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Nanotechnology and Nanosensors in the welfare of Energy and Environment (NTE)

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***Abstract*:- Nano Technology is a branch of science and the evaluation includes many applications in agricultural, medical, industrial and military sector. The nanosensor has wide application in food industry, medical fields such as nano medicines and many more. Nanosensors can be defined as sensitive material used to transmit chemical, physical, or biological information about nanomaterials and recognition molecules. Nanosensors, chemical or mechanical sensors can be used to detect the presence of chemical species and nanoparticles, or monitor physical parameters such as temperature, on the nanoscale. They are used in medical diagnostic applications, food and water quality sensing, and other chemicals. The purpose of the present study is to provide a technical review of recent nanosensor research and development. It is observed that nanosensor technology is developing rapidly and is the subject of a global research effort. Technologies such as nano-electromechanical system, nano opto-electromechanical system, nanophotonics and the combination of nanotechnology with microtechnology offer prospects to yield sensors for a wide range. Nanotechnology can enable sensors to detect very small amounts of chemical vapors. Various types of detecting elements, such as carbon nanotubes, zinc oxide nanowires or palladium nanoparticles can be used in nanotechnology-based sensors. . This allows the detection of a very low concentration of chemical vapors Nanotechnology could help the environment to progress from saving raw materials, energy and water, to decreasing greenhouse gases and dangerous waste, nanotechnology's unique attributes can be utilized in various products, procedures and applications that could undoubtedly support environmental and climate protection.Nanotechnology is helping to considerably improve, even revolutionize, many technology and industry sectors mainly the Energy sector accounted for developing new technology.Nanotechnology has the huge potential to transform people's lives for the better. We start using cheap, lightweight solar plastics, which makes solar energy widely available. Nanoparticles can clean up toxic chemical spills, as well as air-borne pollutants.Nanotechnological products, processes and applications are expected to contribute significantly to environmental and climate protection by saving raw materials, energy and water as well as by reducing greenhouse gases and hazardous wastes.Nanotechnology increases the strengths of many materials and devices, as well as enhances efficiencies of monitoring devices, remediation of environmental pollution, and renewable energy production.Air pollution can be remediated using nanotechnology in several ways. One is through the use of nano-catalysts with increased surface area for gaseous reactions. Catalysts work by speeding up chemical reactions that transform harmful vapors from cars and industrial plants into harmless gases by detecting pollutants by specific sensors, we can help protect the sustainability of human health and the environment. Thus, nanotechnology provides us with a new approach to cut down the waste production, reduce the emission of greenhouse gases and discharge of hazardous chemicals in water bodies.Applications of nanomaterials in environmental fields are Wastewater treatment. Removal of hazardous pollutants. Emission control technologies. Corrosion protection from the automotive industry.Using photocatalytic copper tungsten oxide nanoparticles to break down oil into biodegradable compounds. The nanoparticles are in a grid that provides high surface area for the reaction, is activated by sunlight and can work in water, making them useful for cleaning up oil spills, in these ways Nanotechnology can address the problems in the environment in the recent years with an advanced implemented technology.The Nanomaterials are good the environment because contaminants may be absorbed by nanoparticles, thereby reducing the concentrations of the free molecules of pollutants around the cells and reducing the toxic effects of the pollutants, thus could be utilized in various purification processes.**

Keywords: Nanotechnology, Nanosensors, Selectivity, Portable, Diagnostic, Nanofibers, Nanocellulose particles, Nanocrystals , Water Purification Technology, Anti Bacterial Property, Biodegradable Plastic products, Bionanosensors , Magnetoreception.

INTRODUCTION

Nanotechnology has significantly contributed in benefiting society and shaping the nature of modern life, nanotechnology can boost the economic growth as well as improve the capacity and quality in industrial sectors. It can significantly change the human life, social environment and country's economy.Nanomaterials can be used for particle filtration, gas adsorption, bacteria disinfection and catalytic processes; and they have been components of various types of purification devices used to reduce particulate matter (PM), gaseous precursors (i.e., NOx, VOCs, etc.), and toxic pollutants (e.g., HCHO),Different types of nanocellulose materials available for water purification system includes Cellulose nanocrystals (CNC) and Cellulose nanofibrils (CNF). These are the rod-like nanomaterials whose size ranges from 100 to 2000 nm with the diameter of 2 to 20 nm.Silver aerosol nanoparticles are generated from atomizer has been studied as an antimicrobial agent against Bacteria thus having an Anti Bacterial Property.Another viable method of water purification currently in development that makes use of nanotechnology includes utilizing magnetically active nanoparticles to extract chemicals from water. The process enables the removal of toxins from drinking-water contaminants attracting nanoparticles that consist of magnetic phases. Cost-effective filter materials coated with silver nanoparticles (AgNps) is an alternative technology and can be used in water purification. c. Silver nanoparticles act as a highly effective antibacterial agent that kills E. coli from water as acts as an Anti Bacterial Reagent in the Water Treatment and Purification Technology.

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Nanosensors play a vital role in the field of atmospheric environmental testing. They offer important advantages over conventional methods and cater the need for portable analytical tools with features of selectivity and stability, among other aspects. The development of reliable nanosensors is projected with important realistic requirements and practical value in the area of environmental pollutant screening and monitoring.

Magnetic nanoparticles help make smarter solar cells

Researchers have synthesised high-performance solar cells based on magnetic nanoparticles that can harness solar energy and convert it into electricity more efficiently than existing solar cells1.

Since the process to make these solar cells is eco-friendly and of low cost, they can be used widely to make electricity.

Recent studies have shown that an externally applied magnetic field can accelerate the transport of charge carriers in solar cells. However, it is not always possible to incorporate an electromagnet into a solar cell device.

To find a way, scientists from the Indian Institute of Technology and the CSIR-Indian Institute of Chemical Technology in Hyderabad, India, first deposited a mixture of titanium dioxide paste and ferric oxide nanoparticles on fluorine-doped glass slides coated with tin oxide. They then prepared the solar cells by dipping the coated glass slides in a solution of a specific light-sensitive dye.When exposed to sunlight, the solar cells were found to reduce light loss due to reflection. This, in turn, increased their efficiency in absorbing light. Sunlight also easily penetrated through the glass slides towards the active layer of the cells.

The presence of magnetic nanoparticles in the active layer contributed significantly to the power conversion efficiency of the devices. The nanoparticles generated an internal magnetic field that increased the numbers of dissociated charge carriers in the devices, increasing open circuit voltage.

The dye molecule in the solar cells also played a vital role in enhancing the current, explain the researchers. The dye absorbs the light energy and causes electrons in the dye to jump to a layer containing titanium dioxide paste and then to the external circuit, causing a flow of electrons and leading to a current.

DNA NANOBIOSENSORS

DNA nanobiosensors provide powerful tools for the rapid and sensitive determination of pathogens, diseases, genetic disorders, drug screening, and other in vitro diagnostics applications.158 These provide early diagnosis even before the onset of clinical symptoms. A few nanobiosensors for DNA detection are discussed below.

The ONT-mediated AuNPs aggregation process has been extensively used for the colorimetric screening of DNA binders and triplex DNA binders. The applications of AuNP-based DNA colorimetric methods for disease diagnosis and gene expression have been reported and reviewed. Because AuNPs have unique optical/electrical properties, various detection techniques have been applied in the AuNP-based DNA assay. A one-step homogeneous DNA detection method with high sensitivity was developed using AuNPs coupled with dynamic light scattering (DLS) measurement.159 Single-base pair-mismatched DNAs can be readily discriminated from perfectly matched tDNAs using this assay. This DLS one-step homogeneous DNA detection method with high sensitivity was developed using AuNPs. Citrate–AuNPs with a diameter of 30 nm were initially functionalized with two sets of ssDNA probes before these were used as optical probes for DNA detection. The hybridization between the tDNA and the two AuNP probes led to the formation of NP dimers, trimers, and oligomers. The NP aggregation increased the average diameter of the NP population that was monitored by DLS. A quantitative correlation was established between the average diameter of the resulting NPs and the tDNA concentration. The detection limit of this facile DLS-based assay that requires no additional separation and amplification steps was around 1 pM, which is four orders of magnitude better than that of light absorption-based methods.A fluorescence QD-based ultrasensitive SMD method for quantification of DNA coupled with TIRFM was developed.50 The capture DNA was immobilized on silanized coverslip that was blocked with ethanolamine and BSA before the capture of the tDNA. The QD-labeled DNA probe was hybridized to the tDNA and fluorescent images of the QD-based sandwich DNA hybridization assay on the coverslip were taken with a highly sensitive CCD. Quantification of the tDNA was carried out by counting the bright spots on the images using a calibration curve. The LOD of the method was 1×10^{-14} mol/L. The sensor can be used to quantify mRNA in cells.

A fractal analysis is presented for the binding and dissociation kinetics for some of the examples presented in the literature where nanobiosensors have been used to detect analytes. Nanobiosensors do exhibit the potential to detect analytes in solution at very low concentrations. This is critical for medical applications in that one is able to detect the biomarkers for diseases. This should lead to a better and earlier prognosis, and eventually lead to a better medical protocol for the treatment of the disease. Such advancements are essential if one is to stay “ahead of the curve” especially for diseases like cancer.
The kinetics of binding and dissociation of analyte to receptors on biosensor surfaces is one step in the direction. The nanobiosensor examples presented in this chapter are selected at random from the literature. But, they hopefully provide an overall

perspective of the research presently being done. More importantly, it should shed light and provide guidance on what the future of nanobiosensors should be, at least as far as biological and medical applications is concerned. There should be more emphasis on interfaces, especially biological interfaces, since it is there that "reaction" takes place that includes binding, dissociation, and transduction of the chemical binding to an electrical or other measurement signal. An understanding of these different steps would significantly enhance the efficiency of the biosensor as a whole. Nanobiosensors are particularly suitable in this role. The fractal analysis presented to understand the kinetics should provide valuable insights into the interactions occurring on the biosensor surfaces.

Some of the nanobiosensor examples analyzed include (a) binding (hybridization) of specific DNA to a complementary target using nanoparticle probes (Maxwell et al., 2002), (b) binding and dissociation of DNA on a CNT dual-mode biosensor (Oh et al., 2010), (c) binding of glucose to a wired-enzyme core-shell Au nanoparticle biosensor (Scodeller et al., 2008), (d) binding of different concentrations for enzymatic detection of PSA by nanowire electrodes (Roberts and Kelley, 2007, (e) binding and dissociation for DNA hybridization detection by alkylated non oxidized silicon nanowires in electrolytic solution and (f) binding of (i) 107 cfu/mL and (ii) 106 cfu/mL E. coli 0157:157 to GC-SPs (grating coupled-surface plasmons).

BIOSENSORS

Biosensors are nowadays ubiquitous in biomedical diagnosis as well as a wide range of other areas such as point-of-care monitoring of treatment and disease progression, environmental monitoring, food control, drug discovery, forensics and biomedical research. A wide range of techniques can be used for the development of biosensors. Their coupling with high-affinity biomolecules allows the sensitive and selective detection of a range of analytes. We give a general introduction to biosensors and biosensing technologies, including a brief historical overview, introducing key developments in the field and illustrating the breadth of biomolecular sensing strategies and the expansion of nanotechnological approaches that are now available.

A biosensor is a device that measures biological or chemical reactions by generating signals proportional to the concentration of an analyte in the reaction. Biosensors are employed in applications such as disease monitoring, drug discovery, and detection of pollutants, disease-causing micro-organisms and markers that are indicators of a disease in bodily fluids (blood, urine, saliva, sweat). A typical biosensor is represented in Figure 1; it consists of the following components.

Analyte: A substance of interest that needs detection. For instance, glucose is an 'analyte' in a biosensor designed to detect glucose.

Bioreceptor: A molecule that specifically recognises the analyte is known as a bioreceptor. Enzymes, cells, aptamers, deoxyribonucleic acid (DNA) and antibodies are some examples of bioreceptors. The process of signal generation (in the form of light, heat, pH, charge or mass change, etc.) upon interaction of the bioreceptor with the analyte is termed bio-recognition.

Transducer: The transducer is an element that converts one form of energy into another. In a biosensor the role of the transducer is to convert the bio-recognition event into a measurable signal. This process of energy conversion is known as signalisation. Most transducers produce either optical or electrical signals that are usually proportional to the amount of analyte–bioreceptor interactions.

Electronics: This is the part of a biosensor that processes the transduced signal and prepares it for display. It consists of complex electronic circuitry that performs signal conditioning such as amplification and conversion of signals from analogue into the digital form. The processed signals are then quantified by the display unit of the biosensor.

Display: The display consists of a user interpretation system such as the liquid crystal display of a computer or a direct printer that generates numbers or curves understandable by the user. This part often consists of a combination of hardware and software that generates results of the biosensor in a user-friendly manner. The output signal on the display can be numeric, graphic, tabular or an image, depending on the requirements of the end user.

CHARACTERISTICS OF A BIOSENSOR

There are certain static and dynamic attributes that every biosensor possesses. The optimisation of these properties is reflected on the performance of the biosensor.

Selectivity:-

Selectivity is perhaps the most important feature of a biosensor. Selectivity is the ability of a bioreceptor to detect a specific analyte in a sample containing other admixtures and contaminants. The best example of selectivity is depicted by the interaction of an antigen with the antibody. Classically, antibodies act as bioreceptors and are immobilised on the surface of the transducer. A solution (usually a buffer containing salts) containing the antigen is then exposed to the transducer where antibodies interact only with the antigens. To construct a biosensor, selectivity is the main consideration when choosing bioreceptors.

Reproducibility:-
Reproducibility is the ability of the biosensor to generate identical responses for a duplicated experimental set-up. The reproducibility is characterised by the precision and accuracy of the transducer and electronics in a biosensor. Precision is the ability of the sensor to provide alike results every time a sample is measured and accuracy indicates the sensor's capacity to provide a mean value close to the true value when a sample is measured more than once. Reproducible signals provide high reliability and robustness to the inference made on the response of a biosensor.

Stability:-
Stability is the degree of susceptibility to ambient disturbances in and around the biosensing system. These disturbances can cause a drift in the output signals of a biosensor under measurement. This can cause an error in the meas-ured concentration and can affect the precision and accuracy of the biosensor. Stability is the most crucial feature in applications where a biosensor requires long incubation steps or continuous monitoring. The response of transducers and electronics can be temperature-sensitive, which may influence the stability of a biosensor. Therefore, appropriate tuning of electronics is required to ensure a stable response of the sensor. Another factor that can influence the stability is the affinity of the bioreceptor, which is the degree to which the analyte binds to the bioreceptor. Bioreceptors with high affinities encourage either strong electrostatic bonding or covalent linkage of the analyte that fortifies the stability of a biosensor. Another factor that affects the stability of a measurement is the degradation of the bioreceptor over a period of time.

Sensitivity:-
The minimum amount of analyte that can be detected by a biosensor defines its limit of detection (LOD) or sensitivity. In a number of medical and environmental monitoring applications, a biosensor is required to detect analyte concentration of as low as ng/ml or even fg/ml to confirm the presence of traces of analytes in a sample. For instance, a prostate-specific antigen (PSA) concentration of 4 ng/ml in blood is associated with prostate cancer for which doctors suggest biopsy tests. Hence, sensitivity is considered to be an important property of a biosensor.

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Linearity:-
Linearity is the attribute that shows the accuracy of the measured response (for a set of measurements with different concentrations of analyte) to a straight line, mathematically represented as $y=mc$, where c is the concentration of the analyte, y is the output signal, and m is the sensitivity of the biosensor. Linearity of the biosensor can be associated with the resolution of the biosensor and range of analyte concentrations under test. The resolution of the biosensor is defined as the smallest change in the concentration of an analyte that is required to bring a change in the response of the biosensor. Depending on the application, a good resolution is required as most biosensor applications require not only analyte detection but also measurement of concentrations of analyte over a wide working range. Another term associated with linearity is linear range, which is defined as the range of analyte concentrations for which the biosensor response changes linearly with the concentration.

APPLICATIONS OF BIOSENSORS

Biosensors have a very wide range of applications that aim to improve the quality of life. This range covers their use for environmental monitoring, disease detection, food safety, defence, drug discovery and many more. One of the main applications of biosensors is the detection of biomolecules that are either indicators of a disease or targets of a drug. For example, electrochemical biosensing techniques can be used as clinical tools to detect protein cancer biomarkers . Biosensors can also be used as platforms for monitoring food traceability, quality, safety and nutritional value . These applications fall into the category of 'single shot' analysis tools, i.e. where cost-effective and disposable sensing platforms are required for the application. On the other hand, an application such as pollution monitoring requires a biosensor to function from a few hours to several days. Such biosensors can be termed 'long-term monitoring' analysis tools. Whether it is long-term monitoring or single shot analysis, biosensors find their use as technologically advanced devices both in resource-limited settings and sophisticated medical set-ups: e.g. with applications in drug discovery ; for the detection of a number of chemical and biological agents that are considered to be toxic materials of defence interest for use in artificial implantable devices such as pacemakers and other prosthetic devices ; and sewage epidemiology . A range of electrochemical, optical and acoustic sensing techniques have been utilised, along with their integration into analytical devices for various applications. Figure 2 indicates different areas of research where biosensors have been used.

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MAGNETORECEPTORS IN HUMANS

Magnetoreception (also magnetoception) is a sense which allows an organism to detect a magnetic field to perceive direction, altitude or location. Humans are not thought to have a magnetic sense, but there is a protein (a cryptochrome) in the eye which could serve this function.Many humans are able to unconsciously detect changes in Earth-strength magnetic fields, Magnetoreception (also magnetoception) is a sense which allows an organism to detect a magnetic field to perceive direction, altitude or location. This sensory modality is used by a range of animals for orientation and navigation, and as a method for animals to develop regional maps. In navigation, magnetoreception deals with the detection of the Earth's magnetic field.Magnetoreception is present in bacteria, arthropods, molluscs, and members of all major taxonomic groups of vertebrates.

Humans "are not believed to have a magnetic sense", but humans do have a cryptochrome (a flavoprotein, CRY2) in the retina which has a light-dependent magnetosensitivity. CRY2 "has the molecular capability to function as a light-sensitive magnetic sensor", so the area was thought (2011) to be ripe for further study. A 2019 study found that magnetic fields do affect human alpha brain waves, but it is not known whether this results in any change in behavior.Despite more than 50 years of research, a sensory receptor in animals has yet to be identified for magnetoreception.It is possible that the entire receptor system could fit in a one-millimeter cube and have a magnetic content of less than one ppm. As such, even discerning the parts of the brain where the information is processed presents a challenge.

The most promising leads – cryptochromes, iron-based systems, electromagnetic induction – each have their own pros and cons. Cryptochromes have been observed in various organisms including birds and humans, but does not answer the question of night-time navigation. Iron-based systems have also been observed in birds, and if proven, could form a magnetoreception basis for many species including turtles. Electromagnetic induction has not been observed nor tested in non-aquatic animals. Additionally, it remains likely that two or more complementary mechanisms play a role in magnetic field detection in animals.Then there is the distinction of magnetic usage. Some species may only be able to sense a magnetic compass to find north and south, while others may only be able to discern between the equator and the pole. Although the ability to sense direction is important in migratory navigation, many animals also have the ability to sense small fluctuations in earth's magnetic field to compute coordinate maps with a resolution of a few kilometers or better.For a magnetic map, the receptor system would have to be able to discern tiny differences in the surrounding magnetic field to develop a sufficiently detailed magnetic map. This is not out of the question, as many animals have the ability to sense small fluctuations in the earth's magnetic field. This is not out of the question biologically, but physically has yet to be explained. For example, birds such as the homing pigeon are believed to use the magnetite in their beaks to detect magnetic signposts and thus, the magnetic sense they gain from this pathway is a possible map.

POSSIBILITIES

Magnetoreception is a sense that enables a number of animals to perceive direction, altitude, and location through the detection of a magnetic field. This particular sensory modality has been studied extensively in animals such as migratory birds and sea turtles, but the possibility that humans also possess this ability to navigate via magnetoreception has not been studied to such a degree.

The new, interdisciplinary study was published in eNeuro, and states that it has discovered a “strong, specific human brain response to ecologically-relevant rotations of Earth-strength magnetic fields.”

Our results indicate that human brains are indeed collecting and selectively processing directional input from magnetic field receptors.

“These give rise to a brain response that is selective for field direction and rotation with a pattern of neural activity that is measurable at a group level and repeatable in strongly responding individuals.”34 adult volunteers, 24 male and 12 female, whose ages ranged from 18 to 68, were included in the study. Each participant sat in a wooden chair, preventing any conductivity and within a Faraday cage, an enclosure that blocks electromagnetic fields. Electric currents were then run through wire coils inside the enclosure that mimicked the Earth’s magnetic field. This particular design enabled the researchers to rotate the direction of the magnetic field and measure the brain’s responses to the alterations.

Electroencephalography (EEG), which is a method of recording brain activity through sensors attached to the scalp, was used to record the brain activity of adults during the magnetic field experiments. In some participants, the experiments showed a decrease in alpha-band brain activity, neural oscillations that are thought to play an active role in network coordination and communication.

Nanomaterials in Personal Protection
One of the important areas of fire protection is the appropriate equipment of people participating in rescue operations, defined as the provision of personal protective equip ment.
Personal protective equipment (PPE) is divided into the three following categories:

Protecting against minimal risks (Category I).
Protecting against a specific factor that does not threaten life or health and does not cause permanent damage to the health of the employee (Category II).
Specialist clothing, the task of which is to protect against factors that may cause the
most dangerous consequences for the worker, and the direct effects of which cannot be identified in a timely manner, protective clothing of complex construction to protect against the threat to life or health of the worker, including a firefighter (Category III).

The scope of personal protective equipment includes devices, equipment, and cloth ing that are designed to ensure safety and protect against one or more hazards [27,28].

Therefore, they include protective clothing and measures to protect the lower and upper limbs, head, face, eyes, respiratory system, and hearing, as well as equipment to prevent an employee from falling from a height, and measures to isolate the entire body. All these elements must meet the criteria specified by law and standards in the field of, inter alia,
resistance to temperature or chemicals, durability, possible use in open areas or indoors.External factors such as:

- Fire, hot air, heat radiation, hot water, and steam. High or low temperature.
- Chemicals, including foaming agents.
- Gases generated during combustion or leaking from the installation.
- Biological agents such as viruses, bacteria, and dangerous organisms.
- Other elements such as glass, metal, sharp objects, and electric discharges.

On the other hand, it is necessary to ensure that the equipment is comfortable as wellas functional when undertaking activity. Such a variety of parameters that determine thesafety of people taking part in various types of action require a specialized approach. Forthis reason, the materials of individual PPE are subject to constant modifications, including the use of nanotechnology.

Protective Clothing

Inherently fire-resistant fibers or chemically modified fibers with fire-resistant prop erties are used in protective clothing. Inherently flame retardant fibers that do not melt easily and do not ignite are compounds such as: polyamides (such as: poly(p-phenylene

terephthalamide), imide derivatives (such as: poly(aramid-imide), polyimide, polyetherimide,

compounds containing azole group (such as: polybenzimidazole, polybenzoxazines),

halogenated (such as: chlorinated, fluorinated), melamine-formaldehyde, polyetheretherke tones, phenolic, polyphenylene sulphide, polyacrylate, semi-carbon, glass, and ceramic.

It should be noted that aramid fibers, which are aromatic polyamides, are known under thetrade names Kevlar™, Technora™, Twaron™ (poly(p-phenylene terephthalamide), PPD-T)or Nomex™, Newstar™ (poly(m-phenylene terephthalamide), PD-T, PPDT, or PPTA), and Conex™ (poly(m-phenylene isophthalamide), MPIA) .

These fibers tend to char or form ash when exposed to fire and therefore do not usually

contribute to the overall flammability of polymer matrix composites (PMC). Aramids burn faster than carbon fibers [33]. Cellulose fibers, on the other hand, refer to natural-based fibers used in the reinforcement of PMC, typically for lower performance and biorenewable PMC composites. These types of fibers often burn with the polymer and can negatively affect the combustibility. However, in the presence of flame retardants, cellulose fibers can serve as additional sources of carbonization for fire protection in swelling formulations, which is not observed with glass fiber or carbon fiber.

The aim of these modifications is to achieve above 21% of the parameter called the limited oxygen index (LOI), indicating the minimum percentage of oxygen required for combustion . The techniques used to produce chemically modified refractory fibers are primarily determined by the type of combustible substrate fibers in the process. Both synthetic fibers such as polyester, nylon,

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and acrylic, and natural fibers such as wool, cotton, ,and viscose are used in the modification processes. Flame retardant substances, in the case of synthetic fibers are, among others, halogens, nitrogen, silicon, and phosphorus.

These substances are either incorporated into the polymerization process during melt spinning or doped into the spinning bath during solution-spun fiber preparation. Such modified fibers, in the event of exposure to high temperatures and thermal hazards,create a gas-vapor phase (a non-volatile ester compound) or a solid-state condensed phase (carbonized carbon compound), which reduces flammability [38,39]. Thereby insulation of other underlying materials takes place and helps to maintain the integrity of firefighters protective clothing.

The use of an aerogel nonwoven layer as a thermal liner resulted in a five-fold increase in heat resistance in comparison to the use of a thermal liner alone, and a three-fold increase in heat resistance than when the existing thermal liner and moisture barrier are combined. The possibility of the occurrence of burn injuries under a compressive load of 49 N on a surface heated to 200 ◦C was also tested. It has been found that a firefighter will experience an immediate burn within 30 s if only commercial reinforcement material is used.

A new fire retardant that could be applied to cotton fabrics.

The agent was obtained from sodium hypophosphite, maleic acid, and triethanolamine, as well as TiO_2 nanoparticles, while maleic acid oligomers were obtained by radical polymer ization reactions. The bond between the oligomeric species of maleic acid and cellulose
obtained as a result of the conducted processes is resistant to hydrolysis, which translates into greater durability of the material in the event of repeated washing at home.

Aluminum silicate nanofillers are gaining more and more popularity, including mont morillonite, hectorite, bentonite, and saponite, which, with appropriate dispersion, improve the mechanical properties of polymeric materials, increase resistance to inflammation, and increase the barrier to chemical substances. The use of layered nanofillers allows one to
obtain polymer intercalation nanocomposites and exfoliation nanocomposites. In the first
case, the nanofiller plates are separated by single polymer chains and retain their layered
structure, while in the second case, the nanofiller is evenly distributed in the polymer matrix.

The demand for functional and cost-effective flame-resistant textiles (FRT) is increas ing, which is why conducted research on the development of a simple casting method for the production of flame-resistant gel/textiles (FR-GT) composite materials

based on acrylamide (AAM) and SiO_2. The obtained results showed that the active dif fusion of the aqueous pre-AAM/SiO_2 gel to the textile structure enabled the formation
of strong interfacial adhesion between the hydrogel and the textiles. The presence of the
chemical cross-linking agent polyethylene glycol diacrylate (PEGDA) and the physical properties of
the cross-linking agent SiO_2 limited the expansion of the hydrogel volume during swelling.

Additionally, the hydrogel layer of the nanocomposite polyacrylamide (PAAM)/SiO_2 pre vented burning in high temperature environments, i.e., >100 ◦C, due to the removal of heat from the water during evaporation. The produced hybrid hydrogel-textile composites are used in the production of fireproof materials, including fireproof gloves and life-saving materials such as fireproof blankets.

The nanofibers have a large surface area per unit mass. Nonwoven mesh makes the materials breathable and thermally insulating. Coating is a common method of applying nanofibers to protective clothing. While traditional textiles used in thermal protective clothing rely on a passive insulation mechanism to protect the firefighter, smart clothing can provide active protection. In the case of smart clothing, the solution is injected into the outer layer of the garment through a capillary mesh and the injection process is activated by a temperature sensor embedded in the outer layer of the cloth. On exposure to fire, the injected water evaporates. High heat absorption occurs and, consequently, the temperature rise in the outer layer slows down, providing active protection against exposure to flash fire.

NANOSTRUCTURES IN TOOLS IN FIRE PROTECTION

Early detection of a fire, preferably in its initial stage, is essential in firefighting op erations. The development of tools used for monitoring and signaling the threat aims to produce instruments and methods that will allow the detection of very low concentrations of smoke particles, temperature rise, light emission, or characteristic gaseous combustion products. It should be noted, however, that the emission of smoke, which is a colloidal
system in which the dispersed phase is a liquid or a solid, largely depends on the properties of the material, the method of its combustion, and the stage of fire development. One of
the basic elements of smoke detectors is a stable light source. Moreover, depending on the method of smoke detection, scattering or absorption, a radiation source of different wavelength and intensity is required. Nanotechnology allows one to obtain

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photoelements, the parameters of which significantly exceed conventional materials. The use of photolumi nescent elements based on QD-LED quantum dots (Quantum Dot Light Emitting Device) allows one to increase the sensitivity. Such light sources are characterized by high stability, a narrow range of emitted light, and the possibility of wavelength adjustment, color purity, and processability of the solution.

SMOKE DETECTORS

Smoke detectors also have a light sensor which uses various types of photo elements, such as photodiodes. By using nanowires based on gallium arsenide (GaAs).
graphene or other materials [68–70], the sensitivity of light detectors as well as entire smoke detectors can be increased. The sensitivity of the detector based on GaAs/AlGaAs nanowires is 7.2 × 1010 cm·Hz1/2/W at a wavelength of 855 nm. This value is comparable to the high surface area gallium arsenide sensors. In the research phase there are
devices called nantennas, which are a nanometric version of a regular radio antenna, as a
as a result of their size they are able to absorb light waves [71]. More developed versions of
the device are based on the interaction of gold particle plasmons with the graphene plane,
which makes it possible to detect light with extremely high sensitivity and in the frequency range that was previously characterized by low efficiency, i.e., infrared.

Fire analysis shows that smoke emission is lower during flame combustion for most
materials. In the event of a flame, the thermal decomposition products are oxidized to a gaseous form, thereby reducing the amount of smoke emitted and increasing the amount
of gases. The least noticeable method of combustion is oxygen, in the course of which the products of thermal decomposition are emitted. The smoldering material may remain
unnoticed for a long time; therefore, it is important that even with minimal amounts of combustion products their identification and appropriate signal takes place. There are two
primary exhaust gases in the air that are not normally present in high concentrations in, gaseous hazardous state namely CO2 and CO. Since CO is not normally present in the air, its presence is a direct indicator of a fire. In practice, carbon monoxide detectors are used as sensors for alarming faulty ventilation. The most commonly used materials for the production of gas sensors include polymers, semiconductor metal oxides, or porous silica, and nanomaterials such as
single-wall carbon nanotubes, graphene, and silicene].

Sensors based on carbon nanomaterials allow the detection of various gases, including
CO, at the level of individual molecules. The device analyzes the electrical properties of the nanoparticle connected to the electrodes, therefore, after adsorbing a given particle, e.g., CO, the electrical properties of the device change. Carbon nanotubes and 2D particles in the form of nanotubes or graphene are most often used for this purpose [76,77]. However, due to the weak interaction of the carbon structure with carbon monoxide, the range of detection of devices based on carbon tubes is limited [78]. Therefore, research was conducted on the use of the silicon equivalent of graphene, i.e., silicene. Silicene, due to slight interactions based on chemisorption, shows an increased sensitivity with respect to CO. In addition, heating of the CO molecules causes their desorption from the surface, regeneration, and the possibility of reusing the sensor. It should be noted, however, that the sensor works properly in a nitrogen atmosphere, but the presence of oxygen and water vapor reduces its effectiveness [79]. Carbon nanotubes are functionalized or coated with an alkali metal or alkali salt to improve the durability, life cycle of materials, or reduce the operating voltage.

Carbon nanofibers (CNF) show great potential for detection. CNF surfaces modified with various materials, such as metallic nanoparticles (NP), NP metal oxides, alloys, silica, and polymers, allow for the extension of the use of carbon nanofibers. CNF-based nanomaterial sensors are used to detect various parameters such as pressure, stress, and combustion products.
Depending on the type of material, carbon nanofibers used as sensors are classified into five types:

- Clean CNF.
- CNF is loaded with metal nanoparticles (NPs).
- CNF loaded with metal oxides nanoparticles (NPMOs).
- CNF loaded with metal alloys.
- Nano Additives in Industrial Products
- Carbon and Halloysite Nanotubes as Nanoadditives

The use of a nano additive in the form of carbon nanotubes, especially double-wall car bon nanotubes (DWNT), allows one to obtain polymer nanocomposites with significantly
higher fire resistance compared to the properties of unmodified polymeric materials. The increased fire resistance of nanocomposites containing carbon nanotubes is attributed to the formation of a continuous carbon layer that can act as a heat shield [121]. Moreover, the flame-retardant efficiency clearly depends on the degree of dispersion of the nanotubes and their content in the polymer matrix. In general, introducing about 0.5 wt.% gives the desired effect. The introduction of DWNT into the silicone matrix allows for a significant increase in the fire resistance of the obtained nanocomposite, which makes it possible to use it as a coating material in aeronautics . The best results were obtained with the use of a mixture of DWNT with carbon nanotubes in the amount of 0.25–0.5% by weight. In the case of the silicone matrix, better results were obtained with the use of unmodified nanotubes, which is explained by the increased affinity of such nanotubes for the silicone matrix. The addition of halloysite nanotubes also has a positive effect on the
fire resistance of polymer composites. In order to obtain good miscibility with the polymer matrix, they require modification of the surface properties, most often with the use of (3-aminopropyl) triethoxysilane. The increase in fire resistance is in this case explained by the creation of a thermal barrier and the accumulation of degradation products of the polymeric material, e.g., silicone rubber inside the halloysite nanotubes.

An important factor influencing the properties of nanocomposite materials is the appropriate modification of nanoadditives, enabling the permanent incorporation of the nanoadditives into the structure of the nanocomposite. The selection of the appropriate method of modification of the nanoadditive depends on the morphology and chemical structure of the composite matrix, e.g., on the presence of functional groups that enable the formation of permanent bonds as a result of reacting with the functional groups of the nano additive. Nanoparticles of Silica as Nanoadditives

Silica materials of various structures are widely used fillers for polymer composites
and paints. In recent years, nanoparticles of silica (also commonly known as nanosilica)
have been used more and more widely. An advantage of this is that it is possible to ob tain the desired effect of improving properties by using them in a much smaller amount compared to conventional silicas. The method of introducing these nano silica into the
polymer matrix is of significant importance for obtaining the desired increase in fire re sistance. Hydrophilic nanosilica has reactive silanol groups on its surface that enable the incorporation of nanoparticles into the polymer matrix. However, when a silicone matrix is used, the presence of silanol groups can cause significant processing difficulties due to the formation of hydrogen bonds between the oxygen of the organosilicon polymer chain and the silanol groups of the silica. This can make the processing of the polymer composite much more difficult . In order to avoid these difficulties, it is preferable to use hydrophobic nano silica with blocked hydroxyl groups on the surface. Regardless of the type of nanosilica, it is necessary to disperse the nanoparticles well in the polymer matrix because the mechanism for increasing the fire resistance of the polymer nanocomposite due to the introduction of nanosilica is related to physical processes taking place in the solid phase and not to chemical reactions. Therefore, good dispersion of nanosilica in the polymer matrix has a significant impact on obtaining the desired properties, including fire resistance. The influence of nanosilica particle size on fire resistance was also confirmed.

NANO BIO- FUEL

- A novel biofuel, Cymbopogon flexuosus is used as an alternative energy source.
- Cymbopogon flexuosus biofuel with cerium oxide nano particle.
- Numerical study on the hemispherical piston for a single cylinder diesel engine.
- Resulting in higher thermal efficiency and lower HC, CO, emission.

The main aim of the present research is to effectively utilize the biofuel along with nano additive (Cymbopogon flexuosus biofuel with cerium oxide) powered with a coated and uncoated diesel engine. The work is further extended to study the thermal–stress analysis of the coated engine, to empathize the physical mechanism underlying the impact of coated engine on the engine behavior. In connection with this, for the present work, a novel biofuel and oxygenate additive was preferred. Biofuel- Cymbopogon flexuosus was extracted through the steam distillation technique and oxygenate additive - cerium oxide nano additive was synthesized using combustion technique. Focusing on the coating material, YSZ (Yttria-stabilized zirconia) is preferred, as it is highly used in the high-temperature application and were evaluated based on the thermal–stress analysis. From the simulation study using FEA (finite element analysis), the average temperature, and thermal stress were higher and heat flux, were noted to be lower for coated piston, confirming the substantial improvement in thermal efficiency in the experimental study. As a next step, YSZ was coated on the engine piston, valves and cylinder head by plasma spray coating technique. From the experimental assessment of test samples such as D100, B100, B25, in a uncoated engine and B25 + (A) - Cymbopogon flexuosus biofuel – 25% and diesel – 75% + 20 ppm cerium oxide nano additive) in a coated and uncoated engine. It was identified that the thermal efficiency of the engine was enhanced by 1.75% as on compared with the conventional engine for the modified fuel blend. In the emission point of view, fuel-based emissions such as hydrocarbon; carbon monoxide and smoke were reduced with a penalty of increased oxides of nitrogen emission. Another relevant application of nanotechnology is the use of nano-catalysts for the trans-

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esterification of fatty esters from vegetable oils or animal fats into biodiesel and glycerol [20]. The nano-catalyst spheres replace the commonly used sodium methoxide.

Nanotechnology and Nanosensors

From saving raw materials, energy and water, to decreasing greenhouse gases and dangerous waste, nanotechnology's unique attributes can be utilized in various products available and procedures and applications that could undoubtedly support environmental and climate protection.

Nanotechnology and its Engineering Industrial Operations

- Nano Carbon Black
- Nanomaterial
- Nano Solar Panel

Nanotechnology, also shortened to Nanotech is the use of matter on an atomic , molecular and supramolecular scale for industrial purposes.

Nanotechnology initiative as the manipulation of matter with at least one dimension sized 1- 100 nanometers. This also reflects the quantum mechanics and quantum realms scale of the nanomaterials.

Nano engineering is the branch of engineering that deals with all the aspects of the design, building and use of engines, machines and structures on the nanoscale. At its core, Nano engineering deals with nanomaterials and their interaction to make useful materials, structures, devices and systems.

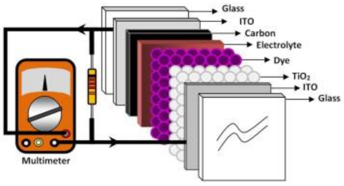
Improvisation of Nano engineering for the production and processing in Industries

Carbon Nanotubes Body Armor- Functional bulletproof materials are essential for law enforcement officers and military personnel, who are at high risk of facing gunfire. Bulletproof vests disperse a bullets force across a larger area than the point of impact, preventing it from penetrating the wearer's body. Nanotechnology is currently being tested as an effective means of enhancing traditional Bullet -Resistant materials like Kelvar.

Solar Cells – They're intensive and can produce large amounts of wastes. Photovoltaic Solar cells are made waterproof using layers of expensive Crystalline silicon that are treated using caustic chemicals. The Gratzel cell which uses a layer of material coated with highly porous titanium dioxide (TiO_2) nanoparticles as it's surface material instead of silicon , is less expensive to produce and allows cells to collect the sun's rays across a wide range of surface. Nano solar Solar Panels are the Nanocrystal solar cells based on a substrate with a coating of Nanocrystals. GdTe or CIGS and the substrates are generally silicone or various organic conductors.

NANOENGINEERING UTILIZATION

Schematic of the Construction of Gratzel Cell used in Solar panels.



Also, Nanotubes are used to make Kevlar Body Armour for Military purposes.

UTILIZATION OF NANOTECHNOLOGY
IN SOLAR CELLS

Nanocrystal Solar cells are the solar cells based on a substrate with a coating of Nanocrystals. The Nanocrystals are typically based on silicon, CdTe or CIGS,and the substrates are generally silicon or various organic conductors.

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The presence of nanoparticles in the active layer of the cell contributed significantly to the power conversion efficiency of the devices. The nanoparticles generates an internal magnetic field that increases the numbers of dissociative charge carriers in the devices,increasing the open circuit voltage.

High performance Solar cells based on magnetic nanoparticles that can harness solar energy and convert it onto electricity more efficiently than the existing solar cell. This process is eco friendly and is of low cost, and can be widely used to produce electricity. The externally applied magnetic field can accelerate the transport of charge carriers in the solar cells.

NANOSENSORS

Magnetic Nanosensors

The major advantage of nanosensors is that they provide extremely high surface area / volume ratio which makes them gain more sensitivity for the detection of a single molecular component or atom or chemical molecules even at trace level.

They offer the potential for new and faster kinds of electronics and more power sources and life saving medical diagnostic applications

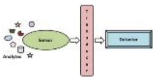
Nanomaterials enabled sensors are being designed for the high efficiency mutiplex functionality and high flexibility sensing applications. These also provide widespread use and potentially low cost monitoring of chemicals, microbes and other analytes in drinking water.
Nano sensors are the nanoscale devices that measure physical quantities and properties, and convert these to significant signals that can be detected and analyzed .

Nano sensors Nano sensors are made generally by Top- Down Lithography, Bottom- Up Assembly, and Molecular Self Assembly. Nano sensors are the chemical or mechanical sensors that can be used to detect the presence of chemical species and nanoparticles, or monitor physical parameters such as temperature and pressure conditions on the Nanoscale. They find use in medical diagnostic applications, food and water quality sensing and other chemicals. It communicates information about the behavior of particles at the Nanoscale level to the macroscopic level .

• Working :- An analyte, sensor, transducer and detector are the components of a Sensor system with feedback from the detector to the sensor. Sensitivity, specificity, and ease of execution are the main goals of designing the Nano sensors. Nano sensors typically work by monitoring electrical changes in the sensor materials .

Example: Carbon Nanotube based sensors work in the principle, where molecule of Nitrogen Dioxide (NO2) is present, it will strip an electronic from the nanotubes, which in turn causes the Nanotube to be less Conductive. If Ammonia (NH3) is present, it reacts with water vapour and donates an electron to the carbon nanotubes, making it more Conductive. By treating the nanotubes with chemical substance and various coating materials, they can be made sensitive and immune to certain molecule and others. Thus Nano sensors have been developed to the point of measurements at the single molecule level.

Carbon Chain bonded
Nanosensors



Also the presence of carbon nanotubes as an additive improve the device's performance. Enrichment of semiconductors species is necessary to
increase the solar cell efficiency since they act as the electrodes for the cells.

APPLICATIONS OF NANO SENSORS

Nanochip

- To detect various chemicals in gases for pollution monitoring.
- For medical diagnostic purposes either on blood borne sensors or in lab – on- a- chip type
- To monitor physical parameters such as temperature, displacement and flow.

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- As accelerometers in MEMS devices like airbag sensors.
- To monitor plant signaling and metabolism to understand plant biology.
- To study the neural transmission in brain for understanding neurophysiology.

Nano sensors include:-

- Carbon Nanotube- Based Fluorescent Nano sensors
- Quantum – Dot Based Fluorescent Nano sensors
- DNA- Based Fluorescent Nano sensors
- Peptide- Based Fluorescent Nano sensors.
- Plasmon Coupling- Based Nano sensors
- Plasmatic Enhancing/ Quenching Based Nano sensors
- Magnetic Resonance Imaging- Based Nano sensors
- Photo acoustic Based Nano sensors devices.
- Multimodal Nano sensors (synergistic Nano sensors with multiple modalities to overcome individual challenges.

NANO SENSORS IN THE USE OF GNSS (GLOBAL NAVIGATION SATELLITE SYSTEM)

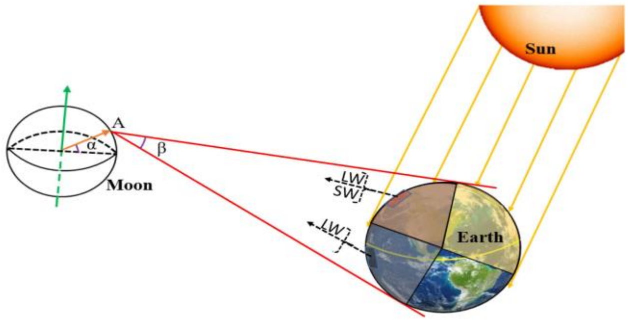
GNSS is fundamentally different from the traditional navigational aids (NAVAIDS) . It has the potential to support all phases of flight by providing seamless global navigation guidance. This could eliminate the need for a variety of ground and airborne systems that were designed to meet specific requirements for certain phases of flight. GNSS provides accurate analysis and guidance in remote and oceanic areas where it is impractical or too costly or impossible to provide reliable and accurate Traditional NAVAID guidance.

GNSS may also be used to support surface operations. The availability of GNSS guidance will allow the phased decommissioning of some or all of the traditional NAVAIDS. This will decrease costs in the l9ng term, resulting in savings for airspace users. GNSS can be implemented in stages, providing increased operational benefits at each stage . This allows aircraft operations to decide, based on weighing of operational benefits against cost when to equip with GNSS Avionics.

Radio Frequency Identification (RFID) - Radio Frequency Identification (RFID) is a wireless data collection technology that uses Electronic waves (EW) to transfer between a transmitter and/ receiver. These RFID tags comprises an antenna and a storage unit microchip memory embedded in a material called substrate that ensures obtaining real time data , control integrity, authenticity. Antithetical Protection, ant counterfeiting , quality and traceability.

NANOSENSING IN GNSS (EARTH SATELLITE SYSTEM)

Optical Nanosensing of three layers of Earth’s Surface using GNSS



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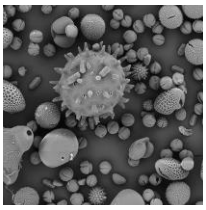
NAN
OTUBES , NANOWIRES AND ITS USES

Scanning Electron Microscope image shows an array of nanoparticles.



Carbon Nanotubes -
A Carbon Nanotube (CNT) is a miniature cylindrical carbon structure that has hexagonal graphite molecules attached at the edges. Nanotubes are rolled up sheets of graphene that form hollow strands with walls that are only one atom thick. It exhibits excellent chemical, thermal, electrical and mechanical properties.

The most popular current use for CNTs is structural reinforcement. They are added to other materials like rebar to concrete because of their high strength, low weight and flexibility. CNT production is also used in bulk composite materials and thin films. Nanowires and Nanotubes are the slender structures.

They exist in many forms, made of metals , semi conductors, insulators and organic compounds- and are used in electronics, energy conversion, optics and chemical sensing among other fields. Due to extreme slenderness , both nanotubes and nanowires are essentially one dimensional.

The wires have an extremely high ratio of surface area to volume that makes them very good as detectors because all that surface area can be treated to bind with specific chemical or biological molecules.

The electrical signals generated by that binding can then easily be transmitted along with the wire. Also nanowires shape can be used to produce narrow beam lasers or light emitting diodes(LEDs) .

NANOFABRICATION

Nanofabrication involves the manufacture of nanostructures that is , products with one or two dimension in the Nano metric range.

Most commonly used as basic units in the manufacture of Nano electronic, semiconductors, optics , etc.

Manufacturing Process of nanofabrication include both bottom up Process (scanning probe manipulation techniques, self assembly) and top- down processes (lithography).

The scanning probe technique involves building up of structures one atom/ molecule at a time, however this method is time – intensive and not industrially / commercially applicable.

In the self assembly process, atoms or molecules organize themselves into patterns or structures in the Nano or micron scale , driven by different forces such as chemical and physical forces.

To achieve better control of the growth and production speed , self assembly may be such as magnetic, electric, or flow or by confirming growth
directed by external fields through templates.

Lithography patterning a surface through exposure to light, laser, or ions followed by etching and or
deposition of the material to form the desired structure.
There are variants of Lithography
such as Photolithography,
X-Ray Lithography,
focused ion beam lithography depending on the source of energy and the surface.

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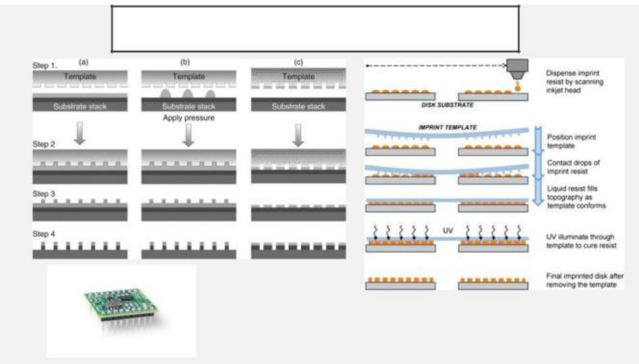
Bottom-up nanofabrication, In this approach, materials of atomic or molecular scales are used as building blocks for the formation of nanostructures. This approach is also known as nanomanipulation, describing the process of moving and modifying objects at the atomic/molecular scale.

Bottom-up processes are based on thermodynamic and kinetic aspects that define the outcome, as opposed to the deterministic nature of top-down approaches.



1.Nanofabrication Process
2. Top- Down Lithography
3.MEMS Sensors- Micro
Electro Mechanical Sensors

MONITORING NANOTECHNOLOGY WITH MICRO TECHNOLOGY (MEMS- MICRO ELECTROMECHANICAL SYSTEM)

Micro- electromechanical systems (MEMS) is a process technology used to create tiny integrated devices or systems that combine mechanical and electrical components. They are fabricated using Integrated Circuit (IC) batch processing techniques and can range in size from a few micrometers to millimeters.

It is a chip based technology where sensors are composed of a suspended mass between a pair of capacitive plates. When the sensors are tilted, a difference in electrical potential is created by the suspended mass . The created difference is then measured as a change in the capacitance.

MEMS sensors can be used in combinations with other sensors for multi sensing applications. In addition to developments based on Nano sensing techniques and nanomaterials, there is a growing trend to combine with MEMS, thereby exploiting the fabrication processes and characterized materials of micro technology.

In addition to the now- widely reported concept of depositing the Nano particulate , gads- responsive materials onto micro engineered silicon substrates, more innovative approaches related to gas and chemical sensing are now being developed.

Chemically modified gold nanowires are integrated into a microfluidic device to detect the cholesterol level in blood, the same group has deposited palladium nanoparticles onto etched porous silicon to detect hydrogen, and several groups have demonstrated ionization based gas sensors utilizing CNT arrays on silicon substrates to detect ammonia and other gases.

NANOPHOTONICS

Nanophotonics or Nano optics is the study of the behavior of light on the nanometers scale and of the interactions of nanometer scale objects with light. It is a branch of optical, optical engineering, electrical engineering and Nanotechnology. It often involves dielectric structures such as Nano antennas or metallic components which can transport and focus light via surface Plasmon polarities. The term Nano Optics usually refers to situations involving ultraviolet (UV) ,visible and near- infrared light (free space wavelengths from 300 to 1200 nanometers. It is designed for making quantitative measurements for intracellular environment.

Applications of Nanophotonics:-

It is possible to squeeze light into a nanometer scale using other techniques like surface plasmons, localized surface Plasmon around nanoscale metal objects and the nanoscale apertures and nanoscale sharp tips used in near field scanning optical microscopy(SNOM & NSOM) and photo assisted scanning tunneling microscopy.

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Nanophotonics strongly localized radiation sources(dipolar emitters such as Fluorescent molecules. . These sources can be decompose into a vast spectrum of plane nano waves with different wavenumbers., which corresponds to the angular spatial frequencies.

Fourier Transform of a spatial field distribution consists of different spatial frequencies corresponding to the very fine features and sharp edges.

A Fourier Transform (FT) is a mathematical Transform that decomposes functions depending on the space or time into functions depending on the space or time into functions depending on the spatial frequency or temporal frequency. That process is also called Analysis.

BIONANOSENSORS

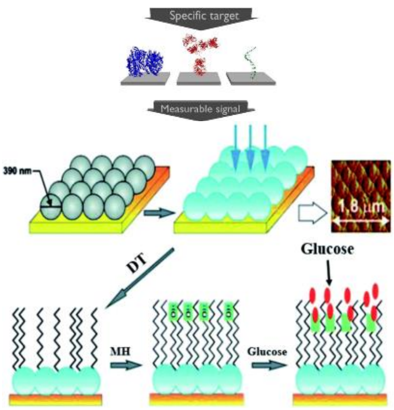
DNA Bio Nanosensors provide powerful tools for the rapid and sensitive determination of pathogens, diseases, genetic disorders, drug screening and other in vitro diagnostic applications. These provide early diagnosis even before the onset of clinical symptoms.

The nanobiosensors consist of the nanomaterials that possess properties that enhance the sensing mechanism, including nanotubes-based sensors, nanoparticles based biosensors, Nanowire- based sensors, quantum dots based sensors among the others.

In the Biosensors, the role of the transducer is to convert the bio recognition event into a measurable signal. This process of energy conversion is known as sognalisation. Most transducers produce either optical or electronic signals but they are usually proportional to the amount amount of analyte- Bioreceptor Interactions.

BIONANOSENSORS PLATFORM FOR RAPID HIV DETECTION

1.Bionanosensors Signals for HIV Detection
2.Detection and Diagnosis using Mechanical, Chemical and Optical Sensors



Piezoelectric Crystal (QCM) - The principle on which piezoelectric biosensors operate is the change in mass via bimolecular, I.e.- Antigen, Antibody , interactions. Quartz crystal, a widely applied piezoelectric biosensor , transduces mass change into altered reason frequency.

Quartz crystal microbalance (QCM) is capable of direct detection of analytes, I.e Bacterial cells and eliminates the need for labeled secondary antibodies. In general , detection devices based on piezoelectric materials that generate surface acoustic waves are capable of relatively simple, robust and rapid real time measurements.

Bionanosensors (BNS) – It is based on antigen – antibody interactions to detect HIV 1 and 2.

MAGNETORECEPTOR

Magnetoreceptpr us a type of Magnetic Nanosensor composed of Nanomaterials such as Aluminium Oxide and Magnetic Protein to detect the neural signals inside the Body . Magnetoreception is a sense which allows an organism to detect the Earth's Magnetic Resonance/ field.

The Magnetic simulation transmits the neural activity mapping and an on-site electromagnetic induction in the semicircular vestibular canals takes place with the magnetic induced degradation voltage spikes .

Magnetoreception takes place based on electrosensitive molecules- The semicircular canals convert into electrosensitive ion channels by the process of Immunohistochemistry.

INTEGRATION OF NANOTECHNOLOGY WITH INTERNET OF THINGS (IOT)

Nano sensors IOT sensors must monitor specific phenomenon in sensing environments to provide relevant data for subsequent analysis.

A flexible nanowire based sensor for real time ammonia (NH3) monitoring . The sensor developed to be used within a watch type device, displaying a lower detection limit and faster response time than traditional NH3 sensors. Primarily due to nanowires extremely high and face area to volume ratio.

IONT & IOT Future Research – A fascinating area tackling the issues surrounding sensor and Nano sensor sensors supplies may have found its solution for energy harvesting, where energy is derived from external sources and then converted into useful electrical energy.

APPLICATION OF NANOTECHNOLOGY IN AGRO ECONOMIC SYSTEM

The Nano technological advances of the signal transduction method has categorized the modest devices into different types such as optical, electrochemical, piezoelectric, piezoelectric, electronic and gravimetric biosensors.

The hybridization of Nano materials with bio sensing offers a great deal of conjointly and multipurpose approaches for enhanced sensitivity for detection and thereby improves the capability in monitoring a single molecular form.

Nano sensors in Pesticide Detection - Pesticides find broad applications in agricultural systems for the avoidance, regulations, or abolition of pests, insects, weeds , fungi to increase the productivity of agro ecosystems. The physicochemical change produced due to the interactions of the target analytes with the bio receptor is converted into an electrical signal.

In recent years, a great deal of superior visual recognition bio and Nano analytes have been employed for detection of several composites from the vast array of samples.

The optical sensor is composed of a recognition element that is specific for the particular residual pes and can network with the constituent, the transducer, which is employed to produce the signal for the binding of a particular Pesticide residue to the sensor. Nano sensors are used in the detection and implementation of plant pathogens.

NANOSENSORS - RECENT PERSPECTIVES OF ATTAINMENTS AND FUTURE PROMISE OF DOWNSTREAM APPLICATIONS

Nano sensors are sensing devices with a dimension of less than or equal to 100 nm. They are incredibly tiny devices that transform physical, chemical, or biological substances into detectable signals.

This device's capacity to detect the physical and chemical changes, nanotechnology has emerged as a technology of choice in a variety of industries.

This device provides efficient and cost effective methods for detection and measurement operations of chemical and physical characteristics.

NANO CANTILEVERS

Nanocantilever
VOC Nanosensors- Made of Volatile organic compounds.

These are a strip of silicon carbide, which is a few hundred nanometers in width, whose vibrational frequency varies in proportion to the mass of objects resting on it are referred to as Nano Cantilever.

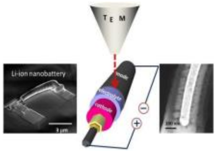
These devices are being used to develop sensors that can detect single molecules. These sensors take advantage of the fact that the Nano cantilever oscillates at a resonance frequency that changes if a molecule lands on the cantilever, changing its weight.

Another use of the Nano particles is in the detection of volatile organic compounds (VOCs). Thus by embedding metal Nano particles made of substances such as gold in a polymer film, we create a VOC Nano sensor. Sensors are also being developed detect molecules that indicates that a particular disease is present in a blood sample.

NANO LITHIUM BATTERIES

- Working of a Lithium ion Battery
  The movement of the lithium ions creates free electrons in the anode which creates a charge at the positive current collector. The electrical current then flows from the current collector through a device being powered (cell phone, computer, etc.) to the negative current collector.

- Nanosized Battery under Transmission Electron Spectroscopy (TEM)



Nano batteries are fabricated batteries employing technology at the nanoscale particles that measure less than 100 nm. These batteries may be Nano in size or may use Nanotechnology in a macro scale battery. Nanoscale batteries can be combined to function as a macro battery such as within a Nano pore battery .Traditional Lithium- ion batteries technologies uses active materials, such as cobalt oxide(Co2) or manganese Dioxide(MnO2) with the particles that range in size between 5and 20 micrometers.

An ion Battery converts chemical energy to electrical energy and is composed generally of a) Anode b) Cathode The c) Electrolyte. The Anode and cathode have two different chemical potentials which depends on the reactions that occur at either terminus. The electrolyte can be a solid or a liquid referring to a dry cell or wet cell respectively and is ionically conductive. The boundary between the electrode and the electrolyte is called the solid electrolyte interphase (SEI). An applied voltage across the electrodes causes the chemical energy stored in the battery to be converted to electrical energy.

Advantages of Nano Batteries:-

• Increasing the available power from a battery and decreasing the time required to recharge a battery . These benefits are achieved by coating the surface of an electrode with nanoparticles , increasing the surface area of the electrode thereby allowing more current to flow between the electrode and the chemicals inside the battery.

Nanomaterials can be used as a coating to separate the electrodes from any liquids in the battery , when the battery is not in use. In the current battery technology, the liquids and solids interact, causing a low level discharge. This decreases the shelf – life of a battery.

APPLICATION OF NANOSENSORS IN WATER TREATMENT

Nanosensors are any biological, chemical, or physical sensory point used to transport information about nanoparticles to the macroscopic world. Quality of Water is an issue of interest to the entire community. It is important to measure parameters such as PH, total hardness, and alkalinity to determine how the environment affects the tributaries. Alkalinity is defined as the buffering capacity of water to neutralize acids . Therefore it is important to design a nanosensor system for the measurement of these parameters for the subsequent water treatment.

IOT has come to represent electrical or electronics devices of varying sizes and capabilities, that are connected to the Internet. The scope of the connections is broadening to M2M communications. Thus , it will provide real time data from the sensor nodes across widely distributed areas. This concept can be used in water supply and management. IONT using nanomaterials will also provide us real time monitoring of water quantity and quality using Nano Carbon particles as well.

Nanosensor has three components- a) Nanomaterial b) Recognition Element c) Mechanism for signal transduction. Nanosensor detects a signal from the analyte with the help of recognition elements that binds specifically to the given target. Monitoring of water quality whether in a small or large scale is a complex process due to various factors like concentration of pollutants, variability, in the nature of pollutants like pathogens, metal ions, inorganic chemicals and water quality sensing parameters like PH, hardness and turbidity.

NANOTECHNOLOGY IN THE FIRE ANDSAFETY MANAGEMENT SYSTEM

• Nanomaterials in Personal Fire Protection - The scope of personal fire protective equipment includes devices, equipment and clothing that are structured with narrow najo carbon tubes to ensure safety and protect against fire. Carbon Nanotubesand 2D particles in the form of nanotubes or graphene nanosheets are most often used for the fire retardancy. When nanofillers such as graphene nanosheets or carbon nanotubes are used as flame retardants for polymers, the major flame retarding mechanism is through the char layer formation. The low filler to filler distance and high interface area of these carbon nanomaterials promote the formation of compact, thick dark layers of char that decelerate the fire speed. The Nanofibers consists of a core of triple nylon phosphate (TPP) – a widely used flame retardant sheathed in a nylon 6 shell. When exposed to firen, the fibers of nylon 6, outer layer melt down and the TPP flows out quickly extinguishing the flame .

Here are many potential benefits that can be gained by leveraging Nanotechnology for the safety methods:-

- Smoke Alarms that can detect particles at the very start of the fire using the Nanosensors.
- Fire Resistant nanocoatings that increase material strength and durability to better withstand high thermal energy.
- Fire suppression systems using various chemical mixtures broken down to particle size to better extinguish the fire.
- Fire resistant nanocoatings on fuel import lines and engine components to prevent vehicle fires suddenly.

NANOTECHNOLOGY IN THE FIRE SAFETY

Nanosensors with the Fire alarms with nano chip transmitting signals during the fire .

CONCLUSION

The purpose of this presentation is thus to provide a technical review of the Nano sensors research. It considers a range of emerging Nano sensing technologies and some specific areas of applications. However the primary efforts surrounding Nano sensors largely remain in research and development

Some Nano sensors in development for defense applications include Nano sensors fir the detection of the Explosives and toxic gases.

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