A Review on Applications of Nanotechnology

Arunkumar A.N. S. Mudliar

Abstract— Nanotechnology can be defined as the manufacture and manipulation of extremely minute machines or systems derived from the study of functional systems. These devices are too small to the point of manipulating the atoms themselves to form materials. Nanotechnology applications to the agriculture medical and food sector are relatively recent compared with their use in drug delivery and pharmaceuticals. Better delivery of nutrients, bioseparation of proteins, rapid sampling of chemical contaminants and nanoencapsulation of nutraceuticals are some of the emerging topics of nanotechnology for food and agriculture. The MEMS technology allows the construction of items such as sensor chips with built-in electronics that are a fraction of the size that was previously not possible. Nanotechnology can enable sensors to detect very small amounts of chemical vapors. Various types of detecting substance, such as carbon nanotubes, zinc oxide nanowires or palladium nanoparticles can be used in nanotechnology-based sensors.

Index Terms— Agriculture, Application, Drug Delivary, Nanotechnology, MEMS, Sensor, Environment.

1 Introduction

THE ability to visualize Nano-sized materials has spread out a world of prospects in an exceedingly variety of fields and scientific endeavors. Because technology is actually a collection of techniques that permit manipulation of properties at a really tiny scale, it will have several applications, such as it is use in drug delivery, diagnostic techniques, chemical and biological sensor using nanotechnology, MEMS [5].

MEMS is the ability to make gears, mirrors, device components, in addition as electronic equipment in semiconducting material surfaces permits the manufacture of miniature sensors like those wont to activate the airbags in your automotive. The MEMS technique leads to shut integration of the mechanical mechanism with the mandatory electronic circuit on one single silicon chip, similar to the procedure used to produce computer chips. Using MEMS to produce devices decrease both the cost and size of the product. The potentials that nanotechnology offers in medicine have been a cause of excitement to many researchers. The detection and treatment of diseases and damage to human body might be revolutionized by the use of nanotechnology in medicine, and many techniques only imagined a few years before are making remarkable progress towards becoming realities Nanotechnology is having a powerful effect on several aspects of food science, from how food is grown to how it is pack. Companies are developing materials that will make a difference not only taste of food, but also in food safety. Nanotechnology is also being used in several applications to improve the environment which includes cleaning up existing pollution, creating new manufacturing techniques to reduce the generation of pollution, and making alternative energy sources more cost effective. This short paper aims to provide an outline on applications of nanotechnology.

2 Applications of Nanotechnology

2.1 Nanotechnology in Medicine

2.1.1 Drug Delivery

One application of nanotechnology in medicine presently being developed involves using nanoparticles involves employing nanoparticles to deliver drugs, heat, light or other elements to specific types of cells (such as cancer cells). Nanoparticles are engineered so that they are drawn to disease cells, which will allow direct treatment of those cells. This technique will not only decrease damage to healthy cells in the body but will enable earlier detection of disease. Another technique to treat cancer cells employs on delivering chemotherapy drugs to cancer cells and applying heat to the cells [2]. Gold nanorods are attached to DNA strands by researchers which act as a scaffold, holding together with the nanorod and the administered drug.When infrared light illuminates the cancer tumor the gold nanorod absorbs the infrared light, turning it into heat. The heat releases the chemotherapy drug and helps destroy the cancer cells [3].

2.1.2 Diagnostic Techniques

Researchers are developing a nanoparticle intended to make very early detection of cancer tumors easier. When the nanoparticles glue to a cancer tumors the nanoparticles release "biomarkers" molecules known as peptides. The idea is that since each nanoparticle carries several peptides as a result a high concentration of these biomarkers will occur even at initial stages of cancer, enabling early detection of the disease.

A test for early detection of kidney damage is being developed. The technique use nanorods functionalized to attach to the type of protein generated by damage kidneys.Tthe color of the nanorod shifts when proteins accumulate on the nanorods. The test is designed to be done fast and inexpensively for early detection of a problem [4].

2.1.3 Anti-Microbial Techniques

Staph infections can be fought by a nanoparticle cream which contains nitric oxide gas, known to kill bacteria. Studies on mice have shown that using the nanoparticle cream to release nitric oxide gas at the site of staph abscesses significantly reduced the infection [9].

Burn dressing that is coated with nanocapsules containing antibiotics will break open, if an infection is started by the harmful bacteria releasing the antibiotics. This allows much quicker treatment of an infection and reduces the number of times a dressing has to be changed [10].

2.2 Chemical and Biological Sensors Using Nanotechnology

Nanotechnology can enable sensors to detect very small amounts of chemical vapors. Detecting substance, like carbon nanotubes can be used in nanotechnology-based sensors which change their electrical characteristics, like resistance or capacitance, once they absorb a gas molecule. Because of the small size of nanotubes or nanoparticles, a few gas molecules are sufficient to vary the electrical characteristics of the sensing element being used. This allows the detection of very low concentration of chemical vapors. The goal is to have small, cheap sensors that can sniff out chemicals just as dogs are used in airports to smell the vapors given off by explosives or drugs.

The capability of manufacturing small, inexpensive sensors that can quickly identify a chemical vapor provides a kind of nano-bloodhound that doesn't need sleep or exercise which can be useful in a number of methods. An obvious application is to arrange these sensors throughout an airport, or any facilities with security purpose, to check for vapors given off by explosive devices.These sensors can also be helpful in industrial plants that use chemicals in manufacturing to discover the leakage of chemical vapors. When hydrogen fuel cells will be used in cars or other applications, a sensor that detects escaped hydrogen gas could be useful in warning of a leakage. This technology should also make possible cheap networks of air quality monitoring stations to improve the tracking of air pollution sources.

2.2.1 Carbon Nanotube Chemical Sensor

A single-walled carbon nanotube (SW-CNT) is a nano scale tube formed by a cylindrical shell of single atomic layer of carbon atoms. Nanotube have diameter of a few nm and length up to 100μm so that they form extremely thin wires. The atomic structure of SWCNT is fashioned by wrapping stripe of single atomic layer of graphite sheet along an explicit direction, and this direction determines the diameter and chirality of the nanotubes. Both experimental and theoretical studies have found that these nano-meter sized CNTs have electronic characteristics, which can be metallic or semiconducting in nature, depending on their radius or chiralities.

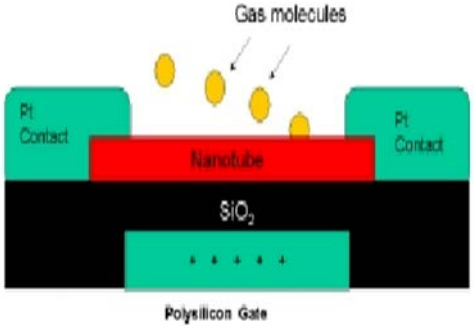

Fig. 1 Carbon Nanotube

Nanotubes can be used as electronic wires between two metal electrodes as shown in Fig.1, and the conductivity between the electrodes can be measured as a function of the gate bias voltage. Since the electronic property of nanotube is a strong function of its atomic structure, mechanical deformations or chemical doping can induce strong changes in conductance. Such changes can be easily detected by electron current signals, and these characteristics make CNTs extremely small sensors sensitive to their chemical and mechanical environments [1].

2.3 Micro Electomechanical System

MEMS techniques allow both electronic circuits and mechanical devices to be manufactured on a silicon chip, similar to the techniques used for integrated circuits. This allows the construction of elements such as sensor chips with built-in electronics that are a fraction of the size that was previously possible. MEMS Accelerometer using MEMS technology has been commercially successful for several years.

2.3.1 MEMS Accelerometer

MEMS accelerometers use capacitance change due to acceleration force as the sensed parameter. A capacitive approach allows several advantages when compared to the piezoresistive sensors used in many other accelerometers. Gaseous dielectric capacitors are relatively not sensitive to temperature. But space changes with temperature due to thermal expansion and with the low thermal coefficient of expansion of many elements can produce a thermal coefficient of capacitance about two orders of magnitude less than the thermal coefficient of resistivity of doped silicon.

Capacitance sensing therefore has the potential to provide a wider temperature range of operation, with no compensation, than piezoresistive sensing [5].

2.4 Nanotechnology in Food

Nanotechnology has a bearing on many aspects of food science, from being grown all the way to how it is packaged. Companies are developing nanomaterial that will surely make a difference not only in the quality of food, but also in food safety, and the health benefits that food delivers.

Silicate nanoparticles is being used by researchers to produce a barrier to gasses, or moisture in a plastic film used for packaging which could scale down the possibly of food spoiling or drying out.

The strength and stability of plastic film used in packaging can be improved by using zinc oxide nanoparticle which can block UV rays and provide protection against bacteria.

Nanosensors currently being developed can detect bacteria and various other contaminates at a packaging plant which will allow for frequent testing at a much lower cost than sending samples to a lab for analysis [7].

Research is also being conducted to develop nanocapsules containing nutrients that would be released when nanosensors detect a vitamin deficiency in your body. This research could result in a super vitamin storage system in your body that will deliver the nutrients you need [8].

Another development being pursued is a network of nanosensors and dispensers used throughout a farm field. The sensors will recognize which and when a plant needs nutrients or water. The dispensers then release fertilizer, nutrients, or water as needed by the plant, optimizing the growth of each plant in the field one by one. This will increase the productivity.

2.5 Nanotechnology in Environment

Epoxy containing carbon nanotubes is currently being used to make windmill blades which are stronger and lower weight and therefore the amount of electricity generated by each windmill is greater [11].

Researchers have shown that an array of silicon nanowires embedded in a polymer could result in low cost but high efficiency solar cells that generate electricity as cost effectively as coal or oil.

3. Conclusion

Nano technology is one of the successfully field in science & Technology due to decrease in its size it can produce remarkable change that will help to human and environment. Nanotechnology or systems / device manufactured at the molecular level, is a multidiscipline scientific field undergoing explosive development. Nanotechnology in food science will produce a high impact which is needed in future. Applications of nanoscience to medicine will revolutionize the health system.

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