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Nanotechnology: An emerging science

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DESCRIPTION

Nanotechnology is science, engineering, and technology conducted at the nanoscale, which is about 1 to 100 nanometers. Nanoscience and nanotechnology are the study and application of extremely small things and can be used across all the other science fields, such as chemistry, biology, physics, materials science, and engineering. Nanoscience and nanotechnology involve the ability to see and to control individual atoms and molecules.

Nano scale

A nanometer is one-billionth of a meter. The National Nanotechnology Initiative provides some excellent comparisons of materials on different scales at Size of Nanoscale. The following are some graphics that demonstrate the relative size of numerous types of materials ranging from the nano- to the macro-scale. Nanomaterials have at least two dimensions that are between 1 and 100 nanometers in size. On this scale, interatomic (coulombic) forces become large, and must be considered when undertaking studies to characterize, experiment, and model the behaviors of nanomaterials.

Nanoparticles "are as small as ~1 nM and may range up to several tens of nanometers in at least one dimension".

•Nanosheets or nanofilms have one dimension in this size range; (e.g., clay minerals)

•Nanorods have two dimensions in this size range

•Nanoparticles have three dimensions in this size range

•Nanotubes are nanoscale materials that have a tube-like structure; e.g., carbon nanotubes in the accompanying figure.

Nanomaterials are everywhere in the Earth system. Nanomaterials impact chemical reactions, reaction rates and fluxes; global biogeochemical cycling; genesis and evolution of life on Earth; transport and fate of potentially hazardous or toxic materials; and environmental and human health. Nanoparticles contribute significantly to the energy and mass budgets of the Earth system. However, the role of nanoparticles is rarely incorporated into studies of the history and processes of the Earth system. Nanoparticles are either not considered in many research projects, or the sampling and analytical methods are not adequate to fully characterize the nature of nanoparticles. This means that a significant component of the Earth system is missing from models of the Earth system.

A consequence of the lack of attention to nanoscience in the Earth, Space and Environmental Sciences is that nanoscience is largely absent from the curriculum in these subjects. To meet disciplinary and institutional missions, e.g. discovery of new knowledge, training the future technical workforce, and in service to society, this module on Teaching Nanoscience has been developed to assist faculty who may be interested in including nanoscience in their courses, to readily find information and resources to help them introduce concepts and examples of applied nanoscience across the curriculum.

The reason that nanotechnology is so interesting is that materials at the nanoscale have entirely different properties than materials on the macroscale. All of the physical, chemical and biological properties and processes we are familiar with on scales of observation within day-to-day human perception may be fundamentally different on the nanoscale: conductivity of heat and electricity, magnetic properties, optical properties, physical strength of materials, reactivity and reaction rates.This has opened up entirely new lines of research to understand the occurrences, composition and structure, of nanoparticles and the fundamental principles that control chemical, physical and biological processes on the nanoscale.

CONCLUSION

Today's scientists and engineers are finding a wide variety of ways to deliberately make materials at the nanoscale to take advantage of their enhanced properties such as higher strength, lighter weight, increased control of light spectrum, and greater chemical reactivity than their larger-scale counterparts. The exciting field of nanodevices is focused on developing miniaturized technology with unique functionality for electronic, magnetic, mechanical, and optical systems. Sensors, actuators, and microfluidic devices are all in high demand to help solve global energy, communications, and critical monitoring challenges.