Glycosmis pentaphylla-Derived Carbon Quantum Dots for Highly Selective and Sensitive Detection of Ciprofloxacin

A Dissertation submitted in partial fulfilment of the requirements for the award of the Degree of

Master of Science in Chemistry

By

AKSHAYA RAMACHANDRAN

(CCAWMCH015)

Submitted to

THE DEPARTMENT OF CHEMISTRY

CHRIST COLLEGE AUTONOMOUS IRINJALAKUDA, 680125

Under the guidance of

Dr. BEENA MATHEW

SCHOOL OF CHEMICAL SCIENCES

MAHATMA GANDHI UNIVERSITY

KOTTAYAM, KERALA

JULY 2024

SCHOOL OF CHEMICAL SCIENCES

MAHATMA GANDHI UNIVERSITY

Kottayam-686 560, Kerala, India

CERTIFICATE

This is to certify that the dissertation entitled ***"Glycosmis pentaphylla*-Derived Carbon Quantum Dots for Highly Selective and Sensitive Detection of Ciprofloxacin**" submitted by **Ms. AKSHAYA RAMACHANDRAN (Reg No: CCAWMCH015)** to CHRIST COLLEGE AUTONOMOUS, Irinjalakuda in partial fulfilment of the requirements for the award of the degree of Master of Science in Chemistry, is a record of original and independent work carried out by her at the School of Chemical Sciences, Mahatma Gandhi University, Kottayam, Kerala during the month of April 2024. No part of this project has been submitted elsewhere for award of any other degree or diploma.

Dr. BEENA MATHEW
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Kottayam
27th July 2024

CHRIST COLLEGE
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CERTIFICATE

This is to certify that **Ms. AKSHAYA RAMACHANDRAN (Reg No:CCAWMCH015)** has successfully completed her project wok entitled "***Glycosmis pentaphylla-Derived Carbon Quantum Dots for Highly Selective and Sensitive Detection of Ciprofloxacin***" under the guidance of **Dr. Beena Mathew**, Senior Professor, School of Chemical Sciences, Mahatma Gandhi University, Kottayam, during the month of April 2024 for the partial fulfilment of the award of the Degree of MASTER OF SCIENCE in CHEMISTRY, Christ College Autonomous Irinjalakuda.

Ms. GREENI K I

Head of the Department

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(AUTONOMOUS) IRINJALAKUDA - KERALA

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Ms. KRISHNAPRIYA K M

Internal Guide

Department of Chemistry

Christ College Autonomous

Irinjalakuda Kerala, 680125.

TABLE OF CONTENTS

DECLARATION

I hereby declare that the dissertation entitled "***Glycosmis pentaphylla-Derived Carbon Quantum Dots for Highly Selective and Sensitive Detection of Ciprofloxacin***" is the original work done by me, under the supervision and guidance of **Dr. Beena Mathew**, Senior Professor, School of Chemical Sciences, Mahatma Gandhi University, Kottayam, in partial fulfilment of the requirements for the award of the degree of Master of Science in Chemistry of Calicut University. No part of this dissertation has been presented earlier to award any degree, diploma, or other titles of recognition.

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27th July 2024

AKSHAYA RAMACHANDRAN

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ACKNOWLEDGEMENT

At the very outset of this report, I would like to extend my sincere obligation to all the persons who have helped me in this endeavour. Without their active guidance, help, cooperation, and encouragement, I would not have made headway in the project.

I bow my head and offer my thanks to God Almighty for the never-failing grace and blessings to complete the project work.

I express my gratitude to our Head of the Department, ***Dr. Greeni K I*** *for providing an opportunity to do the project work.*

I express my heartfelt gratitude to my external supervisor ***Dr. Beena Mathew****, Senior Professor, School of Chemical Sciences, Mahatma Gandhi University, Kottayam, Kerala, for allowing me to do my M.Sc. project under her supervision. I thank her for her guidance, continued assistance, encouragement, and involvement throughout my research work.*

I am grateful to ***Dr. Anitha C Kumar****, former Director, School of Chemical Sciences, Mahatma Gandhi University, Kottayam, Kerala, for permitting me and providing the necessary facilities for this work. I also take this opportunity to thank all the other teaching and non-teaching members of the School of Chemical Sciences for their help and support.*

I sincerely thank ***Ms. Jincy Mathew*** *and* ***Ms. Neena John Plathanam*** *Research Scholars, School of Chemical Sciences, Mahatma Gandhi University, Kottayam, Kerala, for their great support, guidance, and timely assistance during my project work.*

I am also greatly obliged to all members of the Department of Chemistry for their valuable suggestions, support, and inspiration which have enabled me to complete it successfully.

I also acknowledge with a deep sense of reverence, my gratitude towards my parents and members of my family, who has always supported me morally as well as economically.

Last but not least gratitude goes to all of my friends, who directly or indirectly helped me to complete this project report.

AKSHAYA RAMACHANDRAN

ABSTRACT

In the current study, we used the leaves of *Glycosmis pentaphylla* as the carbon source to synthesize carbon quantum dots (CDs) utilising a one-step hydrothermal process without the use of extra chemical reagents or functionalization. Under UV light, the CDs fluoresced blue as they were being created. They have surface functional groups like carboxyl and hydroxyl groups, are biocompatible, have high fluorescence, and are well soluble in water. Ciprofloxacin has been shown to enhance the luminous intensity of CDs, and a linear association between fluorescence intensity and ciprofloxacin concentration was seen over a wide range of concentrations. These outstanding qualities make the CDs suitable for use in biomedical fields.

Keywords: Carbon quantum dots, sensing, ciprofloxacin, fluorescence enhancement, drugs

*Muehlenbeckia platyclada*Derived Carbon Quantum Dots for the Highly Selective and Sensitive Detection of Ciprofloxacin

A Dissertation submitted in partial fulfilment of the requirements for the award of the Degree

of

Master of Science in Chemistry

By

AMRUTHA P N

(CCAWMCH015)

Submitted to

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CHRIST COLLEGE AUTONOMOUS IRINJALAKUDA, 680125

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KOTTAYAM, KERALA

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Kottayam-686 560, Kerala, India

CERTIFICATE

This is to certify that the dissertation entitled ***"Muehlenbeckia platycladaDerived* Carbon Quantum Dots for the Highly Selective and Sensitive Detection of Ciprofloxacin**" submitted by **Ms. AMRUTHA P N (Reg No: CCAWMCH016)** to CHRIST COLLEGE AUTONOMOUS, Irinjalakuda in partial fulfilment of the requirements for the award of the degree of Master of Science in Chemistry, is a record of original and independent work carried out by her at the School of Chemical Sciences, Mahatma Gandhi University, Kottayam, Kerala during the month of April 2024. No part of this project has been submitted elsewhere for award of any other degree or diploma.

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June 2024

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(AUTONOMOUS) IRINJALAKUDA - KERALA

CERTIFICATE

This is to certify that **Ms. AMRUTHA P N (Reg No:CCAWMCH016)** has successfully completed her project wok entitled "***Muehlenbeckia platycladaDerived Carbon Quantum Dots for the Highly Selective and Sensitive Detection of Ciprofloxacin***" under the guidance of **Dr. Beena Mathew**, Senior Professor, School of Chemical Sciences, Mahatma Gandhi University, Kottayam, during the month of April 2024 for the partial fulfilment of the award of the Degree of MASTER OF SCIENCE in CHEMISTRY, Christ College Autonomous Irinjalakuda.

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(Internal supervisor)

Assistant professor

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TABLE OF CONTENTS

DECLARATION

I hereby declare that the dissertation entitled "***Muehlenbeckia platycladaDerived Carbon Quantum Dots for the Highly Selective and Sensitive Detection of Ciprofloxacin***" is the original work done by me, under the supervision and guidance of **Dr. Beena Mathew**, Senior Professor, School of Chemical Sciences, Mahatma Gandhi University, Kottayam, in partial fulfilment of the requirements for the award of the degree of Master of Science in Chemistry of Calicut University. No part of this dissertation has been presented earlier to award any degree, diploma, or other titles of recognition.

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AMRUTHA P N

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AMRUTHA P N

ABSTRACT

In the current study, we used the leaves of *Muehlenbeckia platyclada* as the carbon source to synthesize carbon quantum dots (CQDs) utilizing a one-step hydrothermal process without the use of extra chemical reagents or functionalization. Under UV light, the CQDs fluoresced blue as they were being created. They have surface functional groups like carboxyl and hydroxyl groups are biocompatible, have high fluorescence, and are well soluble in water. Ciprofloxacin has been shown to enhance the luminous intensity of CQDs, and a linear association between fluorescence intensity and ciprofloxacin concentration was seen over a wide range of concentrations. These outstanding qualities make the CQDs suitable for use in biomedical fields.

Keywords: Carbon quantum dots, sensing, ciprofloxacin, fluorescence enhancement, drugs

ELECTRO- ORGANIC SYNTHESIS OF N-PHENYL PYRROLE AND (PHENYL ETHYNYL) COPPER(I)

A dissertation submitted to

UNIVERSITY OF CALICUT

in partial fulfilment of the requirement for Degree of

Master Of Science in Chemistry

By

ANJITHA T V

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Department of Chemistry

CERTIFICATE

This is to certify that dissertation entitled **"ELECTRO-ORGANIC SYNTHESIS OF N-PHENYL PYRROLE AND (PHENYL ETHYNYL) COPPER(I)"** is an authentic record of work carried out by **ANJITHA T V (Reg No: CCAWMCH017)** under the guidance of **Dr. DITTY DIXON,** Associate professor in Chemical Science, Mahatma Gandhi University, Kottayam during the period of April 2024 to May 2024 as partial fulfillment of the requirement for the award of Master of Science in Chemistry.

Certified further to the best of our knowledge that this does not form part of any other dissertation or project work based on which a degree or diploma or a similar title has been awarded earlier to any candidate by any other university.

External Examiner **Head of the Department**

Internal Examiner

MAHATMA GANDHI UNIVERSITY KOTTAYAM

RE-ACCREDITED WITH 'A++' GRADE BY NAAC WITH CGPA 3.61

CERTIFICATE

This is to certify that the project report entitled **"ELECTRO-ORAGANIC SYNTHESIS OF N-PHENYL PYRROLE AND (PHENYL ETHYNYL COPPER(I)"** is an authentic record of the work carried out by **ANJITHA T V (Reg No: CCAWMCH017)** under my supervision and guidance during the period 2022-2024 in partial fulfilment of the degree of Master of Science under the Faculty of Science, Mahatma Gandhi University, Kottayam. The work presented in this report has not been submitted for any other degree or diploma earlier.

Kottayam

May 2024

Dr. DITTY DIXON

Project Supervisor

CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA

CERTIFICATE

This is to certify that the dissertation entitled **"ELECTRO-ORAGANIC SYNTHESIS OF N-PHENYL PYRROLE AND (PHENYL ETHYNYL COPPER(I)"** submitted to the faculty of science University of Calicut in partial fulfilment of the degree of Master of Science in Chemistry is a bonafide record of work carried out by ANJITHA T V. This dissertation was guided and written under my supervision.

Ms GREENI K I

Department Of Chemistry

Christ College, Irinjalakuda

DECLARATION

I hereby declare that the dissertation entitled **"ELECTRO-ORAGANIC SYNTHESIS OF N-PHENYL PYRROLE AND (PHENYL ETHYNYL COPPER(I)"** an authentic record of the project work carried out by me under the guidance and supervision of Dr. Ditty Dixon Associate Professor, School of Chemical Science, Mahatma Gandhi University, Kottayam. It has not formed the part of any other thesis submitted for the award of any Degree/Diploma Associateship/ Fellowship or similar title to any candidate of any University.

Place: Kottayam

ANJITHA T V

CCAWMCH017

Date:

ACKNOWLEDGEMENT

In pursuit of this academic endeavour, I feel that I have been especially fortunate as inspiration, guidance, direction, co-operation, love and care all came in my way in abundance and it seems almost an impossible task for me to acknowledge the same in adequate terms.

First of all, let me thank the God Almighty, for showering all his blessings on me till now.

I am extremely thankful to **Dr. Ditty Dixon**, Associate Professor
School of Chemical Science, Mahatma Gandhi University (Kottayam) for suggesting this project and for providing the facility to carry out my work.

I extent my sincere thanks to **prof. Greeni K. I**, The coordinator of MSc. Chemistry(self) for her guidance without which I would not have been to complete this project. I extend my heartful thanks to other faculty members of our departments.

I am highly indebted to project assistant, **Ms. Anila S**, for her guidance, help and constant encouragement throughout the course of this study.

I would like to take the opportunity to thank all friends and lab mates for their help and motivation. Finally, I would also express my sincere gratitude to my parents, for their encouragement and support throughout. Once again, I thank each and every person who was of great support in deliberating over the problems and findings throughout my dissertation.

ANJITHA T V

CONTENTS

ABSTRACT

Electro-organic synthesis has received increasing attention due to growing need to develop safe and environmentally friendly synthesis for organic molecules. In conventional organic synthesis the energy is supplied to reactant molecules as thermal energy via heating, but this method has higher energy loss. In electro-organic synthesis this energy source is replaced by electric current which is a reliable source of energy. This study is the electro-organic synthesis of N-Phenyl Pyrrole and (Phenyl ethynyl) Copper (I). The synthesis of N-Phenyl Pyrrole is done by Linear Sweep Voltammetry and confirmed by GC-MS and NMR Spectrum. The of (Phenyl Ethynyl) Copper(I) is done by chronoamperometry and confirmed by FT-IR

SYNTHESIS OF LIGNIN GELATINE BIOFILM WITH TANNIC ACID AS CROSSLINKING AGENT FOR FOOD PACKAGING APPLICATIONS

A dissertion submitted to the **University of Calicut** in partial fulfilment of the requirement for the degree of **Master of Science in chemistry**

Submitted by

ANN MARIYA K P

(Reg No: CCAWMCH018)

Department of Chemistry

Christ College (Autonomous)

Irinjalakuda- 680125

Under the guidance

Dr. SARITHA. A

Associate Professor

AMRITA VISHWA VIDYAPEETHAM

AMRITAPURI

DEPARTMENT OF CHEMISTRY

CHRIST COLLEGE (AUTONOMOUS) IRINJALAKUDA

CERTIFICATE

This is to certify that the dissertion entitled **"Synthesis of lignin gelatin biofilm with tannic acid as crosslinking agent for food packaging applications"** is an authentic record of work carried out by **ANN MARIYA K P (Reg No: CCAWMCH018)** under the guidance of **Dr. Saritha A, Associate Professor, Amrita VishwaVidyapeetham, Amritapuri**during the period of April 2024 to June 2024 as partial fulfilment of the requirement for the degree of master of science in chemistry. Certified further to the best of our knowledge that this does not form part of any other dissertation or project work based on which a degree or diploma or a similar title has been awarded earlier to any candidate by any other university.

External Examiner **Head of Department**

Internal Examiner

CHRIST COLLEGE (AUTONOMOUS) IRINJALAKUDA

CERTIFICATE

This is to certify that the dissertation entitled **"Synthesis of lignin gelatin biofilm with tannic acid as crosslinking agent for food packaging applications"**, submitted to the faculty of science, University of Calicut, in partial fulfilment of the degree of Master of Science in Chemistry, is a bonafide record of work carried out by ANN MARIYA K P. This dissertation was guided and written under my supervision.

Ms Krishnapriya K M

Department of Chemistry

Christ College, Irinjalakuda

DECLARATION

I hereby declare that the dissertation entitled **"Synthesis of lignin gelatin biofilm with tannic acid as crosslinking agent for food packaging applications"** being submitted to university of Calicut in partial fulfilment of the requirement for degree of Master of Science in Chemistry is a bonafide record of research work done by me under the guidance of Dr. Saritha A, Associate Professor, Amrita VishwaVidyapeetham, Amritapuri. It has not formed the part of any other thesis submitted for the award of any Degree/Diploma Associateship/ Fellowship or similar title to any candidate of any University.

Place: Amritapuri **ANN MARIYA K P**

Date: 27-07-2024 CCAWMCH018

ACKNOWLEDGEMENT

I express my sincere thanks to **Dr. Saritha A, Associate Professor, AmritaVishwaVidyapeetham, Amritapuri** for giving me the wonderful opportunity to work in her lab. The valuable suggestions provided were of immense help throughout my project work and crafted an extremely knowledgeable experience for me. Without her guidance and persistent help, the completion of this project would not have been possible.

I am extremely thankful to **Ms Krishnapriya K M**, Assistant Professor of MSc. Chemistry (self) for her guidance without which I would not have been to complete this project. I extend my heartful thanks to the other faculty members of our departments.

I am indebted to **Mr. Saran S Kumar** for his exemplary guidance, patience, and support, without which I would not have been able to do this project. I wholeheartedly thank all my lab members who were always there to help me and kindly supported me throughout the project. I would like to thank AmritaVishwaVidyapeetham, Amritapurifor allowing me to do this project and providing all the infrastructure and research facilities. Finally, I thank my family and friends for their valuable support throughout the project.

ANN MARIYA K P

Contents

Influence of the A site composition fluctuations on the properties of high T_C $0.36BiScO_3$- $0.64PbTiO_3$ based piezoceramics

A dissertation Submitted in partial fulfilment of the requirements for the degree of

Master of science

In

Chemistry

By

Anugraha C R

REG NO. CCAWMCH019

Under the guidance of

Dr. Karthik T

Scientist D

Centre materials for electronics technology (CMET), Thrissur

Submitted to ***Christ college (Autonomous)***

Affiliated to

University of Calicut

CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA

DEPARTMENT OF CHEMISTRY

CERTIFICATE

This is to certify that the dissertation entitled "**Influence of the A site composition fluctuations on the properties of high T_C $0.36BiScO_3$- $0.64PbTiO_3$ based piezoceramics**" is an authentic record of work carried out by **Ms. ANUGRAHA C R (Reg No: CCAWMCH019)** under the guidance of **Dr. Karthik T Scientist D Centre materials for electronics technology (CMET) Thrissur**, from April 2024 to June 2024 in partial fulfillment of the requirement for the award of Master of Science in Chemistry.

Certified further to the best of our knowledge that this does not form part of any other dissertation or project work based on which a degree or diploma or a similar title has been awarded earlier to any candidate by any other university.

External Examiner **Head of the Department**

Internal examiner

CERTIFICATE

This is to certify that **Ms.Anugraha C.R**, Post graduate student of **Christ College (Autonomous),Irinjalakuda, Calicut University** has carried out her project work titled"**Influence of the A Site Composition fluctuations on the properties of high T_c $BiScO_3$-$PbTiO_3$ based Piezoceramics**",under my supervision for the partial fulfilment of award of degree of Master of chemistry, at **CENTRE FOR MATERIALS FOR ELECTRONICS TECHNOLOGY (C-MET),THRISSUR** during the period of April 2024 to June 2024 .

Dr. Karthik T.

Scientist D

(Guide)

CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA

CERTIFICATE

This is to certify that the dissertation entitled "**Influence of the A Site Composition fluctuations on the properties of high T_c $BiScO_3$-$PbTiO_3$ based Piezoceramics**" submitted to the University of Calicut in partial fulfillment of the degree of Master of Science in Chemistry is a bona fide record of work carried out by **Ms.ANUGRAHA C R** . This dissertation was guided and written under my supervision.

Dr. Bhagyesh V.B
Department of Chemistry
Christ College (Autonomous)
Irinjalakuda

Declaration

I, Anugraha C.R, Register No:CCAWMCH019, do hereby declare that this project entitled **"Influence of the A site composition fluctuations on the properties of high T_C $0.36BiScO_3$-$0.64PbTiO_3$ based piezoceramics"** submitted to Christ college (Autonomous) Irinjalakuda affiliated to **university of Calicut** in the partial fulfillment of requirements for the award of the degree of **Master of Science in Chemistry**, is a bonafide record of work and investigations carried out by me under the guidance and supervision of **Dr. Karthik T**, Scientist-D, C-MET, Thrissur, during the academic year 2022-2024. This dissertation has not been submitted to any university for the award of any degree or in any other title of recognition.

Place: Thrissur Anugraha C R

June 2024

Acknowledgements

I use this opportunity to express my profound gratitude and regards to my supervisor of this work **Dr. Karthik T**, Scientist-D, Centre for Materials for Electronics Technology (C-MET), Thrissur for giving me the opportunity to do my project and providing invaluable guidance throughout this work. Without his support and encouragement, I couldn't have completed this project successfully.

I also express my gratitude to **Mrs. Greeni K I,**HOD,Department of Chemistry, Christ college (Autonomous) Irinjalakuda affiliated to university of Calicut for her support and motivation .I am obliged to the faculty of Department of Chemistry,Christ college (Autonomous) for the kind consideration throughout the work.

I Would like to acknowledge **Dr.BhagyeshV.B Professor**, Department of Chemistry ,Christ college (Autonomous) Irinjalakuda for arranging my project to do in C-MET .And thanks to her constant encouragement and timely guidance.

I would like to thank all the members of MLC Lab, C-MET Thrissur, especially **Dr. Soumya**,**Mr. Sushant S**, **Mr.Sunny E.K**, **Mrs Anagha Baby, Mr. Vishnu P.C** for their care, help and backup given throughout my project work.

I am grateful to my parents and my friends for their unconditional love, emotion and inspiration given to achieve my goals successfully.

ANUGRAHA C R

CONTENTS

SYNTHESIS AND CHARACTERISATION OF NICKEL COBALTITE FOR SUPERCAPACITOR APPLICATIONS

PROJECT REPORT SUBMITTED TO THE

UNIVERSITY OF CALICUT

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR

THE AWARD OF THE DEGREE OF

MASTER OF SCIENCE

IN

CHEMISTRY

BY

APARNA P R

(Reg.No. CCAWMCH020)

DEPARTMENT OF CHEMISTRY

CHRIST COLLEGE (AUTONOMOUS)
IRINJALAKKUDA-680125

Under the supervision of

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CENTRE FOR MATERIALS FOR ELECTRONICS TECHNOLOGY (C-MET)

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DEPARTMENT OF CHEMISTRY

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This is to certify that the dissertation entitled "**SYNTHESIS AND CHARACTERIZATION OF NICKEL COBALTITE FOR SUPERCAPACITOR APPLICATIONS**" is an authentic record of work carried out by **Ms. APARNA PR (Reg No: CCAWMCH020)** under the guidance of **Ms. RANI PANICKER N, SCIENTIST, C-MET, THRISSUR**, from April 2024 to June 2024 in partial fulfillment of the requirement for the award of Master of Science in Chemistry.

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External Examiner **Head of the Department**

Internal examiner

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Rani Panicker N
(Scientist)

Athani, Thrissur
28.06.2024

CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA

CERTIFICATE

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Ms. KRISHNAPRIYA KM
Department of Chemistry
Christ College (Autonomous)
Irinjalakuda

DECLARATION

I, APARNA P R of Department of Chemistry, Christ College (Autonomous) Irinjalakuda hereby declare that the work described in this report entitled **"SYNTHESIS & CHARACTERIZATION OF NICKEL COBALTITE FOR SUPERCAPACITOR APPLICATIONS,"** is the result of the investigations carried out by me at the Centre for Materials for Electronics Technology (C-MET), Thrissur, under the supervision of Ms.Rani Panicker N, Scientist, C-MET, Thrissur.

APARNA PR

ACKNOWLEDGEMENTS

I express my heartfelt gratitude to Dr. N. Raghu, Ex-Director, and Dr. R. Ratheesh, Centre Head, Centre for Materials for Electronics Technology (C-MET) for giving me an opportunity to carry out my M. Sc. Project work here.

It is of great pleasure to express my deep sense of gratitude to Ms. Rani Panicker N, Scientist, C-MET, Thrissur, under whose expert guidance and supervision I carried out my work. I am very much thankful to her for her constant encouragement and support throughout this work.

I am very much thankful to and Dr. Stanly Jacob K, Scientist and Shri. P. A. Abraham, Senior Technical staff of the Aerogel and Energy Materials Lab, C-MET for their constant help and support during my work.

I also extend my sincere thanks to all the scientists and staff of C-MET for their co-operation.

I extend my profound gratitude to Prof. Greeni K I, Co-ordinator of Department of Chemistry, Prof. Krishnapriya K M, Internal Guide, Christ College, Irinjalakuda and all my teachers for their inspiration, invaluable suggestion and help.

I also express my appreciation to Mr. Amruth, Ms. Devika, Ms. Rinsha and Ms. Denna, the M.Sc project students who were along with me during this period in Aerogel Division for their wholehearted support.

I am also thankful to my parents, friends and all well-wishers for their love, affection and prayers that has always been my strength.

APARNA P R

June 2024

CONTENTS

SYNTHESIS AND CHARACTERIZATION OF ZINC OXIDE AND CHITOSAN-ZINC OXIDE COMPOSITES, AND THEIR APPLICATION IN THE PHOTOCATALYTIC DEGRADATION OF ORGANIC DYES

A dissertation submitted to

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in partial fulfillment of the requirement for Degree of

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Department of Chemistry

CERTIFICATE

This is to certify that the dissertation entitled "**Synthesis and characterization of zinc oxide and chitosan-zinc oxide composites, and their applications in the photocatalytic degradation of organic dyes"** is an authentic record of work carried out by **JIYA K J (Reg No: CCAWMCH021)**under the guidance of **Dr.JORPHIN JOSEPH,** Assistant professor, department of Chemical Oceanography, Cochin University of Science and Technology, Kochi, during the period of April 2024 to June 2024 as partial fulfillment of the requirement for the award of Master of Science in Chemistry. Certified further to the best of our knowledge that this does not form part of any other dissertation or project work based on which a degree or diploma or a similar title has been awarded earlier to any candidate by any other university.

.

External Examiner **Head of the Department**

Internal Examiner

CHRIST COLLEGE (AUTONOMOUS) IRINJALAKUDA

CERTIFICATE

This is to certify that the dissertation entitled **"Synthesis and characterization of zinc oxide and chitosan-zinc oxide composites, and their application in the photocatalytic degradation of organic dyes"** submitted to the faculty of science University of Calicut in partial fulfillment of the degree of Master of Science in Chemistry is a bonafide record of work carried out by **JIYA K J** .This dissertation was guided and written under my supervision.

Ms. FAMY FRANCIS
Department of Chemistry
Christ College,Irinjalakuda

DECLARATION

I hereby declare that the project entitled **"synthesis and characterization of zinc oxide and chitosan-zinc oxide composites, and their application in the photocatalytic degradation of organic dyes"** is a bonafide work done by me, under supervision of Dr. Jorphin Joseph, Department Of Chemical Oceanography , Cochin University of Science and Technology, Kochi, in partial fulfillment for the award of degree of M.Sc. Chemistry. I also affirm that this work has not been submitted before for the award of any degree or diploma elsewhere.

Place: Irinjalakuda

JIYA KJ

CCAWMCHE021

Date:27/7/2024

ACKNOWLEDGEMENTS

The completion of this project could not have been possible without the guidance and assistance of so many people. I would like to take this opportunity to express my gratitude to all those who have been instrumental in the successful completion of this project and preparation of this report.

First and foremost, I would like to express my gratitude to the supervising teacher, **Dr. Jorphin Joseph**, Department of Chemical Oceanography, Cochin University of Science and Technology, Kochi for providing me with an opportunity to carry out this project. I express my heartfelt gratitude for his unwavering support, guidance and valuable insights which enriched my knowledge in this topic.

I express my sincere gratitude to **Ms .FAMY FRANCIS**,Department of Chemistry, Christ College,(Autonomous), Irinjalakuda **,** for their constant encouragement and support . I would also like guidance and care throughout this work to extend my gratitude to all my teachers.

I am profoundly grateful to my co-guide **Ms. Sandhya A**, research scholar, Cochin University of Science and Technology, Kochi for her exceptional guidance and care throughout this work.

I am also thankful to my family and friends for their unending encouragement, understanding and belief in my abilities.

JIYA K J

INDEX

LIST OF FIGURES

LEAD FREE MANGANESE BASED PEROVSKITE NANO CRYSTALS FOR THE FLUORESCENCE 'SWITCH OFF' DETECTION OF TNP

A dissertation submitted to

UNIVERSITY OF CALICUT

in partial fulfilment of the requirement for Degree of

Master of Science in Chemistry

SUBMITTED BY

JIYA SHAJU

(Reg. No. CCAWMCH022)

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Under the supervision of

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CHRIST COLLEGE (AUTONOMOUS) IRINJALAKUDA

CERTIFICATE

This is to certify that the dissertation entitled **"LEAD FREE MANGANESE BASED PEROVSKITE FOR THE FLUORESCENCE 'SWITCH OFF' DETECTION OF TNP"** is an authentic record of work carried out by **JIYA SHAJU (Reg. No. CCAWMCH022)** under the guidance of **Dr. SONY GEORGE**, Assistant Professor in University of Kerala during the period of April 2024 to June 2024 as partial fulfilment of the requirement for the award of Master of Science in Chemistry. Certified further to the best of our knowledge that this does not form part of any other dissertation or project work based on which a degree or diploma or a similar title has been awarded earlier to any candidate by any other university.

External Examiner **Head of the Department**

Internal Examiner

Department of Chemistry

School of Physical and Mathematical Science

University of Kerala, Kariavattom

Thiruvananthapuram

CERTIFICATE

This is to certify that the dissertation entitled **"LEAD FREE MANGANESE BASED PEROVSKITE FOR THE FLUORESCENCE 'SWITCH OFF' DETECTION OF TNP"** is an authentic record of the research work carried out by **Jiya Shaju** under my supervision and guidance at the Department of Chemistry, School of Physical and Mathematical Science, University of Kerala, Kariavattom, Thiruvananthapuram, during April 2024-June 2024, in partial fulfilment of the requirement for the degree of Master of Science in Chemistry, and no part of this dissertation has been presented before for any other degree.

Kariavattom

Dr. Sony George

Associate Professor

Department of Chemistry

University of Kerala, Kariavattom

Thiruvananthapuram

CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA

CERTIFICATE

This is to certify that the project entitled **"LEAD FREE MANGANESE BASED PEROVSKITE FOR THE FLUORESCENCE 'SWITCH OFF' DETECTION OF TNP"** submitted to the faculty of science; University of Calicut in partial fulfilment of the degree of Master of Science in Chemistry is a bonafide record of work carried out by JIYA SHAJU. This dissertation was guided and written under my supervision.

Ms. Rosemol Davis

.

Department of chemistry

Christ College (Autonomous)

Irinjalakuda

DECLARATION

I hereby declare that the dissertation entitled **"LEAD FREE MANGANESE BASED PEROVSKITE FOR THE FLUORESCENCE 'SWITCH OFF' DETECTION OF TNP"** being submitted to University of Calicut in partial fulfillment of the requirement for degree of Master of Science in chemistry is a bonafide record of research work done by me under the guidance of Dr. SONY GEORGE, Assistant Professor, Department of Chemistry, University of Kerala, Kariavattom. It has not formed the part of any other thesis submitted for the award of any Degree/Diploma Associateship/Fellowship or similar title to any candidate of any University.

Place: Kariavattom **Jiya Shaju**

Date: 27 June 2024 CCAWMCH022

ACKNOWLEDGEMENT

My project work stands incomplete without dedicating my gratitude to those few who have contributed to the successful completion of my project. First, I extend my sincere thanks to God for giving me good health and strength to complete the project successfully.

I express my sincere gratitude to my project guide **Dr. Sony George**, Associate Professor, Department of Chemistry, University of Kerala, Kariavattom, for his full dedication, constant support, advice and sincere help in each step of my work.

I express my gratitude to **Dr.Suneesh C.V**., Head of the Department of Chemistry, University of Kerala, Kariavattom, and all other faculty members of the department for giving me the support to do the dissertation at the department of chemistry.

I am extremely thankful to **Prof. Greeni K.I,** The coordinator of MSc. Chemistry (self) for her guidance without which I would not have been to complete this project. I extend my heartful thanks to the other faculty members of our department.

I lovingly acknowledge my sincere thanks to **Ms. Greeshma Rajeevan**, research scholar, Department of Chemistry, University of Kerala, Kariavattom for her co-guidance, support and timely help for the completion of my project. I am also grateful to **Mrs. Susan Varghese, Ms. Merin K Abraham, Mrs. Arathy B K, Ms Geneva Indongo** and **Mr. Ali Ibrahim Shakir** and for their guidance and support.

I would like to express my sincere gratitude to my family, friends and lab mates who gave me immense support and care which helped me a lot in the successful accomplishment of my project work. Finally, I would like to give my heartiest apologies for all those helping hands, names of whom I would have missed unintentionally.

Jiya Shaju

CONTENTS

ELECTROSPUN POLYVINYLIDENE FLUORIDE/ALUMINUM NITRIDE POLYMER NANOCOMPOSITES FOR ENERGY HARVESTING

A dissertation submitted to

UNIVERSITY OF CALICUT

in partial fulfillment of the requirements for the award of the degree of

Master of Science in Chemistry

by

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PROFESSOR

Nanomaterials and Devices Research Laboratory

Department of Materials Science and Engineering

National Institute of Technology Calicut

APRIL 2024

CHRIST COLLEGE (AUTONOMOUS) IRINJALAKUDA

Department of Chemistry

CERTIFICATE

This is to certify that the dissertation entitled "**Electrospun Polyvinylidene Fluoride/Aluminum Nitride Polymer Nanocomposites for Energy Harvesting**" is an authentic record of work carried out by **Ms. KEERTHANA SURESH (Reg No: CCAWMCH023)** under the guidance of **Dr. SONEY VARGHESE**, **Professor, Nanomaterials and Devices Research Laboratory, Department of Materials Science and Engineering, National Institute of Technology Calicut**, from 1st April 2024 to 31st May 2024 as partial fulfillment of the requirement for the award of Master of Science in Chemistry.

Certified further to the best of our knowledge that this does not form part of any other dissertation or project work based on which a degree or diploma or a similar title has been awarded earlier to any candidate by any other university.

External Examiner **Head of the Department**

Internal examiner

NIT CERTIFICATE

CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA

CERTIFICATE

This is to certify that **Ms. Keerthana Suresh (Reg No: CCAWMCH023)** has completed her project work entitled "**Electrospun Polyvinylidene Fluoride/Aluminum Nitride Polymer Nanocomposites for Energy Harvesting**" under the guidance of **Dr. Soney Varghese**, Professor, NDRL, MSED, NITC submitted to the University of Calicut in partial fulfillment of the degree of Master of Science in Chemistry is a bonafide record of work. This dissertation was guided and written under my supervision.

Dr. Bhagyesh V B

Department of Chemistry

Christ College (Autonomous), Irinjalakuda

DECLARATION

I hereby declare that the dissertation entitled "**Electrospun Polyvinylidene Fluoride/Aluminum Nitride Polymer Nanocomposites for Energy Harvesting**" an authentic record of the project work carried out by me under the guidance and supervision of **Dr. SONEY VARGHESE, Professor, Nanomaterials and Devices Research Laboratory, Department of Materials Science and Engineering, National Institute of Technology Calicut**, in partial fulfillment of the requirement for the award of the degree of M.Sc. Chemistry. The contents of this work are original and have not been submitted in whole or in part for consideration for any other degree or qualification in this, or any other university. It does not contain any outcome of work done in collaboration with others, except as specified in the text and acknowledgments.

KEERTHANA SURESH

CCAWMCH023

NIT, Calicut

27/07/2024

ACKNOWLEDGEMENTS

In pursuit of this academic endeavor, I have been especially fortunate as inspiration, guidance, direction, cooperation, love and care all came my way in abundance. It seems almost impossible for me to acknowledge the same in adequate terms.

I am extremely thankful to **Dr. SONEY VARGHESE**, Professor, Nanomaterials and Devices Research Laboratory, Department of Materials Science and Engineering, National Institute of Technology Calicut, for suggesting this project and providing the facility to carry out my work.

I am sincerely grateful to **Ms. Greeni K I**, the coordinator of the Department of Chemistry (self) for her guidance without which I would not have been able to complete this project. I sincerely thank **Dr. Bhagyesh V B**, my internal guide for his guidance, and the other faculty members of our departments.

I want to express my heartfelt gratitude to **Dr. Meril Shelly**, for recommending me to my project guide. Your support and guidance are greatly appreciated.

I am very grateful to my co-guide and research scholar **Ms. Athira M**, who gave me the guidance and assistance I needed to finish the assignment on time. Despite having a hectic schedule handling her research work, she offered excellent help and advice, and I am quite grateful.

I sincerely thank all the staff and scholars in the Department of Materials Science and Engineering (MSED) for considering me as a part of the department throughout my journey. I want to take the opportunity to thank all my friends and lab mates for their help and motivation.

Finally, I would also express my sincere gratitude to my parents, for their encouragement and support, which always inspired me. For my parents who raised me with love and supported me in all my pursuits.

Once again, I thank everyone who greatly supported me in deliberating over the problems and findings throughout my dissertation.

KEERTHANA SURESH

ABSTRACT

The synthesis of PVDF nanofibers and their application in various fields through the utilization of their piezoelectric behavior are highlighted in this work. Piezoelectric properties in PVDF have attracted more interest due to AlN's ability to enhance the piezoelectricity and promote the production of the β phase content. Only the β phase has good electricity. This study used two processes to create lightweight polymer composites based on PVDF-AlN: solution-casting and electrospinning methods. The electrospun PVDF nanofiber film with different compositions of AlN achieved a high β-phase concentration, increasing the piezoelectric output voltage of PVDF/AlN nanofiber film-based piezoelectric nanogenerators (PNG). A device with 1 wt% PVDF/AlN composite was fabricated, resulting in a higher output voltage of 2 V than pure PVDF fiber. The device is tested by using finger tapping to generate electrical energy. The study aims to explore the use of piezoelectric devices for energy storage. The characterization analysis used SEM, XRD, FT-IR, and Raman spectroscopy. The results showed promising potential for utilizing piezoelectric devices in energy storage applications. Further research is needed to optimize the performance and efficiency of these devices for practical implementation.

Keywords: polymer nanocomposites, PVDF, AlN, piezoelectric, energy harvesting

CONTENTS

SYNTHESIS AND CHARACTERIZATION OF ZnO-Co_3O_4 GREEN COMPOSITE PIGMENTS

A dissertation submitted to the University of Calicut in partial fulfillment of the requirements for the award of the degree of

MASTER OF SCIENCE IN CHEMISTRY

By

NAMITHA HYDROSE
(Reg. No: CCAWMCH024)

Under the Guidance of

DR. ABRAHAM JOSEPH

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CERTIFICATE

This is to certify that the dissertation entitled "**SYNTHESIS AND CHARACTERIZATION OF ZnO-Co_3O_4 GREEN COMPOSITE PIGMENTS**" is an authentic record of work carried out by **Ms. NAMITHA HYDROSE (Reg No: CCAWMCH024)** under the guidance of **Dr. ABRAHAM JOSEPH**, **Senior Professor, Department of Chemistry, University of Calicut**, from April 2024 to June 2024 in partial fulfillment of the requirement for the award of Master of Science in Chemistry.

Certified further to the best of our knowledge that this does not form part of any other dissertation or project work based on which a degree or diploma or a similar title has been awarded earlier to any candidate by any other university.

External Examiner **Head of the Department**

Internal examiner

CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA

CERTIFICATE

This is to certify that the dissertation entitled "**SYNTHESIS AND CHARACTERIZATION OF ZnO-Co_3O_4 GREEN COMPOSITE PIGMENTS**" submitted to the University of Calicut in partial fulfillment of the degree of Master of Science in Chemistry is a bona fide record of work carried out by **Ms. NAMITHA HYDROSE**. This dissertation was guided and written under my supervision.

Dr. SHEREEMA R. M
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Irinjalakuda

DECLARATION

I, **NAMITHA HYDROSE**, hereby declare that the dissertation, entitled "**SYNTHESIS AND CHARACTERIZATION OF ZnO-Co_3O_4 GREEN COMPOSITE PIGMENTS**" submitted to the University of Calicut is a bona fide record of project work done by me under the supervision and guidance of **Dr. ABRAHAM JOSEPH**, Senior Professor, Department of Chemistry, University of Calicut and it has not formed the basis for the award of any Degree/Diploma/Associate ship/Fellowship or other similar title to any University.

University of Calicut **NAMITHA HYDROSE**

27-07-2024 **CCAWMCH024**

ACKNOWLEDGEMENTS

I would like to express my deepest gratitude to everyone who contributed to the completion of this project. It gives me immense pleasure to express my deep sense of gratitude to my project guide ***Dr. Abraham Joseph****, Senior Professor, Department Of Chemistry, University Of Calicut; for his invaluable guidance, support, and expertise throughout this project.*

My sincere appreciation goes out to my co-guide, ***Dr. Anupama R Prasad****, Research Associate, Christ College (Autonomous), Irinjalakuda; for introducing me to my project guide and for her unwavering support and guidance at every turn to ensure the work is completed satisfactorily. Despite her demanding schedule, she guided me through the entire project, which I am really grateful for.*

I am grateful to the University of Calicut for providing me an opportunity to carry out the research project.

I would like to thank ***Ms. Greeni K I****, the coordinator of M.Sc. Chemistry, Christ College (Autonomous), Irinjalakuda; for her guidance and support.*

I sincerely appreciate the guidance that I have received from my internal guide, ***Dr. Shereema R M****, and the other faculty members of the department.*

I would also like to thank the Ph.D. research scholars ***Ms. Athira Ajayan, Ms. Anupriya K, Ms. Sreelakshmi T, Ms. Anila Paul, Ms. Vismaya Joseph, and Ms. Arunima K K*** *for providing me the necessary resources as well as valuable insights and feedback that improved the quality of my research project.*

I would also like to thank my family and friends for their unwavering support. Finally, I would like to thank everyone who assisted me with this dissertation.

NAMITHA HYDROSE

CONTENTS

Tabernaemontana divaricata Derived Carbon Quantum Dots for the Highly Selective and Sensitive Detection of Phenylalanine

A Dissertation submitted in partial fulfilment of the requirements

for the award of the Degree of

Master of Science in Chemistry

By

NIVEDYA N

(CCAWMCH025)

Submitted to

THE DEPARTMENT OF CHEMISTRY

CHRIST COLLEGE AUTONOMOUS IRINJALAKUDA, 680125

Under the guidance of

Dr. BEENA MATHEW

SCHOOL OF CHEMICAL SCIENCES

MAHATMA GANDHI UNIVERSITY

KOTTAYAM, KERALA

JUNE 2024

SCHOOL OF CHEMICAL SCIENCES

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Kottayam-686 560, Kerala, India

CERTIFICATE

This is to certify that the dissertation entitled ***"Tabernaemontana divaricata Derived Carbon Quantum Dots for the Highly Selective and Sensitive Detection of Phenylalanine***" submitted by **Ms. NIVEDYA N (Reg No: CCAWMCH025)** to CHRIST COLLEGE AUTONOMOUS, Irinjalakuda in partial fulfilment of the requirements for the award of the degree of Master of Science in Chemistry, is a record of original and independent work carried out by her at the School of Chemical Sciences, Mahatma Gandhi University, Kottayam, Kerala during the month of April 2024. No part of this project has been submitted elsewhere for award of any other degree or diploma.

Dr. Beena Mathew
(External Supervisor)
Senior Professor
School of Chemical Sciences
Mahatma Gandhi University

Kottayam
June 2024

CHRIST COLLEGE
(AUTONOMOUS) IRINJALAKUDA - KERALA

CERTIFICATE

This is to certify that **Ms. NIVEDYA N (Reg No:CCAWMCH025)** has successfully completed her project work entitled ***"Tabernaemontana divaricata Derived Carbon Quantum Dots for the Highly Selective and Sensitive Detection of Phenylalanine"*** under the guidance of **Dr. Beena Mathew**, Senior Professor, School of Chemical Sciences, Mahatma Gandhi University, Kottayam, during the month of April 2024 for the partial fulfilment of the award of the Degree of MASTER OF SCIENCE in CHEMISTRY, Christ College Autonomous Irinjalakuda.

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CHRIST COLLEGE
(AUTONOMOUS) IRINJALAKUDA - KERALA

CERTIFICATE

This is to certify that **Ms. NIVEDYA N (Reg No:CCAWMCH025)** has successfully completed her project work entitled ***"Tabernaemontana divaricata Derived Carbon Quantum Dots for the Highly Selective and Sensitive Detection of Phenylalanine"*** under the guidance of **Dr. Beena Mathew**, Senior Professor, School of Chemical Sciences, Mahatma Gandhi University, Kottayam, during the month of April 2024 for the partial fulfilment of the award of the Degree of MASTER OF SCIENCE in CHEMISTRY, Christ College Autonomous Irinjalakuda.

Dr. SHAREEMA R M
Department of Chemistry
Christ College (Autonomous)
Irinjalakuda, Kerala, 680125

TABLE OF CONTENTS

DECLARATION

I hereby declare that the dissertation entitled ***"Tabernaemontana divaricata Derived Carbon Quantum Dots for the Highly Selective and Sensitive Detection of Phenylalanine***" is the original work done by me, under the supervision and guidance of **Dr. Beena Mathew**, Senior Professor, School of Chemical Sciences, Mahatma Gandhi University, Kottayam, in partial fulfilment of the requirements for the award of the degree of Master of Science in Chemistry, Christ College (Autonomous) Irinjalakuda. No part of this dissertation has been presented earlier to award any degree, diploma, or other titles of recognition.

Kottayam

June 2024

NIVEDYA N

MSc. Chemistry

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ACKNOWLEDGEMENT

At the very outset of this report, I would like to extend my sincere obligation to all the persons who have helped me in this endeavor. Without their active guidance, help, cooperation, and encouragement, I would not have made headway in the project.

I bow my head and offer my thanks to God Almighty for the never-failing grace and blessings to complete the project work.

I express my gratitude to our Head of the Department, ***Ms. Greeni K I*** *for providing an opportunity to do the project work.*

I express my heartfelt gratitude to my external supervisor ***Dr. Beena Mathew****, Senior Professor, School of Chemical Sciences, Mahatma Gandhi University, Kottayam, Kerala, for allowing me to do my M.Sc. project under her supervision. I thank her for her guidance, continued assistance, encouragement, and involvement throughout my research work.*

I am grateful to ***Dr. Anitha C Kumar****, Director, School of Chemical Sciences, Mahatma Gandhi University, Kottayam, Kerala, for permitting me and providing the necessary facilities for this work. I also take this opportunity to thank all the other teaching and non-teaching members of the School of Chemical Sciences for their help and support.*

I sincerely thank ***Ms. Jincy Mathew*** *and* ***Ms. Neena John Plathanam*** *Research Scholars, School of Chemical Sciences, Mahatma Gandhi University, Kottayam, Kerala, for her great support, guidance, and timely assistance during my project work.*

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I also acknowledge with a deep sense of reverence, my gratitude towards my parents and members of my family, who has always supported me morally as well as economically.

Last but not least gratitude goes to all of my friends, who directly or indirectly helped me to complete this project report.

NIVEDYA. N

SYNTHESIS, CHARACTERIZATION AND SENSING APPLICATIONS OF PANI-PVP COMPOSITES

A dissertation submitted to the University of Calicut in partial fulfillment of the requirements for the award of the degree of

MASTER OF SCIENCE IN CHEMISTRY

By

SAHLA S S
(Reg. No: CCAWMCH026)

Under the Guidance of

DR. ABRAHAM JOSEPH

SENIOR PROFESSOR

Department of Chemistry

University of Calicut

Department of Chemistry
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CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA

DEPARTMENT OF CHEMISTRY

CERTIFICATE

This is to certify that the dissertation entitled "**SYNTHESIS, CHARACTERIZATION AND SENSING APPLICATIONS OF PANI-PVP COMPOSITES**" is an authentic record of work carried out by **Ms. SAHLA S S (Reg No: CCAWMCH026)** under the guidance of **Dr. ABRAHAM JOSEPH**, **Senior Professor, Department of Chemistry, University of Calicut**, from April 2024 to June 2024 in partial fulfillment of the requirement for the award of Master of Science in Chemistry.

Certified further to the best of our knowledge that this does not form part of any other dissertation or project work based on which a degree or diploma or a similar title has been awarded earlier to any candidate by any other university.

External Examiner **Head of the Department**

Internal examiner

UNIVERSITY OF CALICUT

TIRUR - CALICUT RD, THENHIPALAM, 673635

KERALA, INDIA

CERTIFICATE

This is to certify that the dissertation, entitled "**SYNTHESIS, CHARACTERIZATION AND SENSING APPLICATIONS OF PANI-PVP COMPOSITES**" submitted to the University of Calicut, in the partial fulfillment of the requirements for the award of Degree of Master of Science in Chemistry is a bona fide record of project work done by **Ms. SAHLA S S** at University of Calicut, during the period April 2024- June 2024, under my supervision and guidance. The dissertation is not formed the basis for the award of any Degree/Diploma/Associate ship/Fellowship or other similar title to any University.

DR. ABRAHAM JOSEPH

Senior Professor

Department of Chemistry

University of Calicut

CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA

CERTIFICATE

This is to certify that the dissertation entitled "**SYNTHESIS, CHARACTERIZATION AND SENSING APPLICATIONS OF PANI-PVP COMPOSITES**" submitted to the University of Calicut in partial fulfillment of the degree of Master of Science in Chemistry is a bona fide record of work carried out by **Ms. SAHLA S S**. This dissertation was guided and written under my supervision.

Greeni K I
Department of Chemistry
Christ College (Autonomous)
Irinjalakuda

DECLARATION

I, **SAHLA S S**, hereby declare that the dissertation, entitled "**SYNTHESIS, CHARACTERIZATION AND SENSING APPLICATIONS OF PANI-PVP COMPOSITES**" submitted to the University of Calicut is a bona fide record of project work done by me under the supervision and guidance of **Dr. ABRAHAM JOSEPH**, Senior Professor, Department of Chemistry, University of Calicut and it has not formed the basis for the award of any Degree/Diploma/Associate ship/Fellowship or other similar title to any University.

University of Calicut **SAHLA S S**

27-07-2024 **CCAWMCH026**

ACKNOWLEDGEMENTS

I would like to express my deepest gratitude to everyone who contributed to the completion of this project. It gives me immense pleasure to express my deep sense of gratitude to my project guide ***Dr. Abraham Joseph****, Senior Professor, Department Of Chemistry, University Of Calicut; for his invaluable guidance, support, and expertise throughout this project.*

My sincere appreciation goes out to my co-guide, ***Dr. Anupama R Prasad****, Research Associate, Christ College (Autonomous), Irinjalakuda; for introducing me to my project guide and for her unwavering support and guidance at every turn to ensure the work is completed satisfactorily. Despite her demanding schedule, she guided me through the entire project, which I am really grateful for.*

I am grateful to the University of Calicut for providing me an opportunity to carry out the research project.

I would like to thank ***Ms. Greeni K I****, my internal guide and the coordinator of M.Sc. Chemistry, Christ College (Autonomous), Irinjalakuda; for her guidance and support. I sincerely appreciate the guidance that I have received from the other faculty members of the department.*

I would also like to thank the Ph.D. research scholars ***Ms. Athira Ajayan, Ms. Anupriya K, Ms. Sreelakshmi T, Ms. Anila Paul, Ms. Vismaya Joseph, and Ms. Arunima K K*** *for providing me the necessary resources as well as valuable insights and feedback that improved the quality of my research project.*

I would also like to thank my family and friends for their unwavering support. Finally, I would like to thank everyone who assisted me with this dissertation.

SAHLA S S

CONTENTS

SYNTHESIS AND STUDIES ON PORPHYRIN BASED CHIRAL MACROCYCLES

A dissertation submitted to the **University of Calicut** in partial fulfilment of the requirement for degree of **Master of Science in Chemistry**

Submitted by

SREELAKSHMI K P

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Department of Chemistry

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Under the guidance

Dr. SOUMEN DE

Assistant Professor

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Thiruvananthapuram- 695551, Kerala

DEPARTMENT OF CHEMISTRY

CHRIST COLLEGE (AUTONOMOUS) IRINJALAKUDA

CERTIFICATE

This is to certify that the dissertation entitled "**Synthesis and Studies on Porphyrin-based Chiral Macrocycles**" is an authentic record of work carried out by **SREELAKSHMI K P (Reg No: CCAWMCH027)** under the guidance of **Dr. Soumen De, Asst. Professor School of Chemistry, Indian Institute of Science Education and Research (IISER) Thiruvananthapuram** during the period of April 2024 to June 2024 as partial fulfilment of the requirement for the degree of master of science in chemistry. Certified further to the best of our knowledge that this does not form part of any other dissertation or project work based on which a degree or diploma or a similar title has been awarded earlier to any candidate by any other university.

External Examiner **Head of Department**

Internal Examiner

SCHOOL OF CHEMISTRY

INDIAN INSTITUTE OF SCIENCE EDUCATION AND RESEARCH

CERTIFICATE

This is to certify that the dissertation entitled "**Synthesis and Studies on Porphyrin-based Chiral Macrocycles**" is the bonafide work of **SREELAKSHMI K P** who carried out the dissertation work under my supervision at **Indian Institute of Science Education and Research (IISER)**, Thiruvananthapuram, Kerala, during April 2024-June 2024. To the best of my knowledge, the work reported by her, does not be a part of any other thesis or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any scholar.

Thiruvananthapuram

Dr. SOUMEN DE
Asst. Professor
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IISER Thiruvananthapuram, Kerala

CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA

CERTIFICATE

This is to certify that the dissertation entitled "**Synthesis and Studies on Porphyrin-based Chiral Macrocycles"**, submitted to the faculty of science, University of Calicut, in partial fulfilment of the degree of Master of Science in Chemistry, is a bonafide record of work carried out by SREELAKSHMI K P. This dissertation was guided and written under my supervision.

Ms Greeni K I

Department of Chemistry

Christ College, Irinjalakuda

DECLARATION

I hereby declare that the dissertation entitled "**Synthesis and Studies on Porphyrin-based Chiral Macrocycles"** being submitted to university of Calicut in partial fulfilment of the requirement for degree of Master of Science in Chemistry is a bonafide record of research work done by me under the guidance of Dr. Soumen De, Asst. Professor School of Chemistry, IISER Thiruvananthapuram. It has not formed the part of any other thesis submitted for the award of any Degree/Diploma Associateship/ Fellowship or similar title to any candidate of any University.

Place: Thiruvananthapuram **SREELAKSHMI K P**

Date: 27/07/2024 CCAWMCH027

ACKNOWLEDGEMENT

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SREELAKSHMI K P

CONTENTS

GRAPHENE BASED NICKEL CATALYST FOR HYDROGEN EVOLUTION REACTION IN ALKALINE MEDIUM

A dissertation submitted to the University of Calicut in partial fulfillment of the requirements for the award of the degree of

MASTER OF SCIENCE IN CHEMISTRY

By

SUMAYYA M S
(Reg. No: CCAWMCH028)

Under the Guidance of

Ms. GREENI K I

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CHRIST COLLEGE (AUTONOMOUS)

IRINJALAKUDA, THRISSUR

(Nationally Re-accredited with A++ grade)

CERTIFICATE

This is to certify that the project entitled **"GRAPHENE BASED NICKEL CATALYST FOR HYDROGEN EVOLUTION REACTION IN ALKALINE MEDIUM** work carried out by **MS. SUMAYYA M** S under my supervision for the partial fulfilment of the degree of Master of Science in Chemistry, through Department of Chemistry, Christ College, Irinjalakuda and no part of this formed the basis for award of any degree, diploma or other similar titles of any university**.**

Place: Irinjalakuda

Ms. Greeni K I

Date: Head of Department, Chemistry

Christ College (Autonomous),

Irinjalakuda

CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA

DEPARTMENT OF CHEMISTRY

CERTIFICATE

This is to certify that the dissertation entitled "**GRAPHENE BASED NICKEL CATALYST FOR HYDROGEN EVOLUTION REACTION IN ALKALINE MEDIUM**" is an authentic record of work carried out by **Ms. SUMAYYA M S (Reg No: CCAWMCH028)** under the guidance of **Ms. GREENI K I**, **Coordinator, Department of Chemistry, Christ College (Autonomous), Irinjalakuda**, from April 2024 to June 2024 in partial fulfillment of the requirement for the award of Master of Science in Chemistry.

Certified further to the best of our knowledge that this does not form part of any other dissertation or project work based on which a degree or diploma or a similar title has been awarded earlier to any candidate by any other university.

External Examiner **Head of the Department**

Internal examiner

CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA

CERTIFICATE

This is to certify that the dissertation entitled "**GRAPHENE BASED NICKEL CATALYST FOR HYDROGEN EVOLUTION REACTION IN ALKALINE MEDIUM**" submitted to the Christ College (Autonomous), Irinjalakuda, in partial fulfillment of the degree of Master of Science in Chemistry is a bona fide record of work carried out by **Ms. SUMAYYA M S**. This dissertation was guided and written under my supervision.

Ms. Greeni K I
Department of Chemistry
Christ College (Autonomous)
Irinjalakuda

DECLARATION

I, **SUMAYYA M S**, hereby declare that the dissertation, entitled "**GRAPHENE BASED NICKEL CATALYST FOR HYDROGEN EVOLUTION REACTION IN ALKALINE MEDIUM**" is a bona fide record of project work done by me under the supervision and guidance of **Ms.GREENI KI**, coordinator, Department of Chemistry, Christ College (Autonomous), Irinjalakuda, and it has not formed the basis for the award of any Degree/Diploma/Associate ship/Fellowship or other similar title to any University.

Place: **SUMAYYA M S**

Date:27-07-2024 **CCAWMCH028**

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I would like to begin by expressing gratitude to god almighty for all his blessings, with great pleasure I express my sincere gratitude to **Ms. Greeni K.I**, Professor, Department of Chemistry, Christ College (Autonomous), Irinjalakuda, for his dynamic effort in guiding and instructing me for the completion of this work successfully.

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SUMAYYA M S

CONTENTS