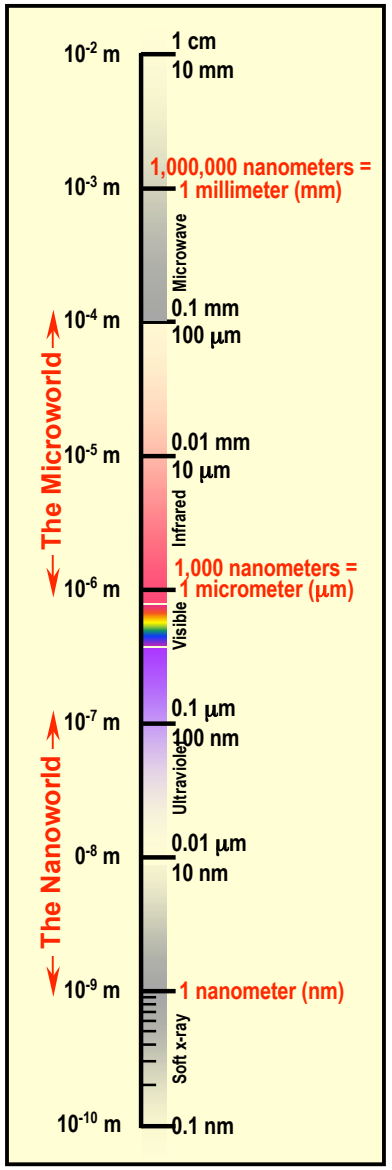




Nanotube transistor



Carbon nanotube
~2 nm diameter



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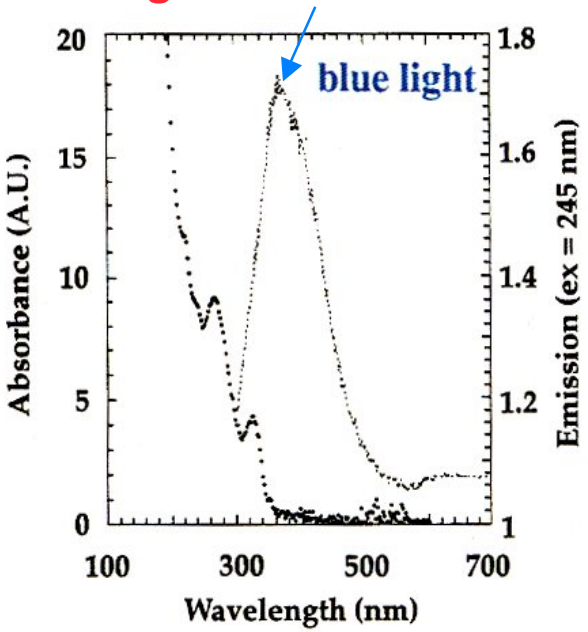
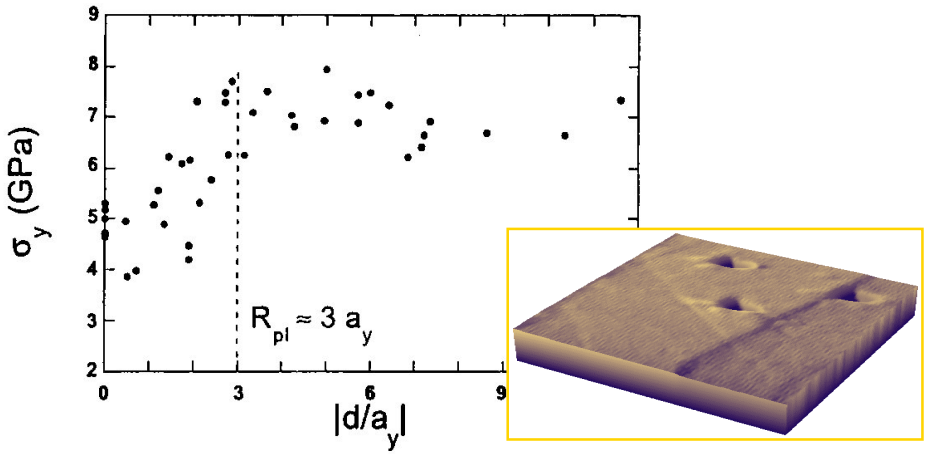
Ordinary materials can behave differently at the nano-scale

Light from Silicon



Steel-like strength from gold



New phenomena from…

- Surfaces and interfaces
- Quantized effects

Lead to…

- New physical effects
- New chemistry
- New mechanical properties

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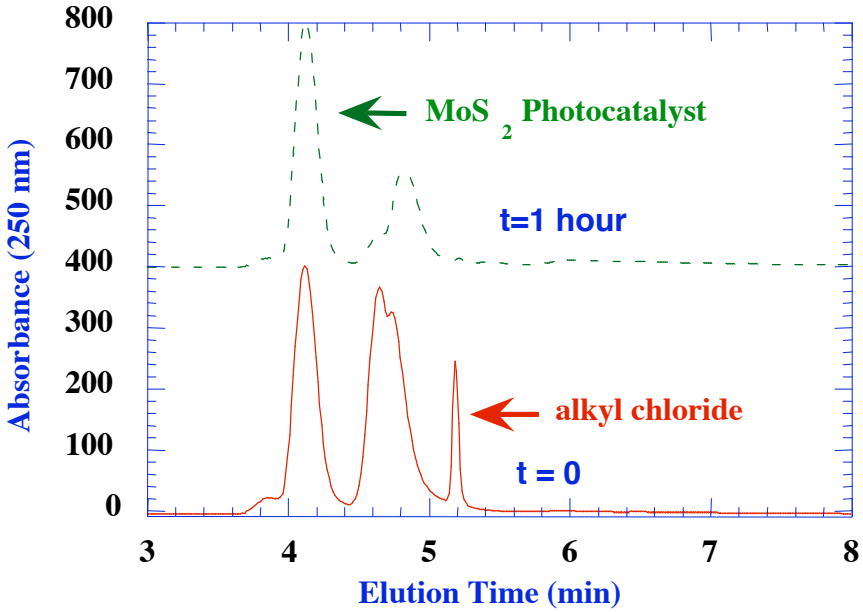
Semiconductor nano-crystals use sunlight to clean up pollutants



3 nm MoS_2 nanocrystals photo-oxidize an alkyl chloride in solution using only visible room light

- **Environmental remediation**
- **Solar photocatalysis/fuel production**

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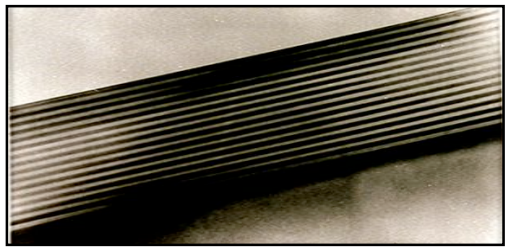
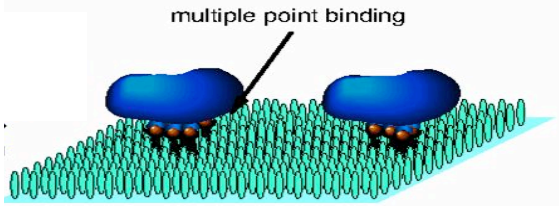
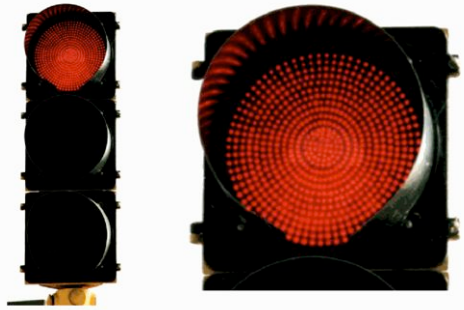
Integrated Nanotechnology will impact our world

Energy

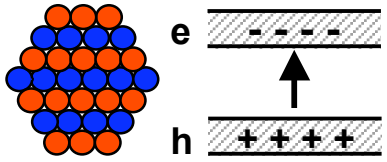


Health Care





Environment



Connecting scientific disciplines and length-scales is key to success

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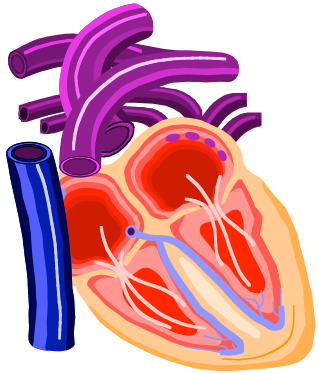
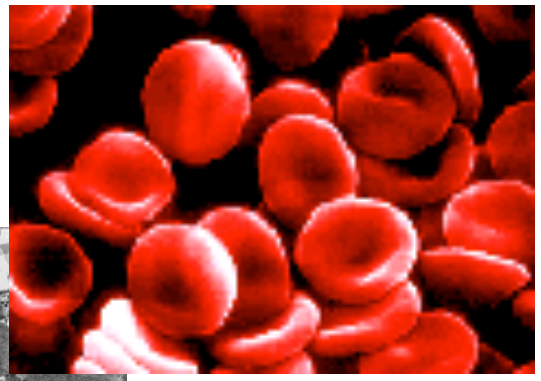
You are the best example of "integrated nanotechnology"

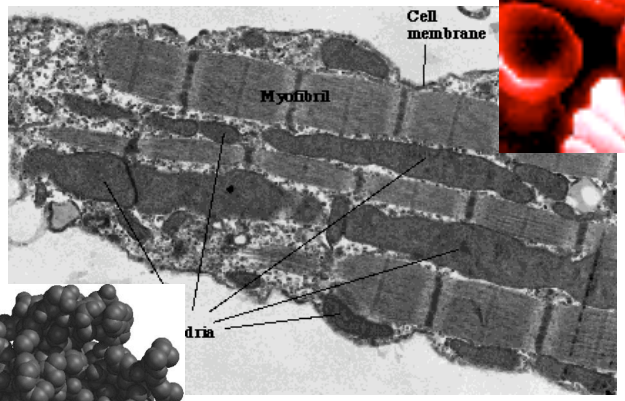
Integrated structures combine multiple length scales and functions.



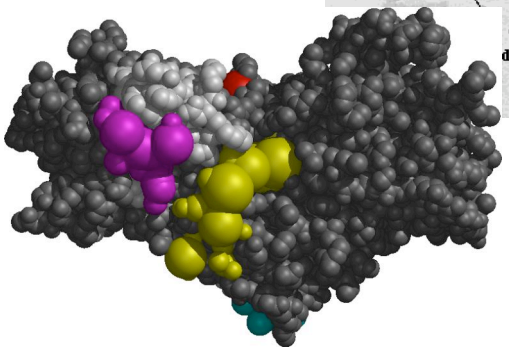
Organs and Tissues



Cells



Sub-cellular mechanical structure



Molecules and Chemical Pathways

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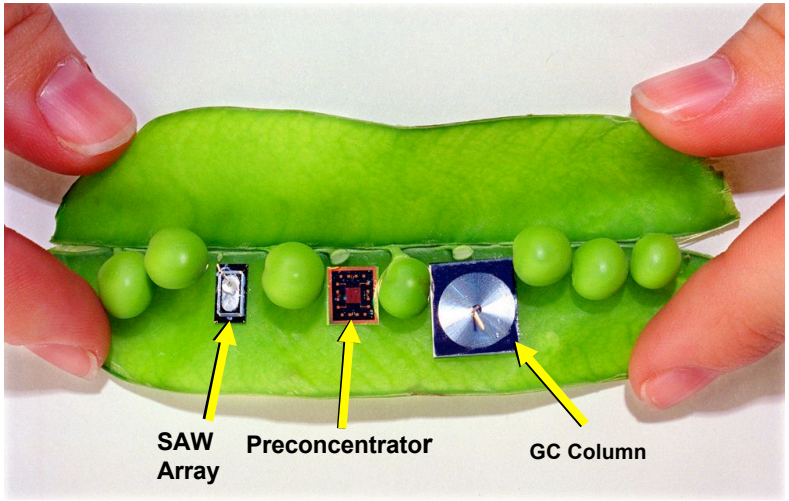
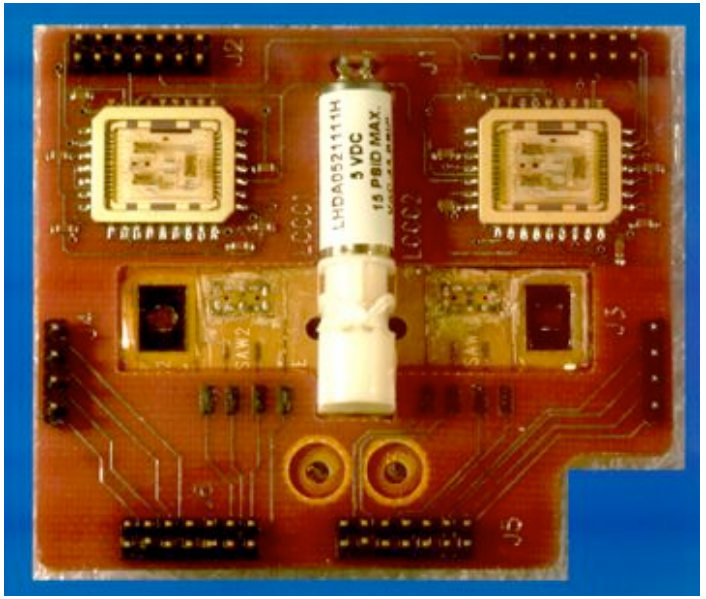
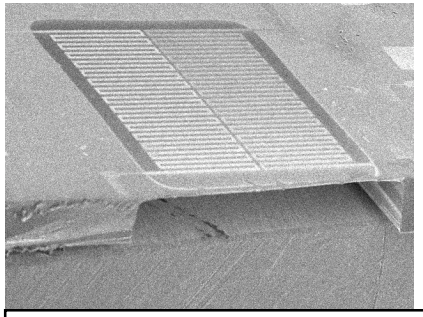
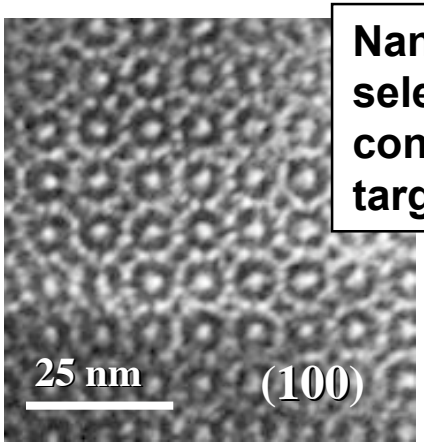
µChemLab™ is engineered down to the molecular level







Micro-scale heater



Nanoporous film selectively concentrates target analytes.

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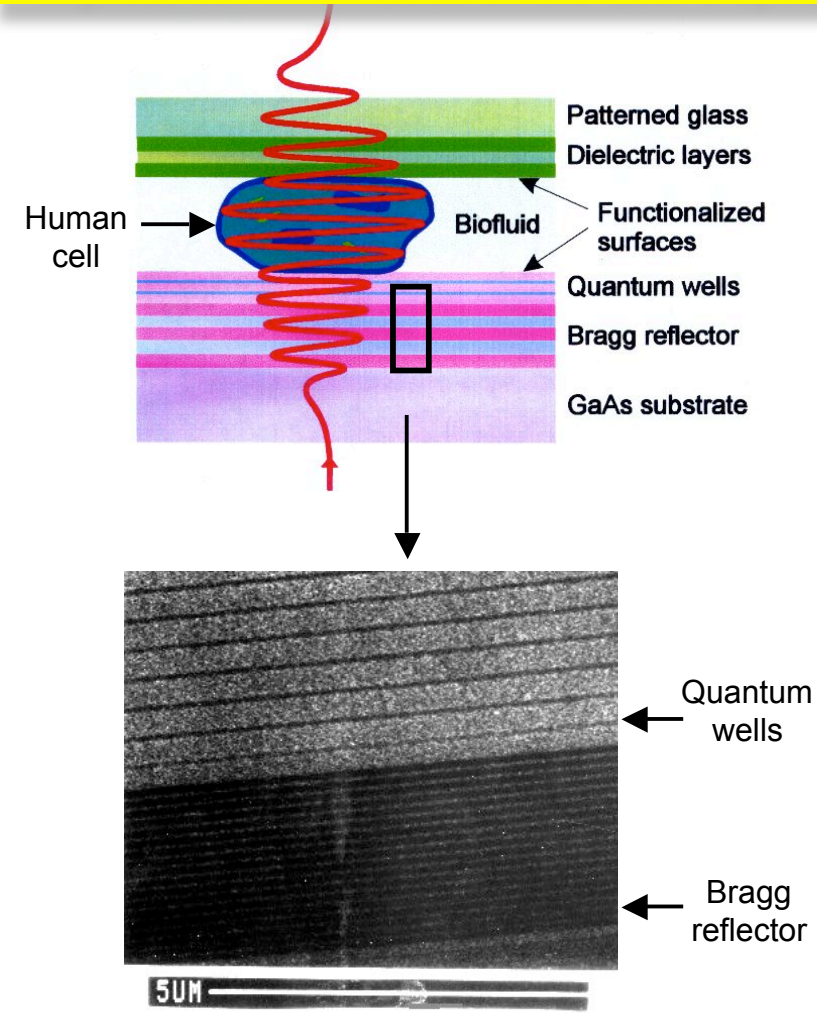
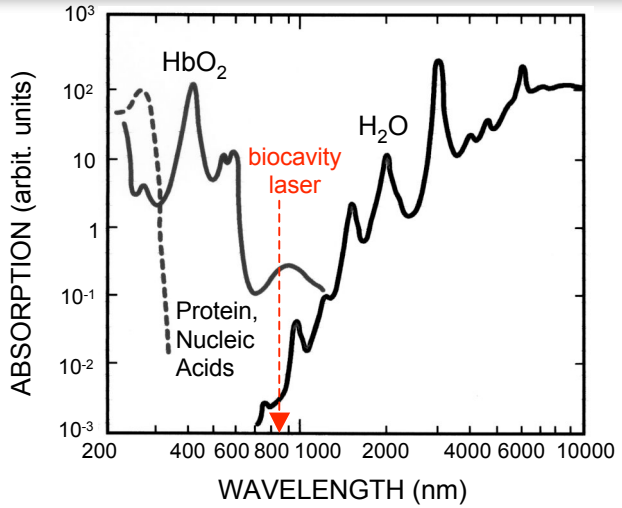
The BioCavity Laser combines nano and micro technologies

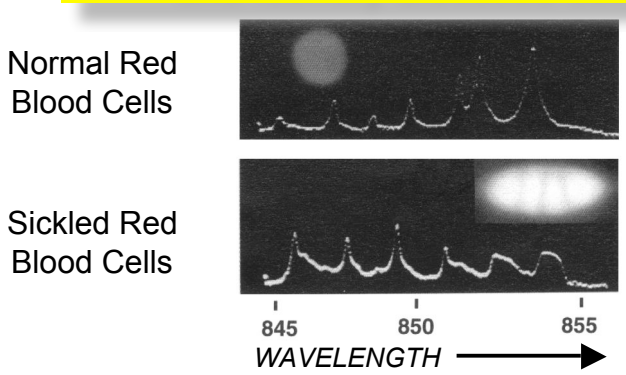
Biological cells form part of a semiconductor laser and impress cell information on the laser's optical output



The semiconductors are tailored to emit where the cells are transparent



Unique emission signatures detect and identify diseased cells



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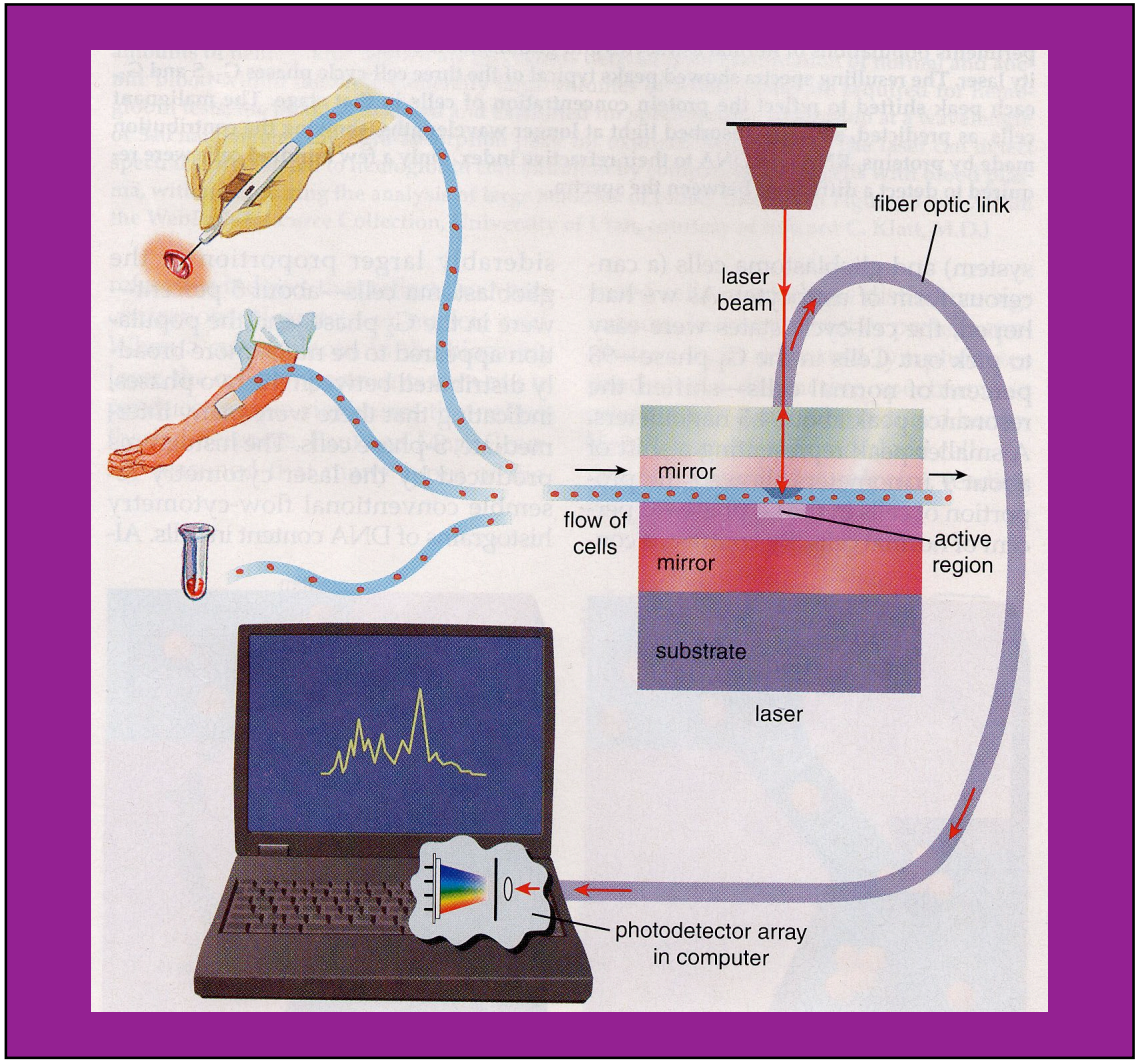
Biocavity laser technology could combine detection and treatment



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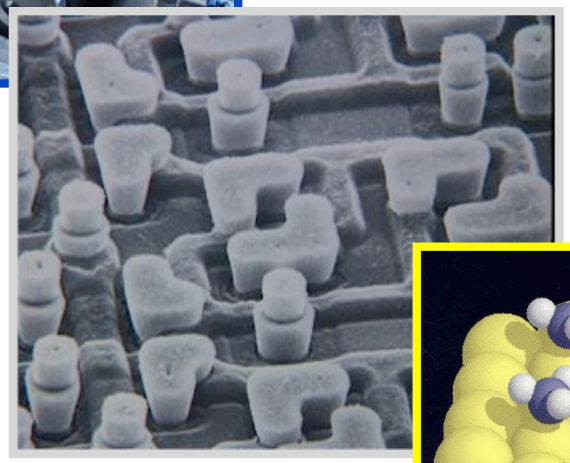
How is nano-technology different from micro-technology?

Conventional Machines

Build and assemble

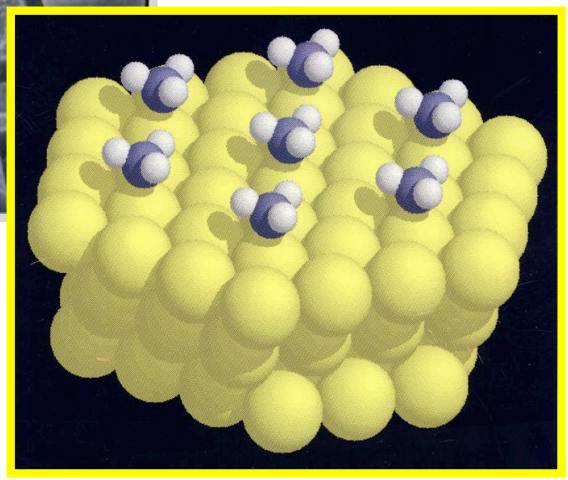
(m - mm)



Microelectronics

Top down - build in place

(10 - 0.1 µm)



Nanotechnology

Bottom up - self assembled

(1- 100 nm)

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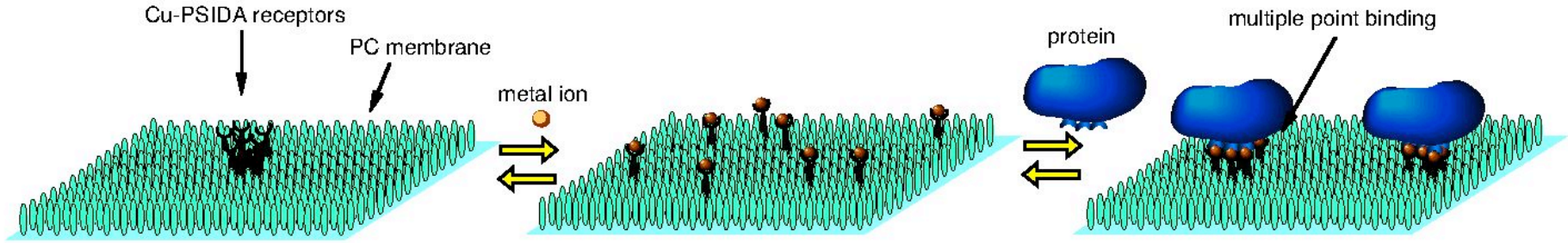
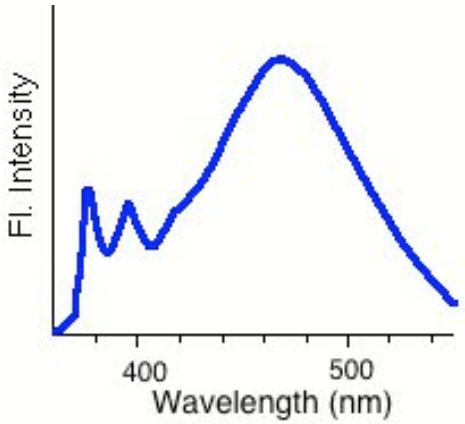
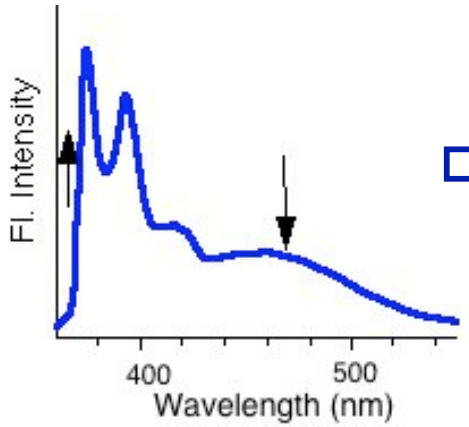
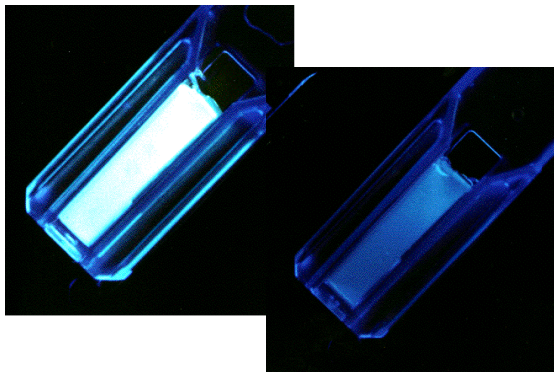
Self-organization in a membrane for molecular recognition









- **Adsorption triggers reversible aggregation of optical receptors**
- **Adsorption detected via change in optical response**

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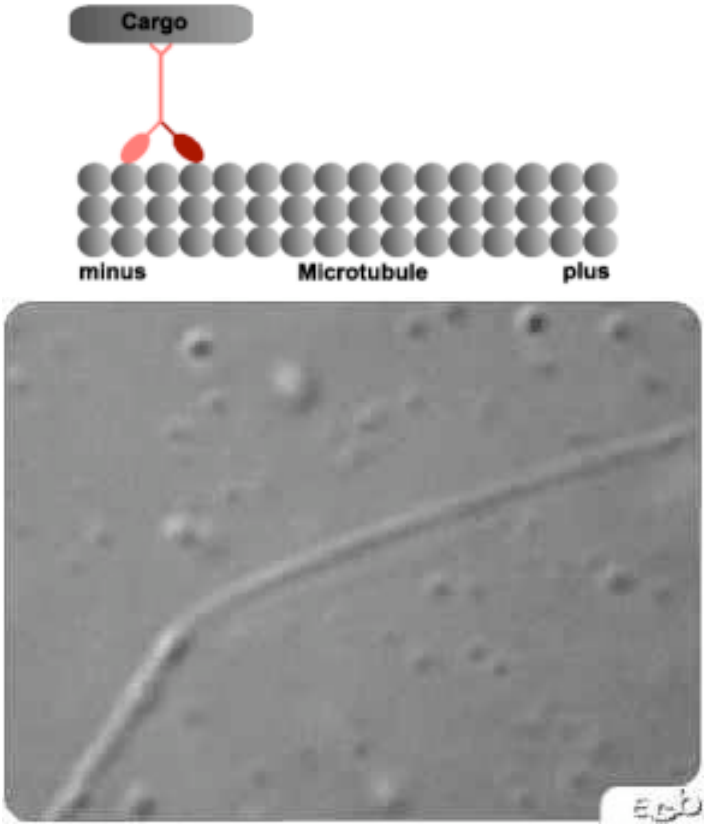
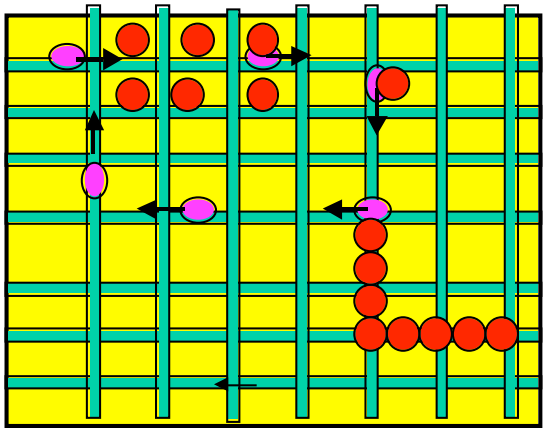
How Nature moves things…

Directed translation of molecular cargo as a result of energy consumption;
Nature's solution to diffusion problems.





*From: Alberts et al. (1998)
"Essential Cell Biology."

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Center for Integrated Nanotechnologies

Sandia National Laboratories • Los Alamos National Laboratory

- Highly collaborative DOE National User Facility
- Focused on nanoscience and its integration across scientific disciplines and multiple length scales.
- Open access to tools and expertise to explore the continuum from scientific discovery to the integration of nanostructures into the micro and macro worlds.

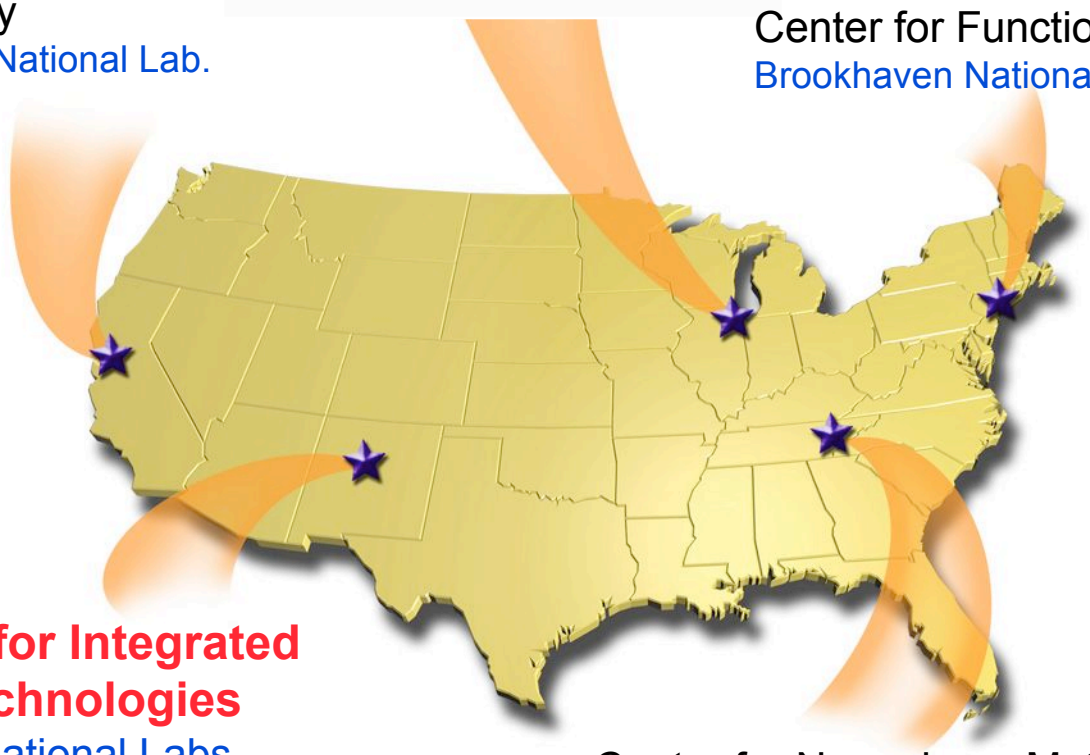
"One scientific community focused on nanoscience integration"

CINT is one of five Department of Energy Nanoscience Centers

Center for Nanoscale Materials
Argonne National Lab.

Molecular Foundry
Lawrence Berkeley National Lab.

Center for Functional Nanomaterials
Brookhaven National Lab.



Center for Integrated Nanotechnologies
Sandia National Labs.
Los Alamos National Lab.

Center for Nanophase Materials Sciences
Oak Ridge National Lab.

Sandia National Laboratories

One scientific community focused on nanoscience integration.

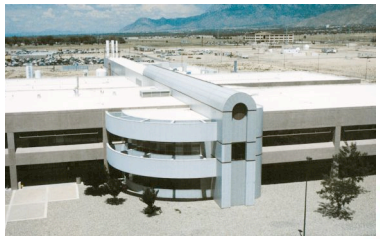
Collaborators
Laboratory
University
Industry

CINT
Core Facility

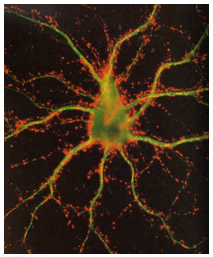
Gateway to SNL

Gateway to LANL

Microelectronics Development Lab



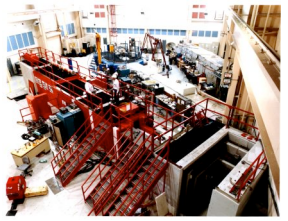
Biosciences

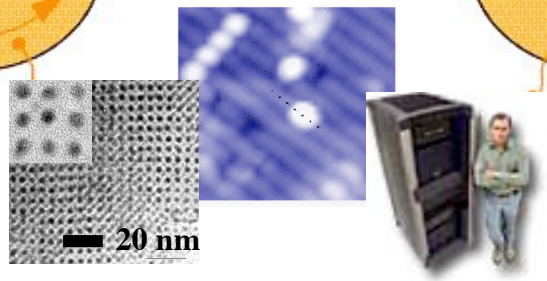


National High Magnetic Field Lab

Compound Semiconductor Research Lab

Los Alamos Neutron Science Center





Synthesis, Characterization, & Theory

Los Alamos NATIONAL LABORATORY

Sandia National Laboratories

CINT has three dedicated facilities

Core Facility in Albuquerque

CINT Gateway to Sandia
Nanomaterials/Microfabrication

CINT Gateway to Los Alamos
Nanomaterials/Biosciences

Buildings Complete	**November 2005**
Begin Operations	**April 2006**
Fully Operational	**May 2007**

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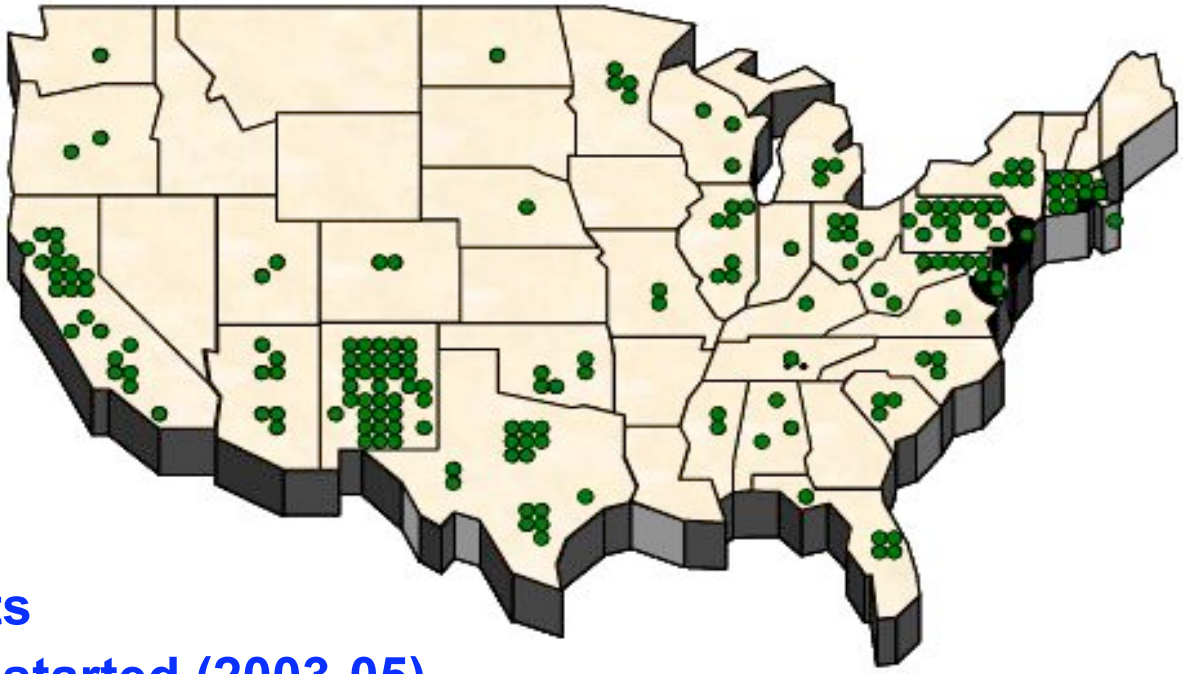
Researchers nationwide are already working with CINT scientists



258 requests

89 projects started (2003-05)

37 academic institutions

3 companies

23 states

3 foreign countries

Sandia National Laboratories

The nanotechnology future is taking shape in New Mexico

Come visit us at the new CINT Core Facility in Albuquerque (2006).

http://CINT.sandia.gov **or** http://CINT.lanl.gov

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