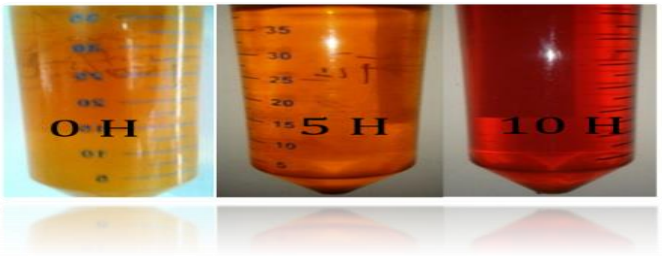
Recent Research Activity: Summary of the Research finding

In academic year 2020-21, about 24 research paper reported/published/prepared for report for publications in Journal indexed in Scopus/WOS/SCI/UGC care list. About 25 M.Tech and Ph.D. scholar actively participated in synthesis, characterization and presentation of research finding in international conferences. The summary/novelties of experimental research work held at Nanotechnology center of AKU are shown on page-32-57.

Magnetic Electronics Nanomaterials



Production of Red color Turmeric Nanopowder

Silica Nanomaterials from Rice husk

Moringa- Potato Food powder,

Bhasma as Nanomedicine

Figure- Cutting edge research activities

Research finding with Nano science centre of AKU affiliation: Highlights

Conversion of waste into wealth and Knowledge

Materials Science and Engineering B 263 (2021) 114871

Contents lists available at ScienceDirect

Materials Science & Engineering B

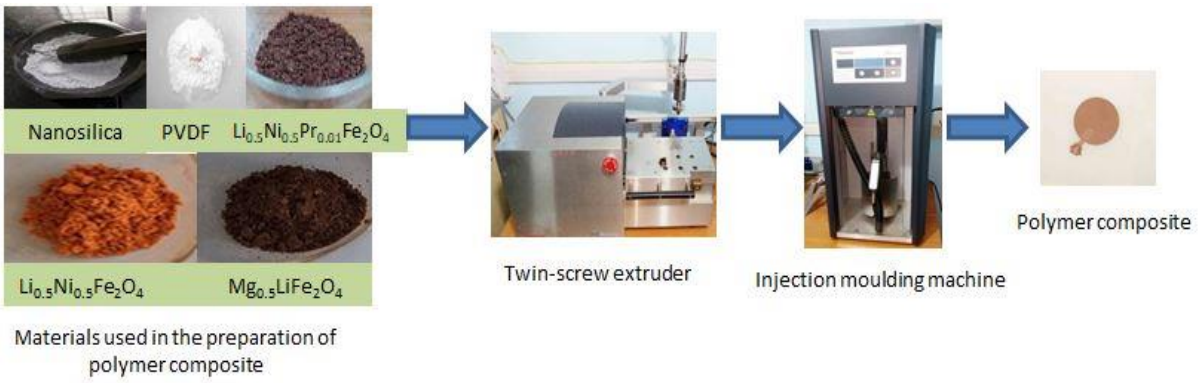
journal homepage: www.elsevier.com/locate/mseb

'Synthesis and properties of amorphous nanosilica from rice husk and its composites

Atul Jyoti [a], Rakesh Kr Singh [a,*], Nishant Kumar [a], Abhay Kr Aman [a], Manoranjan Kar [b]

[a] Aryabhatta Center for Nanoscience and Technology, Aryabhatta Knowledge University, Patna 800001, India
[b] Department of Physics, Indian Institute of Technology, Bihta, Patna 801103, India

Mr. Atul Jyoti Dr. Rakesh K Singh Mr. Nishant



Novelties of Research

- Amorphous Nano silica (SiO_2) was prepared from Agriculture waste rice husk by a cost-effective and environment-friendly method.
- The particle size of SiO_2 was observed from Transmission Electron Microscopy analysis and found to be very small, which suggests the formation of amorphous Nano silica from the rice husk.
- FTIR spectra show the absorption peaks of Si–Oi–Si (silanol) functional group.
- The Nano composite of amorphous Nano silica-Ferrite-PVDF exhibits ferromagnetic nature due to the presence of ferrite in the Nano composite. The magnetic hysteresis loop of Nano composite reveals that the materials can be used as polymer magnet.
- The present study may help to use prepared Nano silica materials in various technological applications.

Research finding with Nano science center of AKU affiliation: Highlights

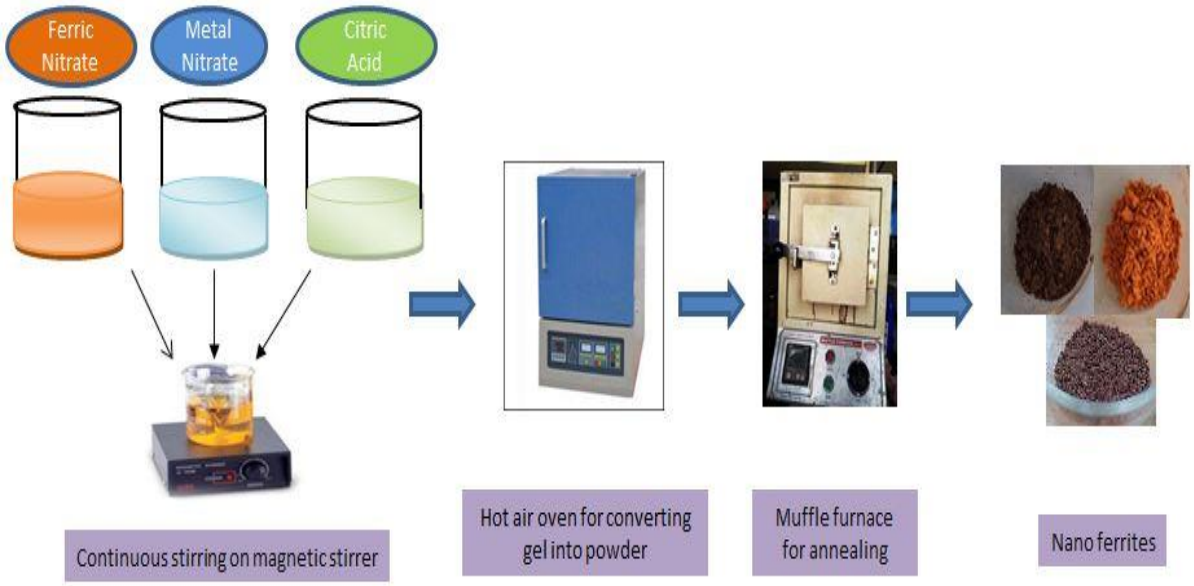
Title of research- Refinement in structural and magnetic properties of citrate precursor sol-gel derived nanocrystalline cobalt ferrite doped with Cerium ($CoFe_{2-x}Ce_xO_4$).

Research team- Gaurav Kumar, Rakesh Kumar Singh, Singh Sonu Kumar, Aniket Manash, Anjalee Prabha, Om priya, Uday Shankar

Journal details- Material Todays Proceedings. (Scopus Indexed) (Status: Under Review)

Novelties of Research

- Spinel Cobalt ferrite ($CoFe_{2-x}Ce_xO_4$) with (x = 0.0, 0.05, 0.10,0.15, 0.20) is prepared using citrate precursor based sol-gel method. The X-ray diffraction pattern reveals that all samples have spinel crystal symmetry indexed to *Fd3m* space group.
- Fullprof Rietveld analysis is performed to find out lattice parameters which increase monotonically due to induced lattice strains in samples. Rietveld calculations are backed by SEM morphological analysis. FTIR spectrum confirms octahedral and tetrahedral site occupancy for all samples.
- The magnetic parameters of samples refines with Ce^{3+} substitution with Magnetization 23.59 to 57.68 emu/g and Retentivity 17.14 to 24.08 emu/g. Coercivity value increased from 739 to 1912 Gauss. Thus influence of rare earth Ce^{3+} substitution at iron site in $CoFe_2O_4$ for improvement of physical properties is discussed in this paper.



Research finding on Animal Origin Calcium based Shankh Bhasma as Nanomedicine

JOURNAL OF NATURAL REMEDIES
DOI: 10.18311/jnr/2021/26225
RESEARCH ARTICLE

Preparation and Exploration of Physical Properties of Calcium based Indian Origin Ayurvedic Medicine-Shankh Bhasma (Marine Drug) as Nanomaterials for its Applications

Sweta Sinha[1], Rakesh Kr. Singh[1*], Nishant Kumar[1], Subhash Pd. Singh[2], Prabhat Kr. Dwivedi[1] and Rekha Kumari[3]

[1]Aryabhatta Centre for Nano Science and Nanotechnology, School of Engineering and Technology, Aryabhatta Knowledge University, Patna – 800001, Bihar, India; rakeshsinghpu@gmail.com
[2]Department of Chemistry, AN College, Patna, Patliputra University, Patna – 800001, Bihar, India
[3]Department of Zoology, AN College, Patna and Department of Education, Govt. of Bihar, Patna – 800001, Bihar, India

Novelties of Research:

- The objective of the present research is to explore the Physical properties of a marine origin Indian Ayurvedic medicine (Shankh Bhasma) as nanomaterials for its applications. S*hankh Bhasma* has been prepared by using the method as mentioned in Ayurvedic text, Aloe vera and buttermilk as ingredient.
- The preparation method was ecofriendly and no hazard chemicals are used or emitted during preparation. X-ray diffraction measurement and Scanning electron microscopy analysis showed that *Bhasma* is in agglomerated nano crystalline materials.
- The photoluminescence measurement shows a broad spectrum in UV region and one prominent emission peak in the visible region at 405nm. Prepared shankh bhasma was examined on E. *coli* and there is no effect on *E. coli*. was observed.
- In this present research, physical property measurement of shankh bhasma using state of the art techniques of 21st century not only support a foundation for the development of low cost ayurvedic natural marine based materials as Nano medicine and its uses in other sectors of science and technology.

Research finding with Nano science centre of AKU affiliation: Highlights

Research finding on Magnetic Nanomaterial for its applications in magneto-optical device, humidity sensor, hydroelectric cell applications and some other related fields

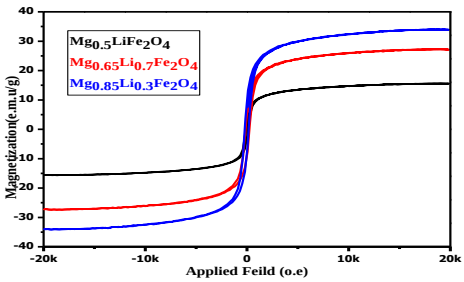
Applied Physics A (2021) 127:183
https://doi.org/10.1007/s00339-020-04233-7

Applied Physics A
Materials Science & Processing

Synthesis and characterization of non-molar lithium–magnesium nanoferrite material for its applications

Rakesh Kr. Singh[1] · Nishant Kumar[1] · Dinesh Rangappa[2]

Received: 20 October 2020 / Accepted: 21 December 2020



Prepared Magnetic nanomaterial's and their magnetization curve

Novelties of Research

- Non-stoichiometric ferrite magnetic nanoparticles $Mg_{0.5+x}Li_{1-2x}Fe_2O_4$ (x = 0, 0.15, 0.35) were prepared using low-cost sol–gel method.
- The XRD study confirms that prepared nanoparticles are a cubic spinel structure having Fd3m space group. The FTIR spectroscopy confirms the spinel nature of ferrite nanomaterial having characteristics absorption peaks at 588 and 435 cm^{-1}.
- HRTEM and SEM image confirms the cubic spinel structure and porosity in the material. The energy band gap was found function of crystallite size. Strong luminescence was observed in the visible range of 580–610 nm.
- The non-molar ratio of Li = 0,0.15 and 0.35 mol leads to a systematic increase in all the magnetic parameters.
- Based on the structural, Magnetic and optical properties, the prepared materials may be potential candidate for magneto-optical device, humidity sensor, hydroelectric cell applications and some other related fields.

Nanotechnology in Ancient Indian Wisdom for happiness and world peace

Research Title- Structural Characterization of Ash of Sri Athi Rudra Homa using Modern Scientific Tools for its Various Applications. (Reported- Springer (IJHS))

Research Team - Rakesh Kr Singh, Nishant Kr, of Nanotechnology center of AKU with collaboration of Prateek Harsora, Divya Kanchibhotla of Art of living foundation, Bangalore

Dr. Rakesh K Singh Dr. Dibya Kanchibhotla

- The Athi Rudra Homa(ARH) is a very rare and auspicious vaidic fire ceremony performed for universal peace, health and prosperity. As with the Agnihotra Homa, this homa too involves chanting and offering of medicinal herbs in the sacred fire, and the ash generated is considered to be very beneficial as minute size functional materials. The objective of the present research was to determine the physical properties of the ash from the ARH, including its crystal structure, surface morphology, the functional groups present, and the light emission behaviour from the ash, using state of the art technology, in order to understand its functional properties for various applications.
- X-ray diffraction and Scanning electron microscope measurement reveal that the size of pure and impure ash is tiny, less than 100nm, and hence this material falls under the category of nanomaterial. Fourier Transform Infrared Spectroscopy indicates the presence of O-H, C-H, C-Cl, C-Br, C-I, N-H functional groups. Due to its nano-crystalline nature and the presence of these functional groups, such material may be useful in agriculture as herbal fertilizer and in some other fields. PL measurement shows broad luminescence in the ultra violet and visible range.
- Due to its physical properties and specially its nanoscale size, luminescence behavior, presence of compound of Ca, N etc, this ‘holy’ ash may be found suitable for use in various areas of science and technology, with potential applications in agriculture, water purification and other sectors.

Research finding with Nano science center of AKU affiliation: Highlights

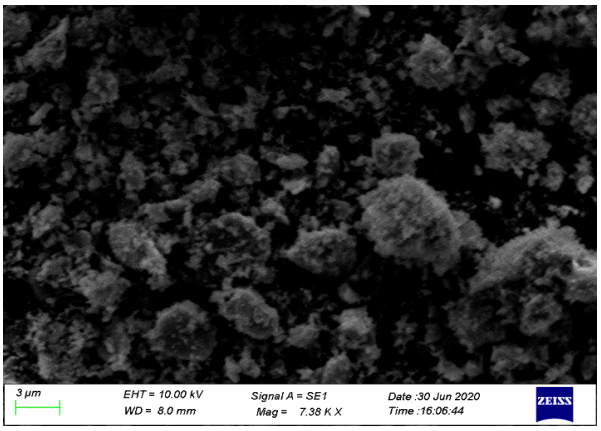
Research finding on Magnetic Nanomaterials for its applications in for its applications in magneto-optical device, humidity sensor, hydroelectric cell applications and some other related fields.

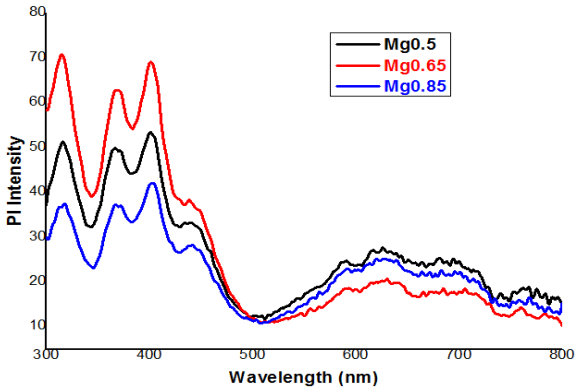
Preparation and characterization of non-molar $Mg_{0.5+x}Li_{1-2x}Fe_2O_4$ (x=0, 0.15 and 0.35) ferrite nanoparticles, annealed at temperature 450° C for varied applications

Cite as: AIP Conference Proceedings 2327, 020003 (2021); https://doi.org/10.1063/5.0039550
Published Online: 09 February 2021

Rakesh Kr. Singh, Nishant Kumar, and Dinesh Rangappa

Dr. Rakesh Kr Singh, Mr. Nishant Kr





Novelties of Research

- Non-molar Li substituted ferrite nanoparticles $Mg_{0.5+x}Li_{1-2x}Fe_2O_4$ (x= 0, 0.15, 0.35) was prepared using low-cost sol gel method, annealed at low temperature 450°C. The XRD study confirms that pure phase spinel structure. and crystalline sizes 25 nm, 42 nm and 29nm respectively.
- The FTIR spectroscopy also confirms the spinel nature, having characteristic absorption peaks at 588 cm^{-1} and 435 cm^{-1}.
- HRTEM measurement confirms the cubic structure and formation of polycrystalline structure having six concentric circles, which indicates the hkl of prepared nanomaterial. The EDAX measurement indicates there is no impurity in the materials having characteristic elements only.
- Strong luminescence was observed in the luminescence of peak intensity in the range of visible range at about 400nm.
- Magnetization measurement shows magnetization 5.53 emu/g, 4.23 emu/g and 0.15 emu/g respectively.
- Present study opens a new window of non-stoichiometries low temperature preparation of Li substituted ferrite materials may be potential candidates for its applications in Magneto-optical device, humidity sensor and hydroelectric cell applications.

Research finding with Nano science center of AKU affiliation: Highlights

Research finding on Magnetic Nanomaterials for its applications in for its applications in magneto-optical device, humidity sensor, hydroelectric cell applications and some other related fields.

ARTICLE IN PRESS

Materials Today: Proceedings xxx (xxxx) xxx

Contents lists available at ScienceDirect

Materials Today: Proceedings

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

Influence of li^{1+} (alkali metal) ion on structural, optical and magnetic properties of nickel ferrite nanomaterials for multifunctional applications

Nishant Kumar [a], Rakesh Kr. Singh [a,*], Shubhas Pd. Singh [b]

[a] Aryabhatta Center for Nanoscience and Technology, Aryabhatta Knowledge University, Patna Pin-800001, India
[b] Department of Chemistry, A N College, Patna, Patliputra University, Pin 800001, India

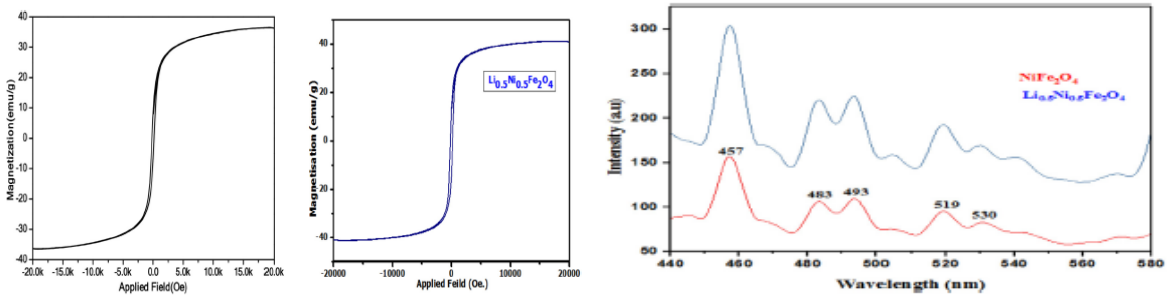


Fig. 9. Photoluminescence Spectra of $NiFe_2O_4$ and $Li_{0.5}Ni_{0.5}Fe_2O_4$.

Research Summary:

- Lithium substituted nickel ferrite nanoparticles, $LixNi_{1-x}Fe2O4$ (x = 0 and 0.5) synthesized using citrate precursor method at a low annealing temperature of 550C.
- Monotonically increase in lattice constant and lattice strain was observed with the substitution of Lithium atom.
- The Indirect band gap were found 2.20 eV for Nickel ferrite and 2.28 eV for substituted Li ferrite. Photoluminescence spectra show that strong luminescence in visible range.
- Magnetic parameter such as remanence, coercivity, and saturation magnetization increases with increase in lithium-ion concentration.
- Prepared Lithium substituted ferrite nanomaterials possess pure phase crystal, uniform growth in magnetism with luminescence in visible range.
- Prepared nanomaterials may be useful in magneto-optical device, humidity sensor, hydroelectric cell applications and some other related fields.

Research finding with Nano science center of AKU affiliation: Highlights

Research finding on Magnetic Nanomaterials for its applications in for its applications in magneto-optical device, humidity sensor, hydroelectric cell applications and some other related fields.

Contents lists available at ScienceDirect

Physica B: Physics of Condensed Matter

journal homepage: http://www.elsevier.com/locate/physb

Tuning in optical, magnetic and Curie temperature behaviour of nickel ferrite by substitution of monovalent K^{+1} ion of $Ni_{0.8}K_{0.2}Fe_2O_4$ nanomaterials for multifunctional applications

Nishant Kumar [a], Rakesh Kr Singh [a,*], Sunil Kumar [b], Prem Kumar [c]

[a] Aryabhatta Center for Nanoscience and Technology, School of Engineering and Technology, Aryabhatta Knowledge University, Pin-800001, Patna, India
[b] Pure and Applied Physics, Guru Ghasidas Vishwavidyalaya (Central University) Bilaspur, Chhattisgarh, India
[c] Sarvajanik Interstarie Vidyalaya, Sarvodaya Nagar, Banka, Bihar, Pin-813102, India

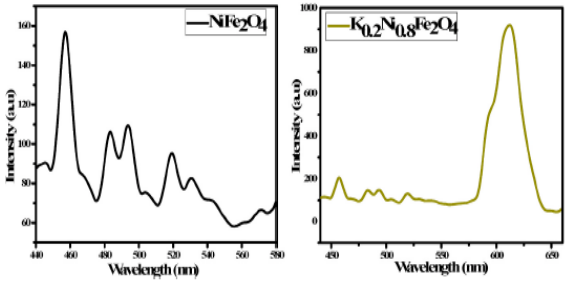


Fig. 10. Photoluminescence spectra (PL) Spectra of $NiFe_2O_4$ and $K_{0.2}Ni_{0.8}Fe_2O_4$.

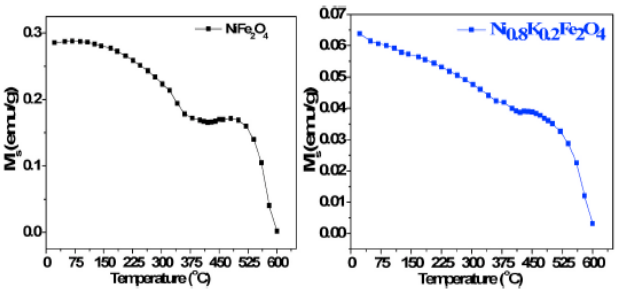


Fig. 12. Temperature-dependent saturation magnetization for $NiFe_2O_4$ and $Ni_{0.8}K_{0.2}Fe_2O_4$.

Novelties of Research:

- Monovalent K1+ ions have been synthesized by sol-gel auto combustion method. The crystallite of nanoparticles of K^{1+} doped nickel ferrite is ~30 nm.
- The band gap was improved similarly substitutions of monovalent potassium also improve luminescence property. Its intensity peaks get shifted towards orange range 610 nm (2.03 eV).
  This shows that the monovalent ion may create defects, leading to porosity and oxygen vacancy in the nanomaterial. The porous structure was confirmed by scanning electron microscope.
- The saturation magnetization and Curie temperature were found to increase with the substitution of monovalent potassium.
- Hence the present materials may be used as functional nanomaterials for various technological applications.

Research finding with Nano science center of AKU affiliation: Highlights

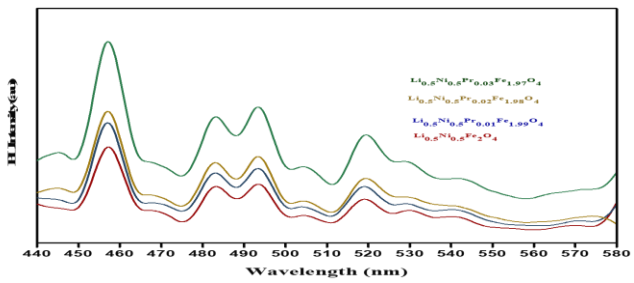
Research finding on Magnetic Nanomaterials for its applications in for its applications in magneto-optical device, humidity sensor, hydroelectric cell applications and some other related fields, **by -Mr. Nishant Kr (Technical Asst.), Faculty member-Dr. Rakesh Kr Singh**

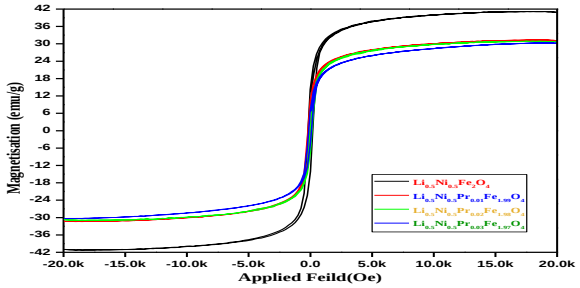
J Mater Sci: Mater Electron

Structural, optical, and magnetic properties of Pr substituted Li–Ni Ferrites prepared by citrate -precursor method

Nishant Kumar[1], Rakesh Kumar Singh[1,*], and Pramendra R. Singh[2]

[1] *Aryabhatta Centre for NanoScience and Nanotechnology, School of Engineering and Technology, Aryabhatta Knowledge University, Patna 800001, India*
[2] *Rajendra College, J P University, Chapra, Bihar, India*





Novelties of Research

- The effect of rare earth element Pr on physical, morphological, optical, multiferroic, and magnetic properties on Li–Ni ferrites are studied.
- X-Ray diffraction revealed a single phase cubic spinal structure having crystallite size 30 to 15 nm with the addition of Pr^{3+}ion. Surface morphology and size were studied using SEM and HRTEM, which show cuboids structure. The bond length was measured using FTIR and found to increase, while force constant decreases systematically with the addition of Pr^{3+} Indirect band gap was was found to decrease from 2.28 to 2.22 eV with higher concentration of praseodymium ion. All the emissions peak in PL spectra lie in the visible range.
- Saturation Magnetization and coercivity both followed the decreasing trend having both least values i.e., saturation magnetization and coercivity at x = 0.03. This shows that the Pr-substituted material might be used in transformer cores due low coercivity and also in opto-electronic devices due to their improved optical and magnetic properties. The P-E loops measurement supports its functional property.

Research finding on Cinnamon food powder as Nano medicine

ICTMIM 2021 IOP Publishing
IOP Conf. Series: Materials Science and Engineering 1126 (2021) 012020 doi:10.1088/1757-899X/1126/1/012020

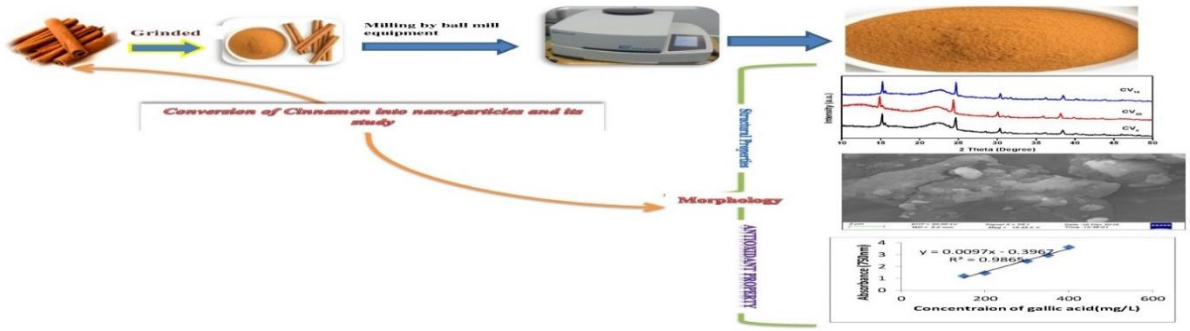
Preparation of superfine cinnamon bark nanocrystalline powder using high energy ball mill and estimation of structural and antioxidant properties.

Archana[1], Aman Kr. Abhay [1], Singh Kr. Rakesh [1], Kr. Nishant [1], Prasad Birendra [2]

1. Aryabhatta centre for Nanoscience and Nanotechnology, School of Engineering and Technology, Aryabhatta Knowledge University, Patna, India, Pin-800001
2. Dept. of Biotechnology, Patna University, Patna, India, Pin-800005
Corresponding author-rakeshsinghpu@gmail.com (Dr. Rakesh Kumar Singh)

Journal details- IOP. Material Science and Engineering (Scopus/Wos Indexed)



Novelties of Research

- Application of Food material for medicinal use is become a common and safe approach to treat various diseases. Although Nanoscience is seeming to most promising area to be explore at every aspect of existing science including medicine and pharmaceuticals. Medicinal properties and application of various spices are well explored science but their nanopowder synthesis and effect is not very much known.
- In this present work, we have used a commonly known spice from Indian kitchen know as Cinnamon, for synthesis of nano powder high energy ball mill instrument was used. The crystallographic study, functional group analysis, were done using modern characterization equipment such as XRD (X-ray diffraction), FTIR (Fourier transform infrared spectroscopy), SEM (Scanning Electron Microscope), and UV-Visible spectroscopy. XRD measurement confirms that crystal structure of powder milled for 5 hours and 10 hours were different. Similarly, morphology of differently milled sample found to be different from general Cinnamon powder.
- This might be due the formation of different fractions of particles were formed as a result of deterioration of cohesion bond due to high energy milling**.** The present study suggested that cinnamon superfine powder could be a potential source of natural antioxidant and thus could be useful as therapeutic agents and also open new window for the progress of surface science of food materials, which are beneficial for biomedical engineering, pharmaceutical, health, and medicine industries.

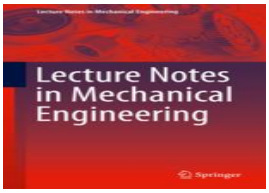
Research finding with Nano science center of AKU affiliation: Highlights

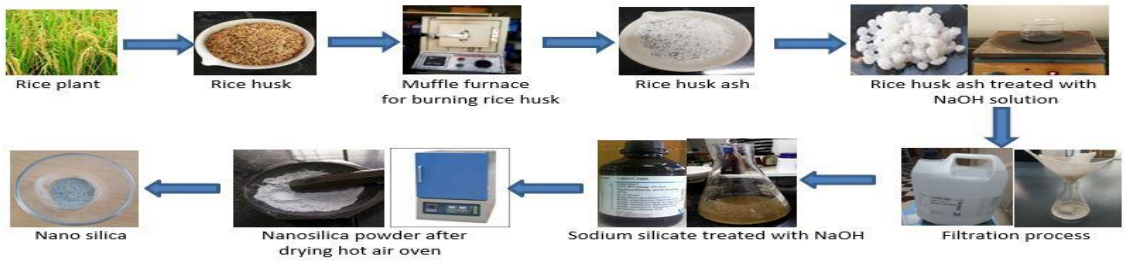
Research finding on Conversion of waste into wealth and Knowledge by Anurag Kr(M.Tech, Mr. Atul Jyoti(M.Tech) , Mr. Nishant Kr(M.Tech) , Faculty member-Dr. Rakesh Kr Singh(Supervisor)

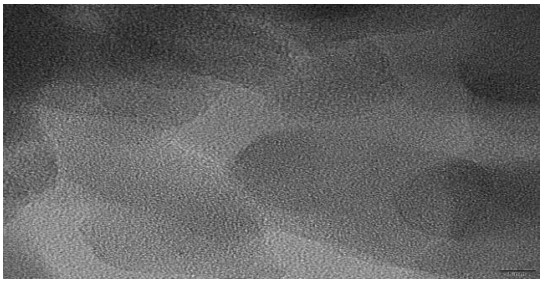
Title of research- Physical properties of Amorphous Nano silica materials from Rice husk (Agriculture waste) and its PVA composite, prepared using green approach for its applications.

Journal details- Springer Lectures notes in Mechanical Engineering (Scopus Indexed) (Status: Accepted in Production)







Novelties of Research

- The small size amorphous Nanoscale silica materials from rice husk were prepared using low-cost ecofriendly approach at temperature 400^0C, 500^0C and 600^0C. Structural properties was prepared silica materials were determined using XRD, HR-TEM and SEM. HR-TEM measurement shows size of about 8nm. Broad XRD peak zone was obtained at near $2\theta=22^o$ that indicates the amorphous nature of silica materials.
- Surface morphology measurement of silica depends on temperature and shows agglomerated porous structure. Photoluminescence, measurement represents wide emission in UV region. PVA/SiO_2 composite was also prepared ecofriendly using low-cost chemical method. Functional group of silica and its composite was measured using FTIR and show the presence of hydrogen bonded silanol group that increases the densification of composite.
- The luminescence emissions of radiations in composite materials are also in UV range but intensity height decreases considerably.
- Physical properties measurement of present research opens a new window for electronics, cement, medicine industries and its use as raw materials or composite materials.

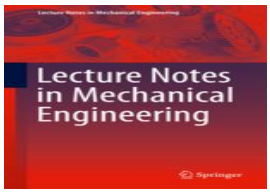
Research finding with Nano science center of AKU affiliation: Highlights

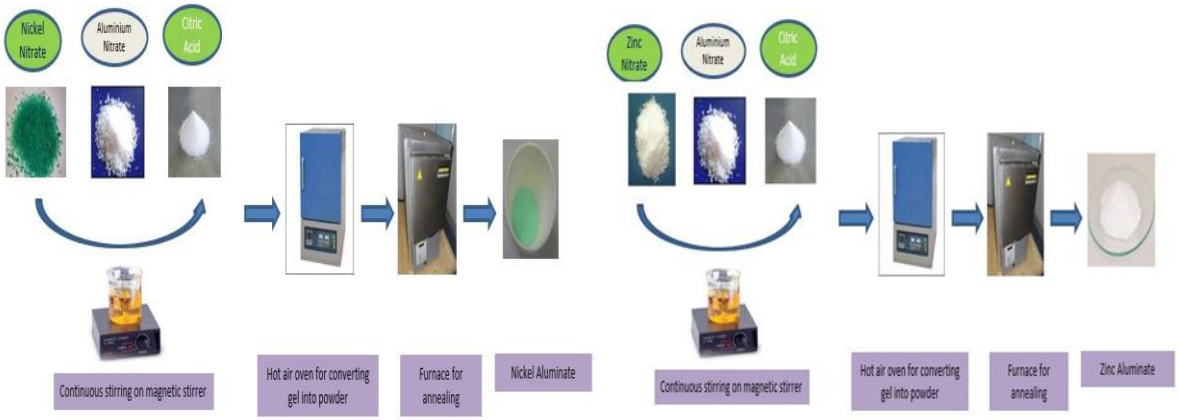
Title of research- Investigating the effect of annealing temperature on structural, Luminescent and magnetic properties of Nickel and Zinc Aluminate nanomaterials, prepared by Sol-gel method.

Research team- Sampurnanad (M.Tech) , Nishant Kumar(Technical staff) Dr. Rakesh Kumar Singh(faculty and Supervisor) .

Journal details- Springer Lectures notes in Mechanical Engineering. (Scopus Indexed) (Status: Accepted in Production)





Novelties of Research

- $ZnAl_2O_4$ and $NiAl_2O_4$ powders were synthesized by citrate precursor method and annealing at 650°C, 750°C and 850°C. The formation of metal aluminates nanoparticles and their particle size was found to depend upon the annealing temperature.
- The XRD patterns reveal that the formation of single phase cubic spinal $ZnAl_2O_4$ and $NiAl_2O_4$ nanoparticles.
- The M-H curves of aluminates nanoparticles reveal that $NiAl_2O_4$ is paramagnetic at room temperature and their coercivity and retentivity increase with increasing annealing temperature otherwise $ZnAl_2O_4$ diamagnetic in nature and their saturation magnetization increases with increasing annealing temperature. The maximum coercivity was found 909.86 G at 850° for Nickel aluminates.
- The PL spectra reveal that both aluminate nanoparticles annealed at different temperatures are in the visible range. Both materials were prepared at the same thermodynamic parameters and utilizing same chemical based citrate precursor method.

Research finding with Nano science center of AKU affiliation: Highlights

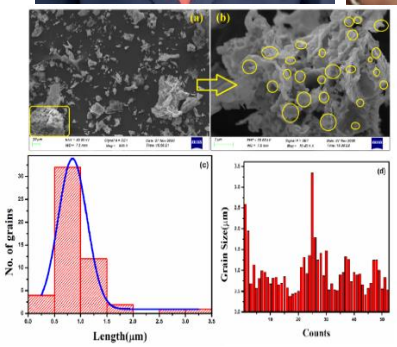
Title of research- Structural, optical and magnetic properties of Cobalt Ferrite nanomaterials, synthesized by green technological approach using Lemon Juice.

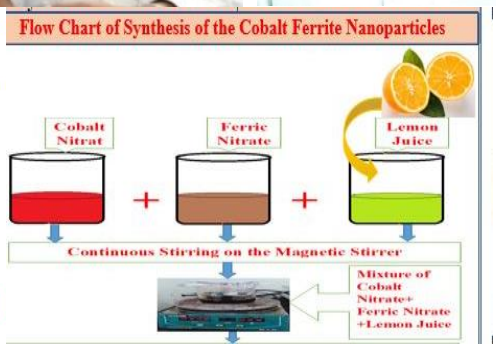
Research team- Shashank B. Das(M.Tech), Vivek Kr(Ph.D.) Nishant Kr(Technical staff), Dr. Rakesh Kr. Singh(faculty and Supervisor) .

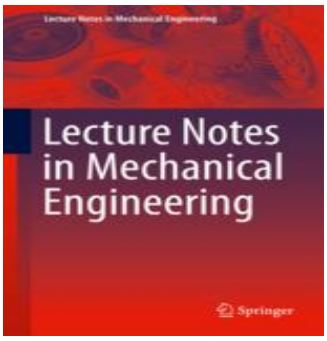
Journal details- Springer Lectures notes in Mechanical Engineering, (Scopus Indexed) (Status: Accepted in Production)











Research Summary:

- Green synthesis of nanomaterials is considered to be cost-effective and eco-friendly methods of synthesis. With this intention to use green synthesis approach, $CoFe_2O_4$ nanoparticles were successfully prepared using lemon juice and metal nitrates as a precursor material.
- FTIR spectroscopic analysis was performed for investigating various molecular vibrations of prepared ceramics. The existence of Fe-O, Co-O etc. vibration bands also clarify the phase formation of $CoFe_2O_4$. Besides these, optical properties were inspected using photoluminescence and UV-VIS spectroscopy.
- Direct band gap was evaluated using Uv-vis spectroscopy where it was measured equal to 3.65 eV using Tauq equation A broad and strong emissions between 457-493 nm (predominantly blue emission) was observed during photoluminescence studies. The magnetic parameters like coercivity displayed systematic increase with rise in annealing temperature.
- The saturation magnetisation (Ms) had significant improvement with annealing temperature.
- The present research studies open a new window that large production of Cobalt ferrite nanomaterial's using green approach can be produced for various applications such as in Electronics industry, Purification of water, Hydroelectric shell etc.

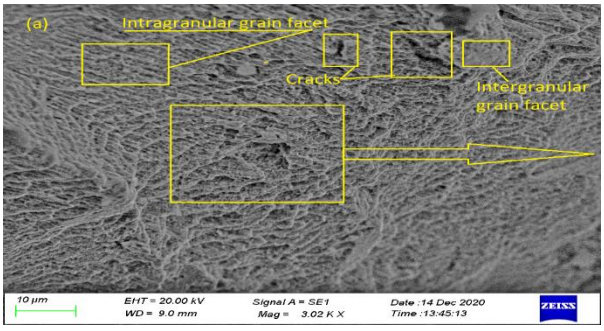
Research finding with Nano science center of AKU affiliation: Highlights

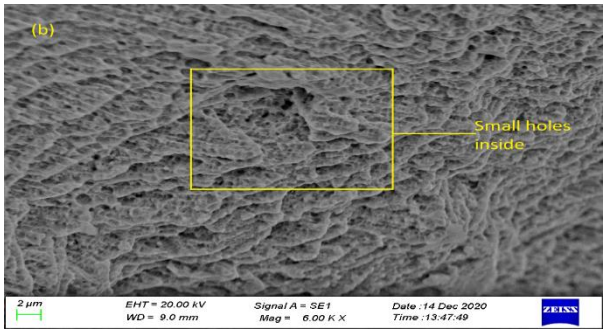
Title of research- Effect of Build Orientation on Tensile properties and Fractography of Additive Manufactured IN718", submission number "116".

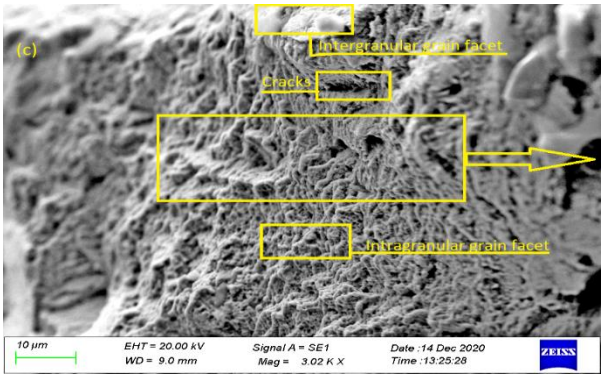
Research team- Dr. Rakesh Kr. Singh, Nishant Kr., et al.

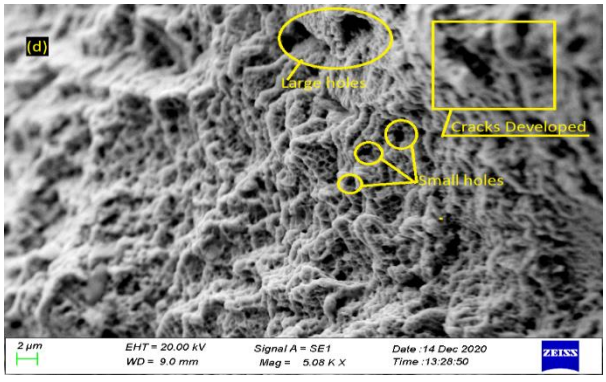
Journal details- Springer Lectures notes in Mechanical Engineering, Accepted (Scopus Indexed)

Research Summary: The additive manufacturing (AM) process is used to fabricate a 3D object from 3D design data. It is still challenging to achieve the desired mechanical properties from the AM technique, as the mechanical property of AM produced part varies with the process parameters used. This work presents a study to investigate the mechanical behavior of AM produced Inconel 718 parts. The Inconel material was especially used in the aviation industry, making propulsion motors and military equipment due to its good yield strength and higher temperature application. The sample was fabricated in three building directions Horizontal (00), Vertical (900), and Inclined (450). Tensile tests were performed on the universal testing machine to investigate the effect of building orientation. The lower tensile strength was observed for the vertically built sample but the ductility is higher than the horizontally built sample. Further, scanning electron microscopy was used for fractography analysis to find out the defects and pores in the fractured surface. Fractography result showed the ductile behavior of the material.









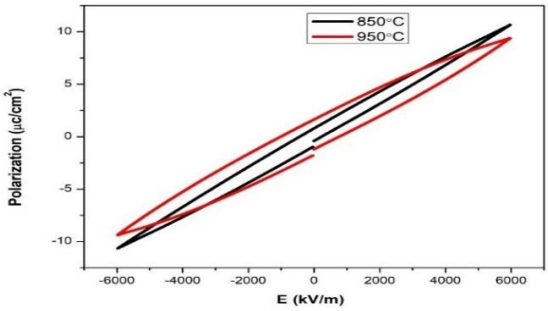
Research finding with Nano science center of AKU affiliation: Highlights

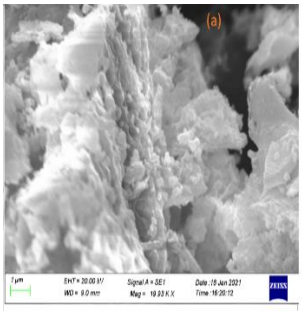
Title of research- Structural, Elastic and Multiferroic property of strontium ferrite nanoceramic prepared by sol-gel derived citrate precursor method**.**

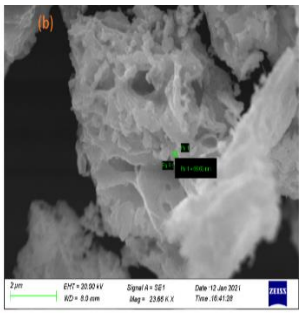
Research team- Singh Sonu kr(M.Tech), Gaurav Kr(M.Tech) , Nishant Kr.(Technical staff), Dr. Rakesh Kr. Singh(Faculty and Supervisor) .

Journal details- Material Todays Proceedings. (Scopus Indexed) (Status: Accepted in Production)







Research Summary:

- Strontium hexaferrite (M-typ) nanoceramic synthesized using low cost based sol-gel citrate precursor process. Intensity pattern of diffraction of X-ray confirms that prepared nanomaterial i.e $SrFe_{12}O_{19}$ possessing pure phase along with presence of some impurity at annealing temperature 850℃ which got eliminated by enhancement of 950℃ of annealing temperature.
- Increasing annealing degree of temperature causes increment in grain size & lattice parameters due to strain induction, as gradual decrease in broadening of XRD peak is observed. SEM measurement supports the XRD results and indicates that sample possess some agglomeration, which may be due to enhancement in annealing temperature. FTIR was used for estimating, functional group occurrence in the prepared materials, force constant & bond length.
- Force constant increases while bond length value decreases with the increased annealing temperature. The elastic property evaluated seems to reduce by enhancement of increasing degree of annealing temperature for hexagonal $SrFe_{12}O_{19}$ sample. Increasing value of annealing temperature leads, reduction in polarization value with the broadening of multiferroic loops suggesting noticeable reduction in electrical leakage.

Research finding with Nano science center of AKU affiliation: Highlights

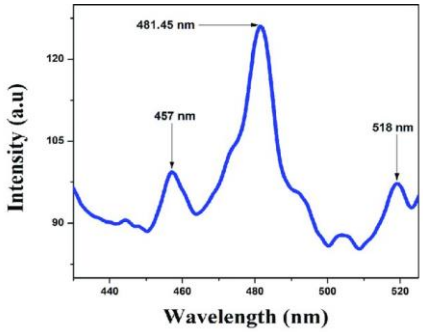
Material Research for possible applications in the electronics industry

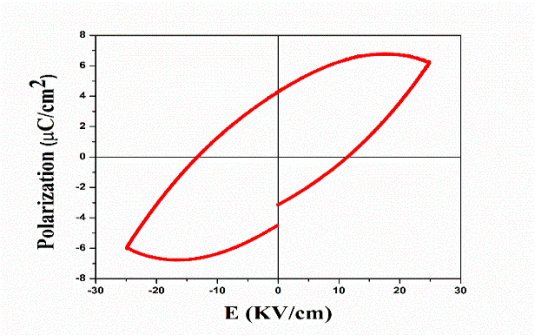
Title of research- Tailoring the structural, optical and multiferroic properties of low temperature synthesized cobalt ferrite nanomaterials, by citrate precursor method**.**

Research team- Shashank Bhushan Das(M.Tech) , Vivek Kr(Ph.D)., Nishant Kr(M.Tech.), Dr. Rakesh Kr. Singh(Faculty and Supervisor) **.**

Journal details- Material Todays Proceedings. (Scopus Indexed) (Status: Accepted)





Research Summary:

- The pure phase of $CoFe_2O_4$ nanomaterials was successfully prepared by the citrate precursor method at an annealing temperature of 500^oC. The pure cubic phase formation with a crystallite size of approximately 29 nm was identified by XRD.
- The molecular vibration wavenumbers were found to be in the range of 466-3439 cm^{-1} by FTIR spectroscopy. The existence of the Fe-O bond at 466 cm^{-1} and Co-O bond at 578 cm^{-1} indicate the spinel phase formation of $CoFe_2O_4$. The Uv-Vis spectroscopy of prepared ferrite has shown a direct and indirect band gap of 3.73 eV and 3.49 eV, respectively. The room temperature PL studies revealed the emission wavelength between 457- 518 nm, where the prominent peak was observed at 481.45 nm which represents a prominent blue emission.
- The multiferroic analysis at 3 KV, indicate an open-mouth shape of the P-E plot of the prepared cobalt ferrite. The multiferroic parameters of synthesized material such as coercive field (E_c), remnant polarization (P_r) and saturation polarization (P_s) were found to be 11.48 KV/cm, 4.26 μC/cm^2 and 6.21 μC/cm^2 respectively. The high P-E loop area represents a high value of leakage current of the prepared ferrite and consequently, the loop behaves as a lossy conductor.
- The high band gap, excellent photoluminescence and lossy conducting P-E loop may contribute towards better electronic properties for possible applications in the electronics industry.

Title of research- Investigating structural, magnetic and multiferroic properties of gadolinium substituted strontium hexaferrite ($SrFe_{12-x}Gd_xO_{19}$).

Research team- Singh S Kumar, Rakesh K Singh, Aniket Manash, Gaurav Kumar and Harendra K Satyapal.

Journal details- IOP. (Scopus Indexed) (Status: Accepted)

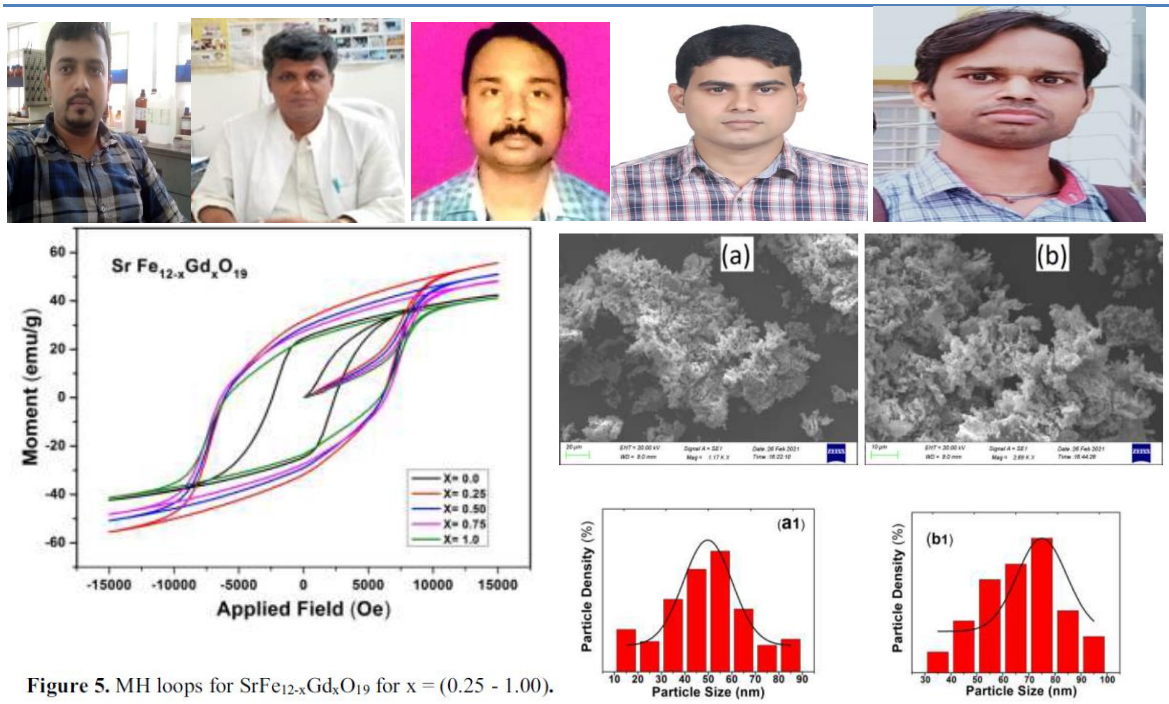


Figure 5. MH loops for $SrFe_{12-x}Gd_xO_{19}$ for x = (0.25 - 1.00).

Novelties of Research

- An economical and citrate precurssor based sol-gel technique is employed for pure phase synthesis of Gd^{3+} doped M-type strontium hexaferrite ($SrFe_{12-x}Gd_xO_{19}$) with x = (0.25 - 1.00).
- FTIR spectrum is in consistent with XRD results. The 'Law of Approach' to saturation is employed to determine magnetic parameters like magnetization (M_s) 40.91 to 57.7 emu/g and retentivity (Mr) ranging from 26.3 to 32.5 emu/g. A remarkable increase in coercivity (H_C) is observed with increasing Gd^{3+} composition, with a value of 2500 to 6310 Gauss.
- Moreover, incorporation of Gd^{3+} in $SrFe_{12-x}Gd_xO_{19}$ lattice, hinders electrical leakage profitably to yield remanance polarization (P_r) and coercive polarization (P_c) of order 0.19 $\mu C/cm^2$ and 17 kV/cm respectively.
- Thus sol-gel method proves to be effective in synthesizing nanomaterials of enhanced physical property along with it being cost effective.

Research finding with Nano science center of AKU affiliation: Highlights

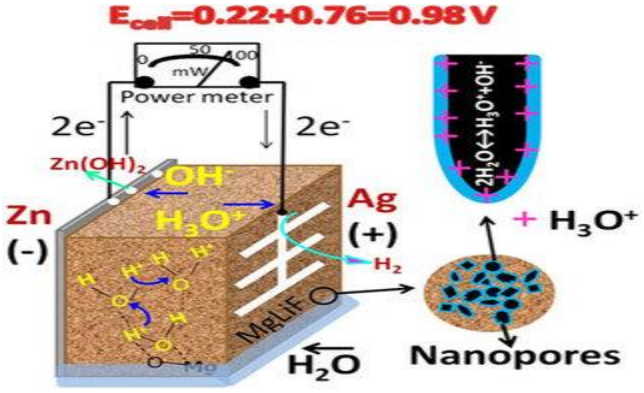
Title of research- A Comprehensive review on hydroelectric cell: A green energy source for sustainable development.

Research team- R. K. Singh, A. Manash, S.S. Kumar, H. K. Satyapal, G. Kumar, U. Shankar.

Journal details- IOP. (Scopus Indexed) (Status: Accepted)

Research Summary:

- A thorough analysis of the hydroelectric cell, in which electric charges are produced by redox reaction, was attempted. As electrodes, zinc & silver are used, with zinc serving as an anode & silver acting as a cathode. Hydroelectric Cell is a capable, environmentally friendly energy generation system that provides several benefits to humans.
- HEC is a straightforward, low-cost, & novel technique. The recently developed HEC is proving to be superior alternative to environmentally friendly electrical energy products. For the HEC fabrication, various ferrite nanomaterials such as magnesium, nickel, and others were used.
- The significance of the recent study is that it focuses on green energy generation, which is an alternative source in today's energy demand. In addition, hydroelectric cell output is predictable and consistent, and it has the capability to substitute conventional methods of generating renewable energy in terms of cost & security.



Hydrolectric Shell invented by Hon'ble Dr. R K Kotnala of CSIR-NPL, Delhi. Dr. Rakesh Kr Singh and his 2 Ph.D. students, Mr. Vivek Kr, Anikat Manus are working in collaboration with Dr. Kotnala Sir.

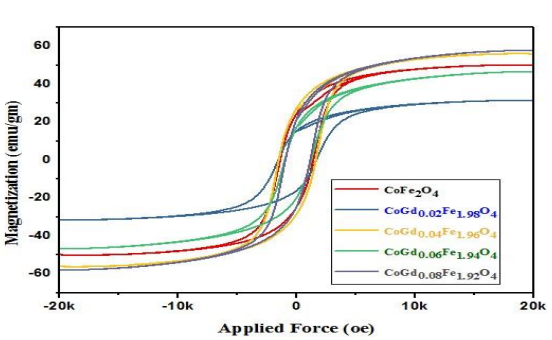
Research finding with Nano science center of AKU affiliation: Highlights

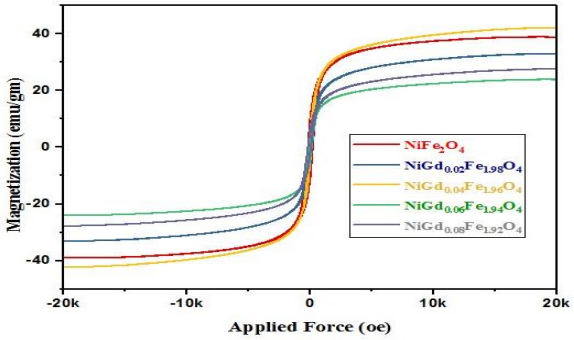
Prepared Materials may be useful in Magneto-Optical devices and Low cost Preparation method may open a new window for mass production of Materials.

Title of research- Influence of gadolinium (Gd^{3+}) rare earth ion on structural, magnetic and optical properties of cobalt and nickel ferrite.

Research team- Shubhra, Nishant Kumar, Vivek Kumar, Dr. Rakesh Kr Singh, Shashank Bhushan Das.

Journal details- Journal of Molecular Structure. (SCI & Scopus Indexed) (Status: Under Review)





Novelties of Research

- The rare earth element Gd^{3+} substituted $CoFe_2O_4$ and $NiFe_2O_4$ nanomaterials
- were prepared using the citrate precursor method. The crystallite size of annealed samples of Gd^{3+} substituted $CoFe_2O_4$ and $NiFe_2O_4$ was found between 15.61-23.49 nm and 12.01-30.95 nm, respectively.
- The direct band gap (E_g) of $CoFe_2O_4$ and $NiFe_2O_4$ samples were found between 1.628-2.406 eV and 1.643-1.661 eV, respectively using Uv-Vis spectroscopy. The room temperature PL studies reveal broad and strong emissions between 457-520 nm with 200 nm excitation, indicating a dominant blue emission and a weak green emission.
- The microstructural analysis using HRTEM confirmed the approximate particle size of 34 nm and 41.58 nm for pure cobalt and nickel ferrite materials, respectively. The coercivity has displayed an initial increase and then decrease in the prepared cobalt ferrite with the increase in the amount of Gd^{3+} substitution whereas the nickel ferrite materials have exhibited a continuous decrease in coercivity. The saturation magnetization (M_s) was noticed between 30.59-57.84 emu/g for $CoFe_2O_4$ and 23.99-42.11 emu/g for $NiFe_2O_4$ samples.
- The substitution of Gd^{3+} in crystal sites may result in significant strain within the crystal structure and the related properties may account for some interesting applications in magneto-optical devices.

Research finding with Nano science center of AKU affiliation: Highlights

Title of research- Sol-gel assisted synthesis and tuning of structural, photoluminescence, magnetic and multiferroic properties by annealing temperature in nanostructured Zinc ferrite

Research team- Vivek Kumar, Nishant Kumar, Shashank Bhushan Das, Dr. Rakesh Kr Singh.

Journal details- Material Today Proceedings. (Scopus Indexed) (Status: Accepted)

Contents lists available at ScienceDirect

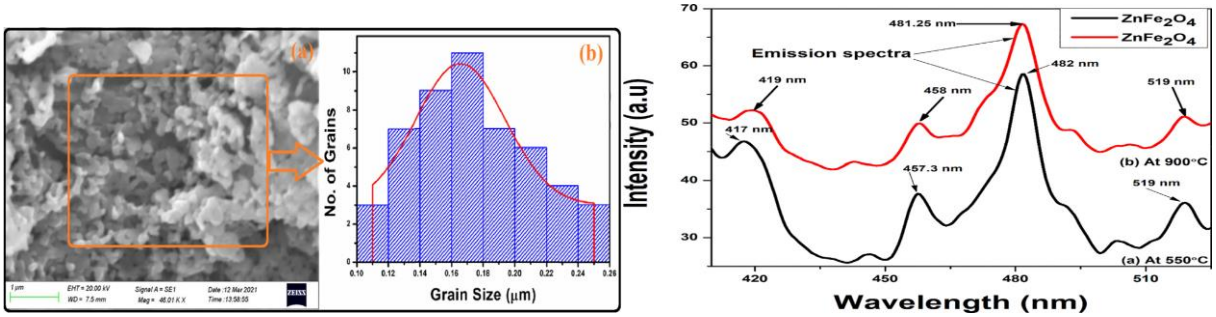
Materials Today: Proceedings

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

Sol-gel assisted synthesis and tuning of structural, photoluminescence, magnetic and multiferroic properties by annealing temperature in nanostructured zinc ferrite

Vivek Kumar [a], Nishant Kumar [a], Shashank Bhushan Das [a], Rakesh Kumar Singh [a,*], Kakali Sarkar [b], Manish Kumar [c]

[a] Aryabhatta Centre for Nanoscience and Nanotechnology, Aryabhatta Knowledge University, Patna 800001, India
[b] Department of Metallurgical and Material Engineering, Jadavpur University, Kolkata 700032, India
[c] Vidya Vihar Institute of Technology, Maranga, Purnea 854303, India



Research Summary:

- The high purity $ZnFe_2O_4$ nanomaterials was successfully synthesized by sol-gel method at an annealing temperature of 900°C. XRD, FTIR, PL, SEM, VSM and multiferroic analyses were performed to characterize the $ZnFe_2O_4$ nanomaterial..
- The PL emission wavelength was noticed between 457- 520 nm where the prominent peak was observed at 481.25 nm. A strong blue and weak green emission in PL spectra were noticed.
- From the SEM analysis, the agglomerated nanoparticles were observed with an average grain size of 0.174 µm, approximately.
- The magnetic constraints like coercivity, saturation magnetization and retentivity of pure $ZnFe_2O_4$ were estimated to be 116.14 Oe, 4.26 emu/g and 0.740 emu/g, respectively at 900°C. Furthermore, the multiferroic analysis between 3-6 KV of pure $ZnFe_2O_4$, indicate a thin P-E plot of very small loop area.
- The small loop area indicates the loss capacitive nature of P-E plots of $ZnFe_2O_4$ prepared at 900°C and consequently, the low leakage current. The multiferroic constraints displayed a systematic increase with the increase in applied electric fields.
- The excellent photoluminescence and lossy capacitive P-E loop may contribute towards better electronic properties for possible applications in the electronics industry.

Contents lists available at ScienceDirect

Materials Today: Proceedings

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

Tuning the structural, magnetic and multiferroic properties of Sm^{3+} substituted barium hexaferrites $BaFe_{12-x}Sm_xO_{19}$ nanoceramics

Harendra Kumar Satyapal, Rakesh Kumar Singh*, Singh Sonu Kumar, Shashank Bhushan Das

Aryabhatta Centre for Nanoscience and Nanotechnology, Aryabhatta Knowledge University, Patna 800001, India

Highlight of Research Paper:

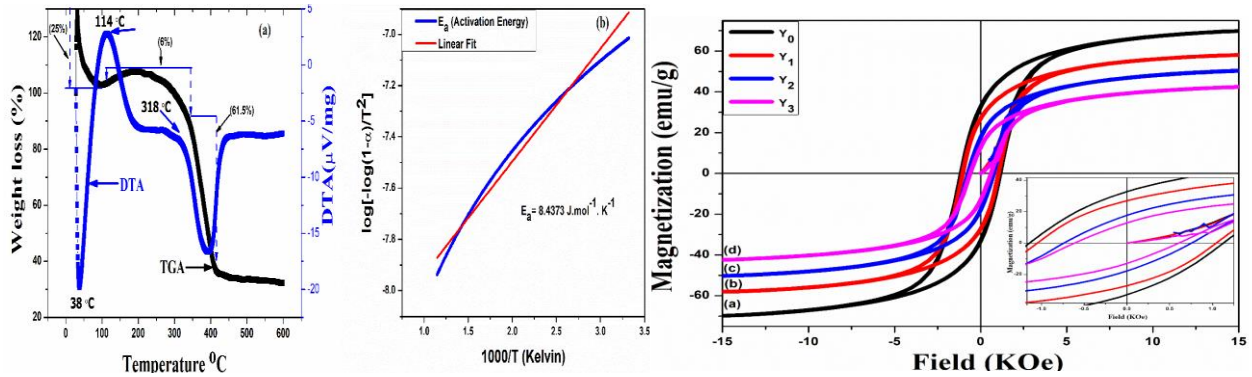
- M- Type hexagonal ferrites $BaFe_{12-x}Sm_xO_{19}$ with (x = 0.0, 0.25, 0.50, 0.75, 1.0) is prepared using citrate precursor-based sol–gel method.
- The magnetic parameters of prepared samples get refined with samarium substitution with appreciable Magnetization 42.62–63.05 emu/g and Retentivity 19.73–29.26 emu/g. Coercivity value increased from 303.5 to 2265.1 Gauss.
- The Magnetocrystalline anisotropy (K_1) is calculated using Law of Approach to Saturation, which ranges from 1.37 to 4.24×10^6 erg/cm^3.
- The FeO_6 octahedron in its perovskite-like hexagonal unit cell and off centering of Fe^{3+} from the center of octahedron is suggested to generate polarization in doped samples.
- Therefore, a correlation between lattice strain mediated structural, magnetic and multiferroic properties enrichment with varying samarium content in hexaferrite lattices is explored in this article.

Research finding with Nano science center of AKU affiliation: Highlights

Title of research- Structural, magnetic , optical , multiferroic and microstructure properties of Y^{3+} substituted cobalt ferrite nanomaterial prepared by a cost-effective sol-gel route.

Research team- Shashank Bhushan Das, Dr. Rakesh Kr Singh, Vivek Kumar, Nishant Kumar, Pallavi Singh and Naman Naik

Journal details- Ceramic International. (SCI & Scopus Indexed) (Status: Revision Submitted)



Research Summary:

- Ferrite nanomaterials are known as popular magnetic materials for their applications in the electronics industry, energy storage and environmental monitoring. Yttrium substituted $CoY_xFe_{2-x}O_4$ nanomaterials, were synthesized at 750℃ by a sol-gel process.
- The surface morphology of $CoFe_2O_4$ and $CoY_{0.3}Fe_{1.7}O_4$samples revealed agglomerated and porous structures with an average grain size of 1.24 and 2.50 μm, respectively, using SEM. HRTEM confirmed particle size of $CoY_xFe_{2-x}O_4$ (where, x =0.0 and 0.3) near 30.40 and 10.92 nm, respectively. The FTIR spectroscopy has identified various bending and stretching vibrations between 463-3428 cm-1 for $CoY_xFe_{2-x}O_4$ samples.
- The increase in Y^{3+} content has increased the direct band gap from 3.39 to 3.91 eV. The room temperature PL spectroscopy of the prepared samples indicated a predominant blue emission between 457-493 nm and a weak green emission between 493-520 nm using 350 nm excitation. The magnetic parameters like the coercivity (Hc), saturation magnetization (Ms), retentivity (Mr) and magnetocrystalline anisotropy constant (K) exhibited a continuous decrease from 1173 to 666 Oe, 69.95 to 42.38 emu/g, 33.24 to 13.45 emu/g and 7.73 105 to 3.01 105 erg/cm3, respectively at room temperature with the increase in Y3+ content. The multiferroic analysis between 3-5 KV has shown the largest P-E loop area of the pure CoFe2O4 materials, which considerably decreased with Y3+ substitution.
- The structural, magnetic, optical and multiferroic properties could make it useful as multifunctional materials in opto-electronic and environmental applications.

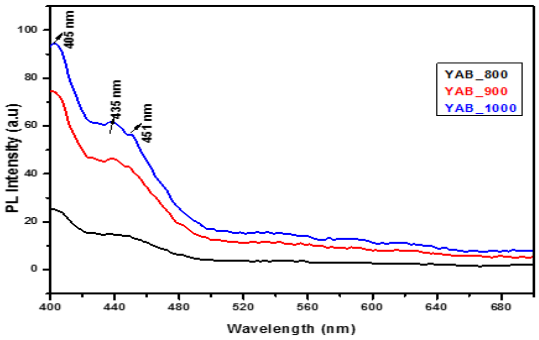
Research finding with Nano science center of AKU affiliation: Highlights

Title of research- Structural, optical , and magnetic properties of Yttrium aluminum borate (YAB) nanomaterial, prepared bu low-cost sol-gel method

Research team- Bibhuti Bikramaditya , Dr. Rakesh Kr Singh, Nishant Kumar,

Journal details- Materials Today Proceedings (Scopus Indexed) (Status: Under Review)





Research Summary:

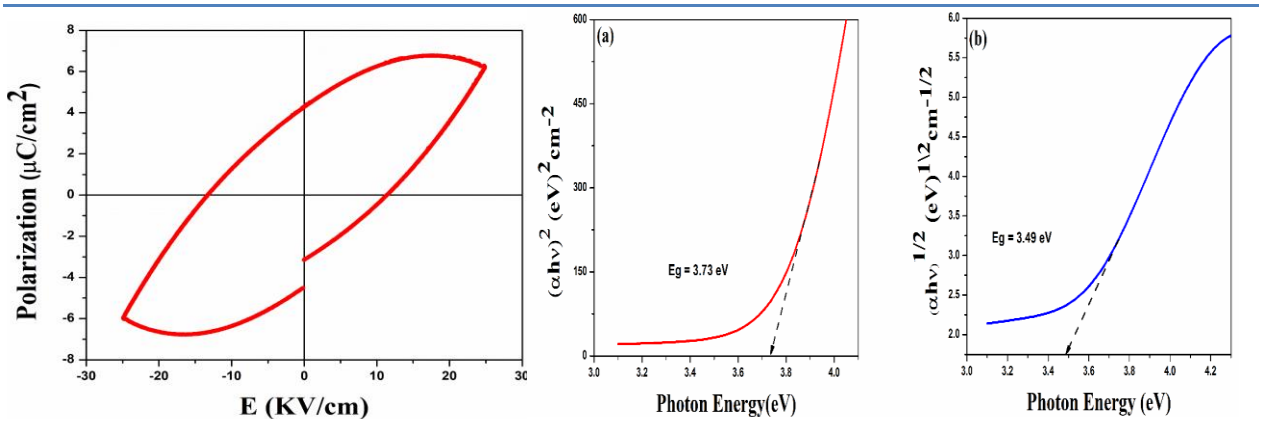
- In this research, we present synthesis, structural optical and magnetic analysis, of the Yttrium Aluminium Borate (YAB) nanomaterials. This material is very useful for optoelectrical and LED devices.YAB materials were synthesized by Sol-gel method.
- The structural and morphological analysis, carried out by using X-ray diffraction (XRD) shows that crystal structure of YAB is of nanometric size ranging between 16 nm to 26 nm at annealing temperature is above 800 degree.
- Photoluminescence property shows that YAB gives intense blue light emission in the visible region. Further energy band gap of the were investigated using Tauc plot which was found to be decreased from 1.782 eV to 1.748 eV respectively with increasing annealing temperature from 800°C to 900°C keeping annealing time constant for 2 hrs.
- This result shows that the band gap is a function of crystallite size and it is very close to energy band gap of GaAs nanomaterial used in the Light Emitting Diode (LED) application, having band energy gap 1.441 ev .
- Vibrating Sample Magnetometer (VSM) shows the paramagnetic nature of the prepared sample. Coercivity increases while Magnetization and retentivity decreases for YAB nanomaterials for the temperature above 800 degree Celsius.
- The prepared YAB nanomaterials may be potential candidate for LED and other related application.

Research finding with Nano science center of AKU affiliation: Highlights

Title of research- Structural characterization and investigation of magneto-optic and multiferroic properties of nanostructured $CoFe_2O_4$ prepared by sol-gel derived facile chemical route.

Research team- Shashank Bhushan Das, Vivek Kumar, Md. Muzzammilul Haque Siddiqui, Nishant Kumar, Rakesh Kumar Singh.

Journal details- Material Today Proceedings (Scopus Indexed) (Status: Accepted)



Research Summary:

- The high purity crystalline CoFe2O4 nanomaterials was prepared by a sol-gel derived facile route . XRD identified the development of the cubic phase with a crystallite size of 25.68 nm.
- The direct and indirect band gap was found 3.88 and 3.80 eV, respectively. The PL spectroscopy revealed emission wavelength between 457- 519 nm at room temperature
- . The sintered nanoparticles were observed with a mean grain size of approximately 1.86 μ m by SEM analysis.
- The magnetic coercivity of $CoFe_2O_4$ confirms its hard magnetic behaviour. The coercivity (Hc), Ms (saturation magnetization) and retentivity (Mr) were found to be 1012 Oe, 83.38 emu/g and 40.67 emu/g, respectively.
- The coercive field (Ec), remanent polarization (Pr) and saturation polarization (Ps) were observed between 10.97-28.11 KV/cm, 3.52-9.65 μC/cm2 and 5.94-11.82 μC/cm2, respectively. The multiferroic constraints exhibited a systematic increase with the increase in applied electric field. The P-E loop resembles a lossy conductor as the loop area is very high. The area increased with the increase in applied electric field, resulting in high leakage current.
- **The high coercivity, moderate Ms, high band gap and photoluminescence of these materials may be accountable for possible applications in the electronics industry.**

Research finding with Nano science center of AKU affiliation: Highlights

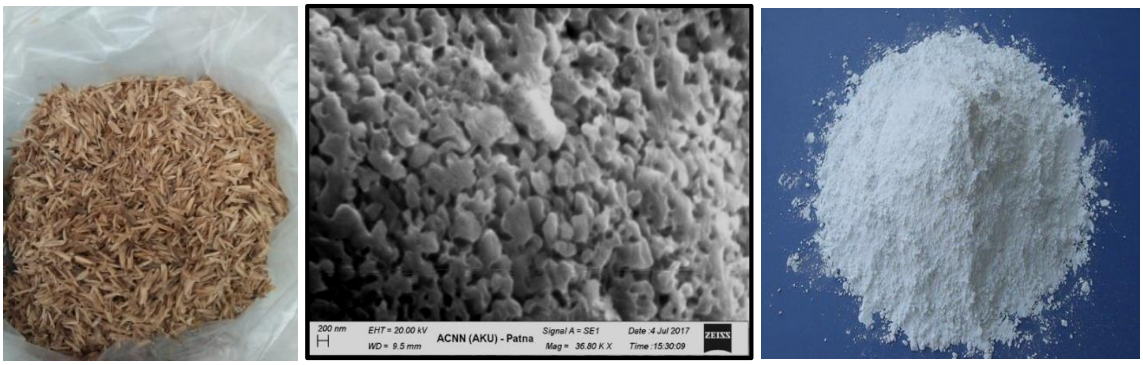
Title of research- Synthesis, Structural and Photolumineiscent property of crystalline Nano silica from rice husk.

Research team- AkanshaKumari[1], Rakesh Kr Singh[1], Abhay Kr Aman Ashwani Kant Bose, Nishant Kumar

Journal details-(Scopus Indexed) (Status: Being Submitted in Journal Silica (Elsevier))

Research Summary:

- The electrical, electronics, Drug industries is heavily reliant of use of Silicon materials for several applications. Green source of production of Silicon materials is very important to meet the growing demand for industrial purpose. The present work reviews the recent nanosilica production using low cost method, from rice husk
- . The 26nm and 55nm crystalline silica particles was prepared from rice husk synthesized by both coprecipation and leaching processes. The prepared materials was characterized using X-ray diffactometer(XRD), Scanning Electron Microscope(SEM), Fourier Transform Infrared Spectroscopy(FTIR) and photoluminescence spectrometer(PL). The SEM images of both the samples showed structural order of the pores within mesoporous structure. Leached sample showed purity around 80%.
- The infrared spectral data also supports the presence of hydrogen bonded silanol group and the siloxane groups in the silica. These nanosilica particles showed Photoluminescence in UV, Visible and NIR region.



Production of Silica materials from Rice hush and their Electron microscopy Image.

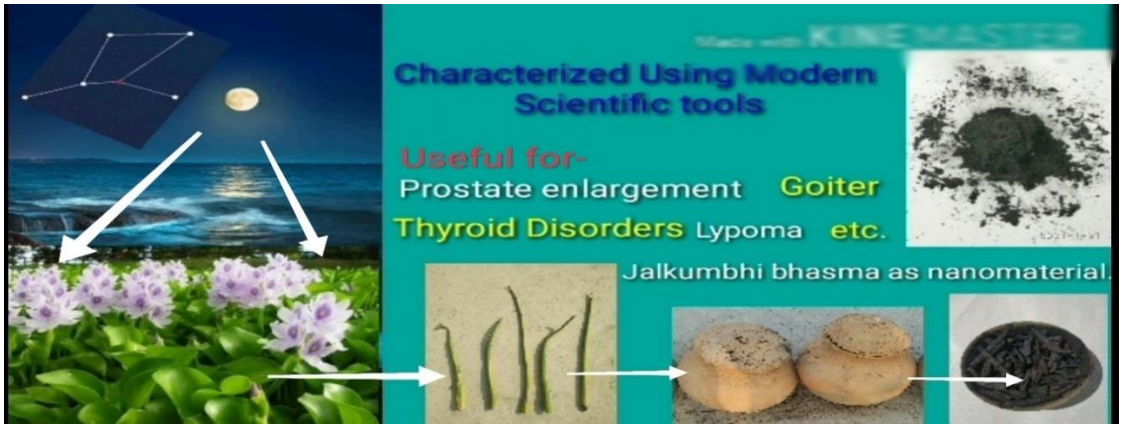
Studies on effect of Radiation of Moon on the crystal structure of Jalkhubhi Bhasma as functional Bio nanomaterials for its applications as medicine and other area of Science & Technology

*Dinesh Pd [1], **Rakesh Kr Singh[2]**, Shambhunath Nath Guha[2], Jitendra Kr Singh[3], Shashank Bhushan Das[1], Nishant Kumar[1], Dineshwar Prasad[4]*

1. *Govt. Ayurvedic College, Begusarai, Dept. of health, Govt. of Bihar, Patna*
2. *University center for Nanoscience and Nanotechnology, Aryabhatta Knowledge university, Patna, PIN-800001*
3. *S.S.Hospital, Malahipakri Chock, Patna*
4. *Govt. Ayurveda College, Patna*



Dr. Rakesh **(Founder Vic-Chancellor, AKU, Patna), Dr. J K Singh**



- Jalkhumbhi Bhasma as Nanomaterials are prepared using ecofriendly green approach in Pushya nakshtra and Rohini nakshtra. The crystal structure was evaluated, using modern scientific tools. X-ray diffaraction measurement shows that crystalline size and lattice constant of Jalkhumbhi bhasma prepared in Push and Rohini nakshtra were found, 26.62 nm and 54.55 nm and lattice constant 6.312A, 6.301A and respectively. This reveal effect of radiation of moon alter the crystal structure.
- The Fourier transform infrared spectroscopy(FTIR) measurement shows functional group present in the materials are of compound of K, Cl, C-Cl, NH2, C-O-C, C=O, Ca and $Ca(OH)_2$ respectively. The magnitude of force constant for are 2.51307 N/cm, 4.16005 N/cm and 2.61932 N/cm, 4.20074 N/cm respectively and this measure the interatomic strength. The photoluminescence spectra (PL) reveals that the broad spectrum from both the materials lies in the visible region showing broad blue emission. The energy band gap value for the most significant intense peak corresponding to 481 nm (2.55 eV) corresponding to 350 nm excitation and 501 nm (2.475 eV) for 370 nm. The optical property shows that prepared jalkhambhi bhasma may be useful as semiconductor electronics nanomaterials, which was prepared using eco-friendly. **This may open a new window for pharmaceutical industries for production of such materials for electronics based industries in addition to use as drug.**

Dr. Rakesh Kr Singh

energy&fuels

pubs.acs.org/EF Article

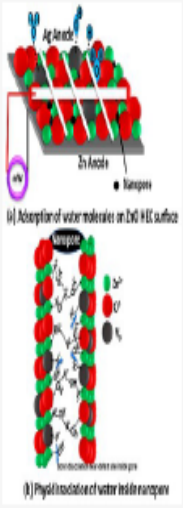
Nonphotocatalytic Water Splitting Process to Generate Green Electricity in Alkali Doped Zinc Oxide Based Hydroelectric Cell

Rekha Gupta, Jyoti Shah, Rakesh Singh, and R. K. Kotnala*

Cite This: https://doi.org/10.1021/acs.energyfuels.1c01164 Read Online

ACCESS | Metrics & More | Article Recommendations | Supporting Information

ABSTRACT: Efficient nonphotocatalytic water molecule splitting and electricity generation has been obtained from alkali (Li, Na, K) doped zinc oxide (ZnO) hydroelectric cells (HECs) at room temperature. The existence of defect centers including zinc and oxygen vacancies in pure and alkali-doped ZnO has been observed by optical spectroscopy. Broadband dielectric spectroscopy has been carried out to investigate the charge transfer mechanism in the physisorbed layer of water molecules on the surface of porous ZnO HEC. Temperature dependence of dielectric relaxation was also determined to identify the reorientation dynamics of water molecules near the defect site in ZnO. Minimum activation energy for dipolar reorientation, $E_a \sim 128.54$ kJ/mol, was calculated for the K-ZnO sample depicting easy hopping of H^+ ions near the defect site. Maximum lattice strain induced by K doping in ZnO led to faster dipolar reorientation and easy hopping of the proton over the physisorbed layer of water molecules on the cell surface. Maximum output power, $P_{out} \sim 5.71$ mW/cm^2, has been delivered by K doped ZnO HEC, which is comparable to the best achieved power density by a ZnO nanoparticle-based dye-sensitized solar cell, ~9.17 mW/cm^2. Zinc oxide based hydroelectric cells are a low cost, environmentally friendly solution for energy generation scarcity for the masses living in remote locations without the use of any harmful chemicals.



Tuning of Structural, Elastic, Luminiscence, Magnetic and Multiferroic properties of rare earth Ce^{3+} substituted strontium hexaferrite Ceramic magnetic nanomaterials for its industrial applications.

Reported for publication in Material Research Express-IOP

Singh Sonu Kr[a], Rakesh Kumar Singh[a*], Aniket Manash[a], Gaurav Kr[a] et al.

[a]*Aryabhatta Centre for Nanoscience and Nanotechnology, Aryabhatta Knowledge University, Patna 800001, India.*

*Corresponding author: Tel.: +919304197595, *Email address:* rakeshsinghpu@gmail.com(Dr. Rakesh Kr Singh)

- Systematic decrease in crystalline size(79.64-66.02nm), strain and systematic increase in cell volume found with increase in composition of Ce(x = 0.0, 0.20, 0.40, 0.60),which are one of the imporant findings, which may highlighted as one of the important feature of this low cost chemical method of preparation of ferrite ceramics materials at nanoscale.
- The largest and minimum value of force constant in tetrahedral and octahedral sites are found 262.987 N/m, 260.360 N/M and 141.257 N/m, 139.973 N/m respectively. This results shows, rare earth Ce substation decreases the interatomic forces. Crystalline size were function of force constant.
- Reduction in stiffness constant and elastic moduli is observed with increasing value of substituation of rare earth element Ce from X = 0.00 to X = 0.60 . **Such elastic properties support significant role in order to overcome physical stressing in case of fabrication as Electronics and Electrical materials at nanoscale for its industrial use.**
- **Prominent peaks are found in visible range, which are one of the feature for its applications in LED, Biological imaging etc**.
- **The 5632 gauss coercive value indicates its application in dense recording media. Squareness ratio (Ms/Mr) is found to be >0.50 for all composition suggesting that $SrFe_{12-X}Ce_XO_{19}$ can be used as permanent magnet.**