Visible-Light-Promoted Photoredox Synthesis of Thioacetylenes by Dehydrogenation Coupling of Thiophenols and Alkynes

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General procedure for the photoredox dehydrocoupling of diphenyl phosphine with thiophenols

A 20 mL Schlenk tube was charged with 0.2 mmol phenylacetylenes, 0.4 mmol thiophenols, CuBr (10 mol%), 0.4 mmol Cs_2CO_3 and 1.0 mL of MeCN, then the vials were sealed and stand on a 25 W white LED plate for 12 h. When completed, the reactions were detected by GC-MS and isolated with flash chromatography using petroleum ether or a mixed solvent of ethyl acetate(EA) and petroleum ether(PE) as eluent.

Supporting Figures

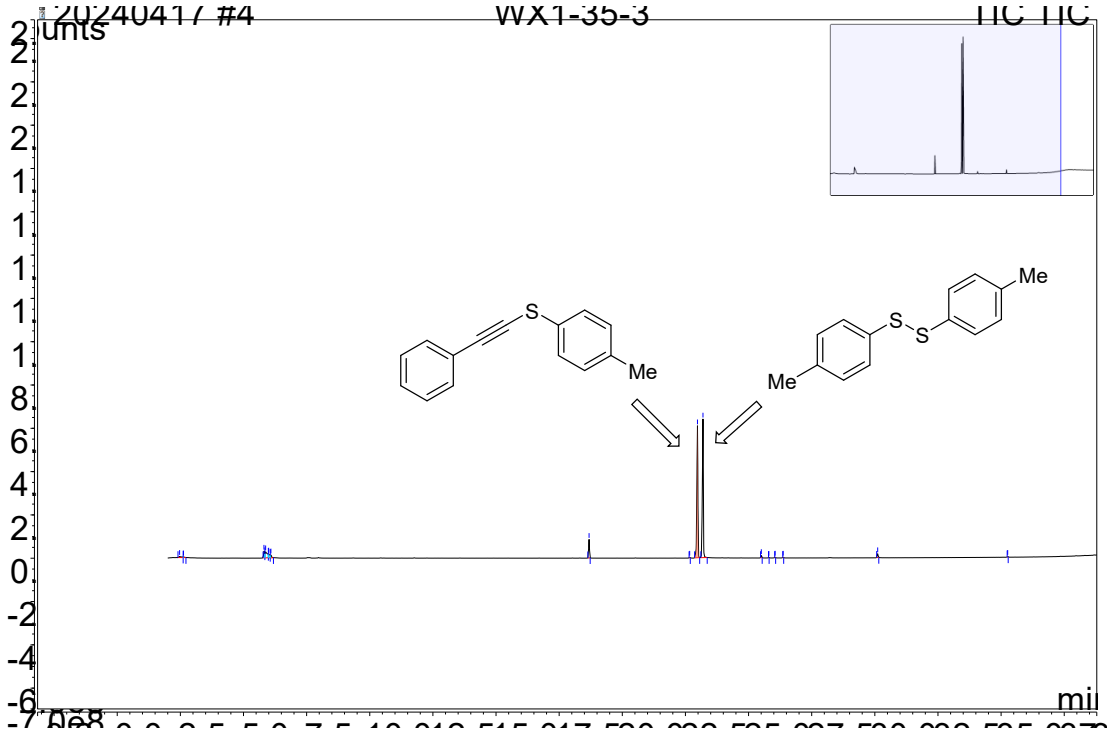

Figure S1. GC-MS spectrum of **"standard conditions"**: visible-light-promoted photoredox synthesis of thioacetylenes with dehydrogenation coupling of thiophenols and phenylacetylenes

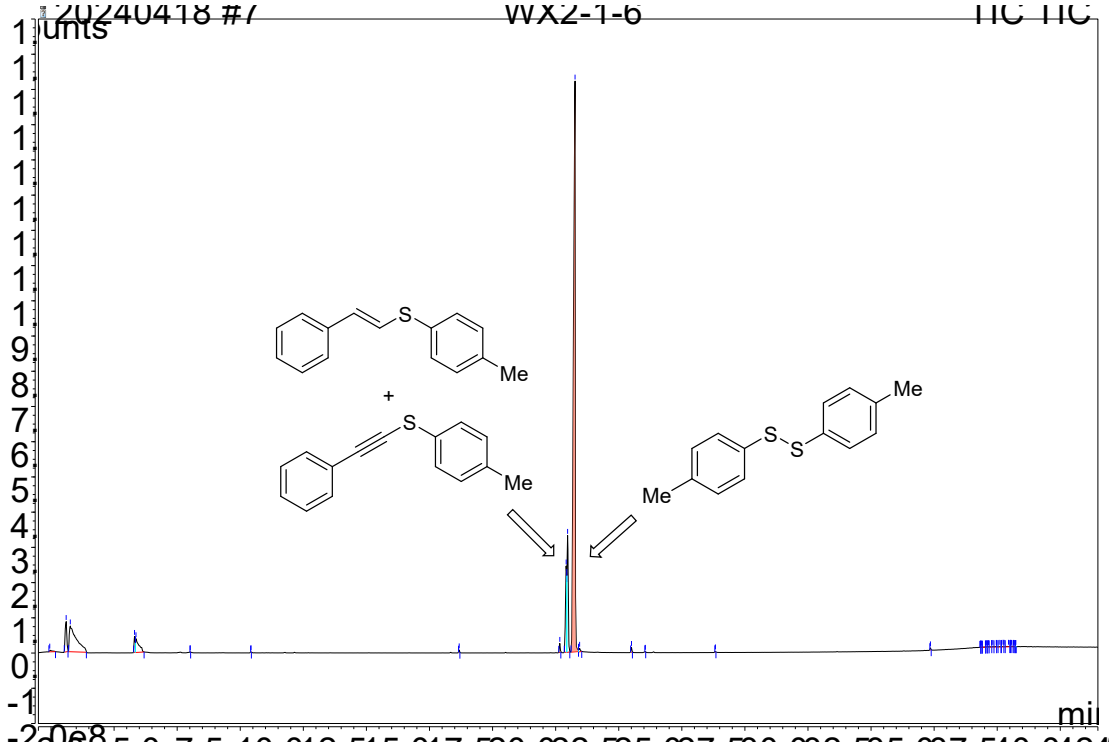

Figure S2. GC-MS spectrum of "standard conditions" **without light** to show the crucial role of visible light.

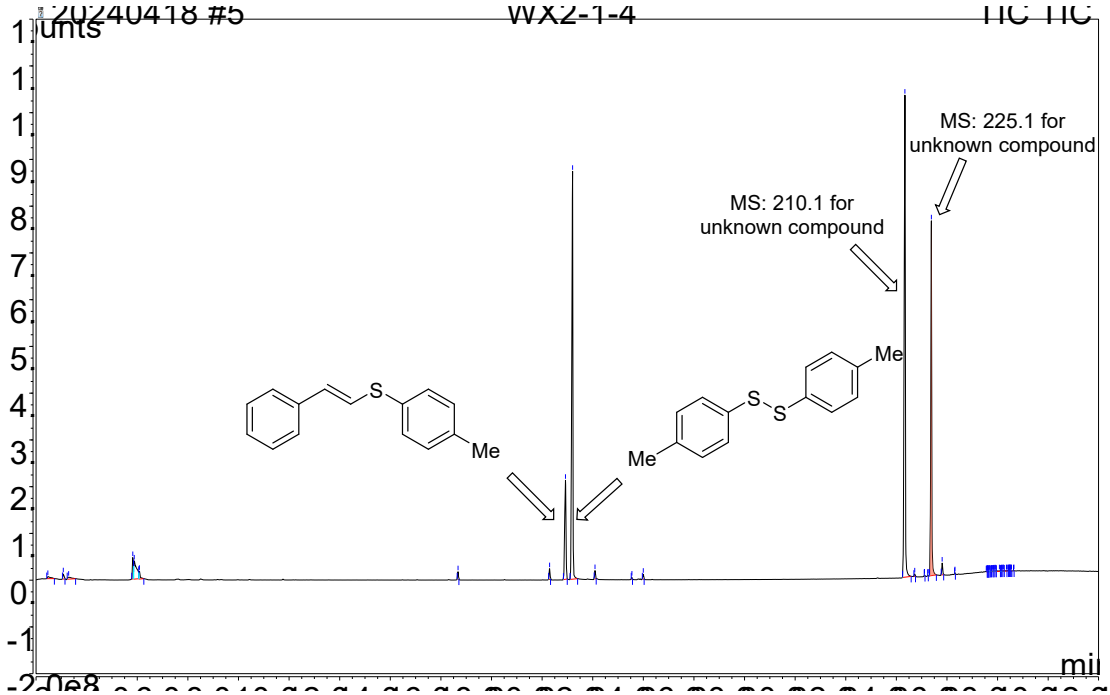

Figure S3. GC-MS spectrum of "standard conditions" **without CuBr** to show the crucial role of catalyst.

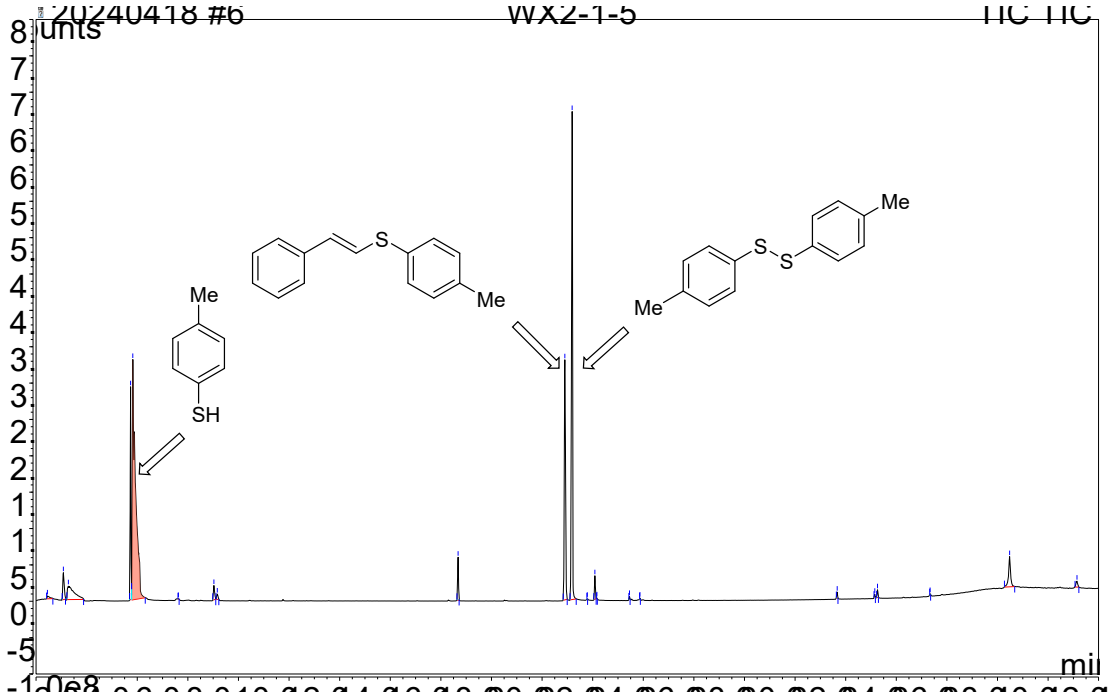

Figure S4. GC-MS spectrum of "standard conditions" **without Cs_2CO_3** to show the crucial role of base.

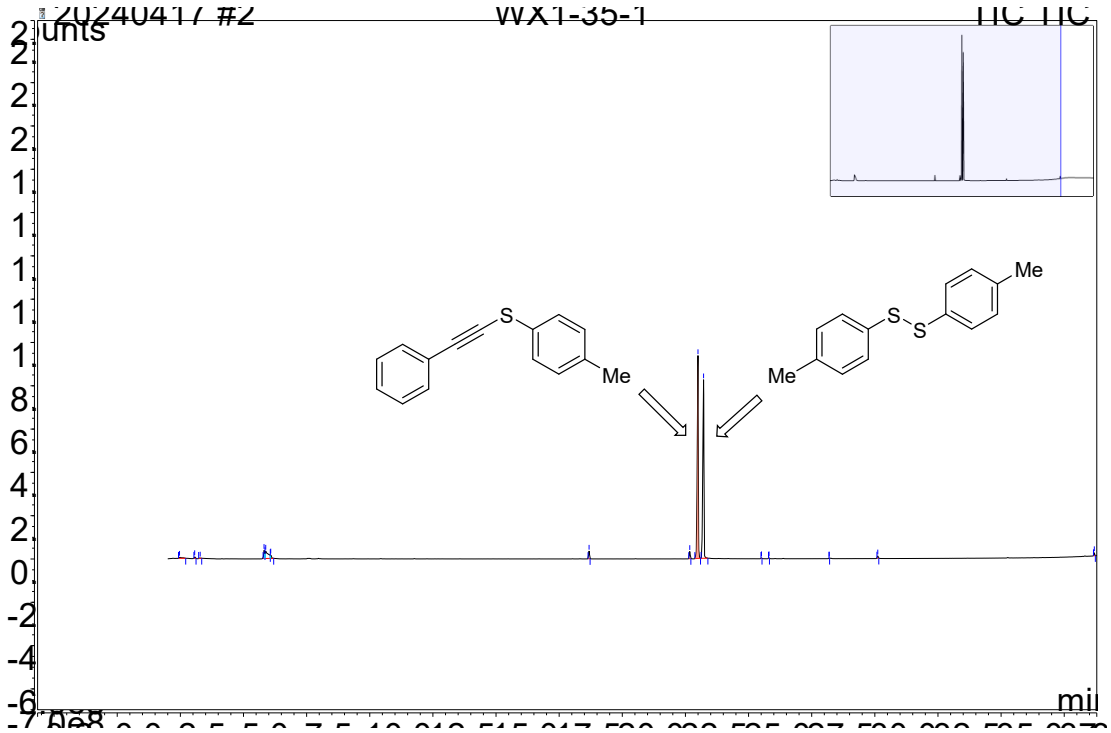

Figure S5. GC-MS spectrum of "standard conditions" **O_2 instead of air** to show the crucial role of air.

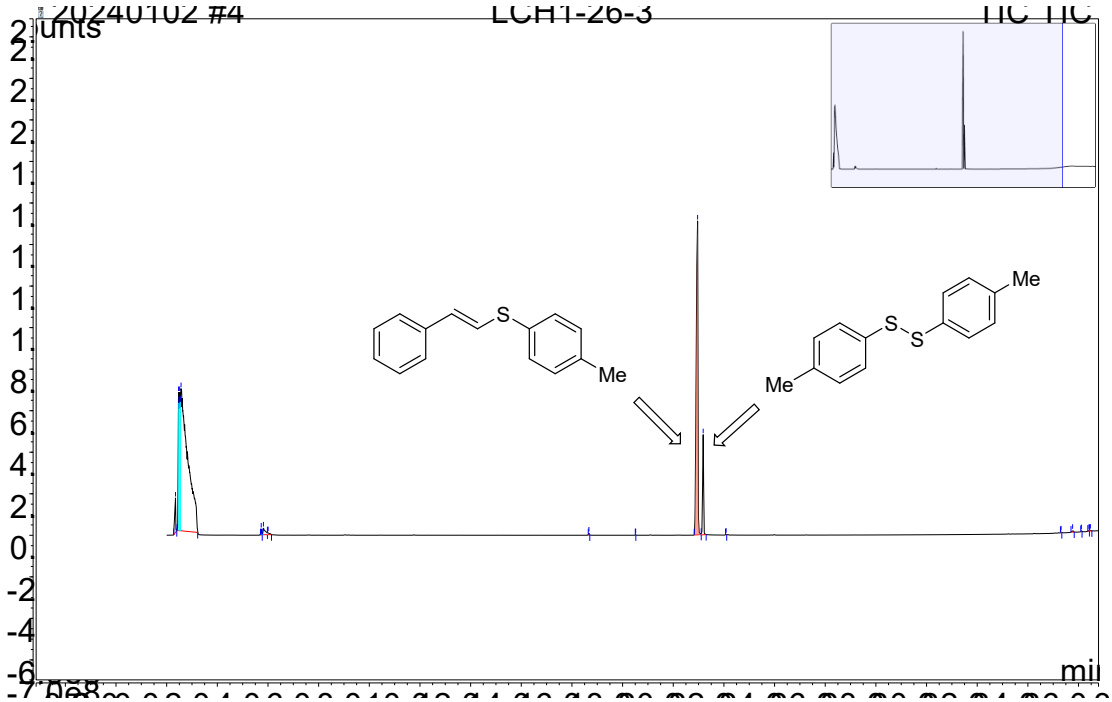

Figure S6. GC-MS spectrum of "standard conditions" **Ar instead of air** to show the crucial role of O_2 in the air.

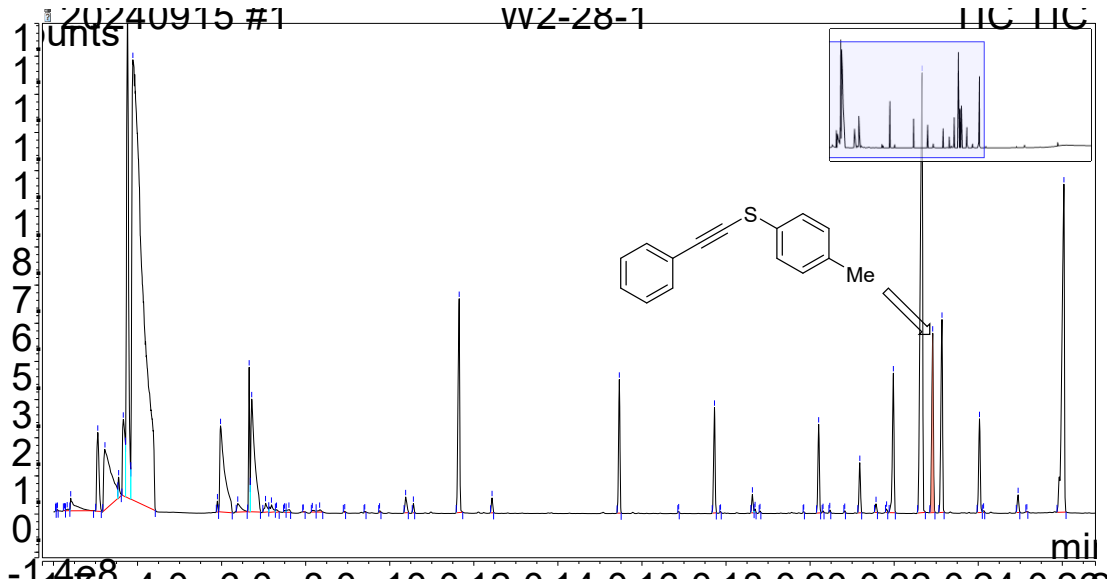

Figure S7. GC-MS spectrum of "standard conditions" **with 5 equiv. TEMPO** to show the inhibition role of TEMPO.

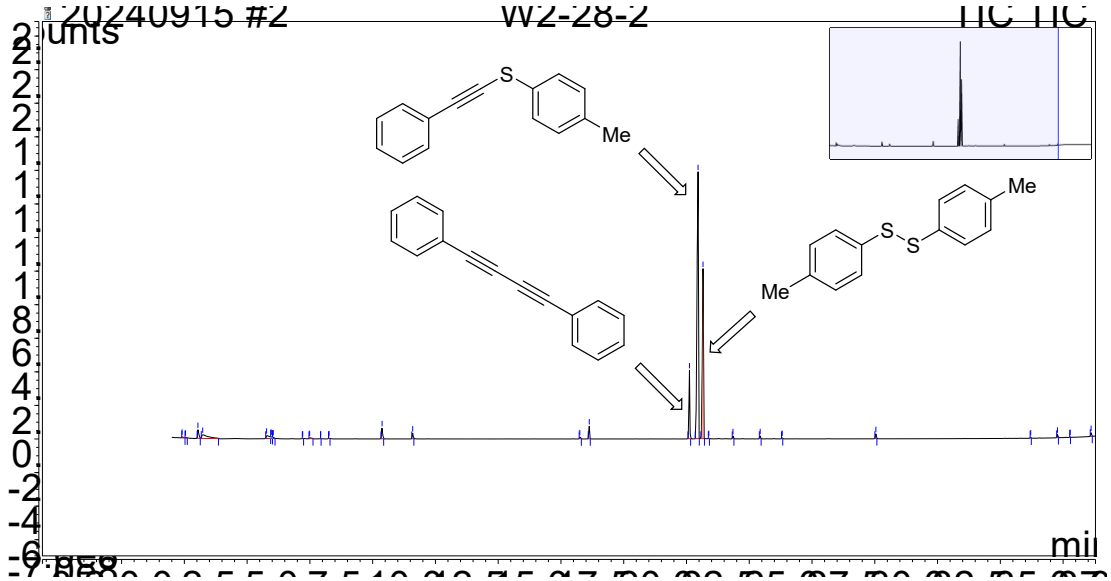

Figure S8. GC-MS spectrum of "standard conditions" **with 1 equiv. disulfide** to show the pathway of catalytic cycle.

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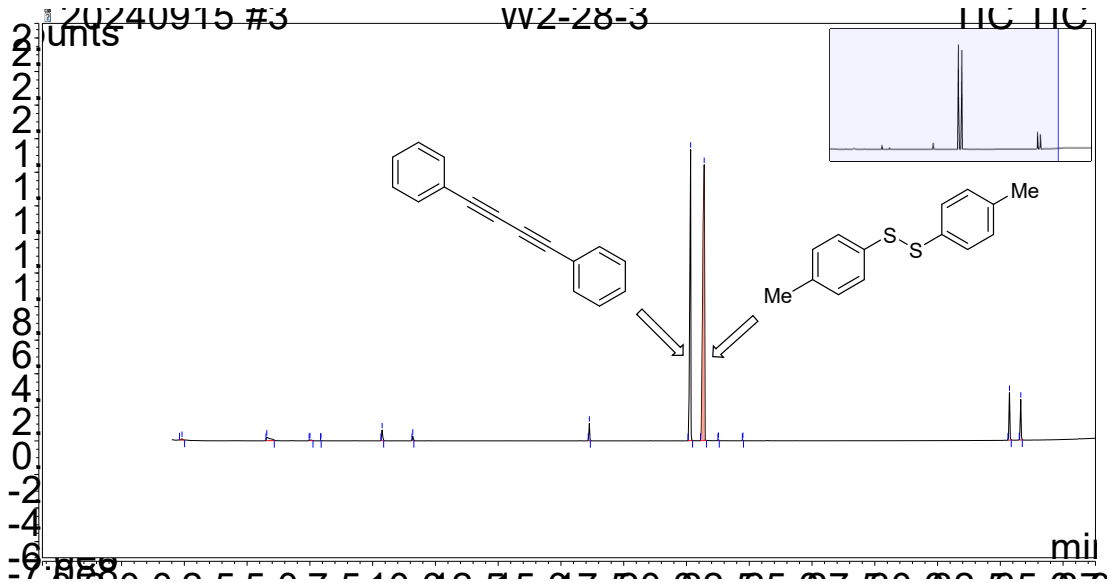


Figure S9. GC-MS spectrum of "standard conditions" **with 0.25 equiv. diyne** to show the pathway of catalytic cycle.

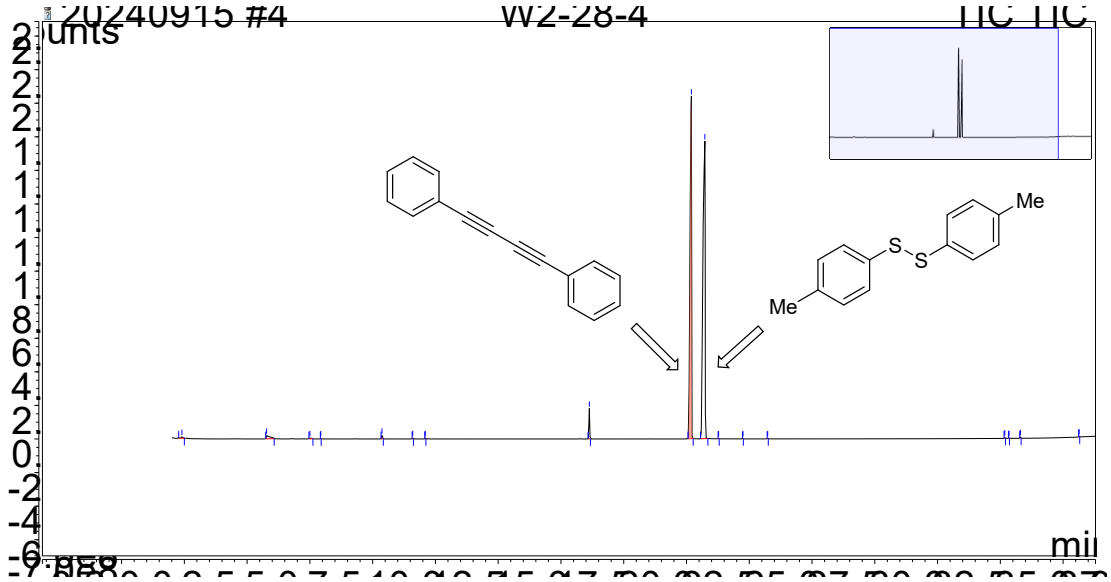
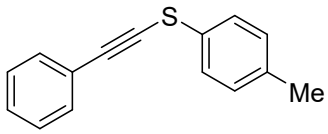


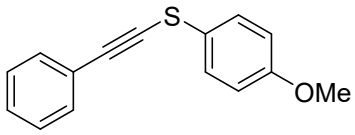
Figure S10. GC-MS spectrum of "standard conditions" **diyne with 2 equiv. disulfide** to show the pathway of catalytic cycle.

Products Characterization



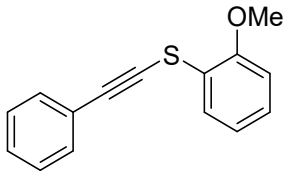
(phenylethynyl)(p-tolyl)sulfane 3a

Eluent: petroleum ether, Rf = 0.6, colorless liquid, 38.1 mg, 85% yield. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.42 (dd, J = 6.7, 3.0 Hz, 2H), 7.31 (d, J = 8.2 Hz, 2H), 7.27 – 7.25 (m, 3H), 7.09 (d, J = 8.0 Hz, 2H), 2.27 (s, 3H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ 135.61, 131.48, 130.65, 129.02, 128.76, 128.16, 127.48, 127.34, 125.55, 96.22, 75.09, 19.98. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{15}H_{13}S^+$: 225.0735; found: 225.0731.



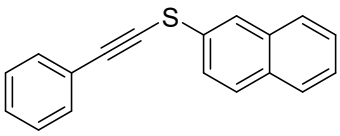
(4-methoxyphenyl)(phenylethynyl)sulfane 3b

Eluent: petroleum ether, Rf = 0.3, colorless liquid, 45.1 mg, 94% yield. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.54 – 7.49 (m, 2H), 7.46 (d, J = 8.7 Hz, 2H), 7.38 – 7.33 (m, 3H), 6.94 (d, J = 8.7 Hz, 2H), 3.83 (s, 3H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ 159.04, 128.93, 128.47, 128.37, 123.09, 123.04, 115.08, 96.30, 55.47. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{15}H_{13}OS^+$: 241.0682; found: 241.0680.



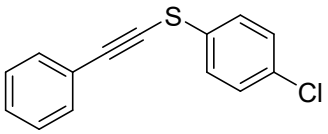
(2-methoxyphenyl)(phenylethynyl)sulfane 3c

Eluent: petroleum ether, Rf = 0.3, colorless liquid, 44.4 mg, 92% yield. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.60 (dd, J = 7.8, 1.6 Hz, 1H), 7.50 – 7.43 (m, 2H), 7.31 – 7.25 (m, 3H), 7.16 – 7.12 (m, 1H), 6.96 (td, J = 7.6, 1.2 Hz, 1H), 6.79 (dd, J = 8.1, 1.0 Hz, 1H), 3.83 (s, 3H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ 154.19, 127.54, 127.37, 126.25, 125.52, 122.03, 120.66, 109.38, 97.41, 74.24, 54.92. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{15}H_{13}OS^+$: 241.0682; found: 241.0680.



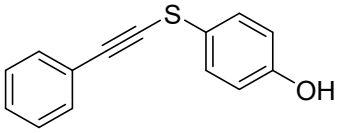
naphthalen-2-yl(phenylethynyl)sulfane 3d

Eluent: petroleum ether, Rf = 0.4, colorless liquid, 39.2 mg, 75% yield. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.98 (s, 1H), 7.88 – 7.83 (m, 2H), 7.81 (d, J = 8.1 Hz, 1H), 7.58 (t, J = 7.1 Hz, 3H), 7.51 (dt, J = 22.5, 7.3 Hz, 2H), 7.42 – 7.38 (m, 3H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ 133.78, 132.06, 131.84, 130.26, 129.03, 128.75, 128.47, 127.87, 127.18, 126.90, 126.01, 124.61, 124.18, 122.92, 98.06, 75.49. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{18}H_{13}S^+$: 261.0732; found: 261.0731.



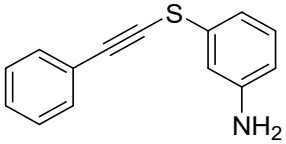
(4-chlorophenyl)(phenylethynyl)sulfane 3e

Eluent: petroleum ether, Rf = 0.6, white solid, 43.3 mg, 88% yield. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 8.14 (d, J = 9.0 Hz, 1H), 7.54 (d, J = 9.0 Hz, 1H), 7.48 (dd, J = 8.0, 1.6 Hz, 1H), 7.44 (dd, J = 7.3, 2.4 Hz, 1H), 7.36 – 7.32 (m, 2H), 7.32 – 7.28 (m, 2H), 7.25 (d, J = 8.7 Hz, 1H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ 131.03, 130.80, 128.43, 128.37, 127.85, 127.56, 127.43, 126.45, 124.68, 123.28, 97.37, 73.73. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{14}H_{10}ClS^+$: 245.0186; found: 245.0183.



4-((phenylethynyl)thio)phenol 3f

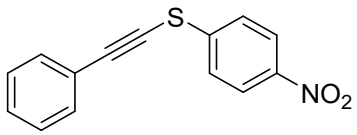
Eluent: EA:PE=1:5, Rf = 0.3, white solid, 44.3 mg, 98% yield. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.52 – 7.48 (m, 2H), 7.41 (d, J = 8.7 Hz, 2H), 7.37 – 7.34 (m, 3H), 6.87 (d, J = 8.7 Hz, 2H), 4.97 (s, 1H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ 154.97, 131.68, 129.09, 128.51, 128.38, 123.30, 123.03, 116.53, 96.44. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{14}H_{11}OS^+$: 227.0525; found: 227.0526.



3-((phenylethynyl)thio)aniline 3g

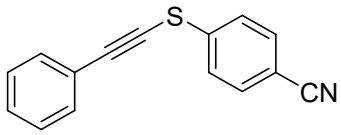
Eluent: EA:PE=1:3, Rf = 0.3, colorless liquid, 34.3 mg, 76% yield. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.63 – 7.46 (m, 2H), 7.45 – 7.32 (m, 3H), 7.15 (t, J = 7.9 Hz, 1H), 6.88 (d, J = 7.8 Hz, 1H), 6.84 (s,

1H), 6.57 (d, J = 7.9 Hz, 1H), 4.15 – 3.36 (m, 2H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ 147.22, 133.78, 131.83, 130.07, 128.64, 128.41, 123.00, 116.31, 113.48, 112.31, 97.91, 75.63. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{14}H_{12}NS^+$: 226.0685; found: 226.0683.



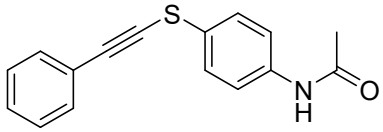
(4-nitrophenyl)(phenylethynyl)sulfane 3h

Eluent: petroleum ether, Rf = 0.5, yellow solid, 46.5 mg, 91% yield. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 8.14 (d, J = 9.0 Hz, 2H), 7.54 (d, J = 9.0 Hz, 2H), 7.48 (dd, J = 8.0, 1.6 Hz, 2H), 7.34 – 7.31 (m, 3H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ 145.22, 141.98, 131.02, 130.79, 128.43, 127.56, 127.43, 126.45, 124.67, 123.27, 120.96, 99.50, 71.41. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{14}H_{10}NO_2S^+$: 256.0427; found: 256.0427.



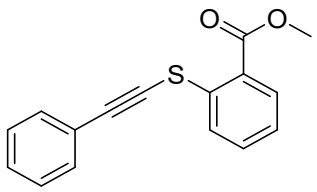
4-((phenylethynyl)thio)benzonitrile 3i

Eluent: EA:PE=1:20, Rf = 0.5, yellow liquid, 33.3 mg, 70% yield. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.65 (d, J = 8.5 Hz, 2H), 7.60 (s, 1H), 7.56 (s, 3H), 7.41 (s, 3H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ 140.59, 132.65, 132.03, 129.37, 128.58, 125.92, 122.09, 118.55, 109.78, 100.37, 72.56. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{15}H_{10}NS^+$:236.0528; found: 236.0528.



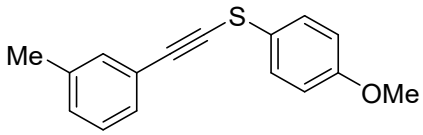
N-(4-((phenylethynyl)thio)phenyl)acetamide 3j

Eluent: EA:PE=1:1, Rf = 0.3, white solid, 45.6 mg, 85% yield. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.57 – 7.49 (m, 4H), 7.44 (dd, J = 19.3, 8.3 Hz, 3H), 7.38 – 7.35 (m, 2H), 2.20 (s, 3H), 1.71 (s, 1H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ 168.45, 136.80, 131.74, 131.33, 128.75, 128.67, 128.43, 128.35, 127.73, 127.33, 122.86, 120.78, 120.54, 97.58, 75.75, 24.62. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{16}H_{14}NOS^+$:268.0791; found: 268.0790.



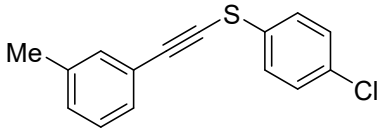
methyl 2-((phenylethynyl)thio)benzoate 3k

Eluent: EA:PE=1:5, Rf = 0.5, yellow liquid, 50.4 mg, 94% yield. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 8.14 – 8.06 (m, 2H), 7.63 – 7.55 (m, 3H), 7.42 – 7.37 (m, 3H), 7.29 (d, J = 10.7 Hz, 1H), 3.98 (s, 3H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ 166.45, 138.40, 133.22, 131.89, 131.36, 128.82, 128.46, 127.14, 125.79, 125.51, 122.84, 99.92, 52.40. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{16}H_{13}O_2S^+$:269.0631; found: 269.0632.



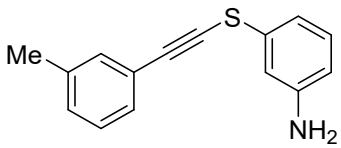
(4-methoxyphenyl)(m-tolylethynyl)sulfane 4a

Eluent: EA:PE=1:20, Rf = 0.3, colorless liquid, 46.3 mg, 91% yield. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.46 (d, J = 8.8 Hz, 2H), 7.35 – 7.30 (m, 2H), 7.24 (t, J = 7.6 Hz, 1H), 7.17 (d, J = 7.5 Hz, 1H), 6.94 (d, J = 8.8 Hz, 2H), 3.83 (s, 3H), 2.36 (s, 3H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ 159.00, 138.08, 132.23, 129.40, 128.85, 128.75, 128.27, 123.16, 122.88, 115.06, 96.55, 76.50, 55.46, 21.25. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{16}H_{15}OS^+$:255.0838; found: 255.0841.



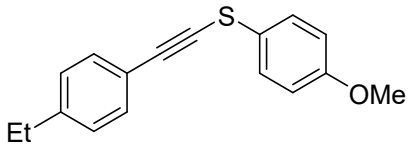
(4-chlorophenyl)(m-tolylethynyl)sulfane 4b

Eluent: petroleum ether, Rf = 0.4, colorless liquid, 42.5 mg, 82% yield. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.44 (d, J = 8.5 Hz, 2H), 7.38 – 7.32 (m, 4H), 7.27 (t, J = 7.7 Hz, 1H), 7.20 (d, J = 7.6 Hz, 1H), 2.38 (s, 3H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ 138.22, 132.45, 132.39, 131.71, 129.83, 129.39, 128.93, 128.37, 127.43, 122.42, 98.68, 74.26, 21.25. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{15}H_{12}ClS^+$:259.0343; found: 259.0345.



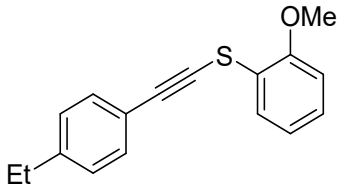
3-((m-tolylethynyl)thio)aniline 4c

Eluent: EA:PE=1:2, Rf = 0.4, yellow liquid, 44.7 mg, 93% yield. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.38 – 7.31 (m, 2H), 7.26 (t, J = 7.6 Hz, 1H), 7.18 (d, J = 7.5 Hz, 1H), 7.15 (t, J = 7.9 Hz, 1H), 6.87 (d, J = 7.8 Hz, 1H), 6.84 (s, 1H), 6.57 (d, J = 8.0 Hz, 1H), 2.37 (s, 3H), 1.28 (s, 2H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ 147.20, 138.12, 133.90, 132.38, 130.04, 129.56, 128.92, 128.30, 122.79, 116.27, 113.43, 112.27, 98.14, 75.11, 21.25. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{15}H_{14}NS^+$:240.0841; found: 240.0843.



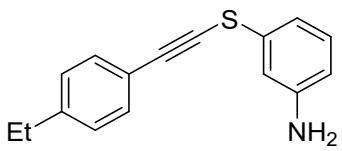
((4-ethylphenyl)ethynyl)(4-methoxyphenyl)sulfane 4d

Eluent: EA:PE=1:20, Rf = 0.4, colorless liquid, 50.5 mg, 94% yield. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.44 (t, J = 8.7 Hz, 4H), 7.19 (d, J = 7.9 Hz, 2H), 6.93 (d, J = 8.6 Hz, 2H), 3.83 (s, 3H), 2.68 (q, J = 7.6 Hz, 2H), 1.26 (t, J = 7.6 Hz, 3H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ 158.94, 145.10, 131.86, 128.73, 127.95, 123.33, 120.22, 115.04, 96.56, 75.90, 55.46, 28.88, 15.37, 1.05. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{17}H_{17}OS^+$:269.0995; found: 269.0993.



((4-ethylphenyl)ethynyl)(2-methoxyphenyl)sulfane 4e

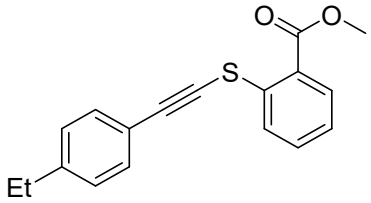
Eluent: EA:PE=1:20, Rf = 0.4, colorless liquid, 47.8 mg, 89% yield. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.70 (d, J = 7.8 Hz, 1H), 7.49 (d, J = 7.6 Hz, 2H), 7.22 (t, J = 7.2 Hz, 3H), 7.05 (t, J = 7.6 Hz, 1H), 6.88 (d, J = 8.1 Hz, 1H), 3.93 (s, 3H), 2.69 (q, J = 7.6 Hz, 2H), 1.27 (t, J = 7.6 Hz, 3H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ 155.18, 145.23, 131.96, 127.99, 127.18, 126.50, 121.67, 120.20, 110.35, 98.68, 74.21, 55.95, 28.90, 15.39, 1.06. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{17}H_{17}OS^+$:269.0995; found: 269.0993.



3-(((4-ethylphenyl)ethynyl)thio)aniline 4f

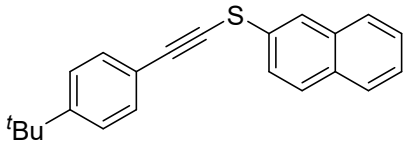
Eluent: EA:PE=1:3, Rf = 0.4, colorless liquid, 43.3 mg, 85% yield. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.47 (d, J = 7.7 Hz, 2H), 7.21 (d, J = 7.8 Hz, 2H), 7.14 (t, J = 7.8 Hz, 1H), 6.88 (d, J = 7.8 Hz, 1H),

6.85 (s, 1H), 6.57 (d, J = 7.9 Hz, 1H), 3.54 (s, 2H), 2.69 (q, J = 7.6 Hz, 2H), 1.27 (t, J = 7.6 Hz, 3H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ 147.08, 145.31, 134.08, 132.03, 130.03, 128.00, 120.13, 116.29, 113.44, 112.27, 98.18, 74.57, 28.90, 15.39. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{16}H_{16}NS^+$:254.0998; found: 254.0996.



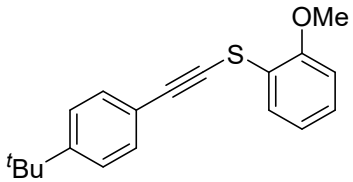
methyl 2-(((4-ethylphenyl)ethynyl)thio)benzoate 4g

Eluent: EA:PE=1:5, Rf = 0.5, yellow liquid, 47.5 mg, 80% yield. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 8.09 (t, J = 7.1 Hz, 2H), 7.58 (t, J = 7.7 Hz, 1H), 7.51 (d, J = 8.0 Hz, 2H), 7.28 (t, J = 3.7 Hz, 1H), 7.22 (d, J = 8.0 Hz, 2H), 3.97 (s, 3H), 2.70 (q, J = 7.6 Hz, 2H), 1.27 (t, J = 7.6 Hz, 3H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ 166.46, 145.49, 138.68, 133.18, 132.07, 131.33, 128.04, 127.15, 125.75, 125.41, 119.98, 100.12, 75.71, 52.37, 28.92, 15.39. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{18}H_{17}O_2S^+$: 297.0944; found: 297.0946.



((4-(tert-butyl)phenyl)ethynyl)(naphthalen-2-yl)sulfane 4h

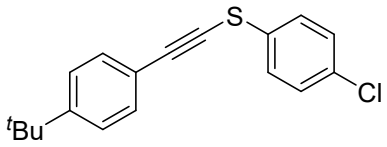
Eluent: petroleum ether, Rf = 0.3, colorless liquid, 56.7 mg, 90% yield. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.97 (s, 1H), 7.84 (d, J = 8.4 Hz, 2H), 7.80 (d, J = 8.1 Hz, 1H), 7.54 (dt, J = 15.6, 8.1 Hz, 4H), 7.51 – 7.47 (m, 1H), 7.42 (d, J = 8.1 Hz, 2H), 1.36 (s, 9H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ 152.27, 133.79, 132.01, 131.83, 130.59, 128.95, 127.86, 127.16, 126.86, 125.93, 125.50, 124.39, 124.09, 119.86, 98.30, 74.43, 34.91, 31.18. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{22}H_{21}S^+$: 317.1358; found: 317.1361.



((4-(tert-butyl)phenyl)ethynyl)(2-methoxyphenyl)sulfane 4i

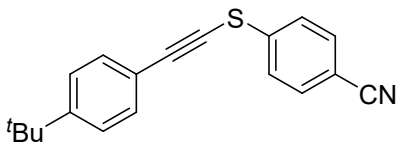
Eluent: petroleum ether, Rf = 0.3, colorless liquid, 43.4 mg, 73% yield. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.70 (d, J = 7.7 Hz, 1H), 7.51 (d, J = 8.2 Hz, 2H), 7.41 (d, J = 8.3 Hz, 2H), 7.23 (t, J = 7.7 Hz,

1H), 7.05 (t, J = 7.6 Hz, 1H), 6.88 (d, J = 8.1 Hz, 1H), 3.93 (s, 3H), 1.36 (s, 9H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ 155.19, 152.07, 131.74, 127.18, 126.50, 125.44, 121.86, 121.67, 120.00, 110.36, 98.64, 74.24, 55.95, 34.88, 31.19. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{19}H_{21}OS^+$: 297.1308; found: 297.1311.



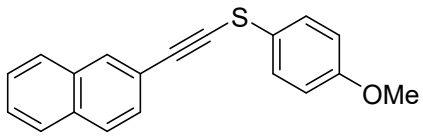
((4-(tert-butyl)phenyl)ethynyl)(4-chlorophenyl)sulfane 4j

Eluent: petroleum ether, Rf = 0.4, white solid, 57.3 mg, 95% yield. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.49 (d, J = 8.3 Hz, 2H), 7.42 (dd, J = 14.2, 8.4 Hz, 4H), 7.34 (d, J = 8.5 Hz, 2H), 1.35 (s, 9H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ 152.45, 132.36, 131.90, 131.83, 129.36, 127.33, 125.51, 119.57, 98.69, 73.74, 34.91, 31.17. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{19}H_{21}OS^+$: 301.0812; found: 301.0816.



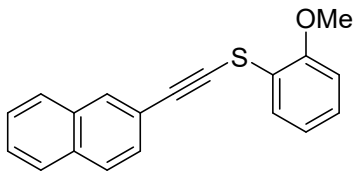
4-(((4-(tert-butyl)phenyl)ethynyl)thio)benzonitrile 4k

Eluent: EA:PE=1:20, Rf = 0.3, white solid, 54.3 mg, 93% yield. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.63 (d, J = 8.4 Hz, 2H), 7.58 (d, J = 8.4 Hz, 2H), 7.51 (d, J = 8.2 Hz, 2H), 7.43 (d, J = 8.2 Hz, 2H), 1.36 (s, 9H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ 152.99, 140.92, 132.60, 132.01, 125.85, 125.61, 119.02, 118.60, 109.65, 100.62, 71.64, 34.97, 31.14. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{19}H_{18}NS^+$: 292.1154; found: 292.1152.



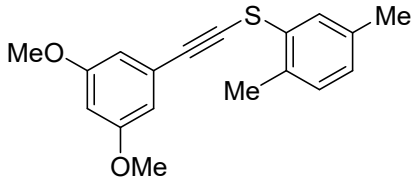
(4-methoxyphenyl)(naphthalen-2-ylethynyl)sulfane 4l

Eluent: EA:PE=1:20, Rf = 0.3, white solid, 56.7 mg, 98% yield. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 8.02 (s, 1H), 7.87 – 7.79 (m, 3H), 7.57 – 7.48 (m, 5H), 6.96 (d, J = 8.8 Hz, 2H), 3.84 (s, 3H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ 159.10, 132.95, 131.53, 129.04, 128.29, 128.06, 127.80, 126.81, 126.66, 123.02, 120.38, 115.13, 96.70, 55.48. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{19}H_{15}OS^+$: 291.0838; found: 291.0835.



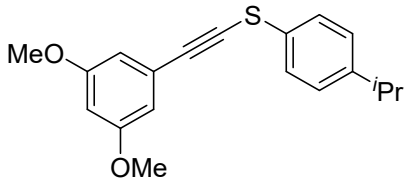
(2-methoxyphenyl)(naphthalen-2-ylethynyl)sulfane 4m

Eluent: EA:PE=1:20, Rf = 0.3, colorless liquid, 47.8 mg, 82% yield. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 8.09 (s, 1H), 7.88 – 7.82 (m, 3H), 7.78 (d, J = 7.7 Hz, 1H), 7.61 (d, J = 8.4 Hz, 1H), 7.56 – 7.49 (m, 2H), 7.30 – 7.23 (m, 1H), 7.10 (t, J = 7.6 Hz, 1H), 6.91 (d, J = 8.1 Hz, 1H), 3.94 (s, 3H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ 155.26, 132.97, 131.69, 128.36, 128.12, 127.84, 127.83, 127.36, 126.88, 126.70, 126.61, 121.75, 121.58, 120.34, 110.45, 98.94, 75.68, 55.98. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{19}H_{15}OS^+$: 291.0838; found: 291.0839.



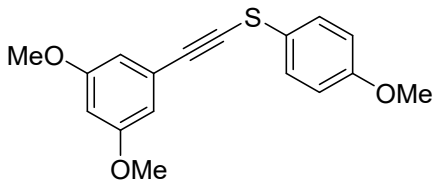
((3,5-dimethoxyphenyl)ethynyl)(2,5-dimethylphenyl)sulfane 4n

Eluent: EA:PE=1:20, Rf = 0.4, colorless liquid, 47.9 mg, 80% yield. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.53 (s, 1H), 7.08 (d, J = 7.6 Hz, 1H), 7.00 (d, J = 7.6 Hz, 1H), 6.70 (s, 2H), 6.50 (s, 1H), 3.83 (s, 7H), 2.38 (s, 3H), 2.35 (s, 3H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ 160.56, 136.73, 132.39, 131.25, 130.23, 127.60, 127.44, 124.33, 109.46, 101.96, 97.25, 75.72, 55.47, 21.15, 19.10. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{19}H_{19}O_2S^+$: 299.1100; found: 299.1104.



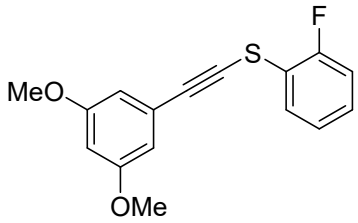
((3,5-dimethoxyphenyl)ethynyl)(4-isopropylphenyl)sulfane 4o

Eluent: EA:PE=1:20, Rf = 0.4, colorless liquid, 46.8 mg, 75% yield. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.44 (d, J = 8.1 Hz, 2H), 7.26 (d, J = 8.0 Hz, 2H), 6.68 (s, 2H), 6.49 (s, 1H), 3.82 (s, 6H), 2.93 (p, J = 6.9 Hz, 1H), 1.28 (s, 3H), 1.27 (s, 3H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ 160.54, 147.80, 129.36, 127.54, 126.74, 124.29, 109.38, 102.00, 97.19, 75.94, 55.47, 33.75, 23.97. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{19}H_{21}O_2S^+$: 313.1257; found: 313.1260.



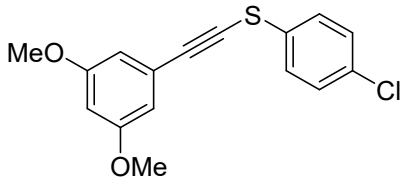
((3,5-dimethoxyphenyl)ethynyl)(4-methoxyphenyl)sulfane 4p

Eluent: EA:PE=1:20, Rf = 0.2, colorless liquid, 56.8 mg, 95% yield. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.45 (d, J = 8.8 Hz, 2H), 6.94 (d, J = 8.7 Hz, 2H), 6.65 (d, J = 2.1 Hz, 2H), 6.47 (s, 1H), 3.83 (s, 3H), 3.81 (s, 6H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ 160.52, 159.09, 129.05, 124.31, 122.85, 115.09, 109.34, 101.95, 96.23, 55.46. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{17}H_{17}O_3S^+$: 301.0893; found: 301.0898.



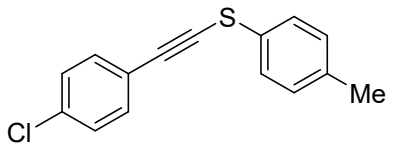
((3,5-dimethoxyphenyl)ethynyl)(2-fluorophenyl)sulfane 4q

Eluent: petroleum ether, Rf = 0.3, colorless liquid, 54.5 mg, 95% yield. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.70 (t, J = 7.6 Hz, 1H), 7.24 (dt, J = 15.0, 7.2 Hz, 2H), 7.10 (t, J = 8.9 Hz, 1H), 6.70 (d, J = 2.2 Hz, 2H), 6.51 (s, 1H), 3.82 (s, 6H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ 160.58, 159.71, 158.08, 128.32, 125.08, 123.84, 120.40, 115.55, 109.61, 102.31, 98.24, 73.27, 55.49. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{16}H_{14}FO_2S^+$: 289.0693; found: 289.0692.



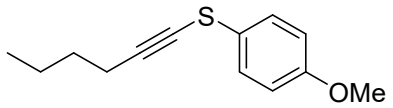
(4-chlorophenyl)((3,5-dimethoxyphenyl)ethynyl)sulfane 4r

Eluent: EA:PE=1:20, Rf = 0.5, colorless liquid, 55.5 mg, 91% yield. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.43 (d, J = 8.5 Hz, 2H), 7.35 (d, J = 8.5 Hz, 2H), 6.68 (d, J = 1.9 Hz, 2H), 6.51 (s, 1H), 3.82 (s, 6H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ 160.59, 132.59, 131.43, 129.43, 127.55, 123.84, 109.54, 102.28, 98.37, 74.50, 55.49. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{16}H_{14}ClO_2S^+$: 305.0398; found: 305.0399.



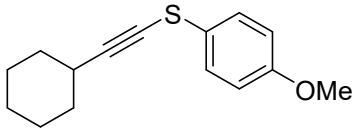
((4-chlorophenyl)ethynyl)(p-tolyl)sulfane 4s

Eluent: petroleum ether, Rf = 0.5, white solid, 50.2 mg, 97% yield. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.44 (d, J = 8.5 Hz, 2H), 7.39 (d, J = 8.1 Hz, 2H), 7.33 (d, J = 8.4 Hz, 2H), 7.20 (d, J = 8.0 Hz, 2H), 2.37 (s, 3H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ 136.88, 134.54, 132.86, 130.13, 128.81, 128.75, 126.78, 121.53, 95.96, 77.56, 21.05. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{15}H_{12}ClS^+$: 259.0343; found: 259.0338.



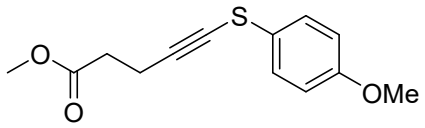
hex-1-yn-1-yl(4-methoxyphenyl)sulfane 4t

Eluent: petroleum ether, Rf = 0.3, colorless liquid, 41.6 mg, 94% yield. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.37 (d, J = 8.2 Hz, 2H), 6.90 (d, J = 8.2 Hz, 2H), 3.82 (s, 3H), 2.44 (t, J = 7.0 Hz, 2H), 1.59 (d, J = 7.5 Hz, 2H), 1.47 (q, J = 7.4 Hz, 2H), 0.95 (t, J = 7.3 Hz, 3H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ 158.67, 128.30, 123.95, 114.89, 98.40, 65.91, 55.44, 30.76, 22.00, 19.99, 13.61. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{13}H_{17}OS^+$: 221.0995; found: 221.0989.



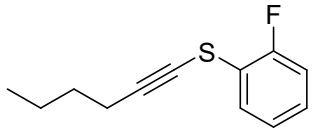
(cyclohexylethynyl)(4-methoxyphenyl)sulfane 4u

Eluent: petroleum ether, Rf = 0.3, colorless liquid, 42.8 mg, 87% yield. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.36 (d, J = 8.4 Hz, 2H), 6.90 (d, J = 8.4 Hz, 2H), 3.82 (s, 3H), 2.61 (s, 1H), 1.88 (d, J = 11.0 Hz, 2H), 1.75 (s, 2H), 1.55 (s, 3H), 1.41 – 1.32 (m, 3H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ 158.58, 128.00, 124.12, 114.88, 102.52, 65.82, 55.43, 32.61, 30.59, 25.84, 24.87. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{15}H_{19}OS^+$: 247.1151; found: 247.1148.



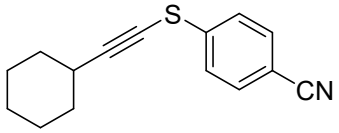
methyl 5-((4-methoxyphenyl)thio)pent-4-ynoate 4v

Eluent: EA:PE=1:20, Rf = 0.3, colorless liquid, 42.7 mg, 85% yield. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.36 (d, J = 7.5 Hz, 2H), 6.90 (d, J = 7.5 Hz, 2H), 3.82 (s, 3H), 3.73 (s, 3H), 2.76 (t, J = 7.2 Hz, 2H), 2.63 (t, J = 7.2 Hz, 2H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ 172.24, 158.83, 128.59, 123.33, 114.94, 95.83, 67.60, 55.44, 51.89, 33.35, 16.21. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{13}H_{15}O_3S^+$: 251.0736; found: 251.0736.



(2-fluorophenyl)(hex-1-yn-1-yl)sulfane 4w

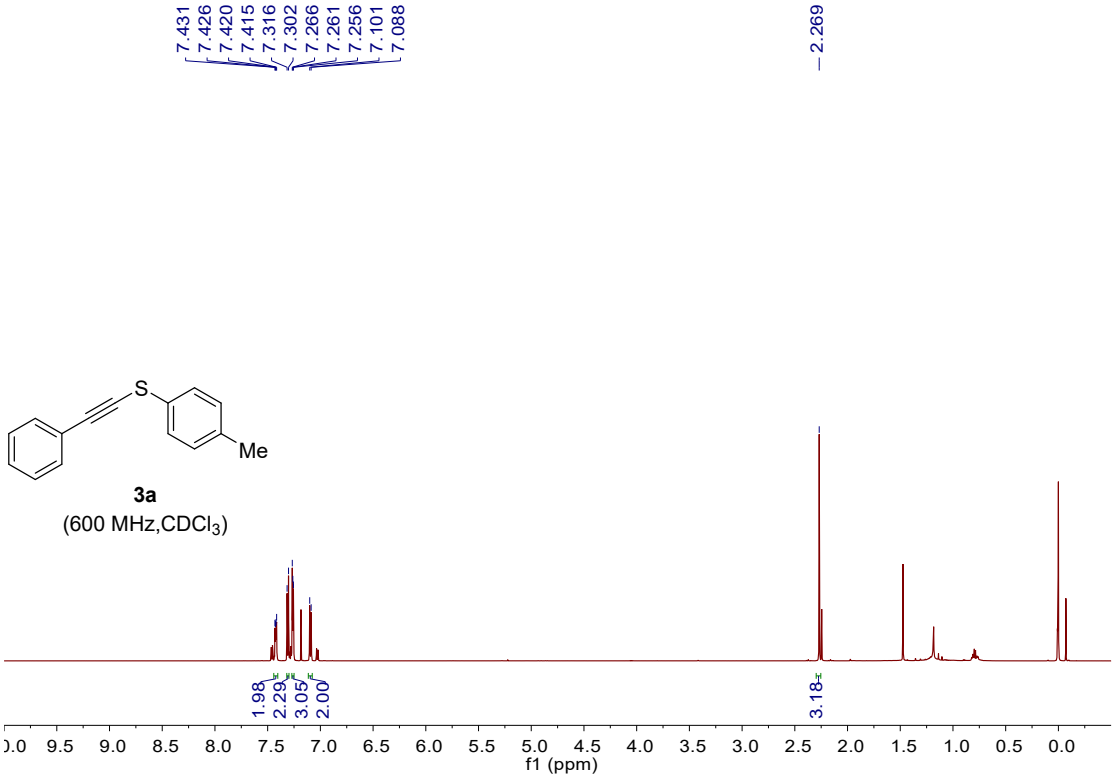
Eluent: petroleum ether, Rf = 0.5, colorless liquid, 39.3 mg, 94% yield. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.67 – 7.58 (m, 1H), 7.24 – 7.16 (m, 2H), 7.08 – 7.01 (m, 1H), 2.48 (t, J = 7.1 Hz, 2H), 1.66 – 1.62 (m, 1H), 1.50 (dt, J = 14.8, 7.3 Hz, 2H), 1.28 (s, 1H), 0.97 (t, J = 7.3 Hz, 3H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ 159.46, 157.84, 127.82, 127.61, 127.57, 124.83, 115.26, 115.13, 62.70, 30.66, 29.72, 22.00, 20.01, 13.59. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{12}H_{14}FS^+$: 209.0795; found: 209.0800.

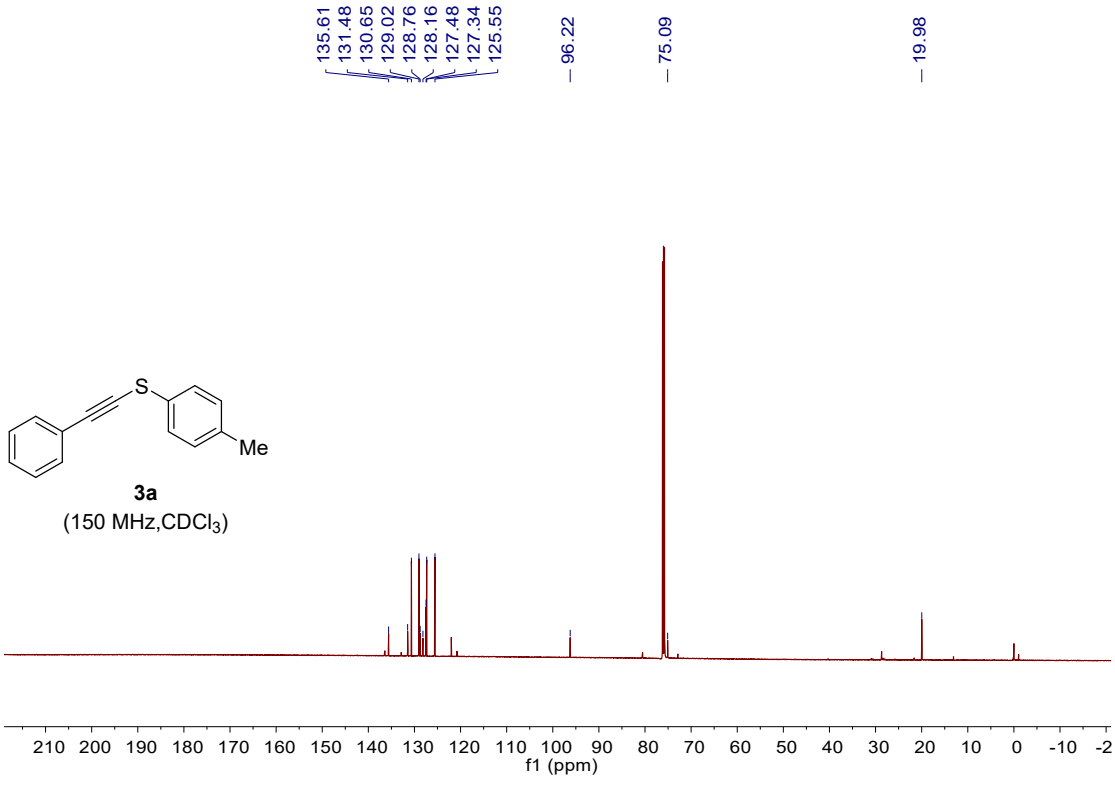


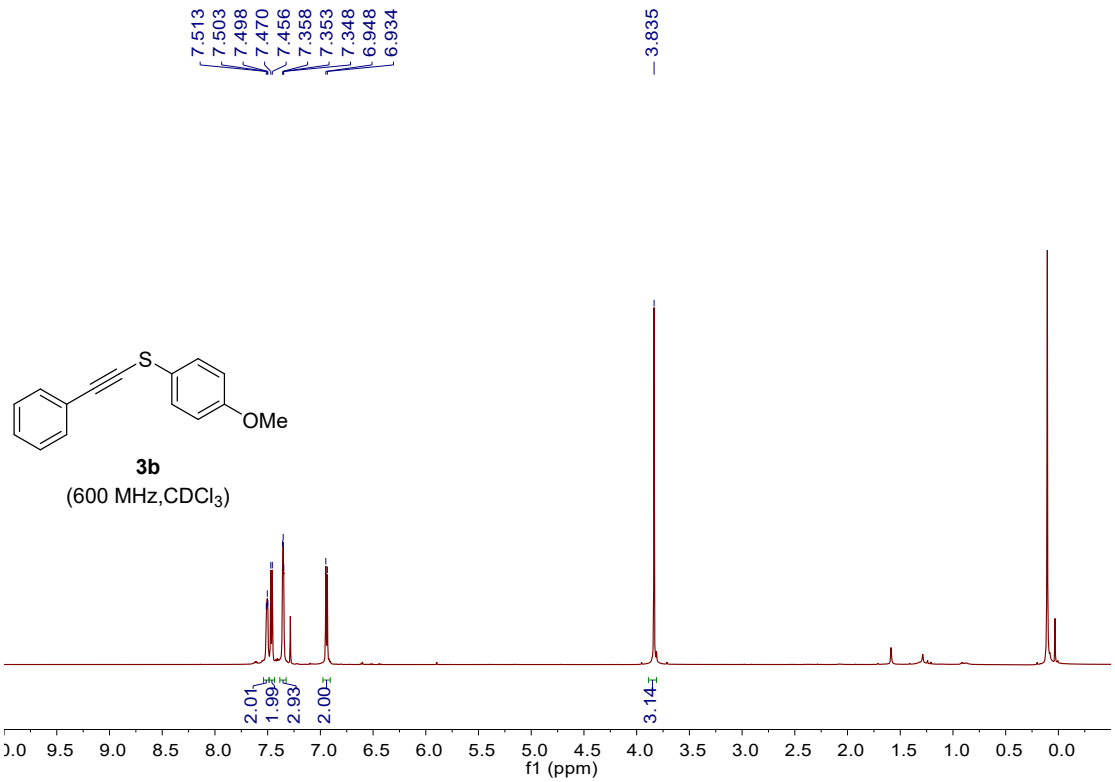
4-((cyclohexylethynyl)thio)benzonitrile 4x

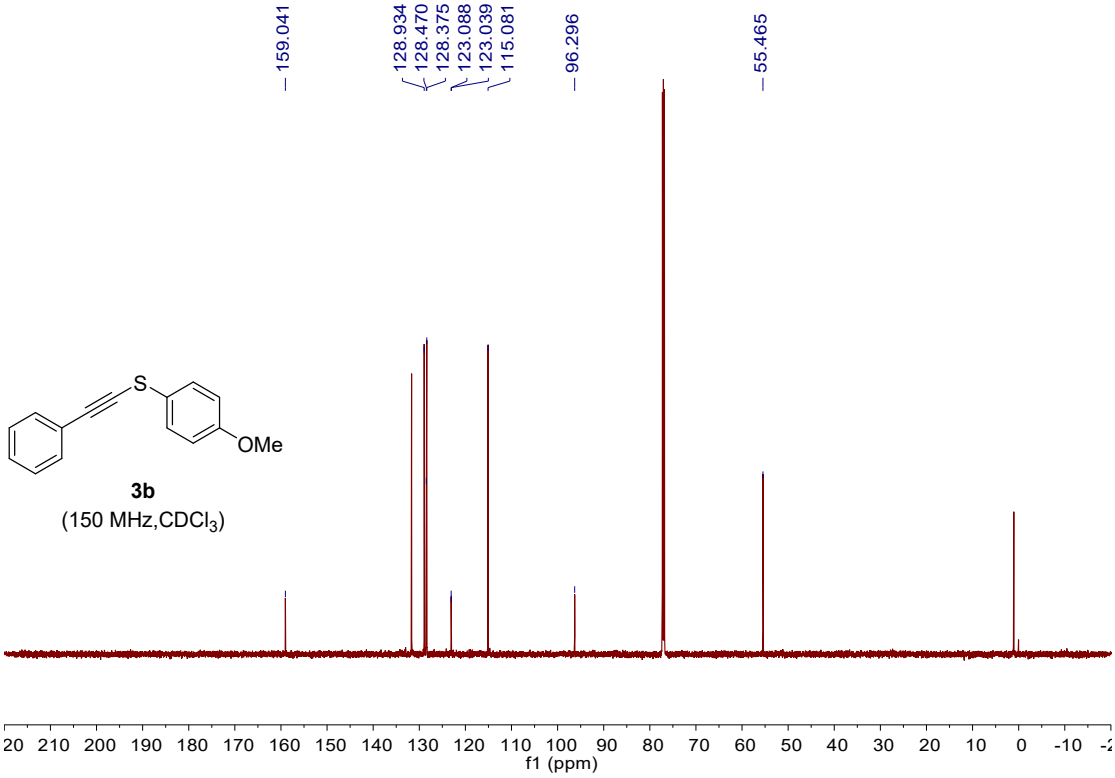
Eluent: EA:PE=1:10, Rf = 0.4, colorless liquid, 44.5 mg, 92% yield. **^{1}H NMR** (600 MHz, $CDCl_3$) δ 7.60 (d, J = 7.6 Hz, 2H), 7.50 (d, J = 7.6 Hz, 2H), 2.68 (s, 1H), 1.92 (d, J = 10.5 Hz, 2H), 1.77 (s, 2H), 1.58 (s, 3H), 1.39 (s, 3H). **^{13}C NMR** (150 MHz, $CDCl_3$) δ 141.68, 132.45, 125.49, 118.70, 109.22, 106.77, 62.22, 32.45, 30.64, 25.74, 24.83. **HRMS** (ESI) m/z: $[M+H]^+$ calcd for $C_{15}H_{16}NS^+$: 242.0998; found: 242.0996.

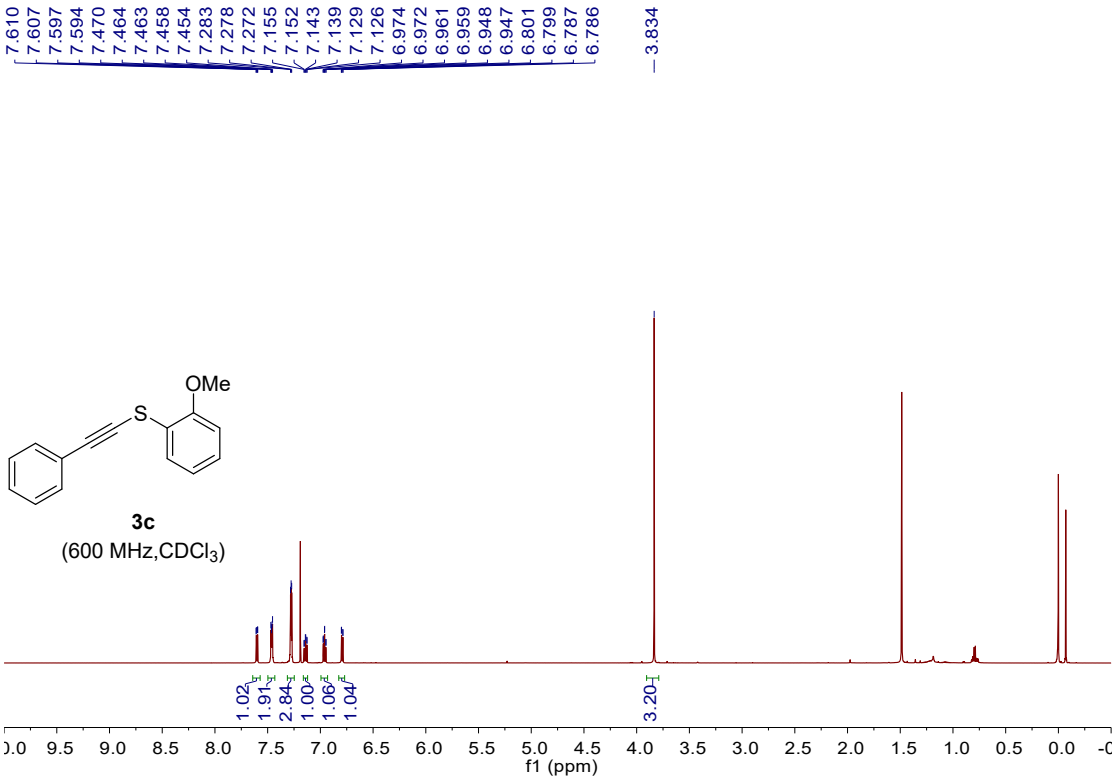
NMR Spectra

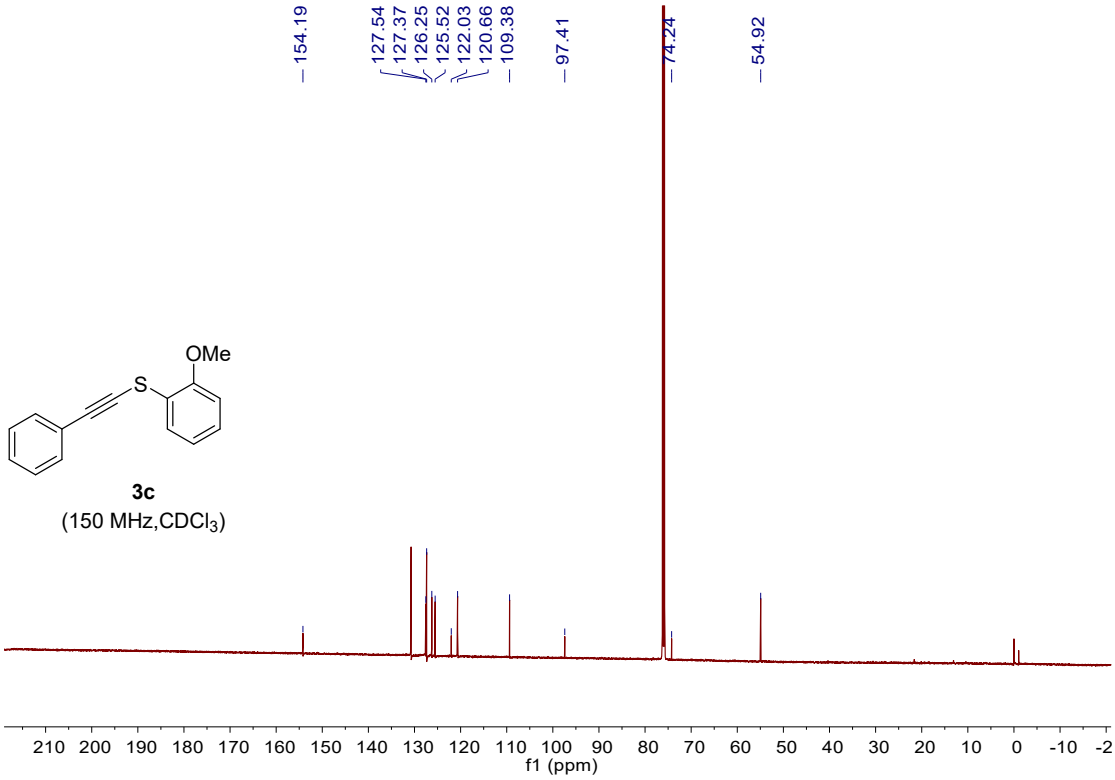

7.431
7.426
7.420
7.415
7.316
7.302
7.266
7.261
7.256
7.101
7.088
2.269
S
Me
3a
(600 MHz,CDCl3)
1.98
2.29
3.05
2.00
3.18
f1 (ppm)

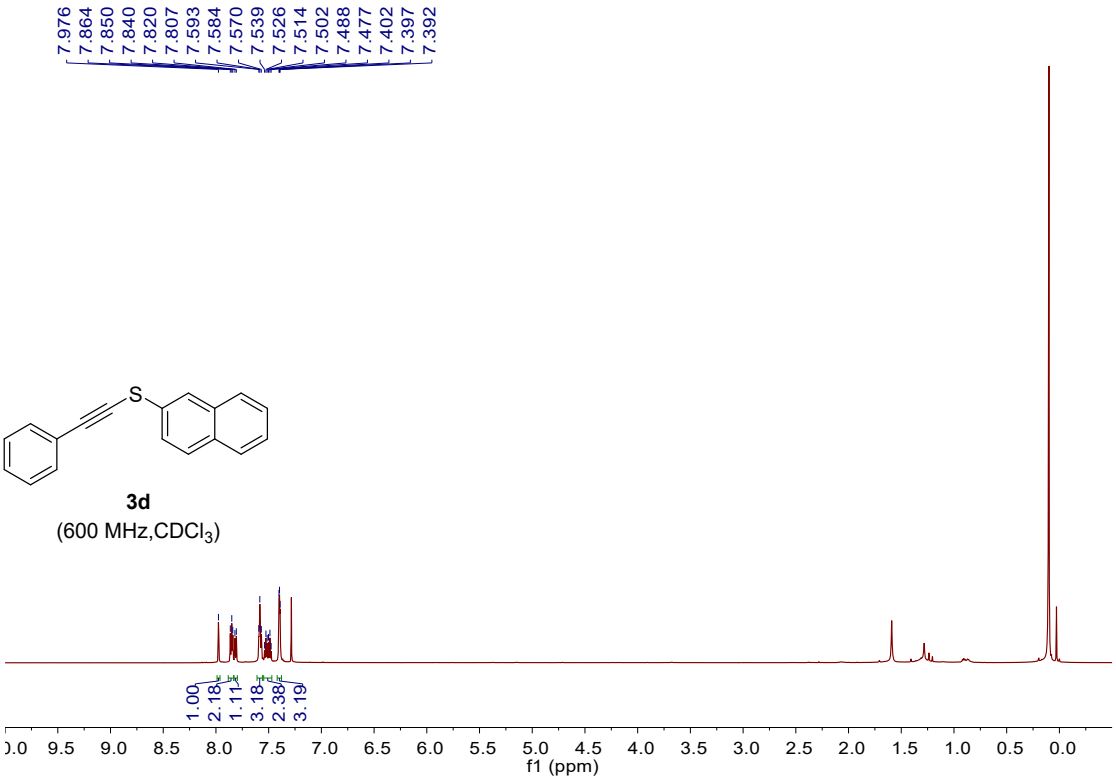

135.61
131.48
130.65
129.02
128.76
128.16
127.48
127.34
125.55
96.22
75.09
19.98
S
Me
3a
(150 MHz,CDCl3)
f1 (ppm)

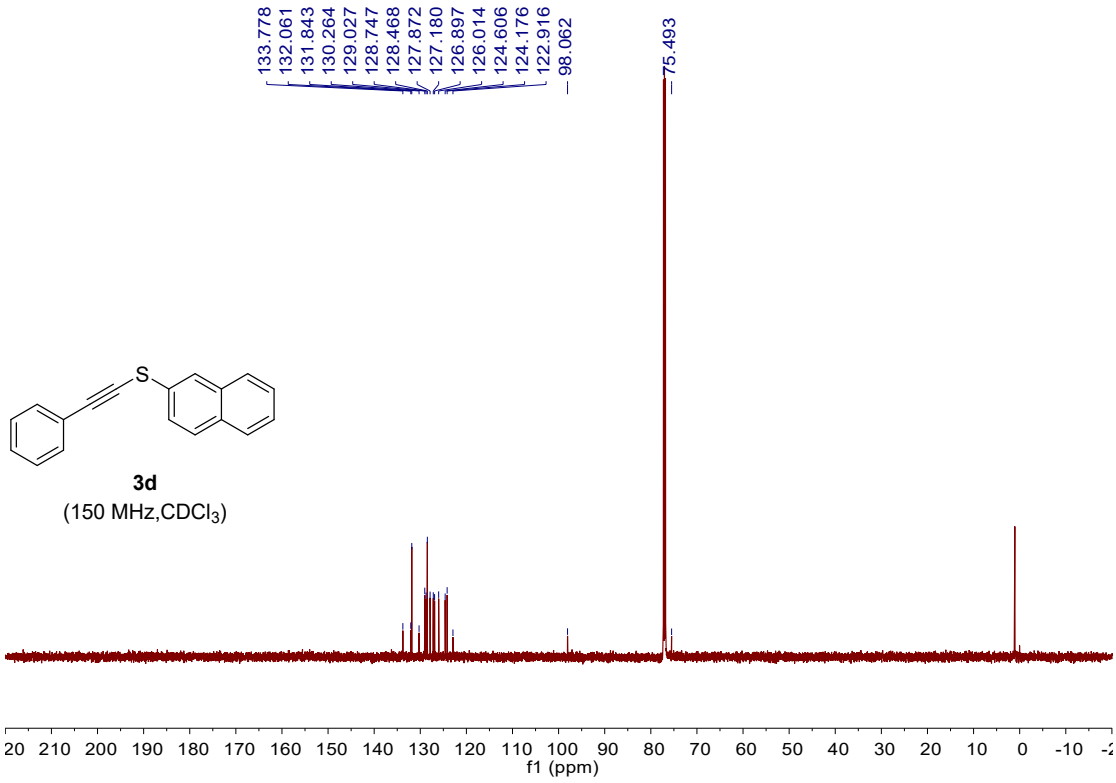

7.513
7.503
7.498
7.470
7.456
7.358
7.353
7.348
6.948
6.934
3.835
S
OMe
3b
(600 MHz,CDCl3)
2.01
1.99
2.93
2.00
3.14
f1 (ppm)

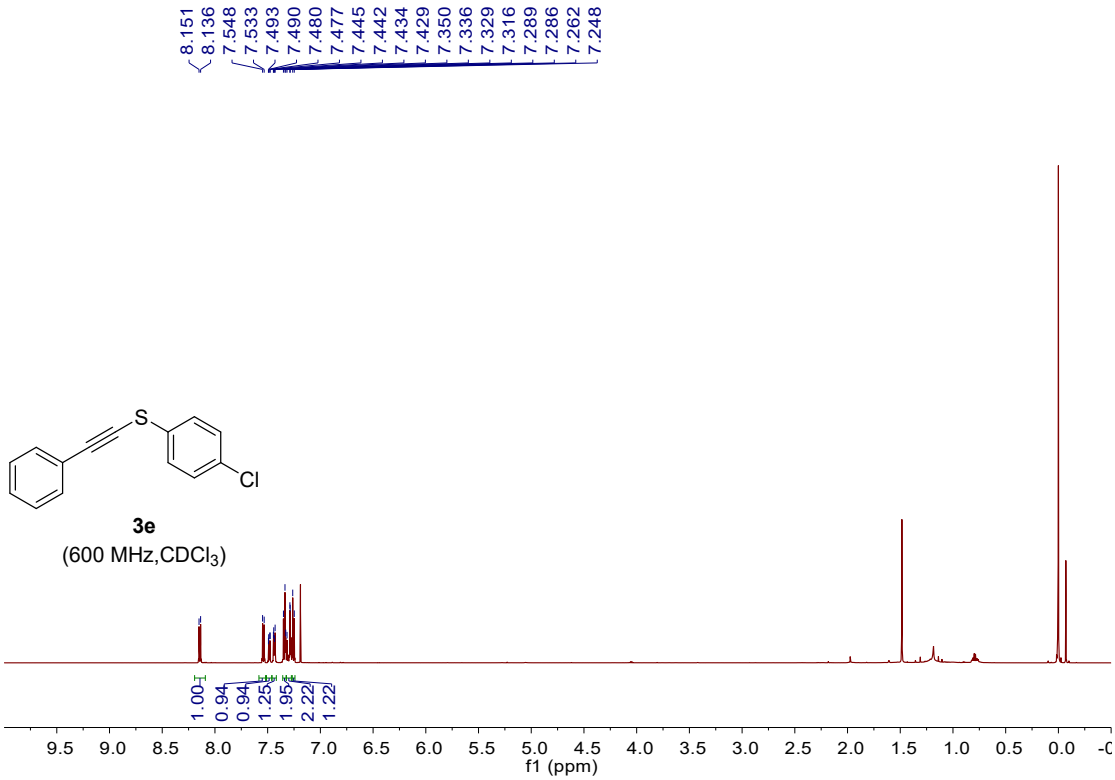

159.041
128.934
128.470
128.375
123.088
123.039
115.081
96.296
55.465
S
OMe
3b
(150 MHz,CDCl3)
f1 (ppm)

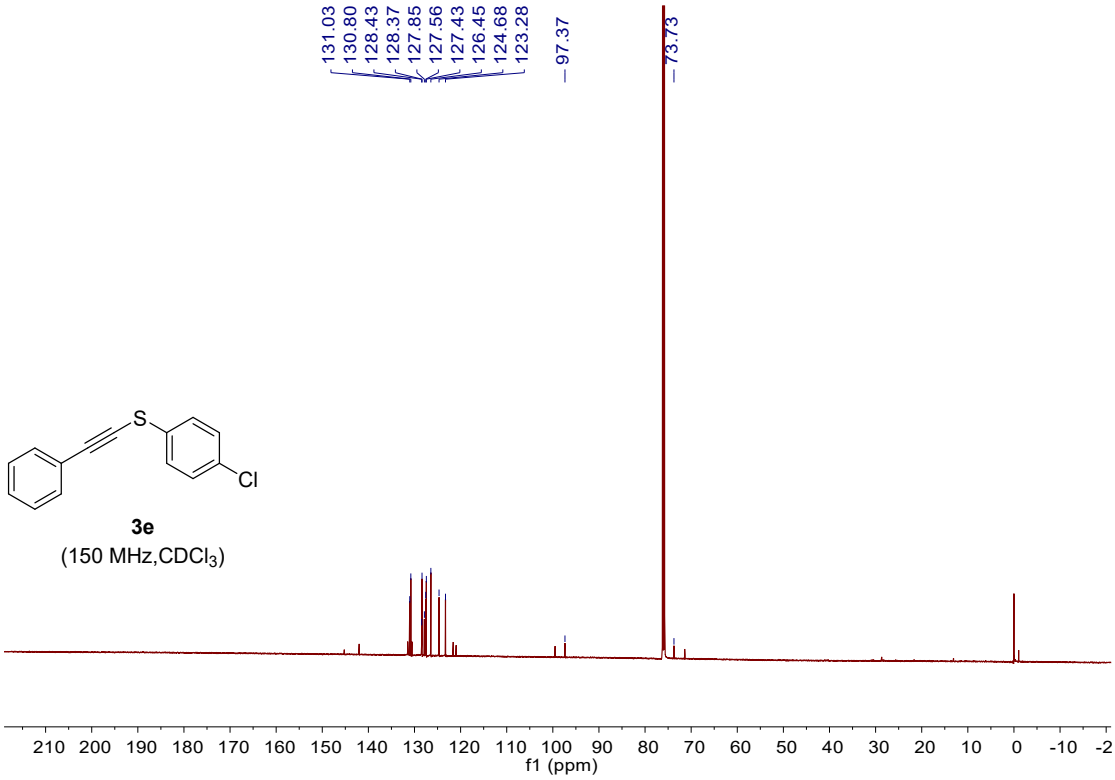

7.610
7.607
7.597
7.594
7.470
7.464
7.463
7.458
7.454
7.283
7.278
7.272
7.155
7.152
7.143
7.139
7.129
7.126
6.974
6.972
6.961
6.959
6.948
6.947
6.801
6.799
6.787
6.786
3.834
OMe
S
3c
(600 MHz,CDCl3)
1.02
1.91
2.84
1.00
1.06
1.04
3.20
f1 (ppm)

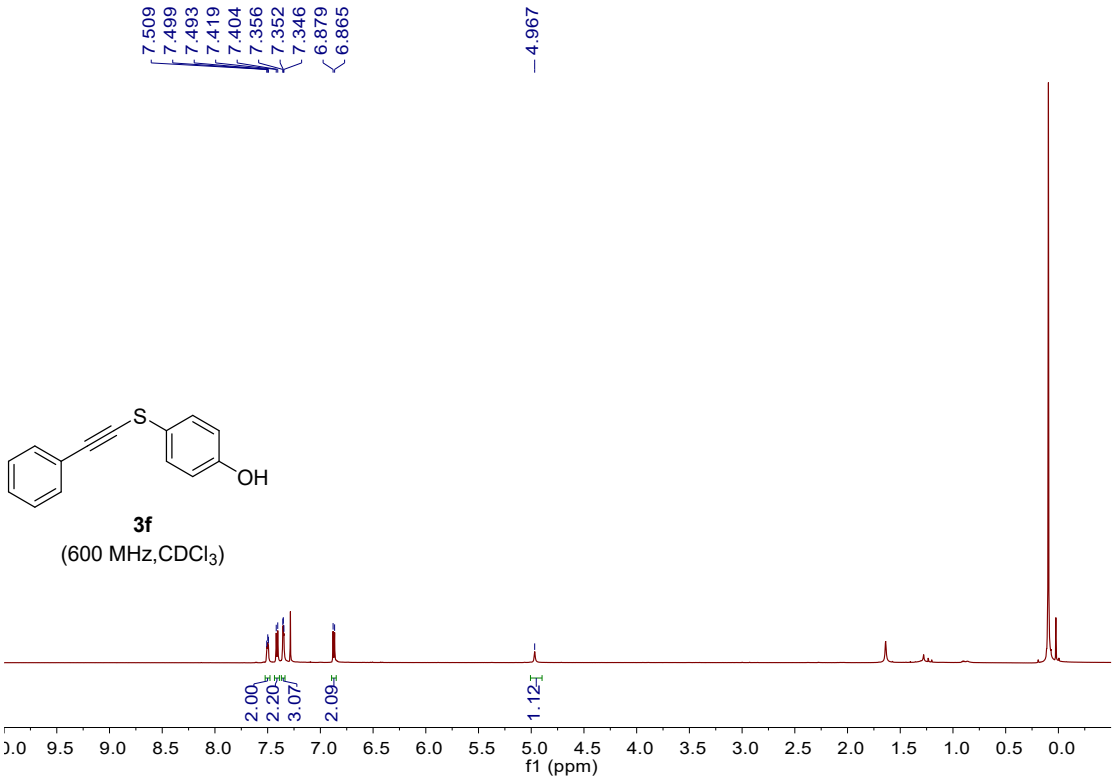

154.19
127.54
127.37
126.25
125.52
122.03
120.66
109.38
97.41
74.24
54.92
OMe
S
3c
(150 MHz,CDCl3)
f1 (ppm)


7.976
7.864
7.850
7.840
7.820
7.807
7.593
7.584
7.570
7.539
7.526
7.514
7.502
7.488
7.477
7.402
7.397
7.392
S
3d
(600 MHz,CDCl3)
1.00
2.18
1.11
3.18
2.38
3.19
f1 (ppm)


133.778
132.061
131.843
130.264
129.027
128.747
128.468
127.872
127.180
126.897
126.014
124.606
124.176
122.916
98.062
75.493
S
3d
(150 MHz,CDCl3)
f1 (ppm)

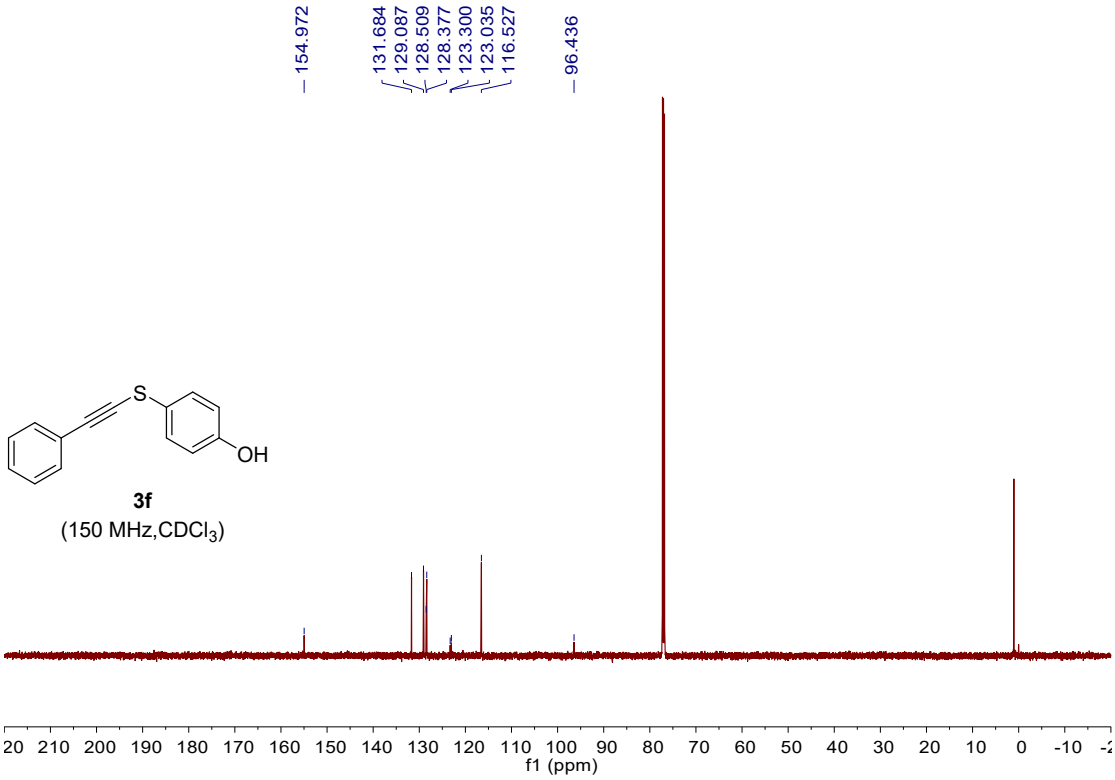

8.151
8.136
7.548
7.533
7.493
7.490
7.480
7.477
7.445
7.442
7.434
7.429
7.350
7.336
7.329
7.316
7.289
7.286
7.262
7.248
S
Cl
3e
(600 MHz,CDCl3)
1.00
0.94
0.94
1.25
1.95
2.22
1.22
f1 (ppm)


131.03
130.80
128.43
128.37
127.85
127.56
127.43
126.45
124.68
123.28
97.37
73.73
S
Cl
3e
(150 MHz,CDCl3)
f1 (ppm)



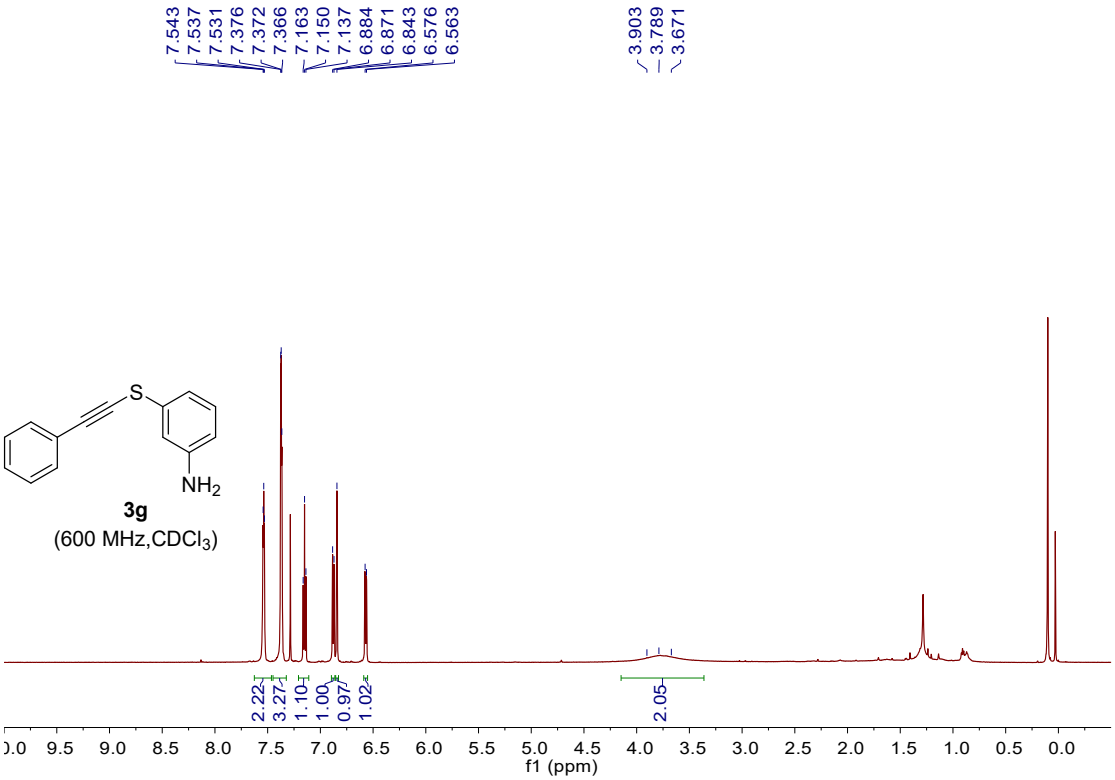
3f

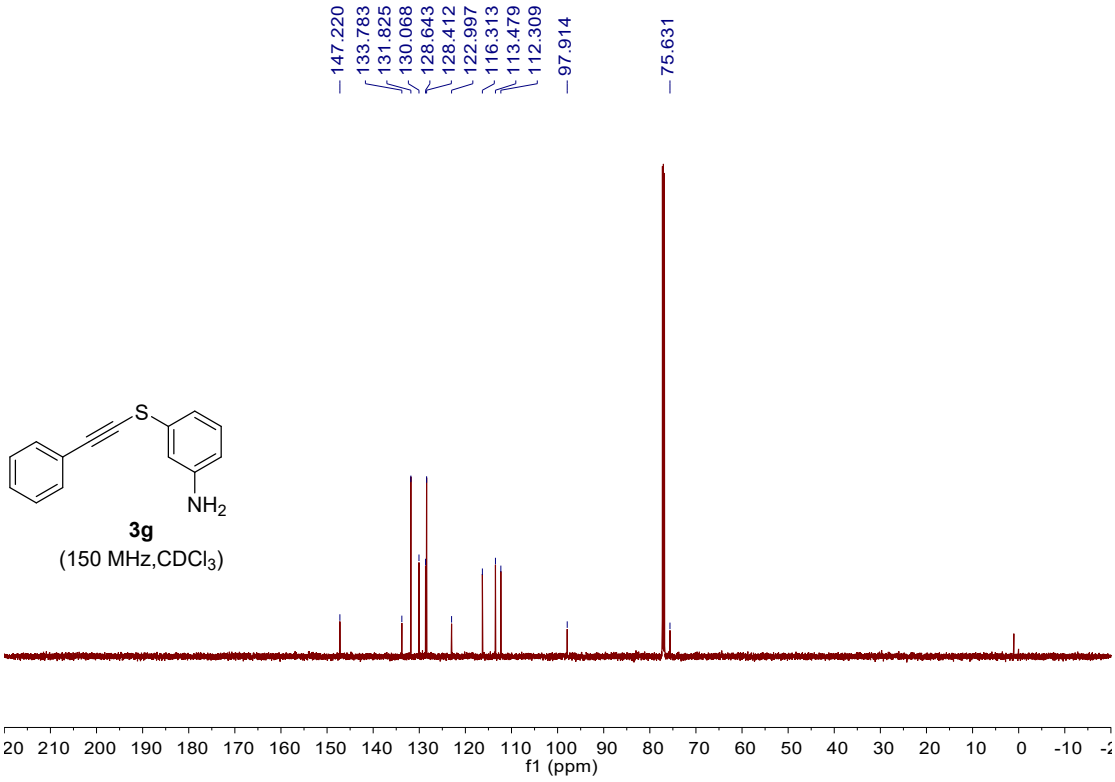
(600 MHz,$CDCl_3$)

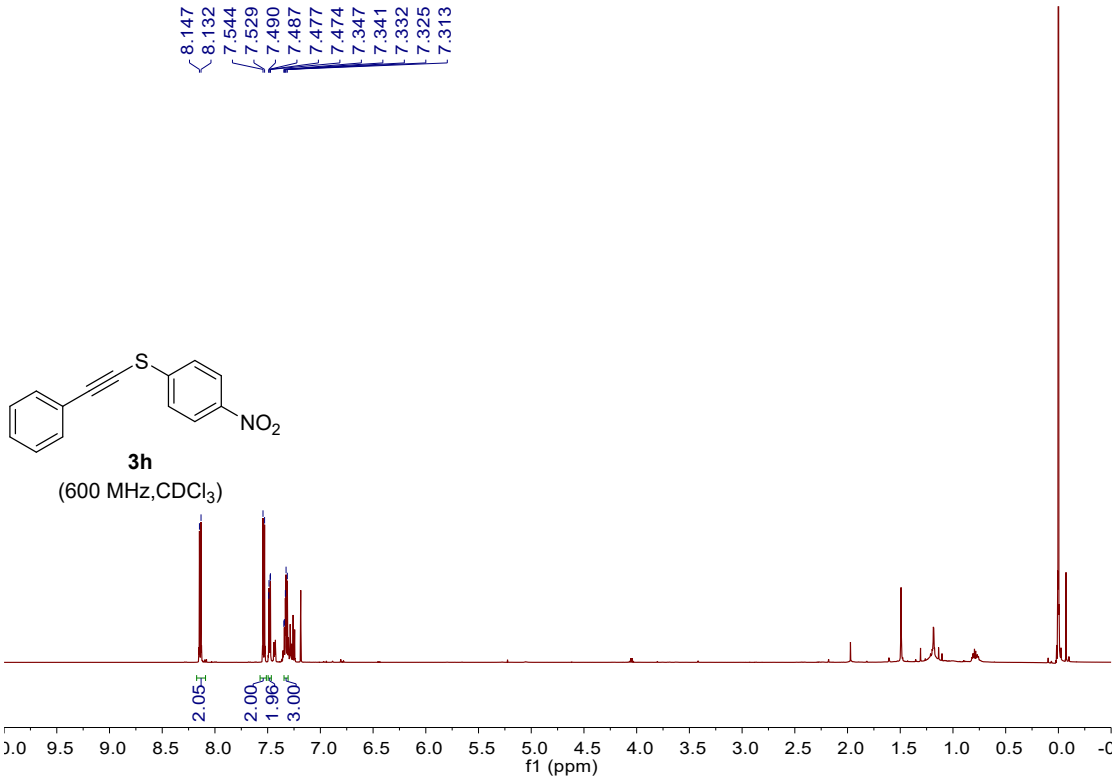


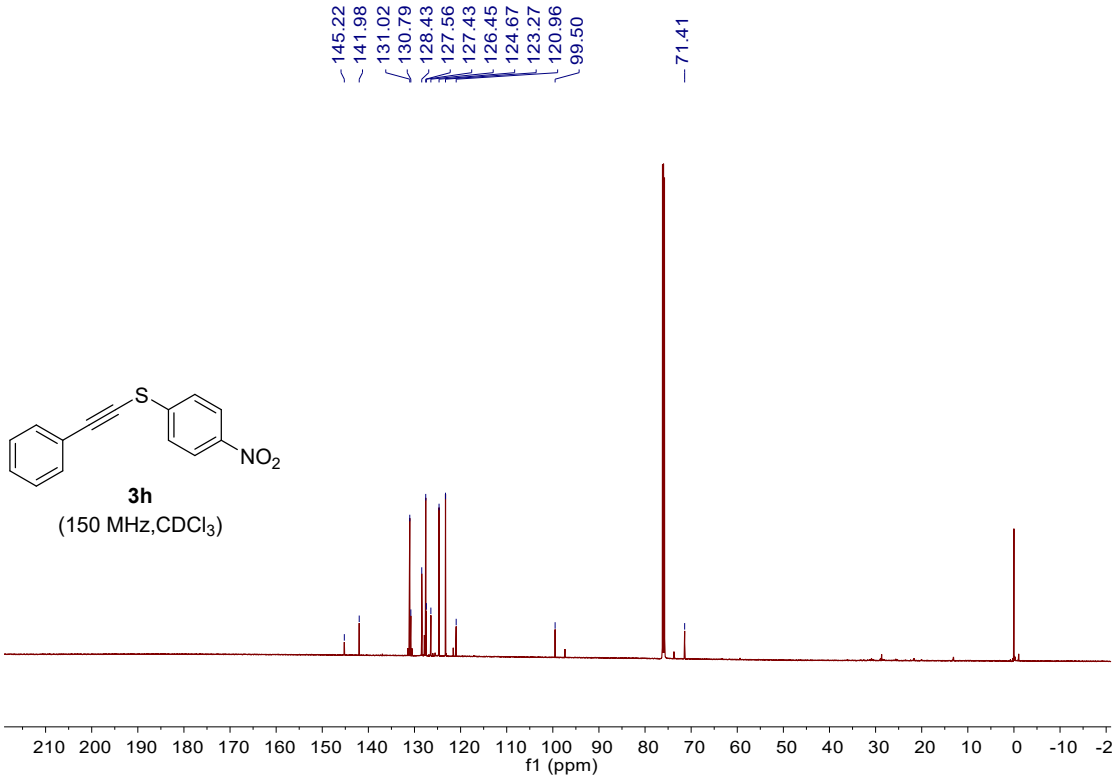
3f

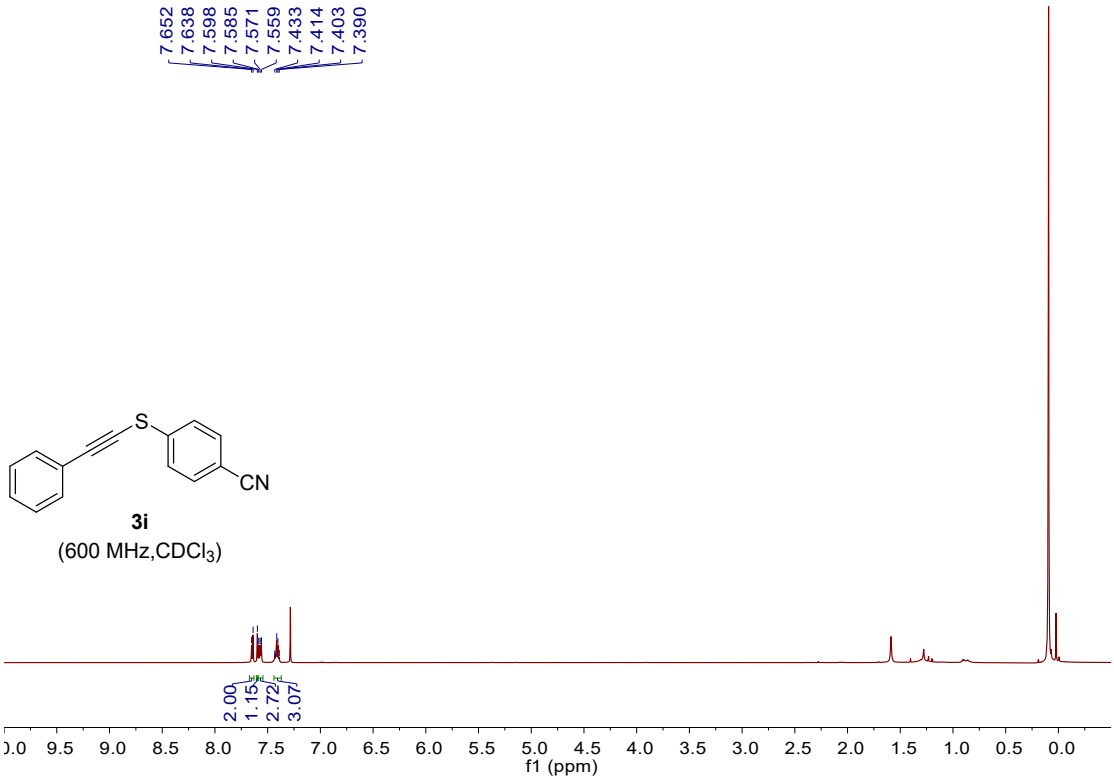
(150 MHz,$CDCl_3$)


7.543
7.537
7.531
7.376
7.372
7.366
7.163
7.150
7.137
6.884
6.871
6.843
6.576
6.563
3.903
3.789
3.671
S
NH2
3g
(600 MHz,CDCl3)
2.22
3.27
1.10
1.00
0.97
1.02
2.05
f1 (ppm)


147.220
133.783
131.825
130.068
128.643
128.412
122.997
116.313
113.479
112.309
97.914
75.631
S
NH2
3g
(150 MHz,CDCl3)
f1 (ppm)

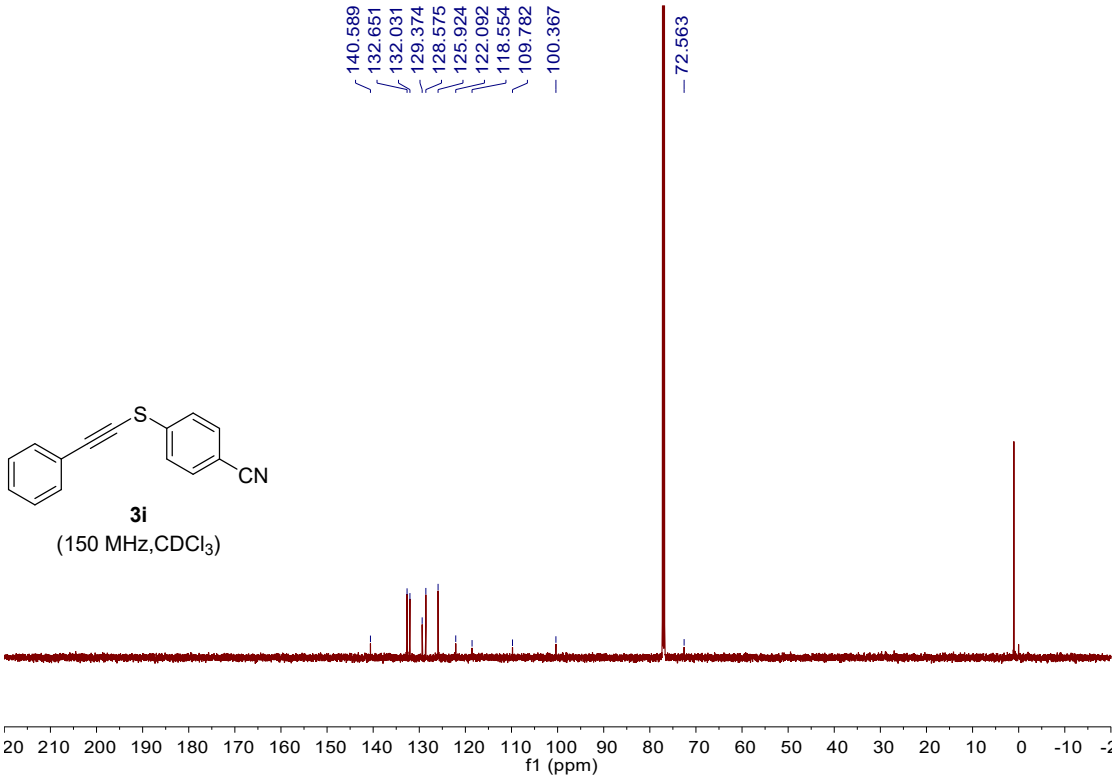

8.147
8.132
7.544
7.529
7.490
7.487
7.477
7.474
7.347
7.341
7.332
7.325
7.313
S
NO2
3h
(600 MHz,CDCl3)
2.05
2.00
1.96
3.00
f1 (ppm)


145.22
141.98
131.02
130.79
128.43
127.56
127.43
126.45
124.67
123.27
120.96
99.50
71.41
S
NO2
3h
(150 MHz,CDCl3)
f1 (ppm)



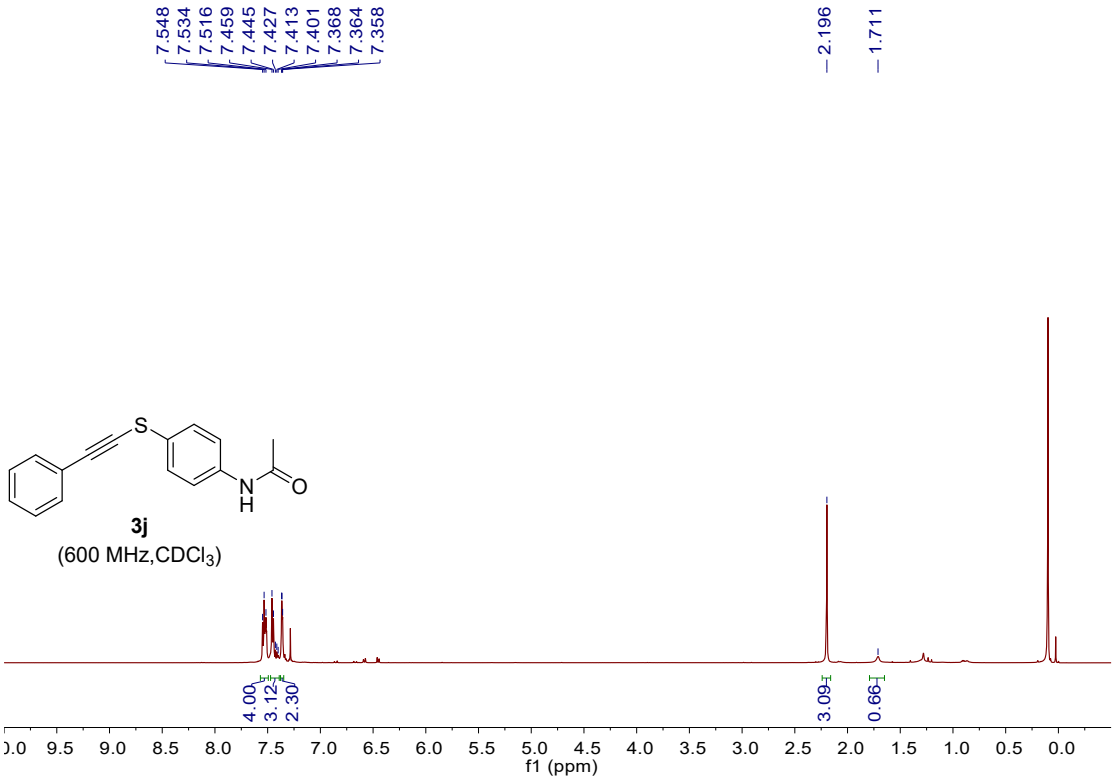
3i

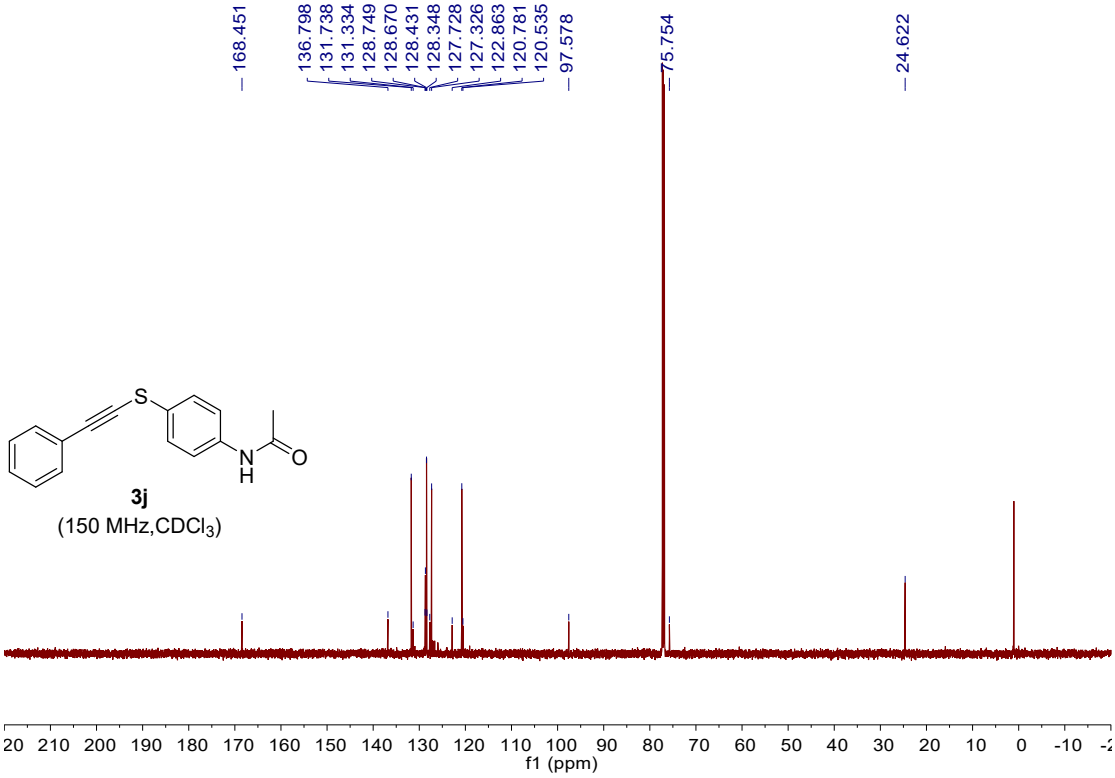
(600 MHz,$CDCl_3$)

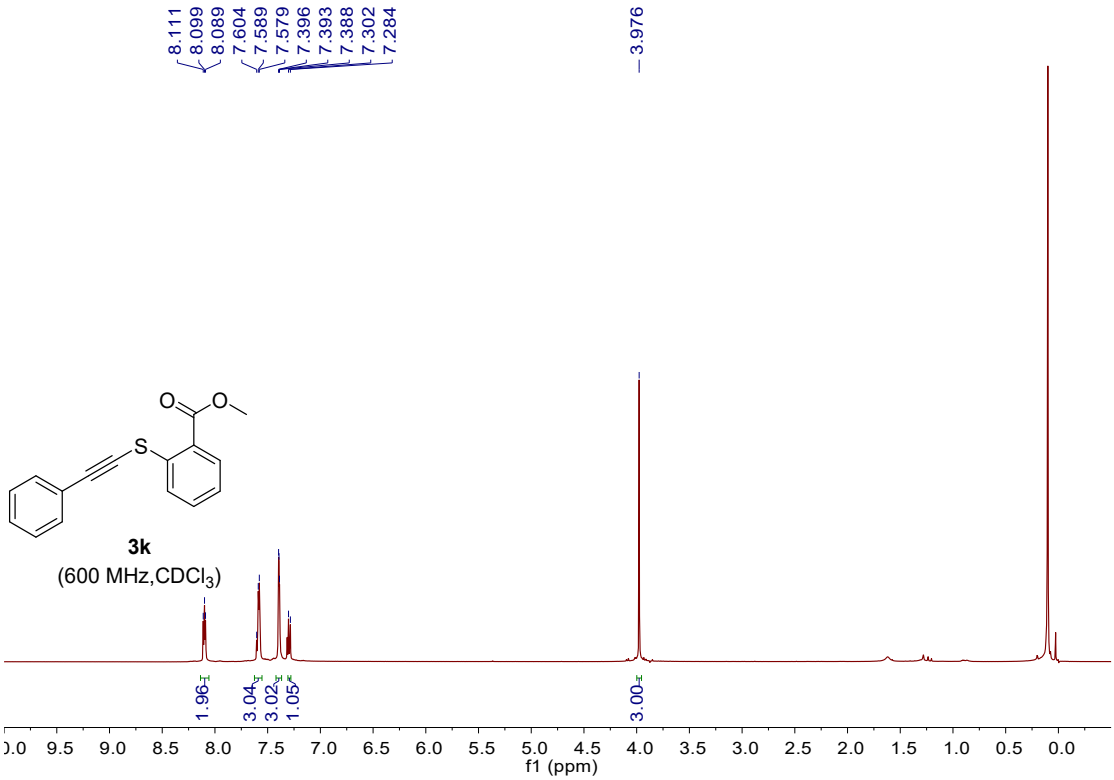


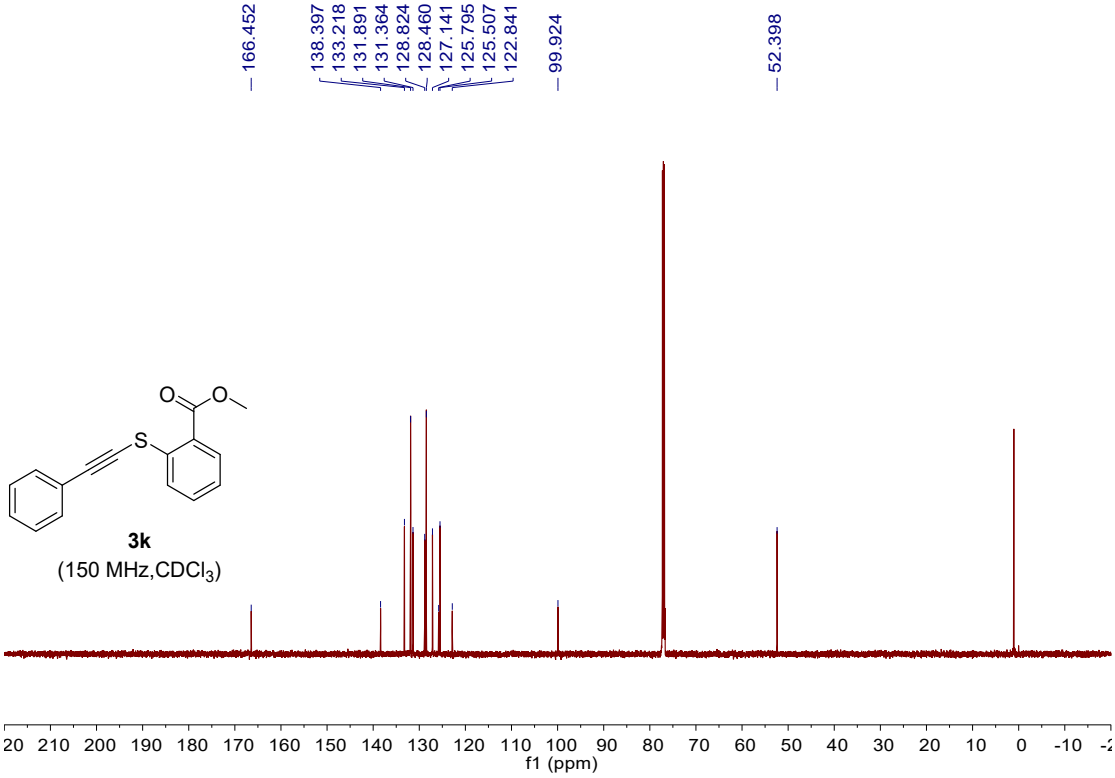
3i

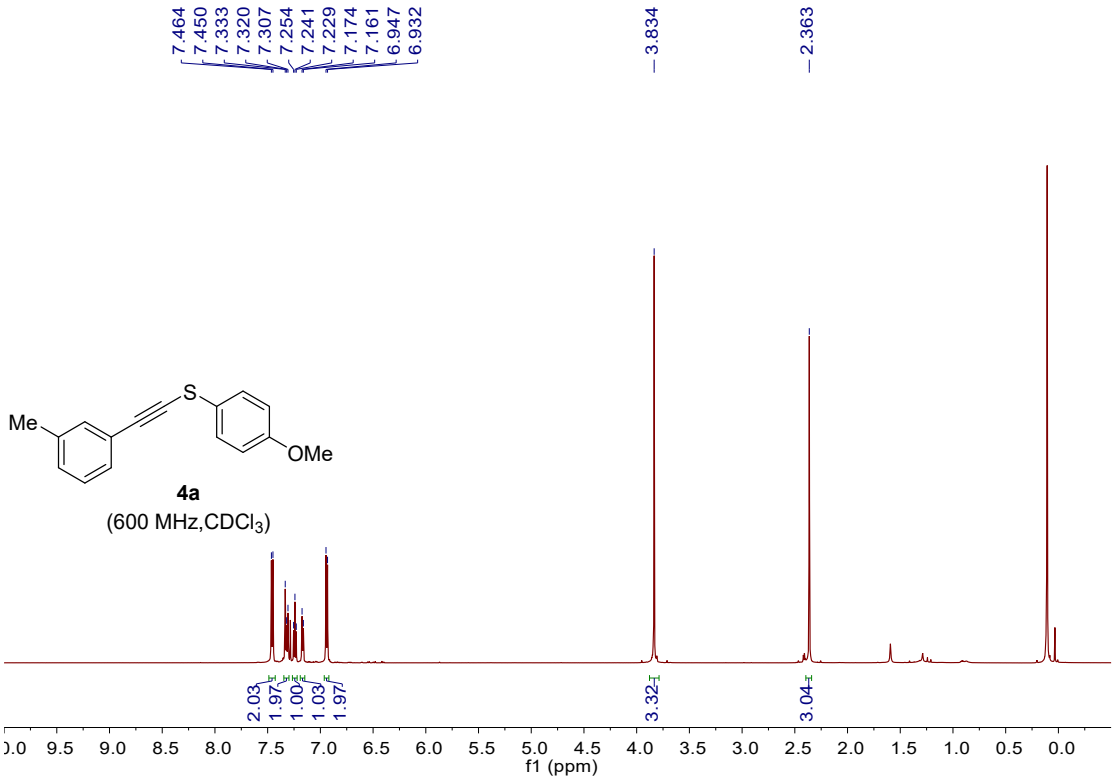
(150 MHz,$CDCl_3$)

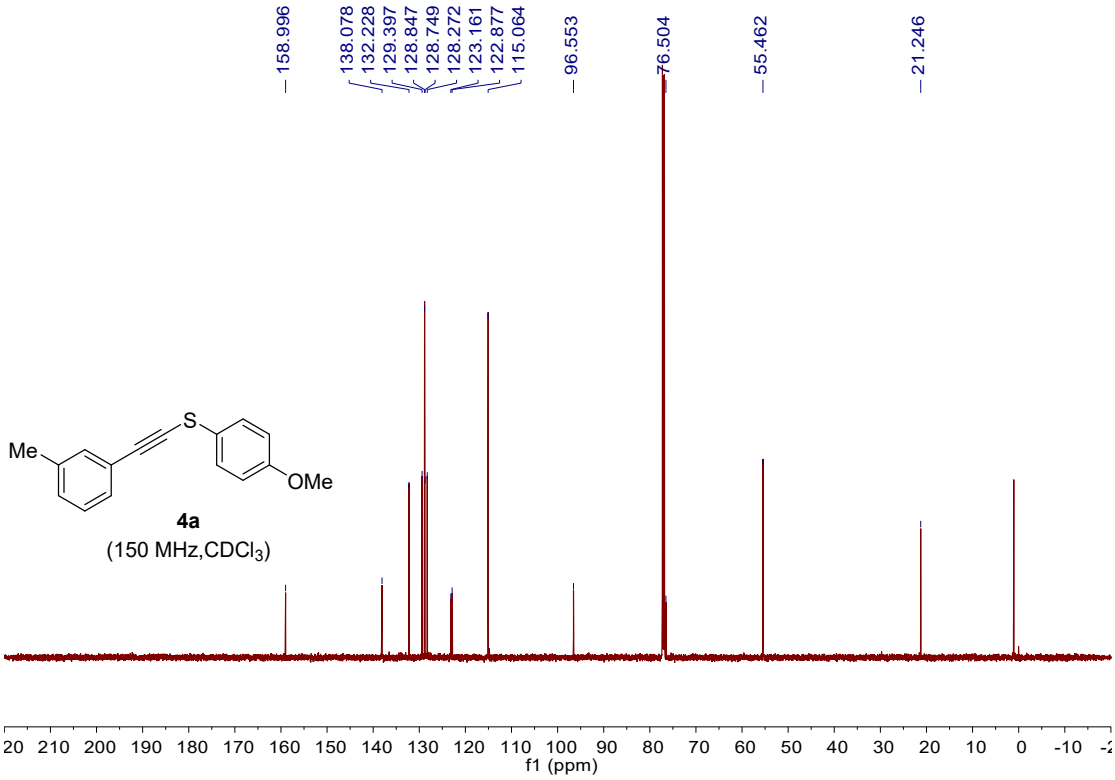

7.548
7.534
7.516
7.459
7.445
7.427
7.413
7.401
7.368
7.364
7.358
2.196
1.711
S
N
H
O
3j
(600 MHz,CDCl3)
4.00
3.12
2.30
3.09
0.66
f1 (ppm)

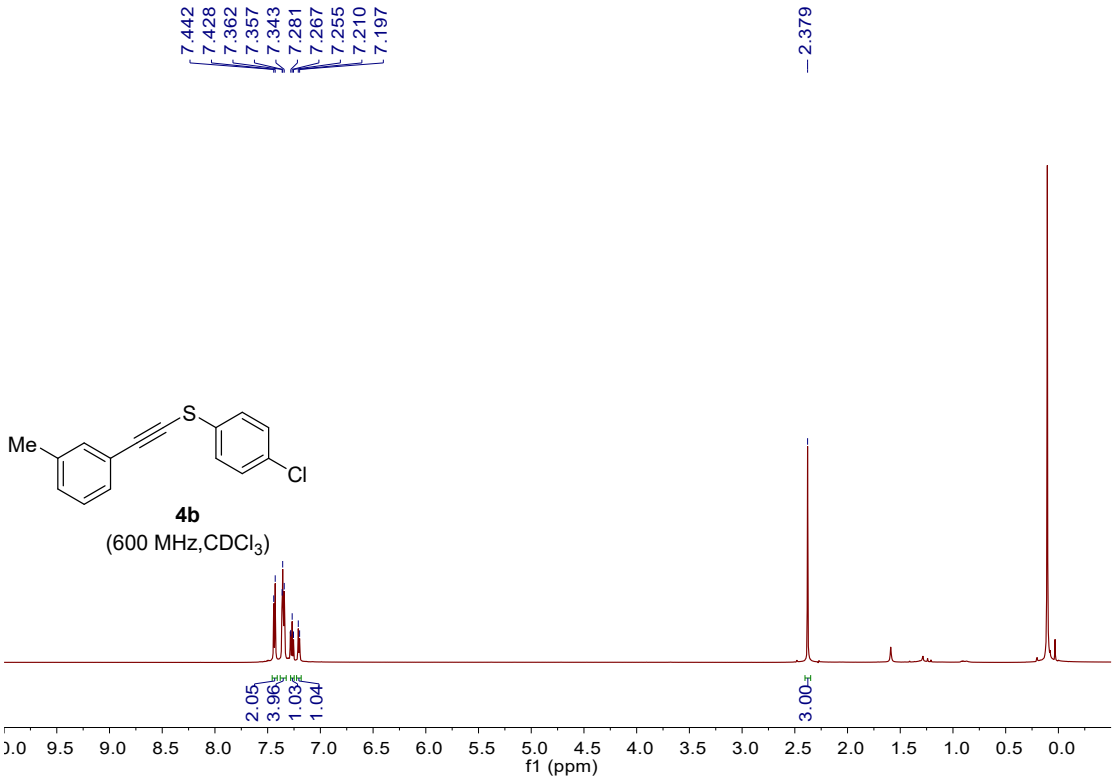

168.451
136.798
131.738
131.334
128.749
128.670
128.431
128.348
127.728
127.326
122.863
120.781
120.535
97.578
75.754
24.622
S
N
H
O
3j
(150 MHz,CDCl3)
f1 (ppm)

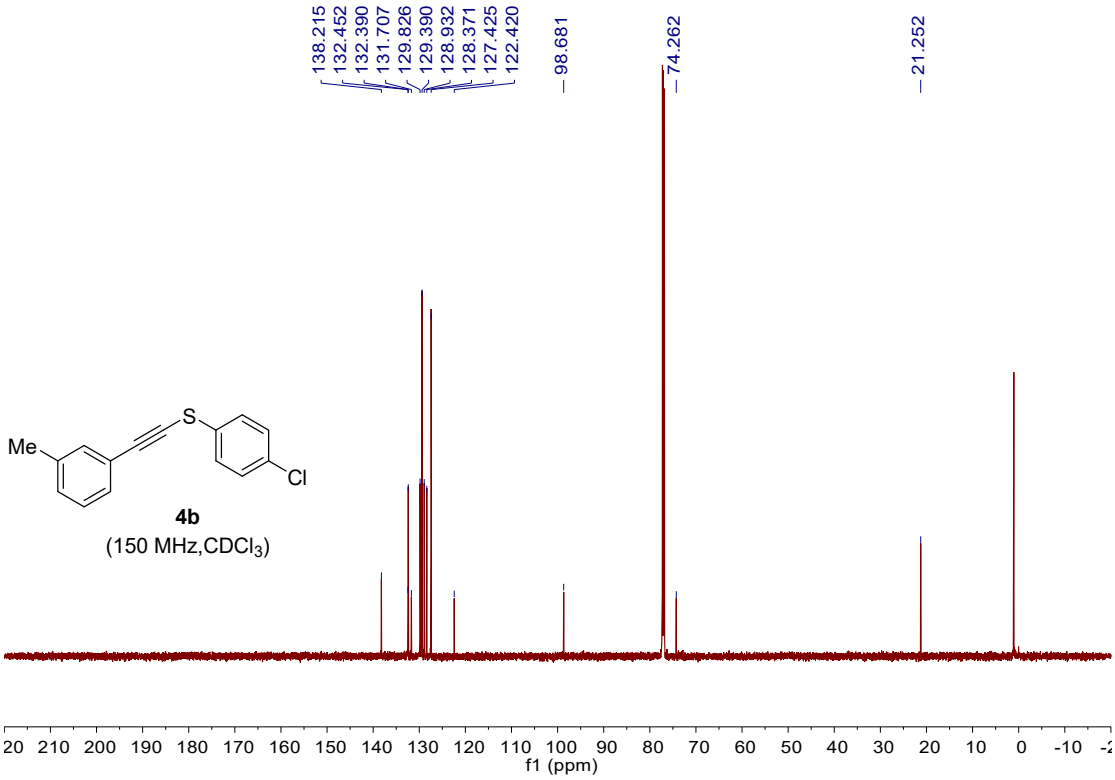

8.111
8.099
8.089
7.604
7.589
7.579
7.396
7.393
7.388
7.302
7.284
3.976
O
O
S
3k
(600 MHz,CDCl3)
1.96
3.04
3.02
1.05
3.00
f1 (ppm)

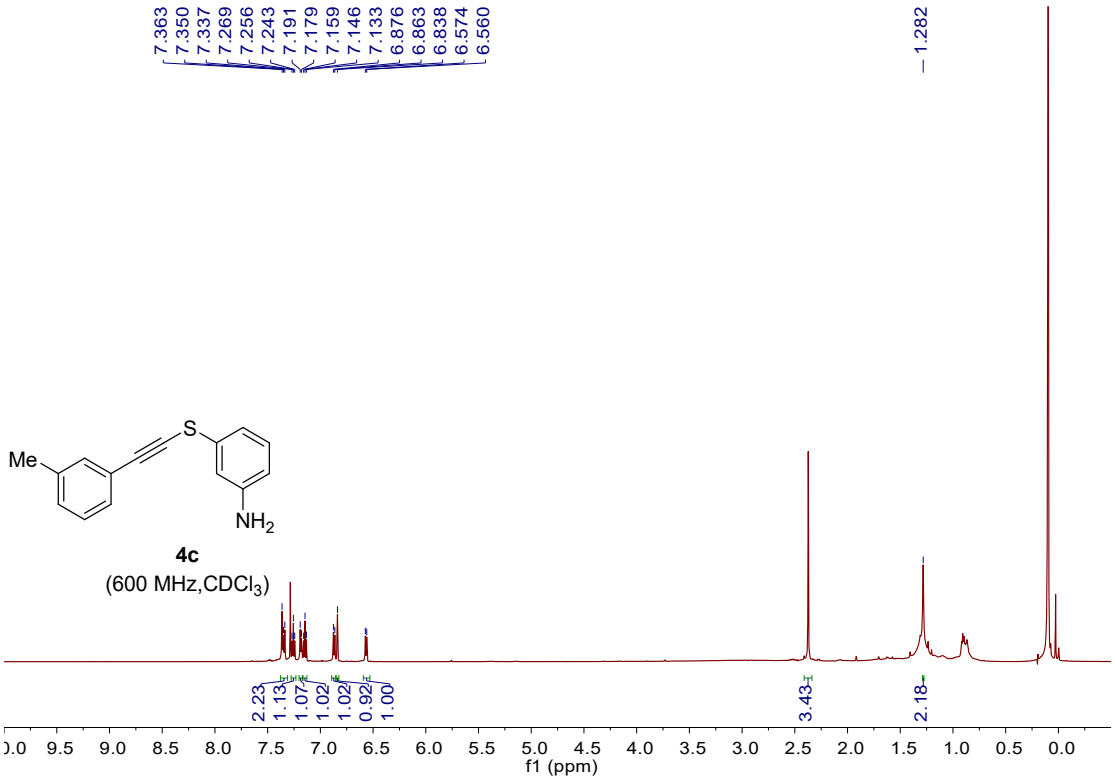

166.452
138.397
133.218
131.891
131.364
128.824
128.460
127.141
125.795
125.507
122.841
99.924
52.398
O
O
S
3k
(150 MHz,CDCl3)
f1 (ppm)

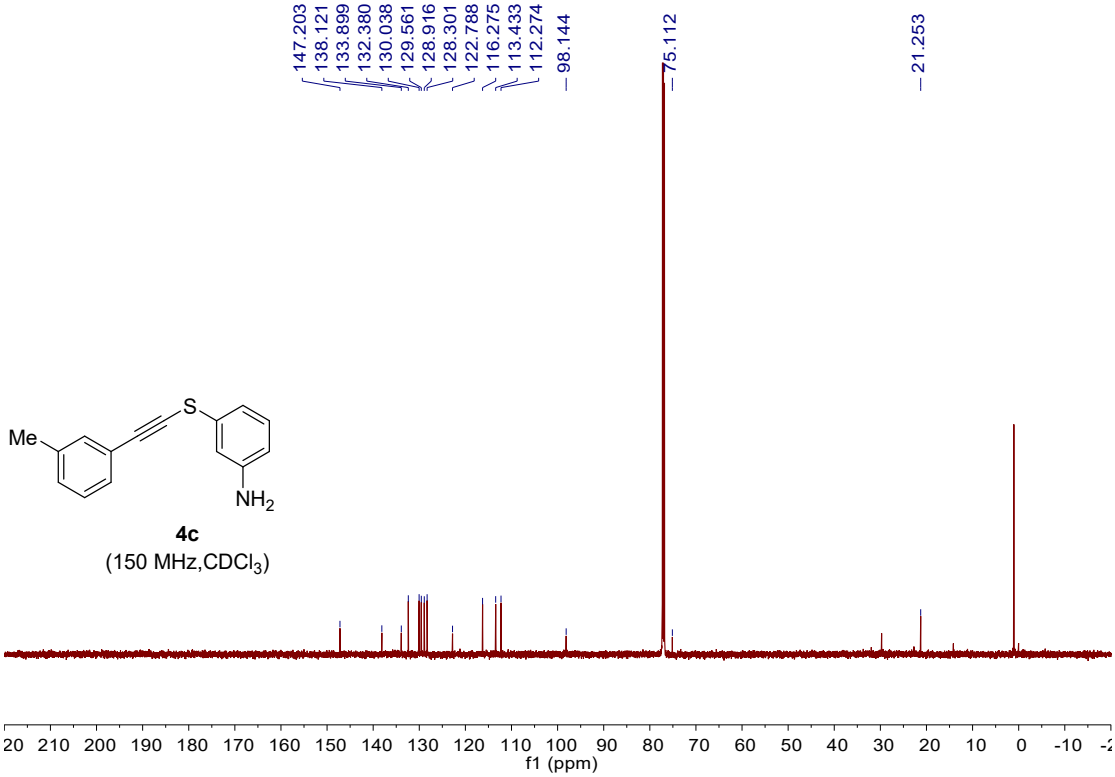

7.464
7.450
7.333
7.320
7.307
7.254
7.241
7.229
7.174
7.161
6.947
6.932
3.834
2.363
Me
S
OMe
4a
(600 MHz,CDCl3)
2.03
1.97
1.00
1.03
1.97
3.32
3.04
f1 (ppm)

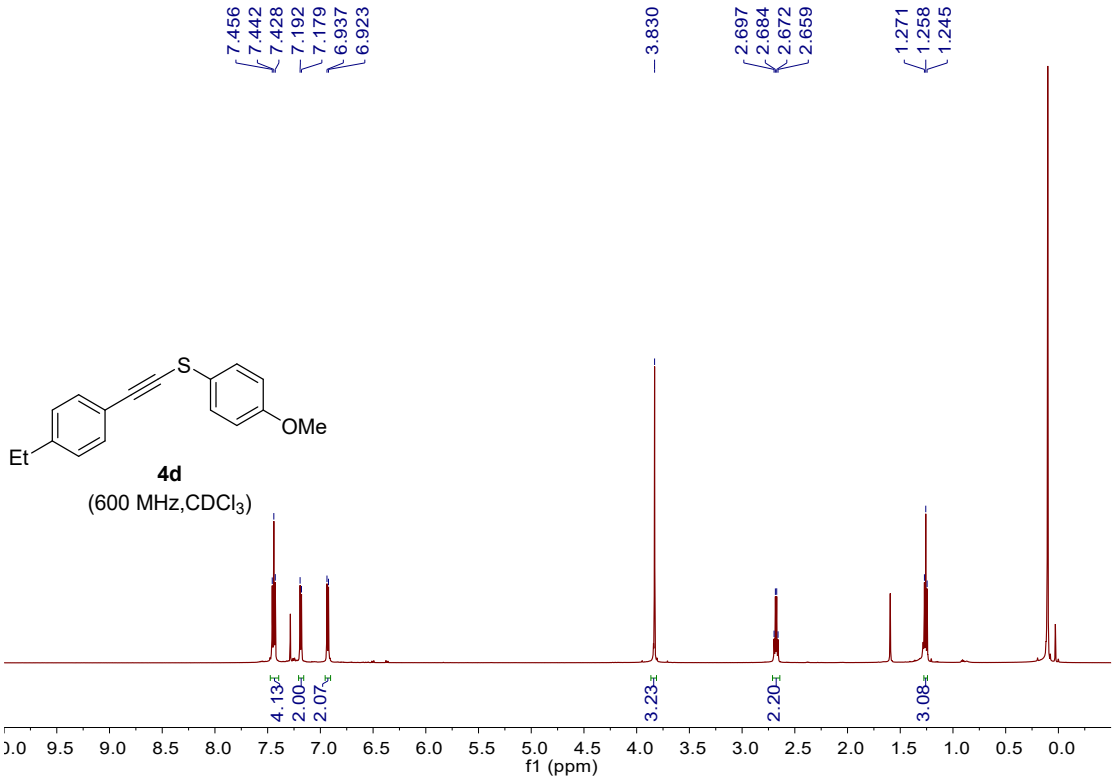

158.996
138.078
132.228
129.397
128.847
128.749
128.272
123.161
122.877
115.064
96.553
76.504
55.462
21.246
Me
S
OMe
4a
(150 MHz,CDCl3)
f1 (ppm)

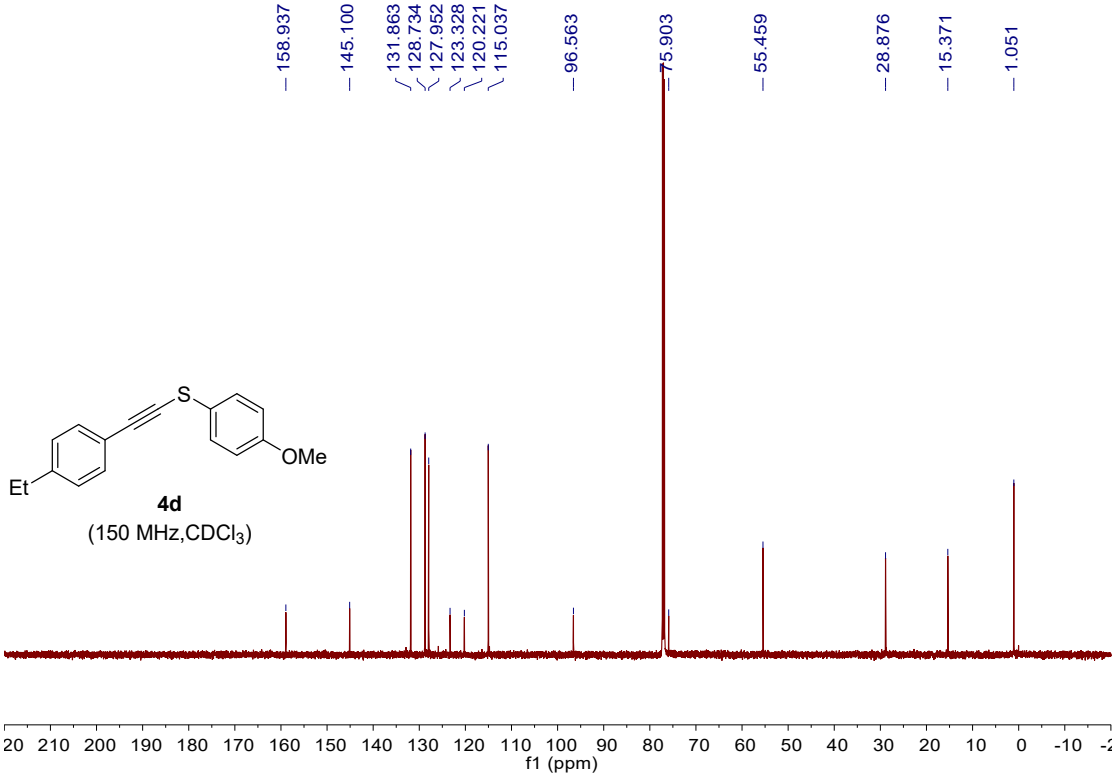

7.442
7.428
7.362
7.357
7.343
7.281
7.267
7.255
7.210
7.197
2.379
Me
S
Cl
4b
(600 MHz,CDCl3)
2.05
3.96
1.03
1.04
3.00
f1 (ppm)

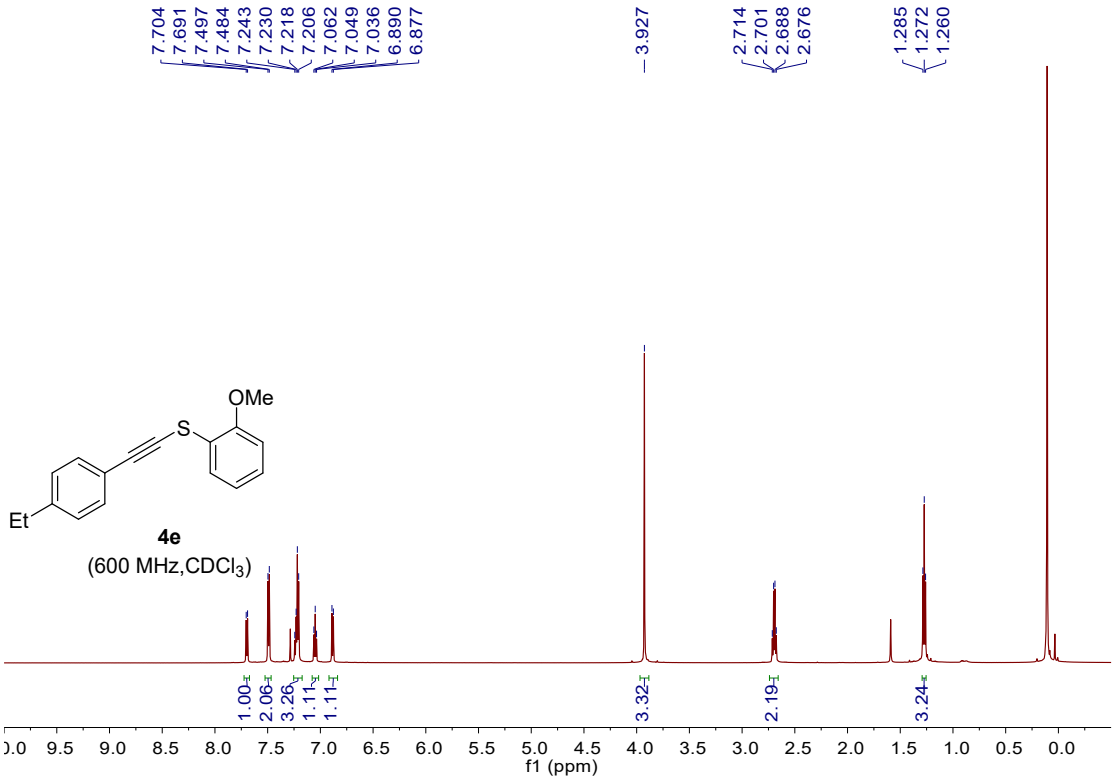

138.215
132.452
132.390
131.707
129.826
129.390
128.932
128.371
127.425
122.420
98.681
74.262
21.252
Me
S
Cl
4b
(150 MHz,CDCl3)
f1 (ppm)

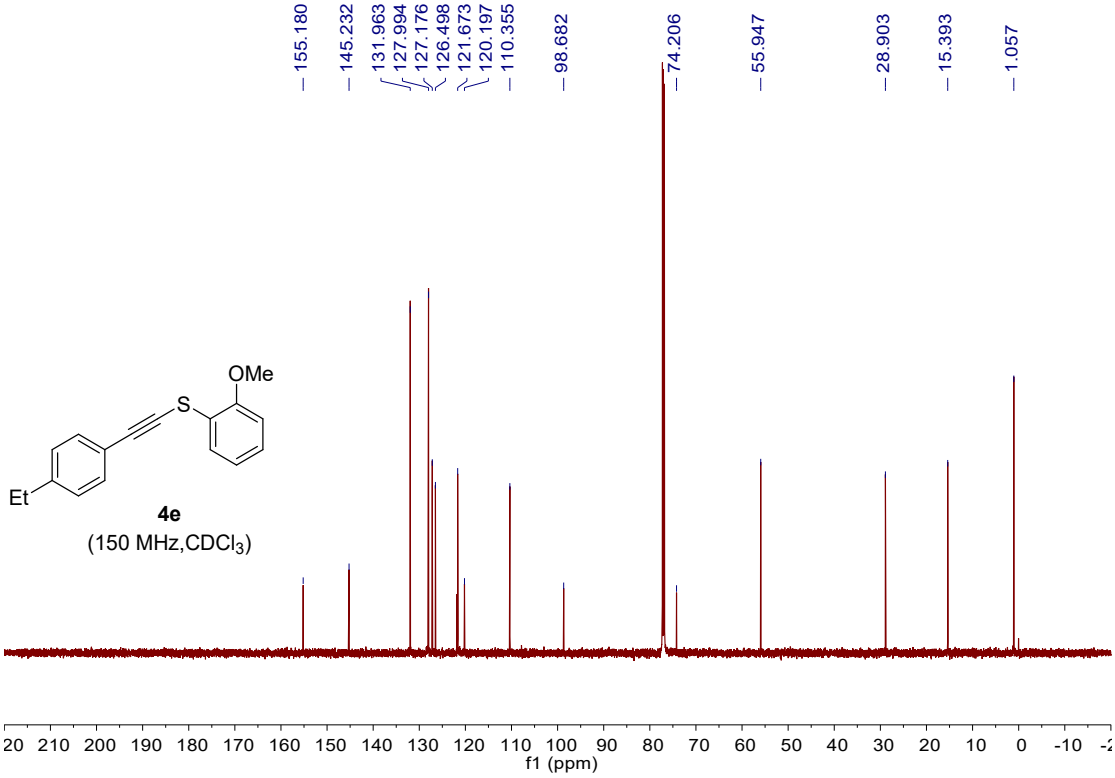

7.363
7.350
7.337
7.269
7.256
7.243
7.191
7.179
7.159
7.146
7.133
6.876
6.863
6.838
6.574
6.560
1.282
Me
S
NH2
4c
(600 MHz,CDCl3)
2.23
1.13
1.07
1.02
1.02
0.92
1.00
3.43
2.18
f1 (ppm)

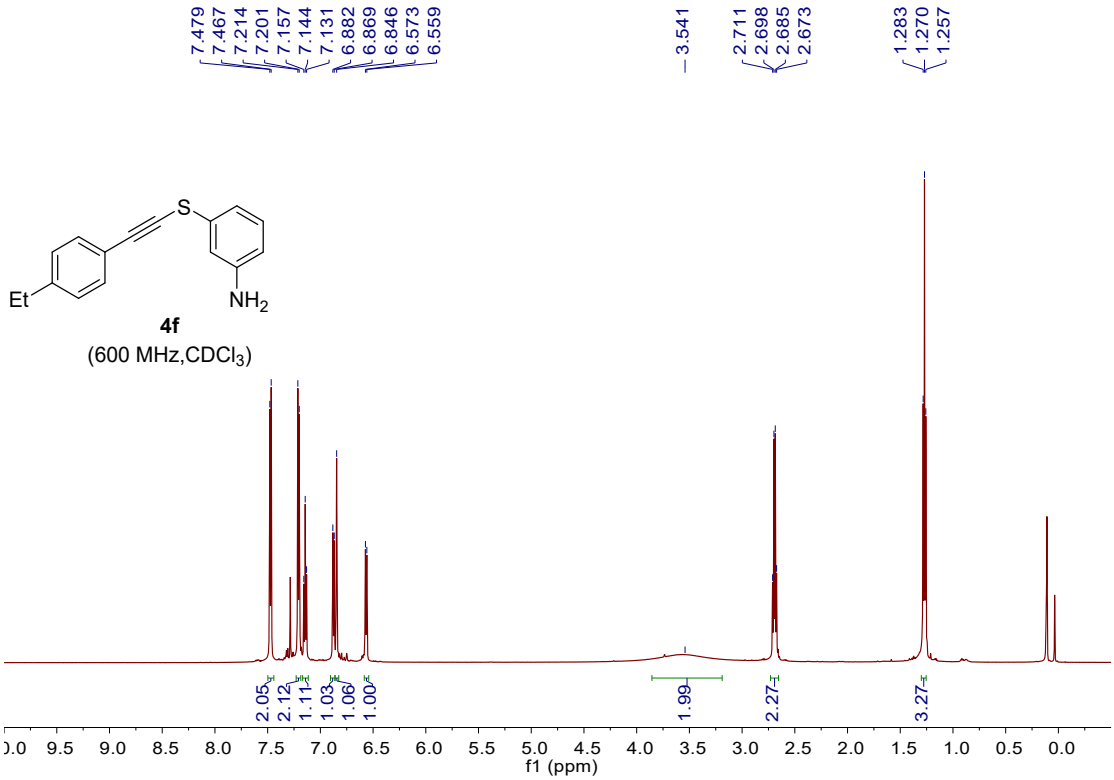

147.203
138.121
133.899
132.380
130.038
129.561
128.916
128.301
122.788
116.275
113.433
112.274
98.144
75.112
21.253
Me
S
NH2
4c
(150 MHz,CDCl3)
f1 (ppm)

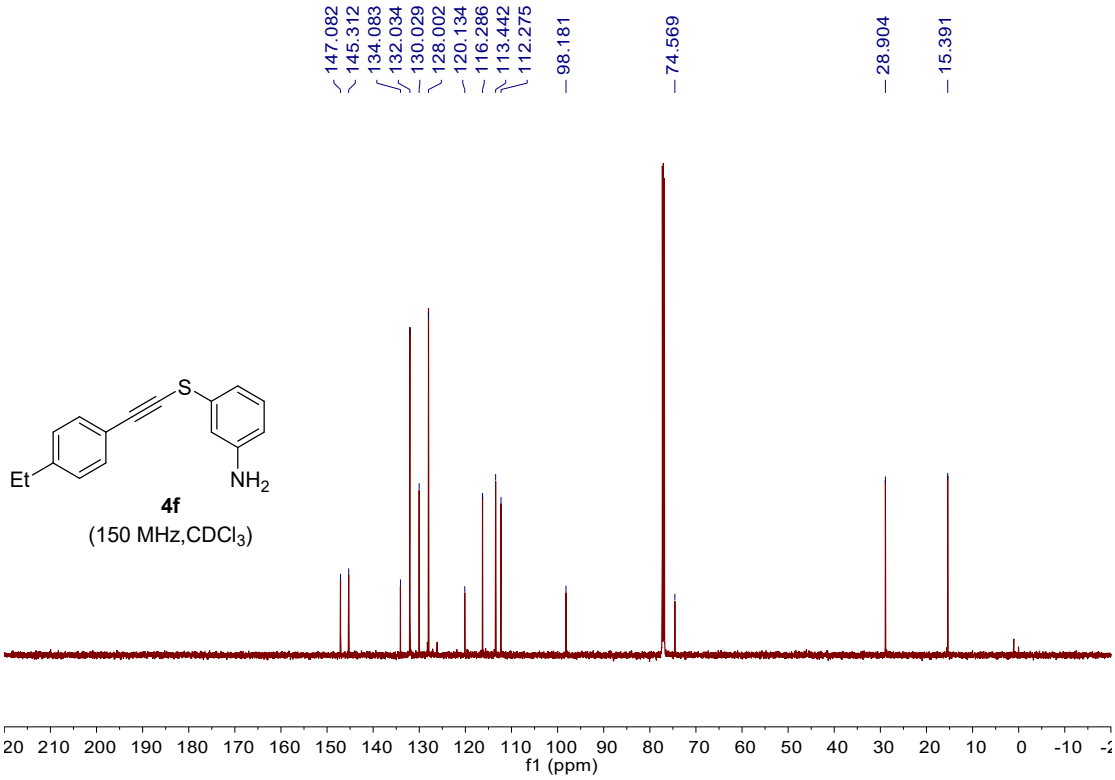

7.456
7.442
7.428
7.192
7.179
6.937
6.923
3.830
2.697
2.684
2.672
2.659
1.271
1.258
1.245
S
OMe
Et
4d
(600 MHz,CDCl3)
4.13
2.00
2.07
3.23
2.20
3.08
f1 (ppm)

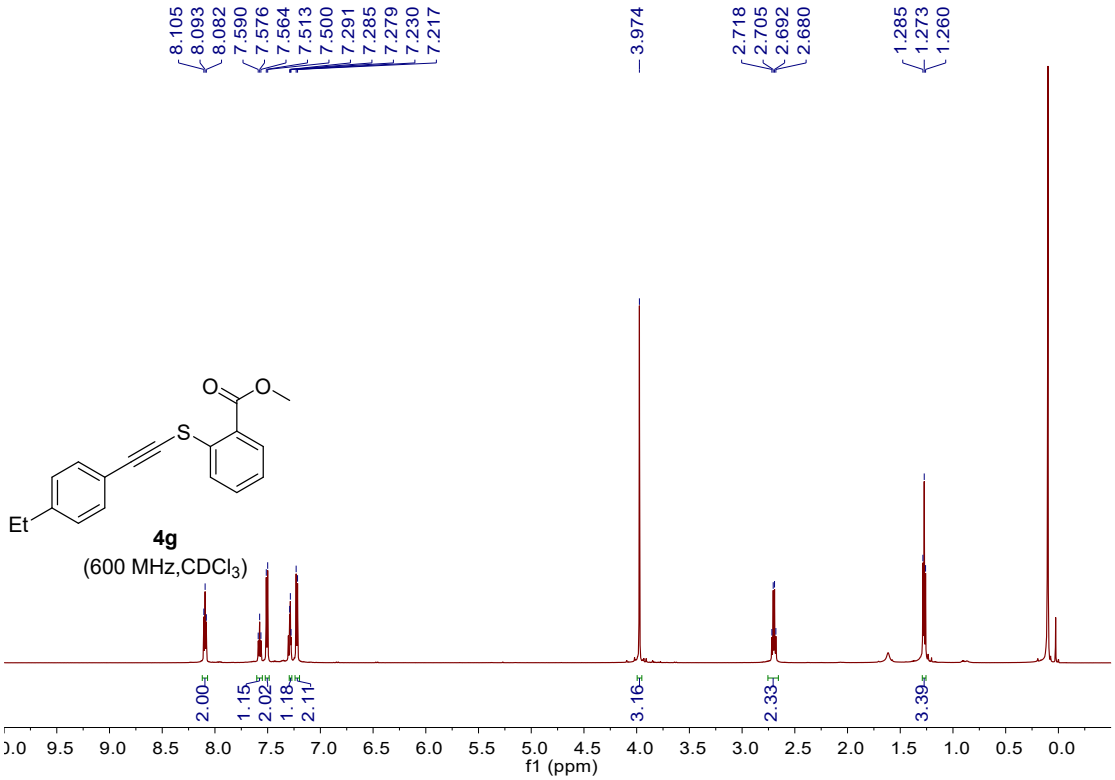

158.937
145.100
131.863
128.734
127.952
123.328
120.221
115.037
96.563
75.903
55.459
28.876
15.371
1.051
S
OMe
Et
4d
(150 MHz,CDCl3)
f1 (ppm)

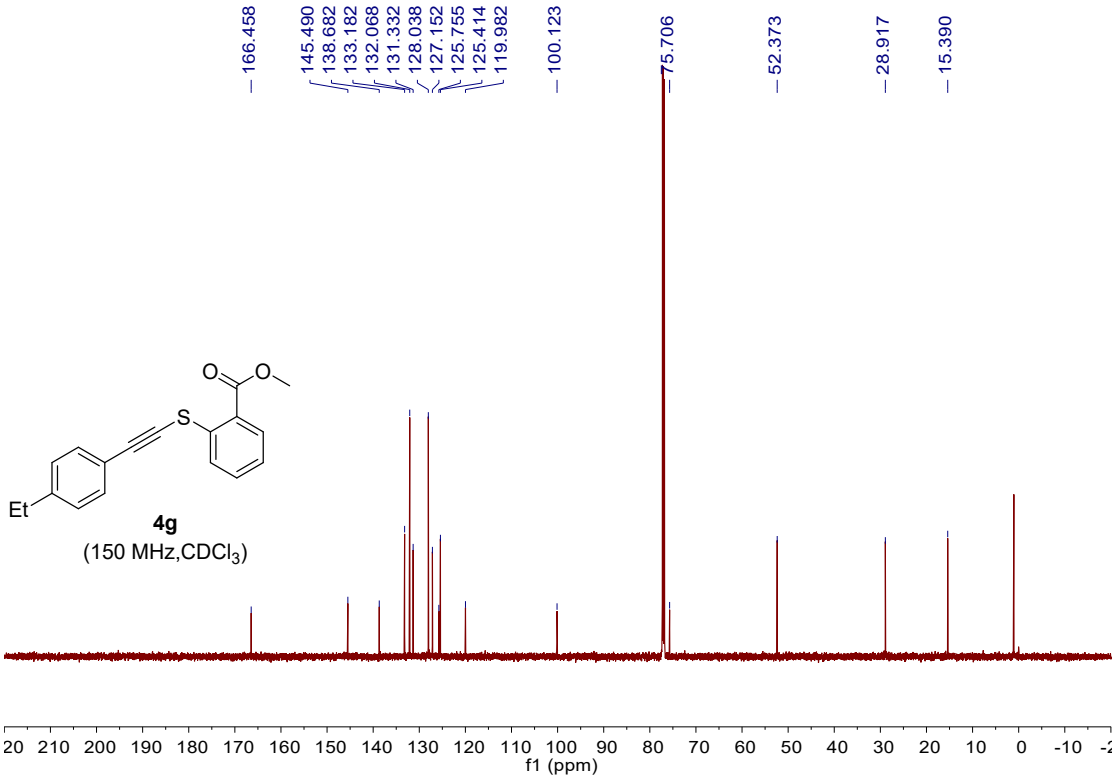

7.704
7.691
7.497
7.484
7.243
7.230
7.218
7.206
7.062
7.049
7.036
6.890
6.877
3.927
2.714
2.701
2.688
2.676
1.285
1.272
1.260
OMe
S
Et
4e
(600 MHz,CDCl3)
1.00
2.06
3.26
1.11
1.11
3.32
2.19
3.24
f1 (ppm)

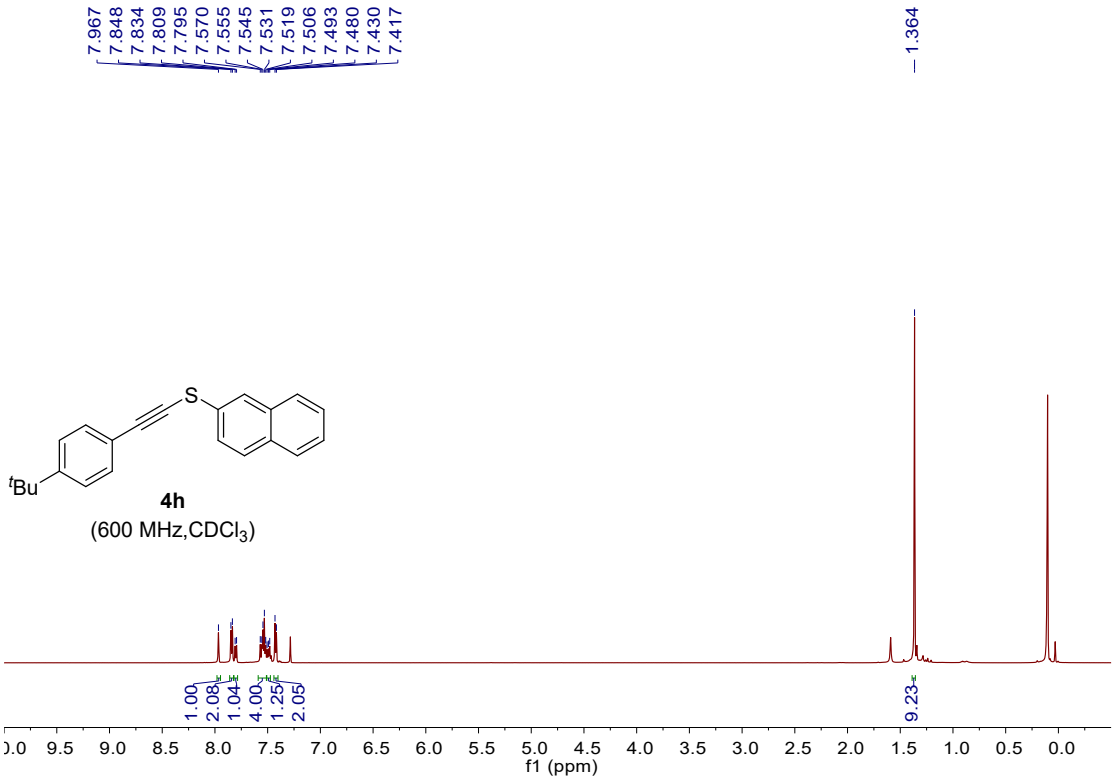

155.180
145.232
131.963
127.994
127.176
126.498
121.673
120.197
110.355
98.682
74.206
55.947
28.903
15.393
1.057
OMe
S
Et
4e
(150 MHz,CDCl3)
f1 (ppm)

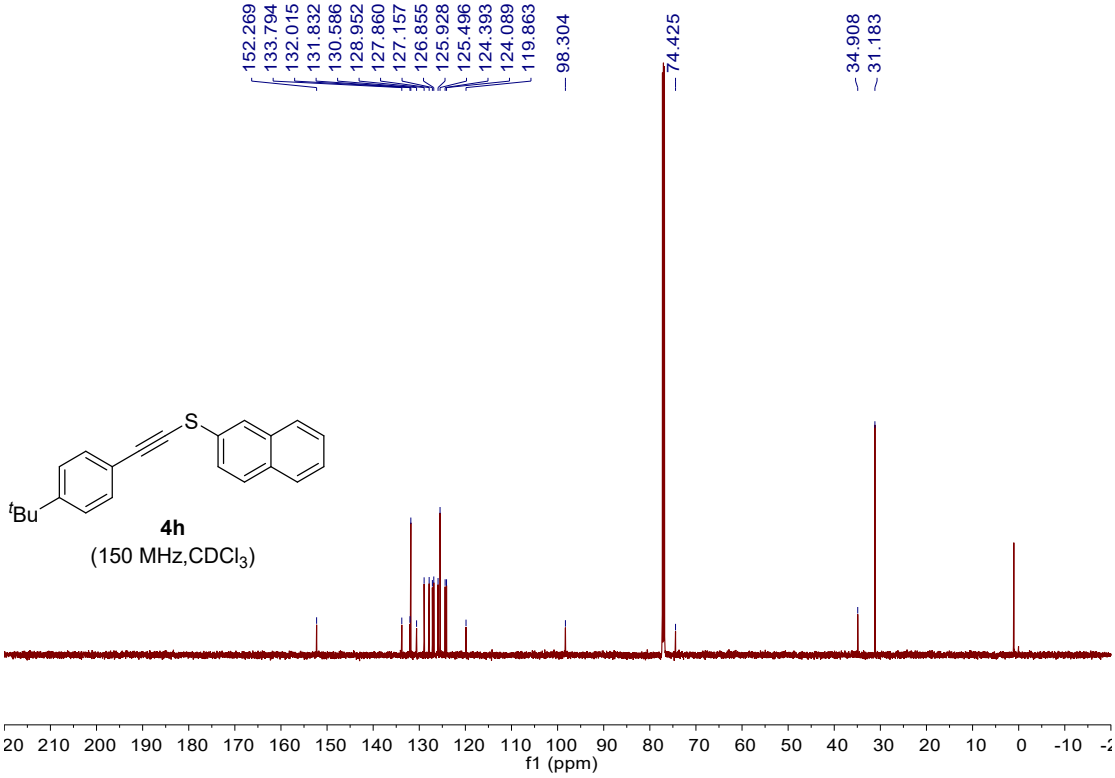

7.479
7.467
7.214
7.201
7.157
7.144
7.131
6.882
6.869
6.846
6.573
6.559
3.541
2.711
2.698
2.685
2.673
1.283
1.270
1.257
S
Et
NH2
4f
(600 MHz,CDCl3)
2.05
2.12
1.11
1.03
1.06
1.00
1.99
2.27
3.27
f1 (ppm)

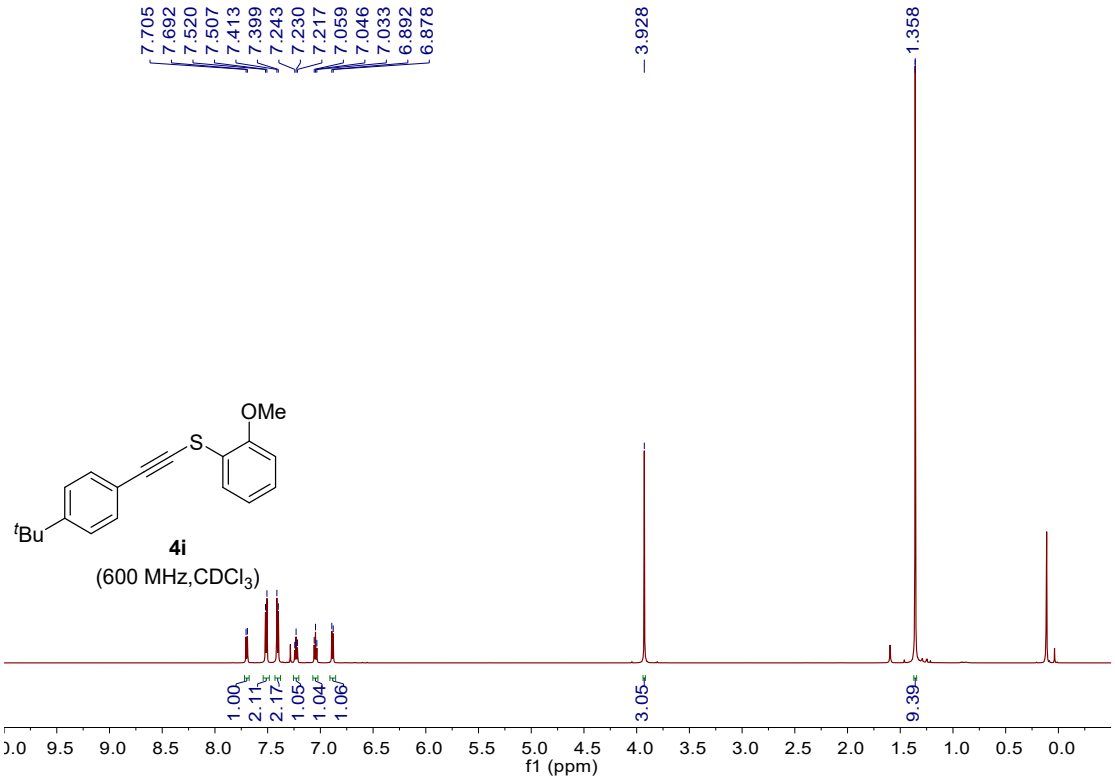

147.082
145.312
134.083
132.034
130.029
128.002
120.134
116.286
113.442
112.275
98.181
74.569
28.904
15.391
S
Et
NH2
4f
(150 MHz,CDCl3)
f1 (ppm)

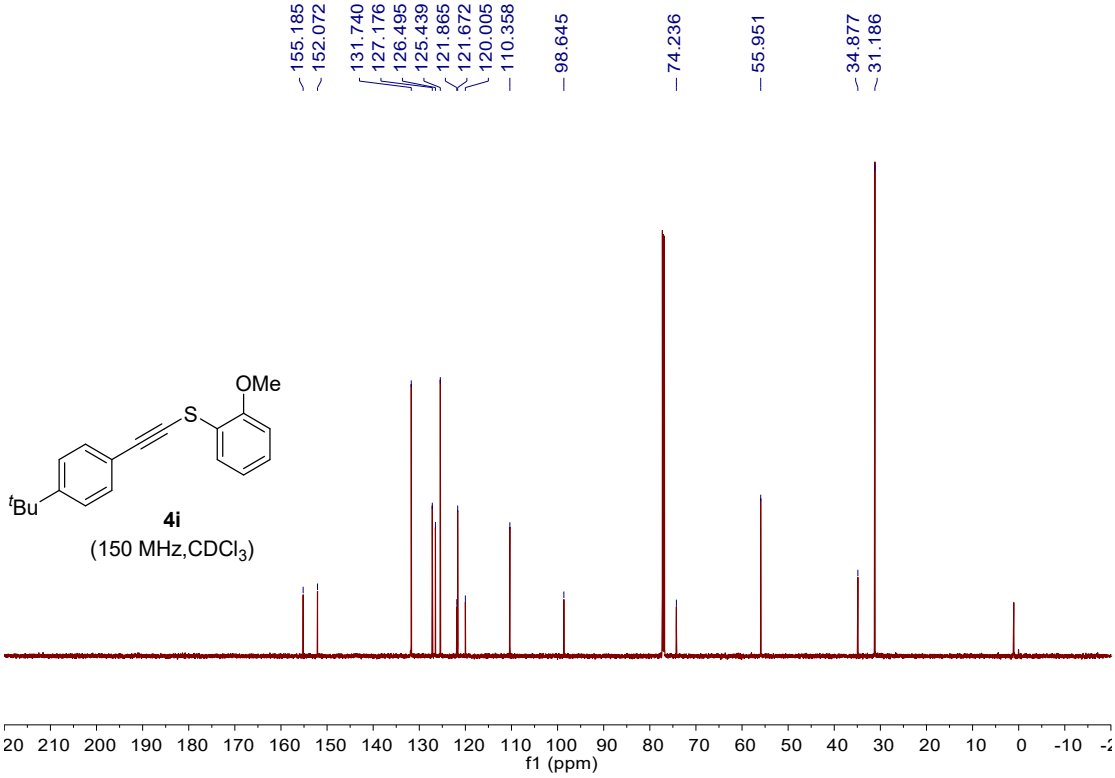

8.105
8.093
8.082
7.590
7.576
7.564
7.513
7.500
7.291
7.285
7.279
7.230
7.217
3.974
2.718
2.705
2.692
2.680
1.285
1.273
1.260
O
O
S
Et
4g
(600 MHz,CDCl3)
2.00
1.15
2.02
1.18
2.11
3.16
2.33
3.39
f1 (ppm)

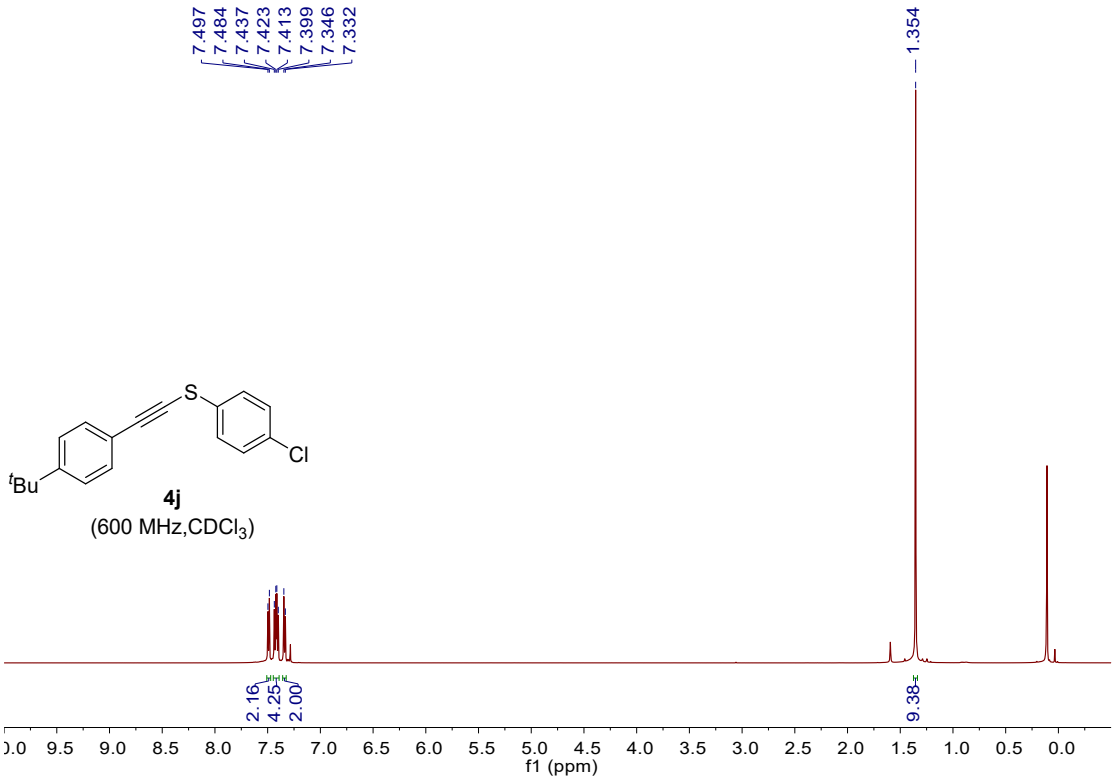

166.458
145.490
138.682
133.182
132.068
131.332
128.038
127.152
125.755
125.414
119.982
100.123
75.706
52.373
28.917
15.390
O
O
S
Et
4g
(150 MHz,CDCl3)
f1 (ppm)

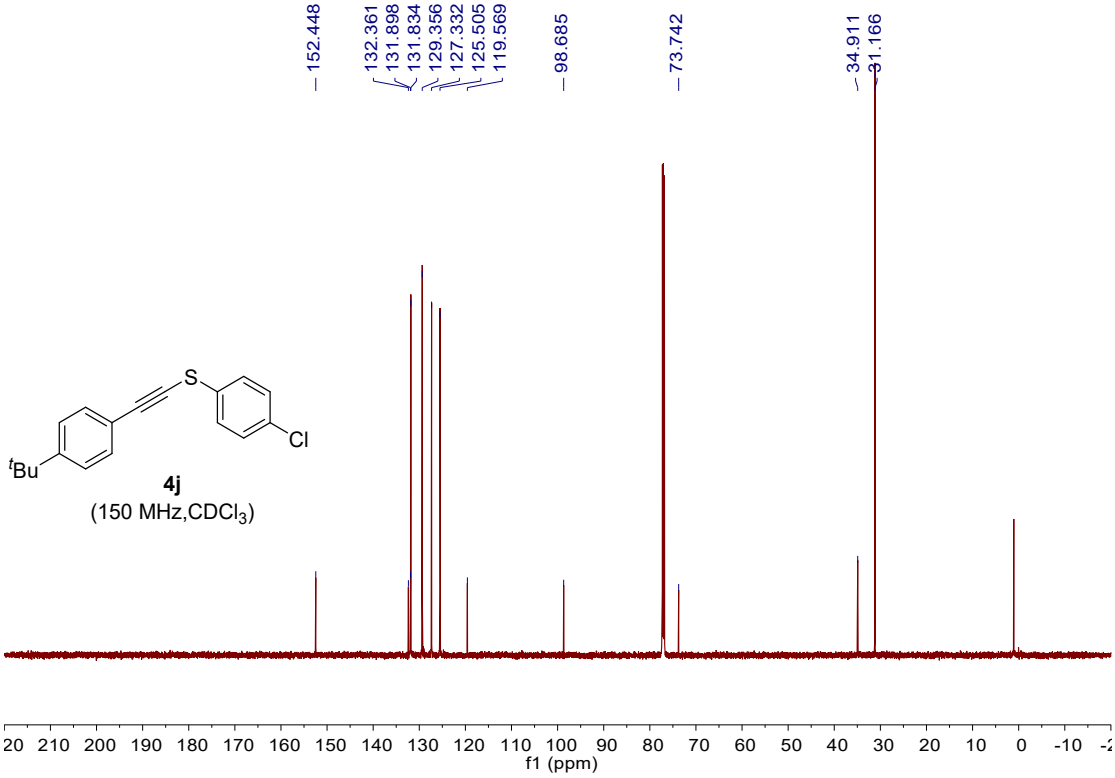

7.967
7.848
7.834
7.809
7.795
7.570
7.555
7.545
7.531
7.519
7.506
7.493
7.480
7.430
7.417
1.364
S
tBu
4h
(600 MHz,CDCl3)
1.00
2.08
1.04
4.00
1.25
2.05
9.23
f1 (ppm)

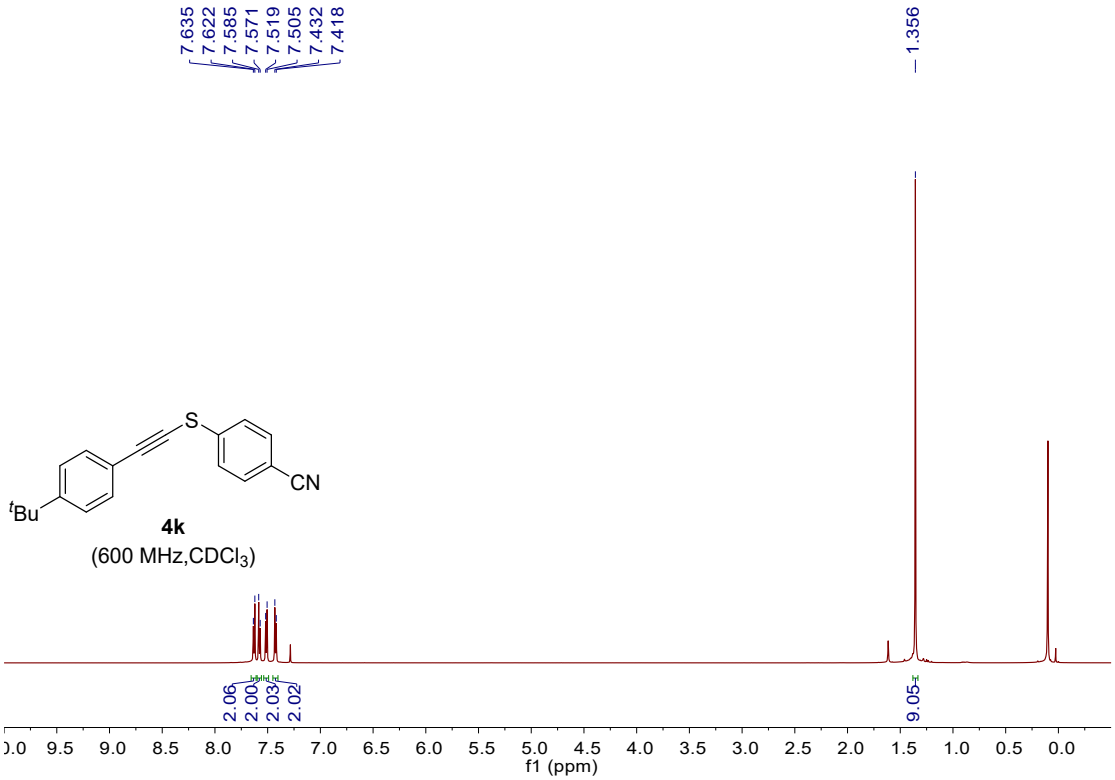

152.269
133.794
132.015
131.832
130.586
128.952
127.860
127.157
126.855
125.928
125.496
124.393
124.089
119.863
98.304
74.425
34.908
31.183
S
tBu
4h
(150 MHz,CDCl3)
f1 (ppm)

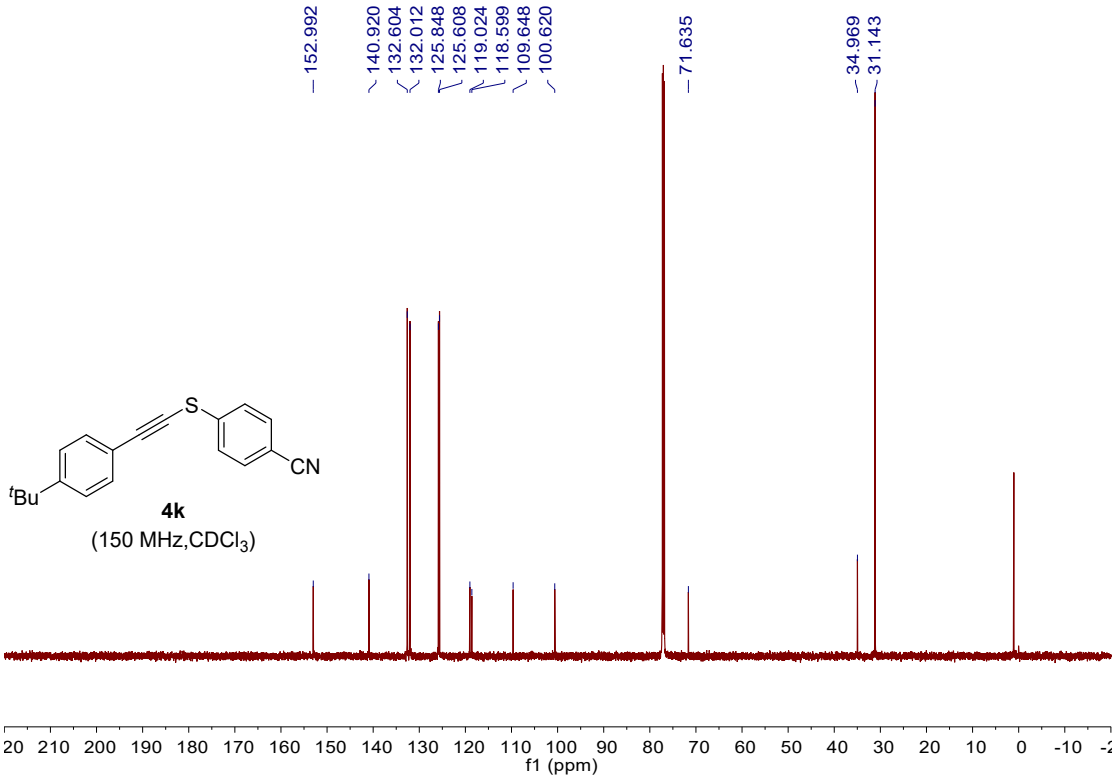

7.705
7.692
7.520
7.507
7.413
7.399
7.243
7.230
7.217
7.059
7.046
7.033
6.892
6.878
3.928
1.358
OMe
S
tBu
4i
(600 MHz,CDCl3)
1.00
2.11
2.17
1.05
1.04
1.06
3.05
9.39
f1 (ppm)

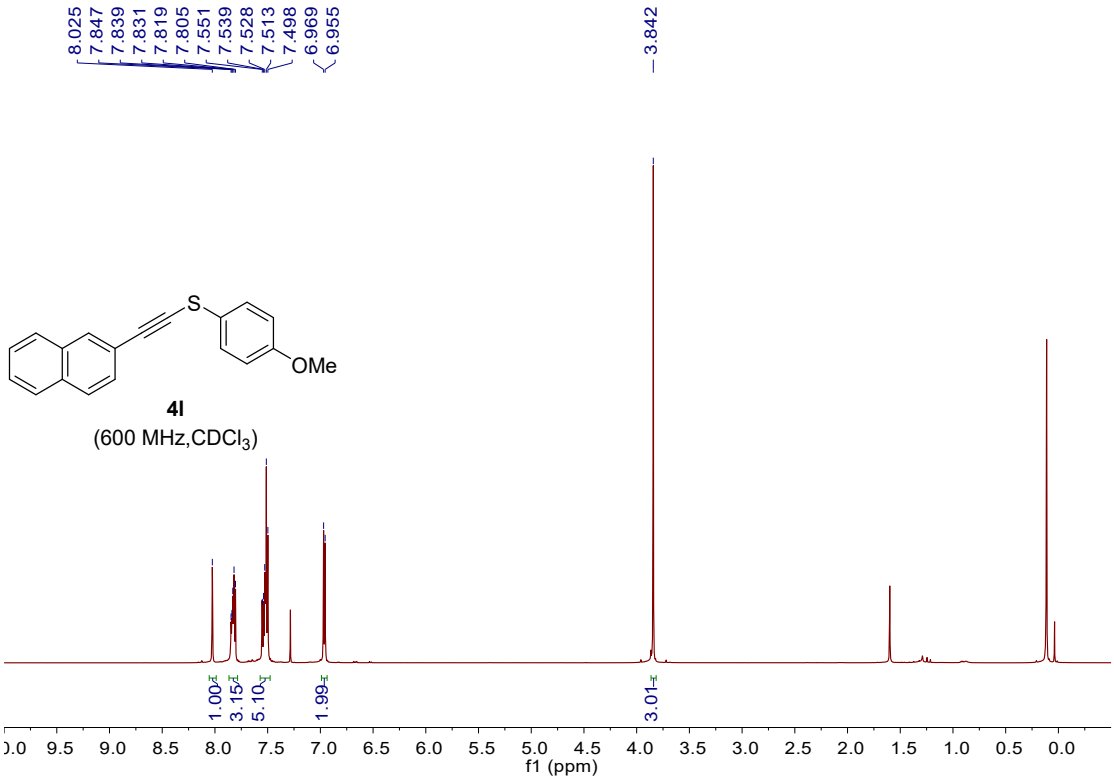

155.185
152.072
131.740
127.176
126.495
125.439
121.865
121.672
120.005
110.358
98.645
74.236
55.951
34.877
31.186
OMe
S
tBu
4i
(150 MHz,CDCl3)
f1 (ppm)

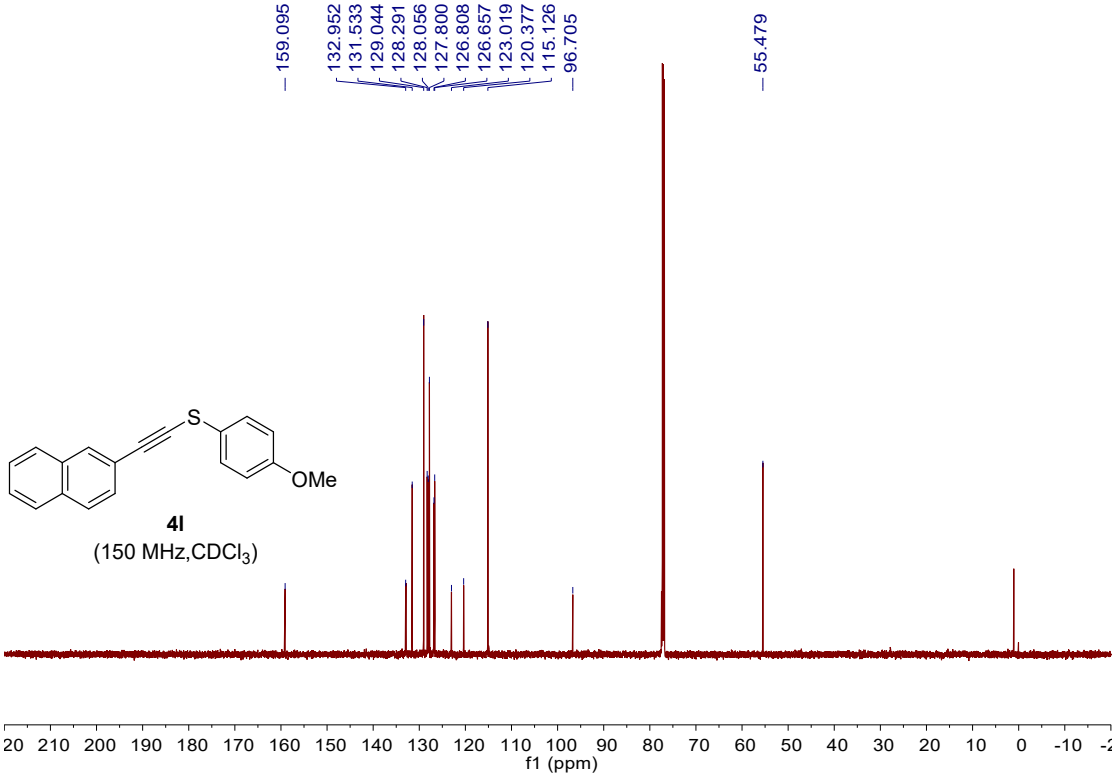

7.497
7.484
7.437
7.423
7.413
7.399
7.346
7.332
1.354
S
Cl
tBu
4j
(600 MHz,CDCl3)
2.16
4.25
2.00
9.38
f1 (ppm)

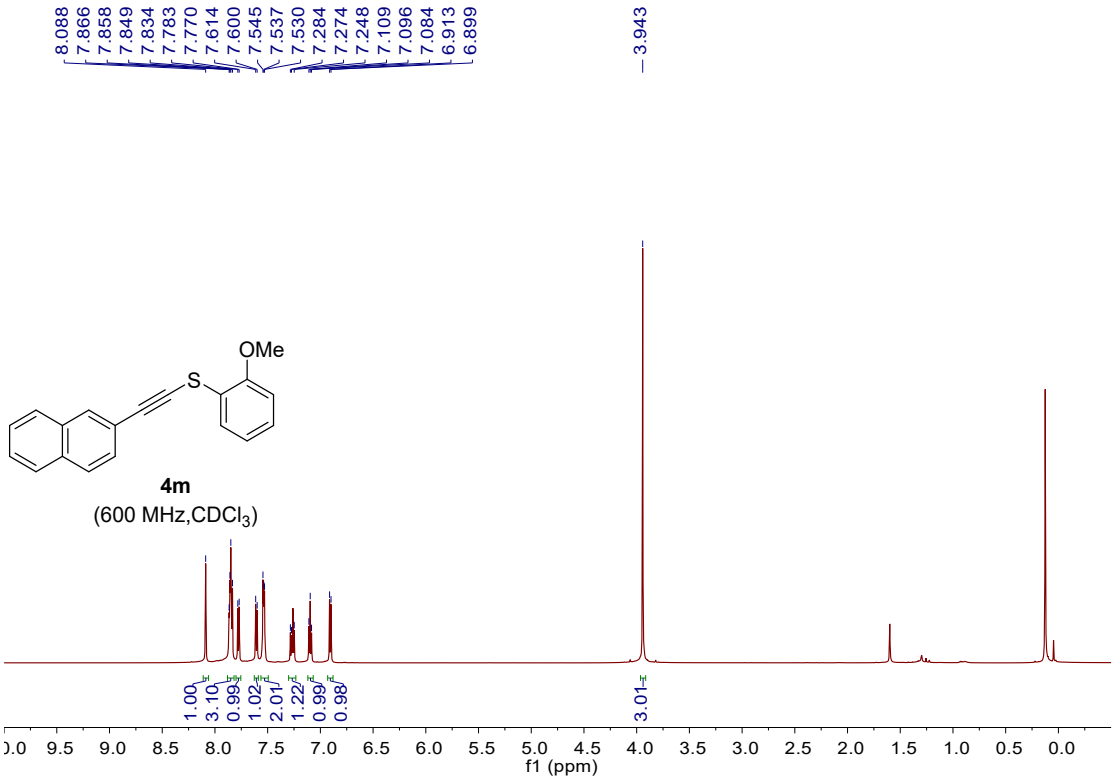

152.448
132.361
131.898
131.834
129.356
127.332
125.505
119.569
98.685
73.742
34.911
31.166
S
Cl
tBu
4j
(150 MHz,CDCl3)
f1 (ppm)

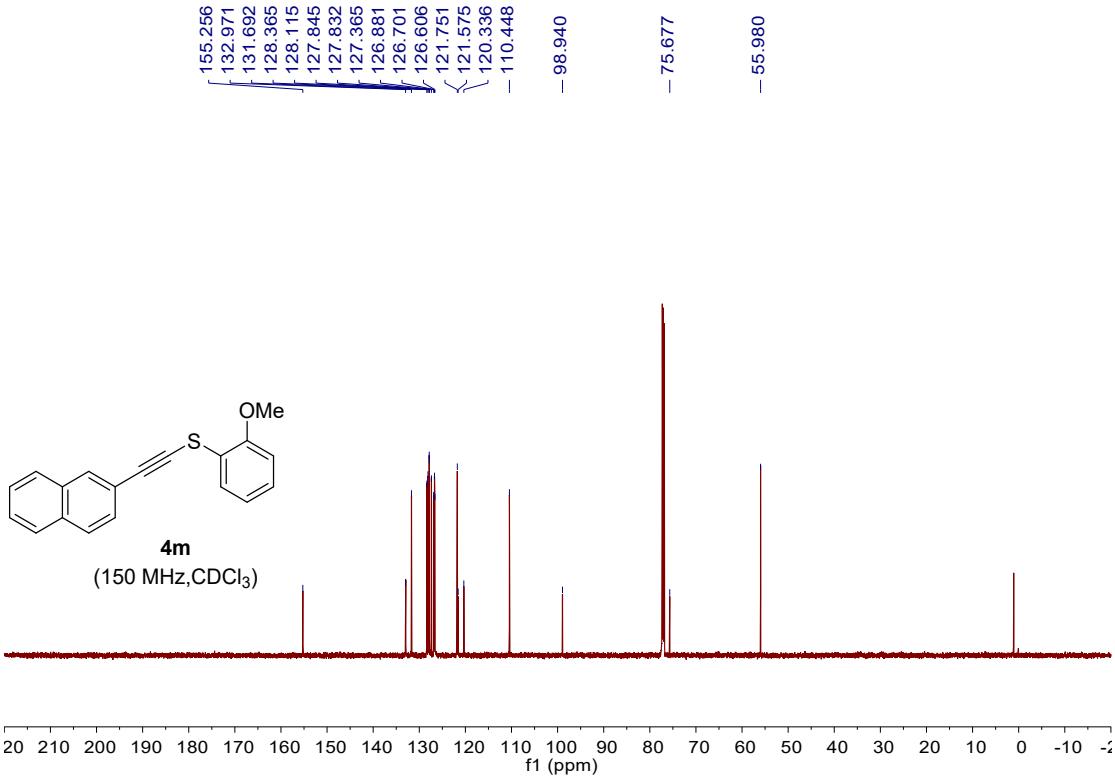

7.635
7.622
7.585
7.571
7.519
7.505
7.432
7.418
1.356
S
CN
tBu
4k
(600 MHz,CDCl3)
2.06
2.00
2.03
2.02
9.05
f1 (ppm)

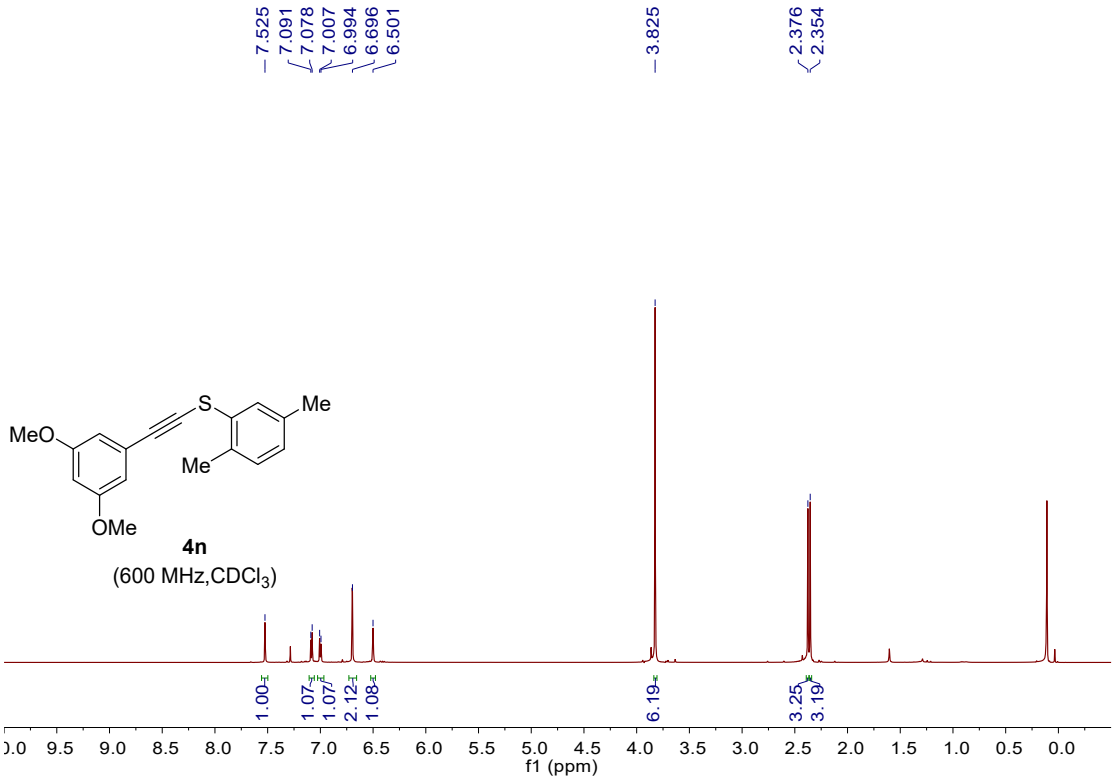

152.992
140.920
132.604
132.012
125.848
125.608
119.024
118.599
109.648
100.620
71.635
34.969
31.143
S
CN
tBu
4k
(150 MHz,CDCl3)
f1 (ppm)

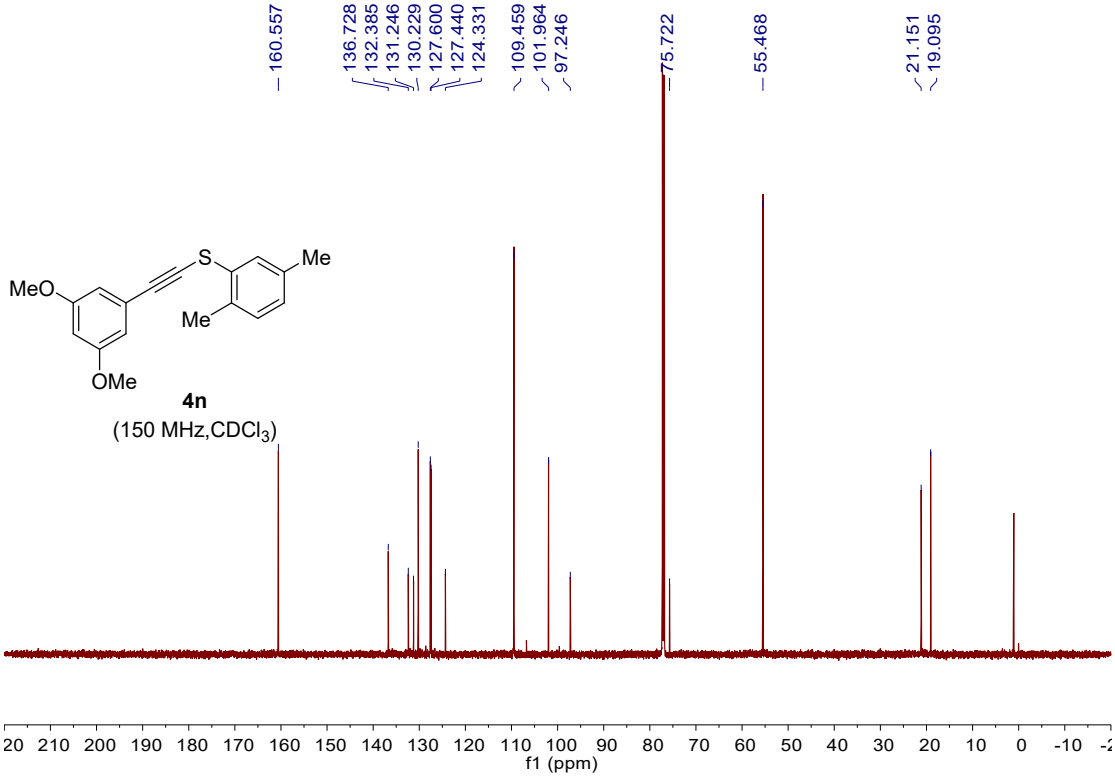

8.025
7.847
7.839
7.831
7.819
7.805
7.551
7.539
7.528
7.513
7.498
6.969
6.955
3.842
S
OMe
4l
(600 MHz,CDCl3)
1.00
3.15
5.10
1.99
3.01
f1 (ppm)

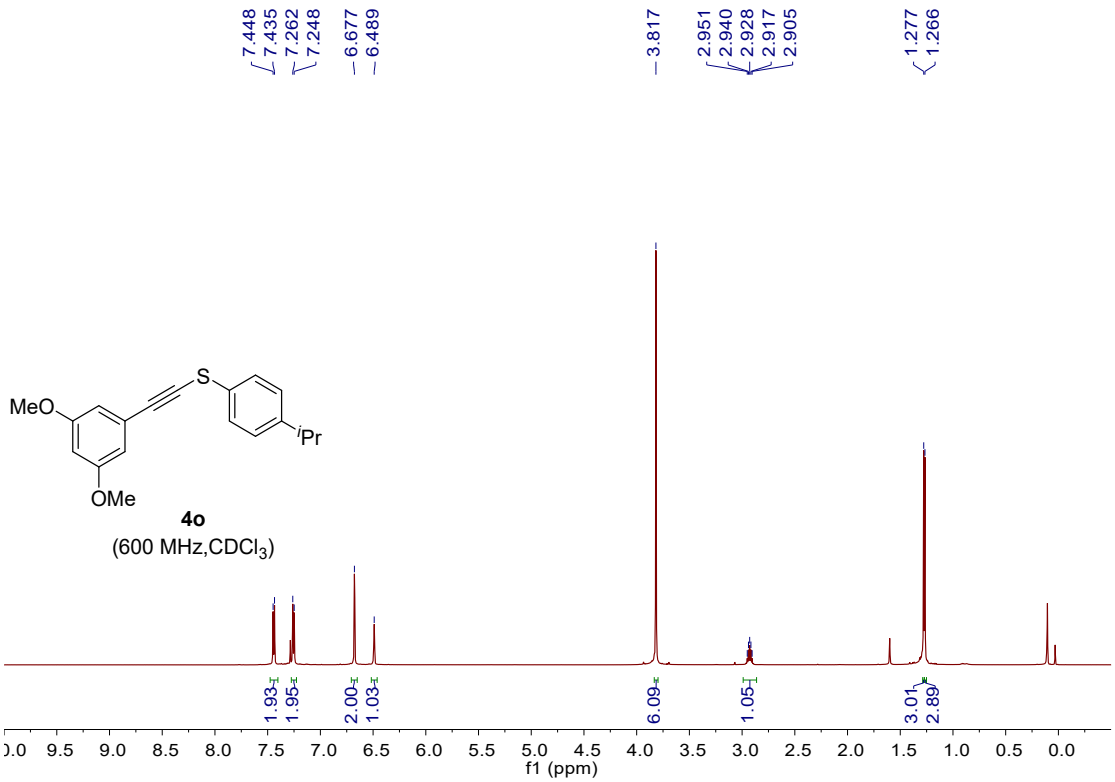

159.095
132.952
131.533
129.044
128.291
128.056
127.800
126.808
126.657
123.019
120.377
115.126
96.705
55.479
S
OMe
4l
(150 MHz,CDCl3)
f1 (ppm)

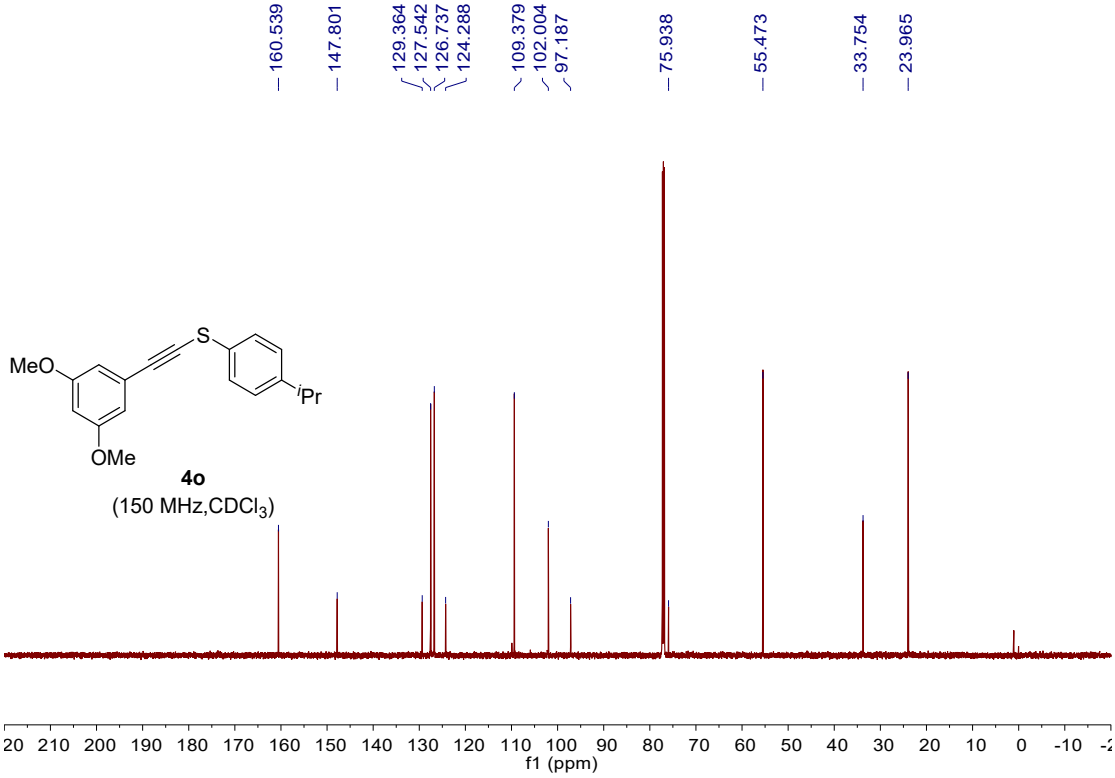

8.088
7.866
7.858
7.849
7.834
7.783
7.770
7.614
7.600
7.545
7.537
7.530
7.284
7.274
7.248
7.109
7.096
7.084
6.913
6.899
3.943
OMe
S
4m
(600 MHz,CDCl3)
1.00
3.10
0.99
1.02
2.01
1.22
0.99
0.98
3.01
f1 (ppm)

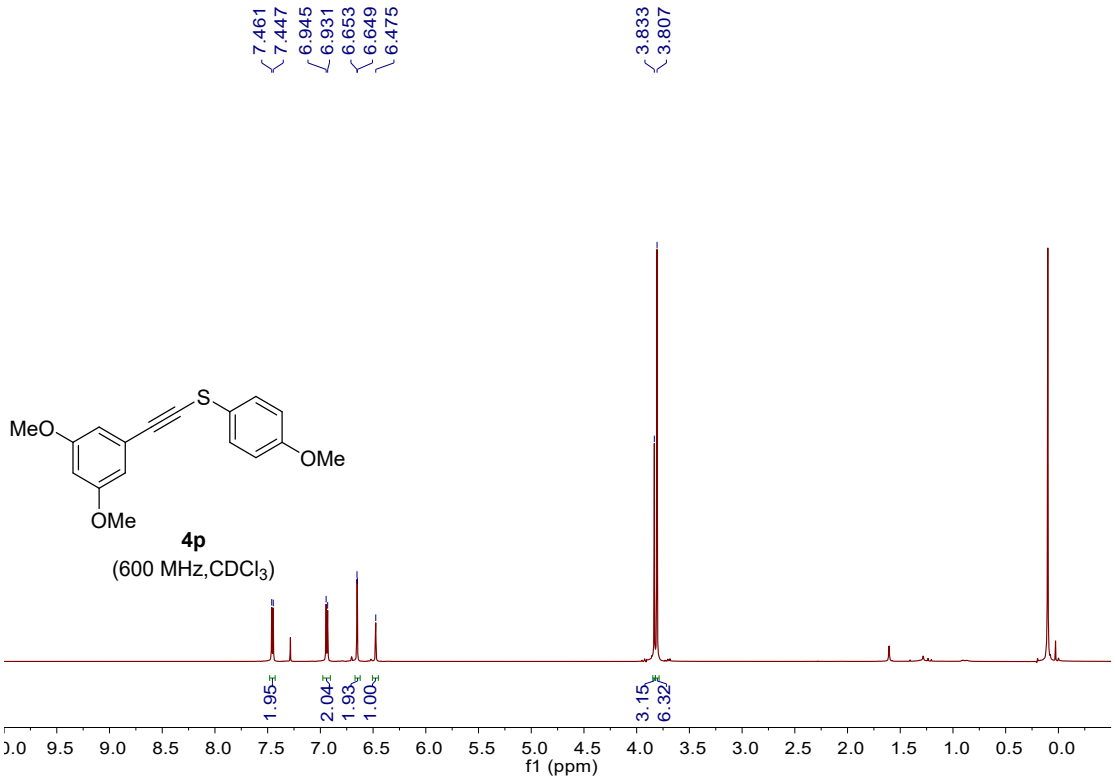

155.256
132.971
131.692
128.365
128.115
127.845
127.832
127.365
126.881
126.701
126.606
121.751
121.575
120.336
110.448
98.940
75.677
55.980
OMe
S
4m
(150 MHz,CDCl3)
f1 (ppm)

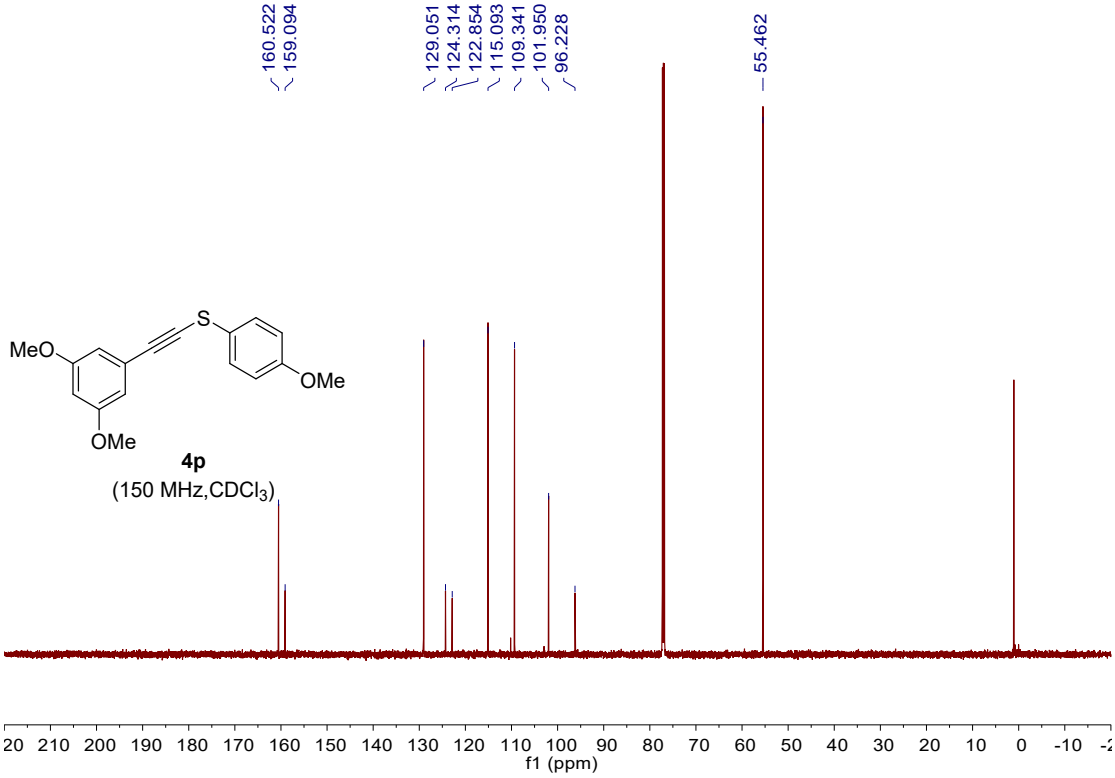

7.525
7.091
7.078
7.007
6.994
6.696
6.501
3.825
2.376
2.354
MeO
OMe
S
Me
Me
4n
(600 MHz,CDCl3)
1.00
1.07
1.07
2.12
1.08
6.19
3.25
3.19
f1 (ppm)

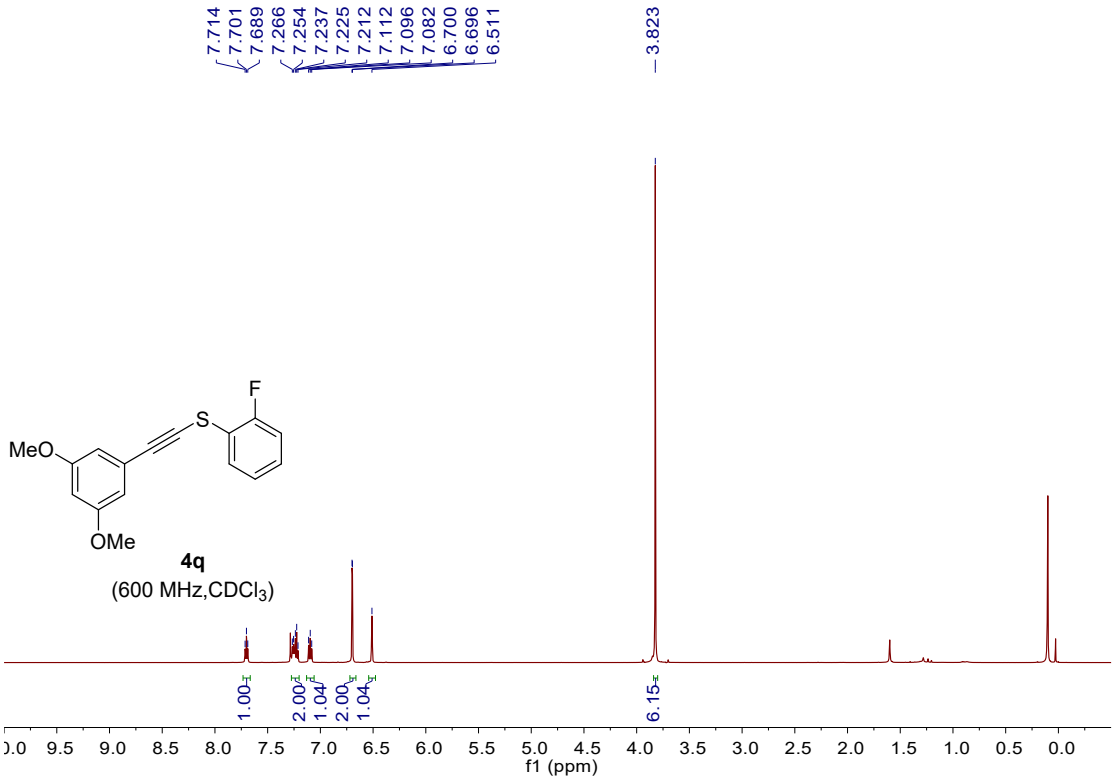

160.557
136.728
132.385
131.246
130.229
127.600
127.440
124.331
109.459
101.964
97.246
75.722
55.468
21.151
19.095
MeO
OMe
S
Me
Me
4n
(150 MHz,CDCl3)
f1 (ppm)

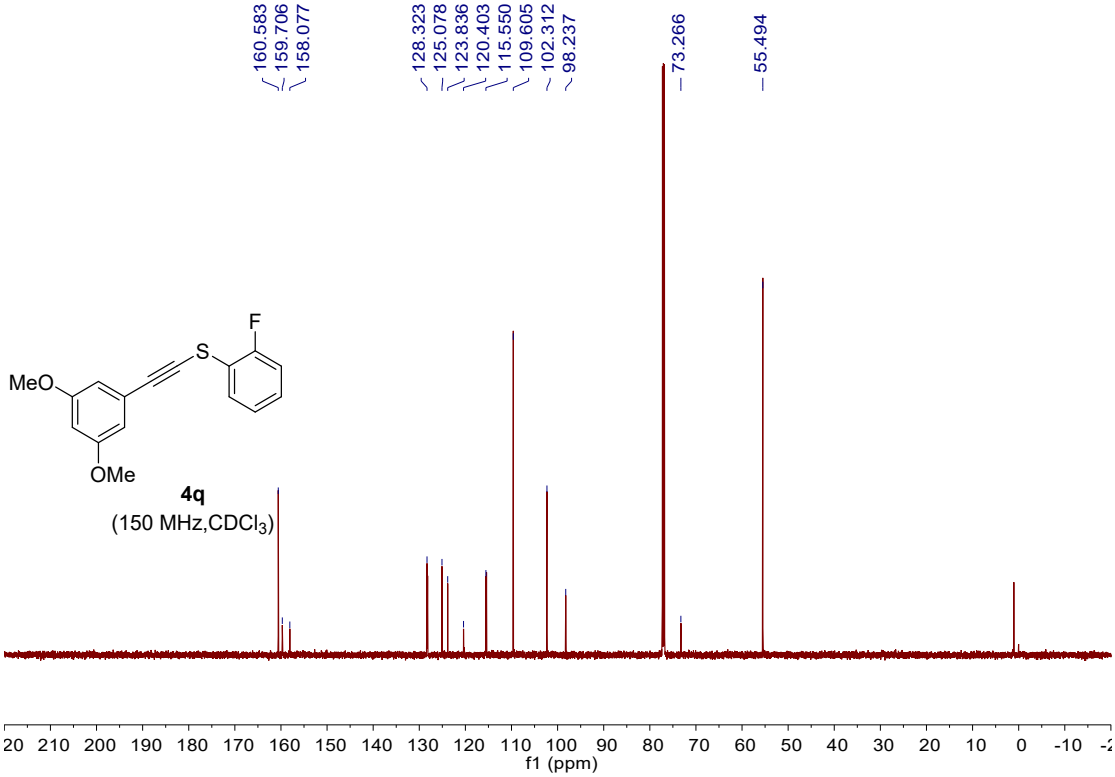

7.448
7.435
7.262
7.248
6.677
6.489
3.817
2.951
2.940
2.928
2.917
2.905
1.277
1.266
MeO
S
iPr
OMe
4o
(600 MHz,CDCl3)
1.93
1.95
2.00
1.03
6.09
1.05
3.01
2.89
f1 (ppm)

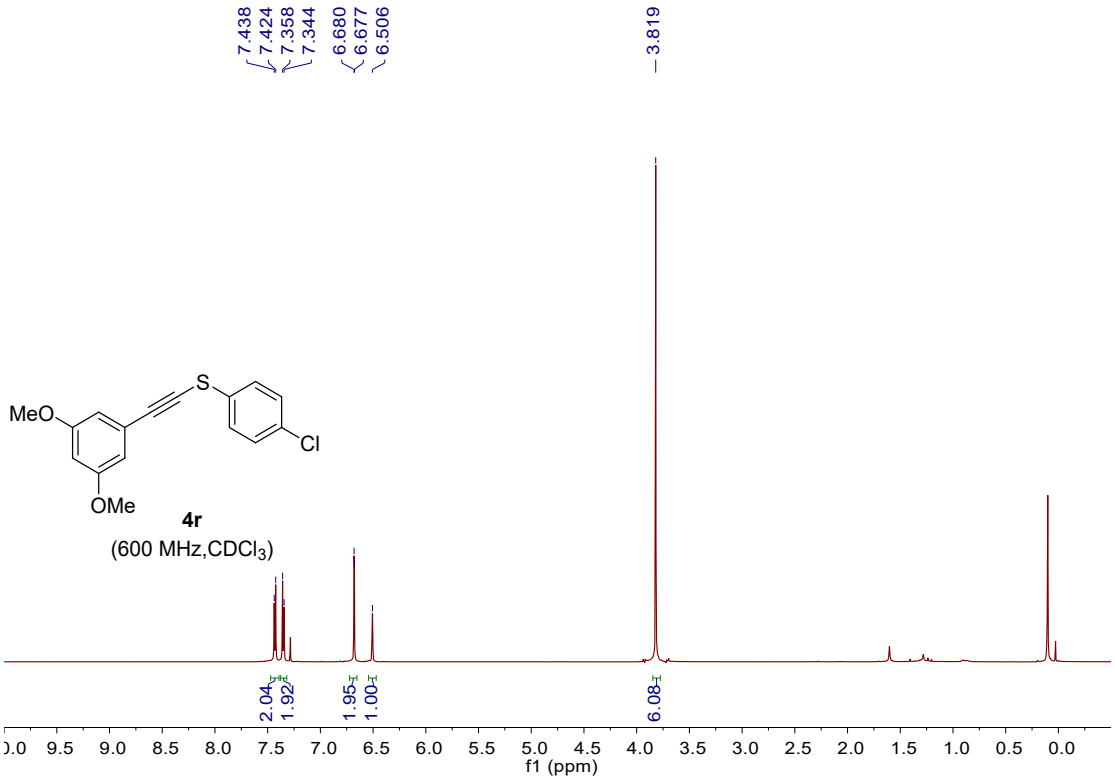

160.539
147.801
129.364
127.542
126.737
124.288
109.379
102.004
97.187
75.938
55.473
33.754
23.965
MeO
S
iPr
OMe
4o
(150 MHz,CDCl3)
f1 (ppm)

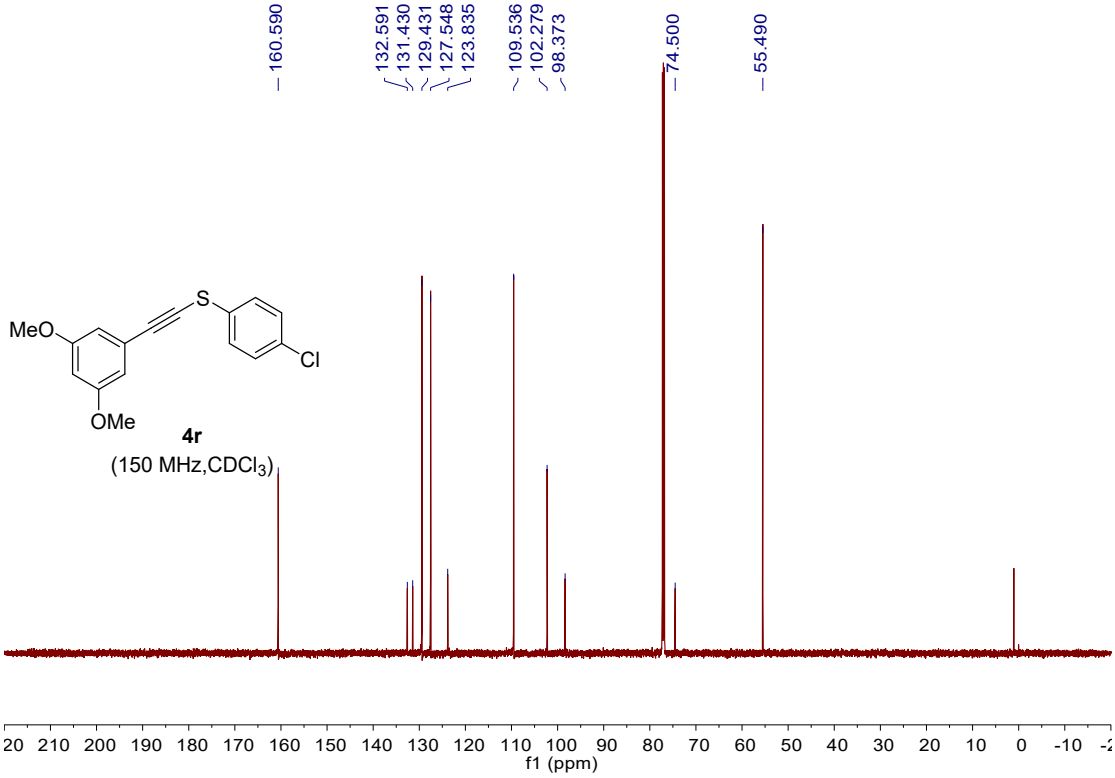

7.461
7.447
6.945
6.931
6.653
6.649
6.475
3.833
3.807
MeO
S
OMe
OMe
4p
(600 MHz,CDCl3)
1.95
2.04
1.93
1.00
3.15
6.32
f1 (ppm)

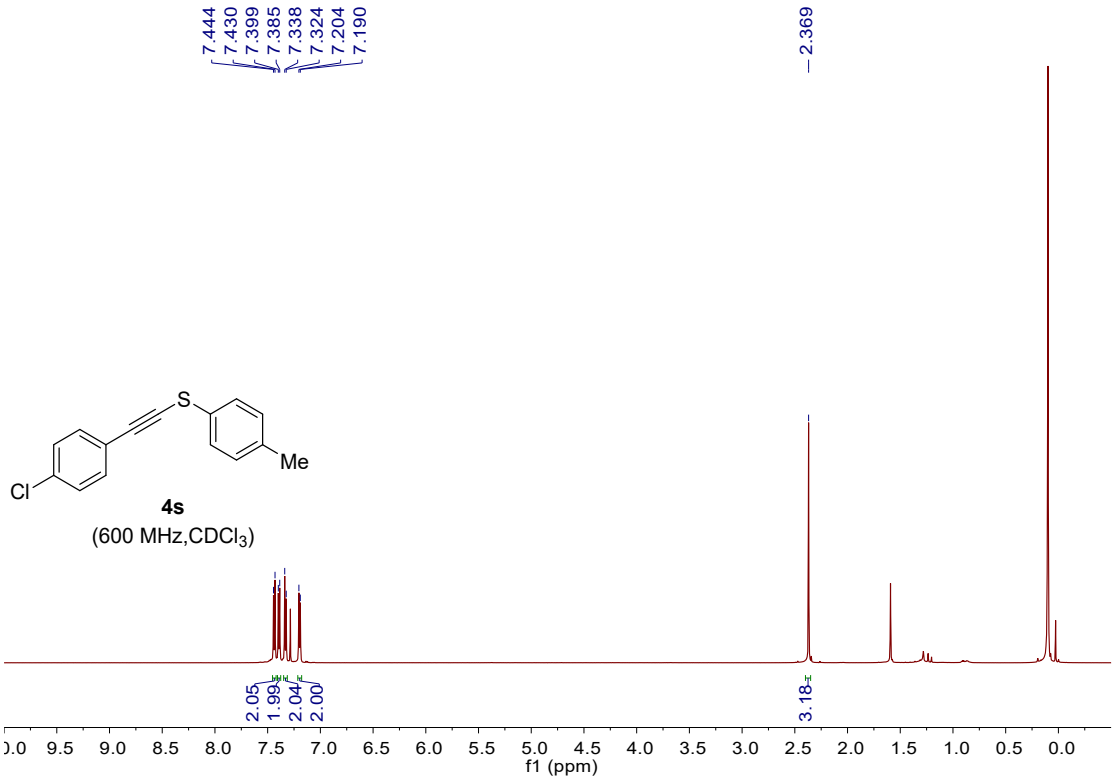

160.522
159.094
129.051
124.314
122.854
115.093
109.341
101.950
96.228
55.462
MeO
S
OMe
OMe
4p
(150 MHz,CDCl3)
f1 (ppm)

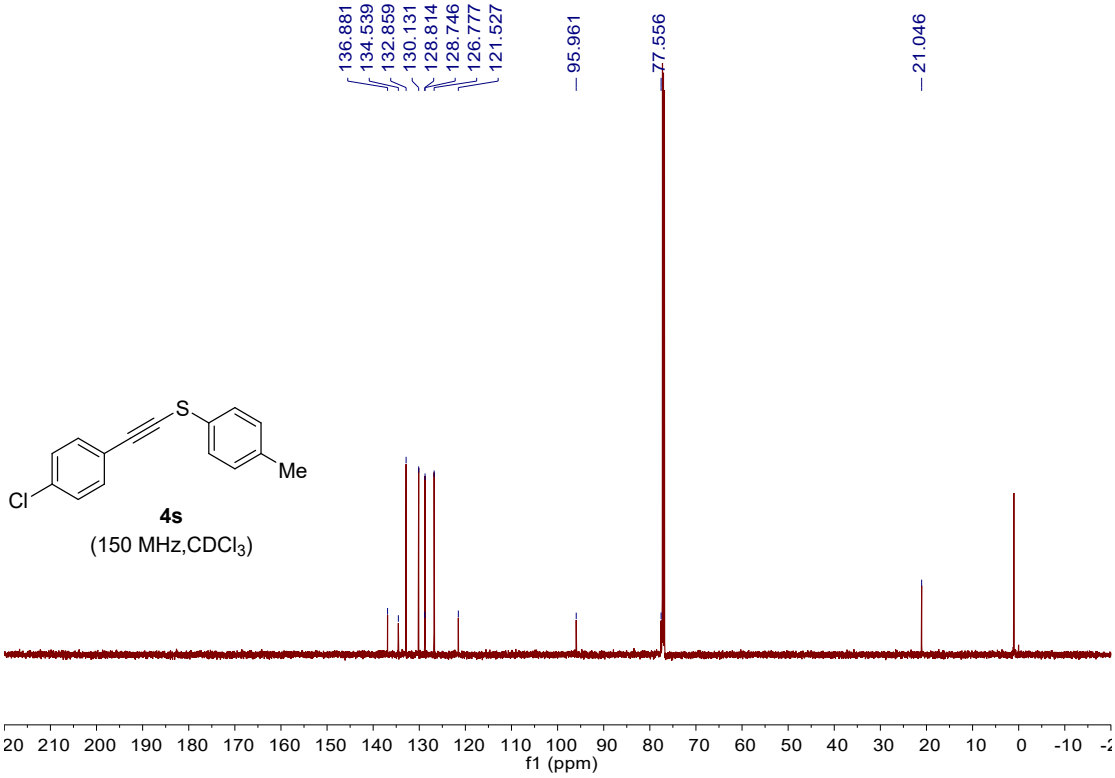

7.714
7.701
7.689
7.266
7.254
7.237
7.225
7.212
7.112
7.096
7.082
6.700
6.696
6.511
3.823
F
S
MeO
OMe
4q
(600 MHz,CDCl3)
1.00
2.00
1.04
2.00
1.04
6.15
f1 (ppm)

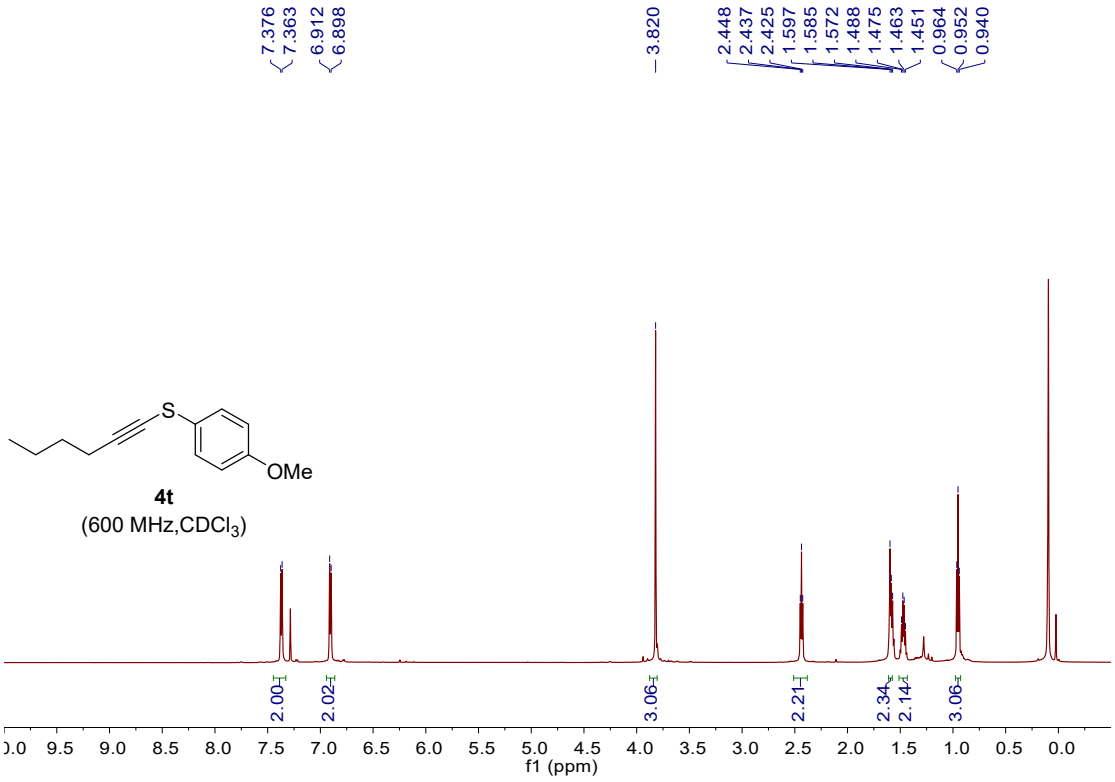

160.583
159.706
158.077
128.323
125.078
123.836
120.403
115.550
109.605
102.312
98.237
73.266
55.494
F
S
MeO
OMe
4q
(150 MHz,CDCl3)
f1 (ppm)

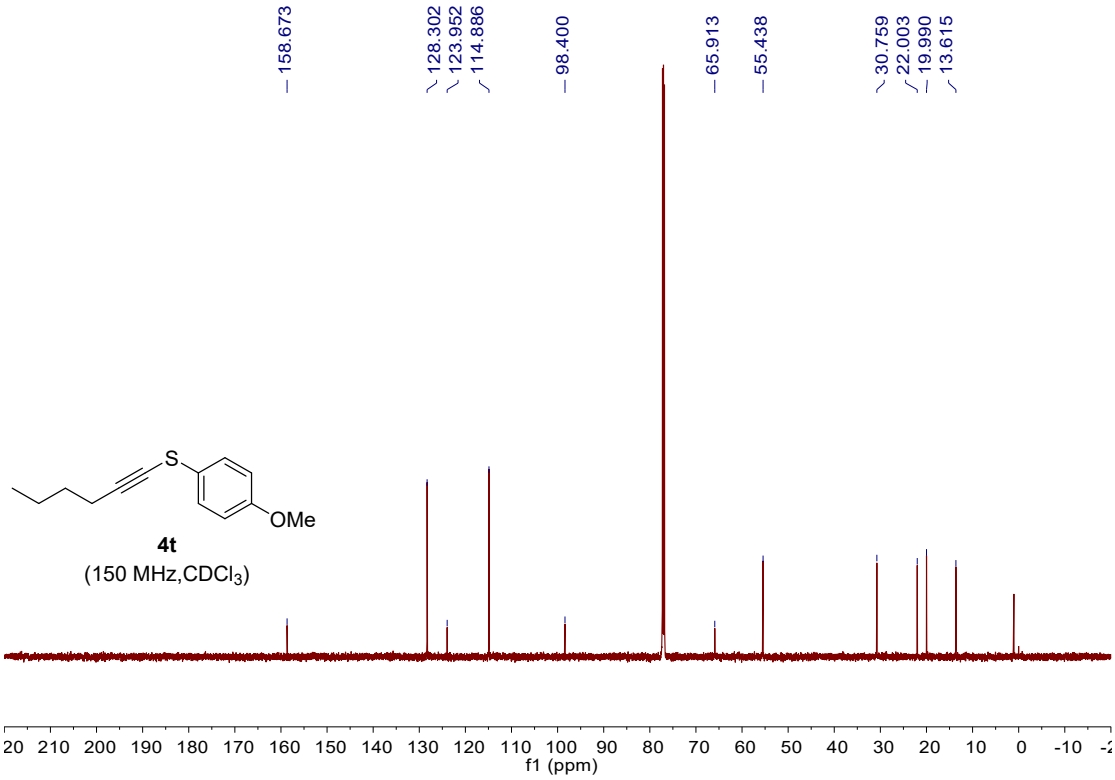

7.438
7.424
7.358
7.344
6.680
6.677
6.506
3.819
MeO
S
Cl
OMe
4r
(600 MHz,CDCl3)
2.04
1.92
1.95
1.00
6.08
f1 (ppm)

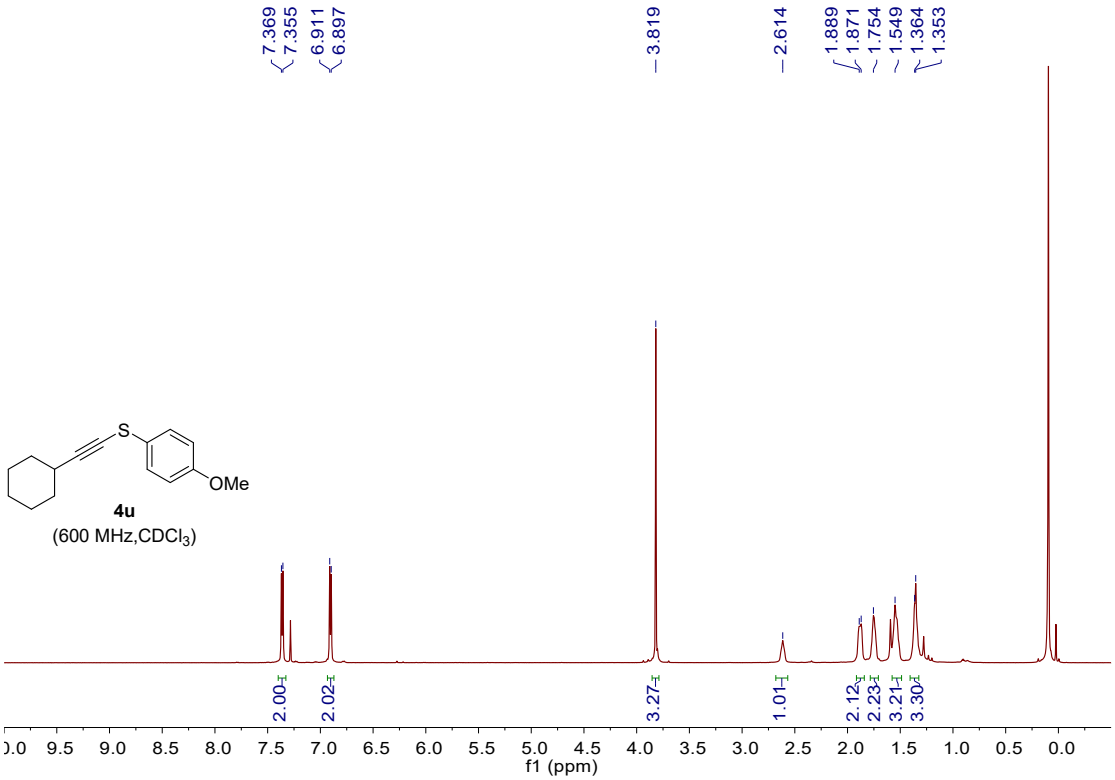

160.590
132.591
131.430
129.431
127.548
123.835
109.536
102.279
98.373
74.500
55.490
MeO
S
Cl
OMe
4r
(150 MHz,CDCl3)
f1 (ppm)

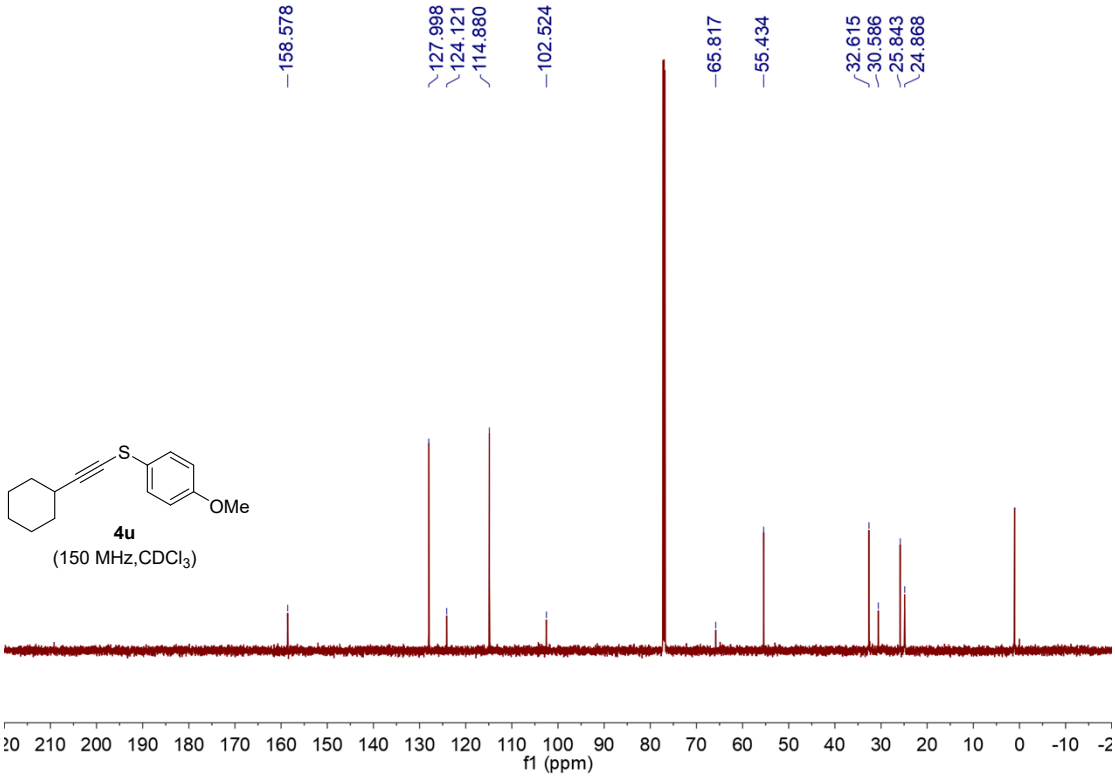

7.444
7.430
7.399
7.385
7.338
7.324
7.204
7.190
2.369
S
Me
Cl
4s
(600 MHz,CDCl3)
2.05
1.99
2.04
2.00
3.18
f1 (ppm)

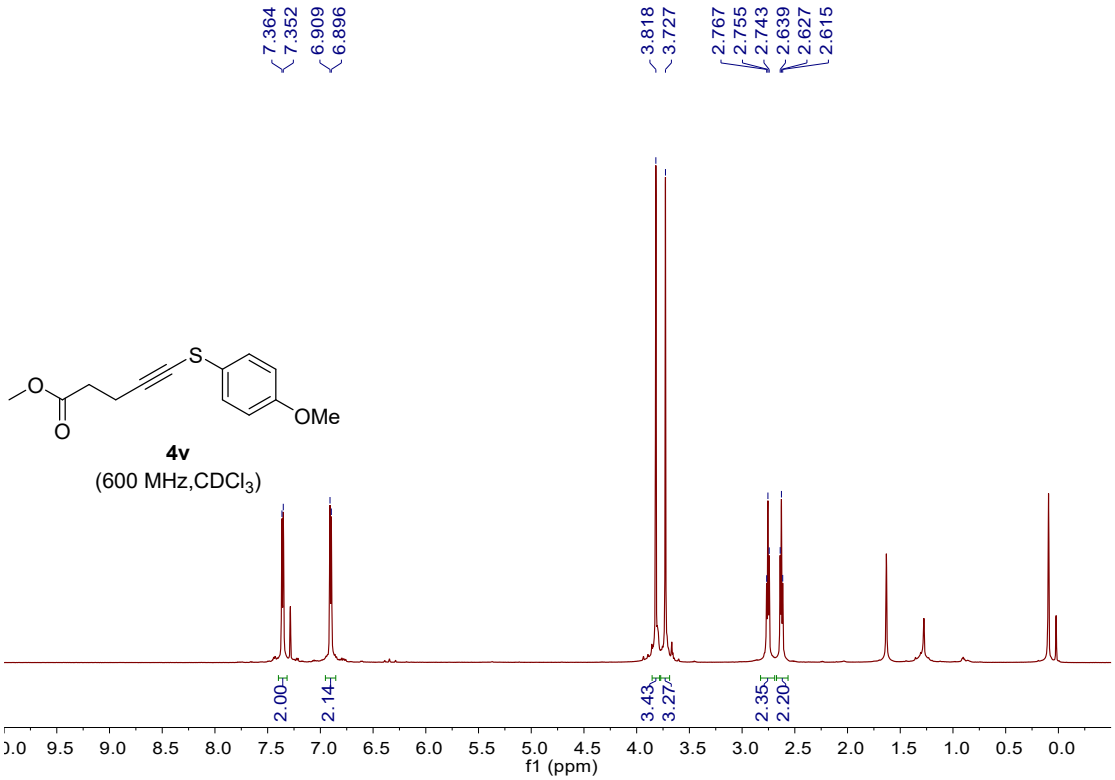

136.881
134.539
132.859
130.131
128.814
128.746
126.777
121.527
95.961
77.556
21.046
S
Me
Cl
4s
(150 MHz,CDCl3)
f1 (ppm)

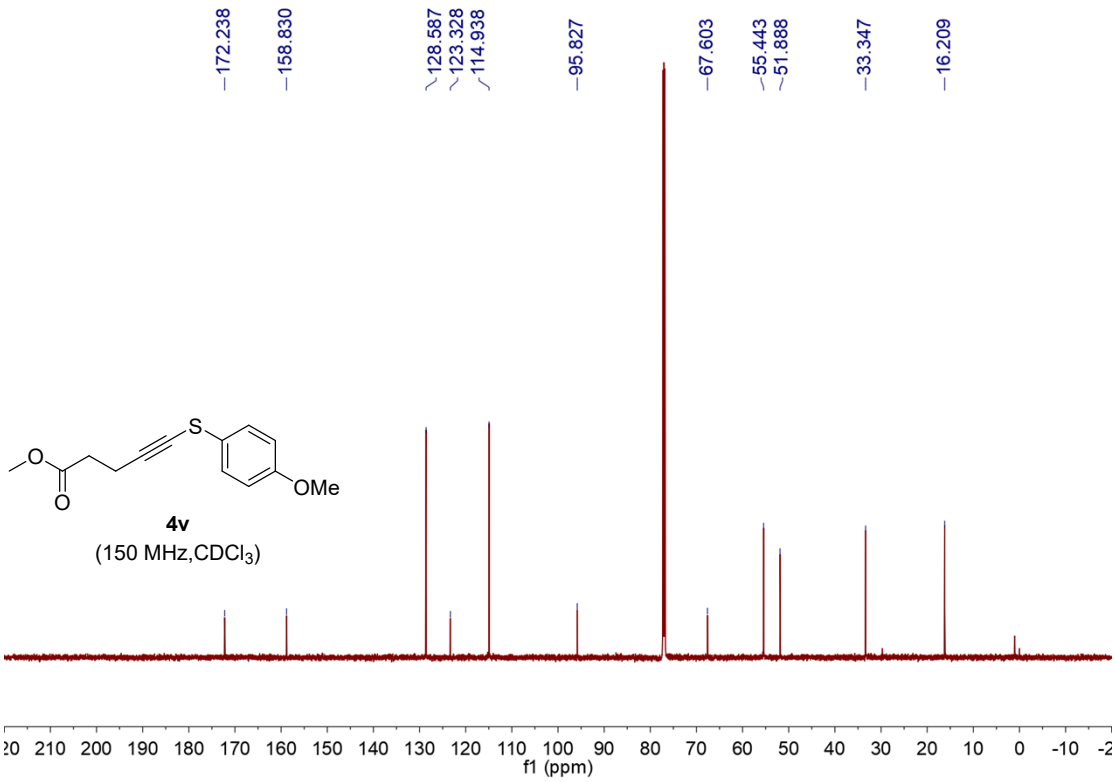

7.376
7.363
6.912
6.898
3.820
2.448
2.437
2.425
1.597
1.585
1.572
1.488
1.475
1.463
1.451
0.964
0.952
0.940
S
OMe
4t
(600 MHz,CDCl3)
2.00
2.02
3.06
2.21
2.34
2.14
3.06
f1 (ppm)

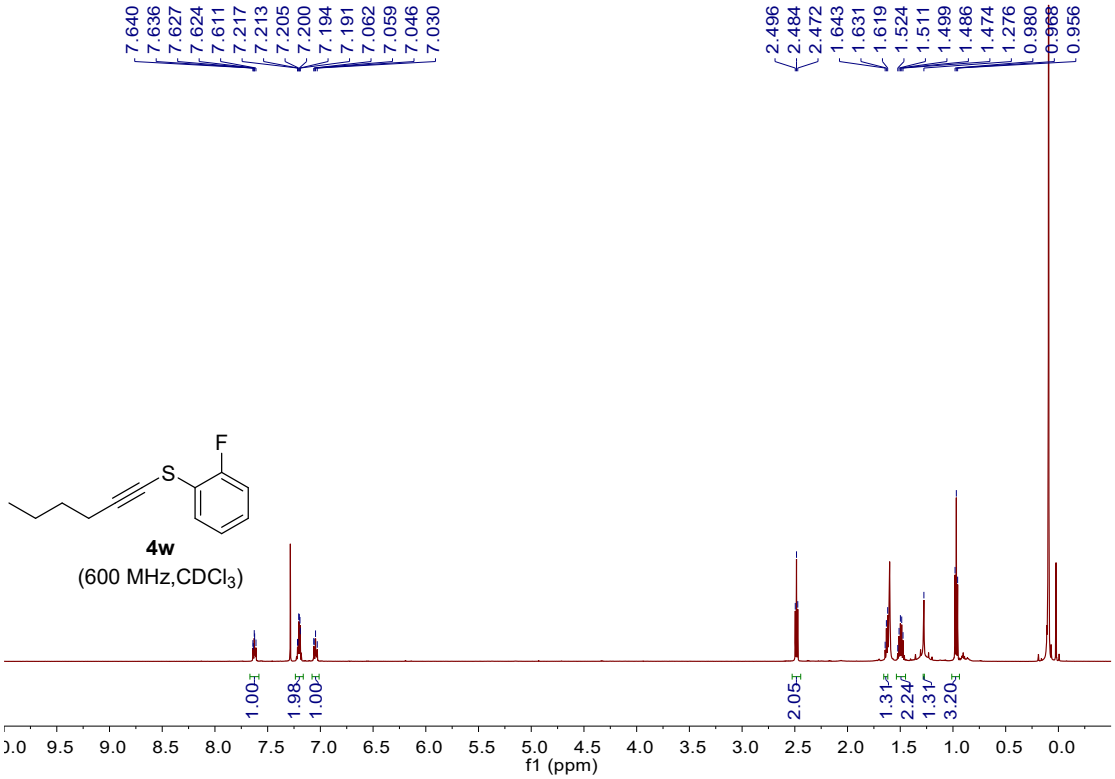

158.673
128.302
123.952
114.886
98.400
65.913
55.438
30.759
22.003
19.990
13.615
S
OMe
4t
(150 MHz,CDCl3)
f1 (ppm)

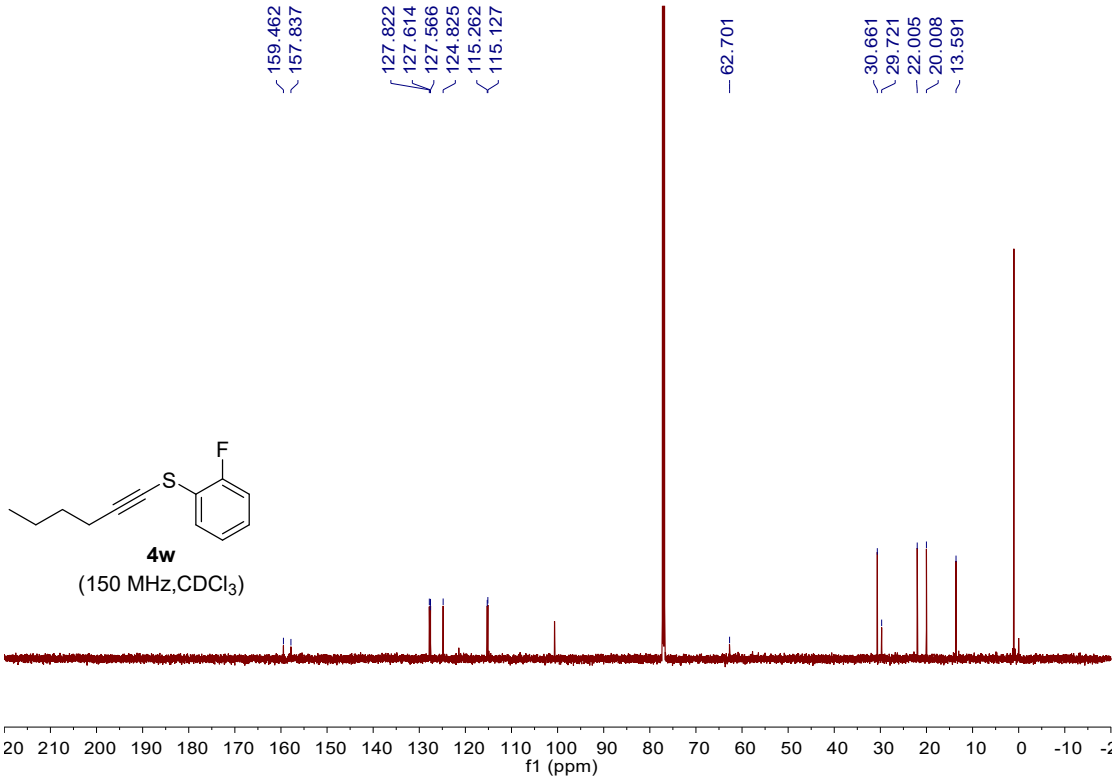

7.369
7.355
6.911
6.897
3.819
2.614
1.889
1.871
1.754
1.549
1.364
1.353
S
OMe
4u
(600 MHz,CDCl3)
2.00
2.02
3.27
1.01
2.12
2.23
3.21
3.30
f1 (ppm)

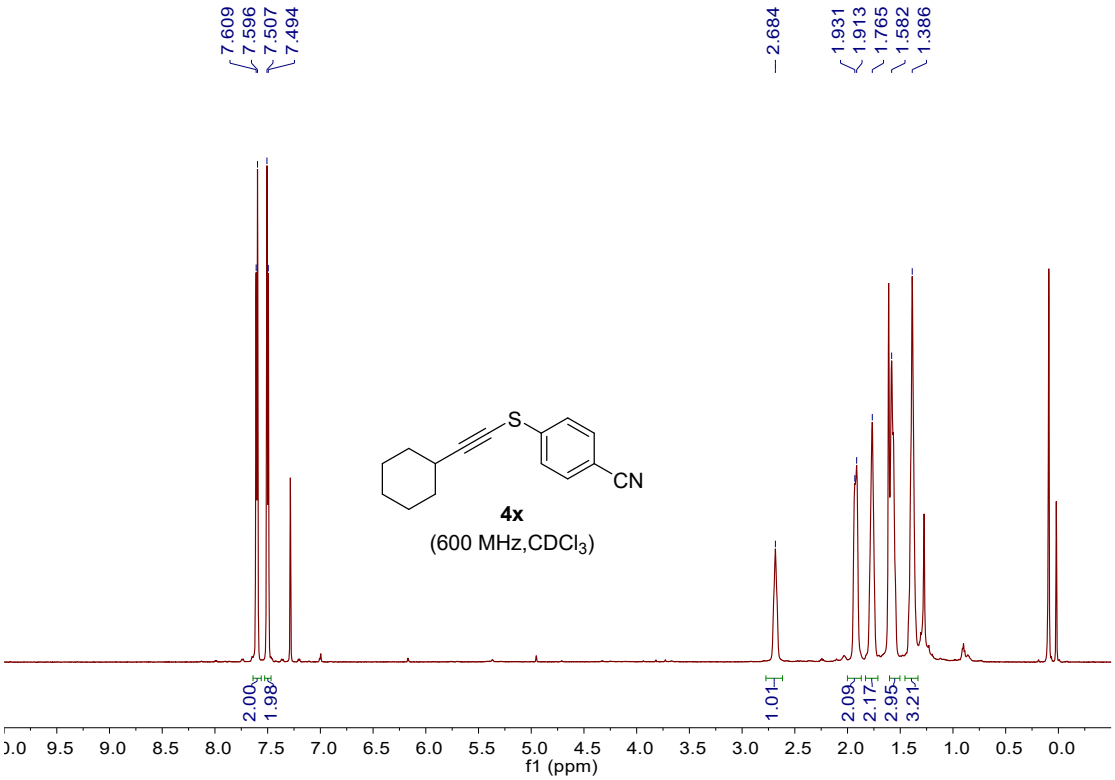

158.578
127.998
124.121
114.880
102.524
65.817
55.434
32.615
30.586
25.843
24.868
S
OMe
4u
(150 MHz,CDCl3)
f1 (ppm)

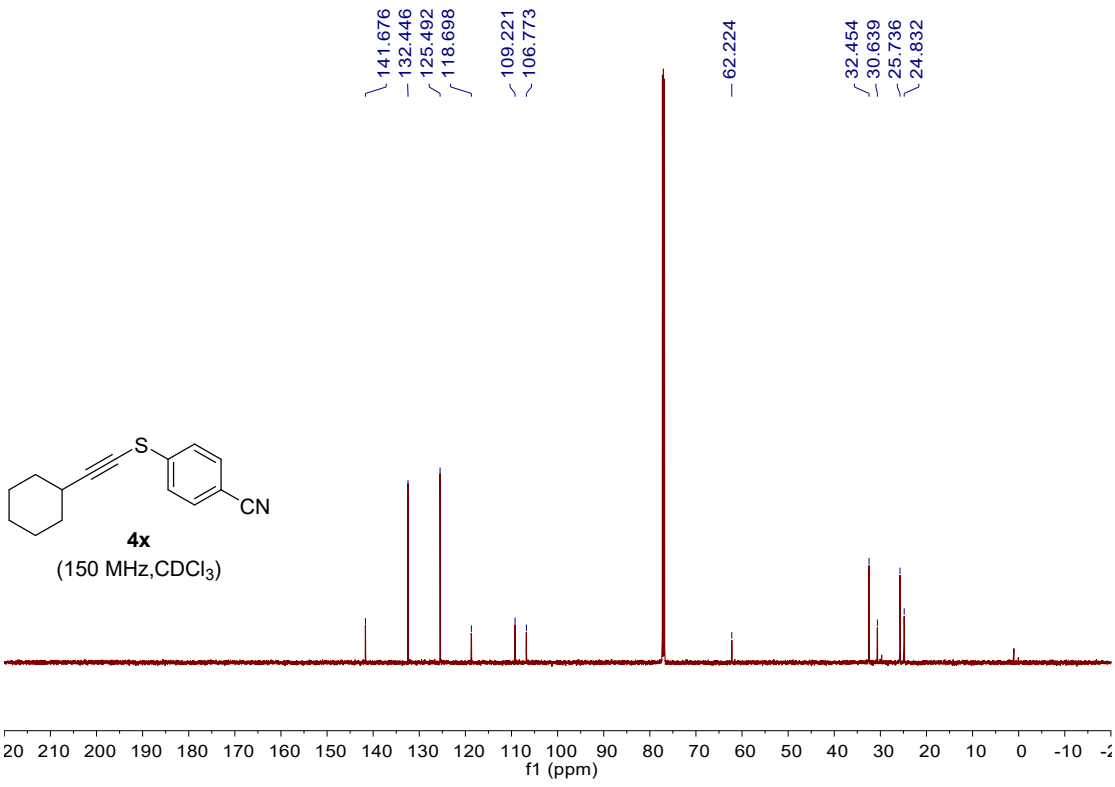

7.364
7.352
6.909
6.896
3.818
3.727
2.767
2.755
2.743
2.639
2.627
2.615
S
O
O
OMe
4v
(600 MHz,CDCl3)
2.00
2.14
3.43
3.27
2.35
2.20
f1 (ppm)


172.238
158.830
128.587
123.328
114.938
95.827
67.603
55.443
51.888
33.347
16.209
S
O
O
OMe
4v
(150 MHz,CDCl3)
f1 (ppm)


7.640
7.636
7.627
7.624
7.611
7.217
7.213
7.205
7.200
7.194
7.191
7.062
7.059
7.046
7.030
2.496
2.484
2.472
1.643
1.631
1.619
1.524
1.511
1.499
1.486
1.474
1.276
0.980
0.968
0.956
F
S
4w
(600 MHz,CDCl3)
1.00
1.98
1.00
2.05
1.31
2.24
1.31
3.20
f1 (ppm)


159.462
157.837
127.822
127.614
127.566
124.825
115.262
115.127
62.701
30.661
29.721
22.005
20.008
13.591
F
S
4w
(150 MHz,CDCl3)
f1 (ppm)


7.609
7.596
7.507
7.494
2.684
1.931
1.913
1.765
1.582
1.386
S
CN
4x
(600 MHz,CDCl3)
2.00
1.98
1.01
2.09
2.17
2.95
3.21
f1 (ppm)


141.676
132.446
125.492
118.698
109.221
106.773
62.224
32.454
30.639
25.736
24.832
S
CN
4x
(150 MHz,CDCl3)
f1 (ppm)