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For Environmental Purposes, The Production And Identification Of Nano-Sized Iron Oxide Is Being Investigated.

Wang Jun[1*], Aiman Al-Odaini[2], Mohammed Saleh Nusari[2]

[1*]*Research Scholar Lincoln University College Malaysia*
[2] *Lincoln University College Malaysia*

Abstract

Just to clarify, this is a method for top-down synthesis of nanomaterials. This process allowed for the creation of magnetic nanoparticles that have catalytic properties. By combining ball milling with annealing, a wide variety of nano powders may be easily produced. Metals, ceramics, and pre-alloyed powders are ground together to form atomic alloys. In a stainless-steel container, combine the graphite powder with four steel balls. Shah and Ahmad state that the container is purged using argon gas. A thorough grinding procedure is performed on the components before they are annealed in a vacuum at 1400°C. Researchers still don't know too much about how the process works. "Ball impacts repeatedly shatter an alloy and then cause it to consolidate at the impact site," states the hypothesis that underpins mechanical alloying. Iturbe-Garca et al. noted that since then, Mg2Ni manufacturing has included a solid-state mechanical alloying process using powdered components. Although they are much smaller than basic units, these microscopic objects are bigger than atoms and molecules.

Keyword: *Semiconductors, Nano-structure materials, Atoms and molecules, Environment*

1. Introduction

Recently, nanostructured materials—which are described as "as grains, layers, or forms smaller than 100 nm"—have brought nanotechnology back into the spotlight. In contrast to more conventional materials, nanomaterials have properties that alter as one approaches the nanoscale. According to Chattopadhyay et al. (2019), to be classified as nanoscale, a material must have a dimension less than 100 nm on at least one side. Thanks to theoretical and experimental efforts all across the world, inorganic nanostructures. According to Wang et al. (2019) and Kim et al. (2021), metal oxides that are mostly present on the surface of nanostructures might find several applications where bulk metal oxides are lacking. Membrane and separation technologies, structural applications using very stiff materials, sensor technologies, optical and electrical devices, tissue devices, and catalysis are all examples of such domains. Another reason one-dimensional "nanostructures" are becoming more popular is because they have intriguing and distinctive properties that their bulk or particle equivalents lack (**Byrappa et al., 2021).**

2. Background of the Study

In order to create materials with a broad range of nanoscale shapes and "morphologies," new manufacturing methods are necessary. In this research, researchers used sol-gel, hydrothermal, and electrospinning techniques to create 1D nanostructures of alumina, iron oxide, and mixed oxide. The potential applications of nanomaterials in ecological engineering and research have aroused the interest of several individuals. People can't stay healthy if they live in unhealthy environments. It is becoming more difficult to fulfil the increasing societal demands for ecological purity. When it comes to finding and eliminating "environmental pollutants," nanomaterials are a potent tool. Environmental remediation and issue solutions with nanomaterials have been the subject of recent study **(Cui et al., 2019).**

3. The purpose of the research

What researchers have here is a top-down approach to synthesising nanomaterials. Atomic level alloying is achieved via milling elemental blends, pre-alloyed powders, and ceramics. Graphite powder and four steel balls that have hardened are put in a stainless steel container. According to Shah and Ahmad (2010), the container is flushed with argon. The components undergo an inert-environment annealing process at 1400°C after a long grinding time. The mechanism of this procedure remains unknown. Mechanics say that when balls collide, "an alloy is continuously fragmented and coalesced at the collision site." This is called mechanical alloying **(Deng et al., 2019).**

4. Literature Review

Nanoscale materials with a wide variety of forms and "morphologies" need novel production techniques. 1D nanostructures composed of alumina, mixed oxides, and iron oxides were synthesised in this study using electrospinning, hydrothermal, and sol-gel techniques. In the search for and removal of "environmental pollutants," nanoparticles may prove to be very effective. Nanomaterials and their potential use in environmental cleanup and problem-solving have been the focus of several recent research **(Fouda et al., 2020).**

Materials like alumina, iron oxide, and composite oxides of these two elements are synthesised and studied in this thesis as one-dimensional nano-polymers. Among the many potentials uses for nanomaterials and composites, scientists have looked at adsorbing toxic metal ions, removing organic dyes from water, and creating antibacterial agents (**Goergen et al., 2021).**

5. Research Questions

1. What are the "analytical techniques to obtain the information on the surface morphology, dimension, porosity, crystalline structure and surface" active sites?
2. What are the "feasibility of using 1D $Fe2O3/Al2O3$ nanomaterials for removal of toxic metal ions such as Cr, Pb, Ni, Cu, As, " Hg?
3. What is the "correlation between surface properties of the synthesized nanomaterial and their sorption" activities?

6. Research Methodology

Anyone may get 99.0 percent pure "aluminium iso-propoxide" (AIP) by using S D fine. The analytical grade is next. Acetic acid (AA) and isopropanol (IPA) were provided by SRL, India, for this experiment. A Nigerian subsidiary of Merck India ltd. provided the nitric acid, Congo red, and sodium hydroxide. None of the chemicals undergo any further purifying processes prior to being used. The solution was diluted and prepared using double distilled water. Using the sol-gel method, researchers can create boehmite (AlOOH) nanoparticles. An experimental approach involving the hydrolysis of aluminium isopropoxide (AIP) produced a fine hydroxide gel containing precipitated aluminium. The second step, once 2-propanol and acetic acid have been blended, is to slowly add water while continually whirling. To ensure smooth operation, researchers were maintain suitable molar ratios of AIP to AIP, H2O to AIP, and IPA to AIP. Filtering, washing with 2-propanol, and drying for 8 hours follow 20 hours of heating to 80°C in a water bath before using the precipitate **(Hung-Low et al., 2019).**

6.1 Research Design

Creating nanoparticles that are "well-defined in size and shape" is a significant challenge. Nanomaterial production may be approached from several angles, with each method catering to a specific range of materials and sizes. Producing a large number of nuclei while inhibiting grain growth and agglomeration is one strategy for synthesising nanomaterials. Here researchers offer the basic concept.

1. Physico-chemical techniques

Synthesis and cost-effective generation of a wide range of nanomaterials, thin films, and composites have been the focus of several recent methodological developments. In this article, researchers were go over the main physical methods that are utilised to "synthesise" nanomaterials.

2. Laser-assisted tissue removal.

Laser ablation is a method for removing carbon from materials by use of pulses of highly concentrated lasers that are triggered by means of heat.It is possible to deposit nanocrystalline powder and thin films with this method. At high speeds, particles hurtle towards the surface that is being targeted.

3. Condensation of inert gases

Gas condensation is an initial process in the synthesis of nanocrystalline metals and alloys. In a low-pressure evaporation chamber, an inert gas (often He or Ar) may be used to cool the material prior to evaporation.

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

Using this method, nanomaterials are synthesised in a top-down manner. This method has been used to synthesise nanoparticles that possess magnetic and catalytic characteristics. Ball milling and subsequent annealing make it easy to synthesise a broad range of nanopowders..

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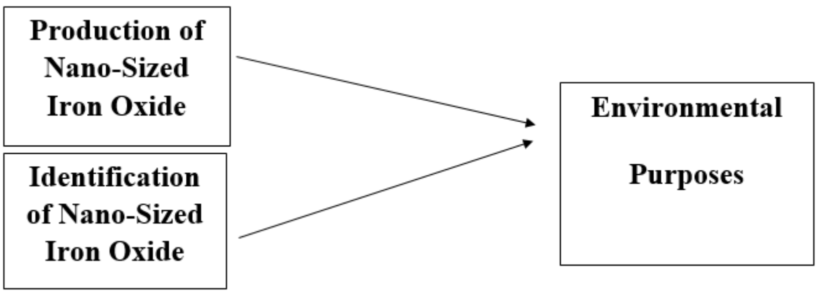
5. The use of chemical vapour deposition.

The chemical vapour deposition (CVD) technique is a common material processing technology. Reacting with a volatile precursor or precursors allows for the formation of a solid layer or thin film on top of a substrate. Coating surfaces with solid thin films is the "most common use of this technology," according to Li et al., (2020).

6. Electrodeposition

By using templates, electrodeposition enables the precise fabrication of nanomaterials that may be adjusted in terms of size and shape. The field of applied electrochemistry has seen rapid expansion due to advancements in materials science (**Iram et al., 2019).**

6.2 Conceptual framework

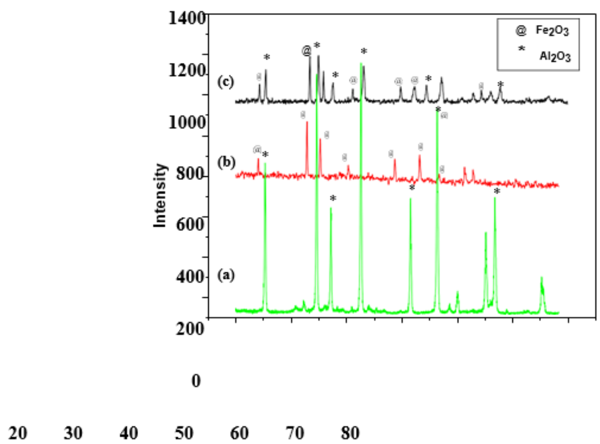


6.3 Data Analysis

Using templates, electrodeposition enables the controlled fabrication of nanomaterials with size and shape tunability. Advances in materials science have been instrumental in the rapid expansion of applied electrochemistry.

7. Result

" The electrospun nanocomposite fibres' structure and purity were determined using XRD analysis. Figure shows the XRD pattern (after calcinations at 1000oC) of the nanocomposite fibre. The crystalline structure of the sintered fibres was shown by the XRD analysis. researchers obtained alumina nanoparticles by sintering boehmite nanoparticles at 1000°C, as shown in Figure by analysing their XRD patterns. According to JCPDS File no. 83-2081, the α-alumina phase, with a corundum crystal structure, is what the XRD data is comprised of. According to JCPDS File no. 84-0311, which shows that the nanofiber with a rhombohedral crystal structure was produced by sintering the as-prepared PVP-Iron acetyl acetonate nanofiber at 1000°C, "The boehmite doped PVP-Iron acetylacetonate mixed nanocomposite fibres sintered at 1000°C for 2 hours also exhibited diffraction peaks that corresponded to the α-Fe2O3 and α-Al2O3 (JCPDS Card No: 84-0311 and No: 83-2081, respectively)."



In Figure 1, researchers can see the whole process of creating PAN-Ag composite nanofibers using electrospinning assisted synthesis. Three methods exist for reducing the Ag+ ions in PAN/Ag+ as-spun composite nanofiber membrane

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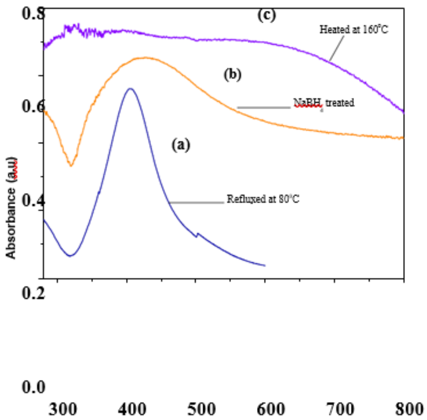
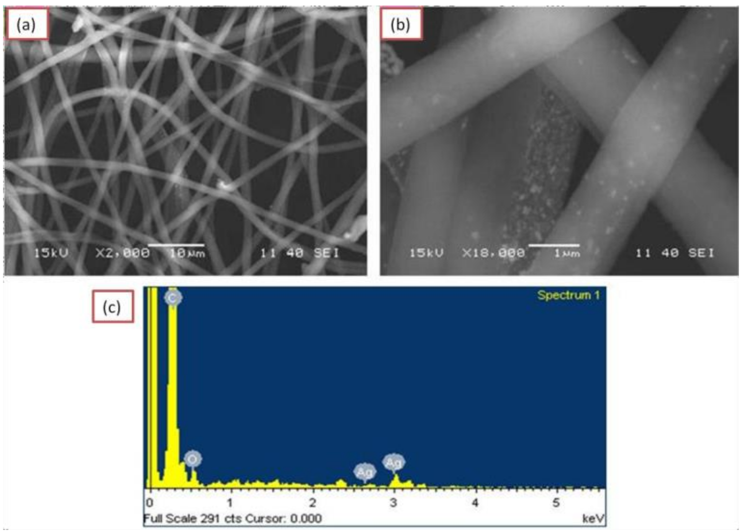
to Ag metallic nanoparticles: treatment with NaBH4, refluxing with DMF, and heat treatment. Presented below is the process that, in these instances, involves reducing Ag+ ions to silver particles. "DMF has been used as a solvent for electrospinning PAN polymer and besides it can also act as a self-reducing agent for reduction of Ag^+ ions (Lee et al., 2005, Rujitanaroj et al., 2010). researchers have refluxed the PAN and $AgNO_3$ solution in DMF solvent to increase the reaction rate. The formation of a yellow-brown color solution after refluxing confirmed the reduction of Ag^+ ion to silver" nanoparticles.



"**Figure 2 UV**-Vis spectra of PAN-Ag nanocomposites prepared by (a) refluxed method, (b)$NaBH_4$ reduction method and (c) heat treatment method.

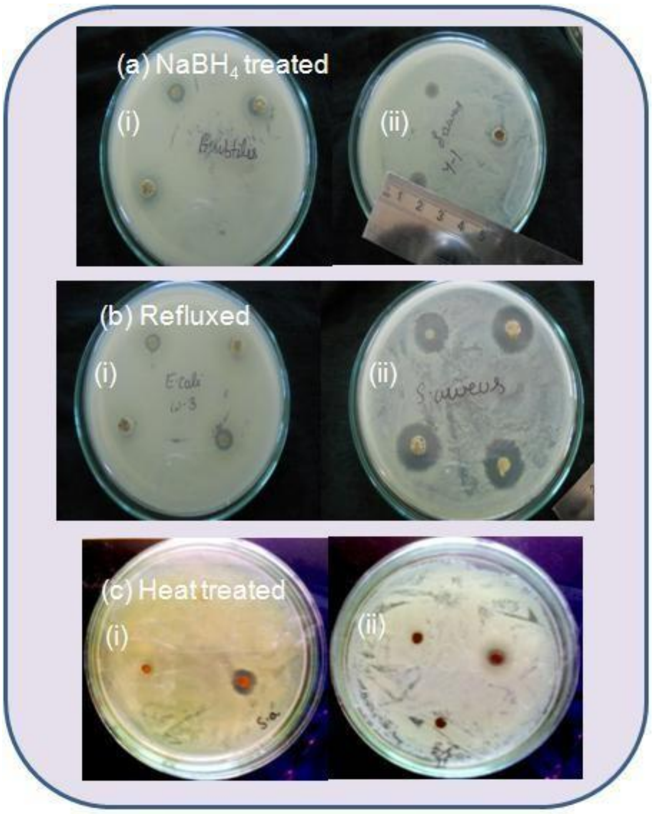
Three reduction processes were used to create PAN-Ag nanocomposites, and their UV-Vis spectra are shown in the figure. An 8 weight percent solution of PAN and AgNO3 in DMF solvent was refluxed at 800 degrees Celsius to produce the Ag functionalized PAN polymer depicted in the figure. Numerous studies have shown that between 400 and 450 nm in the UV-Vis spectrum, one can primarily see the surface plasmon absorption bands of Ag nanoparticles with sizes between 2 and 50 nm (Lee et al., 2005; Lee et al., 2010; Lala et al., 2007). A maximal absorption peak at 405 nm, as shown in Figure, indicates the production of Ag nanoparticles. researchers electrospun the PAN solution containing the nanoparticles to implant the silver nanoparticles on and within the PAN nanofibers membrane. Similarly, the electrospun PAN nanofiber membrane's Ag+ ions were converted to silver nanoparticles using the sodium borohydride and heat treatment techniques in order to generate a membrane impregnated with silver nanoparticles. It was established that Ag nanoparticles had been formed by the presence of a surface plasmon absorption band in the UV-Vis spectra, which fell between 400 and 450 nm. A membrane made of PAN nanofibers functionalized with silver nanoparticles possesses antibacterial properties.



"**Figure 3** SEM images of PAN-Ag nanofiber $NaBH_4$ reduction (a) Lower magnification, (b)Higher magnification and (c) EDAX pattern.

pictures of the PAN-Ag composite membrane that was made using the sodium borohydride reduction process are shown in Figure 3, which are SEM pictures. The photographs show that the produced fibres are smooth and have a tubular form.

An enlarged scanning electron micrograph shows that the PAN fibres do, in fact, contain Ag particles, but in an aggregated condition. It has been discovered that the fibre diameters fall between 500 nm and 1 μm. Researchers analysed the PAN-Ag composite fibres using SEM EDAX to determine their chemical composition. The EDAX pattern of the PAN-Ag composite nanofibers generated using the borohydride reduction technique is shown. It was determined that the composite fibre had an elemental makeup of 78.31% carbon, 12.44% oxygen, and 8.25% silver, confirming that PAN-Ag composite fibres had been formed.".



"**Figure 4**: Photographs showing zone of inhibition of the PAN-Ag composite membrane prepared by (a) $NaBH_4$ treated (i) *B. Subtilis (ii) S. aureus* (b) Refluxed (i) *E. Coli* (ii) *S. aureus,* and (c) Heat treatment *(i) S. aureus* and (ii) *B. Subtilis*.

According to Lala et al. (2007), PAN fibre mats demonstrate nonbacterial qualities when tested against S. aureus and E. coli bacteria. Consequently, there is no inhibition zone when using PAN fibre mats. But according to research (Lala et al., 2007; Rujitanaroj et al., 2010), polymer fibres coated with Ag nanoparticles have potent bactericidal effects. For the antibacterial test against the three strains of bacteria stated earlier, researchers used all three varieties of PAN nanofibers that were functionalized with Ag nanoparticles. Each kind of nanofiber included 8 weight percent AgNO3 relative to PAN. Table 1 displays the duration of the inhibitory zone as it pertains to the three microorganisms (Janczak et al., 2022).

8. Discussion

The one-dimensional nanoscale "alumina, particularly boehmite phase, and iron oxides" that make up ceramics give them interesting physical and chemical characteristics. This dissertation details the creation of one-dimensional nanocomposite materials by the combination of aluminium and iron oxide. By integrating electrospinning, hydrothermal, and sol-gel procedures, nanocomposite materials were successfully produced in this study. Among these materials were alumina rods and fibres, iron oxide, and mixes of the two. Various methods, including FT-IR, XRD, SEM-EDAX, TEM, TGA-DTA, BET, UV-Vis, and AAS, have been used to study the 1d nanomaterials and mixed oxide nanocomposites' production, size, surface morphology, sorption capabilities, and structural and size features. The goal of using alumina-iron oxide-alumina nanocomposites in water extraction is to remove organic colours (such Congo red) and possibly dangerous metal ions from water-based solutions. Needless to say, needle-shaped boehmite is one sol-gel product that has shown to be an excellent CR dye remover. Its remarkable maximal sorption capacity of 198 mg/g allows for the elimination of 99 percent of CR after just 10 minutes of contact. Boehmite loses some of its CR dye-adsorption ability at higher-temperature sintering and ultimately turns into alumina. It is possible to effectively remove the "Congo" red dye from alumina due to the fact that it does not contain an oxyhydroxy group. Alumina nanofibers with a diameter between 100 and 500 nm have been synthesised via electrospinning.

9. Conclusion

Ceramics have fascinating chemical and physical properties due to their composition of one-dimensional nanoscale "alumina, particularly boehmite phase, and iron oxides." In this dissertation, researchers created nanocomposite materials with just one dimension by combining aluminium and iron oxide (Lee et al., 2019).
The researchers were able to create nanocomposite materials by integrating electrospinning, hydrothermal, and sol-gel processes. Materials such as iron oxide, alumina rods and fibres, and combinations of the two were among them. The synthesis, size, surface morphology, sorption capacities, and structural and size properties of the 1d nanomaterials and mixed oxide nanocomposites have been studied utilising a range of methodologies such as FT-IR, XRD, SEM-EDAX, TEM, TGA-DTA, BET, UV-Vis, and AAS. To purge aqueous solutions of toxic metal ions, organic dyes (such Congo red), and water, scientists used nanocomposites composed of alumina and iron oxide-alumina. An excellent sol-gel product for removing CR dyes is, needless to say, needle-shaped boehmite. Its extraordinary maximal sorption capacity of 198 mg/g allows for the removal of 99 percent of CR with as little as 10 minutes of contact. When boehmite undergoes higher-temperature sintering and eventually converts to alumina, its adsorption capacity for CR dye is diminished. Since alumina does not contain an oxyhydroxy group, it may be possible to successfully remove the "Congo" red colour from it. Electrospinning has been used to produce alumina nanofibers with a diameter ranging from 100 to 500 nm. An excellent adsorption mechanism for fluoride (F-) and Cr (VI) removal by alumina nanofibers has been shown. In contrast to Cr (VI), which has a maximum removal rate of 70%, fluoride ions have a maximum removal rate of 50%. Another advantage is that the pseudo-second-order rate rule may be used to adjust the adsorption rate. Chemically synthesised nanocomposites of hydrothermal iron oxide and alumina were used to remove the Congo red colour. With an adsorption capacity of 498 mg/g, a mixed iron oxide-alumina nanocomposite entirely eliminated the Congo red dye after 15 minutes of contact. Meanwhile, "Fe_2O_3-Al_2O_3" nanocomposites have also been created using electrospinning (Kim et al., 2019).

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