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Production and Identification of Nano-Sized Iron Oxide for Ecological Applications

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Abstract

Synthesis of Nanomaterials: "In other words, this is a top-down approach. Through this method, nanoparticles having magnetic and catalytic capabilities have been fabricated. Ball milling and subsequent annealing are simple ways for producing vast amounts of varied Nano powders. Atomic-level alloying is accomplished by the milling of elemental blends, pre-alloyed powders, and ceramics. Put four balls made of hardened steel in a stainless steel container with some graphite powder. The "Argon gas is used to purge the container (Shah and Ahmad, 2010). The pieces are annealed at 1400°C in a vacuum after undergoing extensive grinding. There has been no breakthrough in understanding the mechanism behind this procedure. According to this idea, mechanical alloying involves a process in which "Ball impacts repeatedly shatter an alloy and then cause it to consolidate at the impact site. Manufacturing Mg2Ni since then has included a solid-state mechanical alloying technique using powdered components (Iturbe-Garca et al, 2010). Nanoscale materials have garnered a lot of interest because to the fact that their unusual physical properties set them apart significantly from their more common coarser equivalents (Mandal et al., 2008, Deb et al., 2001). These micro-sized items are larger than atoms and molecules but much smaller than solid blocks. Just because "because they violate the laws and principles of absolute quantum chemistry and classical physics. Nano-phase and nanostructure materials are essential building blocks in many fields, including electronics, due to their ultra-small dimensions, large surface areas, useful interfacial defects, and interface-dominated nature "as well as in the fields of optics, pharma, paint, coating, superconductors, semiconductors, and catalysis. Dye and pigment consumption has increased dramatically in recent years (Dong et al., 2011, Zhou et al., 2010). Dye waste is a well-known environmental pollutant, and some of it is toxic or even carcinogenic (Wang et al., 2005, Zhu et al., 2012). These colours are very apparent in water even at very low concentrations and should be avoided (Hu et al., 2010). Chromophores are what give a molecule its colour, while auxochromes are what make it more water-soluble and increase its affinity "these two elements are the primary reason why molecules of colour may exist (Gupta et al., 2009)

Keyword: Semiconductors, Nano-Structure Materials, Atoms and Molecules

INTRODUCTION

Nanostructured materials, such "as grains, layers, or forms smaller than 100 nm, have sparked a surge in interest in nanotechnology (Hornyak et al., 2009). Unlike other materials, nanomaterials have unique features that are unique to the nanometer scale. At least one dimension of a nanomaterial must fall below" 100 nm (Chattopadhyay et al., 2009). Inorganic nanostructures, comprising metal oxides, ceramics, and composites, have become a mature, interdisciplinary topic during the "past two decades as a consequence of international efforts in both theory and experiment. It is well-known that nanostructured materials are stable, environmentally friendly, and have a wide range of technical applications (Bhushan et al., 2010). Surface-dominant nanostructure metal oxides have the potential to virtually replace all bulk metal oxides in a wide range of applications, including: catalysis, solar cells and hydrogen storage batteries; membrane and separation technology; structural applications that require a high degree of rigidity; sensor technology; optical and electronic devices and devices for tissues; and so on (Wang" et al., 2009, Kim et al., 2010). Another reason for the increased interest in one-dimensional "nanostructures is that they have unique and exciting qualities that cannot be found in their bulk or particle counterpart. This includes nanowires, nanotubes, nanorods and nanofibers (Tiwari et al., 2012, Zhang et al., 2008). Our research has concentrated on iron oxide and alumina 1D nanomaterials as well as a mixed nanocomposite of these two materials. Ceramics rely heavily on alumina and iron oxide as their primary building blocks. Alumina has a wide range of potential qualities in terms of both chemistry and physics. As a catalyst for various chemical processes, in microelectronics, membrane applications, and wastewater treatment, it is a frequently used electrical insulator with great chemical resistance. As a result, iron oxide has a significant impact on the natural world and is widely employed in a variety of technical fields. Because of its antiferromagnetic characteristics, it is an n-type semiconductor. It can be used in a variety of environmental and biochemical applications because of its low toxicity and ability to catalyse several chemical processes. Nanocomposite production, on the other hand, aims to maximise the synergistic impact of the two" metal oxide compounds involved. The ability to control the inter-particle electron transfer in composite nanomaterials provides an advantage over individual nanomaterials (Zhang et al., 2009).

Literature Review

When working with nanoscale materials, new manufacturing methods must be used in order to create diverse shapes and "morphologies. Sol-gel, hydrothermal, and electrospinning methods have been employed in our work to synthesise 1D alumina, iron oxides, and their mixed oxides nanostructures. Many people are interested in the potential applications of nanomaterials in environmental research and engineering. Human health depends on a healthy environment. It is becoming increasingly difficult to fulfil the ever-increasing demands for environmental cleanliness in" the modern society (Zhang et al., 2010). For the identification and remediation of "environmental contaminants, nanomaterials are a potent tool. The use of nanomaterials to clean the environment and tackle environmental concerns has been the subject of recent study. A new class of functional materials, nano-sized materials, can be employed as effective

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adsorbents because of their high surface area to volume ratio and surface active sites. Green chemistry, photo-catalytic degradation of organic dye, remediation of contaminated water, pollutant monitoring and detection, antibacterial activity and so on are all examples" of environmental uses of nanomaterials.

Nano-sized one-dimensional "polymer and ceramic materials such as alumina, iron oxide, and their composite oxides will be synthesised and characterised in this thesis. Toxic metal ions adsorption studies, elimination of organic dye from water and antibacterial applications have all been done with the nanomaterials and" their composites.

Statement of the Problem

Advances in nanoparticle structures for quantitative measurements have been made in recent years thanks to the development "of multifunctional nanomaterials (Chan et al., 1998). Composite materials are made up of a variety of different components that are intermingled. In many cases, the combination of different materials can disguise or lessen the negative qualities of the separate components. Multiple" components may be included into a single nanoparticle since each component is housed in its own compartment (Janczak et al., 2012). At least one phase of a composite "nanomaterial must have a particle size in the nanometer range to qualify. There are several advantages to using a combination of nanomaterials in the form of nanocomposites (Novoselova, 2012). With their unique mix of qualities, these nanocomposites surpass their single-component" counterparts and are regarded as the 21st-century materials of choice.

Objective of the Study

- To investigate "the feasibility of using 1D Fe2O3/Al2O3" nanomaterials for removal of toxic "metal ions such as Cr, Pb, Ni, Cu, As, Hg and also organic dyes from aqueous solution by chemisorption / adsorption" process.

Research Questions

- What are the "feasibility of using 1D Fe2O3/Al2O3 nanomaterials for removal of toxic metal ions such as Cr, Pb, Ni, Cu, As, " Hg?

Research Methodology

An analytical grade of "aluminium iso-propoxide (AIP) with a purity of 99.0% will be achieved from S D fine, India. SRL, India supplied" the isopropanol (IPA) and acetic acid (AA) used in this experiment. Merck, India ltd. "supplied Congo red, sodium hydroxide, and nitric acid. Without any additional purification, all compounds are utilised. For the formulation and dilution of solutions, double distilled water will be employed. Using the sol-gel approach, we will be able to create boehmite (AlOOH) nanomaterials. Hydrolysis of aluminium isopropoxide (AIP) precipitated aluminium in the form of fine hydroxide gel, which will be used as an experimental approach. It will be first mixed with 2-propanol and acetic acid and water will be gently added to the mixture while it will be being stirred constantly. Molar ratios of AIP/AIP, H2O/AIP, and IPA/AIP will be all kept within acceptable ranges during the procedure. Using a water bath, the precipitate will be heated to 80°C for 20 hours, filtered, washed with 2-propanol, and dried for 8" hours.

Research Design

Developing nanomaterials with a "well-defined size and shape is a significant problem. Nanomaterials can be synthesised in a variety of ways, depending on the material of interest and the size range. Nanomaterials may be synthesised by producing a high number of nuclei and preventing the development and aggregation of grains. This is the underlying idea. Physical procedures and chemical methods may be used to synthesise a wide range of metals, metal oxides, sulphides, polymers, and" composite nanomaterials, which can be divided into two groups.

1. Physico-chemical techniques

There have been several ways "to synthesise and commercially produce a variety of nanomaterials, thin films, and nanocomposite during the past few decades. Most of the physical pathways utilised to synthesise" nanomaterials may be summarised as follows.

2. Laser-assisted tissue removal.

Thermally activated high-power laser pulses will be utilised to remove carbon from a target in the laser ablation technique. "Nanocrystalline thin films and powder may be deposited using this approach.. Thus, the target surface is hit by a supersonic stream of particles (plume). Different particles in the plume have a high forward velocity distribution as it extends away from the target. In either a vacuum or" with some background gases, the ablation process takes occur. The substrate must "be heated to a high enough temperature (about 700-800°C). High melting point elements and transition metals can both benefit from this procedure. Compounds of sulphides have been made using this technique. Traces of very poisonous and radioactive elements can also be removed using this procedure. This approach has the benefit of being able to produce materials at a rate of 2-3 gm/min. A reactive pulsed laser ablation of a metallic nickel target in an oxygen environment will be used to create nanocrystalline NiO thin-film electrodes (Wang et al., 2002). Different results will be obtained by laser ablation of gold immersed in various" liquid alkanes, from n-pentane to n-decane (Compagnini et al., 2003, Dahl et al., 2007).

3. Condensation of inert gases

The first method to produce nanocrystalline metals and alloys will be gas condensation. An inert gas, commonly He or Ar, is used in conjunction with a low-pressure evaporation chamber to chill a substance before it is evaporated. As a result, this process is known as "inert gas evaporation," or IGE. "Nanoclusters are formed by collisions between evaporated atoms or molecules and gas atoms or molecules. Thermal evaporation sources such as Joule heated refractory crucibles and electron beam evaporation devices are used to evaporate metallic or inorganic materials in an environment of 1-50 m bar. Gold and palladium nanoparticles will be created by inert gas condensation on a sputtering reactor, where researchers observed that the particles" are icosahedral in form and there is no indication of a core-shell structure.

4. Process using a high-powered ball mill (Mechanical alloying method)

For nanomaterial "synthesis, this is a top-down strategy. Nanoparticles with magnetic and catalytic properties have been created using this technology. In order to produce large quantities of diverse nanopowders, ball milling and subsequent annealing are straightforward methods. Milling of elemental blends, pre-alloyed powders, and ceramics is used to accomplish atomic-level" alloying. Four hardened steel balls are placed in a stainless steel container with graphite powder. The container is flushed with argon (Shah and Ahmad, 2010). After a lengthy period of "milling, the parts are annealed at 1400°C in an inert environment. This process's mechanism is still a mystery. Mechanical alloying, according to this theory, is a process in which an alloy is continuously fragmented and coalesced at the collision site owing to ball collisions. Since then, Mg2Ni has been produced through mechanical alloying of powdered" elements in a solid-state process (Iturbe-Garca et al, 2010).

5. The use of chemical vapour deposition.

Materials processing method known as chemical vapour deposition (CVD) is frequently employed. Substrates are subjected to one or more volatile precursors, which are then reacted to form a solid deposit or thin film on the surface of the substrate. Solid thin-film coatings on surfaces are the "most common use of this technology, but it is also used to generate high-purity nanomaterials and powders, and to fabricate composite materials using infiltration methods (Creighton et al., 2001). Because of CVD's versatility, the chemistry is quite diverse and involves a wide range of chemical reactions. While low temperature CVD produces MWNTs, high temperature CVD (900-1200°C) produces SWNTs, according to the general experience. Depending on the parent materials, carbon nanofibers and nano beads may also be generated (Bhattacharjee et al., 2012). Single-walled carbon nanotubes (SWNTs) with highly graphitized structures will be recently produced utilising an enhanced nitrogen-pretreatment Fe-Mo/MgO catalyst. They concluded that nitrogen pretreatment boosts the catalytic activity and facilitates the growth mechanism to produce longer SWNTs from the overall observation. SWNTs with" extended, highly graphitized lengths will be also manufactured (Patil et al., 2012).

6: Electrodeposition

Nanomaterials with regulated form and size may be created via template-assisted electrodeposition. The growth of "applied electrochemistry has been accelerated by advances in materials science. This technology uses an electrochemical cell and either an active or restricted template as a cathode to create arrays of nanostructured materials with particular layouts. As a result, electro deposition of oxide films from aqueous solution has a number of benefits over other procedures. This technology is particularly useful for vast areas that need low-cost, low-temperature processing. Either an immediate or a gradual nucleation is formed during electro deposition. Research by Moghaddam et al. has examined the synthesis of ZnO nanoparticles and the electrodeposition" of a polypyrrole/ZnO nanocomposite film (2009). In-situ electro "deposition was also used by Li et al. (2013) to create polyaniline nanoparticles (PANI). When PANI" nanoparticles will be electrodeposited, the growth time will be used to regulate their shape.

Data Analysis

In this investigation, we will develop a method for synthesising Fe2O3 and Al2O3 nanocomposites using hydrothermal methods. The Al (NO3)3•9H2O and FeSO4.7H2O salts will be dissolved in equal volumes of distilled water. Then, "All of the components in the solution will be mixed together by vigorously shaking the container. In addition, 25 ml of 2M NH3 solution and 25 ml of NaOH solution will be combined at a ratio of 1:1 to produce a mixed precipitant. Drop by drop, the combined precipitant can be dissolved in the aforementioned combination solution with vigorous stirring. The solution's pH will be measured in real time using a pH metre. In this case, the green precipitate was formed at a pH of 5.6. The precipitate that had developed in the whole solution will be transferred to a new container using a 100 ml teflon-cupped pressure cooker. The pressure cooker will be sealed before being placed in an electric oven preheated to 180 degrees Celsius for a period of six hours. Once the product has cooled to room temperature, it will undergo many rounds of centrifugation and deionization, drying at 50°C for five to six hours, and grinding into a powder "powder. Calcinating the bright yellow powder at temperatures between 500 and 1000 degrees Celsius will produce a Fe2O3-Al2O3 nanocomposite.

Before making Fe2O3-Al2O3 composite nanofibers, Fe2O3 nanofibers will be made using electrospinning. To make a 10% wt% PVP solution, we shall dissolve PVP polymer power in 100% ethanol and violently mix in iron acetylacetonate as an iron precursor." The iron precursor sol will be mixed with the PVP/ethanol solution after 1-2 drops of acetic acid have been added to the mixture. We'll always use a 2:1 polymer to iron precursor ratio. We mixed up some iron acetylacetonate-PVP in a 3 ml plastic syringe using a metal needle. The polymer solution will be fed to the needle tip through syringe pumping at a constant feed rate of 1.5 ml/h. A variable high voltage (Glassman, Japan) power supply (12.5kV) will have one of its electrodes attached to the needle; the other electrode, which will be covered in aluminium film, will be linked to the grounded collector. The distance from the collector to the tip of the needle will be 10 centimetres. All experiments will be conducted at an ambient temperature and humidity level of 45-50%. Nanofibers of Fe2O3 will be produced by calcination of the as-spun "high-temperature composite fibres

The required quantity of "To create a polymer solution, 12 weight percent of polyacrylonitrile (PAN) polymer will be dissolved in DMF solvent. Two to three hours of stirring with a magnetic stirrer at ambient temperature should be enough to produce a transparent solution. The PAN/DMF mixture will be stirred for a further hour after the addition of AgNO3, and then thrown away. At that point, it will be agreed that the answer should be cut in half. One portion of the fluid is removed using a metallic needle attached to a 3 ml plastic syringe in preparation for the electrospinning procedure. The syringe pump will be utilised to continuously dispense the PAN solution containing silver ions to the needle tip. The needle's positive and negative electrodes, made of aluminium foil, will be connected to the grounded collector through a high-voltage power supply (Glassman Japan). The distance between the end and the storage was maintained at 15 centimetres throughout. Each experiment will be conducted at room temperature with 50% to 55% relative humidity. In this situation, heating or chemical reduction might transform the silver ions in the PAN nanofibers into metallic silver. A piece of the as-spun PAN/AgNO3 composite membrane will be immersed in a 160°C 0.1 M NaBH4 aqueous solution for 30 minutes at room temperature. Polyaniline nanofibers "After being washed with distilled water, the silver nanoparticles will spend two hours baking at 60 °C.

CONCLUSION

An important ceramic material with potential chemical and physical characteristics is one-dimensional nanosized "alumina, especially boehmite phase, and iron oxides. We developed one-dimensional aluminium and" iron oxide nanocomposite materials in this dissertation.

Sol-gel, hydrothermal, and electrospinning procedures have all been used to successfully produce rod and fibre "shaped alumina, iron oxide, and iron oxide-alumina mixed nanocomposite in the current study. Different characterization techniques like FT-IR, XRD, SEM-EDAX, TEM, TGA-DTA, BET, UV-Vis and AAS have been used to characterise the synthesised 1d nanomaterials and mixed oxide nanocomposites in terms of their synthesis, structural and size characteristics, surface morphology and sorption capacities. Both the hazardous metal ions like Cr (VI), Pb (II), Hg (II), Ni (II), fluoride (II), and organic dyes like Congo red will be removed from the aqueous solution using the alumina and iron oxide-alumina mixed nanocomposites that will be synthesised. To remove Congo red (CR) dye, it has been shown that needle shaped boehmite generated by the sol-gel process is a particularly effective adsorbent. With a maximum sorption capacity of 198 mg/g, 99 percent of CR may be removed in just 10 minutes of contact time. The adsorption ability of boehmite phase to remove CR dye diminishes with increased sintering temperature and subsequent conversion to alumina. Congo" red dye is effectively removed from alumina thanks to the absence of an oxyhydroxy group. Electrospinning has been used to make alumina nanofibers with a diameter of 100-500 nm. To remove Cr (VI) and fluoride (F-), the nanofibers made from alumina have proven to be an efficient adsorbent. For Cr (VI), the greatest removal will be found to "be 70%, while for fluoride ions, the maximum removal will be found to be 50%. As an added bonus, the pseudo-second-order rate rule governs the rate of adsorption. Chemically produced hydrothermal iron oxide-alumina nanocomposites will be employed to remove Congo red dye. Within 15 minutes of contact, Congo red dye will be completely removed (100 percent) by a mixed iron oxide-alumina nanocomposite, and the adsorption capacity will be reported to be 498 mg/g. The electrospinning process, on the other hand, has produced Fe2O3-Al2O3" nanocomposites.

Adsorbents for hazardous "ions such as Cr, Pb, Hg, and Ni are available. To understand why this material prefers to absorb a metal ion, we may look at the electronegativity of the metals and how they are in the anion/cation state. We observed that the metal removal affinity on the mixed oxide nanocomposite fibres surface" will be Cu Pb Ni Hg.

Limitations of the Study

Advances in nanoparticle structures for quantitative measurements have been made in recent years thanks to the development of "multifunctional nanomaterials (Chan et al., 1998). Composite materials are made up of a variety of different components that are intermingled. In many cases, the combination of different materials can disguise or lessen the negative qualities of the separate components. Multiple components may be included into a single nanoparticle since each component is housed in its own compartment (Janczak et al., 2012). At least one phase of a composite nanomaterial must have a particle size in the nanometer range to qualify. There are several advantages to using a combination of nanomaterials in the form of nanocomposites (Novoselova, 2012). With their unique mix of qualities, these nanocomposites surpass their single-component counterparts and are regarded as the 21st-century materials" of choice.

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