

Aryabhata Center for Nanoscience and Nanotechnology Aryabhata Knowledge University, Patna - Achievements



Hon'ble CM, Sri Nitish Kr Ji and other eminent dignitaries visited and appreciated ongoing academic/research activities under the leadership of Dr. Rakesh Kr Singh. Dr. Rakesh Kumar Singh, has been coordinated in establishing this center as Head/Prof. incharge-Establishment/Academic-incharge from 1st April 2014. At present he is Registrar of this university (from 8th Jan 2022)



On 23rd November 2021, certificate of excellence is awarded to Dr. Rakesh Kr Singh, Faculty member of Nanotechnology center of Aryabhata Knowledge University, Patna for his outstanding performance in the category of Best Young Teacher with research contributions in Modern field of Nano Science” as per recommendation of the selection committee constituted by Hon'ble Chancellor, Universities of Bihar.



This Nanotechnology center well equipped with about 22 high-end research instruments such as Scanning Electron Microscope, Multiferroic system, Vibrating sample magnetometer etc. and its impact is being felt globally. Establishment of Simulation laboratory in nanomaterials research are also in progress under the coordination of Dr. Rakesh Kr Singh. More than 500 scholars/academicians from national/international level academic institutions have visited the Nanotechnology center of this university.



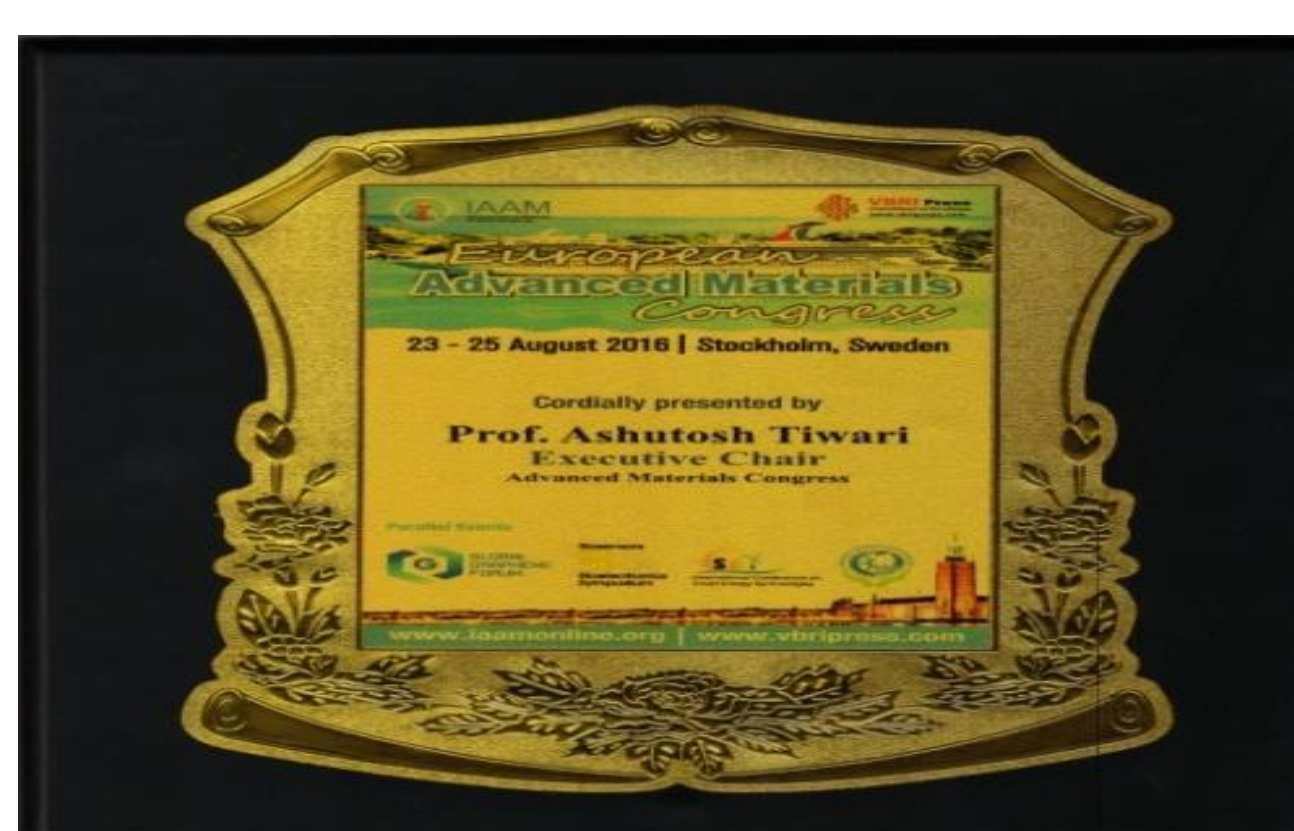
Students of Nanoscience center, working in the area of “production of nanosilica from rice husk”, under the supervision of Dr. Rakesh Kr Singh, receiving 1st prize at Rajbhawan Patna in a state level programme” Innovations and Entrepreneurship in Science Education and Research.

Faculty member and M.Tech / Ph.D. scholar of this research center have published more than 200 papers in peer reviewed/ Impact factor/ Indexed Journals. Thrust areas of research are- Nanotechnology in Food & Agriculture, Nanotechnology in Ayurvedic Science, Nano Electronics Magnetic nanomaterial's, Nano medicine, Nano-Biotechnology, Nanosilica from Rice husk(Agriculture waste) etc. In last 3 year about more than 100 research papers presented in international/national conferences with nanoscience center affiliation. At present about 25 research project/activities are being carried out by faculty members and scholar of Nanotechnology center.



Hon'ble Chief minister Sri Nitish Kr Ji, specially appreciated research activities of Nanoscience and Nanotechnology center of Aryabhata Knowledge University, Patna, during his video conference program of establishment of statue of Aryabhata in campus.

Awards/ Recognitions for Contributions to Knowledge in the area of Nanotechnology in Ayurvedic Science, at Stockholm, Sweden. European Advanced Materials Congress-2016, Stockholm, Sweden



Honored to Dr. Rakesh Kr Singh of Nanotechnology center of Aryabhata Knowledge University, Patna by Executive Chairs of European Advanced Material Congress-2016, at Sweden (Prof. Hisatoshi Kobayashi (Left), National Institute for Material Science, Tsukuba, Japan cum President-International Association of Advanced Materials (IAAM) Sweden).



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

Rakesh Kr. Singh¹ · Nishant Kumar¹ · Dinesh Rangappa²

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Dr. Rakesh Kumar Singh



Mr. Nishant Kumar



Prof. Dinesh Rangappa

POSSIBLE APPLICATION OF PREPARED NANO MATERIALS

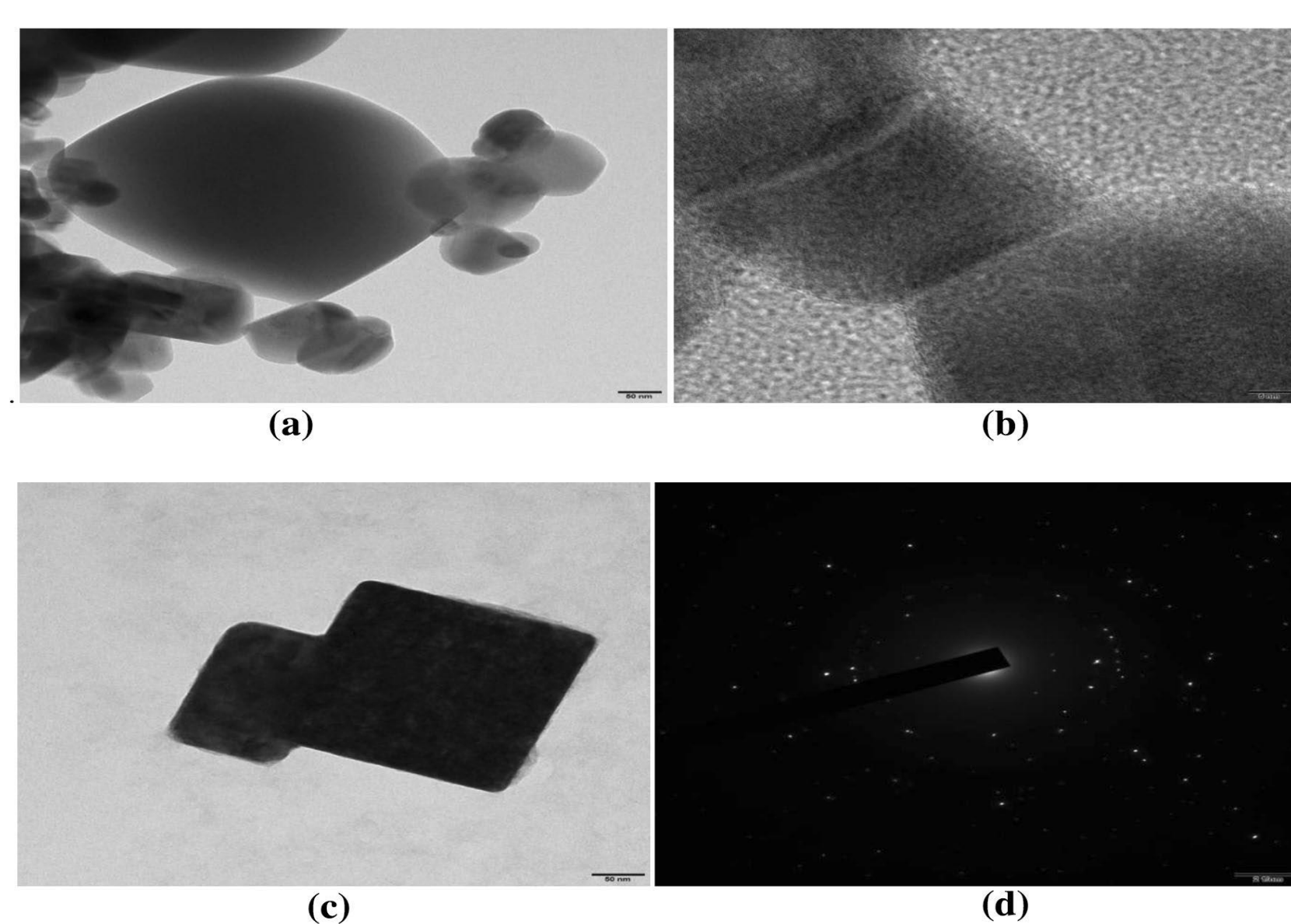


PREPARED FERRITE NANOMATERIALS IN LAB

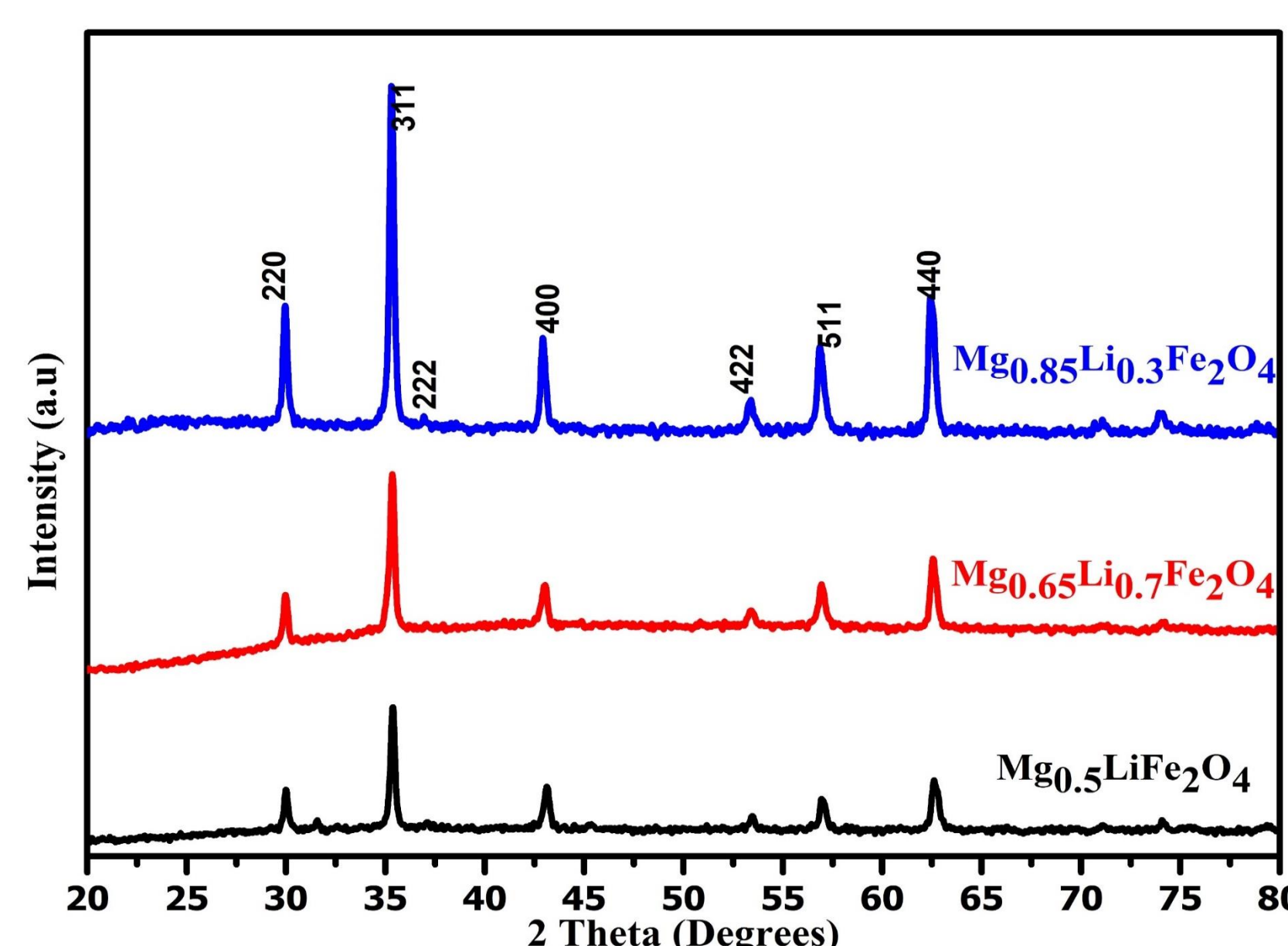
OPTOELECTRONIC DEVICES

MAGNETIC INDUSTRY

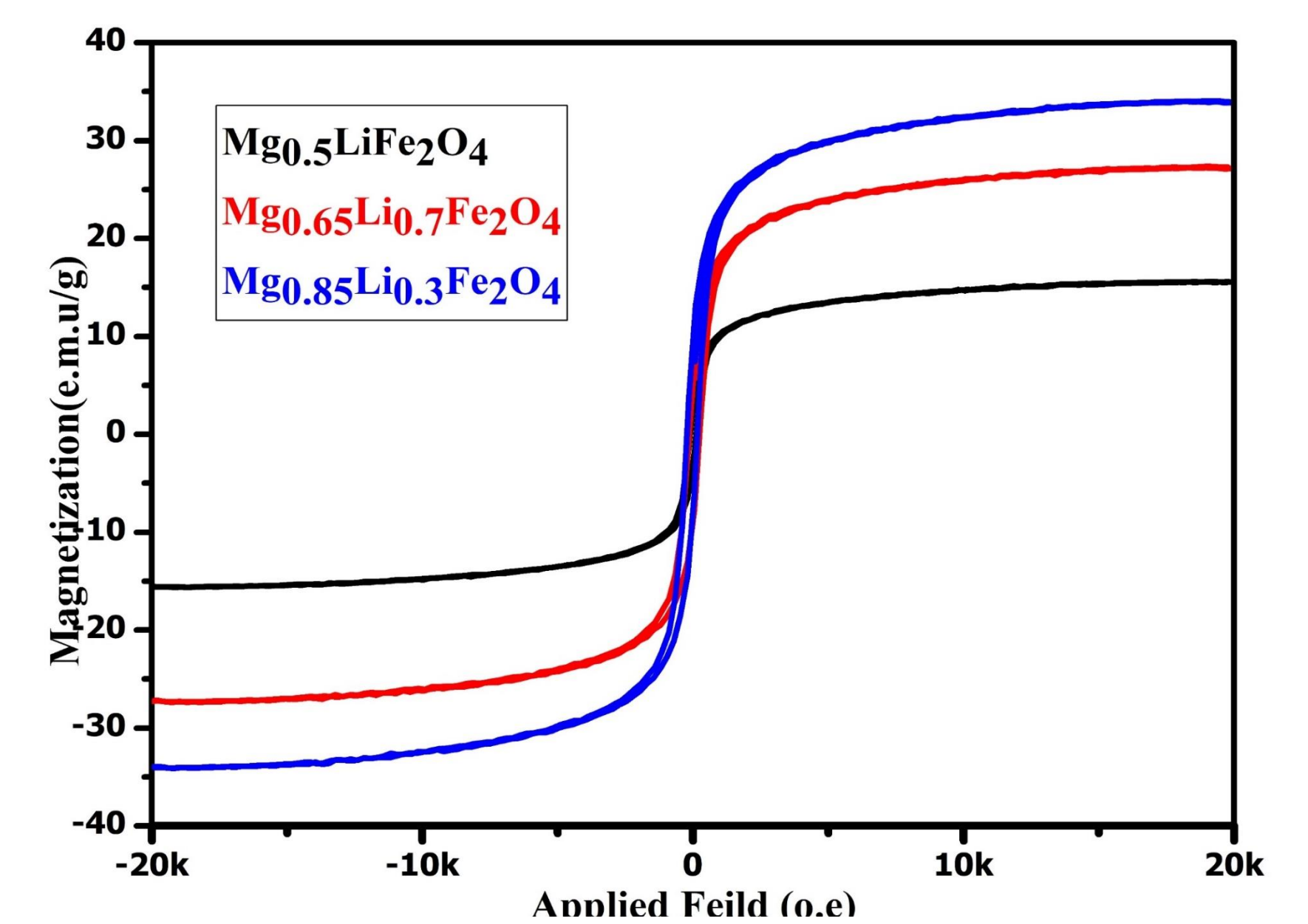
TEM ANALYSIS



STRUCTURAL MEASUREMENTS



MAGNETIC MEASUREMENTS



Research Summary:

- 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 and annealed at temperature 700 °C.
- Thermal analysis measurement confirms that there is a decrease in weight with an increase in temperature which becomes thermally stable till 600 °C.
- XRD study confirms that prepared nanoparticles are a cubic spinel structure having $Fd3m$ space group. The crystallite size lies in the range of 26.41–31 nm.
- HRTEM and SEM image confirms the cubic spinel structure and porosity in the material. The indirect energy band gap was found to be 2.25, 1.89 and 2.03 eV respectively for $x = 0, 0.15$ and 0.35. 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.
- Hence, materials may be potential candidate for magneto-optical device, humidity sensor, hydroelectric cell applications and some other related fields.

STRUCTURAL PROPERTIES

MAGNETIC PROPERTIES

Materials	d-spacing (Å)	Angular Position (2θ) in degree	Lattice constant (Å)	Cell Volume (cm ³)	Molecular Weight (g/mol)	d _x (gm/cc)	Parameter			
								x=0	x= 0.15	x= 0.35
$Mg_{0.5}LiFe_2O_4$	2.535	35.369	8.410	594.850	194.779	4.349	Magnetization (Ms)(emu/gm)	15.53	27.20	33.75
$Mg_{0.65}Li_{0.7}Fe_2O_4$	2.537	35.343	8.416	596.118	196.342	4.374	Coercivity (Hc)/Oe	116.56	143.35	161.37
$Mg_{0.85}Li_{0.3}Fe_2O_4$	2.539	35.319	8.421	597.266	198.427	4.412	Retentivity (Mr)(emu/gm)	2.66	5.22	7.11
							Squareness Ratio (Mr/Ms)	0.171	0.191	0.210

Acknowledgement-

Authors are thankful to TEQUIP-III of Aryabhata Knowledge University, Patna for financial support under Collaborative Research Scheme (Ref-005/Exam/1060/AKU/2019/4455).

Doctoral Research(Ph.D.) Scholar, their Research field and Supervisor; Details

Research Scholar

PhD Supervisor

Functional nanomaterials for various applications



Pushpa Kumar Sharma

Dr. Rakesh Kumar Singh

Biochar for water purification



Aniket Manash

Dr. Rakesh Kumar Singh

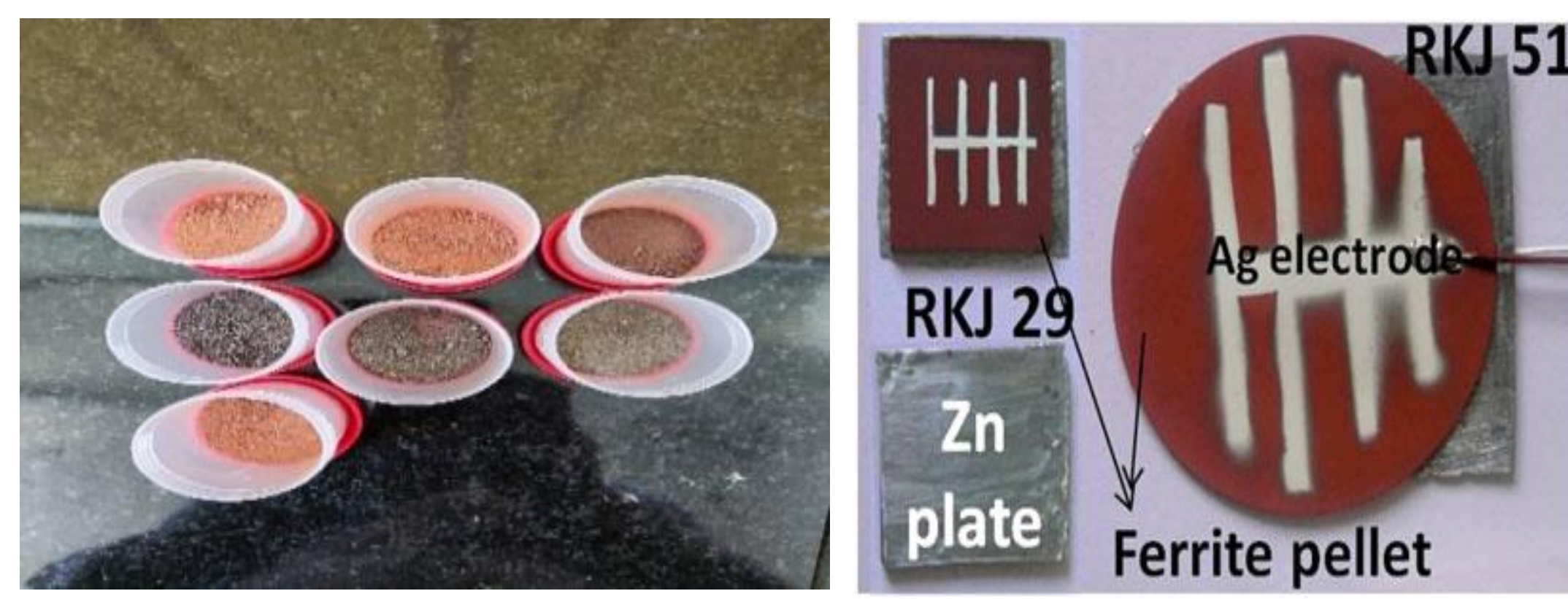
Nanoporous ferrite material for hydroelectric cell



Ritu Kumari

Dr. Rakesh Kumar Singh

Bel Patra superfine nano powder



Vivek Kumar

Dr. Rakesh Kumar Singh

Ionic conduction of splitted water in hydroelectric cell



Pallavi Singh

Dr. Rakesh Kumar Singh

Potato and black pepper superfine nano powder



Naman Kr. Naik

Dr. Rakesh Kumar Singh

Moringa superfine nano powder



Bibhuti Bikramaditya

Dr. Rakesh Kumar Singh

Garnet nanomaterial (YAB) for LED applications.



Prabhat Kr. Dwivedi

Dr. Rakesh Kumar Singh

Study on Bhasma nanoparticles using modern scientific tools

Note: In addition to these Doctoral Research activities 17 M.Tech research projects are being carried out in multidisciplinary area of Nanoscience & Nanotechnology

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

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Published from - IOP. Material Science and Engineering (Scopus/Wos Indexed) USA

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Dr. Archana



Dr. Rakesh Kumar Singh



Dr. Abhay Kumar Aman



Nishant Kumar

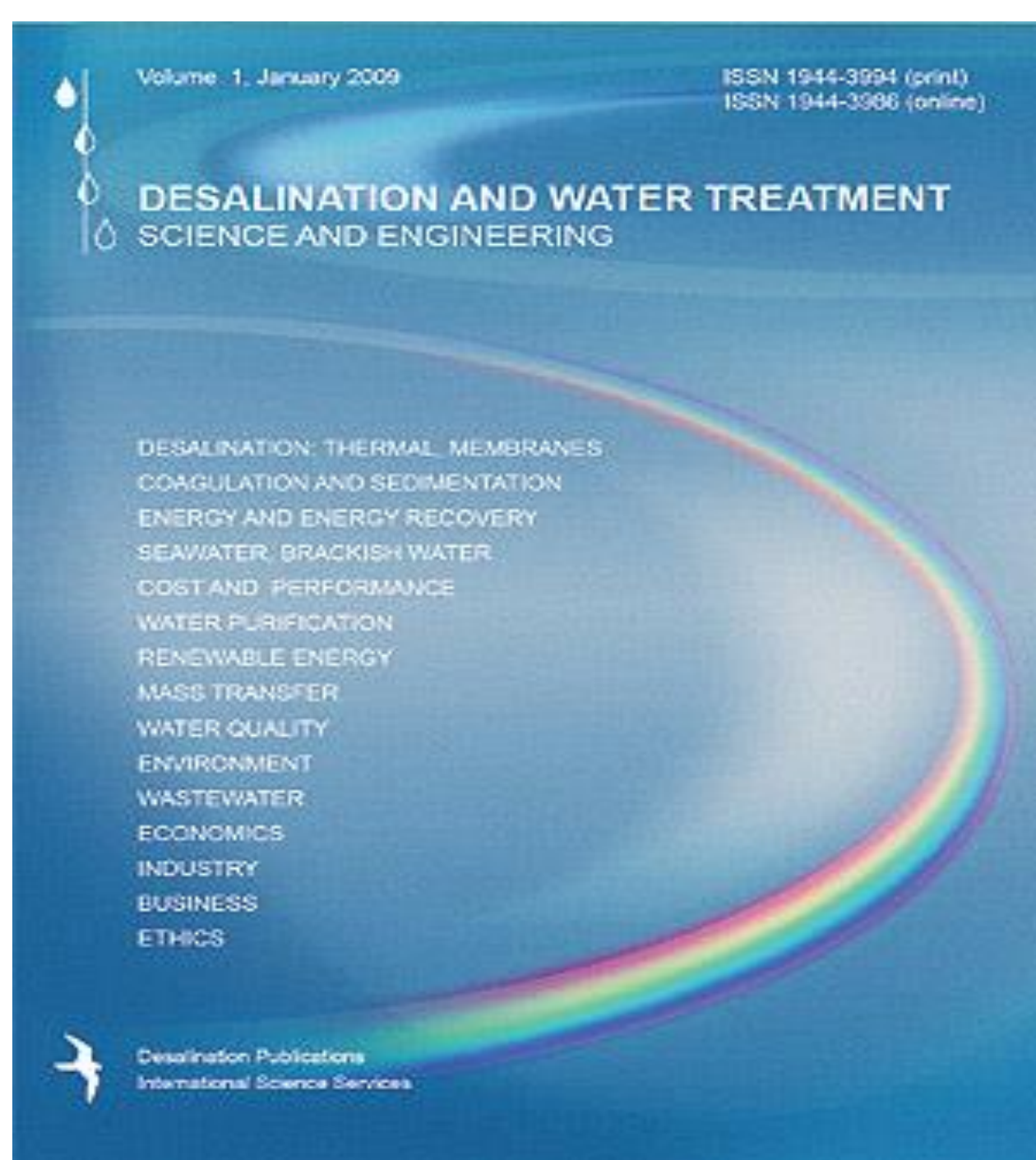


Novelties of Research

- 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. Antioxidant properties of superfine powder was found greater than normal crude powder, which was confirmed by experiment on C.elegen.
- 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.

Acknowledgements :

The authors are extremely thankful to Department of Education, Govt. of Bihar and Aryabhata Knowledge University, Patna for frontiers research establishment, support and functioning of the Nanoscience and Nanotechnology center.



Equilibrium sorption of fluoride on the activated alumina in aqueous solution

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Published from Hopkinton, USA

Research Team



Rakesh Kumar



Dr. Prabhakar Sharma



Dr. Abhay Kumar Aman



Dr. Rakesh Kumar Singh



Highlights of research

- **Removal of fluoride is a desalination technology in which fluoride ions from aqueous solution are adsorbed on suitable adsorbent surfaces. This work aims 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 were 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.**

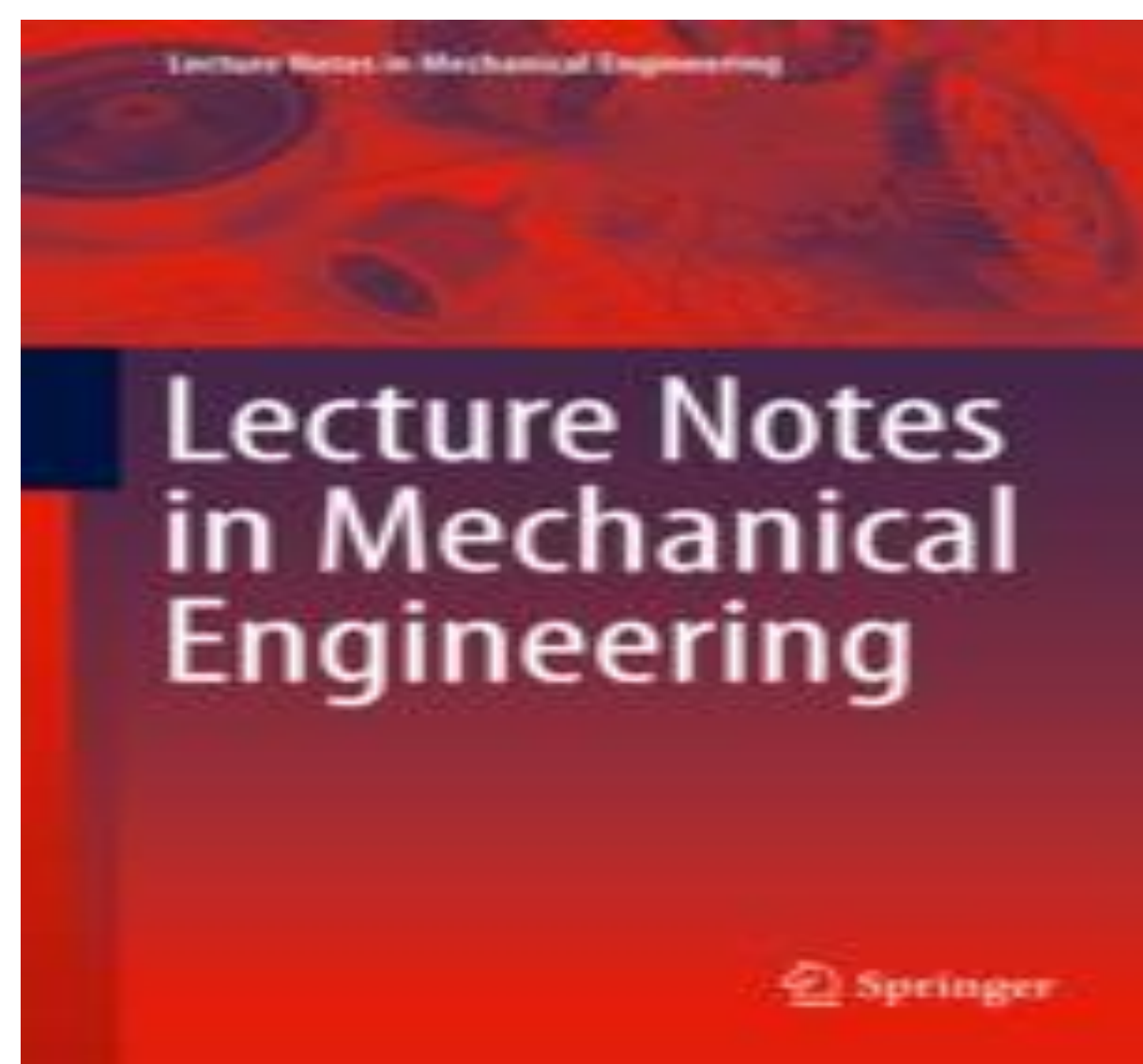
Acknowledgements :

The authors are extremely thankful to Department of Education, Govt. of Bihar and Aryabhata Knowledge University, Patna for frontiers research establishment, support and functioning of the Nanoscience and Nanotechnology center.

Magnetic Electronics Nanomaterials prepared using Lemon

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

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



California

Research Team



Shashank Bhushan Das



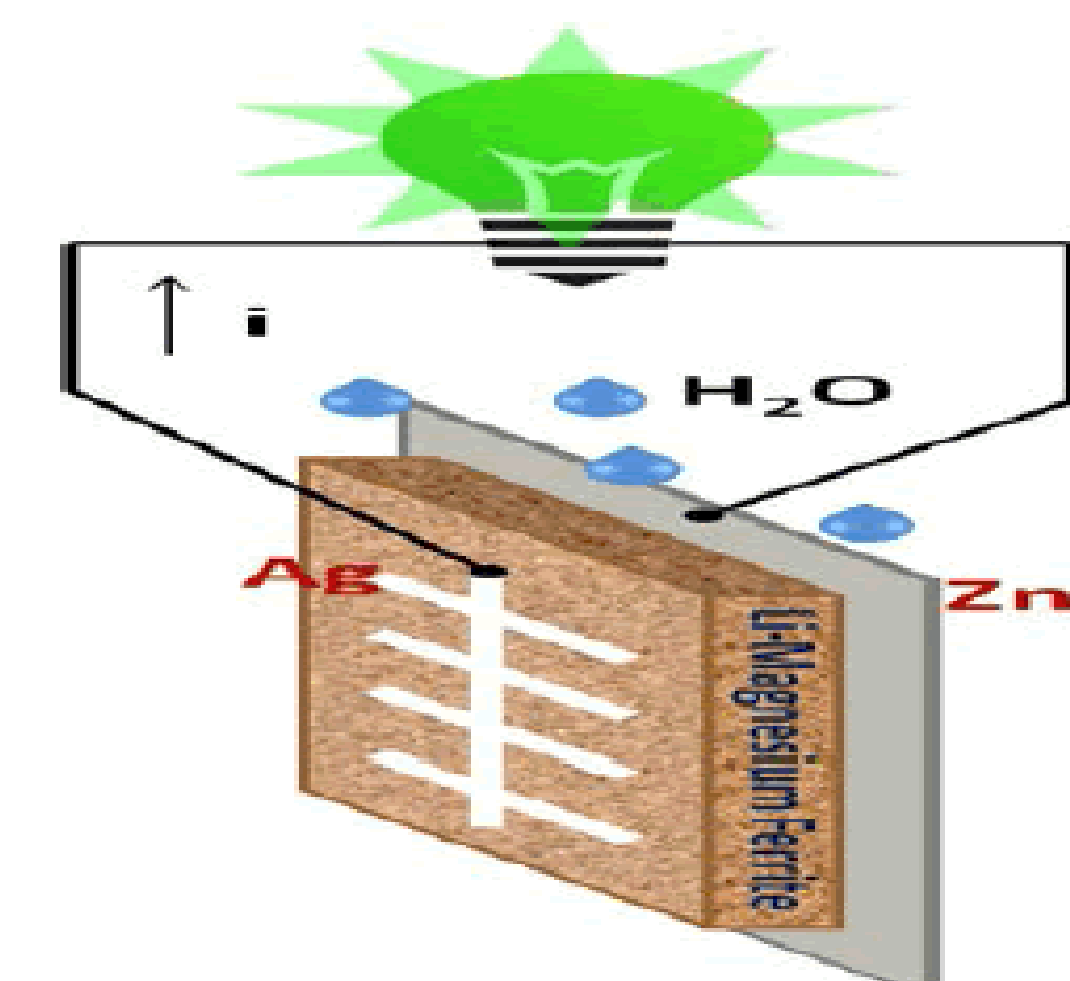
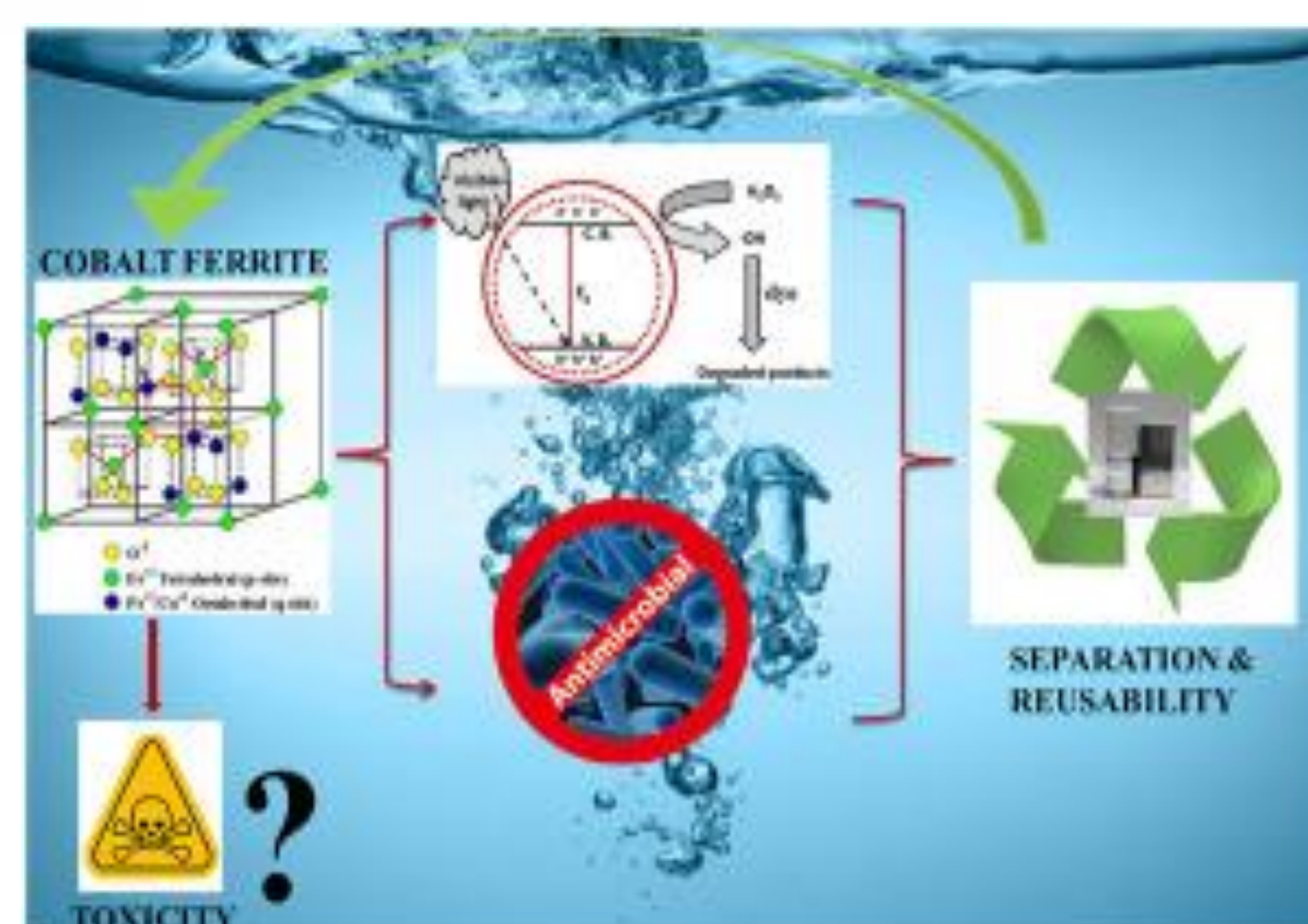
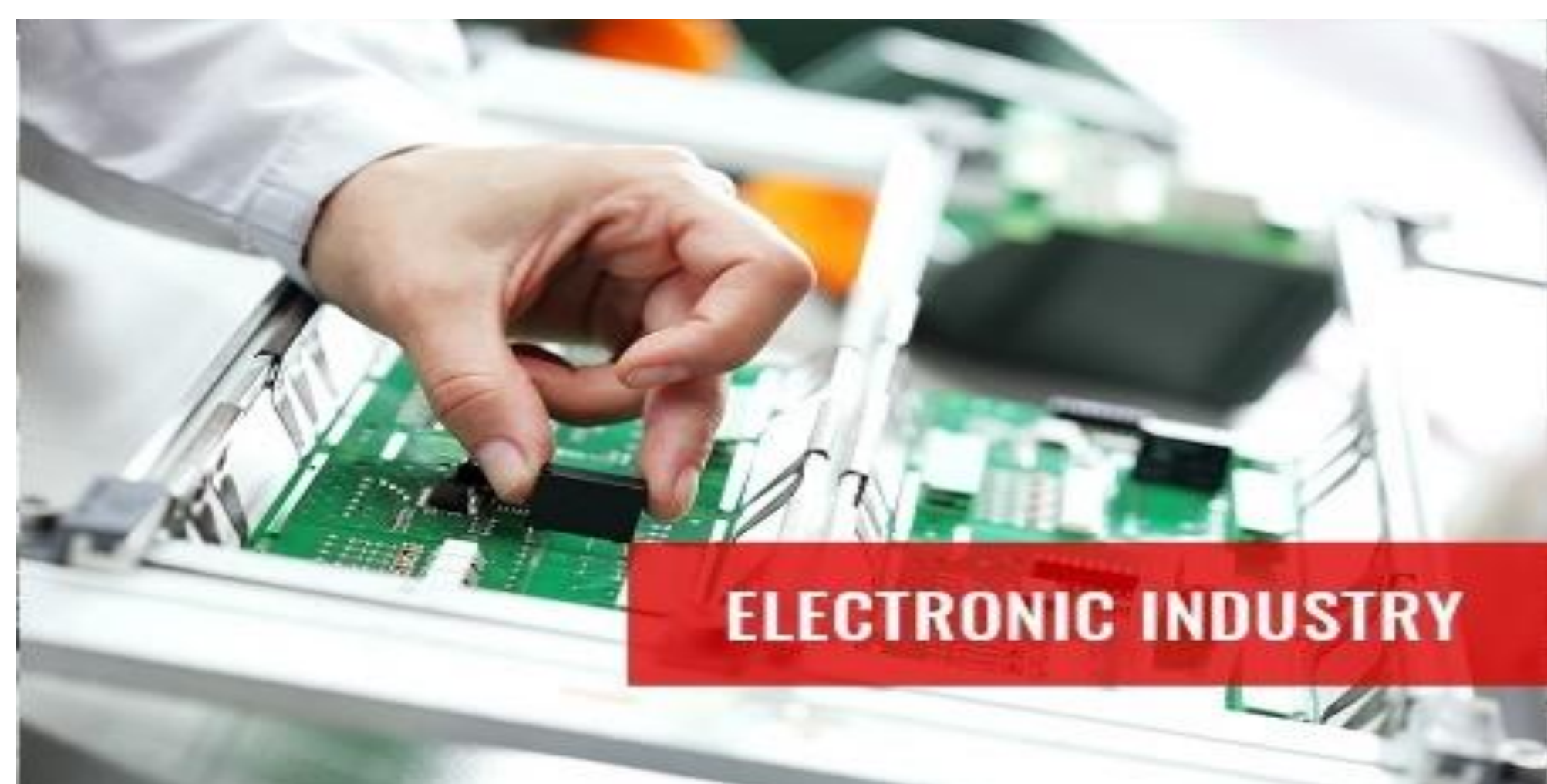
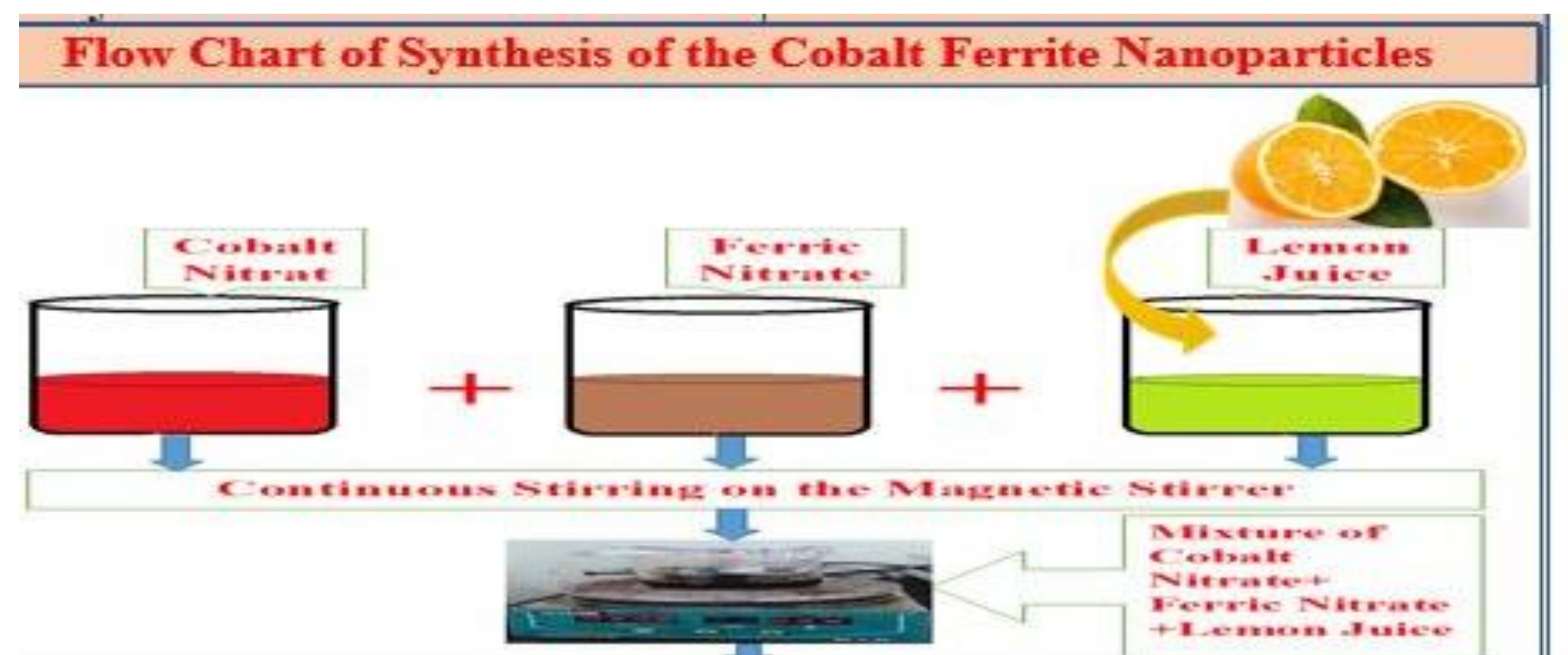
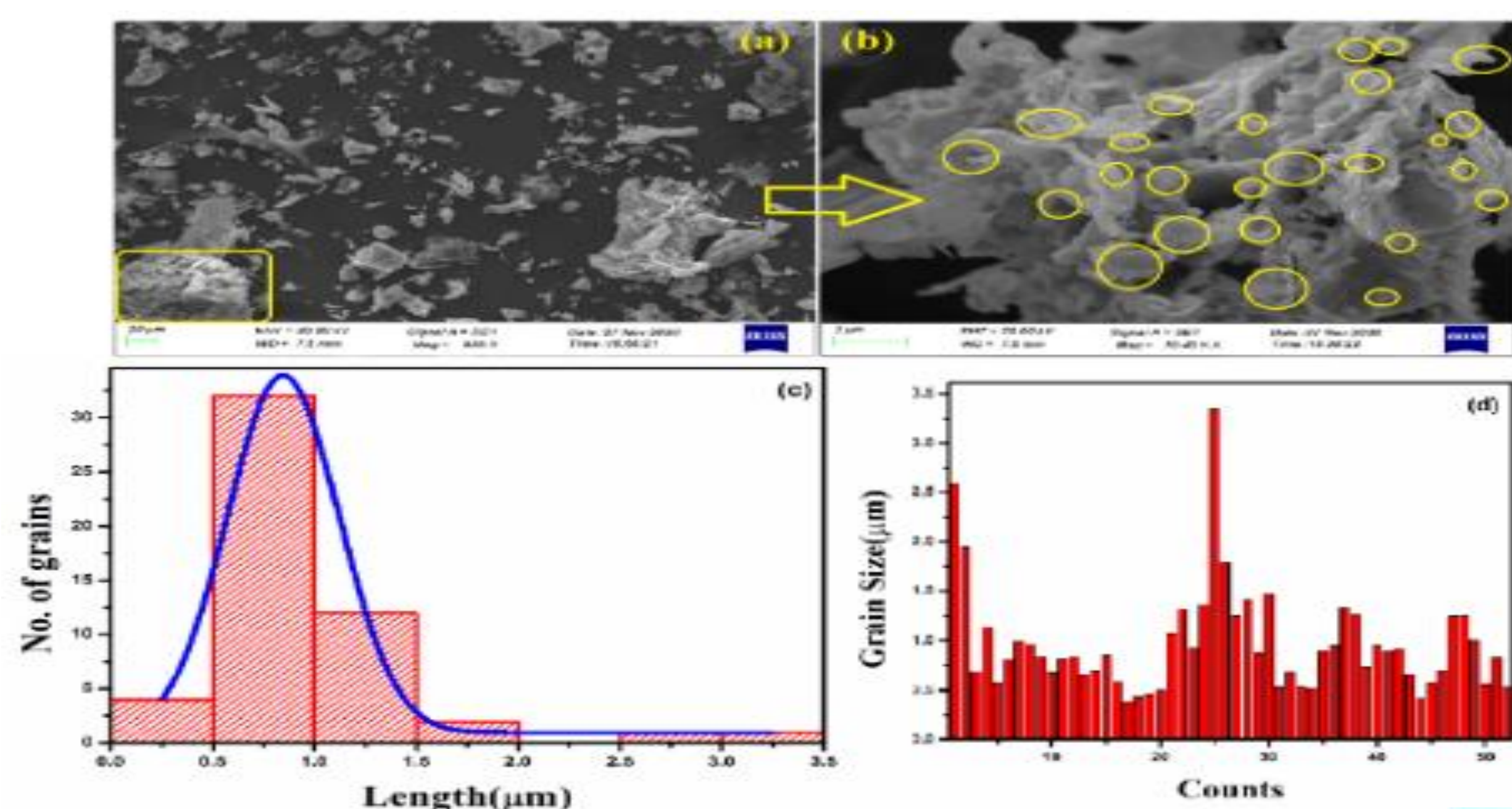
Dr. Rakesh Kumar Singh



Vivek Kumar



Nishant Kumar



Possible applications

Research Highlights

- ✓ Using intention to use green synthesis approach, CoFe_2O_4 nanoparticles were successfully prepared using lemon juice and metal nitrates as a precursor material.
- ✓ Direct band gap was evaluated using Uv-vis spectroscopy where it was measured equal to 3.65 eV using Tauc equation. A broad and strong emissions between 457-493 nm (predominantly blue emission) was observed during photoluminescence studies.
- ✓ The saturation magnetisation (M_s) 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 and can be produced for various applications such as in Electronics industry, Purification of water, Hydroelectric shell etc.

Acknowledgements :

The authors are extremely thankful to Department of Education, Govt. of Bihar and Aryabhata Knowledge University, Patna for frontiers research establishment, support and functioning of the Nanoscience and Nanotechnology center.

Learning Science through low cost experiment
Developing Strong Scientific Human resource in Society at all levels of Study
Initiative of National Anveshika Network of India, IAPT
Coordinated by Padam shree Prof. H.C.Verma, IIT Kanpur



**Prof. H.C.Verma, IIT Kanpur,
 felicitated by Hon'ble Sri Nitish Kr
 Ji, CM, Bihar in year 2018.**

Teaching-learning, Demonstration & its Social Impact



Mohania, Kamur, Sasaram

159, पेज 12, नेटो संस्करण सोमवार, 09 जुलाई 2012, पटना www.livehindustan.com

कानपुर आईआईटी में बिहार के प्रो.एचसी वर्मा व उनकी टीम का इनोवेशन ला रहा रंग, बिहार के स्कूलों की बदली तरवीर

देश के कोने-कोने में साइंटिफिक फीवर

● पटना। अमय शंकर

खगड़िया के अलीली ब्लॉक का हाईस्कूल। यहां साइंस की पढ़ाई तो थोड़ी है पर प्रैक्टिकल के लिए लैब नहीं है। छात्र सिर्फ थ्योरी पढ़ते हैं। लेकिन, इन दिनों यहां प्रैक्टिकल भी हो रहा है। वह भी बिना लैब और ऑपरेटिंग के। महज दो कागज के टुकड़ों के जरिए बरनीली का थ्योरम समझाया जा रहा है।

यह हाल केवल इस स्कूल का ही नहीं है, बल्कि पूरे बिहार और देश के कई स्कूलों का भी है। ऐसा संभव हो पा रहा है आईआईटी कानपुर में बिहार के प्रो. एचसी वर्मा और उनके साथियों के इनोवेटिव प्रयोग की वजह से। उन्होंने 'उत्साही फिजिक्स टीचिंग ग्रुप' नाम से एक टीम बनाई है। यह टीम देश के कोने-कोने में छात्रों और शिक्षकों में साइंटिफिक फीवर डेवलप करने में जुटी है। इससे बिहार के स्कूलों में बदलाव आ रहा है। जो शिक्षक साइंस फिजिक्स पढ़ाने में रुचि नहीं लेते थे, आज वही विभिन्न प्रयोगों के जरिए बच्चों को अलग

हो रहा है बदलाव

इस मिशन से बिहार के गांवों में मौजूद स्कूलों में काफी बदलाव आया है। जिन स्कूलों में कल तक लैब नहीं थी, आज वहां है। गांव के शिक्षक भी अपने स्तर ने नए-नए प्रयोग कर छात्रों को आसानी से चैटर समझा रहे हैं। छात्रों की नीरसता भी दूर हो रही है।

रहे हैं। छात्र भी पढ़ाई भी ध्यान देने लगे हैं। 'उत्साही फिजिक्स टीचिंग ग्रुप' के सीनियर मेंबर डॉ. रकेश कुमार सिंह इन दिनों गांवों में कैंप कर खुद के द्वारा तैयार उपकरणों के जरिए शिक्षकों को फिजिक्स पढ़ाने के तरीके बता रहे हैं।

इनमें लेजर मशीन, बरनीली थ्योरम, मोमेंट ऑफ इनर्सिया, वेज, मोशन, सीबिक इफेक्ट व फिजिक्स के अन्य प्रयोग शामिल हैं। छात्रों की इन प्रयोगों के

5000 शिक्षकों का बन चुका है कार्या 2004 में प्रो. एचसी वर्मा ने नेशनल लेवल पर फिजिक्स के 15 रिसोर्स पर्सन की मदद से 'उत्साही फिजिक्स टीचिंग ग्रुप' का गठन किया। इसमें बिहार के दो प्रोफेसर डॉ. अमरेंद्र नारायण एवं डॉ. रकेश कुमार सिंह शामिल हैं। आठ साल में ग्रुप ने देश के 5000 शिक्षकों को इनोवेटिव शिक्षा की ट्रेनिंग दी है। इनमें 500 शिक्षक बिहार के हैं।

जरिए कॉलेज में प्रयोगशाला में भारी भारकम मशीन के बिना भी छोटे व सस्ते उपकरण से भी छात्रों को साइंस का प्रयोग दिखाया जा सकता है। इससे छात्रों व शिक्षकों में साइंस के प्रति रुचि जागृत होगी। इससे बिहार में भी प्यार साइंस डेवलप होगा व युवा वैज्ञानिक की तावद में बढ़ोतरी होगी। इन युवा वैज्ञानिकों की मदद से भविष्य में बिहार एवं देश में मॉडर्न टेक्नोलॉजी का तीव्र विकास हो सकेगा।



20 Dec 2011, Mohania, Kamur, Sasaram, Bihar

ग्रामीण इलाकों से वैज्ञानिक निकालने की पहल

मोहनिया। एक संवाददाता

साइंस के बच्चों को कोचिंग संस्थानों के आक्रामक बाजारवाद से बचाने एवं उन्हें शोध तथा निर्माण आधारित साइंटिफिक सांच विकसित करने के उद्देश्य से स्थानीय एमपी कॉलेज में फिजिक्स की कार्यशाला आयोजित हुई। ग्रामीण क्षेत्र के कॉलेज में पहली बार इस तरह की कार्यशाला में इंटर, स्नातक एवं पीजी के छात्रों ने वेस्टेड मेटेरियल से फिजिक्स की प्रयोगशाला बनाने की जानकारी देना के ज्ञान-माने वैज्ञानिकों से हासिल की।

आईआईटी कानपुर में फिजिक्स के प्रोफेसर डा. एचसी वर्मा द्वारा गठित उत्साही फिजिक्स टीचिंग ग्रुप के सीनियर रिसोर्स पर्सन एवं पटना वीमेंस कॉलेज के प्रोफेसर डा. रकेश कुमार सिंह ने फिजिक्स के कठिन सिद्धांतों को दैनिक जीवन में उपयोग आने वाली वस्तुओं से प्रयोगिक प्रदर्शन कर समझाया। गुरुत्वाकर्षण ध्वनि तरंग, विद्युत चुम्बकीय तरंग एवं प्रकाश के सिद्धांतों को आसान एवं रोचक ढंग से प्रदर्शित किया।

उनका कहना है कि बोलत, टूटी कलम, रस्सी, धागा आदि वस्तुओं को जिस हद तक फेंक देते हैं उनको सहायता से फिजिक्स के सिद्धांतों को समझा जा सकता है। मात्र सी रुपये में फिजिक्स की प्रयोगशाला स्थापित की जा सकती है। चार घंटे तक चली कार्यशाला में बीएचयू एवं सासाराम के अलावा कैम्प के छात्र-छात्राओं ने भाग लिया।

भारत सरकार रक्षा मंत्रालय के अधीन डीआरडीओ में वैज्ञानिक रह चुके विद्यादान इस्टीव्यूट ऑफ टेक्नोलॉजी के चेयरमैन डा. एसके सिंह ने कार्यशाला में बताया कि आज बच्चे मैनेजमेंट एवं प्रशासनिक सेवाओं में जाने को बेचैन हैं। यदि साइंस को नच्यूरल

मोहनिया के एमपी कॉलेज में आयोजित कार्यशाला में फिजिक्स के सिद्धांत को समझाया गया वैज्ञानिक व प्रोफेसर से सम्बन्धित पटना वीमेंस कॉलेज के डॉ. रकेश कुमार सिंह

तरीके से सीखाया जाए तो वे वैज्ञानिक बनकर देश की सेवा कर सकते हैं। आठ साल से प्रयोगशाला में फिजिक्स के प्रोफेसर डा. अमरेंद्र नारायण एवं डॉ. रकेश कुमार सिंह, प्रो. ओपी सिंह, डा. केवी सिंह, डा. एसबी सिंह, प्रो. डीके उपाध्याय, डा. यूपी सिंह आदि मौजूद रहे।

अभिराम सिंह, प्रो. ओपी सिंह, डा. केवी सिंह, डा. एसबी सिंह, प्रो. डीके उपाध्याय, डा. यूपी सिंह आदि मौजूद रहे।

- **Dr. Rakesh Kr Singh, developed about 500 low cost science experiment at all levels of study, under the supervision of eminent academician Prof. H.C.Verma, IIT Kanpur. He demonstrated these experiment under various situations including classrooms/ conferences, public lecture, School and university students in different district of Bihar. Dr. Rakesh conducted more than 100 workshops with such low cost experiments, including in Rashtriya AviskarAbhiyan programme & Unnat Bharat Abhiyan -Initiative of Govt. of India.**
- **These workshops have attracted attention of students and encouraged them to ask relevant questions in science at all levels of study. Such efforts have also helped in demystifying scientific research and developing scientific thinking in students/ faculty members.**
- **Dr. Rakesh Kr Singh given training programme to almost district of Bihar students and faculty member. SCERT-Dept. of Education, Govt. of Bihar; Kilkari, Dept. of Education, Govt. of Bihar, Bihar School Examination board, Patna, Science for Society Bihar, College/Universities including IIT's, NIT's, BIT invited me to explore such low cost science teaching-learning methodologies**

National Anveshika Network of India (NANI), coordinated by Prof. H C Verma, IIT Kanpur and NANI, Patna unit coordinated by Dr. Amarendra Narayan, Dept. of Physics, Science College, Patna University and Dr. Rakesh Kr Singh of nanotechnology center(At present Registrar), Aryabhata Knowledge University, Patna



Correlation between lattice strain and magnetic properties enhancement of nanocrystalline cobalt ferrite with controlled annealing

Monalisa¹, Saurabh Sharma¹, Harendra Kumar Satyapal^{1,*}, and Rakesh Kumar Singh¹

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Research Team



Monalisa



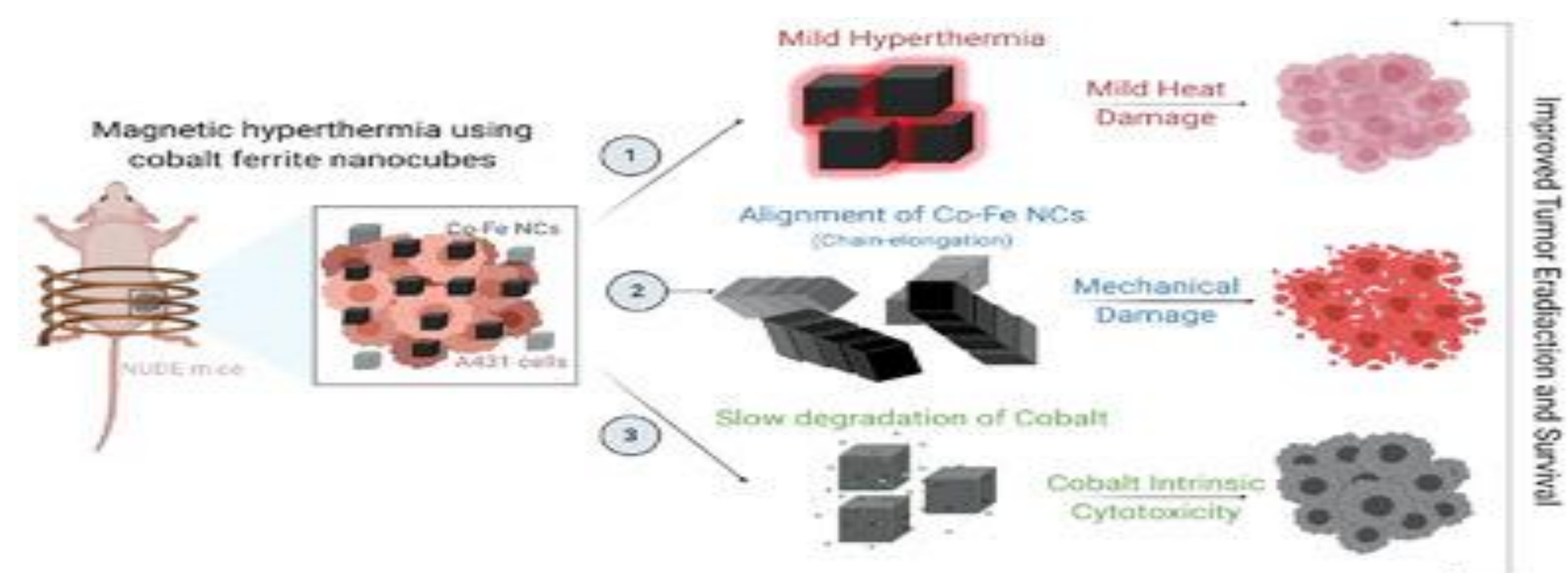
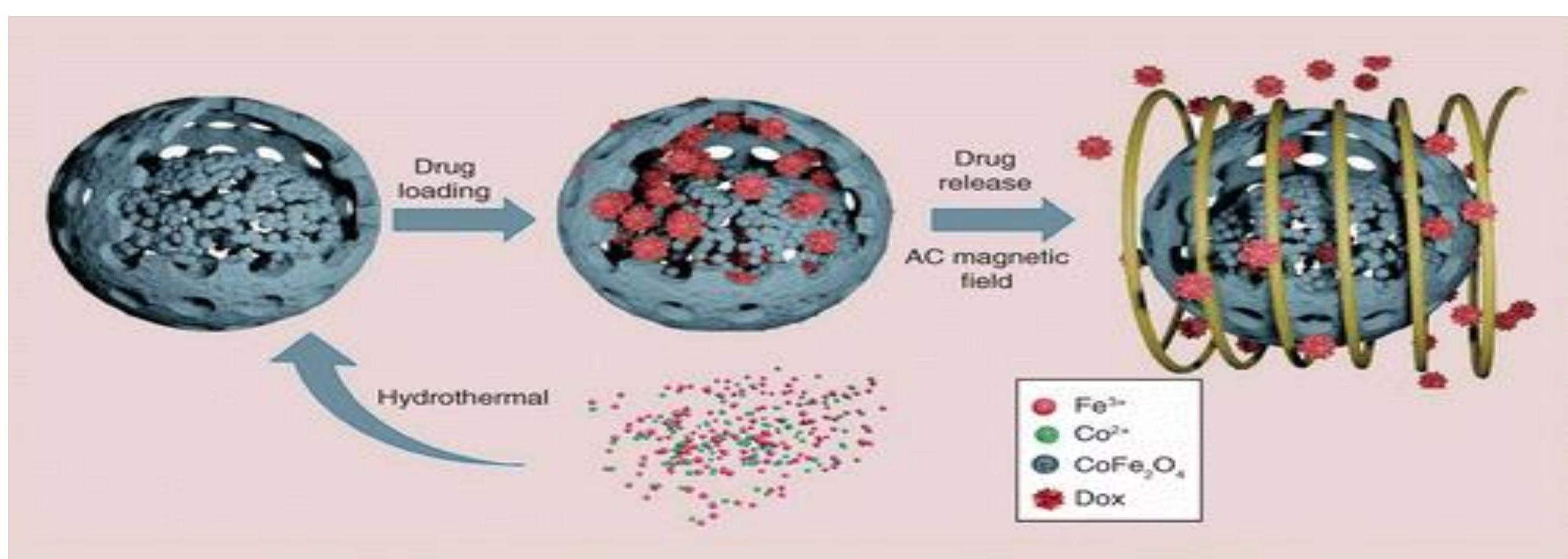
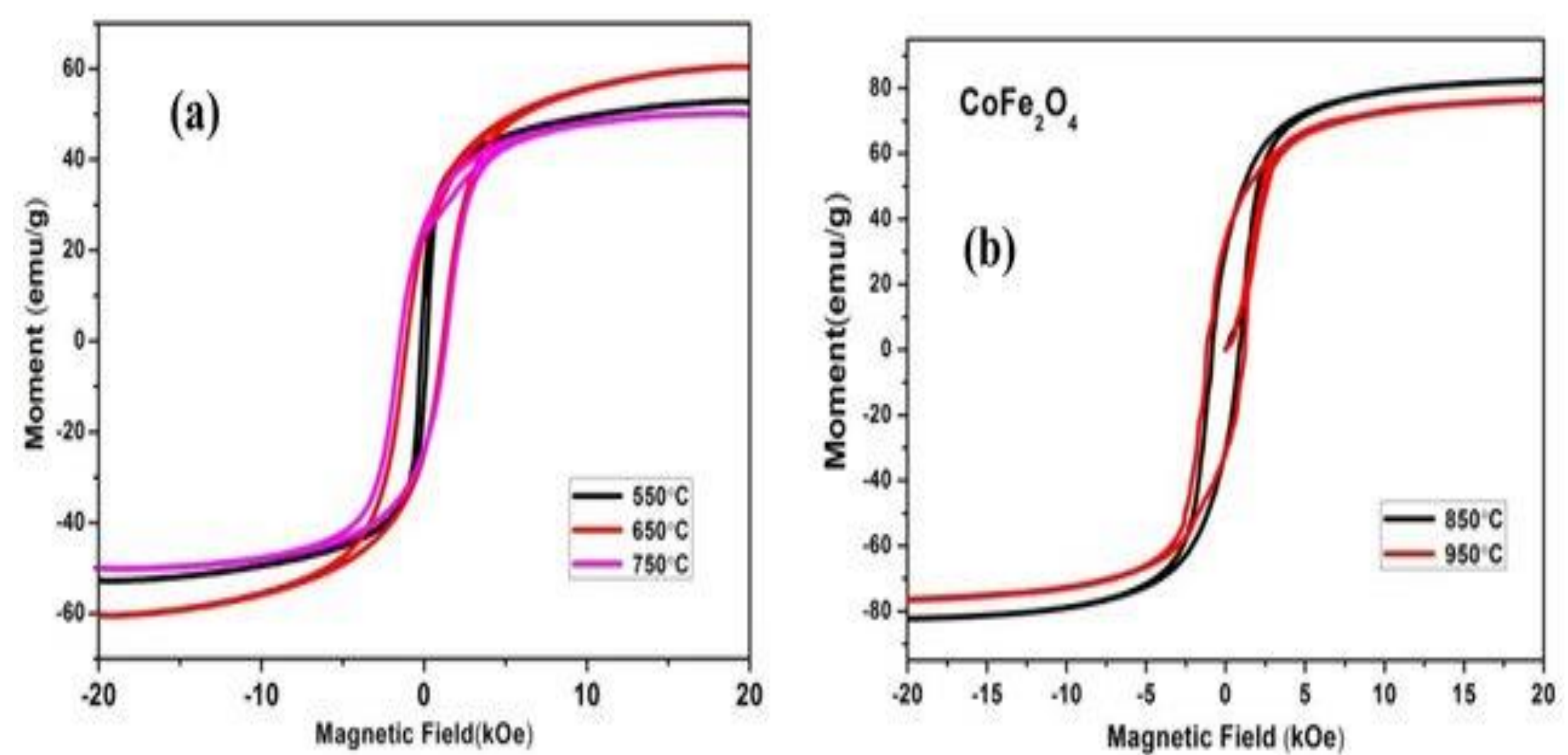
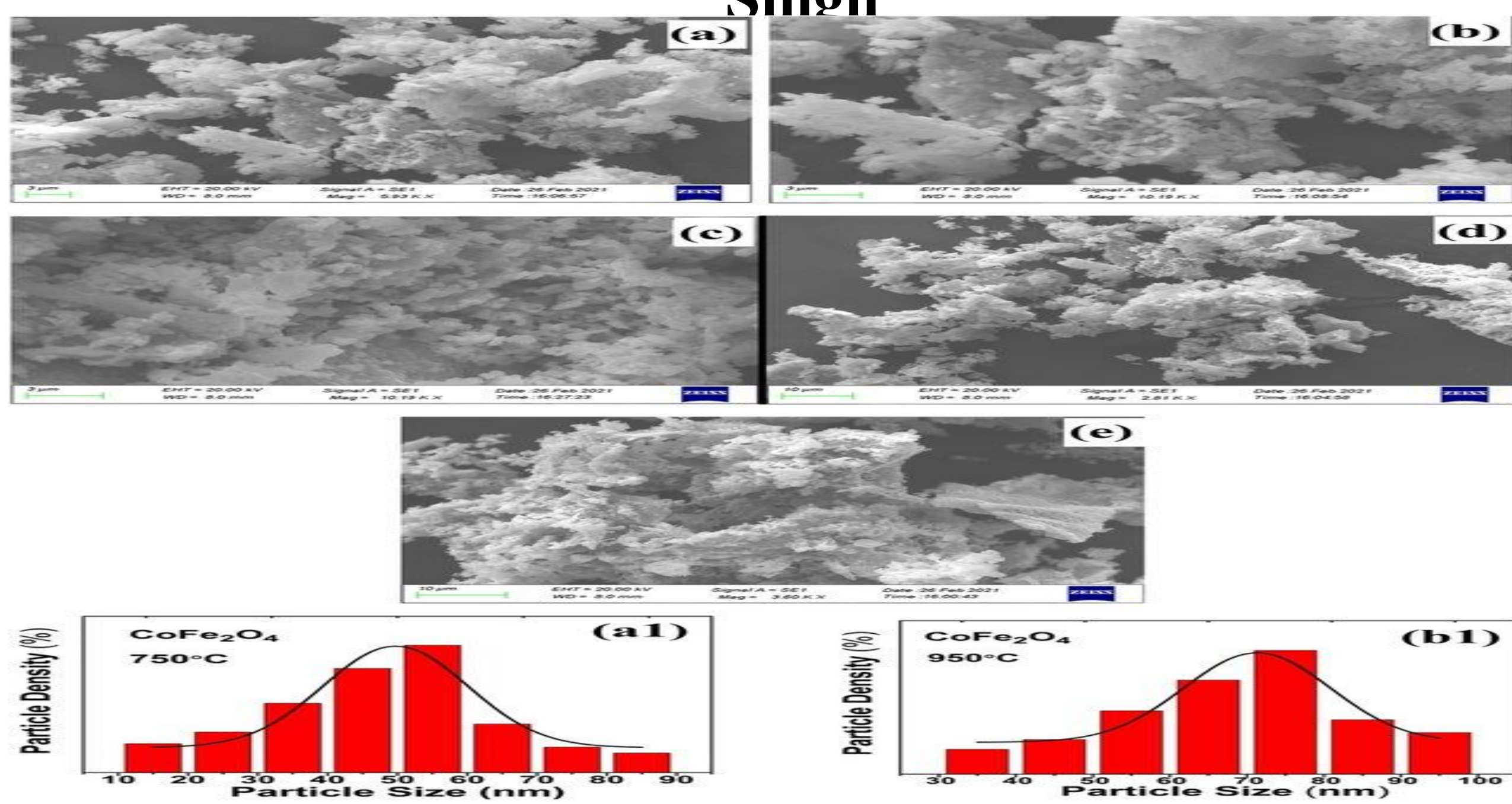
Dr. Rakesh Kumar Singh



Saurabh Sharma



Harendra Kumar Satyapal

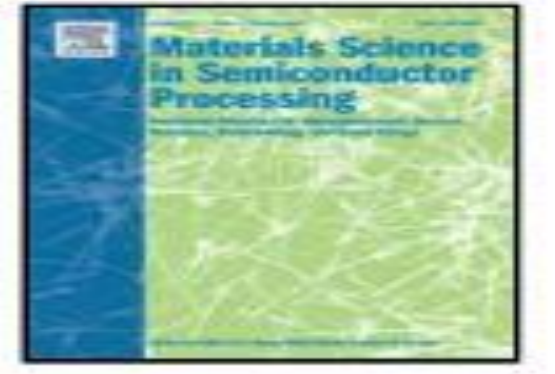


Research Summary:

- Spinel cobalt ferrite (CoFe₂O₄) has been prepared using the citrate precursor sol–gel method. The synthesized samples have been controlled annealing at 550 °C, 650 °C, 750 °C, 850 °C, and 950 °C for 2 h.
- The average crystallite size for samples is found to be 54.32 nm, which increases with an increase in annealing temperature. The lattice strain reaches a maximum value of 2.95×10^{-3} for CoFe₂O₄ annealed at 950 °C. W–H plots calculation is supported by SEM morphological analysis. Lattice parameter (a) is calculated using Fullprof Rietveld refinement of XRD patterns, which show noticeable increments due to induced lattice strains in samples.
- FTIR spectrum is analyzed to find out tetrahedral and octahedral metal–oxygen bond lengths. EDX analysis justifies elemental composition.
- The ‘Law of Approach to saturation’ is employed to quantify magnetic properties like magnetization (Ms), anisotropy field (B₁), and magnetocrystalline anisotropy (k₁). These magnetic properties show improvement due to the annealing effect, with Ms ranging from 24.60 to 77.68 emu/g and retentivity (Mr) 5.12–47.08 emu/g. The coercivity (H_c) shows an appreciable increment from 175 to 1402 Gauss. The anisotropy (k₁) ranges from 2.22 to 11.68×10^6 erg/cm³. These remarkable improvements in magnetic properties motivated us to explore the correlation between induced lattice strain and magnetic response of CoFe₂O₄ nanomaterials at different annealing temperatures.

Acknowledgements :

The authors are extremely thankful to Department of Education, Govt. of Bihar and Aryabhata Knowledge University, Patna for frontiers research establishment, support and functioning of the Nanoscience and Nanotechnology center.



Structural, magnetic, optical and ferroelectric properties of Y^{3+} substituted cobalt ferrite nanomaterials prepared by a cost-effective sol-gel route

Shashank Bhushan Das, Rakesh Kumar Singh*, Vivek Kumar, Nishant Kumar, Pallavi Singh, Naman Kumar Naik

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Published in Material Science in Semiconductor Processing

Research Team



Shashank Bhushan Das



Dr. Rakesh Kumar Singh



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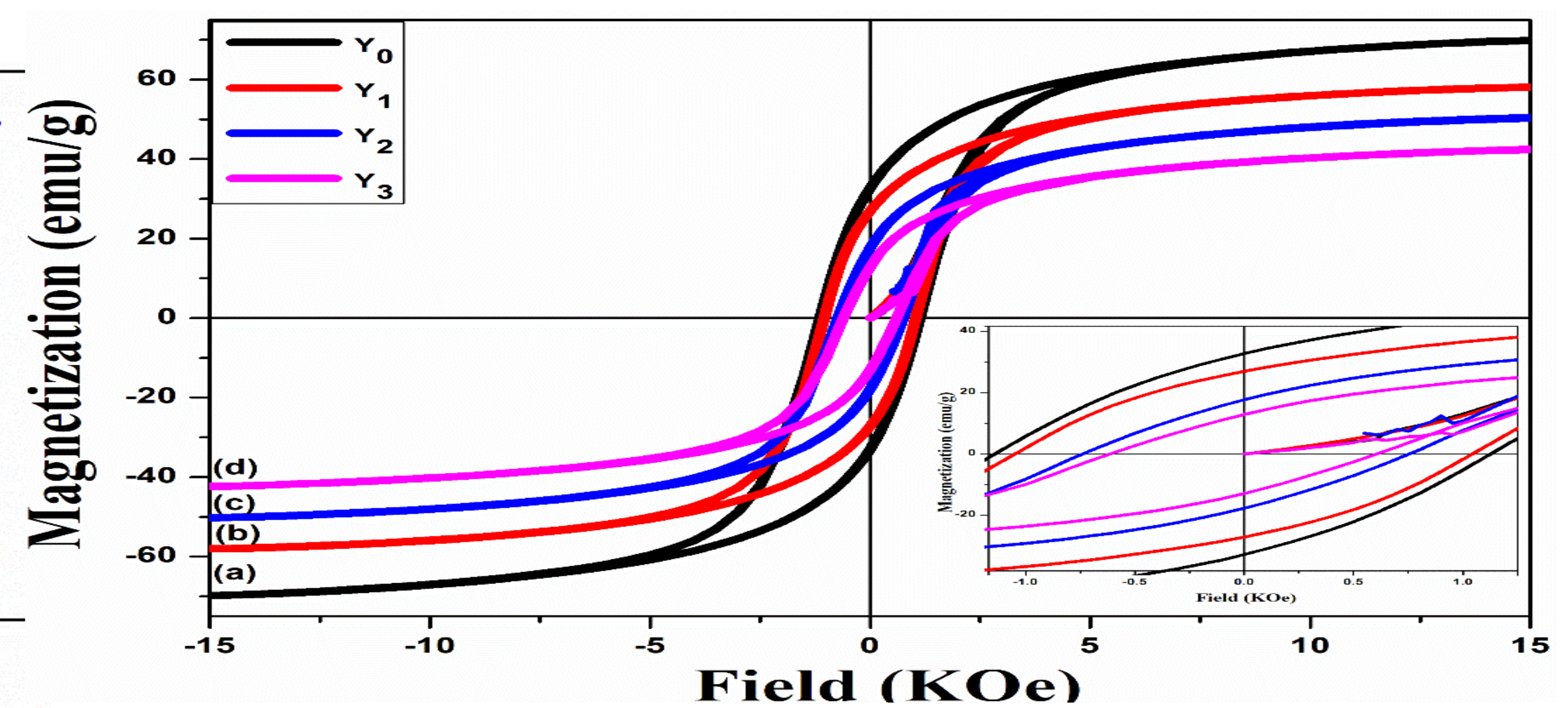
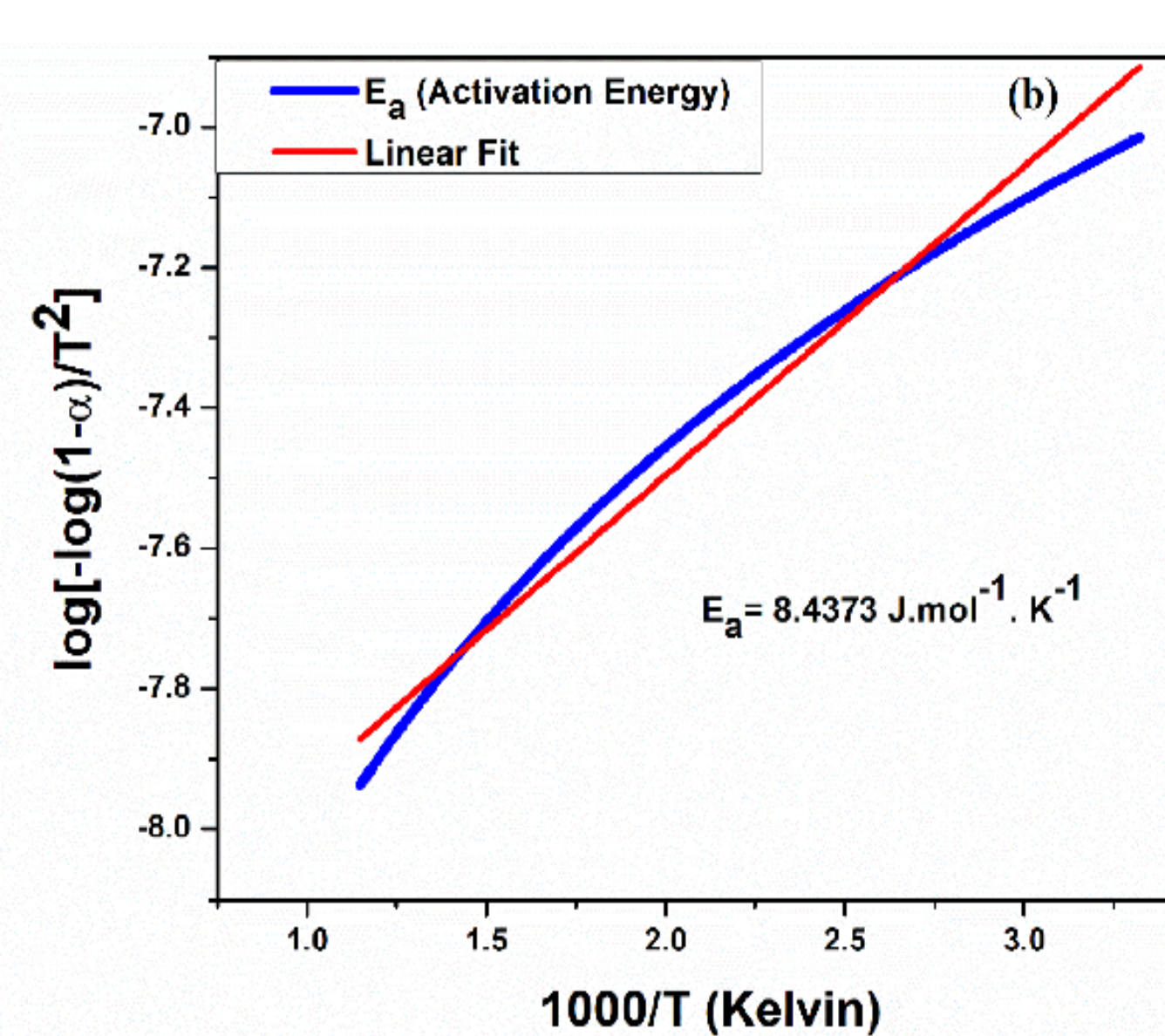
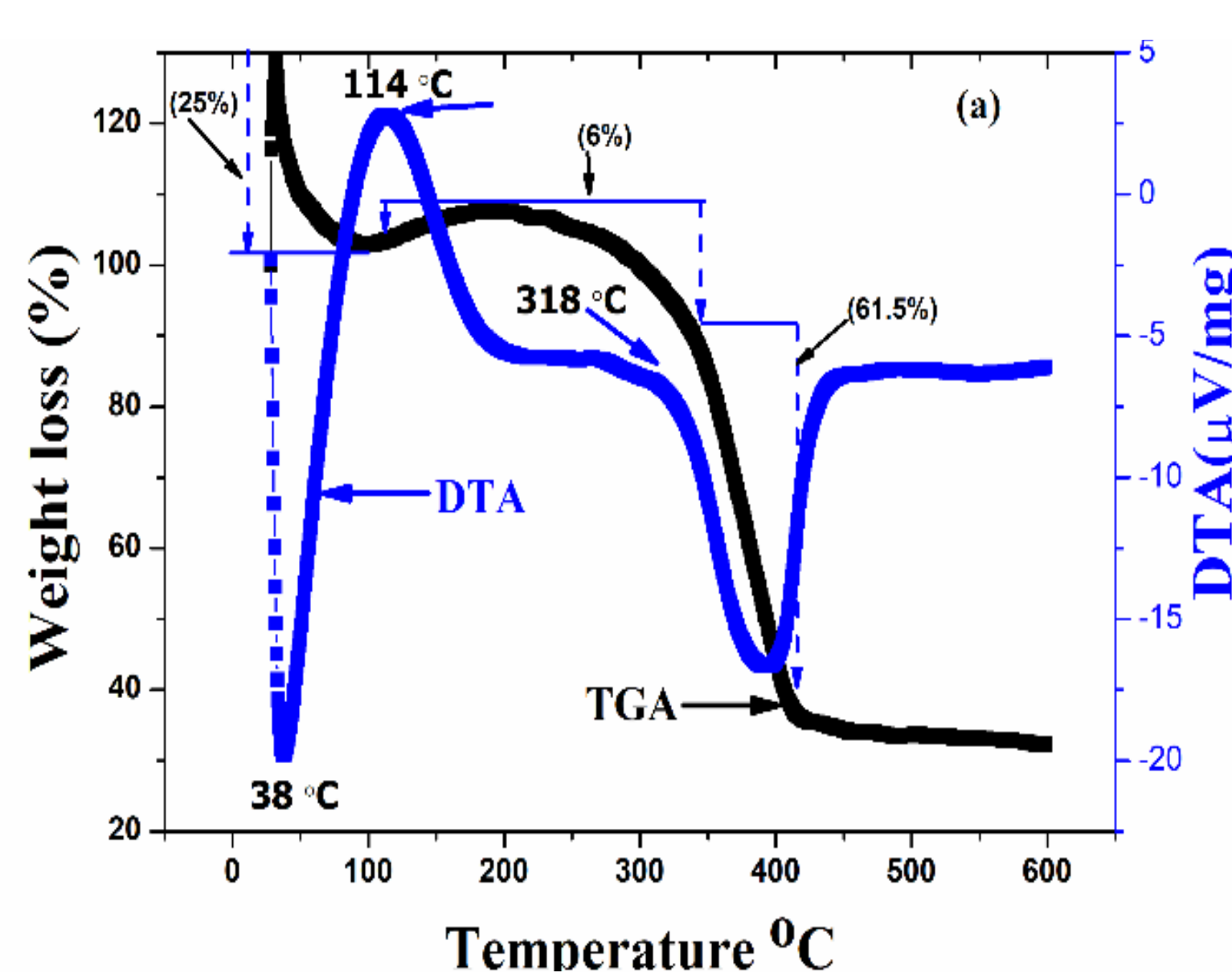
Nishant Kumar



Pallavi Singh



Naman Naik



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 $750^\circ C$ 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 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 (H_c), saturation magnetization (M_s), retentivity (M_r) 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 7.73×10^5 to 3.01×10^5 erg/cm³, respectively at room temperature with the increase in Y^{3+} content. The multiferroic analysis between 3-5 KV has shown the largest P-E loop area of the pure $CoFe_2O_4$ materials, which considerably decreased with Y^{3+} substitution.
- The structural, magnetic, optical and multiferroic properties could make it useful as multifunctional materials in opto-electronic and environmental applications.

Acknowledgements :

The authors are extremely thankful to Department of Education, Govt. of Bihar and Aryabhata Knowledge University, Patna for frontiers research establishment, support and functioning of the Nanoscience and Nanotechnology center.

Nanotechnology for Green Energy Source (Hydroelectric Cell) Research Team



Dr. R.K. Kotnala



Dr. Jyoti Shah



Dr. Rakesh Kumar Singh

Research Published from ACS publishing , Washington.

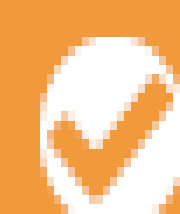
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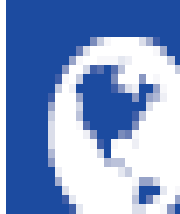
Article

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*

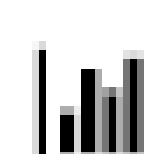


Cite This: <https://doi.org/10.1021/acs.energyfuels.1c01164>

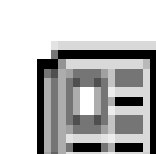


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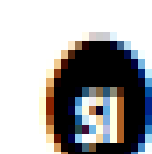
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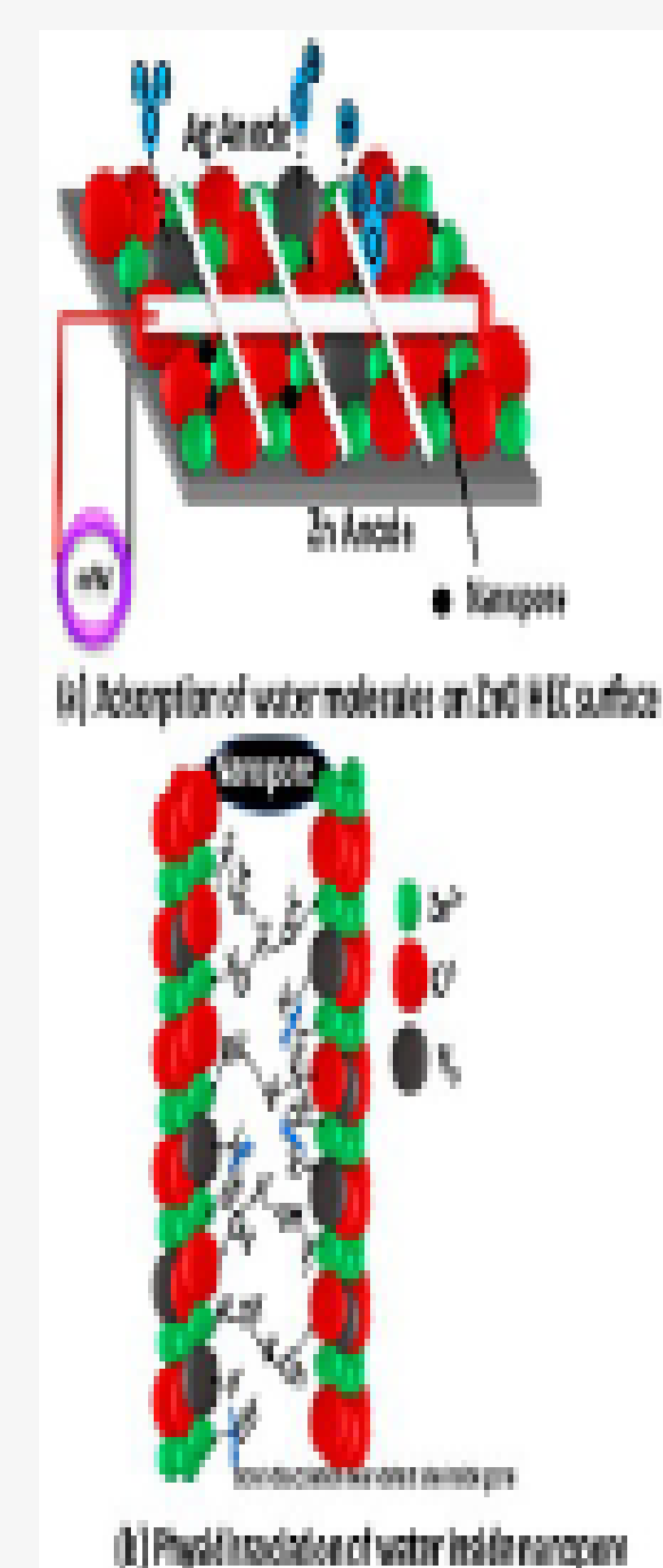


Article Recommendations



Supporting Information

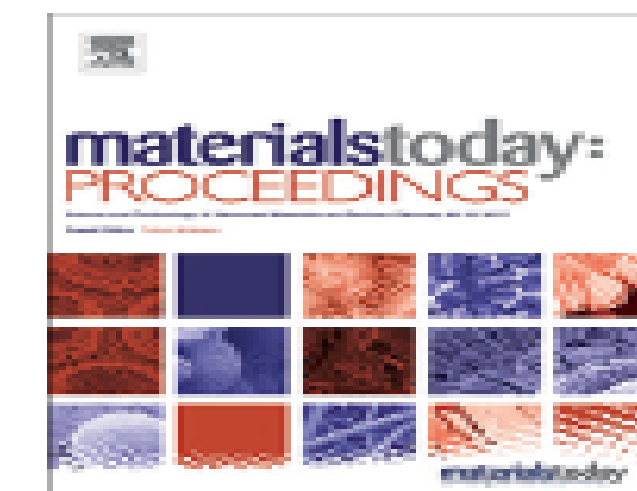
ABSTRACT: Efficient nonphotocatalytic water molecule splitting and electricity generation has been obtained from alkali (Li, Na, K) doped zinc oxide (ZnO) hydroelectric cells (HECs) at room temperature. The existence of defect centers including zinc and oxygen vacancies in pure and alkali-doped ZnO has 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/cm², 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/cm². 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.



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The authors are extremely thankful to Department of Education, Govt. of Bihar and Aryabhata Knowledge University, Patna for frontiers research establishment, support and functioning of the Nanoscience and Nanotechnology center.

Note- Dr. R K Kotnala, at present chairman of NABL-Delhi



Effect of superfine grinding on structural, morphological and antioxidant properties of ginger (*Zingiberofficinale*) nano crystalline food powder

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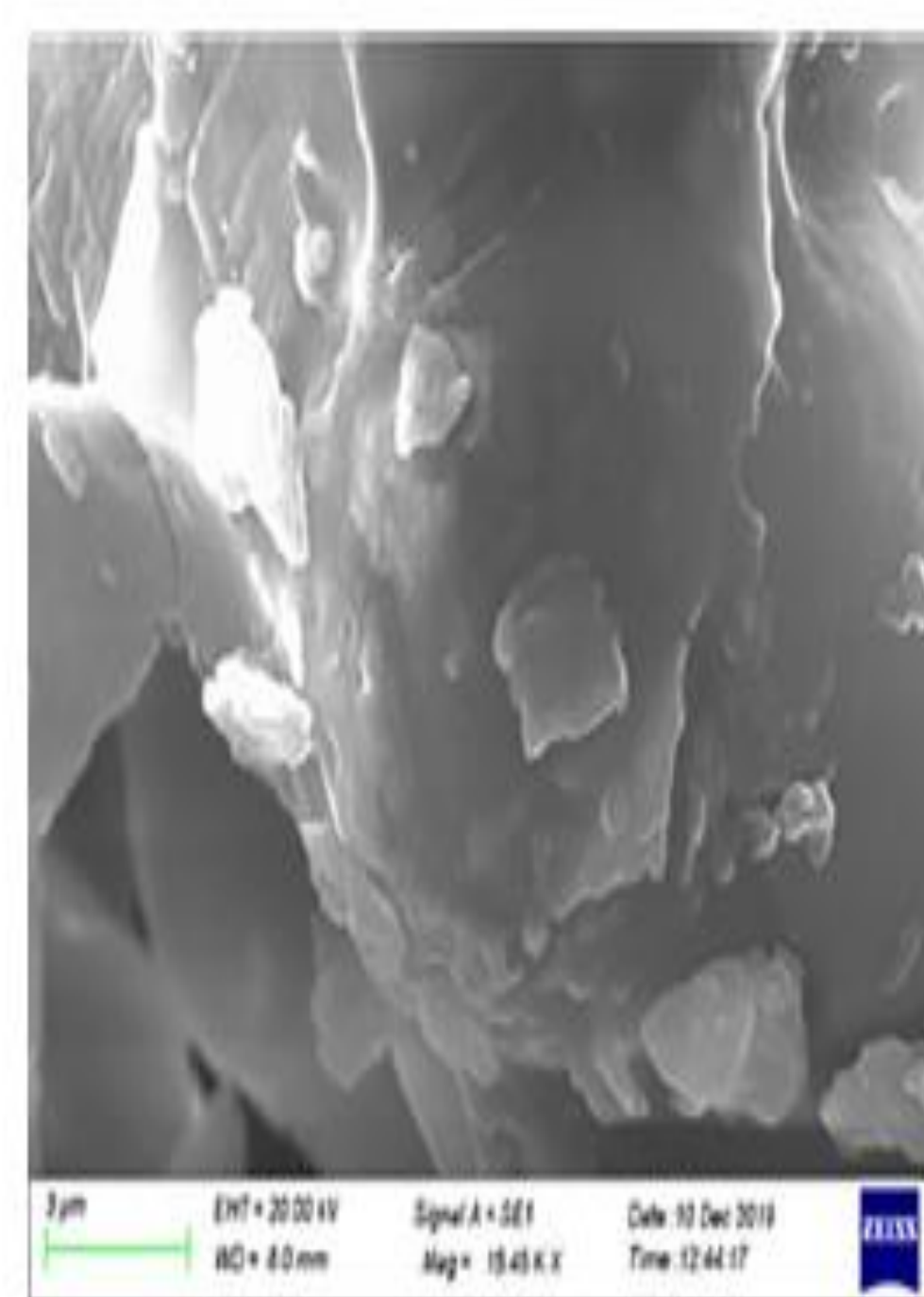
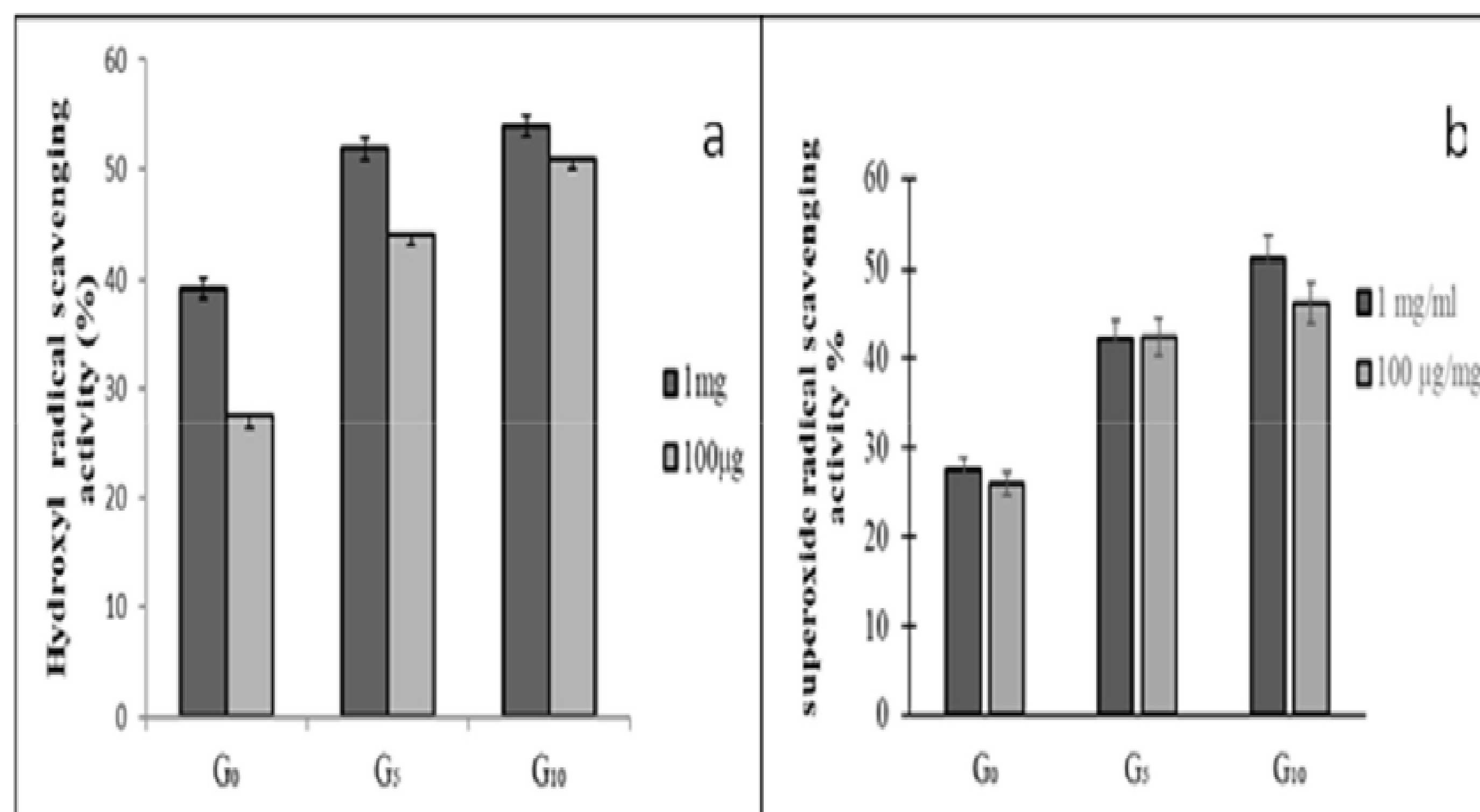
Dr. Abhay Kumar Aman



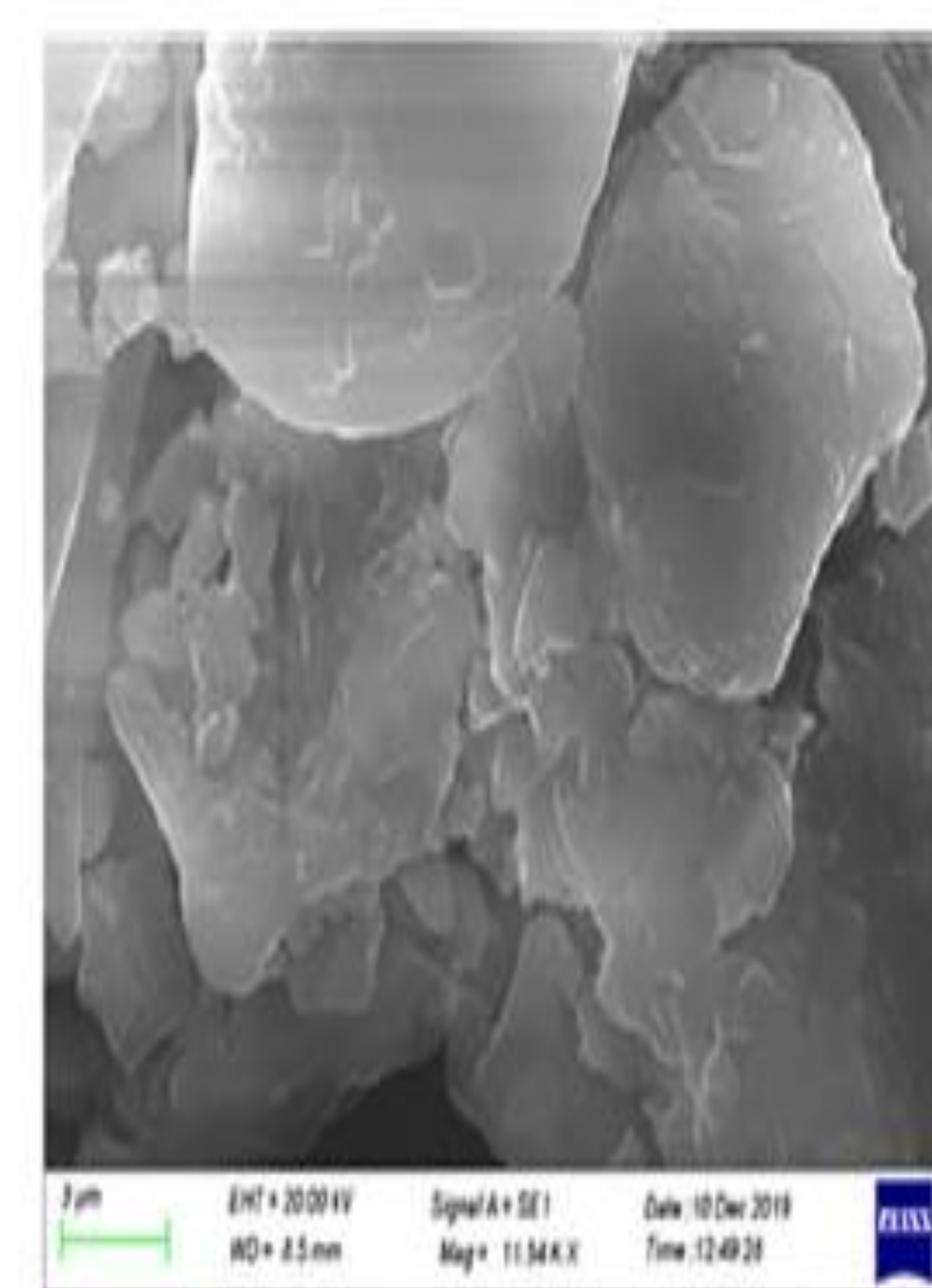
Dr. Rakesh Kumar Singh



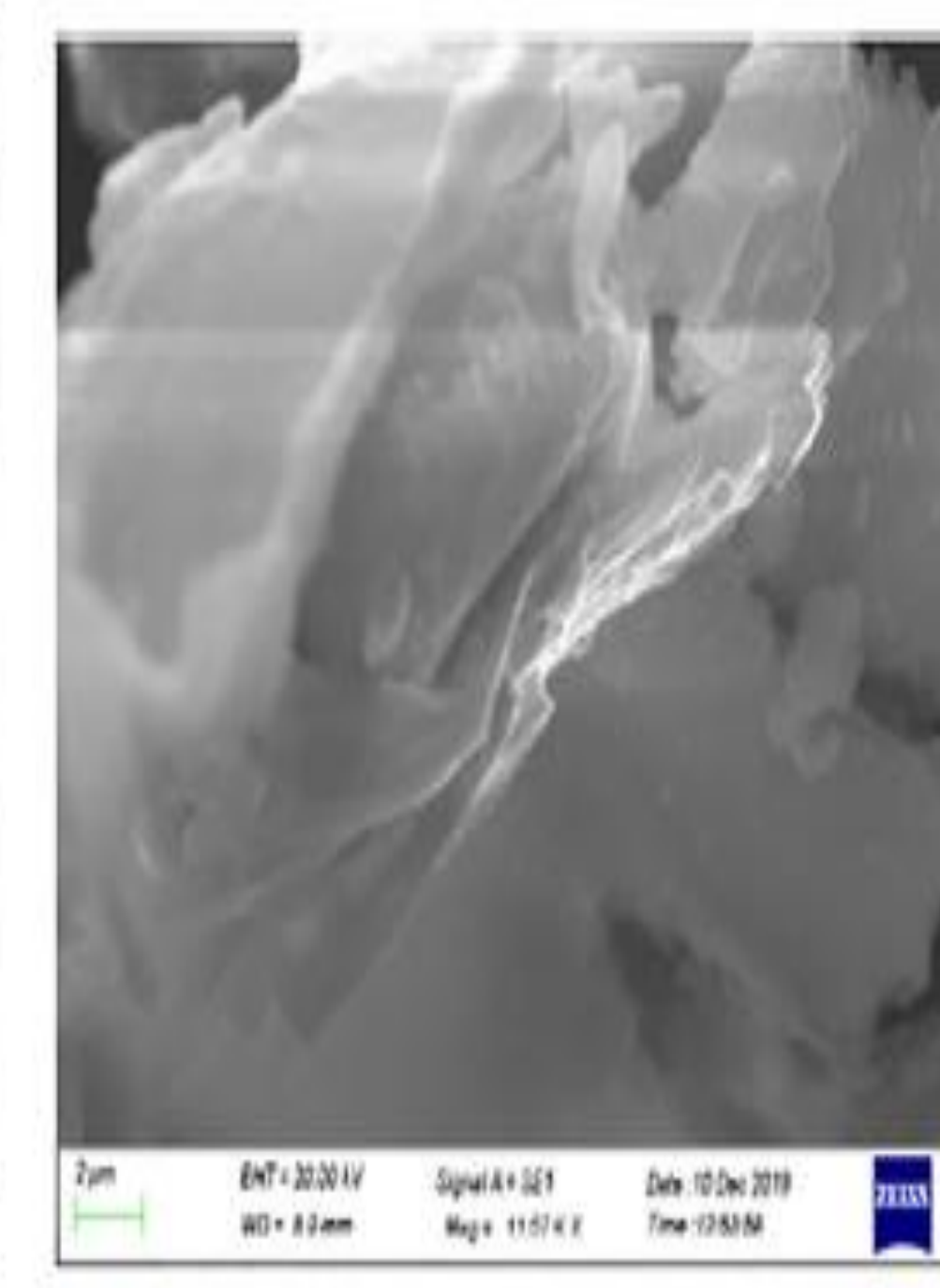
Nishant Kumar



(a) G₀-powder



(b) G₀₅-powder



(c) G₁₀-powder

Novelties of Research

- Regardless of high industrial and scientific interest in the crystal structure, a thorough study of surface science and their biomedical action of superfine food powder is not very much visible. While food powders are a natural product, being used as spices, as medicines in pharmaceutical and environmental sectors at a large scale.
- The superfine ginger powder was prepared using high energy ball milling equipment. The crystal structure, surface morphology, and the functional group were identified and recorded using modern scientific tools, such as X-ray diffraction (XRD), Scanning Electron Microscope (SEM), Fourier transform infrared spectroscopy (FTIR), and UV–Visible spectroscopy.
- The XRD study confirms that the crystal sizes of superfine powder are in between 1 nm and 100 nm and milling of ginger powder for 5 h and 10 h using a high energy ball mill, alters the crystal structure, surface morphology, which is different from ginger powder, which was prepared using mixture grinding. FTIR measurement shows that there is no change in the functional group due to milling for different time duration.
- The aim of the present study is to investigate the changes that occur in the physical and metabolic properties of superfine ginger powder due to milling. The present study shows that the total phenolic content (TPC), antioxidant property, and superoxide radicals scavenging of ginger powder increased due to change in a crystalline structure, surface morphology, and large surface to volume ratio.

Acknowledgements :

The authors are extremely thankful to Department of Education, Govt. of Bihar and Aryabhata Knowledge University, Patna for frontiers research establishment, support and functioning of the Nanoscience and Nanotechnology center.

Nanotechnology in Indian Ancient wisdom.

Research finding presented in International Conference in JNU, Delhi
Accepted for publication in SCI Journal

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

Research team



Dr. Rakesh Kumar Singh

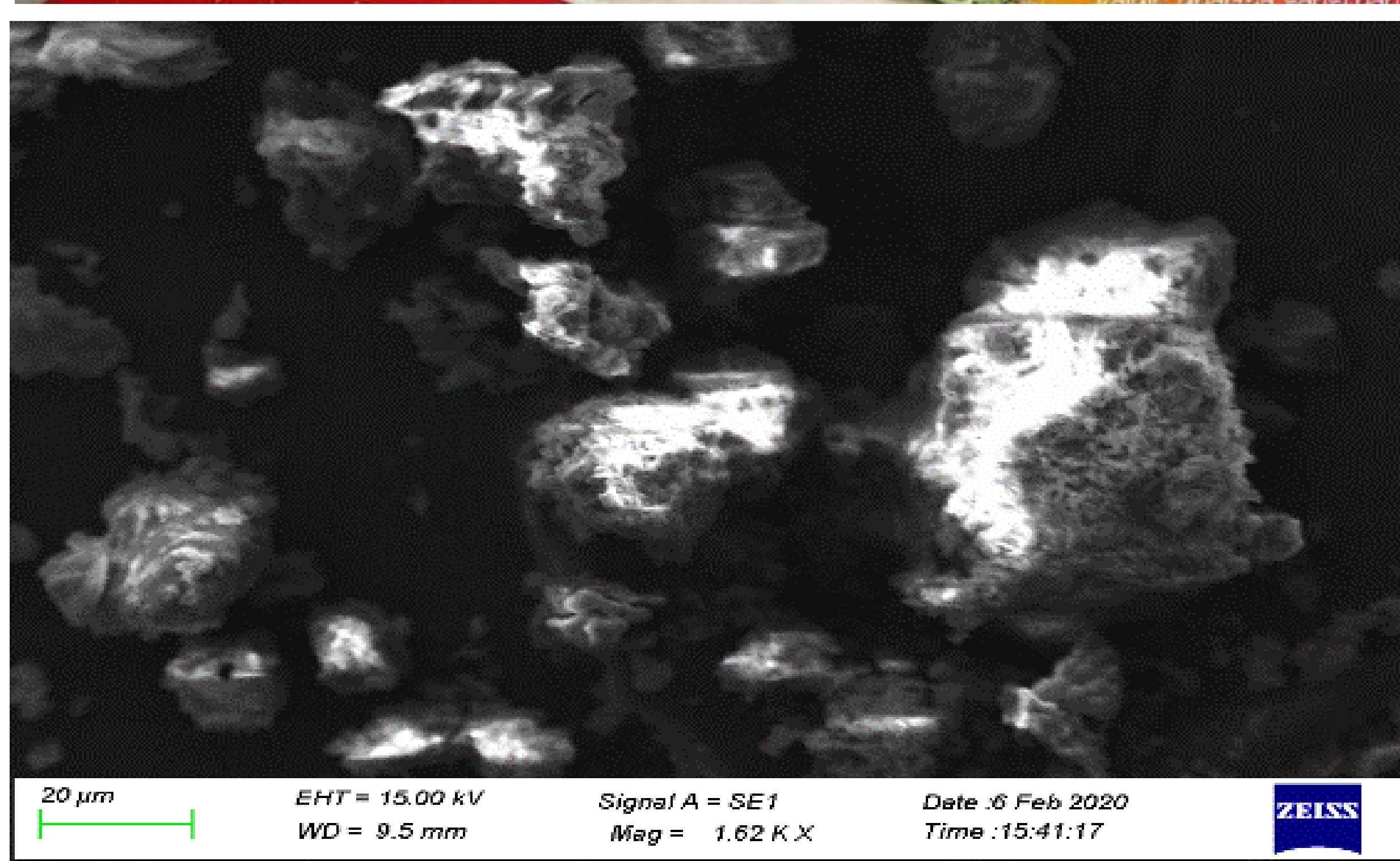
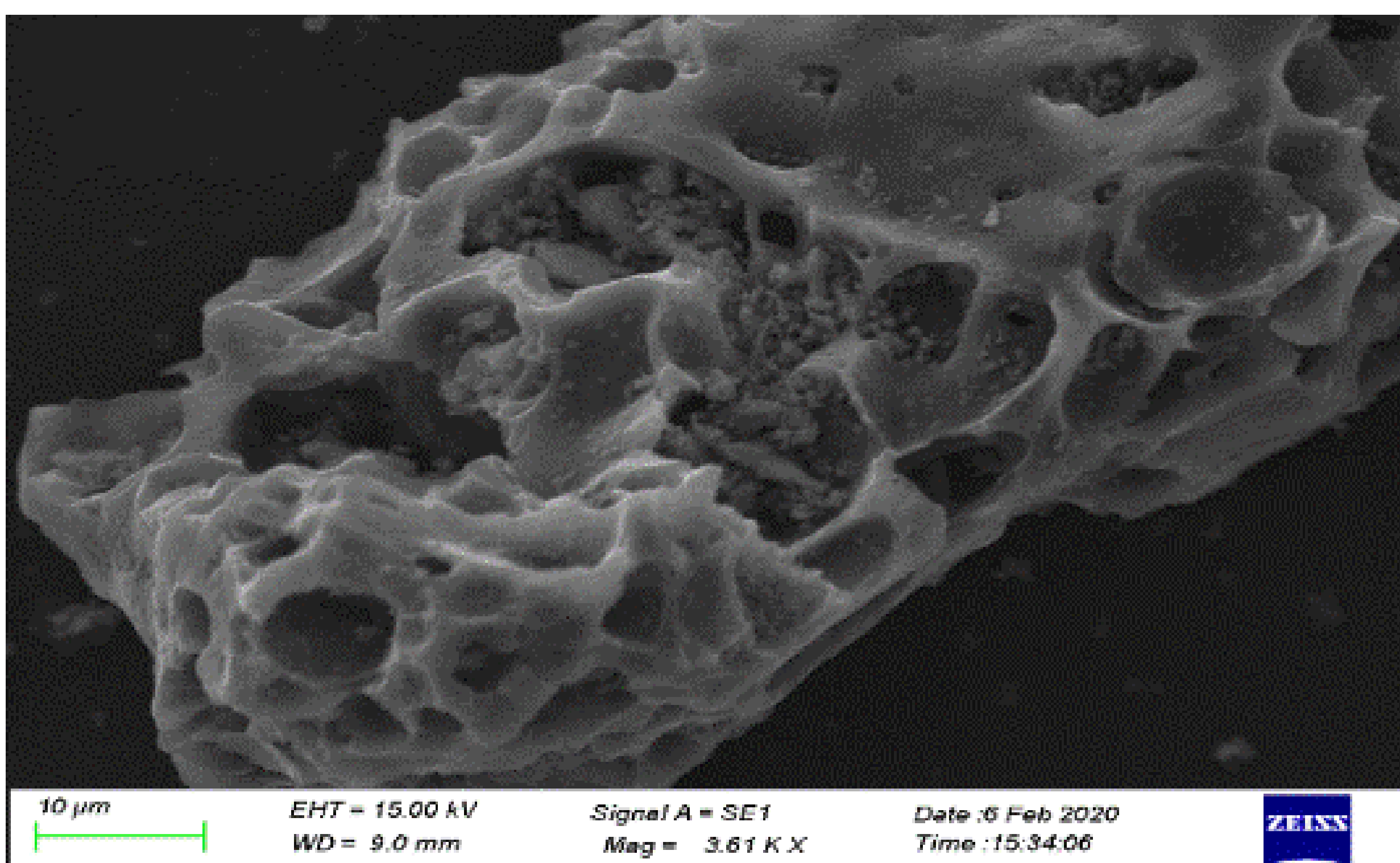


Ms. Divya Kanchibhotla



Nishant Kumar

Prateek Hansora



Electron microscopy image of ash of Hawan as functional nanomaterials

Novelties of Research:

- 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

Acknowledgements :

The authors are extremely thankful to Department of Education, Govt. of Bihar and Aryabhata Knowledge University, Patna for frontiers research establishment, support and functioning of the Nanoscience and Nanotechnology center. The authors are also thankful to Art of living foundation, Bangalore for providing samples and help in writing the manuscript.

Nanotechnology in agriculture

Conversion of waste into wealth and Knowledge

Materials Science and Engineering B 263 (2021) 114871



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'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

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Netherland

Research Team



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Dr. Rakesh Kumar Singh

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Dr. Manoranjan Kar



Rice Husk



Materials used in the preparation of polymer composite



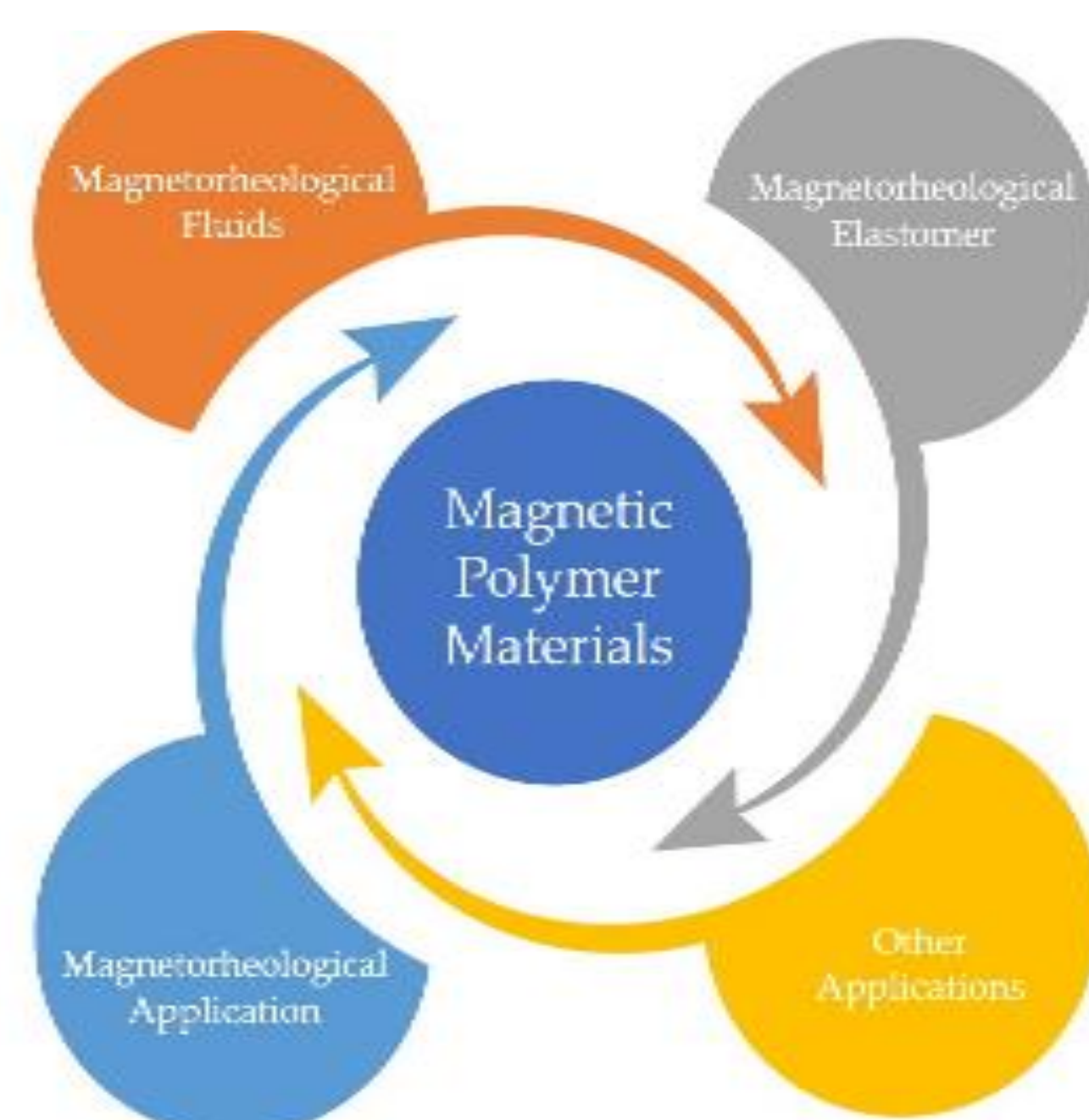
Twin-screw extruder



Injection moulding machine



Polymer composite



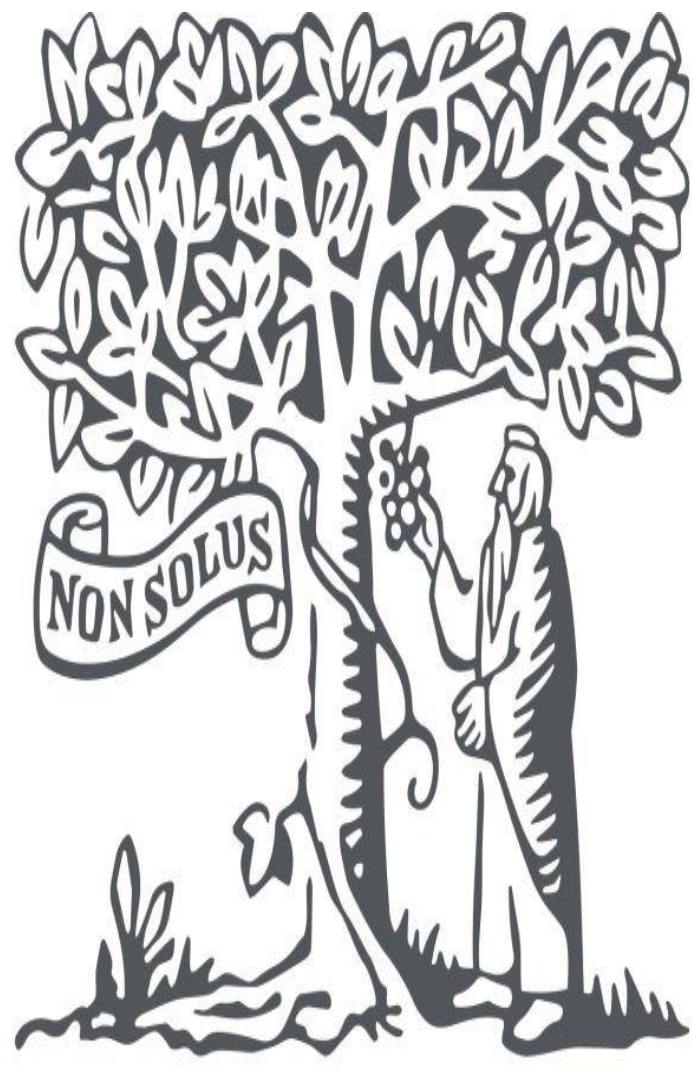
Magnetic Polymer

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–O–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.

Acknowledgements :

The authors are extremely thankful to Department of Education, Govt. of Bihar and Aryabhata Knowledge University, Patna for frontiers research establishment, support and functioning of the Nanoscience and Nanotechnology center.



ELSEVIER



Review on arsenic removal using biochar-based materials

Pushpa Kumari Sharma ^{a, 1}, Rakesh Kumar ^{b, 1}, Rakesh Kumar Singh ^{a, 2}, Prabhakar Sharma ^{b, 3}, Ashok Ghosh ^{c, d, 4}

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^b School of Ecology and Environment Studies, Nalanda University, Rajgir, Bihar, 803116, India

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^d Bihar Pollution Control Board, Patna, 800010, Bihar, India

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Research Team



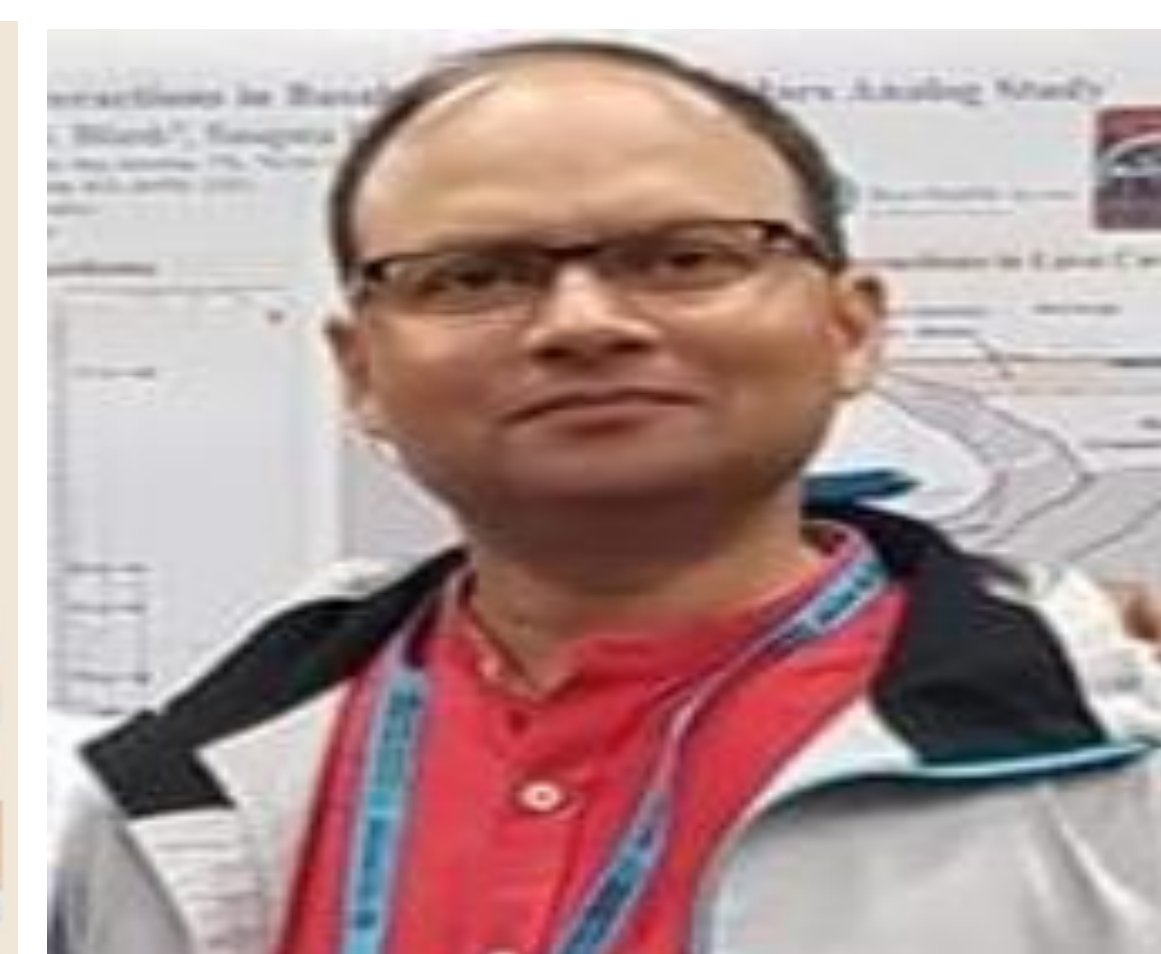
Pushpa Kumari Sharma



Rakesh Kumar



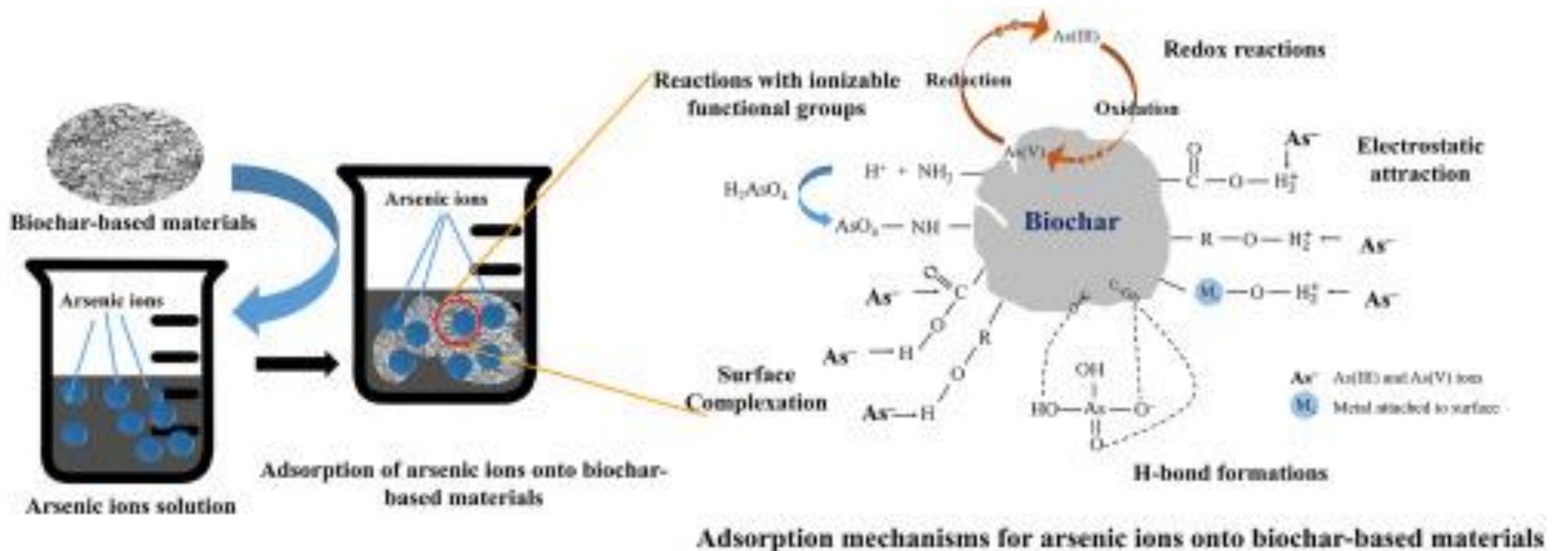
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Dr. Prabhakar Sharma



Prof. Ashok Ghosh

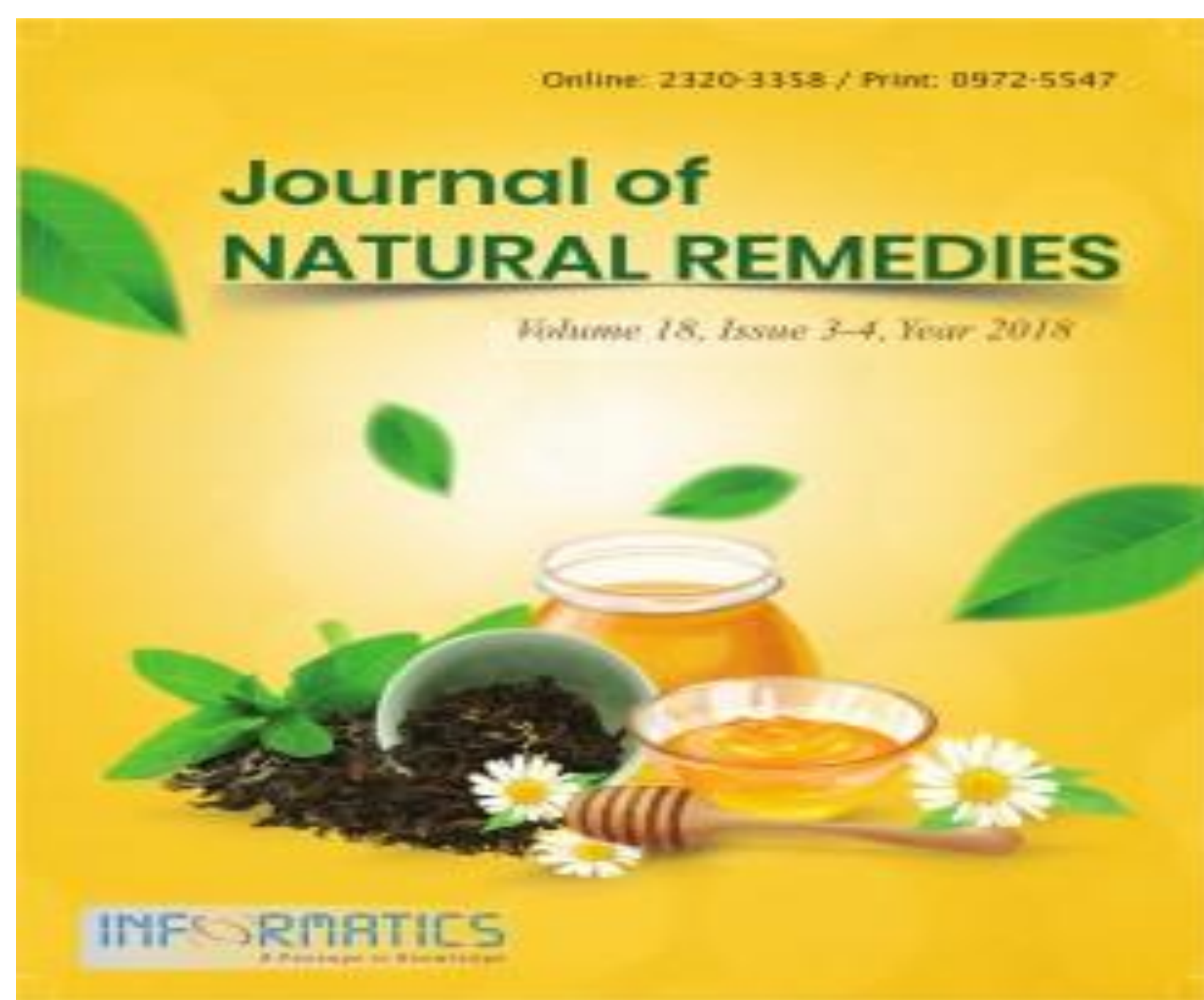


Research Summary:

- This review work significantly summarized the current state of knowledge for arsenic-contaminated water treatment.
- Firstly, this paper insight a brief understanding of arsenic speciation, toxicity, and accumulation in the food chain, and secondly, explains the adsorption techniques for as remediation from the contaminated water.
- Thirdly, this review discusses various factors, such as acidic pH, initial concentration, biochar dose, co-existing ions, and temperature, including regeneration and reusability of biochar-based sorbents.
- Lastly, mechanistic understanding for arsenic adsorption onto biochar materials has been discussed, considering equilibrium adsorption isotherms, kinetics, and thermodynamics analysis. In conclusion, this review also highlighted major challenges and future scope relevant for implications of biochar sorbents in continuous flow systems to scale up for commercial and industrial purpose

Acknowledgements :

The authors are extremely thankful to Department of Education, Govt. of Bihar and Aryabhata Knowledge University, Patna for frontiers research establishment, support and functioning of the Nanoscience and Nanotechnology center.



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

Sweta Sinha¹, Rakesh Kr. Singh^{1*}, Nishant Kumar¹, Subhash Pd. Singh², Prabhat Kr. Dwivedi¹ and Rekha Kumari³

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Dr, Sweta Sinha



Dr, Rakesh Kumar Singh



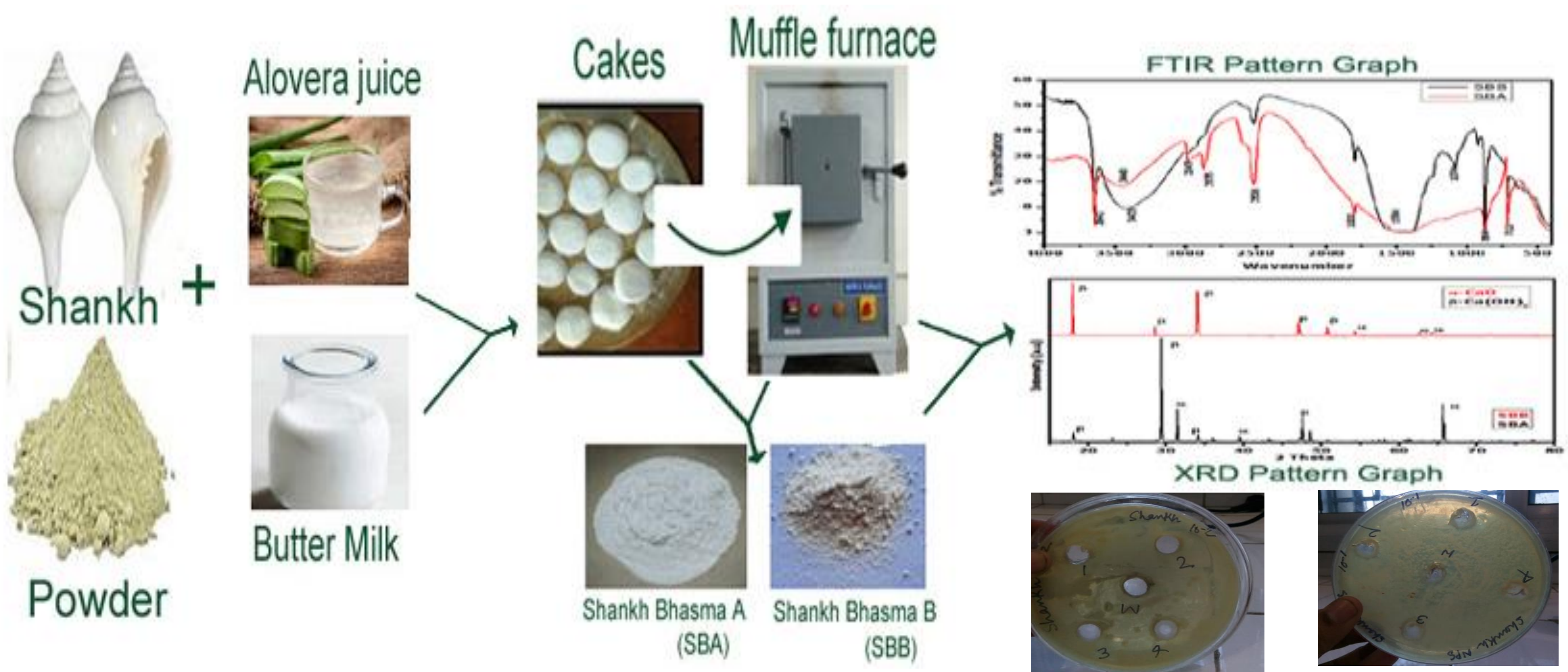
Prof, Rekha Kumari



Prabhat Kr. Dwivedi



Nishant Kumar



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. Shankh 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.

Acknowledgements :

The authors are extremely thankful to Department of Education, Govt. of Bihar and Aryabhatta Knowledge University, Patna for frontiers research establishment, support and functioning of the Nanoscience and Nanotechnology center.



Physical properties of Pr-substituted Li/Ni ferrite magnetic materials at nanometric scale for its multifunctional applications in industries/environment and their cytotoxicity, lymphocyte studies as nanomedicine

Nishant Kumar¹ · Rakesh Kumar Singh¹ · Vivek Kumar¹ · Shashank Bhushan Das¹ · Gufran Ahmed² · Shyam Narayan² · Rekha Kumari³

Research Team



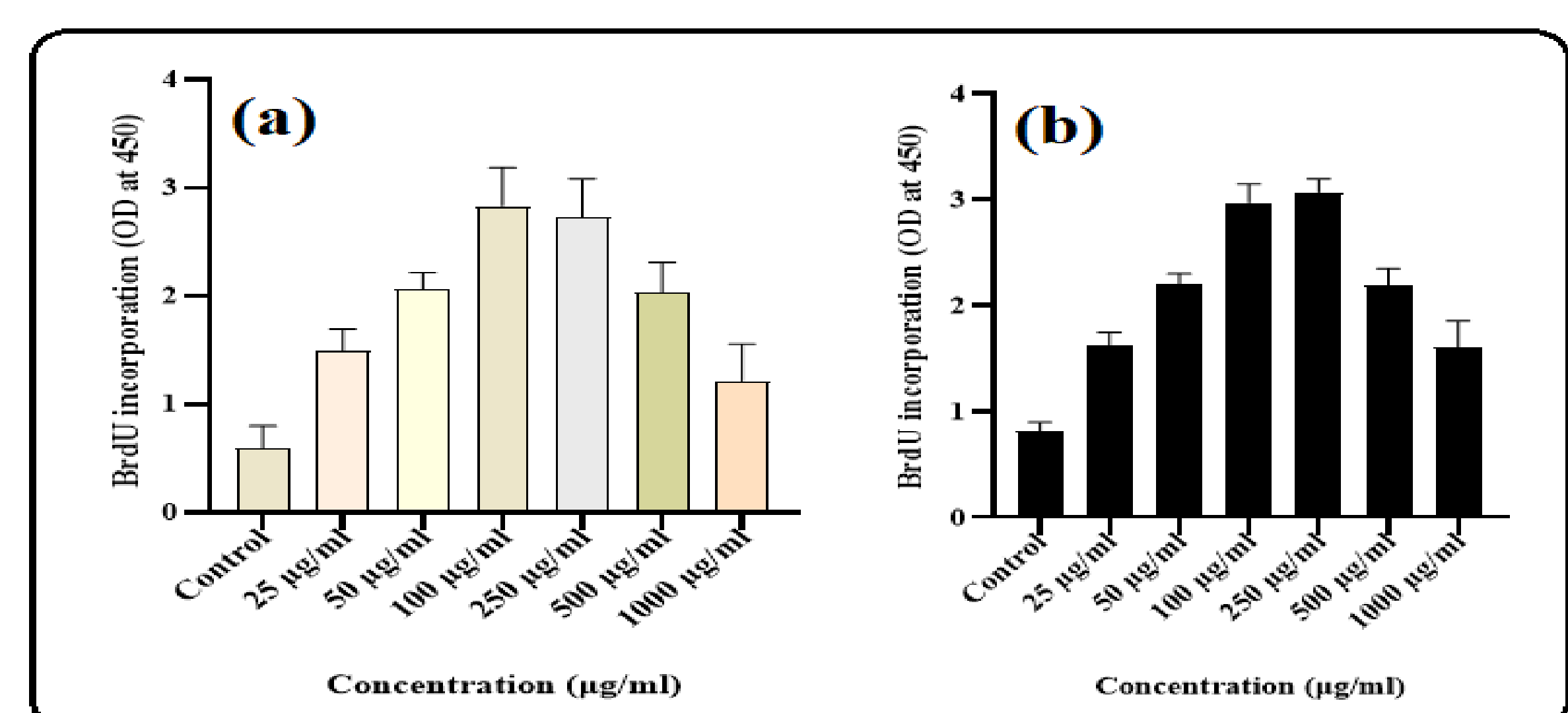
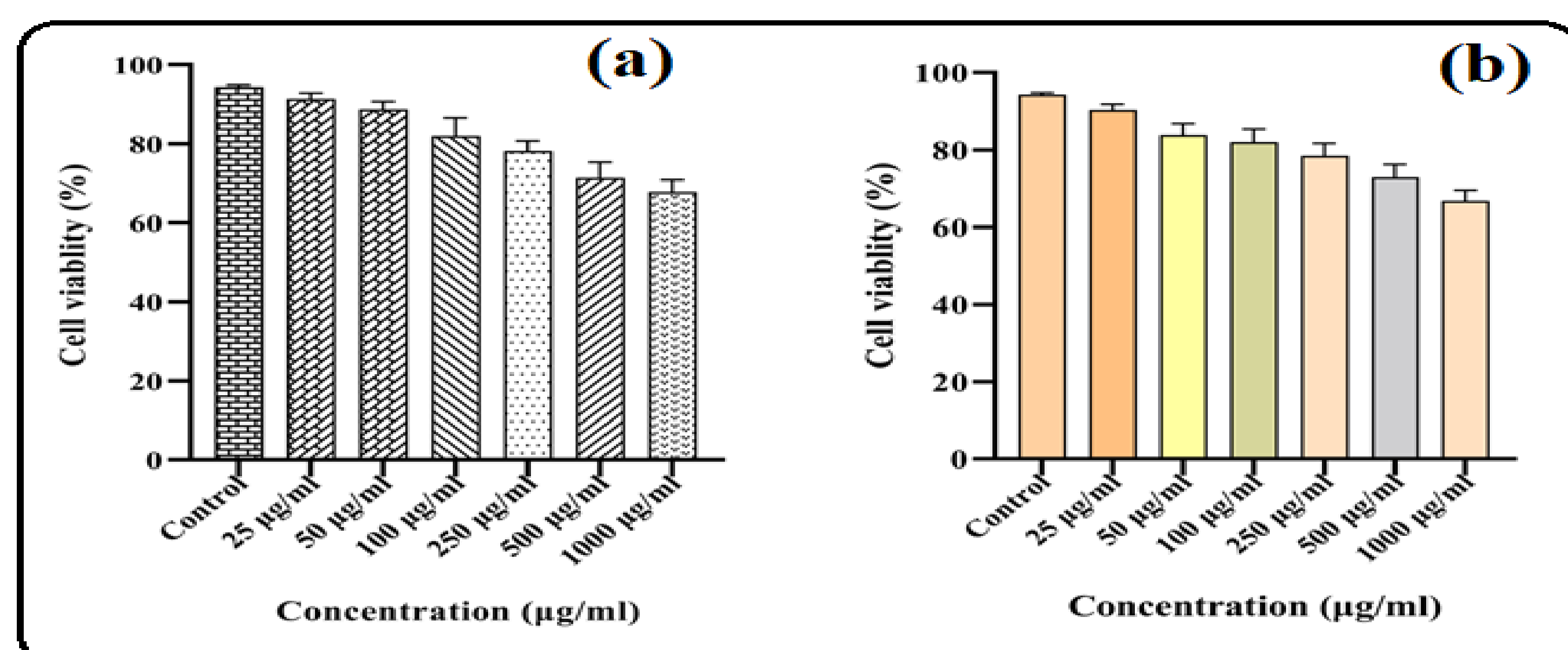
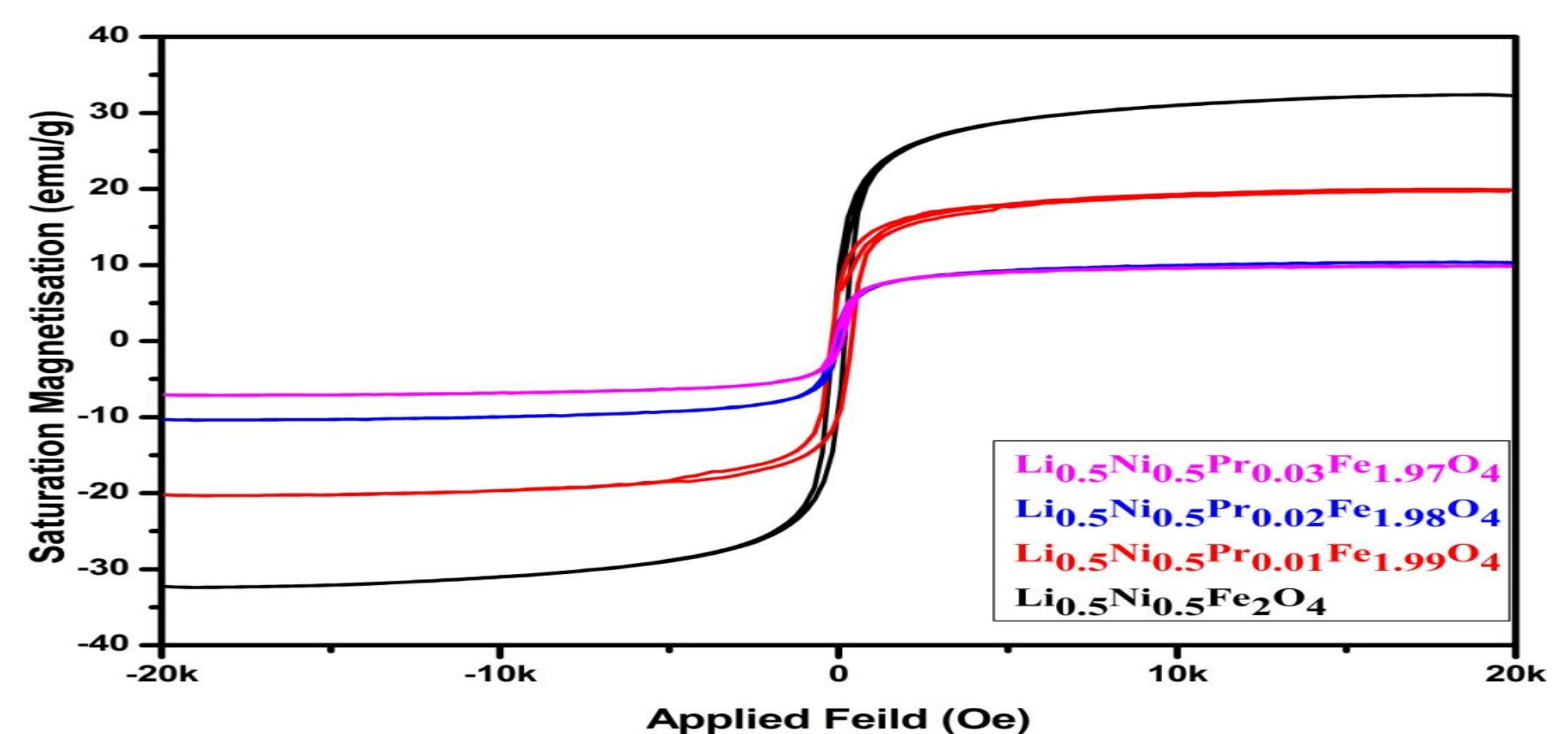
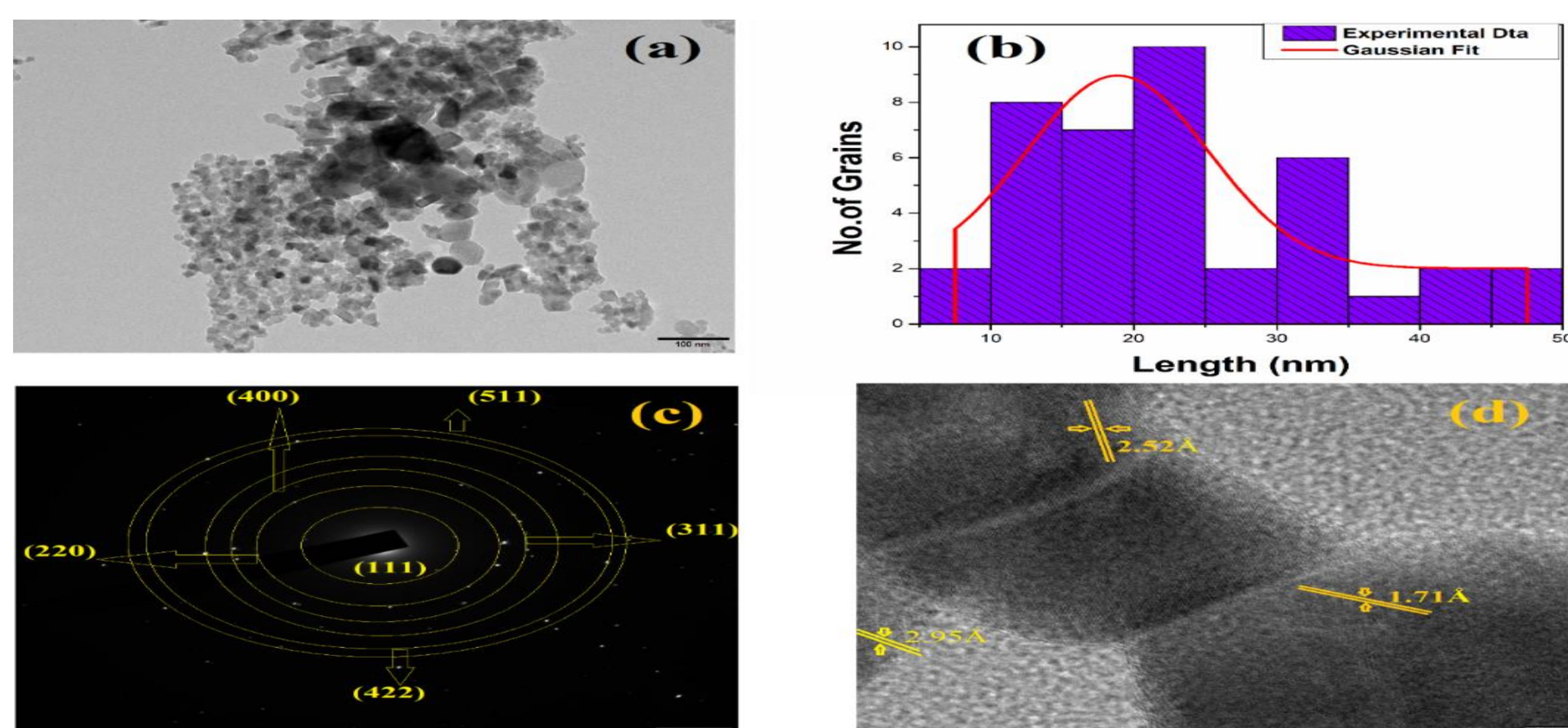
Nishant Kumar

Dr. Rakesh Kumar Singh

Prof. Rekha Kumari

Vivek Kumar

Shashank Bhushan Das



Research Highlights

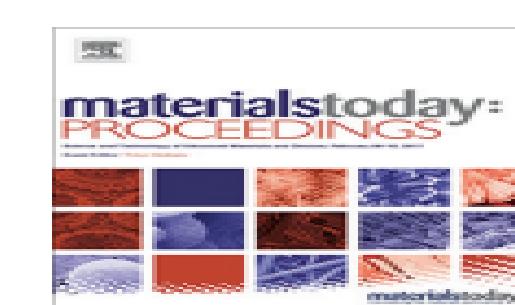
- $\text{Li}_{0.5}\text{Ni}_{0.5}\text{Pr}_x\text{Fe}_{2-x}\text{O}_4$ ($x=0, 0.01, 0.02$ and 0.03) prepared using cost-effective citrate precursor method. The ferrite magnetic materials are iron oxide-based materials and at nanometric scale very promising for its multifunctional applications in Electronics industries, Purification of water and as Nanomedicine. In this present research, structural, surface morphology, optical, electronic, and magnetic properties together with cytotoxicity and lymphoproliferation on murine spleen cells have been investigated.
- The indirect band gap energies were improved with the substitution of rare-earth ion. The saturation magnetization value was found between 33.5 and 6.73 emu/g for $\text{Li}_{0.5}\text{Ni}_{0.5}\text{Pr}_x\text{Fe}_{2-x}\text{O}_4$ ferrites.
- The coercivity was estimated in between 185.24–98.780e for Li-Ni-nanoferrite system. In addition, the observed in-vitro cytotoxicity and lymphoproliferative results appeared to be biocompatible and concentrations dependent as studied by MTT and BrdU assays.
- The present research results indicate that Pr-substituted ferrite might be applied in transformer cores because of reduced coercivity in opto-electronic instruments owing to improved optical properties and iron-oxide based bio-nanomaterials for its uses in health and medical science sector.

Acknowledgements :

The authors are extremely thankful to Department of Education, Govt. of Bihar and Aryabhata Knowledge University, Patna for frontiers research laboratory establishment, support and functioning of the Nanoscience and Nanotechnology center.



ELSEVIER
United Kingdom



Low temperature synthesis and influence of Ce³⁺ substitution on structural and magnetic properties of nanocrystalline cobalt ferrite using citrate precursor sol-gel method

Gaurav Kumar, Rakesh Kumar Singh, Singh Sonu Kumar, Uday Shankar et al



Gaurav Kumar



Dr. Rakesh Kumar Singh



Singh Sonu Kumar

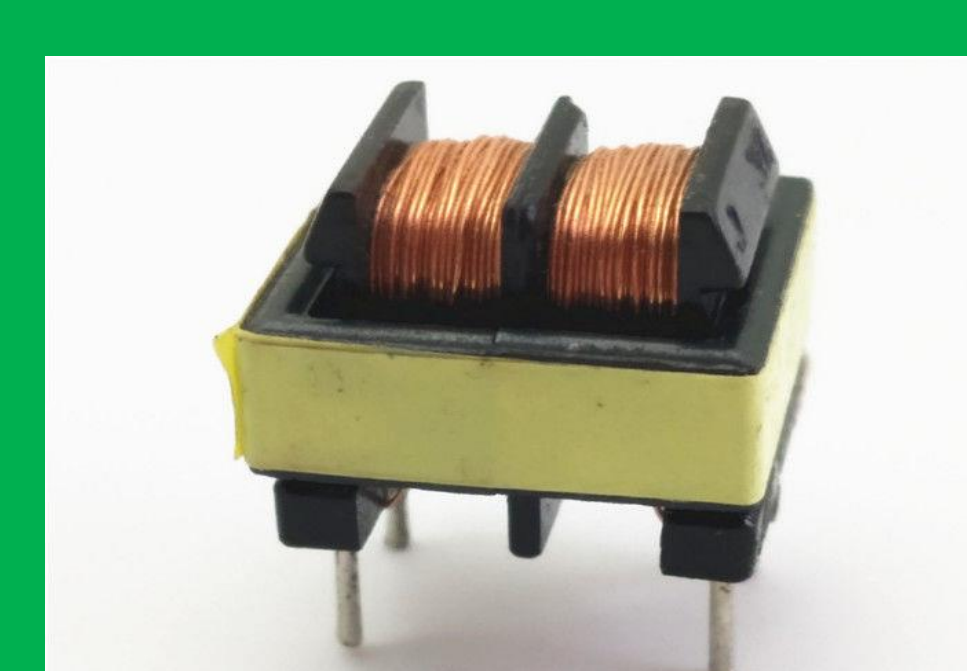
APPLICATION OF PREPARED NANO MATERIALS (IMAGE SOURCES:GOOGLE)



PREPARED FERRITE NANOMATERIALS IN LAB

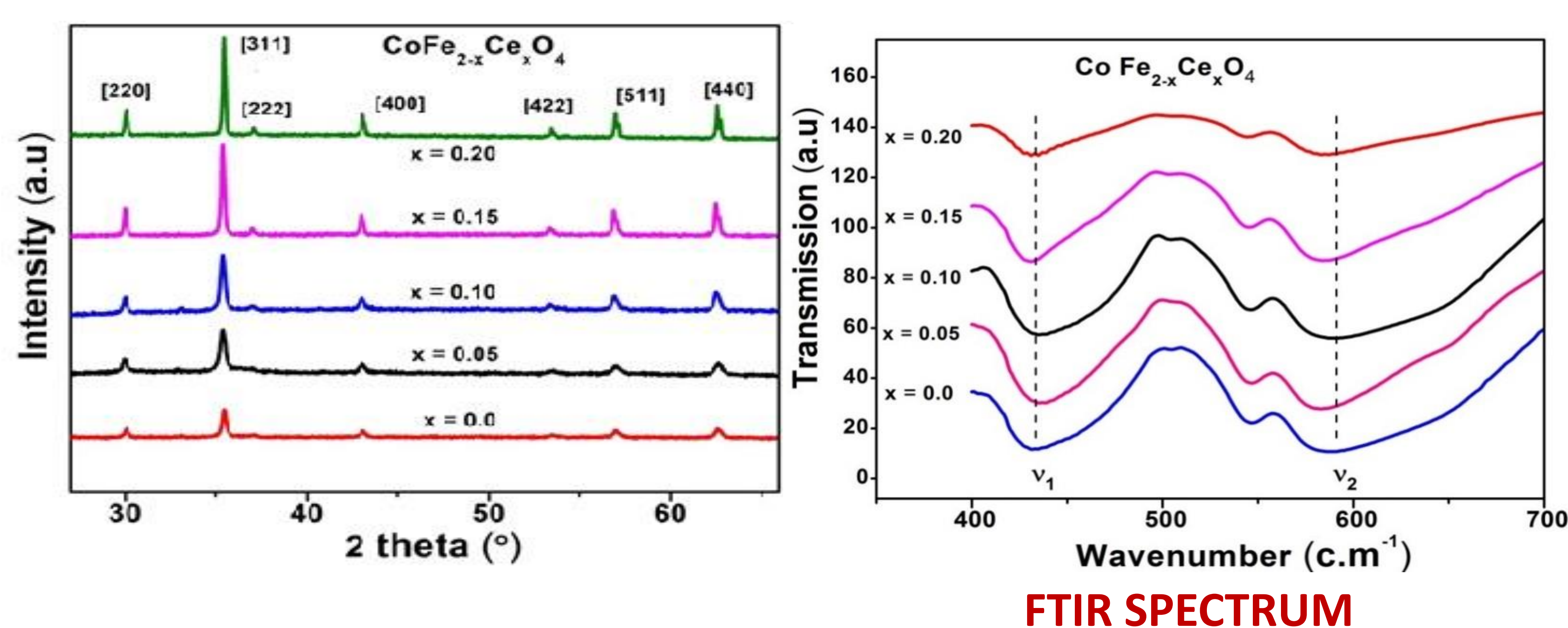


BIO-SENSORS



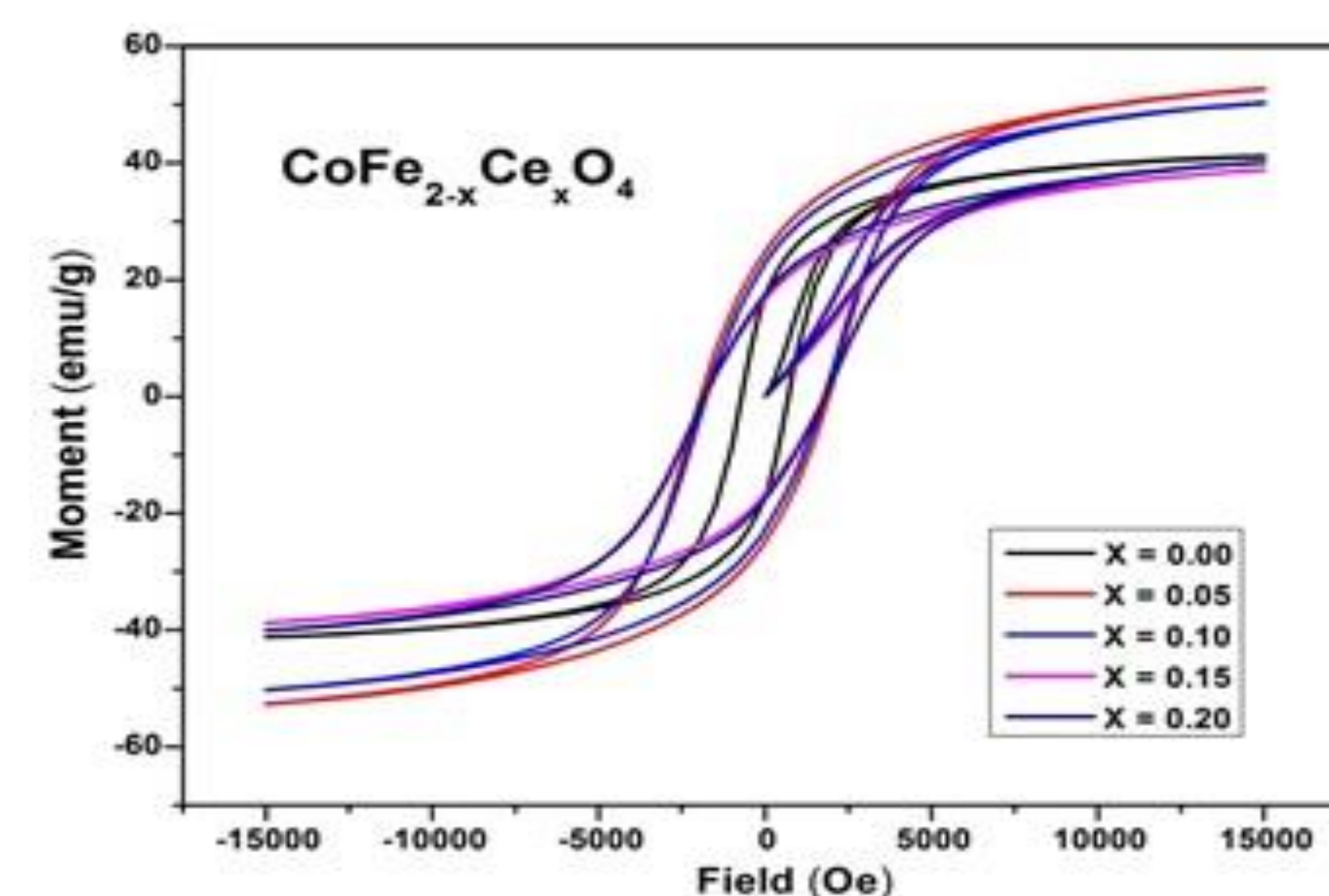
Electrical And Electronics Materials

STRUCTURAL MEASUREMENTS

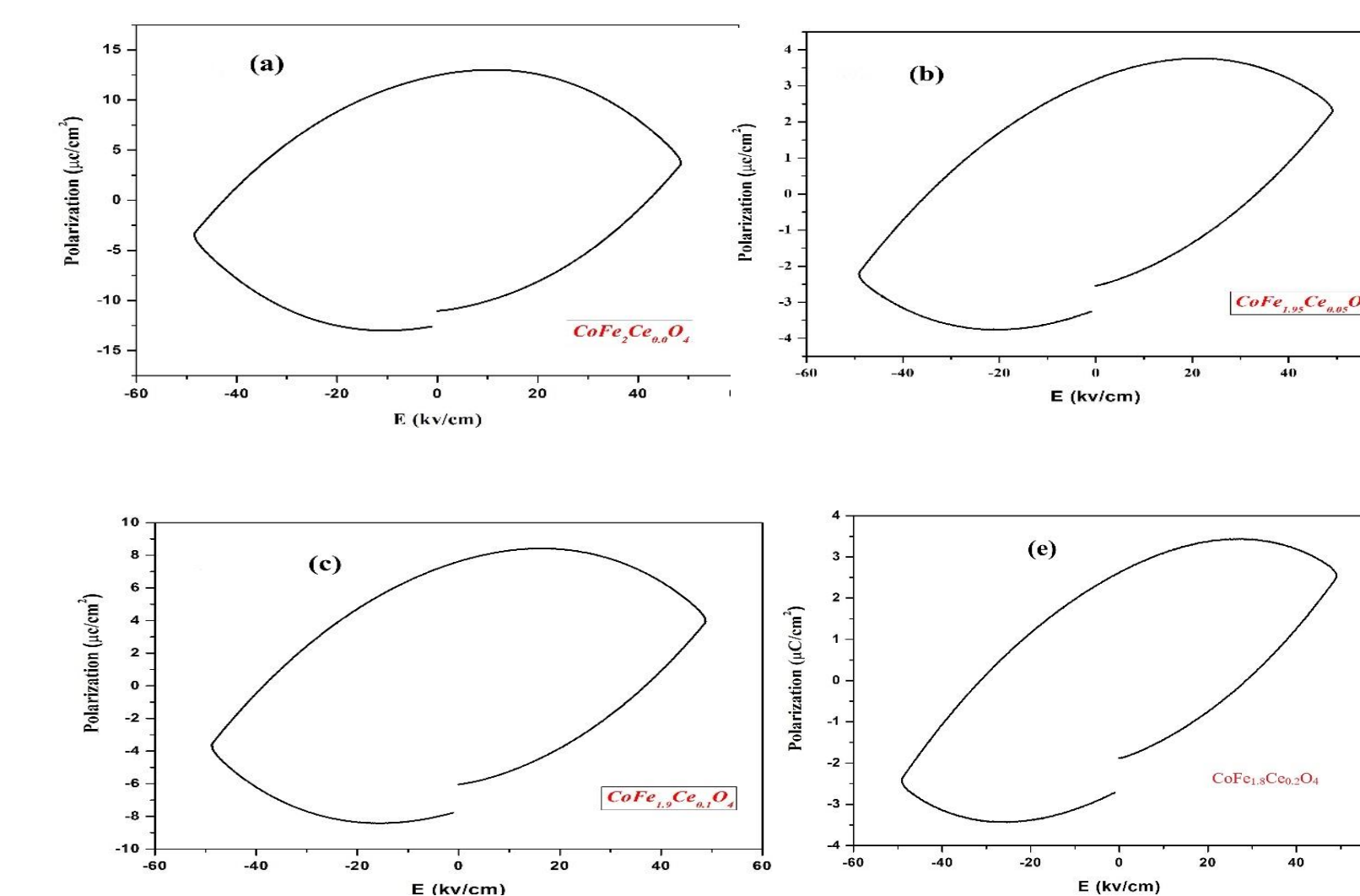


FTIR SPECTRUM

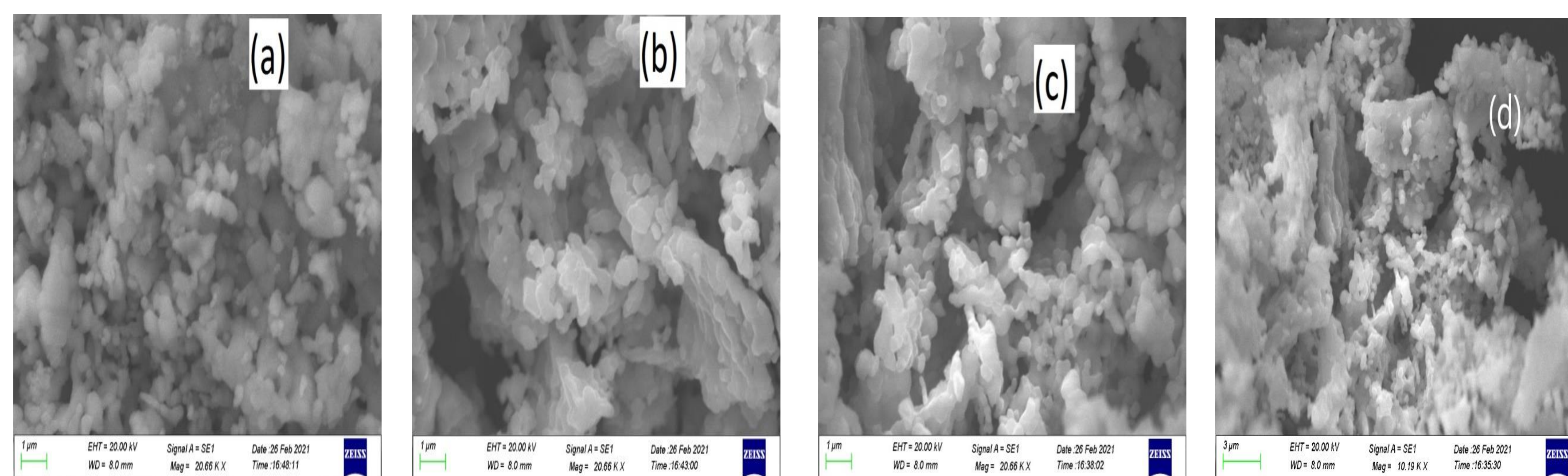
MAGNETIC MEASUREMENTS



HYSTERESIS LOOP



FERRO ELECTRIC LOOP



SEM ANALYSIS

STRUCTURAL PROPERTIES

CoFe _{2-x} Ce _x O ₄	Crystallite size (nm)	a=b=c(Å)	cell volume(Å ³)
x= 0.0	48.89	8.314	574.685
x= 0.05	52.71	8.319	575.722
x= 0.10	54.06	8.322	576.345
x= 0.15	56.98	8.325	576.969
x= 0.20	62.20	8.327	577.385

MAGNETIC PROPERTIES

S.N.	CoFe _{2-x} Ce _x O ₄	Coercive Polarisation (Ec) (KV/cm)	Remanent Polarisation(Pr) (μC/cm ²)
1	X = 0.0	42.00	1.25
2	X = 0.05	24.19	5.51
3	X = 0.10	36.87	7.62
4	X = 0.15	38.97	14.72
5	X = 0.20	28.63	26.19

Acknowledgement

The authors are extremely thankful to Department of Education, Govt. of Bihar and Aryabhata Knowledge University, Patna for frontiers research establishment, support and functioning of the Nanoscience and Nanotechnology center.

Effect of Radiation of Moon on the physical property of Jalkumbhi (*Water hyacinth*) Bhasma as a functional nanomaterials for its applications as medicine and in other areas of Science & Technology.

Dinesh Kumar¹, Shambhu Nath Guha², Rakesh Kr. Singh^{3*}, Jitendra Kr Singh⁵, Dineshwar Prasad⁴, Shashank Bhushan Das³, Nishant Kumar³

Published from United Kingdom

Research Team



Dr. Dinesh Kr

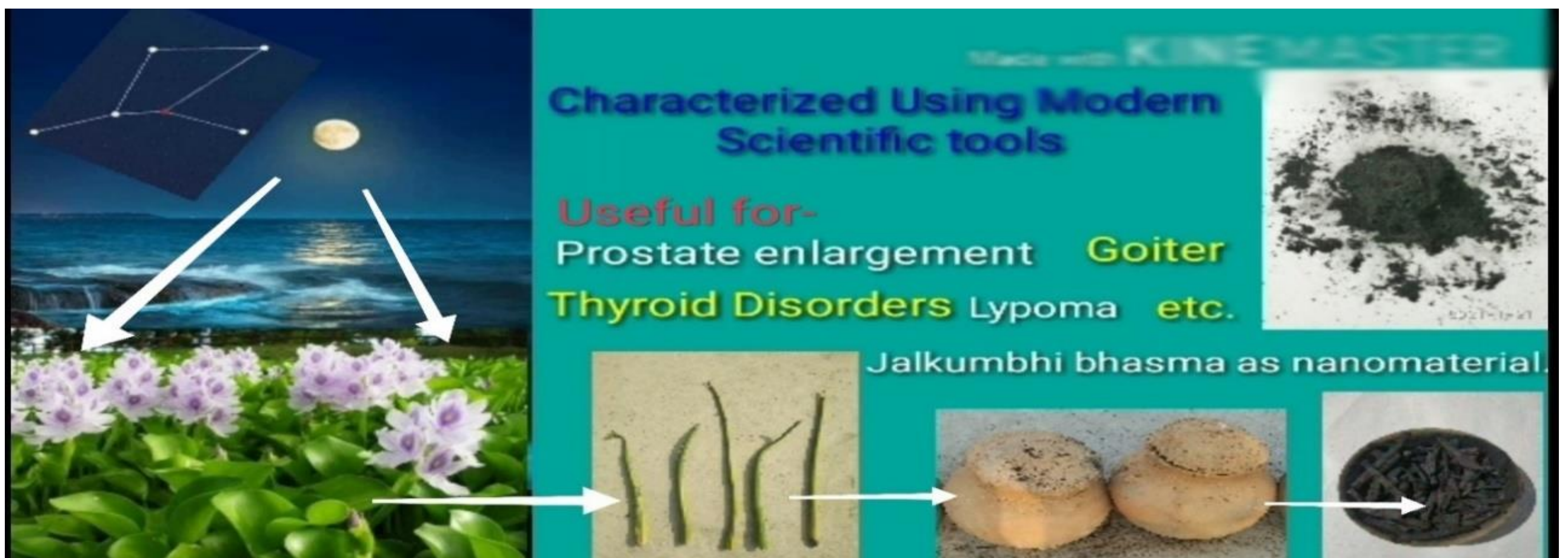
Dr. Rakesh Kr Singh

Prof. S.N. Guha

Nishant Kumar

Dr. Jitendra Kr Singh

Shashank B Das



• Jalkumbhi 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 diffraction measurement shows that crystalline size and lattice constant of Jalkumbhi 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 alters the crystal structure and formation of nanocrystalline materials.

• 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 jalkumbhi 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.

Acknowledgements :

The authors are extremely thankful to Department of Education, Govt. of Bihar and Aryabhata Knowledge University, Patna for frontiers research establishment, support and functioning of the Nanoscience and Nanotechnology center.



Singh Sonu Kumar



Dr. Rakesh Kumar Singh



Aniket Manash



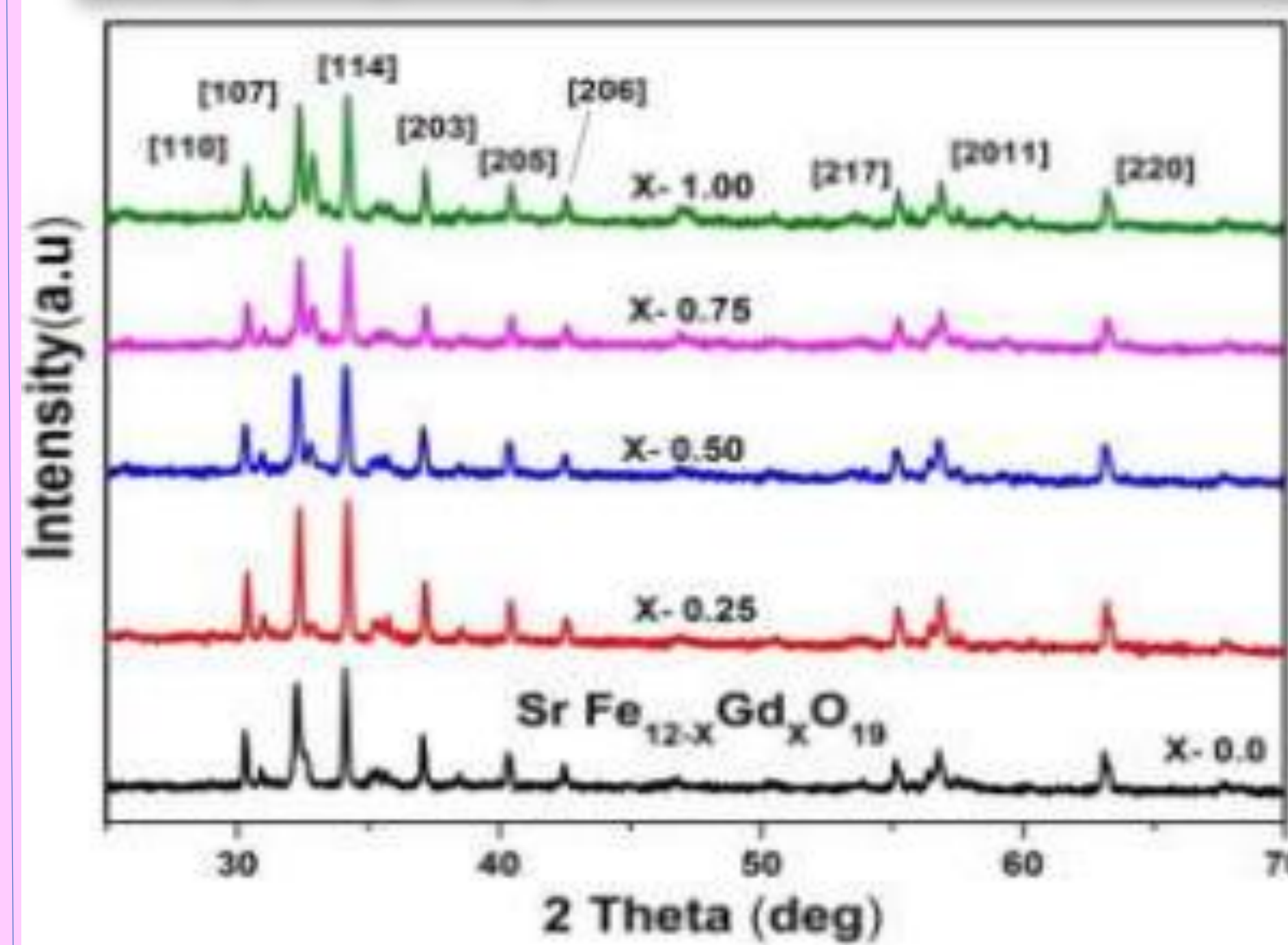
Gaurav Kumar

Nanomaterials for Electronics and Environmental applications

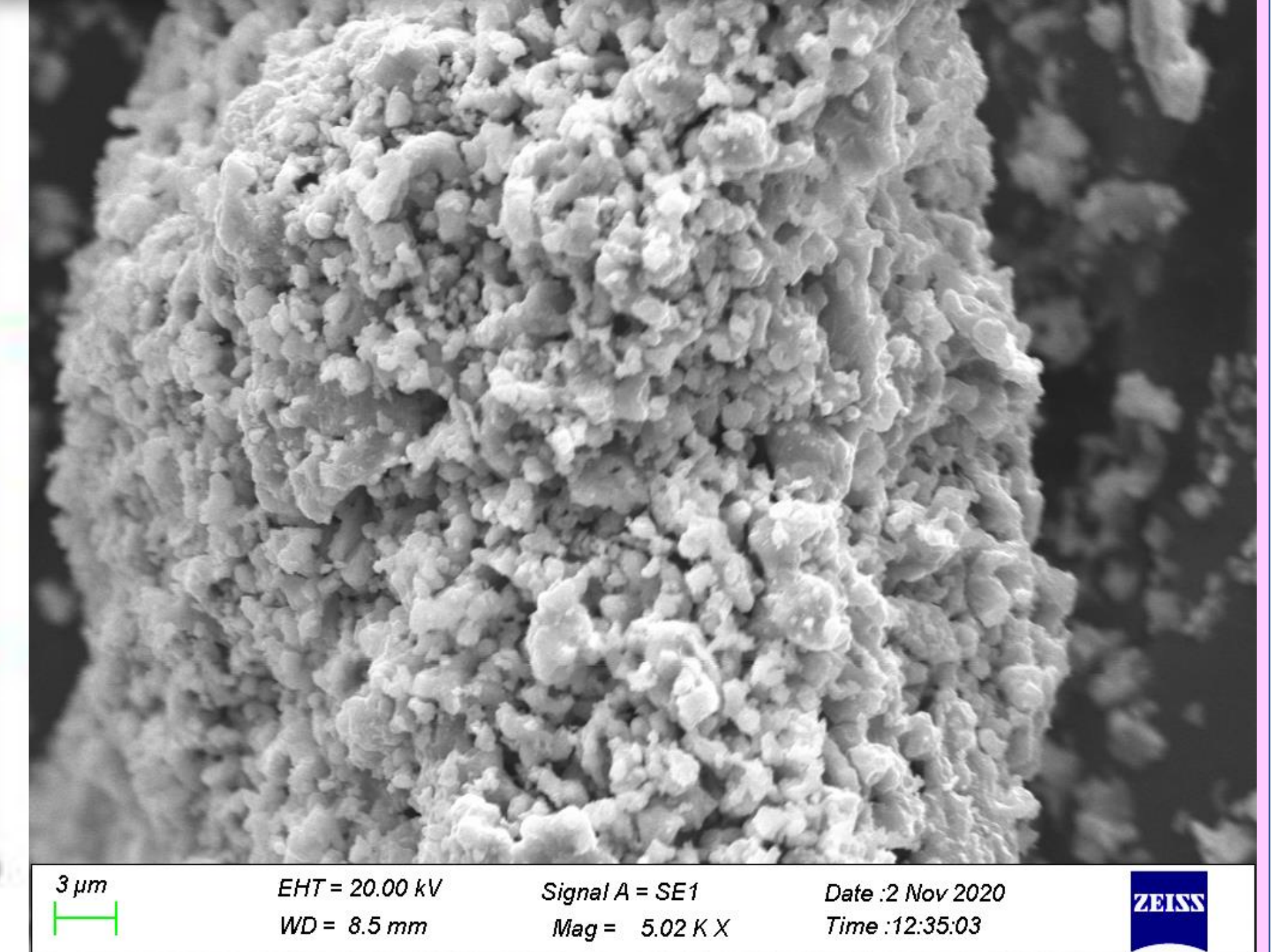
Flowchart of Synthesis Process



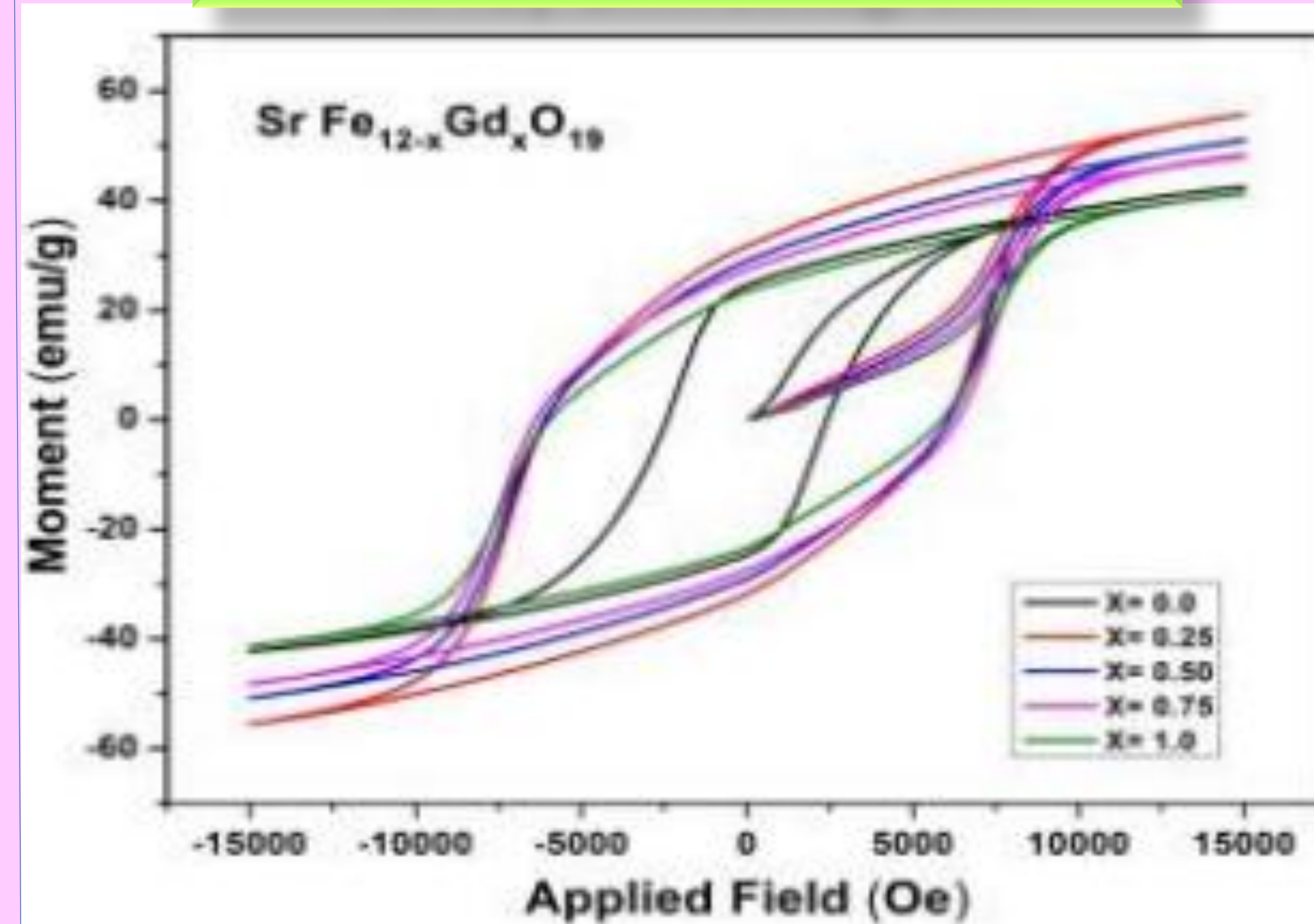
Analyzing Prepared Nanomaterials using Different Characterization tools



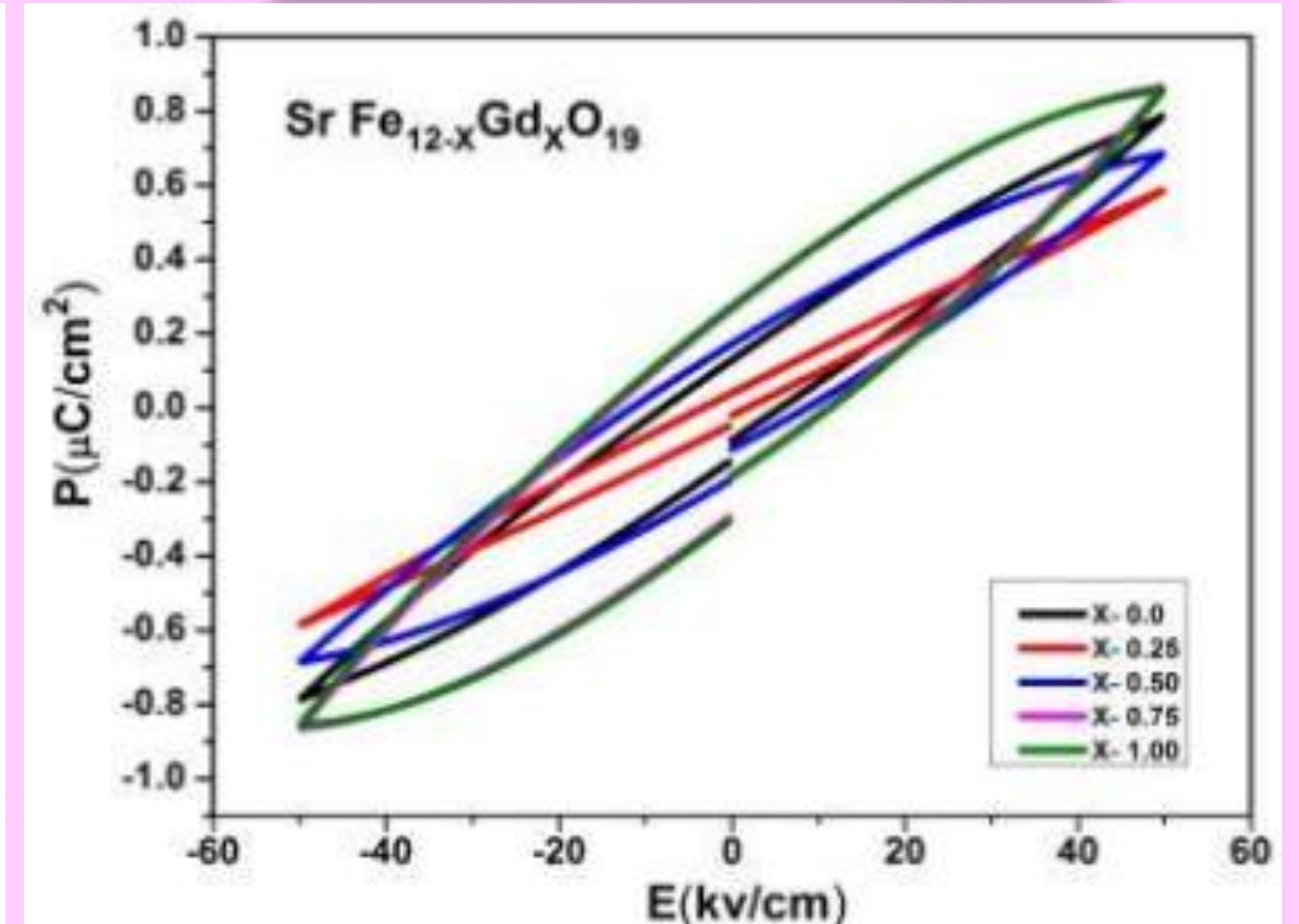
X-ray Diffractogram



Electron Microscopy es



Magnetization Curves



P-E Loop Measurement

Possible Application of Sr based Nanomaterials



Highlights of Research Finding

- Sol-gel technique is employed to synthesize monodispersed samples of strontium hexaferrite $\text{SrFe}_{12-x}\text{Gd}_x\text{O}_{19}$ for $x = (0.25 - 1.00)$.
- The particle size and crystal strain in samples amplified with an increasing Gd^{3+} content in lattice.
- The coercive field of order 6310 Gauss is recorded for $\text{SrFe}_{12}\text{O}_{19}$ doped with 0.75 mole Gd.
- Also, occupancy of Gd^{3+} ions in $\text{SrFe}_{12-x}\text{Gd}_x\text{O}_{19}$ crystals successfully enhanced electrical polarization by prohibiting electrical leakages.
- These tuned physical properties of $\text{SrFe}_{12}\text{O}_{19}$, due to lattice strain mediated by Gd^{3+} substitution suggests its futuristic technological applications in Electronics and Environmental Sector.



Tuning of structural, elastic, luminescence, magnetic, and multiferroic properties of rare earth Ce^{3+} substituted strontium hexaferrite Ceramic magnetic nanomaterials for its industrial applications

Singh Sonu Kumar¹ · Rakesh Kumar Singh¹ · Aniket Manash¹

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Singh Sonu Kumar



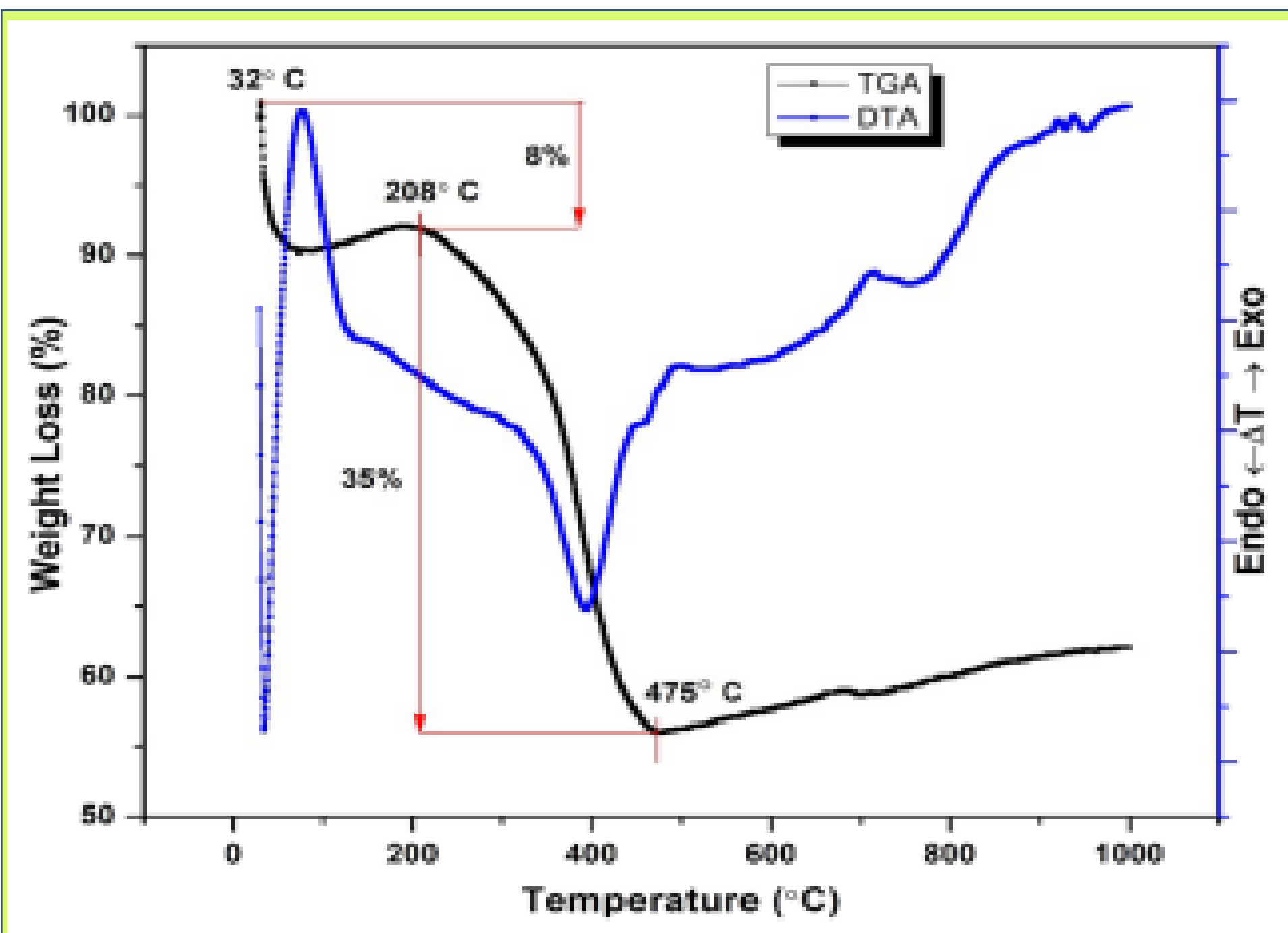
Dr. Rakesh Kumar Singh



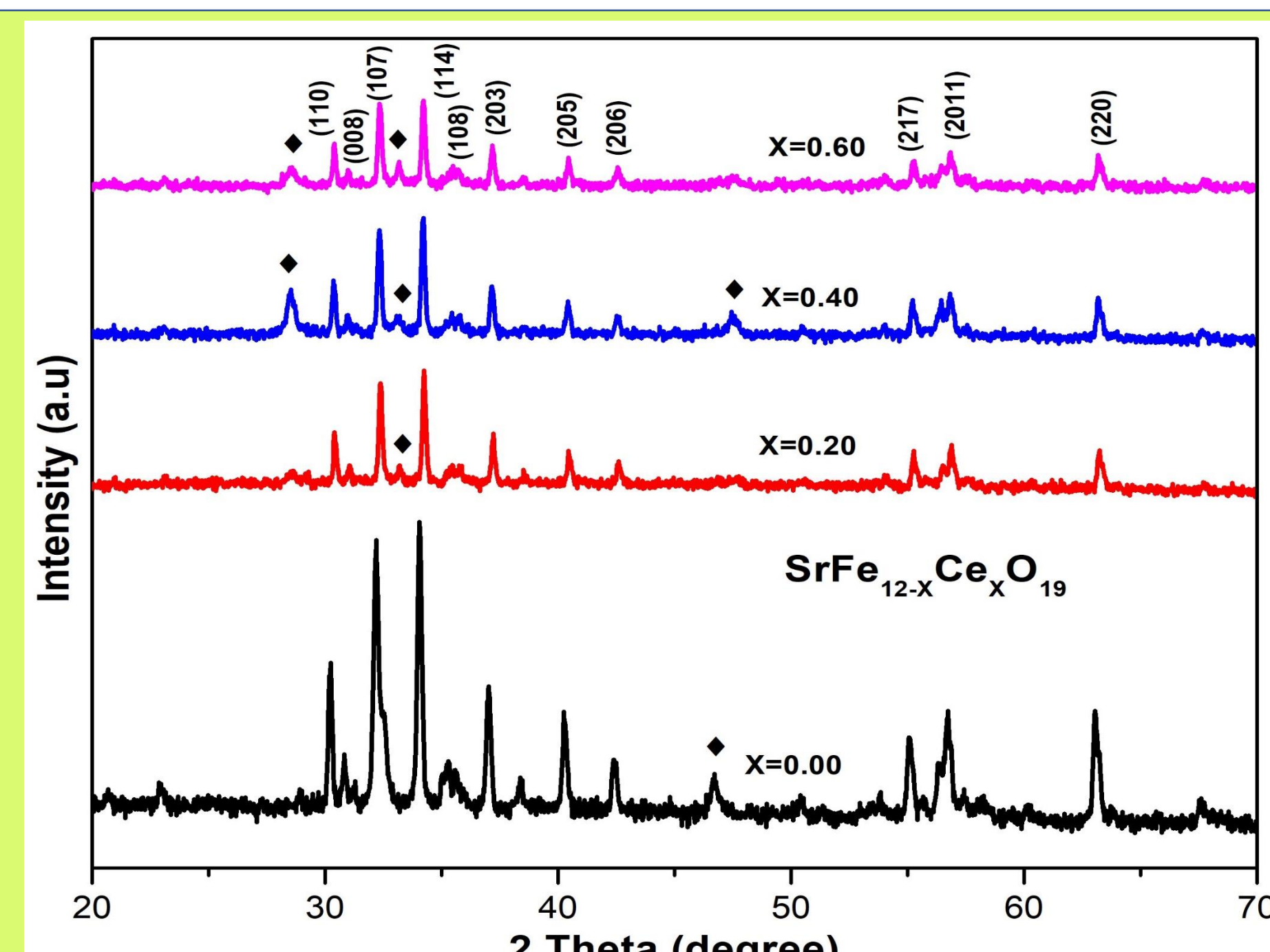
Aniket Manash



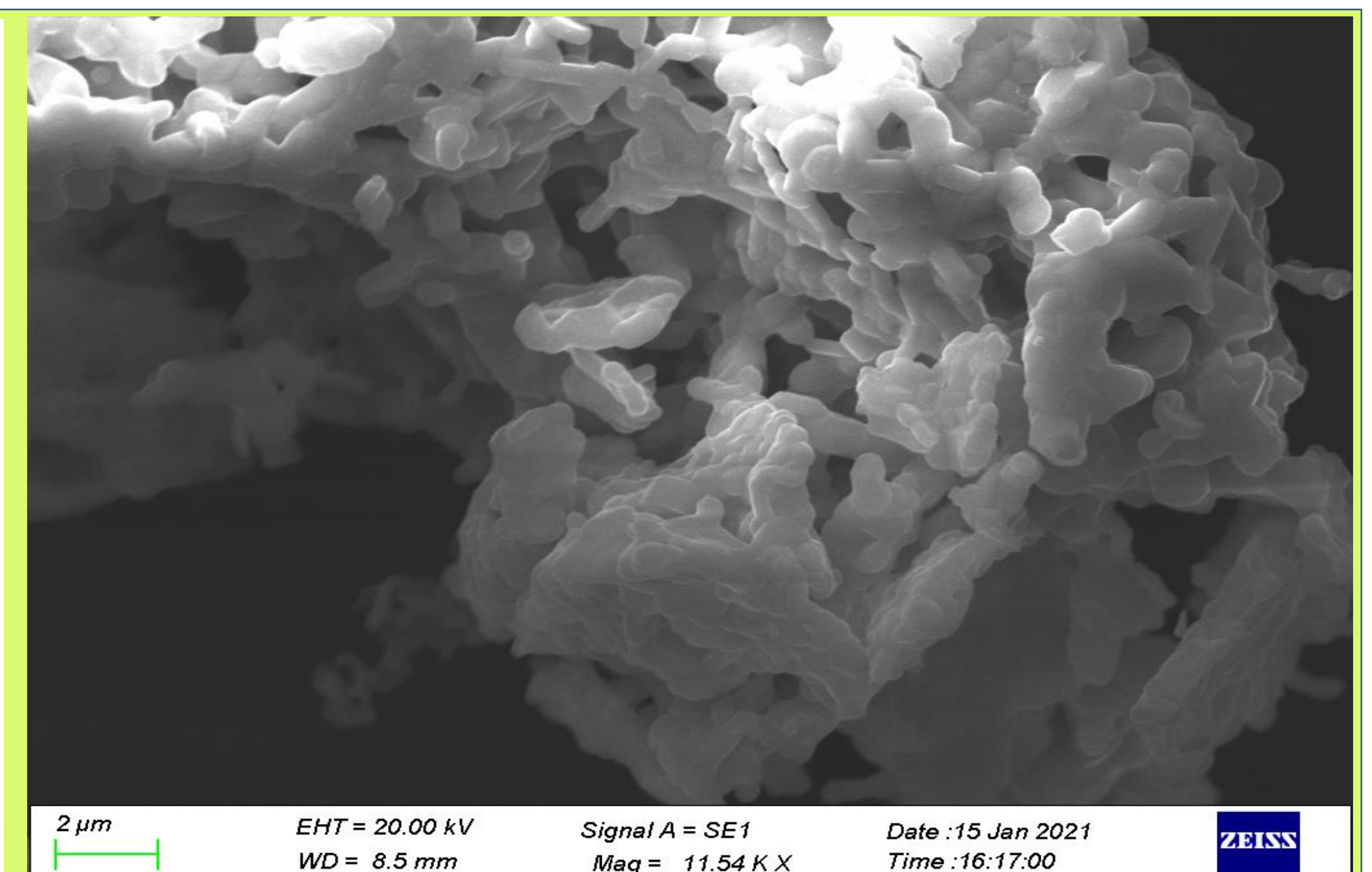
Flowchart of Preparation of Ferrite Magnetic Materials Tree in the Lab



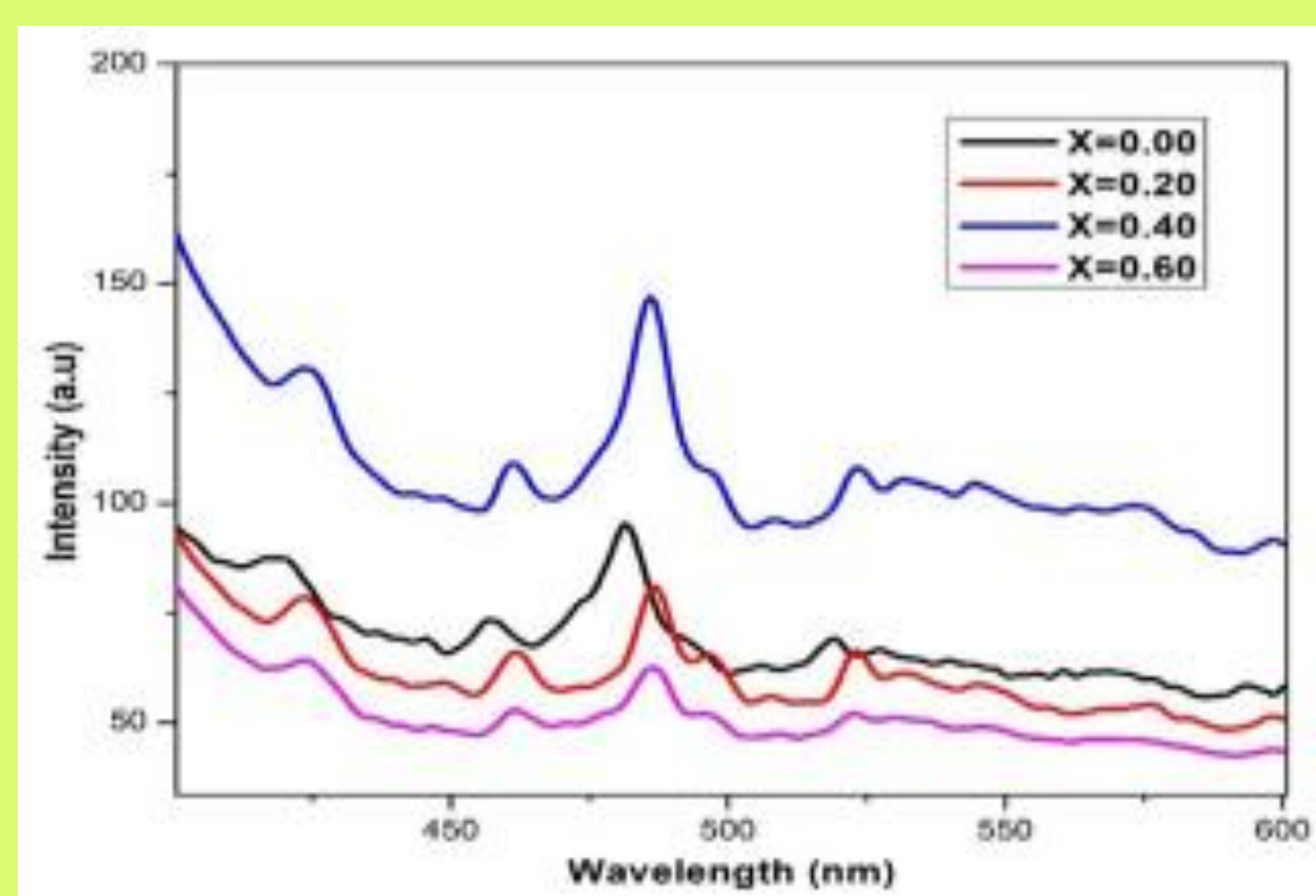
THERMAL MEASUREMENT



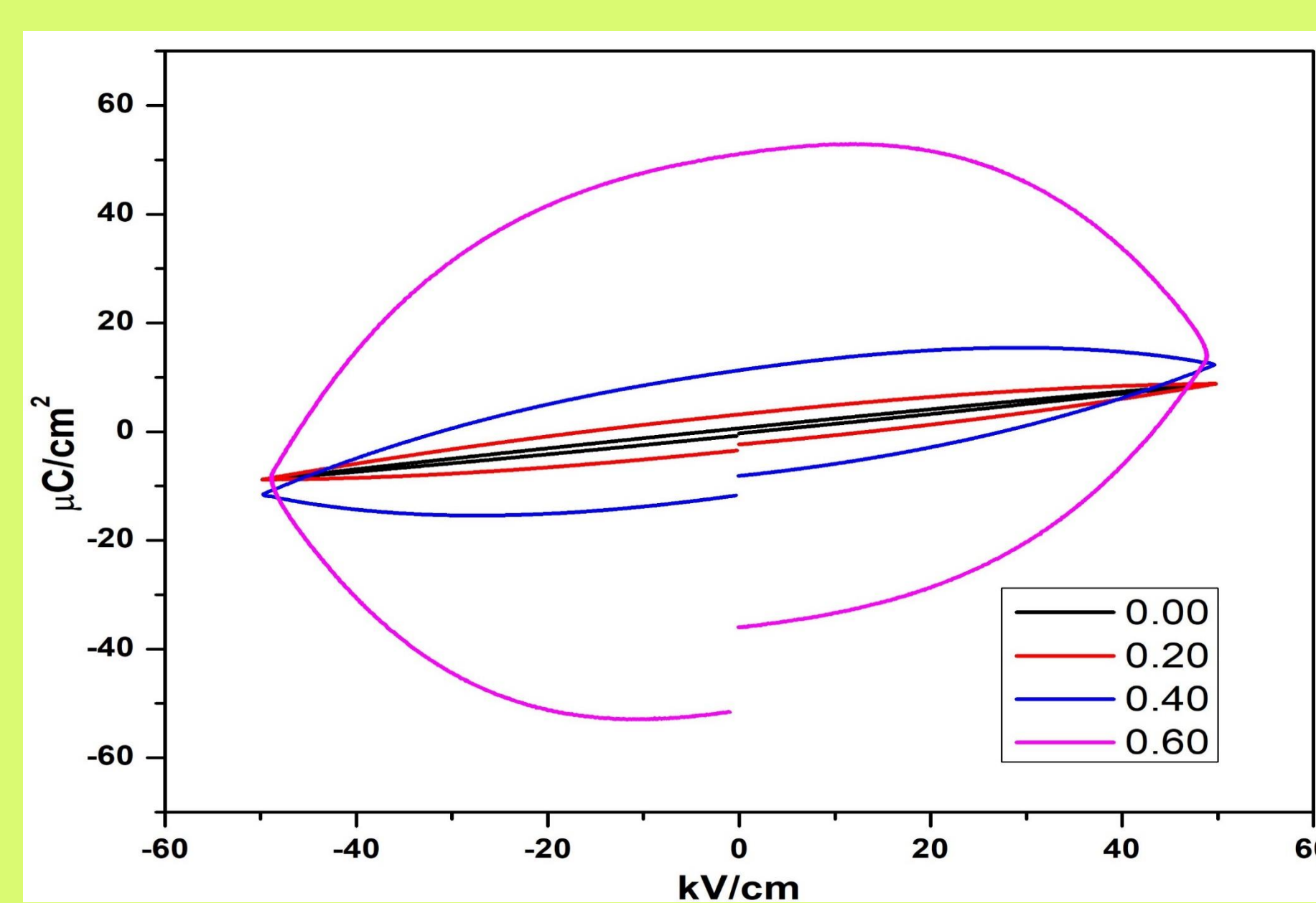
XRD MEASUREMENTS



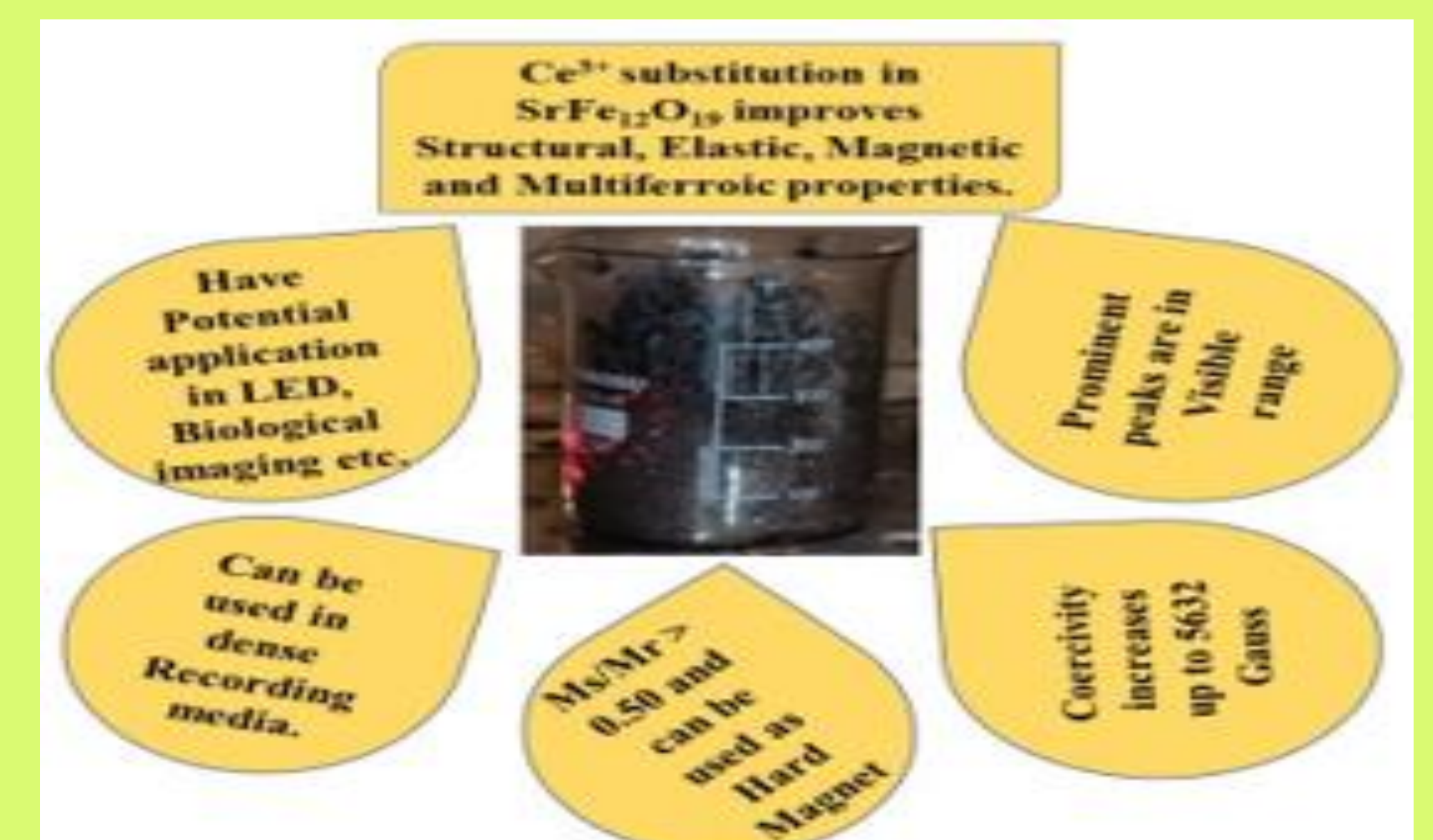
SEM MEASUREMENTS



MAGNETIC MEASUREMENTS



PE- LOOP



Potential Application

Advanced Research Technique used for Probing, Analyzing and Co-relating the Potential Application of Prepared Nanoceramic Material.

Research Highlights and Possible Applications

- Systematic decrease in crystalline size (79.64–66.02 nm) and strain value for the sample $\text{SrFe}_{12-x}\text{Ce}_x\text{O}_{19}$ is seen with increment in Ce^{3+} ($x = 0.0, 0.20, 0.40, 0.60$).
- Prominent peaks are found to be in the visible range, which is one of the features for its applications in LED, Biological imaging, etc
- The coercive value of the order 5632 Oersted indicates its application in dense recording media. The squareness ratio (M_s/M_r) is found to be >0.50 for all compositions suggesting that $\text{SrFe}_{12-x}\text{Ce}_x\text{O}_{19}$ can be used as a permanent magnet.
- Thus P-E loop measurement supports the functional properties of rare-earth substituted hexaferrite magnetic nanomaterials for its various applications in Electronics, Electrical, and Environmental applications.

Acknowledgement:- Author are thankful to Dept. of Education, Govt. of Bihar and Aryabhata Knowledge university, Patna, for frontiers research establishment, support and functioning of the Nanoscience & Nanotechnology center.

Nanotechnology in electronic industry and biomedical sector.

Studies on the structural properties and band gap engineering of Ag⁺ modified MgFe₂O₄ nanomaterials prepared by low-cost sol-gel method for multifunctional application

Published in Journal of Superconductivity & Novel magnetism

Research Team



Uday Shankar



Dr. Rakesh Kumar Singh



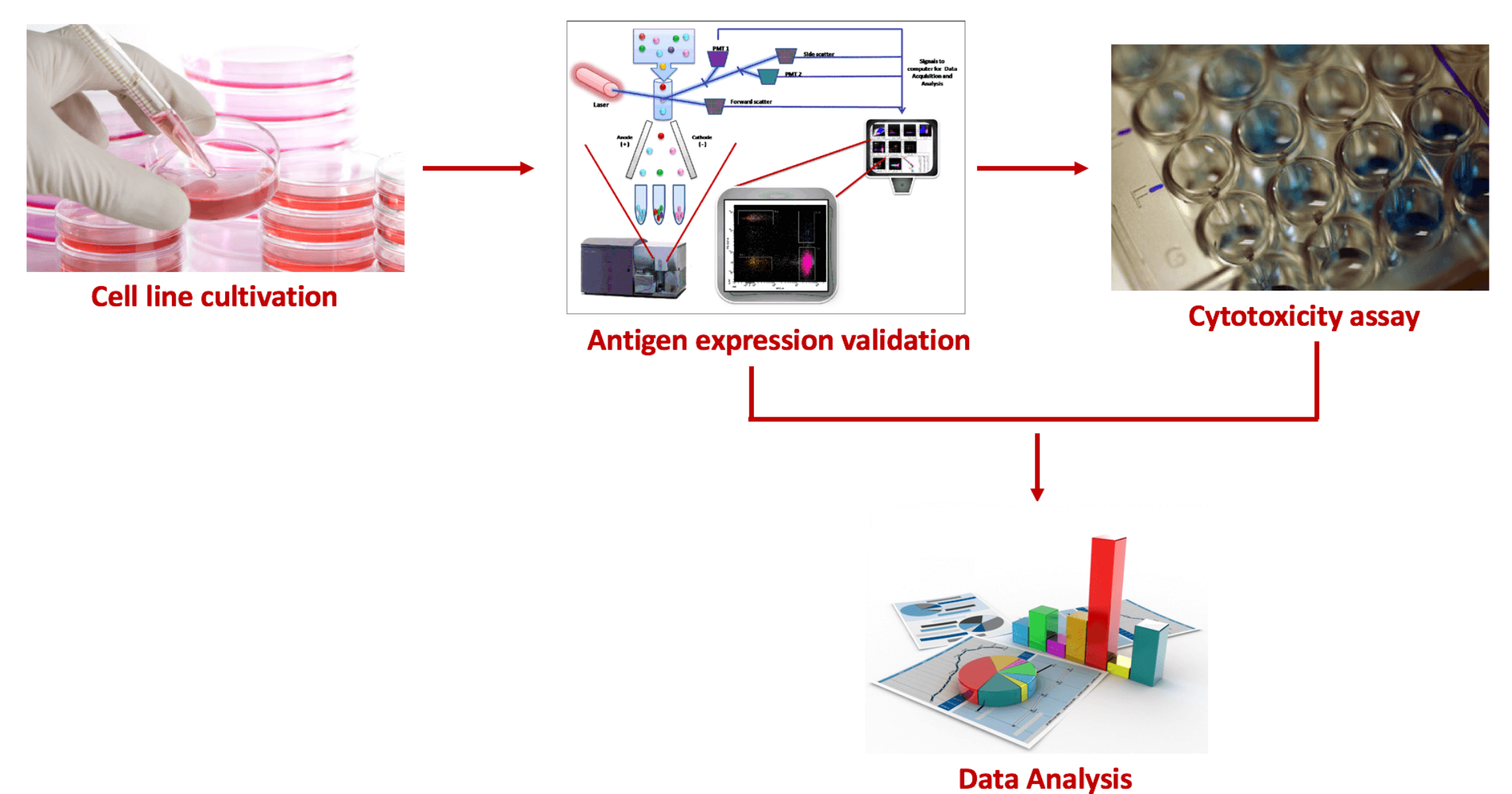
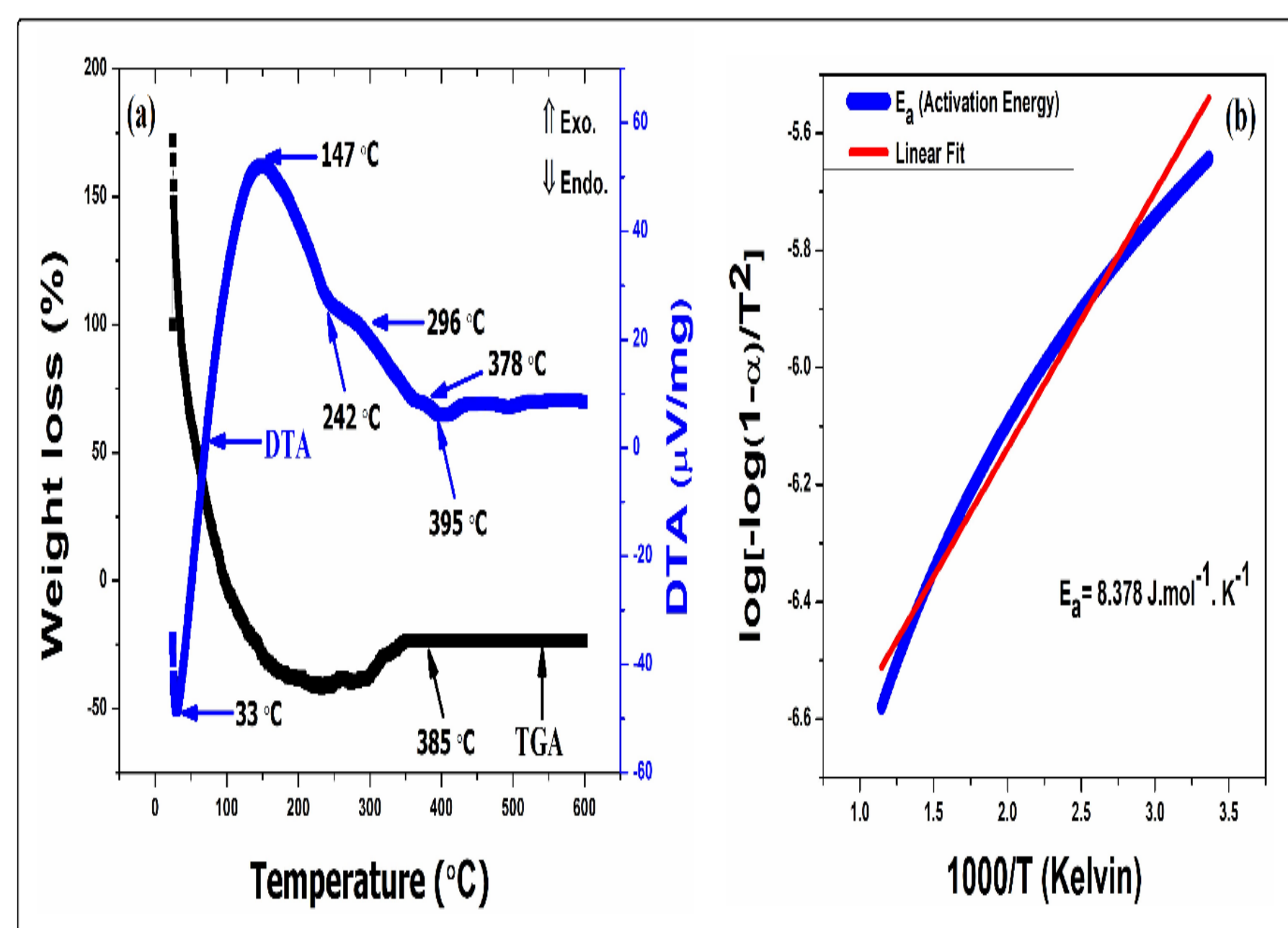
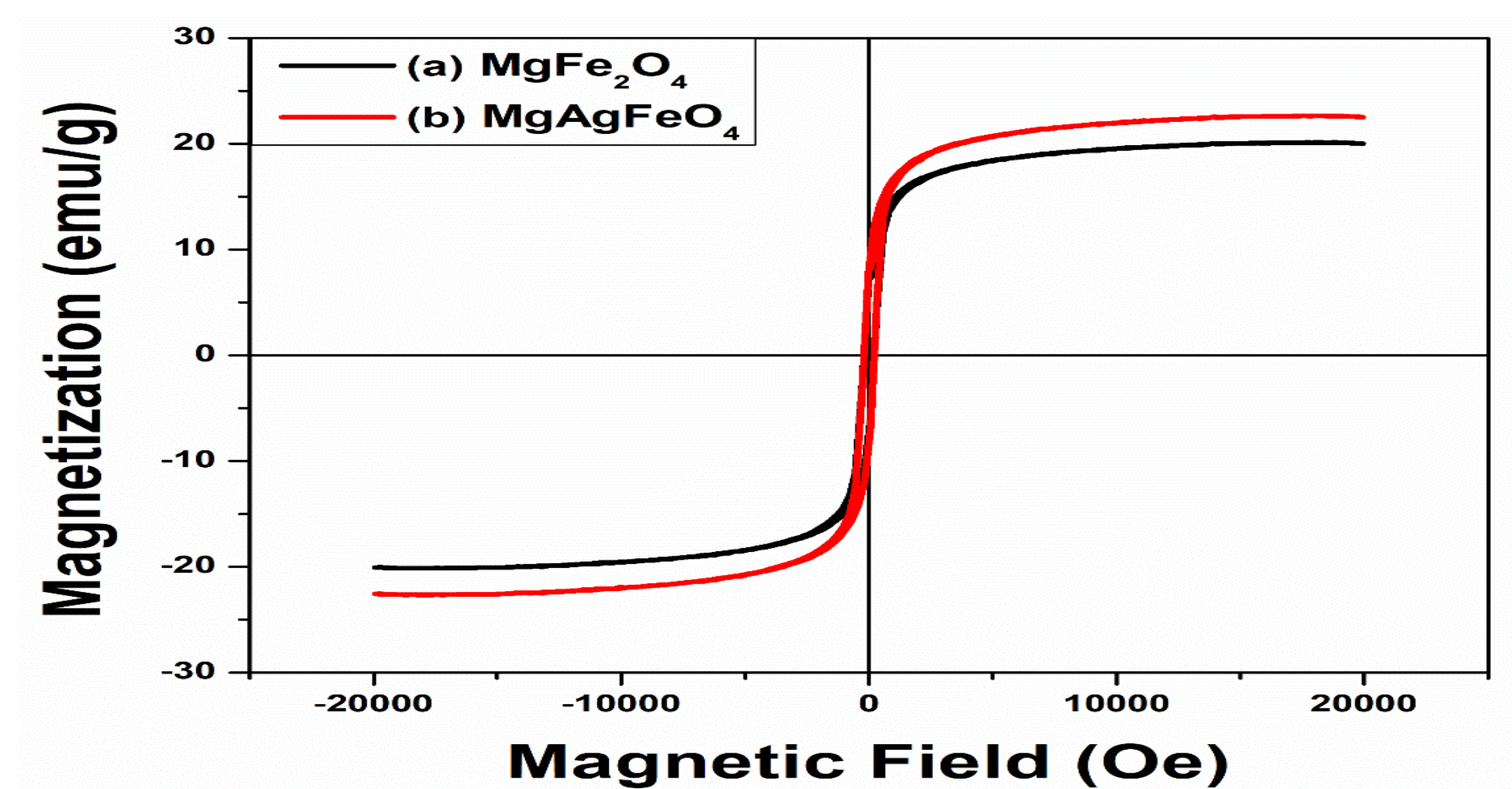
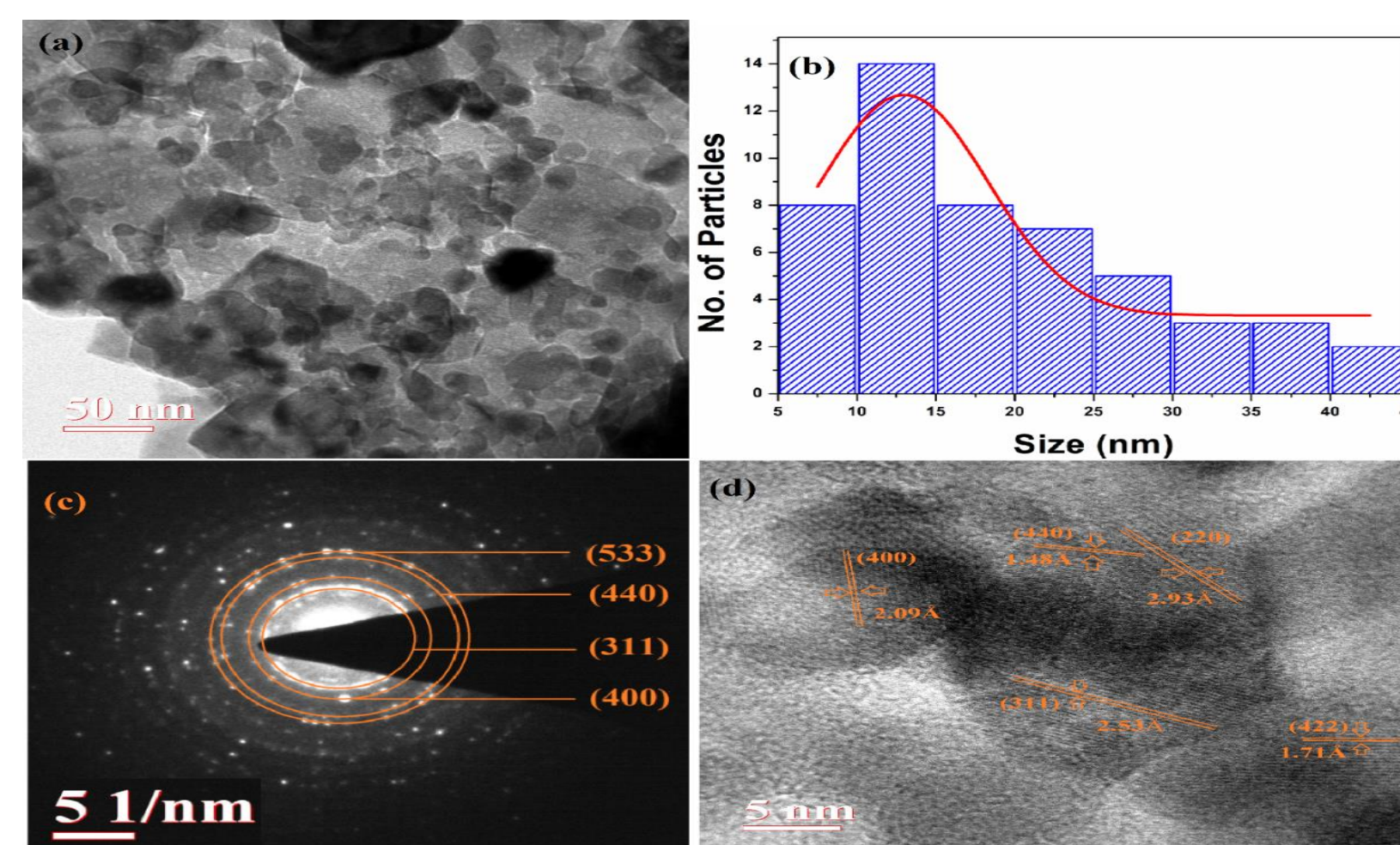
Shashank Bhushan Das



Vivek Kumar



Nishant Kumar



Research Summary:

- Ag⁺ substituted MgFe₂O₄ nanomaterials were successfully prepared by a citrate precursor method at 550°C for 2 hrs. The TG-DTA confirmed the annealing temperature beyond 400°C to get crystalline phase
- The SEM micrographs have shown porous structures in the prepared samples, which decreased with the increase in Ag⁺ content. The existence of metal oxide bonds between 423 and 571 cm⁻¹ points towards spinel phase of MgFe₂O₄ by FTIR
- The increase in Ag⁺ content has resulted in the increase of the direct and indirect band gaps of prepared materials. The average particle size was approximately measured to be 19.23 nm and 12.76 nm for MgFe₂O₄ and MgAgFeO₄, respectively by HRTEM.
- Magnetic measurements revealed that the coercivity (H_c) decreased, but saturation magnetization (M_s) and retentivity (M_r) increased with the increase in Ag⁺ content. The material thus prepared may exhibit excellent properties for its applications in antimicrobial activity, biomedicine and electronics industry.

Acknowledgements :

The authors are extremely thankful to Department of Education, Govt. of Bihar and Aryabhata Knowledge University, Patna for frontiers research establishment, support and functioning of the Nanoscience and Nanotechnology center.