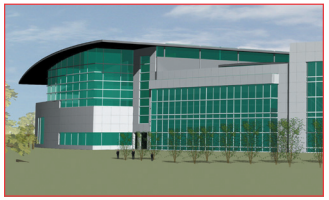
A Nanoscience Research Center In the Northeast United States



A rendering of the Center for Functional Nanomaterials to be built at Brookhaven National Laboratory

What is the Center for Functional Nanomaterials?

The Center for Functional Nanomaterials (CFN) at Brookhaven Lab will provide scientists with state-of-the-art capabilities to tailor materials at the atomic level, with the aim of understanding how to improve materials' chemical or physical functioning. The "functional nanomaterials" resulting from this understanding are expected to have broad applications as the basis of future technology, such as faster computers, improved solar energy conversion, and more efficient catalysis of chemical reactions.

Why establish this facility at Brookhaven?

Brookhaven National Laboratory is an ideal location to establish one of the five Nanoscale Science Research Centers being built by the Office of Science of the U.S. Department of Energy at its national labs, as its researchers have a long history of achievement in developing an understanding of the structure and function of materials down to the nanoscale. Once the center is built, the Laboratory will then be able to expand its nanoscience collaborations involving faculty at universities across the country, many of whom are performing complementary studies.

Among the many tools that Brookhaven employs in performing nanoscience, the following three Laboratory facilities will complement the new center:

- NATIONAL SYNCHROTRON LIGHT SOURCE: where intense light reveals the structure and function of a range of materials and specimens.
- LASER ELECTRON ACCELERATOR FACILITY: where molecular charge transport is studied during certain chemical reactions.
- TRANSMISSION ELECTRON MICROSCOPE: where the electronic, magnetic, and optical properties of materials are examined at the atomic level.

National Synchrotron Light Source at Brookhaven

A View of Brookhaven

Funded by the U.S. Department of Energy, Brookhaven National Laboratory is a multipurpose research institution located on a 5,300-acre site on Long Island, New York. The Laboratory operates large-scale scientific facilities and performs research in physics, chemistry, biology, medicine, applied science, and advanced technology.

In addition to Brookhaven's 3,000 scientists, engineers, and support staff, some 4,000 researchers from across the country and around the world come to the Laboratory each year to use its research facilities and collaborate with its scientific staff.

An aerial view of Brookhaven National Laboratory.

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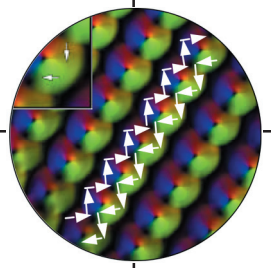
Office of Science
U.S. DEPARTMENT OF ENERGY

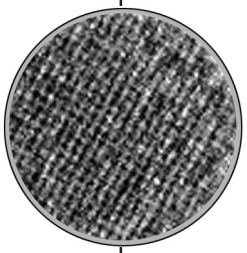
BROOKHAVEN NATIONAL LABORATORY

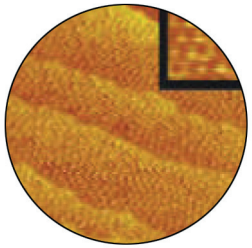
managed for the U.S. Department of Energy
by Brookhaven Science Associates, a company
founded by Stony Brook University and Battelle

Center for Functional Nanomaterials

Brookhaven National Laboratory







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Nanoscience: Manipulating Materials At the Atomic Level

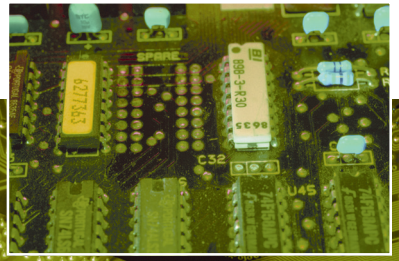
What is nanoscience?

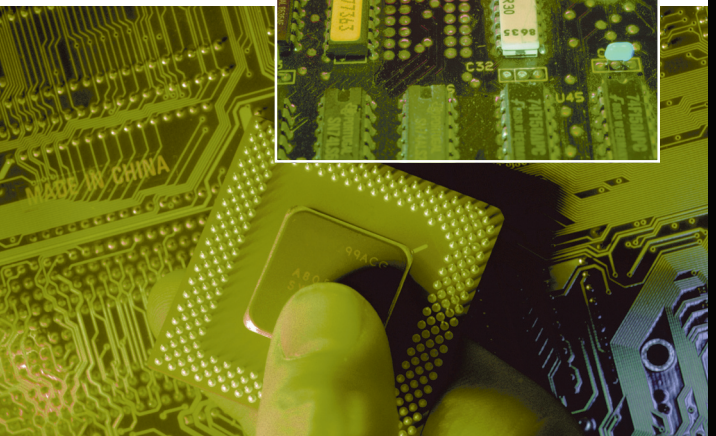
Nanoscience is the study of materials at ultra-small dimensions — on the scale of a nanometer, which is a billionth of a meter (0.000000001 meter). For example, today's smallest electronic component in an integrated circuit is 250 nanometers per side. Proteins, the molecules that catalyze chemical reactions in cells, are 1 to 20 nanometers in size. In contrast, the diameter of a human hair is approximately 10,000 nanometers.

Nanoscale science, engineering, and technology is an emerging, interdisciplinary area involving materials scientists, chemists, physicists, biologists, and other researchers. Their goal: to work atom by atom, molecule by molecule to design and assemble new materials that have desired properties and functions. Once developed, these nanomaterials will be the basis of the products and processes of tomorrow.

What are the possible benefits of nanoscience?

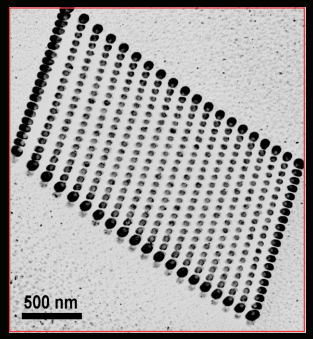
- Faster computers
- Improved solar energy conversion
- Stronger and lighter materials
- Improved chemical and biological sensing
- Efficient and rapid detection and remediation of pollutants and pathogens in the environment
- More efficient catalysts to speed up chemical processes
- Molecular motors
- New drugs





Main Nanoscience Project Areas at Brookhaven National Laboratory

Research at the Center for Functional Nanomaterials (CFN) will focus on six project areas —



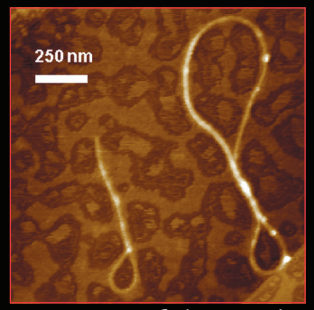
Nickel nanoparticle array

Strongly Correlated Metal Oxides

Superconductors are materials that, below a certain temperature, can conduct electricity with no resistance. Since many superconductors are metal oxides, understanding how they operate at the nanoscale may lead to their everyday use to provide much less expensive electrical power.

Charge Injection And Transport

Understanding the transfer of electrons between molecules within a material at the nanoscale is important in creating more sophisticated electronics and other devices, such as photonics, which convert light into electricity.



Carbon nanotubes

Magnetic Nanoassemblies

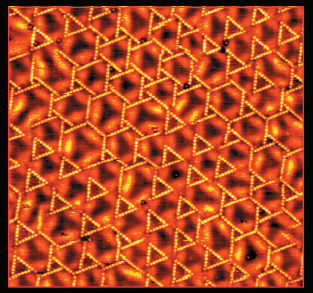
Because the spin of electrons and nuclei are responsible for magnetism, learning how to manipulate magnetic materials on the nanoscale may increase the storage capacity and retrieval speed of magnetic storage devices and enable advanced multifunctional sensors.

Nanometer-Thin Organic Films

Improving the physical and chemical properties of organic films, which are used in protective coatings, sensor equipment, and more, may result from developing a nanoscale understanding of how the molecules within the film interact with each other and with the molecules of the substrate on which the films are grown.

Nanocatalysts

By changing the structure and function of catalysts on the nanoscale, new and improved ways of speeding up chemical reactions could be developed. This could reduce the cost and environmental impact of existing products and processes, and increase the development of new, energy-efficient, environmentally friendly goods and methods.



Sulfur atom nanoclusters on a copper layer deposited on a ruthenium single crystal

Applications of Nanoscience

Brookhaven scientists, university researchers, and their industrial partners will explore ways to apply the knowledge gained within the above five project areas to develop new devices and processes for the benefit of humankind.

Center for Functional Nanomaterials
Brookhaven National Laboratory

For more information on nanoscience at Brookhaven, go to www.cfn.bnl.gov