DEVELOPMENT OF Fe_3O_4/GRAPHENE NANOCATALYST FOR OXYGEN REDUCTION REACTION IN ALKALINE ZINC-AIR CELL

PROJECT REPORT

SUBMITTED TO,

UNIVERSITY OF CALICUT

In partial fulfilment of requirement for the award of Masters of Science in Chemistry 2021-2023

BY

ADITHYA P.C.

CCAVMCH001

DEPARTMENT OF CHEMISTRY

CHRIST COLLEGE, IRINJALAKUDA

UNDER THE GUIDENCE OF

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ASSOCIATE PROFESSOR& HEAD,

DEPARTMENT OF CHEMISTRY

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DEPARTMENT OF CHEMISTRY, CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA

CERTIFICATE

This is to certify that the project work entitled, "**DEVELOPMENT OF Fe_3O_4/GRAPHENE NANOCATALYST FOR OXYGEN REDUCTION REACTION IN ALKALINE ZINC-AIR CELL"** is an authentic record of the study carried out by ADITHYA P.C. (Reg.no CCAVMCH001), CHRIST COLLEGE AUTONOMOUS IRINJALAKUDA as part of MSc practical during the year 2021-2023 and the result of this work have not been presented for the award of any other Degree/Diploma in any University.

PLACE: IRINJALAKUDA

DATE : 21-07-2023

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This is to certify that the content of this project work entitled, "**DEVELOPMENT OF Fe_3O_4/GRAPHENE NANOCATALYST FOR OXYGEN REDUCTION REACTION IN ALKALINE ZINC-AIR CELL**" is the original research work done by ADITHYA P.C under my supervision and guidance at the Department of Chemistry, Christ College (Autonomous), Irinjalakuda. I further certify that the work has not been submitted either partly or fully to any other University or Institution for the award of any Degree or Diploma.

PLACE: IRINJALAKUDA

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DECLARATION

I hereby declare that the dissertation entitled, "**DEVELOPMENT OF Fe_3O_4/GRAPHENE NANOCATALYST FOR OXYGEN REDUCTION REACTION IN ALKALINE ZINC-AIR CELL**" is a genuine record of project work done by me under the guidance of Dr. V T JOY, Associate Professor and Head of the department, chemistry, Christ college (Autonomous), Irinjalakuda and has not been submitted to any university or institution for the award of any degree or diploma.

I further declare that the results presented in this work and consideration made therein contribute to the advancement of knowledge in Chemistry.

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DATE: 21/07/2023

ACKNOWLEDGEMENT

Upon the successful completion of this project, I would like to extend my sincere and deepest gratitude to the following without whom the work would not be possible. Primarily I would like to thank God Almighty for being able to complete this project on time and for the favorable circumstances that made it. I wish to express my sincere gratitude to my project guides Dr. V T JOY, Associate Professor and HOD of Chemistry Department, Christ College, Irinjalakuda for the guidance, for providing necessary advice, for patience in hearing my ideas, and for all the endeavors they took for the completion of this project. Without their enormous support and guidance, this study would not be possible. I extend my thanks to Dr. V.T Joy, Associate Professor and Head of the Department of Chemistry, Christ College, Irinjalakuda, and all other teaching and non-teaching staff of the department for their suggestions, comments and encouragement during this work. I am also indebted to Rev. Dr. Jolly Andrews CMI, Principal, Christ College, Irinjalakuda, for providing all the available facilities for this work.

Lastly, I would like to thank my family members and friends for their support.

ADITHYA P.C

ABSTRACT

Zinc air batteries are a promising energy storage technology because of their high specific energy density, low cost, and relative safety. However, modifications must be done to increase their efficiency in terms of both energy and power density in order to fully realise their benefits. This research focuses on developing new cathode materials for zinc air flow batteries with enhanced electrochemical and mass transport capabilities. Fe_3O_4 was deposited on graphene to create the oxygen reduction catalyst, and the zinc-air cell was assembled for evaluating the catalyst's performance. In zinc air fuel cell, the catalyst exhibited outstanding activity for the oxygen reduction reaction. Zinc – air batteries offer many advantages over existing forms of large-scale energy storage. The inherent safety combined with facile electrochemistry make zinc air fuel cells particularly attractive for energy storage applications.

Contents

CONSTRUCTION OF ZINC OXIDE MODIFIED M-CQD AS PHOTOCATALYST FOR THE DEGRADATION OF DYES

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

Master of Science in Chemistry

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Year: 2021-2023

Submitted to

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This is to certify that the dissertation entitled "Construction of Zinc Oxide modified M-CQDs as Photocatalyst for the Degradation of Dyes" submitted by **ANJALI MENON (Reg No:CCAVMCH002)** 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 School of Chemical Sciences, Mahatma Gandhi University, Kottayam, Kerala during the month of May 2023. No part of this project has been submitted elsewhere for award of any other degree.

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This is to certify that **Ms. ANJALI MENON (Reg No: CCAVMCH002)** has successfully completed her project wok entitled "***Construction of Zinc Oxide modified M-CQDs as Photocatalyst for the Photodegradation of Dyes***" under the guidance of **Dr. Beena Mathew**, Professor, School of Chemical Sciences, Mahatma Gandhi University, Kottayam, during the month of April-June 2023 for the partial fulfilment of the award of Degree of MASTER OF SCIENCE in CHEMISTRY, Christ College (Autonomous), Irinjalakuda.

Dr. V. T JOY

Head of the Department

Department of chemistry

Christ College Irinjalakuda

DECLARATION

I hereby declare that the dissertation entitled "***Construction of Zinc Oxide modified M-CQDs as Photocatalyst for the Degradation of Dyes***" is the original work done by me, under the supervision and guidance of **Dr. Beena Mathew**, 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 Mahatma Gandhi University. No part of this dissertation has been presented earlier to award any degree, diploma, or other titles of recognition.

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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, **Dr. V. T. JOY f**or providing an opportunity to do the project work.

I express my heartfelt gratitude to my external supervisor **Dr. Beena Mathew**, 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 sincerely thank my internal supervisor **Dr. Rani Varghese** and class in-charge **Dr. Arun S**, Department of Chemistry, Christ College (Autonomous), for their sincere support and guidance.

I am grateful to **Dr. K. S. Devaky**, and **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. Neena** and **Ms. Jincy**, Research Scholars, School of Chemical Sciences, Mahatma Gandhi University, Kottayam, Kerala, for her great support, guidance, and timely assistance during my project work.

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.

ANJALI MENON

ABSTRACT

Solar-light-driven photo catalysis is an emerging, renewable and sustainable approach in environmental remediation to mitigate organic pollutants from wastewater. M-CQDs have been employed due to their increased surface area, inexpensive price, high number of active sites, non-toxicity, and enhanced thermal stability. The expanded light absorption range of the CQDs was attributed to the accumulation of electrons, in accordance with the quantum confinement effect. In the present work, we synthesized the photocatalyst M-CQDs, by hydrothermal synthesis method. In view of inherent deficiencies in the prepared CQDs namely, band gap alignment and high recombination rate, some modification strategies like doping have been explored. The M-CQDs have been modified by doping with ZnO to enhance photocatalytic efficiency. The photodegradation of organic pollutants like dyes specifically Rhodamine B have been connected using the new photocatalyst. The novel M-CQD/ ZnO photocatalyst was characterized FT-IR spectra, UV-Visible spectra, and XRD studies.

Keywords: Carbon quantum dots, photodegradation, organic pollutants, M-CQDs, dyes

TABLE OF CONTENTS

"SYNTHESIS AND EVALUATION OF PACLITAXEL LOADED SERICIN-LIPID HYBRID NANOPARTICLES FOR ANTI-CANCER DRUG DELIVERY"

A Dissertation submitted in partial fulfilment of the requirements

for the award of the Degree of

Master of Science in Chemistry

By

ANNA SHAJI

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Submitted to

THE DEPARTMENT OF CHEMISTRY

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This is to certify that Ms. Anna Shaji (Reg No: CCAVMCH003) has successfully completed her project work entitled **"Synthesis and Evaluation of Paclitaxel Loaded Sericin Lipid Hybrid Nanoparticles for Anti-cancer Drug Delivery"** under the guidance of Dr JOSHY K.S, Associate professor, International and Interuniversity Centre for Nanoscience and Nanotechnology , Mahatma Gandhi University, Kottayam, during 1 April 2023- 30 June 2023 for the partial fulfilment of the award of Degree of MASTER OF SCIENCE in CHEMISTRY, Christ College (Autonomous), Irinjalakuda.

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DECLARATION

I hereby declare that the dissertation entitled **"Synthesis and Evaluation of Paclitaxel Loaded Sericin Lipid Hybrid Nanoparticles for Anti-cancer Drug Delivery"** is the original work done by me, under the supervision and guidance of Dr JOSHY K.S, Assistant professor, International and Interuniversity Centre for Nanoscience and Nanotechnology, Mahatma Gandhi University, Kottayam, in partial fulfilment of the requirements for the award of the degree of Master of Science in Chemistry of Mahatma Gandhi University. No part of this dissertation has been presented earlier to award any degree, diploma, or other titles of recognition.

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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 during the project work entitled **"Synthesis and Evaluation of Paclitaxel Loaded Sericin Lipid Hybrid Nanoparticles for Anti-cancer Drug Delivery"**. 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. Joy V T** for providing an opportunity to do the project work.

I express my heartfelt gratitude to my external supervisor **Dr.Sreekala M S**, Joint Director, International and Interuniversity Centre for Nanoscience and Nanotechnology, 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 sincerely thank my internal supervisor **Dr. Digna Varghese**, Assistant professor Department of Chemistry, Christ College (Autonomous), for her sincere support and guidance.

I sincerely thank **Dr.Joshy K.S**, Associate Professor, School of Nanoscience and Nanotechnology, Mahatma Gandhi University, Kottayam, Kerala, for her great support, guidance, and timely assistance during my project work.

I extend my sincere gratitude to Mr. Prajisha Prabhakar, Research Scholar, Mahatma Gandhi University, Kottayam, for the support and co-operation for the successful completion of my work.

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

TABLE OF CONTENTS

4. RESULTS AND DISCUSSION

Design, synthesis and characterization of PTX-NPs

4.1 Transmission electron microscopy

4.2 Fourier transform spectroscopy

4.3 Determination of drug loading and drug content

4.4 In vitro drug release

4.5 UV-Visible spectroscopy

4.6 Cell culture studies

ABSTRACT

The creation of innovative nanocarriers for the delivery of anticancer drugs has emerged as a "promising niche." Since they might impair the course of the therapy, the toxicity of the carrier and its effectiveness in treatment methods have become crucial considerations. In this study, a drug delivery system composed of a polymer(PEG) coated sericin-lipid blend , which is able to release paclitaxel efficiently, was contrived. Here, paclitaxel was encapsulated inside the sericin-lipid blend nanocarriers coated with a PEG shell. The paclitaxel encapsulated nanoparticles had a spherical shaped structure with a mean diameter of 50±12.4nm. The developed drug delivery system has showed a drug loading capacity of more than 90% and exhibited pH-responsive release of paclitaxel. Moreover, the desirable features of the nanoparticles include biodegradability, biocompatibility, and blood compatibility. The potency of the drug delivery system was tested against breast cancer cells (MDA-MB 231), which provided excellent results establishing the vigour of paclitaxel-loaded nanoparticles in human breast cancer interventions. Furthermore, paclitaxel-loaded nanoparticles predominate as an essential tool in cancer therapy because to their negligible systemic toxicity, minimal side effects, and anti-tumor activities.

SYNTHESIS OF A CROSS-LINKABLE, TRIPHENYLAMINE-BASED HOLE TRANSPORTING MATERIAL FOR PEROVSKITE SOLAR CELLS

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

Master of Science in Chemistry

By

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Submitted to

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Under the guidance of

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DECLARATION

I hereby declare that the work embodied in this report entitled "**SYNTHESIS OF A CROSS-LINKABLE TRIPHENYLAMINE-BASED HOLE TRANSPORTING MATERIAL FOR PEROVSKITE SOLAR CELLS**" are results of the investigation carried out by me at the Photosciences and Photonics section of Chemical Sciences and Technology Division, National Institute for Interdisciplinary Science and Technology (CSIR-NIIST), Trivandrum, Kerala under the guidance of Dr. Joshy Joseph and the same has not been submitted elsewhere for a degree.

In keeping with the general practice of reporting scientific observations, due acknowledgements have been made wherever the work described is based on the findings of other investigators.

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ACKNOWLEDGEMENT

First, I thank the Almighty for his providence, wisdom and health, which helped me

tocomplete the project successfully.

I sincerely thank Dr. Joshy Joseph, Chemical Sciences and Technology Division of the National Institute for Interdisciplinary Science and Technology, Trivandrum, for his guidance and constant encouragement throughout the project.

I thank our principal, the Head Of the Department Dr. Joy and my internal mentor Dr. Robinson, Christ College (Autonomous) Irinjalakuda, for allowing me to do the project work.

I express my deepest gratitude to Dr. Samatha Mathew, Mrs. Shibna B, Mrs. Nishna, Ms. Anagha Thomas, Mr. HrishikesA and Mrs. Neha for their immense help in conducting experiments and preparing the project report. I wish to express my gratitude to my labmates, Ms. Gopika Suresh, Ms. Anjali Krishna, Ms. Sandra Wilson, Ms. Darshana and Ms. Anna Mariya Thomas, for helping me to clear my doubts and for their valuable assistance.

I express my gratitude to all my friends and classmates for their motivation and mental support. Finally, I thank my parents and family members for their moral support.

ANNAROSE C F

ABSTRACT

Perovskite solar cells are an emerging type of solar cells that have hetero junction kind structures, which are formed by stacking different layers of semiconducting materials together in a planar or mesoscopic architecture. These cells have gained immense popularity due to their low cost and high efficiency, making them an alternative to traditional silicon-based solar cells. One main content in solar cells is hole-transporting materials; different kinds of hole-transporting materials have been synthesised. Still, in this project, we have synthesised and characterised cross-linkable triphenylamine-based hole transporting material for perovskite solar cells.

INTRODUCTION

In this modern era, the emission of greenhouse gases in large amounts requires carbon-free energy sources. Here we discovered the importance of solar energy, an alternative to fossil fuels. Solar cells, also known as photovoltaic cells, are a kind of device that can convert solar energy into electrical energy. They offer a sustainable, clean and renewable source of energy. Solar cells have been found to have environmental and economic benefits that include reduced greenhouse gas emissions, increased efficiency, reduced cost, etc. Thus solar cells have emerged as a vital component in future energy. Now considering solar cells, most of the solar cells are silicon cells. Depending on the cost and energy efficiency, they consist of amorphous silicon cells, monocrystalline and polycrystalline silicon solar cells. It is found that the efficiency of solar cells depends on the cell material and manufacturing costs. The efficiency of solar cells is one of the essential criteria upon which the researchers look.

Solar cells are built on semiconductor materials, most commonly silicon. As the sunlight get strikes the cells, the photons will result in the knocking out of electrons from their outer orbital. The knocked-out electrons will reach the external circuit, resulting in the electric current flow. The solar cells' size, quality and efficiency depend on the solar cells' performance in converting light energy into electrical energy. The future of solar cells is found to be incredibly bright. But there found be some challenges to overcome; nowadays, technology is continually working to improve the efficiency and working of solar cells, and one of the innovative ideas among them is the introduction of perovskites. These perovskites-based solar cells have gained popularity because of their low cost and high efficiency. Thus they found it to be an alternative to traditional silicon-based solar cells.

In perovskite solar cells, the crystalline structure absorbs and converts light energy into electricity. They are named perovskite solar cells because of their unique atomic arrangement, and they are found to be similar in structure to the naturally occurring mineral perovskite[4-10]. The Perovskite solar cells have the potential to absorb a broader range of wavelengths which increases solar energy efficiency. The advantages of perovskite solar cells are that they are found to be cheaper to produce when compared to silicon-based solar cells, are more efficient in converting sunlight to electrical energy

and have a high absorption rate[10-16]. The efficiency of the perovskite solar cells makes them more promising for commercialisation in future. The cheaper rate of perovskite material and easier deposition of perovskite layer reduces the manufacturing cost and make them competitive with the usual photovoltaic devices. Perovskite cells can be made from different materials, like organic compounds, which helps them optimise their property. In particular, perovskite solar cells using methylammonium lead halide perovskites are promising, and they exhibited power conversion efficiencies of 3.8-6.5% in liquid-based dye-sensitized solar cells[1-3].

Despite their efficiency and low cost, these types of cells have certain limitations and challenges. In the presence of intense moisture and heat, these cells are found to degrade quickly; sometimes, fluctuations in temperature and light can affect the efficiency and performance of perovskite solar cells. Thus researches are ongoing to overcome stability issues, durability issues, toxicity concerns and other commercialisation challenges[25-35]. If we can overcome these challenges, they can be used in vast areas. We are here to focus on the hole-transporting materials used in perovskite solar cells. Hole-transporting materials help transport and extract the holes in perovskite solar cells. Perovskite solar cells work so that holes and electrons are generated on irradiation. The electrons thus generated get transferred into the conduction band of the semiconductor. Therefore the spot on the perovskite gets transferred to the whole conductor. After that, the hole gets injected into the electrode. The hole transporting material in perovskite solar cells helps minimise losses due to the recombination art interface that improves the device's performance [17-25].

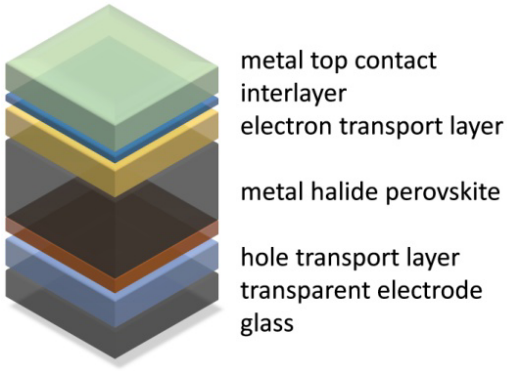

Figure 1

The above figure shows the standard diagram of a perovskite solar cell. While considering the hole transporting materials in perovskite solar cells, the homo energy levels of the positive charge extraction layer be comparable[36-40]*. So here we decided to synthesise hole transporting material in a limited period which is low cost and has an efficient energy conversion*

PREPARATION AND CHARACTERISATION OF PVA-CHITOSAN FILMS

PROJECT REPORT

SUBMITTED TO

UNIVERSITY OF CALICUT

In partial fulfilment of the requirements for the award of Master of Science in Chemistry 2021-2023

BY

BHAVYA MADHUSUDANAN

CCAVMCH005

DEPARTMENT OF CHEMISTRY

CHRIST COLLEGE, IRINJALAKUDA

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(AUTONOMOUS)

CERTIFICATE

This is to certify that the project work entitled **"PREPARATION AND CHARACTERISATION OF PVA-CHITOSAN FILMS"** is an authentic record of study carried out by BHAVYA MADHUSUDANAN (Reg. No. CCAVMCH005) as a part of MSc. Practical during the year 2021-2023 and the result of this work have not been presented for the award of any other degree/diploma in any university.

Place: Irinjalakuda

Date :

Dr. V.T JOY

Department of Chemistry

Christ College, Irinjalakuda

CERIFICATE BY THE GUIDE

This is to certify that the content of this project work entitled **"PREPARATION AND CHARACTERISATION OF PVA-CHITOSAN FILMS"** is the original research work done by BHAVYA MADHUSUDANAN under my supervision and guidance at the Department of Chemistry, Christ College (Autonomous), Irinjalakuda. I further certify that the work has not been submitted either partly or fully to any other University or institution for the award of any Degree/Diploma.

Place:

Date :

Dr. TITTO VARUGHESE

Asst. Professor

Department of Chemistry

Christ College, Irinjalakuda

DECLARATION

I hereby declare that the dissertation entitled, "PREPARATION AND CHARACTERISATION OF PVA-CHITOSAN FILMS" is a genuine record of project work done by me under the guidance of Dr. Titto Varughese, Asst. Professor, Department of Chemistry, Christ College (Autonomous), Irinjalakuda and has not been submitted to any university or institution for the award of any Degree or Diploma.

I further declare that the results presented in this work and consideration made therein contribute to the advancement of knowledge in Chemistry.

Place:

Date :

BHAVYA MADHUSUDANAN

ACKNOWLEDGEMENT

Upon the successful completion of this project, I would like to extend my sincere and deep gratitude to the following without whom the work would not be possible. Primarily I would like to thank the Almighty God for being able to complete this project on time and for the favorable circumstances that made this possible. I wish to express my sincere gratitude to my project guide Dr. Titto Varughese, Assistant Professor, Department of Chemistry, Christ College, Irinjalakuda for hid guidance, for providing necessary advice and for all the endeavors he took for the completion of this project. Without his whole hearted support and guidance, this study would not have been possible. I also extend my sincere thanks to Dr. V.T Joy, Head of Department of Chemistry, Christ College, Irinjalakuda, and all other teaching and non-teaching staff of the department for their valuable suggestions, comments and encouragement during this work. I also extend my sincere thanks and gratitude to Rev. Dr. Jolly Andrews CMI, Christ College, Irinjalakuda, for providing all the available facilities for the completion of this work. Lastly, I would like to thank my classmates and parents for their support and effort for completion of this work.

BHAVYA MADHUSUDANAN

CONTENTS

ABSTRACT

PREPARATION AND CHARACTERISATION OF PVA-CHITOSAN FILMS

The project examines how to develop a chitosan film with better properties upon blending with another polymer. A film of poly vinyl alcohol (PVA) and chitosan was developed using simple casting method. Fourier transform infrared spectroscopy (FT-IR) was used to examine this poly vinyl alcohol- chitosan (PVA-CH) and also its physical properties were studied. These PVA-CH films prepared in varying concentrations were subjected to sorption studies using water and methanol. Biodegradability studies were also conducted for these films. The films formed are composites of PVA and chitosan was being demonstrated by the FT-IR spectroscopy. It is true that this discovery opens the door to the creation of chitosan-based materials for bio-films.

ONE POT MULTICOMPONENT SYNTHESIS OF CHROMENE DERIVATIVES

Project report submitted to the University of Calicut in partial fulfilment of the requirement for the award of the Degree,

MASTER OF SCIENCE IN CHEMISTRY

Submitted by

DEVIKA P

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Ref. CC/CHEM/AS/2021-23/01
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Dr. Arun S
Asst. Professor in Chemistry

CERTIFICATE

This is to certify that **DEVIKA P** (Reg.No. CCAVMCH006) has carried out a project work entitled **"ONE POT MULTICOMPONENT SYNTHESIS OF CHROMENE DERIVATIVES"** is an authentic record of the research project carried out by my supervision and guidance in the P.G & Research Department of Chemistry, Christ College, Irinjalakuda. It is further certified that this project report has not previously formed the basis for the award of any Degree, Diploma, Fellowship or other similar title of recognition by any other university or Institutions.

Dr. Arun S

DECLARATION

I DEVIKA P (CCAVMCH006) do hereby declare that the dissertation entitled, "ONE POT MULTICOMPONENT SYNTHESIS OF CHROMENE DERIVATIVES" submitted to the University of Calicut in partial fulfilment of the requirement for the award of degree of Master of Science is a genuine record of project work done by me under the guidance of Dr.Arun.S, Assistant Professor of the department of chemistry, Christ College (Autonomous) Irinjalakuda and has not been submitted to any university or institution for the award of any degree or diploma.

I further declare that the results presented in this work and consideration made therein contribute to the advancement of knowledge in Chemistry.

Place: Irinjalakuda
Date: 21/07/2023

DEVIKA P

ACKNOWLEDGEMENT

First and foremost, I would like to extend my sincere and heartfelt gratitude to my guide Dr.Arun.S, Department of Chemistry ,Christ College (Autonomous) Irinjalakuda for his valuable and inspiring guidance, critical assessment and constant encouragement throughout all stages of this work. I'm greatly indebted to him for the successful completion of this work within the specified period.

I express my sincere gratitude to Dr.V.T.Joy ,Head of the Department of Chemistry and to all faculty members in the Department of Chemistry for their support.

I wish to acknowledge my gratitude to Rev.Dr.Jolly Andrews, CMI, Principal of Christ College (Autonomous) Irinjalakuda for providing timely help and necessary facilities.

I extend my heartfelt thanks to Seena Chakko and Ramya K, research scholars, Christ College (Autonomous) Irinjalakuda for their valuable support and ceaseless assistance throughout the work.

I must express my love and sincere gratitude to my parents for their cooperation and the support that they provided me during the project work. I cheerfully express my profound thanks to my dear friends for their support and cooperation.

Above all I humbly thank God Almighty who showered his abundant grace on me to make this project a success.

DEVIKA P

ABBREVIATIONS USED

(1) MCRs - MULTICOMPONENT REACTIONS

(2) MDR - MULTICOMPONENT DOMINO REACTIONS

(3) SAR - STRUCTURE ACTIVITY RELATIONSHIP

(4) DOS - DIVERSITY ORIENTED SYNTHESIS

(5) NCE - NOVEL CHEMICAL ENTITIES

CONTENTS

"Synthesis and Characterization of Clove Oil-Loaded Starch Nanoparticles for Advanced Antimicrobial Applications"

A Dissertation submitted in partial fulfilment of the requirements

for the award of the Degree of

Master of Science in Chemistry

By

JIYAMOL TOMY

(CCAVMCH007)

Submitted to

THE DEPARTMENT OF CHEMISTRY

CHRIST COLLEGE (AUTONOMOUS),

IRINJALAKUDA

Under the guidance of

Dr SREEKALA M S

International and Interuniversity Centre for

Nanoscience and Nanotechnology

Mahatma Gandhi University, Kottayam, Kerala

INTERNATIONAL AND INTERUNIVERSITY CENTRE FOR NANOSCIENCE AND NANOTECHNOLOGY

മഹാത്മാഗാന്ധി സർവ്വകലാശാല, കേരളം
ാ ിയദർശിനി ഹ ി ൽസ്, കോ ്ട്ടയം, കേ രള ം ഇ ന്ത്യ
686560

Mahatma Gandhi University Kerala
Priyadarsini Hills, Kottayam, Kerala, India - 686560

Date: 14/07/2023

TO WHOM IT MAY CONCERN

This is to certify that **Ms. Jiyamol Tomy**, student of Department of Chemistry, Christ College (Autonomous), Irinjalakuda has successfully completed her masters project in the area of **"Synthesis and Characterization of Clove Oil Loaded Starch Nanoparticles for Advanced Antimicrobial Applications "** during 1 April 2023 to 30 June 2023 under my guidance at International and Interuniversity Centre for Nanoscience and Nanotechnology (IIUCNN), Mahatma Gandhi University, Kottayam.

I wish her all the very best for her future endeavours.

With best regards

Dr. Sreekala M S
Joint Director
International and Interuniversity Centre for
Nanoscience and Nanotechnology
Mahatma Gandhi University, Kottayam

+91 9446866088 sreekalams@mgu.ac.in website: iiucnn.mgu.ac.in

CHRIST COLLEGE (Autonomous), IRINJALAKUDA.
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Website: www. christcollegeijk.edu.in, Email : drtomcherian@gmail.com

Ref. CC/CHEM/TM/2022-23/01
Date: 20th July 2023

Dr. Tom Cherian
Asst. Professor in Chemistry

CERTIFICATE

This is to certify that **JIYAMOL TOMY** (**Reg.No. CCAVMCH007**) has carried out a project work entitled **"SYNTHESIS AND CHARACTERIZATION OF CLOVE OIL- LOADED STARCH NANOPARTICLES FOR ADVANCED ANTIMICROBIAL APPLICATIONS"** is an authentic record of the research project carried out by my supervision and guidance in the P.G & Research Department of Chemistry, Christ College, Irinjalakuda. It is further certified that this project report has not previously formed the basis for the award of any Degree, Diploma, Fellowship or other similar title of recognition by any other university or Institution.

Dr. Tom Cherian

DECLARATION

I hereby declare that the dissertation entitled **" Synthesis and Characterization of Clove Oil-Loaded Starch Nanoparticles for Advanced Antimicrobial Applications"** is the original work done by me, under the guidance of Dr SREEKALA MS, Joint Director of IIUCNN Mahatma Gandhi University, Kottayam, in partial fulfilment of the requirements for the award of the degree of Master of Science in Chemistry of Mahatma Gandhi University. No part of this dissertation has been presented earlier to award any degree, diploma, or other titles of recognition.

Kottayam

July 2023

JIYAMOL TOMY

MSc Chemistry

Christ College (Autonomous),

Irinjalakuda

ACKNOWLEDGEMENT

At the very outset of this report, I would like to extend my sincere obligation to all the persons who have helped me during the project work entitled **"Synthesis and Characterization of Clove Oil-Loaded Starch Nanoparticles for Advanced Antimicrobial Applications"**. 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 Joy V T** for providing an opportunity to do the project work.

I express my heartfelt gratitude to my external supervisor **Dr Sreekala M S**, Joint Director, International and Interuniversity Centre for Nanoscience and Nanotechnology, 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 sincerely thank my internal supervisor **Dr Tom Cherian**, Department of Chemistry, Christ College (Autonomous), for his sincere support and guidance.

I sincerely thank **Ms Akhila B** Scholar of School of Chemical Science, Mahatma Gandhi University, Kottayam, Kerala, for her great support, guidance, and timely assistance during my project work.

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

JIYAMOL TOMY

TABLE OF CONTENTS

List of Figures

1.Abstract

Starch nanoparticles (SNPs) have attracted growing attention due to their unique properties as a sustainable alternative to common nanomaterials since they are natural, renewable and biodegradable. In this work, ultrasonication followed by an acid hydrolysis process was carried out to produce nano starch. The characterization of nano starch is done using various techniques, including FTIR, DLS, and SEM.The as-prepared SNPs showed good uniformity and crystalline nature, with a diameters range of 90 – 150nm. The CO-loaded SNPs alsoexhibited the sizes of approximately 250 - 400 nm.Thus,it can be used as an antimicrobial additive food material.These antimicrobial nanoparticles are now projected to be useful in biomedical and functional food applications.

Comparative Study of the Fluorescence Sensing Performance of Nitrogen-doped Carbon Quantum Dots Towards the Detection of Epinephrine

A dissertation submitted in partial fulfillment of the requirements for the award of the Degree

Of

Master of Science in Chemistry

by

KAVYA MEJO

(CCAVMCH008)

Submitted to

THE DEPARTMENT OF CHEMISTRY

CHRIST COLLEGE
(AUTONOMOUS), IRINJALAKUDA

Under the guidance

of

Dr. Beena Mathew

SCHOOL OF CHEMICAL SCIENCES
MAHATMA GANDHI UNIVERSITY
KOTTAYAM, KERALA
JULY 2023

SCHOOL OF CHEMICAL SCIENCES

MAHATMA GANDHI UNIVERSITY
Kottayam-686 560, Kerala, India

CERTIFICATE

This is to certify that the dissertation entitled "***Comparative Study of the Fluorescence Sensing Performance of Nitrogen-doped Carbon Quantum Dots Towards the Detection of Epinephrine***" submitted by **Ms. Kavya Mejo (Reg No: CCAVMCH008)** 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 May 2023 - June 2023. No part of this project has been submitted elsewhere for the award of any other degree.

Kottayam
July 2023

(External Supervisor)
Senior Professor
School of Chemical Sciences
Mahatma Gandhi University
Kottayam-686 560

DEPARTMENT OF CHEMISTRY
CHRIST COLLEGE
IRINJALAKUDA, KERALA

CERTIFICATE

This is to certify that **Ms. Kavya Mejo (Reg No: CCAVMCH008)** has successfully completed her project work entitled "***Comparative Study of the Fluorescence Sensing Performance of Nitrogen-doped Carbon Quantum Dots Towards the Detection of Epinephrine***" under the guidance of **Dr. Beena Mathew**, Senior Professor, School of Chemical Sciences, Mahatma Gandhi University, Kottayam, during the month of May 2023-June 2023 for the partial fulfilment of the award of the Degree of MASTER OF SCIENCE in CHEMISTRY, Christ College (Autonomous), Irinjalakuda.

Dr. V. T. Joy

Head of the Department

Department of Chemistry

Christ College, (Autonomous)

Irinjalakuda

TABLE OF CONTENTS

DECLARATION

I hereby declare that the dissertation entitled "***Comparative Study of the Fluorescence Sensing Performance of Nitrogen-doped Carbon Quantum Dots Towards the Detection of Epinephrine***" 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 Mahatma Gandhi University. No part of this dissertation has been presented earlier to award any degree, diploma, or other titles of recognition.

Kottayam

July 2023

KAVYA MEJO

MSc Chemistry

Christ College, (Autonomous),

Irinjalakuda

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 Principal and our Head of the Department, ***Dr. V. T. Joy*** *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.*

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

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.

KAVYA MEJO

ABSTRACT

In the present work, we synthesized three nitrogen-doped carbon quantum dots (N-CQDs) from L-Ascorbic acid carbon source and glycine, imidazole, and melamine as the nitrogen dopants using a simple one-pot thermal method. The as-prepared N-CQDs exhibited blue fluorescence under UV light. They contain surface functionalities such as carboxyl and hydroxyl groups, good water solubility, and strong fluorescence. It is confirmed that epinephrine could quench the fluorescent intensity of N-CQDs, and a linear correlation between the intensity of fluorescence and the concentration of epinephrine (EPI) in a wide range was observed. These exceptional properties render a potential application of the CQDs in biomedical areas.

Keywords: Nitrogen-doped carbon quantum dots, sensing, epinephrine, fluorescence quenching, neurotransmitter agent.

Synthesis of rapid sensitive and humidity responsive flexible bio-based film from methacrylated carrageenan and natural rubber for intelligent food packaging application

A dissertation submitted in partial fulfilment of the requirements for the award

of the degree of

Master of Science in Chemistry

By

LENA T L

(CCAVMCH009)

Submitted to
THE DEPARTMENT OF CHEMISTRY

CHRIST COLLEGE

(AUTONOMOUS), IRINJALAKUDA

Under the guidance of
Dr. Sushanta Kumar Sahoo
MAY 2023

MATERIAL SCIENCE AND TECHNOLOGY DIVISION (MSTD)

CSIR-NATIONAL INSTITUTE FOR INTERDISCIPLINARY SCIENCE AND TECHNOLOGY (NIIST)

TRIVANDRUM-695019

JUNE 2023

DEPARTMENT OF CHEMISTRY,
CHRIST COLLEGE,
IRINJALAKUDA, KERALA

CERTIFICATE

This is to certify that **Ms. LENA T L (Reg. No: CCAVMCH009)** has successfully completed her project work entitled "***Synthesis of rapid sensitive and humidity responsive flexible bio-based film from methacrylated carrageenan and natural rubber for intelligent food packaging application***" under the guidance of **Dr. SUSHANTA KUMAR SAHOO**, Principal scientist, Material Science and Technology Division, National Institute for Interdisciplinary Science and Technology (CSIR-NIIST) during the month of April-July 2023 for the partial fulfilment of the award of Degree of Master of Science in CHEMISTRY, Christ College (Autonomous), Irinjalakuda.

Dr.Dijo Damien
(Internal Supervisor)
Department of Chemistry
Christ College (Autonomous)
Irinjalakuda

Dr. V T Joy
Head of the Department
Department of Chemistry
Christ College (Autonomous)
Irinjalakuda

DECLARATION

I hereby declare that the work embodied in this report entitled "***SYNTHESIS OF RAPID, SENSITIVE AND HUMIDITY RESPONSIVE FLEXIBLE BIO-BASED FILM FROM METHACRYLATED CARRAGEENAN AND NATURAL RUBBER FOR INTELLIGENT FOOD PACKAGING APPLICATION*** "are results of the investigation carried out in Material Science and Technology Division, National Institute for Interdisciplinary Science and Technology (CSIR-NIIST), Trivandrum, Kerala under the guidance of Dr.Sushanta Kumar Sahoo and the same has not been submitted elsewhere for a degree.

In keeping with the general practice of reporting scientific observations, due acknowledgements have been made wherever the work described is based on the findings of other investigators.

Trivandrum

June 2023

LENA T L

MSc Chemistry

Christ college (Autonomous)

Irinjalakuda

ACKNOWLEDGEMENT

First, I thank the Almighty for his providence, wisdom and health, which helped me to complete the project successfully.

I wish to take this opportunity to thank all the people who helped me for the successful completion of my Dissertation project work.

First and foremost, with great regard and respect I extend my sincere gratitude to my supervisor Dr. Sushanta Kumar Sahoo, Scientist, Material Sciences and Technology Division (MSTD), CSIR-National Institute for Interdisciplinary Science and Technology (NIIST), Thiruvananthapuram for his valuable suggestions, encouraging guidance and constant motivation throughout my project work.

I sincerely thank, Dr. C. Anandharamakrishnan, Director, NIIST, Thiruvananthapuram for providing the necessary facilities and infrastructure to carry out this study.

I am very much thankful to Dr. Ananthakumar S, Head, Material Science and Technology Division, NIIST, Thiruvananthapuram for providing me all facilities of the division.

I express my deep sense of gratitude and sincere thanks to Ms. Sangeetha U.K for her co-supervision through continuous support, inspiration, fruitful discussions, valuable suggestions and encouragement during my project. Also, I wish to thank all my lab mates including Parvathy, Ben John, Venky, Nandhana, Arya, Aparna, Siji and all the members of MSTD for their help, support, suggestions, love and care.

I thank our principal and the Head Of the Department Dr. Joy, Christ College (Autonomous) Irinjalakuda, for allowing me to do the project work.

I would also like to extend my gratitude towards my coordinator Dr. Dijo Damien, Professor,Christ college (Autonomous),Irinjalakuda for his initial encouraging words through which I was able to pursue my dissertation in CSIR-NIIST, Thiruvananthapuram. I would like to thank all teachers and non-teaching staff of the college for their blessing and timely support during the work. I also take this opportunity to express my heartful gratitude to my Family and friends for their help and support during the course of my work.

TABLE OF CONTENTS

List of figures

List of Tables

Abstract

In the world of packaging, "intelligent packaging" is a cutting-edge technology that can track packed food in real-time and prevent food loss, food wastage, and food-related health issues. Humidity responsive packaging films can help to regulate quality of packaged foods. Biodegradable natural polymers are generally hydrophilic and moisture sensitive, and should be moisture responsive to avoid the wastage of food. In current work, flexible and humidity sensitive sensor film is developed from methacrylated carrageenan(MACAR) grafted with natural rubber (NR) integrated with a rapid reaction to show change in transparency in humidity. The optimized film with equal proportion of NR and MACAR showed single phase microstructure morphology, strong heat stability, highly hydrophobic water contact angle of 113.7°, better water resistance etc.Due to its capability to alter the transparency with increase in humidity, the developed bio-based and biodegradable film can be emerged as the ideal choice for quick humidity sensing in the field of intelligent packaging.

COMPARISON OF CONSTITUENTS OF GINGER OIL OBTAINED FROM *ZINGIBER OFFICINALE* AND *CURCUMA AMADA*

PROJECT REPORT

SUBMITTED TO

UNIVERSITY OF CALICUT

In partial fulfilment of the requirements for the award of Master of Science in Chemistry 2021-2023

BY

NIDHINKRISHNA K R

CCAVMCH010

DEPARTMENT OF CHEMISTRY

CHRIST COLLEGE, IRINJALAKUDA

UNDER THE GUIDANCE OF

Dr. TITTO VARUGHESE

Asst. PROFESSOR

CHRIST COLLEGE, IRINJALAKUDA

DEPARTMENT OF CHEMISTRY

CHRIST COLLEGE (AUTONOMOUS), IRINJALAKUDA

CERTIFICATE

This is to certify that the project work entitled "**COMPARISON OF CONSTITUENTS OF GINGER OIL OBTAINED FROM *ZINGIBER OFFICINALE* AND *CURCUMA AMADA***" is an authentic record of study carried out by NIDHINKRISHNA K.R (Reg no. CCAVMCH010) as a part of MSc. Practical during the year 2021-23 and the result of this work have not been presented for the award of any other degree/diploma in any university.

Place:

Date:

Dr. V.T JOY

Department of Chemistry

Christ College, Irinjalakuda

CERTIFICATE BY THE GUIDE

This is to certify that the content of this project work entitled "**COMPARISON OF CONSTITUENTS OF GINGER OIL OBTAINED FROM *ZINGIBER OFFICINALE* AND *CURCUMA AMADA*"** is the original research work done by NIDHINKRISHNA K.R under my supervision and guidance at the department of Chemistry, Christ College (Autonomous), Irinjalakuda. I further certify that the work has not been submitted either partly or fully to any other University or institution for the award of any degree or diploma.

Place:

Date:

Dr.TITTO VARUGHESE

Asst. PROFESSOR

Department of Chemistry

Christ College, Irinjalakuda

DECLARATION

I hereby declare that the dissertation entitled, "**COMPARISON OF CONSTITUENTS OF GINGER OIL OBTAINED FROM *ZINGIBER OFFICINALE* AND *CURCUMA AMADA***" is a genuine record of project work done by me under the guidance of Dr. Titto Varughese, Assistant Professor, Department of Chemistry, Christ College (Autonomous), Irinjalakuda and has not been submitted to any university or institution for the reward of any degree or diploma.

I further declare that the results presented in this work and consideration made therein contribute to the advancement of knowledge in Chemistry.

Place:

Date:

NIDHINKRISHNA K.R

ACKNOWLEDGEMENT

Upon the successful completion of this project, I would like to extend my sincere and deepest gratitude to the following without whom the work would not be possible. Primarily I would like to thank God Almighty for being able to complete this project on time and for the favourable circumstances that made it. I wish to express my sincere gratitude to my project guide Dr. Titto Varughese, Assistant Professor, Department of Chemistry, Christ College, Irinjalakuda for his guidance, for providing necessary advice, and for all the endeavours he took for the completion of this project. Without his enormous support and guidance, this study would not be possible. I extend my thanks to Dr. V.T Joy, Head of the department of Chemistry, Christ College, Irinjalakuda and all other teaching and non-teaching staff of the department for their suggestions, comments and encouragement during this work. I am also indebted to Rev. Dr. Jolly Andrews CMI, principal, Christ College, Irinjalakuda for providing all the available facilities for this work. Lastly, I would like to thank my classmates and parents for their support and the effort.

NIDHINKRISHNA K.R

CONTENTS

ABSTRACT

The objective of this project was to extract the essential oil from ginger (Zingiber officinale) and mango ginger (Curcuma amada) using the hydrodistillation method, Soxhlet extractor, ultrasonicator methodologies. The chemical constituents of the essential oil were characterized through Thin-layer chromatography(TLC) and Gas Chromatography-Mass Spectrometry (GC-MS). The main components detected in the essential oil of Ginger (Zingiber officinale) were α-Pinene, Camphene, Beta-Pinene, Beta- Myrcene, Zingiberene, Terpenol, α-Farnesene,Nerolidol, Beta-Sesquiphellandrene,Beta-Bisabolene,Citral, etc. and that in mango ginger were β-curcumene, ar-curcumene, camphor, camphene etc.

SYNTHESIS, SPECTRAL CHARACTERIZATION AND FLUORESCENCE PROPERTIES OF AZINE

Project report submitted to
Christ College (Autonomous) Irinjalakuda,
Affiliated to the University of Calicut
in partial fulfilment of the requirements for the degree of,

MASTER OF SCIENCE

IN

CHEMISTRY

By

RIJU P
(Reg. No. CCAVMCH011)

DEPARTMENT OF CHEMISTRY
CHRIST COLLEGE (AUTONOMOUS)
IRINJALAKUDA, THRISSUR, KERALA- 680125
2021- 2023

CHRIST COLLEGE (AUTONOMOUS) IRINJALAKUDA, THRISSUR
Reaccredited by NAAC with A^{++} grade
POSTGRADUATE & RESEARCH DEPARTMENT OF CHEMISTRY
IRINJALAKUDA NORTH, CHRIST COLLEGE RD,
IRINJALAKUDA, KERALA 680125
PHONE (O) : 0480 282 5258, (M) : +91 9496441322
Website : www.christcollegeijk.edu.in, Email : drdignavarghese@gmail.com

Ref. CC/CHEM/DV/2021-23
Date : 21st July 2023

Dr. Digna Varghese
Asst. Professor in Chemistry

CERTIFICATE

Certified that the project report entitled, ***"Synthesis, spectral characterization and fluorescence properties of azines"*** submitted by **Mr. Riju P** is an authentic report of project work carried out by him under my supervision in partial fulfilment of the requirements for the degree of Master of Science at the Department of Chemistry, Christ College (Autonomous), Irinjalakuda, and further that no part thereof has been presented before for any other degree.

Place : Irinjalakuda
Date :

Dr. Digna Varghese
Assistant Professor
Dept. of Chemistry
Christ College (Autonomous)
Irinjalakuda

DECLARATION

I hereby declare that the dissertation entitled, ***"Synthesis, spectral characterization and fluorescence properties of azines."*** is a genuine record of project work done by me under the guidance of **Dr. DIGNA VARGHESE,** Assistant Professor, department of Chemistry, Christ College (Autonomous), Irinjalakuda and has not been submitted to any university or institution for the award of any degree or diploma. I further declare that the results presented in this work and consideration made therein contribute to the advancement of knowledge in Chemistry.

Place : Irinjalakuda **RIJU P**

Date : **(Reg. No. CCAVMCH011)**

Christ College (Autonomous) Irinjalakuda

ACKNOWLEDGEMENT

Upon the successful completion of this project, I would like to extend my sincere and deepest gratitude to the following without whom the work would not be possible. Primarily I would like to thank God Almighty for being able to complete this project on time and for the favorable circumstances that made it. I wish to express my sincere gratitude to my project guide Dr. Digna Varghese, Assistant Professor, Chemistry, Christ College (Autonomous) Irinjalakuda for their guidance, for providing necessary advice, for patience in hearing my ideas, and for all the endeavors they took for the completion of this project. Without their enormous support and guidance, this study would not be possible. I extend my thanks to Dr. V.T Joy, Head of the Department of Chemistry, Christ College (Autonomous) Irinjalakuda, and all other teaching and non-teaching staff of the department for their suggestions, comments and encouragement during this work. I am also indebted to Rev. Dr. Jolly Andrews CMI, Principal, Christ College (Autonomous) Irinjalakuda, for providing all the available facilities for this work. Lastly, I would like to thank my family members and friends for their support.

RIJU P

Table of Contents

MULTICOMPONENT SYNTHETIC PROTOCOLS FOR THE SYNTHESIS OF PYRIMIDINONE DERIVATIVES

Dissertion submitted to the Christ College (Autonomous) in partial fulfillment to the requirements for the degree of

MASTER OF SCIENCE

IN

CHEMISTRY

Submitted by

SONA BABU

(Register number: CCAVMCH012)

Department of Chemistry

Christ College (Autonomous), Irinjalakuda

2021 - 2023

CHRIST COLLEGE (Autonomous), IRINJALAKUDA.
POSTGRADUATE & RESEARCH DEPARTMENT OF CHEMISTRY
IRINJALAKUDA NORTH, CHRIST COLLEGE RD,
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PHONE (O): 0480 282 5258, (M): +91-9895592695.
Website: www. christcollegeijk.edu.in, Email : arunkalazans@gmail.com

Ref. CC/CHEM/AS/2021-23/01
Date: 20th July 2023

Dr. Arun S
Asst. Professor in Chemistry

CERTIFICATE

This is to certify that **SONA BABU** (Reg.No. CCAVMCH012) has carried out a project work entitled **"MULTICOMPONENT SYNTHETIC PROTOCOLS FOR THE SYNTHESIS OF PYRIMIDINONE DERIVATIVES"** is an authentic record of the research project carried out by my supervision and guidance in the P.G & Research Department of Chemistry, Christ College, Irinjalakuda. It is further certified that this project report has not previously formed the basis for the award of any Degree, Diploma, Fellowship or other similar title of recognition by any other university or Institutions.

Dr. Arun S

DECLARATION

I hereby declare that the project entitled "**MULTICOMPONENT SYNTHETIC PROTOCOLS FOR THE SYNTHESIS OF PYRIMIDINONE DERIVATIVES"** submitted to Christ College (Autonomous), Irinjalakuda, Kerala (affiliated to university of Calicut) for the award of post graduate degree of Masters of Chemistry is a record of genuine work done by me under the guidance and supervision of Dr. Arun S, Assistant Proffesor, Department of Chemistry, Christ College (Autonomous), Irinjalakuda.

Place: Irinjalakuda

Date: 21/07/2023 SONA BABU

ACKNOWLEDEMENT

No creation in this world is a solo effort. Neither tis project. It would not have been possible without the kind support and help of many individuals and organizations. I take this opportunity to express my gratitude to all of them.

I thank my God for providing me with everything that I required in completing this project.

I would like to express my special thanks to Dr. Arun S, Assistant Professor of Department of Chemistry for his help and supervision and support throughout work.

I would like to express my special thanks to Dr. V.T. Joy, Head of the Department of chemistry.

I wish to acknowledge my gratitude to Rev. Dr. Jolly Andrews, CMI Principal of Christ College (Autonomous), Irinjalakuda and library staff for providing the timely help and facilities.

I wish to express our sincere thanks to PhD research scholars Eldhose Varghese, Ramya.K, Seena Chacko for their valuable support.

I wish to place on record my tanks to all teaching and non-teaching staff of Christ College for their constant support and encouragement during my project work.

My sincere thanks to my parents and friends and all those who have been provided a great support and help in the successful completion of my project work.

SONA BABU

CONTENTS

Page no.

DEPARTMENT OF CHEMISTRY

CHRIST COLLEGE, IRINJALAKUDA

CERTIFICATE

This is to certify that the project work entitled, "**INFLUENCE OF EPOXY CROSSSLINKING ON CHITOSAN PVA FILMS**" is an authentic record of the study carried out by SONA MATHEW (Reg No. CCAVMCH013) as the part of M.Sc. practical during the year 2021-2023 and the result of this work have not been presented for the award of any other degree/diploma in any university.

Place :Irinjalakuda

Date :

Dr V.T JOY

DEPARTMENT OF CHEMISTRY

CHRIST COLLEGE IRINJALAKKUDA

CERTIFICAT BY THE GUIDE

This is to certify that the content of this project work entitled,"**INFLUENCE OF EPOXY CROSSLINKING IN CHITOSAN /PVA FILM "** is the original research work done by HILDA V S under my supervision and guidance at the Department of Chemistry, Christ College (Autonomous), Irinjalakuda. I further certify that the work has not been submitted either partly or fully to any other University or Institution for the award of any Degree or Diploma.

Place :
Date :

Dr .TITO VARGHESE
Asst. Professor, department of chemistry
Christ College Irinjalakkuda

DECLARATION

I hereby declare that the dissertation entitled, ,"**INFLUENCE OF EPOXY CROSSLINKING IN CHITOSAN /PVA FILM "** is a genuine record of project work done by me under theguidance of Dr. V T JOY, Head of the department, chemistry, Christ college (Autonomous), Irinjalakuda and Dr.TITTO VARGHESE , Assistant professor, chemistry, Christ college (Autonomous), Irinjalakkuda and has not been submitted to any university or institution for the award of any degree or diploma.

I further declare that the results presented in this work and consideration made therein contribute to the advancement of knowledge in Chemistry.

Place :
Date : SONA MATHEW

ACKNOWLEDGEMENT

Upon the successful completion of this project, I would like to extend my sincere and deepest gratitude to the following without whom the work would not be possible. Primarily I would like to thank God Almighty for being able to complete this project on time and for the favorable circumstances that made it. I wish to express my sincere gratitude to my project guide Dr. TITTO VAEGHESE, Assistant professor, chemistry, Christ college (Autonomous), Irinjalakkuda for their guidance, for providing necessary advice, for patience in hearing my ideas, and for all the endeavors they took for the completion of this project. Without their enormous support and guidance, this study would not be possible. I extend my thanks to Dr. V.T Joy, Head of the Department of Chemistry, Christ College, Irinjalakuda, and all other teaching and non-teaching staff of the department for their suggestions, comments and encouragement during this work. I am also indebted to Rev. Dr. Jolly Andrews CMI, Principal, Christ College, Irinjalakuda, for providing all the available facilities for this work.Lastly, I would like to thank my family members and friends for their support.

SONA MATHEW

CONTENTS

ABSTRACT

INFLUENCE OF CROSSLINKING ON CHITOSAN

The present research it is reported the development and characterization of novel polymer blends based on chitosan and poly(vinyl alcohol) (PVA). The hybrid polymeric network was synthesized and modified by chemical crosslinking using epichlorohydrin for potential use in a variety of biomedical applications. The project deals with influence of epoxy crosslinking on chitosan/ PVA film . Chitosan /PVA crosslinked with epichlorohydrin film was prepared .The crosslinked film was investigated by FTIR spectroscopy . The physical characteristics of the films were evaluated by through sorption studies and biodegradability .

"SYNTHESIS OF NANOSILICA ENTRAPPED KCARRAGEENAN BEADS FOR THE REMOVAL OF CHROMIUM IN WATER"

A Dissertation submitted in partial fulfilment of the requirements

for the award of the Degree of

***Master* of Science in Chemistry**

By

SREELAKSHMI P

(CCAVMCH015)

Submitted to

THE DEPARTMENT OF CHEMISTRY

CHRIST COLLEGE (AUTONOMOUS),

IRINJALAKUDA

Under the guidance of

Dr . LAKSHMIPRIYA RAVINDRAN

International and Interuniversity Centre for Nanoscience and Nanotechnology Mahatma Gandhi University, Kottayam, Kerala

INTERNATIONAL AND INTERUNIVERSITY CENTRE FOR NANOSCIENCE AND NANOTECHNOLOGY

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Date: 14/07/2023

TO WHOM IT MAY CONCERN

This is to certify that **Ms. Sreelakshmi P**, student of Department of Chemistry, Christ College (Autonomous), Irinjalakuda has successfully completed her masters project in the area of **"Synthesis of Nanosilica Entrapped K-Carrageenan Beads for the Removal of Chromium in Water"** during 1 April 2023 to 30 June 2023 at International and Interuniversity Centre for Nanoscience and Nanotechnology (IIUCNN), Mahatma Gandhi University, Kottayam.

I wish her all the very best for her future endeavours.

With best regards

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CERTIFICATE BY THE SUPERVISOR

This is to certify that the Minor Project Report titled "SYNTHESIS OF NANOSILICA ENTRAPPED K – CARRAGEENAN BEADS FOR THE REMOVAL OF CHROMIUM IN WATER", submitted by Sreelakshmi P(CCAVMCH015) from Christ college (Autonomous) Irinjalakuda, to the School of Nanoscience and Nanotechnology, Mahatma Gandhi University , Kottayam for the award of the degree of MSc Chemistry is a bonafide record of the research work done by her under my supervision. To the best of my knowledge, the contents of this report, in full or in parts, have not been submitted to any other Institute or University for the award of any degree or diploma.

MG University, Kottayam.
July 2023

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CERTIFICATE

This is to certify that **SREELAKSHMI P** (**Reg.No. CCAVMCH015**) has carried out a project work entitled **"SYNTHESIS OF NANOSILICA ENTRAPPED K- CARRAGEENAN BEADS FOR THE REMOVAL OF CHROMIUM IN WATER"** is an authentic record of the research project carried out by my supervision and guidance in the P.G & Research Department of Chemistry, Christ College, Irinjalakuda. It is further certified that this project report has not previously formed the basis for the award of any Degree, Diploma, Fellowship or other similar title of recognition by any other university or Institution.

Dr. Tom Cherian

DECLARATION

I hereby declare that this project titled **SYNTHESIS OF NANOSILICA ENTRAPPED K-CARRAGEENAN BEADS FOR THE REMOVAL OF CHROMIUM IN WATER** , submitted to award the compilation of project in final semester of Master of Chemistry from MG University is an authentic record of my work, carried out under the guidance of Dr. SREEKALA MS, Associate Professor, School Of Chemical Science, Mahatma Gandhi University, Kottayam Kerala, during the period April 2023 to June 2023 and the project report has not been submitted previously for the award of any degree.

SREELAKSHMI P

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ACKNOWLEDGEMENT

First of all I would like to thank God, the Almighty of his divine grace and blessings throughout this work.

I would like to express my boundless and great respect and gratitude to **Dr. SREEKALA M.S**, Associate professor, School Of Chemical Science, Joint Director International And Inter University Central For Nanoscience And Nanotechnology, School Of Nanoscience And Nanotechnology, MG University Kottayam and **Dr. LAKSHMIPRIYA RAVEENDRAN**, Assistant professor, School of Energy Materials, MG University Kottayam for their expert guidance, valuable suggestions, helpful and meaningful decisions, constructive criticism, constant encouragement and whole hearted support without which this project work would not have been materialised. I consider it as a previlage to have been able to work under their supervision and guidance.

I am extremely grateful to Mrs. AKHILA B, Research Scholar, MG University, Kottayam for her great support and encouragement and help during the entire course of my work.

I would like to express my sincere appreciation and gratitude to Dr. V T JOY, Head Of The Department, Department of Chemistry and Dr.TOM CHERIAN, Assistant Professor, Christ College (Autonomous) Irinjalakuda, for their leadership and guidance in all official matters regarding project. I express my sincere gratitude to all other faculties of the Department of Chemistry, Christ College (Autonomous), Irinjalakuda, for their keen support and consultations.

Finally, but immensely I remember with gratitude all my classmates, parents, family members, relatives and friends for their cooperation, love and concern whenever I was in need.

SREELAKSHMI P

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

Water is an essential resource on Earth and the maintenance of its quality led to the incentive of water reuse programmes.One of the greatest challenges facing the 21st century involve providing sustainable supplies of clean water and energy. The impact of growing population and the climate change effect the water availability and quality. There also have high possibility of water-borne diseases. In this study we synthesized nanosilica from rice husk and it was encapsulated with Kappa Carrageenan beads and its efficiency for the removal of Chromium from water was tested. These beads are bio-degradable, easy to prepare, safe and bio-compatible. The crosslinking agents were used during the synthesis of beads which gives the hydrogel a 3D network structure making it insoluble. Recently, nanomaterials with excellent adsorption capacities, great chemical reactivity, and environment friendly performance have attracted widespread interest as potential adsorbents for heavy metal removal. So Carrageenan beads were synthesized by entrapping various concentrations of nanaosilica to improve the adsorption properties. The synthesized beads were characterized by Fourier Transform – Infrared Spectroscopy (FT-IR) and Scanning Electron Microscopy (SEM). The beads were used for the removal of chromium heavy metal in water. The adsorption studies was conducted for the chromium solution and analysed by UV – Visible Spectroscopy.

"Fabrication and Antibacterial Studies of Poly (Vinylidene Fluoride - Hexafluoropropylene) (PVDF-HFP) Piezo Membrane Reinforced with *Azadirachta Indica* Leaf Extract Reduced Zinc Oxide"

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

Master of Science in Chemistry

By

SONA VARGHESE

(CCAVMCH014)

Submitted to

THE DEPARTMENT OF CHEMISTRY

CHRIST COLLEGE (AUTONOMOUS),
IRINJALAKUDA

Under the guidance of

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പ്രിയദർശിനി ഹിൽസ്, കോട്ടയം, കേരളം, ഇന്ത്യ - 686560 | Priyadarsini Hills, Kottayam, Kerala, India - 686560

Date: 03/07/2023

TO WHOM IT MAY CONCERN

This is to certify that **Ms. Sona Varghese**, student of Department of Chemistry, Christ College (Autonomous), Irinjalakuda has successfully completed her masters project in the area of **"Fabrication and Antibacterial Studies of Poly(Vinylidene Fluoride - Hexafluoropropylene) (PVDF-HFP) Piezo Membrane Reinforced with *Azadirachta Indica* Leaf Extract Reduced Zinc Oxide "** during 1 April 2023 to 30 June 2023 at International and Interuniversity Centre for Nanoscience and Nanotechnology (IIUCNN), Mahatma Gandhi University, Kottayam.

I wish her all the very best for her future endeavours.

With best regards

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CERTIFICATE BY THE SUPERVISOR

This is to certify that the Project Report titled **"Fabrication and Antibacterial Studies of Poly(Vinylidene Fluoride – Hexafluoropropylene) (PVDF-HFP) Piezo Membrane Reinforced with *Azadirachta Indica* Leaf Extract Reduced Zinc Oxide",** submitted by Sona Varghese (CCAVMCH014) for the award of the degree of M.Sc Chemistry is a bonafide record of the research work done by her under my supervision. To the best of my knowledge, the contents of this report , in full or in parts ,have not been submitted to any other Institute or University for the award of any degree or diploma.

Place : Mahatma Gandhi University,
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Date : 03/07/2023

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Date: 20th July 2023

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Asst. Professor in Chemistry

CERTIFICATE

This is to certify that **SONA VARGHESE** (Reg.No . CCAVMCH014) has carried out a project work entitled **"Fabrication and Antibacterial Studies of Poly (Vinylidene Fluoride - Hexafluoropropylene) (PVDF-HFP) Piezo Membrane Reinforced with *Azadirachta Indica* Leaf Extract Reduced Zinc Oxide"** is an authentic record of the research project carried out by my supervision and guidance in the P.G & Research Department of Chemistry, Christ College, Irinjalakuda. It is further certified that this project report has not previously formed the basis for the award of any Degree, Diploma, Fellowship or other similar title of recognition by any other university or Institutions.

Dr. Arun S

DECLARATION

I hereby declare that the dissertation entitled **"Fabrication and Antibacterial Studies of Poly(Vinylidene Fluoride - Hexafluoropropylene) (PVDF-HFP) Piezo Membrane Reinforced with *Azadirachta Indica* Leaf Extract Reduced Zinc Oxide"** is the original work done by me, under the supervision and guidance of Dr. SANDHYA P.K, Assistant professor**,** School of Nanoscience and Nanotechnology, Mahatma Gandhi University, Kottayam, in partial fulfilment of the requirements for the award of the degree of Master of Science in Chemistry of Mahatma Gandhi University. No part of this dissertation has been presented earlier to award any degree, diploma, or other titles of recognition.

Kottayam

July 2023

SONA VARGHESE

MSc Chemistry

Christ College (Autonomous),

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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 during the project work entitled **"Fabrication and Antibacterial Studies of Poly(Vinylidene Fluoride - Hexafluoropropylene) (PVDF-HFP) Piezo Membrane Reinforced with *Azadirachta Indica* Leaf Extract Reduced Zinc Oxide"**. 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. Joy V T** for providing an opportunity to do the project work.

I express my heartfelt gratitude to my external supervisor **Dr. Sreekala M S**, Joint Director, International and Interuniversity Centre for Nanoscience and Nanotechnology, 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 sincerely thank my internal supervisor **Dr.Arun S**, Assistant Professor,Department of Chemistry, Christ College (Autonomous), for his sincere support and guidance.

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I extend my sincere gratitude to **Mr. Abhijith V** , Research Scholar,School of Chemical Sciences for the support and co-operation for the successful completion of my work.

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

SONA VARGHESE

TABLE OF CONTENTS

LIST OF FIGURES

ABSTRACT

An excellent option for obtaining energy from renewable sources is the piezoelectric nanogenerator, which operates based on the piezoelectric effect. These nanogenerators transform the mechanical energy found in nature into electrical energy. In this study an antibacterial piezoelectric membrane is prepared by using polyvinylidene fluoride (PVDF) and zinc oxide (ZnO) obtained from *A.indica* leaf extract. This piezoelectric membrane can be used for the fabrication of nanogenerators, which are efficient energy harvesting tools and are also utilised in patches to treat wounds. In this study, the production of ZnO nanoparticles is done using a green method. Piezoelectric membrane is formed by the incorporation of ZnO nanoparticle into the PVDF matrix. Various techniques like X-ray diffraction (XRD), Fourier-transform infrared spectroscopy (FTIR), Scanning Electron Microscope (SEM) and UV-Visible spectroscopy were performed for the characterization of ZnO nanoparticle and techniques like X-ray diffraction (XRD), Fourier-transform infrared spectroscopy (FTIR) were performed for characterization of the piezoelectric membrane and the antibacterial activities is studied using the bacterial strains *E. coli* and *S. aureus*. The results obtained from this study showed that the developed piezoelectric membrane exhibits excellent piezoelectric and antibacterial properties, making it suitable for the development of energy-harvesting devices and for biomedical applications. The green approach for synthesizing ZnO is safe for the environment and does not use any hazardous chemicals. The synergistic effect of ZnO in improving the β phase as well as imparting antibacterial property to the membrane making it suitable candidate for wound healing.