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FUTURE OF NANOMATERIALS

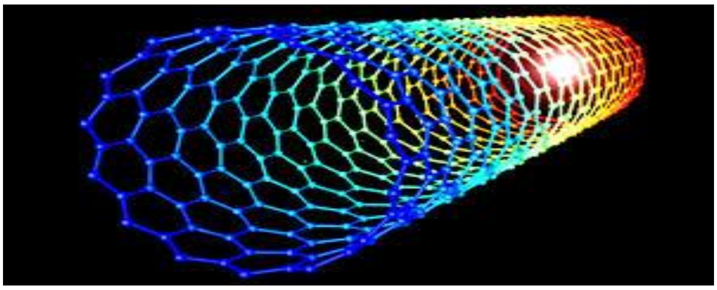
[1]Mohit Randive,[2]Ameya Mandaokar,[3] Ujjwal Nimbalkar, [4]Meghesh Balpande
[1]Scholar,[2]Scholar, [3]Scholar, [4]Scholar
[1]Department of Mechanical Engineering,
[1]S.B. Jain Institute of Technology, Management & Research, Nagpur, India

Abstract: Nanotechnology is usually described as an emerging technology—one that not only holds promise for society, but is also capable of revolutionizing our approaches to common problems. Nanotechnology isn't a totally new field; however, it's only recently that discoveries during this field have advanced thus far on warrant examination of their impact upon the world around us. Nanoparticles fall under three major groups: natural, incidental, and engineered, noted Vicki Colvin, Rice University. Naturally occurring nanomaterials like volcanic ash, ocean spray, magneto tactic bacteria, mineral composites et al. exist in our surroundings. Incidental nanoparticles, also referred to as waste particles, are produced as a result of some industrial processes. The third category of nanoparticles is engineered nanoparticles—these are the particles related to nanotechnology. Engineered nanoparticles are sub-classified by the type of basic material and/or use: metals, semiconductors, metal oxides, nano clays, nanotubules, and quantum dots. Within each category the shapes, sizes, and surface coatings further determine structure and performance of those molecules. Each such material has been specifically designed for function, Nanotechnology has direct beneficial applications for medicine and the environment, but like all technologies it may have unintended effects that can adversely impact the environment, both within the physical body and within the natural ecosystem. While taking advantage of this new technology for health, environmental, and sustainability benefits, science must examine the environmental and health implications.

Index Terms–Purification, treatment, military, medicine, safety.

Introduction

Nanomaterial is defined as a "material with any external dimension within the nanoscale or having internal structure or surface structure within the nanoscale", with nanoscale defined because the "length range approximately from 1 nm to 100 nm". This includes both nano-objects, which are discrete pieces of fabric and nanostructured materials, which have internal or surface structure on the nanoscale; a nanomaterial could also be a member of both these categories.



(fig – 1: carbon nanotube)

1. Nanoparticles

Nanoparticles have all three dimensions on the nanoscale. Nanoparticles also can be embedded during a bulk solid to make a nanocomposite.

1.1. One-dimensional nanostructures

The smallest possible crystalline wires with a cross-section as small as one atom are often engineered in cylindrical confinement. Carbon nanotubes, a natural semi-1-D nanostructure, are often used as a template for synthesis. Confinement provides mechanical stabilization and prevents linear atomic chains from disintegration; other structures of 1-D nanowires are predicted to be mechanically stable even upon isolation from the templates.

1.2. Two-dimensional nanostructures

2D materials are crystalline materials consisting of a two-dimensional single layer of atoms. Box-shaped graphene (BSG) nanostructure is an example of 3D nanomaterial. BSG nanostructure has appeared after mechanical cleavage of pyrolytic graphite. This nanostructure may be a multilayer system of parallel hollow nanochannels located along the surface and having quadrangular cross-section. The thickness of the channel walls is approximately adequate to 1 nm. the standard width of channel facets makes about 25 nm. Thin films with nanoscale thickness are considered nanostructures but are sometimes not considered nanomaterials because they are doing not exist separately from the substrate.

1.3. Bulk nanostructures:

Some bulk materials contain features on the nanoscale, including nanocomposites, nanocrystalline materials, nanostructured films, and nanotextured surfaces.

2. Advantages of Nanomaterials

1. With nanomaterials, we can create unique materials and products which are stronger, lighter, cheaper, durable, precise.
2. Less pollution.
3. Mass production in food and consumables.
4. Manufacturing at very low cost or no cost.
5. Automatic pollution clears up.

3. Disadvantages of Nanomaterials

1. Nano pollution is created by toxic waste.
2. Atomic weapons could be more accessible and destructive.
3. Health and safety issue: nanoparticle can cause serious illness or damage to the human body carbon nanotubes could cause infection to the lungs.
4. The recycling and disposal of nanotubes are difficult.
5. Loss of jobs in manufacturing and farming etc.
6. Mass production in food and consumable oil and diamonds could become worthless.

4.Applications of Nanomaterials

1. Nanomaterials in electronics
   - In electrical circuits, as an electrical cable wire, as a paper battery, in display technologies, in the solar cells.
2. Nanomaterials in the environment
   - In hydrogen storage.
   - In catalysis.
3. Nanomaterials in medical
   - Nanoscale devices can be employed for drug delivery.
   - Nanoparticles can be used to deliver drugs in a targeted fashion to specific cells in the body.

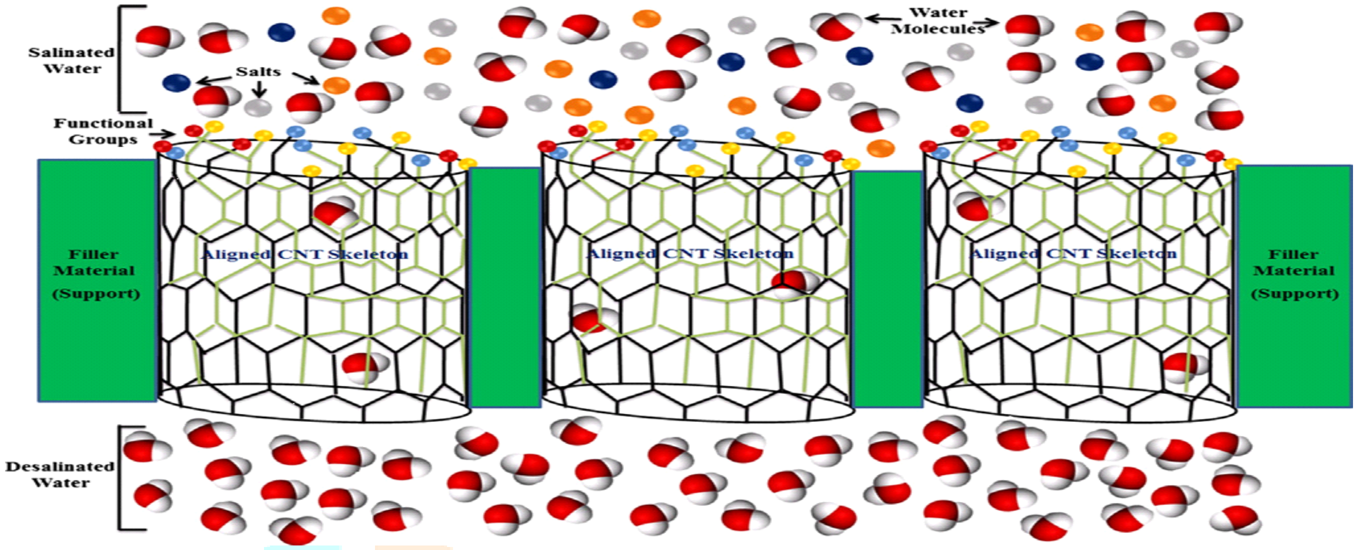
5.Advance Applications

I. Carbon Nanotube Membrane for Water Purification: A Bright Future in Water Desalination

To address the undeniable need of pure water, various water treatment technologies like reverse osmosis (OS), ultrafiltration (UF), electrolysis and electrolysis, etc., are not capable of fixing pollutants in an effective way. So, with respect to this membrane technology has got some attention because of their interesting inherent features. Membranes technology has given immeasurable facilities to purify water. Other than that RO, NF, UF are pressure-driven membrane processes they need high input pressure and consequent energy which make them costlier and they also emit greenhouse gasses.

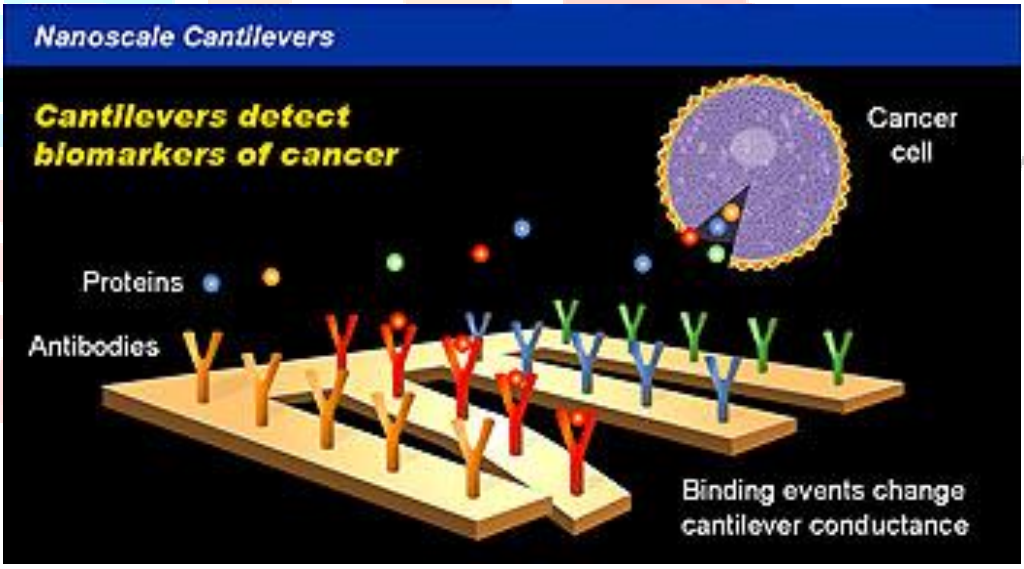
Now, in the carbon nano-tube membrane purification process we use (CNT) Membranes which has very tiny pores that allow only water molecules to pass through it and the pollutant and salt molecules are left behind.

Generally, the CNT membrane is of thickness 2-6 micrometers and pores are of diameter (0.1-2) micrometer. Although (RO), (UF), etc. also purification and desalination process CNT –membrane could be used at all levels from the point of generation to the point of use treatment. Generally, microorganisms foul the membrane but in the case of CNT, there is no such thing. Generally, CNT ruptures the bacterial cells through the production of reactive oxygen species. We can say that this process has brought a new revolution in membrane technology.



(fig – 2: carbon nanotube water purification process)

II. Nanotechnology and Cancer Treatment



(fig – 3: carbon nanotube drug treatment)

Cancer is caused by damage to genes that control the expansion and division of the cell. Generally, we use the traditional process for the detection of cancer like x-rays and CT-scan but this process isn't very sensitive and detection is merely possible only after the expansion of cancerous cells. But some research proves that in nanotechnology methods, certain NP are often designed to soak up certain wavelengths of radiation and if they enter the cancerous cell, they're going to burn them.

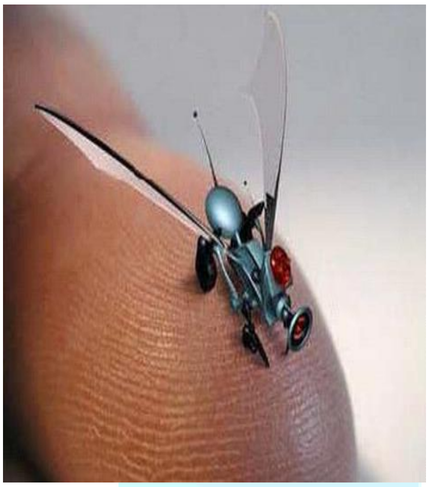
Nano-particle also can be wont to detect cancers as their sizes are in nm. There are some tools of nanotechnology having applications in cancer detection: Cantilevers, Nano-tubes. But there's some more threat in using in cancer treatment as a number of them are toxic, but further research goes on to resolve its issue of toxicity.

In a report of the seminar in 2004Nanoscience and nanotechnologies Opportunities and Uncertainties, the United Kingdom's Royal Society recommended that nanomaterials be regulated as new chemicals. Research laboratories and factories should treat nanomaterials "as if they were hazardous ". That release of nanomaterials into the environment be avoided as far as possible, which products containing nanomaterials be subject to new safety testing requirements before their commercial release. Yet regulations worldwide still fail to differentiate between materials in their nanoscale and bulk form. this suggests that nanomaterials remain effectively unregulated. there's no regulatory requirement for nanomaterials to face new health and safety testing or environmental impact assessment before their use in commercial products if these materials have already been approved in bulk form.

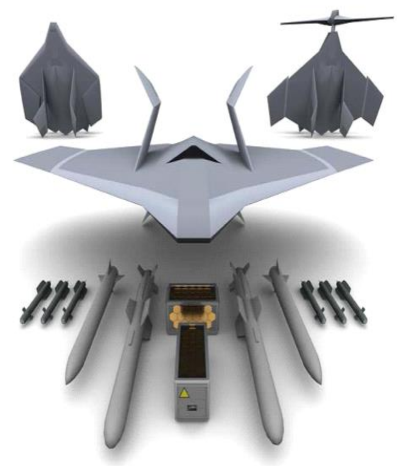
III. Military Nanotechnology

At present every country is working on modifying its weapon and military power in which nanotechnology is playing a vital role. They are working on compaction their weapon and make them stronger by using nano-materials. Some of their application are -In the research field: -

1. Nano sensor (having weight less than 10 gram): - For monitoring the enemy.
2. Nano-poison: -This is the special type of poison which do not kill people but it has an ability to trigger someone brain function. Example: - A lair poison will make someone for revealing the truth others and also, an alcoholic poison will make a person unable to stop drinking.
3. In UCAV (Un-Manned Combat Aerials Vehicle): -These vehicles are compact and weight. Generally, nanotechnology enables weapons are too small and more destructive as compared to conventional weapons.These pilotless UCAV can be deployed in hostile terrain and adverse weather when fighter flying is not possible.



(fig – 4: NAV)

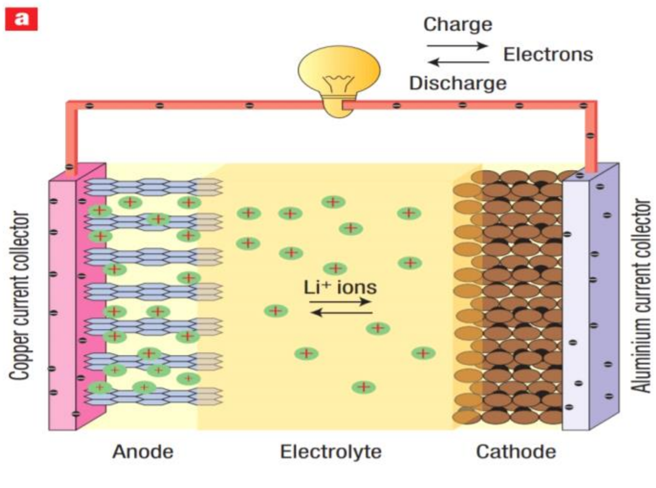


(fig – 5: UCAV)

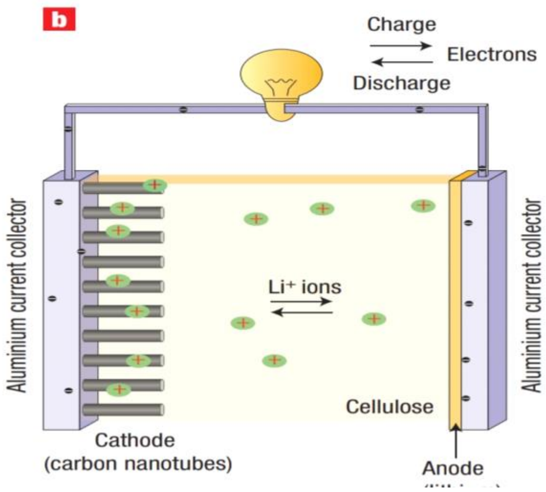
IV. Paper Power Battery

A battery is usually made from a negative electrode (anode) and a positive electrode (cathode). it's wont to power the varied devices Where Lithium ions batteries are the foremost successful commercial batteries. These batteries are wont to laptops, phones, etc. but they're expensive and explorable. So, writing within the proceeding of the National Academy Science USA, Pulikel Ajayan and associates at Rensselaer polytechnic describe the fabrication of a paper-thin and versatile energy memory device which we call paper power battery.

The devices (paper battery) are made by a growing a consistent film of vertical carbon nano-tubes on a silicon substrate and impregnating them with cellulose to make a nano-composite paper where cellulose is partially dissolved in an ionic liquid which acts as an electrolyte then it's solidified to offer paper accumulator. Generally, these batteries which ultimately make the devices more compact. Nevertheless, this latest work may be a significant advance within the field of battery technology.



(fig. 9 conventional lithium ion battery)



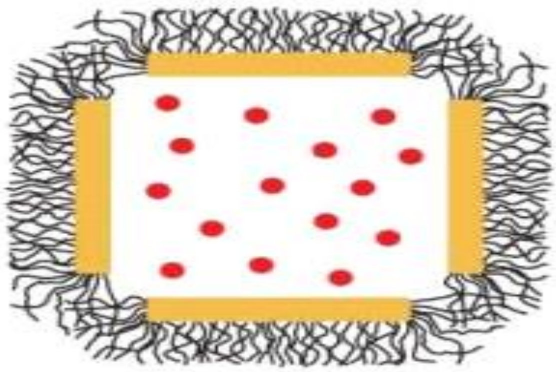
(fig. 10 lithium ion paper battery)

V. Nano-Materials in Drug Delivery

Nanomaterials have a size range below 100 nm and that they also exhibit properties like mechanical, chemical, and biological, thanks to this property they need many applications. As they need chemical resistance, so recently they're being researched on using them as a medium of drug delivery inside the body. Generally, they need the power to guard drugs against degradation within the alimentary canal. This technology also enables the delivery of medicine that's poorly soluble. Nanomaterials have a special ability that they release the drug on top of things manner resulting in fewer side-effects. Moreover, we will say that scientists were looking medium of transferring medicines such as the drug gives an equivalent benefit or relief during a smaller dose.

In simple terms, a nanometer is one-billionth of a meter and therefore the properties of materials at this atomic or subatomic level differ significantly from properties of equivalent materials at larger sizes. Although, the initial properties of nanomaterials studied were for its physical, mechanical, electrical, magnetic, chemical, and biological applications, recently, attention has been geared towards its pharmaceutical application, especially within the area of drug delivery. this is often due to the challenges with the utilization of huge size materials in drug delivery, a number of which include poor bioavailability, in vivo stability, solubility, and intestinal absorption sustained and targeted delivery to the location of the action, therapeutic effectiveness, generalized side effects, and plasma fluctuations of medicine. Of recent, several sorts of research in nano-drug delivery are designed to beat these challenges through the event and fabrication of nanostructures.

It has been reported that nanostructures have the power to guard drugs against the degradation within the alimentary canal, the technology can allow target delivery of medicine to varied areas of the body. The technology enables the delivery of medicine that are poorly water-soluble and may provide means of bypassing the liver, thereby preventing the first-pass metabolism Nanotechnology increases the oral bioavailability of medicine thanks to their specialized uptake mechanisms like absorptive endocytosis and are ready to remain within the blood circulation for an extended time, releasing the incorporated drug during a controlled fashion, resulting in fewer plasma fluctuations and minimized side-effects.



(fig. 11 gold nano cage covered with polymers)

VI. Nanotechnology Safety in Automobile Industry

Automotive industry is the one of the most major industry using nanotechnology. Nanomaterials can also be used in car Fluids as it will ultimately

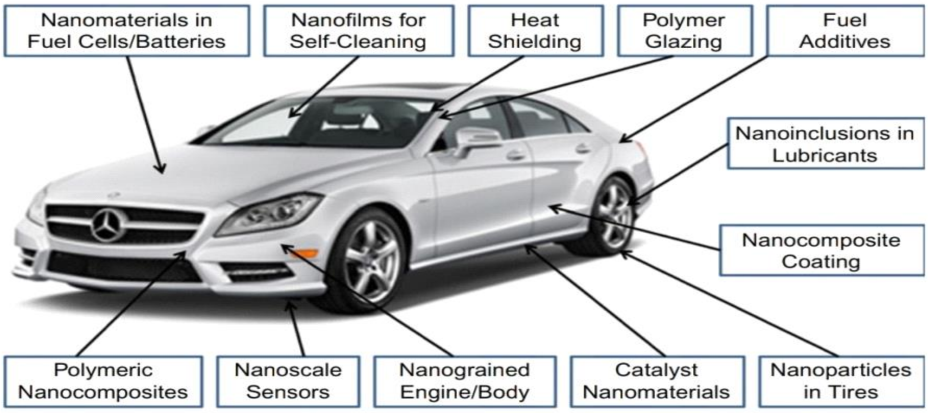
- Increase the Life of engine by 100%.
- Reduce the friction by 70%.
- Lower the consumption of fuel.
- Reducing the oil consumption caused by high temperature and friction.

As some Nanomaterials are toxic so more effort and time need to be spent on nanotechnology products utilized in the automotive industry.

The following is a list of these nanotechnology applications relating to the automotive industry

- Functional coating and lubrication. Self-cleaning, scratch and wear resistance, UV prevention, anticorrosion and antifogging, and oil additives.
- Nanostructured materials/nanocomposites/nanoparticles. Lightweight structure, thermal protection, high strength, greater hardness, increased electrical conductivity, less air release from tires (blockage by nano clay and graphene nanoflakes), noise reduction, and longer vehicle and parts duration.
- Nanotechnology-based energy generation and storage. Fuel cells, solar cells, catalysts, and batteries.
- Data processing and communication. Image processing, vehicle location, and vehicle telematics.
- Sensing and electronics. Motion sensors, airbag sensors, pressure monitoring, atmospheric control, and security control.

- Nano dispersed fluids and lubricants. Vibration damping (heat dissipation) and reduced friction and erosion in the engine and gear systems.



(fig. 12 some nano material and nano devices use to improve the performance of an automobile)

6. DISCUSSION

These materials have created a high interest in recent years by virtue of their unusual mechanical, electrical, optical and magnetic properties. Some examples are given below:

Nanophase ceramics are of particular interest because they're more ductile at elevated temperatures as compared to the coarse-grained ceramics. Nanostructured semiconductors are known to point out various non-linear optical properties. Semiconductor Q-particles also show quantum confinement effects which can cause special properties, just like the luminescence in silicon powders and silicon germanium quantum dots as infrared optoelectronic devices. Nanostructured semiconductors are used as window layers in solar cells. Nanosized metallic powders are used for the assembly of gas tight materials, dense parts and porous coatings. Cold welding properties combined with the ductility make them suitable for metal-metal bonding especially within the electronic industry.

Single nanosized magnetic particles are mono-domains and one expect that also in magnetic nanophase materials the grains correspond with domains, while boundaries the contrary to disordered walls. Very small particles have special atomic structures with discrete electronic states, which produce to special properties additionally to the superparamagnetic behavior.

Magnetic nanocomposites are used for mechanical force transfer (ferrofluids), for high-density information storage, and magnetic refrigeration. Nanostructured metal clusters and colloids of mono- or plus metallic composition have a special impact on catalytic applications. they'll function precursors for a replacement sort of heterogeneous catalysts (Cortex-catalysts) and are shown to supply substantial advantages concerning activity, selectivity, and lifelong in chemical transformations and electrocatalysis (fuel cell) Enantioselective catalysis was also achieved using chiral modifiers on the surface of nanoscale metal particles.

Nanostructured metal-oxide thin films are receiving growing attention for the belief of gas sensors (NOx, CO, CO2, CH4, and aromatic hydrocarbons) with enhanced sensitivity and selectivity. Nanostructured metal-oxide (MnO2) finds application for rechargeable batteries for cars or commodity. Nanocrystalline silicon films for highly transparent contacts in thin-film photovoltaic cell and nanostructured titanium dioxide porous films for its high transmission and significant area enhancement resulting in strong absorption in dye-sensitized solar cells. Polymer-based composites with a high content of inorganic particles resulting in a high dielectric constant are interesting materials for photonic bandgap structure.

7. CONCLUSION

I would wish to say that Nanotechnology may be a fresh technology that has just begun, it's a revolutionary science that will change all that we knew before. the longer term that we were watching just in fantasy movies will in the near future be real. This new technology will, first of all, keep us healthy due to nanorobots which will repair every damage that we've in our bodies. Secondly, it'll give scientists the power to control the mixture of atoms in an object and to show it into a lighter, stronger, and more durable object than before, just by using carbon nanotubes that are known to be 100 times stronger than steel and additionally thereto they're very flexible. Nanotechnology will give us abundant energy because it'll transform energy more effectively, for instance, windmills which are known to possess the power to rework wind energy into electricity, well new windmills which will use Nanotechnology will have lighter and stronger blades (using carbon nanotubes) which will transform tons more energy than before. So, in this way, nanotechnology will change our present future.

8. FUTURE SCOPE

Nanomaterials will bring benefits throughout society and its activities and this provides a sign of where nanotechnology will take us:

1. **Nanobots**: Fantasy and comic books say you'll build nanobots to cure deadly diseases. Sure, these robots are still an extended way away, but they're being built up one component at a time.
2. **Nano-sensors**: The reason why nanoscience is so fascinating is that materials behave differently once you scale right down to the nanoscale. as an example, a cloth you've got could be diamagnetic (non-magnetic) in its bulk form, but the instant you create nanoparticles of an equivalent material, they become paramagnetic. These properties help design effective and efficient sensors for gas leakage, nuclear radiation, fault/fissure detection, mechanical stress detection, seismographs, etc.
3. **Hydrophobic Materials**: Hydrophobic materials repel water, almost like lotus leaves or duck feathers. These hydrophobic materials when coated on window panes, solar panels, etc. because water drops to bounce off its surface, helping within the effective trapping of sunlight. This improves the general performance of the solar array or photochromatic windows. Chemical and physics methods like etching, laser patterning, etc. are used lately to return up with better hydrophobic surfaces.
4. **Cancer Research**: Gold nanoparticles are often used as "sniffers" for the detection of cancer and other diseases. As cancerous cells grow, genes and proteins within cells change and end in the discharge of volatile organic compounds that will be detected. Nanoparticles can smell (detect) these markers even in tiny concentrations. Researchers a couple of years ago reported new gold nanoparticle sensors which will tell not only whether an individual has cancer, but which kind--lung, breast, and prostate or carcinoma.
5. **Genetic Therapy and Medicine**: Every other day, scientists announce a replacement breakthrough within the ability of nanoparticles to deliver genes, drugs, or chemical messengers inside cells. Nanoparticles of various shapes and chemical makeup can hunt and target specific cells of a chemist's choosing, and perform a spread of tasks. This image depicts DNA molecules (light green), packaged into nanoparticles by employing a polymer with two different segments. One segment is charged, which binds the polymer to the DNA.
6. **Nanomaterials in Food and Agriculture:**The effects of nanotechnology in the agriculture sector have a lot to be understood and desired. At times, discoveries even get controversial, and religious communities label such research as messing with the hands of God. Hand of God or not, nanoparticles could be used as a pesticide or as a fertilizer, but there are showing that nanomaterials in agriculture can be dangerous, and even border on being fatal. In an article published by the Proceedings of the National Academy of Sciences, scientists report zinc oxide, a common wide bandgap semiconducting metal oxide, used commonly in cosmetics and electronics, can accumulate in plant tissues and prevent proper nitrogen fixation, photosynthesis, etc. resulting in massive damage to crops.

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