Recent Advancements in Nanotechnology and their Applications

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Abstract- W***henever we go to a zoo or Bird sanctuary, we see peacocks dancing with their colourful feathers. We have often wondered how the colour of the peacock feather does not fade away for so many years, even we keep peacock feathers in our books. This phenomenon of long lasting original colours has come from Nano materials coated in a peacock's feather; and they diffract light. Everything in this universe, from large galaxies to small micro organisms work on a molecular scale. Our internal organs and their processes also occur at molecular level. Therefore, everything in our body and in the physical universe is already based on Nanotechnology***

Nanotechnology has helped in transformation and modernization of materials by making possible the manipulation of materials at the atomic level. Nanotechnology, is the ability to work with matter, measured in the length of approximately 1 to 100 nanometers (1 nanometer = 1x10^{-9} m) . One nanometer is equivalent to the breadth of three or four atoms.

In this paper we have discussed the use of Nanotechnology in various areas Industry. RFID (Radio Frequency Identification) is new emerging area, which works on radio frequency & used for material tracking. While nanotechnology applications in textile, chemical, mechanical materials are already taking the world by storm, it's something of a surprise that its potential application in machinery and processes has not yet been explored. In this paper we tried to cover the application of nanotechnology in the advancements made in material science and technology.

We are today at the convergence of nano, bio and information technologies. We believe, this era will create a historic revolution and we must be in the proper control to contribute towards this social change.

Key words — **Nanotechnology, Molecular Nanotechnology, Nano Materials, Nano Composites, RFID.**

I. INTRODUCTION

Nanotechnology is the **engineering of functional systems at the molecular scale.** It includes current work and concepts that are highly advanced. It is the design, characterization, production, and application of structures, devices, and systems by controlled manipulation of size and shape that produces structures, devices, and systems with superior characteristics or properties.

Nanotechnology refers to the projected ability to construct items from the bottom up or top down approach using techniques and tools to make highly advanced products. Nanotechnology is essentially a set of techniques that allow manipulation of properties at a very small scale, it can have many applications. Molecular nanotechnology is an emerging, interdisciplinary field combining principles of molecular chemistry and physics with the engineering principles of mechanical design, structural analysis, computer science, electrical engineering, and systems engineering.

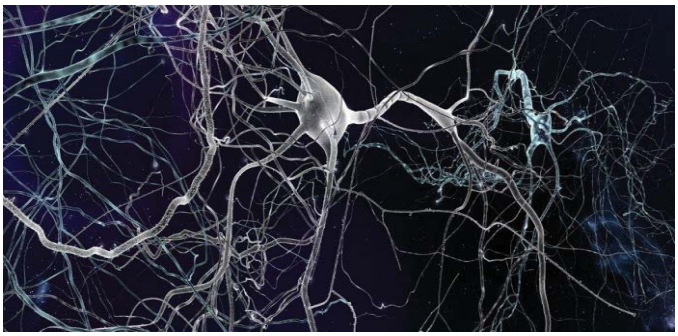

Fig. 1 View of Neurons at Molecular level by using Nanotechnlogy

II.EVOLUTION

In the world of Nanotechnology, several phases have been identified that are emerging. Each phase leads to the next phase and all this happens because of technology and time in the Nanotech world. It helps us to visualize the evolution of Nanotechnology and its impact on the business world. One thing is pretty sure that progress is being made continuously and it's not reversible.

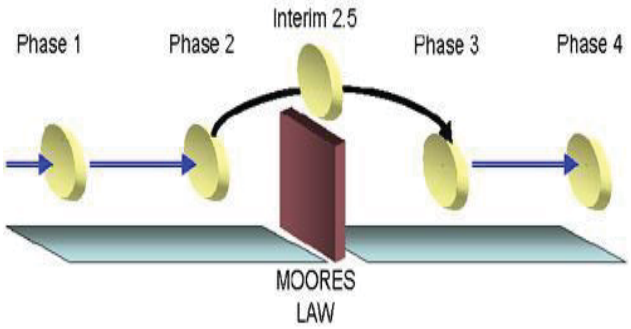

Fig 2- Phases of Nanotechnology

This diagram shows how the focus will shift over time. Phase 1 represents where we are today, Phase 2 could be 3 to 4 years, Phase 2.5 is an interim phase between 4 to 6 years, Phase 3 could be 6 to 8 years, and Phase 4 is the 8 to 10 years mark.

III.APPLICATIONS

In modern world, Nanotechnology can be used in various fields and disciplines. Its contribution in our daily lives is remarkable. Every single object that we see, the food which we eat, the machines which help us in our chores function by means of Nanotechnology.

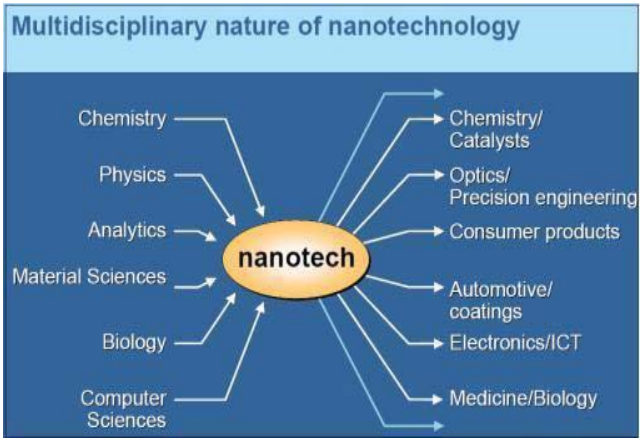

Fig 3- Multi Disciplinary Nature of Nanotechnology

Some daily life applications of Nanotechnology are as follows:

1) **Agriculture/ Food**
Agricultural chemicals, Food stuffs, crops etc

2) **Electrochemistry**
Batteries, Fuel cells, Solar cells etc

3) **Electronics**
Memory, semi conductor devices, chips, sensors etc

4) **Biology**
Functioning of Cell, study of Genes, pharmacy etc

5) **Textiles**
Fabric, garment finishing, colour etc

6) **Material Sciences**
Fluids, polymers, Particles etc

7) **Optics**
Displays, Lithography, Photonics etc

8) **Security Systems**
Forensics, Punch machines etc

Some detailed applications of Nanotechnology in different fields are explained below:

MECHANICAL APPLICATIONS

Solid lubricants are used when conditions do not allow the usage of standard lubricating oil. This is generally under the vaccum or in oxidizing atmosphere. . H-BN and Graphite are intensively used as a solid lubricant in Industry.

H-BN is especially interesting for having both, low friction coefficient and a high range of suitable temperature in air (up to 900°C). Nano-onion powder are exceptional solid lubricants.

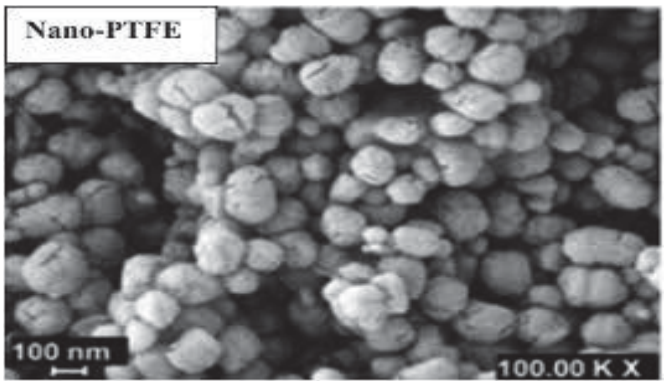

Fig 4- Nano Lubricants

CHEMICAL APPLICATIONS

Nano- Shielding Nano tubes and onions of carbon have the ability to provide shell to many materials inside their structure. It has been confirmed for many simple elements (Y, B, Bi, Gd, Ti etc) and also for some compounds. Therefore its important to protect the nano material from their environment especially from oxidation.

Magnetic particles from the data storage could be protected from the air. It also offers a possibility to synthesis diverse hybrid nano composites like metallic nano roads inside the tube cavity. Nanotechnology is a manufacturing technology in the 100 nm to 0.1nm range. An electro-mechanical system technology is used in nanotechnology to produce more refined components and parts to integrate microelectronic circuit and controller systems. Under a microscope, even the smoothest crystalline coatings, such as polished chrome show irregular gaps between the crystals. These defects are identified and rectified by using Nanotechnology.

ELECTRONIC APPLICATIONS

Electron sources are essential for screens or electron microscope. Carbon Nano tube can emit a high electron field emission current from their tip, when exposed to the bias voltage. The threshold voltage is exceptionally low because of the tip curvature. Emission surface were realized by different post-synthesis methods. Hence this application may seem the closest to commercialization of present.

APPLICATION OF NANOTECHNOLOGY IN MACHINERIES

1) SURFACE COATING

Arc bond sputtering and super lattice technology are recent developments in the field of surface coating technology. These techniques combine multiple nano-scale layers of specific metals known to have excellent hardness properties and chemical resistances which has a new and improved periodical structure.

The application of these new coatings on industrial products is designed to change their physical properties, thus improving an individual product's toughness, resistance, performance and durability.

2) NANOCRYSTALLINE MATERIALS

It includes ceramics, metals, and metal oxide nanoparticles. These materials are assembled from nanometer-sized building blocks, mostly crystallites. The building blocks may differ in their atomic structure, crystallographic orientation, or chemical composition.

Materials assembled of nanometer-sized building blocks are micro structurally heterogeneous, consisting of the building blocks (e.g. crystallites) and the regions between adjacent building blocks (e.g. grain boundaries)

3) NANO COMPOSITES

Nanocomposites are materials with a nanoscale structure that improve the macroscopic properties of products. Nanocomposites are generally clay, polymer or carbon, or a combination of these materials with nanoparticle building blocks. Nanocomposites, materials with nanoscale separation of phases can generally be divided into two types:

(a) Multi layer Structures
Multilayer structures are typically formed by gas phase deposition or from the self-assembly of monolayers

(b) Organic or Inorganic Composites
Inorganic/organic composites can be formed by sol-gel techniques, bridging between clusters or by coating nanoparticles, in polymer layers

IV. NANOSENSORS TO REPLACE RFID CHIPS ON CONSUMER PRODUCTS

Background Of RFID Technology: - An RFID tag is a uniquely identified object that can be embedded to any physical body to track its position or location. Tags cover the entire spectrum the passive tags powered in the presence of a reader, to a continuously signal-emitting active tag.

Both active as well as passive RFID tags consist of a small microchip that contains a unique ID encoded within it & fall within a range of frequencies that are used according to the ISO specifications for air interface (ISO-18000 2-7).

Some of these specified frequencies are more suitable to passive operation (i.e. shorter range, larger bandwidth, lower power) while some are more suitable to active RFID technology. The rest of the tag consists of a mechanism to transmit this unique ID to an "Interrogator" or a reader that can identify this tag.

Advantages of RFID

a. Greater control over inventory.
b. Increased Security
c. Greater visibility of Facility
d. Reduction in Maintenance and Record keeping time
e. Better organization of assets and resources
f. Delivers accurate and precise information

Risks for Adoption of RFID

a. High Initial and Operating Cost
b. Data which is to be filtered is available in large amount.
c. High Complexity
d. Product Tagging doesn't always work.
e. Extremely Sensitive to liquids and moisture.
f. Technology gets updated day by day.

RFID: PRIVACY AND SECURITY ISSUES

As customized technologies are getting evolved, the issues of privacy and security will take centre stage. In order to ensure privacy, customers would have to opt into a programme where special offers are presented to them in-store via a Bluetooth-enabled device which gives retailers the ability to add a Java applet to a phone or a PDA that can only be read by the store the customer is in, so the customer is not constantly tortured with outside offers. Security issues will also become an increasing concern as more stores add high-speed Internet connections.

The IBM Privacy Research Institute is working with retailers and other businesses to develop technologies and guidelines to protect consumer privacy, while enabling retailers to obtain the necessary data. IBM predicts that privacy concerns will be a non-issue if retailers pay attention to how to protect their customers.

V. FUTURE PROSPECTS

RFID Tracking and Nanotechnology is not just one that bounces a signal that was received by a transmitter, but one that emanates a unique number (like a RIN RFID identification number) only for RFID's. We realize that already we have RTLS (real-time locator systems) with this technology embedded.

This would have to be done using Nanotech, for an internal power source, and a transmitter would have to be embedded, or an encoding device. In other words, since the power source is usually too weak to respond to a satellite signal, it would have to record where it was (latitude and longitude).

VI. CONCLUSION

There are many important incentives which make it seem possible that the pace of development will continue to grow. Accordingly, the technology is expected to mature within 10-12 years and this will impact the manufacturing industry by bringing new tools for the manufacture of machines and order of magnitude improvements in mechanical properties and performance.

Nanotechnology can be defined as a mysterious predator waiting to wreak havoc on an unsuspecting society. In the real world, scientists are developing applications based on micro molecules that do indeed have the potential to change the way we live-but for the better.

"Nanotechnology is an enabling technology that makes existing applications work better or more efficiently"

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