Supplementary Information (SI) for Organic & Biomolecular Chemistry.
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Supplementary Information

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

Yangyang Hu,‡[a] Chunlei Yu,‡[b] Ya'nan Ran,[a] Miao Yu,[a] Jingwen Sun,[a] Huiying Liu,[a] Jiahui Zhang[a], Haijun Wang[a] and Lei Liu*[a]

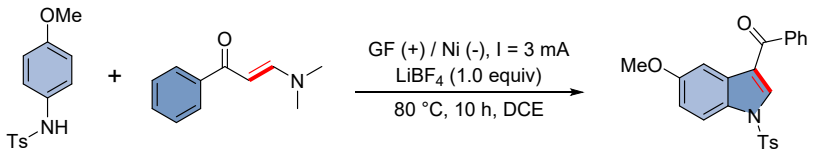
[a]College of Pharmacy, Qiqihar Medical University, Qiqihar, Heilongjiang, 161006, P. R. China
[b]The Institute of Medicine, Qiqihar Medical University, Qiqihar, Heilongjiang, 161006, P. R. China

Table of Contents

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



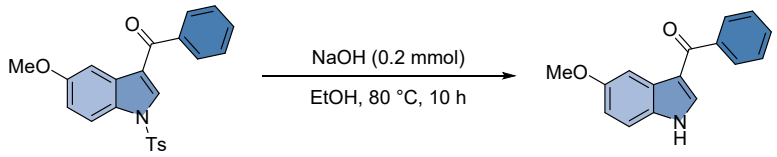
1a **2a** **3aa**

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

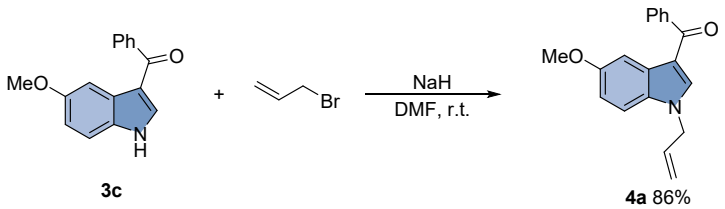
(a) The synthesis of 3c



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

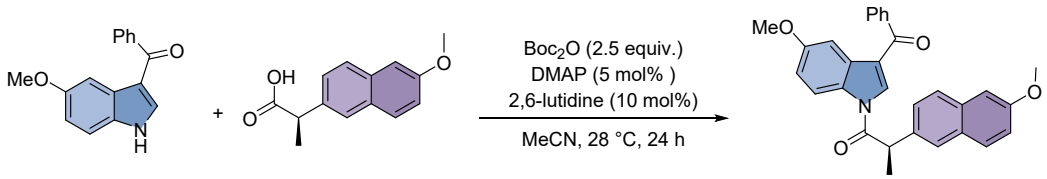


3c **4a** 86%

(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.

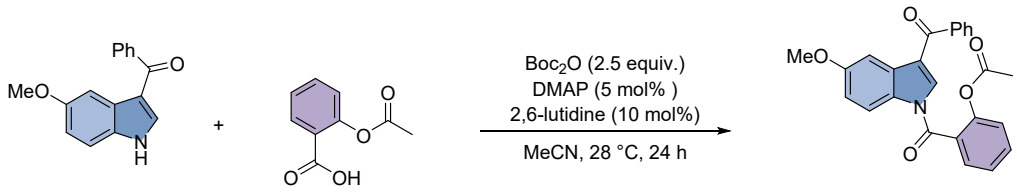
(c)The synthesis of 4b



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.

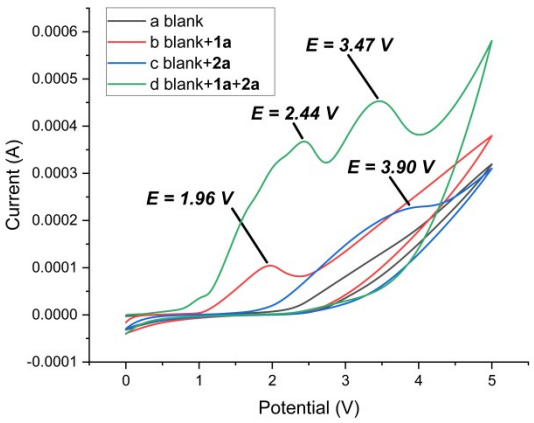
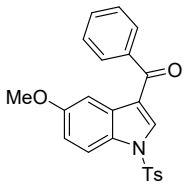


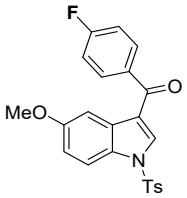
Figure S1. Cyclic voltammograms.

5. Spectra data of products



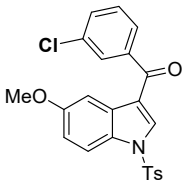
(5-methoxy-1-tosyl-*1H*-indol-3-yl)(phenyl)methanone(3aa)

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.



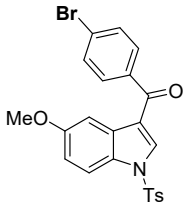
(4-fluorophenyl)(5-methoxy-1-tosyl-*1H*-indol-3-yl)methanone(3ab)

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.



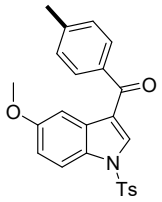
(3-chlorophenyl)(5-methoxy-1-tosyl-*1H*-indol-3-yl)methanone(3ac)

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.



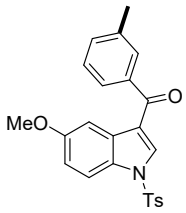
(4-bromophenyl)(5-methoxy-1-tosyl-*1H*-indol-3-yl)methanone(3ad)

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.



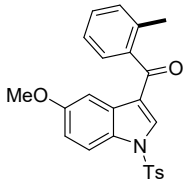
(5-methoxy-1-tosyl-*1H*-indol-3-yl)(p-tolyl)methanone(3ae)

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.



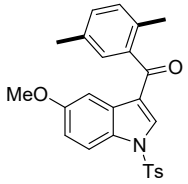
(5-methoxy-1-tosyl-*1H*-indol-3-yl)(m-tolyl)methanone(3af)

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.



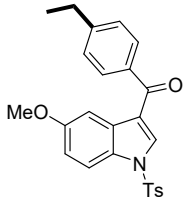
(5-methoxy-1-tosyl-*1H*-indol-3-yl)(o-tolyl)methanone(3ag)

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 193.4, 157.7, 145.9, 139.4, 136.5, 135.1, 134.5, 131.3, 130.4, 130.2, 129.6, 129.1, 128.1, 127.1, 125.5, 121.6, 115.9, 114.1, 104.4, 55.8, 21.7, 19.8. **HRMS (ESI)** calculated for $C_{24}H_{22}NO_4S^+$ $[M+H]^+$: 420.1269; found: 420.1266.



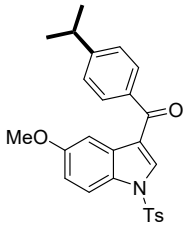
(2,5-dimethylphenyl)(5-methoxy-1-tosyl-*1H*-indol-3-yl) methanone(3ah)

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.



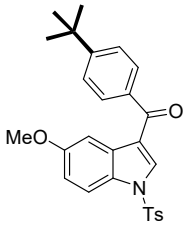
(4-ethylphenyl)(5-methoxy-1-tosyl-*1H*-indol-3-yl)methanone(3ai)

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.



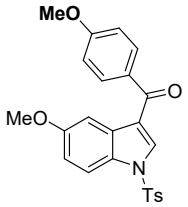
(4-isopropylphenyl)(5-methoxy-1-tosyl-*1H*-indol-3-yl)methanone(3aj)

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.



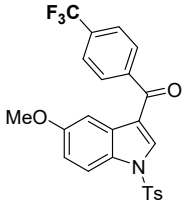
(4-(tert-butyl)phenyl)(5-methoxy-1-tosyl-*1H*-indol-3-yl)methanone（3ak）

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.



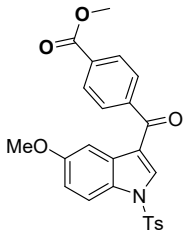
(5-methoxy-1-tosyl-*1H*-indol-3-yl)(4-methoxyphenyl)methanone（3al）

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.



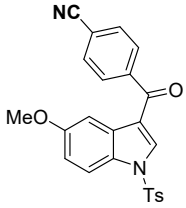
(5-methoxy-1-tosyl-*1H*-indol-3-yl)(4-(trifluoromethyl)phenyl) methanone（3am）

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.



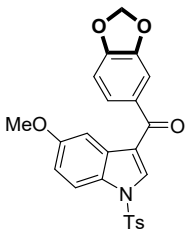
methyl 4-(5-methoxy-1-tosyl-*1H*-indole-3-carbonyl)benzoate(3an)

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.



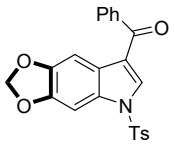
4-(5-methoxy-1-tosyl-*1H*-indole-3-carbonyl)benzonitrile（3ao）

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.



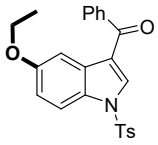
benzo[d][1,3]dioxol-5-yl(5-methoxy-1-tosyl-*1H*-indol-3-yl)methanone（3ap）

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.



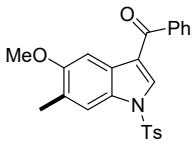
phenyl(5-tosyl-*5H*-[1,3]dioxolo[4,5-f]indol-7-yl)methanone（3ba）

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.



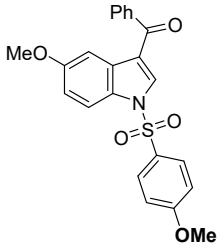
(5-ethoxy-1-tosyl-*1H*-indol-3-yl)(phenyl)methanone（3ca）

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.



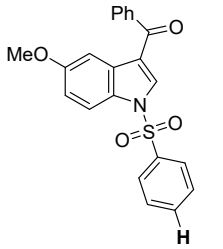
(5-methoxy-6-methyl-1-tosyl-*1H*-indol-3-yl)(phenyl)methanone（3ea）

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.



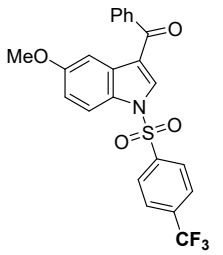
(5-methoxy-1-((4-methoxyphenyl)sulfonyl)-*1H*-indol-3-yl)(phenyl) methanone（3ia）

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.



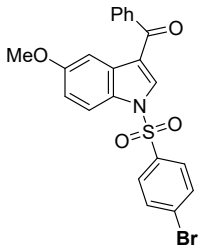
(6-methoxy-1-(phenylsulfonyl)-*1H*-indol-3-yl)(phenyl)methanone（3ja）

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.



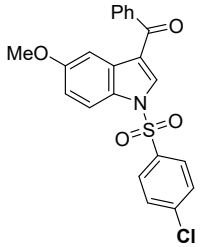
(5-methoxy-1-((4-(trifluoromethyl)phenyl)sulfonyl)-*1H*-indol-3-yl) (phenyl) methanone（3ka）

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.



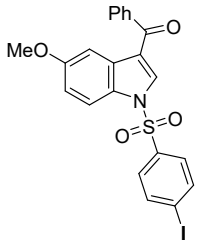
(1-((4-bromophenyl)sulfonyl)-5-methoxy-*1H*-indol-3-yl)(phenyl) methanone(3la)

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.



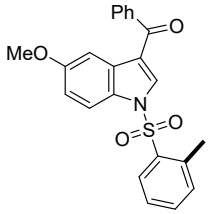
(1-((4-chlorophenyl)sulfonyl)-5-methoxy-*1H*-indol-3-yl)(phenyl) methanone(3ma)

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.



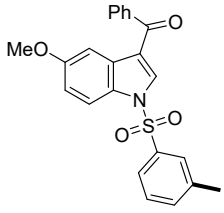
(1-((4-iodophenyl)sulfonyl)-5-methoxy-*1H*-indol-3-yl)(phenyl) methanone(3na)

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.



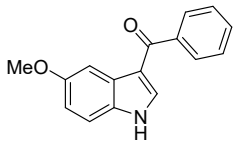
(5-methoxy-1-(o-tolylsulfonyl)-*1H*-indol-3-yl)(phenyl) methanone(3oa)

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.



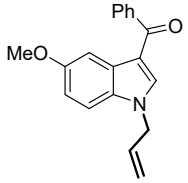
(6-methoxy-1-(m-tolylsulfonyl)-*1H*-indol-3-yl)(phenyl)methanone（3pa）

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.



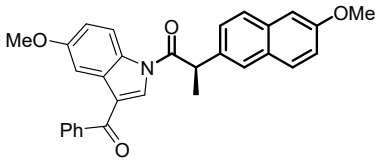
(5-Methoxy-*1H*-indol-3-yl)(phenyl)methanone(3c)

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.



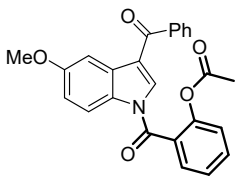
(1-Allyl-5-methoxy-*1H*-indol-3-yl)(phenyl)methanone(4a)

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.

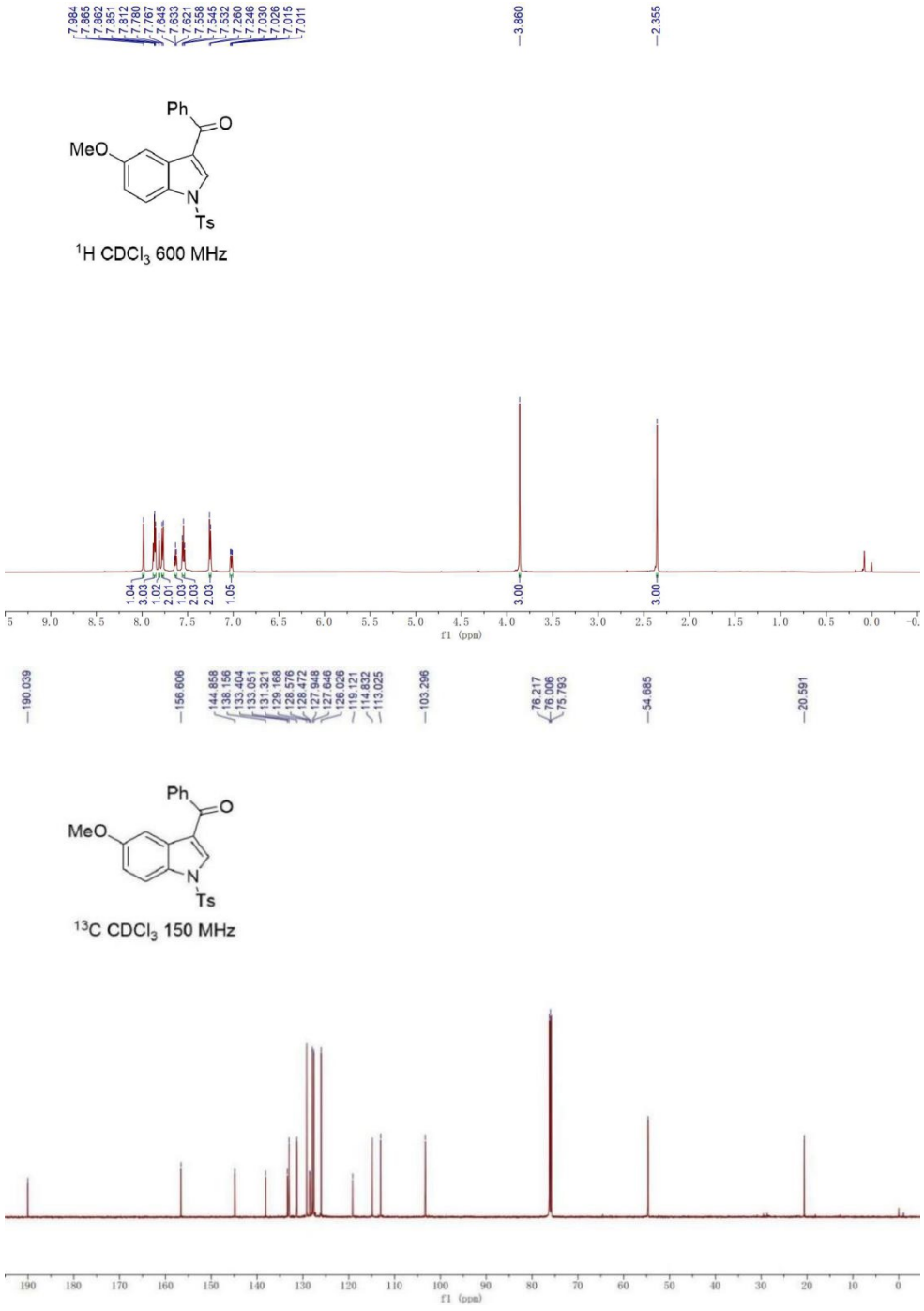


2-(3-Benzoyl-5-methoxy-*1H*-indole-1-carbonyl)phenyl acetate(4c)

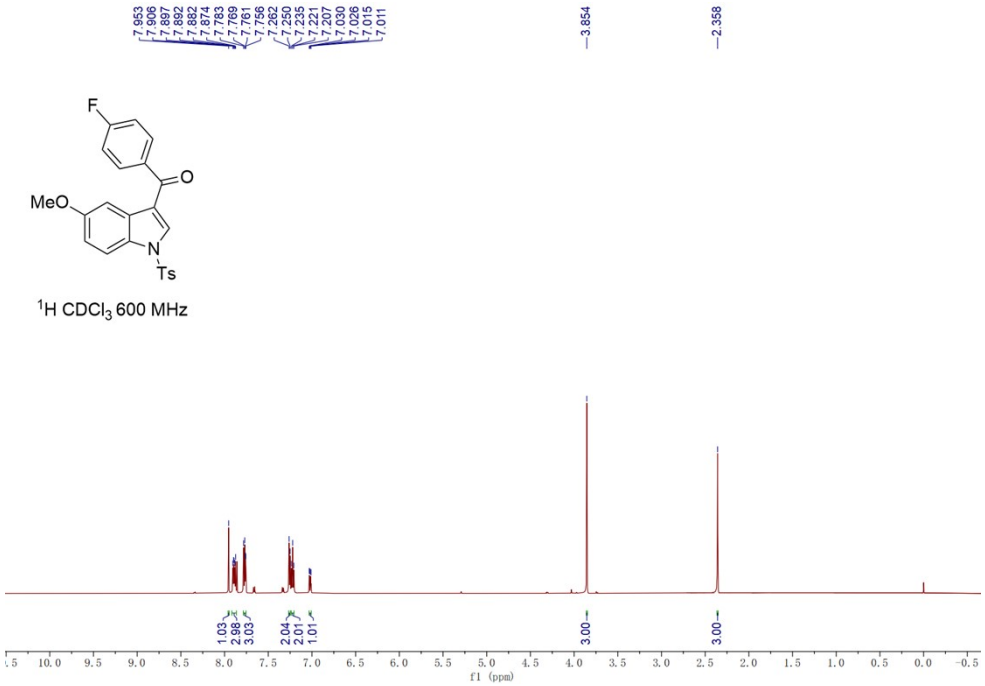
Yellow solid, 57 mg,yield: 69 % **^{1}H NMR** (600 MHz, Chloroform-*d*) δ 8.30 (m, 1H), 7.88 – 7.78 (m, 6H), 7.57 (dt, *J* = 52.8, 7.7 Hz, 5H), 7.05 – 7.02 (m, 1H), 3.89 (s, 3H), 2.64 (s, 3H).**^{13}C NMR** (150 MHz, Chloroform-*d*) δ 191.4, 168.5, 157.6, 139.5, 133.08, 132.3, 130.7, 129.23, 128.9, 128.7, 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

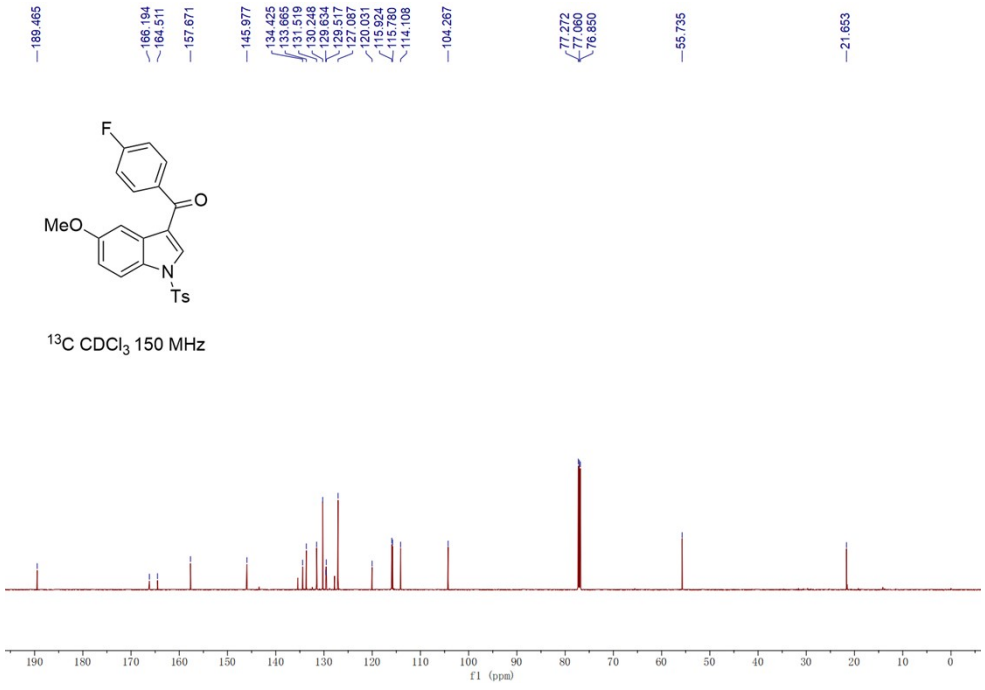
3aa



3ab



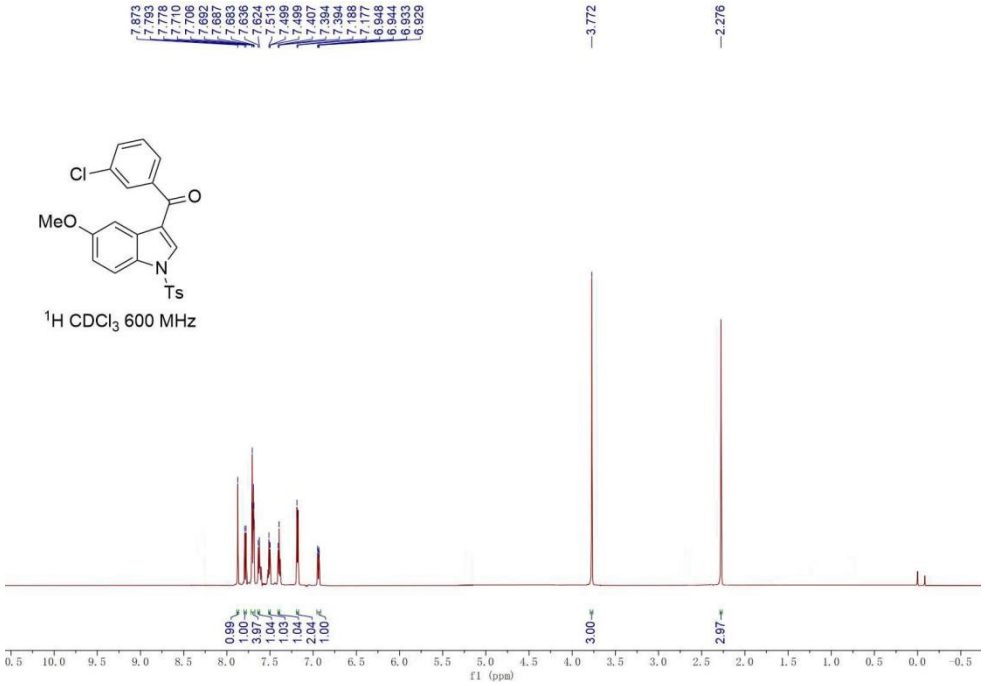
^{1}H $CDCl_3$ 600 MHz

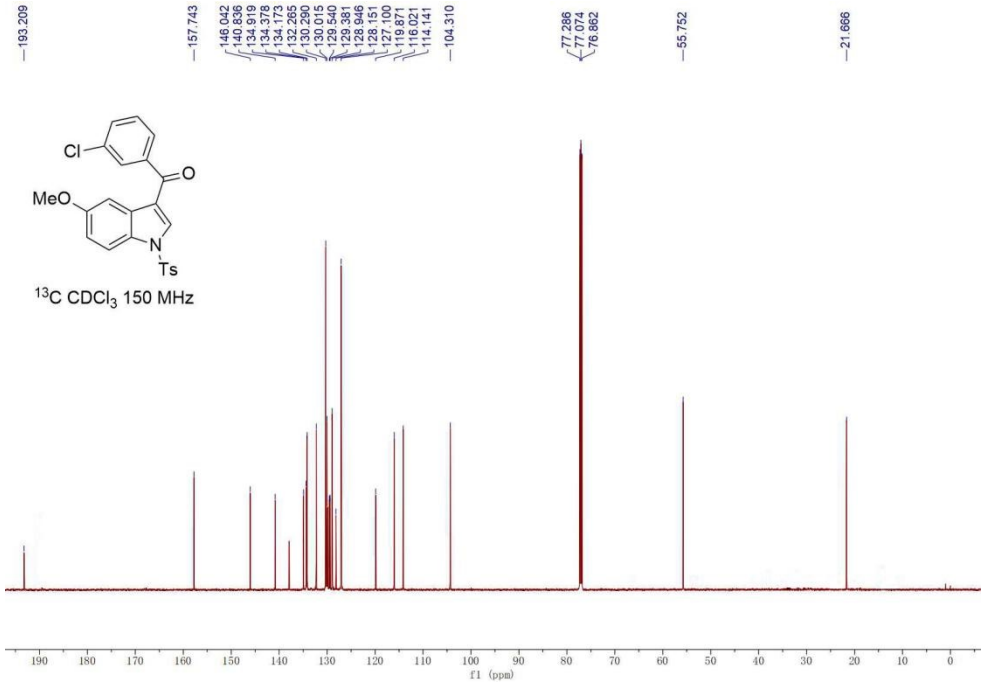


^{13}C $CDCl_3$ 150 MHz

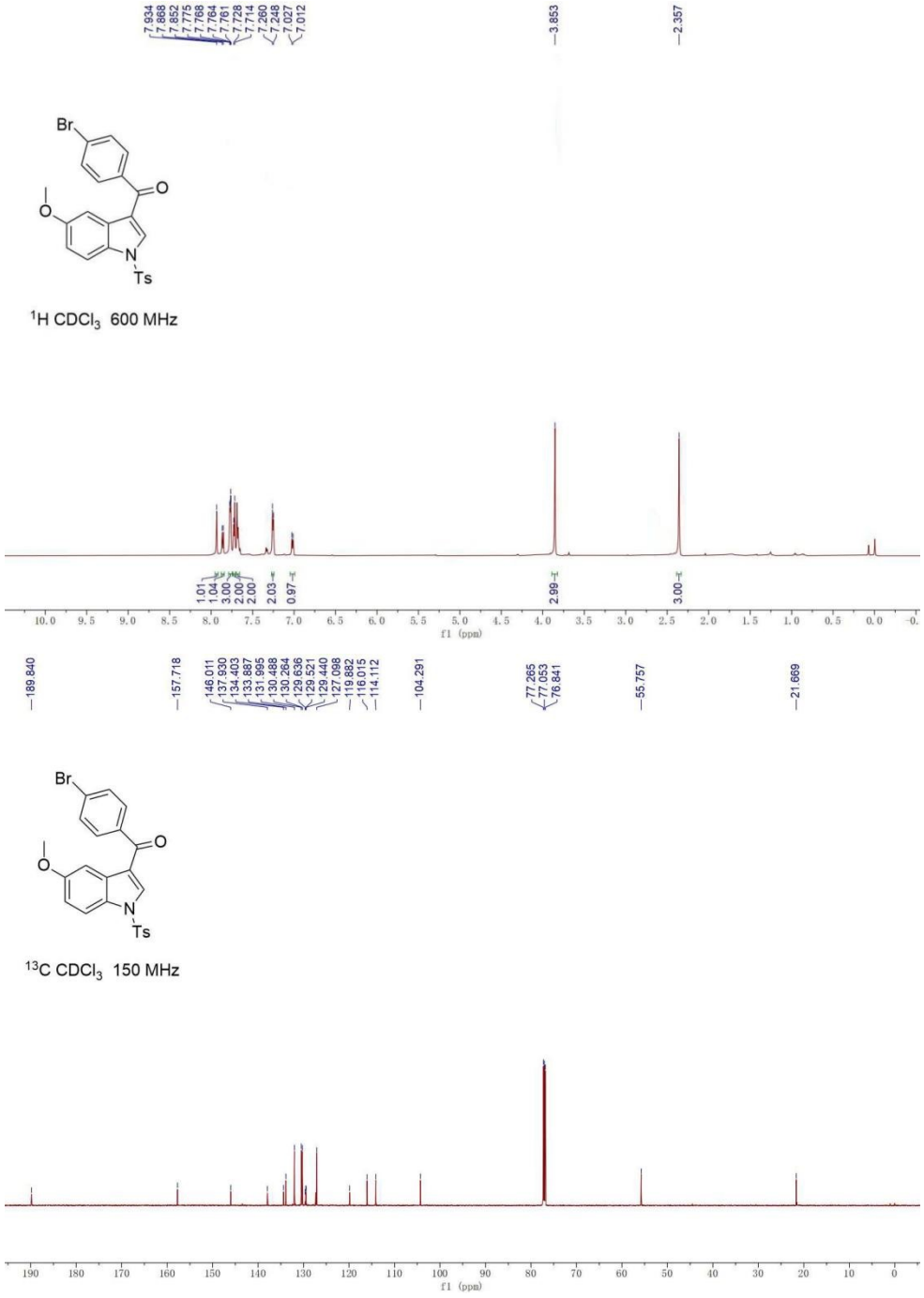
^{19}F $CDCl_3$ 470MHz

3ac

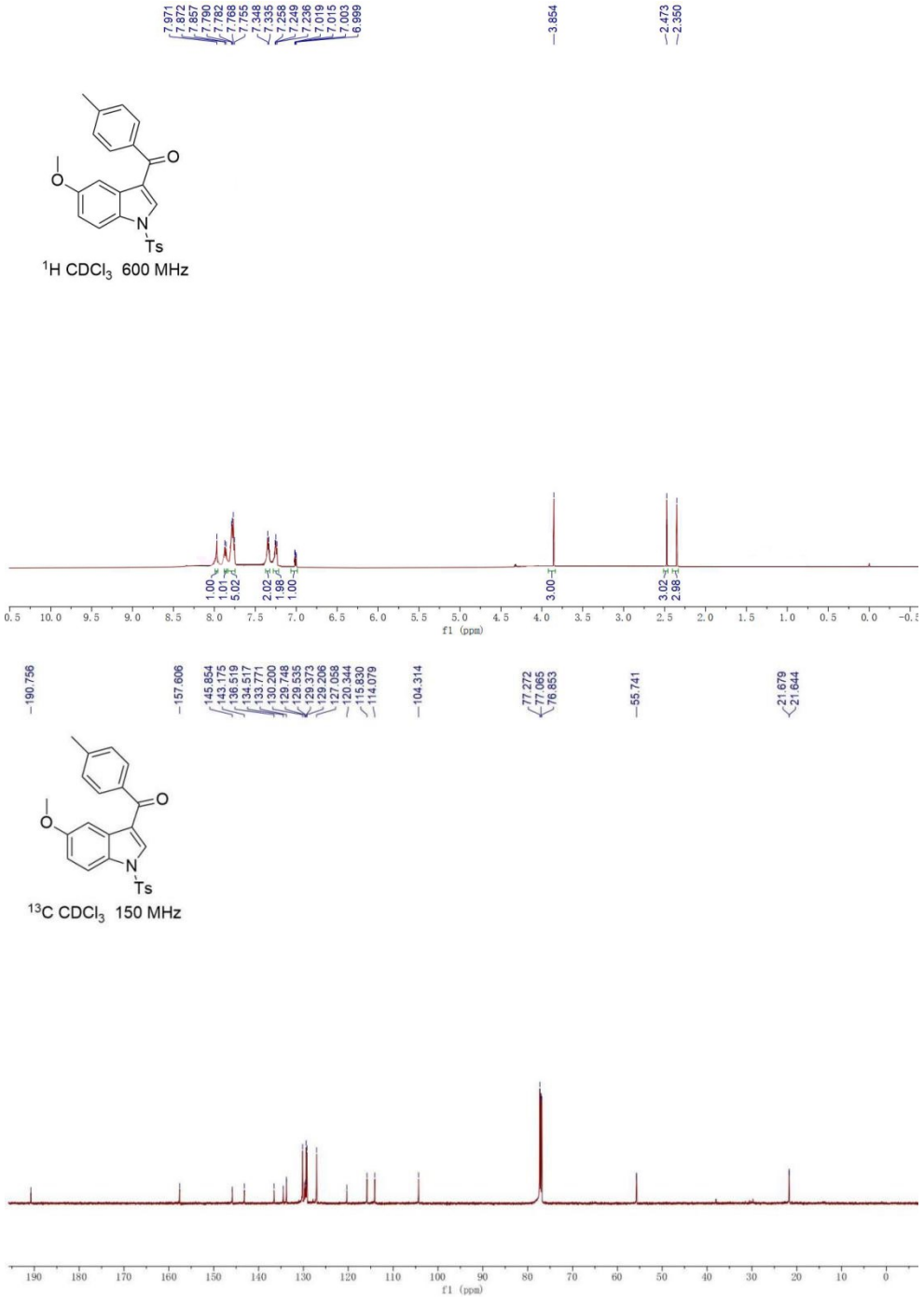

7.873
7.793
7.778
7.710
7.706
7.692
7.687
7.683
7.636
7.624
7.513
7.499
7.499
7.407
7.394
7.394
7.188
7.177
6.948
6.944
6.933
6.929
3.772
2.276
Cl
O
MeO
N
Ts
1H CDCl3 600 MHz
0.99
1.00
3.97
1.04
1.03
1.04
2.04
1.00
3.00
2.97
f1 (ppm)


193.209
157.743
146.042
140.836
134.919
134.378
134.173
132.265
130.290
130.015
129.540
129.381
128.946
128.151
127.100
119.871
118.021
114.141
104.310
77.286
77.074
76.862
55.752
21.666
Cl
O
MeO
N
Ts
13C CDCl3 150 MHz
f1 (ppm)

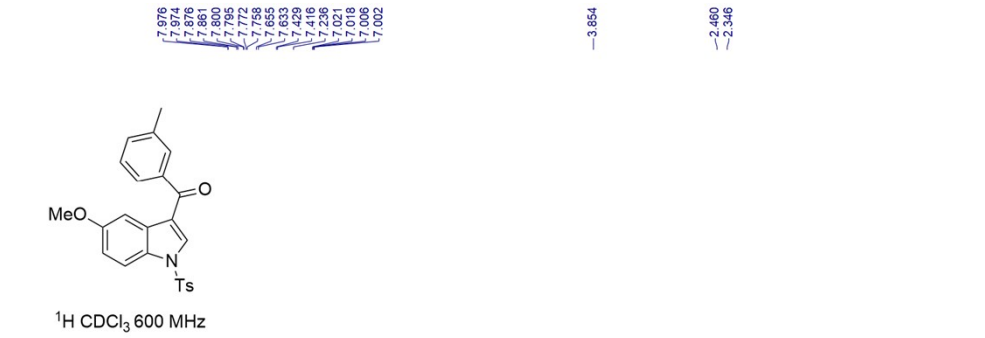
3ad


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)
189.840
157.718
146.011
137.930
134.403
133.887
131.995
130.488
130.284
129.636
129.521
129.440
127.098
118.892
116.015
114.112
104.291
77.265
77.053
76.841
55.757
21.669
Br
O
O
N
Ts
13C CDCl3 150 MHz
f1 (ppm)

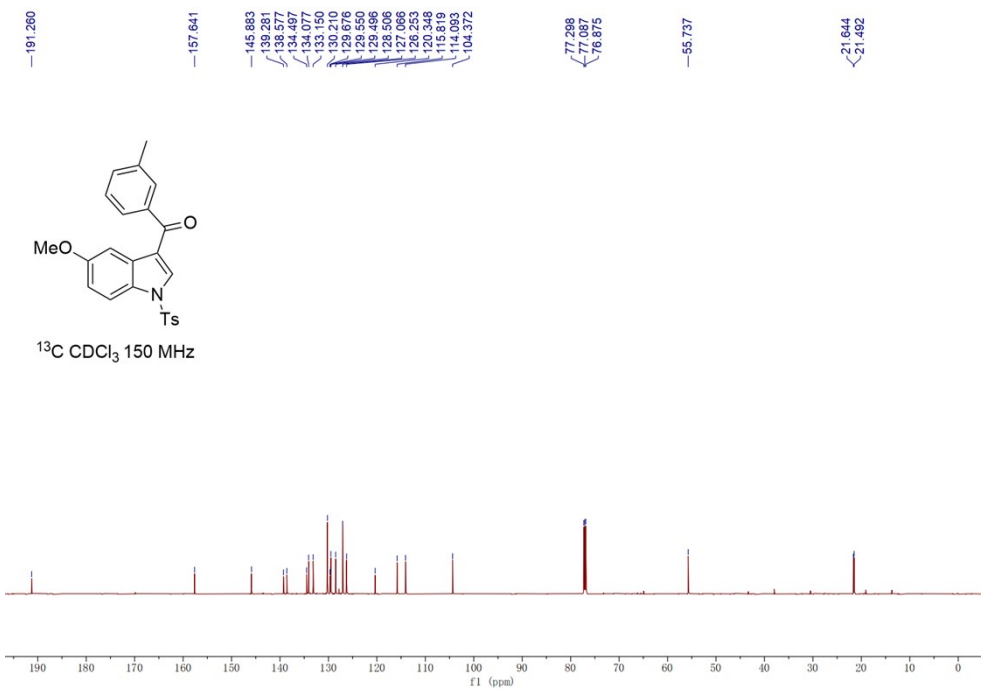
3ae


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)
190.756
157.606
145.854
143.175
136.519
134.517
133.771
130.200
129.748
129.355
129.373
128.206
127.058
120.344
115.830
114.079
104.314
77.272
77.065
76.853
55.741
21.679
21.644
O
O
N
Ts
13C CDCl3 150 MHz
f1 (ppm)

3af

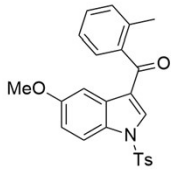


^{1}H $CDCl_3$ 600 MHz

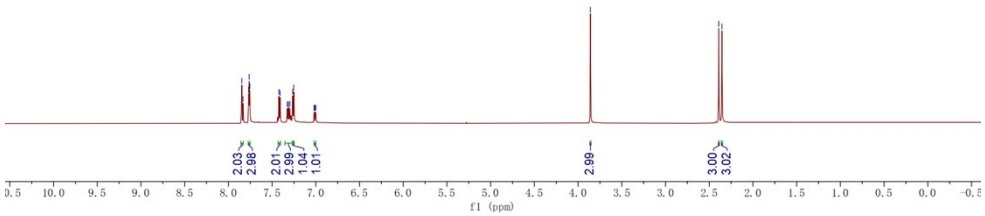


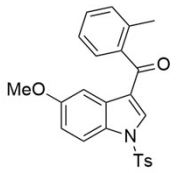
^{13}C $CDCl_3$ 150 MHz

3ag

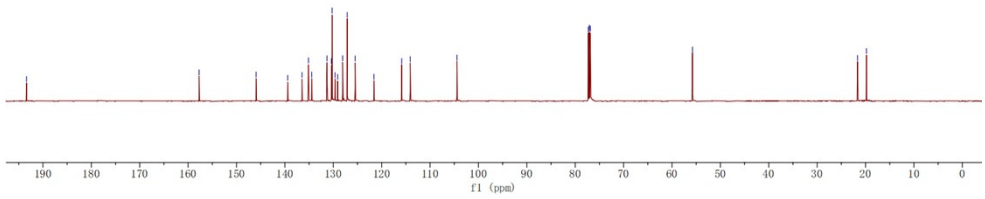


^{1}H $CDCl_3$ 600 MHz

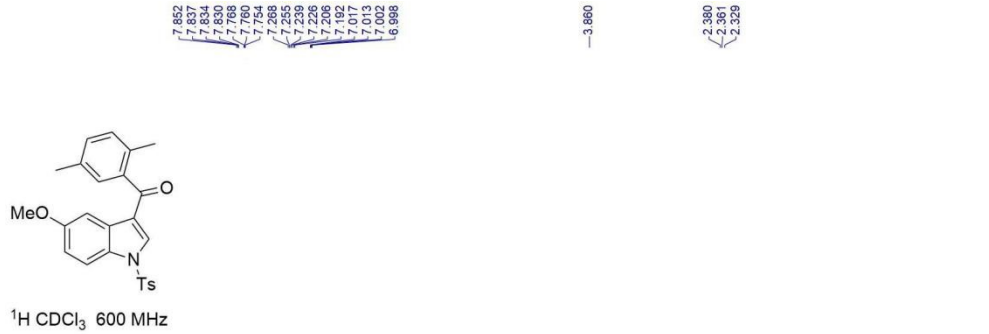




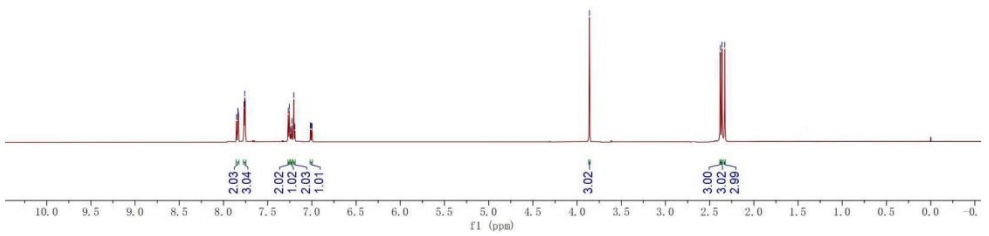
^{13}C $CDCl_3$ 150 MHz



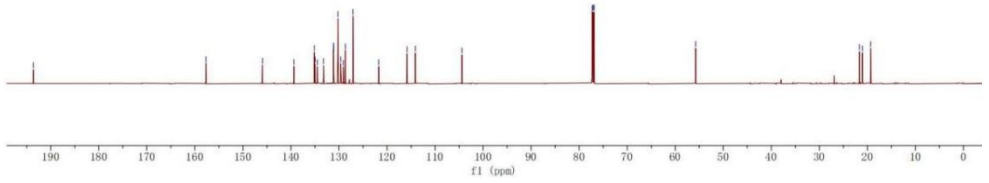
3ah



^{1}H $CDCl_3$ 600 MHz

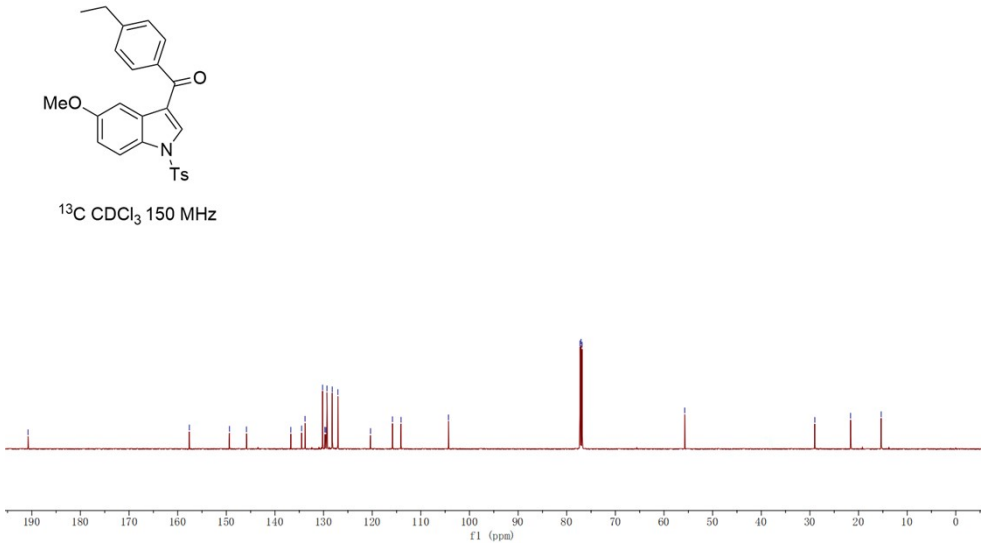


^{13}C $CDCl_3$ 150 MHz



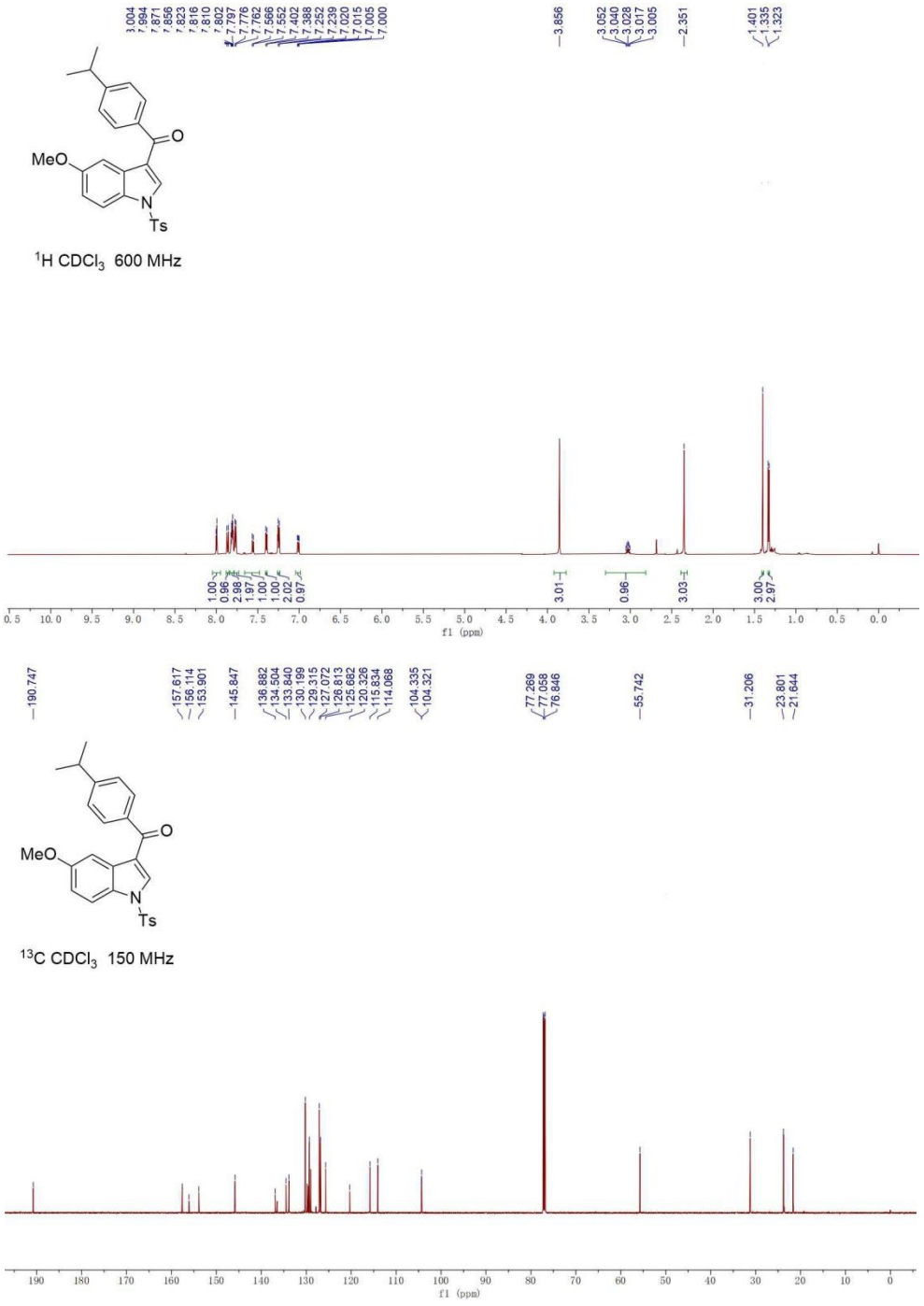
3ai

^{1}H $CDCl_3$ 600 MHz

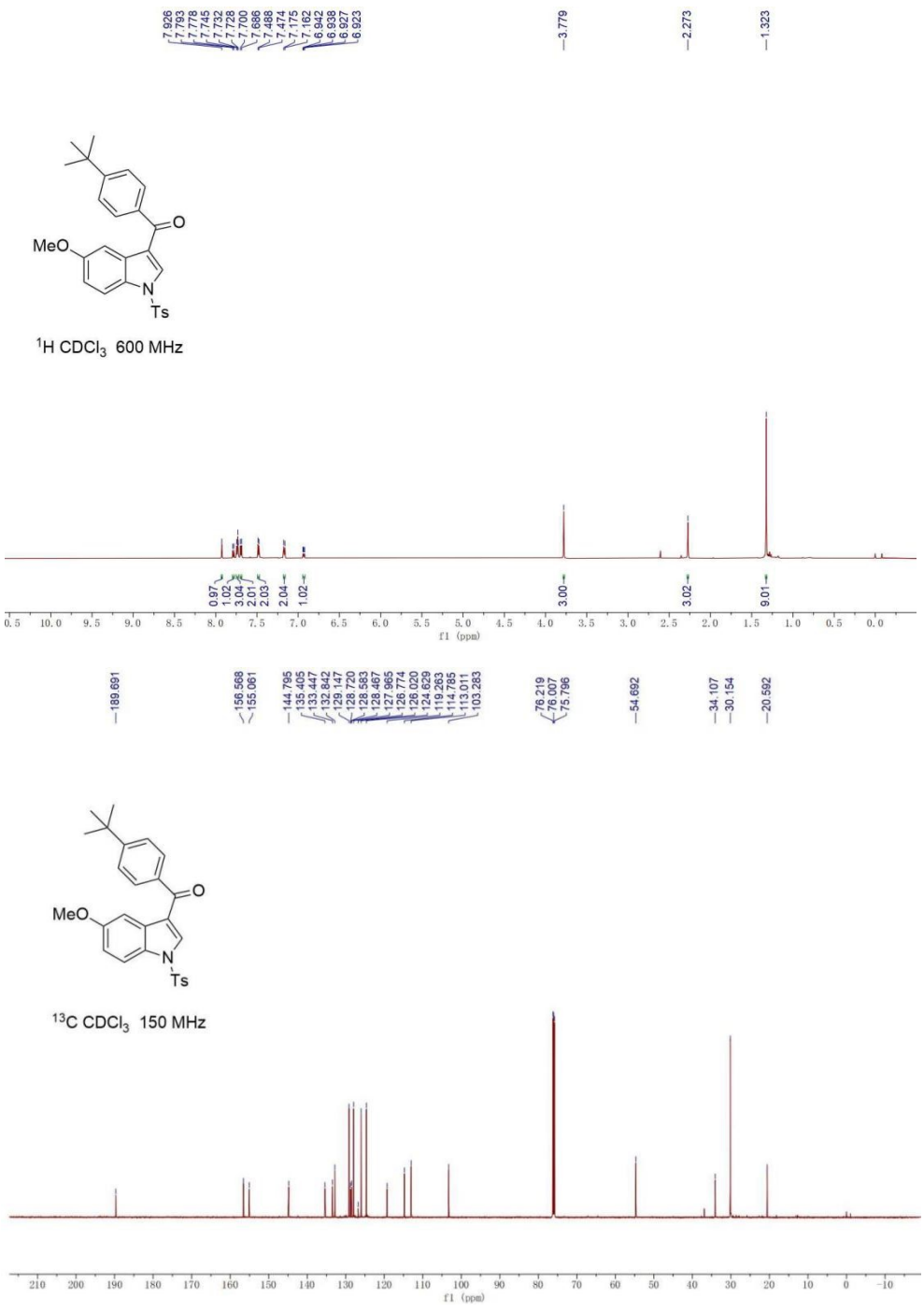


^{13}C $CDCl_3$ 150 MHz

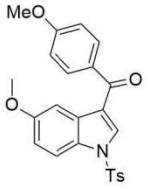
3aj


3.004
7.994
7.871
7.856
7.823
7.816
7.810
7.802
7.797
7.776
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
1.00
2.02
0.97
3.01
0.96
3.03
3.00
2.97
f1 (ppm)
190.747
157.617
156.114
153.901
145.847
136.882
134.504
133.840
130.199
129.315
127.072
126.813
125.682
120.326
115.834
114.068
104.335
104.321
77.269
77.058
76.846
55.742
31.206
23.801
21.644
MeO
O
N
Ts
^{13}C CDCl$_3$ 150 MHz
f1 (ppm)

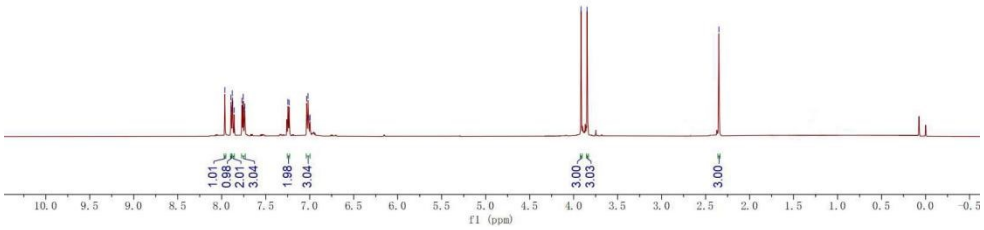
3ak

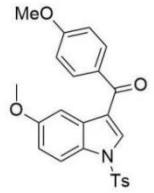

7.926
7.793
7.778
7.745
7.732
7.728
7.700
7.686
7.468
7.414
7.175
7.162
6.942
6.938
6.927
6.923
3.779
2.273
1.323
MeO
N
Ts
1H CDCl3 600 MHz
0.97
1.02
3.04
2.01
2.03
2.04
1.02
3.00
3.02
9.01
f1 (ppm)
189.691
156.568
155.061
144.795
135.405
133.447
132.842
129.147
128.720
128.583
128.467
127.965
126.774
126.020
124.629
115.263
114.785
113.011
103.283
76.219
76.007
75.796
54.692
34.107
30.154
20.592
MeO
N
Ts
13C CDCl3 150 MHz
f1 (ppm)

3al

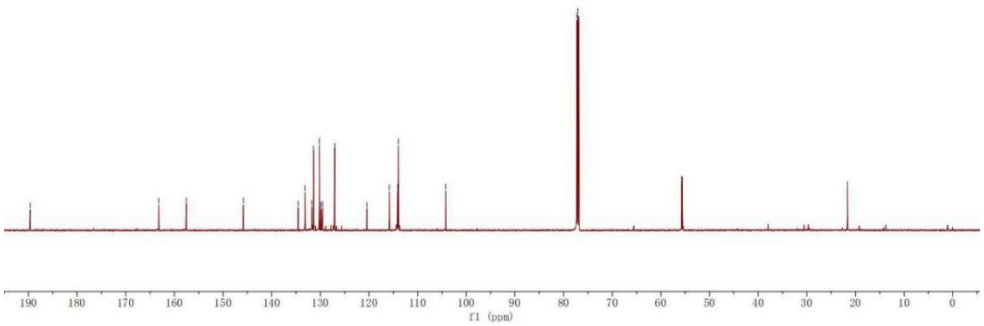


^{1}H $CDCl_3$ 600 MHz

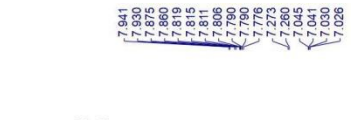


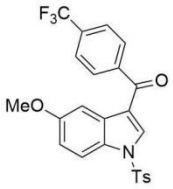


^{13}C $CDCl_3$ 150 MHz

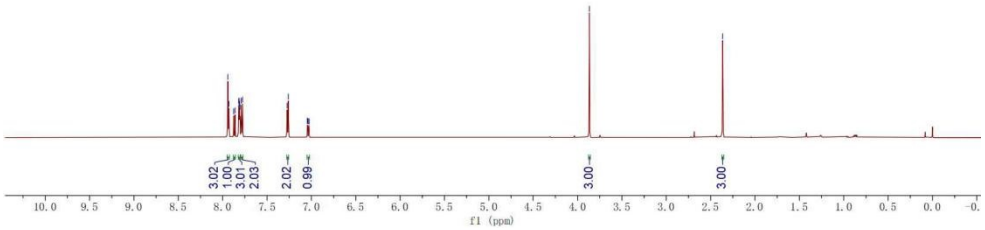


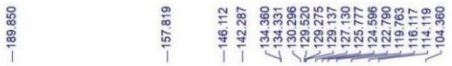
3am

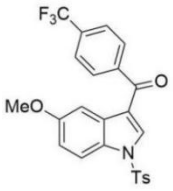




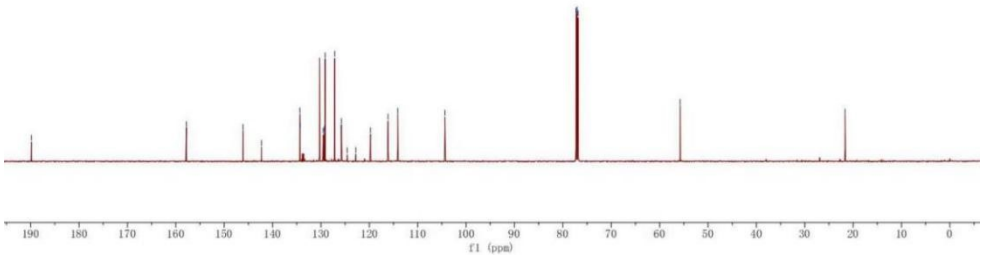
^{1}H $CDCl_3$ 600 MHz

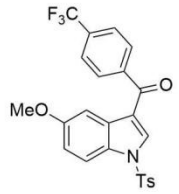






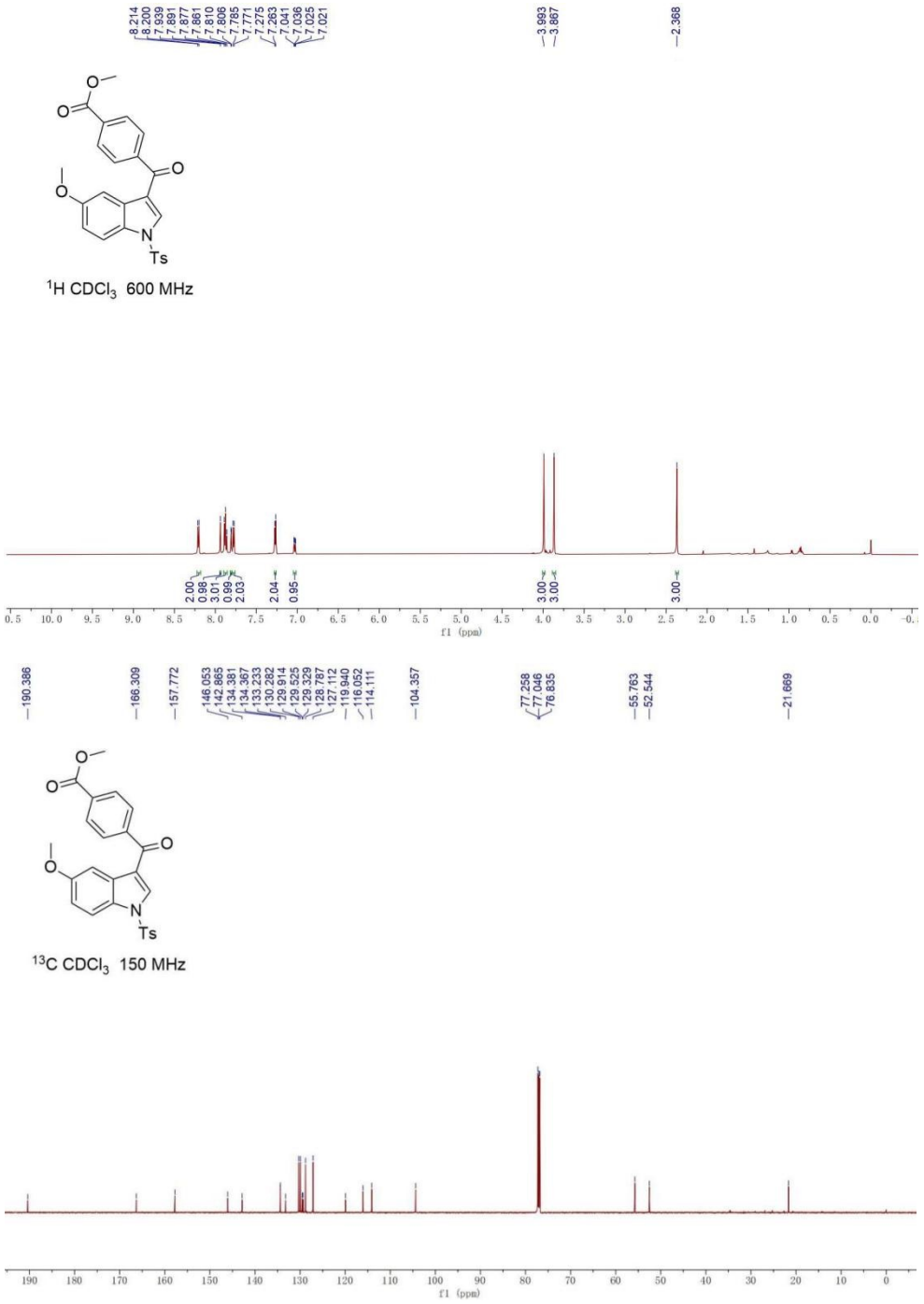
^{13}C $CDCl_3$ 150 MHz



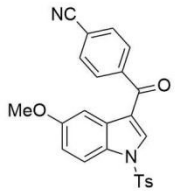


^{19}F $CDCl_3$ 470MHz

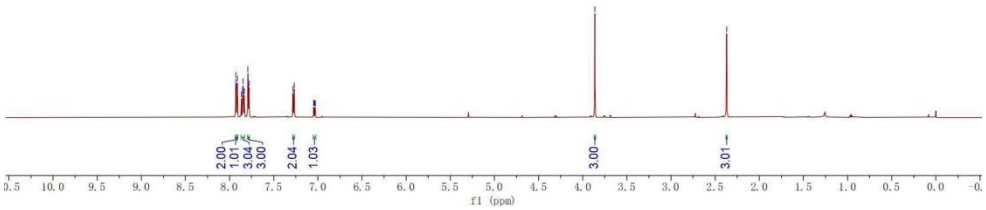
3an

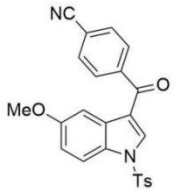

8.214
8.200
7.939
7.891
7.877
7.861
7.810
7.806
7.785
7.771
7.275
7.263
7.041
7.036
7.025
7.021
3.993
3.867
2.368
Ts
1H CDCl3 600 MHz
2.00
0.98
3.01
0.99
2.03
2.04
0.95
3.00
3.00
3.00
f1 (ppm)
190.386
168.309
157.772
146.053
142.865
134.381
134.367
133.233
130.282
129.514
129.525
129.329
128.787
127.112
119.940
116.052
114.111
104.357
77.258
77.046
76.835
55.763
52.544
21.669
Ts
13C CDCl3 150 MHz
f1 (ppm)

3ao

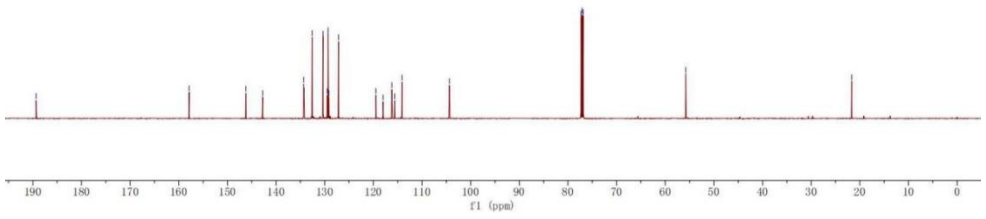


^{1}H $CDCl_3$ 600 MHz

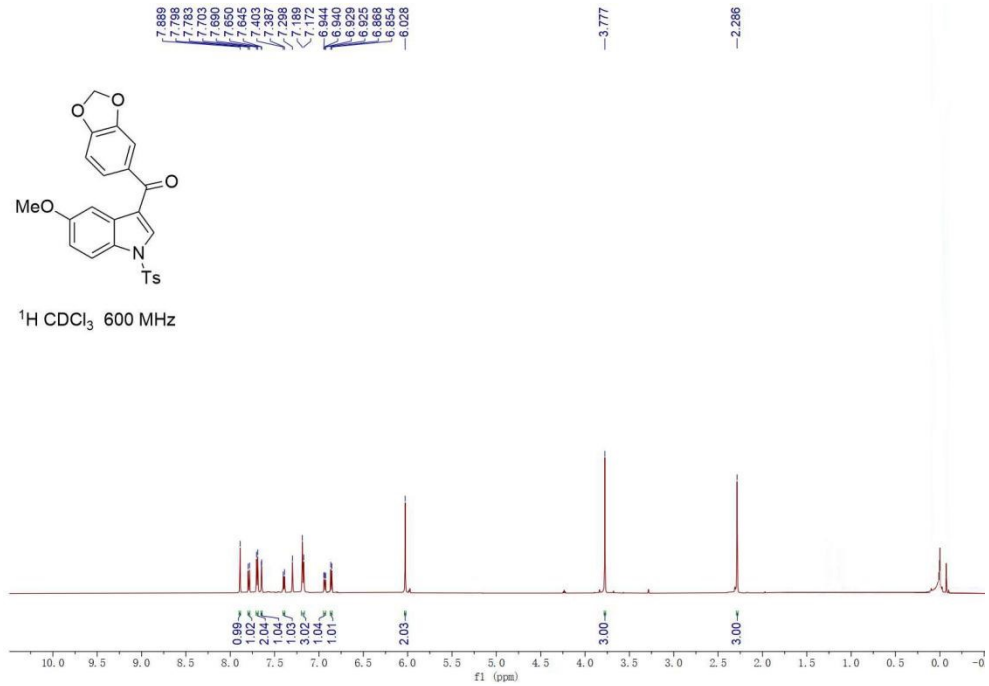




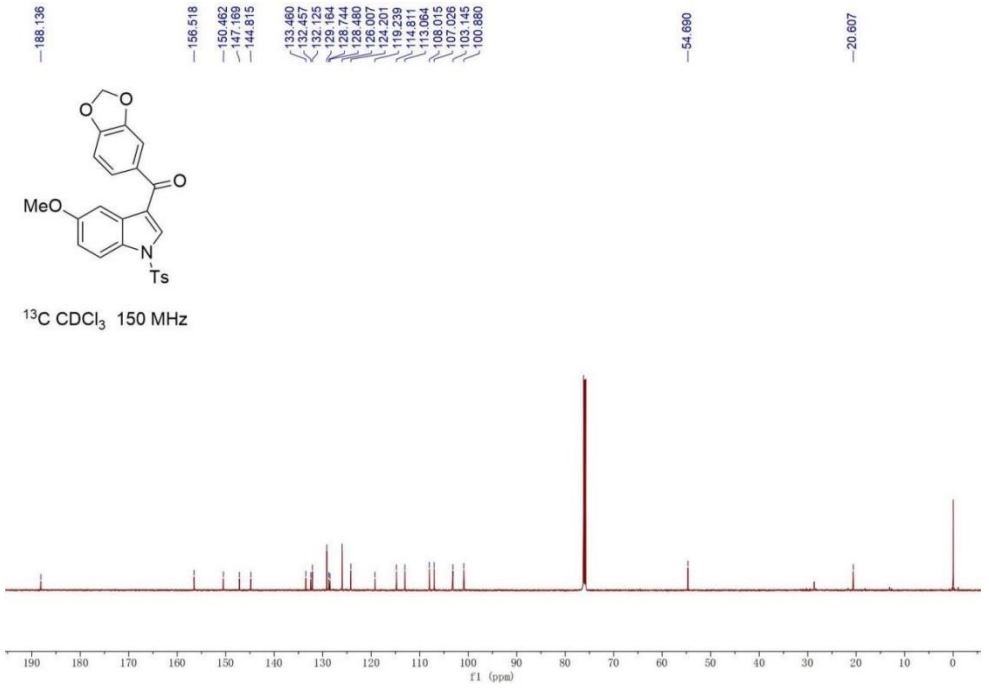
^{13}C $CDCl_3$ 150 MHz



3ap

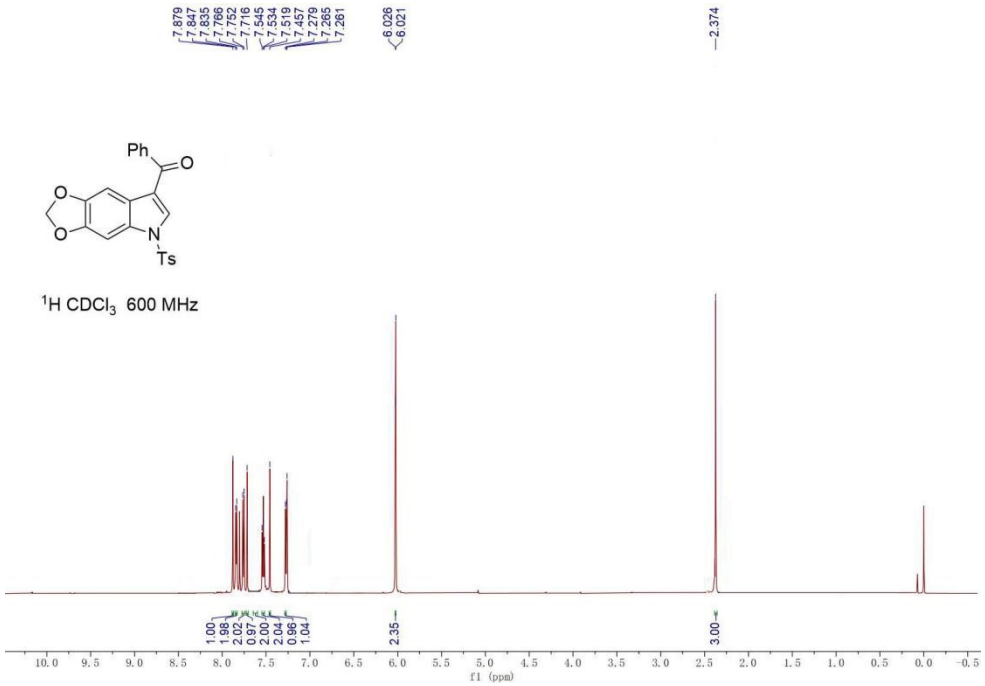


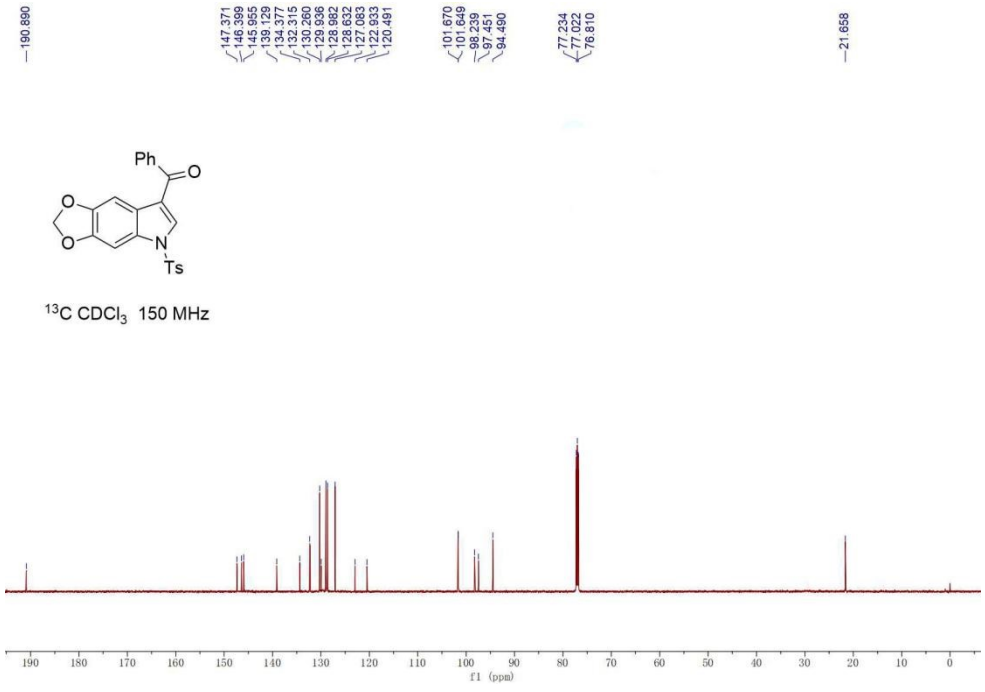
^{1}H $CDCl_3$ 600 MHz



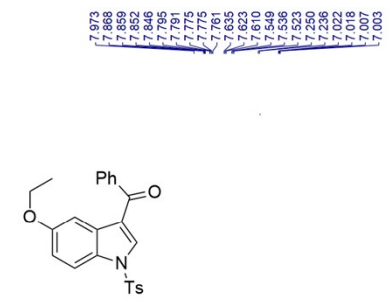
^{13}C $CDCl_3$ 150 MHz

3ba

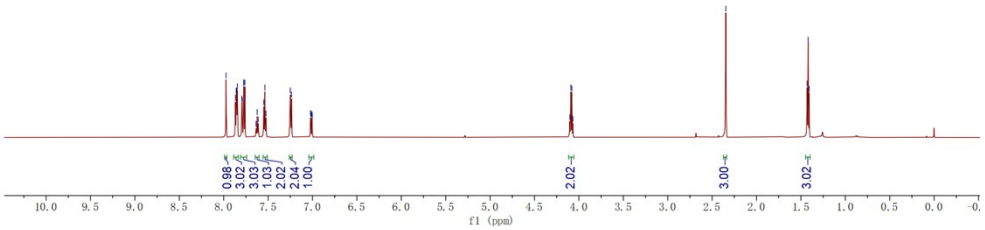

7.879
7.847
7.835
7.766
7.762
7.716
7.545
7.534
7.519
7.457
7.279
7.265
7.261
6.026
6.021
2.374
Ph
O
O
O
N
Ts
1H CDCl3 600 MHz
1.00
1.98
2.02
0.97
2.00
2.04
0.96
1.04
2.35
3.00
f1 (ppm)

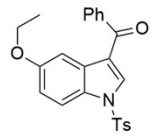

190.890
147.371
146.399
145.955
139.129
134.377
132.315
130.260
129.936
128.982
128.632
127.083
122.933
120.491
101.670
101.649
98.239
97.451
94.490
77.234
77.022
76.810
21.658
Ph
O
O
O
N
Ts
13C CDCl3 150 MHz
f1 (ppm)

3ca

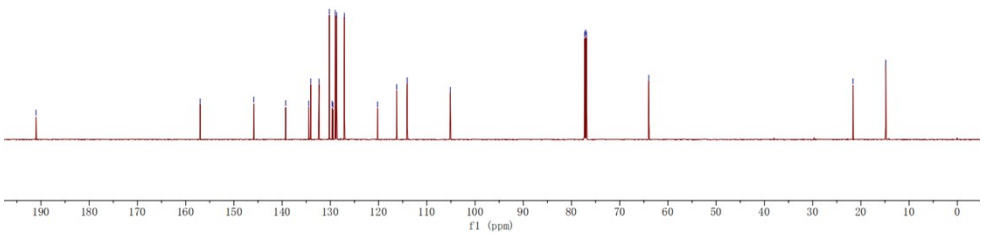


^{1}H $CDCl_3$ 600 MHz

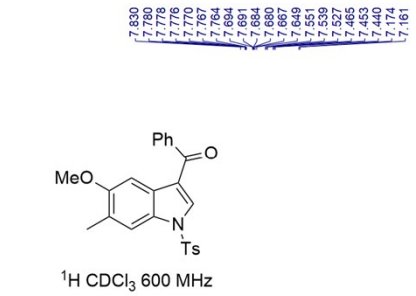




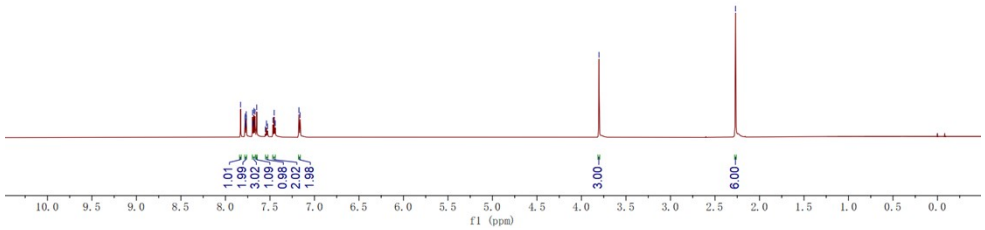
^{13}C $CDCl_3$ 150 MHz

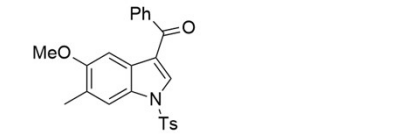


3ea

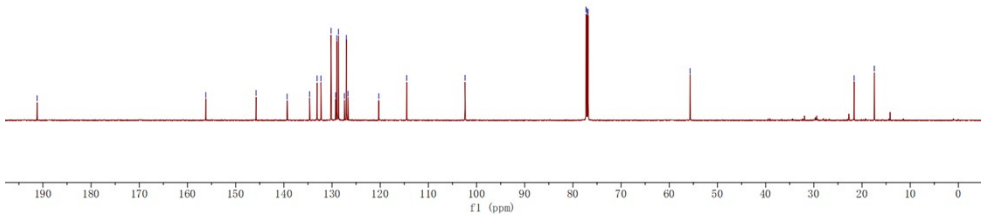


^{1}H $CDCl_3$ 600 MHz

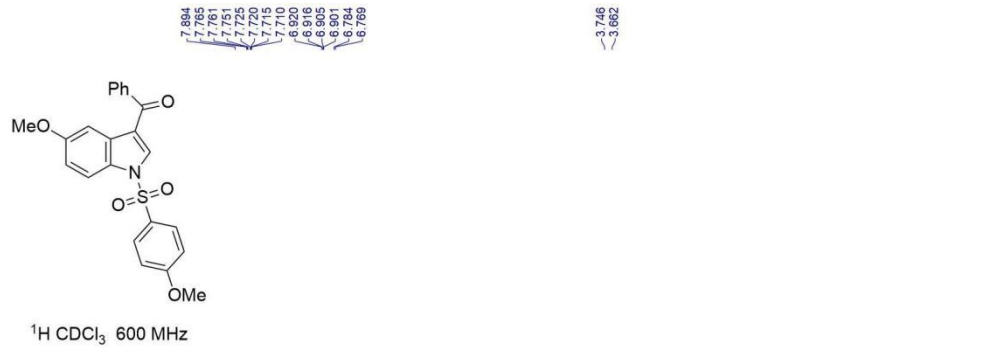




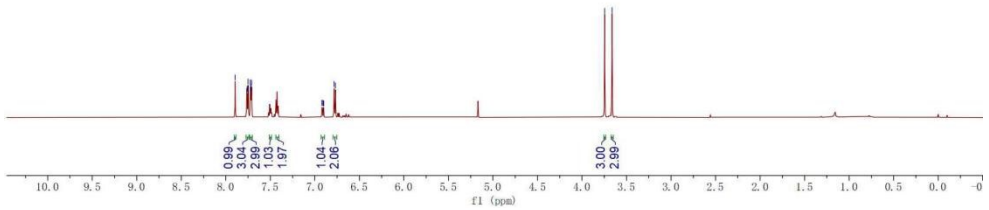
^{13}C $CDCl_3$ 150 MHz



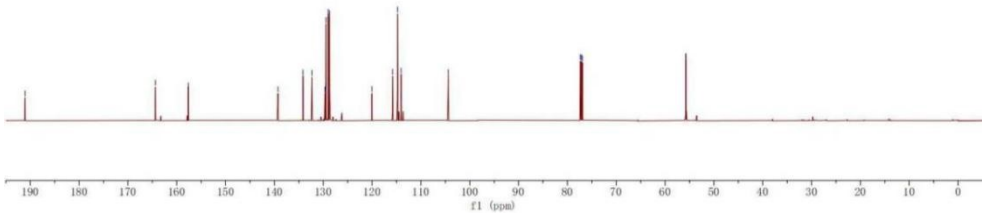
3ia



^{1}H $CDCl_3$ 600 MHz

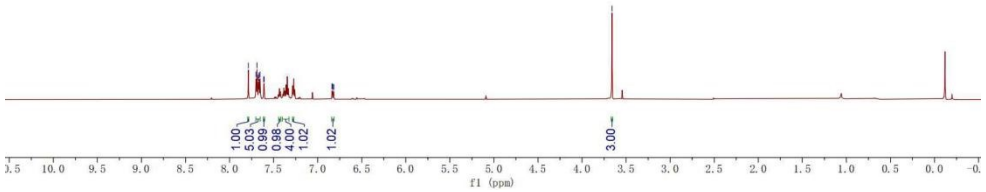


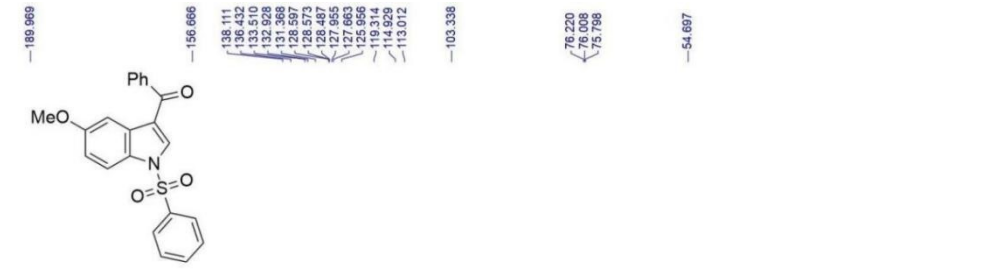
^{13}C $CDCl_3$ 150 MHz



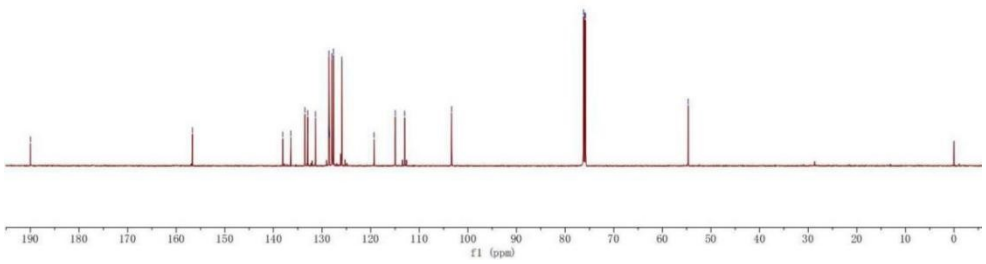
3ja

^{1}H $CDCl_3$ 600 MHz

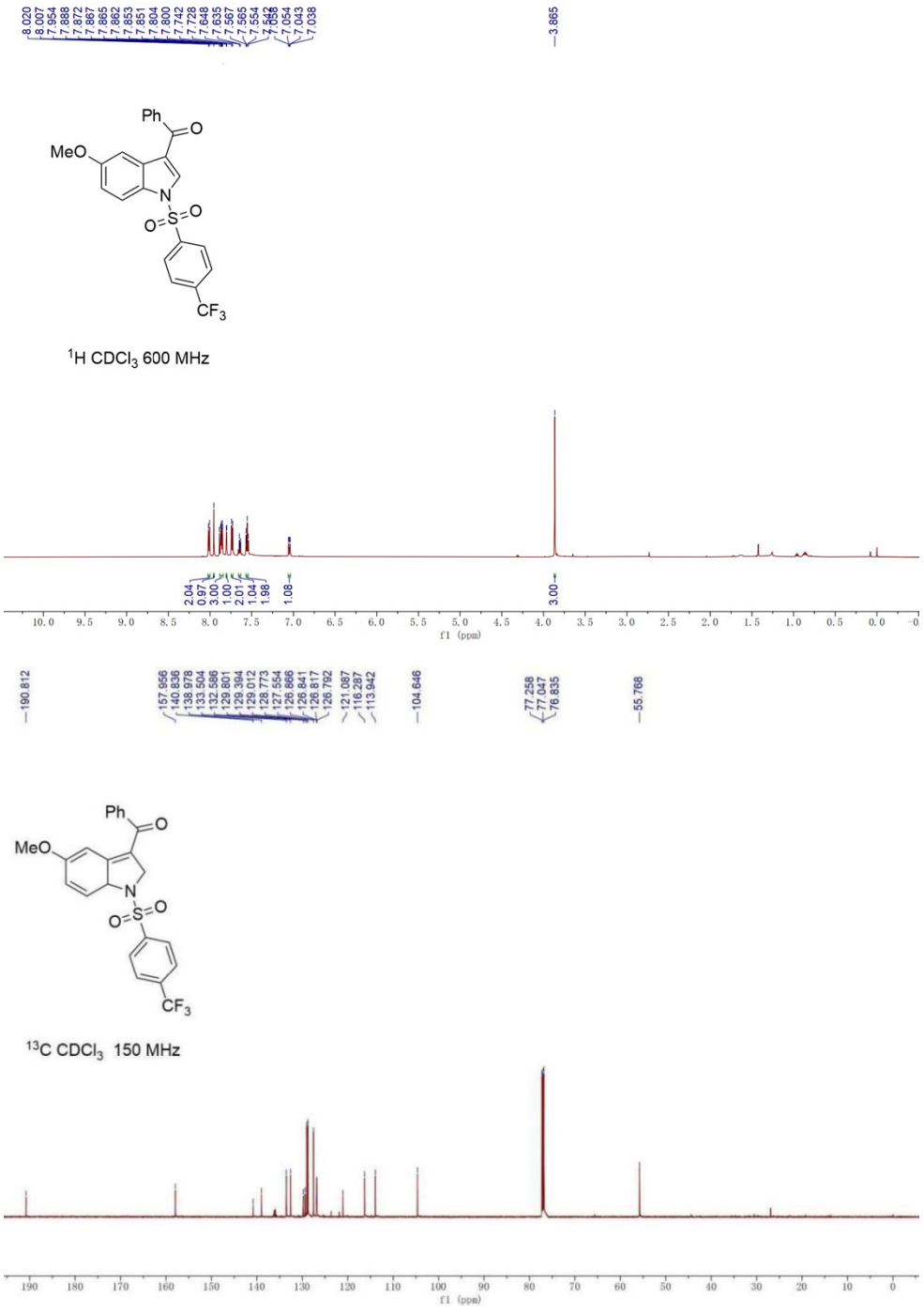


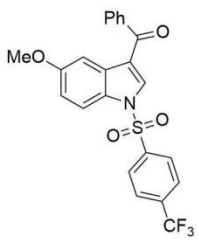


^{13}C $CDCl_3$ 150 MHz



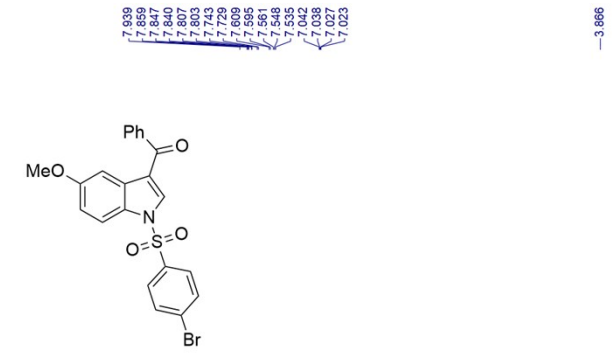
3ka


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
f1 (ppm)
190.812
157.956
140.836
138.978
133.504
132.586
129.801
129.394
129.012
128.773
127.554
126.866
126.841
126.817
126.792
121.087
116.287
113.942
104.646
77.258
77.047
76.835
55.768
13C CDCl3 150 MHz
f1 (ppm)

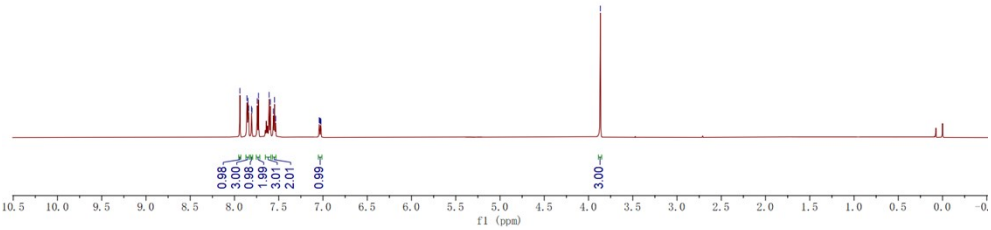


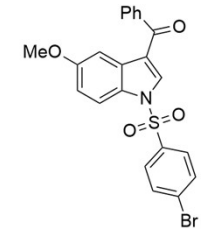
^{19}F $CDCl_3$ 470MHz

3la

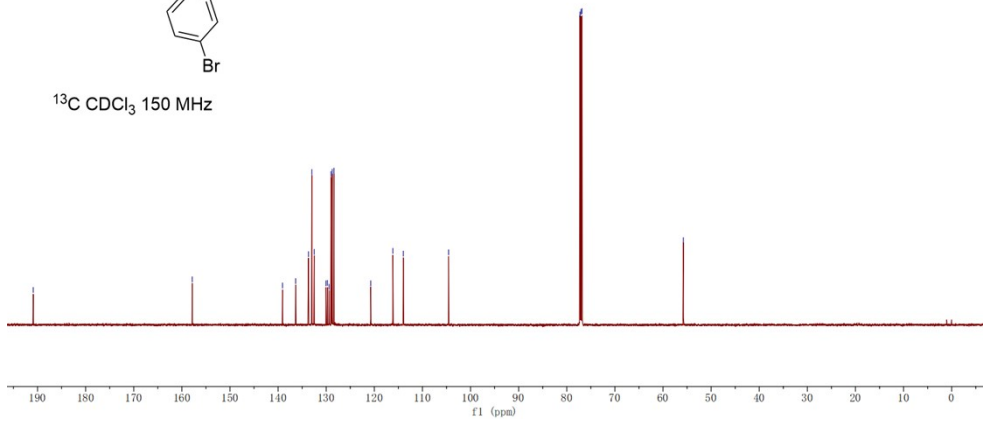


^{1}H $CDCl_3$ 600 MHz

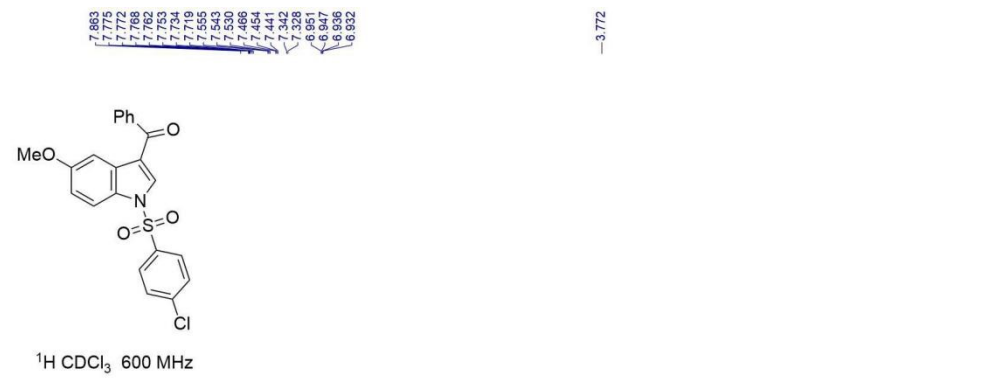




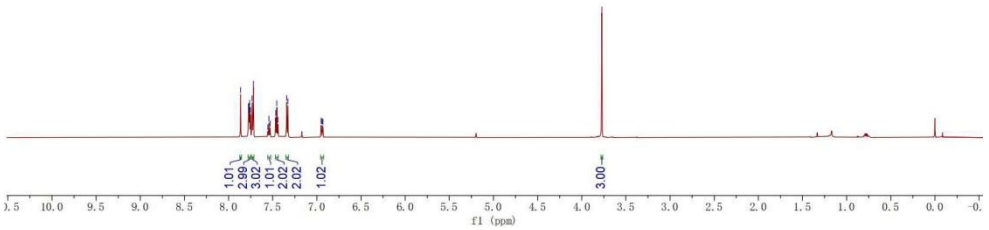
^{13}C $CDCl_3$ 150 MHz



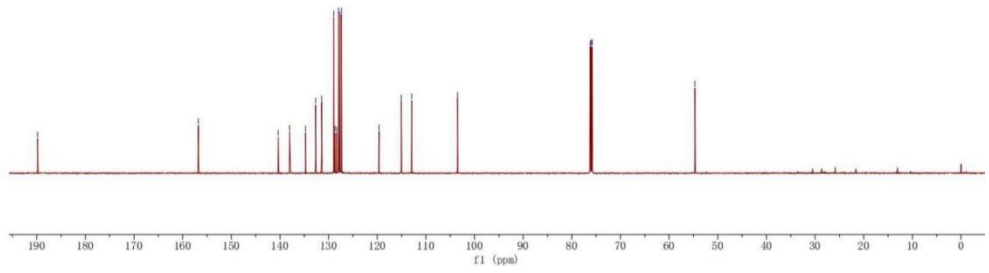
3ma



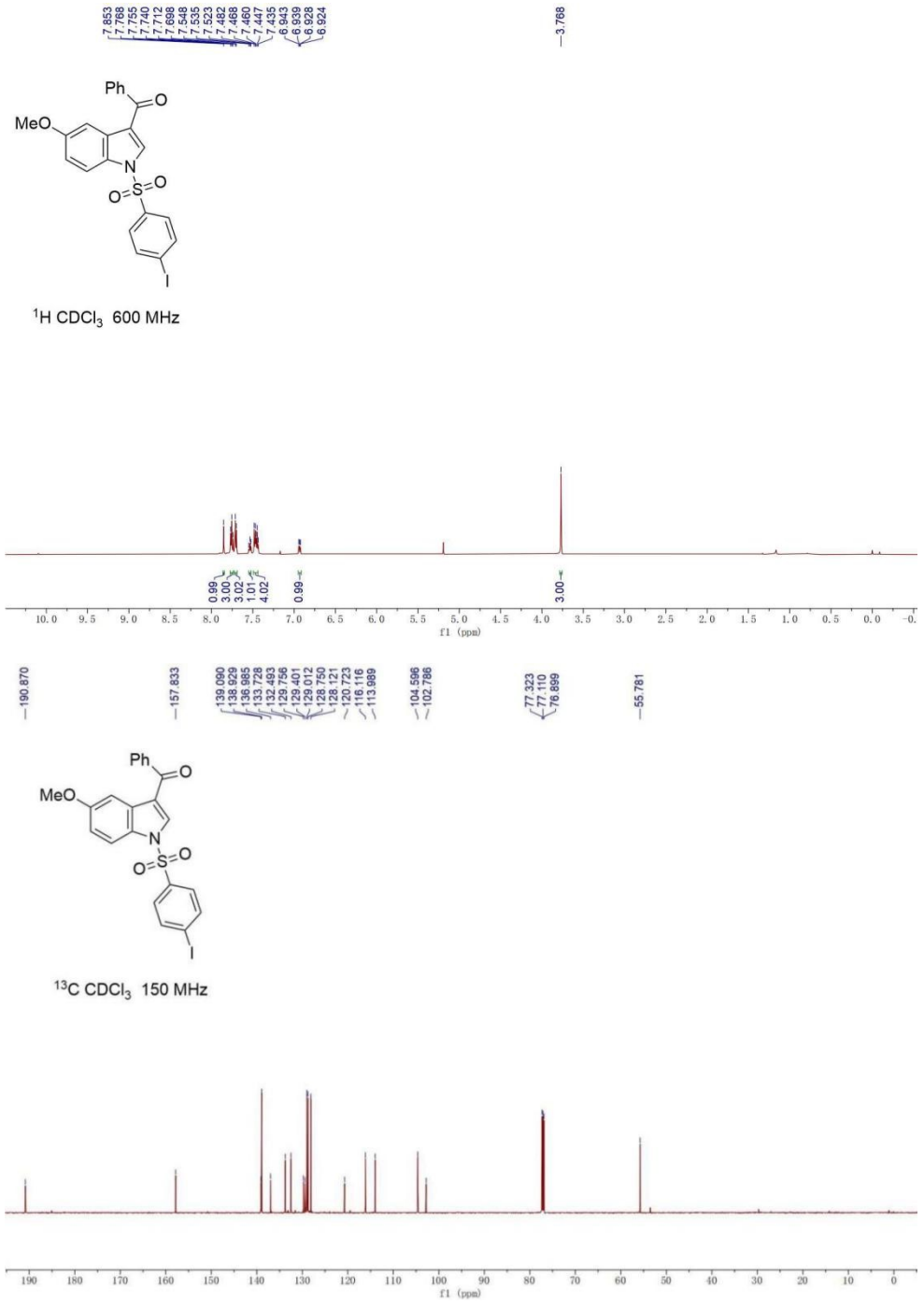
^{1}H $CDCl_3$ 600 MHz



^{13}C $CDCl_3$ 150 MHz

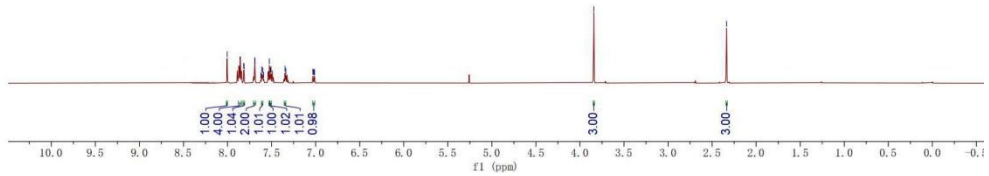


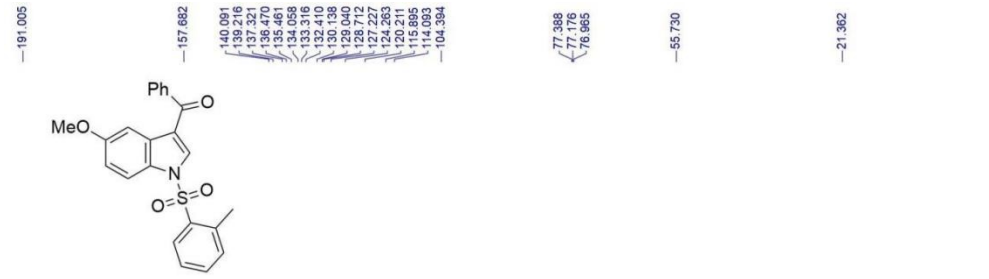
3na


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)
190.870
157.833
139.090
138.929
136.985
133.728
132.493
129.756
129.401
129.072
128.759
128.121
120.723
116.116
113.989
104.596
102.786
77.323
77.110
76.899
55.781
13C CDCl3 150 MHz
f1 (ppm)

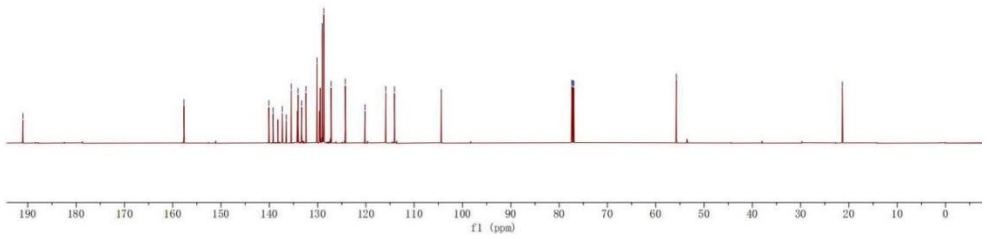
3oa

^{1}H $CDCl_3$ 600 MHz

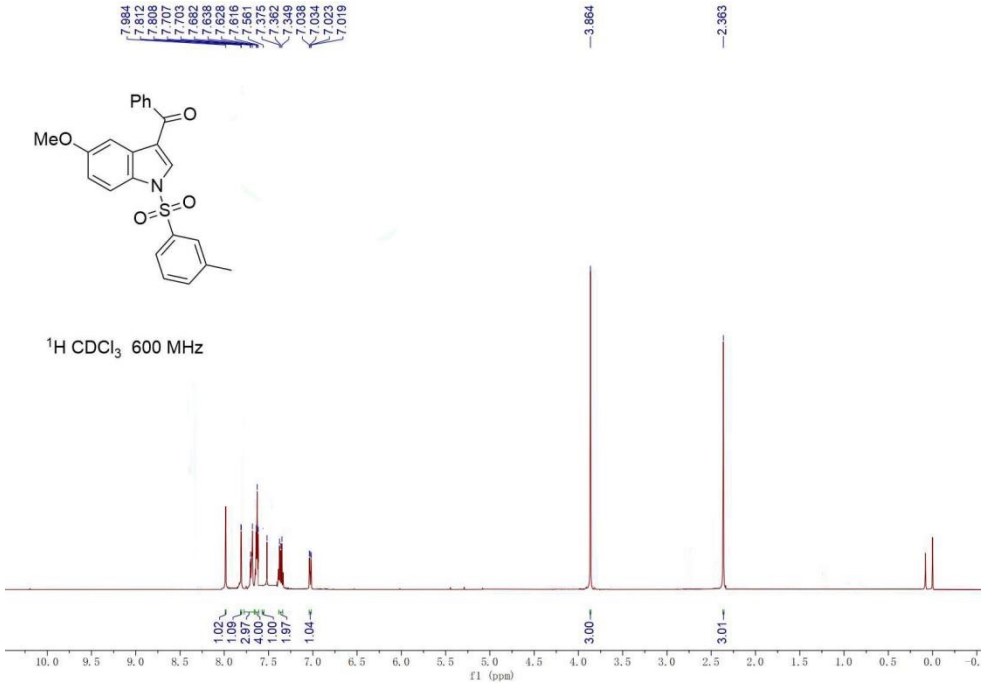


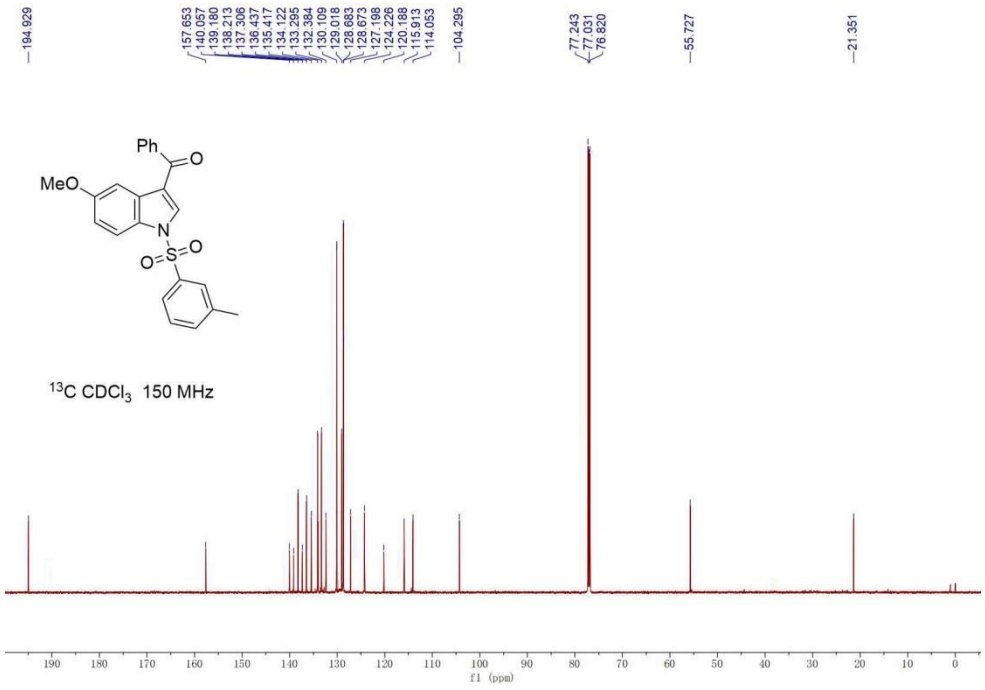


^{13}C $CDCl_3$ 150 MHz

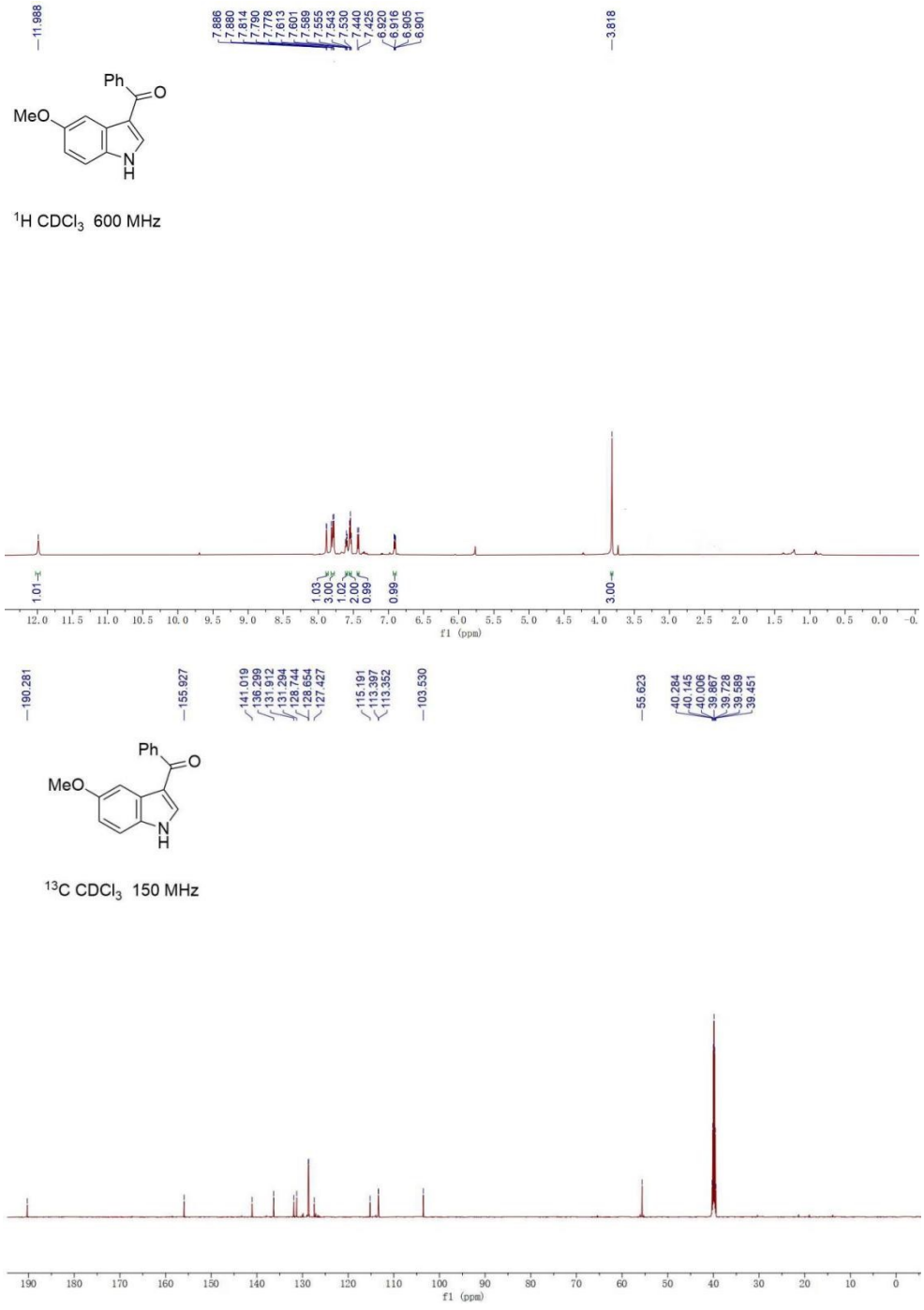


3pa

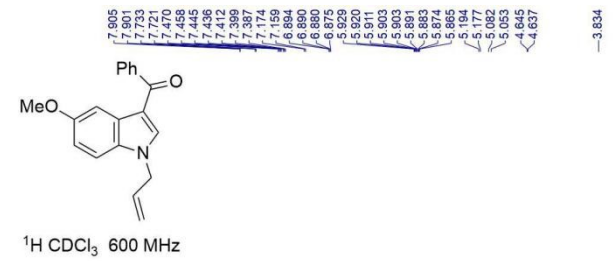

7.984
7.812
7.808
7.707
7.703
7.682
7.638
7.628
7.616
7.561
7.375
7.362
7.349
7.038
7.034
7.023
7.019
3.864
2.363
Ph
O
MeO
N
O=S=O
1H CDCl3 600 MHz
1.02
1.89
2.97
4.00
1.00
1.97
1.04
3.00
3.01
f1 (ppm)


194.929
157.653
140.057
139.180
138.213
137.306
136.437
135.417
134.122
133.295
132.384
130.109
129.018
128.683
128.673
127.198
124.226
120.188
115.913
114.053
104.295
77.243
77.031
76.820
55.727
21.351
Ph
O
MeO
N
O=S=O
13C CDCl3 150 MHz
f1 (ppm)

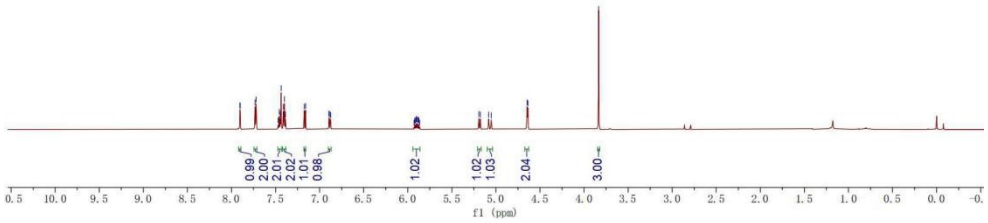
3c

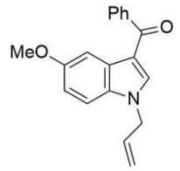

11.988
7.886
7.880
7.814
7.790
7.778
7.613
7.601
7.589
7.555
7.543
7.530
7.440
7.425
6.920
6.916
6.905
6.901
3.818
Ph
O
MeO
N
H
1H CDCl3 600 MHz
1.01
1.03
3.00
1.02
2.00
0.99
0.99
3.00
f1 (ppm)
190.281
155.927
141.019
136.299
131.612
131.294
128.744
128.654
127.427
115.191
113.397
113.352
103.530
55.623
40.284
40.145
40.006
39.867
39.728
39.589
39.451
Ph
O
MeO
N
H
13C CDCl3 150 MHz
f1 (ppm)

4a

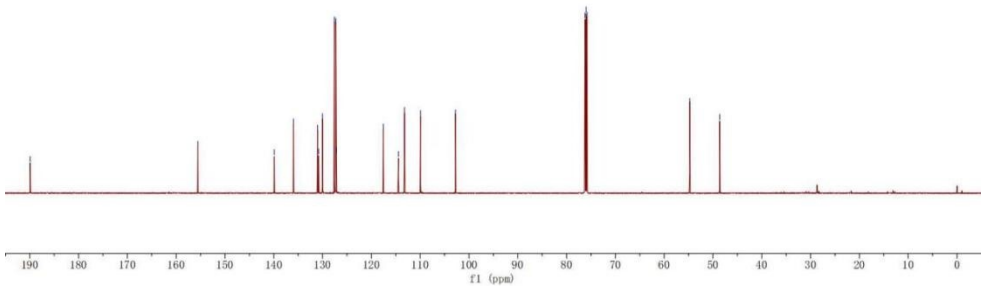


^{1}H $CDCl_3$ 600 MHz

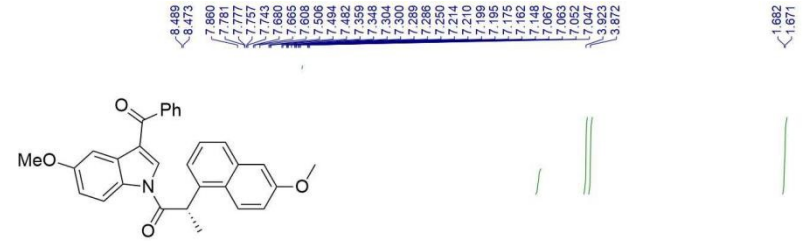




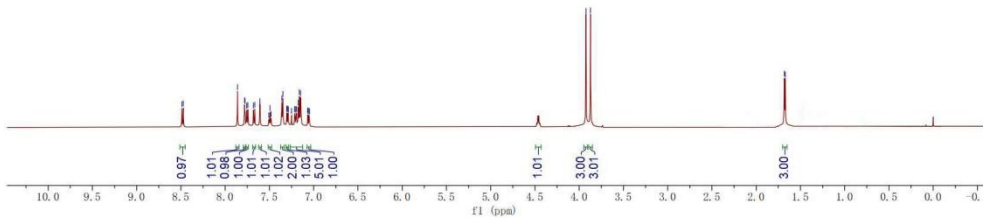
^{13}C $CDCl_3$ 150 MHz

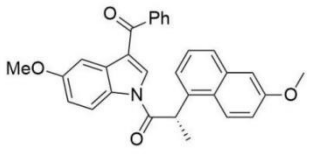


4b

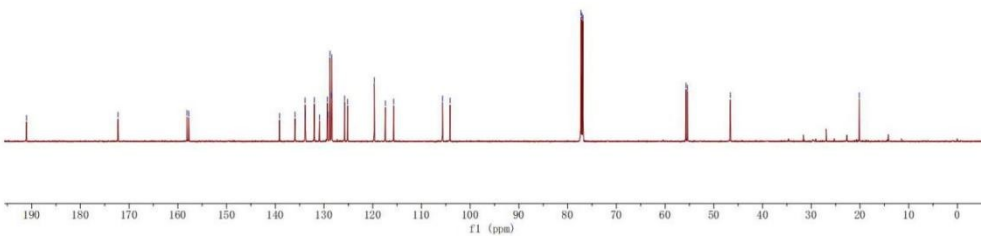


^{1}H $CDCl_3$ 600 MHz

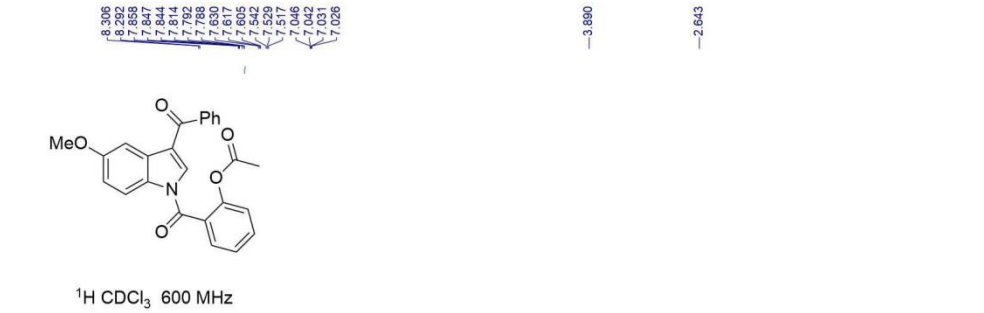




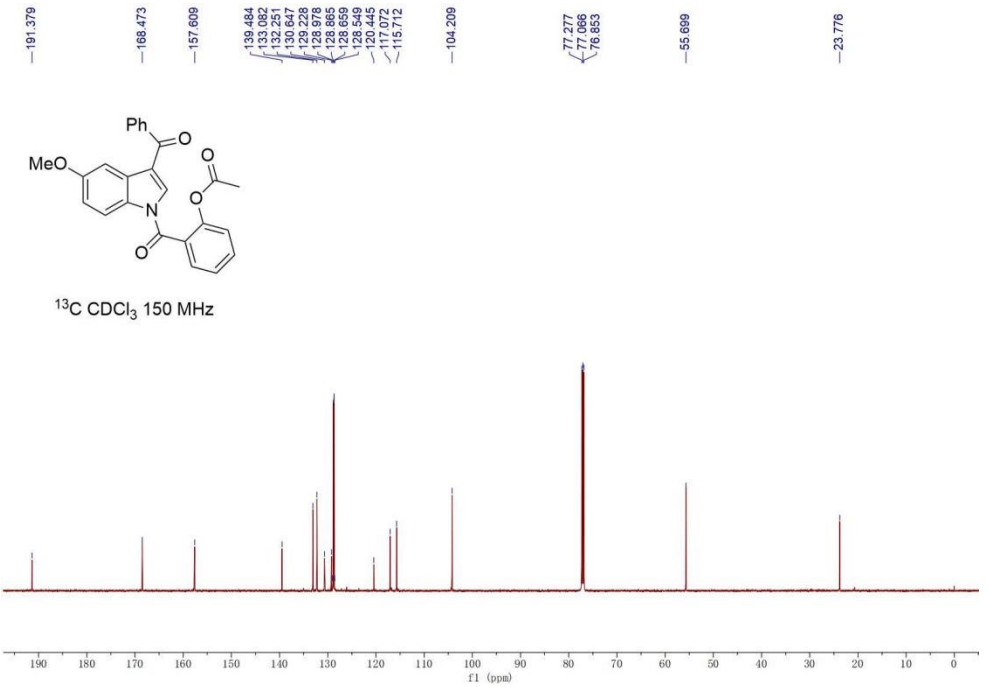
^{13}C $CDCl_3$ 150 MHz



4c



^{1}H $CDCl_3$ 600 MHz



^{13}C $CDCl_3$ 150 MHz