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Supporting Information

Superiority of polymeric scavenger over its hexapodal monomer towards efficient ReO_4^- removal in water

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Contents

1. All chemicals were used as received without further purification. Hexakis(bromomethyl)-benzene,1-Vinyl- imidazole, Sodium perrhenate($NaReO_4$) were purchased from Sigma-Aldrich. NaOH, HNO_3, $NaNO_3$, NaCl, Na_2SO_4, $TBAH_2PO_4$, $NaClO_4$, $NaBF_4$ and other reagent were analytically pure and used as received. ReO_4^- stock solution was prepared by dissolving desired amount of $NaReO_4$ solid in Mili-Q ultrapure water.

2. Spectroscopic Measurement Instrumentation:

NMR experiments were carried out on FT-NMR Bruker DPX 300 MHz NMR spectrometer. All the samples for NMR spectroscopy were prepared by dissolving the samples in DMSO-d_6 and H_2O (Locking was performed using a capillary tube filled with D_2O) having concentrations ≈ 10^{-3}(M). Chemical shifts for ^1H and ^{13}C NMR were reported in parts per million (ppm), calibrated to the residual solvent peak set. High resolution ESI-MS experiments were carried out with a Waters QtoF Model YA 263 mass spectrometer in positive ESI mode. Sample for mass spectrometry was prepared by dissolving the compound in CH_3CN/H_2O with concentration ≈ 10^{-6} .The concentration of ReO_4^- in solution were measured by inductively coupled plasma –atomic emission spectrometry(ICP-AES ,Perkin Elmer optima 2100 DV).The FT-IR was recorded on a SHIMADZU FTIR-8400S infrared spectrophotometer with KBr pellets.

2.1.X-Ray single-Crystal structure measurement:

The crystallographic details of Complex **[Him-Re]** are given in (Table S1). In each case, a crystal of suitable size was dipped in paratone oil after collecting from the mother liquor. Further, it was mounted on nylon loop and data collected at 104 K under cold nitrogen gas stream. The X-ray diffraction data for the crystal collected on a Bruker D8 Venture Microfocous diffractometer equipped with a PHOTON II detector, using MoKα (λ = 0.71073 Å) radiation, controlled by the APEX3(v2017.3-0) software package and processes using SAINT[1]. The raw data were integrated and corrected for Lorentz and polarization effects using the Bruker APEX II/APEX III program suite. Integration and reduction were processed with SAINT[1] software. An empirical absorption correction was applied to the collected reflections with SADABS.[2] The structures were solved by direct methods using SHELXTL[3] and were refined on F^2 by the full-matrix least-squares technique using the SHELXL-2014[4] program package. Graphics were generated using PLATON-97[5] and MERCURY 3.7.[6] Crystallographic data have been deposited with the CCDC (2027400).

3. Synthesis and characterization

3.1. Synthesis and characterization of monomer [Him-Br]:

The hexapodal imidazolium monomer **[Him-Br]** was synthesized by the quaternization reaction between hexakis(bromomethyl)-benzene and 1-Vinyl- imidazole. Initially hexakis(bromomethyl)-benzene 0.318 g (0.5 mmol) was dissolved in 40 ml of acetonitrile at 80 ºC under argon atmosphere, then 1-Vinyl- imidazole 0.315ml (3.25 mmol) was added in drop by drop fashion to the refluxing solution over a long period of time (6 hours). After the addition was completed, the solution was allowed to reflux for the 48 hours and gradual yellowish white precipitation was observed of **[Him-Br]**. After completion, the solution was filtered and solid mass was washed with dry acetonitrile for removal of excess 1-ethyl-imidazole. Then solid mass was dissolved in minimum amount of mild hot water. Finally, the water medium was dried in open air in a flat surface for 48 hours. Then solid mass was dried in an oven at 60 ºC for 48 hours to remove a little trace of water from it.(Yield 82%).

^{1}H NMR (DMSO-*d*$_6$, 298K, 300 MHz) δ ppm: 5.43-5.39 (dd, 6H), 5.91 (s, 12H), 6.07-6.01 (dd, 6H), 7.33-7.25 (dd, 6H), 8.00-7.99 (d, 6H), 8.20-8.19 (d, 6H). 9.70 (s, 6H) **^{13}C NMR** (DMSO-*d*$_6$, 298K, 75 MHz) δ ppm: 48.53, 109.75, 118.80, 124.39, 128.84, 136.30, 139.18 **^{13}C- DEPT-135 NMR (**DMSO-*d*$_6$, 298K, 75 MHz**):** 49.53 (CH_2), 110.72 (CH_2), 119.77 (CH), 125.37 (CH), 129.82 (CH), 137.29 (CH). **ESI-MS:** m/z: calcd for $C_{42}H_{48}Br_5N_{12}$ [**Him-Br**]$^+$ 1118.9995, found 1118.9993; calcd for $C_{42}H_{48}Br_4N_{12}$ [**Him-Br**]$^{2+}$, 520.0403, found 520.0406. FTIR in KBr disc (ν/cm^{-1}): 950, 1550, 1656, 2800-3000

3.2. Synthesis of polymeric networks [PHIm-Br]:

Hexapodal imidazolium based polymeric network **[PHIm-Br]** was synthesized by the free radical polymerization of monomer **[Him-Br]** using AIBN in DMSO. In a typical process 9 g (7.5 mmol) monomer **[Him-Br]** and 1g (6.1 mmol) AIBN were dissolved by 30 ml DMSO in 100 ml round-bottomed flask equipped with a magnetic stir bar. The solution was purged with N_2 for 20 minute and then the solution was heated for 6 hours at 75 °C. Then the obtained polymer was collected and thoroughly washed with H_2O and ethanol to remove the remaining catalyst and unconsumed monomer. Further purification of polymer **[PHIm-Br]** was done by Soxhlet extraction with ethanol for 24 h and the resulted mass was dried by high vacuum pump to generate pure [**PHIm-Br**]. FTIR in KBr disc (ν/cm^{-1}): 1553, 1648, 2800-3000

3.3. Preparation of monomer perrhenate complex [Him-Re]:

An aliquot of 10ml 12.9 mM aqueous solution of **[Him-Br]** was added to the 10 equivalent aqueous $NaReO_4$ solutions at pH =7. Then the mixture was stirred for 6 min with 250 rpm and a white solid precipitate was observed. Then the white solid mass was separated by whatman grade 1 filter paper. Finally solid mass was dried in an oven at 60 ºC for 48 hours and we get the complex **[Him-Re].**

3.4. Characterization of extracted complex [Him-Re]:

^{1}H NMR (DMSO-*d*$_6$, 298K, 300 MHz*)* δ ppm: 5.49-5.45 (dd, 6H), 5.73 (s, 12H), 6.02-5.96 (dd, 6H), 7.25-7.17 (dd, 6H), 7.71-7.70 (d, 6H), 8.19-8.18 (d, 6H). 9.35 (s, 6H) **^{13}C NMR** (DMSO-*d*$_6$, 298K, 75 MHz) δ ppm: 48.08, 110.43, 119.46, 124.00, 128.81, 136.01, 139.00 **^{13}C- DEPT-135 NMR (**DMSO-*d*$_6$, 298K, 75 MHz**):** 47.93 (CH_2), 110.28 (CH_2), 119.31 (CH), 123.85 (CH), 128.65 (CH), 135.84 (CH). **ESI-MS:** m/z: calcd for $C_{42}H_{48}N_{12}0_{20}$ Re_5 [**Him-Re**]$^+$ 1971.0834, found 1971.0832; calcd for $C_{42}H_{48}N_{12}0_{16}Re_4$ [**Him-Re**]$^{2+}$, 861.0751, found 861.0756.

4. Experimental Section:

4.1. Batch Experiment: All the extraction experiments were conducted at room temperature (25ºC) using MiliQ water. The pH value of solution was adjusted by using NaOH and HNO_3 solution. All the extraction experiments were performed at pH= 7. In a typical experiment, for monomer **[HIm-Br**], 1 ml 4.3 mM **[HIm-Br**] solution was added to 10 ml of ~630 ppm $NaReO_4$ solution along with 10 equiv. of different anions such as Cl^-, SO_4^{2-}, $H_2PO_4^-$, AcO-, NO_3^-, BF_4^- and ClO_4^-. The mixture was stirred for 10 min and the resultant solution was centrifuged for another 10 min. After that, the solution was allowed to settle for 30 min and finally filtered through a 0.45 µm nylon membrane filter. For the polymeric scavenger **[PHIm-Br],** 10 mg **[PHIm-Br]** to 10 ml ~100 ppm aqueous solution of $NaReO_4$ along with lower and higher excess (10 and 400 eqv. w.r.t. ReO_4^-) of different anions as mentioned above. The solution was stirred for 20 minutes and allowed to settle for 30 min. Finally the solution separated by 0.45µm nylon membrane filter. The concentration of Re in the filtrate was determined by ICP-OES measurement in both cases.

4.2. Anion extraction selectivity experiment:

4.2.1. Anion extraction selectivity experiment for Monomer [HIm-Br]:

The effect of interfering anion was studied by adding 10 equivalent different anion are Na_2SO_4(5.7mM)), $NaNO_3$(6.1 mM)), NaCl(5.4 mM), $TBAH_2PO_4$(5.8 mM), $NaClO_4$(5.7 mM),

$NaBF_4$(5.3 mM), TBAAcO(6.0 mM) in a solution of 10 ml 635 ppm $NaReO_4$ and Monomer [**Him-Br**] (0.76 mM). After being stirred at a rate of 200 rpm for 10 minutes, and the resultant solution was centrifuged for 10 min and settled for 30 min. Finally, the solution was separated with a 0.45µm nylon membrane filter. The filtrate was diluted with 10% nitric acid and was subjected to inductively coupled plasma optical emission spectrometry (ICP-OES).

4.2.2. Anion extraction selectivity experiment for Polymer [PHIm-Br]:

The effect of interfering anion was studied by adding 10 and 400 equivalent different anion are Na_2SO_4(5.7mM)), $NaNO_3$(6.1 mM)), NaCl(5.4 mM), $TBAH_2PO_4$(5.8 mM), $NaClO_4$(5.7 mM), $NaBF_4$(5.3 mM), TBAAcO(6.0 mM) in a 10 ml solution of 97.24 ppm $NaReO_4$ and 10 mg of polymer [P**Him-Br**] . After being stirred at a rate of 200 rpm for 20 minutes, and the resultant solution was centrifuged for 10 min and settled for 30 min. Finally, the solution was separated with a 0.45µm nylon membrane filter. The filtrate was diluted with 10% nitric acid and was subjected to inductively coupled plasma optical emission spectrometry (ICP-OES).

4.3. pH effect :

4.3.1. pH effect study for Monomer [HIm-Br]:

The effect of pH for extraction of ReO_4^- was carried out by ranging pH values from 1 to 14. 1 ml 4.6 Mm of **[HIm-Br]** was added to 10 ml of aqueous solution containing ~610 ppm ReO_4^-. After being stirred at a rate of 200 rpm for 10 minutes, and the resultant solution was centrifuged for 10 min and settled for 30 min. Finally, the solution was separated with a 0.45µm nylon membrane filter for ICP measurement

4.3.2. pH effect study for Monomer [HIm-Br]:

The effect of pH for extraction of ReO_4^- was carried out by ranging pH values from 1 to 14. 10 mg **[PHIm-Br]** was added to 10 ml of aqueous solution containing ~97 ppm ReO_4^-. After being stirred at a rate of 200 rpm for 5 minutes, and the resultant solution was centrifuged for 5 min and settled for 30 min. Finally, the solution was separated with a 0.45µm nylon membrane filter for ICP measurement

4.4 Recyclability study.

4.4.1. Recyclability for Monomer bounded complex:

This reversible anion exchange process was carried out by treating complex [**Him-Re**] (20 mg) with 10 ml 1 M TBABr solution in CH_3CN at 333K for 3 h by stirred at a rate of 200 rpm.

After cooling the solution the suspension was separated by whatman grade 1 filter paper followed by washing with distilled water for three times.

4.4.2. Recyclability for Polymer bounded complex:

This reversible anion exchange process was carried out by treating complex **[PHIm-Re]** (20 mg) with 10 ml 1.5 M TBABr solution in CH_3CN at 343K for 6 h by stirred at a rate of 200 rpm. After cooling the solution the suspension was separated by whatman grade 1 filter paper followed by washing with distilled water for three times.

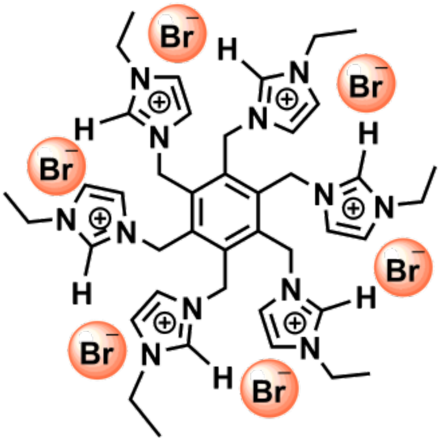


Fig.S1a: Previously reported N-ethyl substituted imidazolium based monomeric receptor **[L-Br].**

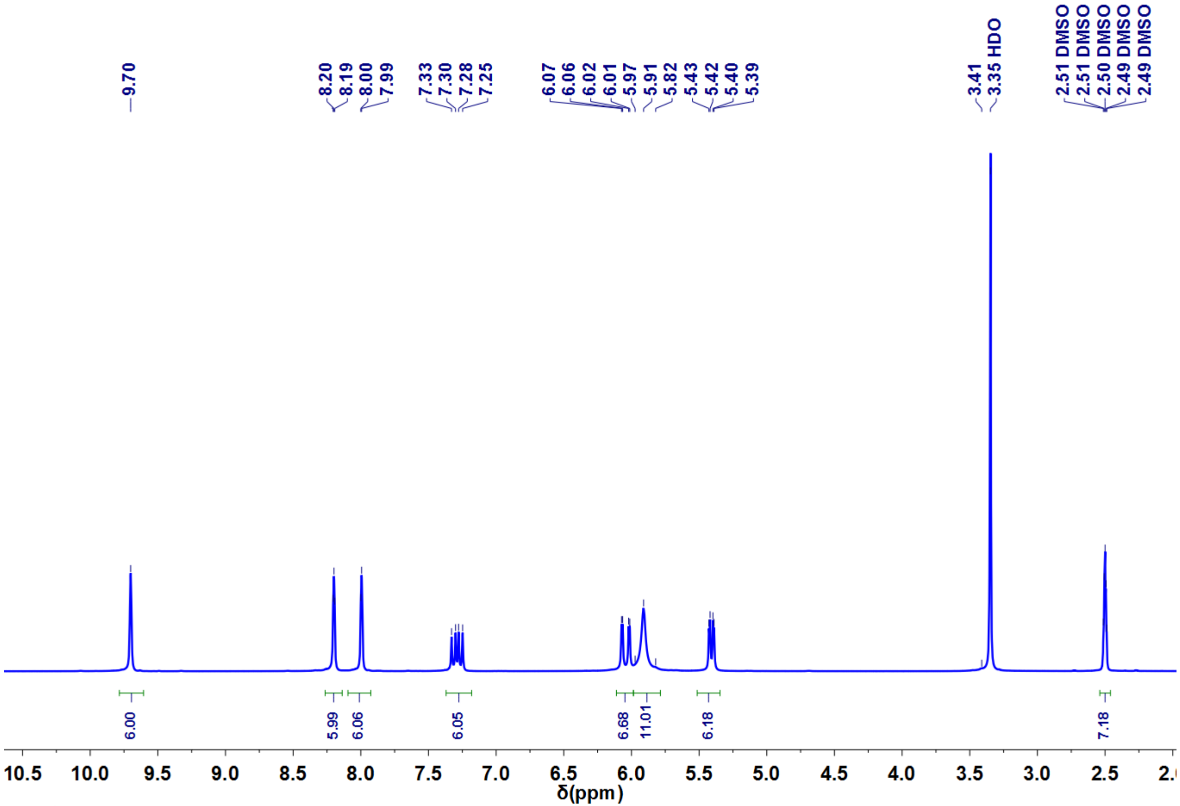


Fig. S1: ^{1}H-NMR spectrum of **[HIm-Br]** in DMSO-d_6 at 298 K in 300 MHz

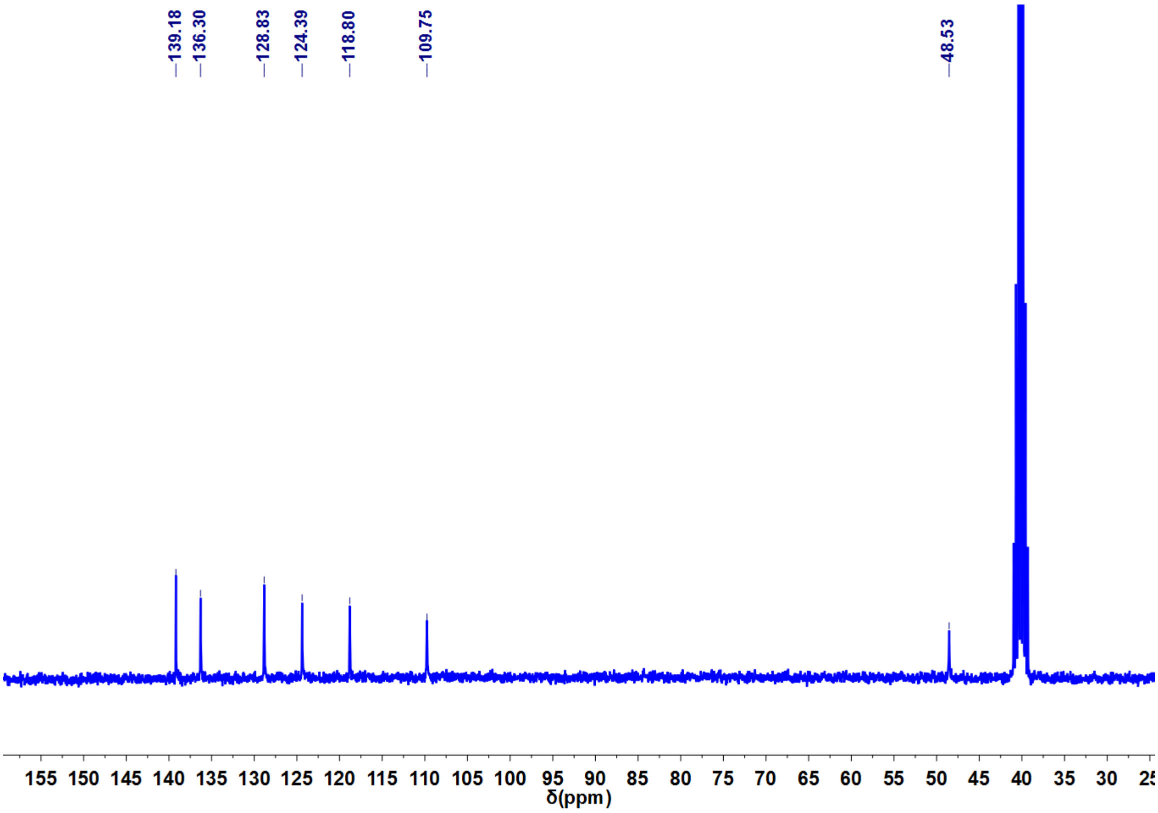


Fig. S2: ^{13}C-NMR spectrum of **[HIm-Br]** in DMSO-d_6 at 298 K in 100 MHz

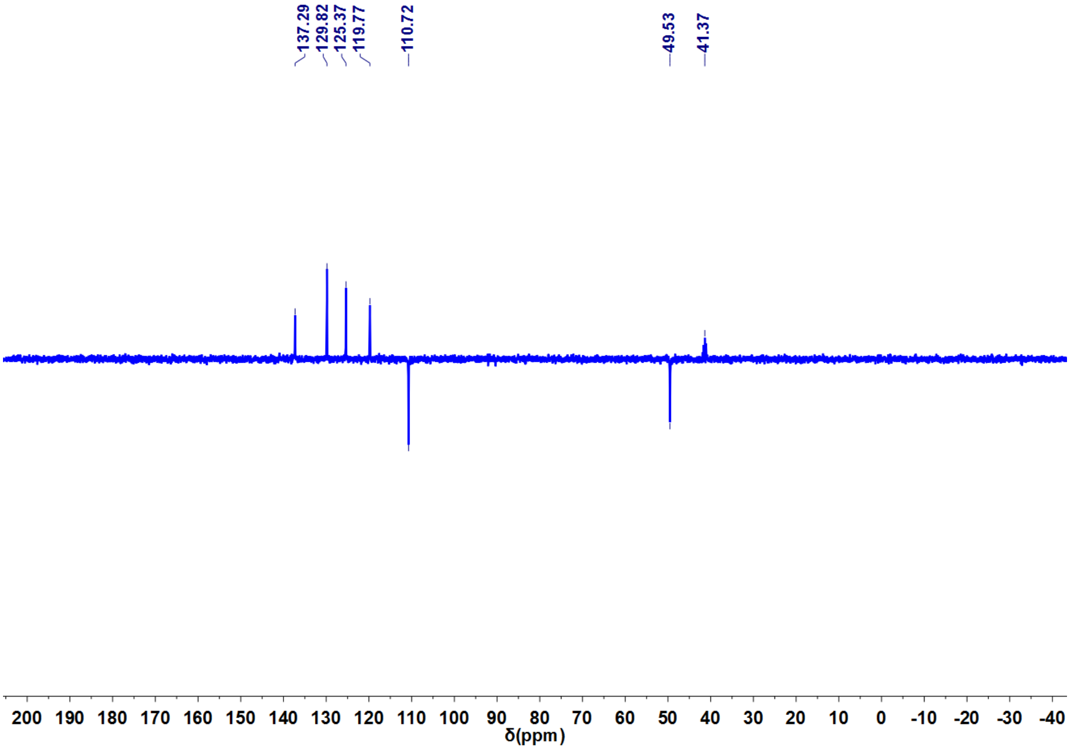


Fig. S3: ^{13}C-DEPT-135 spectrum of **[HIm-Br]** in DMSO-d_6 at 298K in 75 MHz

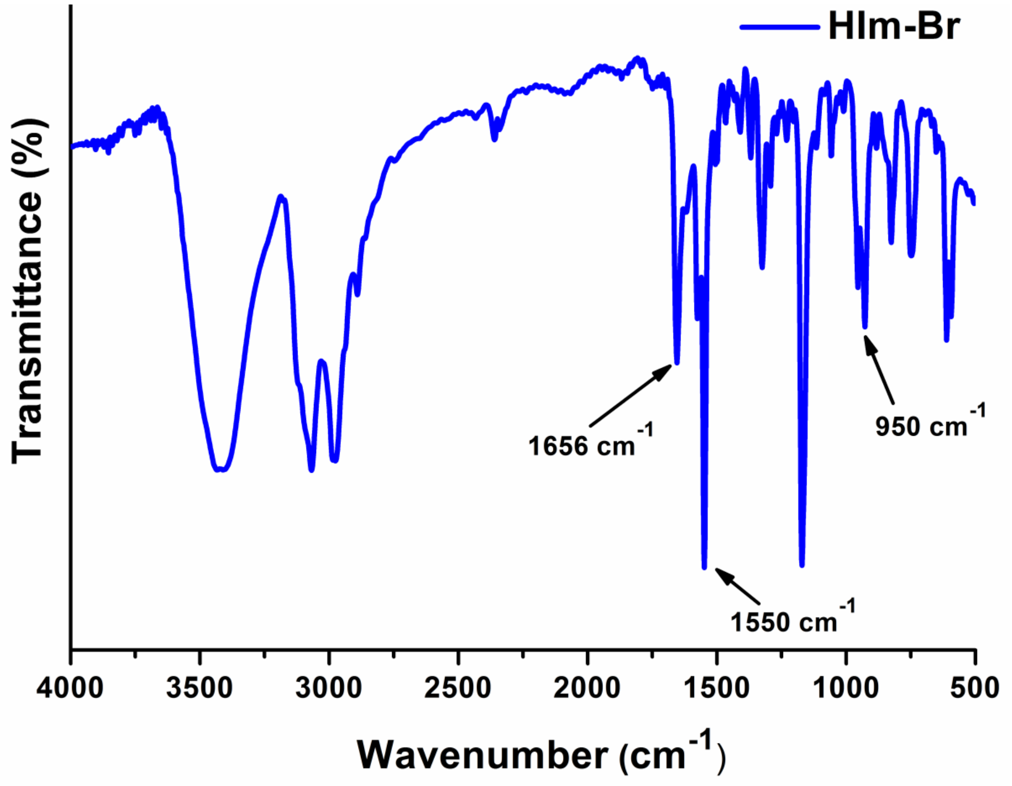


Fig. S4: FT-IR spectrum of **[HIm-Br]**

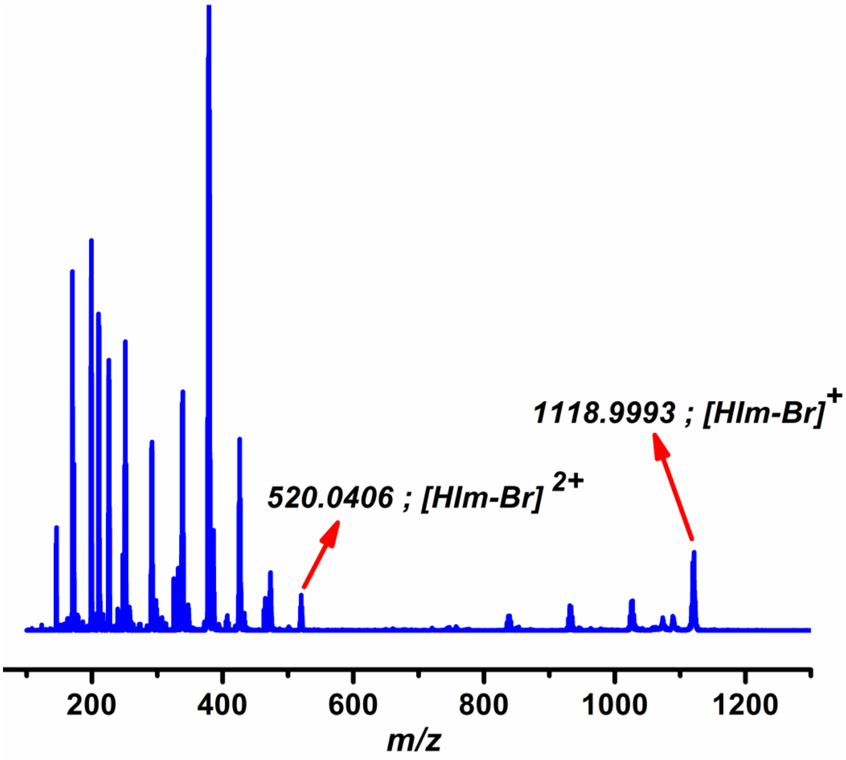


Fig. S5: ESI-MS (+ve) spectrum of **[HIm-Br]** at 298K.

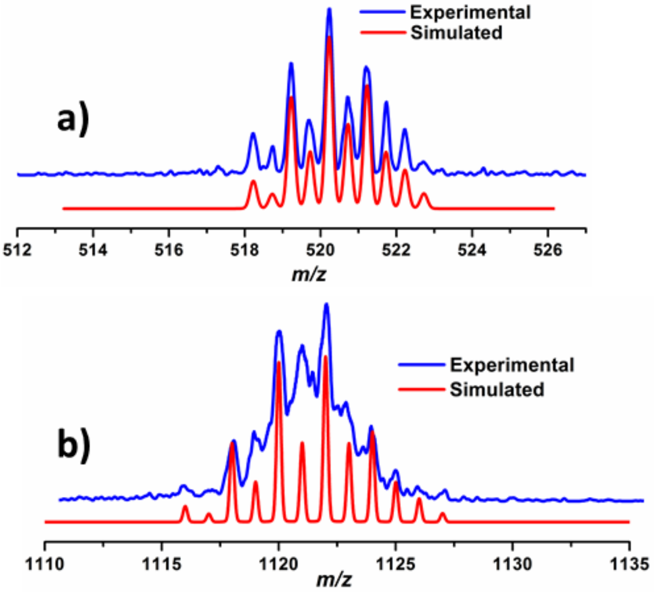


Fig. S6: Isotropic distribution of ESI-MS (+ve) spectrum of (a) **[HIm-Br]** $^{2+}$and (b) **[HIm-Br]** $^{+}$ at 298K.

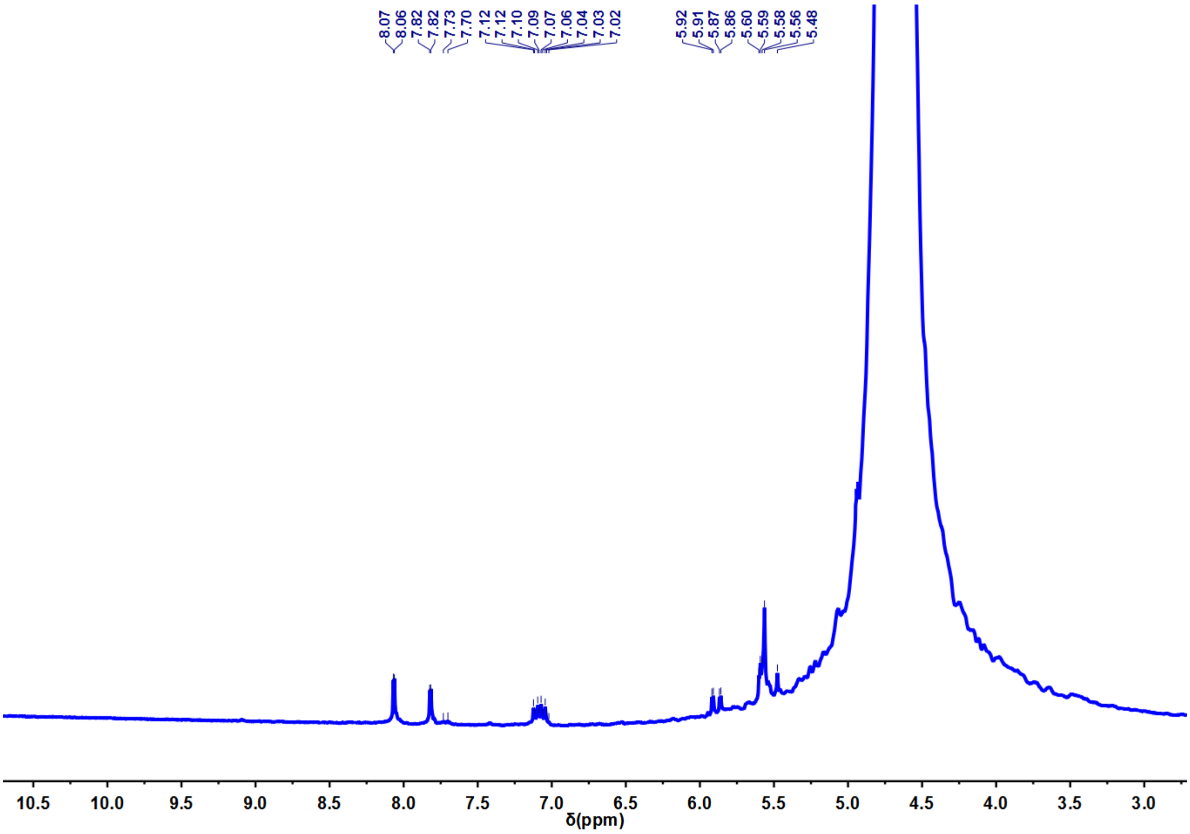


Fig. S7: ^{1}H-NMR spectrum of receptor **[HIm-Br]** in D_2O at 298 K in 300 MHz

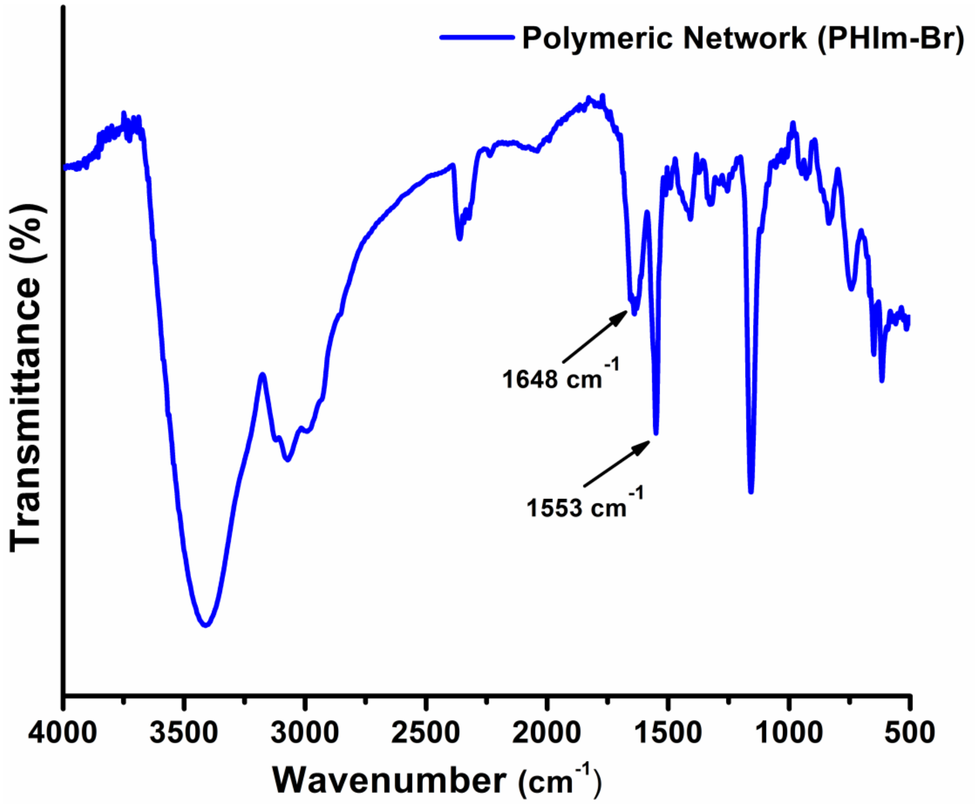


Fig. S8: FT-IR spectrum of polymeric network **[PHIm-Br]**

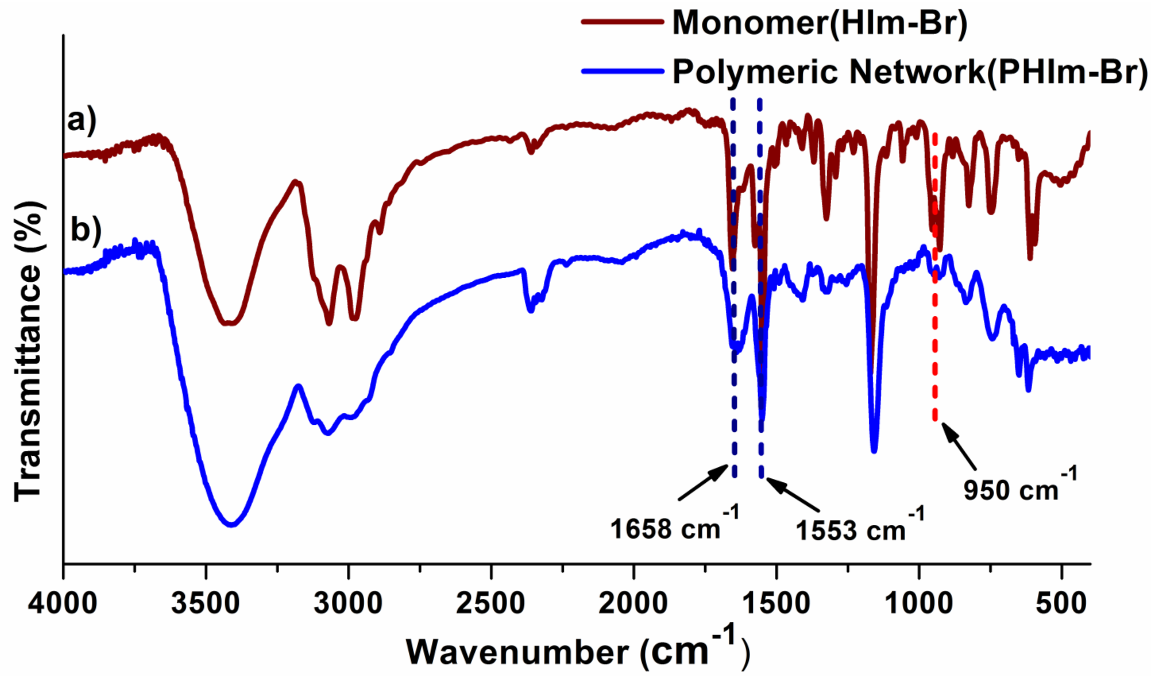


Fig. S9: FT-IR spectrum of (a) Monomer **[Him-Br]** (b) Polymeric network **[PHIm-Br]**

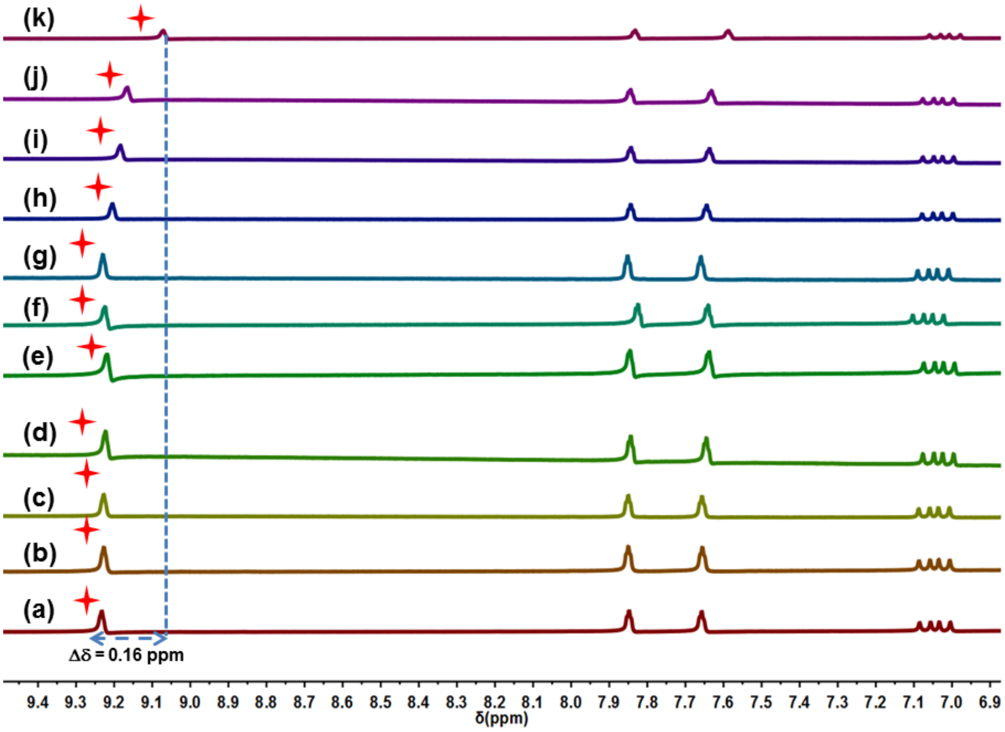


Fig. S10:Partial ^{1}H-NMR spectra of (a) Receptor **[HIm-Br]** (7.3 mM) and **[HIm-Br]** (7.3 mM) with 10 equivalents of (b) TBAF (c) TBACl (d) NaI (e) TBAH$_2$PO$_4$ (f) TBAAcO (g) Na$_2$SO$_4$ (h) TBABF$_4$ (i) NaNO$_3$ and (j) NaCLO$_4$ (k) NaReO$_4$ (5 equivalent) in H_2O at 298 K (Locking was performed using an capillary tube filled with D_2O)

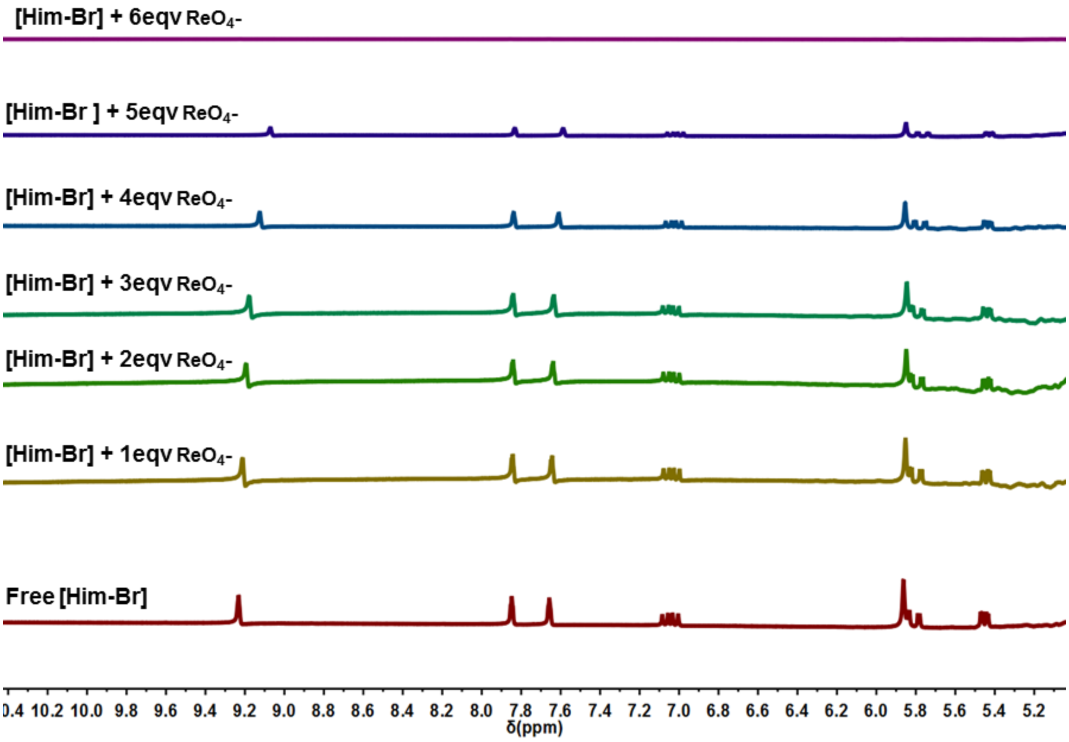


Fig. S11: ^{1}H-NMR spectrum of **[HIm-Br]** (14.4 mM) in H_2O with different equivalents of NaReO$_4$ in 300 MHz at 298 K. (Locking was performed using an capillary tube filled with (D_2O))

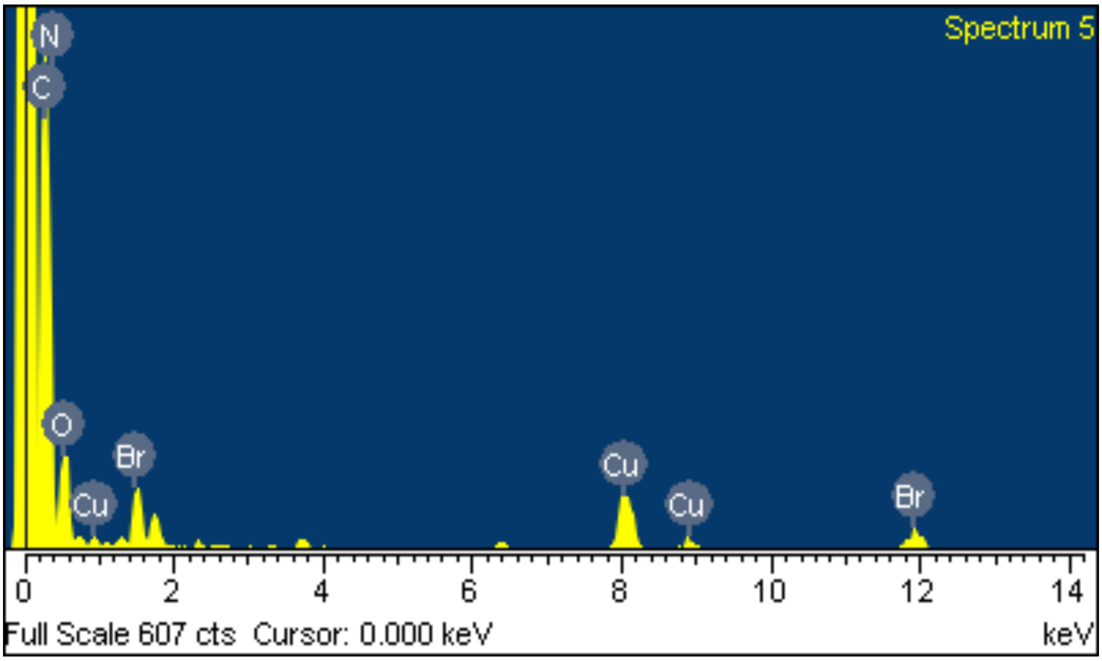
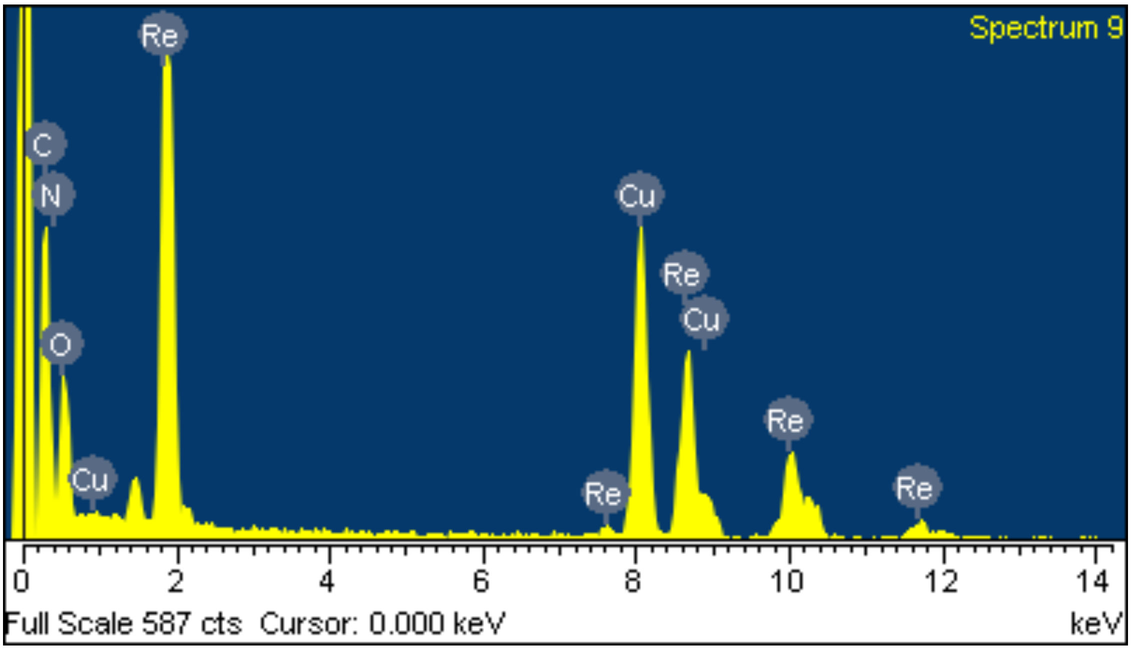


Fig. S12: TEM EDX data of free **[HIm-Br]**

Fig. S13: TEM EDX data of **[HIm-Re]** after extraction.



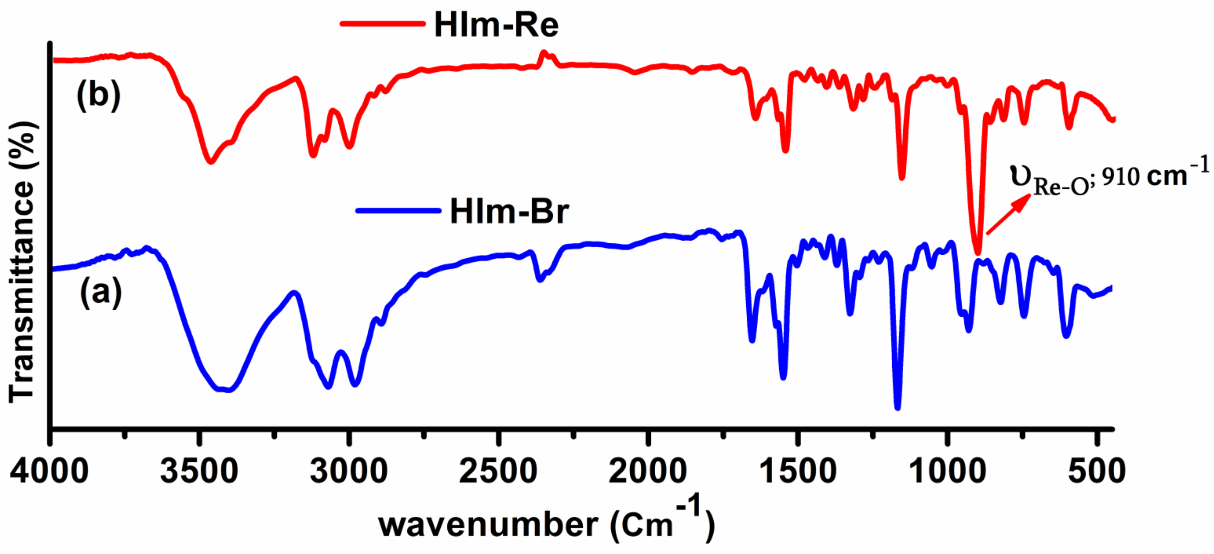


Fig. S14: FT-IR spectrum of (a) Free monomer **[Him-Br]** (b) After ReO_4^- extraction **[HIm-Re]**

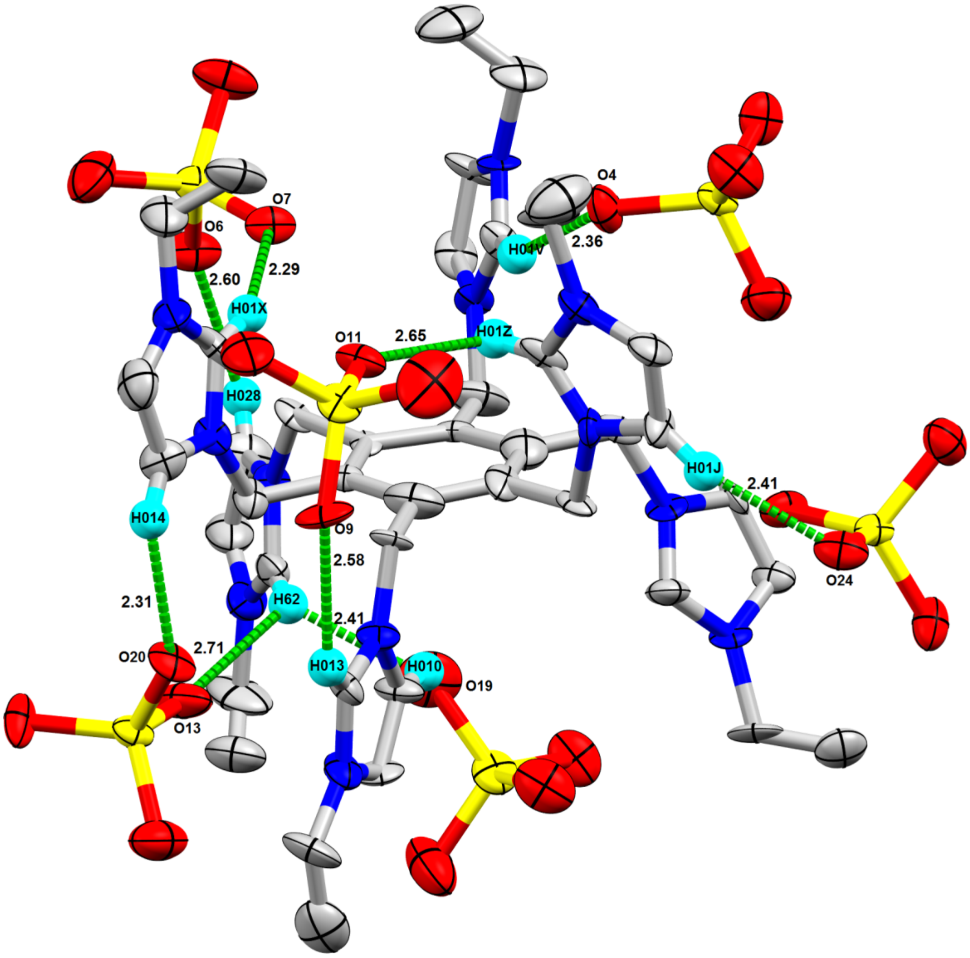


Fig. S15: Single crystal X-ray structure of **[HIm-Re]** with thermal ellipsoid drawn at the 50% probability level. Colour code; C: grey, H: cyan blue, N blue, O: red, Re: yellow. All interactive hydrogen atoms and distance (in A° unit) shown here. Solvent molecules are omitted for clarity

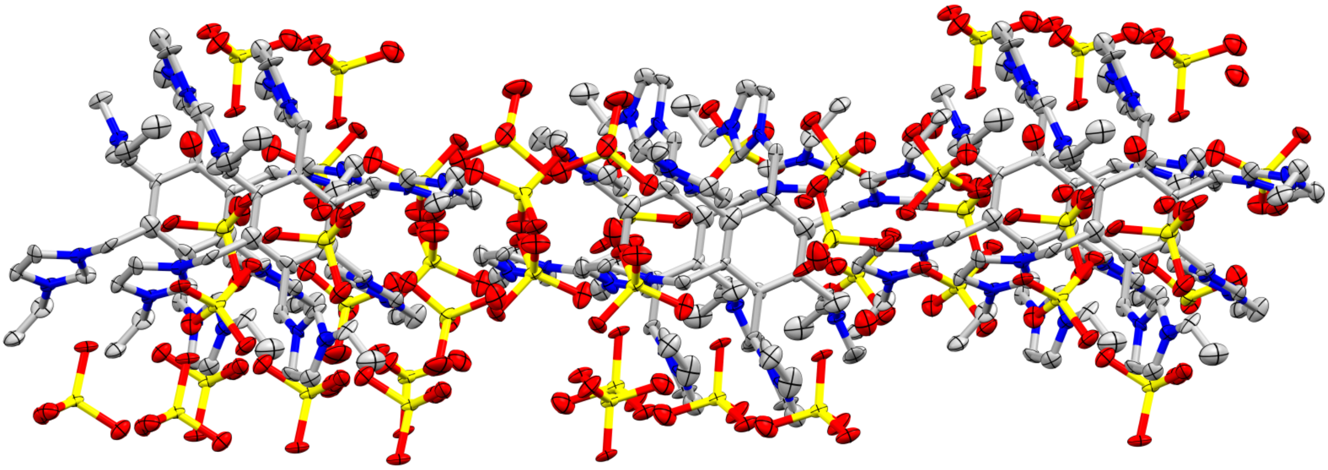


Fig. S16: Crystal packing diagram of Complex **[HIm-Re]** . Colour code; C: grey, N: blue, O: red, Re: yellow, hydrogen atoms, solvent molecules are omitted for clarity**.**

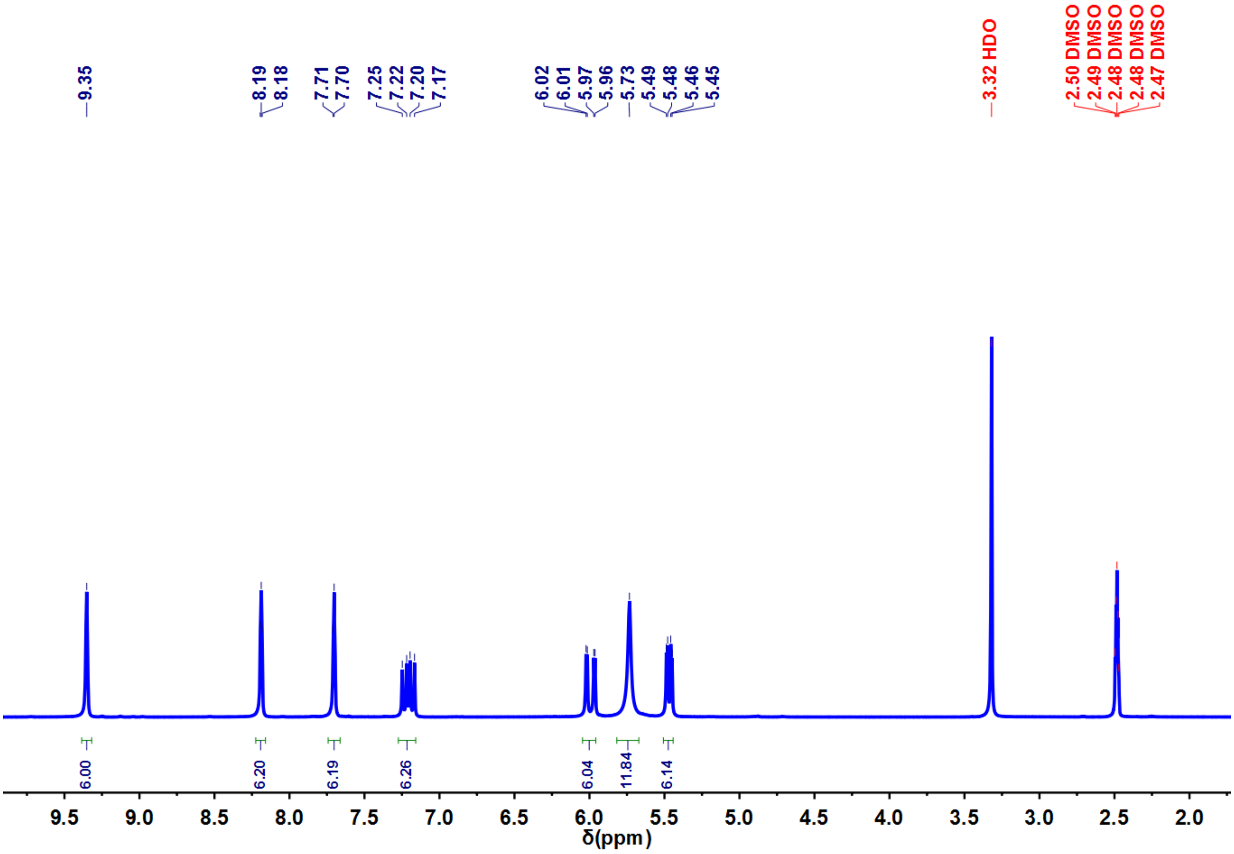


Fig. S17: ^{1}H-NMR spectrum of Complex **[HIm-Re]** in DMSO-d_6 at 298 K in 300 MHz

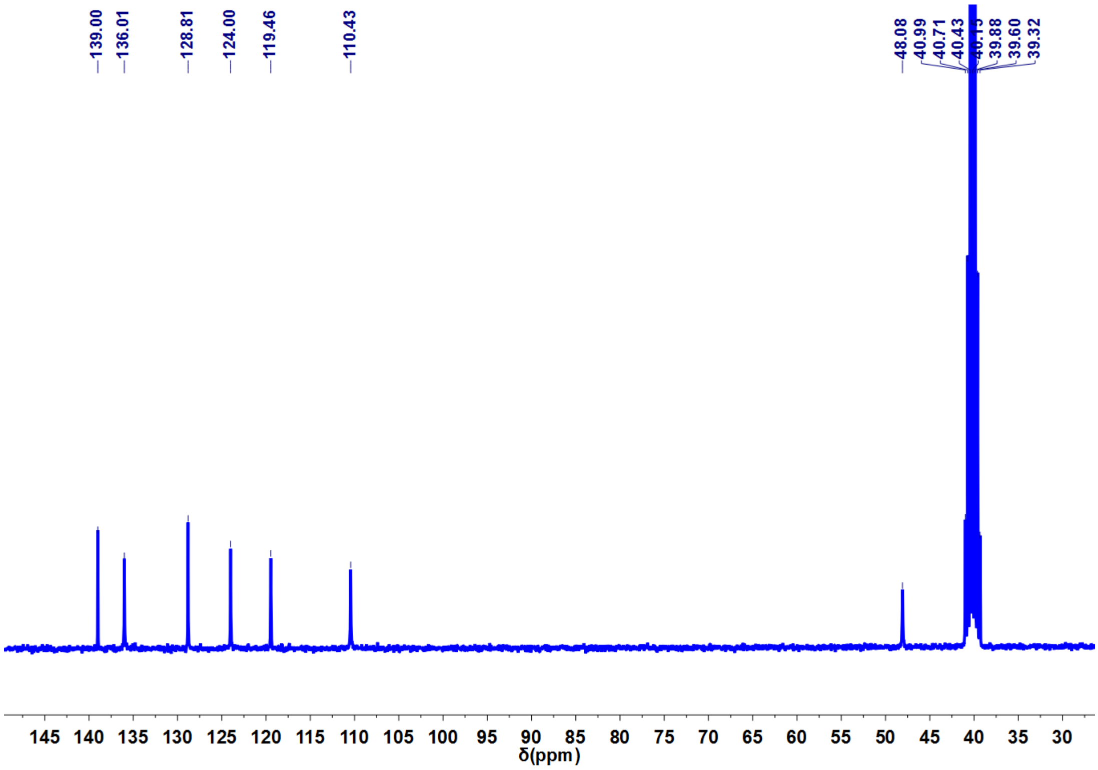


Fig. S18: ^{13}C-NMR spectrum of Complex **[HIm-Re]** in DMSO-d_6 at 298 K in 100 MHz

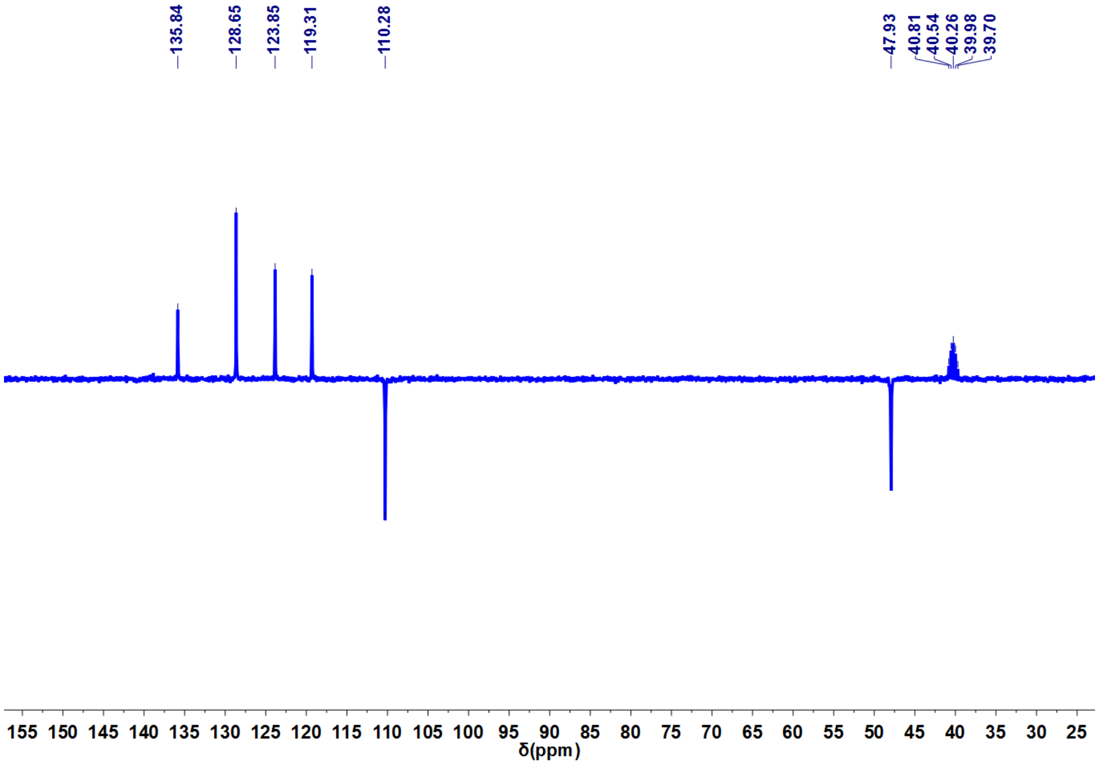


Fig. S19: ^{13}C-DEPT-135 spectrum of Complex **[HIm-Re]** in DMSO-d_6 at 298K in 75 MHz

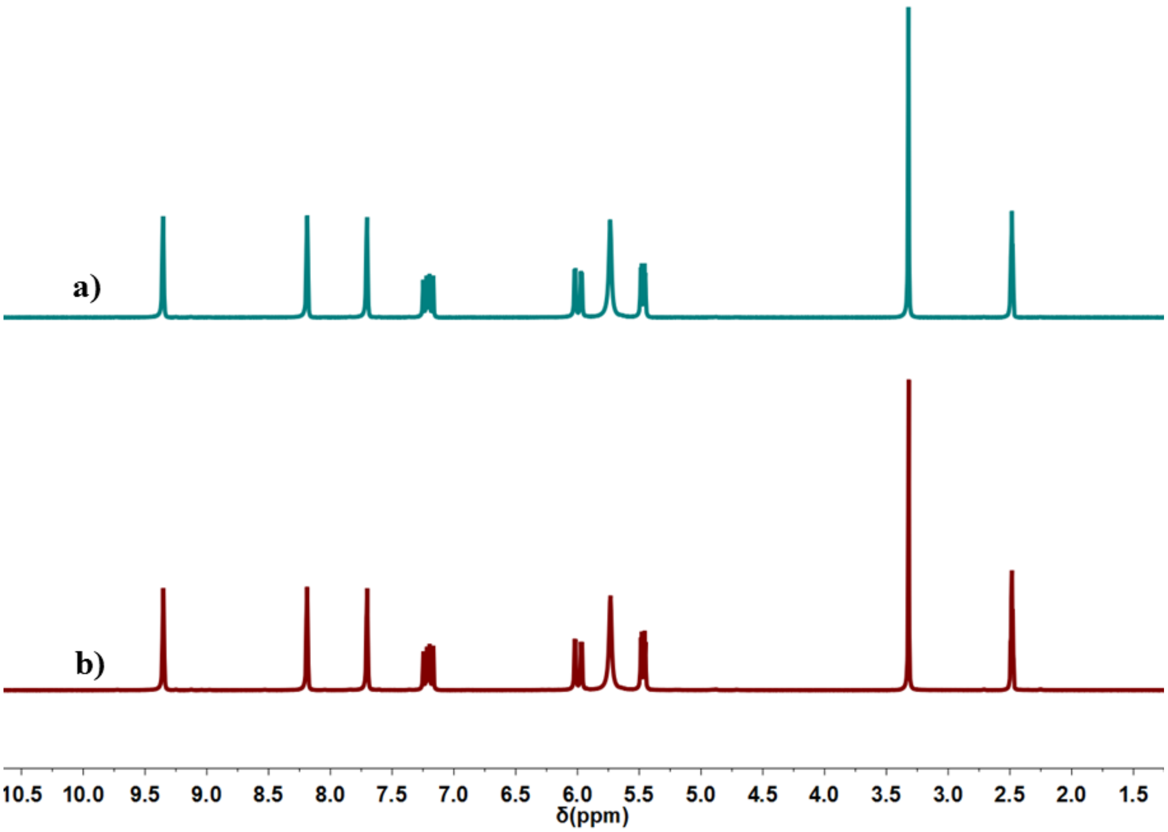


Fig. S20: Stack plot of ^{1}H-NMR spectra of (a) Extracted mass of Complex **[HIm-Re]** in DMSO-d_6 and (b) Pure crystal of Complex **[HIm-Re]** in DMSO-d_6 at 298K in 300 MHz

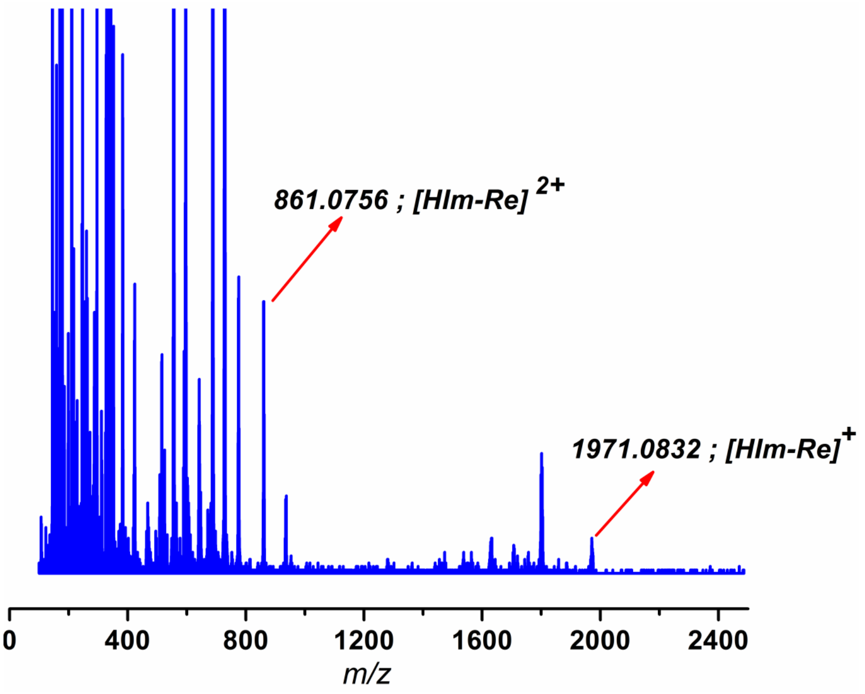


Fig. S21: ESI-MS(+ve) spectrum of Complex **[HIm-Re]** at 298K

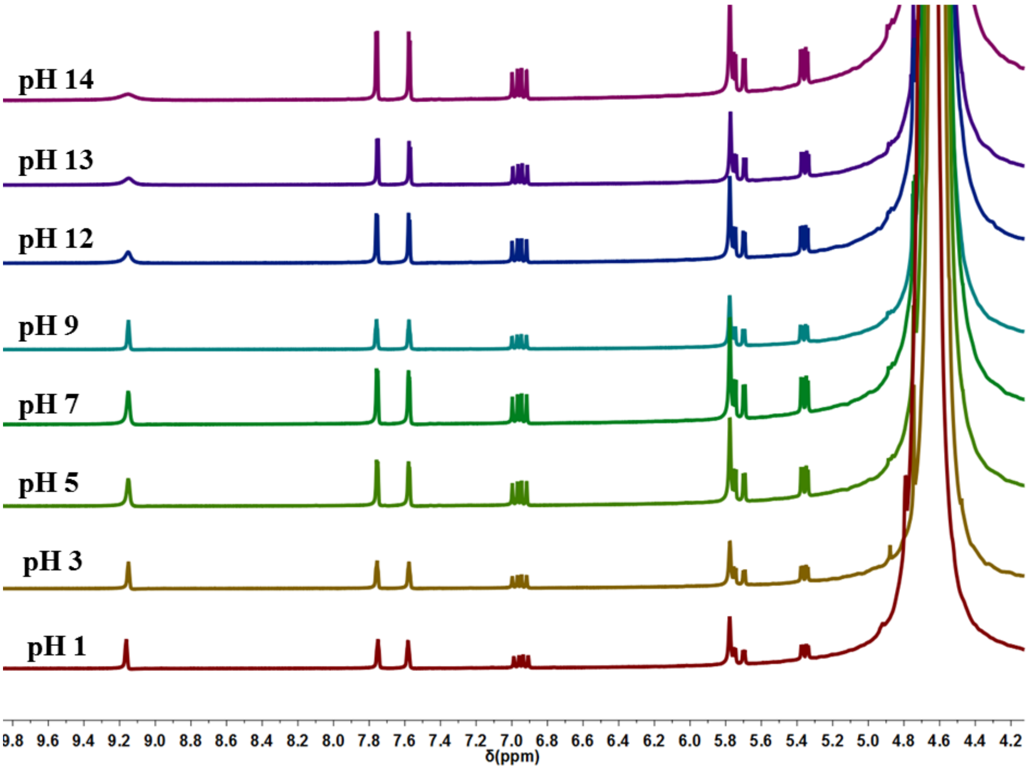


Fig. S22: ^{1}H-NMR spectrum of **[Him-Br]** (15 mM) in *H_2O* at different pH range in 300 MHz. (Locking was performed using a capillary tube filled with *D_2O*)

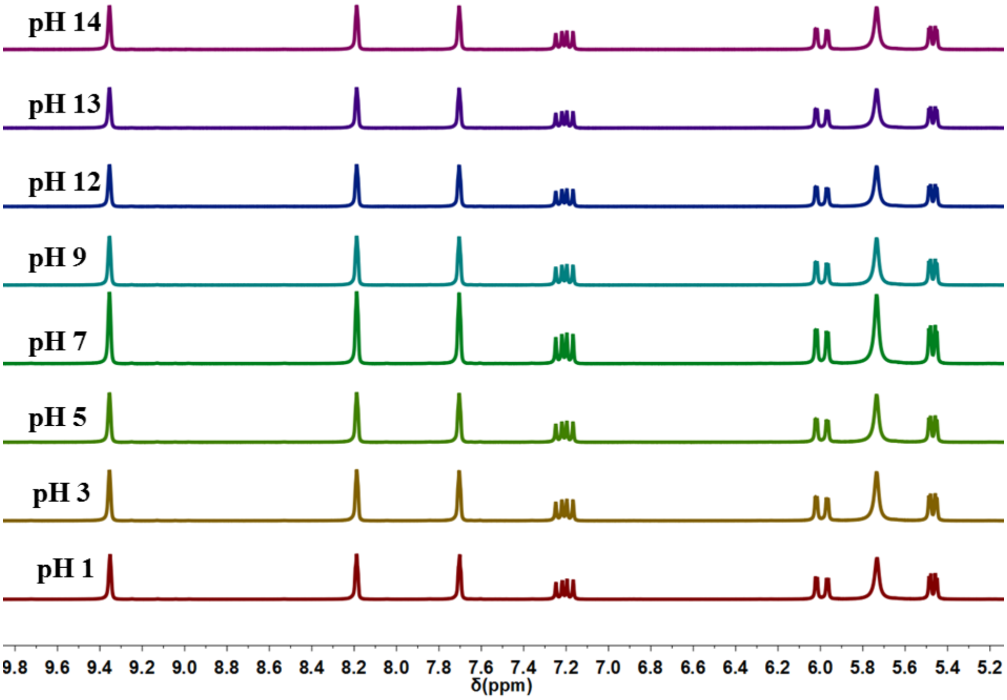


Fig. S23: ^{1}H-NMR spectrum of **[Him-Re]** in *DMSO-d_6* at 298 Kin 300 MHz, after being immersed the Complex **[Him-Re]** in different pH water solution for 12 hours.

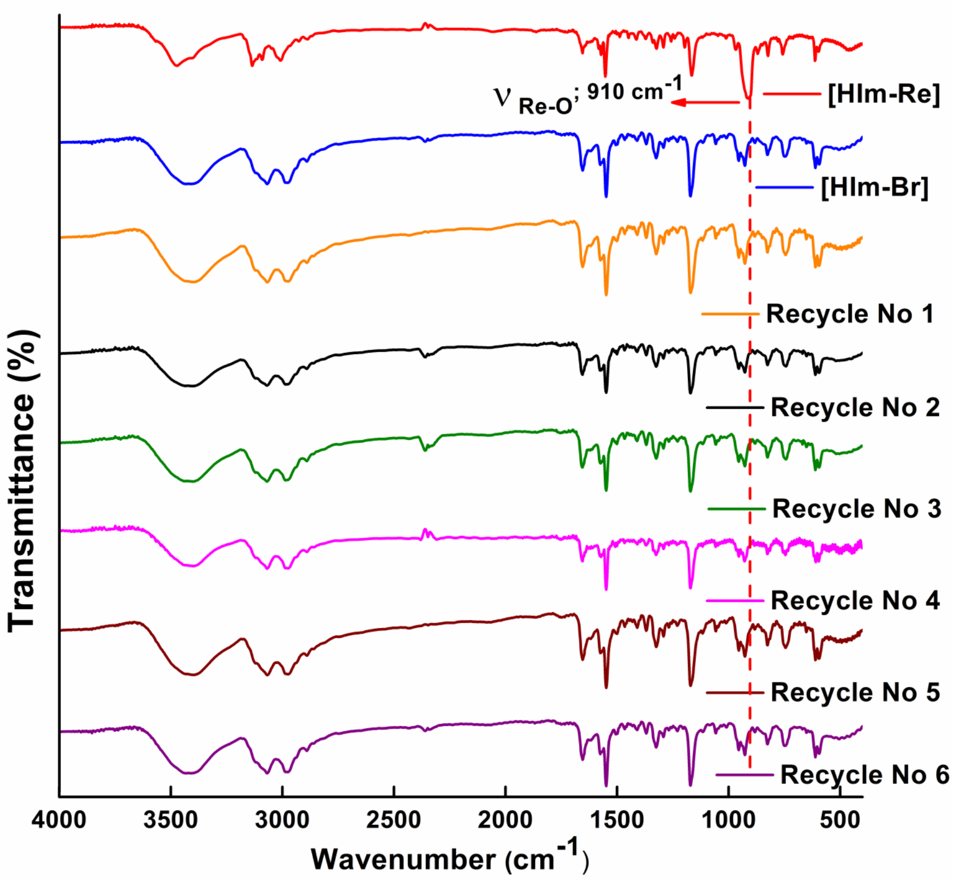


Fig. S24: IR Spectra of recycled monomeric receptor **[HIm-Br]**

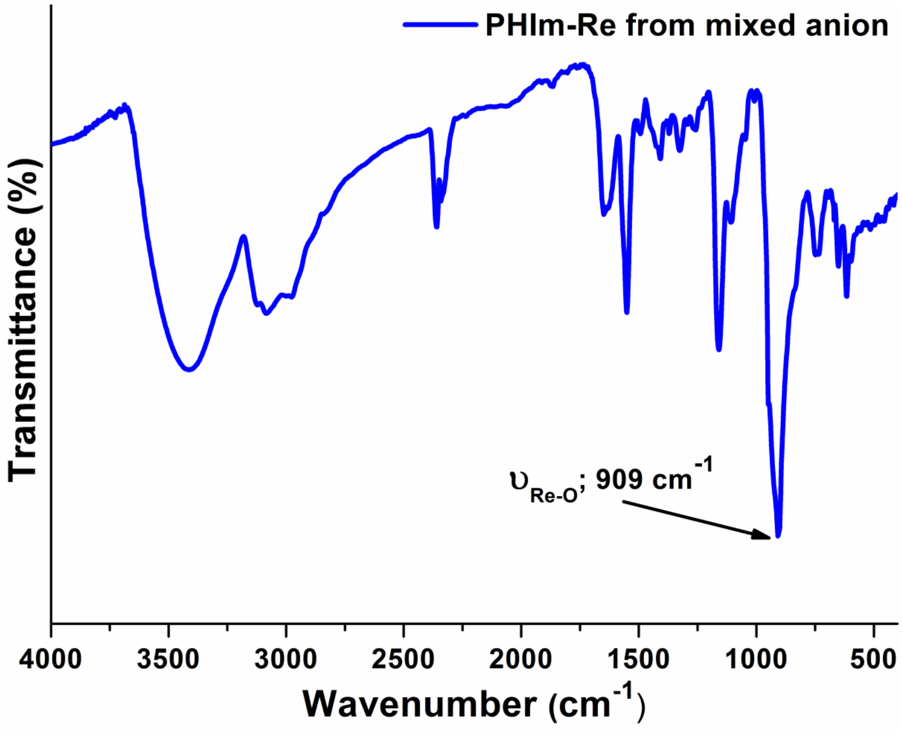


Fig. S25: FT-IR spectrum of **[PHIm-Re]** from mixed anion (such as Cl-, SO_4^{2-}, $H_2PO_4^-$, AcO^-, NO_3^-,BF_4^-, ClO_4^-)

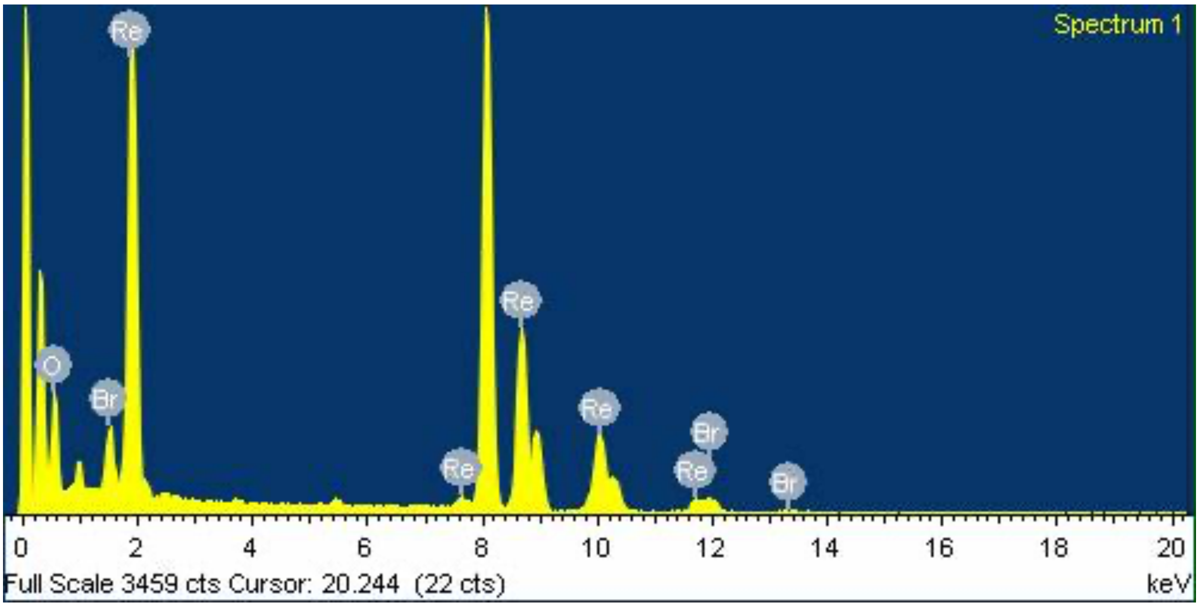


Fig. S26: TEM EDX data of **[PHIm-Re]** from mixed anion (such as Cl-, SO_4^{2-}, $H_2PO_4^-$, AcO, NO_3^-,BF_4^-, ClO_4^-)

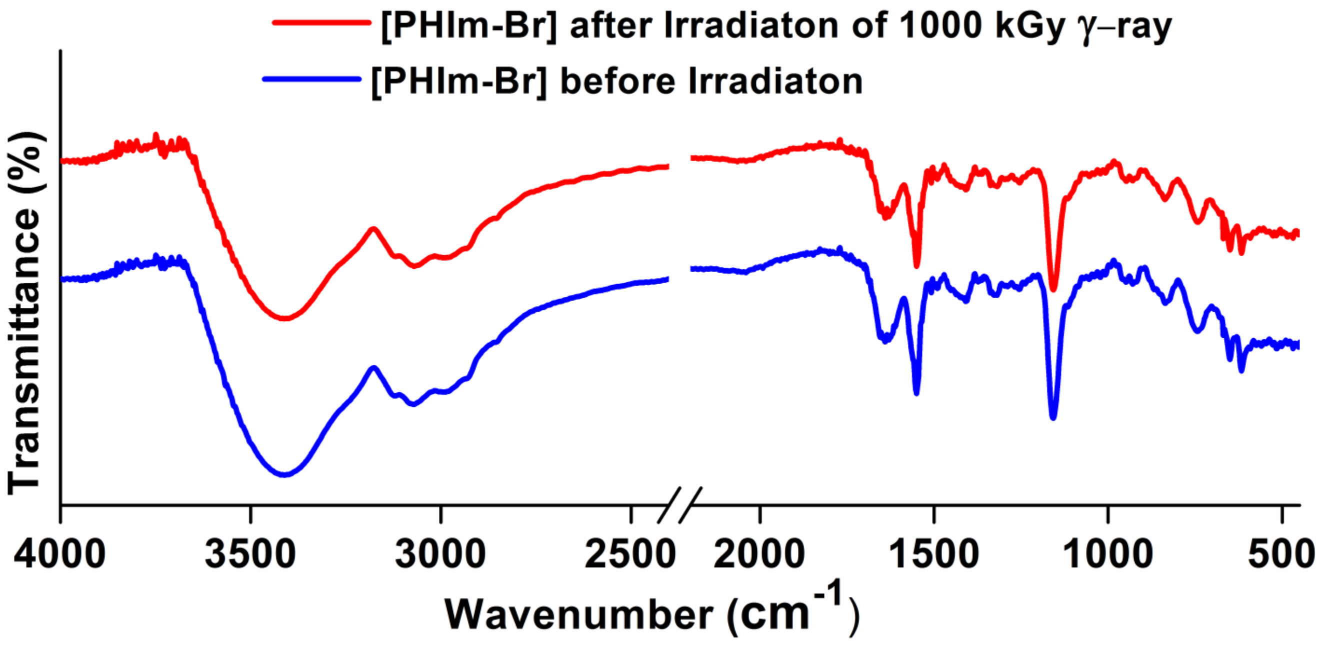


Fig. S27: FT-IR spectrum of **[PHim-Br]** before and after irradiation of 1000 kGy γ-ray

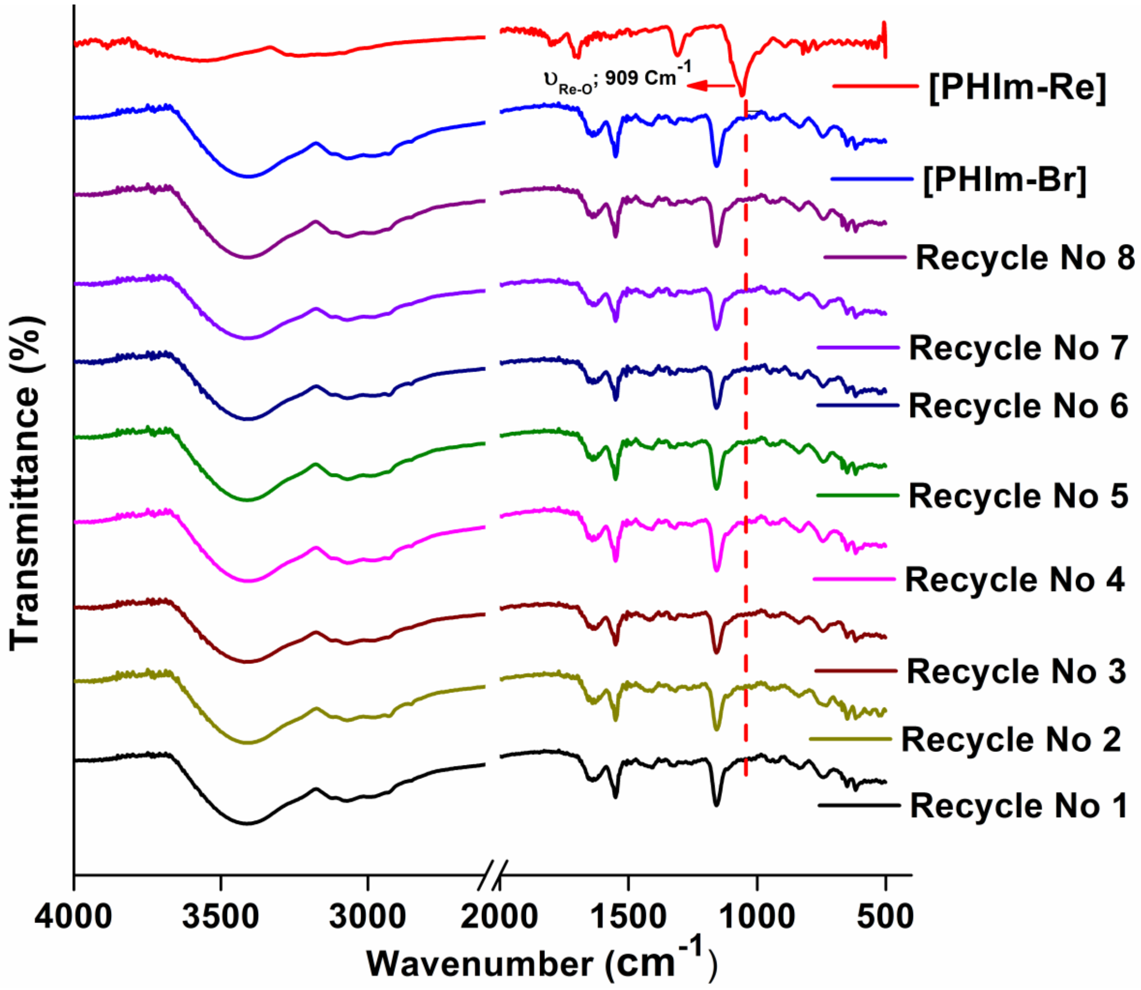


Fig. S28: IR Spectra of recycled receptor **[PHIm-Br]**

Table S1: Crystallographic details of [**Him-Re**] obtained from water-ACN solvent mixture.

Compound reference	Complex **[Him-Re]**
Chemical formula	$C_{42}H_{48}N_{12}O_{27}Re_6$
Formula Mass	2276.17
Crystal system	triclinic
a/Å	12.5252(19)
b/Å	13.3924(19)
c/Å	19.020(3)
α/°	90.778(5)
β/°	95.203(5)
γ/°	06.280(5)
Unit cell volume/Å^3	3047.3(8)
Temperature/K	104(2)
Space group	$P\bar{1}$
No. of formula units per unit cell, Z	2
Radiation type	MoKα
No. of reflections measured	33267
No. of independent reflections	12832
R_{int}	0.0733
Final R_1 values ($I > 2\sigma(I)$)	0.0714
Final $wR(F^2)$ values ($I > 2\sigma(I)$)	0.1746
Final R_1 values (all data)	0.0986
Final $wR(F^2)$ values (all data)	0.1941
Goodness of fit on F^2	1.036
CCDC number	2027400

Table S2: ReO_4^- removal efficiency of **[Him-Br]** in presence of different concentration of **ReO_4^-**

Solution	Initial concentration of Re (ppm)	Final concentration of Re (ppm)	Removal Efficiency (%)	Errors in % of Removal Efficiency
ReO_4^-	415.6	109.2	73.7	1.6
ReO_4^-	510.5	84.6	83.4	1.5
ReO_4^-	650.4	89.5	86.2	2.1
ReO_4^-	785.5	107.8	86.3	1.3

Table S3: ReO_4^- removal efficiency of **[Him-Br]** in presence of 10 equivalent amount of different anion.

Solution	Initial concentration of Re (ppm)	Final concentration of Re (ppm)	Removal Efficiency (%)	Errors in % of Removal Efficiency
ReO_4^-	630.6	85.3	86.4	2.3
ReO_4^- + Cl^-	630.6	105.6	83.2	1.7
ReO_4^- + SO_4^{2-}	630.6	110.9	82.4	2.0
ReO_4^- + $H_2PO_4^-$	630.6	118.8	81.2	1.8
ReO_4^- + AcO^-	630.6	104.2	83.5	1.6
ReO_4^- + NO_3^-	630.6	119.1	81.1	1.7
ReO_4^- + BF_4-	630.6	116.7	81.5	2.1
ReO_4^- + ClO_4^-	630.6	124.9	80.2	1.8
ReO_4^- + Cl^- + SO_4^{2-} + $H_2PO_4^-$ + AcO^- +NO_3^- + BF_4^-+ ClO_4^-	630.6	169.4	73.1	2.2

Table S4: ReO_4^- removal efficiency of **[Him-Br]**in different pH value of solution

pH	Initial concentration of Re (ppm)	Final concentration of Re (ppm)	Removal Efficiency (%)	Errors in % of Removal Efficiency
1	630.8	96.2	84.7	1.9
3	630.8	91.3	85.5	2.1
5	630.8	89.7	85.8	1.6
7	630.8	87.5	86.1	1.7
9	630.8	88.9	86.0	2.3
12	630.8	95.8	84.8	1.5
14	630.8	114.9	81.8	1.8

Table S5: ReO_4^- removal efficiency of recycled **[Him-Br]**

Cycle No	Initial concentration of Re (ppm)	Final concentration of Re (ppm)	Removal Efficiency (%)	Errors in % of Removal Efficiency
1	631.1	101.7	83.9	2.5
2	631.1	105.8	83.2	1.4
3	631.1	107.3	83.0	1.8
4	631.1	114.5	81.9	1.3
5	631.1	122.6	80.6	2.1
6	631.1	136.5	78.4	1.9

Table S6: ReO_4^- removal efficiency of **[PHIm-Br]** in different retention time interval.

Sample stirring time	Initial concentration of Re (ppm)	Final concentration of Re (ppm)	Removal Efficiency (%)	Errors in % of Removal Efficiency
5 min	95.3	7.13	92.5	1.8
10 min		3.14	96.7	2.1
15 min		1.71	98.2	1.7
20 min		0.98	99.0	2.0
25 min		0.98	99.0	2.1
30 min		0.98	99.0	1.7
60 min		0.98	99.0	1.9

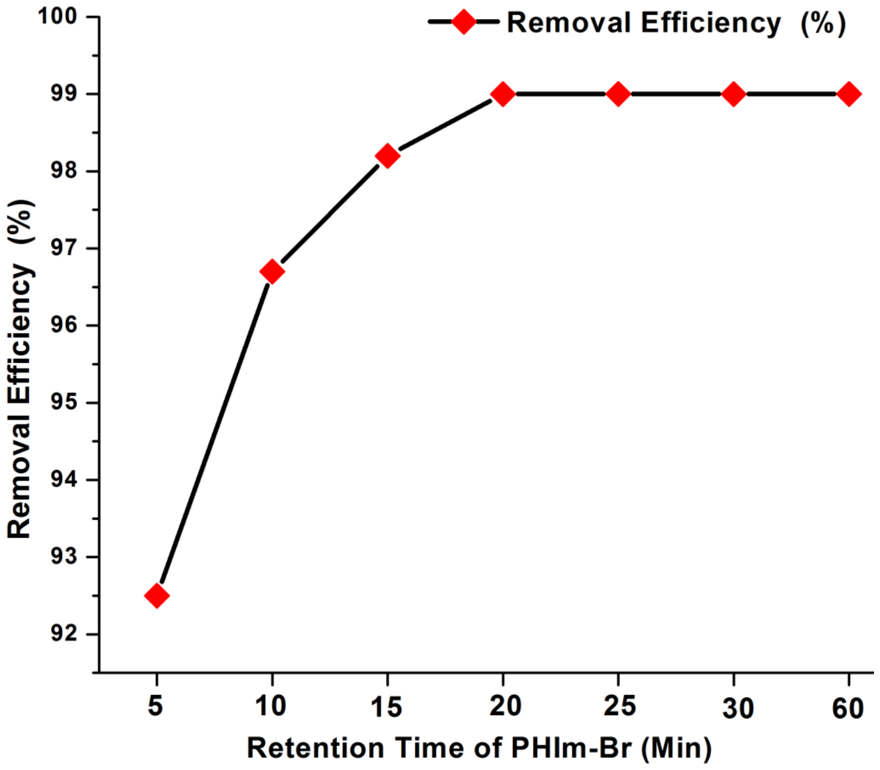


Fig. S29: Plot of removal efficiency of **[PHim-Br]** with retention time.

Table S7: ReO_4^- removal efficiency of **[PHIm-Br]** in presence of 10 equivalent amount of different anion.

Solution	Initial concentration of Re (ppm)	Final concentration of Re (ppm)	Removal Efficiency (%)	Errors in % of Removal Efficiency
ReO_4^-	95.5	0.99	99.0	2.4
ReO_4^- + Cl^-	95.5	1.65	98.3	2.1
ReO_4^- + SO_4^{2-}	95.5	1.70	98.2	2.0
ReO_4^- + $H_2PO_4^-$	95.5	1.27	98.6	1.8
ReO_4^- + AcO^-	95.5	1.25	98.7	1.5
ReO_4^- + NO_3^-	95.5	2.46	97.4	2.1
ReO_4^- + BF_4^-	95.5	2.39	97.5	1.6
ReO_4^- + ClO_4^-	95.5	2.84	97.0	2.1
ReO_4^- + Cl^- + SO_4^{2-} + $H_2PO_4^-$ + AcO^- +NO_3^- + BF_4^-+ ClO_4^-	95.5	5.12	94.6	2.0

Table S8: ReO_4^- removal efficiency of **[PHIm-Br]** in presence of 400 equivalent amount of different anion.

Solution	Initial concentration of Re (ppm)	Final concentration of Re (ppm)	Removal Efficiency (%)	Errors in % of Removal Efficiency
ReO_4^-	95.5	0.99	99.0	2.1
$ReO_4^- + Cl^-$	95.5	2.15	97.7	2.0
$ReO_4^- + SO_4^{2-}$	95.5	2.63	97.2	1.8
$ReO_4^- + H_2PO_4^-$	95.5	2.10	97.8	2.3
$ReO_4^- + AcO^-$	95.5	2.20	97.6	2.1
$ReO_4^- + NO_3^-$	95.5	3.95	95.8	1.7
$ReO_4^- + BF_4^-$	95.5	3.15	96.7	2.3
$ReO_4^- + ClO_4^-$	95.5	4.20	95.6	2.2
$ReO_4^- + Cl^- + SO_4^{2-} + H_2PO_4^- + AcO^- + NO_3^- + BF_4^- + ClO_4^-$	95.5	7.90	91.7	1.9

Table S9: ReO_4^- removal efficiency of **[PHIm-Br]** before and after irradiation of 1000 kGy γ-ray

Polymer [PHIm-Br]	Initial concentration of Re (ppm)	Final concentration of Re (ppm)	Removal Efficiency (%)	Errors in % of Removal Efficiency
Before irradiation	98.7	0.95	99.0	2.2
	210.5	2.16	99.0	2.3
	420.6	3.95	99.1	1.8
	630.5	5.80	99.1	2.0
	805.4	6.00	99.3	1.9
After irradiation of 1000 kGy γ-ray	98.7	3.80	96.1	2.3
	210.5	7.95	96.2	2.1
	420.6	16.10	96.1	1.9
	630.5	24.35	96.1	2.1
	805.4	30.36	96.2	2.0

Table S10: ReO_4^- removal efficiency of **[PHIm-Br]** in different pH value of solution

pH	Initial concentration of Re (ppm)	Final concentration of Re (ppm)	Removal Efficiency (%)	Errors in % of Removal Efficiency
1	95.8	1.60	98.3	1.7
3	95.8	0.97	98.9	1.6
5	95.8	0.91	99.1	2.1
7	95.8	0.86	99.1	2.2
9	95.8	0.96	99.0	1.8
12	95.8	1.98	97.9	2.0
14	95.8	4.10	95.7	2.1

Table S11: ReO_4^- removal efficiency of recycled **[PHIm-Br].**

Cycle No	Initial concentration of Re (ppm)	Final concentration of Re (ppm)	Removal Efficiency (%)	Errors in % of Removal Efficiency
1	95.9	0.97	98.9	1.6
2	95.9	1.20	98.7	1.8
3	95.9	1.33	98.6	2.1
4	95.9	1.80	98.1	2.5
5	95.9	1.96	97.9	2.1
6	95.9	2.90	97.1	1.7
7	95.9	3.55	96.3	1.5
8	95.9	4.25	95.5	2.3
9	95.9	6.30	93.4	1.6
10	95.9	9.65	90.0	2.2

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