Research innovations/ Novelties by research group with Nano science center of AKU affiliation and Nalanda University, Rajbir



Research Team – Dr. Rakesh Kumar Singh, Dr. Abhay Kr Aman, Prabhakar Sharma et. al

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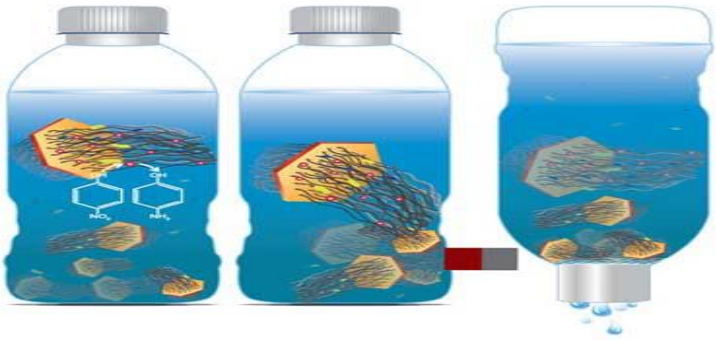
Title of research- Purification of water through activated Alumina materials accepted in SCI Journal, *Desalination and Water Treatment,* www.deswater.com



Summary of research

- Removal of fluoride is a desalination technology in which fluoride ions from aqueous solution are adsorbed on suitable adsorbent surfaces. This work aim to determine equilibrium sorption of fluoride on surface modified activated nano-alumina in aqueous solution.
- Results indicated that adsorption occurred rapidly in beginning, and equilibrium was reached on surface modified, i.e., grinded activated alumina. At equilibrium, adsorption capacity was about 28 mg g-1 (i.e., mg of fluoride per g of alumina) in case of activated alumina, whereas it was noted as 39 mg g-1 for grinded activated alumina for pH of 3.0 and fixed fluoride concentration of 100 mgL^{-1} in aqueous solution.
- Furthermore, adsorption isotherms and kinetics was performed in which Freundlich model indicated better fit, indicating heterogeneous nonlinear monolayer sorption among adsorbed particles. Overall, the present research reveals that the grinded activated alumina can be a prospective adsorbent for treatment of fluoride contaminated water.

Research novelty of faculty/scholar with Nano science center of AKU affiliation
Highlights

Title of research- Preparation of superfine grinding Cinnamon Food Nano powder using high energy ball mill and Evaluation of their Structural and Antioxidant Properties for for health and Biomedical Applications.

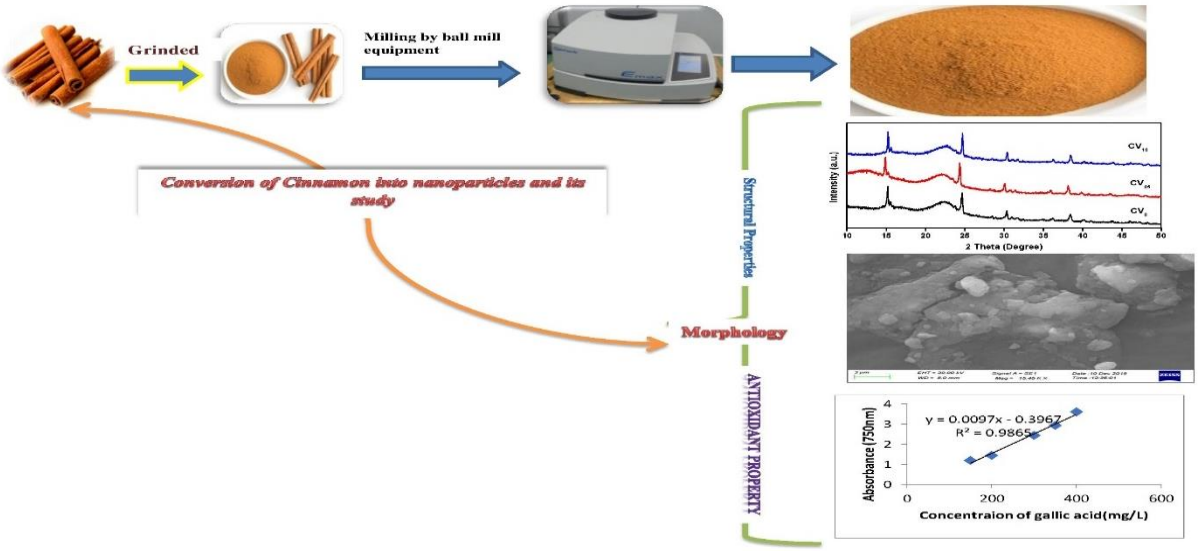
Research team- **Archana, Dr. Rakesh Kumar Singh, Dr. Abhay Kr Aman, Nishant kr et al.**

Journal details- Emerging Material Research (SCI and Scopus Indexed)




Highlight of Research paper-

- Superfine Cinnamon food Nano powder of different morphology and crystal structures were successful prepared using high energy ball milled for High industrial and scientific interest. The crystal structure, functional group, were evaluated using modern scientific tools. pressure grinding produces new surface structure, which are beneficial for physicochemical behavior.
- The phenolic content, Hydroxyl radicals and superoxide radicals scavenging activity, antioxidant properties was found to increase as the milling hour and superfine behavior increases. The present research finding opens a new window for progress of surface science of food nano powder for **Biomedical powder engineering, pharmaceutical, health and medicine industries**.



Graphical abstract for production of Food nano powder for Biomedical Engineering/Health sector

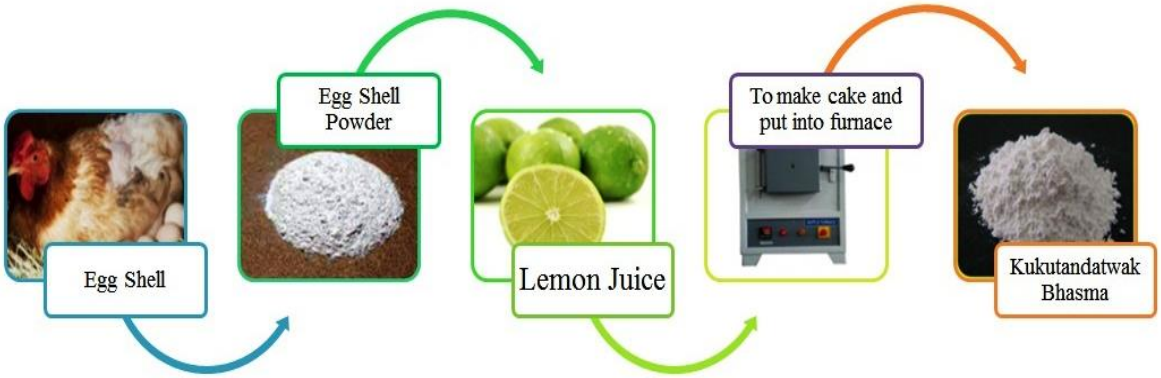
Research innovations/novelty of faculty/scholar with Nano science center of AKU affiliation- Highlights (Academic Year: 2019-20)

Research Paper accepted for publication in Journal Materials Today Proceeding- Elsevier (Scopus indexed)

Title of the paper- Calcium oxide (CaO) Nanomaterial (KukutandatwakBhasma) from Egg shell: Green Synthesis, Physical Properties and Antimicrobial behaviour.

Research Team- Sweta Sinha, Abhay Kr. Aman, Rakesh Kr. Singh, Nishant Kr, et al.



- CaO nanomaterials from natural waste egg cell as kukutandatwak bhasma was successfully prepared using the eco-friendly green approach. XRD and Electron microscopy analysis determined its average size below 100 nm.
- **This supports the requirement of multiple calcinations or heat treatment as recommended in classical Ayurveda text proposed by Indian forefather**. Thus, continuous heat treatment imparts specific behaviour that might be responsible for the therapic activity as a special class of medicine as a natural substitute.
- The antimicrobial evaluation revealed that KukutandatwakBhasma as nanomedicine is more effectual antifungal than antibacterial. The clear zone of inhibition for fungus Beauveria*Bassiana, Pacelomyceslilacinus TricodermaHarzianum* showed the significant antifungal property of KB Nanoparticles against soil-born fungus. It may be suggested that kukutandatwakBhasmacan be used as a promising antifungal agent in sericulture, mushroom cultivation, in treatment of pathogens and as a hand wash agent as a natural substitute. Green approach of preparing CaO nanomaterials from waste egg shell and their possible applications in health and medicine may open a new window for devlopemnt of society. **Magnetic and luminescence behavior obtained of this CaO nanomaterials from natural egg shell may also be useful as magneto-optical devices and related field.**

Research novelty by faculty/scholar with Nano science center of AKU affiliation

Highlights (Academic Year: 2019-20)

Journal of Materials Science: Materials in Electronics (2020) 31:9231–9241
https://doi.org/10.1007/s10854-020-03454-z

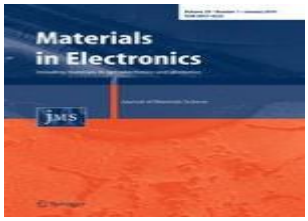
Structural, optical, and magnetic properties of non-stoichiometric lithium substituted magnesium ferrite nanoparticles for multifunctional applications

Nishant Kumar[1] · Rakesh Kr Singh[1] · Harendra Kr Satyapal[1]

Received: 2 January 2020 / Accepted: 21 April 2020 / Published online: 13 May 2020

Journal details- J. Materials Science and Materials in Electronics (SCI and Scopus indexed)





- In the present research article, structural, optical and magnetic properties along with Curie temperature of lithium substituted magnesium ferrite nanoparticles, $Mg_{0.5+x}Li_{1-2x}Fe_2O_4$ ($0 \leq x \leq 0.35$) have been reported. Scanning Electron Microscopy are used for grain size determination with surface morphology analysis and found agglomerated nanocrystalline of different size.
- The energy band gap was found 2.5 eV, 1.98 eV and 2.41eV respectively for the three prepared nanomaterials. While enhancement in Photoluminescence spectra measured using Photoluminescence spectrometer(PL) observed with decrease in lithium concentration. The magnetic parameter like saturation magnetization (coercivity and anisotropic constants were found to be increasing with the decrease in lithium ion concentration
- This non-stoichiometric structure was observed to affects the Curie temperature from 479°C to 454°C which opens provides the possibility of **this nanomaterials for broad range of applications in memory devices, isolators, circulator etc.**

. Research novelty of faculty/scholar with Nano science center of AKU affiliation

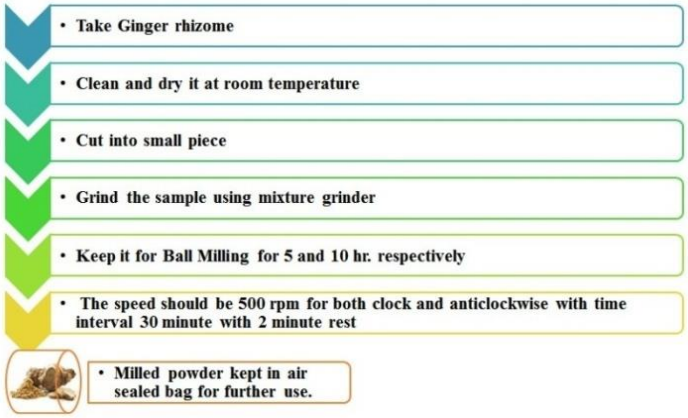
Highlights

Paper accepted for publication in Materials Today Proceeding-An International Journal, Elsevier (Scopus indexed)

Title of the research -Effect of superfine grinding on Structural, Morphological and Antioxidant properties of Ginger (*Zingiberofficinale*) Nano powder for health and Biomedical applications.

Research group - Archana, Dr. Abhay Kr. Aman, Dr. Rakesh Kr. Singh, Mr. Nishant Kr



- The superfine ginger food nanopowder powder was prepared successfully using high energy ball milling equipment. Scanning electron microscopy measurement indicates that pressure grinding for different time duration changes the surface morphology, which can have a considerable impact on the physical-chemical behaviour of prepared ginger powder for various industrial applications.
- Antioxidant behavior depends on superfine properties of ginger powder. A well-researched and thorough analysis through surface science of such natural food materials using advanced technology can lead to the industrial and scientific development of various medicinal uses for mankind. Therefore, the present research opens a new window for the progress of surface science of superfine ginger powder for the pharmaceutical, **health, and medicine sector**.

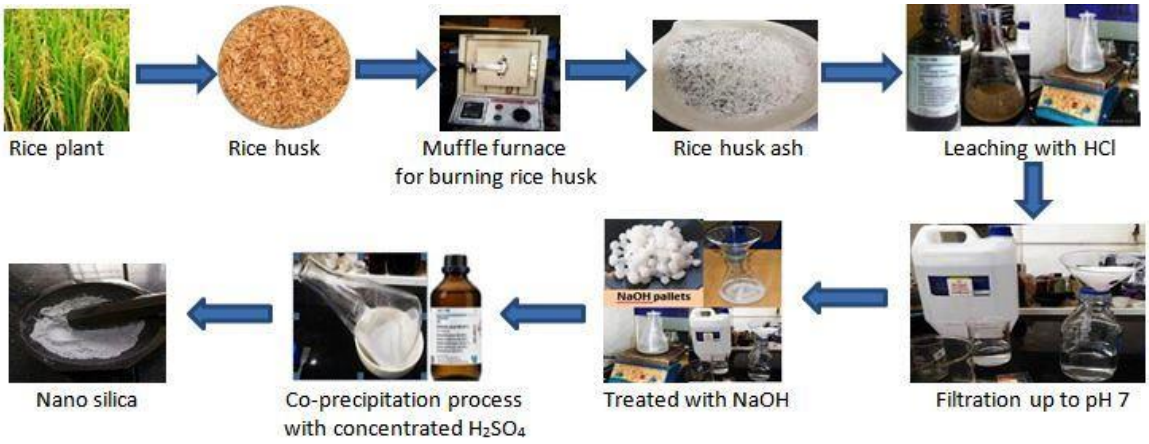
Research novelty by faculty/scholar with Nanoscience center of AKU and IIT Patna affiliation- Highlights(Academic Year: 2019-20)

Paper under review for publication in Journal of Materials Science and Engineering: B(SCI Journal)

Title of research -Synthesis and Physical properties of amorphous Nanosilica from Rice husk(agriculture waste) and its composite materials.

Research Team- Atul Jyoti, Dr. Rakesh Kr Singh, N. Kr, Dr. A. K Aman, Dr. M.Kar et al.

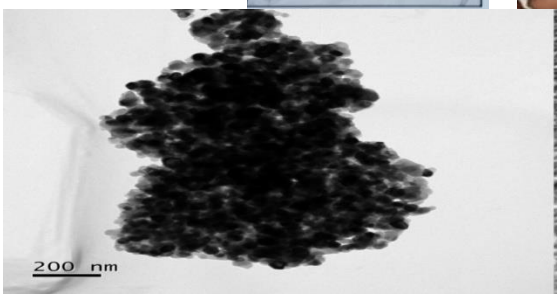


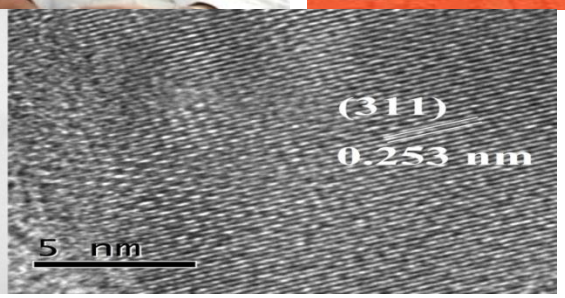



- Small size amorphous nano silica (SiO_2) was prepared by using cost-effective and environment-friendly method. FTIR spectra shows the absorption peaks indicating the existence of Si-O-Si (silanol) functional group. The photoluminescence spectrum reveals the broad excitation of radiation in the visible region.
- The magnetic hysteresis loops of silica-ferrite composite reveal that these materials can be used as polymer magnet
- Polymer could be prepared by using amorphous silica, magnetic ferrite, and PVDF polymer. Nano-silica as an engineering material has numerous applications in various area of science and technology including, Electronics, biomedical science and optoelectronics devices etc. due to its physical characteristics. Hence, Measurement of physical characteristics of nano silica from rice husk (Agriculture waste) and its magnetic polymer composite may suggest scientific communities for various industrial applications.

Research novelty by faculty/scholar with Nanoscience center of AKU and NIT Patna affiliation-Highlights

Title of research - Effect of doping different rare earth ions on microstructural, optical, and magnetic properties of nickel–cobalt ferrite nanoparticles.
Journal- Journal of Materials Science: Materials in Electronics- SCI journal
Research team- Kamar Tanbir, Dr. Rakesh Kumar Singh, Dr. Samart Mukhar Jee et al.



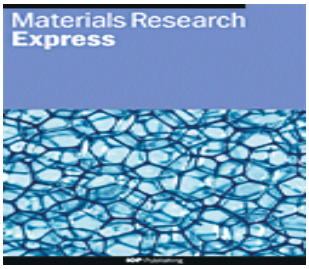


- Different rare earth ion-doped nano size Ni–Co spinel ferrites have been synthesized using standard chemical co-precipitation route. The mean crystallite size was found to be in the range of 15 ± 4 nm obtained.
- An excellent size and shape homogeneity among the nanoparticles were also achieved which was confirmed by the HRTEM image.
- The complete paramagnetic behavior of rare earth ions at room temperature resulted in reduction of super exchange interactions, and therefore the Curie temperature was observed to reduce as seen from *M*–*T* plots.
- It is well established that the nano size nickel ferrite particles exhibit soft ferrimagnetic semiconducting nature but this Co-Ni combination exhibited almost 5.1 k Oe coercivity along with moderate saturation magnetization at 60 K even in very small size. **This prepared Ni-Co nano ferrite can be useful for permanent magnet applications at low temperature**.
- The width of the optical energy bands becomes narrower and also results in increase of band gap. **These ferrite nanoparticles can be used to block red and infra-red region of EM spectrum due to their excellent absorption properties over that range.**

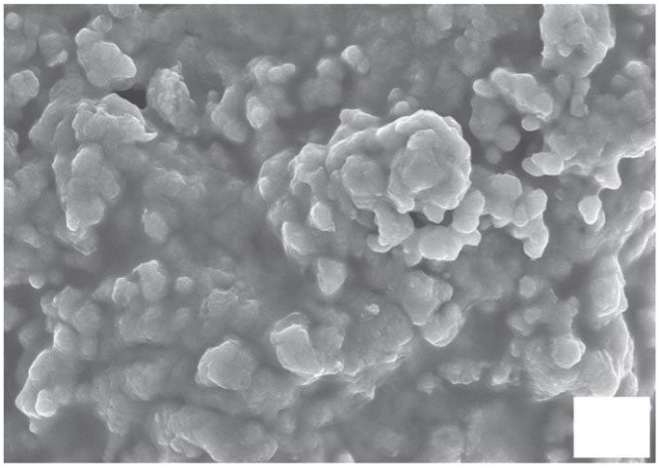
Sol-gel synthesis, crystalline phase, optical absorption, and photoluminescence behavior of cerium-doped ($Ba_{0.5}Sr_{0.5}$) $FeO_{3-\delta}$ powders

Journal detail- Mater. Res. Express (SCI journal)

Research team- Dr. Rakesh Kr Singh and S.K. Jaisawal et al.



The cerium- and iron-based perovskite type materials have received attention due to their applications in solid oxide fuel cells, sensors, catalysts, and gas separation membranes. An attempt has been made here to synthesize such compounds and characterize them for crystalline phases, photoluminescence and optical absorption properties. They are shown to exhibit phases as perovskite-type cubic cubic as well as orthorhombic in the composition range Their photoluminescence spectra provide evidence for structural defects including oxygen vacancies. The optical absorption peaks at 620 and 700 nm are attributed to various charge transfer transitions. The characteristics make the prepared materials system technological viable for oxygen separation from air.



Scanning electron micrograph of prepared nanomaterials

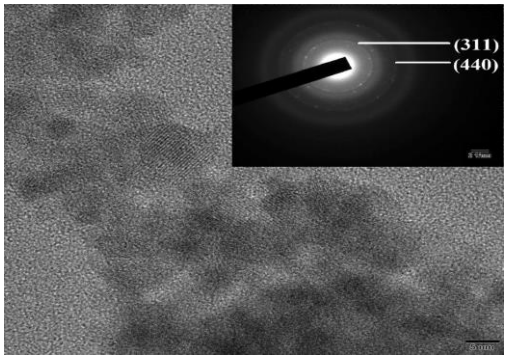
Research publication by faculty/scholar with Nanoscience center of AKU and NIT Patna affiliation- Highlights

Research title- Gd‑doped soft Mn–Zn nanoferrites: synthesis, microstructural, magnetic and dielectric characterizations.
Journal- Journal of Materials Science: Materials in Electronics (2020) 31:3529–3538.

Research Team - Kamar Tanbir, Dr. Rakesh Kumar Singh, Dr. Samart Mukhar Jee et al.



- Composition-dependent Gd-doped soft Mn–Zn of range of 3 ± 1 nm spinel ferrites were prepared using chemical co-precipitation method.
- The observed superparamagnetic behavior of all the samples at room temperature is due to the non-magnetic nature of Gd ions and tiny size of the particles. **Such kind of nanoparticles with proper biofriendly coating is suitable for targeted drug delivery and hyperthermia cancer applications.**
- The presence of magnetically dead surface layer and disordered surface spins was reflected by the reduction in saturation magnetization with increasing Gd content at 5 K. The Néel temperature was observed below 50 K for all the prepared samples**.**
- **The synthesized nanoferrites were excellent absorber near red and infrared region of EM spectrum at room temperature as observed in Tauc plots**. **These nanoparticles can be suitable candidate to block infrared rays.**
- All the samples exhibited good dielectric behavior at low frequencies. The effective contributions of grain boundaries in overall impedance were verified by the single semi-circle arc in the Nyquist plots. We broadly conclude that the sample with 15% Gd doping has shown the most advantageous properties such as RT superparamagnetism and large bandgap.



High resolution image and SAED pattern (Inset) nano ferrite materials

Research Novelty by faculty/scholar with Nanoscience center of AKU affiliation
Highlights (Academic Year: 2019-20)

Materials Today: Proceedings 28 (2020) 234–240

Contents lists available at ScienceDirect

Materials Today: Proceedings

journal homepage: www.elsevier.com/locate/matpr

Low temperature synthesis and influence of rare earth Nd^{3+} substitution on the structural, magnetic behaviour of M-type barium hexa ferrite nanomaterials

Harendra Kumar Satyapal, Rakesh Kumar Singh *, Nishant Kumar, Saurabh Sharma

Aryabhatta Centre for Nanoscience and Nanotechnology, School of Engineering and Technology, Aryabhatta Knowledge University, Patna 800001, India

- The Neodymium substituted barium hexaferrite nanomaterials ((BaFe12-X NdXO19) for (x = 0.0 to 1.0) has been synthesized using low cost citrate precursor-based sol gel method in low temperature range.
- Saturation magnetization values are highest for 0.25 mol doped Barium hexaferrite and of the order of 58.24 emu/g. Whereas maximum coercivity values are found for 0.75 mol Nd doped barium hexaferrite. The maximum coercivity value is (5234.4) Gauss.
- It is observed that magnetization and anisotropy values are maximum for 0.25 mol Nd doped Barium lattice but both these magnetic values decrease for higher concentration of Nd in a similar fashion with minimum values for 1 mol Nd concentration.
- The Curie point is observed to be shifted to a lower temperature value (429 C) from 446 C with Neodymium substitution. The decrease in theFe3+ ions may be one reason guided by decrement in exchange interactions between iron ions. **The present study suggests that it favors low energy loss in the prepared material. So, it may be fruitful in high density magnetic recording purpose.**

Research finding presented at San Francisco, California and Raj bhavan, Patna

AGU FALL MEETING
San Francisco, CA | 9-13 December 2019
GH23B-1237

Equilibrium Sorption of Fluoride on the Activated Alumina in Aqueous Solution

Rakesh Kumar[1], Prabhakar Sharma[1], Rakesh Kumar Singh[2]
[1]School of Ecology & Environment Studies, Nalanda University, Rajgir, India
[2]Aryabhatta Centre for Nanoscience & Nanotechnology, Aryabhatta Knowledge University, Patna, India

आर्यभट्ट ज्ञान विश्वविद्यालय ARYABHATTA KNOWLEDGE UNIVERSITY
Nālandā UNIVERSITY

NATIONAL SCIENCE DAY 2020 (RAJ BHAWAN,PATNA)

CONVERSION OF WASTE INTO WEALTH & KNOWLEDGE

NANO SILICA PRODUCTION FROM RICE HUSK & THEIR APPLICATIONS FOR VARIOUS INDUSTRIES

Innovator: Md Muzzammilul Haque Siddiqui
Group Members: Manu Shreshtha, Shubham Kr Choudhary, Ashwani Kant Bose, Rahul Kr Raman,
Mentor: Dr Rakesh Kumar Singh, Academic Head (I/C)
Aryabhatta Centre for Nanoscience and Nanotechnology, Aryabhatta Knowledge University, Patna

ACNN

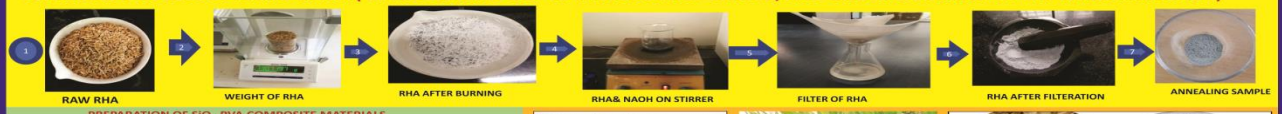
GENERAL INTRODUCTIONS

- Rice husk is agricultural waste burn in air to form husk. In this process the organic matter decomposes and Silica obtain as major component.
- During milling of paddy (Rice) about 78% of weight is received as rice and the rest 22% as husk.
- This husk contains about 75% of organic matters, burning of husk to yield rice husk ash (RHA).
- This RHA contains 85-90% amorphous silica.
- The bulk density is around 90 kg/m³ .
- Silica naturally exists in the form of nanoparticles. Living plants rice absorbs silica in the form of silicic acid from soil, & silica accumulates around cellulose micro component.
- Silica is the second most abundent element in the earths crust.
- Silica nanomaterials are biocompatible and degrade over time in the body

OBJECTIVES

- Using this low cost chemical based method Nanosilica can be produced from rice husk in large quantity for commercialization.
- The main reason is that Rice husk is available in abundant as by product in our society. In this innovation prepared useful material are being obtained by research group of Nanotechnology center of AKU from waste material.
- All the Modern Characterization Techniques such as: XRD, VSM, SEM, AFM & STM, PL, UV-VISIBLE-NIR, FTIR etc. facilities are available at AKU. Thus various properties of nano silica can be obtained using modern scientific tools.
- Production of Crystalline and Amorphous Nanosilica using low cost method can be obtained for various applications as mentioned.

SYNTHESIS PROCESS OF NANO SILICA (BEING CARRIED OUT AT NANOSCIENCE CENTER, AKU UNDER GUIDANCE OF DR. RAKESH KR SINGH)



PREPARATION OF SiO_2-PVA COMPOSITE MATERIALS

National Science Day-2020 (Raj Bhavan , Patna)

Aryabhatta Knowledge University ,Patna

Ferrite Magnetic Nano Materials and their Applications

Innovator: Shashank Bhushan Das
Group Members: Uday Shankar , Singh Sonu Kr. , Om Priya , Gaurav Kr.
Mentor: Dr. Rakesh Kr. Singh, Academic(I/C)
Center for Nanoscience and Nanotechnology, Aryabhatta Knowledge University , Patna

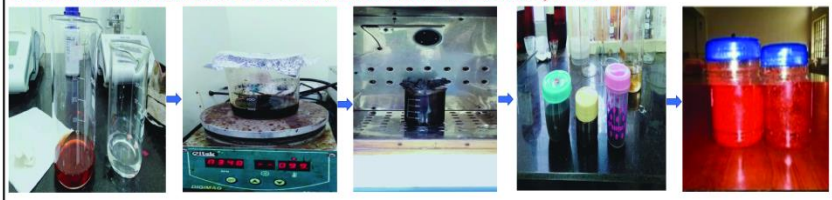
Summary

Ferrites are iron oxide materials have importance in several field of engineering and technology due to its Magnetic property , high resistivity and low eddy current loss. The properties of Ferrite changes drastically at Nanoscale. Nano Ferrite are being used in water purification, Storage devices , Sensors, LED, Medical Science etc.

Our main objective is to be synthesized of different size of ferrite nanomaterials for applications in several sector as mentioned.

We will work/collaborate with related company that can commercialize the different nanoscale ferrite particles, prepared by our group. Such activities boost up the entrepreneurship

Ferrite Nano Materials Production at Nanoscience Center , AKU



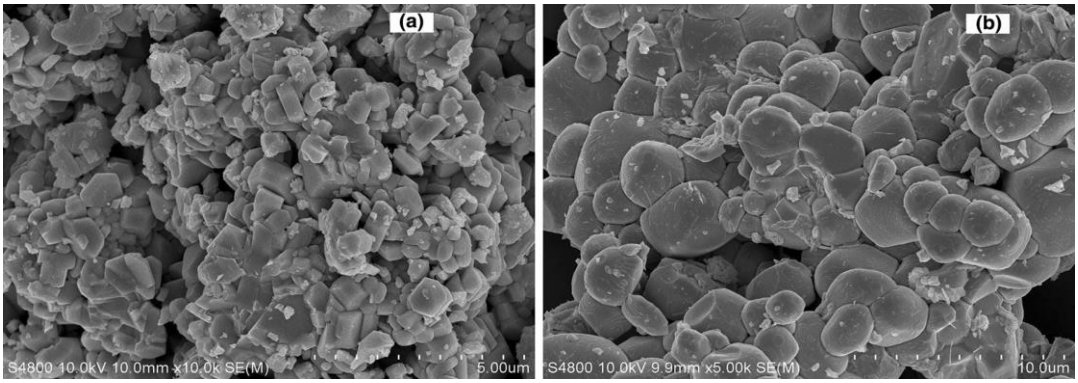
Research publication by faculty/scholar with Nanoscience center of AKU and BIT Patna affiliation

Highlights (Academic Year: 2019-20)

Effect of Fe Concentration on Ferroelectric and Magnetic Properties of Lead Iron Niobate

Journal of ELECTRONIC MATERIALS-Springer

Research group- Dr. Rakesh Kr Singh et al.



- Magnetoelectric (ME) multiferroics show multiple functional properties due to the coexistence of magnetic and electric ordering parameters and coupling between them. Lead (Pb)-based transition metal oxides with ABO_3 perovskite structure is the promising candidates.
- Lead iron niobate, $Pb(Fe1/2Nb1/2)O_3$ (PFN) belongs to type-I multiferroics, which has received much attention in recent years due to its potential technological applications'-ray diffraction patterns suggest the formation of pyrochlore-free monoclinic symmetry of PFN in PbNbFeO3.
- Crystallite size is found to be in 24– 29 nm range and decreases with the increase in Fe concentration. Raman analysis shows the existence of both bending and stretching of Fe-Nb-Fe bonds. Magnetic properties enhance with the increase in Fe concentration in the sample. Magnetic coercivity decreases, whereas remnant magnetization increases with the increase in Fe concentration due to the magneto crystalline anisotropy of the sample. **Such materials may be useful as Electronics Materials for industries**.