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Iron-based nanomaterial sheets for electromechanical applications

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Abstract

Now a day's Single-Walled Carbon nanotubes (SWCNTs) having the greatest attention on the earth. This area favors a 2-D graphene sheet configurationally which is rolled up into a hollow cylindrical structure. Having just one surface or wall of the cylinder, the cylindrical formation is named as Single-Walled Carbon Nanotubes. The structure appears sort of a set of cylinders having the same center with a continuing layer separation of 0.34 Å termed as multi-walled carbon nanotubes. A mixture of Nanopowder of iron oxide and a blend of Single-Walled Carbon Nanotubes provides great promising properties towards the Electromechanical applications by enhancing their electrical and mechanical properties. In this paper, we will discuss the characteristics and behavior of the newly synthesized nanoparticle sheet whose major constituent is iron. This paper will also explore the advantages and disadvantages of the conventional Iron sheets used in electromechanical applications. for synthesizing the nano iron sheets, among different methods we used the nano-emulsion method in which we mixed two nanoparticles in a different phase to get the desired result.

Introduction

In the domain of nanoscale, the properties exhibited by the nanoparticle cannot be observed in bulk or counterpart of atoms. Therefore it is a great deal to prepare nanomaterials that provide desired characteristics. Because of synthesizing simplicity in the laboratory and their elegant characteristics, Iron Oxide Nanostructures (IONs) gains a unique position in between the other metal oxides of nano size. Iron oxide nanostructure-based material, exploited for different purposes in various research because of their magnetic, optical, electrical, and catalytic behaviors. Despite that, in some cases, it is necessary to combine IONs with other nanostructured materials to forms enhanced properties nanocomposites. Concerning this Single-Walled Carbon Nanotubes (SWCNTs), a valuable option having great potential for synthesizing the nanocomposites. This hybridized nanocomposites can be used for developing a new class of electrical and mechanical components or in other words in electromechanical applications like transformers, inductor, bobbins and other electromechanical components,to increase the life span of the components and to prevents from the hazard because of malfunctioning, like overheating causes fire, etc. This paper describes Fe_3O_4(IONs)-SWCNTs nanocomposite for electromechanical applications and stared with the introductory information and preparation of IONs and SWCNTs separately. Various types of iron oxides are available in nature amongst them mostly hematite, maghemite and magnetite are found in nature. By reducing or oxidizing annealing process all forms of iron oxide can be converted in other forms.

Many researchers used earlier hematite, maghemite, and magnetite iron oxides for their research to form nanocomposite Therefore in this paper we are mainly focusing on Magnetite (Fe_3O_4).

Magnetite ($Fe^{II}Fe^{III}{}_3O_4$) is also named as iron (II, III) oxide or ferrous ferrite. Magnetite molecular formula Fe_3O_4 can be depicted as $FeO\_Fe_2O_3$. Magnetite having the strongest magnetism among all the natural minerals. It differs from all other iron oxides because this having Fe^{++} and Fe^{+++} ions both at the same time. Fe_3O_4 having CCP structure forming cubic inverse spinal structure.

Graphene sheets rolled in the cylindrical formed are known as carbon nanotubes. Generally, two types are depending upon the number of graphene sheets used. If one graphene sheet is rolled in the cylindrical form then it is known as Single-walled carbon nanotube and if more number of the sheet is rolled concentrically then it is known as multi-wall carbon nanotubes. The Young's Modulus of SWCNTs having greater than 1 TPa and the Tensile strength is around 200Gpa. The thermal conductivity can be higher up to 2500 W/mK. With

a perfect mass to weight ratio, a very small radius of the tip of the curvature, and sensible heat emitting properties, SWCNTs have proven that it is a wonderful candidate for emission.

Section snippets

Materials and methodology

The research objectives achieved through three hypothesis-driven tasks.Task 1 focuses on the synthesis of highly dispersed and stable nanoparticles like Iron oxide nanopowder and blends of Single-Walled Carbon nanotubes. The optimal stabilizers will be determined by Single-Walled Carbon Nanotubes (SWCNTs) based on effectiveness, environmental friendliness, and cost [3]. Then Iron oxide nanoparticles will be synthesized with the aid of selected low-cost and “green” stabilizers [1]. Task 2 was…

Nano-emulsion method

Nano-emulsion can be defined as the isotropic dispersion of relatively two immiscible liquids which is thermodynamically stable and that is stabilized by anionic, cationic and/or non-ionic surfactants, generally along with a co-surfactant which is widely used to obtain IONs. Depending upon the relative concentrations, molecules of surfactants self-assembled in various structures in the mixture (experimental set up is shown in Fig. 1). Much different technique can be used to synthesized…

Results and discussion

The magnetic properties of the synthesized pure Fe_3O_4 IONs and Fe_3O_4 IONs-SWCNTs nanocomposites are shown by the M–H curve in Fig. 5. The phase purity morphology and microstructure of the samples were investigated by Transmission Electron Microscopy (TEM), Electron Diffraction, and Scanning Electron Microscope (SEM) [2]. Magnetic Properties were investigated at 25 °C with the help of a Vibrating sample magnetometer in the presence of applied magnetic field [2], [4], [5], [6]….

Biomedical

Synthesized composites can be used for contrast agents in MRI, labeling of the cell, handling and separation of cells, drug released in a controlled way, magnetofection, cell purifying, magnetic separation, and in severe inflammation.…

Food and agriculture

This can be used as a crop boosting product. Before sowing seeds the seed can be treated with the composites. This can also be used in the packaging of food, encapsulations, remote sensing devices, etc.…

Health care

Imaging and nanoscale biosensor, therapeutic targets in tumor…

Conclusion

This research directly addresses the priority need for research “concerning the applications of nanotechnology in electromechanical components”. New class nanosheets which were synthesized by combining of Nanopowder of Iron Oxide and Single Walls Carbon Nanotubes (SWCNTs), having physically stable, thermally powerful, and environmental friendly nanosheets and characterized, and a cost-effective, higher strength to weight technology based on the new materials was developed for electrical…

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.…

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