
Dedicated to…
My parents

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Napaam, Tezpur-784028, Sonitpur, Assam, India

DECLARATION

I do hereby declare that the thesis entitled "**Exploration of Polymeric Hydrogels: Potential Applications as Adhesives, Photocatalysts, and Electroactive Materials"**, is the result of investigations carried out by me in the Department of Chemical Sciences, Tezpur University, India. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or falsified any idea/data/source in my submission. I have also acknowledged all sources, wherever the work described is based on the findings of other investigators. Neither this work as a whole nor any part of it has been submitted to any other University or Institute for academic credit.

Asfi Ahmed

Date: 20-05-2025 (**Asfi Ahmed**)

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She has fulfilled all the requirements for submitting the thesis for the award of the degree of Doctor of Philosophy in Science. All help and assistance she received from various sources have been duly acknowledged. No part of this thesis has been reproduced elsewhere for any award or other degree.

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CERTIFICATE FROM THE EXTERNAL EXAMINER AND ODEC

This is to certify that the thesis entitled "**Exploration of Polymeric Hydrogels: Potential Applications as Adhesives, Photocatalysts, and Electroactive Materials**" submitted to Tezpur University, in the Department of Chemical Sciences, under the School of Sciences, in partial fulfillment for the award of the degree of Doctor of Philosophy in Science has been examined by us on …… and found to be satisfactory.

The committee recommends awarding Ms. Asfi Ahmed the degree of Doctor of Philosophy.

Supervisor	**Co-Supervisor**	**External Examiner**
Date:	**Date:**	**Date:**

PREFACE

The escalating demand for polymeric materials to fulfill human needs has led to the synthesis of polymeric hydrogels. Their unique ability to absorb and retain water or other biological fluids up to a thousand times their weight and their tunable functionality make them highly valuable for a wide range of applications including both biomedical and industrial fields. In addition, many hydrogels are biocompatible, biodegradable, and soft in nature, thus possessing similarities to natural tissue. Furthermore, they are responsive to different environmental stimuli. Due to these remarkable properties, hydrogels are well suited for numerous medical practices and other applications such as tissue adhesion, wound healing, controlled release of drugs, actuators, etc. Moreover, their tremendous water-absorbing property and the presence of different functional groups allow them to absorb and chemically bind organic pollutants and hence are applicable in water remediation processes.

The present thesis focuses on developing and evaluating different hydrogel materials and highlights their potential applications as adhesives, photocatalysts, and electric field-responsive materials. The contents of this thesis are compiled into six chapters which include a general introduction of hydrogel discussing their potential applications in the said fields, followed by comprehensive experimental studies of hydrogel in those areas. Finally, the major findings of this thesis work and its future scope have been discussed in the last chapter.

This study is expected to contribute valuable insights to the rapidly evolving field of hydrogels and open new avenues for further research in this field.

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Date:

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Date:

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ABBREVIATIONS AND SYMBOLS

AAc	Acrylic acid
AAm	Acrylamide
AMPS	2-Acrylamido-2-methylpropane sulphonic acid
APS	Ammonium persulfate
a.u.	Arbitrary unit
q_e	Adsorption capacity
BioMEMS	Biomedical microelectrochemical systems
BQ	Benzoquinone
CHN	Carbon, Hydrogen, Nitrogen
cm	Centimeter
CO_2	Carbon dioxide
CV	Crystal violet
3D	Three-dimensional
DA	Dopamine
DC	Dopamine chrome
DQ	Dopamine quinone
DDS	Drug delivery system
DOPA	3,4-dihydroxyphenylalanine
DMEM	Dulbecco's Modified Eagles Medium
DMSO	Dimethyl sulfoxide
DSC	Differential Scanning Calorimetry
EAH	Electroactive hydrogel
EDTA	Ethylenediamine tetraacetic acid
EDX	Energy-dispersive X-ray spectroscopy
e^-	Electron
Em	Emission
Eq.	Equation
Etc.	et cetera
eV	Electron volt
Ex	Excitation
FBS	Fetal bovine serum

FTIR	Fourier Transform Infrared Spectroscopy
g-C_3N_4	Graphitic Carbon Nitride
g	Gram
HCl	Hydrochloric acid
h	Hour(s)
h^+	Hole
H_2O	Water
IPA	Isopropanol
KBr	Potassium bromide
kg	Kilogram
KPa	Kilo Pascal
kV	Kilo Volt
DL	Leucodopamine
LED	Light emitting diode
MB	Methylene blue
MBA	*N,N′*-Methylenebisacrylamide
min	Minute
mA	Milliampere
mg	Milli gram(s)
MJm^{-3}	Megajoule per cubic meter
mL	Millilitre
MO	Methyl orange
MPa	Mega Pascal
MTT	(3-[4,5-dimethylthiazol-2-yl]-2,5 diphenyl tetrazolium bromide)
N_2	Nitrogen
NaCl	Sodium Chloride
NaOH	Sodium hydroxide
nm	Nanometer
OH^-	Hydroxyl radical
O_2	Oxygen
$\cdot O_2^-$	Superoxide
OD	Optical density
PAAc	Poly(acrylic acid)

PBS	Phosphate buffered saline
PANi	Polyaniline
PDA	Polydopamine
pH	Potential of hydrogen
$K_2S_2O_8$	Potassium persulphate
PL	Photoluminescence
PTFE	Polytetrafluoroethylene
RhB	Rhodamine
rpm	Revolutions per minute
s	Second
SEM	Scanning electron microscopy
$\cdot SO_4$	Sulphate
TEM	Transmission electron microscopy
TGA	Thermogravimetric analysis
UTM	Universal Testing Machine
UV	Ultraviolet
UV-Vis	Ultraviolet-Visible
Vis	Visible
V	Volt
VB	Vitamin B_{12}
wt%	Weight percentage
XPS	X-ray photoelectron spectroscopy
XRD	X-ray diffraction
θ	Theta
%	Percentage
°C	Degree Centigrade
°	Degree
α	Alpha

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