

Supporting Information

Physicochemical properties of air and water stable rhenium ionic liquids

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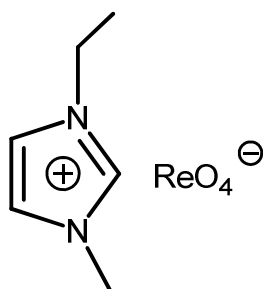
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General Remarks:

¹H, ¹³C NMR and ¹⁷O NMR are measured in DMSO with a mercury-VX 300 spectrometer and a 400-MHz Bruker Avance DPX-400 spectrometer. IR spectra are recorded on a JASCO FT/IR-4100 spectrometer. ESI-MS spectra are measured on a Finnigan LCQ Classic mass spectrometer. Raman spectrum are measured on a Microscopic Confocal Raman Spectrometer (RM2000) produced by Renishaw.

[C₂mim][ReO₄]:



C₆H₁₁N₂O₄Re (361.37), elemental analysis calcd.: C, 19.94, H, 3.07, N, 7.75; found: C, 19.85, H, 2.98, N, 7.71; IR (cm⁻¹): ν = 893 (Re=O), 863 (Re=O); ¹H-NMR (DMSO, 400Hz, r.t., ppm): δ = 9.08 (1H, s, mz-H²), 7.75 (1H, d, mz-H⁴), 7.66 (1H, d, mz-H⁵), 4.21 - 4.16 (2H, q, -CH₂-), 3.85 (3H, s, N-CH₃), 1.42 (3H, t, -CH₃); ¹³C-NMR (DMSO, 100Hz, r.t., ppm): δ = 136.84 (mz-C²), 124.52 (mz-C⁴), 122.52 (mz-C⁵), 44.76 (-CH₂-), 36.34 (N-CH₃), 15.61 (-CH₃). ESI-MS (methanol, m/z, %): cation, 111.0 (C₆H₁₁N₂⁺, 100%).

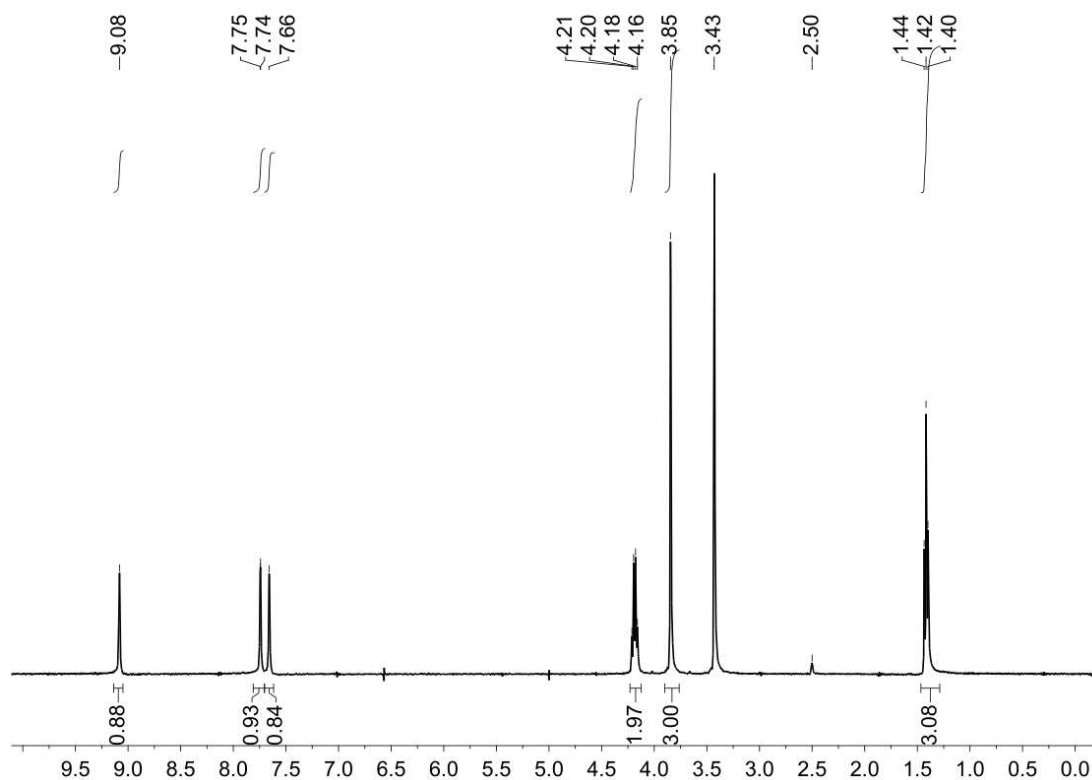


Figure S1-1 ¹H NMR spectra of [C₂mim][ReO₄]

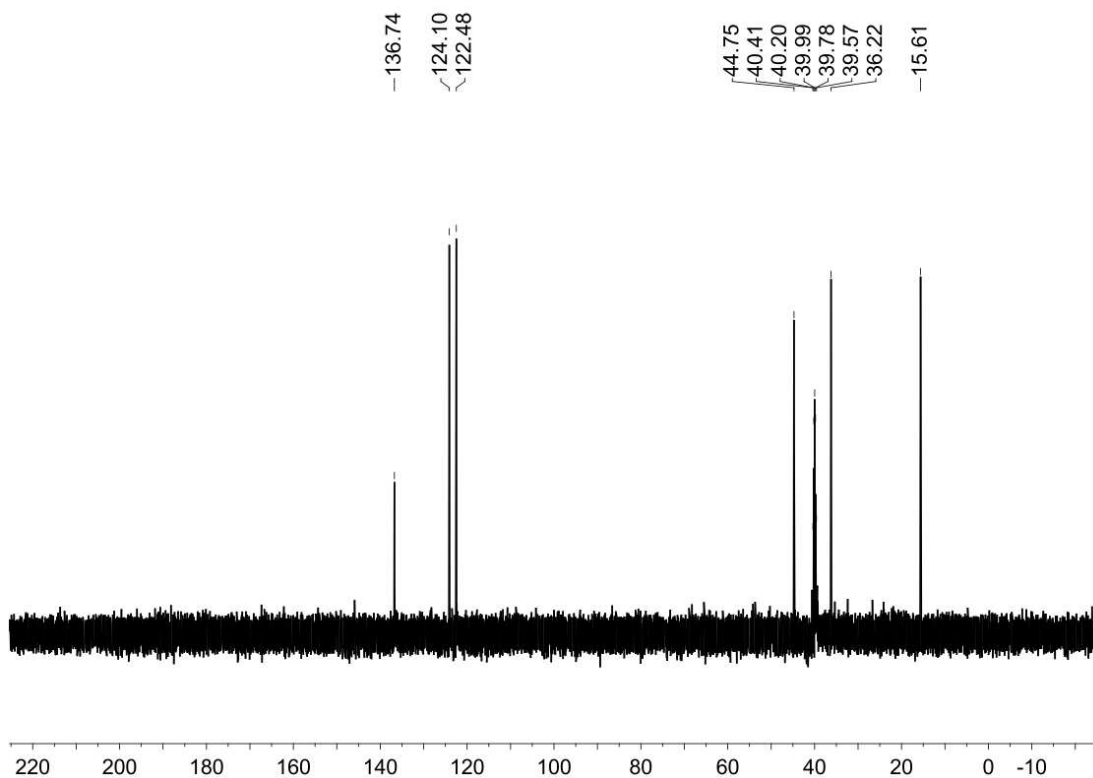
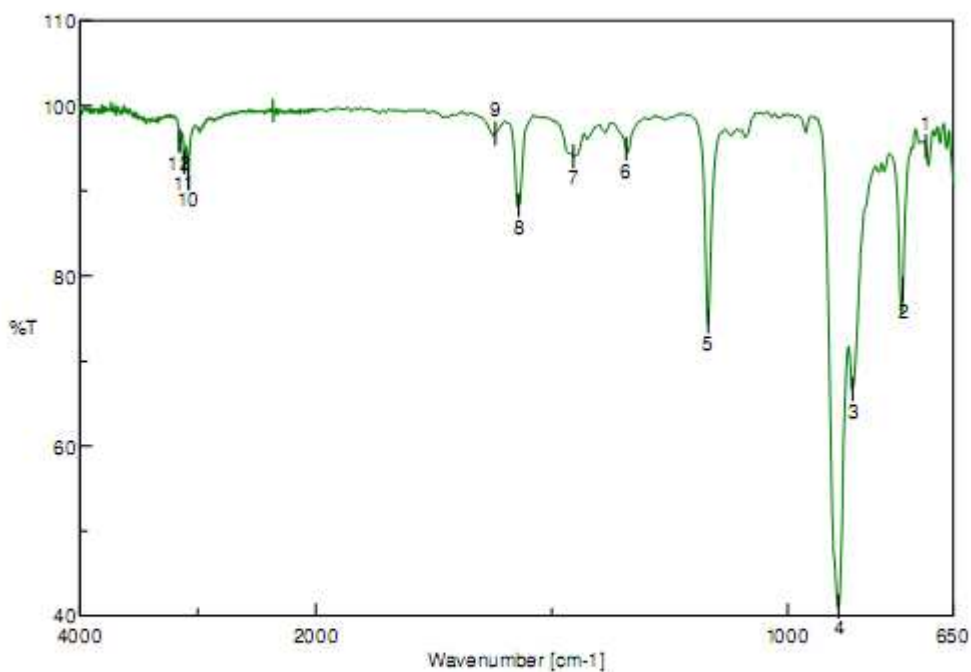


Figure S1-2 ^{13}C NMR spectra of $[\text{C}_2\text{mim}][\text{ReO}_4]$



Result of Peak Picking

No.	Position	Intensity	No.	Position	Intensity	No.	Position	Intensity
1	707.747	95.2348	2	756.923	78.3856	3	862.989	66.6703
4	892.88	41.0857	5	1168.65	74.598	6	1343.18	94.9438
7	1455.03	94.0251	8	1570.74	88.2603	9	1619.91	96.7377
10	3083.62	91.5043	11	3117.37	93.3559	12	3156.9	95.854

Figure S1-3 IR spectra of $[\text{C}_2\text{mim}][\text{ReO}_4]$

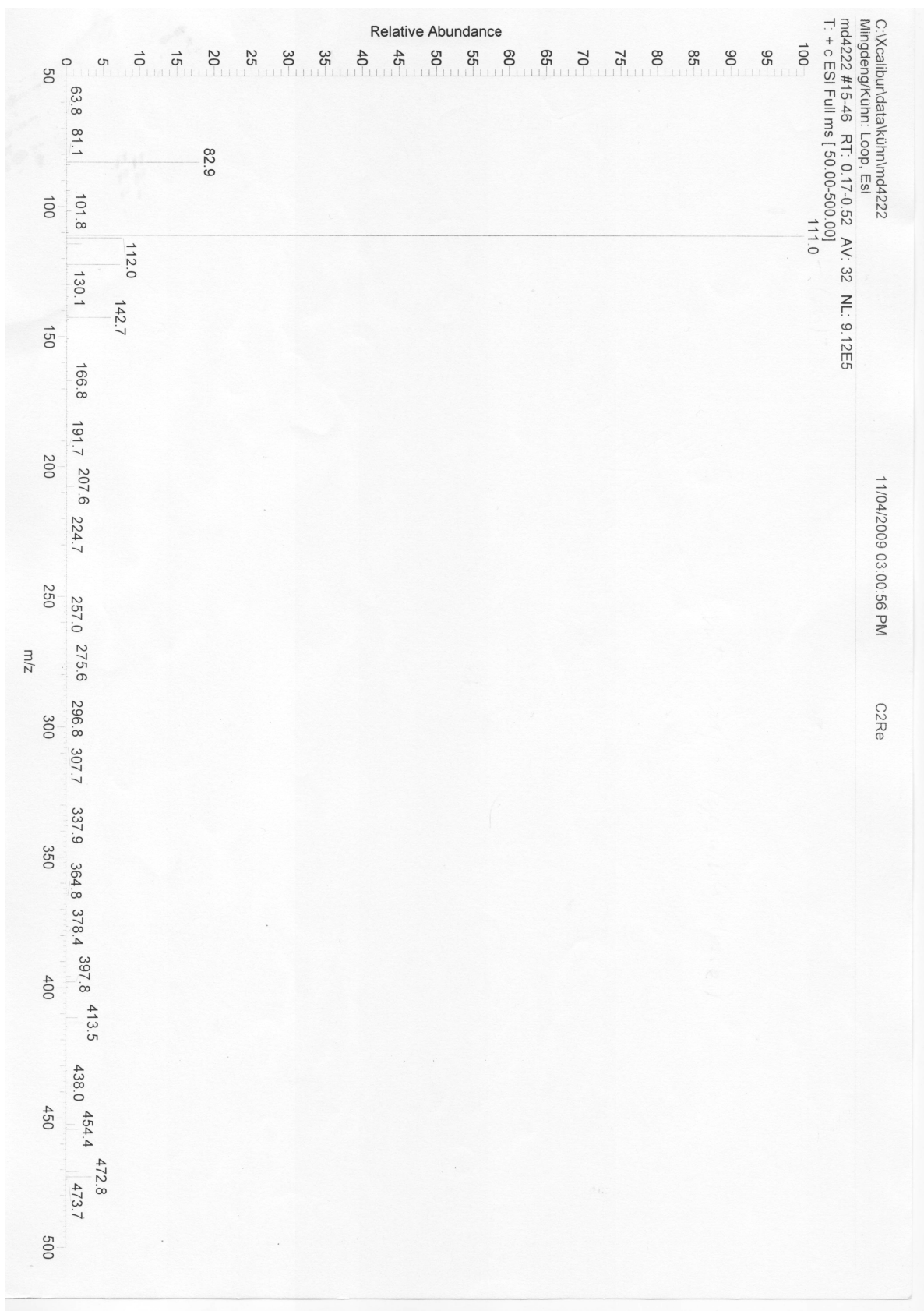


Figure S1-4 ESI-MS spectra of [C₂mim][ReO₄]

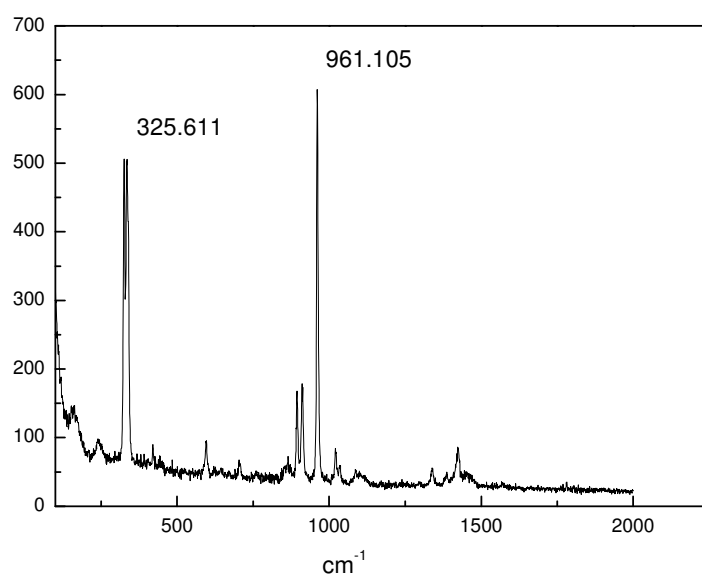
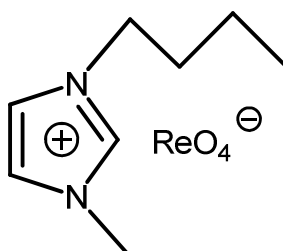


Figure S1-6 Raman spectrum of [C₂mim][ReO₄]

[C₄mim][ReO₄]:



C₈H₁₅N₂O₄Re (389.42), elemental analysis calcd.: C, 24.67, H, 3.88, N, 7.19; found: C, 25.21, H, 4.12, N, 7.17; IR (cm⁻¹): ν = 898 (Re=O), 863 (Re=O); ¹H-NMR (DMSO, 400Hz, r.t., ppm): δ = 9.04 (1H, s, m_z-H²), 7.71 (1H, d, m_z-H⁴), 7.65 (1H, d, m_z-H⁵), 4.17 - 4.14 (2H, t, -CH₂-), 3.85 (3H, s, N-CH₃), 1.80-1.73 (2H, m, -CH₂-), 1.29-1.23 (2H, m, -CH₂-), 0.89 (3H, t, -CH₃); ¹³C-NMR (DMSO, 100Hz, r.t., ppm): δ = 137.00 (m_z-C²), 124.11 (m_z-C⁴), 122.76 (m_z-C⁵), 49.17 (-CH₂-), 36.22 (N-CH₃), 31.93, 19.36 (-CH₂-), 13.77 (-CH₃). ESI-MS (methanol, m/z, %): cation, 139.1 (C₈H₁₅N₂⁺, 100%).

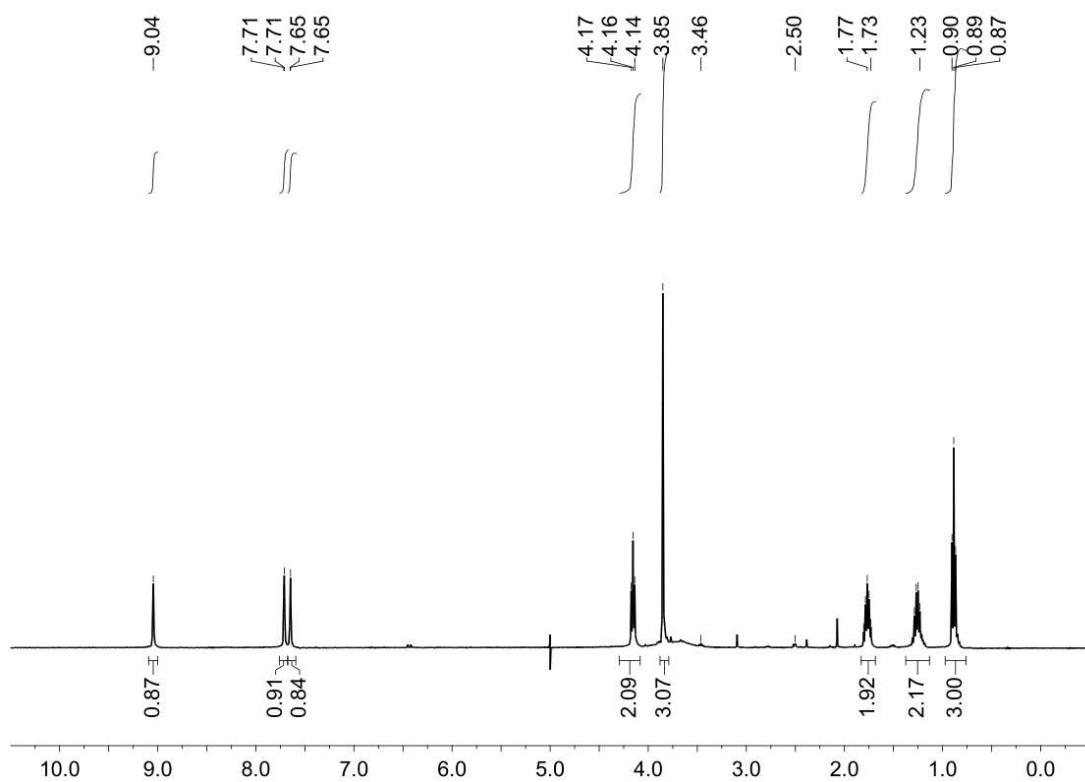


Figure S2-1 ¹H NMR spectra of [C₄mim][ReO₄]

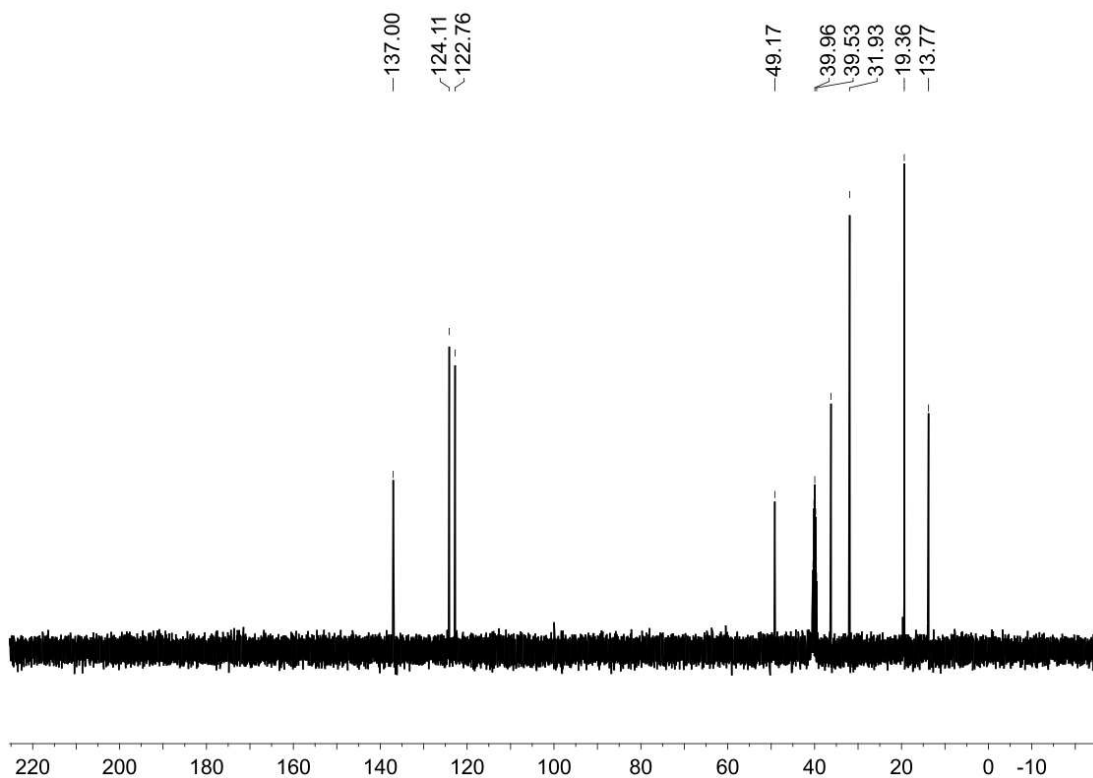
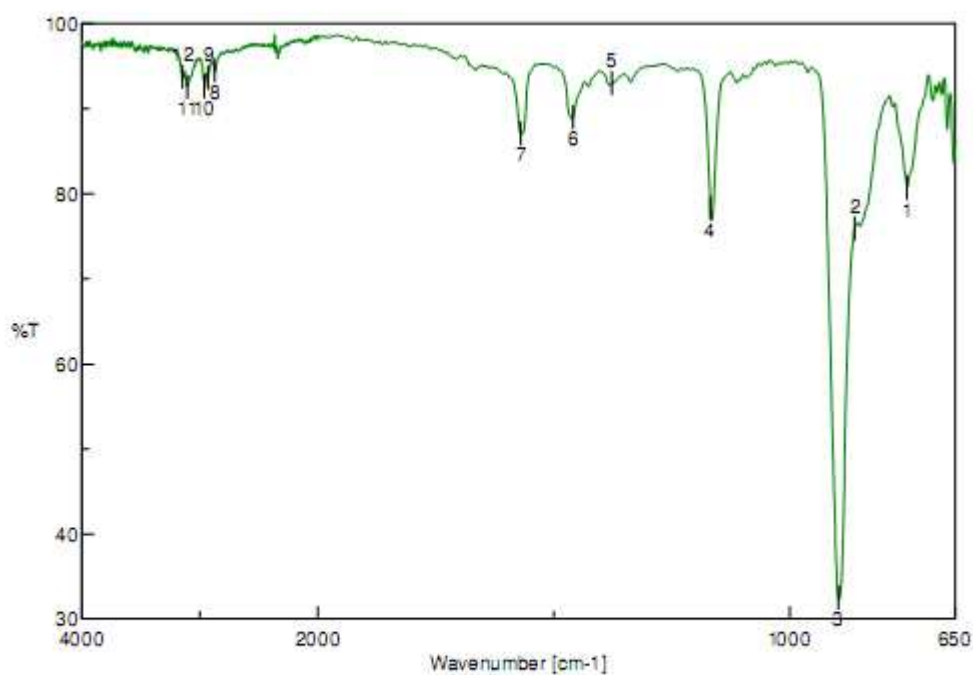


Figure S2-2 ^{13}C NMR spectra of $[\text{C}_4\text{mim}][\text{ReO}_4]$



Result of Peak Picking

No.	Position	Intensity	No.	Position	Intensity	No.	Position	Intensity
1	752.102	80.7176	2	862.989	75.9011	3	897.701	32.4728
4	1168.65	78.251	5	1376.93	92.9947	6	1459.85	89.0124
7	1570.74	87.0752	8	2875.34	94.5336	9	2933.2	93.6445
10	2962.13	92.6191	11	3107.72	92.5301	12	3146.29	93.7434

Figure S2-3 IR spectra of $[\text{C}_4\text{mim}][\text{ReO}_4]$

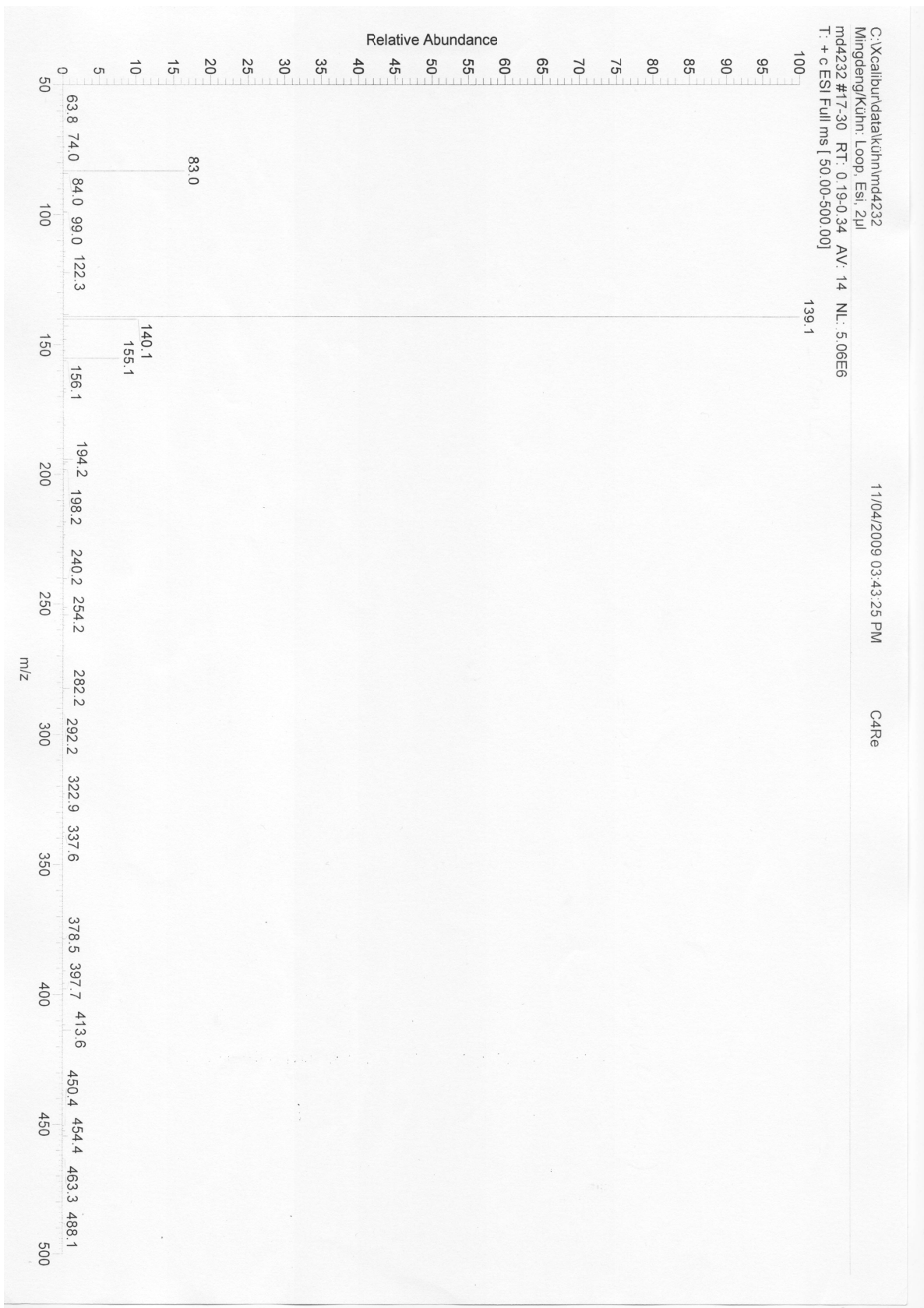


Figure S2-4 ESI-MS spectra of $[C_4mim][ReO_4]$

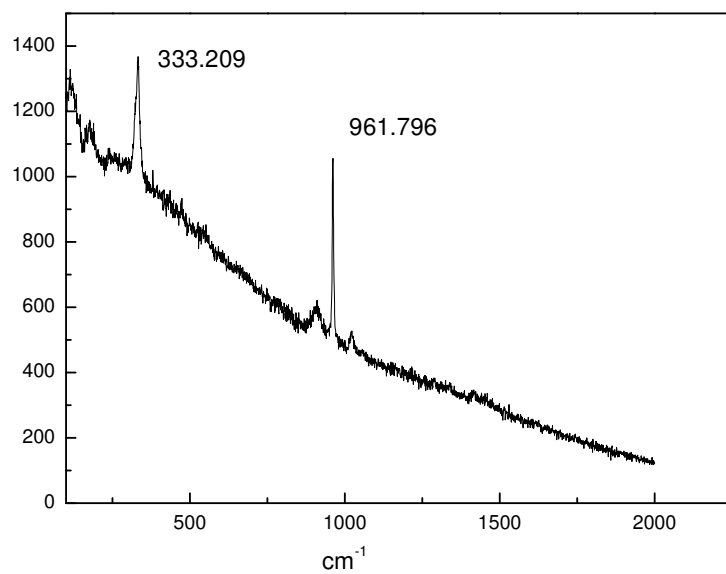
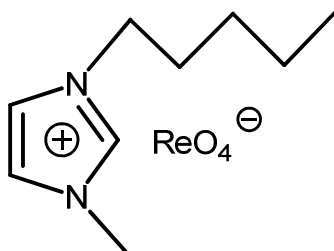


Figure S2-6 Raman spectrum of [C₄mim][ReO₄]

[C₅mim][ReO₄]:



C₉H₁₇N₂O₄Re (403.45), elemental analysis calcd.: C, 26.79, H, 4.25, N, 6.94; found: C, 26.48, H, 4.24, N, 6.90; IR (cm⁻¹): ν = 893 (Re=O), 858 (Re=O); ¹H-NMR (DMSO, 400Hz, r.t., ppm): δ = 9.03 (1H, s, mz-H²), 7.71 (1H, d, mz-H⁴), 7.64 (1H, d, mz-H⁵), 4.17 - 4.13 (2H, t, -CH₂-), 3.86 (3H, s, N-CH₃), 1.81-1.77 (2H, m, -CH₂-), 1.33-1.18, (4H, m, 2 \times -CH₂-), 0.85 (3H, t, -CH₃); ¹³C-NMR (DMSO, 100Hz, r.t., ppm): δ = 136.99 (mz-C²), 124.10 (mz-C⁴), 122.74 (mz-C⁵), 49.47 (-CH₂-), 36.21 (N-CH₃), 29.64, 28.20, 22.07 (-CH₂-), 14.20 (-CH₃). ESI-MS (methanol, m/z, %): cation, 153.1 (C₉H₁₇N₂⁺, 100%).

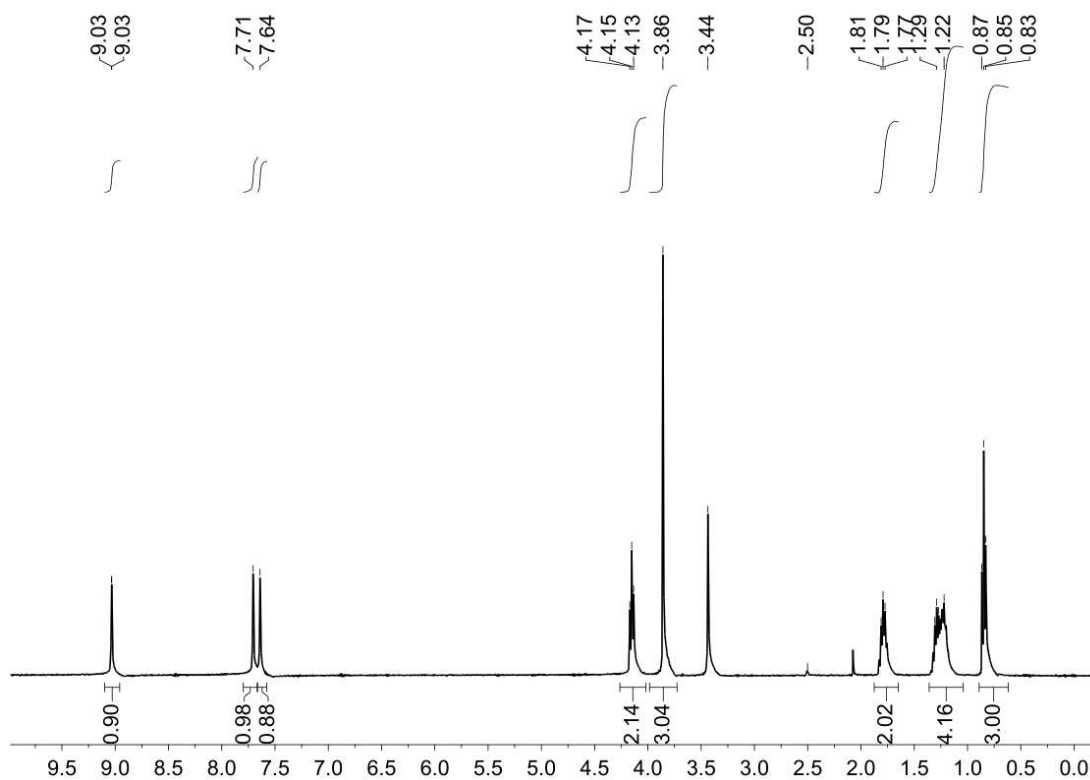


Figure S3-1 ¹H NMR spectra of [C₅mim][ReO₄]

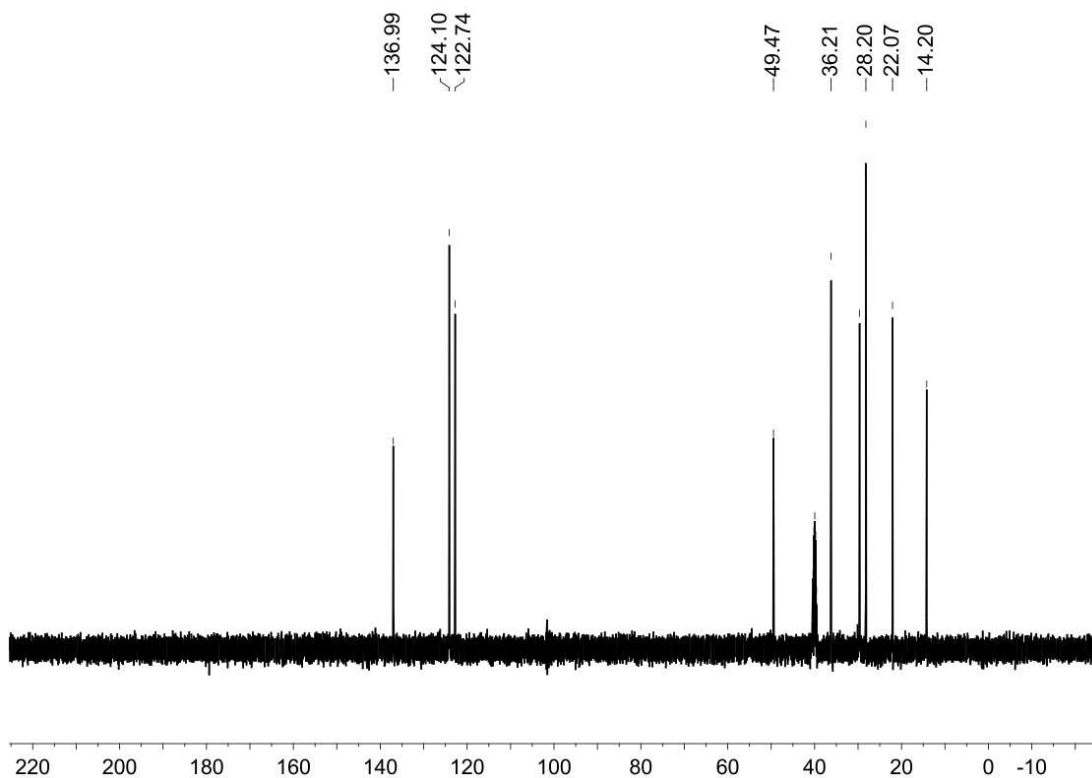
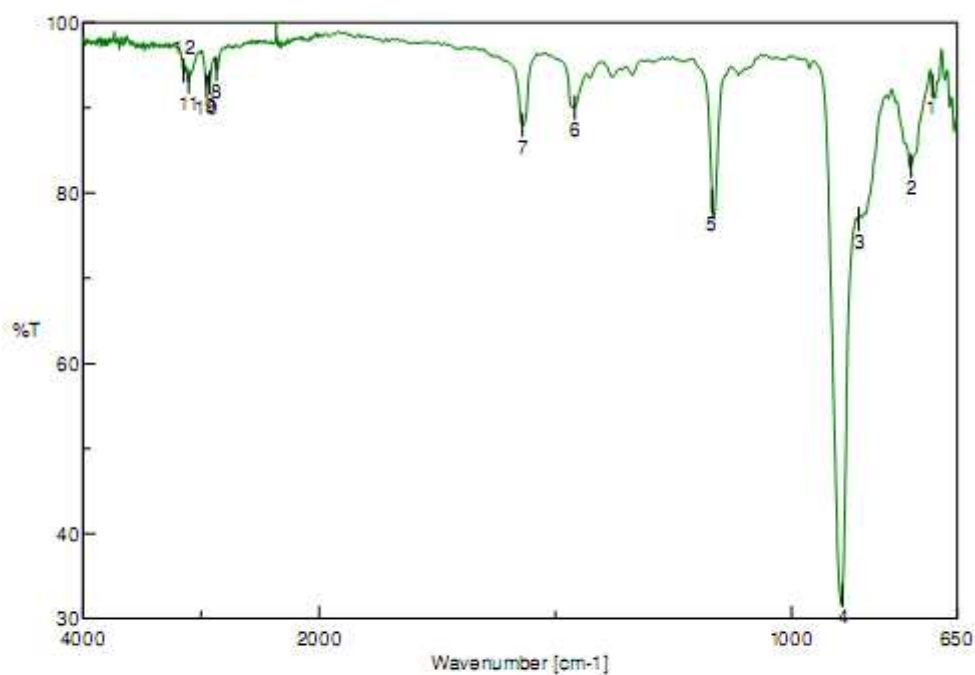


Figure S3-2 ^{13}C NMR spectra of $[\text{C}_5\text{mim}][\text{ReO}_4]$



Result of Peak Picking

No.	Position	Intensity	No.	Position	Intensity	No.	Position	Intensity
1	702.926	92.552	2	747.281	83.1754	3	858.168	76.9289
4	892.88	32.7182	5	1168.65	79.0223	6	1459.85	90.0306
7	1570.74	87.988	8	2870.52	94.5176	9	2928.38	92.9554
10	2957.3	92.5573	11	3107.72	93.0351	12	3146.29	94.3366

Figure S3-3 IR spectra of $[\text{C}_5\text{mim}][\text{ReO}_4]$

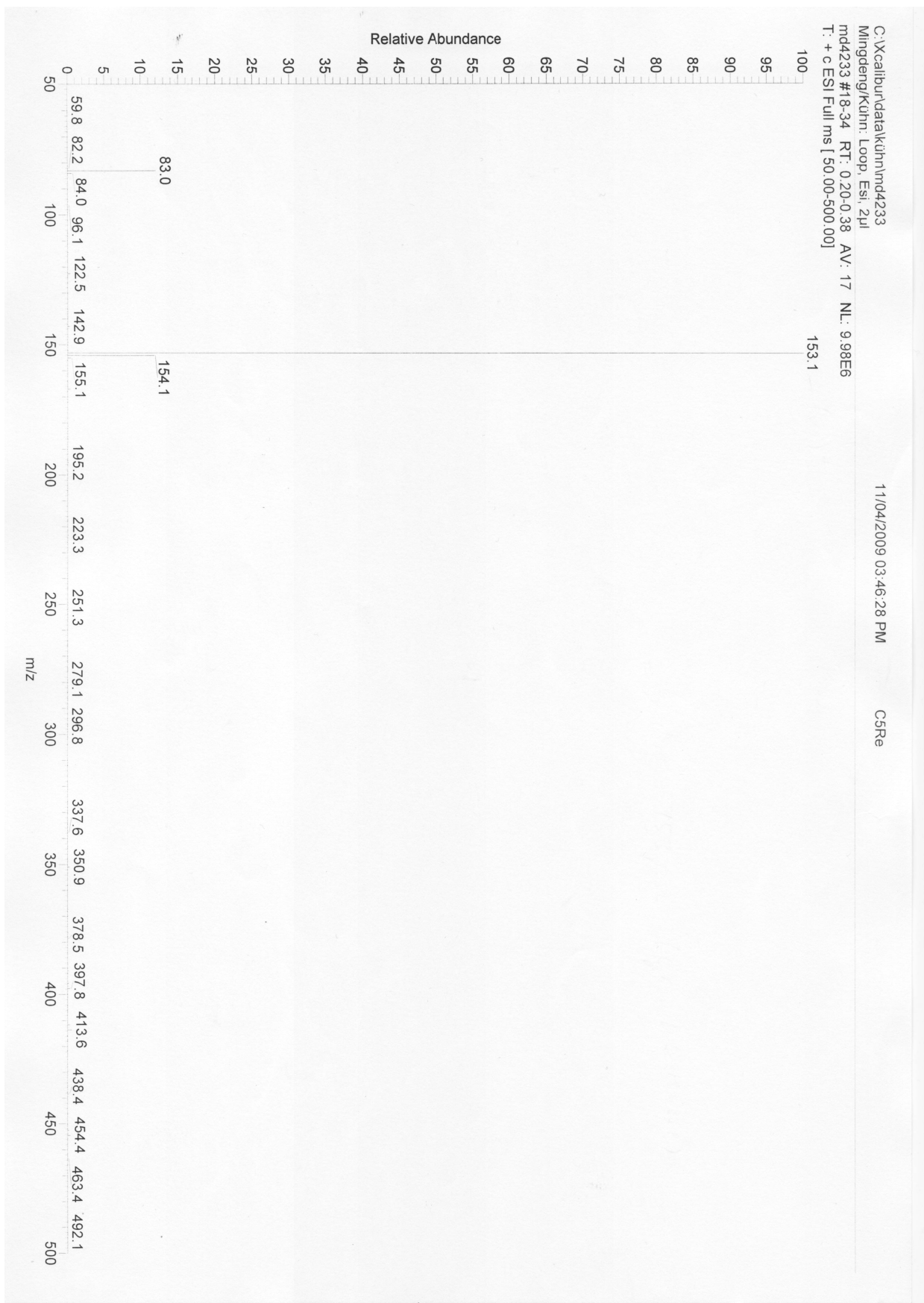


Figure S3-4 ESI-MS spectra of [C₅mim][ReO₄]

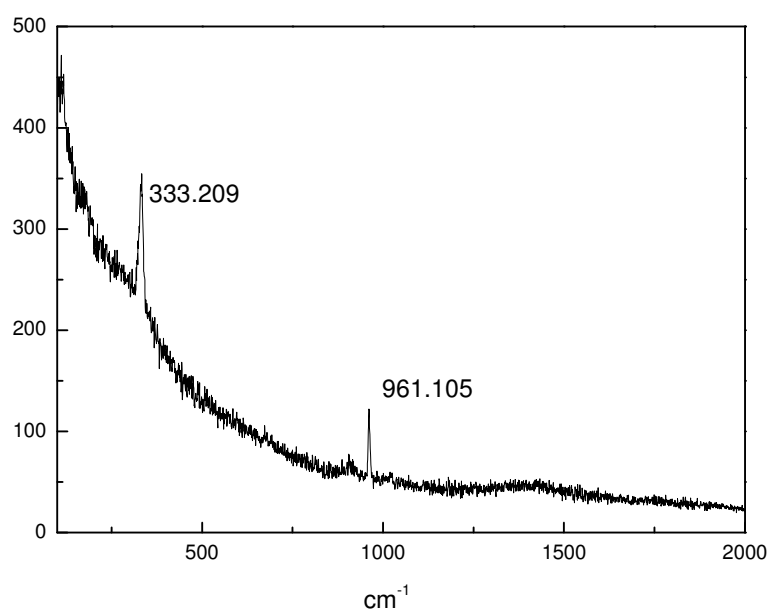
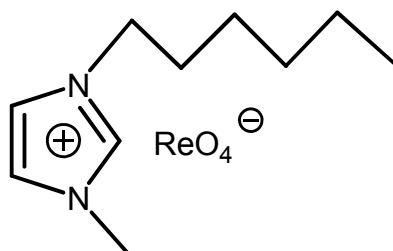


Figure S3-6 Raman spectrum of [C₅mim][ReO₄]

[C₆mim][ReO₄]:



C₁₀H₁₉N₂O₄Re (417.48), elemental analysis calcd.: C, 28.77, H, 4.59, N, 6.71; found: C, 28.74, H, 4.69, N, 6.64; IR (cm⁻¹): ν = 893 (Re=O), 839 (Re=O); ¹H-NMR (DMSO, 400Hz, r.t., ppm): δ = 9.53 (1H, s, m_z-H²), 7.96 (1H, d, m_z-H⁴), 7.87 (1H, d, m_z-H⁵), 4.23 - 4.19 (2H, t, -CH₂-), 3.89 (3H, s, N-CH₃), 1.77-1.73 (2H, m, -CH₂-), 1.19 (6H, m, 3 \times -CH₂-), 0.77 (3H, t, -CH₃); ¹³C-NMR (DMSO, 100Hz, r.t., ppm): δ = 137.00 (m_z-C²), 124.11 (m_z-C⁴), 122.76 (m_z-C⁵), 49.47 (-CH₂-), 36.22 (N-CH₃), 31.11, 29.93, 25.73, 22.42 (-CH₂-), 14.31 (-CH₃). ESI-MS (methanol, m/z, %): cation,167.1 (C₁₀H₁₉N₂⁺, 100%).

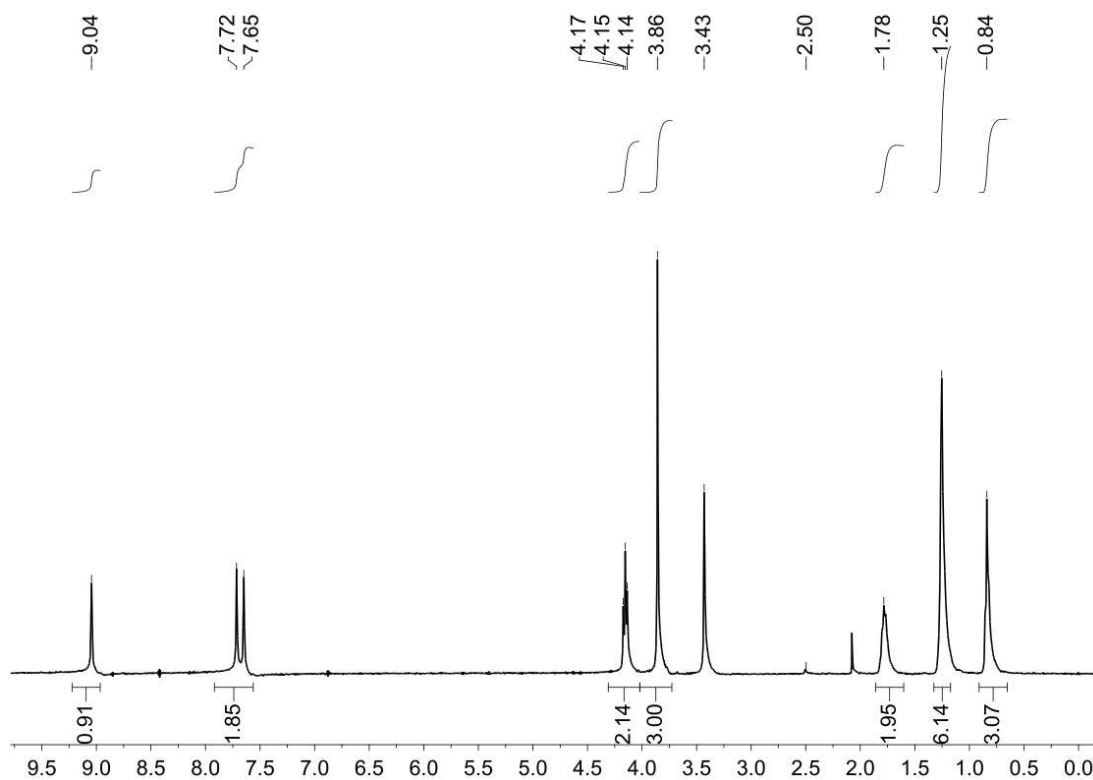


Figure S4-1 ¹H NMR spectra of [C₆mim][ReO₄]

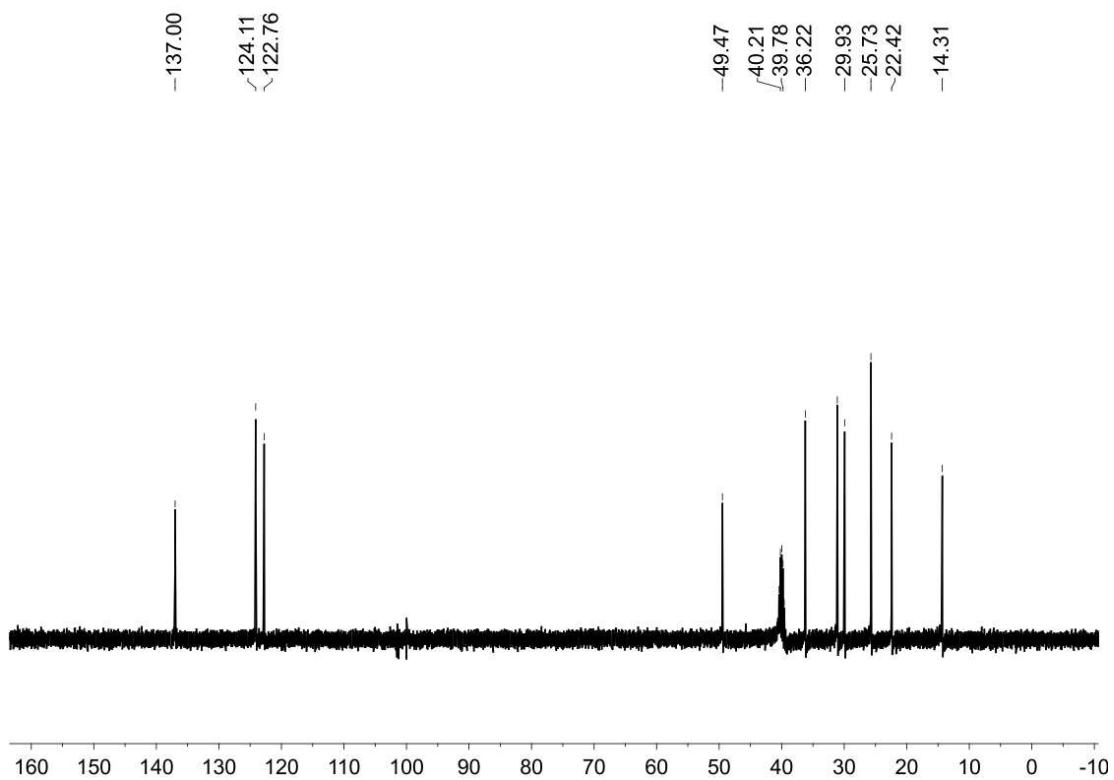
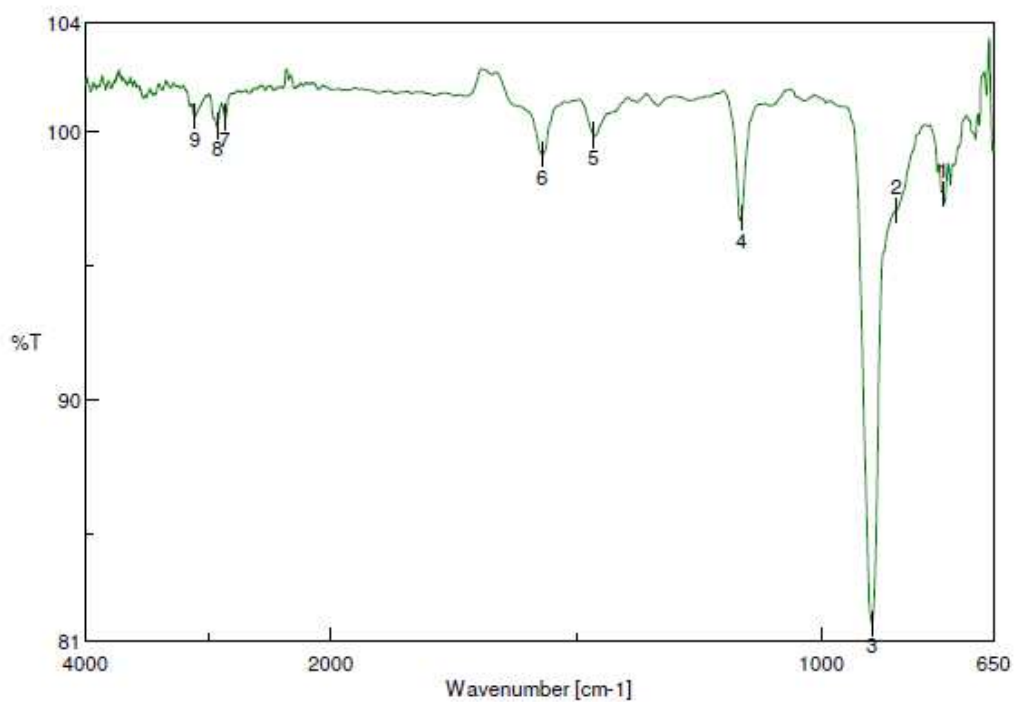


Figure S4-2 ^{13}C NMR spectra of $[\text{C}_6\text{mim}][\text{ReO}_4]$



Result of Peak Picking								
No.	Position	Intensity	No.	Position	Intensity	No.	Position	Intensity
1	752.102	97.6592	2	848.525	97.05	3	897.701	81.6841
4	1163.83	96.7432	5	1464.67	99.8519	6	1570.74	99.125
7	2860.88	100.518	8	2928.38	100.188	9	3107.72	100.533

Figure S4-3 IR spectra of $[\text{C}_6\text{mim}][\text{ReO}_4]$

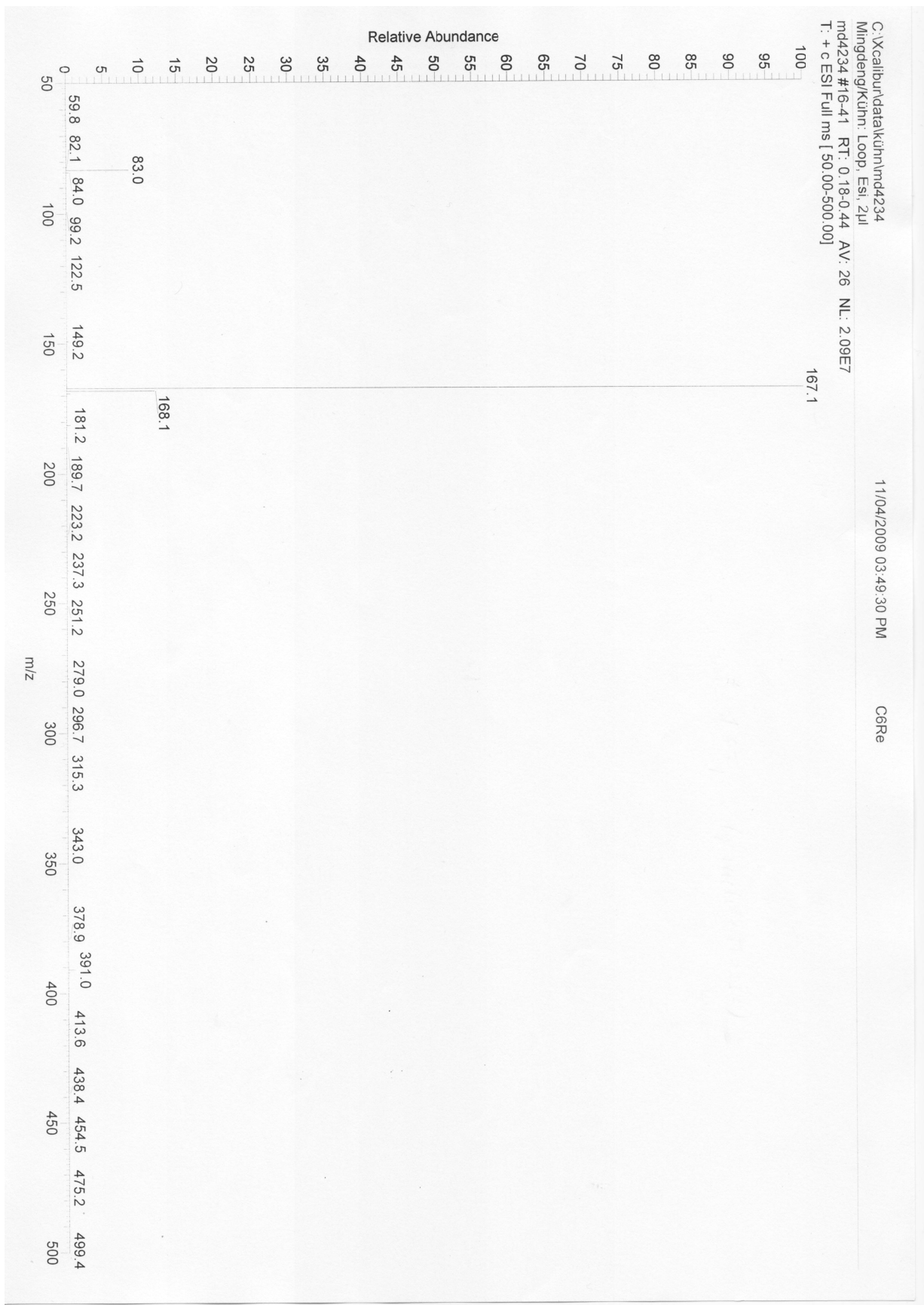


Figure S4-4 ESI-MS spectra of $[C_6mim][ReO_4]$

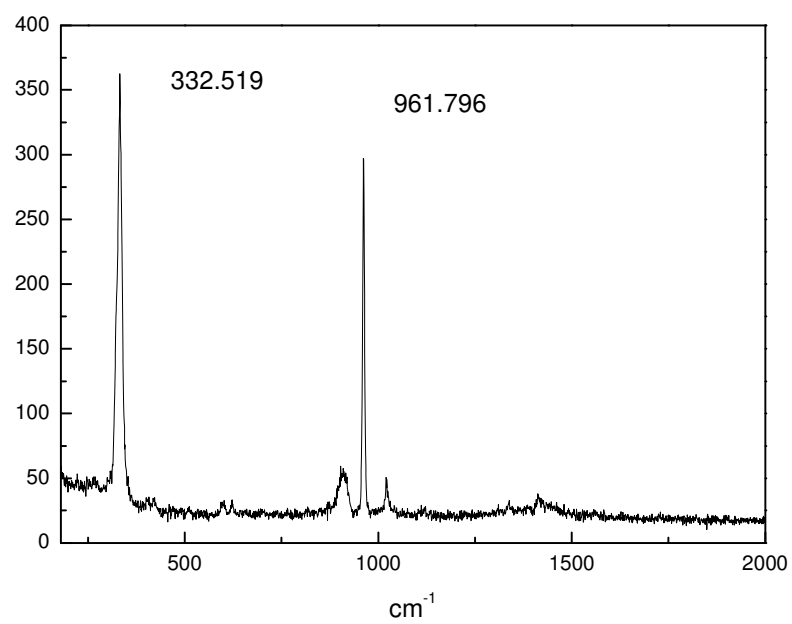


Figure S4-6 Raman spectrum of [C₆mim][ReO₄]