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LATEST ADVANCEMENTS IN NANOTECHNOLOGY: AN OVERVIEW

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ABSTRACT

Nanotechnology is not simply working at smaller dimensions; rather working at nanoscale enables us to utilize the unique, physical, chemical, mechanical, structural, electrical, magnetic and optical properties of materials that naturally occur at that scale. A nanometer is billionth of a meter. Nanotechnology is used in almost every field. Being an enabling technology, it has the potential to open up new vistas in the field of R & D in various multiple disciplines and have wide domain of sectoral application, ranging from health care / medicines, electronics, textiles, agriculture, construction, water treatment and food processing to cosemetics. Electronics also get smaller all the time but there is a limit to how tiny they can. But now with the help of nanotechnology we can shrink capacitors, key components that store energy etc. Now Nanoscale pillars could radically improve conversion of heat to electricity. Studies on new physical properties and applications of Nanomaterials and nanostructures are possible only when nanostructured materials are made available with desired size, morphology, crystal and microstructure and chemical composition. These changes will generate large amount of wealth and forcewrenching change in existing material and institution.

Keywords: Nanotechnology, Nanostructure, Nanomaterials, Nanoparticles, Photovolatic Cell low cost material

INTRODUCTION

Nanotechnology involves the manufacturing and application of instruments and materials that have unique properties because of their small size. A nanometer is one billionth of a meter (10-9M) and is the unit of length that is generally most appropriate for describing the size of single molecules. Nanotechnology is an extremely wide termthe definition of which varies from field to field. At the nanoscale, familiar materials can have dramatically different, properties: Changes can affect color, elasticity, strength

conductivity and other properties. Nanoparticles also have an increased surface area relative to their volume making them especially reactive and useful in energy storage for making composite materials or as drug delivery devices. Nanomaterials are also able to be integrated with biological materials producing new structure that have properties of both type of materials.

The nanoscale marks the nebulous boundary between the classical and quantum mechanical words; thus, realization of nanotechnology promises to bring revolutionary capabilities. The idea and concepts behind nanoscience and nanotechnology started with a talk entitled "There is plenty of room at the bottom" by Physicist Richard Fenyman atan American physical society meeting at the California institute of technology on 29 December 1959 (Fenyman 1960) long before the term nanotechnology was used, In this talk Fenyman described a process in which scientists would be able to manipulate and central individual atom and molecules. Over a decade later, in his explorations of ultra precision machining, Prof. Taniguchi coined the term a nanotechnology (Taniguchi 1974), It wasn't until 1981, with development of the scanning tunneling microscope that could and in viewing individual atoms that modern nanotechnology began. Eric Drexeler expanded Taniguchi's definition and popularised nanotechnology in his book Engines of creation: The Coming Era of Nanotechnology (Drexler 1986) fabrication of nanomedicine, nanoelectronics and other nanodevices undoubtedly solve an enormous amount of the problems faced by mankind today.

There are two main types of approaches to nanotechnology: The "top down" approach and the "botton up" approach. The "top down" approach involves taking larger structures that are either reduced down in size untill they reach the nanoscale, or are deconstructed into their composite parts. On the other hand, the "bottom up" approach is where materials are constructed from the atomic or molecular components.

WHY IS IT IMPORTANT?

The implications of nanotechnology are wide-ranging and could include medicine, military applications, computing and astronomy. Nanotechnology is being usedalready in certain materials like self cleaning glass, sunscreens, lipsticks and even antibacterial socks. Nanotechnology may be used to deliver drugs to just the right place inside the body. Today nanotechnology is able to create many new material and device. Some of most innovative technology advancement areas:

1. HEALTH: DRUG DELIVERY

Drug delivery focuses on maximizing bioavaibility both at specific places in the body and over a period of time. This can potentially be achieved by molecular targeting by nanoengineered devices. A benefit of using nanoscale for medical technologes is that smaller devices are less invasive and can possibly be implanted inside the body, plus biochemical reaction times are much shorter. These devices are faster and more sensitive than typical drug delivery. The efficiency of drug delivery though nanomedicine is largely based upon:

a) Efficient encapsulation of the drugs
b) Successful delivery of drugs to the targeted region of the body and
c) Successful release of the drug. Nanoparticles have beneficial properties that can be used to improve drug delivery. Complex drug delivery mechanisms are being developed, including the ability to get drugs through cell membranes and intocell cytoplasm.

Triggered response is one way for drug molecules to be used more efficiently. Drugs are placed in the body and only activate on encountering a particular signal. For example a drug with poor solubility will be replaced by a drug delivery system where both hydrophilic and hydrophobic environments exist, improving the solubility. Drug delivery systems may also be able to prevent tissue damage though regulated drug release, reduce drug clearance ate, or lower the volume of distribution and reduce the effect on non-target tissue. In this technology the required drug dose is used and side- effects are lowered significantly as the active agent is deposited in the morbid region only. The highly selective approach can reduce cost and pain to patient. The nanoengineered materials are being developed for effectively treating illness and diseases such as cancer. Nanowires are used to prepare sensor test chips, which can detect proteins and other

biomarkers left behind by cancer calls and make diagnosis of cancer possible in the early stage from a single drop of a patient's blood.

2. DISEASES: EARLY DETECTION

Nontechnology application for early diseases detection are getting a significant amount of traction and attention. Nanomedicine is an application of nanotechnology which works in the field of Health and medicine. Nano- medicine make use of nanomaterials and nanoelectronics biosensors. With the help of nanomedicine early detection and preventation improved diagnosis, proper treatment and follow up of disease is possible with the held nanotechnology. Nanosensors that detect heart attack before they happen could save both lives and money that is exactly what Rric Tepol, MD, at San Diegobased Scripps. Health has been working on with Axel Scherer, PH.D of Caltech. Their technology involves blood stream nanosensors chip that might sense the precursor of a heart attack. A person with such a ting chip might get a warning on their smart phone other wireless devices that they shouldimmediately see their cardologists.

3. NANOTECHNOLOGY IN MILITARY APPLICATION

The US Army is conducting extensive R & D designed to lead to the development of nanomaterials systems for military application incorporting unique properties such as self-repair, selective removal, corrosion resistance, sensing, ability to modify coatings. Nanomaterials enabled smart sensor technologies are being developed to enhance military intelligence gathering by soldiers in the field. Chemical and biological nanosensors can be used to detect harmful chemicals and biological weapons. They can also be used as damage detection systems- physical nanosensors could detect fractures in military equipment. Nanoscale thermal barrier coating systems are under development by the US Army and Air Force for aircraft surfaces (metal and fibreglass) that are exposed to moderate short- duration heating; high temp. hard environment in military vehicles; and in military gas turbine engines to increases component life and engine performance.

4. NANOTECHNOLOGY IN COMPUTING

Various companies and Universities are developing four methods of using nanowires or nanoparticles to increase the amount of memory started on solid state drives. Magnetic nanowires made of an alloy of iron and nickel are being used to create dense memory devices. Researchers at IBM have developed a method to magnetize sechons of these nanowires By applying a current they can move the magnetized sections along the length of the wire. As the magnetized sections move along the wire, the data is read by a stationary sensor. This method is called race track memory. The plan is to grow hunderds of millions of U-shaped race track nanowires on a silicon substrate to create low- cost, high density memory chips. Silicon dioxide nanowires used to create memory devices. An alternative method being developed to increase the density of memory devices is to store information on magnetic nanoparticles. Arrays of magnetic nanoparticles, called nanodots, which are about 6 nm in diameter. Eachdot would contain information determined by whether or not they are magnetized. Using billions of these 6 nm diameter dots in a memory device could increases memory density

5. ENERGY STORAGE: SOLAR POWER

Solar Power is the future of energy storage, but it comes with a hefty price tag. Nanoparticles have been shown to enhance the absorption of light, increase the conversion of light to electricity, and provide better thermal storage and transport with these advancement. Nanotechnology has the potential to improve solar energy efficiency and reduce cost.

Solar is the most common renewable energy whose potential is highly region dependent. However, the annual direct solar irradiation in some region exceeds 300 W/m^2 interestingly several of the regions that are likely to experience the maximum increase in urbanization are in solar rich regions. Subsequently a lot of studies and technical advances have been focused on solar efficiency, structure

and cost. This resulted in a drastic drop of solar energy installed price by about 50% since 2010. Despite this achievement the efficiency of multicrystallinesilicon photovoltaic cells, which is the widely installed panels is hovering around 10 to 17 %. This means that the photovoltaic power density could surpass 120 W/m^2 under optimal conditions. The world solar heat collectors thermal power density average is 67 W/m^2 and the used to domestic solar hot-water heaters is on the increase because it is low-cost and compact. The nanotechnology manufacturing technique, ALD is seen as the future technology of PV Solar Cell Production.

6. NANOTECHNOLOGY IN FOOD

The achievement of nanotechnology has been recognized by many industries. Even though foods are complex biological systems and also undergo a variety of processing. The rapid development in food industries improved tastes, colour, flavor, texture and consistency of foodstuffs, increased absorption an bioavailability of nutrients and health supplements, new food packaging materials with improved mechanical barrier and antimicrobial properties, nano- sensors for traceability and monitoring and condition of food during transport and storage.

7. NANOTECHNOLOGY IN WATER TREATMENT

According to World Health Organization “1.1 billion people have no access to any type of improved drinking water.” This lack of access to clean, safe water poses dire health risk to much of the world’s population, including: death from diarrheal disease, schistosomiasis infection, and intestinal parasites. Scientists and Engineers are focused on applying nanotechnology to resolve these issues and make water safe and purified.

Water purification using nanotechnology exploits nanoscopic materials such as carbon nanotubes and alumina fibres for nanofiltration, It also utilizes the exsistance of nanoscopic pores in zeolite filtration membrane, as well as nanocatalysts and magnetic nanoparticles. Nanosensors, such as those based on titanium oxide nanowires or palladium nanoparticles are used for analytical

detection of contaminants in water samples. The impurities that nanotechnology can tackle depend on the state of purification of water to which the technique is applied, the team adds. It can be used for removal of sediments, chemical effluents, charged particles bacteria and other pathogens. They explain that toxic trace elements such as arsenic and Viscous liquid impurities such as oil can also be removed using nanotechnology.

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