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Nanotechnology in Business

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Abstract

Nanotechnology is the use of materials science involving matter at dimensions of roughly one to one hundred nanometers. Due to the advantages offered by this unique manipulation, nanotechnology is adopted in a variety of different industries such as chip fabrication, manufacturing, construction, healthcare, agriculture, military, and energy. The inherent nature of nanotechnology has led analysts to suggest that it may constitute a basis for long-term productivity and economic growth. This paper is an introduction to the use of nanotechnology in business.

Keywords*: nanoscale, nanotechnology, nanomaterials, business.*

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INTRODUCTION

Nanotechnology refers to the field of science that investigates and modifies the characteristics of individual atoms and molecules. It allows for both the improvement of existing and the development of completely new products, processes, and services.

Nanotechnology has solutions for all the problems of mankind and fulfills almost all desires for human prosperity. Small as well as large companies will play a major role in the commercialization of nanotechnology. The applications of nanotechnology in different areas provide lots of business opportunities. This includes food, medicine, cosmetics, cleaner water, better quality air, electronics, sunscreens, fuel cells, solar cells, batteries, space travels, chemical sensors, sporting goods, fabrics, cleaning products, energy, environment, health, and life span increase [1]. General Electric is one of the largest nanotechnology firms in the world, alongside other companies such as IBM, Intel, and Taiwan Semiconductor Manufacturing Company.

OVERVIEW ON NANOTECHNOLOGY

Nanotechnology (science on the scale of single atoms and molecules) has been called the second Industrial Revolution because of the special properties of materials at the nanoscale. It is a branch of green technology which has the potential to revolutionize many aspects of our lives. . It is transforming the world of materials and its influence will be broad. It will not only initiate the next Industrial Revolution, it will offer technological solutions.

The term “nanotechnology” was coined in 1974 by Norio Tanigutchi, a professor at Tokyo Science University. Nanotechnology is the science of small things—at the atomic level or nanoscale level. It has the idea that the technology of the future will be built on atoms. It has impact on every area of science and technology [2]. Nanotechnology involves imaging, measuring, modeling, and manipulating matter at the nano scale. At this level, the physical, chemical, and biological properties of materials fundamentally differ from the properties of individual atoms and molecules or bulk matter [3].

Nanotechnology covers a wide variety of disciplines like physics, chemistry, biology, biotechnology, information technology, engineering, and their potential applications. Although nanotechnology and nanomaterials permeate all industries, there is no "nanotechnology" industry because it is an enabling technology. The production of nanomaterials is expensive, labor-intensive, and potentially hazardous to the environment. There is a need to develop environmentally friendly methods that are safe for the environment and cost effective as well. Green nanotechnology aims to produce nanomaterials without deteriorating the environment or human health [4].

APPLICATIONS OF NANOTECHNOLOGY IN BUSINESS

Nanotechnology offers huge possibilities for contemporary science and industry. Nanotechnology and nanomaterials can be applied in all kinds of industrial sectors. Some of these industries are shown in Figure 1 [5]. Nanotechnology is commonly applied in the following areas [6-8]:

- *Electronics:* Nanotechnology has contributed to major advances in computing and electronics, leading to faster, smaller, and more portable systems that can manage and store larger amounts of information. Carbon nanotubes are close to replacing silicon as a material for making smaller, faster, and more efficient microchips and devices. Graphene is an ideal candidate for the development of flexible touchscreens. Electronics applications dominate as

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microprocessors and memory chips are built using new nanoscale processes. Figure 2 shows application of nanotechnology in electronics [9].

- *Energy:* It has been shown possible to manufacture solar panels that double the amount of sunlight converted into electricity. Nanotechnology also lowers costs, produces stronger and lighter wind turbines, improves fuel efficiency, and saves energy. It produces faster microprocessors that consume less energy, batteries that last 10 times longer or solar panels that yield twice as much energy. In the area of energy harvesting, researchers are developing thin-film solar electric panels. Nano-engineered materials in automotive products include high-power rechargeable battery systems. Flexible electronics have been developed using semiconductor nanomembranes for applications in smartphone and e-reader displays.
- *Medicine:* Some nanomaterials are ideal for improving early diagnosis and treatment of cancer, with invisible particles that fight cancer cells. They are able to attack cancer cells selectively without harming other healthy cells. Nanotechnology has been used to develop a pacemaker that could help prevent heart failure and extend the lives of those who have suffered from cardiovascular disease. Nanomedicine is the application of nanotechnology in medicine and draws on the natural scale of biological phenomena to produce precise solutions for disease prevention, diagnosis, and treatment. Nanomedicine researchers are looking at ways that nanotechnology can improve vaccines, including vaccine delivery without the use of needles. Figure 3 shows the use of nanotechnology in medicine [10].
- *Environment:* Air purification with ions, wastewater purification with nanobubbles or nanofiltration systems for heavy metals are some of its environmentally-friendly applications.
- *Food:* Nanotechnology is invading and penetrating every aspect of our life, and the food sector is no exception. Food nanotechnology is the application of nanotechnology in the food industry. The most studied applications of nanotechnology in food production (also called nano-food or food nanotechnologies) currently focus on the food production, food processing, food safety, food packaging, food detection, food storage, food detection, food protection, food monitoring, and quality control of foods. Many scientists, engineers, and financial experts have realized that nanotechnology can lead the food industry in the 21st century. Leading food companies like Heinz, Kraft foods, and Nestle are investing in nanotechnology and they are working toward commercializing nanofood products. Nanobiosensors could be used to detect the presence of pathogens in food or nanocomposites to improve food production. The use of nanotechnology can potentially elongate the life of fruits and vegetables. The ability to use nanotechnology will allow food companies to design and provide food products that would be safer, cheaper, and more sustainable than the foods today [11]. Figure 4 Different sized nanoparticles are used in nanotechnologies of food science [12].
- *Automobiles:* Nanoscale powders and nanoparticles will be able to enhance the physical properties of automobile, aircraft, and spacecraft. Planes, trains, and automobiles will be lighter, faster, and more fuel-efficient and constructed of lighter, stronger materials.
- *Textile:* Nanotechnology makes it possible to develop smart fabrics that do not wrinkle, as well as more durable materials to make motorcycle helmets or sports equipment.

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These are just some of the many applications of nanotechnology.

BENEFITS

Nanotechnology basically involves controlling matter at the atomic and molecular level. Education is perhaps the single most important tool for turning technology into an engine for opportunities for all. Nanotechnology is helping to improve, even revolutionize, many industry sectors including information technology, homeland security, medicine, transportation, energy, food safety, and environmental science, etc. Other benefits include the following [13]:

- *Job Creation:* Technology-based innovations creates new industries, makes existing ones globally competitive, and drives future economic growth. Investing more in training scientists and engineers creates jobs. Nanotechnology can also help millions to escape from the poverty trap by offering many ways to get more people into the workforce.
- *Productivity:* As with many other technologies, nanotechnology helps us to increase our productivity and efficiency. It requires fewer people to produce the same unit of outcome, but also increases our capacity to purchase more units of outcome.
- *Materials:* Nanotechnology can unlock the potential of materials and unleash big business opportunities. Energy, health, and chemicals production and use can also be radically transformed by nanotechnology, while improving our lives through cleaner energy sources. Nanoscale materials are beginning to enable durable lightweighting smart fabrics. Lightweighting of cars, trucks, airplanes, boats, and space craft could lead to significant fuel savings. The use of nanotechnology-enabled lightweight, high-strength materials would apply to almost any automobile.
- *Pollution Prevention*: Nanotechnology holds great potential for pollution prevention and sustainability. Scientists and engineers have been seeking for ways to make nanotechnology beneficial to the environment. This has been branded as “green nanotechnology” since it promotes technologies that will ensure minimal environmental impact. It may have the potential to address major global sustainability challenges.

CHALLENGES

While technology lowers the number of repetitive and physically intense jobs, it creates others that did not exist before. Like any emerging technology, there are benefits and challenges associated with nanotechnology. It is quite challenging for a new company to determine the right time to enter the market. Financing nanotech ventures is not an easy task as it typically requires a lot of money and time. Other challenges include [14,15]:

- *Complexity:* Nanotechnology is not an easy discipline. It is a complex field due to its dependency on various scientific disciplines, approaches, and advanced instrumentation. Nanoscale manufacturing processes are R&D-intensive, complex, and demanding. Working at the nanoscale requires sophisticated equipment and specialized tools.
- *Human Resources:* There are challenges arising for recruiting human resources, especially for R&D and production activities. The need for employees, who combine specialist and general knowledge and can manage interdisciplinary teams is also a challenge. The human resource challenges are making companies more dependent on recruiting personnel from abroad. The availability of foreign recruits naturally depends on legal issues, the

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competitiveness of universities, and the overall attractiveness of the country as a location for R&D activities.

- *Poor R&D Process:* The poor process of R&D, which prolongs new product development times, can make nanotechnology less attractive to investors. The novelty of nanotechnology makes its entry and positioning in value chains harder. Intellectual property rights may become an issue as commercialization progresses and nanotechnology matures. The end users of nanotechnology, particularly the poor and developing countries, should be given opportunities to participate in the development of the technology.
- *Risks:* Nanotechnology comes with some potential business risks. Products utilizing the technology have not undergone rigorous testing and evaluation. At the nano-scale, materials are more explosive due to the fact that their surface area is relatively large related to their mass. The risk assessment to understand the potentially harmful effects of products resulting from nanotechnology have not kept pace with their proliferation. There is lack of understanding regarding the environmental, health, and safety effects of exposure to engineered nanoscale materials.
- *Environmental Issues:* Biological or environmental challenges can impede the transfer of nanotechnology from the lab to the industry. Biological challenges include insufficient knowledge involving the interaction of nanomaterials *in vitro* and *in vivo*. Environmental challenges include nanomaterials entering the environment either directly or indirectly.
- *Economic Issues:* Some economic challenges can hinder the transfer of innovations from the lab to the industry. These include limited investment in relevant R&D activities, lack of laboratory equipment and appropriate infrastructure, and insufficient funding opportunities to engage in research. Governments could act as venture capitalists to overcome market failure in the capital market.
- *Regulatory Issues:* There is a lack of regulatory guidelines for nanotechnology and nanotechnology-enabled products. Some regulatory challenges include inadequate policies to foster the development and operation of nanotechnology businesses. There is a lack of technology transfer protocols. The multidisciplinary nature of nanotechnology also presents regulatory challenges.
- *Ethical Issues*: Besides scientists and engineers, policy makers, business people, journalists, transhumanists, politicians, and science fiction authors all talk about "societal and ethical implications" of nanotechnology. They perceive that nanotech will radically change society, bring about a new industrial revolution, and create new jobs.

CONCLUSION

Nanotechnology is the study, research, and reengineering of the properties of atoms and molecules. It is a major breakthrough technology of this century. It is also regarded as an enabling technology (or set of technologies) or general purpose technology. A general purpose technology, nanotech is a key element of technology infrastructure in that it is the foundation to the design, development, deployment, and use of other technologies.

With almost limitless applications, nanotechnology is fast becoming the world's foremost science. Since nanotechnology is a set of techniques used to manipulate the properties of matter at microscopic scale, it can support many applications. Nanotechnology is already widely present in our daily life. It is present in everything from textiles to food packaging to transportation. It

will impact our daily life in a profound way [16]. Although nanotechnology's future is bright, its potential is largely untapped. More information about the business potential of nanotechnology can be found in the books in [8,17-31] and the following related journals:

- *Nanotechnology*
- *Journal of Nanoscience and Nanotechnology*
- *Journal of Nanotechnology and Materials Science*
- *Journal of Nanoparticle Research*
- *International Journal of Nano Dimension*
- *International Journal of Green Nanotechnology*,
- *International Journal of Green Nanotechnology: Physics and Chemistry*.

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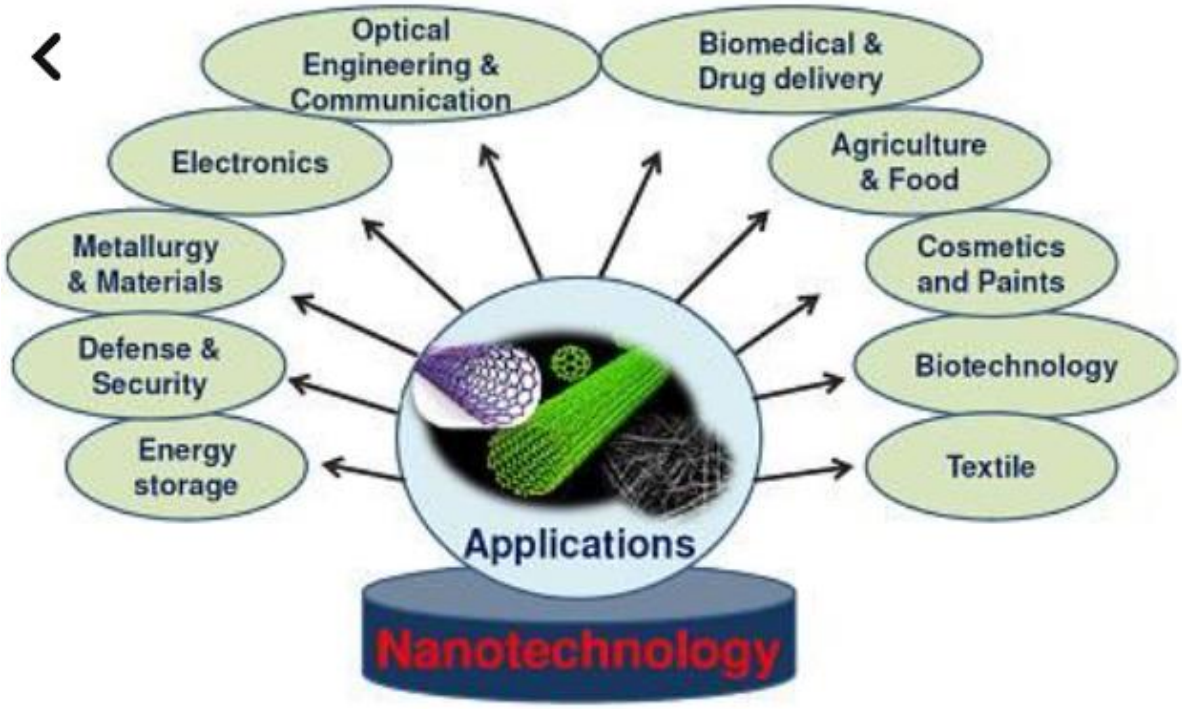

Figure 1 Some industries using nanotechnology [5].

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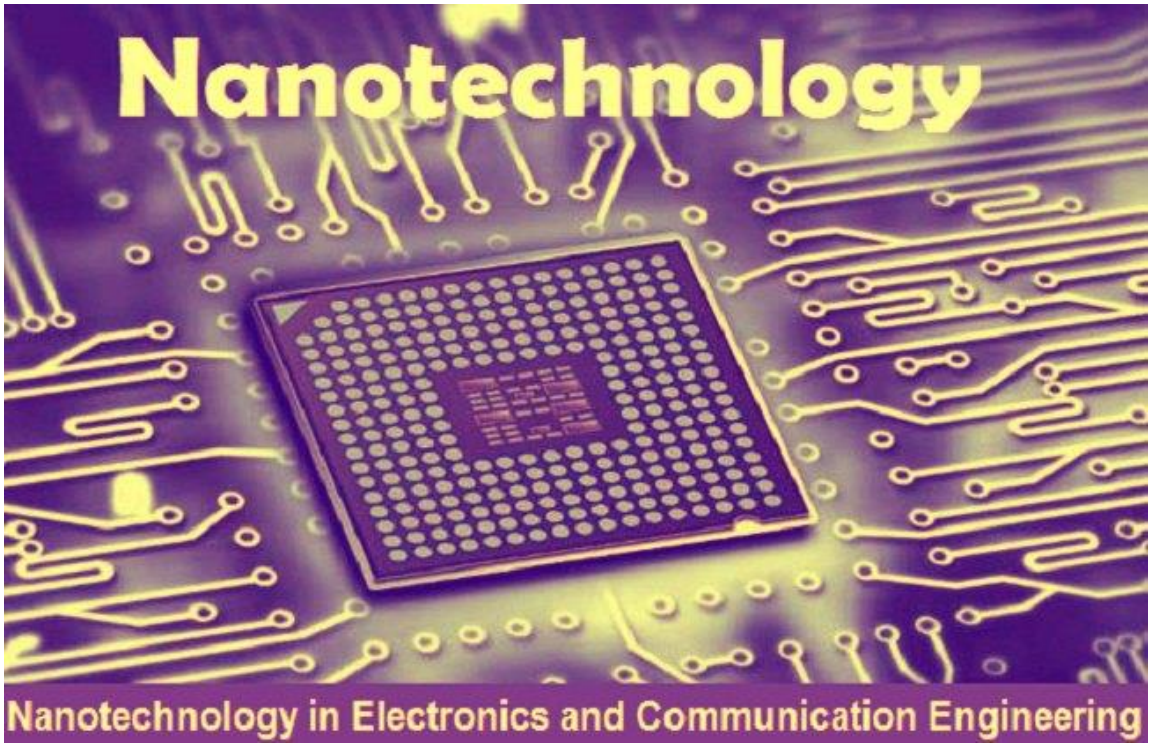

Figure 2 Application of nanotechnology in electronics [9].

Figure 3 Nanotechnology in medicine [10].

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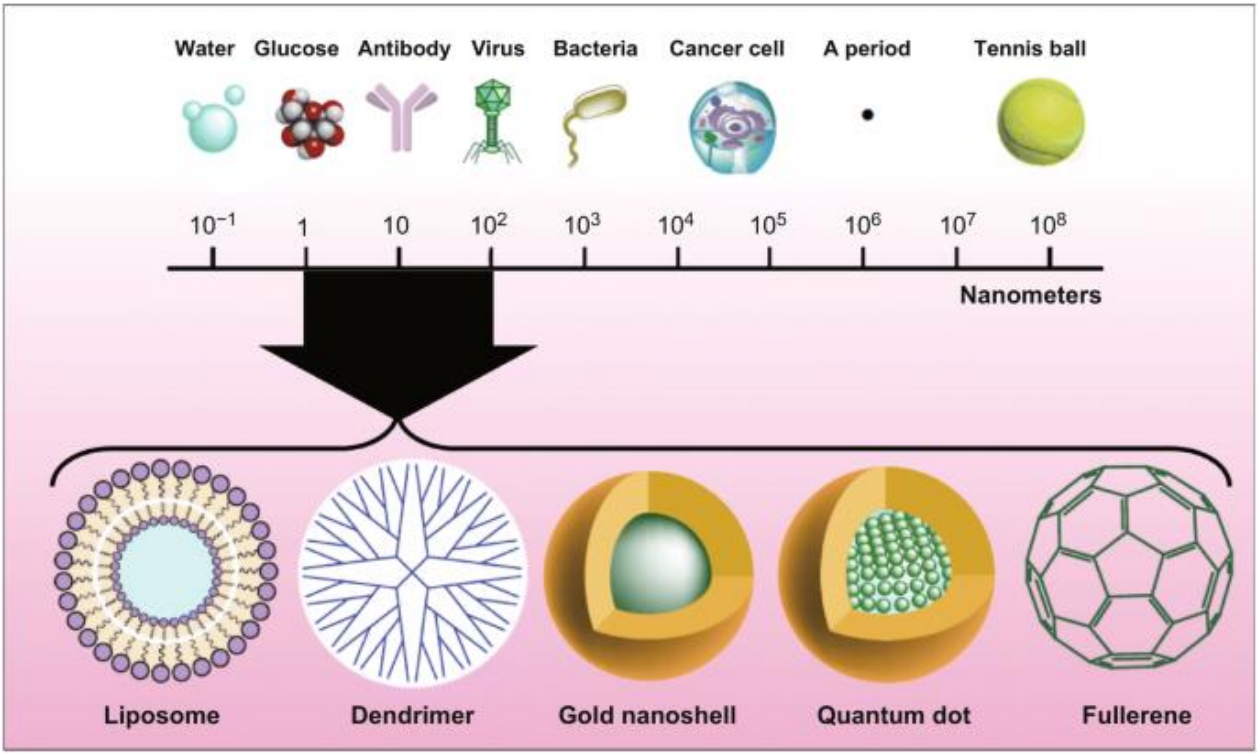

Figure 4 Different sized nanoparticles are used in nanotechnologies of food science [12].

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