# Nanotechnology Research Practices and Future Trends

by IMRAN KHAN

Since 1991, with the accidental discovery of Carbon Nano Tubes (CNT), the technology era entered into a unique phase. Although, the term "Nanotechnology" itself a fascinating word but a lot of complications associated with it. For a common reader, the study concerning the scale of measurement using different materials in the range 10-9m, is nanometric or nanotechnology. Unique properties were reported with Materials at nanometric scale which off course became a source of motivation to investigate materials at nanometric scale. In nanotechnology, nanoparticles are the core elements playing vital role with certain unique properties. These features not only include electrical, mechanical, optical but somehow biological. I am not going to discuss the more technical things but a bird's eye view or the face of Nanotechnology to give an insight to a general reader to understand the impact of Nanotechnology in our daily life. For certain people, nanotechnology is not of much interest but going through different applications and impact on current technology and overcoming the different limitations, challenges and enhancing or boosting the industrial sector will be a source of interest. The technology (Nano) equally affected almost all the fields, although the full impact of nanotechnology is not fully understood and still in progress.

Enhancement in different physical properties using Nanoparticles is now a days an innovative way for product quality. The market capturing capabilities is also an indication of the importance of nanotech industry. The global budget for nanotechnology is continuously increasing with the application of nanoparticles. The production of cosmetics, food, paints, powders, electronics, drug delivery, disease control and the treatment of surfaces used the largest quantities of these nanoparticles addressing different challenges in traditional technology. To elaborate this argument, I shall give a few examples currently in use on an industrial scale as well as ongoing research to address different challenges in our lives. Food Packaging industry is using approximately 10% nanoparticles. Smart packaging and use of preservative was an obstacle for traditional food packaging industry. The application of nanoparticles yield a product with an Improved , Active, Intelligent, Smart Packaging with quality of food and reduction in cost due to absence of preservatives. Cosmetics, which is on top with 60% usage of nanoparticles and it covers Personal health care. The main product is effective inorganic sunscreens and beauty creams.


Paints and Coatings industry, with the inclusion of nanoparticles, are covering almost 10%, mainly Automotive and Construction. The biggest issue in paints industry is Surface finishing i.e problem occurred due to corrosion and scratch (a big hurdle for traditional lubricant/ varnish industry) and improvement of UV light resistance. All these challenges are main concern when using nanoparticles. Electrical and Electronics industry is also covering 10% usage of nanoparticles as a whole. As compare to traditional technologies, Nanotech has a pledge over high performance and smaller components, e,g, capacitors for small consumer devices such as mobile phones, displays that are cheaper, larger, more brighter, and more efficient and high efficacy solar panels. Semiconductor nanoparticles are being applied to manufacture of low cost solar cells. Flexible electronics gets a boost using nanoparticles which not only increases electrical and thermal conductivity many folds but mechanically stronger parts. Researchers made a transistor which works similar like synapses in the nervous system and named it as NOMFET (Nanoparticle Organic Memory

Field-Effect Transistor). They got it using gold nanoparticles with organic molecules. Researchers have demonstrated that sunlight, concentrated on nanoparticles, can produce steam with high energy efficiency. The "solar steam device" system is intended to be used in areas of developing countries without electricity for applications such as purifying water or disinfecting dental instruments. A lead free solder comprised of copper nanoparticles, reliable enough for space missions and other high stress environments. Silicon nanoparticles coating anodes of lithium-ion batteries can increase battery power and reduce recharge time. A layer of closely spaced palladium nanoparticles is being used in a hydrogen sensor. When hydrogen is absorbed, the palladium nanoparticles swell, causing shorts between nanoparticles.

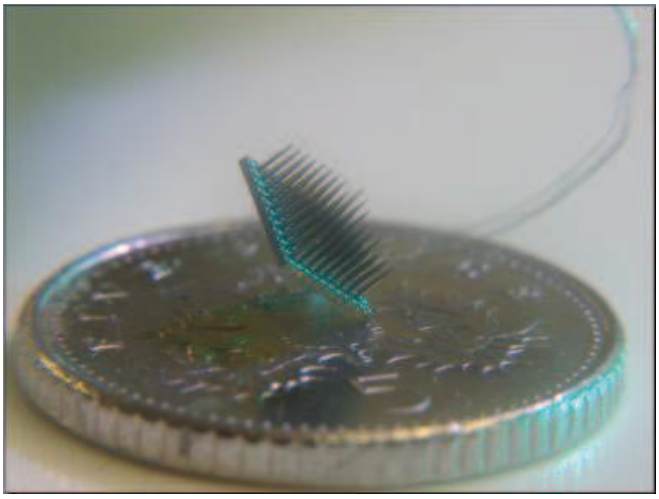
These shorts lower the resistance of the palladium layer. Researchers have used nanoparticles called nanotetrapods studded with nanoparticles of carbon to develop low cost electrodes for fuel cells. This electrode may be able to replace the expensive platinum needed for fuel cell catalysts. A catalyst using platinum-cobalt nanoparticles is being developed for fuel cells that produce twelve times more catalytic activity than pure platinum. In order to achieve this performance, researchers anneal nanoparticles to form them into a crystalline lattice, reducing the spacing between platinum atoms on the surface and increasing their reactivity.


Magnetic nanoparticles have tendency to Increase density storage media many folds.Hydrogen storage applications using metal Nano-clusters, Renewable energy, Catalysts for combustion engines to improve efficiency, hence economy are few more examples.


Researchers at MIT found nanoparticles with an ability not only to deliver vaccine but to protect it from surrounding. In a new research, developed “nanodiamonds” using carbon nanoparticles for medical applications, For example nanodiamonds with protein molecules attached can be used to increase bone growth around dental or joint implants. Researchers have demonstrated a way to use nanoparticles for early diagnosis of infectious disease. The nanoparticles attach to molecules in the blood stream indicating the start of an infection. Researchers have developed two types of nanobubbles, which form around gold nanoparticles. When the nanobubble formed around a hollow nanoparticle is heated with a laser the nanobubble can destroy cancer cells. However when a nanobubble formed around a solid nanoparticle is heated with a laser the nanobubble opens a temporary hole in a cell wall and allows drugs to be injected. The researchers are planning this method to selectively destroy certain types of cells, and modify others. Researchers are investigating the use of bismuth nanoparticles to concentrate radiation used in radiation therapy to treat cancer tumors. Initial results indicate that the bismuth nanoparticles would increase the radiation dose to the tumor by 90 percent. The revolutionary nanoparticles have tendency to early diagnose Cancer cells. Researchers developed a nanoparticle intended to make very early detection of cancer tumors easier. When such type of nanoparticles attach to a cancer tumor, the nanoparticles release "biomarkers", molecules called peptides. The idea is that since each nanoparticle carries several peptides a high concentration of these biomarkers will occur even at very early stages of cancer, allowing early detection of the disease. A method being developed to fight skin cancer uses gold nanoparticles to which RNA molecules are attached. The nanoparticles are contained in an ointment that is applied to the skin.

The nanoparticles penetrate the skin and the RNA molecules attach to a cancer related gene. This method

stops the gene from generating proteins that are involved in the growth of skin cancer tumors. Magnetic nanoparticles can attach to cancer cells in the blood stream. These nanoparticles may allow doctors to remove cancer cells before they can establish new tumors. Iron oxide nanoparticles can be used to improve Magnetic Resonance Imaging (MRI) of cancer tumors. The nanoparticle is coated with a peptide that binds to a cancer tumor. Once the nanoparticles are attached to the tumor, the magnetic property of the iron oxide enhances the images from the MRI scan. A method for early detection of a disease uses nanoparticles that form clumps when they attach to proteins or other molecules that indicate the disease being tested for. The test is designed to be inexpensive and simple to perform. The solution turns blue if the nanoparticles are clumped around a protein indicating the disease; if the protein is not present the solution turns red.



Researchers have found that aluminosilicate nanoparticles can reduce bleeding in trauma patients who have external wounds by activating the blood clotting mechanism, causing blood in a wound to clot more quickly. Z-Medica is producing medical gauze that uses aluminosilicate nanoparticles for use on external wounds. For trauma patients with internal bleeding, another approach to reducing blood loss is required. Researchers at Chase Western Reserve University are developing polymer nanoparticles that act as synthetic platelets. Lab tests have shown that injecting these synthetic platelets significantly reduces blood loss. Nanoparticles composed of polyethylene glycol-hydrophilic carbon clusters (PEG-HCC) have been shown to absorb free radicals at a much higher rate than the proteins in our bodies can. This method may reduce the harm that is caused by the release of free radicals after a trauma such as a brain injury. Nanoparticles, when activated by x-rays, generate electrons that cause the destruction of cancer cells to which they are attached. This method is intended to be used in place of radiation therapy which can cause much greater damage to healthy tissue. Nanoparticles coated with proteins can attach to damaged portions of arteries. This method could allow delivery of drugs to damaged regions of arteries to fight cardiovascular disease.

I am going to end this admiration for nanotechnology with the more recent application of nanotech i.e the merger of Nanotechnology and Additive Manufacturing technology. The idea is to use nanoparticles into different host materials commonly employed in different additive manufacturing techniques for example stereo lithography, selective laser sintering and 3-D printing to get functional parts with certain specific functionalities. The merger of two technologies is just emerging and applications ranging from biomedical science to aeronautics, sportswear and electronics etc. But with all this, indeed there is still a gap to fully understand and elaborate the effects of nanotechnology and still needs attention to work out the full potential of nanotech. All these applications are encouraging and proving the impact of nanotechnology. A more comprehensives research is required, ranging from academic to industrial scale, to combat different challenges in our daily life.

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