Key Indicator 3.1 – Resource Mobilization for Research

3.1.1.1: Total Grants from Government and non-governmental for research projects, endowments in the institution during the year (INR in Lakhs)

Academic Year 2017-18 to 2021-22

Academic Year	2021-22	2020-21	2019-20	2018-19	2017-18
Total Grants	37.08	Nil	1.35	1.35	Nil

Krishna Mahavidyalaya Shivnagar 415108 Rethare Bk.

Principal
Krishna Mahavidyalaya, Rethare Bk.
Tal. Karad : 415 108 (M.S)

Year 2021-22

Name of the Research Project/ Endowments	Name of the Principal Investigator /Co-investigator	Department of Principal Investigator	Year of Award	Amount Sanctioned (in Lakh)	Duration of the project	Name of the Funding Agency	Type (Government /non-Government)
Fabrication of Ternary nanocomposite electrodes based on CO3O4-rGO-Conducting Polymer for high performance energy storage application (File No. EEO/2021/000984)	Dr. D. S. Dalavi	Physics	2022	36.98	3 Years	Department of Science and Technology, Science and Engineering Research Board (SERB) under Empowerment and equity opportunities for excellence in Science	Government
Synthesis and Characterization of Co_3O_4 thin film by hydrothermal route for supercapacitor application	Dr. D. S. Dalavi	Physics	2022	0.1	1 year	Shivaji University Minor Research Project under lead college activity	Government
			Total	**37.08**			

ECG /2021/000984

The updated RTGS details of the KRISHNA MAHAVIDYALAYA, RETHARE (BK) , Julewadi, Satara, Maharashtra-415302 is as below:

PFMS Unique Code	MHST00012031
Account Name	**PRINCIPAL, KRISHNA MAHAVIDYALAYA, SERB GRANT**
Account Number	**60410861354**
Bank Name & Branch	Bank of Maharashtra Anu Sonai Complex, At Post. Shenoli, Tal. Karad, Dist. Satara.
IFSC/RTGS Code	MAHB0000562
Email id of A/C Holder	kmr_sspm@yahoo.co.in

T. Thangaraju

डॉ. टी. थंगाराजू
वैज्ञानिक 'एफ'

FILE NO. EEQ/2021/000984

SCIENCE & ENGINEERING RESEARCH BOARD(SERB)

(A statutory body of the Department of Science & Technology, Government of India)

5Science and Engineering Research Board
3rd & 4th Floor, Block II
Technology Bhavan, New Mehrauli Road
New Delhi - 110016

Dated: 10 March, 2022

ORDER

Subject: Financial Sanction of the research project titled **Fabrication of Ternary nanocomposite electrodes based on CO_3O_4-rGO-Conducting Polymer for high performance energy storage application** under the guidance of Dr. Dhanaji Suresh Dalavi, PHYSICS, KRISHNA MAHAVIDYALAYA, RETHARE (BK) , Julewadi, Satara, Maharashtra-415302 - Release of 1st grant.

Sanction of **Science and Engineering Research Board (SERB)** is hereby accorded to the above mentioned project at a total cost of **Rs. 3698332/- (Rs.** Thirty Six Lakh Ninety Eight Thousand Three Hundred and Thirty Two **Only)** with break-up of **Rs. *1620000*/- under Capital (Non-recurring) head** and **Rs.*2078332*/- under General (Recurring) head** for a duration of 36 months. The items of expenditure for which the total allocation of **Rs. 3698332/-** has been approved are given below:

The following budget may be considered for **KRISHNA MAHAVIDYALAYA, RETHARE (BK), Julewadi**

S. No	Head	Total (in Rs.)
A	**Non-recurring**	
1	Equipment -> Electrochemical Workstation	1620000
A'	*Total (Non-Recurring)*	***1620000***
B	**Recurring Items**	
1	Recurring - I : (Manpower) Recurring - II : (Consumables, Travel, Contingencies) Recurring - III : Scientific Social Responsibility	1257120 450000 35000
2	Recurring - IV : (Overhead Charges)	336212
B'	*Total (Recurring)*	***2078332***
C	**Total cost of the project (A' + B')**	**3698332**

2. Sanction of the grant is subject to the conditions as detailed in Terms & Conditions available at website (www.serb.gov.in).

3. The expenditure involved is debitable to **Fund for Science & Engineering Research (FSER)**
This release is being made under Empowerment and Equity Opportunities for Excellence in Science. (Task force Committee) (SC)

4. Overhead expenses are meant for the host Institute towards the cost for providing infrastructural facilities and general administrative support etc. including benefits to the staff employed in the project.

5. While providing operational flexibility among various subheads under head Recurring-II, it should be ensured that not more than Rs. 1.5 lakh each should be spent for travel and contingency.

6. Budget sanctioned under Scientific Social Responsibility (SSR) is meant only for activites enlisted under SSR norms and under no circumstances it can be reappropriated.

7. As per rule 211 of GFR, the accounts of project shall be open to inspection by sanctioning authority/audit whenever the institute is called upon to do so.

8. The sanctioned equipment would be procured as per GFR and its disposal of the same would be done with prior approval of SERB.

9.The institute will furnish to the SERB, separate Utilization certificate(UCs) financial year wise to the SERB for Recurring (Grants-in-aid General) & Non-Recurring (Grants for creation of capital assets) and an audited statement of accounts pertaining to the grant immediately after the end of each financial year.

10. The institute will maintain separate audited accounts for the project. A part or whole of the grant must be kept in an interest earning bank account which is to be reported to SERB. The interest thus earned will be treated as credit to the institute to be adjusted towards further installment of the grant.

11. The manpower sanctioned in the project, if any is co-terminus with the duration of the project and SERB will have no liability to meet the fellowship and salary of supporting staff if any. beyond the duration of the project

12. The institute may refund any unspent balance to SERB by means of a Demand Draft favoring "FUND FOR SCIENCE AND ENGINEERING RESEARCH" payable at New Delhi.

13. The project File no. EEQ/2021/000984 should be mentioned in all communications arising from the above project. The organization/institute/university should ensure that the technical support/financial assistance provided to them by SERB should invariably be highlighted/ acknowledged in their media releases as well as in bold letters in the opening paragraphs of their Annual Report.

14. In addition, the investigator/host institute must also acknowledge the support provided to them in all publications, patents and any other output emanating out of the project/program funded by SERB.

15. Sanction order for release of funds under a) Non-recurring and b) Recurring will be issued separately depending on the availability of funds. The project become operational from the day the first release of grant received by the implementing Institute.

(Dr. Thangaradjou T)
Scientist F
msls@serb.gov.in

To,
Under Secretary
SERB, New Delhi
Copy forwarded for information and necessary action to: -

1.	The Principal Director of Audit, A.G.C.R.Building, IIIrd Floor I.P. Estate, Delhi-110002
2.	Sanction Folder, SERB , New Delhi.
3.	File Copy
4.	**Dr. Dhanaji Suresh Dalavi** **PHYSICS** **KRISHNA MAHAVIDYALAYA, RETHARE (BK) , Julewadi, Satara, Maharashtra-415302** **Email: dhanuphysics@gmail.com** **Mobile: 919527350402** (Start date of the project may be intimated by name to the undersigned. For guidance, terms & Conditions etc. Please visit www.serb.gov.in.)
5.	**Principal,** **KRISHNA MAHAVIDYALAYA, RETHARE (BK), Julewadi** (Receipt of Grant may be intimated by name to the undersigned)

(Dr. Thangaradjou T)
Scientist F
msls@serb.gov.in

FILE NO. EEQ/2021/000984-G

SCIENCE & ENGINEERING RESEARCH BOARD(SERB)

(a statutory body of the Department of Science & Technology, government of India)

Science and Engineering Research Board
3rd & 4th Floor, Block II
Technology Bhavan, New Mehrauli Road
New Delhi - 110016

Dated: 10 March, 2022

ORDER

Subject: Research project entitled **Fabrication of Ternary nanocomposite electrodes based on CO_3O_4-rGO-Conducting Polymer for high performance energy storage application** under the guidance of Dr. Dhanaji Suresh Dalavi, PHYSICS, KRISHNA MAHAVIDYALAYA, RETHARE (BK) , Julewadi, Satara, Maharashtra-415302.

1. In continuation of SERB's sanction order No. EEQ/2021/000984 dated 10 March, 2022, sanction of the competent authority is hereby accorded to the payment of a sum of **Rs.*2078332/-*** under 'Grants-in-aid General' to KRISHNA MAHAVIDYALAYA, RETHARE (BK) , Julewadi, Satara, Maharashtra-415302 being the grant for the financial year 2021-2022 for implementation of the above said project.

2. Sanction of the grant is subject to the conditions as detailed in Terms & Conditions available at the website (www.serb.gov.in) and as mentioned in the sanction order of even number dated 10 March, 2022.

3. As this is the first grant being released under 'Grants-in-aid General' for the project, no previous U/C is required.

4. The expenditure involved is debitable to Fund for Science & Engineering Research (FSER) This release is being made under **Empowerment and Equity Opportunities for Excellence in Science. (Task force Committee) (SC).**

5. The Sanction has been issued with the approval of the competent authority on **09 March, 2022** and vide Diary No. **SERB/F/9856/2021-2022** dated **09 March, 2022**..

6. The release amount of **Rs. 698800/-** (Rupees Six Lakh Ninety Eight Thousand Eight Hundred only) will be drawn by the Under Secretary of the SERB and will be disbursed by means of RTGS transaction as per their Bank details given below:

PFMS Unique Code	MHST00012031
Account Name	Principal Krishna Mahavidyalaya UGC A/C
Account Number	20240700009
Bank Name & Branch	Bank of Maharashtra Anu Sonai Complex, At Post. Shenoli, Tal. Karad, Dist. Satara.
IFSC/RTGS Code	MAHB0000562
Email id of A/C Holder	kmr_sspm@yahoo.co.in
Email id of PI	dhanuphysics@gmail.com

(Dr. Thangaradjou T)
Scientist F
msls@serb.gov.in

To,
Under Secretary
SERB, New Delhi
Copy forwarded for information and necessary action to: -

1.	The Principal Director of Audit, A.G.C.R.Building, IIIrd Floor I.P. Estate, Delhi-110002
2.	Sanction Folder, SERB , New Delhi.
3.	File Copy
4.	**Dr. Dhanaji Suresh Dalavi** **PHYSICS** **KRISHNA MAHAVIDYALAYA, RETHARE (BK) , Julewadi, Satara, Maharashtra-415302** **Email: dhanuphysics@gmail.com** **Mobile: 919527350402** (Start date of the project may be intimated by name to the undersigned. For guidance, terms & Conditions etc. Please visit www.serb.gov.in.)
5.	**Principal,** **KRISHNA MAHAVIDYALAYA, RETHARE (BK), Julewadi** (Receipt of Grant may be intimated by name to the undersigned)

(Dr. Thangaradjou T)
Scientist F
msls@serb.gov.in

EEQ/2021/000984

The updated RTGS details of the KRISHNA MAHAVIDYALAYA, RETHARE (BK) , Julewadi, Satara, Maharashtra-415302 is as below:

PFMS Unique Code	MHST00012031
Account Name	**PRINCIPAL, KRISHNA MAHAVIDYALAYA, SERB GRANT**
Account Number	**60410861354**
Bank Name & Branch	Bank of Maharashtra Anu Sonai Complex, At Post. Shenoli, Tal. Karad, Dist. Satara.
IFSC/RTGS Code	MAHB0000562
Email id of A/C Holder	kmr_sspm@yahoo.co.in

T. Thangaraju

डॉ. टी. थंगाराजू
वैज्ञानिक 'एफ'

FILE NO. EEQ/2021/000984-C

SCIENCE & ENGINEERING RESEARCH BOARD(SERB)

(a statutory body of the Department of Science & Technology, government of India)

Science and Engineering Research Board
3rd & 4th Floor, Block II
Technology Bhavan, New Mehrauli Road
New Delhi - 110016

Dated: 10 March, 2022

ORDER

Subject: Research project entitled **Fabrication of Ternary nanocomposite electrodes based on CO_3O_4-rGO-Conducting Polymer for high performance energy storage application** under the guidance of Dr. Dhanaji Suresh Dalavi, PHYSICS, KRISHNA MAHAVIDYALAYA, RETHARE (BK) , Julewadi, Satara, Maharashtra-415302.

1. In continuation of SERB's sanction order No. EEQ/2021/000984 dated 10 March, 2022, sanction of the competent authority is hereby accorded to the payment of a sum of **Rs.*1620000/-*** under 'Grants-in-aid Capital' to KRISHNA MAHAVIDYALAYA, RETHARE (BK) , Julewadi, Satara, Maharashtra-415302 being the grant for the financial year 2021-2022 for implementation of the above said project.

2. Sanction of the grant is subject to the conditions as detailed in Terms & Conditions available at the website (www.serb.gov.in) and as mentioned in the sanction order of even number dated 10 March, 2022.

3. As this is the first grant being released under 'Grants-in-aid Capital' for the project, no previous U/C is required.

4. The expenditure involved is debitable to Fund for Science & Engineering Research (FSER) This release is being made under **Empowerment and Equity Opportunities for Excellence in Science. (Task force Committee) (SC).**

5. The Sanction has been issued with the approval of the competent authority on **09 March, 2022** and vide Diary No. **SERB/F/9855/2021-2022** dated **09 March, 2022**.

6. The release amount of **Rs. 1620000/-** (Rupees Sixteen Lakh Twenty Thousand only) will be drawn by the Under Secretary of the SERB and will be disbursed by means of RTGS transaction as per their Bank details given below:

PFMS Unique Code	MHST00012031
Account Name	Principal Krishna Mahavidyalaya UGC A/C
Account Number	20240700009
Bank Name & Branch	Bank of Maharashtra Anu Sonai Complex, At Post. Shenoli, Tal. Karad, Dist. Satara.
IFSC/RTGS Code	MAHB0000562
Email id of A/C Holder	kmr_sspm@yahoo.co.in
Email id of PI	dhanuphysics@gmail.com

(Dr. Thangaradjou T)
Scientist F
msls@serb.gov.in

To,
Under Secretary
SERB, New Delhi
Copy forwarded for information and necessary action to: -

1.	The Principal Director of Audit, A.G.C.R.Building, IIIrd Floor I.P. Estate, Delhi-110002
2.	Sanction Folder, SERB , New Delhi.
3.	File Copy
4.	**Dr. Dhanaji Suresh Dalavi** **PHYSICS** **KRISHNA MAHAVIDYALAYA, RETHARE (BK) , Julewadi, Satara, Maharashtra-415302** **Email: dhanuphysics@gmail.com** **Mobile: 919527350402** (Start date of the project may be intimated by name to the undersigned. For guidance, terms & Conditions etc. Please visit www.serb.gov.in.)
5.	**Principal,** **KRISHNA MAHAVIDYALAYA, RETHARE (BK), Julewadi** (Receipt of Grant may be intimated by name to the undersigned)

(Dr. Thangaradjou T)
Scientist F
msls@serb.gov.in

स्थापना : १९५४

"स्वावलंबी शिक्षण हेच आमचे धोरण"
। कर्मवीर ।

रयत शिक्षण संस्थेचे,

सद्गुरू गाडगे महाराज कॉलेज, कराड

स्वायत्त महाविद्यालय - शिवाजी विद्यापीठ, कोल्हापूर संलग्नित

विद्यानगर, कराड पिन - ४१५ १२४ जि. सातारा (महाराष्ट्र) पो. ऑ. बॉ. नं. ३
फोन : कार्यालय : (०२१६४) २७१३४६ फॅक्स : (०२१६४) २७१३४६
Website : www.sgm.edu.in E-mail : sgmkarad@yahoo.com

कला, विज्ञान, वाणिज्य व व्यवसाय शिक्षण (कनिष्ठ व वरिष्ठ)

नॅक मानांकन : A+ CGPA 3.63 • आयएसओ प्रमाणित कॉलेज : 9001 : 2015
• रूसा बेनिफिशियरी व नॅक, बेंगलोर प्रमाणित मेन्टॉर कॉलेज •
Jr. College Index No. j.21.02.003

• संस्थापक •

पद्मभूषण
डॉ. कर्मवीर भाऊराव पाटील
डी.लिट.

• प्राचार्य :
डॉ. मोहन राजमाने
एम.एस्सी., पीएच्.डी.

संदर्भ क्र. : 1825/2021-22 दिनांक : ०७/०१/२०२२

REGISTERED AD

प्रति,

मा.प्राचार्य,
कृष्णा महाविद्यालय, रेठरे बु ॥
जि.सातारा

विषय : अग्रणी महाविद्यालय योजनेअंतर्गत रिसर्च प्रोजेक्टसाठी द्यावयाच्या अॅडव्हान्सबाबत.

महोदय,

शिवाजी विद्यापीठाच्या Research Promotion Activity for students of the affiliated Colleges या योजनेअंतर्गत आपल्या विद्यार्थ्यांच्या "Synsthesis and Characterization of CO3O4 this film by hydrothermal route for supercapacitor application" या रिसर्च प्रपोजलसाठी विद्यापीठाने रू. १०००० /- मंजूर केले असून सदर अॅडव्हान्स रकमेचा चेक नं. 93E026 दि. १५/०१/२०२२ ने सोबत पाठविला आहे. कृपया सदर रकमेची पोहोच पावती त्वरीत पाठवून द्यावी.

वरील रिसर्च प्रोजेक्टसाठी मंजूर रक्कम रू.१०,०००/- खर्च करून त्याचा हिशोब व प्रोजेक्ट रिपोर्ट या अग्रणी महाविद्यालयाकडे ३१/०३/२०२२ पूर्वी सादर करावा.

कळावे, ही विनंती.

आपला विश्वासू,

प्राचार्य,
अग्रणी महाविद्यालय
सद्गुरू गाडगे महाराज कॉलेज, कराड

सोबत : वरीलप्रमाणे.

Key Indicator 3.1 – Resource Mobilization for Research

3.1.1.1: Total Grants from Government and non-governmental for research projects, endowments in the institution during the year (INR in Lakhs)

Year 2020-21

Name of the Research Project/ Endowments	Name of the Principal Investigator /Co-investigator	Department of Principal Investigator	Year of Award	Amount Sanctioned (in Lakh)	Duration of the project	Name of the Funding Agency	Type (Government /non-Government)
Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
			Total	**00**			

Krishna Mahavidyalaya, Shivnagar 415108 Rethare Bk.

Principal
Krishna Mahavidyalaya, Rethare Bk.
Tal. Karad : 415 108 (M.S)

Key Indicator 3.1 – Resource Mobilization for Research

3.1.1.1: Total Grants from Government and non-governmental for research projects, endowments in the institution during the year (INR in Lakhs)

Year 2019-20

Name of the Research Project/ Endowments	Name of the Principal Investigator /Co-investigator	Department of Principal Investigator	Year of Award	Amount Sanctioned (in Lakh)	Duration of the project	Name of the Funding Agency	Type (Government /non-Government)
Synthesis and characterization of nanostructured Tungsten oxide conducting polymers core-shell nanostructures for efficient electrochromic smart windows	Dr. D. S. Dalavi	Physics	2018	1.25	2 years	Shivaji University, Kolhapur	Government
Synthesis and characterization of WO3 thin film by sol gel route for electrochromic smart window application.	Dr. D. S. Dalavi	Physics	2019	0.1	1 year	Shivaji University Minor Research Project under lead college activity	Government
			Total	**1.35**			

Krishna Mahavidyalaya, Rethare Bk. Shivnagar 415108

Principal
Krishna Mahavidyalaya, Rethare Bk.
Tal. Karad : 415 108 (M.S)

SHIVAJI UNIVERSITY, KOLHAPUR-416 004 MAHARASHTRA
Colleges and University Development Section
PHONE :EPABX-2609000, 2609145
FAX :0091-231-2691533 & 0091-231-2692333
Website : www.unishivaji.ac.in E-mail: stats@unishivaji.ac.in
शिवाजी विद्यापीठ, कोल्हापूर -४१६००४ महाराष्ट्र(महाविद्यालये व विद्यापीठ विकास विभाग)
दुरध्वनी: (ईपीएबीएक्स) २६०९०००, २६०९१४५
फॅक्स: ००९१-२३१-२६९१५३३,२६९२३३३,२६९३२९४

Estd: 1962
NAAC "A" Grade

Ref No. : SU/C&U.D.Section/86/233 Date: 10 MAY 2018

To,
Dr. Dhanaji Suresh Dalavi,
Krishna Mahavidyalaya,
Rethare Bk., Dist: Satara.

Sub: Your project entitled, "*Synthesis of Tungsten Oxide - Conducting Polymers Core-Shell nanostructures for efficient Electrochromic Smart Windows*"
Ref : Our Office Circular No : SU / C.&U.D. Section/ UGK/ 347, dt. 11/07/2017.

Sir / Madam,

With reference to your application for financial assistance for scheme under Research Initiation Scheme-2017-2018, I am directed to inform you that the research project entitled ***"Synthesis of Tungsten Oxide - Conducting Polymers Core-Shell nanostructures for efficient Electrochromic Smart Windows"*** has been accepted for the financial support under the shceme for the period of two years **(2018-2019 to 2019-2020).** The total grant for the projects will be **₹.125000/- (₹. One Lakhs Twenty Five Thousand Only).** The first installment (i.e.advance) of **₹.112500/- (₹. One Lakhs Twelve Thousand Five Hundred Only)** will be released after receiving the following documents i.e. ***University approval letter (Change in Staff), appointment letter, Confirmation Order, Undertaking duly signed by the P.I and Principal in the prescribed format, Acceptance letter (Annex. B), Aadhar Card Zerox, Pan Card Zerox, Passbook zerox (Joint passbook), Advance Stamp Receipt etc.,***

The Details of the funds sanctioned. :

Sr. No	Item	Amount sanctioned in Rs.			Grant released as First installment
		1st Year	2nd Year	Total	
A)	**Recurring**				
	1) Books and Journals	₹.0/-	₹.0/-	₹. 0/-	₹. 0/-
	2) Hiring Services	₹. 0/-	₹.0/-	₹. 0/-	₹. 0/-
	3) Field Work and Travel	₹.0/-	₹.0/-	₹. 0/-	₹. 0/-
	4) Chemical and Glassware	₹.10000/-	₹.10000/-	₹.20000/-	10000/-
	5) Contingency	₹.2500/-	₹.2500/-	₹. 5000/-	₹. 2500/-
B)	**Non-recurring**				
	*Equipment	₹. 100000/-	₹. 0/-	₹. 100000/-	₹. 100000/-
	Total	**₹. 112500/-**	**₹. 12500/-**	**₹. 125000/-**	**₹. 112500/-**

* Name of the Equipment Equipment : **Hydorthermal reactor, Programmable furnace, Spin Coater with Micro Centrifuge and Digital Balance**

Kindly submit the above documents with duly signed in prescribed format to Registrar, Shivaji University, Kolhapur, at the earliest so as to release the grant.

Thanking you,

Yours faithfully,

Deputy Registrar,
Colleges and University Development Section
Shivaji University, Kolhapur

Encl. :- As above
Copy to:

- Account (P.G. Bill) Section
- The Principal/Head, Krishna Mahavidyalaya, Rethare Bk., Dist- Satara
- Dr. P. V. Anbhule, Co-ordinator, Department of Chemistry, Shivaji University, Kolhapur.

Shetkari Shikshan Prasarak Mandal's

Krishna Mahavidyalaya, Rethare Bk

IQAC 2019-2020

ACTIVITY REPORT
PHYSICS DEPARTMENT

IQAC ACTIVITY No:

NAME OF THE ACTIVITY: "Lead college Activity-Research Project: "Synthesis and characterization o WO_3 thin film by sol gel method for smart window application."			
DATE	**FACULTY**	**DEPARTMENT/COMMITTEE**	**COORDINATOR NAME**
Throughout the academic year	Science	Physics	Dr. Dhanaji S. Dalavi
TIME	**VENUE**	**NUMBER OF PARTICIPANTS**	**NATURE: Outdoor/Indoor**
	Physics laboratory	04 students+01 teacher	Indoor
SUPPORT/ASSISTANCE:	Nil		

BRIEF INFORMATION ABOUT THE ACTIVITY (**CRITERION NO. -**):

TOPIC/SUBJECT OF THE ACTIVITY	**"Lead college Activity-Research Project: "Synthesis and characterization of WO_3 thin film by sol-gel method for smart window application."**
OBJECTIVES	to analyze a scientific occurrence with an investigation or to solve a problem with an invention.
METHODOLOGY	Experimental work
OUTCOMES	students become active, engaged learners. It also helped students to develop independent critical thinking skills.

PROOFS & DOCUMENTS ATTACHED (Tick mark the proofs attached):

1. Notice & Letters	2. Student list of	3. **Activity report**	4. **Photos**	5. Feedback form
6. **Feedback analysis**	7. News clip with details	8. Certificate	9. Any other	10.

IQAC CELL ACTIVITY NUMBER:

NAME OF TEACHER & SIGNATURE	NAME OF HEAD/ COMMITTEE INCHARGE & SIGNATURE	PRINCIPALS SIGNATURE	IQAC COORDINATOR (SEAL & SIGNATURE)
Dr. Dhanaji S. Dalavi	Dr. Dhanaji S. Dalavi		

HEAD
DEPARTMENT OF PHYSICS
KRISHNA MAHAVIDYALAYA,
Rethare Bk; Shivnagar - 415108

Principal
Krishna Mahavidyalaya, Rethare Bk,
Tal. Karad : 415 108 (MS)

IQAC, Coordinator,
KRISHNA MAHAVIDYALAYA,
Rethare Bk; Shivnagar - 415108
Tal. Karad, Dist. Satara

"Education through self-help is our motto." - Karmaveer

Rayat Shikshan Sanstha's

Estd.: 1954

SADGURU GADAGE MAHARAJ COLLEGE, KARAD

VIDYANAGAR, Pin - 415 124, Dist. Satara (M.S.) INDIA P.O. Box No.3
Ph. Office : (02164) 271346 Resi. (02164) 271794 **Fax.** (02164) 271346
Website : www.sgm.edu.in **E-mail :** sgmkarad@yahoo.com

ARTS, SCIENCE, COMMERCE & VOCATIONAL (Junior & Senior)

■ **Jr. College No.** j.21.02.003 ■ **(Affiliated to Shivaji University, Kolhapur)** ■

Accredited **A+** with **CGPA 3.63** by NAAC ● **ISO 9001 : 2015 Certified College**

● **Principal : Dr. Mohan Rajmane** M.Sc., Ph.D.

Ref. No. 1689/19-20 **Date :** 01/ 11/ 2019

To

The Principal,
Krishna Mahavidyalaya Rethare (Bk.)
Tal.Karad, Dist. Satara.

Sub. : Submission of Research Project under Research Promotion Activity ofr College Students.

I am pleased to inform you that the Research Project under the Research Promotion Activity of the Shivaji University, Kolhapur is received with following details.

Name of Project Advisor	Name of Students	Title of Project	Amount Estimate Rs.
Dr. D. S. Dalavi	1) Lad Divya Dilip	Synthesis, Characterization of WO3 thin film by sol-gel route for electrochromic smart windows application. .	10,000/-
	2) Mohini Rajendra Harale		
	3) Ashlesha Arun Patil		
	4) Aniket Anil Dmame		

Financial assistance under this scheme is subject to final approval and directions of the university.

Thank you,

Yours faithfully,

Principal,
Lead College,
Sadguru Gadage Maharaj College,
KARAD

Dr. Dalavi D.S.
07/11/19

Krishna Mahavidyalaya, Shivnagar
Inward No.. 9646
Date 7/11/2019

स्थापना : १९५४

''स्वावलंबी शिक्षण हेच आमचे ब्रीद''-कर्मवीर

रयत शिक्षण संस्थेचे,

सद्गुरू गाडगे महाराज कॉलेज, कराड

स्वायत्त महाविद्यालय - शिवाजी विद्यापीठ, कोल्हापूर संलग्नित

विद्यानगर, कराड पिन - ४१५ १२४ जि. सातारा (महाराष्ट्र) पो. ऑ. बॉ. नं. ३

फोन : कार्यालय : (०२१६४) २७१३४६ फॅक्स : (०२१६४) २७१३४६

Website : www.sgm.edu.in E-mail : sgmkarad@yahoo.com

कला, विज्ञान, वाणिज्य व व्यवसाय शिक्षण (कनिष्ठ व वरिष्ठ)

नॅक मानांकन : A+ CGPA 3.63 • आयएसओ प्रमाणित कॉलेज : 9001:2015

Jr. College No. j.21.02.003

प्राचार्य :
डॉ. मोहन राजमाने
एम.एस्सी., पीएच्.डी.

पद्मभूषण
डॉ. कर्मवीर भाऊराव पाटील

संदर्भ क्र. : 2269/19-20 **REGISTERED AD** दिनांक : १७/०२/२०२०

प्रति,

मा.प्राचार्य,
कृष्णा महाविद्यालय, रेठरे बु ॥
जि.सातारा

विषय : अग्रणी महाविद्यालय योजनेअंतर्गत रिसर्च प्रोजेक्टसाठी द्यावयाच्या ॲडव्हान्सबाबत.

महोदय,

शिवाजी विद्यापीठाच्या Research Promotion Activity for students of the affiliated Colleges या योजनेअंतर्गत आपल्या विद्यार्थ्यांच्या "Synthesis Characterization of WO3 thin film by sol-gel route for electrochromic smart windows application" या रिसर्च प्रपोजलसाठी विद्यापीठाने रू. १०००० /- मंजूर केले असून सदर ॲडव्हान्स रकमेचा चेक नं. 960393 दि. १८/०२/२०२० ने सोबत पाठविला आहे. कृपया सदर रकमेची पोहोच पावती त्वरीत पाठवून द्यावी.

वरील रिसर्च प्रोजेक्टसाठी मंजूर रक्कम रू.१०,०००/- खर्च करून त्याचा हिशोब व प्रोजेक्ट रिपोर्ट या अग्रणी महाविद्यालयाकडे त्वरीत सादर करावा.

कळावे, ही विनंती.

आपला विश्वासू,

प्राचार्य,
अग्रणी महाविद्यालय
सद्गुरू गाडगे महाराज कॉलेज, कराड

SADGURU GADAGE MAHARAJ COLLEGE KARAD

सोबत : वरीलप्रमाणे.

24/2/2020
Dr Dalavi
Lead college
Res Project.
Dr. Dalavi
Physics

Krishna Mahavidyalaya, Shivaji
Inward No.- 1357
Date- 25/02/20.

NVGaikwad . Sir .

संहती कार्यसाधिका । शिलं परं भूषणम्

Shetkari Shikshan Prasarak Mandal's

KRISHNA MAHAVIDYALAYA, RETHARE BK.

Shivnagar, Tal. Karad, Dist. Satara, 415108 (M.S.)

Email : kmr_sspm@yahoo.co.in Website : www.krishnamahavidyalaya.com

NAAC 'B+' Grade (CGPA 2.65)

Principal (I/C) : Dr. Salunkhe C. B., M.Sc., Ph. D. Founder : Hon. Jaywantrao Bhosale

Ref. No. : KMR/313/2019-2020 Date : 03-03-2020 .

प्रति.
मा . समन्वयक
अग्रणी महाविद्यालय
सदगुरू गाडगे महाराज कॉलेज
कराड जि . सातारा .

विषय :- अग्रणी महाविद्यालया अंतर्गत राबवलेल्या रिसर्च प्रोजेक्टच्या खर्चाचा अहवाल.

महोदय.

शिवाजी विद्यापीठाच्या Research Promotion activity for students of the affiliated collages या योजनेअंतर्गत या महाविद्यालयातील विद्यार्थ्यांच्या “Synthesis, Characterization of WO_3 thin film by sol-gel route for electrochromic smart windows application” या रिसर्च प्रोपोसलं साठी विद्यापीठाने रु. १०,०००/- मंजूर केले होते. सदर रिसर्च प्रोपोसलं साठी आपणाकडून रु. १०,०००/- चा ॲडव्हान्स रकमधे चेक नं. 107313 दि. 18/02/2020 रोजी मिळाला असून त्यानुसार वरील रिसर्च प्रोजेक्टसाठी मंजूर रकमेच्या खर्चाचा तपशील व अहवाल आपणाकडे पाठवत आहे.

खर्चाचा तपशील खालीलप्रमाणे .

अ . नं	तपशील	साहित्य	खर्च
१.	Shri. Samarth Trading Company	Chemicals	7500.00
२.	Bhadi and Company	Stationary	154.00
३.	Chingale Surgicals	Stationary	1030.00
४.	Dhiraj Stationers	Stationary	684.00
५.	Anushka Stationers	Stationary	654.00
६.	Uma Xerox	Xerox	25.00
		Total	10,047=00

Received
12/3/20

समन्वयक

Principal
Krishna Mahavidyalaya, Rethare Bk.
Tal. Karad

FORMAT FOR STATEMENT OF EXPENDITURE

1. **SUK file No:** SGM/1689/2019-2020 dated 01/11/2019
2. **Title of the Lead college Project:** "Synthesis, Characterization of WO_3 thin film by sol-gel route for electrochromic smart windows application".
3. **Name of the Project Advisor:** Dr. Dhanaji S. Dalavi, Physics.
4. **Number of students participated in the project:** 04
5. **Duration of the Activity:** July 2019 to March 2020.

Sanction No. and date	Grant sanctioned	Details of expenditure incurred item wise		Amount
SGM/1689/2019-2020 dated 01/11/2019 & SGM/2289/2019-2020 dated 17/02/2020 Advance cheque No. 107313.	**10, 000/-**	Shri. Samarth Trading Company	Chemicals	7500.00
		Bhadi and Company	Glass cutter	154.00
		Chingale Surgicals	Stationary	1030.00
		Dhiraj Stationers	Stationary	684.00
		Anushka Stationers	Stationary	654.00
		Uma Xerox	Xerox	25.00
		Total Expenditure		**10, 047.00**
		Grant Received		**10,000.00**

It is certified that the sanctioned amount of Rs. 10,000/- (Rupees Ten thousand only) out of the total grant of Rs. 10,000/- (Rupees Ten Thousand) has been received for the project work to the Department of Physics, Krishna Mahavidyalaya, Rethare (Bk) by the Shivaji University, Kolhapur. its Letter No. SGM/2289/2019-2020, **cheque No. 107313. dated 17/02/2020** has been utilized for the purpose for which it was sanctioned and in accordance with the terms and conditions laid down by the Shivaji University, Kolhapur.

Project Advisor

Dalavi

Dr. Dhanaji S. Dalavi

Dr. Dhanaji S. Dalavi
Associate Professor (Physics)
Krishna Mahavidyalaya
Rethare (Bk) Tal. Karad

27/2/2020

Principal
Krishna Mahavidyalaya, Rethare (Bk)
Tal. Karad 415108 (MS)

Principal

UTILIZATION CERTIFICATE

Certified that the Rs.10,000/- (Ten Thousand Only) has been sanctioned by the Shivaji University, Kolhapur to couduct the lead college Project entitled **"Synthesis, Characterization of WO_3 thin film by sol-gel route for electrochromic smart windows application".** on 2019-2020 has been incurred by the observing scrupulously all the rules and as per rates prescribed by the Shivaji University, Kolhapur.

The unspent balance of Rs. **Nil** is refunded to the Shivaji University, Kolhapur wide challan dated---------- in the bank ---------- in A/C No--------- receipt No.-------dated----------

The excess expenditure of Rs. **Nil** over the advance is receivable from Shivaji University, Kolhapur.

The expenditure incurred of **Rs. 10, 047** out of which **Rs. 10,000/-** has been received wide cheque **No. 107313. dated 17/02/2020** and remaining Rs.**Nil** is receivable from Shivaji University, Kolhapur.

The penal interest of Rs. **Nil** is credited to the University, vide receipt No.-------dated------ under the budget head A.4.R.2.

Certified that the original vouchers, bills and stamped receipt for the above mentioned of A/C are retained in this office and will be made available as and when required.

Place: Shivnagar

Date:

Project Advisor

Dr. Dhanaji S. Dalavi

Dr. Dhanaji S. Dalavi
Associate Professor (Physics)
Krishna Mahavidyalaya,
Rethare (BK) Tal. Karad

Principal
Krishna Mahavidyalaya, Rethare Bk
Tal. Karad - 415108 (MS)
Principal

Dr. Dhanaji S. Dalavi,
Assistant Professor
Department of Physics,
Krishna Mahavidyalaya,
Rethare (Bk).
Date: 27/02/2020

To,

The Principal,

Krishna Mahavidyalaya, Rethare (Bk)

Shivnagar-415108

Subject: Submission of Bills toward purchase of chemicals and Glassware under lead college Activity research project.

Respected Sir,

With reference to above mentioned subject, we have purchased chemicals and glassware through Research Promotion activity for students of the affiliated college initiated by Shivaji University, Kolhapur for the research project entitled **"Synthesis, Characterization of WO_3 thin film by sol-gel route for electrochromic smart windows application".**

Herewith I kindly request you to issue check of Rs. 7,500/- in favour of **Shri. Samarth Trading Company, Islampur** toward the purchase of chemicals and glassware's.

Thanking You

Yours Faithfully

Principal
Krishna Mahavidyalaya, Rethare (Bk)
Tal. Karad 415108 (MS)

Project Advisor
Research Promotion Activity
Dr. Dhanaji S. Dalavi
Assistant Professor (Physics)
Krishna Mahavidyalaya,
Rethare (Bk.), Tal. Karad

Ref.

Department Physics

To,

Date— 19-1-2020

The Principal,
KRISHNA MAHAVIDYALAYA, SHIVNAGAR

Subject– Request to pass the bills for payment,

Sir,

Please find herewith the following bills for the payment while passing the bills I have checked the price of each item and is according to the price quoted by the party.

Sr. No.	Name of the Firm	Bill No. / Date	Amount	Deductions if any	Net Paid
	Shri Samarth Trading Company Islampur- 415409	CO 42 / 19-1-2020		-	7500=00
	Rs. Seven Thousand Five Hundred only				7500=00

Thanking you,

Yours faithfully,

Lab / Assistant

Head

Department

DEPARTMENT OF PHYSICS

KRISHNA MAHAVIDYALAYA, SHIVNAGAR

Department

KRISHNA MAHAVIDYALAYA
SHIVNAGAR 415109

GSTIN : 27AMVPP2791E1ZG

TAX INVOICE

Shri Samarth Trading Company

Peth Sangli Road, Opp. Ganesh Servicing Center, Shripadnagar, ISLAMPUR - 415 409
Tal. Walwa, Dist. Sangli. Tel. (02342) 225394, 225773 Mob. 9822256373
E-mail : samarth.trading@yahoo.com samarth4092@gmail.com

Original Buyer's Copy

voice No.:- CO/411/2019-20
oice date:-19/01/2020
verse Charge (Y/N):
te: Maharashtra

PO No.:-
Date :-15/01/2020 **Code 27**

Transport Mode:-
Vehicle number:-
Date of Supply :-
Challan No.:-

Bill to Party

me: The Principal, Krishna Mahavidyalaya
dress :-Rethare BK
:.:- Satara
TIN:-
e:- Maharashtra **Code 27**

Ship to Party

Name:-
Address:-
GSTIN:-
State:- **Code**

Product Description	Make	GST	Qty	Rate	Amount	Discount	Taxable Value	CGST		SGST		Total
								Rate	Amount	Rate	Amount	
Cobalt Nitrate Hexahydrate AR 250gm	Loba	18%	1	2300.00	2300.00	1035.00	1265.00	9	113.85	9	113.85	1492.70
Cobalt Acetate AR 250gm	Loba	18%	1	2850.00	2850.00	1282.50	1567.50	9	141.08	9	141.08	1849.65
drochloric Acid 2.5 Lit	Loba	18%	1	780.00	780.00	351.00	429.00	9	38.61	9	38.61	506.22
Acetone AR 2.5 Lit	Loba	18%	1	1100.00	1100.00	495.00	605.00	9	54.45	9	54.45	713.90
Ammonia Solution 28-30% AR 2.5Lit	Loba	18%	1	620.00	620.00	279.00	341.00	9	30.69	9	30.69	402.38
Hydrogen Peroxide 35% AR	Loba	18%	2	450.00	900.00	405.00	495.00	9	44.55	9	44.55	584.10
Absolute Ethanol 99.9 % AR 500ml	China	18%	2	347.00	694.00	312.30	381.70	9	34.35	9	34.35	450.41
TO Conducting Glass Substrate (10x10)		18%	1	2313.00	2313.00	1040.85	1272.15	9	114.49	9	114.49	1501.14
Total			10		11557.00	5200.65	6356.35		572.07		572.07	7500.49

Total Invoice amount in words

Thousand Five Hundred Rupees Only.

Total Amount before Tax	6356.35
Add: CGST	572.07
Add: SGST	572.07
Total Tax Amount	1144.14
Total Amount after Tax:	7500.49
Round Off Total Amount	7500.00

Bank Details

C: 579505040000105 Bank Name : Union Bank of India
C: UBIN0557951 Branch : Islampur

tion :

are that this invoice shows the actual price of the goods
d and that all particulars are true and correct.
y GSTIN/UIN : 27AMVPP2791E1ZG
y PAN : AMVPP2791E

Shri Samarth Trading Company, Islampur • Pin No. 415 409 (Sangli)

Common Seal

Certified that the particulars given above are true and correct

For SHRI SAMARTH TRADING COMPANY

Authorised signatory

Dr. Dhanaji S. Dalavi,
Assistant Professor
Department of Physics,
Krishna Mahavidyalaya,
Rethare (Bk).
Date: 27/02/2020.

To,

The Principal,

Krishna Mahavidyalaya, Rethare (Bk)

Shivnagar-415108

Subject: Submission of Bills toward purchase of contingency under lead college Activity research project.

Respected Sir,

With reference to above mentioned subject, we have purchased contingent items of Rs.2,547/- through Research Promotion activity for students of the affiliated college initiated by Shivaji University, Kolhapur for the research project entitled **"Synthesis, Characterization of WO_3 thin film by sol-gel route for electrochromic smart windows application"**. For the purchase of said items I have paid Rs. 2,547/-

Herewith I kindly request you to issue check of Rs. 2,547/- in favour of **Dr. Dhanaji Suresh Dalavi** toward the purchase of contingent items.

Thanking You

Yours Faithfully

Principal
Krishna Mahavidyalaya, Rethare Bk
Tal. Karad 415108 (MS)

Project Advisor
Research Promotion Activity
Dr. Dhanaji S. Dalavi
Assistant Professor (Physics)
Krishna Mahavidyalaya,
Rethare (Bk.), Tal. Karad

GST INVOICE

BHADI

BHADI & COMPANY

• *Hardware Merchant* •

H.O. : 31/32, Shaniwar Peth, KARAD - 415110 ☎ 222821

M/s. प्राचार्य कृष्णा महाविद्यालय रेठरे बुद्रुक

Party GST No. :

INVOICE No. 186

Date: 22/12/2019

Particulars	HSN Code	Qty.	Rate	Amount
उद्वाहन ऑटो		1	130/-	130=00

Rs. in words one hundred fifty four only.

Amount before Tax		130=00
9 %	Add : GST	11=70
9 %	Add : CGST	11=70
%	Add : IGST	153=40
	Round off	00=60
	Grand Total	154=00

GSTIN No. : 27AAUPB2903K1ZL
Bank of Baroda :
A/c No. 31090200000002
IFSC Code : BARBOKARADDX
Branch - Karad

Subject to Karad Jurisdiction

For BHADI & CO.

BILL OF SUPPLY

Cash Sale

NGALE SURGICALS I,Opp. Popatbhai Petrol Pump, Shaniwar N/UIN : 27AWSPC0007D1Z1 act : 7385406433	Invoice No. CS 9	Dated 27/01/2020
er cipal krushna mahavidyalay rethre bk d N/UIN :	Delivery No.	Dated

Description of Goods	HSN	Qty	Rate	Per	Amount
PLANE FORCEP	9018	5.00	80.00	NO	400.00
EXAM GLOVES L	40149	1.00	250.00	NO	250.00
COTTON 100 GM	0	6.00	45.00	NO	270.00
			Gross Amount		920.00
Round Off @ Sale					0.40
SGST(OUTPUT) 6%					55.20
CGST(OUTPUT) 6%					55.20
TOTAL =		12.00			1,030.00

panys Bank Details
k Name :- UCO BANK
No. :- 21710210001073
ch/IFSC Code :- KARAD /UCBA0002171
ds Once Sold Will Not Be Taken Back Or Exchanged.

Subject to KARAD Juridiction.

For CHINGALE SURGICALS
Chingale Surgicals
Authorised Signatory
Proprietor

"Composition taxable person not eligible to collect tax on supplies"

are by : e.Sense InfoSolutions, Karad (9921946393)

दि. 27/02/2020

कॅश-मेमो

रेज स्टेशनर्स

सोमवार पेठ, कराड, जि. सातारा

कृष्णा महाविद्यालय

वर्णन	नग	दर	रुपये	पैसे
—	2	180	360	00
मार्कर	2	72	144	00
पेन पाकीट	1	—	180	
		एकूण -	684	00

Acc. Page - 1001

Order No. — Date —

Bill No. 2747 Date 27.2.20

Amount of bill Rs. 684/-

Deduction if any Rs. .....

Bill passed for Rs. 684/-

Salami

HEAD
DEPARTMENT OF PHYSI
KRISHNA MAHAVIDYALA
SHIVNAGAR 415108

No. 182 CASH MEMO Mob. 8600505861

UMA STORES & XEROX

Near Krishna Mahavidyalaya, Julewadi. Tal.- Karad, Dist. - Satara.

Shree Principle Krishna mahavidy

Rethare B.K Date 05/11/2019

Description	Total	Rate	Amount Rs. Ps.
Xerox Paper	25	1	25/-
		Total-	25/-

Authorised sang.

Acc-Page 1001

Order No. ..... Date. .....

Bill No. 182 Date 5-11-19

Amount of bill Rs. 25/-

Deduction if any Rs. .....

Bill passed for Rs. 25/-

Salami

HEAD
DEPARTMENT OF PHYSICS
KRISHNA MAHAVIDYALAYA
SHIVNAGAR 415108

कॅश-मेमो

अनुष्का स्टेशनरी ॲन्ड जनरल स्टोअर्स

कार्वेनाका, कराड. मो. ९७६७२७९१७२

श्री. कृष्णा महाविद्यालय रेठरे

दिनांक ०३/०२/२०१० रा.

तपशील	नग	किमंत	रुपये
प्लास्टिक डबा	2	40	80/-
व्हाइटनर	4	20	80/-
टिशू पेपर	2	25	50/-
कटर	2	20	40/-
क्लीप	1	35	35/-
फेव्हीकॉल	1	45	45/-
फाईल	6	10	60/-
फेव्हिक्विक	2	30	60/-
मार्कर CD	8	8	64/-
फोम टेप	3	20	60/-
फॉईल पेपर	1	80	80/-
		अक्षरी रु. एकूण -	654/-

अनुष्का शालेय स्टेशनरी
ॲन्ड जनरल स्टोअर्स
कार्वे नाका, कराड ☎:९८८१५७६८७३

सही/शिक्का

All Page No 1000

Order No..... Date.....

Bill No..... Date.....

Amount of bill Rs. 654=00

Deduction if any Rs.....

Bill passed for Rs. 654/-

Patani

HEAD
DEPARTMENT OF PHYSICS
KRISHNA MAHAVIDYALAYA
SHIVNAGAR 415108

UNIVERSITY, KOLHAPUR

RESEARCH SENSITIZATION SCHEME FOR COLLEGE STUDENTS

UNDER LEAD COLLEGE, ACTIVITY

SUBMISSION OF PROJECT REPORT

TITLE OF THE PROJECT: SYNTHESIS, CHARACTERIZATION OF WO_3 THIN FILM BY SOL-GEL ROUTE FOR ELECTROCHROMIC SMART WINDOWS APPLICATION.

BY

MISS. LAD DIVYA DILIP,

MISS. MOHINI HARALE RAJENDRA,

MISS. PATIL ASHLESHA ARUN,

MR. DAMAME ANIKET ANIL

UNDER THE GUIDANCE OF

DR. DHANAJI S. DALAVI

ASSISTANT PROFESSOR,

KRISHNA MAHAVIDYALAYA, RETHARE, BK

ACADEMIC YEAR: 2019-2020

UNIVERSITY, KOLHAPUR

RESEARCH SENSITIZATION SCHEME FOR COLLEGE STUDENTS

UNDER LEAD COLLEGE, ACTIVITY

SUBMISSION OF PROJECT REPORT

TITLE OF THE PROJECT: SYNTHESIS, CHARACTERIZATION OF WO_3 THIN FILM BY SOL-GEL ROUTE FOR ELECTROCHROMIC SMART WINDOWS APPLICATION.

BY

MISS. LAD DIVYA DILIP,

MISS. MOHINI HARALE RAJENDRA,

MISS. PATIL ASHLESHA ARUN,

MR. DAMAME ANIKET ANIL

UNDER THE GUIDANCE OF

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DECLARATION

We hereby declare that, the project report entitled **"Synthesis, Characterization of WO_3 thin film by sol-gel route for electrochromic smart windows application"** submitted by us has been completed and written by us, has not previously formed and published in any other University in India or any other country or examining body to the best of our knowledge.

Place: Shivnagar

Date: 29/02/2019

Name of project students.

1. Lad Divya Dilip.
2. Patil Ashlesha Arun
3. Mohini Harale Rajendra.
4. Damame Aniket Anil.

CERTIFICATE

This is to certify that thesis entitled **"Synthesis, Characterization of WO_3 thin film by sol-gel route for electrochromic smart windows application"** which is being submitted herewith is the result of original research work completed by **Miss. Lad Divya Dilip, Miss. Patil Arun Ashlesha, Miss. Mohini Harale Rajendra, Mr. Damame Aniket Anil** under my supervision and guidance and to the best of my knowledge and belief, the work embodied in this project work has not formed earlier.

Place: Shivnagar

Date: 29/02/2020

Project Advisor

(Dr. Dhanaji S. Dalavi)

UNIVERSITY, KOLHAPUR

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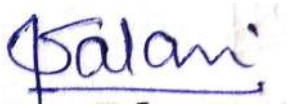

(Dr. Dhanaji S. Dalavi)

1. Introduction:

The term chromogenic is referred to as the change in optical properties of the compound when it is subjected to change in their environment. So, depending upon the chosen environment chromogenic devices are divided into thermochromic device, photochromic device, electrochromic device, phase dispersed liquid crystal device, gasochromic device and suspended particle liquid crystal device. The history of electrochromism started in 1704, when Diesbach discovered the Prussian blue, an excellent dye which had also electrochromic properties. This material changes its color from dark blue to transparent when a voltage is applied across it. In 1815 the electrochromism of WO_3 was discovered, by Berzelius [1]. In fact, it was showed that pure WO_3 changed color on reduction when warmed under a flow of dry hydrogen gas. Later in 1824 Wohler effected a similar chemical reduction with sodium metal. Kobosew and Nekrasso in 1830, recorded that WO_3 powders could acquire the color blue by electrochemical reduction in an acidic solution. The first step towards an electrochromic device was taken in 1942 by Talmey, in studies on the coloration associated with electrolytic reduction of artificially produced particulate molybdenum and tungsten oxide layers. In 1953 Kraus made a very clear description of electrochromism in tungsten oxide films. As none of these studies attracted much attention, probably most current investigators attribute the first widely accepted suggestion of an electrochromic device to Deb, in 1969, with the tungsten oxide films, and after this point, there was a visible increase of the interest in electrochromism. In spite of the innovation on Deb's first electrochromic device it wasn't able to keep up with the fast development of liquid crystal devices [1, 2].

In 1971, Blanc and Staebler produced an electrochromic effect superior to most of the previously published. They applied electrodes to the opposing faces of doped, crystalline SrTiO3 (Strontium Titanium Trioxide) and observed an electrochromic color move into the crystal from the two electrodes. In 1972, Beegle developed a display having identical counter and working electrodes as the one from Blanc and Staebler, but made of WO_3 [1, 2]. Nowadays, Deb's paper form 1973 is quoted as the work responsible for the true birth of electrochromic technology. Faughan et al. [3] in 1975 accomplished a significant progress in developing the electrochromic display device. This was followed by an increase in

electrochromic devices developed for display applications. Nevertheless, electrochromism has remained an active area for basic and applied research, with large possibilities for applications in emerging technologies.

The interest was boosted in the mid-1980s with the awareness that electrochromism was of much interest as a mean to achieve energy efficiency in buildings, using smart windows [4]. The smart windows and other electrochromic systems consist of two electrodes and an electrolyte. When applied voltage with appropriate polarity, charge in the cell drives in and out of the electrochromic material and an electrochemical redox reaction causes a corresponding color change. Therefore, electrochromic materials are currently attracting much interest in industry for their commercial applications [5]. In the recent year various attempts has been made to prepare nanostructured electrochromic devices with the help of various sophisticated physical and chemical techniques and tools. Physical techniques require sophisticated instruments which are of high cost which impact on the end product to be delivered in the market. Sol-gel route is the simple and inexpensive technique which is capable to produce highly transparent nanostructured WO_3 thin film.

Therefore, in the present project an emphasis has been given to synthesize WO3 thin films by simple, low cost sol-gel dip coating technique.

2. Synthesis of Nanostructured WO_3 thin film:

The precursor solution used for the deposition of WO_3 thin films was prepared by dissolving 7.48 g of tungsten metal powder (99% pure, Sigma Aldrich) in 80 ml of H_2O_2 (30%) [6]. The reaction mixture that was kept for 48 h with constant stirring yielded a deep yellow-coloured PTA sol. As reaction being exothermic, it was conducted between 0 and 10^oC in an ice bath. After completion of reaction the reaction mixture was filtered with whatman filter paper and heated at 55 ^oC in order to remove excess peroxide. As-prepared sol was used as a starting precursor for the deposition of WO_3 thin films and kept for to form gel. The WO_3 thin film of desired thickness was deposited by using sol-gel dip coating method.

3. Characterization:

The structural properties of the films were studied by X-ray diffraction (XRD) patterns recorded using X-ray diffractometer (Bruker AXS Analytical Instruments Pvt. Ltd., Germany), D2 phaser model with Cu-Ka radiation (k = 1.5418 A°). The scanning rate of 10^o/min was applied to record the patterns in the range of 10^o -80^o. The infrared (IR) spectrum of powder collected from all NiO samples were recorded using Perkin–Elmer IR spectrophotometer (model-100) in the spectral range of 400–4,000 cm^{-1}. The pellets were prepared by mixing KBr with WO_3 powder collected by scratching film from glass substrates, in the ratio 300:1 and then pressing the powder between two pieces of polished steel. The surface morphology of the films was examined by scanning electron microscopy (SEM; Model JEOL-JSM-6360, Japan, operated at 20 kV) with a thin layer of gold sputter coated prior to analyses. The optical transmittance spectra of fully colored and fully bleached states were measured over the range of 350–1,100 nm using an UV-vis spectrophotometer (Shimadzu, model: UV-1800, Japan). All the electrochromic measurements were performed in an electrolyte (1 M $LiClO_4$+Propylene carbonate) in a conventional three-electrode arrangement comprising platinum wire as the counter electrode and SCE serving as the reference electrode using electrochemical quartz crystal measurements (model-CHI-400A) made by CH Instruments, USA. Colorimetric determinations were done with the help of Shimadzu color analysis software by analyzing the transmittance spectra of color/bleach state to evaluate the L*a*b* and Yxy coordinate values. These obtained values were used as reference data in order to get the observed color in reduced and oxidized state for all samples from online color analysis software with 1931 2° observer and D-65 illuminant proposed by CIE Yxy and L*a*b* coordinate.

4. Results and Discussion:

4.1 X-Ray Diffraction:

The X-ray diffraction (XRD) pattern of nanostructured WO_3 thin film deposited on ITO/glass substrate is shown in Fig.1. It was observed that, the XRD exhibits a broad hump in the low 2θ region for nanostructured WO_3 thin film typically of an amorphous in nature. Normally, amorphous WO_3 film is more suitable than crystalline WO_3 film for

electrochromic applications. A crystallized structure is less favorable for ions to diffuse through because of the densely packed atomic structure and due to this lithium ion movement through the film is obstructed by the dense structure leading to a lower response time. X-ray diffraction patterns realized on these film allowed to confirmed that WO_3 film is totally amorphous. Such characteristics, typical of amorphous materials combined with a nanostructured WO_3, are favorable for a fast-electrochromic response.

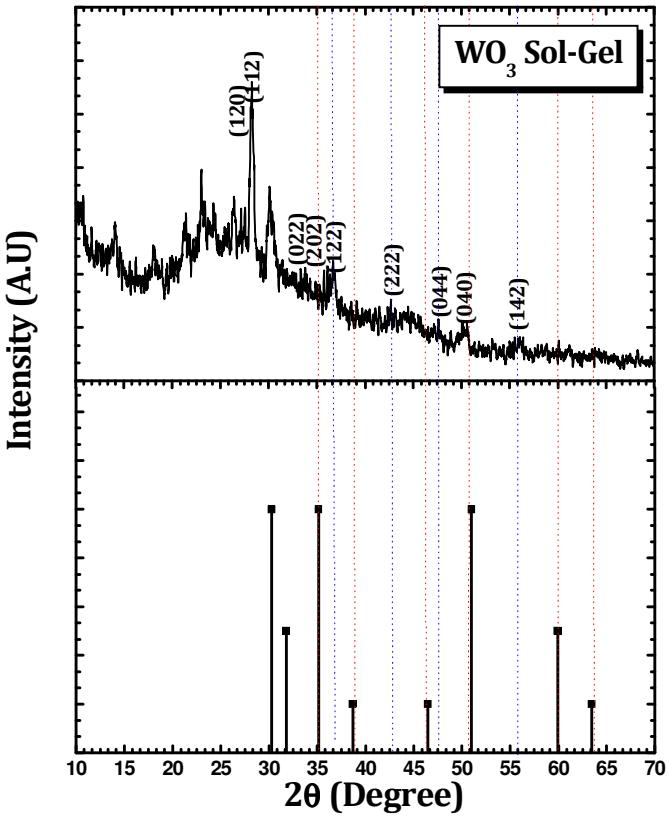

Figure.1 X-ray diffraction pattern of sol-gel deposited WO_3 thin film

4.2 FT-IR Analysis:

Fig 2. Shows FT-IR spectra of sol gel deposited nanostructured WO_3 thin film. A single absorption band observed at 950 cm^{-1} is characteristic for the terminal W=O stretching vibration in tungsten trioxide [7].

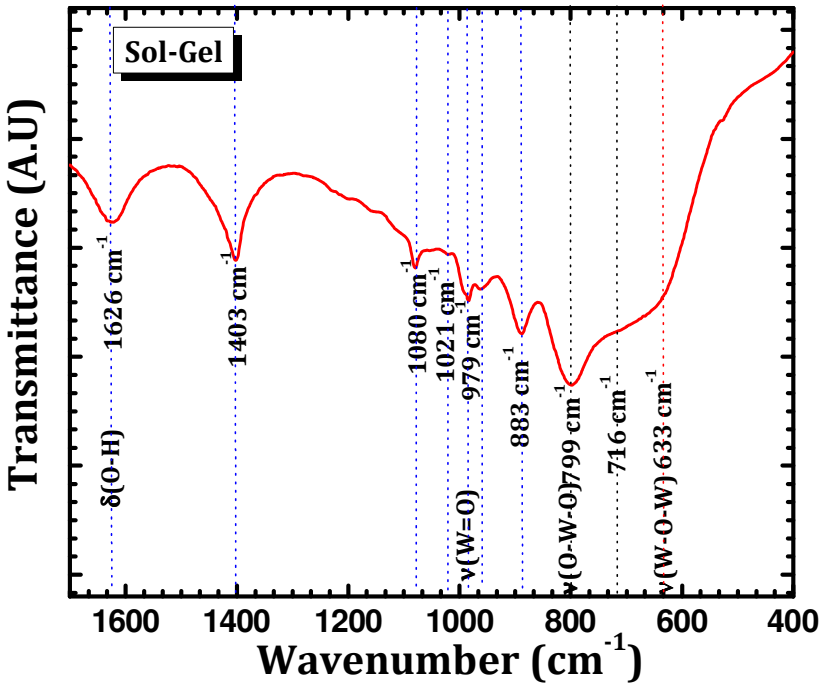

Figure.2 FT-IR spectrum of sol-gel deposited WO_3 thin film.

A well-defined bands seen at 799 and 883 cm^{-1}, in the spectra of nanostructured WO_3 thin film is due to the (O–W–O) inter bridging stretching mode in WO_3 [8]. However, the band at 633 cm^{-1} is due to W–O–W stretching vibrations. A band centered at 1626 cm^{-1} ascribable to the δ(H–O–H) deformation mode is also observed in spectrum of the NPs-WO_3 thin film and a band due to the W–OH…OH_2 stretching mode of hydroxyl groups linked to tungsten on one side and hydrogen bonded with water molecules, on the other, is produced at 1403 cm^{-1}[9].

4.3 Morphological Study:

Fig. 3 (a and b) shows low- and high-resolution SEM images of nanostructured WO_3 thin film. Fig. 3 (a and b) revealed agglomerated nanoclusters with average nanoparticles size of 30-40 nm. The film is uniform in nature with high surface are which is beneficial for good electrochromic performance. The thickness of the deposited film is observed to be ~950 nm as depicted in Fig. 3(c). The existence of tungsten and oxygen in the prepared film

was confirmed by the EDS results as shown in Fig 3 (d). It is noted that the high oxygen content in the results was due to the influence of the ITO glass substrate, which was also confirmed by the existence of In and Sn in the EDS analysis.

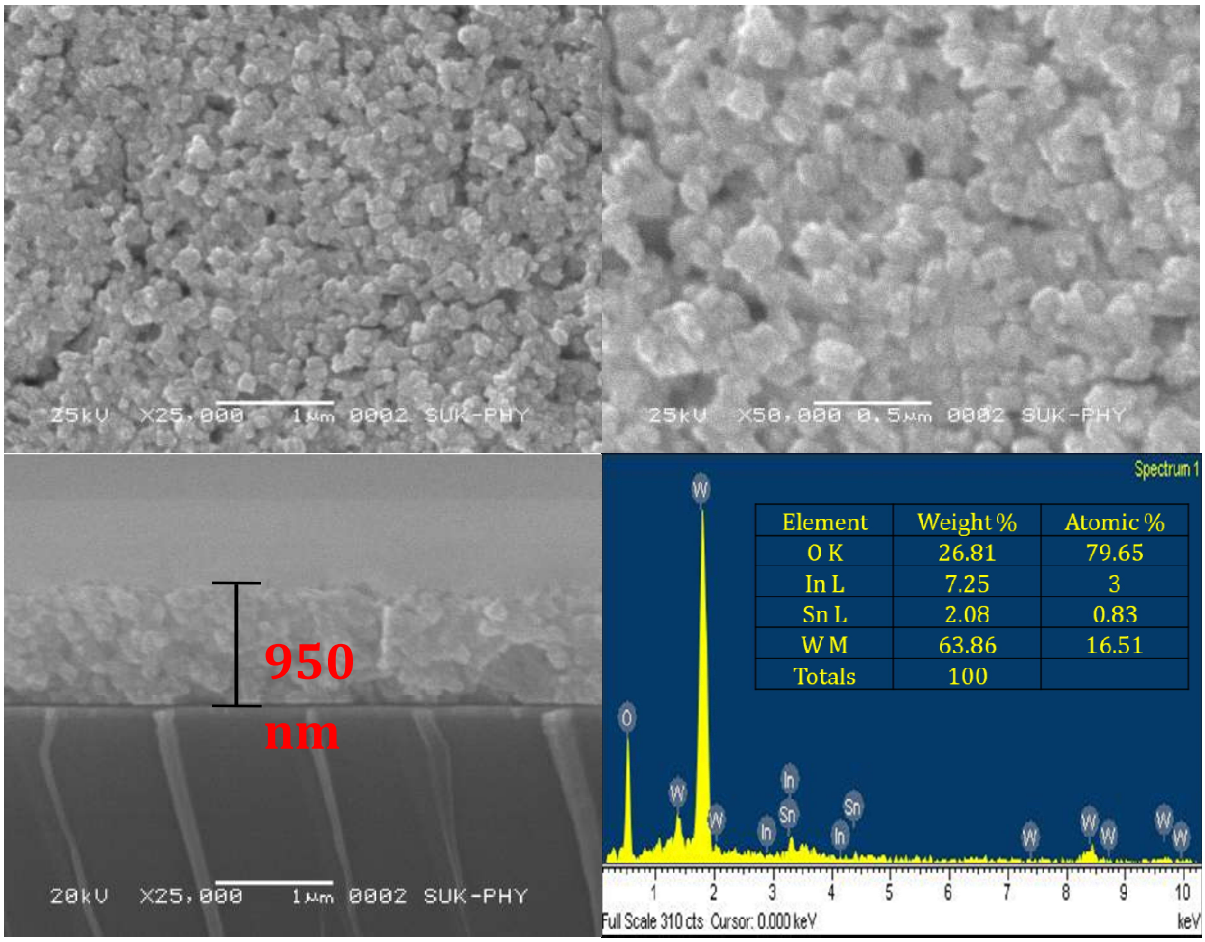

Figure.3 (a and) shows low- and high-resolution images (c) cross sectional image of and (d) EDS spectrum of nanostructured WO_3 thin film deposited on ITO coated conducting glass substrate.

4.4 Electrochromic Study:

Cyclic voltammetry (CV) technique is employed to investigate the cathodic/anodic behavior of WO_3 thin film. The CV was recorded at different scan rates carrying from 20 mV/Sec to 100 mV/sec in 1 M $LiClO_4$-PC electrolyte with a potential window of +1.4 to -1.4 V. The shape of the curves is typical of electrochromism in nanostructured WO_3 film. It is observed that the cathodic and anodic current densities for the nanostructured WO_3 film

was 4.5 mA/cm^2 (cathodic) and 2.5 mA/cm^2 (anodic) at the scan rate of 20 mV/Sec and achieved a value as high as 6 mA/cm^2 (cathodic) and 3.9 mA/cm^2 (anodic) at 100 mV/Sec. The progressive increase in the cathodic and anodic current densities with respect to scan rate indicates the reduction of the W^{6+} ionic state to the W^{5+} state due to intercalation of Li^+ ions towards extreme cathodic potentials as a result of {$WO_3 + Li^+ + e^- \rightarrow Li_xWO_3$} reaction and eventually responsible for blue coloration. Upon anodic polarization (+1.4V), oxidation of WO_3 takes place with simultaneous deintercalation of Li^+ ions and e^- from the film to acquire a transparent (bleached) state as a result of {$Li_xWO_3 \rightarrow WO_3 + Li^+ + e^-$} reaction. When the potentials swept from -1.4 V to +1.4 V the reduced W (i.e: W^{5+}) gets converted into W^{6+} state. It is well known that the area under the curve is directly related to the amount of charge intercalated in the film. This confirms that the nanostructured WO_3 thin film shows pronounced electrochromic properties.

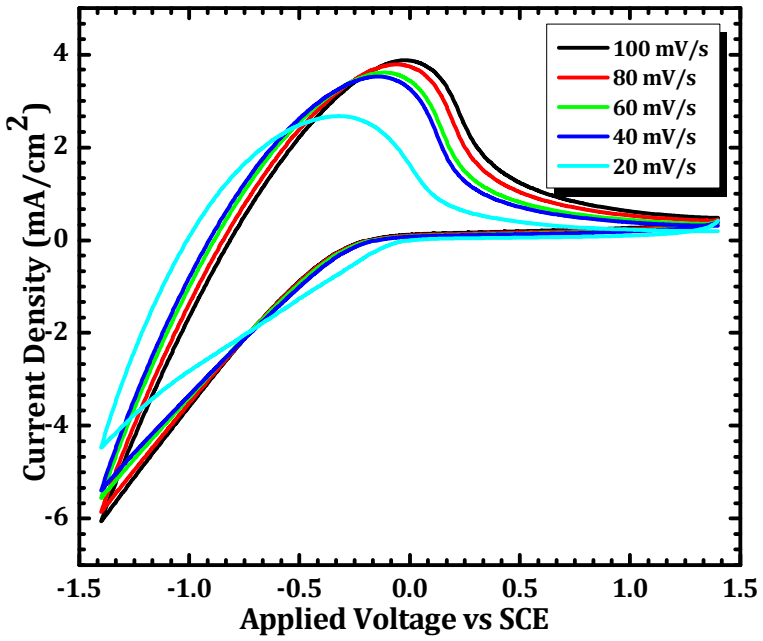

Figure.4 Cyclic voltammograms for the coloration and bleaching cycles of the nanostructured WO_3 thin film recorded in 1M $LiClO_4$-PC electrolyte at different scan rates with a potential window from +1.4 to -1.4V versus SCE.

4.5 X-Ray Photoelectron Spectroscopy Analysis:

X-ray photoelectron spectroscopic (XPS) analysis was carried out on the nanostructured WO_3 thin film to investigate the generation of reduced and oxidized tungsten species under the influence of cathodic and anodic potentials. The binding energies of the samples were corrected using a value of 284.6eV for the C 1s peak of carbon. There is no other contaminated element except C in the nanostructured WO_3 film. Fig. 5 (a) shows the XPS spectra of nanostructured WO_3 film under the action of anodic (+1.4 V) potential.

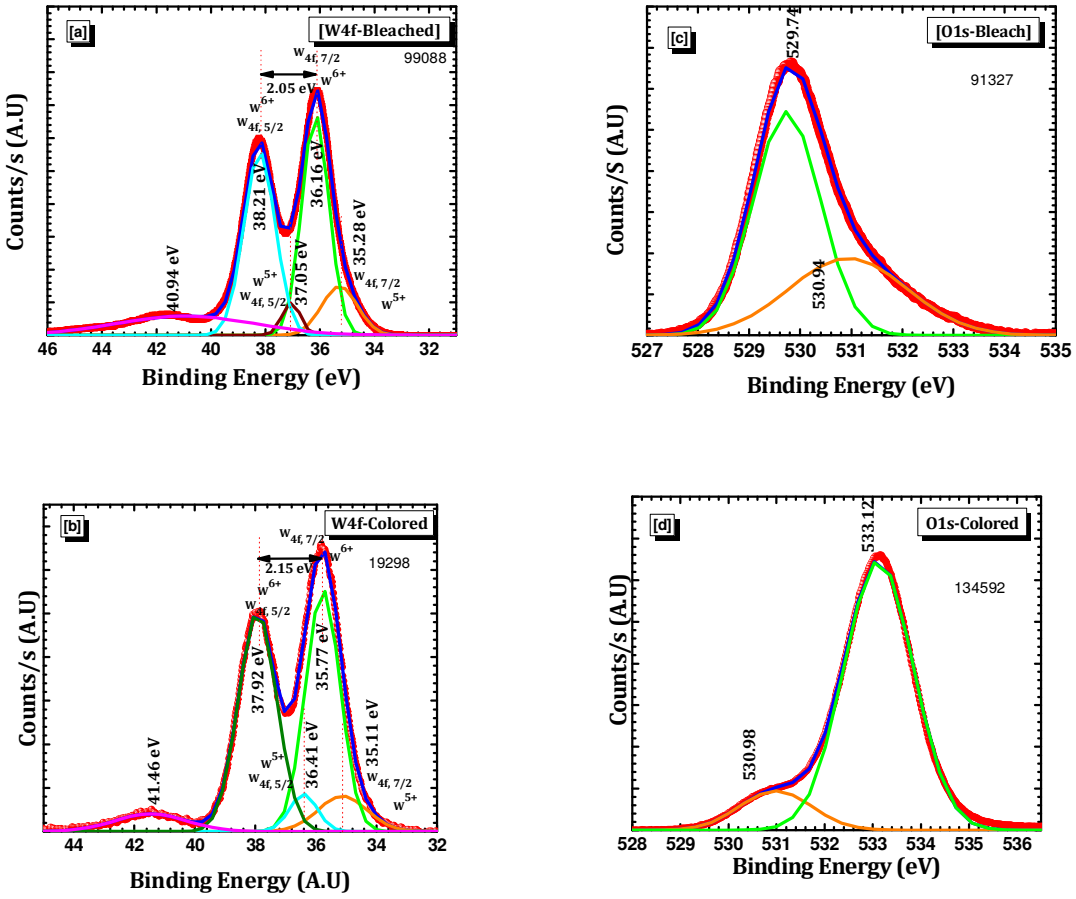

Figure 5. High resolution XPS spectra (a and b) of the W (4f) and (c and d) O (1s) core levels of the WO_3 thin film in bleached and colored state, respectively.

The analysis using XPS revealed a tungsten 4f spectrum in the bleached state composed of the $W4f_{5/2}$ and $W4f_{7/2}$ peaks, which may be deconvoluted into Gaussian peaks centered at

38.21 and 36.11 eV, with XPS $W4f_{7/2}$–$W4f_{5/2}$ spin-orbit separation being 2.05 eV and the area ratio of the two peaks of each doublet being 0.96 corresponds to the tungsten in W^{6+} valence state, which suggests that the film have nominal stoichiometry [10]. On the other hand, the other doublet at 35.28 and 37.05 eV corresponds to a typical W^{5+} oxidation state of W. However, during cathodic (-1.4 V) potential (colored state) peaks corresponds to $W4f_{7/2}$ and $W4f_{5/2}$ shifts toward lower binding energies located at 35.77 eV, 35.11 eV and 37.92 eV, 36.41 eV respectively (Fig.5 (b)). This indicates that the redox reaction takes place between W^{6+} and W^{5+}. The XPS O1s spectrum in both bleached and colored state has been deconvoluted into two components (Fig.5 (c, d)). The binding energy of the first component situated at 529.74 eV (before coloration) above the W $4f_{7/2}$ core level line, corresponds to the W=O bond in the oxide (Fig.5 (c)). However, there is increase in the intensity and shift in binding energy towards higher energy (533.12 eV) after coloration. The second component in both bleached and colored state observed at about 530.94 eV and 530.98 eV could be assigned to water bounded in the film structure or to water molecules adsorbed on the sample surface [11].

4.6 Reversibility:

Chronocoulometry gives quantitative information about the number of protons/ions intercalated or deintercalated on the application of a potential double step for a known amount of time. The reversibility is then given by the ratio of charges deintercalated to the charges intercalated,

i.e.

$$\text{Reversibility} = \frac{Q_{di}}{Q_i}$$

From the chronocoulometry studies (Fig. 6), the electrochromic reversibility of nanostructured WO_3 film was found to be 75 %.

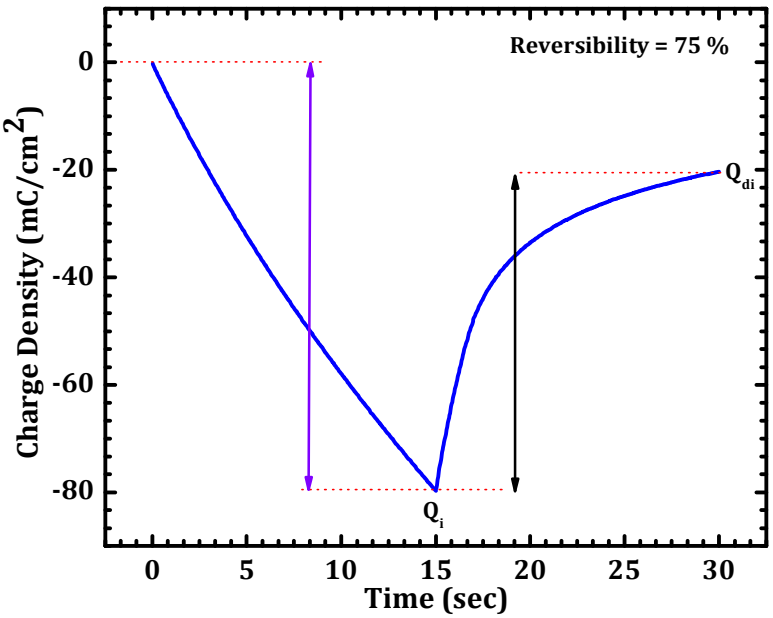

Figure. 6 Chronocoulometry curves of a nanostructured WO_3 thin films recorded in recorded in 1M $LiClO_4$-PC electrolyte upon application of step potential of −1 to +1.4 V vs SCE.

4.7 Optical Transmittance Study:

Fig.7 (a) shows the optical transmission spectra of WO_3 thin film at different applied potentials of -0.2, -0.6, -1.0 and -1.4 V respectively, in the wavelength range from 300 to 1100 nm. The optical transmittance of nanostructured WO_3 thin film in the bleached state (+1.4 V) was found to be 67 % at 555 nm and it changes immensely to 3 % as the potential switched to -1.4 V. Therefore, the optical transmittance modulation of nanostructured WO_3 thin film was 64 %. The enhancement in the transmittance modulation of nanostructured WO_3 thin film because of large surface area and increased textural boundaries where actual coloration/bleaching processes take place. The coloration efficiency (g) describes the optical density change (ΔOD) at a specific wavelength as a function of the injected/ejected electronic charge (Qi), i.e., the amount of charge required to change the optical density, as shown in Eq. 2 [12].

$$\eta = \left(\frac{\Delta OD}{Q_i}\right)_{\lambda=550\,nm} = \left(\frac{\ln(T_b/T_c)}{Q_i}\right), \qquad (2)$$

where T_b is the bleached transmittance and T_c is the colored transmittance. The coloration efficiency of the nanostructured WO_3 thin films has been shown in the Table.1. The high coloration efficiency supports from the fact that nanostructured WO_3 with smaller dimensions prepared by sol-gel provide larger surface area for charge-transfer reactions. It makes the diffusion of ions easier among the materials.

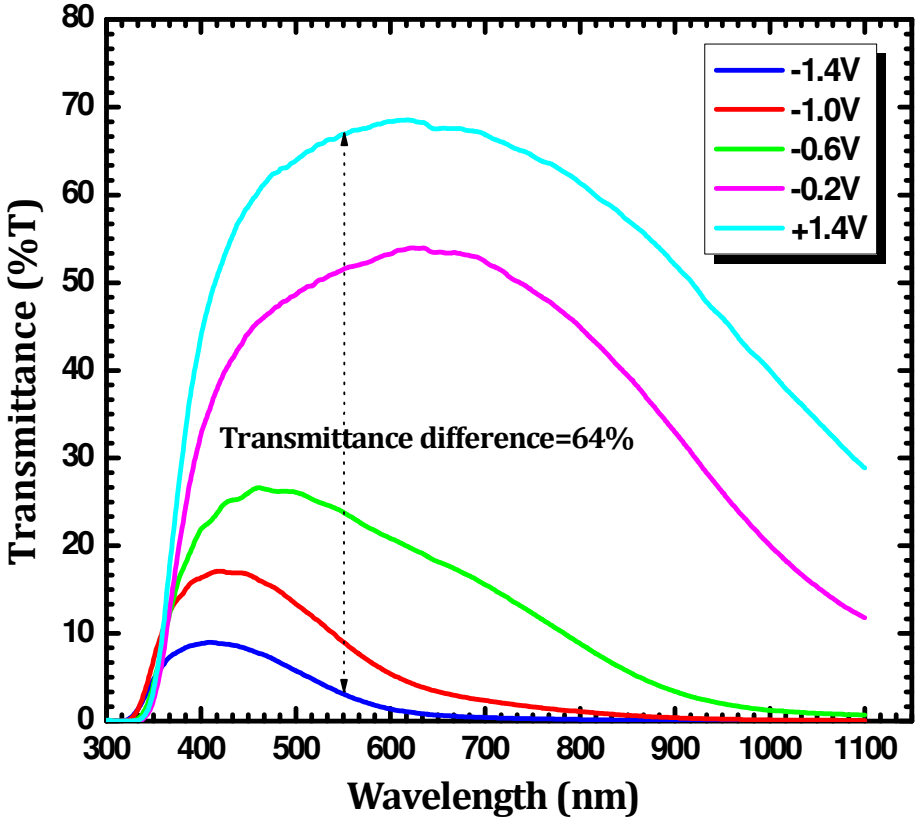

Figure 7. Optical transmission spectra showing colored and bleached states of WO_3 thin film with respect to applied potential.

Table.1 shows various preparative parameters evaluated from electrochromic and optical transmittance studies.

Applied Voltage	Photopic Transmittance T (%)		Photopic Transmittance difference $\Delta T_{Photopic}$ (%)	Optical Density $(\Delta OD)_{\lambda=555\ nm}$	Coloration efficiency (cm^2/C) λ=555 nm
	(T_P) bleached	(T_P) colored			
-0.2	67	51.5	15.5	0.2631	
-0.6	67	24	43	1.02	116
-1.0	67	9	58	2.007	
-1.4	67	3	64	3.10	

4.8 Chromaticity Analysis:

A two-dimensional x-y representation known as the chromaticity diagram utilized to identify the colors of WO_3 thin film in its oxidized and reduced state as shown in Fig.8 (a-b). The shift in x-y co-ordinates occurs once the potential switched from oxidized to reduced state. Fig.4 (a) shows the CIE chromaticity curve of nanostructured WO_3 thin film at different applied potentials. Initially when nanostructured WO_3 thin film is in oxidized state, exhibits a transparent state and its position on the chromaticity curve is close to the white point. As cathodic potential increased from +1.4 to -1.4 V, color of the film immensely changes from transparent to dark blue state as seen by the shift in the position of the x-y coordinate on the chromaticity diagram. In the CIE 1931 Yxy color space, the tristimulus value Y is defined as a measure of the brightness or luminance of the color [13, 14]. Fig.8 (b) shows the relative luminous transmittance (% Y) with applied potential for nanostructured WO_3 thin film. As the potential is switched from +1.4 V to -1.4 V vs SCE, a large change in the xy coordinates occurs as the relative luminance changes from 67 % (bleached) to 3 % (colored) having luminous transmittance difference (ΔY) of 64 %.

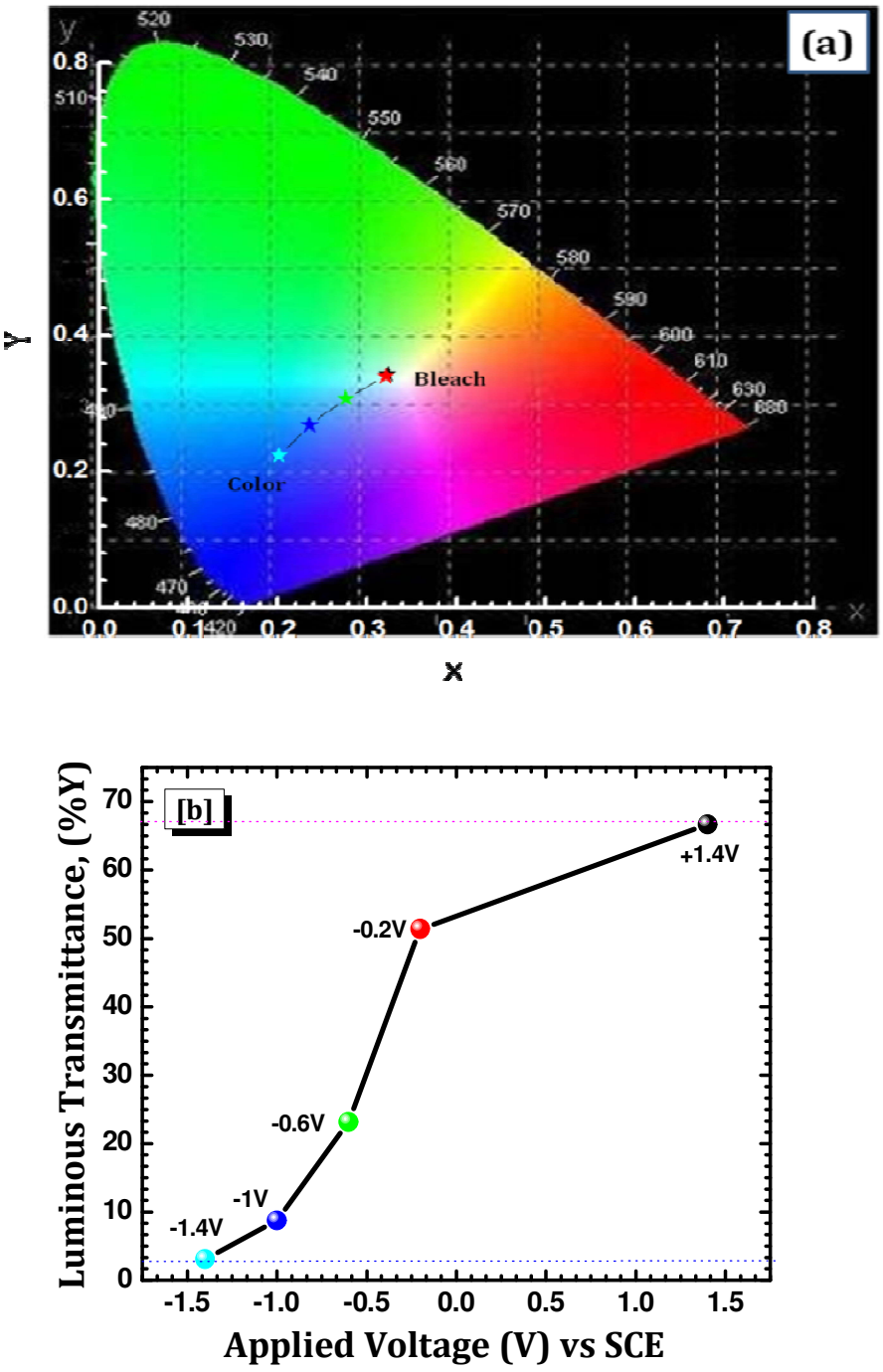

Figure 8. (a) CIE 1931Yxy chromaticity diagram and (a) Luminous transmittance for WO_3 thin film at different applied voltage. The dotted horizontal lines (Fig.8 (b)) indicate difference of luminous transmittance in its colored and bleached state.

Conclusions:

Nanostructured WO_3 thin film has been deposited by sol-gel dip coating method for energy efficient electrochromic smart window application. The XRD pattern confirms the formation of nanocrystalline WO3 thin film with amorphous background which is suitable for electrochromic window application. A well-defined bands observed at 799 and 883 cm^{-1}, in the FT-IR spectra of nanostructured WO_3 thin film is due to the (O–W–O) inter bridging stretching mode in WO_3 confirms the formation of WO_3. From electrochromic study it has been concluded that the sol-gel deposited nanostructured WO_3 thin films exhibits transmittance modulation of 64 % at 555 nm, reversibility of 75 % and coloration efficiency of about 116 cm^2/C. The good transmittance modulation and excellent coloration efficiency of the WO_3 thin films is due to large surface area provided by nanostructured WO_3 thin film. From CIE system of colorimetric analysis and Luminous transmittance modulation it has been evidenced that the color of the WO_3 thin immensely changes from transparent to deep blue which confirms that the film deposited by sol-gel route are well suited for energy efficient electrochromic smart window application.

Acknowledgement:

Project advisor Dalavi and students are thankful to Shivaji University Kolhapur to sanction research proposal through Research Promotion activity for students of affiliated college. We are also thankful to Principal, S.G.M College, Karad for the release of grant.10,000/- and organized Research workshop for our college student to upgrade knowledge in the field of research. We also thankful to our Principal, Dr. C. B. Salunkhe and Co-ordinator, Mr. N. V. Gaikwad, Krishna Mahavidyalaya, Rethare (Bk), for successful implementation of the project.

References:

1. P. M. S. Monk, R. J. Mortimer, D. R. Rosseinsk, Cambridge University Press. (2007).
2. C. G. Granqvist, Handbook of inorganic Electrochromic Materials, Elsevier. 2002, 106.
3. B. W. Faughnan, R. S. Crandall, P. M. Heyman, RCA Rev. 1975, 36 177.
4. E. Avendano, L. Berggren, G. A. Niklasson, C. G. Granqvist, A. Azens, Thin Solid Films. 2006, 496 30.
5. Y. Takahashi, N. Hayashi, K. Oyaizu, K. Honda, H. Nishide, Polymer Journal, 2008, 40 763.
6. D. S. Dalavi, R. S. Devan, R. A Patil, R. S. Patil, Y. R. Ma, S. B. Sadale, I. Y. Kim, J. H. Kim, P. S. Patil J Phys Chem C 1: 2013, 3722–3728.
7. A-C. Dippel, T. Schneller, W. Lehmann, B. Reichenberg and R. Waser, J. Mater. Chem, 2008, **18,** 3501
8. M. Deepa, P. Singh, S. N. Sharma and S. A. Agnihotry, Sol. Energy Mater. Sol. Cells, 2006, **90,** 2665
9. B. Orel, N. Groselj, U. Krasovec, R. Jese, A. Georg, J. Sol-Gel Sci. Technol. 2002, **24,** 5.
10. Y.F. Lu, H. Qiu: J. Appl. Phys, 2000, **88,** 1082.
11. J. Zhang, J. P. Tu, X. H. Xia, Y. Qiao and Y. Lu, Sol. Energy Mater. Sol. Cells, 2009, 93, 1840.
12. J.S.E.M. Svensson and C.G. Granqvist, Proc. SPIE Vol, 1984, **502,** 30.
13. V. Wittwer, O. F. Schirmer, P. Schlotter, Disorder, Solid State Commun, 1978, **25,** 977.
14. D. S. Dalavi, R. S. Devan, R. S. Patil, Y-R. Ma, P. S. Patil, Mat. Letters, 2013, **90,** 60.

Key Indicator 3.1 – Resource Mobilization for Research

3.1.1.1: Total Grants from Government and non-governmental for research projects, endowments in the institution during the year (INR in Lakhs)

Year 2018-19

Name of the Research Project/ Endowments	Name of the Principal Investigator /Co-investigator	Department of Principal Investigator	Year of Award	Amount Sanctioned (in Lakh)	Duration of the project	Name of the Funding Agency	Type (Government /non-Government)
Synthesis and characterization of nanostructured Tungsten oxide conducting polymers core-shell nanostructures for efficient electrochromic smart windows	Dr. D. S. Dalavi	Physics	2018	1.25	2 years	Shivaji University, Kolhapur	Government
Fabrication of Nanostructured PANI thin film for electrochromic smart window and supercopacitor application	Dr. D. S. Dalavi	Physics	2017	0.1	1 year	Shivaji University Minor Research Project under lead college activity	Government
			Total	**1.35**			

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Principal
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Tal. Karad : 415 108 (M.S)

Shetkari Shikshan Prasarak Mandal's

Krishna Mahavidyalaya, Rethare Bk

IQAC 2018-2019

ACTIVITY REPORT
PHYSICS DEPARTMENT

IQAC ACTIVITY No:

NAME OF THE ACTIVITY: "Lead college Activity-Research Project: "Application of nanostructured PANI film for electrochromic smart window and supercapacitor application"			
DATE	**FACULTY**	**DEPARTMENT/COMMITTEE**	**COORDINATOR NAME**
Throughout the academic year	Science	Physics	Dr. Dhanaji S. Dalavi
TIME	**VENUE**	**NUMBER OF PARTICIPANTS**	**NATURE: Outdoor/Indoor**
10.00 am-11.00 am	Physics laboratory	04 students+01 teacher	Indoor
SUPPORT/ASSISTANCE:	Nil		

BRIEF INFORMATION ABOUT THE ACTIVITY (**CRITERION NO. -**):

TOPIC/SUBJECT OF THE ACTIVITY	**"Lead college Activity-Research Project: "Application of nanostructured PANI film for electrochromic smart window and supercapacitor application"**
OBJECTIVES	to analyze a scientific occurrence with an investigation or to solve a problem with an invention.
METHODOLOGY	Experimental work
OUTCOMES	students become active, engaged learners. It also helped students to develop independent critical thinking skills.

PROOFS & DOCUMENTS ATTACHED (Tick mark the proofs attached):

1. Notice & Letters	2. Student list of	**3. Activity report**	**4. Photos**	5. Feedback form
6. **Feedback analysis**	7. News clip with details	8. Certificate	9. Any other	10.

IQAC CELL ACTIVITY NUMBER:

NAME OF TEACHER & SIGNATURE	NAME OF HEAD/ COMMITTEE INCHARGE & SIGNATURE	PRINCIPALS SIGNATURE	IQAC COORDINATOR (SEAL & SIGNATURE)
Dalavi Dr. Dhanaji S. Dalavi	Dalavi Dr. Dhanaji S. Dalavi HEAD DEPARTMENT OF PHYSICS KRISHNA MAHAVIDYALAYA, Rethare Bk; Shivnagar - 415108	Principal Krishna Mahavidyalaya, Rethare Bk, Tal. Karad: 415 108 (MS)	Dalavi IQAC, Coordinator, KRISHNA MAHAVIDYALAYA, Rethare Bk; Shivnagar - 415108 Tal. Karad, Dist. Satara

संहती कार्यसाधिका । शिलं परं भूषणम्
Shetkari Shikshan Prasarak Mandal's
KRISHNA MAHAVIDYALAYA, RETHARE BK.
Shivnagar, Tal. Karad, Dist. Satara, 415108 (M.S.)
Email : kmr_sspm@yahoo.co.in Website : www.krishnamahavidyalaya.com
NAAC 'B+' Grade (CGPA 2.65)
Principal : **Dr. Salunkhe C. B.,** M.Sc., Ph.D. Founder : **Hon. Jaywantrao Bhosale**

Ref. No. : KMR/

Date : 08/09/2018

To,
The Co-coordinator
Lead College Activity
SGM College, Karad

Subject: Submission of application for financial support to research project
Reference: SU/Post graduate admission/6780 dated 5th July, 2018

Respected Sir,

With reference to the above mentioned subject, herewith I am forwarding project proposal entitled **"Fabrication of nanostructured Polyaniline thin film for electrochromic smart windows and supercapacitor application"** under research sensitization scheme for college students initiated by Shivaji University, Kolhapur from June 2017.

Herewith I kindly request you to consider the said project proposal for possible selection.

Yours' Faithfully
PRINCIPAL (I/C)
KRISHNA MAHAVIDYALAYA
RETHARE (BK.), TAL. KARAD

Received 11/8/2018

: Founder :

Padmabhushan
rmaveer Bhaurao Patil
D.Lit.

"Education through self-help is our motto." - Karmaveer

Estd.: 1954

Rayat Shikshan Sanstha's

Sadguru Gadage Maharaj College, Karad

NAAC ACCREDITED : A CGPA 3.63 (Junior & Senior)

VIDYANAGAR, Pin - 415 124, Dist. Satara (M.S.) INDIA P.O. Box No.3
Ph. Office : (02164) 271346 Resi. (02164) 271794 Fax. (02164) 271346
Website : www.sgm.edu.in E-mail : sgmkarad@yahoo.com

ARTS, SCIENCE, COMMERCE & VOCATIONAL

Jr. College No. j.21.02.003 (Affiliated to Shivaji University, Kolhapur)

Principal : Dr. Mohan Rajmane M.Sc., Ph.D.

Ref. No. 1517/ 2018-19

Date :

27/ 10/ 2018

To

The Principal,
Krishna Mahavidyalaya Rethare (Bk.)
Tal.Karad, Dist. Satara.

Sub. : Submission of Research Project under Research Promotion Activity ofr College Students.

I am pleased to inform you that the Research Project under the Research Promotion Activity of the Shivaji University, Kolhapur is received with following details.

Name of Project Advisor	Name of Students	Title of Project	Amount Estimate Rs.
Dr. D. S. Dalavi	1) Desavale Suryashree Vilasrao	Fabrication of Nanostructured Polyaniline thin film for electrochromic smart windows and supercapacitor application.	10,000/-
	2) Jadhav Amol Vijay		
	3) Harale Mohini Rajendra		
	4) Jadhav Nikita Bharat		

Financial assistance under this scheme is subject to final approval and directions of the university.

Thank you,

Yours faithfully,

Principal,
Sadguru Gadage Maharaj College,
KARAD

SADGURU GADAGE MAHARAJ COLLEGE KARAD

a/c

स्थापना : १९५४

''स्वावलंबी शिक्षण हेच आमचे ब्रीद''-कर्मवीर
रयत शिक्षण संस्थेचे,

सद्गुरू गाडगे महाराज कॉलेज, कराड

विद्यानगर, कराड पिन - ४१५ १२४ जि. सातारा (महाराष्ट्र) पो. ऑ. बॉ. नं. ३
फोन : कार्यालय : (०२१६४) २७१३४६ निवास : (०२१६४) २७१७९४ फॅक्स : (०२१६४) २७१३४६
Website : www.sgm.edu .in E-mail : sgmkarad@yahoo.com

• संस्थापक •

पद्मभूषण डॉ. कर्मवीर भाऊराव पाटील
डी.लिट.

• प्राचार्य,
डॉ. मोहन राजमाने
एम.एस्सी., पीएच्.डी.

कला, विज्ञान, वाणिज्य व व्यवसाय शिक्षण
(कनिष्ठ व वरिष्ठ)
(शिवाजी विद्यापीठ, कोल्हापूर संलग्नित)

नॅक मानांकन : A+ CGPA 3.63

संदर्भ क्र. : १९६४/१९-२०

दिनांक : ०८/०१/२०१९

REGISTERED AD

प्रति,

मा.प्राचार्य,
कृष्णा महाविद्यालय, रेठरे बु ॥
जि.सातारा

महो

विषय : अग्रणी महाविद्यालय योजनेअंतर्गत रिसर्च प्रोजेक्टसाठी द्यावयाच्या अॅडव्हान्साबाबत.

संदर्भ : आपलेकडील जा.क्र. केएमआर दि.०८/०१/२०१८ चे पत्र.

महोदय,

आपलेकडील वरील संदर्भपत्रास अनुसरून कळवू इच्छितो की, शिवाजी विद्यापीठाच्या Research Promotion Activity for students of the affiliated Colleges या योजनेअंतर्गत आपल्या विद्यार्थ्यांच्या "Fabrication of Nanostructured Polyaniline thin film for electrochromic smart windows and supercapacitor application" या रिसर्च प्रपोजलसाठी विद्यापीठाने रू. १०००० /- मंजूर केले असून सदर रिसर्च प्रपोजलसाठी सोबत रू.८०००/- चा अॅडव्हान्स रकमेचा चेक नं. ७३४३० दि. १० /०१/२०१९ ने सोबत पाठविला आहे. कृपया सदर रकमेची पोहोच पावती त्वरीत पाठवून द्यावी.

वरील रिसर्च प्रोजेक्टसाठी मंजूर रक्कम रू.१०,०००/- खर्च करून त्याचा हिशोब व प्रोजेक्ट रिपोर्ट या अग्रणी महाविद्यालयाकडे त्वरीत सादर करावा म्हणजे उर्वरीत रक्कम अदा करणे सोईचे होईल.

कळावे, ही विनंती.

आपला विश्वासू,

समन्वयक,
अग्रणी महाविद्यालय,
स.गा.म.कॉलेज, कराड

SADGURU GADAGE MAHARAJ COLLEGE KARAD

प्राचार्य,
अग्रणी महाविद्यालय
सद्गुरू गाडगे महाराज कॉलेज, कराड

सोबत : वरीलप्रमाणे.

संहती कार्यसाधिका । शिलं परं भूषणम्
Shetkari Shikshan Prasarak Mandal's
KRISHNA MAHAVIDYALAYA, RETHARE BK.
Shivnagar, Tal. Karad, Dist. Satara, 415108 (M.S.)
Email : kmr_sspm@yahoo.co.in Website : www.krishnamahavidyalaya.com
NAAC 'B+' Grade (CGPA 2.65)
Principal (I/C) : Dr. Salunkhe C. B., M.Sc., Ph. D. Founder : Hon. Jaywantrao Bhosale

Ref. No. : KMR/ Date :

प्रति.
मा . समन्वयक
अग्रणी महाविद्यालय
सदगुरू गाडगे महाराज कॉलेज
कराड जि . सातारा .

विषय :- अग्रणी महाविद्यालया अंतर्गत राबवलेल्या रिसर्च प्रोजेक्टच्या खर्चाचा अहवाल.

महोदय.

शिवाजी विद्यापीठाच्या Research Promotion activity for students of the affiliated collages या योजनेअंतर्गत या महाविद्यालयातील विद्यार्थ्यांच्या "Fabrication of Nanostructured Polyaniline thin films for electrochromic window and supercapacitor application" या रिसर्च प्रोपोसलं साठी विद्यापीठाने रु. १०००/- मंजूर केले होते. सदर रिसर्च प्रोपोसलं साठी आपणाकडून रु. ८०००/- चा ऍडव्हान्स रकमेचा चेक नं. ७३४३० दि. १०/०१/२०१९ रोजी मिळाला असून त्यानुसार वरील रिसर्च प्रोजेक्टसाठी मंजूर रकमेच्या खर्चाचा तपशील व अहवाल आपणाकडे पाठवीत आहे.

तरी उर्वरित रु.२०32/- या महाविद्यालयास पाठविण्यात यावेत हि नम्र विनंती

खर्चाचा तपशील खालीलप्रमाणे .

अ . नं	तपशील	साहित्य	खर्च
१	Shri. Samarth Trading Company	Chemicals	6620.00
२	Shri. Samarth Trading Company	Glasswares	2026.00
३	Anushka Stationary and General Stores	Stationary	1216.00
	Uma Stores and Xerox	Glass Cutter	120.00
४	Agrani Workshop, SGM college, Karad	Students and Advisor Travelling	150.00
५		Total	10,032=00

समन्वयक
अग्रणी महाविद्यालय विभाग
कृष्णा महाविद्यालय, [illegible], ता. कराड (सातारा)

Dr. C. B. Salunkhe
PRINCIPAL
KRISHNA MAHAVIDYALAYA
RETHARE (BK.), TAL. KARAD

Ref.

Department Physics

To,

Date— 27-2-2019

The Principal,
KRISHNA MAHAVIDY LYA, SHIVNAGAR

Subject– Request to pass the bills for payment,

Sir

Please find herewith the following bills for the payment while passing the bills I have checked the price of each item and is according to the price quoted by the party.

Sr. No.	Name of the Firm	Bill No. / Date	Amount	Deductions if any	Net Paid
	Shri Samrath				
1)	Treding Com.	co/0345 / 22-2-2019	6620-	—	6620=00
	Islampur -				
	415409				
2)	—"—	co/346 / 22-2-19	2026		2026=00
	Rs. Eight thousand Six hundred				8646=00
	Forty six only				

Thanking you,

Yours faithfully,

Lib / Lab / Assistant
Physics Department

HEAD
Head, PHYSICS
Department

DEPARTMENT OF PHYSICS
KRISHNA MAHAVIDYALAYA, SHIVNAGAR

KRISHNA MAHAVIDYALAYA, SHIVNAGAR 415108

GSTIN : 27AMVPP2791E1ZG

TAX INVOICE

Shri Samarth Trading Company

Peth Sangli Road, Opp. Ganesh Servicing Center, Shripadnagar, ISLAMPUR - 415 409
Tal. Walwa, Dist. Sangli. Tel. (02342) 225394, 225773 Mob. 9822256373
E-mail : samarth.trading@yahoo.com samarth4092@gmail.com

Original Buyer's Copy

Invoice No: CO/0345/2018-19 **(Physics Dept.)**
Invoice date: 22 / 02 / 2019
Reverse Charge (Y/N): **PO No.**
State: Maharashtra **Date :** **Code 27**

Transport Mode:
Vehicle number:
Date of Supply :
Challan No.

Bill to Party

Name: The Principal, Krishna Mahavidyalaya,
Address : Shivnagar
Dist : Satara
GSTIN:
State: Maharashtra **Code 27**

Ship to Party

Name:
Address:
GSTIN:
State: **Code**

S. No.	Product Description	HSN code	GST	Qty	Rate	Amount	Discount	Taxable Value	CGST Rate	CGST Amount	SGST Rate	SGST Amount	Total
1	Ferric Chloride Hexa. 500 gm.		18%	1	270.00	270.00	108.00	162.00	9	14.58	9	14.58	191.16
2	Potassum Ferrcyanide 500 gm.		18%	1	1500.00	1500.00	600.00	900.00	9	81.00	9	81.00	1062.00
3	Polyvhyl Alcohol 500 gm.		18%	1	560.00	560.00	224.00	336.00	9	30.24	9	30.24	396.48
4	Ammonia (25-30%) 2.5 Lit.		18%	1	580.00	580.00	232.00	348.00	9	31.32	9	31.32	410.64
5	Hydrogen Peroxide (35%) 500 ml.		18%	2	350.00	700.00	280.00	420.00	9	37.80	9	37.80	495.60
6	Sodium Dodecyl sulphate 500 gm.		18%	1	560.00	560.00	224.00	336.00	9	30.24	9	30.24	396.48
7	Absolut Ethanol 500 ml.		18%	2	360.00	720.00	288.00	432.00	9	38.88	9	38.88	509.76
8	Polyethylenye Glycol 500 ml.		18%	1	400.00	400.00	160.00	240.00	9	21.60	9	21.60	283.20
9	Zinc Acetate 500 gm.		18%	1	530.00	530.00	212.00	318.00	9	28.62	9	28.62	375.24
10	Potassium Hydroxide 500 gm.		18%	1	330.00	330.00	132.00	198.00	9	17.82	9	17.82	233.64
11	Acetonitrile 500 ml.		18%	1	530.00	530.00	212.00	318.00	9	28.62	9	28.62	375.24
12	Hexamethylenetetramine (HMTA) 500 gm.		18%	1	300.00	300.00	120.00	180.00	9	16.20	9	16.20	212.40
13	Dietanolamine 500 ml.		18%	1	360.00	360.00	144.00	216.00	9	19.44	9	19.44	254.88
14	Potassium Persulphate 500 gm.		18%	1	470.00	470.00	188.00	282.00	9	25.38	9	25.38	332.76
15	Potassium Chloride 500 gm.		18%	1	190.00	190.00	76.00	114.00	9	10.26	9	10.26	134.52
16	Whatman Paper Pkt.No. (12.5cm)		18%	1	1350.00	1350.00	540.00	810.00	9	72.90	9	72.90	955.80
	Total			18		9350.00	3740.00	5610.00		504.90		504.90	6619.80

Total Invoice amount in words

Six Thousand Six Hundred Twenty Rupees Only.

Total Amount before Tax	5610.00
Add: CGST	504.90
Add: SGST	504.90
Total Tax Amount	1009.80
Total Amount after Tax:	6619.80
Round Off Total Amount	6620.00

Bank Details

Bank A/C: 579505040000105 Bank Name : Union Bank of India
Bank IFSC: UBIN0557951 Branch : Islampur

Declaration :
We declare that this Invoice shows the actual price of the goods described and that all particulars are true and correct.

Company GSTIN/UIN : 27AMVPP2791E1ZG
Company PAN : AMVPP2791E

Common Seal

Certified that the particulars given above are true and correct

For SHRI SAMARTH TRADING COMPANY

Authorised signatory

GSTIN : 27AMVPP2791E1ZG

TAX INVOICE

Shri Samarth Trading Company

Peth Sangli Road, Opp. Ganesh Servicing Center, Shripadnagar, ISLAMPUR - 415 409
Tal. Walwa, Dist. Sangli. Tel. (02342) 225394, 225773 Mob. 9822256373
E-mail : samarth.trading@yahoo.com samarth4092@gmail.com

Original Buyer's Copy

Invoice No: CO/0346/2018-19 (Physics Dept.)
Invoice date: 22/02 /2019
Reverse Charge (Y/N):
State: Maharashtra

PO No.
Date :
Code 27

Transport Mode:
Vehicle number:
Date of Supply :
Challan No.

Bill to Party

Name: The Principal , Smt. K.R. P Kanya Mahavidyalaya
Address-Rethare BK.
Dist. Satara
GSTIN:
State: Maharashtra **Code 27**

Ship to Party

Name:
Address:
GSTIN:
State: **Code**

S. No.	Product Description	HSN code	GST	Qty	Rate	Amount	Discount	Taxable Value	CGST Rate	CGST Amount	SGST Rate	SGST Amount	Total
1	Beaker 25 ml. Borosil		18%	2	99.00	198.00	59.40	138.60	9	12.47	9	12.47	163.55
2	Beaker 50 ml. Borosil		18%	2	68.00	136.00	40.80	95.20	9	8.57	9	8.57	112.34
3	Beaker 100ml. Borosil		18%	2	72.00	144.00	43.20	100.80	9	9.07	9	9.07	118.94
4	Beaker 250ml. Borosil		18%	2	75.00	150.00	45.00	105.00	9	9.45	9	9.45	123.90
5	Funnel 50mm.Borosil		18%	1	110.00	110.00	33.00	77.00	9	6.93	9	6.93	90.86
6	Pipette 5ml. Borosil		18%	2	160.00	320.00	96.00	224.00	9	20.16	9	20.16	264.32
7	Measuring Cylinder (small 25ml)		18%	1	315.00	315.00	94.50	220.50	9	19.85	9	19.85	260.19
8	Measuring Cylinder (small 50ml)		18%	1	340.00	340.00	102.00	238.00	9	21.42	9	21.42	280.84
9	Petri Dish 100 x 17 mm. Borosil		18%	2	245.00	490.00	147.00	343.00	9	30.87	9	30.87	404.74
10	Conical Flask 250ml.Borosil		18%	2	125.00	250.00	75.00	175.00	9	15.75	9	15.75	206.50
	Total			17		2453.00	735.90	1717.10		154.54		154.54	2026.18

Total Invoice amount in words

Two Thousand Twenty-six Rupees Only.

Total Amount before Tax	1717.10
Add: CGST	154.54
Add: SGST	154.54
Total Tax Amount	309.08
Total Amount after Tax:	2026.18
Round Off Total Amount	2026.00

Bank Details

Bank A/C: 579505040000105 Bank Name : Union Bank of India
Bank IFSC: UBIN0557951 Branch : Islampur

Declaration :
We declare that this Invoice shows the actual price of the goods described and that all particulars are true and correct.

Company GSTIN/UIN : 27AMVPP2791E1ZG
Company PAN : AMVPP2791E

Common Seal

Certified that the particulars given above are true and correct

For SHRI SAMARTH TRADING COMPANY

Authorised signatory

Shri Samarth Trading Company

Peth-Sangli Road, Opp. Ganesh Servicing Center Shripadnagar, ISLAMPUR.
Pin 415 409, Tal. Walwa, Dist. Sangli. Tel (02342) 225394, 225773
Mob. 9822256373 E-mail : samarth.trading@yahoo.com
GSTIN : 27AMVPP2791E1ZG

Date : 05/03/2019 Receipt No. : 540

Received with thanks from M/s. The principal, Krishna Mahavidyalaya, Rethare BK

Rupees Eight thousand six Hundred Fourty six rupees only.

By Cash / D.D. / Cheque No. 024361 Date : 05/03/2019

In Part / Full / Advance Payment of Our Bill No. 0345/0346 Date : / /20

22-2-2019

For Shri Samarth Trading Company

Rs. 8646/-

Subject to realisation of cheque.

Dr. C. B. Salunkhe
PRINCIPAL
KRISHNA MAHAVIDYALAYA
RETHARE (BK.), TAL. KARAD

No. 64 CASH MEMO Mob. 8600505861

UMA STORES & XEROX

Near Krishna Mahavidyalaya, Julewadi, Tal.- Karad, Dist. - Satara.

Shree प्राचार्य, कृष्णा महाविद्यालय

Date 01/07/2019

Description	Total	Rate	Amount Rs. Ps
Glass cutter	- 01	120	120
		Total-	120/-

One hundred twenty only

Authorised sang.

॥ श्री ॥

[illegible]

[illegible]

[illegible]

श्री [illegible] [illegible]

क्रिकेट २१/०२/२०१३ प. [illegible]

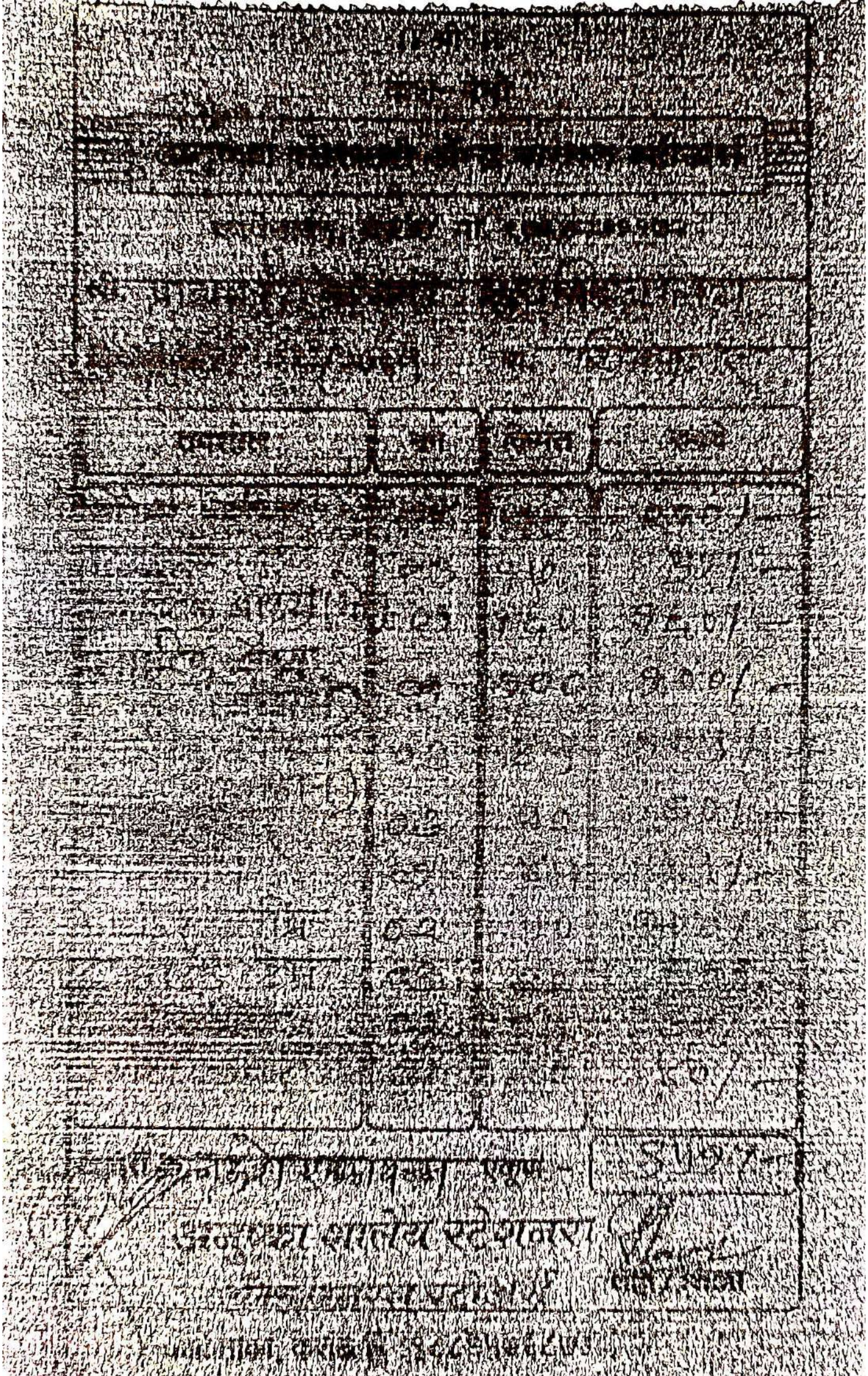
तपशील	नग	किंमत	रुपये
[illegible]	०६	७०	४२०/-
[illegible]	०२	२५	५०/-
[illegible]	०१	४०	४०/-
[illegible]	०२	५५	५५/-
			९६५/-

[illegible] - ९६५/-

[illegible]

[illegible]

[illegible]



Krishna Mahavidyalaya, Rethare Bk.

Tal. Karad, Dist. Satara

Name of Tournament : Lead college workshop. (Jr./Sr.)

Venue of : S.G.M. College, Karad.

Date of Matches : 30 Oct, 2018.

Sr. No.	Name of Student	T. A. Rs.	T. A. Ps.	D. A. Rs.	D. A. Ps.	Total Rs.	Total Ps.	Signature of Student
1)	Mohioi Rajendra Harale	50 =	00			50 =	00	Harale.
2)	Nikita Bharat Jadhav	50 =	00			50 =	00	Jadhav.
3)	Dr. Dhanaji S. Dalavi.	50 =	00			50 =	00	Dalavi.
	(Research promotion activity for student of Affilated colleges. या योजनेअंतर्गत विद्यार्थ्यांसाठी. कार्यशाळा.							
	Research project of, ~~₹~~ 10,000/- मंजूर.							
	Total					150 =	00	

Certified that the above Expenditure of Rs. one hundred fifty only. has actually incurred by me.

Dalavi.
TEAM MANAGER

Rec Rs. 150/- only 31/3

Dr. C. B. Salunkhe
PRINCIPAL

Shivaji University, Kolhapur

RESEARCH SENSITIZATION SCHEME FOR COLLEGE STUDENTS

UNDER LEAD COLLEGE, ACTIVITY

Submission of Project Report

Title of the Project: Fabrication of Nanostructured Polyaniline thin film for electrochromic smart windows and supercapacitor application.

By

Miss. Desavale Suryashree Vilasrao,

Mr. Jadhav Amol Vijay,

Miss. Mohini Harale Rajendra,

Miss. Jadhav Nikita Bharat

Under the Guidance of

Dr. Dhanaji S. Dalavi

Assistant Professor,

Krishna Mahavidyalaya, Rethare (Bk)

Academic Year: 2018-2019

DECLARATION

We hereby declare that, the project report entitled "**Fabrication of Nanostructured Polyaniline thin films for electrochromic window and supercapacitor application**" submitted by us has been completed and written by us, has not previously formed and published in any other University in India or any other country or examining body to the best of our knowledge.

Place: Shivnagar

Date: 27/02/2019

Name of project students.

1. Desavale Suryashree Vilasrao. Davale
2. Jadhav Amol Vijay
3. Harale Mohini Rajendra. Harale
4. Jadhav Nikita Bharat. Jadhav

CERTIFICATE

This is to certify that thesis entitled **"Fabrication of Nanostructured Polyaniline thin films for electrochromic window and supercapacitor application" which** is being submitted herewith is the result of original research work completed by **Miss. Desavale Suryashree Vilasrao, Mr. Jadhav Amol Vijay, Miss. Mohini Harale Rajendra, Miss. Jadhav Nikita Bharat** under my supervision and guidance and to the best of my knowledge and belief, the work embodied in this project work has not formed earlier.

Place: Shivnagar

Date: 27/02/2019

Project Advisor

Dalavi

(Dr. Dhanaji S. Dalavi)

1 INTRODUCTION

Conducting polymers show the remarkable properties of be combining properties of organic polymers in tandem with electronic properties of semiconductors. The ability to tailor the structure of a conjugated polymer allows the rational synthesis of conducting polymers with a broad range of electronic properties [1]. The electronic character of the polymer can be easily manipulated by changing the nature of the repeating unit and the functional groups. Over the past 25 years, the conducting polymers belonging to polyenes or polyaromatics such as polyaniline, polypyrrole, polythiophene, poly(*p*-phenylene) have attracted most attention [2,3] New chemical and physical properties are imparted to conducting polymers by the addition of an appropriate functional group to a conventional polymer [4]. The character and position of the side chains will affect properties like solubility, band gap, ionic conductivity, morphology and miscibility with other substances [5]. The ability to dope conjugated polymers electrochemically is significant, because of the easy combination of synthesis and characterization methods. Electrochemically synthesized polymer allows the determination of molecular weight and molecular weight distribution. Many applications of conjugated polymers, such as light emitting electrochemical cells [6,7], microactuators [8,9], energy storage [10], photovoltaic[11] and electrochromic devices (ECDs) [12,13,14], and sensors [15] are based on electrochemical transition between doped and neutral states or rely on the stability of a specific doping level.

Of the many conducting polymers available, PANI is emerging as a novel material due to its techno-commercial applications and ease of synthesis [16]. Polyaniline (PANI) exists in a variety of forms that differ in chemical and physical properties [17–20]. The most common green protonated emeraldine has conductivity on a semiconductor level of the order of 10 S cm^{-1}, many orders of magnitude higher than that of common polymers ($<10^{-9}$ S cm–1) but lower than that of typical metals (>104 S cm^{-1}). The changes in physicochemical properties of PANI occurring in the response to various external stimuli are used in various applications [21–22], e.g., in organic electrodes, sensors, and actuators [23–25].Other uses are based on the combination of electrical properties typical of semiconductors with materials parameters characteristic of polymers, like the development of “plastic” microelectronics [26],electrochromic devices [27], tailor-made composite systems [28,29], and “smart” fabrics [30].

The establishment of the physical properties of PANI reflecting the conditions of preparation is thus of fundamental importance by an occasionally expressed opinion that “there

are as many polyaniline as the number of people who prepare them". The efficient polymerization of aniline is achieved only in an acidic medium, where aniline exists as an anilinium cation. PANI film is a multichromic polymer i.e. several colors appear as the polymer traverses from the oxidized state to reduced state. Fully reduced PANI is transparent and called leucoemeraldine, with a chemical structure as shown in Figure 1. The dark blue semi-oxidized state in which both the forms are in equal proportion is named emeraldine base and the violet blue fully oxidized material is termed pernigraniline base. Unlike other polyaromatics, none of these states are electronically conducting, not even the fully oxidized pernigraniline form. Instead, PANI becomes conducting when the oxidized states are protonated and a green emeraldine salt is formed. This highly conducting doped form can actually be reached through two completely different pathways. If the emeraldine base is treated with any acid, protonic acid doping occurs as protonation of the imine nitrogen atoms −N==) creates positively charged protonatedimines ($-NH^{+}-$), balanced by negative ions from the acid. This is called as non-redox doping. Chemical or electrochemical doping of the reduced leucoemeraldine base can also be utilized to obtain the very same conducting salt [31].Colorless leucoemeraldine which constitutes the bleached state is formed by chains of benzoid rings separated by nitrogen. This is in the insulating state with a single absorption band at 3.8 eV corresponding to Π-Π^{*} transitions in the benzoid rings. When the Nitrogen atoms become charged, a sharp polaron band appears at~3eV.In ES, 1eV absorption is attributed to intrachain free carrier excitation [32] Anodicaly coloring PANI is reported to have high contrast and multichromic efficiency [33]. A variety of inorganic and organic acids of different concentration have been used in the syntheses of PANI; the resulting PANI, protonated with various acids, differs in solubility, conductivity, and stability Higher acidity of the reaction medium also leads to the increase in the conductivity. Variation in pH on deposition of PANI is very profound. Acid doping of PANI leads to an increase in conductivity by more than eight orders of magnitude [34]. PANI obtained at lower potentials yield higher coloration yields. Over oxidation of PANI leads to degradation of polymer, so that is another parameter which needs to be looked into.

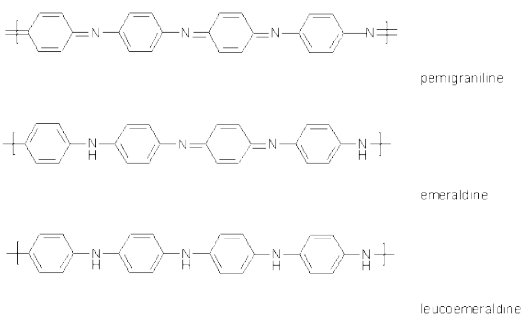


Fig.1. Various possible oxidation states of polyaniline.

The electrochromic process occurring in a PANI ECD in an electrolyte comprising of $LiClO_4$ in a solvent like Propylene Carbonate and Acetonitrile can be written as

$$PANI + xClO_4^- \leftrightarrow (PANI^{x+})(ClO_4^-)_x \text{----------1}$$

Many deposition methods like CBD, electrodeposition, dip coating, etc exist for the deposition of PANI films. However, the In-situ chemical polymerizaion approach has several advantages in that the conducting polyaniline blends and composites are supplied in the form of free standing films and also that the electrical properties of the composites can be modified by simplyvarying the conditions of electrolysis [31].The chemical synthesis is clean. When PANI film is oxidized by chlorate ions, it turns bluish green due to formation of emeraldine base. PANI exists in the quininoid form in this case.When ions reduce the film, the PANI film achieves the insulating state changing from bluish green to transparent yellow due to the benzoid form. An ECD having the following configuration Glass/ITO/PANI/$LICLO_4$+PC+ACN/Graphite was set up and tested for its coloration efficiency, response time and optical density.

2. Experimental Procedure and Characterization Technique.

In a typical experiment 0.5 g of PVA powder with an average degree of polymerization of 1750 was dissolved in 50 ml distilled water at 80 ^oC and stirred for an hour. An FTO electrode of 2 cm^2 with resistance of about 15–20 cm^2 was washed with distilled water and acetone successively. After drying the electrode at room temperature the PVA solution was casted onto FTO substrate to form a PVA thin film by spin coating method. The electrode coated with the PVA film is ready after drying at room temperature for one day. The polyaniline solution was prepared at room temperature using a chemical bath (In-situ chemical polymerizaion) consisting of ammonium persulphate (APS), hydrochloric acid (HCl), aniline and distilled water. 2ml of

aniline was dissolved into 30 ml of 1M HCl in a beaker. In another beaker 1.15 g of $(NH_4)_2S_2O_8$ (APS) was dissolved in 20 ml of 1M HCl. The solution in the second beaker was poured slowly into the first beaker and PVA coated electrode was dipped into PANI solution for 10 min. After deposition, the electrodes were rinsed with distilled water for removing loosely bound PANI precipitate particles. The thickness of films increases by increasing the deposition cycles. The thin films of PVA/PANI were allowed to dry at 100^oC for 5 h.

Prior to deposition, ITO glass substrates were given full cleaning treatment. First they were cleaned with distilled water, acetone, ethanol, isopropyl alcohol and ultrasonic bath. Then they were kept in the vacuum oven for 10 minutes. These cleaned ITO's were stored for further use of deposition of films. The number of cycles was varied in order to obtain smooth, well adherent films. SEM images were taken to obtain information regarding the morphology of PANI films. The films were characterized for the vibrational spectra using FT-RAMAN spectroscopy. The Fourier transform Raman (FT-Raman) spectra of the films were recorded in the spectral range of 250–1000 cm^{-1} using FT-Raman spectrometer (Bruker MultiRAM, Germany) that employs Nd:YAG laser source with an excitation wavelength 1064 nm and resolution 4 cm^{-1}. Electrochemical characterization were carried our using electrochemical quartz crystal microbalance (EQCM) measurements (model-CHI-400A) made by CH Instruments, USA. Optical characterizations were carried out using UV-Vis spectrophotometer (UV 1800, Schimadzu, Japan). In-situ transmittance studies were carried out using a He-Ne Laser (λ=632.8 nm), a Si photodiode and a storage oscilloscope. Colorimetric studies were done using computer controlled software for a 2º observer using D-65 illuminant. Colorimetric determinations were done with the help of Shimadzu color analysis software by analyzing the transmittance spectra of color/bleach state to evaluate the L*a*b* and Yxy co-ordinate values. These obtained values were used as reference data in order to get the observed color in reduced and oxidized state for all samples from online color analysis software with 1931 2° observer and D-65 illuminant proposed by CIE *Yxy* and *L*a*b** coordinates.

3. Results and Discussion:

3.1 Scanning electron microscopy study

The morphological features of PANI samples deposited by in-situ chemical bath deposition are shown in Fig.1. As the number of layers increases PANI thin films transfers its

morphology from smooth to granular structure which provide enough pathways for movement of ions and solvent molecules within the films, thereby improving its coloration efficiency [35].

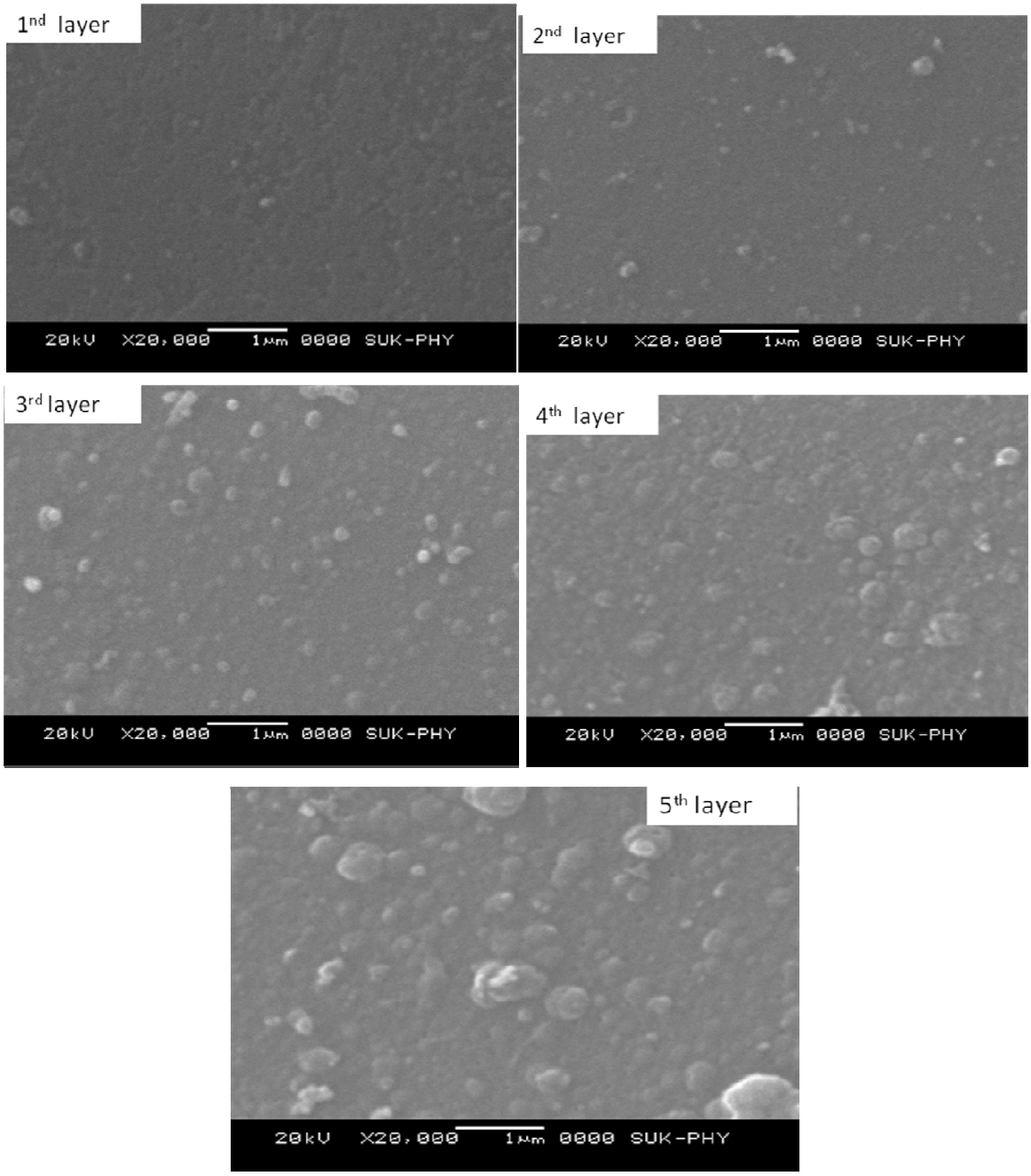


Fig.1 SEM images of PANI thin films

3.2 Raman Spectroscopy:

Raman spectroscopy is a powerful tool to understand the vibrational properties of molecules. It provides definite structural characterizations of PANI because of characteristic dependence of Raman spectrum on the ring constituents of aromatic compounds.

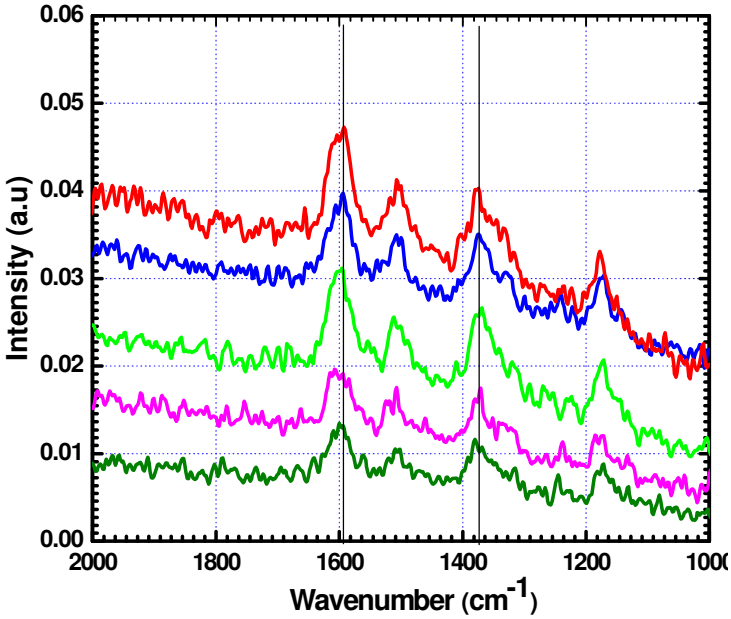


Fig.2. Raman spectra of PANI films deposited for different number of cycles.

Fig.2 shows the Raman spectra of PANI films deposited for different number of cycles. In the spectra,-C-H bending of quinoid ring at 1180 cm^{-1}, –C-H bending of benzoid ring at 1247 cm^{-1},and C-C stretching of the benzene ring was observed at 1498 cm^{-1} and 1600 cm^{-1} respectively revealing the presence of doped emeraldine PANI structure [36,37].

3.3 Optical studies

The UV-Vis absorbance spectra of PANI film was studied by measuring their visible absorption spectra in the range of 190-1100 nm range. The Fig.3 shows the absorbance vs wavelength studies of PANI thin film in two different states. In the as deposited state or the colored state, the absorbance spectra show a broad absorption peak at 600 nm. When insertion of ClO_4^- ions takes place, PANI turns to a transparent pale yellow color. The absorbance in this case is into the far NIR and the film appears transparent. Similar reports have been reported by other groups [38].

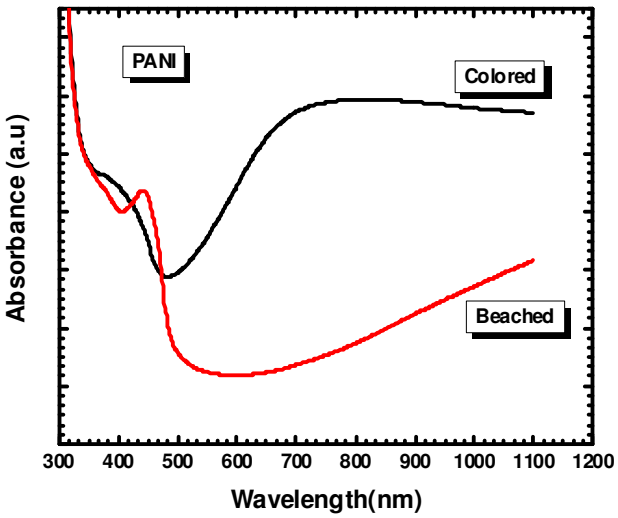


Fig.3. Absorption spectra of PANI (P5) sample in their colored and bleached state in the range of 190-1100 nm. Potential was swept from +1 V to -1 V vs SCE.

3.4 Cyclic voltammetry

Cyclic voltammetry of PANI films was performed in the three electrode cell in 0.5 M $LiClO_4$+PC+CAN (Fig.4). A potential window of -1 to 1 V for cyclic voltammetry studies was chosen at different scan rates from 20mV/s to 100 mV/s. PANI film shows two cathodic peaks at +0.38 V (C1) and -0.28V (C2). Upon the reversal of the potential from -1 V to +1V two anodic peaks were observed at -0.45 V (A1) and +0.6 V (A2) respectively. The cyclic voltammetry was carried out at different scan rates to gather information about the intercalation/deintercalation kinetics.

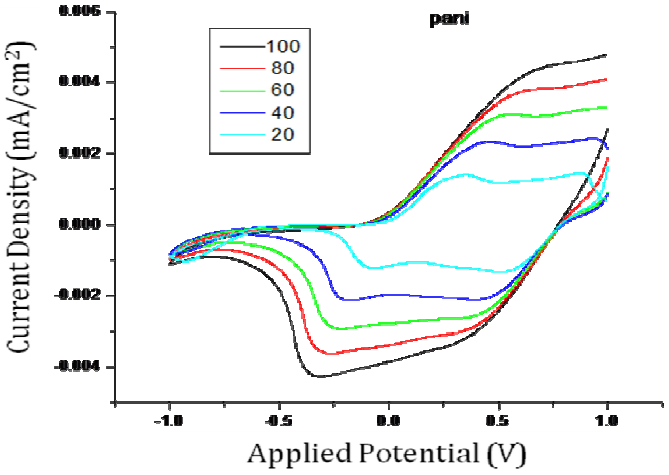


Fig.4 Cyclic voltammograms of PANI film recorded in 0.5 $LiClO_4$+PC+CAN electrolyte. The potential swept from -1 to +1V versus SCE at the scan rate of 20 mV/sec to 100 mV/sec.

Fig.5 shows the plot of square root of scan rate vs the peak anodic and cathodic current. The linear curves show that the reaction is not limited by the ion mobility in the film. The diffusion coefficient calculated for the anodic and cathodic peak current were found to be $6.7x10^{-11}cm^2/s$ and 4.4×10^{-11} cm^2/s

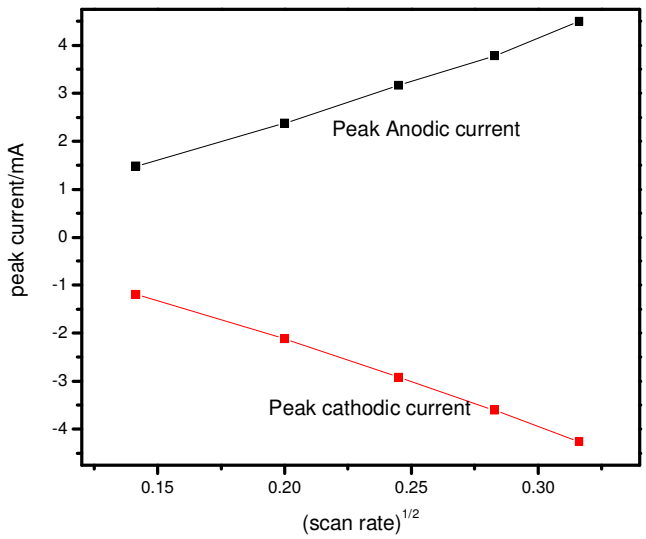


Fig.5. Graph showing linear variation of peak current with root of scan rate.

3.5 In-situ Transmittance-Response time studies:

In-situ characterizations of PANI films were carried out to find the transmittance modulation as a function of time.A square wave potential of ± 1V was applied with a pulse width of 15s. Initially as deposited PANI is in the colored state.When a negative pulse of -1V was applied, the film switched from its conducting emeraldine state to transparent leucoemeraldine state. The bleaching time is defined as the time taken for the transmittance to change from 0 to 80% of its maximum value. This switching time referred to as bleaching time t_b as seen from the graph was found to be 0.80 s.In the reverse cycle,on the application of a positive pulse,the film started to regain its colored state.This time is referred to as coloring time t_c. The coloring time is defined as the time taken for the film transmittance to change from100% to 20% of its maximum value.This time was found to be1.10 s.Such fast response time makes the conducting polymers ideal candidates for switching applications.

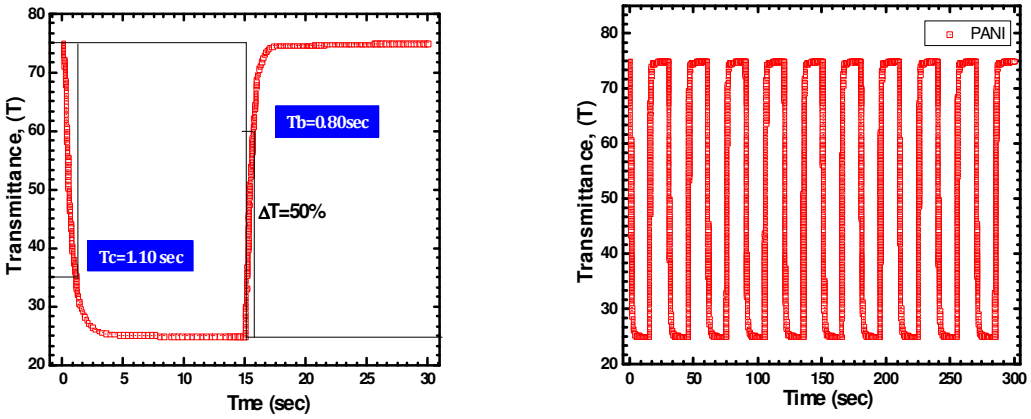


Fig.6 In-Situ Transmittance-Time response of PANI thin film in colored and bleached state a) for one cycle b) for 10 cycles.

3.6 Coloration Efficiency

The coloration efficiency (η) at a particular wavelength correlates with the optical contrast, i.e. the change in optical density with charges intercalated per unit electrode area (q/A) and it can be expressed as:

$$C.E = \frac{\Delta OD}{Q_i} = \frac{2.303 \log \frac{T_b}{T_c}}{q/A} \quad \text{---------- (3)}$$

where T_b and T_c are the transmittance in the colored and bleached state and Q_i is the number of charges into the film. The coloration efficiency was found to be 90.60 $cm^{2/}/C$

3.7 Colorimetric studies

Fig.7 shows the PANI films were characterized using color software for a 2° observer using D-65 illuminant.The values of Lab are listed in the table.1.The xy value plotted for different values of the applied potential. Unlike other polymers,PANI exhibits a parabolic curve on the chromaticity diagram.The trajectory of PANI film follows a curved path is shown in the chromaticity diagram.In the initial state,when PANI is in as deposited condition,it exhibits a bluish green color.As the applied negative potential increases,the color of the film changes from blue to green.With further increase in the negative potential,the film becomes light yellow or nearly transparent in color.The Lab values in the initial and final stages are listed in the table.1. In the colored state, L value is 57.17 i.e: in this case, the transmittance is low. The negative value of 'a' at -11.44 and a high value of 'b' at 26.59 signify the bluish green tinge in the film. In the bleached state, the L value changes to 86.25 signifying an increase in transparency of the film. The value of 'a' and 'b' now fall down to -2.77 and 7.65 indicating a weak yellow color.The dominant wavelength is found by drawing a straight line from the white point through the position of the point at a specific coordinate. In the transparent state this wavelength is given by 575 nm. In the colored state, the dominant wavelength is found to be 500 nm. The changes in L values in the colored and bleached state give the transmittance attenuation.This change in transmittance is found to be 31.78.

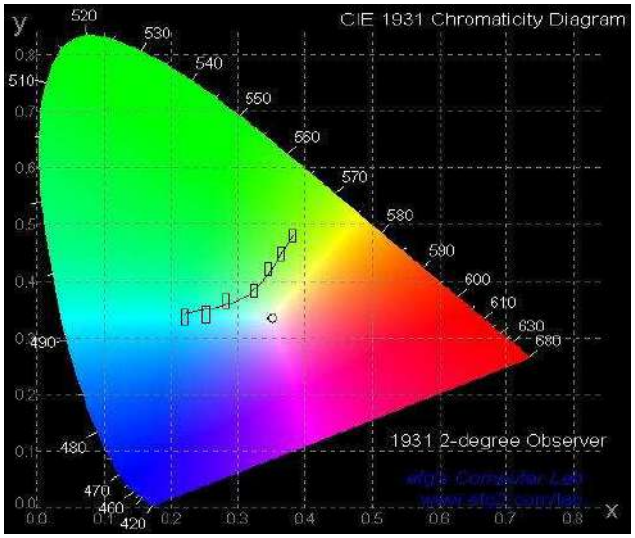


Fig.7. CIE 1931 xy chromaticity diagrams for oxidation/reduction (colored/bleached) of PANI thin film.

4 Conclusions

PANI films were successfully deposited by in-situ chemical polymerization. The films s had a smooth surface with a good adherence to the substrate.The thickness of the films was varied with the number of cycles. SEM studies show transfer from smooth to granular structure of in-situ chemically polymerized PANI films with increase in deposition cycle which are advantageous for easy ion insertion /extraction.Raman spectra show the characteristic stretching and bending vibrations.ECD comprising of PANI films show an optical modulation of 50 %. The device shows a fast response time of 1.10 sec and 0.80 sec for coloring and bleaching respectively.The films show a large variation of 31.78 in L^* value showing a good optical modulation.

References:

1. J.R. Reynolds, A. Kumar, J.L. Reddinger, B. Sankaran, S.A. Sapp, G.A.Sotzing, Synth. Met. 85 (1997) 1295.
2. D. Kumar, R.C. Sharma, Eur. Polym. J.34 (1998) 1053.
3. L.B. Groenendaal, F. Jonas, D. Freitag, H. Pielartzik, J.R. Reynolds, Adv. Mater. 12 (2000) 481.
4. A. Cirpan, S. Alkan, L. Toppare, Y. Hepuzer, Y. Yagci, J. Poly. Sci.: Part A: Poly. Chem. 40 (2002) 4131.
5. T. Johansson, W. Mammo, M. Svensson, M. AnderssonJ. Mater. Chem. 13 (2003)1316.
6. Q. Pei, G. Yu, C. Zhang, Y. Yang, A.J. Heeger, Science. 269 (1995) 1086.
7. T. Johansson, W. Mammo, M. Svensson, M.R. Andersson, Chem. Mater. 11(1999) 3133
8. Q. Pei, H. Jarvinen, J.E. Osterholm, O. Inganaes, J. Laakso, Macromolecules. 25 (1992) 4297.
9. E.W.H. Jager, O. Inganas, I. Lundstr¨om, Science. 288 (2000) 2335.
10. Y. Gofer, J.G. Killian, H. Sarker, T.O. Poehler, P.C. Searson, J. Electroanal. Chem. 443 (1998) 103.
11. T. Yohannes, O. Inganas, J. Electrochem.Soc. 143 (1996) 2310.
12. E. Sahin, P. Camurlu, L. Toppare, V.M. Mercore, I. Cianga, Y. Yagci,, Electroanal. Chem. 579 (2005) 189.
13. E. Aslan, P. Camurlu, L. Toppare, J. Macromol.Sci., Pure Appl. Chem. A42 (4) (2005) 451.
14. G. Sonmez, H. Meng, F.Wudl, Chem. Mater. 16(2004) 574.
15. J. Bobacka, Anal. Chem.71 (1999) 4932.
16. S.Shreepathi[Dodecylbenzenesulfonic Acid: A Surfactant and Dopant for the Synthesis of ProcessablePolyaniline and its Copolymers:Thesis.
17. A. G. MacDiarmid and A. J. Epstein. Faraday Discuss. Chem. Soc. 88 (1989) 317.
18. J. Stejskal, P. Kratochvil, A. D. Jenkins. Polymer 37 (1996) 367.
19. D. C. Trivedi. In Handbook of Organic Conductive Molecules and Polymers, H. S. Nalwa (Ed.), Wiley, Chichester2 (1997) 505.
20. N. Gospodinova and L. Terlemezyan. Prog. Polym. Sci. 23 (1998) 1443.
21. B. G. Levi. Phys. Today 53 (12) (2000) 19.
22. A. G. MacDiarmid. Angew. Chem., Int. Ed. 40(2001) 2581.
23. Z. Jin, Y. Su, Y. Duan. Sens. Actuators B 72(2001) 75.
24. P. T. Sotomayor, I. M. Raimundo, A. J. G. Zarbin, J. J. R. Rohwedder, G. O. Netto, O. L.Alves. Sens. Actuators B 74(2001) 157.
25. L. A. P. Kane-Maguire and G. G. Wallace. Synth. Met. 119(2001) 39.
26. R. J. Hamers. Nature 412 (2001) 489.
27. D. R. Rosseinsky and R. J. Mortimer. Adv. Mater. 13(2001) 783.
28. J. Prokes, I. Krivka, E. Tobolkova, J. Stejskal. Polym. Degrad. Stab. 68 (2000) 261.

29. G. K. Elyashevich, L. Terlemezyan, I. S. Kuryndin, V. K. Lavrentyev, P. Mokreva, E. Yu. Rosova, Yu. N. Sazanov. Thermochim. Acta 374 (2001) 23.
30. M. A. El-Sherif, J. Yuan, A. G. MacDiarmid. J. Intelligent Mater. Syst. Struct. 11 (2000) 407.
31. J. Anand, S. Palaniappan, and D. N. Sathyanarayana, Prog. Polym. Sci. 23 (1998)993.
32. A. G. MacDiarmid and A. J. Epstein. *Faraday Discuss. Chem. Soc*. **88**(1989) 317.
33. L. Zhang, S. X. Xiong, J. Ma, X. Lu, Solar. Ener. Mater. Sol. Cells 93 (2009) 625.
34. J. C. Chiang, A. G. MacDiarmid, Synth. Met., 13 (1986) 193.
35. C. Peng, J. Jin, G. Z. Chen, Electrochimica acta. 53 (2007) 525.
36. D. S. Patil, J. S. Shaikh, D. S. Dalavi, S. S. kalagi, P. S. Patil, Mat. Chem and Phy 128 (2011) 449.
37. X. B. Yan, Z. J. Han, Y. Yang, B. K. Tay, Sensors and actuators B 123 (2007)107.
38. X. F. Yu, Y. X. Li, N. F. Zhu, Q. B. Yang, and K. Kalantar-zadeh, Nanotechnology 18 (2007) 015201

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शिवाजी विद्यापीठ, कोल्हापूर -४१६००४ महाराष्ट्र(महाविद्यालये व विद्यापीठ विकास विभाग)
दुरध्वनी: (ईपीएबीएक्स) २६०९०००, २६०९१४५
फॅक्स: ००९१-२३१-२६९१५३३,२६९२३३३,२६९३२९४

Estd: 1962
NAAC "A" Grade

Ref No. : SU/C&U.D.Section/86/233 Date: 10 MAY 2018

To,
Dr. Dhanaji Suresh Dalavi,
Krishna Mahavidyalaya,
Rethare Bk., Dist: Satara.

Sub: Your project entitled, "*Synthesis of Tungsten Oxide - Conducting Polymers Core-Shell nanostructures for efficient Electrochromic Smart Windows*"
Ref : Our Office Circular No : SU / C.&U.D. Section/ UGK/ 347, dt. 11/07/2017.

Sir / Madam,

With reference to your application for financial assistance for scheme under Research Initiation Scheme-2017-2018, I am directed to inform you that the research project entitled ***"Synthesis of Tungsten Oxide - Conducting Polymers Core-Shell nanostructures for efficient Electrochromic Smart Windows"*** has been accepted for the financial support under the shceme for the period of two years **(2018-2019 to 2019-2020).** The total grant for the projects will be **₹.125000/- (₹. One Lakhs Twenty Five Thousand Only).** The first installment (i.e.advance) of **₹.112500/- (₹. One Lakhs Twelve Thousand Five Hundred Only)** will be released after receiving the following documents i.e. ***University approval letter (Change in Staff), appointment letter, Confirmation Order, Undertaking duly signed by the P.I and Principal in the prescribed format, Acceptance letter (Annex. B), Aadhar Card Zerox, Pan Card Zerox, Passbook zerox (Joint passbook), Advance Stamp Receipt etc.,***

The Details of the funds sanctioned. :

Sr. No	Item	Amount sanctioned in Rs.			Grant released as First installment
		1st Year	2nd Year	Total	
A)	**Recurring**				
	1) Books and Journals	₹.0/-	₹.0/-	₹. 0/-	₹. 0/-
	2) Hiring Services	₹. 0/-	₹.0/-	₹. 0/-	₹. 0/-
	3) Field Work and Travel	₹.0/-	₹.0/-	₹. 0/-	₹. 0/-
	4) Chemical and Glassware	₹.10000/-	₹.10000/-	₹.20000/-	10000/-
	5) Contingency	₹.2500/-	₹.2500/-	₹. 5000/-	₹. 2500/-
B)	**Non-recurring**				
	*Equipment	₹. 100000/-	₹. 0/-	₹. 100000/-	₹. 100000/-
	Total	**₹. 112500/-**	**₹. 12500/-**	**₹. 125000/-**	**₹. 112500/-**

* Name of the Equipment Equipment : **Hydorthermal reactor, Programmable furnace, Spin Coater with Micro Centrifuge and Digital Balance**

Kindly submit the above documents with duly signed in prescribed format to Registrar, Shivaji University, Kolhapur, at the earliest so as to release the grant.

Thanking you,

Yours faithfully,

Deputy Registrar,
Colleges and University Development Section
Shivaji University, Kolhapur

Encl. :- As above
Copy to:

- Account (P.G. Bill) Section
- The Principal/Head, Krishna Mahavidyalaya, Rethare Bk., Dist- Satara
- Dr. P. V. Anbhule, Co-ordinator, Department of Chemistry, Shivaji University, Kolhapur.

संहती कार्यसाधिका । शिलं परं भूषणम्
Shetkari Shikshan Prasarak Mandal's
KRISHNA MAHAVIDYALAYA, RETHARE BK.
Shivnagar, Tal. Karad, Dist. Satara, 415108 (M.S.) Ph. : 02164-266346, Fax : 02164- 266347
Email : kmr_sspm@yahoo.co.in Website : www.krishnamahavidyalaya.com
NAAC "B+" Grade (CGPA 2.65)
Founder : Hon. Jaywantrao Bhosale President : Dr. Suresh Jaywantrao Bhosale
Principal : Dr. Salunkhe C. B., M.Sc; Ph.D.

Key Indicator 3.1 – Resource Mobilization for Research

3.1.1.1: Total Grants from Government and non-governmental for research projects, endowments in the institution during the year (INR in Lakhs)

Year 2017-18

Name of the Research Project/ Endowments	Name of the Principal Investigator /Co-investigator	Department of Principal Investigator	Year of Award	Amount Sanctioned (in Lakh)	Duration of the project	Name of the Funding Agency	Type (Government /non-Government)
Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
			Total	**00**			

Krishna Mahavidyalaya, Rethare Bk. Shivnagar 415108

Principal
Krishna Mahavidyalaya, Rethare Bk.
Tal. Karad : 415 108 (M.S)