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2. A Study on Nanotechnology Applications and Physics

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Abstract:

Many technology and industry areas, including information technology, energy, environmental research, medicine, homeland security, food safety, and transportation, are benefiting greatly from nanotechnology's innovations. If you think about it, today's nanotechnology is the result of all the development made in the fields of chemistry, physics, materials science, and biotechnology in recent years. Our world's environmental problems can be solved with nanotechnology since it has the potential to be cost-effective, ecologically friendly, and permanent. In recent years, there has been a steep increase in nanotechnology in the domains of medicine, particularly in the delivery of targeted drugs. Nanotechnology has the potential to address global challenges in (1) water purification, (2) clean energy technologies, (3) greenhouse gas management, (4) materials supply and usage, and (5) green manufacturing and chemistry.

In the field of food and agriculture, nanotechnology is being used to improve nutrient delivery, separate proteins via bio-separation, rapidly sample for biological and chemical pollutants, and nano-encapsulate nutraceuticals. In numerous technology and industry sectors, nanotechnology is helping to significantly improve or even revolutionise. These include information technology, energy and environmental science, medicine, homeland security, food safety, and transportation. New materials with unique features can be created using nanotechnology, which takes advantage of recent advancements in chemistry, physics, materials science, and biotechnology. As more and more Nano-engineered materials reach the global market, the ongoing revolution in nanotechnology will lead to the fabrication of nanomaterials with properties and functionalities that will have positive changes in the lives of our citizens, be it in health, the environment, electronics or any other field. Nanotechnology. When it comes to power generation, conventional fuel resources can no longer be the primary source of power because of rising demand and increased emissions of carbon dioxide. Energy sources based on cutting-edge technologies must be pushed as a means of cutting emissions. Innovations in organic photovoltaics and other nanostructured and composite solar cell systems, such as roll-to-roll manufacturing processes, hold considerable promise in terms of the technology's future growth and development.

Keywords:

Nanotechnology, Nanomaterial, drug delivery, Physics.

2.1 Introduction:

In nanoscience and nanotechnology, we study materials at the atomic and molecular levels, typically with structures smaller than 100 nm in diameter. "Nanoscience" can be characterized as a scientific study of phenomena and material manipulation at the atomic, molecular and macromolecular scales, where the properties differ from those at a larger scale, as well as novel functional applications. In the context of nanotechnology, this is the design, fabrication, and use of structures, devices, and systems by controlling the material's size and shape at a nanometer (10-9 of a meter). [1]

Richard Feynman's "There's Plenty of Room at the Bottom" lecture at a conference of the American Physical Society at Caltech on December 29, 1959, inspired the idea of nanotechnology, in which he believed that the complete Encyclopedia Britanica could sit in the head of a pin. Norio Taniguchi, a professor at Tokyo's Science University, first used the word "nanotechnology" in a 1974 paper to describe the processing, separation, consolidation, and deformation of materials down to the atoms or molecules scale. However, it wasn't until the 1980s when the scanning electron microscope was invented that nanotechnology began to gain traction. [2]

With the growing need to protect our environment, the challenge of satisfying the world's energy needs is exacerbated. Clean, inexpensive, and renewable energy sources are being investigated by many scientists, along with strategies for reducing energy consumption and the environmental toxin burden. Nanotechnology-enhanced prototype solar panels are more efficient at converting sunlight into electricity than normal designs, opening the door to more affordable solar power in the future. [3] When it comes to production and installation, nanostructured solar cells are already more cost-effective and easier to utilize because they can be manufactured in flexible rolls rather than single panels.

Figure 2.1 shows an example of a nanotechnology application.

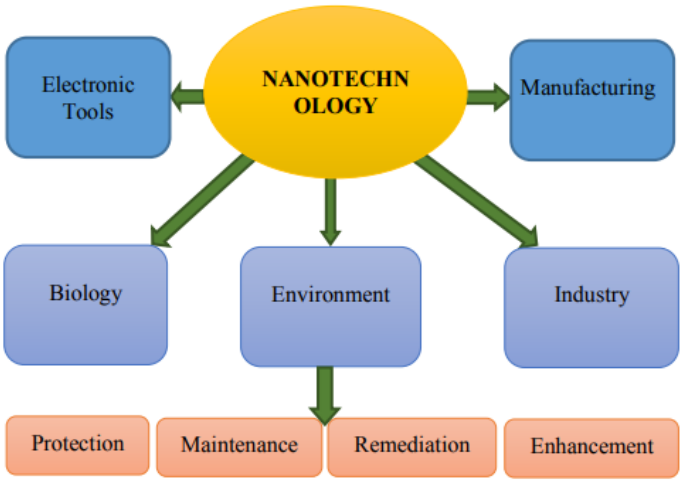

Figure 2.1: Application of Nanotechnology

Nanotechnology can be used in agriculture in different ways.

- Crop improvement
- Increase efficient fertilizers and pesticides
- Soil management.
- Plant disease detection.
- Water management
- Analysis of gene expression and Regulation
- Post-Harvest Technology

2.2 Nano Technological Applications in Food Industry:

Both developed and developing countries are investing in nanotechnology in an effort to get a foothold in the market. Nutraceuticals, gel and viscosifying agents, nutrient propagation, mineral and vitamin fortification, and nano-encapsulation of tastes are all examples of food processing techniques that incorporate the incorporation of nanomaterials into the process. [4]

2.3 Advantages and Disadvantages of Nanotechnology:

Even though nanotechnology is advancing in a number of fields, it is not without its drawbacks. It encourages the use of renewable power, extends the electronics limit, and helps in medical progress.

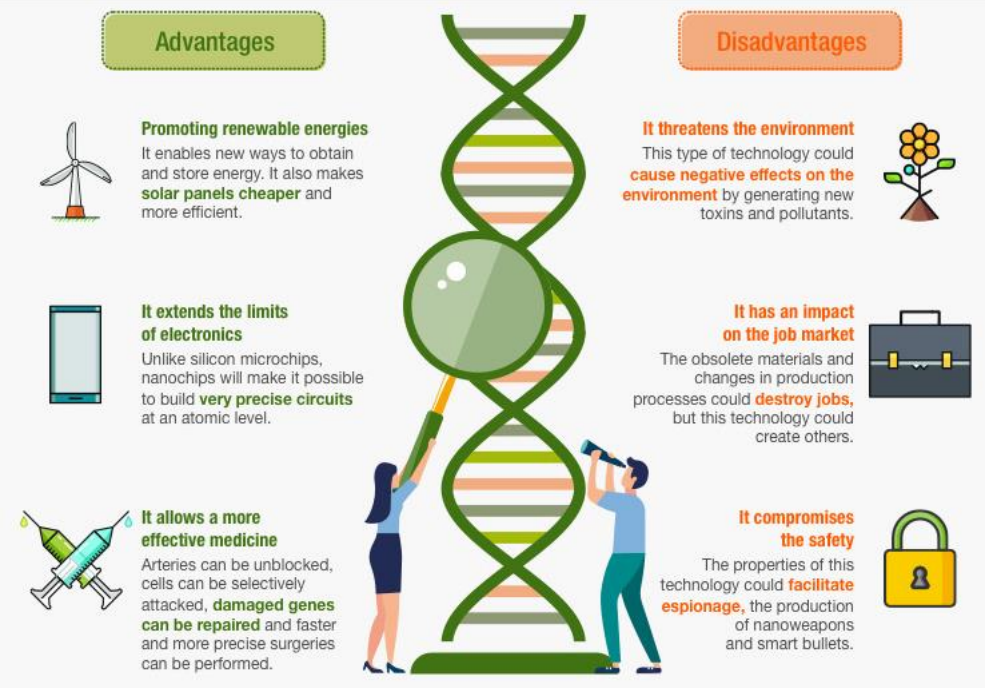

Figure 2.2: Advantages and Disadvantages of Nanotechnology

2.4 Review of Literature:

By modifying enzymes at the molecular level, researchers hope to speed up the conversion of wood chips, maize stalks (not only the kernels, as is the case today), and unfertilized perennial grasses into ethanol for use as fuel (Chaturvedi and Dave, 2014). [5]

In an effort to minimise the cost of fuel cells for alternative transportation, nanostructured materials are being researched to dramatically improve hydrogen membrane and storage materials and the catalysts required. Researchers are also striving to create a hydrogen fuel tank that is both safe and lightweight. A number of nanotechnology-based alternatives are being explored to transform waste heat from computers, autos, residences, and power plants into useful electrical power (Pratsinis, 2016; Sabet et al., 2016). [6]

Toxic organic compounds have been produced and put into the environment in recent decades such that they can be used either directly or indirectly for a long time. A few examples of these include pesticides, fuels, polychlorinated biphenyls (PCBs), and polycyclic aromatic hydrocarbons (PAHs) (Jones, 2007). [7]

The elimination of chemical contaminations from a polluted area is a vital stage in environmental remediation, according to Mahdavian (2010) [8]. There have been numerous investigations into the development of more effective materials for adsorbing a wide range of contaminants. It was common practice to employ montmorillonite and bentonites to absorb oil spills since they were thought to be the smallest particles and could hold large quantities of chemicals. In order to detect Acidovorax avenae subsp. citrulli, Zhao et al. (2011) [9] developed a quick and sensitive DNA strip sensor based on gold nanoparticle-labeled oligonucleotide probes. Qualitative and semi-quantitative results on the target DNA were achieved; the strip sensor's qualitative detection limit was 4 nM. Anti-counterfeiting Nano barcodes were designed by Oxonica Inc. (USA) for use with desserts or pellets and given via a modified microscope. The use of nano-biodegradable packaging is also on the rise. For food packaging and carry bags, bioplastics may be able to take the role of fossil fuel-based plastics thanks to the utilization of nanomaterials.

Organophosphates can also be detected in plants, fruits, and water using Nano sensors. There is a pressing need for extremely sensitive and selective analytical techniques for pesticide residue detection because of its water solubility, toxicity, and widespread use in agriculture (Valdés et al. 2009). [10]

Foods like wine, coffee, juice, and milk may all be analysed using Nano sensors. The sensors are built utilising layer-by-layer macromolecule ultra-thin films that have a 10,000-fold more surface area than the human tongue. Additional bacteria can be detected by attaching Nano sensors to packaging. Instead of sending the packed food to a lab for testing, the sensors can be used to detect variations in colour that indicate changes in food quality. Gastro sensors and thermometers, as well as nanoparticle-based sensors and array biosensors, are frequently seen in food packaging. Nanocantilevers and electronic noses are other examples of sensors that are commonly found in food packaging (Tang et al. 2009) [11]

2.5 Objectives:

- To learn about nanotechnology as a research topic
- To investigate the latest developments in nanoscience and nanotechnology across a range of scientific disciplines
- Nanotechnology in food management will be studied.
- To study the use of nanotechnology in industry

2.6 Research Methodology:

It is the systematic, theoretical investigation of the methods used in a particular field of study. It is the study of a field's corpus of methods and principles from a theoretical perspective. Parameters like paradigm, theoretical model and phases are typically included in this type of research.

Secondary sources must be thoroughly reviewed and analysed in order to use analytical and descriptive methods to the research. Close reading of a few secondary materials would be necessary to expand the textual analysis and provide additional insights.

2.7 Result and Discussion:

Nanofoods are products that were grown, processed, or packaged using nanotechnology or nanotech materials. [12]

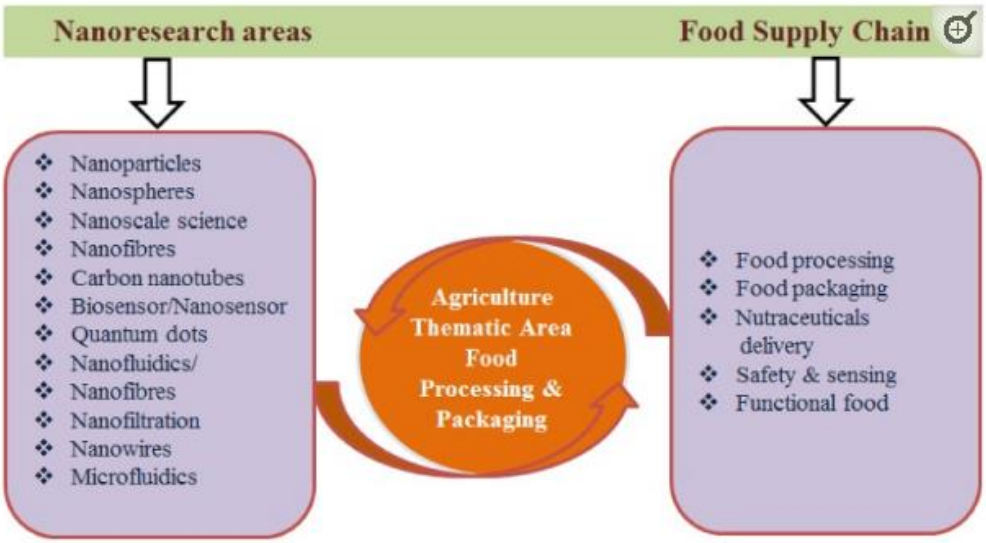

Figure 2.3: Framework for Integrating Nano Research Areas and the Food Supply Chain

Food processing, packing, and preservation require a number of procedures, all of which are aided by nanotechnology and a variety of nanomaterials. [13]

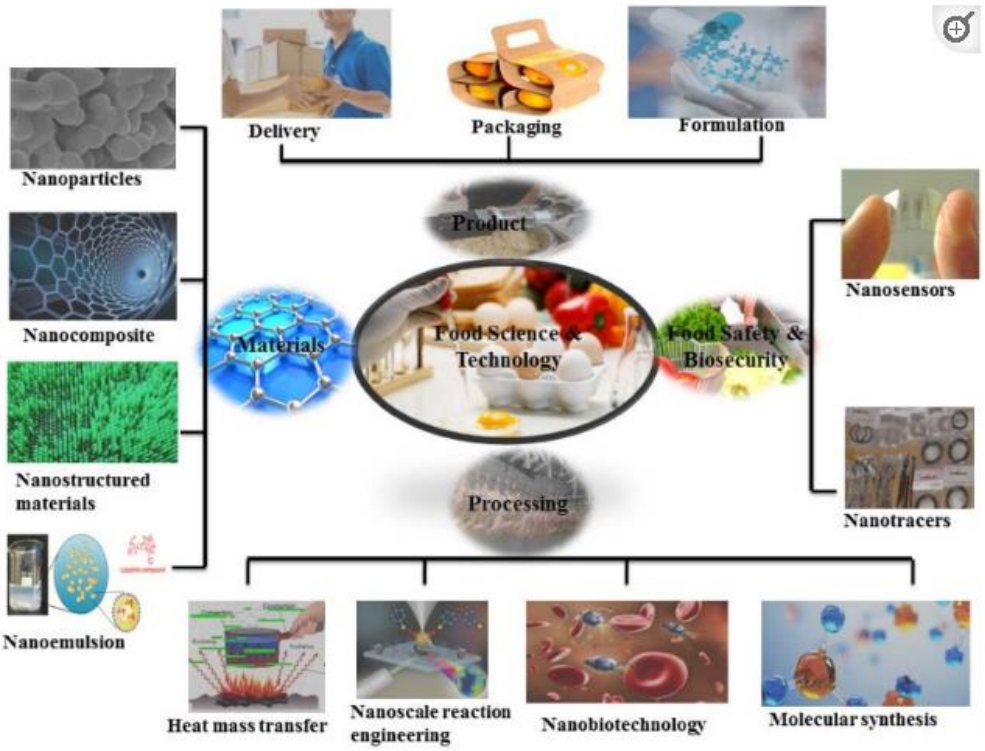

Figure 2.4: Food Management Steps

To study things down to the atomic scale in physics, chemistry, and computer science, nanoscience and nanotechnology have advanced in a variety of directions, allowing researchers to look at objects using a variety of microscopes, from room-sized computers to mobile slim laptops, and to study the nucleus of a cell in great detail in order to better understand single multicellular life. [14] Figure 2.5 summarizes all of these advancements in many branches of research in a general overview.

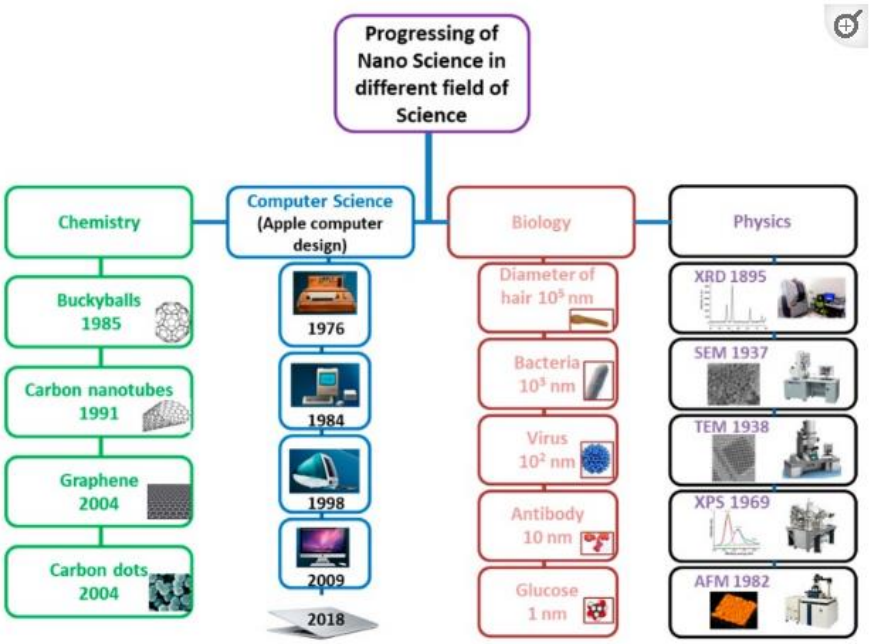

Figure 2.5: Progress in Nanoscience and Nanotechnology in Different Fields of Science.

Science and technology have long considered nanotechnology to be as transformative as the arrival of electricity or biotechnology or digital information. There was a 25 percent annual rise in discoveries, inventions, nanotechnology workers in R&D, funding programmes, and markets between 2001 and 2008. [15,17] In 2009, the global market for nanotechnology-based products totaled $254 billion. The long-term outlook for 2000-2020 (solid line) and 2009 outcomes for the market of final products utilizing nanotechnology. The focus of R&D shifts from basic discoveries in the years 2000-2010 (Nano1 in the figure) to applications-driven fundamental and Nano system research in the years 2010-2020. (Nano2) [18]

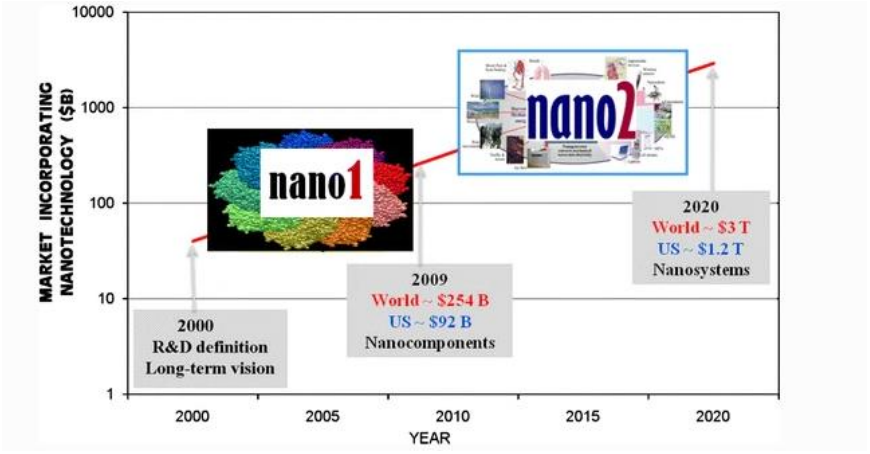

Figure 2.6: Nanotechnology Research Direction

2.8 Conclusion:

Building physically, chemically, and physiologically stable structures one atom or molecule at a time is the goal of nanotechnology, which takes an atomic or molecular approach. Astonishingly high levels of precision can now be achieved by manipulating individual atoms or molecules, thanks to advancements in science and technology. Even if nanotechnology's impact on society appears to be limited at the time, ongoing investment and labour are expected to yield results and innovations. The first step will be to improve food safety and quality. Finally, the use of nanotechnology in food processing can improve nutritional value while also ensuring product safety and promoting a healthy food culture. In the wake of biotechnology and information technology comes nanotechnology. The advancement of nanotechnology in aims to enhance the quality of life. As it continues to advance, nanotechnology will have a positive effect on both society and the environment.

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