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SUPPORTING INFORMATION

Title: Cationic Rhodium(I)/Bisphosphane Complex-Catalyzed Isomerization of Secondary Propargylic Alcohols to α,β-Enones

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Ref. No.: O200700071

I. Experimental Procedures and compound characterization data

[**1i**, **18**, **2a**, **2c**, **2d**, **2e**, **2f**, **2h**, **2i**, **2j**, **2l**, **2p**, **2q**, **2u**, **2v**, **2w**, **2b**-*d*, **2u**-*d*, **7a**, **7b**, **7c**, **9a**, **9b**, **9d**, and Table 4 (entries 1, 2, 3, 5, and 6)]

Alcohol 1i:[1] Phenylacetylene (2.0 g, 20.0 mmol) was added to a stirred solution of CuI (0.20 g, 1.0 mmol) and triethylamine (5.6 mL) in THF (100 mL) at RT, and the mixture was stirred for 1 h. Ethyl oxalyl chloride (3.4 g, 25.0 mmol) was added and the mixture was stirred at RT overnight. The reaction was quenched with saturated $NaHCO_3$ and extracted with Et_2O. The organic layer was washed with brine, dried over Na_2SO_4, and concentrated. The residue was purified on a silica gel column chromatography (hexane:EtOAc = 8:1), which furnished 2-oxo-4-phenylbut-3-ynoic acid ethyl ester (2.1 g, 10.2 mmol, 51% yield) as a yellow oil. A mixture of 2-oxo-4-phenylbut-3-ynoic acid ethyl ester (0.50 g, 2.50 mmol), $NaBH_4$ (71 mg, 1.88 mmol), and $CeCl_3 \cdot 7H_2O$ (1.0 g, 2.68 mmol) in EtOH (7 mL) was stirred at RT for 10 min. The reaction was hydrolyzed with diluted HCl, brine was added, and the mixture was extracted with CH_2Cl_2. The organic layer was concentrated and the residue was purified on a silica gel column chromatography (hexane:EtOAc = 7:1), which furnished alcohol **1i** (0.40 g, 1.97 mmol, 79% yield) as a pale yellow oil. ^{1}H NMR ($CDCl_3$, 300 MHz): δ = 7.50–7.41 (m, 2H), 7.38–7.27 (m, 3H), 5.06 (d, J = 7.2 Hz, 1H), 4.36 (q, J = 7.2 Hz, 2H), 3.15 (d, J = 7.2 Hz, 1H), 1.36 ppm (t, J = 7.2 Hz, 3H). ^{13}C NMR ($CDCl_3$, 75 MHz): δ = 170.3, 131.9, 128.8, 128.2, 121.8, 85.3, 84.2, 62.8, 61.9, 14.0 ppm.

Alcohol 18:[2] To a solution of iodobenzene (2.0 g, 10.0 mmol) and pent-4-yn-2-ol (0.84 g, 10.0 mmol) in Et_3N (80 mL) was added $PdCl_2(PPh_3)_2$ (140 mg, 0.2 mmol). The mixture was stirred for 5 min, and CuI (19 mg, 0.1 mmol) was added. The mixture was stirred at 50 °C for 2 h. The resulting mixture was cooled to RT, and ammonium salt

was removed by filtration. The solution was concentrated and the residue was purified on a silica gel column chromatography (hexane:EtOAc = 10:1), which furnished alcohol **18** (1.5 g, 9.15 mmol, 92% yield) as an orange oil. ^{1}H NMR ($CDCl_3$, 300 MHz): δ = 7.55–7.45 (m, 2H), 7.45–7.24 (m, 3H), 4.15–3.95 (m, 1H), 2.64 (dd, J = 16.5 and 5.1 Hz, 1H), 2.55 (dd, J = 16.5 and 6.6 Hz, 1H), 1.98 (d, J = 4.8 Hz, 1H), 1.33 ppm (d, J = 6.0 Hz, 3H). ^{13}C NMR ($CDCl_3$, 75 MHz): δ = 131.6, 128.2, 127.9, 123.3, 86.1, 83.0, 66.5, 29.9, 22.4 ppm.

Ketone 2a:[3] (Table 2, entry 2) Yield 98% (78.5 mg). Orange oil. ^{1}H NMR ($CDCl_3$, 300 MHz): δ = 7.62–7.50 (m, 3H), 7.50–7.26 (m, 3H), 6.75 (d, J = 16.2 Hz, 1H), 2.71 (q, J = 7.2 Hz, 2H) 1.17 ppm (t, J = 7.2 Hz, 3H). ^{13}C NMR ($CDCl_3$, 75 MHz): δ = 200.9, 142.2, 134.5, 130.3, 128.9, 128.2, 126.0, 34.0, 8.2 ppm.

Ketone 2c:[4] (Table 2, entry 3) Yield 97% (84.2 mg). Orange oil. ^{1}H NMR ($CDCl_3$, 300 MHz): δ = 7.61–7.50 (m, 3H), 7.50–7.26 (m, 3H), 6.75 (d, J = 16.2 Hz, 1H), 2.65 (t, J = 7.2 Hz, 2H) 1.72 (sext, J = 7.2 Hz, 2H), 0.98 ppm (t, J = 7.2 Hz, 3H). ^{13}C NMR ($CDCl_3$, 75 MHz): δ = 200.4, 142.2, 134.5, 130.3, 128.8, 128.1, 126.2, 42.7, 17.7, 13.8 ppm.

Ketone 2d:[5] (Table 2, entry 4) Yield 95% (89.5 mg). Pale yellow solid; m.p. 32–33 °C. ^{1}H NMR ($CDCl_3$, 300 MHz): δ = 7.60–7.50 (m, 3H), 7.50–7.30 (m, 3H), 6.75 (d, J = 15.9 Hz, 1H), 2.67 (t, J = 7.2 Hz, 2H), 1.74–1.60 (m, 2H), 1.47–1.30 (m, 2H), 0.92 ppm (t, J = 7.2 Hz, 3H). ^{13}C NMR ($CDCl_3$, 75 MHz): δ = 200.5, 142.2, 134.5, 130.3, 128.8, 128.1, 126.1, 40.7, 26.5, 22.5, 14.0 ppm.

Ketone 2e:[6] (Table 2, entry 5) Yield 98% (85.5 mg). Orange oil. ^{1}H NMR ($CDCl_3$, 300 MHz): δ = 7.60–7.50 (m, 3H), 7.50–7.30 (m, 3H), 6.82 (d, J = 16.2 Hz, 1H), 2.94 (sept, J = 6.9 Hz, 1H) 1.19 ppm (d, J = 6.9 Hz, 6H). ^{13}C NMR ($CDCl_3$, 75 MHz): δ = 203.7, 153.7, 142.3, 134.6, 130.3, 128.8, 128.2, 124.4, 114.5, 55.6, 39.2, 18.4 ppm.

Ketone 2f:[7] (Table 2, entry 6) Yield 96% (90.0 mg). Pale yellow oil. ^{1}H NMR ($CDCl_3$, 300 MHz): δ = 7.69 (d, J = 15.6 Hz, 1H), 7.65–7.50 (m, 2H), 7.50–7.34 (m, 3H), 7.13 (d, J = 15.6 Hz, 1H), 1.20 ppm (s, 9H). ^{13}C NMR ($CDCl_3$, 75 MHz): δ = 204.1, 142.8, 134.8, 130.1, 128.8, 128.2, 120.6, 43.2, 26.2 ppm.

Ketone 2h:[8] (Table 2, entry 8) Yield 32% (21.1 mg). Orange oil. ^{1}H NMR ($CDCl_3$, 300 MHz): δ = 9.72 (d, J = 7.5 Hz, 1H), 7.62–7.52 (m, 3H), 7.52–7.43 (m, 3H), 6.73 ppm (dd, J = 15.9 and 7.5 Hz, 1H). ^{13}C NMR ($CDCl_3$, 75 MHz): δ = 193.7, 152.8, 134.0, 131.2, 129.0, 128.6, 128.5 ppm.

Ketone 2i:[9] (Table 2, entry 9) Yield 48% (46.9 mg). Pale yellow oil. ^{1}H NMR ($CDCl_3$,

300 MHz): δ = 7.86 (d, J = 16.2 Hz, 1H), 7.80–7.50 (m, 2H), 7.40–7.32 (m, 3H), 7.37 (d, J = 16.2 Hz, 1H), 4.00 (q, J = 7.2 Hz, 2H), 1.41 ppm (t, J = 7.2 Hz, 3H). ^{13}C NMR ($CDCl_3$, 75 MHz): δ = 182.8, 162.1, 148.4, 133.9, 131.6, 129.01, 128.96, 120.5, 62.4, 14.0 ppm.

Ketone 2j:[10] (Table 2, entry 10) Yield 46% (52.6 mg). Pale yellow oil. ^{1}H NMR ($CDCl_3$, 400 MHz): δ = 7.70 (d, J = 16.0 Hz, 1H), 7.62–7.53 (m, 2H), 7.45–7.33 (m, 3H), 6.94 (d, J = 16.0 Hz, 1H), 4.27 (s, 2H), 3.48 ppm (s, 3H). ^{13}C NMR ($CDCl_3$, 75 MHz): δ = 197.1, 143.5, 134.2, 130.7, 128.9, 128.4, 121.4, 77.1, 59.3 ppm.

Ketone 2l:[11] (Table 2, entry 12) Yield 98% (93.5 mg). Orange solid; m.p. 47–49 °C. ^{1}H NMR ($CDCl_3$, 400 MHz): δ = 7.60–7.44 (m, 3H), 6.95–6.85 (m, 2H), 6.63 (d, J = 16.0 Hz, 1H), 3.84 (s, 3H), 2.68 (q, J = 7.2 Hz, 2H), 1.16 ppm (t, J = 7.2 Hz, 3H). ^{13}C NMR ($CDCl_3$, 100 MHz): δ = 200.7, 161.3, 141.8, 129.7, 127.0, 123.7, 114.2, 55.3, 33.9, 8.4 ppm.

Ketone 2p:[12] (Table 2, entry 16) Yield 96% (99.8 mg). Orange oil. ^{1}H NMR ($CDCl_3$, 300 MHz): δ = 8.39 (d, J = 15.9 Hz, 1H), 8.16 (d, J = 8.4 Hz, 1H), 7.94–7.80 (m, 2H), 7.74 (d, J = 7.7 Hz, 1H), 7.60–7.40 (m, 3H), 6.81 (d, J = 15.9 Hz, 1H), 2.74 (q, J = 7.2 Hz, 2H), 1.21 ppm (t, J = 7.2 Hz, 3H). ^{13}C NMR ($CDCl_3$, 75 MHz): δ = 200.6, 138.9, 133.6, 131.8, 131.5, 130.5, 128.7, 128.4, 126.8, 126.1, 125.4, 124.9, 123.2, 34.4, 8.2 ppm.

Ketone 2q:[10] (Table 2, entry 17) Yield 46% (34.6 mg). Orange oil. ^{1}H NMR ($CDCl_3$, 300 MHz): δ = 7.49 (d, J = 2.1 Hz, 1H), 7.33 (d, J = 15.6 Hz, 1H), 6.65 (d, J = 15.6 Hz, 1H), 6.65 (d, J = 3.3 Hz, 1H), 6.48 (dd, J = 3.3, 2.1 Hz, 1H), 2.64 (q, J = 7.5 Hz, 2H), 1.15 ppm (t, J = 7.5 Hz, 3H). ^{13}C NMR ($CDCl_3$, 75 MHz): δ = 200.4, 151.1, 144.7, 128.3, 123.1, 115.4, 112.4, 34.5, 8.2 ppm.

Ketone 2u:[13] (Scheme 5) Yield 56% (51.1 mg). Pale yellow oil. ^{1}H NMR ($CDCl_3$, 300 MHz): δ = 6.82 (dt, J = 15.6, 6.9 Hz, 1H), 6.09 (dt, J = 15.6, 1.8 Hz, 1H), 2.51 (t, J = 7.5 Hz, 2H), 2.25–2.15 (m, 2H), 1.73–1.53 (m, 2H), 1.53–1.38 (m, 2H), 1.38–1.17 (m, 6H), 1.00–0.80 ppm (m, 6H). ^{13}C NMR ($CDCl_3$, 75 MHz): δ = 200.8, 147.3, 130.3, 41.9, 32.4, 31.5, 28.8, 28.0, 22.5, 17.7, 14.0, 13.8 ppm.

Ketone 2v:[14] (Scheme 6) Yield 67% (25.1 mg). Pale yellow oil. ^{1}H NMR ($CDCl_3$, 300 MHz): δ = 7.94–7.88 (m, 2H), 7.60–7.50 (m, 1H), 7.50–7.40 (m, 2H), 7.07 (dt, J = 15.3, 6.9 Hz, 1H), 6.88 (dt, J = 15.3, 1.5 Hz, 1H), 2.37–2.25 (m, 2H), 1.58–1.30 (m, 4H), 0.93 ppm (t, J = 7.2 Hz, 3H). ^{13}C NMR ($CDCl_3$, 75 MHz): δ = 190.9, 150.1, 138.0, 132.5,

128.5, 128.4, 125.8, 32.5, 30.2, 22.3, 13.8 ppm.

Ketone 2w:[15] (Scheme 6) Yield 67% (*E*-isomer: 18.1 mg, *Z*-isomer: 37.0 mg). Pale yellow oil. ^{1}H NMR ($CDCl_3$, 300 MHz) *E*-isomer: δ = 6.77 (dd, *J* = 15.9, 6.6 Hz, 1H), 6.05 (dd, *J* = 15.9, 1.2 Hz, 1H), 2.57 (q, *J* = 7.5 Hz, 2H), 2.25–2.05 (m, 1H), 1.85–1.60 (m, 4H), 1.40–1.00 ppm (m, 9H); *Z*-isomer: δ = 6.02 (dd, *J* = 11.4, 0.9 Hz, 1H), 5.86 (dd, *J* = 11.4, 9.6 Hz, 1H), 3.35–3.12 (m, 1H), 2.48 (q, *J* = 7.2 Hz, 2H), 1.78–1.60 (m, 5H), 1.45–0.95 ppm (m, 8H). ^{13}C NMR ($CDCl_3$, 75 MHz) *E*-isomer: δ = 201.6, 152.0, 127.5, 40.6, 33.2, 31.8, 25.9, 25.7, 8.2 ppm; *Z*-isomer: δ = 202.0, 153.4, 124.5, 37.5, 37.3, 32.3, 25.9, 25.4, 7.8 ppm.

Ketone 2b-*d*: (Scheme 7) Yield 94% (69.0 mg). Colorless oil. ^{1}H NMR ($CDCl_3$, 300 MHz): δ = 7.57–7.50 (m, 2.25H), 7.44–7.35 (m, 3H), 6.72 (t, *J* = 2.4 Hz, 0.75H), 2.39 ppm (s, 3H). ^{2}H NMR ($CDCl_3$, 61 MHz): δ = 7.68–7.35 (m, 0.75D), 6.85–6.60 ppm (m, 0.25D).

Ketone 2u-*d*: (Scheme 16) Yield 31% (14.4 mg). Pale yellow oil. ^{1}H NMR ($CDCl_3$, 300 MHz): δ = 6.82 (dt, *J* = 15.6, 6.9 Hz, 0.46H), 6.13–6.04 (m, 1H), 2.51 (t, *J* = 6.9 Hz, 2H), 2.25–2.15 (m, 2H), 1.73–1.53 (m, 2H), 1.52–1.38 (m, 1.08H), 1.38–1.17 (m, 6H), 1.00–0.80 ppm (m, 6H). ^{2}H NMR ($CDCl_3$, 61 MHz): δ = 6.95–6.80 (m, 0.54D), 1.55–1.35 ppm (m, 0.46D).

Ketone 7a:[16] (Table 6, entry 1) Yield 73% (81.5 mg). Colorless solid; m.p. 58–59 °C. ^{1}H NMR ($CDCl_3$, 300 MHz): δ = 2.68 (s, 4H), 2.45 (t, *J* = 7.2 Hz, 4H), 1.66–1.50 (m, 4H), 1.38–1.18 (m, 8H), 0.89 ppm (t, *J* = 7.2 Hz, 6H). ^{13}C NMR ($CDCl_3$, 75 MHz): δ = 209.7, 42.7, 35.9, 31.3, 23.4, 22.4, 13.8 ppm.

Ketone 7b:[17] (Table 6, entry 2) Yield 79% (92.1 mg). Pale yellow oil. ^{1}H NMR ($CDCl_3$, 300 MHz): δ = 8.02–7.92 (m, 2H), 7.60–7.49 (m, 1H), 7.49–7.40 (m, 2H), 3.27 (t, *J* = 6.0 Hz, 2H), 2.85 (t, *J* = 6.0 Hz, 2H), 2.52 (t, *J* = 7.5 Hz, 2H), 1.62 (quint, *J* = 7.5 Hz, 2H), 1.40–1.20 (m, 4H), 0.89 ppm (t, *J* = 6.9 Hz, 3H). ^{13}C NMR ($CDCl_3$, 75 MHz): δ = 209.6, 198.5, 136.5, 133.0, 128.4, 127.9, 42.8, 36.0, 32.2, 31.3, 23.4, 22.3, 13.8 ppm.

Ketone 7c:[18] (Table 6, entry 3) Yield 89% (52.9 mg). Pale yellow solid; m.p. 146–147 °C. ^{1}H NMR ($CDCl_3$, 300 MHz): δ = 8.08–8.00 (m, 4H), 7.62–7.53 (m, 2H), 7.52–7.43 (m, 4H), 3.46 ppm (s, 4H). ^{13}C NMR ($CDCl_3$, 75 MHz): δ = 198.6, 136.7, 133.1, 128.6, 128.1, 32.5 ppm.

Furan 9a:[19] (Table 6, entry 4) Yield 78% (94.2 mg). Pale yellow oil. ^{1}H NMR ($CDCl_3$,

300 MHz): δ = 5.83 (s, 2H), 2.56 (t, J = 7.5 Hz, 4H), 1.68–1.42 (m, 4H), 1.42–1.22 (m, 8H), 0.89 ppm (t, J = 6.6 Hz, 6H). ^{13}C NMR ($CDCl_3$, 75 MHz): δ = 154.6, 104.8, 31.4, 28.0, 27.8, 22.4, 14.0 ppm.

Furan 9b:[20] (Table 6, entry 5) Yield 47% (58.0 mg). Pale yellow oil. ^{1}H NMR ($CDCl_3$, 300 MHz): δ = 7.70–7.55 (m, 2H), 7.40–7.29 (m, 2H), 7.25–7.15 (m, 1H), 6.54 (d, J = 3.3 Hz, 1H), 6.05 (d, J = 3.3 Hz, 1H), 2.67 (t, J = 7.5 Hz, 2H), 1.76–1.60 (m, 2H), 1.44–1.24 (m, 4H), 0.96–0.84 ppm (m, 3H). ^{13}C NMR ($CDCl_3$, 75 MHz): δ = 156.4, 152.0, 131.2, 128.6, 126.7, 123.3, 106.8, 105.6, 31.4, 28.1, 27.8, 22.4, 14.0 ppm.

Furan 9d:[21] (Table 6, entry 7) Yield 59% (74.7 mg). Yellow solid; m.p. 84–85 °C. ^{1}H NMR ($CDCl_3$, 300 MHz): δ = 7.80–7.70 (m, 4H), 7.46–7.35 (m, 4H), 7.34–7.20 (m, 2H), 6.70 ppm (s, 2H). ^{13}C NMR ($CDCl_3$, 75 MHz): δ = 153.3, 130.7, 128.7, 127.3, 123.7, 107.2 ppm.

Table 4, entry 1: (*S*)-**1b** {$[\alpha]^{25}_D$ = –19.6° (c = 1.04 in Et_2O, 42.4% ee); lit.[22] $[\alpha]^{25}_D$ = –33.9° (c = 1.10 in Et_2O, 97% ee, (*S*)-**1b**)} was obtained for 14 h at 57.5% conversion. Selectivity factor = 2.8. CHIRALCEL OD-H, hexane:2-PrOH = 90:10, 1.0 mL/min, retention times: 7.2 min (minor isomer) and 14.4 min (major isomer).

Table 4, entry 2: (*S*)-**1a** {$[\alpha]^{25}_D$ = –15.0° (c = 1.49 in Et_2O, 76.0% ee); lit.[23] $[\alpha]^{25}_D$ = +19.2° (c = 1.24 in Et_2O, 94% ee, (*R*)-**1a**)} was obtained for 72 h at 58.5% conversion. Selectivity factor = 7.3. CHIRALCEL OD-H, hexane:2-PrOH = 95:5, 1.0 mL/min, retention times: 8.8 min (minor isomer) and 24.4 min (major isomer).

Table 4, entry 3: (*S*)-**1c** {$[\alpha]^{25}_D$ = –1.93° (c = 1.29 in $CHCl_3$, 53.8% ee); lit.[24] $[\alpha]^{25}_D$ = +3° (c = 0.75 in $CHCl_3$, 85% ee, (*R*)-**1c**)} was obtained for 31 h at 54.3% conversion. Selectivity factor = 4.4. CHIRALCEL OD-H, hexane:2-PrOH = 95:5, 1.0 mL/min, retention times: 8.5 min (minor isomer) and 25.0 min (major isomer).

Table 4, entry 5: (*S*)-**1e** {$[\alpha]^{25}_D$ = –0.28° (c = 1.72 in $CHCl_3$, 58.1% ee); lit.[25] $[\alpha]^{25}_D$ = +3.2° (c = 6.80 in $CHCl_3$, 90% ee, (*R*)-**1e**)} was obtained for 28 h at 51.2% conversion. Selectivity factor = 6.1. CHIRALCEL OD-H, hexane:2-PrOH = 95:5, 1.0 mL/min, retention times: 7.6 min (minor isomer) and 17.2 min (major isomer).

Table 4, entry 6: (*S*)-**1f** {$[\alpha]^{25}_D$ = –0.23° ($CHCl_3$, c = 1.73, 61.7% ee); lit.[25] $[\alpha]^{25}_D$ = +2.4° (c = 4.00 in $CHCl_3$, 94% ee, (*R*)-**1f**)} was obtained for 12 h (40 °C) at 58.2% conversion. Selectivity factor = 4.7. CHIRALCEL OD-H, hexane:2-PrOH = 95:5, 1.0 mL/min, retention times: 8.7 min (minor isomer) and 12.8 min (major isomer); lit.[24] CHIRALCEL OD, hexane:2-PrOH = 90:10, retention times: 7.4 min (*R* isomer) and

10.1 min (*S* isomer).

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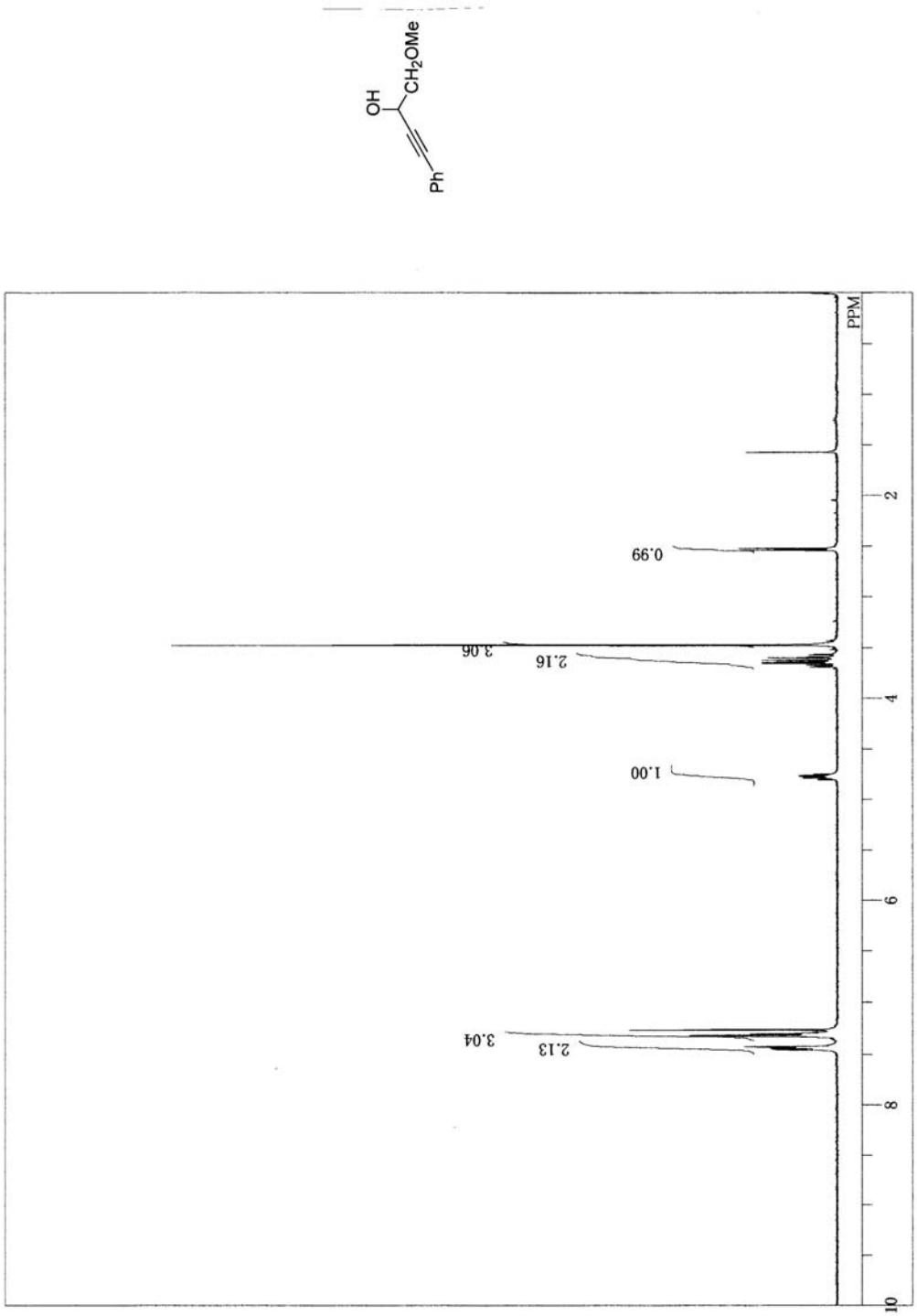
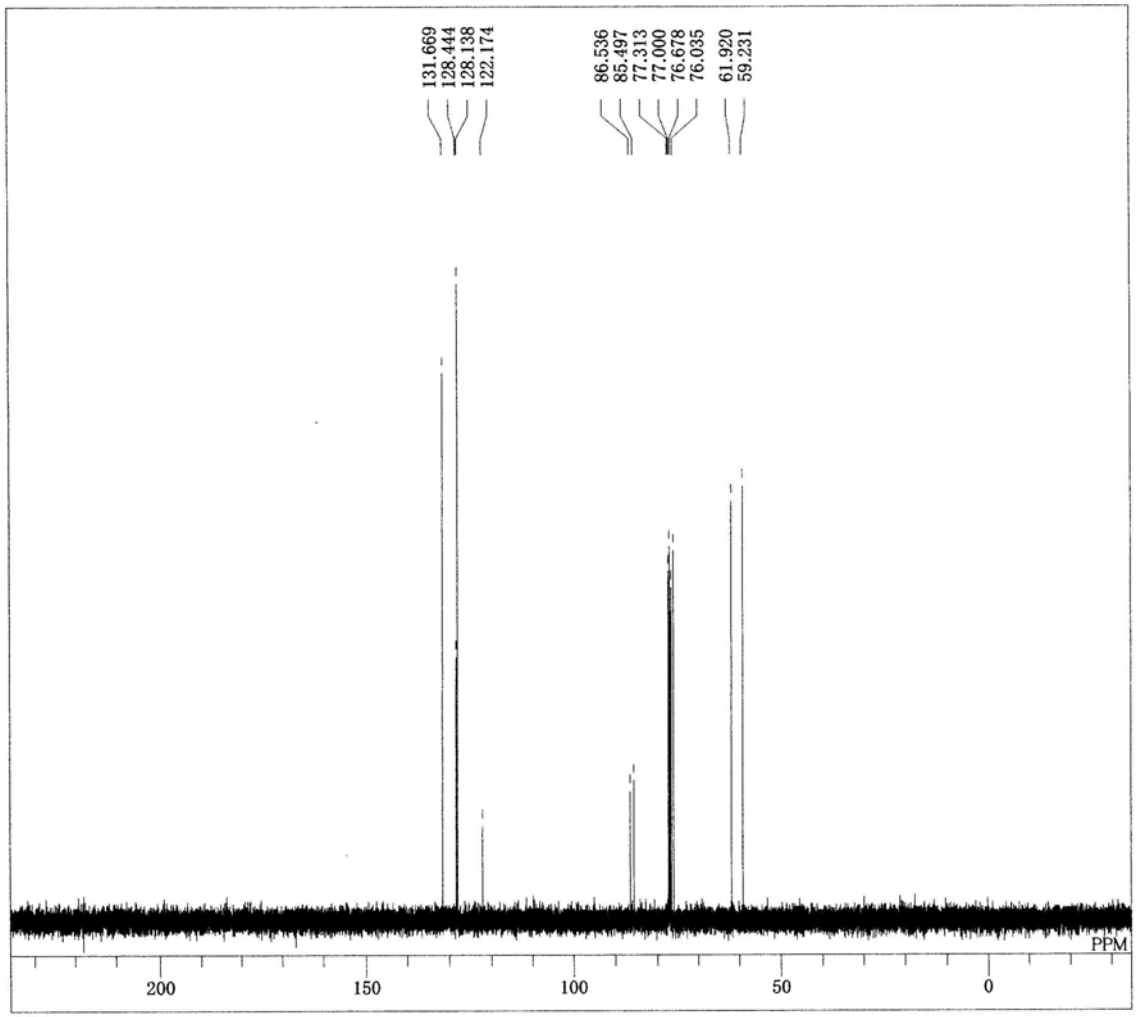
II. ^{1}H and ^{13}C NMR spectra of all new compounds

(**1j**, **1l**, **1m**, **1n**, **1p**, **1q**, **1r**, **1t**, **6b**, **8a**, **8b**, **8c**, **10a**, **10b**, **11a**, **11b**, **19**, **2k**, **2m**, **2n**, **2o**, **2s**, **2t**, **12a**, **12b**, **13a**, **13b**, and **20**)

Alcohol 1j

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128.138
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86.536
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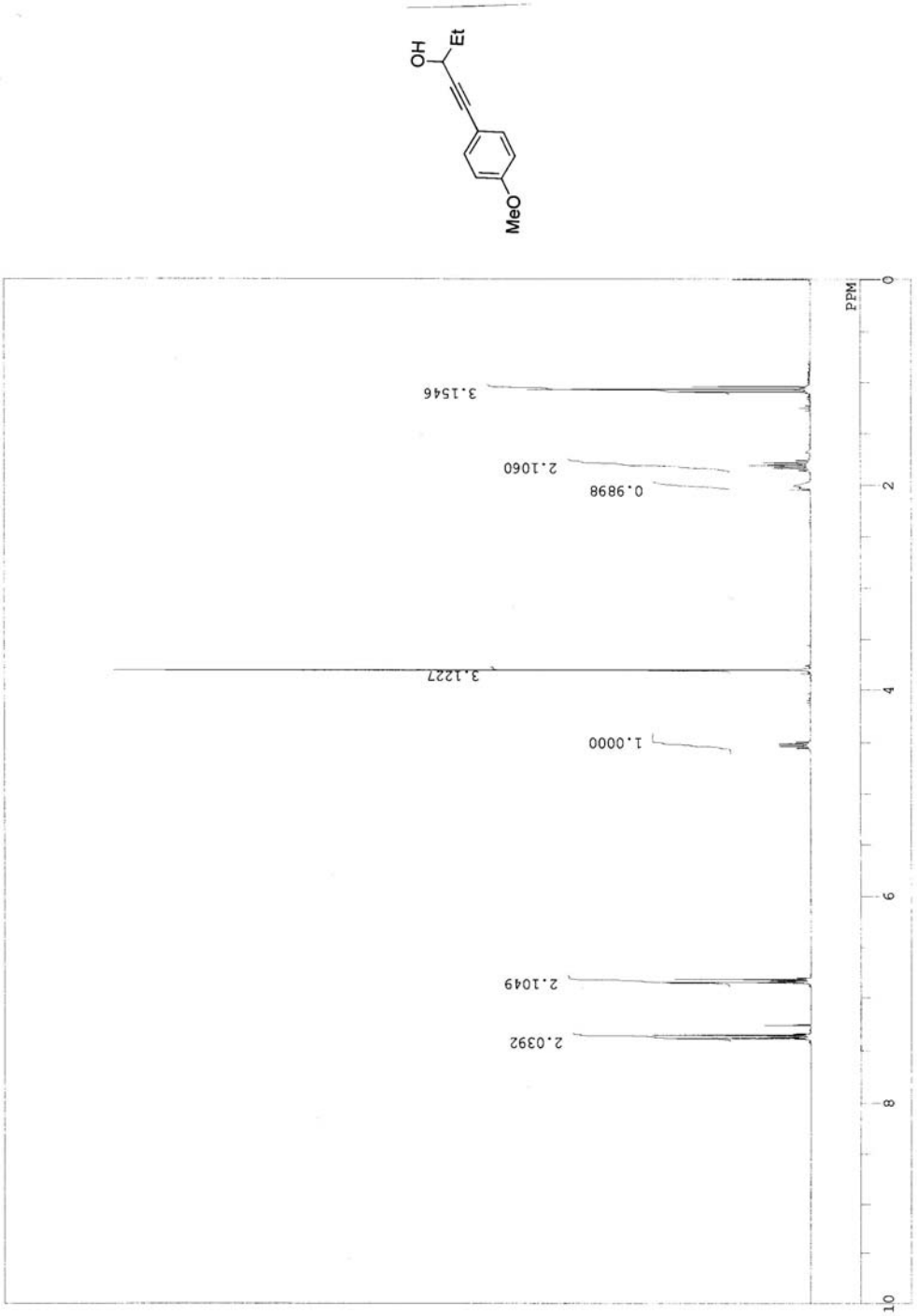
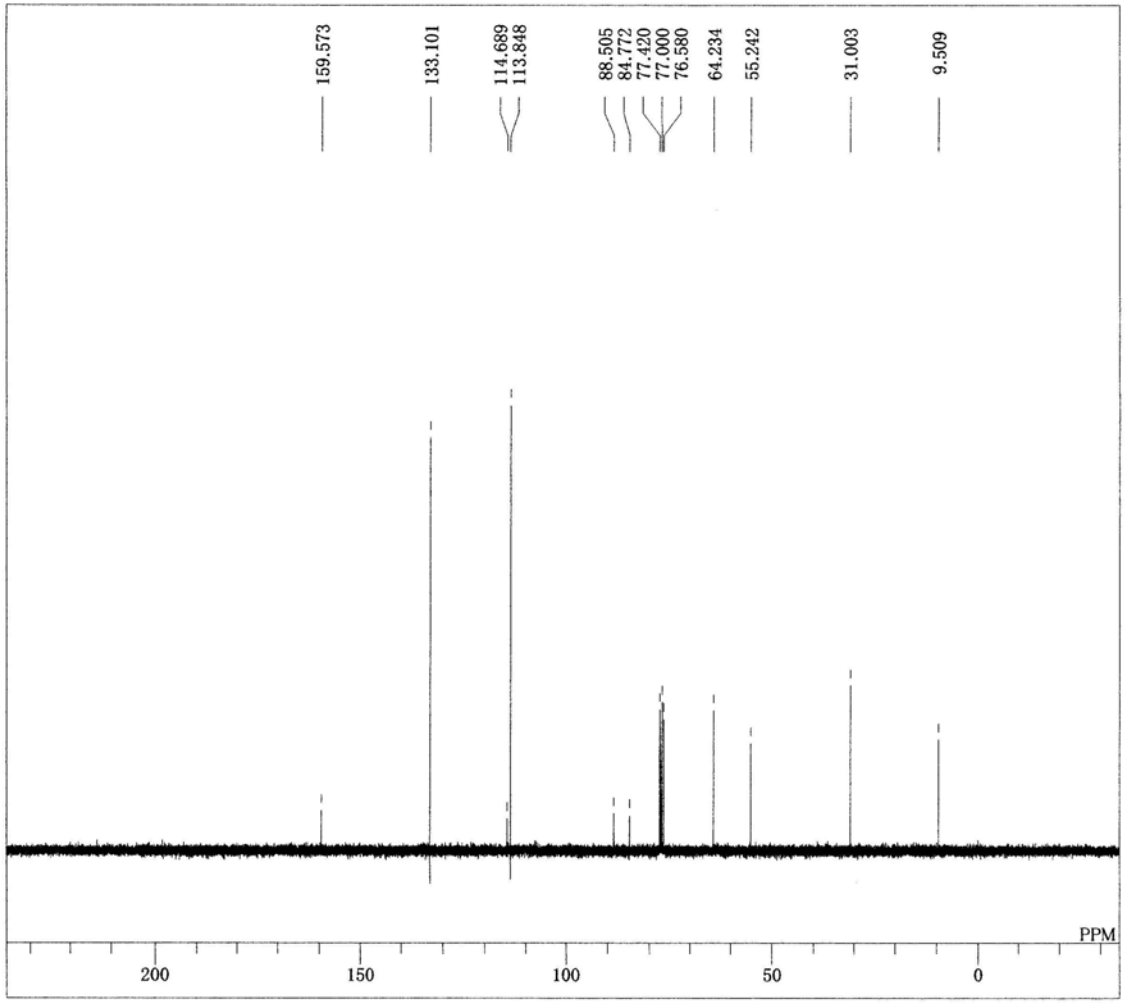
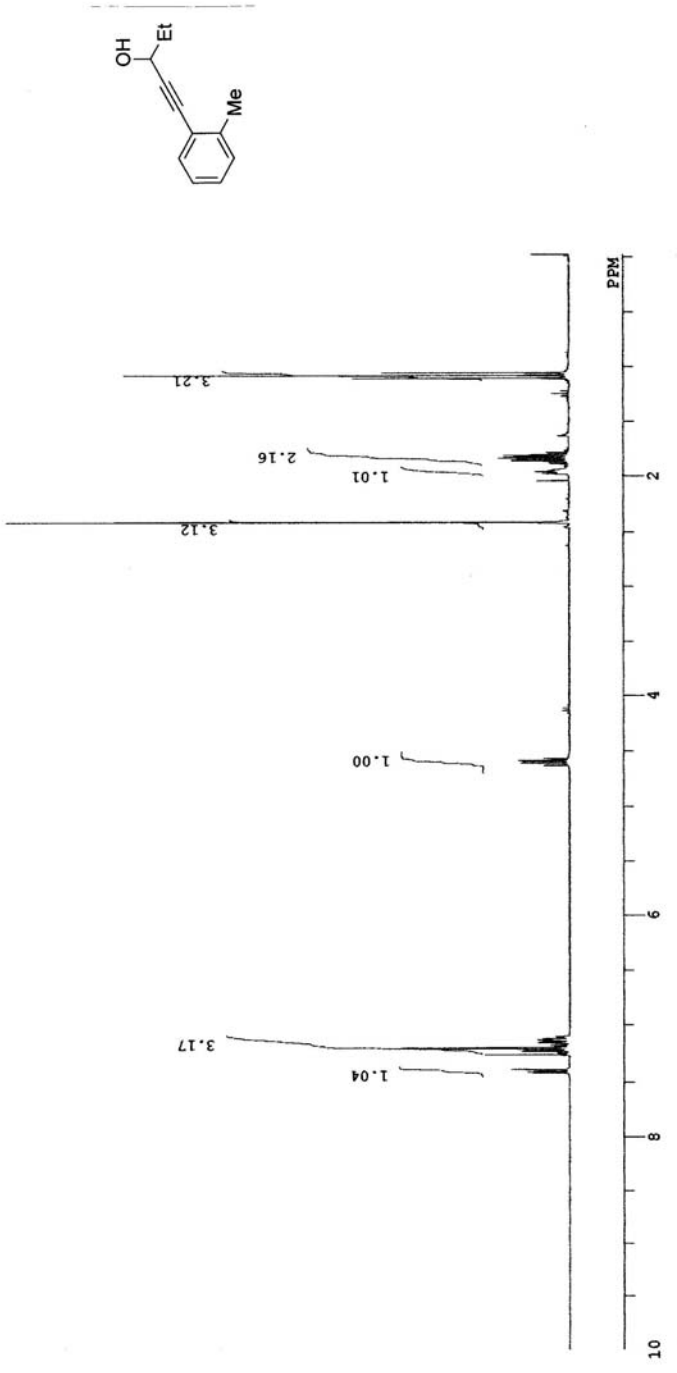
100
50
0

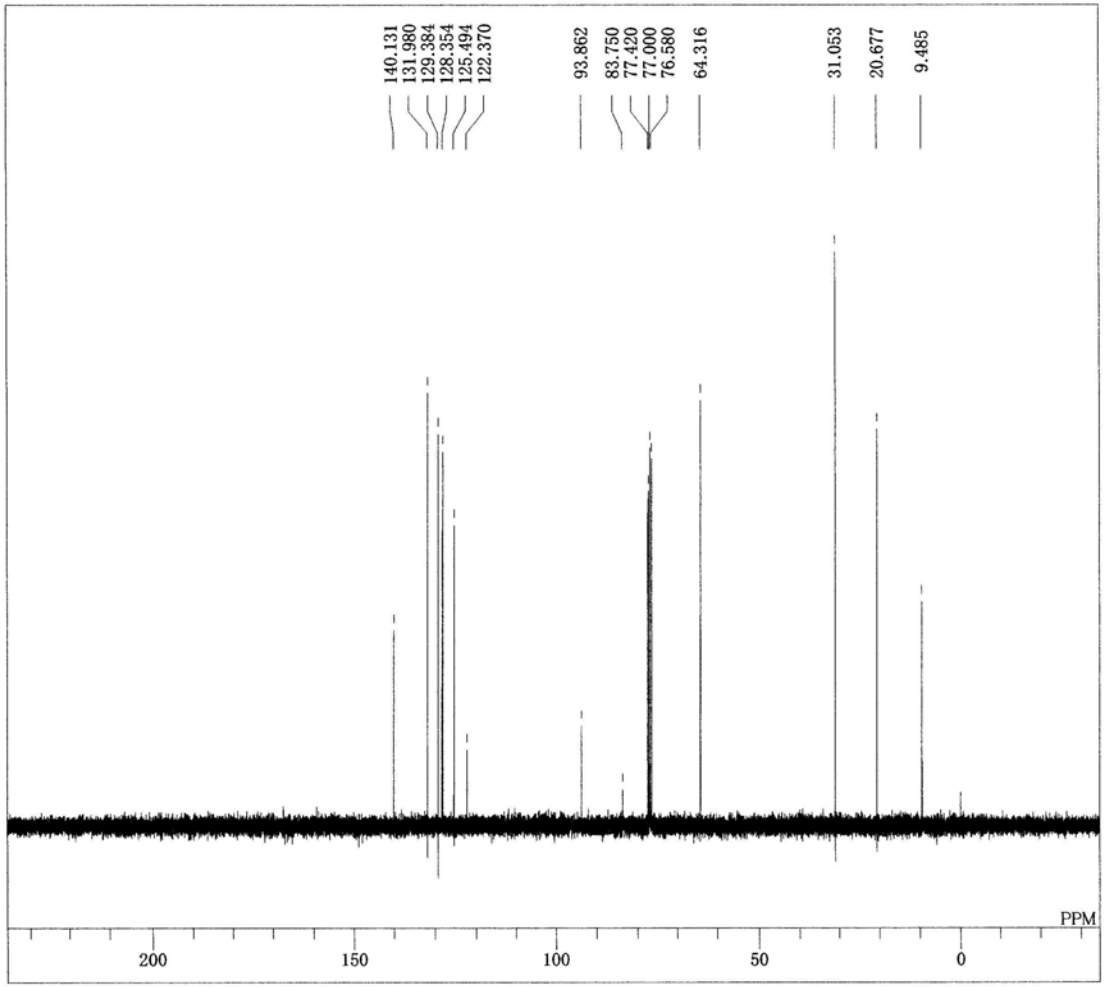
Alcohol 1l


OH
Et
MeO
PPM
0
2
4
6
8
10
3.1546
2.1060
0.9898
3.1227
1.0000
2.1049
2.0392

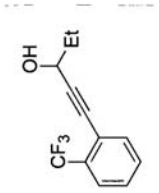

159.573
133.101
114.689
113.848
88.505
84.772
77.420
77.000
76.580
64.234
55.242
31.003
9.509
PPM
200
150
100
50
0

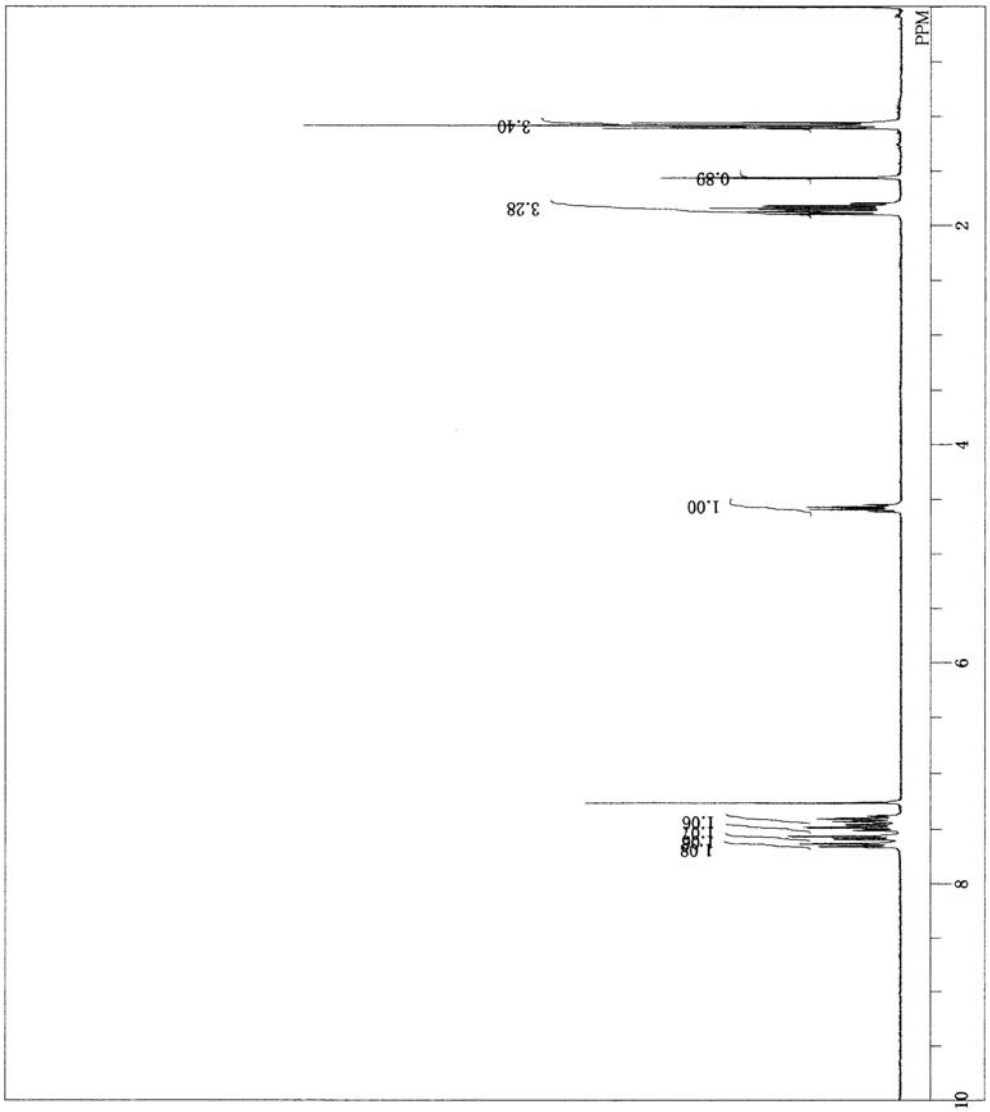
Alcohol 1m

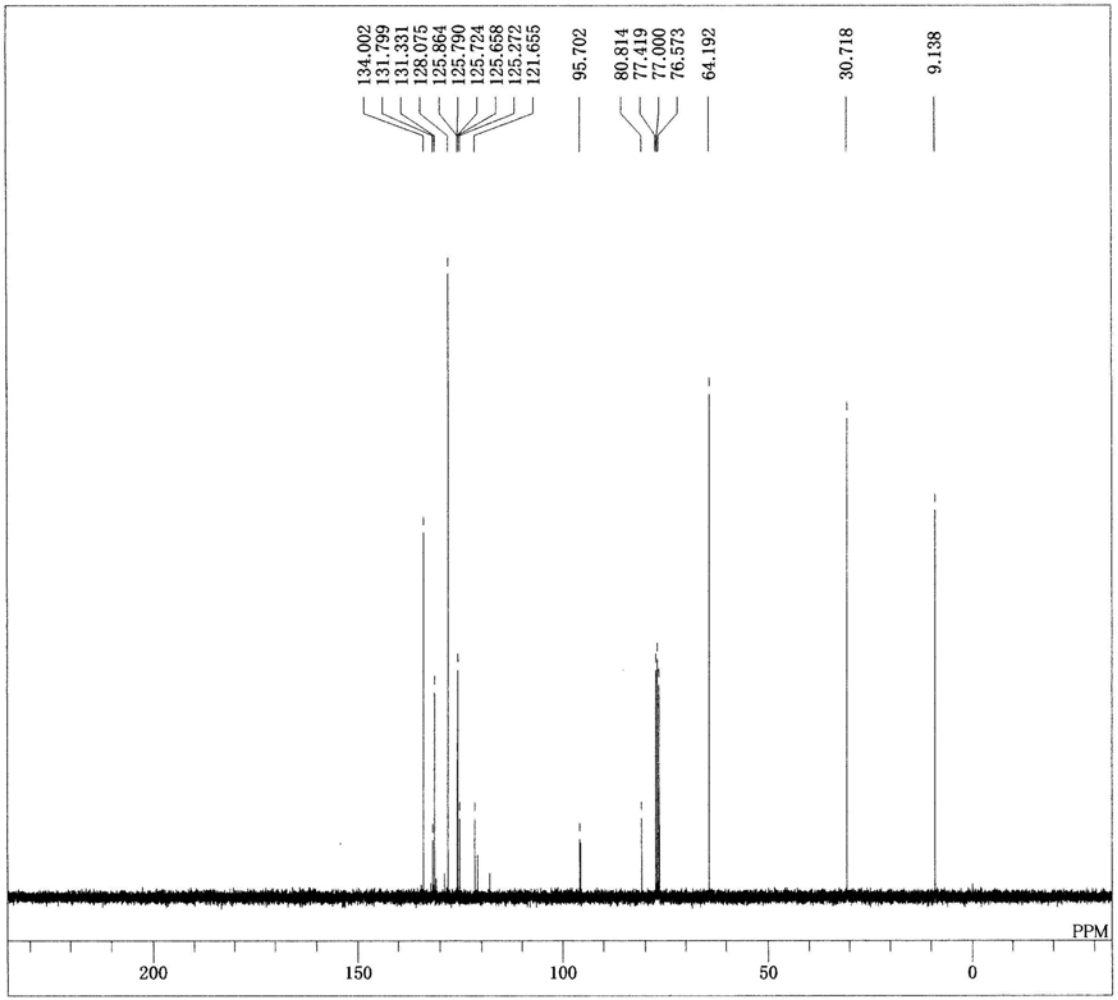



140.131
131.980
129.384
128.354
125.494
122.370
93.862
83.750
77.420
77.000
76.580
64.316
31.053
20.677
9.485
PPM
200
150
100
50
0

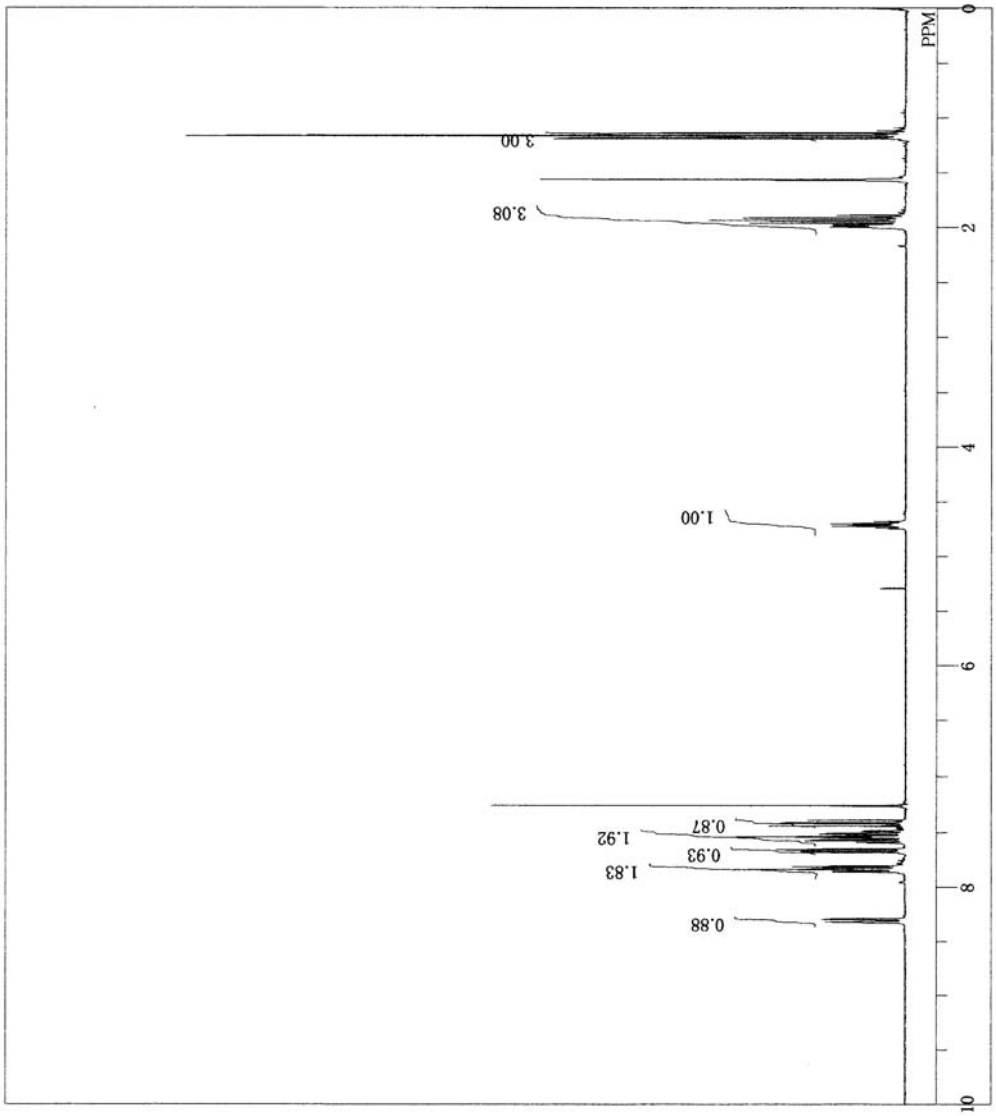
Alcohol 1n

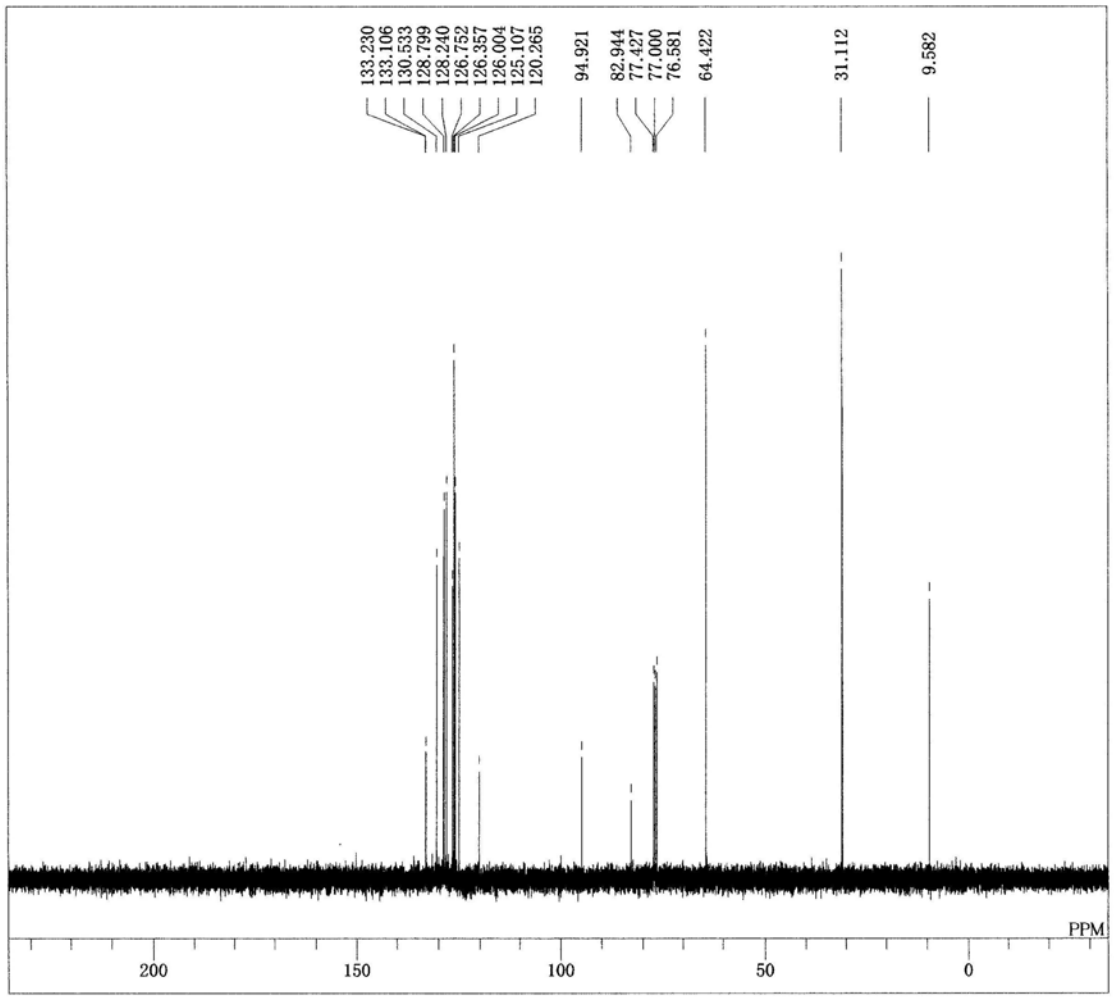




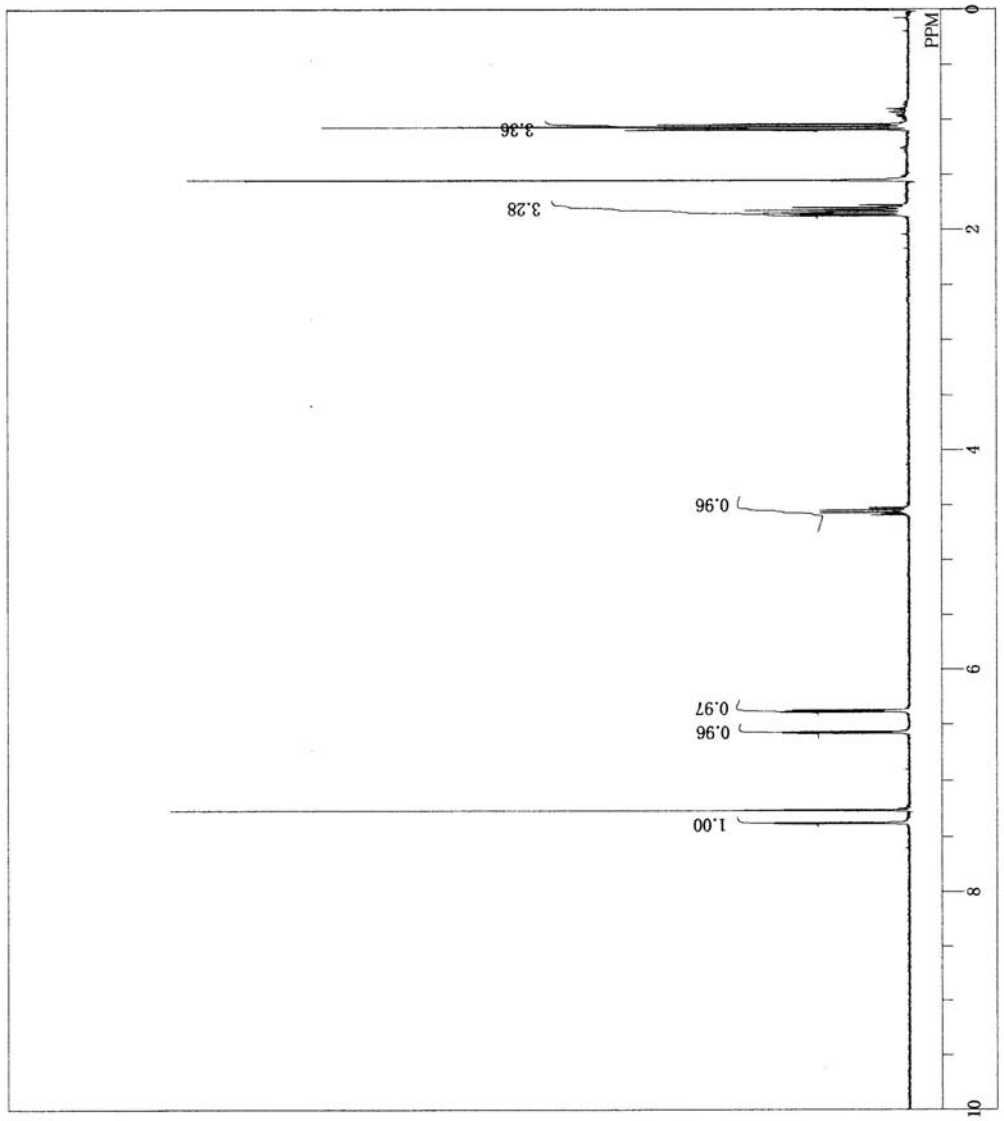

134.002
131.799
131.331
128.075
125.864
125.790
125.724
125.658
125.272
121.655
95.702
80.814
77.419
77.000
76.573
64.192
30.718
9.138
PPM
200
150
100
50
0

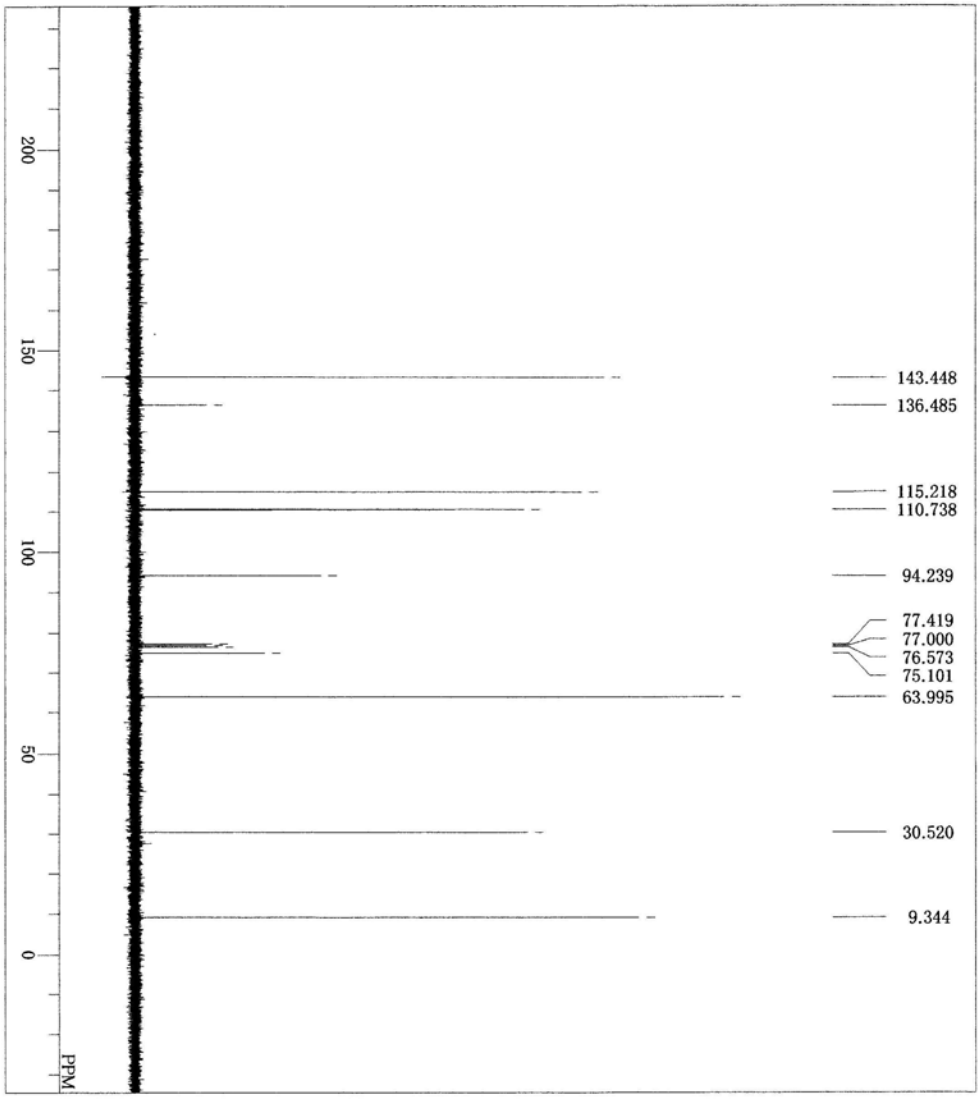
Alcohol 1p



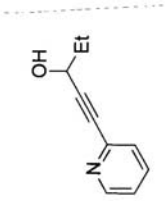

133.230
133.106
130.533
128.799
128.240
126.752
126.357
126.004
125.107
120.265
94.921
82.944
77.427
77.000
76.581
64.422
31.112
9.582
PPM
200
150
100
50
0

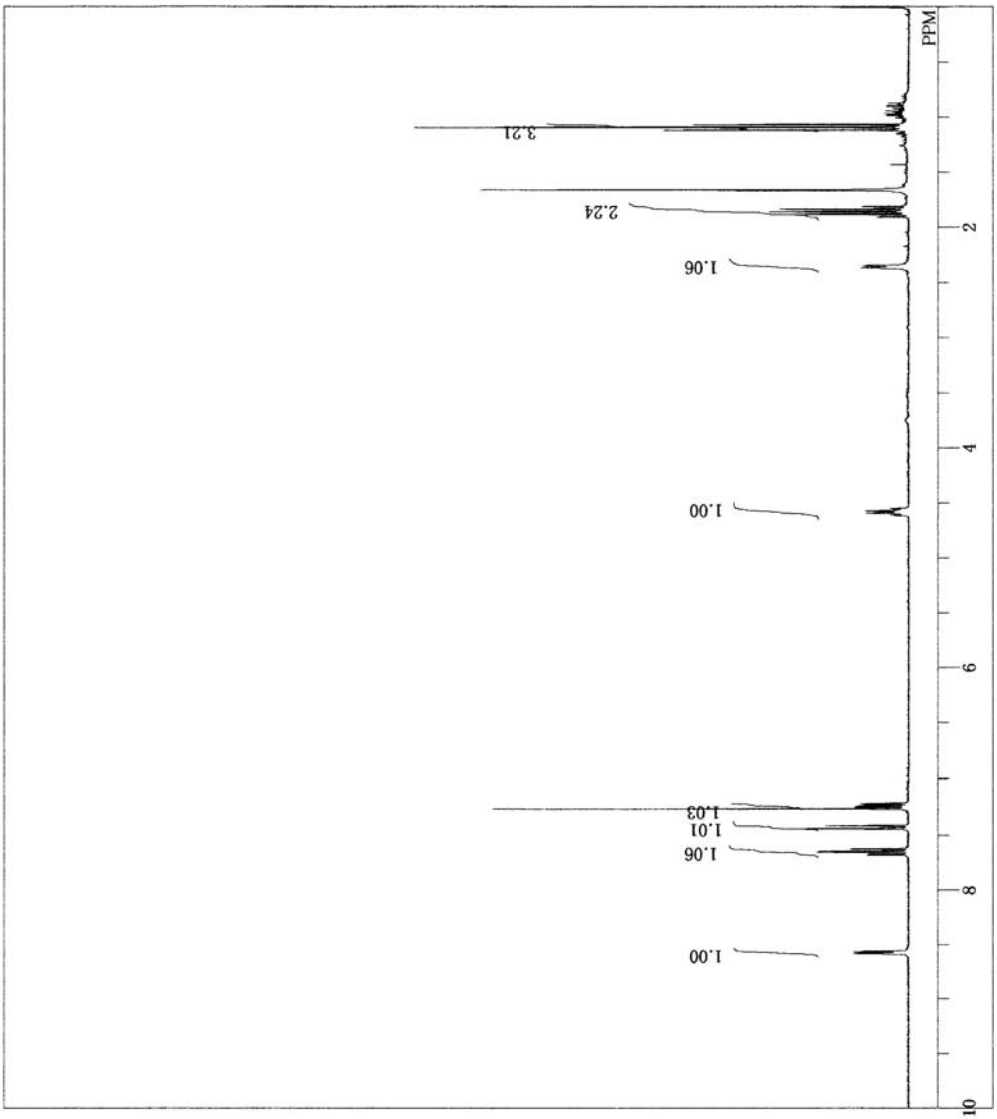
Alcohol 1q

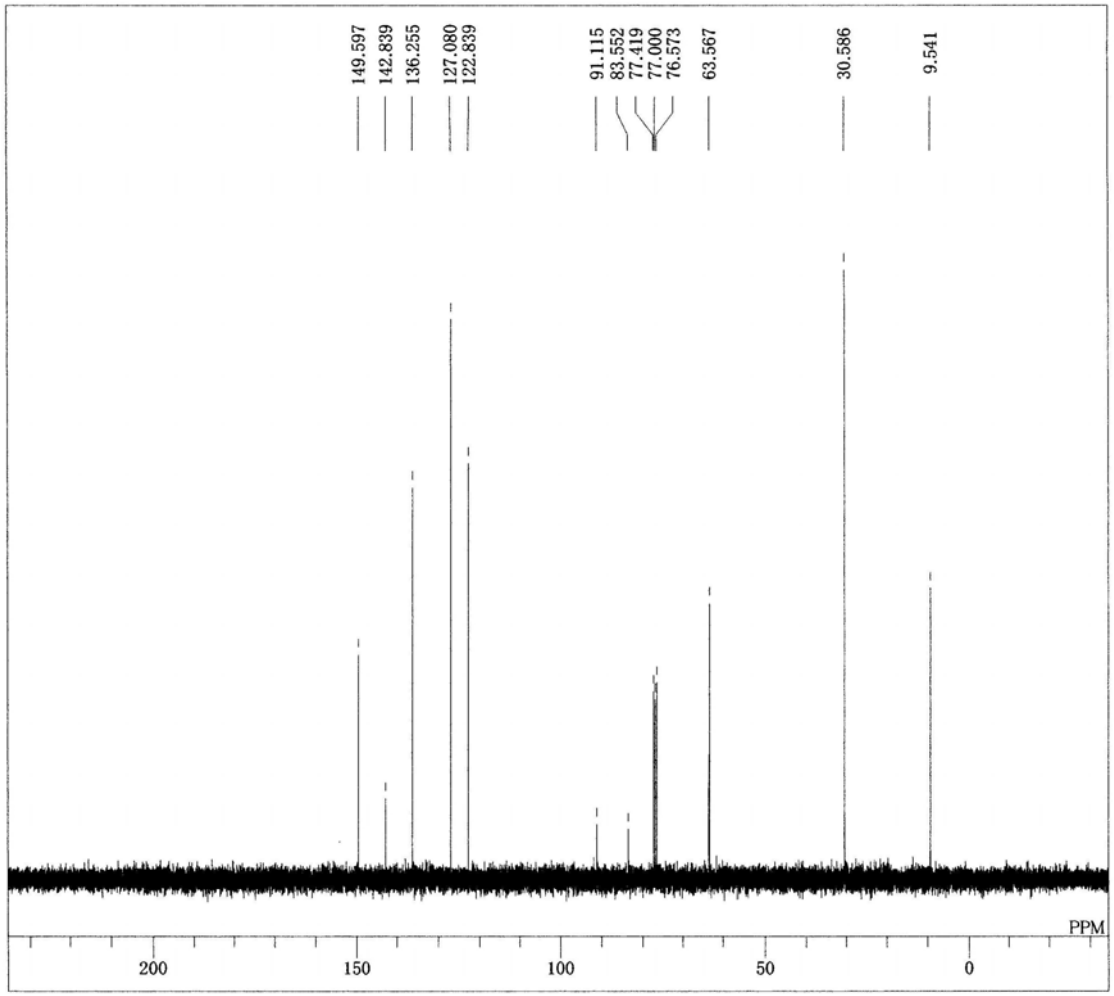



200
150
100
50
0
PPM
143.448
136.485
115.218
110.738
94.239
77.419
77.000
76.573
75.101
63.995
30.520
9.344

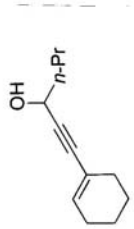
Alcohol 1r

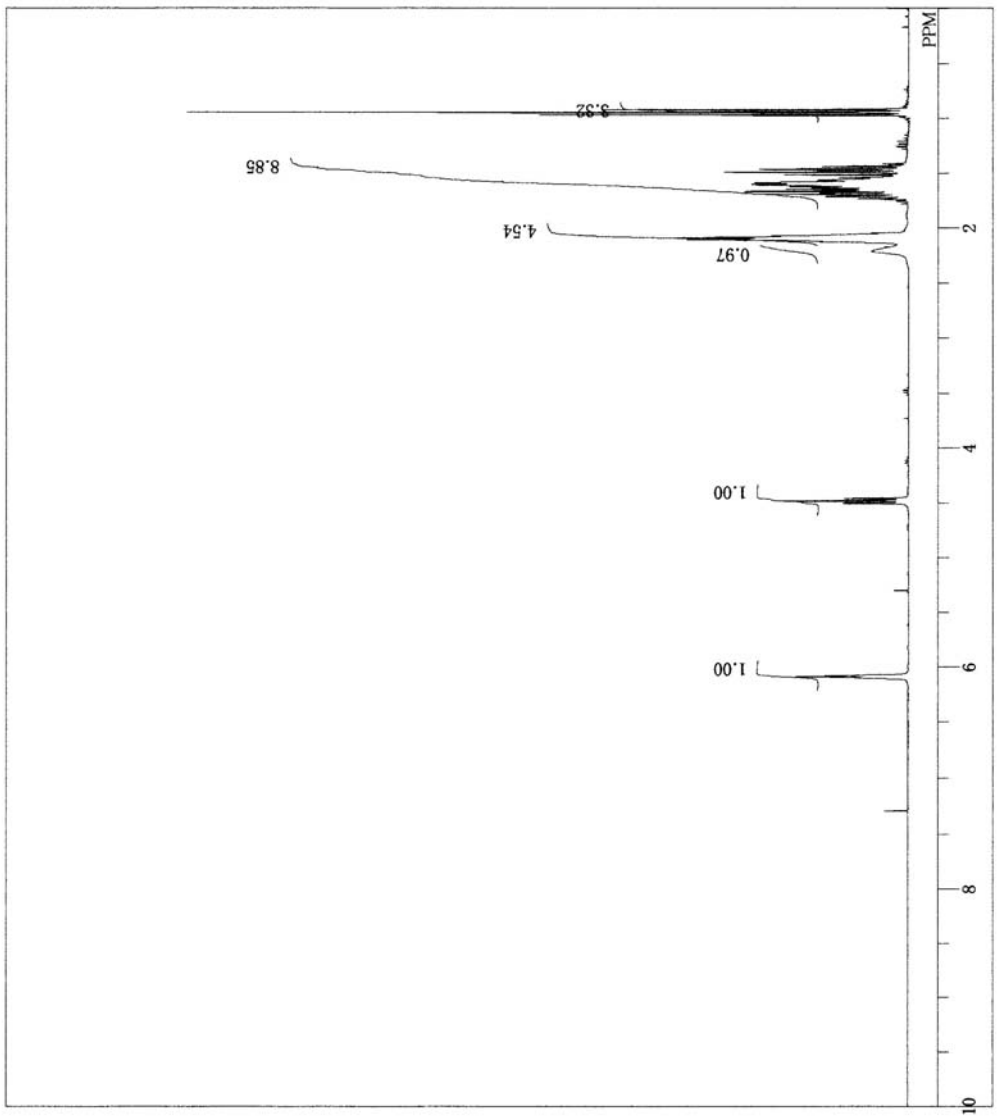


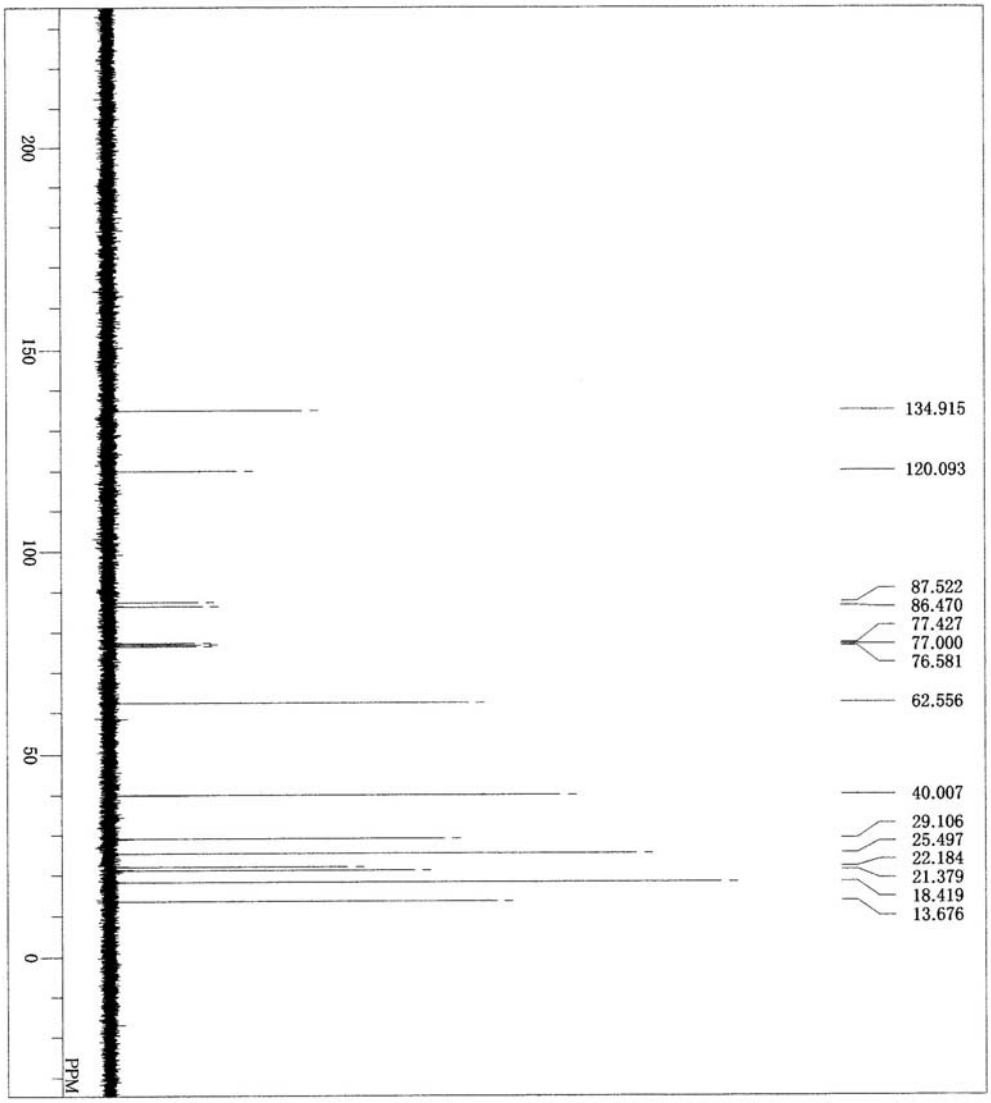



149.597
142.839
136.255
127.080
122.839
91.115
83.552
77.419
77.000
76.573
63.567
30.586
9.541
PPM
200
150
100
50
0

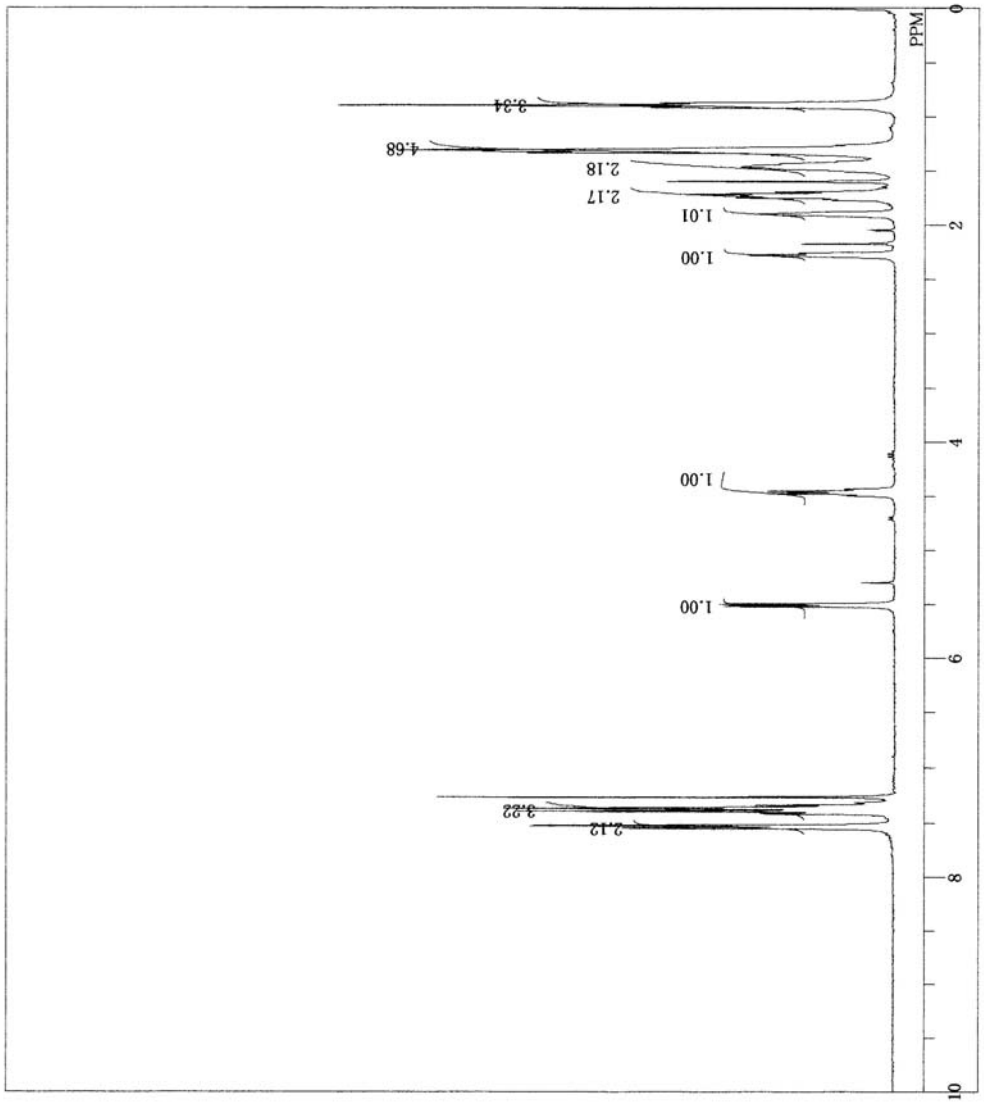
Alcohol 1t

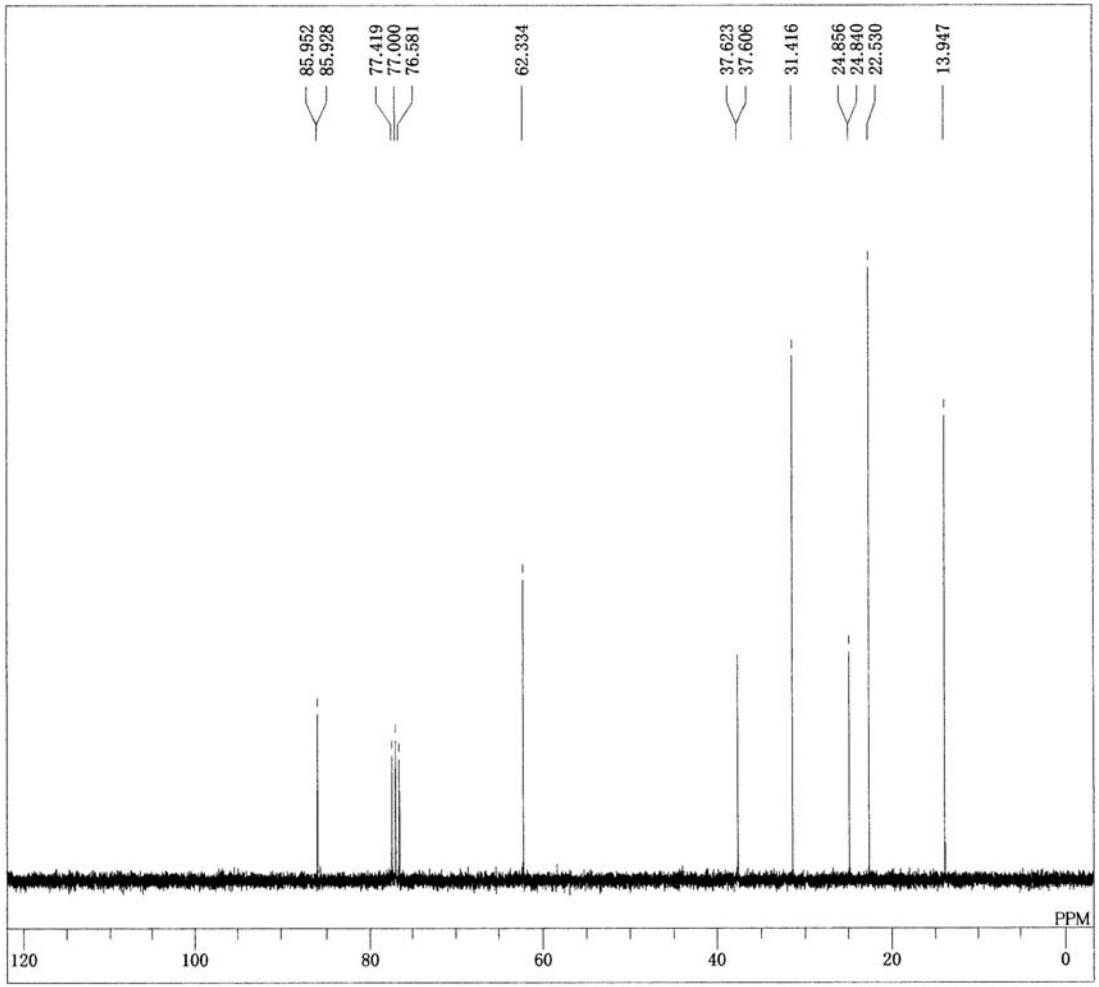




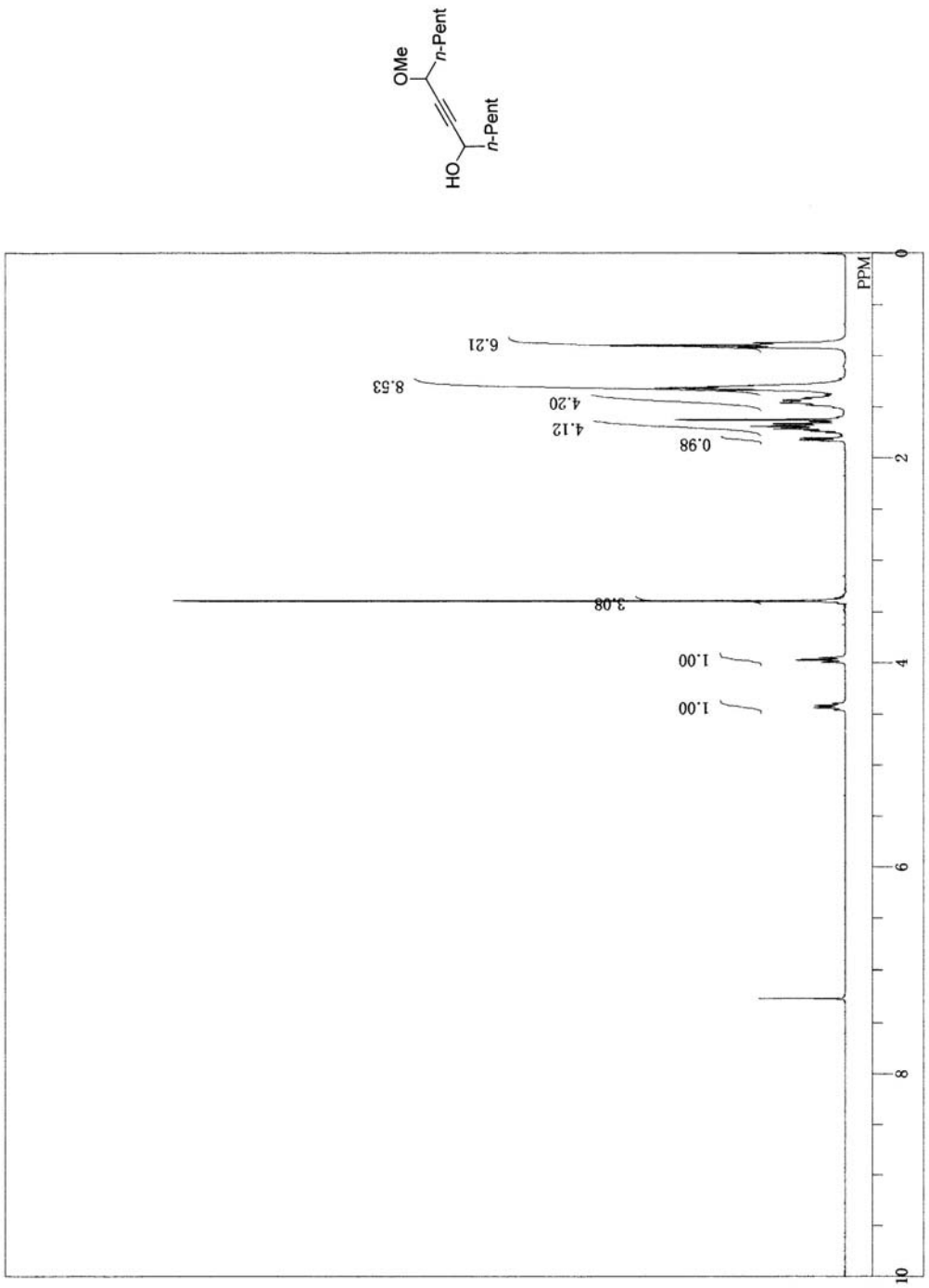

200
150
100
50
0
PPM
134.915
120.093
87.522
86.470
77.427
77.000
76.581
62.556
40.007
29.106
25.497
22.184
21.379
18.419
13.676

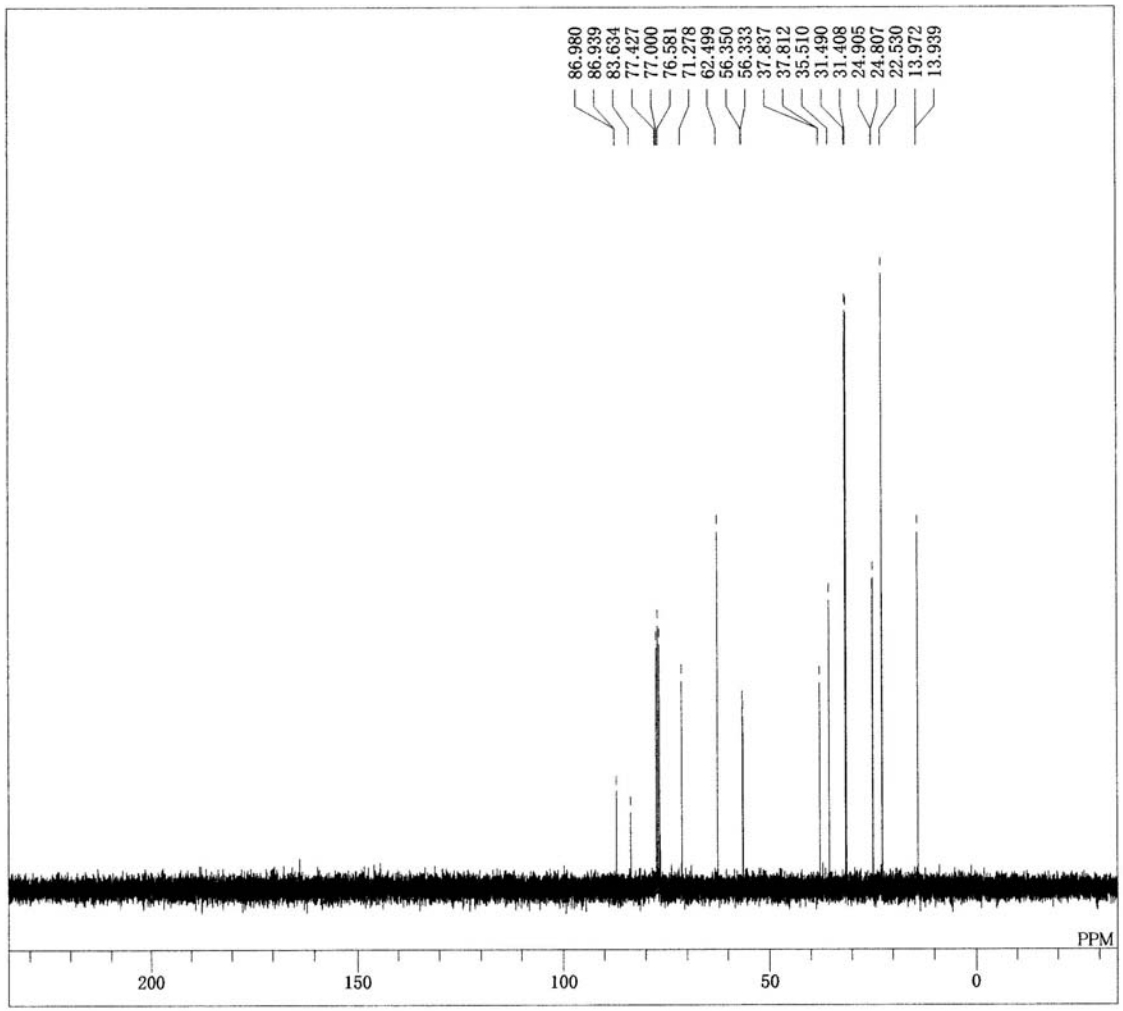
Alcohol 6b


OH
n-Pent
HO
Ph
PPM
0
2
4
6
8
10
3.34
4.68
2.18
2.17
1.01
1.00
1.00
1.00
3.22
2.12

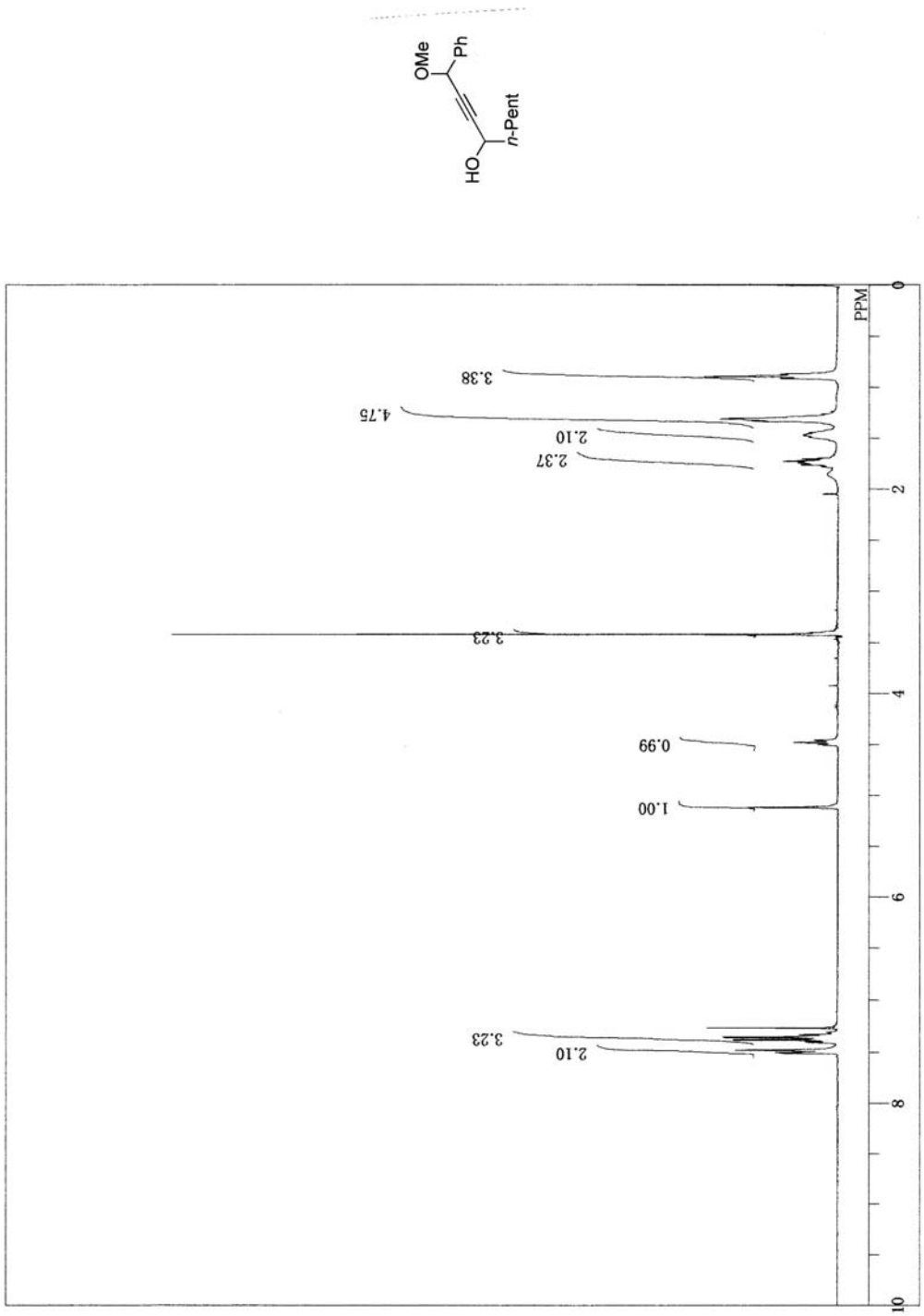

85.952
85.928
77.419
77.000
76.581
62.334
37.623
37.606
31.416
24.856
24.840
22.530
13.947
PPM
120
100
80
60
40
20
0

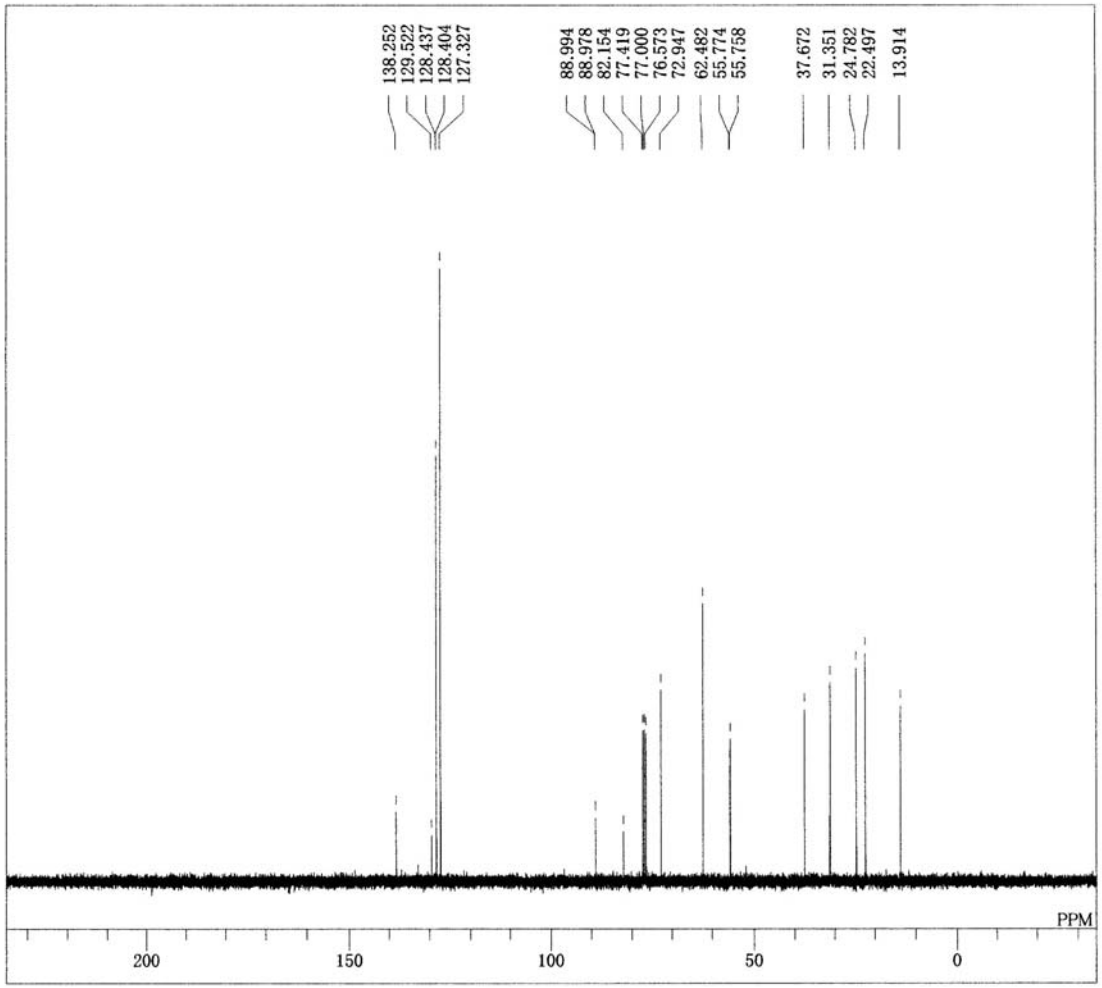
Alcohol 8a



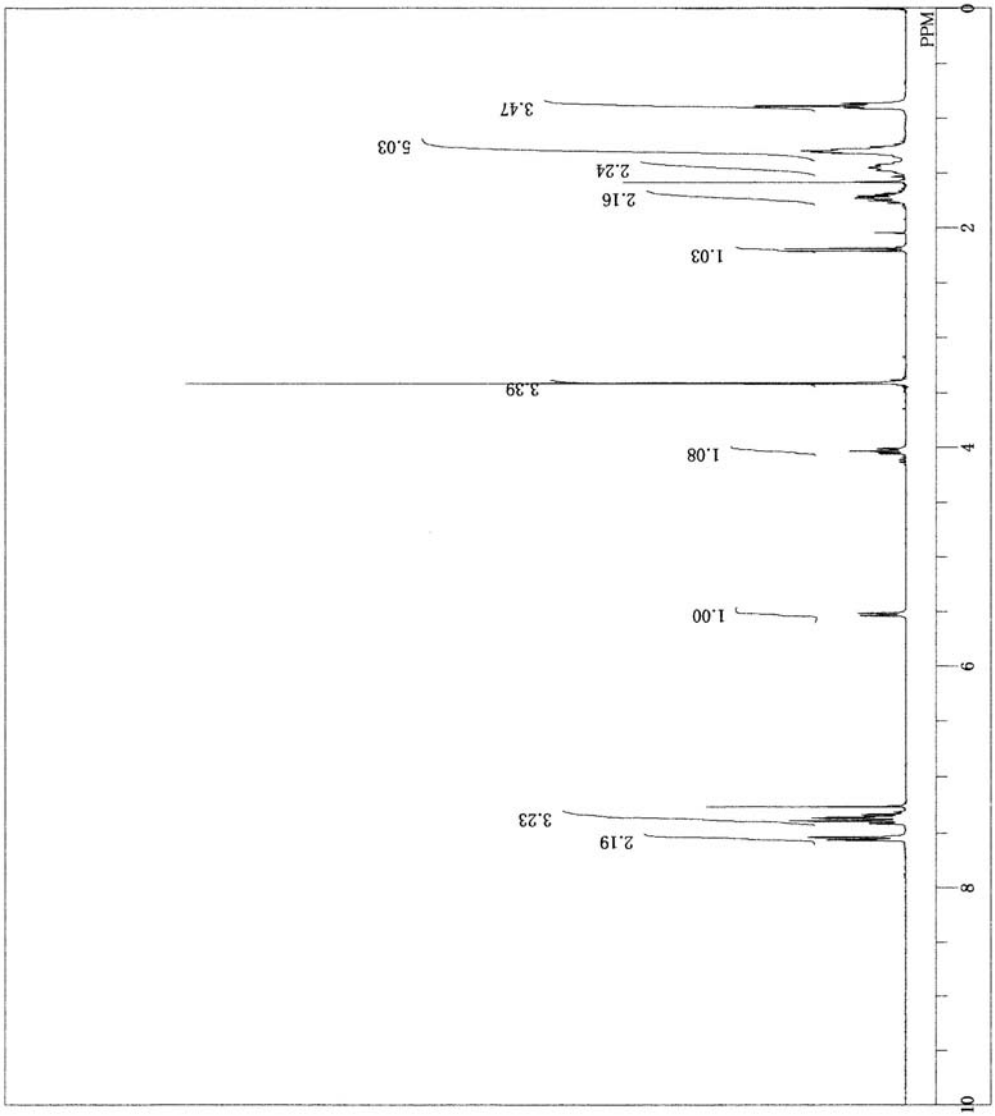

86.980
86.939
83.634
77.427
77.000
76.581
71.278
62.499
56.350
56.333
37.837
37.812
35.510
31.490
31.408
24.905
24.807
22.530
13.972
13.939
PPM
200
150
100
50
0

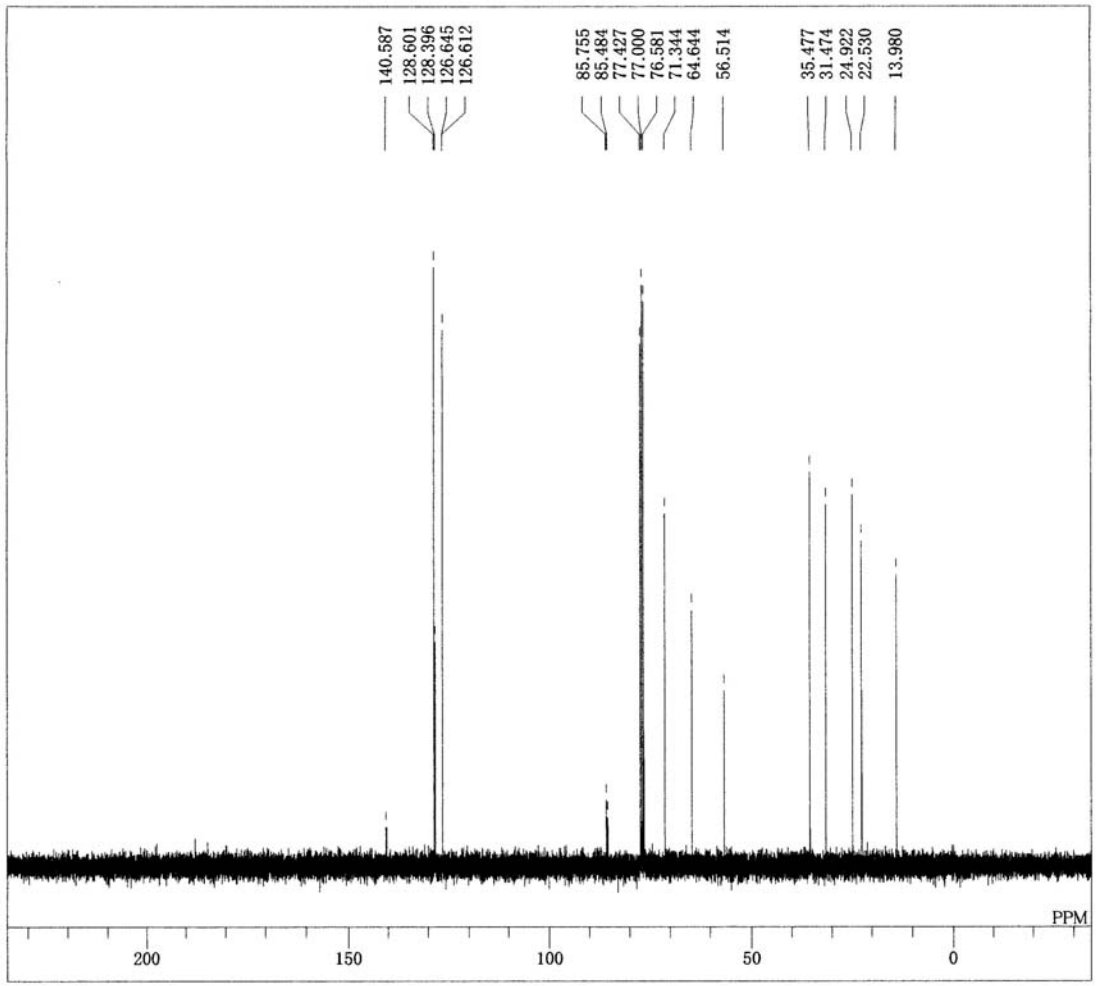
Alcohol 8b



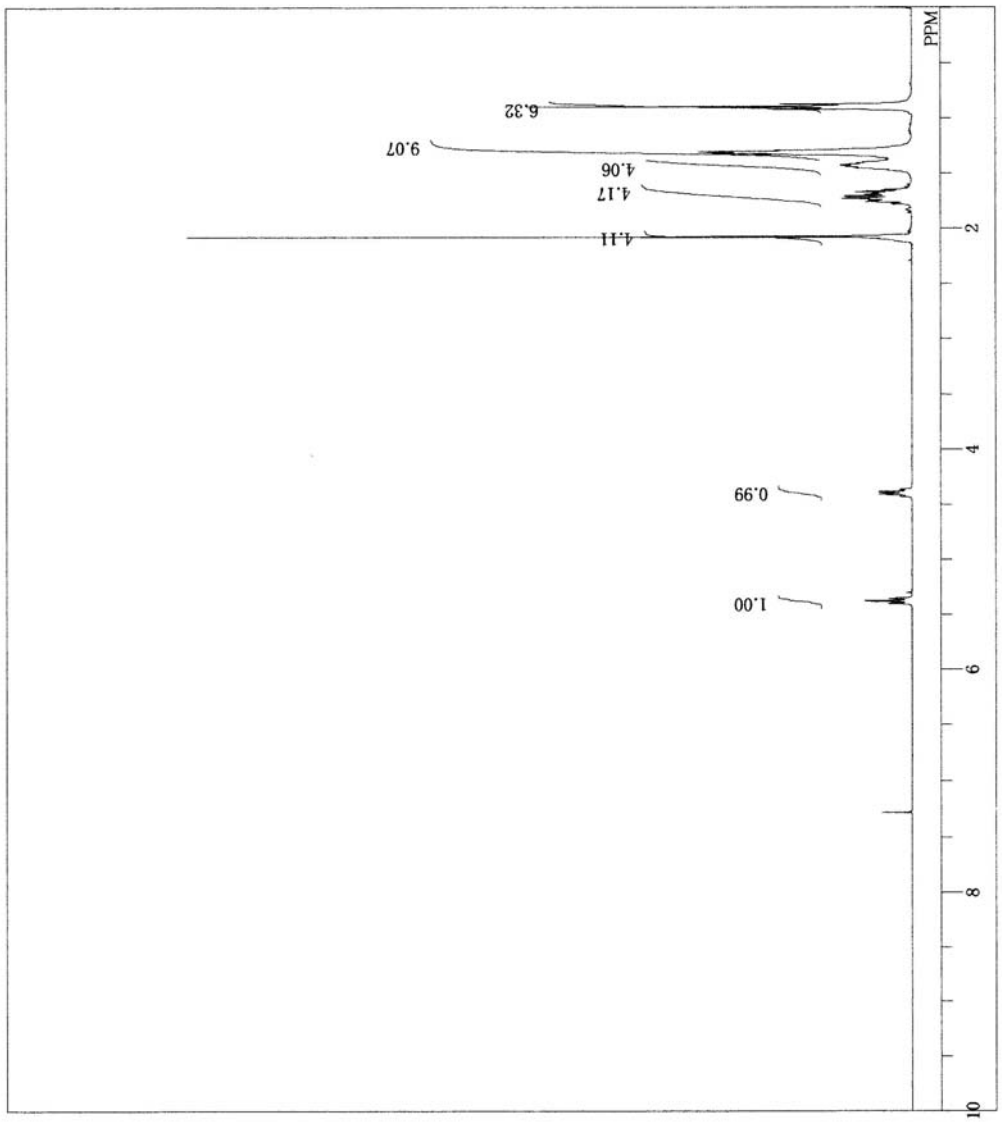

138.252
129.522
128.437
128.404
127.327
88.994
88.978
82.154
77.419
77.000
76.573
72.947
62.482
55.774
55.758
37.672
31.351
24.782
22.497
13.914
PPM
200
150
100
50
0

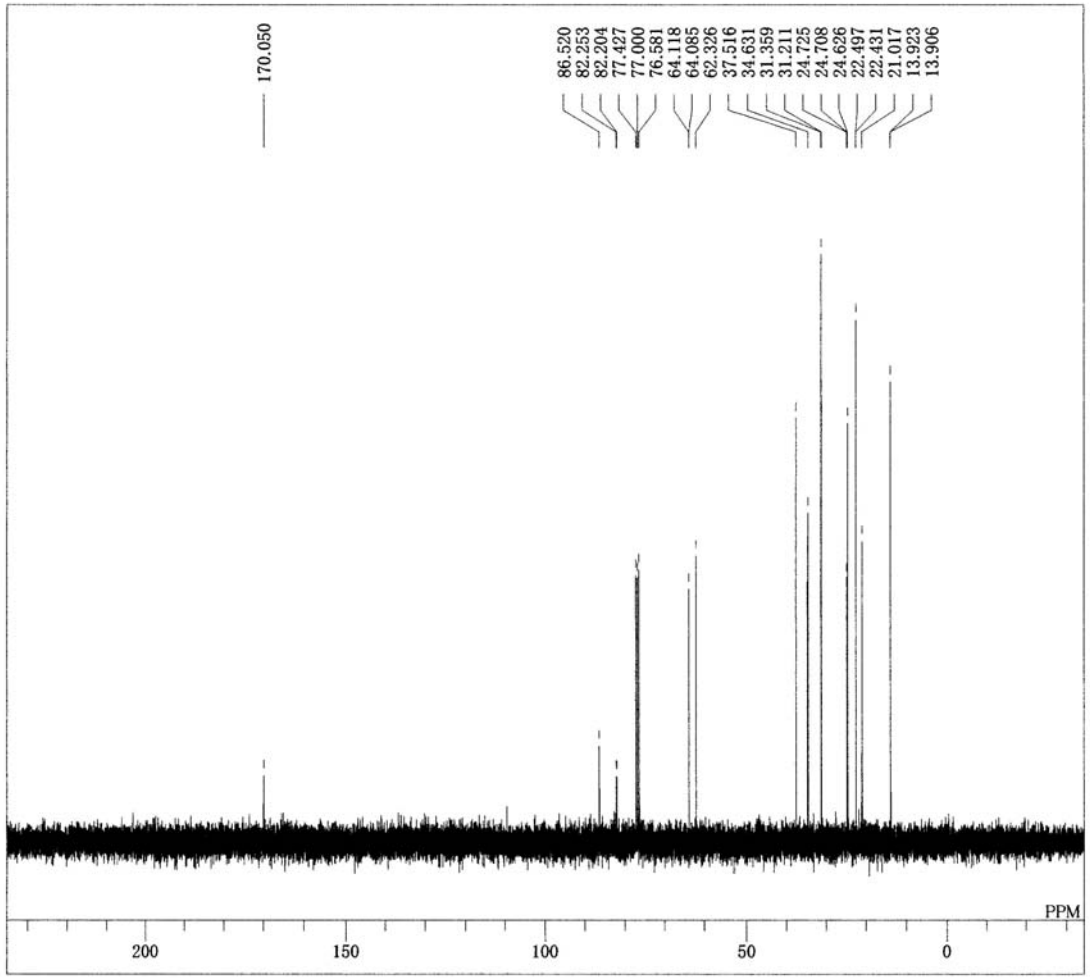
Alcohol 8c


OMe
n-Pent
Ph
HO
PPM
0
2
4
6
8
10
3.47
5.03
2.24
2.16
1.03
3.39
1.08
1.00
3.23
2.19

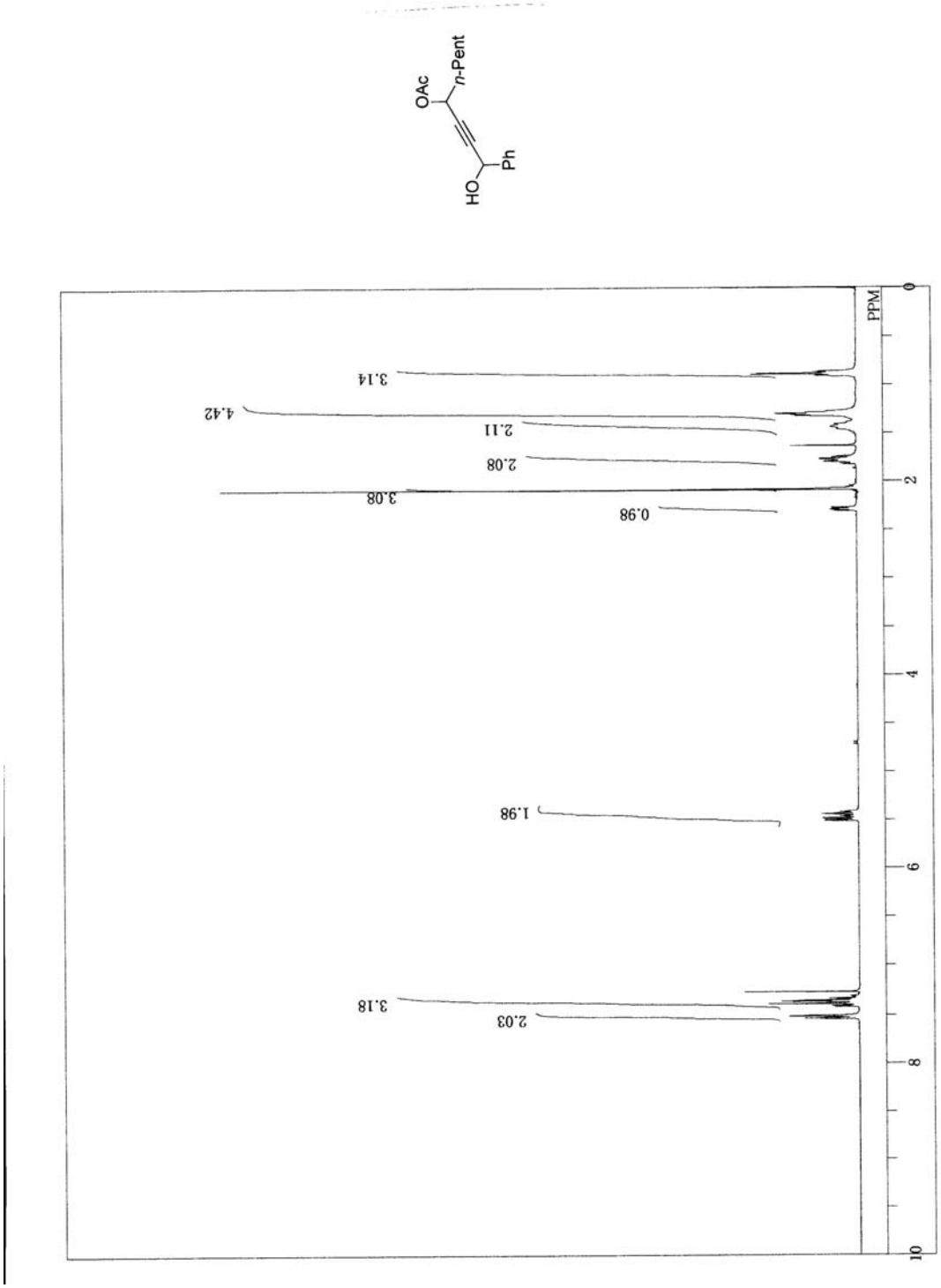

140.587
128.601
128.396
126.645
126.612
85.755
85.484
77.427
77.000
76.581
71.344
64.644
56.514
35.477
31.474
24.922
22.530
13.980
PPM
200
150
100
50
0

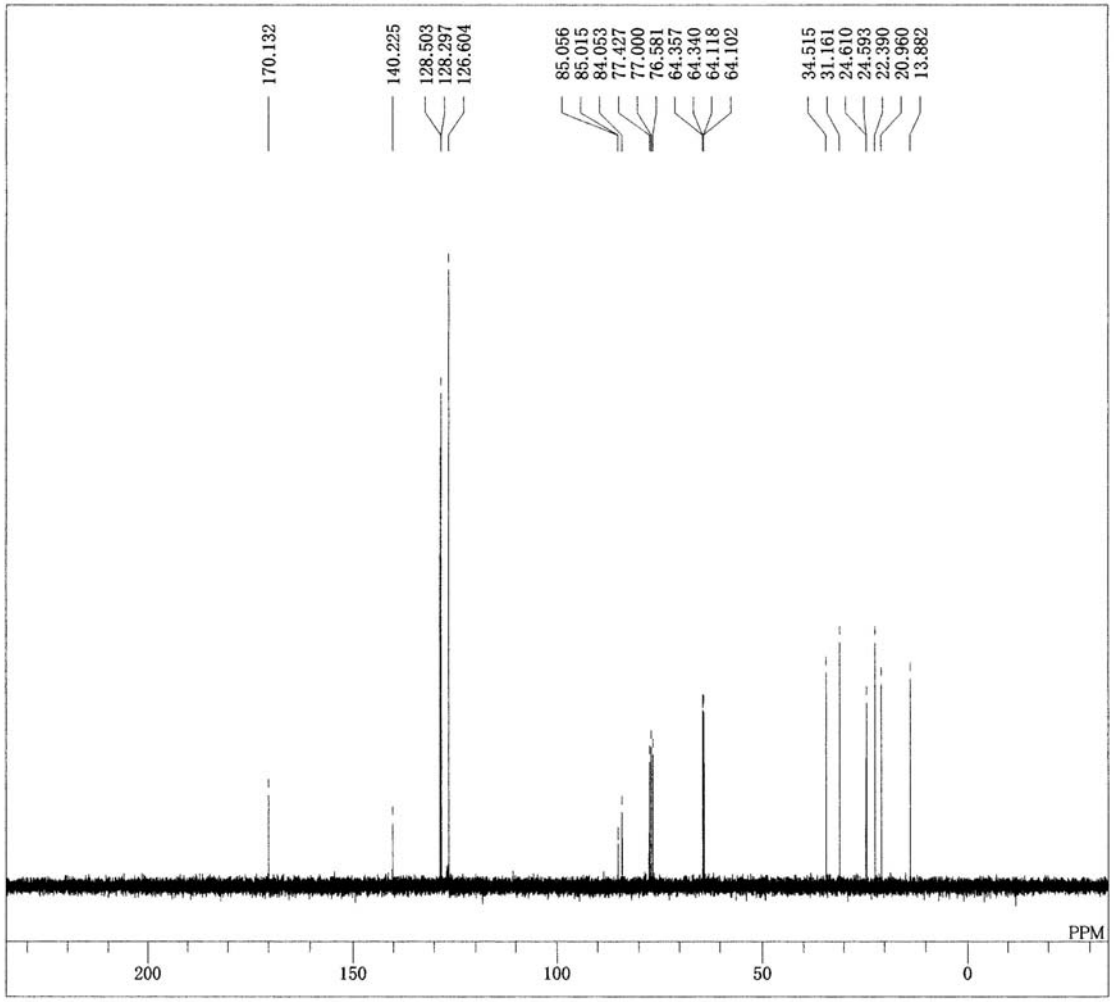
Alcohol 10a



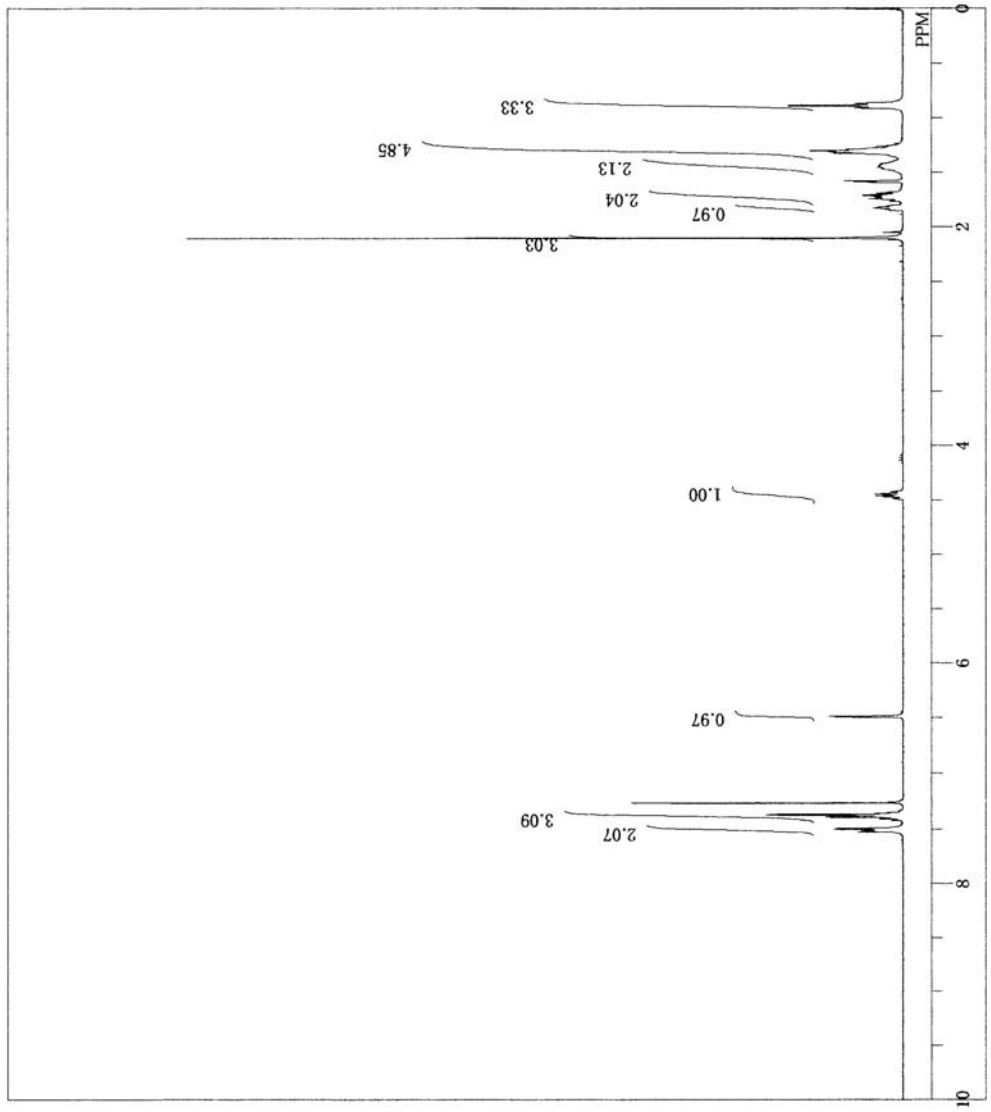

170.050
86.520
82.253
82.204
77.427
77.000
76.581
64.118
64.085
62.326
37.516
34.631
31.359
31.211
24.725
24.708
24.626
22.497
22.431
21.017
13.923
13.906
PPM
200
150
100
50
0

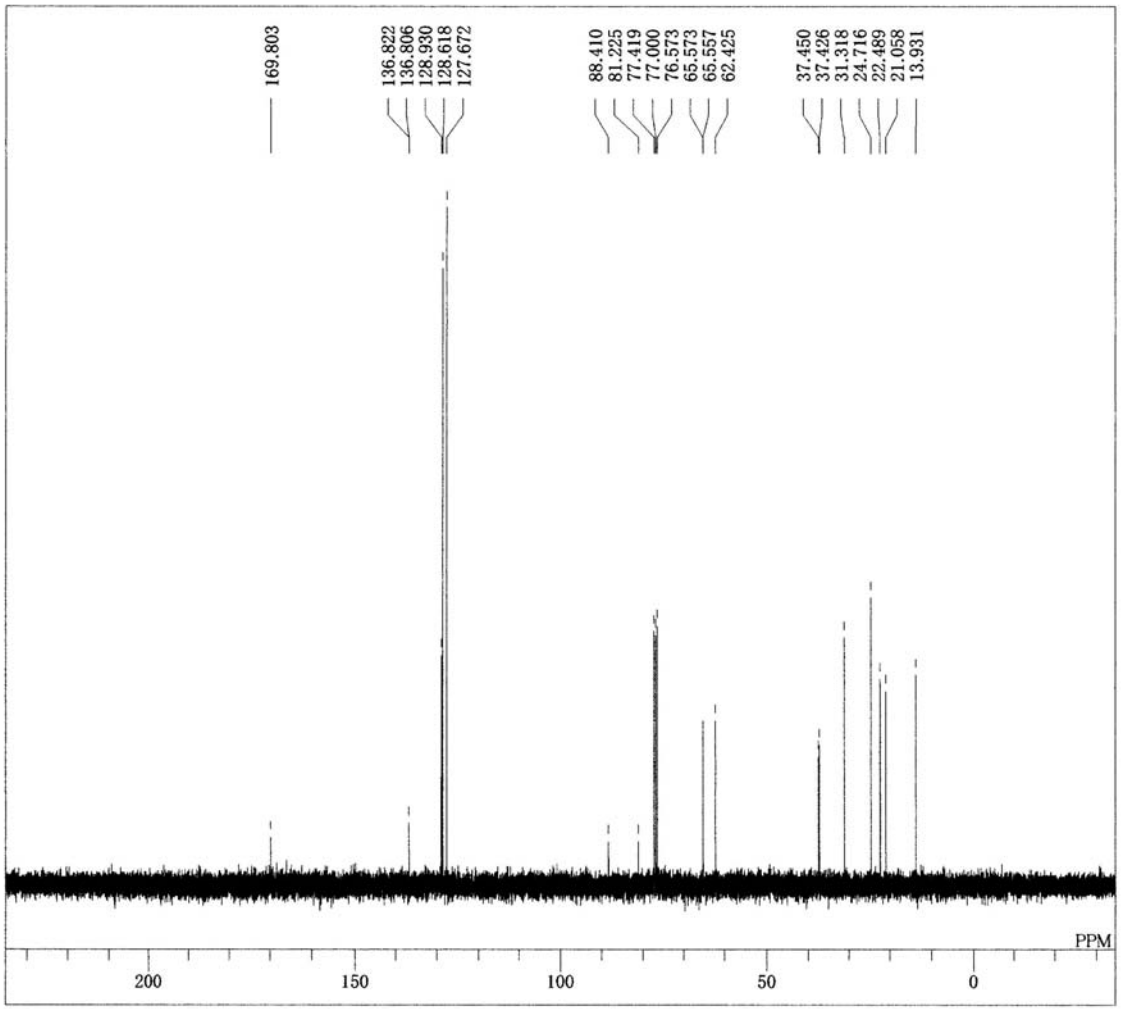
Alcohol 10b



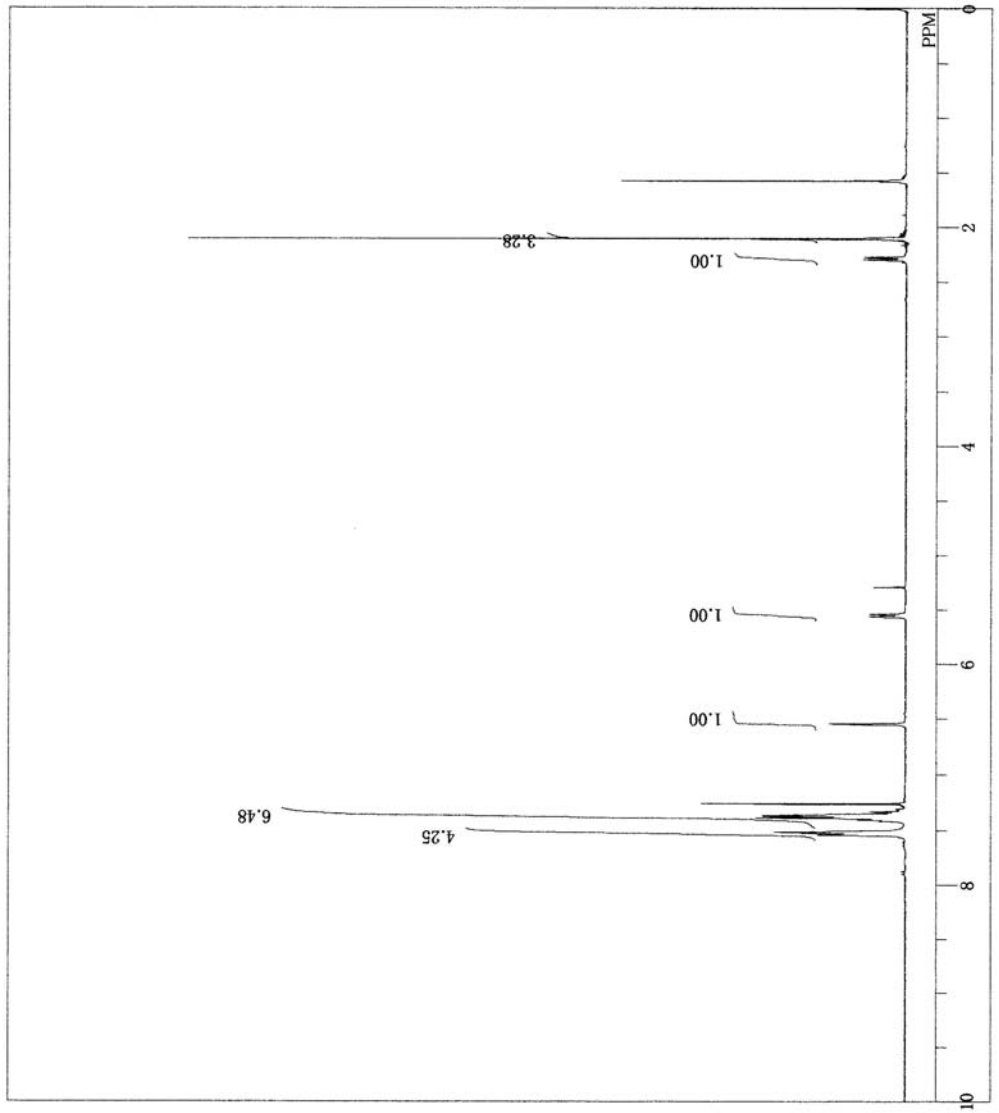

170.132
140.225
128.503
128.297
126.604
85.056
85.015
84.053
77.427
77.000
76.581
64.357
64.340
64.118
64.102
34.515
31.161
24.610
24.593
22.390
20.960
13.882
PPM
200
150
100
50
0

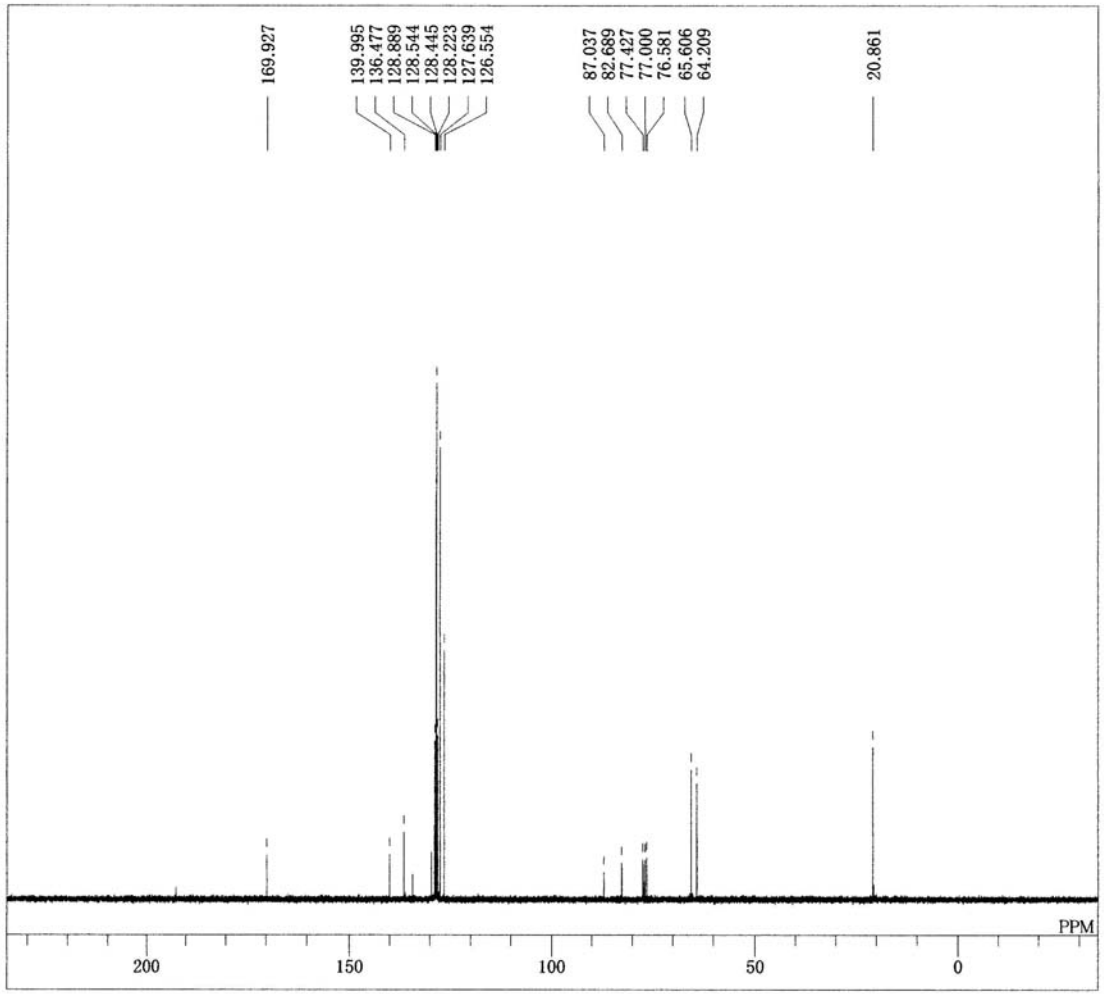
Alcohol 11a


OAc
Ph
n-Pent
HO
PPM
0
2
4
6
8
10
3.33
4.85
2.13
2.04
0.97
3.03
1.00
0.97
3.09
2.07

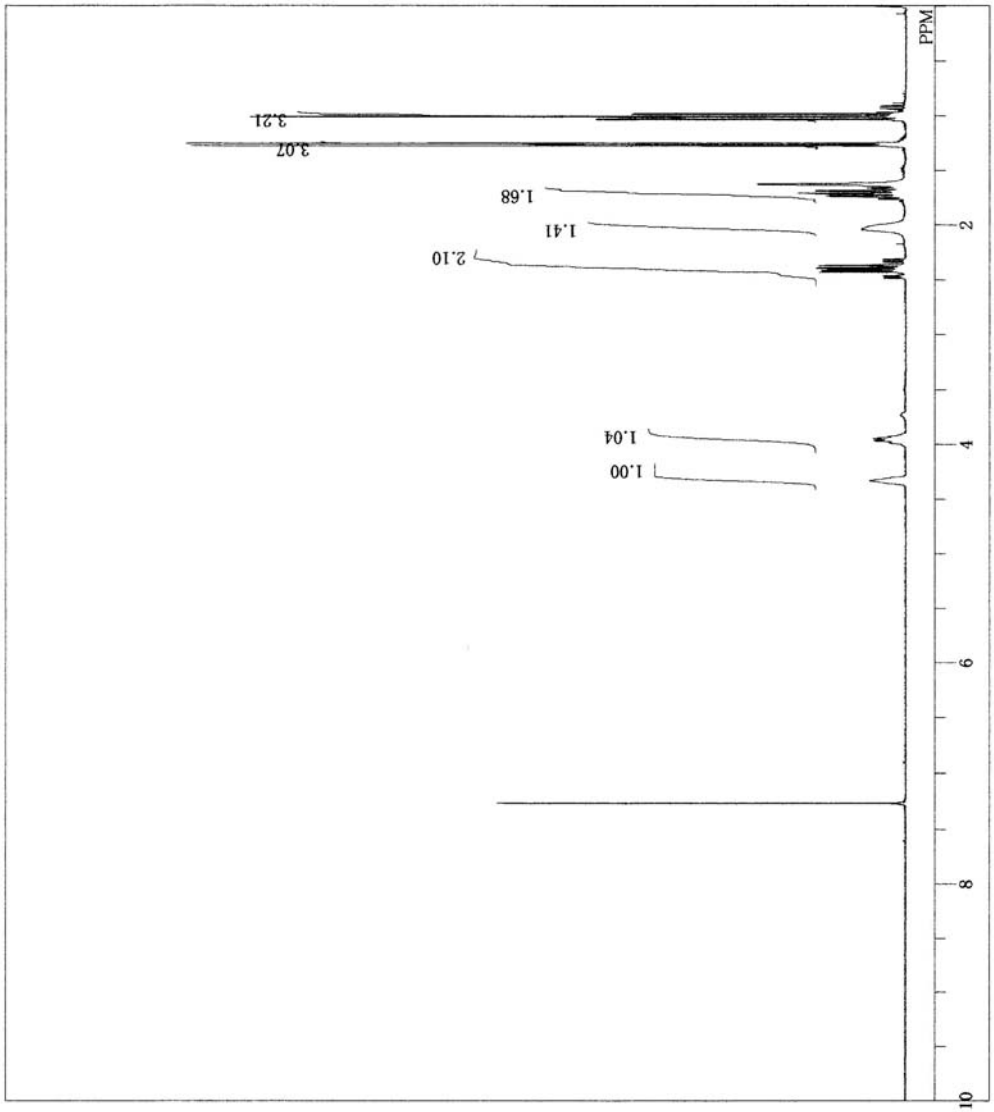

169.803
136.822
136.806
128.930
128.618
127.672
88.410
81.225
77.419
77.000
76.573
65.573
65.557
62.425
37.450
37.426
31.318
24.716
22.489
21.058
13.931
PPM
200
150
100
50
0

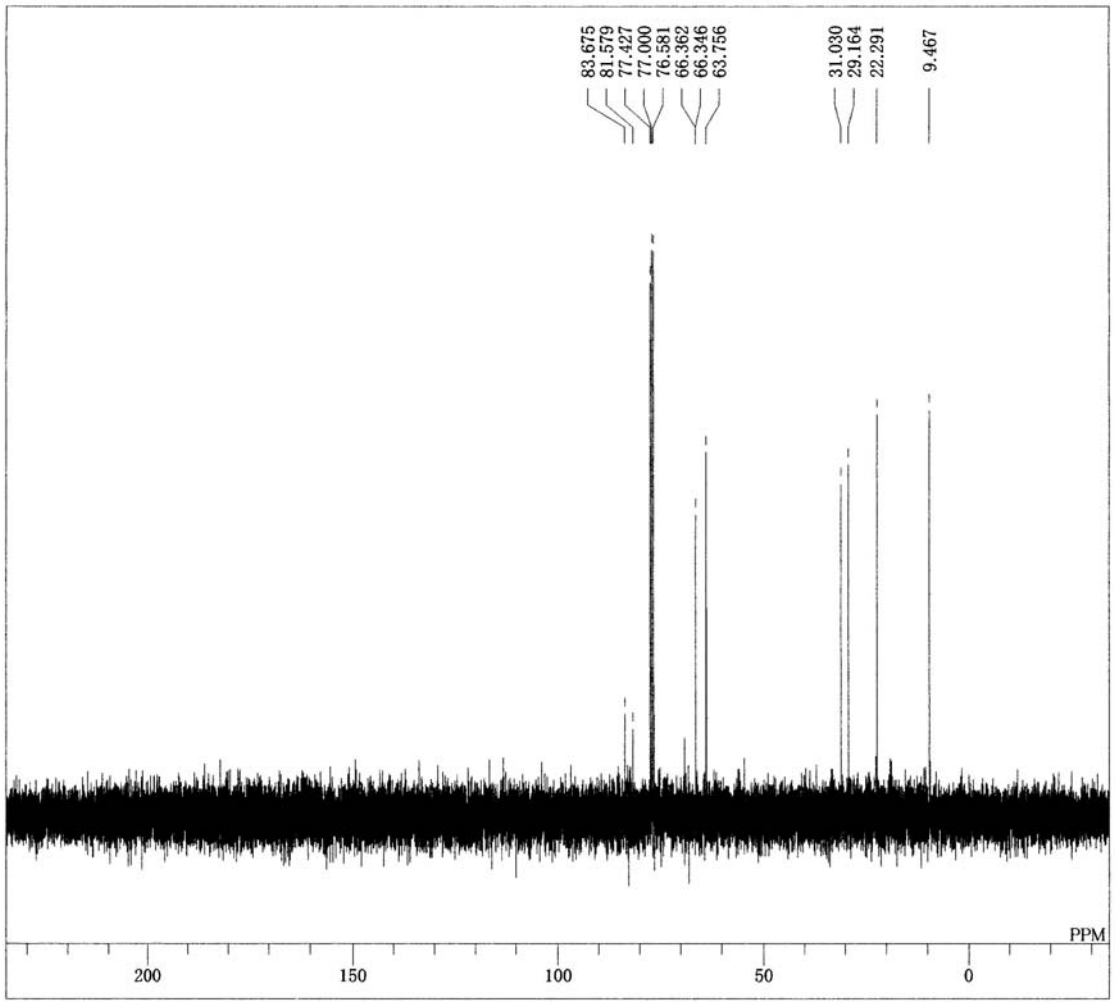
Alcohol 11b



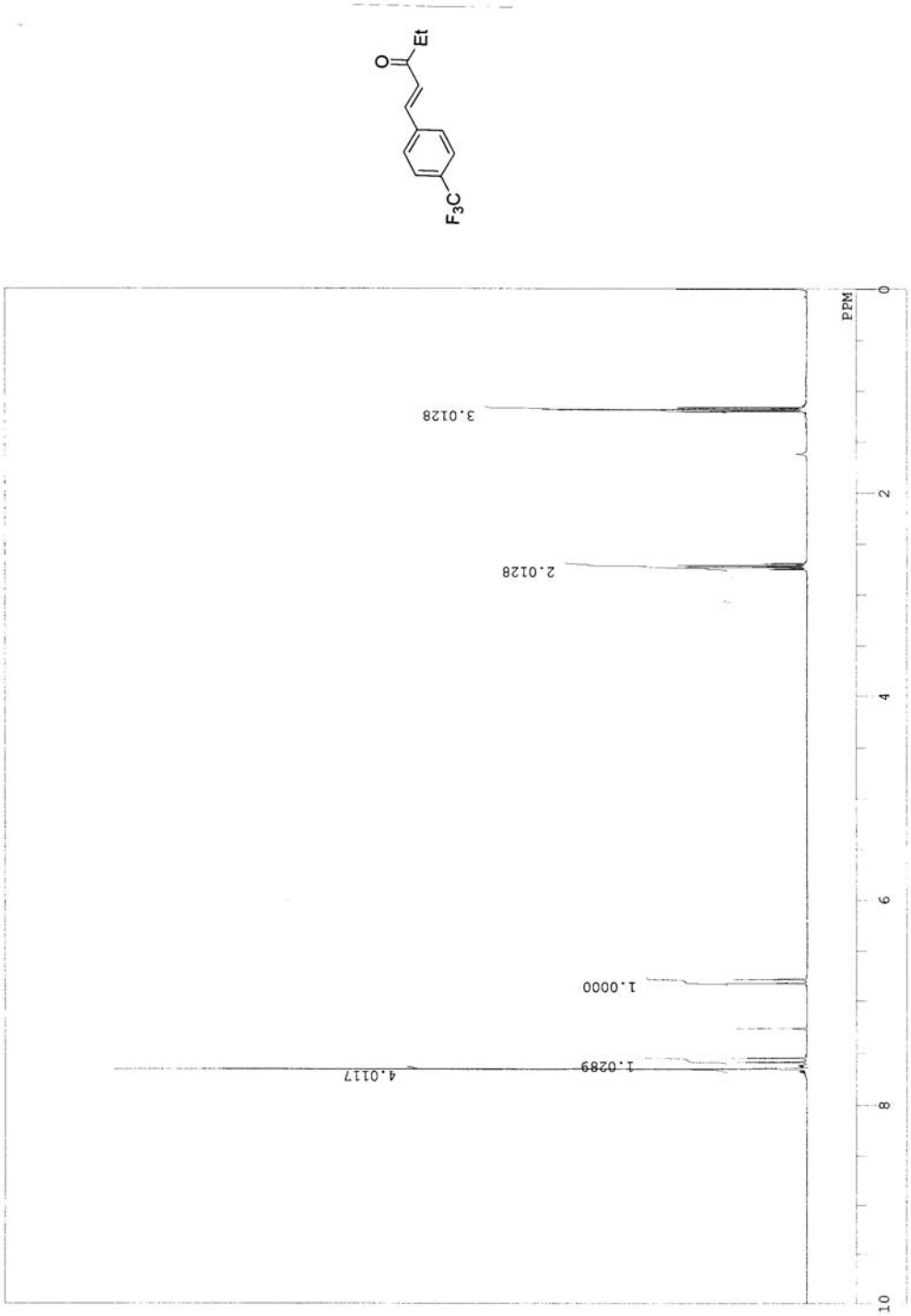

169.927
139.995
136.477
128.889
128.544
128.445
128.223
127.639
126.554
87.037
82.689
77.427
77.000
76.581
65.606
64.209
20.861
PPM
200
150
100
50
0

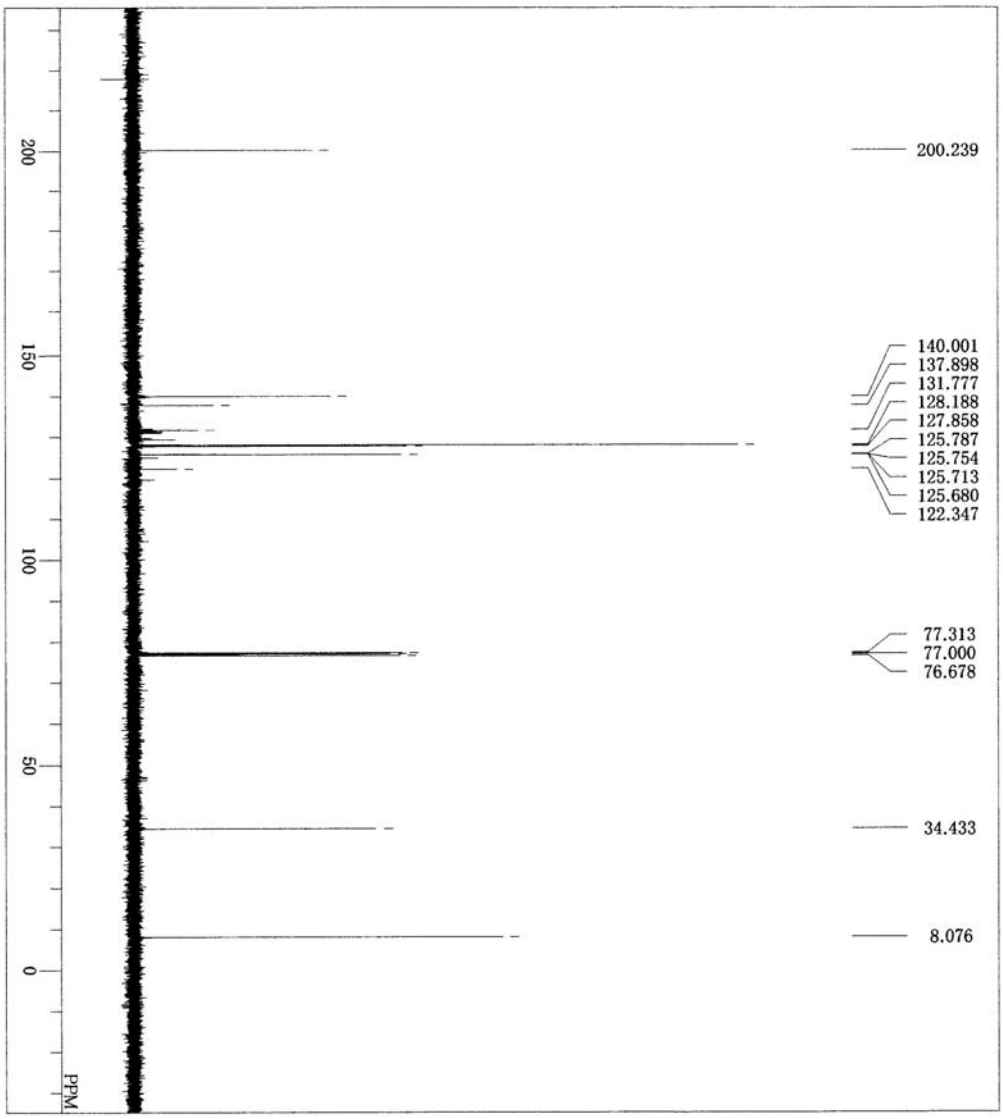
Alcohol 19



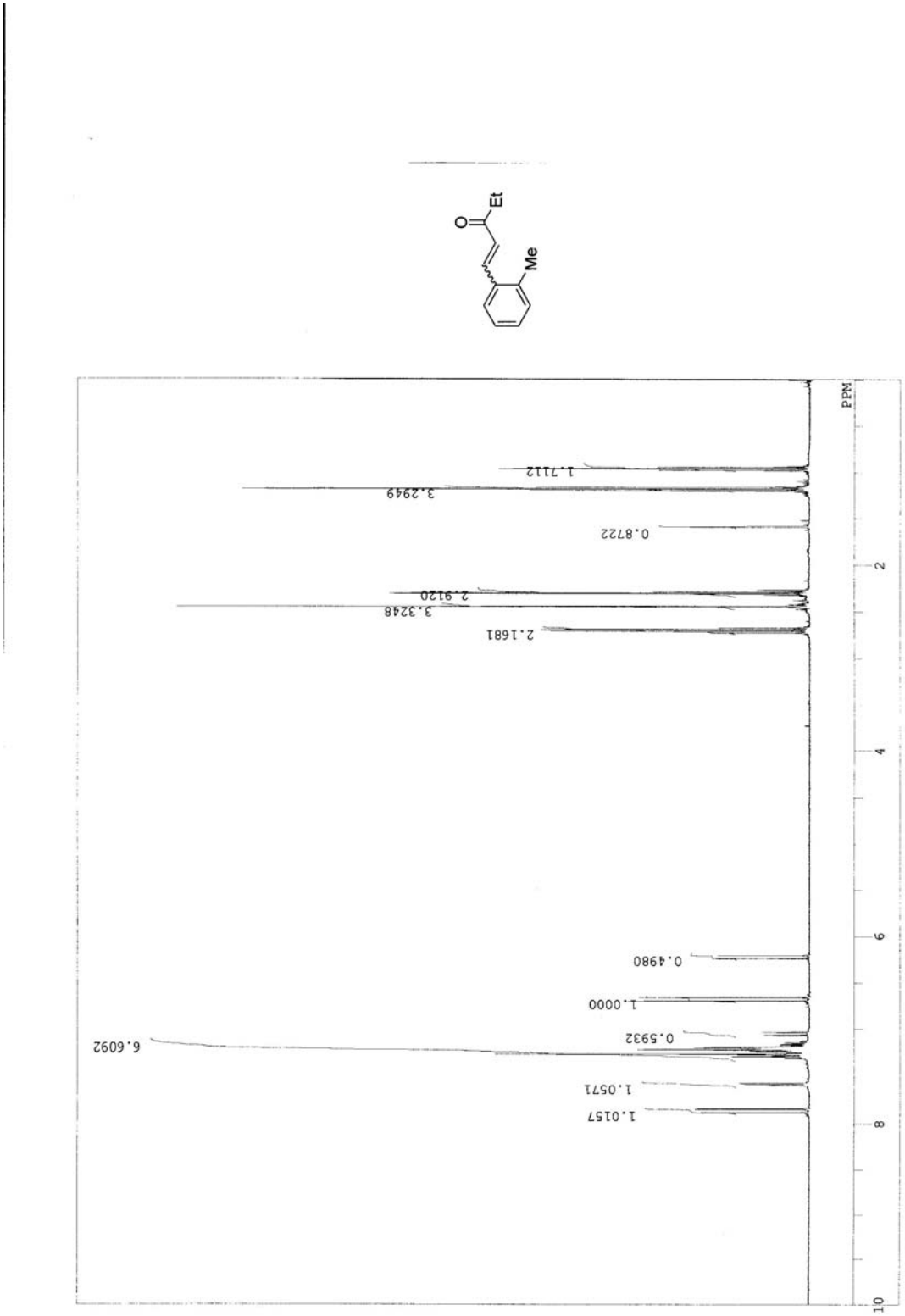

83.675
81.579
77.427
77.000
76.581
66.362
66.346
63.756
31.030
29.164
22.291
9.467
PPM
200
150
100
50
0

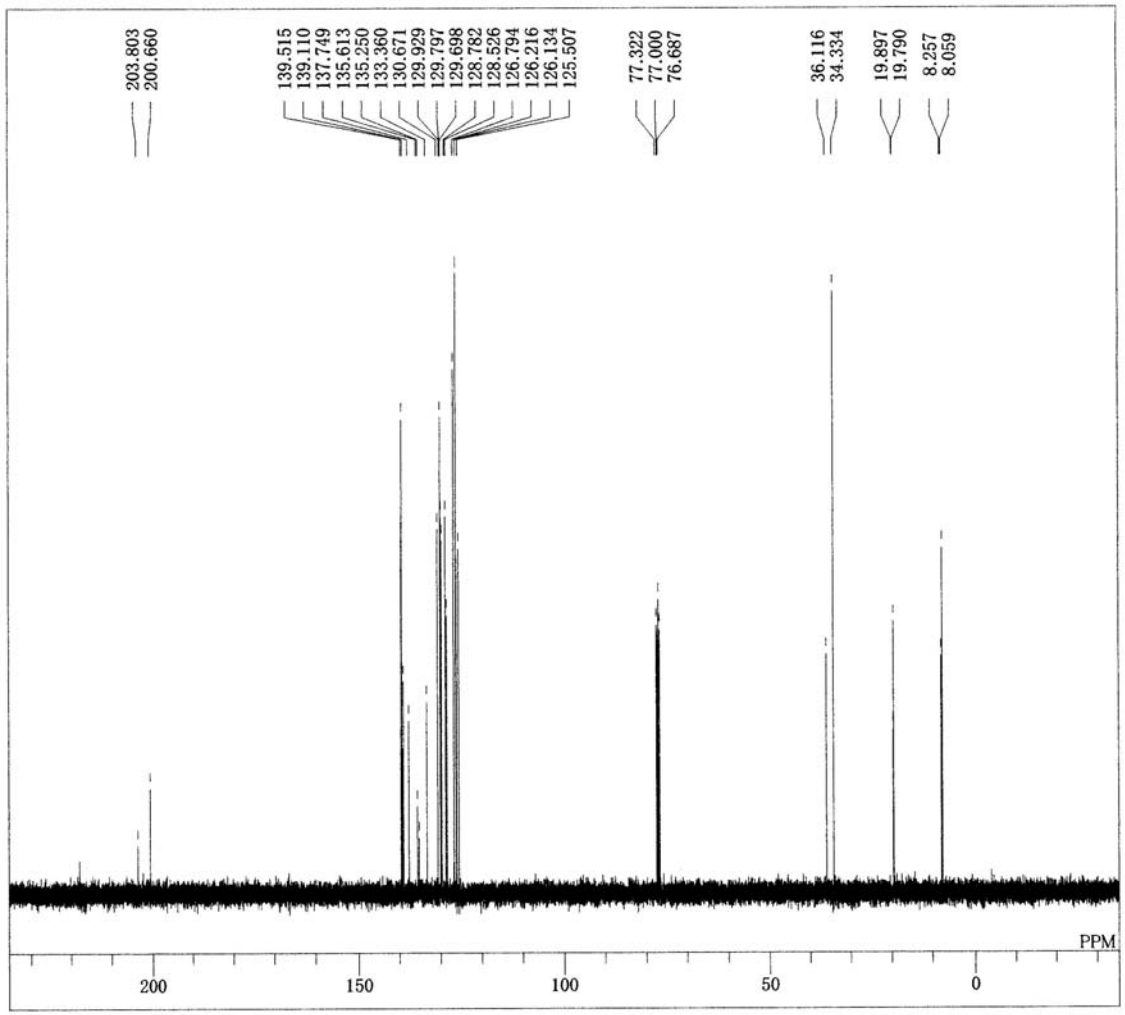
Ketone 2k



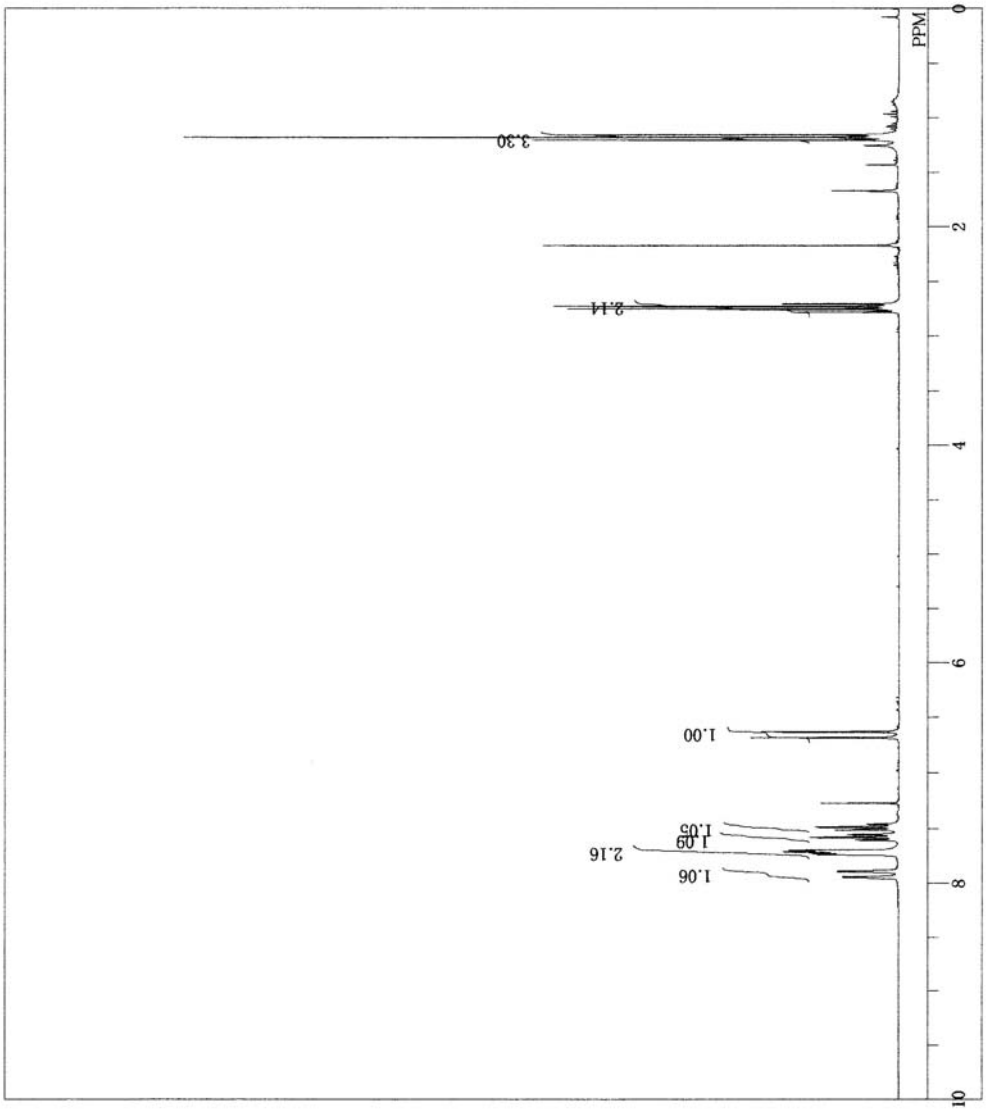

200.239
140.001
137.898
131.777
128.188
127.858
125.787
125.754
125.713
125.680
122.347
77.313
77.000
76.678
34.433
8.076
200
150
100
50
0
PPM

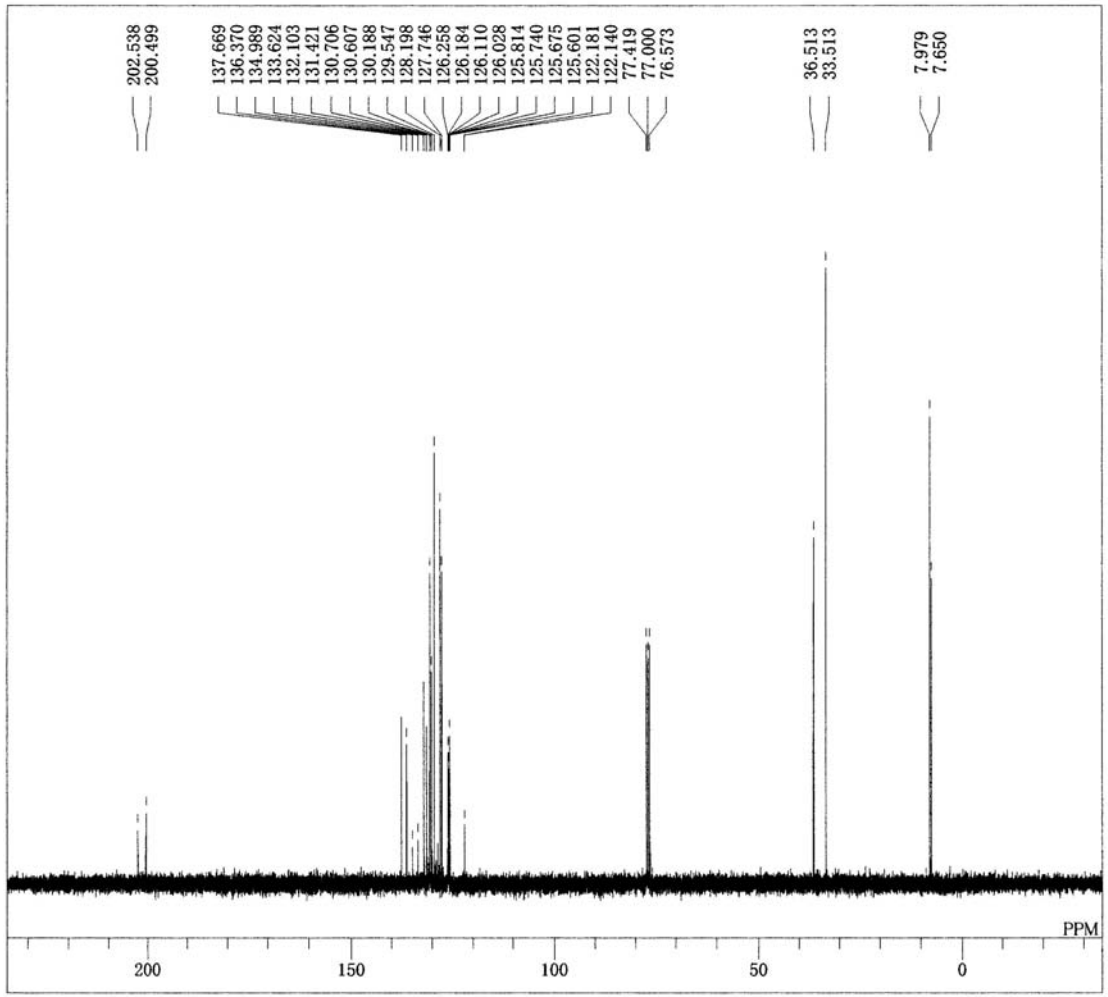
Ketone 2m (*E*:*Z* = 67:33)



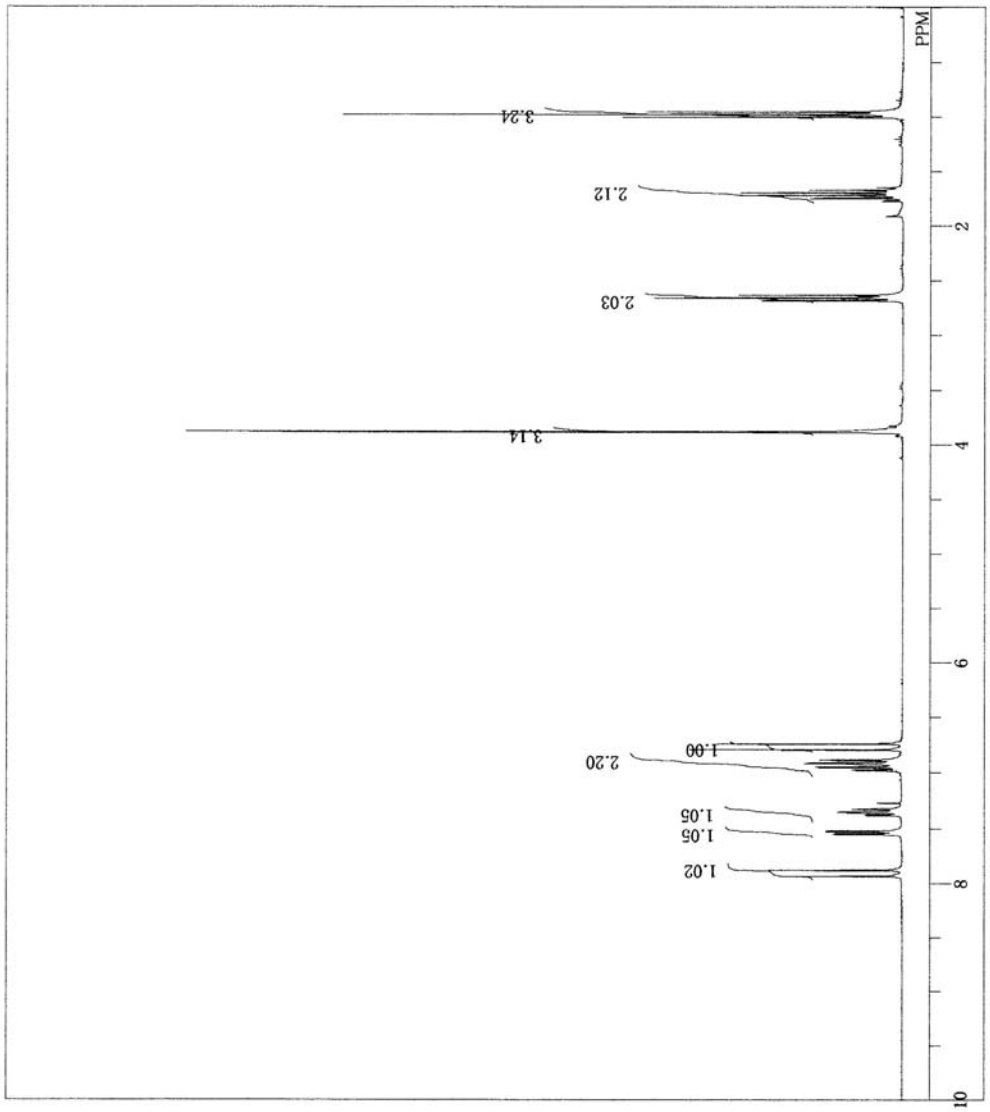

203.803
200.660
139.515
139.110
137.749
135.613
135.250
133.360
130.671
129.929
129.797
129.698
128.782
128.526
126.794
126.216
126.134
125.507
77.322
77.000
76.687
36.116
34.334
19.897
19.790
8.257
8.059
PPM
200
150
100
50
0

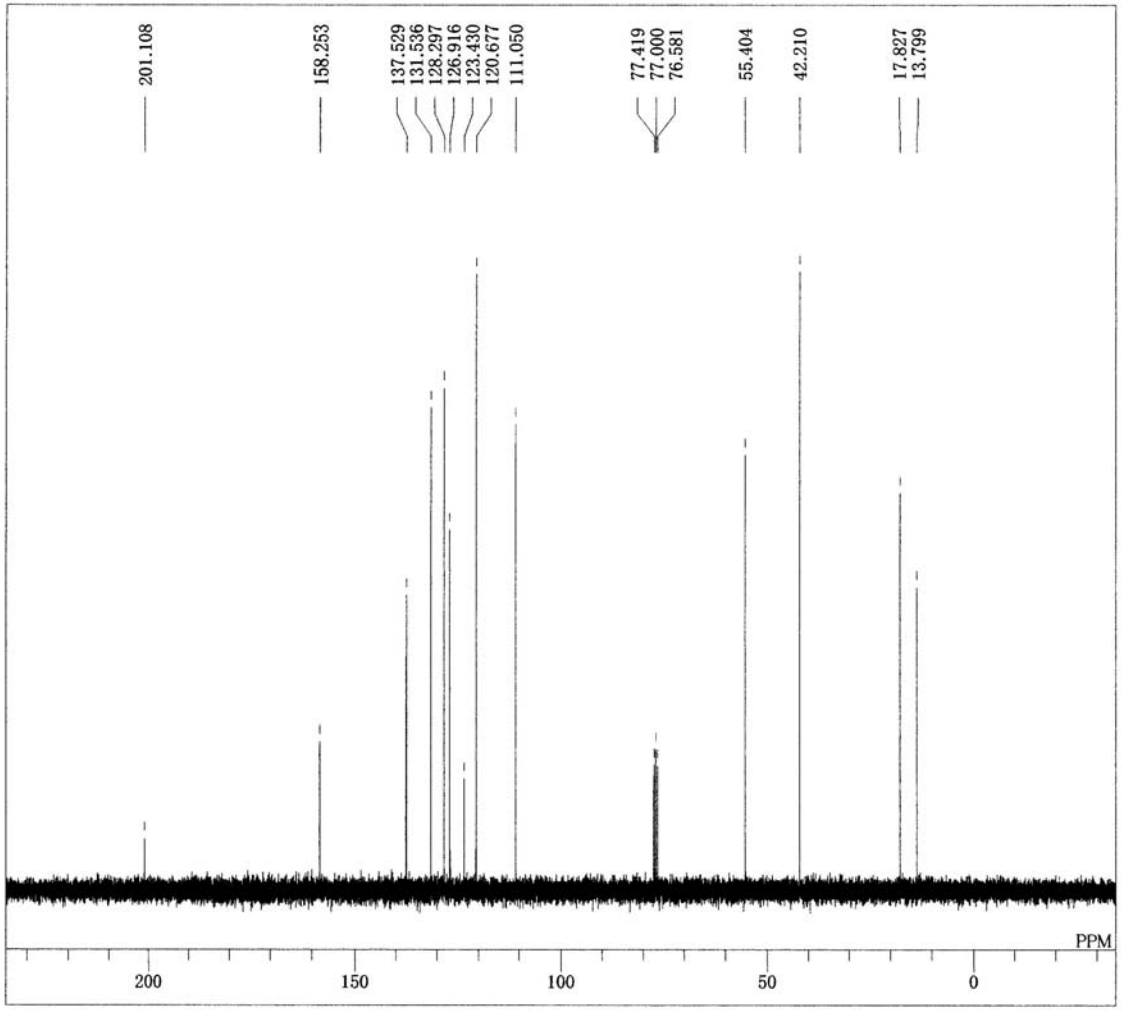
Ketone 2n (*E*:*Z* = 57:43)



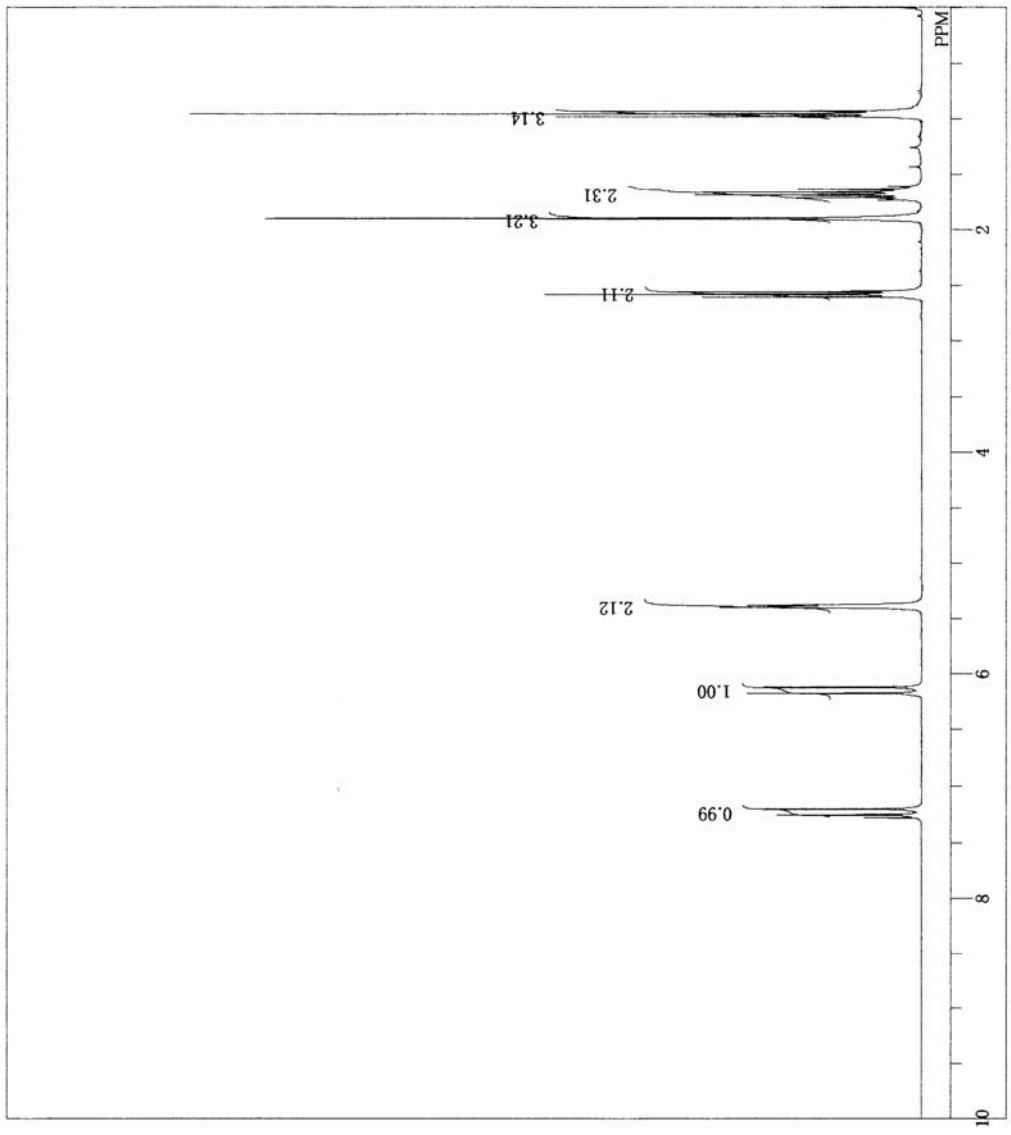

202.538
200.499
137.669
136.370
134.989
133.624
132.103
131.421
130.706
130.607
130.188
129.547
128.198
127.746
126.258
126.184
126.110
126.028
125.814
125.740
125.675
125.601
122.181
122.140
77.419
77.000
76.573
36.513
33.513
7.979
7.650
PPM
200
150
100
50
0

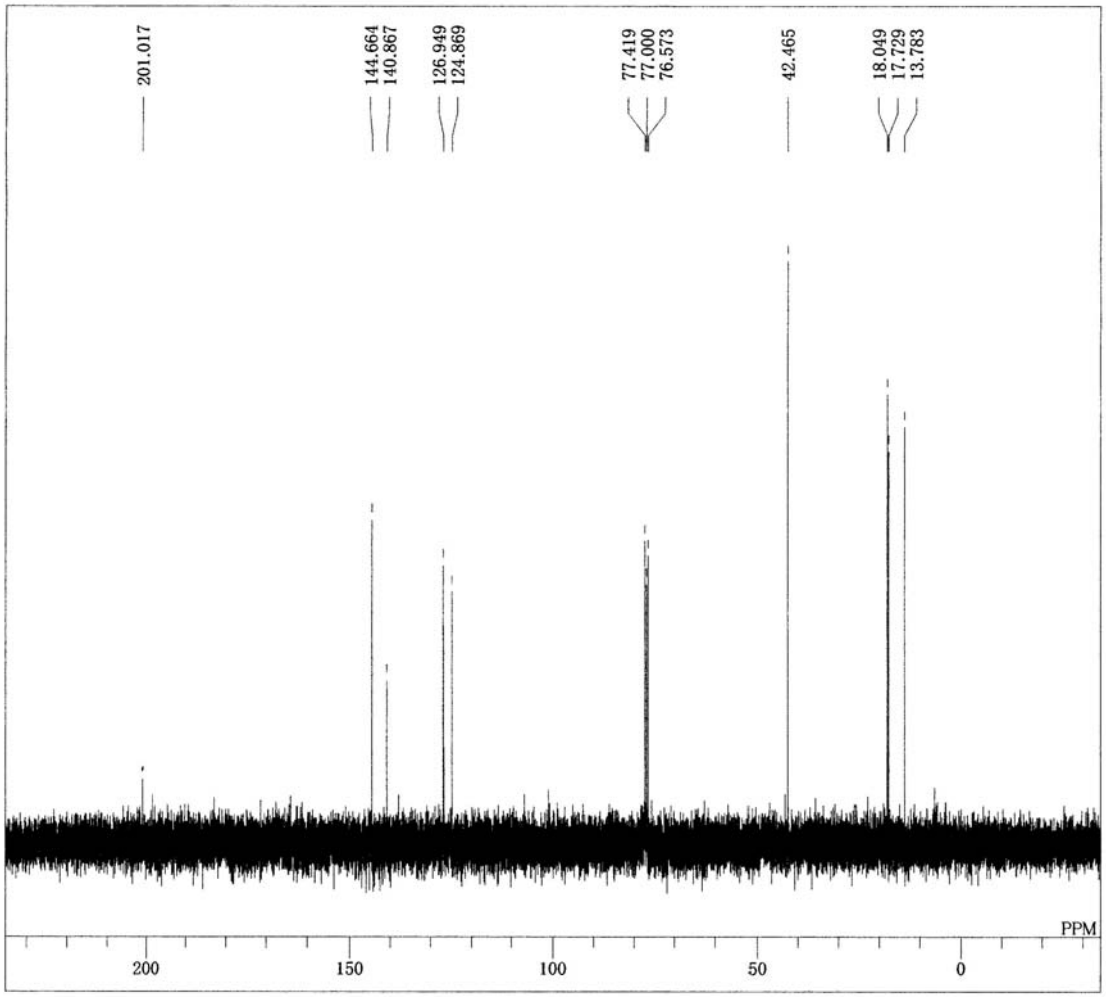
Ketone 2o



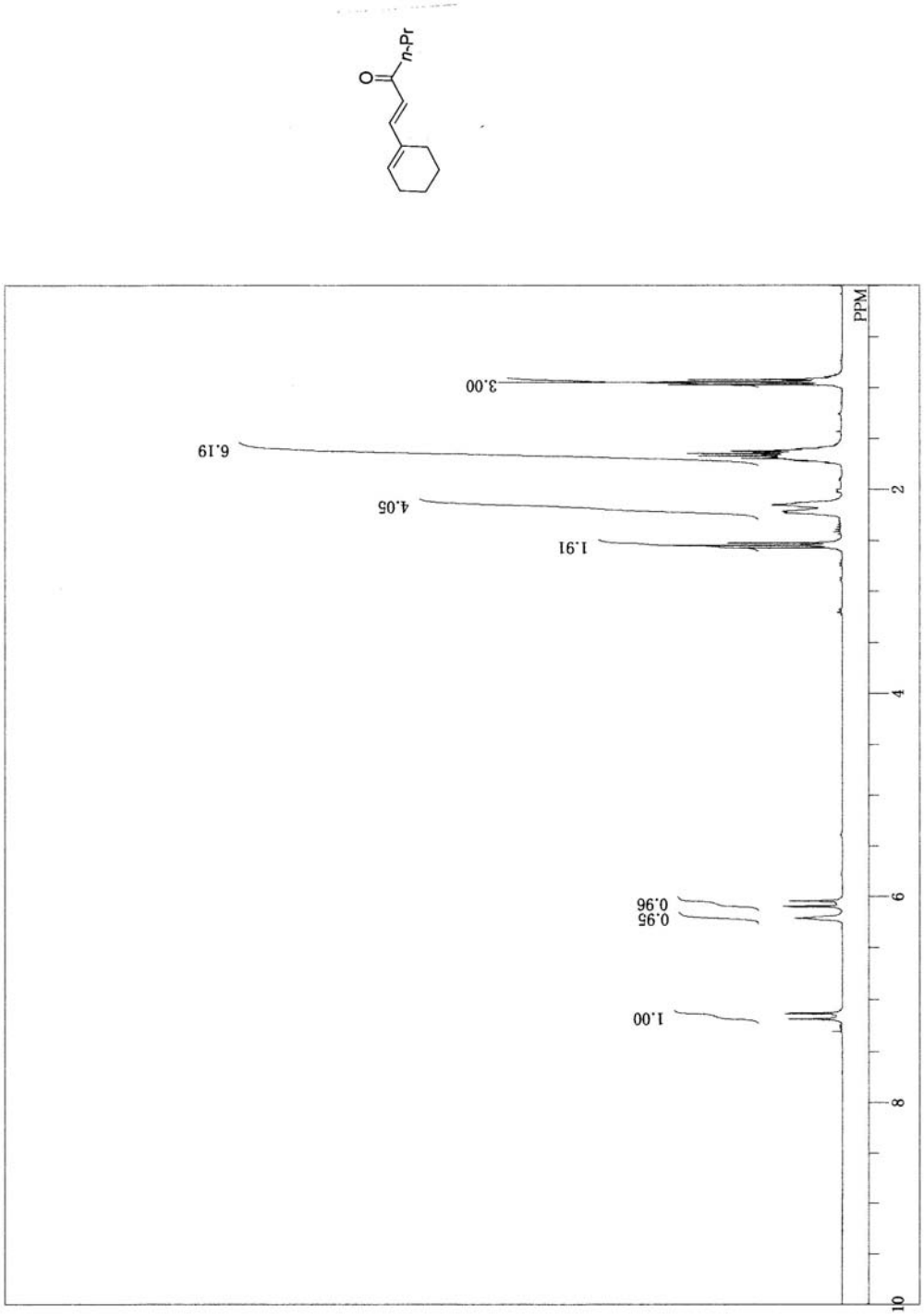

201.108
158.253
137.529
131.536
128.297
126.916
123.430
120.677
111.050
77.419
77.000
76.581
55.404
42.210
17.827
13.799
PPM
200
150
100
50
0

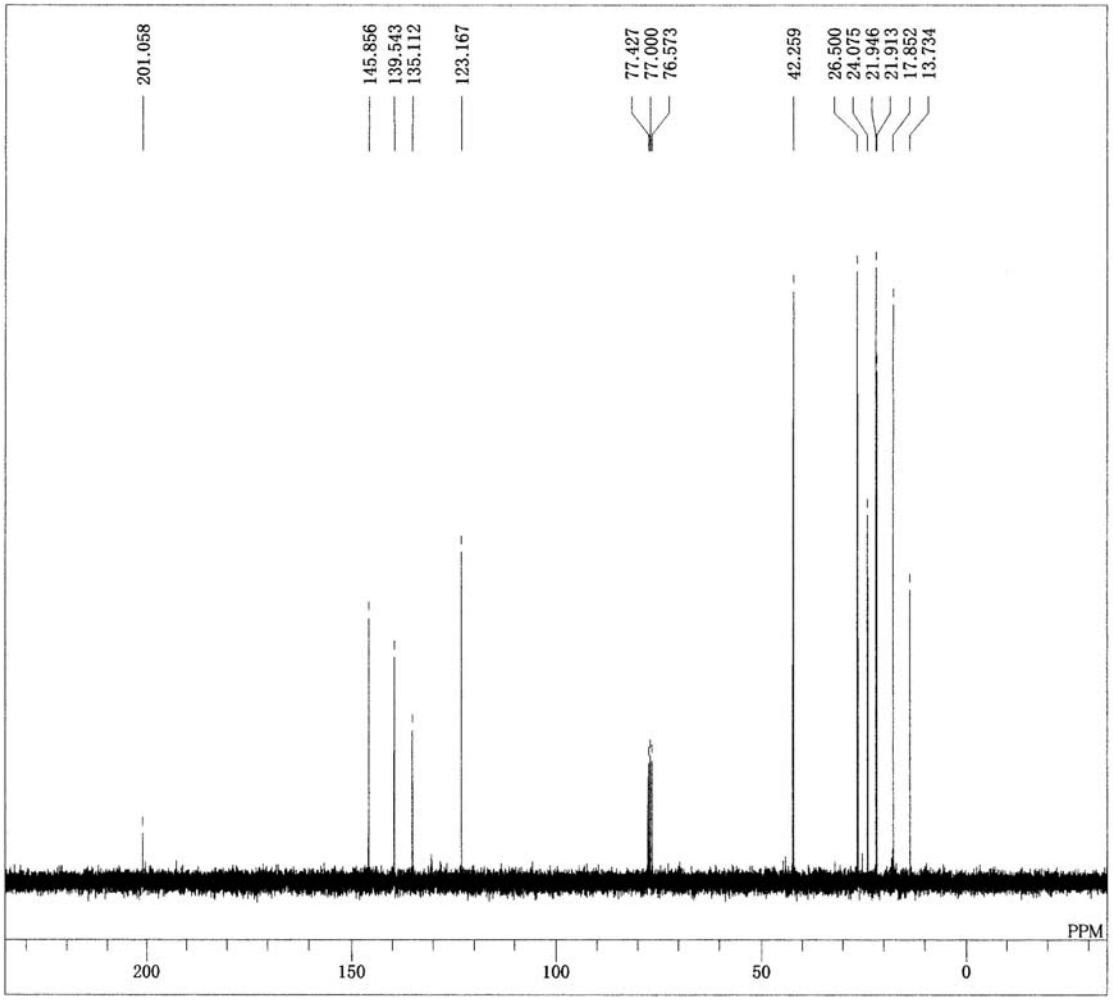
Ketone 2s



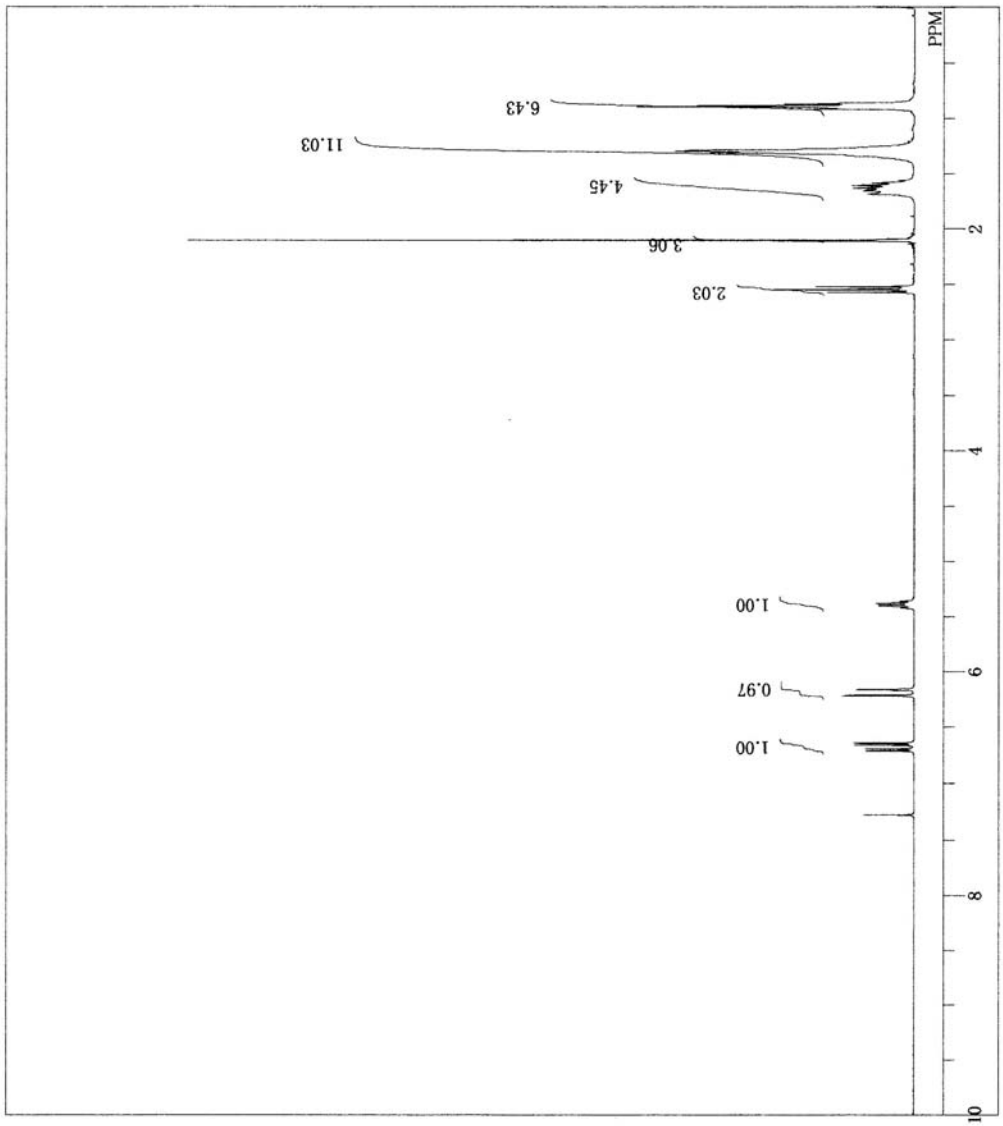

201.017
144.664
140.867
126.949
124.869
77.419
77.000
76.573
42.465
18.049
17.729
13.783
PPM
200
150
100
50
0

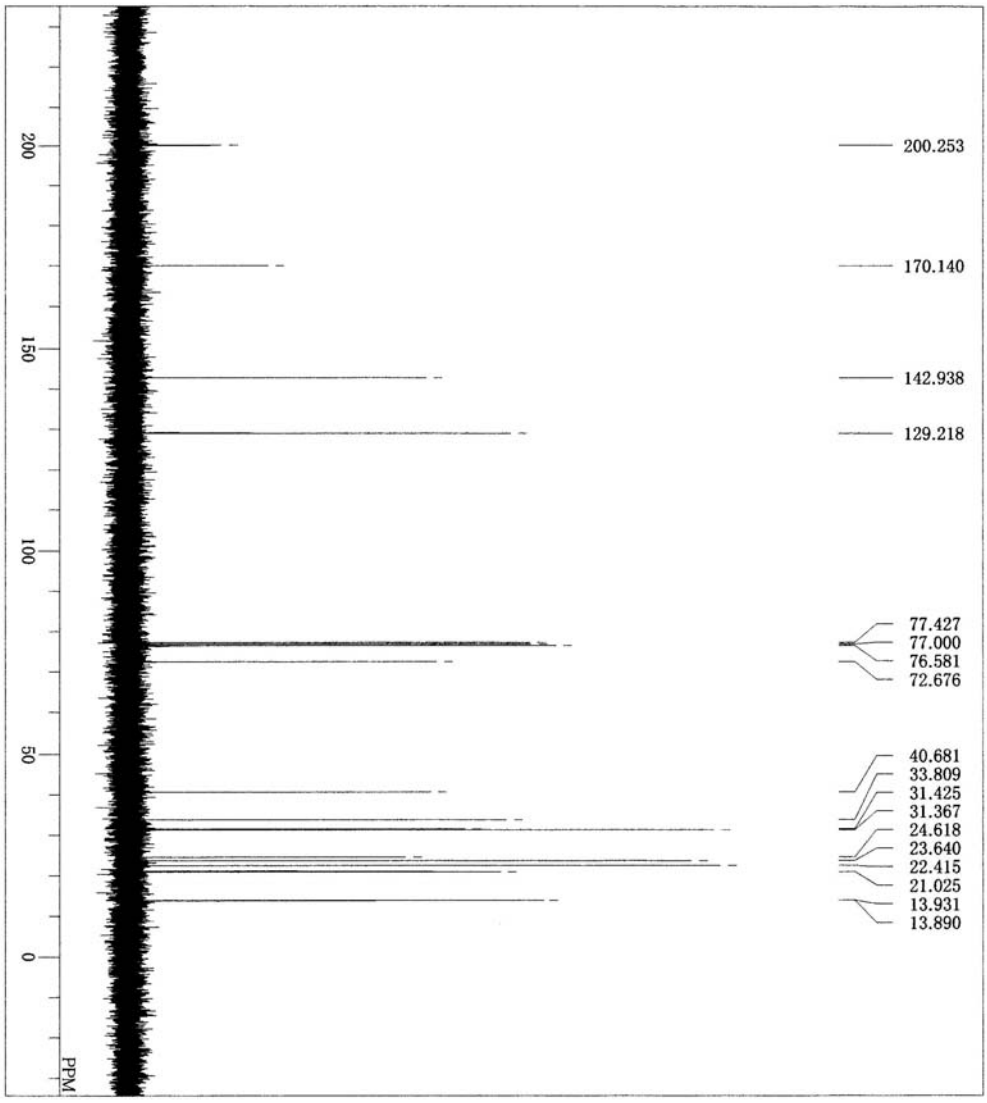
Ketone 2t



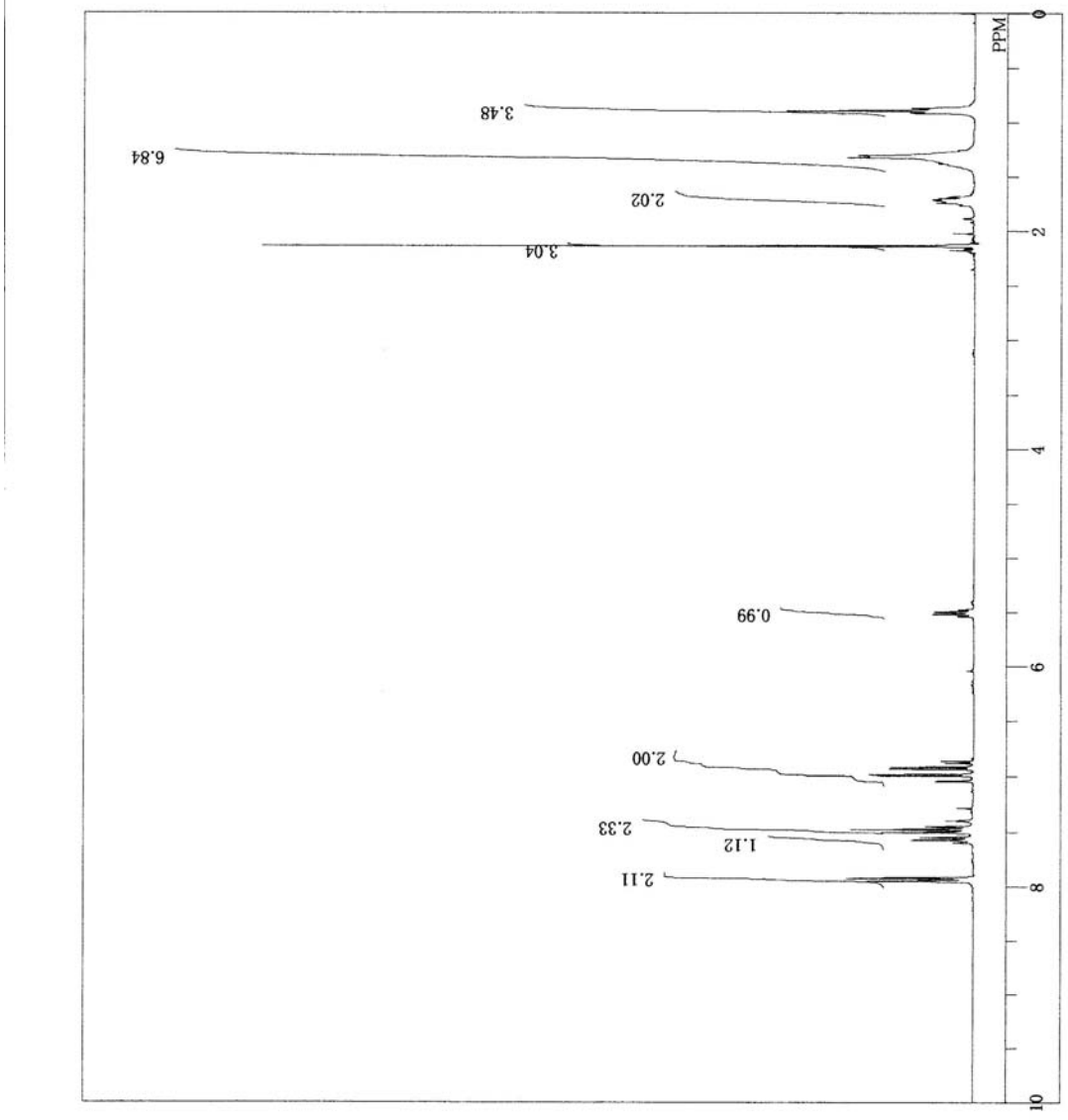

201.058
145.856
139.543
135.112
123.167
77.427
77.000
76.573
42.259
26.500
24.075
21.946
21.913
17.852
13.734
PPM
200
150
100
50
0

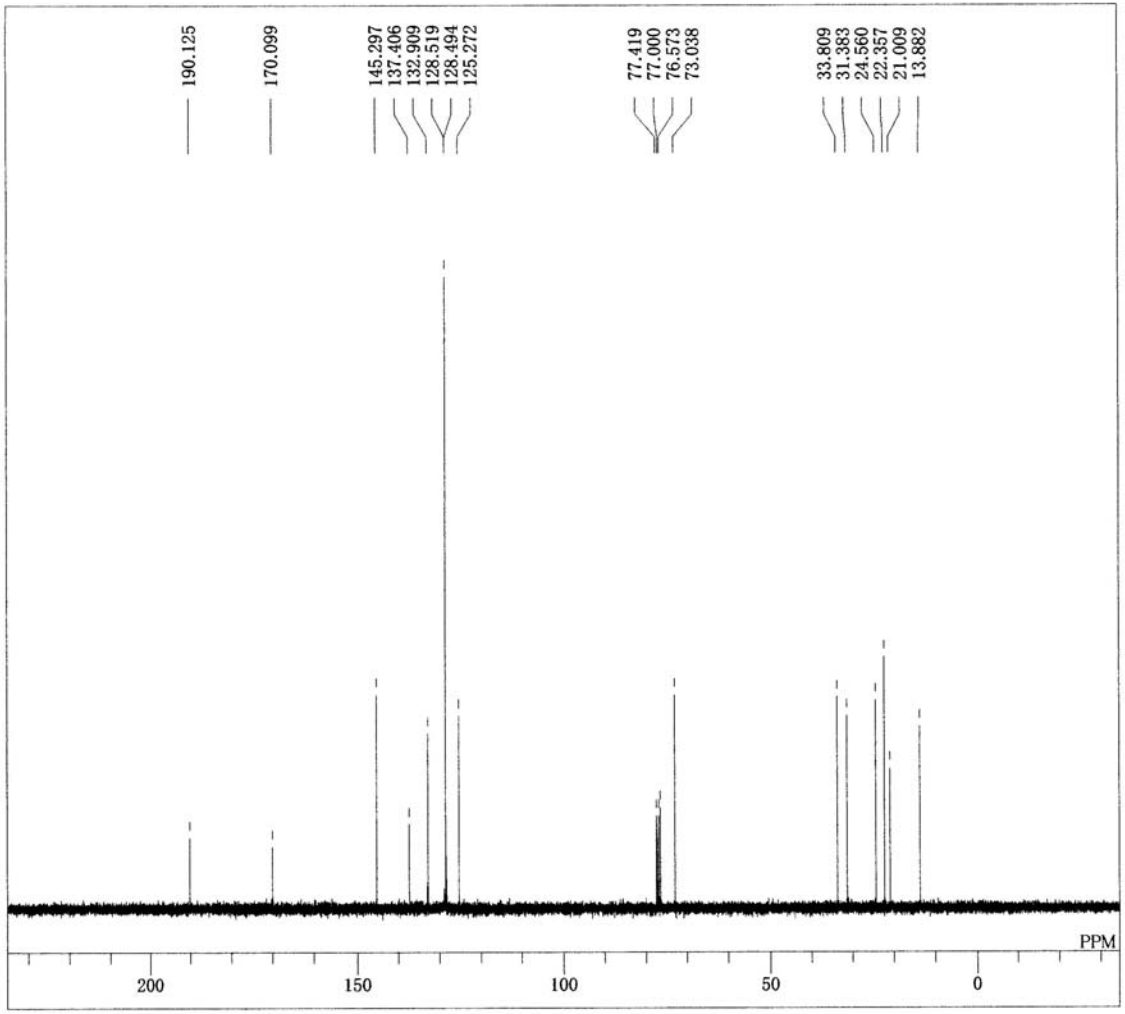
Ketone 12a



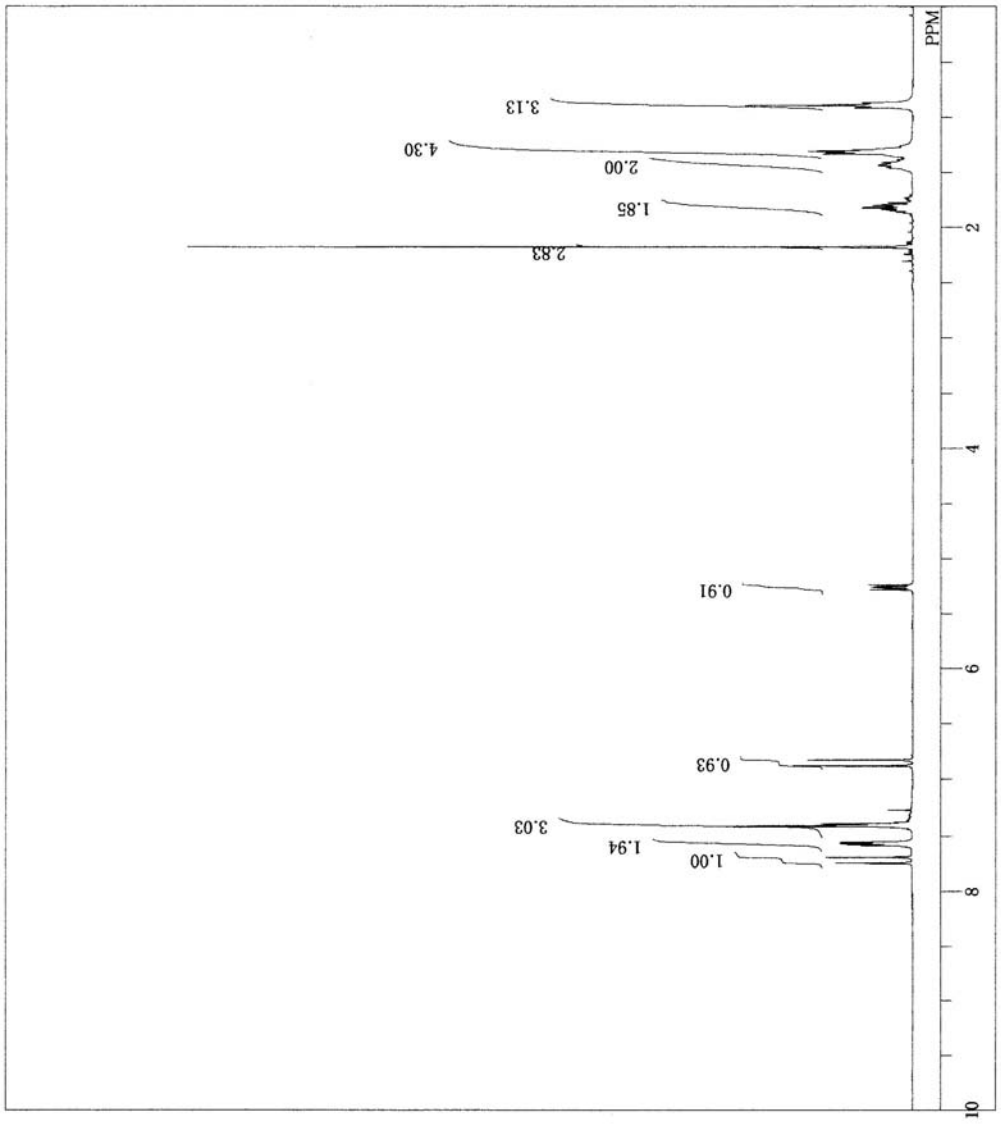

200
150
100
50
0
PPM
200.253
170.140
142.938
129.218
77.427
77.000
76.581
72.676
40.681
33.809
31.425
31.367
24.618
23.640
22.415
21.025
13.931
13.890

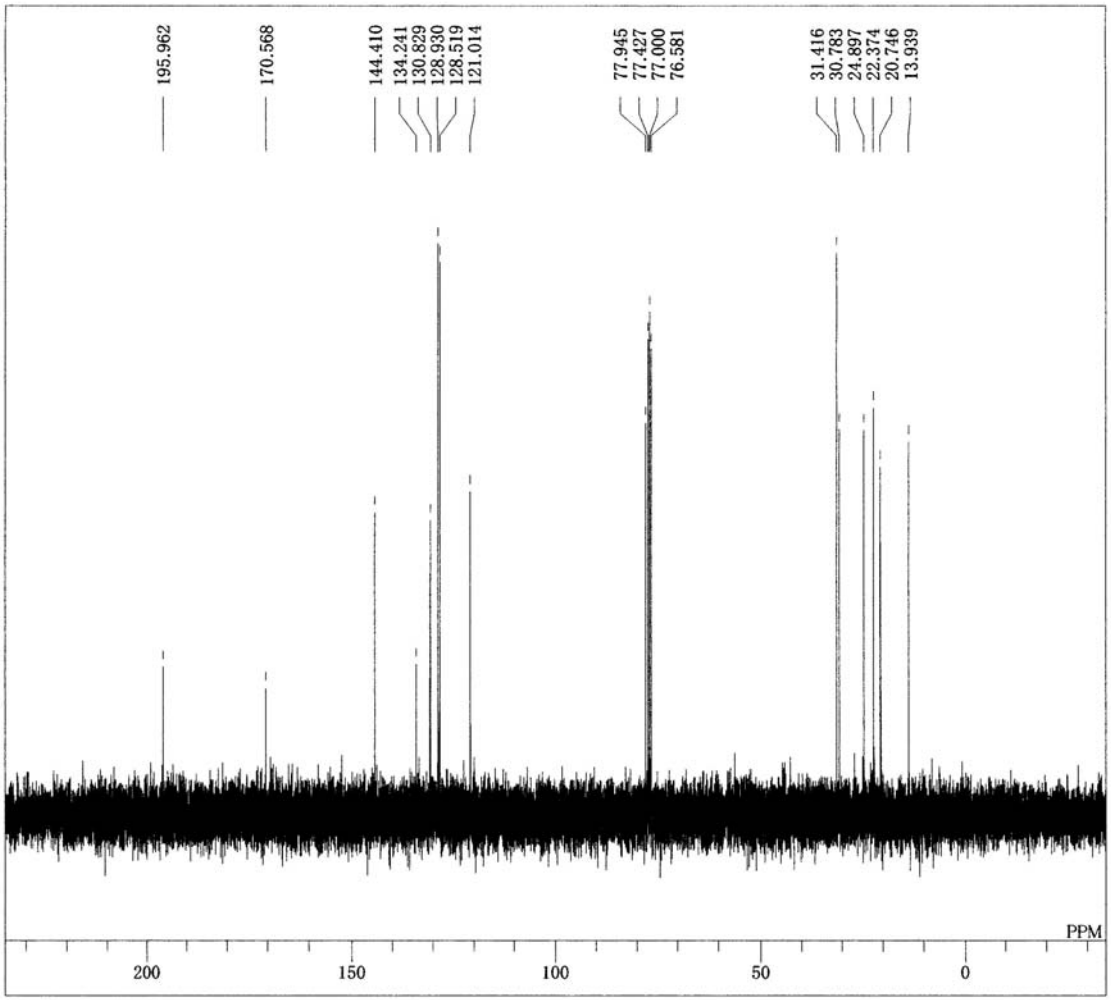
Ketone 12b



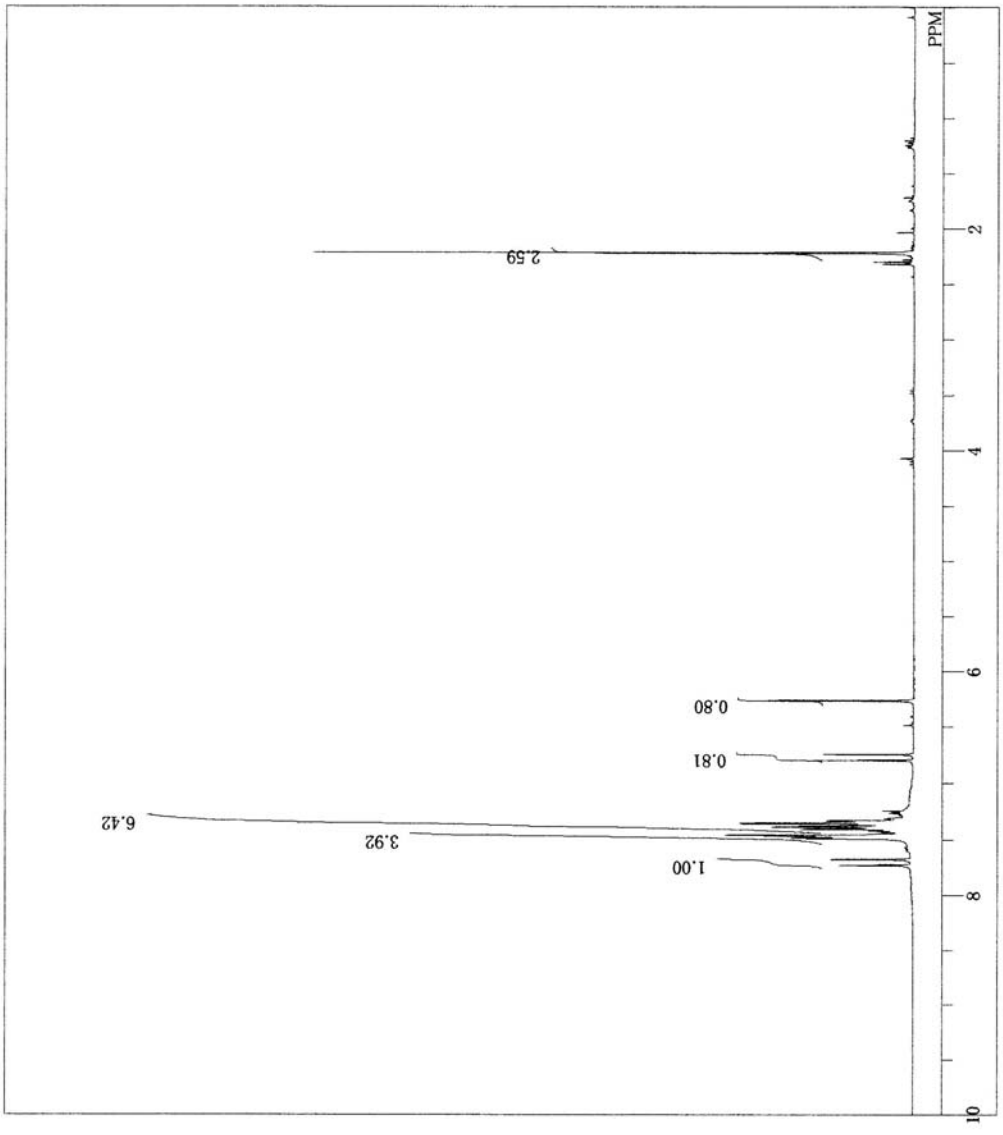

190.125
170.099
145.297
137.406
132.909
128.519
128.494
125.272
77.419
77.000
76.573
73.038
33.809
31.383
24.560
22.357
21.009
13.882
PPM
200
150
100
50
0

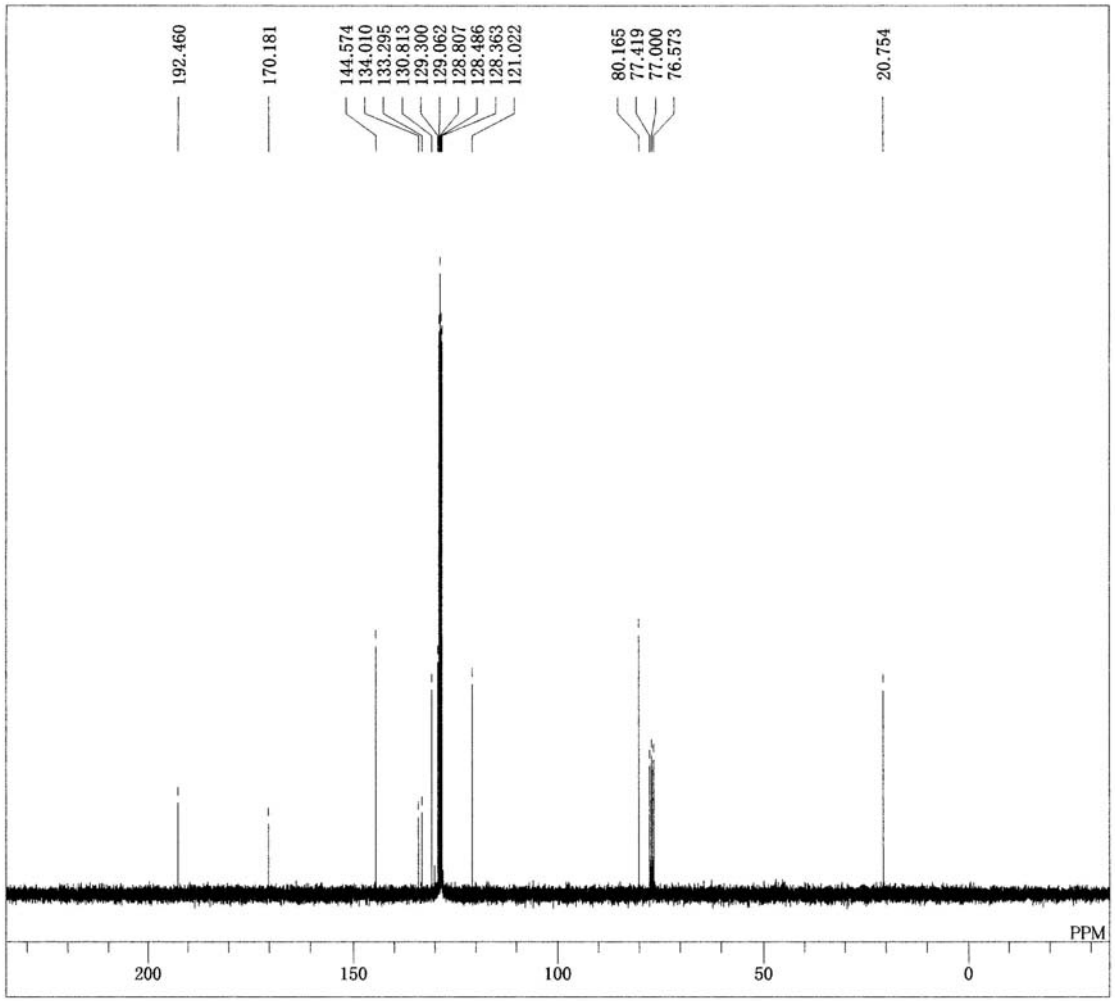
Ketone 13a


Ph
OAc
O
n-Pent
PPM
3.13
4.30
2.00
1.85
2.83
0.91
0.93
3.03
1.94
1.00
10
8
6
4
2

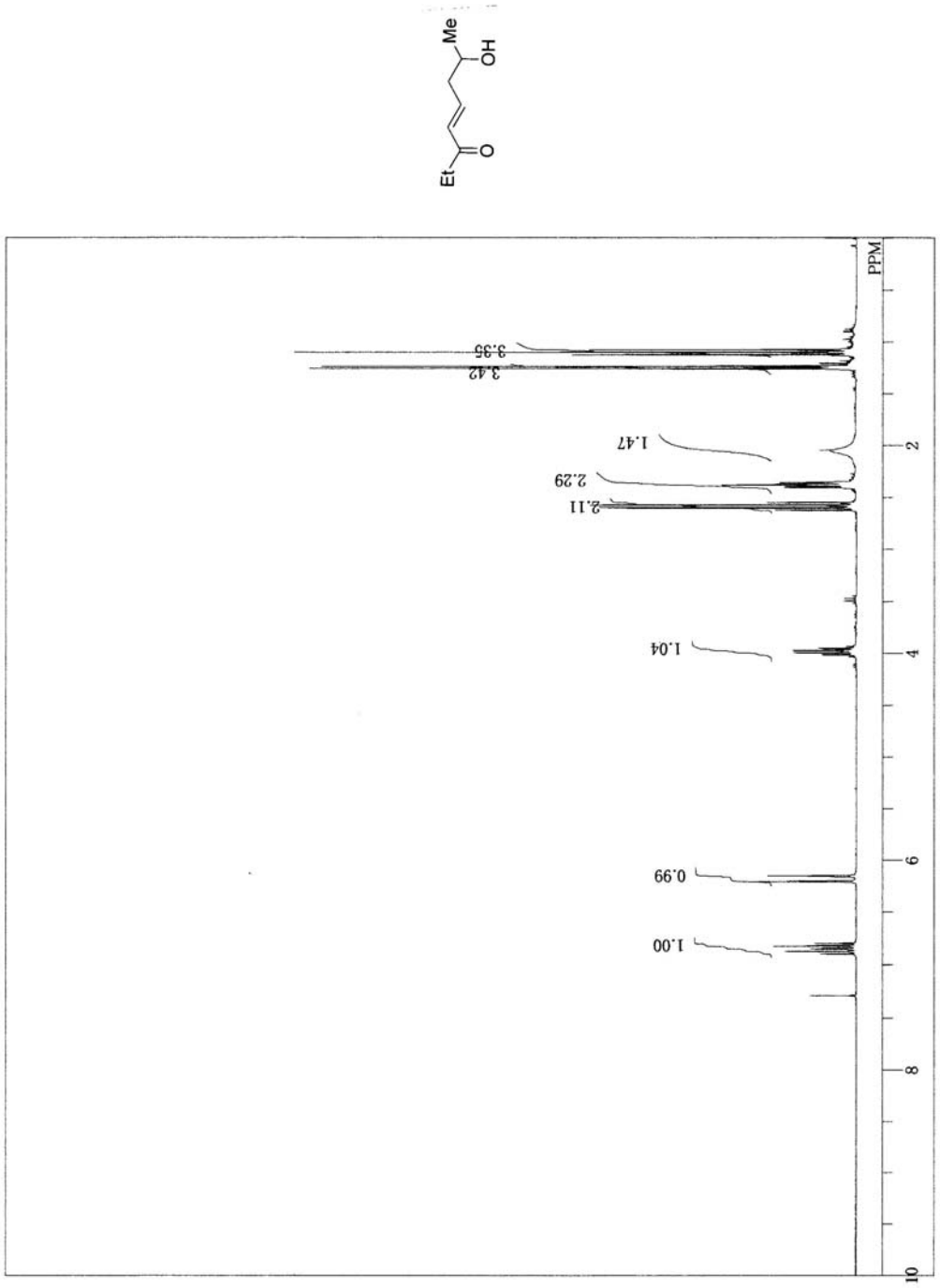

195.962
170.568
144.410
134.241
130.829
128.930
128.519
121.014
77.945
77.427
77.000
76.581
31.416
30.783
24.897
22.374
20.746
13.939
PPM
200
150
100
50
0

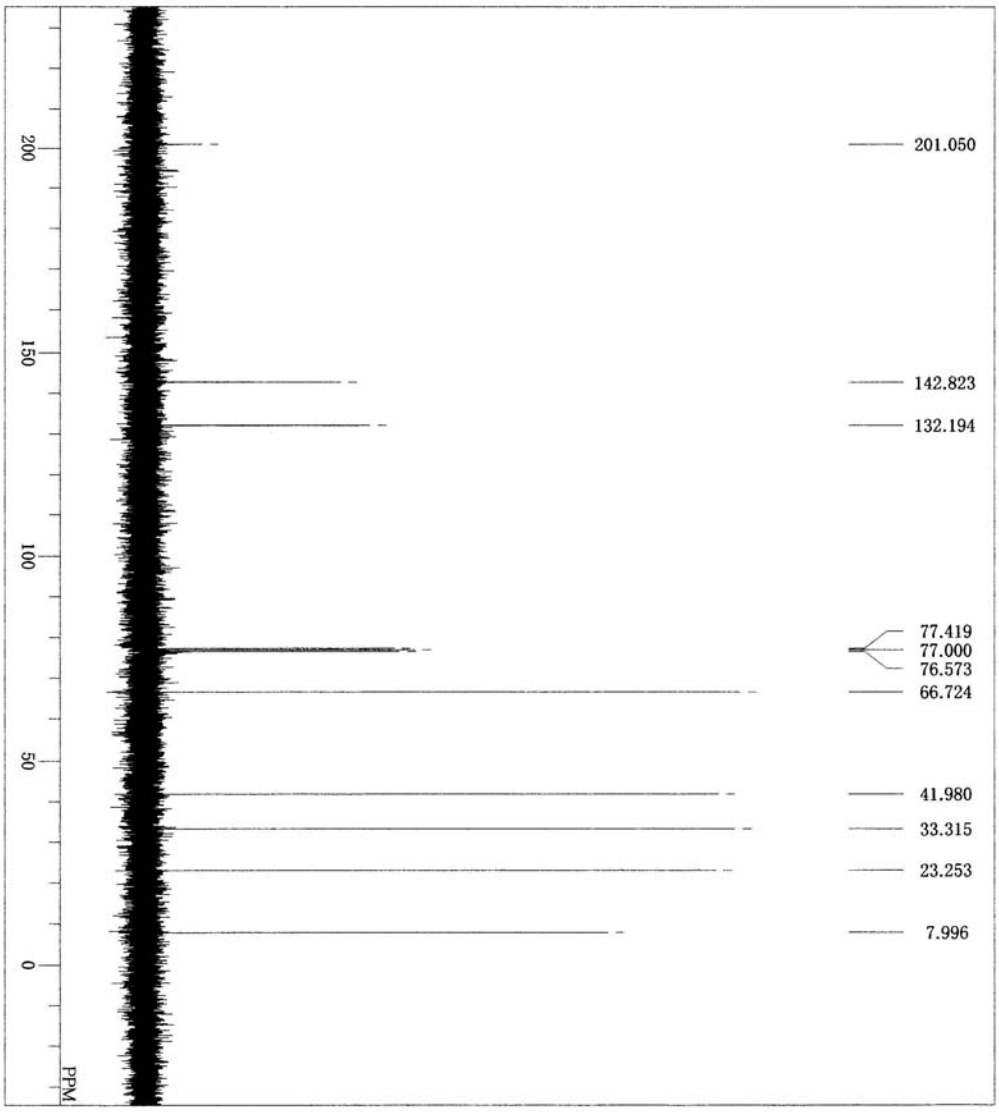
Ketone 13b




192.460
170.181
144.574
134.010
133.295
130.813
129.300
129.062
128.807
128.486
128.363
121.022
80.165
77.419
77.000
76.573
20.754
PPM
200
150
100
50
0

Ketone 20:




200
150
100
50
0
PPM
201.050
142.823
132.194
77.419
77.000
76.573
66.724
41.980
33.315
23.253
7.996