What is *Nanotechnology*?

Making, Measuring, Manipulating, all at nanometer scale.

1 inch = 25,400,000 nanometer
1 human hair = 150,000 nanometer
Nano-scale: how small is 1 nanometer?
Imagine the possibilities: materials with ten times the strength of steel and only a small fraction of the weight -- shrinking all the information housed at the Library of Congress into a device the size of a sugar cube --- detecting cancerous tumors when they are only a few cells in size.

President William J. Clinton
January 21, 2000
California Institute of Technology
Nano-Quote:

- $32 billion in nanotechnology sale, 2008.
- $2.6 trillion, by 2014.
All kinds of ‘Nano’

Nanosphere  Nanoparticle  Quantumdot
Nanorod  Nanowire  Nanochain
Nanoribbon  Nanotube  Nanokids  Nanobelt
Brandenburg gate constituted by CO molecules

Pattern Single Atoms

Is that small?
Is that possible?
Is that cool?
Nanocar Rolls Into Action

World's first molecular car zips about on fullerene wheels

Nano Lett. 2005, 5, 2330
NANOTECHNOLOGY: THE NEXT BIG THING

U.S. National Nanotechnology Initiative aims to create another Industrial Revolution

William Schulz
C&EN, Washington

By anyone’s measure, nanotechnology is the next big thing. In fact, according to government R&D planners, nanotechnology is nothing short of the next Industrial Revolution.

But to keep the ball rolling, government planners will also have to keep alive the drumbeat of promise about the fruits of nanotechnology research. By their own estimate, government R&D analysts say, payoffs from significant investments in nanotechnology are at least 20 years away.

“We are constantly faced with ‘How do we keep this going through the system?’” says Duncan T. Moore, the Administration’s point man for nanotechnology in the White House Office of Science & Technology Policy (OSTP). As with any cross-agency government program, he says, the President’s recently announced National Nanotechnology Initiative (NNI) will likely face many challenges over the next decade that it is scheduled to be in operation.

“A lot of the old barriers [between R&D agencies] have been broken down,” Moore says, to jumpstart the nanotechnology initiative. Six of the nation’s largest R&D agencies—the National Science Foundation, the Defense Advanced Research Projects Agency, the National Institute of Standards and Technology, the National Aeronautics and Space Administration, the Department of Energy, and the Department of Health and Human Services—will provide financial support to nanotechnology research.

The initiative, he says. What’s more, the Administration has requested an extra $495 million in funding for those agencies’ NNI programs in fiscal 2001. Details of how each agency involved with NNI will carry out its portion of the initiative can be found at http://www.nano.gov.

The initiative got its official start in August 1999 when the National Science & Technology Council’s (NSTC) Interagency Working Group on Nanoscience, Engineering, and Public Policy, chaired by Moore, released its first report, “Nanostructure Science & Technology.” It is, the authors say, a blueprint for the federal government to assess how to make strategic R&D investments in nanotechnology.

“Nanostructure Science & Technology” outlines a trinity of nanotechnology: “Classical,” or bottom-up, nanotechnology; “Mesoscale,” or middle-up, nanotechnology; and “Top-down,” or up-up, nanotechnology.

Luncheon briefing on Capitol Hill to help acquaint members and congressional staff with the field of nanotechnology and its promise.

Entitled “Tiny Dynamite: The Nanotechnology Revolution,” the briefing received national attention when the White House released its first report on the state of nanotechnology in the United States. The report, released in August 1999, is a blueprint for the federal government to assess how to make strategic R&D investments in nanotechnology.

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This image of 112 carbon monoxide molecules on a copper surface was made at IBM’s Almaden Research Center using a scanning tunneling microscope. Each letter is 4 nm high by 3 nm wide. About 250 million nanotubes of this size could be written on a cross section of a human hair; this corresponds to 300 300-page books. President Clinton used the image to unveil NNI.
Changing emission color by changing the particle size
The Electromagnetic (Radiation) Spectrum
Splitting white light through a prism
Organic Light-emitting diode (OLED) devices: --- color matters ---

Figure 1: OLED Display Revenue Forecast

Source: DisplaySearch Q2’09 Quarterly OLED Shipment and Forecast Report
OLED TV: never cool like this

Thin: millimeter
Flat: full view angle
Bright: 1,000,000:1 and ...
Flexible, foldable!
E-book: fold it as you like
Breaking Through

Printable electronics is attracting growing interest and is gearing up for commercial applications

Alexander H. Tullo
Solar cell powered windows:

Hong Kong Science Park
One day, power your house by painting solar cells
One day, power yourself using solar cell paints ...