History of Nanotechnology

4th Century: The Lycurgus Cup (Rome) is an example of dichroic glass; colloidal

gold and silver in the glass allow it to look opaque green when lit from outside but

translucent red when light shines through the inside.

9th-17th Centuries: Glowing, glittering “luster” ceramic glazes used in the Islamic

world, and later in Europe, contained silver or copper or other metallic nanoparticles.

6th-15th Centuries: Vibrant stained-glass windows in European cathedrals owed

their rich colors to nanoparticles of gold chloride and other metal oxides and chlorides;

gold nanoparticles also acted as photocatalytic air purifiers.

13th-18th Centuries: “Damascus” saber blades contained carbon nanotubes and

cementite nanowires an ultrahigh-carbon steel formulation that gave them strength,

resilience, the ability to hold a keen edge, and a visible moiré pattern in the steel that give

the blades their name.

1857: Michael Faraday discovered colloidal “ruby” gold, demonstrating that

nanostructured gold under certain lighting conditions produces different-colored solutions.

1936: Erwin Müller, working at Siemens Research Laboratory, invented the field

emission microscope, allowing near-atomic-resolution images of materials.

1947: John Bardeen, William Shockley, and Walter Brattain at Bell Labs discovered

the semiconductor transistor and greatly expanded scientific knowledge of

semiconductor interfaces, laying the foundation for electronic devices and the

Information Age.

1951: Erwin Müller pioneered the field ion microscope, a means to image the

arrangement of atoms at the surface of a sharp metal tip; he first imaged tungsten atoms.

1981: Gerd Binnig and Heinrich Rohrer at IBM’s Zurich lab invented the scanning

tunneling microscope, allowing scientists to "see" (create direct spatial images of)

individual atoms for the first time. Binnig and Rohrer won the Nobel Prize for this discovery

in 1986.

1985: Rice University researchers Harold Kroto, Sean O’Brien, Robert Curl, and

Richard Smalley discovered the Buckminsterfullerene (C60), more commonly known as the

buckyball, which is a molecule resembling a soccer ball in shape and composed entirely

of carbon, as are graphite and diamond. The team was awarded the 1996 Nobel Prize in

Chemistry for their roles in this discovery and that of the fullerene class of molecules more

generally.

1985: Bell Labs’s Louis Brus discovered colloidal semiconductor nanocrystals

(quantum dots), for which he shared the 2008 Kavli Prize in Nanotechnology.

1986: Gerd Binnig, Calvin Quate, and Christoph Gerber invented the atomic force

microscope, which has the capability to view, measure, and manipulate materials down

to fractions of a nanometer in size, including measurement of various forces intrinsic to

nanomaterials.

1989: Don Eigler and Erhard Schweizer at IBM's Almaden Research Center

manipulated 35 individual xenon atoms to spell out the IBM logo. This demonstration of the

ability to precisely manipulate atoms ushered in the applied use of nanotechnology.

1991: Sumio Iijima of NEC is credited with discovering the carbon nanotube (CNT),

although there were early observations of tubular carbon structures by others as well. Iijima

shared the Kavli Prize in Nanoscience in 2008 for this advance and other advances in the

field. CNTs, like buckyballs, are entirely composed of carbon, but in a tubular shape. They

exhibit extraordinary properties in terms of strength, electrical and thermal conductivity,

among others.

1992: C.T. Kresge and colleagues at Mobil Oil discovered the nanostructured

catalytic materials MCM-41 and MCM-48, now used heavily in refining crude oil as well as

for drug delivery, water treatment, and other varied applications.

1999: Cornell University researchers Wilson Ho and Hyojune Lee probed secrets of

chemical bonding by assembling a molecule [iron carbonyl Fe(CO)2] from constituent

components [iron (Fe) and carbon monoxide (CO)] with a scanning tunneling

microscope.

1999: Chad Mirkin at Northwestern University invented dip-pen nanolithography

(DPN), leading to manufacturable, reproducible “writing” of electronic circuits as well as

patterning of biomaterials for cell biology research, nanoencryption, and other

applications.

1999–early 2000’s: Consumer products making use of nanotechnology began

appearing in the marketplace, including lightweight nanotechnology-enabled

automobile bumpers that resist denting and scratching, golf balls that fly straighter, tennis

rackets that are stiffer (therefore, the ball rebounds faster), baseball bats with better flex

and "kick," nano-silver antibacterial socks, clear sunscreens, wrinkle- and stain-resistant

clothing, deep-penetrating therapeutic cosmetics, scratch-resistant glass coatings, fasterrecharging batteries for cordless electric tools, and improved displays for televisions, cell

phones, and digital cameras