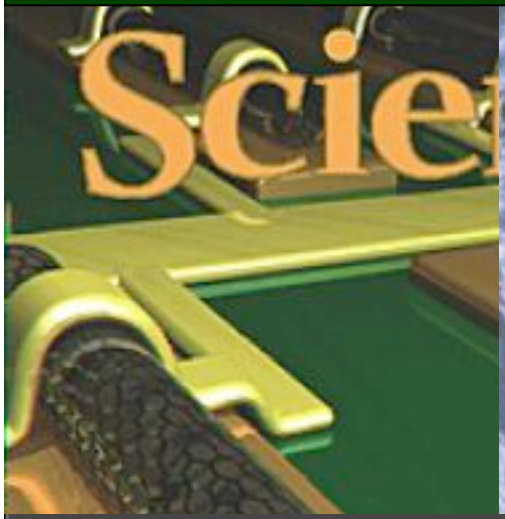
Class 2, Pretty picture nano slides

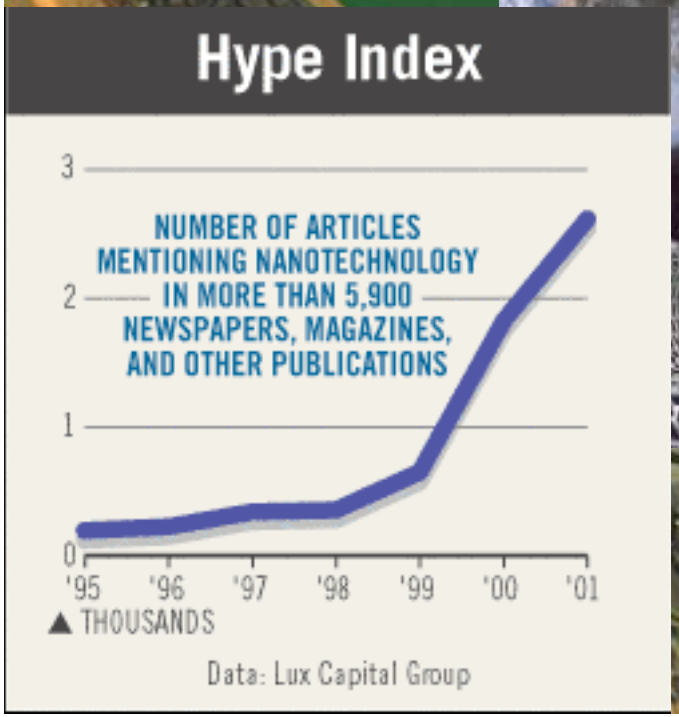
C. Tahan, Wisconsin-Madison

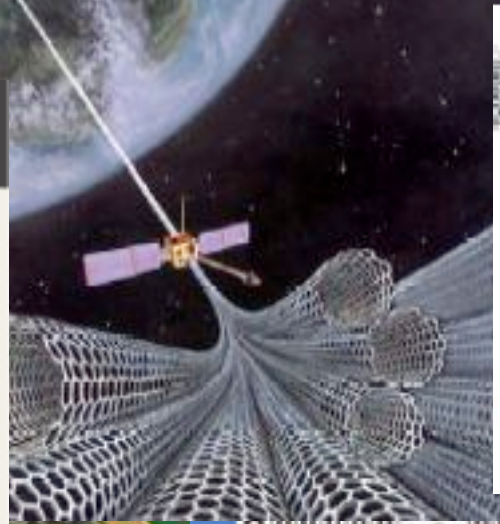
STS 201, “Nanotechnology and Society”

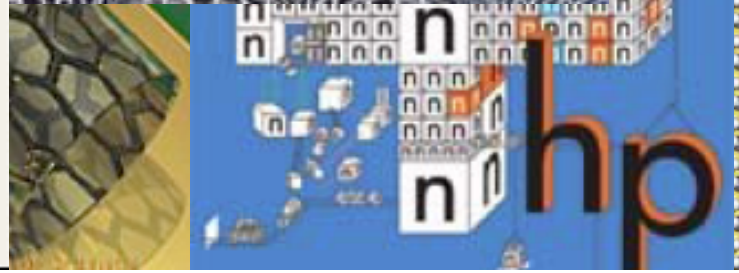
Spring 2005

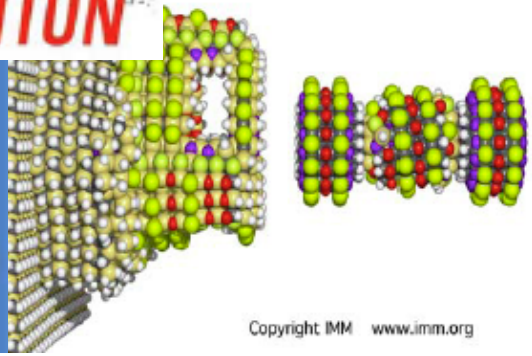
Nanotechnology











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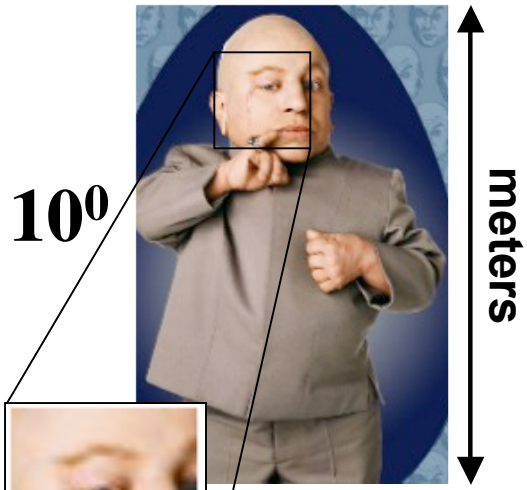
Nanotechnology

kilometer	km	1000	$1X10^{3}$
meter	m	1	$1X10^{0}$
millimeter	mm	1/1000	$1X10^{-3}$
micrometer	μm	1/1000000	$1X10^{-6}$
nanometer	nm	1/1000000000	**$1X10^{-9}$**
angstrom	Å	1/10000000000	$1X10^{-10}$

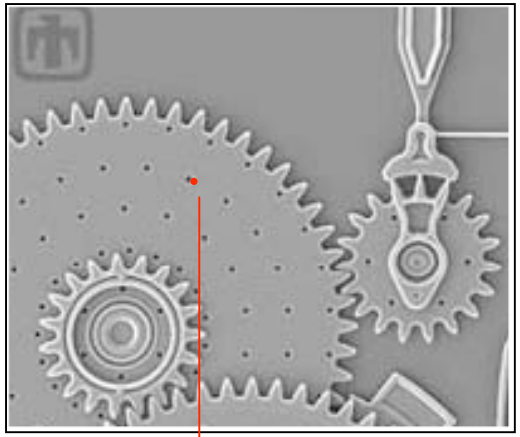
A nanometer is one billionth of a meter

Size and Scale: Factors of 1000



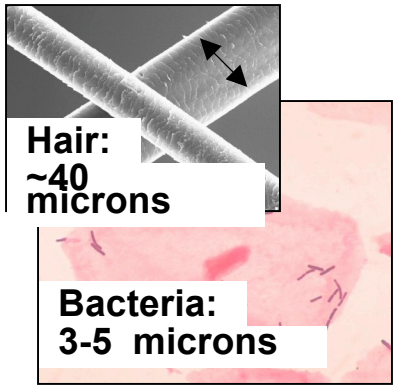
10^0

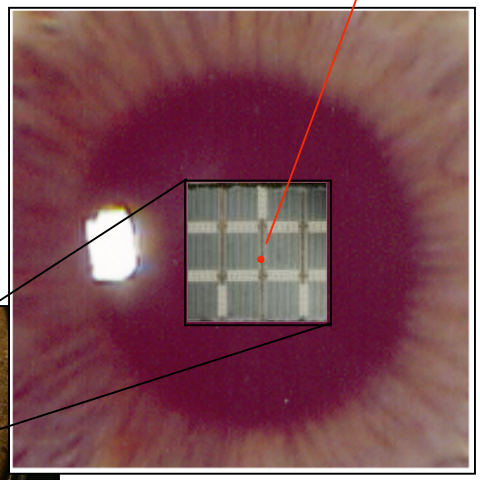
meters



10^{-6}

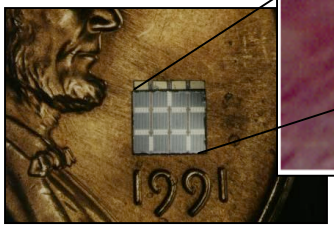
micrometers

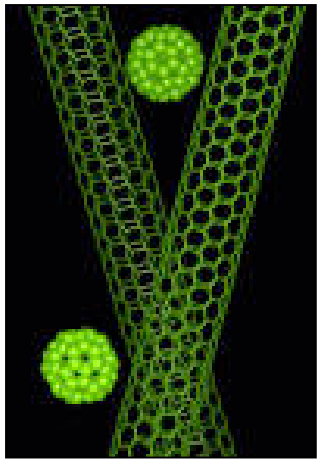




10^{-3}

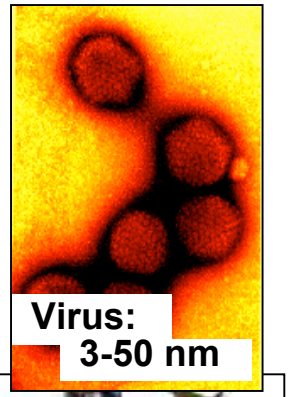
millimeters

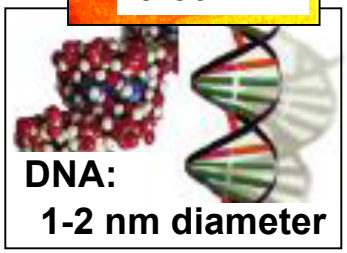




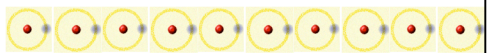
10^{-9}

nanometers





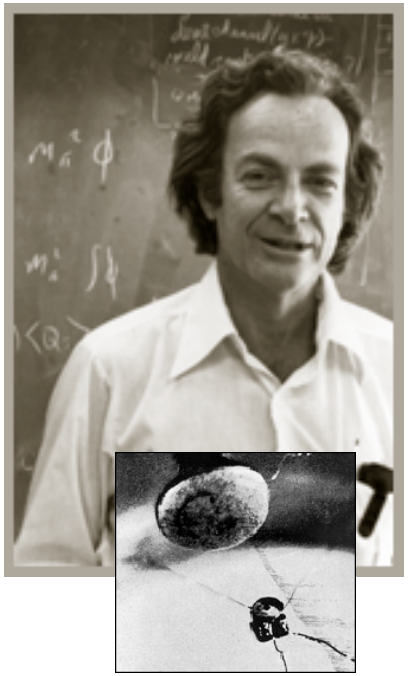
1 nm = 10 Hydrogen atoms:



Defining Nanotechnology

Federal Gov.'s def:

Nanotechnology is the creation of functional materials, devices, and systems through control of matter on the nanometer length scale, exploiting novel phenomena and properties (physical, chemical, biological) present only at that length scale.



History

c. 1960

Feynman:

- **miniaturization**
- **info. storage**
- **precision chemistry**
- **tiny machines making tinier machines**

c. 1980s

- **"nanotech" popularized**
- **idea of molecular self-assemblars**

c. 1990

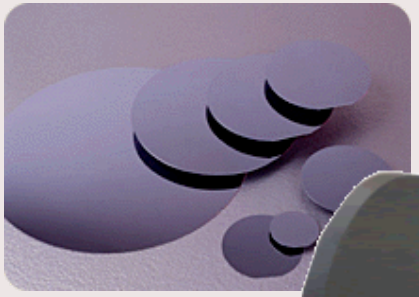
- **science and technology started to catch up**

New properties at nanoscale

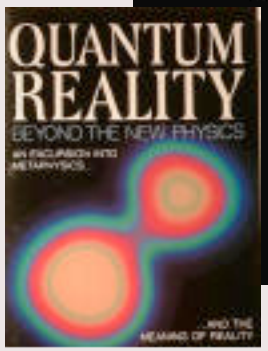
The amazing shrinking silicon crystal...

Silicon nanocrystal

< 100 nm

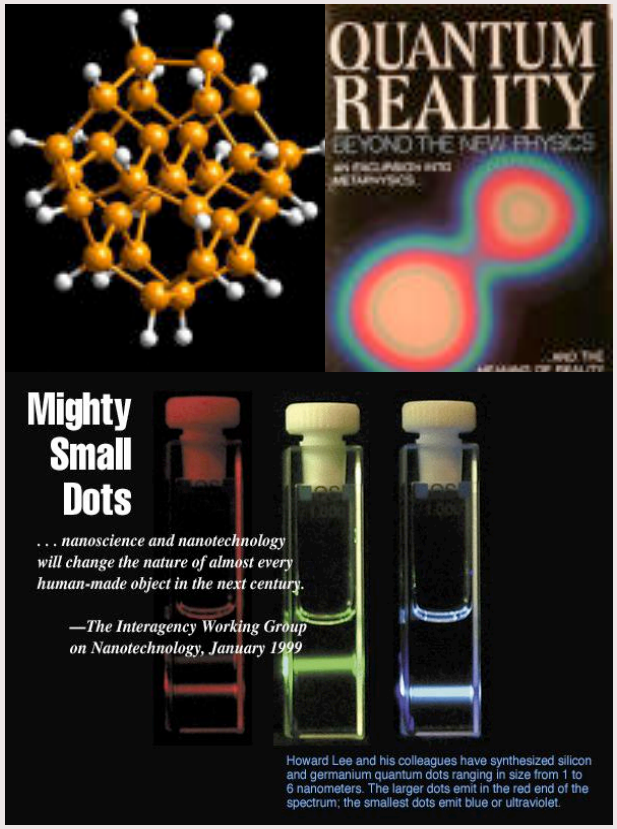


Bulk silicon wafers for computer chips



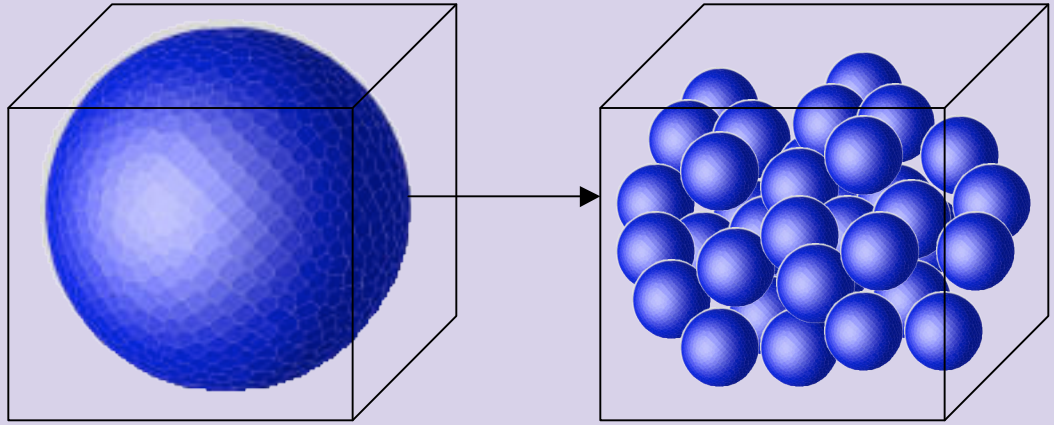
Quantum	Chemical	Biological

New properties at nanoscale



Completely different physical behavior than bulk.

Reactivity may depend on surface area.

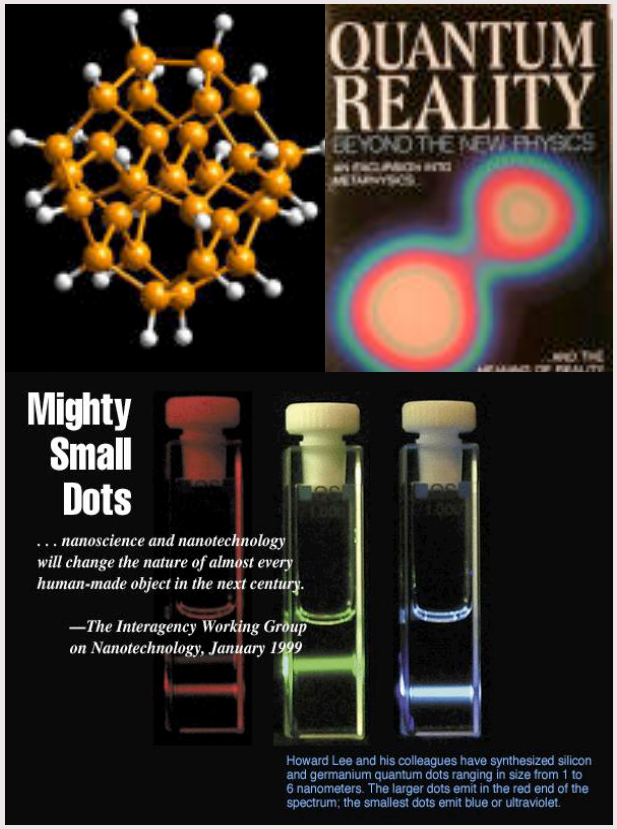


More, smaller particles = more surface area

"A catalyst of 10 nm nanoparticles is 100 times more reactive than the same amount of material in 1 micron particles."

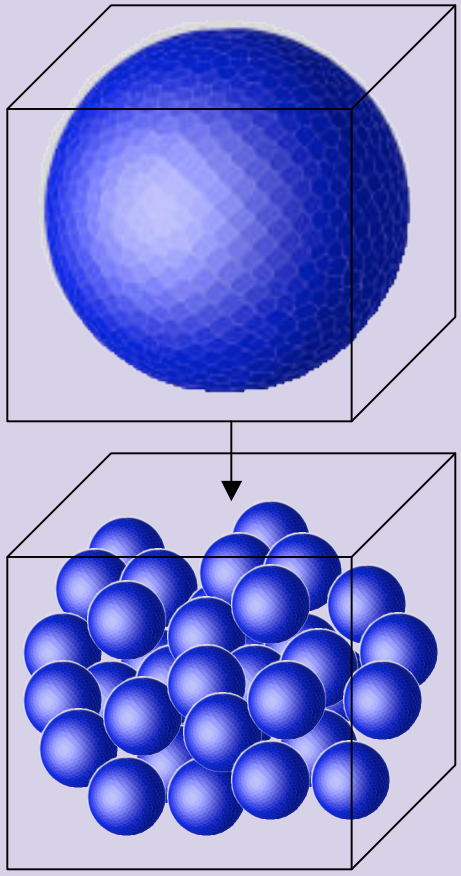
Quantum | **Chemical** | **Biological**

New properties at nanoscale



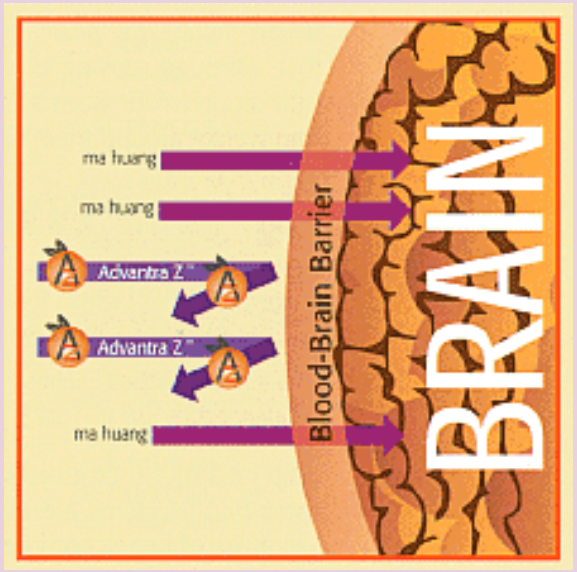
Completely different physical behavior than bulk.

Quantum



More surface area per volume. More reactive.

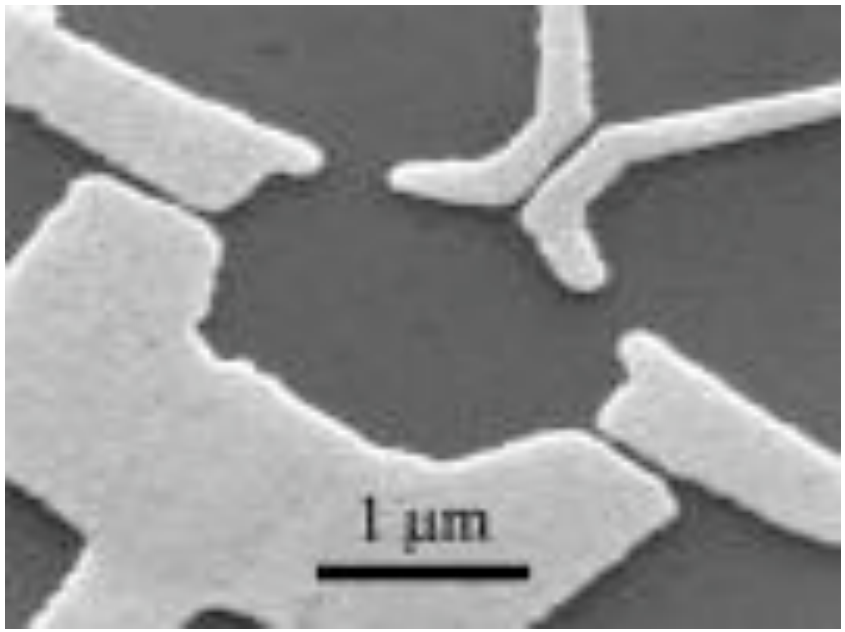
Chemical



Nanoparticles can cross the blood brain barrier. Microparticles can't

Biological

Lithographic quantum dot

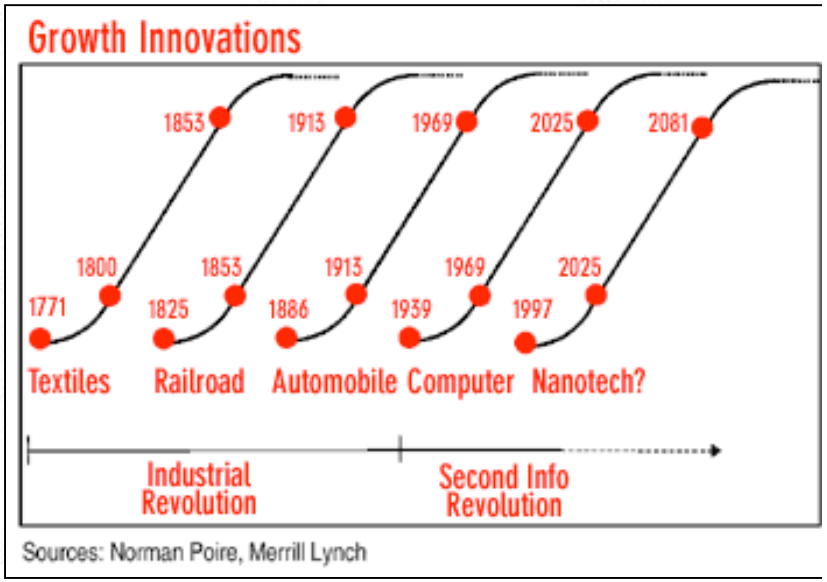


Nanotech -is- Interdisciplinary

Physics, Chemistry, Materials Science, Biology, Engineering, Informatics, … and even Humanities!

National Nanotechnology Initiative
(Budget authority, dollars in millions)

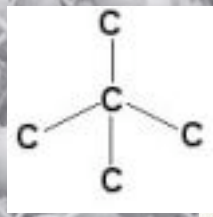
	2001 Actual	2005 Request	Dollar Change 2001 to 2005	% Change 2001 to 2005
National Science Foundation	150	305	155	103
Defense	125	276		
Energy	88	211		
National Institutes of Health	40	89		
Commerce (NIST)	33	53		
NASA	22	35		
Agriculture	0	5		
EPA	5	5		
Justice	1	2		
Homeland Security	0	1		
TOTAL	**464**	**982**		

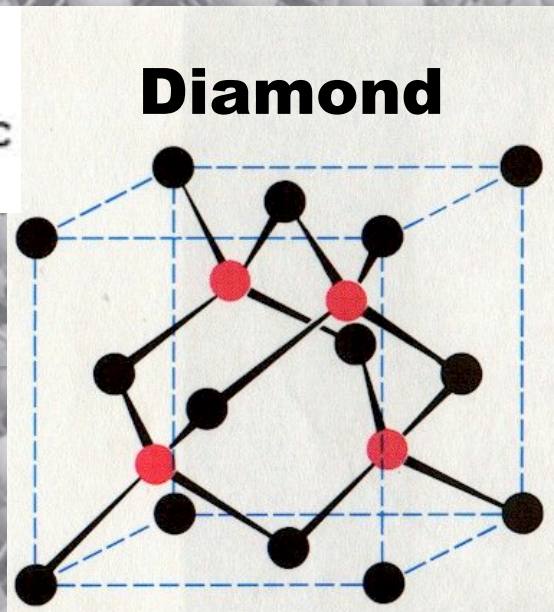


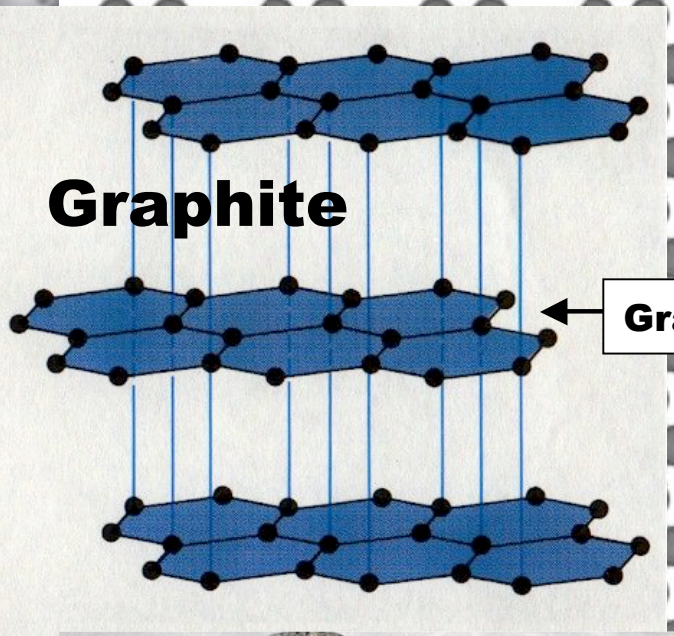
Sources: Norman Poire, Merrill Lynch

Example: Carbon in the macro

Allotropes of Carbon: different crystal structures with different properties.



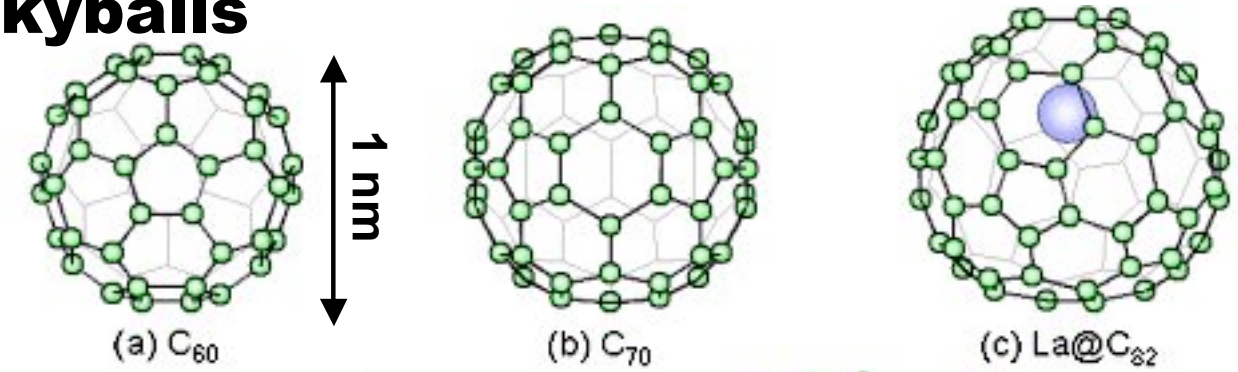




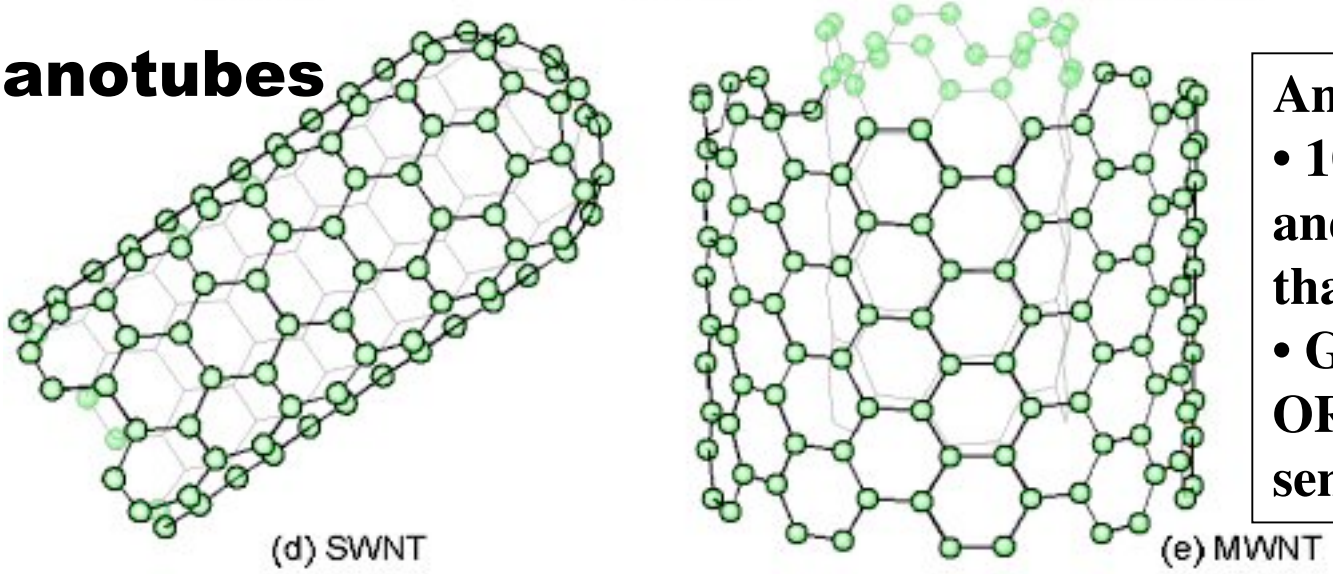
Example: Carbon in the nano

A new form of Carbon: buckminsterfullerenes

buckyballs



nanotubes



Amazing properties:

- **100 times stronger and 6 times lighter than steel**
- **Good conductores OR good semiconductors**