

**Dedicated to**

*My Beloved Parents*

*&*

*Brother*

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## KEYWORDS

Polymer immobilization, Merrifield resin, Chitosan, Water-soluble polymer, Peroxyniobium(V) compounds, Heterogeneous catalysts, Homogeneous catalyst, Olefin epoxidation, Phenol hydroxylation, Sulfoxidation, Organic-solvent-free reactions, 5-Hydroxymethyl-2-furancarboxylic acid (HMFCFA), 5-Hydroxymethylfurfural (HMF) oxidation, Maltol, Deferiprone, Tris(maltolato)oxyniobium(V), Acid Phosphatase Inhibition, Kinetics Study.

## Declaration

I hereby declare that the thesis entitled “*Synthesis and Characterization of Homo- and Heteroleptic Niobium(V) Complexes. Exploration of Their Catalytic and Biochemical Potential*” being submitted to the Department of Chemical Sciences, Tezpur University, is a record of original research work carried out by me. Any text, figures, results or designs that are not of own devising are appropriately referenced in order to give credit to the original author(s). All sources of assistance have been assigned due acknowledgement. I also declare that neither this work as a whole nor a part of it has been submitted to any other university or institute for any other degree, diploma or award.

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Place: Tezpur

Date: 5.01.2024



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### CERTIFICATE FROM SUPERVISOR

I certify that the thesis entitled “*Synthesis and Characterization of Homo- and Heteroleptic Niobium(V) Complexes. Exploration of Their Catalytic and Biochemical Potential*” submitted to the 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 Chemical Sciences is a record of research work carried out by Miss Hiya Talukdar under my supervision and guidance. All help received by her from various sources have been duly acknowledged. No part of this thesis has been submitted elsewhere for award of any other degree.

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### CERTIFICATE OF THE EXTERNAL EXAMINER AND ODEC

This is to certify that the thesis entitled “*Synthesis and Characterization of Homo- and Heteroleptic Niobium(V) Complexes. Exploration of Their Catalytic and Biochemical Potential*” submitted by Hiya Talukdar to Tezpur University in the Department of Chemical Sciences under the School of Sciences in partial fulfilment of the requirement for the award of the degree of Doctor of Philosophy in Chemical Sciences has been examined by us on \_\_\_\_\_ and found to be satisfactory.

Signature of:

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## LIST OF TABLES

Table	Page No.
<b>1.1</b> Common stereochemistry of Nb compounds in different oxidation states	1.6
<b>1.2</b> Some homoleptic and heteroleptic peroxidoniobate (pNb) complexes described in the literature	1.13 & 1.14
<b>1.3</b> The summary of different combinations of metal complexes and macro-ligands, as well as catalyzed reactions	1.37 & 1.38
<b>3.1</b> Analytical data of the complexes <b>3.1-3.3</b>	3.9
<b>3.2</b> <sup>13</sup> C NMR chemical shifts for <b>MR</b> , amino acid linked <b>MR</b> and polymer bound complexes	3.18
<b>3.3</b> TGA data for amino acid functionalized <b>MR</b> and metal-polymer complexes	3.20 & 3.21
<b>3.4</b> Effect of catalyst loading on styrene oxidation catalyzed by <b>3.1</b>	3.23
<b>3.5</b> Effect of temperature on styrene oxidation by catalyst <b>3.1</b>	3.24
<b>3.6</b> Effect of reaction time on styrene oxidation with 30% H <sub>2</sub> O <sub>2</sub> catalyzed by <b>3.1</b>	3.25
<b>3.7</b> Epoxidation of various alkenes with H <sub>2</sub> O <sub>2</sub> catalyzed by compounds <b>3.1-3.3</b>	3.28
<b>3.8</b> Screening of reaction conditions for oxidation of thioanisole with 50% H <sub>2</sub> O <sub>2</sub> catalyzed by <b>MRNNb (3.2)</b> under solvent-free condition	3.30
<b>3.9</b> Selective oxidation of sulfide to sulfone with 50% H <sub>2</sub> O <sub>2</sub> catalyzed by catalysts <b>3.1-3.3</b> at room temperature	3.32 & 3.33
<b>3.10</b> Activity of catalyst <b>3.1</b> in epoxidation of olefins <i>vis-à-vis</i> some reported heterogeneous Nb-based catalysts	3.37
<b>4.1</b> Analytical data for the synthesized complex <b>NbPMA (4.1)</b>	4.7
<b>4.2</b> <sup>13</sup> C NMR chemical shifts of the polymer-bound complex	4.11
<b>4.3</b> TGA data of the complex <b>NbPMA (4.1)</b>	4.12
<b>4.4</b> Effect of temperature on HMF conversion to HMFCA catalyzed by <b>3.3</b>	4.14
<b>4.5</b> Effect of amount of H <sub>2</sub> O <sub>2</sub> on HMF oxidation to HMFCA catalyzed by <b>3.3</b>	4.15
<b>4.6</b> Effect of catalyst loading on HMF oxidation to HMFCA catalyzed by <b>3.3</b>	4.16



4.7	Impact of amount of base on the conversion of HMF to HMFCFA	4.18
4.8	Effect of reaction time on HMF oxidation to HMFCFA by catalysts <b>MRVNb (3.3)</b> and <b>NbPMA (4.1)</b> with H <sub>2</sub> O <sub>2</sub>	4.20
4.9	Effect of solvent on HMF oxidation to HMFCFA with H <sub>2</sub> O <sub>2</sub> catalyzed by <b>3.3</b>	4.21
4.10	Oxidation of HMF over different polymer supported Nb and Ta catalysts	4.22
5.1	Analytical data for the synthesized complex <b>ChpNb (5.1)</b>	5.6
5.2	BET surface area, V <sub>tot</sub> and the pore radius of chitosan and polymer bound peroxidometal complex	5.10
5.3	<sup>13</sup> C NMR spectral data for chitosan and chitosan anchored pNb complex	5.13
5.4	Thermogravimetric analysis data of the polymer immobilized complex	5.14
5.5	Optimization of reaction conditions for selective hydroxylation of phenol catalyzed by <b>ChpNb (5.1)</b>	5.19
5.6	Optimization of reaction conditions for styrene epoxidation catalyzed by <b>ChpNb (5.1)</b>	5.24
5.7	Optimization of reaction conditions for sulfide oxidation by <b>ChpNb (5.1)</b>	5.27
5.8	Selective oxidation of sulfides to sulfoxides with 30% H <sub>2</sub> O <sub>2</sub> catalyzed by <b>ChpNb (5.1)</b> and <b>ChpTa</b> in presence of H <sub>2</sub> O	5.28
5.9	The catalytic activity of <b>ChpNb</b> and <b>ChpTa</b> <i>vis-à-vis</i> some reported supported Nb or Ta-based catalysts in phenol hydroxylation, styrene epoxidation and sulfide oxidation	5.33 & 5.34
6.1	Crystal data and structure refinement details for [NbO(malt) <sub>3</sub> ] <sub>2</sub> ·9H <sub>2</sub> O ( <b>6.1</b> )	6.4 & 6.5
6.2	Analytical data for the synthesized Nb(V) complexes	6.9
6.3	<sup>1</sup> H and <sup>13</sup> C NMR chemical shifts for free ligands and niobium(V) complexes <b>6.1-6.3</b>	6.13
6.4	Thermogravimetric data of niobium(V) complexes	6.18
6.5	Selected bond lengths (Å) and bond angles (°) of [NbO(malt) <sub>3</sub> ] <sub>2</sub> ·9H <sub>2</sub> O ( <b>6.1</b> )	6.20
6.6	Potential hydrogen bonds in the complex [NbO(malt) <sub>3</sub> ] <sub>2</sub> ·9H <sub>2</sub> O ( <b>6.1</b> )	6.21

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<b>6.7</b>	Bond lengths (Å) and bond angles (°) of the pNb complexes (a) <b>6.2</b> and (b) <b>6.3</b> corresponding to the central metal atom Nb connected to the surrounding oxygen atoms of the ligands obtained at the M06-2X/def2-TZVPP level of theory	6.23
<b>6.8</b>	The values of IC <sub>50</sub> and inhibitor constants ( $K_i$ and $K_{ii}$ ) determined for ACP inhibition	6.30

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## LIST OF FIGURES

Figure	Page No.
1.1 Application of niobium and various niobium-based compounds.	1.2
1.2 Mapping of Nb-AIM (a) views along the c axis and (b) a axis and of Nb-SIM (c) views along the c axis and (d) a axis.	1.5
1.3 Structural classification of metal-dioxygen complexes.	1.9
1.4 The structure of the $[\text{Nb}(\text{O}_2)_4]^{3-}$ anion in $\text{Na}_3[\text{Nb}(\text{O}_2)_4] \cdot 13\text{H}_2\text{O}$ showing the disorder in the peroxido oxygen atom positions. Two different conformations are shown in black and white lines.	1.11
1.5 Environment of the metal atom reported for halide-free heteroleptic peroxido complexes of niobium derived from the corresponding tetraperoxidoniobate.	1.15
1.6 ORTEP representation of $[\text{Nb}(\text{O}_2)_3(\text{quin-2-c})]^{2-}$ . Thermal ellipsoids are drawn at the 50% probability level.	1.16
1.7 ORTEP representation of the bimetallic molecular anion, $[\text{Nb}_2(\text{O}_2)_4(\text{tart})(\text{Htart})]^{5-}$ with 50% ellipsoid probability.	1.17
1.8 The peroxidoniobium complexes tested for their (A) insulin-like activity: $[\text{Nb}(\text{O}_2)_4]^{3-}$ and $[\text{Nb}(\text{O}_2)_3(\text{quin-2-c})]^{2-}$ [quin-2-c = quinoline-2-carboxylate ion], (B) anti-cancer activity: $[\text{Nb}(\text{Asc})(\text{O}_2)_3]^{3-}$ [Asc = ascorbate anion], (C) acid phosphatase inhibition: $[\text{Nb}(\text{O}_2)_3(\text{val})(\text{H}_2\text{O})]^{2-}$ [val=valinato] and (D) $[\text{Nb}_2(\text{O}_2)_6(\text{carboxylate})_2]\text{-PA}$ [PA = poly(sodium acrylate)].	1.19
1.9 Selective oxidations of organic compounds by peroxido-Nb systems in the presence of hydrogen peroxide.	1.21
1.10 Structures of the peroxidoniobium catalysts in sulfide oxidation reaction: (a) $\text{Na}_2[\text{Nb}(\text{O}_2)_3(\text{arg})] \cdot 2\text{H}_2\text{O}$ [arg = arginate] and (b) $\text{Na}_2[\text{Nb}(\text{O}_2)_3(\text{nic})(\text{H}_2\text{O})] \cdot \text{H}_2\text{O}$ [nic = nicotinate].	1.22
1.11 The ionic liquid [TBA][LA]-stabilized Nb oxocluster.	1.24
1.12 Different approaches for the formation of metal-containing polymers.	1.28
1.13 Structural representation of cellulose, chitin and chitosan.	1.30
1.14 Examples of different metal complexes immobilized on modified chitosan support.	1.31
1.15 Silica-supported chitosan@vanadium catalyst reported by Shen <i>et al.</i>	1.32
1.16 Structure of Merrifield resin. The ball represents the polymer main chain.	1.32
1.17 Examples of some polymer anchored ligands obtained by the reaction of PS-CH <sub>2</sub> Cl with different organic compound.	1.33

<b>1.18</b>	Some water-soluble polymers used for metal ion interaction.	1.39
<b>1.19</b>	General structure of the three PQS-bound NHC–Au(I) complexes.	1.42
<b>1.20</b>	Polymer-platinum conjugation through leaving ligands, here bidentate carboxylato groups.	1.43
<b>3.1</b>	Scanning electron micrographs of (a) <b>MR</b> , (b) <b>MRV</b> , (c) <b>MRVNb (3.1)</b> , (d) <b>MRN</b> , (e) <b>MRNNb (3.2)</b> , (f) <b>MRG</b> and (g) <b>MRGNb (3.3)</b> .	3.8
<b>3.2</b>	EDX spectra of (a) <b>MRVNb (3.1)</b> , (b) <b>MRNNb (3.2)</b> and (c) <b>MRGNb (3.3)</b> .	3.10
<b>3.3</b>	XRD patterns of (a) <b>MR</b> , (b) <b>MRVNb (3.1)</b> , (c) <b>MRNNb (3.2)</b> , (d) <b>MRGNb (3.3)</b> , and (e) reference powder X-ray diffraction pattern of Na <sub>3</sub> NbO <sub>8</sub> (JCPDS code 52-0708).	3.10
<b>3.4</b>	(a) XPS spectra of Nb (3d <sub>5/2</sub> ) and (3d <sub>3/2</sub> ) and (b) XPS survey spectra for the compounds. “Black line” represents <b>MRVNb (3.1)</b> , “Blue line” represents <b>MRNNb (3.2)</b> and “Red line” represents <b>MRGNb (3.3)</b> .	3.11
<b>3.5</b>	FTIR spectra of (a) <b>MR</b> , (b) <b>MRV</b> and (c) <b>MRVNb (3.1)</b> .	3.13
<b>3.6</b>	FTIR spectra of (a) <b>MR</b> , (b) <b>MRN</b> and (c) <b>MRNNb (3.2)</b> .	3.13
<b>3.7</b>	FTIR spectra of (a) <b>MR</b> , (b) <b>MRG</b> and (c) <b>MRGNb (3.3)</b> .	3.14
<b>3.8</b>	Raman spectra of (a) <b>MRVNb (3.1)</b> , (b) <b>MRNNb (3.2)</b> and (c) <b>MRGNb (3.3)</b> .	3.15
<b>3.9</b>	Diffuse reflectance UV-visible spectra of <b>MRVNb</b> , <b>MRNNb</b> and <b>MRGNb</b> .	3.16
<b>3.10</b>	<sup>13</sup> C NMR spectra of (a) <b>MRV</b> and (b) <b>MRVNb (3.1)</b> .	3.17
<b>3.11</b>	<sup>13</sup> C NMR spectra of (a) <b>MRN</b> and (b) <b>MRNNb (3.2)</b> .	3.17
<b>3.12</b>	<sup>13</sup> C NMR spectra of (a) <b>MRG</b> and (b) <b>MRGNb (3.3)</b> .	3.19
<b>3.13</b>	Thermograms of the complexes <b>MRVNb</b> , <b>MRNNb</b> and <b>MRGNb</b> .	3.20
<b>3.14</b>	Styrene conversion versus catalyst amount (Catalyst <b>3.1</b> ).	3.23
<b>3.15</b>	Diagram depicting the conversion of styrene and epoxide selectivity shown by the polymer immobilized catalysts <b>3.1-3.3</b> along with the precursor complex, Na <sub>3</sub> [Nb(O <sub>2</sub> ) <sub>4</sub> ]·13H <sub>2</sub> O ( <b>TpNb</b> ).	3.24
<b>3.16</b>	Styrene conversion versus temperature (Catalyst <b>3.1</b> ).	3.25
<b>3.17</b>	Effect of time on styrene epoxidation.	3.26
<b>3.18</b>	Effect of solvent on styrene conversion.	3.27
<b>3.19</b>	Heterogeneity test for (a) styrene and (b) MPS.	3.34
<b>3.20</b>	Reusability of Catalyst <b>3.1</b> for selective oxidation of sulfide and styrene.	3.34
<b>3.21</b>	FTIR spectra of (a) Catalyst <b>3.1</b> and (b) Catalyst <b>3.2</b> after 5 <sup>th</sup> catalytic	3.35

	cycle.	
<b>3.22</b>	IR spectra of (a) <b>MRVNb (3.1)</b> and (b) Diperoxidoniobate complex recovered after oxidation of styrene by Catalyst <b>3.1</b> , in absence of H <sub>2</sub> O <sub>2</sub> .	3.40
<b>4.1</b>	SEM images of (a) <b>PMA</b> , (b) <b>NbPMA</b> and (c) EDX spectrum of <b>NbPMA</b> .	4.7
<b>4.2</b>	FTIR spectra of (a) <b>PMA</b> and (b) <b>NbPMA (4.1)</b> .	4.8
<b>4.3</b>	(a) Raman spectrum and (b) FTIR spectrum of <b>NbPMA (4.1)</b> .	4.9
<b>4.4</b>	UV-Visible absorption spectrum of <b>NbPMA (4.1)</b> .	4.9
<b>4.5</b>	<sup>13</sup> C NMR spectra of (a) <b>PMA</b> and (b) <b>NbPMA (4.1)</b> in D <sub>2</sub> O.	4.10
<b>4.6</b>	<sup>93</sup> Nb NMR spectrum of <b>NbPMA (4.1)</b> in D <sub>2</sub> O.	4.11
<b>4.7</b>	Thermogram of <b>NbPMA (4.1)</b> .	4.12
<b>4.8</b>	HMF conversion versus temperature (catalyst: <b>3.3</b> ).	4.14
<b>4.9</b>	Effect of oxidant concentration in HMF conversion to HMFCa.	4.15
<b>4.10</b>	HMF conversion versus catalyst amount.	4.17
<b>4.11</b>	Impact of amount of base on the conversion of HMF to HMFCa.	4.18
<b>4.12</b>	Effect of time on HMF oxidation by <b>3.3</b> and <b>4.1</b> .	4.21
<b>4.13</b>	Effect of solvent on HMF conversion to HMFCa.	4.21
<b>4.14</b>	Reusability of <b>MRGNb (3.3)</b> for selective oxidation of HMF.	4.24
<b>4.15</b>	FTIR spectra of (a) <b>MRGNb</b> and (b) <b>MRGNb</b> after 5 <sup>th</sup> cycle.	4.24
<b>4.16</b>	Hot filtration test for HMF oxidation to HMFCa by <b>MRGNb (3.3)</b> .	4.25
<b>5.1</b>	FESEM images of <b>Chitosan</b> (a) 4 μm, (b) 10 μm; <b>ChpNb</b> (c) 1 μm, (d) 2 μm.	5.7
<b>5.2</b>	SEM images of <b>Chitosan</b> (a) 10 μm, (b) 50 μm; <b>ChpNb</b> (c) 10 μm, (d) 50 μm and (e) EDX spectrum of <b>ChpNb</b> .	5.7
<b>5.3</b>	PXRD patterns of (a) <b>Chitosan</b> and (b) <b>ChpNb (5.1)</b> .	5.8
<b>5.4</b>	(a) XPS spectrum and (b) XPS survey spectrum of <b>ChpNb (5.1)</b> .	5.9
<b>5.5</b>	Adsorption/desorption isotherm of <b>ChpNb (5.1)</b> .	5.9
<b>5.6</b>	FTIR spectra of (a) <b>Chitosan</b> and (b) <b>ChpNb (5.1)</b> .	5.11
<b>5.7</b>	(a) Raman spectrum of <b>ChpNb (5.1)</b> and (b) FTIR spectrum of <b>ChpNb (5.1)</b> .	5.11
<b>5.8</b>	Diffuse reflectance UV-visible spectrum of <b>ChpNb (5.1)</b> .	5.12
<b>5.9</b>	<sup>13</sup> C NMR spectra of (a) <b>Chitosan</b> and (b) <b>ChpNb (5.1)</b> .	5.13
<b>5.10</b>	TGA-DTG plots of <b>ChpNb (5.1)</b> .	5.14
<b>5.11</b>	Proposed structure of <b>ChpNb (5.1)</b> . “  ” represents polymer	5.15




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chain.	
<b>5.12</b>	Effect of catalyst loading on phenol hydroxylation. 5.16
<b>5.13</b>	Effect of H <sub>2</sub> O <sub>2</sub> concentration on phenol hydroxylation. 5.17
<b>5.14</b>	Conversion of phenol with time. 5.18
<b>5.15</b>	Effect of solvent on phenol conversion. 5.20
<b>5.16</b>	Diagram showing the conversion of phenol and selectivity of HQ and CT by <b>ChpNb</b> , <b>ChpTa</b> along with the precursor complexes, Na <sub>3</sub> [Nb(O <sub>2</sub> ) <sub>4</sub> ]·13H <sub>2</sub> O ( <b>TpNb</b> ) and Na <sub>3</sub> [Ta(O <sub>2</sub> ) <sub>4</sub> ]·H <sub>2</sub> O ( <b>TpTa</b> ). 5.21
<b>5.17</b>	Effect of H <sub>2</sub> O <sub>2</sub> concentration on oxidation of styrene. 5.22
<b>5.18</b>	Effect of catalyst loading on styrene oxidation. 5.22
<b>5.19</b>	Styrene conversion versus time. 5.23
<b>5.20</b>	Effect of solvent on styrene conversion. 5.25
<b>5.21</b>	Bar diagram showing the conversion of styrene by <b>ChpNb</b> , <b>ChpTa</b> along with the precursor complexes, Na <sub>3</sub> [Nb(O <sub>2</sub> ) <sub>4</sub> ]·13H <sub>2</sub> O and Na <sub>3</sub> [Ta(O <sub>2</sub> ) <sub>4</sub> ]·H <sub>2</sub> O. 5.25
<b>5.22</b>	Recyclability of the catalyst <b>ChpNb</b> ( <b>5.1</b> ) in sulfide oxidation and styrene epoxidation. 5.29
<b>5.23</b>	FTIR spectra of (a) <b>ChpNb</b> and (b) <b>ChpNb</b> after 5 <sup>th</sup> catalytic cycle. 5.30
<b>5.24</b>	Raman spectra of (a) fresh catalyst <b>ChpNb</b> and (b) recovered catalyst <b>ChpNb</b> . 5.30
<b>5.25</b>	PXRD patterns of (a) fresh catalyst <b>ChpNb</b> and (b) recovered catalyst <b>ChpNb</b> . 5.31
<b>5.26</b>	Heterogeneity test for (a) styrene epoxidation and (b) sulfide oxidation in water catalyzed by <b>ChpNb</b> ( <b>5.1</b> ). 5.31
<b>6.1</b>	FTIR spectra of (a) <b>Maltol</b> , (b) complex <b>6.1</b> and (c) complex <b>6.2</b> . 6.10
<b>6.2</b>	FTIR spectra of (a) <b>Deferiprone</b> and (b) complex <b>6.3</b> . 6.10
<b>6.3</b>	Raman spectra of complexes (a) <b>6.1</b> , (b) <b>6.2</b> and (c) <b>6.3</b> . 6.11
<b>6.4</b>	UV–Vis absorption spectra of (a) <b>6.1</b> (conc.: 2.5 × 10 <sup>-5</sup> M), (b) <b>6.2</b> (conc.: 2.5 × 10 <sup>-5</sup> M; Inset conc.: 2.0 × 10 <sup>-2</sup> M) and (b) <b>6.3</b> (conc.: 2.5 × 10 <sup>-5</sup> M; Inset conc.: 2.0 × 10 <sup>-2</sup> M) in H <sub>2</sub> O. 6.12
<b>6.5</b>	<sup>1</sup> H NMR spectrum of <b>6.1</b> in Methanol- <i>d</i> <sub>4</sub> . 6.15
<b>6.6</b>	<sup>13</sup> C NMR spectrum of <b>6.1</b> in Methanol- <i>d</i> <sub>4</sub> . 6.15
<b>6.7</b>	<sup>1</sup> H NMR spectrum of <b>6.2</b> in D <sub>2</sub> O. 6.16
<b>6.8</b>	<sup>13</sup> C NMR spectrum of <b>6.2</b> in D <sub>2</sub> O. 6.16

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<b>6.9</b>	<sup>1</sup> H NMR spectrum of <b>6.3</b> in D <sub>2</sub> O.	6.17
<b>6.10</b>	<sup>13</sup> C NMR spectrum of <b>6.3</b> in D <sub>2</sub> O.	6.17
<b>6.11</b>	TGA-DTG plots of (a) <b>6.1</b> , (b) <b>6.2</b> and (c) <b>6.3</b> .	6.18
<b>6.12</b>	Proposed structures of (a) <b>6.2</b> and (b) <b>6.3</b> ; structure of (c) <b>6.1</b> in the current study.	6.19
<b>6.13</b>	ORTEP representation of [NbO(malt) <sub>3</sub> ] <sub>2</sub> ·9H <sub>2</sub> O with 50% ellipsoid probability. The outer coordination sphere water molecules are excluded for clarity.	6.20
<b>6.14</b>	(a), (b) Water tap through O–H···O hydrogen bonding along the crystallographic axis [001] connecting the host molecules in [NbO(malt) <sub>3</sub> ] <sub>2</sub> ·9H <sub>2</sub> O ( <b>6.1</b> ).	6.21
<b>6.15</b>	Optimized structures of ground state geometries of the complexes (a) <b>6.2</b> and (b) <b>6.3</b> obtained at the M06-2X/def2-TZVPP level of theory.	6.22
<b>6.16</b>	<sup>1</sup> H NMR spectra of complex <b>6.2</b> in D <sub>2</sub> O. The spectra were recorded as follows: (a) solution of complex <b>6.2</b> instantly after preparation and (b) solution of (a) after 12 h.	6.24
<b>6.17</b>	<sup>13</sup> C NMR spectra of the complex <b>6.2</b> in D <sub>2</sub> O. The spectra were recorded as follows: (a) solution of <b>6.2</b> instantly after preparation and (b) solution of (a) after 12 h.	6.24
<b>6.18</b>	UV-visible spectra of complex <b>6.1</b> recorded immediately after preparation and 12 h later (a) at natural pH (5.2) of the complex and (b) at pH = 4.6.	6.25
<b>6.19</b>	The effect of Nb(V) complexes and free ligands on ACP catalyzed rates of hydrolysis of <i>p</i> -NPP at pH 4.6 at stated concentrations of inhibitors.	6.26
<b>6.20</b>	L-B plots for the ACP inhibition in the absence and presence of $\blacklozenge$ 0 $\mu$ M, $\blacksquare$ 25 $\mu$ M, $\blacktriangle$ 50 $\mu$ M, $\times$ 75 $\mu$ M, $\blacktimes$ 100 $\mu$ M concentrations of (A) <b>6.2</b> , (B) <b>6.3</b> , (C) <b>6.1</b> and (D) $\blacklozenge$ 0 $\mu$ M, $\blacksquare$ 2.5 $\mu$ M, $\blacktriangle$ 5 $\mu$ M, $\times$ 7.5 $\mu$ M, $\blacktimes$ 10 $\mu$ M concentrations of <b>NbPMA (4.1)</b> .	6.29

## LIST OF SCHEMES

Scheme		Page no.
1.1	The preparation progress of Hb–HCa <sub>2</sub> Nb <sub>3</sub> O <sub>10</sub> modified electrode.	1.4
1.2	Metal catalyzed oxidation with peroxides.	1.10
1.3	pH-dependence of the substitution of fluoro ligands by peroxido groups in niobate complexes.	1.12
1.4	Synthesis of indenyl peroxidoniobium complexes.	1.18
1.5	An illustration of the green synthetic approach for preparation of KNN powders from aqueous solutions through a) niobium(V)-peroxido-citrate b) niobium(V)-peroxido-glycine precursors.	1.20
1.6	Interconversion between the different forms of Nb-POMs in presence of aqueous H <sub>2</sub> O <sub>2</sub> and formation of the active hydroperoxido species.	1.23
1.7	Proposed mechanism for epoxidation of allylic alcohols with H <sub>2</sub> O <sub>2</sub> catalyzed by the monomeric peroxoniobate anion of IL.	1.23
1.8	Proposed mechanism for epoxidation of allylic alcohols with H <sub>2</sub> O <sub>2</sub> catalyzed by Nb-oxocluster complex.	1.25
1.9	Plausible mechanism for the epoxidation using pre-treated Nb(salan)(O <i>t</i> Pr) <sub>3</sub> as a catalyst.	1.25
1.10	Synthesis of 4-azidomethyl substituted PS-supported chiral vanadyl catalysts by click chemistry.	1.34
1.11	Synthesis of MR-supported Pd catalyst reported by Jang.	1.35
3.1	Synthesis of PS-DVB-supported pNb complexes. “  ” represents polymer chain.	3.7
3.2	Epoxidation of styrene by <b>MRVNb (3.1)</b> .	3.22
3.3	Epoxidation of limonene with 30% H <sub>2</sub> O <sub>2</sub> catalyzed by <b>MRVNb (3.1)</b> (*major product).	3.29
3.4	Proposed catalytic cycles for epoxidation of olefins and oxidation of sulfides to sulfones. “  ” represents polymer chain.	3.39
4.1	Schematic representation of biomass conversion into value-added chemicals.	4.1
4.2	Synthesis of WSP-supported pNb catalyst. “  ” represents polymer chain.	4.6
5.1	Proposed catalytic cycle for A. epoxidation of styrene, B. hydroxylation of phenol and C. oxidation of sulfides to sulfoxides (M = Nb or Ta). “*” represents polymer chain.	5.36
6.1	Synthesis of oxidoniobium(V) complex <b>6.1</b> and peroxidoniobium(V) complexes, <b>6.2</b> and <b>6.3</b> .	6.8



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## LIST OF ABBREVIATIONS

NMRI	Nuclear magnetic resonance imaging
MRI	Magnetic resonance imaging
PON	Polyoxoniobate
CFI	Complement factor I
Hb	Hemoglobin
KNN	$K_{0.5}Na_{0.5}NbO_3$
MCF	Mesocellular foam
SBA	Santa Barbara Amorphous
MCM-41	Mobil Composition of Matter No. 41
MOF	Metal organic framework
Cp	Cyclopentadiene
thd	2-[3-[(4-Amino-2-methyl-5-pyrimidinyl)methyl]- 2-(1,2-dihydroxyethyl)-4-methyl-1,3-thiazol-3- ium-5-yl]ethyl trihydrogen diphosphate
acac	Acetylacetonato
silox	Siloxide
dmpe	1,2-Bis(dimethylphosphino)ethane
PPP	Phosphinophenylphosphine
pV	Peroxidovanadium
pNb	Peroxidoniobium
TpNb	$[Nb(O_2)_4]^{3-}$
gu	Guanidinium
DTPA	Diethylenetriaminepentaacetic acid
EDTA	Ethylenediaminetetraacetic acid
hq	Hydroxyquinolate
quin-2-c	Quinoline-2-carboxylate ion
ox	Oxalate
tart	Tartaric acid
glyc	Glycollate
Hmal	Malic acid
Asc	Ascorbate anion

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Httha	Triethylenetetraminehexaacetic acid
pdta	Propanediaminetetraacetate
pic	Picolinic acid
dipic	Pyridine-2,6-dicarboxylic acid
bpy	2,2'-Bipyridine
phen	Phenanthroline
pzdc	Pyrazine-2,3-dicarboxylate
FFA	Free fatty acid
IL	Ionic liquid
CE	Crown ether
TBA/LA	Tetrabutylammonium/lactate
NPs	Nanoparticles
TPPTS	$P(m\text{-C}_6\text{H}_4\text{SO}_3\text{Na})_3$
MR	Merrifield resin
PS-DVB	Polystyrene divinylbenzene copolymer
CSDVB	Cross-linked poly(styrene-divinylbenzene)
PPESK	Poly(phthalazinone ether sulfone ketone)
PA	Poly(sodium acrylate)
PMMA	Poly(methylmethacrylate)
PS-BBP	Polystyrene functionalized with 2,6-bis(benzimidazolyl)pyridine
POP	Porous organic polymer
TPA	Triphenyl amine
PAN	Polyacrylonitrile
PEI	Polyethyleneimine
PAAc	Polyacrylic acid
P4VP	Poly(4-vinyl pyridine)
PEG	Polyethyleneglycol
P-HPHZ	Polymer anchored N,N'-bis (o-hydroxy acetophenone) hydrazine
PS-naph	Amino polystyrene anchored azo ligand
PNB	Polynorbornene
c-PMA <sub>n</sub>	Cross-linked poly(methyl acrylate)

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PAACA	Poly(acrylic acid-co-acrylamide)
PS-An	Chloromethylated polystyrene functionalized with anthranilic acid
HCPs	Hyper-cross-linked polymers
COP	Covalent organic polymer
DIOP	4,5-bis(diphenylphosphinomethyl)-2,2-dimethyl-1,3-dioxidolane
NHC	<i>N</i> -heterocyclic carbene
PS	Polystyrene
WSP	Water-soluble polymer
EDX	Energy Dispersive X-Ray
AAS	Atomic absorption spectroscopy
ICP-OES	Inductively coupled plasma optical emission spectrophotometer
CHN	Carbon, hydrogen and nitrogen
SEM	Scanning Electron Microscope
PXRD	Powder X-ray diffraction
XPS	X-ray photoelectron spectroscopy
BET	Brunauer–Emmett–Teller
TGA	Thermogravimetric analysis
HPLC	High performance liquid chromatography
GC-MS	Gas chromatography-mass spectrometry
MPS	Methyl phenyl sulfide
RT	Room temperature
MRVNb	$[\text{Nb}(\text{O}_2)_3(\text{val})]^{2-}\text{-MR}$ [val = valine]
MRNNb	$[\text{Nb}(\text{O}_2)_3(\text{asn})]^{2-}\text{-MR}$ [asn = asparagine]
MRGNb	$[\text{Nb}(\text{O}_2)_3(\text{gly})]^{2-}\text{-MR}$ [gly = glycine]
Sty	Styrene
TLC	Thin layer chromatography
Calix	Calixarene
KIT	Korea Advanced Institute of Science and Technology
MMM	Mixed matrix membrane

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CNTs	Carbon nano tubes
DMC	Dimethyl carbonate
NbPMA	[Nb(O <sub>2</sub> ) <sub>3</sub> (carboxylate)] <sup>2-</sup> -PMA [PMA = poly(sodium methacrylate
HMF	5-Hydroxymethyl-2-furfural
HMFCA	5-Hydroxymethyl-2-furancarboxylic acid
wt.	Weight
ChpNb	[Nb(O <sub>2</sub> ) <sub>3</sub> (NH <sub>2</sub> )(OH)] <sup>-</sup> -chitosan
PH	Phenol
RB	Round-bottomed flask
TpTa	[Nb(O <sub>2</sub> ) <sub>4</sub> ] <sup>3-</sup>
BJH	Barrett-Joyner-Halenda
eq.	Equivalent
LD <sub>50</sub>	Lethal dose, 50%
malt	Maltol
def	Deferiprone
EC <sub>50</sub>	Half maximal effective concentration
ACP	Acid phosphatase
ALP	Alkaline phosphatase
<i>p</i> -NPP	<i>p</i> -nitrophenyl phosphate
IC <sub>50</sub>	Half maximal inhibitory concentration
GST-PTP1B	Glutathione S-transferase-tagged protein tyrosine phosphatase 1B
PTPase	Protein tyrosine phosphatase