



# Applications of Nanomaterials in Environmental science and medicine

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## Abstract

Nanomaterials are at the leading edge of the speedily emerging field of nanotechnology. Their exclusive size-dependent possessions make these materials superior and essential in many spaces of human activity. This brief assessment efforts to summarise the most recent developments in the field of applied Nanomaterials, in individual their application in environmental science and medicine, and deliberates their commercialisation predictions.

**Key words;** nanoparticles, Nanomaterials, environment, Nano medicine, catalysis , cancer therapy , biomolecules, environmental science

## Introduction

Nanotechnology is enabling technology that deals with nano-meter sized substances. It is projected that nanotechnology will be established at several levels: materials, devices and systems. The Nanomaterials level is the most innovative at present, both in scientific knowledge and in commercial applications. A decade ago, nanoparticles were deliberate because of their size-dependent physical and chemical properties Now they have entered a commercial exploration period .

Out of plethora of size-dependant physical properties available to someone who is interested in the practical side of Nanomaterials, optical and magnetic effects are the most used for biological applications.

The aim of this review is firstly to give reader a significant prospective of nanomaterial application to environmental science and medicine, secondly to try to overview the most recent progresses in this field, and finally to discuss the hard road to commercialisation. Hybrid bio Nanomaterials can also be applied to build novel electronic, optoelectronics and memory devices (see for example, Nevertheless, this will not be discussed here and will be a subject of a separate article.

Generally, Nanomaterials are currently classified as

- (i) metal-based ,
- (ii) carbonbased
- (iii) dendrimers, and
- (iv) Composites. Generally, carbon-based Nanomaterials contain carbon, and are found in morphologies such as hollow tubes, spheres ellipsoids. Metal-based Nanomaterials are metal based materials that we commonly regarded as, nano silver, nano gold and oxide dramatic dots, s with metal bases. Titanium dioxide is one such example. They are a focus of the pharmaceutical and biomedical industries.

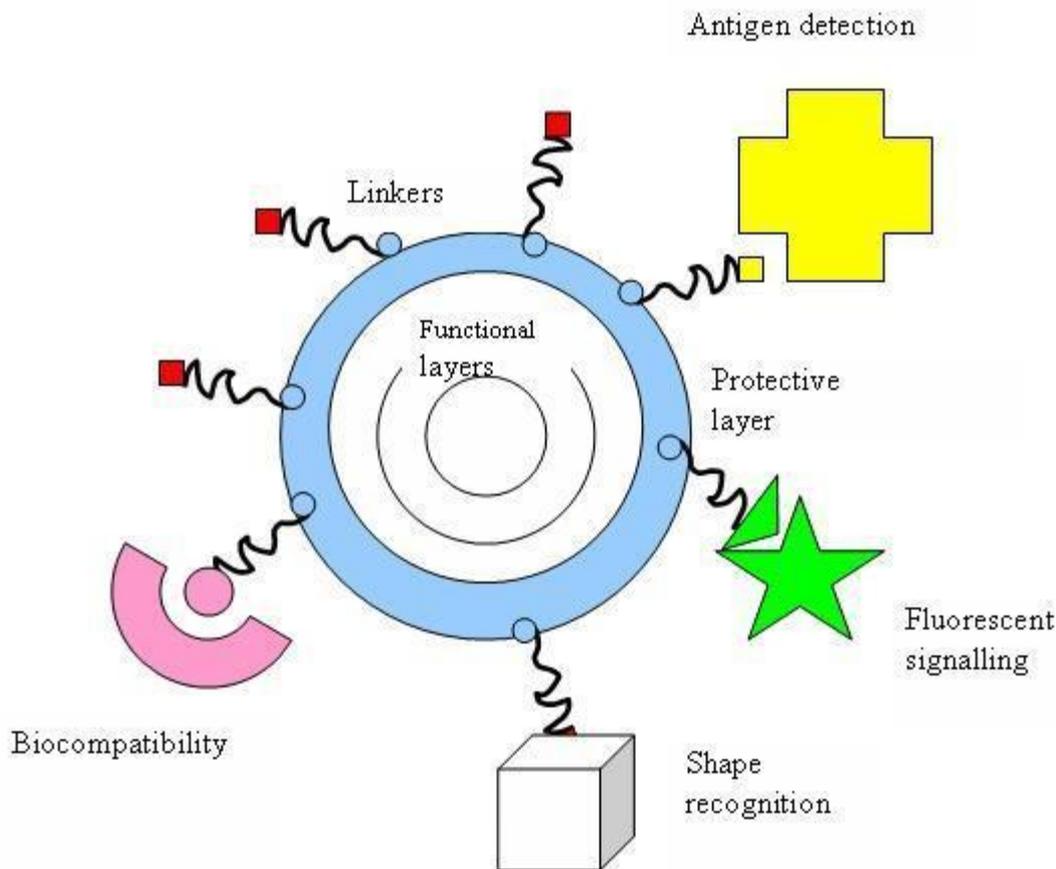
## **NANOPARTICLES AND NANOMATERIALS**

Composites are combination of nanoparticles or nanoparticles and other materials. Nanoparticles, such as nano sized clays, are already being added to yields ranging from auto parts to packaging materials, to enhance mechanical, thermal, barrier, and flame-retardant properties. Although Ag, zinc oxide, copper oxide , cerium dioxide , titanium dioxide , iron oxide , fullerenes, carbon nanotubes , and a small number of others remain the most widely used and researched Nanomaterials , some newer Nanomaterials have been produced in recent years. The greatest interest and development has been in broad classes of materials including nano composites and nano hybrids.

Nano composites are Nanomaterials enclosed or encapsulated with other materials, which may not have nano scale features, whereas nano hybrids are the linking of 2 or more discrete NMs to give different functionality . Such NMs can be based on semiconductor substrates such as GaAs, CdSe, CdS, SiGe, and others, modified with shells and coatings, along with mixtures of carbon-carbon and carbon-metal or metal oxides

### **Applications**

- Fluorescent natural labels Drug and gene conveyance
- Bio recognition of pathogens Detection of proteins Probing of DNA structure Muscle engineering Tumour destruction via heating (hyperthermia)
- Separation and sanitisation of biological fragments and compartments
- MRI distinction enhancement



configurations utilised in nano-bio materials applied to medical or biological problems.

### Tissue work

Natural bone external is quite often contains features that are about 100 nm across. If the surface of an artificial bone implant were left smooth, the body would try to reject it. Because of that smooth surface is likely to cause production of a fibrous tissue covering the surface of the implant. This layer reduces the bone-implant contact, which may result in loosening of the implant and additional tenderness. It was established that by creating nano-sized features on the external of the hip or knee prosthesis one could reduce the chances of denial as well as to stimulate the making of osteoblasts. The osteoblasts are the cells responsible for the growth of the bone matrix and are found on the advancing surface of the developing bone.

The effect was demonstrated with polymeric, ceramic and, more recently, metal materials. More than 90% of the human bone cells from disruption adhered to the nanostructured metal surface, but only 50% in the control sample. In the end this findings would allow to design a more durable and longer lasting hip or knee replacements and to reduce the chances of the implant getting loose.

Titanium is a well-known bone repairing material widely used in orthopaedics and dentistry. It has a high fracture resistance, ductility and weight to strength ratio. Unfortunately, it suffers from the lack of bioactivity, as it does not support sell adhesion and growth well. Apatite coatings are known to be bioactive and to bond to the bone. Hence, several techniques were used in the past to produce an apatite

coating on titanium. Those coatings suffer from thickness non-uniformity, poor adhesion and low mechanical strength. In addition, a stable porous structure is required to support the nutrients transport through the cell growth.

It was shown that using a biomimetic approach – a slow growth of nanostructured apatite film from the simulated body fluid – resulted in the formation of a strongly adherent, uniform nanoporous layer. The layer was found to be built of 60 nm crystallites, and possess a stable nanoporous structure and bioactivity.

A real bone is a nanocomposite material, composed of hydroxyapatite crystallites in the organic matrix, which is mainly self-possessed of collagen. Thanks to that, the bone is mechanically tough and, at the same time, plastic, so it can recover from a mechanical damage. The actual nanoscale mechanism leading to this useful combination of properties is still debated.

An artificial hybrid material was prepared from 15–18 nm ceramic nanoparticles and poly (methyl methacrylate) copolymer. Using tribology approach, a viscoelastic performance (healing) of the human teeth was established. An investigated hybrid material, deposited as a coating on the tooth surface, improved scratch resistance as well as possessed a healing behaviour similar to that of the tooth.

## Cancer therapy

Photodynamic cancer therapy is based on the destruction of the cancer cells by laser generated atomic oxygen, which is cytotoxic. A greater quantity of a special dye that is used to generate the atomic oxygen is taken in by the cancer cells when compared with a healthy tissue. Hence, only the cancer cells are destroyed then exposed to a laser radiation. Unfortunately, the remaining dye molecules migrate to the skin and the eyes and make the patient very sensitive to the daylight exposure. This effect can last for up to six weeks.

To avoid this side effect, the hydrophobic version of the dye molecule was enclosed inside a porous nanoparticle. The dye stayed trapped inside the Ormosil nanoparticle and did not spread to the other parts of the body. At the same time, its oxygen generating ability has not been affected and the pore size of about 1 nm freely allowed for the oxygen to diffuse out.

## NANOMATERIALS ON THE ENVIRONMENT

*The growing production and use of NMs in diverse industrial processes, construction, and medical and consumer products is resulting in increasing exposure of humans and the environment. Humans encounter Nanomaterials from many sources and exposure routes, including ingestion of food, direct dermal contact through consumer products and by inhalation of airborne Nanomaterials. The increasing use of Nanomaterials in our life or the customer productions has inevitably caused the accumulation exposure of the nanoparticles into the environment, yet the fate of these particles may greatly depend on their environmental mediums, physical or chemical property.*

*Positive Impacts on the Environment Engineered Nanomaterials exhausted into the atmospheric environment tend to be exposed to sunlight and UV wavelengths at significantly higher degrees than those released into other compartments . This exposure is likely to increase the possible outcomes of photochemical changes to Nanomaterials.*

*Nanotechnology based detection systems vary in their mechanisms and designs but they share the same goal, that is, timely and accurate detection of trace pathogens or other contaminants [26]. Nanotechnology is of great use in many fields, in particular in the agrofood industry, where is it used primarily in: primary production, food processing and packaging and food supplements*

*Nanofertilizers have beneficial effects over conventional ones. This is the case of the use of zinc oxide nanoparticles in Zn fertilizers to increase their solubility [62; 63]. De la Rosa et al. [64] found that by applying zinc oxide nanoparticles through the foliar spray, growth and biomass of alfalfa, tomato, and cucumber can be increased*

*The presence of NMs was also demonstrated to exert low to high toxicity impacts on aquatic life. According to the toxicological investigations, Nanomaterials may affect unicellular aquatic organisms and creatures (e.g., fish and Daphnia) . Several studies suggest that the toxicity of silver nanoparticles is attributed to their release of silver ions in cells as both silver nanoparticles and silver ions have been reported to have similar cytotoxicity.*

## **CONCLUSION**

The environment and on human beings. Accordingly, Nanomaterials can be compared as drugs because it is well known that they have both desired and undesirable effects. Until now, Nanomaterials have been explored for many different applications in diverse sectors including catalysis, sensing, photovoltaic, energy, environment, and biomedical. However, the level of Nanomaterials in the environment is consistently increasing.

The hazards of Nanomaterials to plants, animals and microbes have had an indirect effect on our humans. Increased attention needs to be directed towards the new Nanomaterials because the development of knowledge of these nanoparticles is still in its infancy. Since the shape, size and composition of nanoparticles can have both significant effects on their function and possible risks to human health, extensive research is needed to fully understand their synthesis, characterization, and possible toxicity.

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