Supplementary Information

Electrochemical [3+2] Cycloaddition of Anilines and Enamine ketone: Construction of 3-benzoylindole derivatives

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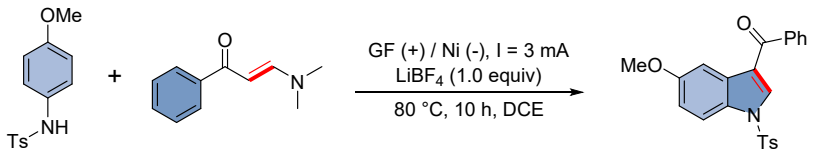
1. General Information

Compounds and solvents were purchased from commercial sources and were used as received without further purification unless stated otherwise. All products were purified by flashchromatography on silica gel (200-300 mesh). The chemical yields referred are isolated products. ^{1}H NMR spectra were recorded at 600 MHz, ^{13}C NMR spectra were recorded at 150 MHz, ^{19}F NMR spectra were recorded at 470 MHz (Bruker Avance). Chemical shifts are reported in part per million (ppm) relative to residual solvent of $CDCl_3$ (7.26 ppm for ^{1}H NMR, 77.16 ppm for ^{13}C NMR). The used abbreviations are as follows: s (singlet), d (doublet), t (triplet), dd (double of doublet), dt (doublet of triplet), m (multiplet). Multiplets which arise from accidental equality of coupling constants of magnetically non-equivalent protons are marked as virtual (*virt.*). High resolution mass spectra (HRMS) data were measured on a FT-ICR-MS SolariX 7T. Reactions were monitored by TLC analysis using silica gel 60 Å F-254 thin layer plates and compounds were visualized with a UV light at 254 nm or 365 nm. Flash column chromatography was performed on silica gel 60 Å, 10-40 μm. CV curves were recorded using a three-electrode scheme. The working electrode was a glassy carbon electrode, A platinum electrode served as counter electrode. Ag/AgCl (KCl sat'd) was used as the reference electrode. The working electrode was polished before recording each CV curve.

2. General procedure of the synthesis of the products



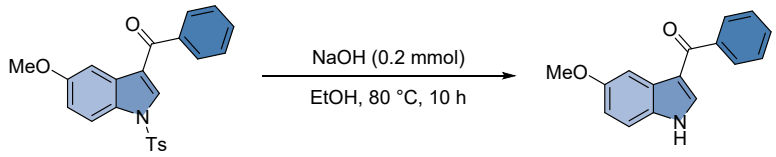
1a **2a** **3aa**

In an undivided cell constructed from non-borosilicate glass and equipped with a magnetic stirrer, a nickel plate (1.5 × 1.0 cm^2) served as the cathode, while a graphite felt (1.5 × 1.0 cm^2) acted as the anode. Substrate aniline **1a** (0.3 mmol, 1.0 equiv.), enamine **2a** (0.6 mmol, 2.0 equiv.), and the electrolyte $LiBF_4$ (0.3 mmol, 1.0 equiv.) were introduced into the solvent DCE (6 mL). The reaction proceeded under a constant current of 3 mA, with the internal temperature maintained at approximately 80 °C. Upon completion, the solvent was removed using a rotary evaporator. The remaining crude product was then purified by silica gel column chromatography

with a petroleum ether/ethyl acetate solvent system ((PE/EA = 10:1) to yield the corresponding product.

3. Further functionalization of product

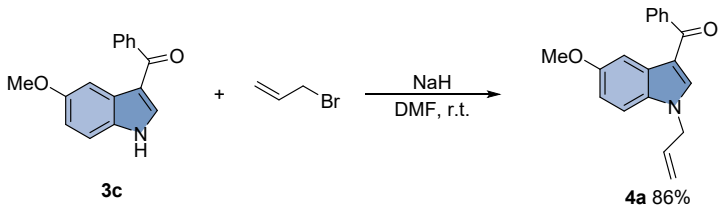
(a) The synthesis of 3c



3aa 0.1 mmol **3c** 90%

3aa (0.1 mmol, 1.0 equiv.) and sodium hydroxide (NaOH, 0.2 mmol, 2.0 equiv.) were sequentially added to a 25 mL round-bottom flask charged with 10 mL of anhydrous ethanol, and the mixture was stirred thoroughly to ensure complete dissolution. The reaction flask was then placed in a thermostatically controlled oil bath, gradually heated to 80 ℃, and maintained at this temperature under vigorous stirring for 10 hours. The reaction progress was monitored by thin-layer chromatography every 2 hours using a petroleum ether/ethyl acetate mixture (v/v = 5:1) as the eluent until the starting material spot disappeared, indicating reaction completion. After cooling to room temperature, the ethanol solvent was removed under reduced pressure via rotary evaporation to yield the crude product. Purification was carried out by silica gel column chromatography with a gradient elution system of petroleum ether/ethyl acetate (v/v from 10:1 to 7:1), and the target fractions were collected and concentrated under reduced pressure to afford the final pure product.

(b)The synthesis of 4a

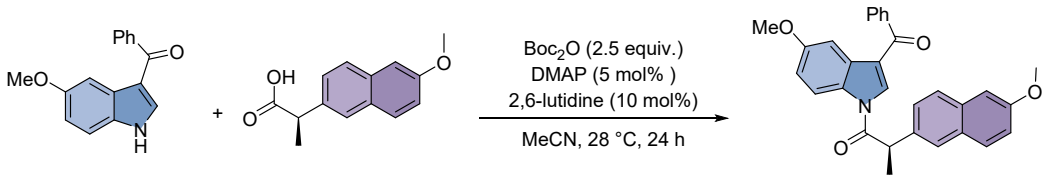


3c **4a** 86%

(5-Methoxy-*1H*-indol-3-yl)(phenyl)methanone (**3c**, 0.1 mmol, 1.0 equiv.) was added to a dry 50 mL round-bottom flask charged with 10 mL of anhydrous N,N-dimethylformamide (DMF), followed by the slow addition of sodium hydride (NaH, 0.15 mmol, 1.5 equiv.). The mixture was

stirred at room temperature for 30 minutes. Allyl bromide (0.2 mmol, 2.0 equiv.) was then slowly added dropwise to the reaction mixture, and stirring was continued at room temperature. The reaction progress was monitored every hour by thin-layer chromatography using a petroleum ether/ethyl acetate mixture (v/v = 5:1) as the eluent until the starting material spot disappeared, indicating completion. After quenching the reaction with 10 mL of water, the mixture was extracted three times with ethyl acetate (20 mL each). The combined organic layers were washed with 20 mL of saturated brine, dried over anhydrous sodium sulfate, and filtered. The solvent was removed under reduced pressure via rotary evaporation to yield the crude product. Purification was performed by silica gel column chromatography using a gradient elution system of petroleum ether/ethyl acetate (v/v from 10:1 to 7:1). The target fractions were collected and concentrated under reduced pressure to afford the final pure product.

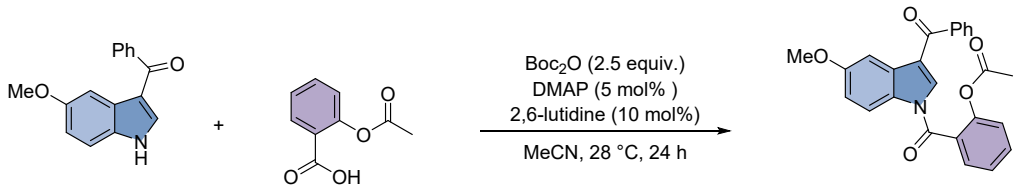
(c)The synthesis of 4b



3c **Napthal** **4b** 74%

Intermediate (5-methoxy-*1H*-indol-3-yl)(phenyl)methanone **(3c**, 0.2 mmol, 1.0 equiv.), naproxen (0.4 mmol, 2.0 equiv.), di-tert-butyl dicarbonate (Boc_2O, 0.2 mmol, 1.0 equiv.), 4-dimethylaminopyridine (DMAP, 5 mol%), and 2,6-lutidine (10 mol%) were sequentially added to a dry 50 mL round-bottom flask charged with 10 mL of acetonitrile. The reaction mixture was stirred at 28 ℃ for 24 hours, with aliquots withdrawn every 4 hours to monitor progress by thin-layer chromatography using a petroleum ether/ethyl acetate mixture (v/v = 3:1) as the eluent until the starting material spot disappeared, confirming completion. The acetonitrile was subsequently removed under reduced pressure to afford the crude product, which was purified via silica gel column chromatography using a gradient elution system of ethyl acetate/petroleum ether (v/v = 6:1). The target compound 4b was collected and concentrated under reduced pressure to yield the final product.

(d)The synthesis of 4c



3c **Aspirin** **4c** 69%

Intermediate (5-methoxy-*1H*-indol-3-yl)(phenyl)methanone (**3c**, 0.2 mmol, 1.0 equiv.), aspirin (0.4 mmol, 2.0 equiv.), di-tert-butyl dicarbonate (Boc_2O, 0.2 mmol, 1.0 equiv.), 4-dimethylaminopyridine (DMAP, 5 mol%), and 2,6-lutidine (10 mol%) were sequentially added to a dry 50 mL round-bottom flask charged with 10 mL of acetonitrile. The reaction mixture was stirred at 28 ℃ for 24 hours, with aliquots withdrawn every 4 hours to monitor progress by thin-layer chromatography using a petroleum ether/ethyl acetate mixture (v/v = 4:1) as the eluent until the starting material spot disappeared, confirming completion. The acetonitrile was subsequently removed under reduced pressure to afford the crude product, which was purified via silica gel column chromatography using a gradient elution system of ethyl acetate/petroleum ether (v/v = 6:1). The target compound 4c was collected and concentrated under reduced pressure to yield the final product.

4. Cyclic voltammetry studies.

The cyclic voltammograms were recorded in an electrolyte of $LiBF_4$ (0.1 M) in DCE (10.0 mL) using a glassy carbon disk working electrode (diameter, 3 mm), a Ni wire auxiliary electrode and an Ag/AgCl reference electrode. The scan rate is 100 mV/s.

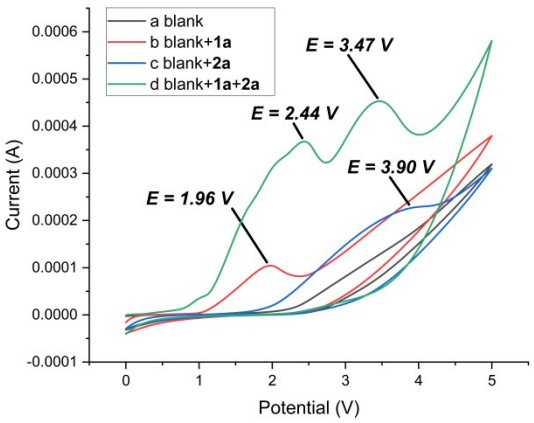
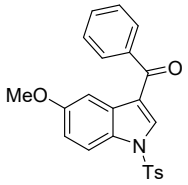


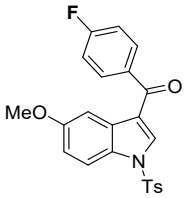
Figure S1. Cyclic voltammograms.

5. Spectra data of products



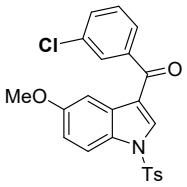
(5-methoxy-1-tosyl-*1H*-indol-3-yl)(phenyl)methanone(3aa)

Yellow solid, 80% yield. 97 mg **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 7.98 (s, 1H), 7.92 – 7.86 (m, 3H), 7.80 (s, 1H), 7.74 (d, *J* = 8.1 Hz, 2H), 7.62 (m, 1H), 7.56 (t, *J* = 7.5 Hz, 2H), 7.26 (d, *J* = 8.1 Hz, 2H), 7.02 (m, 1H), 3.84 (s, 3H), 2.34 (s, 3H). **^{13}C NMR** (150 MHz, Chloroform-*d*) δ 191.2, 157.8, 146.0, 139.3, 134.6, 134.2, 132.5, 130.3, 129.7, 129.6, 129.1, 128.8, 127.2, 120.3, 115.9, 114.2, 104.5, 55.8, 21.8. **HRMS (ESI)** calculated for $C_{23}H_{20}NO_4S^+$ $[M+H]^+$: 406.1113; found: 406.1112.



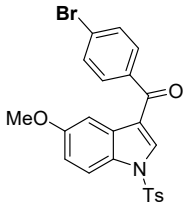
(4-fluorophenyl)(5-methoxy-1-tosyl-*1H*-indol-3-yl)methanone(3ab)

Yellow solid, 76 % yield. 96 mg **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 7.95 (s, 1H), 7.92 – 7.87 (m, 3H), 7.79 – 7.75 (m, 3H), 7.26 (d, *J* = 7.5 Hz, 2H), 7.22 (t, *J* = 8.7 Hz, 2H), 7.02 (dd, *J* = 9.0, 2.7 Hz, 1H), 3.85 (s, 3H), 2.36 (s, 3H). **^{13}C NMR** (150 MHz, Chloroform-*d*) δ 189.5, 166.2, 164.5(s, J = 252.5 Hz), 157.7, 145.9, 134.4, 133.7, 131.5 (d, J = 8.9 Hz), 130.2, 129.6 (d, J = 17.6 Hz), 129.5, 127.1, 120.0, 115.9 (d, J = 5.3 Hz), 115.8, 114.1, 104.3, 55.7, 21.6. **^{19}F NMR** (470 MHz, $CDCl_3$) δ- 106.14. **HRMS (ESI)** calculated for $C_{23}H_{19}FNO_4S^+$ $[M+H]^+$: 424.1019; found: 424.1021.



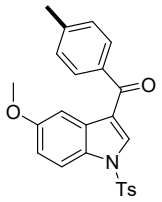
(3-chlorophenyl)(5-methoxy-1-tosyl-*1H*-indol-3-yl)methanone(3ac)

Yellow solid, 70 % yield. 92 mg **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 7.88 (s, 1H), 7.80 (d, *J* = 9.3 Hz, 1H), 7.72 – 7.69 (m, 4H), 7.64 (dt, *J* = 7.5, 1.3 Hz, 1H), 7.54 – 7.51 (m, 1H), 7.41 (t, *J* = 7.5 Hz, 1H), 7.19 (s, 2H), 6.95 (dd, *J* = 9.0, 2.7 Hz, 1H), 3.79 (s, 3H), 2.29 (s, 3H).**^{13}C NMR** (150 MHz, Chloroform-*d*) δ 189.5, 157.8, 146.0, 140.8, 134.9, 134.4, 134.2, 132.3, 130.3, 130.0, 129.6, 129.4, 128.9, 127.8, 127.1, 119.9, 116.0, 114.1, 104.3, 55.8, 21.7. **HRMS (ESI)** calculated for $C_{23}H_{19}ClNO_4S^+$ $[M+H]^+$: 440.0123; found: 440.0120.



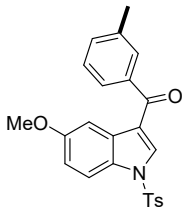
(4-bromophenyl)(5-methoxy-1-tosyl-*1H*-indol-3-yl)methanone(3ad)

Yellow solid, 74 % yield. 107 mg **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 7.93 (s, 1H), 7.86 (d, *J* = 9.3 Hz, 1H), 7.77 (dd, *J* = 5.4, 3.0 Hz, 3H), 7.72 (d, *J* = 8.1 Hz, 2H), 7.68 (d, *J* = 8.1 Hz, 2H), 7.25 (d, *J* = 7.8 Hz, 2H), 7.02 (d, *J* = 8.7 Hz, 1H), 3.85 (s, 3H), 2.36 (s, 3H).**^{13}C NMR** (150 MHz, Chloroform-*d*) δ 189.8, 157.7, 146.0, 137.9, 134.40, 133.9, 132.0, 130.5, 130.3, 129.6, 129.5, 129.4, 127.1, 119.9, 116.0, 114.1, 104.3, 55.8, 21.7. **HRMS (ESI)** calculated for $C_{23}H_{19}BrNO_4S^+$ $[M+H]^+$: 484.0281; found: 484.0282.



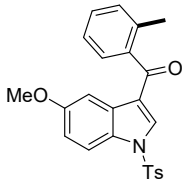
(5-methoxy-1-tosyl-*1H*-indol-3-yl)(p-tolyl)methanone(3ae)

Yellow solid, 65 % yield. 82 mg **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 7.97 (s, 1H), 7.86 (d, *J* = 9.3 Hz, 1H), 7.77 (dd, *J* = 15.0, 6.6 Hz, 5H), 7.34 (d, *J* = 7.8 Hz, 2H), 7.28 – 7.22 (m, 2H), 7.01 (dd, *J* = 9.0, 2.4 Hz, 1H), 3.85 (s, 3H), 2.47 (s, 3H), 2.35 (s, 3H).**^{13}C NMR** (150 MHz, Chloroform-*d*) δ 190.8, 157.6, 145.9, 143.2, 136.5, 134.5, 133.8, 130.2, 129.8, 129.5, 129.4, 129.2, 127.1, 120.3, 115.8, 114.1, 104.3, 55.7, 21.7, 21.6. **HRMS (ESI)** calculated for $C_{24}H_{22}NO_4S^+$ $[M+H]^+$: 420.1269; found: 420.1266.



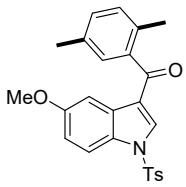
(5-methoxy-1-tosyl-*1H*-indol-3-yl)(m-tolyl)methanone(3af)

Yellow solid, 60 % yield. 75 mg **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 7.97 (d, *J* = 0.9 Hz, 1H), 7.87 (d, *J* = 9.3 Hz, 1H), 7.80 (d, *J* = 2.7 Hz, 1H), 7.77 (d, *J* = 8.1 Hz, 2H), 7.64 (d, *J* = 13.2 Hz, 3H), 7.42 (d, *J* = 7.5 Hz, 2H), 7.24 (s, 1H), 7.01 (dd, *J* = 9.0, 2.4 Hz, 1H), 3.85 (s, 3H), 2.46 (s, 3H), 2.35 (s, 3H).**^{13}C NMR** (150 MHz, Chloroform-*d*) δ 191.3, 157.6, 145.9, 139.3, 138.6, 134.5, 134.1, 133.2, 130.2, 129.7, 129.5, 129.5, 128.5, 127.1, 126.3, 120.4, 115.8, 114.1, 104.4, 55.7, 21.6, 21.5. **HRMS (ESI)** calculated for $C_{24}H_{22}NO_4S^+$ $[M+H]^+$: 420.1269; found: 420.1272.



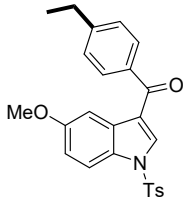
(5-methoxy-1-tosyl-*1H*-indol-3-yl)(o-tolyl)methanone(3ag)

Yellow solid, 55 % yield. 69 mg **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 7.84 (d, *J* = 9.3 Hz, 2H), 7.77 – 7.75 (m, 3H), 7.42 (d, *J* = 7.5 Hz, 2H), 7.35 – 7.27 (m, 3H), 7.25 (s, 1H), 7.01 (dd, *J* = 9.0, 2.7 Hz, 1H), 3.86 (s, 3H), 2.39 (s, 3H), 2.36 (s, 3H).**^{13}C NMR** (150 MHz, Chloroform-*d*) δ 193.5,157.8,146,139.5,136.6,135.2,134.6,131.4,130.5,130.3,129.7,129.2,128.2,127.2,125.6,121.7, 116,114.2,104.5,55.9,21.8,19.9. **HRMS (ESI)** calculated for $C_{24}H_{22}NO_4S^+$ $[M+H]^+$: 420.1269; found: 420.1266.



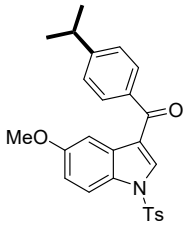
(2,5-dimethylphenyl)(5-methoxy-1-tosyl-*1H*-indol-3-yl) methanone(3ah)

Yellow solid, 62 % yield. 80 mg **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 7.86 – 7.82 (m, 2H), 7.77 – 7.75 (m, 3H), 7.26 (d, *J* = 7.8 Hz, 2H), 7.23 (d, *J* = 7.8 Hz, 1H), 7.20 (d, *J* = 8.1 Hz, 2H), 7.01 (dd, *J* = 9.0, 2.7 Hz, 1H), 3.86 (s, 3H), 2.38 (s, 3H), 2.36 (s, 3H), 2.33 (s, 3H).**^{13}C NMR** (150 MHz, Chloroform-*d*) δ 193.7, 157.7, 145.9, 139.4, 135.1, 134.9, 134.5, 133.2, 131.1, 131.1, 130.2, 129.7, 129.1, 128.7, 127.1, 121.7, 115.8, 114.1, 104.4, 55.8, 21.7, 21.0, 19.3. **HRMS (ESI)** calculated for $C_{25}H_{24}NO_4S^+$ $[M+H]^+$: 434.1426; found: 434.1423.



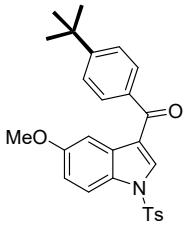
(4-ethylphenyl)(5-methoxy-1-tosyl-*1H*-indol-3-yl)methanone(3ai)

Yellow solid, 64 % yield. 83 mg **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 7.98 (s, 1H), 7.87 (d, *J* = 9.3 Hz, 1H), 7.80 (d, *J* = 8.1 Hz, 3H), 7.77 (d, *J* = 8.7 Hz, 2H), 7.37 (d, *J* = 7.8 Hz, 2H), 7.24 (d, *J* = 8.1 Hz, 2H), 7.01 (dd, *J* = 9.0, 2.7 Hz, 1H), 3.86 (s, 3H), 2.78 (t, *J* = 7.8 Hz, 2H), 2.35 (s, 3H), 1.32 (s, 3H).**^{13}C NMR** (150 MHz, Chloroform-*d*) δ 190.8, 157.6, 149.4, 145.8, 136.7, 134.5, 133.8, 130.2, 129.8, 129.5, 129.3, 128.2, 127.1, 120.3, 115.8, 114.1, 104.3, 55.7, 28.9, 21.6, 15.4. **HRMS (ESI)** calculated for $C_{25}H_{24}NO_4S^+$ $[M+H]^+$: 434.1426; found: 434.1428.



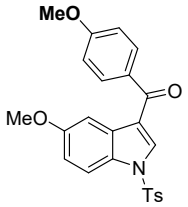
(4-isopropylphenyl)(5-methoxy-1-tosyl-*1H*-indol-3-yl)methanone(3aj)

Yellow solid, 60 % yield. 80 mg **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 8.00 (d, *J* = 6.0 Hz, 1H), 7.86 (d, *J* = 9.3 Hz, 1H), 7.81 (dt, *J* = 7.8, 3.9 Hz, 3H), 7.77 (d, *J* = 8.7 Hz, 2H), 7.56 (d, *J* = 8.4 Hz, 1H), 7.40 (d, *J* = 8.1 Hz, 1H), 7.25 (d, *J* = 8.1 Hz, 2H), 7.01 (dd, *J* = 9.0, 2.7 Hz, 1H), 3.86 (s, 3H), 3.03 (p, *J* = 6.9 Hz, 1H), 2.35 (s, 3H), 1.40 (s, 3H), 1.33 (d, *J* = 6.9 Hz, 3H).**^{13}C NMR** (150 MHz, Chloroform-d) δ 190.7, 157.6, 156.1, 153.9, 145.8, 136.9, 134.5, 133.8, 130.2, 129.3, 127.1, 126.8, 125.7, 120.3, 115.8, 114.1, 104.3, 104.3, 55.7, 31.2, 23.8, 21.6. **HRMS (ESI)** calculated for $C_{26}H_{26}NO_4S^+$ $[M+H]^+$: 448.1582; found: 448.1585.



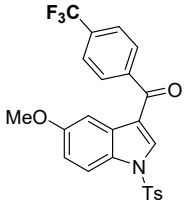
(4-(tert-butyl)phenyl)(5-methoxy-1-tosyl-*1H*-indol-3-yl)methanone（3ak）

Yellow solid, 61 % yield. 84 mg**^{1}H NMR** (600 MHz, Chloroform-*d*) δ 7.93 (s, 1H), 7.79 (d, *J* = 9.3 Hz, 1H), 7.74 (d, *J* = 8.1 Hz, 3H), 7.69 (d, *J* = 8.1 Hz, 2H), 7.48 (d, *J* = 8.1 Hz, 2H), 7.17 (d, *J* = 8.1 Hz, 2H), 6.93 (dd, *J* = 9.0, 2.7 Hz, 1H), 3.78 (s, 3H), 2.27 (s, 3H), 1.32 (s, 9H).**^{13}C NMR** (150 MHz, Chloroform-*d*) δ 189.7, 156.6, 155.1, 144.8, 135.4, 133.5, 132.8, 129.2, 128.7, 128.6, 128.5, 127.9, 126.8, 126.0, 124.6, 119.3, 114.8, 113.0, 103.3, 54.7, 34.1, 30.2, 20.6. **HRMS (ESI)** calculated for $C_{27}H_{28}NO_4S^+$ $[M+H]^+$: 462.1739; found: 462.1742.



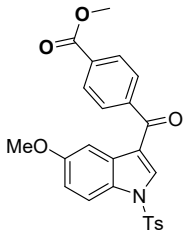
(5-methoxy-1-tosyl-*1H*-indol-3-yl)(4-methoxyphenyl)methanone（3al）

Yellow solid, 72 % yield. 94 mg **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 7.96 (s, 1H), 7.89 (d, *J* = 1.8 Hz, 1H), 7.88 – 7.86 (m, 2H), 7.77 – 7.73 (m, 3H), 7.24 (d, *J* = 8.1 Hz, 2H), 7.04 – 6.99 (m, 3H), 3.92 (s, 3H), 3.85 (s, 3H), 2.35 (s, 3H).**^{13}C NMR** (150 MHz, Chloroform-*d*) δ 189.6, 163.2, 157.5, 145.8, 134.53, 133.1, 131.7, 131.4, 130.2, 129.9, 129.5, 127.0, 120.4, 115.8, 114.1, 113.9, 104.2, 55.7, 55.6, 21.6. **HRMS (ESI)** calculated for $C_{24}H_{22}NO_4S^+$ $[M+H]^+$: 436.1218; found: 436.1217.



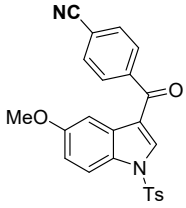
(5-methoxy-1-tosyl-*1H*-indol-3-yl)(4-(trifluoromethyl)phenyl) methanone（3am）

Yellow solid, 69 % yield. 98 mg **^{1}H NMR** (600 MHz, Chloroform-*d*)δ 7.92 (d, *J* = 6.3 Hz, 3H), 7.86 (d, *J* = 9.3 Hz, 1H), 7.80 (dd, *J* = 5.4, 2.7 Hz, 3H), 7.80 – 7.74 (m, 2H), 7.26 (d, *J* = 8.1 Hz, 2H), 7.02 (dd, *J* = 9.0, 2.7 Hz, 1H), 3.84 (s, 3H), 2.34 (s, 3H).**^{13}C NMR** (150 MHz, Chloroform-*d*) δ 189.9, 157.8, 146.1, 142.3, 134.4, 134.3 (d, *J* = 4.5 Hz), 130.3, 129.5, 129.3, 129.1, 127.1, 125.8 (q, *J* = 3.6 Hz), 124.6, 122.8, 119.8, 116.1, 114.1, 104.4, 55.8, 21.7.**^{19}F NMR** (470 MHz, Chloroform-*d*) δ -62.94. **HRMS (ESI)** calculated for C24H19F3NO4S+ [M+H]+: 474.0987; found: 474.0985.



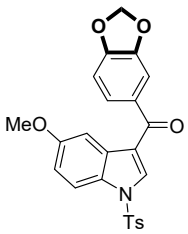
methyl 4-(5-methoxy-1-tosyl-*1H*-indole-3-carbonyl)benzoate(3an)

Yellow solid, 78 % yield. 108 mg **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 8.21 (d, *J* = 8.4 Hz, 2H), 7.94 (s, 1H), 7.88 (t, *J* = 8.7 Hz, 3H), 7.81 (d, *J* = 2.7 Hz, 1H), 7.78 (d, *J* = 8.1 Hz, 2H), 7.27 (d, *J* = 6.9 Hz, 2H), 7.03 (dd, *J* = 9.0, 2.7 Hz, 1H), 3.99 (s, 3H), 3.87 (s, 3H), 2.37 (s, 3H).**^{13}C NMR** (150 MHz, Chloroform-*d*) δ 190.4, 166.3, 157.8, 146.1, 142.8, 134.4, 134.4, 133.2, 130.3, 129.9, 129.5, 129.3, 128.8, 127.1, 119.9, 116.1, 114.1, 104.4, 55.8, 52.5, 21.7. **HRMS (ESI)** calculated for $C_{25}H_{22}NO_6S^+$ [M+H]$^+$: 464.1168; found: 464.1164.



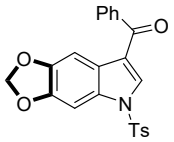
4-(5-methoxy-1-tosyl-*1H*-indole-3-carbonyl)benzonitrile（3ao）

Yellow solid, 74 % yield. 95 mg **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 7.94 – 7.92 (m, 2H), 7.91 (s, 1H), 7.87 – 7.83 (m, 3H), 7.80 – 7.77 (m, 3H), 7.27 (d, *J* = 8.4 Hz, 2H), 7.04 (dd, *J* = 9.0, 2.7 Hz, 1H), 3.86 (s, 3H), 2.37 (s, 3H).**^{13}C NMR** (150 MHz, Chloroform-*d*) δ 189.3, 157.9, 146.2, 142.8, 134.3, 134.2, 132.6, 130.3, 129.5, 129.3, 129.2, 127.2, 119.5, 118.0, 116.2, 115.6, 114.1, 104.4, 55.8, 21.7. **HRMS (ESI)** calculated for $C_{24}H_{19}N_2O_4S^+$ [M+H]$^+$: 431.1065; found: 431.1069.



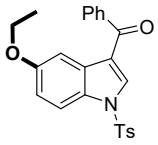
benzo[d][1,3]dioxol-5-yl(5-methoxy-1-tosyl-*1H*-indol-3-yl)methanone（3ap）

Yellow solid, 60 % yield. 81 mg **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 7.89 (s, 1H), 7.79 (d, *J* = 9.3 Hz, 1H), 7.70 (d, *J* = 8.4 Hz, 2H), 7.65 (d, *J* = 2.7 Hz, 1H), 7.40 (d, *J* = 9.6 Hz, 1H), 7.18 (d, *J* = 10.2 Hz, 3H), 6.93 (dd, *J* = 9.0, 2.7 Hz, 1H), 6.86 (d, *J* = 8.1 Hz, 1H), 6.03 (s, 2H), 3.78 (s, 3H), 2.29 (s, 3H).**^{13}C NMR** (150 MHz, Chloroform-*d*) δ 188.1, 156.5, 150.5, 147.2, 144.8, 133.5, 132.5, 132.1, 129.2, 128.7, 128.5, 126.0, 124.2, 119.2, 114.8, 113.1, 108.0, 107.0, 103.1, 100.9, 54.7, 20.6. **HRMS (ESI)** calculated for $C_{24}H_{20}NO_6S^+$ $[M+H]^+$: 450.1011; found: 450.1009.



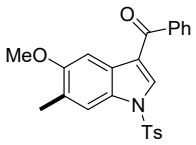
phenyl(5-tosyl-*5H*-[1,3]dioxolo[4,5-f]indol-7-yl)methanone（3ba）

Yellow solid, 50 % yield. 63 mg **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 7.80 (s, 1H), 7.76 (d, *J* = 6.9 Hz, 2H), 7.68 (d, *J* = 8.4 Hz, 2H), 7.64 (s, 1H), 7.57 – 7.51 (m, 2H), 7.45 (t, *J* = 7.5 Hz, 2H), 7.19 (d, *J* = 2.4 Hz, 1H), 7.15 – 7.12 (m, 1H), 5.94 (s, 2H), 2.30 (s, 3H).**^{13}C NMR** (150 MHz, Chloroform-d) δ 189.9, 146.3, 144.9, 138.1, 133.4, 131.3, 129.2, 128.6, 127.9, 127.6, 126.3, 126.1, 121.9, 119.5, 107.8, 104.4, 100.6, 93.5, 20.6. **HRMS (ESI)** calculated for $C_{23}H_{18}NO_5S^+$ $[M+H]^+$: 420.0905; found: 420.0909.



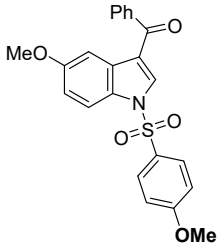
(5-ethoxy-1-tosyl-*1H*-indol-3-yl)(phenyl)methanone（3ca）

Yellow solid, 77 % yield. 97 mg **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 7.97 (s, 1H), 7.86 (dd, *J* = 8.7, 4.5 Hz, 3H), 7.81 – 7.74 (m, 3H), 7.62 (t, *J* = 7.5 Hz, 1H), 7.54 (t, *J* = 7.8 Hz, 2H), 7.24 (d, *J* = 8.1 Hz, 2H), 7.01 (dd, *J* = 9.0, 2.7 Hz, 1H), 4.09 (q, *J* = 6.9 Hz, 2H), 2.35 (s, 3H), 1.42 (t, *J* = 6.9 Hz, 3H).**^{13}C NMR** (150 MHz, Chloroform-*d*) δ 191.0, 157.0, 145.9, 139.3, 134.5, 134.1, 132.3, 130.2, 129.6, 129.5, 129.0, 128.7, 127.1, 120.2, 116.3, 114.1, 105.1, 63.9, 21.7, 14.8. **HRMS (ESI)** calculated for $C_{24}H_{22}NO_4S^+$ $[M+H]^+$: 420.1269; found: 420.1272.



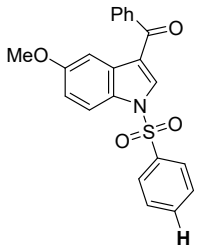
(5-methoxy-6-methyl-1-tosyl-*1H*-indol-3-yl)(phenyl)methanone（3ea）

Yellow solid, 70 % yield. 88 mg **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 7.83 (s, 1H), 7.77 (dt, *J* = 6.9, 1.4 Hz, 2H), 7.70 – 7.66 (m, 3H), 7.65 (s, 1H), 7.53 (d, *J* = 7.5 Hz, 1H), 7.45 (t, *J* = 7.5 Hz, 2H), 7.17 (d, *J* = 8.1 Hz, 2H), 3.80 (s, 3H), 2.27 (s, 6H).**^{13}C NMR** (150 MHz, Chloroform-*d*) δ 191.2, 156.2, 145.8, 139.3, 134.7, 133.1, 132.3, 130.2, 129.2, 129.0, 128.7, 127.4, 127.0, 126.7, 120.3, 114.5, 102.4, 55.7, 21.7, 17.5. **HRMS (ESI)** calculated for $C_{24}H_{22}NO_4S^+$ $[M+H]^+$: 420.1269; found: 420.1265.



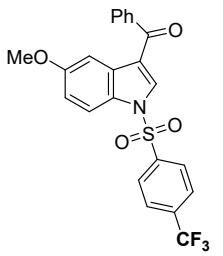
(5-methoxy-1-((4-methoxyphenyl)sulfonyl)-*1H*-indol-3-yl)(phenyl) methanone（3ia）

Yellow solid, 62 % yield. 78 mg **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 7.89 (s, 1H), 7.77 – 7.74 (m, 3H), 7.73 – 7.70 (m, 3H), 7.51 – 7.49 (m, 1H), 7.42 (t, *J* = 7.5 Hz, 2H), 6.91 (dd, *J* = 9.0, 2.7 Hz, 1H), 6.78 (d, *J* = 9.0 Hz, 2H), 3.75 (s, 3H), 3.66 (s, 3H).**^{13}C NMR** (150 MHz, Chloroform-*d*) δ 191.1, 164.4, 157.6, 139.3, 134.2, 132.3, 129.7, 129.5, 129.4, 128.9, 128.7, 120.0, 115.8, 114.8, 114.1, 114.1, 104.4, 55.8, 55.7. **HRMS (ESI)** calculated for $C_{23}H_{20}NO_5S^+$ $[M+H]^+$: 422.1062; found: 422.1065.



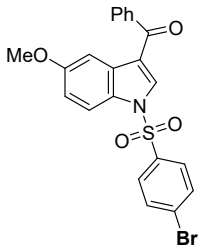
(6-methoxy-1-(phenylsulfonyl)-*1H*-indol-3-yl)(phenyl)methanone（3ja）

Yellow solid, 57 % yield. 67 mg **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 7.79 (s, 1H), 7.70 – 7.65 (m, 5H), 7.61 (d, *J* = 2.7 Hz, 1H), 7.44 – 7.42 (m, 1H), 7.40 – 7.32 (m, 4H), 7.27 (s, 1H), 6.83 (dd, *J* = 9.0, 2.7 Hz, 1H), 3.66 (s, 3H).**^{13}C NMR** (150 MHz, Chloroform-*d*) δ 189.9, 156.7, 138.1, 136.4, 133.5, 132.9, 131.4, 128.6, 128.6, 128.5, 127.9, 127.7, 125.9, 119.3, 114.9, 113.0, 103.3, 54.7. **HRMS (ESI)** calculated for $C_{22}H_{18}NO_4S^+$ $[M+H]^+$: 392.0956; found: 392.0958.



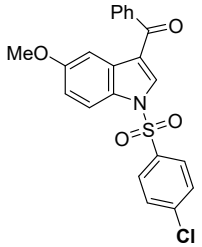
(5-methoxy-1-((4-(trifluoromethyl)phenyl)sulfonyl)-*1H*-indol-3-yl) (phenyl) methanone（3ka）

Yellow solid, 40 % yield. 55 mg **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 8.04 (d, *J* = 8.4 Hz, 2H), 7.98 (s, 1H), 7.92 – 7.86 (m, 3H), 7.80 (d, *J* = 2.7 Hz, 1H), 7.74 (d, *J* = 8.4 Hz, 2H), 7.68 – 7.62 (m, 1H), 7.56 (d, *J* = 7.8 Hz, 2H), 7.08 (dd, *J* = 9.0, 2.7 Hz, 1H), 3.90 (s, 3H).**^{13}C NMR** (150 MHz, Chloroform-*d*) δ 190.8, 157.9, 140.8, 138.9, 133.5, 132.6, 129.8, 129.5, 129.0, 128.8, 127.6, 126.8 (q, *J* = 3.6 Hz), 121.1, 116.3, 113.9, 104.7, 77.3, 77.1, 76.8, 55.8.**^{19}F NMR** (470 MHz, $CDCl_3$) δ -63.44. **HRMS (ESI)** calculated for $C_{23}H_{17}F_3NO_4S^+$ $[M+H]^+$: 460.0830; found: 460.0828.



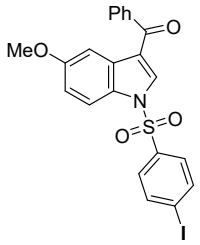
(1-((4-bromophenyl)sulfonyl)-5-methoxy-*1H*-indol-3-yl)(phenyl) methanone(3la)

Yellow solid, 50 % yield. 70 mg **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 7.94 (s, 1H), 7.87 – 7.83 (m, 3H), 7.80 (d, *J* = 2.7 Hz, 1H), 7.74 (d, *J* = 8.7 Hz, 2H), 7.60 (d, *J* = 8.7 Hz, 3H), 7.55 (t, *J* = 7.8 Hz, 2H), 7.03 (dd, *J* = 9.0, 2.7 Hz, 1H), 3.87 (s, 3H).**^{13}C NMR** (150 MHz, Chloroform-*d*) δ 190.9, 157.9, 139.1, 136.4, 133.7, 132.9, 132.5, 130.1, 129.8, 129.4, 129.0, 128.7, 128.4, 120.8, 116.1, 113.9, 104.6, 55.8. **HRMS (ESI)** calculated for $C_{22}H_{17}BrNO_4S^+$ $[M+H]^+$: 470.0061; found: 470.0065.



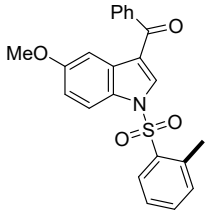
(1-((4-chlorophenyl)sulfonyl)-5-methoxy-*1H*-indol-3-yl)(phenyl) methanone(3ma)

Yellow solid, 54 % yield. 69 mg **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 7.86 (s, 1H), 7.78 – 7.75 (m, 3H), 7.73 (d, *J* = 9.0 Hz, 3H), 7.54 (t, *J* = 7.5 Hz, 1H), 7.45 (t, *J* = 7.5 Hz, 2H), 7.33 (d, *J* = 8.7 Hz, 2H), 6.94 (dd, *J* = 9.0, 2.7 Hz, 1H), 3.77 (s, 3H).**^{13}C NMR** (150 MHz, Chloroform-*d*) δ 189.8, 156.8, 140.4, 138.0, 134.7, 132.6, 131.4, 128.9, 128.7, 128.3, 127.9, 127.7, 127.3, 119.6, 115.0, 112.9, 103.5, 54.7. **HRMS (ESI)** calculated for $C_{22}H_{17}ClNO_4S^+$ $[M+H]^+$: 426.0567; found: 426.0565.



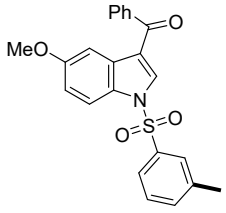
(1-((4-iodophenyl)sulfonyl)-5-methoxy-*1H*-indol-3-yl)(phenyl) methanone(3na)

Yellow solid, 58 % yield. 90 mg **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 7.85 (s, 1H), 7.75 (t, *J* = 8.4 Hz, 3H), 7.71 (d, *J* = 8.7 Hz, 3H), 7.54 (t, *J* = 7.5 Hz, 1H), 7.49 – 7.44 (m, 4H), 6.93 (dd, *J* = 9.0, 2.7 Hz, 1H), 3.77 (s, 3H).**^{13}C NMR** (150 MHz, Chloroform-*d*) δ 190.9, 157.839, 139.1, 138.9, 136.9, 133.7, 132.5, 129.8, 129.4, 129.0, 128.8, 128.1, 120.7, 116.1, 113.9, 104.6, 102.8, 55.8. **HRMS (ESI)** calculated for $C_{22}H_{17}INO_4S^+$ $[M+H]^+$: 517.9923; found: 517.9925.



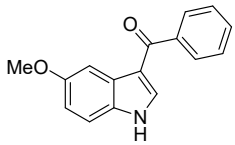
(5-methoxy-1-(o-tolylsulfonyl)-*1H*-indol-3-yl)(phenyl) methanone(3oa)

Yellow solid, 66 % yield. 80 mg **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 8.00 (s, 1H), 7.88 – 7.84 (m, 4H), 7.81 (d, *J* = 2.7 Hz, 1H), 7.69 (d, *J* = 1.5 Hz, 2H), 7.61 (d, *J* = 5.4 Hz, 1H), 7.53 (s, 1H), 7.51 (d, *J* = 3.9 Hz, 1H), 7.35 (s, 1H), 7.02 (dd, *J* = 9.0, 2.7 Hz, 1H), 3.84 (s, 3H), 2.34 (s, 3H).**^{13}C NMR** (150 MHz, Chloroform-*d*) δ 191.0, 157.7, 140.1, 139.2, 137.3, 136.5, 135.5, 134.1, 133.3, 132.4, 130.1, 129.0, 128.7, 127.2, 124.3, 120.2, 115.9, 114.1, 104.4, 55.7, 21.4. **HRMS (ESI)** calculated for $C_{23}H_{19}NO_4S^+$ $[M+H]^+$: 406.1113; found: 406.1115.



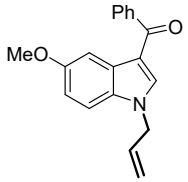
(6-methoxy-1-(m-tolylsulfonyl)-*1H*-indol-3-yl)(phenyl)methanone（3pa）

Yellow solid, 68 % yield. 83 mg **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 7.98 (s, 1H), 7.89 – 7.87 (m, 1H), 7.76 (d, *J* = 2.4 Hz, 3H), 7.50 (t, *J* = 7.2 Hz, 2H), 7.43 (s, 1H), 7.42 (s, 1H), 7.41 (s, 1H), 7.39 (s, 1H), 7.13 (d, *J* = 3.6 Hz, 1H), 6.83 (dd, *J* = 9.0, 2.7 Hz, 1H), 3.74 (s, 3H), 2.37 (s, 3H).**^{13}C NMR** (150 MHz, Chloroform-*d*) δ 189.9, 156.5, 138.2, 137.0, 135.1, 133.6, 133.1, 132.2, 131.3, 129.0, 128.4, 127.8, 127.6, 125.9, 125.8, 118.0, 114.7, 112.6, 103.4, 54.6, 19.1. **HRMS (ESI)** calculated for $C_{16}H_{13}NO_2^+$ $[M+H]^+$: 406.1113; found: 406.1110.



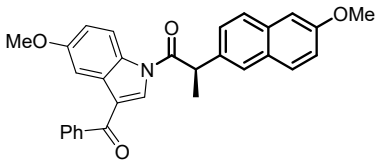
(5-Methoxy-*1H*-indol-3-yl)(phenyl)methanone(3c)

Yellow solid, 23 mg,yield: 90 % **^{1}H NMR** (600 MHz, DMSO-d6) δ 11.99 (s, 1H), 7.88 (m, 1H), 7.82 – 7.77 (m, 3H), 7.60 (t, *J* = 7.2 Hz, 1H), 7.54 (t, *J* = 7.5 Hz, 2H), 7.43 (m, 1H), 6.91 (m, 1H), 3.82 (s, 3H).**^{13}C NMR** (150 MHz, DMSO-d6) δ 190.3, 155.9, 141.0, 136.3, 131.9, 131.3, 128.7, 128.6, 127.4, 115.2, 113.4, 113.4, 103.5, 55.6. **HRMS (ESI)** calculated for $C_{16}H_{13}NO_2^+$ $[M+H]^+$: 252.1025; found: 252.1022.



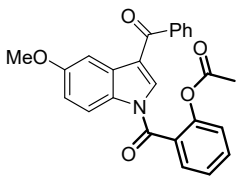
(1-Allyl-5-methoxy-*1H*-indol-3-yl)(phenyl)methanone(4a)

Yellow solid, 25 mg,yield: 86 % **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 7.90 (m, 1H), 7.73 (d, *J* = 7.2 Hz, 2H), 7.45 (d, *J* = 12.9 Hz, 2H), 7.42 – 7.38 (m, 2H), 7.17 (m, 1H), 6.88 (m, 1H), 5.94 – 5.86 (m, 1H), 5.19 (m, 1H), 5.07 (m, 1H), 4.64 (d, *J* = 5.1 Hz, 2H), 3.83 (s, 3H).**^{13}C NMR** (150 MHz, Chloroform-*d*) δ 189.9, 155.6, 139.9, 135.9, 131.0, 130.8, 130.0, 127.6, 127.3, 127.2, 117.5, 114.5, 113.23, 109.9, 102.8, 54.8, 48.6. **HRMS (ESI)** calculated for $C_{19}H_{17}NO_2S^+$ $[M+H]^+$: 292.1338; found: 292.1340.



1-(3-Benzoyl-5-methoxy-*1H*-indol-1-yl)-2-(6-methoxynaphthalen-2-yl)propan-1-one(4b)

Yellow solid, 68 mg,yield: 74 % **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 8.48 (m, 1H), 7.86 (s, 1H), 7.78 (m, 1H), 7.75 (m, 1H), 7.67 (m, 1H), 7.61 (s, 1H), 7.49 (t, *J* = 7.5 Hz, 1H), 7.35 (d, *J* = 6.9 Hz, 2H), 7.29 (m, 1H), 7.26 – 7.12 (m, 5H), 7.06 (m, 1H), 4.46 (q, *J* = 6.9 Hz, 1H), 3.92 (s, 3H), 3.87 (s, 3H), 1.68 (d, *J* = 6.6 Hz, 2H).**^{13}C NMR** (150 MHz, Chloroform-*d*) δ 191.1, 172.3, 158.1, 157.8, 139.1, 135.9, 133.9, 133.8, 132.0, 130.9, 129.3, 129.2, 128.8, 128.4, 128.4, 125.8, 125.2, 119.7, 117.4, 115.7, 105.7, 104.1, 55.7, 55.4, 46.6, 20.2. **HRMS (ESI)** calculated for $C_{30}H_{25}NO_4^+$ $[M+H]^+$: 464.1862; found: 464.1865.

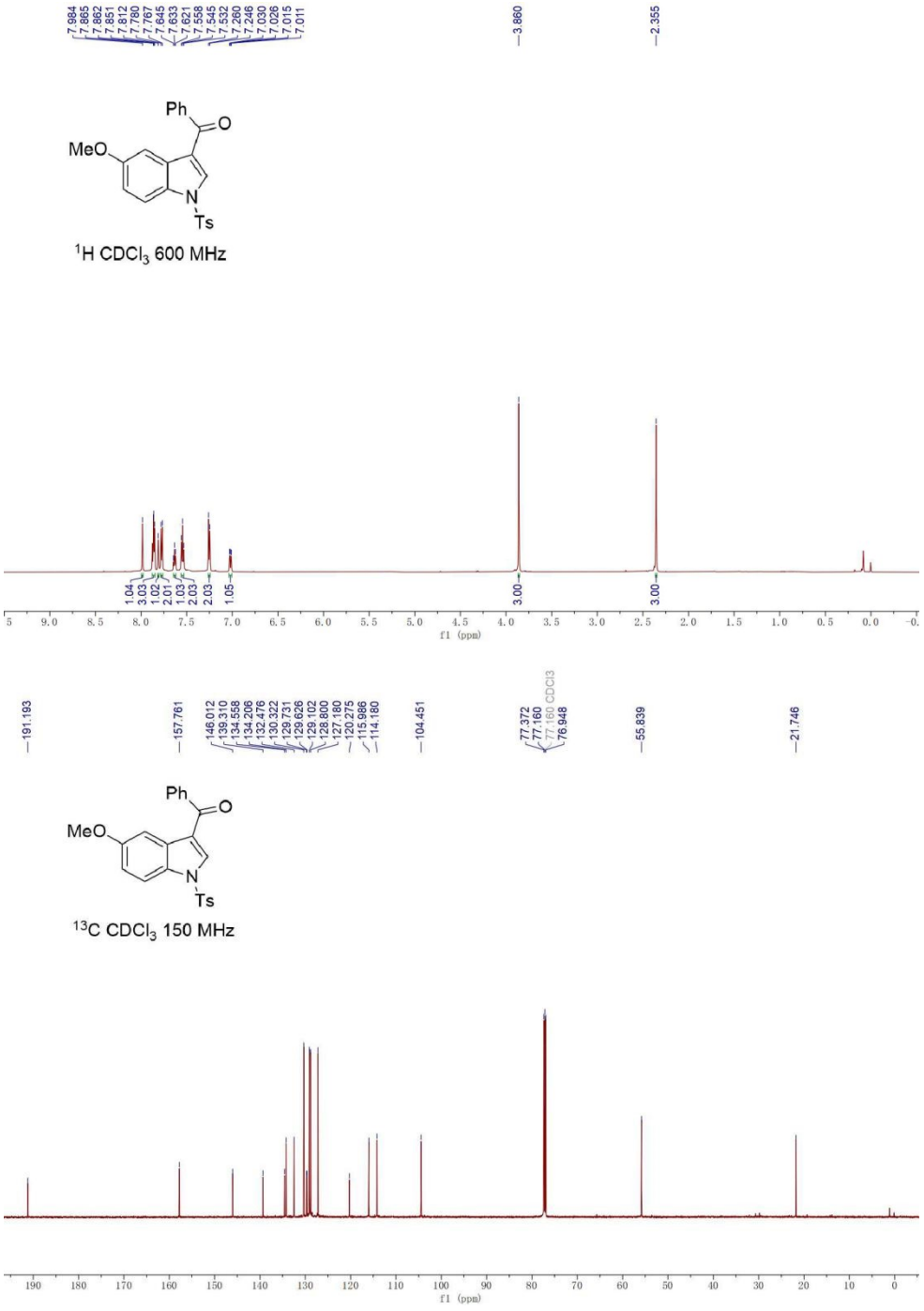


2-(3-Benzoyl-5-methoxy-*1H*-indole-1-carbonyl)phenyl acetate(4c)

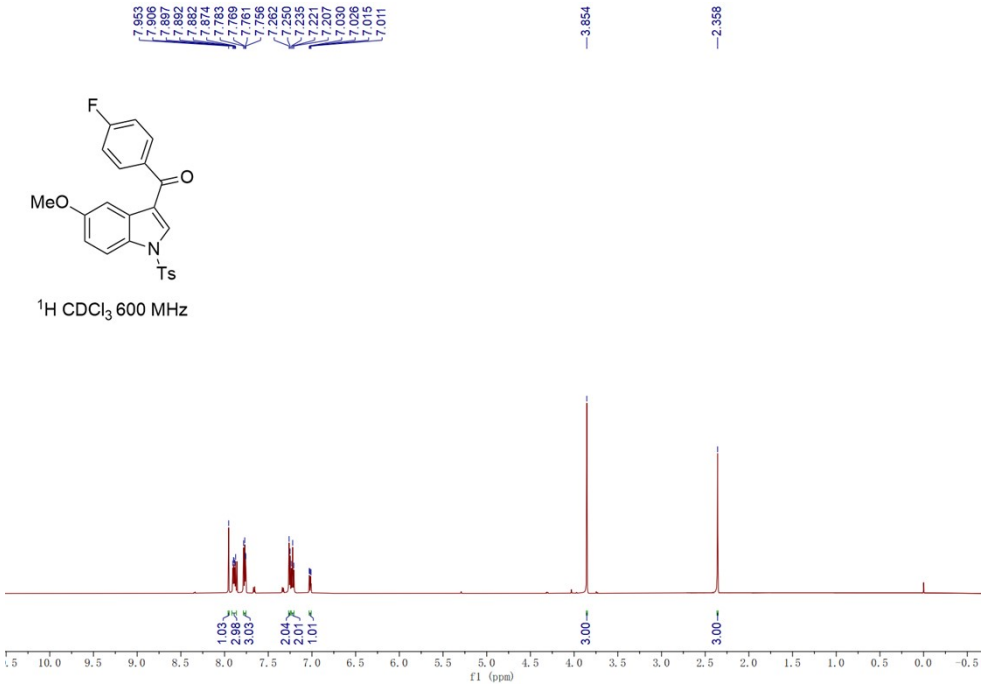
Yellow solid, 57 mg,yield: 69 % **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 8.30 (m, 1H), 7.88 – 7.78 (m, 6H), 7.57 (dt, *J* = 52.8, 7.7 Hz, 5H), 7.05 – 7.02 (m, 1H), 3.89 (s, 3H), 2.64 (s, 3H).**^{13}C NMR** (150 MHz, Chloroform-*d*) δ 191.4, 168.5, 157.6, 139.5, 133.08, 132.3, 130.7, 129.23, 128.9, 128.7, 128.5, 120.5, 117.1, 115.7, 104.2, 55.7, 23.8. **HRMS (ESI)** calculated for $C_{25}H_{20}NO_5^+$ $[M+H]^+$: 414.1341; found: 414.1339.

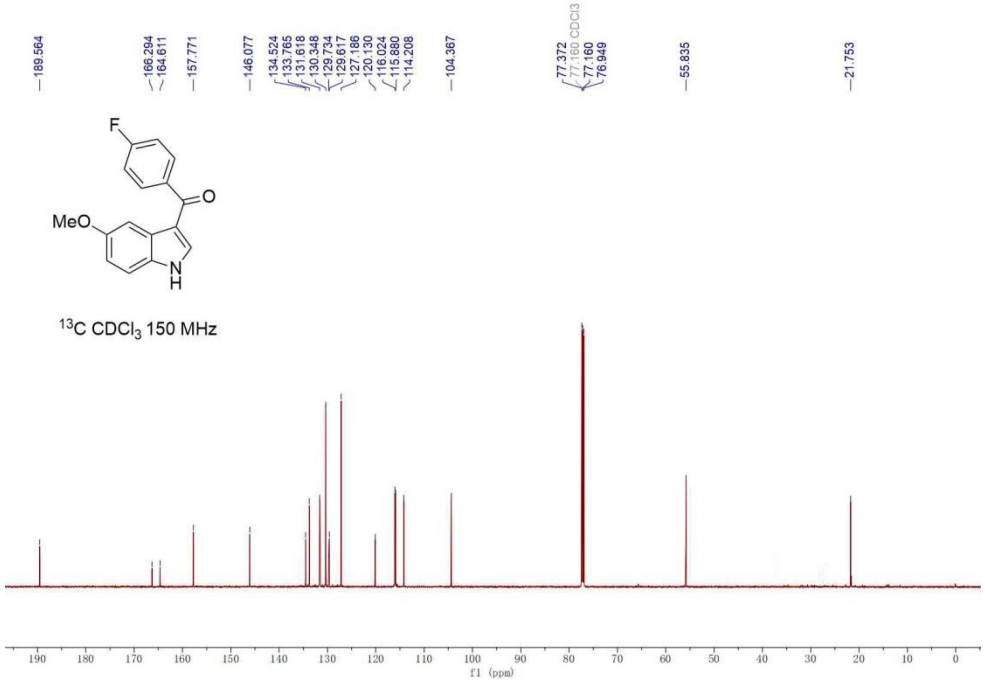
6. NMR Spectra

3aa



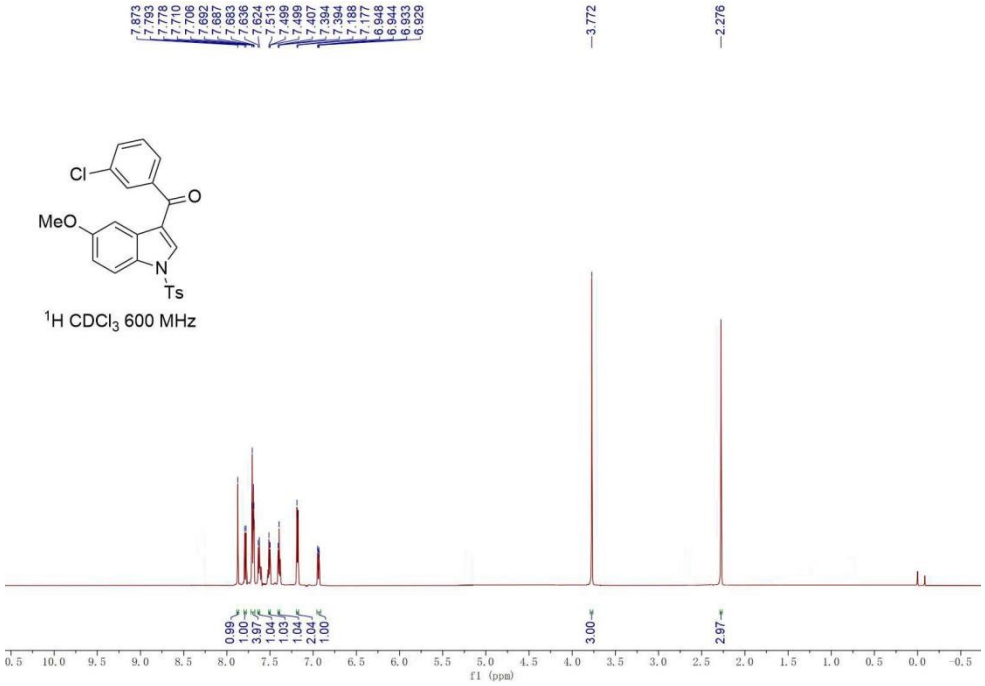
3ab

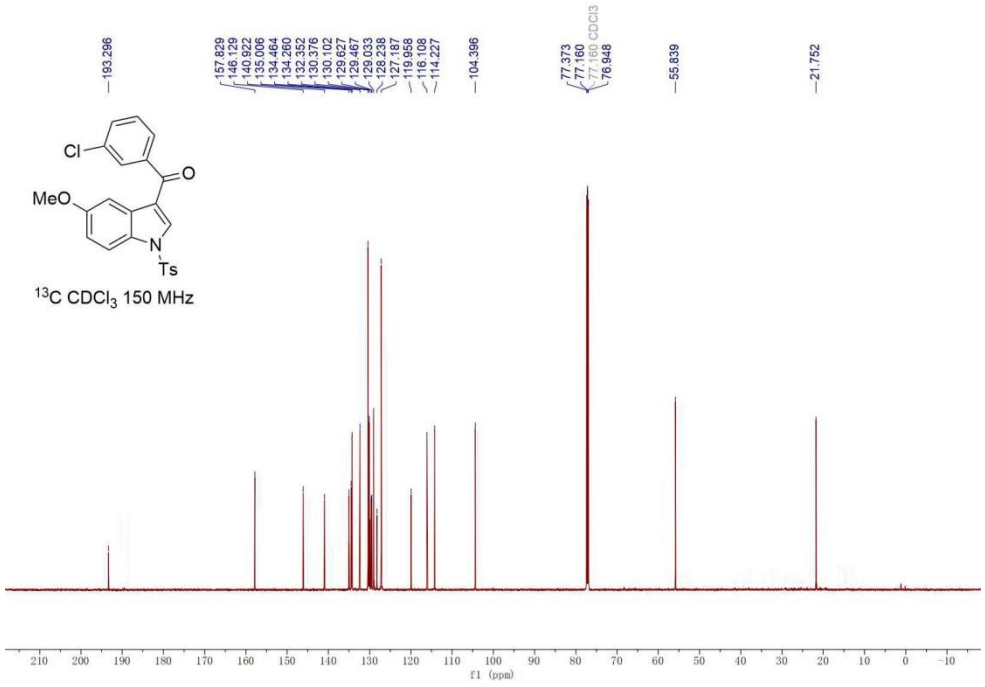

7.953
7.906
7.897
7.892
7.882
7.874
7.783
7.769
7.761
7.755
7.262
7.250
7.235
7.221
7.207
7.030
7.026
7.015
7.011
3.854
2.358
F
O
MeO
N
Ts
1H CDCl3 600 MHz
1.03
2.98
3.03
2.04
2.01
1.01
3.00
3.00
f1 (ppm)


189.564
166.294
164.611
157.771
146.077
134.524
133.765
131.618
130.348
129.734
129.617
127.186
120.130
116.024
115.880
114.208
104.367
77.372
77.160 CDCl3
77.160
76.949
55.835
21.753
F
O
MeO
N
H
13C CDCl3 150 MHz
f1 (ppm)

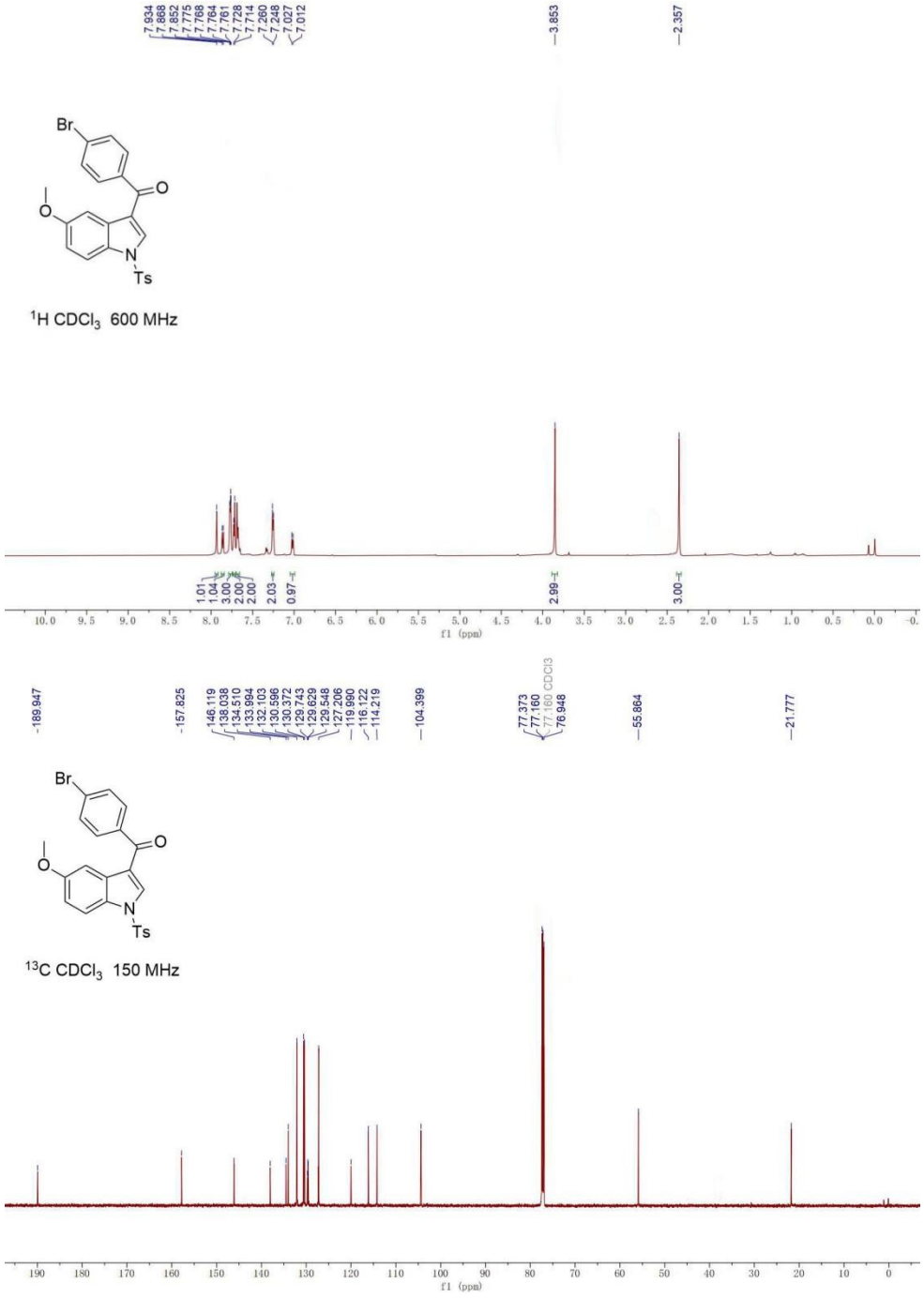
^{19}F $CDCl_3$ 470MHz

3ac

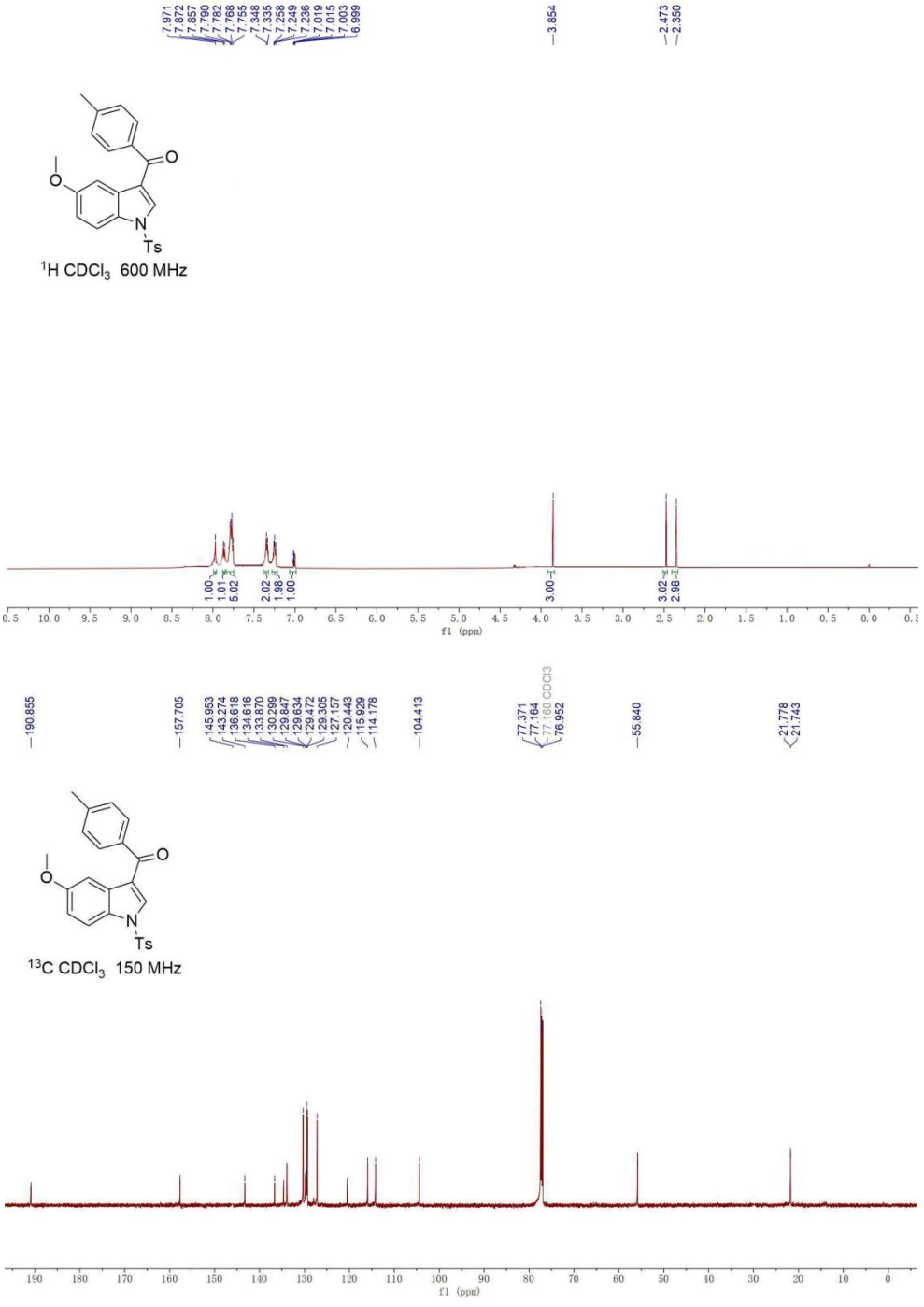

7.873
7.793
7.778
7.710
7.706
7.692
7.687
7.683
7.636
7.624
7.513
7.499
7.499
7.407
7.394
7.394
7.188
7.177
6.948
6.944
6.933
6.929
3.772
2.276
Cl
O
MeO
N
Ts
1H CDCl3 600 MHz
0.99
1.00
3.97
1.04
1.03
1.04
2.04
1.00
3.00
2.97
f1 (ppm)


193.296
157.829
146.129
140.622
133.586
133.464
134.260
132.352
130.376
130.102
128.627
128.467
128.033
128.238
127.187
119.958
116.108
114.227
104.396
77.373
77.160
77.160 CDCl3
76.948
55.839
21.752
Cl
O
MeO
N
Ts
13C CDCl3 150 MHz
f1 (ppm)

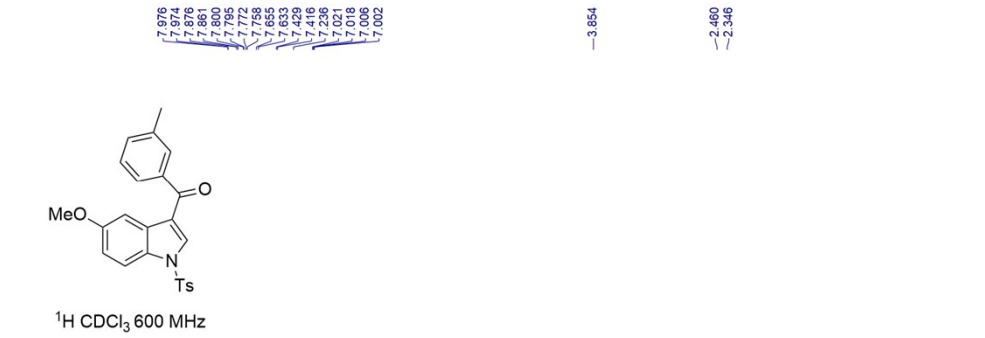
3ad


7.934
7.868
7.852
7.775
7.768
7.764
7.761
7.728
7.714
7.260
7.248
7.027
7.012
3.853
2.357
Br
O
O
N
Ts
1H CDCl3 600 MHz
1.01
1.04
3.00
2.00
2.00
2.03
0.97
2.99
3.00
f1 (ppm)
189.947
157.825
146.119
138.038
134.510
133.994
132.103
130.596
130.372
129.743
129.629
129.548
127.206
119.990
116.122
114.219
104.399
77.373
77.160
77.160 CDCl3
76.948
55.864
21.777
13C CDCl3 150 MHz
f1 (ppm)

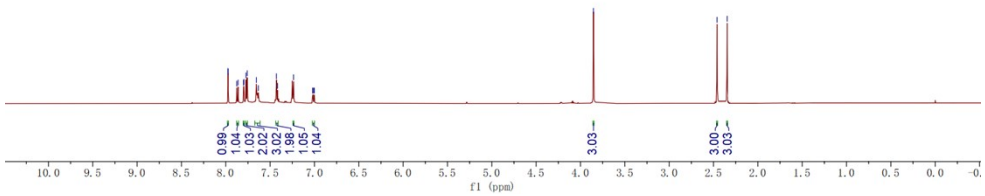
3ae

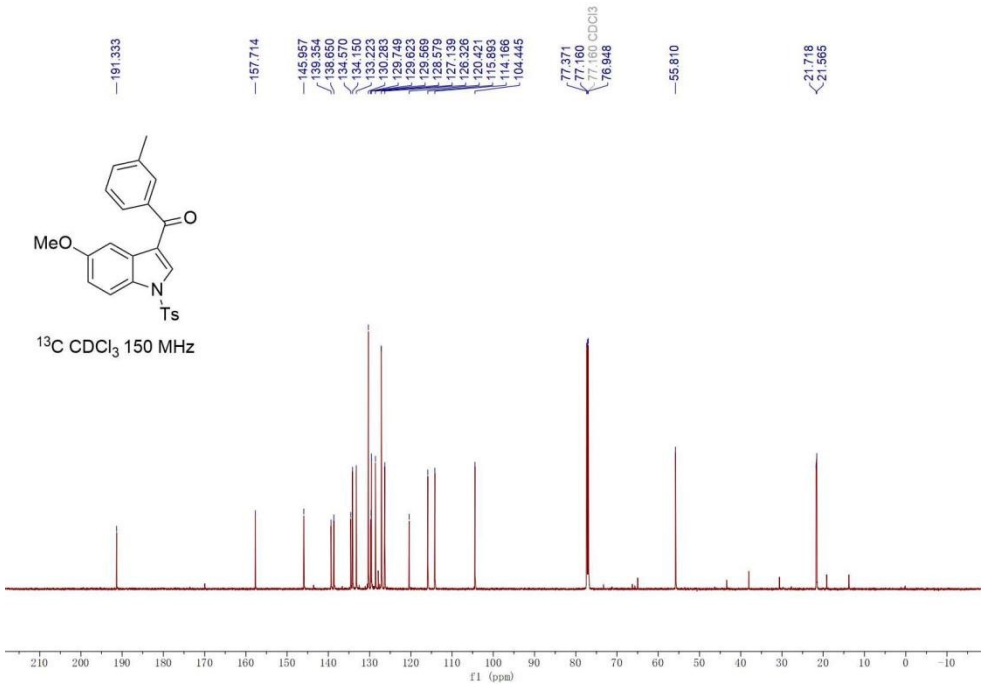

7.971
7.872
7.857
7.790
7.782
7.768
7.755
7.348
7.335
7.258
7.249
7.236
7.019
7.015
7.003
6.999
3.854
2.473
2.350
O
O
N
Ts
1H CDCl3 600 MHz
1.00
1.01
5.02
2.02
1.98
1.00
3.00
3.02
2.98
f1 (ppm)
190.855
157.705
145.953
143.274
136.618
134.616
133.870
130.299
129.847
129.634
129.472
129.305
127.157
120.443
115.929
114.178
104.413
77.371
77.164
77.160 CDCl3
76.952
55.840
21.778
21.743
13C CDCl3 150 MHz
f1 (ppm)

3af



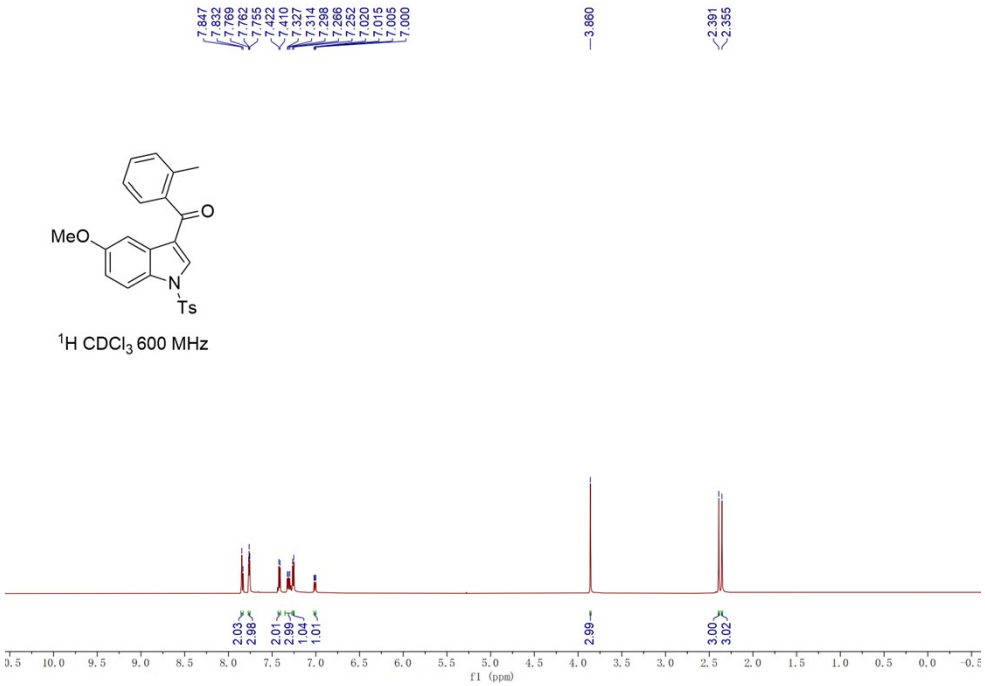
^{1}H $CDCl_3$ 600 MHz

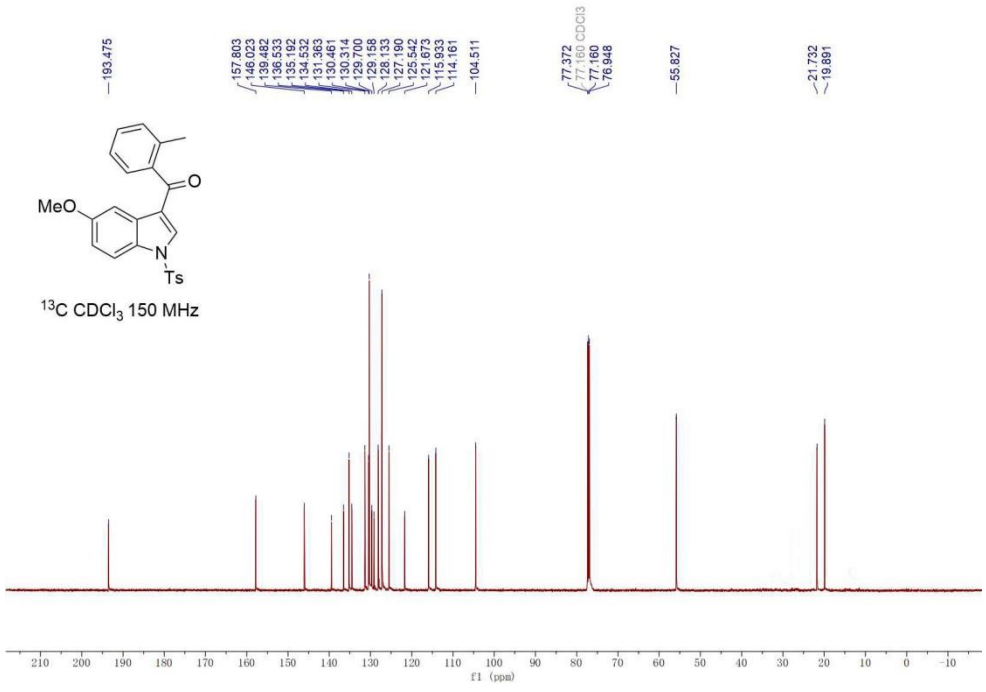




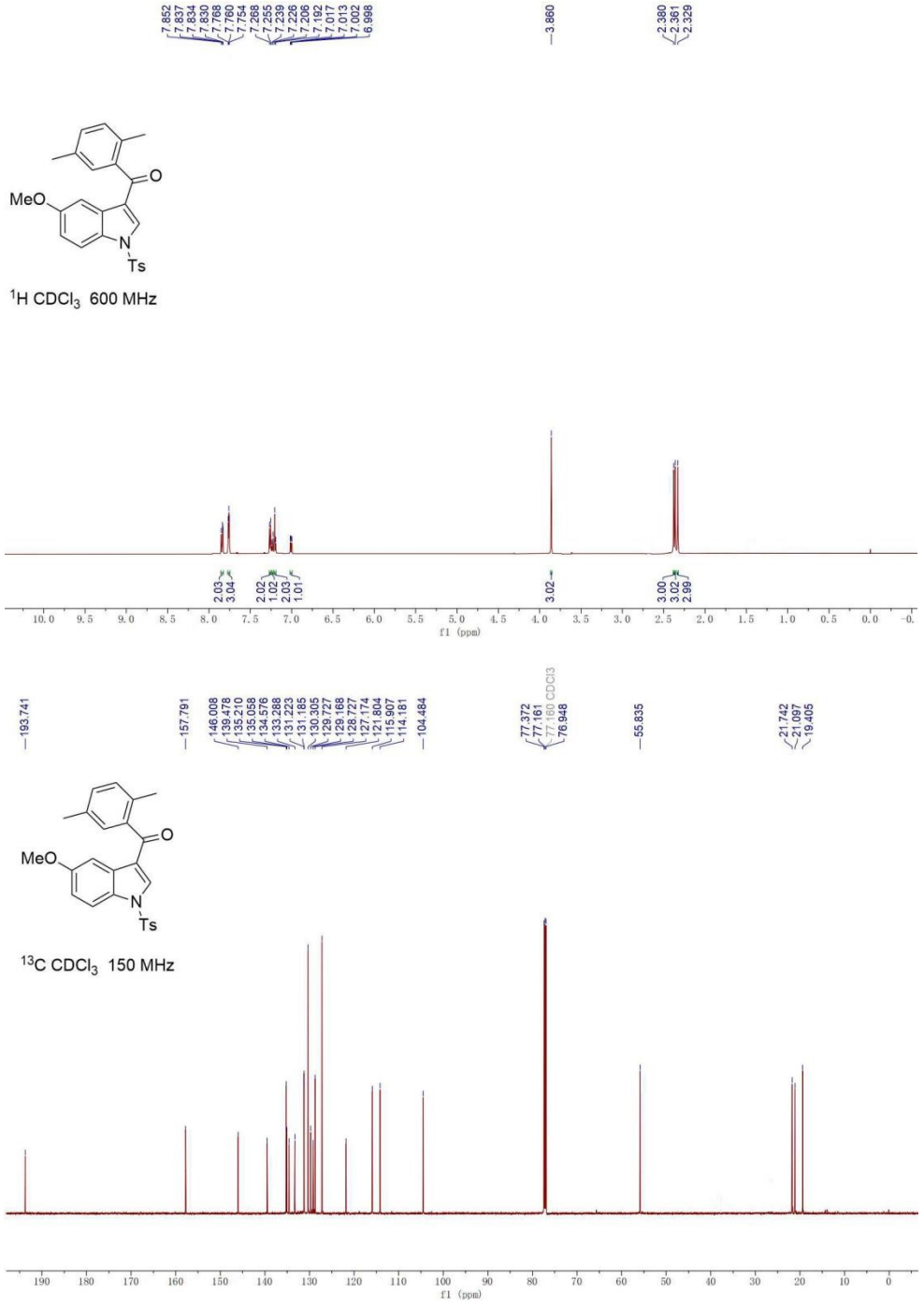
^{13}C $CDCl_3$ 150 MHz

3ag


7.847
7.832
7.769
7.762
7.755
7.422
7.410
7.327
7.314
7.298
7.266
7.252
7.020
7.015
7.005
7.000
3.860
2.391
2.355
MeO
O
N
Ts
^{1}H CDCl$_3$ 600 MHz
2.03
2.98
2.01
2.99
1.04
1.01
2.99
3.00
3.02
f1 (ppm)

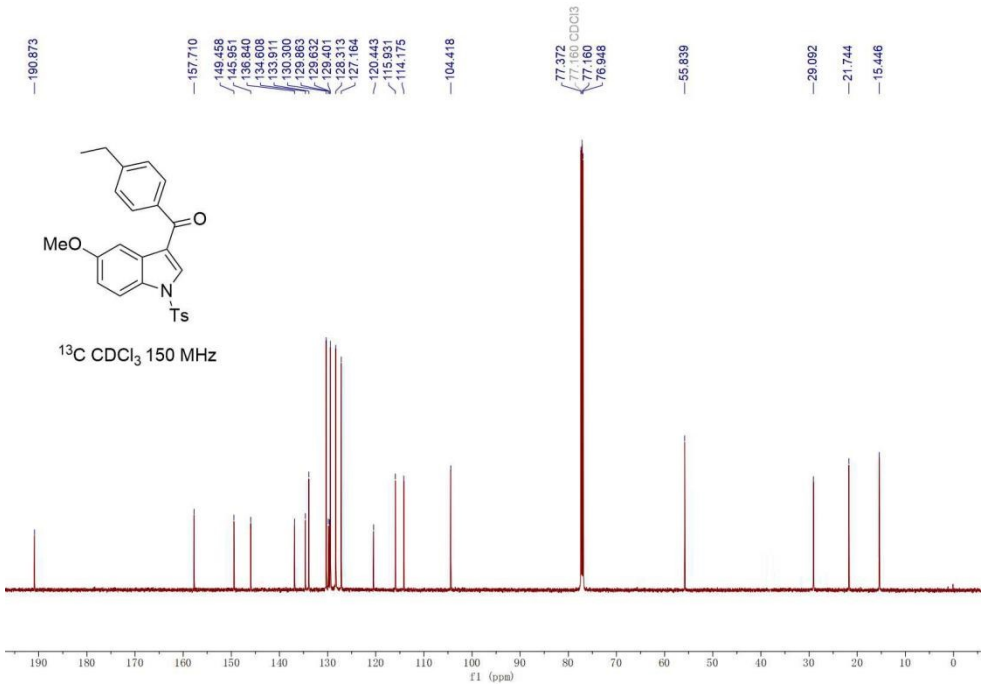

193.475
157.803
146.023
139.482
136.533
135.192
134.532
131.383
130.461
130.314
129.700
128.158
128.133
127.190
125.542
121.673
115.933
114.161
104.511
77.372
77.160
76.948
55.827
21.732
19.891
MeO
O
N
Ts
^{13}C CDCl$_3$ 150 MHz
f1 (ppm)

3ah


7.852
7.837
7.834
7.830
7.768
7.760
7.754
7.268
7.255
7.239
7.226
7.206
7.192
7.017
7.013
7.002
6.998
3.860
2.380
2.361
2.329
MeO
O
N
Ts
1H CDCl3 600 MHz
2.03
3.04
2.02
1.02
2.03
1.01
3.02
3.00
3.02
2.99
f1 (ppm)
193.741
157.791
146.008
139.478
135.210
135.058
134.576
133.288
131.223
131.185
130.305
129.727
129.168
128.727
127.174
121.804
115.907
114.181
104.484
77.372
77.161
77.160 CDCl3
76.948
55.835
21.742
21.097
19.405
MeO
O
N
Ts
13C CDCl3 150 MHz
f1 (ppm)

3ai


7.984
7.873
7.858
7.808
7.795
7.773
7.759
7.374
7.361
7.252
7.238
7.020
7.016
7.005
7.001
3.856
2.789
2.777
2.764
2.751
2.351
1.318
MeO
N
Ts
O
^{1}H CDCl$_3$ 600 MHz
0.98
1.04
3.01
1.98
2.02
2.00
1.04
3.00
2.02
3.01
3.00
f1 (ppm)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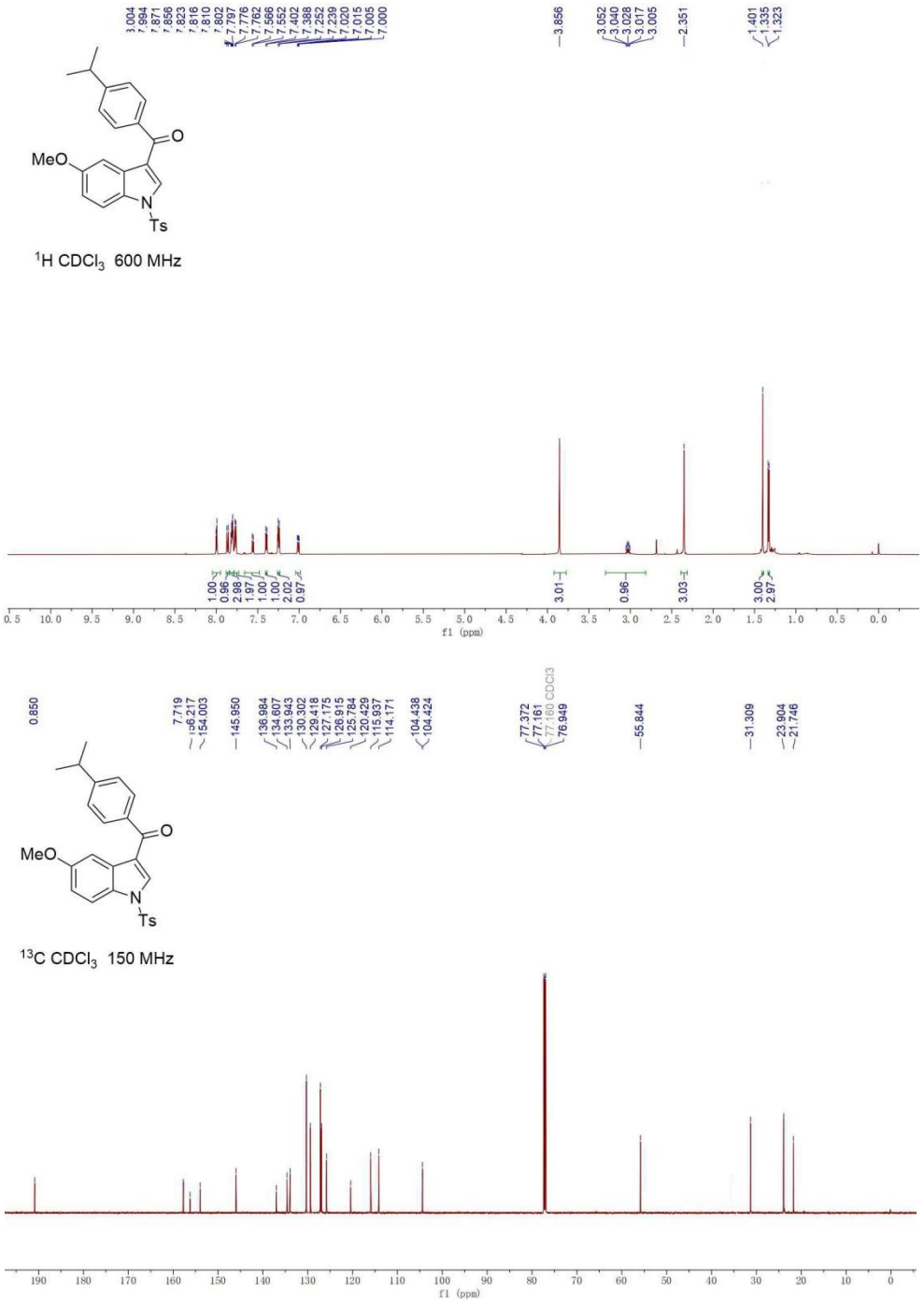
157.710
149.458
145.851
136.840
134.608
133.911
130.300
129.863
129.632
129.401
128.313
127.164
120.443
115.931
114.175
104.418
77.372
77.160 CDCl3
76.948
55.839
29.092
21.744
15.446
MeO
N
Ts
O
^{13}C CDCl$_3$ 150 MHz
f1 (ppm)

3aj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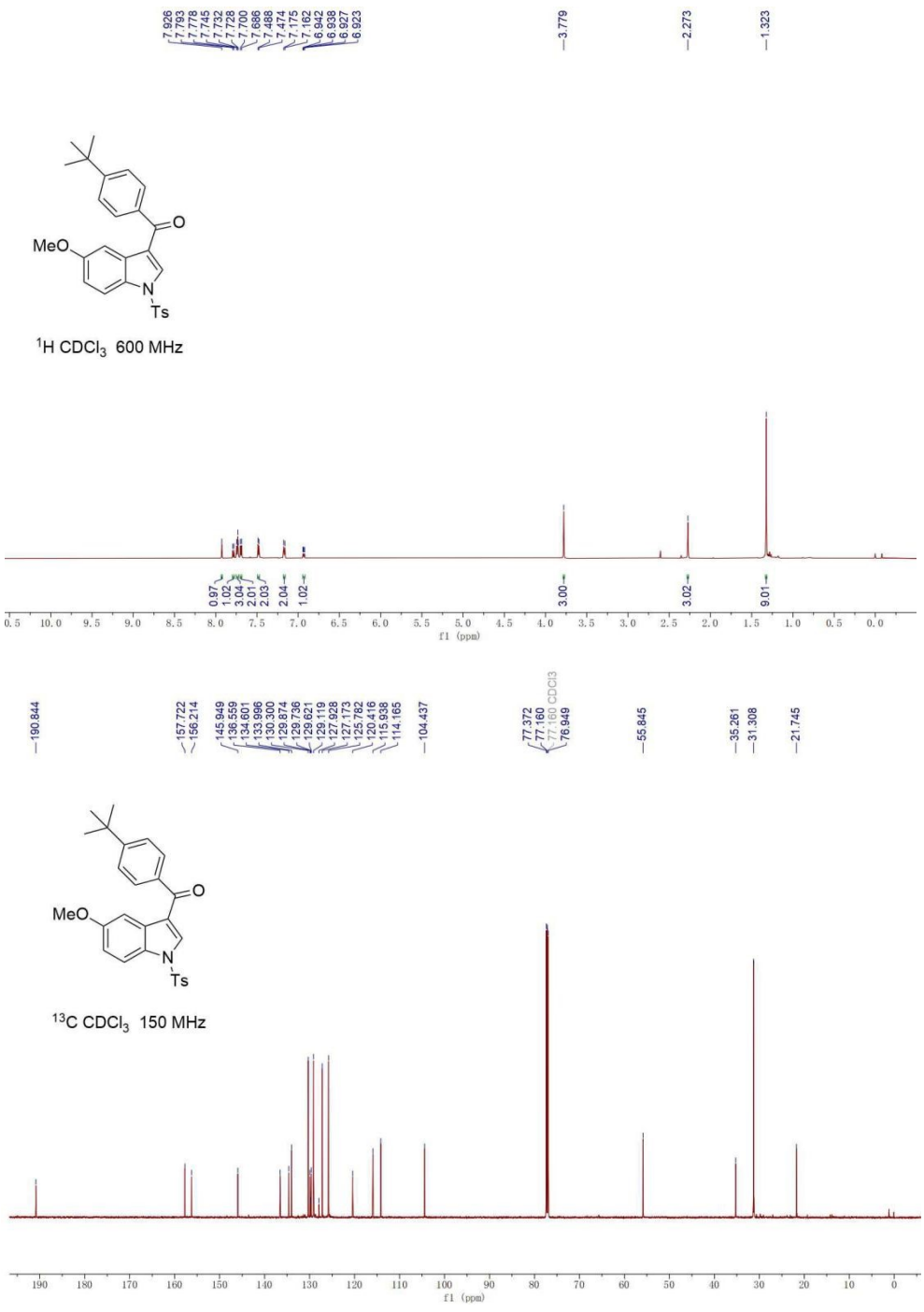
7.994
7.871
7.856
7.823
7.816
7.810
7.802
7.797
7.778
7.762
7.566
7.552
7.402
7.388
7.252
7.239
7.020
7.015
7.005
7.000
3.856
3.052
3.040
3.028
3.017
3.005
2.351
1.401
1.335
1.323
MeO
O
N
Ts
^{1}H CDCl$_3$ 600 MHz
1.00
0.96
2.98
1.97
1.00
2.02
0.97
3.01
0.96
3.03
3.00
2.97
f1 (ppm)
0.850
7.719
6.217
154.003
145.950
136.984
134.607
133.943
130.302
129.418
127.175
126.915
125.784
120.429
115.937
114.171
104.438
104.424
77.372
77.161
77.160 CDCl3
76.949
55.844
31.309
23.904
21.746
MeO
O
N
Ts
^{13}C CDCl$_3$ 150 MHz
f1 (ppm)

3ak


7.926
7.793
7.778
7.745
7.732
7.728
7.700
7.686
7.468
7.414
7.175
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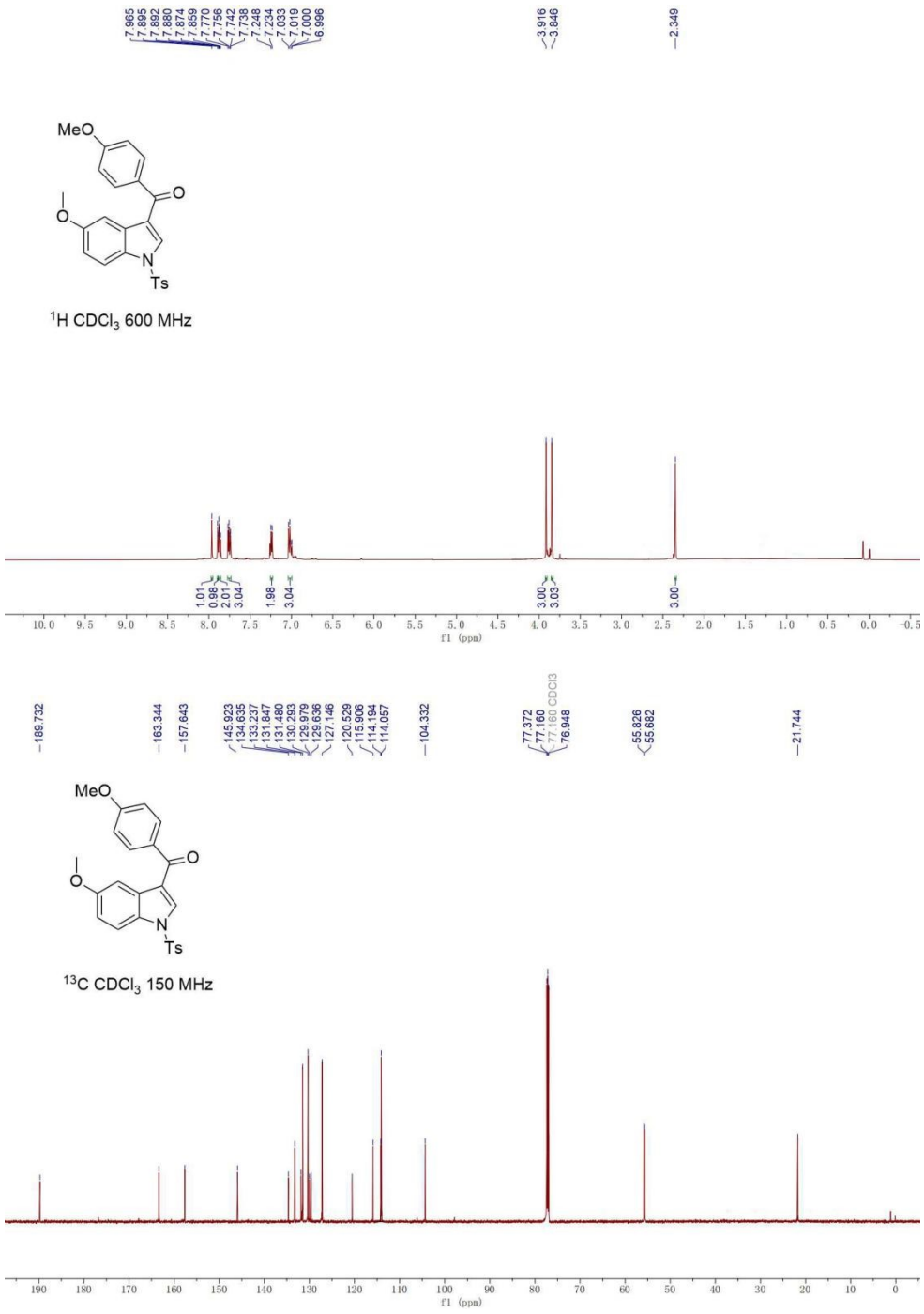
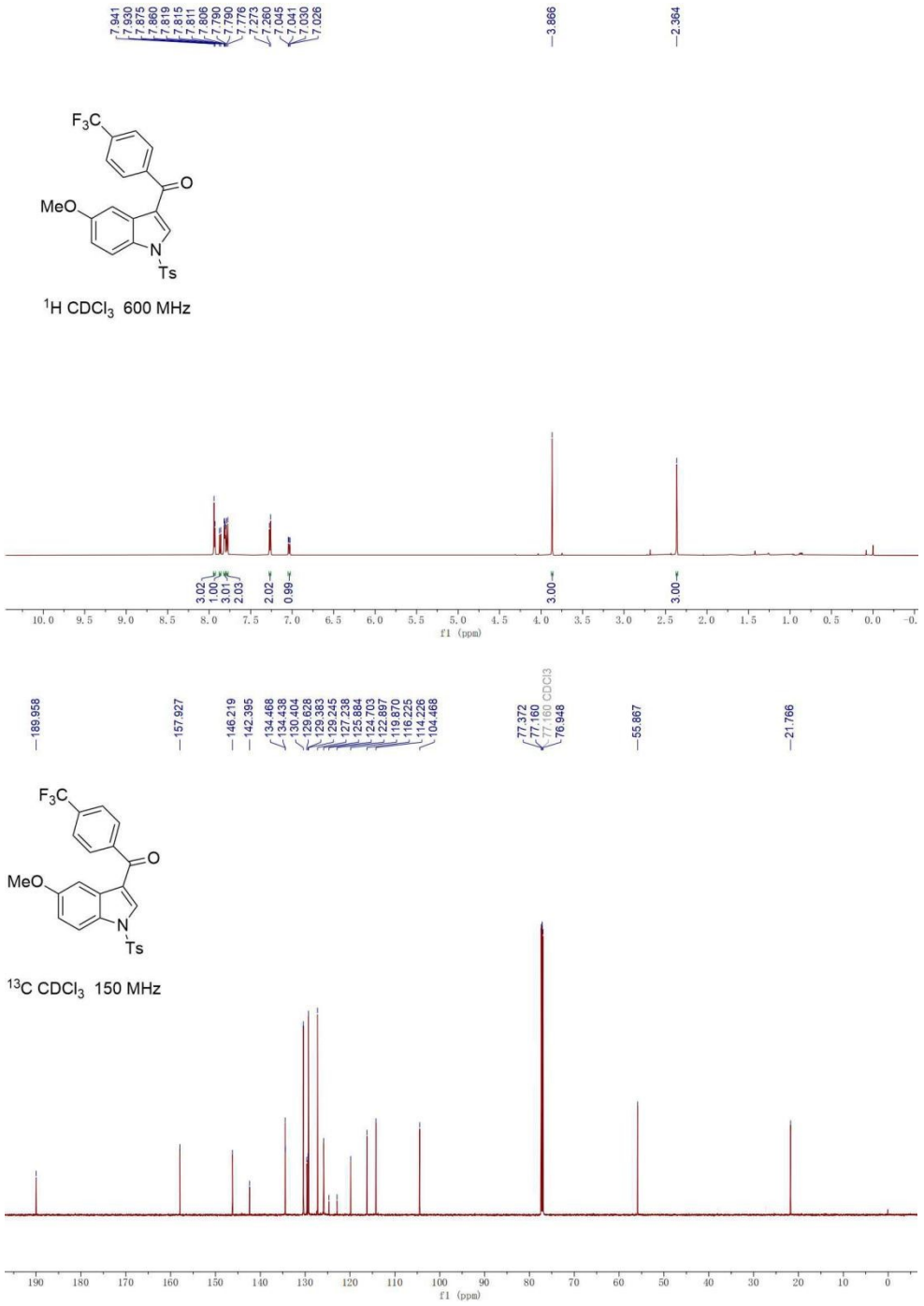
6.942
6.938
6.927
6.923
3.779
2.273
1.323
MeO
N
Ts
1H CDCl3 600 MHz
0.97
1.02
3.04
2.01
2.03
2.04
1.02
3.00
3.02
9.01
f1 (ppm)
190.844
157.722
156.214
145.949
136.559
134.601
133.986
130.300
129.874
129.736
129.621
129.119
127.928
127.173
125.782
120.416
115.938
114.165
104.437
77.372
77.160
77.160 CDCl3
76.949
55.845
35.261
31.308
21.745
MeO
N
Ts
13C CDCl3 150 MHz
f1 (ppm)

3al


7.965
7.895
7.892
7.880
7.874
7.659
7.770
7.756
7.742
7.738
7.248
7.234
7.033
7.019
7.000
6.996
3.916
3.846
2.349
MeO
O
O
N
Ts
1H CDCl3 600 MHz
1.01
0.98
2.01
3.04
1.98
3.04
3.00
3.03
3.00
f1 (ppm)
189.732
163.344
157.643
145.923
134.635
133.237
131.847
131.480
130.293
129.979
129.636
127.146
120.529
115.906
114.194
114.057
104.332
77.372
77.160
77.160 CDCl3
76.948
55.826
55.682
21.744
MeO
O
O
N
Ts
13C CDCl3 150 MHz
f1 (ppm)

3am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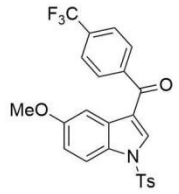
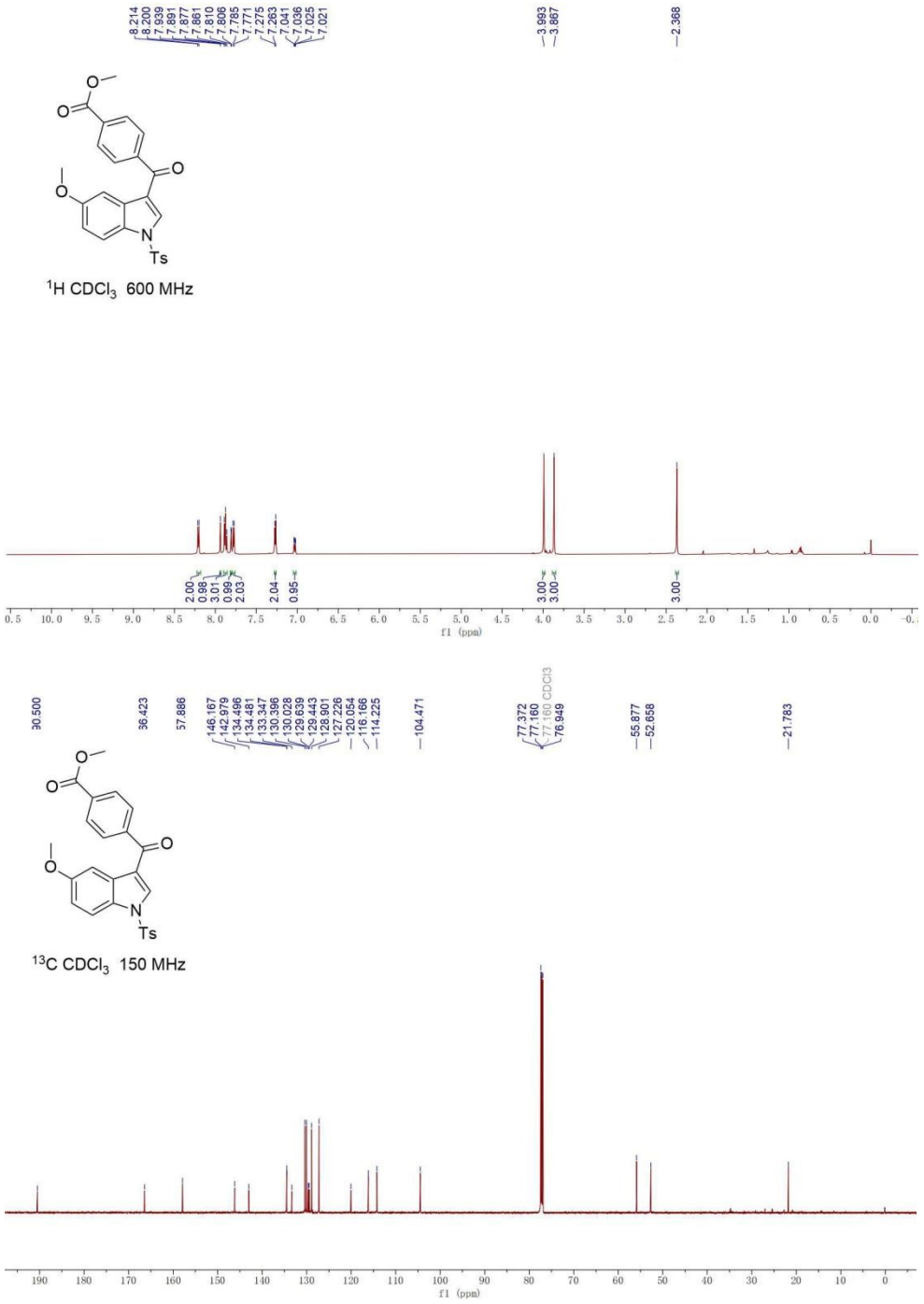
7.860
7.819
7.815
7.811
7.806
7.790
7.790
7.776
7.273
7.260
7.045
7.041
7.030
7.026
3.866
2.364
F3C
O
MeO
N
Ts
1H CDCl3 600 MHz
3.02
1.00
3.01
2.03
2.02
0.99
3.00
3.00
f1 (ppm)
189.958
157.927
146.219
142.395
134.468
134.438
130.404
129.628
129.383
129.245
127.238
125.884
124.703
122.897
119.870
116.225
114.226
104.468
77.372
77.160
77.160 CDCl3
76.948
55.867
21.766
13C CDCl3 150 MHz
f1 (ppm)

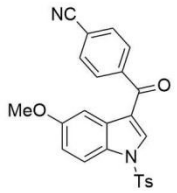


^{19}F $CDCl_3$ 470MHz

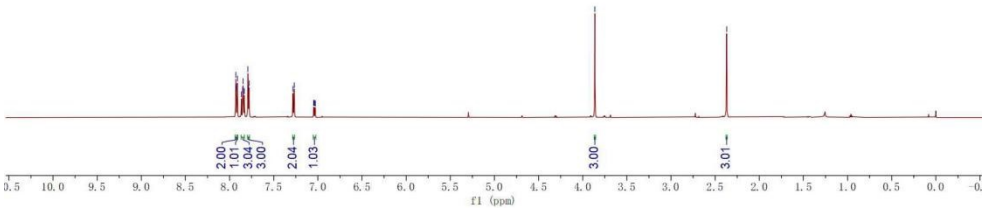
3an

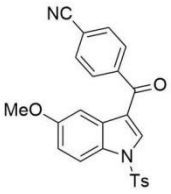

8.214
8.200
7.939
7.891
7.877
7.861
7.810
7.806
7.785
7.771
7.275
7.263
7.041
7.036
7.025
7.021
3.993
3.867
2.368
Ts
1H CDCl3 600 MHz
2.00
0.98
3.01
0.99
2.03
2.04
0.95
3.00
3.00
3.00
f1 (ppm)
90.500
36.423
57.886
146.167
142.979
134.496
134.481
133.347
130.396
130.028
129.639
129.443
128.901
127.226
120.054
116.166
114.225
104.471
77.372
77.160
77.160 CDCl3
76.949
55.877
52.658
21.783
Ts
13C CDCl3 150 MHz
f1 (ppm)

3ao

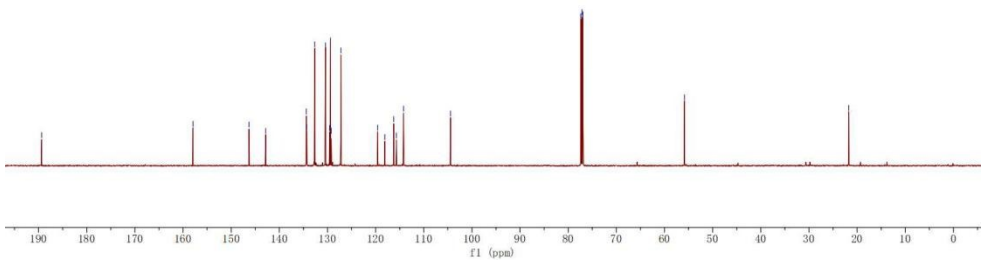


^{1}H $CDCl_3$ 600 MHz

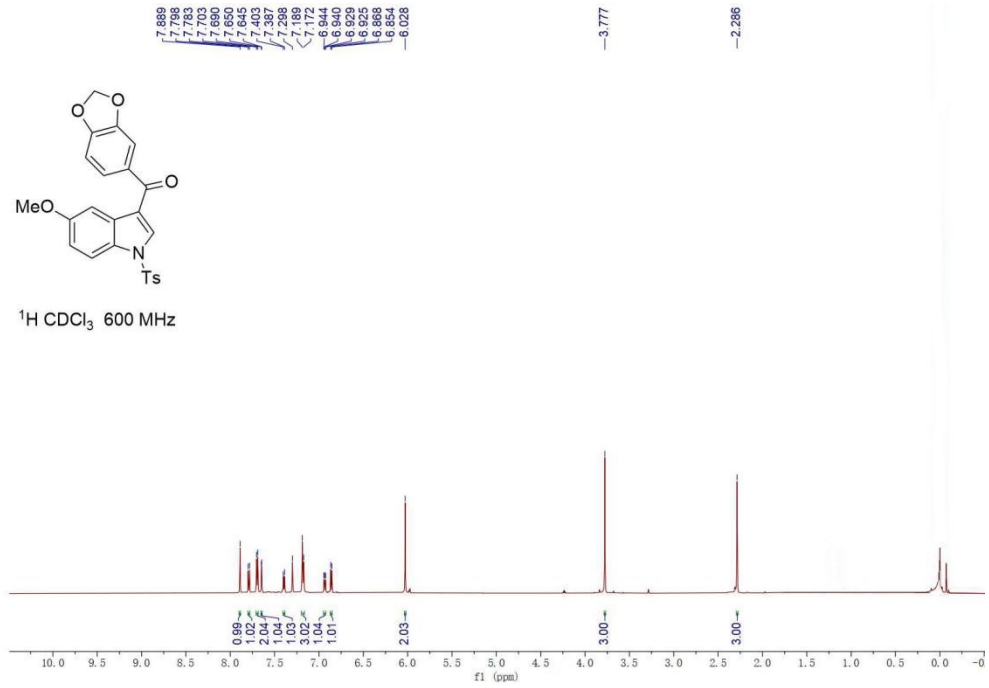


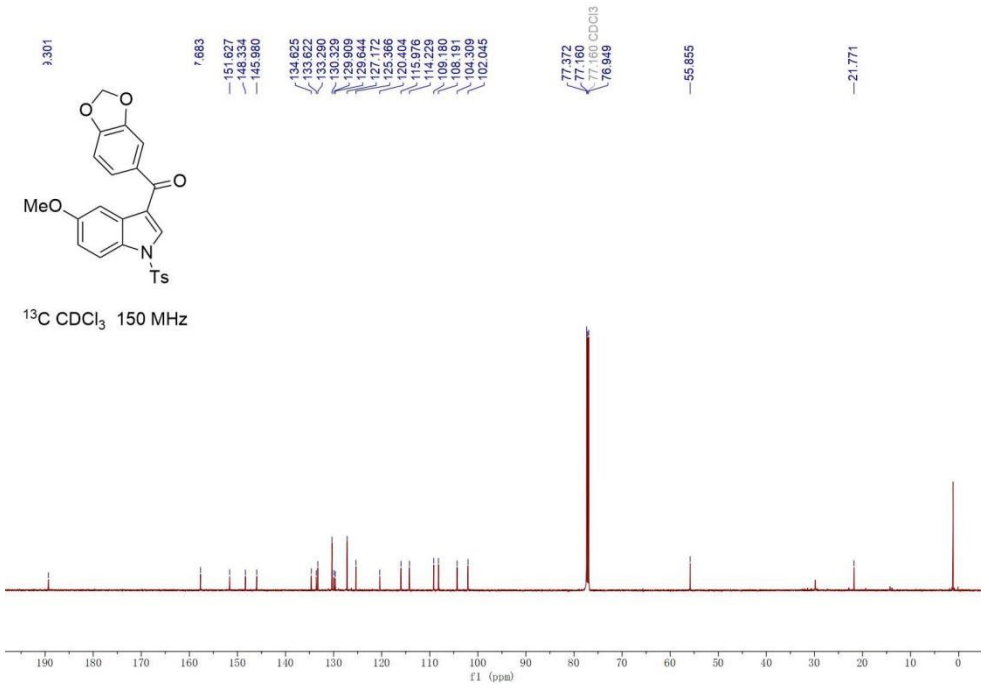


^{13}C $CDCl_3$ 150 MHz

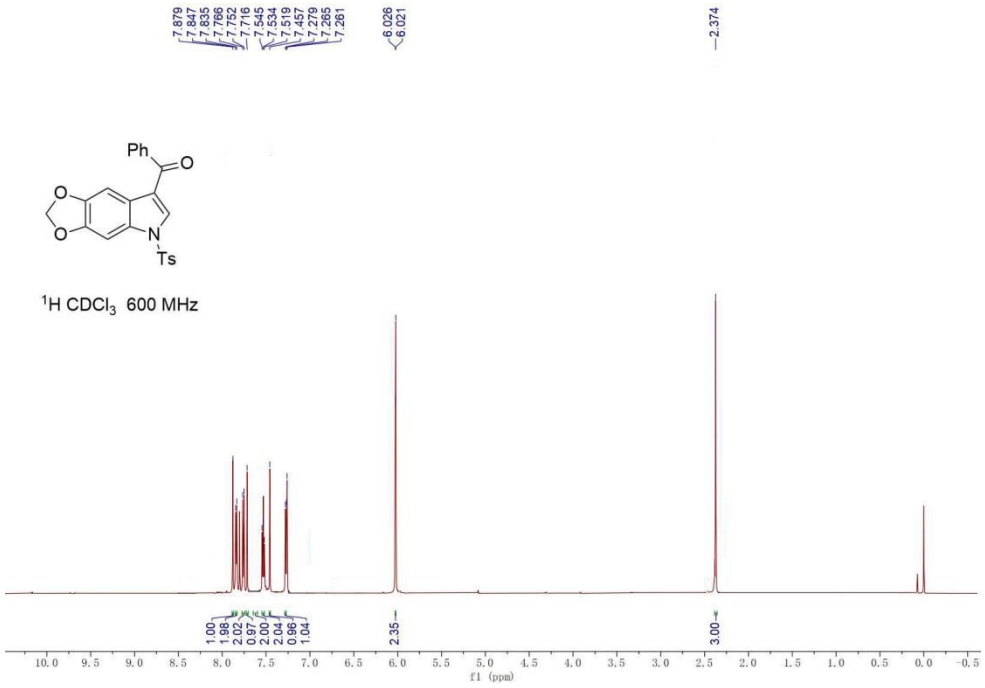


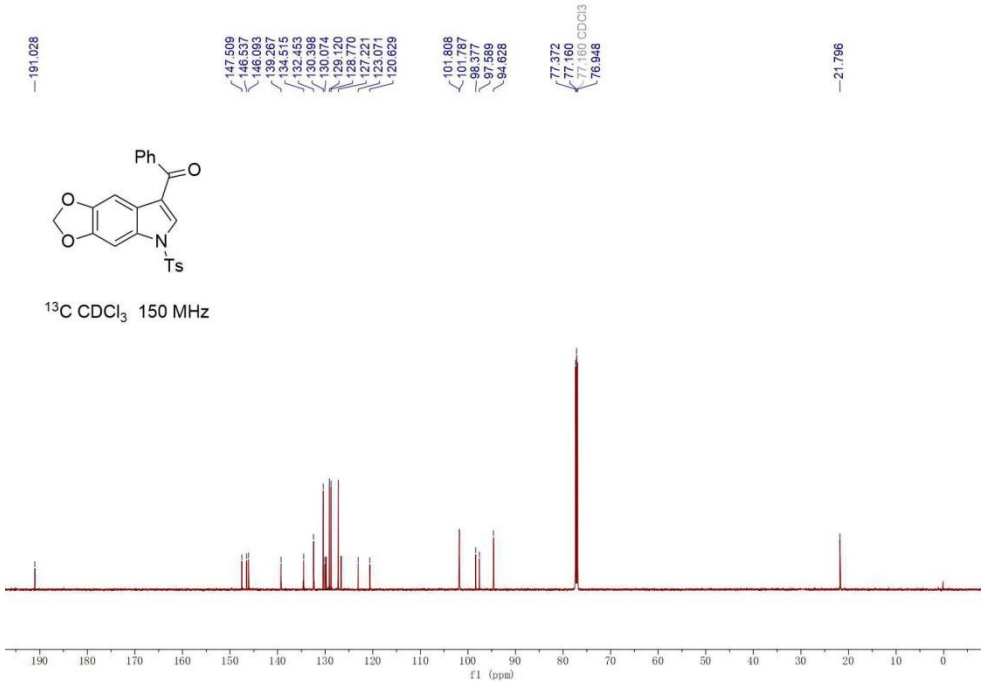
3ap


7.889
7.798
7.783
7.703
7.690
7.650
7.645
7.403
7.387
7.298
7.189
7.172
6.944
6.940
6.929
6.925
6.868
6.854
6.028
3.777
2.286
MeO
N
Ts
1H CDCl3 600 MHz
0.99
1.02
2.04
1.04
1.03
3.02
1.04
1.01
2.03
3.00
3.00
f1 (ppm)

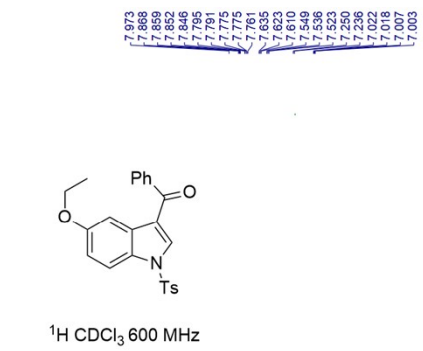

151.627
148.334
145.980
134.625
133.622
133.280
130.329
129.909
129.644
127.172
125.366
120.404
115.976
114.229
109.160
108.151
104.309
102.045
77.372
77.160
CDCl3
76.949
55.855
21.771
MeO
N
Ts
13C CDCl3 150 MHz
f1 (ppm)

3ba

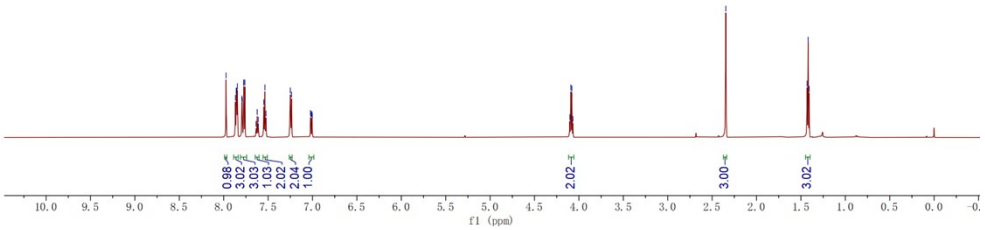

7.879
7.847
7.835
7.796
7.792
7.716
7.545
7.534
7.519
7.457
7.279
7.265
7.261
6.026
6.021
2.374
Ph
O
O
O
N
Ts
1H CDCl3 600 MHz
1.00
1.98
2.02
0.97
2.00
2.04
0.96
1.04
2.35
3.00
f1 (ppm)

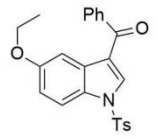

191.028
147.509
146.537
146.093
139.267
134.515
132.453
130.398
130.074
129.120
128.770
127.221
123.071
120.629
101.808
101.787
98.377
97.589
94.628
77.372
77.160
76.948
CDCl3
21.796
Ph
O
O
O
N
Ts
13C CDCl3 150 MHz
f1 (ppm)

3ca

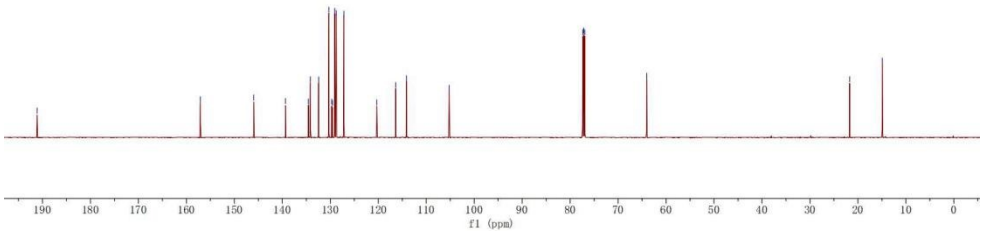


^{1}H $CDCl_3$ 600 MHz



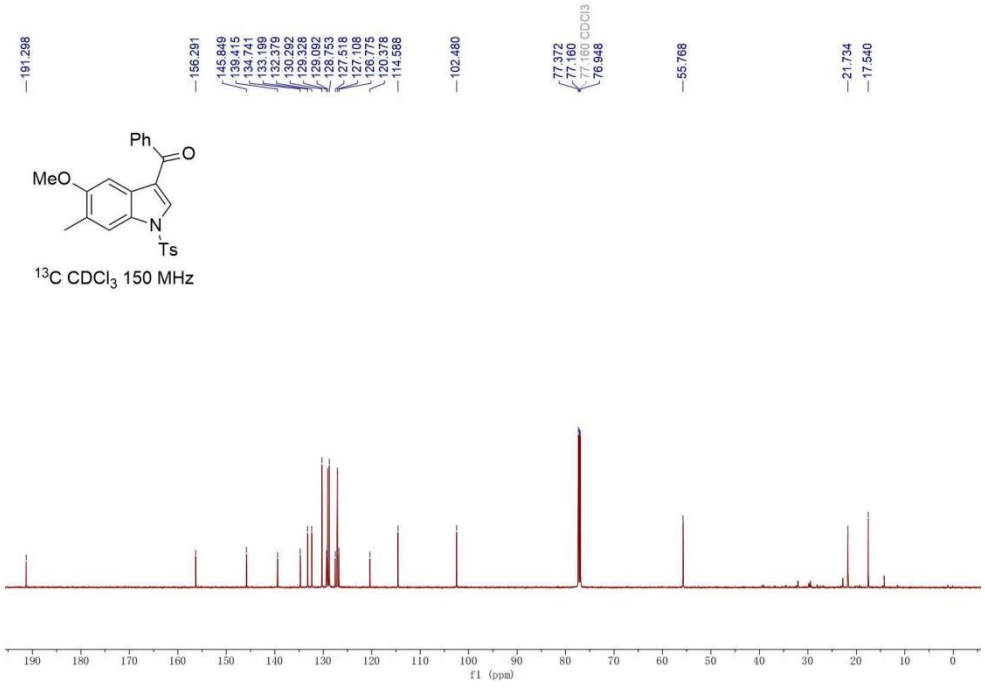


^{13}C $CDCl_3$ 150 MHz

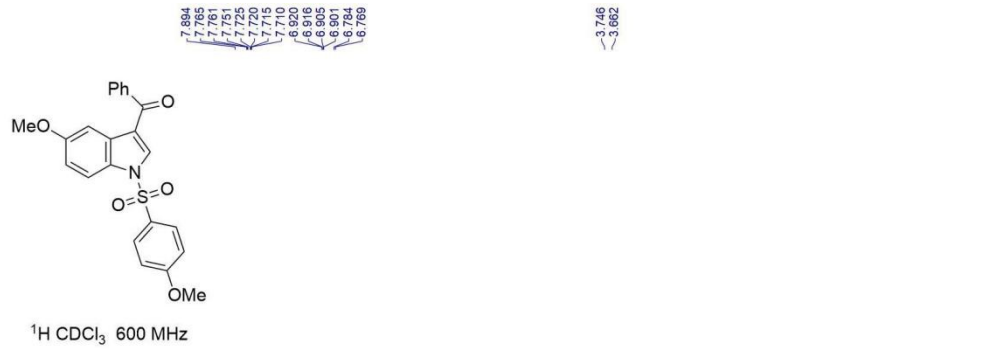


3ea

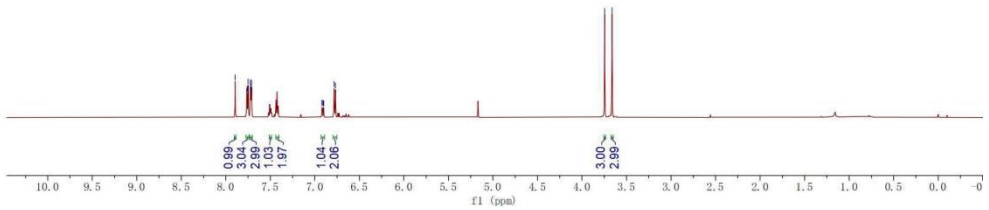

7.830
7.780
7.778
7.776
7.770
7.767
7.764
7.694
7.691
7.684
7.680
7.667
7.649
7.551
7.539
7.527
7.465
7.453
7.440
7.174
7.161
3.803
2.269
Ph
O
MeO
N
Ts
1H CDCl3 600 MHz
1.01
1.99
3.02
1.09
0.98
2.02
1.98
3.00
6.00
f1 (ppm)

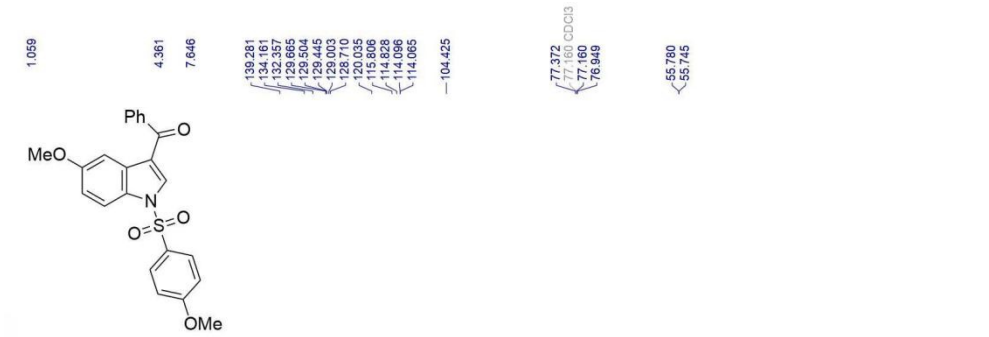

191.298
156.291
145.849
139.415
134.741
133.199
132.379
130.292
129.328
129.092
128.753
127.518
127.108
126.775
120.378
114.588
102.480
77.372
77.160
77.160 CDCl3
76.948
55.768
21.734
17.540
Ph
O
MeO
N
Ts
13C CDCl3 150 MHz
f1 (ppm)

3ia

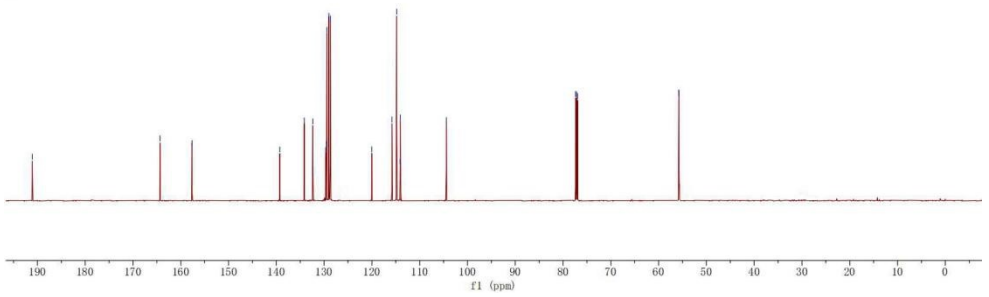


^{1}H $CDCl_3$ 600 MHz



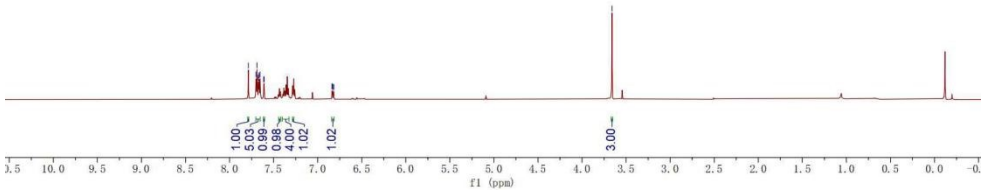


^{13}C $CDCl_3$ 150 MHz

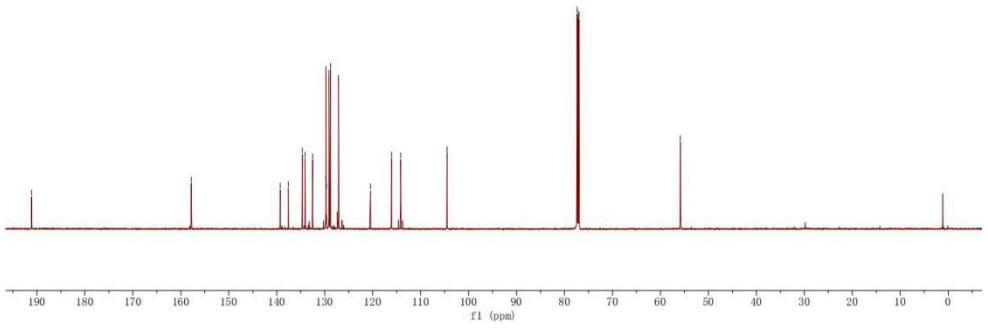


3ja

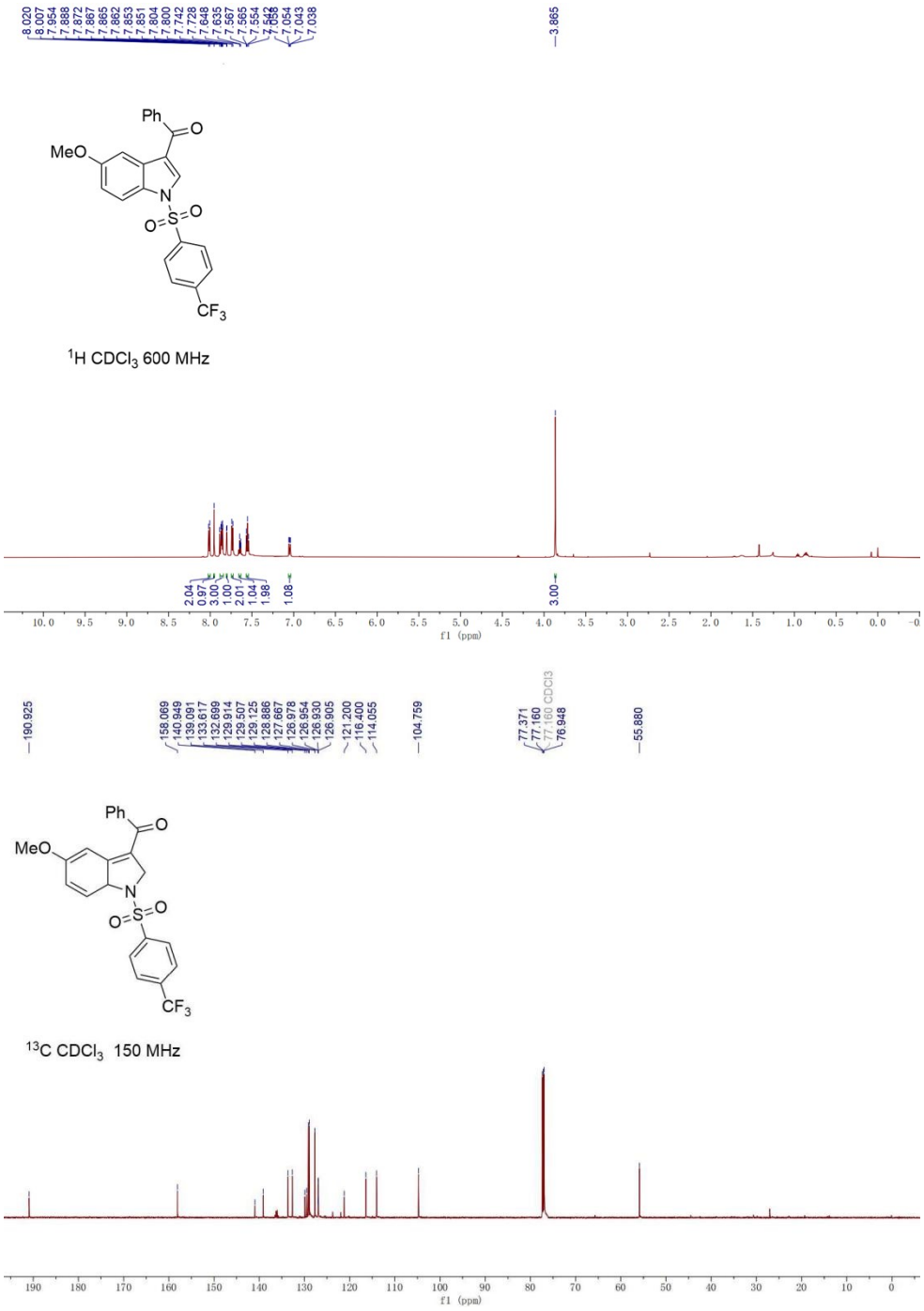
^{1}H $CDCl_3$ 600 MHz

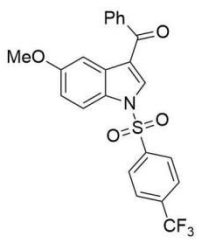


^{13}C $CDCl_3$ 150 MHz



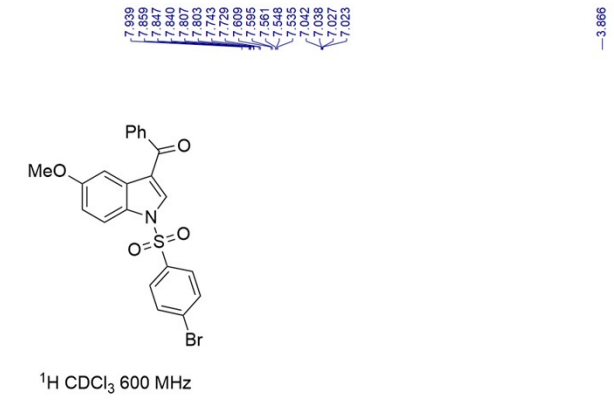
3ka


8.020
8.007
7.954
7.888
7.872
7.867
7.865
7.862
7.853
7.851
7.804
7.800
7.742
7.728
7.648
7.635
7.567
7.565
7.554
7.542
7.058
7.054
7.043
7.038
3.865
Ph
O
MeO
N
O=S=O
CF3
1H CDCl3 600 MHz
2.04
0.97
3.00
1.00
2.01
1.04
1.98
1.08
3.00
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)
190.925
158.069
140.949
139.091
133.617
132.699
129.914
129.507
129.125
128.886
127.667
126.978
126.954
126.930
126.905
121.200
116.400
114.055
104.759
77.371
77.160
77.160 CDCl3
76.948
55.880
Ph
O
MeO
N
O=S=O
CF3
13C CDCl3 150 MHz
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

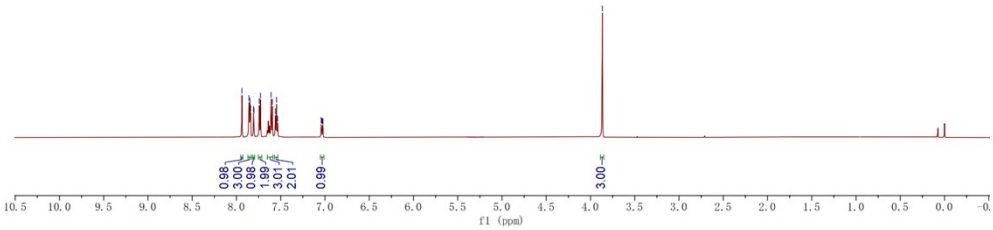


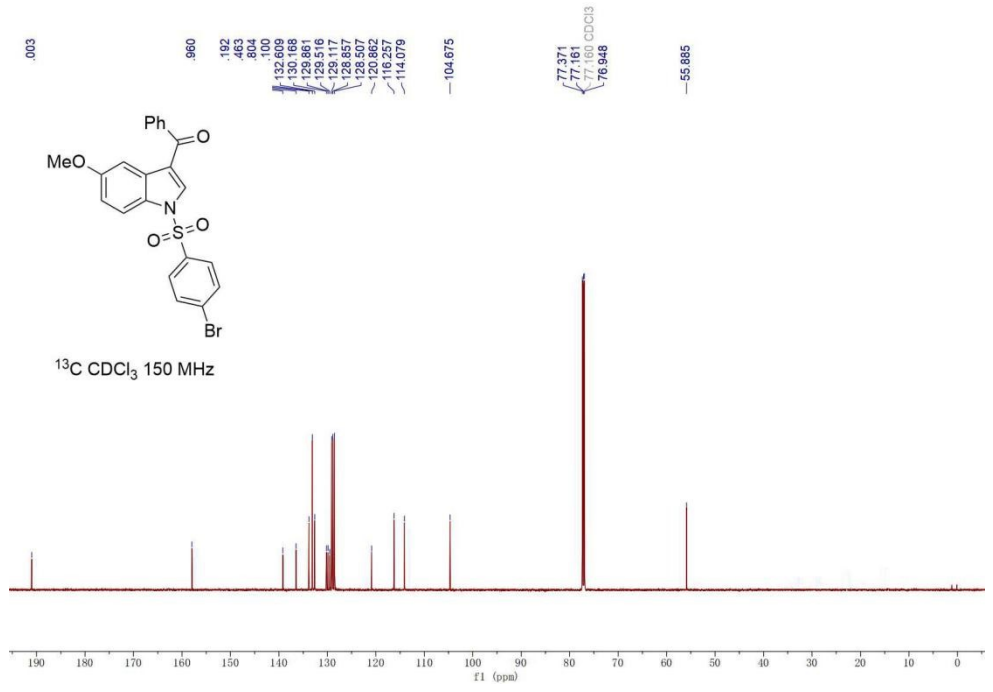
^{19}F $CDCl_3$ 470MHz

3la



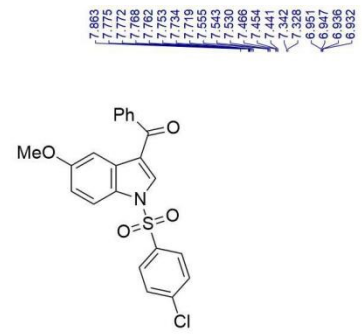
^{1}H $CDCl_3$ 600 MHz



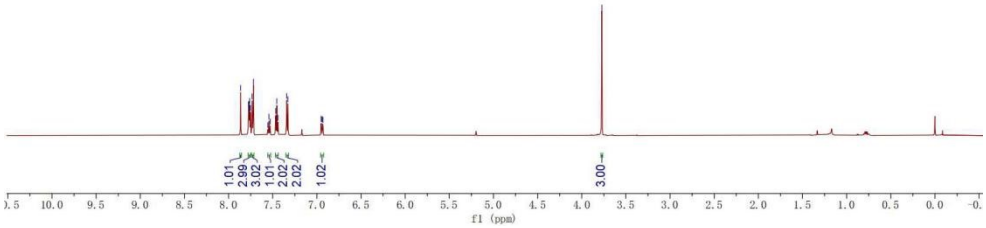


^{13}C $CDCl_3$ 150 MHz

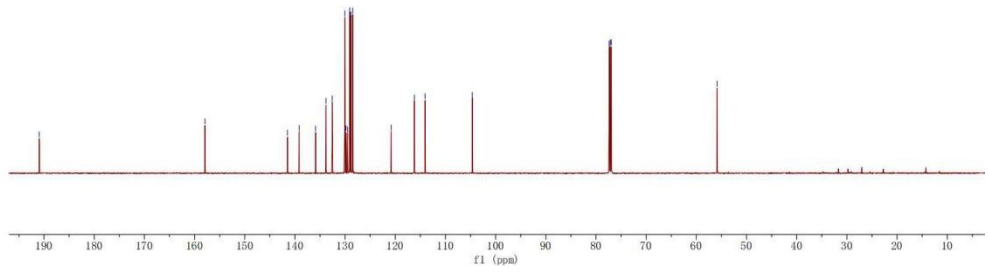
3ma



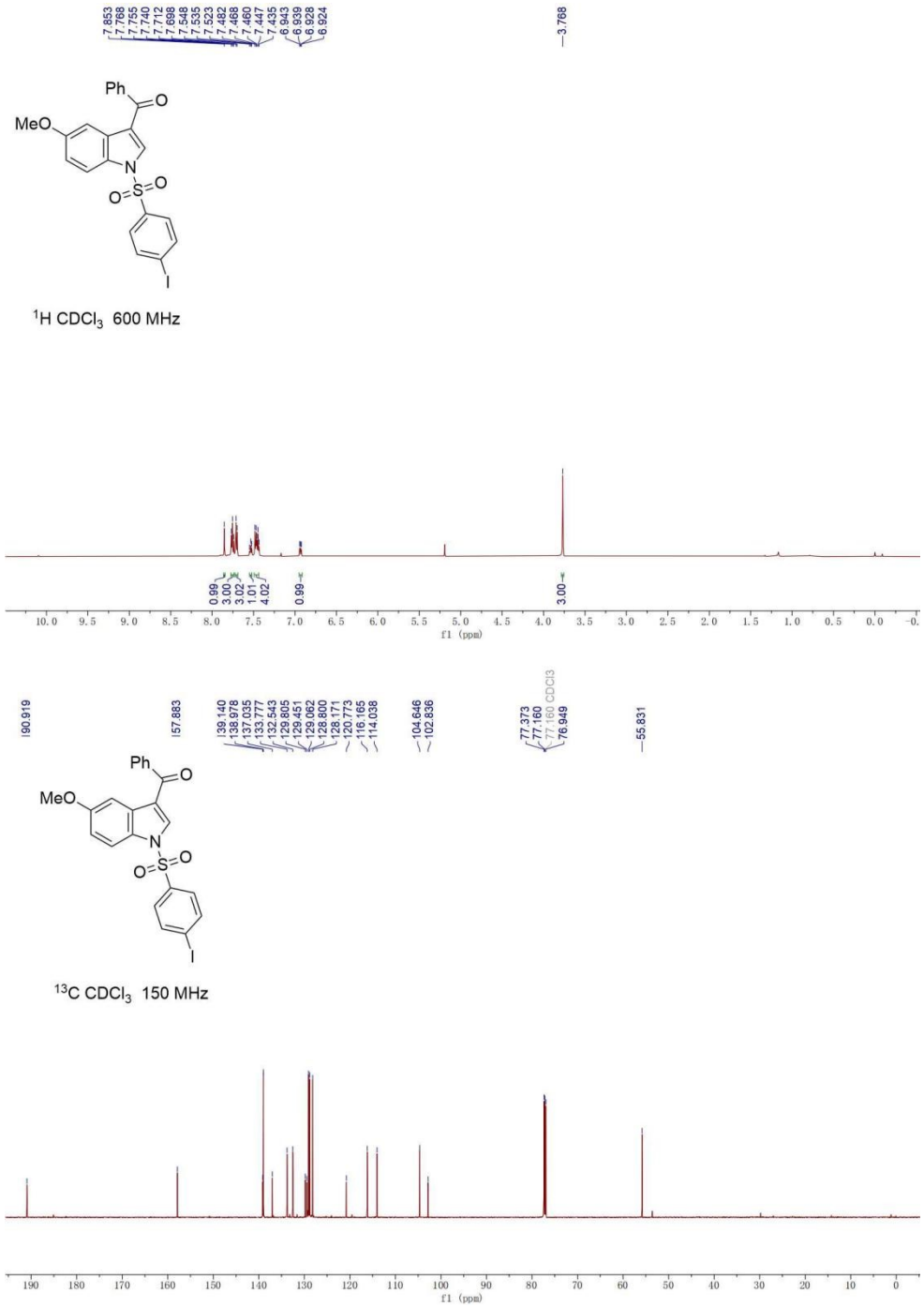
^{1}H $CDCl_3$ 600 MHz



^{13}C $CDCl_3$ 150 MHz

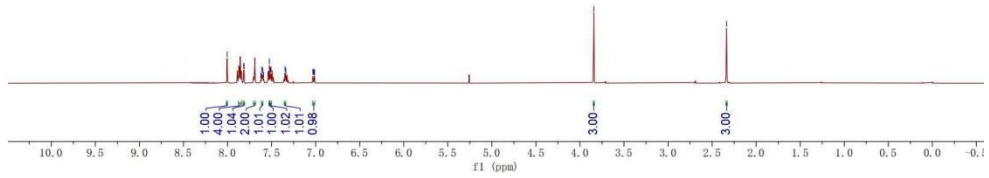


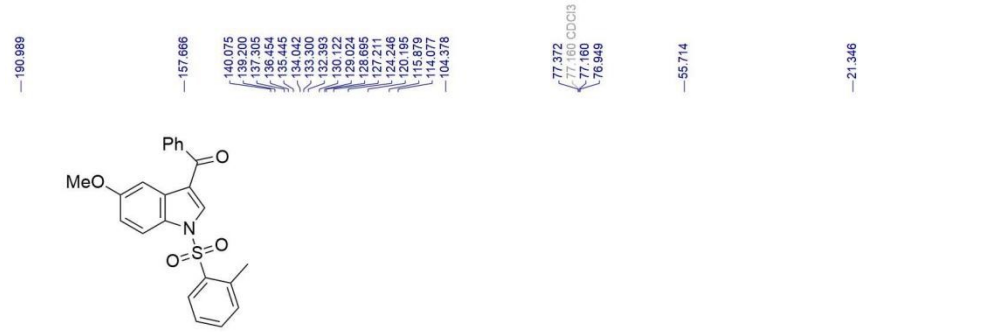
3na


7.853
7.768
7.755
7.740
7.712
7.698
7.548
7.535
7.523
7.482
7.468
7.460
7.447
7.435
6.943
6.939
6.928
6.924
3.768
Ph
O
MeO
N
O=S=O
I
1H CDCl3 600 MHz
0.99
3.00
3.02
1.01
4.02
0.99
3.00
f1 (ppm)
190.919
157.883
139.140
138.978
137.035
133.777
132.543
129.805
129.451
129.062
128.600
128.171
120.773
116.165
114.038
104.646
102.836
77.373
77.160
77.160 CDCl3
76.949
55.831
13C CDCl3 150 MHz
f1 (ppm)

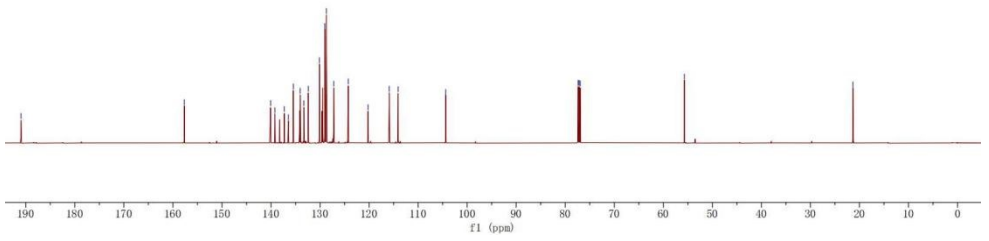
3oa

^{1}H $CDCl_3$ 600 MHz

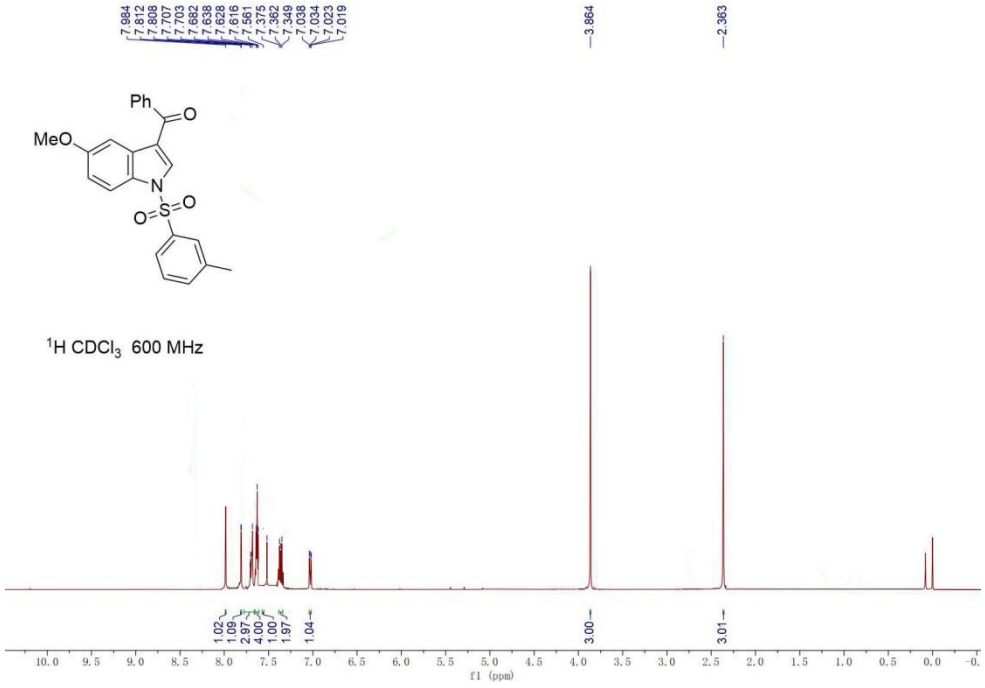


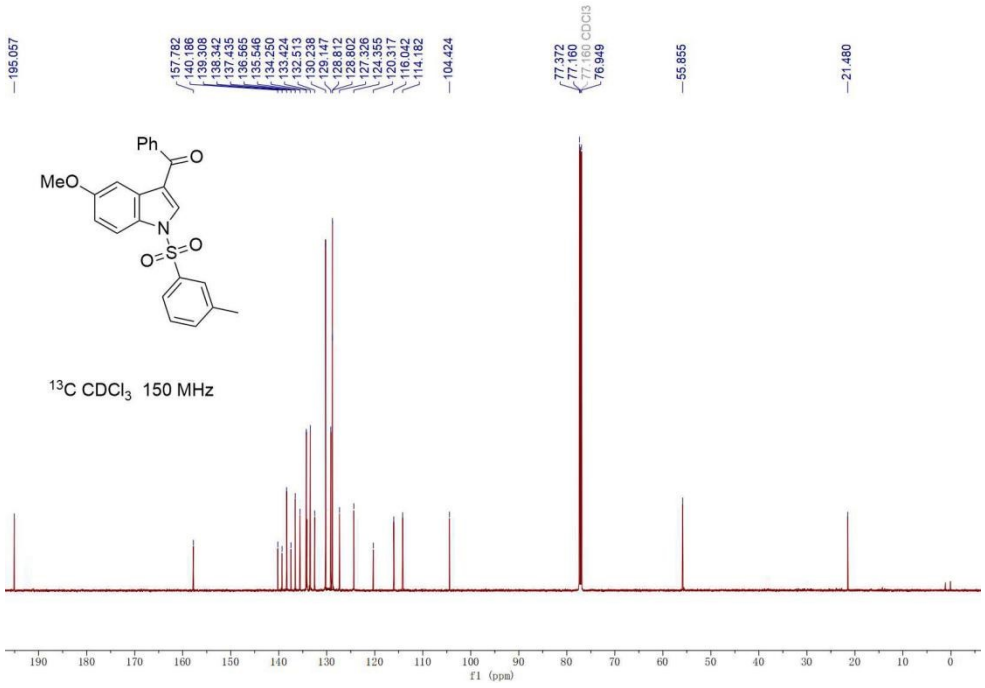


^{13}C $CDCl_3$ 150 MHz

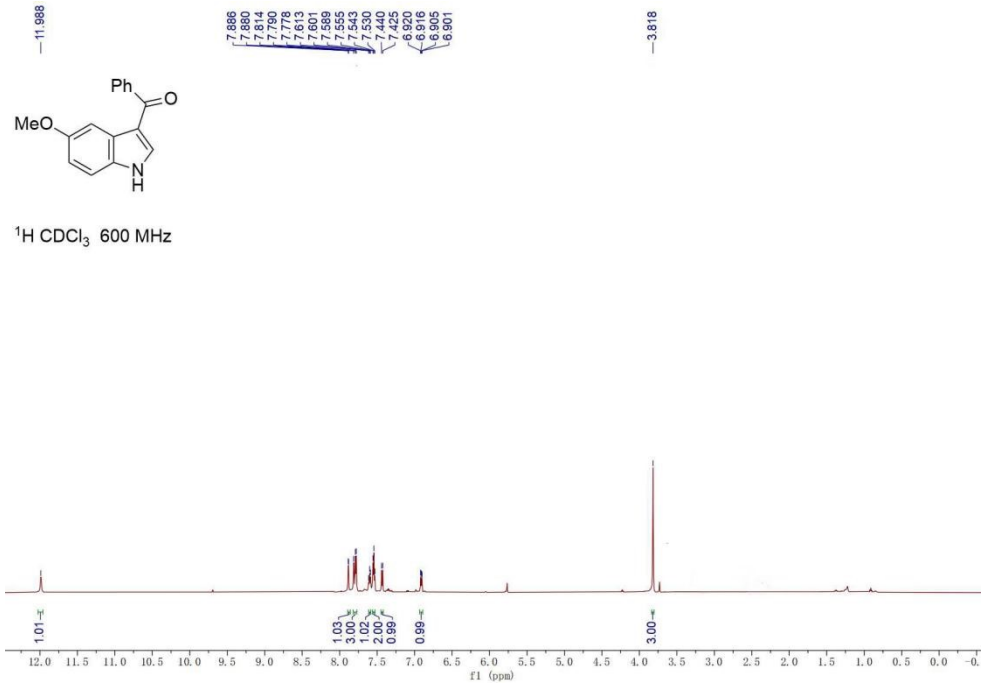


3pa

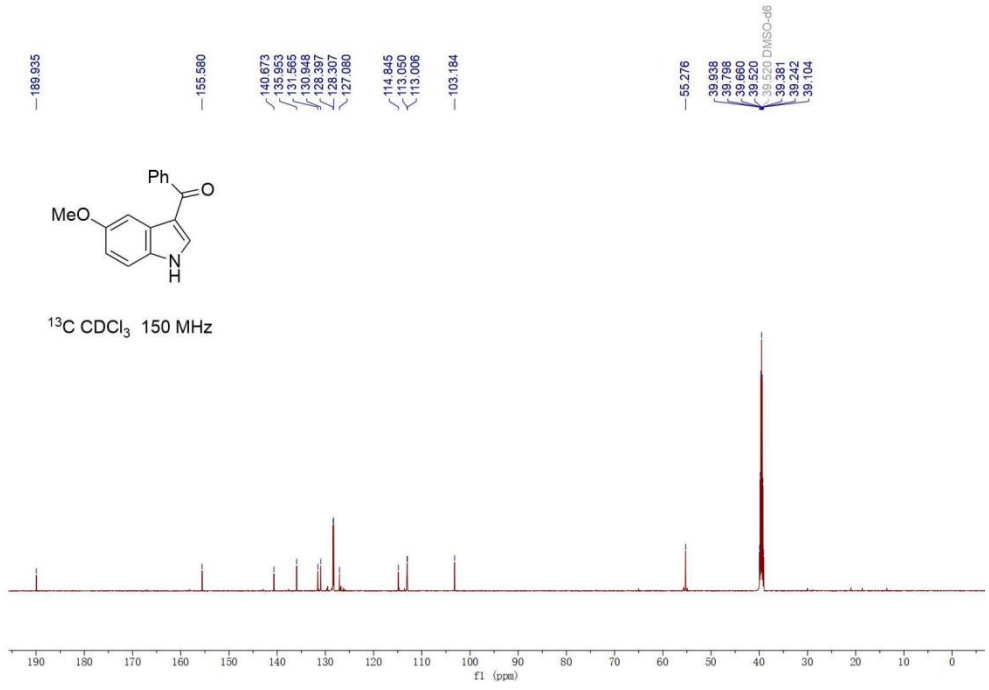

7.984
7.812
7.808
7.707
7.703
7.682
7.638
7.628
7.616
7.561
7.375
7.362
7.348
7.038
7.034
7.023
7.019
3.864
2.363
Ph
O
MeO
N
O=S=O
1H CDCl3 600 MHz
1.02
1.89
2.97
4.00
1.00
1.97
1.04
3.00
3.01
f1 (ppm)


195.057
157.782
140.186
139.308
138.342
137.435
136.565
135.546
134.250
133.424
132.513
130.238
129.147
128.812
128.802
127.326
124.355
120.317
116.042
114.182
104.424
77.372
77.160
77.160 CDCl3
76.949
55.855
21.480
Ph
O
MeO
N
O=S=O
13C CDCl3 150 MHz
f1 (ppm)

3c

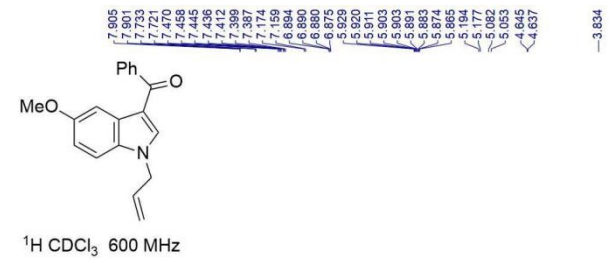


^{1}H $CDCl_3$ 600 MHz

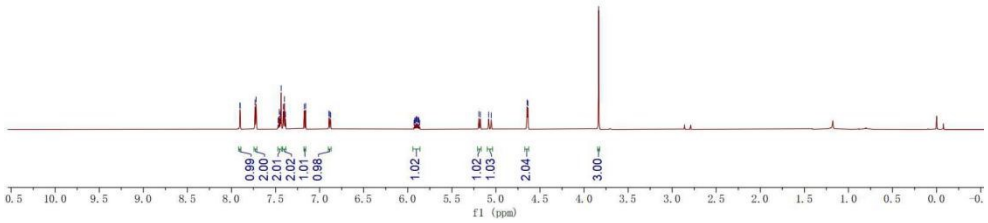


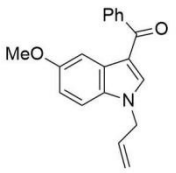
^{13}C $CDCl_3$ 150 MHz

4a

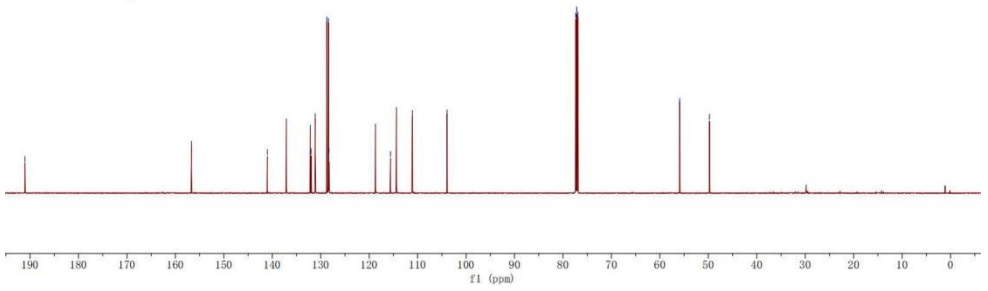


^{1}H $CDCl_3$ 600 MHz

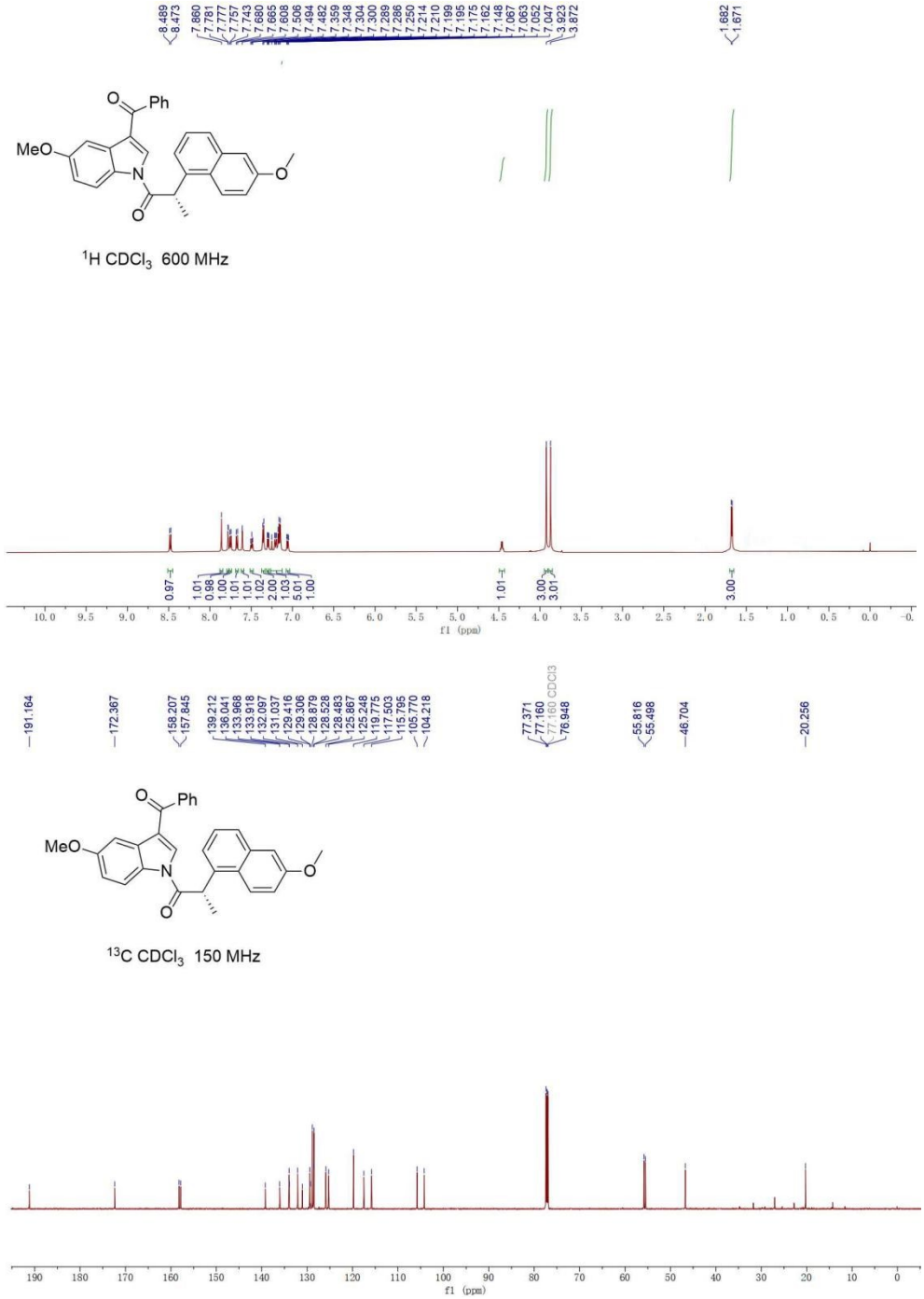




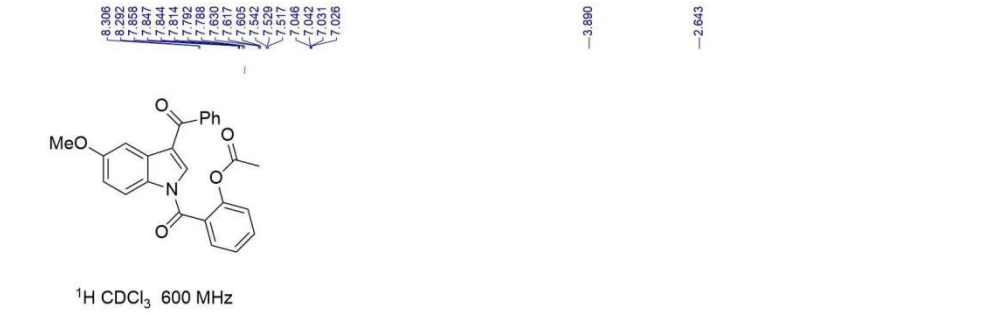
^{13}C $CDCl_3$ 150 MHz



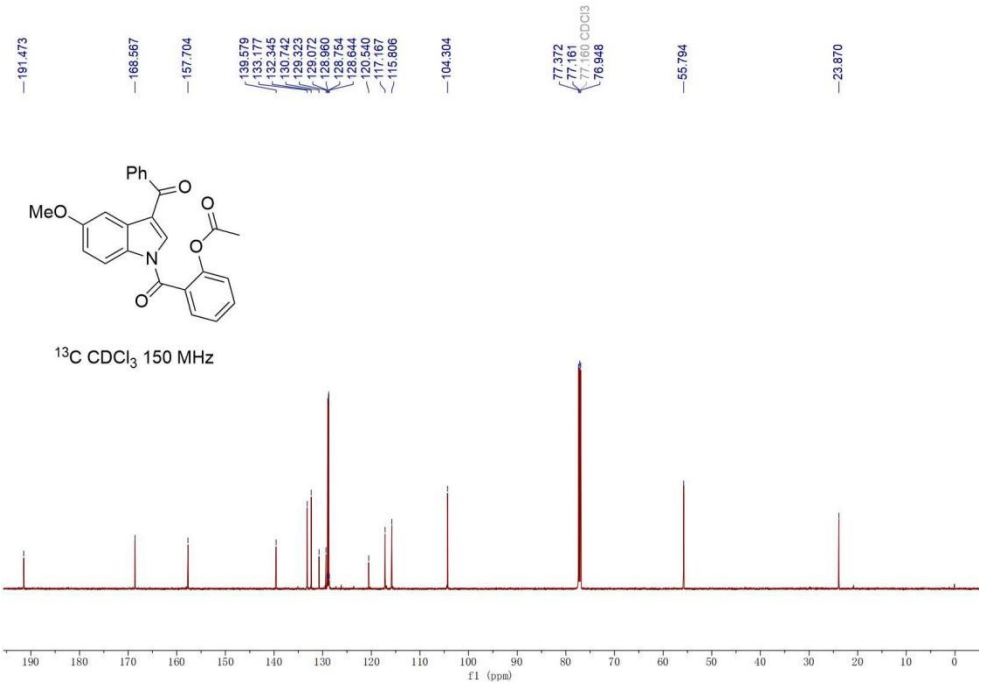
4b


8.489
8.473
7.860
7.781
7.777
7.757
7.743
7.680
7.665
7.608
7.506
7.494
7.482
7.359
7.348
7.304
7.300
7.288
7.250
7.214
7.210
7.199
7.195
7.175
7.162
7.148
7.067
7.063
7.052
7.047
3.923
3.872
1.682
1.671
Ph
MeO
N
O
O
O
1H CDCl3 600 MHz
0.97
1.01
0.98
1.00
1.01
1.01
1.02
2.00
1.03
5.01
1.00
1.01
3.00
3.01
3.00
f1 (ppm)
191.164
172.367
158.207
157.845
139.212
136.041
133.968
133.918
132.097
131.037
129.416
129.306
128.879
128.528
128.483
125.867
125.248
119.775
117.503
115.795
105.770
104.218
77.371
77.160
77.160 CDCl3
76.948
55.816
55.498
46.704
20.256
Ph
MeO
N
O
O
O
13C CDCl3 150 MHz
f1 (ppm)

4c



^{1}H $CDCl_3$ 600 MHz



^{13}C $CDCl_3$ 150 MHz