ENHANCING THE ANTICORROSIVE AND ANTIMICROBIAL ACTIVITIES OF POLYURETHANE COATING USING 4-NITRO-O-PHENYLENEDIAMINE COUPLED WITH APTMS-SiO_2

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AUGUST, 2024

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A DISSERTATION SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF MASTER OF SCIENCE (M.Sc) IN INDUSTRIAL CHEMISTRY IN THE DEPARTMENT OF CHEMISTRY, COLLEGE OF SCIENCE AND TECHNOLOGY, COVENANT UNIVERSITY, OTA, OGUN STATE, NIGERIA

AUGUST, 2024

ACCEPTANCE

This is to attest that this dissertation is accepted in partial fulfilment of the requirement for the award of the degree of Master of Science (M.Sc.) in Industrial Chemistry in the department of Chemistry, College of Science and Technology, Covenant University, Ota, Nigeria.

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Prof. Akan B. Williams
(Dean, School of Postgraduate Studies) **Signature and Date**

DECLARATION

I, **ADEBAMIRO, OLUWAFAYOKUNMI MODUPE (22PCC02438),** declare that this dissertation is a representation of my work, and is written and implemented by me under the supervision of Dr. Tolutope Oluwasegun Siyanbola of the Department of Chemistry, College of Science and Technology, Covenant University, Ota, Ogun State. I attest that this dissertation has not been submitted elsewhere for the award of a masters' degree. All Information cited from published and unpublished literature has been duly acknowledged.

ADEBAMIRO, OLUWAFAYOKUNMI MODUPE

Signature and Date

CERTIFICATION

We certify that the dissertation titled **"ENHANCING THE ANTICORROSIVE AND ANTIMICROBIAL ACTIVITIES OF POLYURETHANE COATING USING 4-NITRO-O-PHENYLENEDIAMINE COUPLED WITH APTMS-SiO_2"** is the original work carried out by **ADEBAMIRO, OLUWAFAYOKUNMI MODUPE (22PCC02438)** in the Department of Chemistry, Covenant University, Ota, Ogun State, Nigeria under the supervision of Dr. Tolutope.O. Siyanbola of the Department of Chemistry. We have examined and found this proposal acceptable as part of the requirements for the award of the degree of Master of Science in Industrial Chemistry.

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(Head of Department) **Signature and Date**

Prof. Olayide. S. Lawal
(External Examiner) **Signature and Date**

Prof. Akan. B. Willams
(Dean, School of Postgraduate Studies) **Signature and Date**

DEDICATION

I dedicate my work to Almighty God, the acquisition of knowledge, and the progress of scientific inquiry, expecting it to enhance our comprehension of the subject matter.

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LIST OF ABBREVIATIONS AND ACRONYMS

4NPD:	4-nitro-o-phenylenediamine
$ASiO_2$:	(3-Amino Propyl)trimethoxysilane- silicon(iv)oxide
ATR:	Attenuated Total Reflectance
CSO:	Castor seed oil
DMF:	Dimethylformamide
DMSO:	Dimethylsulfoxide
DTG:	Differential Thermogravimetric Analysis
FT-IR:	Fourier Transform- Infrared Spectroscopy
HDDA:	1,6-hexanediol diacrylate
HMDI:	Hexamethylene diisocyanate
MIBK:	Methyl isobutyl ketone
NaCl:	Sodium chloride
NIPU:	Non-isocyanate polyurethane
NM:	Nanomaterial
NMR:	Nuclear Magnetic Resonance
PECH-triol:	Poly(epichlorohydrin-triol)
PO:	Palm oil
PU:	Polyurethane
PUA:	Polyurethane acrylate
PUU:	Polyurethane Urea
PUR:	Poly Urea

ROP:	Ring-opening Polymerization
SEM:	Scanning Electron Microscopy
SFFO:	Safflower oil
SFO:	Sunflower oil
SMO:	Silica Modified
TDI:	Toluene diisocynate
Tg:	Glass transition temperature
TGA:	Thermogravimetric Analysis
TMPTA:	Trimethylolpropane triacrylate
TPGDA:	Tripropylene glycol diacrylate
TPSO:	Thevetia peruviana seed oil
UN SDG:	United Nations Sustainable Development goals
UV:	Ultraviolet
VOC:	Volatile organic compound
VSO:	Vegetable seed
WPUD:	Water-bone polyurethane dispersion
XRD:	X-ray diffraction

ABSTRACT

The research explores the synthesis and properties of polyurethane-urea coatings derived from castor seed oil (CSO), Toluene diisocyanate (TDI) and 4-nitro-o-phenylenediamine (4NPD) as a sustainable alternative to petrochemical-based polymers. Given the increasing environmental concerns and the need for biodegradable materials, this study focuses on utilising renewable plant biomass materials, particularly non-edible vegetable oils, to produce environmentally friendly polymeric coatings. The experimental approach involved the synthesis of poly(epichlorohydrin-triol) (PECH-triol) and its subsequent reaction with CSO and toluene diisocyanate (TDI) to form polyurethane. The inclusion of 4NPD and APTMS-SiO_2 aimed to enhance the attendant properties of the resultant coatings. Comprehensive analyses were conducted to characterise the synthesised materials. Fourier Transform Infrared Spectroscopy (FT-IR) and Nuclear Magnetic Resonance (NMR) confirmed the successful incorporation of 4-nitro-o-phenylenediamine 4NPD and APTMS-SiO_2 into the polyurethane matrix. X-ray Diffraction (XRD) analysis revealed the crystallinity of the coatings. The salt spray test shows that the more the nanomaterial, the higher it resists corrosion. The water contact angle demonstrates that the 3% APTMS-SiO_2 is more hydrophobic than the others, while Thermogravimetric Analysis (TGA) demonstrated their thermal stability. Furthermore, antimicrobial tests showed significant activity against various bacterial and fungal strains. It is hereby concluded that 4NPD enhances the coating strength and adhesives. It was also observed that PUU-ASiO_2 with 3% ASiO_2 show a more substantial effect on the attendant property of Polyurethane-urea coatings.

Keywords: 4-nitro-o-phenylenediamine, Antimicrobial, Polyurethane-urea, Nanomaterial, Castor oil