



TO MY BELOVED FAMILY

MAA, DEUTA, TUMON

AND

RAJDEEP



TEZPUR UNIVERSITY

(A Central University established by an Act of Parliament)

Napaam-784028, Tezpur, Sonitpur, Assam, India

DECLARATION BY THE CANDIDATE

I, **Ms. Niharika Kashyap**, hereby declare that the thesis entitled “**Strategic design and utilization of task-specific ionic liquids and ionic liquid-polyoxometalate hybrids**” 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 “**Strategic design and utilization of task-specific ionic liquids and ionic liquid-polyoxometalate hybrids**” submitted by Ms. Niharika Kashyap 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: 29-08-2024

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CERTIFICATE OF THE EXTERNAL EXAMINER AND ODEC

This is to certify that the thesis entitled “**Strategic design and utilization of task-specific ionic liquids and ionic liquid-polyoxometalate hybrids**” submitted by Ms. Niharika Kashyap to Tezpur University in partial fulfilment of the requirements for the award of the degree of Doctor of Philosophy in Chemical Sciences has been examined by us on and found to be satisfactory.

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

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List of Figures

Chapter 1A: General Introduction and Review of Literature	Page No.
Fig. 1A.1 Examples of Lewis acidic ionic liquids.	1A.2
Fig. 1A.2 Examples of Brönsted Acidic ionic liquids.	1A.3
Fig. 1A.3 Examples of Brönsted-Lewis acidic ionic liquids.	1A.4
Fig. 1A.4. Examples of basic ionic liquids and few anions used for preparation of basic ionic liquids.	1A.5
Fig. 1A.5 Ionic liquid based on H-phosphonate anions synthesized and used by Zarrougui et al. [77] for separation of uranium (VI) from transition metals.	1A.8
Fig. 1A.6: (a) Structure of $PW_{12}O_{40}^-$ anion; Proceedings of the Royal Society of London. Series A, Containing Papers of a Mathematical and Physical Character, 144(851):75-100, 1934 (b) Structure of 9(18)-tungstophosphate anion $[P_2W_{18}O_{62}]^{6-}$; Acta Crystallographica, 6(2):113-126, 1953.	1A.10
Fig. 1A.7: Structures of polyoxomolybdates synthesized by Zhou and his group [140].	1A.18
Fig.1A.8: A photo-responsive surfactant encapsulated polyoxometalate based complex (Azo-SEP) developed by Wu and co-workers [139].	1A.19
Fig. 1A.9 Structures of few 3-substituted indole derivatives with pharmacological properties	1A.22
Fig. 1A.10: Structures of ILs prepared by Reyna-González et al. [229] and Guillon et al. [230].	1A.28
Fig. 1A.11: Structures of ILs used in metal extraction by Depuydt et al. [234].	1A.30
Fig. 1A.12: Chemical structures of (a) $[Hbet][Tf_2N]$ and (b) $[P_{444}C_1COOH] Cl$.	1A.31
Fig. 1A.13: Structures of two carboxylic acid functionalized ionic liquids reported by Ding et al. [237].	1A.31

Chapter-2: Solvent responsive self-separative behaviour of Brønsted acidic ionic liquid-polyoxometalate hybrid catalysts on H₂O₂ mediated oxidation of alcohols	Page No.
Fig. 2.1: FT-IR spectra of (a) H ₃ PMo ₁₂ O ₄₀ ·nH ₂ O and [DEDSA] ₃ [PMo ₁₂ O ₄₀] and (b) H ₃ PW ₁₂ O ₄₀ ·nH ₂ O and [DEDSA] ₃ [PW ₁₂ O ₄₀] respectively.	2.5
Fig. 2.2: ¹ H NMR spectra of (a) [DEDSA] ₃ [PMo ₁₂ O ₄₀] and (b) [DEDSA] ₃ [PW ₁₂ O ₄₀].	2.6
Fig. 2.3: ¹³ C NMR spectra of (a) [DEDSA] ₃ [PMo ₁₂ O ₄₀] and (b) [DEDSA] ₃ [PW ₁₂ O ₄₀].	2.7
Fig. 2.4: ³¹ P NMR spectra of (a) [DEDSA] ₃ [PMo ₁₂ O ₄₀] and (b) [DEDSA] ₃ [PW ₁₂ O ₄₀].	2.8
Fig. 2.5: ³¹ P NMR spectra of (a) H ₃ PMo ₁₂ O ₄₀ ·nH ₂ O and (b) H ₃ PW ₁₂ O ₄₀ ·nH ₂ O.	2.9
Fig. 2.6: TGA curves of [DEDSA] ₃ [PW ₁₂ O ₄₀], [DEDSA] ₃ [PMo ₁₂ O ₄₀], [DEDSA]Cl·4H ₂ O, H ₃ PMo ₁₂ O ₄₀ ·25H ₂ O and H ₃ PW ₁₂ O ₄₀ ·14H ₂ O.	2.10
Fig. 2.7: Powder XRD analysis patterns of (a) [DEDSA] ₃ [PMo ₁₂ O ₄₀] and H ₃ PMo ₁₂ O ₄₀ ·nH ₂ O (b) [DEDSA] ₃ [PW ₁₂ O ₄₀] and H ₃ PW ₁₂ O ₄₀ ·nH ₂ O.	2.12
Fig. 2.8: Raman spectra of (a) [DEDSA] ₃ [PMo ₁₂ O ₄₀] and (b) [DEDSA] ₃ [PW ₁₂ O ₄₀].	2.13-2.14
Fig. 2.9: UV-Vis DRS spectra of (a) [DEDSA] ₃ [PMo ₁₂ O ₄₀] and H ₃ PMo ₁₂ O ₄₀ ·nH ₂ O (b) [DEDSA] ₃ [PW ₁₂ O ₄₀] and H ₃ PW ₁₂ O ₄₀ ·nH ₂ O	2.15
Fig. 2.10: SEM images of (a) [DEDSA] ₃ [PMo ₁₂ O ₄₀] and (b) [DEDSA] ₃ [PW ₁₂ O ₄₀].	2.16
Fig. 2.11: EDX patterns of (a) [DEDSA] ₃ [PMo ₁₂ O ₄₀] and (b) [DEDSA] ₃ [PW ₁₂ O ₄₀].	2.16
Fig. 2.12: Photographs of (a) [DEDSA] ₃ [PMo ₁₂ O ₄₀] and (b) [DEDSA] ₃ [PW ₁₂ O ₄₀] switching from homogeneous reaction medium in left testube to heterogeneous one by self-precipitating in testube kept in right after evaporation of acetonitrile solvent and pouring dry CH ₂ Cl ₂ afterwards.	2.20

Fig. 2.13: FT-IR spectrum providing evidence of formation of peroxophosphometalates after treating [DEDSA] ₃ PW ₁₂ O ₄₀ with H ₂ O ₂ .	2.22
Fig. 2.14: Recyclability diagram of the [DEDSA] ₃ [PW ₁₂ O ₄₀] for the model reaction	2.23
Fig. 2.15: FT-IR spectra of the fresh [DEDSA] ₃ [PW ₁₂ O ₄₀] and recycled [DEDSA] ₃ [PW ₁₂ O ₄₀] after 7 th cycle.	2.24
Fig. 2.16: (a) ¹ H NMR spectrum of [DEDSA]Cl and (b) ¹³ C NMR spectrum of [DEDSA]Cl	2.26-2.27

Chapter-3: A mechanistic study on solar energized degradation of herbicide into value-added product using - SO₃H functionalized ionic liquid-polyoxometalate based heterogeneous catalyst in aqueous medium	Page No.
Fig. 3.1: FT-IR spectra of (a) H ₃ PMo ₁₂ O ₄₀ ·nH ₂ O, [DBDSA]Cl and [DBDSA] ₃ [PMo ₁₂ O ₄₀] (b) H ₃ PW ₁₂ O ₄₀ ·nH ₂ O, [DBDSA]Cl and [DBDSA] ₃ [PW ₁₂ O ₄₀] respectively.	3.5
Fig. 3.2: (a) ¹ H NMR spectrum of [DBDSA]Cl and (b) ¹³ C NMR spectrum of [DBDSA]Cl.	3.7
Fig 3.3: ¹ H NMR spectra of (a) ¹ H NMR of [DBDSA] ₃ [PMo ₁₂ O ₄₀], (b) ¹³ C NMR spectra of [DBDSA] ₃ [PMo ₁₂ O ₄₀], (c) ¹ H NMR of [DBDSA] ₃ [PW ₁₂ O ₄₀], (d) ¹³ C NMR spectra of [DBDSA] ₃ [PW ₁₂ O ₄₀].	3.8- 3.9
Fig. 3.4: ³¹ P NMR spectra of (a) [DBDSA] ₃ [PMo ₁₂ O ₄₀], (b) [DBDSA] ₃ [PW ₁₂ O ₄₀], (c) H ₃ PMo ₁₂ O ₄₀ ·nH ₂ O (d) H ₃ PW ₁₂ O ₄₀ ·nH ₂ O.	3.10-3.11
Fig. 3.5: TGA curves of [DBDSA] ₃ [PW ₁₂ O ₄₀], [DBDSA] ₃ [PMo ₁₂ O ₄₀], [DBDSA]Cl·5H ₂ O, H ₃ PMo ₁₂ O ₄₀ ·25H ₂ O and H ₃ PW ₁₂ O ₄₀ ·14H ₂ O.	3.13
Fig. 3.6: Powder XRD analysis patterns of (a) H ₃ PMo ₁₂ O ₄₀ ·nH ₂ O, (b) [DBDSA] ₃ [PMo ₁₂ O ₄₀], (c) H ₃ PW ₁₂ O ₄₀ ·nH ₂ O and (d) [DBDSA] ₃ [PW ₁₂ O ₄₀].	3.14
Fig. 3.7: Raman spectra of (a) [DBDSA] ₃ [PMo ₁₂ O ₄₀] and (b) [DBDSA] ₃ [PW ₁₂ O ₄₀].	3.15-3.16
Fig. 3.8: UV –Vis DRS of (a) [DBDSA] ₃ [PMo ₁₂ O ₄₀] and H ₃ PMo ₁₂ O ₄₀ ·nH ₂ O (b) [DBDSA] ₃ [PW ₁₂ O ₄₀] and H ₃ PW ₁₂ O ₄₀ ·nH ₂ O.	3.17

Fig. 3.9: Tauc plots of (a) [DBDSA] ₃ [PMo ₁₂ O ₄₀] and H ₃ PMo ₁₂ O ₄₀ ·nH ₂ O (b) [DBDSA] ₃ [PW ₁₂ O ₄₀] and H ₃ PW ₁₂ O ₄₀ ·nH ₂ O.	3.18
Fig. 3.10: SEM images of (a) [DBDSA] ₃ [PMo ₁₂ O ₄₀] and (b) [DBDSA] ₃ [PW ₁₂ O ₄₀].	3.19
Fig. 3.11: EDX patterns of [DBDSA] ₃ [PMo ₁₂ O ₄₀] and [DBDSA] ₃ [PW ₁₂ O ₄₀].	3.20
Fig. 3.12: HPLC chromatogram monitoring degradation of metobromuron with respect to time at 245 nm using 20mg of catalyst (1) [DBDSA] ₃ [PMo ₁₂ O ₄₀]/0.1 mL 30% H ₂ O ₂ /sunlight, (2) [DBDSA] ₃ [PW ₁₂ O ₄₀]/ 0.1 mL 30% H ₂ O ₂ /sunlight.	3.22
Fig. 3.13: Schemes of mechanism for the formation of different degradation products of metobromuron using [DBDSA] ₃ [PW ₁₂ O ₄₀]/0.1 mL 30% H ₂ O ₂ /sunlight.	3.25-3.26
Fig. 3.14: Mass spectra of degradation products (1, 2, 3, 4, 5) observed using [DBDSA] ₃ [PW ₁₂ O ₄₀]/0.1 mL 30% H ₂ O ₂ /sunlight (4 hours).	3.26-3.27
Fig. 3.15: Mass spectra of degradation products observed using [DBDSA] ₃ [PW ₁₂ O ₄₀]/0.1 mL 30% H ₂ O ₂ /sunlight (8 hours).	3.27
Fig. 3.16: Comparative % TOC removal plots of metobromuron using (a) [DBDSA] ₃ [PMo ₁₂ O ₄₀]/0.1 mL 30% H ₂ O ₂ /sunlight (8 hours) and next 18 hours in absence of sunlight, (b) [DBDSA] ₃ [PW ₁₂ O ₄₀]/ 0.1 mL 30% H ₂ O ₂ /sunlight (8 hours) and next 18 hours in absence of sunlight.	3.29
Fig. 3.17: FT-IR spectrum of isolated catalyst in experiment [DBDSA] ₃ [PW ₁₂ O ₄₀]/0.1 mL 30% H ₂ O ₂ /sunlight	3.31
Fig. 3.18: Recyclability study based on TOC removal % using [DBDSA] ₃ [PW ₁₂ O ₄₀] for 3 consecutive cycles.	3.32
Fig. 3.19: PXRD of the used catalyst [DBDSA] ₃ [PW ₁₂ O ₄₀] after 3 consecutive reaction cycles	3.33
Fig. 3.20: ³¹ P NMR of spent [DBDSA] ₃ [PW ₁₂ O ₄₀] after 3 consecutive reaction cycles.	3.33
Fig. 3.21: UV-Visible spectra of the reaction solution after catalyst filtration after 26 hours of reaction time.	3.34

Chapter-4: Study of catalytic activity of methylene bridged dicationic -SO₃H functionalized imidazolium phosphomolybdate hybrids for one pot sequential synthesis of 3-substituted indoles	Page No.
Fig. 4.1: FT-IR spectra of H ₃ PMo ₁₂ O ₄₀ ·nH ₂ O, [DILPOM]-1, [DILPOM]-2, [DILPOM]-3	4.6
Fig. 4.2: (a) ¹ H NMR of [DILPOM]-1, (b) ¹ H NMR of [DILPOM]-2, (c) ¹ H NMR of [DILPOM]-3	4.7-4.8
Fig. 4.3: (a) ¹³ C NMR of [DILPOM]-1, (b) ¹³ C NMR of [DILPOM]-2, (c) ¹³ C NMR of [DILPOM]-3	4.9-4.10
Fig. 4.4: (a) ³¹ P NMR of [DILPOM]-1, (b) ³¹ P NMR of [DILPOM]-2, (c) ³¹ P NMR of [DILPOM]-3 (d) ³¹ P NMR of H ₃ PMo ₁₂ O ₄₀ ·nH ₂ O.	4.10-4.12
Fig. 4.5: TGA graphs of [DILPOM]-1, [DILPOM]-2, [DILPOM]-3, [DIL-1]·16H ₂ O, [DIL-2]·25H ₂ O, [DIL-3]·21H ₂ O and H ₃ PMo ₁₂ O ₄₀ ·25H ₂ O.	4.13
Fig. 4.6: Powder XRD analysis patterns of (a) H ₃ PMo ₁₂ O ₄₀ ·nH ₂ O, (b) [DILPOM]-1, (c) [DILPOM]-2, (d) [DILPOM]-3.	4.15
Fig. 4.7: Raman spectra of (a) [DILPOM]-1, (b) [DILPOM]-2, (c) [DILPOM]-3.	4.16
Fig. 4.8: UV –Vis DRS spectra of (a) H ₃ PMo ₁₂ O ₄₀ ·nH ₂ O vs [DILPOM]-1, (b) H ₃ PMo ₁₂ O ₄₀ ·nH ₂ O vs [DILPOM]-2 (c) H ₃ PMo ₁₂ O ₄₀ ·nH ₂ O vs [DILPOM]-3.	4.17
Fig. 4.9: SEM images of (a) H ₃ PMo ₁₂ O ₄₀ ·nH ₂ O, (b) [DILPOM]-1, (c) [DILPOM]-2, (d) [DILPOM]-3.	4.18
Fig. 4.10: EDX patterns of (a) [DILPOM]-1, (b) [DILPOM]-2, (c) [DILPOM]-3.	4.19
Fig. 4.11: FT-IR study for Brønsted- Lewis acidic sites of the POM-IL hybrids.	4.20
Fig. 4.12: NH ₃ -TPD graphs of [DILPOM]-1,2,3.	4.21
Fig. 4.13: Substrate scope study of 3-substituted indoles.	4.26
Fig. 4.14: Bar diagram for recyclability of catalyst.	4.28

Fig. 4.15: FT-IR spectrum of recycled DILPOM-3 after 4 th catalytic cycle	4.29
Fig. 4.16: ³¹ P NMR of the spent [DILPOM]-3 after 4 th catalytic cycle.	4.29
Fig. 4.17: NH ₃ -TPD of the spent [DILPOM]-3 catalyst after 4 th catalytic cycle.	4.30

Chapter-5: Investigative study on the dual functional behaviour of dicationic ionic liquid as extractant and hydrophobic biphasic solvent for extraction of Pb(II) in water	Page No.
Fig. 5.1: FT-IR spectra of IL-1 and IL-2.	5.5
Fig. 5.2: (a) ¹ H NMR of IL-1, (b) ¹³ C NMR of IL-1.	5.7
Fig. 5.3: (a) ¹ H NMR of IL-2, (b) ¹³ C NMR of IL-2	5.8
Fig. 5.4: TGA graph of IL-1 and IL-2	5.9
Fig. 5.5: (a) Biphasic mixture of IL-1 and water, (b) biphasic mixture of IL-1-lead metal complex soluble in ionic liquid with aqueous Pb(II) metal solution, (c) biphasic mixture of IL-2 and water (d) biphasic mixture of IL-2-lead metal complex soluble in ionic liquid with aqueous Pb(II) metal solution (e) precipitation of lead oxalate after reaction of oxalic acid with metal loaded-IL-2.	5.10
Fig. 5.6: Histogram representing extraction percentage of Pb(II) with IL-1 and IL-2 in 30 minutes (reaction condition): 20 mL of 7.25 mM aqueous solution of Pb(NO ₃) ₂ ; molar quantity variation IL-1 (0.05, 0.1, 0.3, 0.5, 0.7, 0.9 mmol) and IL-2 (0.1, 0.3, 0.5, 0.7, 0.9, 1.2 mmol); error bars arise from n = 3 independent trials.	5.13
Fig. 5.7: Histogram representing extraction percentage of Pb(II) with respect to time (10 minutes, 30 minutes, 45 minutes); error bars arise from n = 3 independent trials.	5.13
Fig. 5.8: Histogram representing extraction percentage using 0.2 mmol of (a) IL-1 and (b) IL-2 with varying Pb(II) metal concentration in 20mL of aqueous Pb(NO ₃) ₂ metal salt solutions (2.25 mM, 3.65 mM, 7.25 mM, 14.5 mM); error bars arise from n = 3 independent trials.	5.14-5.15
Fig. 5.9: (a) FT-IR spectra of IL-2 and Pb-IL2 complex loaded in ionic liquid phase (b) FT-IR spectra Pb-IL1 complex loaded in ionic liquid phase	5.16

Fig. 5.10: TGA plots of metal loaded ionic liquid (a) IL-1 and (b) IL-2	5.17
Fig. 5.11: EDX spectra of (a) Pb loaded IL1; (Pb-IL1) and (b) Pb loaded IL2; (Pb-IL2)	5.17
Fig. 5.12: (a) Graph between log D and log [IL-1] for the extraction of Pb(II), (b) Graph between log D and log [IL-2] for the extraction of Pb(II). Reaction condition: 20 mL of 7.25 mM aqueous metal solution of Pb(NO ₃) ₂ , IL-1 = 0.05, 0.1, 0.3, 0.5, 0.7 0.9 mmol, IL-2 = 0.1, 0.3, 0.5, 0.7, 0.9, 1.2 mmol. Reaction time = 30 minutes	5.19
Fig. 5.13: Proposed structure of the Pb-IL complexes formed	5.20
Fig. 5.14: FT-IR spectrum of oxalate salt of lead obtained by oxalic acid precipitation method with Pb-IL2 loaded ionic liquid phase	5.21
Fig. 5.15: FT-IR spectra of regenerated ionic liquid (IL-2) compared to the fresh IL-2	5.22
Fig. 5.16: PXRD of PbO containing both the α as well as β phase obtained after calcination at 500 °C.	5.22
Fig. 5.17: (a) Oxalate salt of lead obtained after reaction of oxalic acid solution with Pb-IL2 containing ionic liquid phase (b) PbO obtained after calcination	5.23
Fig. 5.18: EDX spectrum confirming formation of PbO after calcination at 500 °C.	5.23
Fig. 5.19: EDX spectra of oxalate salt of lead obtained by oxalic acid precipitation method with Pb-IL1.	5.24
Fig. 5.20: TGA plots of Pb(II) loaded IL-1 and oxalate salt of Pb(II) loaded IL-1.	5.24
Fig. 5.21: Photographs displaying comparative extraction experiments of Pb(II), Co(II), Ni(II) using IL-2.	5.25
Fig. 5.22: Histogram displaying comparative extraction percentages of Pb(II), Ni(II) and Co(II) using 0.9 mmol of IL-2; error bars arise from n = 3 independent trials.	5.25
Fig. 5.23: Photographs displaying selective extraction experiments from mixture of Pb(II), Co(II), Ni(II).	5.26
Fig. 5.24: Histogram showing selective extraction experiments from mixture of Pb(II), Co(II), Ni(II); error bars arise from n = 3 independent trials.	5.27

List of Schemes

Chapter 1A: General Introduction and Review of Literature	Page No.
Scheme 1A.1 Representative reactions catalyzed by TSILs (A and B) [Cole et al. [30]]; Representative reaction of Fischer esterification catalyzed by TSIL (C) [Forbes et al. [53]].	1A.7
Scheme 1A.2 Application of thermomorphic polymer-supported $PW_{12}O_{40}^{3-}$ complex designed by Hamamoto et al. for oxidation of 1-phenyl-1-propanol catalyzed by Catalyst D [137].	1A.16
Scheme 1A.3: Application of diethylamine terminated PIB oligomer bound Keggin POM, (Catalyst E) for DBT oxidations, Yahya et al. [168].	1A.17
Scheme 1A.4: PMA-SiO ₂ catalysed synthesis of 3-substituted indole [202].	1A.23
Scheme 1A.5: -SO ₃ H functionalized polyoxometalate hybrids reported by Leng et al. and used for acid catalyzed reaction.	1A.25
Scheme 1A.6: Anion-exchanged supported IL covalently bounded on the DE surfaces used as catalyst for aza-Michael reaction [208].	1A.26
Scheme 1A.7: Formation of metal complexes using task specific ionic liquids with aminodiacetic acid moieties [233].	1A.30

Chapter-2: Solvent responsive self-separative behaviour of Brønsted acidic ionic liquid-polyoxometalate hybrid catalysts on H₂O₂ mediated oxidation of alcohols	Page No.
Scheme 2.1: Synthesis of [DEDSA] ₃ PM ₁₂ O ₄₀ .	2.3
Scheme 2.2: Model reaction for oxidation of alcohol.	2.17
Scheme 2.3: Mechanism of oxidation of alcohol using [DEDSA] ₃ PM ₁₂ O ₄₀ via peroxo intermediate formation.	2.23

Chapter-3: A mechanistic study on solar energized degradation of herbicide into value-added product using -SO₃H functionalized ionic liquid-polyoxometalate based heterogeneous catalyst in aqueous medium	Page No.
Scheme 3.1: Synthesis of [DBDSA] ₃ PM ₁₂ O ₄₀ hybrid materials.	3.3
Scheme 3.2: Mechanism of degradation using IL-POM catalyst in IL-POM/ 30% H ₂ O ₂ /sunlight.	3.31

Chapter-4: Study of catalytic activity of methylene bridged dicationic -SO₃H functionalized imidazolium phosphomolybdate hybrids for one pot sequential synthesis of 3-substituted indoles	Page No.
Scheme 4.1: Synthesis of [DILPOM]-1/2/3 hybrids.	4.4
Scheme 4.2: Model reaction for optimization of sequential Claisen-Schmidt condensation followed by Michael-Like addition.	4.22
Scheme 4.3: Plausible mechanism of sequential one-pot synthesis of Michael-adduct via Claisen-Schmidt Condensation.	4.31

Chapter-5: Investigative study on the dual functional behaviour of dicationic ionic liquid as extractant and hydrophobic biphasic solvent for extraction of Pb(II) in water	Page No.
Scheme-5.1: Synthesis of IL-1 and IL-2.	5.4

List of Tables

Chapter-2: Solvent responsive self-separative behaviour of Brønsted acidic ionic liquid-polyoxometalate hybrid catalysts on H₂O₂ mediated oxidation of alcohols	Page No.
Table 2.1 ICP-OES analyses for metal content of the IL-POM hybrids.	2.10
Table 2.2. Study of temperature effects and catalyst amount for the model reaction.	2.18
Table 2.3. Study of solvent effects for the model reaction using [DEDSA] ₃ [PW ₁₂ O ₄₀] catalyst.	2.19
Table 2.4. Substrate scope for oxidation of alcohols using IL-POM hybrid.	2.21-2.22
Table 2.5. Spectral data of the parent ionic liquid and ionic liquid-polyoxometalate hybrids.	2.27-2.28

Chapter-3: A mechanistic study on solar energized degradation of herbicide into value-added product using -SO₃H functionalized ionic liquid-polyoxometalate based heterogeneous catalyst in aqueous medium	Page No.
Table 3.1: ICP-OES analyses for metal content of the IL-POM hybrids.	3.12
Table 3.2: NPOC value of the degraded metobromuron solution at different time intervals in various experimental condition.	3.28-3.29
Table 3.3: Comparison table of the catalyst [DBDSA] ₃ PW ₁₂ O ₄₀ with various reported techniques for degradation of metobromuron.	3.29
Table 3.4: Spectral data of the parent ionic liquid and ionic liquid-polyoxometalate hybrids.	3.37-3.38

Chapter-4: Study of catalytic activity of methylene bridged dicationic -SO₃H functionalized imidazolium phosphomolybdate hybrids for one pot sequential synthesis of 3-substituted indoles	Page No.
Table 4.1: Optimization of reaction conditions for synthesis of 3-substituted indoles.	4.23
Table 4.2: Comparison table of the catalyst [DILPOM]-3 with various reported catalysts for synthesis of 4a using chalcone and indole.	4.27
Table 4.3: Spectral data of IL-POM hybrids, selected chalcones, Michael adducts.	4.34-4.40

Chapter-5: Investigative study on the dual functional behaviour of dicationic ionic liquid as extractant and hydrophobic biphasic solvent for extraction of Pb(II) in water	Page No.
Table 5.1: Extraction percentage of Pb(II) from 20 mL of 7.25 mM Pb(NO ₃) ₂ aqueous solution using variable amount of IL-1 and IL-2 for 30 minute of reaction time.	5.12
Table 5.2: Extraction percentage of Pb(II) using 0.2 mmol of IL-1 and IL-2 from varying concentration of 20 mL of aqueous molar solution of Pb(NO ₃) ₂ in 30 minute of reaction time.	5.14
Table 5.3: Extraction percentages for comparative extraction experiments.	5.25
Table 5.4: Extraction percentages for selective extraction experiments from multi-metal solution.	5.26
Table 5.5: Spectral data of IL-1 and IL-2.	5.32

List of Abbreviations

Ionic liquids (ILs)
Room-temperature ionic liquid (RTILs)
Functionalised ionic liquids (FILs)
Task specific ionic liquids (TSILs)
Brønsted acidic ionic liquid (BAILs)
Brønsted-Lewis Acidic Ionic Liquids (BLAILs)
Basic ionic liquids (BILs)
Task-oriented ionic liquid (TOIL)
Supported liquid phases (SLPs)
Mobile Composition of Matter (MCM)
Polyoxometalates (POMs)
Phase transfer catalysts (PTCs)
Polyisobutylene oligomer-bounded Keggin polyoxometalates (PIB-POM)
Advanced oxidation process (AOP)
Dispersive Liquid-Liquid Microextraction (DLLME)
Homogeneous liquid-liquid extraction (HLLE)
Proton (^1H)
Carbon-13 isotope (^{13}C)
Nuclear Magnetic Resonance (NMR)
Powder X-ray Diffraction (PXRD)
Brunauer-Emmett-Teller (BET)
Scanning Electron Microscopy (SEM)
Energy Dispersive X-Ray (EDX)
Fourier Transform-Infrared (FT-IR)
Carbon Hydrogen Nitrogen (CHN)
Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP-OES)
Joint Committee on Powder Diffraction Standards (JCPDS)
UV-Vis Diffuse Reflectance spectroscopy (UV-Vis DRS)
Thin Layer Chromatography (TLC)
Dicationic Ionic liquids (DIL)
Diethyldisulfoammonium (DEDSA)
Dibutyl disulfoammonium cation (DBDSA)

Ionic liquid-polyoxometalate (IL-POM)
High-Performance Liquid Chromatography (HPLC)
Gas Chromatography-Mass spectrometry (GC-MS)
Total organic carbon (TOC)
Non-purgeable organic content (NPOC)
Phosphotungstic acid (PTA)
Phosphomolybdic acid (PMA)
Temperature Programmed Desorption (TPD)
Dichloromethane (DCM)
Flame atomic absorption spectroscopy (FAAS)
Deuterated chloroform (used as NMR solvent) (CDCl_3)
Dimethyl sulfoxide (used as NMR solvent) ($\text{DMSO-}d_6$)
Dichloromethane (DCM)
Methanol (MeOH)
Ethanol (EtOH)
parts per billion (ppb)
That is (i.e.)
Coupling constant in NMR (J)
Singlet in NMR (s)
Doublet in NMR (d)
Triplet in NMR (t)
Milligram (mg)
Millilitre (mL)
Millimole (mmol)
Mole (mol)
Melting Point (M.p.)
Number (No.)
Parts per million (in NMR) (ppm)
Room Temperature (r.t.)
Ultra Violet Visible (UV-Vis)
Hour (h)