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Optimizing Processing Conditions to Produce Cobalt Ferrite Nanoparticles of Desired Size and Magnetic Properties Harnessing Microbial Subsurface Metal Reduction Activities to Synthesise Nanoscale Cobalt Ferrite with Enhanced Magnetic Properties Synthesis and Characterization of Iron Rich-cobalt Ferrite Nanoparticles by Massart's Procedure *Ferrite Nanoparticles* Synthesis and Characterization of Cobalt Rich Cobalt Ferrite Nanoparticles by Massart's Procedure *Mössbauer Studies of Cobalt Ferrite Nanoparticles Synthesized by Hydrolysis* **Magnetic Spinels** *Hetero-coagulation of Cobalt Ferrite Nanoparticles on Alumina* **Preparation of Cobalt Ferrite Nanoparticles by Polymer Matrix Templated Synthesis** Recent Trends in Materials Science and Applications **Electrophoretic Deposition of Cobalt Ferrite Nanoparticles Into 3D Felt Effect of Citrate Ion on the Formation of Cobalt Ferrite Nanoparticles** Synthesis and Characterization of Cobalt Ferrite Spinel Nanoparticles Doped with Erbium Magnetic Nanoparticles for Biomedical Applications **NANO-CRYSTALINE SPINEL FERRITE MATERIAL SYNTHESIZED BY DIFFERENT PREPARATIVE CONDITIONS AND THEIR CHARACTERIZATIONS** Ferrites **Modern Ferrites in Engineering Synthesis and Characterization of Magnetically-switchable Cobalt-containing Nanoparticles Exchange Bias in Core/Shell Ferrite Nanoparticles Spinel Nanoferrites Journal of Nano Research Journal of Nano Research Water-dispersible Magnetic Nanoparticles for Biomedical Applications Introduction to Magnetic Materials** Magnetic Ferrites and Related Nanocomposites **Magneto-electric Nanoparticles Cobalt Ferrite (CoFe2O4) -- Barium Titanate (BaTiO3) for Non-invasive Neural Modulations Magnetocaloric Effect in Nanoparticles and Bulk Clathrates Nanophysics, Nanomaterials, Interface Studies, and Applications** Advanced Functional Materials *Ferrite Catalysts* **Functional Magnetic Nanoparticles Biomedical Applications of Cobalt-spinel Ferrite Nanoparticles for Cancer Cell Extraction and Drug Delivery** *Magnetic Oxides and Composites* **Design and Control of the Superparamagnetic Properties of Cobalt-based Spinel Ferrite Nanoparticles** Synthesis and Characterization of Ni0.5Co0.5FeAlO4 Ferrite **Magnetic Properties of Fine Particles Cobalt Oxides** *Fabrication and Properties of Materials* Solution Precursor Plasma Spray System **Molecular Chemistry of Sol-Gel Derived Nanomaterials**

Non-invasive brain stimulation is valuable for studying neural circuits and treating various neurological disorders in human. However, current technologies of noninvasive brain stimulation usually have low spatial and temporal precision and poor brain penetration, which greatly limit their application. A new class of nanoparticles known as magneto-electric nanoparticles (MENs) is highly efficient in coupling an externally applied magnetics wave with generating local electric fields for neuronal activity modulation. Here, a new type of MENs was developed that consisted of $CoFe_2O_4$- $BaTiO_3$ and had excellent magneto-electrical coupling properties. Calcium imaging technique was used to demonstrate their efficacy in evoking neuronal activity in organotyic and acute cortical slices that expressed GCaMP6 protein. For in vivo noninvasive delivery of MENs to brain, fluorescently labeled MENs were intravenously injected and attracted to pass through blood brain barrier to a targeted brain region by applying a focal magnet field. Magnetic wave (~450 G at 10 Hz) applied to mouse brain was able to activate cortical network activity, as revealed by in vivo two-photon and mesoscopic imaging of calcium signals at both cellular and global network levels. The effect was further confirmed by the increased number of c-Fos expressing cells after magnetic stimulation. Histological analysis indicated that neither brain delivery of MENs nor the subsequent magnetic stimulation caused any significant increases in the numbers of GFAP and IBA1 positive astrocytes and microglia in the brain. MENs stimulation also show high efficacy in short-term pain relieve when tested with a tibial nerve injury mouse model. The study demonstrates the feasibility of using MENs as a novel efficient and non-invasive technique of brain stimulation, which may have great potential for translation. The aim of this volume is to advance the understanding of the fundamental properties of fine magnetic particles and to discuss the latest developments from both the theoretical and experimental viewpoints, with special emphasis being placed on the applications in different branches of science and technology. All aspects of fine magnetic particles are covered in the 46 papers. The topics are remarkably interdisciplinary covering theory, materials preparation, structural characterization, optical and electrical properties, magnetic properties studied by different techniques and applications. Some new fundamental properties, such as quantum tunneling and transverse fluctuations of magnetic moments are also explored. Research workers involved in these aspects of materials technology will find this book of great interest. Magnetic spinels including ferrites are insulating magnetic oxides and chalcogenides with strong coupling to microwave frequencies and low eddy current losses making them indispensable for applications in wireless communications. The 13 chapters and preface of this book discuss other potential applications of magnetic spinels along with various methods used for their synthesis and their varied properties resulting from substituting different metal ions at the A and B sites. These applications include ferrofluids, anticorrosion coatings, absorber coatings for photothermal conversion, biomedicine, and environmental applications such as oxidation of volatile organic compounds and removal of arsenic and heavy metals from water. Emphasis is placed on structure-property correlations and on the nature of magnetism in spinels and their nanoparticles with current information provided for future research. This book presents some of the latest achievements in nanotechnology and nanomaterials from leading researchers in Ukraine, Europe, and beyond. It features selected peer-reviewed contributions from participants in the 4th International Science and Practice Conference Nanotechnology and Nanomaterials (NANO2016) held in Lviv, Ukraine on August 24-27, 2016. The International Conference was organized jointly by the Institute of Physics of the National Academy of Sciences of Ukraine, Ivan Franko National University of Lviv (Ukraine), University of Tartu (Estonia), University of Turin (Italy), and Pierre and Marie Curie University (France). Internationally recognized experts from a wide range of universities and research institutions share their knowledge and key results on topics ranging from nanooptics, nanoplasmonics, and interface studies to energy storage and biomedical applications. Magnetic nanoparticles of cobalt ferrite have been synthesized by co-precipitation method. XRD and TEM analyses have been performed for structural characterization while for magnetic characterization VSM and PPMS have been used. A detailed study of the magnetic hysteresis loop was performed to elucidate the effects of particle sizes. Temperature dependence of coercivity in these nanoparticles followed a simple model of thermal activation of the particle moments over the anisotropy barriers while the saturation magnetization followed the modified Bloch. The results of size dependent saturation magnetization, coercivity and exchange bias have been explained in the light of the surface spin disorder in ferrite nanoparticles. Magnetic characterization of Ni-CoFe2O4 has been performed and explained with reference to the variation in doping concentration, surface spin disorder and the role of bulk and surface anisotropy. Blocking effects have been studied both in CoFe2O4 and NiFe2O4 systems and it was found that the blocking temperature increases with increasing particle size while it decreases with increasing nickel concentration in CoFe2O4 nanoparticles. The book focuses on the relevant basic concepts of Magnetic oxides, as well as on synthesis routes and important applications of spinel ferrites, hexaferrites and magnetic oxide nanomaterials. Keywords: Magnetic Oxides, Spinel Ferrites, Hexaferrites, Magnetoelectric Ceramic Composites, Soft Ferrites, Nano-Size Spinel Ferrites, Magnetic Nanoparticles, Device Miniaturization. Magnetic nanoparticles (MNPs) have many applications in the biomedical field because of their non-toxicity, high chemical stability, and biocompatibility. They are used in DNA or protein separation, hyperthermia, tissue engineering, magnetic resonance imaging, cancer therapy, drug delivery, bone and dental repair, biosensors, etc. The book focuses on magnetic nanoparticles and coated nanoparticles (ferrites nanoparticles, bimetallic-magnetic nanoparticles, magnetic fluid); their synthesis, characterization, and in vivo or in vitro biomedical applications. Keywords: Iron Oxide Magnetic Nanomaterials, Magnetic Spinel Ferrite Nanoparticles, Magnetic Oxide Nanoparticles, Ferromagnetic Nickel Nanostructures, Cobalt Ferrite with Niobium Pentoxide, Hyperthermia, Oncologic Magnetic Thermotherapy, Cancer Therapy, Cancer Diagnosis, Drug Delivery. Immune System Related Diseases. Nanoparticle system research and characterization is the focal point of this research and dissertation. In the research presented here, magnetite, cobalt, and ferrite nanoparticle systems have been explored in regard to their magnetocaloric effect (MCE) properties, as well as for use in polymer composites. Both areas of study have potential applications across a wide variety of interdisciplinary fields. Magnetite nanoparticles have been successfully dispersed in a polymer. The surface chemistry of the magnetic nanoparticle proves critical to obtaining a homogenous and well separated high density dispersion in PMMA. Theoretical studies found in the literature have indicated that surface interface energy is a critical component in dispersion. Oleic acid is used to alter the surface of magnetite nanoparticles and successfully achieve good dispersion in a PMMA thin film. Polypyrrole is then coated onto the PMMA composite layer. The bilayer is characterized using cross-sectional TEM, cross-sectional SEM, magnetic characterization, and low frequency conductivity. The results show that the superparmagnetic properties of the as synthesized particles are maintained in the composite. With further study of the properties of these nanoparticles for real and functional uses, MCE is studied on a variety of magnetic nanoparticle systems. Magnetite, manganese zinc ferrite, and cobalt ferrite systems show significant broadening of the MCE and the ability to tune the peak temperature of MCE by varying the size of the nanoparticles. Four distinct systems are studied including cobalt, cobalt core silver shell nanoparticles, nickel ferrite, and ball milled zinc ferrite. The results demonstrate the importance of surface characteristics on MCE. Surface spin disorder appears to have a large influence on the low temperature magnetic and magnetocalorie characteristics of these nanoparticle systems. In this presentation it is demonstrated that the unique magnetic properties of superparamagnetic cobalt-spinel ferrite nanoparticles can be employed in several novel applications. A method to selectively capture and remove pathogens from infected organisms to improve longevity is presented. Evidence is provided to show that automated methods using modified forms of hemofiltration or peritoneal dialysis could be used to eliminate the particle/pathogen or particle/infected cell conjugates from the organism postoperatively. It is shown that disparately functionalized nanoparticles can be used in concert as drug carrier and release mechanisms. Lastly, we provide preliminary evidence to support the use of magnetic nanoparticles for controlling reaction kinetics. This periodical edition includes peer-reviewed scientific and engineering papers on all aspects of research in the area of nanoscience and nanotechnologies and wide practical application of the achieved results. Due to their unique electrical and magnetic characteristics, ferrites are useful for a wide range of technological applications including refrigerators, air conditioners, microwave ovens, radio and telecommunication devices, and computers. This book presents knowledge about ferrites, their fabrication, characterizations, and applications in different areas. It is a useful resource for students, scientists, and engineers working in the field of ferrites. This periodical edition includes peer-reviewed scientific and engineering papers on all aspects of research in the area of nanoscience and nanotechnologies and wide practical application of the achieved results. Presenting the wide range of synthetic possibilities opened by sol-gel processes in the field of organic-inorganic materials, Molecular Chemistry of Sol-Gel Derived Nanomaterials discusses the state of the art in the synthesis of the various nanomaterials. The text includes examples of applications, including photoluminescent nanocomposites, grafted nanomaterials for selective separations of ions or isotopes, for cascade syntheses, chelation of transition metals and lanthanides by lamellar structured nanomaterials, and immobilized enzymes on mesoporous nanomaterials. This indispensable text for graduate students, engineers, and scientists concludes with a look toward future developments. This book gathers the proceedings of the plenary sessions, invited lectures, and papers presented at the International Conference on Recent Trends in Materials Science and Applications (ICRTMSA-2016). It also features revealing presentations on various aspects of Materials Science, such as nanomaterials, photonic crystal fibers, quantum dots, thin film techniques, crystal growth, spectroscopic procedures, fabrication and characterisation of new materials / compounds with enhanced features, and potential applications in nonlinear optical and electro-optic devices, solar cell device, chemical sensing, biomedical imaging, diagnosis and treatment of cancer, energy storage device etc. This book will be of great interest to beginning and seasoned researchers alike. This book summarizes the state-of-the-art knowledge on ferrites as well as the cutting-edge applications of these versatile materials. The main families of ferrites and their modern synthesis and processing methods are covered in this review book. Furthermore, the different morphologies of these materials and their current and incipient applications are also discussed. Selected peer-reviewed full text papers from the International e-Conference on Material Science and Nanotechnology (e-ICMSN 2020) Selected peer-reviewed full text papers from the International e-Conference on Material Science and Nanotechnology (e-ICMSN 2020), December 17-19, 2020, Latur, India (virtual) Synthesis of advanced materials as nanopartciles is currently gaining widespread interest in material processing technology. Cobalt ferrite nanoparticles attract great research interests due to their potential application in ferrofluids, data storage, absorbing materials, magnetic fluids, magnetic recording media and magnetic resonance imaging. The structural stability of the cobalt ferrite nanoparticles is essential in all technical applications. In order to achieve highly homogeneous cobalt ferrite nanoparticles and to avoid using the milling process, various techniques, such as chemical co-precipitation, hydrothermal, sol-gel, glass crystallization, microemulsion, citrate precursor, salt melt method have been developed. The synthesis of cobalt ferrite nanoparticles by chemical co-precipitation technique is the focus of this book. As it is well known, chemical co-precipitation is an economical way to produce homogeneous cobalt ferrite nanoparticles. This book covers the detailed study on ferrite nanoparticles and their potential applications in different fields. The contents of this book are useful for the researchers. ABSTRACT: The magnetocaloric effect (MCE) has been a recognized phenomenon for over a hundred years and is typically observed as the heating of a magnetic material when a magnetic field is applied and cooling of the material when the field is removed.

Besides low temperature physics, MCE has been utilized for cooling at higher temperatures for various applications. High efficiency and no dependence on pressurized gases have pushed forward the research on MCE and magnetic cooling systems. Research into the MCE in nanoparticle systems has mostly been within the last two decades. Besides novel properties inherent to nanoparticle systems, benefits such as ease of tunability and materials processing for thin film applications continue to fuel the pursuit of MCE research in nanoparticle systems. We characterized the MCE in cobalt ferrite nanoparticles, manganese zinc ferrite nanoparticles, cobalt nanoparticles, and CocoreAgshell nanoparticles. In addition, we had the opportunity to characterize the MCE in Eu8Ga16Ge30 Type I and Type VIII clathrates. The cobalt ferrite nanoparticles were synthesized in our lab using a decomposition of metalorganic salts technique. The product particles were capped with oleic acid. These particles were characterized with XRD, EDS, and TEM. DC magnetic characterization was performed on all samples. Change in entropy was calculated using a Maxwell's relation and magnetization data as a function of applied field and temperature. MCE studies in cobalt ferrite and manganese zinc ferrite revealed a broad but low magnitude change in entropy over a wide temperature span. MCE studies in cobalt and CocoreAgshell revealed a large MCE correlating with a sharp low temperature transition associated with the blocking of surface spins. MCE studies in both clathrates revealed a large MCE at low temperatures. These studies indicate the possibility of dual functionality for these clathrates since these materials also possess excellent thermoelectric properties. This book has given an overview of the sol-gel auto-combustion preparation method and characterization of Ni0.5Co0.5FeAlO4. This work focused on the structural properties XRD,TGA, SEM, TEM, FTIR, Magnetic Properties, Dielectric Properties were measured.By using the TG curve the exact temperature of formation of ferrite phase was obtained.The properties such as dielectric constant, dielectric loss tangent as a function of frequency and temperature. The addition of aluminium results in increasing the resistivity which decreases the dielectric losses and saturation magnetization. Sintering temperature and synthesis rout plays important role in the fabrication of nano-structured ferrite materials. Attempts are made to synthesis the ferrites by changing their sintering temperature and synthesis route in order to study the structural, electrical and magnetic properties. In the present investigation we have prepared the nanocrystalline powder of Ni-Co-Fe-Al-O ferrite and sintered at four different temperature 5000C, 6000C, 7000C and 8000C. Effect of sintering temperature on the structural, electric and magnetic properties of Ni-Co-Fe-Al-O ferrite nanoparticles were studied. This book highlights the complexity of spinel nanoferrites, their synthesis, physio-chemical properties and prospective applications in the area of advanced electronics, microwave devices, biotechnology as well as biomedical sciences. It presents an overview of spinel nanoferrites: synthesis, properties and applications for a wide audience: from beginners and graduate-level students up to advanced specialists in both academic and industrial sectors. There are 15 chapters organized into four main sections. The first section of the book introduces the readers to spinel ferrites and their applications in advanced electronics industry including microwave devices, whereas the second section mainly focus on the synthesis strategy and their physio-chemical properties. The last sections of the book highlight the importance of this class of nanomaterials in the field of biotechnology and biomedical sector with a special chapter on water purification. Magnetic nanoparticles have attracted a great attention due to their diverse potential applications in biology and technology and a substantial number of synthetic methods have been developed to produce these materials. Chemical synthesis approaches have been a particular focus of the field, because of their ability to tune the size, shape and composition, as well as surface of the nanoparticles. To produce magnetic nanoparticles for biomedical applications, one of the primary requirements is to make nanoparticles that are dispersible and stable in aqueous medium under physiological conditions. The focus of this thesis has been the development of methods to synthesise magnetic nanoparticles of different compositions and shape that are dispersible and stable in water. Monodisperse water-dispersible magnetic Co nanoparticles were fabricated using a facile reduction method in water in the presence of hydrophilic polymers. The size and shape of the nanoparticles were both tunable by varying the conditions of synthesis. The size of the spherical nanoparticles would be tuned between 2-7.5 nm by changing the concentration of the polymer. The synthesis approach could also be used to produce nanorods of 15 x 36 nm. The spherical nanoparticles were superparamagnetic at room temperature and were stable in water and in electrolyte solutions of up to 0.23 mM NaCI. The preliminary use of the Co nanoparticles as a MRI contrast enhancer was tested and provided evidence that these materials have considerable potential in this application. Using a similar method, water-dispersible and colloidal stable CoPt nanoparticles were prepared. The effect of structure, functional group and combinations of stabilising ligands on the morphology of the nanoparticles was investigated. It was found that multiple-thiol functional groups play a critical role in the formation of hollow nanoparticles. The size of hollow nanoparticles could be tuned in the range of7-54 nm by changing the concentration and molecular weight of the ligands. The hollow nanoparticles were water-dispersible and superparamagnetic at room temperature. They were stable in wide range of pH from I to 12.5 and at electrolyte concentrations as high as 2 M NaCI. An experiment on tracking stem cells labelled with the CoPt hollow nanoparticles indicated that MRl can effectively detect low numbers of labelled cells due to the enhanced contrast provided by the nanoparticles. CoPt hollow nanoparticles may, thus, have potential applications in MRI. CoFe and cobalt ferrite nanoparticles were synthesised by thermal decomposition in organic solvent to take advantage of the superior control over monodispersity and morphology of the nanoparticles afforded by solvent based syntheses. In the case of CoFe nanoparticles, a layer of Pt was also deposited on the nanoparticles to make core/shell structures. Varying reaction conditions, such as reaction time, had an insignificant effect on monodispersity, size and shape of Co Fe nanoparticles. However, these parameters had a substantial impact on the cobalt ferrite nanoparticles. Cobalt ferrite nanoparticles with sizes in a broad range from 4 nm to over 30 nm and diverse shapes including spherical, cubic and star-like, were synthesised by changing surfactant concentration and reaction time. Ligand exchange using hydrophilic silane and/or polymer ligands were demonstrated to be efficacious on CoFe, CoFelPt and cobalt ferrite nanoparticles. After ligand exchange, the nanoparticles were reasonably stable in water. The work presented in this thesis demonstrates that chemical synthesis is an efficient route to the production of magnetic nanoparticles of diverse composition and shape and so magnetic properties. Moreover, these materials were found to be stable in aqueous solutions. However, it is clear that the application of such magnetic nanoparticles in biology and medicine will require substantial further effort in the development of ligand shells able to withstand the rigours of the biological environment. Given the success of chemical synthesis demonstrated in this thesis, the development of ligand shell systems is now a major challenge of the field. As electronic devices become more integrated in everyday life, there is an increasing necessity for miniaturization with exceptional efficiency. The use of tunable magnetic materials for information storage and transfer can meet this demand with many significant advantages over current technologies. The implementation of this science is contingent on optimizing the voltage control of magnetism (VCM), which has additional applications in healthcare and sensing. This work seeks to improve VCM in multiferroic composites and magnetoioics. In chapter 3 of this thesis, we report a straightforward and scalable synthesis of superparamagnetic cobalt ferrite nanoparticles that allows for precise size selection.

The particles produced via this route also have remarkable size and shape uniformity, making them ideal for use in a strain-mediated multiferroic composite. In chapter 4 we advance fundamental understanding toward achieving unprecedented magnetic control in nanostructured Sm-Co magnets via electrochemical hydrogen charging. The structural and magnetic properties of SmCo5 and Sm2Co17, as well as the kinetics and thermodynamics involved in their hydrogenation, are documented for future work. Oxidation in air and in electrolyte is identified as a key challenge. This Brief describes the influence of the different organic chelating agents on the topography, physical properties and phases of SPPS-deposited spinel ferrite splats. The author describes how by using the SPPS process, the coating is produced directly from a solution precursor and how all physical and chemical reactions such as evaporation, decomposition, crystallization and coating formation occur in a single step. The author details not only the innovative approach to liquid feeding, but also focuses on its effects on the spinel ferrite system. The results of experimentation as well as detailed explanations of the experiments are included. As a fast-emerging and growing class of magnetic materials, ferrites have generated an increasing amount of interest for providing specific magnetic properties through controlled mixture in composites. The study of magnetic ferrite nanocomposites requires a multidisciplinary approach, involving novel synthesis techniques and an understanding of solid-state physics, electronic engineering, and material science. Magnetic Ferrites and Related Nanocomposites covers recent trends of various types of ferrite nanocomposites and evaluating the mechanisms for interpreting static and dynamic magnetic properties. Sections cover the fundamentals of magnetism, introducing different kinds of ferrites, ferrite characterization techniques, magneto-electric ferrite nanocomposites, exchange spring ferrite nanocomposites, shielding effectiveness and microwave absorption characteristics of ferrite-carbon materials, photocatalytic application of ferrite nanocomposites, and novel synthesis techniques for fabricating ferrite in nanoparticles, bulks, thin films, and nanofiber configurations. This book is an important reference for scientists, researchers, graduate students, and practitioners active in this field in order to broaden their understanding of ferrite nanocomposites and their impact on modern technology. Provides background information regarding various basic magnetic phenomena and related theories, and defines the different natures of magnetic materials Covers a wide range of hard and soft ferrites and related nanocomposites, particularly focusing on the correlation between structural features and magnetic analysis Explores the role of substituted cations on the structural, thermal, magnetic, and microwave characteristics of ferrites and their nanocomposites Discusses the mechanism involved for magnetic properties of major types of ferrite-ferroelectric magneto-electric components, exchange spring ferrite nanocomposites for fabricating next-generation permanent magnets, ferrite carbon nanocomposites for suppressing high-frequency electromagnetic radiation, and ferrite photocatalysts for omitting pollutants from our environment Assesses the major challenges of experimental characterization and novel manufacturing techniques for fabrication of high quality ferrite, in terms of purity, shape, size, and distribution, and the application on an industrial scale For the proposed solar sulfur-ammonia thermochemical water-splitting cycle, cobalt ferrite nanoparticles have potential use as an electrocatalyst, for the anodic reaction step of ammonium sulfite oxidizing to ammonium sulfate for the production of hydrogen. Electrophoretic deposition (EPD) of cobalt ferrite nanoparticles was investigated as a method of coating three-dimensional graphite electrodes to provide a high surface area and perhaps enhance the electrocatalytic activity. EPD was performed from 5 different bath compositions into several different substrates including aluminum, graphite paper, 3 mm carbon felt, and 6 mm graphite felt. The bath compositions were 2 g/L of cobalt ferrite nanoparticles in 100 % acetylacetone, 100 % acetylacetone with 0.2 wt. % polyethylenimine

(PEI), in 100 % ethanol, and in 90/10 vol. % water/isopropanol with 1 mM or 0.05 mM of hexadecyltrimethlyammonium bromide (CTAB). The deposit morphologies were studied using a scanning electron microscope (SEM). The SEM showed full penetration and coating of the felt in 100 % ethanol bath into both 3 mm carbon felt and 6 mm graphite felt. Linear sweep voltammetry in 2 M ammonium sulfite was used to test the electrocatalytic activity of the EPD deposits. The highest electrochemical activity for cobalt ferrite on 3 mm carbon felt was deposits from 100 % acetylacetone with 0.2 wt. % polyethylenimine. The highest electrochemical activity for cobalt ferrite on 6 mm graphite felt was found in deposits from 90/10 vol. % water/isopropanol with 0.05 mM CTAB, followed by deposits from 100 % acetylacetone with 0.2 wt. % polyethylenimine. Unparalleled in the breadth and depth of its coverage of all important aspects, this book systematically treats the electronic and magnetic properties of stoichiometric and non-stoichiometric cobaltites in both ordered and disordered phases. Authored by a pioneer and a rising star in the field, the monograph summarizes, organizes and streamlines the otherwise difficult-to-obtain information on this topic. An introductory chapter sets forth the crystal chemistry of cobalt oxides to lay the groundwork for an understanding of the complex phenomena observed in this materials class. Special emphasis is placed on a comprehensive discussion of cobaltite physical properties in different structural families. Providing a thorough introduction to cobalt oxides from a chemical and physical viewpoint as a basis for understanding their intricacies, this is a must-have for both experienced researchers as well as entrants to the field. Because of their unique properties (size, shape, and surface functions), functional materials are gaining significant attention in the areas of energy conversion and storage, sensing, electronics, photonics, and biomedicine. Within the chapters of this book written by well-known researchers, one will find the range of methods that have been developed for preparation and functionalization of organic, inorganic and hybrid structures which are the necessary building blocks for the architecture of various advanced functional materials. The book discusses these innovative methodologies and research strategies, as well as provides a comprehensive and detailed overview of the cutting-edge research on the processing, properties and technology developments of advanced functional materials and their applications. Specifically, Advanced Functional Materials: Compiles the objectives related to functional materials and provides detailed reviews of fundamentals, novel production methods, and frontiers of functional materials, including metalic oxides, conducting polymers, carbon nanotubes, discotic liquid crystalline dimers, calixarenes, crown ethers, chitosan and graphene. Discusses the production and characterization of these materials, while mentioning recent approaches developed as well as their uses and applications for sensitive chemiresistors, optical and electronic materials, solar hydrogen generation, supercapacitors, display and organic light-emitting diodes, functional adsorbents, and antimicrobial and biocompatible layer formation. This volume in the Advanced Materials Book Series includes twelve chapters divided into two main areas: Part 1: Functional Metal Oxides: Architecture, Design and Applications and Part 2: Multifunctional Hybrid Materials: Fundamentals and Frontiers The excellent chemical stability, good mechanical hardness, and a large positive first order magnetocrystalline anisotropy constant of cobalt ferrite ($CoFe_2O_4$) make it a promising candidate for magneto-optical recording media. For practical applications, the capability to control particle size at the nanoscale is required in addition to precise control of the composition and structure of $CoFe_2O_4$. It has been well established that a fine tuning in cobalt ferrite nanocrystal size within the magnetic single domain region would lead to the achievement of extremely high coercivity values at room temperature. The development of a size-sensitive phase separation method for cobalt ferrite that is based on a selective dissolution of the superparamagnetic fraction and subsequent size-sensitive magnetic separation of single-domain nanoparticles is presented. The attained room temperature coercivity value (11.9 kOe) was mainly attributed to the enlargement of the average crystal size within the single domain region coupled with the removal of the superparamagnetic fraction. The strong influence of crystal size, ferrite composition, and cation distribution in the ferrite lattice on the corresponding magnetic properties at the nanoscale was also confirmed. The superparamagnetic and magnetic single domain limits were experimentally determined. Nanoscale ferrimagnetic particles have a diverse range of uses from directed cancer therapy and drug delivery systems to magnetic recording media and transducers. Such applications require the production of monodisperse nanoparticles with well-controlled size, composition, and magnetic properties. To fabricate these materials purely using synthetic methods is costly in both environmental and economical terms. However, metal-reducing microorganisms offer an untapped resource to produce these materials. Here, the Fe(III)-reducing bacterium Geobacter sulfurreducens is used to synthesize magnetic iron oxide nanoparticles. A combination of electron microscopy, soft X-ray spectroscopy, and magnetometry techniques was employed to show that this method of biosynthesis results in high yields of crystalline nanoparticles with a narrow size distribution and magnetic properties equal to the best chemically synthesized materials. In particular, it is demonstrated here that cobalt ferrite (CoFe2O4) nanoparticles with low temperature coercivity approaching 8 kOe and an effective anisotropy constant of (almost equal to) 106 erg cm?3 can be manufactured through this biotechnological route. The dramatic enhancement in the magnetic properties of the nanoparticles by the introduction of high quantities of Co into the spinel structure represents a significant advance over previous biomineralization studies in this area using magnetotactic bacteria. The successful production of nanoparticulate ferrites achieved in this study at high yields could open up the way for the scaled-up industrial manufacture of nanoparticles using environmentally benign methodologies. Production of ferromagnetic nanoparticles for pioneering cancer therapy, drug delivery, chemical sensors, catalytic activity, photoconductive materials, as well as more traditional uses in data storage embodies a large area of inorganic synthesis research. In particular, the addition of transition metals other than Fe into the structure of magnetite (Fe3O4) has been shown to greatly enhance the magnetic properties of the particles, tailoring them to different commercial uses. However, synthesis of magnetic nanoparticles is often carried out at high temperatures with toxic solvents resulting in high environmental and energy costs. Additionally, these ferrite nanoparticles are not intrinsically biocompatible, and to make them suitable for insertion into the human body is a rather intricate task. A relatively unexplored resource for magnetic nanomaterial production is subsurface Fe(III)-reducing bacteria, as these microorganisms are capable of producing large quantities of nanoscale magnetite (Fe3O4) at ambient temperatures. Metal-reducing bacteria live in environments deficient in oxygen and conserve energy for growth through the oxidation of hydrogen or organic electron donors, coupled to the reduction of oxidized metals such as Fe(III)-bearing minerals. This can result in the formation of magnetite via the extracellular reduction of amorphous Fe(III)-oxyhydroxides causing the release of soluble Fe(II) and resulting in complete recrystallization of the amorphous mineral into a new phase. Some previous studies have reported altering the composition of biogenic magnetite produced by Fe(III)-reducing bacteria for industrial and environmental applications. However, research into the commercial exploitation of bacteria to form magnetic minerals has focused primarily on magnetotactic bacteria which form magnetosomal magnetite internally using very different pathways to those bacteria forming magnetite outside the cell. Magnetotactic bacteria live at the sediment-water interface and use internal nanomagnets to guide them to their preferred environmental niche using the Earth's magnetic field. Since magnetotactic bacteria generally grow optimally under carefully controlled microaerobic conditions, the culturing processes for these organisms are challenging and result in low yields of nanomagnetite. Despite these limitations, magnetotactic bacteria have been shown to incorporate (almost equal to)1% Co into the magnetite structure in vivo, and $CoFe_2O_4$ was synthesized in vitro, altering the magnetic properties of the material formed. Although these previous studies are an important first step, in order to obtain the degree of control over the magnetic properties required by potential applications, Co must be incorporated into the spinel structure together with high nanoparticle yields. It is not clear at present how this could be achieved using the highly regulated intracellular magnetosome systems. We present an alternative and efficient method to produce large quantities of highly crystalline magnetite and cobalt ferrite nanoparticles using the Fe(III)-reducing bacterium, Geobacter sulfurreducens, at ambient temperatures through the extracellular dissimilatory reduction of Fe(III)-oxyhydroxides without and with addition of cobalt.

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