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Supporting information

Synthesis of Aromatic Terminal Allenes and Aliphatic Terminal Alkynes from Hydrazones Using Calcium Carbide as an Acetylene Source

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1. Experimental section

1.1 General Information

^{1}H NMR and ^{13}C NMR spectra were recorded on a Mercury-600 MB instrument using $CDCl_3$ as solvent and Me_4Si as internal standard. Calcium carbide was purchased from Shanghai Macklin Biochemical Company (purity: 98%), and ground into powder prior to use. Unless otherwise noted, the solvents and reagents were reagent grade and were used without any further purification. Column chromatographic separations were carried out on a flash chromatographic system using silica gel, and petroleum ether (60−90 ^{o}C) and ethyl acetate as eluent. For thin layer chromatography (TLC), silica gel plates precoated with GF-254 were used. Various ketone and aldehyde *p*-tosylhydrazones were synthesized by reactions of the corresponding aromatic aldehydes with *p*-tosylhydrazine according to literature procedure.[1]

1.2 The general procedure for the preparation of aromatic terminal allenes (2a-s) from aromatic ketone *p*-tosylhydrazones

Aromatic ketone *p*-tosylhydrazones (1 mmol), calcium carbide (3 mmol, 0.20 g for 98 % purity), potassium *tert*-butoxide (2 mmol, 0.22 g), cuprous chloride (1.2 mmol, 0.12 g) and water (4 mmol, 0.07 mL) in DMF (4 mL) were stirred at 90 ℃ for 3 h. After the reaction was complete, the resulting mixture was filtered to remove the solid, and the liquor was extracted with ethyl acetate (3×10 mL), and washed with saturated brine (3×10 mL). The resulting organic phase was dried with anhydrous sodium sulfate, and concentrated under reduced pressure. The residue was isolated by column chromatography using petroleum ether as eluent to give the pure products.

1.3 The general procedure for the preparation of aromatic terminal allenes (5a-t) from aromatic aldehyde *p*-tosylhydrazones

Aromatic aldehyde *p*-tosylhydrazones (1 mmol), calcium carbide (3 mmol, 0.20 g for 98 % purity), potassium *tert*-butoxide (2 mmol, 0.22 g), cuprous chloride (1.2 mmol, 0.12 g) and water (4 mmol, 0.07 mL) in DMF (4 mL) were stirred at 60 ℃ for 1 h. After the reaction was complete, the resulting mixture was filtered to remove the solid, and the liquor was extracted with ethyl acetate (3×10 mL), and washed with saturated brine (3×10 mL). The resulting organic phase was dried with anhydrous sodium sulfate, and concentrated under reduced pressure. The residue was isolated by column chromatography using petroleum ether as eluent to give the pure products.

1.4 The general procedure for the preparation of aliphatic terminal alkynes (7a-e) from aliphatic ketone *p*-tosylhydrazones

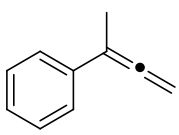
Aliphatic ketone *p*-tosylhydrazones (1 mmol), calcium carbide (3 mmol, 0.20 g for 98 % purity), potassium *tert*-butoxide (2 mmol, 0.22 g), cuprous chloride (1.2 mmol, 0.12 g) and water (4 mmol, 0.07 mL) in DMF (4 mL) were stirred at 120 ℃ for 12 h. After the reaction was complete, the resulting mixture was filtered to remove the solid, and the liquor was extracted with ethyl acetate (3×10 mL), and washed with saturated brine (3×10 mL). The resulting organic phase was dried with anhydrous sodium sulfate, and concentrated under reduced pressure. The residue was isolated by column chromatography using petroleum ether as eluent to give the pure products.

1.5 The general procedure for the preparation of aliphatic terminal alkynes (10a-b) from aliphatic aldehyde *p*-tosylhydrazones

Aliphatic aldehyde *p*-tosylhydrazones (1 mmol), calcium carbide (3 mmol, 0.20 g for 98 % purity), potassium *tert*-butoxide (2 mmol, 0.22 g), cuprous chloride (1.2 mmol, 0.12 g) and water (4 mmol, 0.07 mL) in DMF (4 mL) were stirred at 120 ℃ for 12 h. After the reaction was complete, the resulting mixture was filtered to remove the solid, and the liquor was extracted with ethyl acetate (3×10 mL), and washed with saturated brine (3×10 mL). The resulting organic phase was dried with anhydrous sodium sulfate, and concentrated under reduced pressure. The residue was isolated by column chromatography using petroleum ether as eluent to give the pure products.

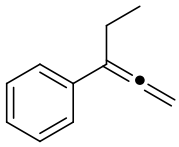
2. Analytical data of the products 2a-s, 5a-t, 7a-e, 9a, 10a-b

3-Phenyl-1,2-butadiene (2a)[2-4]



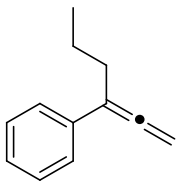
Yellow oily liquid (123.7 mg, 95% yield). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.42 (d, *J* = 7.4 Hz, 2H), 7.33 (t, *J* = 7.8 Hz, 2H), 7.21 (t, *J* = 7.3 Hz, 1H), 5.03 (q, *J* = 3.1 Hz, 2H), 2.11 (t, *J* = 3.1 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 208.95, 136.69, 128.27, 126.51, 125.63, 99.76, 76.82, 16.65. HRMS: *m/z* $(M+H)^+$ calcd for $C_{10}H_{11}$: 131.0855; Found: 131.0858.

3-Phenyl-1,2-pentadiene (2b)[3, 5, 6]



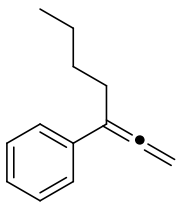
Yellow oily liquid (103.8 mg, 91% yield). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.43 (d, *J* = 7.6 Hz, 2H), 7.33 (t, *J* = 7.8 Hz, 2H), 7.21 (t, *J* = 7.4 Hz, 1H), 5.11 (t, *J* = 3.7 Hz, 2H), 2.45 (qt, *J* = 7.3, 3.6 Hz, 2H), 1.18 (t, *J* = 7.4 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 208.38, 136.54, 128.30, 126.51, 125.89, 106.69, 78.64, 22.39, 12.45. HRMS: *m/z* $(M+H)^+$ calcd for $C_{10}H_{13}$: 145.1012; Found: 145.1010.

3-Phenyl-1,2-hexadiene (2c)[7, 8]



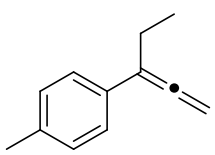
Yellow oily liquid (133.8 mg, 85% yield). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.43 (d, *J* = 7.8 Hz, 2H), 7.35 – 7.32 (m, 2H), 7.21 (t, *J* = 7.1 Hz, 1H), 5.08 (t, *J* = 3.3 Hz, 2H), 2.45 – 2.40 (m, 2H), 1.61 (h, *J* = 7.4 Hz, 2H), 1.02 (t, *J* = 7.4 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 208.67, 136.52, 128.32, 126.50, 125.97, 104.82, 77.94, 31.62, 21.10, 13.94. HRMS: *m/z* $(M+H)^+$ calcd for $C_{12}H_{15}$: 159.1168; Found: 159.1172.

3-Phenyl-1,2-heptadiene (2d)[5, 6, 9]



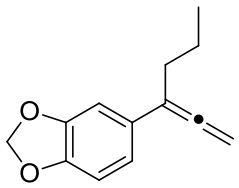
Yellow oily liquid (123.8 mg, 72% yield). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.44 (d, *J* = 7.3 Hz, 2H), 7.36 – 7.32 (m, 2H), 7.22 (t, *J* = 6.8 Hz, 1H), 5.09 (t, *J* = 3.2 Hz, 2H), 2.45 (ddd, *J* = 11.0, 6.7, 3.3 Hz, 2H), 1.58 (dt, *J* = 15.3, 7.3 Hz, 2H), 1.45 (dq, *J* = 14.6, 7.3 Hz, 2H), 0.97 (t, *J* = 7.3 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 208.64, 136.55, 128.32, 126.50, 125.98, 105.01, 77.96, 30.06, 29.22, 22.52, 13.97. HRMS: *m/z* $(M+H)^+$ calcd for $C_{13}H_{17}$: 173.1325; Found: 173.1328.

3-(4-Methylphenyl)-1,2-pentadiene (2e)[5]



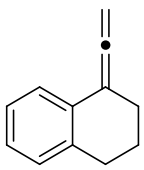
Yellow oily liquid (138.8 mg, 88% yield). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.33 (d, *J* = 8.2 Hz, 2H), 7.16 (d, *J* = 8.3 Hz, 2H), 5.11 (t, *J* = 3.7 Hz, 2H), 2.45 (dq, *J* = 7.4, 3.7 Hz, 2H), 2.36 (s, 3H), 1.18 (t, *J* = 7.3 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 208.20, 136.20, 133.54, 129.06, 125.80, 106.52, 78.56, 22.46, 21.03, 12.48. HRMS: *m/z* $(M+H)^+$ calcd for $C_{12}H_{15}$: 159.1168; Found: 159.1164.

3-Piperyl-1,2-hexadiene (2f)



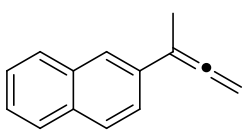
Yellow oily liquid (134.9 mg, 67% yield). ^{1}H NMR (600 MHz, $CDCl_3$) δ 6.92 (s, 1H), 6.85 (d, *J* = 7.7 Hz, 1H), 6.76 (d, *J* = 8.1 Hz, 1H), 5.93 (s, 2H), 5.03 (t, *J* = 3.3 Hz, 2H), 2.35 – 2.31 (m, 2H), 1.59 – 1.53 (m, 2H), 0.97 (t, *J* = 7.3 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 208.36, 147.80, 146.31, 130.63, 119.00, 108.02, 106.77, 104.63, 100.91, 77.97, 31.93, 21.07, 13.87. HRMS: *m/z* $(M+H)^+$ calcd for $C_{13}H_{15}O_2$: 203.1067; Found: 203.1066.

1-Vinylidene-1,2,3,4-tetrahydronaphthalene (2g)[10]



Yellow oily liquid (142 mg, 91% yield). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.51 (d, *J* = 7.2 Hz, 1H), 7.18 – 7.10 (m, 3H), 5.09 (t, *J* = 3.3 Hz, 2H), 2.83 (t, *J* = 6.3 Hz, 2H), 2.60 (dq, *J* = 9.6, 3.3 Hz, 2H), 1.92 (p, *J* = 6.2 Hz, 2H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 206.55, 131.13, 136.35, 129.17, 126.84, 126.47, 126.02, 100.99, 77.90, 30.10, 28.67, 22.82. HRMS: *m/z* $(M+H)^+$ calcd for $C_{12}H_{13}$: 157.1012; Found: 157.1008.

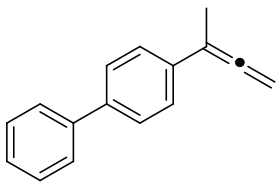
3-(2-Naphthyl)-1,2-butadiene (2h)[3, 10, 11]



Yellow oily liquid (172.8 mg, 96% yield). ^{1}H NMR (600 MHz, DMSO-d_6) δ 7.89 (d, *J* = 7.9 Hz, 1H), 7.84 (t, *J* = 7.8 Hz, 2H), 7.80 (s, 1H), 7.56 (d, *J* = 8.7 Hz, 1H), 7.50 – 7.44 (m, 2H), 5.23 (q, *J* = 2.6 Hz, 2H), 2.15 (t, *J* = 3.1 Hz, 3H). ^{13}C NMR (151 MHz, DMSO-d_6) δ 209.31, 133.90,

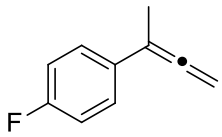
133.66, 132.29, 128.34, 128.15, 127.87, 126.77, 126.29, 124.94, 123.64, 99.94, 78.47, 16.84. HRMS: *m/z* $(M+H)^+$ calcd for $C_{14}H_{13}$: 181.1012; Found: 181.1015.

3-Biphenyl-1,2-butadiene (2i)[10]



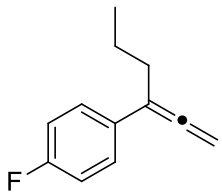
Yellow oily liquid (191.7mg, 93% yield). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.60 (d, *J* = 7.3 Hz, 2H), 7.57 (d, *J* = 8.3 Hz, 2H), 7.48 (d, *J* = 8.3 Hz, 2H), 7.44 (t, *J* = 7.7 Hz, 2H), 7.34 (t, *J* = 7.3 Hz, 1H), 5.06 (q, *J* = 3.0 Hz, 2H), 2.14 (t, *J* = 3.2 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 209.12, 140.79, 139.32, 135.74, 128.72, 127.15, 126.98, 126.91, 126.04, 99.53, 76.96, 16.67. HRMS: *m/z* $(M+H)^+$ calcd for $C_{16}H_{15}$: 207.1168; Found: 207.1171.

3-(4-Fluorophenyl) -1,2-butadiene (2j)[10]



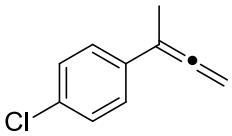
Yellow oily liquid (125.8 mg, 85% yield). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.37 (dd, *J* = 8.7, 5.4 Hz, 2H), 7.02 (t, *J* = 8.7 Hz, 2H), 5.03 (q, *J* = 3.4 Hz, 2H), 2.09 (t, *J* = 3.2 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 208.76 (*J* =2.6 Hz), 161.73 (*J* =244.3 Hz), 132.63 (*J* =3.3 Hz), 127.13 (*J* =8.0 Hz), 115.11 (*J* =21.8 Hz), 98.99, 77.01, 16.80. HRMS: *m/z* $(M+H)^+$ calcd for $C_{10}H_{10}F$: 149.0761; Found: 149.0760.

3-(4-Fluorophenyl)-1,2-hexadiene (2k)



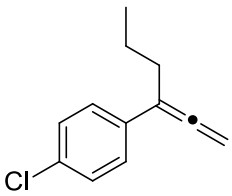
Yellow oily liquid (128 mg, 73% yield). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.36 (dd, *J* = 8.7, 5.5 Hz, 2H), 7.00 (t, *J* = 8.7 Hz, 2H), 5.06 (d, *J* = 3.4 Hz, 2H), 2.37 (tt, *J* = 7.4, 3.3 Hz, 2H), 1.57 (h, *J* = 7.4 Hz, 2H), 0.99 (t, *J* = 7.4 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 208.44, 161.66 (*J* =244.4 Hz), 132.44 (*J* =3.2 Hz), 127.43 (*J* =7.5 Hz), 115.12 (*J* =21.3 Hz), 104.01, 78.11, 31.78, 21.00, 13.86. HRMS: *m/z* $(M+H)^+$ calcd for $C_{12}H_{14}F$: 177.1074; Found: 177.1073.

3-(4-Chlorophenyl)-1,2-butadiene (2l)[3, 10, 12]



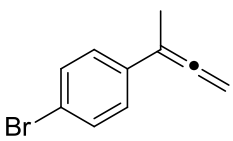
Yellow oily liquid (128 mg, 78% yield). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.32 (d, *J* = 8.6 Hz, 2H), 7.28 (d, *J* = 8.7 Hz, 2H), 5.03 (q, *J* = 3.0 Hz, 2H), 2.07 (t, *J* = 3.2 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 208.89, 135.25, 132.23, 128.36, 126.88, 99.03, 77.23, 16.60. HRMS: *m/z* $(M+H)^+$ calcd for $C_{10}H_{10}Cl$: 165.0466; Found: 165.0468.

3-(4-Chlorophenyl)-1,2-hexadiene (2m)



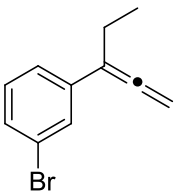
Yellow oily liquid (140.7 mg, 73% yield). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.32 (d, *J* = 8.6 Hz, 2H), 7.27 (d, *J* = 8.6 Hz, 2H), 5.07 (t, *J* = 3.3 Hz, 2H), 2.37 – 2.34 (m, 2H), 1.60 – 1.53 (m, 2H), 0.99 (t, *J* = 7.3 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 208.57, 135.06, 132.15, 128.40, 127.20, 104.05, 78.36, 31.52, 20.99, 13.86. HRMS: *m/z* $(M+H)^+$ calcd for $C_{12}H_{14}Cl$: 193.0779; Found: 193.0781.

3-(4-Bromophenyl)-1,2-butadiene (2n)[3, 10]



Yellow oily liquid (165.2 mg, 79% yield). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.43 (d, *J* = 8.6 Hz, 2H), 7.26 (d, *J* = 8.6 Hz, 2H), 5.02 (q, *J* = 3.2 Hz, 2H), 2.07 (t, *J* = 3.1 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 208.88, 135.76, 131.32, 127.25, 120.36, 99.10, 77.31, 16.55. HRMS: *m/z* $(M+H)^+$ calcd for $C_{10}H_{10}Br$: 208.9960; Found: 208.9959.

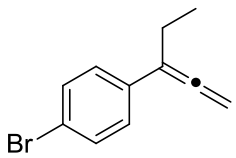
3-(3-Bromophenyl)-1,2-pentadiene (2o)



Yellow oily liquid (171.7mg, 77% yield). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.55 (s, 1H), 7.32 (d, *J* = 7.7 Hz, 2H), 7.18 (t, *J* = 7.9 Hz, 1H), 5.14 (t, *J* = 3.7 Hz, 2H), 2.39 (qt, *J* = 7.3, 3.7 Hz, 2H), 1.15

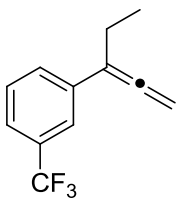
(t, *J* = 7.3 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 208.40, 138.98, 129.73, 129.40, 128.92, 124.39, 122.64, 105.85, 79.30, 22.26, 12.34. HRMS: *m/z* $(M+H)^+$ calcd for $C_{11}H_{12}Br$: 223.0117; Found: 223.0119.

3-(4-Bromophenyl)-1,2-pentadiene (2p)[5]



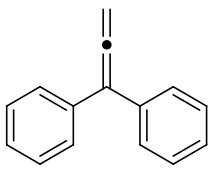
Yellow oily liquid (169.5 mg, 76% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.44 (d, *J* = 8.6 Hz, 2H), 7.28 (d, *J* = 8.2 Hz, 2H), 5.12 (s, 2H), 2.40 (dq, *J* = 7.3, 3.6 Hz, 2H), 1.15 (t, *J* = 7.2 Hz, 3H). ^{13}C NMR (101 MHz, $CDCl_3$) δ 208.50, 135.80, 131.61, 127.73, 120.54, 106.21, 79.53, 22.49, 12.61. HRMS: *m/z* $(M+H)^+$ calcd for $C_{11}H_{12}Br$: 223.0117; Found: 223.0115.

3-(3-Trifluoromethylphenyl)-1,2-pentadiene (2q)



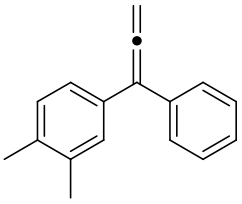
Yellow oily liquid (91.2 mg, 43% yield). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.63 (s, 1H), 7.57 (t, *J* = 6.7 Hz, 1H), 7.43 (t, *J* = 9.3 Hz, 2H), 5.17 (t, *J* = 3.7 Hz, 2H), 2.44 (qt, *J* = 7.3, 3.7 Hz, 2H), 1.16 (t, *J* = 7.3 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 208.47, 137.62, 129.02, 128.66, 123.12, 123.10, 122.56, 122.53, 105.95, 22.26, 12.28. HRMS: *m/z* $(M+H)^+$ calcd for $C_{12}H_{12}F_3$: 213.0886; Found: 213.0890.

1,1-Diphenyl-1,2-propadiene (2r)[3, 4, 11]



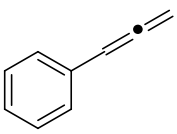
Yellow oily liquid (188.2 mg, 98% yield). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.39 – 7.33 (m, 8H), 7.28 (t, *J* = 6.9 Hz, 2H), 5.27 (s, 2H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 209.86, 136.24, 128.40, 128.38, 127.19, 109.13, 78.03. HRMS: *m/z* $(M+H)^+$ calcd for $C_{15}H_{13}$: 193.1012; Found: 193.1011.

1-Phenyl-1-(3,4-dimethylphenyl)-1,2-propadiene (2s)[13]



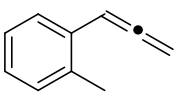
Yellow oily liquid (195.7 mg, 89% yield). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.37 – 7.33 (m, 4H), 7.27 (t, *J* = 7.1 Hz, 1H), 7.15 (s, 1H), 7.12 (d, *J* = 7.8 Hz, 1H), 7.09 (d, *J* = 7.9 Hz, 1H), 5.24 (s, 2H), 2.28 (s, 3H), 2.26 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 209.71, 136.58, 136.49, 135.67, 133.60, 129.66, 129.56, 128.36, 128.31, 127.04, 125.86, 108.97, 77.78, 19.76, 19.45. HRMS: *m/z* $(M+H)^+$ calcd for $C_{17}H_{17}$: 221.1325; Found: 221.1329.

Phenylpropadiene (5a)[18-20]



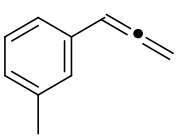
Yellow oily liquid (60.3 mg, 52% yield). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.31 (d, *J* = 4.8 Hz, 4H), 7.21 (dt, *J* = 9.3, 4.6 Hz, 1H), 6.18 (t, *J* = 6.8 Hz, 1H), 5.15 (d, *J* = 6.8 Hz, 2H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 209.77, 133.89, 128.58, 126.86, 126.66, 93.93, 78.74. HRMS: *m/z* $(M+H)^+$ calcd for C_9H_9: 117.0669; Found: 117.0671.

(2-Methylphenyl)propadiene (5b)[3, 4, 21]



Yellow oily liquid (59.8 mg, 46% yield). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.39 (d, *J* = 7.7 Hz, 1H), 7.18 – 7.09 (m, 3H), 6.35 (t, *J* = 6.9 Hz, 1H), 5.12 (d, *J* = 6.8 Hz, 2H), 2.36 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 210.37, 134.85, 132.08, 130.41, 127.15, 126.78, 126.10, 91.13, 77.91, 19.78. HRMS: *m/z* $(M+H)^+$ calcd for $C_{10}H_{11}$: 131.0855; Found: 131.0853.

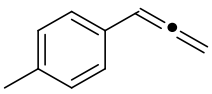
(3-Methylphenyl)propadiene (5c)[3, 21]



Yellow oily liquid (65 mg, 50% yield). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.23 (t, *J* = 7.6 Hz, 1H), 7.15 (s, 1H), 7.13 (d, *J* = 7.8 Hz, 1H), 7.05 (d, *J* = 7.6 Hz, 1H), 6.17 (t, *J* = 6.8 Hz, 1H), 5.16 (d, *J* = 6.8 Hz, 2H), 2.37 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 209.79, 138.19, 133.77, 128.50,

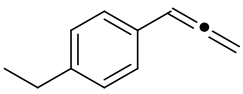
127.73, 127.34, 123.87, 93.95, 78.64, 21.34. HRMS: *m/z* $(M+H)^+$ calcd for $C_{10}H_{11}$: 131.0855; Found: 131.0854.

(4-Methylphenyl)propadiene (5d)[3, 20, 21]



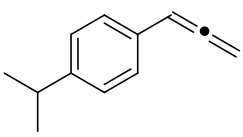
Yellow oily liquid (62.4 mg, 48% yield). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.23 (d, *J* = 8.0 Hz, 2H), 7.15 (d, *J* = 7.8 Hz, 2H), 6.17 (t, *J* = 6.8 Hz, 1H), 5.15 (d, *J* = 6.8 Hz, 2H), 2.36 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 209.61, 136.63, 130.89, 129.34, 126.59, 93.75, 78.65, 21.16. HRMS: *m/z* $(M+H)^+$ calcd for $C_{10}H_{11}$: 131.0855; Found: 131.0856.

(4-Ethylphenyl)propadiene (5e)[22]



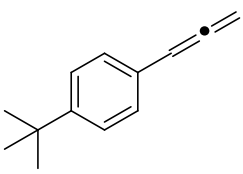
Yellow oily liquid (67.7 mg, 47% yield). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.26 (d, *J* = 8.2 Hz, 2H), 7.18 (d, *J* = 8.4 Hz, 2H), 6.19 (t, *J* = 6.8 Hz, 1H), 5.16 (d, *J* = 6.8 Hz, 2H), 2.67 (q, *J* = 7.6 Hz, 2H), 1.27 (t, *J* = 7.6 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 209.68, 143.09, 131.16, 128.16, 126.67, 93.76, 78.61, 28.61, 15.62. HRMS: *m/z* $(M+H)^+$ calcd for $C_{11}H_{13}$: 145.1012; Found: 145.1010.

(4-Isopropylphenyl)propadiene (5f)



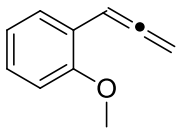
Yellow oily liquid (71.1 mg, 45% yield). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.22 (d, *J* = 8.1 Hz, 2H), 7.16 (d, *J* = 8.2 Hz, 2H), 6.14 (t, *J* = 6.8 Hz, 1H), 5.11 (d, *J* = 6.8 Hz, 2H), 2.91 – 2.84 (m, 1H), 1.24 (d, *J* = 1.8 Hz, 3H), 1.23 (d, *J* = 1.9 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 209.66, 147.71, 130.26, 126.67, 123.13, 93.65, 78.56, 33.81, 23.93. HRMS: *m/z* $(M+H)^+$ calcd for $C_{12}H_{15}$: 159.1168; Found: 159.1170.

(4-*tert*-Butylphenyl)propadiene (5g)[21]



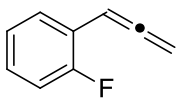
Yellow oily liquid (72.3 mg, 42% yield). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.36 (d, *J* = 8.4 Hz, 2H), 7.26 (d, *J* = 8.3 Hz, 2H), 6.17 (t, *J* = 6.8 Hz, 1H), 5.14 (d, *J* = 6.8 Hz, 2H), 1.34 (s, 9H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 209.77, 149.96, 130.92, 126.39, 125.56, 93.58, 78.55, 34.52, 31.31. HRMS: *m/z* $(M+H)^+$ calcd for $C_{13}H_{17}$: 173.1325; Found: 173.1322.

2-Methoxyphenyl)propadiene (5h)[3, 20, 23]



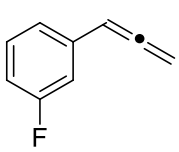
Yellow oily liquid (59.8 mg, 41% yield). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.40 (d, *J* = 7.5 Hz, 1H), 7.18 (t, *J* = 7.8 Hz, 1H), 6.93 (t, *J* = 7.4 Hz, 1H), 6.86 (d, *J* = 8.1 Hz, 1H), 6.57 (t, *J* = 6.9 Hz, 1H), 5.11 (d, *J* = 6.9 Hz, 2H), 3.84 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 210.14, 155.84, 127.90, 127.71, 122.34, 120.75, 110.90, 87.77, 77.96, 55.54. HRMS: *m/z* $(M+H)^+$ calcd for $C_{10}H_{11}O$: 147.0804; Found: 147.0803.

(2-Fluorophenyl)propadiene (5i)[24]



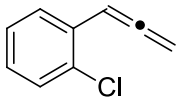
Yellow oily liquid (73.7 mg, 55% yield). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.39 (t, *J* = 7.6 Hz, 1H), 7.16 (q, *J* = 6.5, 5.6 Hz, 1H), 7.08 (t, *J* = 7.4 Hz, 1H), 7.03 – 6.99 (m, 1H), 6.39 (t, *J* = 6.9 Hz, 1H), 5.16 (d, *J* = 6.9 Hz, 2H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 210.25, 159.47 (*J* =247.6 Hz), 128.18, 128.11 (*J* =4.3 Hz), 124.07 (*J* =3.5 Hz), 121.48 (*J* =12.2 Hz), 115.5 (*J* =21.3 Hz), 86.38 (*J* =6.3 Hz), 78.74. HRMS: *m/z* $(M+H)^+$ calcd for C_9H_8F: 135.0605; Found: 135.0607.

(3-Fluorophenyl)propadiene (5j)[25]



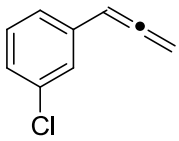
Yellow oily liquid (77.7 mg, 58% yield). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.26 – 7.23 (m, 1H), 7.05 (d, *J* = 7.7 Hz, 1H), 7.01 (d, *J* = 10.3 Hz, 1H), 6.89 (t, *J* = 8.6 Hz, 1H), 6.13 (t, *J* = 6.8 Hz, 1H), 5.17 (d, *J* = 6.8 Hz, 2H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 209.92, 163.14 (*J* =243.8 Hz), 136.45 (*J* =7.9 Hz), 129.93 (*J* =8.4 Hz), 122.4 (*J* =2.8 Hz), 113.71 (*J* =21.3 Hz), 113.20 (*J* =22.3 Hz), 93.32 (*J* =2.6 Hz), 79.19. HRMS: *m/z* $(M+H)^+$ calcd for C_9H_8F: 135.0605; Found: 135.0606.

(2-Chlorophenyl)propadiene (5k)[3]



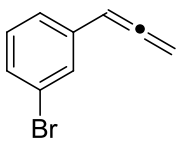
Yellow oily liquid (81 mg, 54% yield). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.47 (d, *J* = 7.6 Hz, 1H), 7.33 (d, *J* = 7.4 Hz, 1H), 7.20 (t, *J* = 7.2 Hz, 1H), 7.12 (t, *J* = 7.6 Hz, 1H), 6.62 (t, *J* = 6.8 Hz, 1H), 5.18 (d, *J* = 6.8 Hz, 2H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 210.49, 131.9, 131.72, 129.61, 128.19, 127.85, 126.75, 90.35. 78.91. HRMS: *m/z* $(M+H)^+$ calcd for C_9H_8Cl: 151.0309; Found: 151.0310.

(3-Chlorophenyl)propadiene (5l)[3, 25]



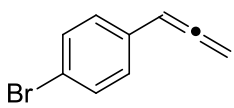
Yellow oily liquid (82.5 mg, 55% yield). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.28 (s, 1H), 7.22 (t, *J* = 7.8 Hz, 1H), 7.17 – 7.14 (m, 2H), 6.10 (t, *J* = 6.8 Hz, 1H), 5.18 (d, *J* = 6.8 Hz, 2H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 209.91, 135.97, 134.53, 129.72, 126.85, 126.52, 124.80, 93.08, 79.30. HRMS: *m/z* $(M+H)^+$ calcd for C_9H_8Cl : 151.0309; Found: 151.0307.

(3-Bromophenyl)propadiene (5m)[13]



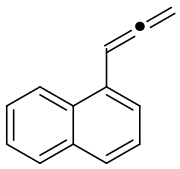
Yellow oily liquid (109 mg, 56% yield). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.45 (s, 1H), 7.32 (d, *J* = 8.1 Hz, 1H), 7.20 (d, *J* = 7.9 Hz, 1H), 7.16 (t, *J* = 7.7 Hz, 1H), 6.09 (t, *J* = 6.8 Hz, 1H), 5.19 (d, *J* = 6.8 Hz, 2H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 209.90, 136.27, 130.02, 129.76, 129.46, 125.26, 122.77, 92.99, 79.33. HRMS: *m/z* $(M+H)^+$ calcd for C_9H_8Br : 194.9804; Found: 194.9805.

(4-bromophenyl)propadiene (5n)[3, 21, 26]



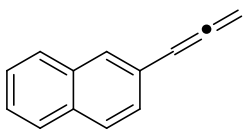
Yellow oily liquid (105.3 mg, 54% yield). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.42 (d, *J* = 8.4 Hz, 2H), 7.15 (d, *J* = 8.4 Hz, 2H), 6.10 (t, *J* = 6.8 Hz, 1H), 5.14 (d, *J* = 6.8 Hz, 2H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 209.79, 132.95, 131.67, 128.18, 120.49, 93.19, 79.24. HRMS: *m/z* $(M+H)^+$ calcd for C_9H_8Br : 194.9804; Found: 194.9806.

(1-Naphthyl)propadiene (5o)[3, 27, 28]



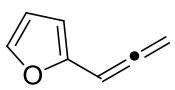
Yellow oily liquid (114.5 mg, 69% yield). ^{1}H NMR (600 MHz, $CDCl_3$) δ 8.23 (d, *J* = 8.2 Hz, 1H), 7.88 (d, *J* = 8.5 Hz, 1H), 7.76 (d, *J* = 8.1 Hz, 1H), 7.62 (d, *J* = 7.1 Hz, 1H), 7.55 – 7.50 (m, 2H), 7.47 (t, *J* = 7.7 Hz, 1H), 6.89 (t, *J* = 6.9 Hz, 1H), 5.23 (d, *J* = 6.9 Hz, 2H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 211.05, 133.95, 130.81, 130.14, 128.66, 127.48, 126.01, 125.71, 125.62, 125.33, 123.51, 90.45, 77.83. HRMS: *m/z* $(M+H)^+$ calcd for $C_{13}H_{11}$: 167.0855; Found: 167.0856.

(2-Naphthyl)propadiene (5p)[20, 22, 29]



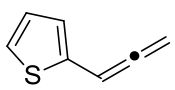
Yellow oily liquid (117.8 mg, 71% yield). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.79 (t, *J* = 8.8 Hz, 3H), 7.66 (s, 1H), 7.51 (d, *J* = 8.5 Hz, 1H), 7.48 – 7.41 (m, 2H), 6.35 (t, *J* = 6.8 Hz, 1H), 5.23 (d, *J* = 6.8 Hz, 2H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 210.32, 133.67, 132.59, 131.40, 128.22, 127.69, 127.64, 126.20, 125.60, 125.39, 124.61, 94.31, 79.06. HRMS: *m/z* $(M+H)^+$ calcd for $C_{13}H_{11}$: 167.0855; Found: 167.0852.

(1-Furyl)propadiene (5q)[30]



Yellow oily liquid (55 mg, 52% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37 (s, 1H), 6.39 (dd, *J* = 3.2, 1.9 Hz, 1H), 6.23 (s, 1H), 6.16 (t, *J* = 6.9 Hz, 1H), 5.22 (dt, *J* = 6.9, 0.9 Hz, 2H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 209.35, 142.07, 122.77, 111.40, 107.16, 84.96, 79.45. HRMS: *m/z* $(M+H)^+$ calcd for C_7H_7O : 107.0491; Found: 107.0490.

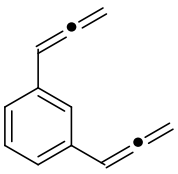
(1-Thienyl)propadiene (5r)[22]



Brown liquid (78 mg, 64% yield). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.16 (d, *J* = 5.1 Hz, 1H), 6.96 – 6.93 (m, 1H), 6.90 (d, *J* = 3.5 Hz, 1H), 6.39 (t, *J* = 6.8 Hz, 1H), 5.15 (d, *J* = 6.8 Hz, 2H). ^{13}C

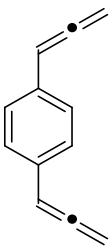
NMR (151 MHz, $CDCl_3$) δ 209.38, 137.86, 127.36, 124.64, 124.50, 88.45, 79.16. HRMS: *m/z* $(M+H)^+$ calcd for C_7H_7S: 123.0263; Found: 123.0260.

1,3-Di(propa-1,2-dien-1-yl)benzene (5s)



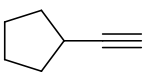
Yellow oily liquid (100.1 mg, 65% yield). ^1H NMR (600 MHz, $CDCl_3$) δ 7.24 (t, *J* = 7.6 Hz, 1H), 7.21 (s, 1H), 7.14 (d, *J* = 7.4 Hz, 2H), 6.14 (t, *J* = 6.8 Hz, 2H), 5.15 (d, *J* = 6.8 Hz, 4H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 209.79, 134.22, 128.79, 125.26, 124.89, 93.75, 78.82. HRMS: *m/z* $(M+H)^+$ calcd for $C_{12}H_{11}$: 155.0855; Found: 155.0850.

1,4-Di(propa-1,2-dien-1-yl)benzene (5t)[31]



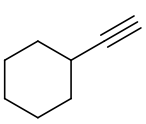
Yellow oily liquid (101.6 mg, 66% yield). ^1H NMR (600 MHz, $CDCl_3$) δ 7.23 (s, 4H), 6.14 (t, *J* = 6.6 Hz, 2H), 5.14 (d, *J* = 6.6 Hz, 4H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 209.88, 132.48, 126.90, 93.75, 78.83. HRMS: *m/z* $(M+H)^+$ calcd for $C_{12}H_{11}$: 155.0855; Found: 155.0858.

Cyclopentylethyne (7a)[14]



Colorless liquid (59 mg, 63% yield). ^1H NMR (600 MHz, $CDCl_3$) δ 2.66 (t, *J* = 7.6 Hz, 1H), 2.31 (s, 1H), 1.89 (t, *J* = 5.6 Hz, 2H), 1.72 – 1.69 (m, 2H), 1.64 – 1.60 (m, 2H), 1.55 – 1.52 (m, 2H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 82.20, 64.70, 33.56, 30.49, 24.99. HRMS: *m/z* $(M+H)^+$ calcd for C_7H_{11}: 95.0855; Found: 95.0855.

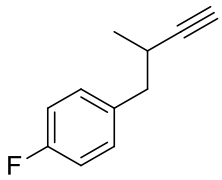
Cyclohexylethyne (7b)[15, 16]



Colorless liquid (67 mg, 62% yield). ^1H NMR (600 MHz, $CDCl_3$) δ 2.42 (t, *J* = 9.0 Hz, 1H), 1.78 (d, *J* = 10.4 Hz, 2H), 1.69 (dd, *J* = 9.1, 3.6 Hz, 2H), 1.53 (s, 1H), 1.47 – 1.41 (m, 2H), 1.31 – 1.25

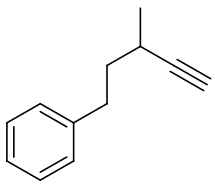
(m, 4H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 81.87, 65.06, 32.26, 29.48, 25.72, 24.75. HRMS: *m/z* $(M+H)^+$ calcd for C_8H_{13}: 109.1012; Found: 109.1014.

3-Methyl-4-(4-fluorophenyl)-1-butyne (7c)



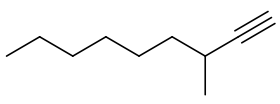
Colorless liquid (108 mg, 67% yield). ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.22 – 7.16 (m, 2H), 6.98 (t, *J* = 8.5 Hz, 2H), 2.81 – 2.75 (m, 1H), 2.69 (d, *J* = 9.0 Hz, 2H), 2.07 (s, 1H), 1.20 (d, *J* = 6.1 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 161.61 (*J* =242.7 Hz), 134.93 (*J* =3.4 Hz), 130.56 (*J* =8.1 Hz), 114.91 (*J* =20.7 Hz), 88.12, 69.24, 41.94, 27.76, 20.41. HRMS: *m/z* $(M+H)^+$ calcd for $C_{11}H_{12}F$: 163.0918; Found: 163.0919.

3-Methyl-5-phenyl-1-pentyne (7d)[17]



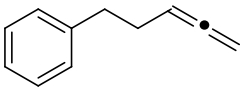
Colorless liquid (102 mg, 65% yield). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.30 (t, *J* = 7.6 Hz, 2H), 7.23 – 7.19 (m, 3H), 2.88 – 2.83 (m, 1H), 2.77 – 2.71 (m, 1H), 2.49 – 2.44 (m, 1H), 2.12 (d, *J* = 2.4 Hz, 1H), 1.82 – 1.73 (m, 2H), 1.23 (d, *J* = 6.9 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 141.91, 128.48, 128.34, 125.82, 88.68, 68.75, 38.47, 33.51, 25.20, 20.95. HRMS: *m/z* $(M+H)^+$ calcd for $C_{12}H_{15}$: 159.1168; Found: 159.1168.

3-Methyl-1-nonyne (7e)



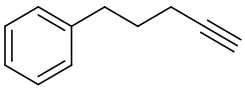
Colorless liquid (90.8 mg, 66% yield). ^{1}H NMR (600 MHz, $CDCl_3$) δ 2.50 – 2.44 (m, 1H), 1.46 – 1.25 (m, 11H), 1.16 (d, *J* = 6.9 Hz, 3H), 0.89 – 0.86 (m, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 82.29, 65.25, 36.64, 31.72, 29.07, 27.29, 26.45, 22.61, 20.65, 14.04. HRMS: *m/z* $(M+H)^+$ calcd for $C_{10}H_{19}$: 139.1481; Found: 139.1480.

5-Phenyl-1,2-pentadiene (9a)[26, 32, 33]



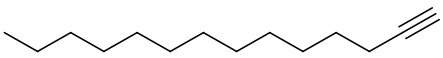
Yellow oily liquid (24.5 mg, 17% yield). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.29 – 7.26 (m, 2H), 7.19 (d, *J* = 8.2 Hz, 3H), 5.14 (p, *J* = 6.7 Hz, 1H), 4.67 (dt, *J* = 6.6, 3.2 Hz, 2H), 2.74 – 2.71 (m, 2H), 2.34 – 2.29 (m, 2H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 208.53, 141.70, 128.45, 128.26, 125.83, 89.39, 75.08, 35.35, 29.94. HRMS: *m/z* $(M+H)^+$ calcd for $C_{11}H_{12}$: 145.1012; Found: 145.1009.

5-Phenyl-1-pentyne (10a)[34-36]



Yellow oily liquid (97.8 mg, 68% yield). ^{1}H NMR (600 MHz, $CDCl_3$) δ 7.30 – 7.28 (m, 2H), 7.21 (d, *J* = 7.2 Hz, 3H), 2.81 (t, *J* = 7.7 Hz, 1H), 2.76 – 2.73 (m, 2H), 2.21 (td, *J* = 7.0, 2.6 Hz, 2H), 1.88 – 1.84 (m, 2H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 141.46, 128.50, 128.35, 125.91, 84.17, 68.65, 34.62, 30.04, 17.81 . HRMS: *m/z* $(M+H)^+$ calcd for $C_{11}H_{12}$: 145.1012; Found: 145.1011.

Tetradec-1-yne (10b)[37]



Colorless liquid (122.1 mg, 63% yield). ^{1}H NMR (600 MHz, $CDCl_3$) δ 2.17 (td, *J* = 7.1, 2.6 Hz, 2H), 1.93 (t, *J* = 2.6 Hz, 1H), 1.54 – 1.49 (m, 2H), 1.38 (p, *J* = 7.2 Hz, 2H), 1.30 – 1.25 (m, 16H), 0.87 (t, *J* = 7.0 Hz, 3H). ^{13}C NMR (151 MHz, $CDCl_3$) δ 84.78, 67.97, 31.89, 29.63, 29.60, 29.58, 29.48, 29.32, 29.09, 28.74, 28.48, 22.66, 18.37, 14.08. HRMS: *m/z* $(M+H)^+$ calcd for $C_{14}H_{27}$: 195.2107; Found: 195.2109.

3. The ^{1}H NMR and ^{13}C NMR spectra for products 2a−s, 5a−t, 7a−e, 9a, 10a−b

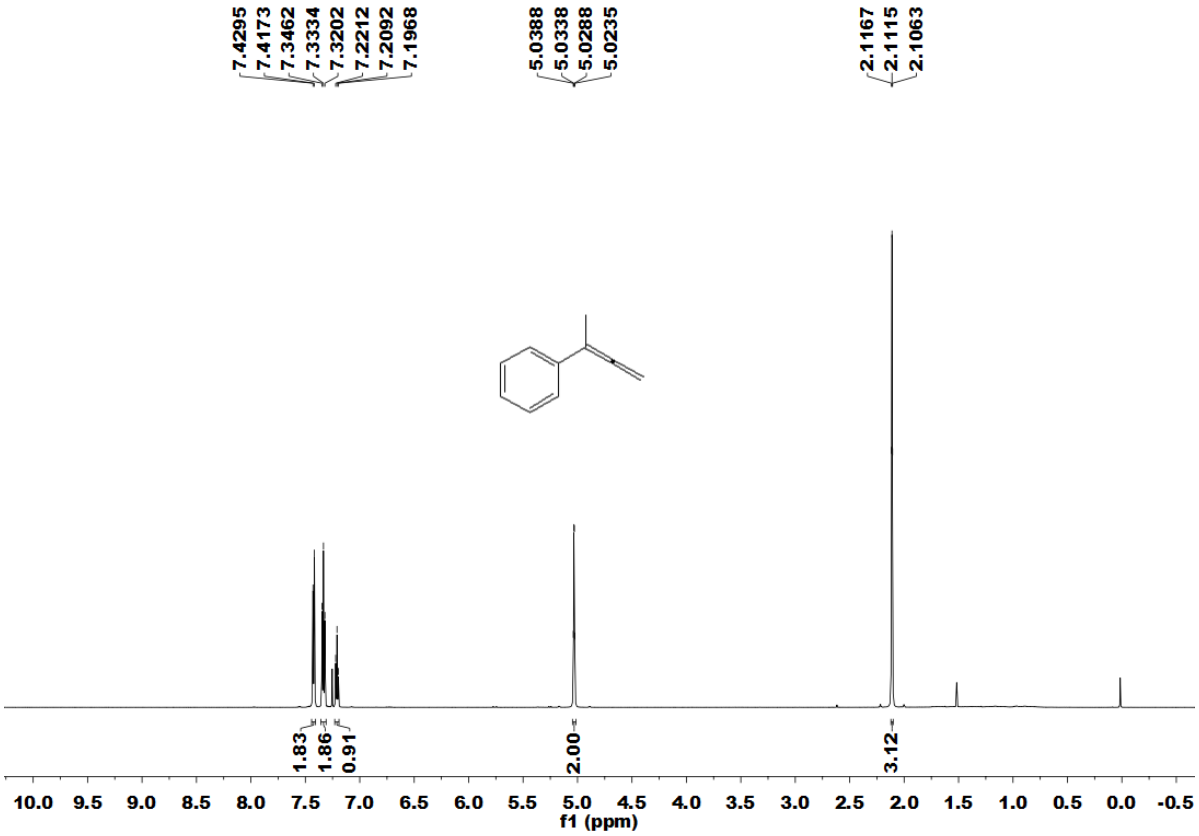


Fig. S1 ^{1}H NMR of 3-Phenyl-1,2-butadiene (**2a**)

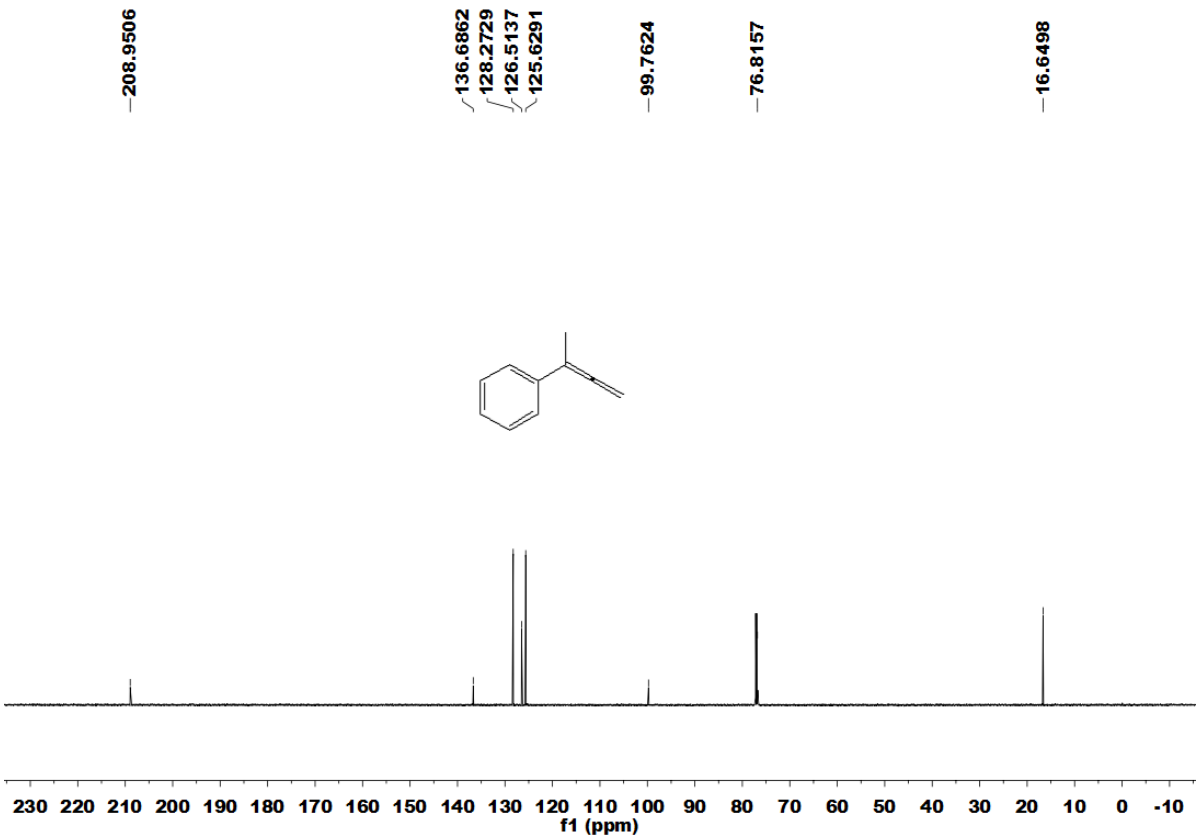


Fig. S2 ^{13}C NMR of 3-phenyl-1,2-butadiene (**2a**)

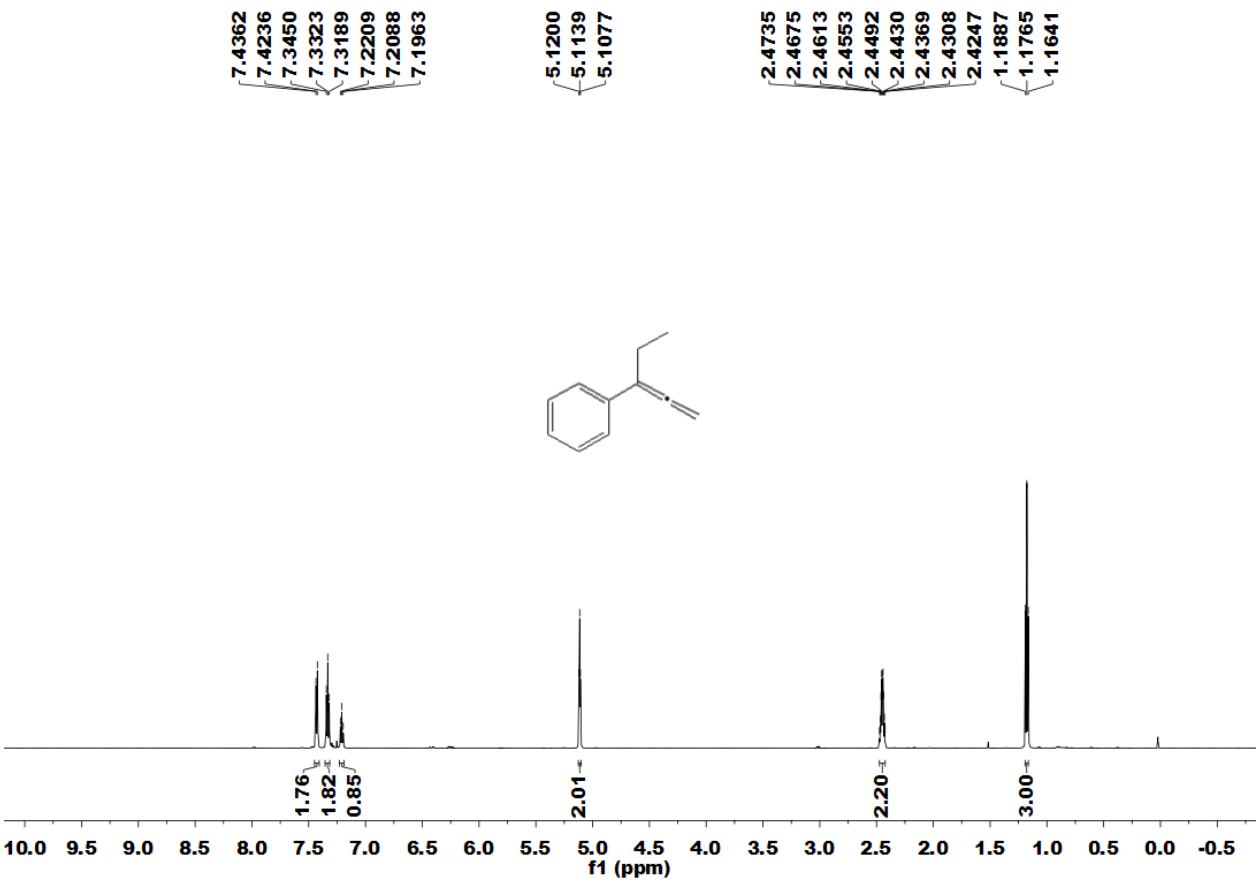


Fig.S3 ^{1}H NMR of 3-phenyl-1,2-pentadiene (**2b**)

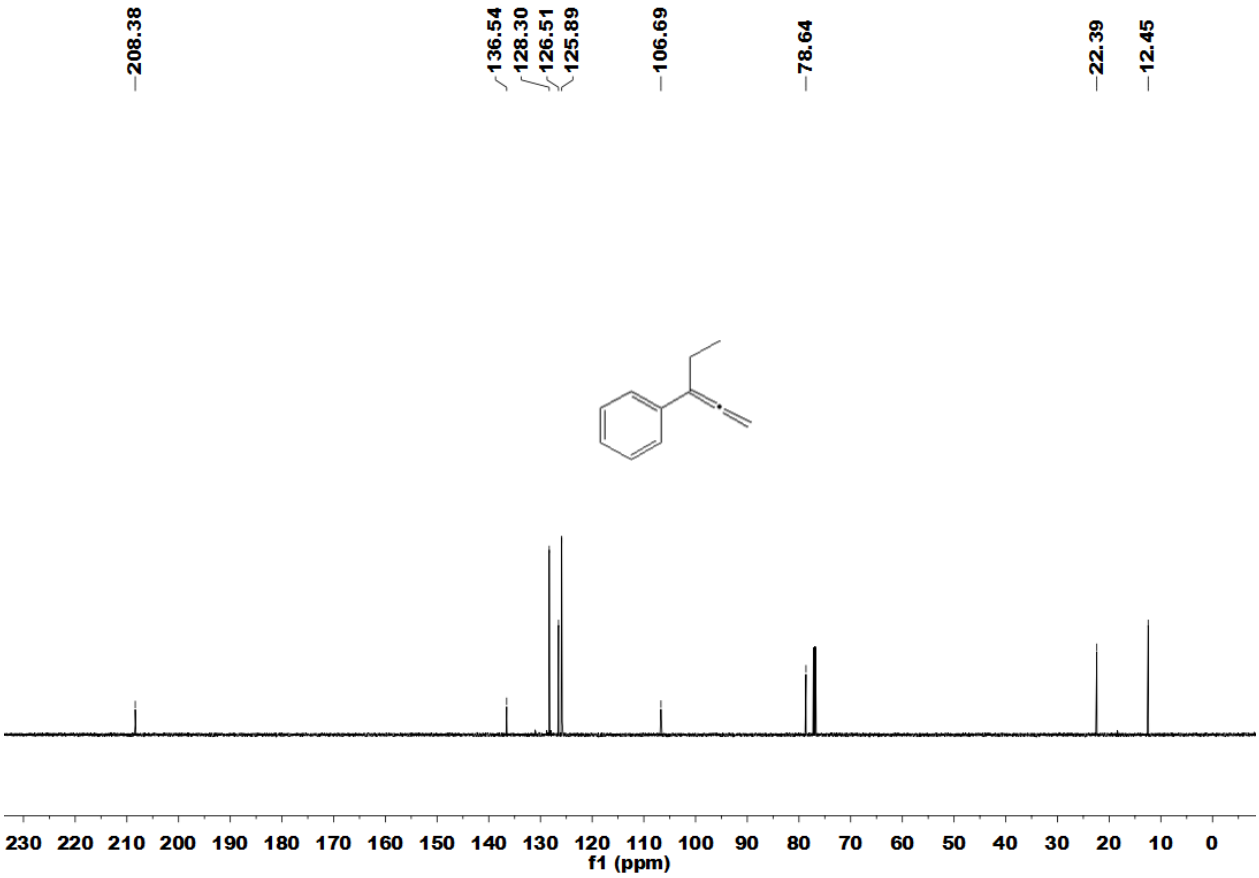


Fig. S4 ^{13}C NMR of 3-phenyl-1,2-pentadiene (**2b**)

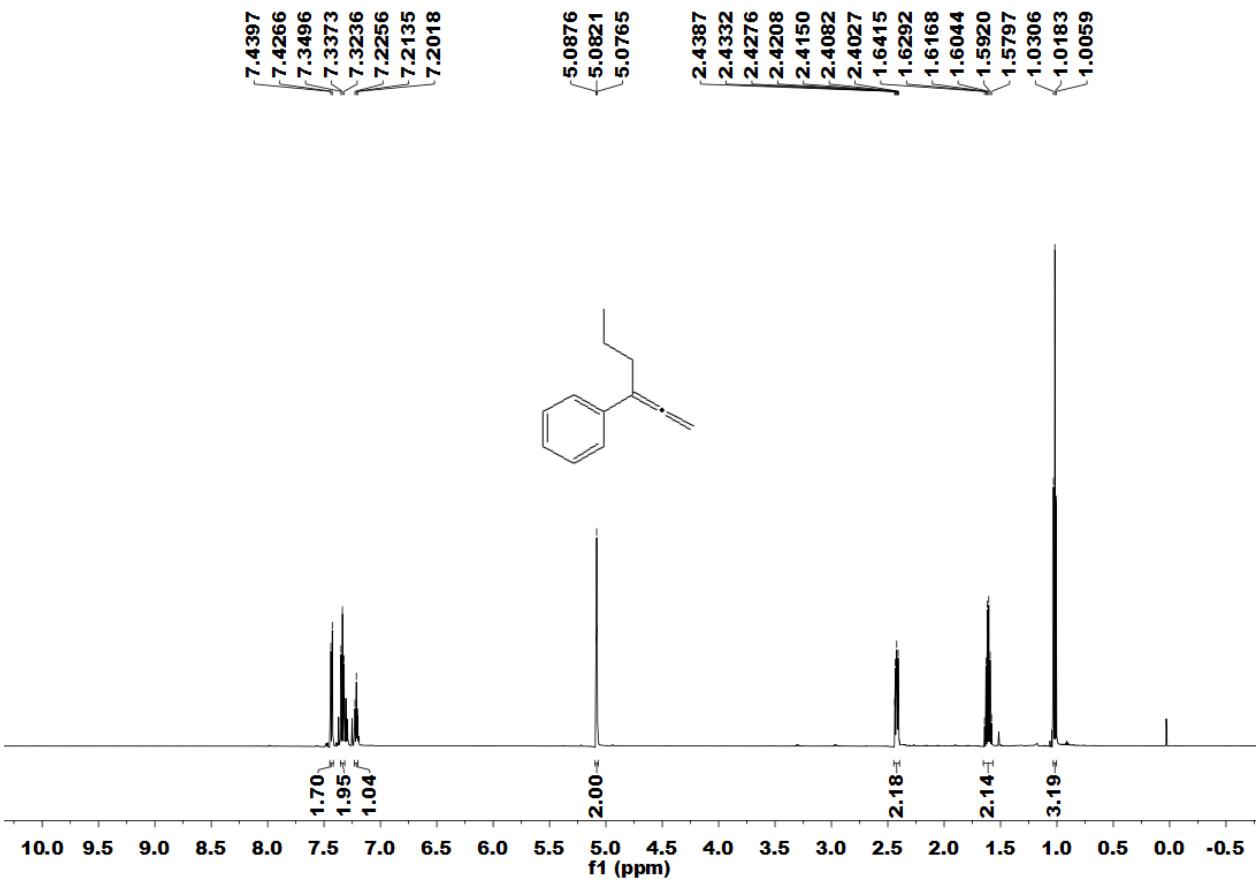


Fig. S5 ^{1}H NMR of 3-phenyl-1,2-hexadiene (**2c**)

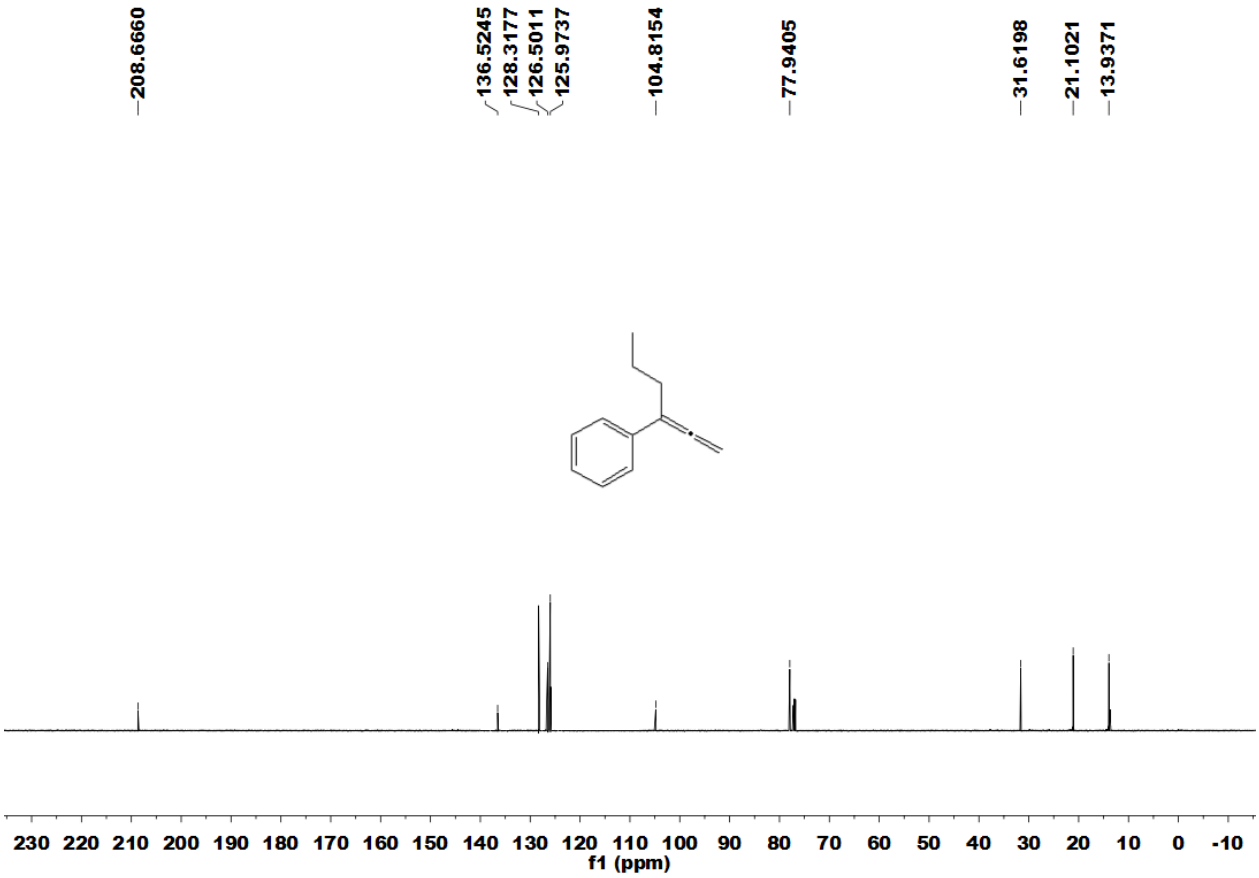


Fig. S6 ^{13}C NMR of 3-phenyl-1,2-hexadiene (**2c**)

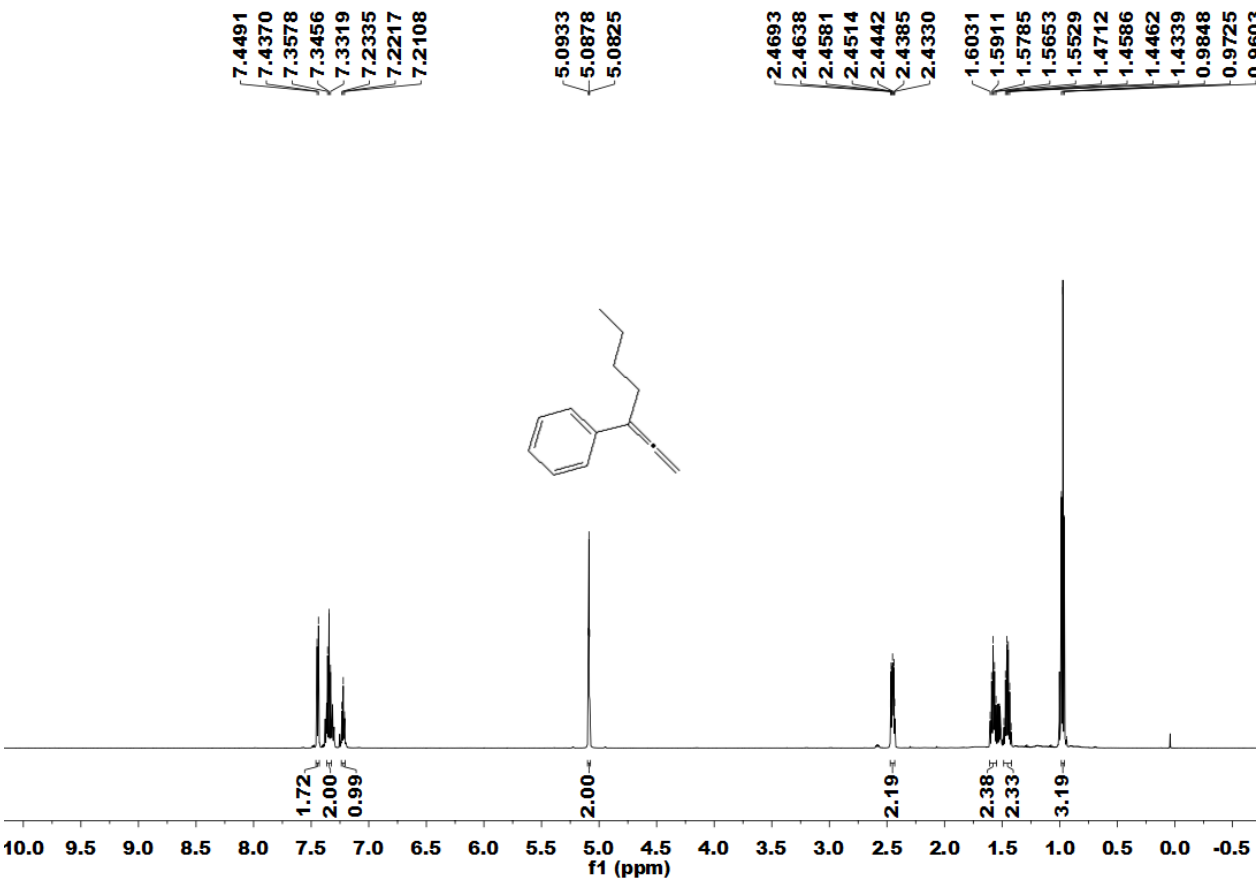


Fig. S7 ^{1}H NMR of 3-phenyl-1,2-heptadiene (**2d**)

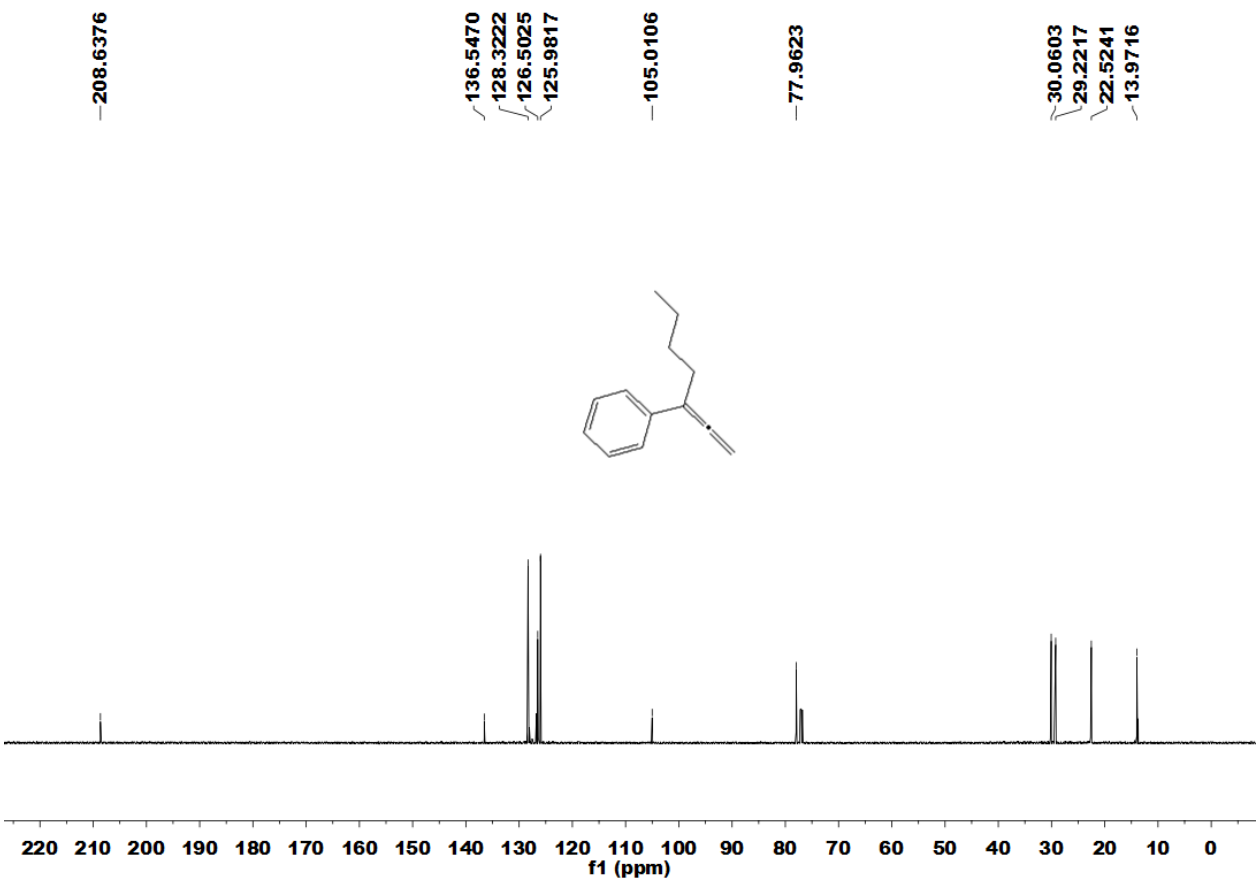


Fig. S8 ^{13}C NMR of 3-phenyl-1,2-heptadiene (**2d**)

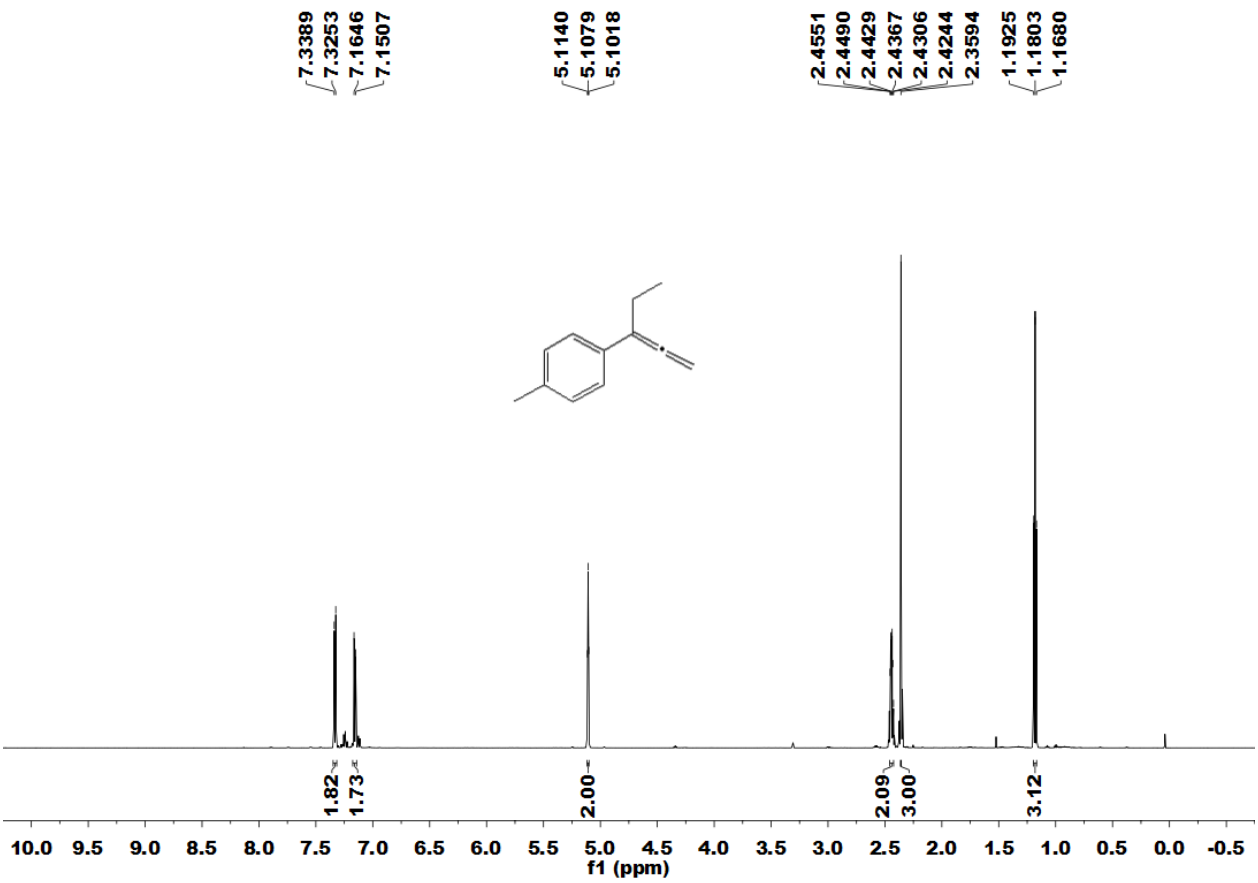


Fig. S9 ^{1}H NMR of 3-(4-methylphenyl)-1,2-pentadiene (**2e**)

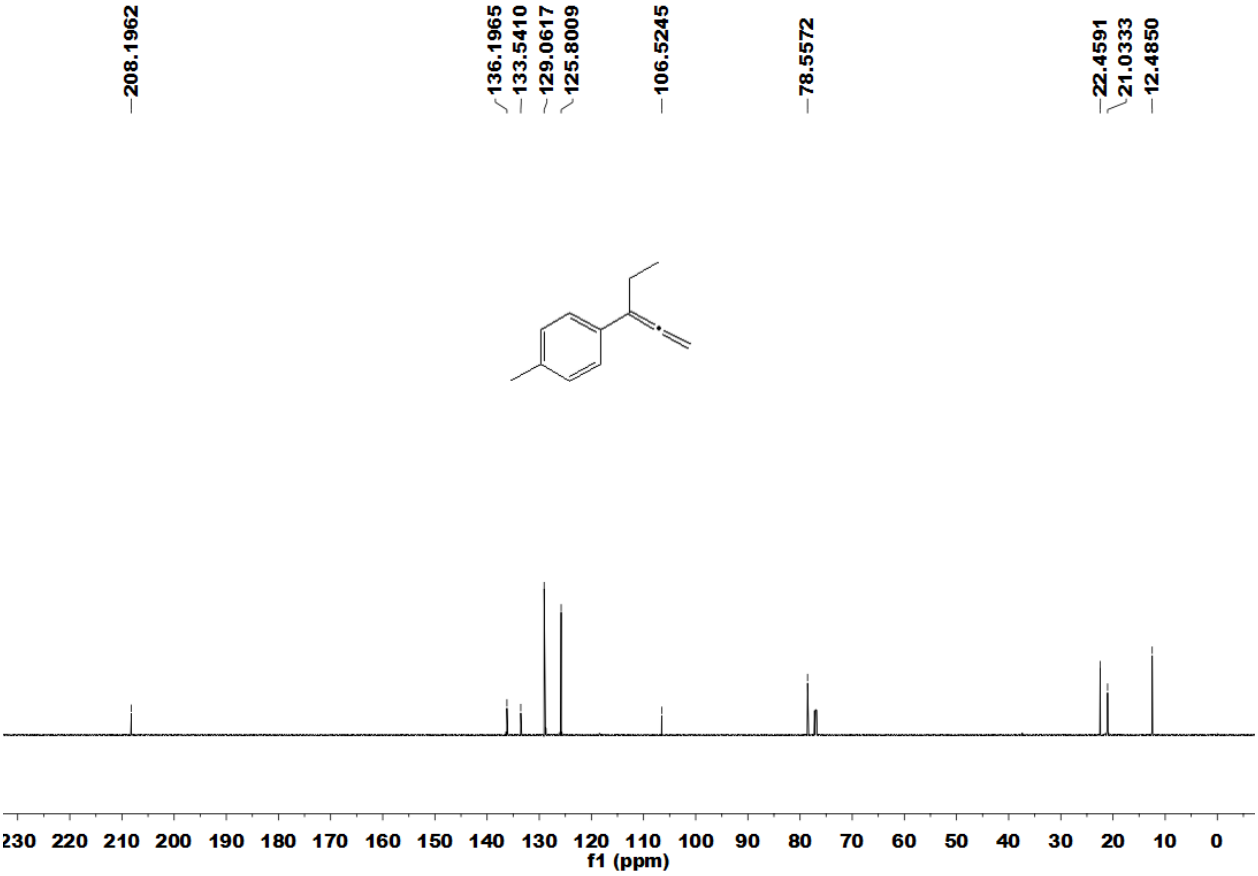


Fig. S10 ^{13}C NMR of 3-(4-methylphenyl)-1,2-pentadiene (**2e**)

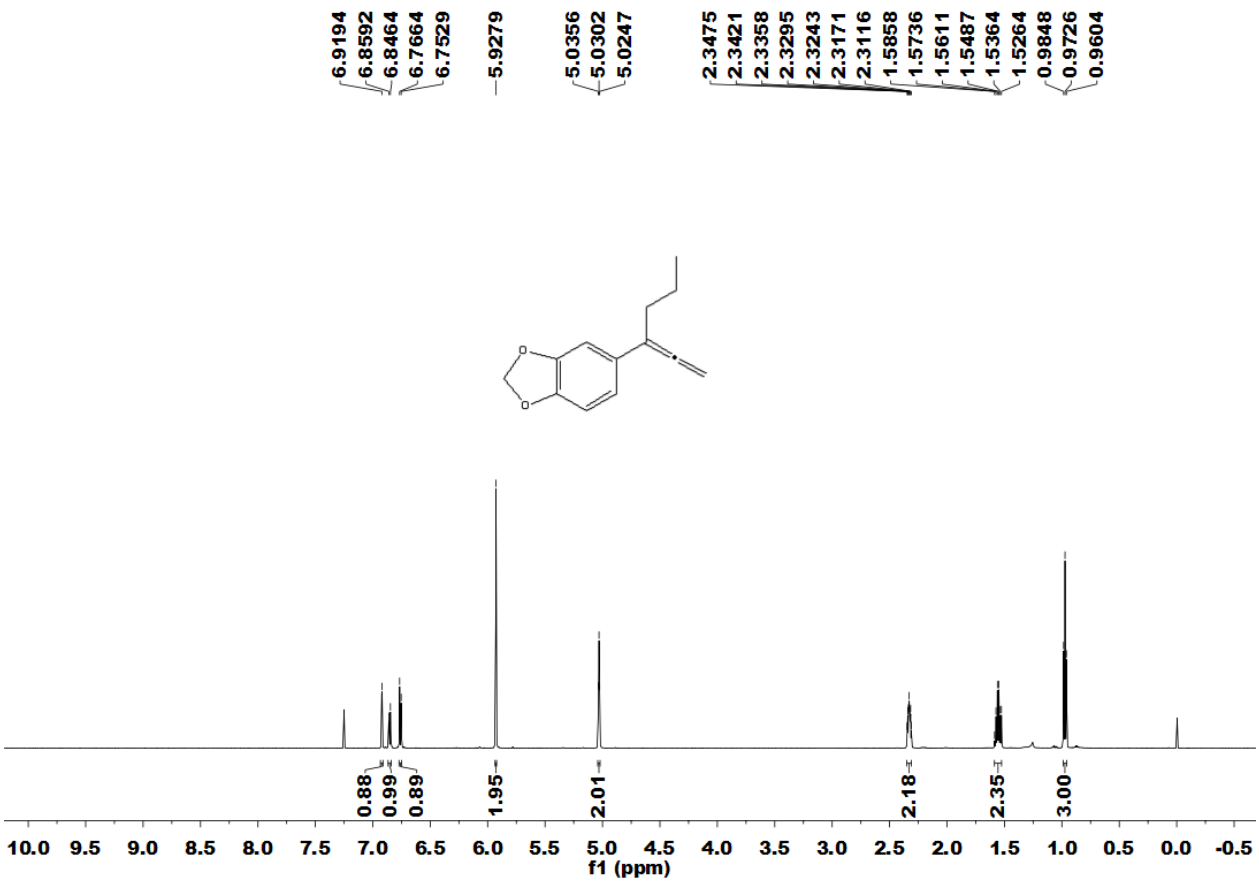


Fig. S11 ^{1}H NMR of 3-piperyl-1,2-hexadiene (**2f**)

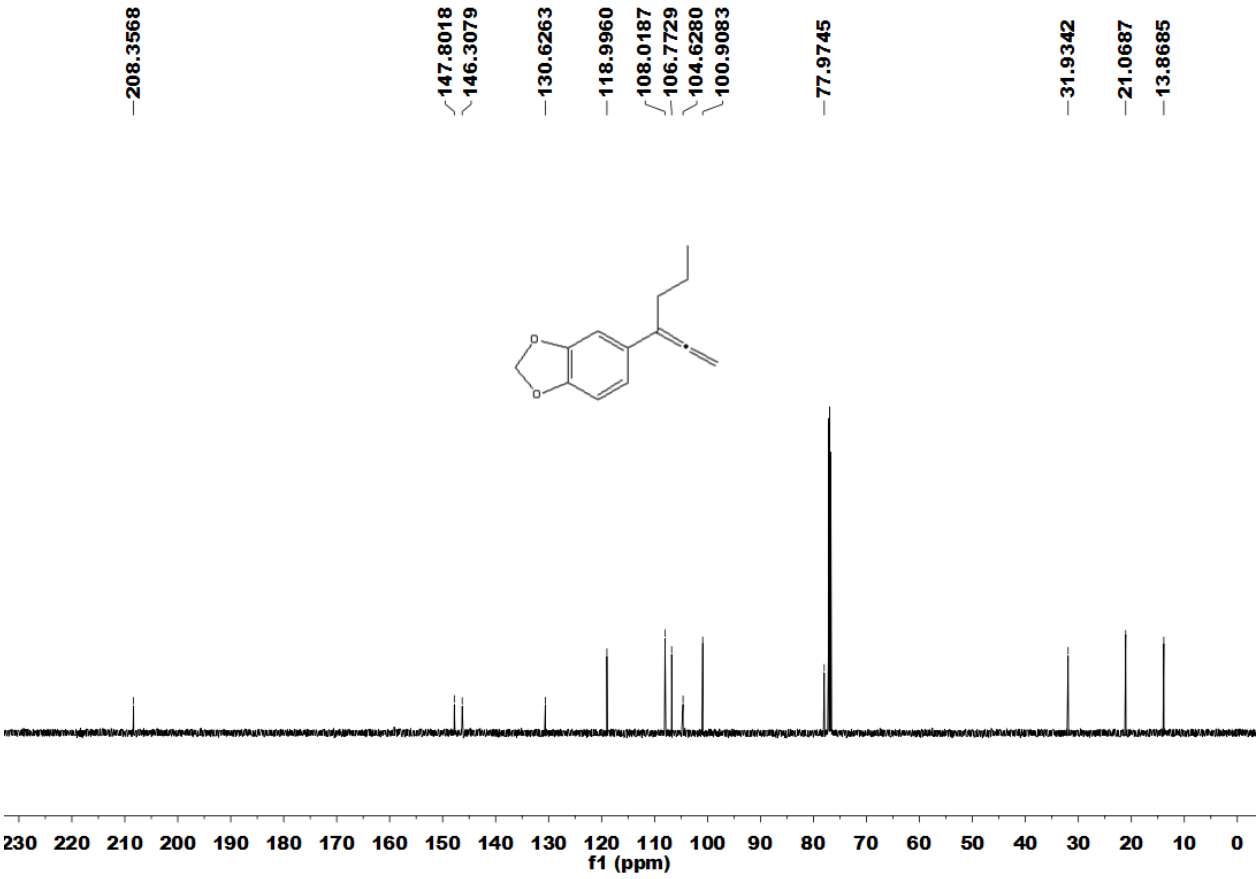


Fig. S12 ^{13}C NMR of 3-piperyl-1,2-hexadiene **(2f)**

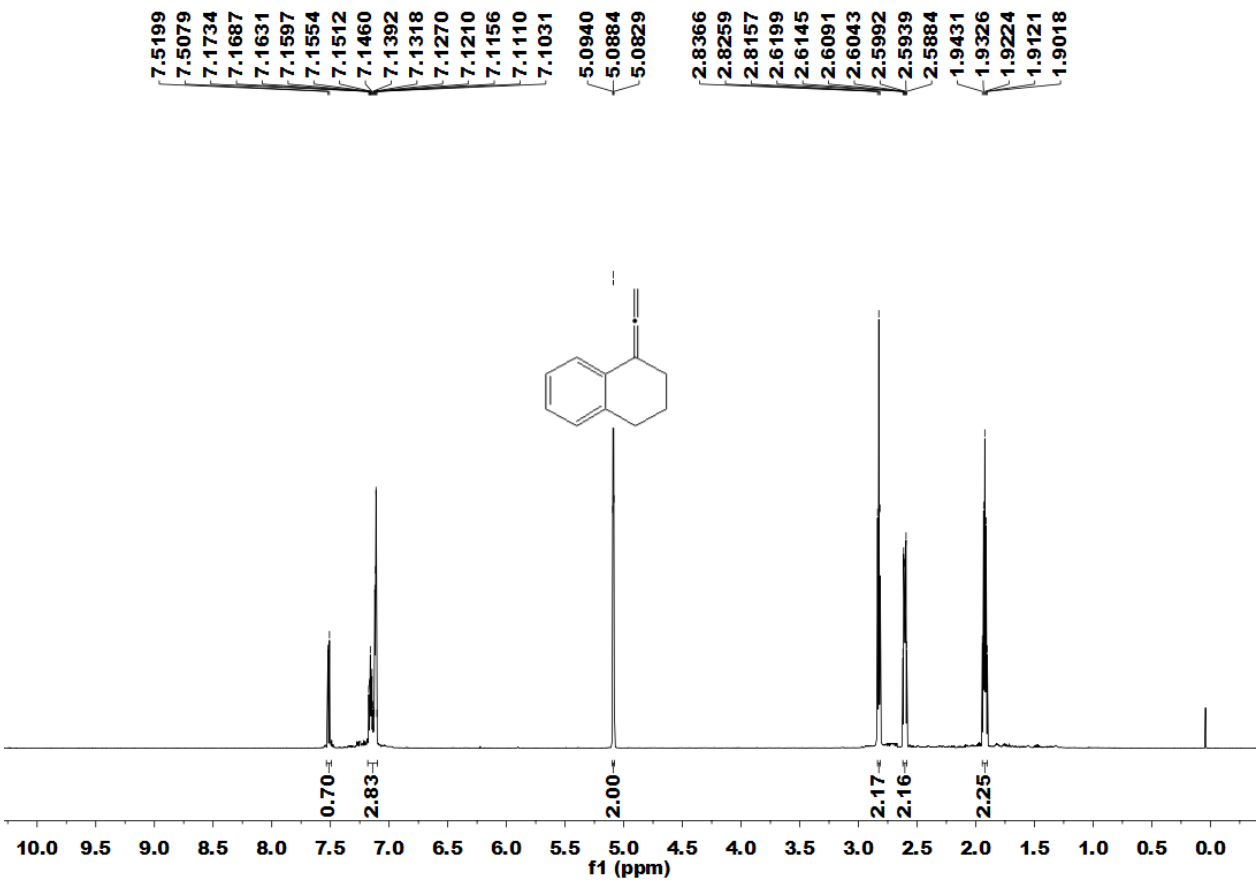


Fig. S13 [1]H NMR of 1-vinylidene-1,2,3,4-tetrahydronaphthalene (**2g**)

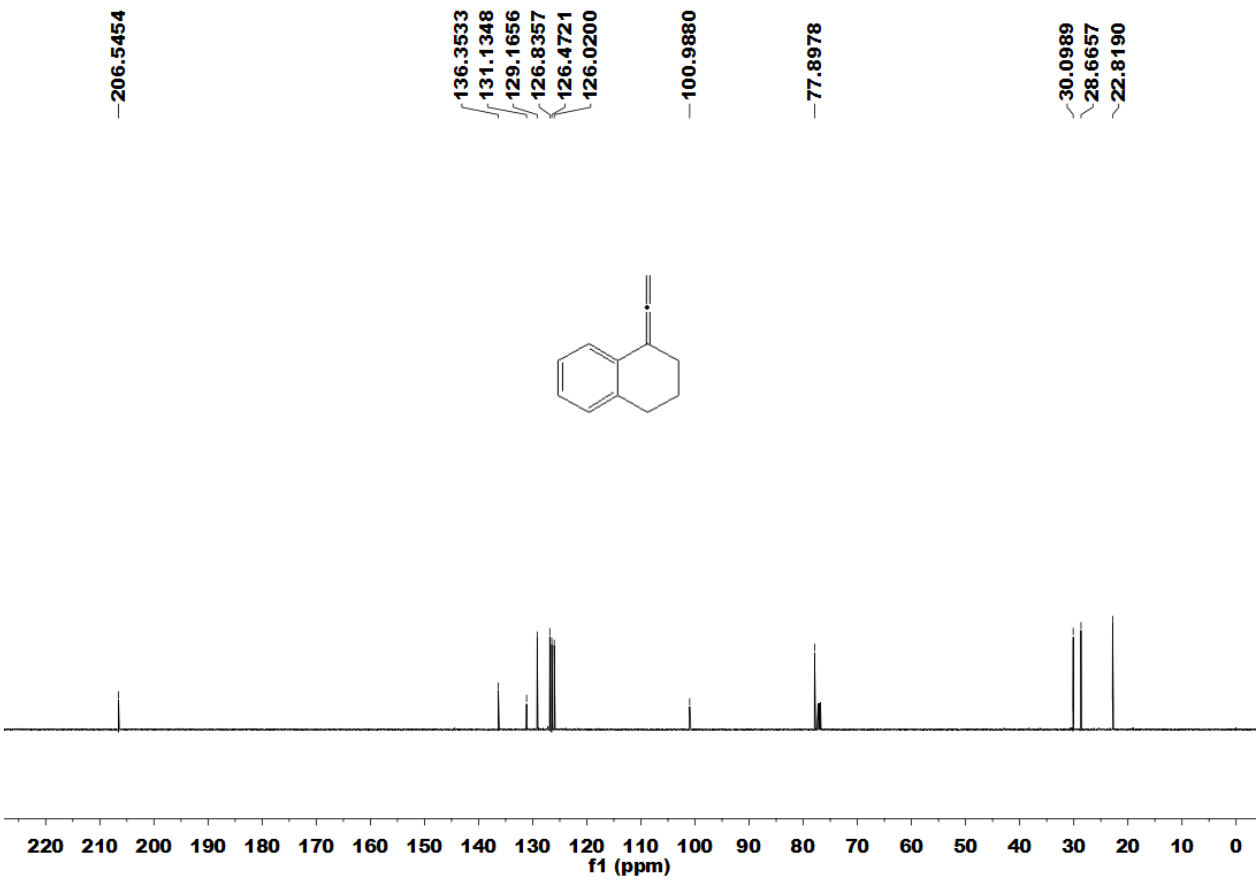


Fig. S14 [13]C NMR of 1-vinylidene-1,2,3,4-tetrahydronaphthalene (**2g**)

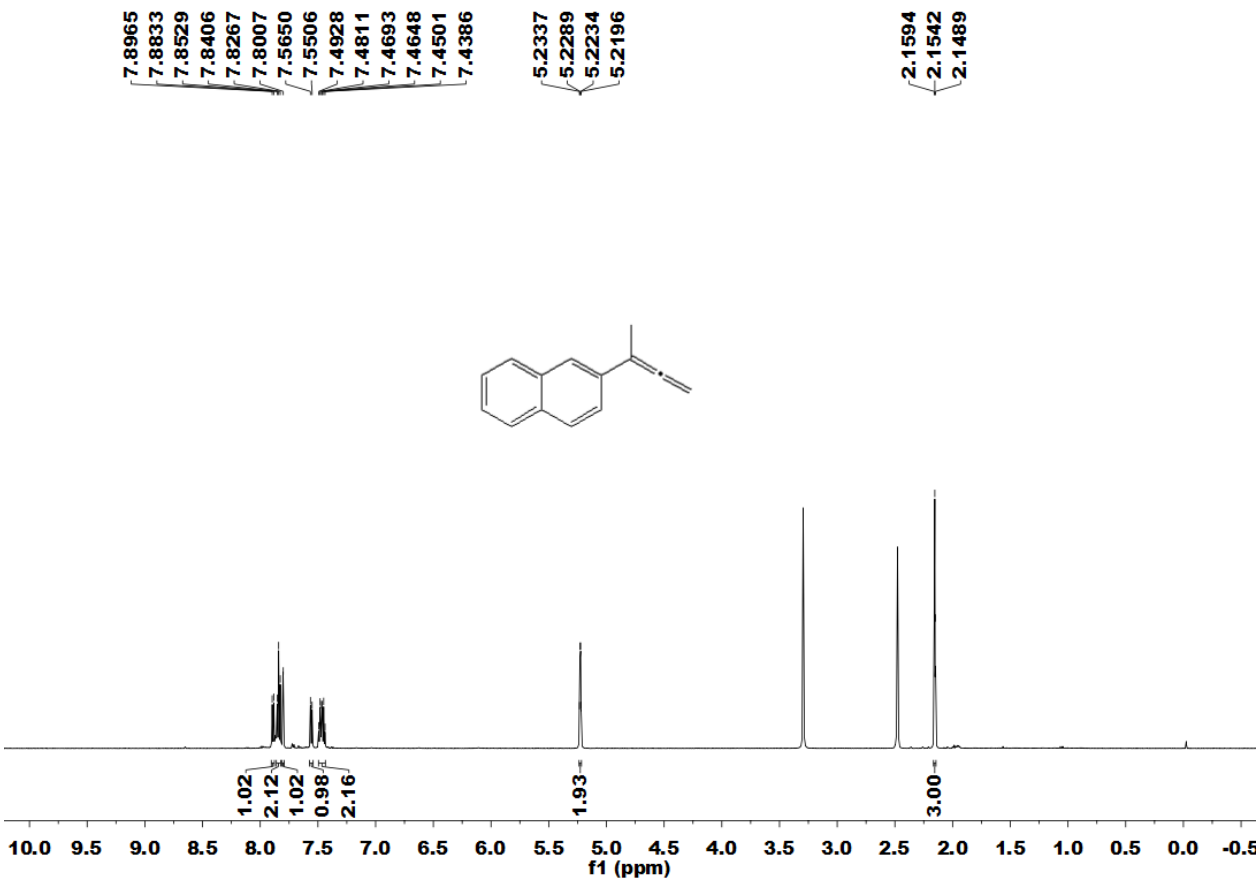


Fig. S15 ^{1}H NMR of 3-(2-naphthyl)-1,2-butadiene (**2h**)

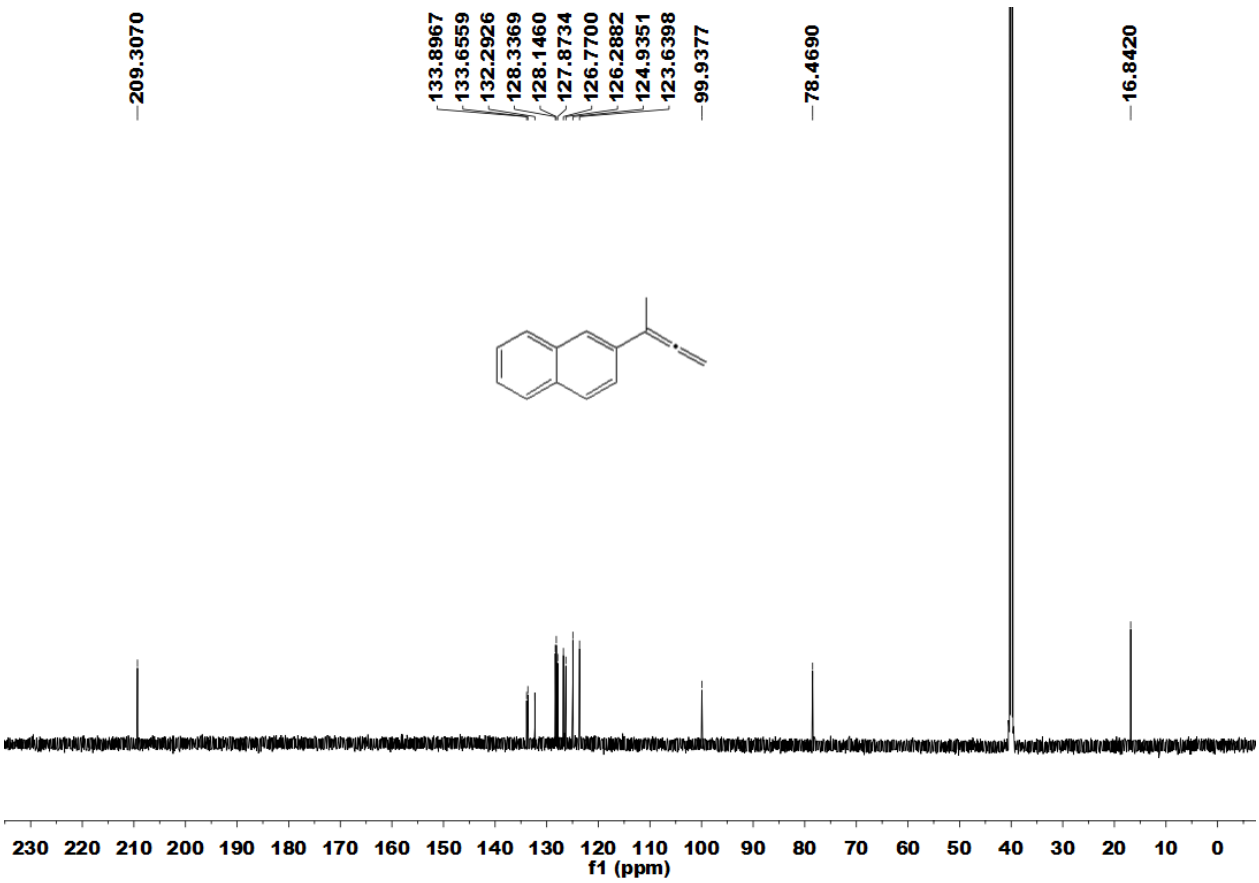
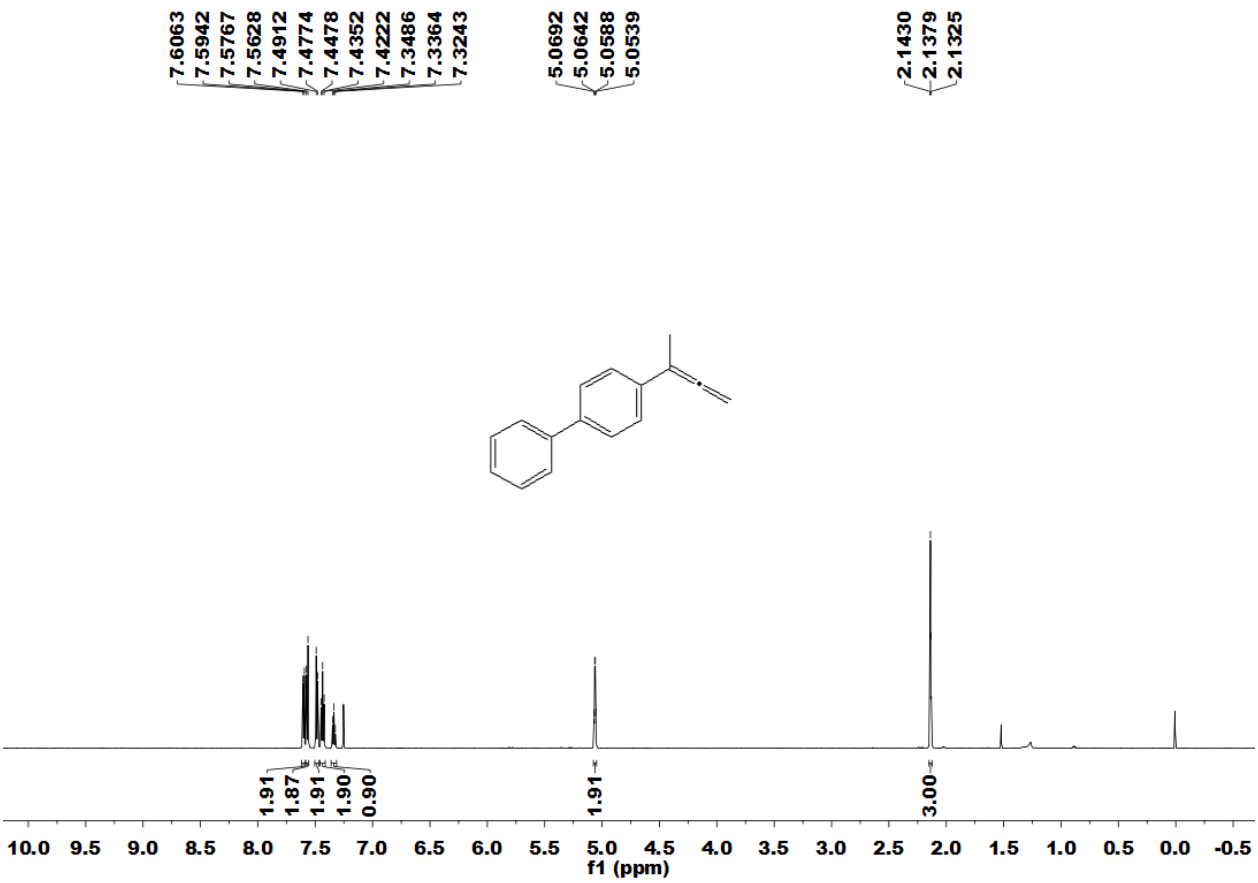


Fig. S16 ^{13}C NMR of 3-(2-naphthyl)-1,2-butadiene (**2h**)



FFig. S17 [1]H NMR of 3-biphenyl-1,2-butadiene (**2i**)

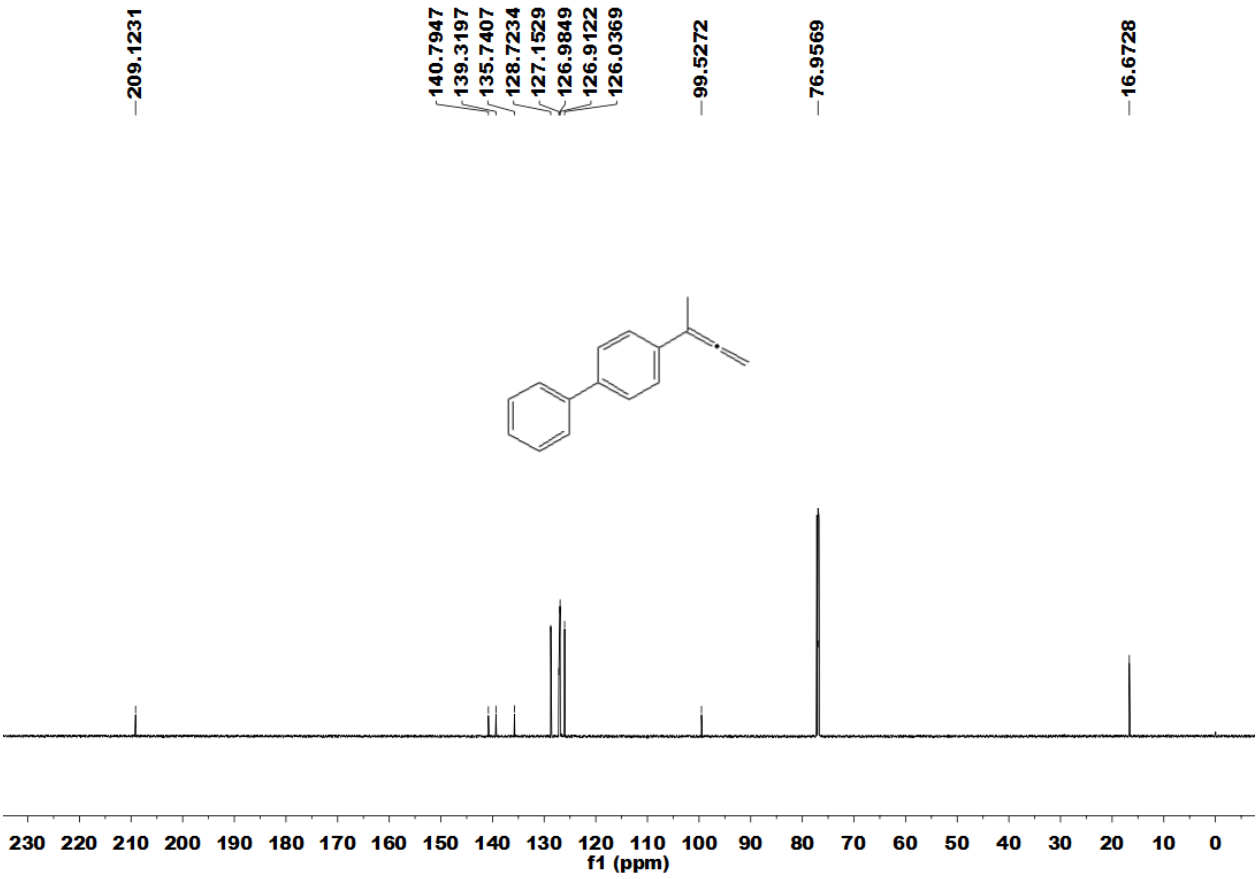


Fig. S18 [13]C NMR of 3-biphenyl-1,2-butadiene (**2i**)

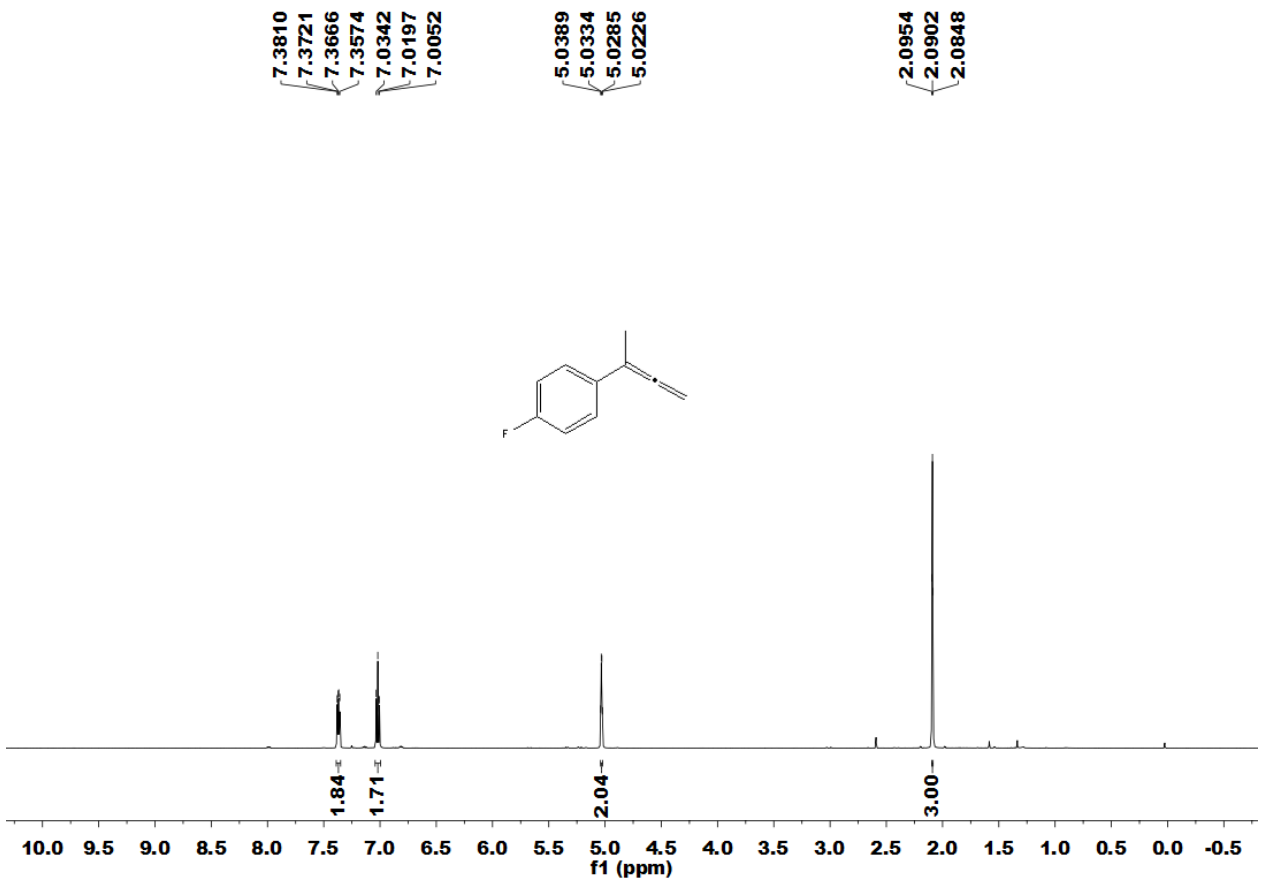


Fig. S19 [1]H NMR of 3-(4-fluorophenyl) -1,2-butadiene (**2j**)

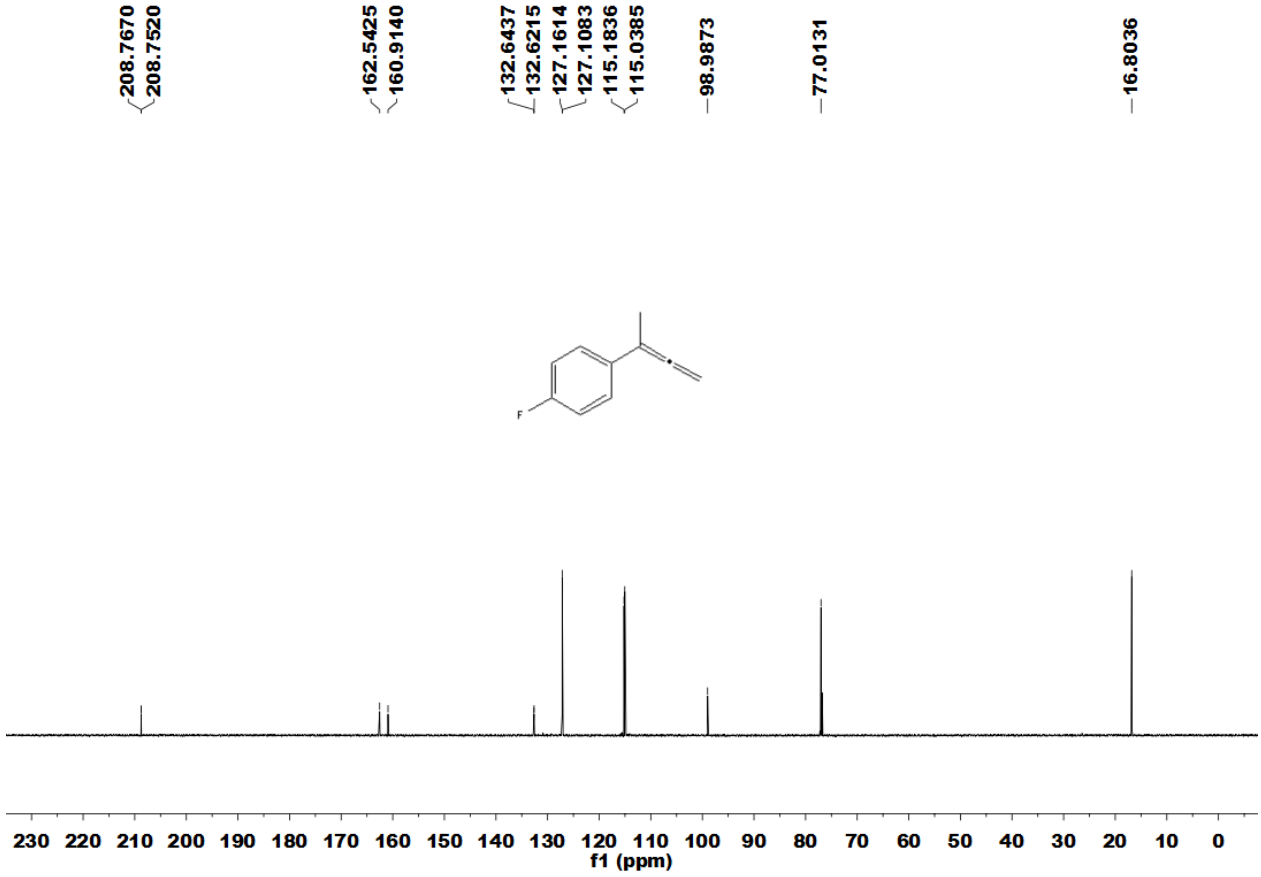


Fig. S20 [13]C NMR of 3-(4-fluorophenyl) -1,2-butadiene (**2j**)

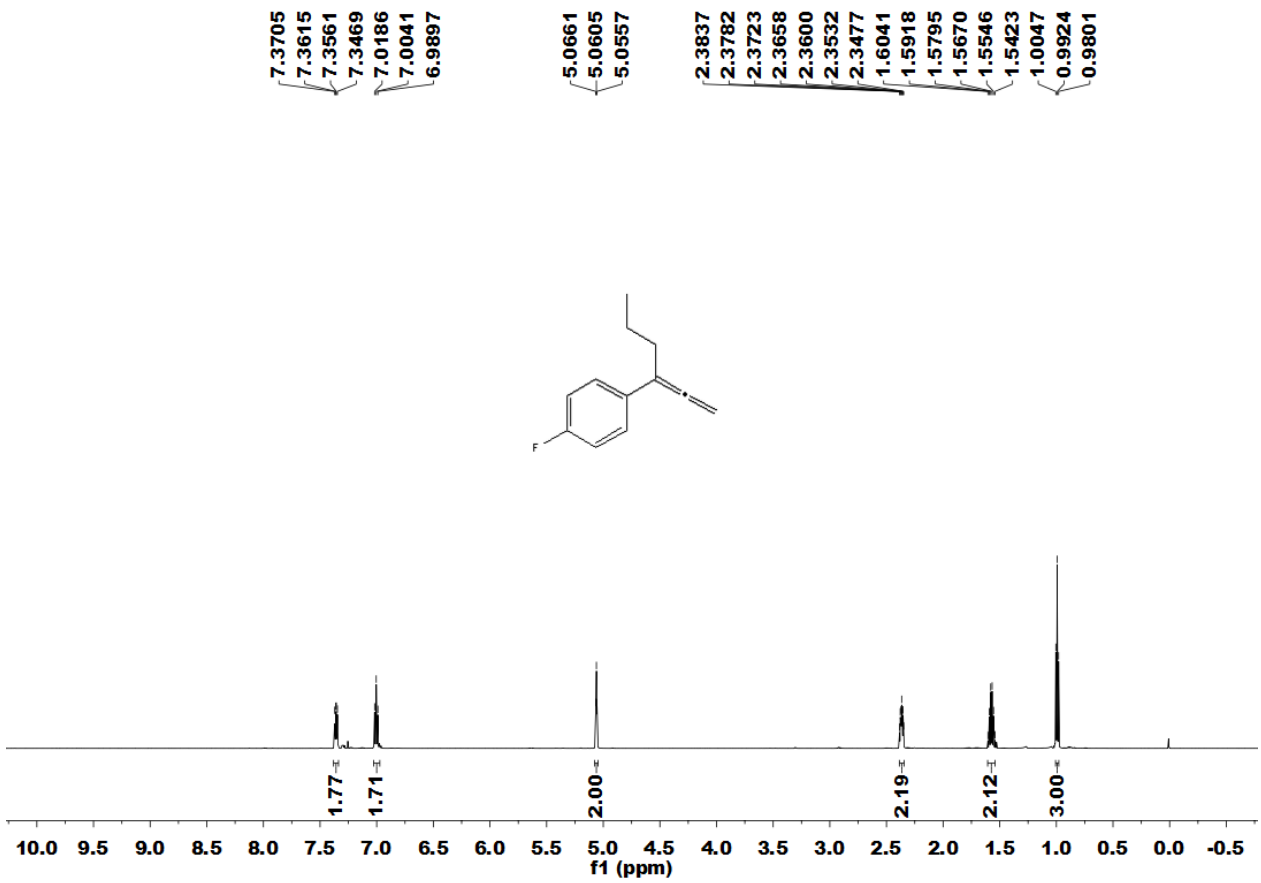


Fig. S21 ^{1}H NMR of 3-(4-fluorophenyl)-1,2-hexadiene (**2k**)

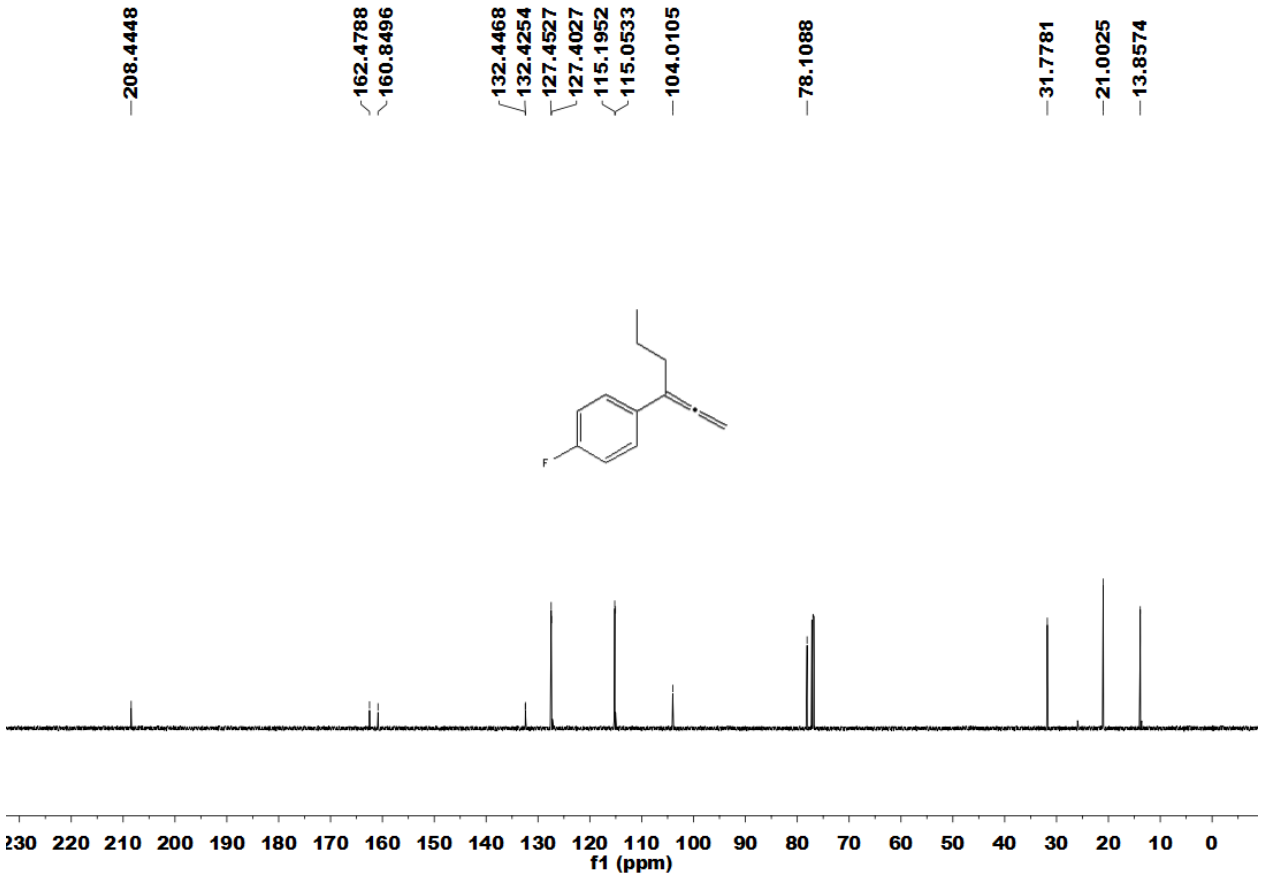


Fig. S22 ^{13}C NMR of 3-(4-fluorophenyl)-1,2-hexadiene (**2k**)

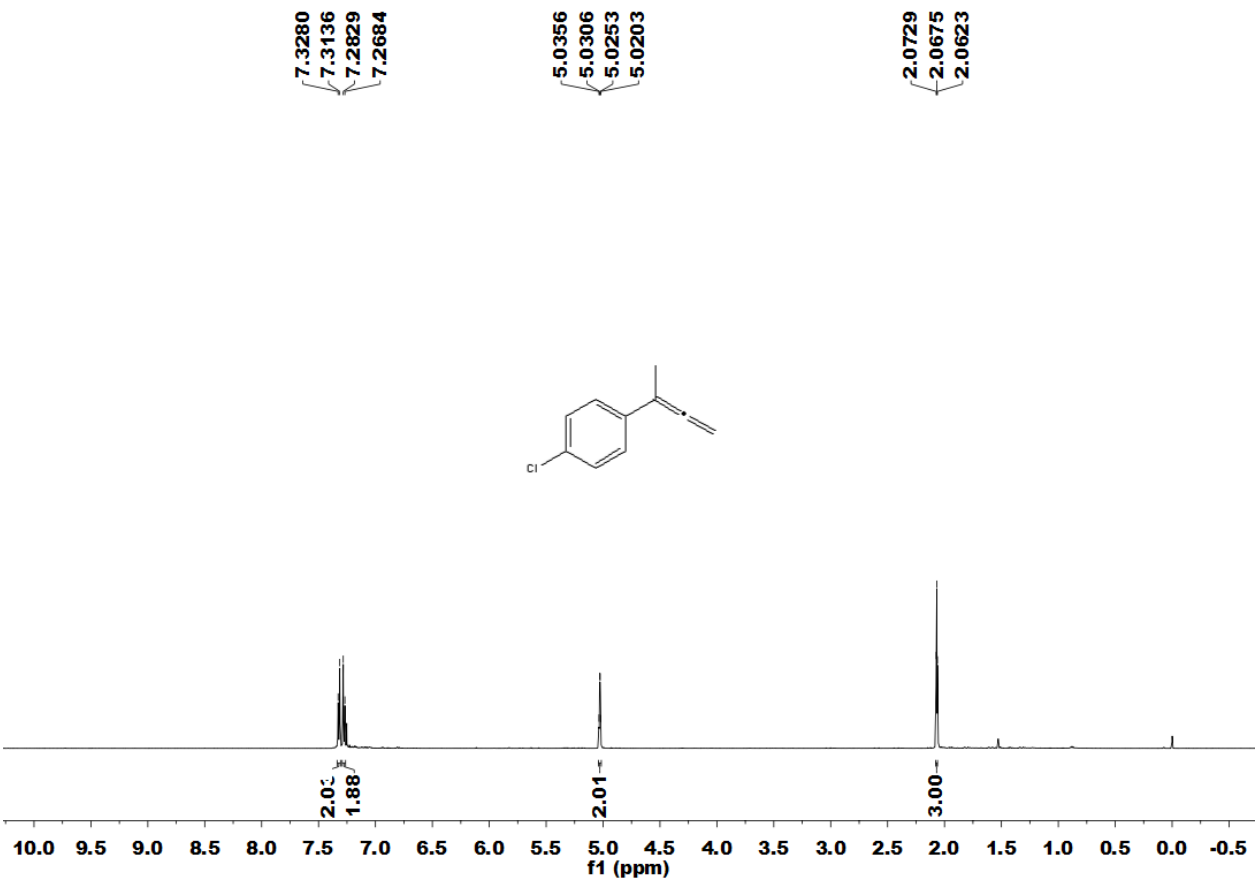


Fig. S23 ^{1}H NMR of 3-(4-chlorophenyl)-1,2-butadiene (**2l**)

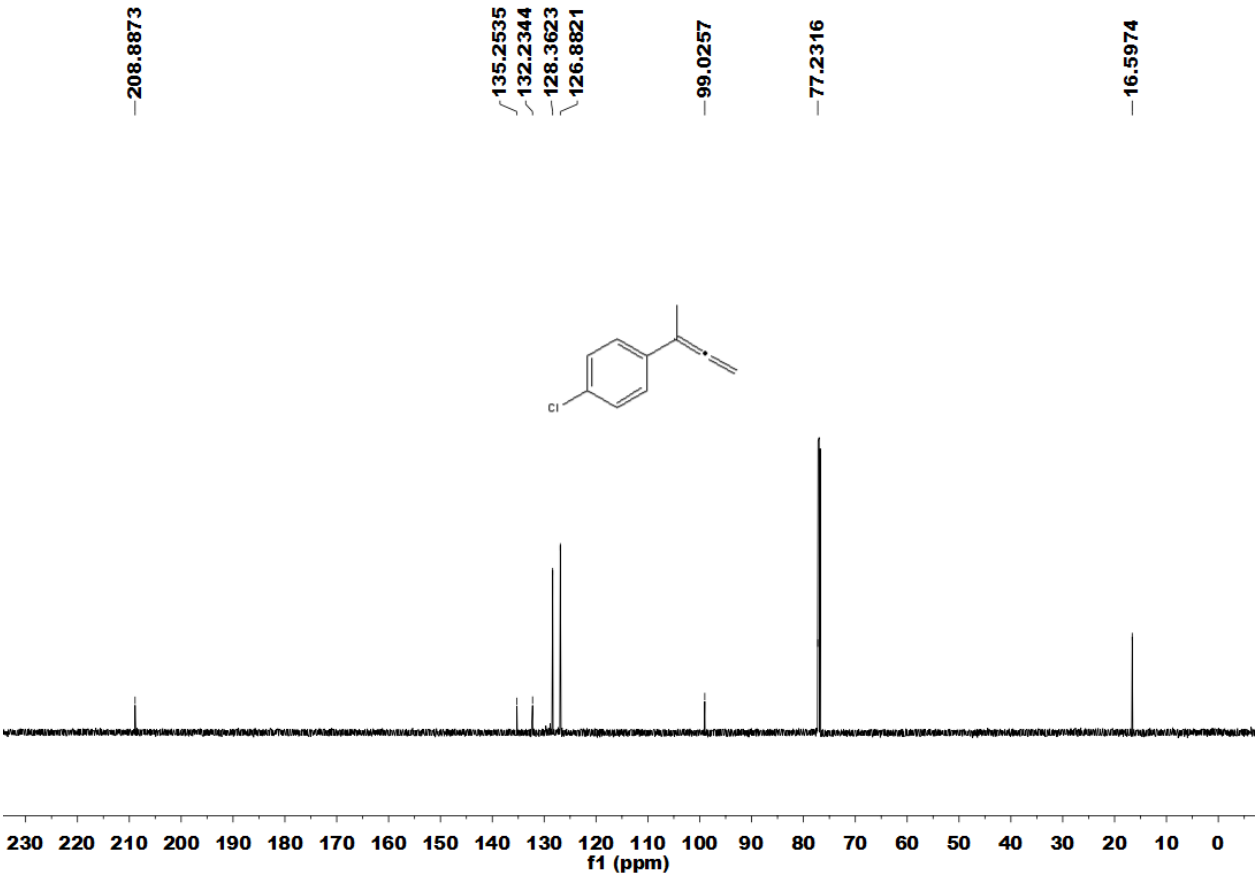


Fig. S24 ^{13}C NMR of 3-(4-chlorophenyl)-1,2-butadiene (**2l**)

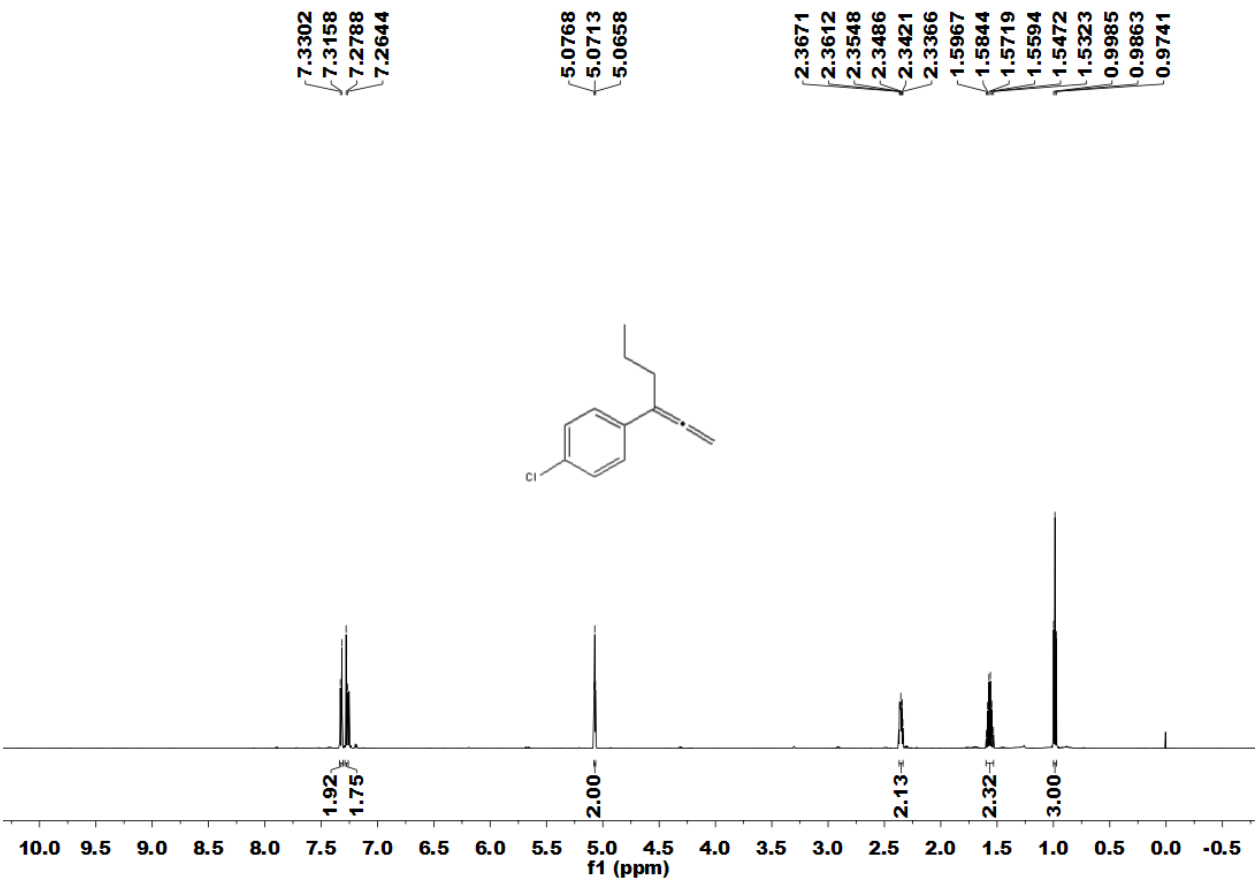


Fig. S25 ^{1}H NMR of 3-(4-chlorophenyl)-1,2-hexadiene (**2m**)

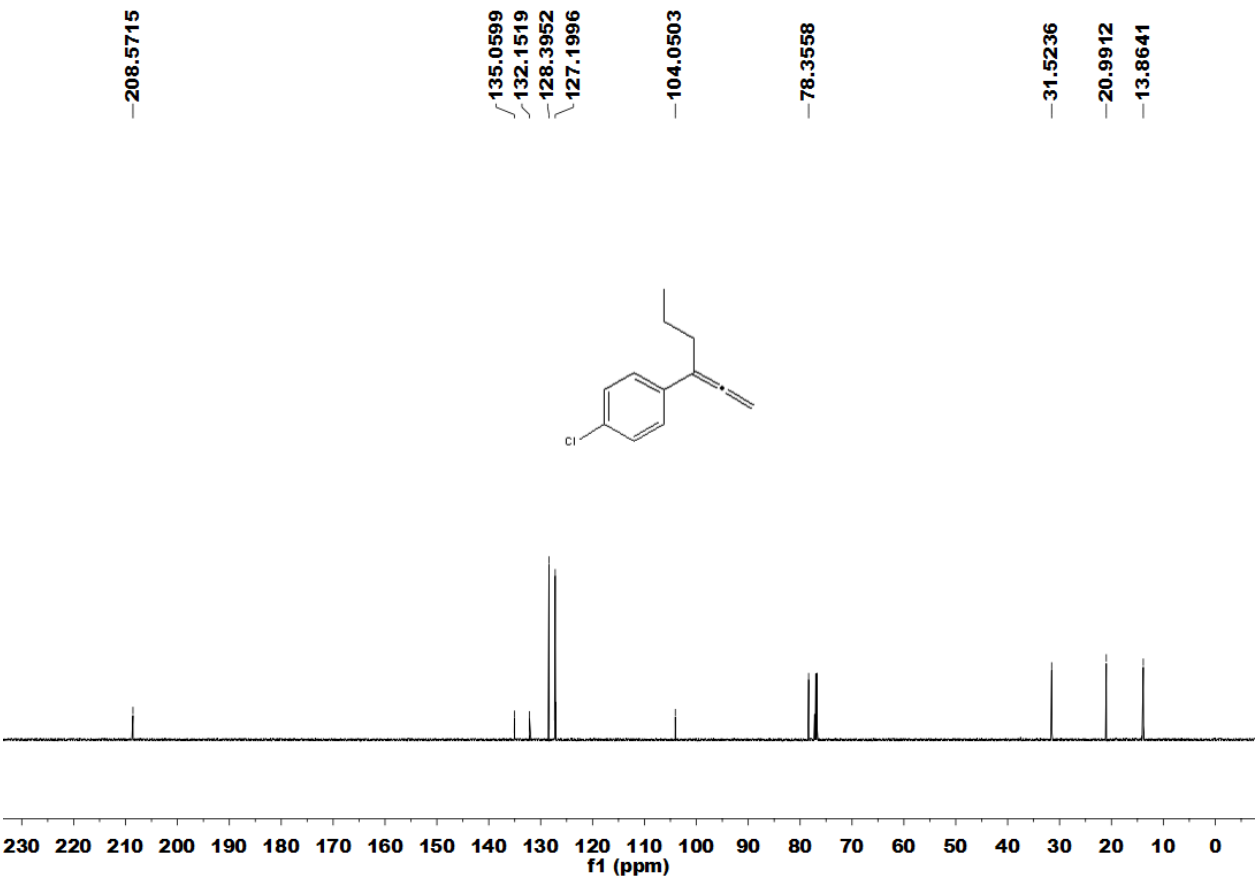


Fig. S26 ^{13}C NMR of 3-(4-chlorophenyl)-1,2-hexadiene (**2m**)

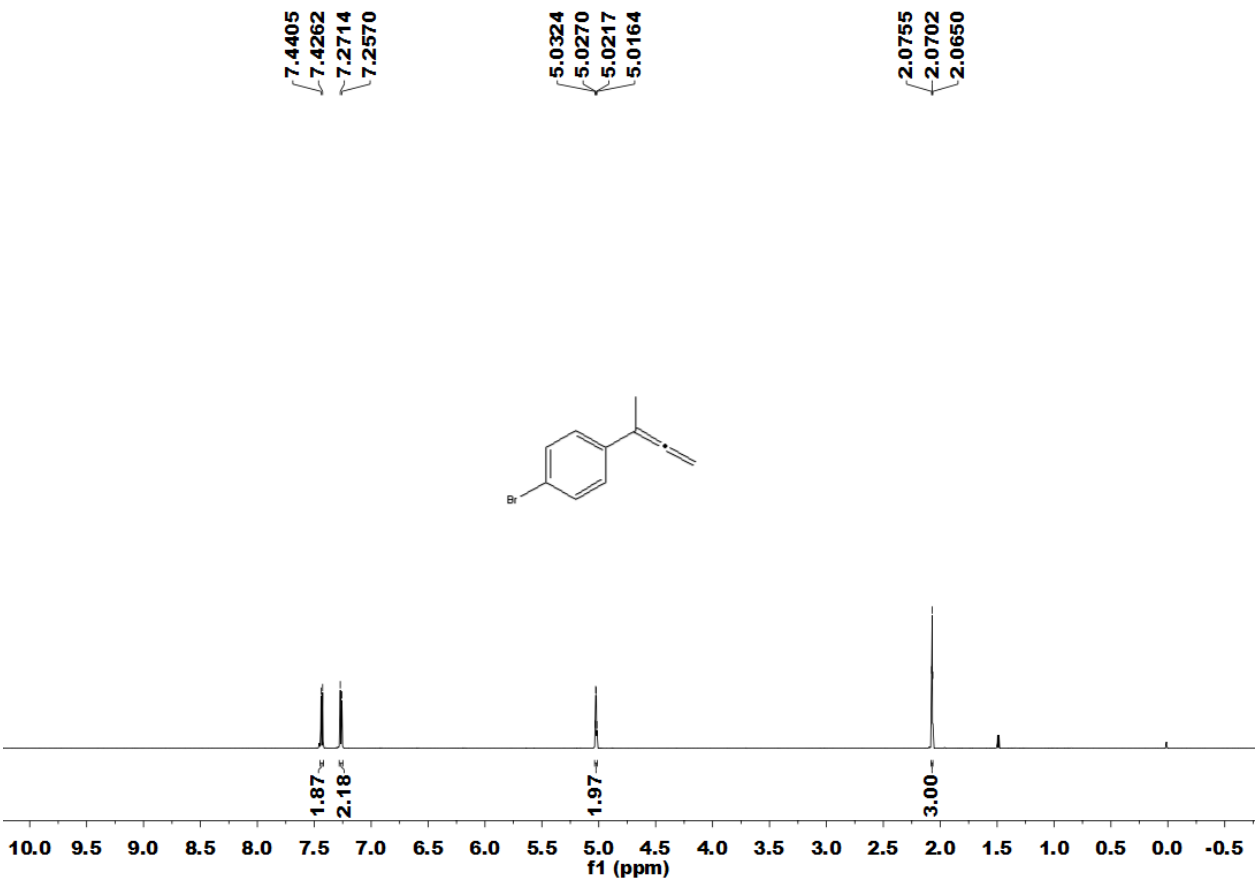


Fig. S27 ^{1}H NMR of 3-(4-bromophenyl)-1,2-butadiene **(2n)**

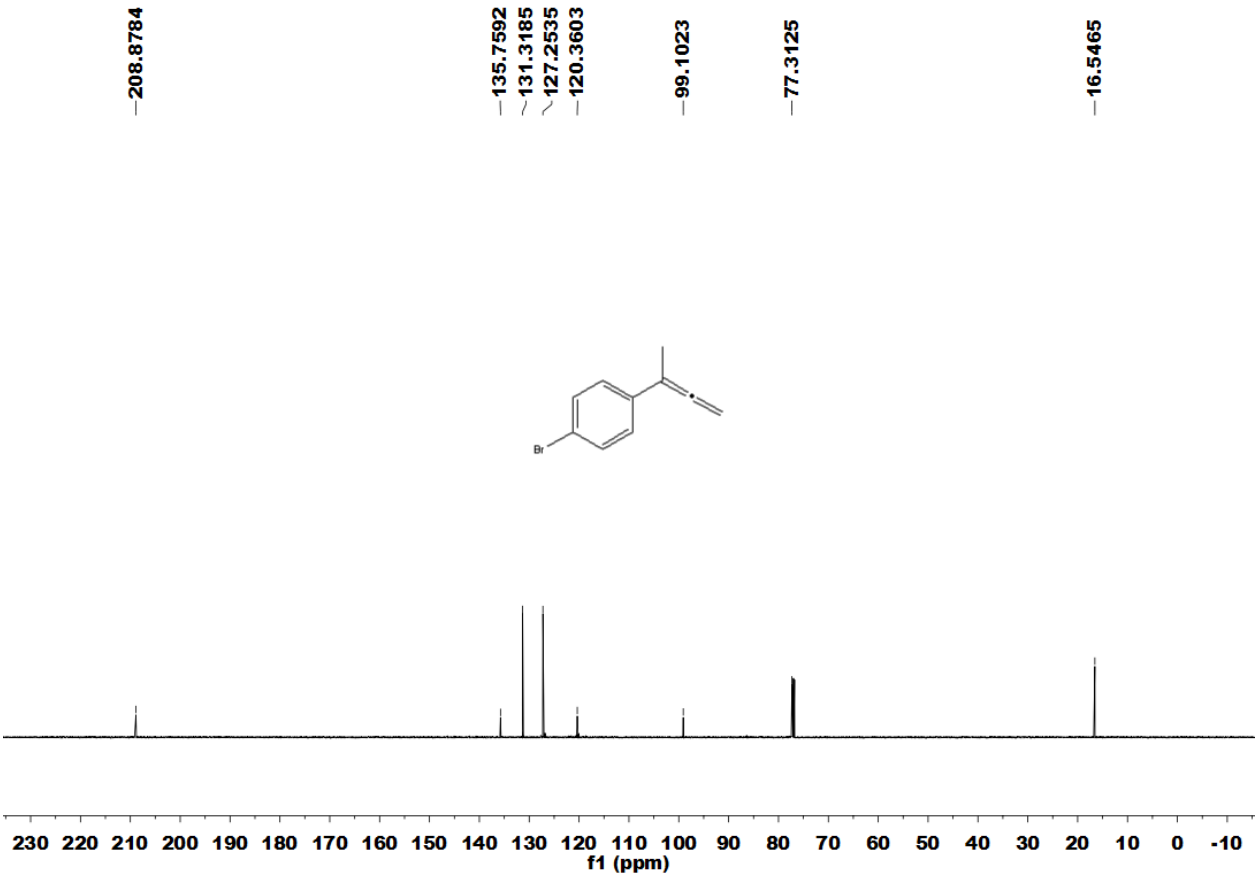


Fig. S28 ^{13}C NMR of 3-(4-bromophenyl)-1,2-butadiene **(2n)**

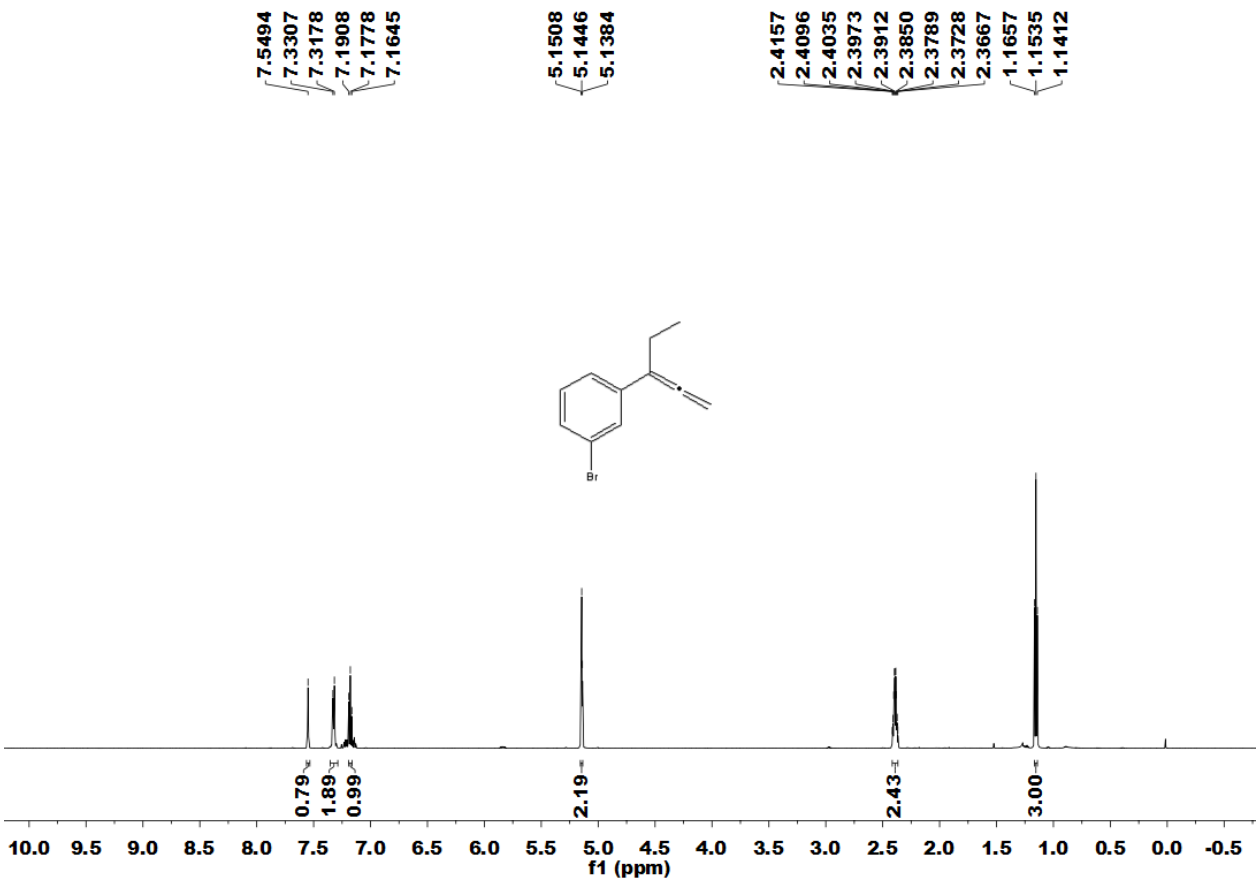


Fig. S29 ^{1}H NMR of 3-(3-bromophenyl)-1,2-pentadiene (**2o**)

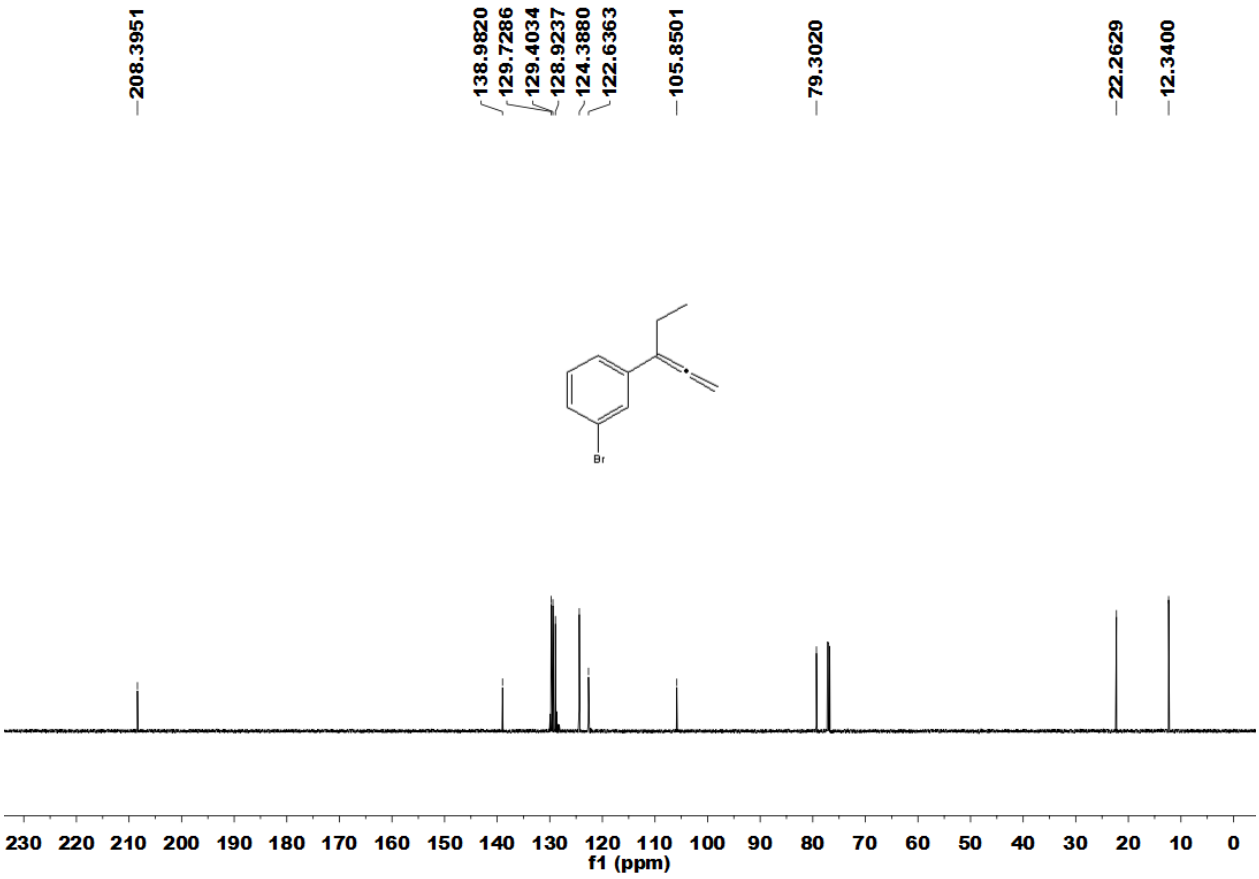


Fig. 30 ^{13}C NMR of 3-(3-bromophenyl)-1,2-pentadiene **(2o)**

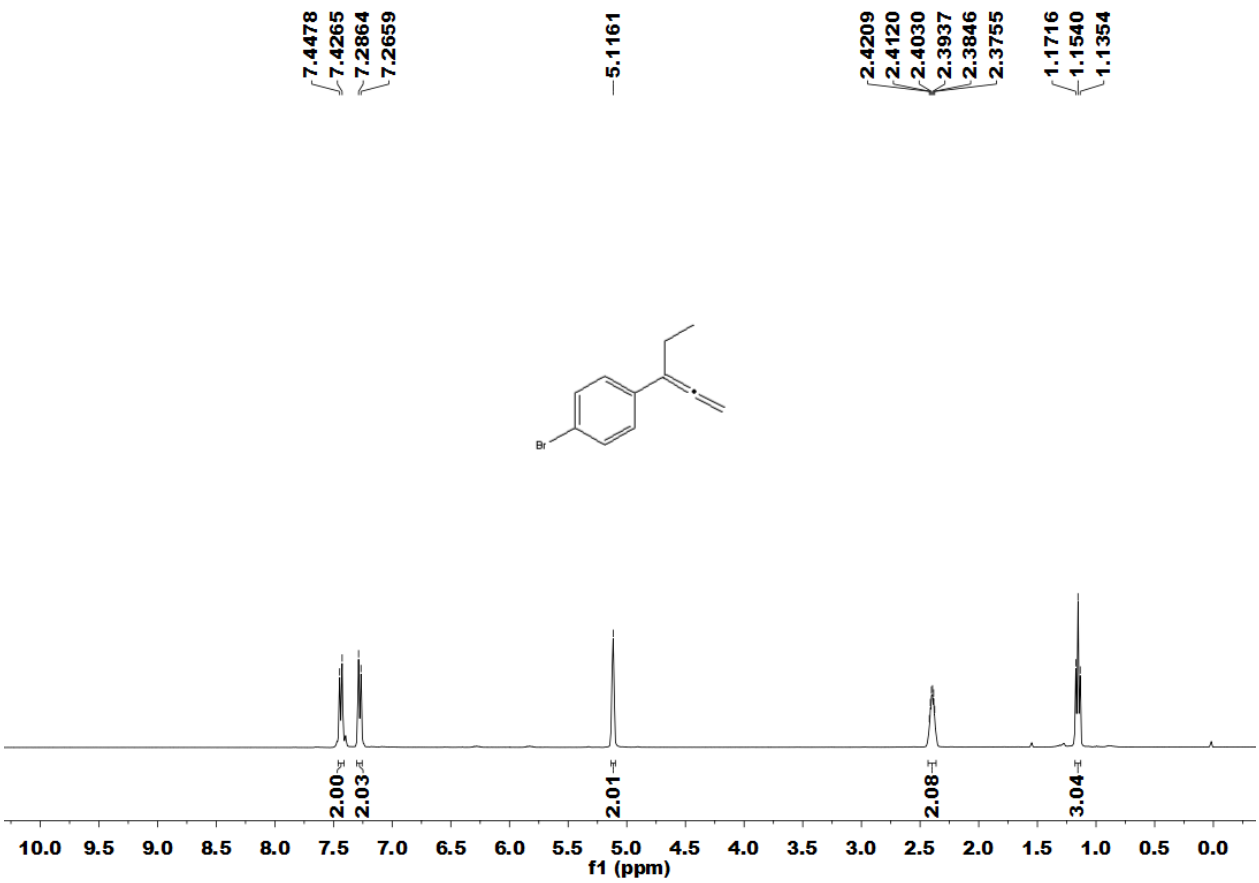


Fig. S31 ^{1}H NMR of 3-(4-bromophenyl)-1,2-pentadiene (**2p**)

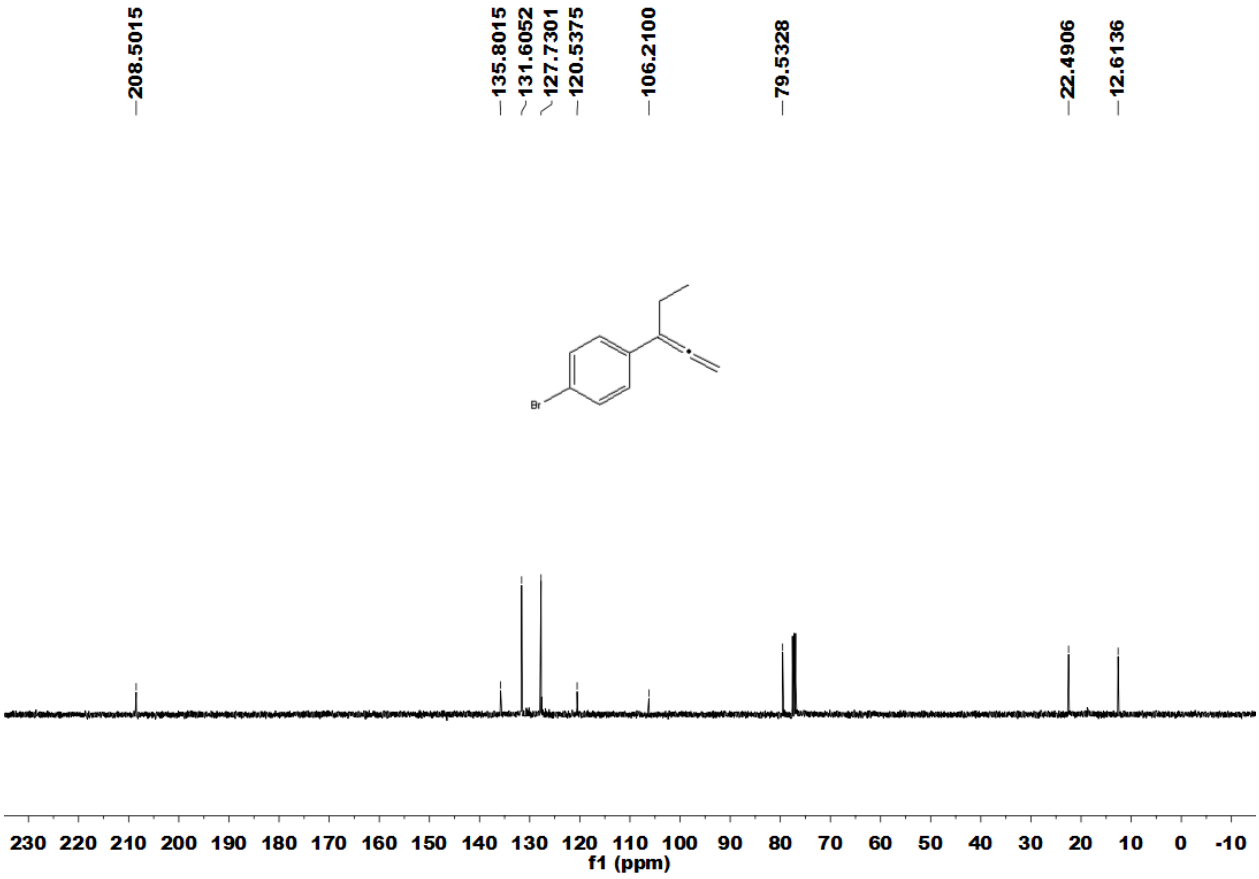


Fig. S32 ^{13}C NMR of 3-(4-bromophenyl)-1,2-pentadiene (**2p**)

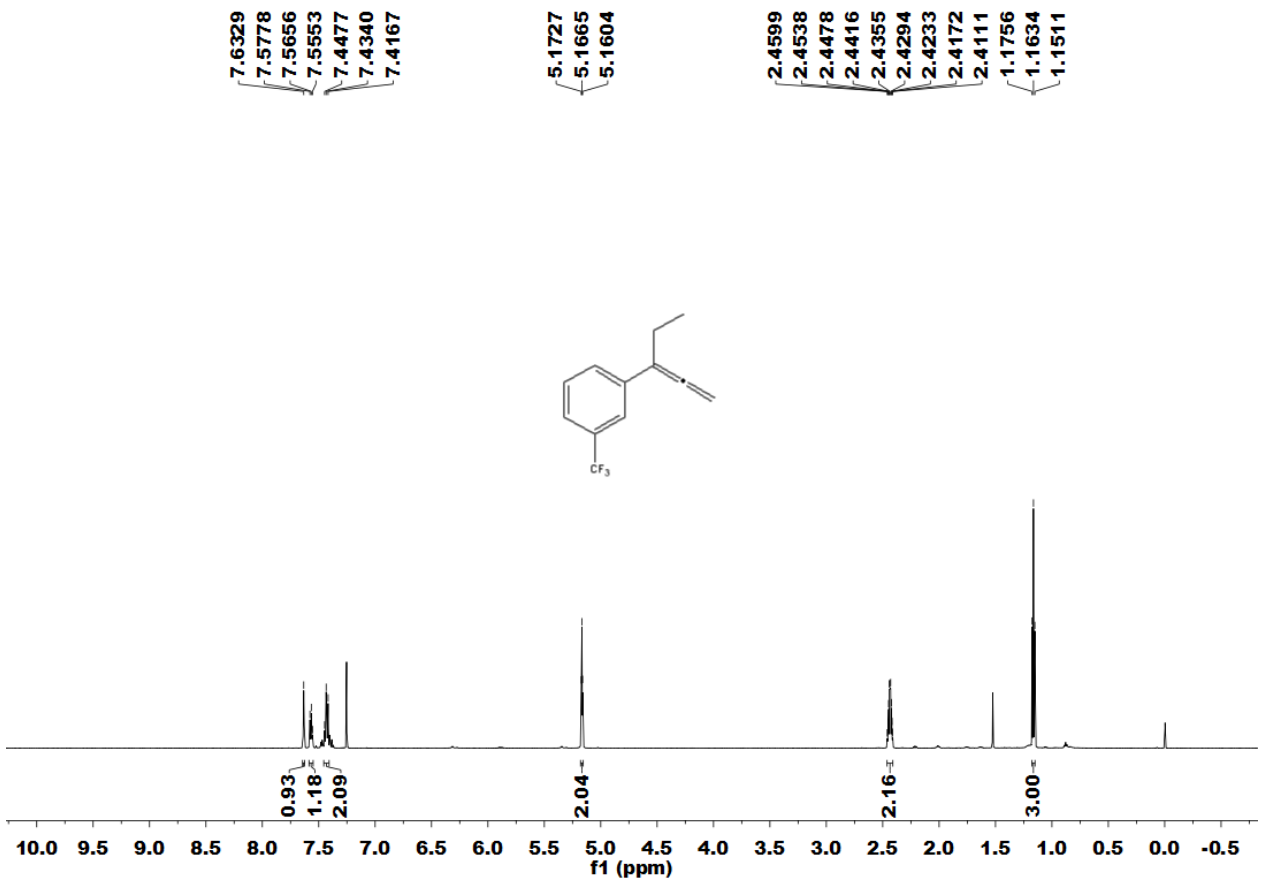


Fig. S33 ^{1}H NMR of 3-(3-trifluoromethylphenyl)-1,2-pentadiene (**2q**)

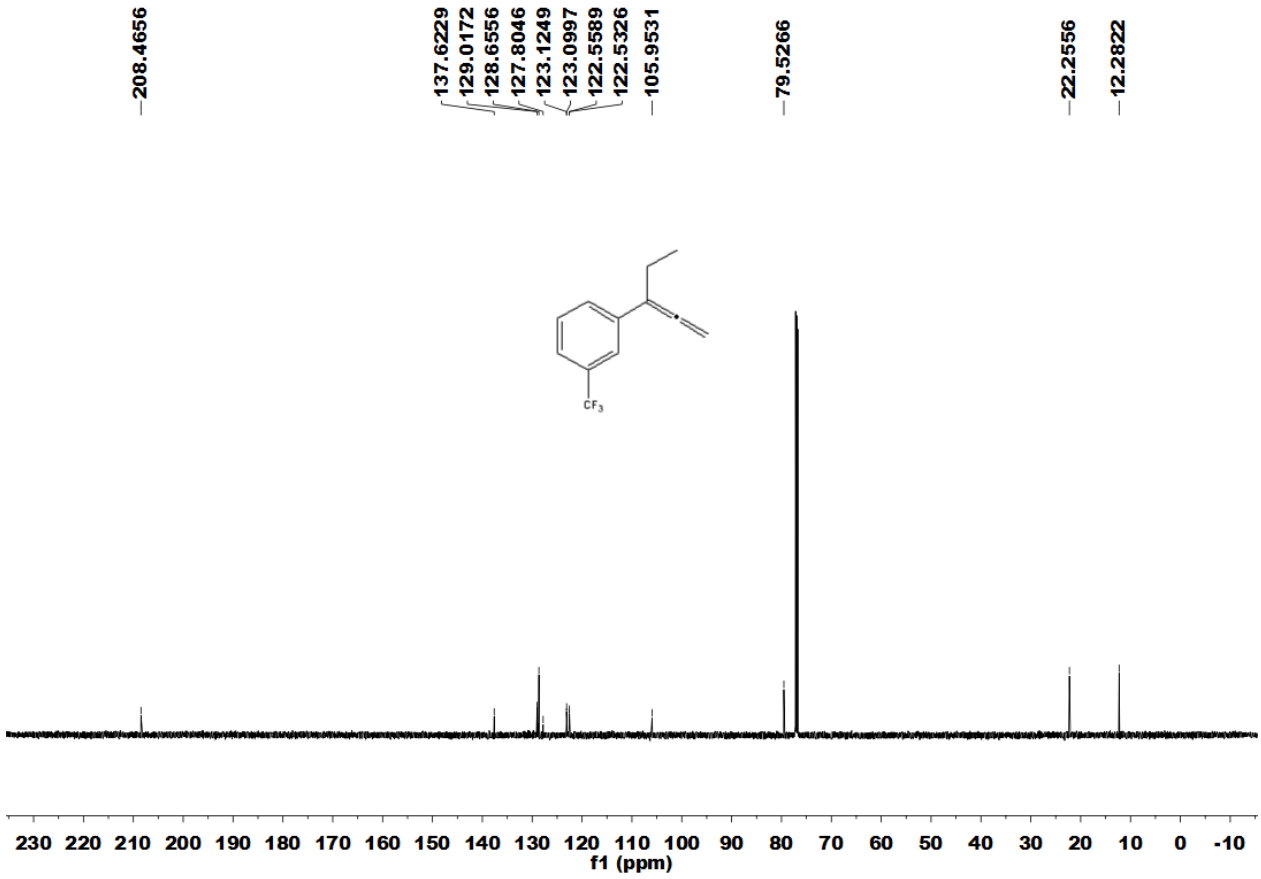


Fig. S34 ^{13}C NMR of 3-(3-trifluoromethylphenyl)-1,2-pentadiene (**2q**)

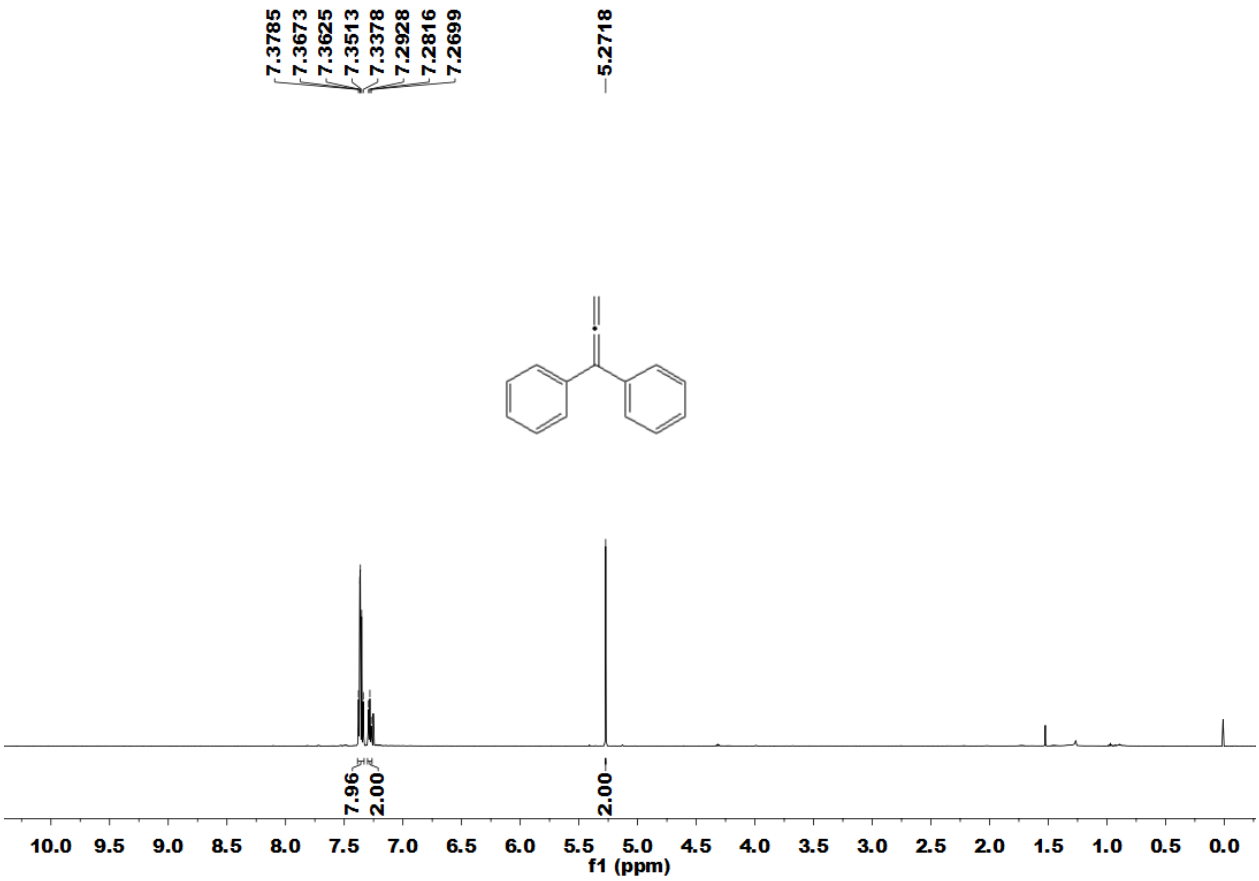


Fig. S35 ^{1}H NMR of 1,1-diphenyl-1,2-propadiene (**2r**)

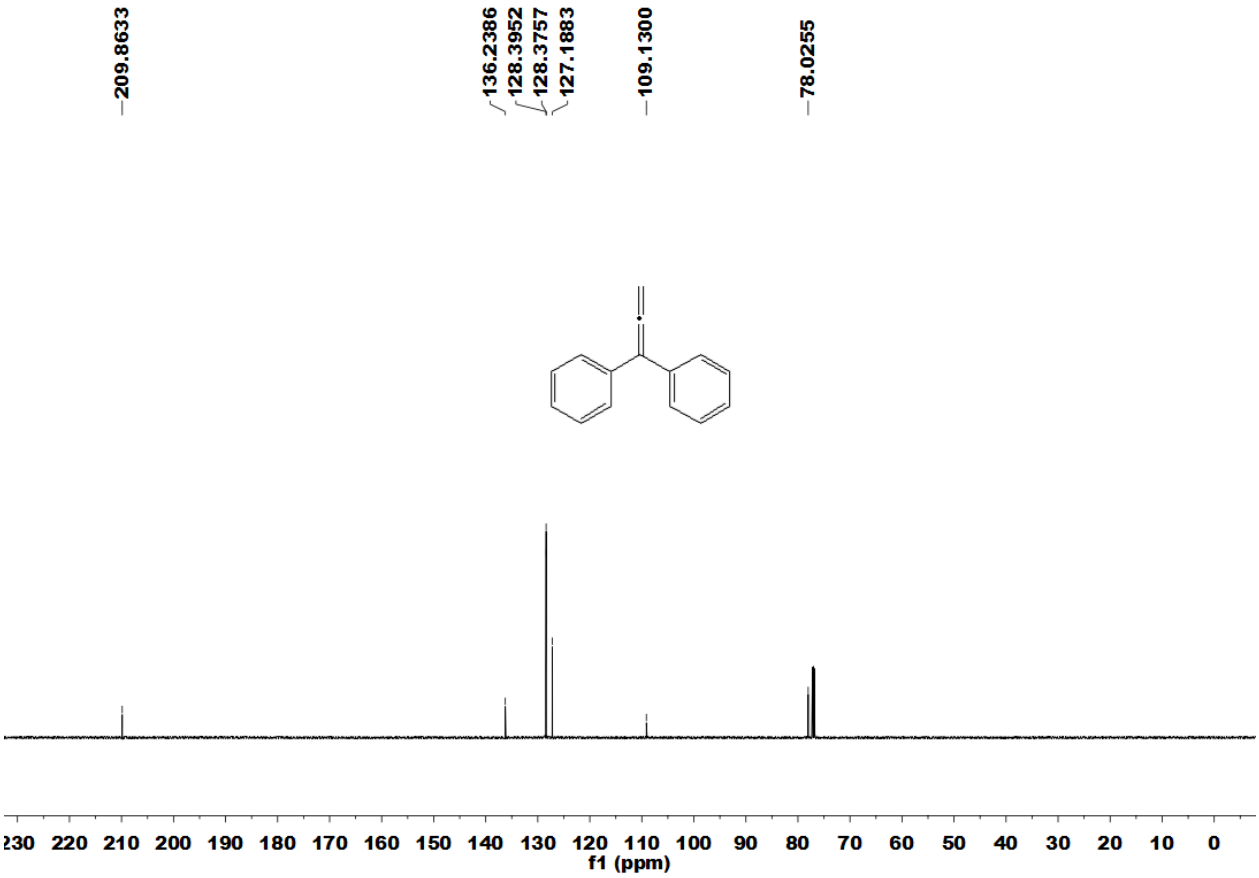


Fig. S36 ^{13}C NMR of 1,1-diphenyl-1,2-propadiene (**2r**)

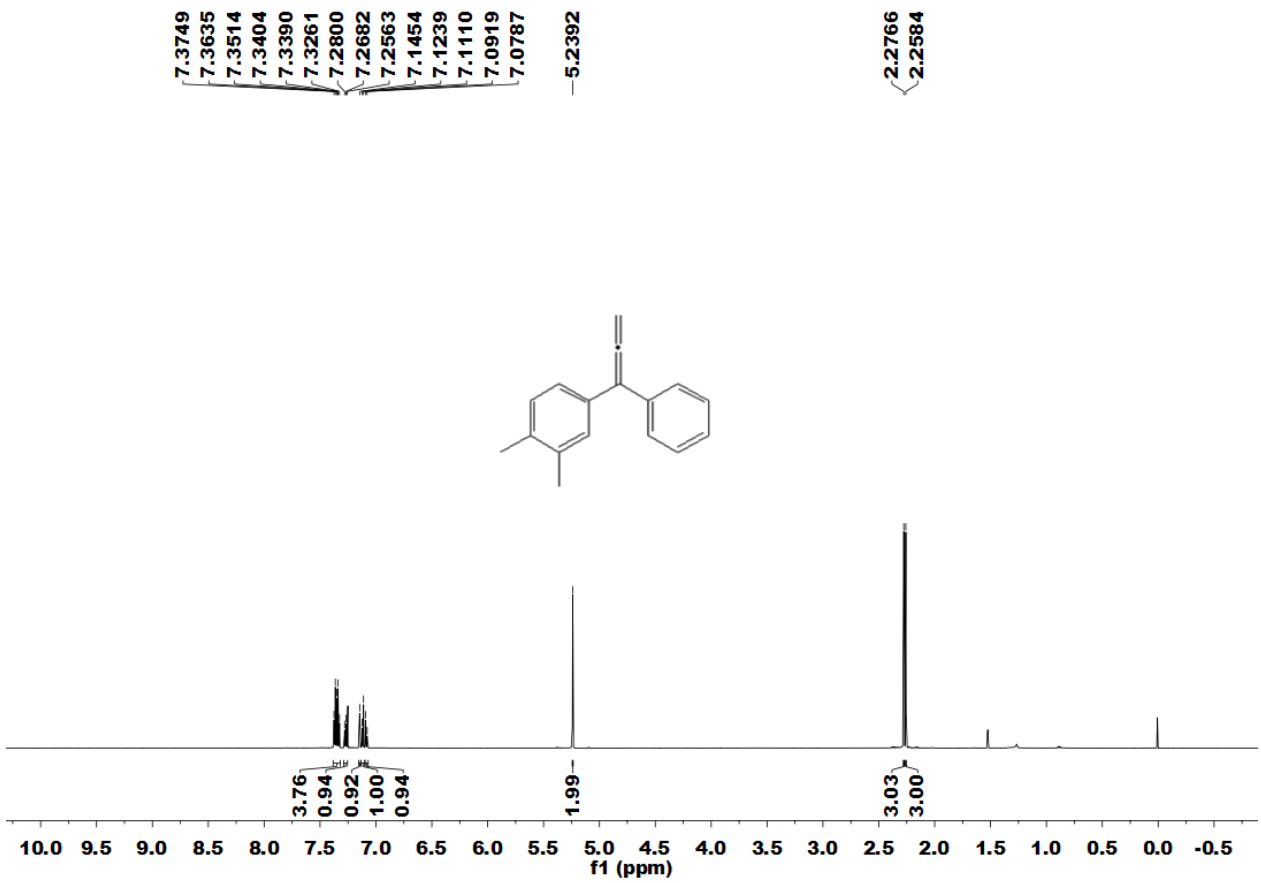


Fig. S37 ^{1}H NMR of 1-phenyl-1-(3,4-dimethylphenyl)-1,2-propadiene (**2s**)

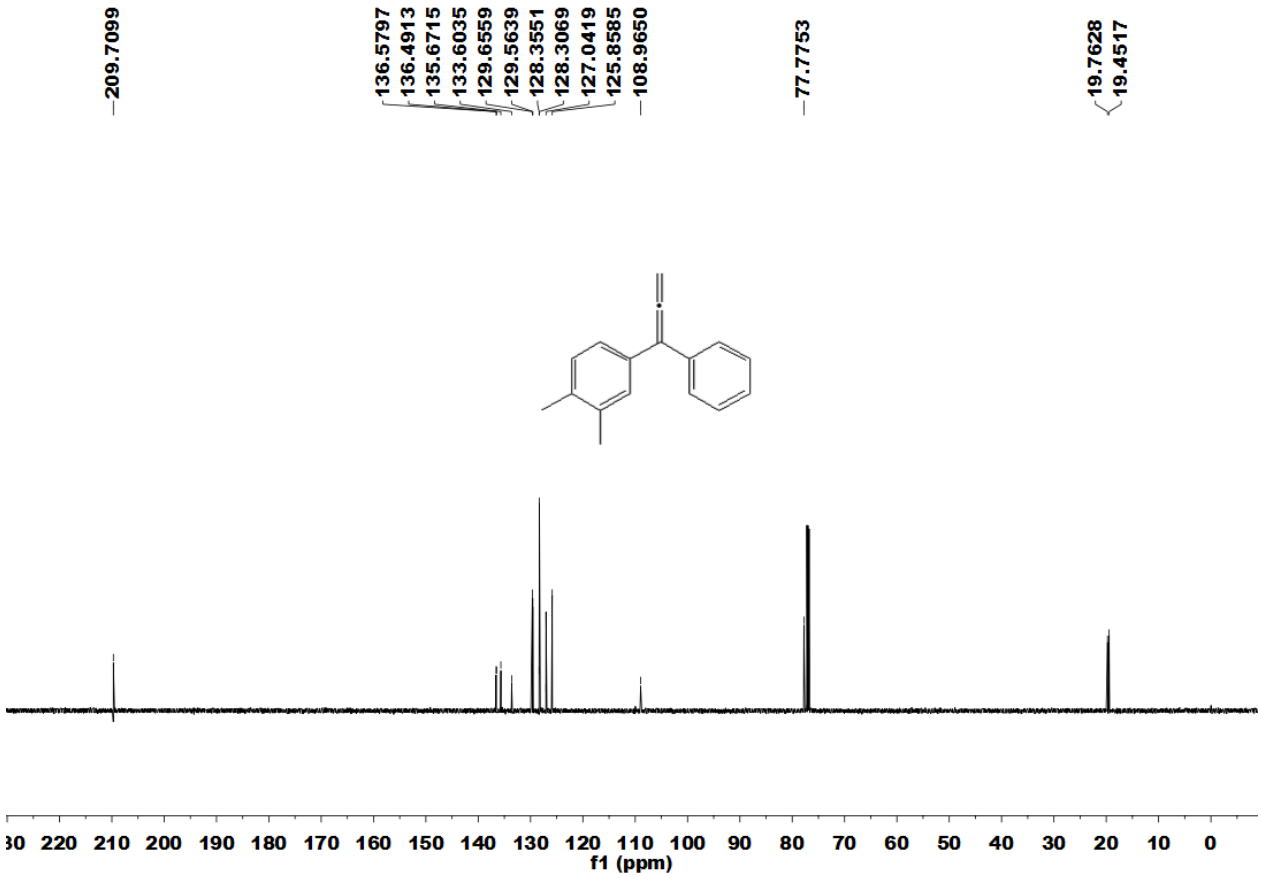


Fig. S38 ^{13}C NMR of 1-phenyl-1-(3,4-dimethylphenyl)-1,2-propadiene (**2s**)

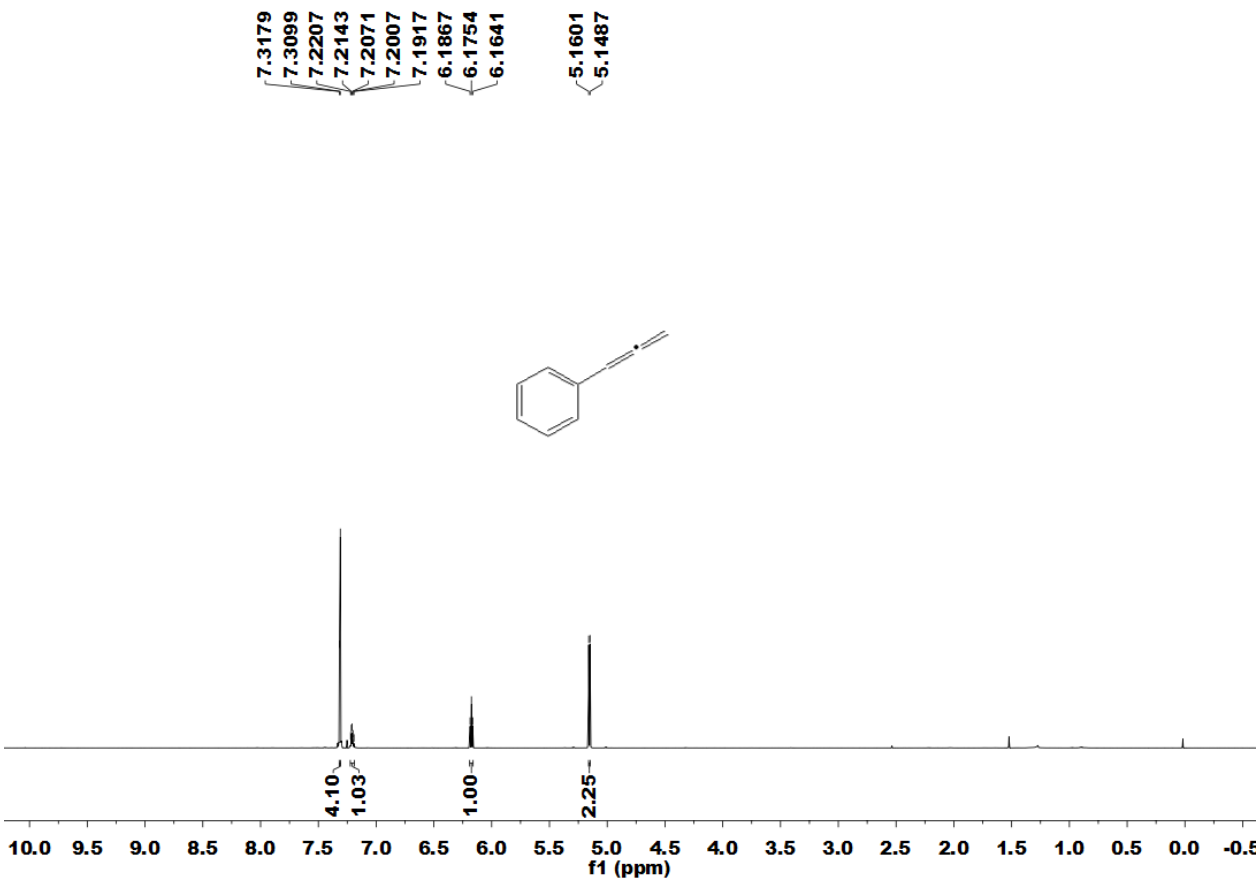


Fig. S39 ^{1}H NMR of phenylpropadiene **(5a)**

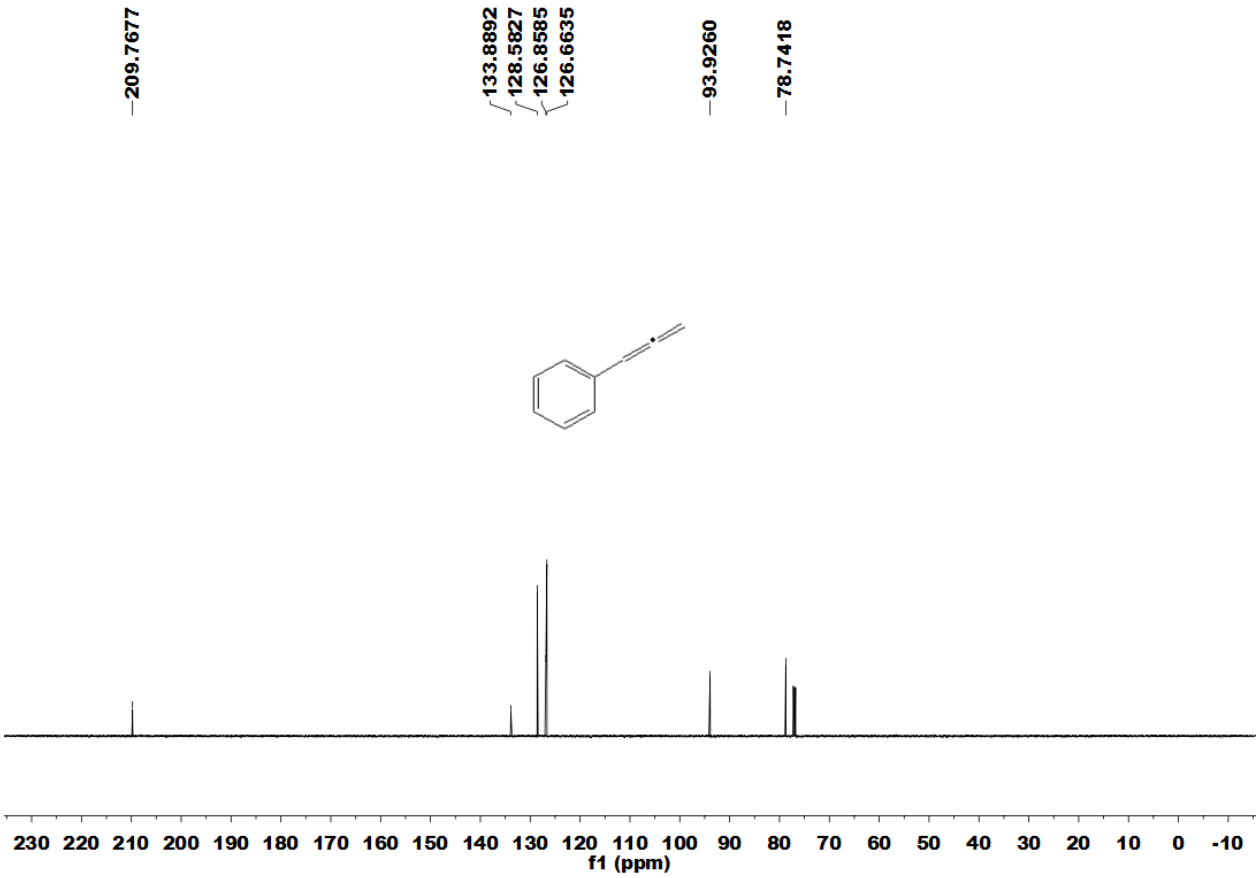


Fig. S40 ^{13}C NMR of phenylpropadiene **(5a)**

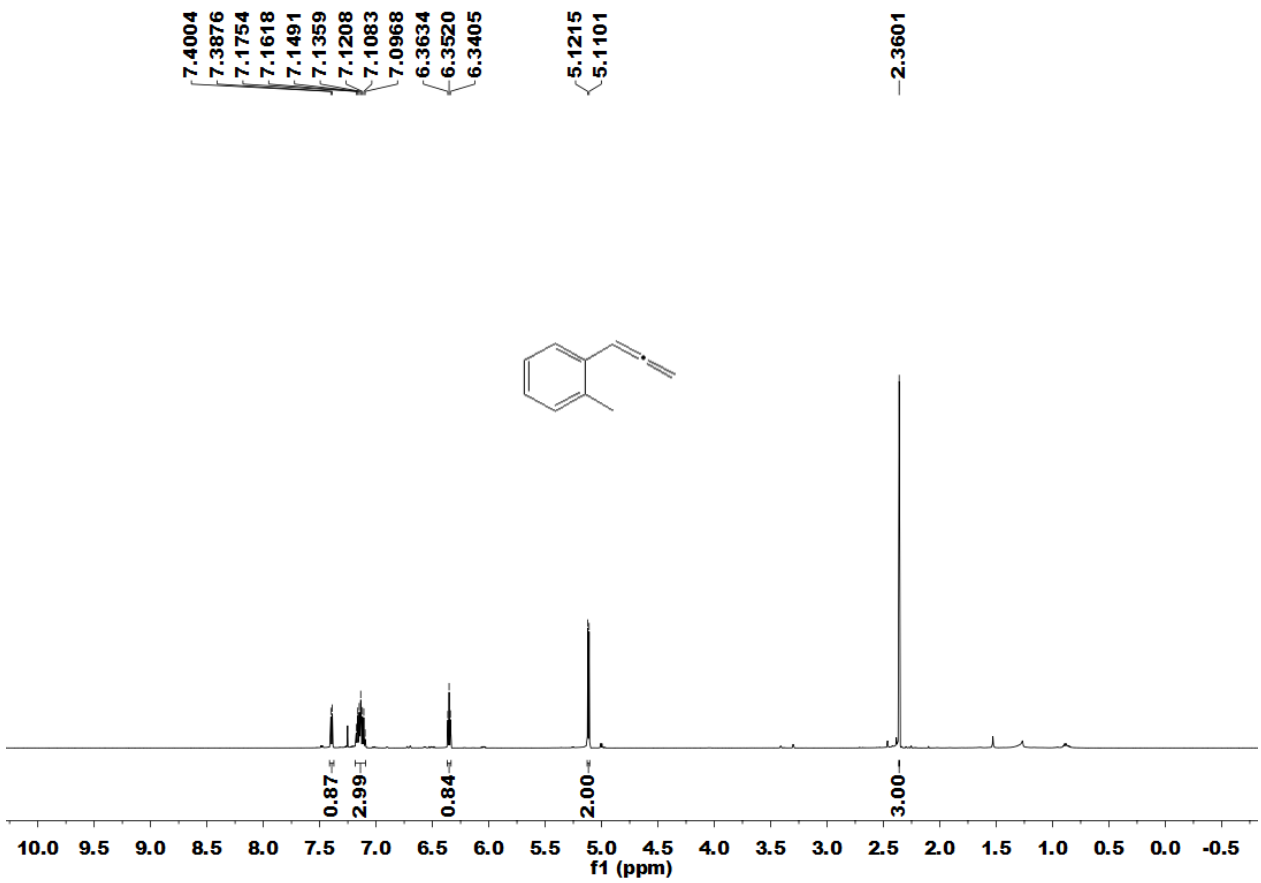


Fig. S41 ^{1}H NMR of (2-methylphenyl)propadiene **(5b)**

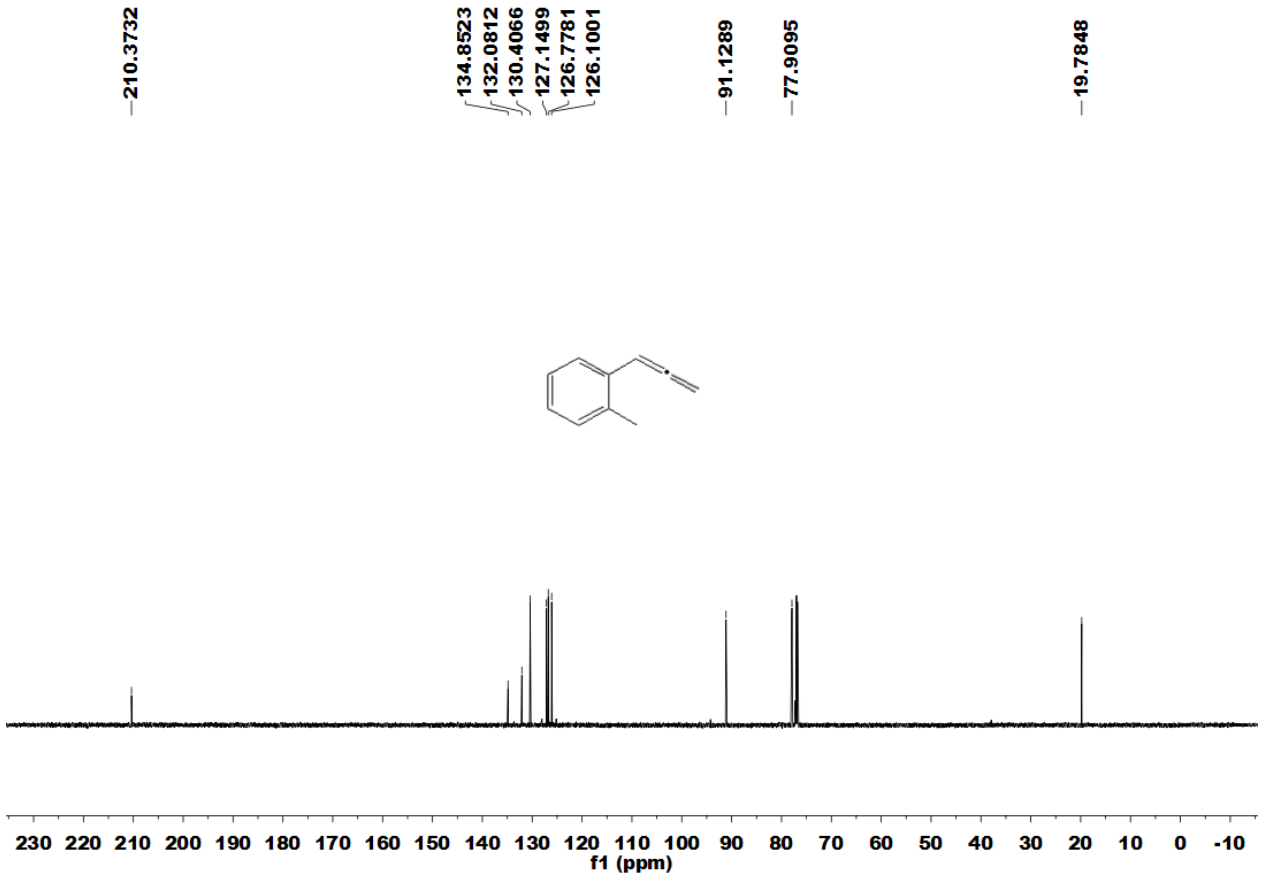


Fig. S42 ^{13}C NMR of (2-methylphenyl)propadiene **(5b)**

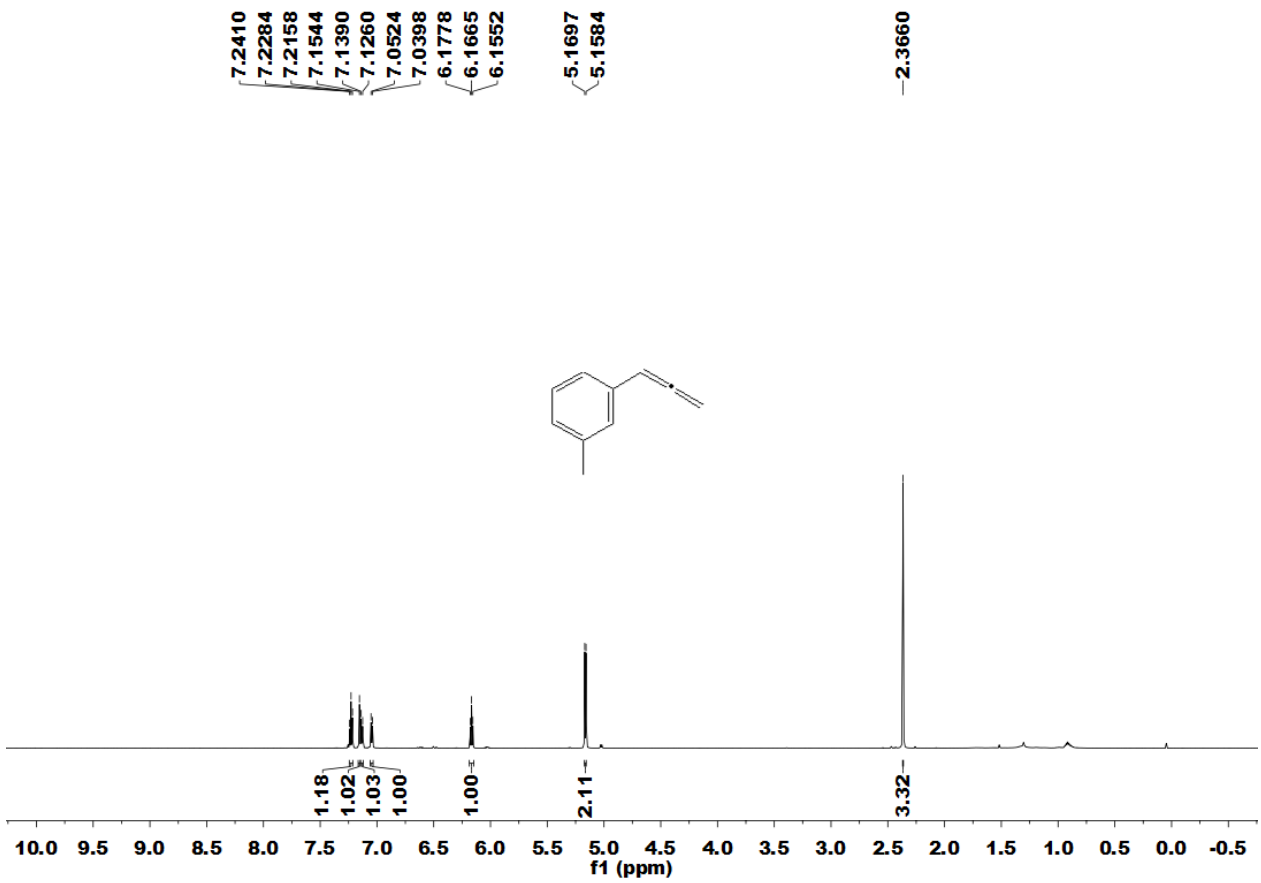


Fig. S43 ^{1}H NMR of (3-methylphenyl)propadiene **(5c)**

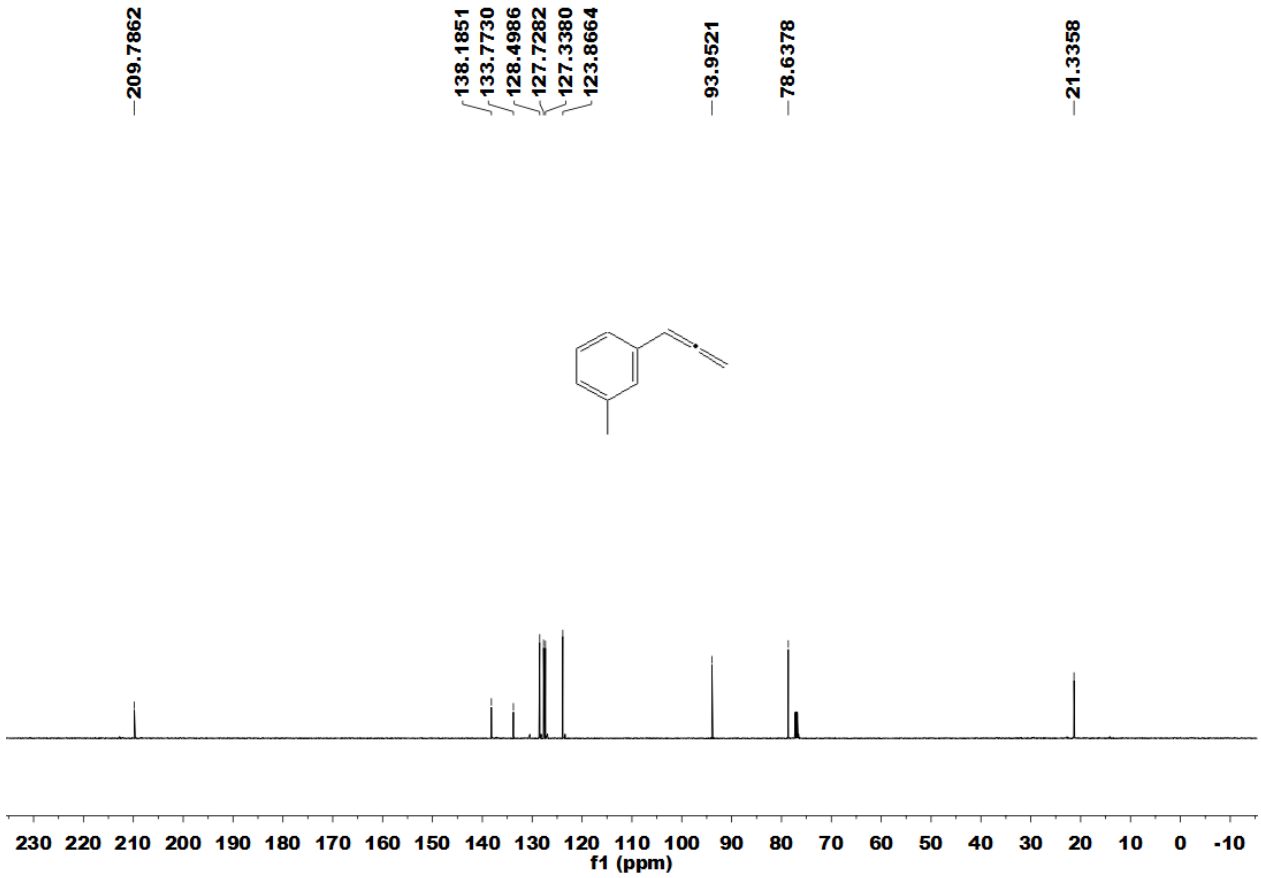


Fig. S44 ^{13}C NMR of (3-methylphenyl)propadiene **(5c)**

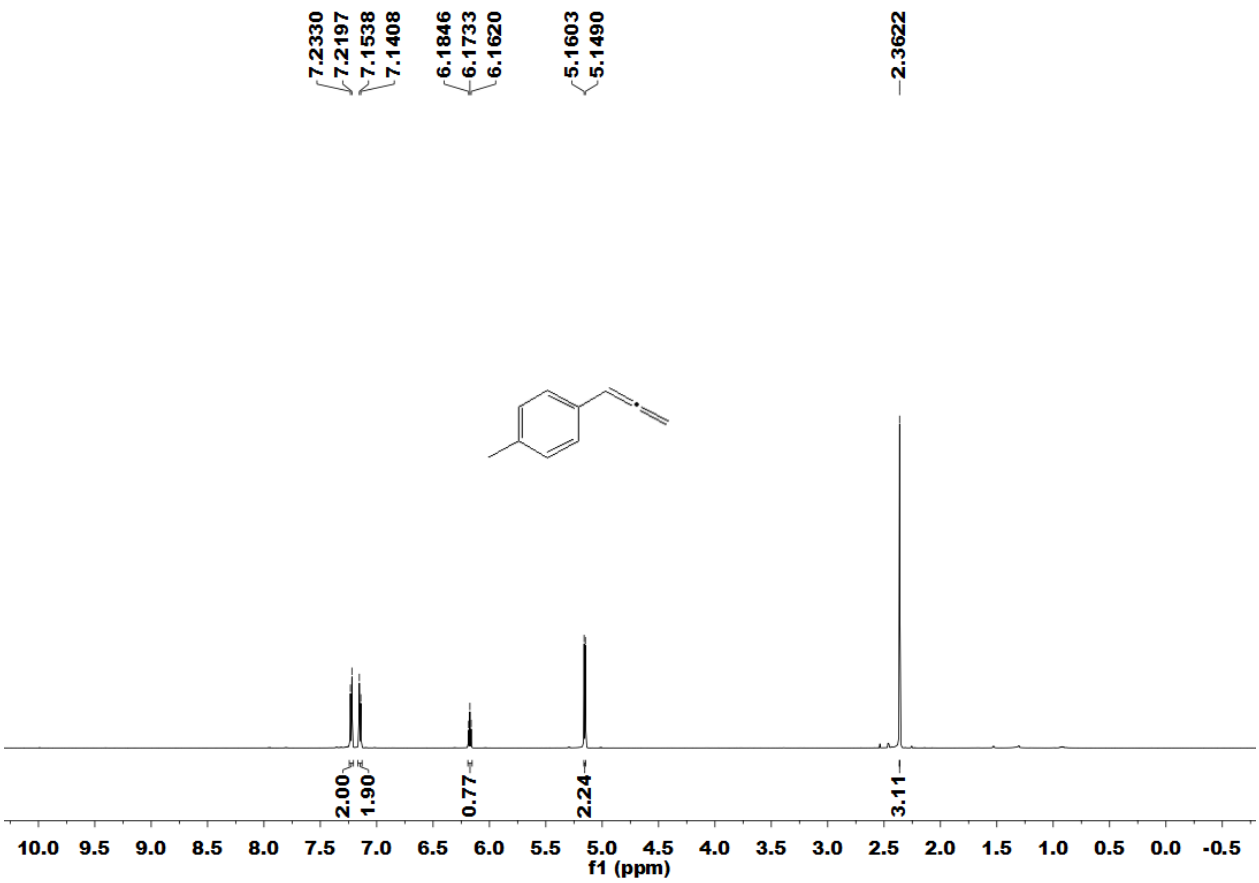


Fig. S45 ^{1}H NMR of (4-methylphenyl)propadiene **(5d)**

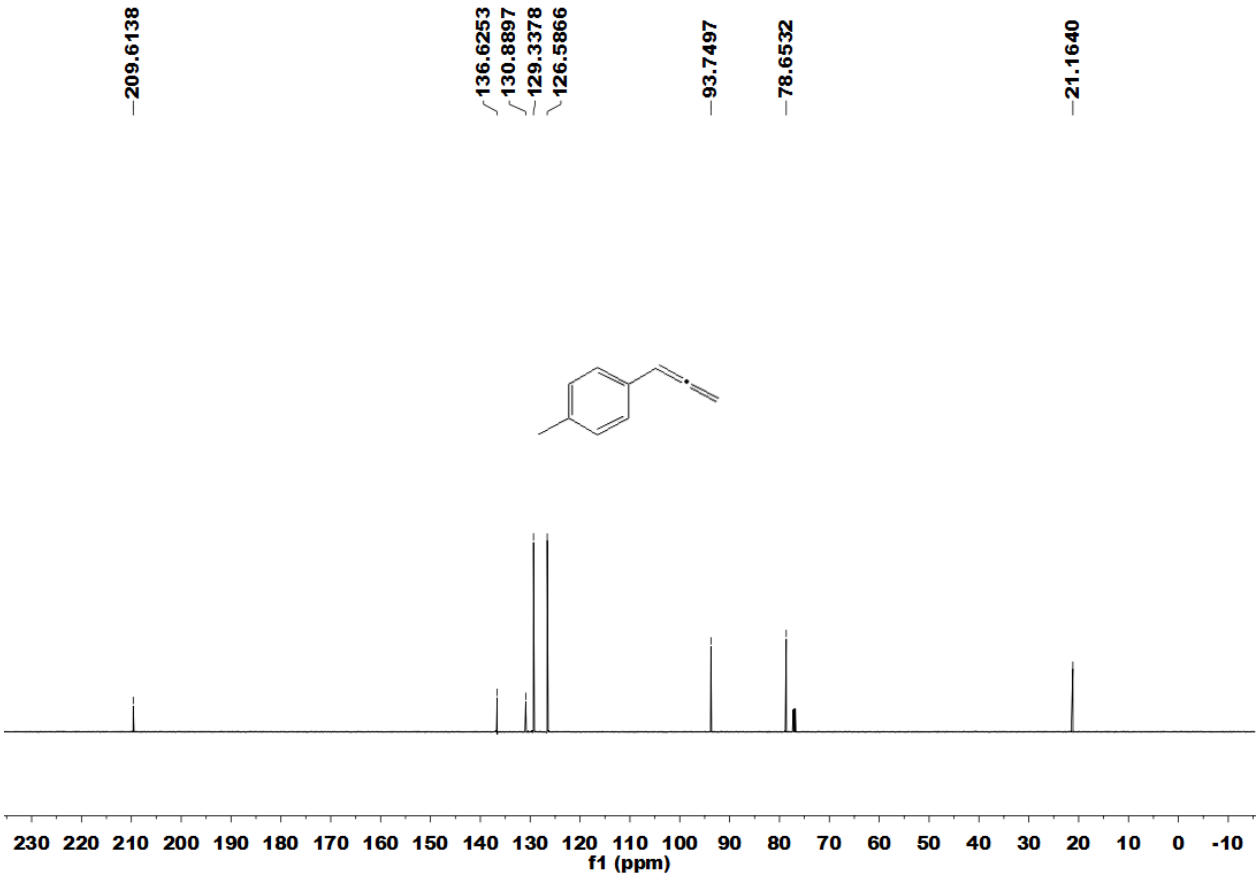


Fig. S46 ^{13}C NMR of (4-methylphenyl)propadiene **(5d)**

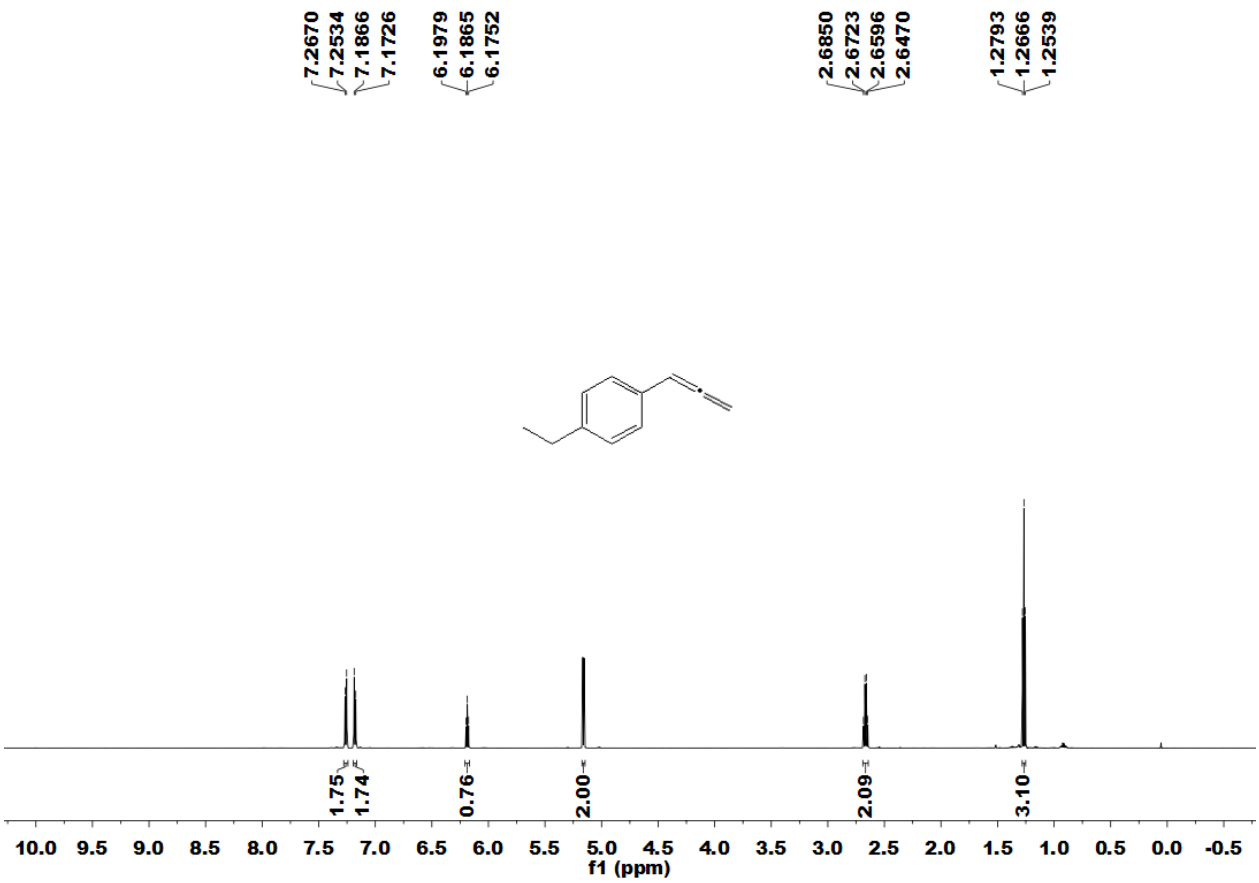


Fig. S47 ^{1}H NMR of 4-ethylphenyl)propadiene **(5e)**

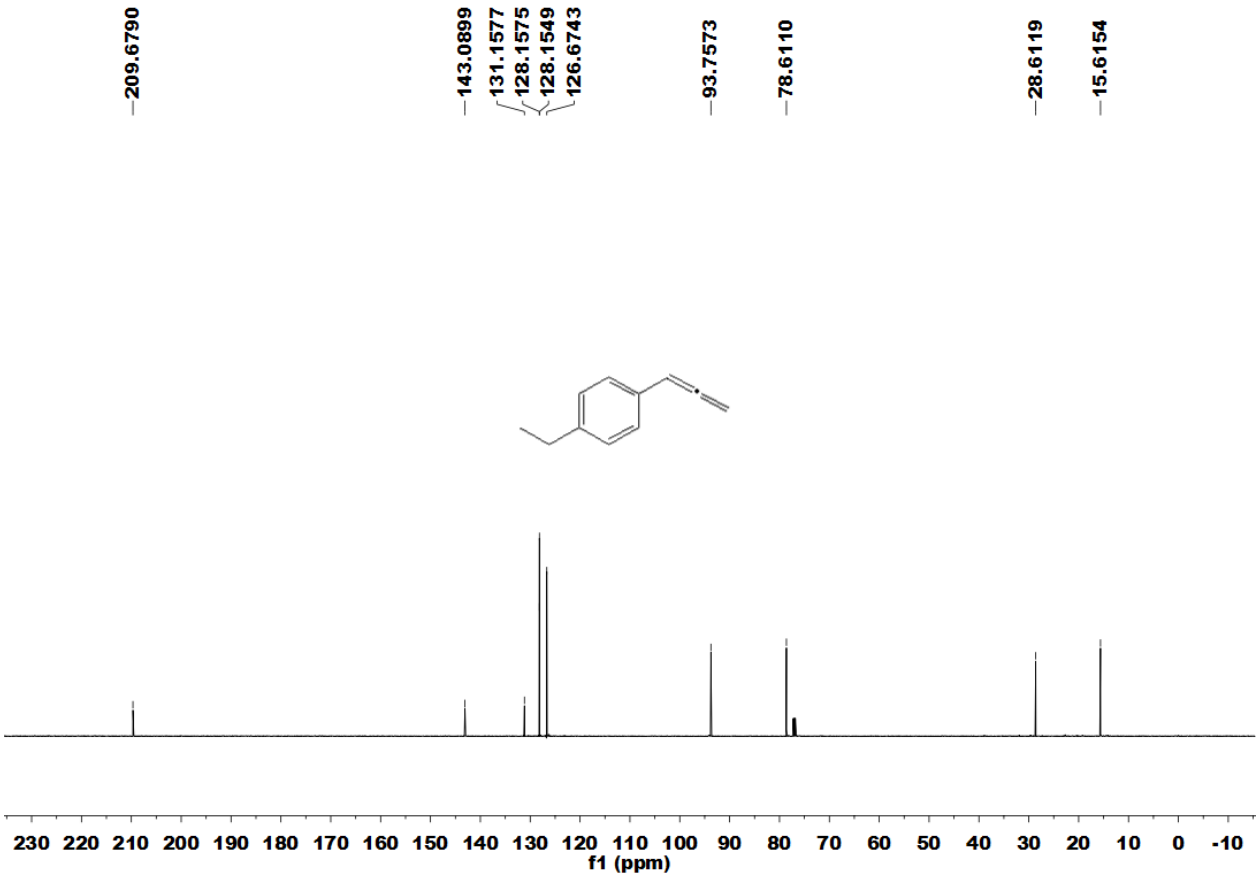


Fig. S48 ^{13}C NMR of 4-ethylphenyl)propadiene **(5e)**

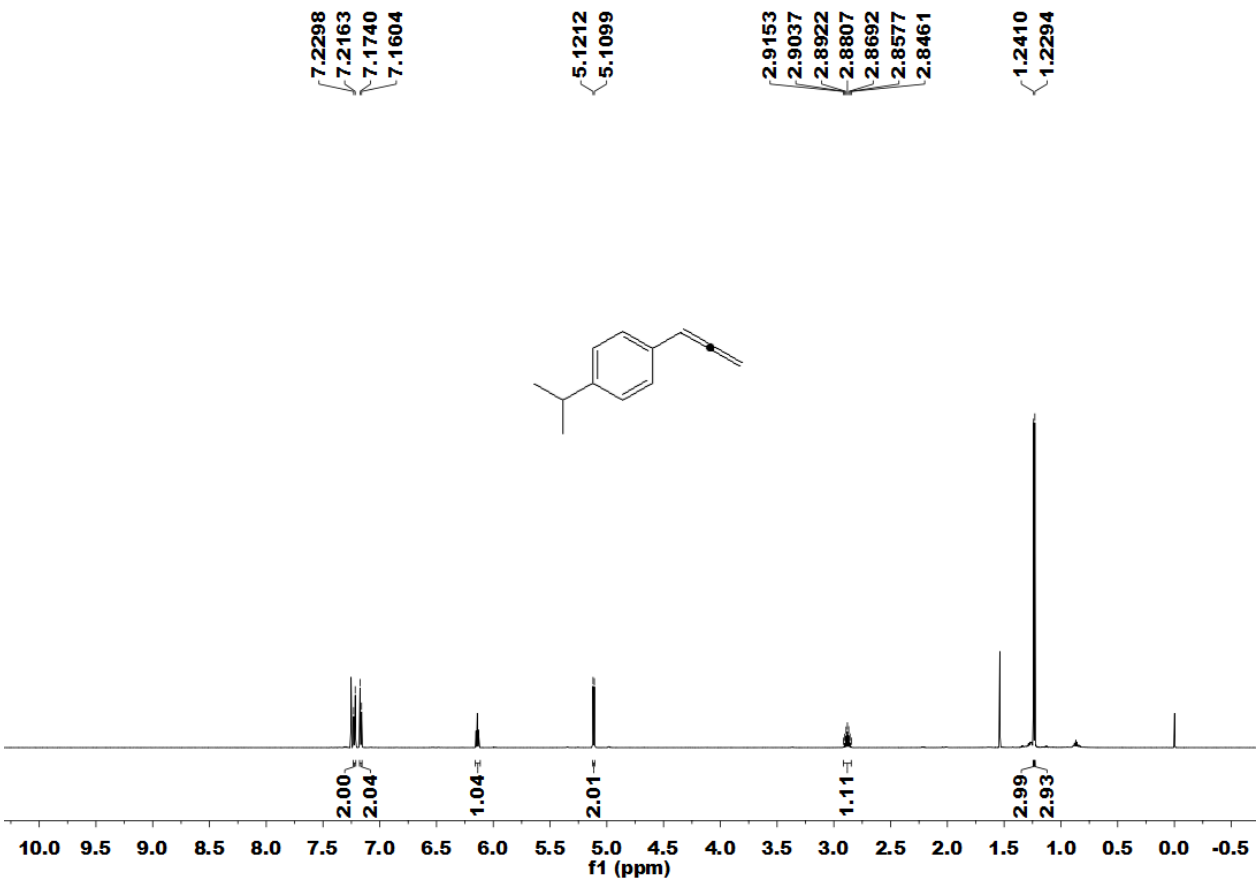


Fig. S49 ^{1}H NMR of (4-isopropylphenyl)propadiene **(5f)**

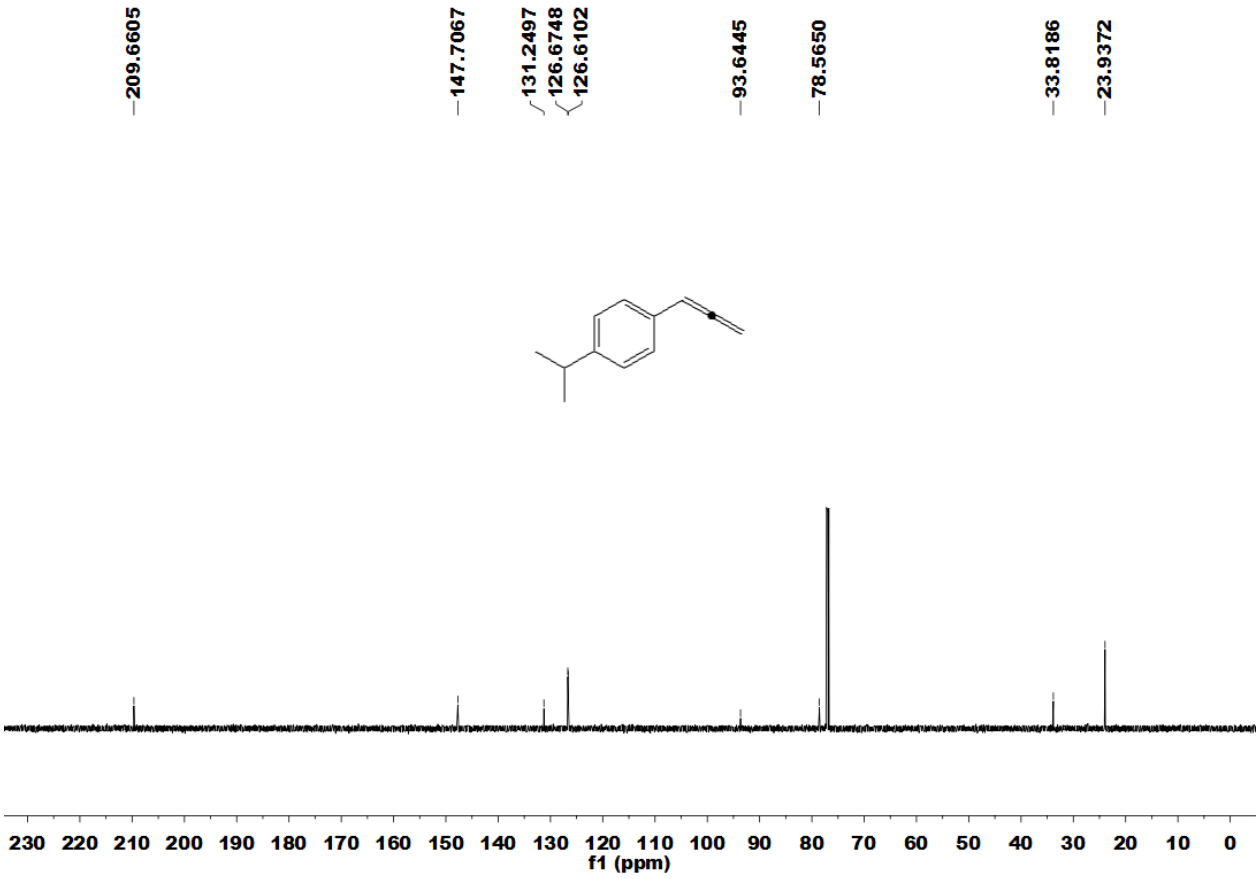


Fig. S40 ^{13}C NMR of (4-isopropylphenyl)propadiene **(5f)**

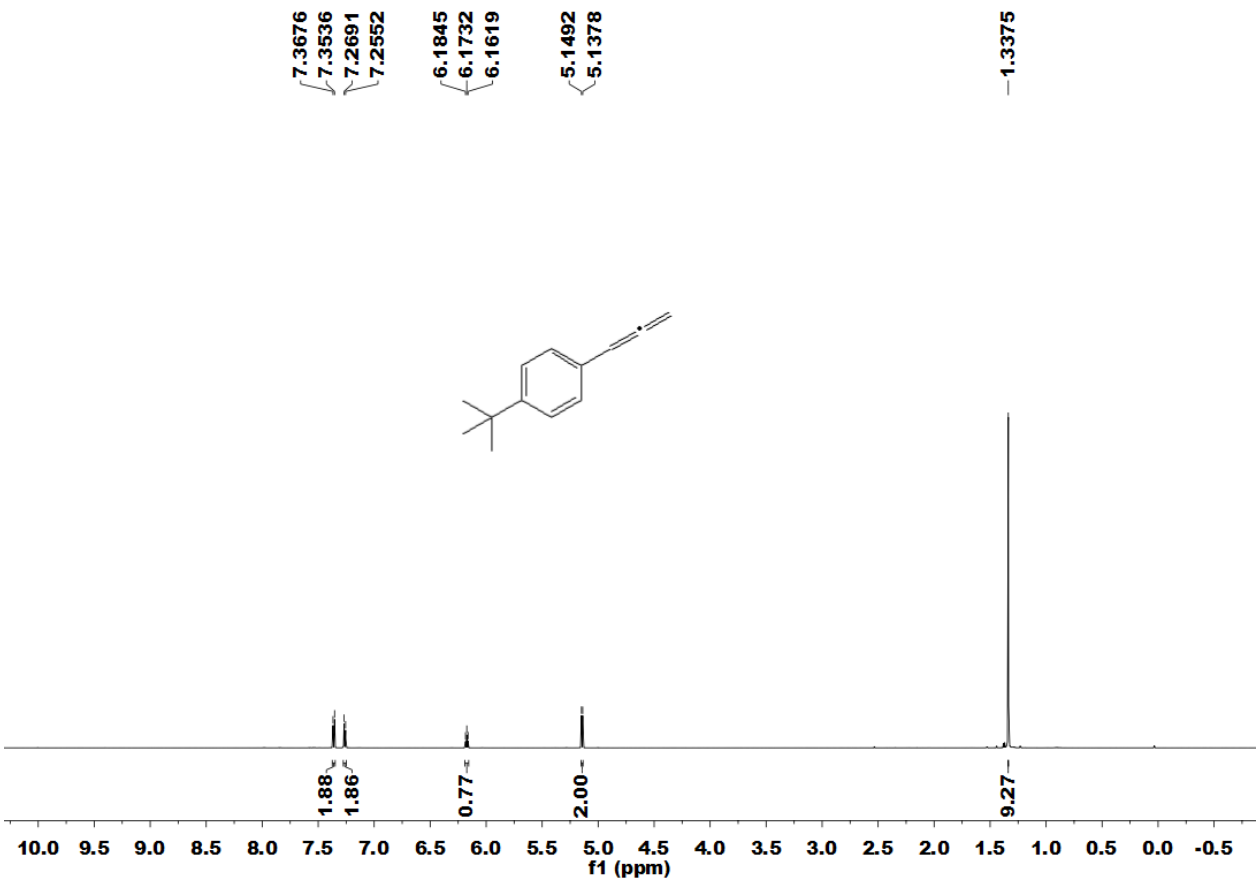


Fig. S51 ^{1}H NMR of (4-*tert*-butylphenyl)propadiene **(5g)**

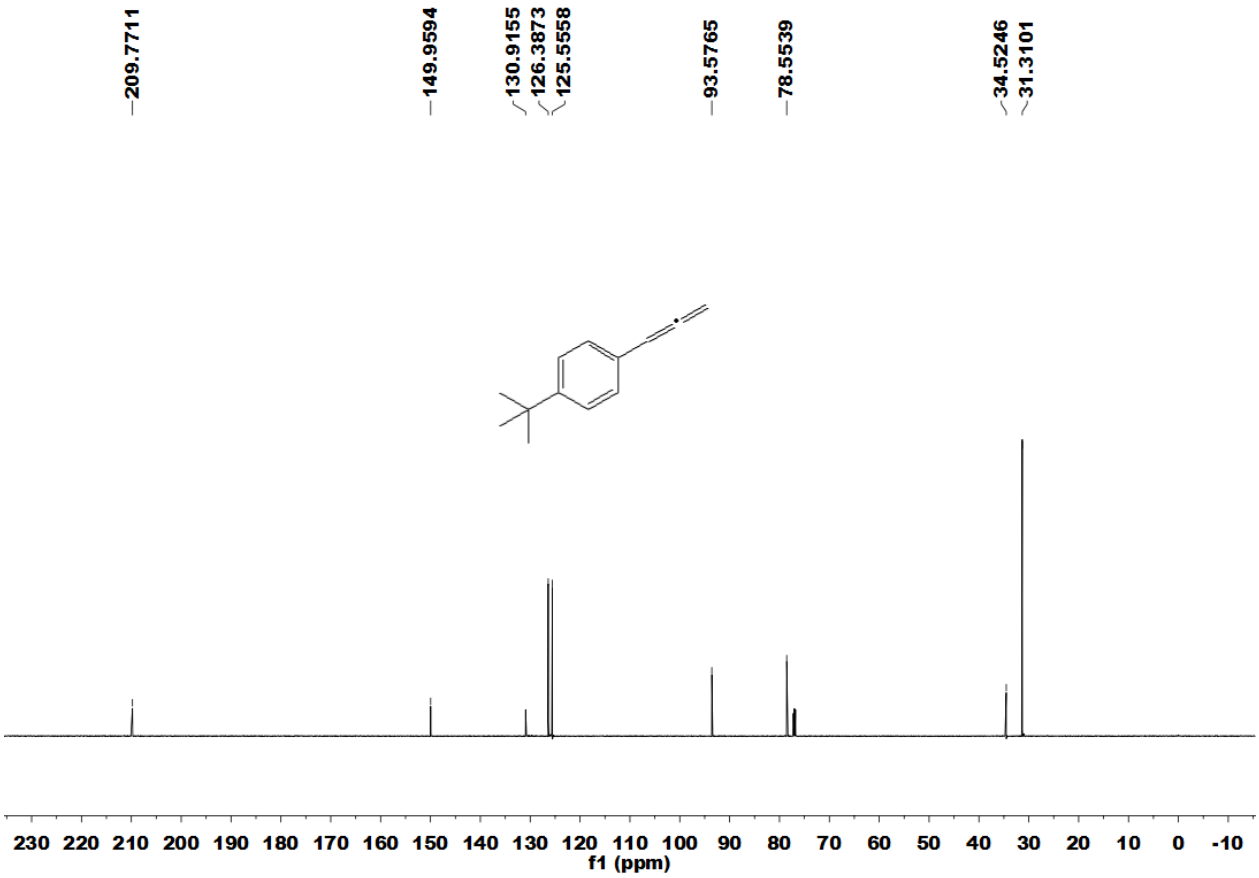


Fig. S52 ^{13}C NMR of (4-*tert*-butylphenyl)propadiene **(5g)**

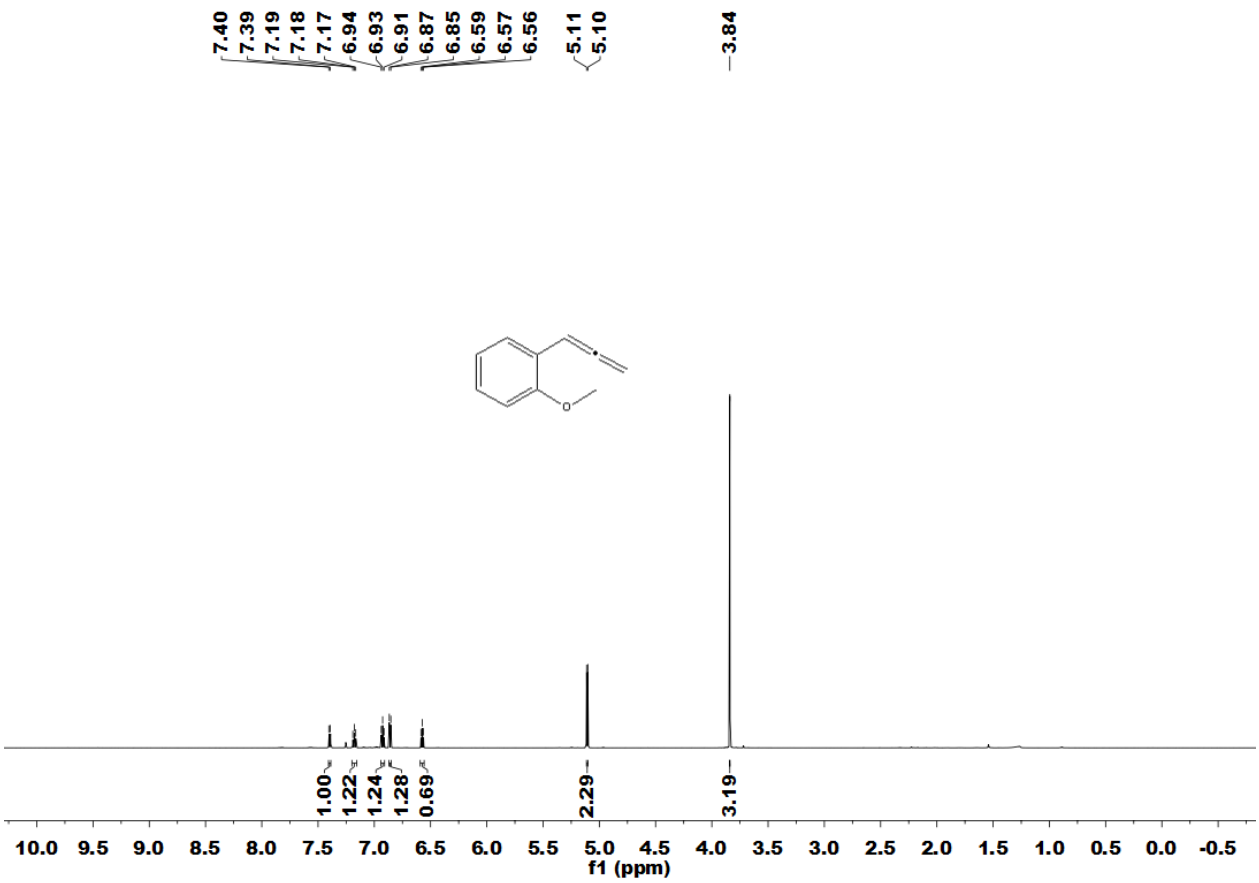


Fig. S53 ^{1}H NMR of 2-methoxyphenyl)propadiene **(5h)**

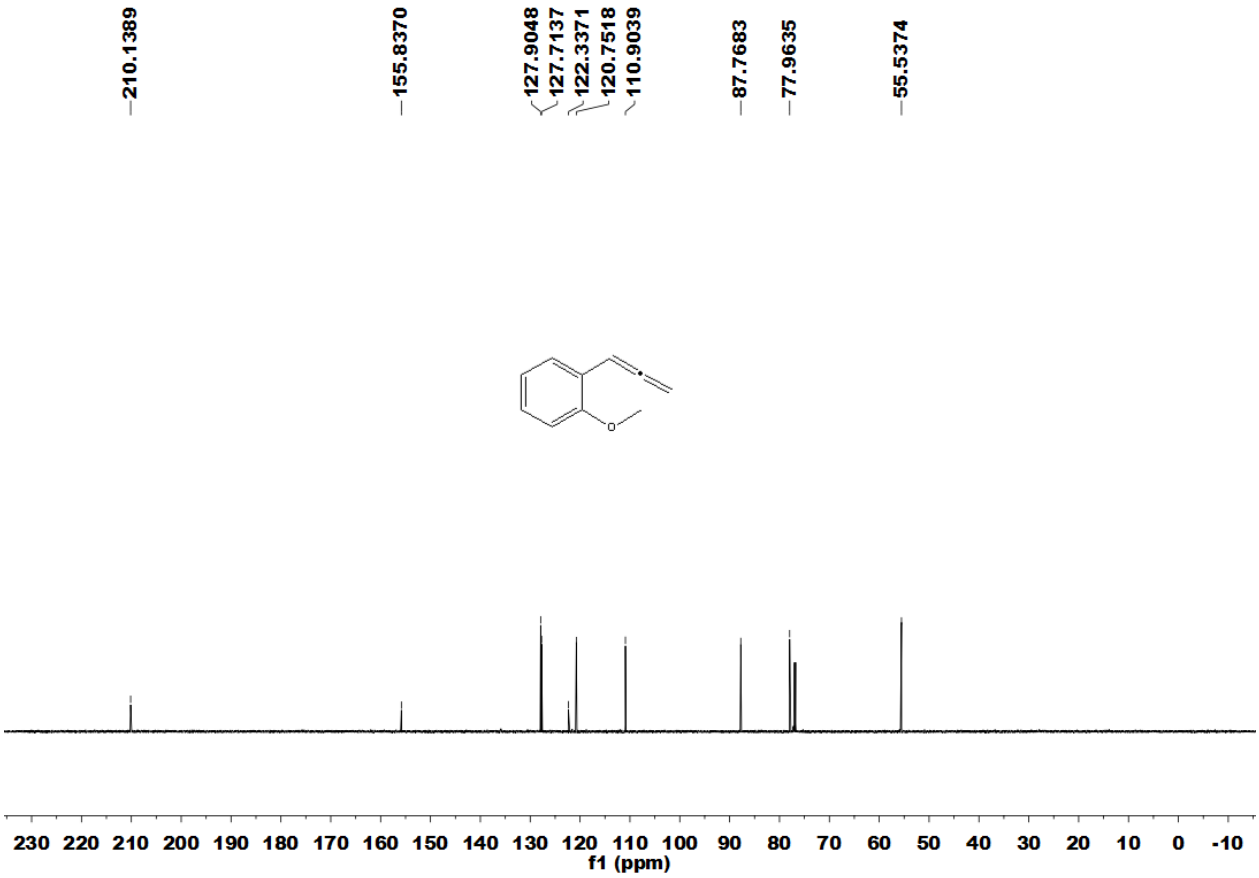


Fig. S54 ^{13}C NMR of 2-methoxyphenyl)propadiene **(5h)**

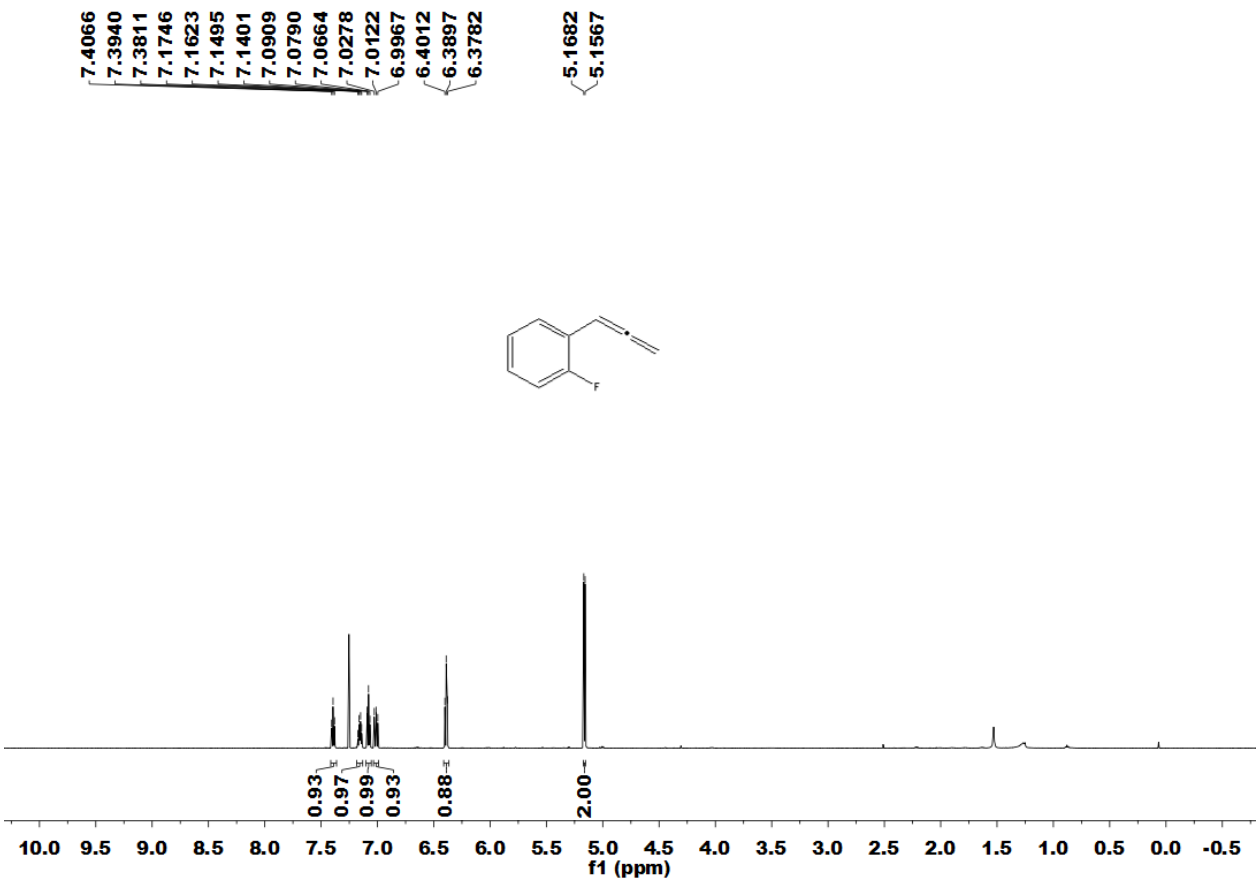


Fig. S55 ^{1}H NMR of (2-fluorophenyl)propadiene **(5i)**

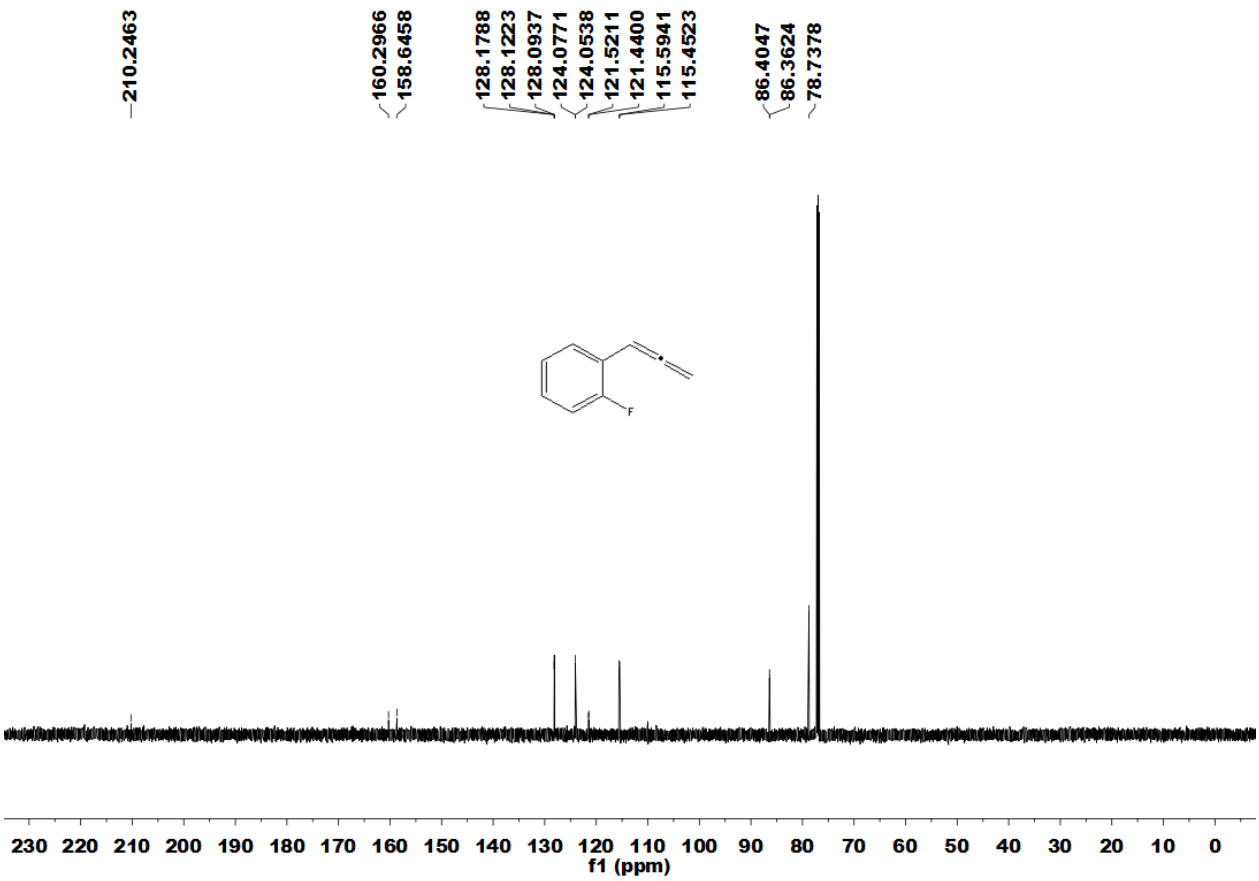


Fig. S56 ^{13}C NMR of (2-fluorophenyl)propadiene **(5i)**

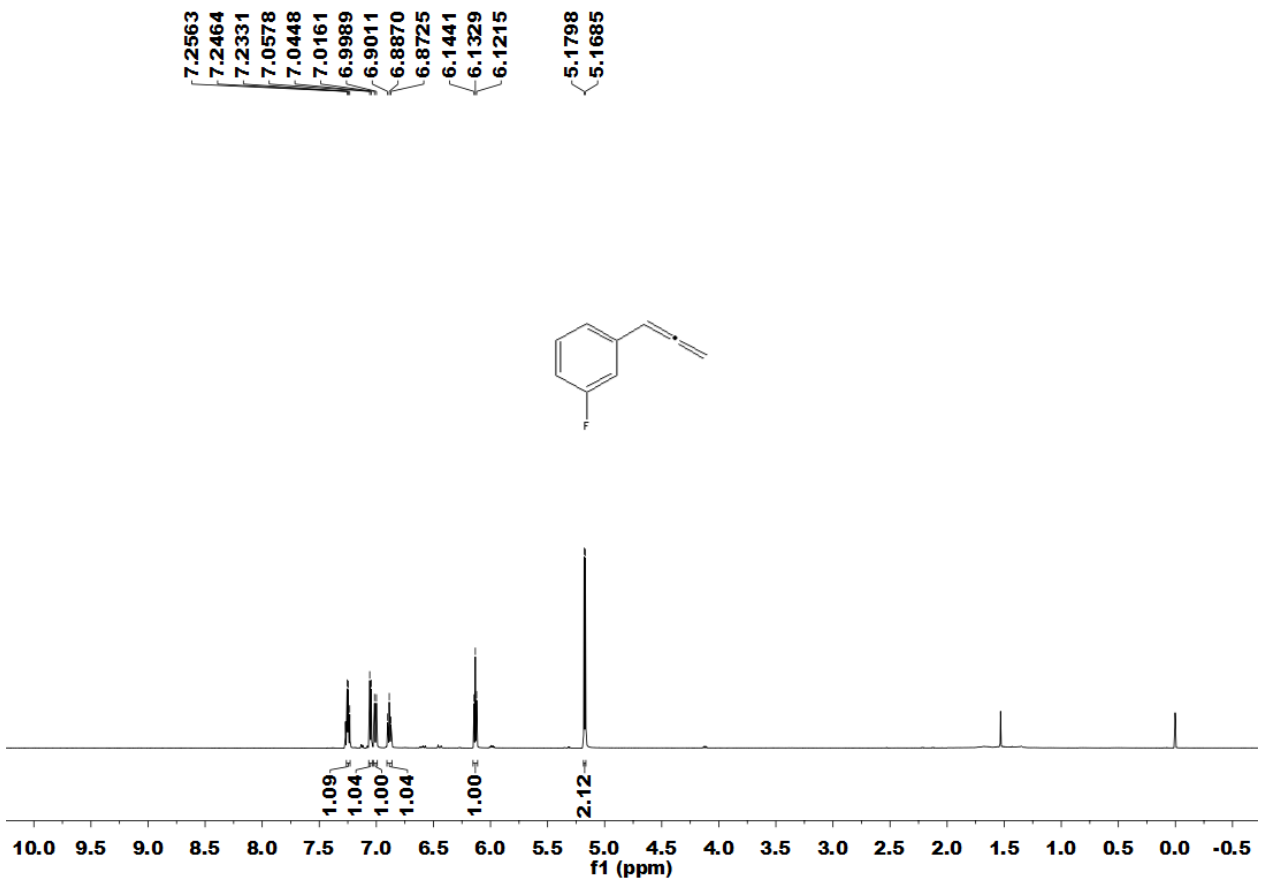


Fig. S57 ^{1}H NMR of (3-fluorophenyl)propadiene **(5j)**

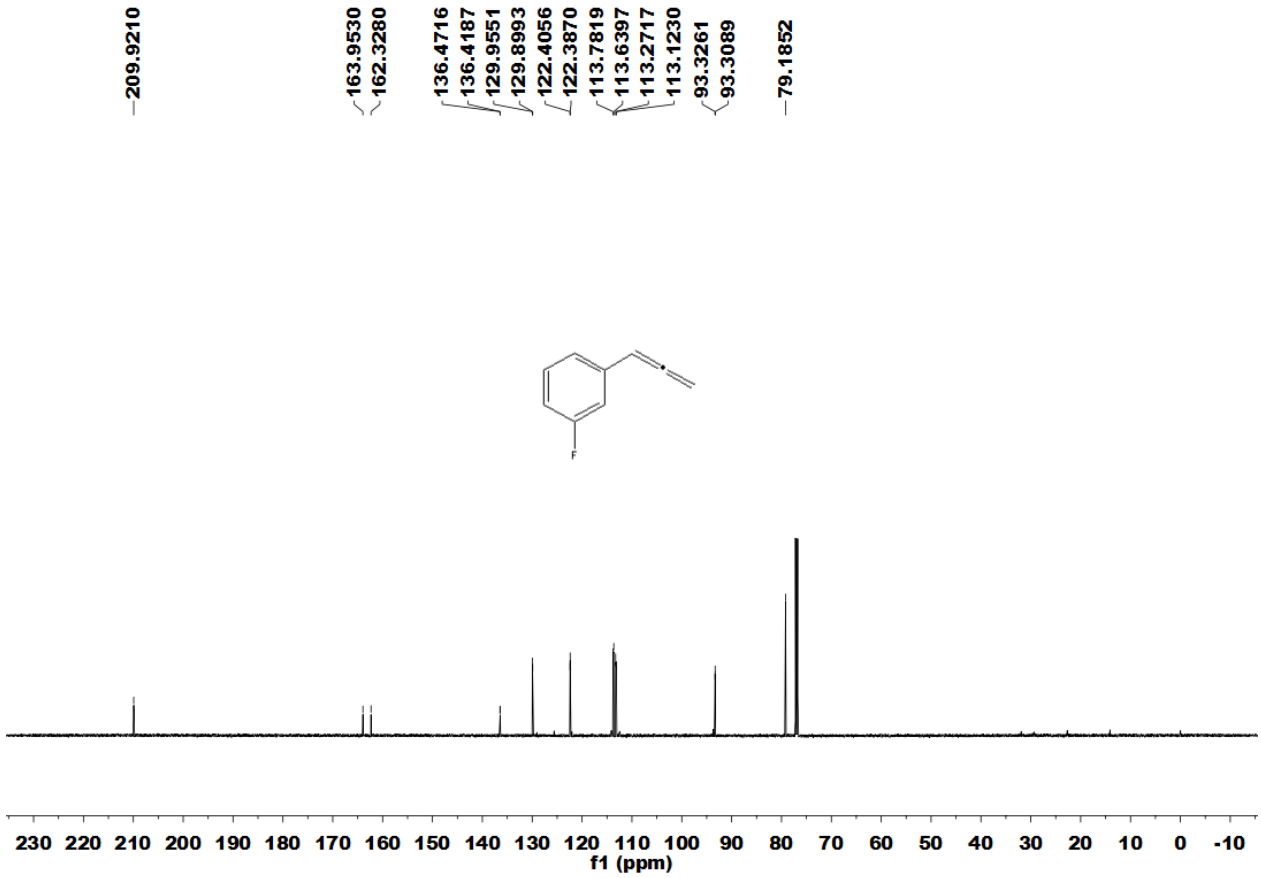


Fig. S58 ^{13}C NMR of (3-fluorophenyl)propadiene **(5j)**

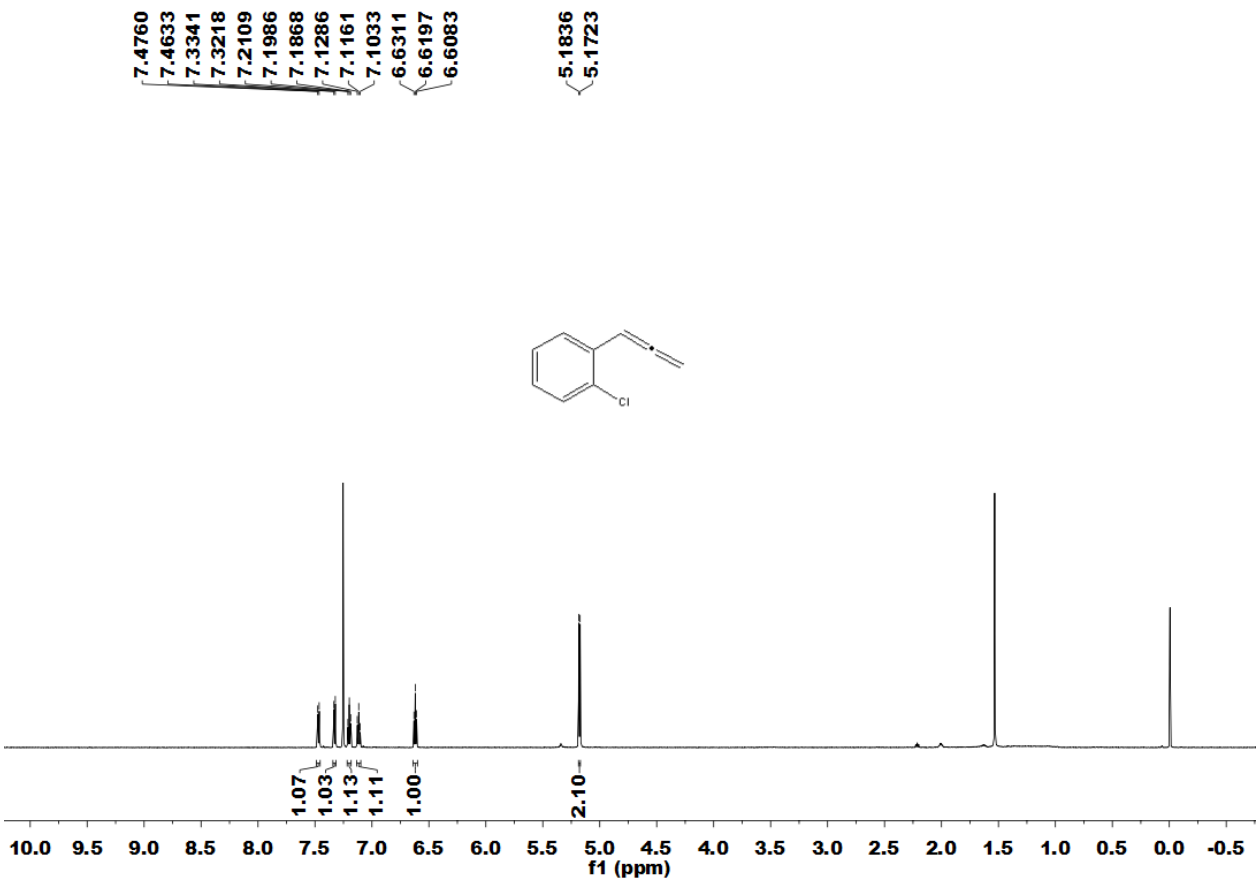


Fig. S59 ^{1}H NMR of (2-chlorophenyl)propadiene **(5k)**

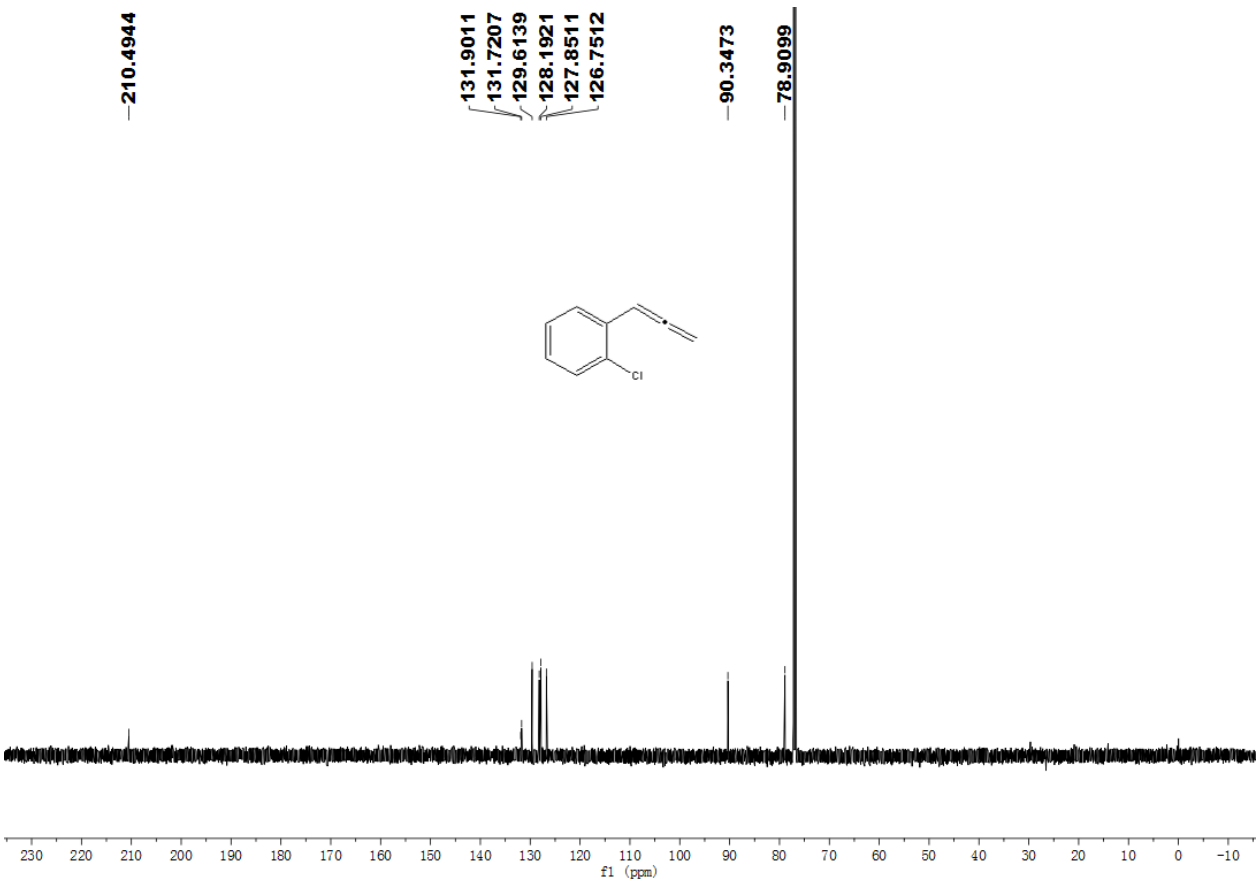


Fig. S60^{13}C NMR of (2-chlorophenyl)propadiene **(5k)**

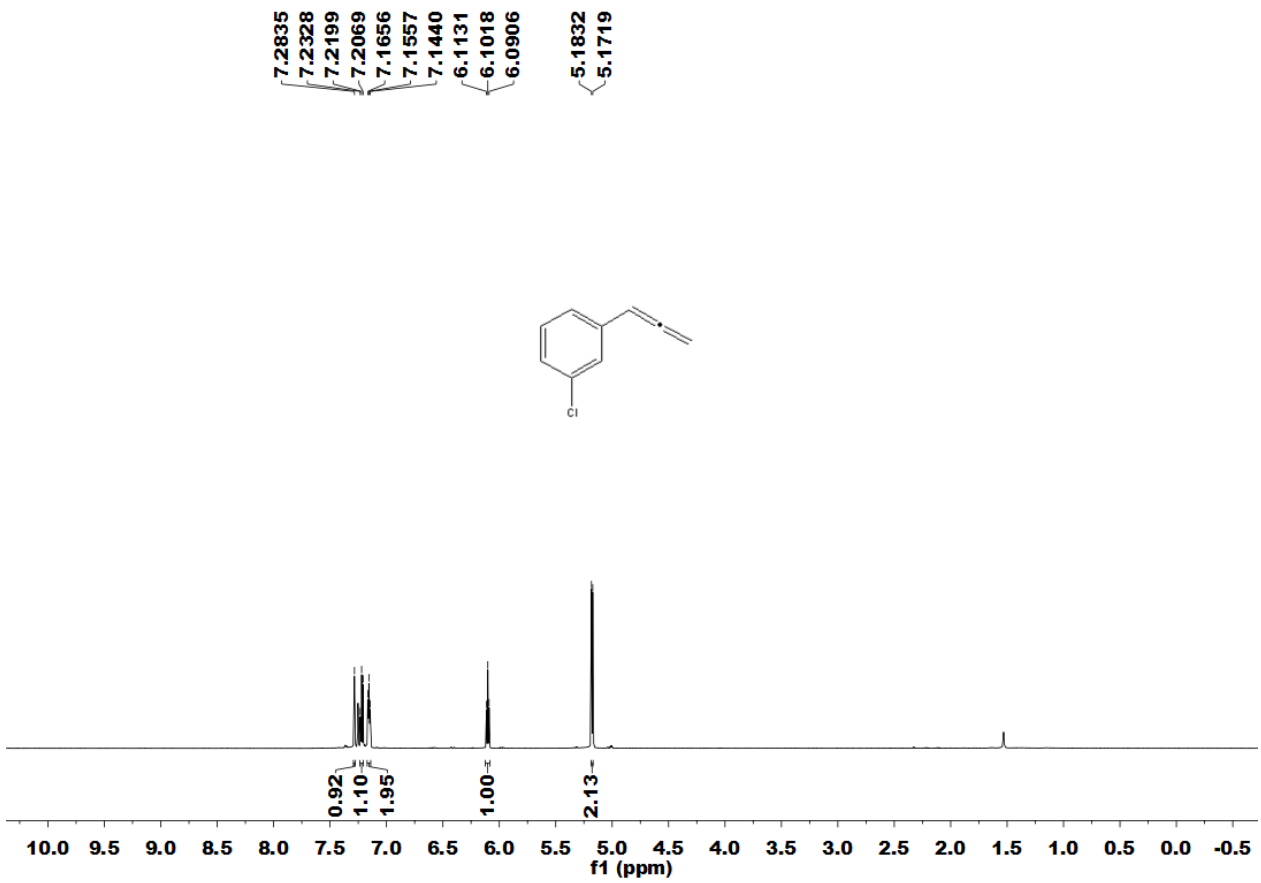


Fig. S61 ^{1}H NMR of (3-chlorophenyl)propadiene **(5l)**

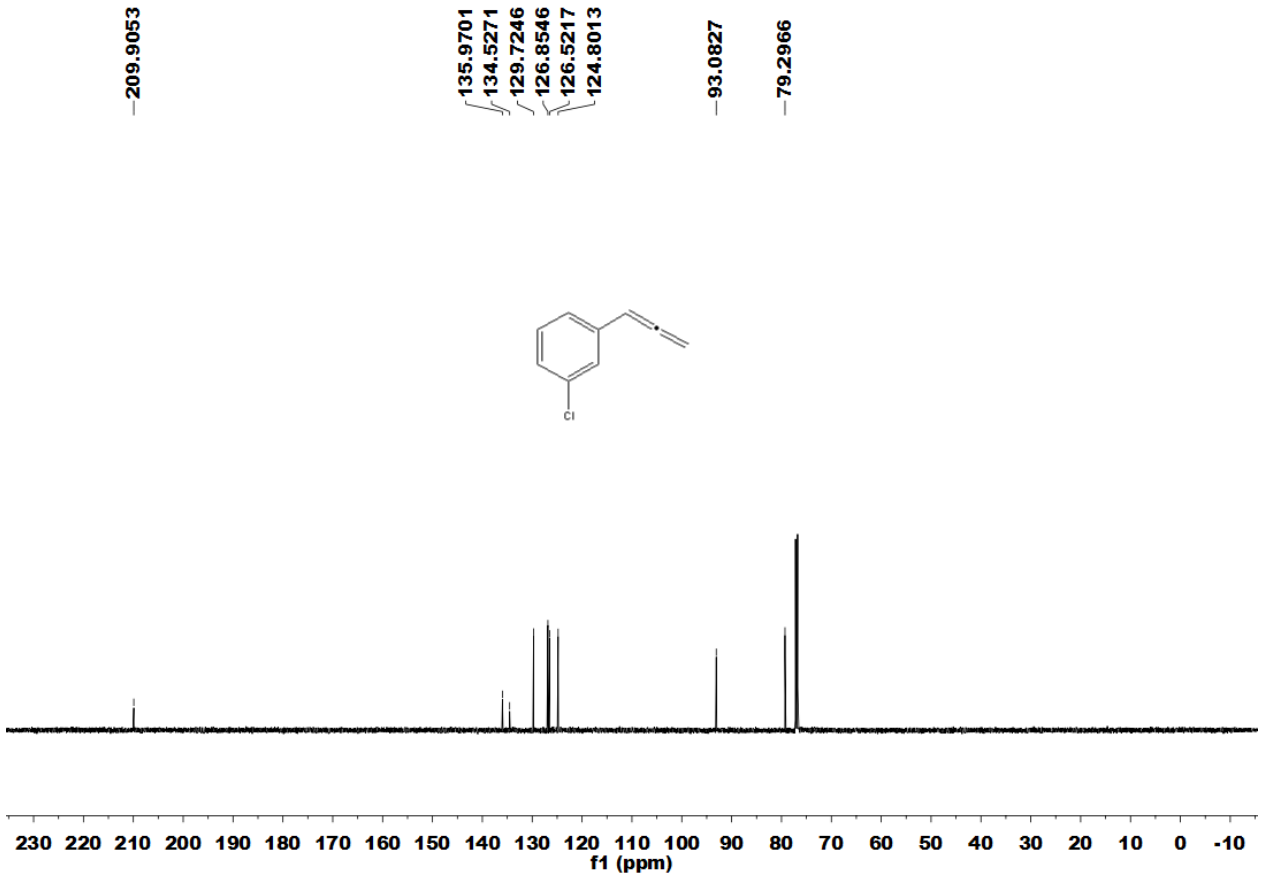


Fig. S62 ^{13}C NMR of (3-chlorophenyl)propadiene **(5l)**

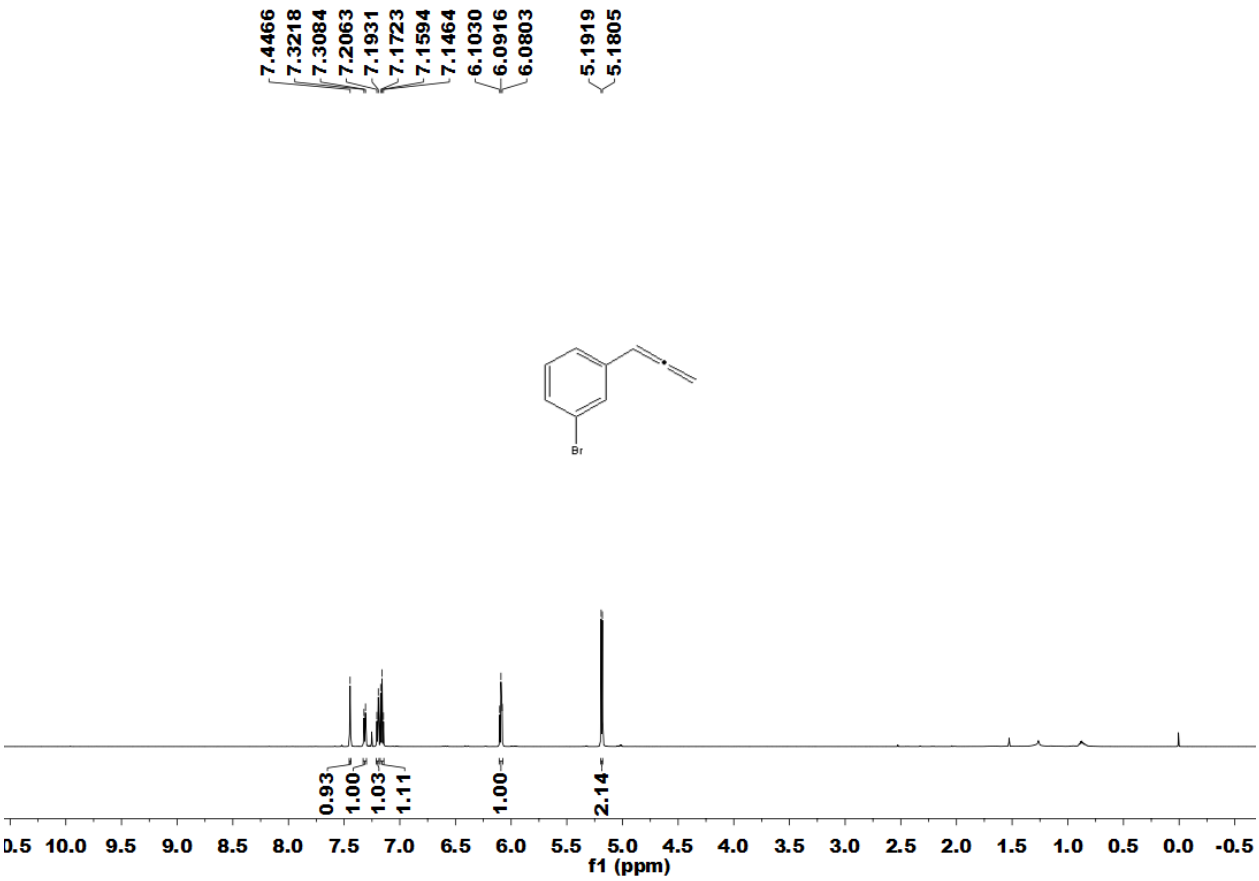


Fig. S63 ^{1}H NMR of (3-bromophenyl)propadiene **(5m)**

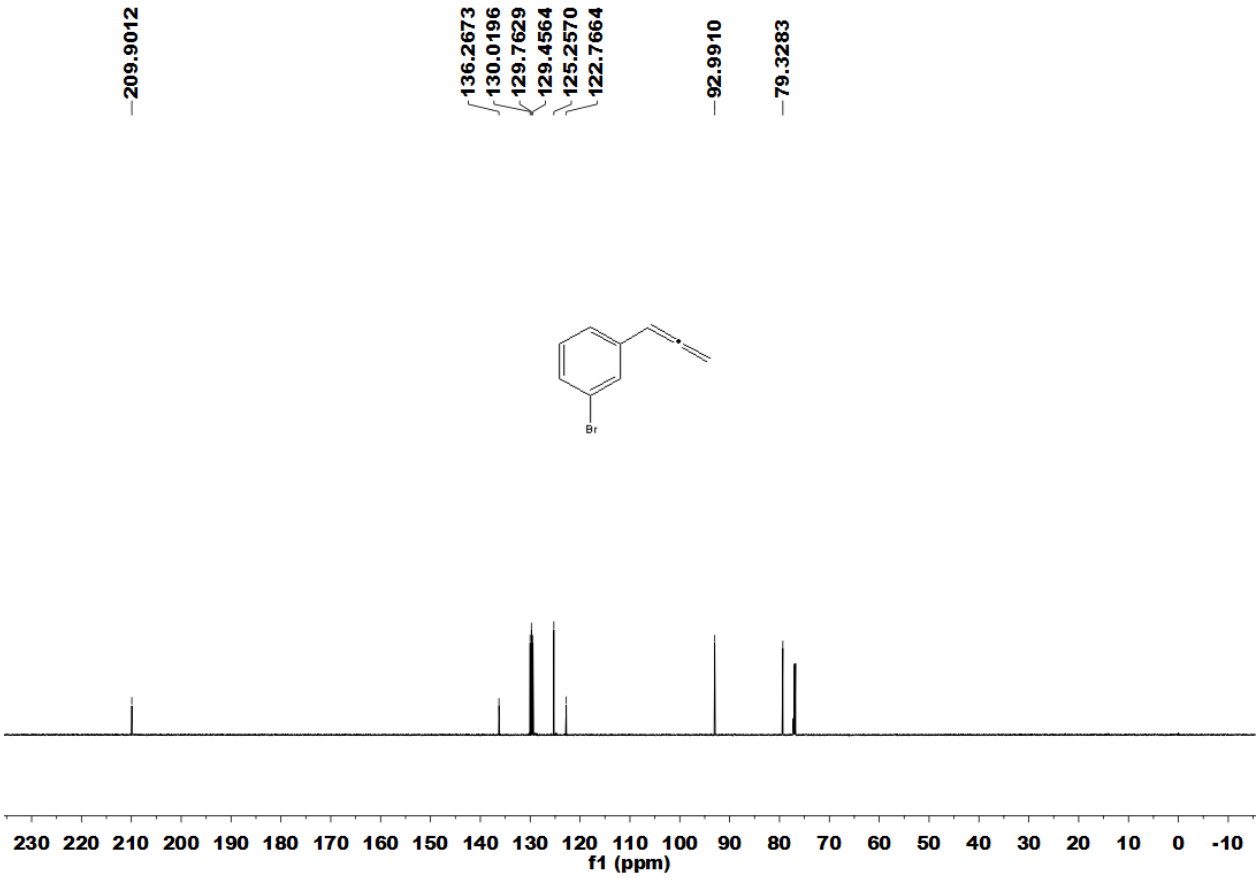


Fig. S64 ^{13}C NMR of (3-bromophenyl)propadiene **(5m)**

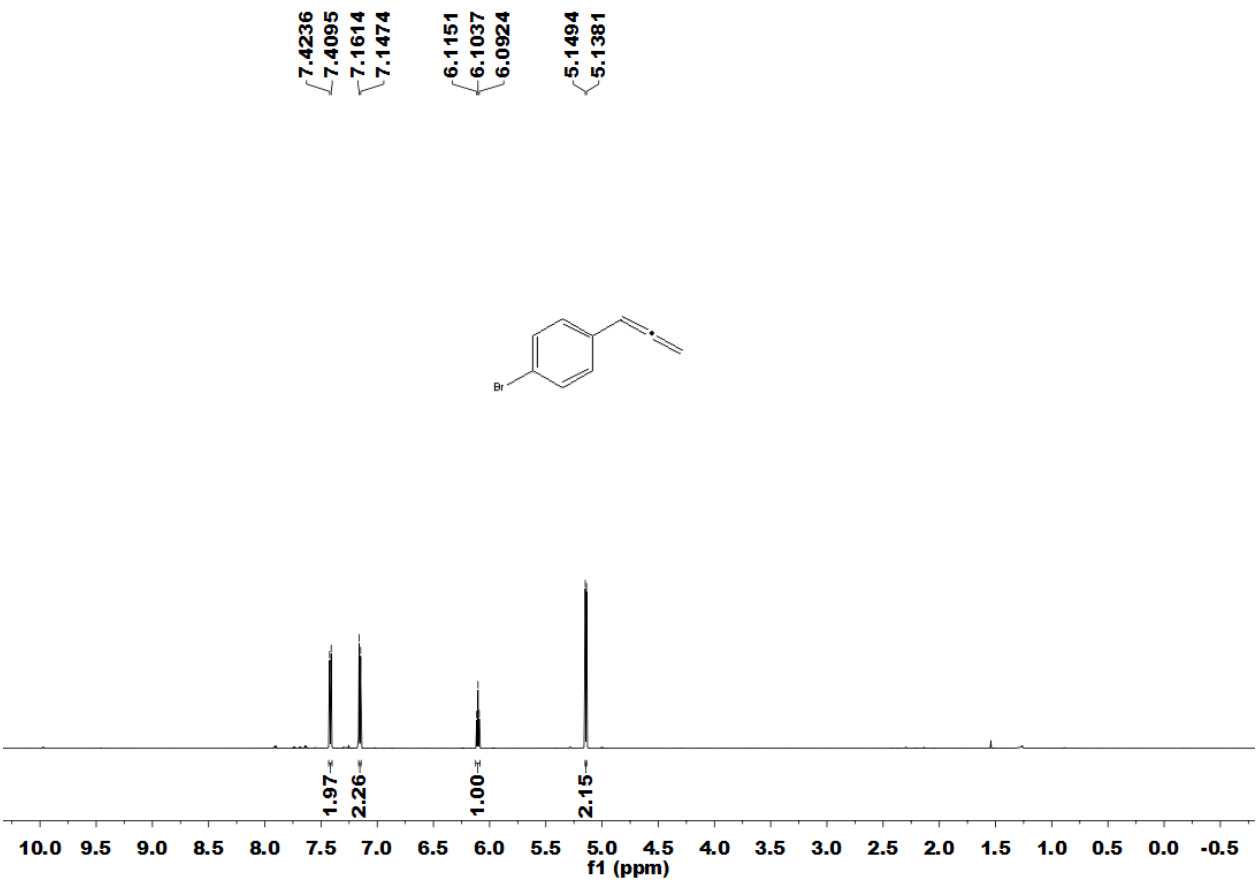


Fig. S65 ^{1}H NMR of (4-bromophenyl)propadiene **(5n)**

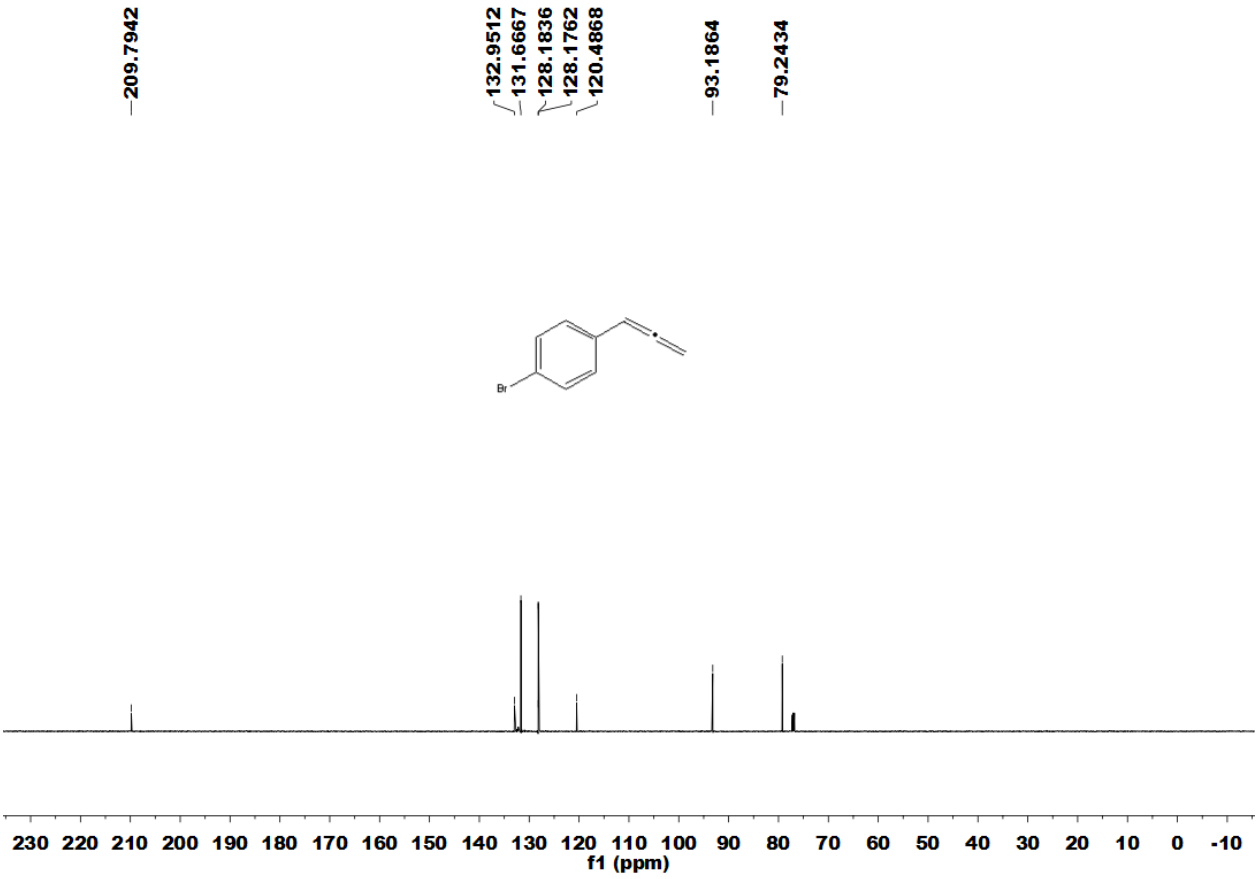


Fig. S66 ^{13}C NMR of (4-bromophenyl)propadiene **(5n)**

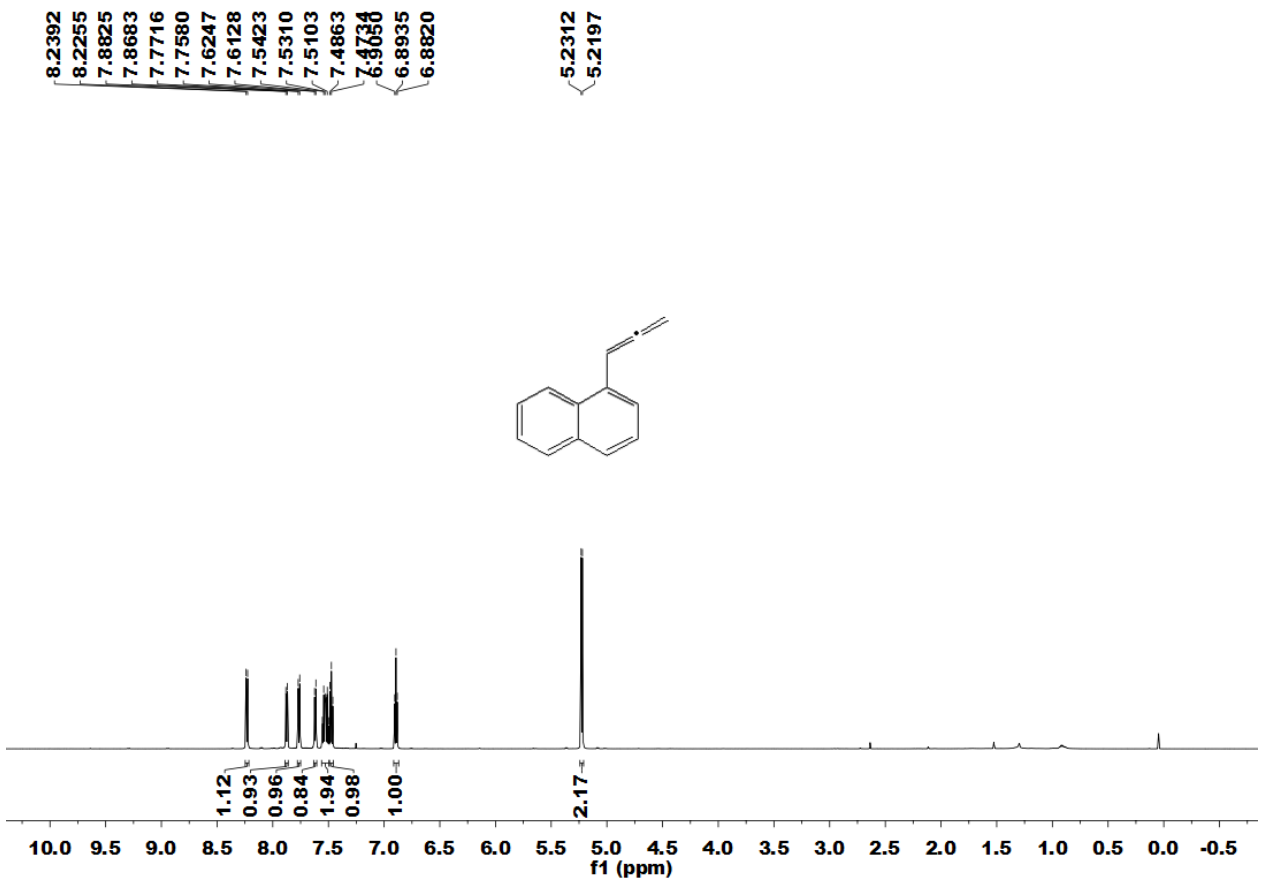


Fig. S67 ^{1}H NMR of (1-naphthyl)propadiene **(5o)**

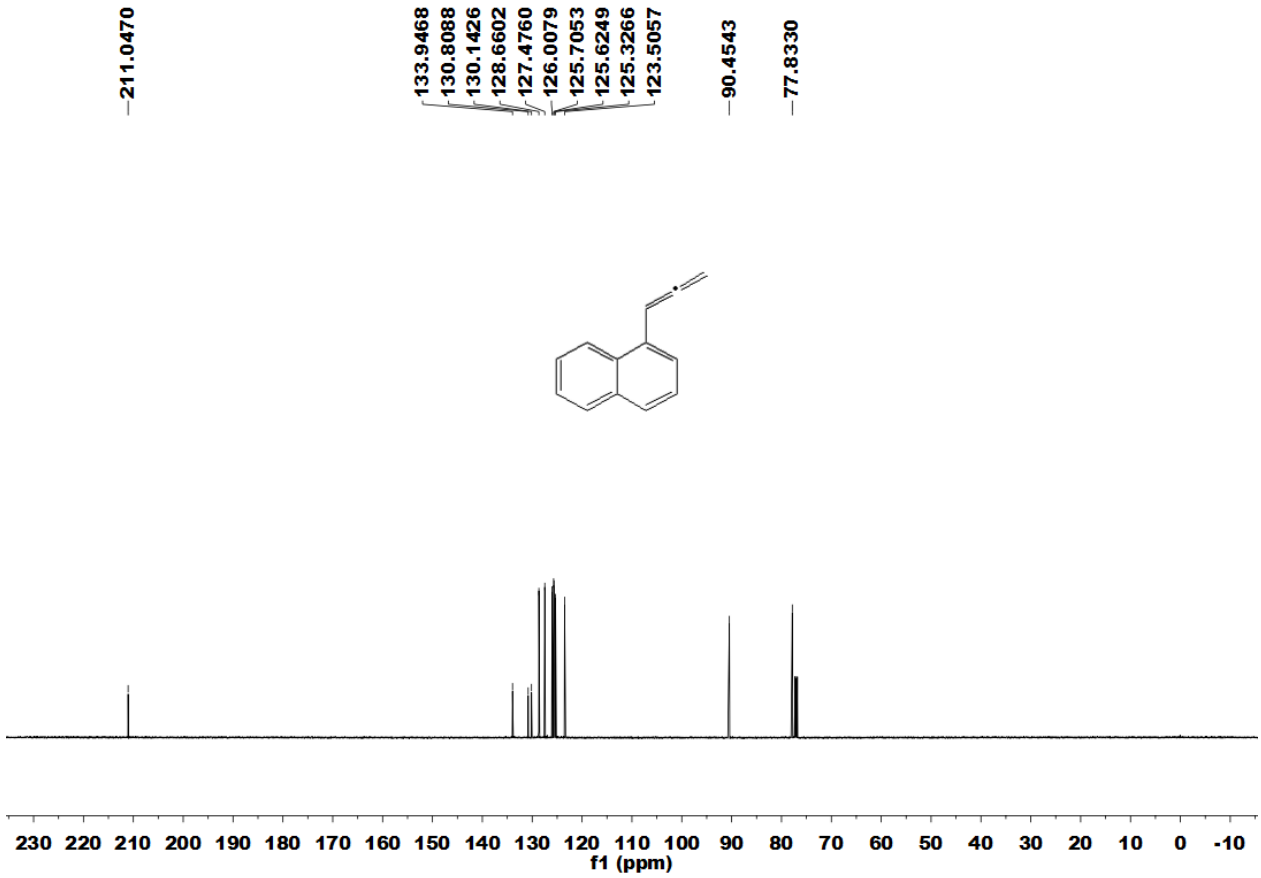


Fig. S68 ^{13}C NMR of (1-naphthyl)propadien**e (5o)**

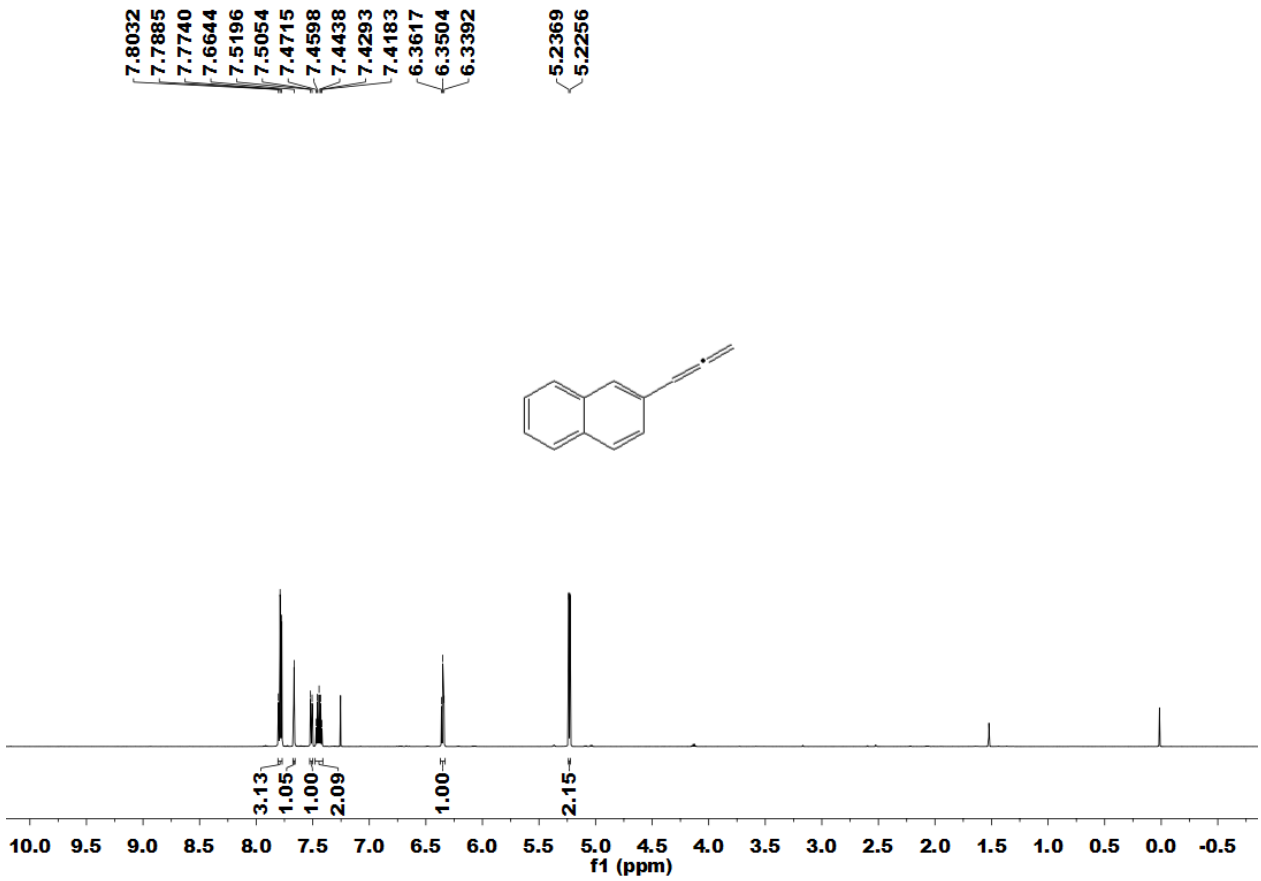


Fig. S69 ^{1}H NMR of (2-naphthyl)propadiene **(5p)**

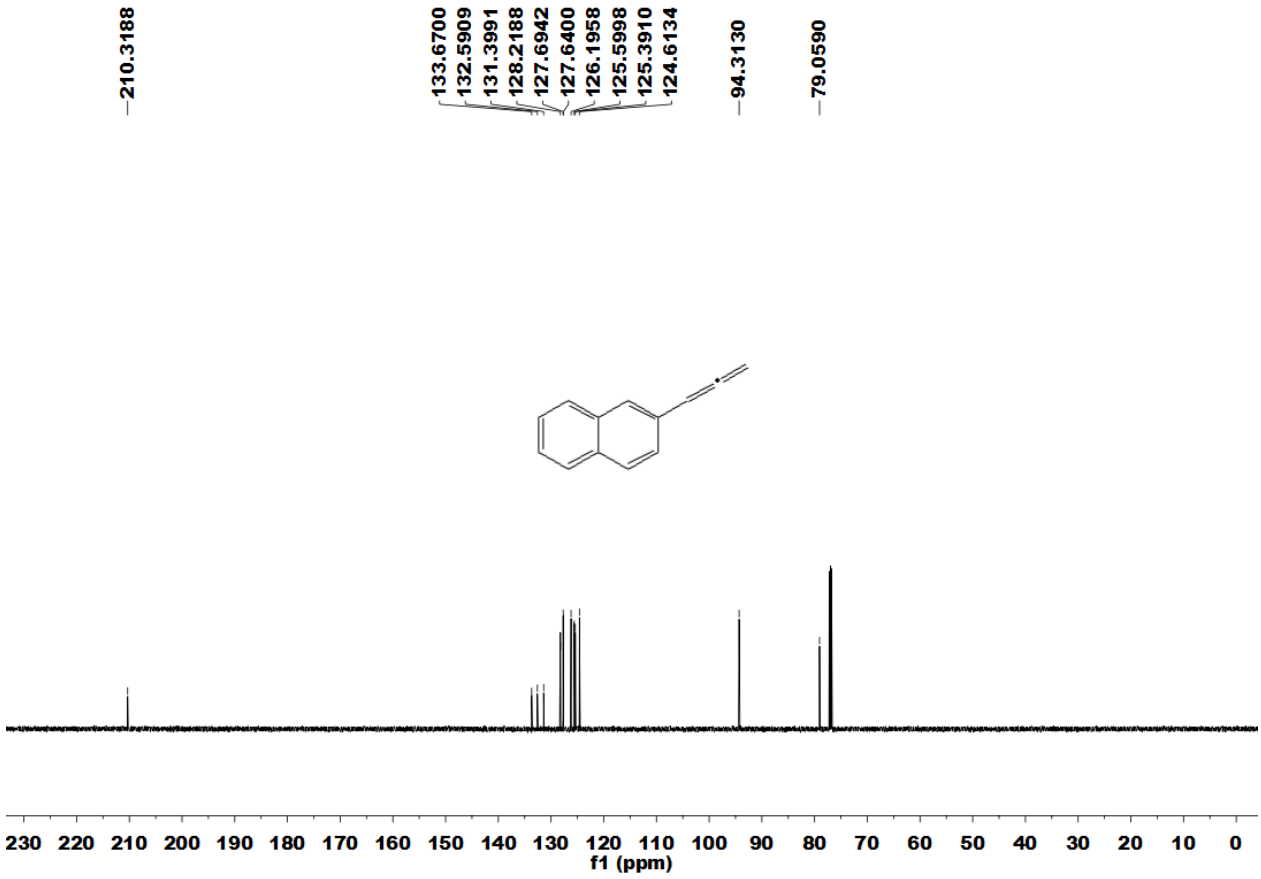


Fig. S70 ^{13}C NMR of (2-naphthyl)propadiene **(5p)**

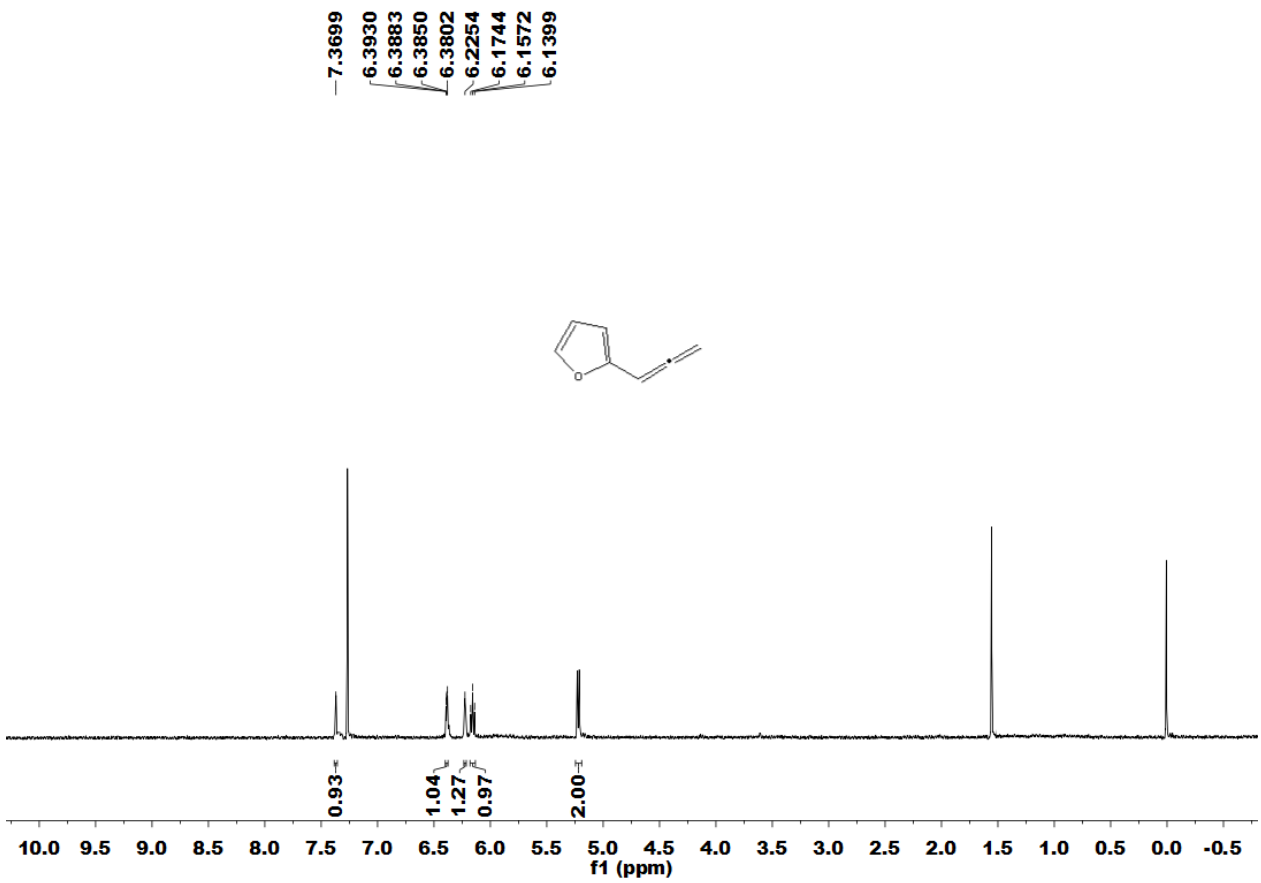


Fig. S71 ^{1}H NMR of (1-furyl)propadiene **(5q)**

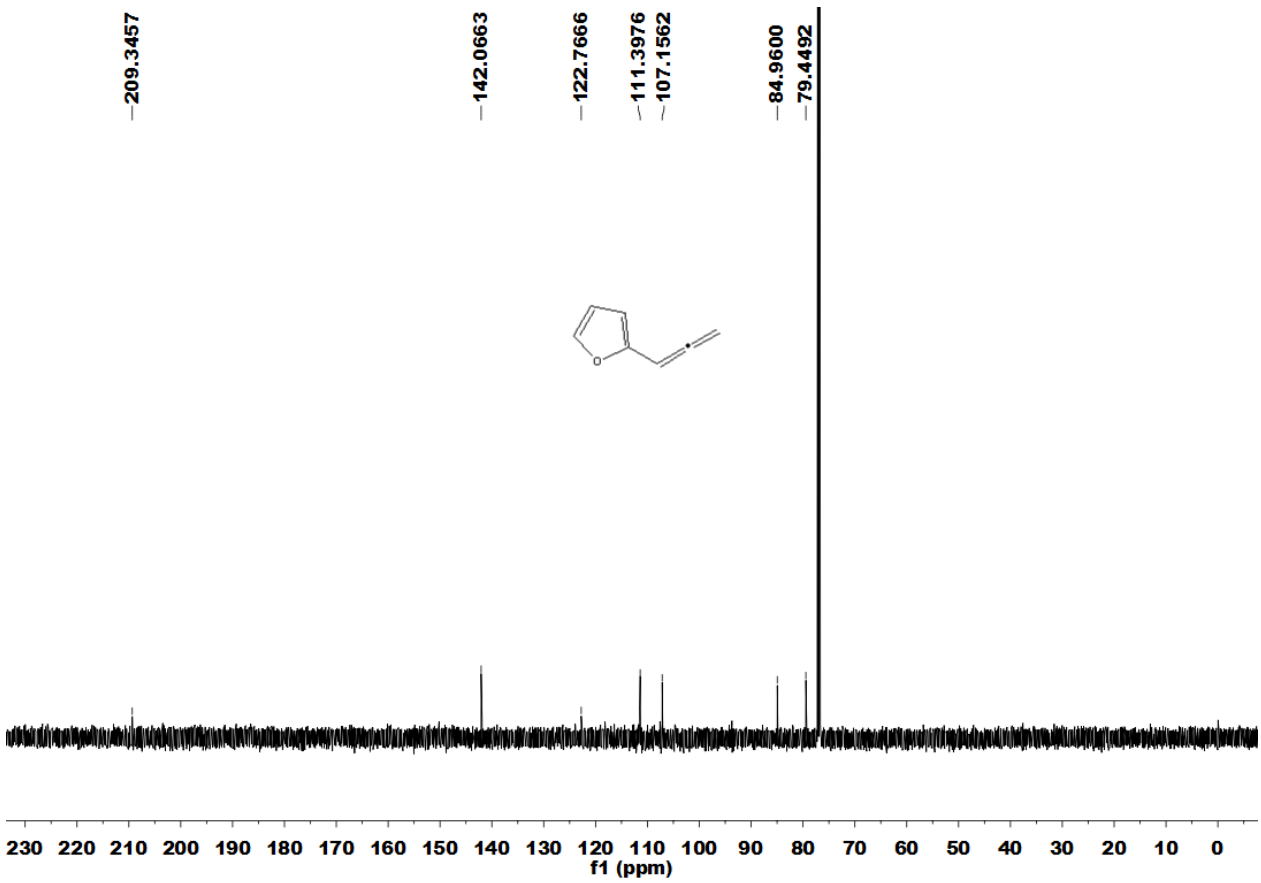


Fig. S72 ^{13}C NMR of (1-furyl)propadiene **(5q)**

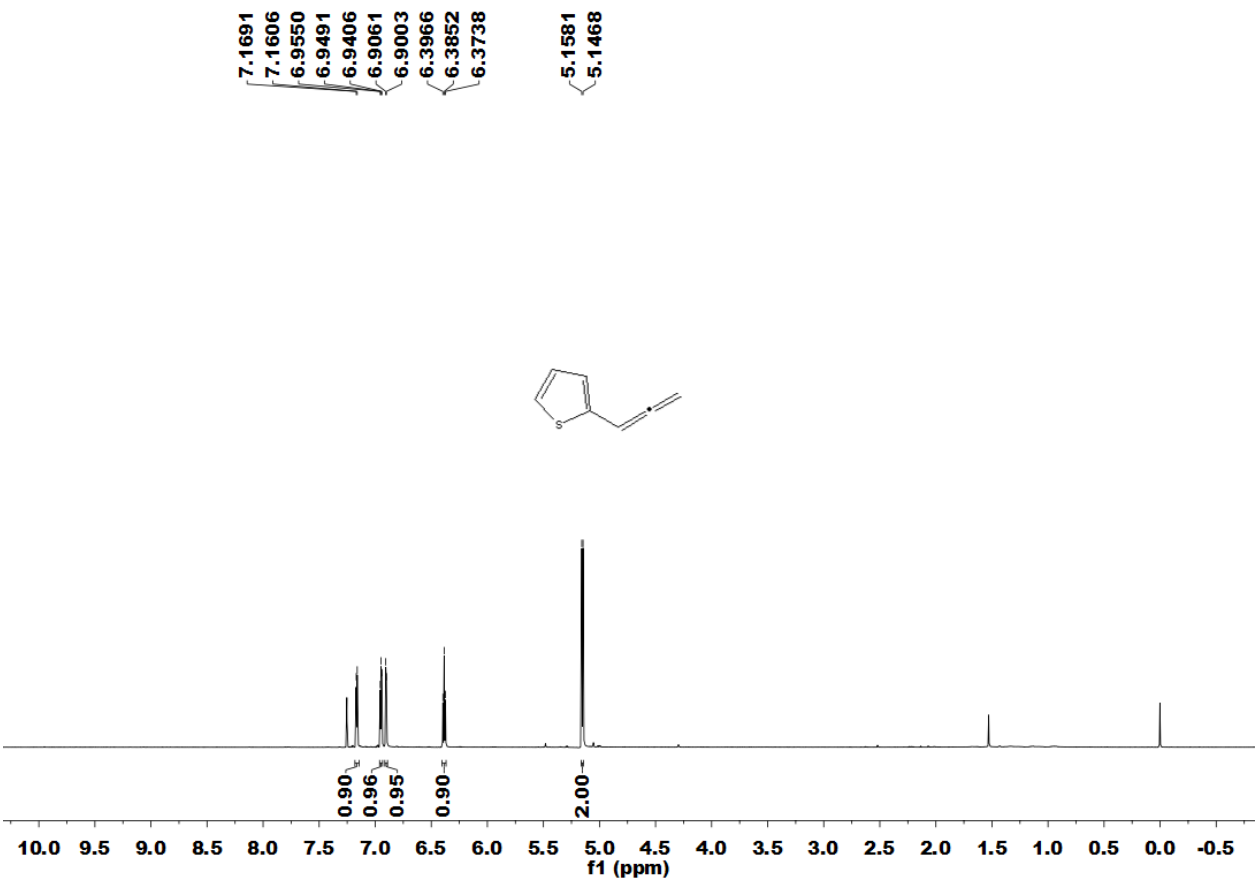


Fig. S73 ^{1}H NMR of (1-thienyl)propadiene **(5r)**

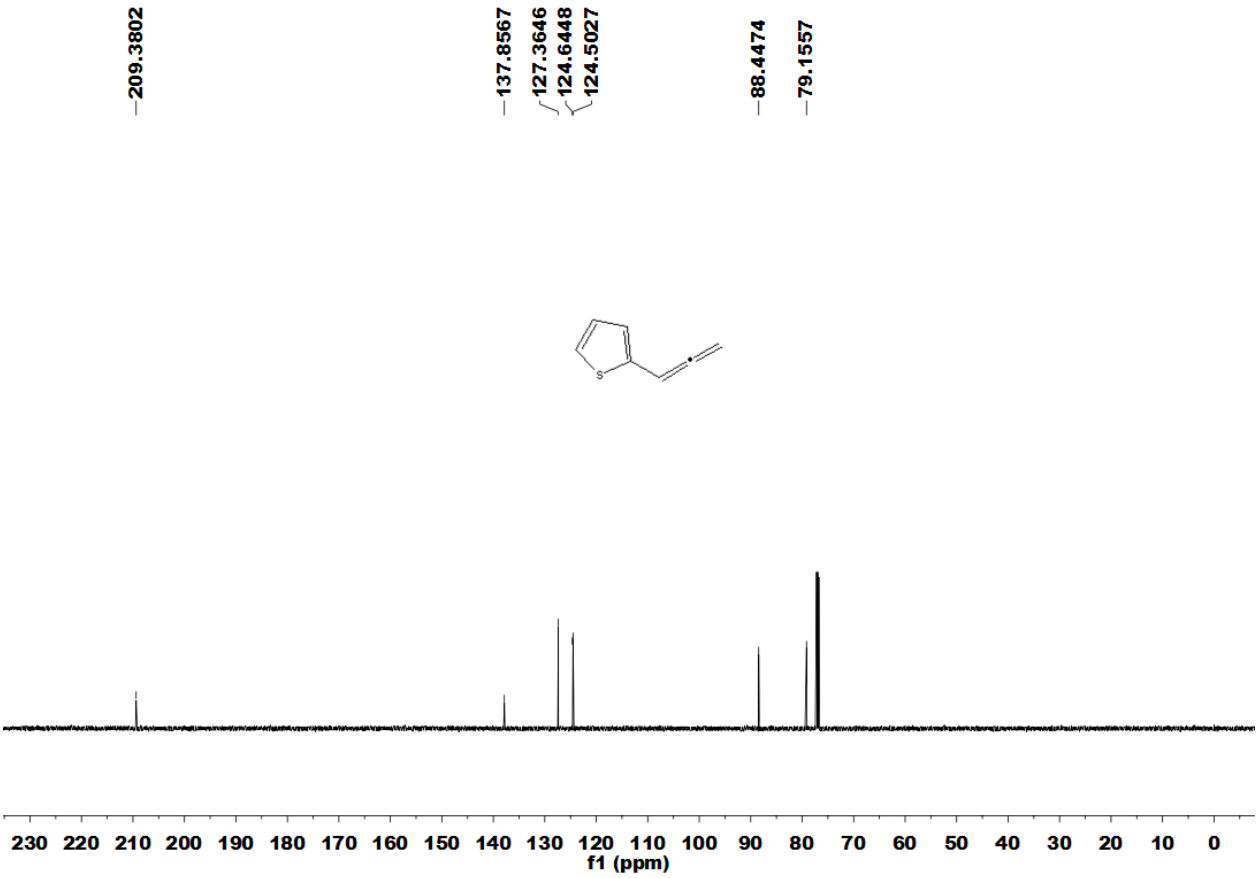


Fig. S74 ^{13}C NMR of (1-thienyl)propadiene **(5r)**

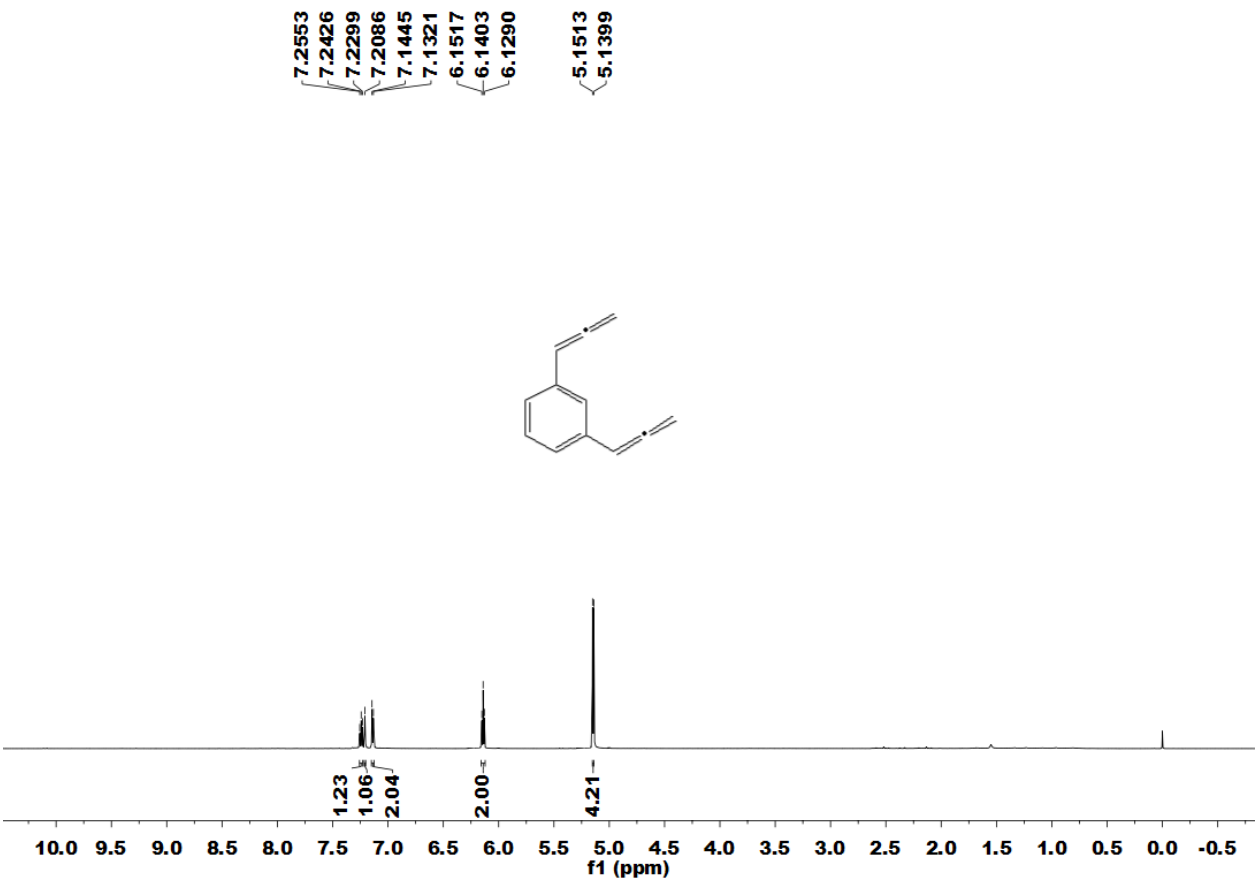


Fig. S75 ^{1}H NMR of 1,3-di(propa-1,2-dien-1-yl)benzene **(5s)**

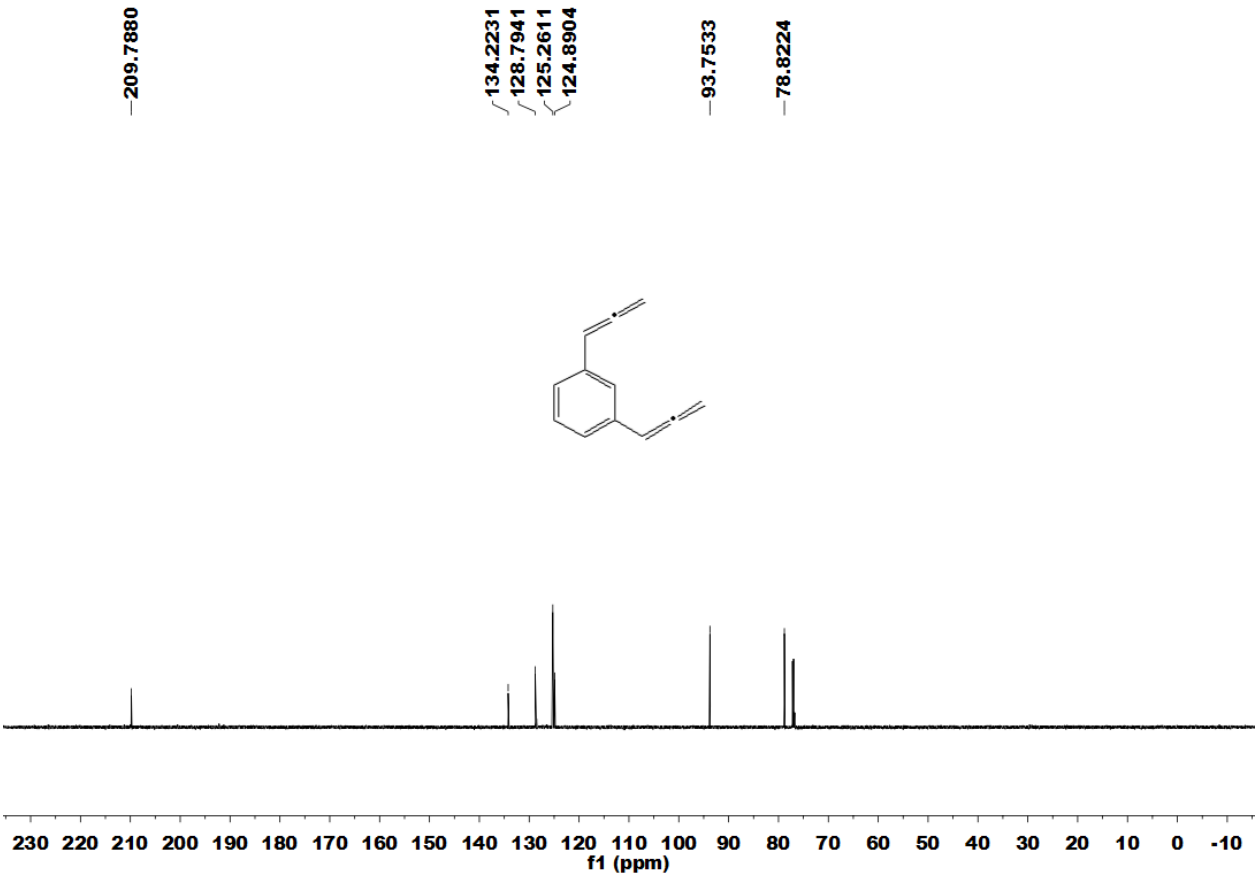


Fig. S76 ^{13}C NMR of 1,3-di(propa-1,2-dien-1-yl)benzene **(5s)**

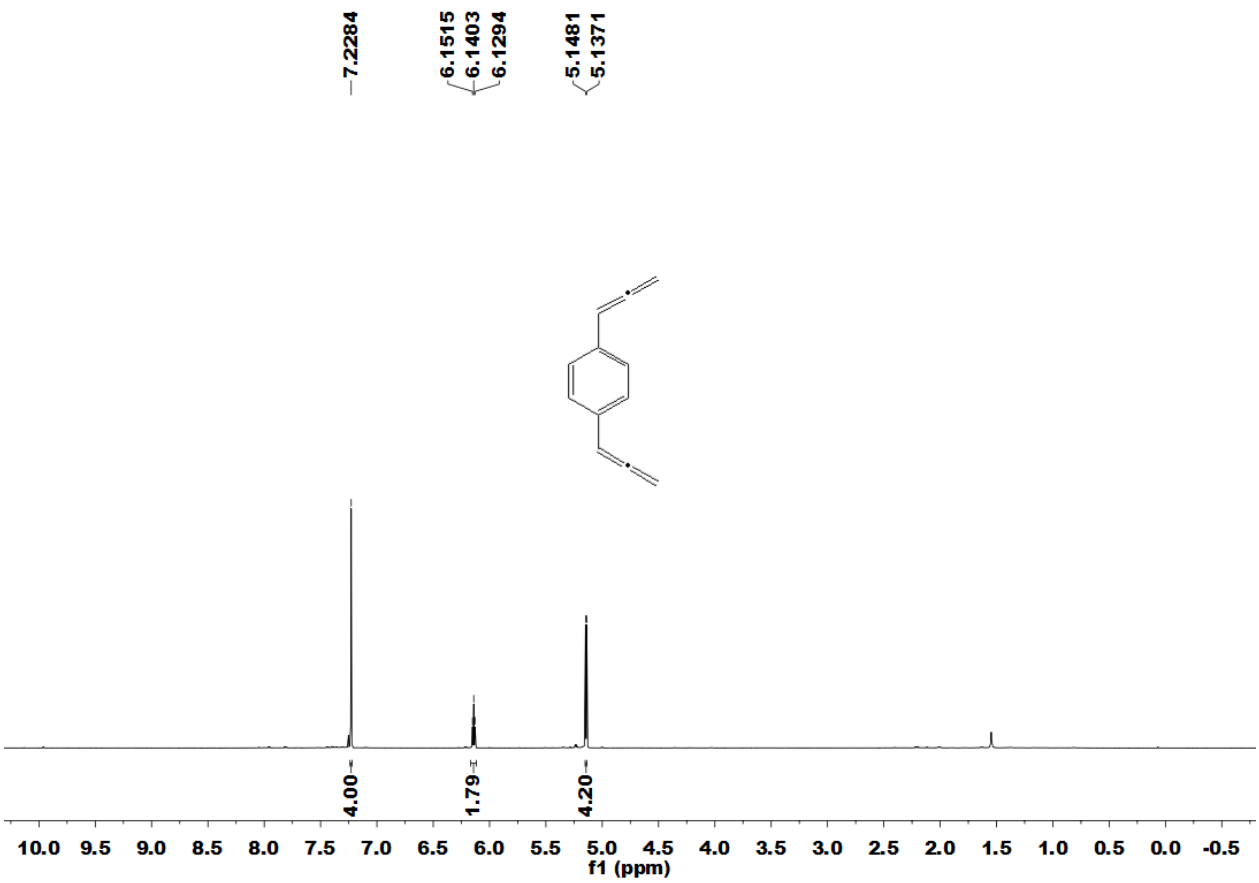


Fig. S77 ^{1}H NMR of 1,4-di(propa-1,2-dien-1-yl)benzene **(5t)**

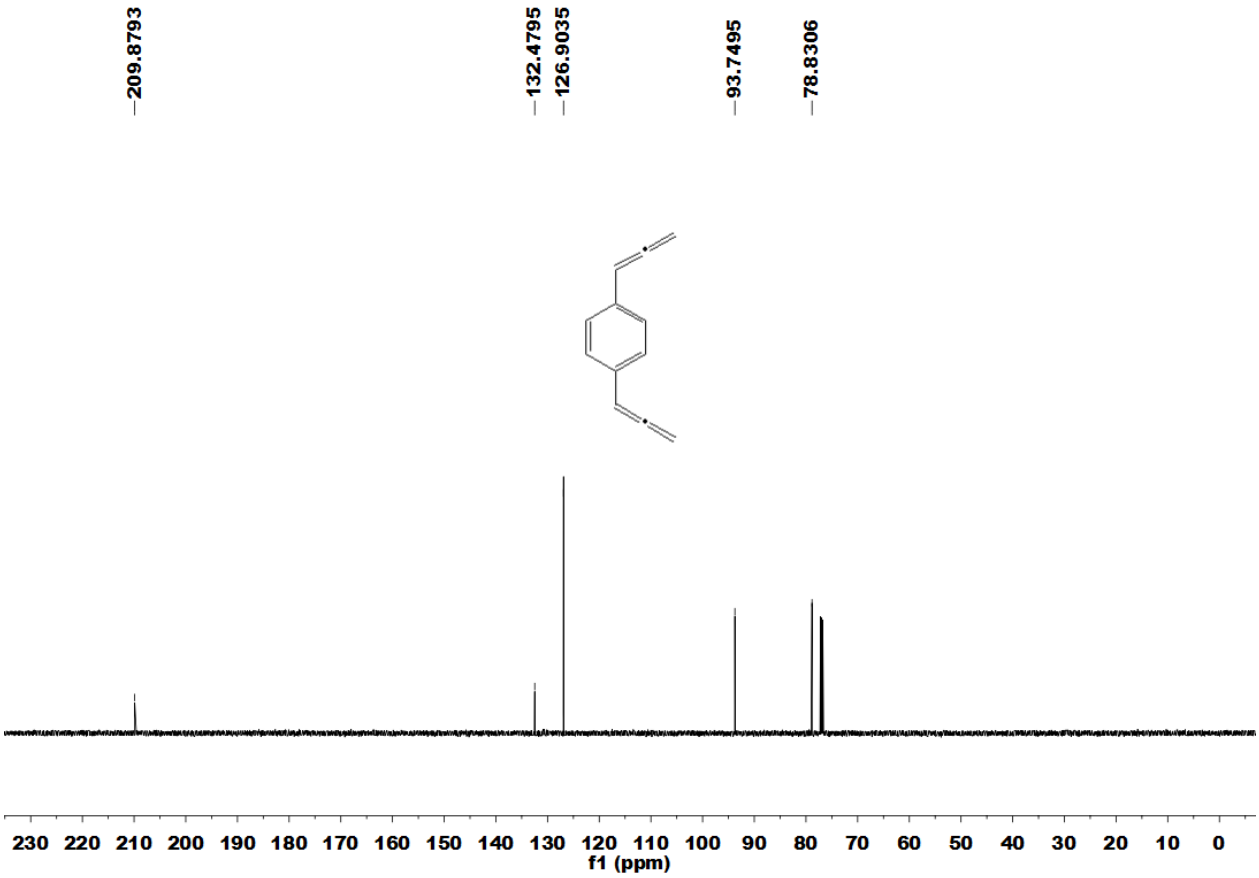


Fig. S78 ^{13}C NMR of 1,4-di(propa-1,2-dien-1-yl)benzene **(5t)**

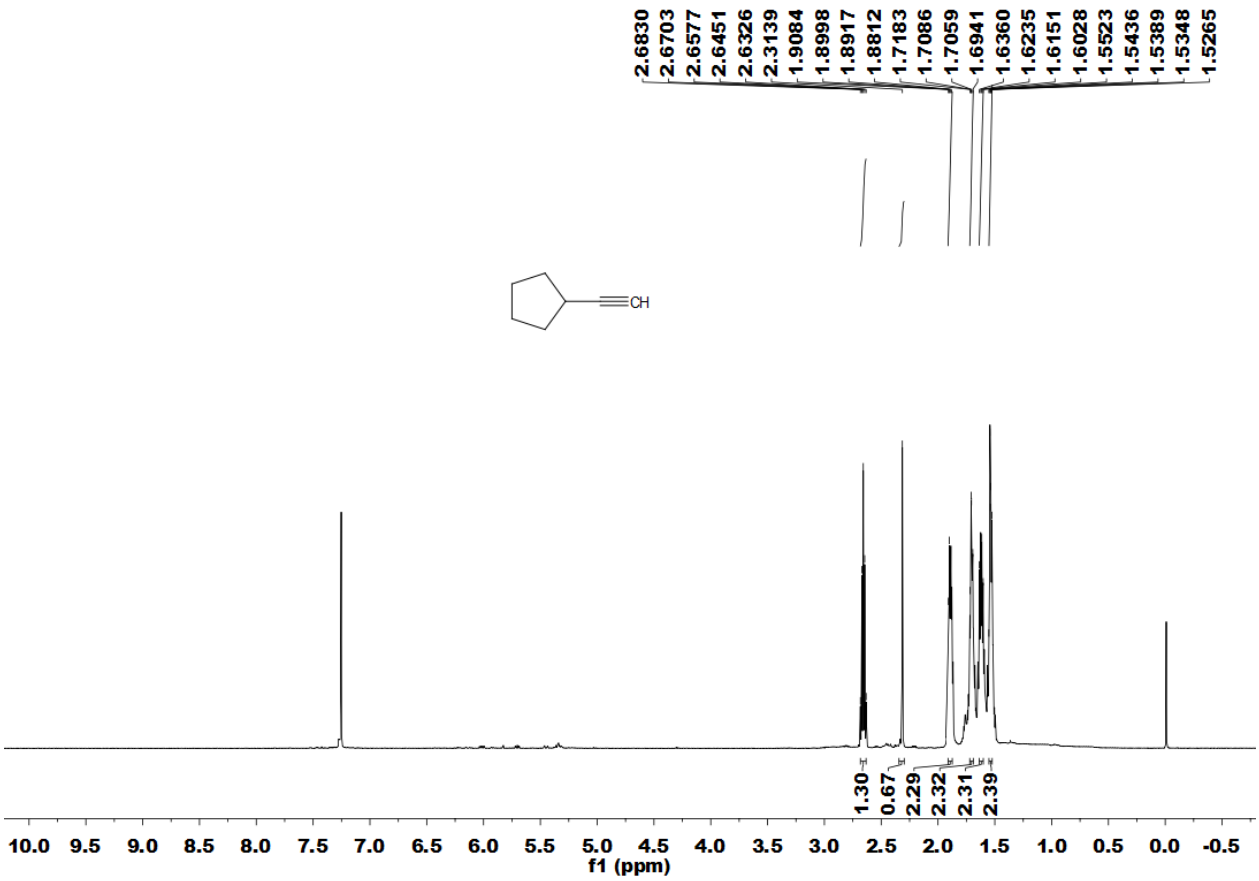


Fig. S79 ^{1}H NMR of cyclopentylethyne **(7a)**

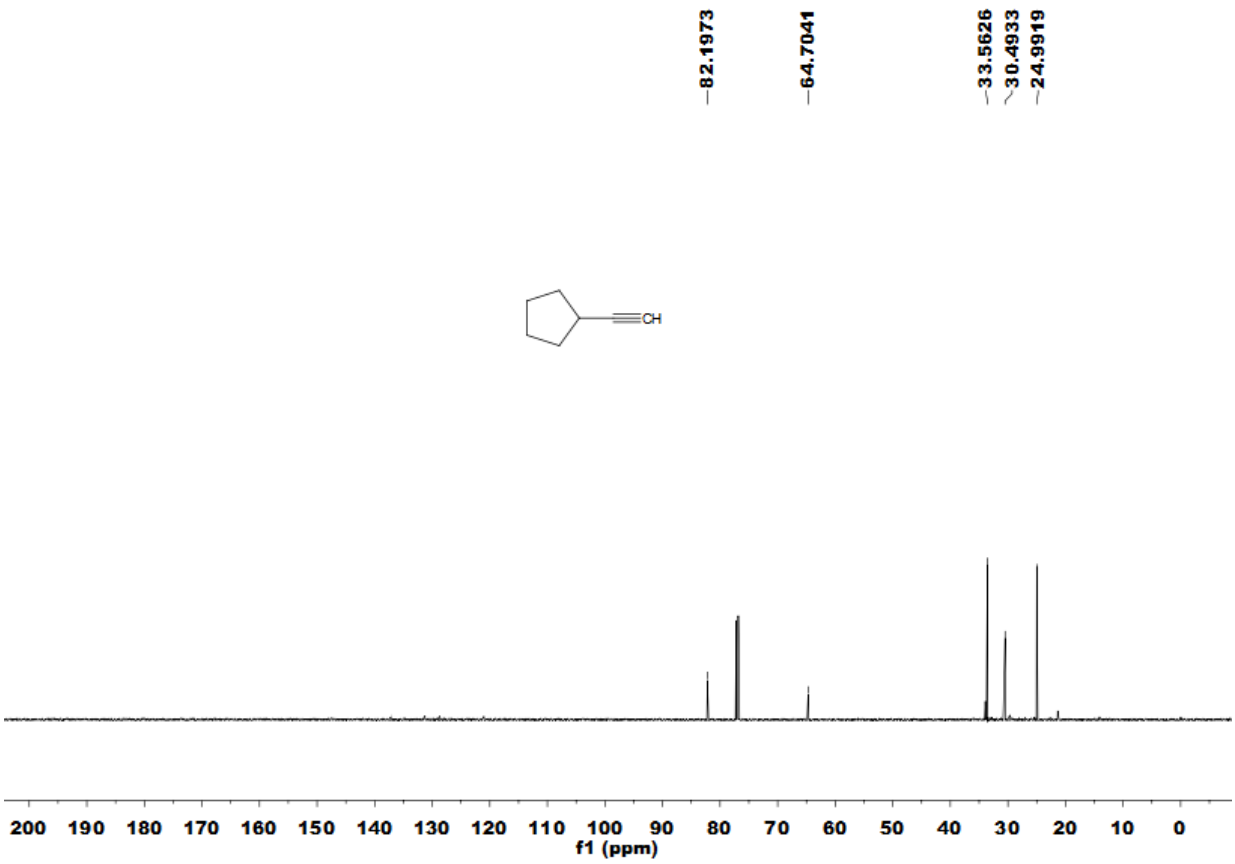


Fig. S80 ^{13}C NMR of cyclopentylethyne **(7a)**

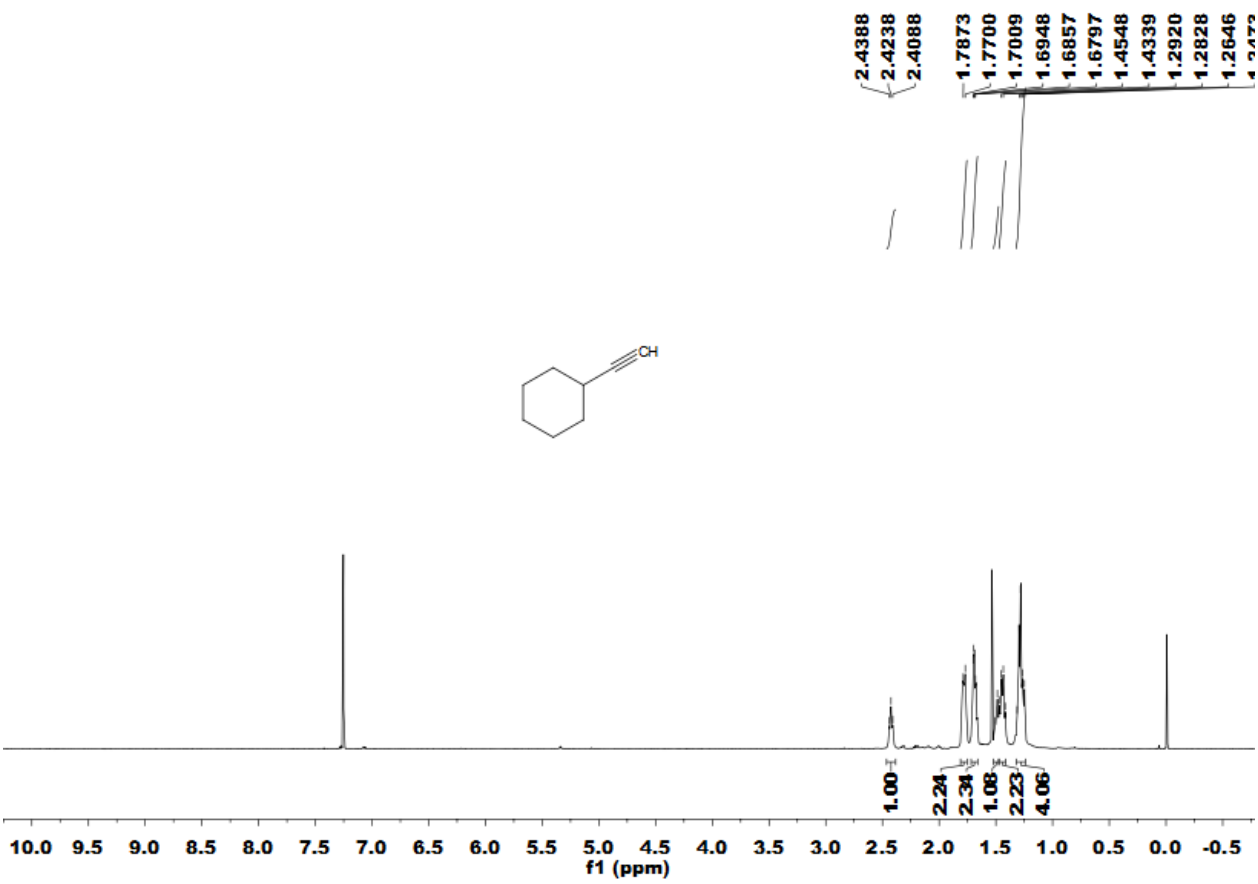


Fig. S81 ^{1}H NMR of cyclohexylethyne **(7b)**

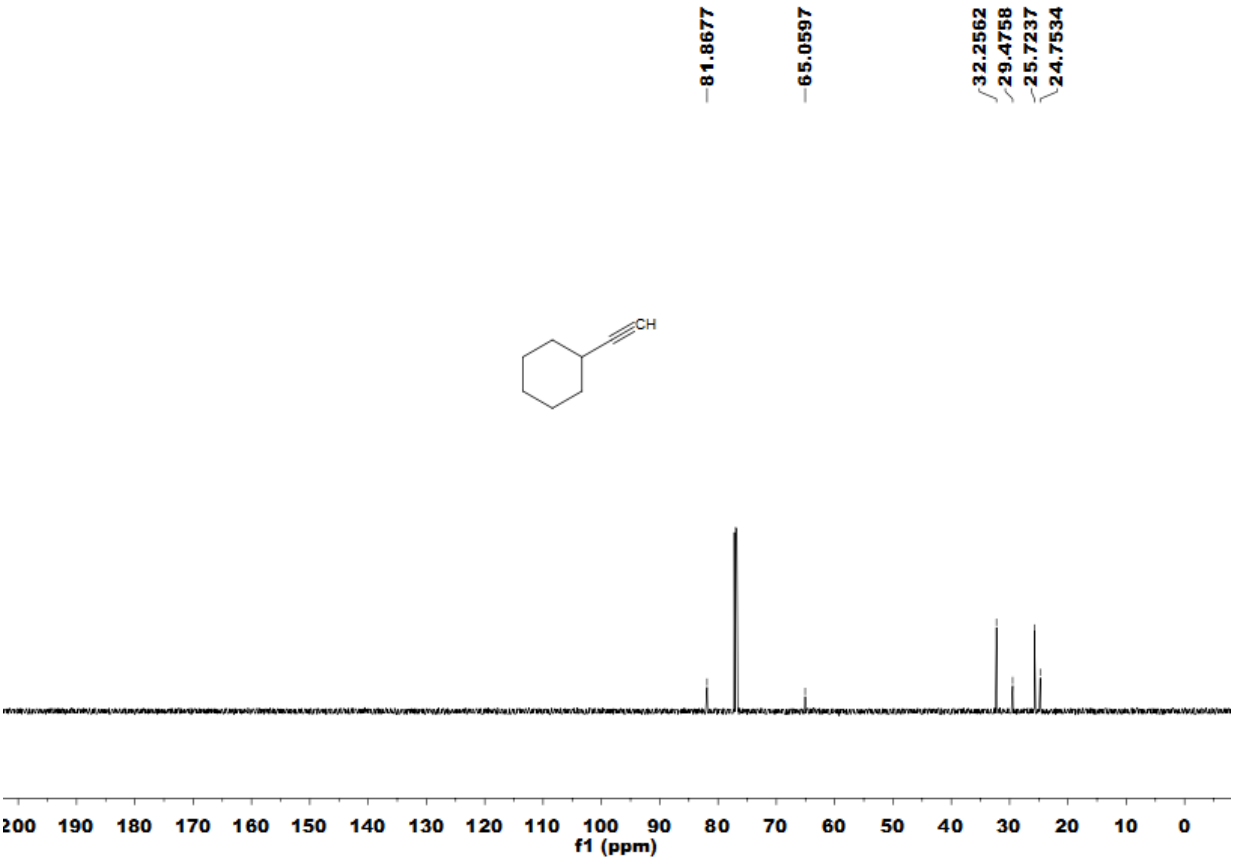


Fig. S82 ^{13}C NMR of cyclohexylethyne **(7b)**

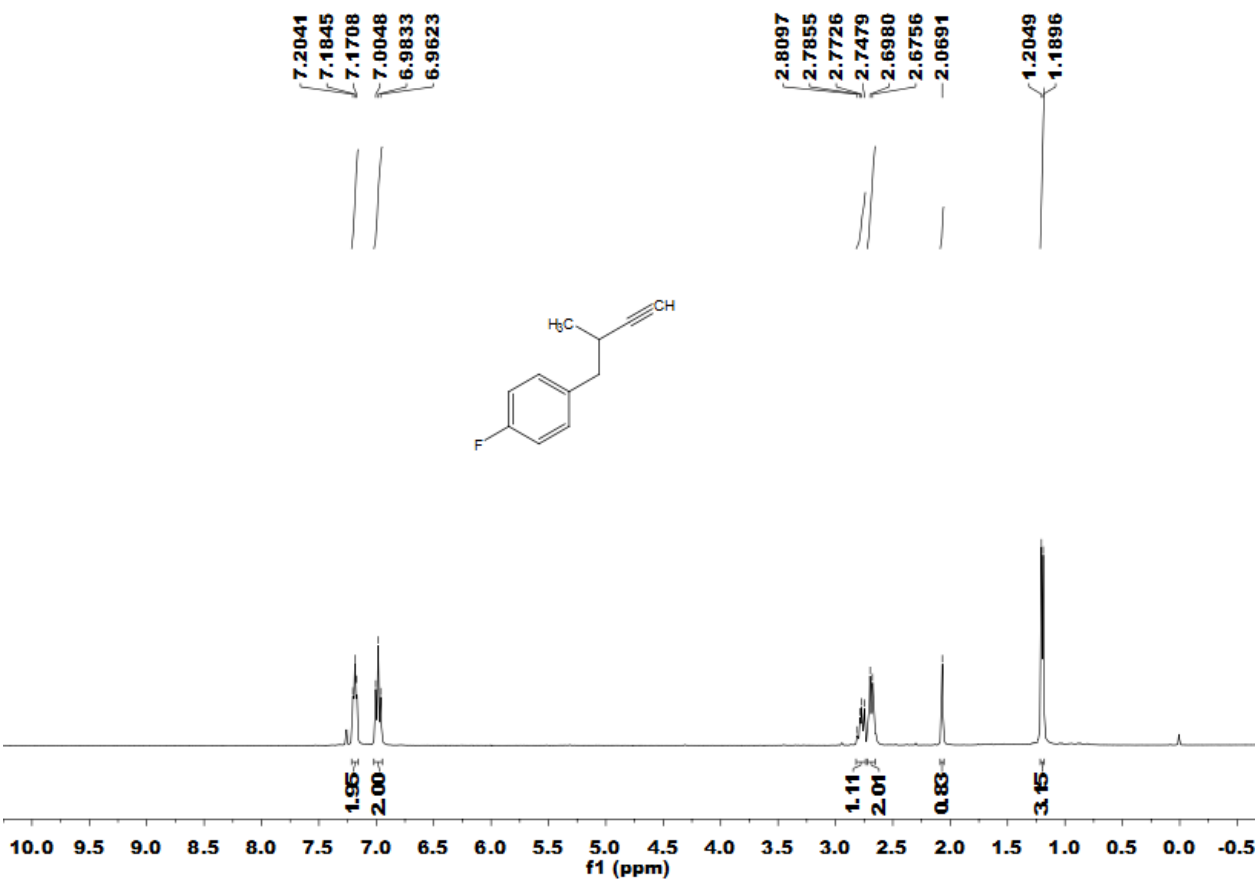


Fig. S83 [1]H NMR of 3-methyl-4 (4-fluorophenyl)-1-butyne **(7c)**

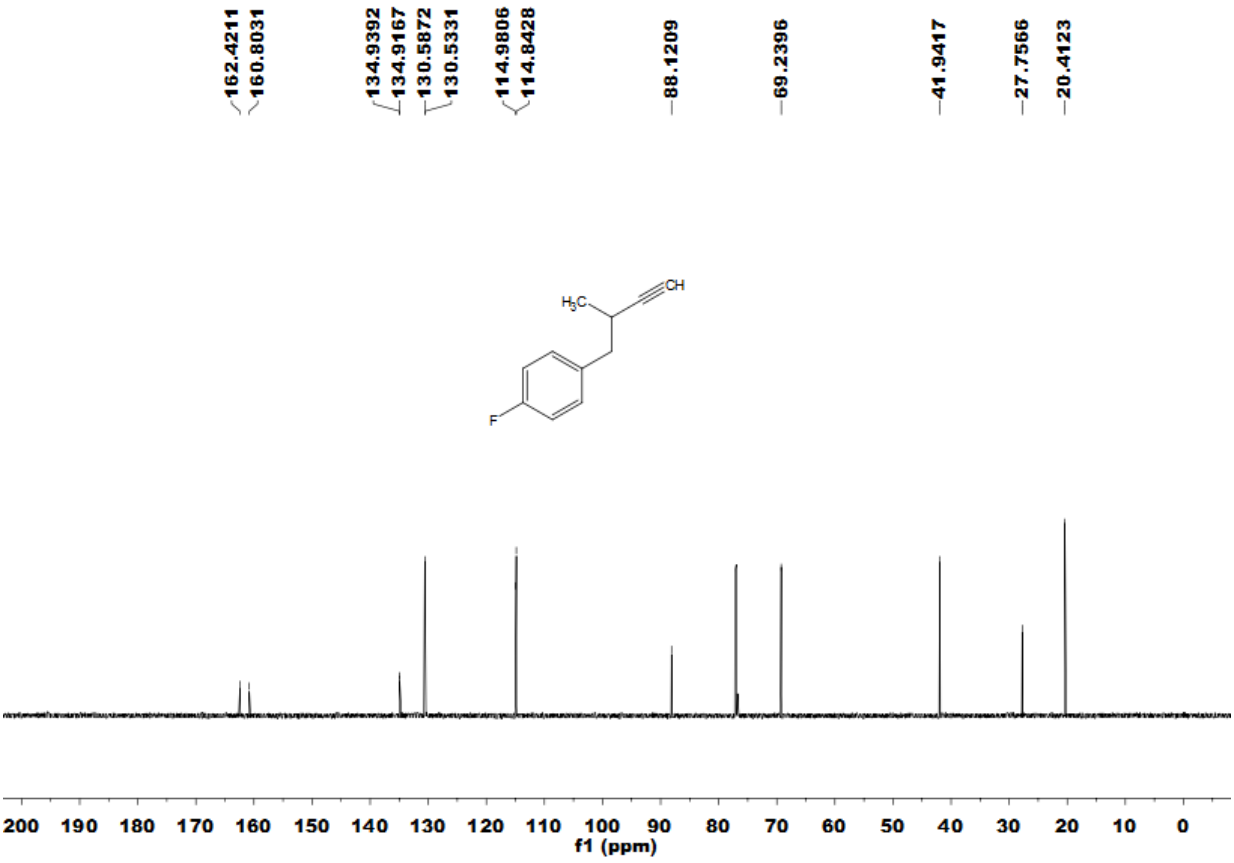


Fig. S84 [13]C NMR of 3-methyl-4-(4-fluorophenyl)-1-butyne **(7c)**

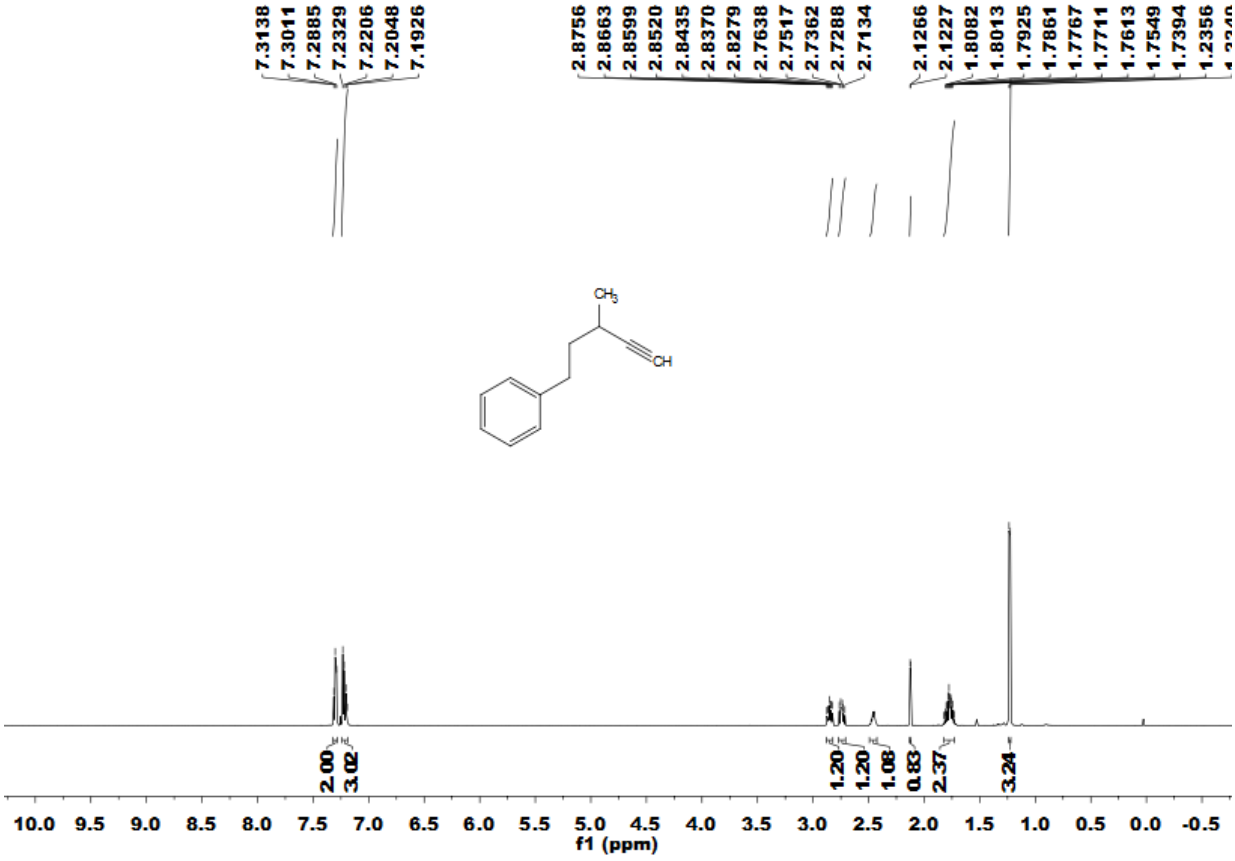


Fig. S85 ^{1}H NMR of 3-methyl-5-phenyl-1-pentyne **(7d)**

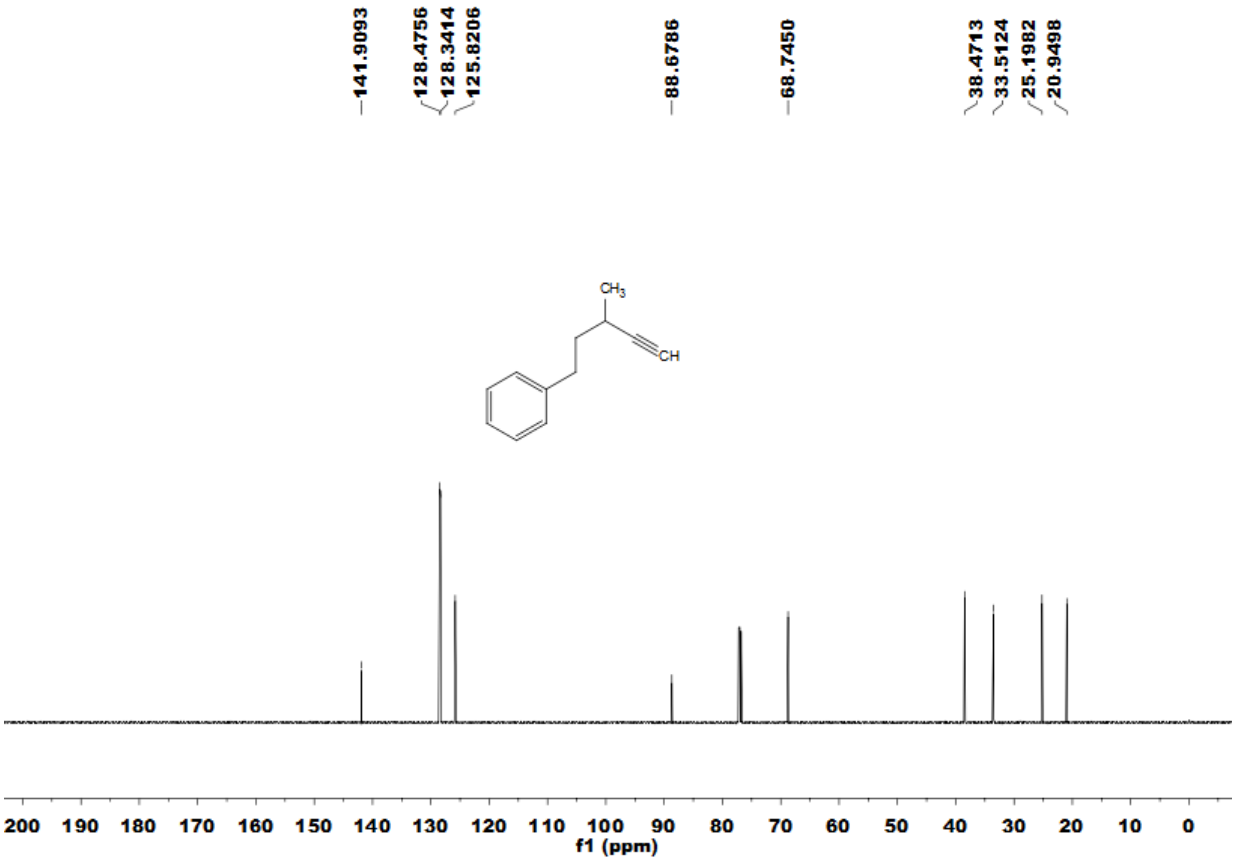


Fig. S86 ^{13}C NMR of 3-methyl-5-phenyl-1-pentyne **(7d)**

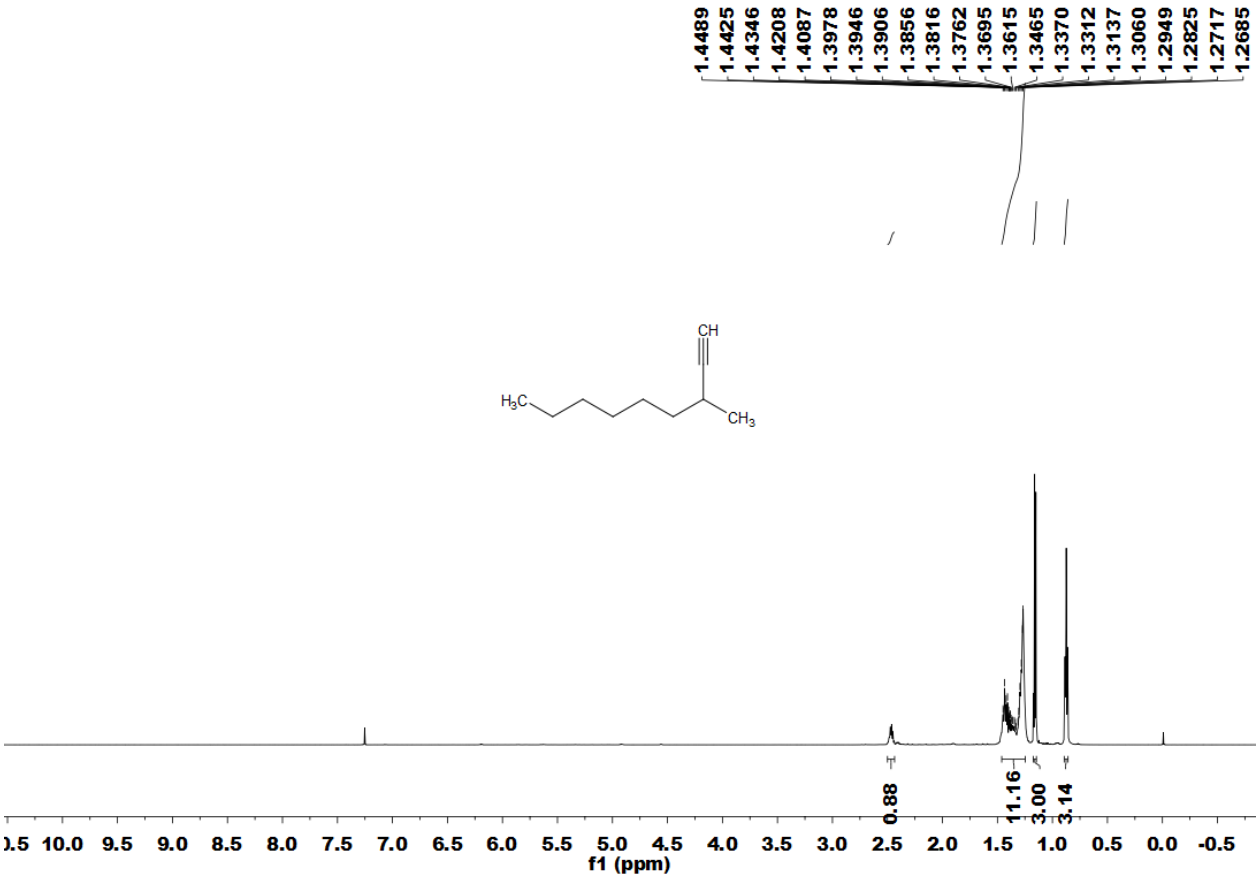


Fig. S87 ^{1}H NMR of 3-methyl-1-nonyne **(7e)**

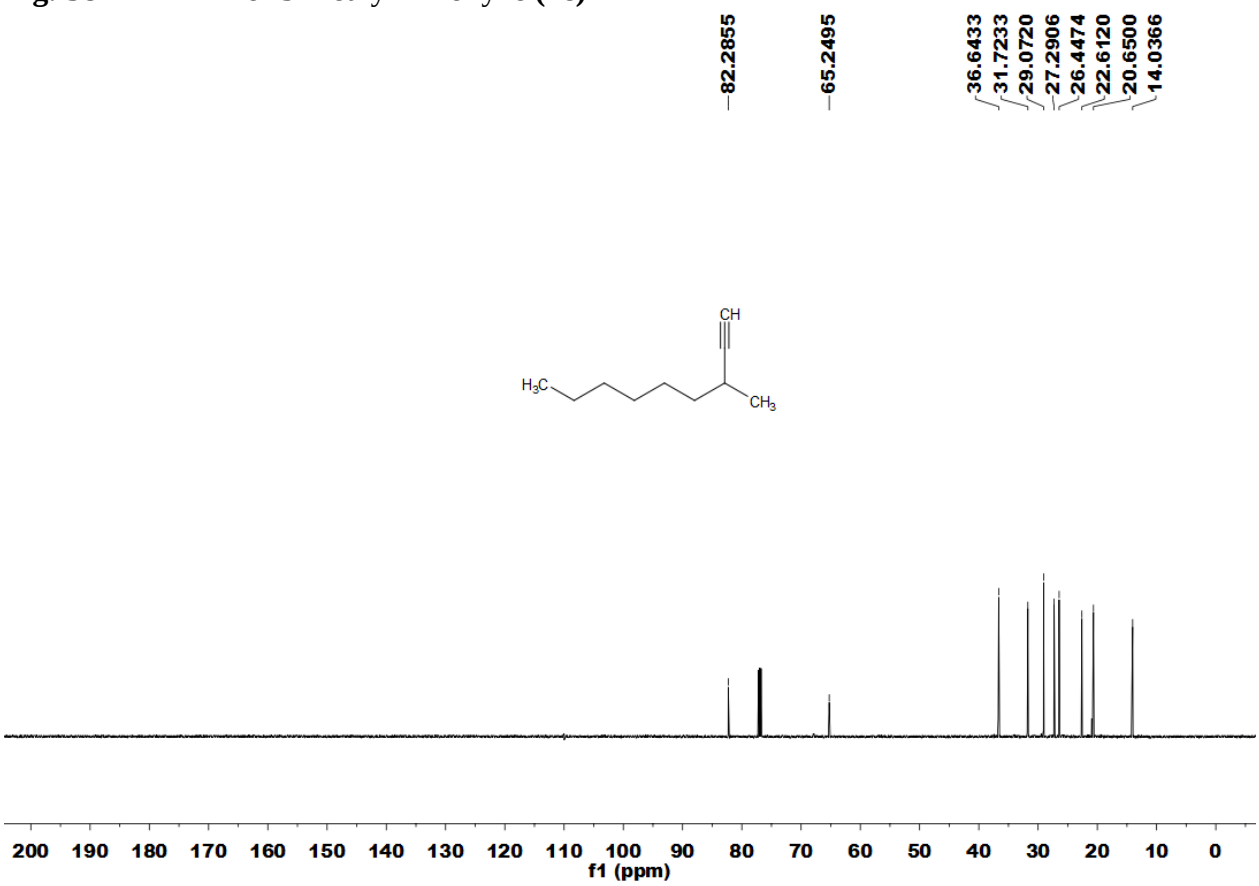


Fig. S88 ^{13}C NMR of 3-methyl-1-nonyne **(7e)**

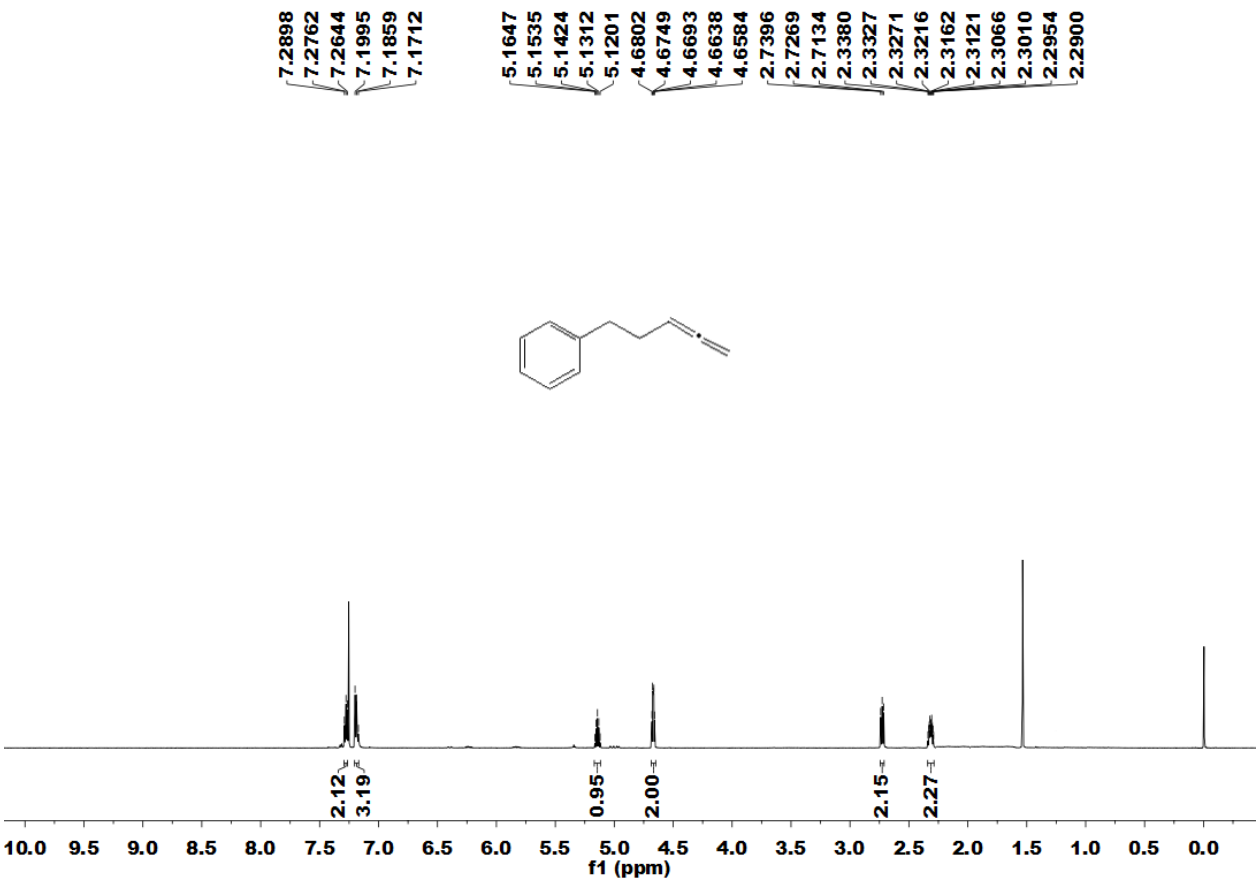


Fig. S89 ^{1}H NMR of 5-phenyl-1,2-pentadiene **(9a)**

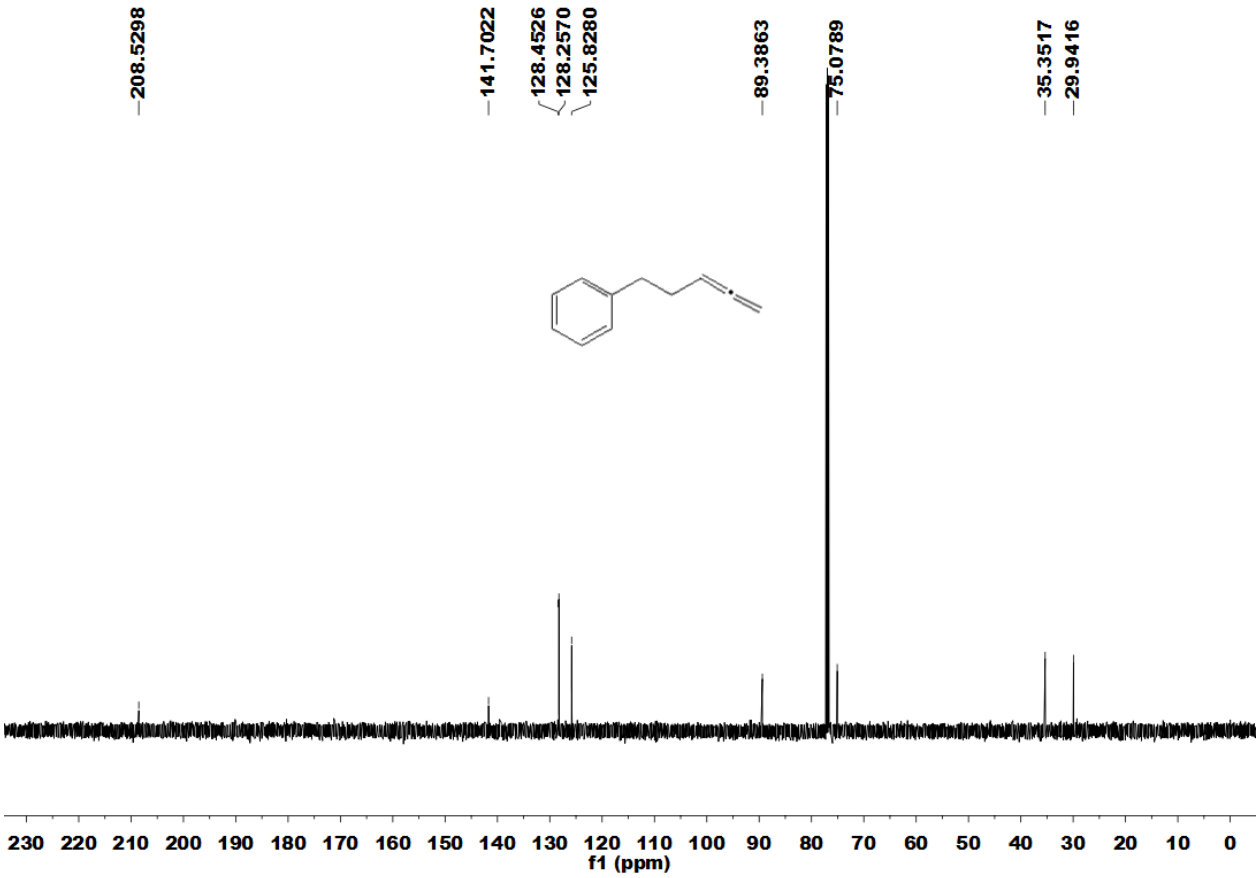


Fig. S90 ^{13}C NMR of 5-phenyl-1,2-pentadiene **(9a)**

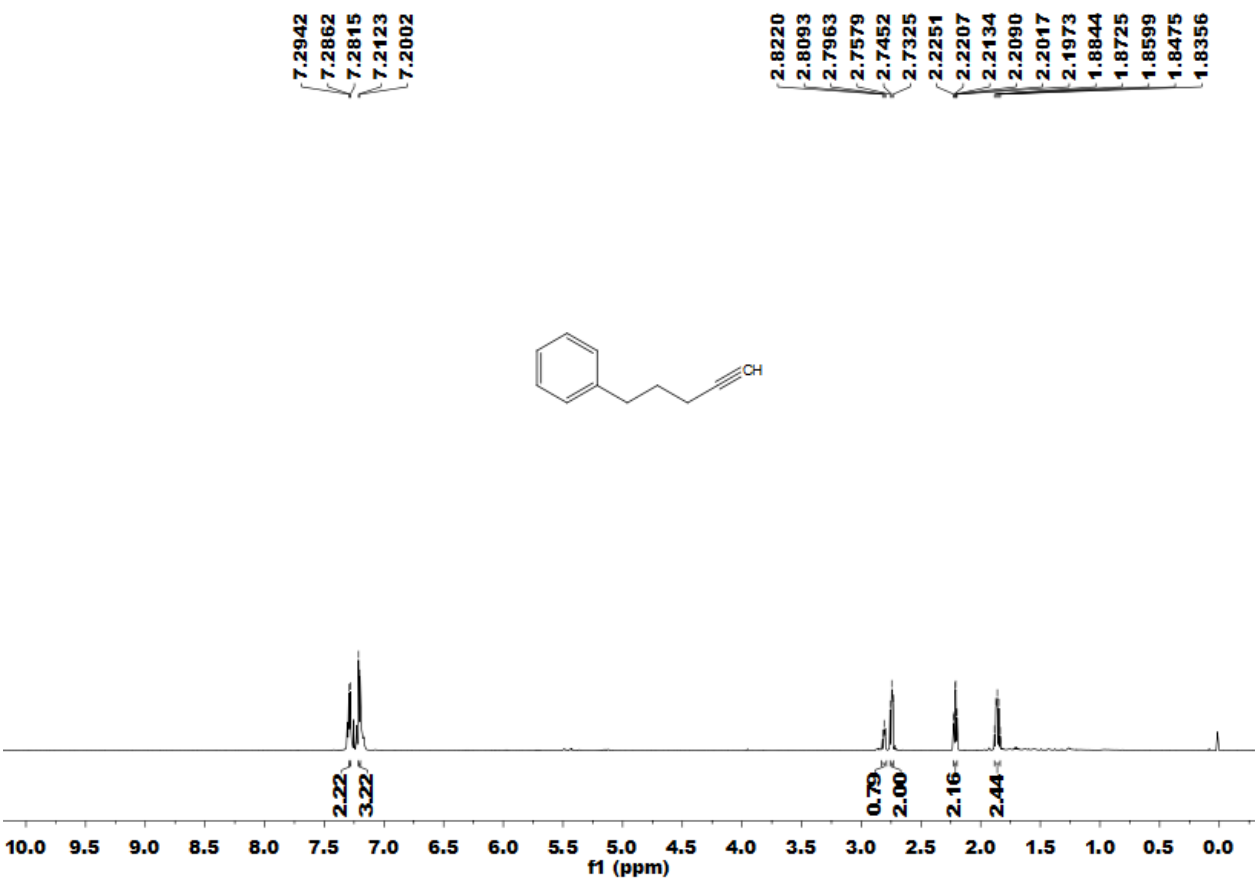


Fig. S91 ^{1}H NMR of 5-phenyl-1-pentyne **(10a)**

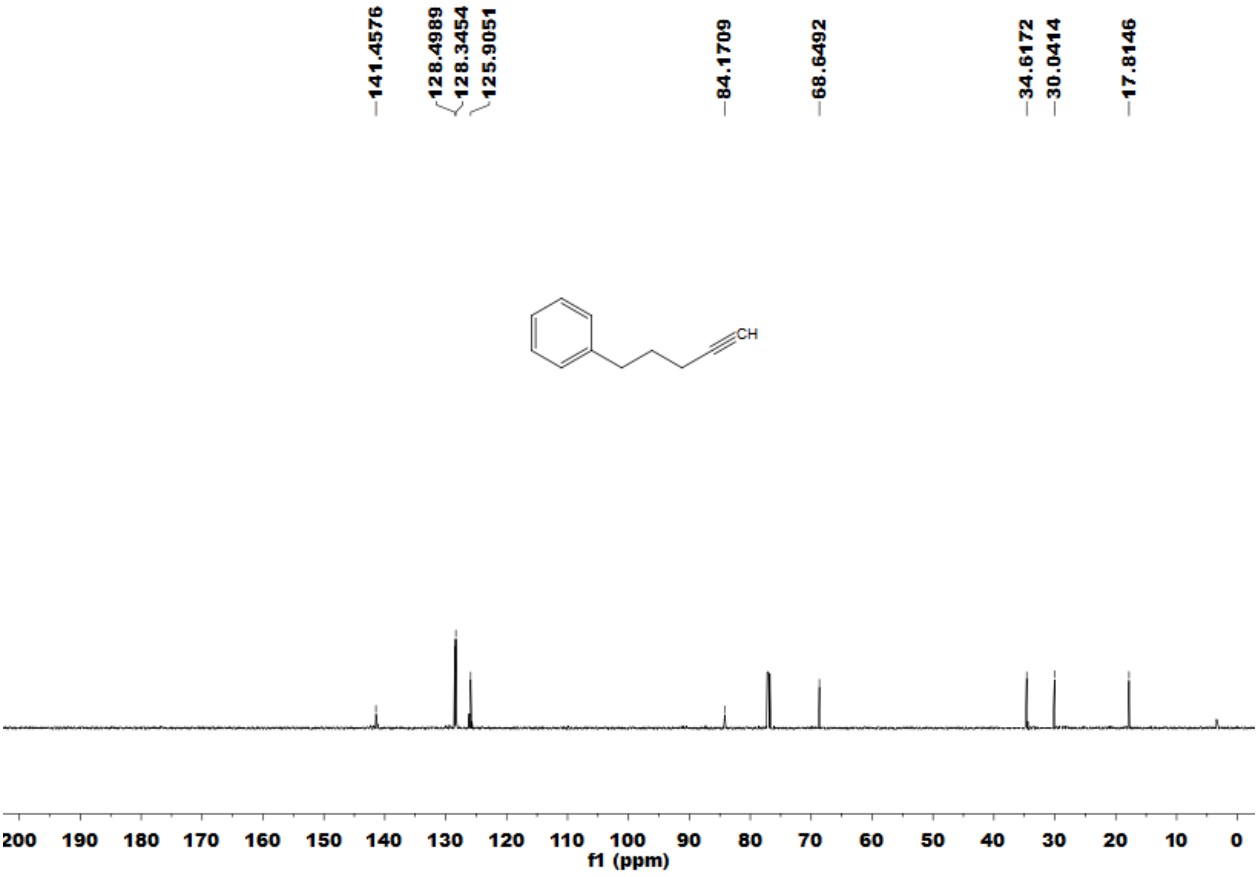


Fig. S92 ^{13}C NMR of 5-phenyl-1-pentyne **(10a)**

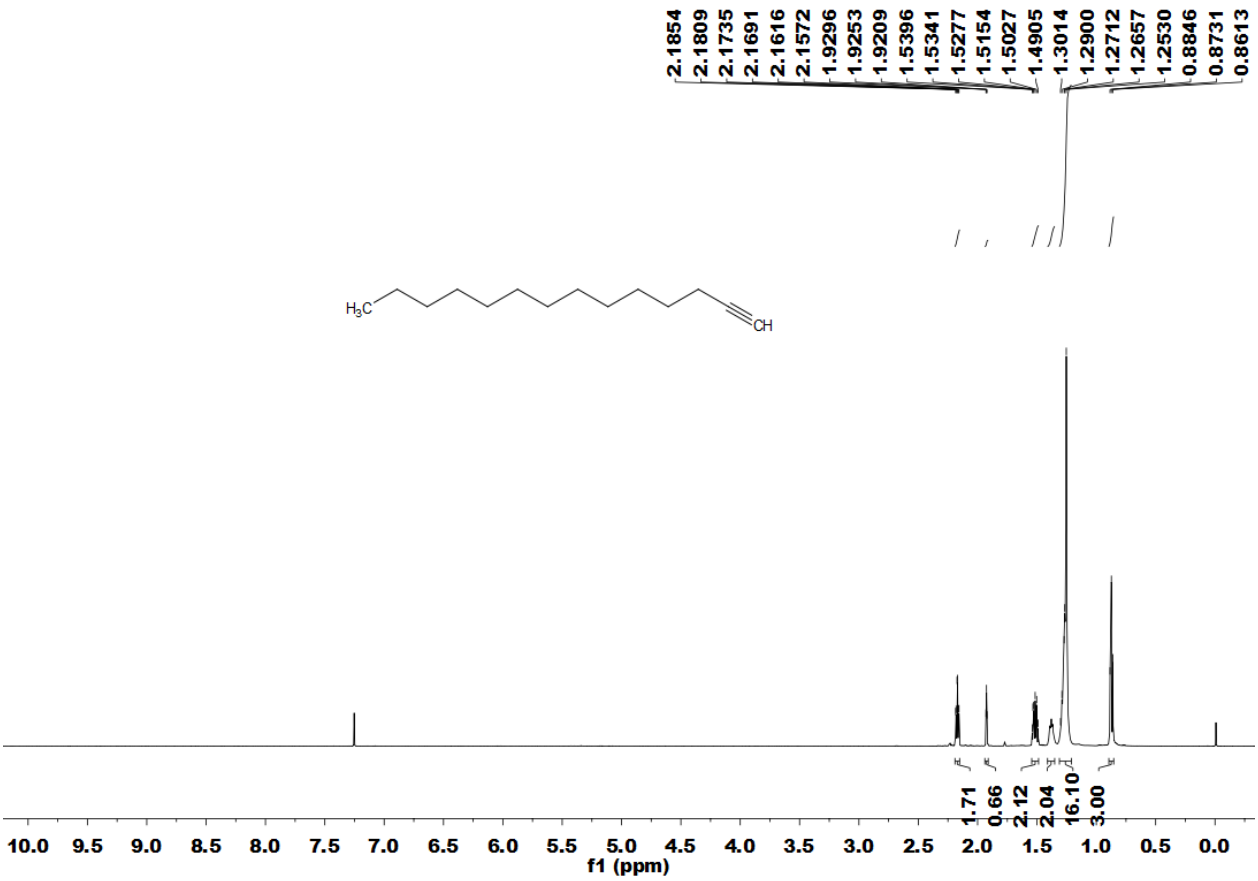


Fig. S93 ^{1}H NMR of tetradec-1-yne **(10b)**

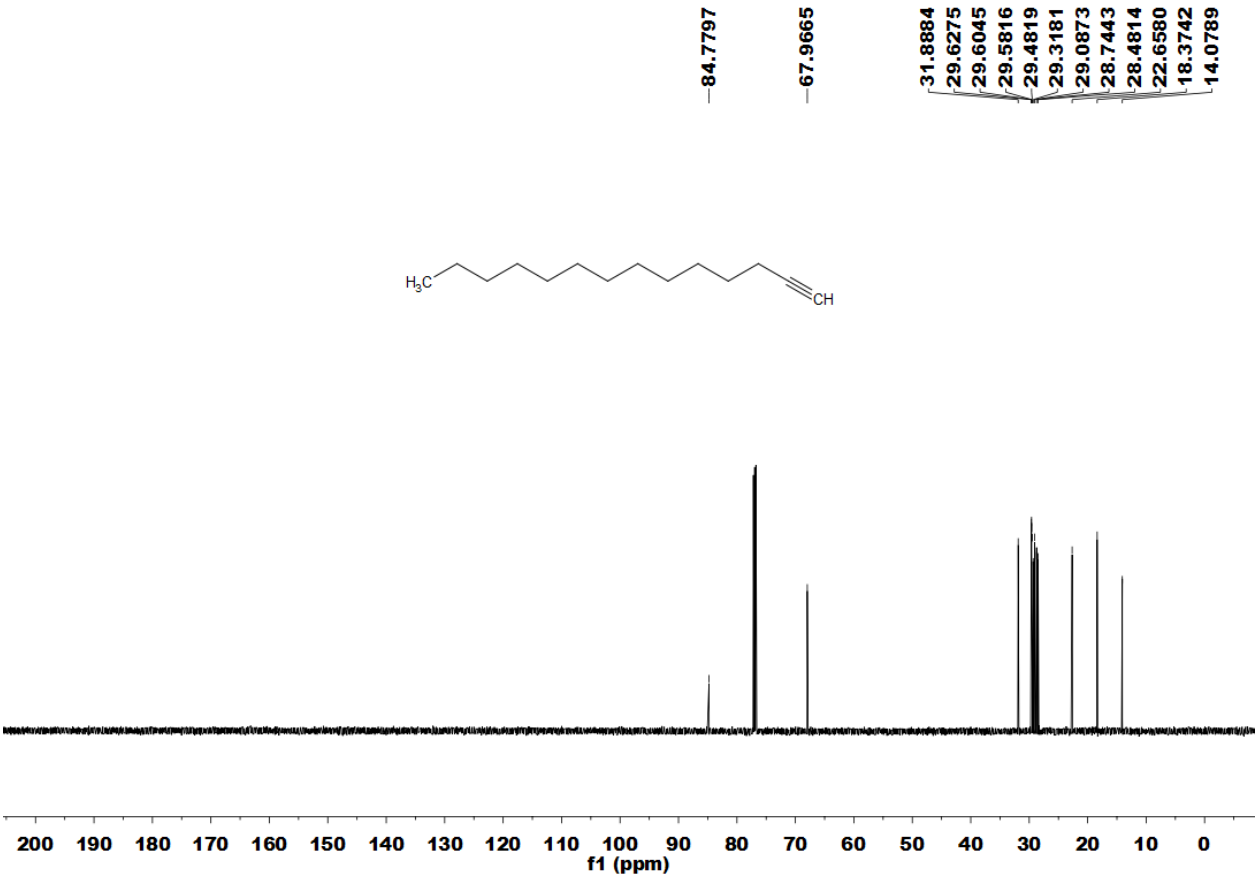


Fig. S94 ^{13}C NMR of tetradec-1-yne **(10b)**

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