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Nanotechnology Applications in Science and Engineering

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Abstract: - Nanotechnology is helping to considerably improve, even revolutionize, many technology and industry sectors: information technology, energy, environmental science, medicine, homeland security, food safety, and transportation, among many others. Today's nanotechnology harnesses current progress in chemistry, physics, materials science, and biotechnology to create novel materials that have unique properties because their structures are determined on the nanometer scale. This paper summarizes the various applications of nanotechnology in recent decades.

Key Words: - Nanotechnology, Environmental Science, Agriculture, Food safety.

I. INTRODUCTION

The difficulty of meeting the world"s energy demand is compounded by the growing need to protect our environment. Many scientists are looking into ways to develop clean, affordable, and renewable energy sources, along with means to reduce energy consumption and lessen toxicity burdens on the environment. Prototype solar panels incorporating nanotechnology are more efficient than standard designs in converting sunlight to electricity, promising inexpensive solar power in the future. Nanostructured solar cells already are cheaper to manufacture and easier to install, since they can use print-like manufacturing processes and can be made in flexible rolls rather than discrete panels. Nanotechnology is improving the efficiency of fuel production from normal and low-grade raw petroleum materials through better catalysis, as well as fuel consumption efficiency in vehicles and power plants through higher-efficiency combustion and decreased friction (Low et al., 2015). Nano-bioengineering of enzymes is aiming to enable conversion of cellulose into ethanol for fuel, from wood chips, corn stalks (not just the kernels, as today), and unfertilized perennial grasses (Chaturvedi and Dave, 2014).

To power mobile electronic devices, researchers are developing thin-film solar electric panels that can be fitted onto computer cases and flexible piezoelectric nanowires woven into clothing to generate usable energy on-the-go from light, friction, and/or body heat. Energy efficiency products are increasing in number and kinds of application. In addition to those noted above, they include more efficient lighting systems for vastly reduced energy consumption for illumination; lighter and stronger vehicle chassis materials for the transportation sector; lower energy consumption in advanced electronics; low-friction Nano-engineered lubricants for all kinds of higher-efficiency machine gears, pumps, and fans; light-responsive smart coatings for glass to complement alternative heating/cooling schemes; and high-light-intensity, fast-recharging lanterns for emergency crews. Besides lighter cars and machinery that requires less fuel, and alternative fuel and energy sources, there are many eco-friendly applications for nanotechnology, such as materials that provide clean water from polluted water sources in both large-scale and portable applications, and ones that detect and clean up environmental contaminants.

II. SENSORS AND MEDICINE APPLICATION

Molecular imaging for the early detection where sensitive biosensors constructed of nanoscale components (e.g., Nano-cantilevers, nanowires, and Nano-channels) can recognize genetic and molecular events and have reporting capabilities, thereby offering the potential to detect rare molecular signals associated with malignancy. Multifunctional therapeutics where a nanoparticle serves as a platform to facilitate its specific targeting to cancer cells and delivery of a potent treatment, minimizing the risk to normal tissues. Research enablers such as microfluidic chip-based Nano labs capable of monitoring and manipulating individual

cells and Nano scale probes to track the movements of cells and individual molecules as they move about in their environments. Nano-bio systems, Medical, and Health Applications. Nanotechnology has the real potential to revolutionize a wide array of medical and procedures so that they are more personalized, portable, cheaper, safer, and easier to administer. Below are some examples of important advances in these areas (George, 2015, Ng et al., 2015; Weiss, 2015; Yashveer et al., 2014; Schulte et al., 2014; Boisseau and Loubaton, 2011).

III. Nanotechnology for Environmental Protection

In the last few decades, highly toxic organic compounds have been synthesized and released into the environment in order to be used directly or indirectly over a long period. Among some of these elements are pesticides, fuels, polycyclic aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs) (Jones, 2007). Some combined chemical compounds resist highly against biodegradation via native flora in comparison with organic substances easily degraded through introduction into the environment. Thus, dangerous chemical compounds have been one of the most serious issues in the contemporary world. The management of contaminated soil and ground water is a major environmental concern. The presence of elevated concentrations of a wide range of contaminants in soils, sediments and surface-and ground waters, affects the health of millions of people worldwide (Pereira et al., 2003). Current clean up technology is not significantly and economically adequate to solve all of today's cleans up needs. Nanotechnology is one of the most important trends in science and perceived as one of the key technologies of the present century (Zhang and Elliot, 2006). Nanotechnology could be a powerful tool in dealing with pollution remediation. Several studies indicate that combining nanoparticles with conventional treatment could increase the efficiency of contaminants removal, such as organic materials. In Zhang‟s report (Rickerby and Morrison, 2007), Nano scale iron particles are very effective for the transformation and detoxification of a wide variety of common environmental contaminants, such as chlorinated organic solvents, organochlorine pesticides, and PCBs. Nanoparticles remain reactive towards contaminants in soil and water for extended periods of time and rapid in situ reactions have been observed with TCE reduction up to 99% in a few days after the nanoparticle injection. Many researchers have shown that engineered nanoparticles such as TiO2 and ZnO, carbon nanotube, metallic nanoparticles (e.g., iron, nickel) magnetic nanoparticles and amphiphilic polyurethane nanoparticles could be useful for remediation and treatment of contaminated water, soil or air. Application of nanotechnology in environmental science is categorized into four parts: remediation, protection, maintenance, and enhancement.

IV. Nano Technological Applications in Food Industry

Nanotechnology has been reported as the new industrial revolution, both developed, and developing countries are investing in this technology to secure a market share. At present, the USA leads with a 4-year, 3.7-billion USD investment through its National Nanotechnology Initiative (NNI). The USA is followed by Japan and the European Union, which have both committed substantial funds (750 million and 1.2 billion, including individual country contributions, respectively, per year). Others such as India, South Korea, Iran, and Thailand are also catching up with a focus on applications specific to the economic growth and needs of their countries (Kour et al. 2015). Food processing approaches that involve nanomaterials include integration of nutraceuticals, gelation and viscosifying agents, nutrient propagation, mineral and vitamin fortification, and Nano-encapsulation of flavors (Huang et al. 2010). Thus, systems with physical structures in the nanometer distance range could affect features from food safety to molecular synthesis. Nanotechnology may also have the potential to enhance food quality and safety. Many studies are assessing the ability of Nano sensors to improve pathogen detection in food systems. Nano foods are products that were grown processed or packaged with the aid of nanotechnology or materials produced with nanotechnology. In this review, we discuss some current nanotechnology research in food technology and agriculture, including processing, packaging, nano-additives, cleaning, and sensors for the detection of contaminants, and propose future developments in the developing field of agrifood nanotechnology.

V. Future Transportation Applications

Nano-engineering of steel, concrete, asphalt, and other cementations materials, and their recycled forms, offers great promise in terms of improving the performance, resiliency, and longevity of highway and transportation infrastructure components while reducing their cost. New systems may incorporate innovative capabilities into traditional infrastructure materials, such as the ability to generate or transmit energy. Nano scale sensors and devices may provide cost-effective continuous structural monitoring of the condition and performance of bridges, tunnels, rails, parking structures, and pavements over time. Nano scale sensors and devices may also support an enhanced transportation infrastructure that can communicate with vehicle-based systems to help drivers maintain lane position, avoidTo cite this paper: Mobasser Sh and Firoozi AA. 2016. Review of Nanotechnology Applications in Science and Engineering. J. Civil Eng. Urban., 6 (4): 84-93. Journal homepage: www.ojceu.ir 86 collisions, adjust travel routes to circumnavigate congestion, and other such activities (Agzenai et al., 2015; Firoozi et al., 2015; Golestani et al., 2015; Singh and Sangita, 2015, Sobolev, 2015; De Nicola et al., 2015; Chuah et al., 2014; Firoozi et al., 2014; Wong, 2014; Yusoff et al., 2014). Research is underway to use nanotechnology to spur the growth of nerve cells, e.g., in damaged spinal cord or brain cells. In one method, a nanostructured gel fills the space between existing cells and encourages new cells to grow. There is early work on this in the optical nerves of hamsters. Another method is exploring use of Nano fibers to regenerate damaged spinal nerves in mice (Qazi et al., 2015, Ahmadi and Ahmadi, 2013; Parpura and Verkhratsky, 2013; Zhan et al., 2013; Ehrhardt and Frommer, 2012; Jain, 2012; Nunes et al., 2012).

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