Committee: Environmental Committee

Issue: Bio application of nanomaterials and their consequences on human health and the environment

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Introduction

Nanotechnology as a science started growing after a lecture by physicist Richard Feynman at California Institute of Technology (CalTech) in 1959. The initial idea behind nanotechnology was that scientists would be able to work on the nanoscale by controlling and manipulating atoms and molecules. We had to wait until 1981 when the scanning tunneling microscope was discovered and the modern era of nanotechnology began. Nowadays a lot of money is invested every year on nanotechnology RnD (Research and Development) and the applications of these inventions are huge. The most fascinating fact is that by controlling individual atoms we can construct new materials, which we call nanomaterials, with innovative applications. A variety of other sciences such as: Medicine, Physics, Chemistry, Pharmaceutics, Mechanical Engineering, Electrical Engineering and many more use nanomaterials in order to improve their products or the quality of their research. The bio application of nanomaterials is a very controversial discussion topic. The inventions in this field are revolutionary and they promise to change the approach of the process of treating many serious diseases as for example cancer, HIV and more. At the same time many are those who are puzzled about the implications of the use of nanomaterials, since their effects on human life and the environment are yet unknown. Some scientists have claimed that nanomaterials could cause health problems varying from dermal diseases to lung cancer inflicted on researchers who are working with nanomaterials inside the laboratories. However, no reports have been found, stating that the use of nanomaterials as a cure method has negative effects on someone's health. However, we have to keep in mind that all these potential treatment techniques are still on experimental level.

Furthermore, nanomaterials are not only potentially harmful to human health, but many scientists are concerned that they may also be detrimental to the environment. For example, the combination of nanotechnology and geoengineering could have a terrible effect (as for example rise of the CO2 levels) on the environment but on the other hand we can never know before actual research takes place. As we can all understand the lack of research is the only thing we have to be afraid of.

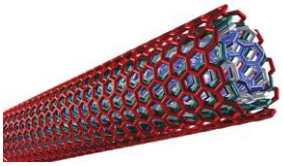
Definition of Key-Terms

Nanotechnology: The intentional manipulation of matter in the nanoscale.

Nanoscale: A measurement scale for length. When we work on the nanoscale we work on a scale from 1-100 nanometers. One nanometer is one billionth of a meter. (1nm= 10^{-9}m)

Nanomaterials:

Materials of which a single unit is between 1-100 nanometers. Despite their very small scale their properties are very similar to other materials in a normal scale. The combination of these two factors, their scale and their properties, make them a very attractive option to scientists when they design a new product regardless of the product's use.

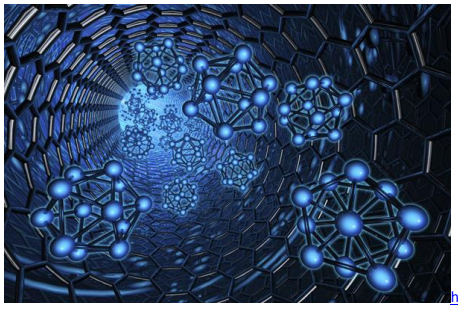


1. *A nanostructure*

2. *Products such as a racket…*

3. *… or a lipstick are made by nanomaterials*

Molecules: A combination of two or more atoms retained together by chemical bonds. Molecules are electrically neutral.



http://www.redbrick.me/wp-content/uploads/2014/02/nanomaterials.jpg

Enzymes:

Enzymes are biological catalysts and their main job is to catalyze or accelerate chemical reactions.

Background Information

The use of nanomaterials

Nanomaterials existed in our environment long before humans. That means that nanomaterials are not a human creation, nor a synthetic product. We can find them outside in our world. Archeological findings have shown us that even humans in the past, that didn't have the technological advantages that we have today, knew about nanomaterials. A characteristic example is the Lycurgus Cup, which is all made by nanoparticles (70nm) of gold and silver (nanoparticles of gold and silver are particles of common gold and silver sized in the nanoscale). The nanoparticles on this cup are responsible for the dichroic effect (the ability of the cup to change its color under different lighting).

Figure 4.: Lycurgus Cup

Nanomaterials today

Over the years more and more scientists have turned their attention to nanomaterials. Every year scientists study more nanomaterials and discover their amazing properties that fit to very specific jobs. For example, a whole division of nanomaterials research works on nanozymes. The nanoenzymes are nanomaterials which act and look like enzymes. Some scientists call them artificial enzymes and they use them for: bio sensing, bio imaging, tumor diagnosis and therapy, antibiofouling, etc. Another characteristic example of the use of nanomaterials is an invention that could one day help blind people see. The whole idea behind this project is converting visual information from light signals to electrical signals that the brain can easily understand. It is easy to understand that the field of nanomaterials has a great future ahead and it has to be protected by **proper regulations**.

Regulations that will distinctly define the right use of nanomaterials (according to the characteristics and the effects they might have). We must also set regulations that define the circumstances under which a new invention in the field of nanomaterials is legal to be commercialized. For example, an international test could be created that would check if a new invention meets all the criteria that are deemed necessary so that a product can reach the hands of consumers.

OECD Nanomaterials Testing

The very small scale of nanomaterials makes it necessary for additional testing beyond the existing standard tests for normal sized materials. Such tests are in development by the OECD (Organization for Economic Co-operation and Development) that is aiming at the creation of an evaluation test for nanomaterials and especially for nanomaterials heading for commercial use. (More information here: http://www.oecd.org/chemicalsafety/nanosafety/testing-programme-manufactured-nanomaterials.html)

Nanomaterials in Medicine and Pharmacy

Many people are pinning their hopes for life on nanomaterials. Many articles stating that nanomaterials may be the answer to cancer or other terminal diseases are being published and the hopes of people suffering from such diseases revive. A whole new field of medicine, called nanomedicine, has been founded and its goal is to find new treatment methods against many serious diseases using nanomaterials and the nanotechnology in general as an ally. For example, some scientists are trying to defeat cancer using nanoparticles made of gold. These nanoparticles will allow the cancer drug to be transported directly where the cancer cells are and release the drug leaving the other healthy cells unharmed and not affected by the drug. It is of high importance that the researchers complete their research, covering every possible aspect which could cause problems to human health or to the environment in the future. Furthermore, both researchers and consumers should be protected by any potential negative effect of the exploitation of nanomaterials. That means that proper regulations covering the ways that a research takes place have to be introduced in order to protect researchers.

Nanomaterials and their effects on the environment

Engineered nanomaterials are becoming a part of our everyday life. Such materials can be used in food packaging, drug delivery systems, cosmetics, therapeutics, biosensors, and others because their amazing skills combined with their very small scale provide the scientists with the tools they need. Nanomaterials have even been integrated in the manufacture of space shuttles that will allow practical and more ergonomic unmanned space travel. The very small size of that spacecraft (20-Gram) will give it the power to travel at a fifth of the speed of light and reach a nearby star

in just 30 years (http://www.huffingtonpost.com/entry/nano-spacecraft-yuri-milner_us_5709b86ce4b0142232493a18). One of the crucial issues that have to be addressed in the near future, before extensive production of nanomaterials, is their toxicity to humans and their impact on the environment. The question is still open and it is our duty to find ways to protect our home, earth. We also have to keep in mind that nanomaterials are not synthetic products although they can also be produced by synthesis. Nanomaterials can also be found outside in the world. That means that nanomaterials are not an enemy of the environment we just need to find the perfect way to use them.

Synthesis of nanomaterials

1. Bottom up method

   This method begins with the miniaturization of other material components. Then, when reaching the atomic scale, starts the self-assembly process which leads to the creation of nanostructures. An example of this process is quantum dot formation or the formation of nanoparticles from colloidal dispersion. This is the less expensive method of nanomaterial synthesis.

2. Top-down method

   This method uses the creation of a larger scale pattern, which afterwards gets reduced to the nanoscale. It is slow and definitely not suitable for large scale production because such materials are not cheap and quick to manufacture. An example is application of severe plastic deformation.

Ethics in nanomaterials

There is a plethora of ethical questions behind the use of nanomaterials. As we know many scientists invest their time researching on genetics. Nanomaterials have brought a new age to this science offering many alternatives. Some scientists claim that they can use nanomaterials in order to recreate any human organ and plant it to the body but until now something like that hasn't been achieved (the most common method of organ recreation is still achieved via stem cells). However, this revolution doesn't stop there. What will happen if someone creates human clones made of nanomaterials? Even extreme scenarios such as the creation of human clones that may potentially save the human race in the case of an earth-scaled destruction have also been heard. Every scientist may be capable of bringing his\her ideas to reality

without any regulation via the use of nanotechnology. Therefore we can easily understand that nanotechnology has no limits and it is up to our hands to decide if we want to set those limits or not.

Major Countries and Organizations Involved

United States of America (USA)

Some people characterize USA as the "king" of nanotechnology having spent over $3,000,000,000 on nanotechnology research and having published over 7000 papers until now. You can find many papers that could help you with your research on this link: http://crnano.org/papers.htm

Another very interesting article is the following: http://crnano.org/safe.htm

China

China is the biggest economy in the world and is trying hard to become the biggest power in technology globally. China invests over $1,300,000,000 on nanotechnology research and has published around 2900 papers and 38900 articles.

India

Although India has many other serious problems to deal with, Indian researchers are doing their best to stay on the top of the line in nanotechnology research. Publishing more than 8000 articles per year India is undoubtedly one of leading countries concerning nanotechnology research. India has had the second largest growth rate on nanotechnology after Saudi Arabia by having a growth of 12%.

Germany

Germany is the leading European country concerning nanotechnology advances, investing a lot every year. Many companies have realized the potential of nanotechnology and they are trying to lead this field. Germany has published over 7000 articles in 2014 about nanotechnology.

United Kingdom (UK)

According to statistics based on the number of articles, UK is the second biggest power in nanotechnology in Europe. Having published more than 3900 articles only in 2014, UK is a countable power in nanotechnology.

Taiwan

Taiwan is considered to be also one of the biggest powers in nanotechnology. It may not be the most technologically advanced country but having understood the importance and the power of nanotechnology, they have already invested more than 200.000.000$ on nanotechnology research and they have brought new information about nanomaterials that could possibly harm the environment.

Japan

Japan is considered to be the capital of technology and as the capital of technology they couldn't fall behind in nanotechnology. Today Japan is the third biggest country considering nanotechnology according to statistics, having published more than 603 papers about nanomaterials.

Russian Federation

It would be impossible for Russia not to be in that list when it is the 5th biggest power in the industry of nanotechnology. Russia has published more than 400 papers and 3000 articles about nanotechnology.

UNITAR (United nations Institute for Training and Research)

UNITAR is the only UN body responsible for issues regarding nanotechnology. Its mission is "To develop capacities, to enhance global decision-making and to support country level action for shaping a better future." An example of UNITAR work is the creation of some skills-building workshops that will help people living in poor countries learn about Nano.

National Nanotechnology Initiative(NNI)

National Nanotechnology Initiative is a governmental program made by the US for engineering research in the nanoscale. Its main goal is to deliver a high profile world class nanotechnology RnD program.

For further research: http://www.nano.gov/

Timeline of Events

Date	Description of event
1857	Michael Faraday discovered colloidal “ruby” gold. It’s the first time we realize that gold nanoparticles can change their color.
1939	Erwin Müller working for Siemens Laboratories invented the field emission microscope. High Resolution near-atomic images of materials.
1947	John Bardeen, William Shockley, and Walter Brattain lay the foundation for the information age by inventing the semiconductor transistor.
1959	Richard Feynman gives the first lecture about nanotechnology at Caltech with the title "There's Plenty of Room at the Bottom".
1981	Gerd Binnig and Heinrich Rohrer invented the scanning tunneling microscope at IBM’s lab in Zurich.
1985	Louis Brus discovered the colloidal semiconductor nanocrystals, for which he won the 2008 Kavli Prize in Nanotechnology.
1990s	The first nanotechnology companies started operating.
2000s	The first consumer products made by nanomaterials appear.
2014	The NNI releases the 2014 Progress Review on the Coordinated Implementation of the Environmental, Health, and Safety Research Strategy.

Relevant UN Treaties, Resolutions and Events

UN Treaty/Resolution/Event 1

Security Council Resolution 1540 (2004)

On 28 April 2004, the United Nations Security Council unanimously adopted Resolution 1540 which states that the proliferation of nuclear, chemical and biological weapons constitutes a threat to international peace and security.

UN Treaty/Resolution/Event 2

Experts meet In January 2013 discussing about the future of nanotechnology and its effects on the environment.

Previous Attempts to solve the Issue

The bio application of nanomaterials and their effects on human health and the environment is a hot discussion topic nowadays. However, there are no previous attempts to solve this issue. The reason behind this fact is that this topic never gained the necessary attention it needed. Many articles have been published stating how important it is to prepare our law system for possible dangers generated by the lack of research on the field of nanotechnology, but nothing realistic has been proposed until now.

The only project about the risks of nanotechnology proposes the creation of an environmental test and risk assessment strategy. This strategy contains the results of the discussion which have been held between experts on January 2013.

Possible Solutions

There is a lot that can be done in order to combat the issue. When speaking about the possible negative effects of nanomaterials in human health we have to make sure that no one will be provided with a disease treatment that has not successfully fulfilled all the necessary tests.

Cooperation with international organizations responsible for this matter

Every scientific research center has to cooperate with the World Health Organization (WHO) and UNITAR in order to be examined for working under the existing regulation.

The creation of a data bank

A data bank, must be funded by the UN, where every new nanomaterial which has been examined by the researchers inside the laboratories will be recorded so researchers will not have to check it again.

Algorithms and Mathematical Models

Another possible solution is the creation of algorithms and mathematical models which will facilitate the procedure of evaluating the nanomaterials according with their applications and reach results and conclusions much faster than our current practices.

Raising public awareness

Last but not least, we have to try to raise public awareness on issues regarding nanotechnology. For example, the UNITAR has already tried something in the past by creating workshops for children in poor countries.

The whole existing evaluation process of nanomaterials can be found here: https://enveurope.springeropen.com/articles/10.1186/s12302-015-0053-6

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