Estd: 1962
NAAC "A" Grade

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

Ref No. : SU/C&U.D.Section/**88/** 584 Date: 27 JUL 2018

To,
Dr. Gaurav Mahadev Lohar,
Lal Bahadur Shastri College of Arts, Science And Commerce,
Satara

Sub. :- Grants Release order under **Research Initiation Scheme 2017-2018.**

Sir/Madam,

With reference to above mentioned subject, I am directed to inform you that, the University authorities have approved your research proposal entitled ***"Performance and evaluation of copper oxide reduced graphene oxide composite for supercapacitor and biosensor applications"*** under **Research Initiation Scheme 2017-2018.**

- As per project guidelines, total grants of **₹. 70000/-** has been sanctioned to your research project and out of grant **₹. 55000/-** sending herewith as a first installment vide cheque bearing number **329328** dt. **10/7/2018.**
- The second installment of remaining grants will be released in second year of the project, provided annual progress report is submitted by you on or before the end of the first year of the project.
- The effective date of start of the project should be the date on which grant is credited to you. The total period of the project will be for two years and under no circumstances it will be extended further.

Thanking you,

INWARD
Inward No. 332/18-19
Date 31/8/18
File No.

Yours faithfully,

Deputy Registrar,
Shivaji University, Kolhapur.

Encl. : As above.

Copy to;
The Principal/~~Head of the Department~~
Lal Bahadur Shastri College of Arts, Science And Commerce, Satara

Prof. Dr. G. M. Lohar (Physics)
2/8/18

SHIVAJI UNIVERSITY, KOLHAPUR

RESEARCH INITIATION SCHEME

Statement of Expenditure in respect of Research Project

1. **Name of Principal Investigator:** Dr. G. M. Lohar
2. **Name of College/Institution:** Lal Bahadur Shastri College of Arts, Science and Commerce, Satara.
3. **University approval No. and Date:** SU/C&U.D.Section/88/584 dated 27Jul 2018.
4. **Title of the Research Project:** Performance and evaluation of Copper oxide reduced graphene oxide composite for supercapacitor and biosensor application
5. **Effective date of starting the project:** 27/07/2018

- **Period of Expenditure:** From 27/07/2018 to 29/03/2019.
- **Details of Expenditure**

Item	Sanctioned Amount (Rs.)	Expenses incurred (Rs.)
A) Non-recurring component:	-	-
i) Equipment	40000/-	40000/-
ii) Books/Journals	-	-
B) Recurring component:	-	-
(i) Hiring Services	-	-
(ii) Field Work and Travel	-	-
(iii) Chemicals and glassware	25000/-	12500/-
(iv) Contingency (including special needs)	5000/-	2500/-
Total (Rs.)	**Rs. 70000/-**	**Rs. 55000/-**

(b) (1) As a result of check or audit objective, some irregularity is noticed, at a later Date, action will be taken to refund, adjust or regularize the objected amounts.

1. (2) It is certified that the grant of Rs. **55000/-**(Rupees **Fifty five thousand only**) received from the University under the scheme of support for Research Project entitled **Performance and evaluation of Copper oxide reduced graphene oxide composite for supercapacitor and biosensor application** vide University letter No.**SU/C&U.D.Section/88/584** dated **27Jul 2018** has been fully utilized for the purpose for which it was sanctioned and in accordance with the terms and conditions laid down by the University.

Principal Investigator
Dr. G. M. LOHAR
Project Investigator
Shivaji University Project
Department of Physics
Lal Bahadur Shastri College of Arts, Science & Commerce, Satara

GANESH KHATAVKAR & ASSOCIATES
M.No.132071
FRN 133687W
SATARA
Statutory Auditor
Chartered Accountants

For Ganesh Khatavkar & Associates
Chartered Accountants
Ganesh Khatavkar (Proprietor)
FRN:133687W

Principal
PRINCIPAL
Lal Bahadur Shastri College of Arts, Science & Commerce, Satara

UDIN No:- 15132071AAAADV3623.

SHIVAJI UNIVERSITY, KOLHAPUR
RESEARCH INITIATION SCHEME

Utilization certificate

Certified that the grant of Rs.55000/- Rupees **Fifty Thousand only** received from the University under the scheme of support for Research Project **entitled Performance and evaluation of Copper oxide reduced graphene oxide composite for supercapacitor and biosensor application** vide Shivaji University letter No.F. **SU/C&U.D.Section/88/584** dated **27.Jul 2018** has been fully utilized for the purpose for which it was sanctioned and in accordance with the terms and conditions laid down by the University.

Principal Investigator
Dr. G. M. LOHAR
Project Investigator
Shivaji University Project
Department of Physics
Lal Bahadur Shastri College of Arts, Science & Commerce, Satara

Principal
PRINCIPAL
Lal Bahadur Shastri College of Arts, Science & Commerce, Satara

GANESH KHATAVKAR & ASSOCIATES
M.No.132071
FRN 133687W
SATARA
Chartered Accountants

For Ganesh Khatavkar & Associates
Chartered Accountants
Ganesh Khatavkar
(Proprietor)
FRN:133687W

UDIN No:- 15122021AAAADV7683

SHIVAJI UNIVERSITY, KOLHAPUR

RESEARCH INITIATION SCHEME

Statement of Expenditure in respect of Research Project

1. **Name of Principal Investigator:** Dr. Gaurav Mahadev Lohar.
2. **Institution:** Lal Bahadur Shastri college of Arts, Science and Commerce Satara.
3. **University approval No. and Date:** SU/C&U.D.Section/88/584 dated 27 Jul 2018.
4. **Title of the Research Project:** Performance and evaluation of copper oxide reduced graphene oxide composite for supercapacitor and biosensor applications.
5. **Effective date of starting the project:** 27/07/2018.
6. **(a) Period of Expenditure:** From 01/04/2019 to 31/03/2020.

(b) Details of Expenditure:

Item	Sanctioned Amount (Rs.)	Expenses incurred (Rs.)	
		27/07/2018 to 31/03/2019	01/04/2019 to 31/03/2020
B) Non-recurring component:	-	-	-
i) Equipment	40,000/-	40,000/-	-
ii) Books/Journals	-	-	-
B) Recurring component:	-	-	-
(i) Hiring Services	-	-	-
(ii) Field Work and Travel	-	-	-
(iii) Chemicals and glassware	25,000/-	12,500/-	12,500/-
(iv) Contingency (including special needs)	5,000/-	2,500/-	2,500/-
Total (Rs.)	**Rs. 70,000/-**	**Rs. 55,000/-**	**Rs. 15,000/-**

(c) (1) As a result of check or audit objective, some irregularity is noticed, at a later Date, action will be taken to refund, adjust or regularize the objected amounts.

(2) It is certified that the grant of **Rs. 15,000/- (Rupees Fifteen thousand only)** received from the University under the scheme of support for Research Project entitled "Performance and evaluation of copper oxide reduced graphene oxide composite for supercapacitor and biosensor applications" vide University letter No. **SU/C&U.D.Section/88/584 dated 27 Jul 2018** has been fully utilized for the purpose for which it was sanctioned and in accordance with the terms and conditions laid down by the University.

Principal Investigator

Dr. G. M. LOHAR
Project Investigator
Shivaji University Project
Department of Physics
Lal Bahadur Shastri College of
Arts, Science & Commerce, Satara

NIKHIL OSWAL & ASSOCIATES
M.No.183801
FRN No. 147098W
CHARTERED ACCOUNTANTS

Statutory Auditor

Principal

PRINCIPAL
Lal Bahadur Shastri College of
Arts, Science & Commerce, Satara

SHIVAJI UNIVERSITY, KOLHAPUR
RESEARCH INITIATION SCHEME

Utilization certificate

Certified that the grant of Rs. **15,000/-** Rupees **Fifteen thousand only** received from the University under the scheme of support for Research Project entitled "**Performance and evaluation of copper oxide reduced graphene oxide composite for supercapacitor and biosensor applications**" vide Shivaji University letter No. **SU/C&U.D.Section/88/584** dated **27 Jul 2018** has been fully utilized for the purpose for which it was sanctioned and in accordance with the terms and conditions laid down by the University.

Principal Investigator
Dr. G. M. LOHAR
Project Investigator
Shivaji University Project
Department of Physics
Lal Bahadur Shastri College of
Arts, Science & Commerce, Satara

Principal
PRINCIPAL
Lal Bahadur Shastri College of
Arts, Science & Commerce, Satara

For NIKHIL OSWAL & ASSOCIATES
CHARTERED ACCOUNTANTS

NIKHIL OSWAL & ASSOCIATES * CHARTERED ACCOUNTANTS *
M No.183801
FRN No. 147098W

NIKHIL I. OSWAL
(PROPRIETOR)

SHIVAJI UNIVERSITY, KOLHAPUR

RESEARCH INITIATION SCHEME

Final Report of the work done on the Research Project

9. **Project report No. 1st /2nd:** Second
10. **University approval No. and Date:** SU/C&U.D.Section/88/584 dated 27 Jul 2018.
11. **Period From:** 01/04/2019 to 31/03/2020
12. **Title of the Research Project:** Performance and evaluation of copper oxide reduced graphene oxide composite for supercapacitor and biosensor applications.
13. **Name of Principal Investigator:** Dr. Gaurav Mahadev Lohar.
14. **Department and college where work has progressed:** Department of Physics, Lal Bahadur Shastri college of Arts, Science and Commerce Satara.
15. **Effective date of starting the project:** 27/07/2018.
16. **Grant approved and expenditure incurred during the period of the report:**

- **Total Amount approved: 70,000/-**
- **Total expenditure: 70,000/-**

1.	Brief objective of the project	1. To synthesis graphene oxide using chemical method. 2. To synthesis copper oxide reduced graphene oxide powder using the chemical method. 3. To synthesis copper oxide reduced graphene oxide thin films using the chemical method 4. To optimize deposition parameters such as, pH value, bath temperature, composition, deposition time, concentration, etc. 5. To study the structural, morphological, electrochemical properties of copper oxide reduced graphene oxide. 6. To study the supercapacitive properties of copper oxide reduced graphene oxide thin films. 7. To study the biosensing properties of copper oxide reduced graphene oxide thin films.
2.	Work done so far and results achieved and publications, if any, resulting from the work (Give details of the papers and names of the journals in which it has been published or accepted for publication	**G. M. Lohar**, O. C. Pore, A. V. Fulari, Electrochemical behavior of CuO/rGO nanopellets for flexible supercapacitor, non-enzymatic glucose, and H_2O_2 sensing application, **Ceramics International** 47 (2021) 16674-16687. DOI: https://doi.org/10.1016/j.ceramint.2021.02.238
3.	Has the progress been according to original plan of work and towards achieving the objective. if not, state reasons	The progress is according to the original plan of work.
4.	Please indicate the difficulties, if any, experienced in implementing the project.	Nil
5.	If project has not been completed, please indicate the approximate time by which it is likely to be completed. A summary of the work done for the period (Annual basis) may please be sent to the University on a separate sheet.	Nil

6.	If the project has been completed, please enclose a summary of the findings of the study. Two bound copies of the final report of work done may also be sent to the University.	Summary of the findings of the study attached with final report.
7.	Any other information which would help in evaluation of work done on the project. At the completion of the project, the first report should indicate the output, such as (a) Manpower trained (b) Ph. D. awarded (c) Publication of results (d) other impact, if any.	(a) During first year Manpower trained. (b) **Publication:** G. M. Lohar, O. C. Pore, A. V. Fulari, Electrochemical behavior of CuO/rGO nanopellets for flexible supercapacitor, non-enzymatic glucose, and H_2O_2 sensing application, Ceramics International 47 (2021) 16674-16687. DOI: https://doi.org/10.1016/j.ceramint.2021.02.238

Principal Investigator
Dr. G. M. LOHAR
Project Investigator
Shivaji University Project
Department of Physics
Lal Bahadur Shastri College of
Arts, Science & Commerce, Satara

Principal
PRINCIPAL
Lal Bahadur Shastri College of
Arts, Science & Commerce, Satara

Summary of the Findings

In summary, CuO/rGO composites are synthesized using chemical methods for electrochemical supercapacitors, non-enzymatic glucose, and H_2O_2 sensing application. A modified hummers method is used to synthesis the GO, and CuO/rGO composites are synthesized using the coprecipitation route. The copper oxide monoclinic crystals are formed and attached to GO sheets. The morphological analysis confirms the formation of CuO/rGO nanopellets. The CuO/rGO nanopellets with the highest concentration of Cu show maximum specific capacitance of 188 F g^{-1} at a current density of 0.2 A g^{-1} with electrochemical stability of 96.3% over 2000 GCD cycles. The measured energy and power densities are 265 W kg^{-1} and 7.32 W h kg^{-1}, respectively. CuO/rGO composite with least Cu concentration shows glucose sensitivity of 0.805 mA mM^{-1} cm^{-2} and 0.2982 mA mM^{-1} cm^{-2} for CC and ITO substrate, respectively. Further H_2O_2 sensing is studied on ITO substrate, which manifests H_2O_2 sensitivity of 84.39 μA mM^{-1} cm^{-2}. In conclusion, CuO/rGO have excellent electrochemical efficiency and can be useful in supercapacitors and biosensor applications. This work is also a forum for creating stable and flexible electrochemical supercapacitors and reliable, flexible, and cost-effective glucose sensing devices.

SHIVAJI UNIVERSITY, KOLHAPUR

RESEARCH INITIATION SCHEME

Proforma for submission of Information at the time of submittingthe Final Report of the Work Done on the Project

(To be submitted within two months after completion of project period)

1	Name & Address of the Principal Investigator	Dr. Gaurav Mahadev Lohar, Department of Physics, Lal Bahadur Shastri College of Arts, Science, and Commerce, Satara, 415002.
2	Name & Address of the Institution / Department	Department of Physics, Lal Bahadur Shastri College of Arts, Science, and Commerce, Satara, 415002.
3	University Approval No.	SU/C&U.D.Section/88/584 **Date:** 27 Jul 2018
4	Date of Implementation	27/07/2018
5	Tenure of the Project	Two years
6	Total Grant Allocated	70,000/-
7	Total Grant Received	70,000/-
8	Final Expenditure	70,000/-
9	Title of the Project	Performance and evaluation of copper oxide reduced graphene oxide composite for supercapacitor and biosensor applications.
10	Objectives of the Project	1. To synthesis graphene oxide using chemical method. 2. To synthesis copper oxide reduced graphene oxide powder using the chemical method. 3. To synthesis copper oxide reduced graphene oxide thin films using the chemical method 4. To optimize deposition parameters such as, pH value, bath temperature, composition, deposition time, concentration, etc. 5. To study the structural, morphological, electrochemical properties of copper oxide reduced graphene oxide. 6. To study the supercapacitive properties of copper oxide reduced graphene oxide thin films. 7. To study the biosensing properties of copper oxide reduced graphene oxide thin films.
11	Whether Objectives were achieved	Objectives are achieved.
12	Summary of the Findings / Publications	Separate sheet attached. **G. M. Lohar**, O. C. Pore, A. V. Fulari, Electrochemical behavior of CuO/rGO nanopellets for flexible supercapacitor, non-enzymatic glucose, and H_2O_2 sensing application, **Ceramics International** 47 (2021) 16674-16687. **DOI:** https://doi.org/10.1016/j.ceramint.2021.02.238
13	Possible Applications (Give Details)	Possible applications in electrochemical supercapacitor, nonenzymatic biosensing and H_2O_2 sensing.

Principal Investigator

Dr. G. M. LOHAR
Project Investigator
Shivaji University Project
Department of Physics
Lal Bahadur Shastri College of
Arts, Science & Commerce, Satara

Principal

PRINCIPAL
Lal Bahadur Shastri College of
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Estd: 1962
"A++"
Accredited by NAAC
with CGPA 3.52

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शिवाजी विद्यापीठ, कोल्हापूर -४१६००४ महाराष्ट्र (महाविद्यालये व विद्यापीठ विकास विभाग)
दुरध्वनी: (ईपीएबीएक्स) २६०९४९२, २६०९१४५
□ **फॅक्स: ००९१-२३१-२६९१५३३,२६९२३३३,२६९३२९४**

SU/C&U.D./SRM/670

Annexure – H

SHIVAJI UNIVERSITY, KOLHAPUR
RESEARCH INITIATION SCHEME

Project Completion Certificate

This is to certify that Mr./Mrs./Ms/Dr./Prof. **Dr. Gaurav Mahadev Lohar** of **Lal Bahadur Shastri College of Arts, Science And Commerce, Satara** has successfully completed research scheme entitled **"Performance and evaluation of copper oxide reduced graphene oxide composite for supercapacitor and biosensor applications"** sanctioned by Shivaji University, Kolhapur under **Research Initiation Scheme** during **dt. 10/07/2018 to 09/07/2020.** He /She worked as Principal Investigator/Co- Principal Investigator for the project.

Date :- 25 APR 2022

25/04/22

Signature
Coordinator,
Research Initiation Scheme
Shivaji University, Kolhapur