Supporting Information

Electrochemical Diselenylation of Indolizines via Intermolecular C-Se Formation of 2-Methylpyridines, α-Bromoketones with Diselenides

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A. General Methods

^{1}H and ^{13}C NMR spectra were recorded using a Bruker DRX-400 spectrometer using $CDCl_3$ as solvent. The chemical shifts are referenced to signals at 7.26 and 77.0 ppm, respectively. The data of HRMS was carried out on a high-resolution mass spectrometer (LCMS-IT-TOF). IR spectra were obtained either as potassium bromide pellets or as liquid films between two potassium bromide pellets with a Bruker TENSOR 27 spectrometer. Melting points were determined with a Büchi Melting Point B-545 instrument. The instrument for electrolysis is dual display potentiostat (CHI 660E) (made in China). The anode electrode is vitreous carbon plate (10 mm×10 mm×1 mm) and cathodic electrode was platinum plate (10 mm×10 mm×0.1 mm). Unless otherwise noted, materials were obtained from commercial suppliers and used without further purification.

B. General Procedure for the Preparation of 4 and 5

2-Bromoacetophenone (0.8 mmol, 1.6 equiv), 2-methylpyridine (0.5 mmol, 1 equiv), diphenyl diselenide (0.5 mmol 1 equiv), KI (1 mmol), K_2CO_3 (0.5 mmol), DMF (6 mL) and H_2O (5 mL) were placed in a 20 mL undivided electrolytic cell with a vitreous carbon plate anode (10 mm×10 mm×1 mm) and a platinum plate cathode (10 mm×10 mm×0.1 mm). The electrolysis was carried out at 50 ^oC under a constant current of 10 mA for 8 hours (monitored by TLC). When the reaction was finished, the resulting reaction solution was quenched with 100 mL brine and extracted with 4×60 mL ethylacetate. The extract was dried with Na_2SO_4. The solvent was removed with a rotary evaporator. The pure product was obtained by flash column chromatography on silica gel.

C. General procedure for cyclic voltammetry

Cyclic voltammetry was performed in a three-electrode cell connected to a schlenk line under nitrogen at room temperature. The working electrode was a steady vitreous carbon plate electrode, the counter electrode was a platinum plate. The reference was an Ag/AgCl electrode submerged in saturated aqueous KCl solution, and separated from reaction by a salt bridge. Then 10mL electrolyte solution containing 0.05 M *n*-Bu_4NPF_6 in the mixed solvent of DMF and H_2O was poured into electrochemical cell. The concentration of samples was 0.01 M. The scan rate was 0.1 V/s, ranging from 0 V to 2.0 V.

D. Cyclic voltammogram

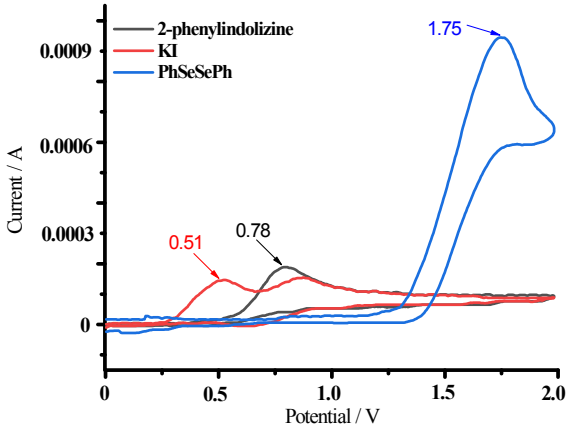
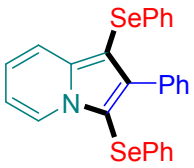


Figure S1 Cyclic voltammetry of 2-phenylindolizine **6aa**, KI and diphenyl diselenide **3a** in the mixed solvent of DMF and H_2O.

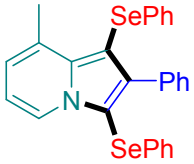
E. Analytical data

2-phenyl-1,3-bis(phenylselanyl)indolizine (4aa)



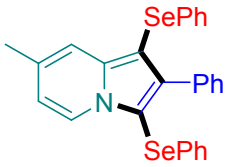
Yellow solid (194.4 mg, 77%), mp 136.2-138.5 °C; IR (KBr): 3055, 2921, 1475, 1344, 747, 687 cm^{-1}; ^1H NMR (400 MHz, Chloroform-*d*) δ ppm 8.42 (d, J = 7.0 Hz, 1H), 7.74 (d, J = 8.9 Hz, 1H), 7.44-7.40 (m, 2H), 7.33-7.38 (m, 3H), 7.22-7.12 (m, 8H), 7.06-6.98 (m, 3H), 6.73 (t, J = 6.8 Hz, 1H). ^{13}C NMR (100 MHz, Chloroform-*d*) δ ppm 142.4, 140.0, 134.9, 134.6, 132.2, 130.8, 129.4, 128.9, 128.1, 127.9, 127.5, 127.4, 126.2, 125.7, 125.4, 121.7, 118.8, 112.5, 105.5, 94.7. ^{77}Se NMR (76 MHz, Chloroform-d) δ ppm 227.8, 205.9. HRMS MALDI (m/z): calcd for $C_{26}H_{19}NSe_2$ $[M + H]^+$: 505.9922, found: 505.9926.

8-methyl-2-phenyl-1,3-bis(phenylselanyl)indolizine (4ab)



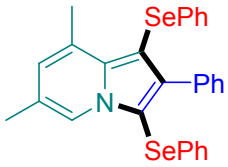
Brown solid (199.8 mg, 77%), mp 92.3-95.8 °C; IR (KBr): 3067, 2917, 1578, 1476, 734, 691 cm^{-1}; ^1H NMR (400 MHz, Chloroform-*d*) δ ppm 8.34 (d, J = 6.9 Hz, 1H), 7.26 (t, J = 2.0 Hz, 5H), 7.14-7.03 (m, 8H), 6.98 (d, J = 8.1 Hz, 2H), 6.68 (d, J = 6.7 Hz, 1H), 6.54 (t, J = 6.9 Hz, 1H), 2.75 (s, 3H). ^{13}C NMR (100 MHz, Chloroform-*d*) δ ppm 144.0, 138.4, 137.6, 135.3, 132.3, 130.9, 129.9, 129.4, 128.9, 128.0, 127.4, 127.3, 127.3, 126.1, 125.0, 124.5, 122.8, 111.9, 106.3, 94.2, 20.4. HRMS MALDI (m/z): calcd for $C_{27}H_{21}NSe_2$ $[M + H]^+$: 520.0079, found: 520.0082.

7-methyl-2-phenyl-1,3-bis(phenylselanyl)indolizine (4ac)



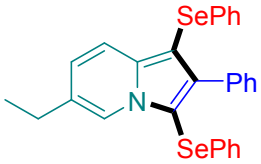
Brown solid (210.2 mg, 81%), mp 185.3-187.4 °C; IR (KBr): 3054, 2922, 2382, 1508, 735, 686cm^{-1}; ^1H NMR (400 MHz, Chloroform-*d*) δ ppm 8.28 (d, J = 7.5 Hz, 1H), 7.47 (s, 1H), 7.38-7.34 (m, 2H), 7.33-7.29 (m, 3H), 7.19-7.09 (m, 8H), 7.02 (d, J = 8.0 Hz, 2H), 6.55 (d, J = 7.2 Hz, 1H), 2.35 (s, 3H). ^{13}C NMR (100 MHz, Chloroform-*d*) δ ppm 142.6, 140.5, 135.3, 134.8, 132.6, 132.6, 130.8, 129.4, 129.0, 127.9, 127.9, 127.5, 127.5, 127.4, 126.1, 125.3, 125.3, 117.1, 115.2, 104.6, 93.0, 21.1. HRMS MALDI (m/z): calcd for $C_{27}H_{21}NSe_2$ $[M + H]^+$: 505.0079, found: 505.0082.

6,8-dimethyl-2-phenyl-1,3-bis(phenylselanyl)indolizine (4ad)



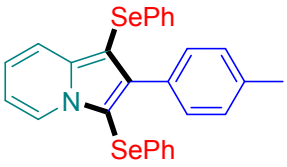
Yellow solid (213.2 mg, 80%), mp 137.1-139.6 °C; IR (KBr): 3064, 2921, 1475, 734, 689 cm^{-1}; ^1H NMR (400 MHz, Chloroform-*d*) δ ppm 8.24 (s, 1H), 7.31 (s, 5H), 7.22-7.15 (m, 5H), 7.12 (d, J = 7.6 Hz, 3H), 7.05 (d, J = 8.0 Hz, 2H), 6.65 (s, 1H), 2.78 (s, 3H), 2.24 (s, 3H). ^{13}C NMR (100 MHz, Chloroform-*d*) δ ppm 143.7, 137.8, 137.3, 135.4, 132.7, 130.9, 129.4, 129.3, 129.0, 127.8, 127.4, 127.2, 126.3, 126.0, 124.9, 122.2, 121.4, 105.8, 93.7, 20.2, 18.2. HRMS MALDI (m/z): calcd for $C_{28}H_{23}NSe_2$ $[M + H]^+$: 534.0235, found: 534.0239.

6-ethyl-2-phenyl-1,3-bis(phenylselanyl)indolizine (4ae)



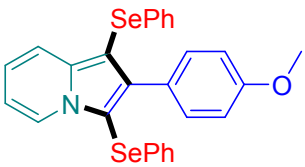
Brown solid (218.5 mg, 82%), mp 209.8-212.1 °C; IR (KBr): 3055, 2921, 2312, 1475, 732, 687 cm^{-1}; ^1H NMR (400 MHz, Chloroform-*d*) δ ppm 8.26 (s, 1H), 7.68 (d, J = 9.1 Hz, 1H), 7.43 (d, J = 7.7 Hz, 2H), 7.36 (d, J = 5.1 Hz, 3H), 7.23-7.12 (m, 8H), 7.08 (d, J = 7.9 Hz, 2H), 6.94 (d, J = 9.2 Hz, 1H), 2.63 (q, J = 7.5 Hz, 2H), 1.25 (t, J = 7.5 Hz, 3H). ^{13}C NMR (100 MHz, Chloroform-*d*) δ ppm 142.1, 139.1, 135.2, 134.8, 132.5, 130.8, 129.4, 128.9, 128.4, 128.0, 128.0, 127.4, 127.3, 126.1, 125.3, 123.9, 122.7, 118.4, 105.3, 94.2, 26.0, 15.0. HRMS MALDI (m/z): calcd for $C_{28}H_{23}NSe_2$ $[M + H]^+$: 534.0235, found: 534.0239.

1,3-bis(phenylselanyl)-2-(p-tolyl)indolizine (4ba)



Brown solid (228.4 mg, 88%), mp 123.9-126.4 °C; IR (KBr): 3058, 2917, 1475, 734, 691 cm^{-1}; ^1H NMR (400 MHz, Chloroform-*d*) δ ppm 8.41 (d, J = 7.0 Hz, 1H), 7.73 (d, J = 8.9 Hz, 1H), 7.31 (d, J = 8.1 Hz, 2H), 7.17 (d, J = 10.0 Hz, 10H), 7.05 (d, J = 8.0 Hz, 2H), 7.02-6.98 (m, 1H), 6.72 (t, J = 6.8 Hz, 1H), 2.38 (s, 3H). ^{13}C NMR (100 MHz, Chloroform-*d*) δ ppm 142.6, 140.0, 137.1, 135.1, 132.3, 131.7, 130.6, 129.4, 128.9, 128.3, 128.0, 127.9, 126.1, 125.8, 125.3, 121.7, 118.8, 112.4, 105.4, 94.7, 21.3. HRMS MALDI (m/z): calcd for $C_{27}H_{21}NSe_2$ $[M + H]^+$: 520.0079, found: 520.0082.

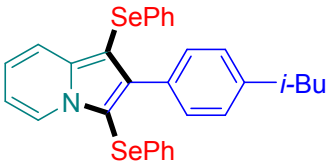
2-(4-methoxyphenyl)-1,3-bis(phenylselanyl)indolizine (4ca)



Brown oil (224.7 mg, 84%); IR (KBr): 3057, 2920, 1473, 1230, 733, 689 cm^{-1}; ^1H NMR (400 MHz, Chloroform-d) δ 8.39 (d, J = 7.0 Hz, 1H), 7.70 (d, J = 8.9 Hz, 1H), 7.33 (d, J = 8.7 Hz, 2H), 7.2-7.10 (m, 8H), 7.05-6.97 (m, 3H), 6.88 (d, J = 8.7 Hz, 2H), 6.73-6.69 (m, 1H), 3.80 (s, 3H). ^{13}C NMR (100 MHz, Chloroform-*d*) δ ppm 159.0, 142.2,

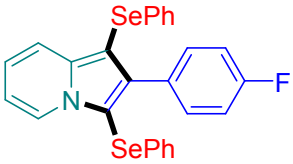
140.1, 135.1, 132.4, 131.9, 129.5, 129.0, 128.0, 127.9, 127.0, 126.2, 125.8, 125.4, 121.7, 118.8, 113.1, 112.4, 105.4, 94.7, 55.1. HRMS MALDI (m/z): calcd for $C_{27}H_{21}NOSe_2$ $[M + H]^+$: 536.0028, found: 536.0032.

2-(4-isobutylphenyl)-1,3-bis(phenylselanyl)indolizine (4da)



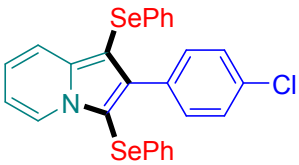
Brown oil (224.4 mg, 80%); IR (KBr): 3057, 2951, 2312, 1474, 731, 689 cm^{-1}; ^1H NMR (400 MHz, Chloroform-*d*) δ ppm 8.42 (d, J = 6.9 Hz, 1H), 7.74 (d, J = 8.9 Hz, 1H), 7.37 (d, J = 8.0 Hz, 2H), 7.23-7.12 (m, 10H), 7.07 (d, J = 7.9 Hz, 2H), 7.02-6.98 (m, 1H), 6.72 (t, J = 6.9 Hz, 1H), 2.52 (d, J = 7.1 Hz, 2H), 1.88-1.98 (m, 1H), 0.96 (d, J = 6.5 Hz, 6H). ^{13}C NMR (100 MHz, Chloroform-*d*) δ ppm 142.3, 140.8, 140.0, 135.0, 132.3, 131.8, 130.5, 129.4, 128.9, 128.3, 128.2, 128.0, 126.1, 125.7, 125.4, 121.6, 118.8, 112.3, 105.4, 94.8, 45.2, 30.0, 22.5. HRMS MALDI (m/z): calcd for $C_{30}H_{27}NSe_2$ $[M + H]^+$: 562.0548, found: 562.0553.

2-(4-fluorophenyl)-1,3-bis(phenylselanyl)indolizine (4ea)



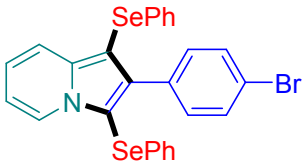
Brown solid (185.7 mg, 71%), mp 152.9-155.7 °C; IR (KBr): 3053, 2921, 1471, 837, 734, 688 cm^{-1}; ^1H NMR (400 MHz, Chloroform-*d*) δ ppm 8.40 (d, J = 7.0 Hz, 1H), 7.71 (d, J = 8.9 Hz, 1H), 7.36-7.30 (m, 2H), 7.21-7.09 (m, 8H), 7.04-6.97 (m, 5H), 6.73 (t, J = 6.8 Hz, 1H). ^{13}C NMR (100 MHz, Chloroform-*d*) δ ppm 162.4 (J = 246.5 Hz), 141.5, 140.1, 134.8, 132.4 (J = 8.0 Hz), 132.2, 130.6 (J = 3.3 Hz), 129.5, 129.0, 128.1, 127.9, 126.3, 125.8, 125.5, 121.9, 118.9, 114.6 (J = 21.5 Hz), 112.6, 105.7, 94.8. HRMS MALDI (m/z): calcd for $C_{26}H_{18}FNSe_2$ $[M + H]^+$: 523.9835, found: 523.9831.

2-(4-chlorophenyl)-1,3-bis(phenylselanyl)indolizine (4fa)



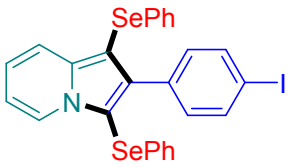
Yellow solid (164.4 mg, 61%), mp 139.7-142.1 °C; IR (KBr): 3067, 2925, 1476, 833, 734, 691 cm^{-1}; ^1H NMR (400 MHz, Chloroform-*d*) δ ppm 8.31 (d, J = 7.1 Hz, 1H), 7.62 (d, J = 8.9 Hz, 1H), 7.20 (s, 4H), 7.10-6.99 (m, 8H), 6.92 (t, J = 7.5 Hz, 3H), 6.64 (t, J = 7.2 Hz, 1H). ^{13}C NMR (100 MHz, Chloroform-*d*) δ ppm 141.2, 140.2, 134.7, 133.5, 133.1, 132.1, 129.6, 129.0, 128.1, 127.9, 127.8, 126.3, 125.8, 125.6, 122.0, 118.9, 112.7, 105.6, 94.7. HRMS MALDI (m/z): calcd for $C_{26}H_{18}ClNSe_2$ $[M + H]^+$: 539.9529, found: 539.9532.

2-(4-bromophenyl)-1,3-bis(phenylselanyl)indolizine (4ga)



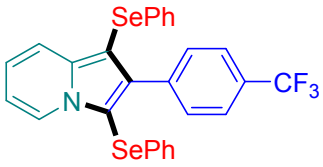
Yellow solid (172.0 mg, 59%), mp 137.7-139.8 °C; IR (KBr): 3051, 2921, 1495, 829, 734, 687 cm^{-1}; ^1H NMR (400 MHz, Chloroform-*d*) δ ppm 8.41 (d, J = 7.0 Hz, 1H), 7.72 (d, J = 8.9 Hz, 1H), 7.45 (d, J = 8.5 Hz, 2H), 7.24 (d, J = 8.5 Hz, 2H), 7.20-7.09 (m, 8H), 7.04-6.98 (m, 3H), 6.74 (t, J = 6.8 Hz, 1H). ^{13}C NMR (100 MHz, Chloroform-*d*) δ ppm 141.2, 140.2, 134.7, 133.6, 132.4, 132.1, 130.7, 129.6, 129.0, 128.1, 127.9, 126.4, 125.8, 125.6, 122.0, 121.9, 118.9, 112.7, 105.6, 94.6. HRMS MALDI (m/z): calcd for $C_{26}H_{18}BrNSe_2$ $[M + H]^+$: 583.9026, found: 583.9026.

2-(4-iodophenyl)-1,3-bis(phenylselanyl)indolizine (4ha)



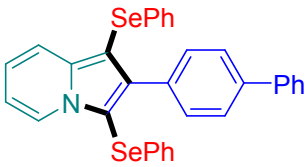
Yellow solid (170.3 mg, 54%), mp 163.6-166.2 °C; IR (KBr): 3053, 2922, 1487, 837, 731, 692 cm^{-1}; ^1H NMR (400 MHz, Chloroform-*d*) δ ppm 8.40 (d, J = 6.9 Hz, 1H), 7.72 (d, J = 8.8 Hz, 1H), 7.65 (d, J = 8.0 Hz, 2H), 7.20-7.08 (m, 10H), 6.98-7.03 (m, 3H), 6.74 (t, J = 6.8 Hz, 1H). ^{13}C NMR (100 MHz, Chloroform-*d*) δ ppm 141.3, 140.2, 136.7, 134.7, 134.2, 132.6, 132.1, 129.6, 129.1, 128.1, 127.9, 126.4, 125.8, 125.6, 122.0, 118.9, 112.7, 105.5, 94.6, 93.8. HRMS MALDI (m/z): calcd for $C_{26}H_{18}INSe_2$ $[M + H]^+$: 631.8889, found: 631.8892.

1,3-bis(phenylselanyl)-2-(4-(trifluoromethyl)phenyl)indolizine (4ia)



Yellow solid (197.7 mg, 69%), mp 145.5-147.9 °C; IR (KBr): 3067, 2925, 1475, 1326, 1125, 734, 691 cm^{-1}; ^1H NMR (400 MHz, Chloroform-*d*) δ ppm 8.46 (d, J = 7.0 Hz, 1H), 7.78 (d, J = 8.9 Hz, 1H), 7.62 (d, J = 8.0 Hz, 2H), 7.53 (d, J = 8.0 Hz, 2H), 7.23-7.13 (m, 8H), 7.05 (t, J = 7.1 Hz, 3H), 6.78 (t, J = 6.9 Hz, 1H). ^{13}C NMR (100 MHz, Chloroform-*d*) δ ppm 140.9, 140.2, 138.4, 134.6, 132.0, 131.1, 129.6, 129.2 (J = 33.5 Hz), 129.1, 128.1, 127.9, 126.4, 125.8, 125.7, 124.5 (J = 3.8 Hz), 124.3 (J = 270.8 Hz), 122.1, 119.0, 112.9, 105.8, 94.75. HRMS MALDI (m/z): calcd for $C_{27}H_{18}F_3NSe_2$ $[M + H]^+$: 573.9796, found: 573.9800.

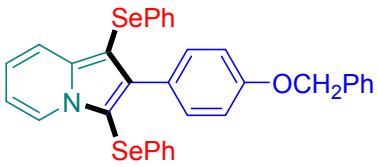
2-([1,1'-biphenyl]-4-yl)-1,3-bis(phenylselanyl)indolizine (4ja)



Yellow solid (215.0 mg, 74%), mp 94.1-96.7 °C; IR (KBr): 3055, 2931, 1470, 737, 689 cm^{-1}; ^1H NMR (400 MHz, Chloroform-*d*) δ ppm 8.45 (d, J = 6.9 Hz, 1H), 7.76 (d, J = 8.9 Hz, 1H), 7.60-7.66 (m, 4H), 7.52 (d, J = 8.2 Hz, 2H), 7.45 (t, J = 7.6 Hz, 2H), 7.35 (t, J = 7.4 Hz, 1H), 7.24-7.13 (m, 8H), 7.09 (d, J = 8.1 Hz, 2H), 7.05-7.00 (m, 1H),

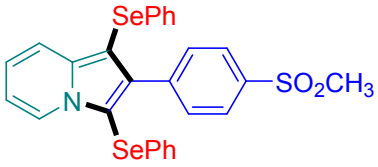
6.75 (t, J = 6.8 Hz, 1H). ^{13}C NMR (100 MHz, Chloroform-*d*) δ ppm 142.0, 140.8, 140.2, 140.0, 135.0, 133.6, 132.3, 131.2, 129.5, 129.0, 128.6, 128.1, 127.9, 127.1, 127.0, 126.2, 125.8, 125.4, 121.8, 118.8, 112.5, 105.5, 94.7. HRMS MALDI (m/z): calcd for $C_{32}H_{23}NSe_2$ $[M + H]^+$: 582.0235, found: 582.0240.

2-(4-(benzyloxy)phenyl)-1,3-bis(phenylselanyl)indolizine (4ka)



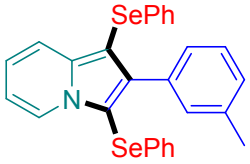
Brown oil (235.2 mg, 77%); IR (KBr): 3064, 2924, 1475, 1238, 733, 689 cm^{-1}; ^{1}H NMR (400 MHz, Chloroform-*d*) δ ppm 8.44 (d, J = 7.0 Hz, 1H), 7.76 (d, J = 8.9 Hz, 1H), 7.49 (d, J = 7.2 Hz, 2H), 7.36-7.46 (m, 5H), 7.25-7.14 (m, 8H), 7.09 (d, J = 7.9 Hz, 2H), 7.02 (d, J = 8.7 Hz, 3H), 6.74 (t, J = 6.8 Hz, 1H), 5.09 (s, 2H). ^{13}C NMR (100 MHz, Chloroform-*d*) δ ppm 158.3, 142.1, 140.0, 136.9, 135.0, 132.3, 131.9, 129.4, 128.9, 128.5, 128.0, 127.8, 127.8, 127.5, 127.2, 126.1, 125.7, 125.4, 121.7, 118.7, 113.9, 112.4, 105.3, 94.6, 69.8. HRMS MALDI (m/z): calcd for $C_{33}H_{25}NOSe_2$ $[M + H]^+$: 612.0341, found: 612.0346.

2-(4-(methylsulfonyl)phenyl)-1,3-bis(phenylselanyl)indolizine (4la)



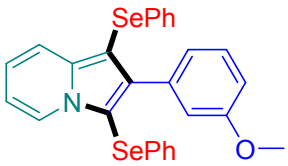
Brown oil (195.3 mg, 67%); IR (KBr): 3067, 2924, 1475, 1311, 1145, 734, 688, 544 cm^{-1}; ^{1}H NMR (400 MHz, Chloroform-*d*) δ ppm 8.44 (d, J = 7.0 Hz, 1H), 7.88 (d, J = 8.3 Hz, 2H), 7.75 (d, J = 8.9 Hz, 1H), 7.57 (d, J = 8.4 Hz, 2H), 7.21-7.08 (m, 8H), 7.04 (d, J = 9.0 Hz, 1H), 7.02-6.97 (m, 2H), 6.78 (t, J = 6.8 Hz, 1H), 3.06 (s, 3H). ^{13}C NMR (100 MHz, Chloroform-*d*) δ ppm 140.5, 140.3, 140.1, 138.9, 134.4, 131.8, 131.7, 129.6, 129.1, 128.0, 127.8, 126.5, 126.5, 125.8, 125.7, 122.3, 119.0, 113.1, 106.0, 94.7, 44.4. HRMS MALDI (m/z): calcd for $C_{27}H_{21}NO_2SSe_2$ $[M + H]^+$: 583.9697, found: 583.9700.

1,3-bis(phenylselanyl)-2-(m-tolyl)indolizine (4ma)



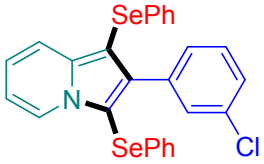
Brown oil (210.2 mg, 81%); IR (KBr): 3057, 2912, 1473, 736, 694 cm^{-1}; ^{1}H NMR (400 MHz, Chloroform-*d*) δ ppm 8.41 (d, J = 7.0 Hz, 1H), 7.74 (d, J = 8.9 Hz, 1H), 7.24-7.11 (m, 12H), 7.05 (d, J = 8.0 Hz, 2H), 7.00-6.95 (m, 1H), 6.69 (t, J = 6.8 Hz, 1H), 2.29 (s, 3H). ^{13}C NMR (100 MHz, Chloroform-*d*) δ ppm 142.6, 140.0, 136.8, 135.1, 134.5, 132.4, 131.7, 129.4, 128.9, 128.3, 128.2, 128.0, 127.8, 127.3, 126.2, 125.7, 125.4, 121.6, 118.8, 112.4, 105.6, 94.9, 21.4. HRMS MALDI (m/z): calcd for $C_{27}H_{21}NSe_2$ $[M + H]^+$: 520.0079, found: 520.0082.

2-(3-methoxyphenyl)-1,3-bis(phenylselanyl)indolizine (4na)



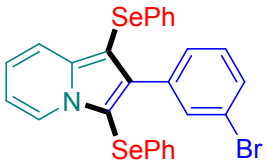
Brown oil (214.0 mg, 80%); IR (KBr): 3067, 2921, 1475, 736, 688 cm^{-1}; ^1H NMR (400 MHz, Chloroform-*d*) δ ppm 8.47 (d, J = 7.0 Hz, 1H), 7.79 (d, J = 8.9 Hz, 1H), 7.29 (t, J = 7.9 Hz, 1H), 7.25-7.18 (m, 7H), 7.17-7.13 (m, 1H), 7.11-7.01 (m, 4H), 6.96 (s, 1H), 6.93 (d, J = 8.1 Hz, 1H), 6.75 (t, J = 6.8 Hz, 1H), 3.54 (s, 3H). ^{13}C NMR (100 MHz, Chloroform-*d*) δ ppm 158.6, 142.3, 140.2, 135.9, 135.2, 132.5, 129.4, 128.9, 128.4, 127.9, 127.8, 126.1, 125.7, 125.3, 123.1, 121.8, 118.8, 115.6, 113.9, 112.5, 105.6, 94.5, 54.7. HRMS MALDI (m/z): calcd for $C_{27}H_{21}NOSe_2$ $[M + H]^+$: 536.0028, found: 536.0032.

2-(3-chlorophenyl)-1,3-bis(phenylselanyl)indolizine (4oa)



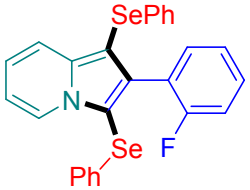
Brown oil (207.5 mg, 77%); IR (KBr): 3052, 2920, 1475, 731, 691 cm^{-1}; ^1H NMR (400 MHz, Chloroform-*d*) δ ppm 8.47 (d, J = 6.5 Hz, 1H), 7.80 (d, J = 9.3 Hz, 1H), 7.43 (d, J = 12.5 Hz, 1H), 7.36-7.27 (m, 3H), 7.25-7.13 (m, 8H), 7.04 (dd, J = 13.4, 5.3 Hz, 3H), 6.75 (t, J = 6.8 Hz, 1H). ^{13}C NMR (100 MHz, Chloroform-*d*) δ ppm 140.8, 140.0, 136.5, 134.6, 133.1, 131.9, 130.9, 129.5, 129.0, 128.9, 128.7, 128.3, 128.1, 127.4, 126.4, 125.7, 125.6, 121.9, 118.9, 112.7, 105.8, 95.0. HRMS MALDI (m/z): calcd for $C_{26}H_{18}ClNSe_2$ $[M + H]^+$: 539.9529, found: 539.9531.

2-(3-bromophenyl)-1,3-bis(phenylselanyl)indolizine (4pa)



Brown solid (215.7 mg, 74%), mp 96.9-99.2 °C; IR (KBr): 3055, 2926, 1473, 734, 691 cm^{-1}; ^1H NMR (400 MHz, Chloroform-*d*) δ ppm 8.44 (d, J = 7.1 Hz, 1H), 7.77 (d, J = 8.7 Hz, 1H), 7.53 (s, 1H), 7.46 (d, J = 8.1 Hz, 1H), 7.34 (d, J = 7.6 Hz, 1H), 7.23-7.14 (m, 9H), 7.06-7.00 (m, 3H), 6.75 (t, J = 6.8 Hz, 1H). ^{13}C NMR (100 MHz, Chloroform-*d*) δ ppm 140.7, 140.0, 136.7, 134.6, 133.8, 132.0, 130.3, 129.5, 129.4, 129.0, 129.0, 128.4, 128.1, 126.4, 125.7, 125.7, 121.9, 121.4, 118.9, 112.7, 105.9, 95.0. HRMS MALDI (m/z): calcd for $C_{26}H_{18}BrNSe_2$ $[M + H]^+$: 583.9021, found: 583.9026.

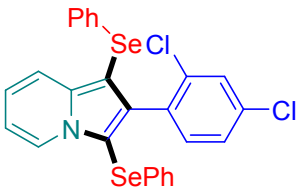
2-(2-fluorophenyl)-1,3-bis(phenylselanyl)indolizine (4qa)



Green solid (185.7 mg, 71%), mp 107.9-110.4 °C; IR (KBr): 3054, 2921, 1475, 741, 687 cm^{-1}; ^1H NMR (400 MHz, Chloroform-*d*) δ ppm 8.37 (d, J = 7.1 Hz, 1H), 7.72 (d, J = 8.9 Hz, 1H), 7.38-7.33 (m, 1H), 7.29 (t, J = 7.5 Hz, 1H), 7.20-7.11 (m, 10H),

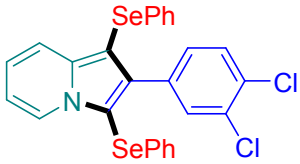
7.07 (d, J = 7.8 Hz, 2H), 7.02-6.97 (m, 1H), 6.72 (t, J = 6.8 Hz, 1H). ^{13}C NMR (100 MHz, Chloroform-*d*) δ ppm 161.3 (J = 246.5 Hz), 139.6, 137.0, 134.3, 133.0 (J = 2.9 Hz), 131.5, 129.6 (J = 8.1 Hz), 129.3, 128.8, 128.4, 128.3, 126.3, 125.6, 125.5, 123.3 (J = 3.6 Hz), 122.8 (J = 15.4 Hz), 121.5, 118.8, 115.4 (J = 22.3 Hz), 112.5, 106.7, 95.9. HRMS MALDI (m/z): calcd for $C_{26}H_{18}FNSe_2$ [M + H]$^+$: 523.9828, found: 523.9831.

2-(2,4-dichlorophenyl)-1,3-bis(phenylselanyl)indolizine (4ra)



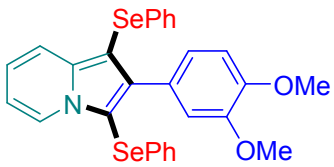
Brown oil (209.1 mg, 73%); IR (KBr): 3069, 2923, 1461, 732, 691 cm^{-1}; ^{1}H NMR (400 MHz, Chloroform-*d*) δ ppm 8.39 (d, J = 7.1 Hz, 1H), 7.74 (d, J = 9.0 Hz, 1H), 7.51 (d, J = 1.9 Hz, 1H), 7.24-7.13 (m, 10H), 7.10-7.05 (m, 2H), 7.04-6.99 (m, 1H), 6.74 (t, J = 6.6 Hz, 1H). ^{13}C NMR (100 MHz, Chloroform-*d*) δ ppm 139.3, 139.2, 135.4, 134.2, 133.9, 133.5, 132.9, 131.2, 129.3, 129.0, 128.8, 128.6, 128.5, 126.4, 126.3, 125.6, 125.6, 121.6, 118.8, 112.6, 106.6, 95.9. HRMS MALDI (m/z): calcd for $C_{26}H_{17}Cl_2NSe_2$ [M + H]$^+$: 573.9134, found: 573.9138.

2-(3,4-dichlorophenyl)-1,3-bis(phenylselanyl)indolizine (4sa)



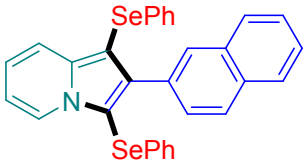
Brown oil (223.4 mg, 78%), IR (KBr): 3052, 2921, 1469, 731, 696 cm^{-1}; ^{1}H NMR (400 MHz, Chloroform-*d*) δ ppm 8.44 (d, J = 7.0 Hz, 1H), 7.76 (d, J = 8.9 Hz, 1H), 7.45 (d, J = 2.0 Hz, 1H), 7.39 (d, J = 8.3 Hz, 1H), 7.22-7.12 (m, 9H), 7.06-7.00 (m, 3H), 6.76 (t, J = 6.8 Hz, 1H). ^{13}C NMR (100 MHz, Chloroform-*d*) δ ppm 140.2, 139.8, 134.7, 134.4, 132.7, 131.9, 131.6, 131.5, 130.1, 129.6, 129.5, 129.1, 128.4, 128.1, 126.5, 125.8, 125.8, 122.1, 119.0, 112.9, 105.9, 94.9. HRMS MALDI (m/z): calcd for $C_{26}H_{17}Cl_2NSe_2$ [M + H]$^+$: 573.9134, found: 573.9138.

2-(3,4-dimethoxyphenyl)-1,3-bis(phenylselanyl)indolizine (4ta)



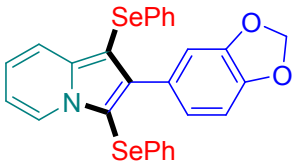
Brown solid (231.7 mg, 82%), mp 155.9-159.0 °C; IR (KBr): 3057, 2924, 1476, 1233, 731, 692 cm^{-1}; ^{1}H NMR (400 MHz, Chloroform-*d*) δ ppm 8.46 (d, J = 7.0 Hz, 1H), 7.75 (d, J = 8.9 Hz, 1H), 7.22-7.11 (m, 8H), 7.05 (d, J = 6.5 Hz, 2H), 7.01 (d, J = 9.0 Hz, 1H), 6.97 (d, J = 8.2 Hz, 1H), 6.84 (d, J = 8.3 Hz, 2H), 6.74 (t, J = 6.2 Hz, 1H), 3.87 (s, 3H), 3.40 (s, 3H). ^{13}C NMR (100 MHz, Chloroform-*d*) δ ppm 148.3, 147.8, 142.2, 140.5, 135.5, 132.8, 129.5, 129.0, 127.7, 127.6, 127.2, 126.1, 125.8, 125.3, 122.7, 121.9, 118.7, 114.0, 112.5, 110.2, 105.4, 94.3, 55.6, 55.0. HRMS MALDI (m/z): calcd for $C_{28}H_{23}NO_2Se_2$ [M + H]$^+$: 566.0133, found: 566.0138.

2-(naphthalen-2-yl)-1,3-bis(phenylselanyl)indolizine (4ua)



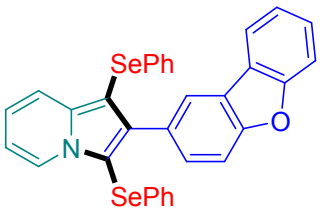
Brown solid (185.9 mg, 67%), mp 113.9-115.4 °C; IR (KBr): 3067, 2912, 1475, 733, 689 cm^{-1}; ^1H NMR (400 MHz, Chloroform-*d*) δ ppm 8.43 (d, J = 7.0 Hz, 1H), 7.87 (d, J = 8.2 Hz, 2H), 7.76 (d, J = 8.9 Hz, 1H), 7.55 (d, J = 8.5 Hz, 1H), 7.46 (d, J = 7.1 Hz, 1H), 7.41 (d, J = 7.2 Hz, 1H), 7.32 (d, J = 6.5 Hz, 1H), 7.25-7.21 (m, 1H), 7.15-7.11 (m, 3H), 7.07 (s, 5H), 7.02 (t, J = 9.8 Hz, 3H), 6.76 (t, J = 6.6 Hz, 1H). ^{13}C NMR (100 MHz, Chloroform-*d*) δ ppm 141.3, 139.5, 134.2, 133.2, 133.1, 133.0, 131.7, 129.2, 128.9, 128.8, 128.7, 128.6, 128.1, 128.0, 126.4, 126.3, 125.7, 125.6, 125.5, 125.4, 124.8, 121.5, 118.7, 112.4, 107.3, 97.1. HRMS MALDI (m/z): calcd for $C_{30}H_{21}NSe_2$ $[M + H]^+$: 556.0079, found: 556.0083.

2-(benzo[d][1,3]dioxol-5-yl)-1,3-bis(phenylselanyl)indolizine (4va)



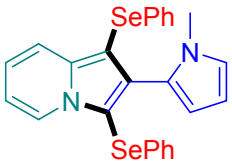
Brown oil (208.6 mg, 76%); IR (KBr): 3053, 2931, 1453, 737, 682 cm^{-1}; ^1H NMR (400 MHz, Chloroform-*d*) δ ppm 8.41 (d, J = 7.0 Hz, 1H), 7.73 (d, J = 8.9 Hz, 1H), 7.22-7.11 (m, 8H), 7.06-6.98 (m, 3H), 6.93-6.87 (m, 2H), 6.81 (d, J = 7.9 Hz, 1H), 6.72 (t, J = 6.8 Hz, 1H), 5.95 (s, 2H). ^{13}C NMR (100 MHz, Chloroform-*d*) δ ppm 147.0, 146.8, 142.1, 139.9, 134.8, 132.2, 129.5, 129.0, 128.3, 128.0, 127.9, 126.2, 125.7, 125.4, 124.5, 121.8, 118.8, 112.5, 111.2, 107.6, 105.5, 100.9, 94.7. HRMS MALDI (m/z): calcd for $C_{27}H_{19}NO_2Se_2$ $[M + H]^+$: 549.9820, found: 549.9824.

2-(dibenzo[b,d]furan-2-yl)-1,3-bis(phenylselanyl)indolizine (4wa)



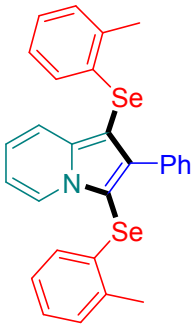
Brown oil (229.1 mg, 77%); IR (KBr): 3061, 2924, 1462, 735, 683 cm^{-1};^1H NMR (400 MHz, Chloroform-*d*) δ ppm 8.49 (d, J = 7.0 Hz, 1H), 7.90-7.85 (m, 1H), 7.80 (d, J = 8.9 Hz, 1H), 7.67 (d, J = 7.5 Hz, 1H), 7.58-7.53 (m, 2H), 7.50 (d, J = 8.5 Hz, 1H), 7.46-7.41 (m, 1H), 7.29 (t, J = 7.1 Hz, 1H), 7.21 (d, J = 3.1 Hz, 8H), 7.09-7.03 (m, 3H), 6.77 (t, J = 6.2 Hz, 1H). ^{13}C NMR (100 MHz, Chloroform-*d*) δ ppm 156.4, 155.7, 142.3, 140.2, 135.2, 132.5, 131.4, 130.0, 129.5, 129.0, 128.4, 128.1, 126.9, 126.3, 125.8, 125.6, 124.3, 123.6, 123.2, 122.5, 121.9, 120.6, 118.9, 112.6, 111.5, 110.7, 106.0, 95.3. HRMS MALDI (m/z): calcd for $C_{32}H_{21}NOSe_2$ $[M + H]^+$: 596.0028, found: 596.0033.

2-(1-methyl-1H-pyrrol-2-yl)-1,3-bis(phenylselanyl)indolizine (4xa)



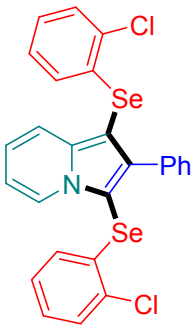
Brown oil (147.3 mg, 58%); IR (KBr): 3068, 2920, 1544, 1020, 735, 685 cm^{-1}; ^1H NMR (400 MHz, Chloroform-*d*) δ ppm 8.35 (d, J = 7.0 Hz, 1H), 7.68 (d, J = 8.9 Hz, 1H), 7.20-7.03 (m, 10H), 7.01-6.95 (m, 3H), 6.77-6.73 (m, 1H), 6.10 (d, J = 1.2 Hz, 1H), 3.16 (s, 3H). ^{13}C NMR (100 MHz, Chloroform-*d*) δ ppm 139.4, 133.4, 133.0, 131.3, 129.5, 129.4, 128.9, 128.8, 128.1, 126.7, 126.0, 125.7, 121.8, 119.0, 113.6, 112.9, 108.6, 104.5, 97.8, 97.4, 34.6. HRMS MALDI (m/z): calcd for $C_{25}H_{20}N_2Se_2$ $[M + H]^+$: 509.0031, found: 509.0034.

2-phenyl-1,3-bis(o-tolylselanyl)indolizine(5ab)



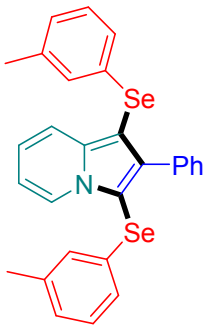
Brown solid (207.9 mg, 78%), mp 115.8-118.3 °C; IR (KBr): 3051, 2923, 1475, 731, 688 cm^{-1}; ^1H NMR (400 MHz, Chloroform-*d*) δ ppm 8.31 (d, J = 7.0 Hz, 1H), 7.66 (d, J = 8.9 Hz, 1H), 7.37-7.33 (m, 2H), 7.28-7.32 (m, 3H), 7.17-7.07 (m, 3H), 7.06-7.02 (m, 1H), 7.01-6.96 (m, 1H), 6.92 (t, J = 7.6 Hz, 2H), 6.76-6.69 (m, 2H), 6.48 (d, J = 7.7 Hz, 1H), 2.39 (d, J = 2.4 Hz, 6H). ^{13}C NMR (100 MHz, Chloroform-*d*) δ ppm 142.9, 140.3, 136.3, 136.0, 135.5, 134.6, 132.8, 130.6, 130.4, 129.8, 127.5, 127.4, 127.2, 126.9, 126.6, 126.5, 126.0, 125.9, 125.1, 121.7, 118.9, 112.5, 104.6, 93.9, 21.2, 21.0. HRMS MALDI (m/z): calcd for $C_{28}H_{23}NSe_2$ $[M + H]^+$: 534.0235, found: 534.0239.

1,3-bis((2-chlorophenyl)selanyl)-2-phenylindolizine (5ac)



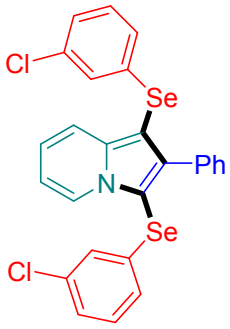
Yellow solid (212.0 mg, 74%), mp 152.9-154.7 °C; IR (KBr): 3062, 2921, 1476, 734, 687 cm^{-1}; ^1H NMR (400 MHz, Chloroform-*d*) δ ppm 8.35 (d, J = 6.9 Hz, 1H), 7.68 (d, J = 8.9 Hz, 1H), 7.36-7.28 (m, 7H), 7.13-7.09 (m, 1H), 7.07-7.02 (m, 2H), δ 6.99 (d, J = 8.5 Hz, 1H), 6.95 (d, J = 7.2 Hz, 1H), 6.77 (t, J = 6.8 Hz, 1H), 6.64 (d, J = 7.9 Hz, 1H), 6.39 (d, J = 7.9 Hz, 1H). ^{13}C NMR (100 MHz, Chloroform-*d*) δ ppm 143.6, 140.7, 135.1, 134.0, 132.6, 132.5, 132.1, 130.5, 129.8, 129.3, 128.1, 127.7, 127.7, 127.2, 127.2, 126.3, 126.0, 122.4, 118.9, 113.0, 104.7, 93.7. HRMS MALDI (m/z): calcd for $C_{26}H_{17}Cl_2NSe_2$ $[M + H]^+$: 509.0031, found: 509.0034.

2-phenyl-1,3-bis(m-tolylselanyl)indolizine (5ad)



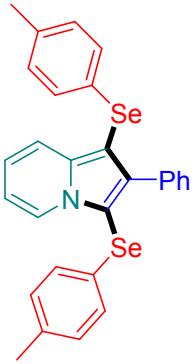
Brown oil (218.5 mg, 82%); IR (KBr): 3057, 2927, 1475, 727, 692 cm^{-1}; ^{1}H NMR (400 MHz, Chloroform-*d*) δ ppm 8.41 (d, J = 7.0 Hz, 1H), 7.72 (d, J = 8.9 Hz, 1H), 7.40-7.43 (m, 2H), 7.37-7.32 (m, 3H), 7.08-6.97 (m, 5H), 6.93-6.88 (m, 3H), 6.78 (d, J = 7.7 Hz, 1H), 6.72 (t, J = 6.8 Hz, 1H), 2.25 (d, J = 3.6 Hz, 6H). ^{13}C NMR (100 MHz, Chloroform-*d*) δ ppm 142.4, 140.0, 139.3, 138.6, 134.9, 134.7, 132.1, 130.9, 129.2, 128.8, 128.7, 128.6, 127.5, 127.4, 127.1, 126.3, 125.8, 125.1, 124.9, 121.6, 118.9, 112.4, 105.6, 94.7, 21.4, 21.4. HRMS MALDI (m/z): calcd for $C_{28}H_{23}NSe_2$ $[M + H]^+$: 534.0235, found: 534.0239.

1,3-bis((3-chlorophenyl)selanyl)-2-phenylindolizine (5ae)



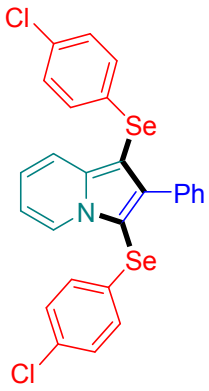
Yellow solid (226.3 mg, 79%), mp 109.1-111.7 °C; IR (KBr): 3062, 2921, 1476, 734, 687 cm^{-1}; ^{1}H NMR (400 MHz, Chloroform-*d*) δ ppm 8.39 (d, J = 6.9 Hz, 1H), 7.70 (d, J = 8.8 Hz, 1H), 7.38-7.33 (m, 5H), 7.09-7.15 (m, 2H), 7.08-7.02 (m, 5H), 6.97 (d, J = 4.9 Hz, 1H), 6.83 (d, J = 7.8 Hz, 1H), 6.77 (t, J = 6.8 Hz, 1H). ^{13}C NMR (100 MHz, Chloroform-*d*) δ ppm 142.9, 140.2, 136.8, 135.3, 134.9, 134.3, 134.1, 130.7, 130.5, 129.9, 127.7, 126.5, 126.0, 125.9, 125.7, 125.6, 122.4, 118.8, 112.9, 105.2, 94.3. HRMS MALDI (m/z): calcd for $C_{26}H_{17}Cl_2NSe_2$ $[M + H]^+$: 509.0031, found: 509.0034.

2-phenyl-1,3-bis(p-tolylselanyl)indolizine (5af)



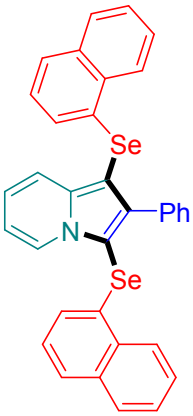
Green solid (229.2 mg, 86%), mp 116.9-119.4 °C; IR (KBr): 3052, 2929, 1470, 729, 682 cm^{-1}; ^{1}H NMR (400 MHz, Chloroform-*d*) δ ppm 8.44 (d, J = 7.0 Hz, 1H), 7.76 (d, J = 8.9 Hz, 1H), 7.44-7.48 (m, 2H), 7.41-7.36 (m, 3H), 7.07 (t, J = 9.0 Hz, 3H), 7.03-6.97 (m, 6H), 6.72 (t, J = 6.2 Hz, 1H), 2.30 (d, J = 2.5 Hz, 6H). ^{13}C NMR (100 MHz, Chloroform-*d*) δ ppm 142.2, 139.8, 136.1, 135.1, 134.8, 131.0, 130.9, 130.2, 129.7, 128.3, 128.3, 128.2, 127.4, 127.3, 125.7, 121.5, 118.8, 112.3, 105.8, 95.0, 20.9, 20.9. HRMS MALDI (m/z): calcd for $C_{28}H_{23}NSe_2$ $[M + H]^+$: 534.0235, found: 534.0239.

1,3-bis((4-chlorophenyl)selanyl)-2-phenylindolizine (5ag)



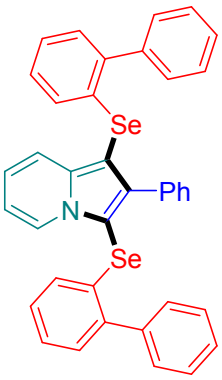
Yellow solid (226.3 mg, 79%), mp 130.2-132.9 °C; IR (KBr): 3068, 2929, 1475, 729, 693 cm^{-1}; ^1H NMR (400 MHz, Chloroform-*d*) δ ppm 8.37 (d, J = 6.9 Hz, 1H), 7.68 (d, J = 8.9 Hz, 1H), 7.36-7.31 (m, 5H), 7.14 (d, J = 8.5 Hz, 2H), 7.10 (d, J = 8.6 Hz, 2H), 7.04-6.99 (m, 3H), 6.92 (d, J = 8.5 Hz, 2H), 6.76 (t, J = 6.8 Hz, 1H). ^{13}C NMR (100 MHz, Chloroform-*d*) δ ppm 142.6, 140.0, 134.4, 133.0, 132.4, 131.5, 130.7, 130.3, 129.6, 129.5, 129.4, 129.1, 127.7, 127.6, 125.7, 122.2, 118.8, 112.8, 105.4, 94.7. HRMS MALDI (m/z): calcd for $C_{26}H_{17}Cl_2NSe_2$ $[M + H]^+$: 509.0031, found: 509.0034.

1,3-bis(naphthalen-1-ylselanyl)-2-phenylindolizine (5ah)



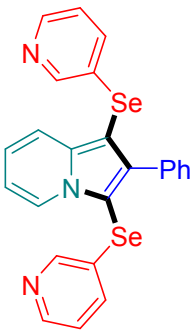
Yellow solid (245.0 mg, 81%), mp 135.2-137.5 °C; IR (KBr): 3041, 2941, 1470, 733, 692 cm^{-1}; ^1H NMR (400 MHz, Chloroform-*d*) δ ppm 8.26 (d, J = 6.9 Hz, 1H), 8.08 (d, J = 8.8 Hz, 1H), 8.01-7.95 (m, 1H), 7.78-7.71 (m, 2H), 7.62-7.53 (m, 3H), 7.46-7.37 (m, 6H), 7.22-7.17 (m, 3H), 7.10 (t, J = 7.8 Hz, 2H), 6.96 (d, J = 7.3 Hz, 1H), 6.88-6.82 (m, 1H), 6.76 (d, J = 7.3 Hz, 1H), 6.56 (t, J = 6.8 Hz, 1H). ^{13}C NMR (100 MHz, Chloroform-*d*) δ ppm 143.0, 140.4, 134.5, 134.1, 133.8, 133.7, 132.2, 132.1, 130.7, 130.5, 128.6, 128.4, 127.6, 127.5, 126.8, 126.4, 126.3, 126.2, 126.0, 126.0, 125.9, 125.7, 125.5, 125.4, 121.8, 118.9, 112.5, 104.4, 93.9. HRMS MALDI (m/z): calcd for $C_{34}H_{23}NSe_2$ $[M + H]^+$: 606.0235, found: 606.0241.

1,3-bis([1,1'-biphenyl]-2-ylselanyl)-2-phenylindolizine (5ai)



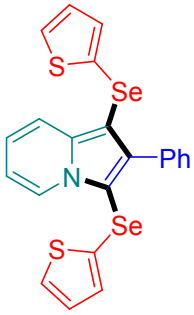
Brown solid (243.1 mg, 74%), mp 162.3-164.4 °C; IR (KBr): 3053, 2911, 1483, 740, 689 cm^{-1}; ^1H NMR (400 MHz, Chloroform-*d*) δ ppm 8.22 (d, J = 7.1 Hz, 1H), 7.60 (d, J = 8.9 Hz, 1H), 7.52-7.35 (m, 13H), 7.33-7.29 (m, 3H), 7.24-7.19 (m, 2H), 7.16 (t, J = 6.7 Hz, 1H), 7.07-7.02 (m, 2H), 6.98-6.94 (m, 1H), 6.82 (d, J = 8.0 Hz, 1H), 6.68 (t, J = 6.8 Hz, 1H), 6.55 (d, J = 7.7 Hz, 1H). ^{13}C NMR (100 MHz, Chloroform-*d*) δ ppm 142.8, 141.8, 141.4, 141.3, 140.8, 140.3, 134.8, 134.5, 132.1, 130.7, 130.4, 129.9, 129.0, 128.8, 128.5, 128.4, 128.3, 127.9, 127.9, 127.7, 127.6, 127.5, 127.3, 127.1, 126.1, 125.9, 125.2, 121.7, 118.9, 112.5, 105.9, 95.1. HRMS MALDI (m/z): calcd for $C_{38}H_{27}NSe_2$ $[M + H]^+$: 658.0548, found: 658.0555.

2-phenyl-1,3-bis(pyridin-3-ylselanyl)indolizine (5aj)



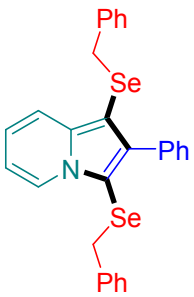
Yellow solid (212.9 mg, 84%), mp 120.8-123.5 °C; IR (KBr): 3026, 2922, 1540, 1406, 1014, 744, 702 cm^{-1}; ^1H NMR (400 MHz, Chloroform-*d*) δ ppm 8.39 (d, J = 7.0 Hz, 1H), 8.36 (d, J = 4.7 Hz, 1H), 8.30 (d, J = 6.8 Hz, 3H), 7.69 (d, J = 8.9 Hz, 1H), 7.38-7.29 (m, 6H), 7.24 (d, J = 8.4 Hz, 1H), 7.09-7.00 (m, 3H), 6.76 (t, J = 6.9 Hz, 1H). ^{13}C NMR (100 MHz, Chloroform-*d*) δ ppm 149.0, 147.6, 146.5, 142.8, 140.0, 136.4, 136.1, 134.1, 131.7, 130.7, 127.8, 127.7, 125.6, 124.4, 124.0, 122.4, 118.7, 113.0, 104.5, 93.8. HRMS MALDI (m/z): calcd for $C_{24}H_{17}N_3Se_2$ $[M + H]^+$: 507.9827, found: 507.9830.

2-phenyl-1,3-bis(thiophen-2-ylselanyl)indolizine (5ak)



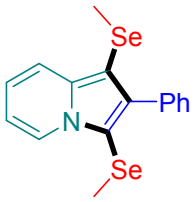
Brown solid (183.5 mg, 71%), mp 95.3-97.8 °C; IR (KBr): 3020, 2922, 1629, 1492, 741, 694 cm^{-1}; ^1H NMR (400 MHz, Chloroform-*d*) δ ppm 8.57 (d, J = 6.4 Hz, 1H), 7.85 (d, J = 8.5 Hz, 1H), 7.54-7.44 (m, 5H), 7.23 (d, J = 5.3 Hz, 1H), 7.18 (d, J = 5.1 Hz, 1H), 7.03 (d, J = 7.0 Hz, 1H), 7.00 (d, J = 3.3 Hz, 1H), 6.93 (d, J = 2.8 Hz, 1H), 6.89-6.85 (m, 1H), 6.84-6.80 (m, 1H), 6.76 (t, J = 6.8 Hz, 1H). ^{13}C NMR (100 MHz, Chloroform-*d*) δ ppm 141.0, 138.8, 134.8, 132.4, 131.8, 131.5, 129.3, 128.7, 128.6, 127.8, 127.5, 127.5, 125.5, 125.4, 121.6, 118.8, 112.3, 107.5, 97.8. HRMS MALDI (m/z): calcd for $C_{22}H_{15}NS_2Se_2$ $[M + H]^+$: 517.9048, found: 517.9051.

1,3-bis(benzylselanyl)-2-phenylindolizine (5al)



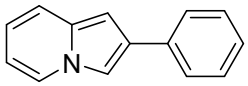
Brown oil (213.2 mg, 80%); IR (KBr): 3024, 2926, 1492, 1342, 743, 692 cm^{-1}; ^1H NMR (400 MHz, Chloroform-*d*) δ ppm 8.23 (d, J = 7.0 Hz, 1H), 7.47-7.43 (m, 3H), 7.38 (d, J = 8.9 Hz, 1H), 7.28 (d, J = 6.6 Hz, 2H), 7.18-7.11 (m, 6H), 6.94 (d, J = 7.8 Hz, 2H), 6.89 (d, J = 7.4 Hz, 2H), 6.82-6.78 (m, 1H), 6.54 (t, J = 6.8 Hz, 1H), 3.76 (s, 2H), 3.67 (s, 2H). ^{13}C NMR (100 MHz, Chloroform-*d*) δ ppm 142.0, 139.3, 139.2, 138.5, 135.4, 131.0, 128.6, 128.4, 128.3, 128.0, 127.3, 127.0, 126.7, 126.2, 125.2, 120.2, 118.5, 111.3, 106.5, 95.8, 33.0, 32.8. ^{77}Se NMR (76 MHz, Chloroform-d) δ ppm 202.2, 184.4. HRMS MALDI (m/z): calcd for $C_{28}H_{23}NSe_2$ $[M + H]^+$: 534.0235, found: 534.0239.

1,3-bis(methylselanyl)-2-phenylindolizine (5am)



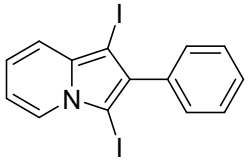
Brown oil (117.8 mg, 62%); IR (KBr): 3057, 2920, 1492, 1340, 748, 698 cm^{-1}; ^{1}H NMR (400 MHz, Chloroform-*d*) δ ppm 8.51 (d, J = 7.1 Hz, 1H), 7.72 (d, J = 9.0 Hz, 1H), 7.45-7.55 (m, 4H), 7.42 (t, J = 7.0 Hz, 1H), 7.00-6.89 (m, 1H), 6.73 (t, J = 6.3 Hz, 1H), 2.00 (s, 3H), 1.94 (s, 3H). ^{13}C NMR (100 MHz, Chloroform-*d*) δ ppm140.1, 138.0, 135.6, 130.9, 127.5, 127.2, 125.5, 120.0, 118.9, 111.6, 107.1, 96.6, 9.8, 8.7. ^{77}Se NMR (76 MHz, Chloroform-d) δ ppm 21.2, 1.6. HRMS MALDI (m/z): calcd for $C_{16}H_{15}NSe_2$ $[M + H]^+$: 381.9609., found: 381.9607.

2-phenylindolizine (6aa)



Brown solid (57.9 mg, 60%); mp 213.6-215.2 °C; IR (KBr): 3101, 1631, 1454, 727, 688 cm^{-1}; ^{1}H NMR (400 MHz, Chloroform-*d*) δ ppm 7.89 (d, J = 7.0 Hz, 1H), 7.67 (d, J = 7.2 Hz, 2H), 7.58 (s, 1H), 7.40 (t, J = 7.7 Hz, 2H), 7.35 (d, J = 9.0 Hz, 1H), 7.29-7.23 (m, 1H), 6.70 (s, 1H), 6.68-6.60 (m, 1H), 6.45 (t, J = 6.5 Hz, 1H). ^{13}C NMR (100 MHz, Chloroform-*d*) δ ppm 135.3, 133.6, 129.4, 128.7, 126.5, 126.2, 125.0, 119.0, 117.3, 110.5, 109.2, 96.6. MS (EI) calcd for $C_{14}H_{11}N$: 193.1, found: 193.1.

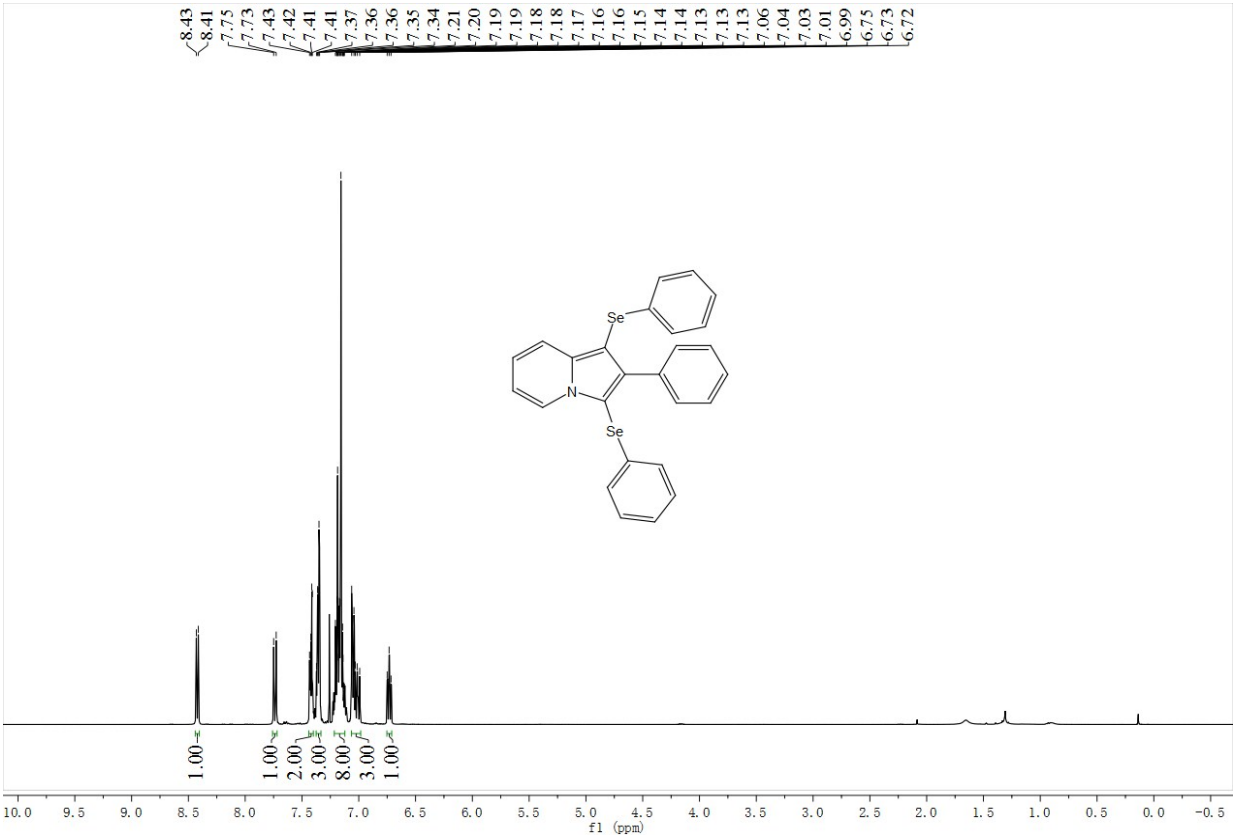
1,3-diiodo-2-phenylindolizine (7aa)

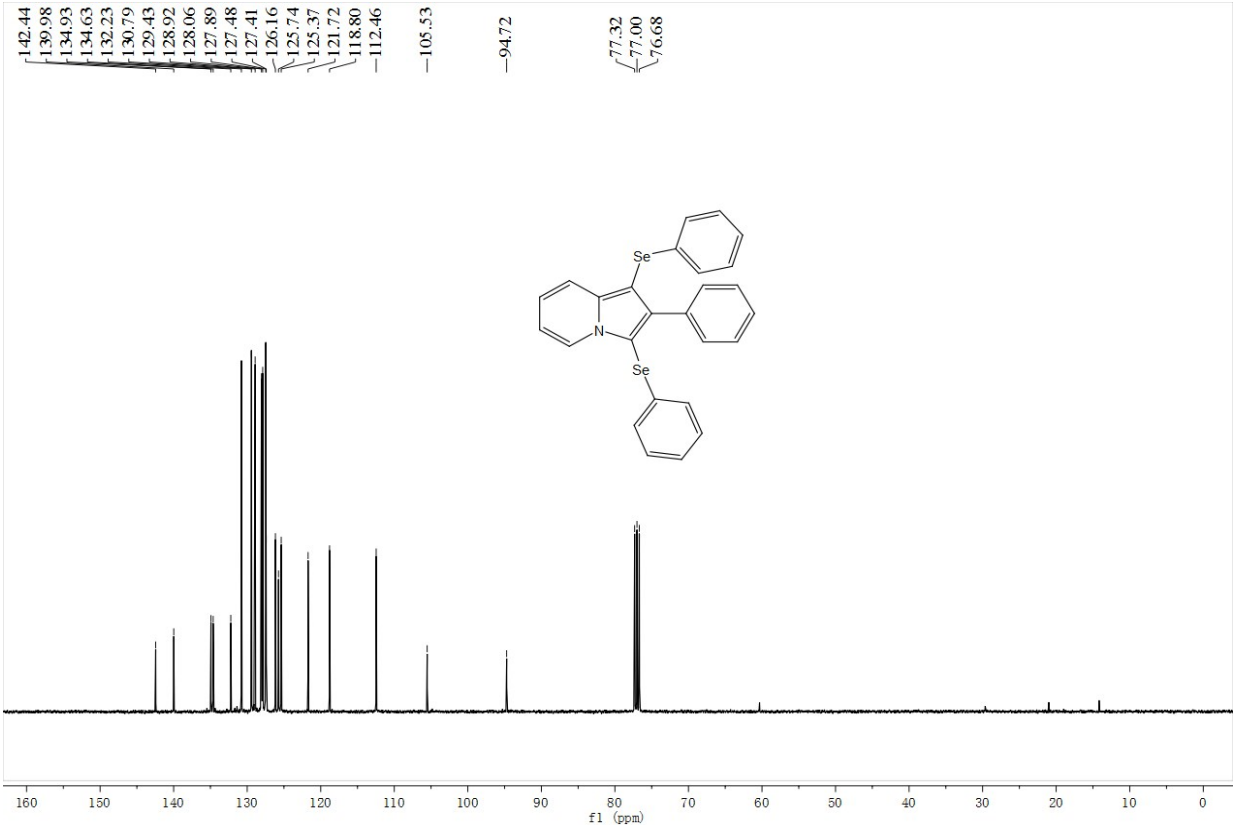


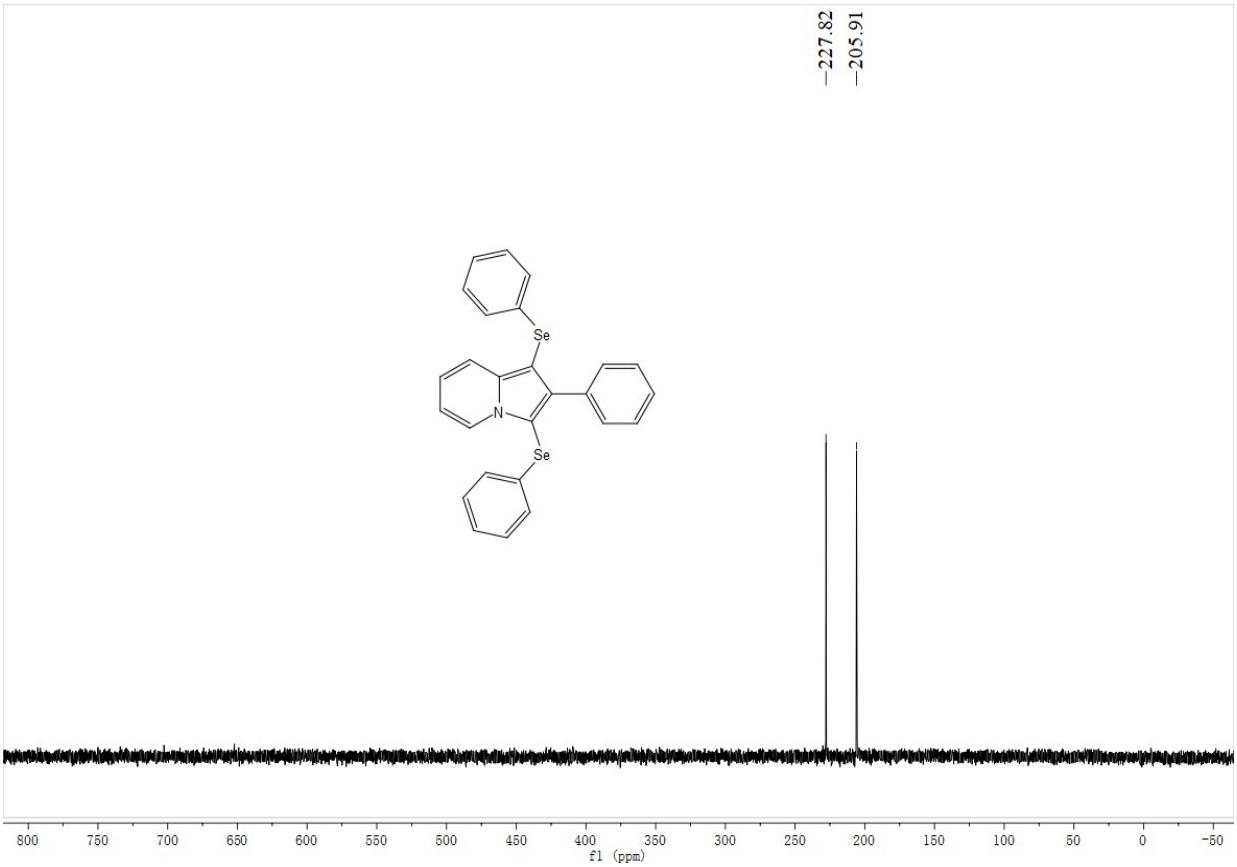
Unstable white solid (193.5 mg, 87%); IR (KBr): 2920, 2848, 1631, 1348, 725, 702 cm^{-1}; ^{1}H NMR (400 MHz, Chloroform-*d*) δ ppm 8.06 (d, J = 7.0 Hz, 1H), 7.55-7.40 (m, 5H), 7.35 (d, J = 9.0 Hz, 1H), 6.91-6.82 (m, 1H), 6.71 (t, J = 6.8 Hz, 1H). ^{13}C NMR (100 MHz, Chloroform-*d*) δ ppm 137.9, 136.4, 135.4, 130.7, 128.0, 127.9, 127.4, 119.8, 119.7, 112.4, 62.2, 55.4. MS (EI) calcd for $C_{14}H_9I_2N$: 444.9, found: 444.9.

F. NMR Spectra

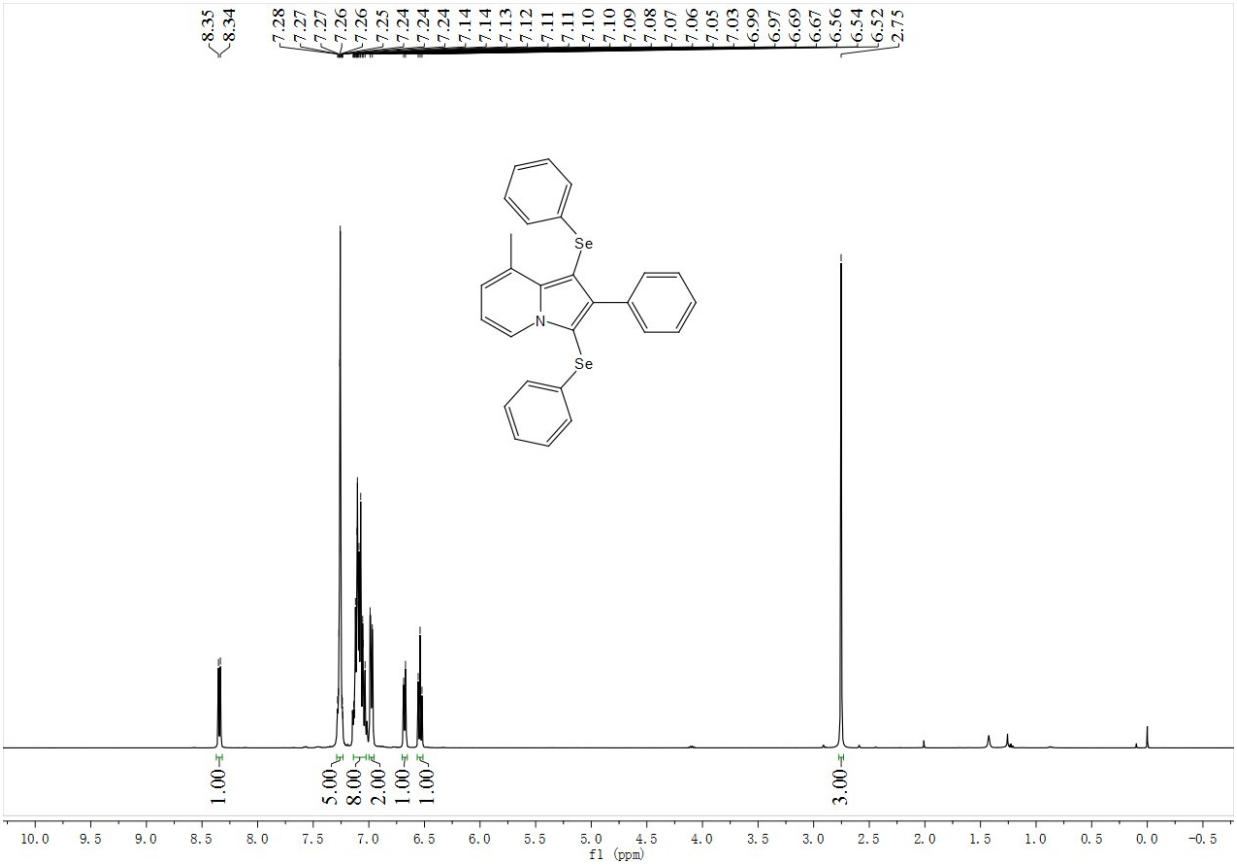
4aa






227.82
205.91
Se
N
Se
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
-50
f1 (ppm)

4ab


8.35
8.34
7.28
7.27
7.27
7.26
7.26
7.25
7.24
7.24
7.24
7.14
7.13
7.12
7.11
7.11
7.10
7.10
7.09
7.08
7.07
7.06
7.05
7.03
6.99
6.97
6.69
6.67
6.56
6.54
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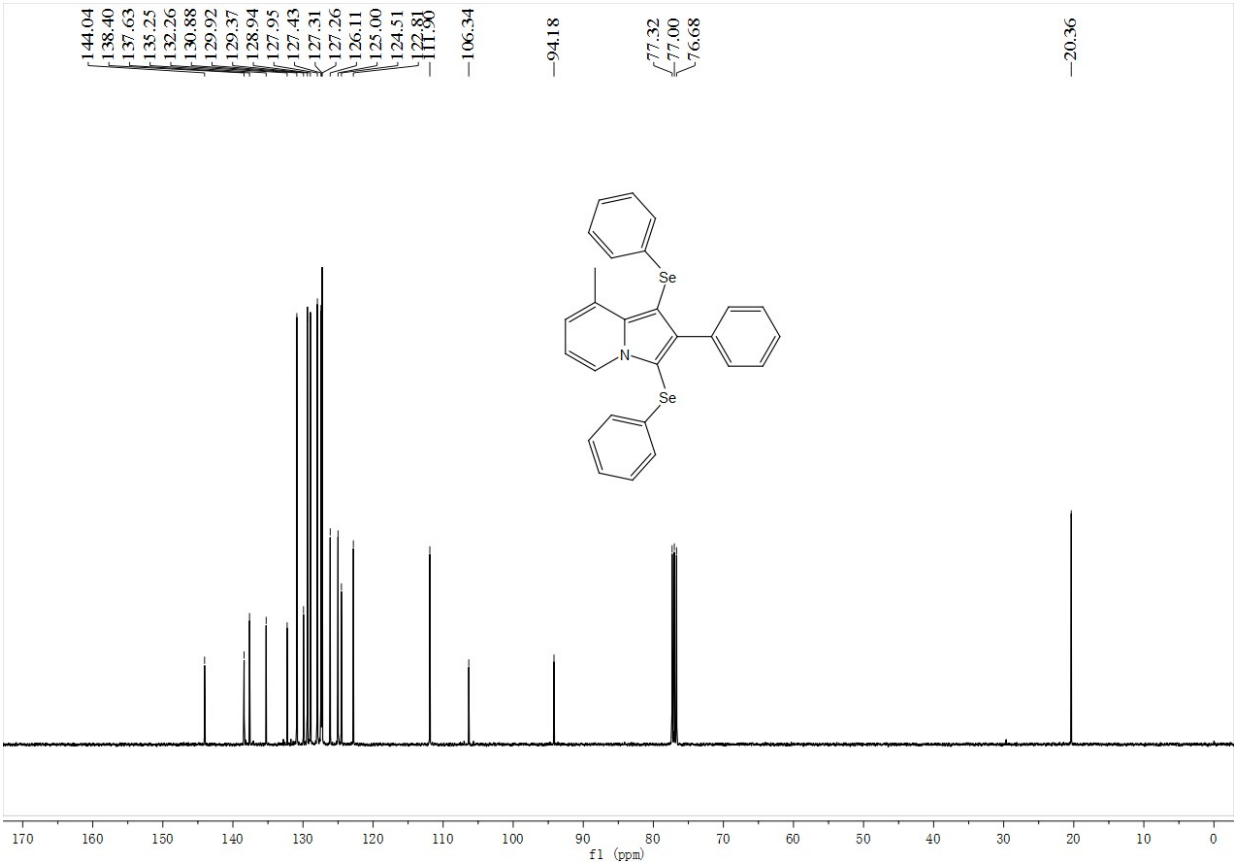
2.00
1.00
1.00
3.00
f1 (ppm)


144.04
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135.25
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129.92
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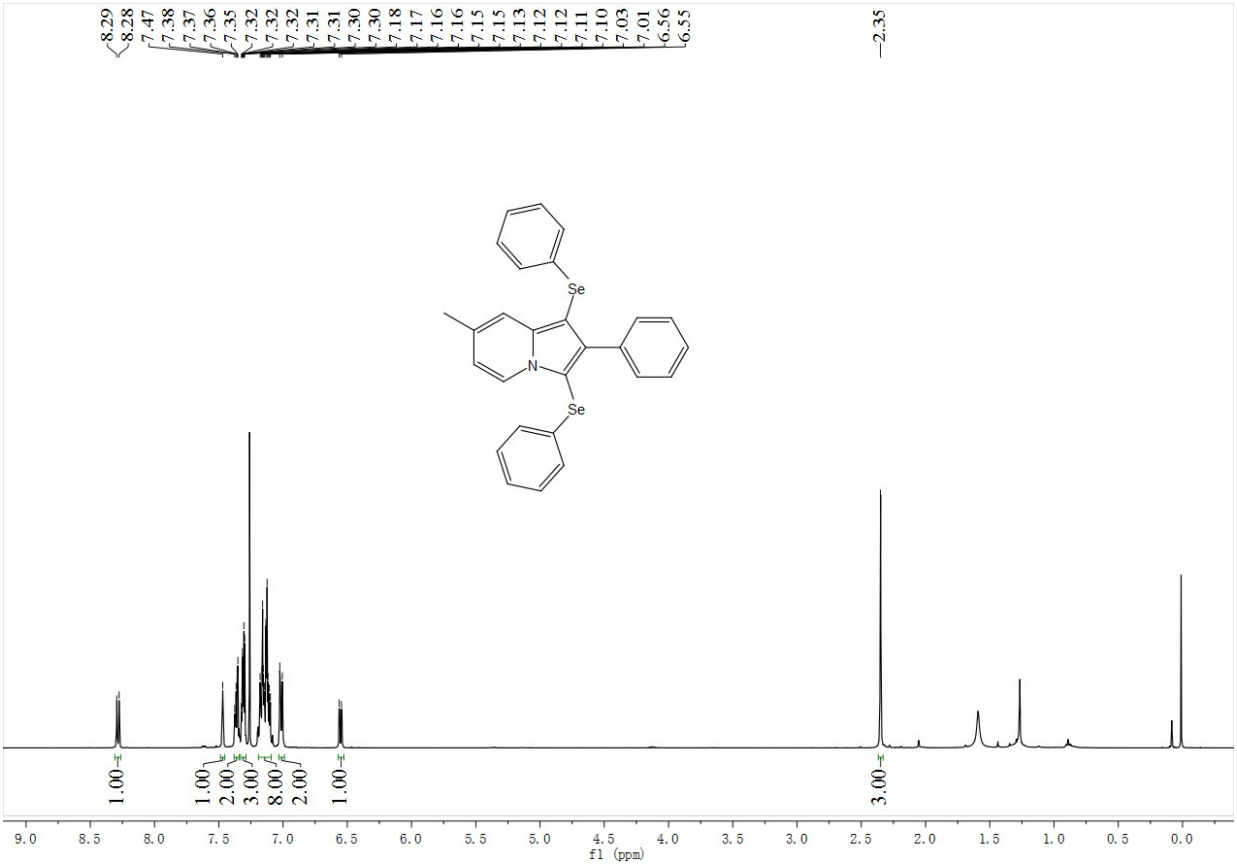
128.94
127.95
127.43
127.31
127.26
126.11
125.00
124.51
122.81
111.90
106.34
94.18
77.32
77.00
76.68
20.36
Se
N
Se
f1 (ppm)

4ac


8.29
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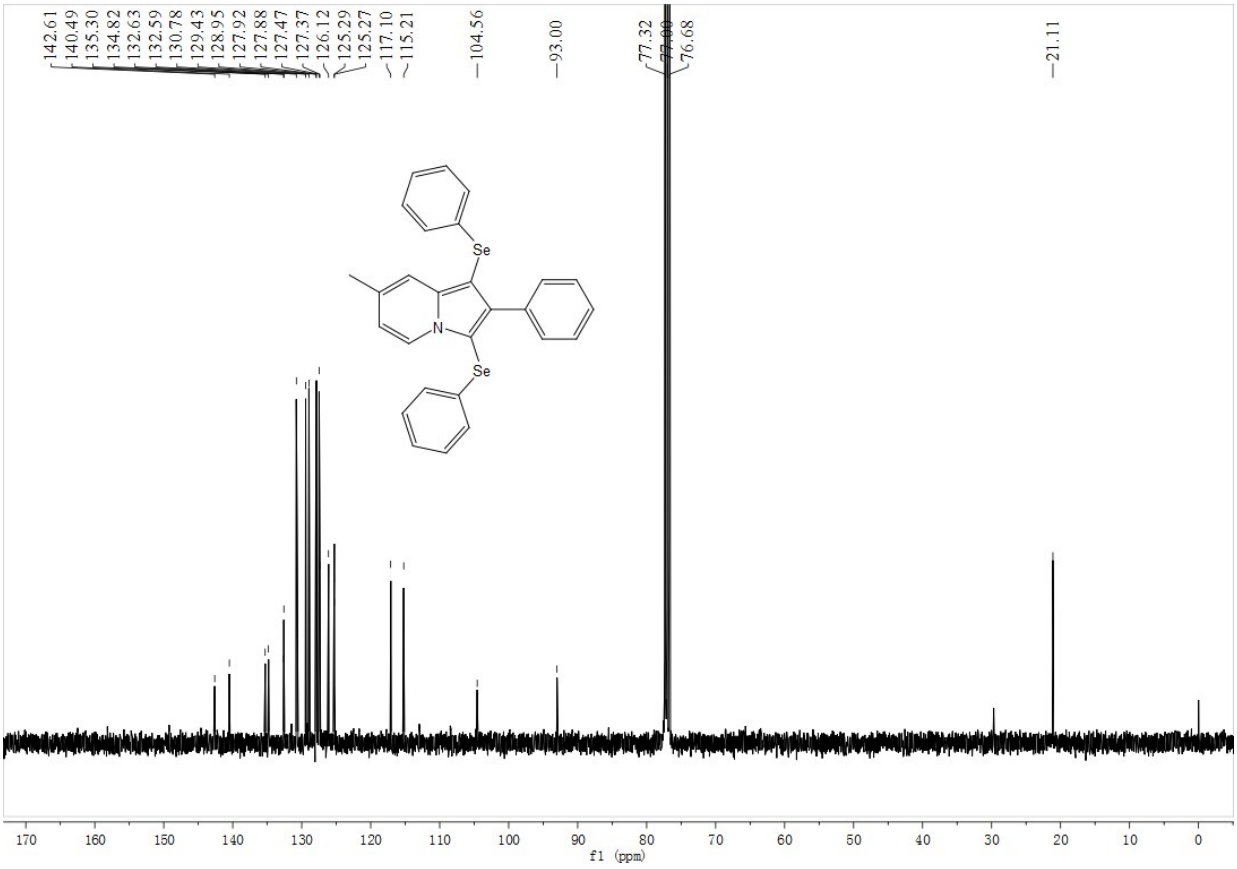
7.36
7.35
7.32
7.32
7.32
7.31
7.31
7.30
7.30
7.18
7.17
7.16
7.16
7.15
7.15
7.13
7.12
7.12
7.11
7.10
7.03
7.01
6.56
6.55
2.35
Se
N
Se
1.00
1.00
2.00
3.00
8.00
2.00
1.00
3.00
f1 (ppm)


142.61
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130.78
129.43
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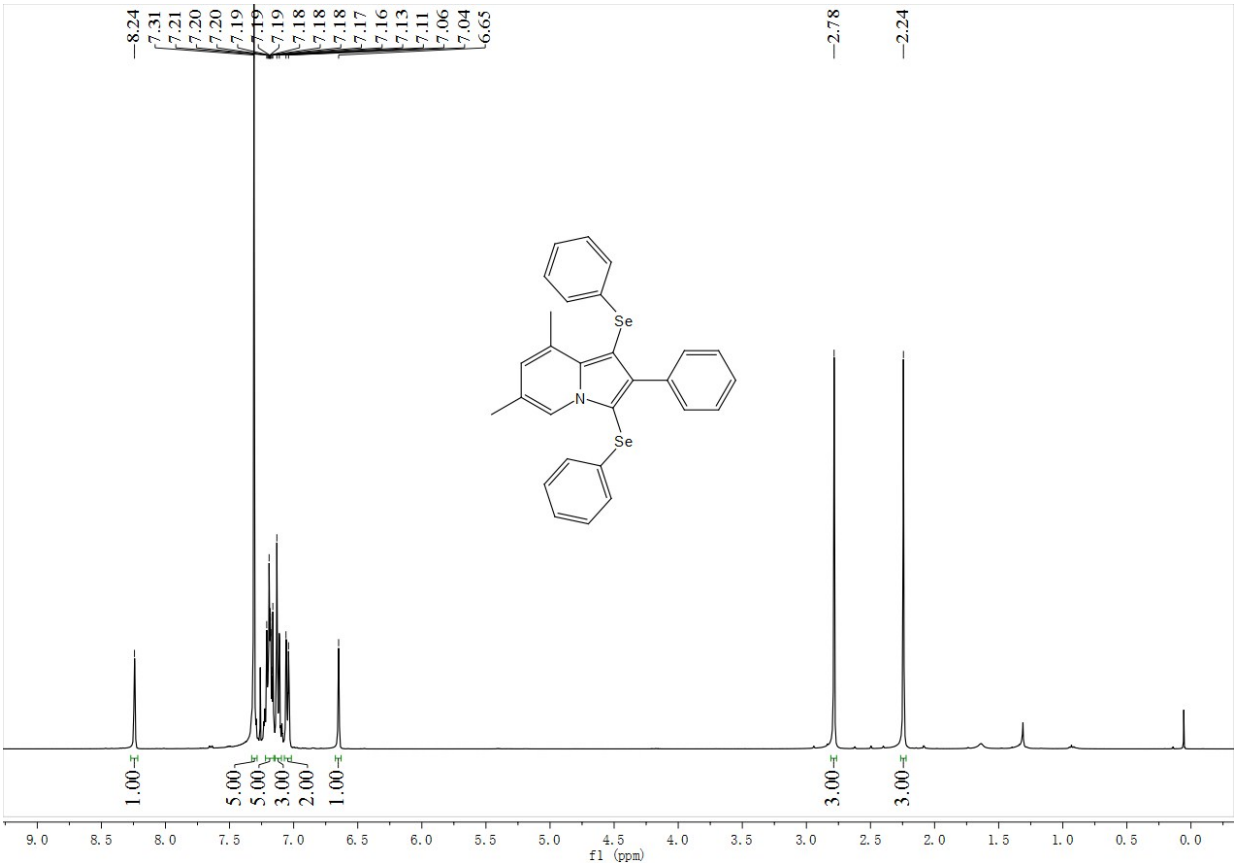
126.12
125.29
125.27
117.10
115.21
104.56
93.00
77.32
77.06
76.68
21.11
Se
N
Se
f1 (ppm)

4ad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7.20
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7.19
7.18
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7.17
7.16
7.13
7.11
7.06
7.04
6.65
2.78
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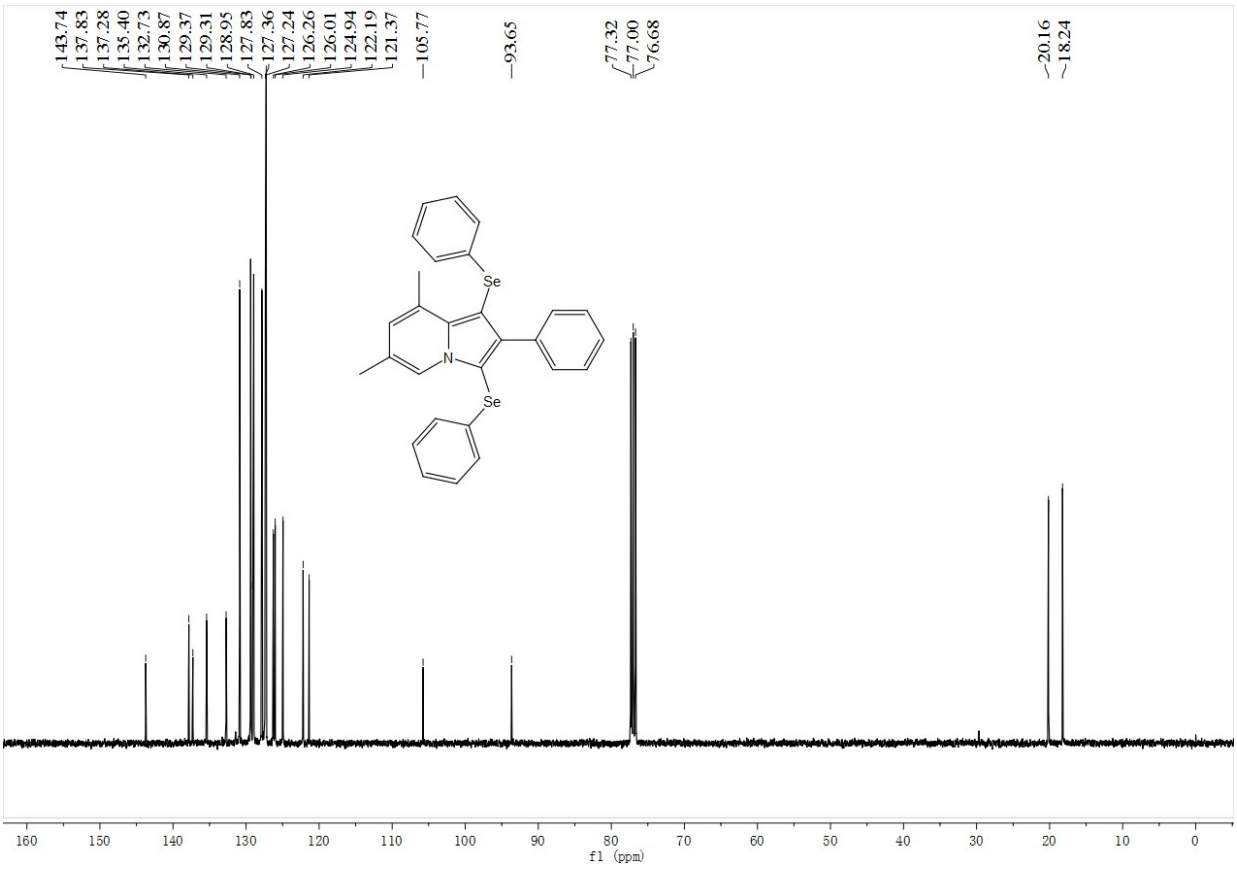
5.00
5.00
3.00
2.00
1.00
3.00
3.00
f1 (ppm)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127.83
127.36
127.24
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126.01
124.94
122.19
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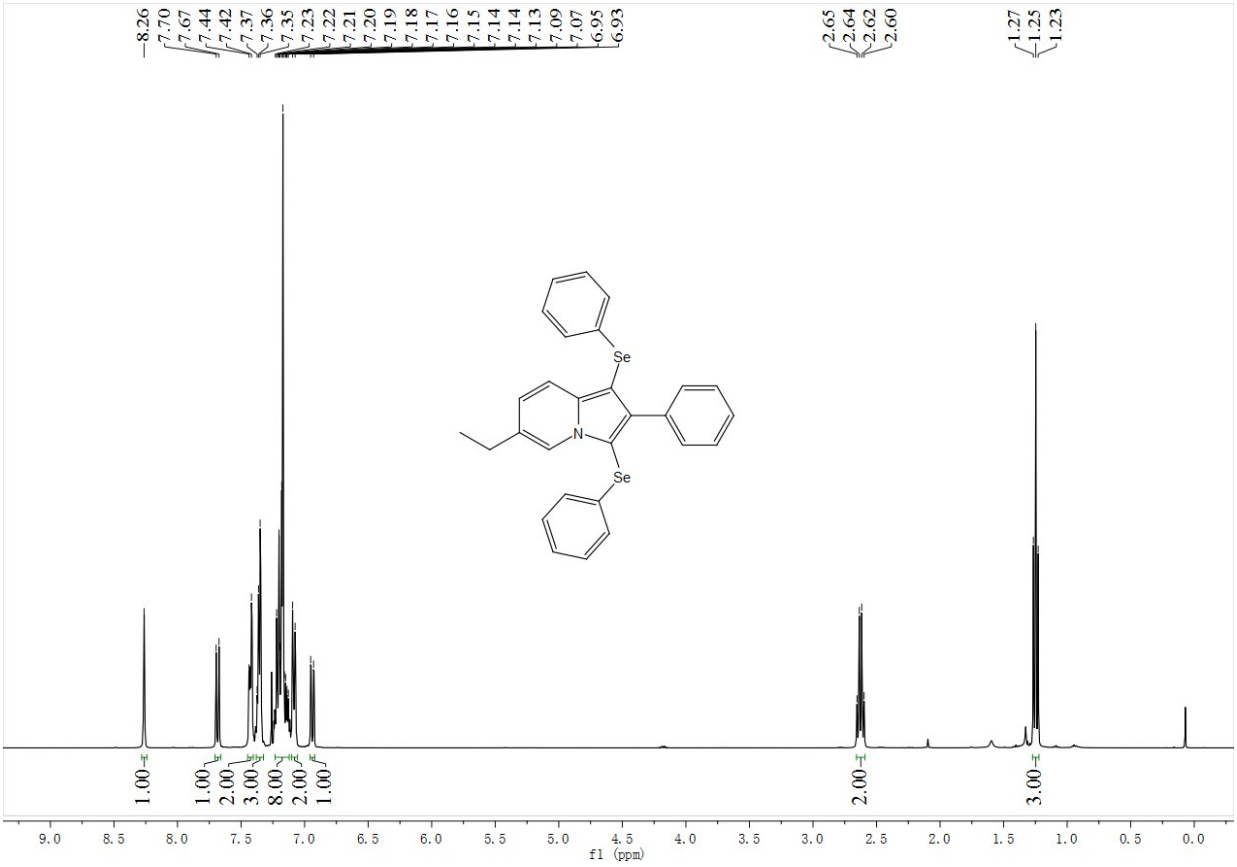
77.32
77.00
76.68
20.16
18.24
Se
N
Se
f1 (ppm)

4ae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7.19
7.18
7.17
7.16
7.15
7.14
7.14
7.13
7.09
7.07
6.95
6.93
2.65
2.64
2.62
2.60
1.27
1.25
1.23
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2.00
3.00
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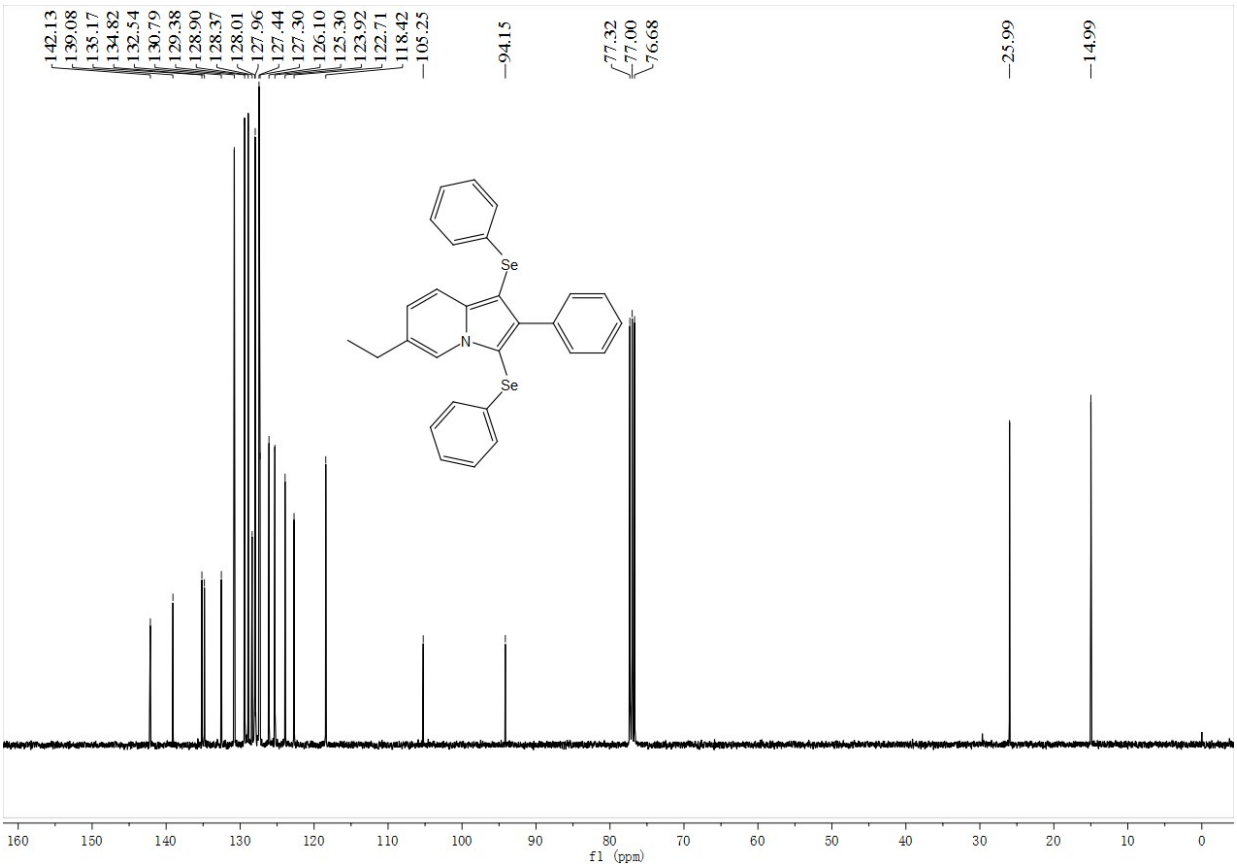
1.00
2.00
3.00
f1 (ppm)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128.01
127.96
127.44
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126.10
125.30
123.92
122.71
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77.00
76.68
25.99
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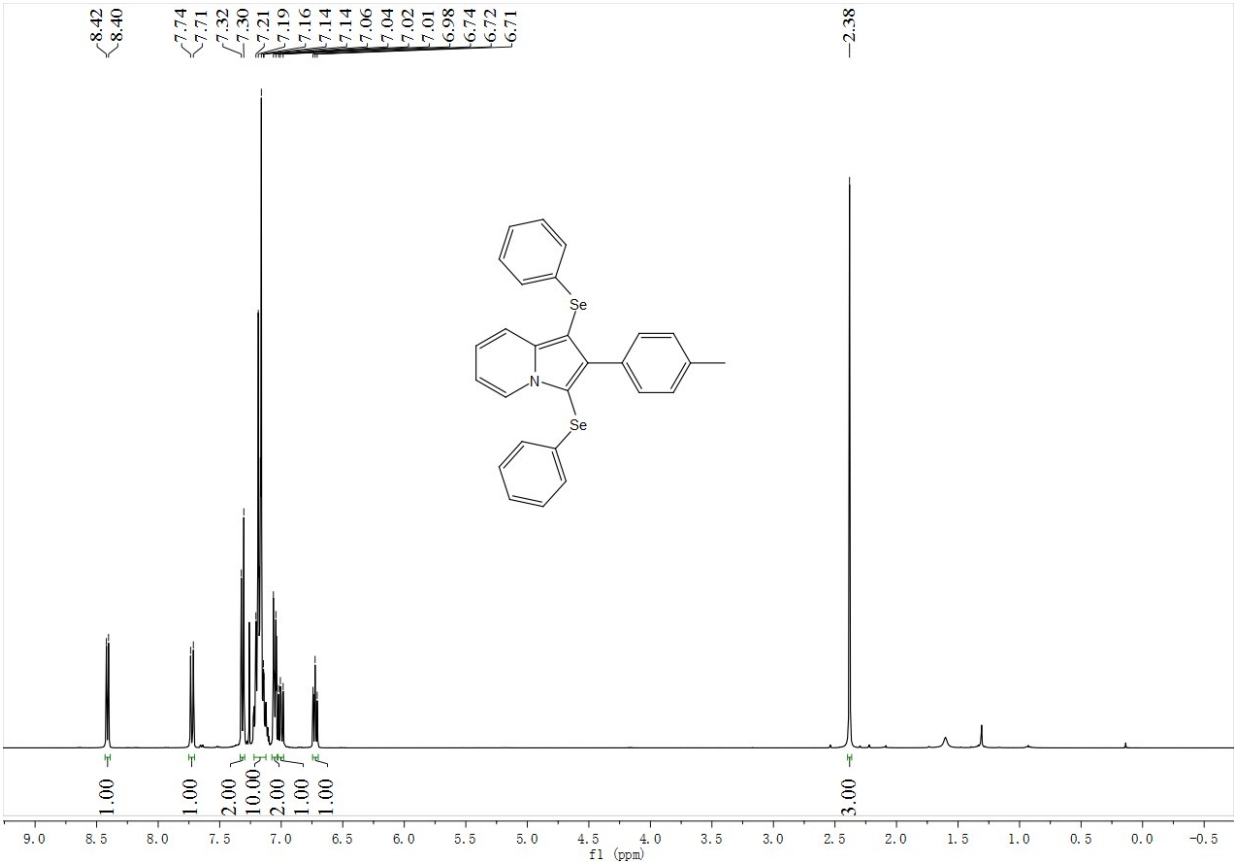
N
Se
f1 (ppm)

4ba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7.14
7.14
7.06
7.04
7.02
7.01
6.98
6.74
6.72
6.71
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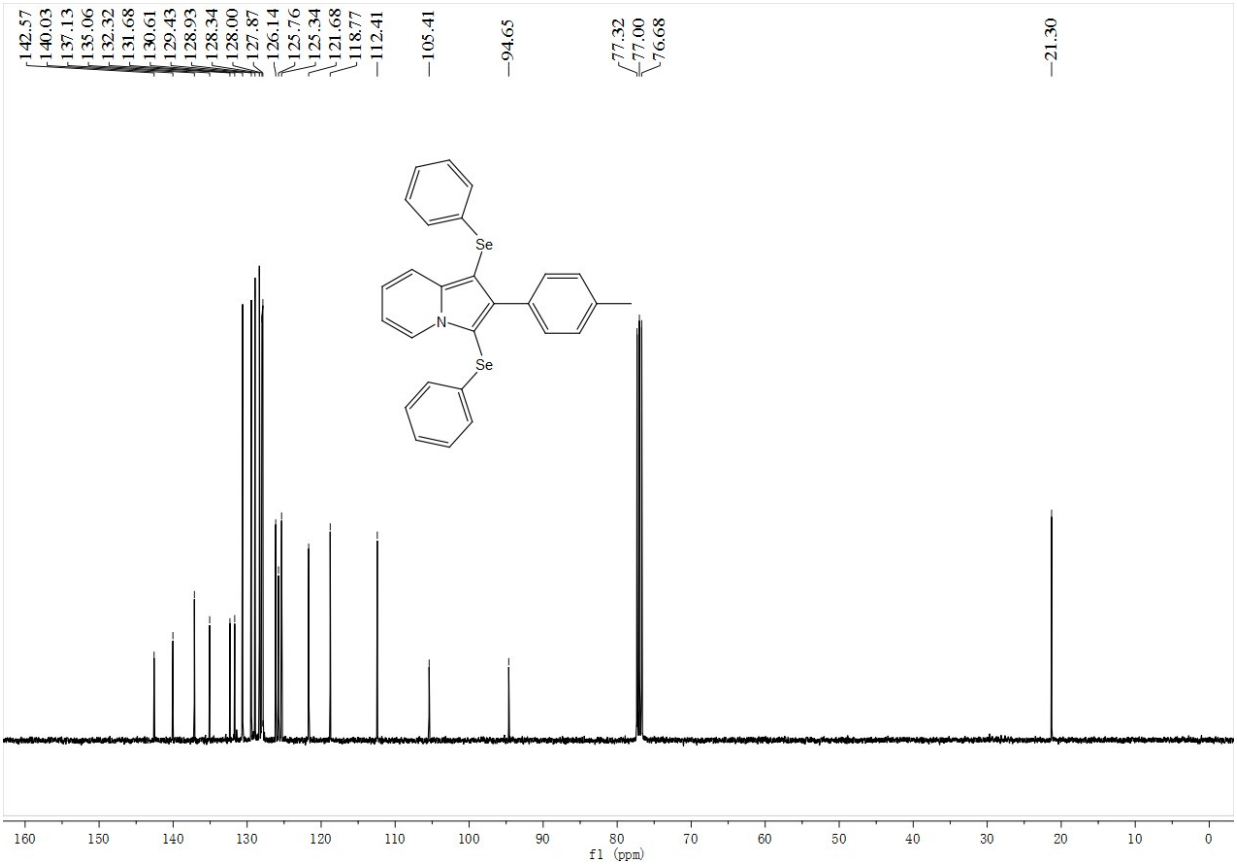
3.00
f1 (ppm)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127.87
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125.76
125.34
121.68
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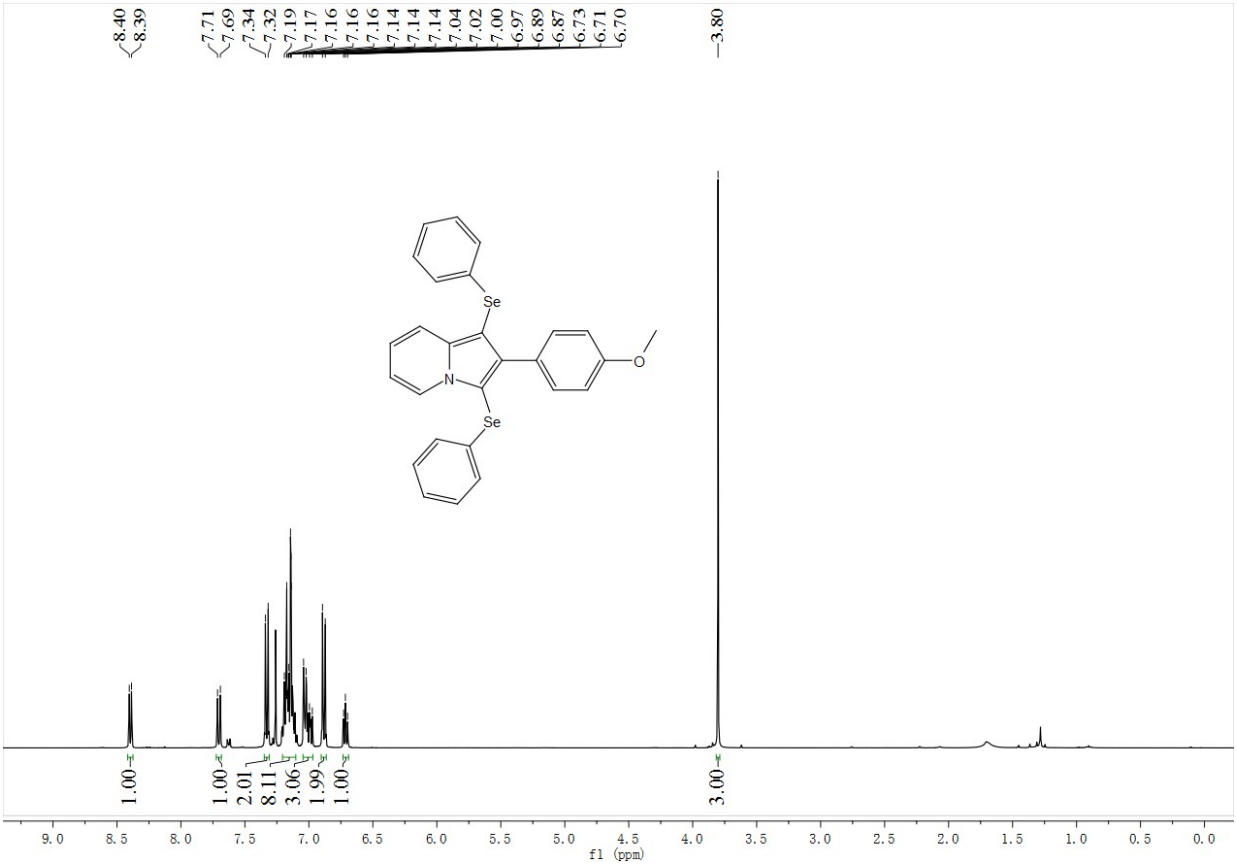
94.65
77.32
77.00
76.68
21.30
Se
N
Se
f1 (ppm)

4ca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7.19
7.17
7.16
7.16
7.16
7.14
7.14
7.14
7.04
7.02
7.00
6.97
6.89
6.87
6.73
6.71
6.70
3.80
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Se
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O
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1.00
2.01
8.11
3.06
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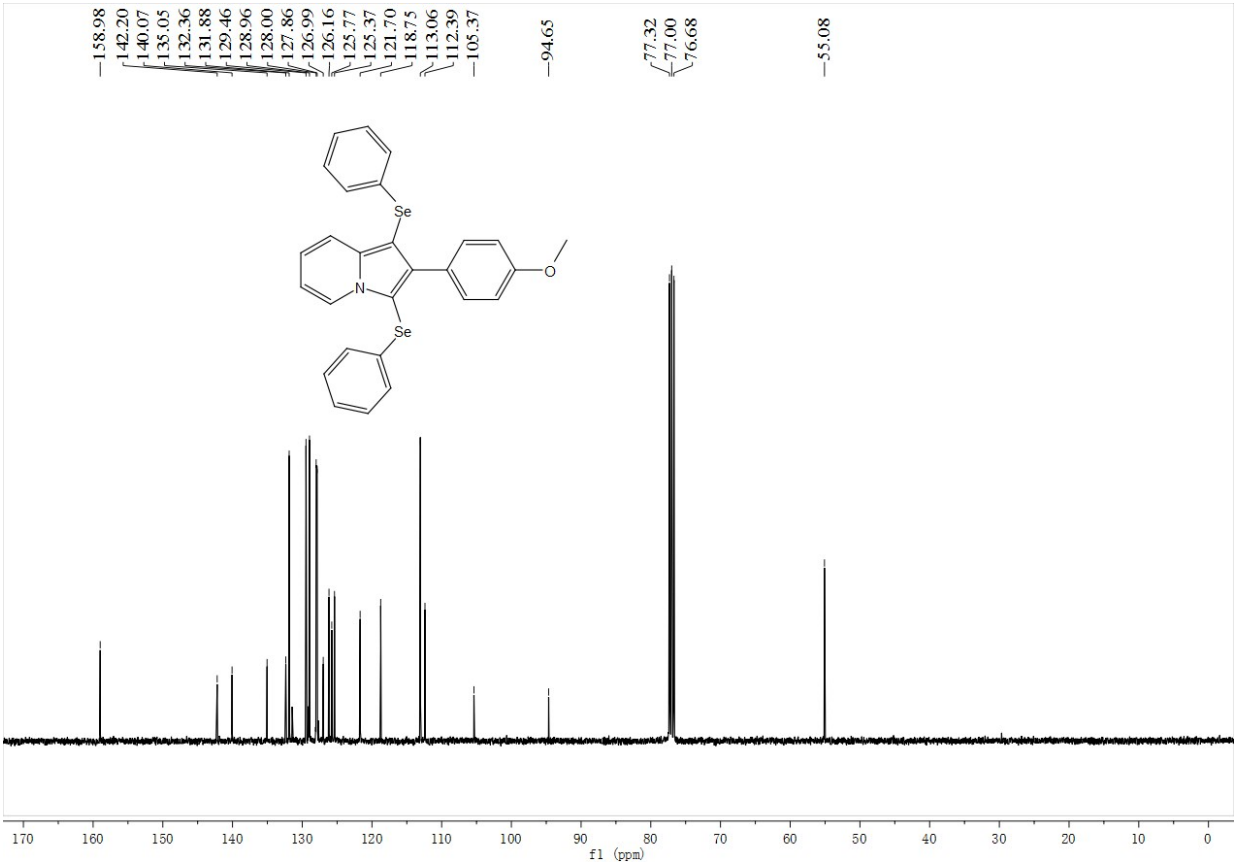
3.00
f1 (ppm)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125.37
121.70
118.75
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94.65
77.32
77.00
76.68
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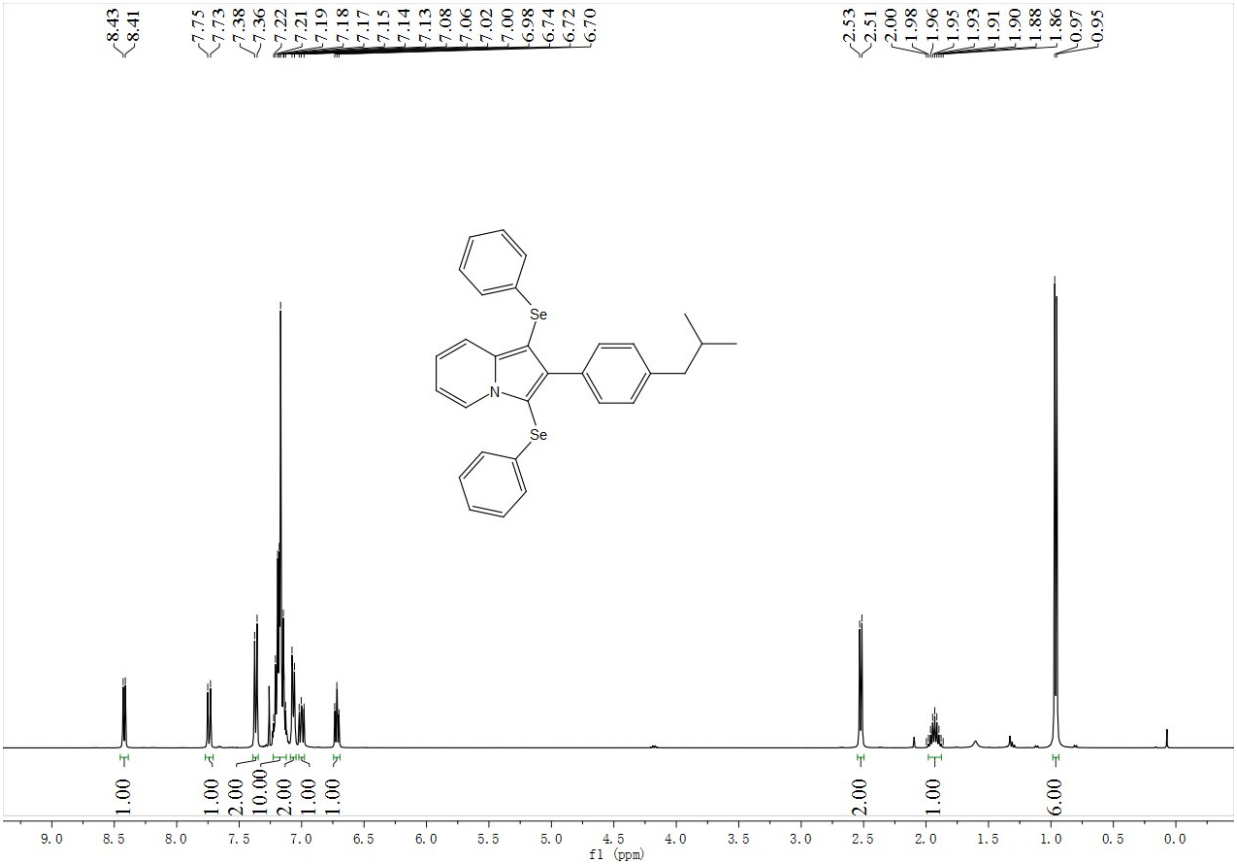
Se
Se
N
O
f1 (ppm)

4da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7.18
7.17
7.15
7.14
7.13
7.08
7.06
7.02
7.00
6.98
6.74
6.72
6.70
2.53
2.51
2.00
1.98
1.96
1.95
1.93
1.91
1.90
1.88
1.86
0.97
0.95
Se
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Se
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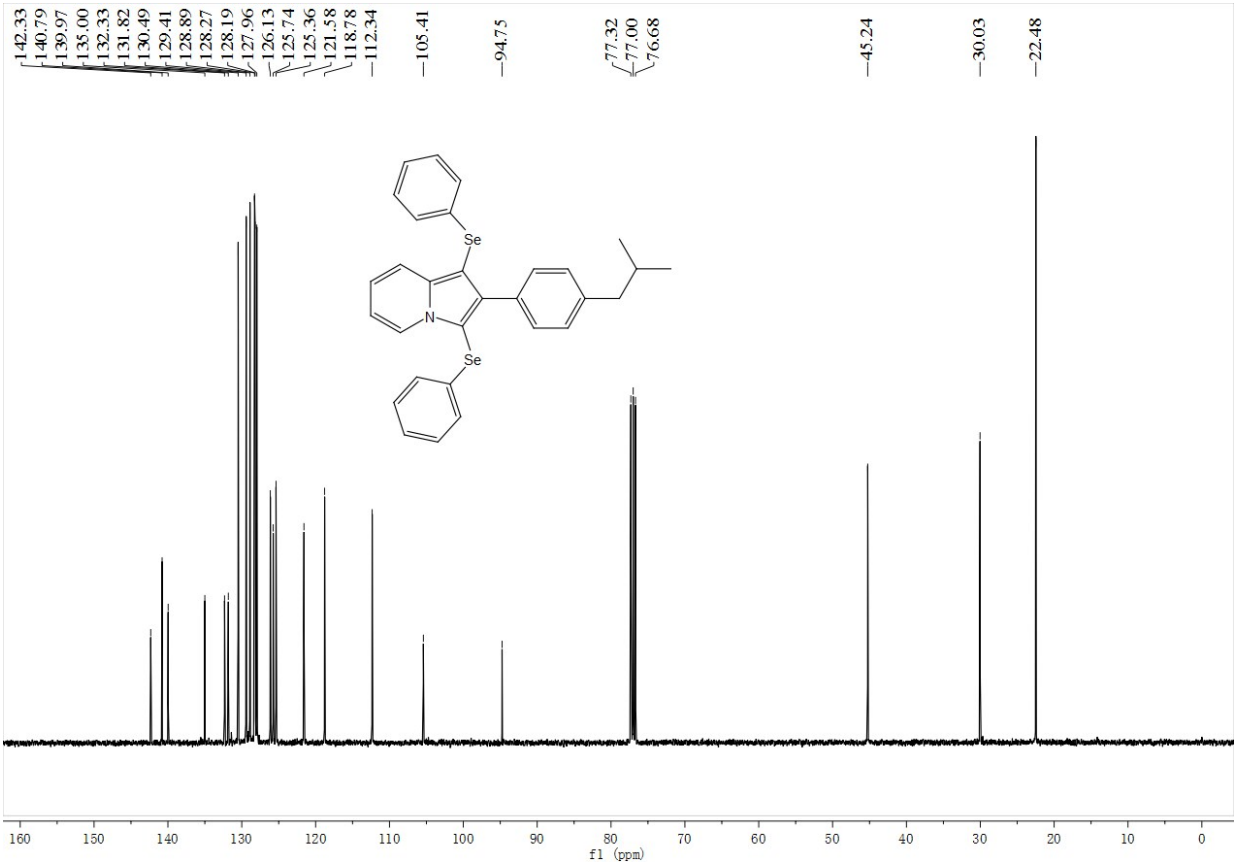
1.00
2.00
10.00
2.00
1.00
1.00
2.00
1.00
6.00
f1 (ppm)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128.19
127.96
126.13
125.74
125.36
121.58
118.78
112.34
105.41
94.75
77.32
77.00
76.68
45.24
30.03
22.48
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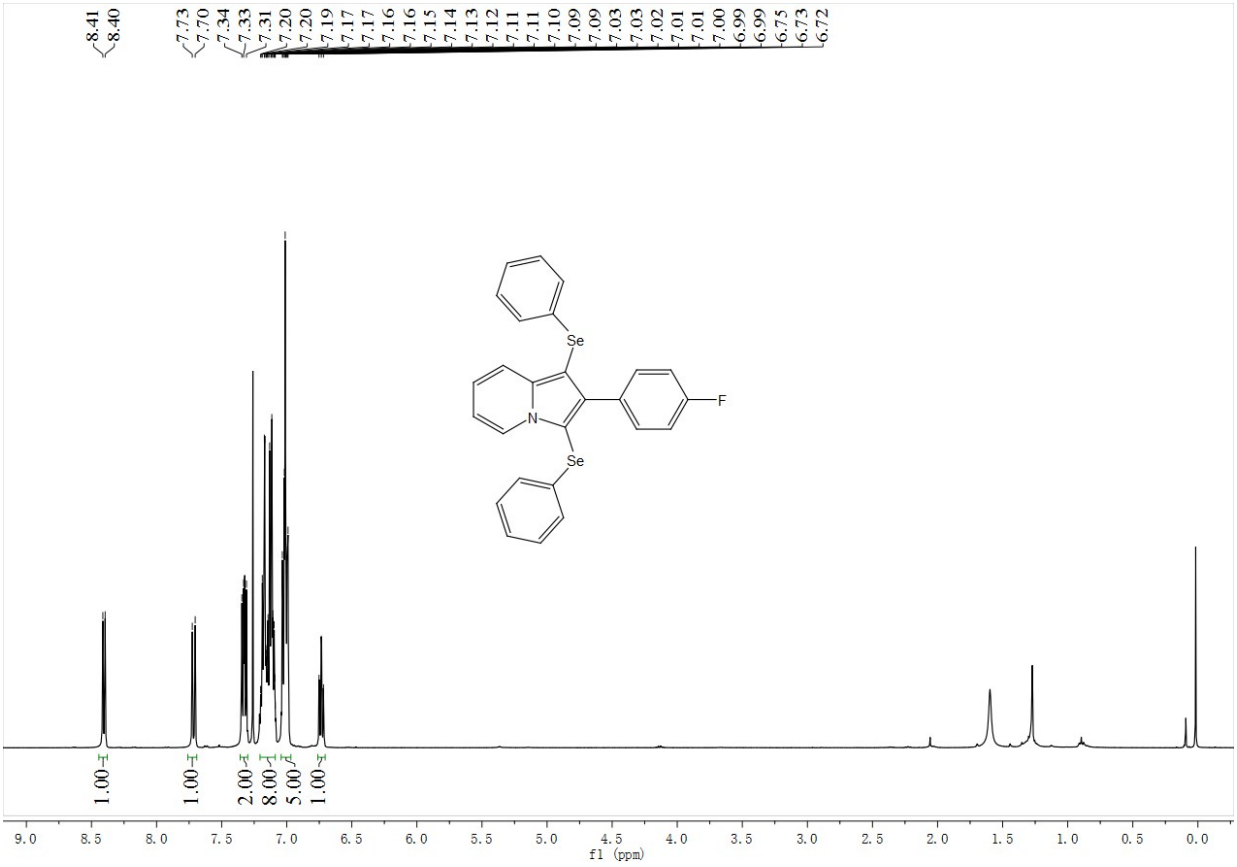
N
Se
f1 (ppm)

4ea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7.16
7.15
7.14
7.13
7.12
7.11
7.11
7.10
7.09
7.09
7.03
7.03
7.02
7.01
7.01
7.00
6.99
6.99
6.75
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Se
N
F
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1.00
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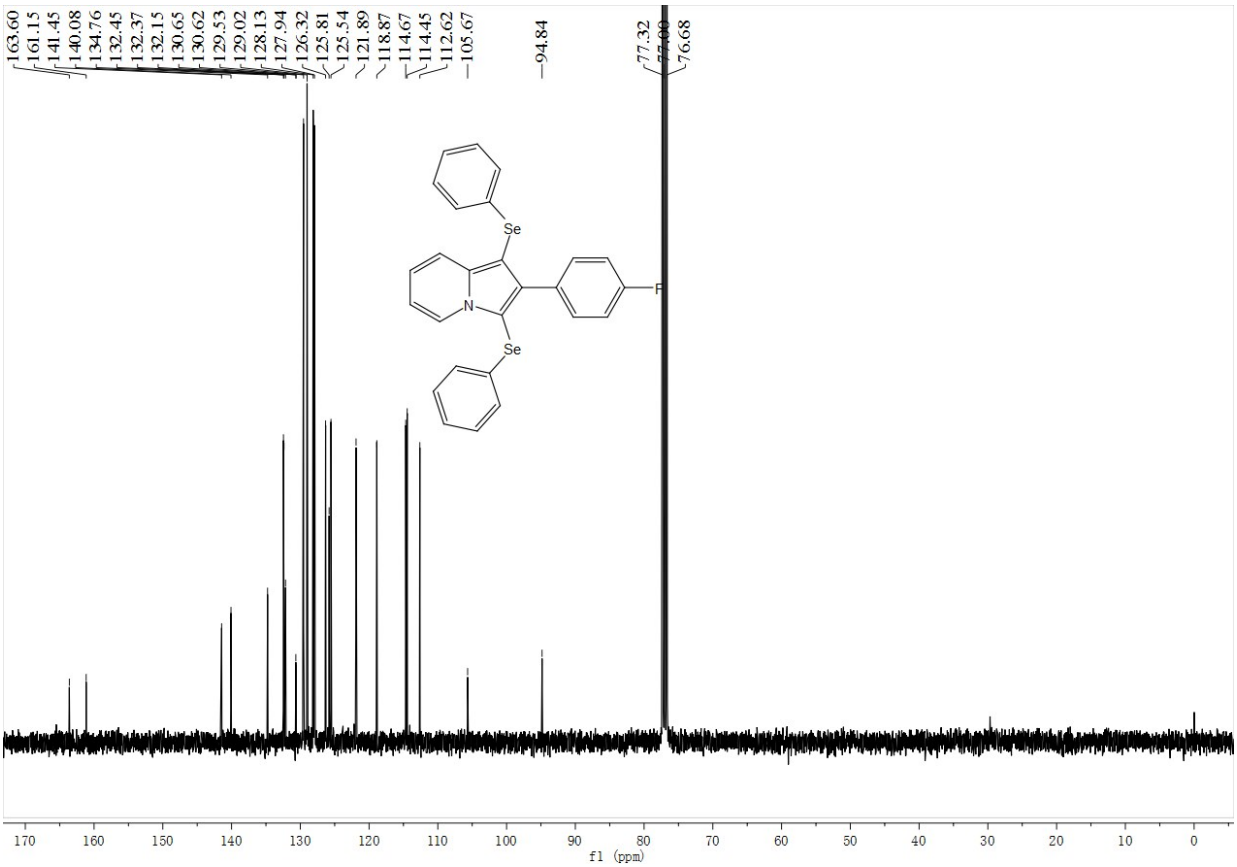
8.00
5.00
1.00
f1 (ppm)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129.02
128.13
127.94
126.32
125.81
125.54
121.89
118.87
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94.84
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77.00
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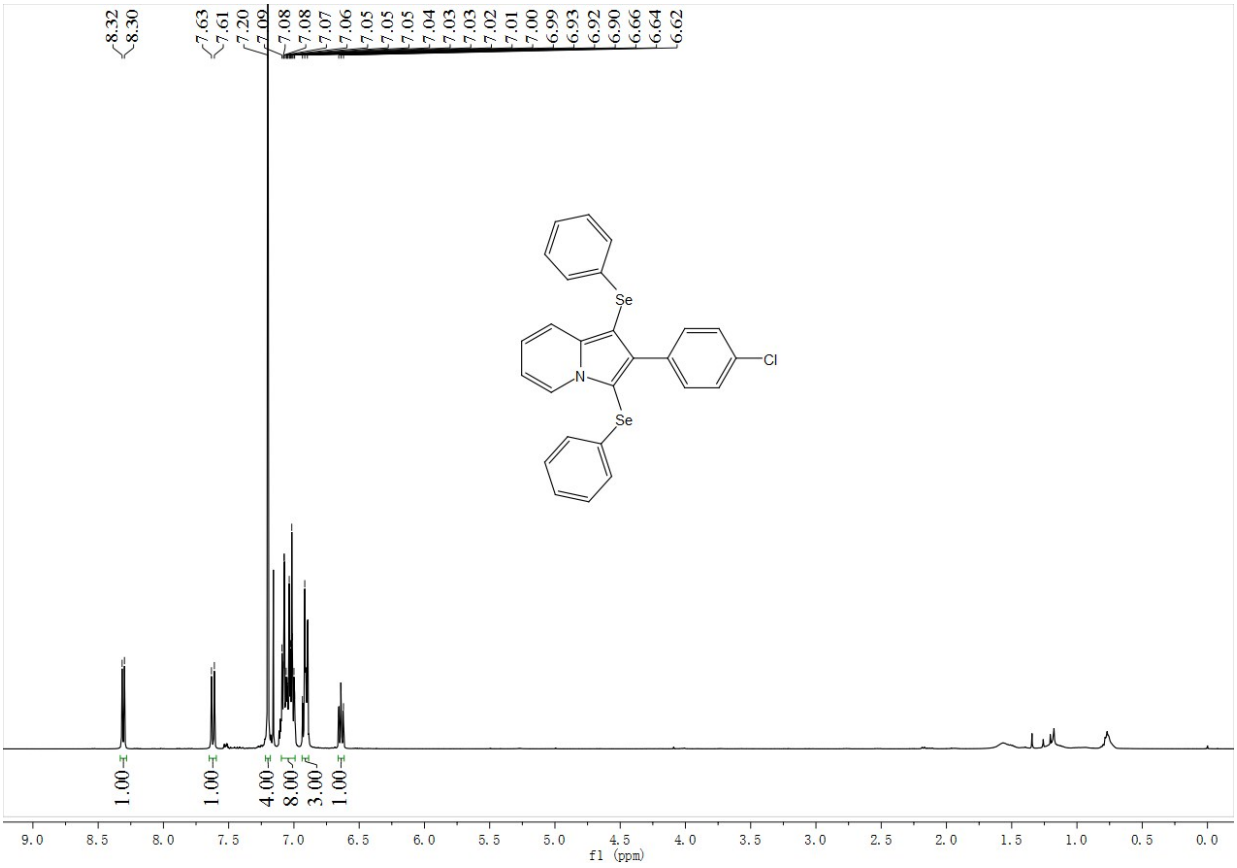
Se
N
F
Se
f1 (ppm)

4fa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7.08
7.08
7.07
7.06
7.05
7.05
7.05
7.04
7.03
7.03
7.02
7.01
7.00
6.99
6.93
6.92
6.90
6.66
6.64
6.62
Se
Cl
N
Se
1.00
1.00
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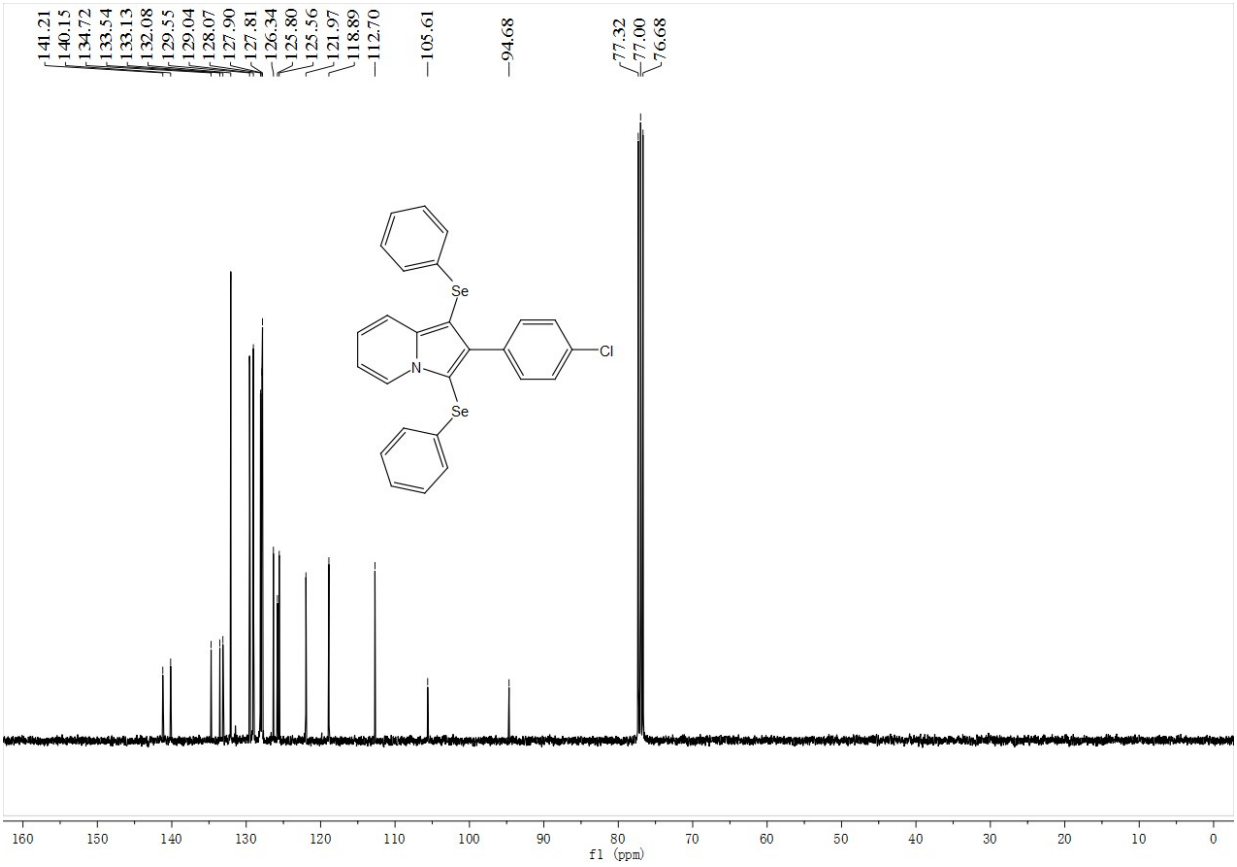
8.00
3.00
1.00
f1 (ppm)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127.81
126.34
125.80
125.56
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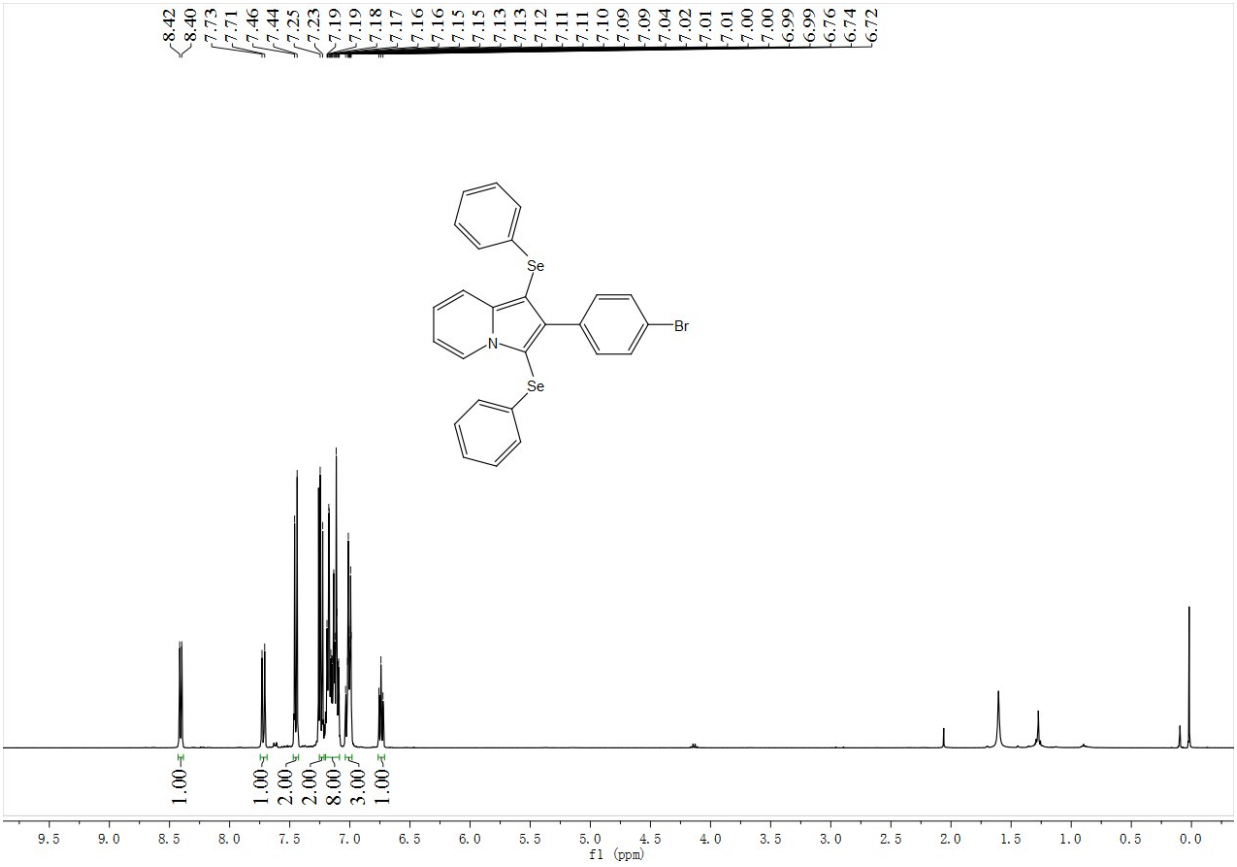
112.70
105.61
94.68
77.32
77.00
76.68
Se
Cl
N
Se
f1 (ppm)

4ga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7.16
7.15
7.15
7.13
7.13
7.12
7.11
7.11
7.10
7.09
7.09
7.04
7.02
7.01
7.01
7.00
7.00
6.99
6.99
6.76
6.74
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Se
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Br
Se
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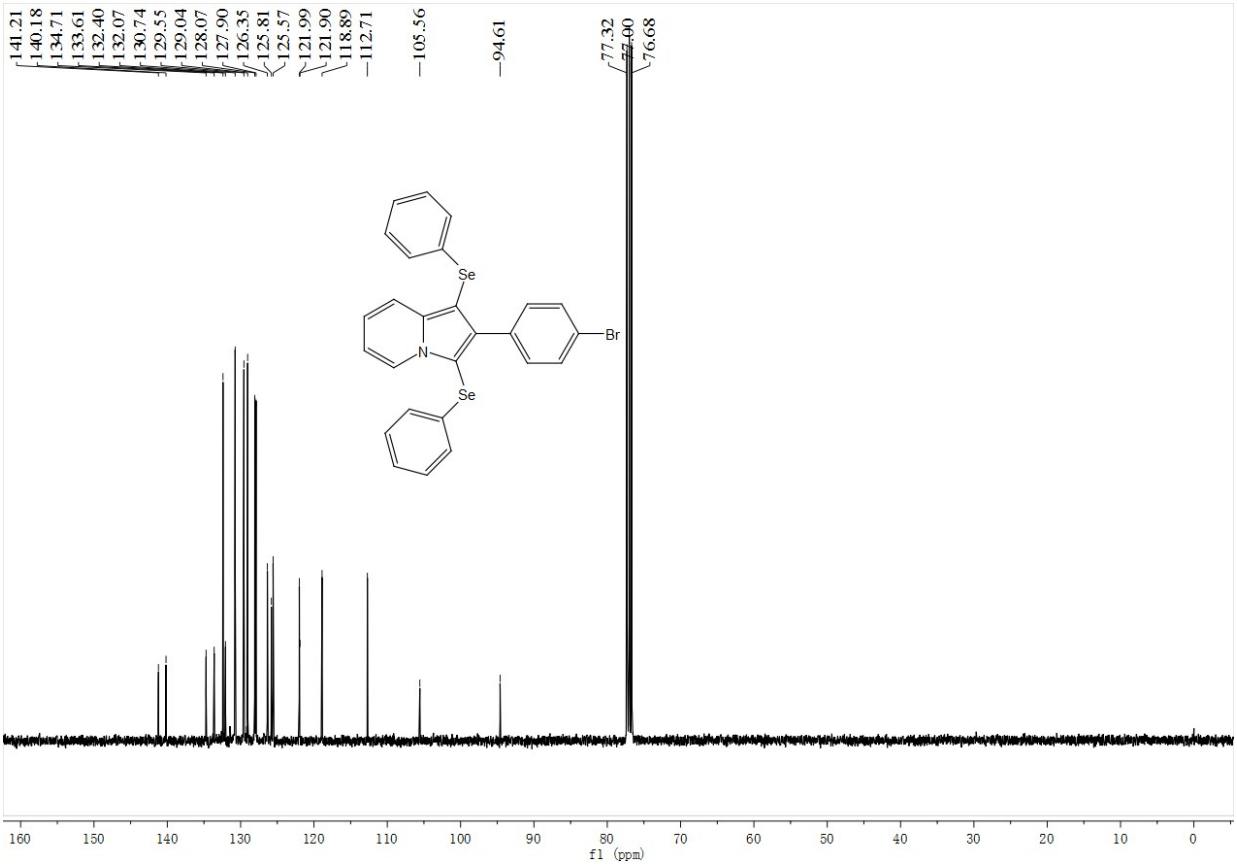
1.00
2.00
2.00
8.00
3.00
1.00
f1 (ppm)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128.07
127.90
126.35
125.81
125.57
121.99
121.90
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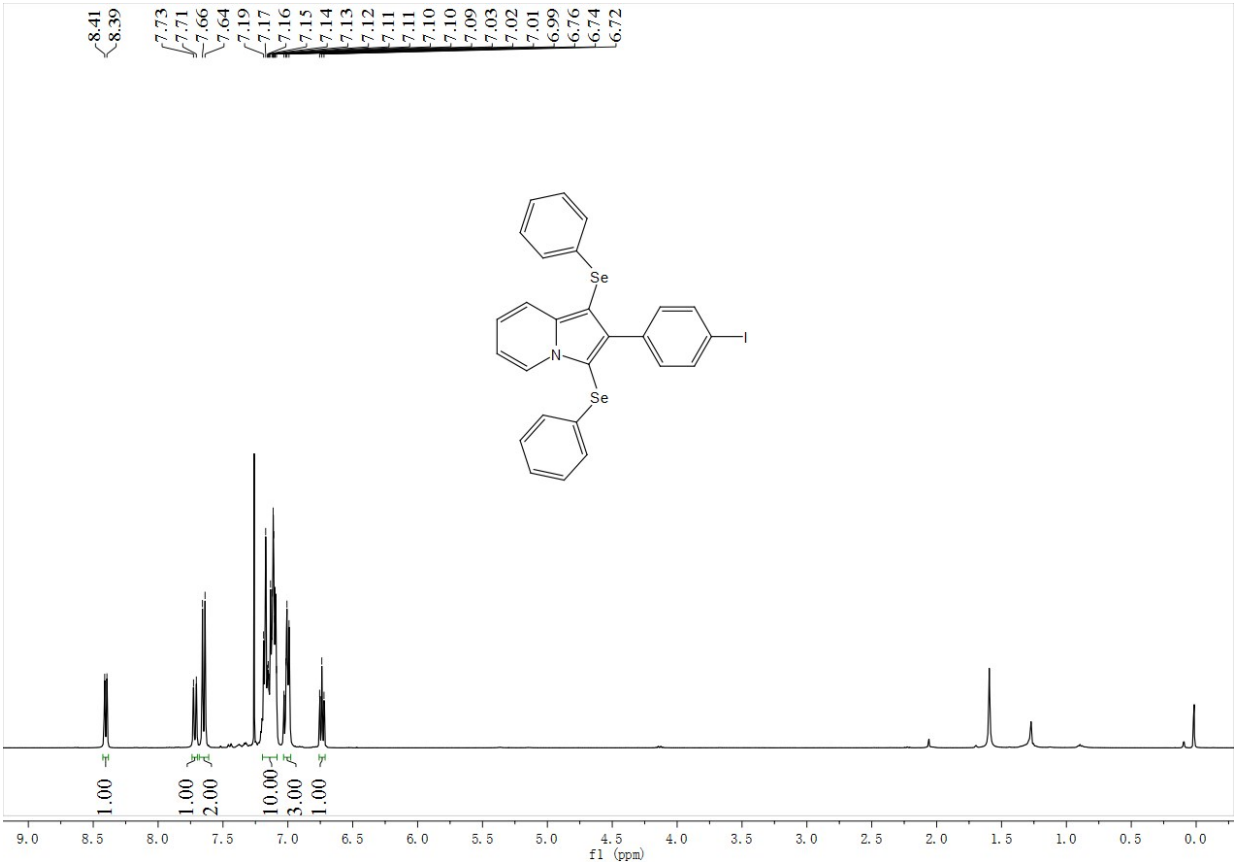
112.71
105.56
94.61
77.32
77.00
76.68
Se
N
Br
Se
f1 (ppm)

4ha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7.14
7.13
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7.11
7.11
7.10
7.10
7.09
7.03
7.02
7.01
6.99
6.76
6.74
6.72
Se
N
Se
I
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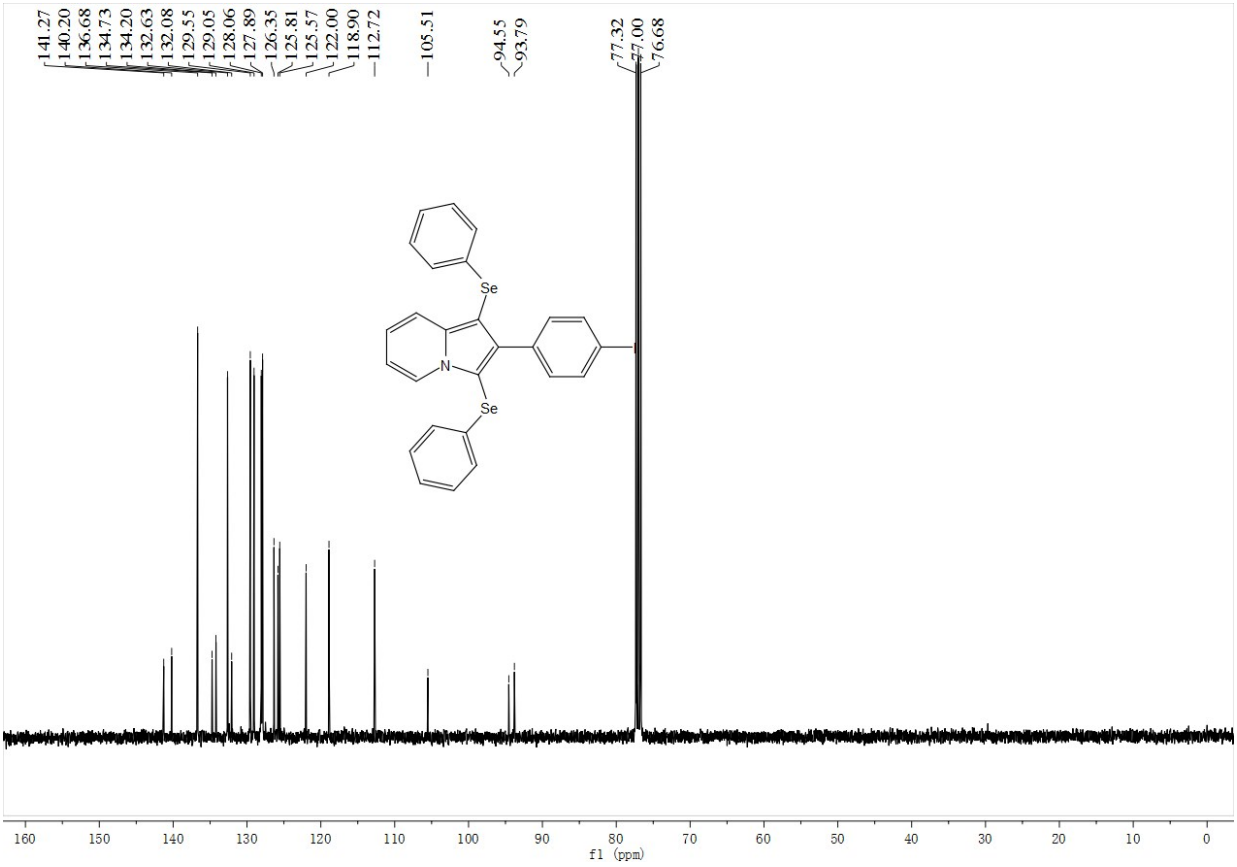
1.00
2.00
10.00
3.00
1.00
f1 (ppm)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128.06
127.89
126.35
125.81
125.57
122.00
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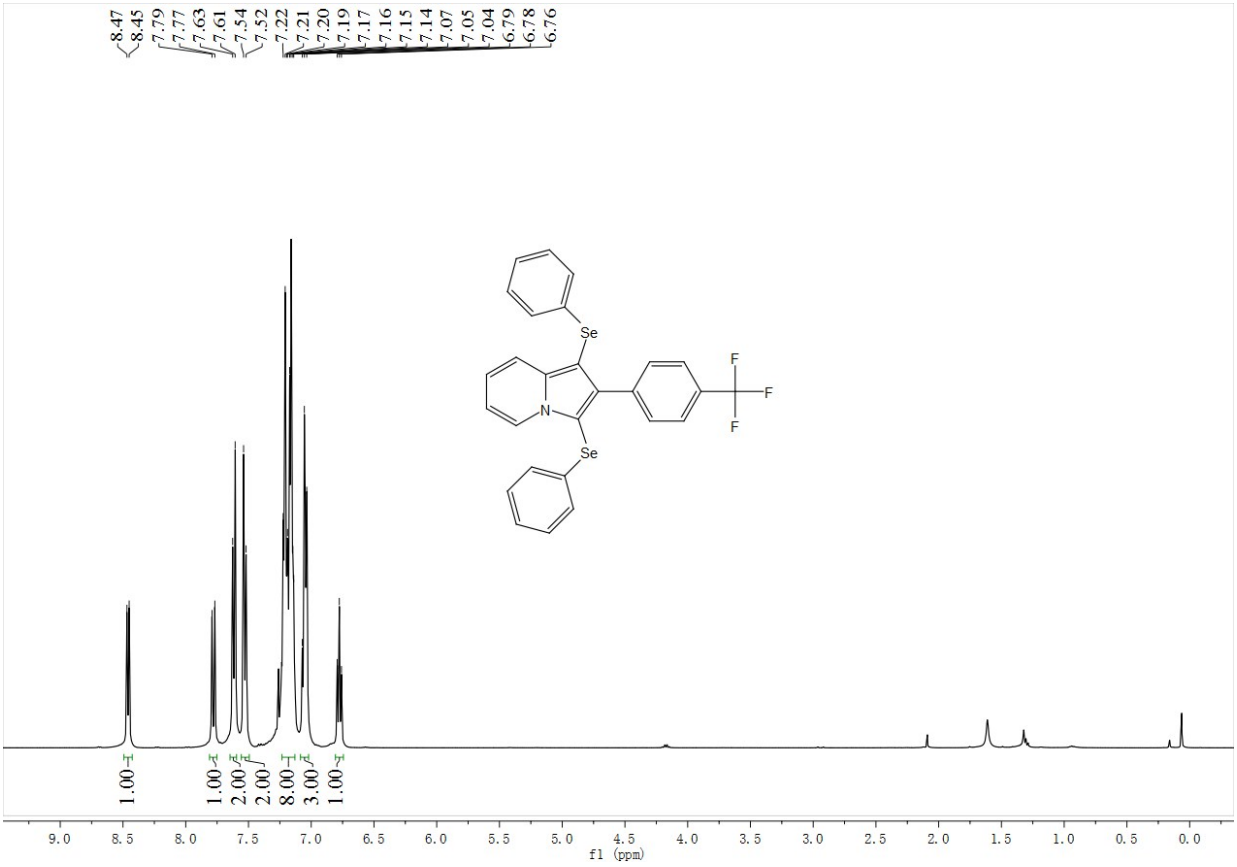
94.55
93.79
77.32
77.00
76.68
Se
N
Se
I
f1 (ppm)

4ia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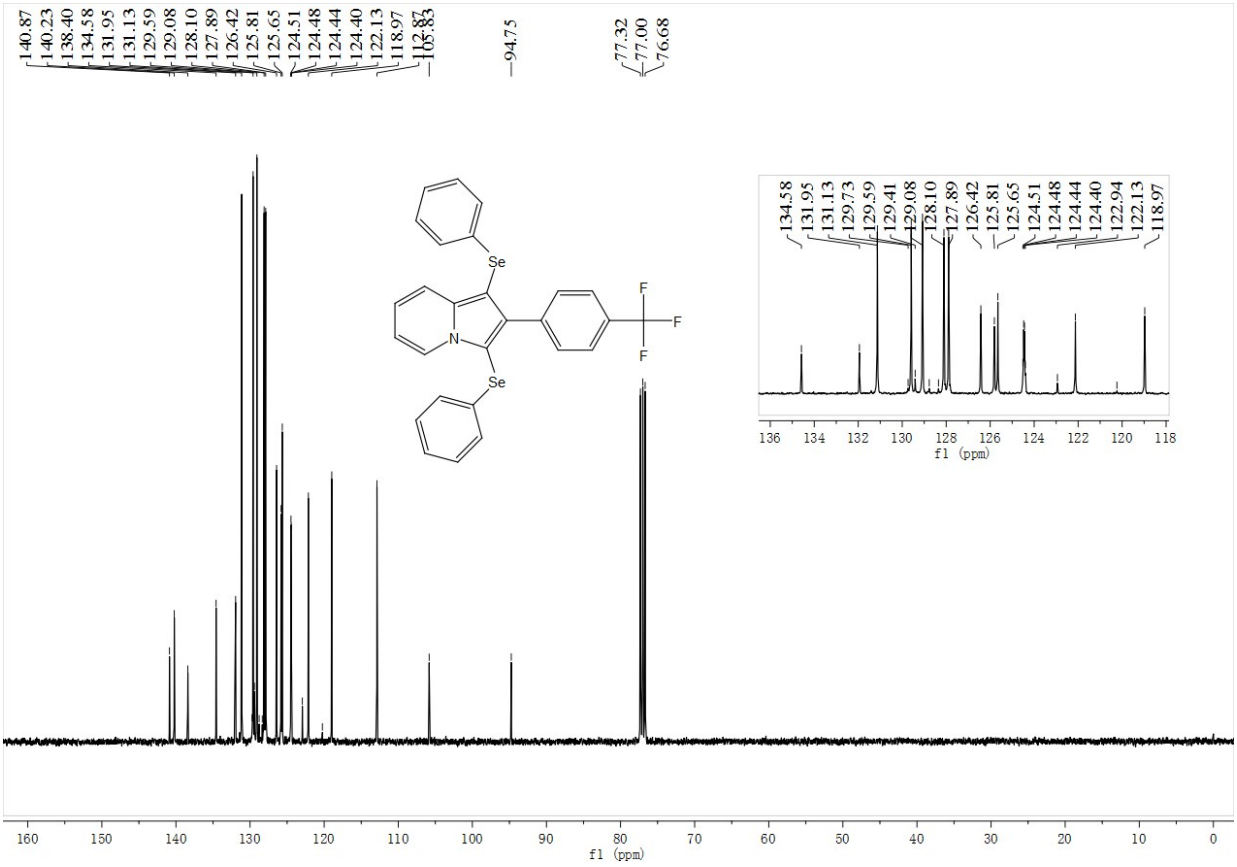
7.17
7.16
7.15
7.14
7.07
7.05
7.04
6.79
6.78
6.76
Se
Se
N
F
F
F
1.00
1.00
2.00
2.00
8.00
3.00
1.00
f1 (ppm)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125.65
124.51
124.48
124.44
124.40
122.13
118.97
112.87
105.83
94.75
77.32
77.00
76.68
Se
Se
N
F
F
F
134.58
131.95
131.13
129.73
129.59
129.41
129.08
128.10
127.89
126.42
125.81
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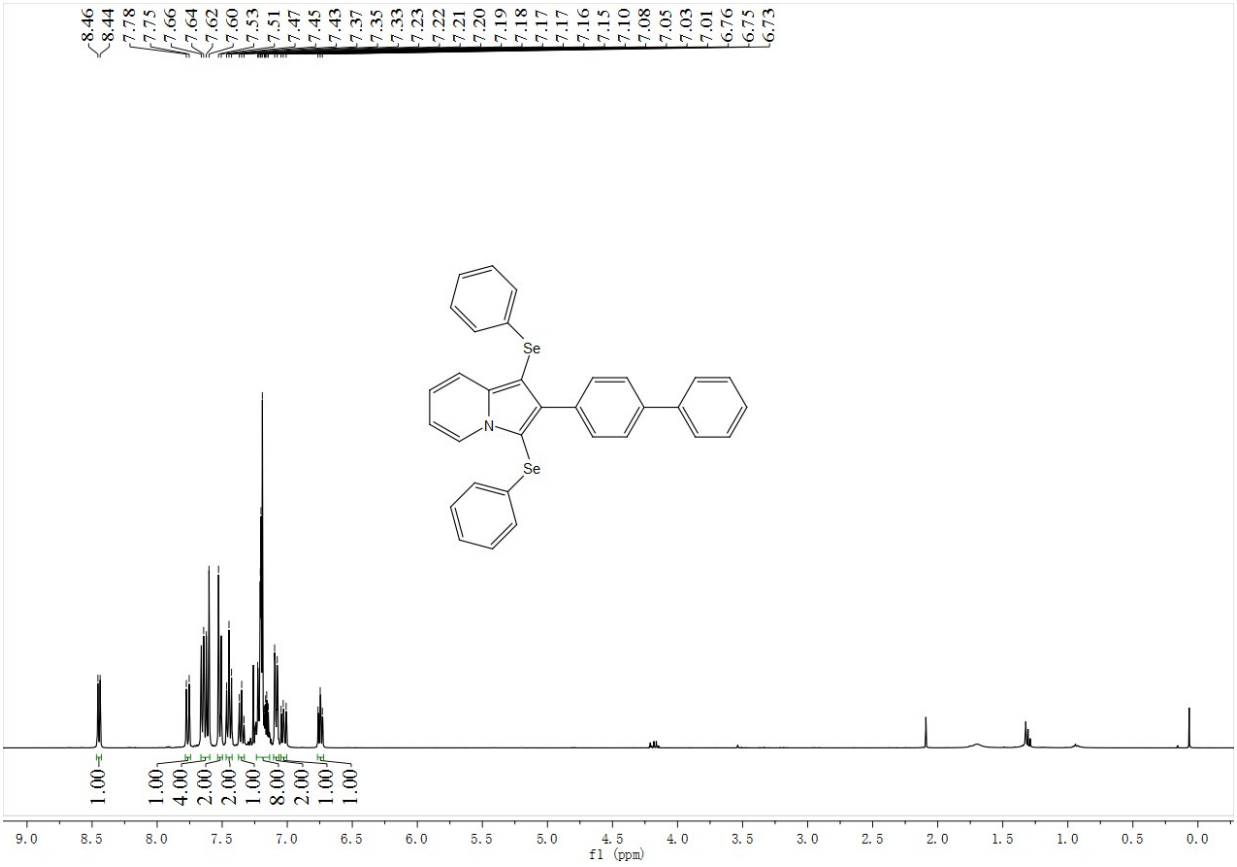
124.48
124.44
124.40
122.94
122.13
118.97
f1 (ppm)
f1 (ppm)

4ja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7.47
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7.43
7.37
7.35
7.33
7.23
7.22
7.21
7.20
7.19
7.18
7.17
7.17
7.16
7.15
7.10
7.08
7.05
7.03
7.01
6.76
6.75
6.73
Se
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4.00
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2.00
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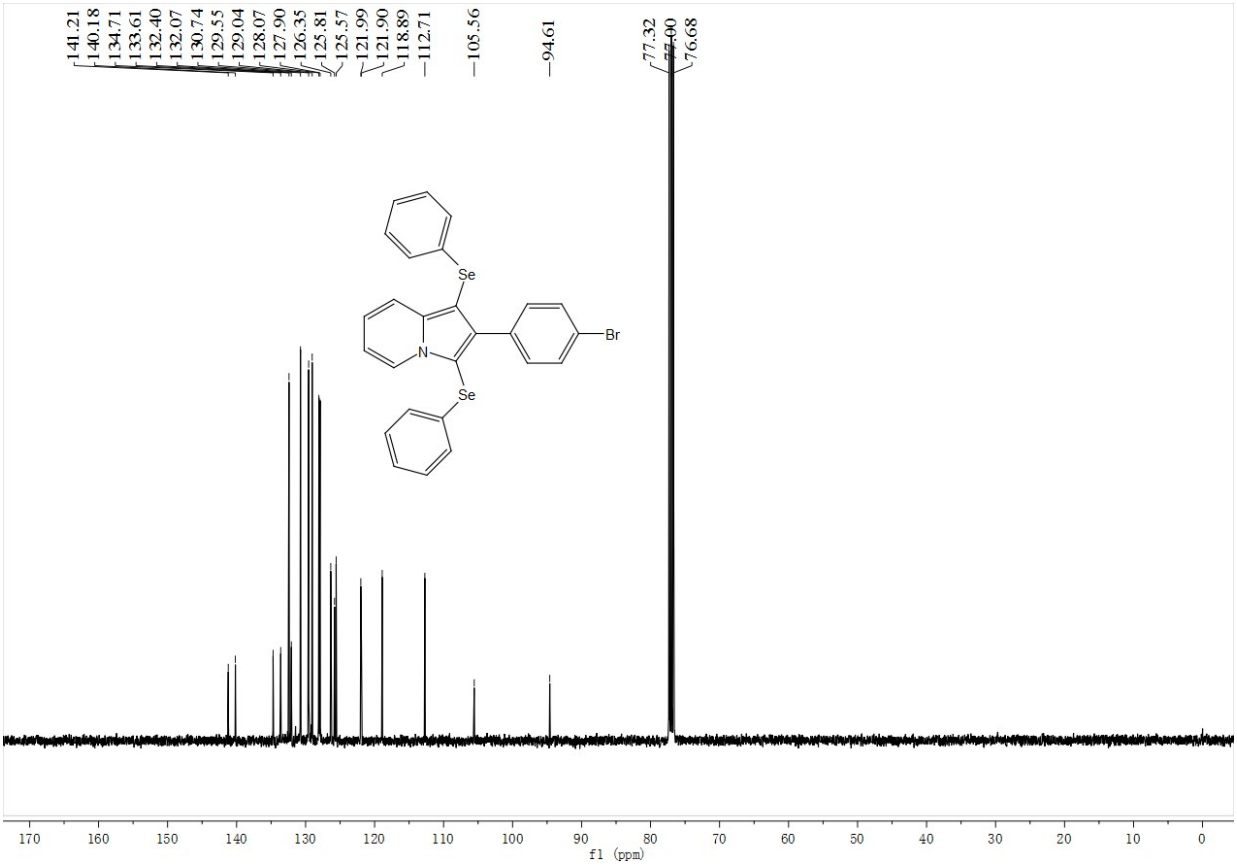
1.00
f1 (ppm)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128.07
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125.81
125.57
121.99
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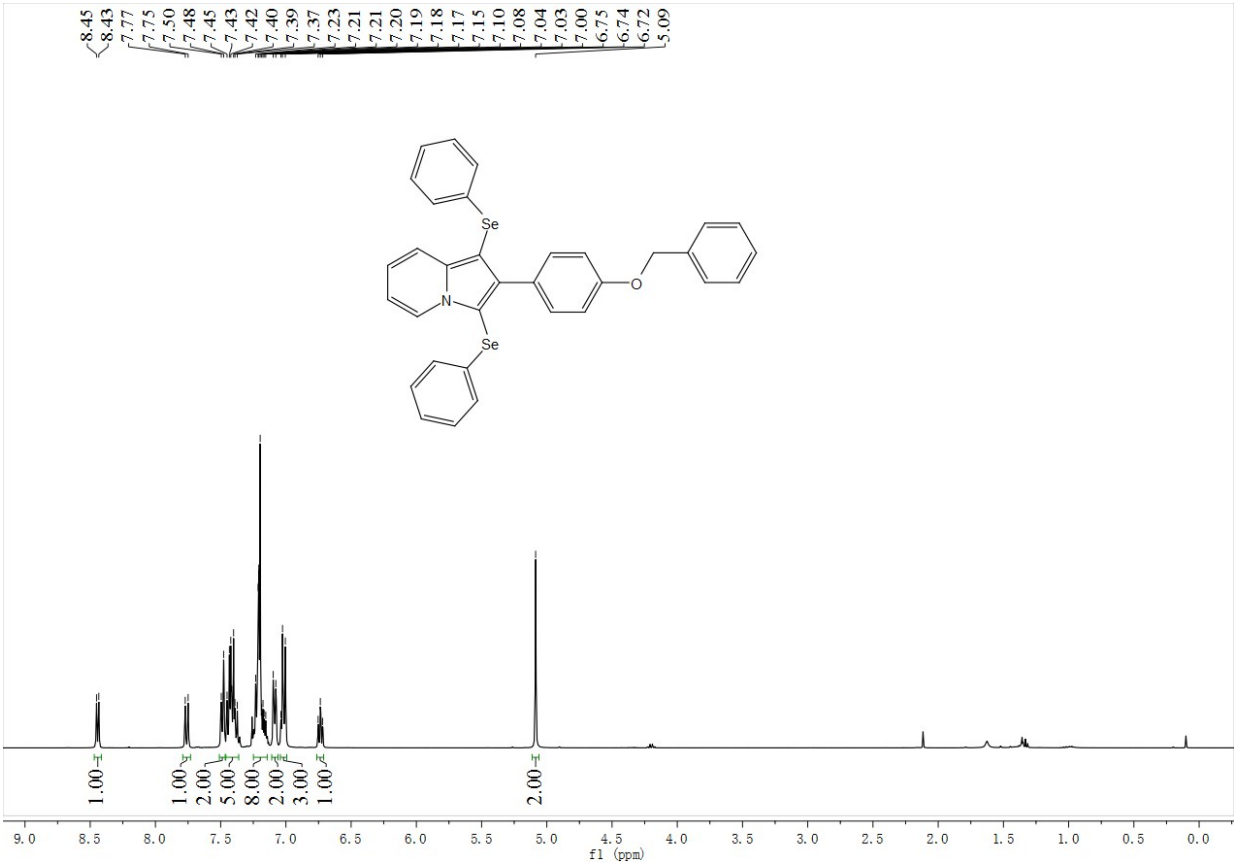
105.56
94.61
77.32
77.00
76.68
Se
N
Br
Se
f1 (ppm)

4ka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7.23
7.21
7.21
7.20
7.19
7.18
7.17
7.15
7.10
7.08
7.04
7.03
7.00
6.75
6.74
6.72
5.09
Se
N
O
Se
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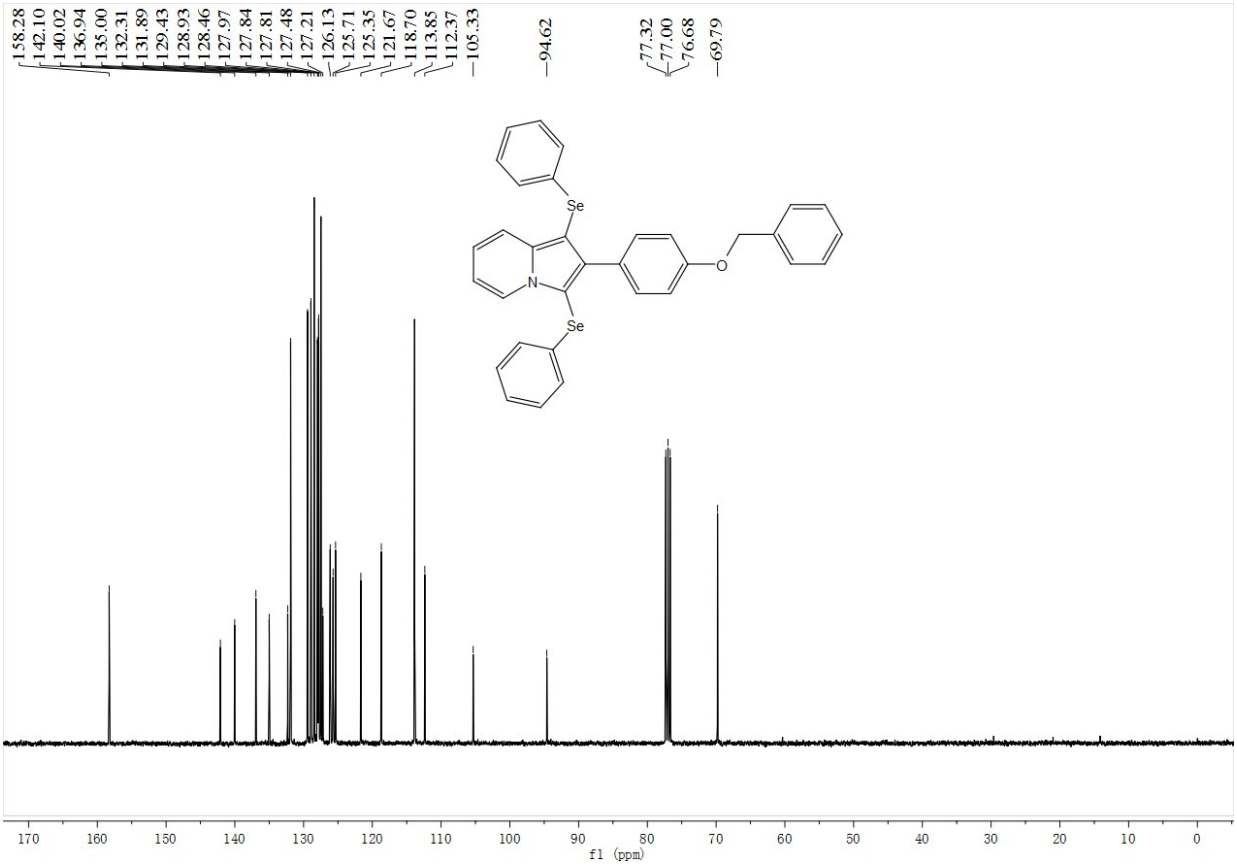
1.00
2.00
5.00
8.00
2.00
3.00
1.00
2.00
f1 (ppm)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128.93
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127.81
127.48
127.21
126.13
125.71
125.35
121.67
118.70
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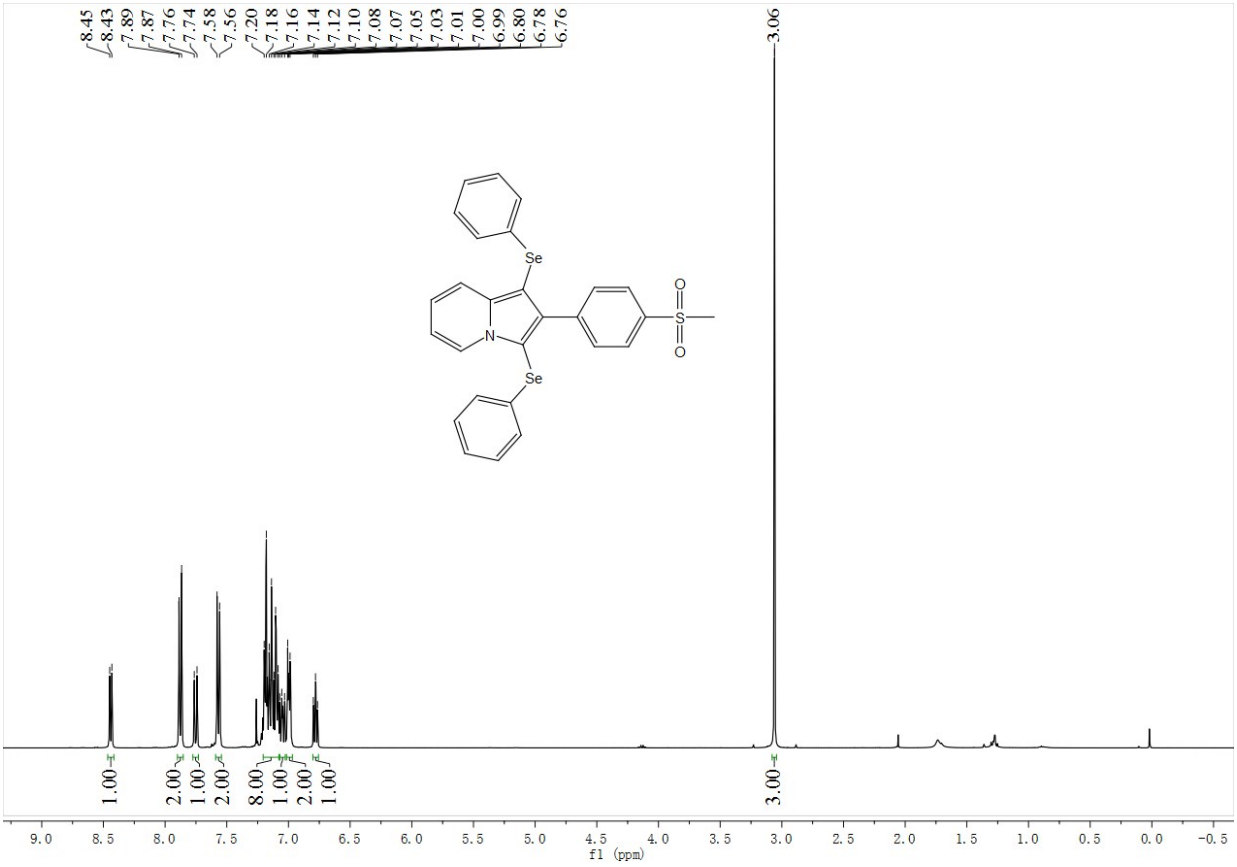
94.62
77.32
77.00
76.68
69.79
Se
N
O
Se
f1 (ppm)

4la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8.43
7.89
7.87
7.76
7.74
7.58
7.56
7.20
7.18
7.16
7.14
7.12
7.10
7.08
7.07
7.05
7.03
7.01
7.00
6.99
6.80
6.78
6.76
3.06
Se
N
Se
O
S
O
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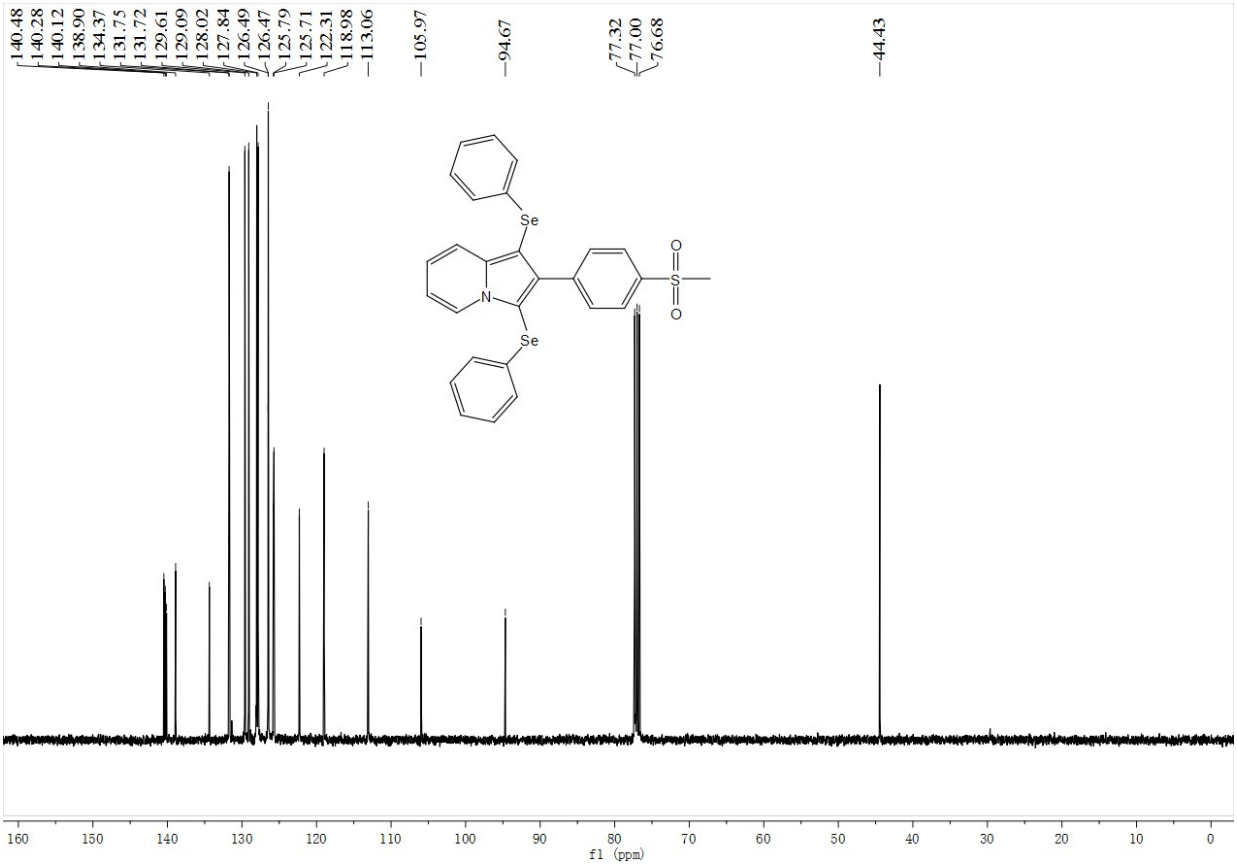
2.00
1.00
2.00
8.00
1.00
2.00
1.00
3.00
f1 (ppm)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129.61
129.09
128.02
127.84
126.49
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125.79
125.71
122.31
118.98
113.06
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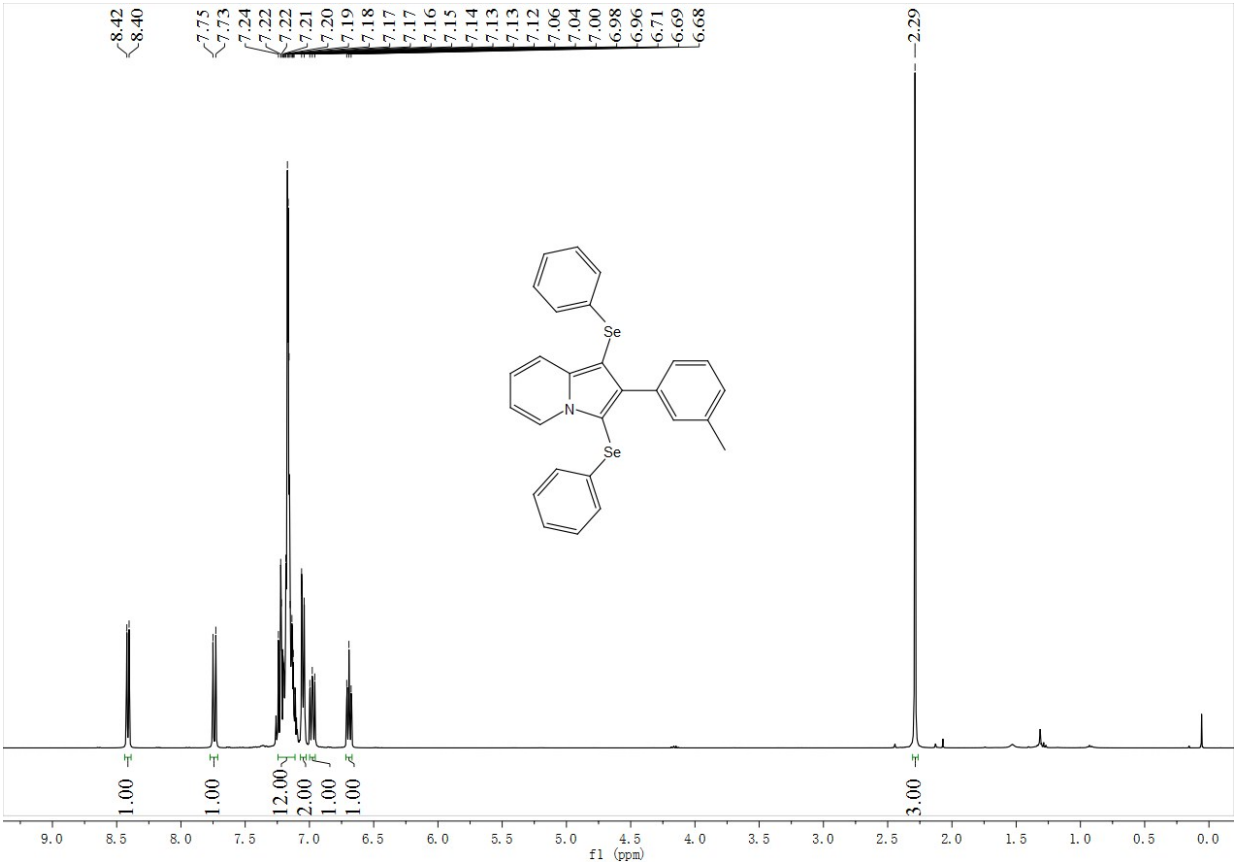
77.32
77.00
76.68
44.43
Se
N
Se
O
S
O
f1 (ppm)

4ma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7.14
7.13
7.13
7.12
7.06
7.04
7.00
6.98
6.96
6.71
6.69
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Se
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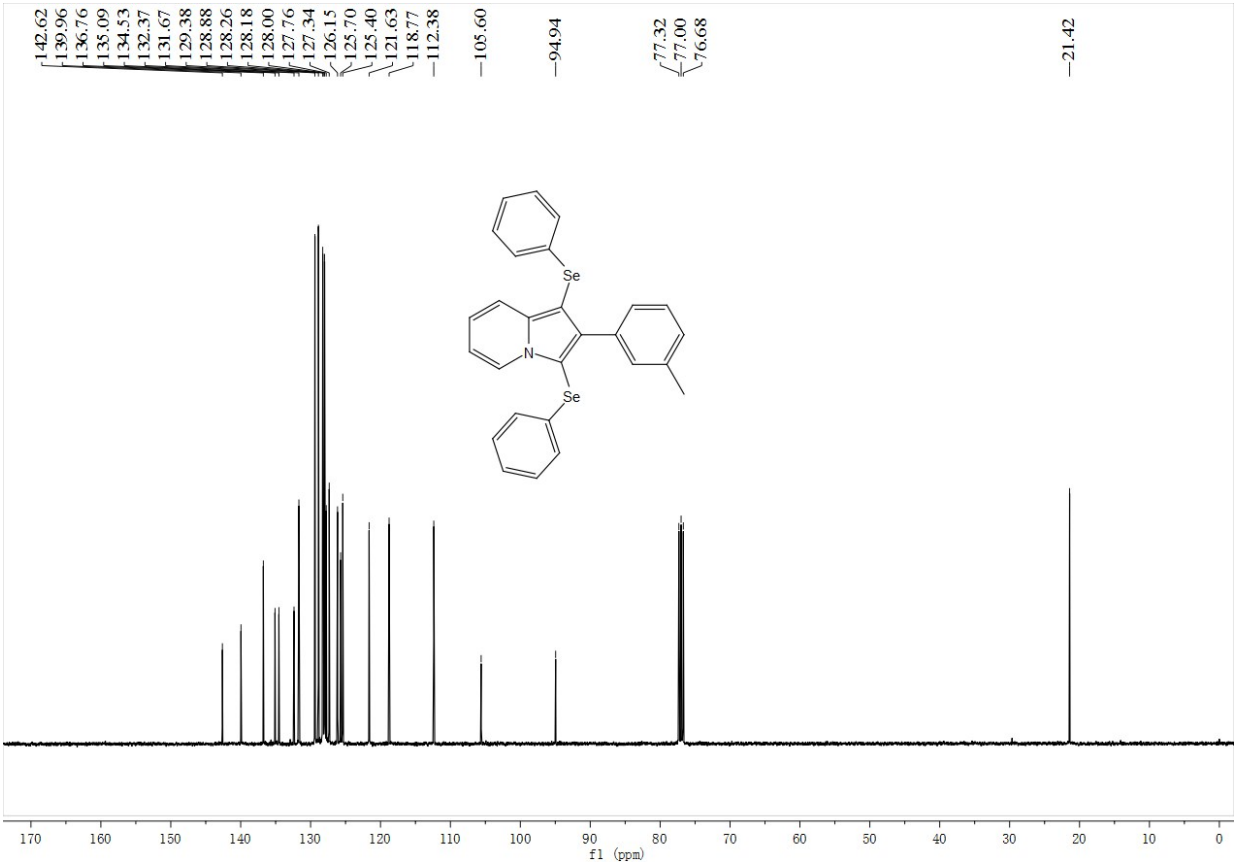
1.00
3.00
f1 (ppm)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132.37
131.67
129.38
128.88
128.26
128.18
128.00
127.76
127.34
126.15
125.70
125.40
121.63
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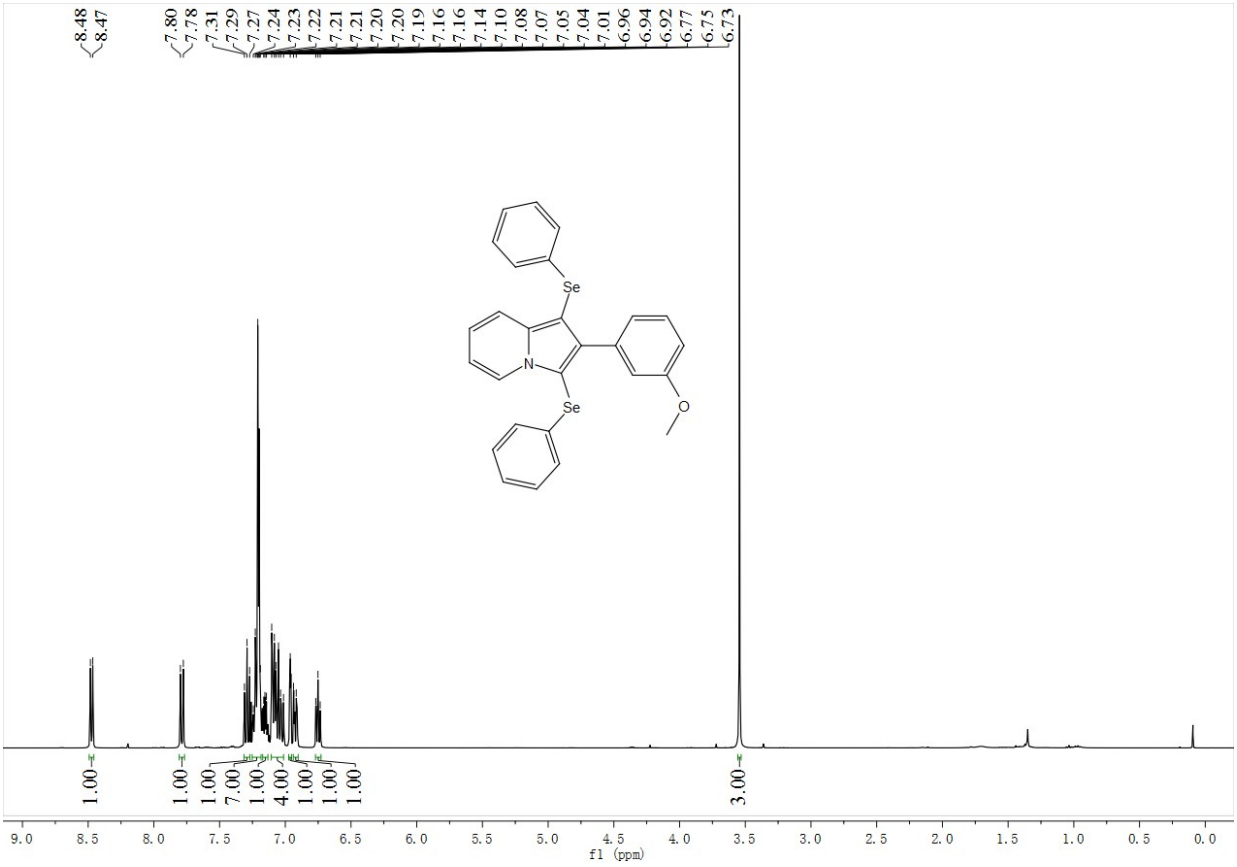
112.38
105.60
94.94
77.32
77.00
76.68
21.42
Se
N
Se
f1 (ppm)

4na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7.29
7.27
7.24
7.23
7.22
7.21
7.21
7.20
7.20
7.19
7.16
7.16
7.14
7.10
7.08
7.07
7.05
7.04
7.01
6.96
6.94
6.92
6.77
6.75
6.73
Se
N
Se
O
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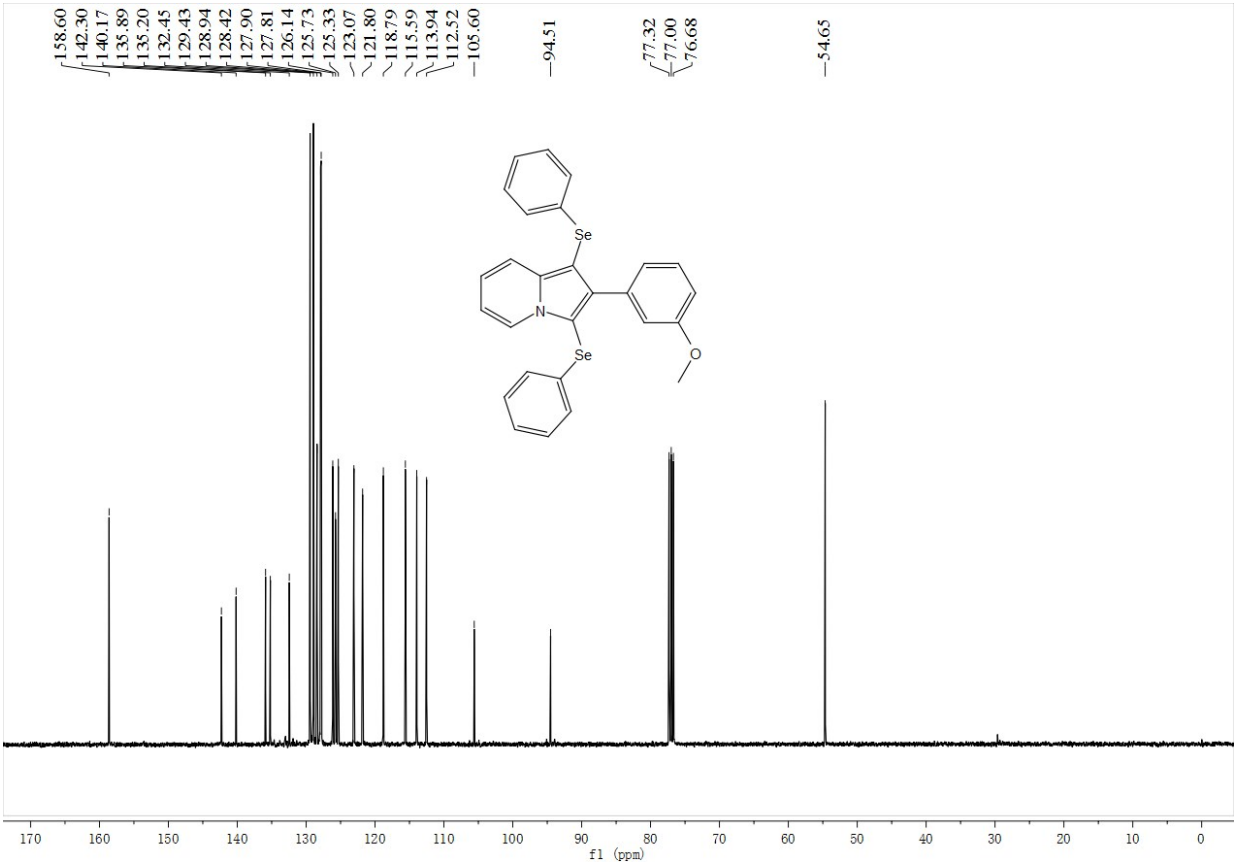
1.00
1.00
7.00
1.00
4.00
1.00
1.00
1.00
3.00
f1 (ppm)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128.94
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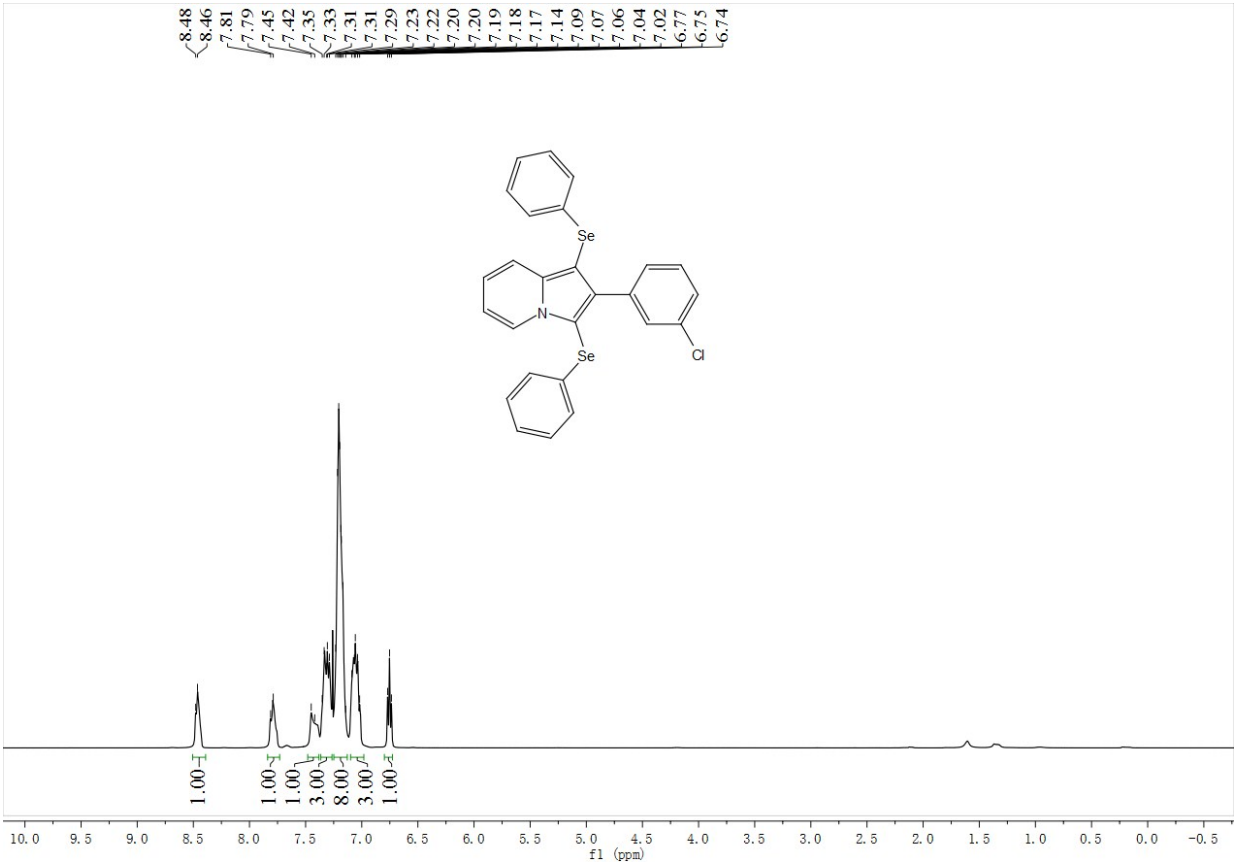
127.90
127.81
126.14
125.73
125.33
123.07
121.80
118.79
115.59
113.94
112.52
105.60
94.51
77.32
77.00
76.68
54.65
Se
N
Se
O
f1 (ppm)

4oa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8.46
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7.79
7.45
7.42
7.35
7.33
7.31
7.31
7.29
7.23
7.22
7.20
7.20
7.19
7.18
7.17
7.14
7.09
7.07
7.06
7.04
7.02
6.77
6.75
6.74
Se
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Se
Cl
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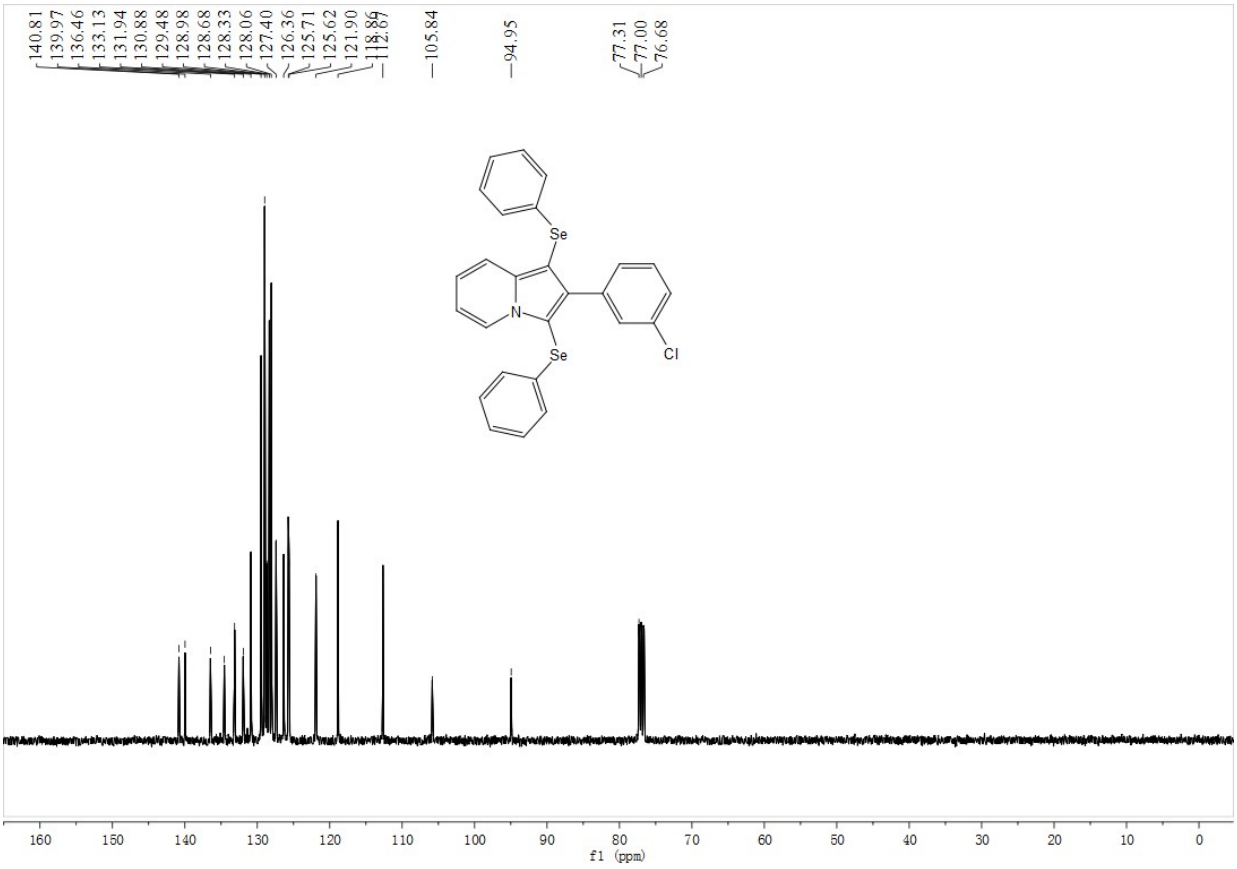
1.00
1.00
3.00
8.00
3.00
1.00
f1 (ppm)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130.88
129.48
128.98
128.68
128.33
128.06
127.40
126.36
125.71
125.62
121.90
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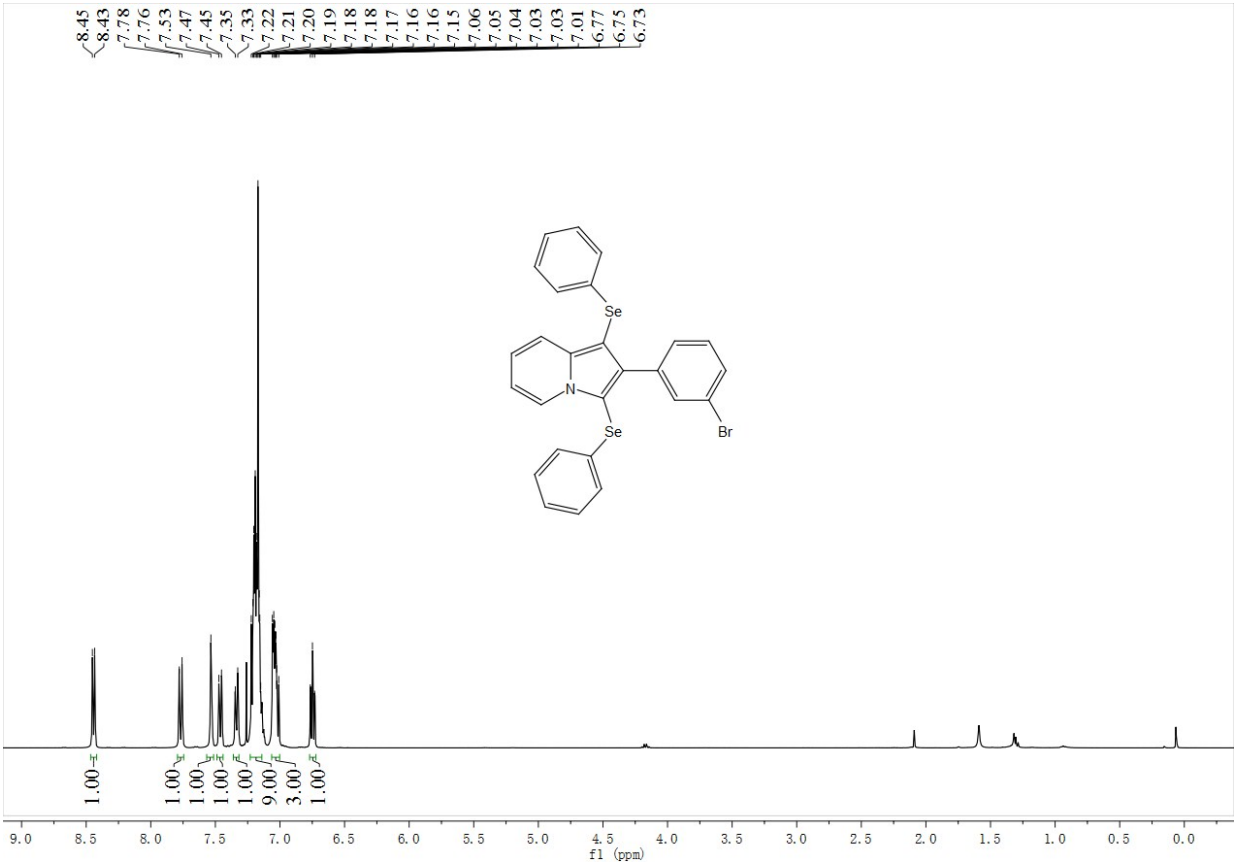
105.84
94.95
77.31
77.00
76.68
Se
N
Se
Cl
f1 (ppm)

4pa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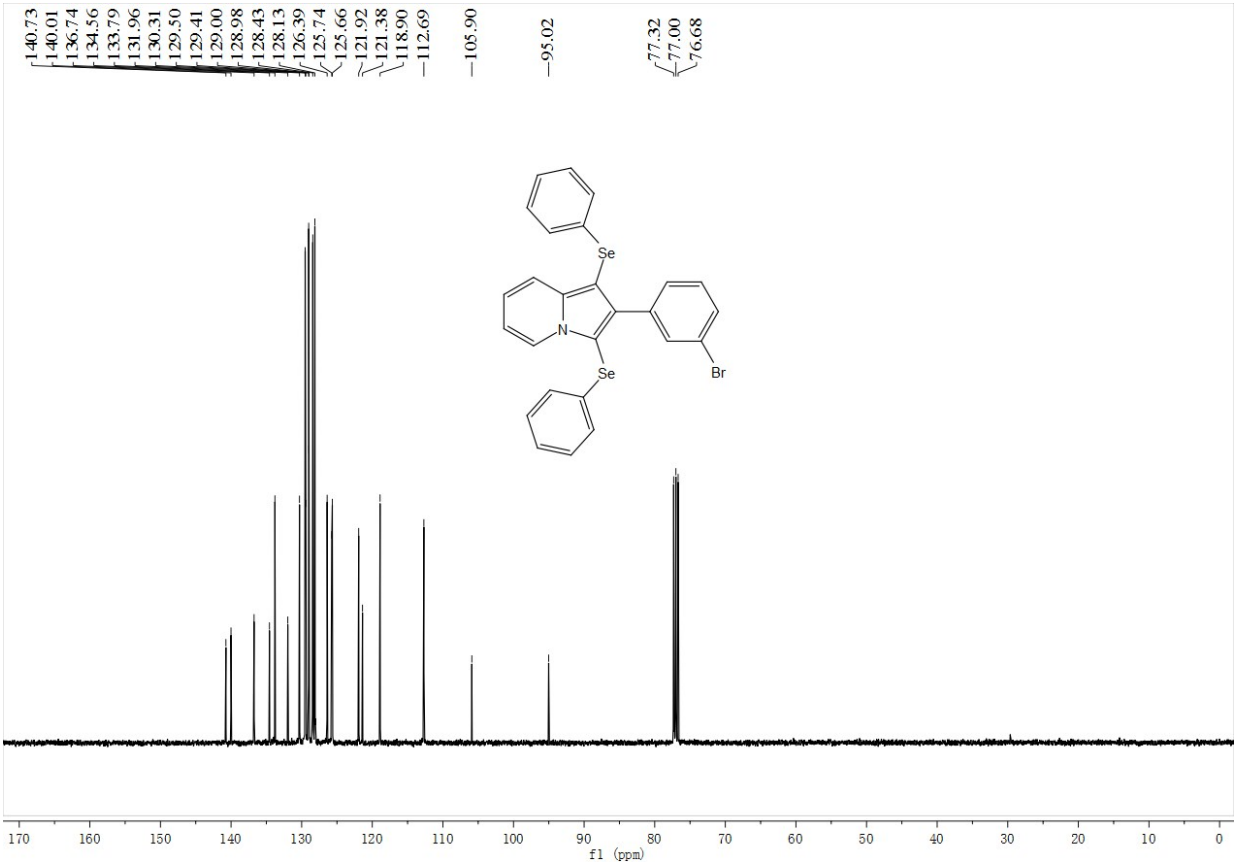
8.43
7.78
7.76
7.53
7.47
7.45
7.35
7.33
7.22
7.21
7.20
7.19
7.18
7.17
7.16
7.16
7.15
7.06
7.05
7.04
7.03
7.03
7.01
6.77
6.75
6.73
Se
N
Se
Br
1.00
1.00
1.00
1.00
1.00
9.00
3.00
1.00
f1 (ppm)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129.50
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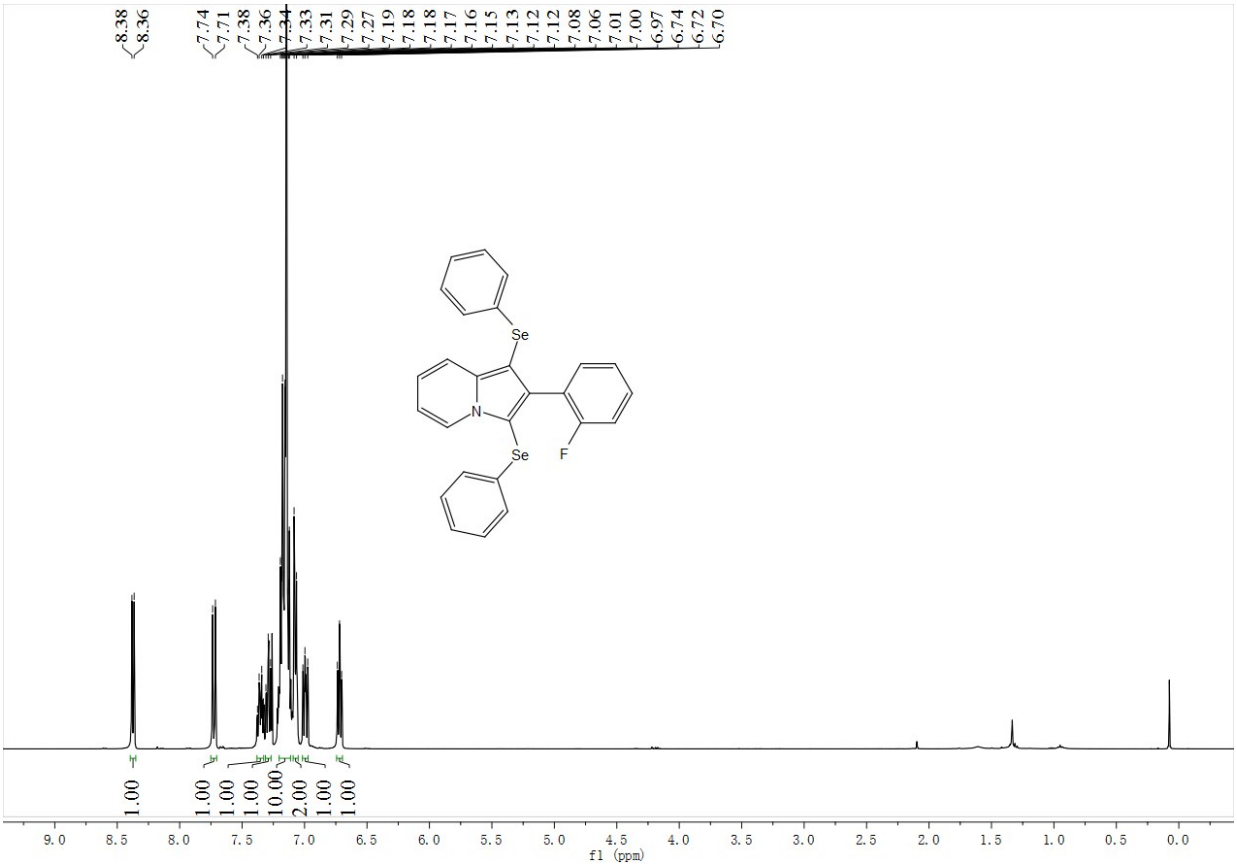
129.00
128.98
128.43
128.13
126.39
125.74
125.66
121.92
121.38
118.90
112.69
105.90
95.02
77.32
77.00
76.68
Se
N
Se
Br
f1 (ppm)

4qa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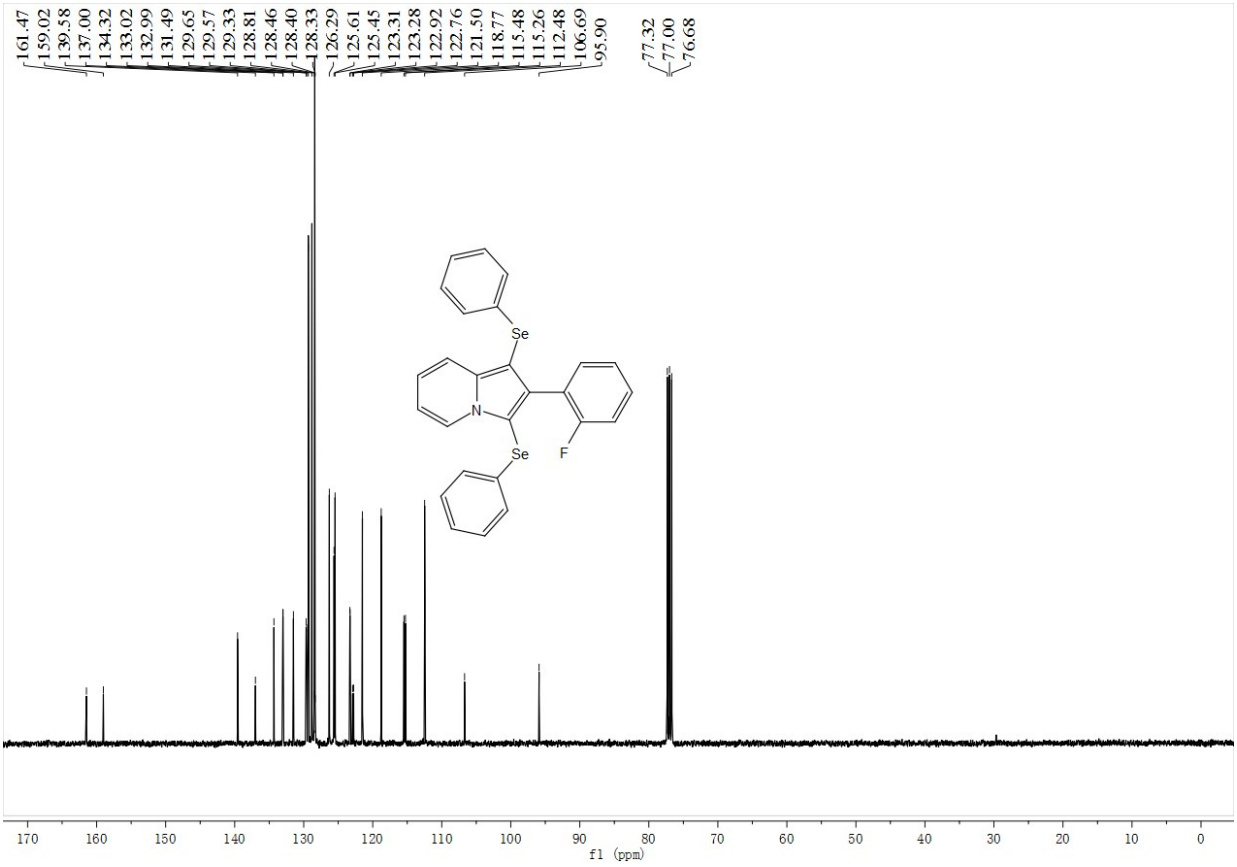
7.38
7.36
7.34
7.33
7.31
7.29
7.27
7.19
7.18
7.18
7.17
7.16
7.15
7.13
7.12
7.12
7.08
7.06
7.01
7.00
6.97
6.74
6.72
6.70
Se
N
Se
F
1.00
1.00
1.00
1.00
10.00
2.00
1.00
1.00
f1 (ppm)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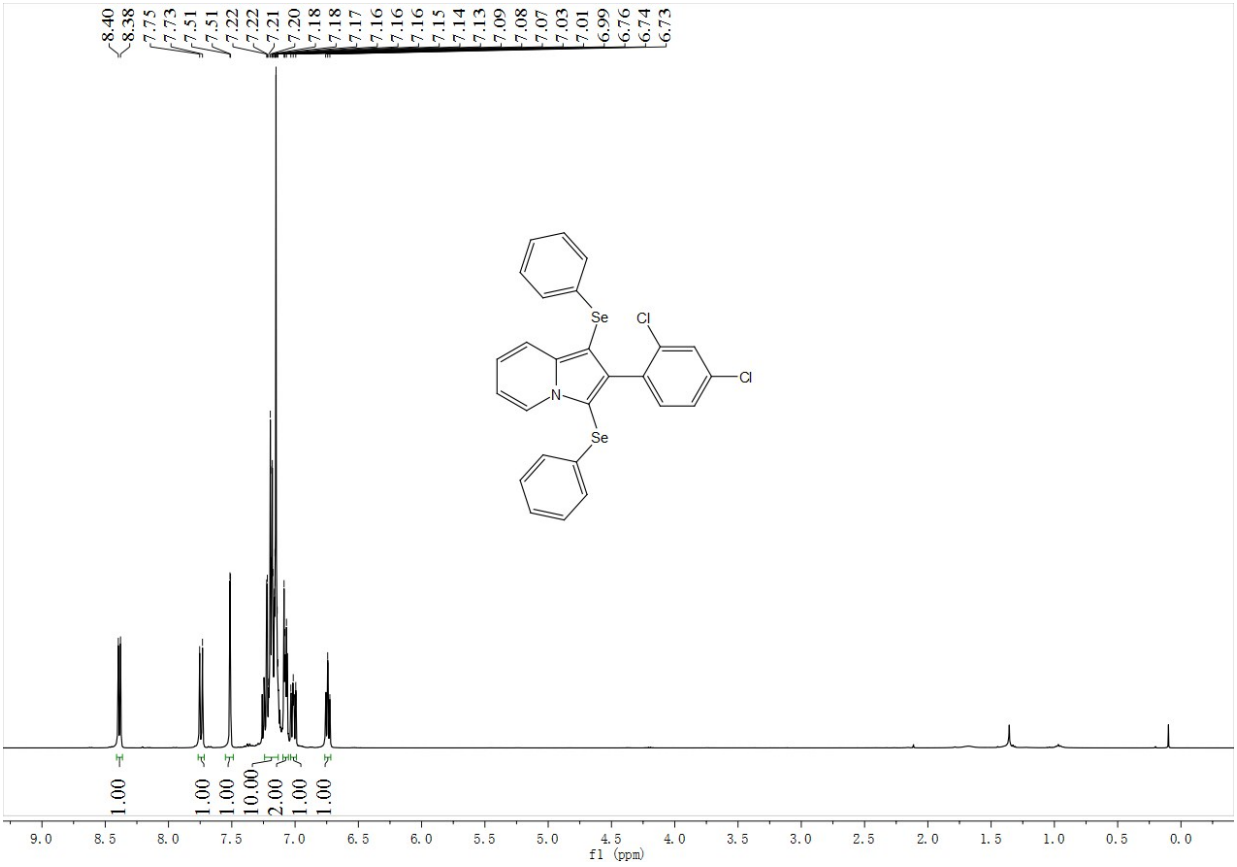
159.02
139.58
137.00
134.32
133.02
132.99
131.49
129.65
129.57
129.33
128.81
128.46
128.40
128.33
126.29
125.61
125.45
123.31
123.28
122.92
122.76
121.50
118.77
115.48
115.26
112.48
106.69
95.90
77.32
77.00
76.68
Se
N
Se
F
f1 (ppm)

4ra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8.38
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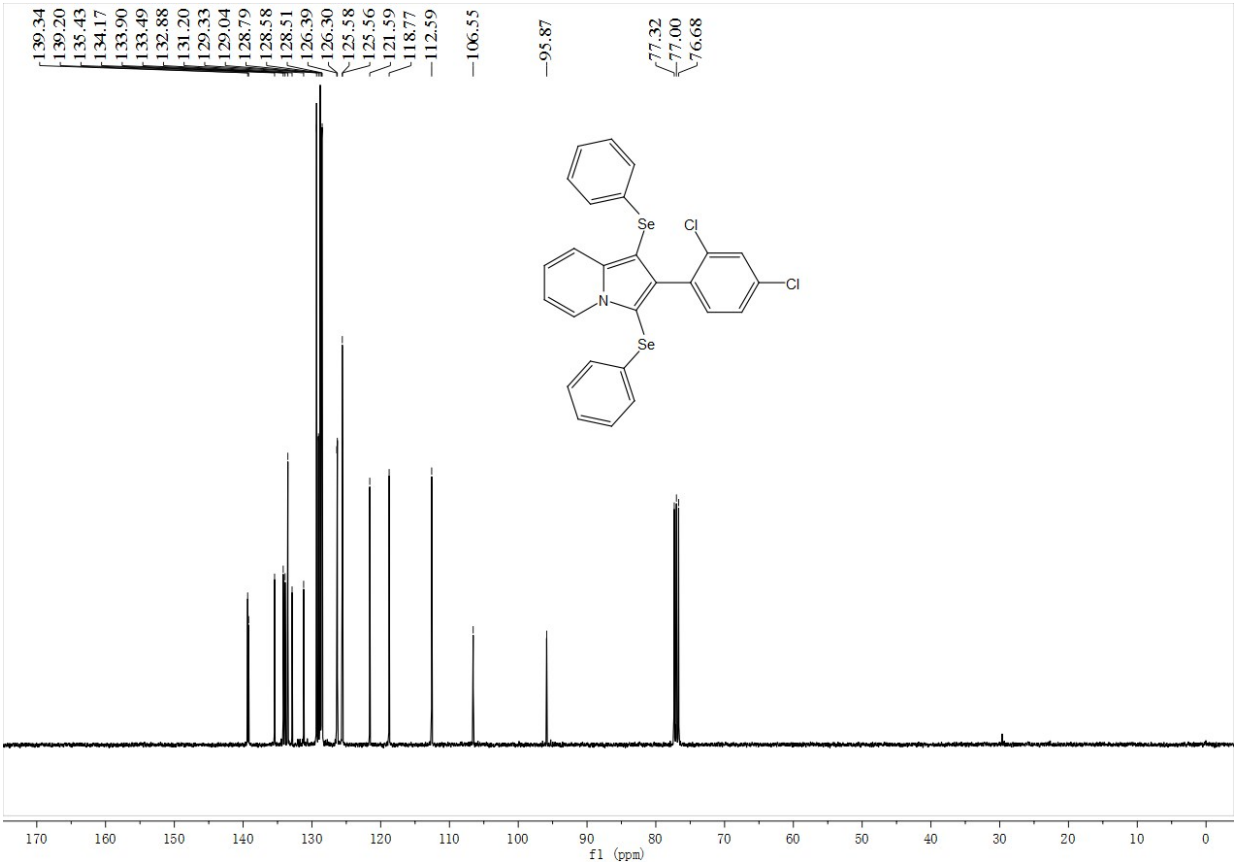
7.73
7.51
7.51
7.22
7.22
7.21
7.20
7.18
7.18
7.17
7.16
7.16
7.16
7.15
7.14
7.13
7.09
7.08
7.07
7.03
7.01
6.99
6.76
6.74
6.73
Se
Cl
Cl
N
Se
1.00
1.00
1.00
10.00
2.00
1.00
1.00
f1 (ppm)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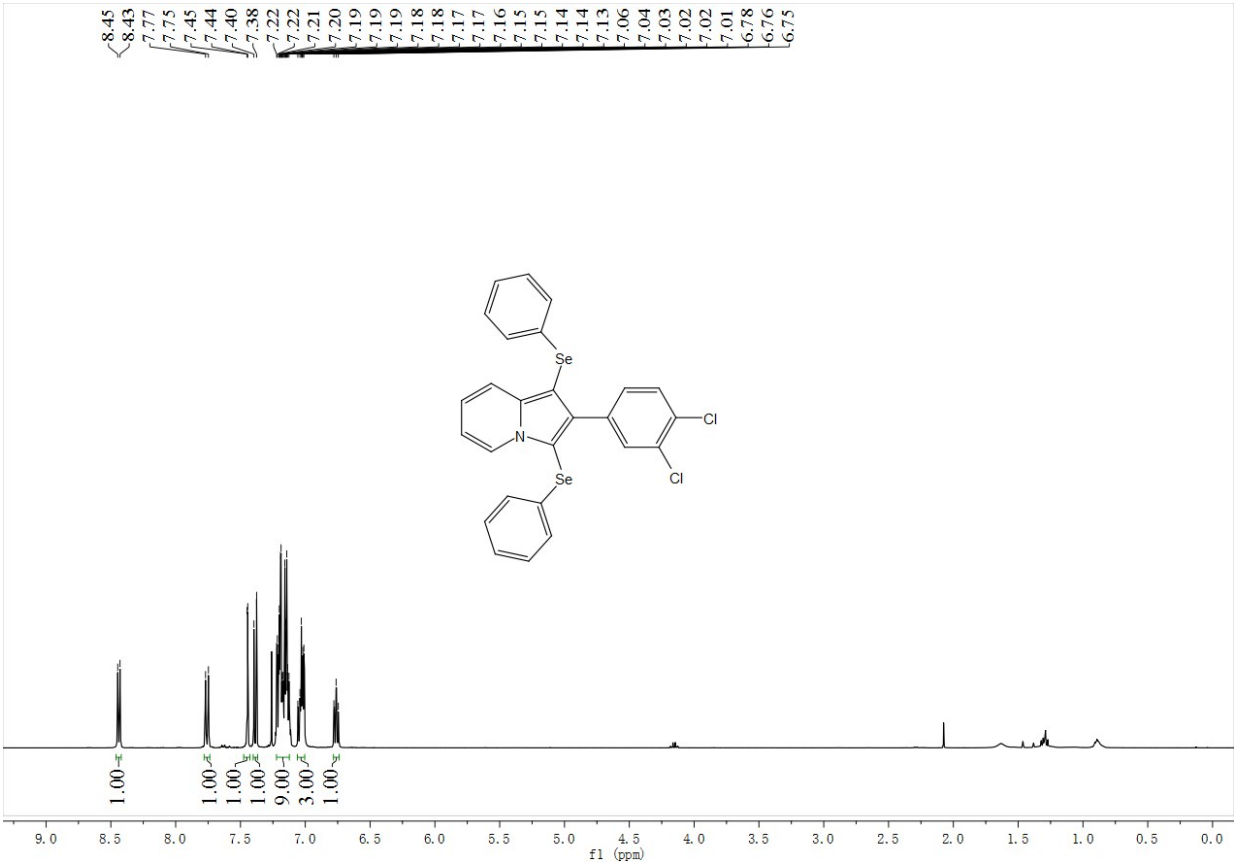
133.49
132.88
131.20
129.33
129.04
128.79
128.58
128.51
126.39
126.30
125.58
125.56
121.59
118.77
112.59
106.55
95.87
77.32
77.00
76.68
Se
Cl
Cl
N
Se
f1 (ppm)

4sa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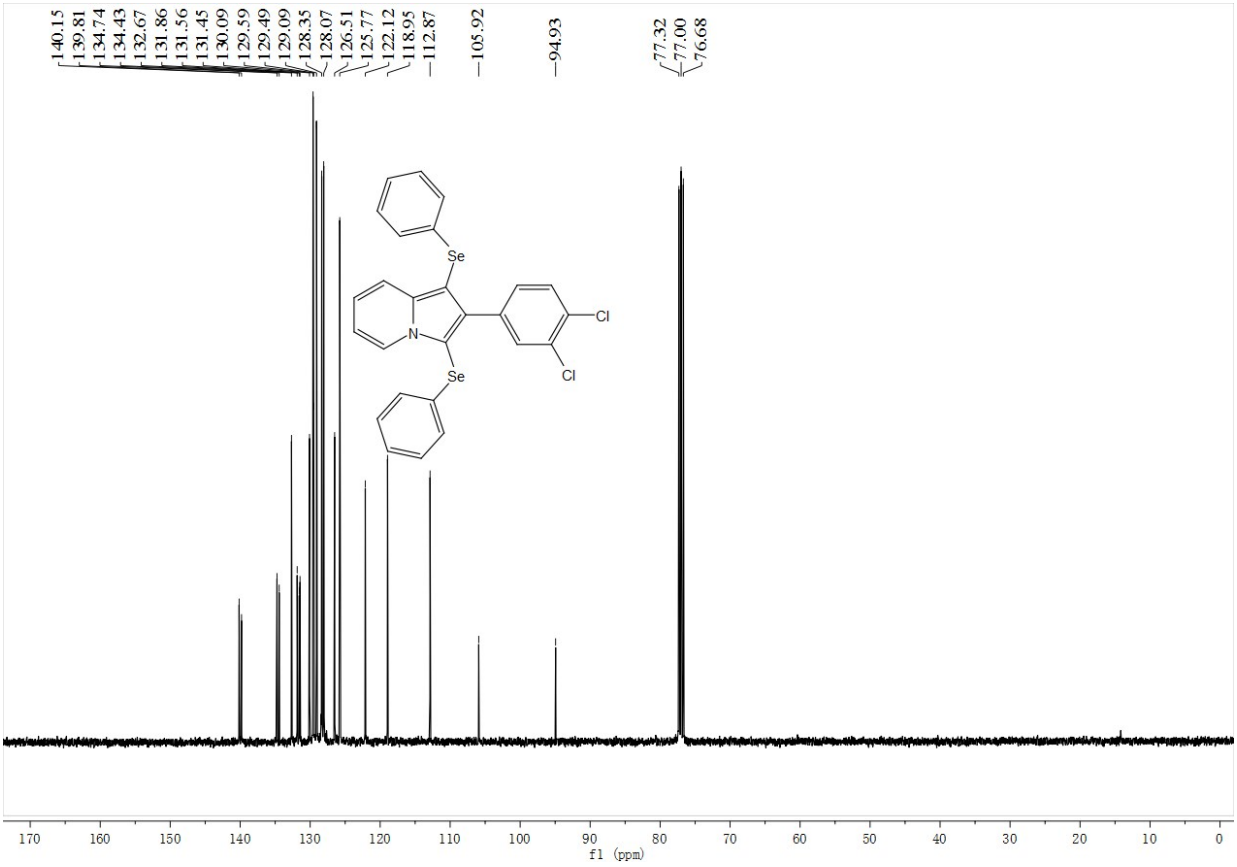
7.75
7.45
7.44
7.40
7.38
7.22
7.22
7.21
7.20
7.19
7.19
7.19
7.18
7.18
7.17
7.17
7.16
7.15
7.15
7.14
7.14
7.13
7.06
7.04
7.03
7.02
7.02
7.01
6.78
6.76
6.75
Se
N
Se
Cl
Cl
1.00
1.00
1.00
1.00
9.00
3.00
1.00
f1 (ppm)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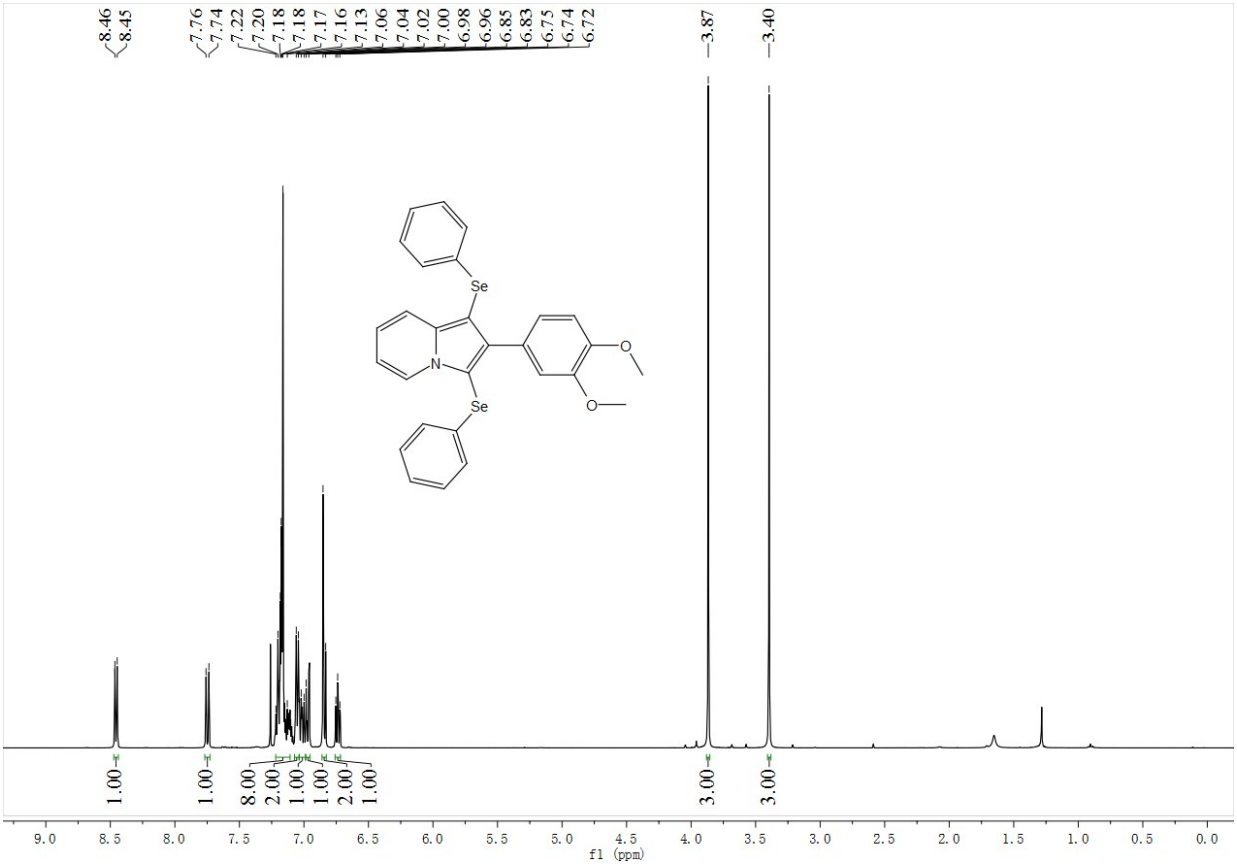
134.43
132.67
131.86
131.56
131.45
130.09
129.59
129.49
129.09
128.35
128.07
126.51
125.77
122.12
118.95
112.87
105.92
94.93
77.32
77.00
76.68
Se
N
Se
Cl
Cl
f1 (ppm)

4ta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7.22
7.20
7.18
7.18
7.17
7.16
7.13
7.06
7.04
7.02
7.00
6.98
6.96
6.85
6.83
6.75
6.74
6.72
3.87
3.40
Se
N
Se
O
O
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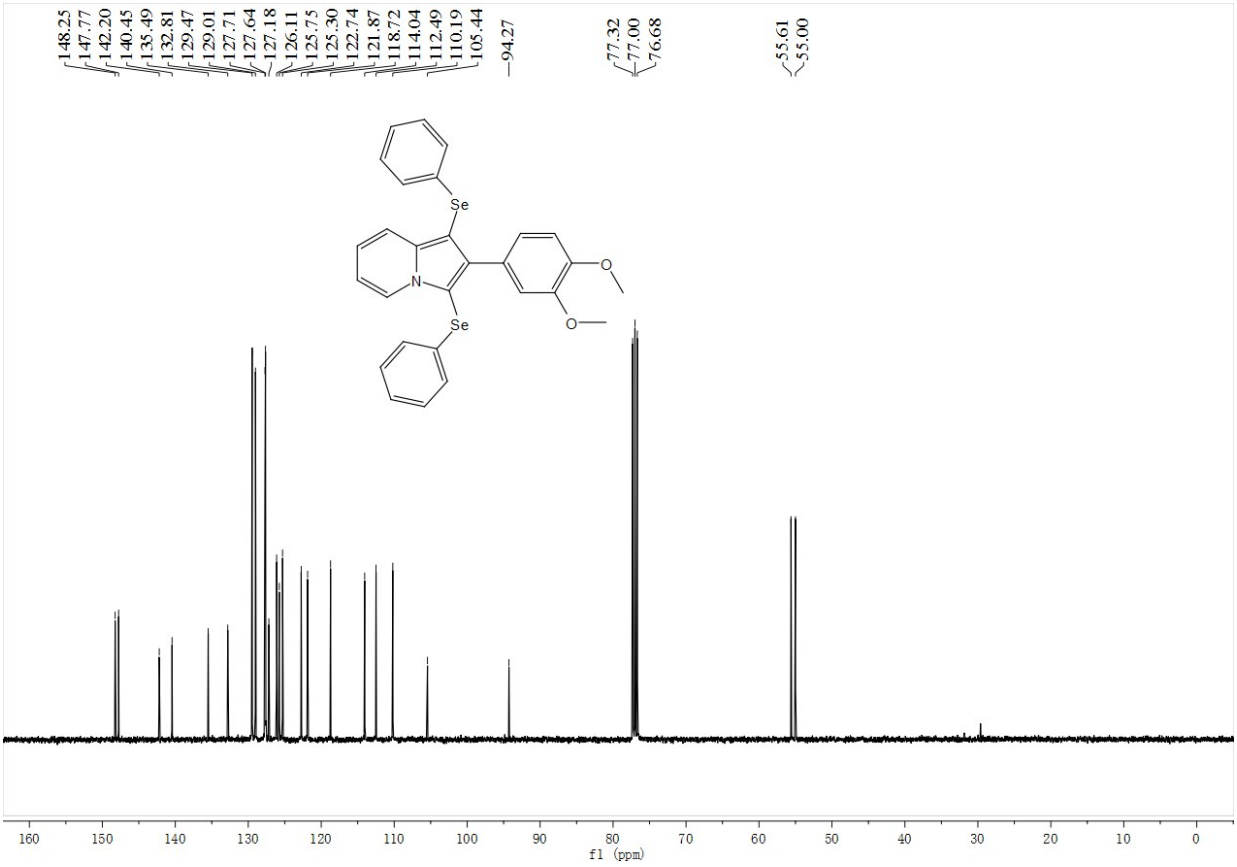
1.00
8.00
2.00
1.00
1.00
2.00
1.00
3.00
3.00
f1 (ppm)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129.47
129.01
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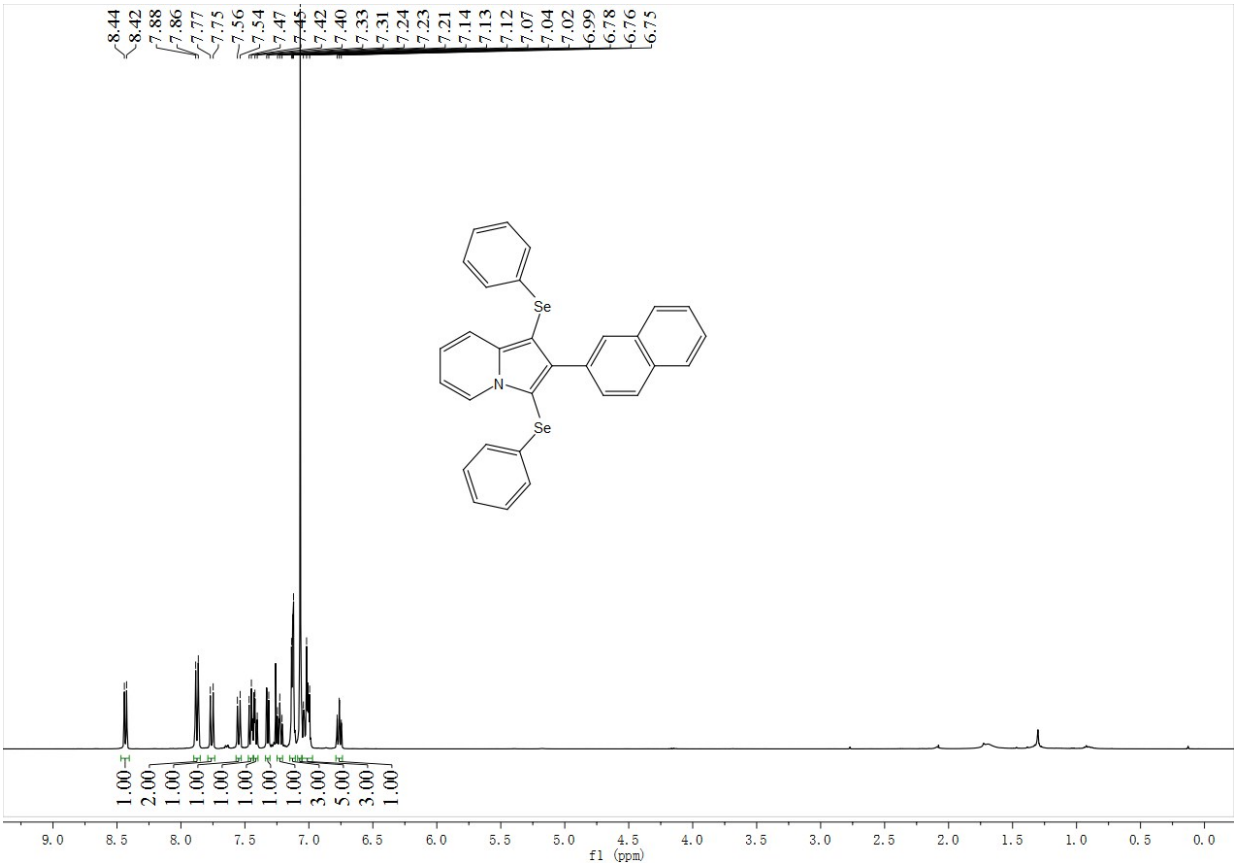
127.64
127.18
126.11
125.75
125.30
122.74
121.87
118.72
114.04
112.49
110.19
105.44
94.27
77.32
77.00
76.68
55.61
55.00
Se
N
Se
O
O
f1 (ppm)

4ua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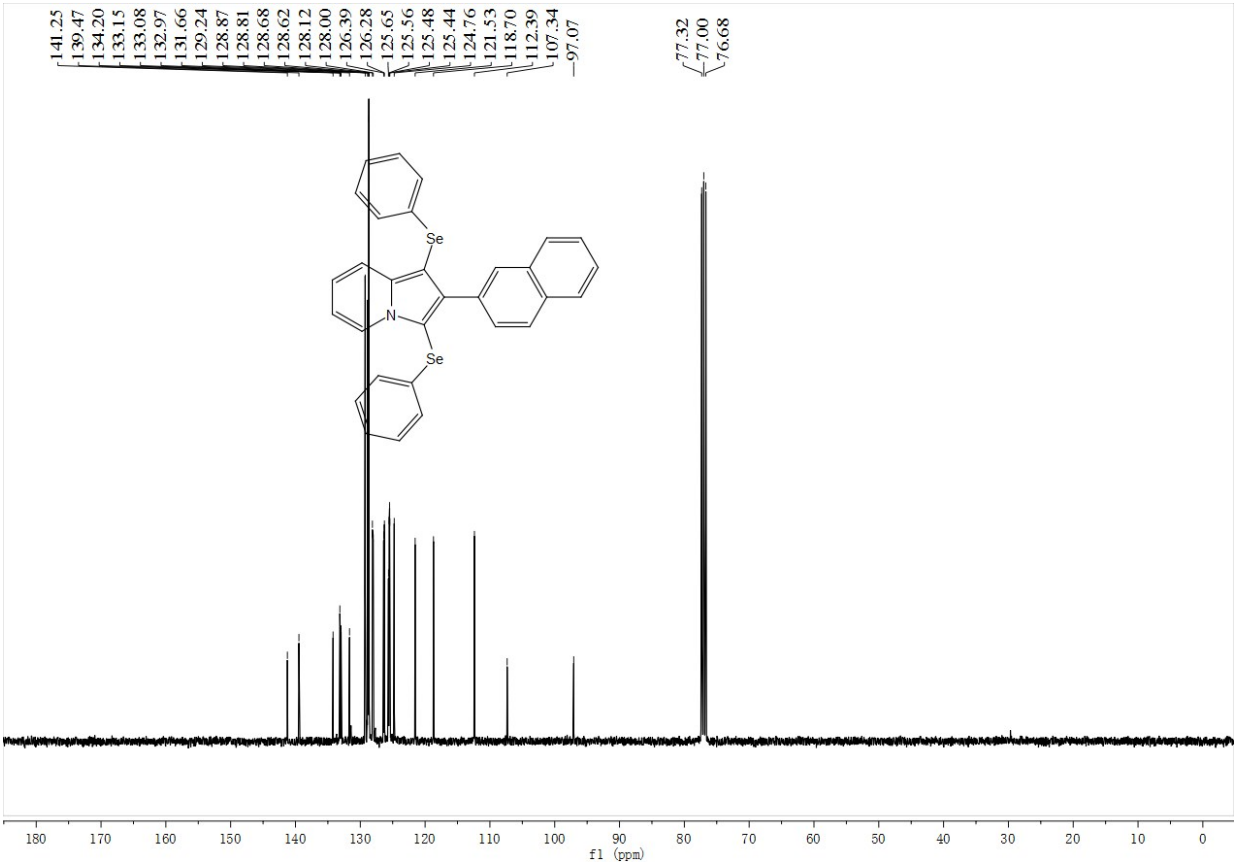
7.75
7.56
7.54
7.47
7.45
7.42
7.40
7.33
7.31
7.24
7.23
7.21
7.14
7.13
7.12
7.07
7.04
7.02
6.99
6.78
6.76
6.75
Se
N
Se
1.00
2.00
1.00
1.00
1.00
1.00
1.00
1.00
3.00
5.00
3.00
1.00
f1 (ppm)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133.08
132.97
131.66
129.24
128.87
128.81
128.68
128.62
128.12
128.00
126.39
126.28
125.65
125.56
125.48
125.44
124.76
121.53
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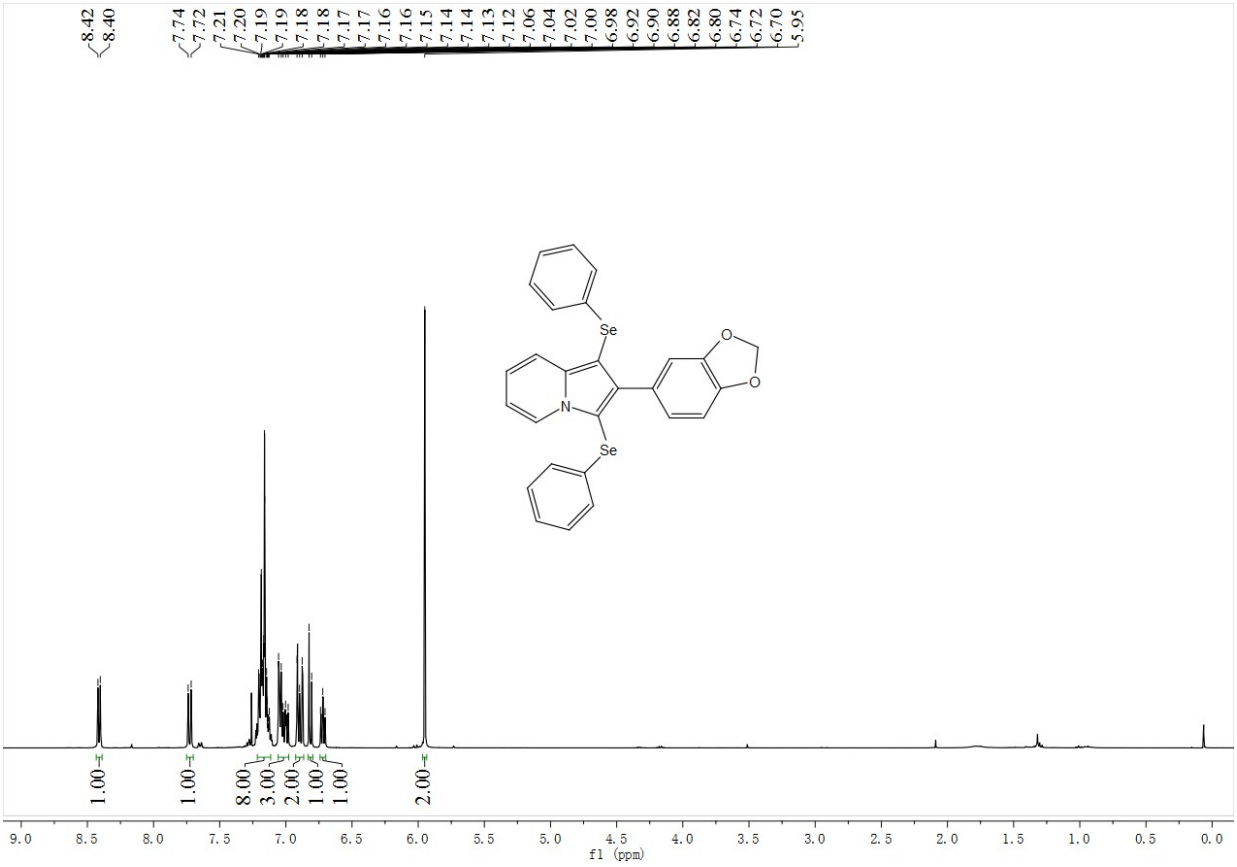
112.39
107.34
97.07
77.32
77.00
76.68
Se
N
Se
f1 (ppm)

4va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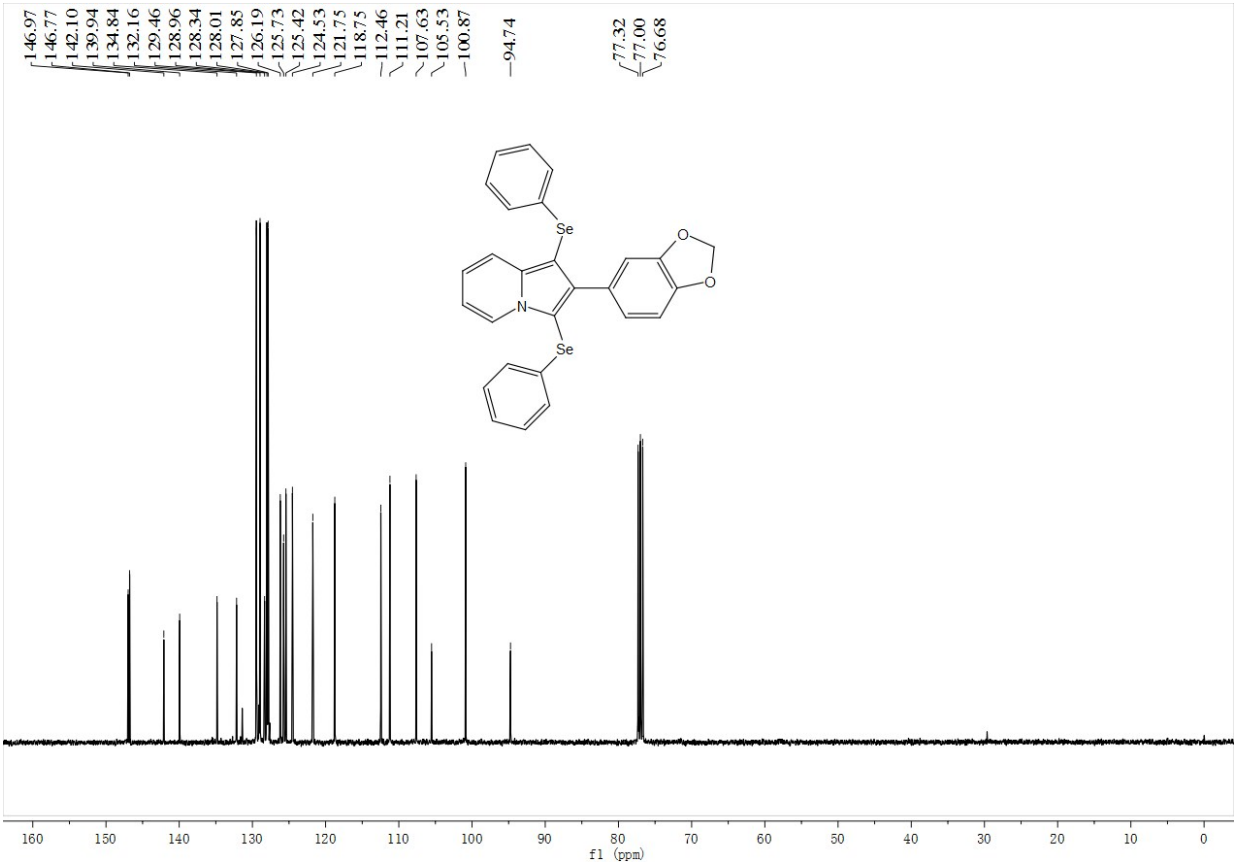
7.72
7.21
7.20
7.19
7.19
7.18
7.18
7.17
7.17
7.16
7.16
7.15
7.14
7.14
7.13
7.12
7.06
7.04
7.02
7.00
6.98
6.92
6.90
6.88
6.82
6.80
6.74
6.72
6.70
5.95
Se
O
O
N
Se
1.00
1.00
8.00
3.00
2.00
1.00
1.00
2.00
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


146.97
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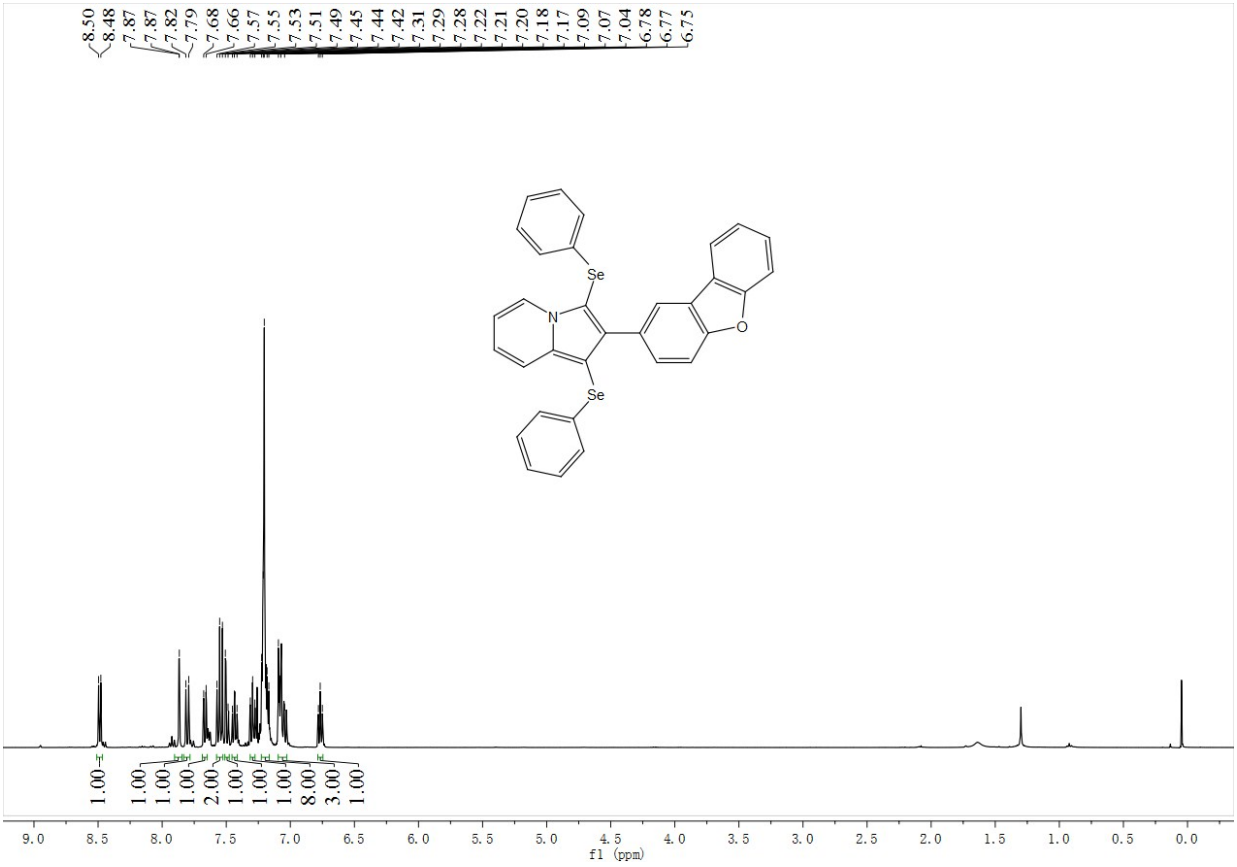
142.10
139.94
134.84
132.16
129.46
128.96
128.34
128.01
127.85
126.19
125.73
125.42
124.53
121.75
118.75
112.46
111.21
107.63
105.53
100.87
94.74
77.32
77.00
76.68
Se
O
O
N
Se
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

4wa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8.48
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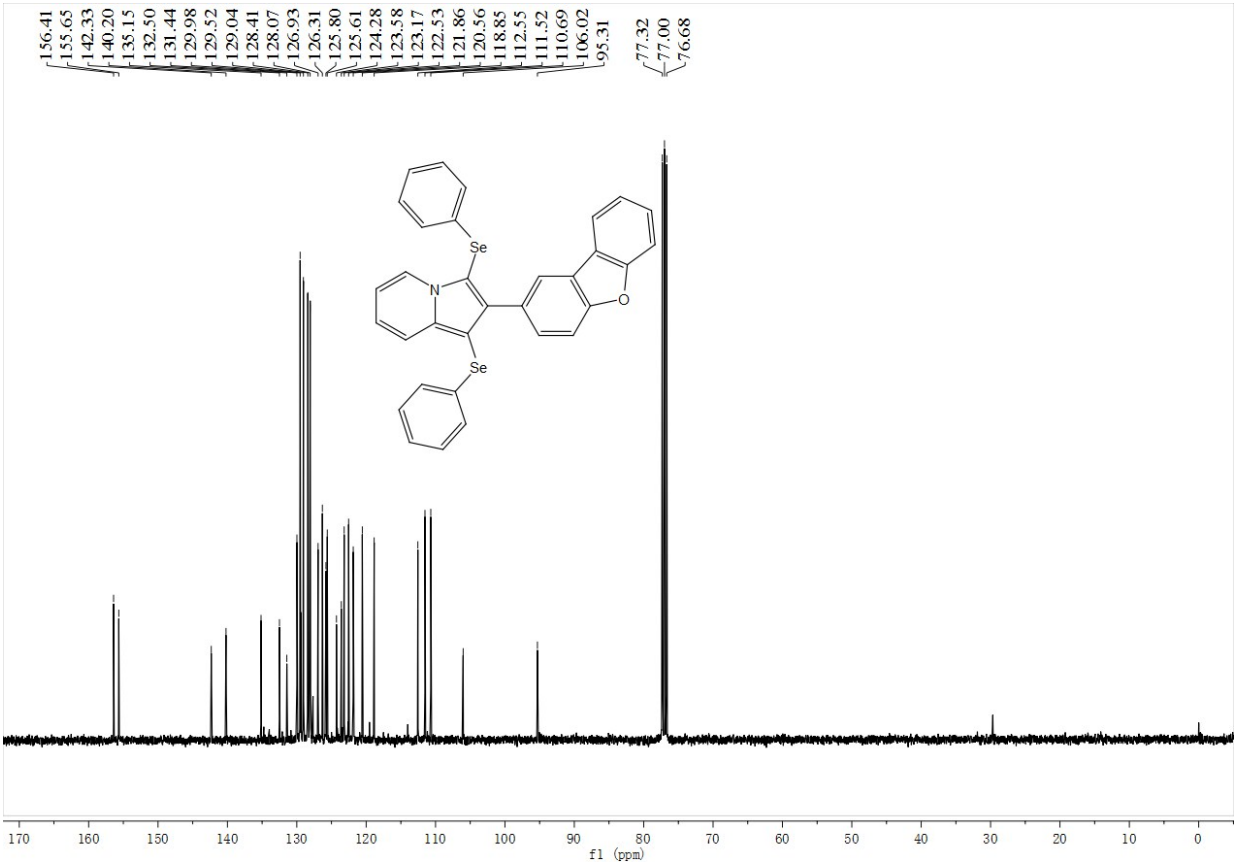
7.79
7.68
7.66
7.57
7.55
7.53
7.51
7.49
7.45
7.44
7.42
7.31
7.29
7.28
7.22
7.21
7.20
7.18
7.17
7.09
7.07
7.04
6.78
6.77
6.75
Se
N
O
Se
1.00
1.00
1.00
1.00
2.00
1.00
1.00
1.00
8.00
3.00
1.00
f1 (ppm)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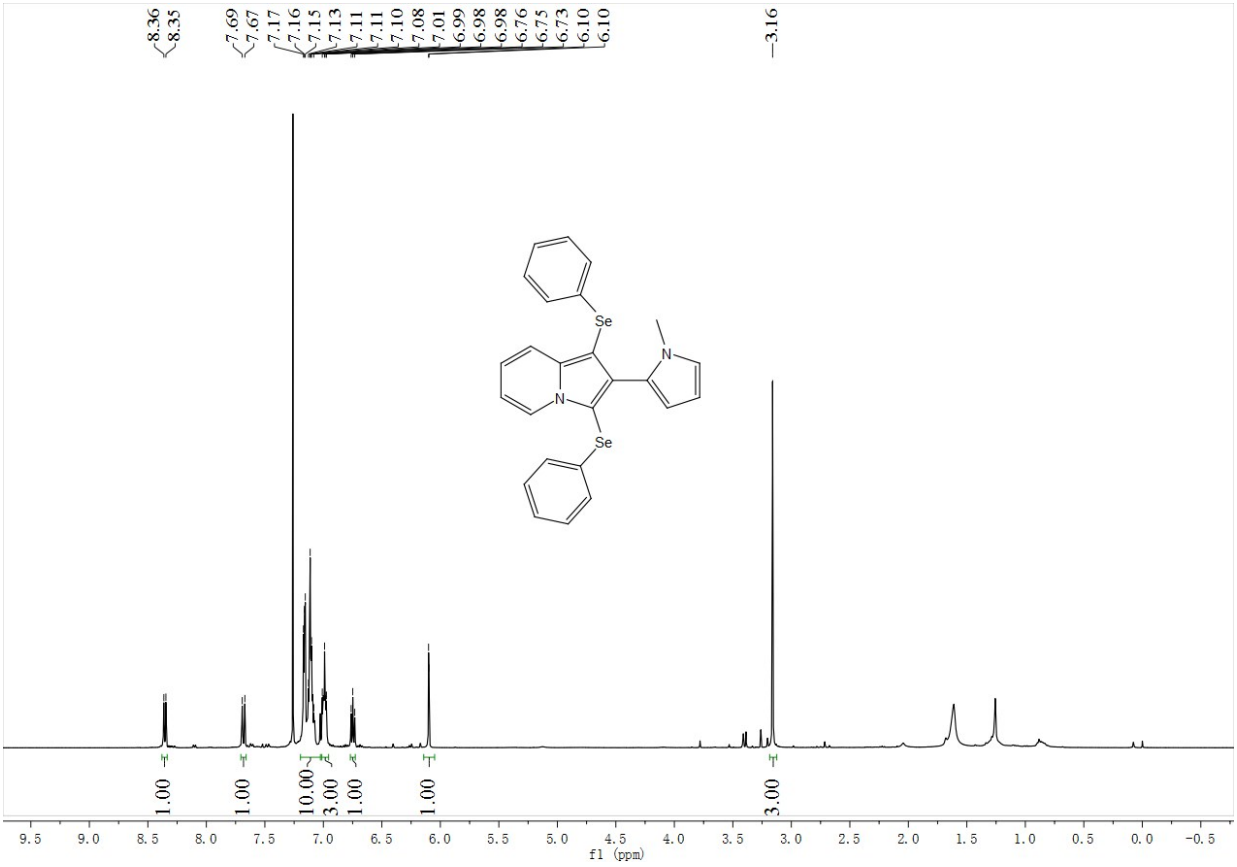
132.50
131.44
129.98
129.52
129.04
128.41
128.07
126.93
126.31
125.80
125.61
124.28
123.58
123.17
122.53
121.86
120.56
118.85
112.55
111.52
110.69
106.02
95.31
77.32
77.00
76.68
Se
N
O
Se
f1 (ppm)

4xa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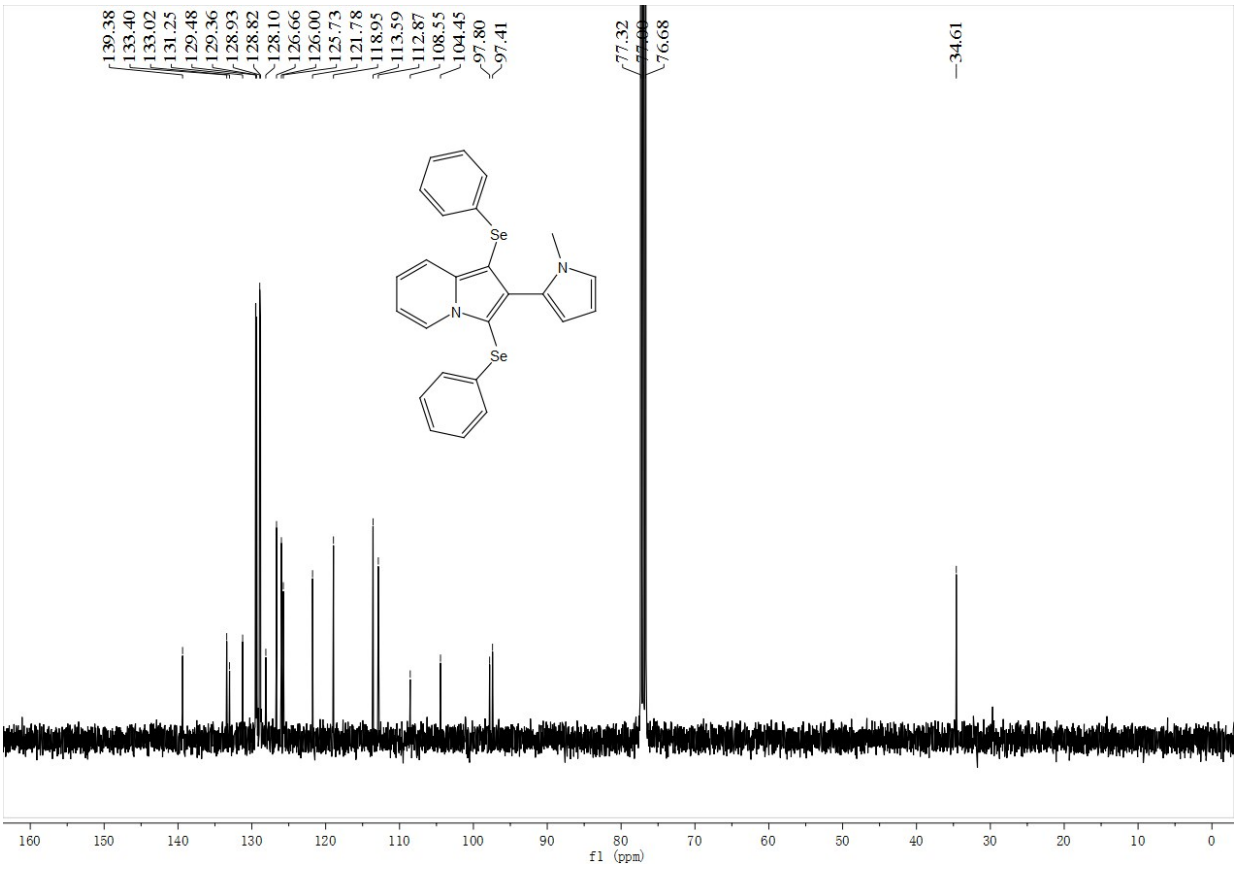
7.16
7.15
7.13
7.11
7.11
7.10
7.08
7.01
6.99
6.98
6.98
6.76
6.75
6.73
6.10
6.10
3.16
Se
N
N
Se
1.00
1.00
10.00
3.00
1.00
1.00
3.00
f1 (ppm)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128.82
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126.66
126.00
125.73
121.78
118.95
113.59
112.87
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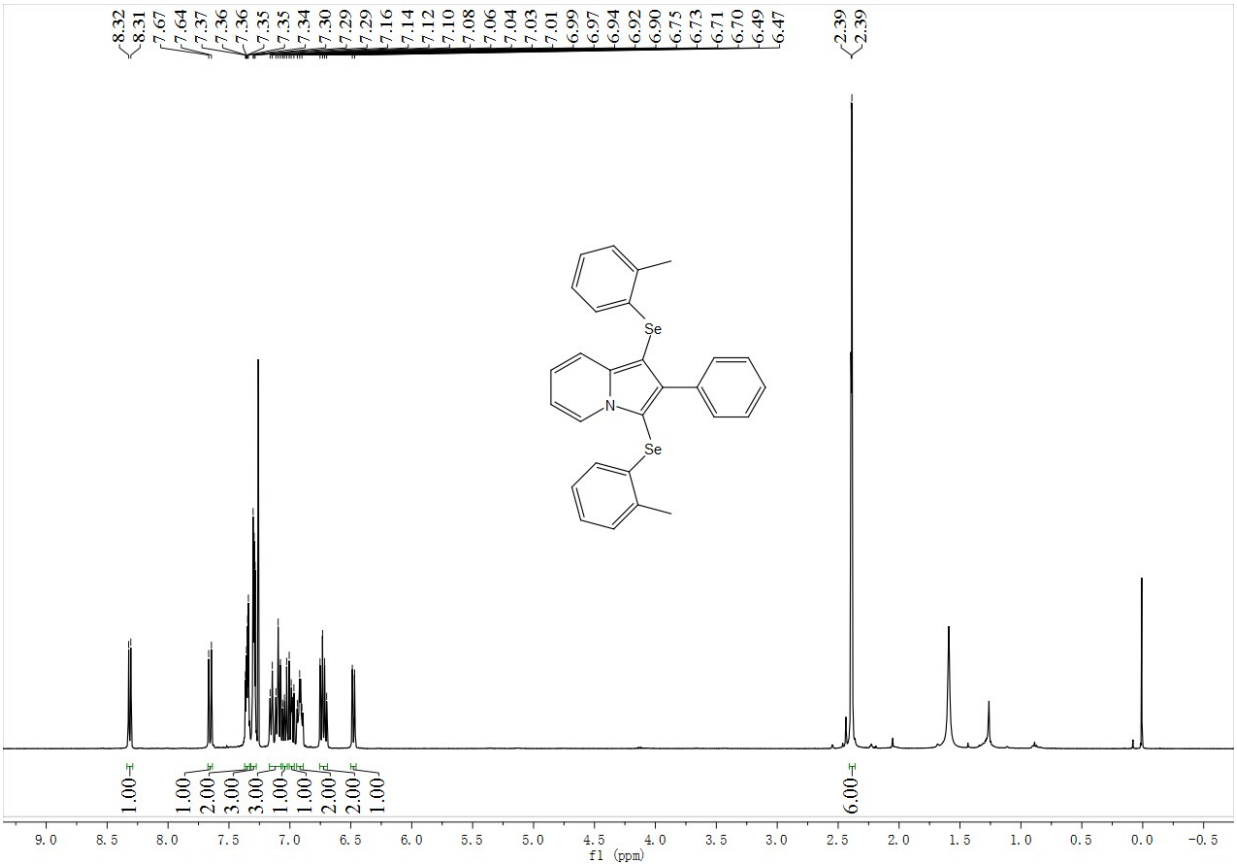
97.80
97.41
77.32
76.68
34.61
Se
N
N
Se
f1 (ppm)

5ab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7.35
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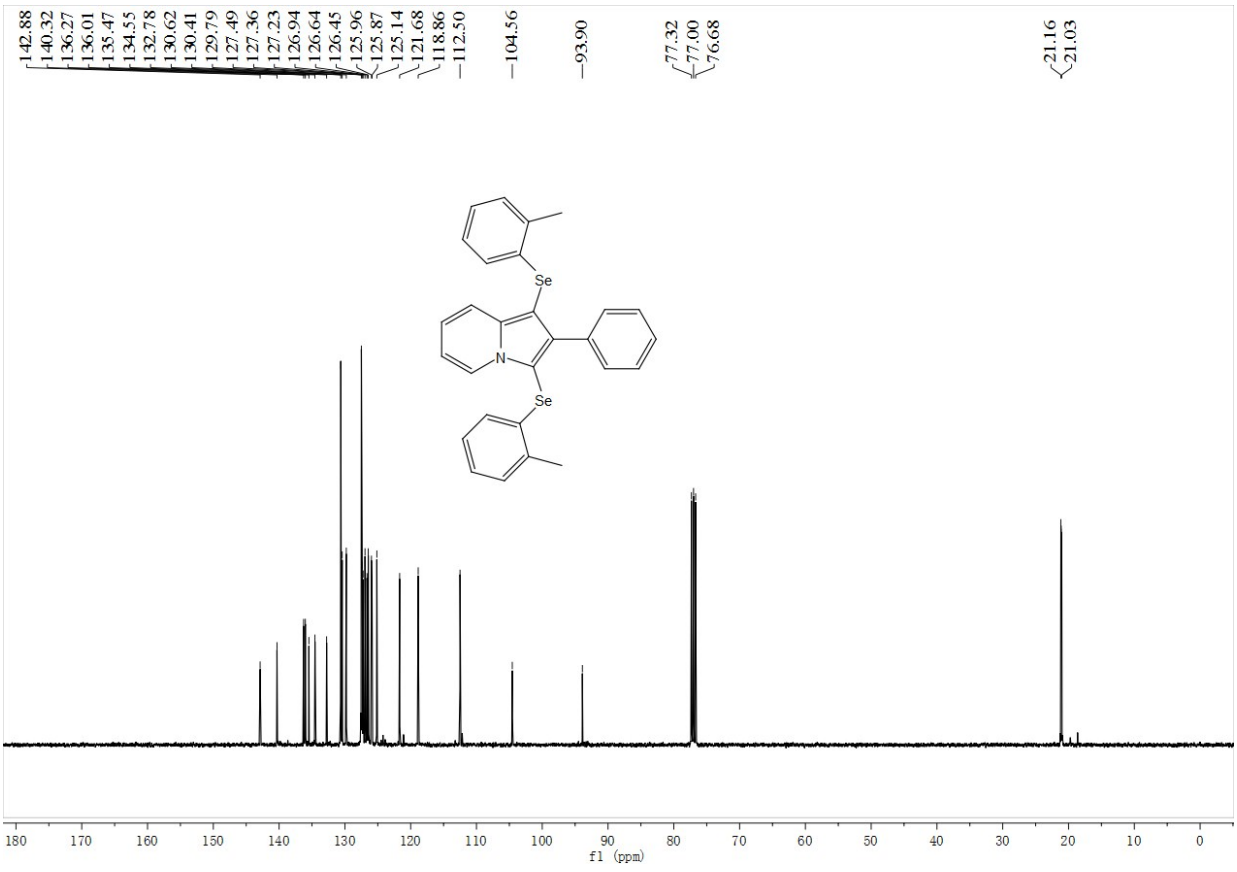
7.34
7.30
7.29
7.29
7.16
7.14
7.12
7.10
7.08
7.06
7.04
7.03
7.01
6.99
6.97
6.94
6.92
6.90
6.75
6.73
6.71
6.70
6.49
6.47
2.39
2.39
Se
N
Se
1.00
1.00
2.00
3.00
3.00
1.00
1.00
2.00
2.00
1.00
6.00
f1 (ppm)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129.79
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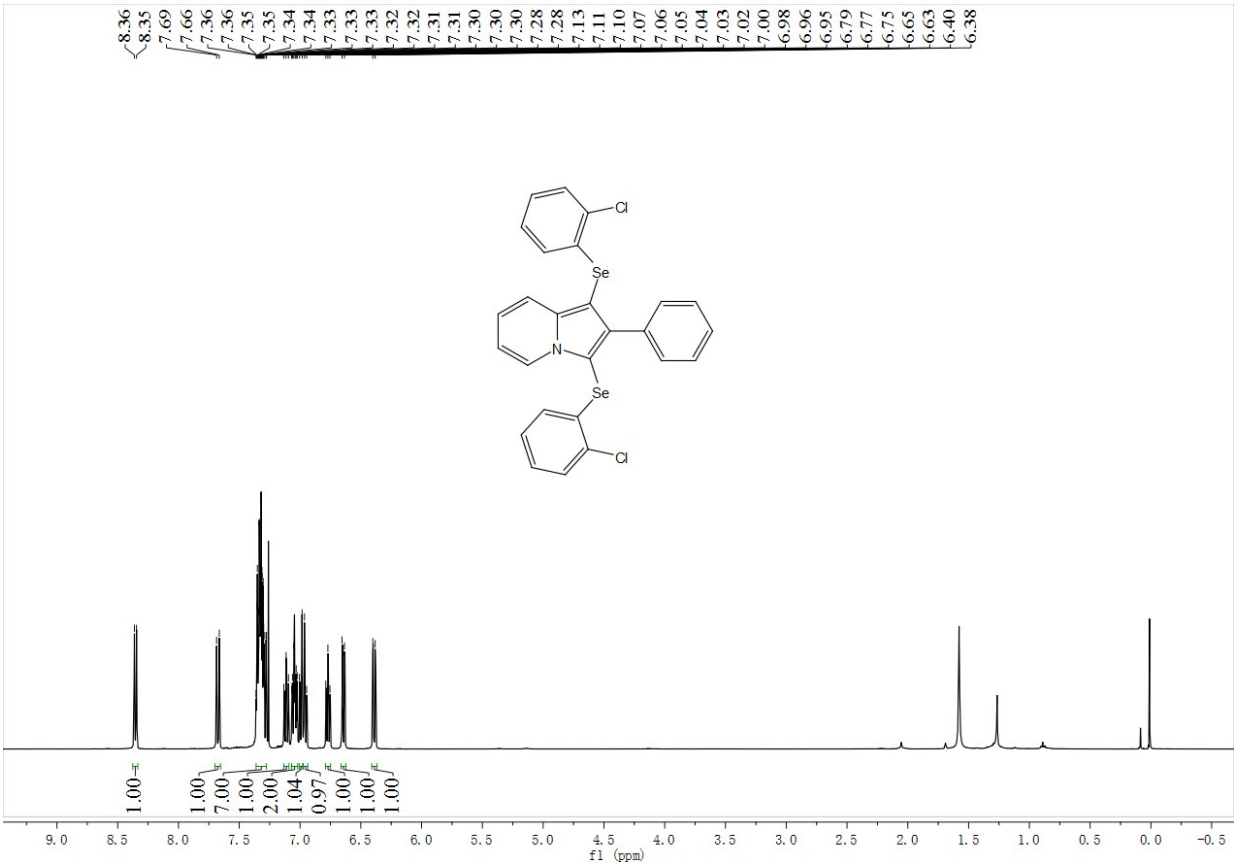
127.36
127.23
126.94
126.64
126.45
125.96
125.87
125.14
121.68
118.86
112.50
104.56
93.90
77.32
77.00
76.68
21.16
21.03
Se
N
Se
f1 (ppm)

5ac


8.36
8.35
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7.35
7.34
7.34
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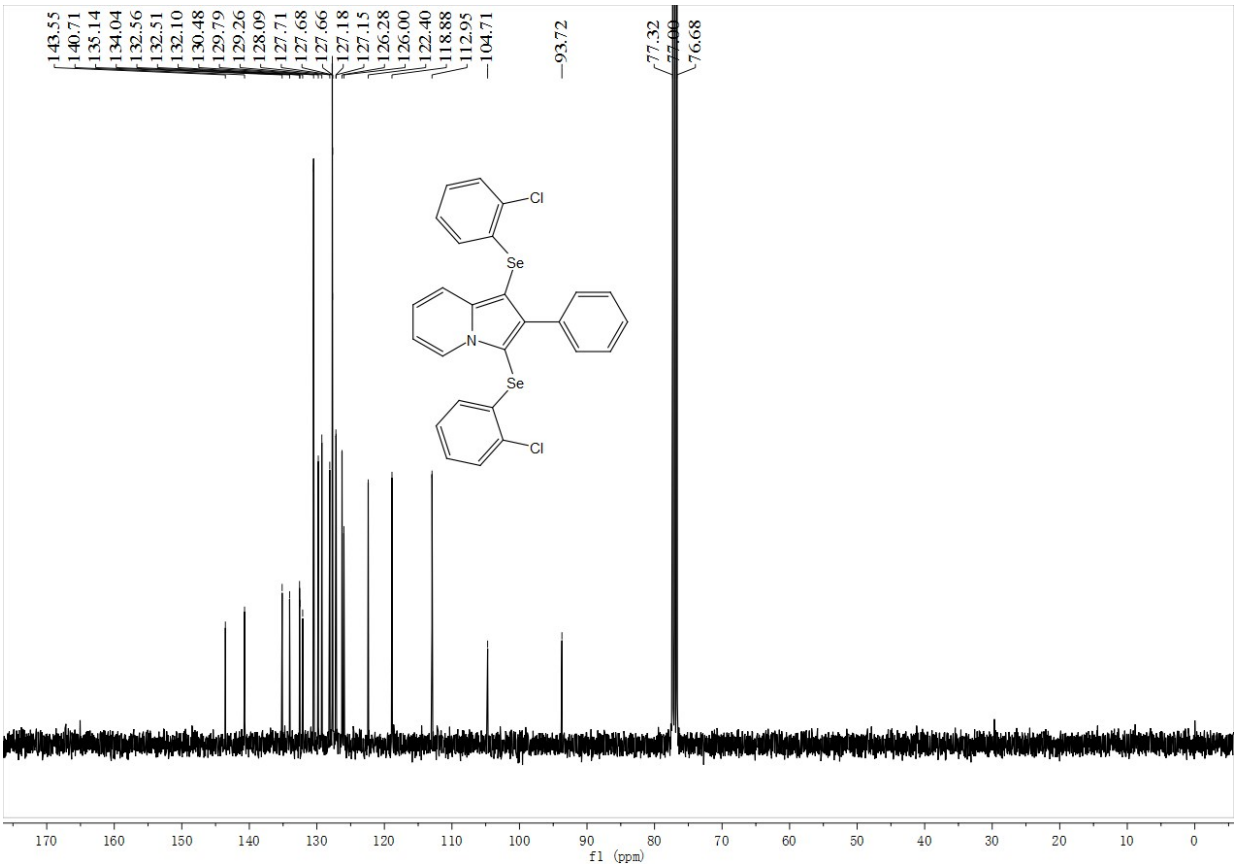
7.10
7.07
7.06
7.05
7.04
7.03
7.02
7.00
6.98
6.96
6.95
6.79
6.77
6.75
6.65
6.63
6.40
6.38
Cl
Se
N
Se
Cl
1.00
1.00
7.00
1.00
2.00
1.04
0.97
1.00
1.00
1.00
f1 (ppm)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132.51
132.10
130.48
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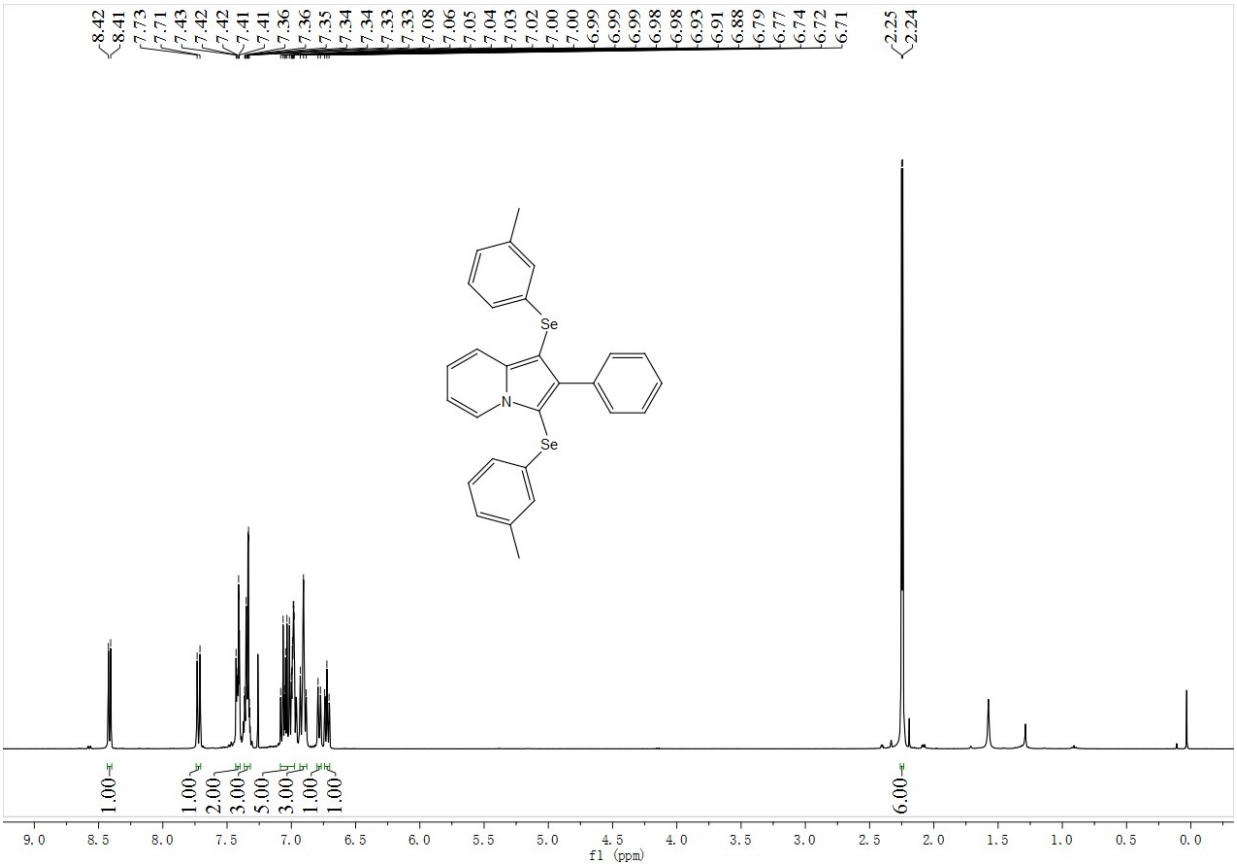
129.26
128.09
127.71
127.68
127.66
127.18
127.15
126.28
126.00
122.40
118.88
112.95
104.71
93.72
77.32
77.00
76.68
Cl
Se
N
Se
Cl
f1 (ppm)

5ad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7.36
7.35
7.34
7.34
7.33
7.33
7.08
7.06
7.05
7.04
7.03
7.02
7.00
7.00
6.99
6.99
6.99
6.98
6.98
6.93
6.91
6.88
6.79
6.77
6.74
6.72
6.71
2.25
2.24
Se
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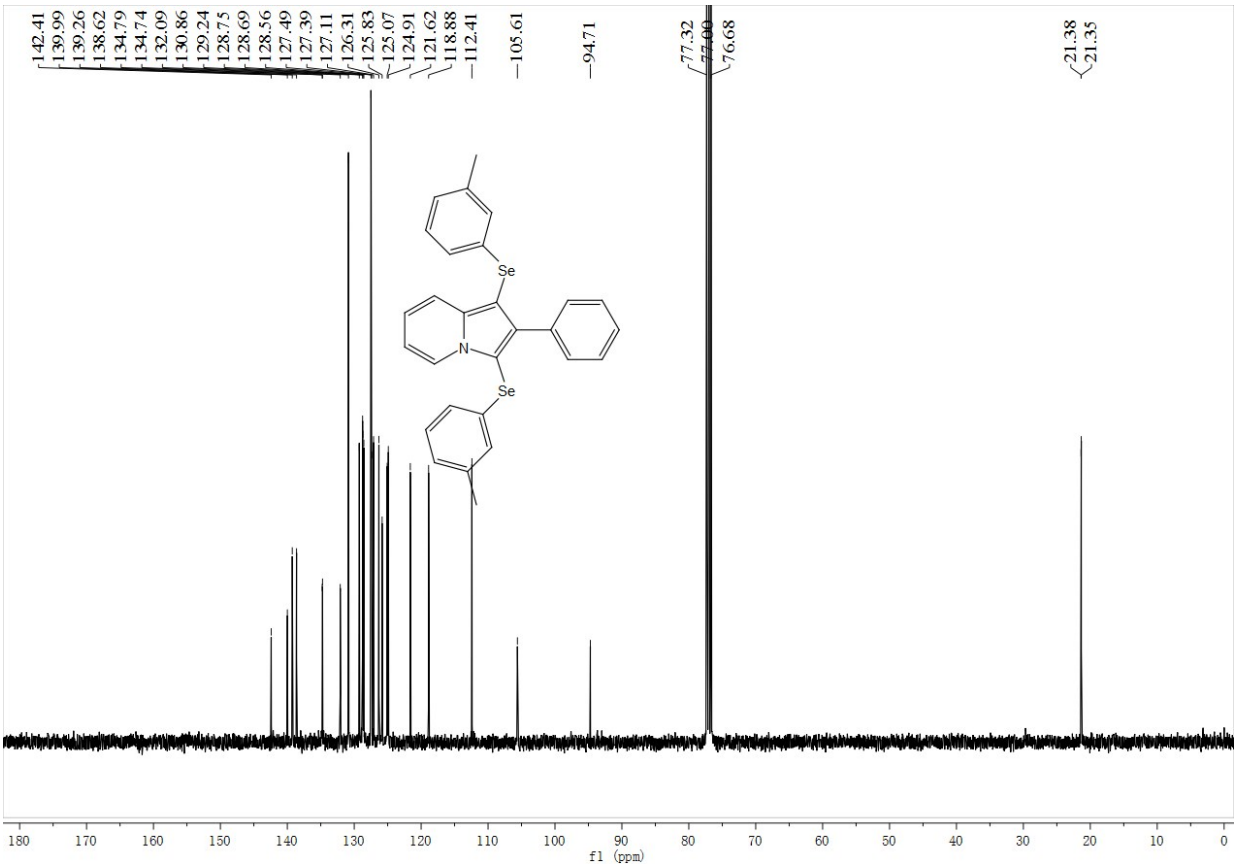
1.00
2.00
3.00
5.00
3.00
1.00
1.00
6.00
f1 (ppm)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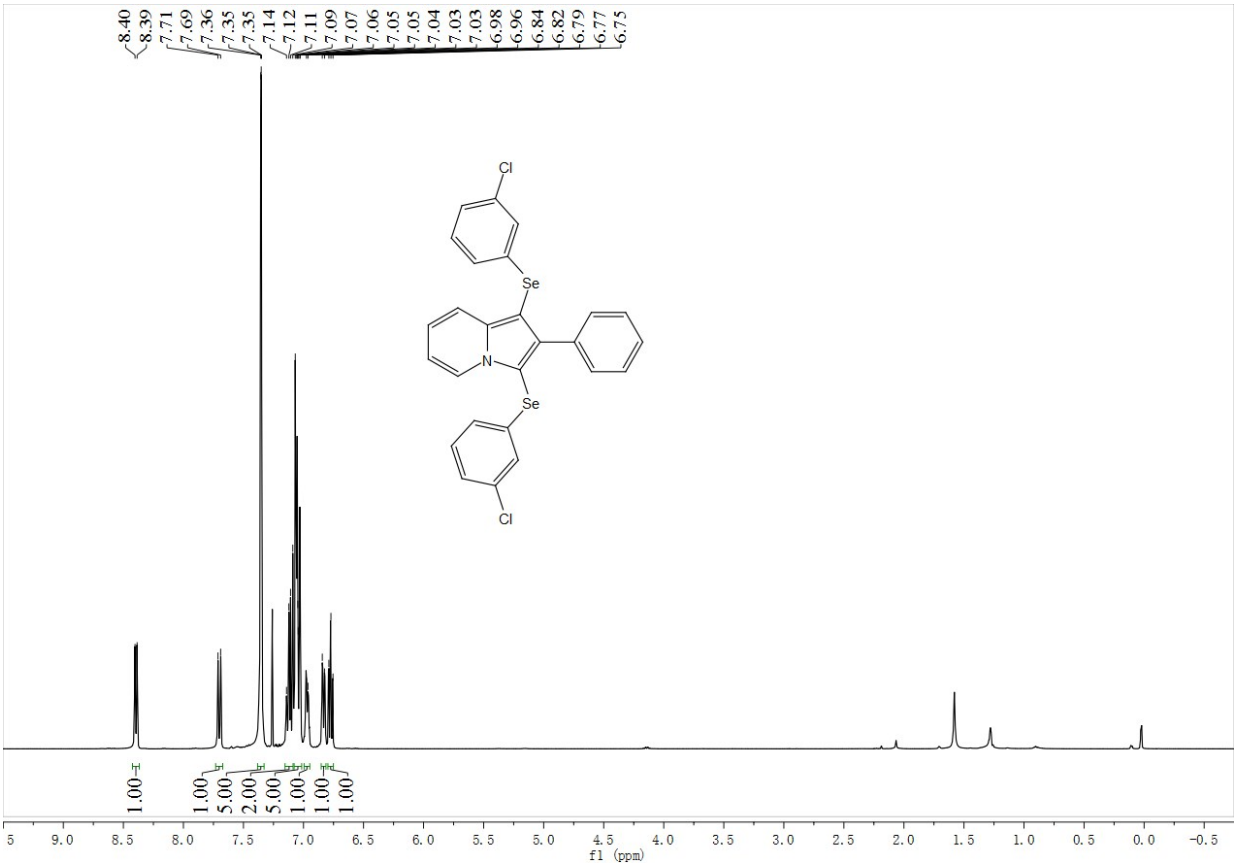
129.24
128.75
128.69
128.56
127.49
127.39
127.11
126.31
125.83
125.07
124.91
121.62
118.88
112.41
105.61
94.71
77.32
77.00
76.68
21.38
21.35
Se
N
Se
f1 (ppm)

5ae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8.39
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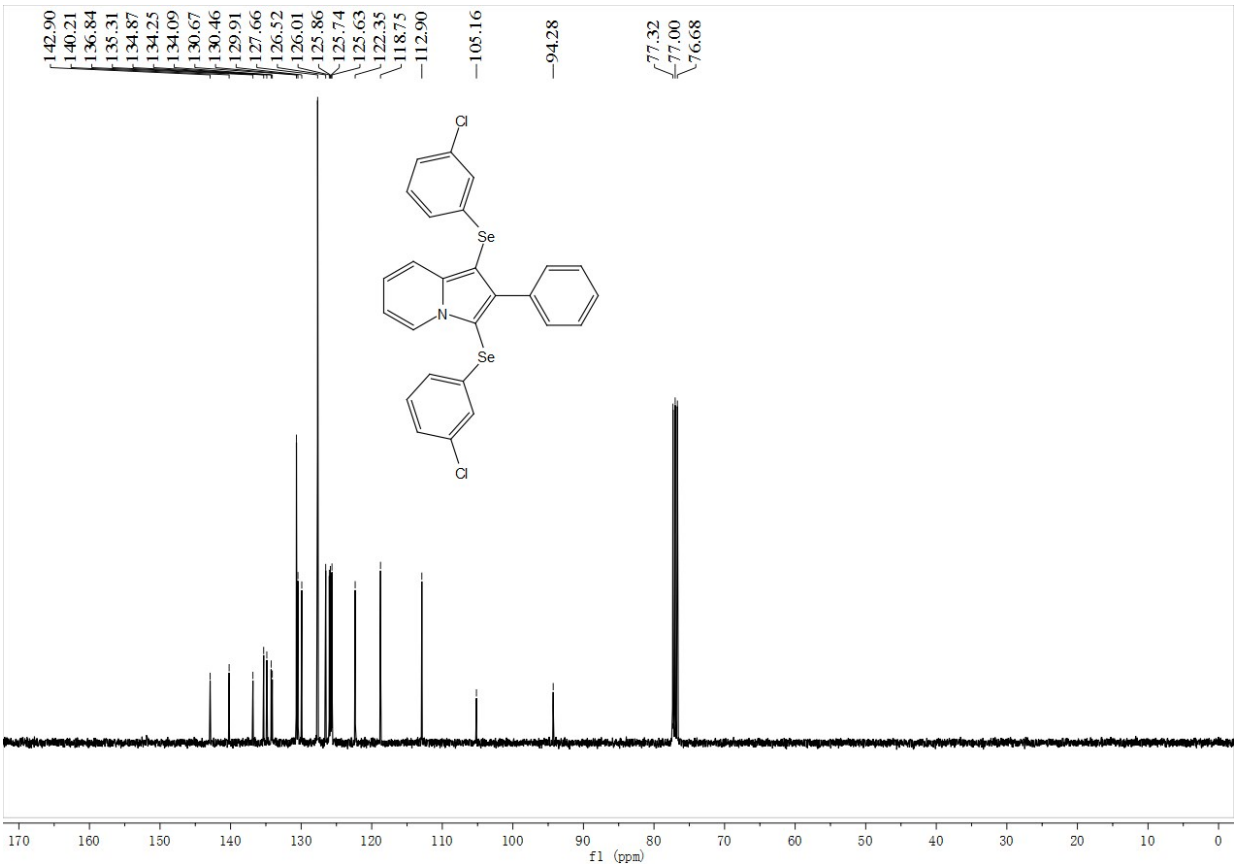
7.35
7.35
7.14
7.12
7.11
7.09
7.07
7.06
7.05
7.05
7.04
7.03
7.03
6.98
6.96
6.84
6.82
6.79
6.77
6.75
Cl
Se
N
Se
Cl
1.00
1.00
5.00
2.00
5.00
1.00
1.00
1.00
f1 (ppm)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134.09
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129.91
127.66
126.52
126.01
125.86
125.74
125.63
122.35
118.75
112.90
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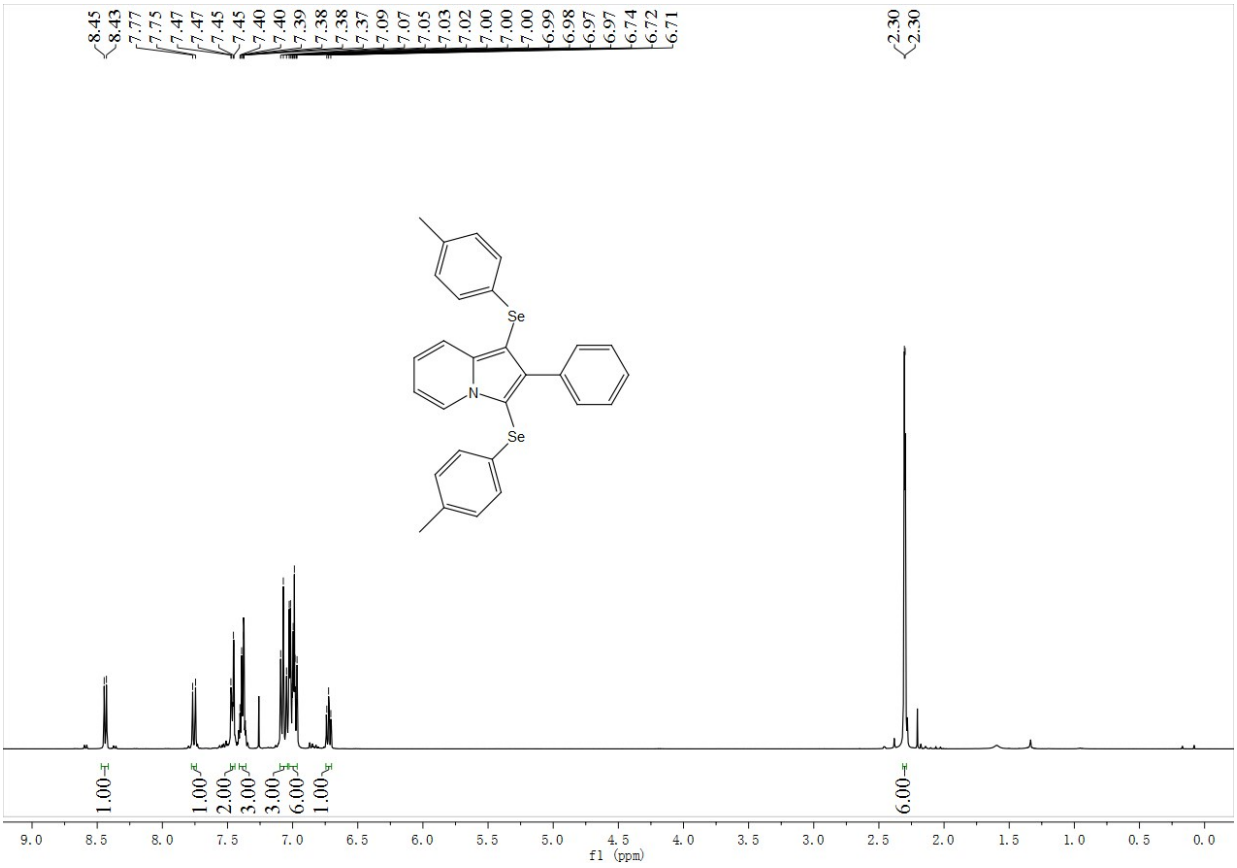
94.28
77.32
77.00
76.68
Cl
Se
N
Se
Cl
f1 (ppm)

5af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7.47
7.45
7.45
7.40
7.40
7.39
7.38
7.38
7.37
7.09
7.07
7.05
7.03
7.02
7.00
7.00
7.00
6.99
6.98
6.97
6.97
6.74
6.72
6.71
2.30
2.30
Se
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Se
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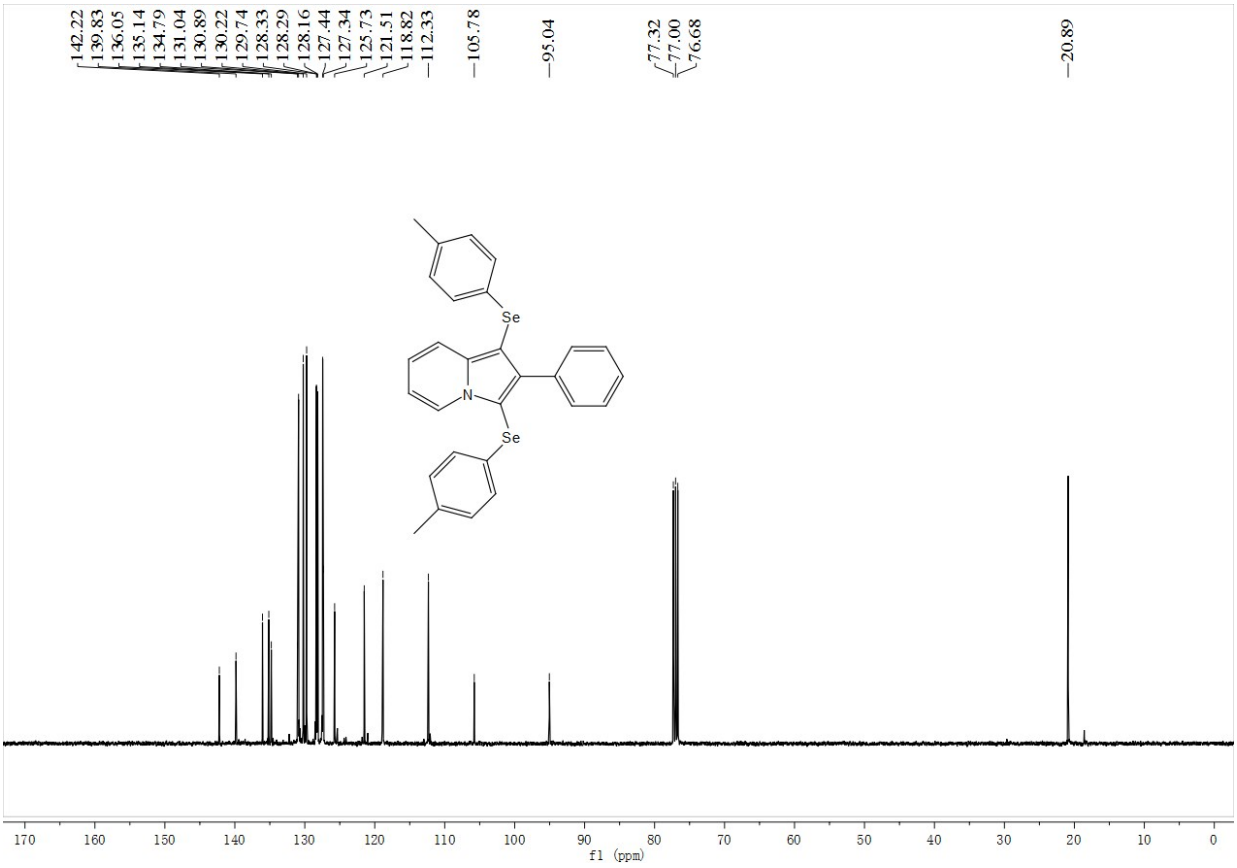
1.00
2.00
3.00
3.00
6.00
1.00
6.00
f1 (ppm)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128.33
128.29
128.16
127.44
127.34
125.73
121.51
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112.33
105.78
95.04
77.32
77.00
76.68
20.89
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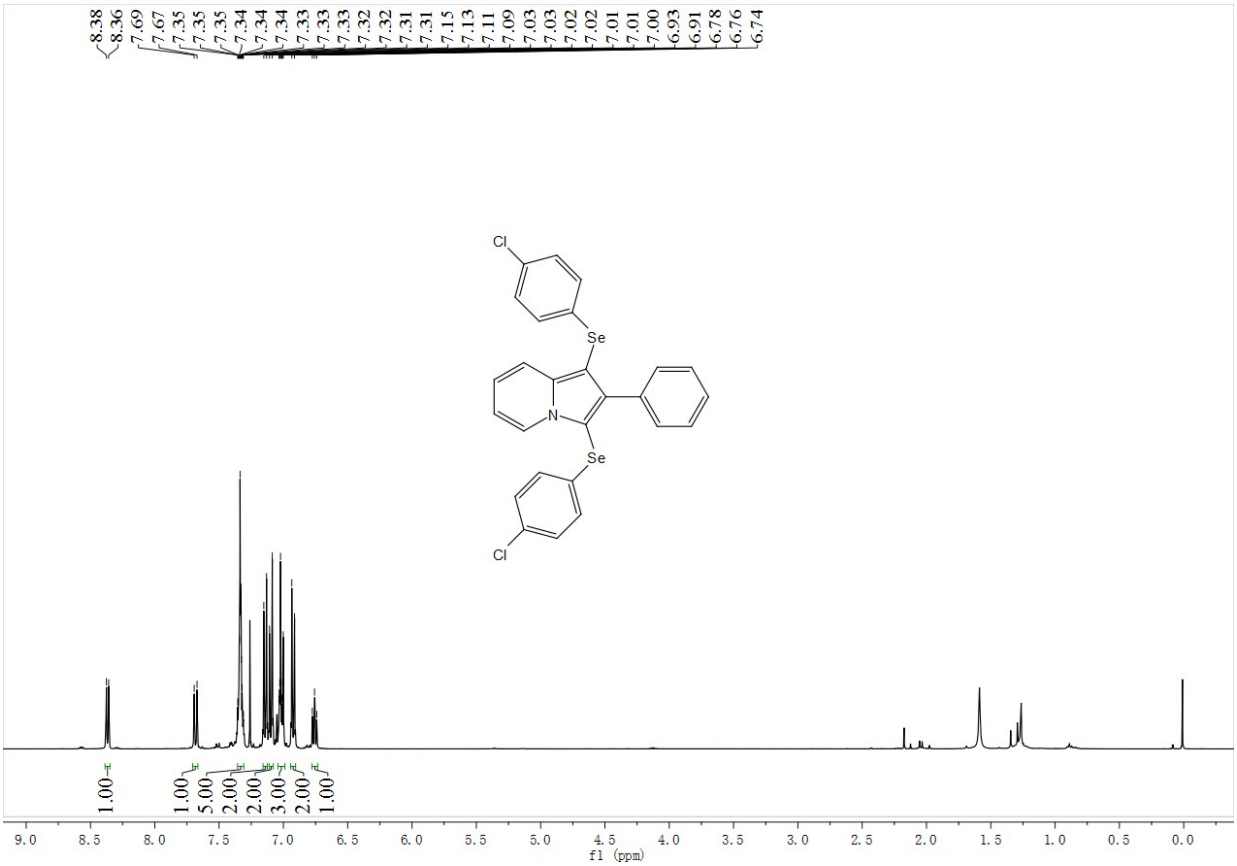
N
Se
f1 (ppm)

5ag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7.35
7.35
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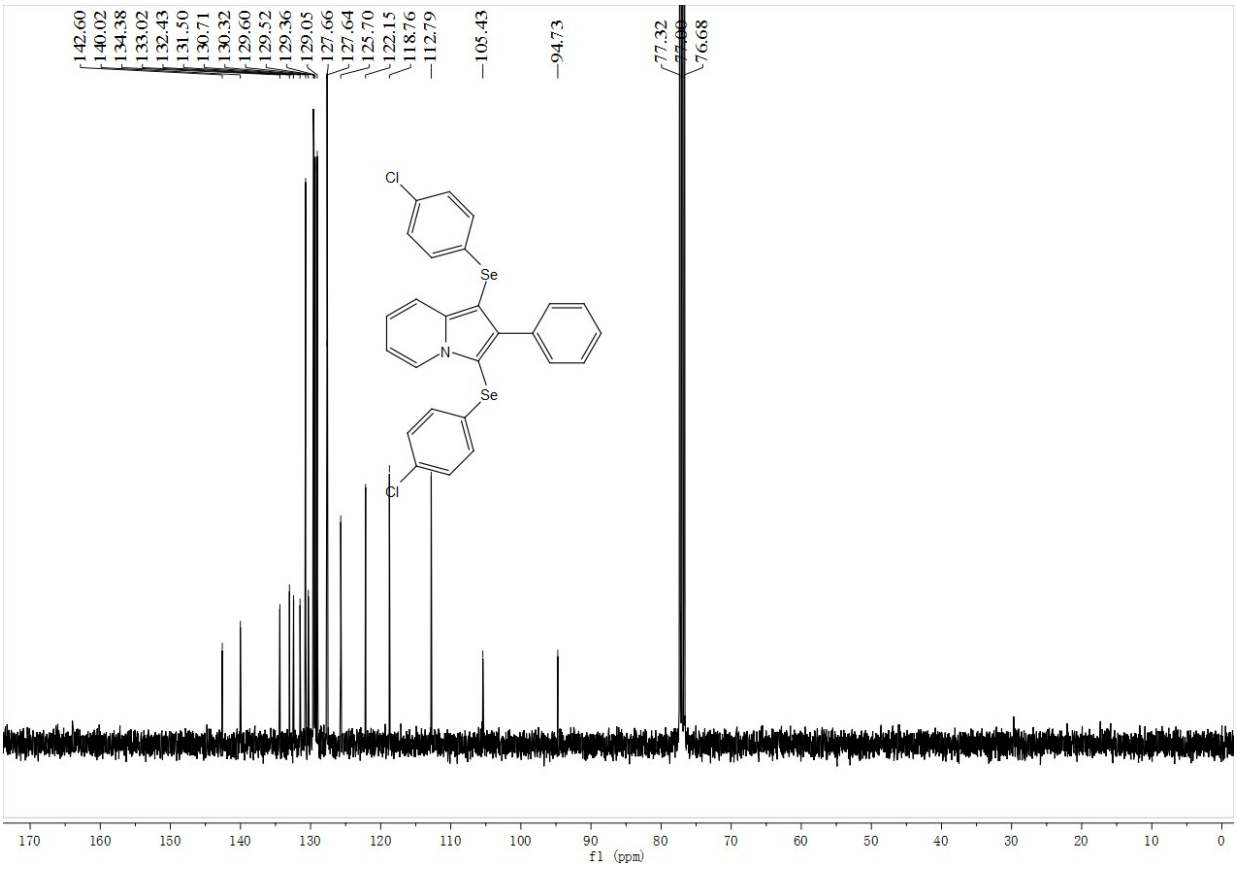
7.33
7.33
7.32
7.32
7.31
7.31
7.15
7.13
7.11
7.09
7.03
7.03
7.02
7.02
7.01
7.01
7.00
6.93
6.91
6.78
6.76
6.74
Cl
Se
N
Se
Cl
1.00
1.00
5.00
2.00
2.00
3.00
2.00
1.00
f1 (ppm)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133.02
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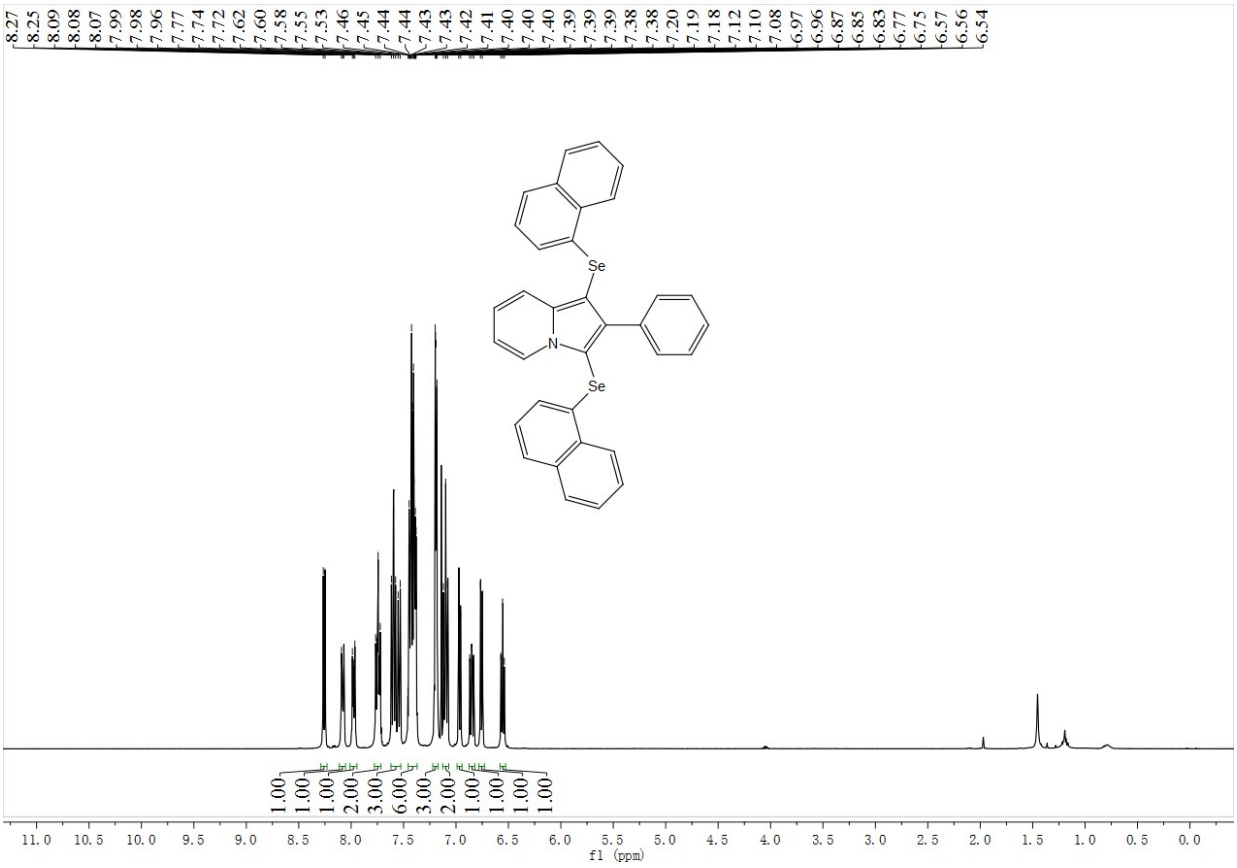
131.50
130.71
130.32
129.60
129.52
129.36
129.05
127.66
127.64
125.70
122.15
118.76
112.79
105.43
94.73
77.32
77.00
76.68
Cl
Se
N
Se
Cl
f1 (ppm)

5ah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7.99
7.98
7.96
7.77
7.74
7.72
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7.60
7.58
7.55
7.53
7.46
7.45
7.44
7.44
7.43
7.43
7.42
7.41
7.40
7.40
7.40
7.39
7.39
7.39
7.38
7.38
7.20
7.19
7.18
7.12
7.10
7.08
6.97
6.96
6.87
6.85
6.83
6.77
6.75
6.57
6.56
6.54
Se
N
Se
1.00
1.00
1.00
2.00
3.00
6.00
3.00
2.00
1.00
1.00
1.00
1.00
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
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3.5
3.0
2.5
2.0
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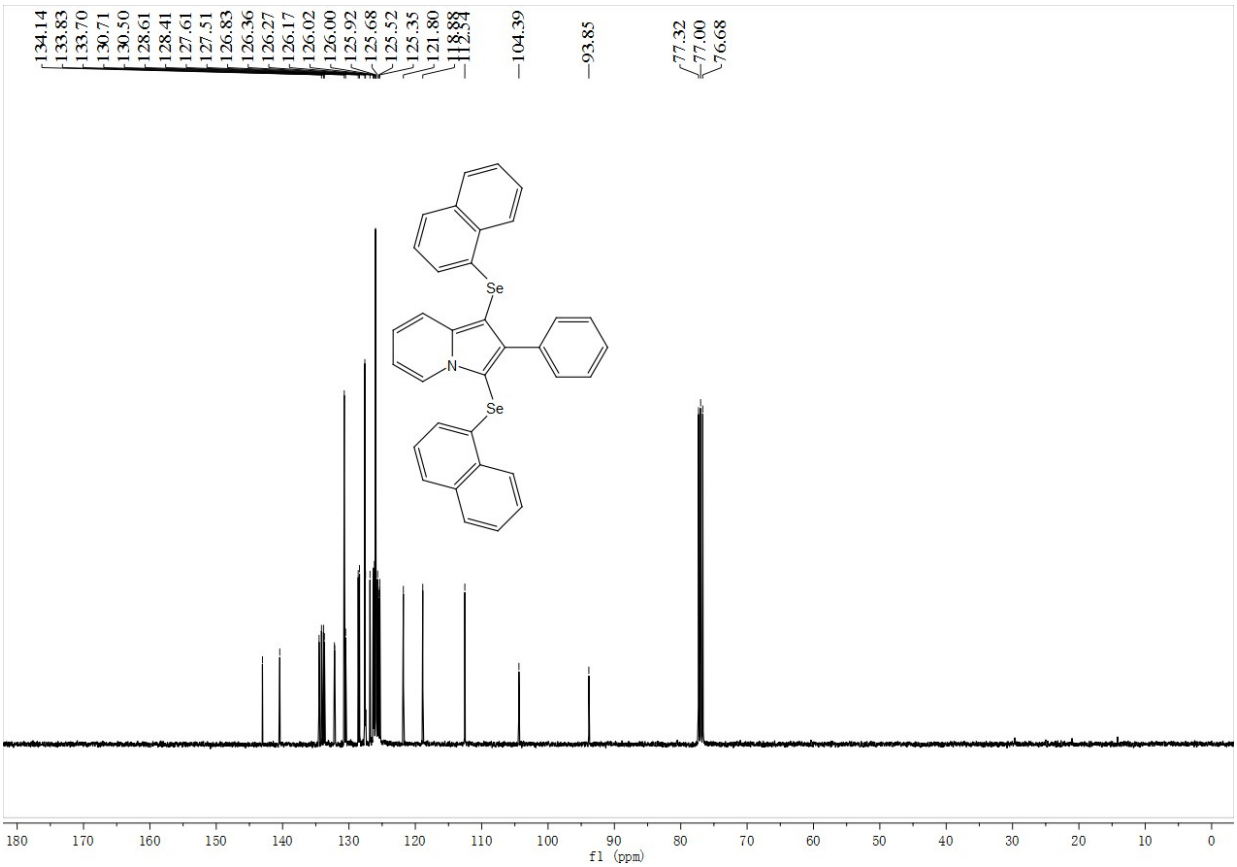
0.0
f1 (ppm)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126.83
126.36
126.27
126.17
126.02
126.00
125.92
125.68
125.52
125.35
121.80
118.88
112.54
104.39
93.85
77.32
77.00
76.68
Se
N
Se
180
170
160
150
140
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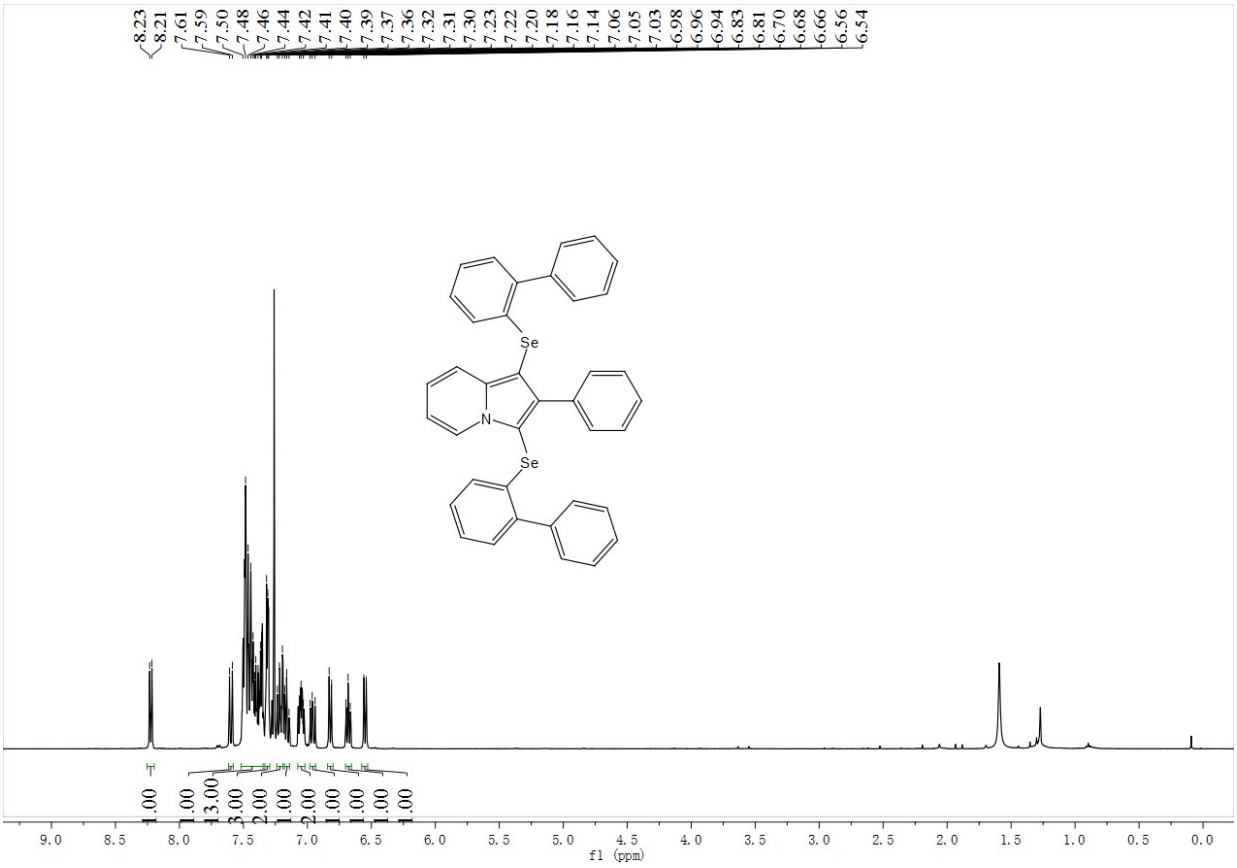
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

5ai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7.41
7.40
7.39
7.37
7.36
7.32
7.31
7.30
7.23
7.22
7.20
7.18
7.16
7.14
7.06
7.05
7.03
6.98
6.96
6.94
6.83
6.81
6.70
6.68
6.66
6.56
6.54
Se
N
Se
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1.00
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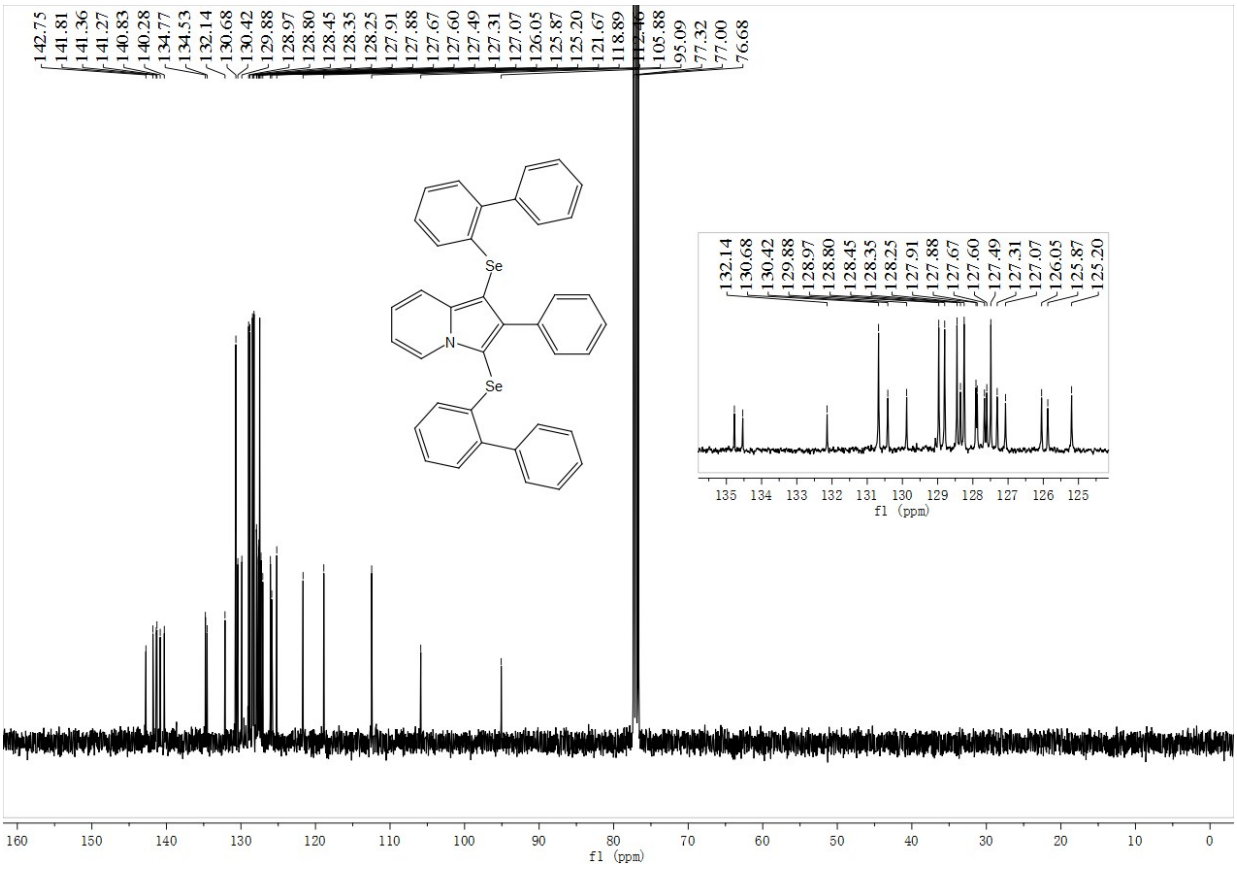
3.00
2.00
1.00
2.00
1.00
1.00
1.00
1.00
f1 (ppm)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140.28
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134.53
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130.68
130.42
129.88
128.97
128.80
128.45
128.35
128.25
127.91
127.88
127.67
127.60
127.49
127.31
127.07
126.05
125.87
125.20
121.67
118.89
112.48
105.88
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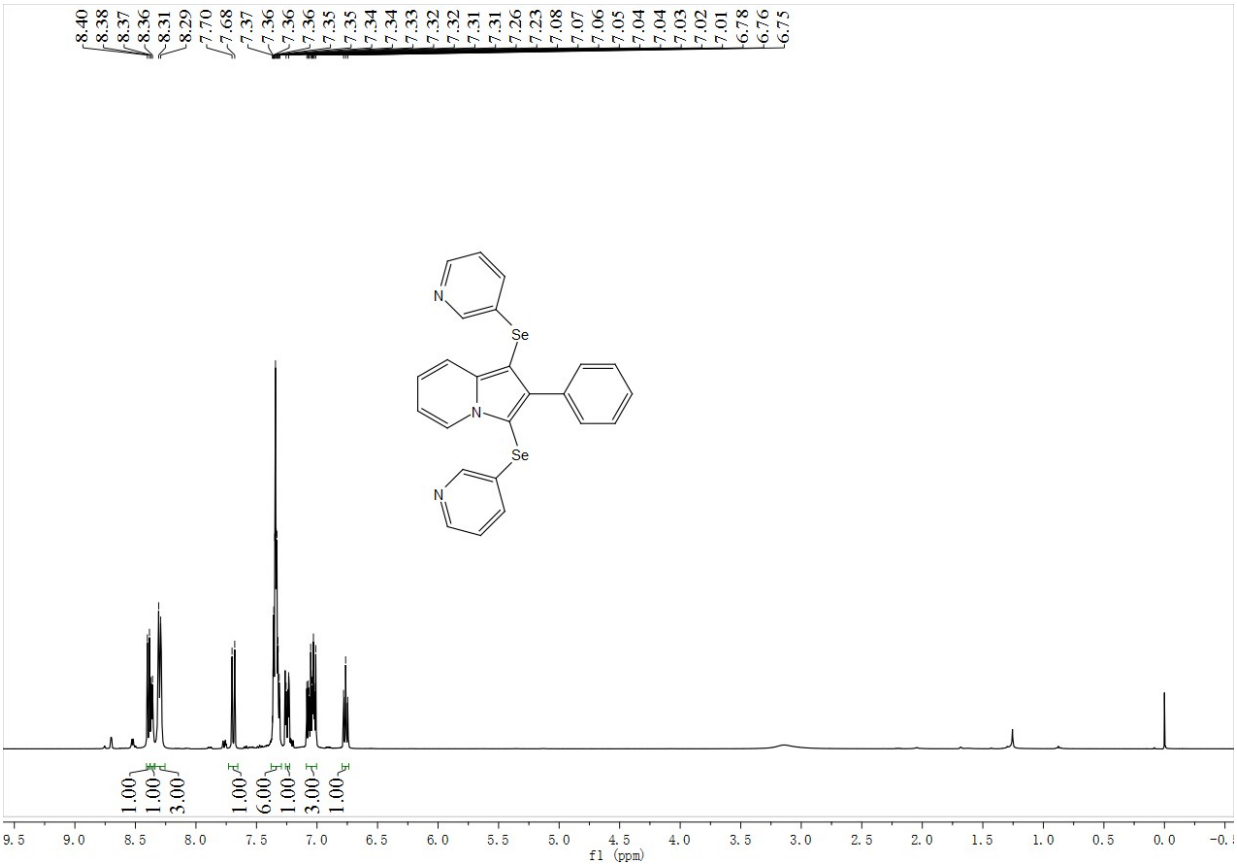
77.32
77.00
76.68
Se
N
Se
f1 (ppm)

5aj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7.36
7.36
7.36
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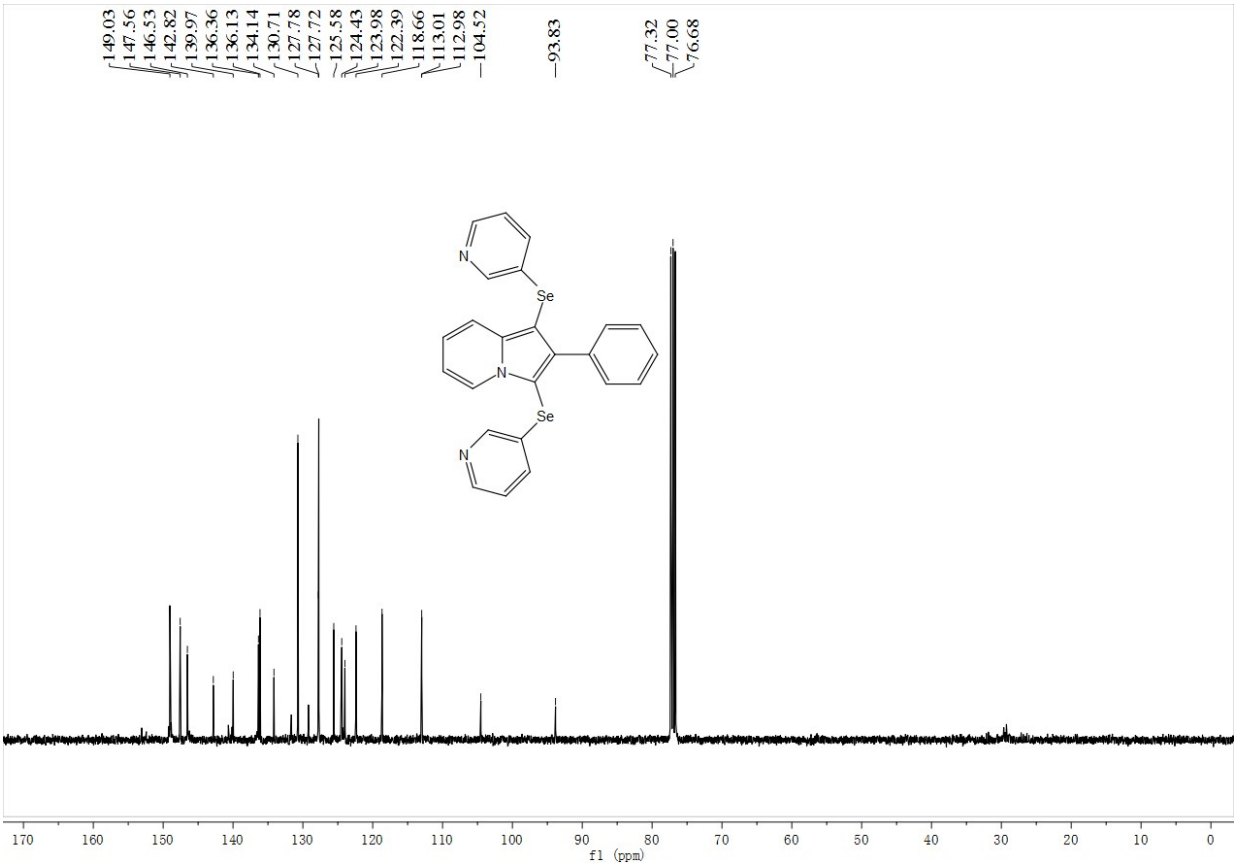
7.34
7.34
7.33
7.32
7.32
7.31
7.31
7.26
7.23
7.08
7.07
7.06
7.05
7.04
7.04
7.03
7.02
7.01
6.78
6.76
6.75
N
Se
N
Se
N
1.00
1.00
3.00
1.00
6.00
1.00
3.00
1.00
f1 (ppm)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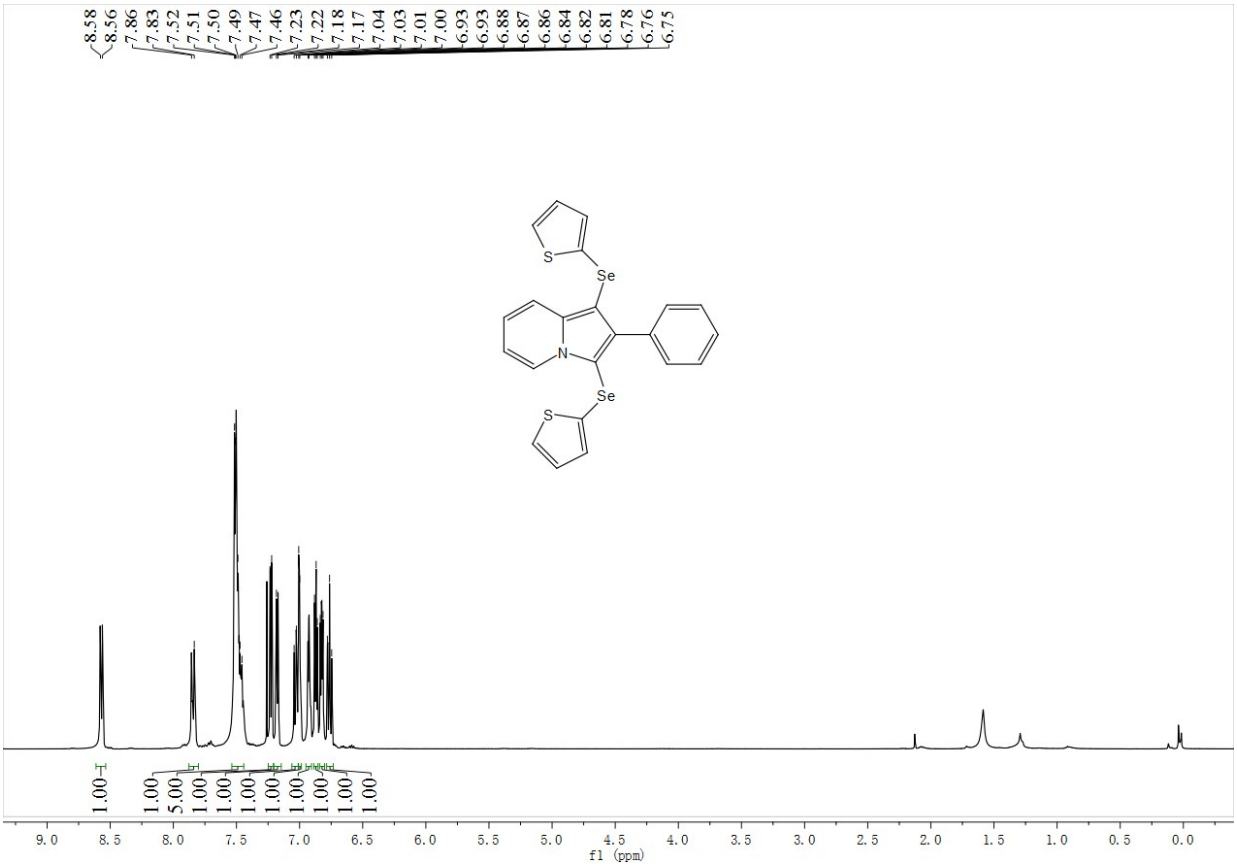
147.56
146.53
142.82
139.97
136.36
136.13
134.14
130.71
127.78
127.72
125.58
124.43
123.98
122.39
118.66
113.01
112.98
104.52
93.83
77.32
77.00
76.68
N
Se
N
Se
N
f1 (ppm)

5ak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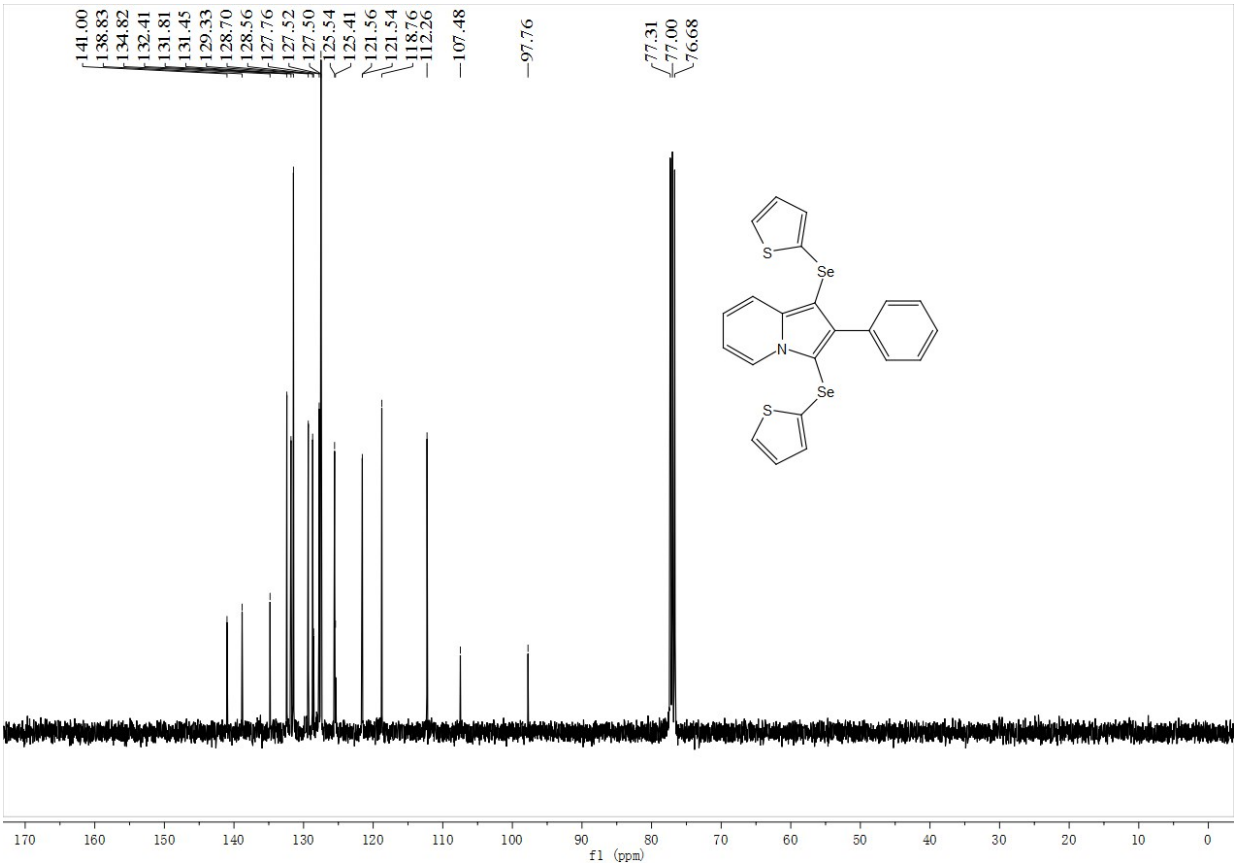
7.51
7.50
7.49
7.47
7.46
7.23
7.22
7.18
7.17
7.04
7.03
7.01
7.00
6.93
6.88
6.87
6.86
6.84
6.82
6.81
6.78
6.76
6.75
Se
Se
S
S
N
1.00
1.00
5.00
1.00
1.00
1.00
1.00
1.00
1.00
1.00
1.00
f1 (ppm)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138.83
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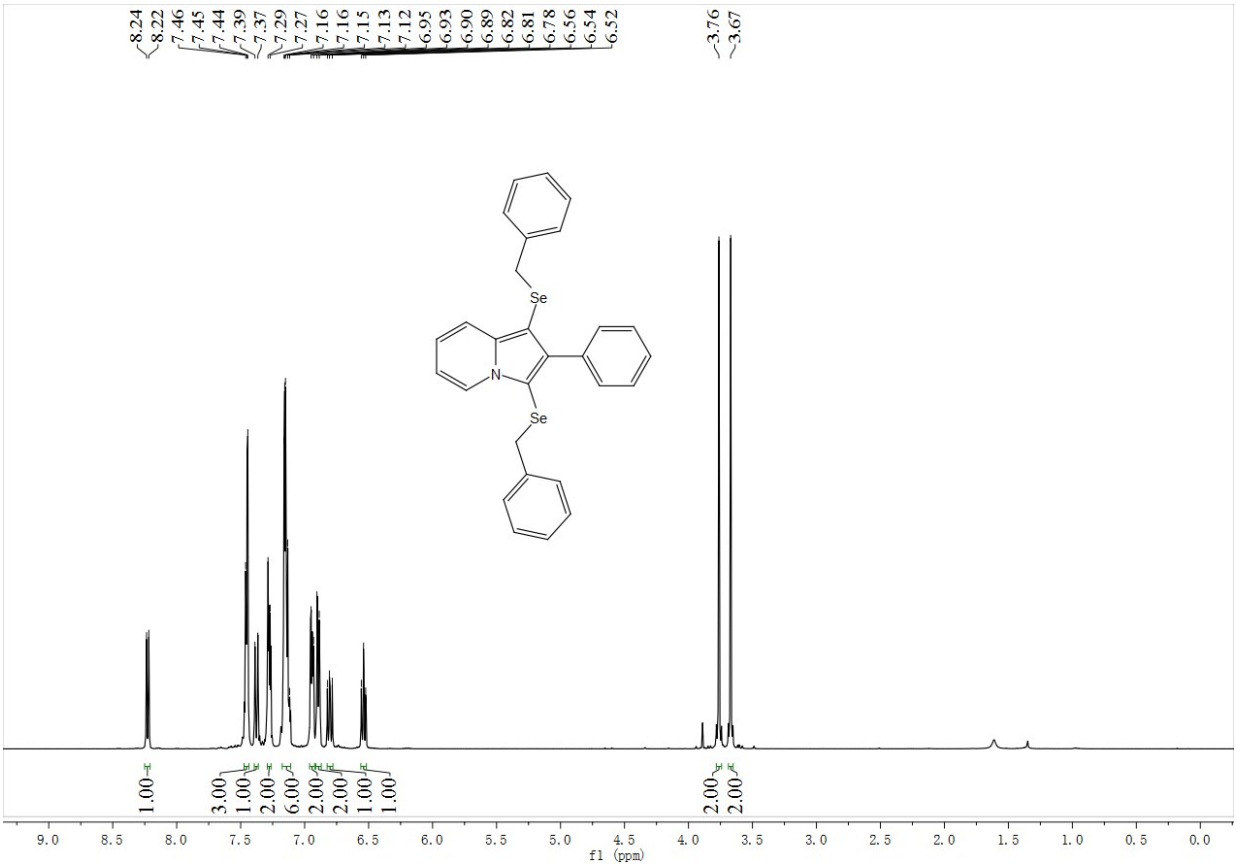
132.41
131.81
131.45
129.33
128.70
128.56
127.76
127.52
127.50
125.54
125.41
121.56
121.54
118.76
112.26
107.48
97.76
77.31
77.00
76.68
Se
Se
S
S
N
f1 (ppm)

5al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8.22
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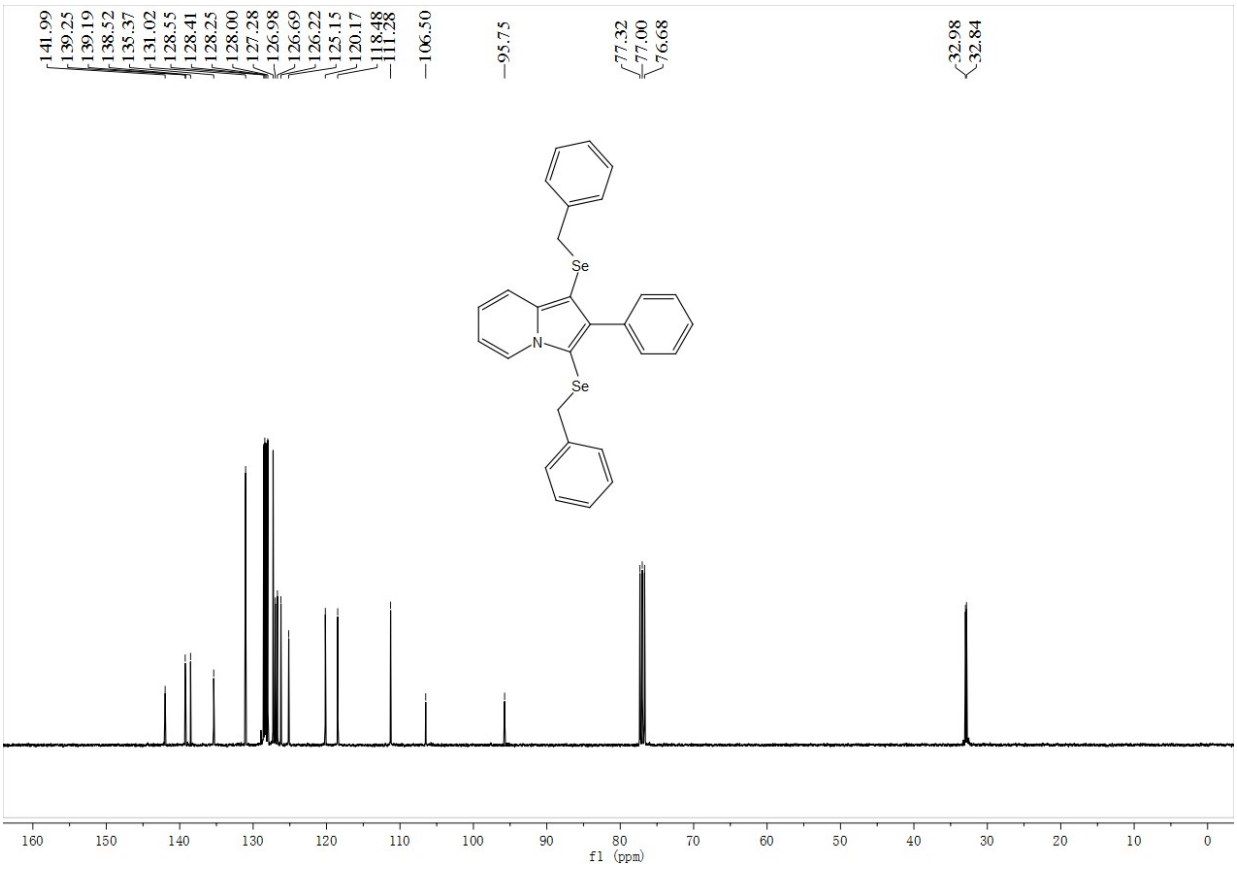
7.45
7.44
7.39
7.37
7.29
7.27
7.16
7.16
7.15
7.13
7.12
6.95
6.93
6.90
6.89
6.82
6.81
6.78
6.56
6.54
6.52
3.76
3.67
Se
N
Se
1.00
3.00
1.00
2.00
6.00
2.00
2.00
1.00
1.00
2.00
2.00
f1 (ppm)


141.99
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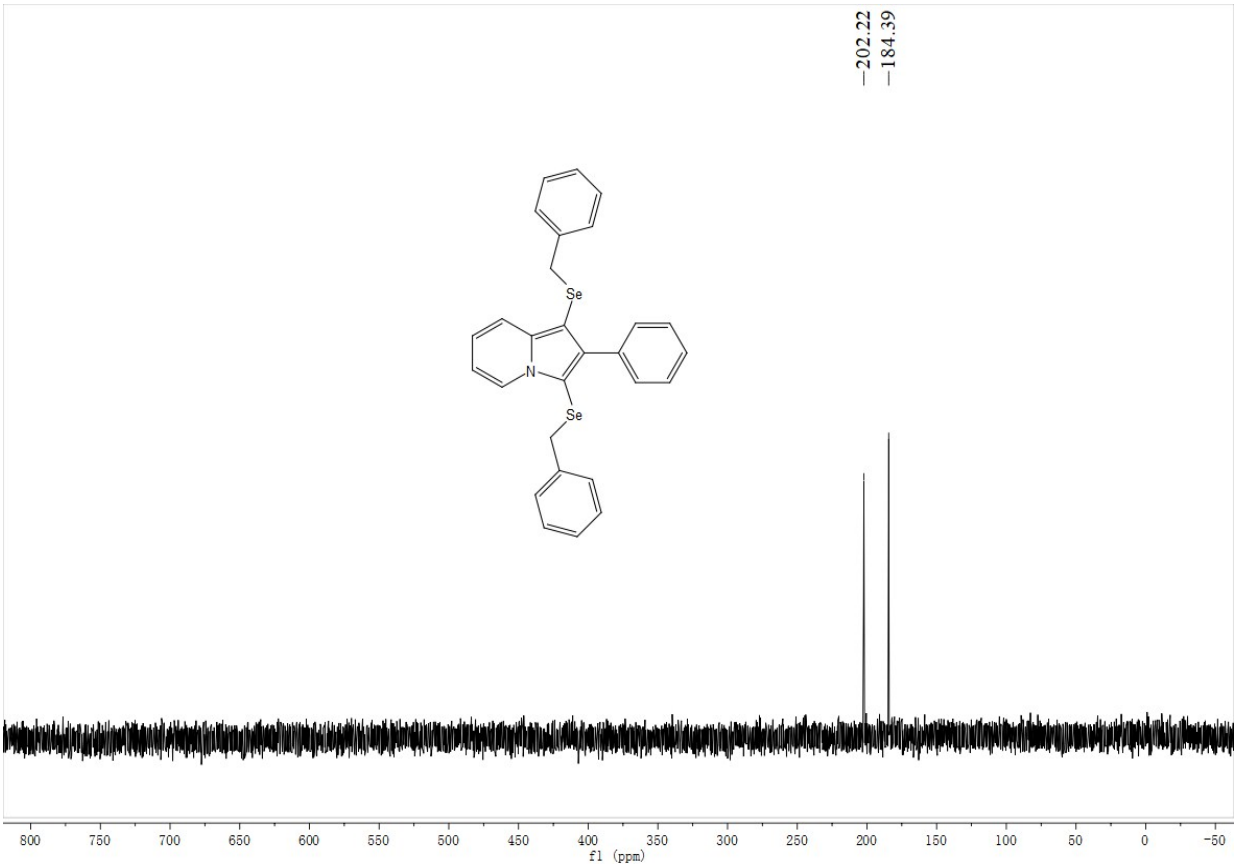
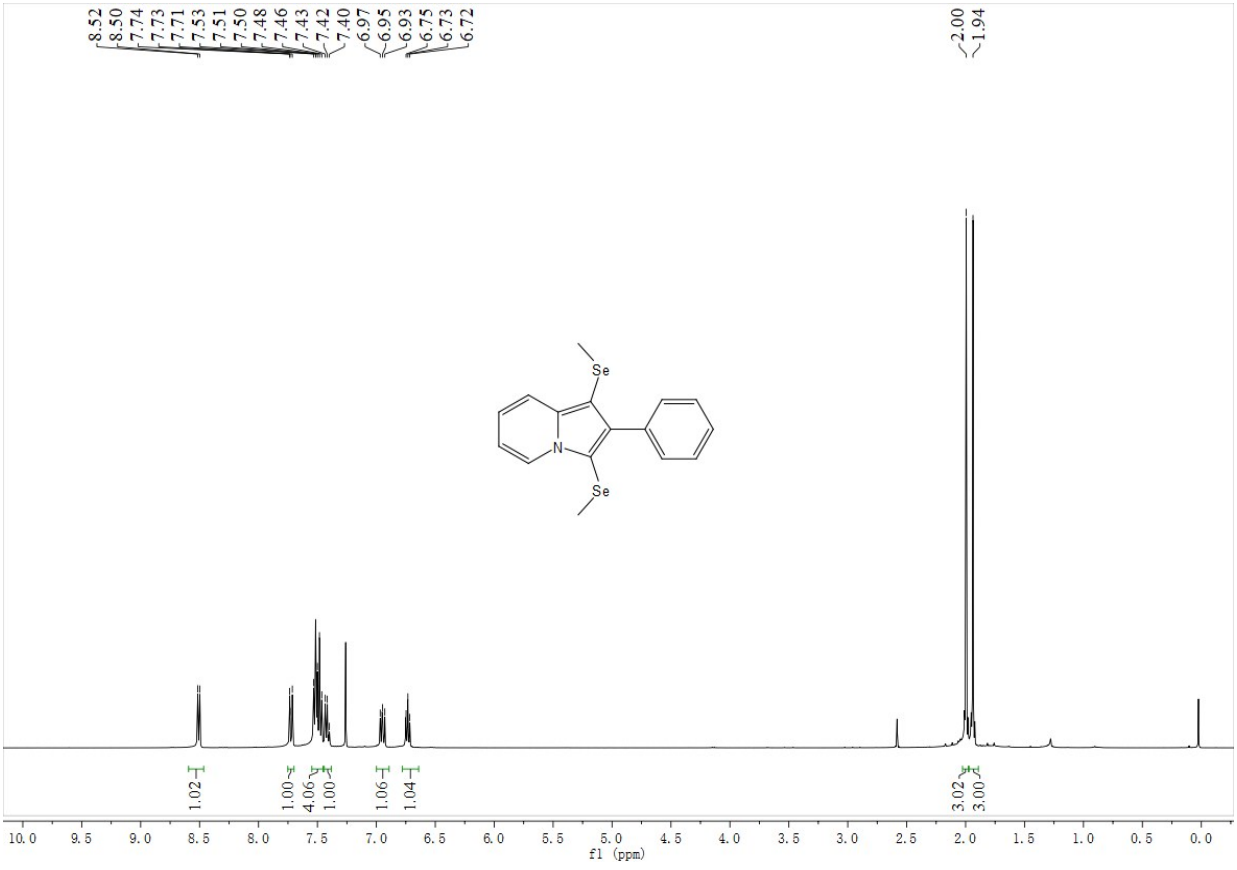
138.52
135.37
131.02
128.55
128.41
128.25
128.00
127.28
126.98
126.69
126.22
125.15
120.17
118.48
111.28
106.50
95.75
77.32
77.00
76.68
32.98
32.84
Se
N
Se
f1 (ppm)


202.22
184.39
Se
N
Se
800
750
700
650
600
550
500
450
400
350
300
250
200
150
100
50
0
-50
f1 (ppm)

5am


8.52
8.50
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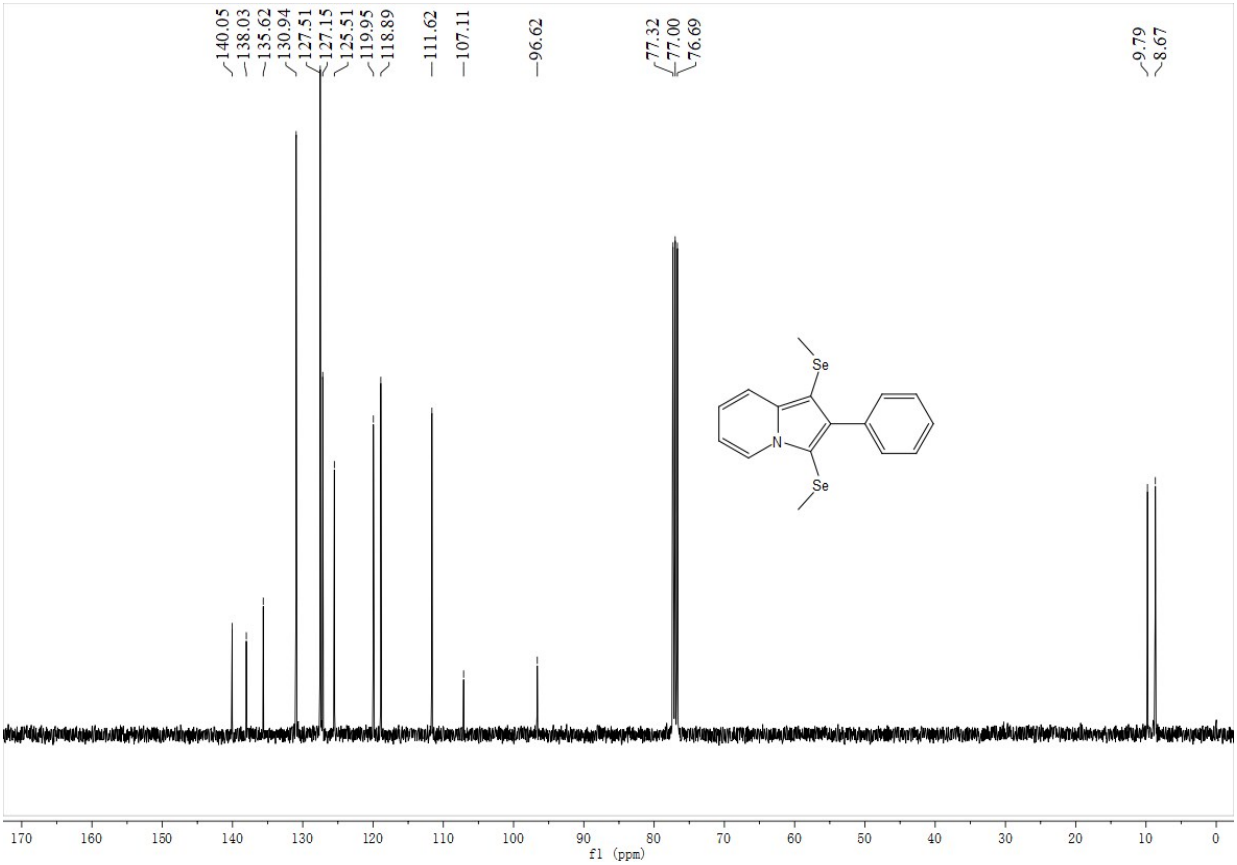
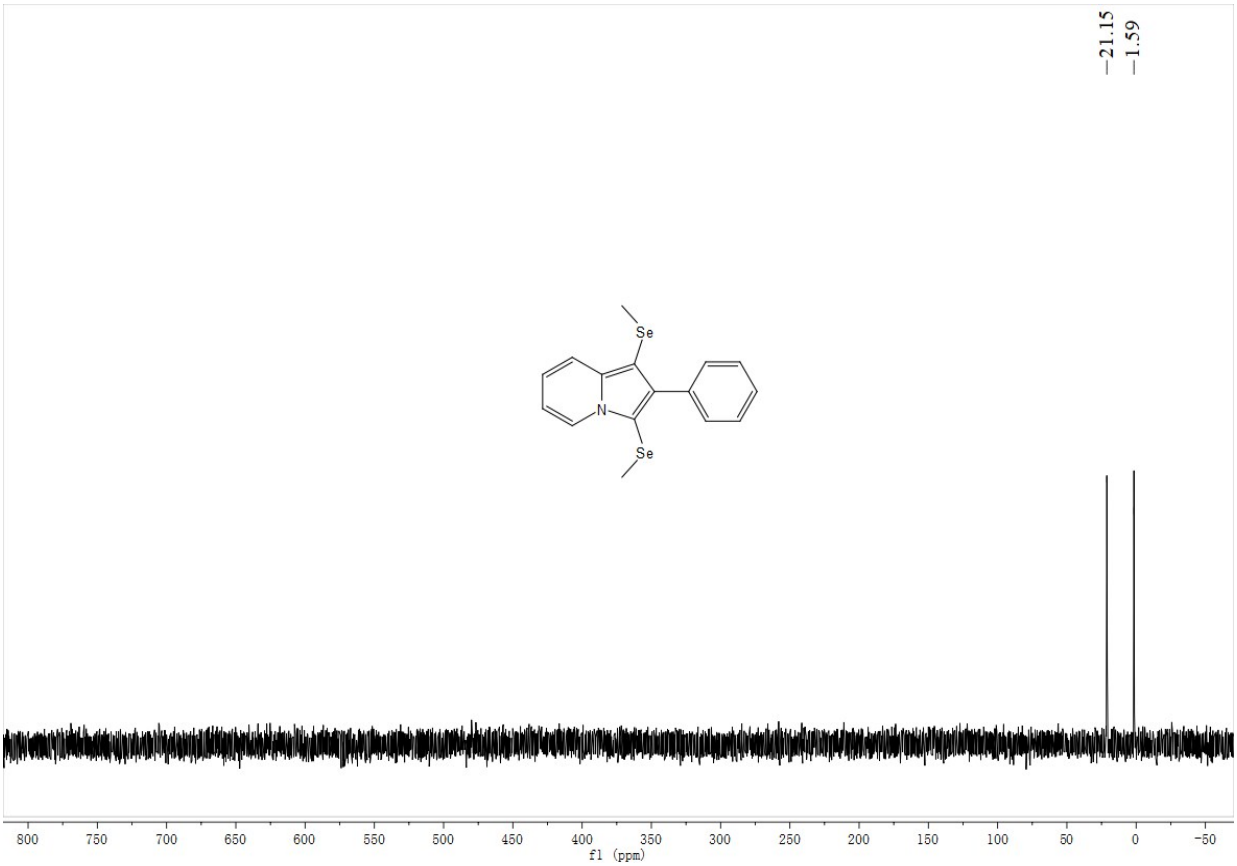
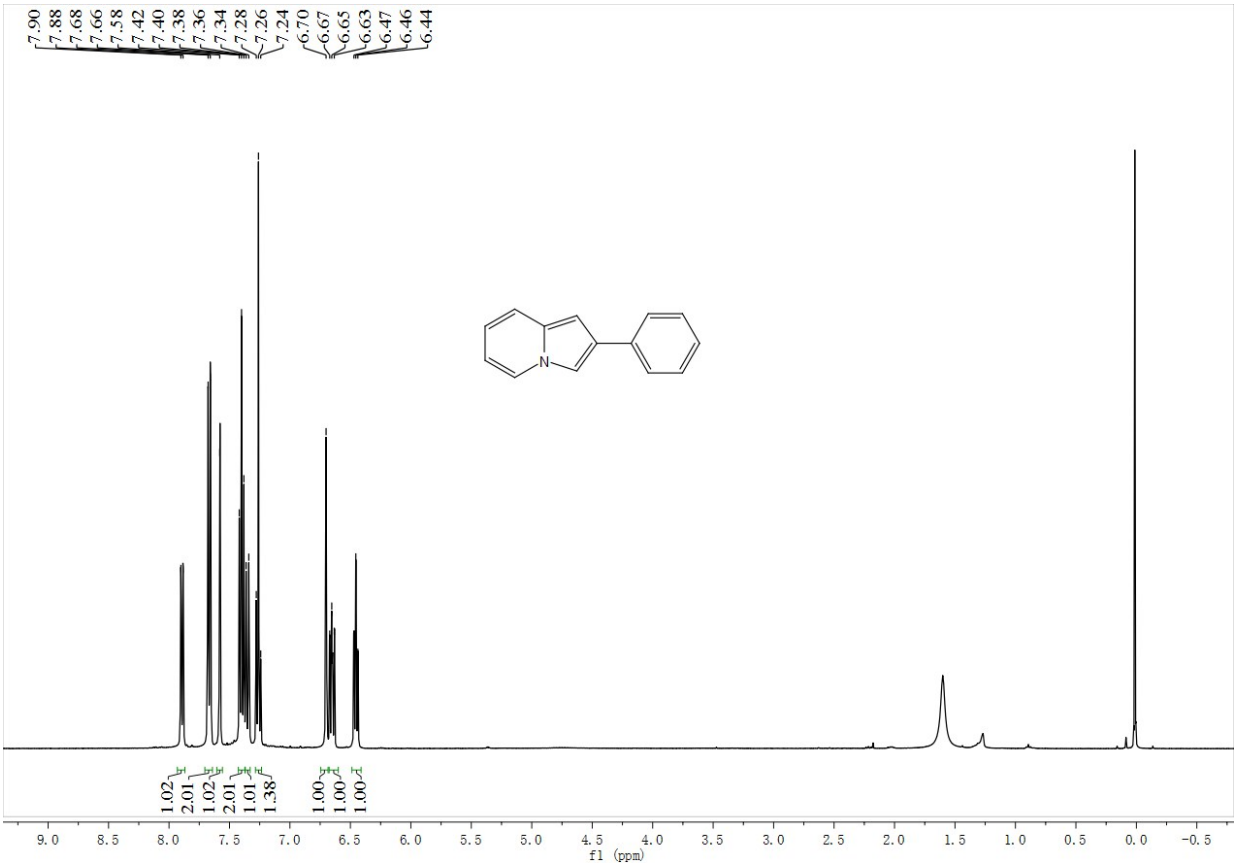
7.50
7.48
7.46
7.43
7.42
7.40
6.97
6.95
6.93
6.75
6.73
6.72
2.00
1.94
Se
N
Se
1.02
1.00
4.06
1.00
1.06
1.04
3.02
3.00
10.0
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)


140.05
138.03
135.62
130.94
127.51
127.15
125.51
119.95
118.89
111.62
107.11
96.62
77.32
77.00
76.69
9.79
8.67
Se
Se
N
170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


21.15
1.59
Se
Se
N
800 750 700 650 600 550 500 450 400 350 300 250 200 150 100 50 0 -50
f1 (ppm)

6aa


7.90
7.88
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7.66
7.58
7.42
7.40
7.38
7.36
7.34
7.28
7.26
7.24
6.70
6.67
6.65
6.63
6.47
6.46
6.44
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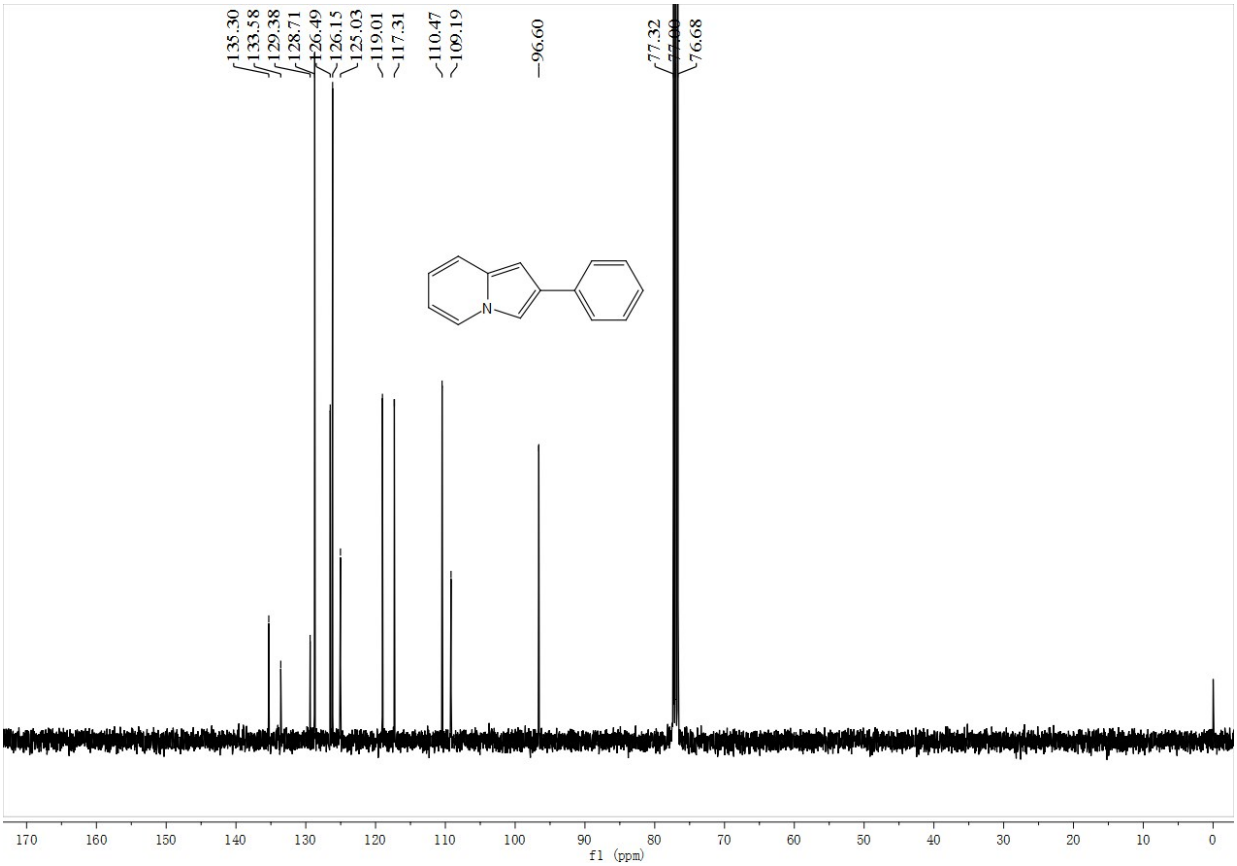
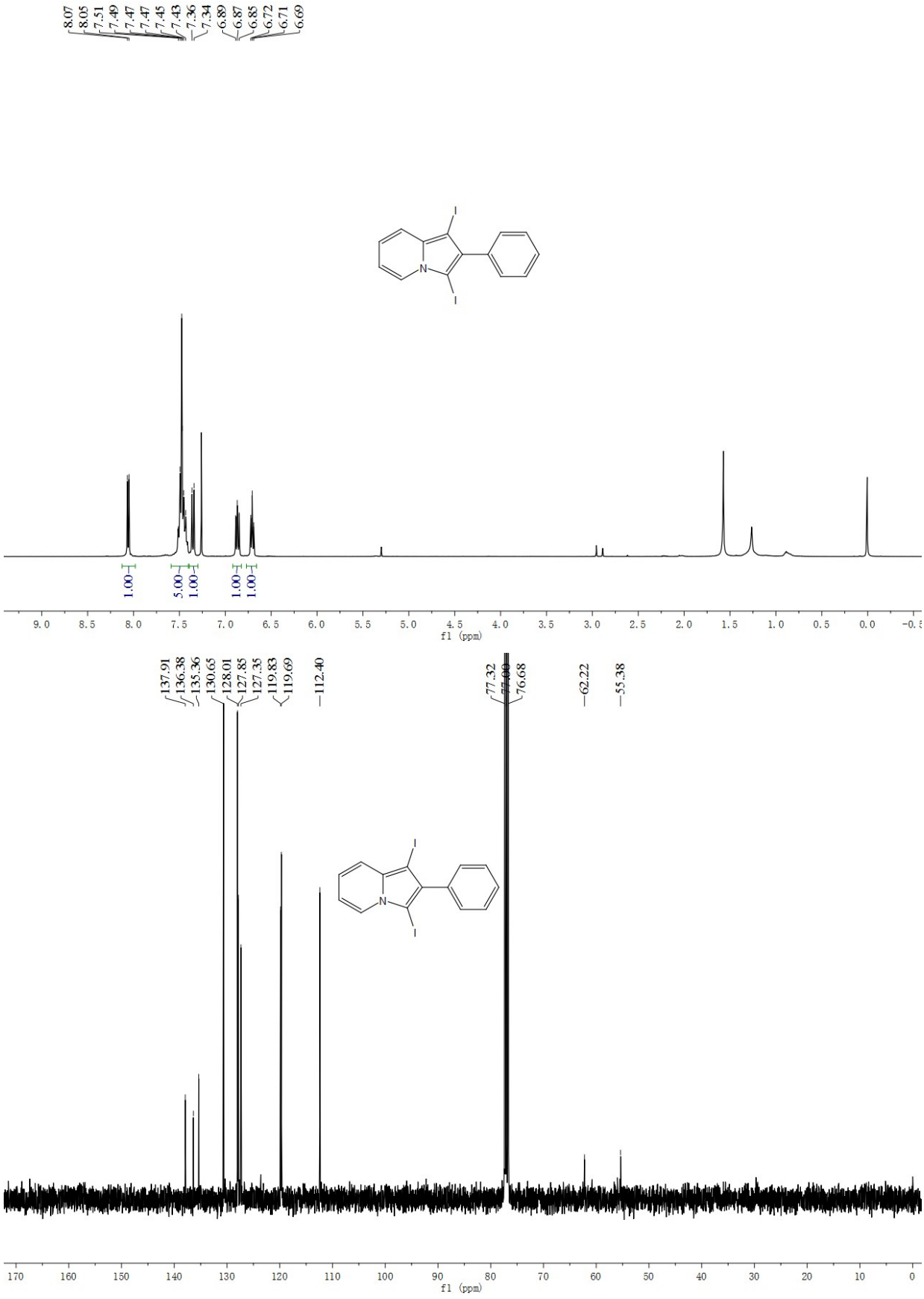
2.01
1.02
2.01
1.01
1.38
1.00
1.00
1.00
f1 (ppm)


135.30
133.58
129.38
128.71
126.49
126.15
125.03
119.01
117.31
110.47
109.19
96.60
77.32
77.00
76.68
f1 (ppm)

7aa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8.05
7.51
7.49
7.47
7.47
7.45
7.43
7.36
7.34
6.89
6.87
6.85
6.72
6.71
6.69
1.00
5.00
1.00
1.00
1.00
f1 (ppm)
137.91
136.38
135.36
130.65
128.01
127.85
127.35
119.83
119.69
112.40
77.32
76.68
62.22
55.38
f1 (ppm)