

Nanotechnology as a Diverse Field

Sudhanshu Dwivedi¹

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Abstract:

Currently, nanotechnology is one of the emerging field in research and development globally and has become the highly energized discipline. Nanotechnology is defined as phenomena and operation of material at nanoscale, from 0.1 nm to 100 nm, which is applied to different field such as physics, chemistry, biology, engineering, etc. Nanotechnology techniques are rapidly developing in the fields of medical imaging, targeted drug delivery, biosensors also. It is basically helping significantly to improve and even revolutionize, many technologies and industry sectors. It also involved in the creation and manipulation at nanometer scale, either by scaling up from single groups of atoms or by purifying bulk materials. In this paper an effort has been done to study the current development and future perspective of nanotechnology on the basis of the different secondary information available. The paper initiated with short description about what nanotechnology is and how it's connected to other science, further describing about the view of different researchers on the application of nanotechnology in different discipline.

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Authors:

1. Amity Institute of Nanotechnology, Noida, INDIA

Introduction

“Nano” the term defines and is used as a prefix for one billionth, or if talking numbers it is represented as 10 to the times -9. The very concept of the scientific study of Nano came to the light by a Nobel Laureate and a physicist named Richard P Feynman, it was through his famous lecture held in December 1959 in a meeting at the American Physical Society where he quoted saying “There is a plenty room at the bottom”.

Although the term “nanotechnology” was coined by a professor in the Tokyo University of Science. Norio Taniguchi invented this term in the year 1974, where he wanted to describe extra-high precision and ultra-fine dimensions. It has created great deal of delight around the world and has been referred to as key technology of the 21st century. If it gets properly addressed it would open gate of opportunities for strengthening the economy of developing countries.

It is basically study of phenomena and operation of material at atomic, molecular and macromolecular level, it is done to understand and exploit properties that are different from properties of greater atoms.

The simple answer to the question that what is Nano particle is any particle which has size less than 100 nm. Currently the standard groups have agreed upon the size of Nano particles to be > 1 and < 100 nm i.e. on

Where do we find Nano particles?

scale it can range from 1 to 100nm, and if any particle goes below 1nm it shall be excluded as cluster of atoms cannot be considered to be Nano particle. In addition to this particles are three dimensional, it shall have two or three dimensions between 1-100 nm. So in case of nanotubes the diameter remains 10nm and the length goes > 100 nm.

Nanoparticles demonstrate physical properties that are very dissimilar in nature from both bulk materials and small molecules not only this it vary hugely from Nano scale particles too. It is the transitional portion in the middle of the atom and the solid, the very concept of the Nano world relies upon the conjunction of scientific domain with the technological domain, which in the early times were separate. Scientist came to realize the importance of these particles when they found that size can actually put an influence over the physiochemical properties of any substance for instance the optical properties.

ASTM has jotted down standard for a particle to be called as Nano in a clear way. Which is used by different field as Nano particles has become a boom, creating wonders in every field of science. Nanotechnology usually follows only two approaches:

1. Bottom Up approach
2. Top Down approach

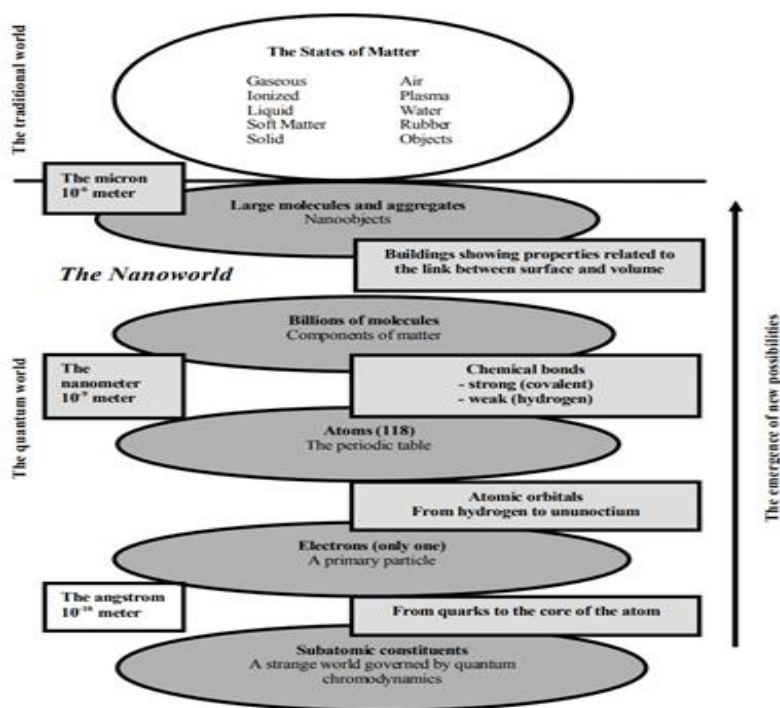


Fig 1: Level of structure depicting the presence of Nano particles.

Various field of science which can corroborate with Nanotechnology

Science needs innovation, it is as unstable as wind with every passing year scientists and researchers are facing challenges which need to be tackled right from the bottom, and the revolution started back in eighteenth century in order to change the world, nanotech has emerged as one of the largest multidisciplinary, giving pathway to the gates of innovation. With the help of information technology and strong footed engineering it has been paving ways towards development.

In this paper we will be focusing on the various fields which in conjugation to nanotechnology is promoting diversification and is continuously evolving. Many scientist believe so as Alan Leo quotes-“Get ready for your Nano Future.”

Nano technology can be integrated with many fields of science and can be proved very useful. Following are the list of areas which can come in corroboration with nanotechnology:

- Biochemistry
- Medicine
- Dentistry
- Diagnostics
- Construction
- Biology
- Biotechnology
- Chemistry
- Forensic Sciences
- Agriculture
- Energy
- Electronics
- Textile
- Transport
- Cosmetics
- Water treatment etc.

Nanotechnology has proved its hold in dentistry, Mitra with her colleagues has conducted a research titled - “An application of nanotechnology in advanced dental material” in the year 2003, wherein she had developed two types of Nano fillers namely: Nanomeric particles and Nonclusters. With the help of these Nano fillers and proprietary resin matrix they tried to prepare a system of wide range of shades and opacity by putting in different optimal combinations. The result were impressive in comparison to commercial composites tested, following characteristics held upper hand when tested:

- Diametral tensile
- Resistance power of fracture
- Compressive strength

Even when checked by three-body test nanocomposite proved to be better statistically. In case of polish retention analysis nanocomposite were found to be better than the hybrids and micro hybrids.

Another pioneer Rasheed clearly stated in his article “Nanotechnology and its Application in Dentistry”. That it is very much likely to uphold the near perfect oral health by use of nanomaterial and Nano robotics made with advanced biotechnology. He goes on emphasizing the wider application of nanotechnology in the field of dentistry and says it can lead to the advent of a new field known as nanodentistry.

Following is the list which states, where nanodentistry would play an important role:

- Nanodentistry can be used to administer local anesthesia.
- It can be used to operate periodontal tissues.
- It can also be used for swift and trouble-free malaligned tooth.
- Dental robots might come in use to shut off denital tubes, therefore would prevent dentin hypersensitivity.
- When incorporated with vinyl poly-siloxane it can be used for impression making
- Viljanen suggested that dental implants can be made if incorporated with nanoparticles
- According to Braceras delivery of drug by local mode can be made easy if tetracycline gets incorporated with microspheres.
- Bony defects can also be corrected and bone growth can be induced with the help of this technology, according to Edward.
- Henkel supports the use of nanodentistry and believes that it can be used in the process of photosensitization, as to bind the antibody quantum dots can readily be used, this can be activated by UV light.

Now although many has worked on and suggested nanotechnology as some kind of blessing but Williams has shown great concern over the challenges that could be faced. In his opinion it is good that many seen nanotechnology as some sort of revolutionizing field, but it has its own cons such as ethical issues that could come up, also not many in medical health sector has no or next to no knowledge of this field, proficiency being the question. So he shows concern over the retention of trained manpower. Also he feels like there would be lack of suboptimal funding and slow strategic decisions, and this field might feel lack of engagement of private enterprises.

Dr. Xu Wang suggested in his work “Application of Nanotechnology in Cancer Therapy and Imaging” that this miracle technique can help develop nanoscale devices which can conjugate with several functional molecules at one time that will include tumor-specific ligands, anticancer drugs, antibodies and imaging probes. The agenda to so depend on the fact that the devices can easily be injected through the leaky blood vessels and it can act together on the targeted tumor specific proteins both on surface and inside the cells. Hence it can be called as delivery vehicle for cancer treatment.

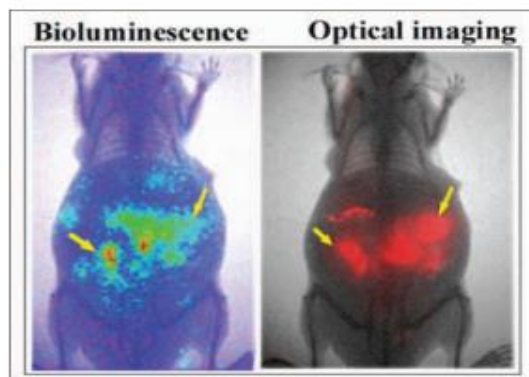


Fig 2: Optical imaging of peritoneal tumor metastases using quantum dots. Pic Credit: Dr. Xu Wang et al. 2008

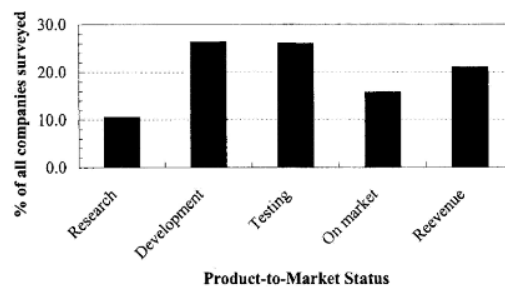
Not only for cancer treatment, might application of nanotechnology be done in molecular diagnostic too. Nano diagnostics by Jain is a work where he tried to explain that nanotechnology on a chip is an extended dimension of microfluidic. Where biological tests are conducted for measuring the existence of or activity of selected substances, and it becomes quicker with the help of nanotechnology. In this scenario what happens is that magnetic nanoparticles of respective antibody label particulate antibody, molecules, structures and microorganisms. Also gold nanoparticles that are generally tagged with short segments of DNA can be implied for detection of genetic sequences.

Apart from field of medicine nanotechnology can be implied over the construction sector as well. Zhu in his paper of the heading “Application of nanotechnology in construction” states-

That there is future potential of nanotechnology in the booming construction industry, he had conducted survey that suggested of the same, and he further adds that there are at present some Nano based materials and products that are already being used by the construction firms for the betterment of approach.

Construction is not the only field along with medicine that had been promoting the use of Nano material there are many industries that had been focusing on the

same. Below is the data of different sectors and companies that shows product development survey conducted in the year 2001.



Stage of product development of nanotech companies (data source: Ref.6)

Fig 3: Stage of product development of over 150 companies that was surveyed in 2001. Pic Credit: Zhu.

Future of Nanotechnology:

Nie suggests that in future century nanotechnology will become the foundation of significant industrial applications and exponential development. He quotes this with an example that in the pharmaceutical communities it has become one of the vital area as with the advancement it gives birth to the miniature devices and diagnostic biosensors or drug delivery systems and imaging probes which are important to the human being.

Not only medical but food and cosmetic industries use Nano material at the fullest, and the need of it has increased dramatically in order to improve the production, packaging and shelf life also for the bioavailability.

Whereas Jin claims that it is found that Nano particles of zinc oxide quantum dot show antimicrobial activity in contradiction of food borne bacteria. In today's scenario nanotechnology put impact on human life on daily basis, as the prospective benefits are many and diverse. Nano medicine that is inclusive of sub sectors such as tissue engineering, biomaterials and biosensor has many benefits. Some of the prospective benefits are improved quality of drugs delivery system, time saving strategy, better healing procedure. However concern raises because of the lack of reliable toxicity data.

When talking about future trend and potential of nanotechnology in the field of construction one can easily find emetine number of areas that could benefit from it some of them are:

- Modified nanostructure materials for increasing binding efficiency.

- Special paints with Nano particles increasing the binding properties.
- Multi-functional resources and constituents.
- Fresh construction techniques, tools for construction.
- Intelligent structures and sensors.
- Monitoring and Diagnostic system can be incorporated for better use.
- Energy efficient lights and computing devices.

Conclusion:

Conclusively, it can be said that the future of nanotechnology will become the foundation of significant industrial applications and exponential development in different discipline. It has emerged as growing and rapidly changing field and also integrated with different fields of science and proven to be very useful. It has played a significant role in different sectors such as food science, cosmetic industries, medical science, etc. in order to develop advance techniques for benefits of the society.



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