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Abstract:

Nanotechnology is said to be the upcoming technology. The promising technology exhibits lots of favorable characteristics which would take the current technology by swing and generate revolution in the current trending technologies. The breaking down of bulk materials into nanoparticles is the reason behind the miraculous effect and the genesis of Nanotechnology. The nanoparticles are characterized by the quantum effects that dominate the behavior of the matter at nanoscale. The surface area to volume ratio almost doubles when compared to the surface area to volume ratio of bulk matter as a result of which the materials become more chemically reactive and affect their strength or electrical properties. The changes in the properties of the material at nanoscale have unleashed a lot of applications in which nanomaterials have a deep impact and bring in lot of advantages to contemplate upon.

Keywords:

nanotechnology, nanoparticles, quantum effect, bulk material, nanoscale, nanomaterials.

1. Introduction

A material is said to be nanomaterials if its size lies between 1-100nm. The miniaturizing of the electronic components and devices is in vogue since its origin; the invention of transistor was the first revolution, followed by the invention of integrated circuits by the virtue of embedded technology. But miniaturizing of matter to micro size was proportional to its bulk matter, in the sense the characteristics of the bulk material hardly changed at micro levels, but with the advent of nanoparticles it is observed, experimented and proved that the characteristics of the material when bulk changes drastically when broken to nano size. This has indeed set in a revolution in the fields of applications of electronics and opened up a plethora of research opportunities having an identity of its own known as Nanotechnology.

2. Nano Materials Characteristics

The surface area of a material increases in nanoparticles as compared to bulk material itself.

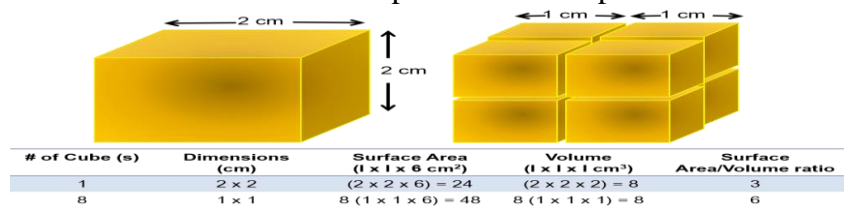


Figure 1

2.1 Salient characteristics of Nanomaterials

As the surface area to volume ratio increases, a greater amount of substance comes in contact with surrounding material as hidden surfaces are exposed which enhances catalytic activity for potential reaction. As the size goes down to Nano, the materials become chemically more reactive and their strength and physical properties also vary profoundly. The reason for variation is the quantum effect that dominates at the nanoscale. For example, a quantum confinement in the semiconductor particles or superparamagnetism in magnetic particles. The colors of the material change as the bulk material is reduced to nano scale in stages due to the phenomena called plasma resonance. As the size is reduced and the shape is changed, the wavelength of these materials change and fall in the visible spectrum range, hence different colors are exhibited at different stages of the making of Nanoparticles

as shown in figure 2. The insulators are found to conduct at nanoscale, as well as the strength of the material increases remarkably.

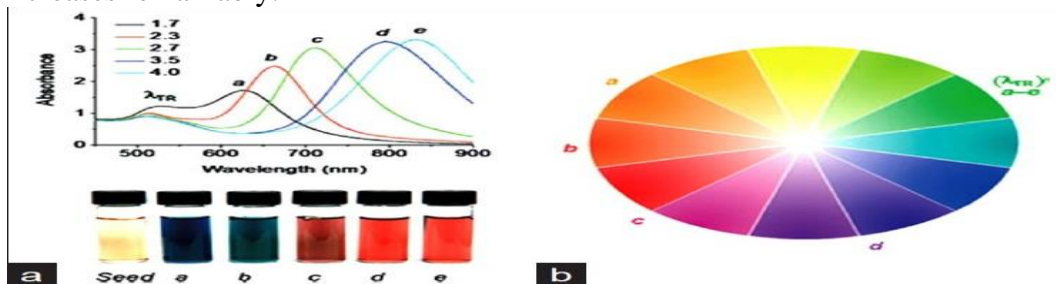


Figure 2

2.3 History of Nanomaterials

The word Nano was coined by Japanese Prof. Taniguchi in the year 1974. But the usage of these dates back thousand years ago wherein the Chinese used nanoparticles as an inorganic dye to introduce red color into porcelains. Different metal nanoparticles were used to get different colors. In 1857, Faraday prepared gold colloids that were stable for almost a century before being destroyed during World War II. Bhasma, the holy ash made by burning various shrubs in India is also nanoparticle which is widely used since ancient times for skin diseases and various therapeutic purposes.



Figure 3: Chinese porcelain painted using NPs, Faraday’s Gold Colloids and Bhasma

3. Types of Nanoparticles

Nanoparticles are classified based on the mode of its preparation as follows

- Naturally occurring Nanoparticles like forest fires, Sea spray, volcanic ash etc.
- Incidental Manmade Nanoparticles like cooking smoke, Industrial effluents, welding fumes etc, which have carbon nanoparticles.
- Engineered Nanoparticles which are designed and manufactured for a specific purpose viz., Metal nanoparticles, Quantum dots, Bucky balls, Nanotubes, Nanocapsules etc.

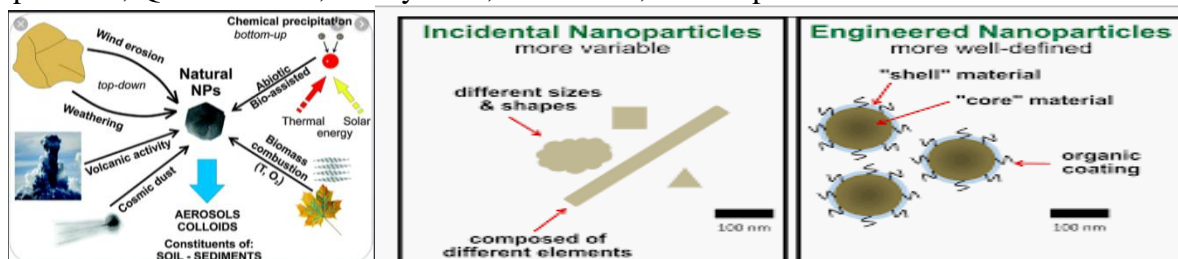


Figure 4: Natural NPs, Incidental NPs and Engineered NPs

Nanostructures are made using two methods: Top down approach and Bottom up approach. In Top down approach the bulk material is patterned and etched out as in the case of fabrication of Integrated Circuits. In bottom up approach, the atoms and molecules are assembled as in case of chemical and biological systems to form a certain specific Nanoparticle i.e., it starts from atomic scale to nanoscale.

4. Applications of Nanoparticles in Medical Field

Huge applications are found in medical field. This helps in enhancing the diagnostics and treatments.

- Because of their small size, nanoscale devices can readily interact with biomolecules on both the surface of the cells and inside of cells. By gaining access to so many areas of the body they have the potential to detect disease and deliver therapeutic molecules.
- Used in diagnostic purposes; In the traditional cancer therapy the area of cancer is incident with harmful radiations to kill the cancer cells, but in the process the healthy cells are also killed and will have tremendous side effects, but using nanotechnology the therapeutic nanoparticles carry the drug to destroy the cancer cells, they are directed to the exact spot of cancer where they specifically kill the cancer cells. This is called Targeted Drug Delivery System.
- In tissue engineering, the damaged skin or organ is grown in the lab using bottom up approach and the replaced without affecting the rest of the organs.
- Any Organ like artificial ear, Limbs can be 3D printed and transplanted. This method is Under clinical trials and some cases have been successfully tried.
- Artificial cells are grown in the lab using Nanoparticles and only the damaged and dysfunctional cells are replaced instead of the whole organ.
- DNA cells are nanosized. The detailed study of these cells leads to the understanding of their behavior, their structures and helps in building similar structures for treatment purposes.

5. Future Scope

Nanorobots/ Nanobots: Like the bacteria moves from one location to another with the help of its flagella, the Nanorobots are formed with tail like structures which has a micro camera to monitor its movement which also has a payload, i.e., therapeutic molecule. It will move through arteries and veins and reaches the location delivering the drug or destroy the cancer cell.

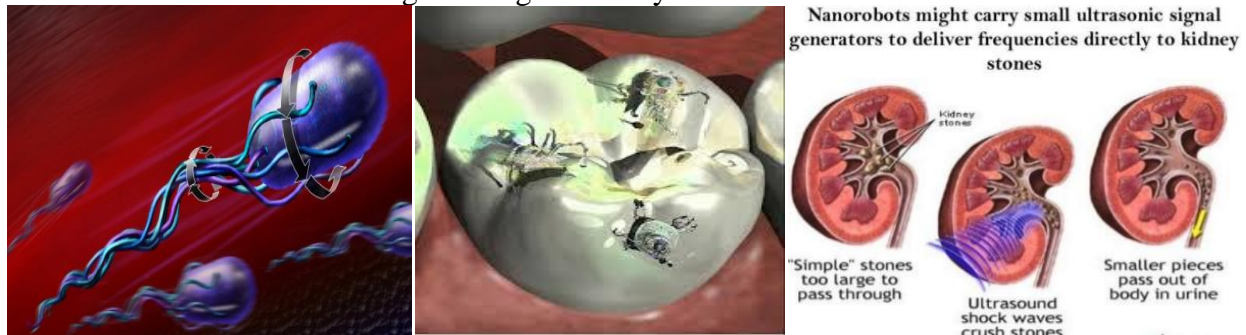


Figure 5: Nanobots for Drug Delivery, mouthwash and Kidney stones removal

Large kidney stones are difficult to pass through urine and the operation to remove these stones is extremely painful. Nano robots can be used to breakdown these kidney stones to small pieces by generating the ultrasound shock waves and these small particles can easily pass through urine. Nanobots are finding their way in day to day life also. In the field of dentistry, A mouth wash full of Nanobots is prepared, which would clean the plaques and keep the teeth healthy.

6. Conclusion

Nanotechnology is the field of possibilities and hence exhaustive research is going on and large numbers of researchers are working on this. The next era is going to be nanoera.

References:

1. The NPTEL lectures on nanotechnology at IIT Roorkee and IISc, Bangalore
2. eBook on Introduction to NanoScience and Nanotechnology by Chattopadhyay
3. eBook on nanomaterials by A.K . Bandyopadhyay.