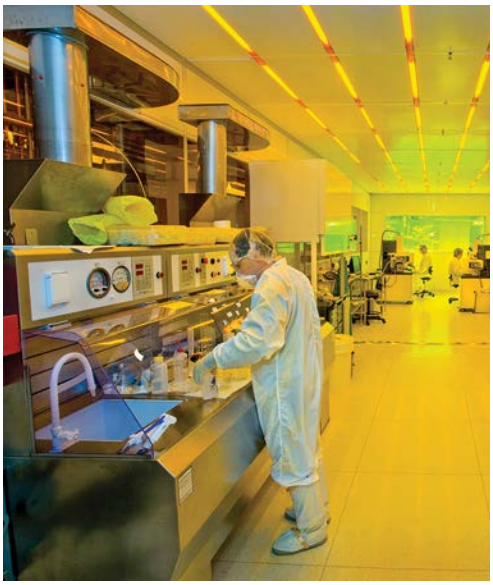

ABOUT THE IMAGES

BES-funded nanoscale research centers provide advanced analytical tools and contaminant-free facilities—often called clean rooms—for materials synthesis, enabling scientists from many universities to study nanoscale phenomena.

(LAWRENCE BERKELEY NATIONAL LABORATORY)

Cryo-electron microscopes are among the powerful analytic tools available at the nanoscale research centers.

(LAWRENCE BERKELEY NATIONAL LABORATORY)

INVENTING NANOSCIENCE

EXPLORING MATERIALS AT ATOMIC SCALE

By 2001, the potential for nanoscience to transform many areas of science was increasingly clear. A Presidential Nanoscience Initiative was launched. Working in collaboration with other federal science agencies, the Basic Energy Sciences (BES) office of DOE proposed and supported the creation of five Nanoscale Science Research Centers open to all scientists, located at DOE National Laboratories to also enable access to existing X-ray and neutron probes. In the decade since these shared research facilities came into full operation, they have enabled an explosion of discoveries in physics, chemistry, materials science and biology, which in turn have begun to yield important new technologies.

The Breakthrough

The discovery that materials behave quite differently in the nanoscale regime—smaller than 100 nanometers—and the development of methods to understand that behavior.

- As the semiconductor industry made electronic components on chips smaller and smaller, they reached the nanoscale regime and had to develop ways to understand and cope with novel behaviors.
- University scientists investigating nanoscale phenomena from the bottom up began to grow materials almost atom by atom, precisely controlling their composition and structure.

The Impact

A rising tide of new technologies set to transform healthcare, a wide range of industry, and the conduct of science itself.

- Tiny semiconductor crystals as small as 50 atoms wide that emit extremely pure colors and are used commercially in the current generation of TV and video screens.
- Nanoscale particles coated with biomolecules are being used for cancer chemotherapy.
- Specialized nanoscale inks for 3-D printers that enable printing of tiny electronic components, production of batteries the size of a grain of sand, and many other advanced manufacturing applications.
- New solar cell materials that are more efficient, and advanced nanoscale structures that may lend themselves to the storage of hydrogen fuels.

The Takeaway

Creating the facilities and tools that enabled fundamental research into the behavior of nanoscale materials is paying off with accelerated innovation and commercial nanotechnologies.

Adapted from chapter 8 of A Remarkable Return on Investment in Fundamental Research, U.S. DOE, June 2018.
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