

University of Mumbai



Academic Planning and
Development Section
No. APD/ICD/2019-20/762
17th March, 2020

Sub : Minor Research Grant Project 2019-20

Sir/Madam,

I am directed to inform you that the said proposal has been considered by the University and the research grant as quoted above is sanctioned to the researcher.

The sanctioned amount will be disbursed in two installments. The first installment of 40% of the sanctioned amount will be disbursed within the month of March. The remaining 60% amount will be disbursed up to 31st December, 2020.

The researcher is expected to spend 60% amount initially from his/her own resources to carry out the work.

Further, I am to inform you that the researcher will have to utilize the 40% sanctioned amount on or before 31st March, 2020 and submit original bills/vouchers of the expenditure along with Utilization Certificate duly certified by the Principal/Director/Head/Institute/University Department/College to the Accounts Section of the University.

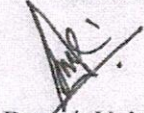
Please note that 60% balance amount, out of sanctioned grant will be released after Poster Presentation & final approval of the committee. Therefore you need to submit of utilization certificate after presentation of your research including bills/vouchers/receipts in original through University Account Section.

The report of the research work carried out by the concerned researcher will have to be submitted to the University on or before 31st December, 2020.

The Principal/Head of the Institute are requested to inform the researcher accordingly and arrange to forward his/her undertaking immediately to enable this office to release first installment of the research grant.

Yours faithfully,




Deepak V. More
Assistant Registrar
(APD Section)

568	Mrs. Prajakta P. Borgaonkar	Vidya Vikas Education Society Vikas Night College of Arts Science and Commerce	40000
569	Amitkumar Suryapratap Singh	Thakur Educational Trust's Thakur College of Science & Commerce	65000
570	Dr Gitesh G Padhye	Thakur Educational Trust's Thakur College of Science & Commerce	70000
571	Krishna Vitthal Dagadkhair	D.E. Society's Kirti M. Doongursee College of Arts Science and Commerce	50000
572	Dr. Yograj Shripad Patil	Manjara Charitable Trust's Rajiv Gandhi Institute of Technology Juhu- Versova Link Road Versova andheri W Mumbai- 400 053	50000
573	Dinesh Himatsinghani	Rishi Dayaram National College of Arts and Commerce and Wassiamul Assomul Science College	60000
574	Dr. Laxman Jathar	Rishi Dayaram National College of Arts and Commerce and Wassiamul Assomul Science College	45000
575	Namrata Ajwani	Rishi Dayaram National College of Arts and Commerce and Wassiamul Assomul Science College	45000
576	Ketankumar Gayakwad	K.J. Somaiya College of Science & Commerce	50000
577	Dr. Pradip B. Sarawade	Department of Geography	65000
578	Santosh Bhaskaran	Vivekanand Education Society's College of Arts Science and Commerce Sindhi society Chembur Mumbai - 400 071	60000
579	Dr. Laxman Shamrao Survase	Shikshan Vikas Mandal's S. H. Kelkar College of Arts Science and Commerce	60000
580	Mrs. Aparna K. Kulkarni	New Horizon Institute of Technology and Management Anand Nagar Kavesar Off. Ghodbunder Road Thane (west) - 400615	60000
581	Ashok Ramchandra Ingle	Bharatiya Vidya Bhavan's Hazarimal Somani College of Arts and Science Jayaramdas Patel College of Commerce & Management Studies	50000
582	Dr. Pratap Patil	Shikshan Prasark Mandal's Ramnarain Ruia College Matunga	40000
583	Dattaram Bajirao Rane	Br. Balasaheb Khardekar College	20000
584	Dr. Harish K. Dubey	Birla College of Arts, Sci. & Comm.	70000
585	Dr. Manasi Manoj Karkare	S.I.E.S's School of Technology	60000
586	Dr. Ajazul Haque	Viva Inst. Of Technology	20000
587	Dr. Namrata Manglani	Shah & Anchor Kutchhi Engg. Cology	25000
588	Dr. Dinesh V. Kala	G. N. Khalsa College, Matunga	50000

Microbiology (Apex Committee)

Project No.	Name of Principal Investigator	College name	Grant Sanction
589	Dr. Zarine P Bhathena	Bharatiya Vidya Bhavan's M.M. College of Arts N.M. Institute of Science and Haji Rashid Jaffer College of Commerce (Bhavan's College)	40000
590	Dr. Ashish Jain	Smt. Chandibai Himathmal Mansukhani College	40000



University of Mumbai



Research Project No: 576

NAME OF THE RESEARCHER
LECTURE IN
AMOUNT SANCTIONED
CO-INVESTIGATOR

Ketan Kumar Gajjarvad

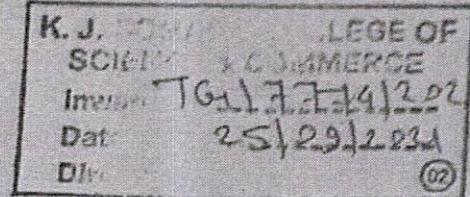
Physics

50,000/-

Ref No. AAM3/ICD/104 of 2021
23rd July, 2021

To,

L. J. Somaiya College of Science & Commerce,
Vidyanagar, Vidyavihar, Mumbai - 400 077



Sub: - Minor Research Grant Project.

Sir/Madam,

I am directed to inform you that the said proposal has been considered by the University and the research grant as quoted above is sanctioned to the researcher.

The sanctioned amount will be disbursed in two installments. The first installment of 70% of the sanctioned amount will be disbursed within the month of August. The remaining 30% amount will be disbursed up to 31st December, 2021.

The researcher is expected to spend 30% amount initially from his/her own resources to carry out the work.

Further, I am to inform you that the researcher will have to utilize the 100% sanctioned amount on or before 31st December, 2021 and submit original bills/vouchers of the expenditure alongwith Utilization Certificate duly certified by the Principal/ Director/ Head/Institute/University Department of the College to The Deputy Registrar, Accounts Section, Mahatma Phule Bhavan, Vidyanagari, Kalina Campus, University of Mumbai, Mumbai - 400 098.



The report of the research work carried out by the concerned researcher will have to be submitted to the University on or before 31st December, 2021.

The Principal/Head of the Institute are requested to inform the researcher accordingly and arrange to forward his/her undertaking immediately to enable this office to release first installment of the research grant.



Yours faithfully,

Assistant Registrar
(Academic Planning & Development Section)

 Estd. 1962 "A++" Accredited by NAAC(2021) With CGPA 3.52	SHIVAJI UNIVERSITY, KOLHAPUR - 416 004, MAHARASHTRA PHONE : EPABX - 2609000 PGBUTR- 0231 2609296/9139, www.unishivaji.ac.in, pgbutr@unishivaji.ac.in शिवाजी विद्यापीठ, कोल्हापूर - ४१६ ००४, महाराष्ट्र दूरध्वनी - इंटीएबीएस - २६०९००० दूरध्वनी पी. जी. बी. यु. टी. आर. - ०२३१ २६०९२९६/९१३९, www.unishivaji.ac.in, pgbutr@unishivaji.ac.in	
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Ref. No. SU/PG-BUTR/Ph.D./O.D./323

4542

Date : 27 OCT 2023

To,
 Shri. Gayakvad Ketankumar Rameshbhai,
 At. Malwadi, Post. Majgaon,
 Tal. Panhala, Dist. Kolhapur

Sub : About re-registration for Ph.D.

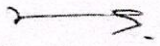
Ref : S.U./P.G.B.U.T.R./Ph.D./9421 dt. 27/08/2018

Sir/Madam,

With reference to above mentioned, I am directed to inform you that the University authorities have permitted you to continue your Ph.D. research Physics from 01/07/2023 subject to following conditions:

- 1) Regular payment of fees Rs. 11160/- per year.
- 2) Submission of biannual i.e. six monthly progress report of research work as per R.Ph.D. 10.
- 3) Submission of thesis within Two years from the date of re-registration.
- 4) Candidate is permitted to submit his/her thesis within this extended period otherwise his/her registration will automatically stand cancelled.
- 5) Other terms & Conditions mentioned in earlier letter refereed here above shall remain the same.

Yours faithfully,


 Dy. Registrar

Copy to :

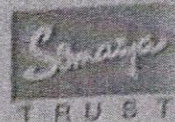
1. The Head,
 Department of Physics,
 Shivaji University,
 Kolhapur.
- ✓ 2. Dr. K. K. Patankar (Guide),
 F-401, Vasant Utkarsh, Near SBI,
 Rajarampuri 7th Lane, Kolhapur. 416008





SOMAIYA
VIDYAVIHAR

K J Somaia College of Science & Commerce



9217614298/2021

Date: 31/12/2021

UTILIZATION CERTIFICATE

It is certified that the amount of Rs. 50,000/- (Rupees Thirty-five thousand only) sanctioned to Mr. Ketankumar Gayakvad, Assistant Professor in Physics, K. J. Somaia College of Science and Commerce(Autonomous), Vidyavihar(East), Mumbai.400077, towards financial assistance to carry out research work, by the University of Mumbai vide Research Project number 576 (Reference number AAMS/ICD/106 of 2021).

Rs. 50,000/- (Rupees Thirty-five thousand only) has been utilized for the purpose for which it was sanctioned and in accordance with the terms and conditions laid down by the University of Mumbai.

Sr.No.	Particulars	Amount
1.	Amount Spent up to 31/08/21 (As per statement-1)	35,257.76/-
2.	Amount Spent up from 01/09/21 to 31/12/21 (As per statement-2)	15,121.00/-
3.	Total Amount Spent	50,378.76/-



Seal of the college

M/s. Manisha Dangle & Associates



Proprietor
CA Manisha Dangle

14/01/2022

Principal
Principal



K J Somaia College of Science & Commerce

Autonomous (Affiliated to University of Mumbai) | Re-accredited "A" Grade by NAAC

ISO 9001 : 2015 Certified | College with Potential for Excellence - UGC

Somaia Vidyavihar, Vidyavihar (E), Mumbai - 400 077, India

P: (91-22) 21020615

E: principal.kjssc@somaia.edu | W: kjssc.somaia.edu.in/en

1. Name of the Principal Investigator: Mr. Ketankumar Gayakvad
2. Dept./Institution/College Name: Department of Physics,
K.J.Somaiya College of Science & Commerce,
Mumbai. 400077.
3. College Address of Principal Investigator: Department of Physics,
K.J.Somaiya College of Science and Commerce,
Vidyavihar(East),
Mumbai. 400077.
4. Designation of Principal Investigator: Assistant Professor
5. Email of Principal Investigator: ketankumar@somaiya.edu
6. Mobile Number: 9766944708
7. Faculty: Science and Technology
8. Subject: Physics
9. Name of the Co-Investigator: Dr. K. K. Patankar,
Associate Professor,
Department of Physics,
Rajaram College,
Kolhapur.400012.
10. Title of the Project:
"Synthesis and characterization of spinel ferrite materials to study their resistive switching performances for RRAM."
11. Sanctioned Amount for the Project: 50,000/-

Signature of the Principal Investigator:

Murli K. Patankar

Signature of the Co-Principal Investigator:

Signature of Principal
College Seal



Project Title: “Synthesis and characterization of spinel ferrite materials to study their resistive switching performances for RRAM.”

Name of the Principal Investigator: Mr. Ketankumar Gayakvad

Designation: Assistant Professor of Physics,

Name of the Institute: K.J. Somaiya College of Science and Commerce,
Mumbai. 400077.

Project Number: 576

Introduction:

Resistive Random Access Memory(RRAM) can be employed for data storage, Neuromorphic and Logic Applications[1][2]. RRAM shows remarkable advantages over other competent memory devices due to its good compatibility with CMOS, low power requirement, non-destructive read out, high endurance, excellent resistive switching, good retention and high operational speed[3][4][5][6].

In general, structure of RRAM is as shown in following figure[7].

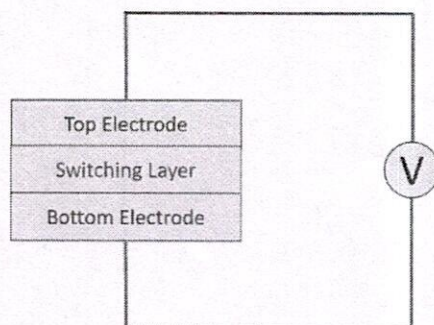


Figure.1 MIM configuration

Spinel ferrites are well known for their memory applications[8][9]. It is because of the unique property of magnetic hysteresis and I-V characteristics[10][11]. With the advent of technology, the size of the equipment is getting reduced. Hence, miniaturization in memory devices is also required. In this Minor Research Project, we have synthesized spinel ferrite materials for resistive switching performances.

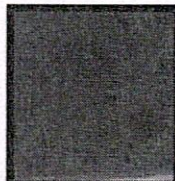

Experimental Details:

We have synthesized Cobalt Ferrite thin films using Solgel Assisted Spin Coating Technique. Cobalt Acetate and Ferric Nitrate were used as precursors solutes whereas 2-methoxy ethanol was employed as solvent. Proper quantity of solutes was added into 2-methoxy ethanol so as Fe:Co ratio will be 2:1. Then the obtained solution was kept for reflux. After refluxing for particular time, the obtained sol has been used for spin coating of Cobalt Ferrite thin films of various concentrations.




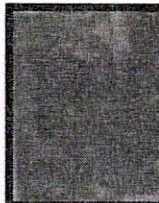
Cobalt ferrite thin films of 0.1 M and 0.2 M metal ions are as shown in table 1.

Table:1 Spin coated cobalt ferrite thin films.

Sr.No.	Concentration	Number of coats	Annealed at 500 °C for 7 hours.
1.	0.10 M	20	
2.	0.20 M	20	

We found that, the thin film of 0.1 M concentration is having better uniformity as compared to that of 0.2 M concentration. Additionally, we have fabricated cobalt ferrite thin films of 0.15 M and 0.25 M.

Table: 2. Spin coated cobalt ferrite thin films.

Sr.No.	Concentration	Number of coats	Annealed at 500 °C for 7 hours.
1.	0.15 M	15	
2.	0.25 M	15	



As-deposited thin film of cobalt ferrite for 0.25 M with 15 coats and 0.20 M with 20 coats is shown in the following figure 2.

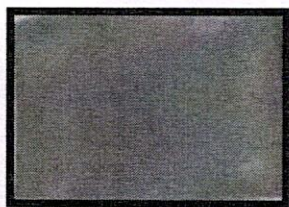


Figure 2a 0.20 M

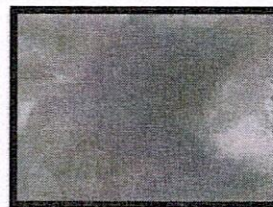


Figure 2b 0.25 M

Cobalt ferrite thin film of 0.10 M metal ion concentration with 15 coats as deposited and annealed at 500 °C are as shown in the following figures.

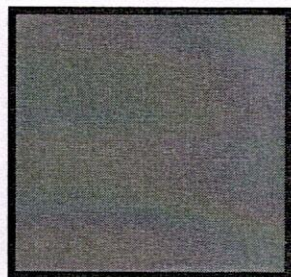


Figure 3a 0.10 M at RT

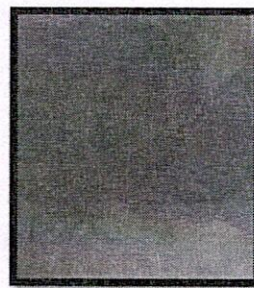


Figure 3b 0.10 M annealed at 500 °C

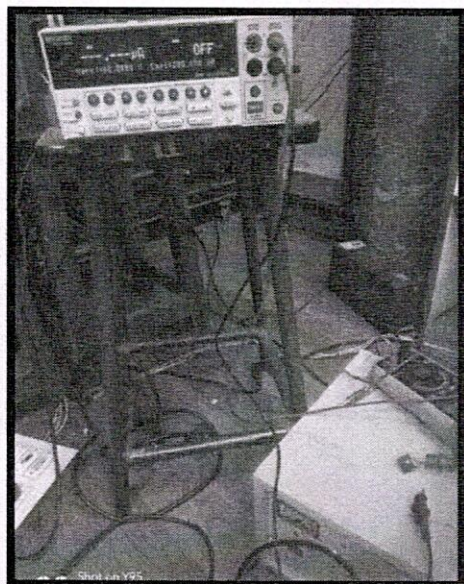


Figure 4a I-V Set Up

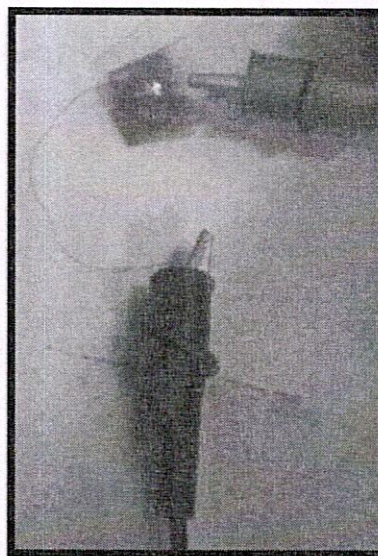


Figure 4b RS device



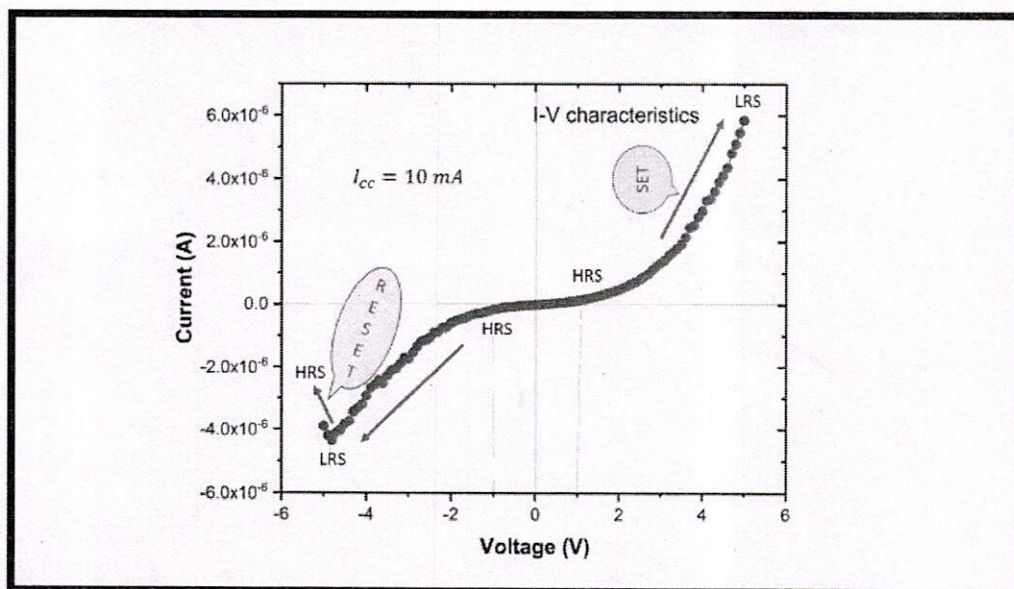


Figure 4c. I-V characteristics of Ag/CFO/FTO resistive switching device.

Conclusions:

1. Solgel assisted spin coated thin film of cobalt ferrite with metal ion concentration of 0.1 M, number of coats 15 and annealed at 500 °C shows Unipolar Resistive Switching for the compliance current of 10 mA. Thus, Cobalt Ferrite can be used as an active material in RRAM device.
2. Among various metal ion concentrations, we found good quality cobalt ferrite thin film for 0.1 M metal ion concentration.

Publication:

K. Gayakvad, K.K. Patankar, Cobalt ferrite as an active material for resistive random-access memory, Pramana. 95 (2021) 172. <https://doi.org/10.1007/s12043-021-02211-z>.



References:

- [1] A. Hao, M. Ismail, S. He, W. Huang, N. Qin, D. Bao, Coexistence of unipolar and bipolar resistive switching behaviors in NiFe₂O₄ thin film devices by doping Ag nanoparticles, *Journal of Applied Physics*. 123 (2018) 085108. <https://doi.org/10.1063/1.5018808>.
- [2] S. Munjal, N. Khare, Valence Change Bipolar Resistive Switching Accompanied With Magnetization Switching in CoFe₂O₄ Thin Film, *Scientific Reports*. 7 (2017) 12427. <https://doi.org/10.1038/s41598-017-12579-x>.
- [3] W. Hu, N. Qin, G. Wu, Y. Lin, S. Li, D. Bao, Opportunity of Spinel Ferrite Materials in Nonvolatile Memory Device Applications Based on Their Resistive Switching Performances, *Journal of the American Chemical Society*. 134 (2012) 14658–14661. <https://doi.org/10.1021/ja305681n>.
- [4] S. Munjal, N. Khare, Compliance current controlled volatile and nonvolatile memory in Ag/CoFe₂O₄/Pt resistive switching device, *Nanotechnology*. 32 (2021) 185204. <https://doi.org/10.1088/1361-6528/abdd5f>.
- [5] K. Gayakwad, K.K. Patankar, Cobalt ferrite as an active material for resistive random-access memory, *Pramana*. 95 (2021) 172. <https://doi.org/10.1007/s12043-021-02211-z>.
- [6] W. Hu, X. Chen, G. Wu, Y. Lin, N. Qin, D. Bao, Bipolar and tri-state unipolar resistive switching behaviors in Ag/ZnFe₂O₄/Pt memory devices, *Applied Physics Letters*. 101 (2012) 063501. <https://doi.org/10.1063/1.4744950>.
- [7] W. Hu, L. Zou, R. Chen, W. Xie, X. Chen, N. Qin, S. Li, G. Yang, D. Bao, Resistive switching properties and physical mechanism of cobalt ferrite thin films, *Applied Physics Letters*. 104 (2014) 143502. <https://doi.org/10.1063/1.4870627>.
- [8] B. Sun, X. Zhang, G. Zhou, C. Zhang, P. Li, Y. Xia, Y. Zhao, Effect of Cu ions assisted conductive filament on resistive switching memory behaviors in ZnFe₂O₄-based devices, *Journal of Alloys and Compounds*. 694 (2017) 464–470. <https://doi.org/10.1016/j.jallcom.2016.10.008>.
- [9] M. Mustaqima, P. Yoo, W. Huang, B.W. Lee, C. Liu, Regulation of the forming process and the set voltage distribution of unipolar resistance switching in spin-coated CoFe₂O₄ thin films, *Nanoscale Research Letters*. 10 (2015) 168. <https://doi.org/10.1186/s11671-015-0876-5>.
- [10] C. Jin, E.Y. Jiang, H.L. Bai, Resistive hysteresis and capacitance effect in NiFe₂O₄/SrTiO₃:Nb(1wt%) junctions, *Applied Surface Science*. 257 (2011) 8998–9001. <https://doi.org/10.1016/j.apsusc.2011.05.080>.
- [11] T.D. Dongale, A.A. Bagade, S. V. Mohite, A.D. Rananavare, M.K. Orlowski, R.K. Kamat, K.Y. Rajpure, Bipolar resistive switching with coexistence of mem-elements in the spray deposited CoFe₂O₄ thin film, *Journal of Materials Science: Materials in Electronics*. 29 (2018) 3231–3238. <https://doi.org/10.1007/s10854-017-8258-7>.



PRINCIPAL
 Government of Maharashtra's
 Ismail Yusuf College of
 Arts, Science & Commerce,
 Jogeshwari (East), Mumbai - 400 060