Nano-Material's and its Potential Applications in the Field of Renewable Energy

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Abstract— **The sustainable energy systems development is among the most essential challenge of the 21st century. Nanotechnology potentially provides solutions changing of problems related to energy technology, because energy conversion process of practical significance occurs at interface and surface, which are ample in nano structured materials. Materials properties can be particularly modified and combined to produce highly effective, modified, multi-functional materials for quick conversion, storage, and 'consumption' of energy. Additionally, in many manufacturing processes, the use of nano-structure precursor leads to a decrease in the cost, necessary quantity of material, or process temperature, which enables production routes of unrivalled energy efficiency.**

Keywords- Nano-material; Renewal energy

I. INTRODUCTION

"Nanotechnology" was first defined by NorioTaniguchi of the Tokyo Science University in 1974. Nanotechnology1-3, shortened to "Nanotech", is the study of manipulating matter on an atomic and molecular scale. In general nanotechnology deal with structures sized between 1 to 100 nm and involves increasing materials or devices within that size. For comparison, Human is 1000 times bigger smaller than the diameter of a 10 nanometers. Nanotechnology has the ability to improve our facility to prevent, detect, and remove environmental contaminants in air, water, and soil in a cost effective and environmentally friendly manner. Over the past decades, there have been many forecasts on the future reduction of the fossil fuel reserves on earth as well as the rapid increase in green-house gas emissions. There is clearly an vital necessity for the development of renewable energy technologies. On a different edge, growth and influence of materials on the nanometer scale have developed at a fast rate. Designated recent and significant advances in the development of nano-materials for renewable energy applications are reviewed here, and special emphases are given to the studies of solar driven photo catalytic hydrogen Production electricity generation with dye-sensitized solar cells, solid-state hydrogen storage, and electric energy storage with lithium ion rechargeable batteries.

The promising of the nanotechnology arrives now in time when the issue of energy crisis and global climate change become a major issue. In the past people were sure about the future shortage of fossil fuels but unconvinced about the climate change. Nowadays, we're definitely sure about global warming and realized that more fossil resources might even jeopardize the climate further. Renewable energies are the answers to both issues. However, most of the renewable energies are either premature or too high in cost for applications. Nanotechnology provides great opportunities for the renewable energy researches. Atomic scale manipulation and engineering at the interface, surface of the components open up devices such as next-generation photovoltaic cells, super-capacitors, hydrogen storage materials, high efficiency thermal electric converter, low cost and long lifetime fuel cells, next generation batteries, etc.

The application of nano-materials can be previously traced back to even before the generation of current science and technology. In 1857, Michael Faraday published a paper which explained how metal nano particles affect the color of church windows. In1959, Richard Feynman (awarded Nobel Prize in Physics in 1965) gave a lecture titled "There's Plenty of Room at the Bottom", suggesting the possibility of manipulating things at atomic level. He speculated on the opportunity and potential of nano-sized materials. This is generally considered to be the foreseeing of nanotechnology. Many of his speculations12-16 has become actuality now. However, the real burst of nanotechnology didn't come until the early 1990s. In the past decades, refined instruments for characterization and manipulation17-20 such as scanning electron microscopy (SEM), transmission electron microscopy (TEM) and scanning probe microscopy (SPM) became more accessible for researchers to approach the nano world. In the early 1990s Huffman and Kraetschmer, discovered how to synthesize and purify large quantities of fullerenes21-26. This opened the door to their characterization and functionalization by hundreds of investigators in government and industrial laboratories.

II. SYNTHESIS OF NANO-MATERIALS

Samples will be prepared by using wet chemical routes. Hydrothermal method, SILAR method, chemical Bath deposition, sol-gel method, and micro-wave assisted method or any combination of these methods will be used by us to prepare ZnO/CNT nano-composites.

A. Sol-gel method:

Sol-gel processing is a wet chemical route for the synthesis of colloidal dispersions of inorganic and organic-inorganic hybrid materials, particularly oxides and oxide-based hybrids. This offers many advantages, including low processing temperature and molecular level homogeneity. It is particularly useful in making complex metal oxides, temperature sensitive organic-inorganic hybrid materials, and thermodynamically unfavorable or metastable materials.

B. Hydrothermal method:

Hydrothermal Synthesis is a common method to produce zeolite/molecular sieve crystals. This method exploits the solubility of almost all inorganic substances in water at elevated temperatures and pressures and subsequent crystallization of the dissolved material from the fluid. The properties of the reactants, including their solubility and reactivity, also change at high temperature. The changes mentioned above provide more parameters to produce different high-qualities nano-particles and nano-tubes, which are not possible at low temperatures.

C. Chemical Bath deposition:

CBD method is one of the inexpensive methods to deposit thin layers and nano-materials. It requires only solution containers and substrate mounting devices. CBD yields unchanging, adherent, consistent and hard films with good reproducibility by a relatively simple process. The growth of thin films strongly depends on development conditions, such as time of deposition, composition and temperature of the solution, and topographical and chemical nature of the substrate.

D. SILAR method:

Successive ionic layer adsorption and reaction (SILAR) method, has developed as one of the solution methods to deposit a multiplicity of compound materials in thin film form. This method is low-cost, simple and convenient for large area deposition. A variety of substrates can be used since the deposition is carried out at or near to room temperature. As a low temperature process, it also avoids oxidation and rust of the substrate. It is also known as modified version of chemical immersion deposition.

E. Micro-wave assisted method:

Microwave assisted wet chemical (MAWC) method is an attractive approach for the growth of ZnO nanostructures because of its simplicity, low temperature process, and most importantly suitability for large-scale production on arbitrary substrate. In MAWC method, the use of microwave radiations enhances the growth rate since it supplies the energy directly to the originator molecules. Hence the efficiency of this method is high. It has the advantages of homogeneous volumetric heating and high reaction rate compared with other physical and chemical methods.

III. Properties Of Nanomaterials

A. Physical properties

Nano-materials and Nanotechnologies attract incredible attention in recent researches. New physical properties andnew technologies both in sample preparation and device fabrication suggest on account of the development of nano-science. Various research fields including physics, chemists, material scientists, and engineers of mechanical and electrical are concerned in this research. We express the exotic physical properties concerning the linear and nonlinear optical spectra, temperature dependence of resistivity's, spin resonance spectra, and magnetic susceptibility measurements. A number of fascinating and provocative results have been developed that lead our perspective sympathetic of quantum tunneling, quantum phase transition, surface effect, quantum size-effect confinement and nonlinear susceptibility enhancements.

B. Mechanical properties

The large quantity of grain boundaries in bulk materials made of nano-particles allows extended grain boundary sliding leading to high plasticity.

C. Chemical Properties

Chemical properties of nano-materials also change at nano-scale. As the percentage of surface atoms in nano-particles is large compared with bulk objects, therefore reactivity of nonmaterials are more than bulk materials. The preponderance of surface is a major reason for the change in behavior of materials at the nano-scale. As up to half of all the atoms in nano-particles are surface atoms, properties such as electrical transport are no longer determined by solid-state bulk phenomenon. The atoms in nano-materials have a higher average energy than atoms in longer structures, because of the larger proportion of surface atoms.

D. Catalytic Properties

Due to their large surface, nano-particles made of transition element oxides exhibit interesting catalytic properties. In special cases, catalysis may be enhanced and more specific by decorating these particles with gold or platinum clusters.

E. Magnetic Properties

In magnetic nano-particles, the energy of magnetic anisotropy may be that small that the vector of magnetization fluctuates thermally; this is called super paramagnetic. Touching super paramagnetic particles are losing this individual property by interaction, except the particles are kept at distance. Combining particles with high energy of anisotropy with super paramagnetic ones leads to a new class of stable magnetic materials.

F. Optical Properties

Distributions of non-agglomerated nano-particles in a polymer are used to tune the index of refraction. In addition, such a process may produce materials with non-linear optical properties. Gold or CdSe nano-particles in glass lead to red or orange coloration. Semi-conducting nano-particles and some oxide-polymer nano-composites exhibit fluorescence showing blue shift with decreasing particle size.

G. Electrical Properties

Electrical Properties of Nano-particles" discuss about fundamentals of electrical conductivity in nano-tubes and nano-rods, carbon nano-tubes, photoconductivity of nano-rods, electrical conductivity of nano-composites. One interesting method which can be used to express the steps in conductance is the mechanical thinning of a nano-wire and measurement of the electrical current at a constant applied voltage. The important point here is that, with decreasing diameter of the wire, the number of electron wave modes contributing to the electrical conductivity is becoming increasingly smaller by well-defined quantized steps.

IV. Applications Of Nano-Materials

The unique and tunable properties of carbon-based nanomaterial senable new technologies for identifying and addressing environmental challenges. This review seriously assesses the contributions of carbon-based nano-materials to a broad range of environmental applications.

A. Bio-solar Cell

Photovoltaic's (PVs) essentially consist of solar cells fabricated from semiconductors that convert energy from sunlight into electrical power. Therefore, potentially they are one of the most important renewable energy sources. Existing crystalline silicon solar cell technologies involve high material costs and face a severe shortage of raw wafers. Consequently, although the ''fuel'' for a solar-powered generator is sunlight, which is ''free,'' the overall cost of solar-generated electricity is still much greater than the cost of electricity generated by burning fossil fuels or through nuclear reactors. The silicon solar cells widely used for terrestrial applications have the greatest efficiency (defined as the electrical energy produced for a given input of solar energy). However, over the years, despite the introduction of thin film technologies, neither greater efficiency nor reduced manufacturing cost of solar cells could be achieved for wider acceptance in terrestrial power generation.

B. Light-activated Protein-sensitized Solar Cells

There have been reports in the literature leveraging light-harvesting proteins as sensitizer's in photovoltaic cells, bR. Photosynthetic reaction center based photovoltaic cell was reported by Lu. Photoelectric differential response of bR-based photocell has been reported by Yao. Oriented bR films were deposited on indium-tin oxide (ITO)-conductive glass by electrophoretic sedimentation and as Langmuir-Blodgett (LB) film. The bR film photo cell was constructed as a sandwich-type electrochemical cell comprising junctions of ITO/bR/electrolyte/counter electrode. Recent studies by Wang et al. have demonstrated that dried bR film can be used in simple highly sensitive photo detector designs. Li et al .have measured the photo voltage generated in an ITO detector by introducing polarization sensitivity through a photo chemical bleaching process. Bertoncello et al. have reported on the photovoltaic performance of bR LB films and compared them with organic and inorganic nano-structured solar materials and concluded significant increases in performance.

C. Fuel cells

A fuel cell is an electrochemical energy conversion device that converts the chemical energy from fuel (on the anode side) and oxidant (on the cathode side) directly into electricity. The heart of fuel cell is the electrodes. The performance of a fuel cell electrode can be optimized in two ways; by improving the physical structure and by using more active electro catalyst. A good structure of electrode must provide ample surface area, provide maximum contact of catalyst, reactant gas and electrolyte, facilitate gas transport and provide good electronic conductance. In this fashion the structure should be able to minimize losses.

V. Elimination of Pollutants

Nano-materials possess extremely large grain boundaries relative to their grain size. Hence, they are very active in terms of their chemical, physical, and mechanical properties. Due to their enhanced chemical action, nano-materials can be used as catalysts to react with such harmful and toxic gases as carbon monoxide and nitrogen oxide in automobile catalytic converters and power generation equipment to prevent environmental pollution get up from burning gasoline and coal.

A. Sun-screen lotion

Prolonged UV exposure causes skin-burns and cancer. Sun-screen lotions containingnano-TiO_2 provides enhanced sun protection factor (SPF) while eliminating stickiness. The added advantage of nano skin blocks (ZnO and TiO_2) arises as they protect the skin by sitting onto it rather than penetrating into the skin. Thus they block UV radiation effectively for prolonged duration. as well, they are transparent, thus retain natural skin color while working better than conventional skin-lotions.

B. Sensors

Sensors rely on the highly active surface to initiate a response with minute change in the concentration of the species to be detected. Engineered monolayer's (few Angstroms thick) on the sensor surface are exposed to the environment and the peculiar functionality (such as change in potential as the CO/anthrax level is detected) is utilized in sensing.

VI. Conclusions

Environmental implications of nano technology, with a research question "What are the renewable energy implications of Nanotechnology", carried out the study with a primary objective of studying the potential applications of nano technology and assessing their potential implications to the environment.

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