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Applications of Nanotechnology and Nanomaterials-A Literature Review

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Abstract: NOT A DAY goes by, it seems, without a news report, a website update, a conference, a meeting, a research publication, a web-log entry, a bold forecast, or a promising investment opportunity in the hot and often-hyped new area called nanotechnology. It is taking the nation and the world by storm. Proponents claim it will revolutionize manufacturing on a scale rivaling that of the Industrial Revolution with lighter, stronger, cheaper, more durable and less expensive everything. From tennis rackets, to pants, to car parts, to pills, the control of matter on the atomic scale opens incredible possibilities for reengineering nature at its most basic level. Detractors, meanwhile, warn that little attention is being paid to safety issues as unregulated products and new technologies continue to spread across the land. Nanotechnology not only produces small structures, but also an anticipated manufacturing technology which can give thorough, inexpensive control of the structure of matter. Nanotechnology can best be described as activities at the level of atoms and molecules that have applications in the real world. Nanotechnology is one of the most active research areas with both novel science and useful applications that has gradually established it in the past two decades. Expenditure on nanotechnology research is significant; however, the research is continuously moving forward motivated by immediate profitable return generated by high value commercial products. Nanotechnology is increasingly attracting worldwide attention because it is widely perceived as offering huge potential in a wide range of end uses. The unique and new properties of nonmaterial have attracted not only scientists and researchers but also businesses, due to their huge economical potential. Nanotechnology is one of the fastest growing new areas in science and engineering. The subject arises from the convergence of electronics, physics and chemistry, biology and material sciences to create new functional systems of nanoscale dimensions.

Key words: Revolutionize · New technologies · Useful applications · Nanoscale dimensions

INTRODUCTION

Nanotechnology involves the ability to control, manipulate or fabricate materials at the atomic scale. These structures are typically less than 100 nanometers in size. A nanometer is one-billionth of a meter, about 10 times the diameter of a hydrogen atom. This is about 80,000 times smaller than the width of a human hair and 100 times smaller than the patterns etched into the silicon wafers of contemporary microelectronics. The nanometer is a dimension of unique properties. Matter can be made stiffer and stronger. It can be made to emit more light or conduct electricity better.

Nanotechnology should not be viewed as a single technique that only affects specific areas. It is more of a 'catch-all' term for a science which is benefiting a whole array of areas, from the environment, to healthcare, to hundreds of commercial products. Although often referred to as the 'tiny science', nanotechnology does not simply mean very small structures and products. Nanoscale features are often incorporated into bulk materials and large surfaces Nanotechnology is already in many of the everyday objects around us, but this is only the start [1].

Nanotechnology Basics: Nanotechnology is the creation of materials and devices by controlling of matter at the levels of atoms, molecules and supramolecular (nanoscale) structures (Roco*et al.,* 1999). In other words, it is the use of very small particles of materials to create new large scale materials (Mann, 2006). Although more thorough definitions were used by some researchers as well, the key is the size of particles because the properties of materials are dramatically affected under a scale of the

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nanometer (nm), 10-9 meter (m). Actually, nanotechnology is not a new science or technology. It was believed first introduced by Richard P. Feynman in his lecture at the California Institute of Technology in 1959. However, the research on this topic has been very active only in recent two decades. This is because the development and application of nanotechnology are relying on the development of other related science and technology such as physics and chemistry that are commonly new to break through at that time. Most promising developments of nanotechnology are fullerene (a new form of carbon, C60) and carbon nanotubes (Sobolev and Gutierrez, 2005).

Understanding and development of nanoscale structures change the traditional process of producing and applying construction materials and elements. The new features of construction materials and elements accordingly change the material usage and force and resistance calculations of project design and its related field construction operation and management. Preparation on nano particles are by Plasma processing.

Both thermal (plasma arc, plasma torch, plasma spray) and low temperature (cold) plasma are used [2].

Chemical Vapor Deposition: Either on a substrate or in the gas phase (for bulk production) Metallic oxides and carbides Electro deposition Sol-gel processing Ball mill or grinding (old fashioned top-down approach).

Construction: Nanotechnology can be used for design and construction processes in many areas since nanotechnology generated products have many unique characteristics. These characteristics can, again, significantly fix current construction problems and may change the requirement and organization of construction process.

These include products that are for:

- Lighter and stronger structural composites
- Low maintenance coating
- Improving pipe joining materials and techniques.
- Better properties of cementitious materials
- Reducing the thermal transfer rate of fire retardant and insulation
- Increasing the sound absorption of acoustic absorber [3].

Coating: The coatings incorporating certain nanoparticles or nanolayers have been developed for certain purpose.

It is one of the major applications of nanotechnology in construction.

For example, TiO2 is used to coat glazing because of its sterilizing and anti-fouling properties. The TiO2 will break down and disintegrate organic dirt through powerful catalytic reaction. Furthermore, it is hydrophilic, which allow the water to spread evenly over the surface and wash away dirt previously broken down.Other special coatings also have been developed, such as thermal control, energy sawing, anti-reflection coating [4].

Nanosensors Nano and microelectrical mechanical systems (MEMS) sensors have been developed and used in construction to monitor and/or control the environment condition and the materials/structure performance. One advantage of these sensors is their dimension. Nanosensor ranges from 10-9 m to 10-5m. The micro sensor ranges from 10-4 to 10-2 m (Liu *et al.,* 2007). These sensors could be embedded into the structure during the construction process.

Smart aggregate, a low cost piezoceramic-based multi-functional device, has been applied to monitor early age concrete properties such as moisture, temperature, relative humidity and early age strength development (Saafi and Romine, 2005; Song and Mo, 2008). The sensors can also be used to monitor concrete corrosion and cracking. The smart aggregate can also be used for structure health monitoring. The disclosed system can monitor internal stresses, cracks and other physical forces in the structures during the structures' life. It is capable of providing an early indication of the health of the structure before a failure of the structure can occur [5].

Biomedical: Nanotechnology provides the field of medicine with promising hopes for assistance in diagnostic and treatment technologies as well as improving quality of life. Humans have the potential to live healthier lives in the near future due to the innovations of nanotechnology. Some of these innovations include [6]:

- Disease diagnosis
- Prevention and treatment of disease
- Better drug delivery system with minimal side effects
- Tissue Reconstruction

Device Using Nanorobots for Checking Blood Contents: Three applications of nanotechnology are particularly suited to biomedicine: diagnostic techniques, drugs and prostheses and implants. Interest is booming in biomedical applications for use outside the body, such as diagnostic sensors and "labon-a-chip" techniques, which are suitable for analyzing blood and other samples and for inclusion in analytical instruments for R and D on new drugs.

For inside the body, many companies are developing nanotechnology applications for anticancer drugs, implanted insulin pumps and gene therapy. Nanotechnology also has applications in tissue engineering. Other researchers are working on prostheses and implants that include nanostructured materials.

Aerospace: The aerospace applications for nanotechnology include high strength, low weight composites, improved electronics and displays with low power consumption, variety of physical sensors, multifunctional materials with embedded sensors, large surface area materials and novel filters and membranes for air purification, nanomaterials in tires and brakes and numerous others. Of all the nanoscale materials, carbon nanotubes (CNTs) have received the most attention across the world. These are configurationally equivalent to a two-dimensional grapheme sheet rolled up into a tubular structure. With only one wall in the cylinder, the structure is called a single-walled carbon nanotube (SWCNT). The structure that looks like a concentric set of cylinders with a constant interlayer separation of 0.34 A is called a multiwalled carbon nanotube (MWCNT).

The opportunities for aerospace industry are through thermal barrier and wear resistant coatings, sensors that can perform at high temperature and other physical and chemical sensors, sensors that can perform safety inspection cost effectively, quickly and efficiently than the present procedures, composites, wear resistant tires, improved avionics, satellite, communication and radar technologies [7].

Agriculture: The EU's vision is of a "knowledge-based economy" and as part of this, it plans to maximize the potential of biotechnology for the benefit of EU economy, society and the environment. There are new challenges in this sector including a growing demand for healthy, safe food; an increasing risk of disease; and threats to agricultural and fishery production from changing weather patterns. However, creating a bio economy is a challenging and complex process involving the convergence of different branches of science.

Nanotechnology has the potential to revolutionize the agricultural and food industry with new tools for the molecular treatment of diseases, rapid disease detection, enhancing the ability of plants to absorb nutrients etc. Smart sensors and smart delivery systems will help the agricultural industry combat viruses and other crop pathogens. In the near future nanostructured catalysts will be available which will increase the efficiency of pesticides and herbicides, allowing lower doses to be used. Nanotechnology will also protect the environment indirectly through the use of alternative (renewable) energy supplies and filters or catalysts to reduce pollution and clean-up existing pollutants.

An agricultural methodology widely used in the USA, Europe and Japan, which efficiently utilisesmodern technology for crop management is called Controlled Environment Agriculture (CEA). CEA is an advanced and intensive form of hydroponically-based agriculture. Plants are grown within a controlled environment so that horticultural practices can be optimized. The computerized system monitors and regulates localised environments such as fields of crops. CEA technology, as it exists today, provides an excellent platform for the introduction of nanotechnology to agriculture. With many of the monitoring and control systems already in place, nanotechnological devices for CEA that provide "scouting" capabilities could tremendously improve the grower's ability to determine the best time of harvest for the crop, the vitality of the crop and food security issues, such as microbial or chemical contamination [8].

Textile Industry: Nanotechnology also has real commercial potential for the textile industry. This is mainly due to the fact that conventional methods used to impart different properties to fabrics often do not lead to permanent effects and will lose their functions after laundering or wearing. Nanotechnology can provide high durability for fabrics, because nano-particles have a large surface area-to-volume ratio and high surface energy, thus presenting better affinity for fabrics and leading to an increase in durability of the function. In addition, a coating of nano-particles on fabrics will not affect their breathability or hand feel.

The first work on nanotechnology in textiles was undertaken by Nano-Tex, a subsidiary of the US-based Burlington Industries [1]. Later, more and more textile companies began to invest in the development of nanotechnologies. Coating is a common technique used to apply nano-particles onto textiles. The coating compositions that can modify the surface of textiles are usually composed of nano-particles, a surfactant, ingredients and a carrier medium [2]. Several methods can apply coating onto fabrics, including spraying, transfer printing, washing, rinsing and padding. Of these methods, padding is the most commonly used [3-5]. The nano-particles are attached to the fabrics with the use of a padder adjusted to suitable pressure and speed, followed by drying and curing. The properties imparted to textiles using nanotechnology include water repellence, soil resistance, wrinkle resistance, anti-bacteria, anti-static and UV-protection, flame retardation, improvement of dyeability and so on. As there are various potential applications of nanotechnology in the textile industry, only some of the well-known properties imparted by nano-treatment are critically highlighted in this paper.

CONCLUSION

Nanotechnology is an enabling technology that will impact the various sectors through composites, advances in electronics, sensors, instrumentation, materials, manufacturing processes, etc. Whatever the impacts of nanotechnology on the entering the market, the safety will remain the prime concern. The field is interdisciplinary but everything starts with material science.

Challenges Include:

- Novel synthesis techniques
- Characterization of nanoscale properties
- Large scale production of materials
- Application development

REFERENCES

1. Russell, E., 2002. Nanotechnologies and shrinking world of textiles, Textile Horizons, 9(10): 7-9.
2. Cramer, Dean, R., E. Ponomarenko, S. Anatolyevna and J.C.T.R. Burckett, 2003. Method of applying nanoparticles, U.S. Pat., 6: 569- 645.
3. Anonymous, 2003. Small-scale technology with the promise of big rewards, Technical Textiles International, 3: 13-15.
4. Xin, J.H., W.A. Daoud and Y.Y. Kong, 2004. A New Approach to UV-Blocking Treatment for Cotton Fabrics, Textile Research Journal, 74: 97-100.
5. Silva, Gabriel A., 2006. Introduction to Nanotechnology and Its Applications to Medicine, (Mar. 2004), pp: 216-220.
6. Balbus, John, 2006. Getting Nanotechnology Right. www.findarticles.com/p/articles/mi_qa3622/is_2005 07/ai_n14716314 (7 Nov).
7. Down on the Farm, – published by the ETC Group, 2004. www.etcgroup.org/documents/ETC_DOTFarm 2004.pdf.
8. A review of potential implications of nanotechnologies for regulations and risk assessment in relation to food" – published by the Food Standards,www.food.gov.uk/multimedia/pdfs/ nanotech.pdf.