



# Macro/Micro/Nanotechnology and the future...

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## Topics

- Pre-Microscope Technology
- Micron Level Understanding in Science
- Nanotechnology Definition
- Nano Examples
- The Future...

# Pre-Microscope Technology

People only believed and understood what they  
could see with naked eye!

So technology of the time included...

# Macro Technology

## Domesticated Animals and Basic Tools



# Macro technology

Discovery of specialized material and ability to shape them...



## Micron Level Understanding in Science

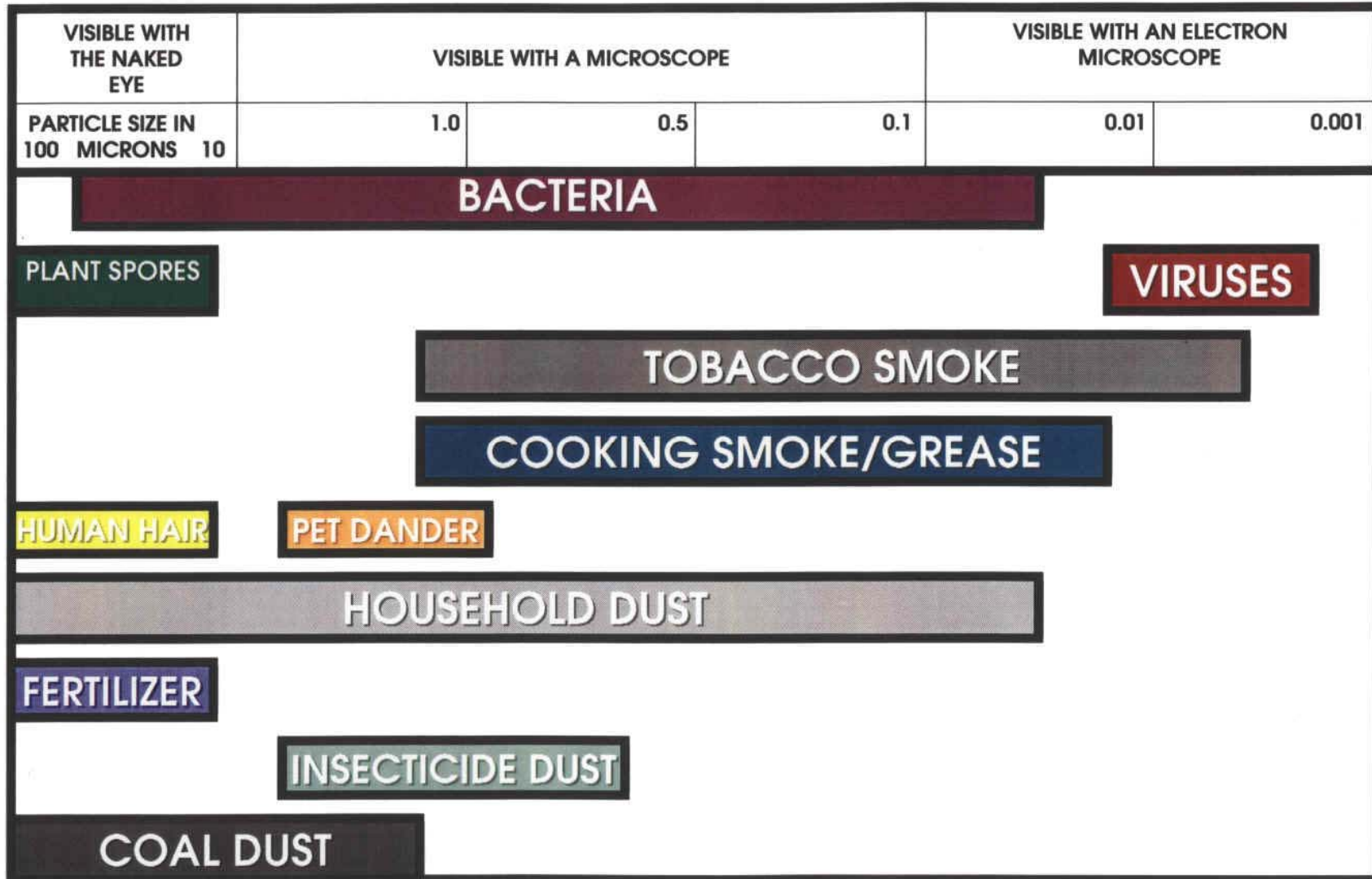
- Knowledge of structures that we cannot be seen with naked eye
- Ability to see and explore them using microscopes
- Ability to shape them using chemical, energy or miniaturized manipulators

# How big is a Micron?

“Micron is one millionth of a Meter”

A single human hair is 40 to 300 Microns

# Measuring in Micron



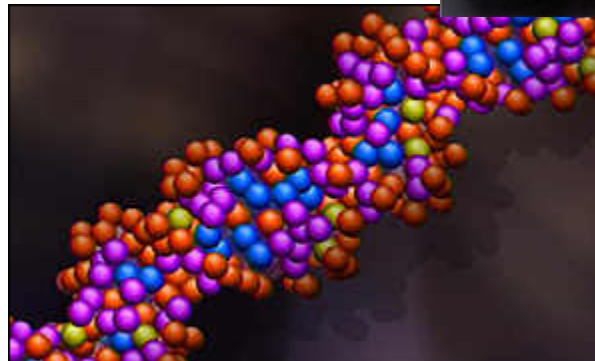
# Benefits of Micron-level Understanding Semiconductor Technology

- Computers
- Cell phones
- Efficient cars
- Planes and space travel
- Smart appliances ...



# Benefits of Micron-level Understanding Medicine

- Medical diagnostic Imaging and other tools
- Drugs
- Micro surgery
- Antibiotics
- Genetics ...



# Nanotechnology Definition

**Nanotechnology is the engineering of functional systems and materials at the molecular scale.**

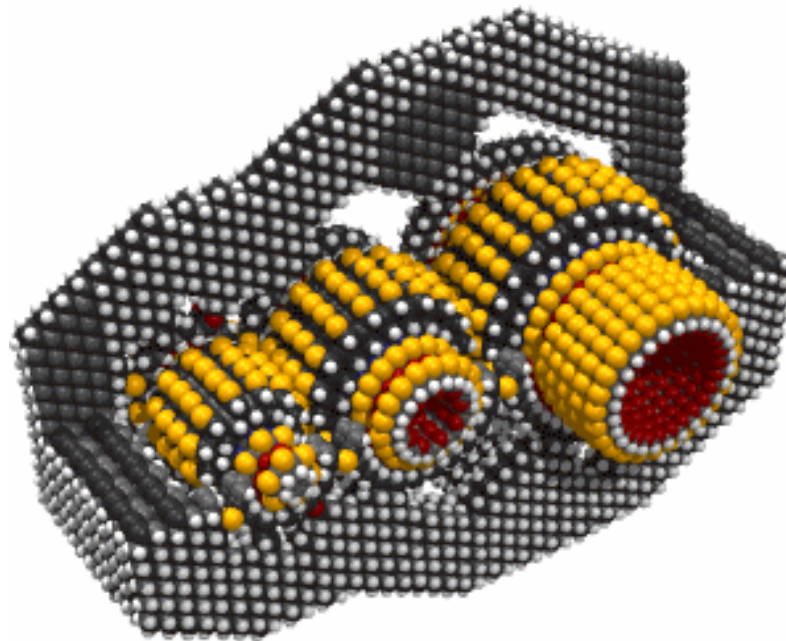
Measurements are in Nanometers or  $10^{-9}$  meter

*Width of a single human hair is  
40,000 to 300,000 Nanometers*

# Nano Technology Vision

## Nano Machine

- Parallel-shaft speed reducer gear is one of the largest Nan mechanical devices ever modeled in atomic detail

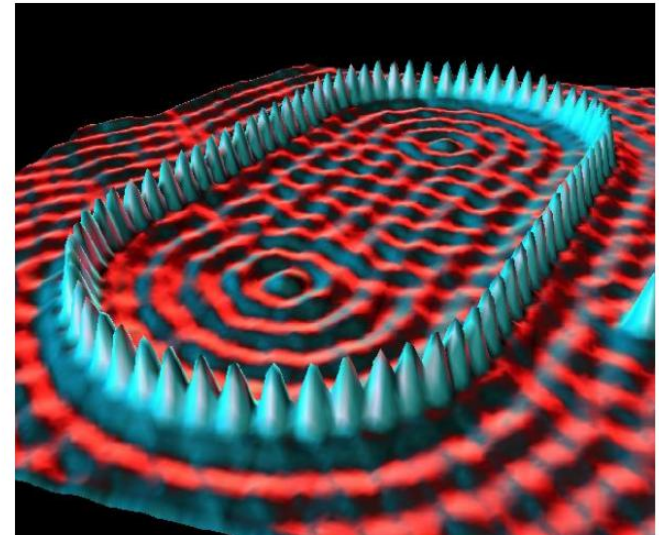


Designer: Mark Sims  
Date: August 31, 2005  
Number of components: 4  
Number of atoms: 15,342  
Width: 11.3 nm  
Height: 7.5 nm  
Depth: 5.6 nm  
Gear Ratio: 13:6  
Speed Ratio: 2.167:1

# A Key tool in Nanotechnology

## Scanning Tunneling Microscope (STM)

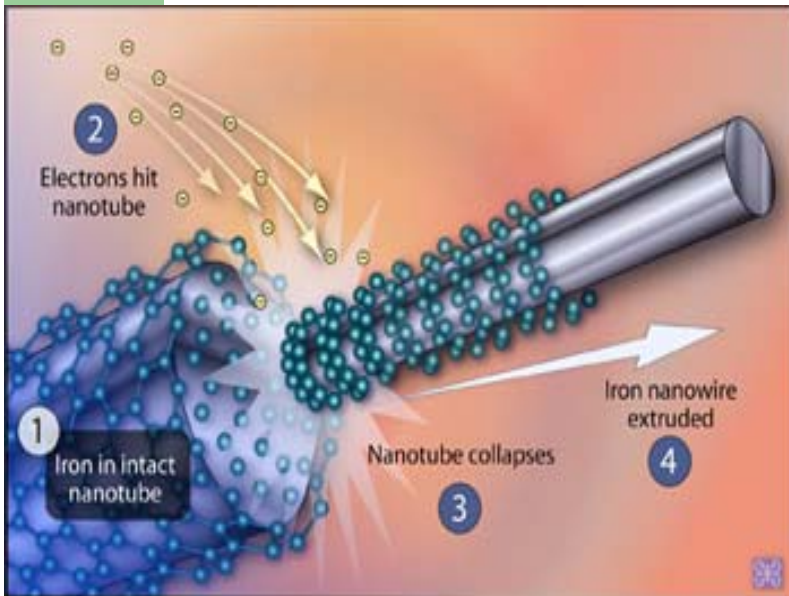
- Allows viewing and manipulation of molecules at an atomic scale ( $2 \times 10^{-10}$  or 0.2 nanometer)
- STM was first used in mid 1980s to see the atomic structure
- Example of STM capability  
“electrons surrounded by 48 iron atoms individually positioned”



Source: NSF

# Nanotechnology Discoveries

## Metal NanoWire (2 nanometer in diameter)



Source: NSF

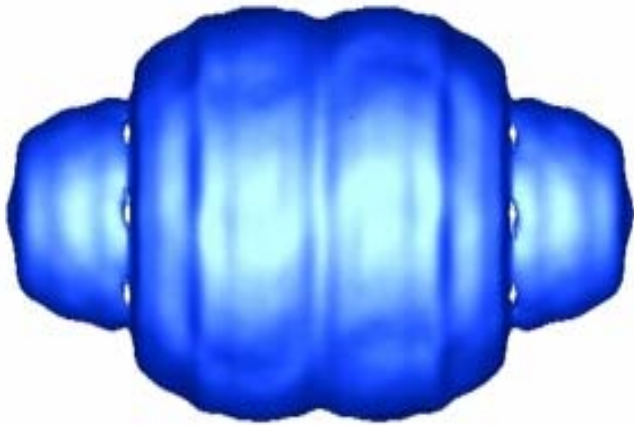
When researchers fire electron beams at multi-layered carbon nanotubes, they collapse, much like a tube of toothpaste, with such force the nanotubes extrude whatever may be inside, even extremely hard iron carbide.

The process--which has applications for manufacturing durable, metal nanowires (2 nanometers in diameters).

The pressures within the tubes reach one-tenth the crushing force in the Earth's core.

# Nanotechnology Discoveries

## Vaults – Drug delivery



The vault is a natural occurring particle (72.5 x 41 nanometers).

Researchers are looking to use as the means of delivering drugs to targeted cells without rejection by the anti-bodies.

Source: NSF

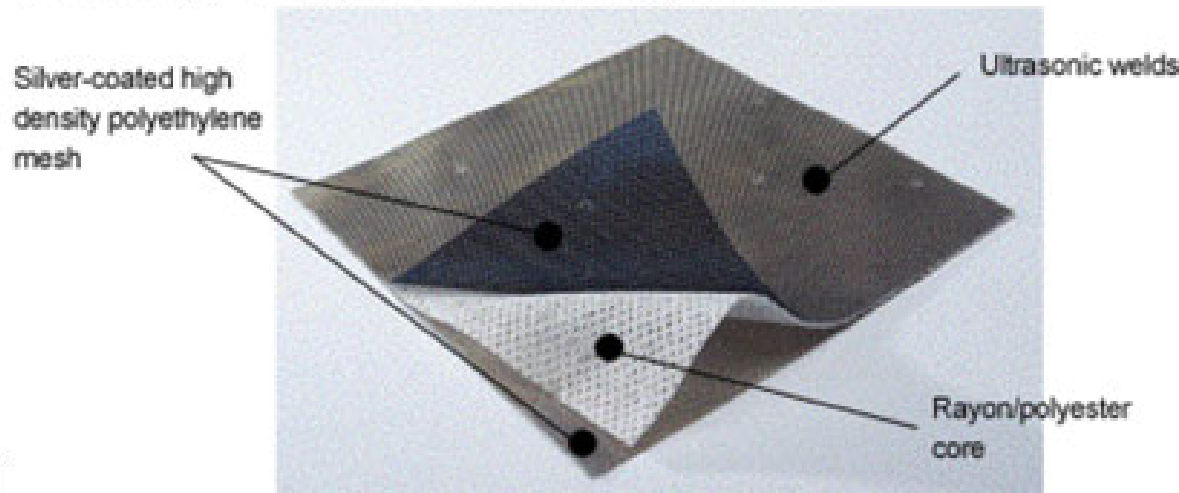
# Nanotechnology in Everyday products

- Extending the semiconductor beyond Micron means more power, smaller size and lower cost.
- Ability to design product at micron or nanometer that include moving parts and sensors.

# Nanotechnology in Everyday products

## Nanosilver Wound Dressing For Burn Victims

Used on Navy submarines, cruise ships, aircrafts and healthcare facilities, San Jose, Calif.-based EnviroSystems' EcoTru nanoemulsive disinfectant cleaner cleans and disinfects in one step. In the post SARS virus scares of 2003, Boeing recommended EcoTru for use on airplanes, which helped EnviroSystems attract 30 airlines as customers. Currently, EcoTru is the only EPA-registered Tox Category IV disinfectant product in the U.S. This means there are no harmful dermal (skin), ocular (eyes), inhalation (breathing) or ingestion (swallowing) effects.





# Nanotechnology in Everyday products

## Golf Balls And The "Nano" Driver



Tokyo-based Maruman & Co. has adopted fullerenes from Honjo Chemical for use in the top of the line "New Majesty" driver, which went on sale on July 5 of 2004. Compared to conventional titanium, the new driver resists bending 12% better, has a hardness 3.6% better than titanium, a 20% more resilient head and an increased flight distance of 15 yards as compared to their old 360cc class driver.

Buffalo, N.Y.-based NanoDynamics might have a nice accompanying stocking stuffer. NanoDynamics came up with a golf ball that can correct its own flight path. The design of the ball--and the undisclosed nanomaterials it's made of--serve to better channel the energy received from the club head, and thus correct a wobble or slight drift. The ball is expected to hit stores in the spring of 2005.



# Nanotechnology in Everyday products

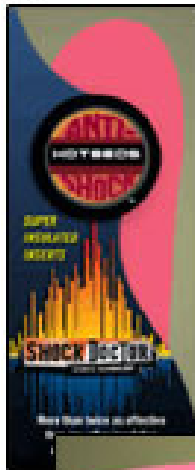
## Washable Bed Mattress

In October, Simmons Bedding Company, one of the world's largest mattress manufacturers, unveiled its latest innovation--the HealthSmart Bed, featuring a zip-off mattress top that may be laundered or dry cleaned. The top is available on all Simmons Beautyrest and BackCare mattresses and is targeted to sell at price points of \$1,399 and above. Its coolmax-channeled fibers wick away sweat and moisture as you sleep and allow fabric to dry quickly in the laundry. In the second layer, Nano-Tex creates a semi-impervious layer that traps fluids and particles so they can be washed away. The third layer is Terry cloth treated with Teflon fabric protector that provides an extra level of protection.



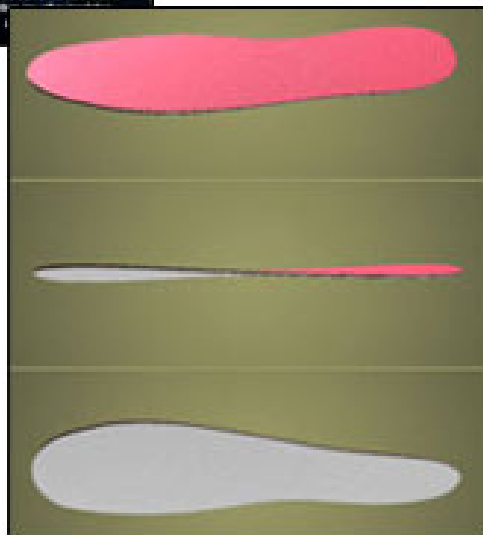
# Nanotechnology in Everyday products

## Footwarmers (Shock Doctor/Aerogel Hotbeds)



Northborough, Mass.-based Aspen Aerogels launched a nanotechnology-based footwarmer in March of 2004, which is now used by the 2004 winner of the North Pole Marathon, the Canadian Ski Team and the U.S. Military's Elite Special Forces. Aspen's Pyrogel AR5401 utilizes highly-insulative nanoporous-aerogel technology, providing 3-to-20 times more

thermal performance at a given thickness when compared to existing materials. Plymouth, Minn.-based Shock Doctor has developed a product called Hotbeds, which is being used in military boots for improving the level of comfort in cold weather operations. Since the Pyrogel AR5401 is so efficient, the Hotbeds are only 2.5mm thick.



# The Future...

Imagination is the only limitation...

More ideas and discoveries:

[http://www.nsf.gov/discoveries/index.jsp?prio\\_area=10](http://www.nsf.gov/discoveries/index.jsp?prio_area=10)