REMEMBER TO INCLUDE PICTURES.

I. INDEX. What is nanotechnology? “science of the very small”

Simply put, nanotechnology is science dealing with materials on a very small scale – the same scale used for atoms and molecules. Nanometers (nm), the main measurement in this field, are one billionth of a meter each and objects classified as “nanomaterials” are 1-100 nm. The concept of nanotechnology was created about 50 years ago, and since then, scientists have been scrambling to pioneer new advances that will transform the way we live.

This website was created as a project for the 2009 Student Bio Expo as well as to educate visitors on the quickly developing field of nanotechnology. Please click on the links to the left to learn more.

II. Overview

A. History

Here is a timeline that includes the major advances in nanotechnology since the 20th century:

1959- American physicist Richard P. Feynman gives a speech at the American Physical Society, and is credited with originating the concept of nanotechnology. (possibly research him?)

1971-Kim Eric Drexler, a genetic engineering student at MIT popularizes the theory of nanotechnology.

1974-Norio Taniguchi is the first to use the term “nanotechnology”.

1985- Richard Errett Smalley makes the first major development in nanotechnology by finding a way to produce carbon in a third form (besides graphite and diamond).

2000- US President Bill Clinton creates the National Nanotechnology Initiative (NNI)

B. How it works

What makes nanotechnology so special? At first glance, nanomaterials seem to be the same as regular sized materials. Let me tell you now, they aren’t. At the nanoscale, molecules and atoms behave differently than they do when they are visible to the human eye. Many of matter’s physical properties are different at that scale, creating the need for more research and information about nanotechnology.

How Nanomaterials are made

There are currently two main ways of creating nanomaterials. The first, nanofabrication (sometimes microfabrication) is made of two stages. First, a single layer is grown on a substrate (a supporting base) during the growth stage. Next, in the lithography transfer stage, the one dimension layer is added to a uniform layer to form a pattern and a second/third dimension. The second main way nanomaterials are made is referred to as the bottom-up approach. With this method, atoms and molecules are manipulated one at a time to build nanomaterials.

Both approaches have their flaws, however. Both are costly, and nanofabrication is not precise all the time. The bottom-up approach is generally new, and because of the unstable nature of nanomaterials, they are hard to manipulate one at a time.

How Devices are powered at the nanoscale

Objects of such a small scale also need energy of a very small scale. The general term for the powerplants that harvests and supplies electrical energy to nanoscale devices are called nanogenerators. Nanogenerators replace the need for large batteries, making the devices more efficient. Recently, scientist Zhong Lin Wang and his team at the Georgia Institute of Technology have found that at the nanoscale, gravity does not affect the materials, so the generators to provide energy for these devices need another source of energy (possibly mechanical, vibration, or hydraulic energy). In the near future, Wang believes that nanogenerators will be used to harvest and recycle wasted energy (any sort of movement) to power nanoscale devices.

III. Impact (and its presence in everyday life)

A. Medicine/Healthcare

Nanotechnology has the potential to revolutionize the medical field. Smaller tools created with nanotechnology will reduce the price of healthcare and will help in researching more diseases, like cancer. In fact, nanoscale devices many help make treatments such as chemotherapy more efficient by targeting specific areas of tumors without hurting healthy tissues.

B. Renewable Energy

Nanotech has also been used to help the environment. Recently, a new coating that makes solar panels more efficient has been developed with nanotechnology. Researchers from the Future Chips Constellation (FCC) at Rensselear Polytechnic Institute in New York have found that the new coating can absorb about 96.21% of all the sun exposure it receives, much higher than the 67.4% regular silicon solar panels now receive. The coating is made out of seven layers of nanoscale silicon dioxide and titanium dioxide rods and can absorb all types of sunlight from many different angles.

D. Space Elevator

In November of 2008, engineers from all over the world attended a conference in Japan to discuss and design a lift that will transport anything directly into space. The ‘space elevator’, as it is called, has received worldwide coverage; NASA has posed this concept with a $4 million prize as a challenge to encourage more designs. Japan Space Elevator Association, Spaceward Foundation and Liftport Group are three companies focused on this project.

Those working on the project right now believe that the power source of the elevator will most likely come from a carbon nanotube cable, which has enough strength to span the length from Earth to space. However, scientists are unsure of how to make a cable long enough. Once completed, the cable would be anchored to Earth and reach into space with a weight to balance it on the other side. Inertia is theorized to keep the cable tight. The space elevator would be used to transport people into space, dispose of nuclear waste and place solar panels in space to provide power to homes.

IV. Safety (and how nanotechnology is used in the world around us today)

Remember to add: 5% of US funding for nanotechnology is used to research its effects on health and safety.

1. Products

Companies have already begun to use nanotechnology in or to make more than 200 consumer products in the US (800 in Canada). One of the reasons for this is the changing physical property nanomaterials have that can improve finished products. Although most consumer products with nanotechnology are constructed with carbon, silver and silica, they have a wide range of applications. Some of the current products on the market include a special paint, manufactured by Behr that blends nano-sized ingredients that is claimed to make it more resistant to mildew and grease. Another product is canola active oil by Sherman Industries that has been manufactured with nanodrops that contain vitamins and minerals. Without the nanodrops, they would be insoluble.

Today, scientists see many applications of nanotechnology in healthcare, medicine, security and engineering. In fact, many consumer products today are made using nanotechnology. (CITE EXAMPLES HERE)

1. Concerns

In December of 2008, the National Research Council (NRC) in the US reported that the US government is not standardizing and regulating nanotech enough, causing a negative reaction from consumers. Many similar organizations around the world, like the Royal Commission on Environmental Pollution in Great Britain and the Council of Canadian Academies agree that more research should be done on nanotechnology, and that a clear set of regulations should be created.

Some of their concerns stem from the fact that nanomaterials cannot be seen by the naked eye, arousing issues in disposing of nanomaterials.

Other concerns come from the general public, who are somewhat scared of nanotechnology after being introduced to it through fictional works, such as Michael Chrichton’s *Prey*. Chrichton’s book tells a fictional account of nanoparticles that can behave on their own and eventually escape from their human creators and develop into self-reliant creatures that feed off of animals (including humans).

V. [Nanotechnology &] Money

Because of its potential, countries all over the world are funding the research of nanotechnology. Some governments, like those of Japan and Russia, have made it a priority to develop nanotech. In 2007, the world collectively spent $13.8 billion USD on research. In the US alone, $1.5 billion came from the government (up from $500 million in 2001) and $3 billion came from private investors. The top five countries competing for dominance in the field of nanotechnology are the US, European Union (EU), Japan, Russia and China.

Currently, an International Nanotech Innovation Park is being developed in Suzhou, China, partly funded by the government, as an industrial base for research. The park is to host nanotech companies, most prominent of which are BioBay and the Suzhou Nanotech and Nanobiotics Institute. The park is also being introduced to companies in Russia, Finland and South Korea, to name a few, to facilitate a cooperative effort in researching nanotech.

VI. Future [of Nanotechnology]

The possible applications of nanotechnology seem endless, especially in health care, reducing environmental impact and national security.

Scientists believe that in the future, nanotechnology will produce

* surgical instruments the size of molecules
* the creation of food from molecules, possibly stopping famine
* pollution free industrial manufacturing
* devices that clean up pollution
* nanobots that cure cancer, AIDS and bacteria/viruses.

Among many other developments.

According to Mihail C. Roco, a senior advisor for nanotechnology at the National Science Foundation, there will be four stages of nanotech development:

1. Development of nanomaterials with a stable structure that are usually used as part of a product (began in 2000)
2. Focused research on nanostructures that change size, shape or conductivity during its use (began in 2005)
3. Development of systems of nanostructures that form self-dependent wholes that operate by themselves (projected to start around 2010)
4. Development of molecular nanosystems that may lead to new types of genetic therapies and anti-aging treatments (projected around 2015-2020)

VII. Reflection

VIII. Bibliography