Electronic Supplementary Material (ESI) for Organic Chemistry Frontiers.

A Photo-induced C-C Bond Formation Methodology to Construct Tetrahydrofluorenones and Related Structures

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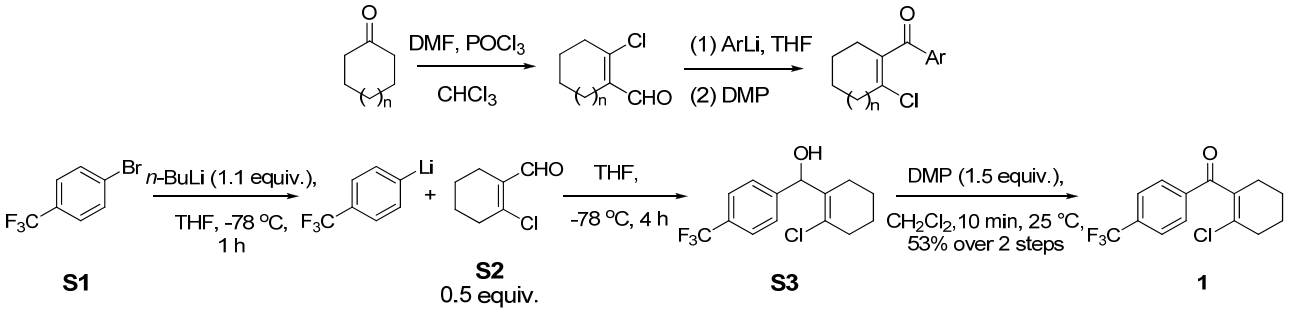
Supporting Information

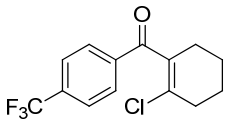
General Experimental Procedures. All reactions were carried out under nitrogen except noted. Anhydrous dichloromethane (CH_2Cl_2) and 1,2-dichloroethane (DCE) were distilled from calcium hydride. Tetrahydrofuran (THF) was distilled from sodium-benzophenone ketyl, and anhydrous toluene was prepared from sodium. Flash column chromatography was performed as described by Still (Still, W. C.; Kahn, M.; Mitra, A. *J. Org. Chem.* **1978**, *43*, 2923–2925), employing Qingdao Haiyang silica gel 60 (200–300 mesh) TLC analyses were performed on EMD 250 μm Silica Gel $HSGF_{254}$ plates and visualized by quenching of UV fluorescence (λ_{max}= 254 nm), or by staining ceric ammonium molybdate, ammonium molybdate, or potassium permanganate. ^1H and ^{13}C NMR spectra were recorded on a Bruker-500, 400 spectrometer. Chemical shifts for ^1H and ^{13}C NMR spectra are reported in ppm (δ) relative to residue protium in the solvent ($CDCl_3$: δ 7.26, 77.0 ppm;) and the multiplicities are presented as follows: s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet. High-resolution mass spectra (HRMS) were acquired on a waters GCT premier. The photo reactor used for this photolysis is Rayonet RPR-200 (Southern New England Ultraviolet Company).

General procedure for the photolysis:

A solution of substrate and diisopropylamine (4 μL / mL) in anhydrous 1,2-dichloroethane (4 mg / mL) was added in a quartz tube. This mixture was degassed by bubbling nitrogen through the solution for 0.5 h. It was then photolyzed at 25 °C in a Rayonet chamber reactor (16 lamps, 50/60 Hz, photos of 254 nm ultraviolet--1.65×10^{16} sec/cm^3) at 254 nm for indicated time shown in tables. TLC showed all substrate consumed (**Cautions**: **Turn off the photo reactor before checking the reaction. Serious eye and skin burns will result from exposure to the direct or indirect rays.**), then 1,2-dichloroethane was evaporated. The residue was purified by silica gel column chromatography to give product.

General procedure for preparation of the precursors of the photolysis:

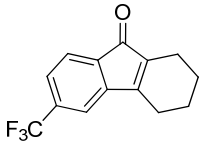




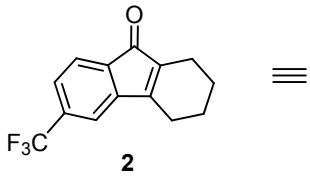
To a solution of **S1** (1.05 mL, 7.5 mmol, 2.0 equiv.) in anhydrous tetrahydrofuran (40 mL) was added *n*-BuLi (3.3 mL, 2.5 M solution in pentane, 8.2 mmol, 2.2 equiv.) at -78 °C over 10 min. After 1 h, a solution of **S2** (549.5 mg, 3.8 mmol, 1.0 equiv.) in anhydrous tetrahydrofuran (5 mL) was added to the above mixture over 10 min at the same temperature. After 6 h, TLC showed all **S2** consumed, the reaction was quenched with water (20 mL). The aqueous phase was extracted with ethyl acetate (20 mL×3), and the organic layer was washed with water (25 mL) and brine (25 mL). The organic phase was dried over anhydrous sodium sulfate, filtered, concentrated, and purified by silica gel column chromatography (10% ethyl acetate–hexane) to give **S3** as colorless oil (790 mg, 72%): R_f = 0.46 (10% ethyl acetate-petroleum ether). The product **S3** was found to be unstable and was carried on to the oxidation step without full characterization.

To a solution of **S3** (790 mg, 2.7 mmol, 1.0 equiv.) in anhydrous dichloromethane (18 mL) was added Dess-Martin Periodinane (1746 mg, 4.1 mmol, 1.5 equiv.) at 25 °C. After stirring for 5 min, a solution of water in dichloromethane (1 μL water /1 mL CH_2Cl_2, 75 μL, 4.1 mmol, 1.5 equiv.) was added. After about 10 min, TLC showed all **S3** consumed, then dichloromethane was evaporated and ethyl acetate (20 mL) and an aqueous solution of 1:1 10% sodium thiosulphate to saturated sodium bicarbonate (20 mL) was then added. After stirring for another 10 min, the biphasic mixture was extracted with ethyl acetate (20 mL×3), the combined organic phase was washed with saturated sodium bicarbonate (20 mL), dried over anhydrous sodium sulfate, filtered, concentrated, and purified by silica gel column chromatography (4% ethyl acetate–hexane) to **1** as white solid (570 mg, 74%): R_f = 0.59 (10% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.02 (d, *J* = 8.1 Hz, 2H), 7.74 (d, *J* = 8.1 Hz, 2H), 2.58 – 2.43 (m, 2H), 2.43 – 2.28 (m, 2H), 1.95 – 1.83 (m, 2H), 1.83 – 1.71 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 196.1, 138.2, 134.7 (q, *J* = 34.0

Hz), 133.9, 131.4, 129.6, 125.8 (q, J = 4.0 Hz), 123.6 (q, J = 271.0 Hz), 33.2, 28.5, 23.3, 21.3 ppm; MS (m/z) (%): EI [M] calcd for $C_{14}H_{12}ClF_3O$ [M]$^+$: 288.05, found 290 (3), 288 (9), 221 (33), 219 (100), 173 (71), 145 (87), 79 (31).



Ketone **2** (40 mg) was prepared according to the general procedure of the photo reaction from **1** in 79% yield. The reaction time is 2 h under 254 nm light. The products were isolated through silica gel flash chromatography (5% ethyl acetate-petroleum ether) as yellow solid: R_f = 0.58 (10% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.47 – 7.42 (m, 2H), 7.14 (s, 1H), 2.52 – 2.44 (m, 2H), 2.29 – 2.24 (m, 2H), 1.89 – 1.80 (m, 2H), 1.80 – 1.70 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 195.8, 157.7, 145.7, 135.4, 134.7 (q, J = 34.0 Hz), 134.4, 125.8 (q, J = 4.0 Hz), 123.7 (q, J = 271.0 Hz), 121.3, 114.7 (q, J = 4.0 Hz), 22.9, 21.7, 21.7, 19.7 ppm; HRMS (EI): Exact mass calcd for $C_{14}H_{11}F_3O$ [M]$^+$: 252.0762; found 252.0763. Recrystallization of **2** from ethyl acetate–hexane gave single crystals suitable for X-ray analysis (CCDC: 1437983).



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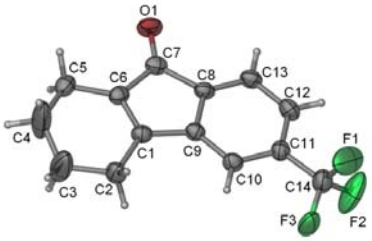
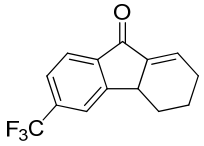
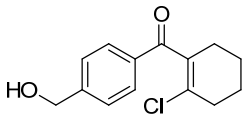


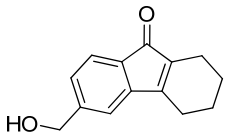
CCDC 1437983



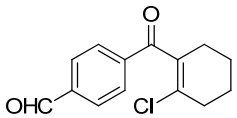
Ketone **3** was isolated through silica gel flash chromatography (7% ethyl acetate-petroleum ether) as yellow solid: R_f = 0.31 (10% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.92 (d, J = 8.0 Hz, 1H), 7.78 (s, 1H), 7.65 (d, J = 8.0 Hz, 1H), 7.02 – 6.90 (m, 1H), 3.57 (d, J = 10.6 Hz, 1H), 2.62 – 2.43 (m, 2H), 2.46 – 2.25 (m, 1H), 2.19 – 2.02 (m, 1H), 1.92 – 1.77 (m, 1H), 1.32 – 1.18 (m, 1H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 191.4, 153.1, 141.2, 140.9, 135.6, 135.5 (q, J = 32.0 Hz), 124.6 (q, J = 4.0 Hz), 124.5, 123.7 (q, J = 271.0 Hz), 122.0 (q, J = 4.0 Hz), 39.6, 26.6, 25.6, 22.3 ppm; HRMS (EI): Exact mass calcd for $C_{14}H_{11}F_3O$ [M]$^+$: 252.0762; found 252.0761.



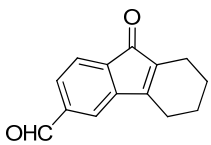
Enone **S14** was prepared as colorless oil: R_f = 0.25 (30% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.86 (d, J = 8.1 Hz, 2H), 7.42 (d, J = 8.1 Hz, 2H), 4.72 (s, 2H), 2.88 (s, 1H), 2.52 – 2.39 (m, 2H), 2.37 – 2.25 (m, 2H), 1.87 – 1.78 (m, 2H), 1.78 – 1.65 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 197.2, 147.1, 134.4, 134.1, 129.9, 129.6 (2C), 126.7 (2C), 64.3, 33.0, 28.6, 23.3, 21.3 ppm; MS (m/z) (%): EI [M] calcd for $C_{14}H_{15}ClO_2$ $[M]^+$: 250.08, found 252 (1), 250 (2), 221 (34), 219 (100), 135 (62), 89 (28), 77 (42).



Ketone **4** (51 mg) was prepared according to the general procedure of the photo reaction from **S4** in 93% yield. The reaction time is 4 h under 254 nm light. The products were isolated through silica gel flash chromatography (15% ethyl acetate-petroleum ether) as yellow solid: R_f = 0.24 (30% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.27 (d, J = 7.4 Hz, 1H), 7.08 (d, J = 7.2 Hz, 1H), 6.93 (s, 1H), 4.64 (s, 2H), 2.46 – 2.32 (m, 2H), 2.25 – 2.13 (m, 2H), 1.83 – 1.75 (m, 2H), 1.75 – 1.62 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 197.3, 157.9, 146.5, 145.5, 134.3, 130.9, 125.9, 121.6, 116.9, 64.9, 22.8, 21.8, 21.8, 19.6 ppm; HRMS (EI): Exact mass calcd for $C_{14}H_{14}O_2$ $[M]^+$: 214.0994; found 214.0993.

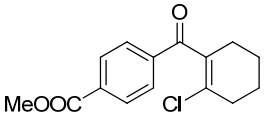


Enone **S5** was prepared as white solid: R_f = 0.43 (30% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 10.08 (s, 1H), 8.02 (d, J = 8.2 Hz, 2H), 7.96 (d, J = 8.2 Hz, 2H), 2.53 – 2.40 (m, 2H), 2.40 – 2.28 (m, 2H), 1.93 – 1.80 (m, 2H), 1.80 – 1.64 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 196.5, 191.5, 139.7, 139.1, 133.9, 131.5, 129.8 (2C), 129.67 (2C), 33.2, 28.5, 23.3, 21.3 ppm; MS (m/z) (%): EI [M] calcd for $C_{14}H_{13}ClO_2$ $[M]^+$: 248.06, found 250 (19), 248 (60), 221 (25), 219 (78), 133 (99), 105 (58), 86 (49), 84 (75), 79 (46), 77 (100).

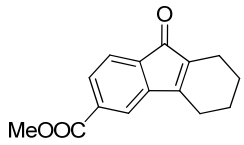


Ketone **5** (58 mg) was prepared according to the general procedure of the photo reaction from **S5** in 70% yield. The reaction time is 4.5 h under 254 nm light. The products were isolated through silica gel flash chromatography (10% ethyl acetate-petroleum ether) as yellow solid: R_f = 0.42 (10% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.99 (s, 1H), 7.70 (d, J = 7.1 Hz, 1H), 7.52 (d, J = 7.1 Hz, 1H), 7.47 (s, 1H), 2.54 – 2.46 (m, 2H), 2.32 – 2.24 (m, 2H), 1.91 – 1.80 (m, 2H), 1.80 – 1.71 (m, 2H) ppm; ^{13}C NMR

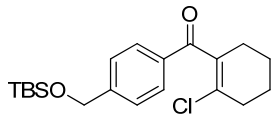
(100 MHz, $CDCl_3$) δ 195.9, 191.6, 158.2, 145.5, 140.2, 136.6, 135.8, 133.7, 121.6, 116.2, 23.0, 21.7, 21.7, 19.7 ppm; HRMS (EI): Exact mass calcd for $C_{14}H_{12}O_2$ $[M]^+$: 212.0837; found 212.0836.



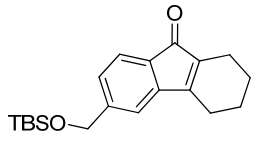
Enone **S6** was prepared as colorless oil: R_f = 0.67 (20% ethyl acetate-petroleum ether); ^1H NMR (400 MHz, $CDCl_3$) δ 8.10 (d, J = 8.4 Hz, 2H), 7.93 (d, J = 8.4 Hz, 2H), 3.91 (s, 3H), 2.55 – 2.39 (m, 2H), 2.39 – 2.25 (m, 2H), 1.91 – 1.80 (m, 2H), 1.80 – 1.63 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 196.6, 166.1, 138.7, 134.1, 134.1, 131.1, 129.9 (2C), 129.1 (2C), 52.3, 33.2, 28.5, 23.3, 21.3 ppm; MS (m/z) (%): EI [M] calcd for $C_{15}H_{15}ClO_3$ $[M]^+$: 278.07, found 280 (2), 278 (5), 219 (100), 163 (40), 77 (19).



Ketone **6** (48 mg) was prepared according to the general procedure of the photo reaction from **S6** in 65% yield. The reaction time is 4 h under 254 nm light. The products were isolated through silica gel flash chromatography (8% ethyl acetate-petroleum ether) as red solid: R_f = 0.67 (20% ethyl acetate-petroleum ether); ^1H NMR (400 MHz, $CDCl_3$) δ 7.90 (d, J = 7.4 Hz, 1H), 7.56 (s, 1H), 7.40 (d, J = 7.4 Hz, 1H), 3.92 (s, 3H), 2.59 – 2.41 (m, 2H), 2.31 – 2.15 (m, 2H), 1.91 – 1.79 (m, 2H), 1.79 – 1.66 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 196.3, 166.4, 158.3, 145.0, 135.3, 134.9, 134.3, 130.7, 121.1, 118.6, 52.4, 23.0, 21.8, 21.8, 19.7 ppm; HRMS (EI): Exact mass calcd for $C_{15}H_{14}O_3$ $[M]^+$: 242.0943; found 242.0942.

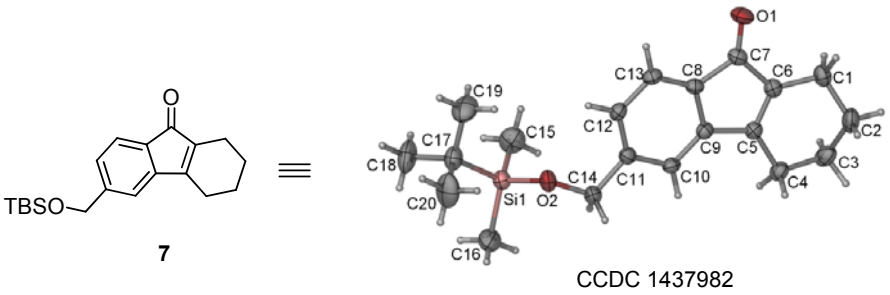


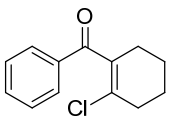
Enone **S7** was prepared as colorless oil: R_f = 0.41 (10% ethyl acetate-petroleum ether); ^1H NMR (400 MHz, $CDCl_3$) δ 7.90 (d, J = 8.4 Hz, 2H), 7.44 (d, J = 8.4 Hz, 2H), 4.80 (s, 2H), 2.57 – 2.42 (m, 2H), 2.42 – 2.25 (m, 2H), 1.93 – 1.81 (m, 2H), 1.81 – 1.68 (m, 2H), 0.95 (s, 9H), 0.11 (s, 6H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 197.0, 147.7, 134.6, 133.8, 129.7, 129.5 (2C), 126.0 (2C), 64.4, 33.1, 28.7, 25.9, 23.5, 21.4, 18.3, -5.4 ppm; MS(ES)$^+$ calcd for $C_{20}H_{29}ClO_2Si$ $(M+H)^+$ 365.17, found 365.23.



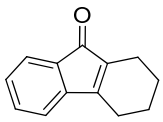
Ketone **7** (50 mg) was prepared according to the general procedure of the photo reaction from **S7** in 86% yield. The reaction time is 4 h under 254 nm light. The products were isolated through silica gel flash chromatography (4% ethyl acetate-petroleum ether) as yellow solid: R_f = 0.42 (10% ethyl acetate-petroleum ether); ^1H NMR (400 MHz, $CDCl_3$) δ 7.31 (d, J = 7.3 Hz, 1H), 7.08 (d, J = 7.3 Hz, 1H), 6.92 (s, 1H), 4.70 (s,

2H), 2.46 – 2.39 (m, 2H), 2.28 – 2.19 (m, 2H), 1.85 – 1.77 (m, 2H), 1.77 – 1.68 (m, 2H), 0.95 (s, 9H), 0.11 (s, 6H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 197.3, 157.7, 147.2, 145.3, 134.2, 130.6, 125.0, 121.5, 116.2, 64.8, 25.9, 22.8, 21.9, 21.9, 19.7, 18.4, -5.3 ppm; HRMS (EI): Exact mass calcd for $C_{20}H_{28}SiO_2$ $[M]^+$: 328.1859; found 328.1861. Recrystallization of **7** from ethyl acetate–hexane gave single crystals suitable for X-ray analysis (CCDC: 1437982).

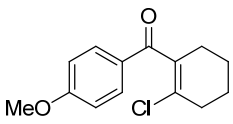




Enone **S8** was prepared as colorless oil: R_f = 0.41 (10% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.93 (d, J = 7.6 Hz, 2H), 7.59 (t, J = 7.3 Hz, 1H), 7.48 (t, J = 7.6 Hz, 2H), 2.56 – 2.42 (m, 2H), 2.42 – 2.27 (m, 2H), 1.94 – 1.83 (m, 2H), 1.83 – 1.68 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 197.3, 135.2, 134.5, 133.6, 130.0, 129.4 (2C), 128.7 (2C), 33.2, 28.7, 23.5, 21.4 ppm; MS (m/z) (%): EI [M] calcd for $C_{13}H_{13}ClO$ $[M]^+$: 220.07, found 222 (16), 220 (48), 185 (44), 143 (22), 105 (88), 77 (100).

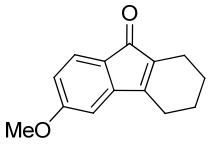


Ketone **8** (35 mg) was prepared according to the general procedure of the photo reaction from **S8** in 79% yield. The reaction time is 3.5 h under 254 nm light. The products were isolated through silica gel flash chromatography (5% ethyl acetate-petroleum ether) as yellow solid: R_f = 0.42 (10% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.36 (d, J = 7.0 Hz, 1H), 7.29 (t, J = 7.4 Hz, 1H), 7.15 (t, J = 7.4 Hz, 1H), 6.94 (d, J = 7.1 Hz, 1H), 2.49 – 2.39 (m, 2H), 2.28 – 2.19 (m, 2H), 1.88 – 1.77 (m, 2H), 1.77 – 1.69 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 197.5, 158.1, 145.0, 133.7, 133.0, 131.7, 128.1, 121.6, 118.1, 22.9, 21.9, 21.9, 19.6 ppm; HRMS (EI): Exact mass calcd for $C_{13}H_{12}O$ $[M]^+$: 184.0888; found 184.0890.

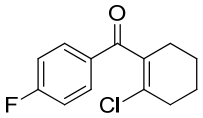


Enone **S9** was prepared as yellow oil: R_f = 0.33 (10% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.90 (d, J = 8.8 Hz, 2H), 6.95 (d, J = 8.8

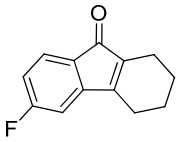
Hz, 2H), 3.87 (s, 3H), 2.50 – 2.40 (m, 2H), 2.38 – 2.30 (m, 2H), 1.91 – 1.80 (m, 2H), 1.80 – 1.70 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 195.9, 164.0, 134.7, 131.8 (2C), 129.2, 128.1, 114.0 (2C), 55.5, 33.1, 28.7, 23.5, 21.5 ppm; MS (m/z) (%): EI [M] calcd for $C_{14}H_{15}ClO_2$ $[M]^+$: 250.08, found 252 (7), 250 (20), 219 (34), 215 (20), 135 (100), 92 (20), 77 (37).



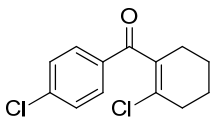
Ketone **9** (49 mg) was prepared according to the general procedure of the photo reaction from **S9** in 89% yield. The reaction time is 6 h under 254 nm light. The products were isolated through silica gel flash chromatography (4% ethyl acetate-petroleum ether) as yellow solid: R_f = 0.32 (10% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.30 (d, J = 8.3 Hz, 1H), 6.53 – 6.49 (m, 2H), 3.82 (s, 3H), 2.43 – 2.33 (m, 2H), 2.24 – 2.19 (m, 2H), 1.84 – 1.76 (m, 2H), 1.76 – 1.64 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 196.4, 164.2, 155.6, 147.6, 135.4, 124.3, 123.3, 108.8, 107.7, 55.6, 22.6, 21.9, 21.9, 19.8 ppm; HRMS (EI): Exact mass calcd for $C_{14}H_{14}O_2$ $[M]^+$: 214.0994; found 214.0995.



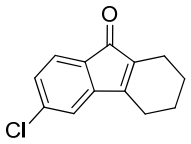
Enone **S10** was prepared as colorless oil: R_f = 0.32 (10% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.94 (dd, J = 8.5, 5.5 Hz, 2H), 7.14 (t, J = 8.5 Hz, 2H), 2.50 – 2.43 (m, 2H), 2.38 – 2.30 (m, 2H), 1.90 – 1.81 (m, 2H), 1.79 – 1.71 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 195.7, 166.1 (d, J = 254.0 Hz), 134.2, 132.1 (d, J = 10.0 Hz), 131.6 (d, J = 3.0 Hz), 130.2, 115.9 (d, J = 22.0 Hz), 33.1, 28.6, 23.4, 21.4 ppm; MS (m/z) (%): EI [M] calcd for $C_{13}H_{12}ClFO$ $[M]^+$: 238.06, found 240 (7), 238 (23), 237 (27), 203 (33), 123 (100), 95 (62), 79 (18), 77 (21).



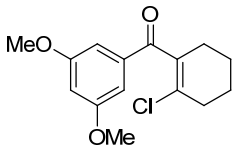
Ketone **10** (37 mg) was prepared according to the general procedure of the photo reaction from **S10** in 70% yield. The reaction time is 5 h under 254 nm light. The products were isolated through silica gel flash chromatography (5% ethyl acetate-petroleum ether) as yellow solid: R_f = 0.32 (10% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.32 (dd, J = 7.8, 5.2 Hz, 1H), 6.81 – 6.73 (m, 1H), 6.65 (dd, J = 8.1, 1.6 Hz, 1H), 2.44 – 2.36 (m, 2H), 2.26 – 2.20 (m, 2H), 1.85 – 1.77 (m, 2H), 1.77 – 1.69 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 195.7, 166.5 (d, J = 251.0 Hz), 155.8, 148.3 (d, J = 10.0 Hz), 135.6, 127.4 (d, J = 3.0 Hz), 123.2 (d, J = 10.0 Hz), 113.1 (d, J = 23.0 Hz), 107.3 (d, J = 25.0 Hz), 22.7, 21.8, 21.7, 19.7 ppm; HRMS (EI): Exact mass calcd for $C_{13}H_{11}FO$ $[M]^+$: 202.0794; found 202.0795.



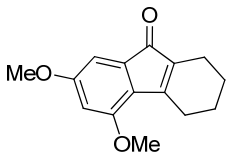
Enone **S11** was prepared as colorless oil: R_f = 0.42 (10% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.93 – 7.77 (m, 2H), 7.55 – 7.38 (m, 2H), 2.56 – 2.41 (m, 2H), 2.41 – 2.26 (m, 2H), 1.91 – 1.81 (m, 2H), 1.81 – 1.67 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 196.1, 140.1, 134.1, 133.6, 130.8 (2C), 130.6, 129.1 (2C), 33.2, 28.6, 23.4, 21.4 ppm; MS (m/z) (%): EI [M] calcd for $C_{13}H_{12}Cl_2O$ $[M]^+$: 254.03, found 256 (5), 254 (8), 221 (33), 219 (100), 139 (89), 111 (58), 79 (23), 77 (24), 75 (31).



Ketone **11** (39 mg) was prepared according to the general procedure of the photo reaction from **S11** in 78% yield. The reaction time is 4.5 h under 254 nm light. The products were isolated through silica gel flash chromatography (5% ethyl acetate-petroleum ether) as yellow solid: R_f = 0.42 (10% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.27 (d, J = 7.5 Hz, 1H), 7.12 (dd, J = 7.6, 1.6 Hz, 1H), 6.90 (d, J = 1.5 Hz, 1H), 2.45 – 2.36 (m, 2H), 2.29 – 2.18 (m, 2H), 1.87 – 1.78 (m, 2H), 1.78 – 1.67 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 195.9, 156.8, 146.9, 139.2, 135.3, 129.8, 127.5, 122.5, 119.1, 22.8, 21.8, 21.7, 19.7 ppm; HRMS (EI): Exact mass calcd for $C_{13}H_{11}ClO$ $[M]^+$: 218.0498; found 218.0499.

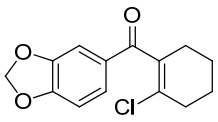


Enone **S12** was prepared as white solid: R_f = 0.40 (20% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.06 (d, J = 2.3 Hz, 2H), 6.67 (t, J = 2.3 Hz, 1H), 3.83 (s, 6H), 2.49 – 2.41 (m, 2H), 2.37 – 2.29 (m, 2H), 1.89 – 1.79 (m, 2H), 1.79 – 1.70 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 197.0, 161.0 (2C), 137.0, 134.5, 129.9, 107.1 (2C), 105.7, 55.6 (2C), 33.0, 28.7, 23.4, 21.4 ppm; MS (m/z) (%): EI [M] calcd for $C_{15}H_{17}ClO_3$ $[M]^+$: 280.09, found 282 (10), 280 (27), 245 (100), 219 (24), 165 (36), 79 (65) , 77 (71).

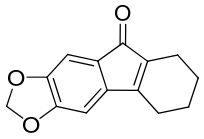


Ketone **12** (38 mg) was prepared according to the general procedure of the photo reaction from **S12** in 69% yield. The reaction time is 6 h under 254 nm light. The products were isolated through silica gel flash chromatography (6% ethyl acetate-petroleum ether) as red solid: R_f = 0.38 (10% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.67 (d, J = 2.0 Hz, 1H), 6.37 (d, J = 2.0 Hz, 1H), 3.80 (s, 3H), 3.79 (s, 3H), 2.67 – 2.60 (m, 2H), 2.21 – 2.13 (m, 2H), 1.78 – 1.70 (m, 2H), 1.70 – 1.61 (m, 2H) ppm; ^{13}C NMR

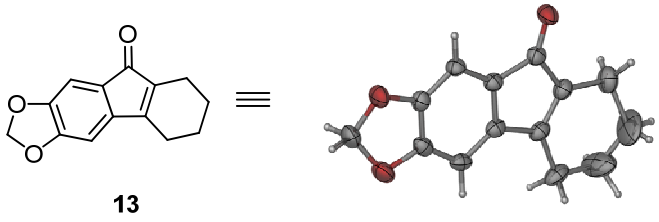
(100 MHz, $CDCl_3$) δ 197.3, 162.0, 160.9, 153.8, 134.9, 129.9, 122.4, 102.6, 101.9, 55.8, 55.5, 26.5, 22.4, 21.8, 19.7 ppm; HRMS (EI): Exact mass calcd for $C_{15}H_{16}O_3$ $[M]^+$: 244.1099; found 244.1100.



Enone **S13** was prepared as colorless oil: R_f = 0.29 (10% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.56 – 7.45 (m, 1H), 7.38 (d, *J* = 1.1 Hz, 1H), 6.84 (d, *J* = 8.1 Hz, 1H), 6.03 (s, 2H), 2.47 – 2.39 (m, 2H), 2.35 – 2.27 (m, 2H), 1.87 – 1.78 (m, 2H), 1.78 – 1.66 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 195.5, 152.3, 148.4, 134.6, 129.9, 129.4, 126.5, 108.5, 108.1, 101.9, 33.0, 28.7, 23.4, 21.4 ppm; MS (m/z) (%): EI [M] calcd for $C_{14}H_{13}ClO_3$ $[M]^+$: 264.06, found 266 (13), 264 (38), 234 (18), 229 (29), 149 (100), 121 (29).

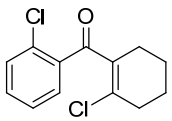


Ketone **13** (43 mg) was prepared according to the general procedure of the photo reaction from **S13** in 76% yield. The reaction time is 4 h under 254 nm light. The products were isolated through silica gel flash chromatography (6% ethyl acetate-petroleum ether) as orange solid: R_f = 0.29 (10% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.90 (s, 1H), 6.48 (s, 1H), 5.97 (s, 2H), 2.41 – 2.28 (m, 2H), 2.27 – 2.12 (m, 2H), 1.83 – 1.74 (m, 2H), 1.74 – 1.64 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 196.2, 156.1, 151.1, 146.8, 141.4, 132.7, 125.5, 104.7, 101.7, 101.4, 22.8, 21.9, 21.9, 19.6 ppm; HRMS (EI): Exact mass calcd for $C_{14}H_{12}O_3$ $[M]^+$: 228.0786; found 228.0784. Recrystallization of **13** from ethyl acetate–hexane gave single crystals suitable for X-ray analysis (CCDC: 1437984).

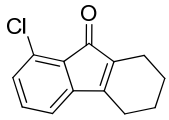


13

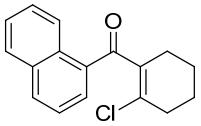
CCDC 1437984



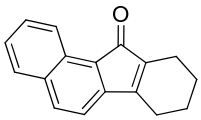
Enone **S14** was prepared as colorless oil: R_f = 0.49 (10% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.55 (d, *J* = 7.6 Hz, 1H), 7.41 – 7.36 (m, 2H), 7.36 – 7.29 (m, 1H), 2.53 – 2.37 (m, 4H), 1.83 – 1.66 (m, 4H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 196.2, 138.6, 135.5, 134.6, 132.0, 131.9, 130.4, 130.3, 126.9, 34.6, 28.1, 23.2, 21.5 ppm; MS (m/z) (%): EI [M] calcd for $C_{13}H_{12}Cl_2O$ $[M]^+$: 254.03, found 256 (8), 254 (10), 221 (34), 219 (100), 139 (93), 111 (55), 79 (39), 77(45), 75 (38).



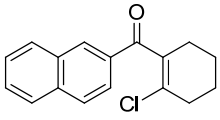
Ketone **14** (39 mg) was prepared according to the general procedure of the photo reaction from **S14** in 68% yield. The reaction time is 4.5 h under 254 nm light. The products were isolated through silica gel flash chromatography (5% ethyl acetate-petroleum ether) as yellow solid: R_f = 0.49 (10% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.21 (t, *J* = 8.2 Hz, 1H), 7.06 (d, *J* = 8.2 Hz, 1H), 6.85 (d, *J* = 7.0 Hz, 1H), 2.47 – 2.38 (m, 2H), 2.29 – 2.21 (m, 2H), 1.85 – 1.78 (m, 2H), 1.78 – 1.68 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 194.3, 156.2, 147.1, 134.6, 133.9, 130.2, 130.0, 126.7, 116.7, 22.7, 21.9, 21.8, 19.7 ppm; HRMS (EI): Exact mass calcd for $C_{13}H_{11}ClO$ $[M]^+$: 218.0498; found 218.0497.



Enone **S15** was prepared as white solid: R_f = 0.43 (10% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.90 (d, *J* = 8.6 Hz, 1H), 8.02 (d, *J* = 8.2 Hz, 1H), 7.95 – 7.86 (m, 2H), 7.64 (t, *J* = 7.4 Hz, 1H), 7.60 – 7.44 (m, 2H), 2.56 – 2.40 (m, 4H), 1.91 – 1.83 (m, 2H), 1.83 – 1.75 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 199.1, 136.3, 134.1, 133.6, 133.4, 132.1, 130.8 (2 C), 128.4, 128.3, 126.5, 125.9, 124.5, 33.7, 29.0, 23.5, 21.6 ppm; MS (m/z) (%): EI [M] calcd for $C_{17}H_{15}ClO$ $[M]^+$: 270.08, found 272 (13), 270 (36), 235 (55), 155 (62), 127 (100), 77 (29).

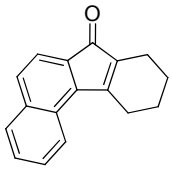


Ketone **15** (55 mg) was prepared according to the general procedure of the photo reaction from **S15** in 92% yield. The reaction time is 5 h under 254 nm light. The products were isolated through silica gel flash chromatography (4% ethyl acetate-petroleum ether) as red solid: R_f = 0.45 (10% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.67 (d, *J* = 8.6 Hz, 1H), 7.83 (d, *J* = 8.0 Hz, 1H), 7.69 (d, *J* = 8.4 Hz, 1H), 7.46 (t, *J* = 7.2 Hz, 1H), 7.30 (t, *J* = 7.6 Hz, 1H), 7.17 (d, *J* = 8.0 Hz, 1H), 2.51 – 2.41 (m, 2H), 2.29 – 2.18 (m, 2H), 1.89 – 1.79 (m, 2H), 1.79 – 1.70 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 199.8, 156.2, 146.0, 134.3, 133.9, 132.5, 128.9, 128.7, 128.3, 125.3, 123.6, 123.2, 117.0, 22.8, 22.1, 22.0, 19.5 ppm; HRMS (EI): Exact mass calcd for $C_{17}H_{14}O$ $[M]^+$: 234.1045; found 234.1048.

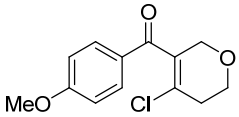


Enone **S16** was prepared as white solid: R_f = 0.43 (10% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.41 (s, 1H), 8.00 (dd, *J* = 11.9, 8.4 Hz, 2H), 7.90 (dd, *J* = 13.2, 8.4 Hz, 2H), 7.58 (dt, *J* = 14.8, 7.1 Hz, 2H), 2.61 – 2.50 (m, 2H), 2.49 –

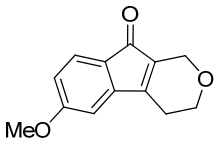
2.39 (m, 2H), 1.97 – 1.87 (m, 2H), 1.87 – 1.77 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 197.3, 135.9, 134.6, 132.6, 132.6, 131.7, 130.1, 129.7, 128.6, 128.6, 127.8, 126.7, 124.4, 33.2, 28.8, 23.5, 21.4 ppm; MS (m/z) (%): EI [M] calcd for $C_{17}H_{15}ClO$ $[M]^+$: 270.08, found 272 (17), 270 (51), 235 (62), 155 (70), 127 (100), 77 (27).



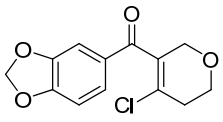
Ketone **16** (40 mg) was prepared according to the general procedure of the photo reaction from **S16** in 91% yield. The reaction time is 3.5 h under 254 nm light. The products were isolated through silica gel flash chromatography (5% ethyl acetate-petroleum ether) as red solid: R_f = 0.42 (10% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.16 – 8.09 (m, 1H), 7.79 – 7.70 (m, 1H), 7.66 – 7.59 (m, 1H), 7.52 – 7.45 (m, 1H), 7.43 – 7.35 (m, 2H), 3.07 – 2.96 (m, 2H), 2.32 – 2.23 (m, 2H), 1.94 – 1.85 (m, 2H), 1.78 – 1.69 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 198.9, 158.3, 143.1, 137.8, 132.8, 129.4, 128.4, 128.1, 127.8, 127.1, 126.8, 124.3, 118.5, 27.4, 22.9, 21.3, 19.9 ppm; HRMS (EI): Exact mass calcd for $C_{17}H_{14}O$ $[M]^+$: 234.1045; found 234.1046.



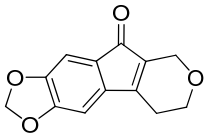
Enone **S17** was prepared as colorless oil: R_f = 0.37 (20% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.94 – 7.86 (m, 2H), 6.95 (dd, J = 6.8, 4.8 Hz, 2H), 4.34 (t, J = 2.5 Hz, 2H), 3.94 (t, J = 5.6 Hz, 2H), 3.86 (s, 3H), 2.60 – 2.51 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 192.8, 164.3, 134.3, 131.9 (2C), 128.2, 126.9, 114.0 (2C), 67.1, 64.9, 55.5, 32.6 ppm; MS (m/z) (%): EI [M] calcd for $C_{13}H_{13}ClO_3$ $[M]^+$: 252.05, found 254 (7), 252 (22), 217 (19), 189 (27), 135 (100), 92 (25).



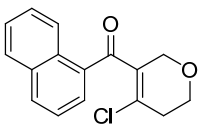
Ketone **17** (48 mg) was prepared according to the general procedure of the photo reaction from **S17** in 65% yield. The reaction time is 4 h under 254 nm light. The products were isolated through silica gel flash chromatography (10% ethyl acetate-petroleum ether) as yellow solid: R_f = 0.36 (20% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.34 (d, J = 7.8 Hz, 1H), 6.59 – 6.53 (m, 2H), 4.41 (t, J = 2.9 Hz, 2H), 3.91 (t, J = 5.4 Hz, 2H), 3.84 (s, 3H), 2.58 – 2.48 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 193.7, 164.4, 153.2, 146.3, 133.7, 130.2, 124.0, 109.6, 108.2, 63.4, 62.5, 55.7, 23.3 ppm; HRMS (EI): Exact mass calcd for $C_{13}H_{12}O_3$ $[M]^+$: 216.0786; found 216.0790.



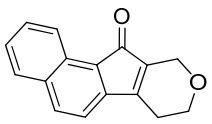
Enone **S18** was prepared as colorless oil: R_f = 0.43 (20% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.53 (dd, *J* = 8.1, 1.3 Hz, 1H), 7.39 (d, *J* = 1.3 Hz, 1H), 6.86 (d, *J* = 8.1 Hz, 1H), 6.05 (s, 2H), 4.33 (t, *J* = 2.4 Hz, 2H), 3.95 (t, *J* = 5.5 Hz, 2H), 2.66 – 2.46 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 192.4, 152.7, 148.5, 134.3, 130.1, 127.2, 126.8, 108.4, 108.2, 102.0, 67.1, 64.9, 32.7 ppm; MS (m/z) (%): EI [M] calcd for $C_{13}H_{11}ClO_4$ $[M]^+$: 266.03, found 268 (3), 266 (9), 149 (22), 86 (66), 84 (100), 49 (74).



Ketone **18** (46 mg) was prepared according to the general procedure of the photo reaction from **S18** in 96% yield. The reaction time is 4 h under 254 nm light. The products were isolated through silica gel flash chromatography (10% ethyl acetate-petroleum ether) as red solid: R_f = 0.41 (20% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.91 (s, 1H), 6.51 (s, 1H), 6.00 (s, 2H), 4.37 (t, *J* = 3.0 Hz, 2H), 3.90 (t, *J* = 5.4 Hz, 2H), 2.54 – 2.38 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 193.5, 153.9, 151.3, 147.4, 140.0, 131.0, 125.3, 105.1, 102.0, 101.7, 63.3, 62.4, 23.5 ppm; HRMS (EI): Exact mass calcd for $C_{13}H_{10}O_4$ $[M]^+$: 230.0579; found 230.0580.

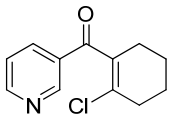


Enone **S19** was prepared as colorless oil: R_f = 0.41 (20% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.74 (d, *J* = 8.5 Hz, 1H), 8.03 (d, *J* = 8.2 Hz, 1H), 7.96 – 7.85 (m, 2H), 7.63 (ddd, *J* = 8.5, 6.9, 1.3 Hz, 1H), 7.60 – 7.48 (m, 2H), 4.54 (t, *J* = 2.5 Hz, 2H), 3.97 (t, *J* = 5.6 Hz, 2H), 2.64 – 2.53 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 196.0, 135.4, 134.0, 133.9, 133.7, 131.1, 130.5, 130.4, 128.5, 128.3, 126.6, 125.6, 124.6, 67.5, 64.8, 33.4 ppm; MS (m/z) (%): EI [M] calcd for $C_{16}H_{13}ClO_2$ $[M]^+$: 272.06, found 274 (6), 272 (17), 237 (49), 207 (20), 155 (42), 127 (100).

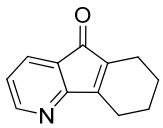


Ketone **19** (45 mg) was prepared according to the general procedure of the photo reaction from **S19** in 75% yield. The reaction time is 4 h under 254 nm light. The products were isolated through silica gel flash chromatography (10% ethyl acetate-petroleum ether) as orange solid: R_f = 0.39 (20% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.63 (d, *J* = 8.6 Hz, 1H), 7.84 (d, *J* = 8.0 Hz, 1H), 7.70 (d, *J* = 8.3 Hz, 1H), 7.48 (t, *J* = 7.6 Hz, 1H), 7.33 (t, *J* = 7.6 Hz, 1H), 7.16 (d, *J* = 8.0 Hz, 1H), 4.43 (t, *J* = 3.1 Hz, 2H), 3.95 (t, *J* = 5.3 Hz, 2H), 2.64 – 2.51 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 197.0, 154.0, 144.5, 134.7, 134.2, 130.9, 129.0

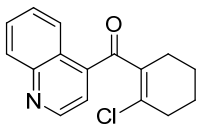
(2 C), 128.3, 125.7, 123.5, 123.1, 117.0, 63.5, 62.4, 23.5 ppm; HRMS (EI): Exact mass calcd for $C_{16}H_{12}O_2$ $[M]^+$: 236.0837; found 236.0838.



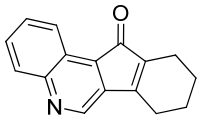
Enone **S20** was prepared as colorless oil: R_f = 0.38 (30% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.03 (s, 1H), 8.75 (d, *J* = 1.2 Hz, 1H), 8.25 – 8.03 (m, 1H), 7.47 – 7.33 (m, 1H), 2.56 – 2.40 (m, 2H), 2.40 – 2.27 (m, 2H), 1.89 – 1.79 (m, 2H), 1.79 – 1.67 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 195.9, 153.7, 151.1, 136.3, 133.6, 131.8, 130.8, 123.7, 33.2, 28.4, 23.3, 21.3 ppm; MS (m/z) (%): EI [M] calcd for $C_{12}H_{12}ClNO$ $[M]^+$: 221.06, found 223 (16), 221 (48), 193 (26), 186 (52), 143 (53), 106 (84), 78 (100), 51 (64).



Ketone **20** (51 mg) was prepared according to the general procedure of the photo reaction from **S20** in 57% yield. The reaction time is 6 h under 254 nm light. The products were isolated through silica gel flash chromatography (15% ethyl acetate-petroleum ether) as yellow solid: R_f = 0.38 (30% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.36 (d, *J* = 5.3 Hz, 1H), 7.55 (d, *J* = 7.1 Hz, 1H), 7.10 – 6.93 (m, 1H), 2.62 – 2.53 (m, 2H), 2.33 – 2.24 (m, 2H), 1.87 – 1.71 (m, 4H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 195.1, 166.7, 158.3, 151.6, 138.2, 128.0, 125.9, 122.0, 21.7, 21.7, 21.7, 19.7 ppm; HRMS (EI): Exact mass calcd for $C_{12}H_{11}NO$ $[M]^+$: 185.0841; found 185.0839.

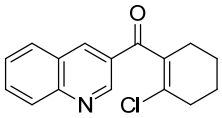


Enone **S21** was prepared as colorless oil: R_f = 0.59 (50% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.98 (d, *J* = 4.4 Hz, 1H), 8.40 (dd, *J* = 8.5, 0.7 Hz, 1H), 8.14 (d, *J* = 8.4 Hz, 1H), 7.72 (ddd, *J* = 8.4, 6.9, 1.3 Hz, 1H), 7.60 (ddd, *J* = 8.3, 6.9, 1.2 Hz, 1H), 7.50 (d, *J* = 4.4 Hz, 1H), 2.56 – 2.36 (m, 4H), 1.85 – 1.54 (m, 4H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 197.6, 149.8, 149.0, 142.4, 136.4, 135.0, 129.8, 129.7, 128.1, 125.3, 124.2, 120.4, 34.2, 28.4, 23.2, 21.4 ppm; MS (m/z) (%): EI [M] calcd for $C_{16}H_{14}ClNO$ $[M]^+$: 271.08, found 273 (8), 271 (22), 236 (100), 143 (38), 128 (47), 101 (34), 79 (29).

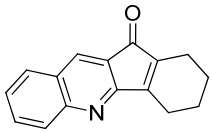


Ketone **21** (38 mg) was prepared according to the general procedure of the photo reaction from **S21**in 84% yield. The reaction time is 3.5 h under 254 nm light. The products were isolated through silica gel flash chromatography (25% ethyl acetate-petroleum ether) as red solid: R_f = 0.61 (50% ethyl acetate-petroleum ether); ^{1}H NMR (400

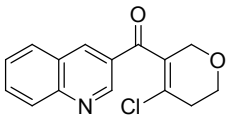
MHz, $CDCl_3$) δ 8.64 (s, 1H), 8.52 (d, *J* = 8.4 Hz, 1H), 7.95 (d, *J* = 8.7 Hz, 1H), 7.63 – 7.55 (m, 1H), 7.51 (dd, *J* = 10.0, 5.3 Hz, 1H), 2.58 – 2.48 (m, 2H), 2.27 – 2.23 (m, 2H), 1.95 – 1.82 (m, 2H), 1.82 – 1.57 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 198.7, 157.7, 151.2, 140.7, 137.2, 132.8, 130.7, 129.6, 129.4, 129.0, 123.8, 122.4, 23.2, 21.9, 21.7, 19.6 ppm; HRMS (EI): Exact mass calcd for $C_{16}H_{13}NO$ $[M]^+$: 235.0997; found 235.0995.



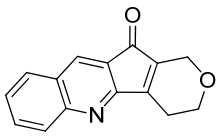
Enone **S22** was prepared as white solid: R_f = 0.45 (50% ethyl acetate-petroleum ether); ^1H NMR (400 MHz, $CDCl_3$) δ 9.36 (d, *J* = 2.1 Hz, 1H), 8.66 (d, *J* = 1.8 Hz, 1H), 8.16 (d, *J* = 8.5 Hz, 1H), 7.97 (d, *J* = 8.2 Hz, 1H), 7.91 – 7.75 (m, 1H), 7.69 – 7.55 (m, 1H), 2.56 – 2.48 (m, 2H), 2.47 – 2.40 (m, 2H), 1.95 – 1.86 (m, 2H), 1.86 – 1.75 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 196.0, 150.0, 149.9, 138.6, 133.8, 132.2, 131.8, 129.5 (2 C), 127.9, 127.5, 127.1, 33.3, 28.6, 23.4, 21.4 ppm; MS (m/z) (%): EI [M] calcd for $C_{16}H_{14}ClNO$ $[M]^+$: 271.08, found 273 (21), 271 (62), 236 (54), 156 (67), 128 (100), 101 (55), 79 (36), 77 (36).



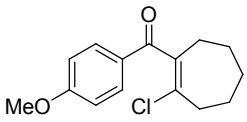
Ketone **22** (38 mg) was prepared according to the general procedure of the photo reaction from **S22** in 78% yield. The reaction time is 4.5 h under 254 nm light. The products were isolated through silica gel flash chromatography (30% ethyl acetate-petroleum ether) as orange solid: R_f = 0.44 (50% ethyl acetate-petroleum ether); ^1H NMR (400 MHz, $CDCl_3$) δ 8.81 – 8.72 (m, 1H), 8.08 – 7.92 (m, 2H), 7.72 – 7.60 (m, 1H), 7.49 – 7.38 (m, 1H), 3.00 – 2.87 (m, 2H), 2.32 – 2.20 (m, 2H), 1.95 – 1.83 (m, 2H), 1.78 – 1.68 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 197.2, 155.5, 153.1, 152.7, 141.7, 135.7, 131.5, 130.5, 127.3, 124.5, 122.7, 120.9, 26.6, 22.5, 20.9, 20.0 ppm; HRMS (EI): Exact mass calcd for $C_{16}H_{13}NO$ $[M]^+$: 235.0997; found 235.0998.



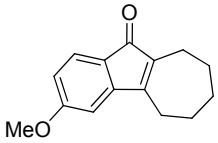
Enone **S23** was prepared as colorless oil: R_f = 0.49 (50% ethyl acetate-petroleum ether); ^1H NMR (400 MHz, $CDCl_3$) δ 9.33 (s, 1H), 8.63 (s, 1H), 8.14 (d, *J* = 8.4 Hz, 1H), 7.93 (d, *J* = 8.0 Hz, 1H), 7.88 – 7.72 (m, 1H), 7.64 – 7.49 (m, 1H), 4.44 (d, *J* = 1.2 Hz, 2H), 3.97 (t, *J* = 4.6 Hz, 2H), 2.61 (d, *J* = 2.4 Hz, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 192.9, 149.8, 149.4, 138.7, 133.3, 132.2, 130.2, 129.4, 129.3, 128.1, 127.5, 126.8, 66.9, 64.7, 32.9 ppm; MS (m/z) (%): EI [M] calcd for $C_{15}H_{12}ClNO_2$ $[M]^+$: 273.06, found 275 (16), 273 (47), 238 (50), 210 (35), 156 (71), 128 (100), 101 (48).



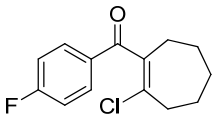
Ketone **23** (31 mg) was prepared according to the general procedure of the photo reaction from **S23** in 56% yield. The reaction time is 2 h under 254 nm light. The products were isolated through silica gel flash chromatography (30% ethyl acetate-petroleum ether) as orange solid: R_f = 0.46 (50% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.89 (s, 1H), 8.07 (t, *J* = 9.4 Hz, 2H), 7.90 – 7.63 (m, 1H), 7.63 – 7.46 (m, 1H), 4.52 (t, *J* = 3.3 Hz, 2H), 4.02 (t, *J* = 5.3 Hz, 2H), 3.26 – 2.97 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 194.9, 153.4, 153.0, 151.4, 142.3, 133.9, 131.9, 130.9, 127.8, 124.1, 122.7, 120.8, 63.6, 62.6, 27.1 ppm; HRMS (EI): Exact mass calcd for $C_{15}H_{11}NO_2$ $[M]^+$: 237.0790; found 237.0788.



Enone **S24** was prepared as colorless oil: R_f = 0.31 (10% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.94 – 7.83 (m, 2H), 7.01 – 6.89 (m, 2H), 3.94 – 3.76 (m, 3H), 2.75 – 2.62 (m, 2H), 2.43 – 2.26 (m, 2H), 1.85 – 1.65 (m, 6H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 196.0, 163.8, 138.7, 133.2, 131.7 (2C), 127.8, 113.9 (2C), 55.4, 39.1, 31.0, 30.6, 26.2, 25.2 ppm; MS (m/z) (%): EI [M] calcd for $C_{15}H_{17}ClO_2$ $[M]^+$: 264.09, found 266 (7), 264 (19), 229 (19), 149 (30), 135 (100), 77 (34).

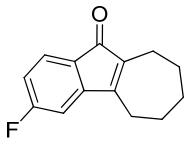


Ketone **24** (49 mg) was prepared according to the general procedure of the photo reaction from **S24** in 71% yield. The reaction time is 4 h under 254 nm light. The products were isolated through silica gel flash chromatography (5% ethyl acetate-petroleum ether) as yellow solid: R_f = 0.31 (10% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.32 (d, *J* = 7.9 Hz, 1H), 6.58 (d, *J* = 2.1 Hz, 1H), 6.51 (dd, *J* = 7.9, 2.1 Hz, 1H), 3.83 (s, 3H), 2.61 – 2.47 (m, 2H), 2.43 – 2.31 (m, 2H), 1.89 – 1.78 (m, 2H), 1.78 – 1.67 (m, 2H), 1.67 – 1.49 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 196.4, 164.3, 157.2, 148.8, 138.1, 123.7, 123.5, 108.6, 107.9, 55.6, 30.9, 26.9, 26.9, 26.5, 23.4 ppm; HRMS (EI): Exact mass calcd for $C_{15}H_{16}O_2$ $[M]^+$: 228.1150; found 228.1152.

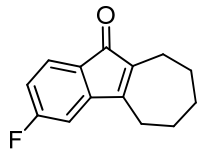


Enone **S25** was prepared as colorless oil: R_f = 0.48 (10% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.05 – 7.78 (m, 2H), 7.21 – 6.95 (m, 2H), 2.83 – 2.59 (m, 2H), 2.47 – 2.18 (m, 2H), 1.91 – 1.59 (m, 6H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 195.8, 166.0 (d, *J* = 254 Hz), 138.3, 134.4, 132.0 (d, *J* = 9 Hz), 131.6 (d, *J* = 3

Hz), 115.8 (d, J = 22 Hz), 39.3, 31.0, 30.6, 26.3, 25.2 ppm; MS (m/z) (%): EI [M] calcd for $C_{14}H_{14}ClFO$ $[M]^+$: 252.07, found 254 (8), 252 (23), 217 (35), 123 (100), 95 (47).



Ketone **25** (49 mg) was prepared according to the general procedure of the photo reaction from **S25** in 54% yield. The reaction time is 2 h under 254 nm light. The products were isolated through silica gel flash chromatography (10% ethyl acetate-petroleum ether) as orange solid: R_f = 0.52 (10% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.37 – 7.30 (m, 1H), 6.80 – 6.70 (m, 2H), 2.60 – 2.51 (m, 2H), 2.45 – 2.38 (m, 2H), 1.87 – 1.79 (m, 2H), 1.79 – 1.71 (m, 2H), 1.62 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 195.8, 166.6 (d, J = 251 Hz), 157.3 (d, J = 2 Hz), 149.6 (d, J = 9 Hz), 138.2, 126.6 (d, J = 3 Hz), 123.6 (d, J = 10 Hz), 112.9 (d, J = 13 Hz), 107.6 (d, J = 26 Hz), 30.7, 27.1, 26.8, 26.4, 23.4 ppm; HRMS (EI): Exact mass calcd for $C_{14}H_{13}FO$ $[M]^+$: 216.0950; found 216.0948. Recrystallization of **25** from ethyl acetate–hexane gave single crystals suitable for X-ray analysis (CCDC: 1437985).



25

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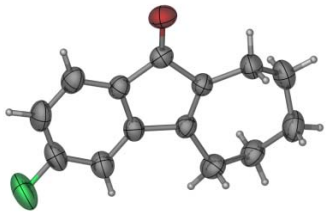
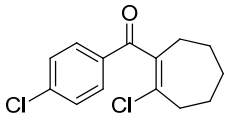
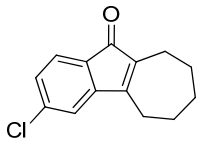


CCDC 1437985

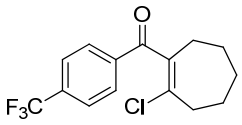


Enone **S26** was prepared as colorless oil: R_f = 0.45 (10% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.85 (d, J = 8.4 Hz, 2H), 7.44 (d, J = 8.4 Hz, 2H), 2.81 – 2.65 (m, 2H), 2.46 – 2.30 (m, 2H), 1.90 – 1.63 (m, 6H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 196.1, 139.9, 138.1, 134.8, 133.6, 130.8 (2C), 129.1 (2C), 39.3, 30.9, 30.7, 26.3, 25.2 ppm; MS (m/z) (%): EI [M] calcd for $C_{14}H_{14}Cl_2O$ $[M]^+$: 268.04, found 268 (4), 233 (60), 159 (100), 139 (99), 111 (55), 95 (33).

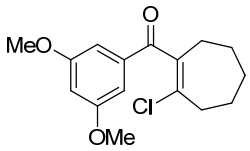


Ketone **26** (41 mg) was prepared according to the general procedure of the photo reaction from **S26** in 63% yield. The reaction time is 4 h under 254 nm light. The products were isolated through silica gel flash chromatography (4% ethyl acetate-petroleum ether) as yellow solid: R_f = 0.42 (10% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.28 (d, J = 7.6 Hz, 1H), 7.12 (d, J = 7.6 Hz, 1H), 6.99 (s, 1H), 2.60 – 2.53 (m, 2H), 2.46 – 2.37 (m, 2H), 1.88 – 1.79 (m, 2H), 1.79 – 1.70 (m, 2H), 1.66 – 1.58 (m, 2H) ppm; ^{13}C

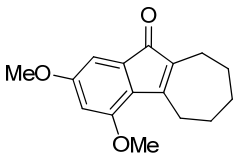
NMR (100 MHz, $CDCl_3$) δ 196.0, 158.4, 148.2, 139.4, 138.0, 129.0, 127.3, 122.8, 119.4, 30.7, 27.1, 26.8, 26.4, 23.4 ppm; HRMS (EI): Exact mass calcd for $C_{14}H_{13}ClO$ $[M]^+$: 232.0655; found 232.0657.



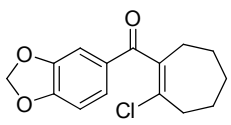
Enone **S27** was prepared as colorless oil: R_f = 0.67 (10% ethyl acetate-petroleum ether); ^1H NMR (400 MHz, $CDCl_3$) δ 8.02 (d, J = 8.1 Hz, 2H), 7.74 (d, J = 8.1 Hz, 2H), 2.82 – 2.69 (m, 2H), 2.46 – 2.34 (m, 2H), 1.92 – 1.69 (m, 6H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 196.4, 138.2, 138.0, 135.7, 134.6 (q, J = 33.0 Hz), 129.7, 125.8 (q, J = 4.0 Hz), 123.6 (q, J = 271.0 Hz), 39.5, 31.0, 30.7, 26.3, 25.2 ppm; MS (m/z) (%): EI [M] calcd for $C_{15}H_{14}ClF_3O$ $[M]^+$: 302.07, found 304 (2), 302 (6), 233 (91), 173 (100), 145 (97), 77 (18).



Enone **S28** was prepared as yellow oil: R_f = 0.25 (10% ethyl acetate-petroleum ether); ^1H NMR (400 MHz, $CDCl_3$) δ 7.05 (d, J = 2.3 Hz, 2H), 6.64 (t, J = 2.3 Hz, 1H), 3.80 (s, 6H), 2.73 – 2.65 (m, 2H), 2.38 – 2.26 (m, 2H), 1.84 – 1.64 (m, 6H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 196.8, 160.9 (2C), 138.5, 136.9, 134.0, 106.9 (2C), 105.6, 55.4, 55.4, 39.2, 30.8, 30.6, 26.2, 25.2 ppm; MS (m/z) (%): EI [M] calcd for $C_{16}H_{19}ClO_3$ $[M]^+$: 294.10, found 296 (3), 294 (9), 259 (100), 165 (34), 137 (24), 122 (29), 77 (24).

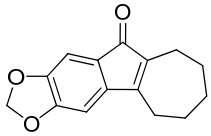


Ketone **28** (42 mg) was prepared according to the general procedure of the photo reaction from **S28** in 92% yield. The reaction time is 2.5 h under 254 nm light. The products were isolated through silica gel flash chromatography (3% ethyl acetate-petroleum ether) as red solid: R_f = 0.24 (10% ethyl acetate-petroleum ether); ^1H NMR (400 MHz, $CDCl_3$) δ 6.68 (d, J = 1.9 Hz, 1H), 6.38 (d, J = 1.8 Hz, 1H), 3.80 (d, J = 2.6 Hz, 6H), 3.03 – 2.85 (m, 2H), 2.41 – 2.18 (m, 2H), 1.86 – 1.65 (m, 4H), 1.61 – 1.53 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 197.3, 164.1, 161.8, 154.3, 134.7, 134.0, 123.0, 103.0, 102.0, 55.8, 55.6, 30.9, 30.0, 26.7, 26.3, 22.6 ppm; HRMS (EI): Exact mass calcd for $C_{16}H_{18}O_3$ $[M]^+$: 258.1256; found 258.1254.

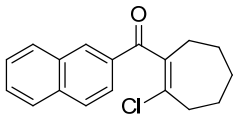


Enone **S29** was prepared as colorless oil: R_f = 0.67 (20% ethyl acetate-petroleum ether); ^1H NMR (400 MHz, $CDCl_3$) δ 7.57 – 7.45 (m, 1H),

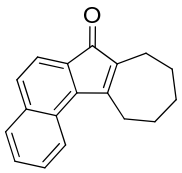
7.39 (s, 1H), 6.92 – 6.77 (m, 1H), 6.03 (d, J = 1.1 Hz, 2H), 2.77 – 2.60 (m, 2H), 2.42 – 2.27 (m, 2H), 1.83 – 1.65 (m, 6H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 195.6, 152.2, 148.3, 138.6, 133.5, 129.8, 126.3, 108.6, 108.1, 101.9, 39.2, 31.0, 30.6, 26.2, 25.2 ppm; MS (m/z) (%): EI [M] calcd for $C_{15}H_{15}ClO_3$ $[M]^+$: 278.07, found 280 (2), 278 (6), 149 (22), 123 (20), 86 (67), 84 (100).



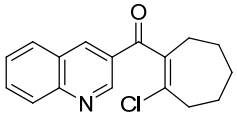
Ketone **29** (57 mg) was prepared according to the general procedure of the photo reaction from **S29** in 93% yield. The reaction time is 4 h under 254 nm light. The products were isolated through silica gel flash chromatography (5% ethyl acetate-petroleum ether) as orange solid: R_f = 0.65 (20% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 6.88 (s, 1H), 6.54 (s, 1H), 5.96 (s, 2H), 2.54 – 2.42 (m, 2H), 2.39 – 2.26 (m, 2H), 1.82 – 1.75 (m, 2H), 1.75 – 1.65 (m, 2H), 1.65 – 1.44 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 196.2, 157.5, 151.3, 146.7, 142.8, 135.3, 124.6, 104.7, 101.8, 101.6, 30.7, 27.2, 27.0, 26.5, 23.3 ppm; HRMS (EI): Exact mass calcd for $C_{15}H_{14}O_3$ $[M]^+$: 242.0943; found 242.0941.



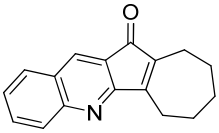
Enone **S30** was prepared as white solid: R_f = 0.43 (10% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.42 (s, 1H), 8.03 (dd, J = 8.6, 1.6 Hz, 1H), 7.98 (d, J = 8.0 Hz, 1H), 7.92 (d, J = 8.6 Hz, 1H), 7.88 (d, J = 8.1 Hz, 1H), 7.63 – 7.57 (m, 1H), 7.57 – 7.51 (m, 1H), 2.84 – 2.74 (m, 2H), 2.49 – 2.39 (m, 2H), 1.89 – 1.74 (m, 6H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 197.4, 138.7, 135.8, 134.3, 132.6, 132.5, 131.7, 129.6, 128.6, 128.6, 127.8, 126.7, 124.5, 39.3, 31.1, 30.7, 26.3, 25.3 ppm; MS (m/z) (%): EI [M] calcd for $C_{18}H_{17}ClO$ $[M]^+$: 284.10, found 286 (8), 284 (22), 249 (45), 155 (87), 135 (29), 127 (100), 77 (31).



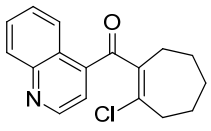
Ketone **30** (43 mg) was prepared according to the general procedure of the photo reaction from **S30** in 74% yield. The reaction time is 4.5 h under 254 nm light. The products were isolated through silica gel flash chromatography (4% ethyl acetate-petroleum ether) as red solid: R_f = 0.42 (10% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.28 – 8.21 (m, 1H), 7.78 – 7.71 (m, 1H), 7.64 (d, J = 7.9 Hz, 1H), 7.49 (d, J = 7.9 Hz, 1H), 7.44 – 7.37 (m, 2H), 3.27 – 3.17 (m, 2H), 2.51 – 2.38 (m, 2H), 2.00 – 1.91 (m, 2H), 1.91 – 1.80 (m, 2H), 1.80 – 1.69 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 198.7, 161.3, 144.0, 138.2, 135.8, 129.6, 128.7, 127.9, 127.9, 126.8, 126.8, 124.4, 118.4, 31.6, 28.6, 26.0, 25.4, 21.2 ppm; HRMS (EI): Exact mass calcd for $C_{18}H_{16}O$ $[M]^+$: 248.1201; found 248.1202.



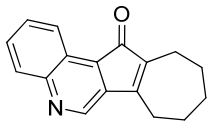
Enone **S31** was prepared as colorless oil: R_f = 0.79 (50% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.36 (d, *J* = 2.1 Hz, 1H), 8.66 (d, *J* = 1.9 Hz, 1H), 8.15 (d, *J* = 8.5 Hz, 1H), 7.95 (d, *J* = 8.1 Hz, 1H), 7.89 – 7.75 (m, 1H), 7.71 – 7.52 (m, 1H), 2.97 – 2.66 (m, 2H), 2.58 – 2.29 (m, 2H), 1.92 – 1.65 (m, 6H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 196.1, 150.1, 149.9, 138.6, 137.9, 136.1, 132.1, 129.5, 129.4, 127.9, 127.5, 127.1, 39.5, 31.1, 30.7, 26.3, 25.2 ppm; MS (m/z) (%): EI [M] calcd for $C_{17}H_{16}ClNO$ $[M]^+$: 285.09, found 287 (13), 285 (39), 250 (47), 156 (88), 128 (100), 101 (45).



Ketone **31** (20 mg) was prepared according to the general procedure of the photo reaction from **S31** in 72% yield. The reaction time is 4 h under 254 nm light. The products were isolated through silica gel flash chromatography (20% ethyl acetate-petroleum ether) as orange solid: R_f = 0.77 (50% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.84 (s, 1H), 8.29 (d, *J* = 8.5 Hz, 1H), 8.06 (d, *J* = 8.5 Hz, 1H), 7.71 (ddd, *J* = 8.4, 6.8, 1.2 Hz, 1H), 7.51 (ddd, *J* = 8.3, 6.8, 1.2 Hz, 1H), 3.36 – 3.12 (m, 2H), 2.60 – 2.39 (m, 2H), 2.08 – 1.92 (m, 2H), 1.92 – 1.80 (m, 2H), 1.80 – 1.71 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 197.4, 158.6, 153.9, 153.6, 142.0, 138.5, 131.3, 131.0, 127.3, 124.7, 123.2, 120.9, 31.1, 28.7, 25.8, 25.5, 21.6 ppm; HRMS (EI): Exact mass calcd for $C_{17}H_{15}NO$ $[M]^+$: 249.1154; found 249.1155.

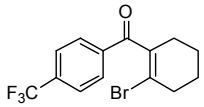


Enone **S32** was prepared as colorless oil: R_f = 0.62 (50% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.00 (d, *J* = 4.3 Hz, 1H), 8.46 (d, *J* = 8.5 Hz, 1H), 8.16 (d, *J* = 8.4 Hz, 1H), 7.75 (t, *J* = 7.7 Hz, 1H), 7.68 – 7.54 (m, 1H), 7.53 (d, *J* = 4.3 Hz, 1H), 2.84 – 2.64 (m, 2H), 2.63 – 2.45 (m, 2H), 1.86 – 1.78 (m, 2H), 1.76 – 1.57 (m, 4H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 198.0, 149.8, 149.1, 142.3, 140.4, 139.5, 129.9, 129.8, 128.1, 125.5, 124.4, 120.2, 40.2, 30.9 (2 C), 26.3, 24.9 ppm; MS (m/z) (%): EI [M] calcd for $C_{17}H_{16}ClNO$ $[M]^+$: 285.09, found 287 (4), 285 (12), 250 (100), 128 (66), 101 (33).

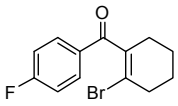


Ketone **32** (20 mg) was prepared according to the general procedure of the photo reaction from **S32** in 76% yield. The reaction time is 4 h under 254 nm light. The products were isolated through silica gel flash chromatography (25% ethyl acetate-petroleum ether) as red solid: R_f = 0.61 (50% ethyl acetate-petroleum ether); ^{1}H NMR (400

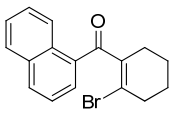
MHz, $CDCl_3$) δ 8.77 (s, 1H), 8.55 (dd, *J* = 8.4, 0.8 Hz, 1H), 7.97 (d, *J* = 8.6 Hz, 1H), 7.59 (ddd, *J* = 8.5, 6.8, 1.5 Hz, 1H), 7.53 (ddd, *J* = 8.1, 6.8, 1.2 Hz, 1H), 2.86 – 2.62 (m, 2H), 2.48 – 2.34 (m, 2H), 1.91 – 1.78 (m, 4H), 1.71 – 1.50 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 199.0, 159.0, 150.9, 140.9, 138.7, 135.5, 130.1, 129.5, 129.5, 129.1, 123.7, 122.3, 30.5, 27.7, 26.9, 26.6, 23.3 ppm; HRMS (EI): Exact mass calcd for $C_{17}H_{15}NO$ $[M]^+$: 249.1154; found 249.1156.



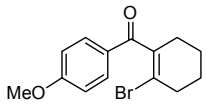
Enone **S33** was prepared as yellow oil: R_f = 0.56 (10% ethyl acetate-petroleum ether); ^1H NMR (400 MHz, $CDCl_3$) δ 8.05 (d, *J* = 8.1 Hz, 2H), 7.76 (d, *J* = 8.1 Hz, 2H), 2.74 – 2.49 (m, 2H), 2.45 – 2.25 (m, 2H), 1.98 – 1.63 (m, 4H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 196.4, 137.4, 137.1, 134.7 (q, *J* = 34.0 Hz), 129.8, 125.8 (q, *J* = 4.0 Hz), 123.6 (q, *J* = 271.0 Hz), 121.4, 35.6, 29.5, 24.2, 21.3 ppm; MS (m/z) (%): EI [M] calcd for $C_{14}H_{12}BrF_3O$ $[M]^+$: 332.00, found 334 (7), 332 (7), 263 (53), 253 (66), 173 (100), 145 (99), 79 (36).



Enone **S34** was prepared as colorless oil: R_f = 0.34 (10% ethyl acetate-petroleum ether); ^1H NMR (400 MHz, $CDCl_3$) δ 8.03 – 7.89 (m, 2H), 7.20 – 7.12 (m, 2H), 2.67 – 2.54 (m, 2H), 2.40 – 2.28 (m, 2H), 1.93 – 1.71 (m, 4H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 196.0, 166.1 (d, *J* = 255.0 Hz), 137.5, 132.3 (d, *J* = 10.0 Hz), 131.0 (d, *J* = 3.0 Hz), 120.5, 116.0 (d, *J* = 22.0 Hz), 35.6, 29.6, 24.2, 21.3 ppm; MS (m/z) (%): EI [M] calcd for $C_{13}H_{12}BrFO$ $[M]^+$: 282.01, found 284 (14), 284 (14), 203 (52), 123(100), 95 (54).

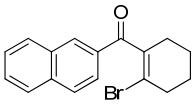


Enone **S35** was prepared as white solid: R_f = 0.44 (10% ethyl acetate-petroleum ether); ^1H NMR (400 MHz, $CDCl_3$) δ 8.99 (d, *J* = 8.6 Hz, 1H), 8.04 (d, *J* = 8.2 Hz, 1H), 7.96 (d, *J* = 7.2 Hz, 1H), 7.90 (d, *J* = 8.0 Hz, 1H), 7.66 (t, *J* = 7.7 Hz, 1H), 7.54 (dt, *J* = 17.8, 7.9 Hz, 2H), 2.73 – 2.56 (m, 2H), 2.56 – 2.40 (m, 2H), 1.96 – 1.75 (m, 4H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 199.5, 139.4, 134.1, 133.9, 132.3, 131.4, 131.0, 128.5, 128.4, 126.5, 126.1, 124.5, 122.0, 36.0, 30.1, 24.3, 21.5 ppm; MS (m/z) (%): EI [M] calcd for $C_{17}H_{15}BrO$ $[M]^+$: 314.03, found 316 (17), 314 (17), 235 (100), 155 (67), 127 (100), 77 (25).

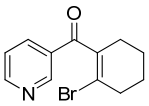


Enone **S36** was prepared as yellow oil: R_f = 0.33 (10% ethyl acetate-petroleum ether); ^1H NMR (400 MHz, $CDCl_3$) δ 7.90 (d, *J* = 8.7 Hz, 2H), 6.95 (d, *J* = 8.7 Hz, 2H), 3.86 (s, 3H), 2.65 – 2.56 (m, 2H), 2.40 – 2.26 (m, 2H), 1.91 – 1.69 (m, 4H) ppm; ^{13}C NMR

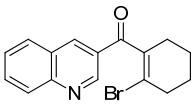
(100 MHz, $CDCl_3$) δ 196.2, 164.0, 137.9, 131.9 (2C), 127.4, 119.5, 114.0 (2C), 55.4, 35.4, 29.6, 24.2, 21.3 ppm; MS (m/z) (%): EI [M] calcd for $C_{14}H_{15}BrO_2$ $[M]^+$: 294.03, found 296 (10), 294 (10), 263 (15), 215 (33), 135 (100), 92 (30), 77 (51).



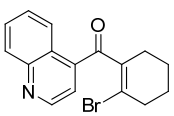
Enone **S37** was prepared as white solid: R_f = 0.41 (10% ethyl acetate-petroleum ether); ^1H NMR (400 MHz, $CDCl_3$) δ 8.42 (s, 1H), 8.07 – 7.97 (m, 2H), 7.97 – 7.84 (m, 2H), 7.67 – 7.50 (m, 2H), 2.73 – 2.63 (m, 2H), 2.47 – 2.38 (m, 2H), 1.98 – 1.80 (m, 4H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 197.6, 137.9, 135.9, 132.6, 131.9, 131.9, 129.70 128.7, 128.7, 127.8, 126.7, 124.5, 120.3, 35.6, 29.7, 24.2, 21.4 ppm; MS (m/z) (%): EI [M] calcd for $C_{17}H_{15}BrO$ $[M]^+$: 314.03, found 316 (18), 314 (18), 235 (49), 155 (44), 127 (100), 77 (32).



Enone **S38** was prepared as colorless oil: R_f = 0.39 (30% ethyl acetate-petroleum ether); ^1H NMR (400 MHz, $CDCl_3$) δ 9.06 (s, 1H), 8.77 (d, J = 4.1 Hz, 1H), 8.20 (d, J = 7.9 Hz, 1H), 7.42 (dd, J = 7.9, 4.8 Hz, 1H), 2.69 – 2.53 (m, 2H), 2.45 – 2.23 (m, 2H), 1.89 – 1.69 (m, 4H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 196.3, 153.7, 151.2, 136.8, 136.5, 130.1, 123.8, 121.8, 35.6, 29.4, 24.1, 21.2 ppm; MS (m/z) (%): EI [M] calcd for $C_{12}H_{12}BrNO$ $[M]^+$: 265.01, found 267 (32), 265 (32), 186 (87), 106 (100), 78 (89), 51 (54).

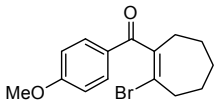


Enone **S39** was prepared as white solid: R_f = 0.47 (50% ethyl acetate-petroleum ether); ^1H NMR (400 MHz, $CDCl_3$) δ 9.37 (d, J = 1.9 Hz, 1H), 8.67 (d, J = 1.9 Hz, 1H), 8.16 (d, J = 8.5 Hz, 1H), 7.96 (d, J = 8.2 Hz, 1H), 7.89 – 7.79 (m, 1H), 7.62 (t, J = 7.5 Hz, 1H), 2.71 – 2.61 (m, 2H), 2.45 – 2.35 (m, 2H), 1.94 – 1.78 (m, 4H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 196.2, 150.0, 149.9, 138.8, 136.9, 132.2, 129.4, 129.4, 127.5, 127.1, 127.0, 121.8, 35.6, 29.5, 24.1, 21.3 ppm; MS (m/z) (%): EI [M] calcd for $C_{16}H_{14}BrNO$ $[M]^+$: 315.03, found 317 (44), 315 (44), 236 (82), 156 (81), 128 (100), 101 (52), 79 (31), 77 (26).

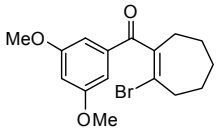


Enone **S40** was prepared as colorless oil: R_f = 0.60 (50% ethyl acetate-petroleum ether); ^1H NMR (400 MHz, $CDCl_3$) δ 9.01 (d, J = 4.4 Hz, 1H), 8.56 (dd, J = 8.5, 0.7 Hz, 1H), 8.15 (d, J = 8.3 Hz, 1H), 7.84 – 7.70 (m, 1H), 7.68 – 7.60 (m, 1H), 7.58 (d, J = 4.4 Hz, 1H), 2.67 – 2.53 (m, 2H), 2.52 – 2.41 (m, 2H), 1.90 – 1.70 (m, 4H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 198.4, 149.8, 149.1, 140.8, 138.1, 129.8, 129.8, 128.4, 125.54, 125.3, 124.4, 121.2, 36.4,

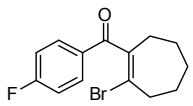
29.7, 24.1, 21.4 ppm; MS (m/z) (%): EI [M] calcd for $C_{16}H_{14}BrNO$ $[M]^+$: 315.03, found 317 (12), 315 (12), 235 (96), 155 (68), 127 (100), 79 (36), 77 (42).



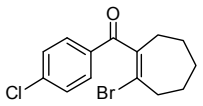
Enone **S41** was prepared as colorless oil: R_f = 0.32 (10% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.92 (d, J = 8.3 Hz, 2H), 6.96 (d, J = 8.2 Hz, 2H), 3.87 (s, 3H), 2.97 – 2.71 (m, 2H), 2.44 – 2.27 (m, 2H), 1.95 – 1.63 (m, 6H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 196.5, 163.9, 142.2, 132.0 (2C), 127.1, 123.2, 114.0 (2C), 55.5, 41.6, 31.9, 30.7, 26.1, 25.6 ppm; MS (m/z) (%): EI [M] calcd for $C_{15}H_{17}BrO_2$ $[M]^+$: 308.04, found 310 (8), 308 (8), 229 (31), 135 (100), 77 (21).



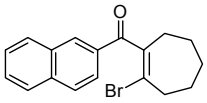
Enone **S42** was prepared as yellow oil: R_f = 0.27 (10% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.10 (d, J = 1.7 Hz, 2H), 6.68 (s, 1H), 3.84 (s, 6H), 2.97 – 2.81 (m, 2H), 2.43 – 2.28 (m, 2H), 1.87 – 1.68 (m, 6H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 197.2, 161.0, 142.0, 136.4, 123.8, 107.3, 105.9, 55.6, 41.7, 31.9, 30.7, 26.1, 25.7 ppm; MS (m/z) (%): EI [M] calcd for $C_{16}H_{19}BrO_3$ $[M]^+$: 338.05, found 340 (3), 338 (3), 259 (100), 165 (27), 137 (18), 122 (23), 77 (19).



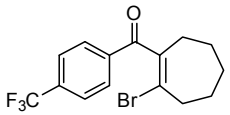
Enone **S43** was prepared as colorless oil: R_f = 0.47 (10% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.05 – 7.87 (m, 2H), 7.21 – 7.08 (m, 2H), 2.94 – 2.83 (m, 2H), 2.44 – 2.21 (m, 2H), 1.95 – 1.66 (m, 6H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 196.1, 166.0 (d, J = 254 Hz), 141.7, 132.3 (d, J = 9 Hz), 130.8 (d, J = 3 Hz), 124.1, 116.0 (d, J = 22 Hz), 41.7, 31.9, 30.7, 26.1, 25.6 ppm; MS (m/z) (%): EI [M] calcd for $C_{14}H_{14}BrFO$ $[M]^+$: 296.02, found 298 (7), 286 (7), 217 (35), 123 (100), 95 (43).



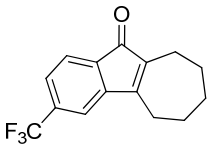
Enone **S44** was prepared as colorless oil: R_f = 0.43 (10% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.88 (d, J=8.6, 2H), 7.46 (d, J=8.6, 2H), 2.99 – 2.83 (m, 2H), 2.46 – 2.26 (m, 2H), 1.90 – 1.64 (m, 6H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 196.3, 141.6, 140.0, 132.8, 131.0 (2C), 129.1 (2C), 124.4, 41.7, 31.9, 30.6, 26.1, 25.6 ppm; MS (m/z) (%): EI [M] calcd for $C_{14}H_{14}BrClO$ $[M]^+$: 311.99, found 314 (4), 312 (4), 277 (20), 233 (25), 139 (100), 111 (48).



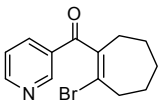
Enone **S45** was prepared as white solid: R_f = 0.42 (10% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.43 (s, 1H), 8.09 – 7.96 (m, 2H), 7.91 (dd, *J*=13.9, 8.4, 2H), 7.59 (ddd, *J*=21.7, 14.3, 7.3, 2H), 3.03 – 2.89 (m, 2H), 2.52 – 2.37 (m, 2H), 1.94 – 1.74 (m, 6H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 197.7, 142.2, 135.9, 132.7, 132.0, 131.8, 129.7, 128.8, 128.7, 127.9, 126.7, 124.7, 124.1, 41.8, 32.1, 30.8, 26.2, 25.7 ppm; MS (m/z) (%): EI [M] calcd for $C_{18}H_{17}BrO$ $[M]^+$: 328.05, found 330 (12), 328 (12), 249 (85), 155 (94), 127 (100), 77 (16).



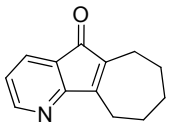
Enone **S46** was prepared as colorless oil: R_f = 0.68 (10% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.05 (d, *J* = 8.1 Hz, 2H), 7.75 (d, *J* = 8.3 Hz, 2H), 2.97 – 2.83 (m, 2H), 2.44 – 2.28 (m, 2H), 1.92 – 1.68 (m, 6H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 196.5, 141.4, 137.3, 134.6 (q, *J* = 33.0 Hz), 129.9, 125.9 (q, *J* = 4.0 Hz), 125.2, 123.6 (q, *J* = 271.0 Hz), 41.8, 31.9, 30.7, 26.1, 25.6 ppm; MS (m/z) (%): EI [M] calcd for $C_{15}H_{14}BrF_3O$ $[M]^+$: 346.02, found 348 (6), 346 (6), 267 (50), 173 (100), 145 (84), 77 (15).



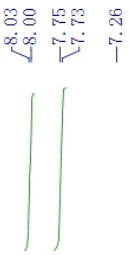
Ketone **27** (30 mg) was prepared according to the general procedure of the photo reaction from **S46** in 69% yield. The reaction time is 3 h under 254 nm light. The products were isolated through silica gel flash chromatography (3% ethyl acetate-petroleum ether) as yellow solid: R_f = 0.67 (10% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.45 (s, 2H), 7.23 (s, 1H), 2.69 – 2.60 (m, 2H), 2.48 – 2.40 (m, 2H), 1.91 – 1.81 (m, 2H), 1.81 – 1.72 (m, 2H), 1.67 – 1.59 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 196.1, 159.4, 146.9, 138.1, 134.7 (q, *J* = 32.0 Hz), 133.6, 125.6 (q, *J* = 4.0 Hz), 123.7 (q, *J* = 271.0 Hz), 121.7, 115.0 (q, *J* = 4.0 Hz), 30.7, 27.2, 26.7, 26.3, 23.3 ppm; HRMS (EI): Exact mass calcd for $C_{15}H_{13}F_3O$ $[M]^+$: 266.0918; found 266.0916.

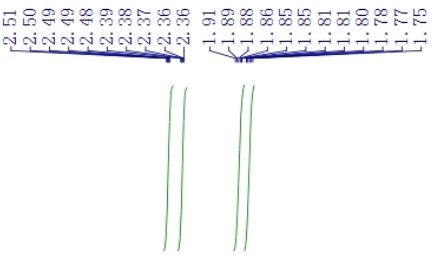


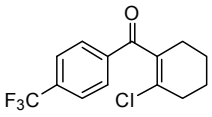
Enone **S47** was prepared as colorless oil: R_f = 0.62 (50% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 9.07 (s, 1H), 8.77 (d, *J* = 4.6 Hz, 1H), 8.21 (d, *J* = 7.9 Hz, 1H), 7.42 (dd, *J* = 7.9, 4.8 Hz, 1H), 3.00 – 2.74 (m, 2H), 2.44 – 2.28 (m, 2H), 1.94 – 1.59 (m, 6H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 196.3, 153.7, 151.3, 141.1, 136.6, 130.0, 125.5, 123.8, 41.8, 31.8, 30.6, 26.0, 25.5 ppm; MS (m/z) (%): EI [M] calcd for $C_{13}H_{14}BrNO$ $[M]^+$: 279.03, found 281 (12), 279 (12), 200 (65), 106 (100), 78 (71), 51 (32).



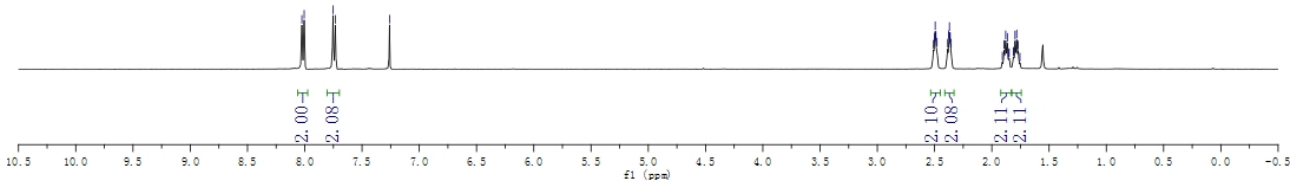
Ketone **33** (18 mg) was prepared according to the general procedure of the photo reaction from **S47** in 76% yield. The reaction time is 2.5 h under 254 nm light. The products were isolated through silica gel flash chromatography (20% ethyl acetate-petroleum ether) as yellow solid: R_f = 0.63 (50% ethyl acetate-petroleum ether); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.38 (d, J = 5.3 Hz, 1H), 7.55 (d, J = 7.1 Hz, 1H), 7.02 (dd, J = 6.9, 5.5 Hz, 1H), 2.92 – 2.69 (m, 2H), 2.57 – 2.34 (m, 2H), 1.89 – 1.80 (m, 2H), 1.83 – 1.70 (m, 2H), 1.70 – 1.45 (m, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$) δ 195.5, 167.5, 159.8, 151.6, 140.5, 128.2, 124.7, 121.9, 30.8, 26.8, 26.4, 25.5, 23.5 ppm; HRMS (EI): Exact mass calcd for $C_{13}H_{13}NO$ $[M]^+$: 199.0997; found 199.0995.

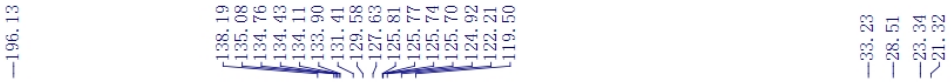


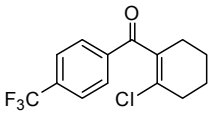




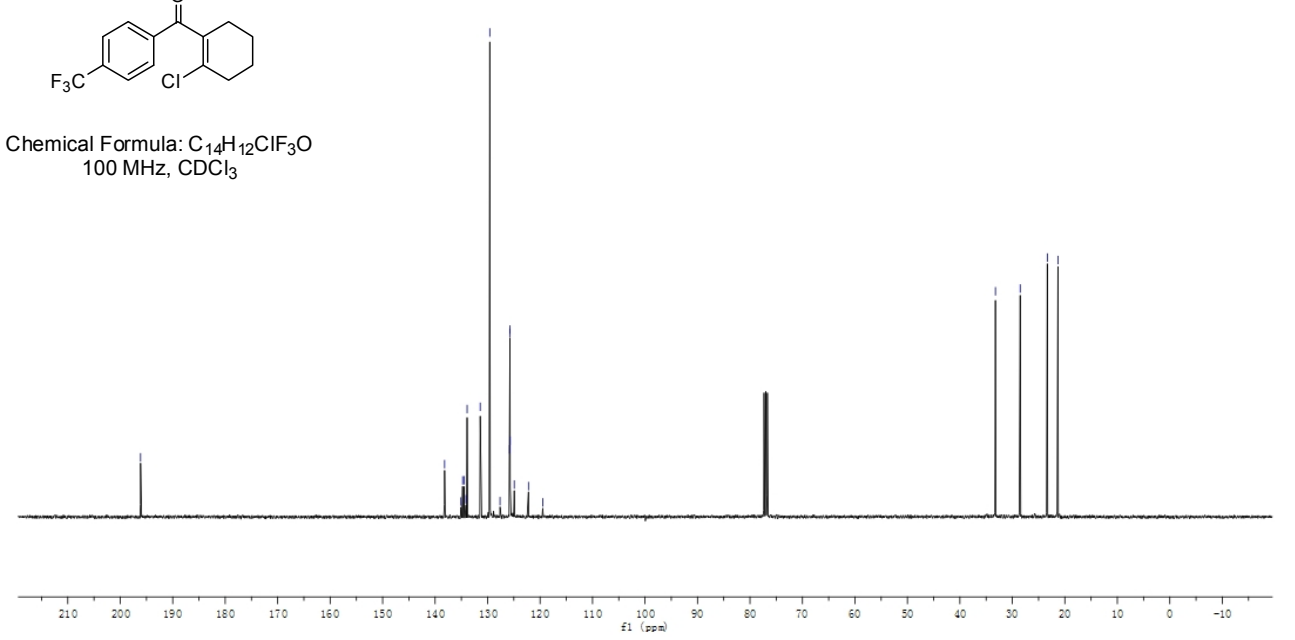
Chemical Formula: $C_{14}H_{12}ClF_3O$
400 MHz, $CDCl_3$

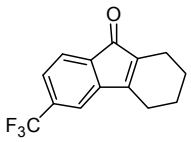




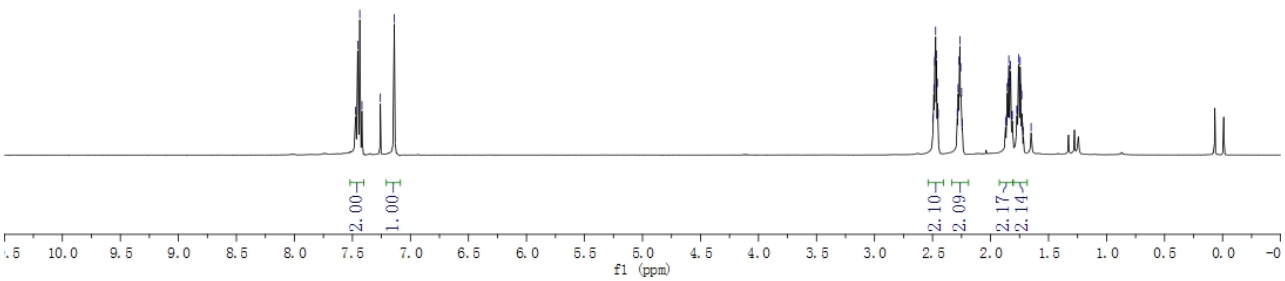


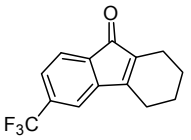
Chemical Formula: $C_{14}H_{12}ClF_3O$
100 MHz, $CDCl_3$



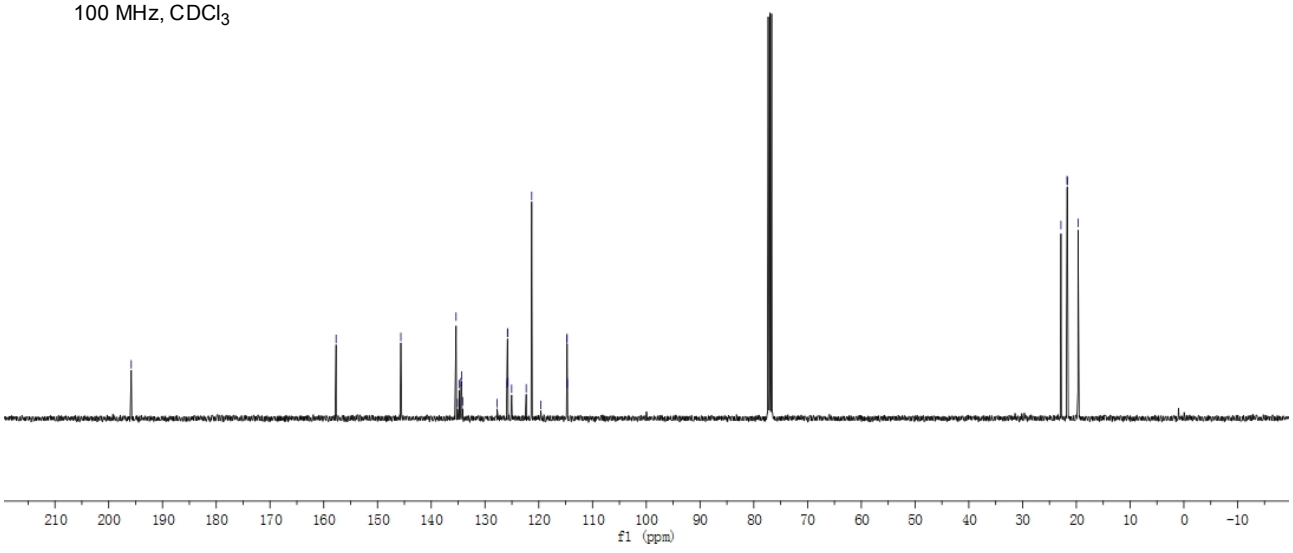


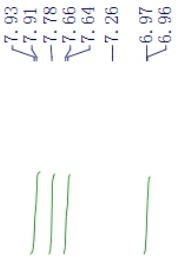
Chemical Formula: $C_{14}H_{11}F_3O$
400 MHz, $CDCl_3$

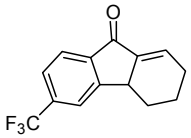




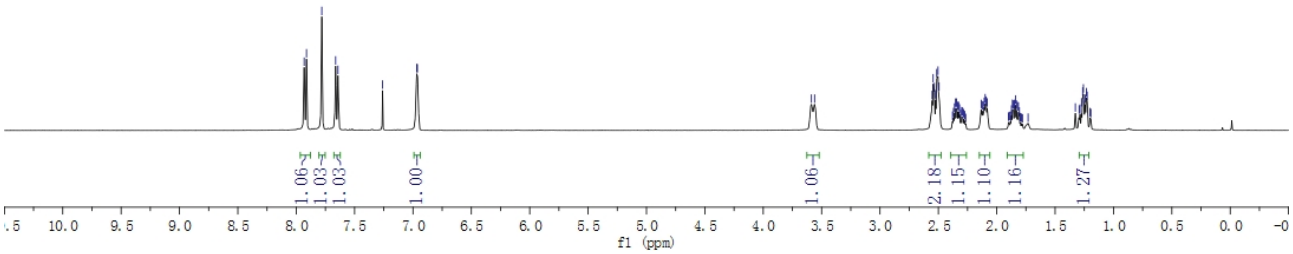
Chemical Formula: $C_{14}H_{11}F_3O$
100 MHz, $CDCl_3$

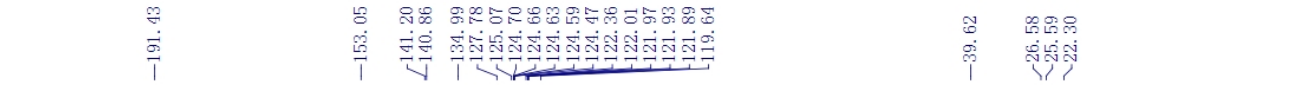


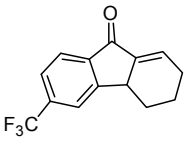




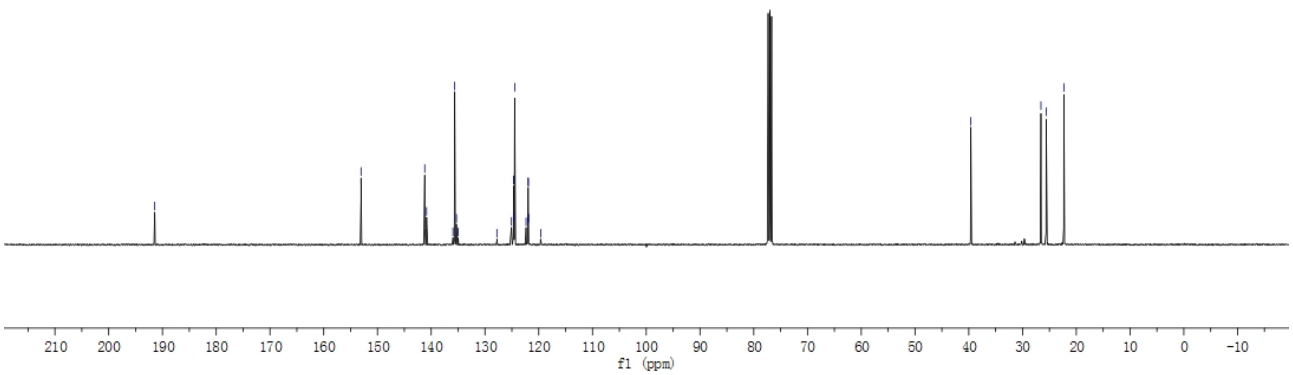
Chemical Formula: $C_{14}H_{11}F_3O$
400 MHz, $CDCl_3$

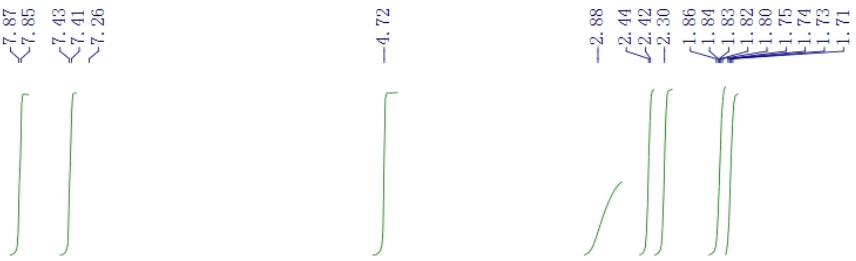


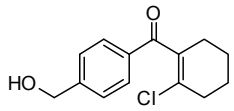




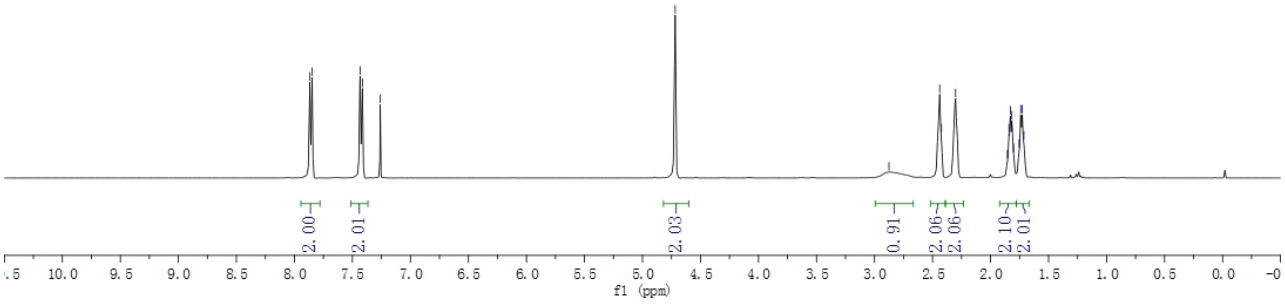
Chemical Formula: $C_{14}H_{11}F_3O$
100 MHz, $CDCl_3$

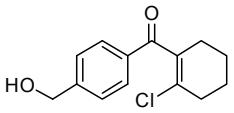




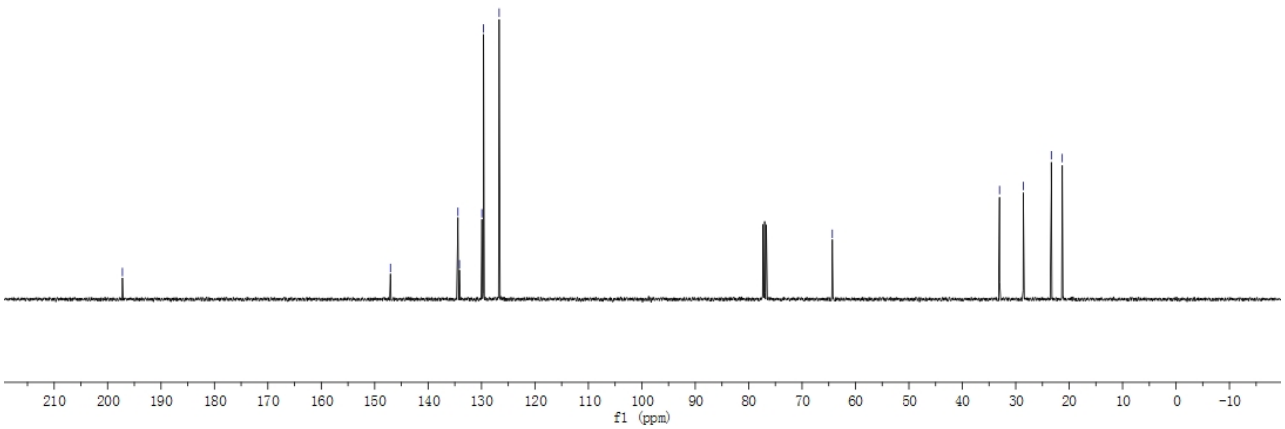


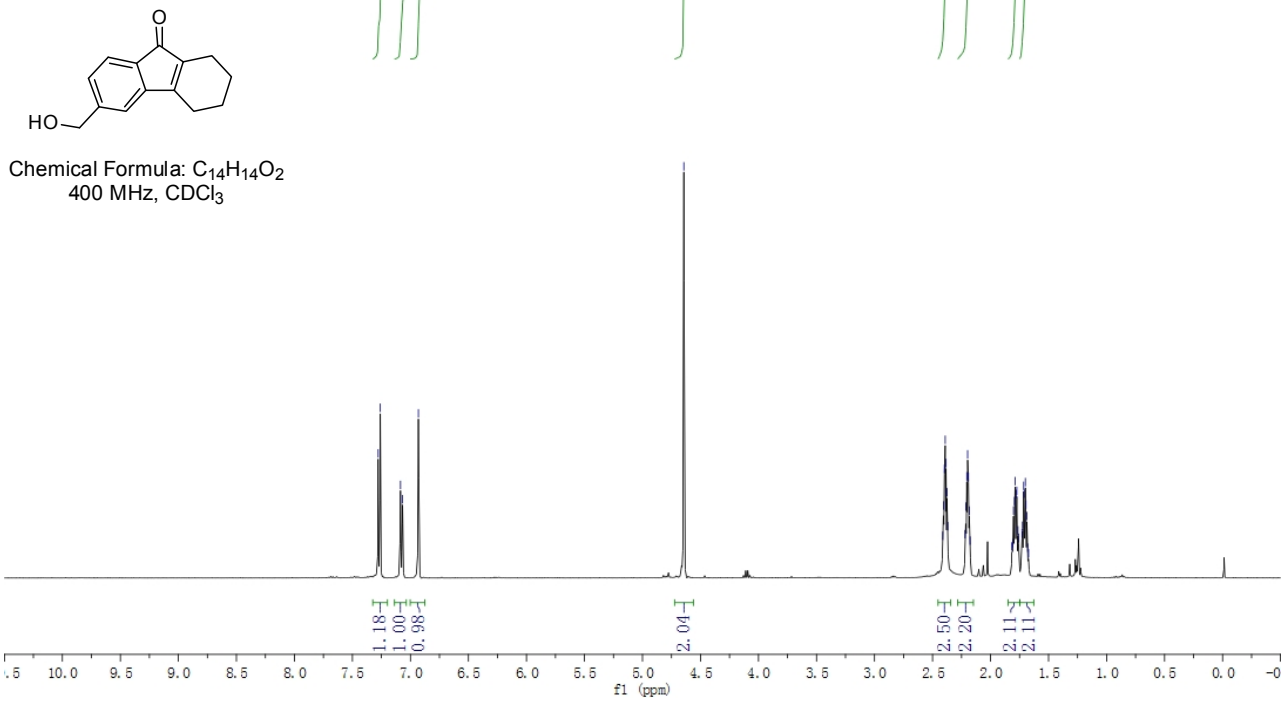
Chemical Formula: $C_{14}H_{15}ClO_2$
400 MHz, $CDCl_3$



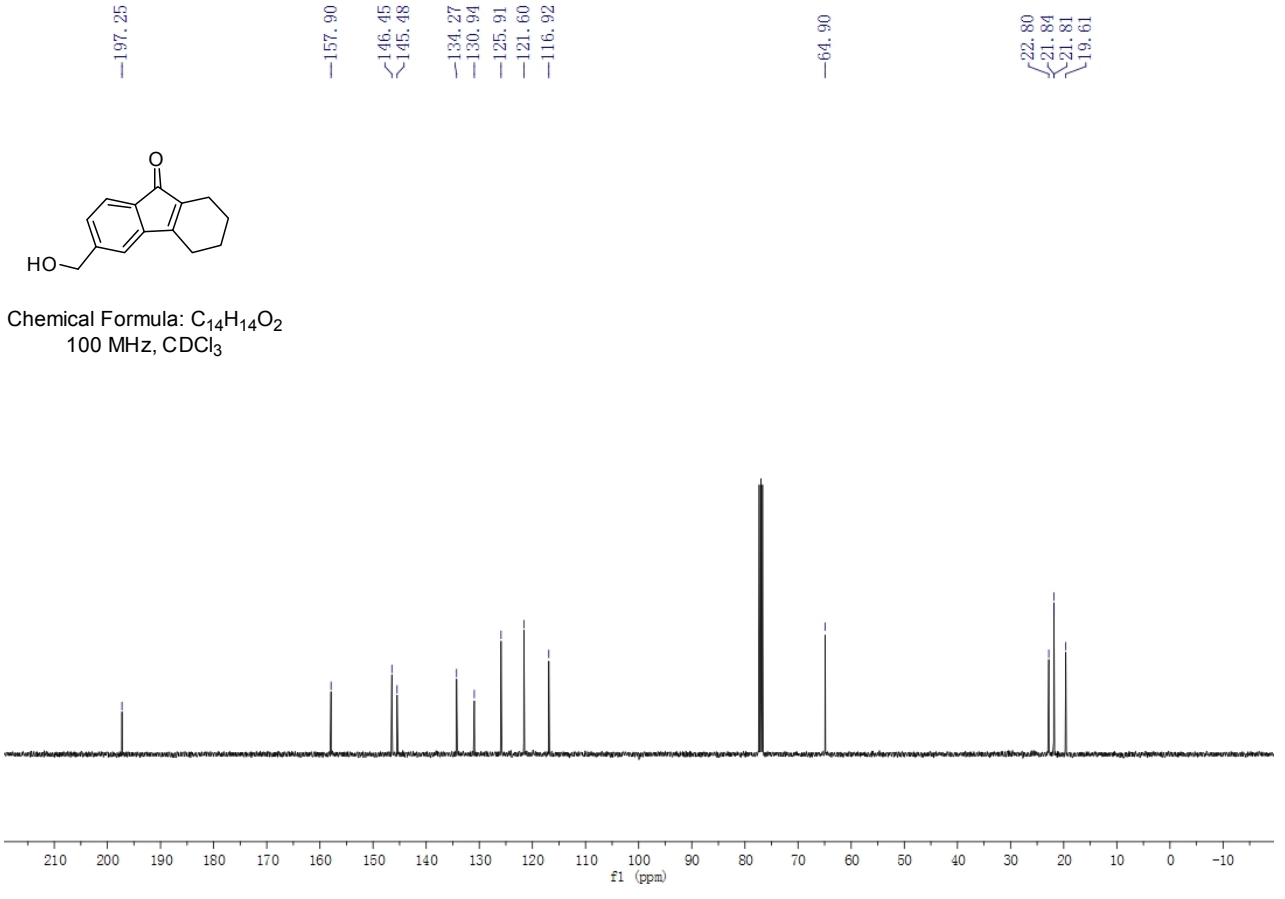


Chemical Formula: $C_{14}H_{15}ClO_2$
100 MHz, $CDCl_3$

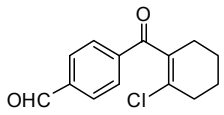




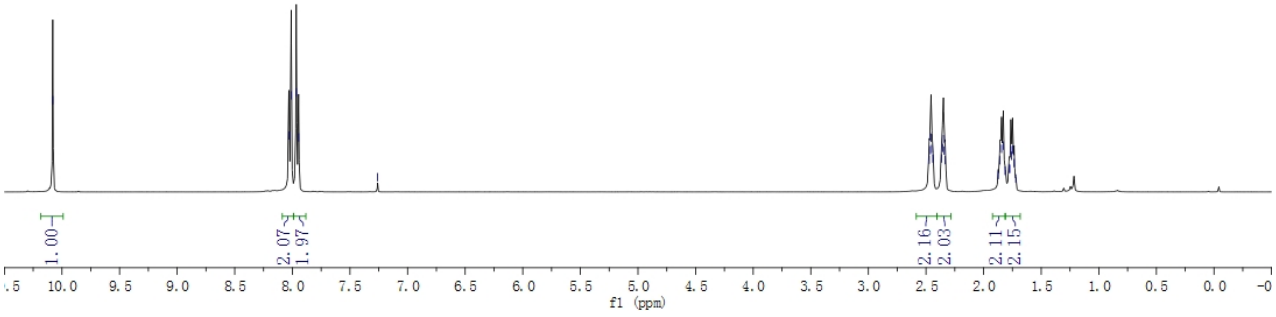
Chemical Formula: $C_{14}H_{14}O_2$
400 MHz, $CDCl_3$

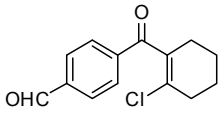


Chemical Formula: $C_{14}H_{14}O_2$
100 MHz, $CDCl_3$

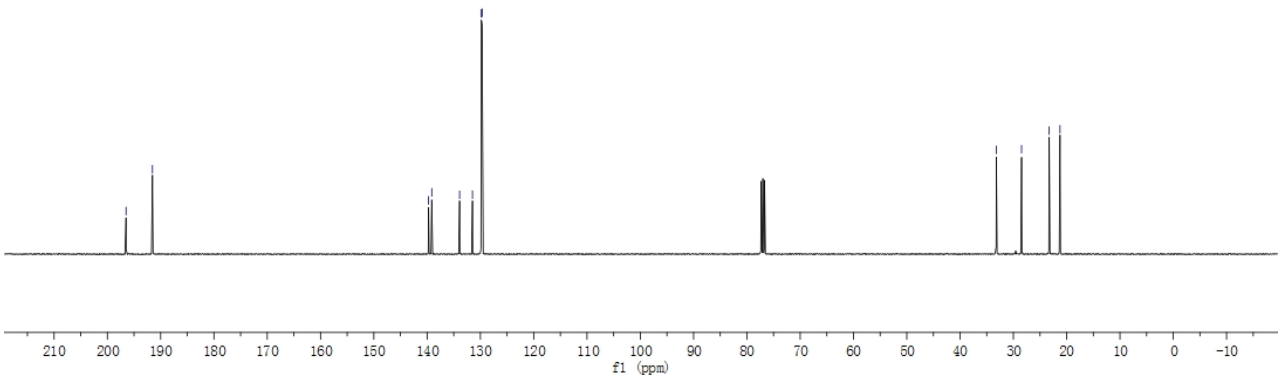


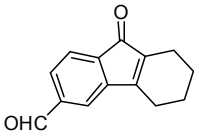
Chemical Formula: $C_{14}H_{13}ClO_2$
400 MHz, $CDCl_3$



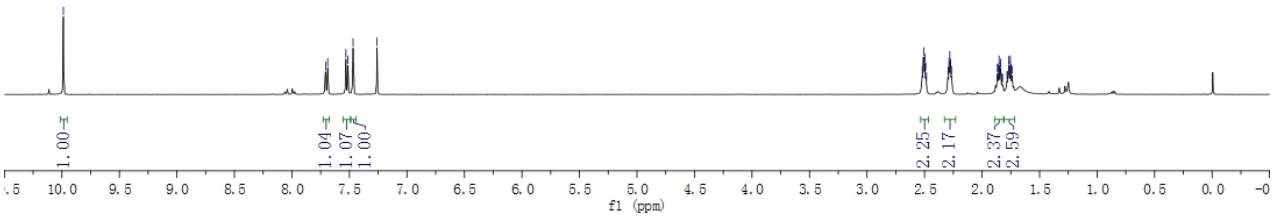


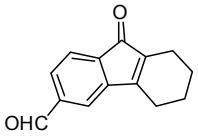
Chemical Formula: $C_{14}H_{13}ClO_2$
100 MHz, $CDCl_3$



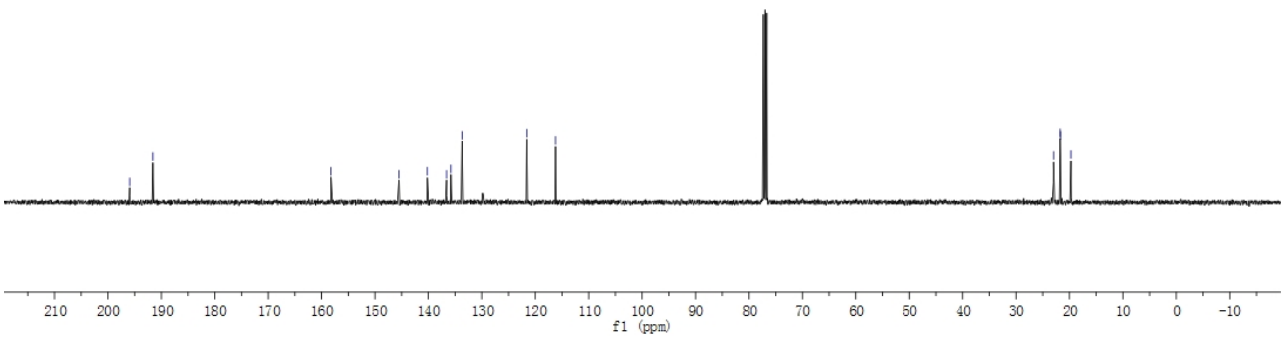


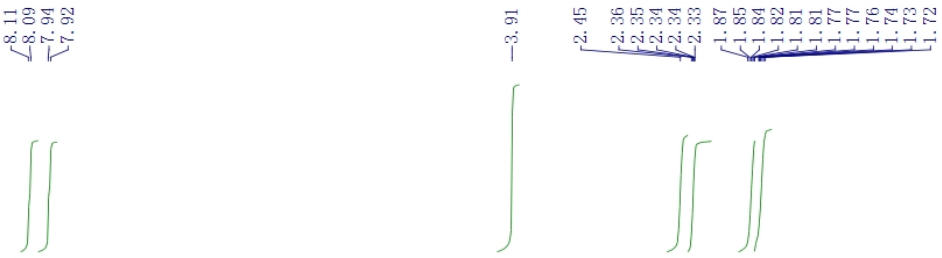
Chemical Formula: $C_{14}H_{12}O_2$
400 MHz, $CDCl_3$

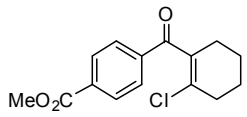




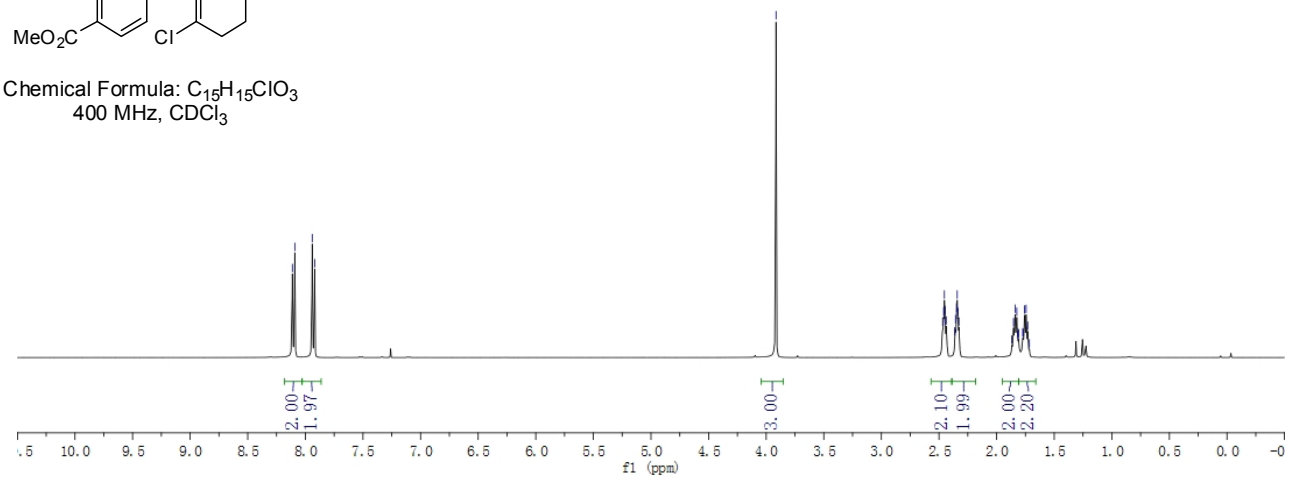
Chemical Formula: $C_{14}H_{12}O_2$
100 MHz, $CDCl_3$

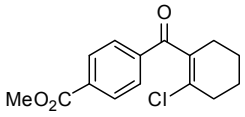




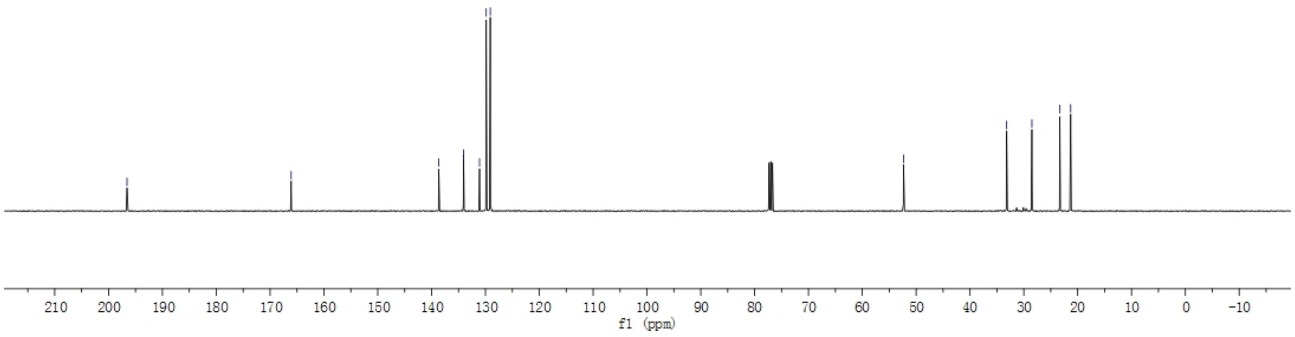


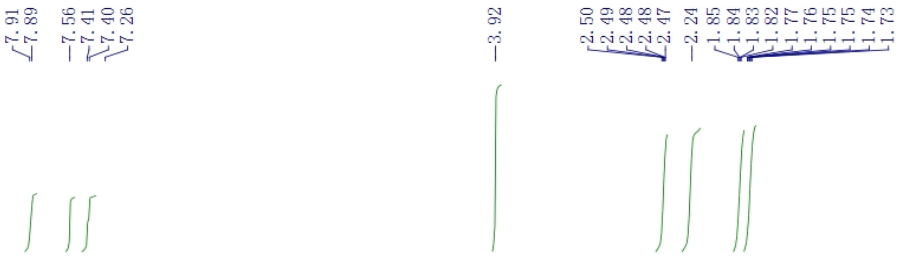
Chemical Formula: $C_{15}H_{15}ClO_3$
400 MHz, $CDCl_3$

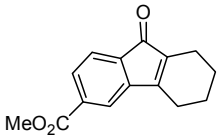




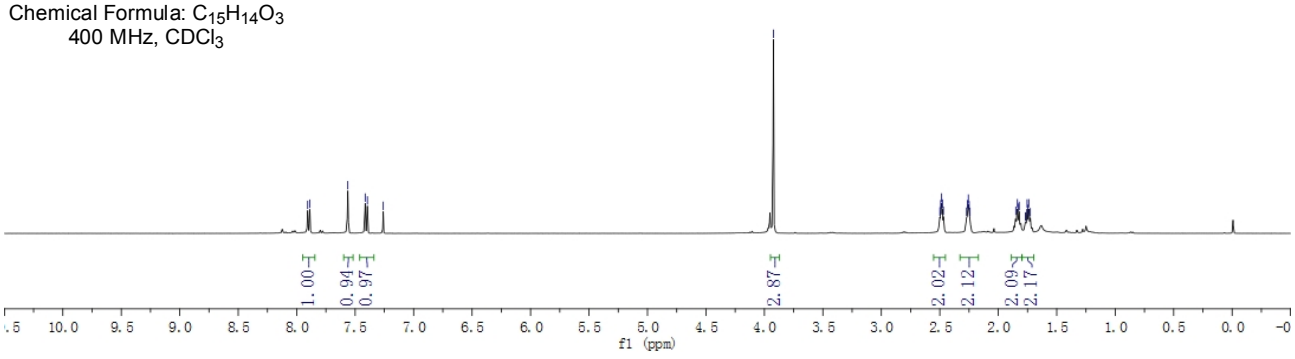
Chemical Formula: $C_{15}H_{15}ClO_3$
100 MHz, $CDCl_3$

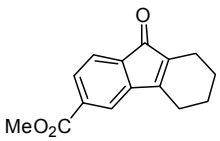




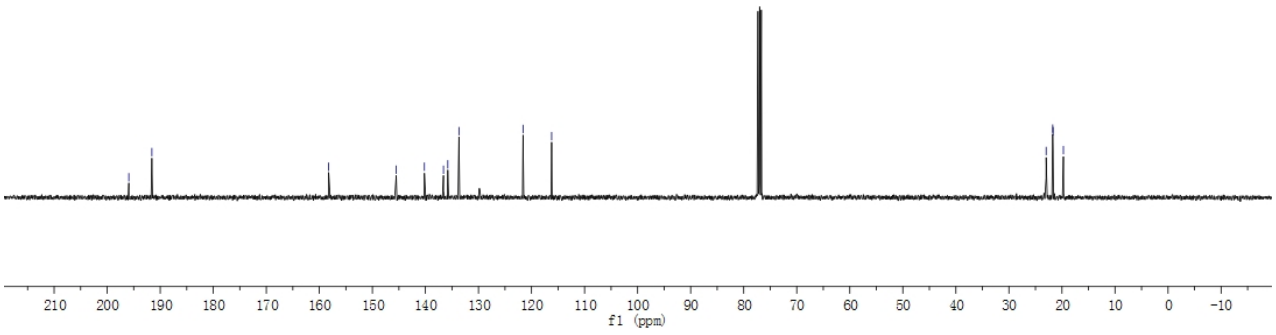


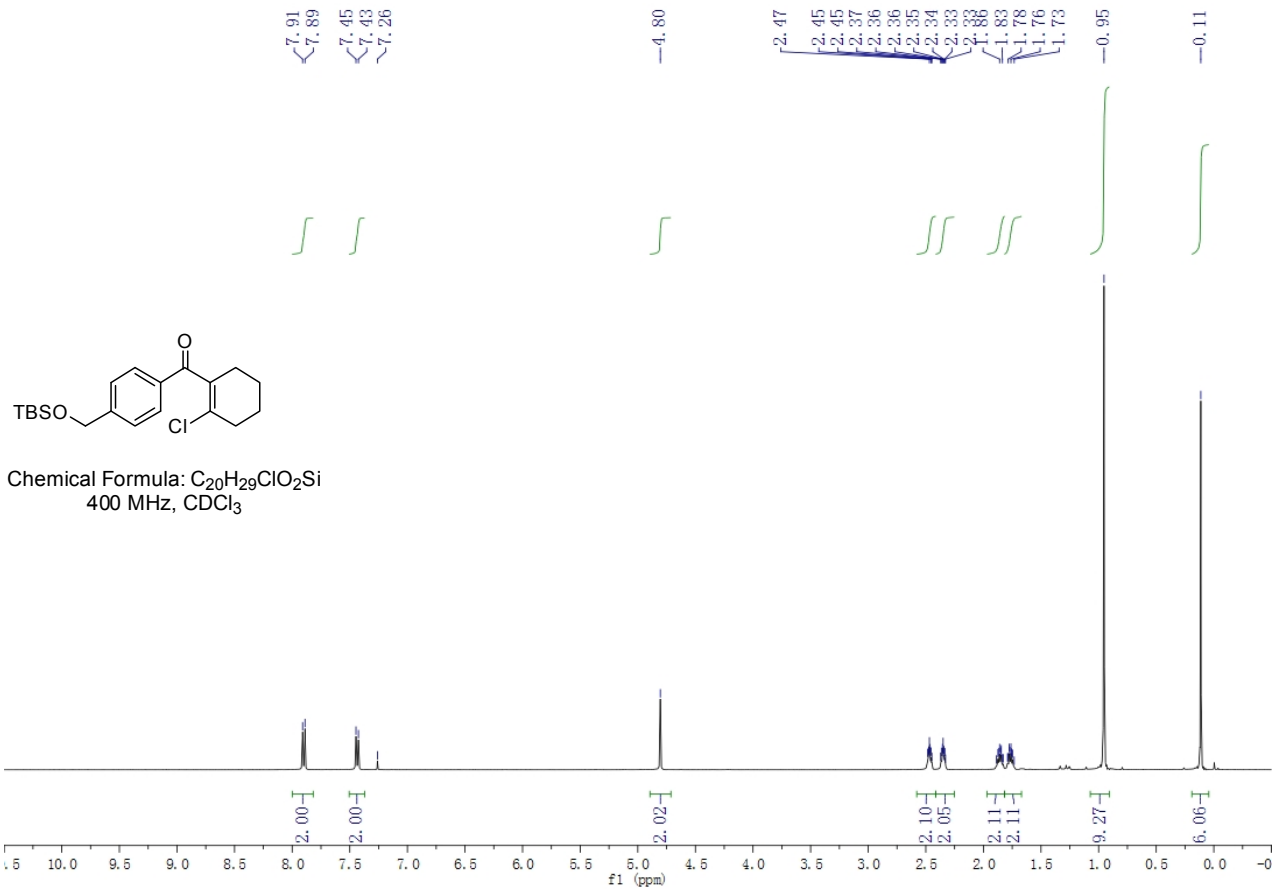
Chemical Formula: $C_{15}H_{14}O_3$
400 MHz, $CDCl_3$



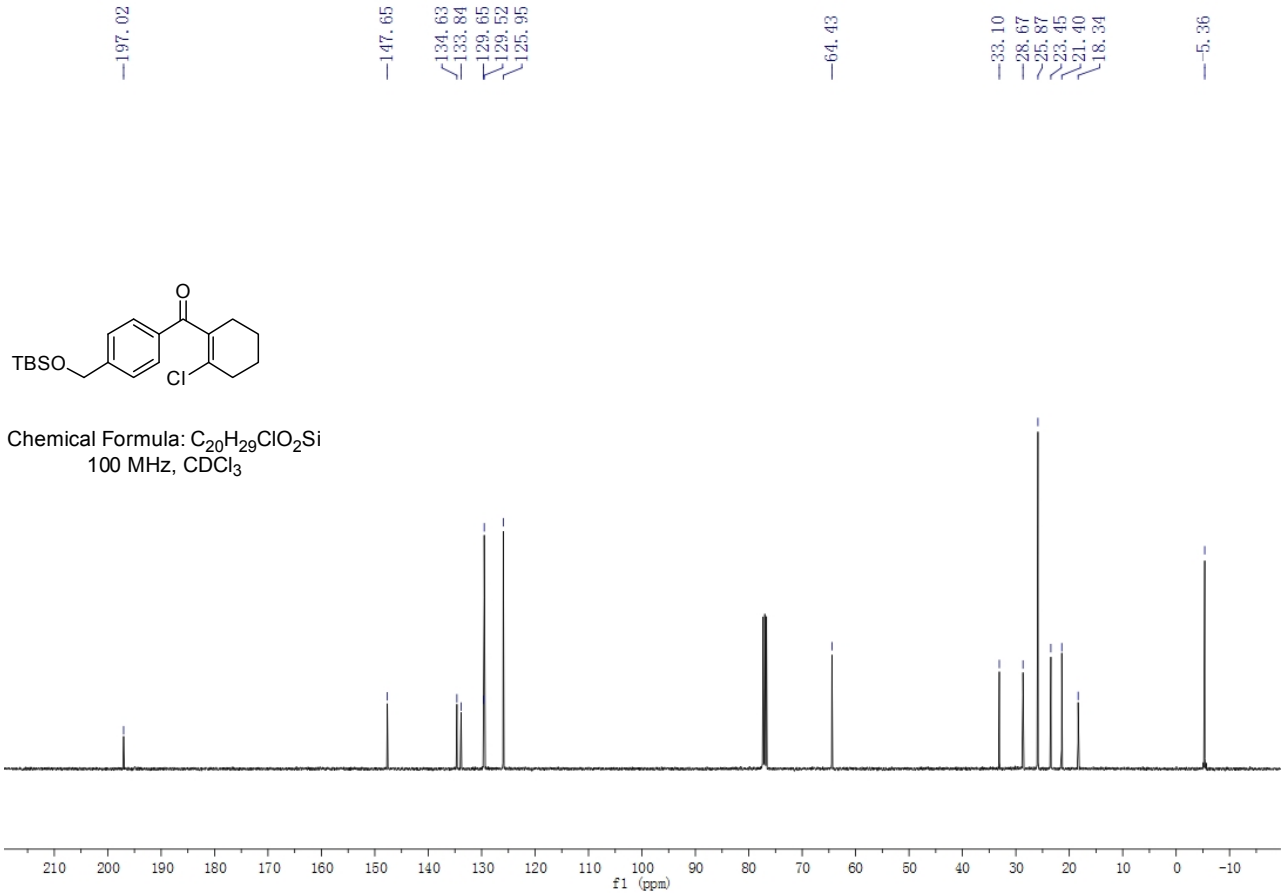


Chemical Formula: $C_{15}H_{14}O_3$
100 MHz, $CDCl_3$

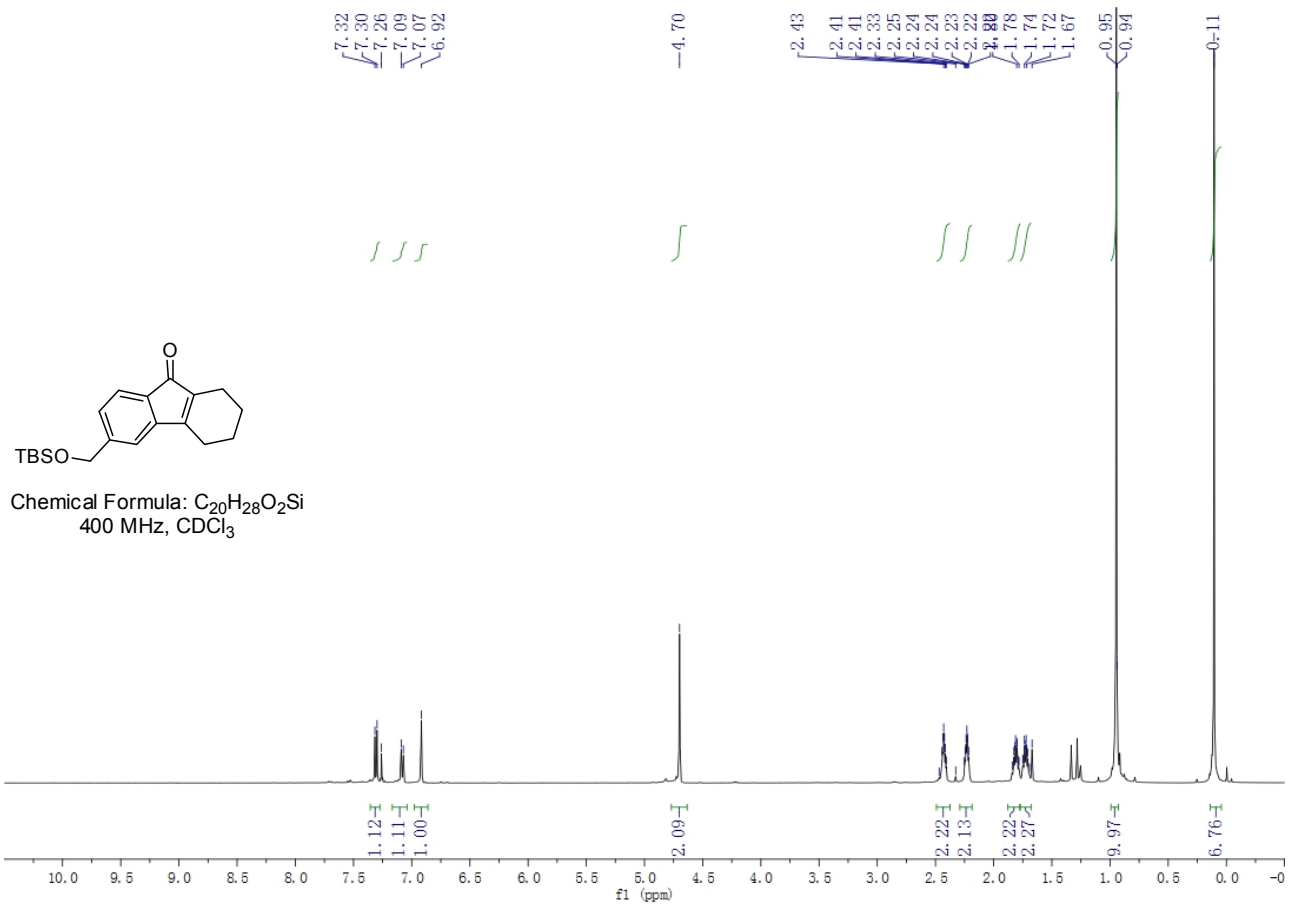




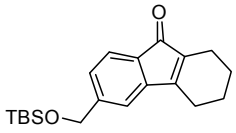
Chemical Formula: $C_{20}H_{29}ClO_2Si$
400 MHz, $CDCl_3$



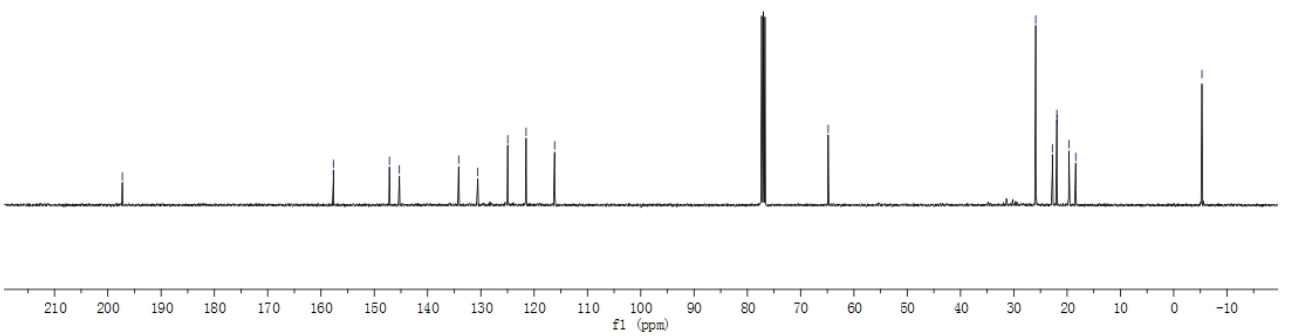
Chemical Formula: $C_{20}H_{29}ClO_2Si$
100 MHz, $CDCl_3$

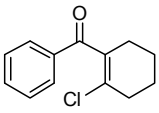


Chemical Formula: $C_{20}H_{28}O_2Si$
400 MHz, $CDCl_3$

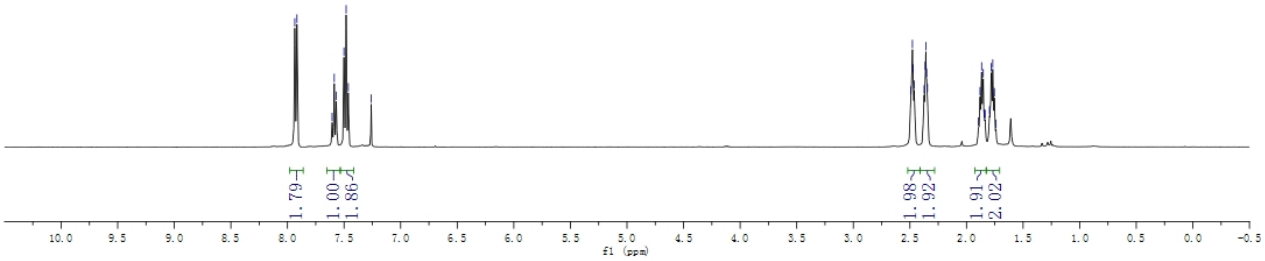


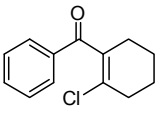
Chemical Formula: $C_{20}H_{28}O_2Si$
100 MHz, $CDCl_3$



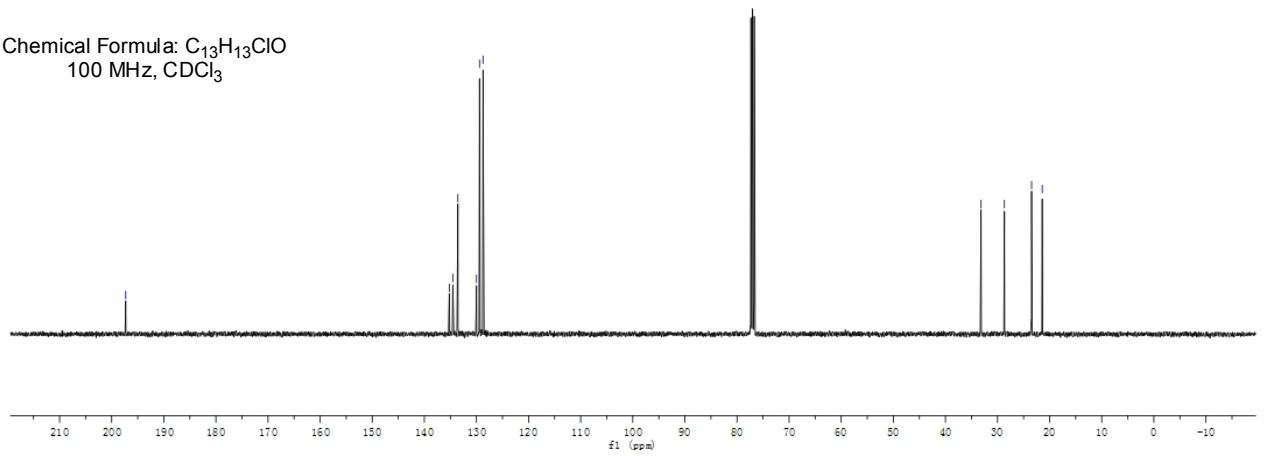


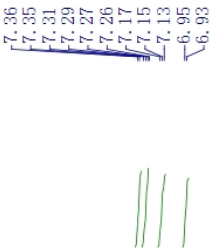
Chemical Formula: $C_{13}H_{13}ClO$
400 MHz, $CDCl_3$

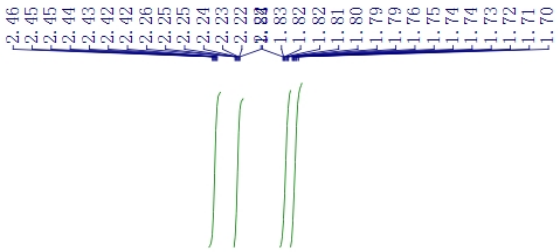


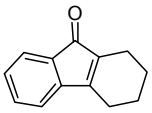


Chemical Formula: $C_{13}H_{13}ClO$
100 MHz, $CDCl_3$

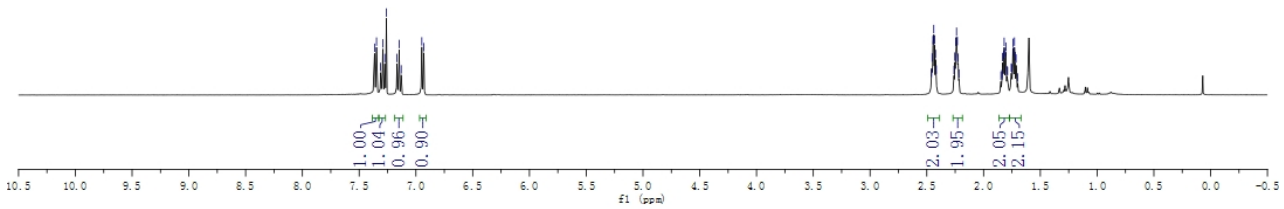




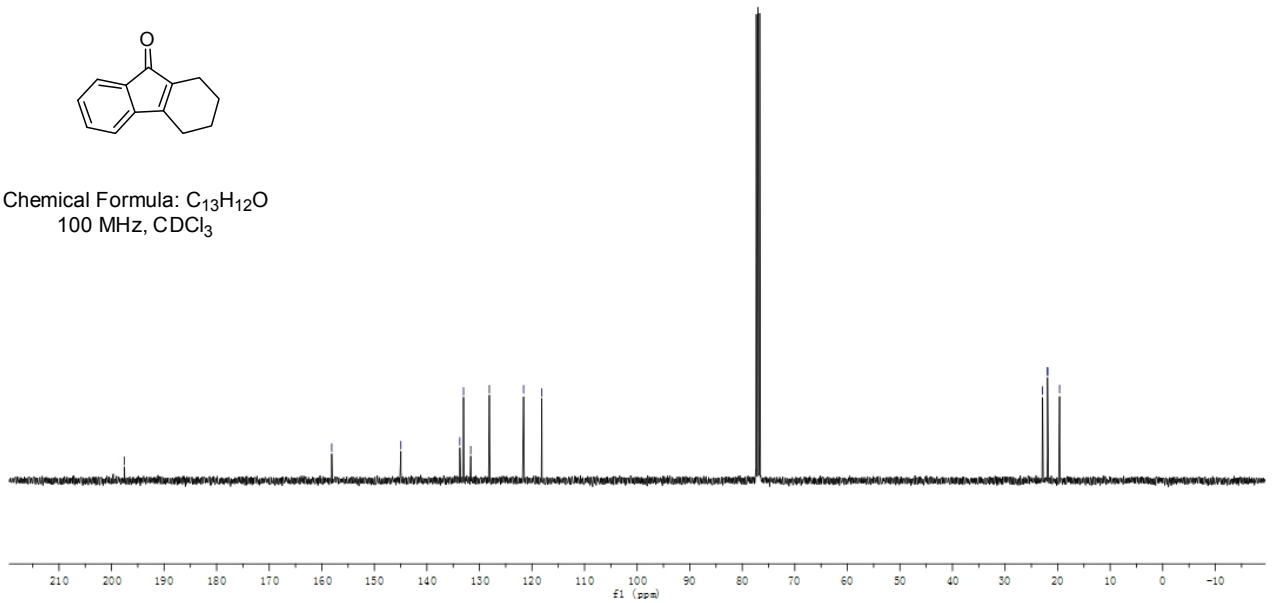


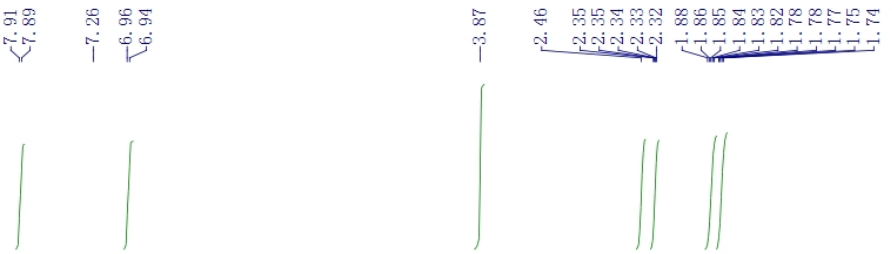


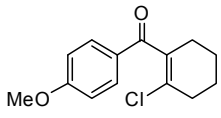
Chemical Formula: $C_{13}H_{12}O$
400 MHz, $CDCl_3$



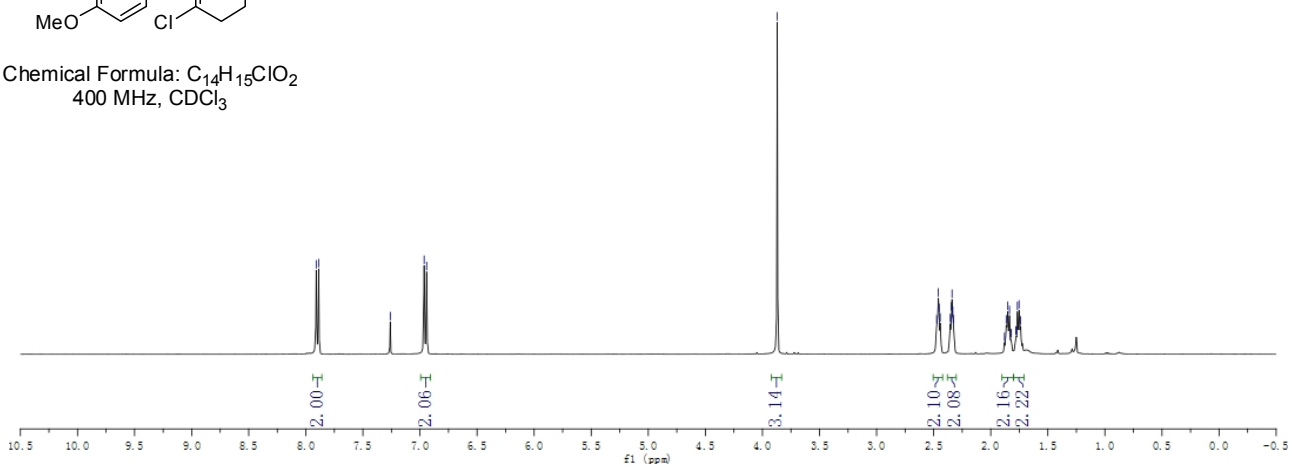
Chemical Formula: $C_{13}H_{12}O$
100 MHz, $CDCl_3$

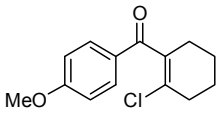




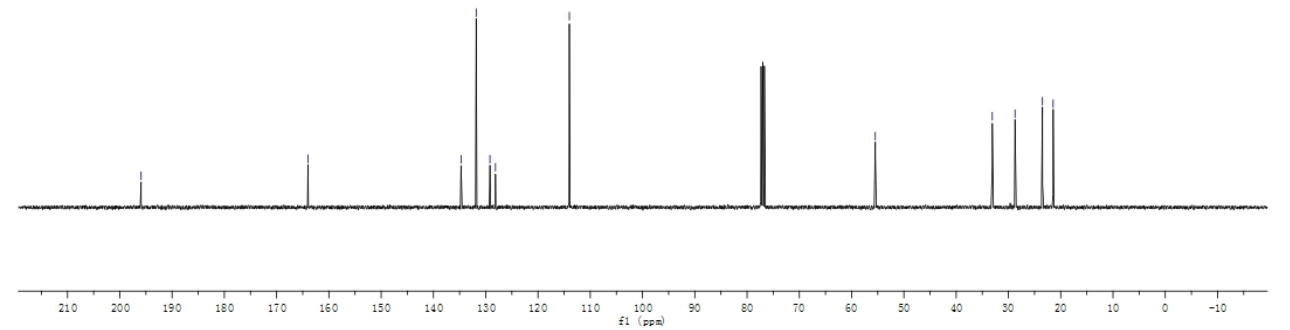


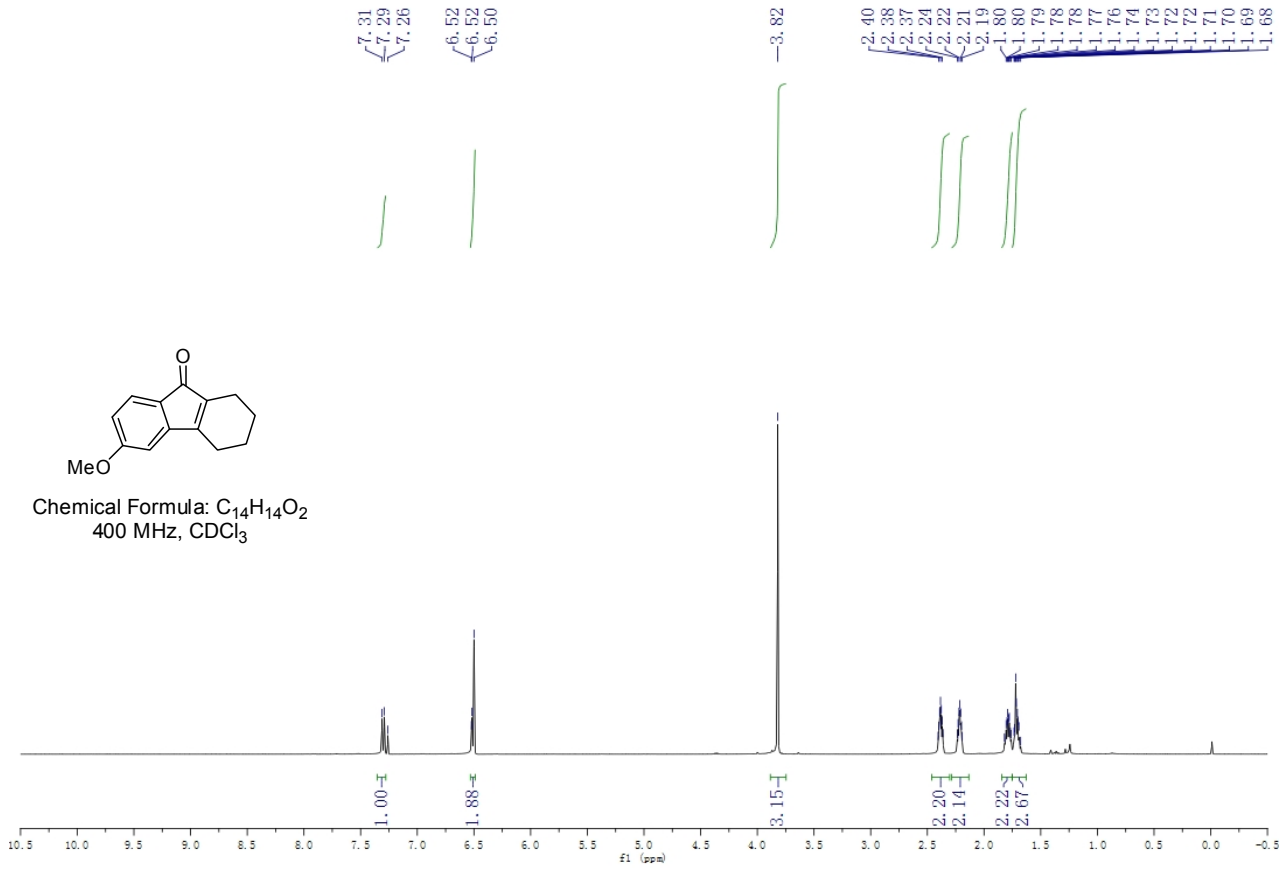
Chemical Formula: $C_{14}H_{15}ClO_2$
400 MHz, $CDCl_3$



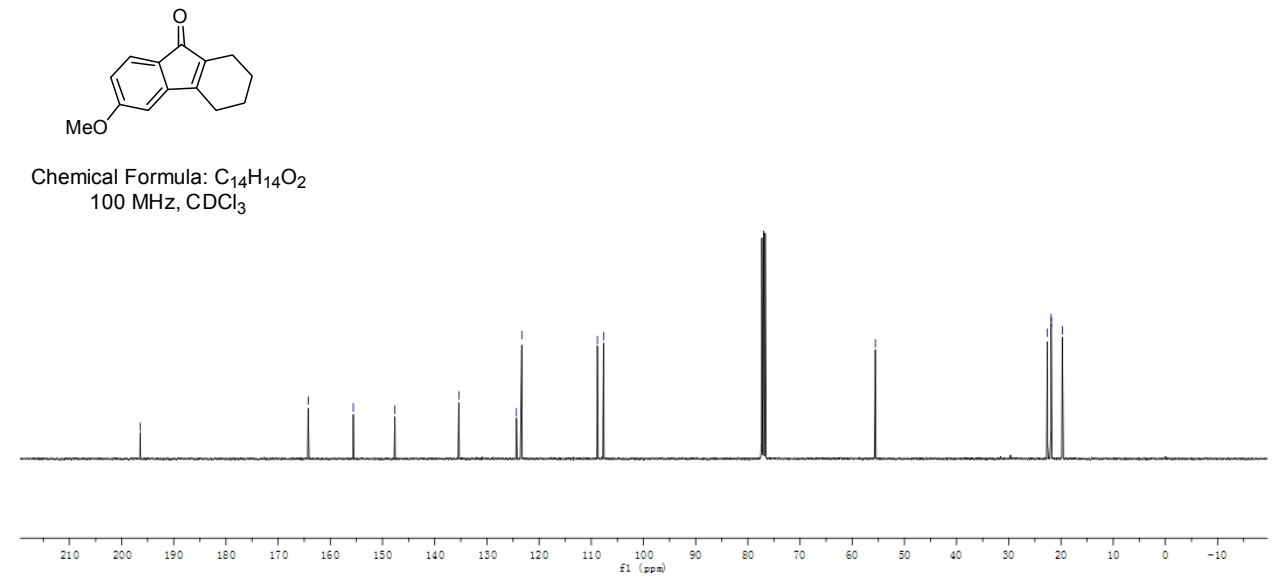


Chemical Formula: $C_{14}H_{15}ClO_2$
100 MHz, $CDCl_3$

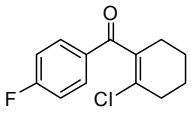




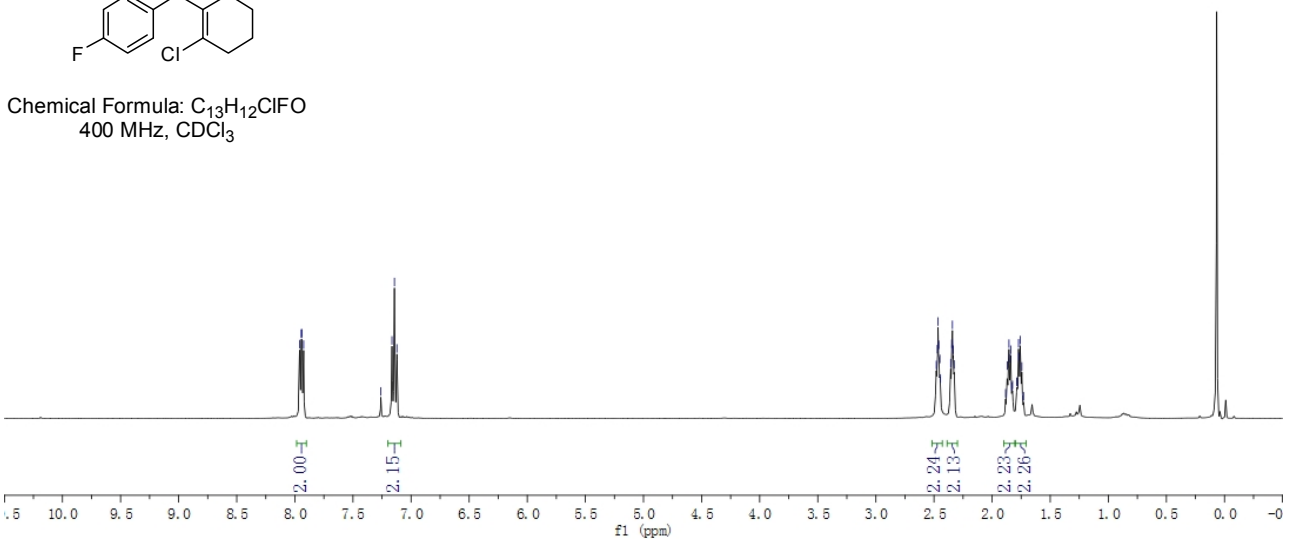
Chemical Formula: $C_{14}H_{14}O_2$
400 MHz, $CDCl_3$

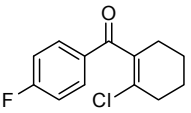


Chemical Formula: $C_{14}H_{14}O_2$
100 MHz, $CDCl_3$

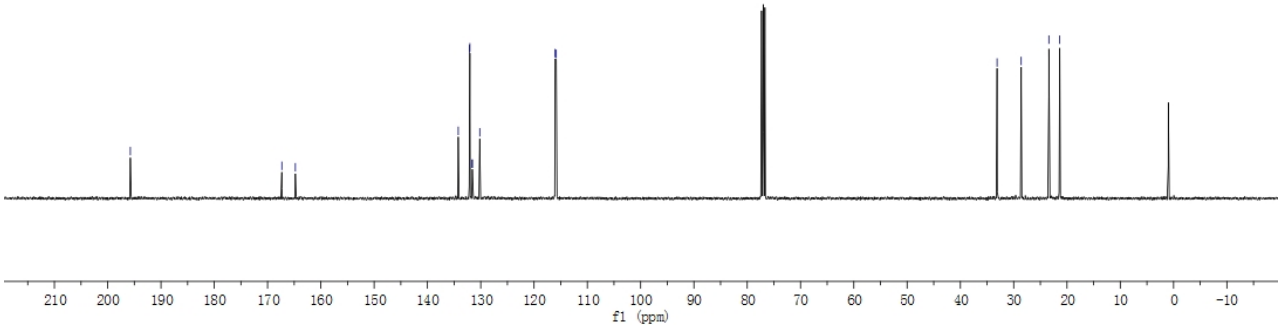


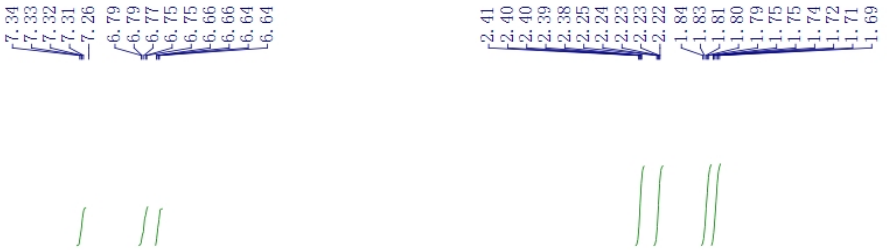
Chemical Formula: $C_{13}H_{12}ClFO$
400 MHz, $CDCl_3$

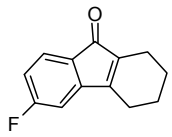




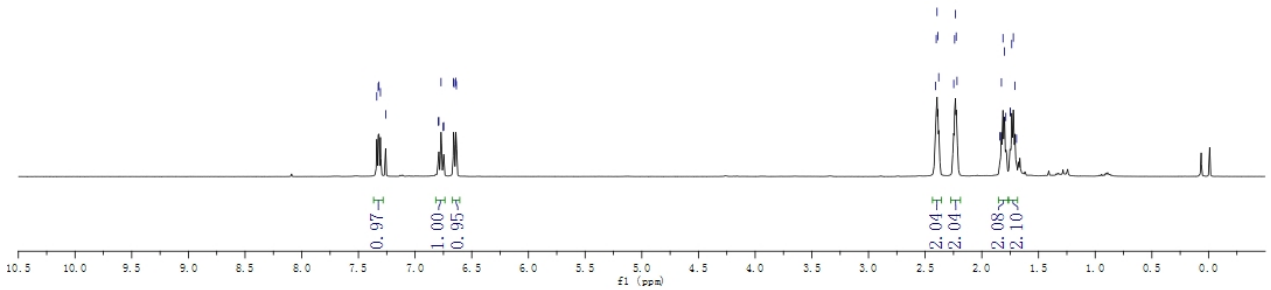
Chemical Formula: $C_{13}H_{12}ClFO$
100 MHz, $CDCl_3$

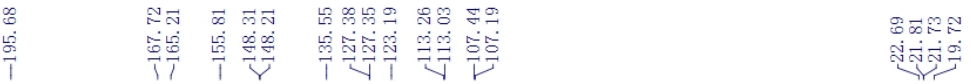


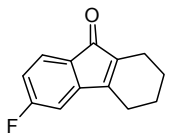




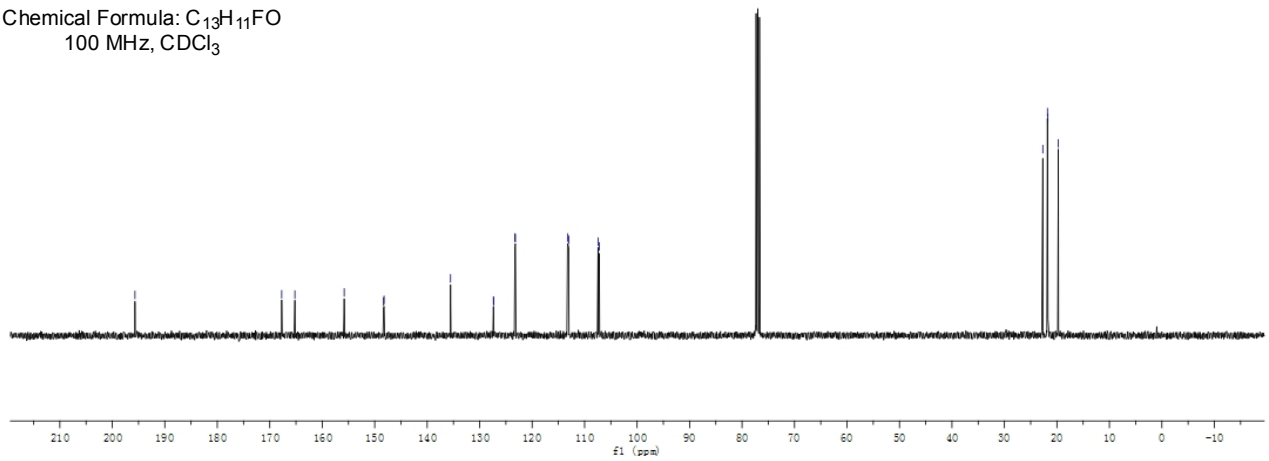
Chemical Formula: $C_{13}H_{11}FO$
400 MHz, $CDCl_3$

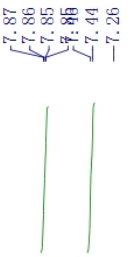


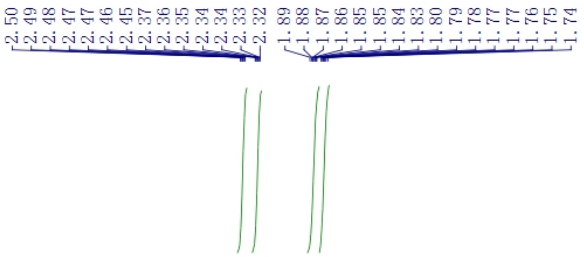


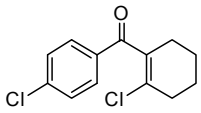


Chemical Formula: $C_{13}H_{11}FO$
100 MHz, $CDCl_3$

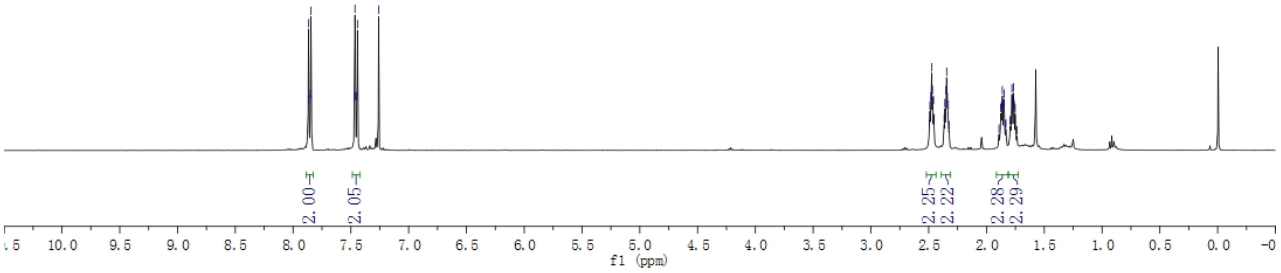


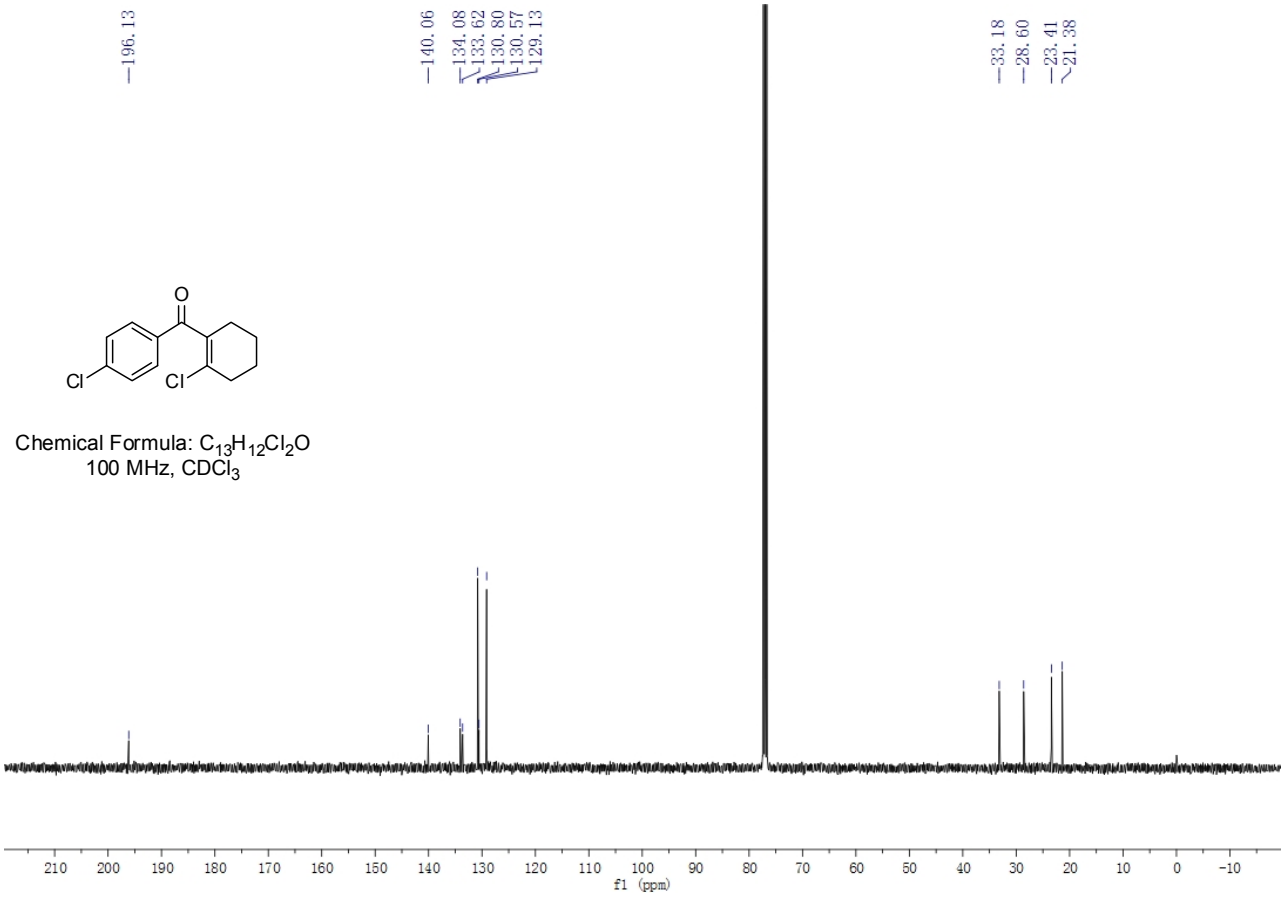




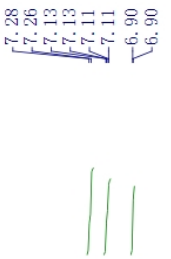


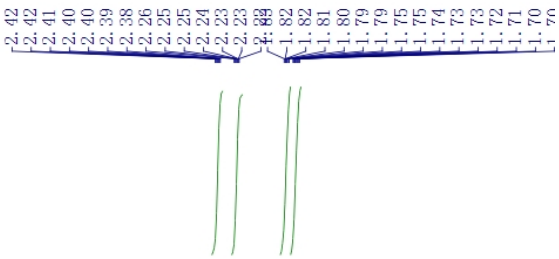
Chemical Formula: $C_{13}H_{12}Cl_2O$
400 MHz, $CDCl_3$

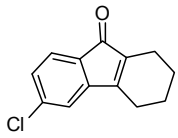




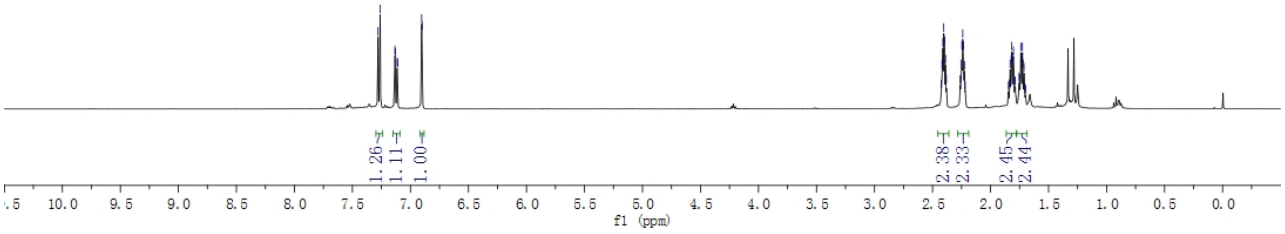
Chemical Formula: $C_{13}H_{12}Cl_2O$
100 MHz, $CDCl_3$

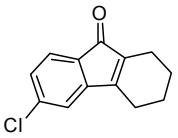




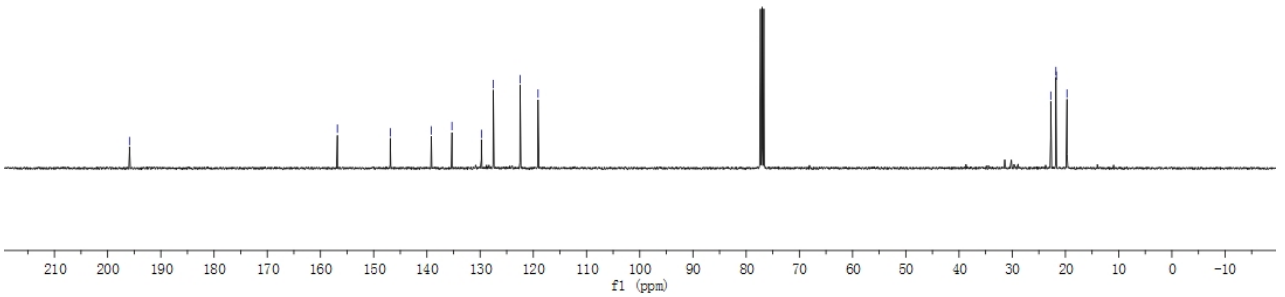


Chemical Formula: $C_{13}H_{11}ClO$
400 MHz, $CDCl_3$

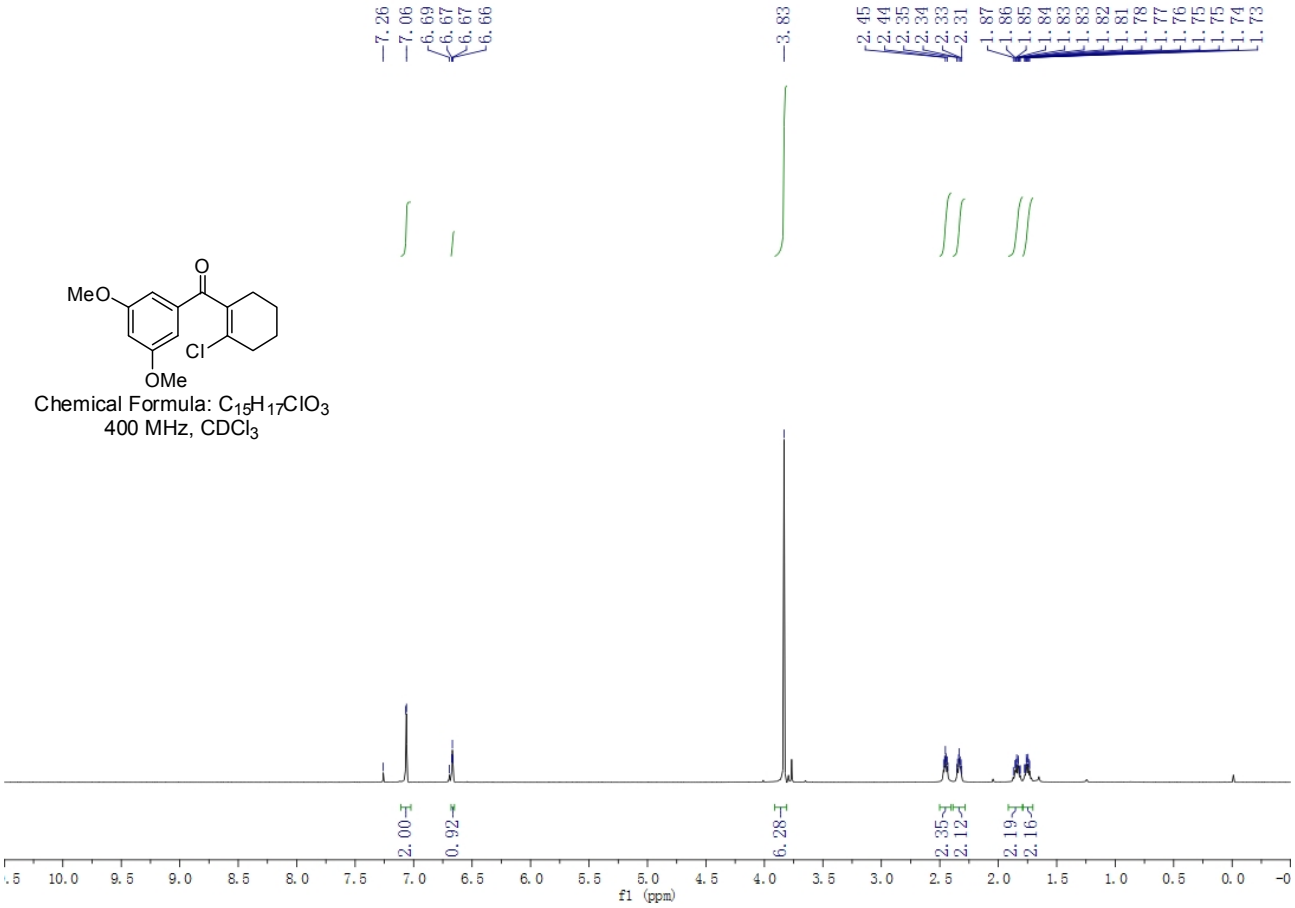


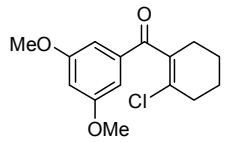


Chemical Formula: $C_{13}H_{11}ClO$
100 MHz, $CDCl_3$

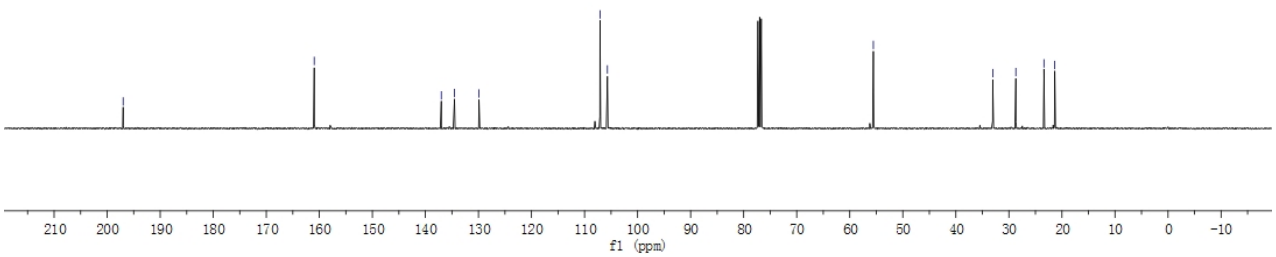


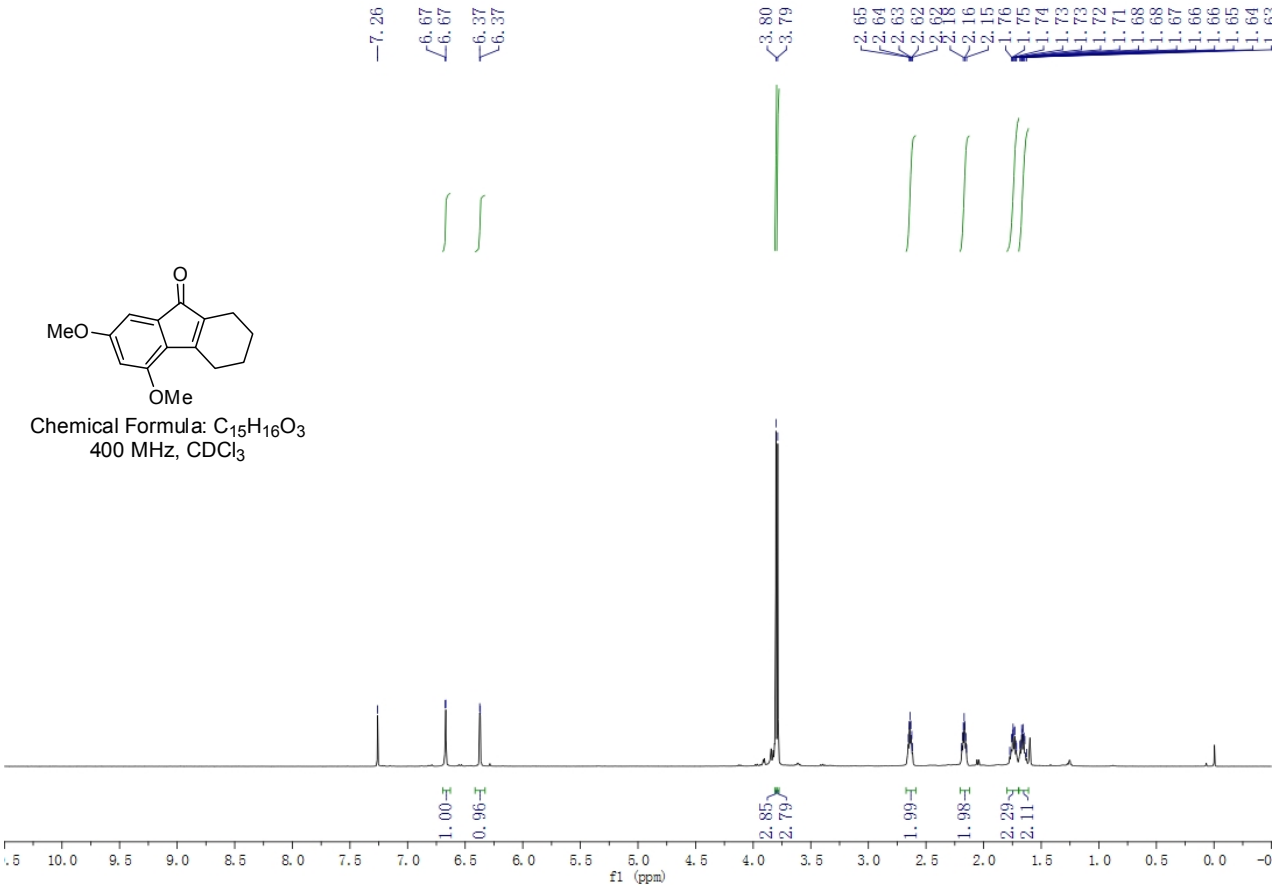
Chemical Formula: $C_{15}H_{17}ClO_3$
400 MHz, $CDCl_3$



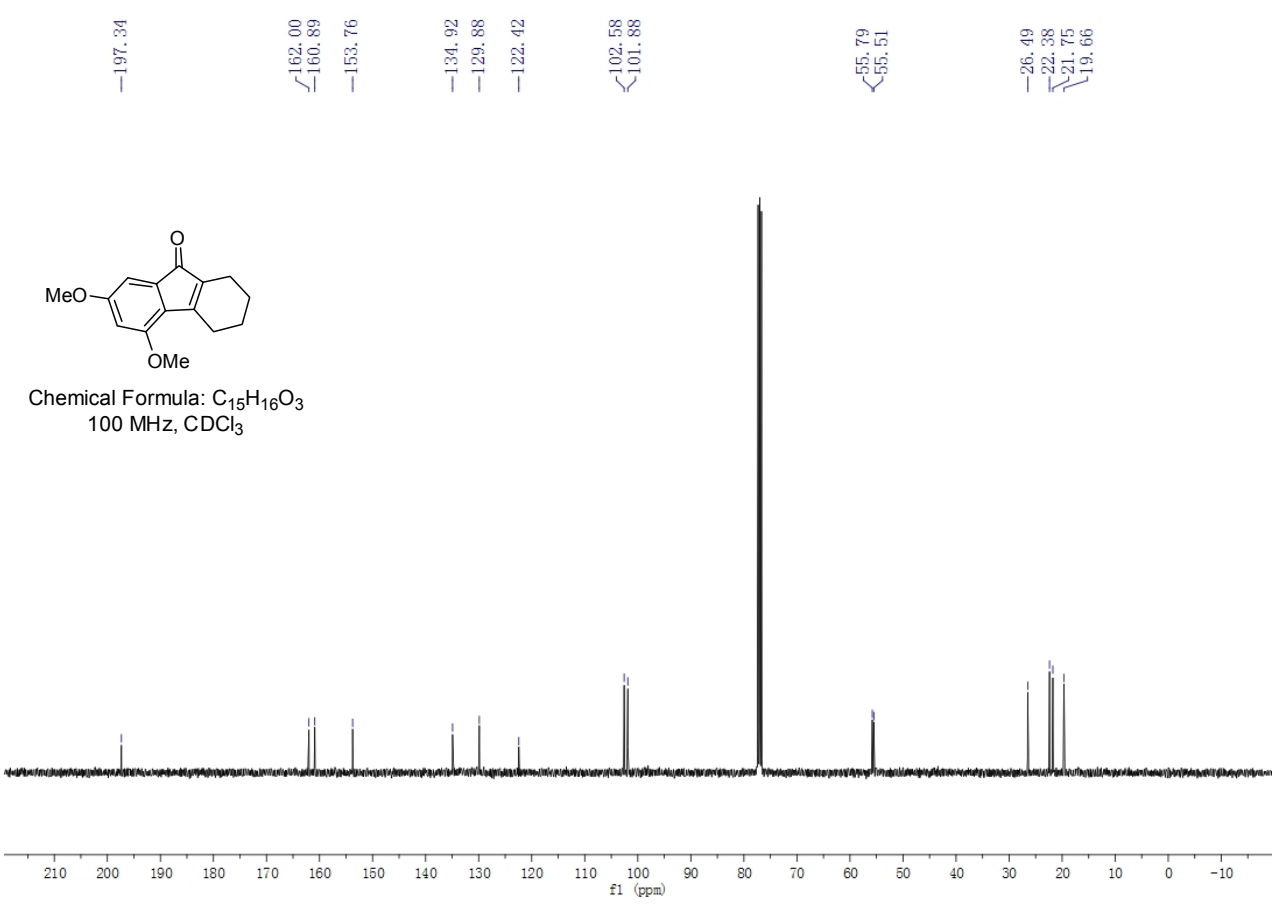


Chemical Formula: $C_{15}H_{17}ClO_3$
100 MHz, $CDCl_3$

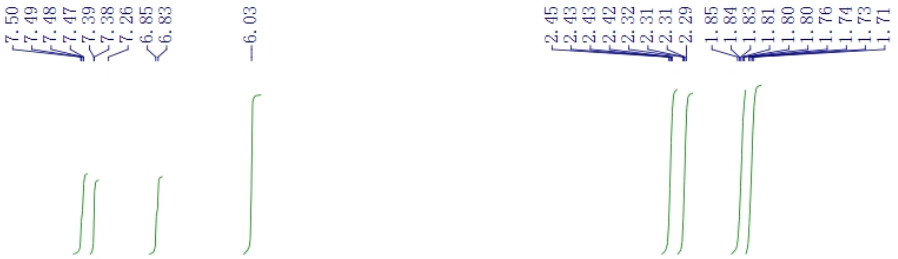


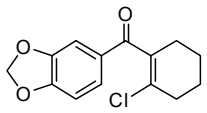


Chemical Formula: $C_{15}H_{16}O_3$
400 MHz, $CDCl_3$

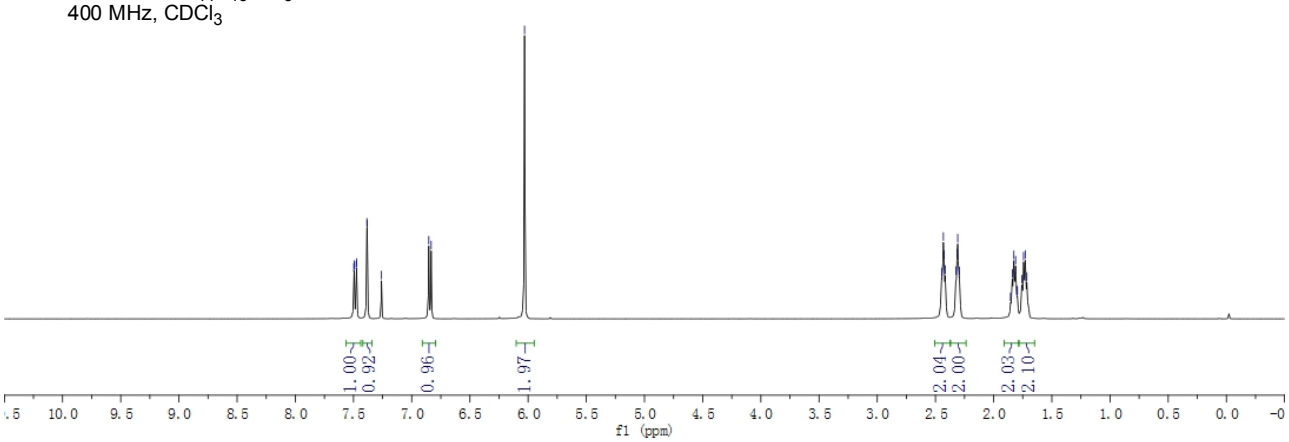


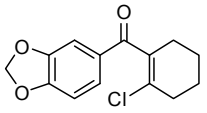
Chemical Formula: $C_{15}H_{16}O_3$
100 MHz, $CDCl_3$



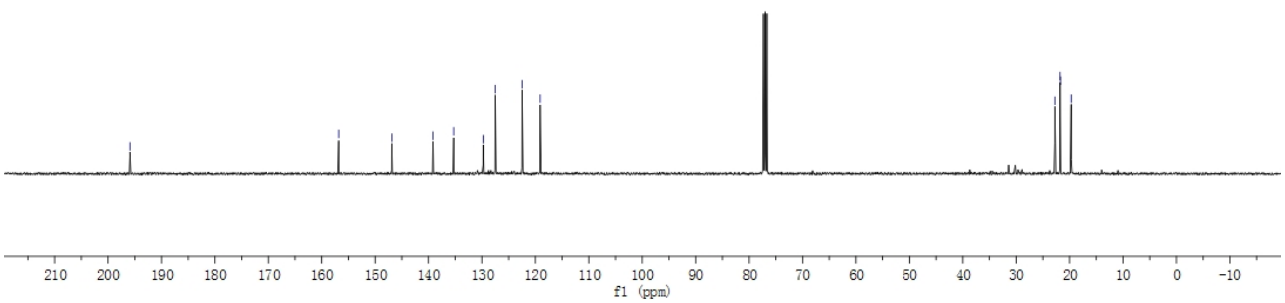


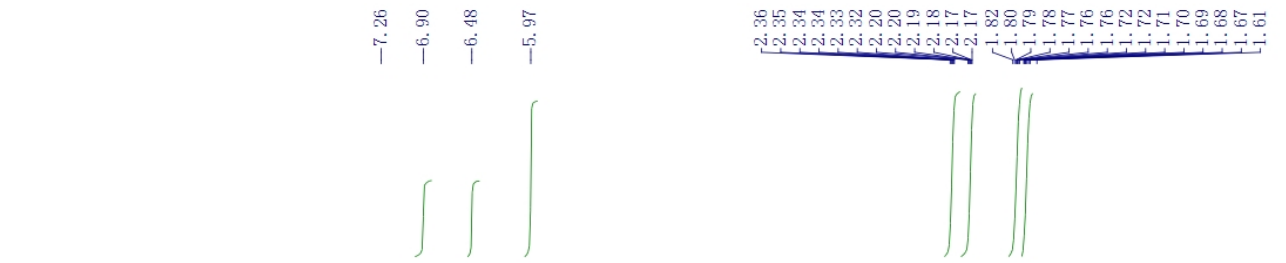
Chemical Formula: $C_{14}H_{13}ClO_3$
400 MHz, $CDCl_3$

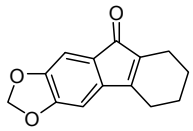




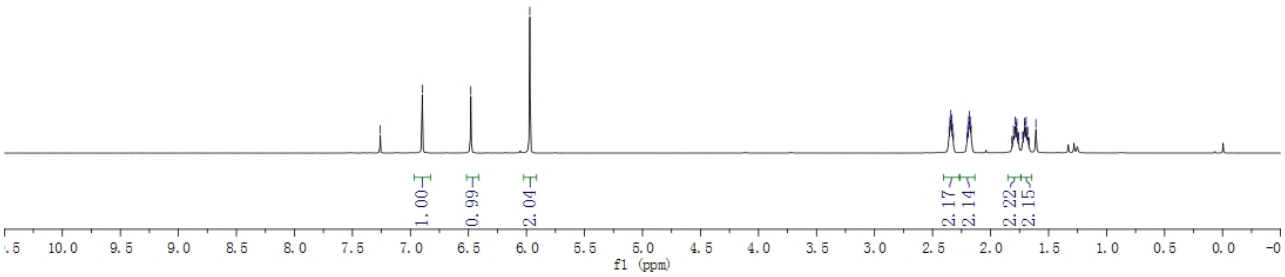
Chemical Formula: $C_{14}H_{13}ClO_3$
100 MHz, $CDCl_3$

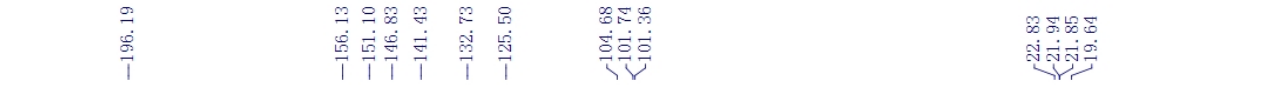


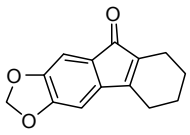




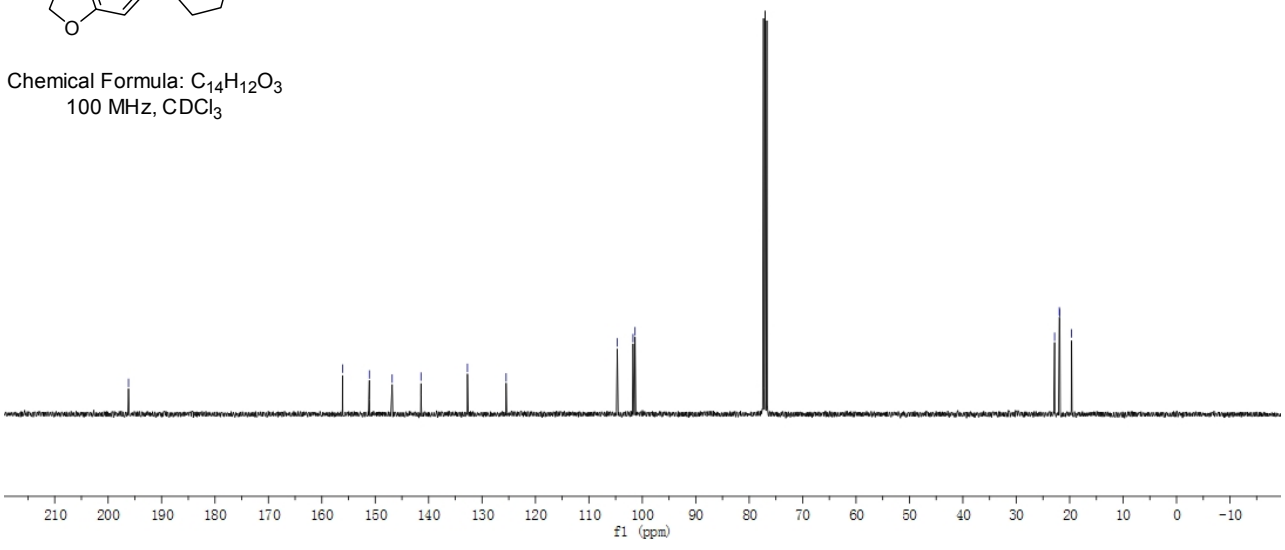
Chemical Formula: $C_{14}H_{12}O_3$
400 MHz, $CDCl_3$

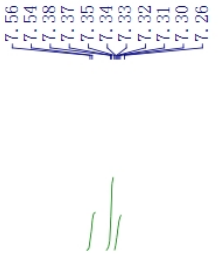


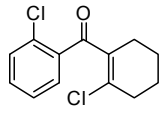




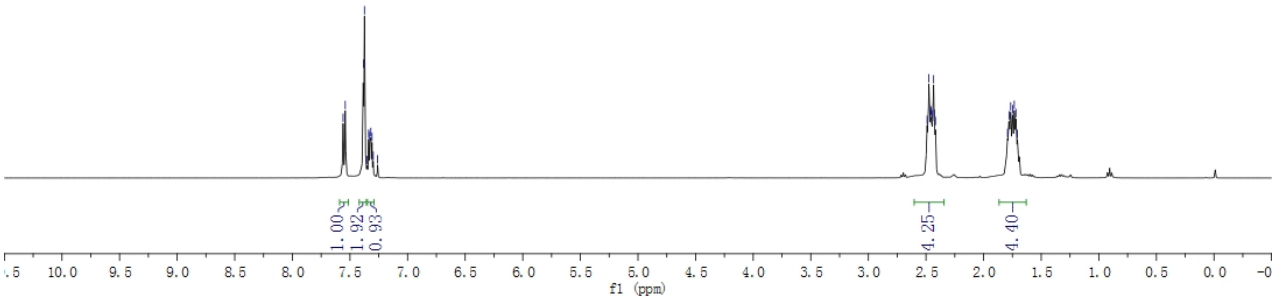
Chemical Formula: $C_{14}H_{12}O_3$
100 MHz, $CDCl_3$

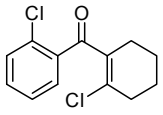




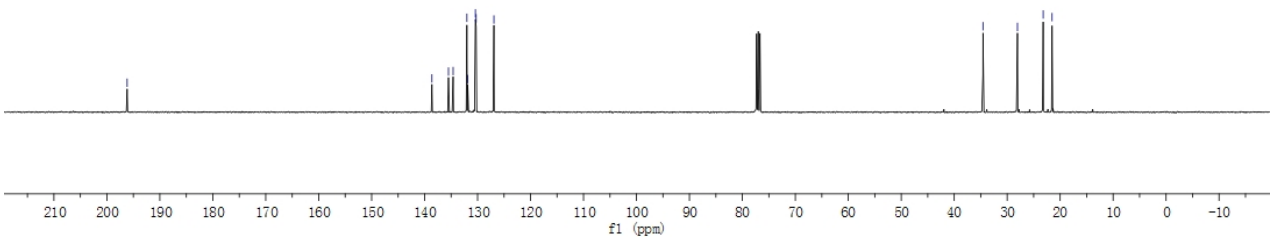


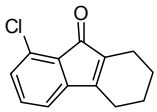
Chemical Formula: $C_{13}H_{12}Cl_2O$
400 MHz, $CDCl_3$



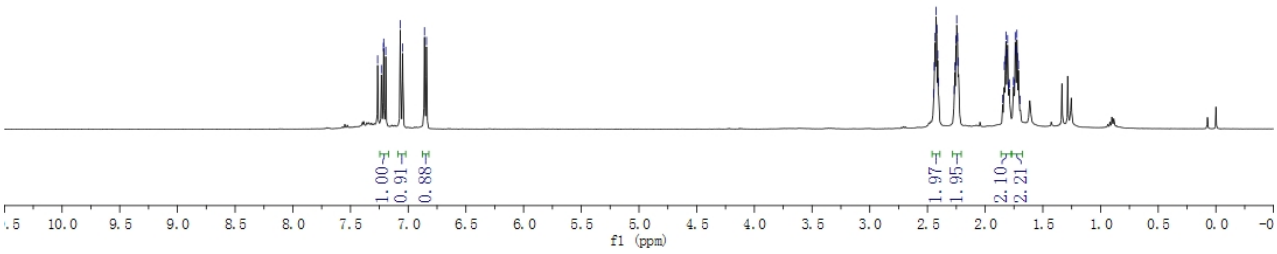


Chemical Formula: $C_{13}H_{12}Cl_2O$
100 MHz, $CDCl_3$

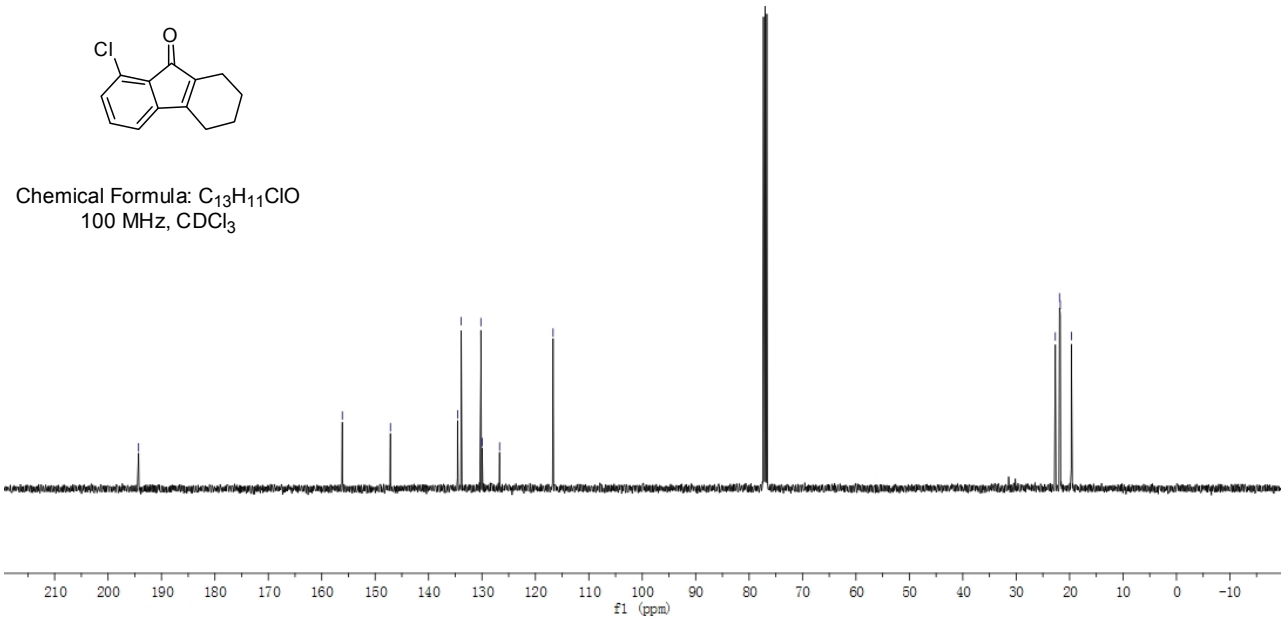


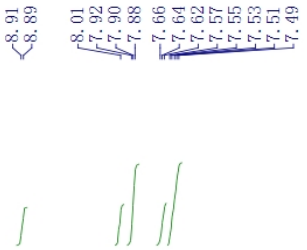


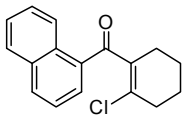
Chemical Formula: $C_{13}H_{11}ClO$
400 MHz, $CDCl_3$



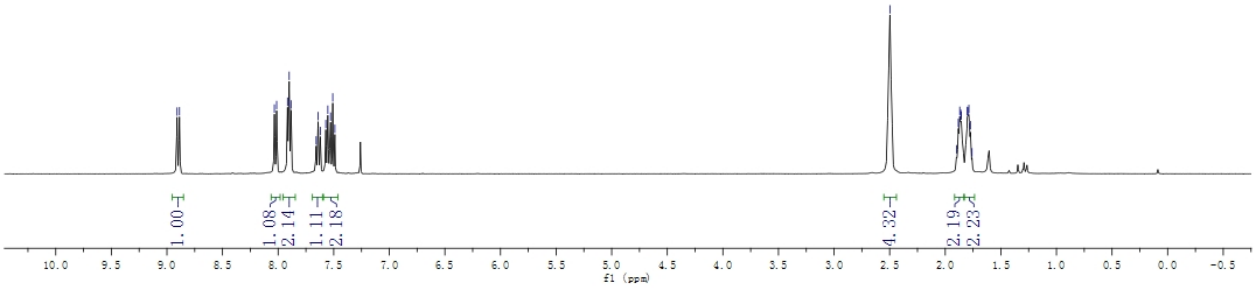
Chemical Formula: $C_{13}H_{11}ClO$
100 MHz, $CDCl_3$

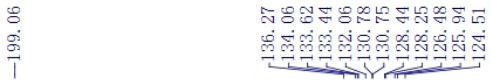


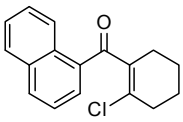




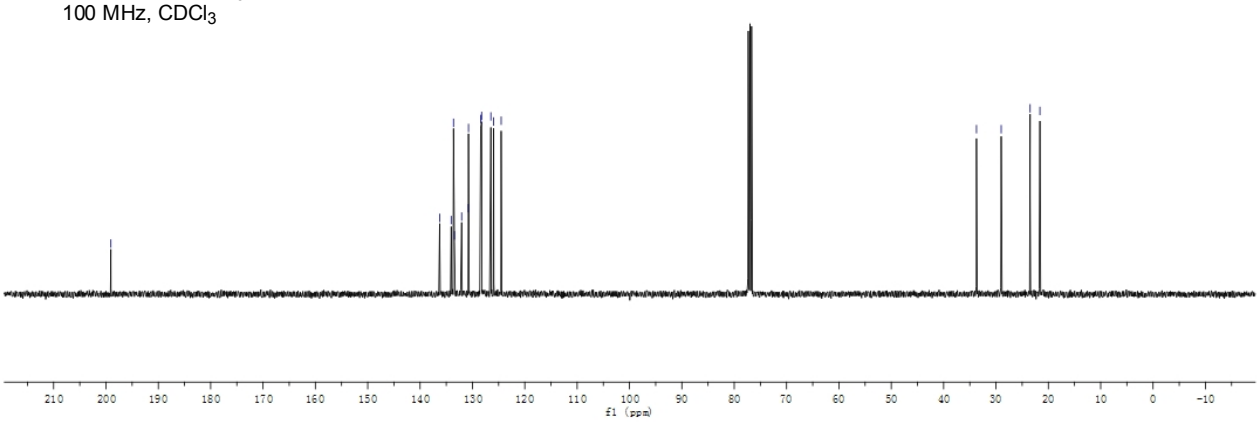
Chemical Formula: $C_{17}H_{15}ClO$
400 MHz, $CDCl_3$

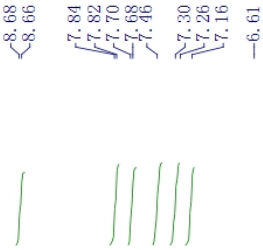


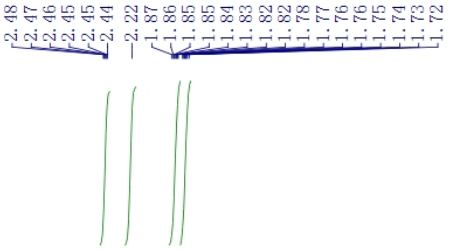


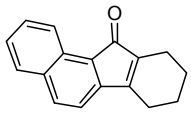


Chemical Formula: $C_{17}H_{15}ClO$
100 MHz, $CDCl_3$

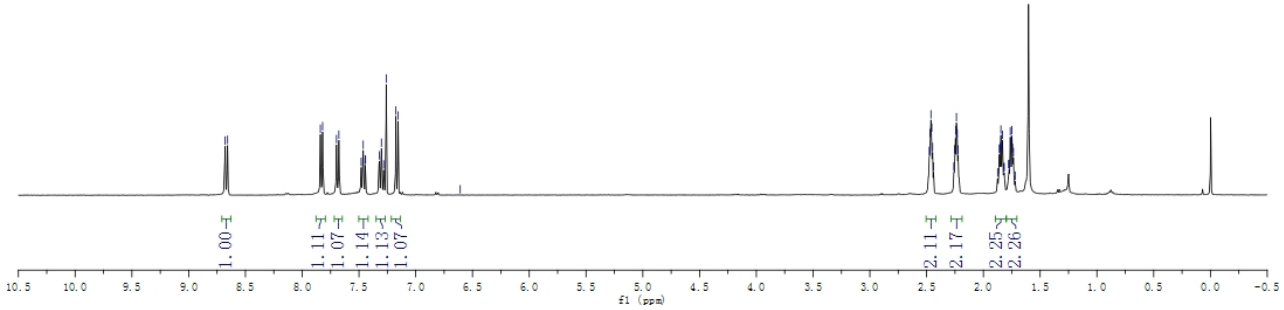


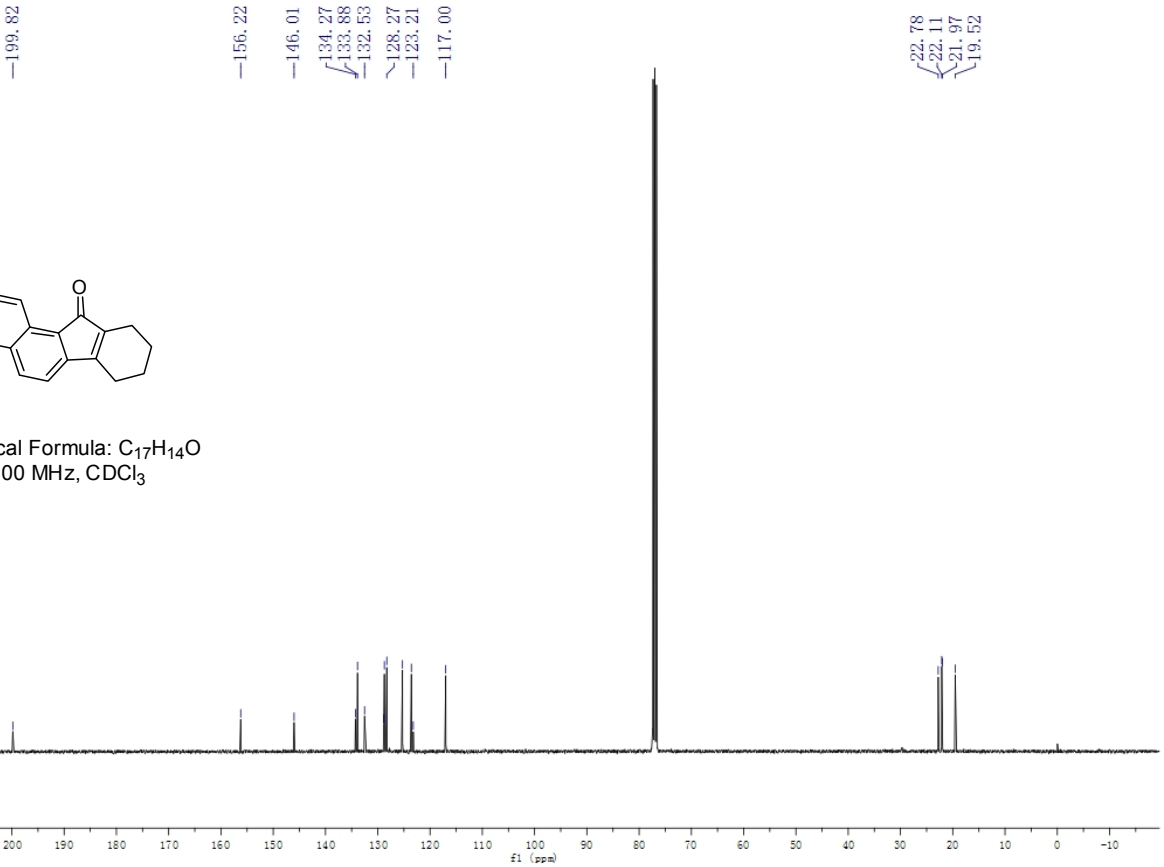


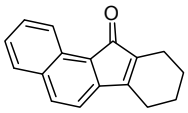




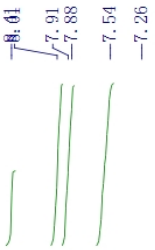
Chemical Formula: $C_{17}H_{14}O$
400 MHz, $CDCl_3$

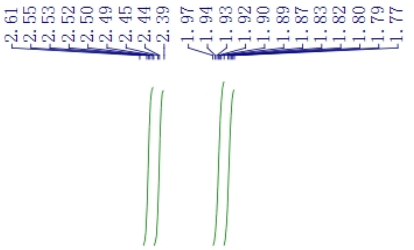


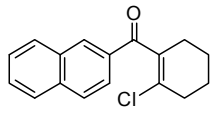




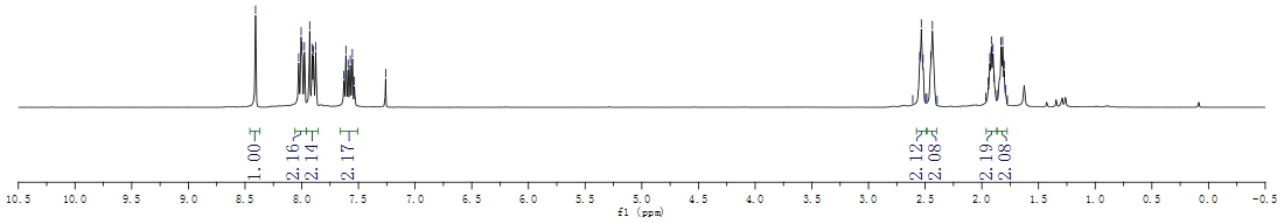
Chemical Formula: $C_{17}H_{14}O$
100 MHz, $CDCl_3$

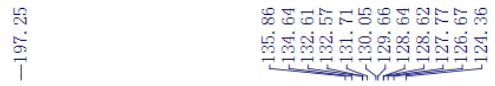


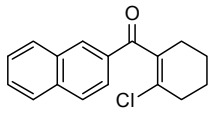




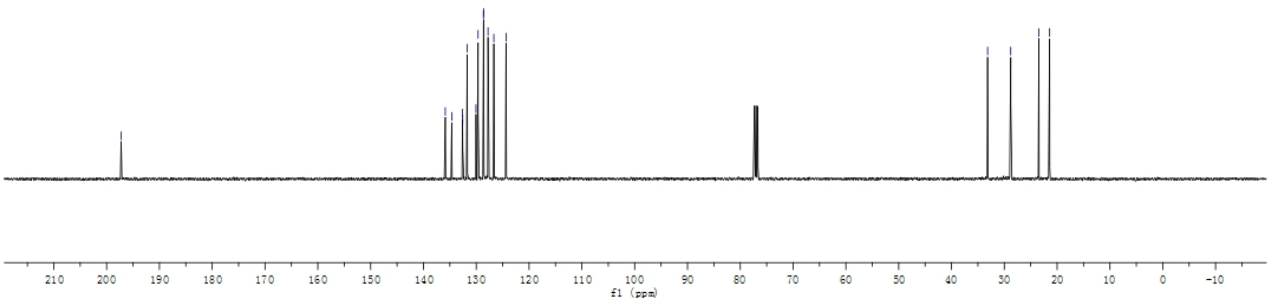
Chemical Formula: $C_{17}H_{15}ClO$
400 MHz, $CDCl_3$

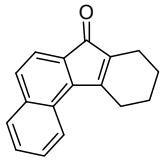




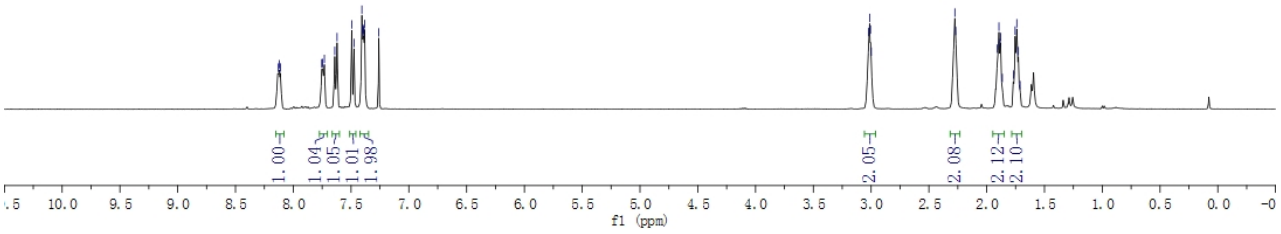


Chemical Formula: $C_{17}H_{15}ClO$
100 MHz, $CDCl_3$

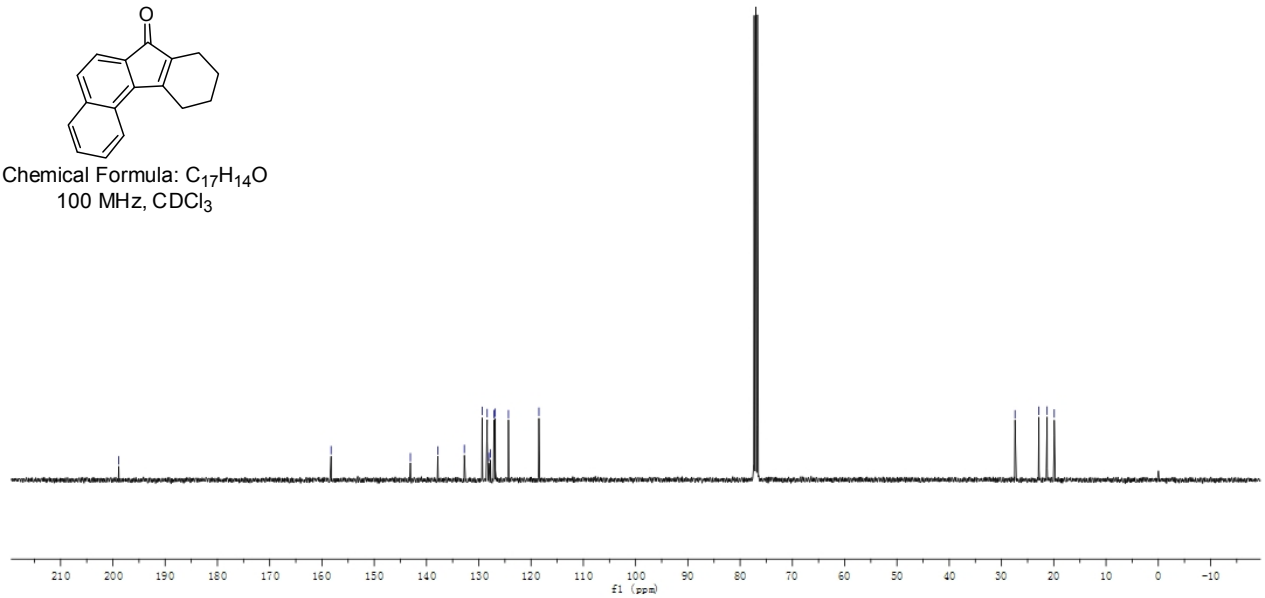


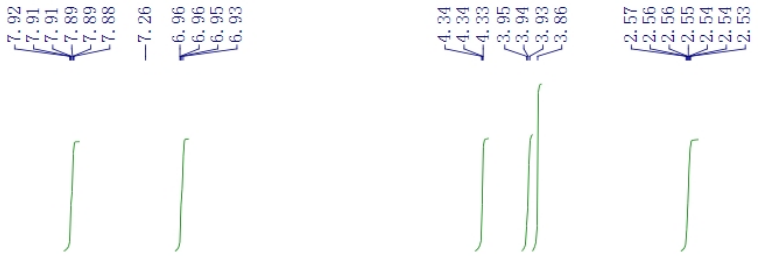


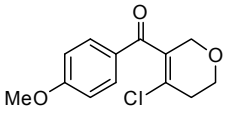
Chemical Formula: $C_{17}H_{14}O$
400 MHz, $CDCl_3$



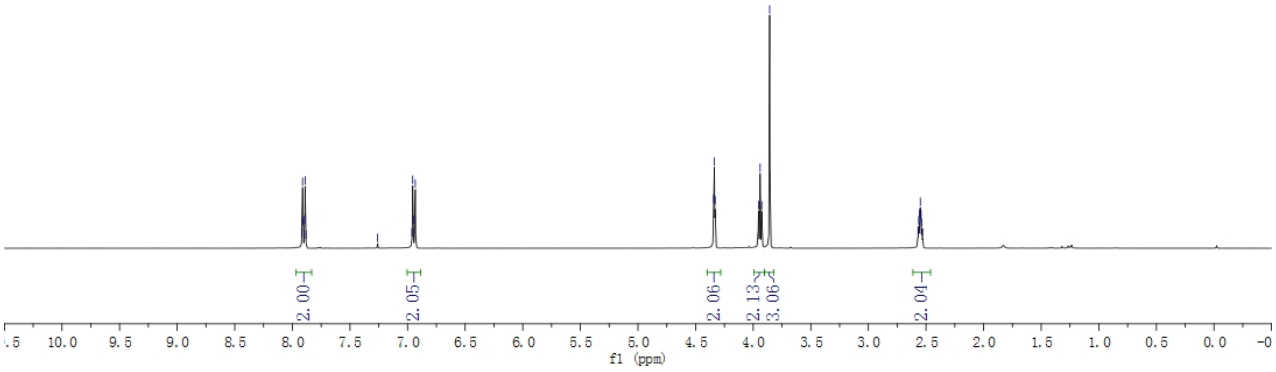
Chemical Formula: $C_{17}H_{14}O$
100 MHz, $CDCl_3$

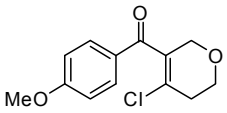




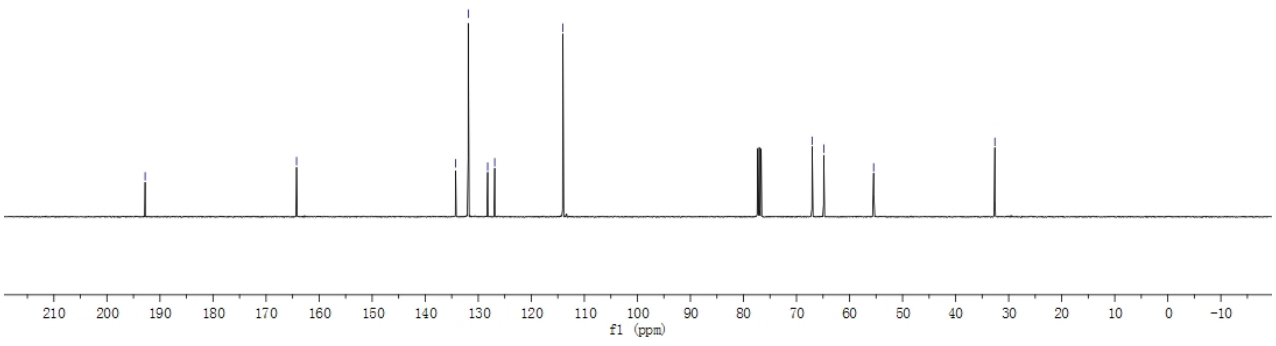


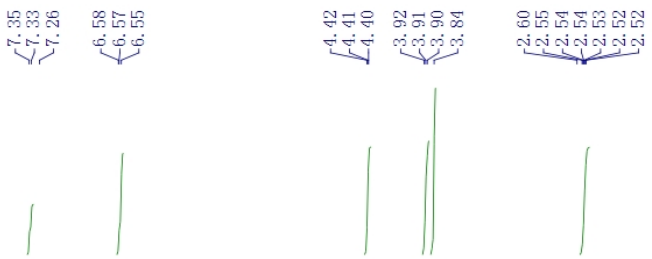
Chemical Formula: $C_{13}H_{13}ClO_3$
400 MHz, $CDCl_3$

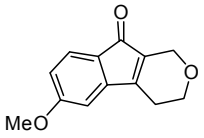




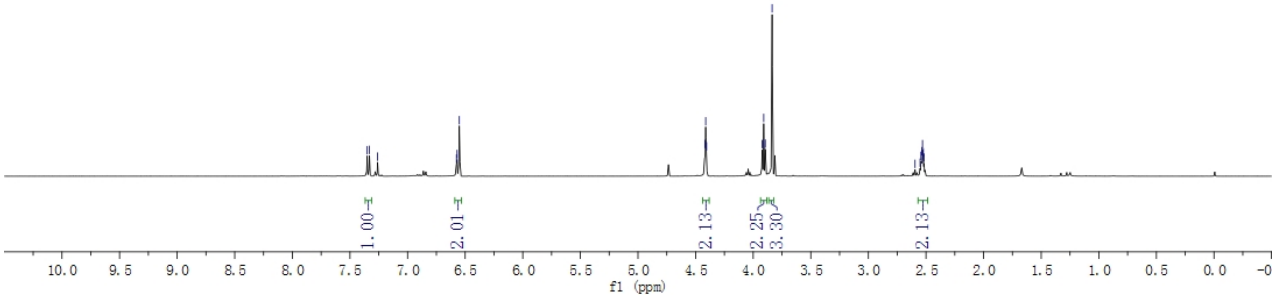
Chemical Formula: $C_{13}H_{13}ClO_3$
100 MHz, $CDCl_3$

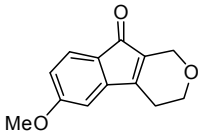




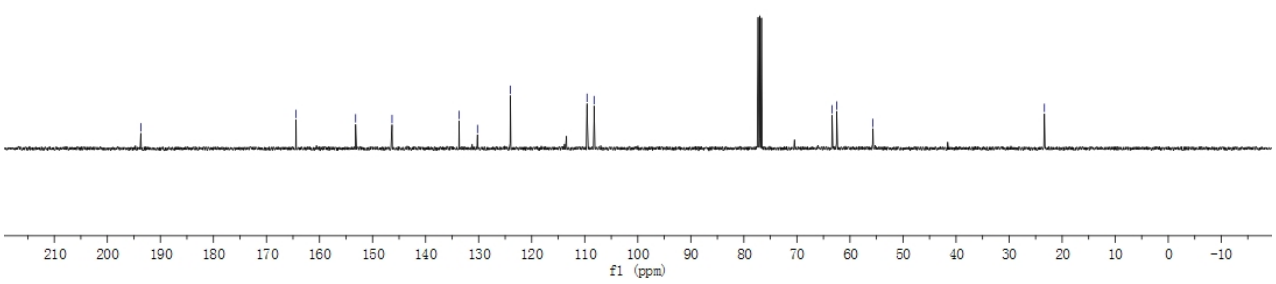


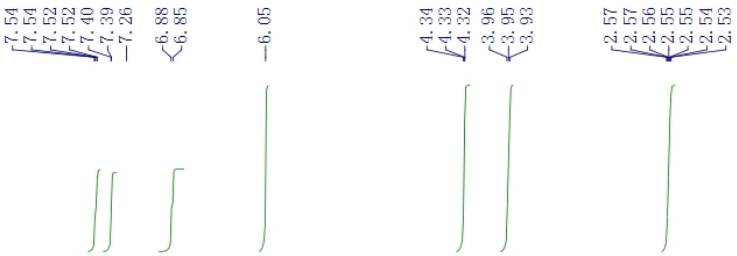
Chemical Formula: $C_{13}H_{12}O_3$
400 MHz, $CDCl_3$

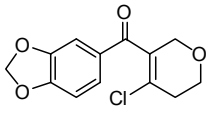




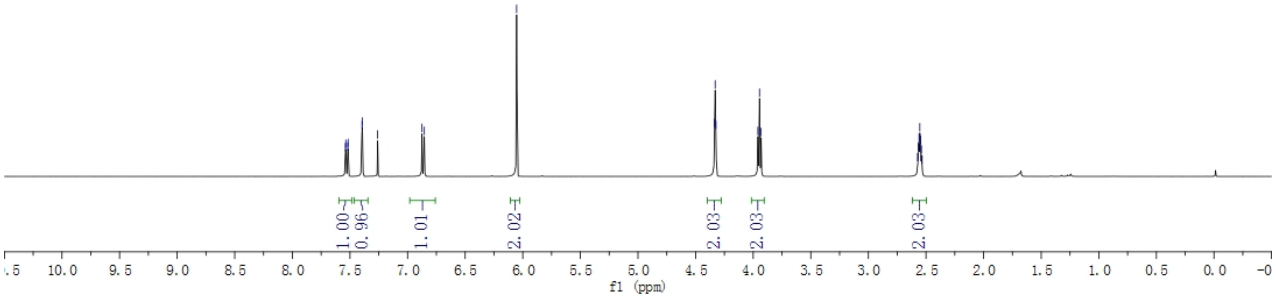
Chemical Formula: $C_{13}H_{12}O_3$
100 MHz, $CDCl_3$

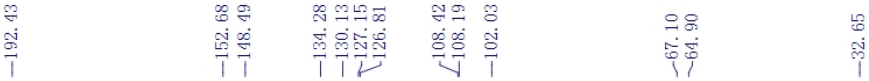


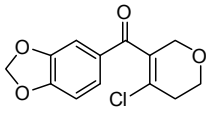




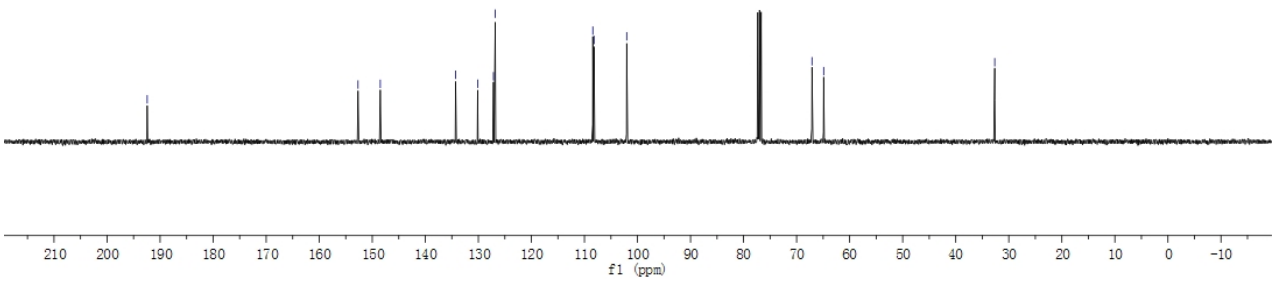
Chemical Formula: $C_{13}H_{11}ClO_4$
400 MHz, $CDCl_3$

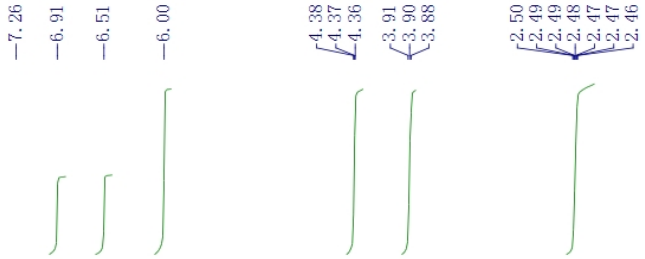


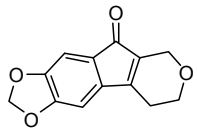




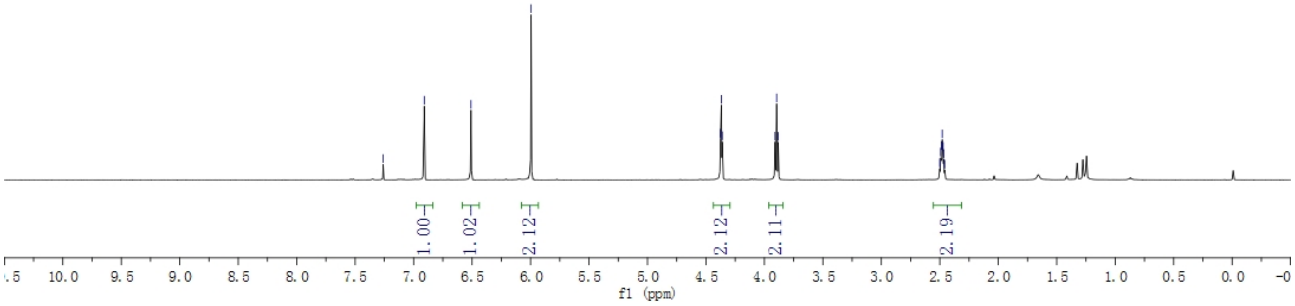
Chemical Formula: $C_{13}H_{11}ClO_4$
100 MHz, $CDCl_3$

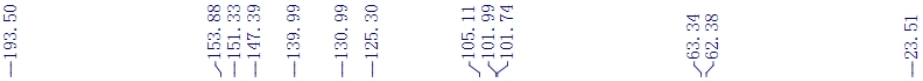


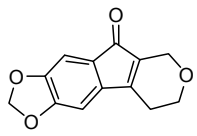




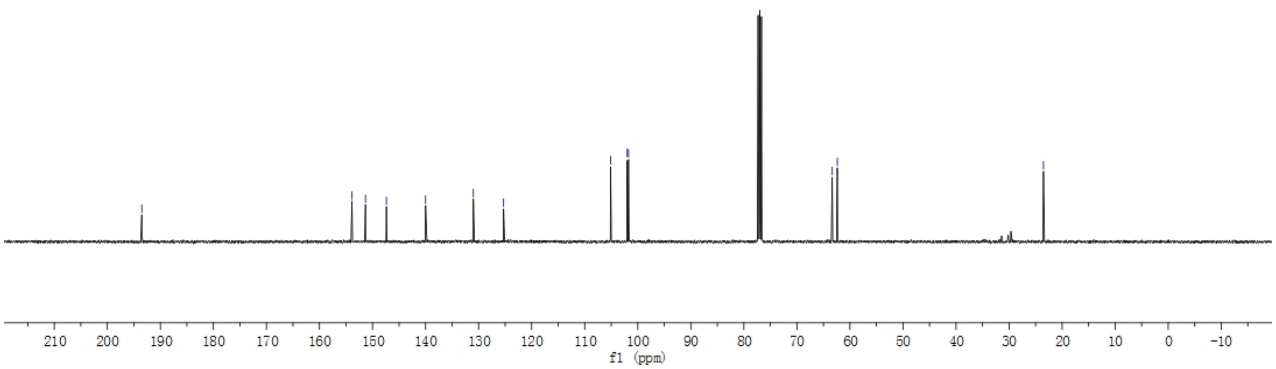
Chemical Formula: $C_{13}H_{10}O_4$
400 MHz, $CDCl_3$

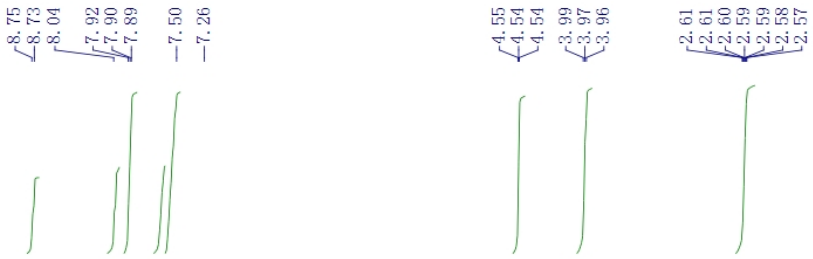


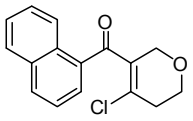




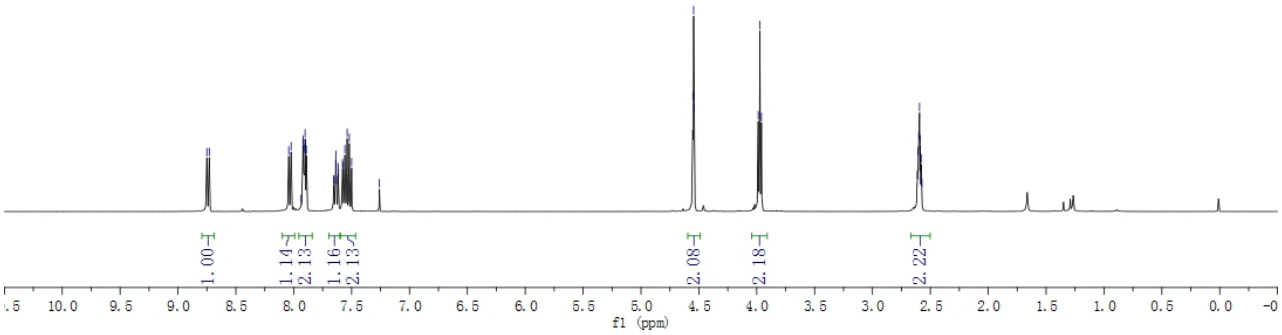
Chemical Formula: $C_{13}H_{10}O_4$
100 MHz, $CDCl_3$

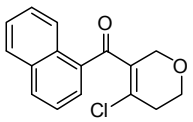




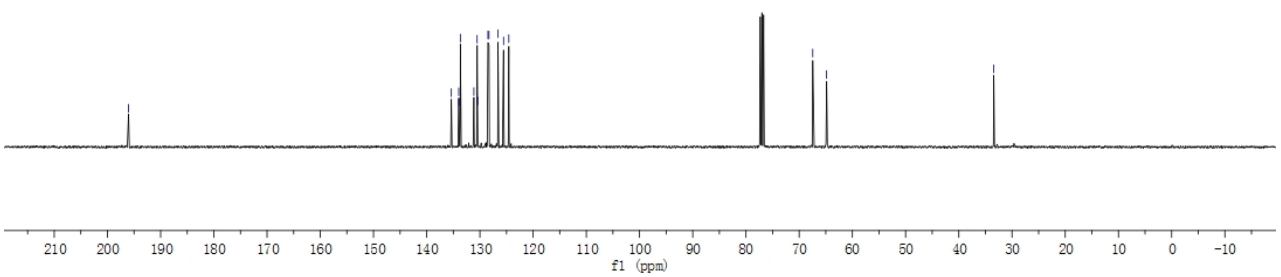


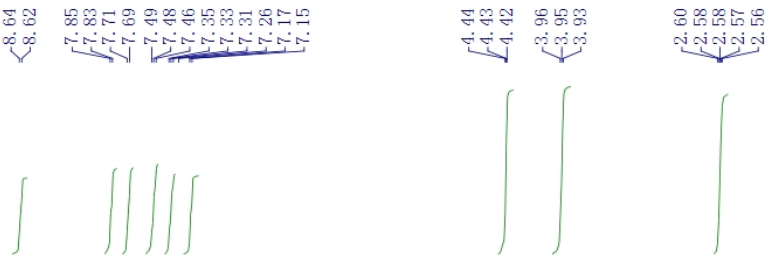
Chemical Formula: $C_{16}H_{13}ClO_2$
400 MHz, $CDCl_3$

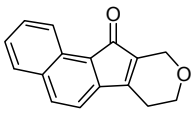




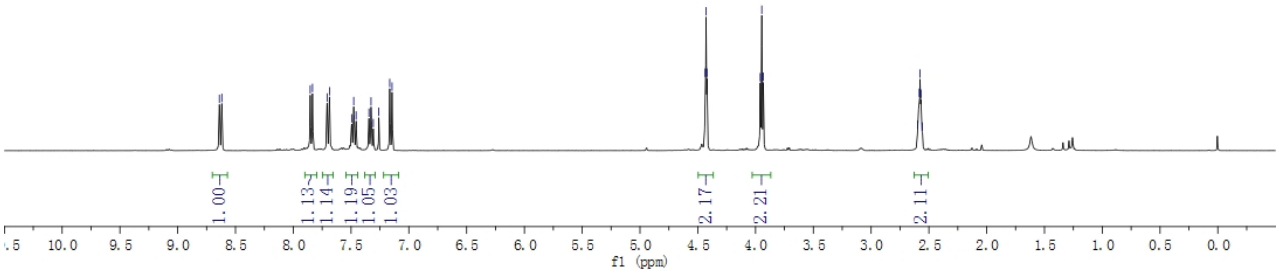
Chemical Formula: $C_{16}H_{13}ClO_2$
100 MHz, $CDCl_3$

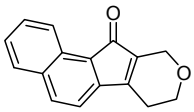




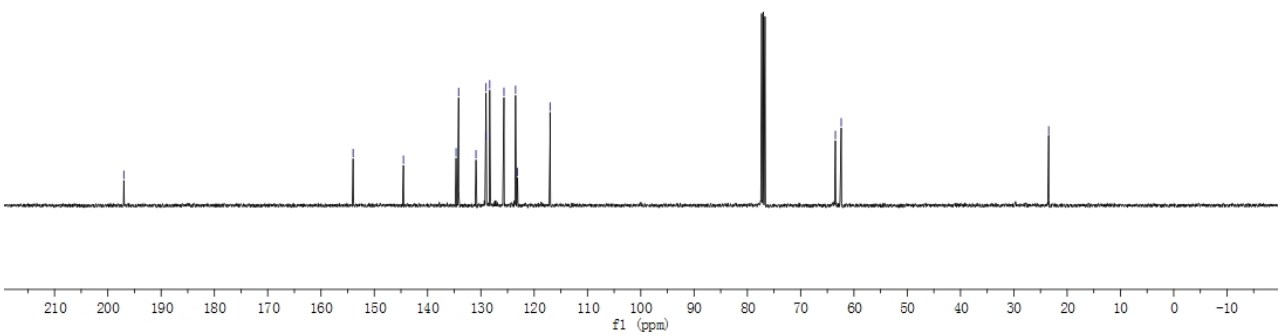


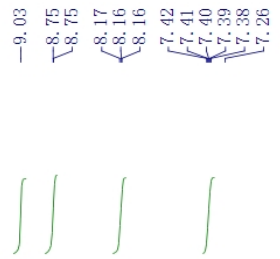
Chemical Formula: $C_{16}H_{12}O_2$
400 MHz, $CDCl_3$

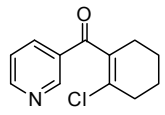




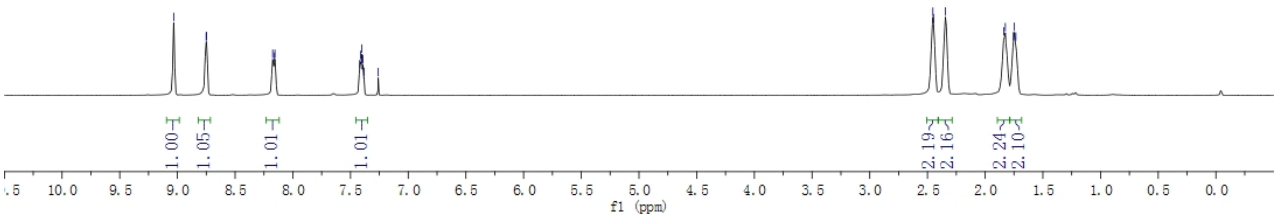
Chemical Formula: $C_{16}H_{12}O_2$
100 MHz, $CDCl_3$

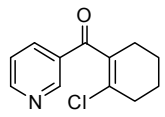




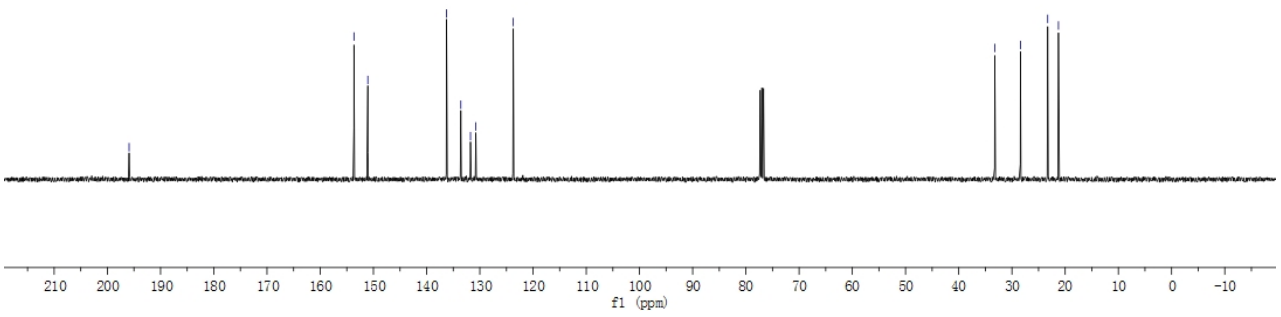


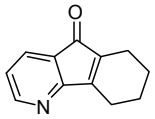
Chemical Formula: $C_{12}H_{12}ClNO$
400 MHz, $CDCl_3$



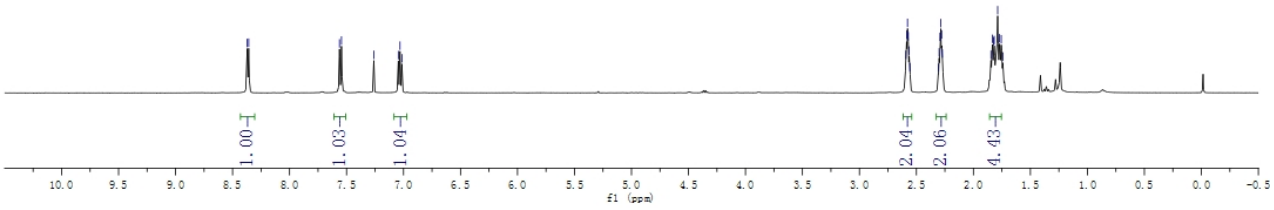


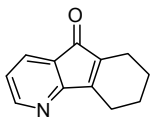
Chemical Formula: $C_{12}H_{12}ClNO$
100 MHz, $CDCl_3$



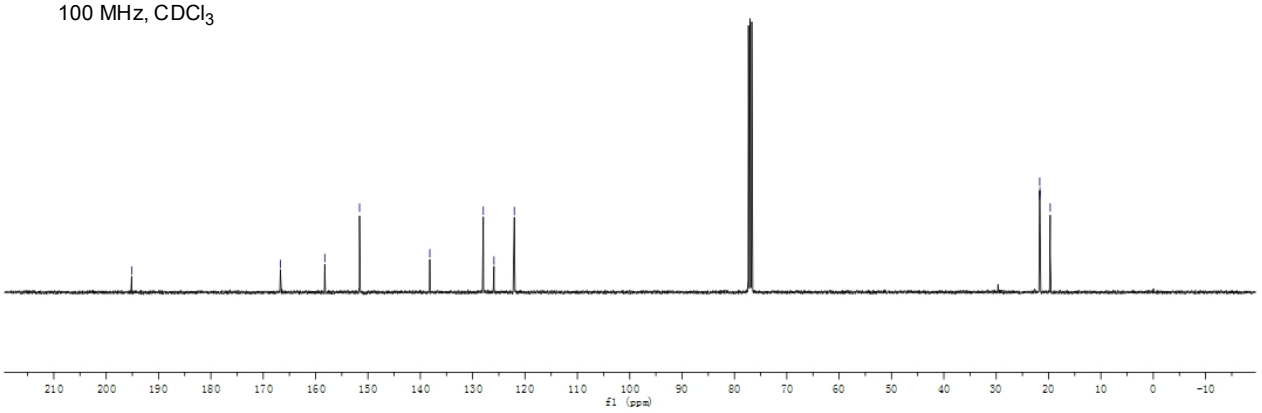


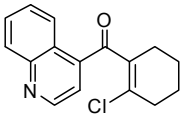
Chemical Formula: $C_{12}H_{11}NO$
400 MHz, $CDCl_3$



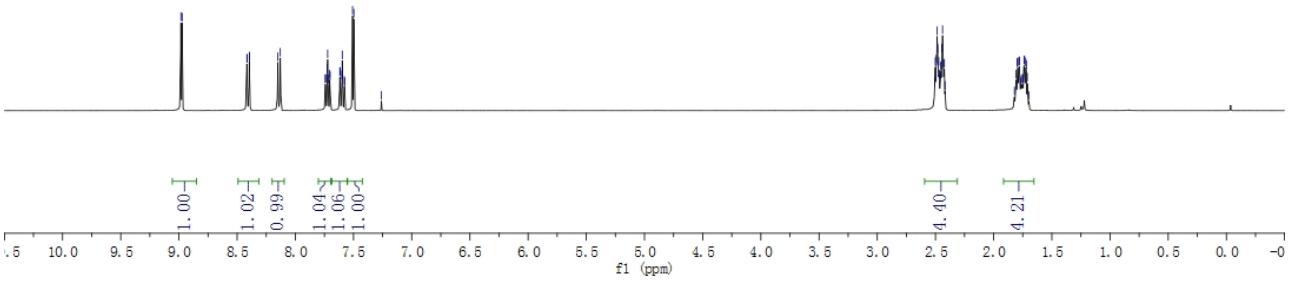


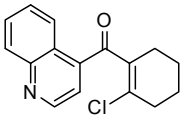
Chemical Formula: $C_{12}H_{11}NO$
100 MHz, $CDCl_3$



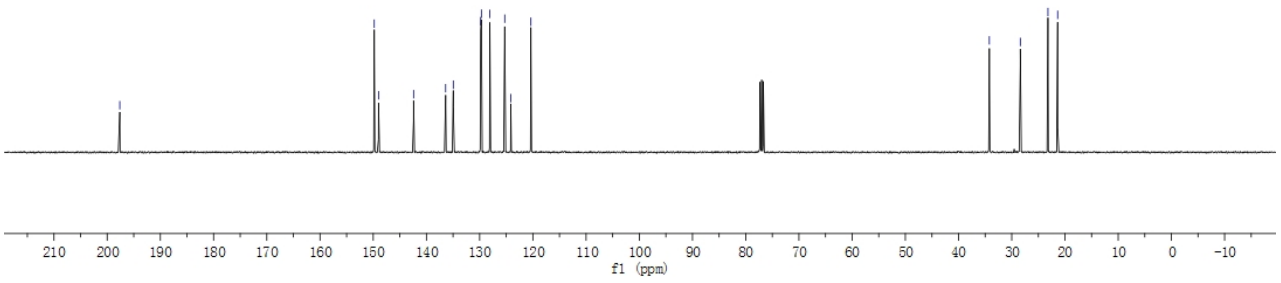


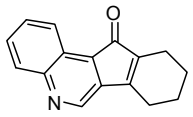
Chemical Formula: $C_{16}H_{14}ClNO$
400 MHz, $CDCl_3$



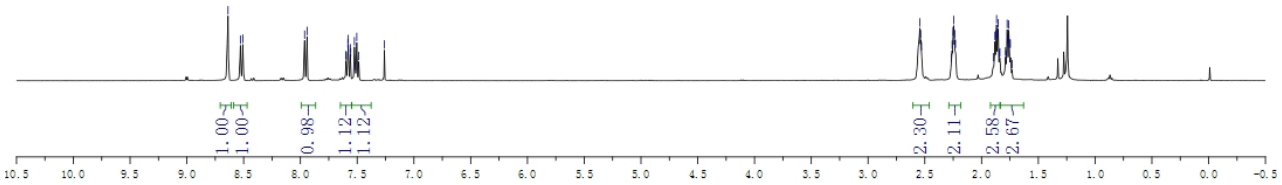


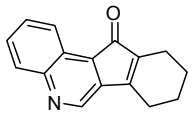
Chemical Formula: $C_{16}H_{14}ClNO$
100 MHz, $CDCl_3$



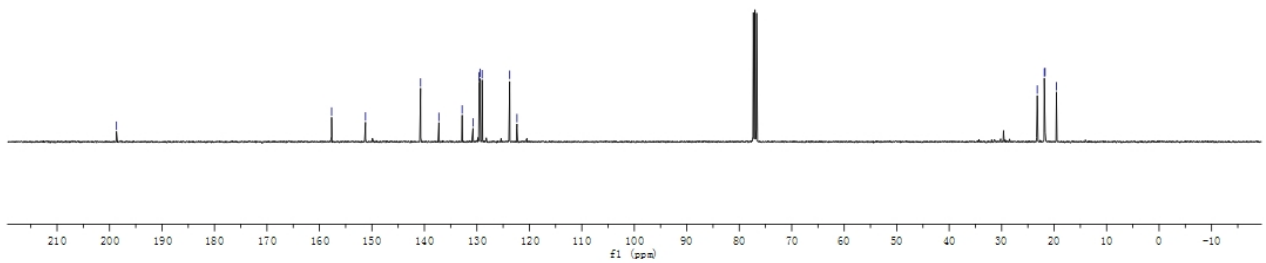


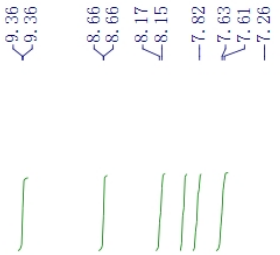
Chemical Formula: $C_{16}H_{13}NO$
400 MHz, $CDCl_3$

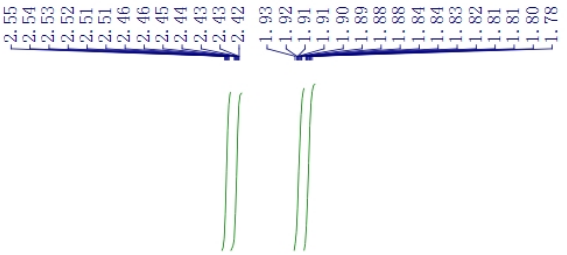


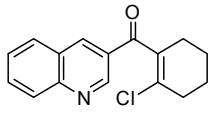


Chemical Formula: $C_{16}H_{13}NO$
100 MHz, $CDCl_3$

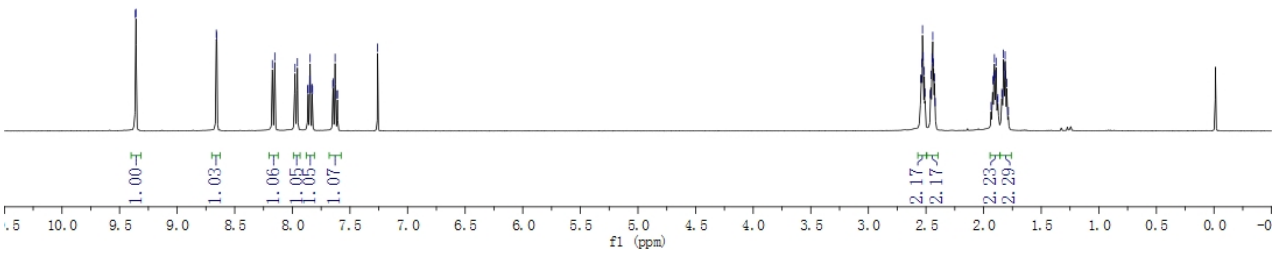


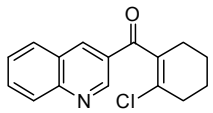




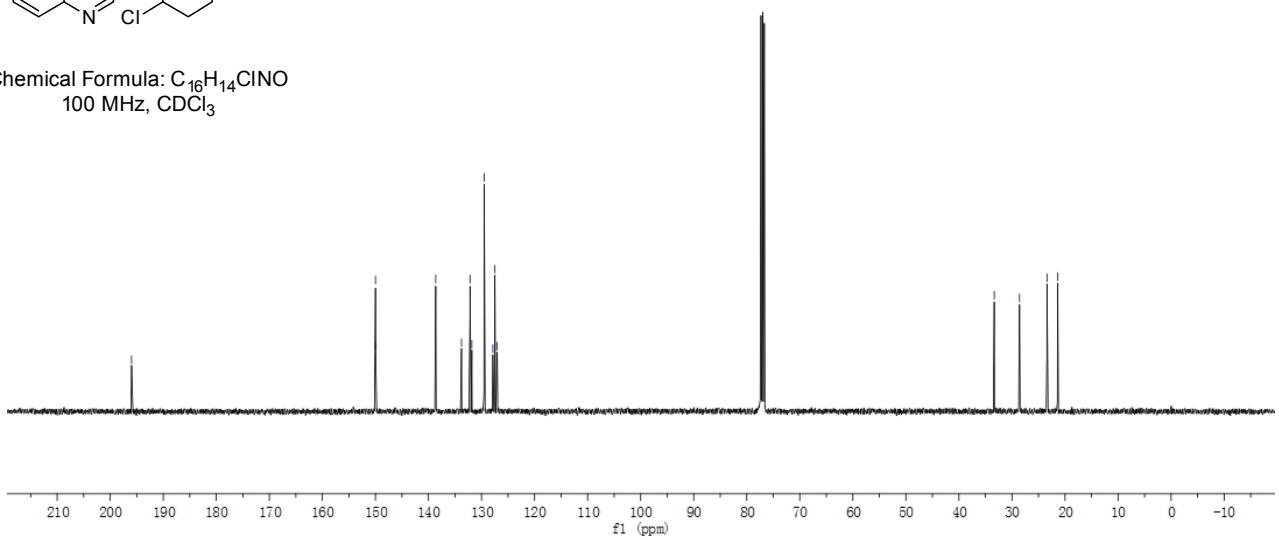


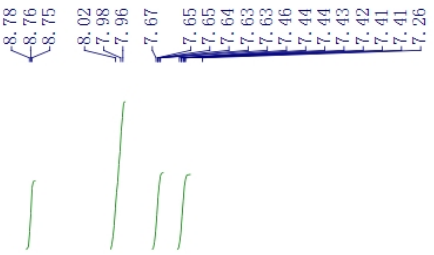
Chemical Formula: $C_{16}H_{14}ClNO$
400 MHz, $CDCl_3$

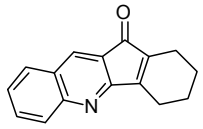




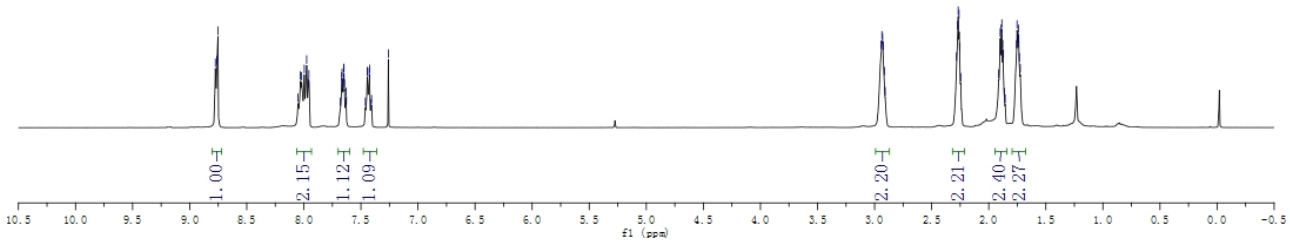
Chemical Formula: $C_{16}H_{14}ClNO$
100 MHz, $CDCl_3$

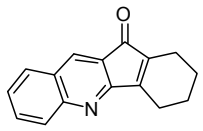




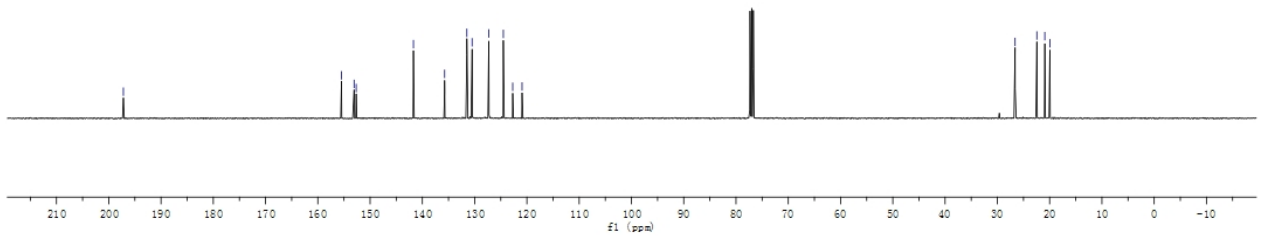


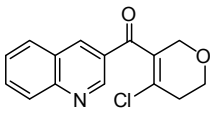
Chemical Formula: $C_{16}H_{13}NO$
400 MHz, $CDCl_3$



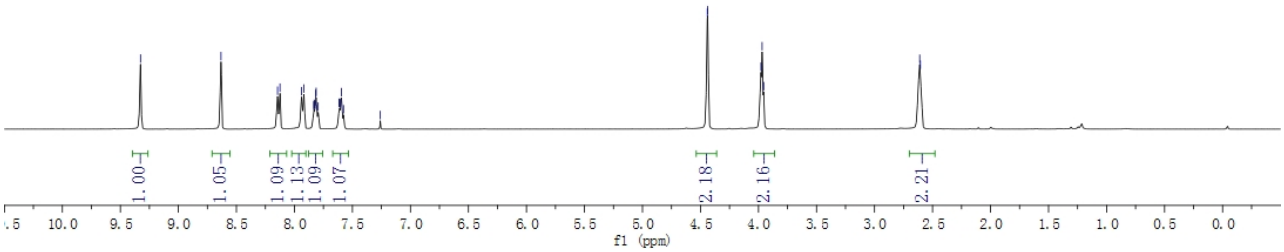


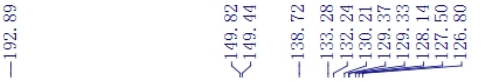
Chemical Formula: $C_{16}H_{13}NO$
100 MHz, $CDCl_3$

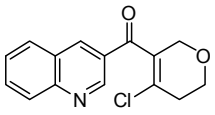




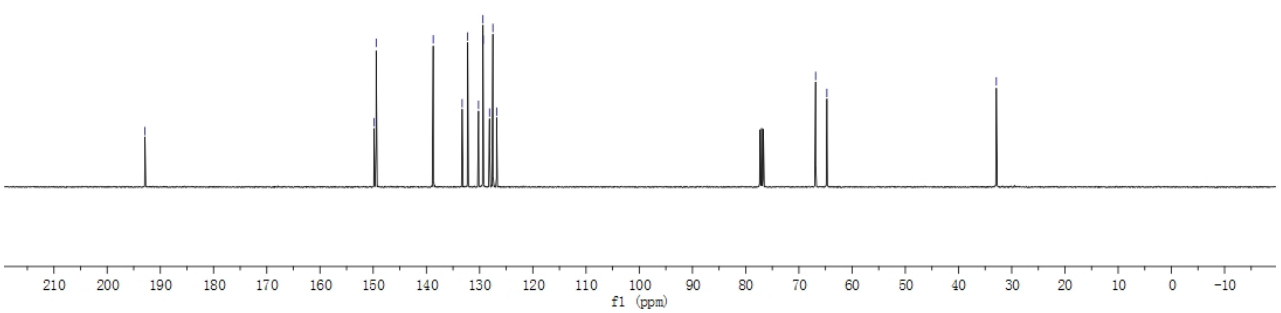
Chemical Formula: $C_{15}H_{12}ClNO_2$
400 MHz, $CDCl_3$

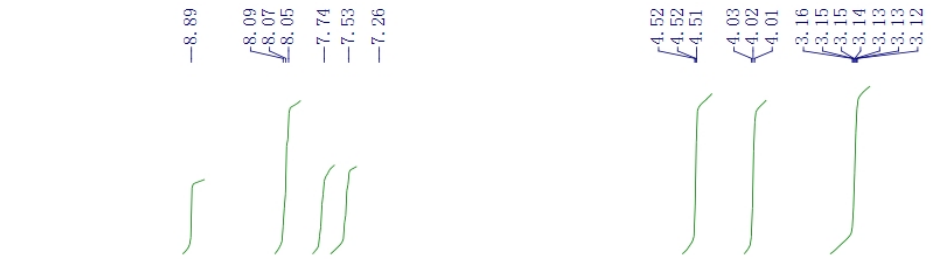


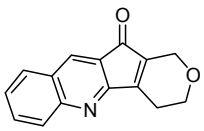




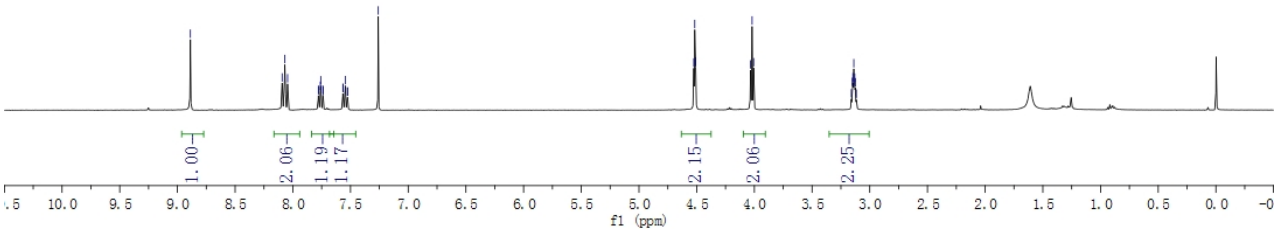
Chemical Formula: $C_{15}H_{12}ClNO_2$
100 MHz, $CDCl_3$

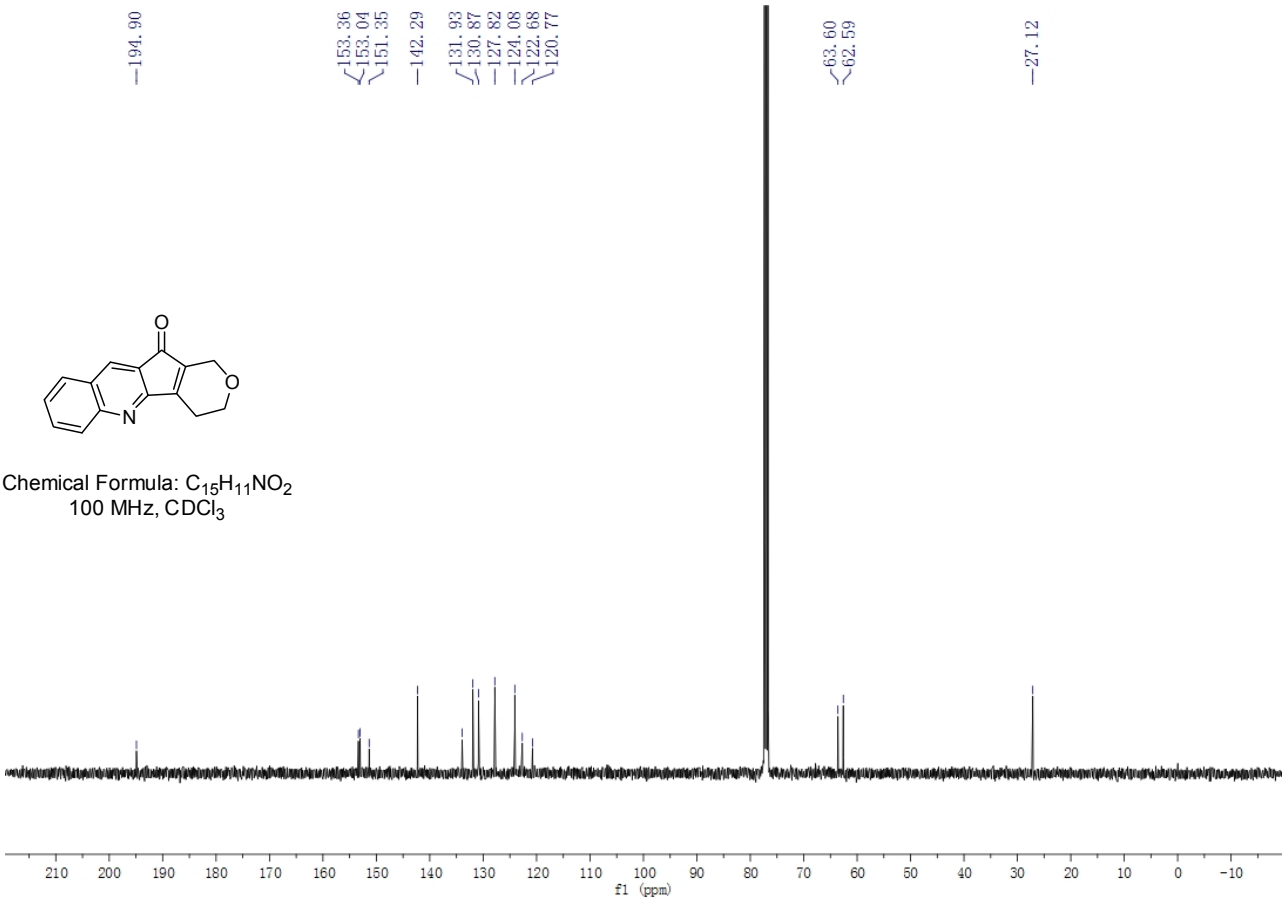




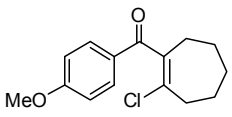


Chemical Formula: $C_{15}H_{11}NO_2$
400 MHz, $CDCl_3$

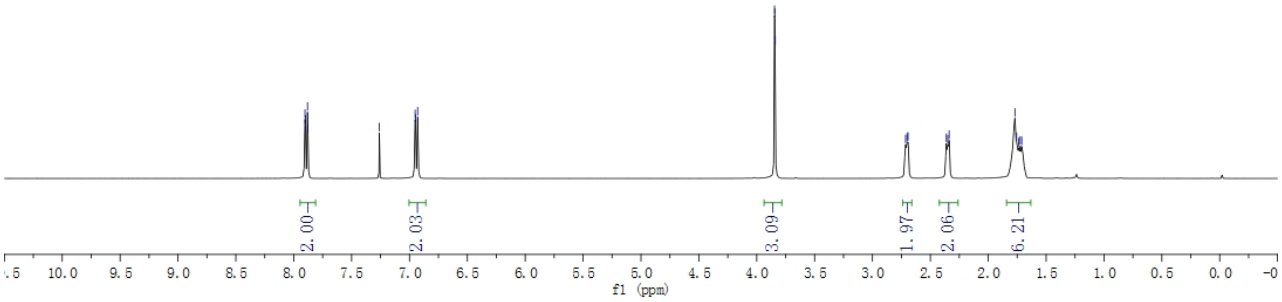


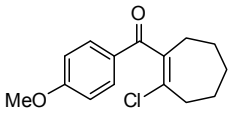


Chemical Formula: $C_{15}H_{11}NO_2$
100 MHz, $CDCl_3$

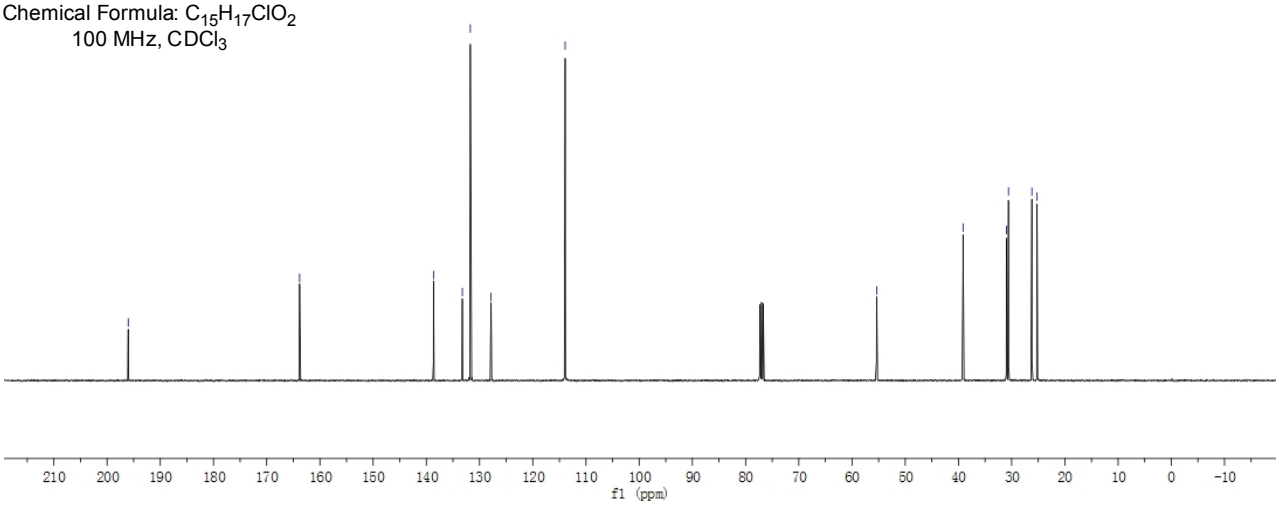


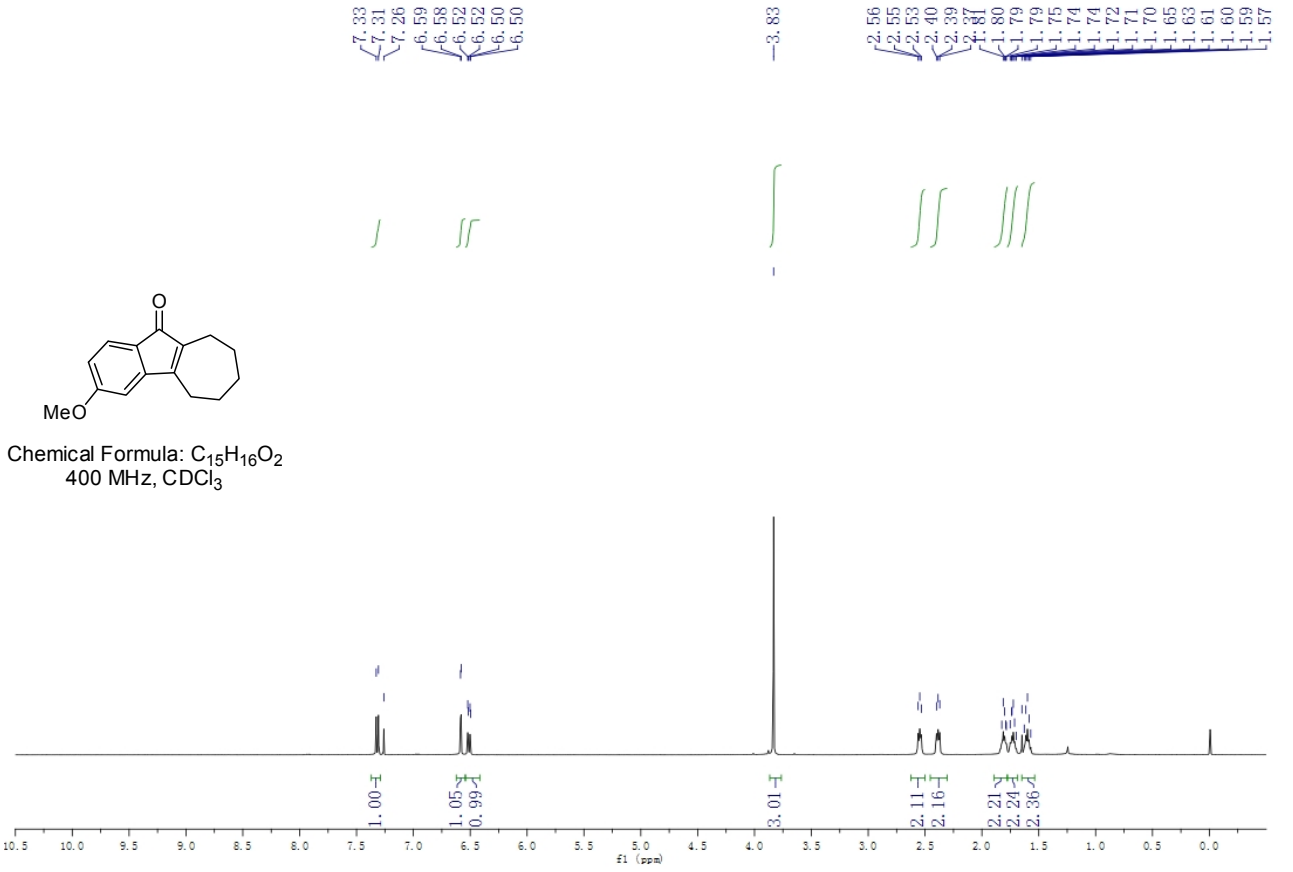
Chemical Formula: $C_{15}H_{17}ClO_2$
400 MHz, $CDCl_3$



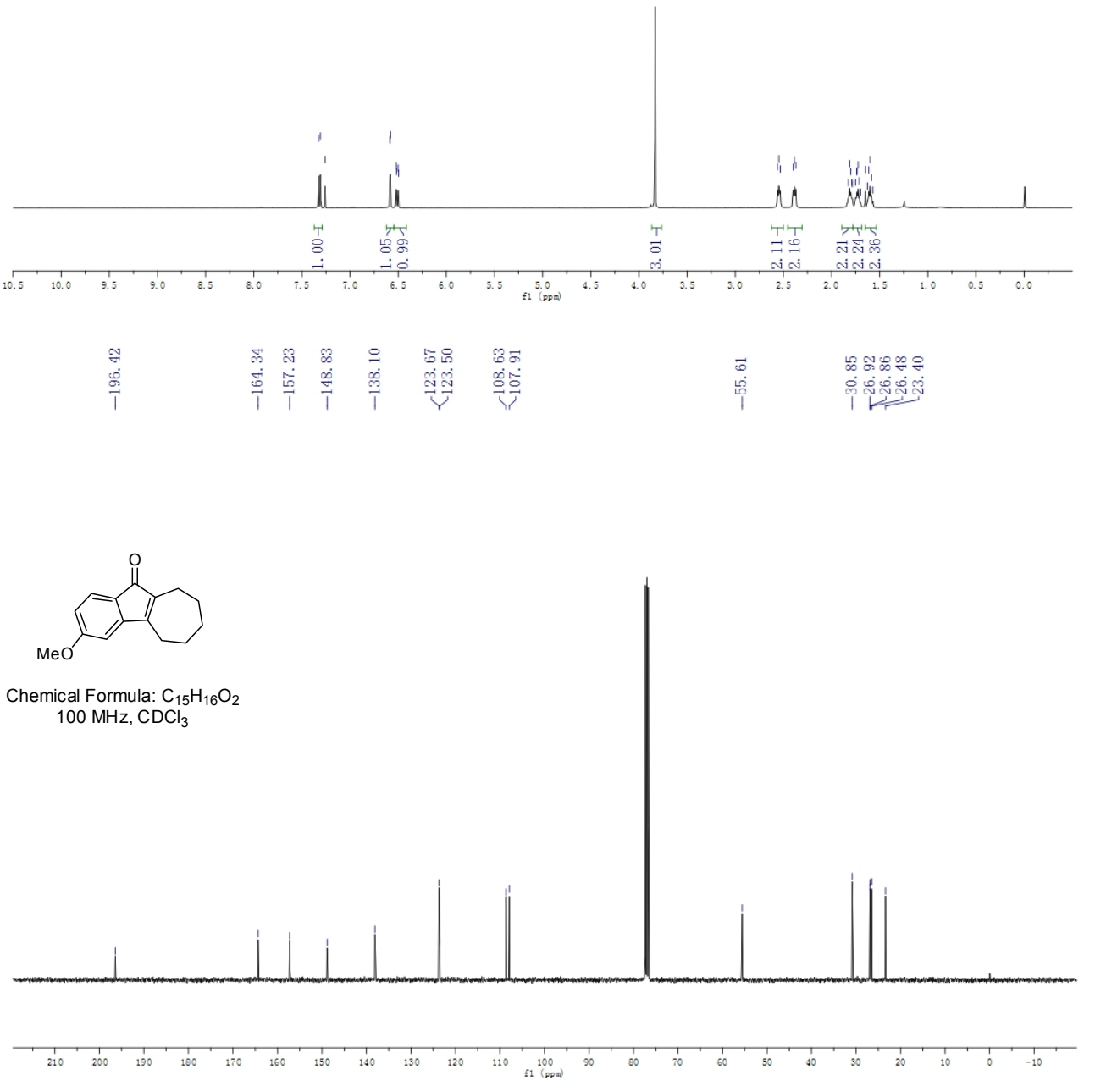


Chemical Formula: $C_{15}H_{17}ClO_2$
100 MHz, $CDCl_3$

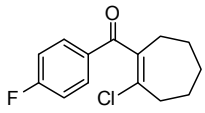




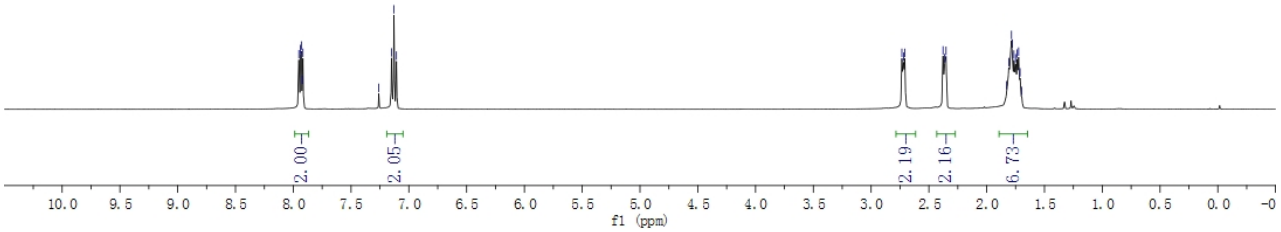
Chemical Formula: $C_{15}H_{16}O_2$
400 MHz, $CDCl_3$

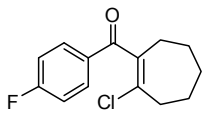


Chemical Formula: $C_{15}H_{16}O_2$
100 MHz, $CDCl_3$

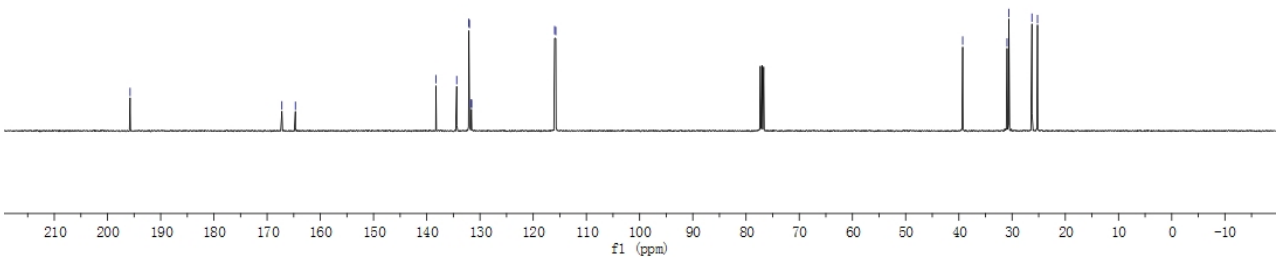


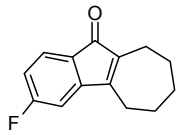
Chemical Formula: $C_{14}H_{14}ClFO$
400 MHz, $CDCl_3$



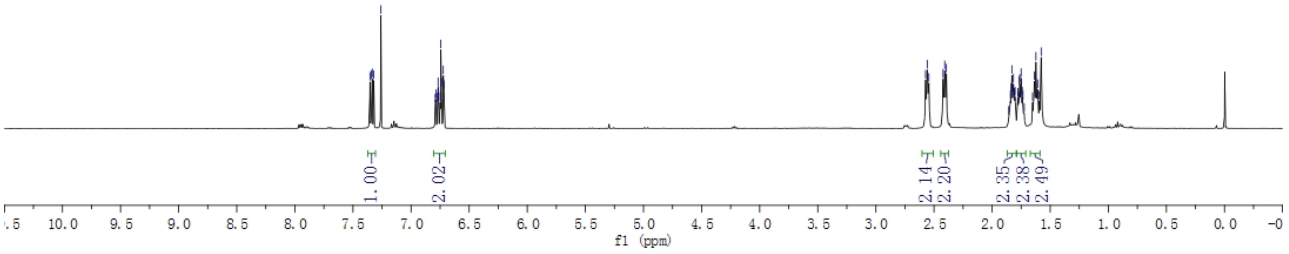


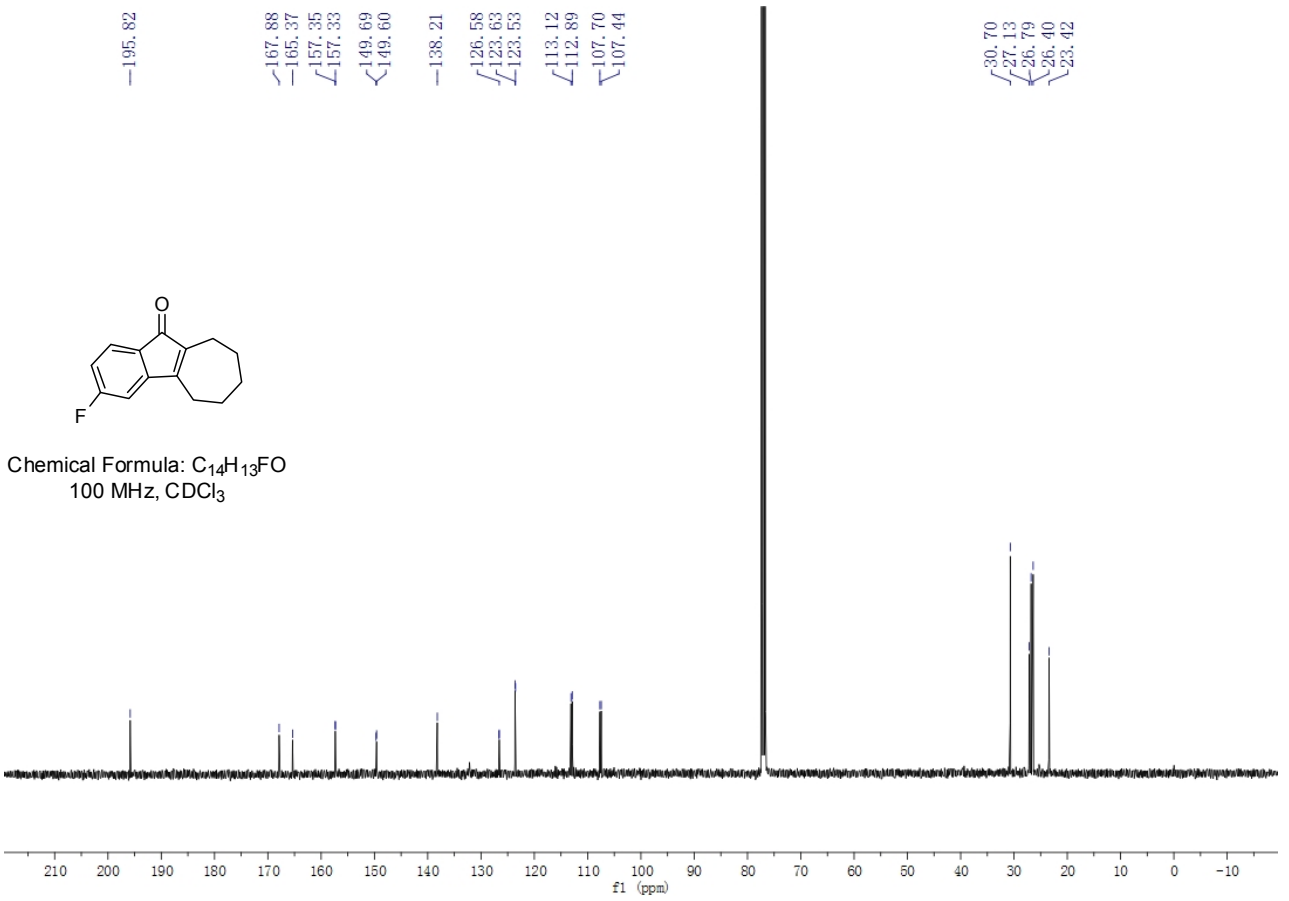
Chemical Formula: $C_{14}H_{14}ClFO$
100 MHz, $CDCl_3$



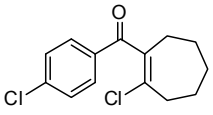


Chemical Formula: $C_{14}H_{13}FO$
400 MHz, $CDCl_3$

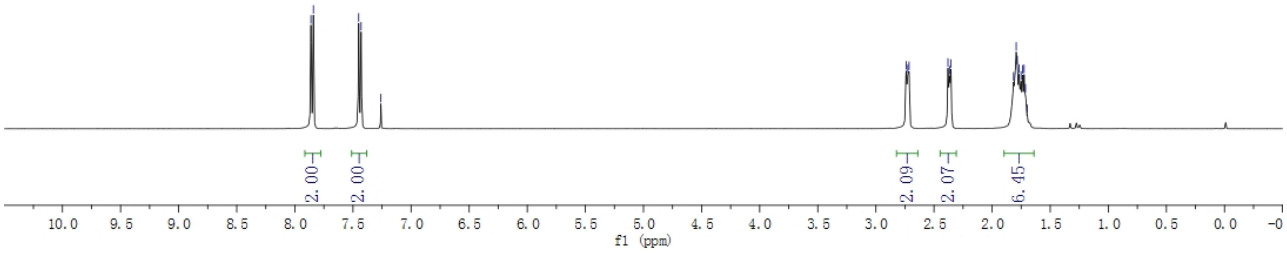


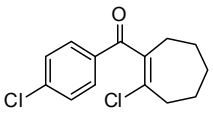


Chemical Formula: $C_{14}H_{13}FO$
100 MHz, $CDCl_3$

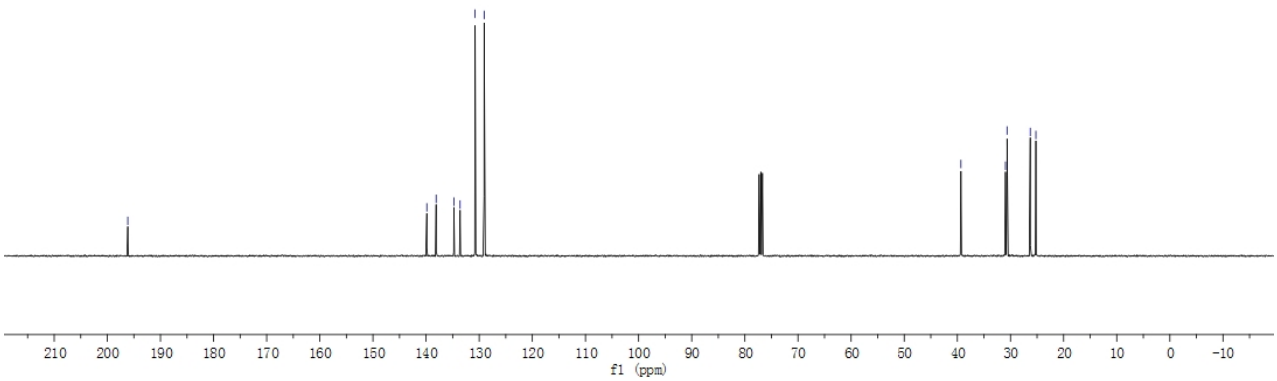


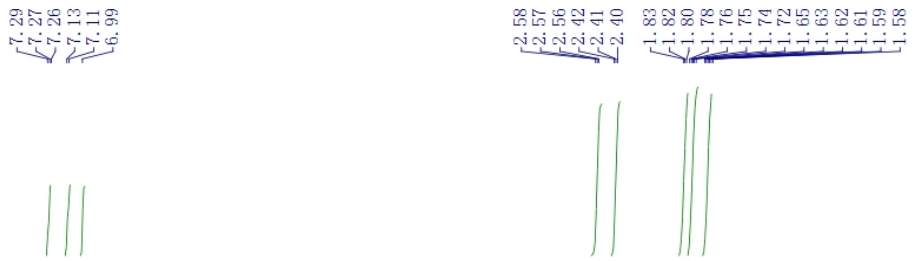
Chemical Formula: $C_{14}H_{14}Cl_2O$
400 MHz, $CDCl_3$

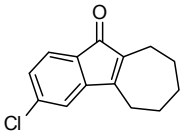




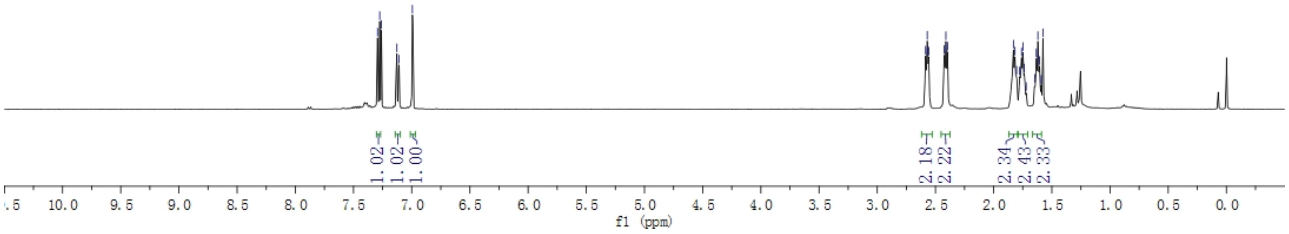
Chemical Formula: $C_{14}H_{14}Cl_2O$
100 MHz, $CDCl_3$

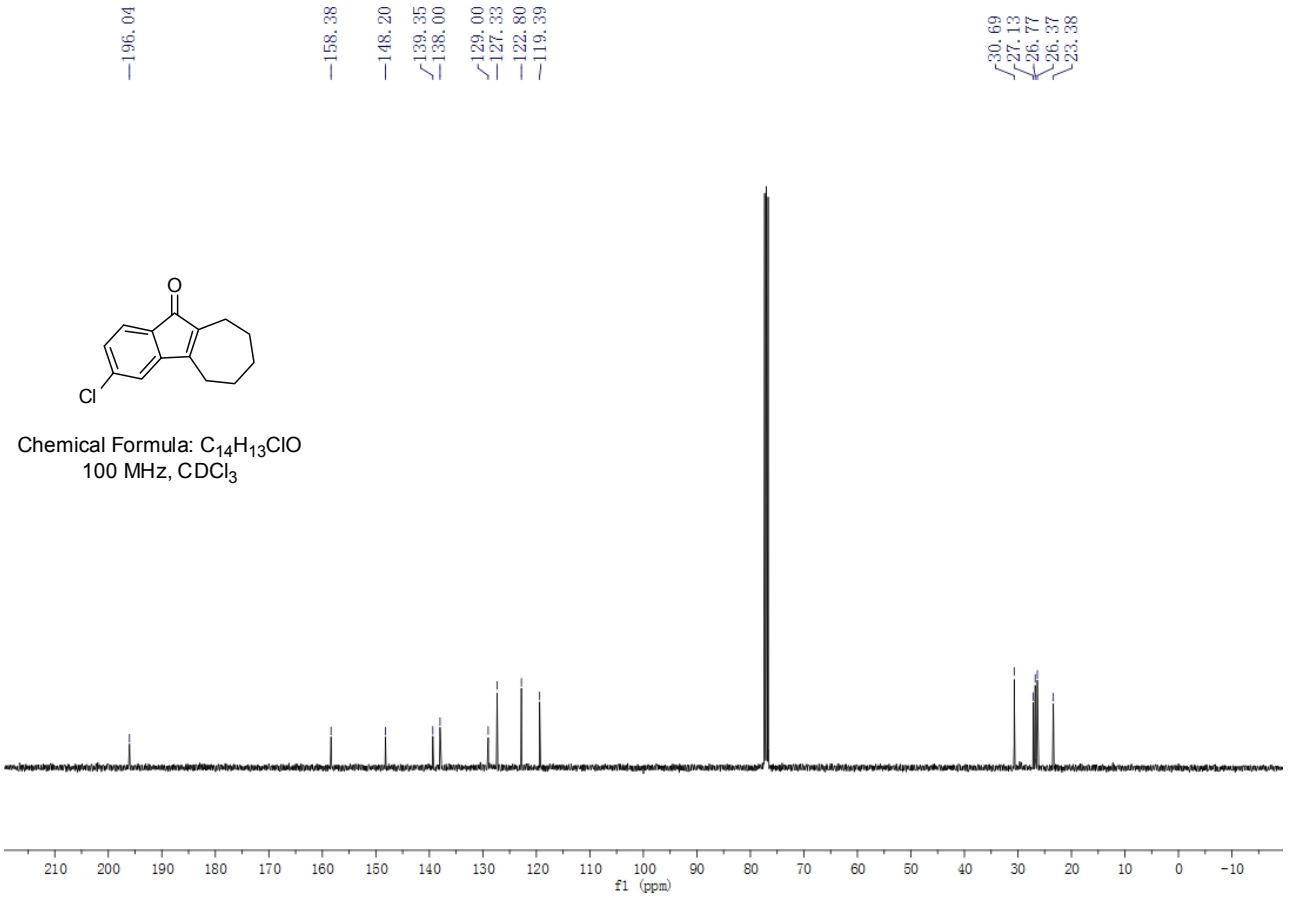




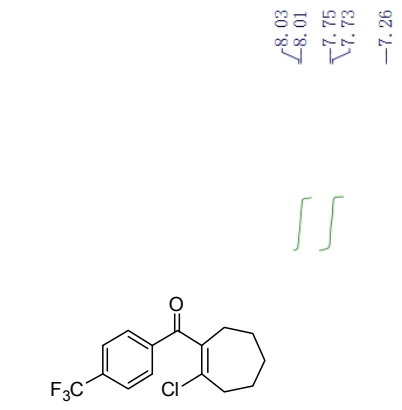


Chemical Formula: $C_{14}H_{13}ClO$
400 MHz, $CDCl_3$

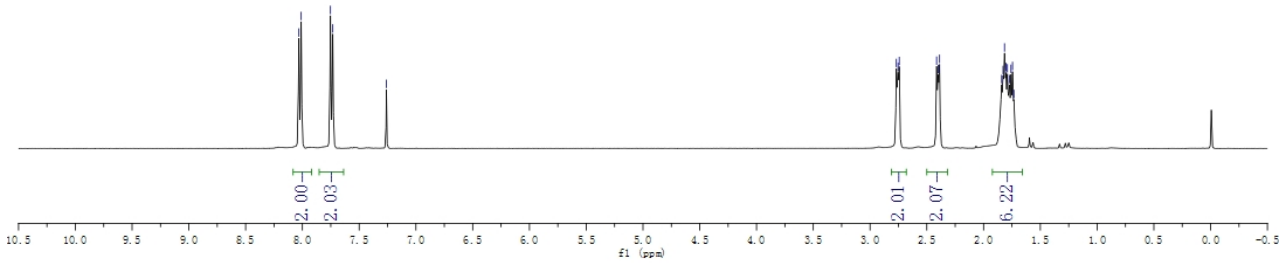


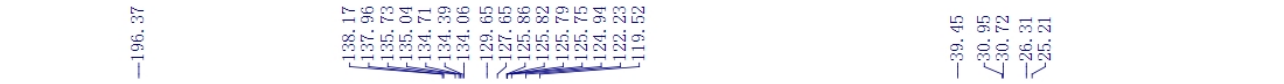


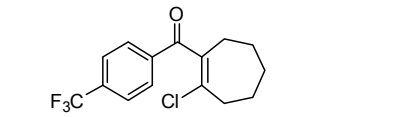
Chemical Formula: $C_{14}H_{13}ClO$
100 MHz, $CDCl_3$



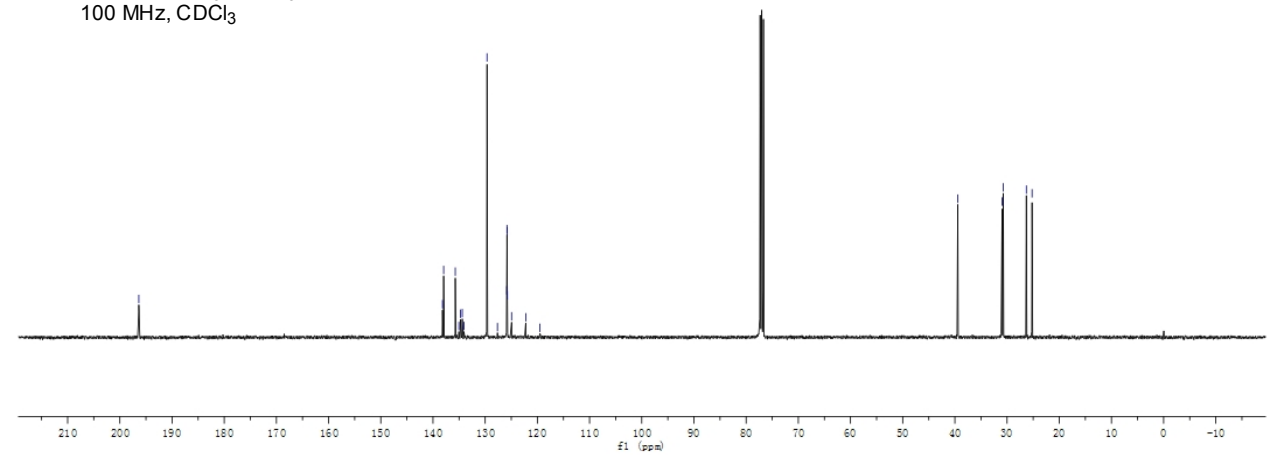
Chemical Formula: $C_{15}H_{14}ClF_3O$
400 MHz, $CDCl_3$



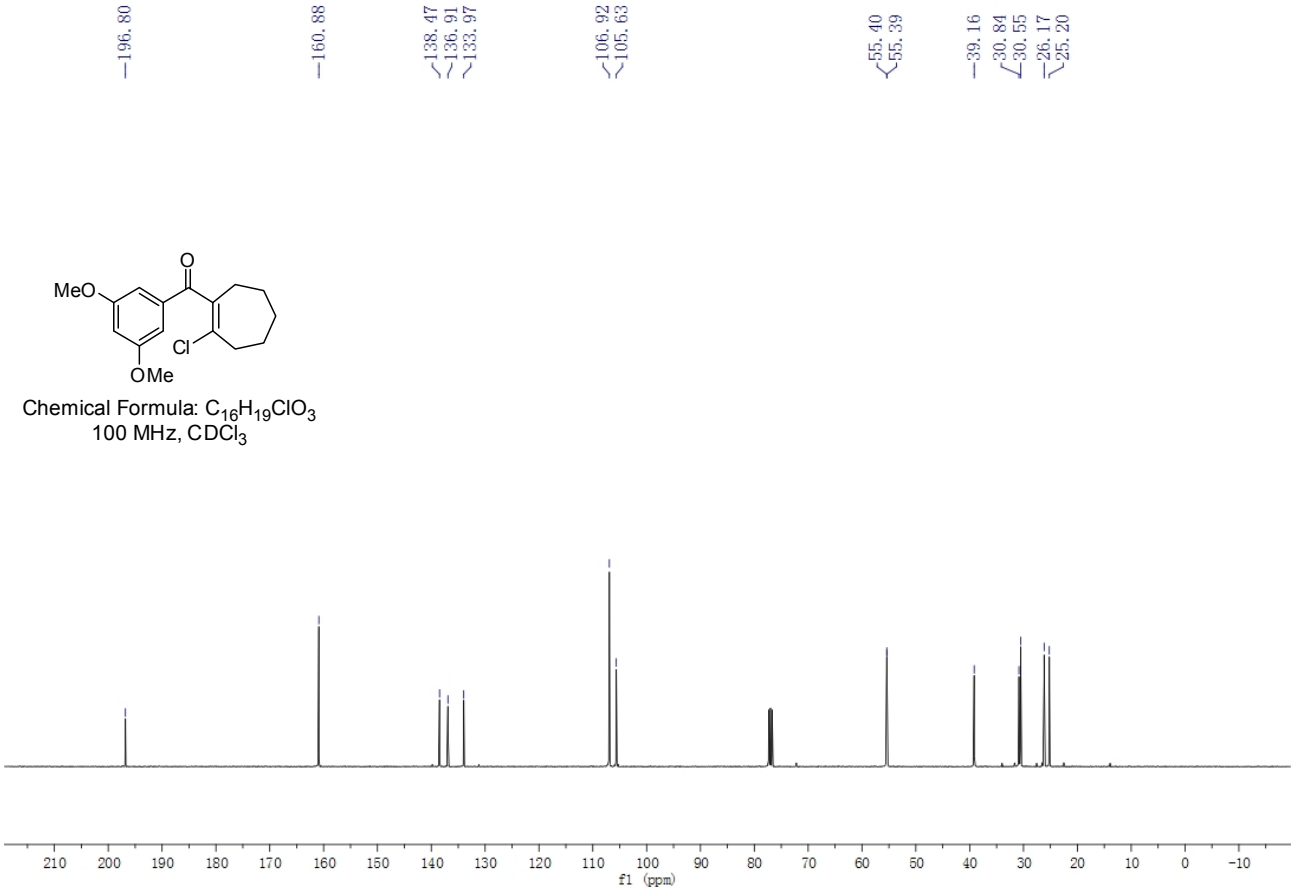




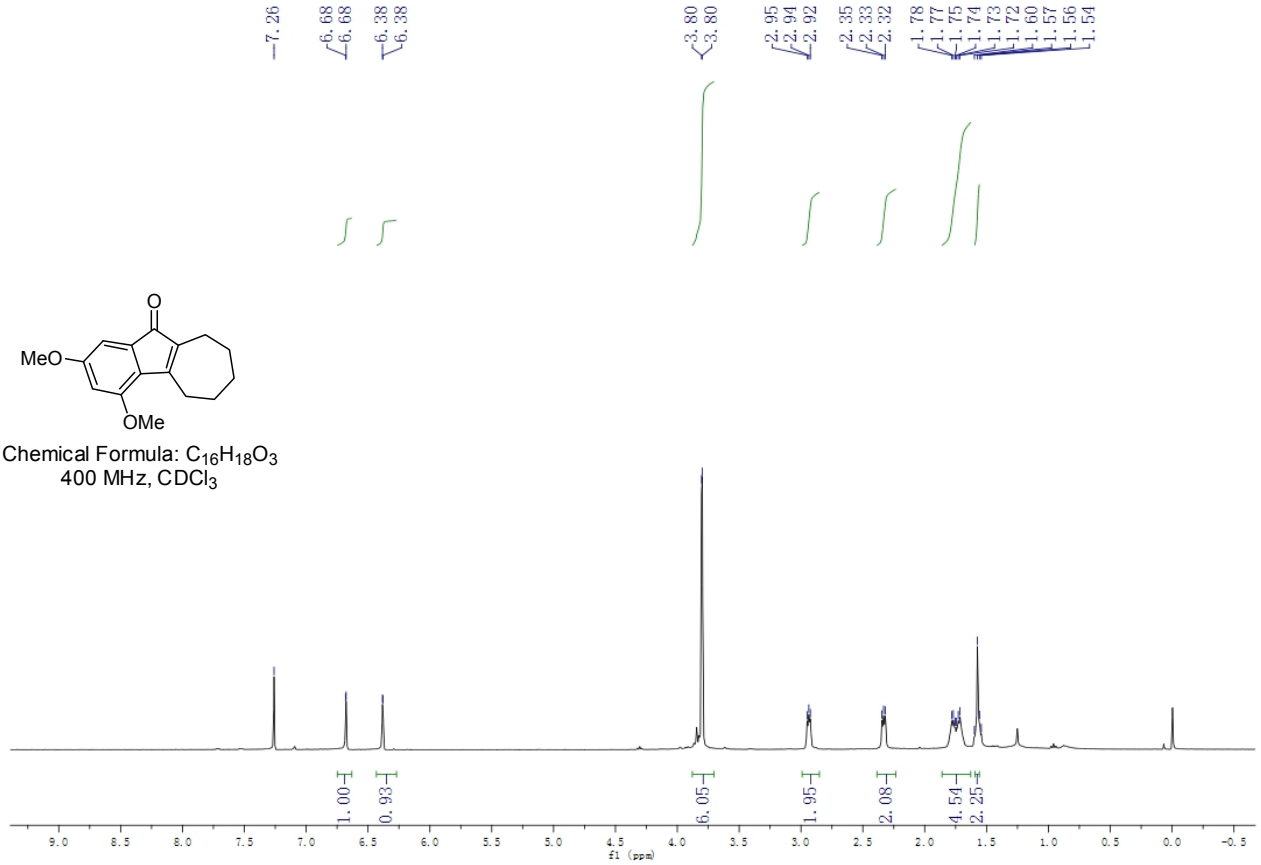
Chemical Formula: $C_{15}H_{14}ClF_3O$
100 MHz, $CDCl_3$



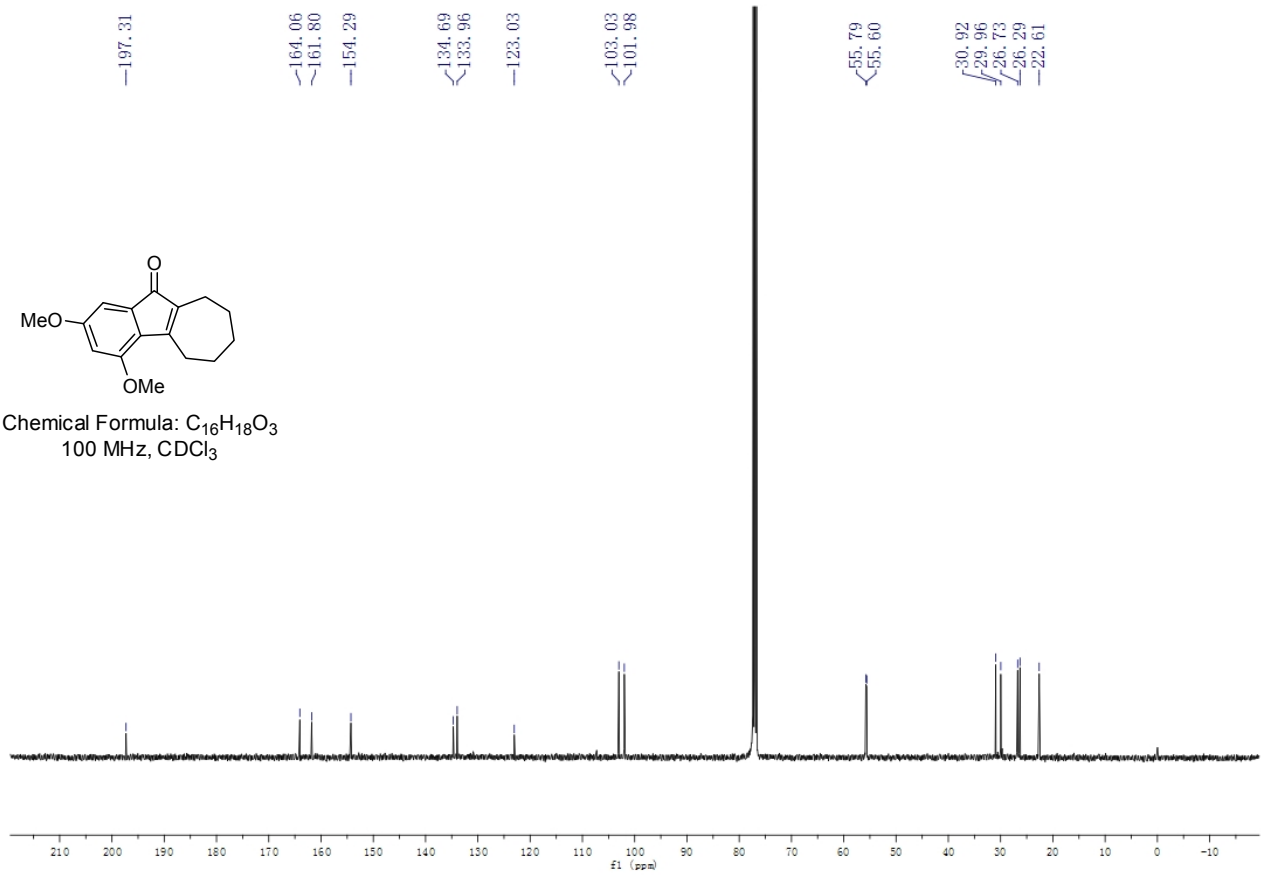
Chemical Formula: $C_{16}H_{19}ClO_3$
400 MHz, $CDCl_3$



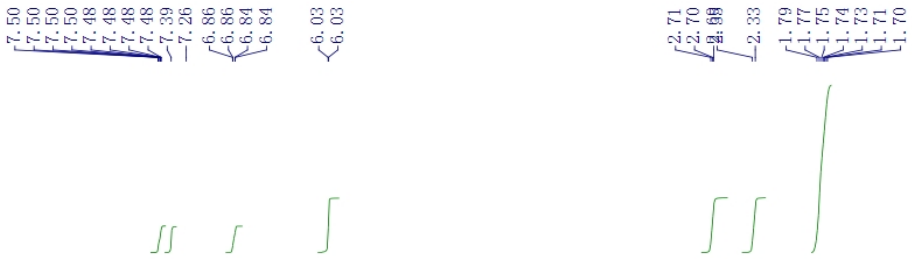
Chemical Formula: $C_{16}H_{19}ClO_3$
100 MHz, $CDCl_3$

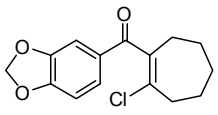


Chemical Formula: $C_{16}H_{18}O_3$
400 MHz, $CDCl_3$

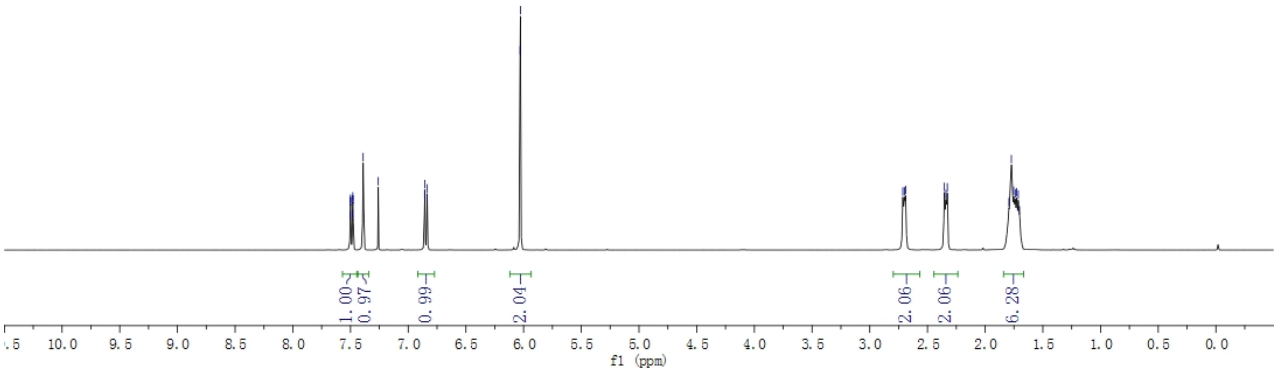


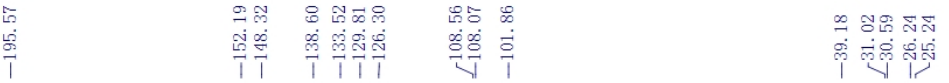
Chemical Formula: $C_{16}H_{18}O_3$
100 MHz, $CDCl_3$

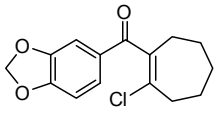




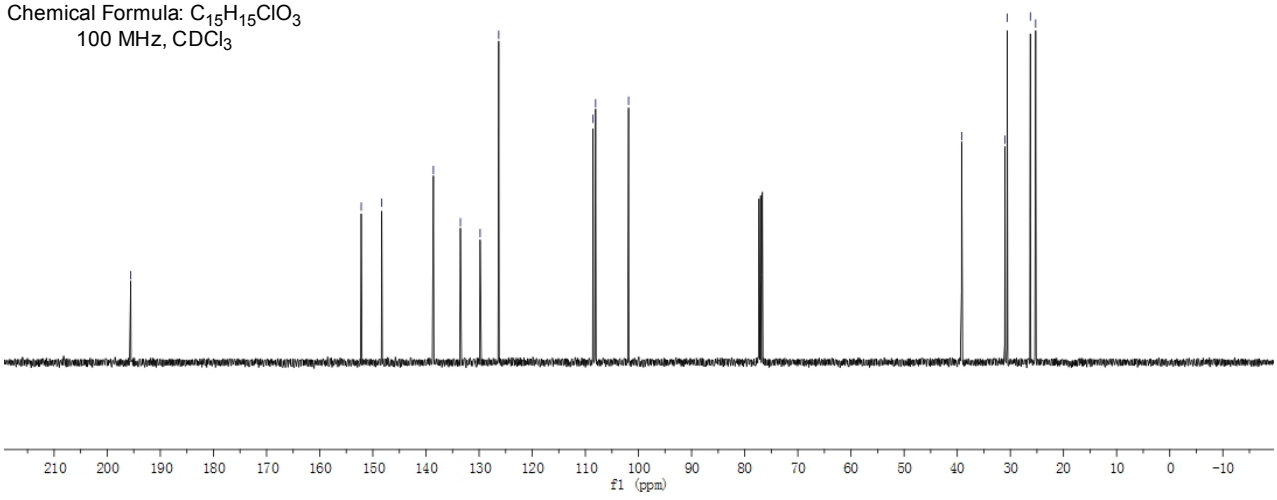
Chemical Formula: $C_{15}H_{15}ClO_3$
400 MHz, $CDCl_3$

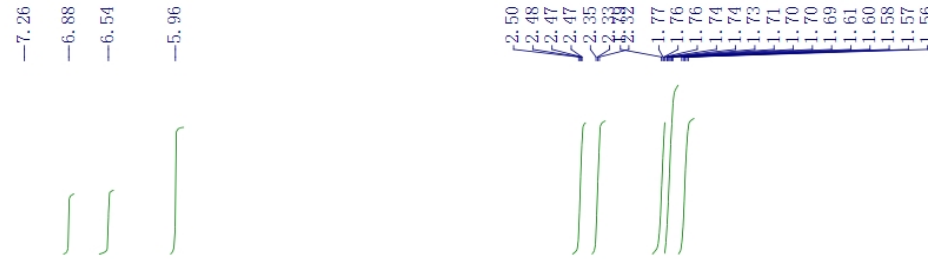


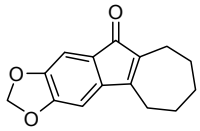




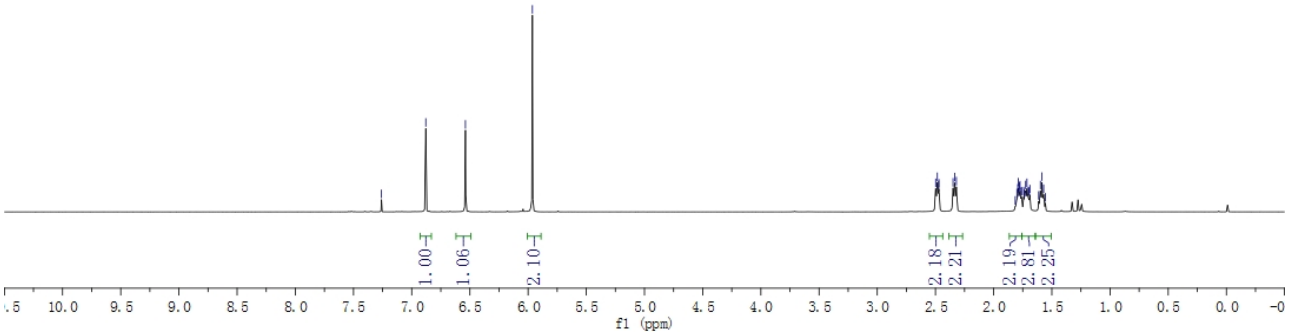
Chemical Formula: $C_{15}H_{15}ClO_3$
100 MHz, $CDCl_3$

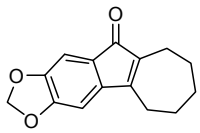




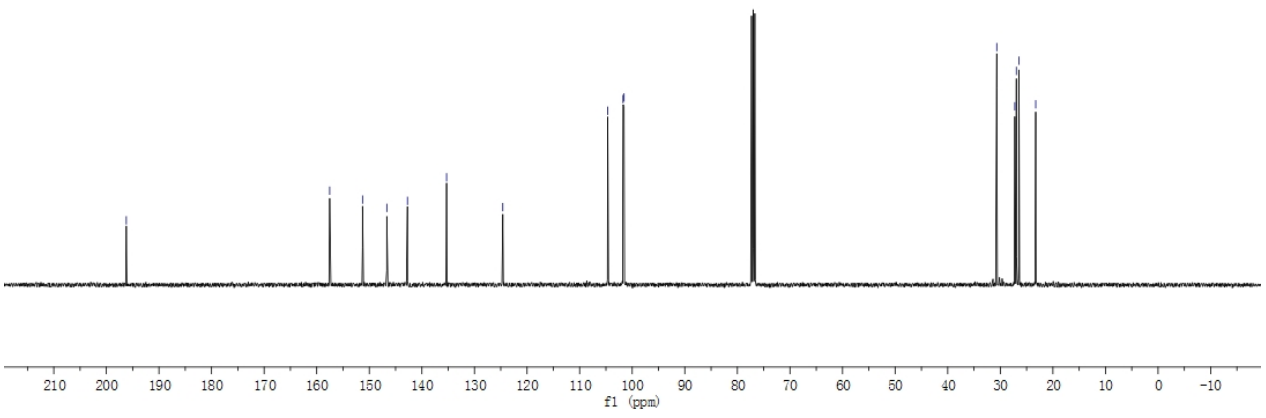


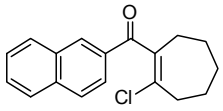
Chemical Formula: $C_{15}H_{14}O_3$
400 MHz, $CDCl_3$



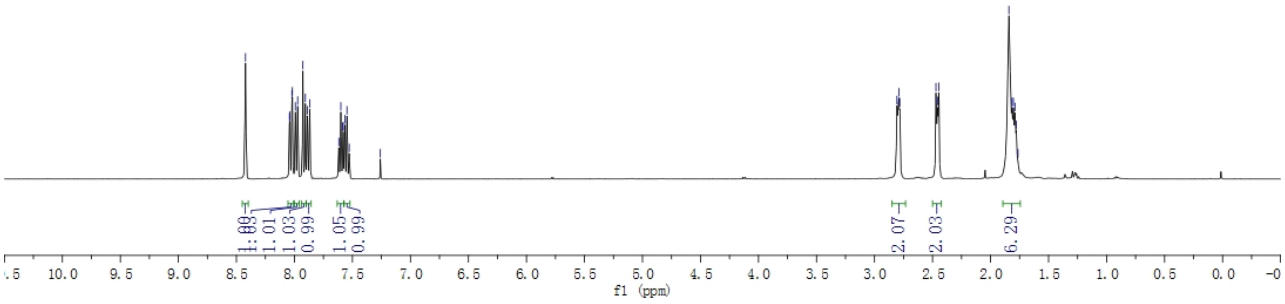


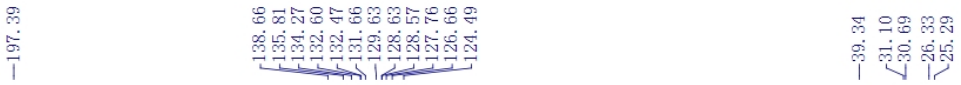
Chemical Formula: $C_{15}H_{14}O_3$
100 MHz, $CDCl_3$

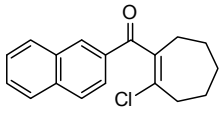




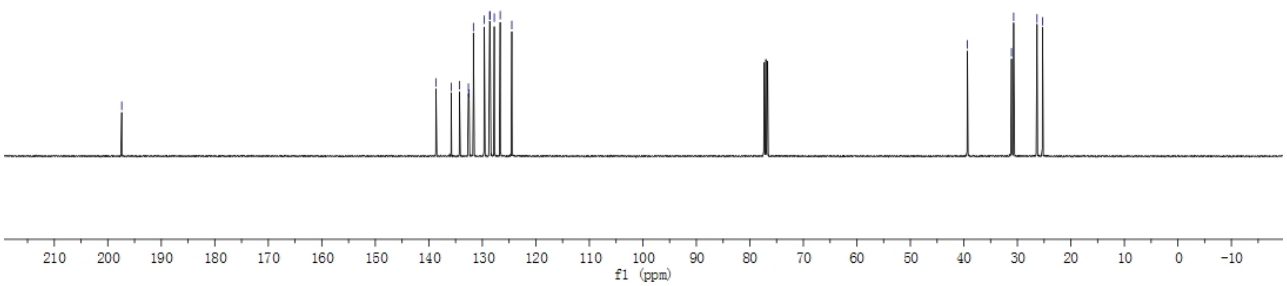
Chemical Formula: $C_{18}H_{17}ClO$
400 MHz, $CDCl_3$

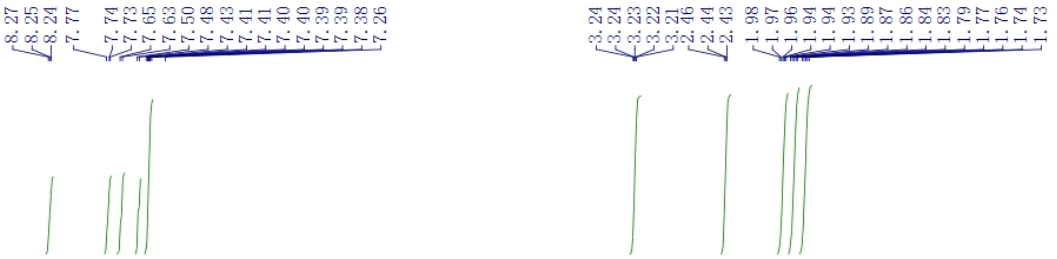


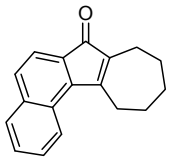




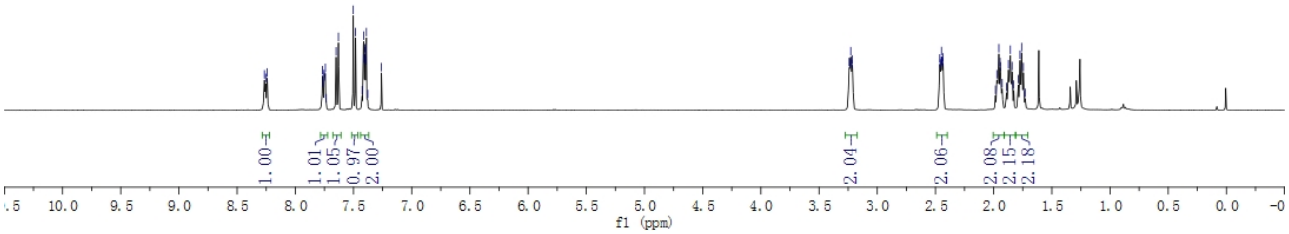
Chemical Formula: $C_{18}H_{17}ClO$
100 MHz, $CDCl_3$

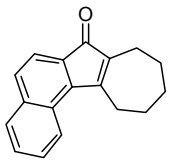




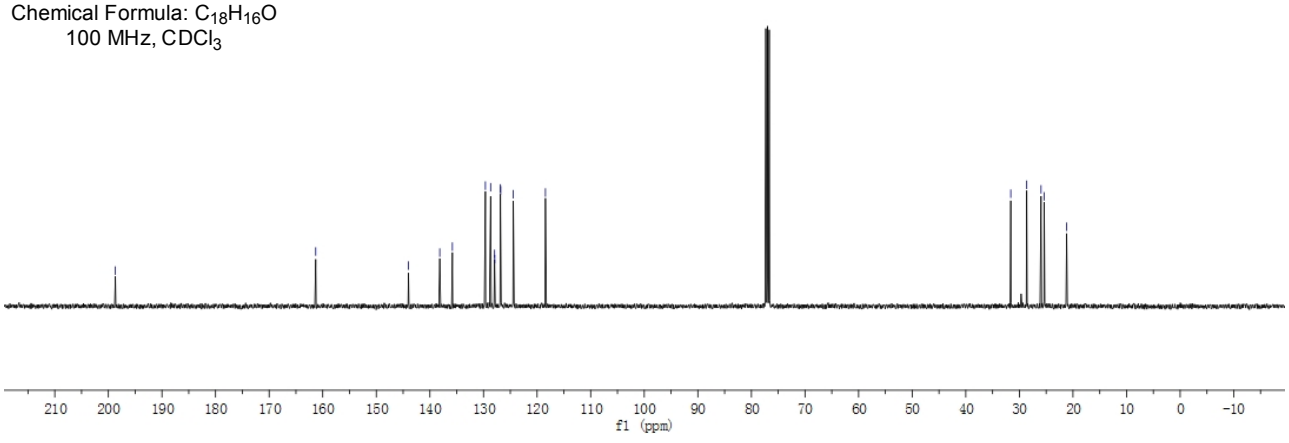


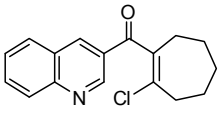
Chemical Formula: $C_{18}H_{16}O$
400 MHz, $CDCl_3$



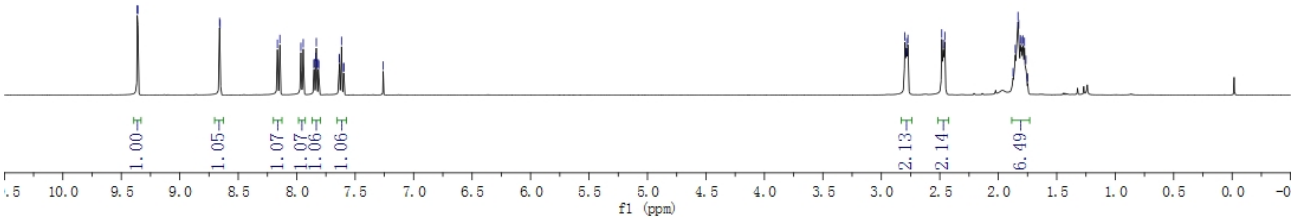


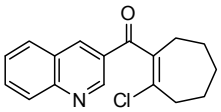
Chemical Formula: $C_{18}H_{16}O$
100 MHz, $CDCl_3$



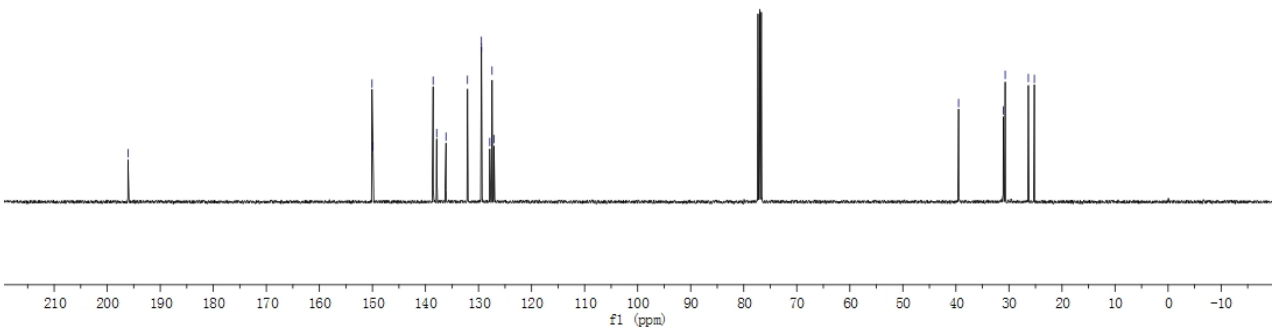


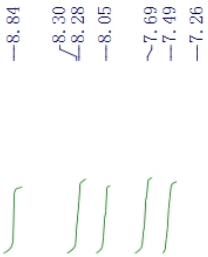
Chemical Formula: $C_{17}H_{16}ClNO$
400 MHz, $CDCl_3$

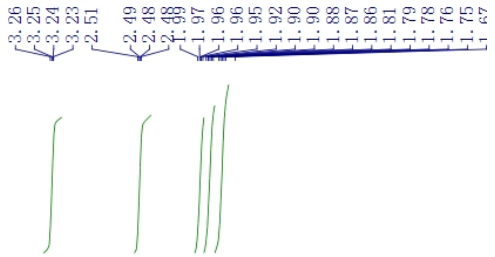


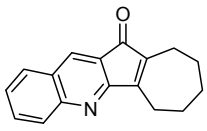


Chemical Formula: $C_{17}H_{16}ClNO$
100 MHz, $CDCl_3$

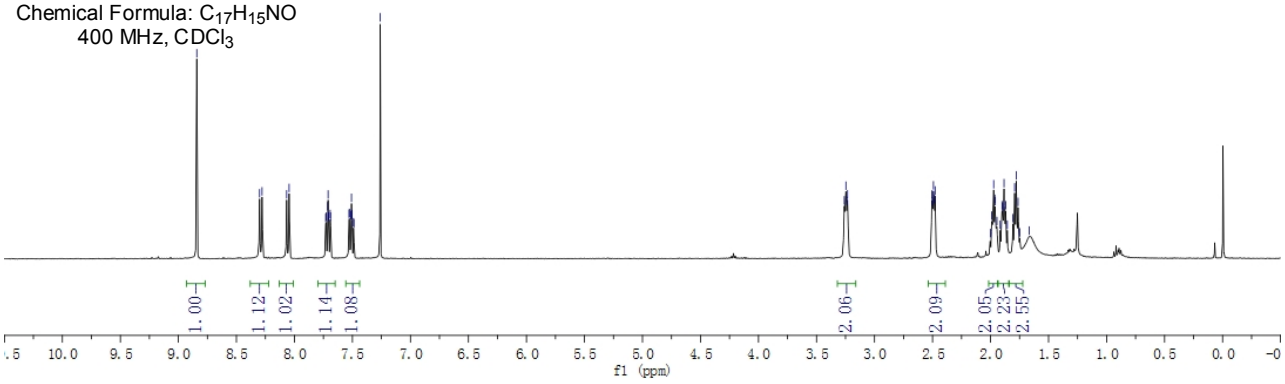


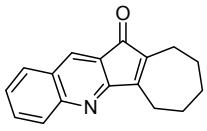




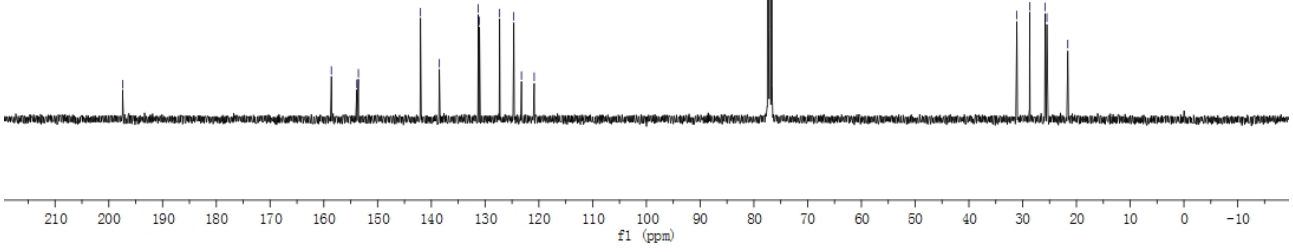


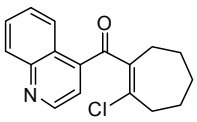
Chemical Formula: $C_{17}H_{15}NO$
400 MHz, $CDCl_3$



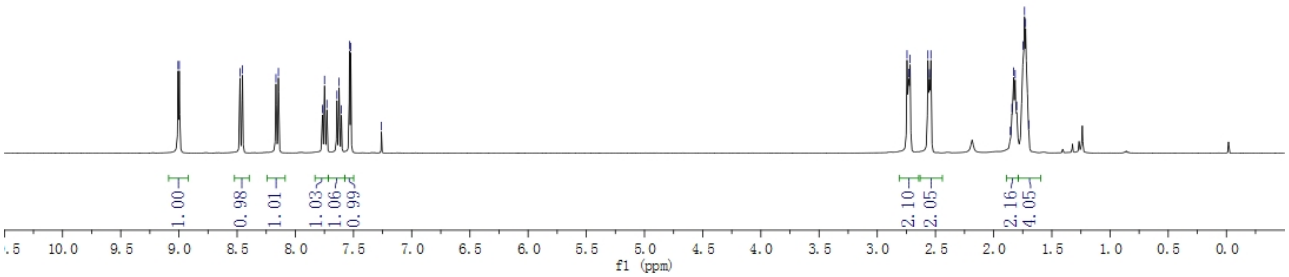


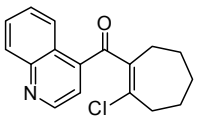
Chemical Formula: $C_{17}H_{15}NO$
100 MHz, $CDCl_3$



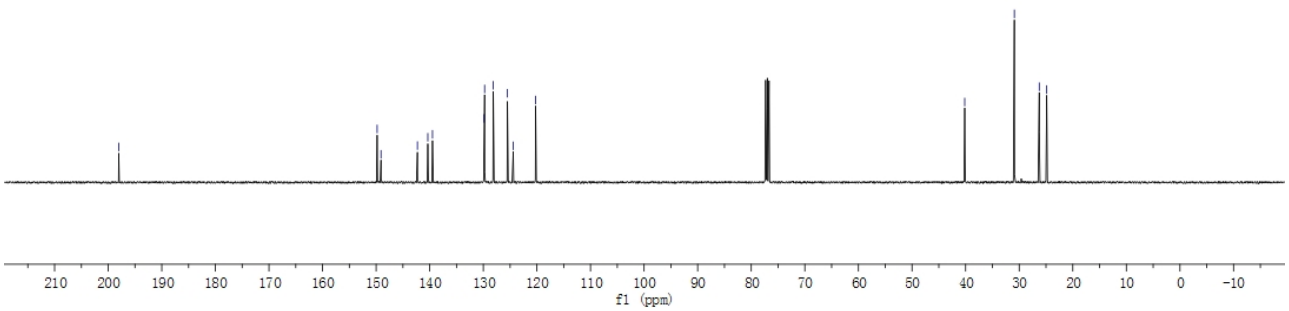


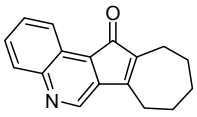
Chemical Formula: $C_{17}H_{16}ClNO$
400 MHz, $CDCl_3$



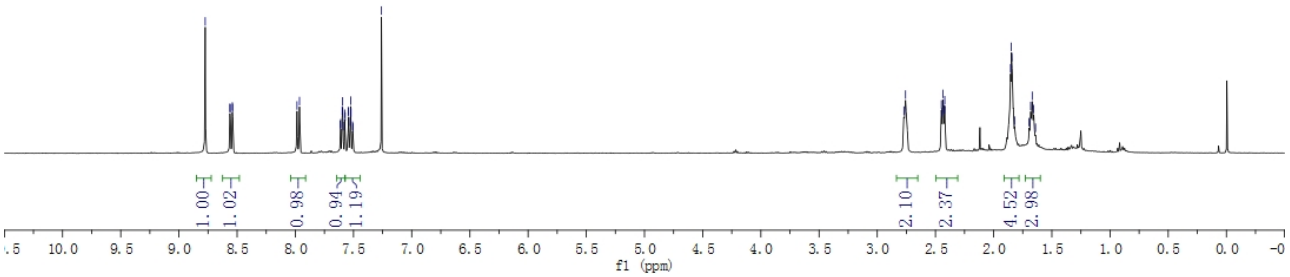


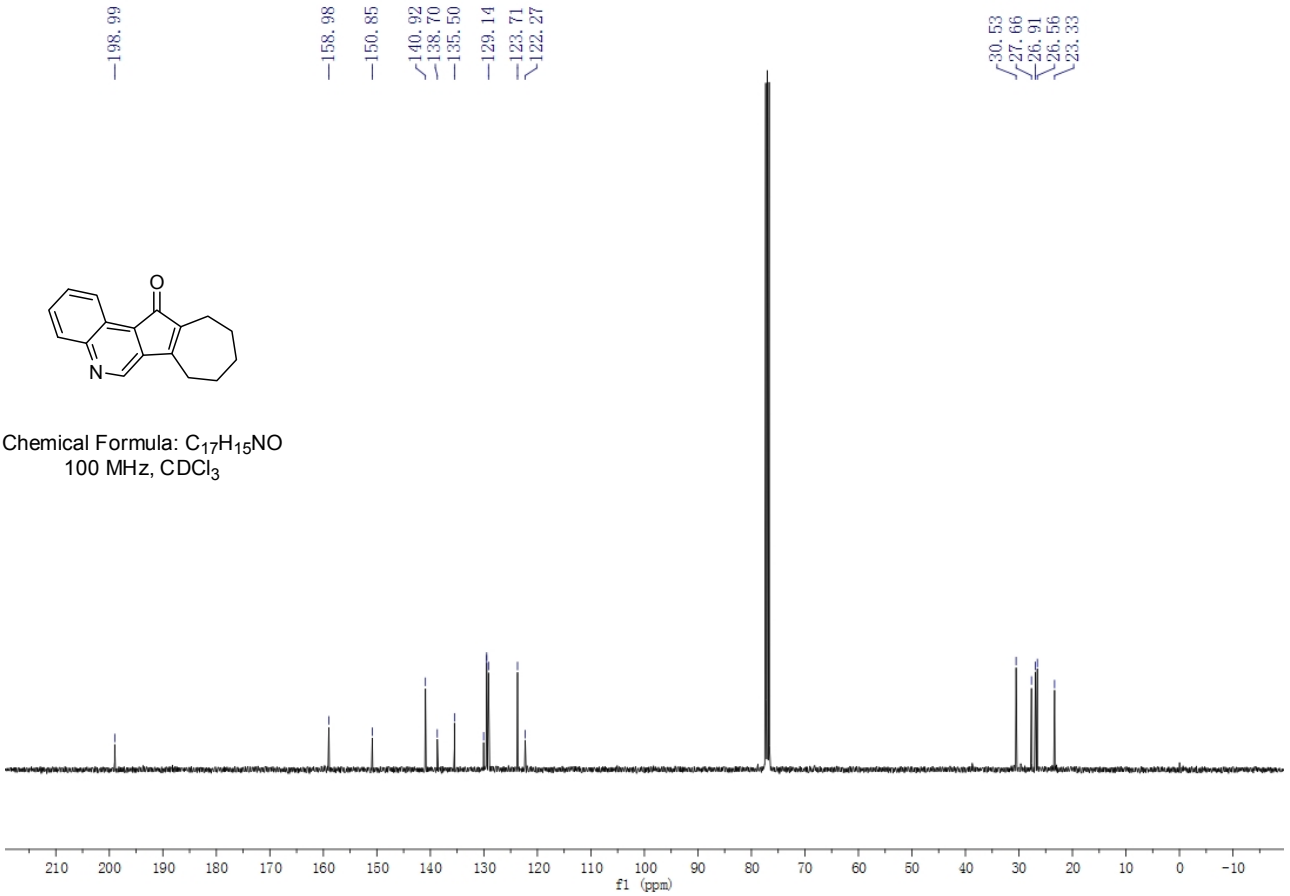
Chemical Formula: $C_{17}H_{16}ClNO$
100 MHz, $CDCl_3$



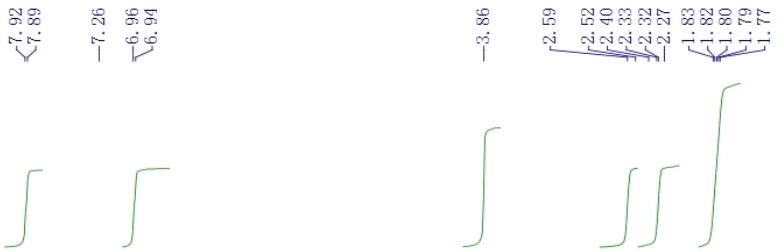


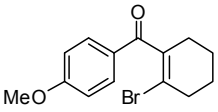
Chemical Formula: $C_{17}H_{15}NO$
400 MHz, $CDCl_3$



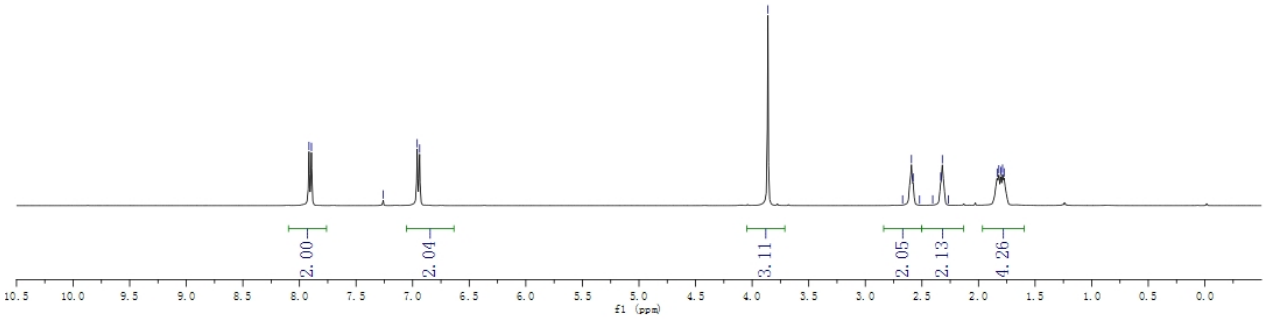


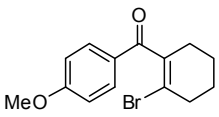
Chemical Formula: $C_{17}H_{15}NO$
100 MHz, $CDCl_3$



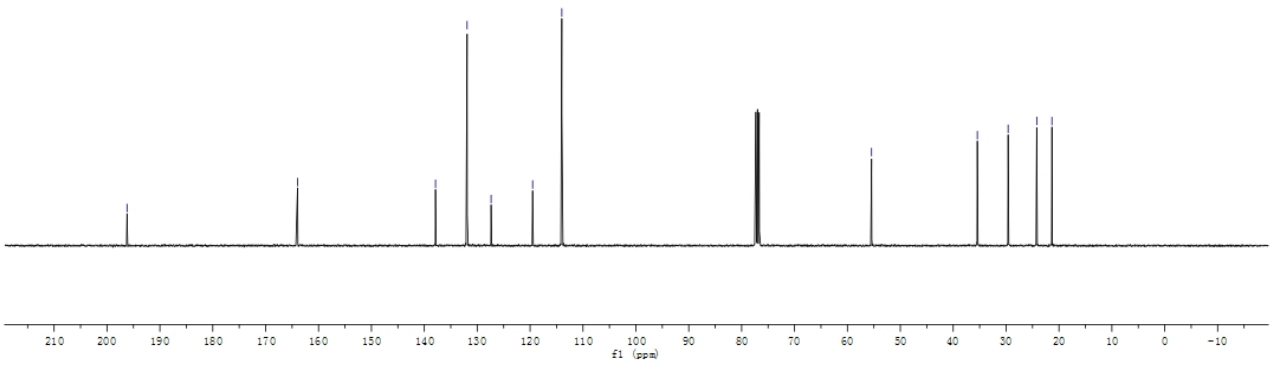


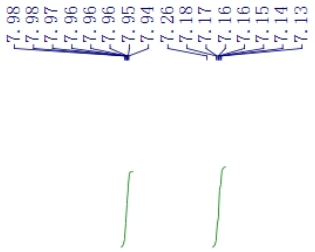
Chemical Formula: $C_{14}H_{15}BrO_2$
400 MHz, $CDCl_3$

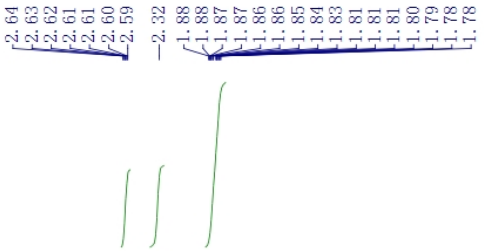


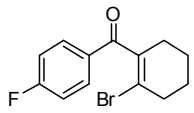


Chemical Formula: $C_{14}H_{15}BrO_2$
100 MHz, $CDCl_3$

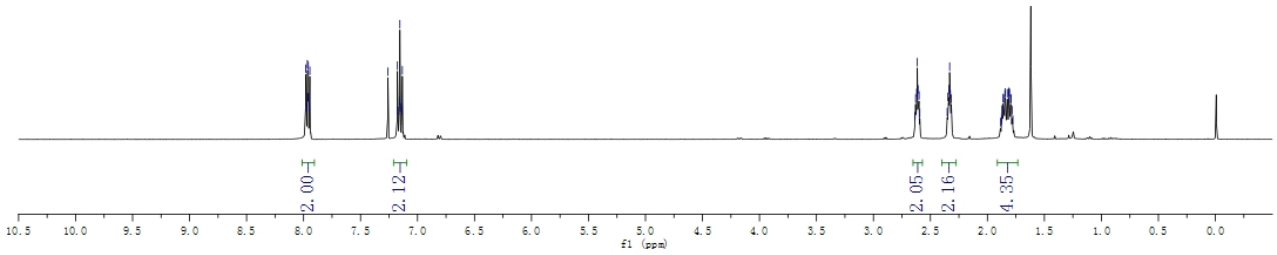


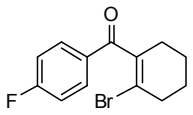




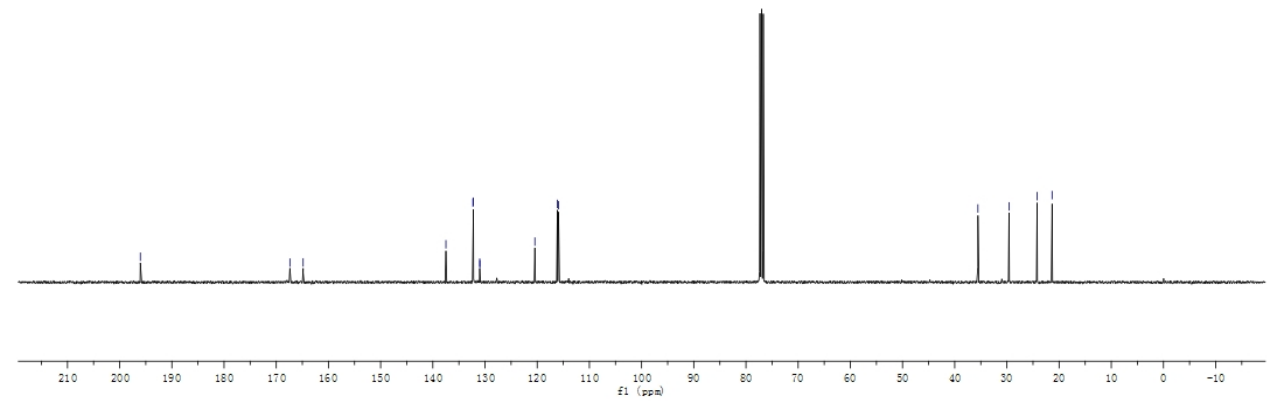


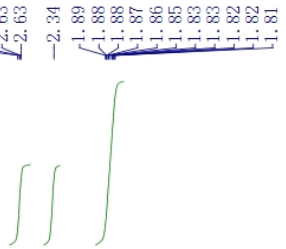
Chemical Formula: $C_{13}H_{12}BrFO$
400 MHz, $CDCl_3$

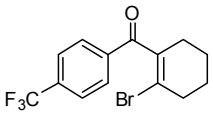




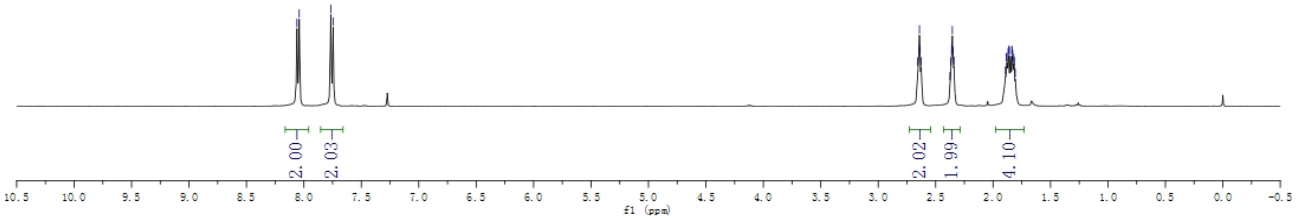
Chemical Formula: $C_{13}H_{12}BrFO$
100 MHz, $CDCl_3$

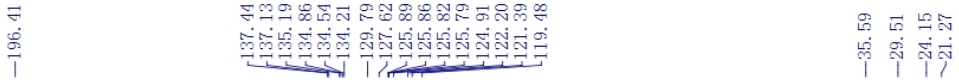


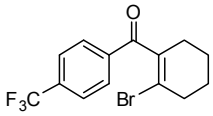




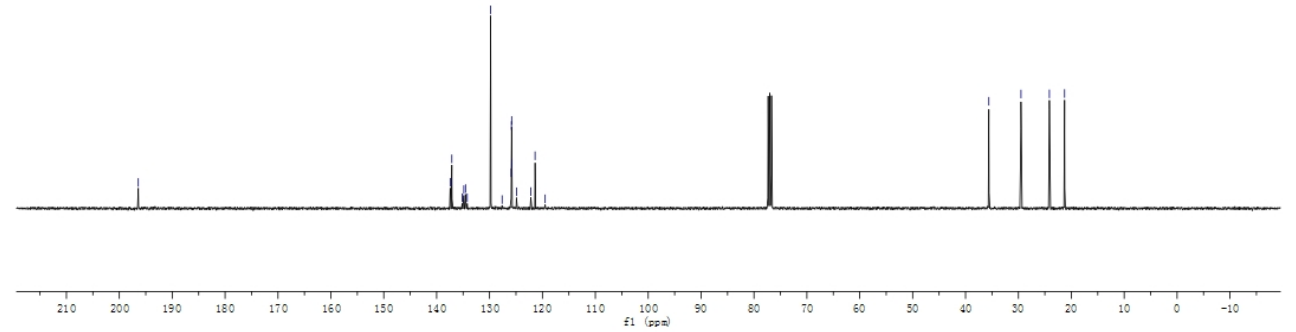
Chemical Formula: $C_{14}H_{12}BrF_3O$
400 MHz, $CDCl_3$

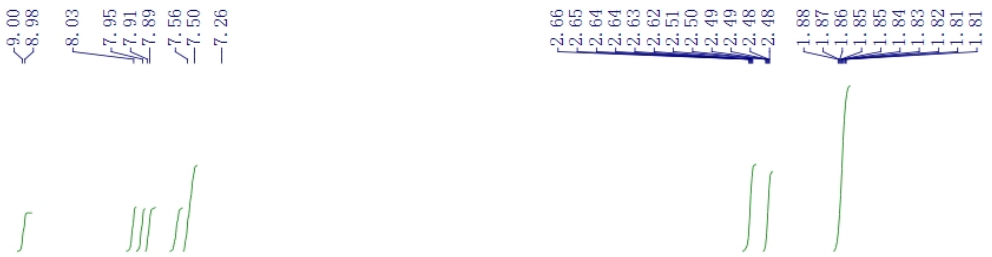


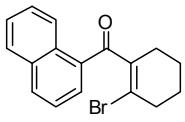




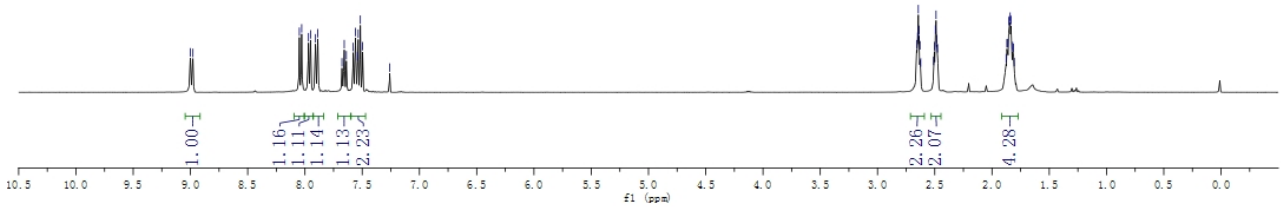
Chemical Formula: $C_{14}H_{12}BrF_3O$
100 MHz, $CDCl_3$

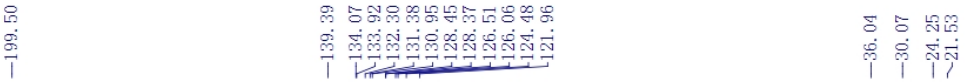


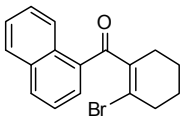




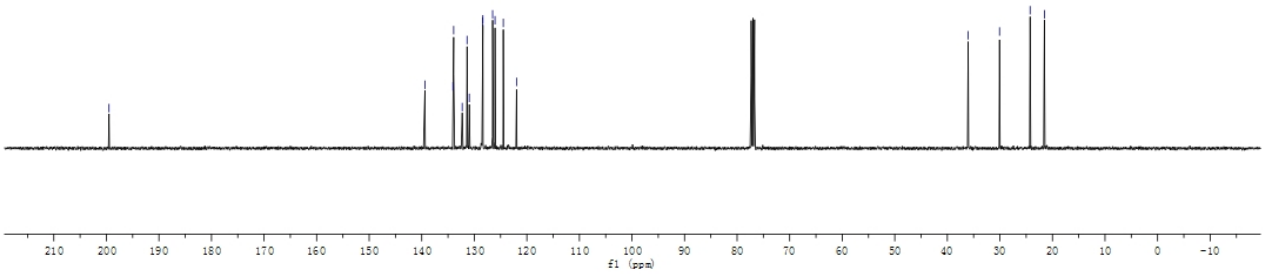
Chemical Formula: $C_{17}H_{15}BrO$
400 MHz, $CDCl_3$

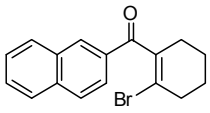




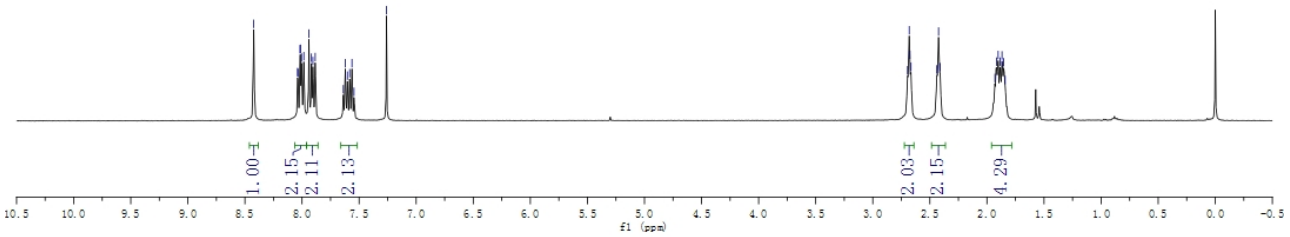


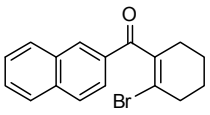
Chemical Formula: $C_{17}H_{15}BrO$
100 MHz, $CDCl_3$



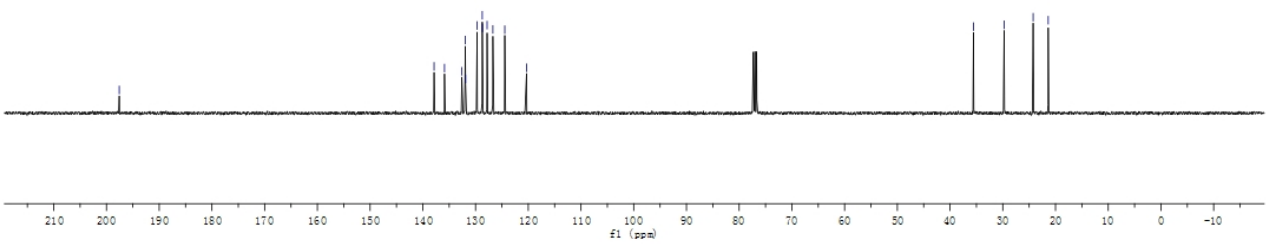


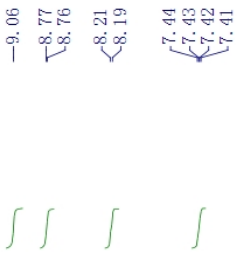
Chemical Formula: $C_{17}H_{15}BrO$
400 MHz, $CDCl_3$

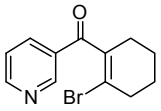




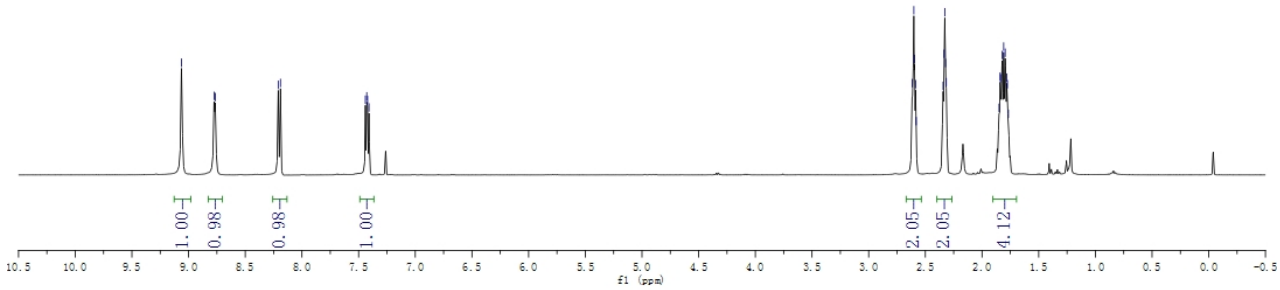
Chemical Formula: $C_{17}H_{15}BrO$
100 MHz, $CDCl_3$

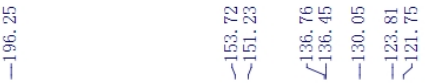


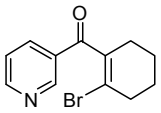




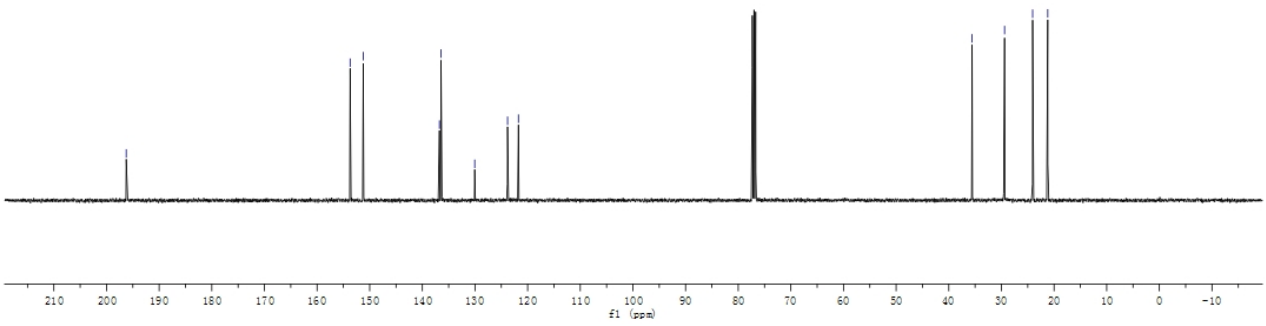
Chemical Formula: $C_{12}H_{12}BrNO$
400 MHz, $CDCl_3$

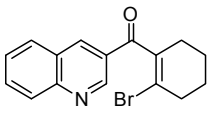




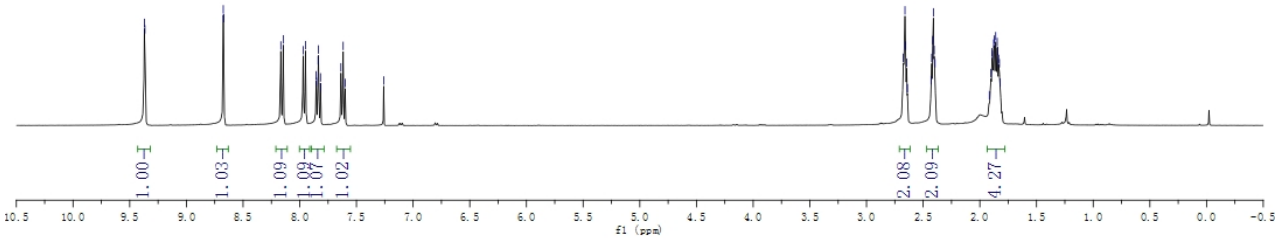


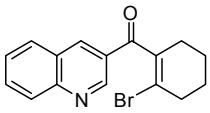
Chemical Formula: $C_{12}H_{12}BrNO$
100 MHz, $CDCl_3$



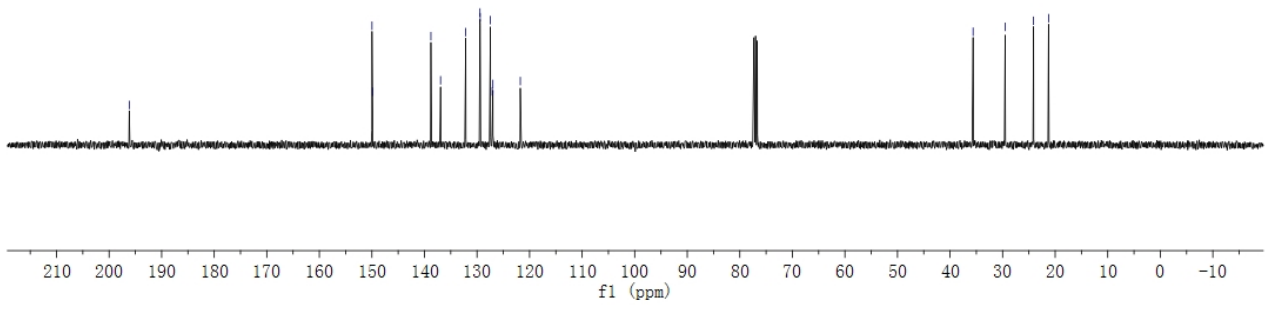


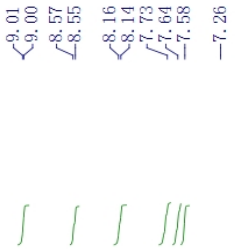
Chemical Formula: $C_{16}H_{14}BrNO$
400 MHz, $CDCl_3$

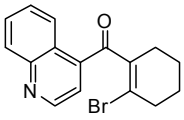




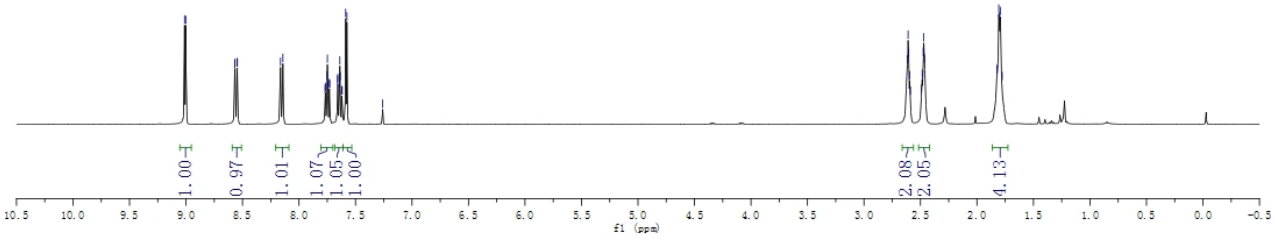
Chemical Formula: $C_{16}H_{14}BrNO$
100 MHz, $CDCl_3$

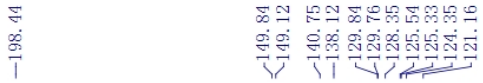


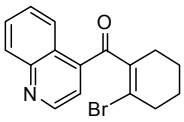




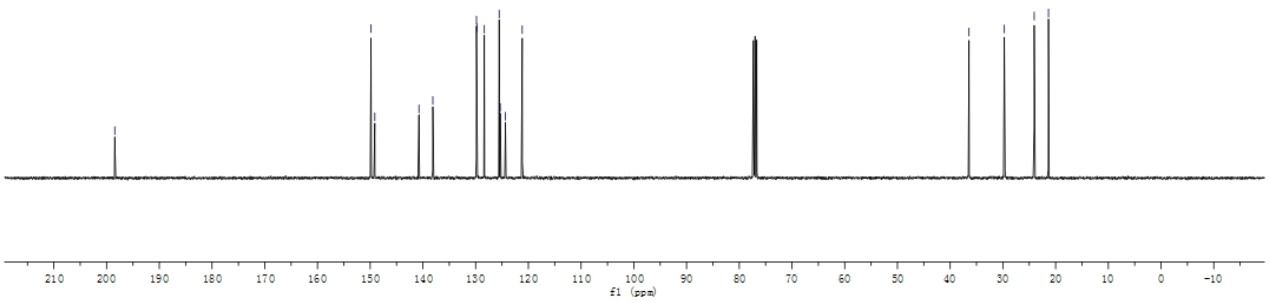
Chemical Formula: $C_{16}H_{14}BrNO$
400 MHz, $CDCl_3$

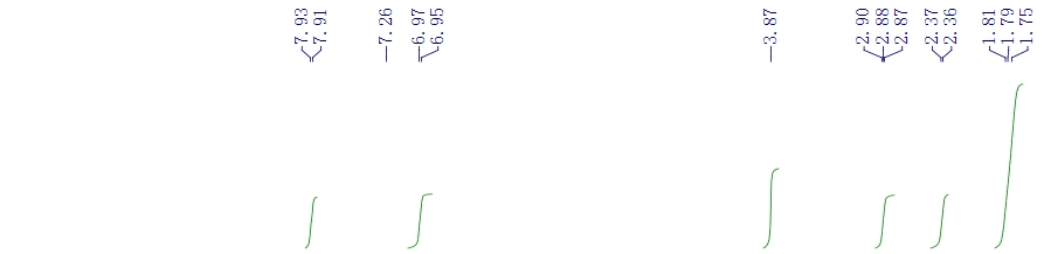


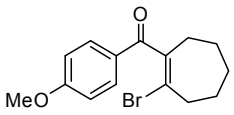




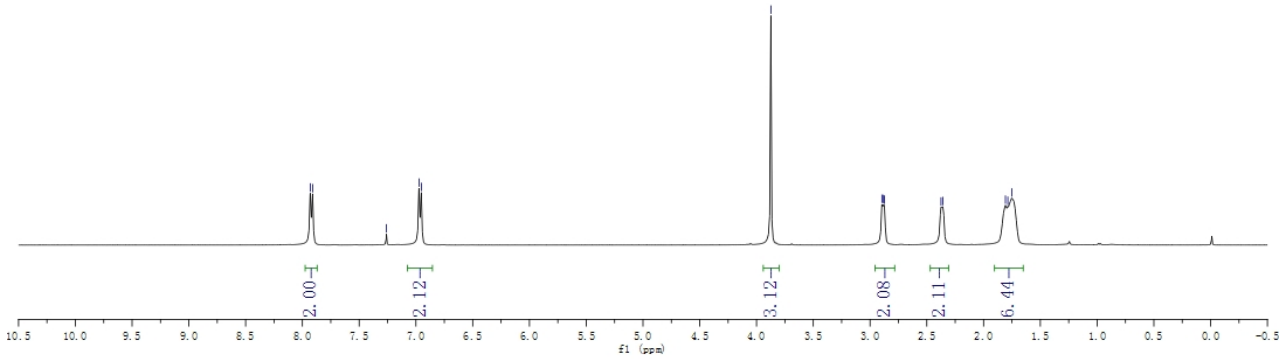
Chemical Formula: $C_{16}H_{14}BrNO$
100 MHz, $CDCl_3$

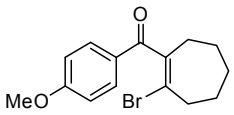




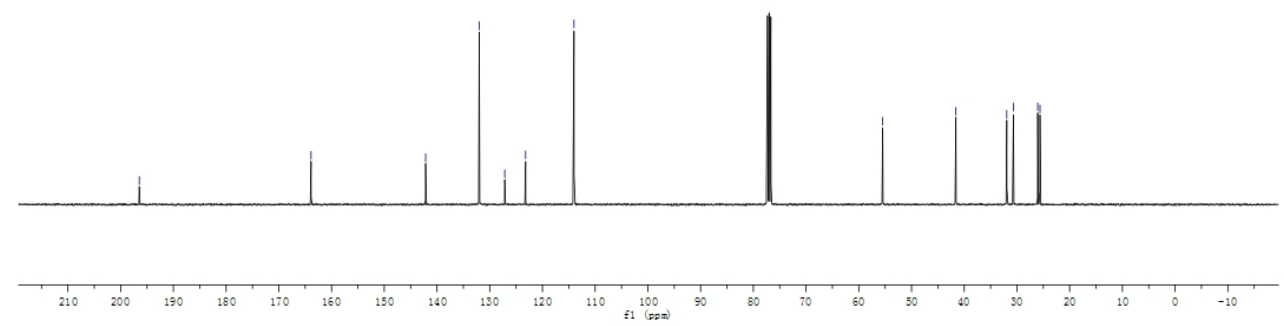


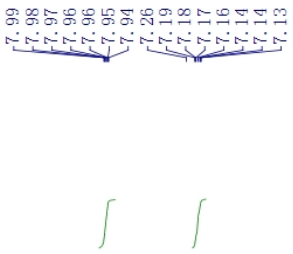
Chemical Formula: $C_{15}H_{17}BrO_2$
400 MHz, $CDCl_3$

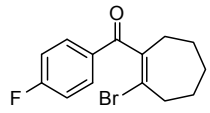




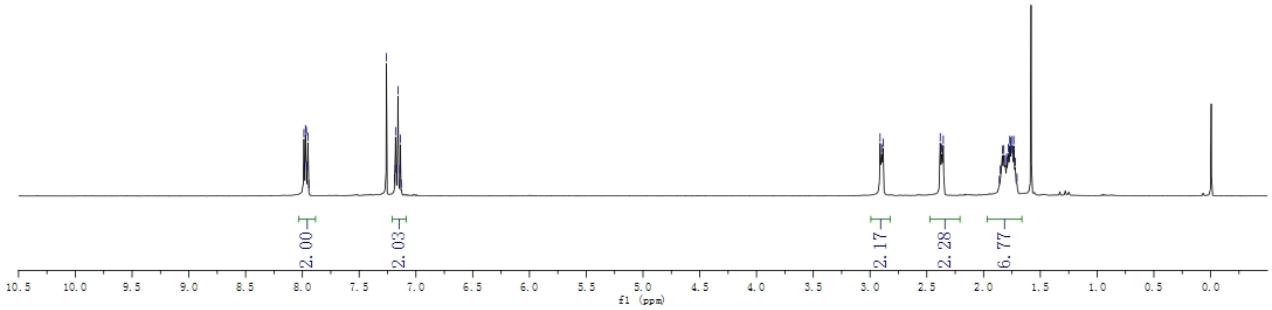
Chemical Formula: $C_{15}H_{17}BrO_2$
100 MHz, $CDCl_3$

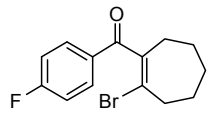




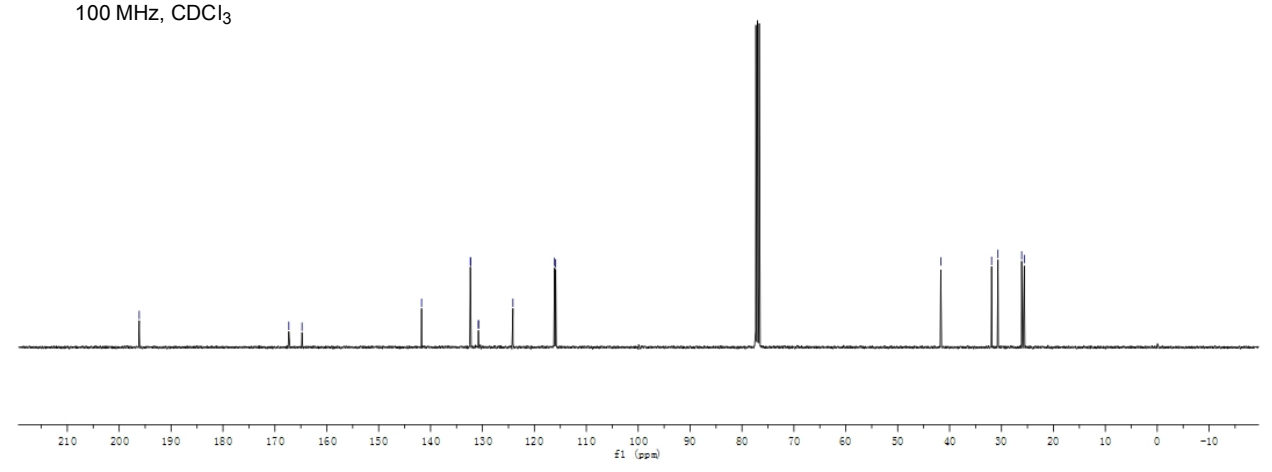


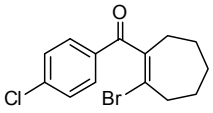
Chemical Formula: $C_{14}H_{14}BrFO$
400 MHz, $CDCl_3$



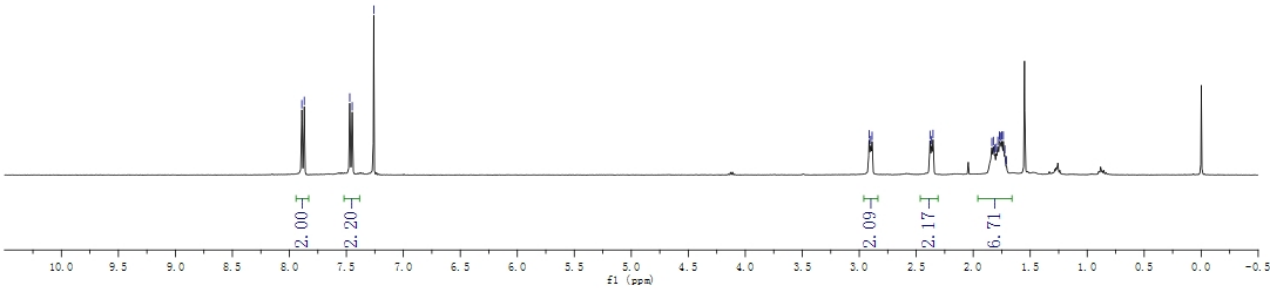


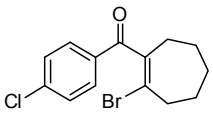
Chemical Formula: $C_{14}H_{14}BrFO$
100 MHz, $CDCl_3$



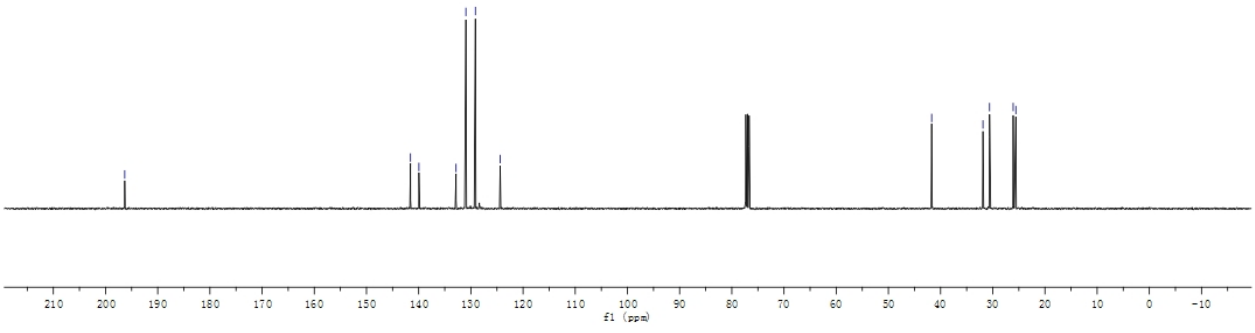


Chemical Formula: $C_{14}H_{14}BrClO$
400 MHz, $CDCl_3$

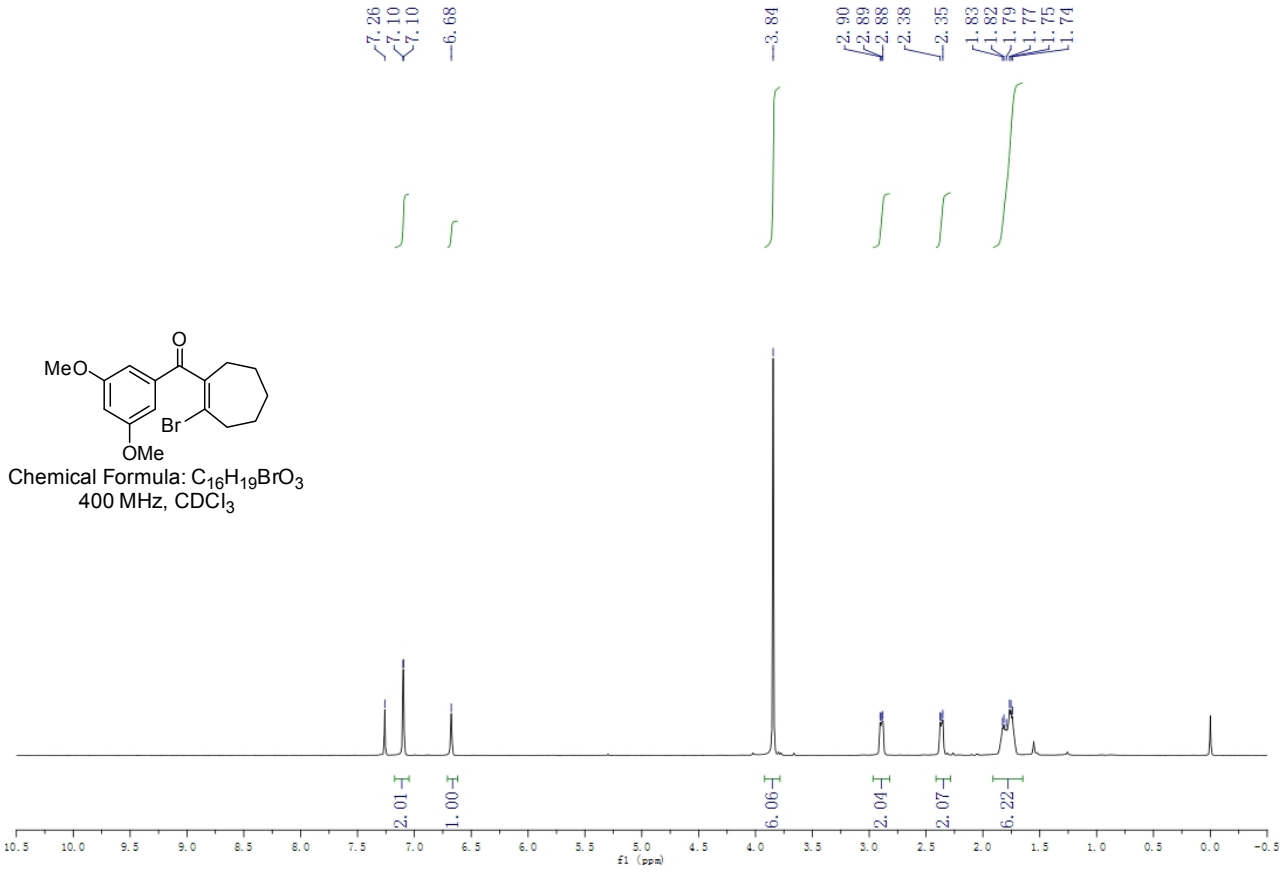




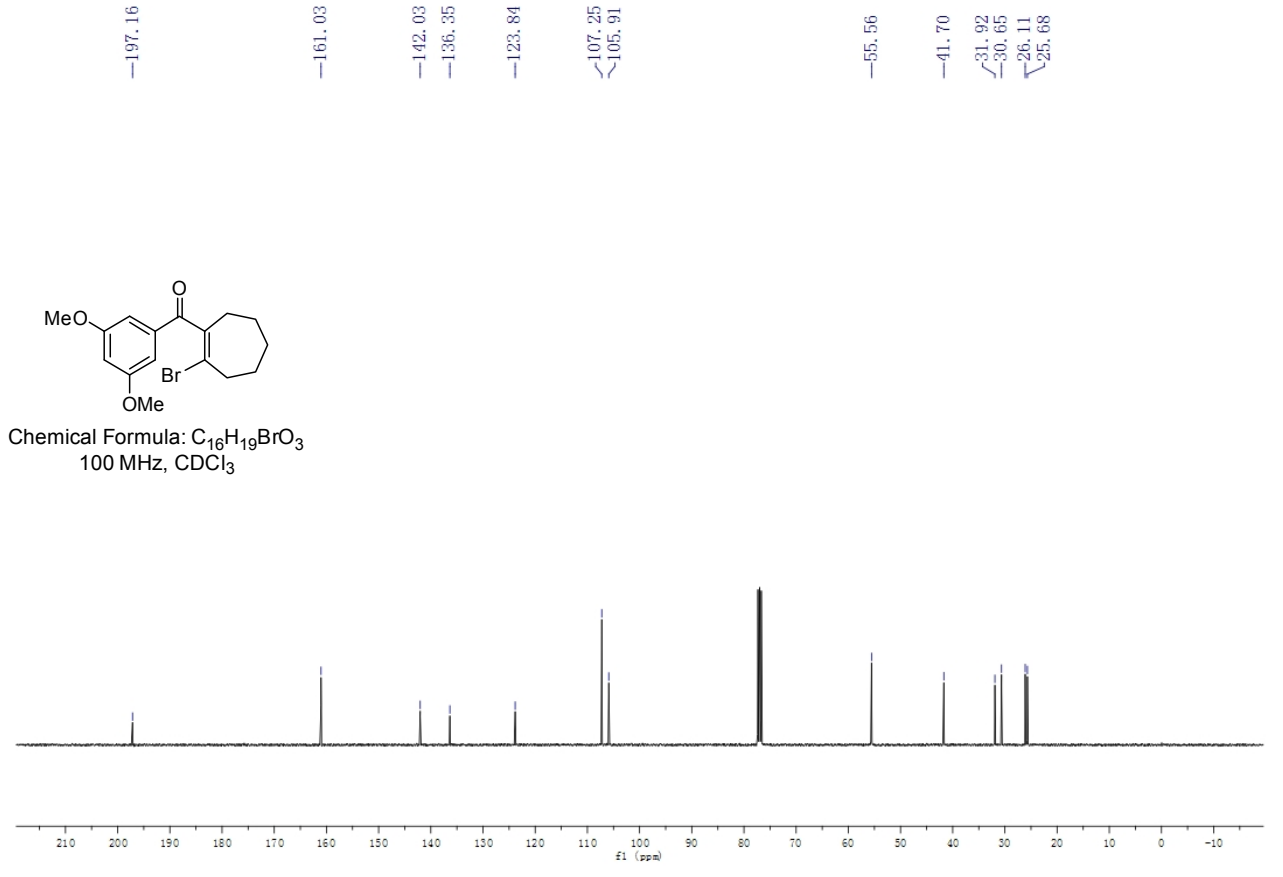
Chemical Formula: $C_{14}H_{14}BrClO$
100 MHz, $CDCl_3$

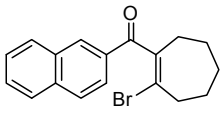


Chemical Formula: $C_{16}H_{19}BrO_3$
400 MHz, $CDCl_3$

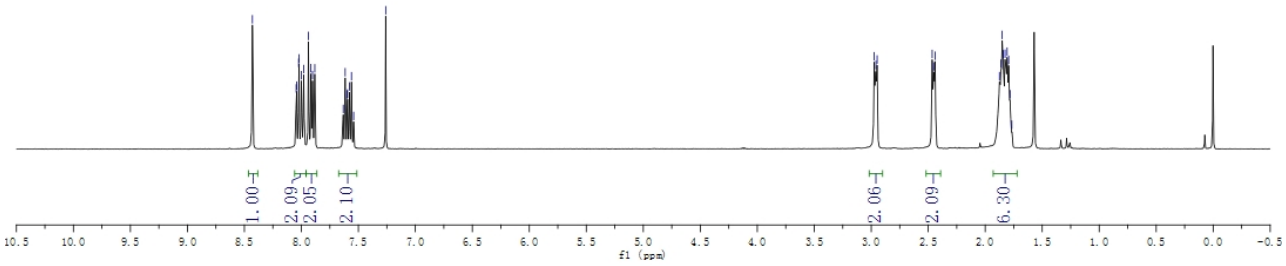


Chemical Formula: $C_{16}H_{19}BrO_3$
100 MHz, $CDCl_3$

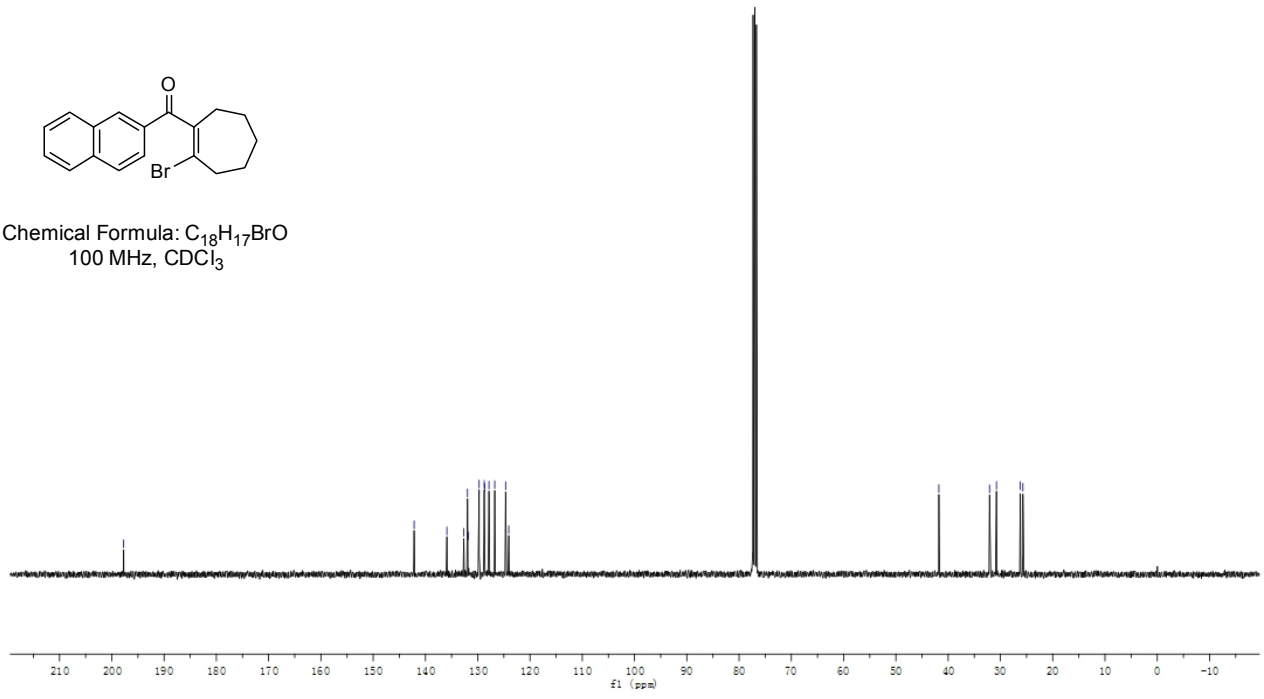


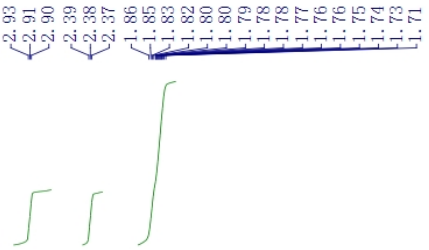


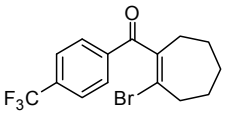
Chemical Formula: $C_{18}H_{17}BrO$
400 MHz, $CDCl_3$



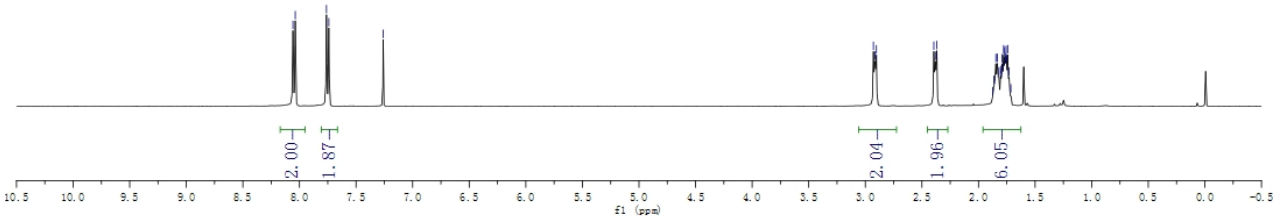
Chemical Formula: $C_{18}H_{17}BrO$
100 MHz, $CDCl_3$



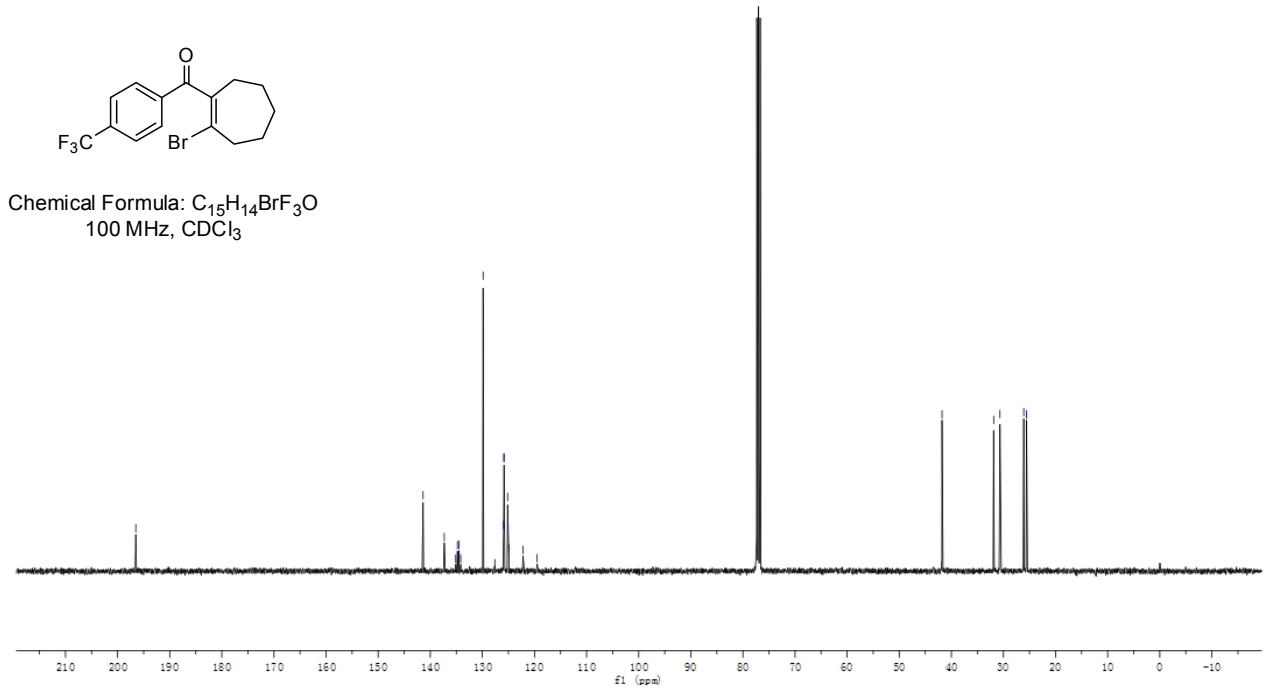




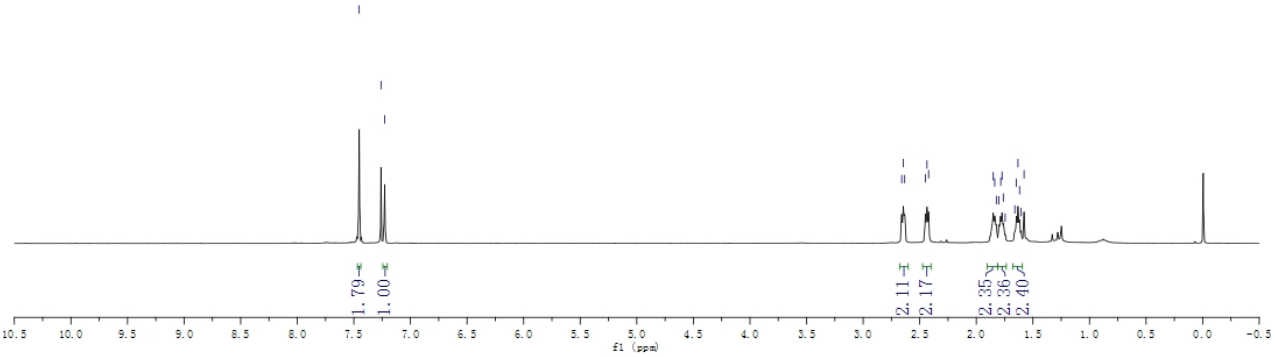
Chemical Formula: $C_{15}H_{14}BrF_3O$
400 MHz, $CDCl_3$

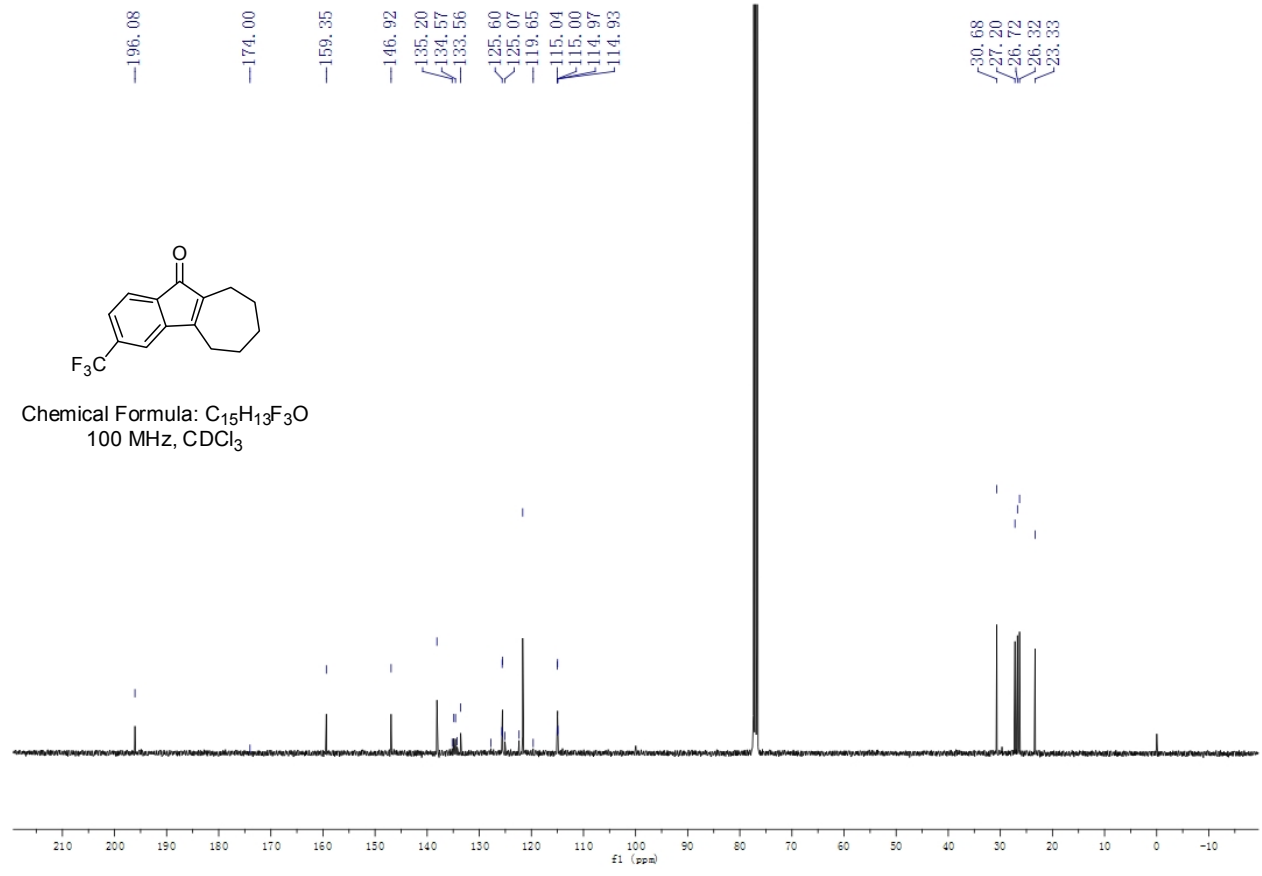


Chemical Formula: $C_{15}H_{14}BrF_3O$
100 MHz, $CDCl_3$

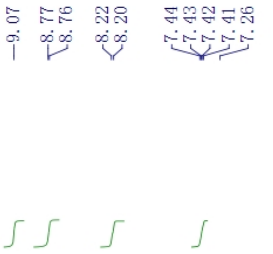


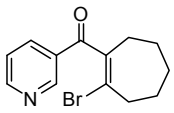
Chemical Formula: $C_{15}H_{13}F_3O$
400 MHz, $CDCl_3$



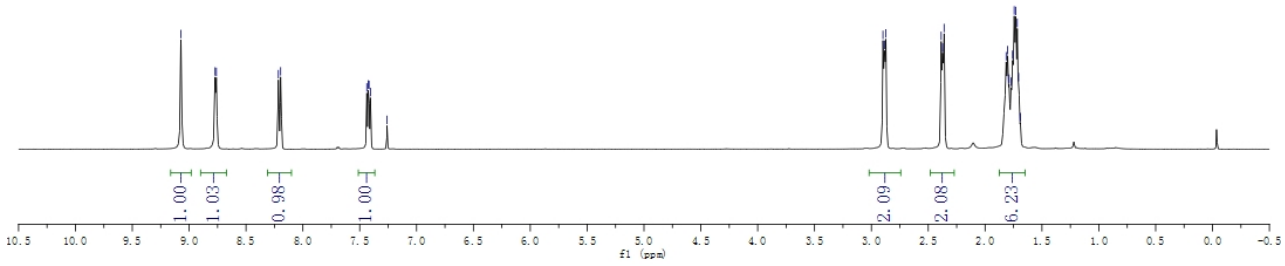


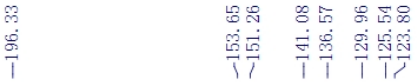
Chemical Formula: $C_{15}H_{13}F_3O$
100 MHz, $CDCl_3$

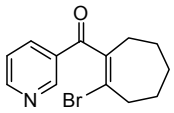




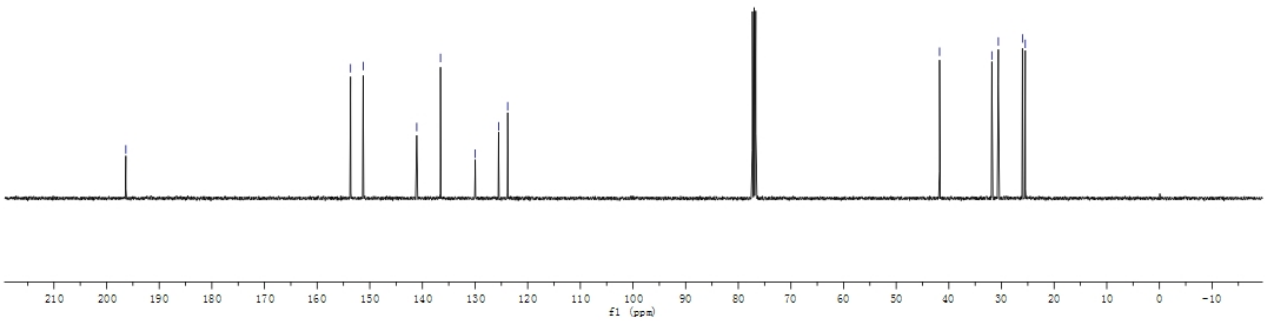
Chemical Formula: $C_{13}H_{14}BrNO$
400 MHz, $CDCl_3$

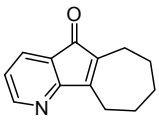




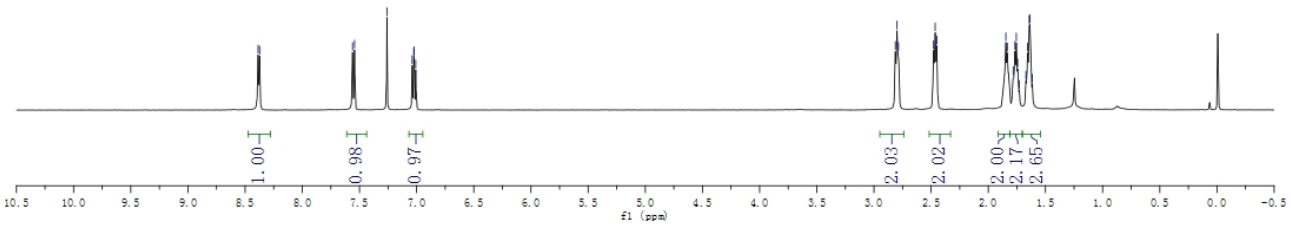


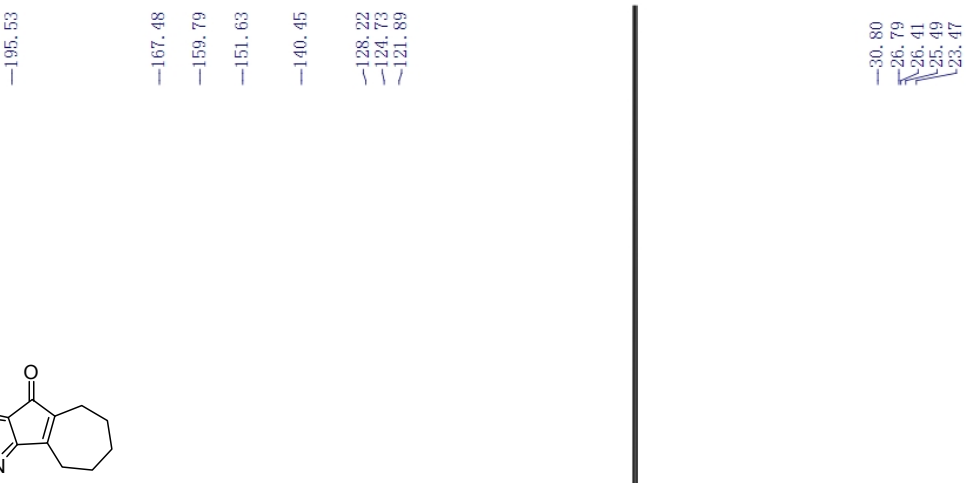
Chemical Formula: $C_{13}H_{14}BrNO$
100 MHz, $CDCl_3$

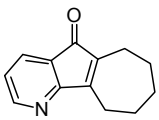




Chemical Formula: $C_{13}H_{13}NO$
400 MHz, $CDCl_3$







Chemical Formula: $C_{13}H_{13}NO$
100 MHz, $CDCl_3$