



*To my beloved parents*



## TEZPUR UNIVERSITY

(A Central University established by an Act of Parliament)

Napaam-784028, Tezpur, Sonitpur, Assam, India

### DECLARATION BY THE CANDIDATE

I, **Ms. Sukanya Das**, hereby declare that the thesis entitled “**Studies on the Physicochemical Properties of Acidic Ionic Liquids and their Applications**” has been submitted to Tezpur University, Assam, in partial fulfilment of the requirements for the award of the degree of **Doctor of Philosophy in Chemical Sciences**, is a record of original research work carried out by me under the guidance of **Prof. Ruli Borah**, Department of Chemical Sciences, Tezpur University.

The contents of the thesis, in full or in part, have not been previously considered for the award of any degree, diploma, or any other similar title or recognition from any University/Institute. I further declare that I have duly acknowledged all sources of assistance and any text, figures, results or design that are not of my own are appropriately referenced in order to give credit to the original author(s).

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## **CERTIFICATE FROM THE SUPERVISOR**

This is to certify that the thesis entitled “**Studies on the Physicochemical Properties of Acidic Ionic Liquids and their Applications**” submitted by Ms. Sukanya Das to Tezpur University for the award of the degree of Doctor of Philosophy in Chemical Sciences is a record of bonafide research work carried out by her under my supervision and guidance. She has been duly registered, completed her Ph.D. course work and the thesis presented is worthy of consideration for the award of Ph.D. degree. All help received by her from various sources have been duly acknowledged. The contents of this thesis, in full or in part, have not been submitted to any other University/Institute for the award of any degree or diploma.

**Date:** 1/07/2024

**Place:** Tezpur University

*R. Borah*  
(Prof. Ruli Borah)



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**Date:**

**Place:** Tezpur University

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### *CERTIFICATE OF THE EXTERNAL EXAMINER AND ODEC*

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The committee recommends **Ms. Sukanya Das** for the award of the degree of **Doctor of Philosophy in Chemical Sciences**.

**Principal Supervisor**

**Date:**

**External Examiner**

**Date:**



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## *List of Abbreviations*

<b>AIL</b>	Acidic ionic liquid
<b>BAIL</b>	Brønsted acidic ionic liquid
<b>BET</b>	Brunauer Emmett Teller
<b>[BDSIM]</b>	1, 3-Disulfo-2-butylimidazolium
<b>[BMIM]</b>	1-Butyl-3 methylimidazolium
<b>CAC</b>	Critical aggregate concentration
<b>CDCl<sub>3</sub></b>	Deuterated Chloroform
<b>CV</b>	Cyclic voltammetry
<b>[DBDSA]</b>	N,N-dibutyl-disulfo-ammonium
<b>DCM</b>	Dichloromethane
<b>[DEDSA]</b>	N,N-diethyl-disulfo-ammonium
<b>DMSO</b>	Dimethyl sulfoxide
<b>DMSO-d<sub>6</sub></b>	Deuterated dimethyl sulfoxide
<b>DRS</b>	Diffuse reflectance spectra
<b>[DSIM]</b>	1, 3-Disulfo-2-imidazolium
<b>DSC</b>	Differential Scanning Calorimetry
<b>[EDSIM]</b>	1, 3-Disulfo-2-ethylimidazolium
<b>EDX</b>	Energy dispersive X-ray
<b>ESI-MS</b>	Electrospray ionization mass spectrometry
<b>ESW</b>	Electrochemical stability window
<b>eV</b>	Electron volt
<b>FT-IR</b>	Fourier-transform infrared
<b>IL</b>	Ionic liquid
<b>LAIL</b>	Lewis acidic ionic liquid
<b>MB</b>	Methylene blue
<b>[MDSIM]</b>	1, 3-Disulfo-2-methylimidazolium
<b>MG</b>	Malachite green
<b>MO</b>	Methyl orange
<b>MCR</b>	Multicomponent reactions
<b>NMR</b>	Nuclear Magnetic Resonance
<b>[OTf]</b>	Triflate

<b>PIL</b>	Protic ionic liquid
<b>PPM</b>	Parts per million
<b>PXRD</b>	Powder X-ray diffraction
<b>RTAIL</b>	Room temperature acidic ionic liquid
<b>RTIL</b>	Room temperature ionic liquid
<b>SAED</b>	Selected area electron diffraction
<b>SEM</b>	Scanning electron microscopy
<b>SFIL</b>	Sulfonic (-SO <sub>3</sub> H) functionalized ionic liquid
<b>TEM</b>	Transmission electron microscopy
<b>[TFA]</b>	Trifluoroacetate
<b>TGA</b>	Thermogravimetric analysis
<b>TOC</b>	Total organic carbon
<b>TSIL</b>	Task specific ionic liquid
<b>[TSPi]</b>	N, N, N', N' - tetrasulfopiperazinium
<b>UV-Vis</b>	Ultraviolet–visible
<b>XPS</b>	X-ray Photoelectron spectroscopy

### *List of Symbols*

$\sigma$	Conductivity
$\Lambda$	Molar conductivity
$\alpha$	Hydrogen bond donor ability
$\mu$	Mobility
$\pi^*$	Dipolarity
$\eta$	Viscosity
$\beta$	Hydrogen bond acceptor ability
$\gamma$	Surface tension
$\rho$	Density
$\bar{\nu}$	Wavenumber
$\lambda$	Wavelength
$\delta$	Chemical shift
$H^{\circ}$	Hammett acidity function
$A$	Absorbance