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"INVESTIGATIONS ON GREEN SYNTHESIS, ACTIVITY OF SOME SPINEL FERRITE NANOCRYSTALS"

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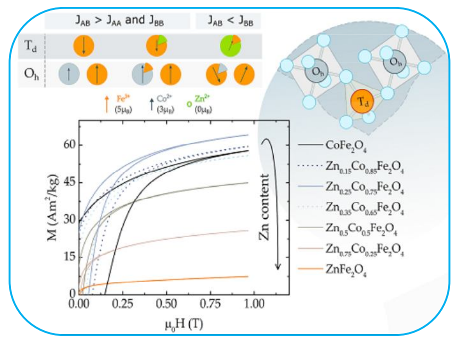
ABSTRACT-



Due to their numerous uses in biomedical, industrial electronic devices, and wastewater treatment, ferrite nanoparticles are of great interest. The characterization of ferrite nanoparticles and their use in a variety of fields are the primary topics of this review, which focuses on green synthesis. The green amalgamation method utilizing plant or their concentrates are talked about. A brief discussion of the applications of ferrite nanoparticle characterization methods is provided. Due to their biocompatibility and high, flexible magnetic properties, spinel ferrite magnetic nanoparticles have received a lot of attention. The eco-friendly sol-gel auto-combustion method was used to create a set of cobalt ferrite-doped zinc-containing magnetic nanoparticles in this study. The obtained particles had a ferromagnetic behavior at room temperature, which was influenced by the chemical composition's saturation magnetization and coercivity values. Cobalt ferrite nanoparticles had a maximum saturation magnetization of 74 Am2/kg, with zinc ions replacing 15–35% of the cobalt molar fraction. While the zinc concentration increased from zero to one hundred percent, the coercivity decreased gradually from 140 to 5 mT. As a result, the magnetic properties of the nanoparticles produced by the proposed method can be adjusted to meet the requirements of numerous potential applications.

KEYWORDS: *antimicrobial properties, cobalt ferrite, zinc ferrite, and magnetic nanoparticles.*

INTRODUCTION

The fields of biomedical, sensors, biosensors, energy storage systems, recording media, data storage, drug delivery, and wastewater treatment all benefit greatly from the use of ferrite nanoparticles. They are advantageous due to their high initial permeability, low losses, high electrical resistivity, and excellent magnetic properties. Physical synthesis of ferrite nanoparticles results in voids and non-uniform particle sizes, whereas chemical synthesis results in environmental toxicity. The environmentally friendly alternatives to chemical and physical methods are biological methods, which can overcome the challenges of synthesis. Utilizing plants, plant extract, microorganisms, fungi, and algae, biological synthesis can reduce energy consumption and eliminate the use of costly and harmful chemicals. The properties, applications, and current state of ferrite nanoparticles made with green synthesis methods will be summarized in this review.

Attractive spinel ferrites nanoparticles with general compound equation MFe2O4 offer extraordinary attractive property tunability by shifting their size and substance piece. For biomedical applications like MRI contrast agents and mediators of heating in magnetic fluid hyperthermia, this kind of material is very appealing. The use of doped ferrites for antimicrobial or antifungal delivery for water purification is also within the scope of interest due to the possible effect on the dynamics of bacterial growth of some metals ions incorporated with MNPs and the possibility to easily filter them by using a magnetic field. Additionally, perspectives of the use of magnetic nanoparticles in water purification are reinforced by their effectiveness to absorb heavy metals. The possibility to control the movement of magnetic nanoparticles by applying a magnetic field gradient opens the

Ferrite Nanoparticles

Ferrites are oxides with magnetism. The first known magnetic material was magnetite, also known as loadstone. Magnetite is Fe2O4. Because of their high magnetic coercivity, ferrites can be divided into two categories: hard ferrites and soft ferrites. Due to their low coercivity, soft ferrites can easily change their magnetization. Depending on their crystal structure, ferrites are categorized as spinel ferrite, garnet ferrite, ortho-ferrite, and hexagonal ferrite. Because of their electrical and magnetic properties, ferrites can be easily synthesized for both indoor and outdoor applications.

Using Nasturtium officinale extract, environmentally friendly magnetic spinel copper ferrite ($CuFe_2O_4$) nanostructures were synthesized in this study. Energy dispersive X-ray mapping analysis, transmission electron microscopy, field emission scanning electron microscopy vibrating sample magnetometry, and other techniques were utilized to ascertain the physicochemical properties of these nanostructures. The $CuFe_2O_4$ formation is adhered to by XRD patterns. Ceramic spinel $CuFe_2O_4$ nanostructures with spherical surface morphologies were revealed by SEM results. MTT assay was used to evaluate the $CuFe_2O_4$ nanostructures' cytotoxicity against rat pheochromocytoma cells. At a concentration of 250 g/mL, the magnetic nanostructures exhibited low toxicity. Based on their low toxicity, it appears that these nanostructures are suitable candidates for drug delivery and other biomedical applications.

Brain tumors and neurological diseases (e.g.,Huntington's,

Alzheimer's, and Parkinson's cause nerve cell damage, reduced motor control, cognitive impairment, and death. Current treatments are expensive and have various side effects such as fatigue, general weakness, nausea, and increased liver enzymes, among others.There- fore, researchers are looking for new methods to differentiate and repair nerve neurons, and prevent diseases. Recentfindings suggest that a number of microstructures and nanomaterials induce neuroprotective effects and preserve neuronal life. Nanomaterials play a significant role in the advancement of science and technology. These nanomaterials are deployed in the protection of neurons and treatment of brain tumors due to their nanometer size, antioxidant, surface plasmonic resonance properties, antimicrobial, magneticproperties etc. New developments in science, innovative production and technology even in energy, computer, mathematic, geometry, and calculation have significant impact on human health and life

Nerve cell damage, decreased motor control, cognitive impairment, and death are all consequences of neurological diseases and brain tumors. Recent findings suggest that a number of microstructures and nanomaterials induce neuroprotective effects and preserve neuronal life.Nanoma-terials play a significant role in the advancement of science and technology These nanoma-terials are deployed in the protection of neurons and treatment of brain tumors due to their nanometer size, antioxidant surface plasmonic resonance properties, antimicrobial magnetic properties, etc. Current treatments are expensive and have various side effects such as fatigue, general weakness, nausea, and increased Innovations in science, production, and technology, including those in energy and computer mathematics and geometry.

Nanoparticles Synthesis

The SGAC method, which is described in detail elsewhere, was used to prepare MNP samples. The metal salts Fe were utilized without further purification. With varying molar ratios, 1-molar aqueous solutions of metal salts in distilled water were made. Under magnetic stirring, the first prepared 1-molar solution of the same volume of citric acid in DW was then added to metal salt mixtures. Dropwise addition of a 30% ammonia solution brought the pH level to 7. The sol was dried for approximately 60 minutes at 150 °C to form a gel. The self-combustion reaction was then started by raising the temperature to 300 °C. An agate mortar was used to grind the collected powders. Structural and Magnetic Properties The PW 1830 powder diffractometer was used for the X-ray diffraction studies, which were conducted in the 2 geometry at angles ranging from 30 to 80 degrees. A JEM-2100 transmission electron microscope at 30 kV was used to study the samples' morphology, and a vibrating sample magnetometer was used to measure the samples' magnetic properties in a field of up to 1.0 T at room temperature. The powder samples were held in plastic holders with diamagnetic glue to keep the powder from moving during the tests. To demonstrate how chemical composition and magnetic structure affect nanoparticle-bacterial cell interaction, further prepared nanoparticles were tested in bacterial culture.

Green Synthesis of Ferrite Nanoparticles

Utilizing biological sources like plants, fungi, algae, and microbes, green synthesis techniques have been used to synthesize ferrite nanoparticles. The research summaries were compiled into the list. Recently, medicinal plants and a variety of nanomaterials have been regarded as promising neuroprotective agents. By using plant extracts to make NPs, scientists hope to boost drugs' neuroprotective effects. Nigella sativa and CuO NPs reduced methadone-induced damage to PC12 cells in one study. In vivo studies demonstrated that iron NPs containing plant saponin could be used as a neuroprotective agent, performing better than plant saponin due to the synergistic effects of iron NPs and saponin. The synergy of metal ions and plant extracts has been demonstrated to treat neurodegenerative diseases and reduce brain damage. The antioxidant properties of the CuO NPs produced by using N. sativa L. are in line with expectations. Sharma et al. found that by reducing nucleic acid damage, inflammatory agents, and the activity of the enzyme caspase-3, these biogenic NPs shielded phaeochromocytoma cells from harmful agents. discovered that neurons were unaffected by magnetic iron oxide nanoparticles. In another study, iron oxide NPs were investigated for the treatment of Parkinson's disease due to their unique magnetic properties, thereby identifying these superparamagnetic NPs as neuroprotective agents. Ruanglertboon et al. also found that these NPs, when used in conjunction with other therapeutic agents, were useful as diagnostic and therapeutic agents in brain and spinal cord injuries. demonstrated that an ethanolic extract of watercress aided in male mice's dexamethasone-induced neuronal destruction. According to the literature and the findings of this study, CFN and N. officinale extract demonstrated promising functionality as well as no toxicity on neuronal PC12 cells; these results established the N. officinale plant as a neuroprotective agent; Consequently, they might be considered appealing neuroprotective agents.

Plant mediated by the synthesis of ferrite nanoparticles

Green synthesis of magnetic copper ferrite nanoparticles with tragacanth gum as a reducing agent revealed the formation of a cubic phase ferrite crystal structure and an average crystalline size of 14 nm. Ali Ramazani and others have demonstrated the use of tragacanth gum as a natural reducing agent in the Sol-gel synthesis of $CuFe_2O_4$ offer magnetic nanoparticles, resulting in the formation of a single-phase cubic spinel structure. Using green synthesis, organic and toxic chemicals are not used in the synthesis of magnetic copper ferritenanoparticles, which takes less time and is better for the environment. Utilizing Hibiscus Rosa Sinensis, the CoFe2O4 ferrite and the Ag-$CoFe_2O_4$ syntheses were made. The spinal type crystal structure resulted in an average crystalline size of 18 nm. Superparamagnetic behavior in nanoparticles was made public by the author Dana Gingasu. Aloe Barbadensis Miller plant extract was used to make Ni-Zn Fe2O4ferrite nanoparticles. With a spine structure, the crystalline size was 40.6 nm. At room temperature, the hysteresis curve demonstrates that nanoparticles are superparamagnetic. Cobalt ferrite nanoparticles can be made by using a variety of sentences and aqueous extracts of ginger and cardamom seeds. The coming about spinal sort structure with great crystallinity with 100 nm size. The use of aqueous ginger/cardamom seed extracts in the synthesis of $CoFe_2O_4$ is concluded by this result. According to author Dana Gingasu[6], the ferrite nanoparticle is an eco-friendly and promising alternative.

Characterization of Ferrite Nanoparticles

Utilizing relevant techniques that can provide the information of nanoparticles with their magnetic properties, size, shape elemental structure and bonding, surface morphology, and the surface area, we can find the properties of ferrite nanoparticles in order to comprehend their significance. The main characteristics of nanoparticles that control their stability and magnetic properties are their size and shape. The nanoparticles' size and shape can be determined using the following methods:

Utilized for direct imaging of the nanoparticle's atomic structure, the High-Resolution Transmission Electron Microscope (HRTEM) was developed. The ultrastructure of a wide variety of nanoparticles can be determined with the help of a Field Emission Scanning Electron Microscope (Fe-SEM). There is only one Transmission Electron Microscope (TEM). technique for characterizing particles in which an electron beam is accelerated to illuminate tiny particles. The eco-friendly sol-gel auto-combustion method was used to create a set of cobalt ferrite-doped zinc-containing magnetic nanoparticles in this study. The obtained particles had a ferromagnetic behavior at room temperature, which was influenced by the chemical composition's saturation magnetization and coercivity values. Cobalt ferrite nanoparticles had a maximum saturation magnetization of 74 Am^2/kg, with zinc ions replacing 15–35% of the cobalt molar fraction. While the zinc concentration increased from zero to one hundred percent, the coercivity decreased gradually from 140 to 5 mT. As a result, the magnetic properties of the nanoparticles produced by the proposed method can be adjusted to meet the requirements of numerous potential applications. To demonstrate how chemical composition and magnetic structure affect nanoparticle-bacterial cell interaction, further prepared nanoparticles were tested in bacterial culture.

Electrical Applications of Ferrite Nanoparticles

Biosensing and Sensors: Ferrite nanoparticles are frequently used in sensing to either respond to or measure physical property. Electrochemical biosensors, electrochemical sensors, and glucose biosensors all make use of ferrite nanoparticles. 5 $ZnFe_2O_4$ nanoparticles were used in the fluorouracil anticancer drug sensor. Storage of energy: Because of their large surface area and conductivity, ferrite nanoparticles are utilized in energy storage. The improvement in electrochemical performance of ferrite-based energy storage devices is influenced by highly conducting material. Microwave Equipment: Due to their remarkable properties, Ferrite nanoparticles are utilized in microwave devices and have properties such as low eddy current, low magnetic losses, high permittivity, stability, resistivity, and low electrical conductivity. Shielding against Electromagnetic Interference (EMI): In recent years, as a result of the development of devices that emit electromagnetic radiation, EMR pollution has affected human brain and tissue. Ferrite nanoparticles are used to shield electrical devices from electromagnetic interference (EMI) to lessen the impact of EMR on biological ecosystems. Media for Recording: The residual magnetization of ferrite nanoparticles is lower and the Ms and Hs are higher. Ferrite nanoparticles are utilized in a variety of applications due to this property, including mobile devices, audiotape, videotape, digital computers, Xero-graphy toners, and data storage systems.

CONCLUSIONS

The green synthesis method is in high demand in the research field right now. This method is environmentally friendly and good for the environment. The green synthesis method can be used to improve this research's ability to produce nanoparticles of the desired size, shape, and properties in the future. Biomedicine sensors, biosensors, energy storage systems, and data storage systems are the subjects of extensive current research. The green synthesis of Zn-Co ferrite MNPs revealed tunable magnetic properties that can be changed by changing the chemical composition. With a maximum of Am_2/kg for x = 0.25 zinc concentration, an increase in zinc content has a non-monotonic effect on the saturation magnetization value and reduces magnetocrystalline anisotropy. This has a strong correlation with a change in spinel structure's magnetic structure: Zn2+ ions can occupy the tetrahedral sites at low Zn concentrations, bringing Fe3+ with a high magnetic moment into the octahedral site. Saturation magnetization and magnetic anisotropy decrease as zinc concentration rises because the ferrimagnetic order between two lattices is disrupted. Here we ought to push that attractive properties associate with microstructural and attractive underlying properties which in their turn are major areas of strength for in on the blend strategy Zn-Co ferrite MNPs prompted the slack in E.coli development, which was found in relationship with the attractive and primary properties of spinel ferrites structure.

The presence of the iron-based nanoparticles ought to have an effect on the iron metabolism system of bacteria. The data on the various effects of nanoparticles on wild-type cells and bacteria transformed with the plasmid can thus indirectly indicate the possibility of their penetration into the cell. Fe-containing MNPs may affect bacterial cells by causing the production of reactive oxygen species and the disruption of the membrane. Despite the fact that an excessive amount of iron can have a significant cytotoxic effect, the role that iron plays in numerous important biochemical processes makes its influence on cell growth a complicated parameter. E. coli uses the DNA-binding protein of starved cells (Dps), which has both ferroxidase activity and the ability to bind DNA, to shield genomes from damage. The integrity of this multi-subunit protein, which contains an inner cavity for iron oxides, is necessary for both activities. Mössbauer spectroscopy and X-ray absorption near edge structure (XANES) revealed that the Dps protein contains both trivalent and divalent iron ions . Therefore, Dps-related metabolic processes should be affected if iron-based MNPs penetrate the cell. Due to their biocompatibility and high, flexible magnetic properties, spinel ferrite magnetic nanoparticles have received a lot of attention.

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