Dual role of Allylsamarium Bromide as Grignard Reagent and a Single Electron Transfer Reagent in the One-Pot Synthesis of Terminal Olefins

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General methods: THF was distilled from sodium benzophenone under nitrogen. All reactions were conducted under a nitrogen atmosphere. Metallic samarium and all solvents were purchased from commercial source, without further purification before use. The flash column chromatography was carried out on Merck silica gel (300–400 mesh). ^{1}H and ^{13}C NMR spectra were recorded on a Varian Mercury 400 MHz or 300MHZ spectrometer as solutions in $CDCl_3$. Chemical shifts in ^{1}H NMR spectra are reported in parts per million (ppm, δ) downfield from the internal standard Me_4Si (TMS). Chemical shifts in ^{13}C NMR spectra are reported relative to the central line of the chloroform signal (δ = 77.50 ppm). High-resolution mass spectra were obtained with a GCT-TOF instrument.

Materials: All chemicals were purchased from Aldrich, Alfa or Acros chemical company and used thus, without further purification. Petroleum ether (PE) used refers to the 60–90 ^{o}C boiling point fraction of petroleum.

General procedure I: Allyl bromide (171μL, 1.7 mmol) and Sm powder (0.2504g, 1.5 mmol) in dry THF (3 mL) under a nitrogen atmosphere at room temperature. The mixture was stirred for about 5 min, and a purple colour formed, The stirring was continued until the Sm powder disappeared (1 h).

General procedure II: A solution of allylsamarium bromide reagent in THF (1.5 mmol) was added to a solution of aldehyde (0.5 mmol) in dry THF (3 mL) under a nitrogen atmosphere at room temperature. The mixture was stirred for about 30 min. Then diethyl phosphate (1.0 mmol) was added (the reaction was monitored by TLC). The reaction mixture was stirred at room temperature and then was quenched with dilute hydrochloric acid. The resulting mixture was extracted with diethyl ether (3×10 mL), and dried over anhydydrous Na_2SO_4. The solvent was removed by evaporation under reduced pressure. Purification by column chromatography on silica gel afforded olefins (300–400 mesh, petroleum ether as eluent).

General procedure of 7: Allyl bromide (171μL, 1.7 mmol) and Sm powder (0.2504g, 1.5 mmol) in dry THF (3 mL) under a nitrogen atmosphere at room temperature. The mixture was stirred for about 5 min, and a purple colour formed, The stirring was continued until the Sm powder disappeared (1 h). Then diethyl phosphate (1.5 mmol)

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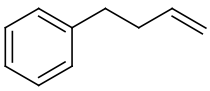
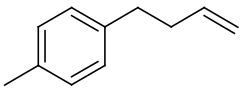
Characterization Data of Compounds

1-(but-3-enyl)benzene 1-(but-3-enyl)-4-chlorobenzene 3a



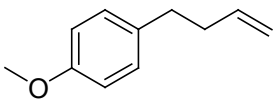
The title compound was obtained according to the general procedure. Colourless oil; Yield: 64%; IR (KBr): 2960, 2926, 2855, 1640, 1452, 1390, 1261, 1097, 1018, 911, 800, 744, 698, 631 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 7.24-7.18 (m, 2H), 7.14-7.08(m, 3H), 5.84-5.74 (m, 1H), 5.00-4.90 (m, 2H), 2.65 (t, J = 8.0 Hz, 2H), 2.34-2.26 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ142.35, 138.59, 128.91, 128.77, 126.29, 115.38, 36.01, 35.86; HRMS(EI^+) calcd for $C_{10}H_{12}$ (M^+): 132.0939; found: 132.0940.

1-(but-3-enyl)-4-methylbenzene 3b



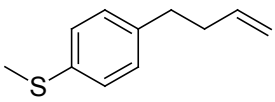
The title compound was obtained according to the general procedure. Colourless oil; Yield: 75%; IR (KBr):3004, 2924, 2858, 1640, 1515, 1451, 1262, 1213, 1118, 1016, 995, 901, 807, 626; ^1H NMR (400 MHz, $CDCl_3$): δ 7.02 (s, 4H), 5.82-5.72 (m, 1H), 5.02-4.88 (m, 2H), 2.59 (d, J = 6.0 Hz, 2H), 2.25 (s, 5H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 139.26, 138.72, 135.71, 129.45, 128.77, 115.29, 36.15, 35.40, 21.50; HRMS(EI^+) calcd for $C_{11}H_{14}$ (M^+): 146.1096; found: 146.1096.

1-(but-3-enyl)-4-methoxybenzene 3c



The title compound was obtained according to the general procedure. Pale yellow oil; Yield: 79%; IR (KBr): 3064, 2965, 2930, 1640, 1504, 1438, 1259, 1157, 912, 814, 786; ^1H NMR (400 MHz, $CDCl_3$): δ 7.03 (d, J = 8.0 Hz 2H), 6.78-6.72 (m, 2H), 5.84-5.72 (m, 1H), 4.98-4.87(m, 2H), 3.70(s, 3H), 2.58(t, J = 7.6 Hz , 2H), 2.30-2.22 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 158.16, 138.66, 134.41, 129.76, 115.32, 114.12, 55.70, 36.28, 34.92; HRMS(EI^+) calcd for $C_{11}H_{14}O$ (M^+):162.1045; found:162.1041.

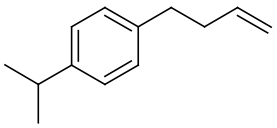
(4-(but-3-enyl)phenyl)(methyl)sulfane 3d



The title compound was obtained according to the general procedure. Pale yellow oil; Yield: 83%; IR (KBr): 3075, 2979, 2920, 2854, 1640, 1494,1438, 1094, 1010, 968, 912, 806,914; ^1H NMR (400 MHz,

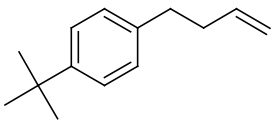
$CDCl_3$): δ 7.11 (d, *J* = 8.0 Hz, 2H), 7.03 (d, *J* = 8.0 Hz, 2H), 5.81-5.69 (m, 1H), 4.94 (d, *J* = 17.2Hz, 1H), 4.90 (d, *J* = 10.0Hz, 1H), 2.58(t, *J* = 7.6 Hz , 2H), 2.37 (s, 3H), 2.30-2.21 (m, 2H); ^{13}C NMR (75 MHz, $CDCl_3$) δ139.36, 138.34, 135.68, 129.40, 127.44, 115.47, 35.90, 35.22, 16.70; HRMS(EI^+) calcd for $C_{11}H_{14}S$ (M^+): 178.0816; found: 178.0816.

1-(but-3-enyl)-4-isopropylbenzene 3e



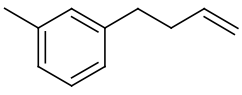
The title compound was obtained according to the general procedure. Colourless oil; Yield: 70%; IR (KBr):2960, 2870, 1639, 1511, 1455, 1389, 1144, 1056, 997, 910, 819, 625, 572; ^1H NMR (400 MHz, $CDCl_3$): δ 7.06 (d, *J* =3.6 Hz, 4H), 5.86-5.70 (m, 1H), 4.98 (d, *J* =16.8 Hz, 2H), 4.90 (d, *J* =9.6 Hz, 2H) 2.58-2.55 (m, 1H), 2.53-2.50 (m, 2H), 2.33-2.20 (m, 2H), 1.16 (d, *J* =6.0 Hz, 6H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 146.77, 139.67, 138.78, 128.77, 126.80, 115.23, 36.05, 35.42, 34.17, 24.56; HRMS(EI^+) calcd for $C_{13}H_{18}$ (M^+): 174.1409; found: 174.0416.

1-tert-butyl-4-(but-3-enyl)benzene 3f



The title compound was obtained according to the general procedure. Colourless oil; Yield: 66%; IR (KBr):2964, 2867, 2813, 1639, 1400, 1384, 1125, 997, 910, 829, 621; ^1H NMR (400 MHz, $CDCl_3$): δ 7.23 (d, *J* = 8.0 Hz, 2H), 7.06 (d, *J* = 8.0 Hz, 2H), 5.86-5.74 (m, 1H), 4.98 (d, *J* = 17.2Hz, 1H), 4.90 (d, *J* = 10.0Hz, 1H), 2.61 (t, *J* = 8.0 Hz , 2H), 2.32-2.26 (m, 2H), 1.24 (s, 9H); ^{13}C NMR (75 MHz, $CDCl_3$) δ149.03, 139.30, 138.81, 128.51, 125.66, 115.23, 35.97, 35.30, 34.83, 31.90; HRMS(EI^+) calcd for $C_{14}H_{20}$ (M^+): 188.1565; found: 188.1568.

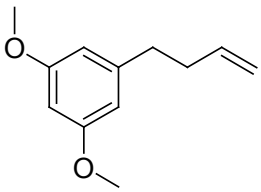
1-(but-3-enyl)-3-methylbenzene 3g



The title compound was obtained according to the general procedure. Colourless oil; Yield: 63%; IR (KBr):3077, 3015, 2924, 2856, 1640, 1608, 1548, 1542, 1261,1092, 995, 911, 782, 699; ^1H NMR (400 MHz, $CDCl_3$): δ 7.12-7.08 (m, 1H), 6.96-6.86(m, 3H), 5.86-5.72 (m, 1H), 5.02-4.82 (m, 2H), 2.60 (t, *J* = 7.6Hz, 2H), 2.32-2.24(m, 2H), 2.26 (s, 3H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 142.30, 138.70, 138.31, 129.72, 128.66, 127.02, 125.88, 115.28, 36.06,

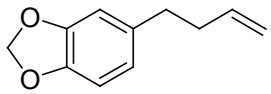
35.79, 21.90; HRMS(EI$^+$) calcd for $C_{11}H_{14}$ (M^+): 146.1096; found: 146.1090.

1-(but-3-enyl)-3,5-dimethoxybenzene 3h



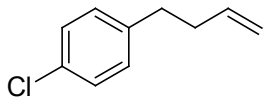
The title compound was obtained according to the general procedure. Colourless oil; Yield: 69%; IR (KBr): 3077, 2961, 2873, 1639, 1601, 1597, 1462, 1428, 1350, 1294, 1260, 1206, 1156, 1096, 1065, 1018, 914, 801, 694; ^{1}H NMR (400 MHz, $CDCl_3$): δ 6.28 (s, 2H), 6.23 (s, 1H), 5.84-5.74 (m, 1H), 4.98 (d, *J* = 16.8 Hz ,1H), 4.91 (d, *J* = 9.2 Hz ,1H), 3.70(s, 6H) 2.58(t, *J* = 7.2 Hz , 2H), 2.32-2.22 (m, 2H); ^{13}C NMR (75 MHz, $CDCl_3$) δ161.14, 144.76, 138.50, 115.39, 106.92, 98.19, 55.690, 36.14, 35.77; HRMS(EI$^+$) calcd for $C_{12}H_{16}O_2$ (M^+): 192.1150; found: 192.1151.

5-(but-3-enyl)benzo[*d*][1,3]dioxole 3i



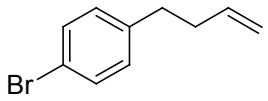
The title compound was obtained according to the general procedure. Colourless oil; Yield: 76%; IR (KBr):3076, 2977, 2926, 2897, 2775, 2057, 1836, 1640, 1503, 1443, 1360, 1246, 1188, 1098, 939, 919, 858, 809, 723, 630; ^{1}H NMR (400 MHz, $CDCl_3$): δ 6.65 (d, *J* = 8.0 Hz, 1H), 6.61 (s, 1H), 6.56 (d, *J* = 8.0 Hz, 1H), 5.84 (s, 2H), 5.82-5.70 (m, 1H), 5.00-4.88 (m, 2H), 2.55 (t, *J* = 7.6 Hz, 2H), 2.30-2.22 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ147.95, 146.03, 138.44, 136.19, 121.59, 115.47, 109.36, 108.54, 101.21, 36.27, 35.59; HRMS(EI$^+$) calcd for $C_{11}H_{12}O_2$ (M^+): 176.0837; found: 176.0842.

1-(but-3-enyl)-4-chlorobenzene 3j



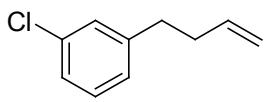
The title compound was obtained according to the general procedure. Colourless oil; Yield: 59%; IR (KBr): 3079, 3003, 2928, 2856, 1895, 1641,1492, 1452, 1407, 1092, 1015, 913, 815, 615 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.39 (d, *J* = 7.6 Hz, 2H), 7.06 (d, *J* = 7.6 Hz, 2H), 5.58-5.54 (m, 1H), 5.20-4.80 (m, 2H), 2.66 (t, *J* = 7.6 Hz, 2H), 2.40-2.25 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 138.07, 131.80, 130.70, 125.87, 115.78, 108.95, 35.76, 35.21; HRMS(EI$^+$) calcd for $C_{10}H_{11}Cl$ (M^+): 166.0549; found: 166.0551.

1-bromo-4-(but-3-enyl)benzene 3k



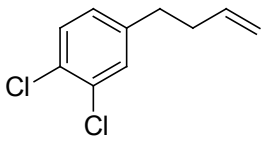
The title compound was obtained according to the general procedure. Colourless oil; Yield: 55%; IR (KBr): 3077, 3012, 2913, 1903, 1640, 1503, 1451, 1398, 1015, 992, 807, 633 cm^{-1};^{1}H NMR (400 MHz, $CDCl_3$): δ 7.32 (d, *J* = 8.4 Hz, 2H), 6.98 (d, *J* = 8.0 Hz, 2H), 5.88-5.76 (m, 1H), 5.06-4.96 (m, 2H), 2.68 (t, *J* = 7.2 Hz, 2H), 2.38-2.30 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 132.11, 132.06, 131.54, 130.92, 130.49, 115.77, 110.25, 35.75, 35.20; HRMS(EI$^+$) calcd for $C_{10}H_{11}Br$ (M^+): 210.0044; found: 210.0047.

1-(but-3-enyl)-3-chlorobenzene 3l



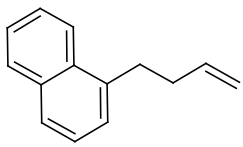
The title compound was obtained according to the general procedure. Colourless oil; Yield: 60%; IR (KBr): 2926, 2855, 1641, 1579, 1471, 1430, 1390, 1158, 1086, 1003, 915, 875, 780; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.18-7.08 (m, 3H), 6.98 (d, *J* = 7.2 Hz,1H), 5.82-5.68 (m, 1H), 4.88-5.00 (m, 2H), 2.61 (t, *J* = 7.6 Hz , 2H), 2.32-2.26 (m, 2H); ^{13}C NMR (75 MHz, $CDCl_3$) δ 144.32, 137.99, 134.47, 129.99, 129.04, 127.13, 126.48, 115.80, 35.68, 35.47; HRMS(EI$^+$) calcd for $C_{10}H_{11}Cl$ (M^+): 166.0549; found: 166.0551.

4-(but-3-enyl)-1,2-dichlorobenzene 3m



The title compound was obtained according to the general procedure. Colourless oil; Yield: 68%; IR (KBr): 3079, 2990, 2928, 2858, 1641, 1581, 1473, 1396, 1258, 1205, 1131, 1031, 994, 915, 878, 817,750; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.26 (d, *J* = 8.0 Hz, 1H), 7.20 (s, 1H), 6.94 (d, *J* = 8.0 Hz, 1H),5.78-5.68 (m, 1H), 5.00-4.90(m, 2H), 2.62-2.54 (m, 2H), 2.30-2.28 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 137.61, 130.86, 130.626, 128.41, 116.09, 35.50, 34.88; HRMS(EI$^+$) calcd for $C_{10}H_{10}Cl_2$ (M^+): 200.0160; found: 200.0164.

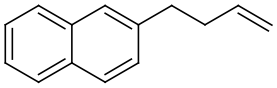
1-(but-3-enyl)naphthalene 3n



The title compound was obtained according to the general procedure. Colourless oil; Yield: 88%; IR (KBr): 3066, 3004, 2930, 2867, 1925, 1639, 1597, 1510, 1480, 1457, 1396, 1261, 1165, 994, 911, 858, 775, 731, 633; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.95 (d, *J* = 8.0

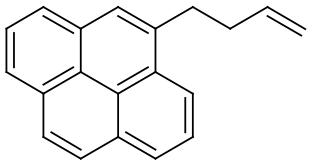
Hz, 1H), 7.76 (d, *J* = 8.0 Hz, 1H), 7.62(d, *J* = 8.0 Hz, 1H), 7.45-7.35(m, 2H), 7.31 (t, *J* = 7.2 Hz, 1H), 7.23 (d, *J* = 6.8 Hz, 1H), 5.92-5.80 (m, 1H), 5.01 (d, *J* = 17.2 Hz, 1H), 4.94 (d, *J* = 10.4 Hz, 1H), 3.08 (d, *J* = 7.6 Hz, 2H), 2.46-2.36 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 125.786, 114.623, 32.332, 30.604, 30.212, 28.657, 23.912, 23.174, 14.596; HRMS(EI^+) calcd for $C_{14}H_{14}$ (M^+): 182.1096; found: 182.1096.

2-(but-3-enyl)naphthalene 3o

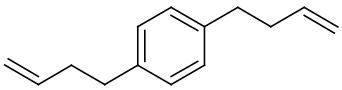


The title compound was obtained according to the general procedure. Colourless oil; Yield: 85%; IR (KBr):3054, 3012, 2926, 2853, 1919, 1740, 1639, 1600, 1508, 1438, 1365, 1270, 1152, 995, 958, 911, 852, 815, 744, 643; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.73-7.65 (m, 3H), 7.54 (s, 1H), 7.38-7.30(m, 1H), 7.25 (d, *J* = 7.2 Hz, 1H), 7.23 (d, *J* = 8.4 Hz, 1H), 5.88-5.72 (m, 1H), 4.98 (d, *J* = 17.2 Hz, 1H), 4.91 (d, *J* = 10.0 Hz, 1H), 2.79 (t, *J* = 7.6 Hz, 2H), 2.42-2.32 (m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 139.84, 138.50, 134.05, 132.44, 128.28, 128.07, 127.90, 127.81, 126.89, 126.34, 125.59, 115.52, 36.00, 35.91; HRMS(EI^+) calcd for $C_{14}H_{14}$ (M^+): 182.1096; found: 182.1099.

2-(but-3-enyl)naphthalene 3p



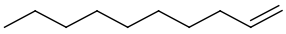
The title compound was obtained according to the general procedure. Pale green oil; Yield: 62%; IR (KBr):3040, 2938, 2874, 1638, 1598, 1504, 1455, 1412, 1389, 1240, 1182, 994, 910, 841, 754, 709, 630; ^{1}H NMR (400 MHz, $CDCl_3$): δ 8.22-8.20 (m, 1H), 8.12-8.06 (m, 2H), 8.06-8.02 (m, 2H), 7.96-7.88(m ,3H), 7.82-7.76(m,1H); 5.98-5.86 (m, 1H), 5.10-4.92(m, 2H), 3.37(t, *J* = 7.6 Hz, 2H), 2.59-2.48(m, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): 138.58, 136.58, 131.88, 131.35, 130.30, 129.08, 127.98, 127.70, 127.06, 125.32, 125.25, 125.16, 123.80, 115.59, 36.33, 33.49; HRMS(EI^+) calcd for $C_{20}H_{16}$ (M^+): 256.1253; found:256.1253.



1,4-di(but-3-enyl)benzene 3q The title compound was obtained according to the general procedure. Colourless oil; Yield: 71%; IR (KBr):3078, 3006, 2926, 2854, 1899, 1826, 1640, 1514, 1452, 1446, 1382, 1335, 1299, 1262, 1205, 1118, 994, 911, 843, 816, 734, 627; ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.04 (s, 4H), 5.85-5.72 (m, 2H), 5.12-4.90 (m, 4H), 2.61 (t, *J* =

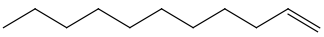
8.0 Hz, 4H), 2.32-2.20 (m, 4H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 139.75, 138.70, 128.80, 115.28, 36.05, 35.43; HRMS(EI^+) calcd for $C_{14}H_{18}$(M^+): 186.1409; found: 186.1413.

dec-1-ene 3r



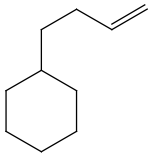
The title compound was obtained according to the general procedure. Colourless oil; Yield: 42%; IR (KBr): 3070, 2959, 2928, 2957, 1642, 1468, 1379, 994, 910; ^{1}H NMR (300 MHz, $CDCl_3$): δ 5.75-5.55 (m, 1H), 4.95-5.10(m, 2H), 1.92-1.88(m, 2H), 1.30-1.10(m, 12H), 0.82(s, 3H); ^{13}C NMR (75 MHz, $CDCl_3$): δ 125.79, 114.62, 32.33, 30.60, 30.21, 28.66, 23.91, 23.17, 14.60; HRMS(EI^+) calcd for $C_{10}H_{20}$ (M^+):140.1565; found: 140.1565.

undec-1-ene 3s



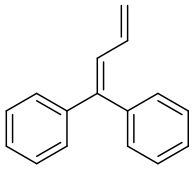
The title compound was obtained according to the general procedure. Colourless oil; Yield: 51%; IR (KBr): 3069, 2961, 2928, 2957, 1642, 1488, 1472, 998, 890; ^{1}H NMR (400 MHz, $CDCl_3$): δ 5.80-5.72 (m, 1H), 5.05-4.85(m, 2H), 2.15-1.92(m, 2H), 1.29-1.10(m, 14H), 0.82(s, 4H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 126.78, 115.72, 30.22, 29.08, 27.23, 23.17, 14.60; HRMS(EI^+) calcd for $C_{11}H_{22}$ (M^+):154.1722; found: 154.722.

(but-3-enyl)cyclohexane 3t



The title compound was obtained according to the general procedure. Colourless oil; Yield: 42%; IR (KBr): 3042, 2938, 2876, 1600, 1468, 1379, 994, 816; ^{1}H NMR (400 MHz, $CDCl_3$): δ 5.91-5.76 (m, 1H), 5.14-5.00(m, 2H), 1.75-1.57(m, 3H), 1.30-1.10(m, 10H), 0.90(s, 2H); ^{13}C NMR (100 MHz, $CDCl_3$): δ 127.49, 116.47, 35.78, 31.26, 30.58, 27.12, 23.35, 14.75; HRMS(EI^+) calcd for $C_{10}H_{18}$ (M^+):138.1409; found: 138.1410.

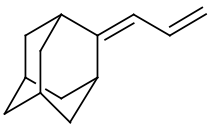
1,1-diphenylbuta-1,3-diene 5a



The title compound was obtained according to the general procedure. Colourless oil; Yield: 91%; IR (KBr): 3080, 3056, 3026, 1640, 1619, 1567, 1493, 1445, 905, 765, 699 cm^{-1} ; ^{1}H NMR (300 MHz, $CDCl_3$): δ 7.29-7.47 (m, 10H), 6.80 (d, J = 11.0 Hz, 1H), 6.47-6.59 (m, 1H), 5.46 (d, J = 16.8 Hz, 1H), 5.20 (d, J = 10.1 Hz, 1H); ^{13}C NMR (75 MHz, $CDCl_3$): δ 143.59, 142.53, 140.09, 135.41,

130.87, 128.97, 128.64, 128.63, 128.04, 127.96, 127.85, 119.08. HRMS(EI$^+$) calcd for $C_{16}H_{14}$ (M^+): 206.1096; found: 206.1096.

Tricyclo[3.3.1.13,7]decane, 2-(2-propen-1-ylidene) 5b



The title compound was obtained according to the general procedure. Colourless oil; Yield: 89%; IR (KBr): 3078, 2900, 1674, 987, 968, 951, 890 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$): δ 6.62-6.50 (m, 1H), 5.71(d, J = 10.8 Hz, 1H), 5.03 (d, J = 16.8 Hz, 1H) , 4.86 (d, J = 10.0 Hz, 1H) , 2.96 (s, 1H) , d 2.31 (s, 1H) , 1.92–1.66(m , 12H) . ^{13}C NMR (100MHz, $CDCl_3$,): δ 139.84, 138.50, 134.05, 132.44, 128.28, 128.07, 127.90, 127.81, 126.89, 126.34, 125.59, 115.52, 36.00, 35.91; HRMS(EI$^+$) calcd for $C_{13}H_{18}$ (M^+): 174.1409; found: 174.1410.

diethyl phosphate $(EtO)_2P(O)H$

^{1}H NMR (400 MHz, DMSO-d_6): δ 7.66 (s, 0.5H), 5.94(s, 0.5H), 4.03 (q, J = 8.0 Hz, 4H) , 5.95 (t, J =12.0 Hz, 6H); ^{31}P NMR (121MHz, DMSO-d_6): δ 9.57.

allylsamarium bromide diethoxy(oxo)phosphate 7

^{1}H NMR (300 MHz, DMSO-d_6): 4.75 (s, 4H), 1.73 (s, 6H); ^{31}P NMR (121MHz, DMSO-d_6): δ 135.65.

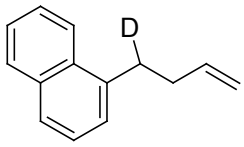
dialkylphosphinylallylsamarium bromide 8

^{1}H NMR (300 MHz, DMSO-d_6): δ 6.15-5.76 (m, 2H), 5.21-5.02(m, 4H), 1.75 (s, 4H) ^{31}P NMR (121MHz, DMSO-d_6): δ 103.63.

$(EtO)_2P(O)D$

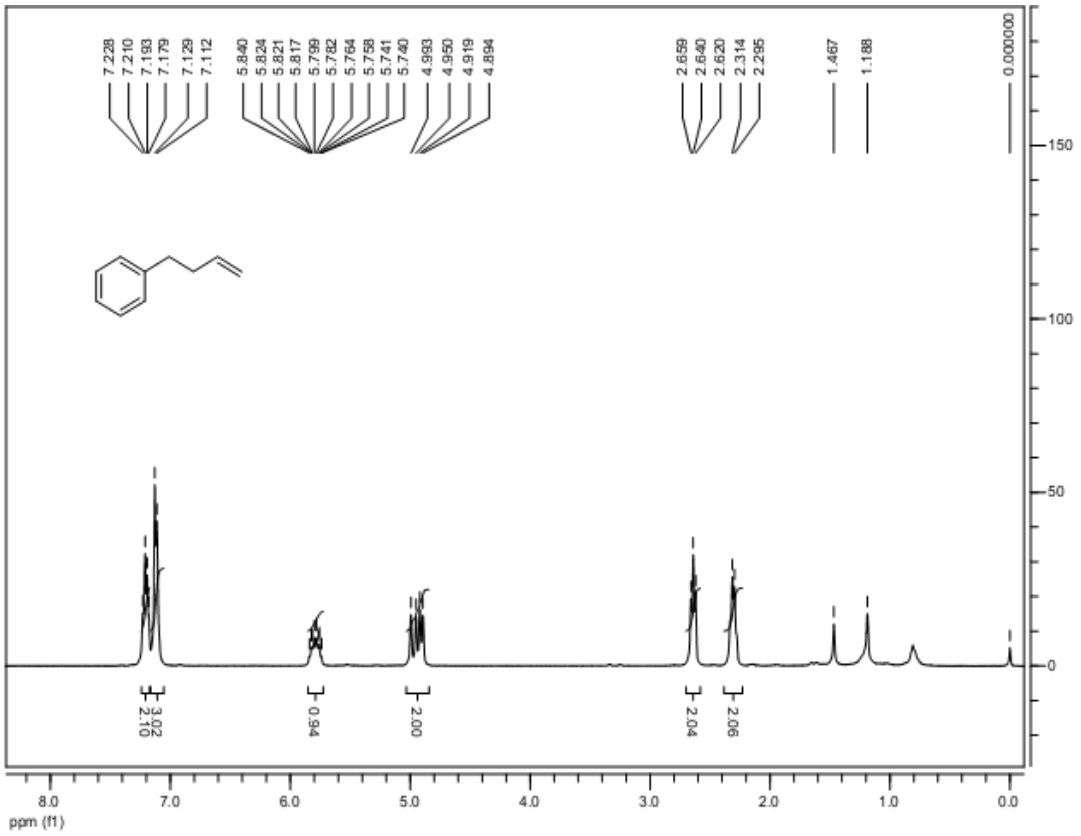
^{1}H NMR (400 MHz, $CDCl_3$): δ 4.16 (q, J = 8.0 Hz, 4H) , 1.36 (t, J =12.0 Hz, 6H).

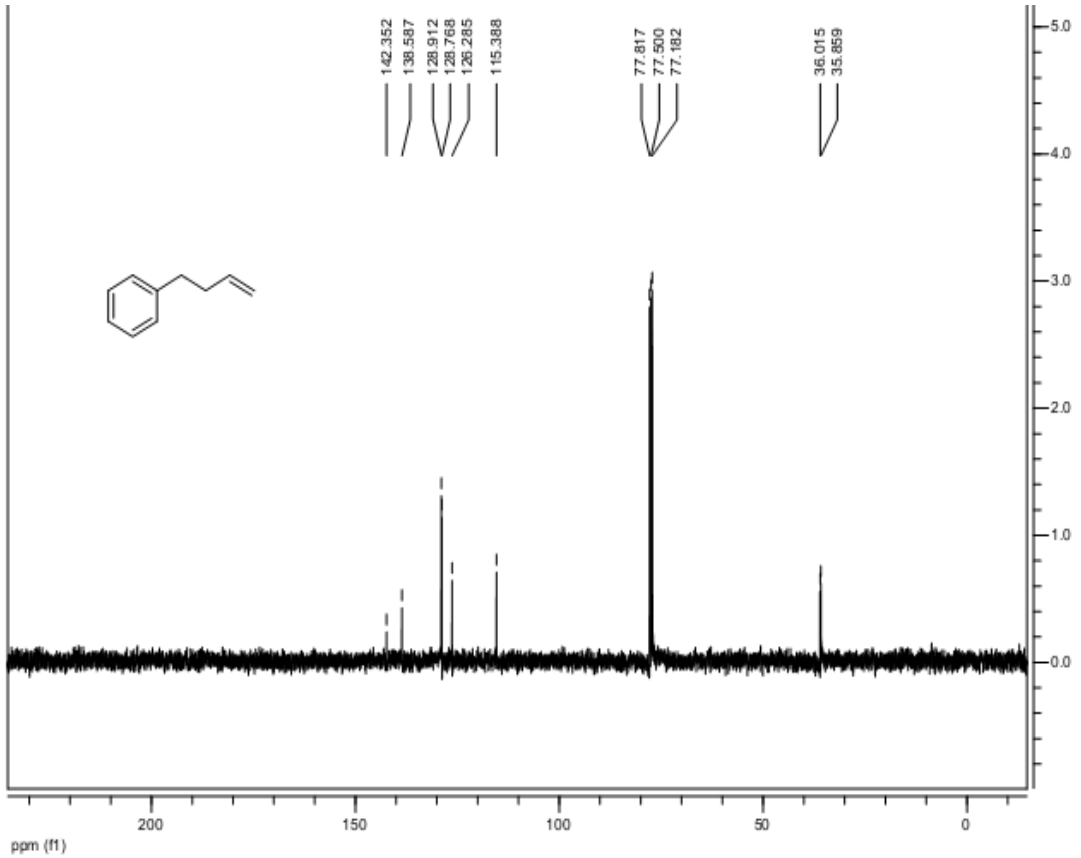
4-D-4-naphthyl-1-butylene



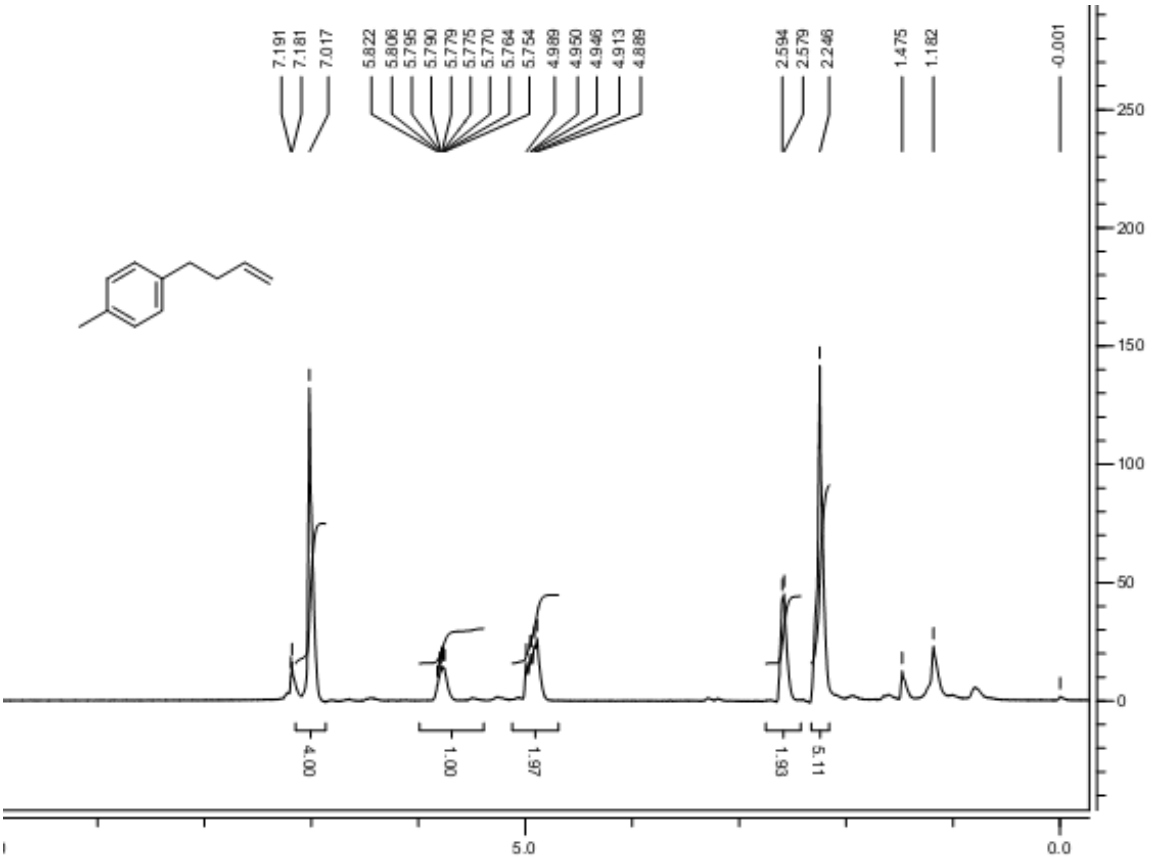
^{1}H NMR (400 MHz, $CDCl_3$): δ 7.95 (d, J = 8.0 Hz, 1H), 7.76 (d, J = 8.0 Hz, 1H), 7.62(d, J = 8.0 Hz, 1H), 7.45-7.35(m, 2H), 7.31 (t, J = 7.2 Hz, 1H), 7.23 (d, J = 6.8 Hz, 1H), 5.92-5.80 (m, 1H), 5.01 (d, J = 17.2 Hz, 1H), 4.94 (d, J = 10.4 Hz, 1H), 3.13 (d, J = 7.6 Hz, 1H), 2.46-2.36 (m, 2H).

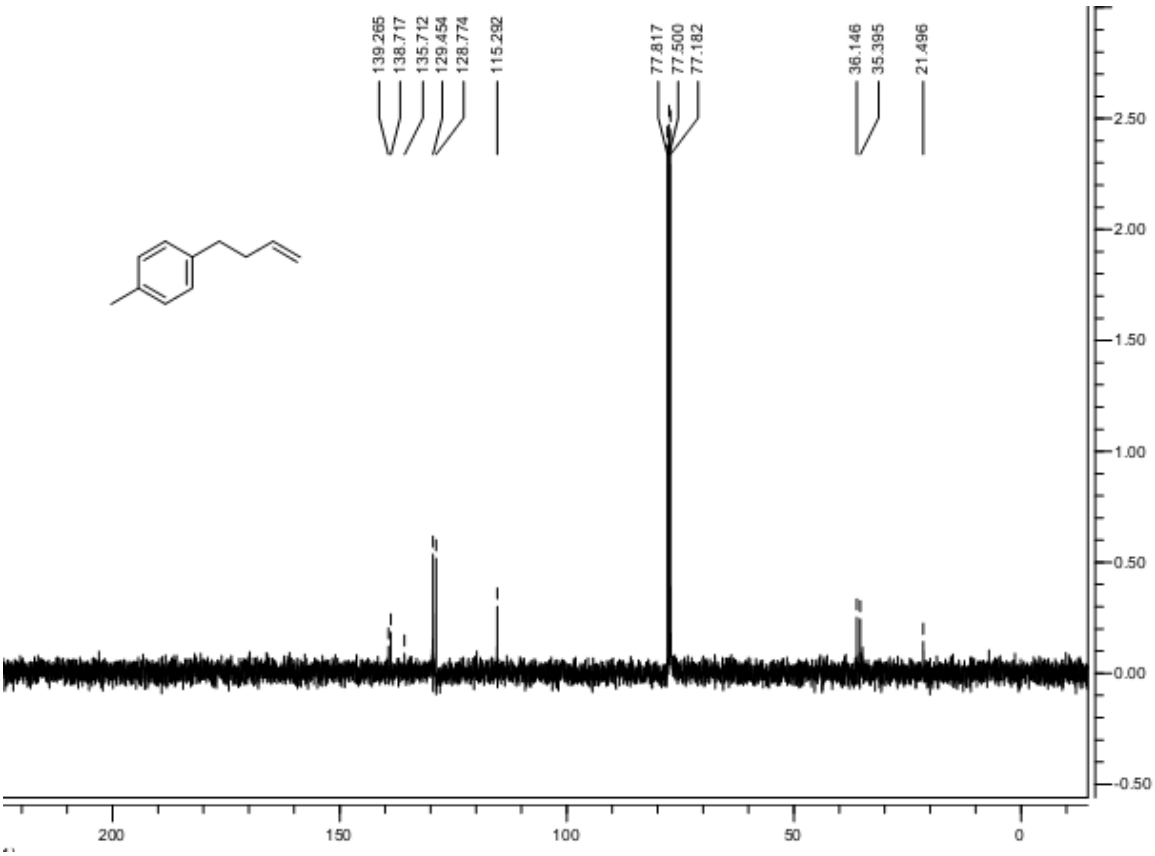
^{1}H- and ^{13}C-NMR for **1-(but-3-enyl)benzene 3a**



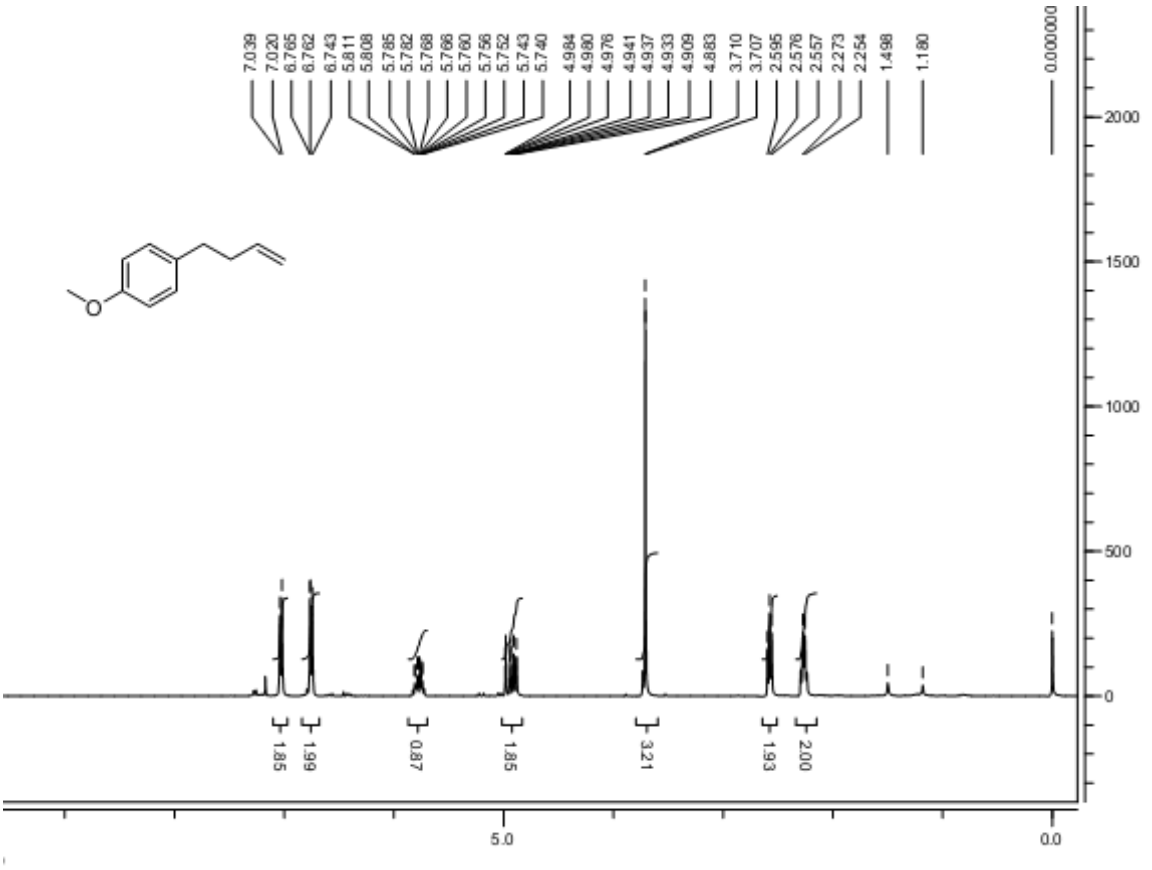


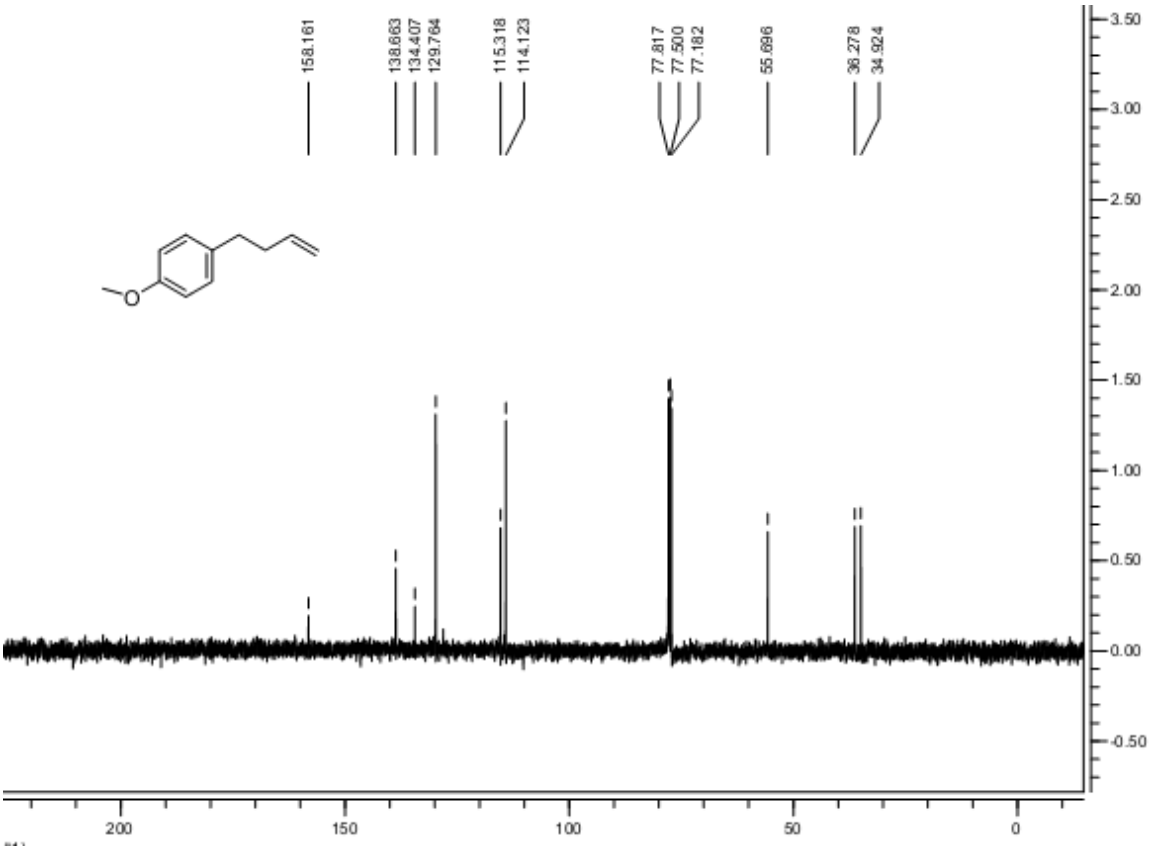
^{1}H- and ^{13}C-NMR for **1-(but-3-enyl)-4-methylbenzene 3b**



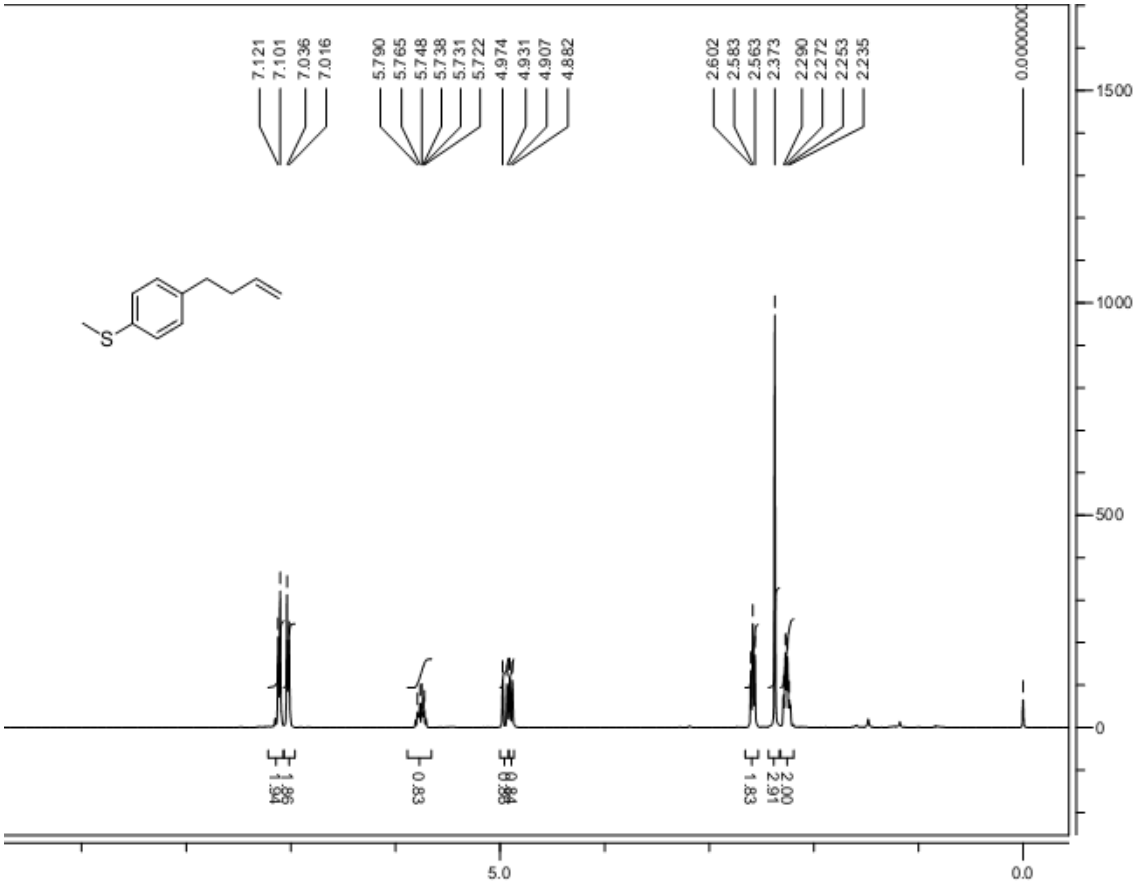


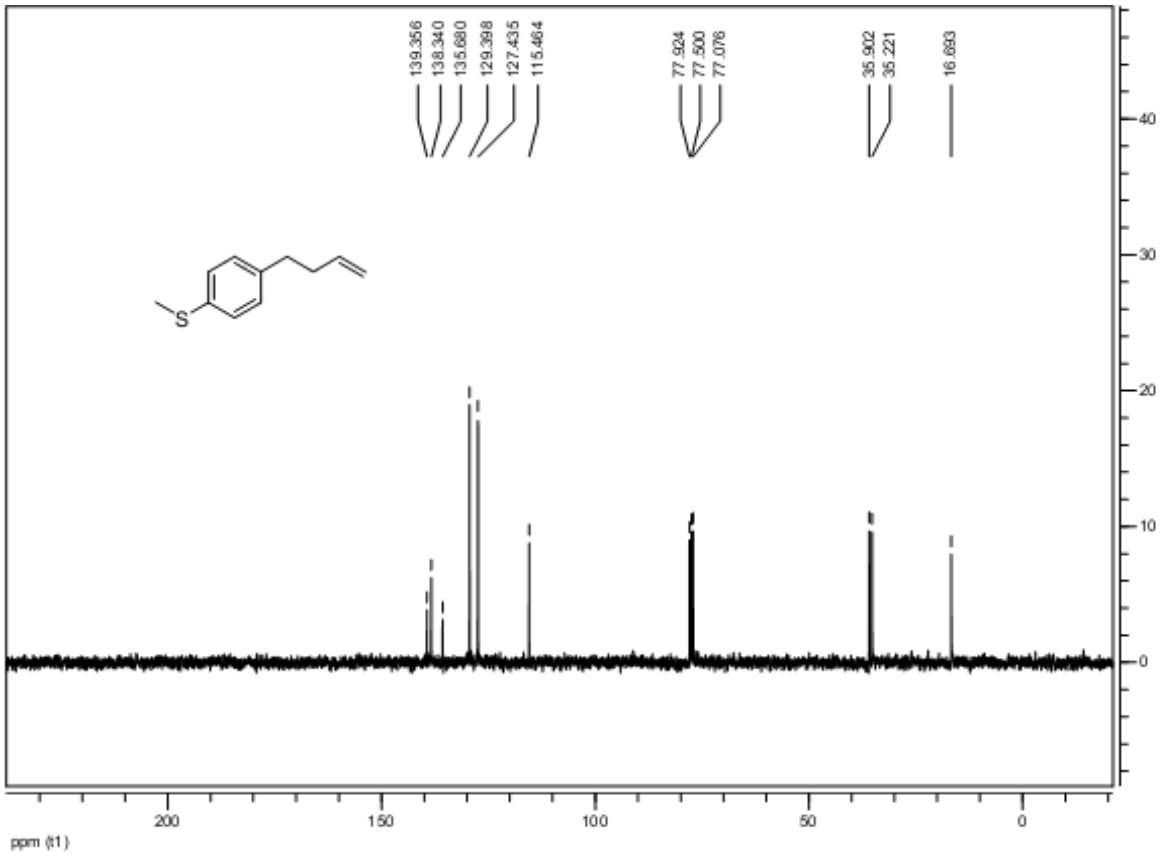
^{1}H- and ^{13}C-NMR for **1-(but-3-enyl)-4-methoxybenzene 3c**



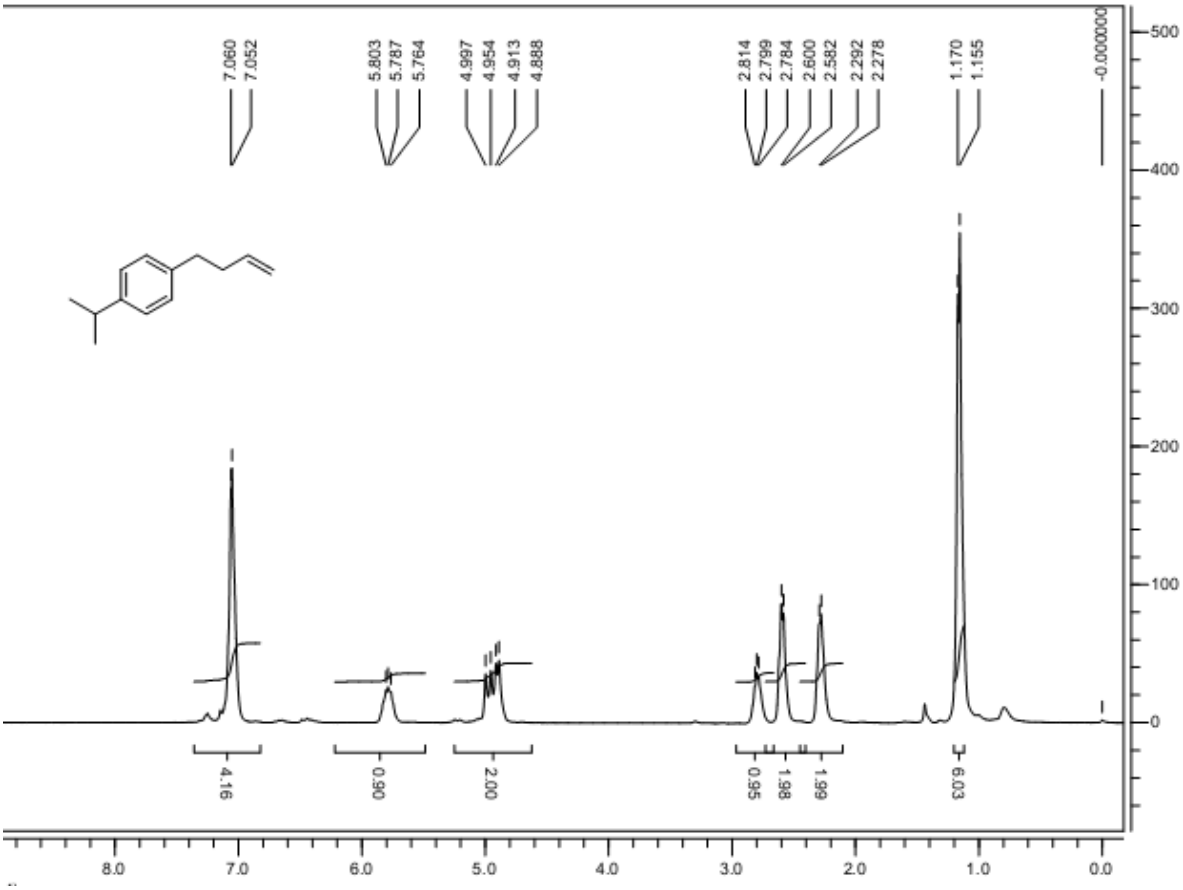


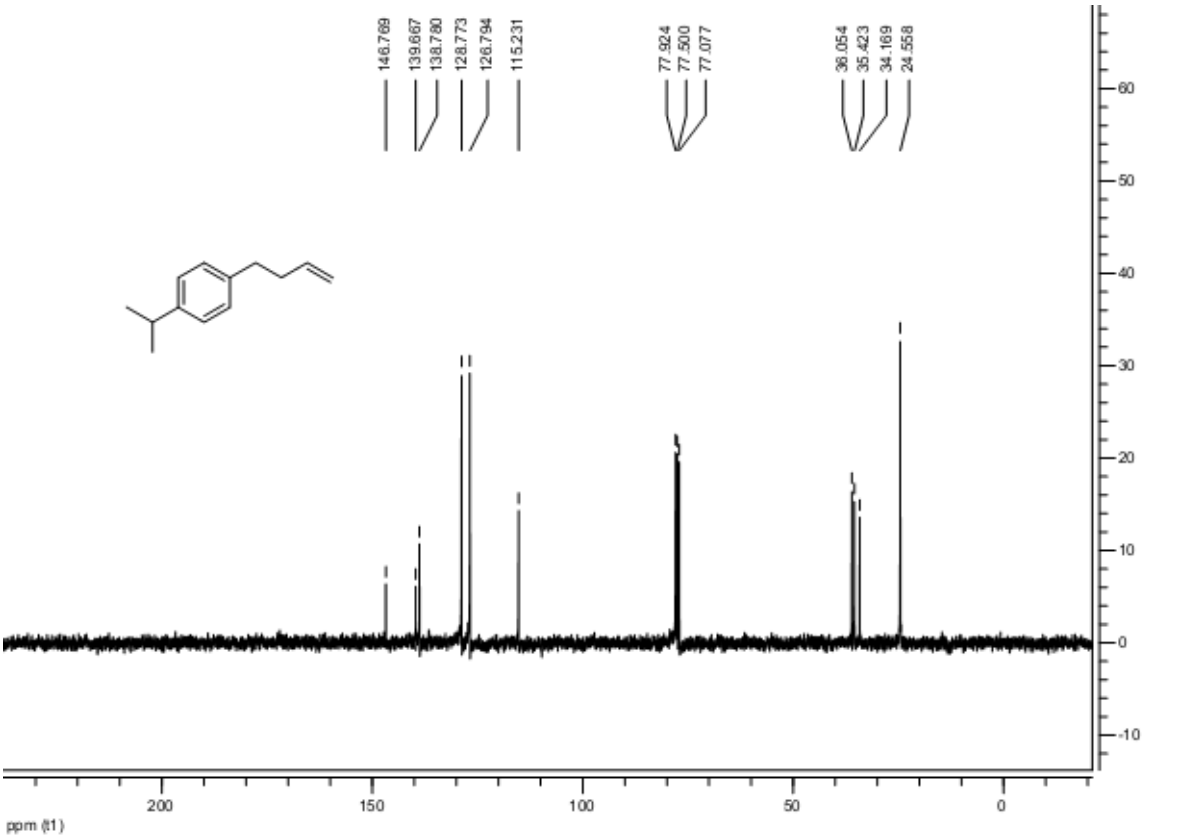
^{1}H- and ^{13}C-NMR for **(4-(but-3-enyl)phenyl)(methyl)sulfane 3d**



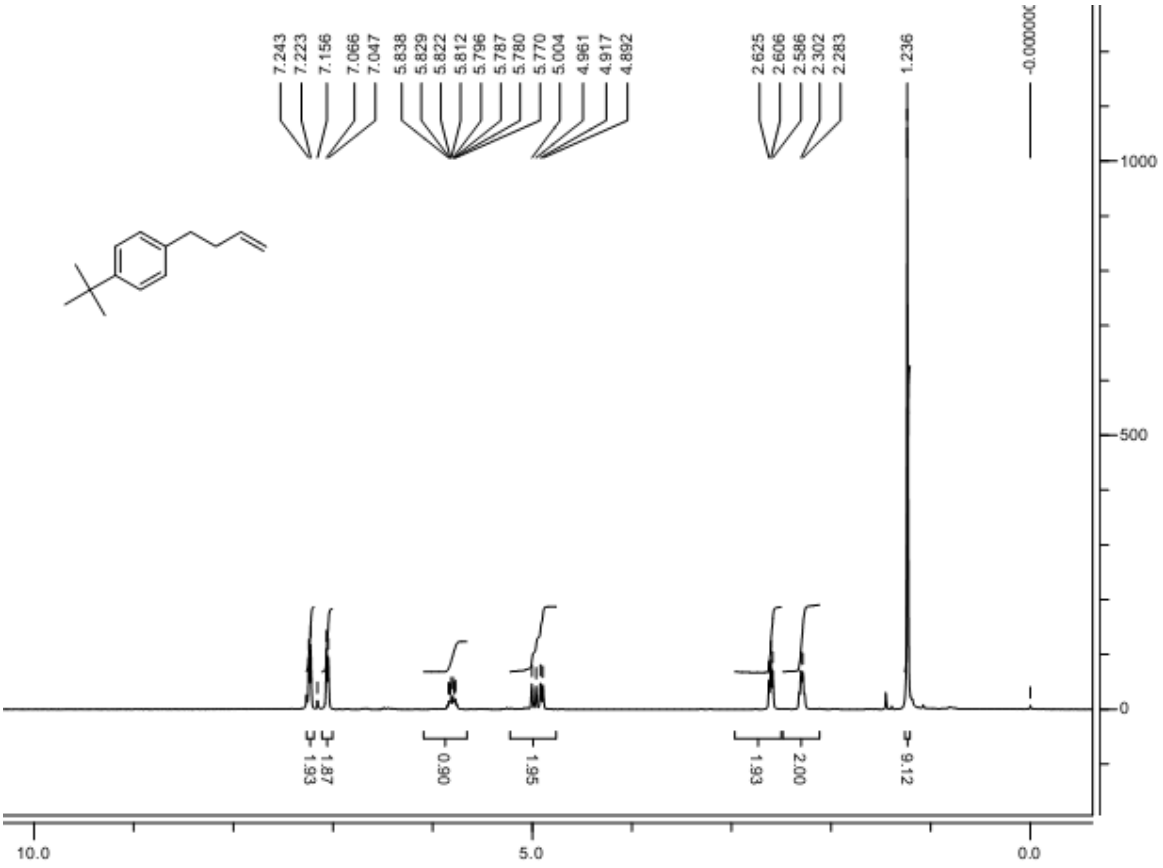


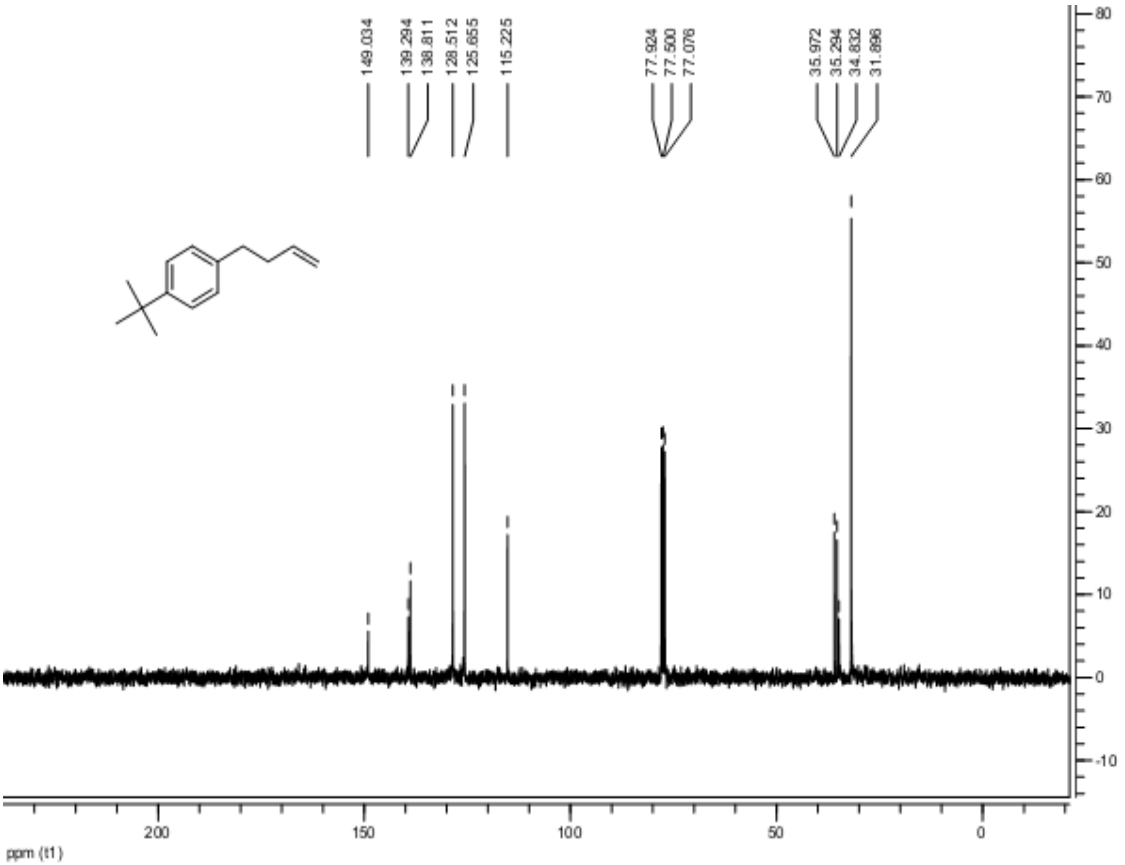
^{1}H- and ^{13}C-NMR for **1-(but-3-enyl)-4-isopropylbenzene 3e**



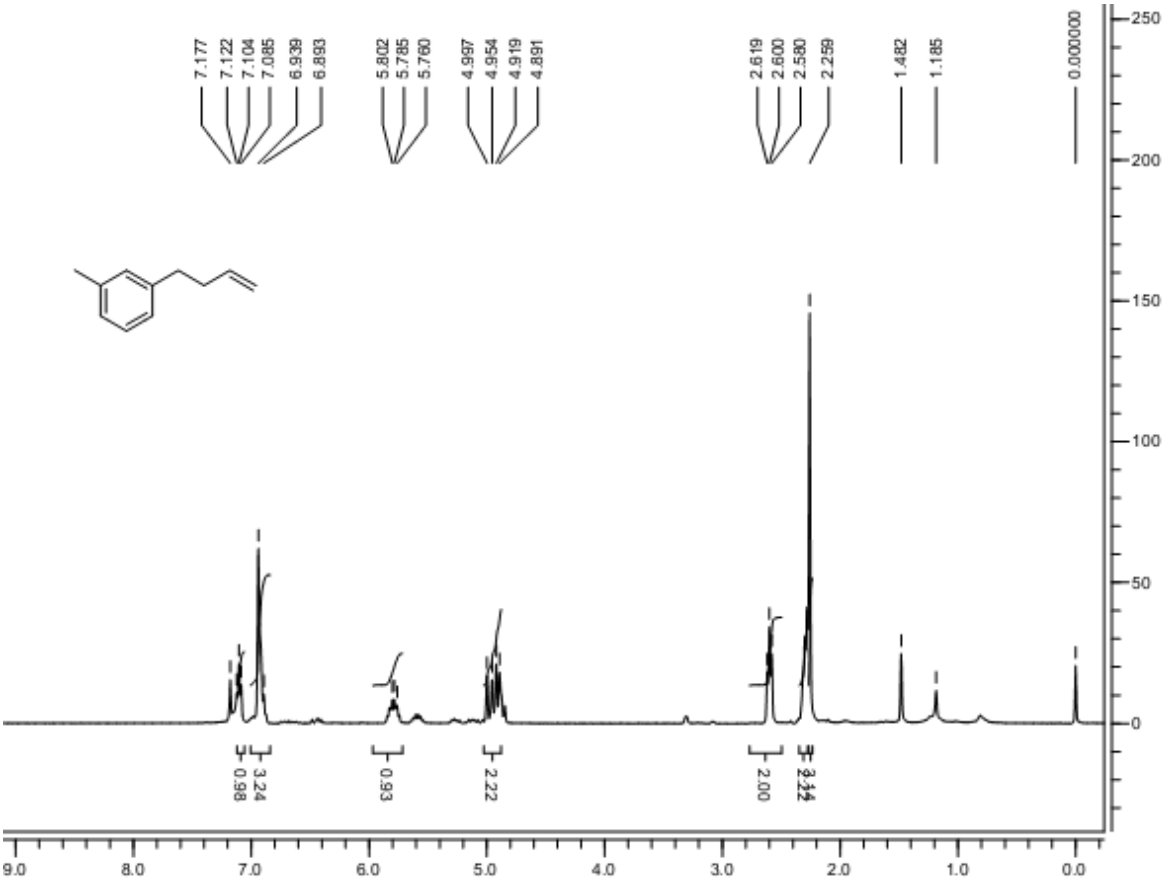


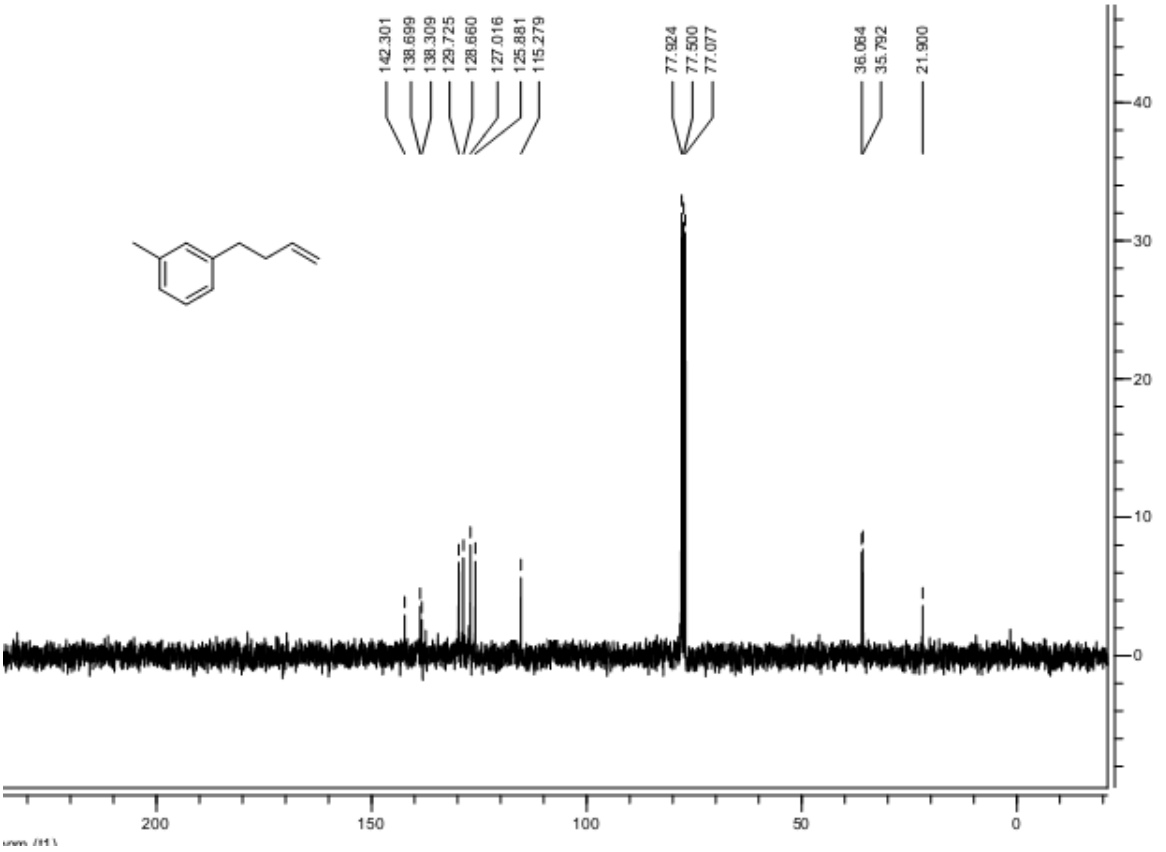
^{1}H- and ^{13}C-NMR for **1-tert-butyl-4-(but-3-enyl)benzene 3f**



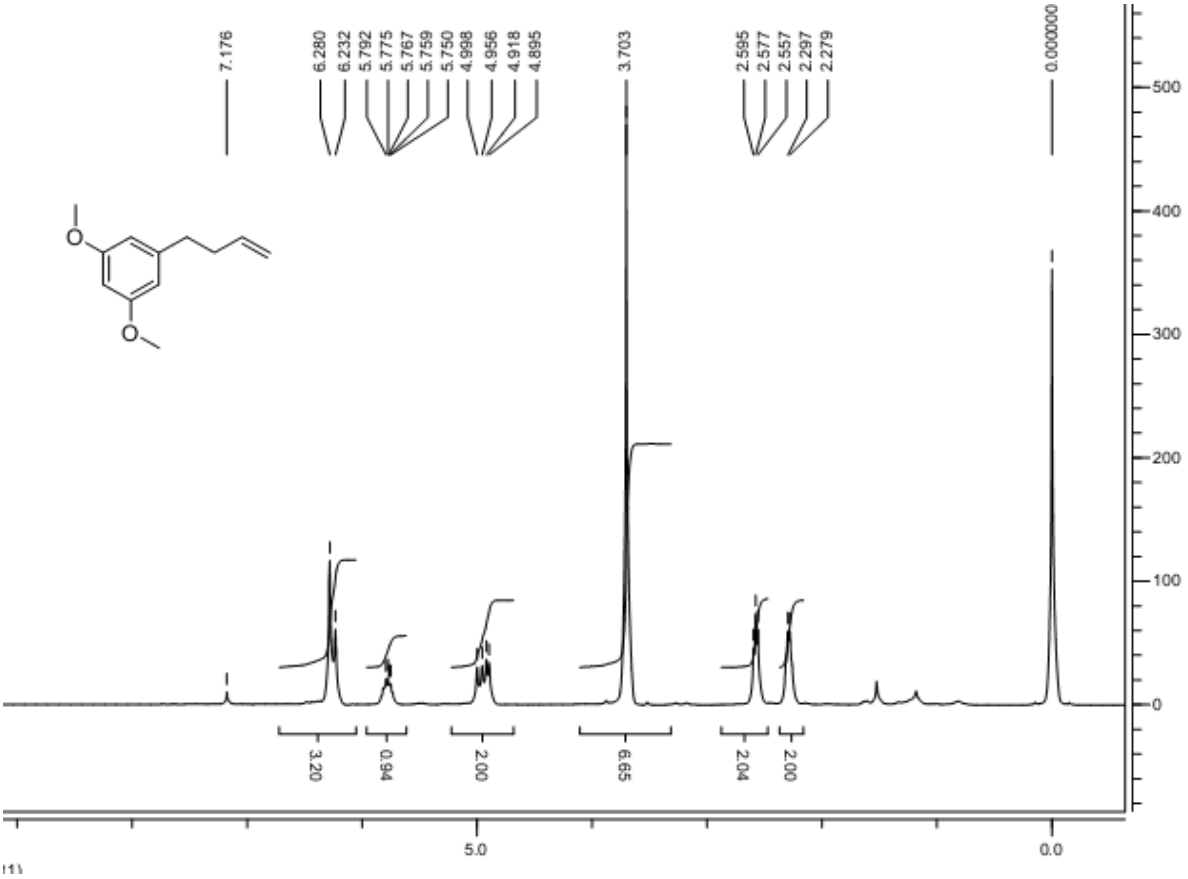


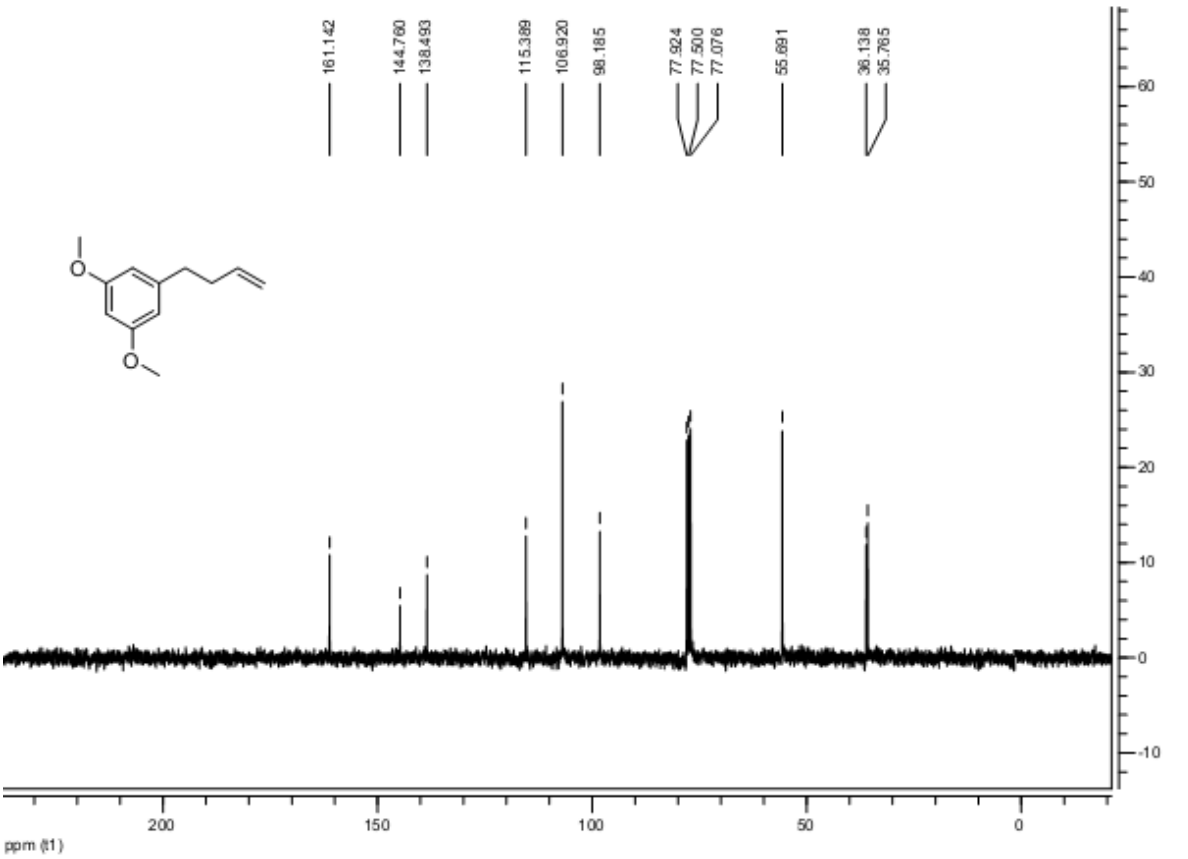
^{1}H- and ^{13}C-NMR for **1-(but-3-enyl)-3-methylbenzene 3g**



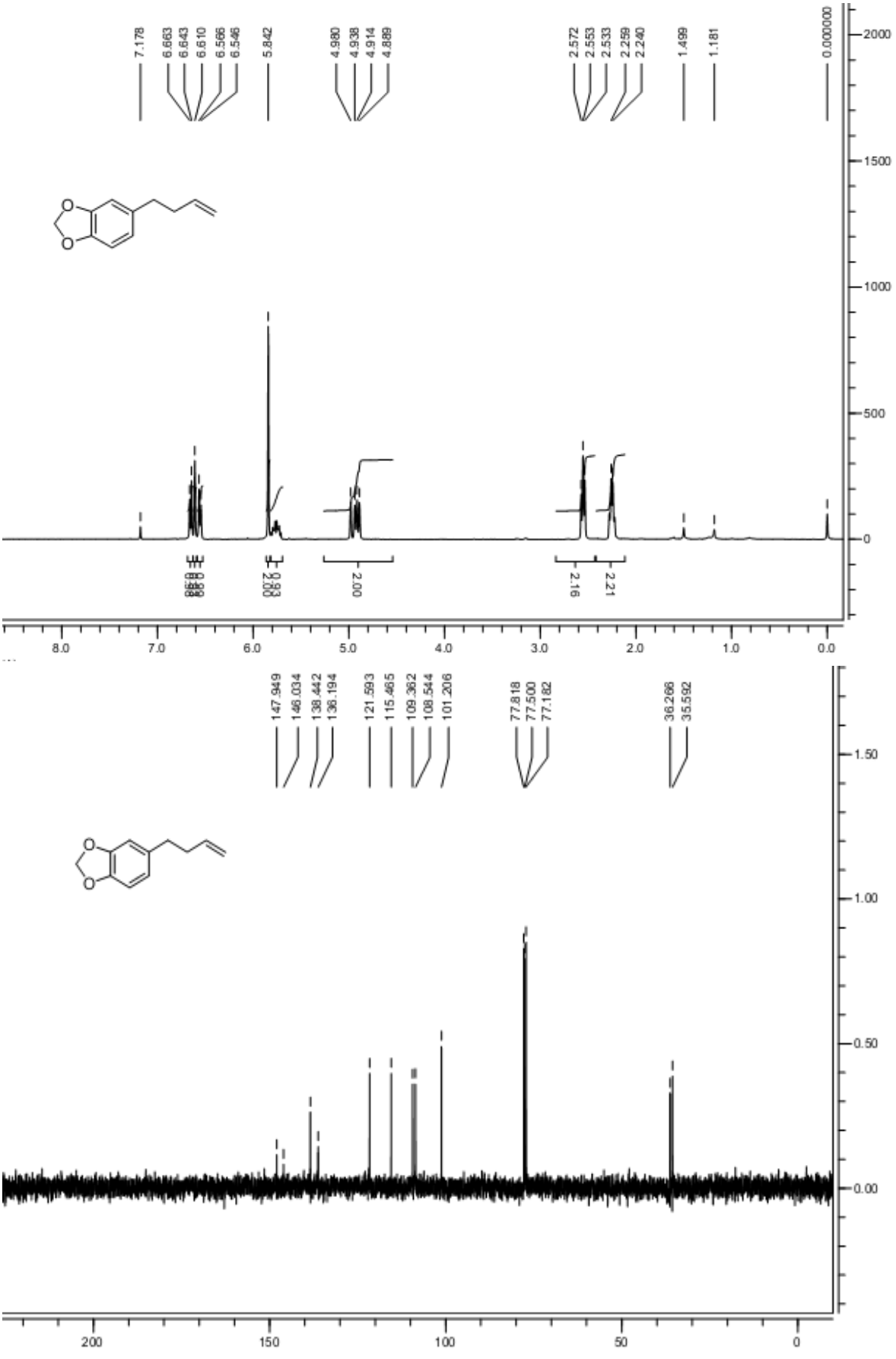


^{1}H- and ^{13}C-NMR for **1-(but-3-enyl)-3,5-dimethoxybenzene 3h**

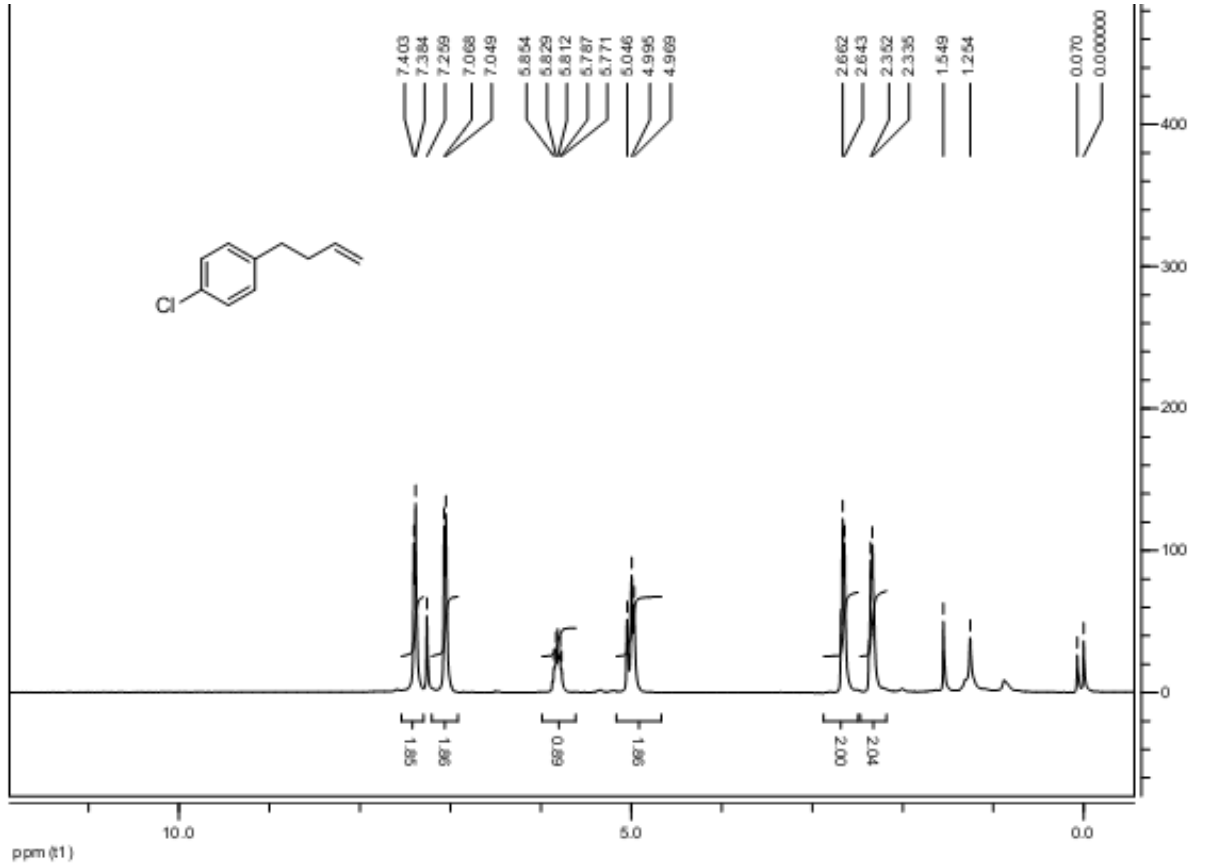


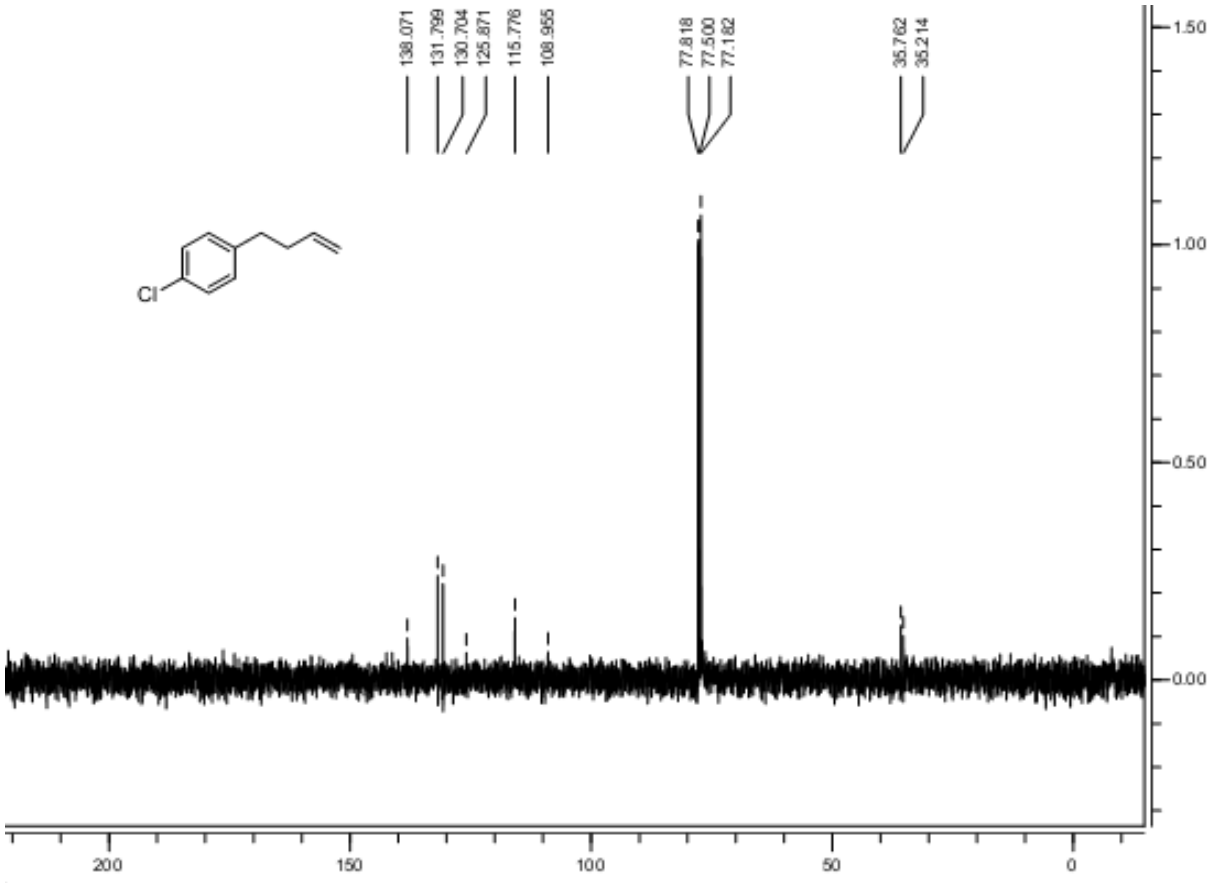


^{1}H- and ^{13}C-NMR for **5-(but-3-enyl)benzo[*d*][1,3]dioxole 3i**

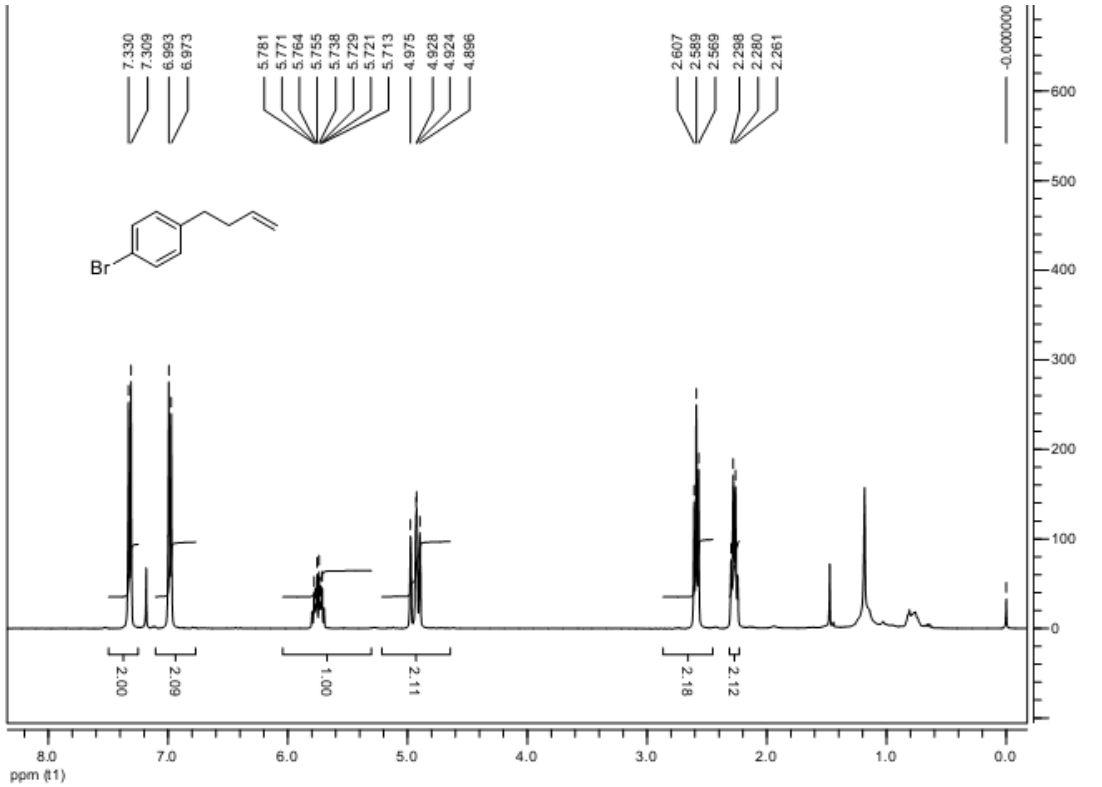


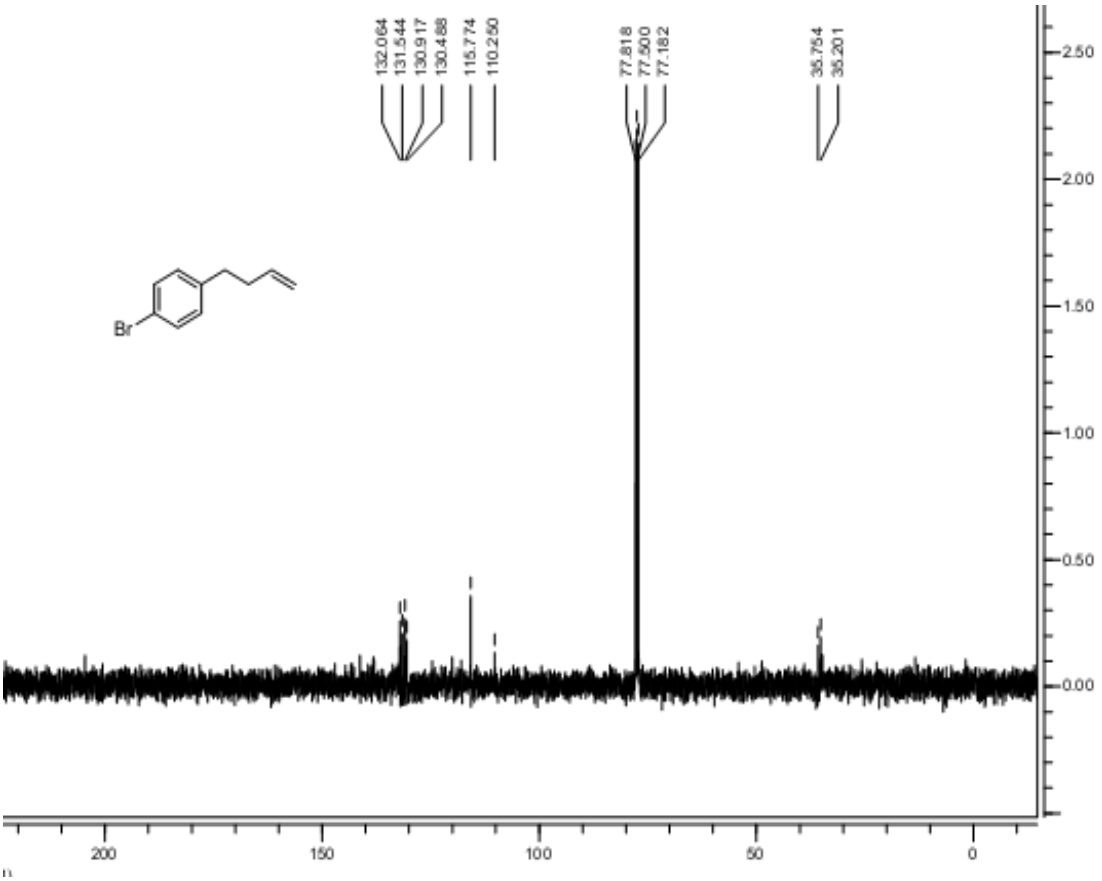
^{1}H- and ^{13}C-NMR for **1-(but-3-enyl)-4-chlorobenzene 3j**



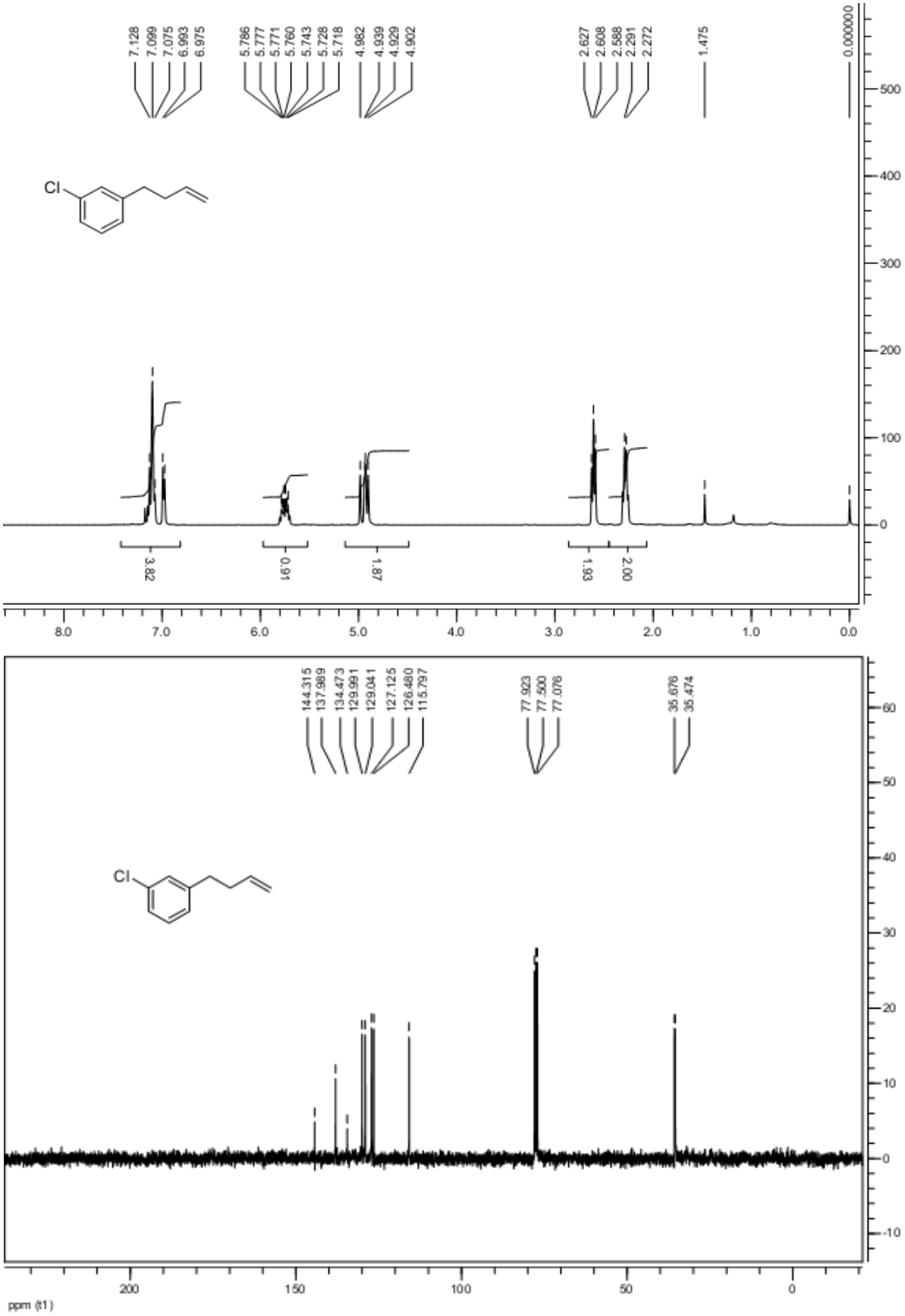


^{1}H- and ^{13}C-NMR for **1-bromo-4-(but-3-enyl)benzene 3k**

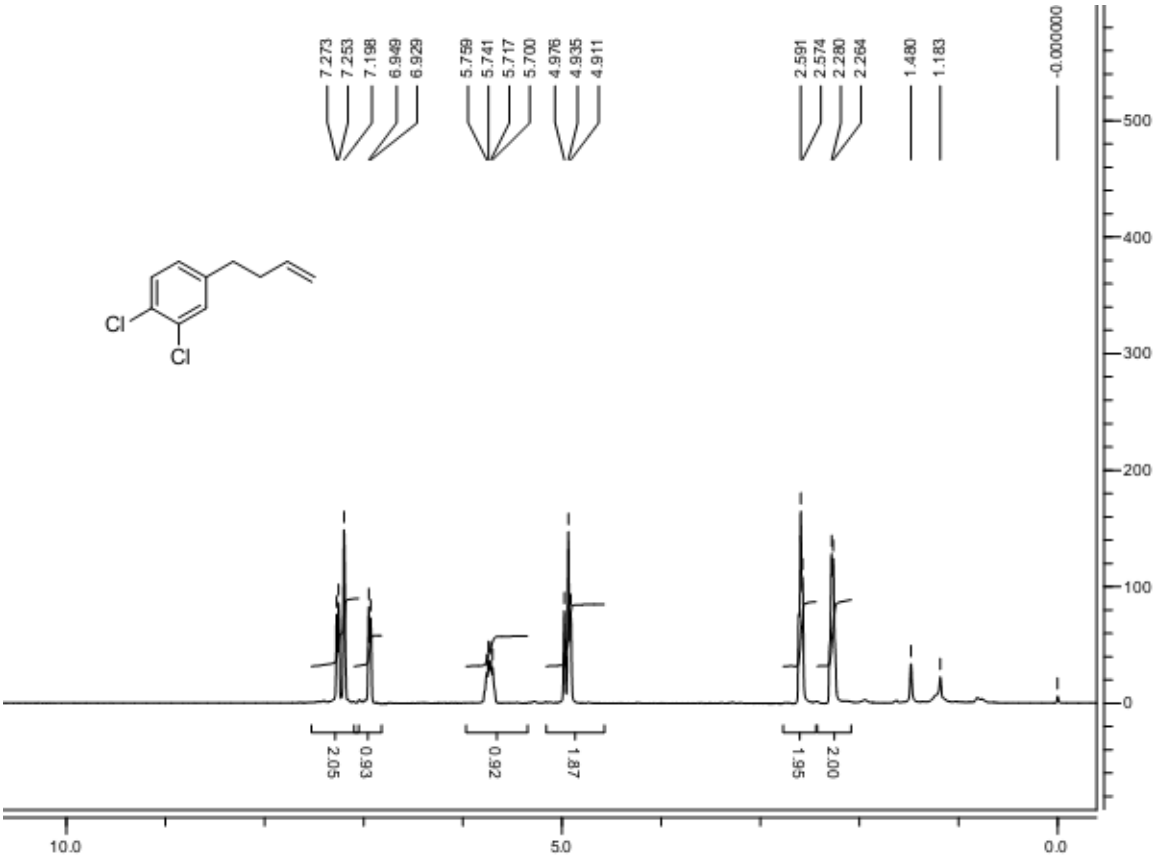


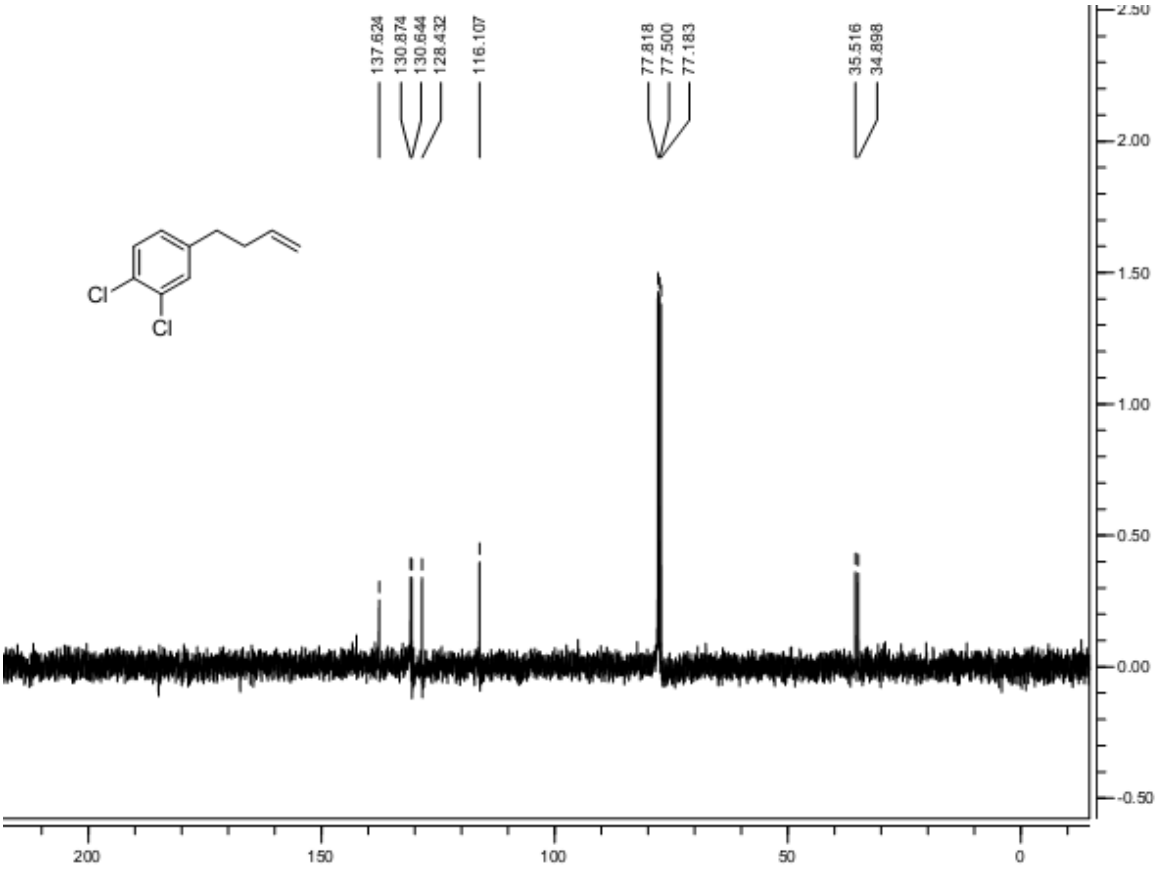


^{1}H- and ^{13}C-NMR for **1-(but-3-enyl)-3-chlorobenzene 3l**

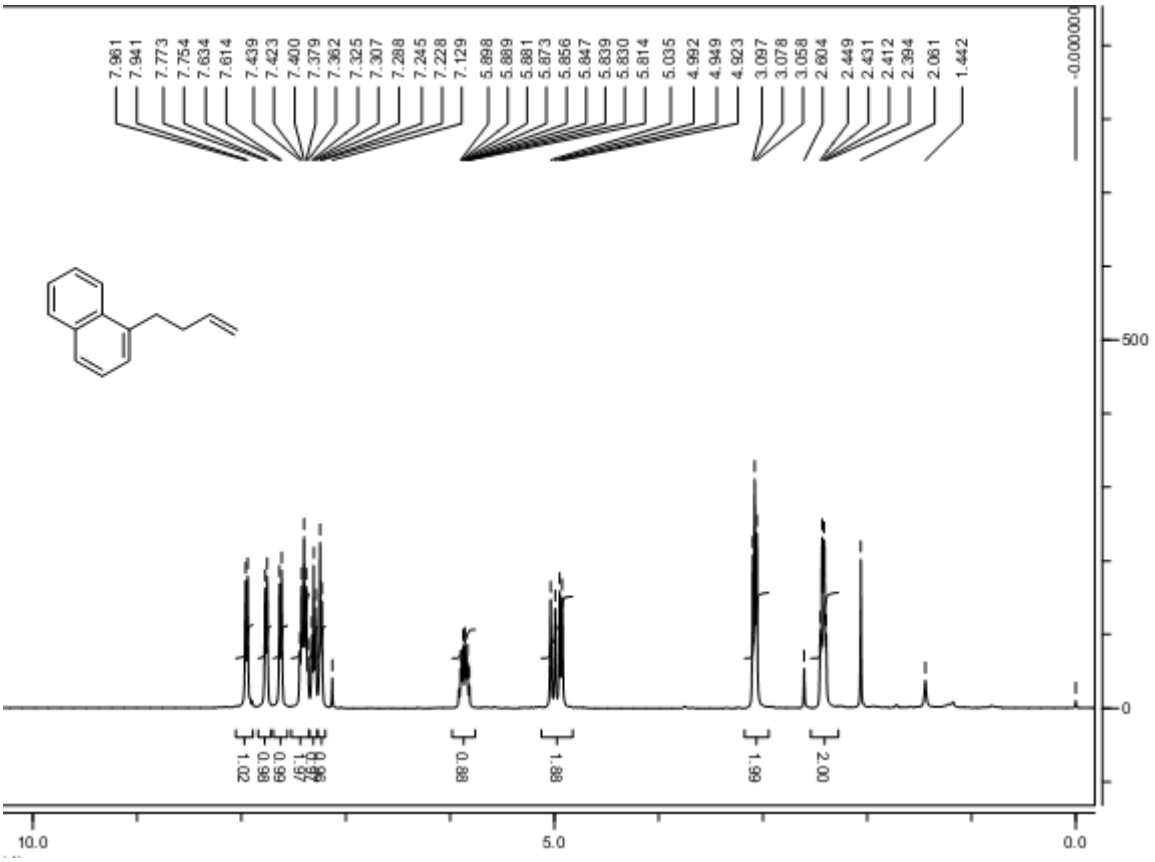


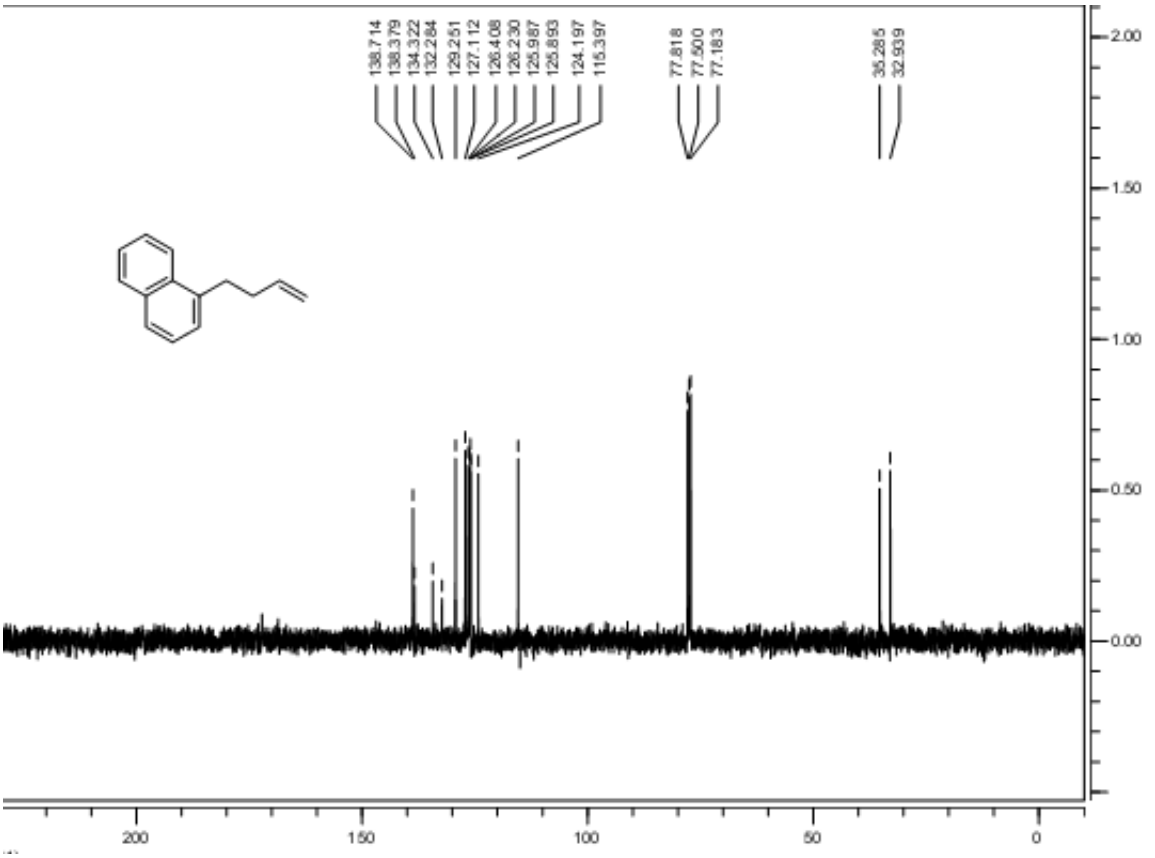
^{1}H- and ^{13}C-NMR for **4-(but-3-enyl)-1,2-dichlorobenzen 3m**



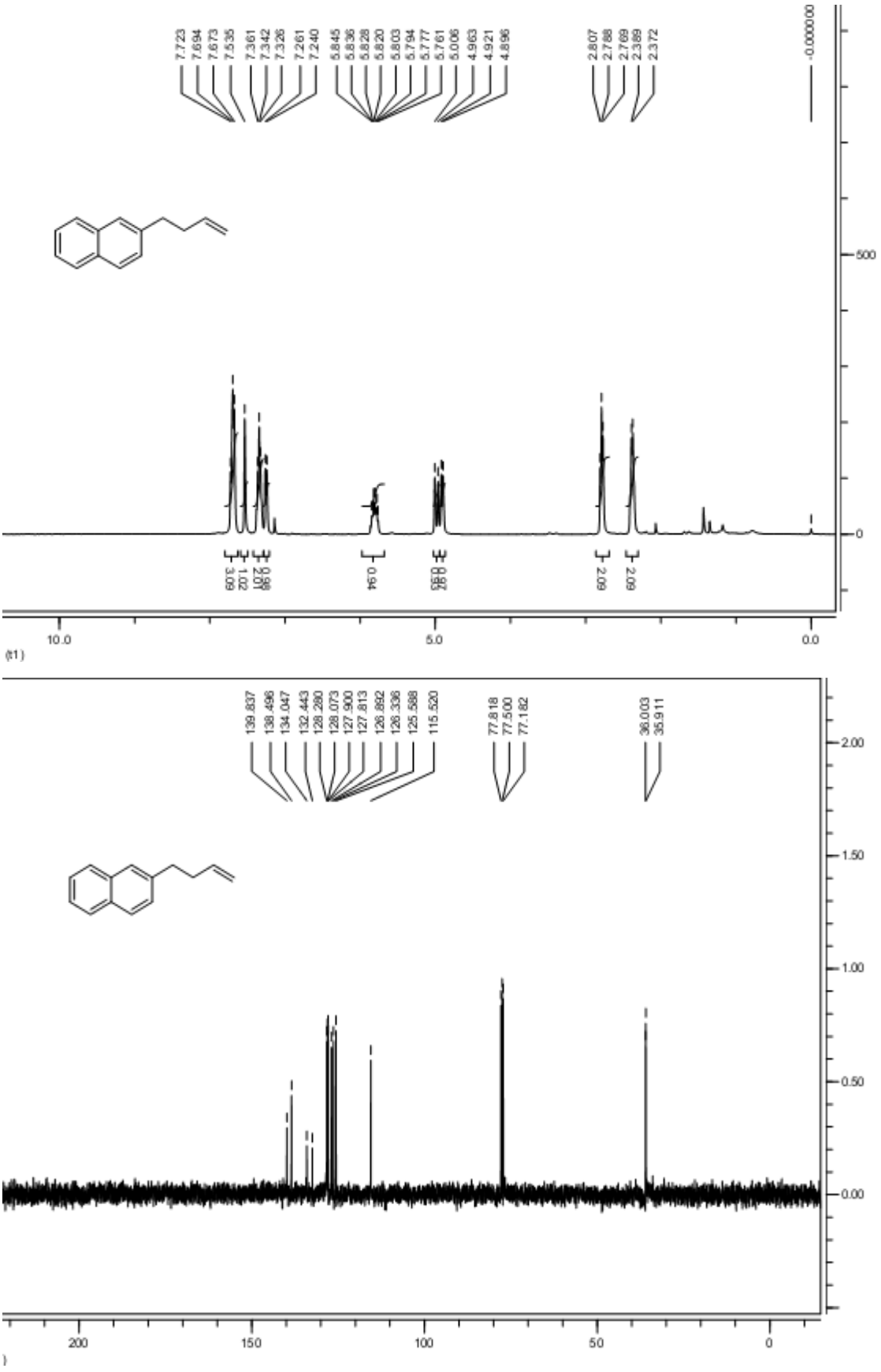


[1]H- and [13]C-NMR for **1-(but-3-enyl)naphthalene 3n**

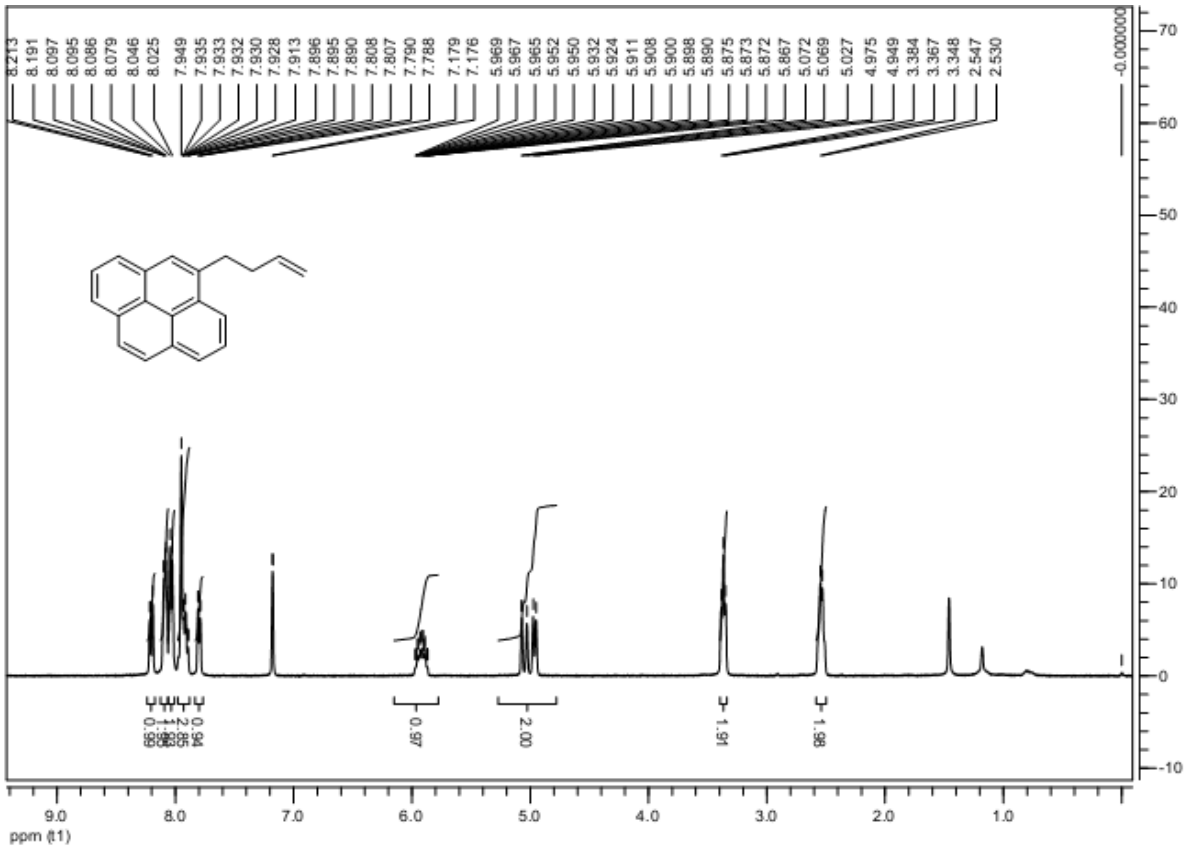


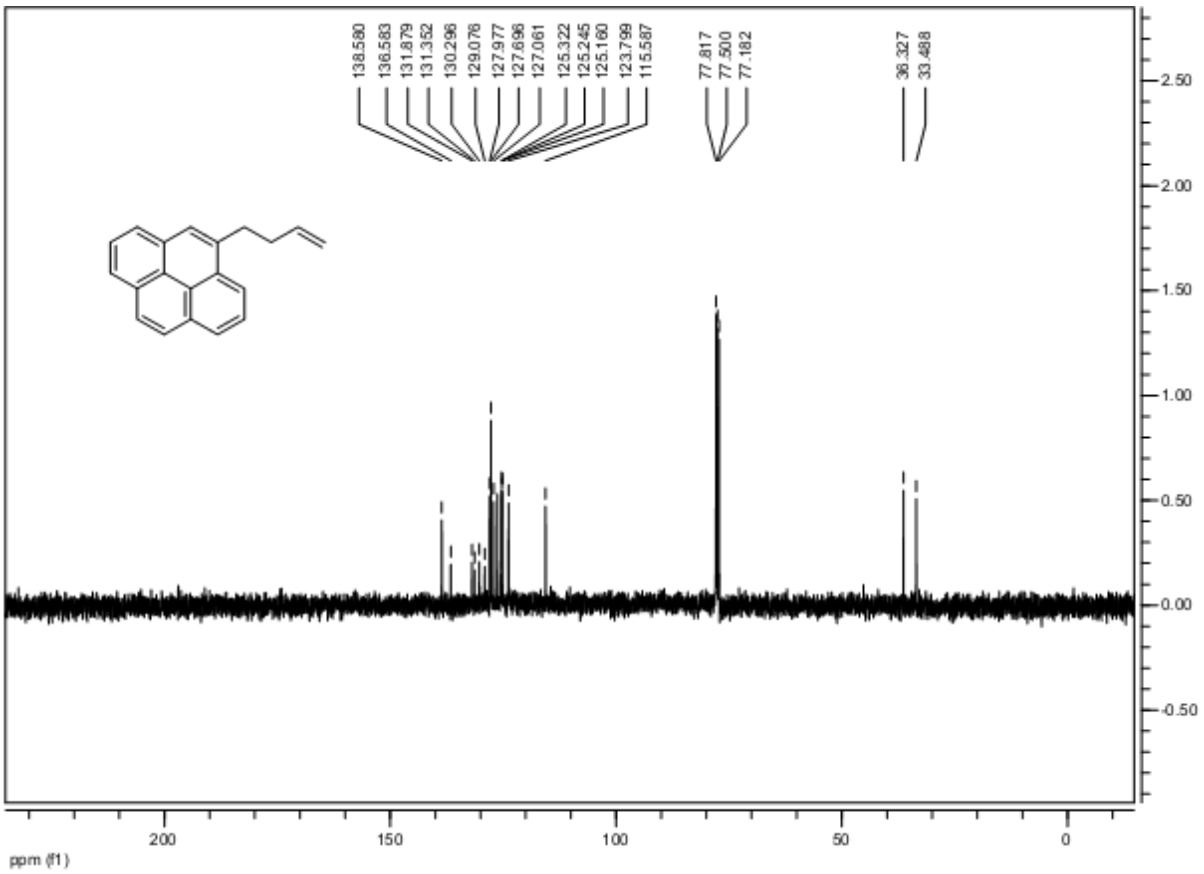


[1]H- and [13]C-NMR for **2-(but-3-enyl)naphthalene 3o**

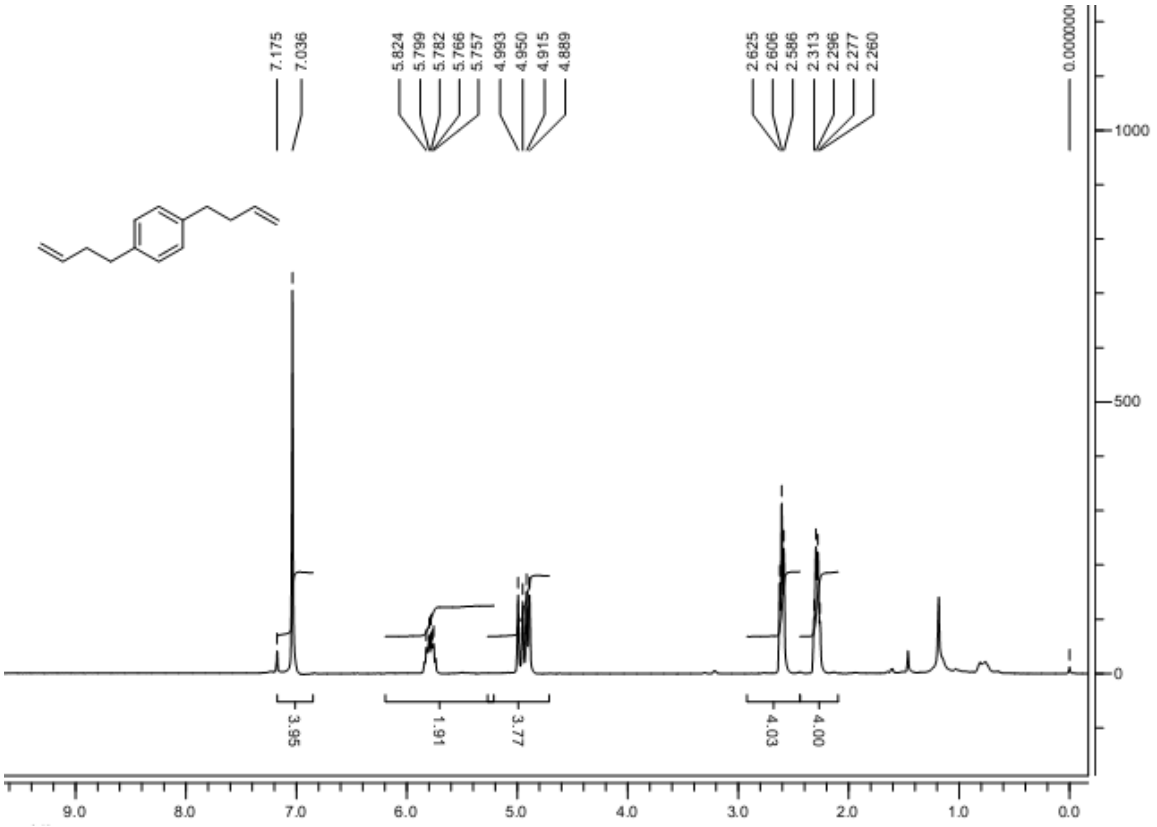


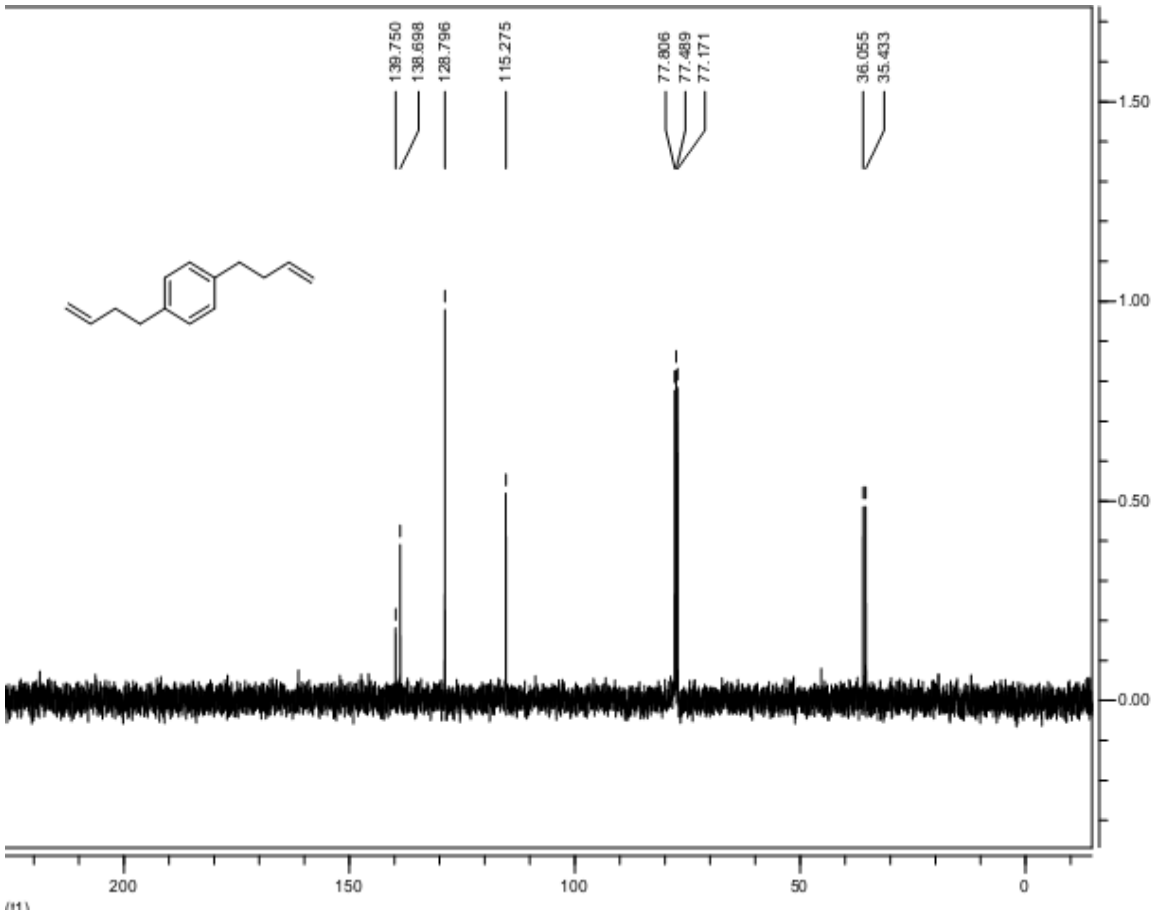
^{1}H- and ^{13}C-NMR for **4-(but-3-enyl)pyrene 3p**



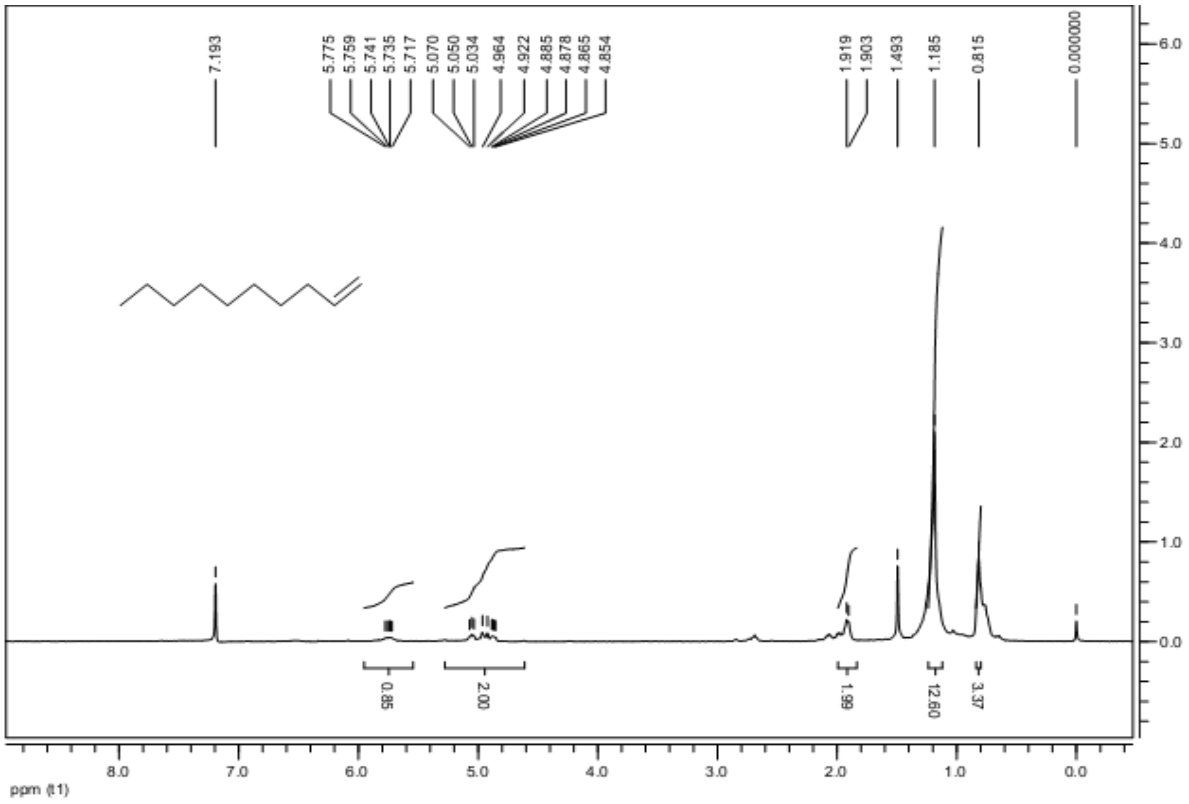


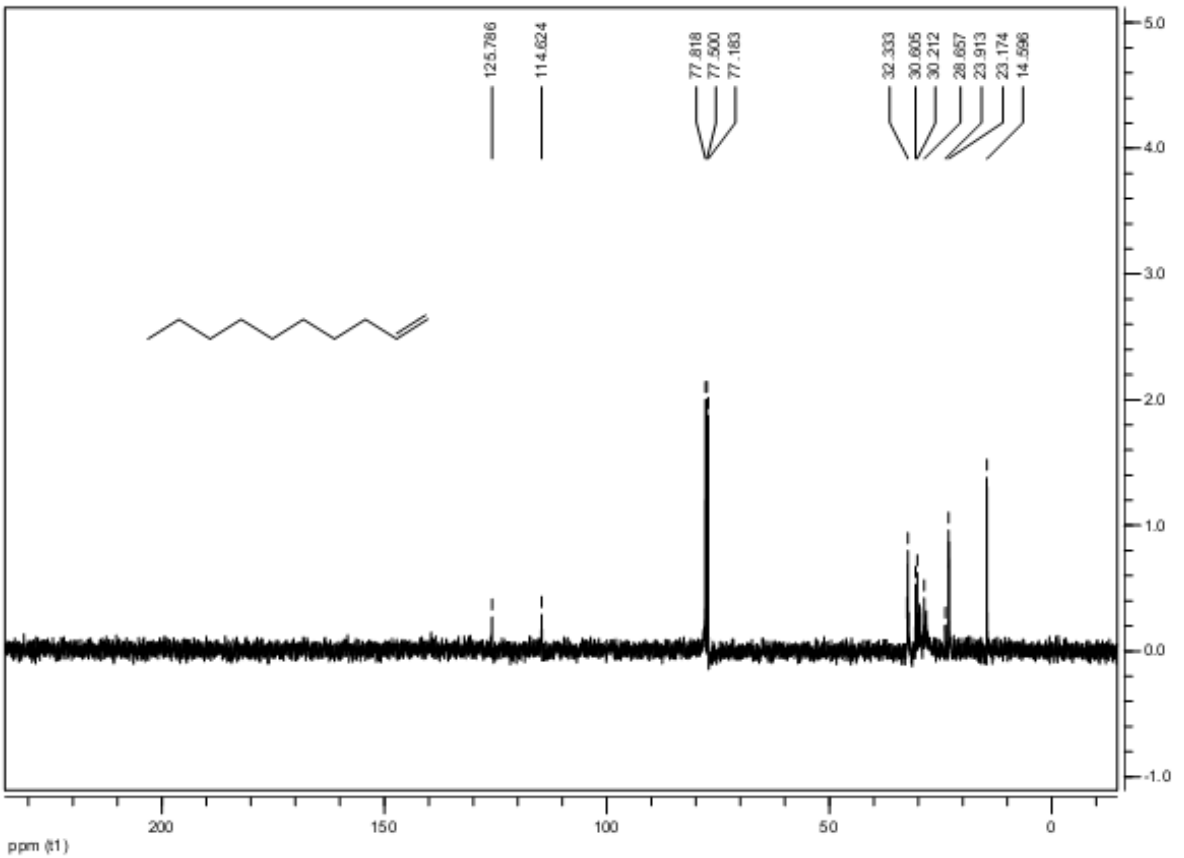
^{1}H- and ^{13}C-NMR for **1,4-di(but-3-enyl)benzene 3q**



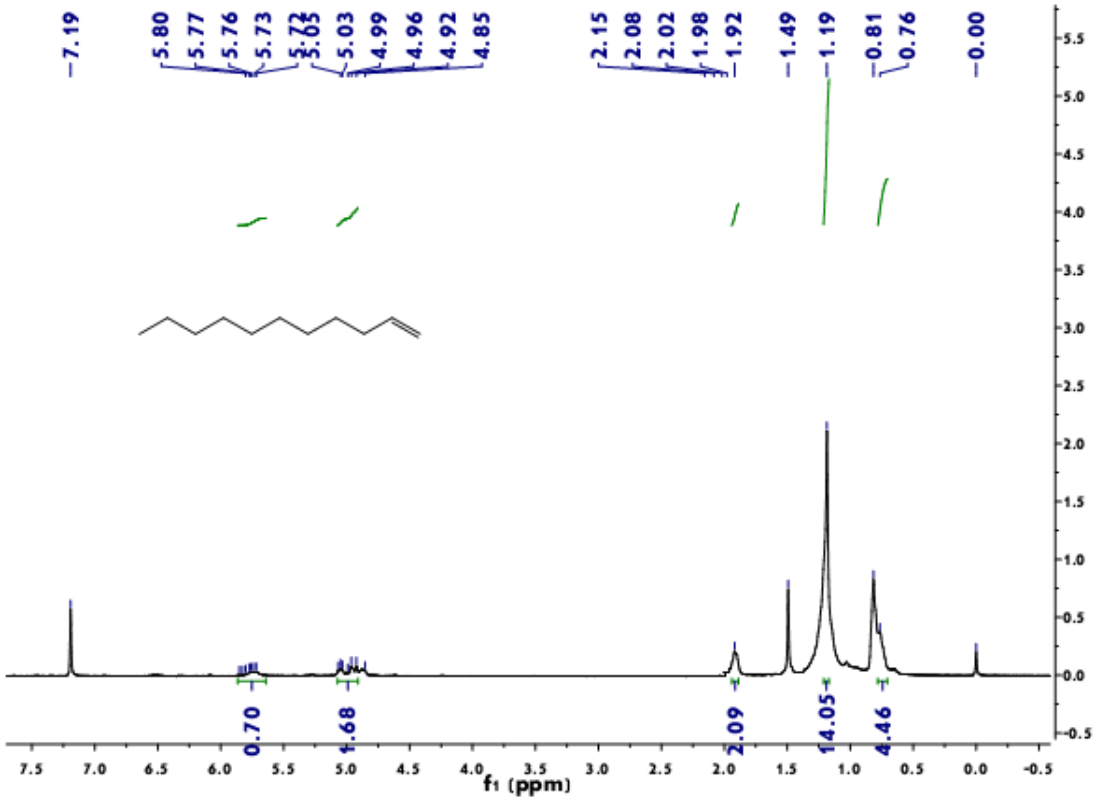


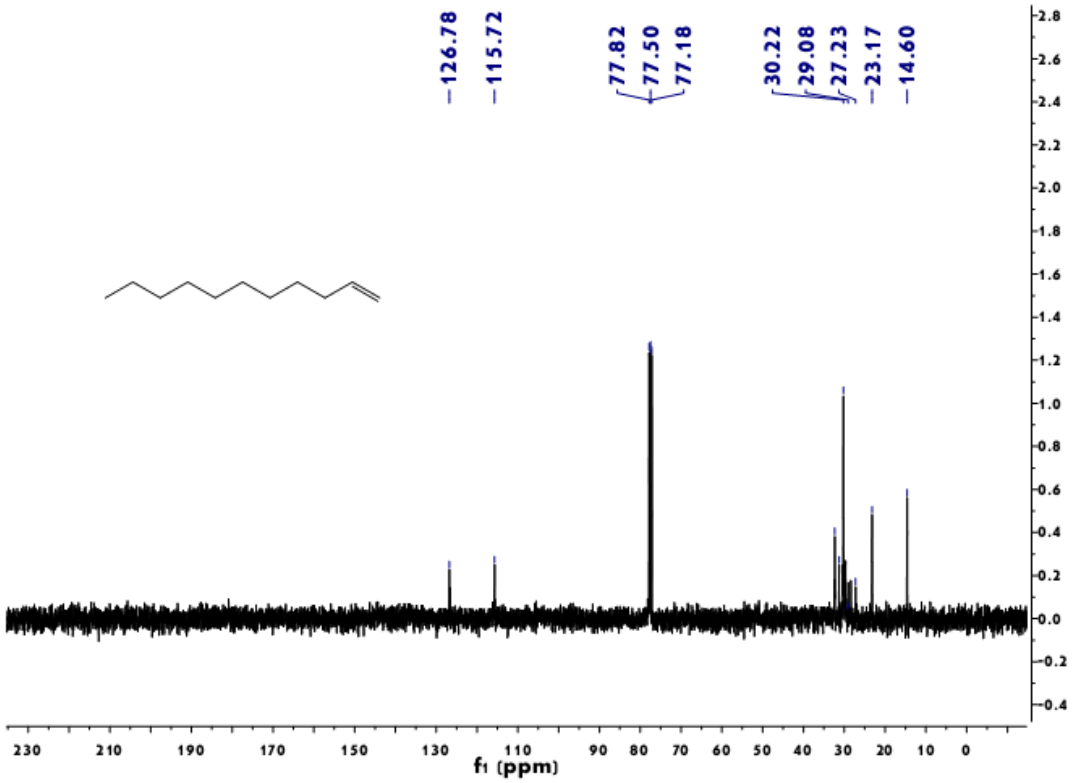
^{1}H- and ^{13}C-NMR for **dec-1-ene 3r**



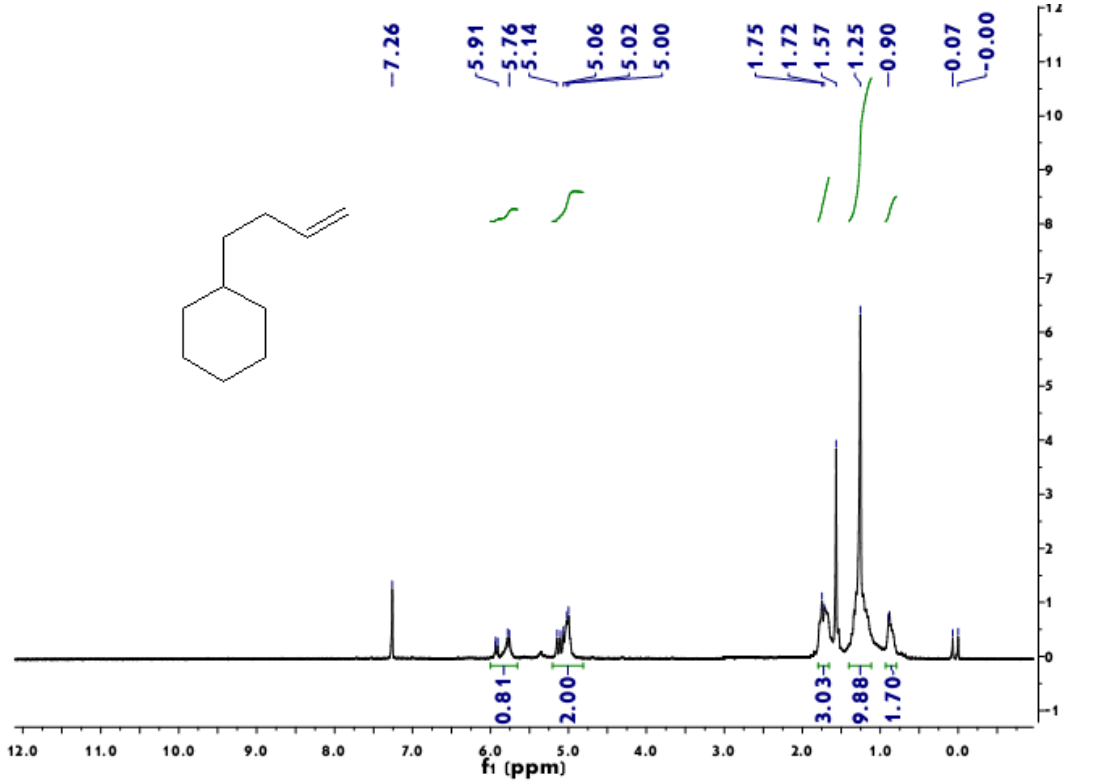


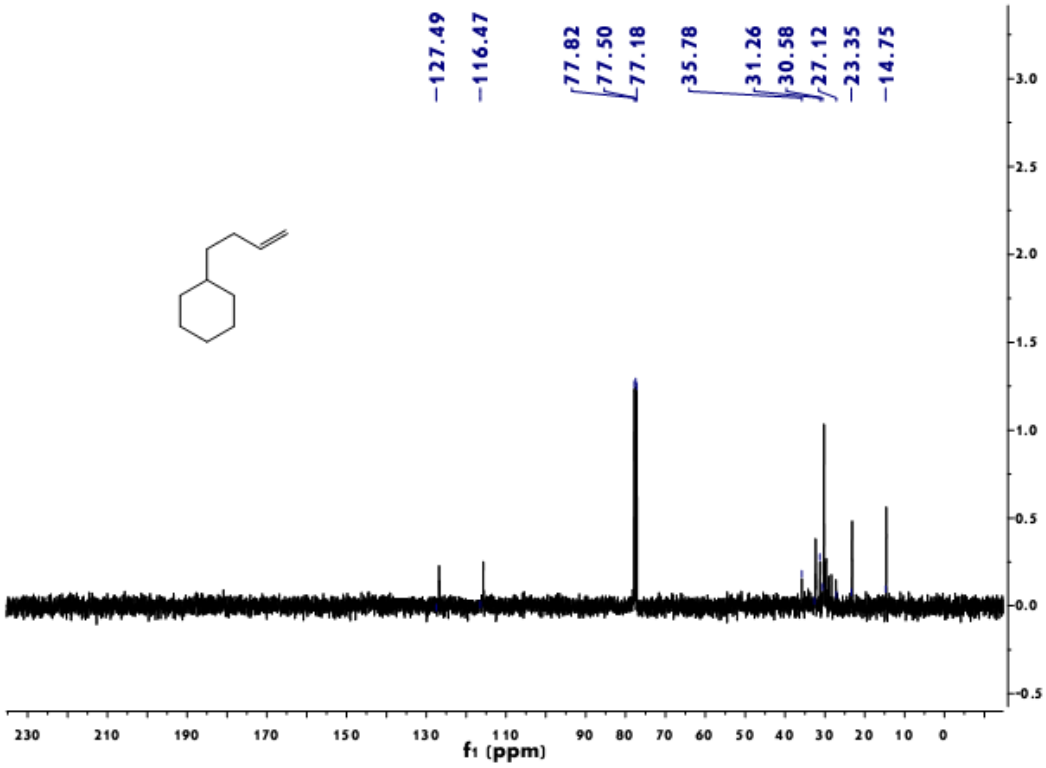
^{1}H- and ^{13}C-NMR for **undec-1-ene 3s**



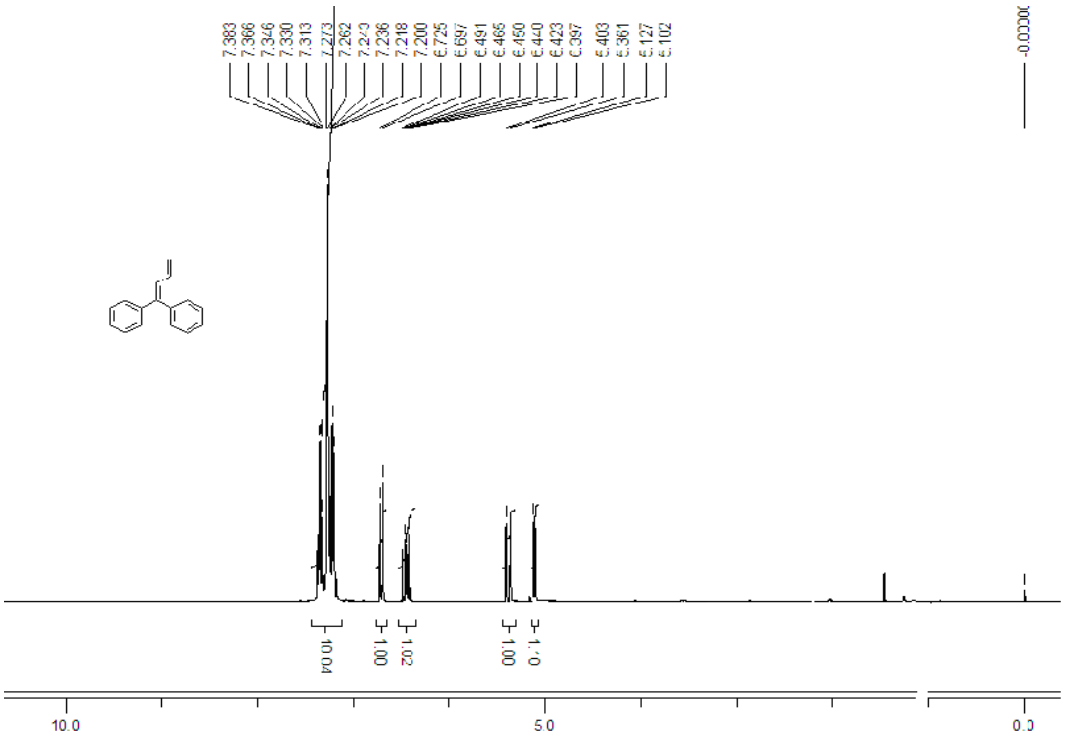


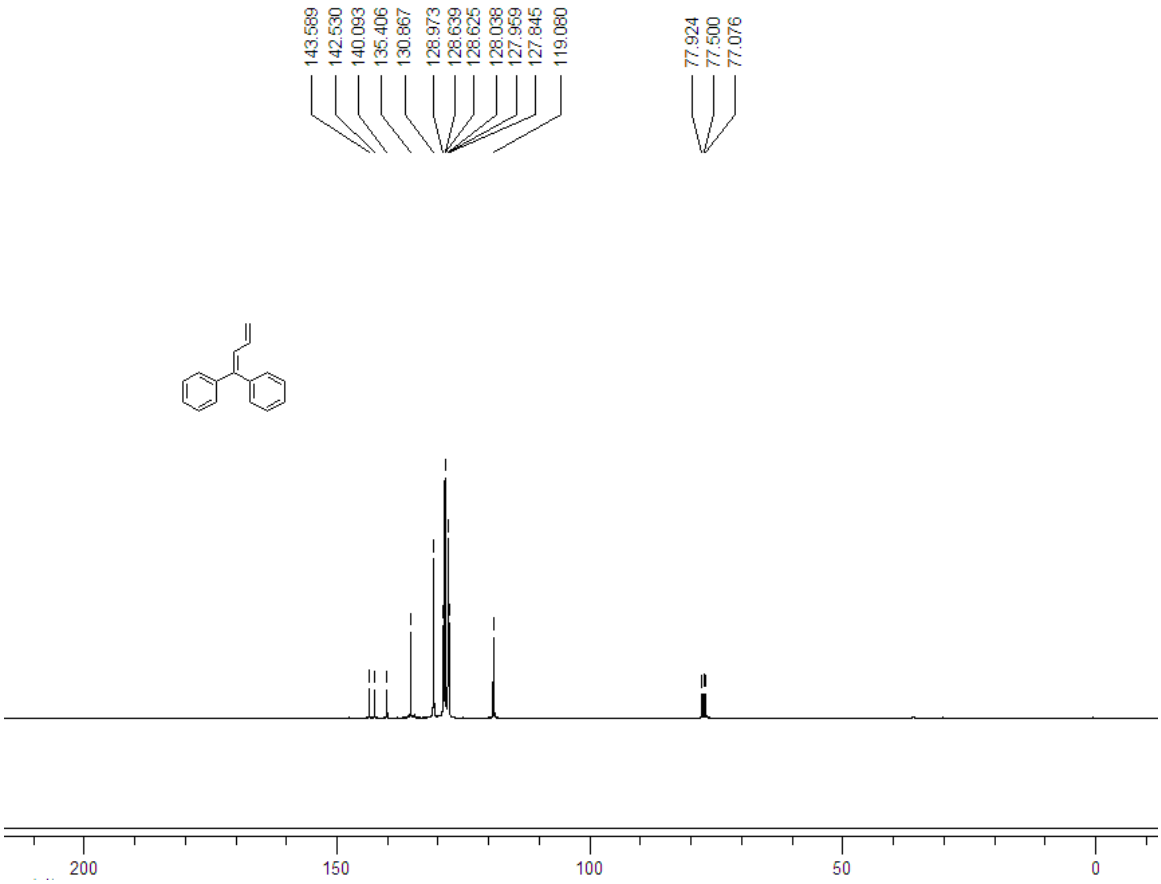
^{1}H- and ^{13}C-NMR for **(but-3-enyl)cyclohexane 3t**



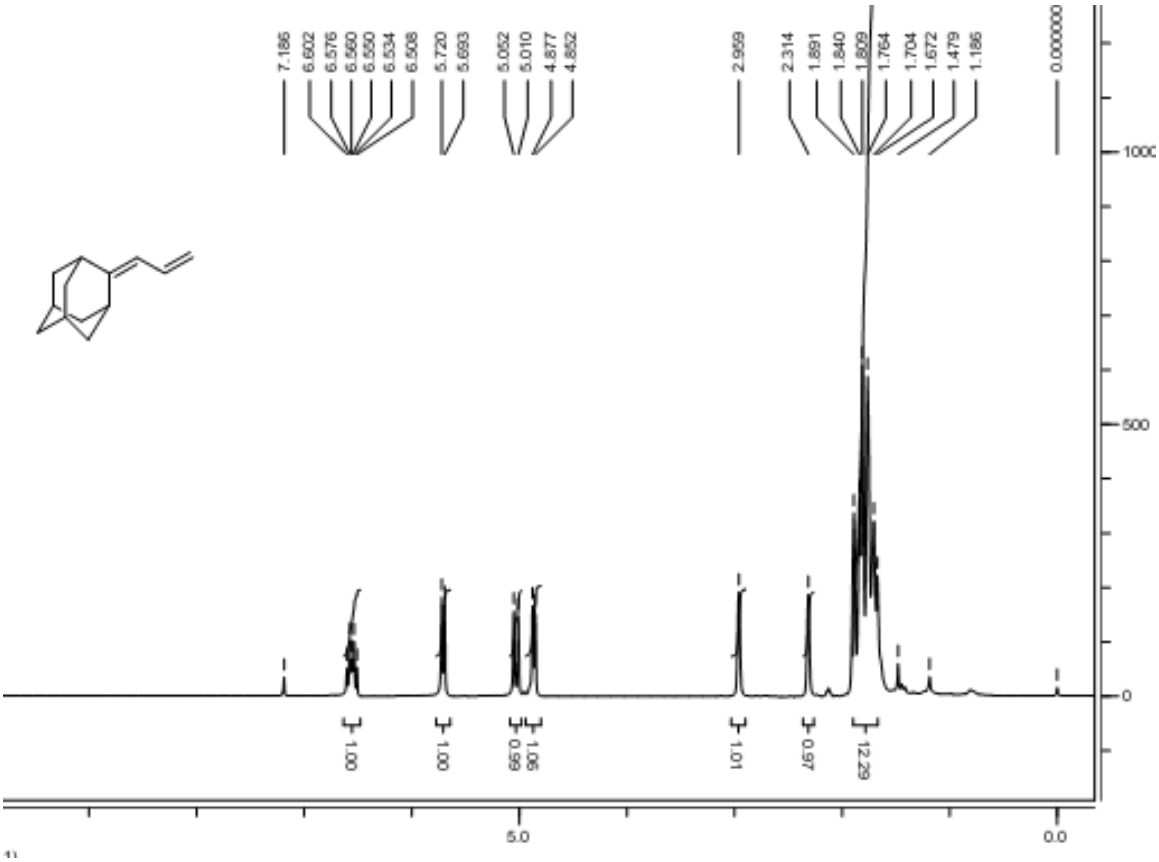


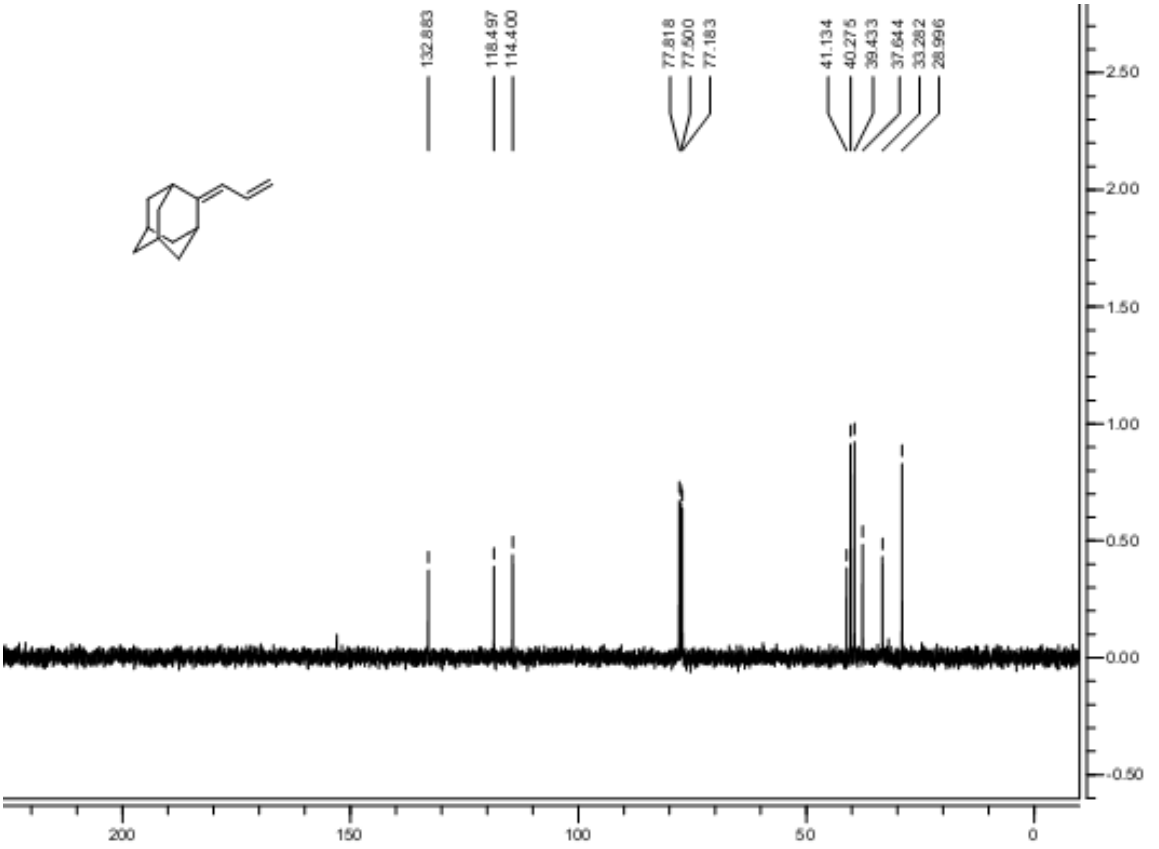
^{1}H- and ^{13}C-NMR for **1,1-diphenylbuta-1,3-diene 5a**



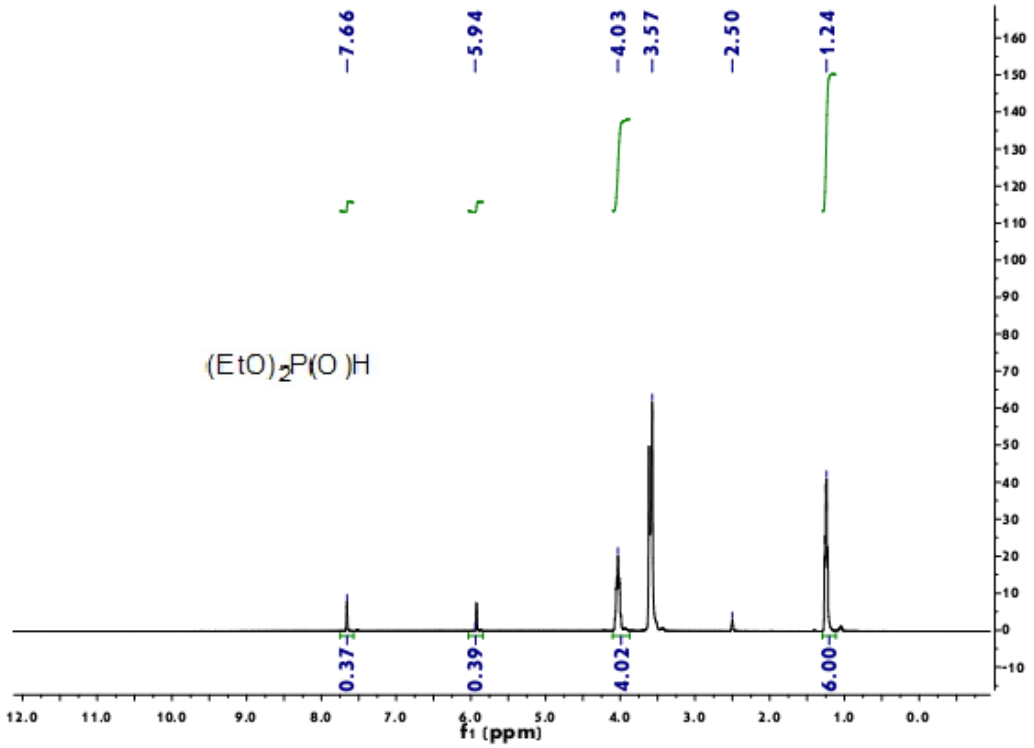


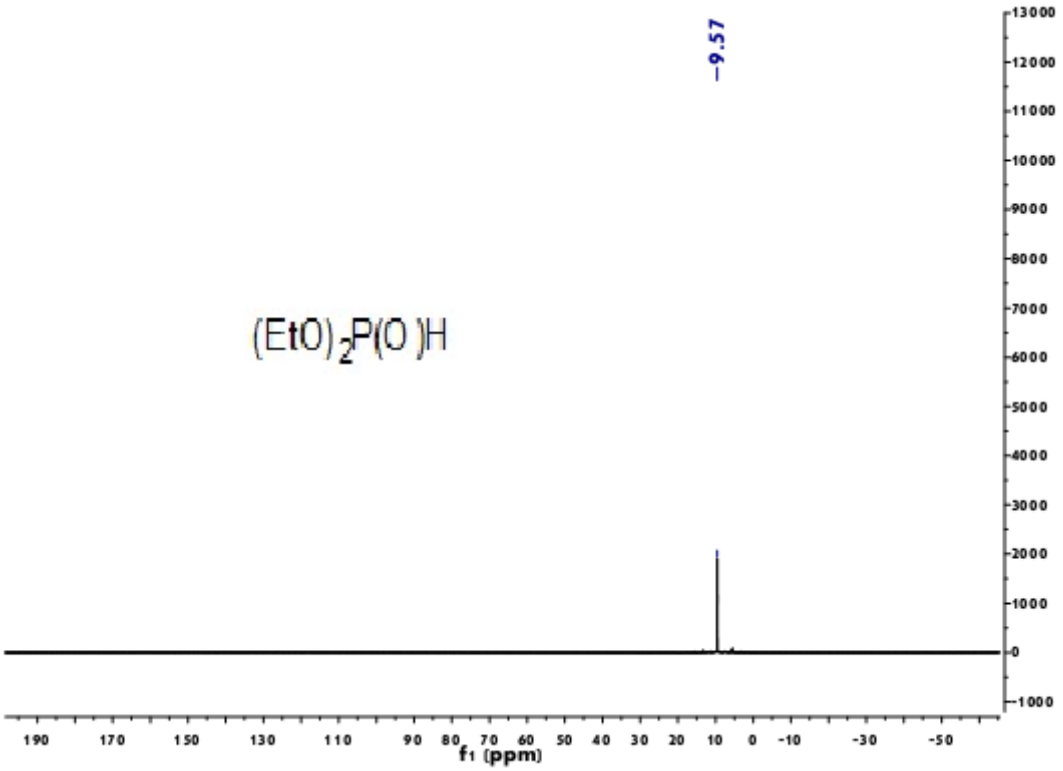
[1]H- and [13]C-NMR for **Tricyclo[3.3.1.13,7]decane, 2-(2-propen-1-ylidene) 5b**



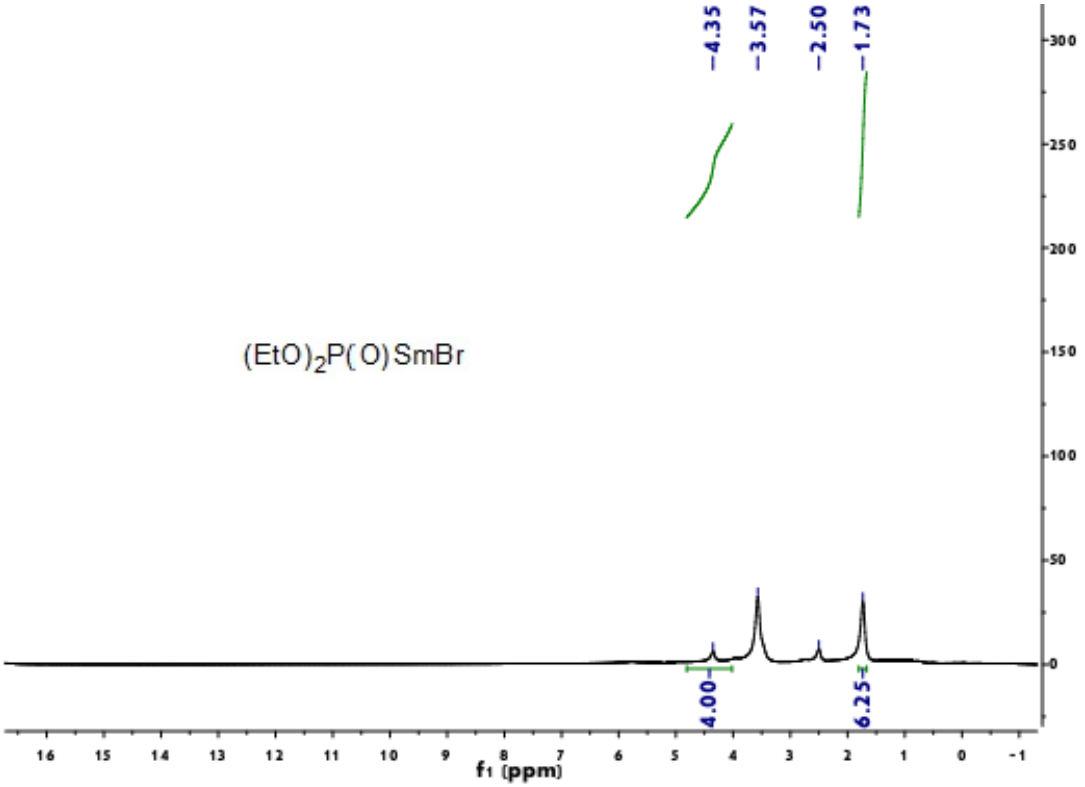


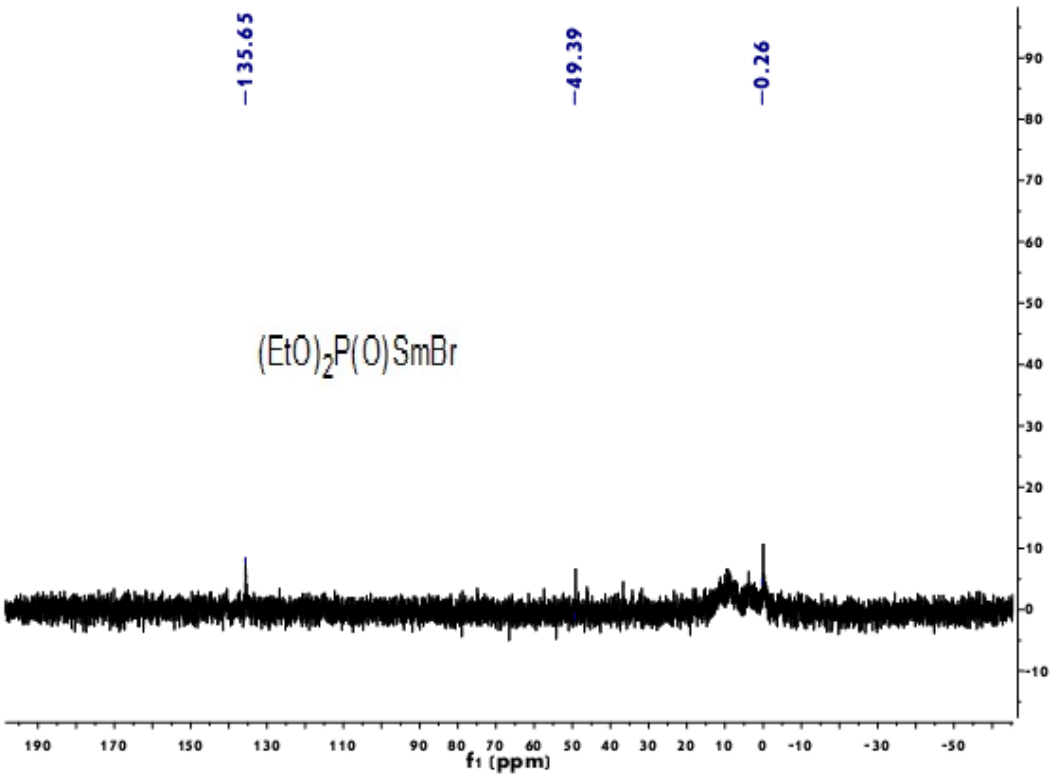
^{1}H- and ^{31}P-NMR for $(EtO)_2P(O)H$



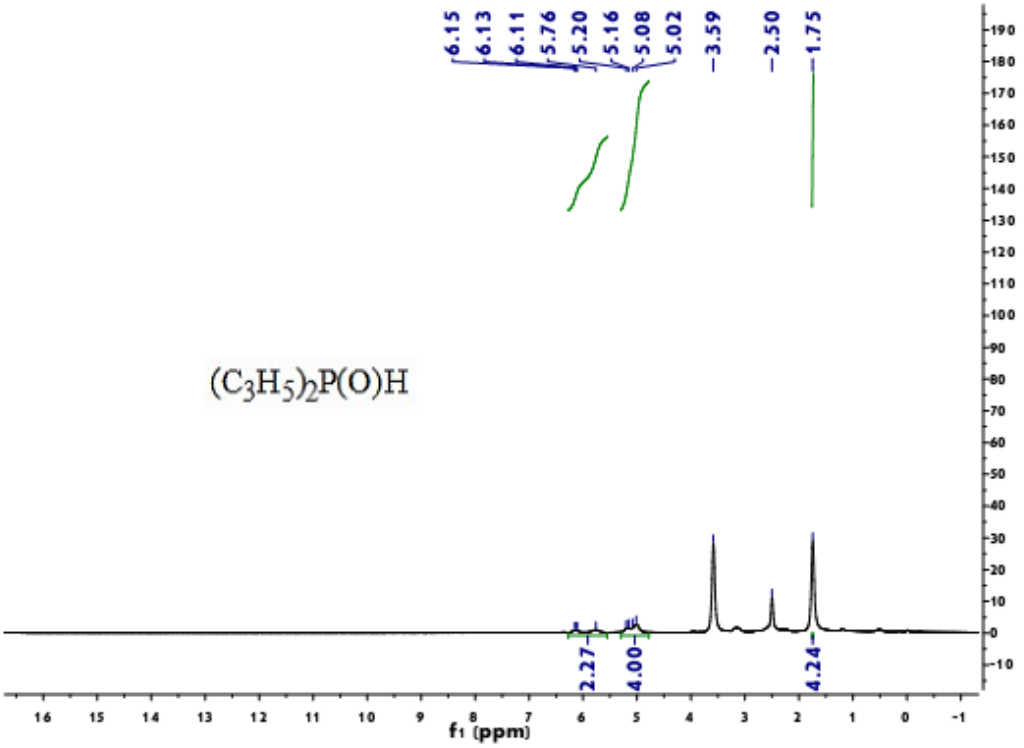


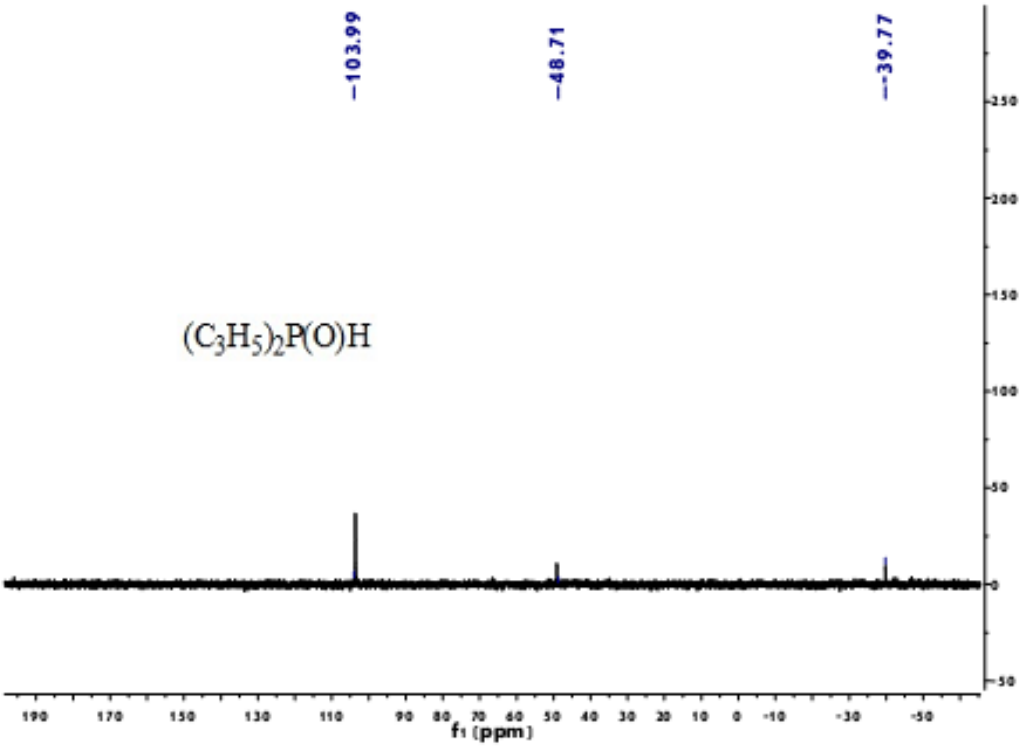
^{1}H- and ^{31}P-NMR for $(EtO)_2P(O)SmBr$ **7**



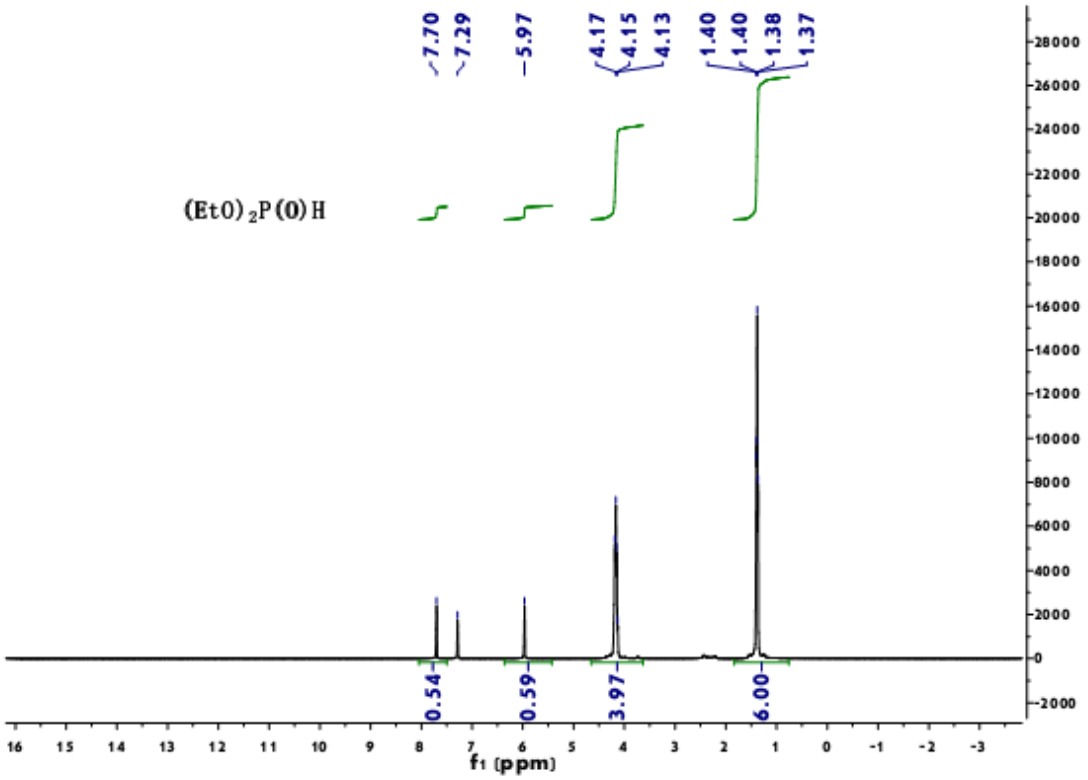


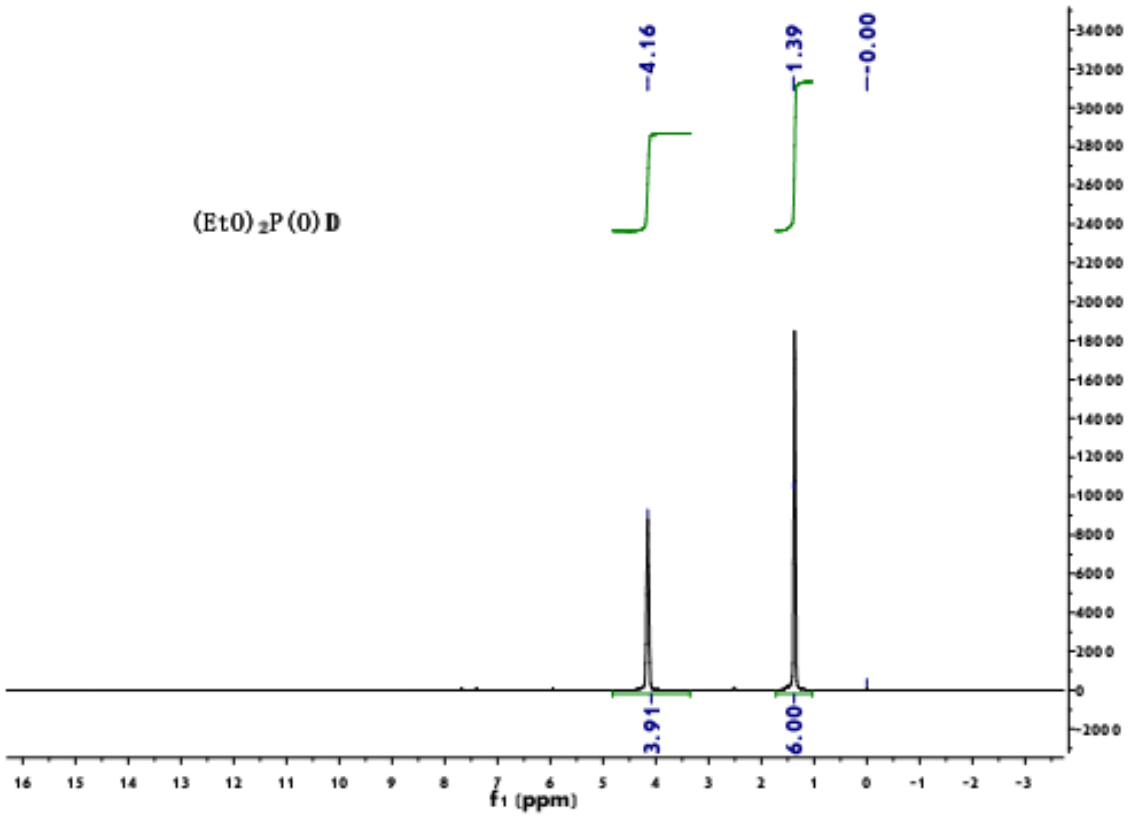
^{1}H- and ^{31}P-NMR for $(C_3H_5)_2P(O)SmBr$ **8**





^1H-NMR for $(EtO)_2P(O)H$ and $(EtO)_2P(O)D$





^{1}H-NMR for 1-(but-3-enyl)naphthalene and 4-D-4-naphthyl-1-butylene