International Journal of Science and Research (IJSR)
ISSN: 2319-7064
Index Copernicus Value (2016): 79.57 | Impact Factor (2017): 7.296

# An Introduction to Nanotechnology and Their Various Applications

**Vinod Kumar Singh**

Assistant Professor & Head of Department (Department of Chemistry), Shivpati Postgraduate College, Shohratgarh, Siddharth Nagar
Affiliated to Siddharth University , Kapilvastu, Siddharth Nagar

**Abstract:** ***Nanomaterials describe, in principle, materials of which a single unit is sized (in at least one dimension) between 1 to 1000 nanometres ($10^{-9}$ meter) but usually is 1 to 100 nm (the usual definition of nanoscale. Nanomaterials research takes a materials science-based approach to nanotechnology, leveraging advances in materials metrology and synthesis which have been developed in support of microfabrication research. Materials with structure at the nanoscale often have unique optical, electronic, or mechanical properties. Nanomaterials are slowly becoming commercialized and beginning to emerge as commodities.***

## 1. Introduction

Scientists have been studying and working with nanoparticles for centuries, but the effectiveness of their work has been hampered by their inability to see the structure of nanoparticles. In recent decades the development of microscopes capable of displaying particles as small as atoms has allowed scientists to see what they are working with.

The ability to see nano-sized materials has opened up a world of possibilities in a variety of industries and scientific endeavors. Because nanotechnology is essentially a set of techniques that allow manipulation of properties at a very small scale, it can have many applications.

### Nanomaterials and their Applications

Nanomaterial Applications using Carbon Nanotubes

Applications being developed for carbon nanotubes include adding antibodies to nanotubes to form bacteria sensors, making a composite with nanotubes that bend when electric voltage is applied bend the wings of morphing aircraft, adding boron or gold to nanotubes to trap oil spills, include smaller transistors, coating nanotubes with silicon to make anodes the can increase the capacity of Li-ion batteries by up to 10 times.

### Carbon Nanotubes In Healthcare

Researchers are improving dental implants by adding nanotubes to the surface of the implant material. They have shown that bone adheres better to titanium dioxide nanotubes than to the surface of standard titanium implants. As well they have demonstrated to the ability to load the nanotubes with anti-inflammatory drugs that can be applied directly to the area around the implant.

### Carbon Nanotubes and the Environment

Carbon nanotubes are being developed to clean up oil spills. Researchers have found that adding boron atoms during the growth of carbon nanotubes causes the **nanotubes to grow into a sponge like material** that can absorb many times it's weight in oil. These nanotube sponges are made to be magnetic, which should make retrieval of them easier once they are filled with oil.

Carbon nanotubes can be used as the pores in membranes to run reverse osmosis desalination plants. Water **molecules pass through the smoother walls of carbon nanotubes more easily** than through other types of nanopores, which requires less power. Other researchers are using carbon nanotubes to develope **small, inexpensive water purification devices** needed in developing countries.

Sensors using **carbon nanotube detection elements** are capable of detecting a range of chemical vapors. These sensors work by reacting to the changes in the resistance of a carbon nanotube in the presence of a chemical vapor.

### Nanomaterial Applications using Graphene

Applications being developed for graphene include using graphene sheets as electodes in ultracapacitors which will have as much storage capacity as batteries but will be able to recharge in minutes, attaching strands of DNA to graphene to form sensors for rapid disease diagnostics, replacing indium in flat screen TVs and making high strenght composite materials. **Hydrogen production without platimum.**Researchers have demonstrated a catalyst made from **graphene doped with cobalt** can be used to produce hydrogen from water. The researchers at looking at this method as a low cost replacement for platimum based catalysts.

**Lower cost of display screens in mobile devices**. Researchers have found that graphene can replace indium-based electrodes in organic light emitting diodes (OLED). These diodes are used in electronic device display screens which require low power consumption. The use of graphene instead of indium not only reduces the cost but eliminates the use of metals in the OLED, which may make **devices easier to recycle**.

**Lithium-ion batteries that recharge faster**. These batteries use graphene on the surface of the anode surface. Defects in the graphene sheet (introduced using a heat treatment) provide pathways for the lithium ions to attach to the anode substate. Studies have shown that the time needed to recharge a battery using the **graphene anode** is much shorter than with conventional lithium-ion batteries.

**Ultracapacitors with better performance than batteries**. These ultracapacitiors store electrons on graphene sheets, taking advantage of the large surface of graphene to provide increase the electrical power that can be stored in the capacitor. Researchers are projecting that these **ultracapacitors** will have as much electrical storage capacity as lithium ion batteries but will be able to be recharged in minutes instead of hours.

**Components with higher strength to weight ratios**. Researchers have found that adding graphene to epoxy composites may result in stronger/stiffer components than epoxy composites using a similar weight of carbon nanotubes. Graphene appears to bond better to the polymers in the epoxy, allowing a more effective coupling of the graphene into the structure of the composite. This property could result in the manufacture of components with high **strength to weight ratio** for such uses as windmill blades or aircraft components.

**Storing hydrogen for fuel cell powered cars**. Researchers have **prepared graphene layers** to increase the binding energy of hydrogen to the graphene surface in a fuel tank, resulting in a higher amount of hydrogen storage and therefore a lighter weight fuel tank. This could help in the development of practical hydrogen fueled cars.

**Lower cost fuel cells**. Researchers at Ulsan National Institute of Science and Technology have demonstrated how to produce **edge-halogenated graphene nanoplatelets that have good catalytic properties**. The researchers prepared the nanoplatelets by ball-milling graphene flakes in the presence of chlorine, bromine or iodine. They believe these halogenated nanoplatelets could be used as a replacement for expensive platinum catalystic material in fuel cells.

**Nanomaterial Applications using Nanocomposites-**
Applications being developed for nanocomposites include a nanotube-polymer nanocomposite to form a scaffold which speeds up replacement of broken bones, making a graphene-epoxy nanocomposite with very high strenght-to-weight ratios, a nanocomposite made from cellulous and nanotubes used to make a flexible battery.

**Nanomaterial Applications using Nanofibers-**
Applications being developed for nanofibers include stimulating the production of cartilage in damaged joints, piezoelectric nanofibers that can be woven into clothing to produce electricty for cell phones or other devices, carbon nanofibers that can improve the preformance flame retandant in funiture.

**Nanomaterial Applications using Nanoparticles-**
Applications being developed for nanoparticles include deliver chemotherapy drugs directly to cancer tumors, resetting the immune system to prevent autoimmune diseases, delivering drugs to damaged regions of arteries to fight cardiovascular disease, create photocatalysts that produce hydrogen from water, reduce the cost of producing fuel cells and solar cells, clean up oil spills, water pollution and air pollution.

**Nanomaterial Applications using Nanowires-**
Applications being developed for carbon nanotubes include using zinc oxide nanowires in a flexible solar cell, silver chloride nanowires to decompose organic molecules in polluted water, using nanowires made from iron and nickel to make dense computer memory - called "race track memory.

**Buckyballs: Uses and Applications | Fullerenes-**
The properties of buckyballs (also known as fullerenes) have caused researchers and companies to consider using them in several fields. The following survey of buckyball applications introduces many of these uses. Click on any of the links below to go to a detailed explanation.

**A survey of buckyball uses:**
Buckyballs may be used to trap free radicals generated during an allergic reaction and **block the inflammation** that results from an allergic reaction.

The antioxidant properties of buckyballs may be able to fight the deterioration of motor function due to **multiple sclerosis**.

Combining **buckyballs, nanotubes, and polymers** to produce inexpensive solar cells that can be formed by simply painting a surface.

Buckyballs may be used to **store hydrogen**, possibly as a fuel tank for fuel cell powered cars.

Buckyballs may be able to reduce the **growth of bacteria in pipes and membranes in water systems**.

Researchers are attempting to modify **buckyballs to fit the section of the HIV molecule that binds to proteins**, possibly inhibiting the spread of the virus.

Making bullet proof vests with **inorganic (tungsten disulfide) buckyballs**.

## 2. Conclusion

Nanotechnology is already having an impact in many spheres of chemical and materials science. It would seem that only our imagination will limit the widespread application of nanotechnology.

## References

[1] Buzea, Cristina; Pacheco, Ivan; Robbie, Kevin (2007). "Nanomaterials and Nanoparticles: Sources and Toxicity". Biointerphases. **2** (4): MR17–MR71. doi:10.1116/1.2815690. PMID 20419892.
[2] Hubler, A.; Osuagwu, O. (2010). "Digital quantum batteries: Energy and information storage in nanovacuum tube arrays". Complexity: NA. doi:10.1002/cplx.20306.
[3] Eldridge, T. (8 January 2014). "Achieving industry integration with nanomaterials through financial markets". Nanotechnology_Now.
[4] McGovern, C. (2010). "Commoditization of nanomaterials". Nanotechnol. Perceptions. **6** (3): 155–178. doi:10.4024/N15GO10A.ntp.06.03.
[5] Boverhof, Darrell R.; Bramante, Christina M.; Butala, John H.; Clancy, Shaun F.; Lafranconi, Mark; West, Jay; Gordon, Steve C. (2015). "Comparative assessment of

nanomaterial definitions and safety evaluation considerations". Regulatory Toxicology and Pharmacology. **73** (1): 137–150. doi:10.1016/j.yrtph.2015.06.001. PMID 26111608.

[6] "ISO/TS 80004-1:2015 - Nanotechnologies — Vocabulary — Part 1: Core terms". International Organization for Standardization. 2015. Retrieved 2018-01-08.