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Importance of Nanotechnology for Environmental Related Issues

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Abstract: ***Green nanotechnology has two goals: producing nanomaterials and products without harming the environment or human health, and producing nano-products that provide solutions to environmental problems. It uses existing principles of green chemistry and green engineering to make nanomaterials and nano-products without toxic ingredients, at low temperatures using less energy and renewable inputs wherever possible, and using lifecycle thinking in all design and engineering stages.***

1. Introduction

In addition to making nanomaterials and products with less impact to the environment, green nanotechnology also means using nanotechnology to make current manufacturing processes for non-nano materials and products more environmentally friendly. For example, nanoscale membranes can help separate desired chemical reaction products from waste materials from plants. Nanoscale catalysts can make chemical reactions more efficient and less wasteful. Sensors at the nanoscale can form a part of process control systems, working with nano-enabled information systems. Using alternative energy systems, made possible by nanotechnology, is another way to "green" manufacturing processes.

The second goal of green nanotechnology involves developing products that benefit the environment either directly or indirectly. Nanomaterials or products directly can clean hazardous waste sites, desalinate water, treat pollutants, or sense and monitor environmental pollutants. Indirectly, lightweight nanocomposites for automobiles and other means of transportation could save fuel and reduce materials used for production; nanotechnology-enabled fuel cells and light-emitting diodes (LEDs) could reduce pollution from energy generation and help conserve fossil fuels; self-cleaning nanoscale surface coatings could reduce or eliminate many cleaning chemicals used in regular maintenance routines;and enhanced battery life could lead to less material use and less waste. Green Nanotechnology takes a broad systems view of nanomaterials and products, ensuring that unforeseen consequences are minimized and that impacts are anticipated throughout the full life cycle.

Nanoremediation and water treatment

Nanotechnology offers the potential of novel nanomaterials for the treatment of surface water, groundwater, wastewater, and other environmental materials contaminated by toxic metal ions, organic and inorganic solutes, and microorganisms. Due to their unique activity toward recalcitrant contaminants, many nanomaterials are under active research and development for use in the treatment of water and contaminated sites.

The present market of nanotech-based technologies applied in water treatment consists of reverse osmosis (RO), nanofiltration, ultrafiltration membranes. Indeed, among emerging products one can name nanofiber filters, carbon nanotubes and various nanoparticles. Nanotechnology is expected to deal more efficiently with contaminants which convectional water treatment systems struggle to treat, including bacteria, viruses and heavy metals. This efficiency generally stems from the very high specific surface area of nanomaterials which increases dissolution, reactivity and sorption of contaminants.

Environmental remediation

Nanoremediation is the use of nanoparticles for environmental remediation. Nanoremediation has been most widely used for groundwater treatment, with additional extensive research in wastewater treatment. Nanoremediation has also been tested for soil and sediment cleanup. Even more preliminary research is exploring the use of nanoparticles to remove toxic materials from gases.

Some nanoremediation methods, particularly the use of nano zerovalent iron for groundwater cleanup, have been deployed at full-scale cleanup sites. Nanoremediation is an emerging industry; by 2009, nanoremediation technologies had been documented in at least 44 cleanup sites around the world, predominantly in the United States. During nanoremediation, a nanoparticle agent must be brought into contact with the target contaminant under conditions that allow a detoxifying or immobilizing reaction. This process typically involves a pump-and-treat process or in situ application.

Nanotech to disinfect water

Nanotechnology provides an alternative solution to clean germs in water, a problem that has been getting worse due to the population explosion, growing need for clean water and the emergence of additional pollutants. One of the alternatives offered is antimicrobial nanotechnology stated that several nanomaterials showed strong antimicrobial properties through diverse mechanisms, such as photocatalytic production of reactive oxygen species that damage cell components and viruses. There is also the case of the synthetically-fabricated nanometallic particles that produce antimicrobial action called oligodynamic disinfection, which can inactivate microorganisms at low concentrations. Commercial purification systems based on titanium oxide photocatalysis also currently exist and studies show that this technology can achieve complete inactivation of fecal coliforms in 15 minutes once activated by sunlight.

There are four classes of nanomaterials that are employed for water treatment and these are dendrimers, zeolites, carbonaceous nanomaterials, and metals containing nanoparticles. The benefits of the reduction of the size of the metals (e.g. silver, copper, titanium, and cobalt) to the nanoscale such as contact efficiency, greater surface area, and better elution properties.

Cleaning Up Oil Spills

The U.S. Environmental Protection Agency (EPA) documents more than ten thousand oil spills per year. Conventionally, biological, dispersing, and gelling agents are deployed to remedy oil spills. Although, these methods have been used for decades, none of these techniques can retrieve the irreplaceable lost oil. However, nanowires can not only swiftly clean up oil spills but also recover as much oil as possible. These nanowires form a mesh that absorbs up to twenty times its weight in hydrophobic liquids while rejecting water with its water repelling coating. Since the potassium manganese oxide is very stable even at high temperatures, the oil can be boiled off the nanowires and both the oil and the nanowires can then be reused. In 2005, Hurricane Katrina damaged or destroyed more than thirty oil platforms and nine refineries. The Interface Science Corporation successfully launched a new oil remediation and recovery application, which used the water repelling nanowires to clean up the oil spilled by the damaged oil platforms and refineries.

Removing plastics from oceans

One innovation of green nanotechnology that is currently under development are nanomachines modeled after a bacteria bioengineered to consume plastics, Ideonella sakaiensis. These nano-machines are able to decompose plastics dozens of times faster than the bioengineered bacteria not only because of their increased surface area but also because of the fact that the energy released from decomposing the plastic is used to fuel the nano-machines.

Nanotechnology for sensors

Perpetual exposure to heavy metal pollution and particulate matter will lead to health concerns such as lung cancer, heart conditions, and even motor neuron diseases. However, humanity's ability to shield themselves from these health problems can be improved by accurate and swift nanocontact-sensors able to detect pollutants at the atomic level. These nanocontact sensors do not require much energy to detect metal ions or radioactive elements. Additionally, they can be made in automatic mode so that they can be readably used at any given moment. Additionally, these nanocontact sensors are energy and cost effective since they are composed with conventional microelectronic manufacturing equipment using electrochemical techniques.

Some examples of nano-based monitoring include:

1) Functionalized nanoparticles able to form anionic oxidants bonding thereby allowing the detection of carcinogenic substances at very low concentrations.
2) Polymer nanospheres have been developed to measure organic contaminates in very low concentrations
3) "Peptide nanoelectrodes have been employed based on the concept of thermocouple. In a 'nano-distance separation gap, a peptide molecule is placed to form a molecular junction. When a specific metal ion is bound to the gap; the electrical current will result conductance in a unique value. Hence the metal ion will be easily detected."
4) Composite electrodes, a mixture of nanotubes and copper, have been created to detect substances such as organophosphorus pesticides, carbohydrates and other woods pathogenic substances in low concentrations.

2. Conclusion

Although green nanotechnology poses many advantages over traditional methods, there is still much debate about the concerns brought about by nanotechnology. For example, since the nanoparticles are small enough to be absorbed into skin and/or inhaled, countries are mandating that additional research revolving around the impact of nanotechnology on organisms be heavily studied. In fact, the field of eco-nanotoxicology was founded solely to study the effect of nanotechnology on earth and all of its organisms. At the moment, scientists are unsure of what will happen when nanoparticles seep into soil and water, but organizations, such as NanoImpactNet, have set out to study these effects.

References

[1] "Environment and Green Nano – Topics – Nanotechnology Project". Retrieved 11 September 2011.
[2] What is Green Engineering, US Environmental Protection Agency "Sustainable Nano Coatings". nanoShell Ltd. Archived from the original on 8 February 2013. Retrieved 3 January 2013.
[3] Nanotechnology and Life Cycle Assessment "Nano Flake Technology – A Cheaper Way to Produce Solar Cells". Archived from the original on 2014-03-08. Retrieved 2014-03-01.
[4] Tian, Bozhi; Zheng, Xiaolin; Kempa, Thomas J.; Fang, Ying; Yu, Nanfang; Yu, Guihua; Huang, Jinlin; Lieber, Charles M. (2007). "Coaxial silicon nanowires as solar cells and nanoelectronic power sources". Nature. **449** (7164): 885–889. Bibcode:2007Natur.449..885T. doi:10.1038/nature06181. ISSN 0028-0836. PMID 17943126. S2CID 2688078.
[5] Johlin, Eric; Al-Obeidi, Ahmed; Nogay, Gizem; Stuckelberger, Michael; Buonassisi, Tonio; Grossman, Jeffrey C. (2016). "Nanohole Structuring for Improved Performance of Hydrogenated Amorphous Silicon Photovoltaics". ACS Applied Materials & Interfaces. **8**(24): 15169–15176. doi:10.1021/acsami.6b00033. hdl:1721.1/111823. ISSN 1944-8244. PMID 27227369.
[6] "Improved Performance Coatings". nanoShell Ltd. Archived from the original on 8 February 2013. Retrieved 3 January 2013.
[7] Cloete, TE; et al., eds. (2010). Nanotechnology in Water Treatment Applications. Caister Academic Press. ISBN 978-1-904455-66-0.[page needed]

[8] Jump up to:[a] [b] Karn, Barbara; Kuiken, Todd; Otto, Martha (2009). "Nanotechnology and in Situ Remediation: A Review of the Benefits and Potential Risks". Environmental Health Perspectives. **117** (12): 1813–1831. doi:10.1289/ehp.0900793. PMC 2799454. PMID 20049198.