Supporting Information for

SYNTHESIS OF ISOQUINOLINIUM VIA RHODIUM(III)-CATALYZED OXIDTIVE ANNULATION BETWEEN ALDIMINES AND ALKYNES

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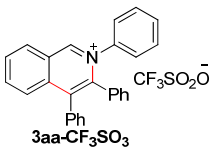
Table of Contents

1. General Methods

NMR data were obtained for ^{1}H at 400 MHz or 600 MHz, and for ^{13}C at 100 MHz. Chemical shifts were reported in ppm from tetramethylsilane with the solvent resonance as the internal standard in $CDCl_3$ solution. ESI HRMS was recorded on a Waters SYNAPT G2 and Water XEVO G2 Q-ToF. UV detection was monitored at 220 nm. TLC was performed on glass-backed silica plates. Column chromatography was performed on silica gel (200-300 mesh), eluting with dichloromethane and methanol. All aldehydes and anilines were commercially available. Substituted isoquinoliniums were prepared according to the literature procedures.

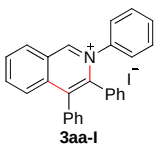
2. General procedure for synthesis of isoquinolinium salts derived fused compounds and Characterization data

General procedure: (E)-*N*-benzylideneaniline **1a** (19.7 mg, 0.10 mmol), diphenylacetylene **2a** (26.7 mg, 0.15 mmol), $[Cp^*RhCl_2]_2$ (3.1 mg, 5 mol%), additive (1 equiv) and acid (1 equiv) were stirred in solvent (1 mL) at Ar atmosphere at 90 °C for 1 h. After completion, the reaction mixture was purified by flash chromatography eluting with dichloromethane and methanol to give the desired product.



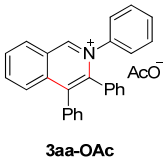
3aa-CF_3SO_3

Procedure for synthesis of 2,3,4-Triphenylisoquinolinium trifluoromethanesulfonate (3aa-CF_3SO_3): (E)-*N*-benzylideneaniline **1a** (19.7 mg, 0.10 mmol), diphenylacetylene **2a** (26.7 mg, 0.15 mmol), $[Cp^*RhCl_2]_2$ (3.1 mg, 5 mol%), $Cu(OAc)_2{\cdot}H_2O$ (20 mg, 1 equiv) and trifluoromethanesulfonic acid (15 mg, 1 equiv) were stirred in methanol (1 mL) at Ar atmosphere at 90 °C for 1 h. After completion, the reaction mixture was purified by flash chromatography eluting with dichloromethane and methanol (10:1) to give the desired product **3aa-CF_3SO_3** as a grey solid (42.6 mg, 82%). IR (KBr) 3565, 3499, 3062, 1625 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$): δ 9.93 (s, 1H), 8.68 (d, *J* = 8.0 Hz, 1H), 8.08 (t, *J* = 8.0 Hz, 1H), 7.98 (t, *J* = 8.0 Hz, 1H), 7.75 (d, *J* = 8.0 Hz, 1H), 7.55-7.53 (m, 2H), 7.37-7.32 (m, 6H), 7.28-7.27 (m, 2H), 7.08-7.03 (m, 5H). ^{13}C NMR (151 MHz, $CDCl_3$): δ 150.5, 142.1, 139.3, 138.8, 137.8, 133.1, 131.9, 131.3, 131.2, 131.0, 130.4, 130.3, 129.5, 129.1, 128.7, 128.4, 127.9, 126.9, 126.8, 126.5, 120.6, 119.4, 112.4. ESI HRMS: calcd. For $C_{27}H_{20}N^+$ 358.1590, found 358.1586.



3aa-I

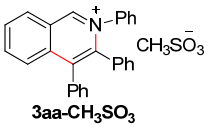
KI was added into isolated product **3aa-CF_3SO_3** (26 mg, 0.05 mmol) in methanol (0.5 mL), and then vigorously stirred overnight at room temperature. The reaction mixture was purified by flash chromatography eluting with dichloromethane and methanol (10:1) to isolated pure desired product **2,3,4-Triphenylisoquinolinium iodide (3aa-I).** 99% yield; IR (KBr) 3422, 3062, 1622 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$): δ 10.09 (s, 1H), 8.74 (d, *J* = 8.0 Hz, 1H), 8.05 (t, *J* = 8.0 Hz, 1H), 7.94 (t, *J* = 8.0 Hz, 1H), 7.72 (d, *J* = 8.0 Hz, 1H), 7.66-7.64 (m, 2H), 7.33-7.29 (m, 8H), 7.13 (d, *J* = 8.0 Hz, 2H), 7.04-6.93 (m, 3H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 149.3, 143.3, 141.1, 138.4, 137.9, 136.8, 132.2, 130.9, 130.3, 130.3, 130.1, 129.4, 128.4, 128.2, 127.7, 127.4, 126.9, 126.0, 125.9, 125.6.



3aa-OAc

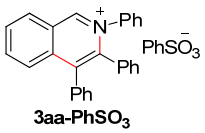
2,3,4-Triphenylisoquinolinium acetate (**3aa-OAc**), (see Table 1, entry 5). 42% yield; IR (KBr) 3453, 2960, 2926, 1713, 1625 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$): δ 11.09 (s, 1H), 9.29 (d, *J* = 8.0 Hz, 1H), 8.08 (t, *J* = 8.0 Hz, 1H), 8.01 (t, *J* = 8.0

Hz, 1H), 7.75 (t, *J* = 8.0 Hz, 1H), 7.66-7.65 (m, 2H), 7.39-7.34 (m, 5H), 7.27-7.26 (m, 3H), 7.09-7.04 (m, 5H), 2.04 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$): δ 152.6, 138.8, 138.4, 137.8, 133.5, 133.2, 131.2, 131.2, 131.2, 130.3, 129.5, 128.7,128.5, 128.0, 127.2, 126.9, 126.1.



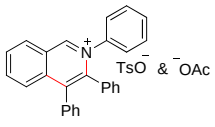
3aa-CH_3SO_3

2,3,4-Triphenylisoquinolinium methanesulfonate (3aa-CH_3SO_3) (see Table 1, entry 8). 30% yield; IR (KBr) 3493, 3434, 3057, 1626 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$): δ 10.58 (s, 1H), 9.07 (s, 1H), 8.10-8.03 (m, 2H), 7.76 (t, *J* = 8.0 Hz, 1H), 7.62 (m, 2H), 7.38-7.34 (m, 6H), 7.28-7.25 (m, 2H), 7.05 (m, 5H), 2.53 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 152.7, 143.9, 142.1, 138.9, 138.6, 137.8, 133.3, 133.2, 131.3, 131.2, 130.4, 129.5, 129.2, 128.8, 128.6, 128.0, 127.2, 127.0, 126.3, 39.4.



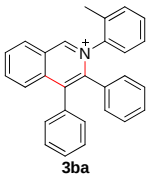
3aa-$PhSO_3$

2,3,4-Triphenylisoquinolinium benzenesulfonate (3aa-$PhSO_3$) (see Table 1, entry 10). 33% yield; IR (KBr) 3427, 3054, 1627 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$): δ 10.48 (s, 1H), 8.94 (d, *J* = 8.0 Hz, 1H), 8.02 (t, *J* = 8.4 Hz, 1H), 7.92 (t, *J* = 6.8 Hz, 1H), 7.70 (d, *J* = 8.4 Hz, 1H), 7.64 (d, *J* = 7.2 Hz, 2H) 7.59 (d, *J* = 7.2 Hz, 2H), 7.31-7.27 (m, 6H), 7.22-7.18 (m, 5H), 7.06-7.00 (m, 5H).



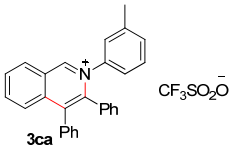
3aa-TsO^- & AcO^-

2,3,4-Triphenylisoquinolinium 4-methylbenzenesulfonate (3aa-TsO&OAc) (see Table 1, entry 11). 29% yield of acetate salt, 43% yield of tosylate salt; ^{1}H NMR (400 MHz, $CDCl_3$): δ 10.50 (s, 1H), 8.93 (d, *J* = 8.0 Hz, 1H), 7.95 (t, *J* = 8.0 Hz, 1H), 7.54 (t, *J* = 6.8 Hz, 1H), 7.48 (d, *J* = 8.0 Hz, 2H), 7.26-7.19 (m, 6H), 7.15-7.13 (m, 2H), 7.00-6.93 (m, 7H), 2.23 (s, 3H), 1.90 (s, 2H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 153.1, 144.1, 143.9, 142.1, 138.8, 138.5, 138.4, 137.6, 133.3, 133.2, 131.3, 131.3, 130.4, 130.2, 129.4, 129.1, 128.7, 128.5, 128.3, 127.9, 127.2, 127.1, 127.0, 126.1, 125.9, 21.3.



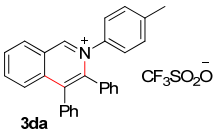
3ba

3,4-Diphenyl-2-o-tolylisoquinolinium trifluoromethanesulfonate (3ba). 85% yield; IR (KBr) 3436, 3057, 1627 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$): δ 9.93 (s, 1H), 8.69 (d, *J* = 8.0 Hz, 1H), 8.06 (t, *J* = 8.0 Hz, 1H), 7.97 (t, *J* = 8.0 Hz, 1H), 7.76 (d, *J* = 8.4 Hz, 1H), 7.37-7.32 (m, 4H), 7.26-7.17 (m, 5H), 7.05 (m, 5H), 2.29 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 150.0, 149.9, 143.4, 141.0, 139.2, 138.3, 137.7, 136.8, 132.2, 131.0, 131.0, 130.3, 130.2, 129.3, 128.2, 128.1, 127.7, 127.5, 126.9, 126.3, 126.0, 125.5, 122.7, 119.6 (q, J = 319 Hz), 21.2. ESI HRMS: calcd. For $C_{28}H_{22}N^+$ 372.1747, found 372.1747.



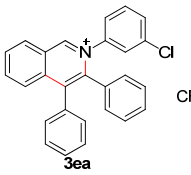
3ca

3,4-Diphenyl-2-m-tolylisoquinolinium trifluoromethanesulfonate (3ca). 80% yield; IR (KBr) 3440, 3069, 1622 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$): δ 9.93 (s, 1H), 8.78 (d, *J* = 8.0 Hz, 1H), 8.11 (t, *J* = 8.0 Hz, 1H), 8.02 (t, *J* = 8.0 Hz, 1H), 7.81 (d, *J* = 8.4 Hz, 1H), 7.66 (d, *J* = 7.6 Hz, 1H), 7.37-7.23 (m, 8H), 7.18-7.16 (m, 1H), 7.08-7.07 (m, 2H), 7.01-7.00 (m, 1H), 6.93-6.91 (m, 1H), 2.09 (s, 3H). ^{13}C NMR (151 MHz, $CDCl_3$): δ 151.2, 144.5, 141.1, 139.6, 138.8, 138.0, 133.0, 132.3, 132.0, 131.4, 131.2, 130.9, 130.6, 130.5, 129.4, 129.3, 128.9, 128.8, 128.2, 127.9, 127.6, 127.3, 127.2, 126.5, 120.5 (q, *J* = 318 Hz),17.6. For $C_{28}H_{22}N^+$ 372.1747, found 372.1748.



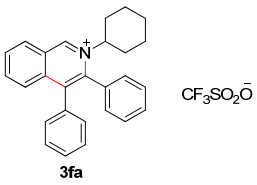
3da

3,4-Diphenyl-2-p-tolylisoquinolinium trifluoromethanesulfonate (**3da**). 79% yield; IR (KBr) 3482, 3060, 1626 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 9.93 (s, 1H), 8.69 (d, *J* = 8.0 Hz, 1H), 8.06 (t, *J* = 8.0 Hz, 1H), 7.97 (t, *J* = 8.0 Hz, 1H), 7.76 (d, *J* = 8.0 Hz, 1H), 7.37-7.26 (m, 4H), 7.26-7.17 (m, 5H), 7.05 (m, 5H), 2.30 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 151.1, 144.5, 140.8, 139.8, 139.3, 138.7, 137.8, 133.2, 132.0, 131.3, 131.2, 130.3, 130.1, 129.2, 128.7, 128.5, 128.0, 127.0, 126.5, 126.5, 120.6 (q, *J* = 319 Hz), 21.2. ESI HRMS: calcd. For $C_{28}H_{22}N^+$ 372.1747, found 372.1752.



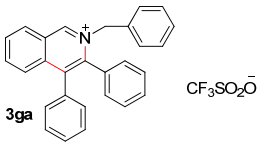
3ea

2-(3-Chlorophenyl)-3,4-diphenylisoquinolinium-trifluoromethanesulfonate (**3ea**). 77% yield; IR (KBr) 3468, 3240, 1624 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 9.88 (s, 1H), 8.62 (d, *J* = 8.0 Hz, 1H), 8.07 (t, *J* = 8.0 Hz, 1H), 7.95 (t, *J* = 7.2 Hz, 1H), 7.76 (d, *J* = 8.8 Hz, 1H), 7.58 (d, *J* = 7.2 Hz, 1H), 7.52 (s, 1H), 7.32-7.31 (m, 5H), 7.28-7.26 (m, 2H), 7.11-7.08 (m, 5H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 150.9, 144.3, 142.7, 139.5, 139.0, 138.1, 135.0, 133.1, 132.0, 131.4, 131.2, 130.9, 130.8, 130.7, 130.3, 129.4, 128.8, 128.5, 128.1, 127.1, 127.0, 125.6, 120.4 (q, *J* = 319 Hz). ESI HRMS: calcd. for $C_{27}H_{19}ClN^+$ 392.1201, found 392.1119, 394.1229.



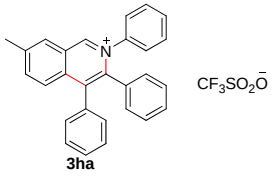
3fa

2-Cyclohexyl-3,4-diphenylisoquinolinium trifluoromethanesulfonate (3fa) 85% yield**;** IR (KBr) 3440, 3065, 3019, 1625 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 10.40 (s, 1H), 8.95 (d, *J* = 7.2 Hz, 1H), 8.00 (t, *J* = 8.0 Hz, 1H), 7.97 (t, *J* = 7.6 Hz, 1H), 7.61 (d, *J* = 7.6 Hz, 1H), 7.39 (m, 3H), 7.29-7.27 (m, 3H),7.23 (m, 2H), 7.12(m, 2H), 4.34 (m, 1H), 2.39-2.36 (m, 2H), 2.13 (m, 2H), 1.93-1.90 (m, 2H), 1.58-1.48 (m, 2H), 1.07-1.04 (m, 2H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 148.2, 143.9, 139.4, 137.6, 137.4, 133.3, 132.1, 131.2, 131.0, 130.3, 129.8, 129.0, 128.7, 128.5, 128.0, 120.8 (q, *J* = 319 Hz), 68.5, 33.6, 25.8, 23.9. ESI HRMS: calcd. for $C_{27}H_{26}N^+$ 364.2060, found 364.2058.



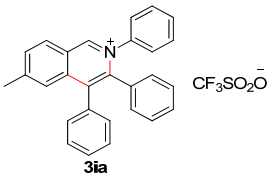
3ga

2-Benzyl-3,4-diphenylisoquinolinium trifluoromethanesulfonate (**3ga**). 52 % yield; IR (KBr) 3431, 3052, 1630 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 10.33 (s, 1H), 8.72 (d, *J* = 8.0 Hz, 1H), 8.02 (t, *J* = 8.0 Hz, 1H), 7.96 (t, *J* = 8.0 Hz, 1H), 7.65 (d, *J* = 8.4 Hz, 1H), 7.28-7.23 (m, 9H), 7.09-7.07 (m, 4H), 6.92 (d, *J* = 7.2 Hz, 2H), 5.89 (s, 2H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 151.3, 144.3, 139.8, 138.1, 137.5, 133.1, 131.9, 131.2, 130.7, 130.6, 130.1, 130.0, 129.3, 129.2, 128.7, 128.6, 128.4, 128.3, 127.3, 63.3. ESI HRMS: calcd. For $C_{28}H_{22}N^+$ 372.1747, found 372.1755.

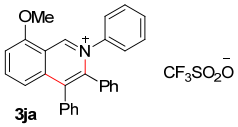


3ha

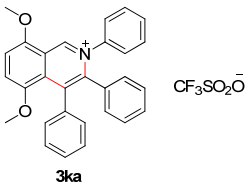
5-Methyl-2,3,4-triphenylisoquinolinium trifluoromethanesulfonate (**3ha**). 78% yield; IR (KBr) 3455, 3066, 1634 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 9.84 (s, 1H), 8.46 (s, 1H), 7.90 (t, *J* = 8.8Hz, 1H), 7.67 (d, *J* = 8.4Hz, 1H), 7.52-7.51 (m, 2H), 7.34-7.32 (m, 6H), 7.24 (m, 2H), 7.04 (m, 5H), 2.66 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 150.0, 143.7, 142.5, 142.2, 140.3, 139.1, 137.1, 133.3, 131.3, 131.2, 130.4, 130.3, 129.6, 129.2, 128.7, 128.5, 128.0, 127.3, 126.8, 126.3, 120.6 (q, *J* = 319 Hz), 21.8. ESI HRMS: calcd. For $C_{28}H_{22}N^+$ 372.1747, found 372.1746.



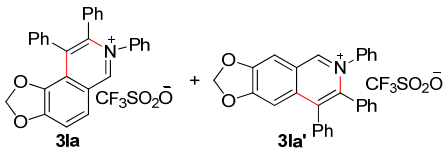
6-Methyl-2,3,4-triphenylisoquinolinium trifluoromethanesulfonate. (**3ia**) 93% yield; IR (KBr) 3476, 3245, 3061, 1626 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 9.83 (s, 1H), 8.55 (d, *J* = 8.8 Hz, 1H), 7.79 (d, *J* = 8.0 Hz, 1H), 7.51-7.49 (m, 3H), 7.34-7.31 (m, 6H), 7.26-7.23 (m, 2H), 7.03-6.99 (m, 5H), 2.58 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 150.5，150.1，144.4，142.1，139.0，138.3，133.7，133.3, 131.7, 131.2, 130.4，130.3，129.5, 129.1, 128.7，128.5, 127.9, 126.9, 125.5, 125.4, 120.6 (q, *J* = 319 Hz), 23.3. ESI HRMS: calcd. for $C_{28}H_{22}N^+$ 372.1747, found 372.1748.



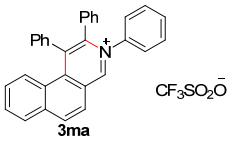
8-Methoxy-2,3,4-triphenylisoquinolinium trifluoromethanesulfonate (**3ja**). 81% yield. IR (KBr) 3488, 3245, 3060, 1622 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 9.74 (s,1H), 8.00 (d, *J* = 8.0 Hz, 1H), 7.56 (t, *J* = 8.0 Hz, 1H), 7.37-7.35 (m, 3H), 7.29-7.26 (m, 7H), 7.14-7.13 (m, 2H), 7.04-7.00 (m, 3H), 4.15 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 157.7, 144.5, 144.0, 141.6, 138.8, 138.7, 137.8, 132.5, 130.2, 130.2, 129.4, 129.3, 128.5, 128.1, 127.6, 127.4, 126.8, 125.9, 119.6 (q, *J* = 319 Hz),118.6, 117.4, 108.2, 55.9. ESI HRMS: calcd. For $C_{28}H_{22}NO^+$ 388.1696, found 389.1693.



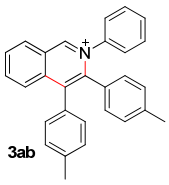
5,8-Dimethoxy-2,3,4-triphenylisoquinolinium trifluoro-methanesulfonate (**3ka**). 75% yield; IR (KBr) 3062, 2920, 1650 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 9.69 (s, 1H), 9.51-9.49 (s, 2H), 7.44 (d, *J* = 8.4 Hz, 1H), 7.34-7.33 (m, 3H), 7.27-7.25 (m, 1H), 7.17-7.16 (m, 2H), 7.12-7.11 (m, 3H), 7.06-7.04 (m, 2H), 6.96-6.94 (m, 3H), 4.07 (s, 3H), 3.38 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 152.3, 149.9, 145.6, 145.1, 142.6, 137.7, 137.1, 131.5, 131.2, 130.3, 129.8, 129.5, 129.4, 128.8, 127.5, 127.1, 126.9, 126.8, 120.9, 120.7 (q, *J* = 319 Hz), 120.1, 110.3, 57.1, 56.8. ESI HRMS: calcd. For $C_{29}H_{24}NO_2^+$ 418.1802, found 418.1807.



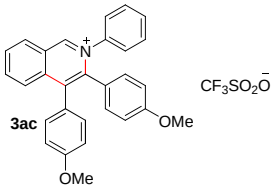
6,7,8-Triphenyl-[1,3]dioxolo[4,5-g]isoquinolin-6-ium trifluoromethanesulfonate (**3la**); **6,7,8-Triphenyl-[1,3]dioxolo[4,5-g]isoquinolin-6-ium trifluoromethanesulfonate** (**3la'**); (**3la**:**3la'** = 10:1). 74% yield; IR (KBr) 3470, 3062, 1630 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 9.74 (s, 1H), 8.43 (d, *J* = 8.0Hz, 1H), 7.62 (d, *J* = 8.8 Hz, 1H), 7.45 (t, *J* = 8.0Hz, 2H), 7.34 (m, 3H), 7.21 (m, 5H), 7.00 (m, 5H), 6.05 (s, 2H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 155.4, 151.4, 143.8, 142.1, 141.9, 131.3, 130.3, 130.1, 129.5, 129.1, 128.3, 127.8, 127.6, 126.8, 122.7, 122.6, 120.6 (q, *J* = 319 Hz), 116.0, 103.9. ESI HRMS: calcd. For $C_{28}H_{20}NO_2^+$ 402.1489, found 402.1493.



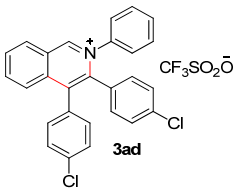
1,2,3-Triphenylbenzo[f]isoquinolinium trifluoromethanesulfonate (**3ma**). 80% yield; IR (KBr) 3463, 3062, 1613 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 10.12 (s, 1H), 8.85 (d, *J* = 7.6 Hz, 1H), 8.25 (t, *J* = 9.2 Hz, 1H), 8.03 (d, *J* = 7.6 Hz, 1H), 7.87 (t, *J* = 7.6 Hz, 1H), 7.82 (t, *J* = 7.6 Hz, 1H), 7.62-7.57 (m, 3H), 7.37-7.36 (m, 3H), 7.32(m, 5H), 7.15-7.13 (m, 2H), 7.06-7.00 (m, 3H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 147.3, 143.5, 142.6, 140.7, 139.7, 139.3, 133.5, 132.4, 131.1, 130.5, 129.7, 129.6, 129.3, 128.8, 128.6, 127.9, 127.1, 123.5, 122.8, 120.5 (q, *J* = 319 Hz). ESI HRMS: calcd. For $C_{31}H_{22}N^+$ 408.1747, found 408.1749.



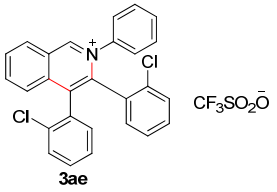
2-Phenyl-3,4-dip-tolylisoquinolinium trifluoromethanesulfonate (**3ab**). 72 % yield; IR (KBr) 3564, 3492, 3066, 1625, 1491 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 9.96 (s, 1H), 8.70 (d, *J* = 8.0 Hz, 1H), 8.05 (t, *J* = 8.0 Hz, 1H), 7.97 (t, *J* = 8.0 Hz, 1H), 7.70 (d, *J* = 8.0 Hz, 1H), 7.50-7.48 (m, 2H), 7.37 (m, 3H), 7.15-7.09 (m, 4H), 6.91-6.89 (m, 2H), 6.84-6.82 (s, 2H), 2.34(s, 3H), 2.15 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 150.9, 144.6, 142.3, 139.5, 139.3, 139.0, 138.6, 137.7, 132.0, 131.2, 131.0, 130.4, 130.2, 129.5, 129.3, 128.7, 128.2, 126.9, 126.8, 126.6, 120.6 (q, *J* = 319 Hz), 21.32, 21.27. ESI HRMS: calcd. For $C_{29}H_{24}N^+$ 386.1903, found 386.1898.



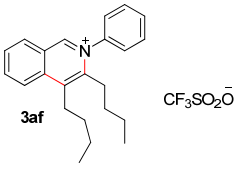
3,4-Bis(4-methoxyphenyl)-2-phenylisoquinolinium trifluoromethanesulfonate (**3ac**). 75% yield; IR (KBr) 3561, 3500, 3066, 1611 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 9.83 (s, 1H), 8.61 (d, *J* = 8.0 Hz, 1H), 8.04 (t, *J* = 8.0 Hz, 1H), 7.93 (t, *J* = 7.6 Hz, 1H), 7.79 (d, *J* = 8.4 Hz, 1H), 7.50-7.48 (m, 2H), 7.37-7.35 (m, 3H), 7.15 (d, *J* = 8.4 Hz, 2H), 6.95 (d, *J* = 8.4 Hz, 2H), 6.85 (d, *J* = 8.4 Hz, 2H), 6.54 (d, *J* = 7.6 Hz, 2H), 3.79 (s, 3H), 3.64 (s, 3H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 159.7, 159.6, 150.6, 144.7, 142.4, 139.5, 139.2, 137.6, 132.7, 131.9, 131.7, 131.1, 130.4, 129.6, 126.9, 126.7, 126.6, 125.3, 123.3, 120.6 (d, *J* = 31.9 Hz), 114.1, 113.5, 55.3, 55.1. ESI HRMS: calcd. For $C_{29}H_{24}NO_2^+$ 418.1802, found 418.1798.



3,4-Bis(4-chlorophenyl)-2-phenylisoquinolinium trifluoromethanesulfonate (**3ad**). 65% yield; IR (KBr) 3564, 3242, 3064, 2924, 1626 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 9.75 (s, 1H), 8.55 (d, *J* = 8.0 Hz, 1H), 8.09 (t, *J* = 8.0 Hz, 1H), 7.96 (t, *J* = 8.0 Hz, 1H), 7.72 (d, *J* = 8.0 Hz, 1H), 7.56-7.55 (m, 2H), 7.42-7.35 (m, 5H), 7.27-7.25 (m, 2H), 7.11-7.09 (m, 2H), 7.05-7.03 (m, 2H). ^{13}C NMR (151 MHz, $CDCl_3$): δ 150.9, 134.5, 141.9, 138.7, 138.4, 138.0, 135.7, 135.2, 132.6, 131.7, 131.7, 131.5, 131.5, 130.7, 129.7, 129.4, 129.0, 128.4, 127.0, 126.8, 126.4, 121.4, 120.4, 119.1(q, *J* = 259 Hz). ESI HRMS: calcd. For $C_{27}H_{18}Cl_2N^+$ 426.0811, found 426.0815, 428.0798, 430.0801.

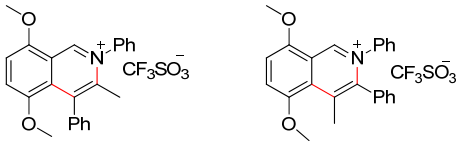


3,4-Bis(2-chlorophenyl)-2-phenylisoquinolinium trifluoromethanesulfonate (3ae). 64% yield; IR (KBr) 3563, 3490, 3069, 1624 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 9.80 (s, 1H), 8.58 (d, *J* = 8.4 Hz, 1H), 8.10 (t, *J* = 7.6 Hz, 1H), 7.96 (t, *J* = 7.6 Hz, 1H), 7.72 (d, *J* = 8.4 Hz, 1H), 7.57 (d, *J* = 7.6 Hz, 2H), 7.39-7.35 (m, 3H), 7.32-7.27 (m, 4H), 7.11-7.03 (m, 3H), 7.03-7.01 (m, 1H). ^{13}C NMR (151 MHz, $CDCl_3$): δ 151.3, 142.9, 141.8, 138.5, 138.1, 137.9, 134.7, 134.5, 133.9, 132.5, 131.9, 131.5, 130.7, 130.0, 129.6, 129.4, 129.2, 127.0, 126.8, 126.3, 120.4 (q, *J* = 318 Hz). ESI HRMS: calcd. For $C_{27}H_{18}Cl_2N^+$ 426.0811, found 426.0824, 426.0841, 430.0847.



3,4-Dibutyl-2-phenylisoquinolinium trifluoromethanesulfonate (3af). 49 % yield; IR (KBr) 3446, 3066, 1631 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$): δ 9.73 (s, 1H), 8.59 (d, *J* = 8.0 Hz, 1H), 8.22-8.16 (m, 2H), 7.92 (t, *J* =7.2

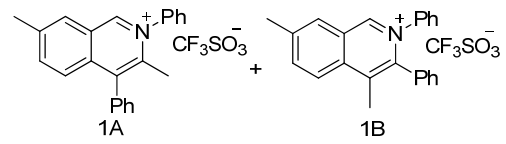
Hz, 1H), 7.69-7.68 (m, 3H), 7.63 (m, 2H), 3.20 (t, J = 8.0 Hz, 2H), 2.86 (t, J = 8.0 Hz, 2H), 1.75-1.71 (m, 2H), 1.65-1.59 (m, 2H), 1.48 (t, J = 8.0 Hz, 2H), 1.24-1.18 (m, 2H), 1.05 (t, J = 7.2 Hz, 3H), 0.73 (t, J = 7.2 Hz, 3H). ^{13}C NMR (100 MHz, $CDCl_3$): δ 149.2, 144.2, 140.1, 137.2, 136.7, 136.3, 131.6, 130.5, 129.6, 129.3, 125.1, 125.0, 122.6, 119.6 (q, J = 319 Hz), 31.7, 30.4, 28.6, 27.5, 22.2, 21.6, 12.7, 12.0. ESI HRMS: calcd. For $C_{23}H_{28}N^+$ 318.2216, found 318.2219.



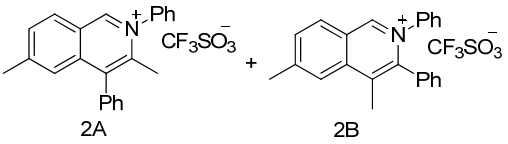
5,8-Dimethoxy-3-methyl-2,4-diphenyl isoquinolin- 2-ium trifluoromethanesulfonate (3kg). 5,8-Dimethoxy-4-methyl-2,3-diphenylisoquinolin-2 -ium trifluoromethanesulfonate (3kg'). (3kg:3kg' = 1.8:1), 82% yield; IR (KBr) 3059, 2941, 2839, 1622, 1600 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$): δ 9.53 (s, 1H), 9.52 (s, 1H), 7.71-7.68 (m, 7H), 7.60 (d, J =8.0 Hz, 1H), 7.45-7.42 (m, 5H), 7.38-7.36 (m, 8H), 7.31-7.29 (m, 4H), 7.25-7.24 (m, 2H), 7.17 (d, J = 8.4 Hz, 2H), 4.05 (s, 3H), 4.03 (s, 4H), 4.00 (s, 3H), 3.38 (s, 4H), 2.75 (s, 2H), 2.18 (s, 5H).

3. Substrate scope of unsymmetrically disubitituted alkynes

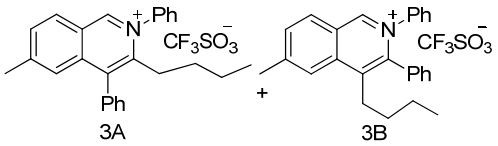
Unfortunately, asymmetric disubstituted alkynes as coupling partners can be employed in the reaction but giving the two isomers which were very hard to separate and confirm the structure. Only the structure of **3kg** and **3kg'** can be confirmed in 82% yield but albeit with poor regioselectivity.



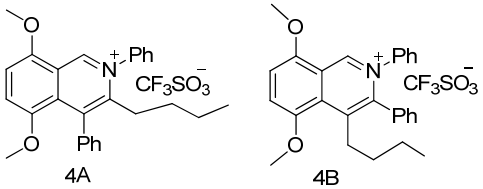
67% **1A:1B** or **1B:1A** = 2.4:1



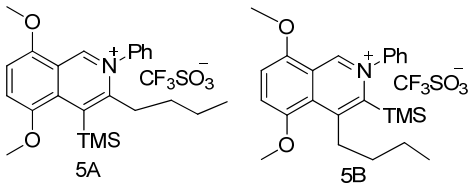
70% **2A:2B** or **2B:2A** = 3.1:1



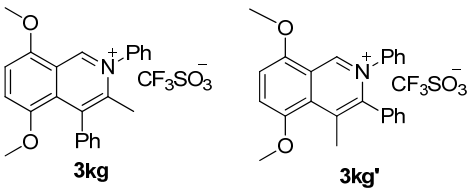
42% **3A:3B** or **3B:3A** = 5.8:1



89% **4A:4B** or **4B:4A** = 2.1:1

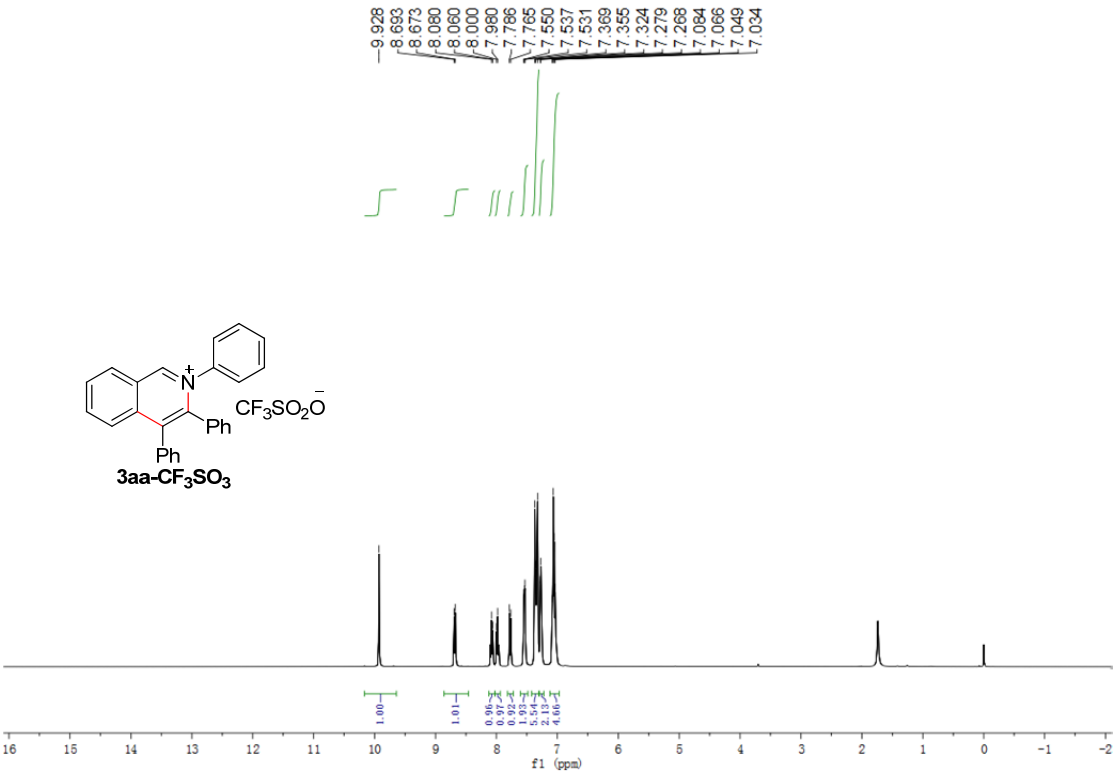


48% **5A:5B** or **5B:5A** = 1:1



82% **3kg:3kg'** = 1.8:1

4. NMR spectra of isoquinolinium salts derived fused compounds and structure determination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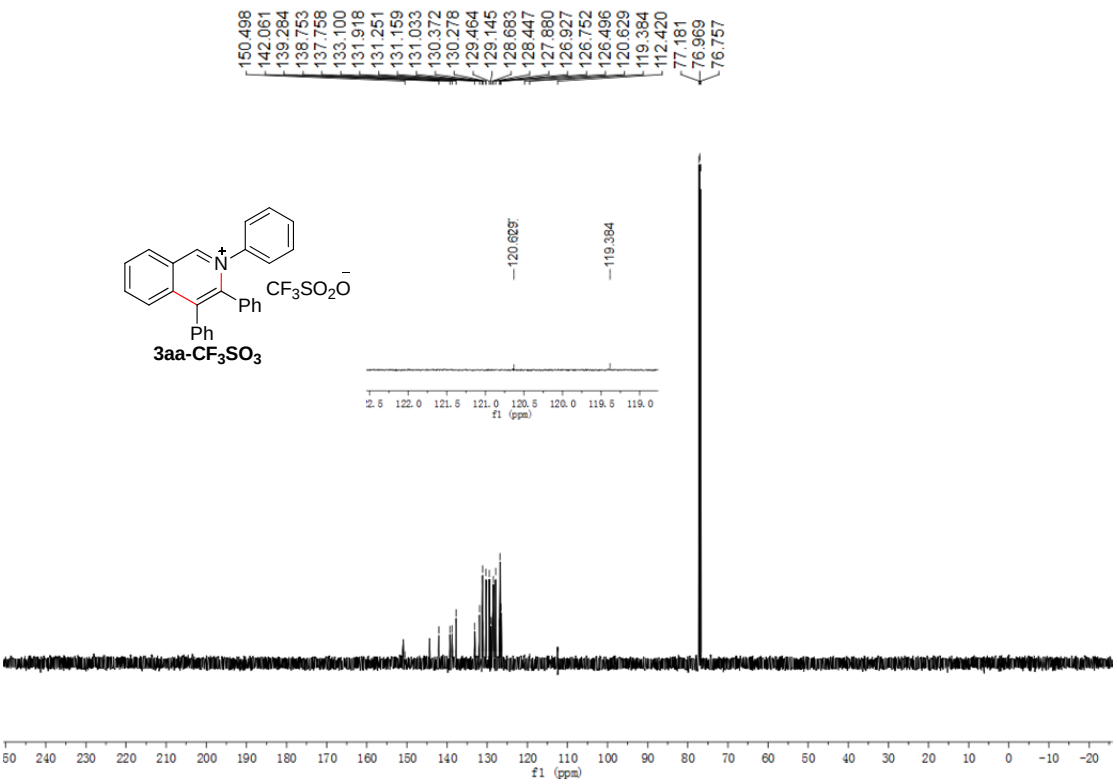
8.673
8.080
8.060
8.000
7.980
7.786
7.765
7.550
7.537
7.531
7.369
7.355
7.324
7.279
7.268
7.084
7.066
7.049
7.034
CF3SO2O
Ph
Ph
3aa-CF3SO3
1.00
1.01
f1 (ppm)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131.918
131.251
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131.033
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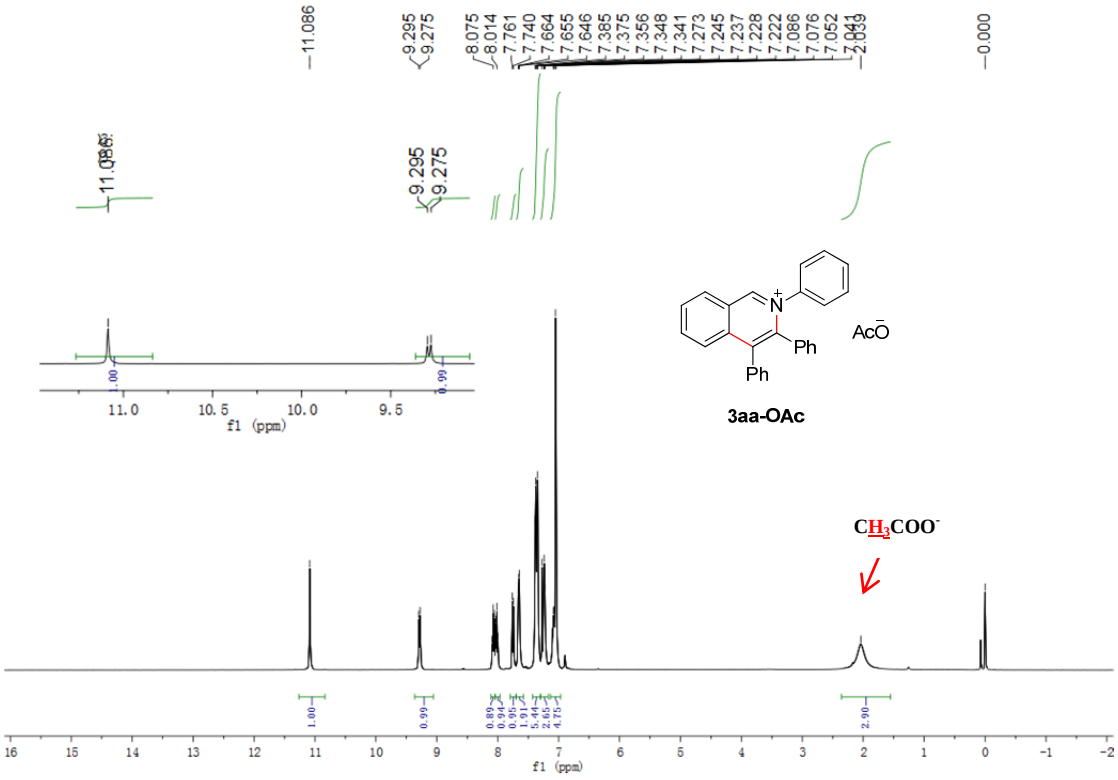
129.145
128.683
128.447
127.880
126.927
126.752
126.496
120.629
119.384
112.420
77.181
76.969
76.757
CF3SO2O
Ph
Ph
3aa-CF3SO3
120.629
119.384
f1 (ppm)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9.295
9.275
8.075
8.014
7.761
7.740
7.664
7.655
7.646
7.385
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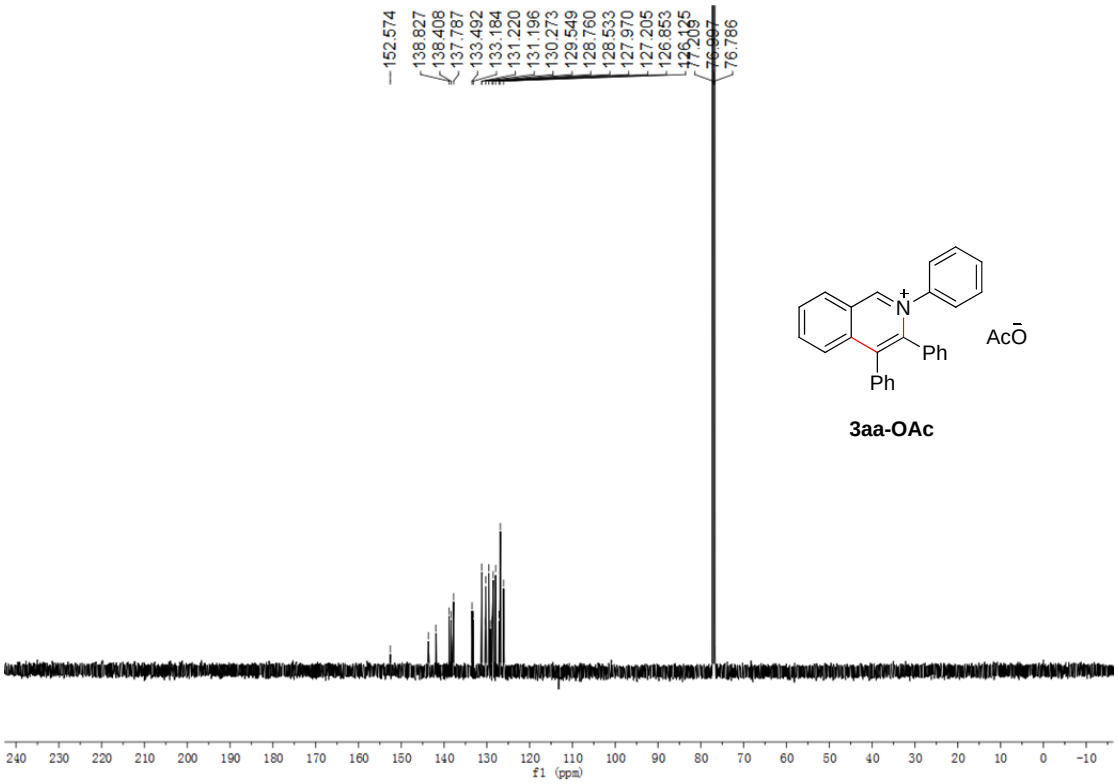
7.356
7.348
7.341
7.273
7.245
7.237
7.228
7.222
7.086
7.076
7.052
7.041
2.039
0.000
Ph
Ph
AcO
3aa-OAc
CH3COO-
f1 (ppm)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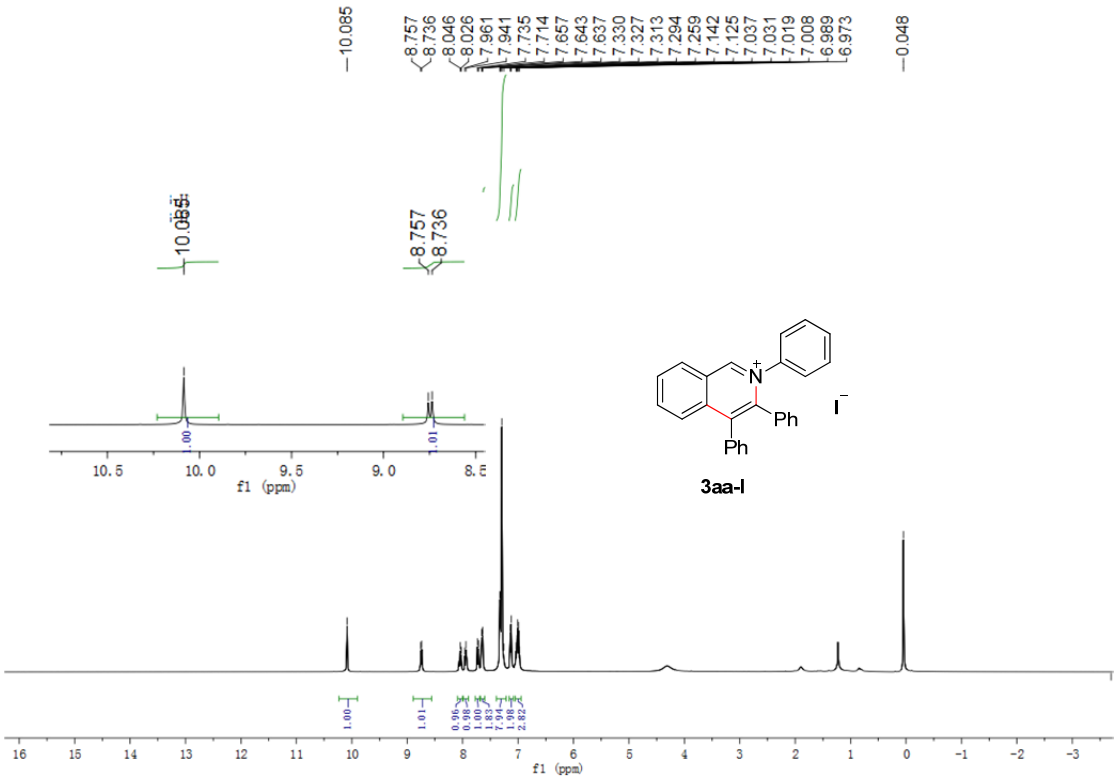
138.827
138.408
137.787
133.492
133.184
131.220
131.196
130.273
129.549
128.760
128.533
127.970
127.205
126.853
126.125
77.208
76.997
76.786
Ph
Ph
AcO
3aa-OAc
f1 (ppm)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8.757
8.736
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8.026
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7.941
7.735
7.714
7.657
7.643
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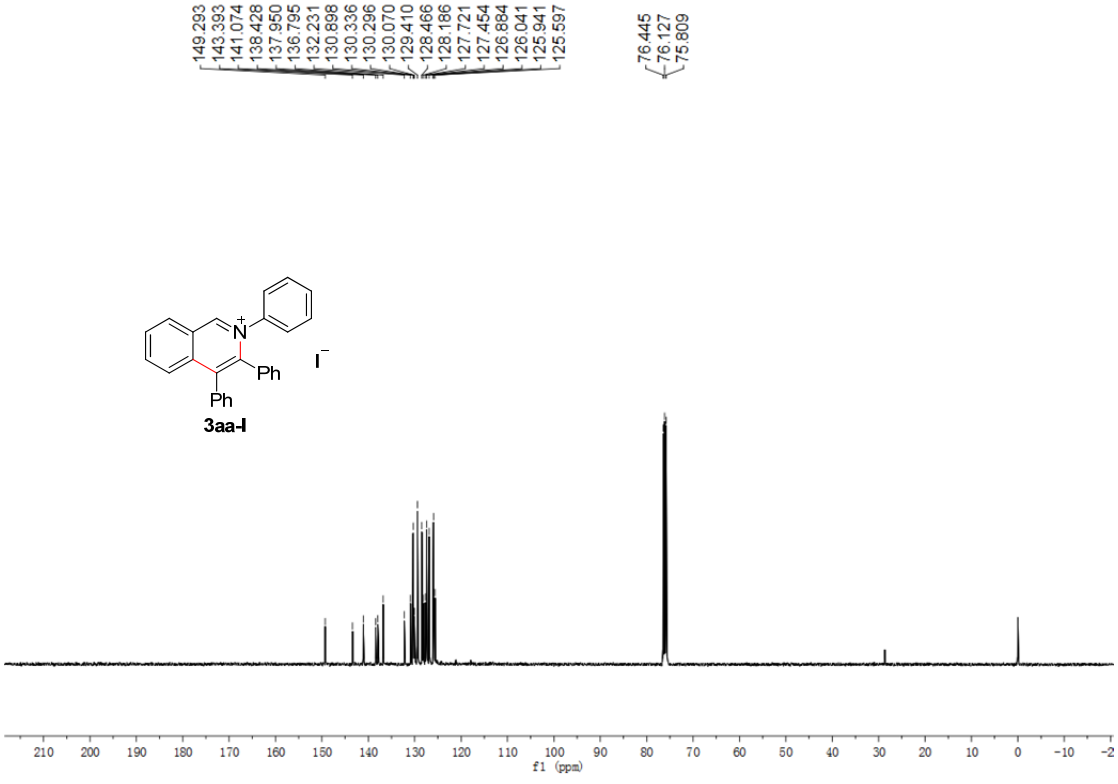
7.330
7.327
7.313
7.294
7.259
7.142
7.125
7.037
7.031
7.019
7.008
6.989
6.973
0.048
f1 (ppm)
Ph
Ph
I
3aa-I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136.795
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130.898
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130.296
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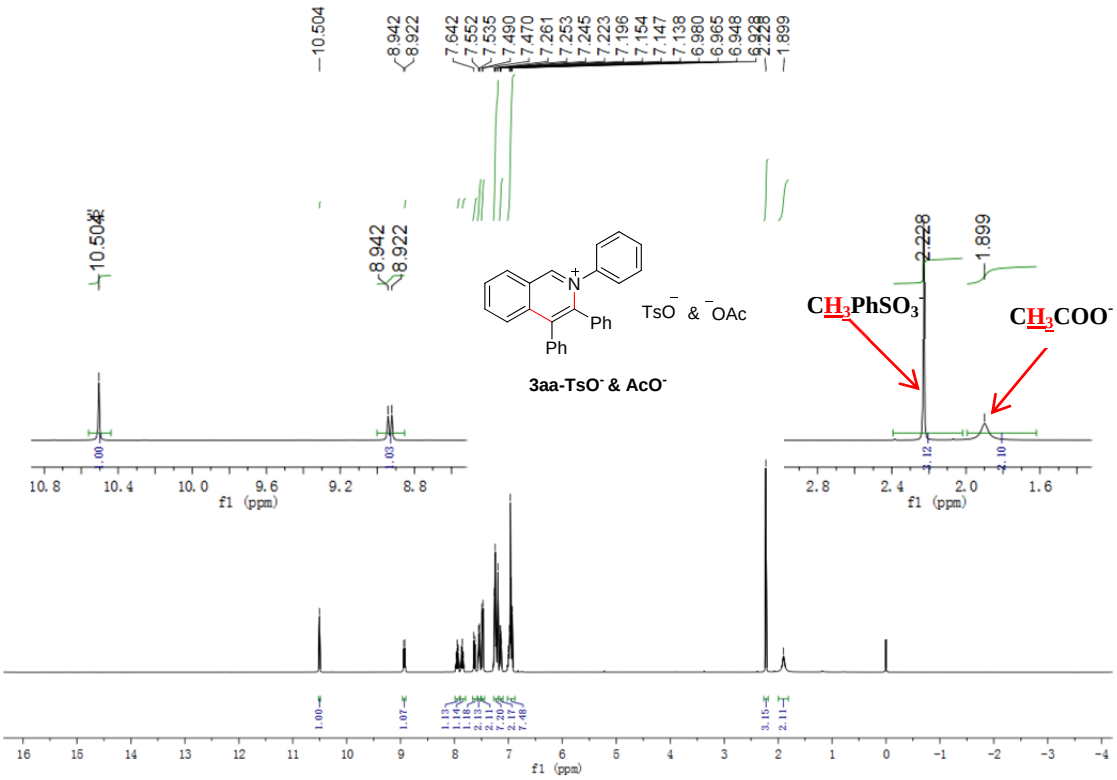
75.809
f1 (ppm)
Ph
Ph
I
3aa-I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8.922
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7.552
7.535
7.490
7.470
7.261
7.253
7.245
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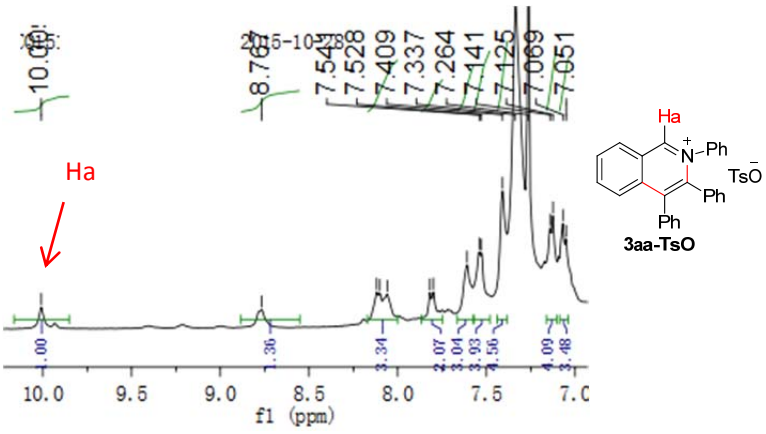
7.154
7.147
7.138
6.980
6.965
6.948
2.228
1.899
Ph
Ph
TsO⁻ & ⁻OAc
3aa-TsO⁻ & AcO⁻
CH3PhSO3⁻
CH3COO⁻
f1 (ppm)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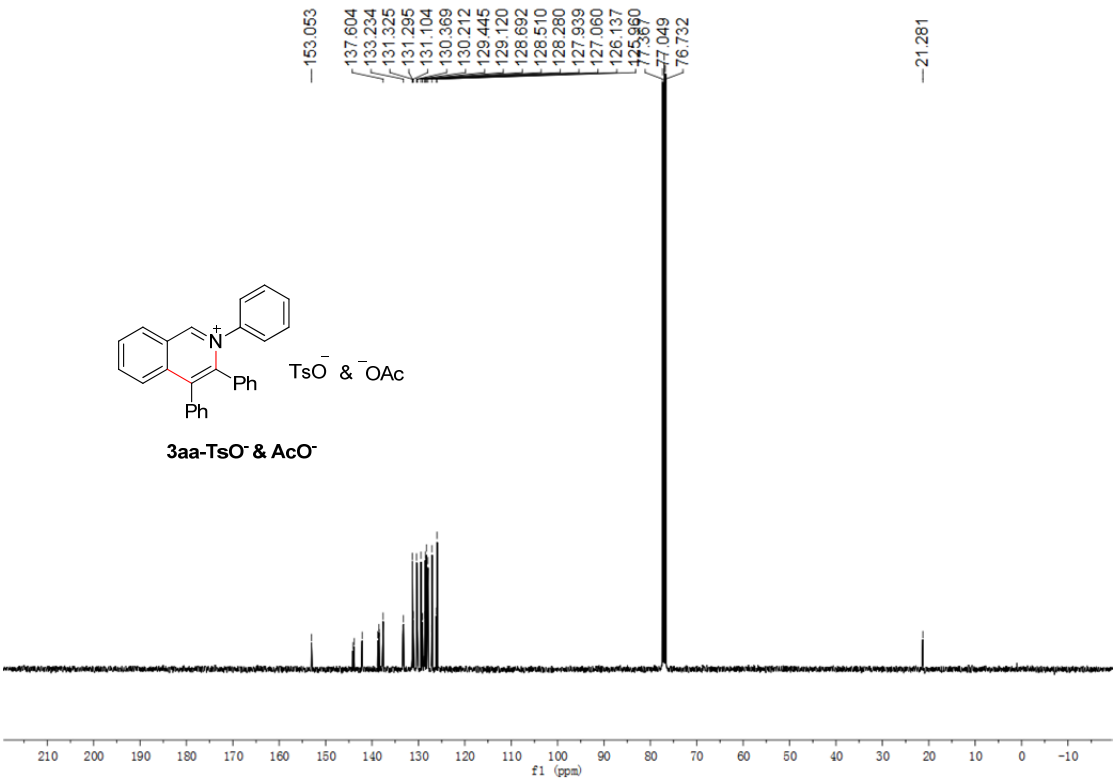
7.528
7.409
7.337
7.264
7.141
7.125
7.069
7.051
Ha
Ha
Ph
Ph
Ph
TsO⁻
3aa-TsO
f1 (ppm)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131.325
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129.120
128.692
128.510
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127.939
127.060
126.137
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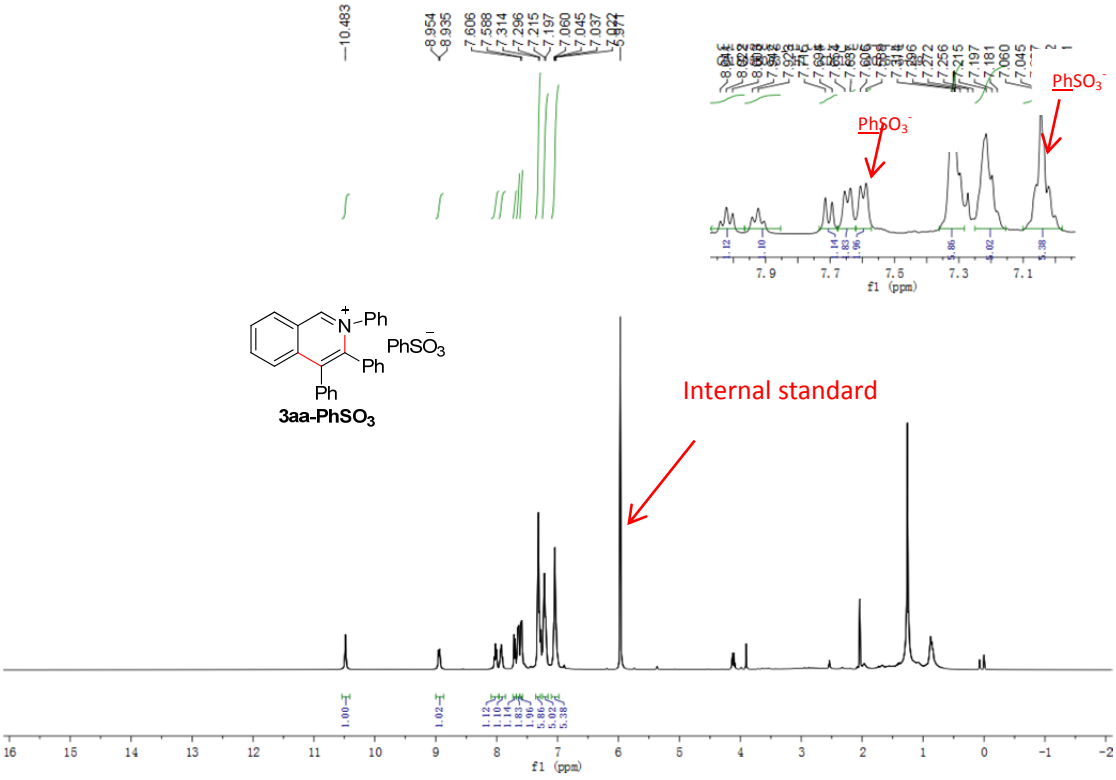
76.732
21.281
Ph
Ph
TsO⁻ & ⁻OAc
3aa-TsO⁻ & AcO⁻
f1 (ppm)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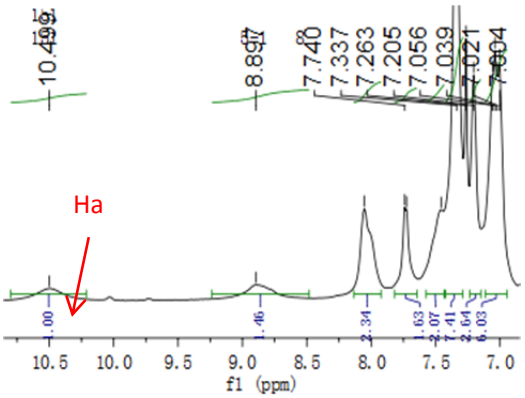
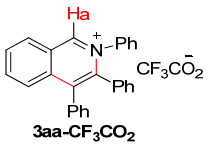
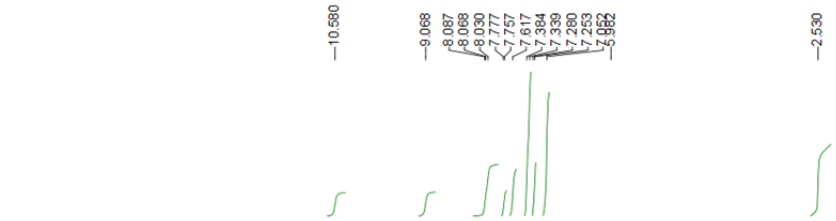
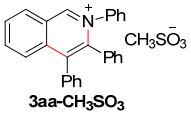
7.588
7.314
7.296
7.215
7.197
7.060
7.045
7.037
PhSO3⁻
PhSO3⁻
Ph
Ph
PhSO3⁻
Ph
3aa-PhSO3
Internal standard
f1 (ppm)



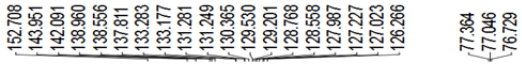


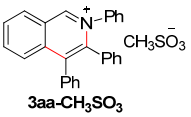
3aa-CF_3CO_2



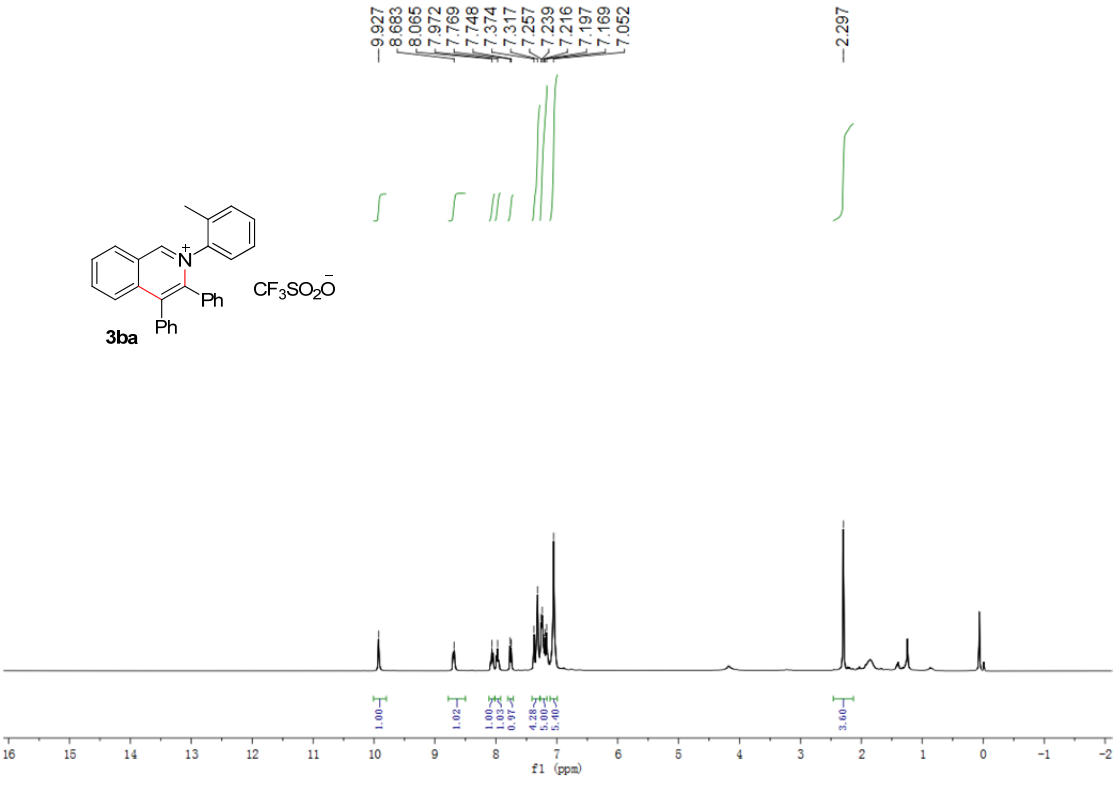


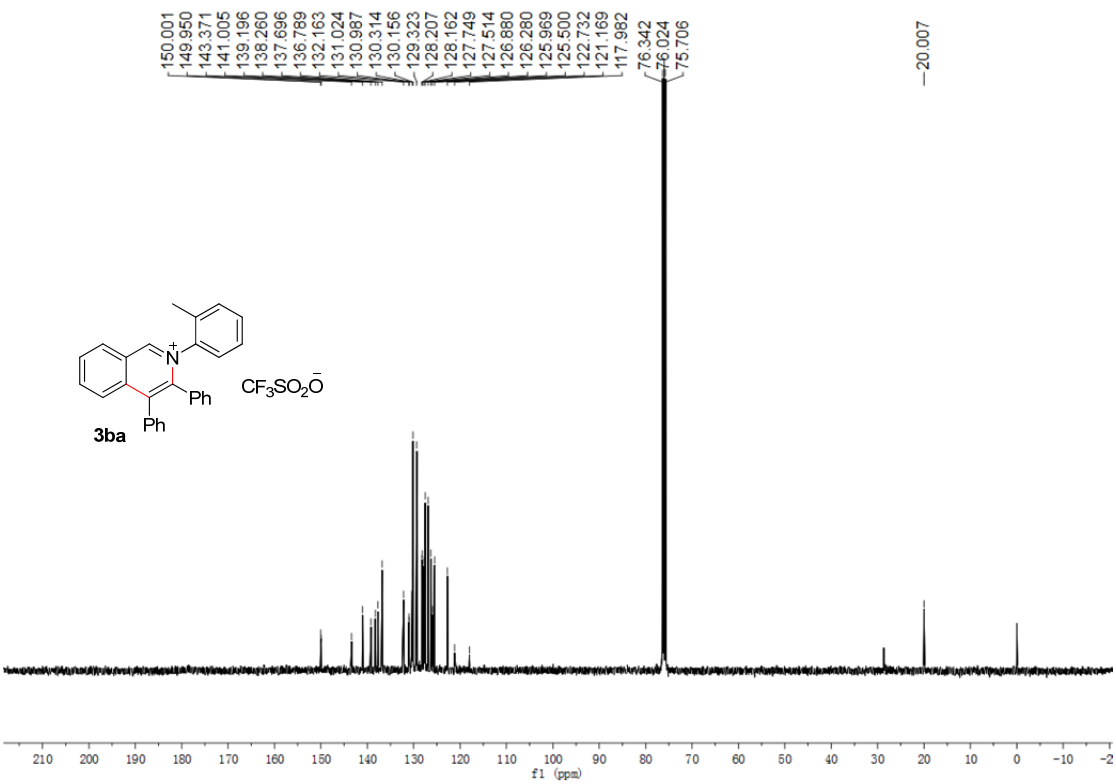
3aa-CH_3SO_3



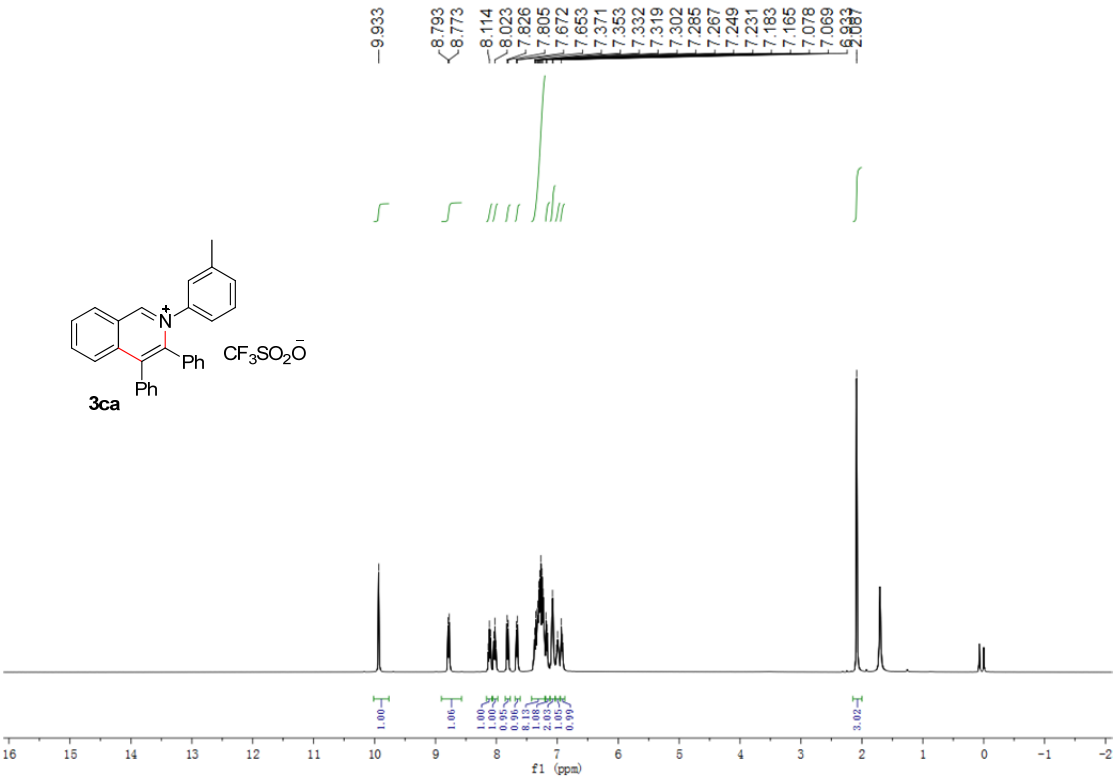


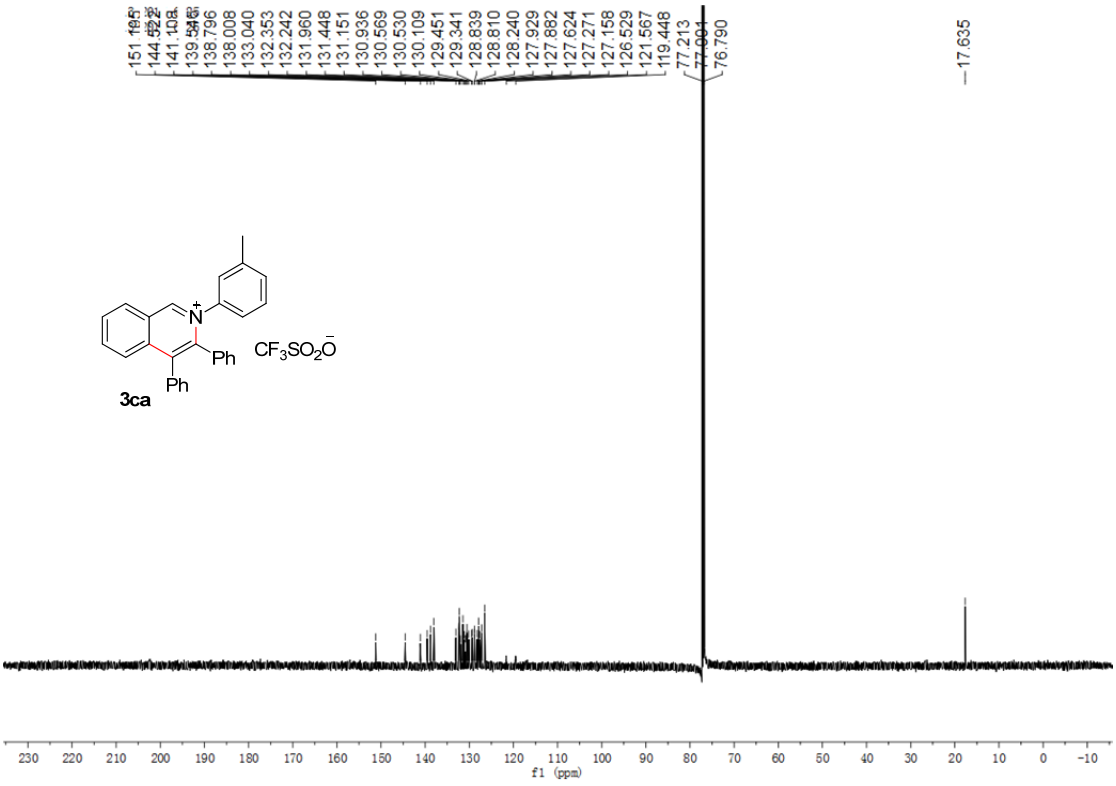
3aa-CH_3SO_3


9.927
8.683
8.065
7.972
7.769
7.748
7.374
7.317
7.257
7.239
7.216
7.197
7.169
7.052
2.297
Ph
Ph
$CF_3SO_2O^-$
3ba
1.00
1.02
1.00
1.03
0.97
4.28
5.00
5.40
3.60
f1 (ppm)

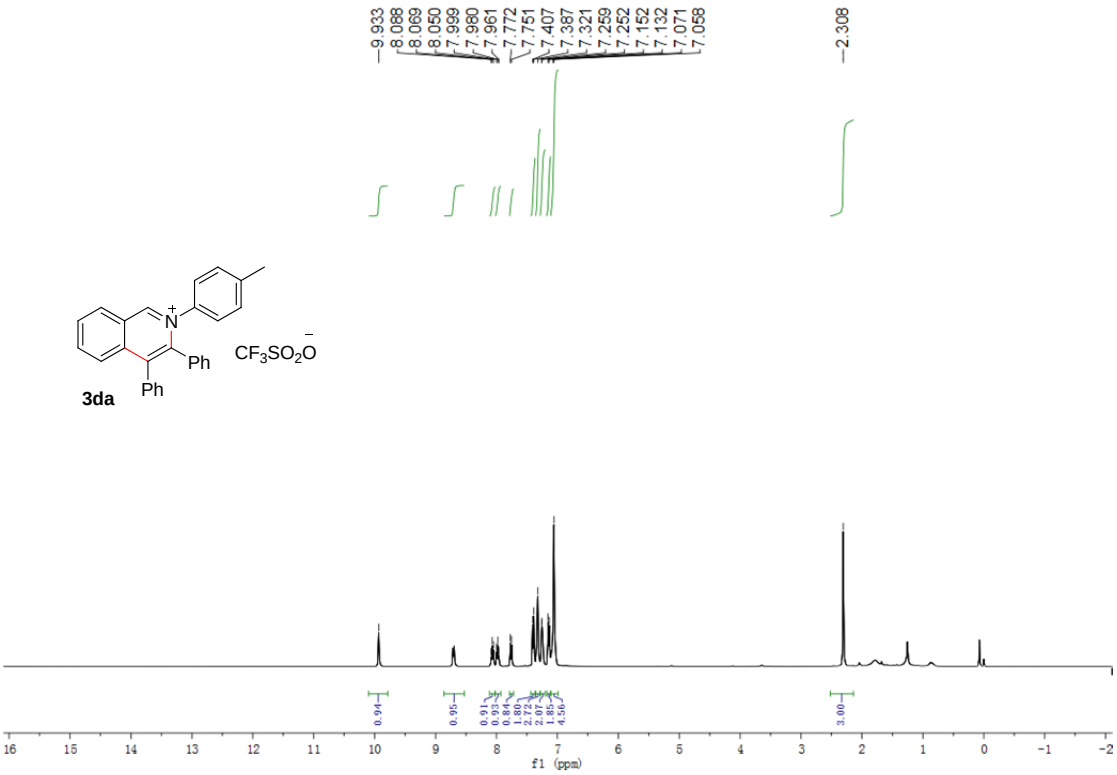

150.001
149.950
143.371
141.005
139.196
138.260
137.696
136.789
132.163
131.024
130.987
130.314
130.156
129.323
128.207
128.162
127.749
127.514
126.880
126.280
125.969
125.500
122.732
121.169
117.982
76.342
76.024
75.706
20.007
Ph
Ph
$CF_3SO_2O^-$
3ba
f1 (ppm)

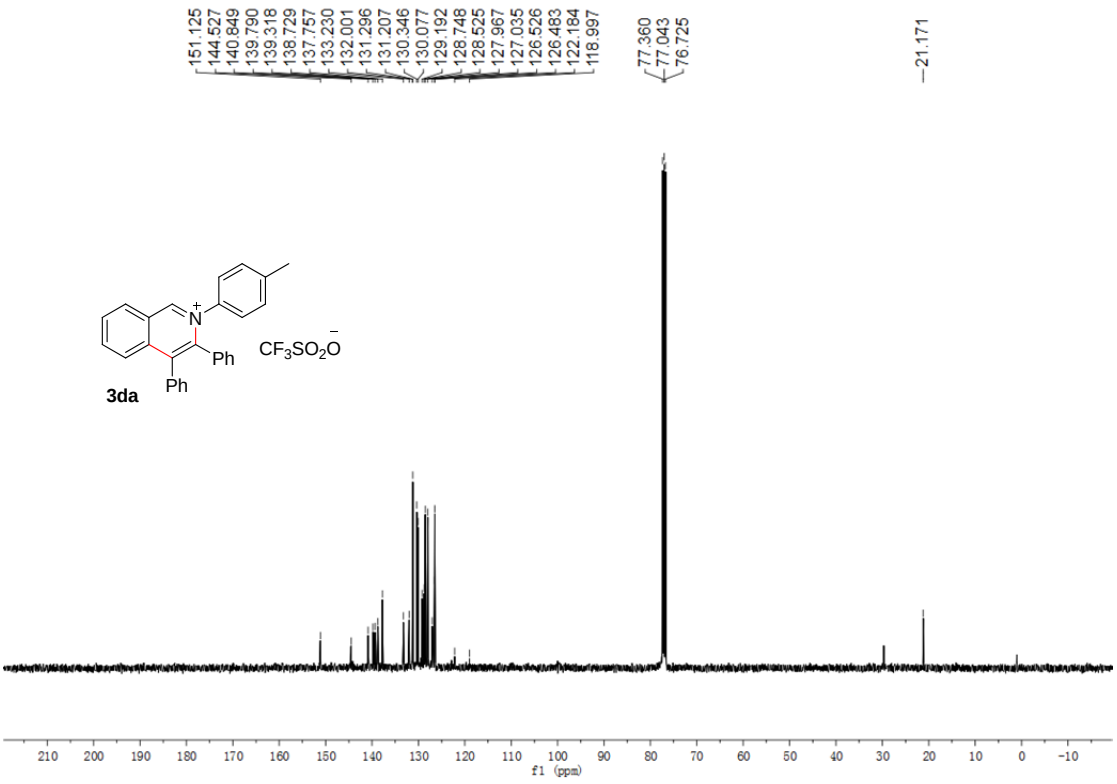
3ca


9.933
8.793
8.773
8.114
8.023
7.826
7.805
7.672
7.653
7.371
7.353
7.332
7.319
7.302
7.285
7.267
7.249
7.231
7.183
7.165
7.078
7.069
2.087
Ph
Ph
CF3SO2O
3ca
f1 (ppm)

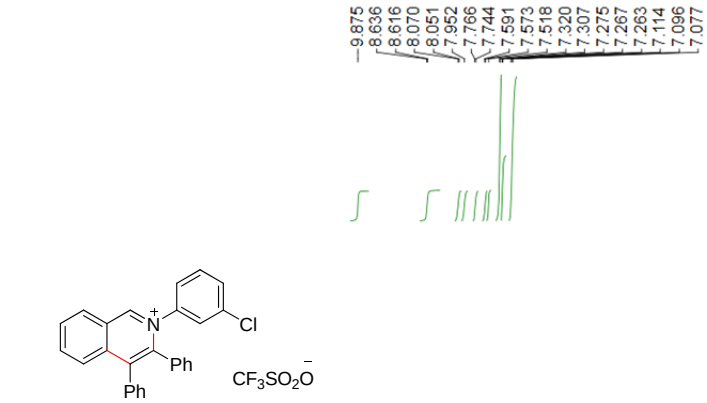

151.165
144.322
141.104
139.546
138.796
138.008
133.040
132.353
132.242
131.960
131.448
131.151
130.936
130.569
130.530
130.109
129.451
129.341
128.839
128.810
128.240
127.929
127.882
127.624
127.271
127.158
126.529
121.567
119.448
77.213
77.001
76.790
17.635
Ph
Ph
CF3SO2O
3ca
f1 (ppm)

3da

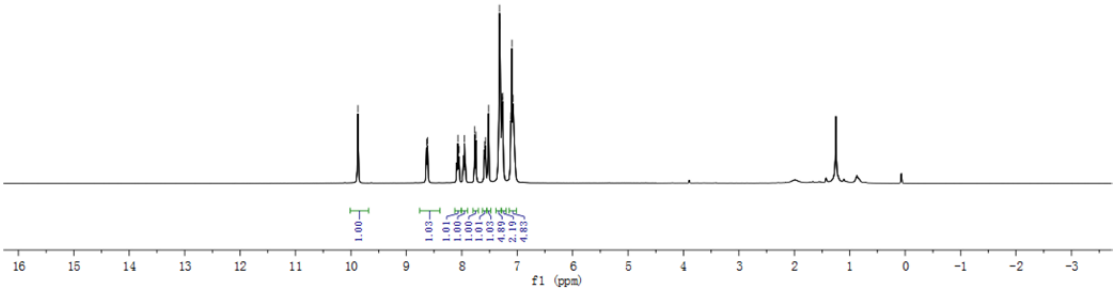

9.933
8.088
8.069
8.050
7.999
7.980
7.961
7.772
7.751
7.407
7.387
7.321
7.259
7.252
7.152
7.132
7.071
7.058
2.308
Ph
Ph
CF3SO2O
3da
0.94
0.95
3.00
f1 (ppm)

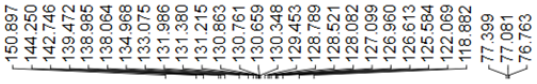

151.125
144.527
140.849
139.790
139.318
138.729
137.757
133.230
132.001
131.296
131.207
130.346
130.077
129.192
128.748
128.525
127.967
127.035
126.526
126.483
122.184
118.997
77.360
77.043
76.725
21.171
Ph
Ph
CF3SO2O
3da
f1 (ppm)

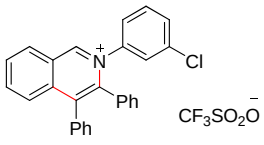
3ea


9.875
8.636
8.616
8.070
8.051
7.952
7.766
7.744
7.591
7.573
7.518
7.320
7.307
7.275
7.267
7.263
7.114
7.096
7.077
Cl
Ph
Ph
CF3SO2O

3ea


1.00
1.03
1.01
1.00
1.00
1.01
1.00
4.89
2.19
4.83
f1 (ppm)

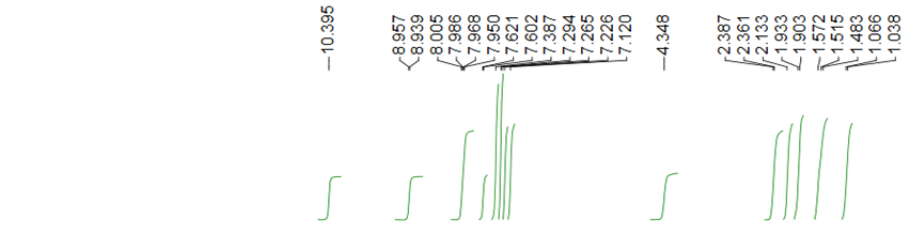

150.897
144.250
142.746
139.472
138.985
138.064
134.968
133.075
131.986
131.380
131.215
130.863
130.761
130.659
130.348
129.453
128.789
128.521
128.082
127.099
126.960
126.613
125.584
122.069
118.882
77.399
77.081
76.763

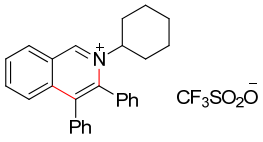

Cl
Ph
Ph
CF3SO2O

3ea

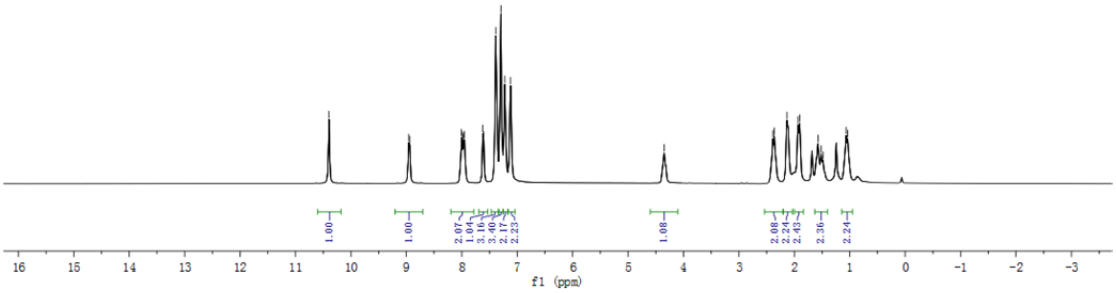
f1 (ppm)

3fa

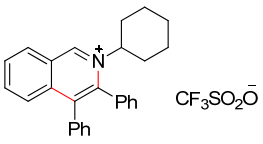

10.395
8.957
8.939
8.005
7.986
7.968
7.950
7.621
7.602
7.387
7.294
7.265
7.226
7.120
4.348
2.387
2.361
2.133
1.933
1.903
1.572
1.515
1.483
1.066
1.038


Ph
Ph
CF3SO2O

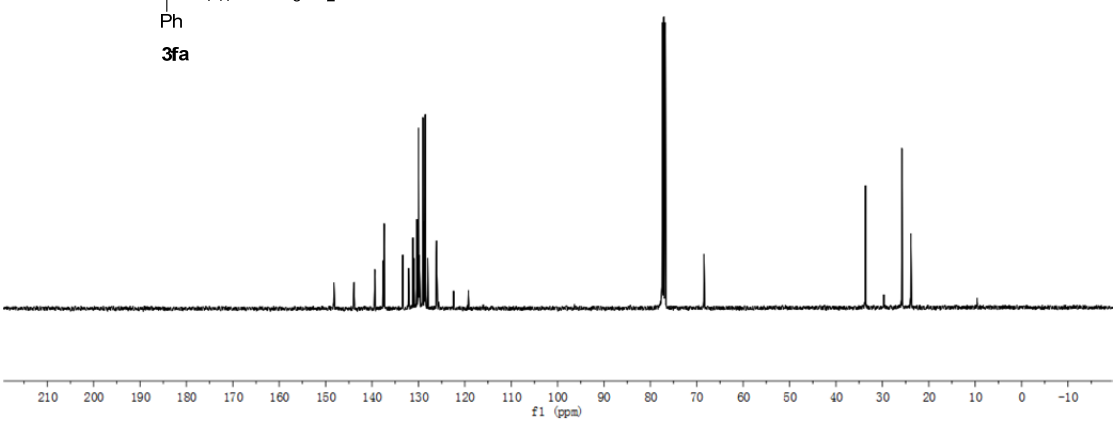
3fa


1.00
1.00
2.07
1.04
3.10
2.40
2.17
2.23
1.08
2.08
2.23
2.43
2.36
2.24
f1 (ppm)

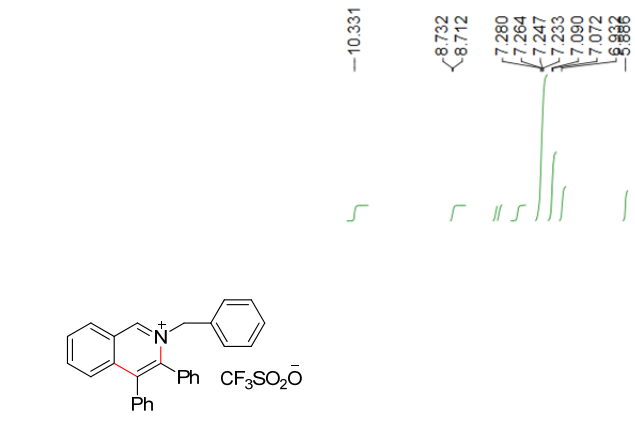

148.203
143.870
139.385
137.644
137.379
133.358
132.127
131.166
130.955
130.319
129.987
129.816
129.035
128.714
128.514
127.986
126.076
122.411
119.224
77.414
77.096
76.778
68.453
33.625
25.792
23.863


Ph
Ph
CF3SO2O

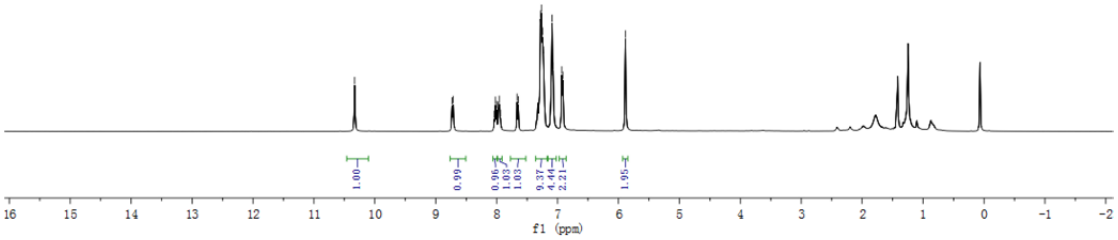
3fa

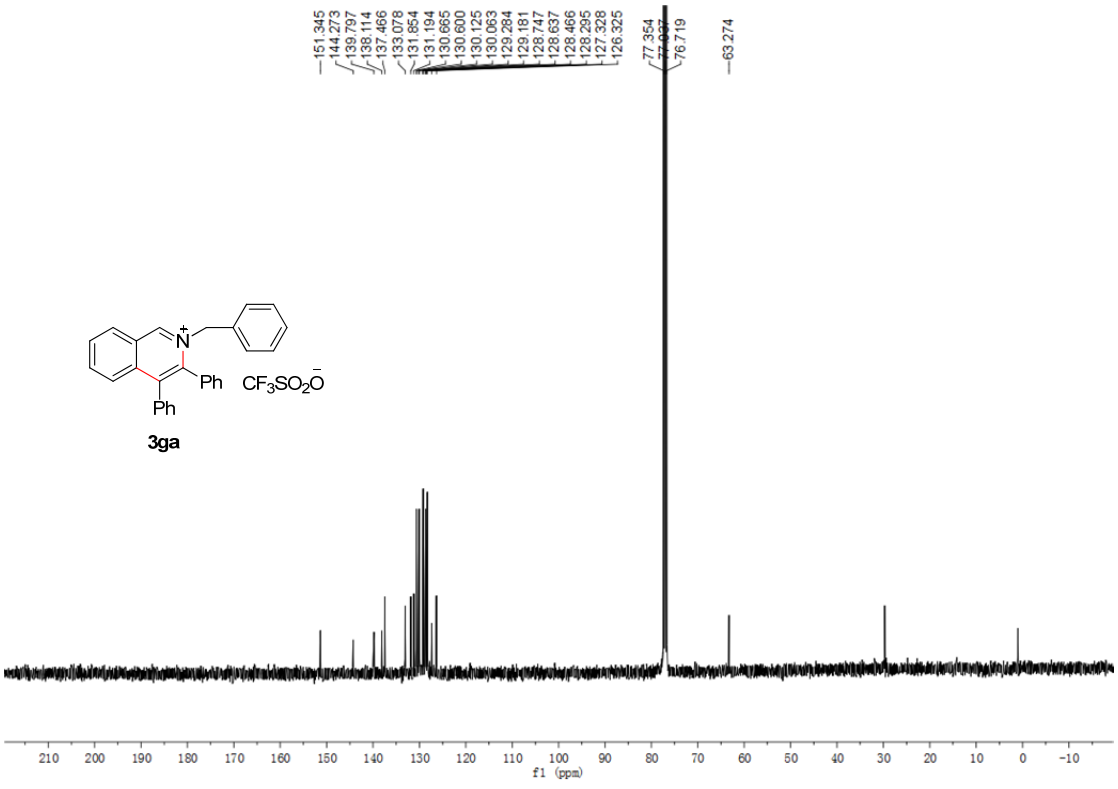

f1 (ppm)

3ga


10.331
8.732
8.712
7.280
7.264
7.247
7.233
7.090
7.072
Ph
Ph
CF3SO2O

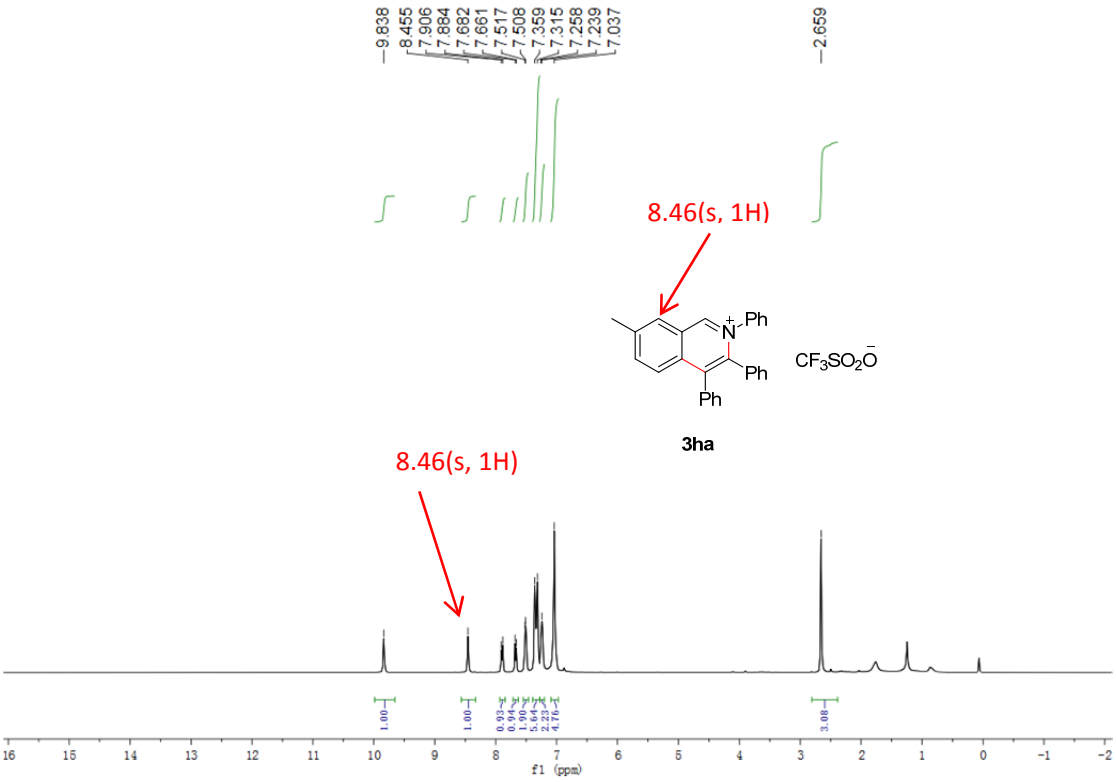
3ga

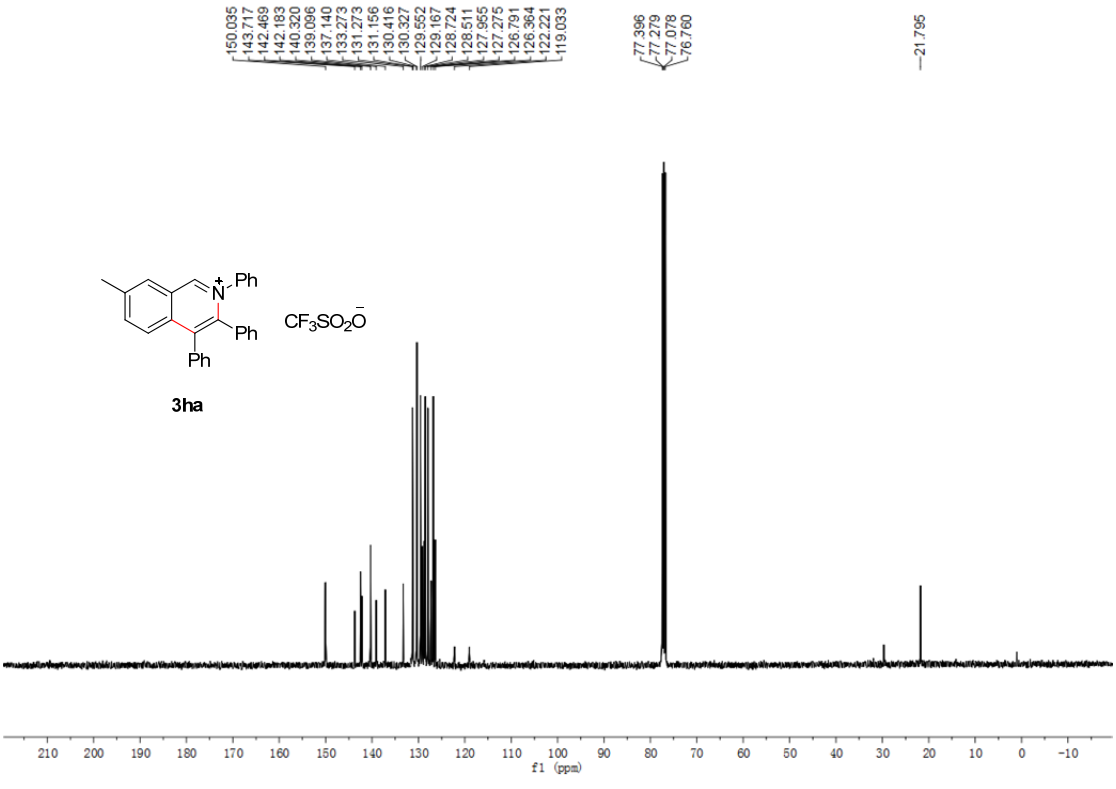

1.00
0.99
0.96
1.00
1.03
9.37
4.44
2.21
1.95
f1 (ppm)


151.345
144.273
139.797
138.114
137.466
133.078
131.854
131.194
130.665
130.600
130.125
130.063
129.284
129.181
128.747
128.637
128.466
128.295
127.328
126.325
77.354
76.719
63.274
Ph
Ph
CF3SO2O
f1 (ppm)

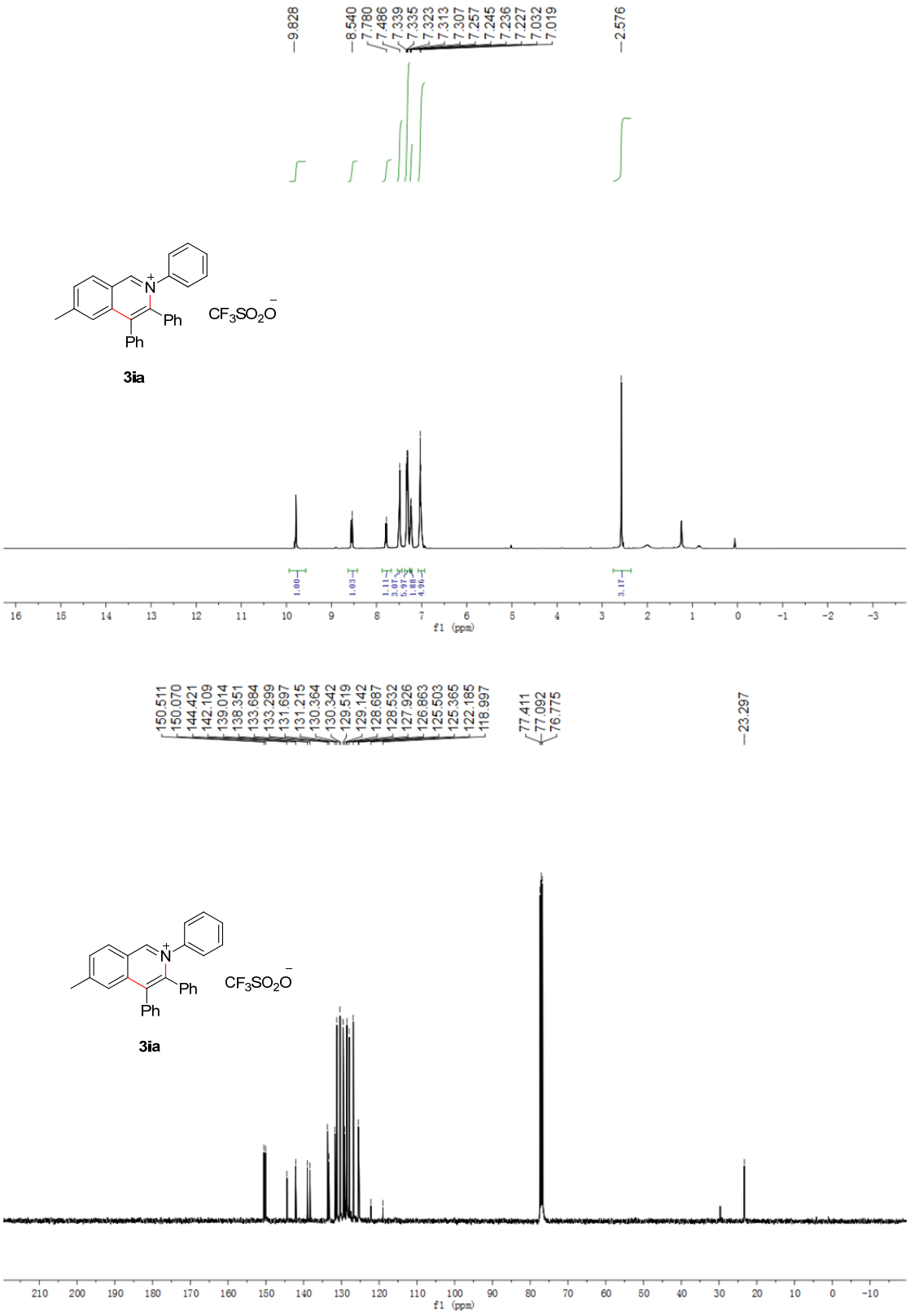
3ga

3ha

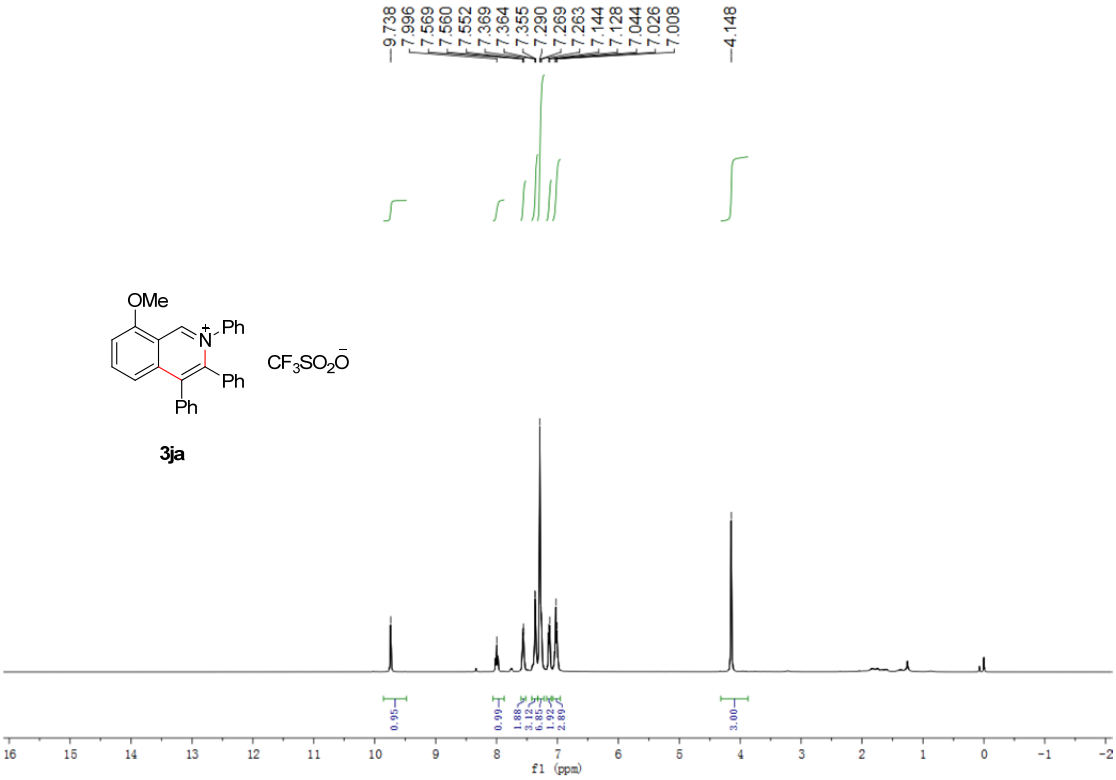

9.838
8.455
7.906
7.884
7.682
7.661
7.517
7.508
7.359
7.315
7.258
7.239
7.037
2.659
8.46(s, 1H)
Ph
Ph
Ph
N+
CF3SO2O−
3ha
8.46(s, 1H)
1.00
1.00
0.93
0.94
1.90
5.64
5.23
4.76
3.08
f1 (ppm)

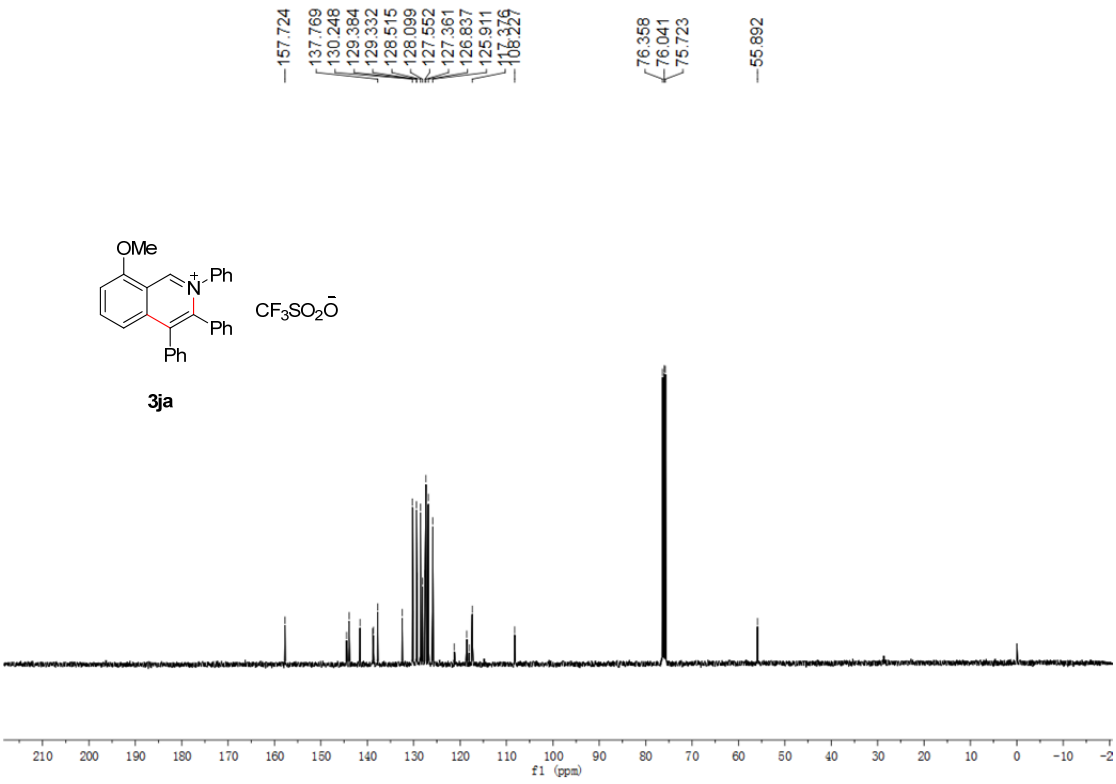

150.035
143.717
142.469
142.183
140.320
139.096
137.140
133.273
131.273
131.156
130.416
130.327
129.552
129.167
128.724
128.511
127.955
127.275
126.791
126.364
122.221
119.033
77.396
77.279
77.078
76.760
21.795
Ph
Ph
Ph
N+
CF3SO2O−
3ha
f1 (ppm)

3ia

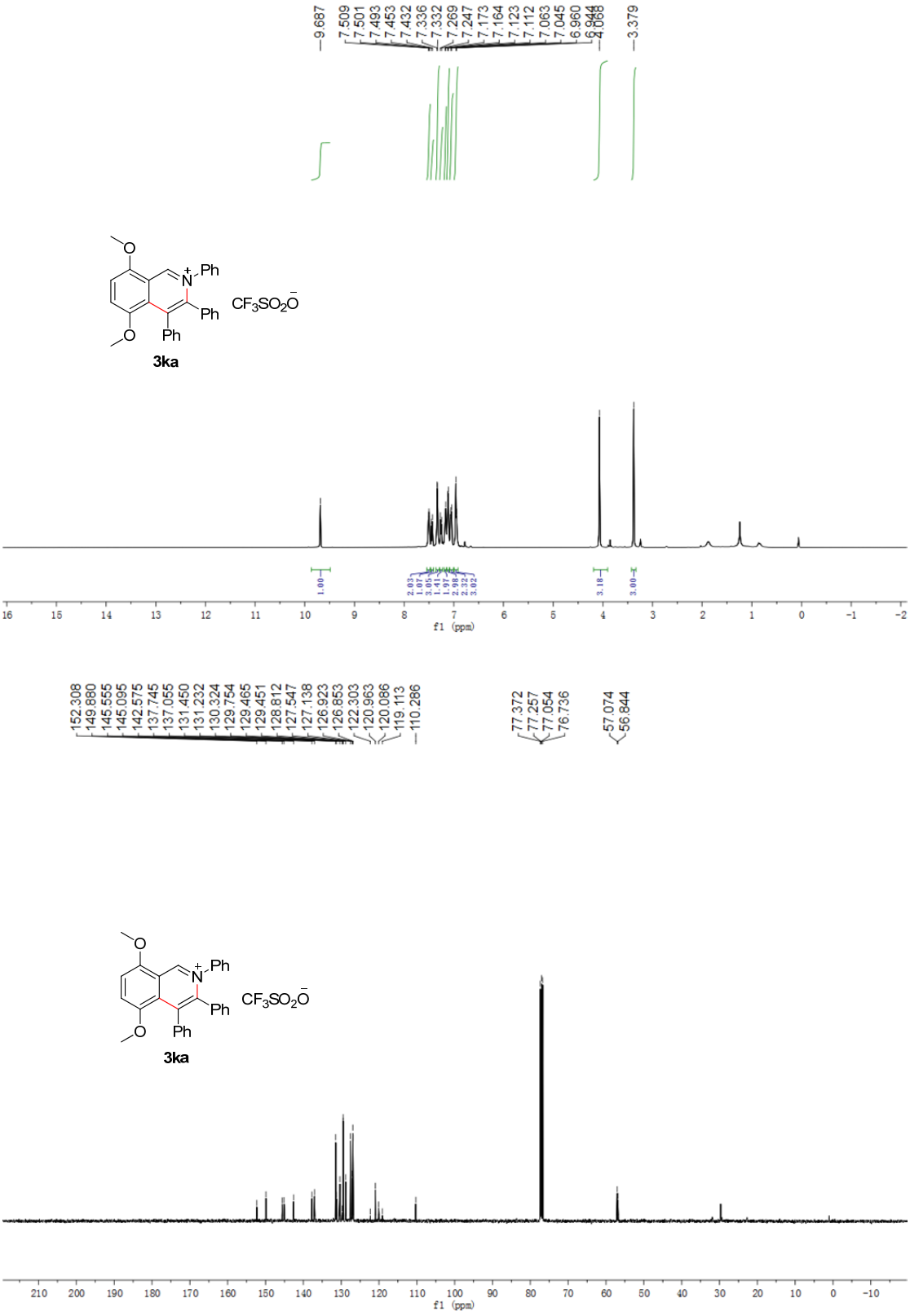

9.828
8.540
7.780
7.486
7.339
7.335
7.323
7.313
7.307
7.257
7.245
7.236
7.227
7.032
7.019
2.576
Ph
Ph
CF3SO2O
3ia
1.00
1.03
3.17
f1 (ppm)
150.511
150.070
144.421
142.109
139.014
138.351
133.684
133.299
131.697
131.215
130.364
130.342
129.519
129.142
128.687
128.532
127.926
126.863
125.503
125.365
122.185
118.997
77.411
77.092
76.775
23.297
Ph
Ph
CF3SO2O
3ia
f1 (ppm)

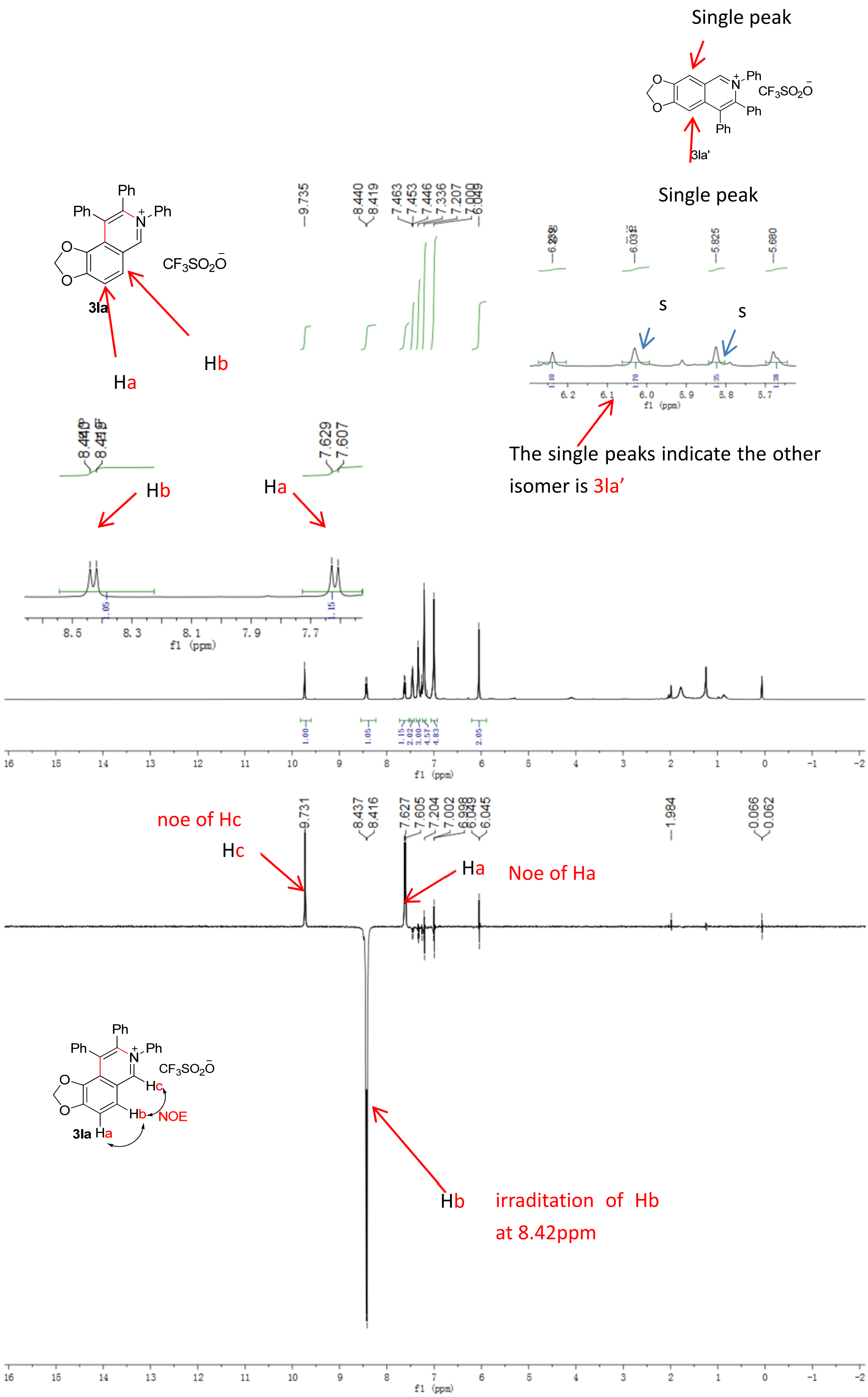
3ja

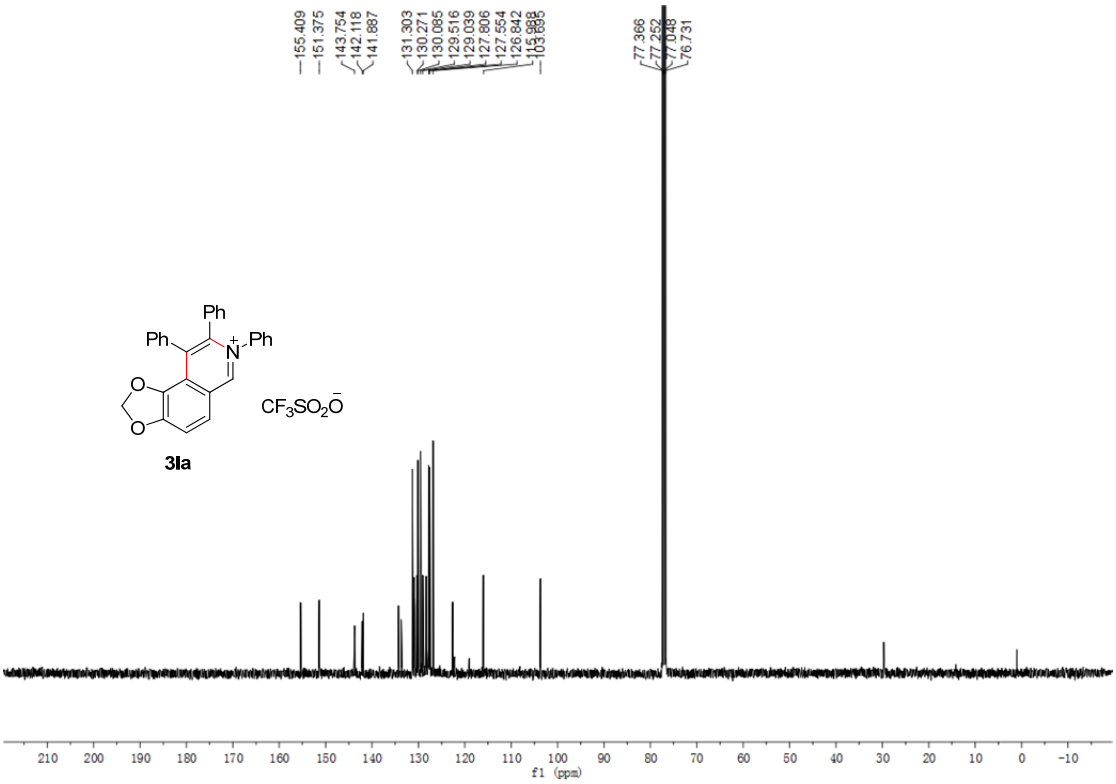

9.738
7.996
7.569
7.560
7.552
7.369
7.364
7.355
7.290
7.269
7.263
7.144
7.128
7.044
7.026
7.008
4.148
OMe
Ph
Ph
Ph
$CF_3SO_2\bar{O}$
3ja
0.95
0.99
1.88
3.12
6.85
1.92
2.89
3.00
f1 (ppm)


157.724
137.769
130.248
129.384
129.332
128.515
128.099
127.552
127.361
126.837
125.911
117.376
108.227
76.358
76.041
75.723
55.892
OMe
Ph
Ph
Ph
$CF_3SO_2\bar{O}$
3ja
f1 (ppm)

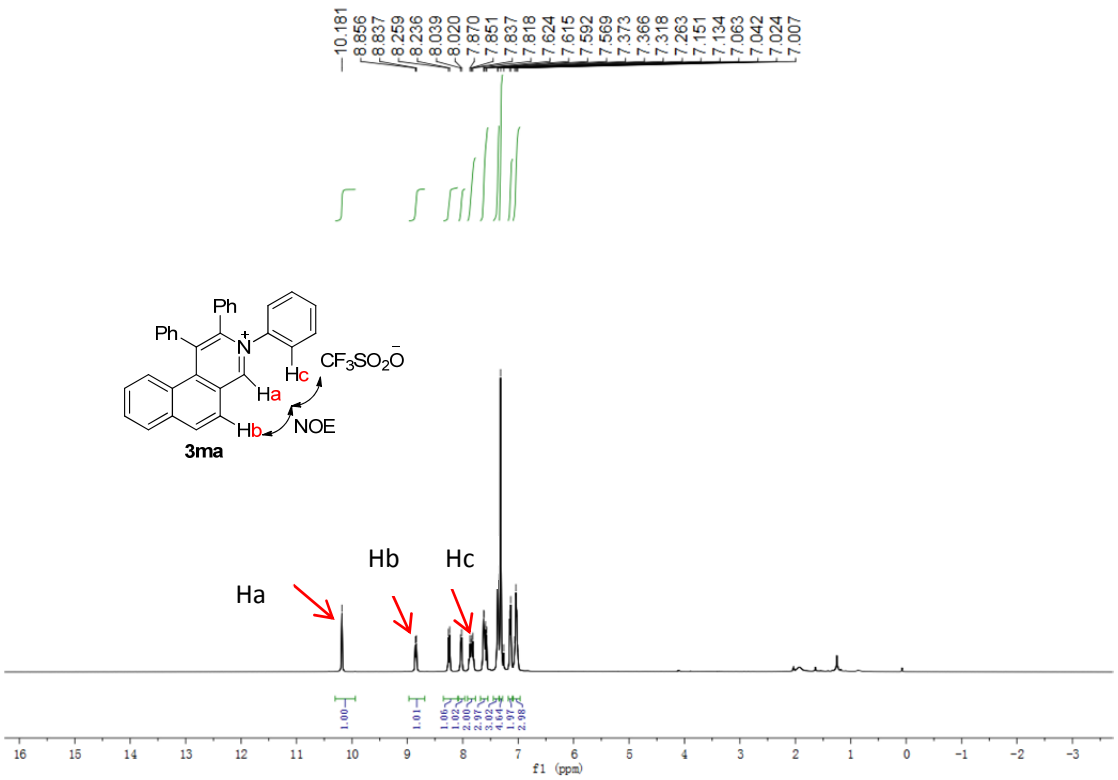
3ka

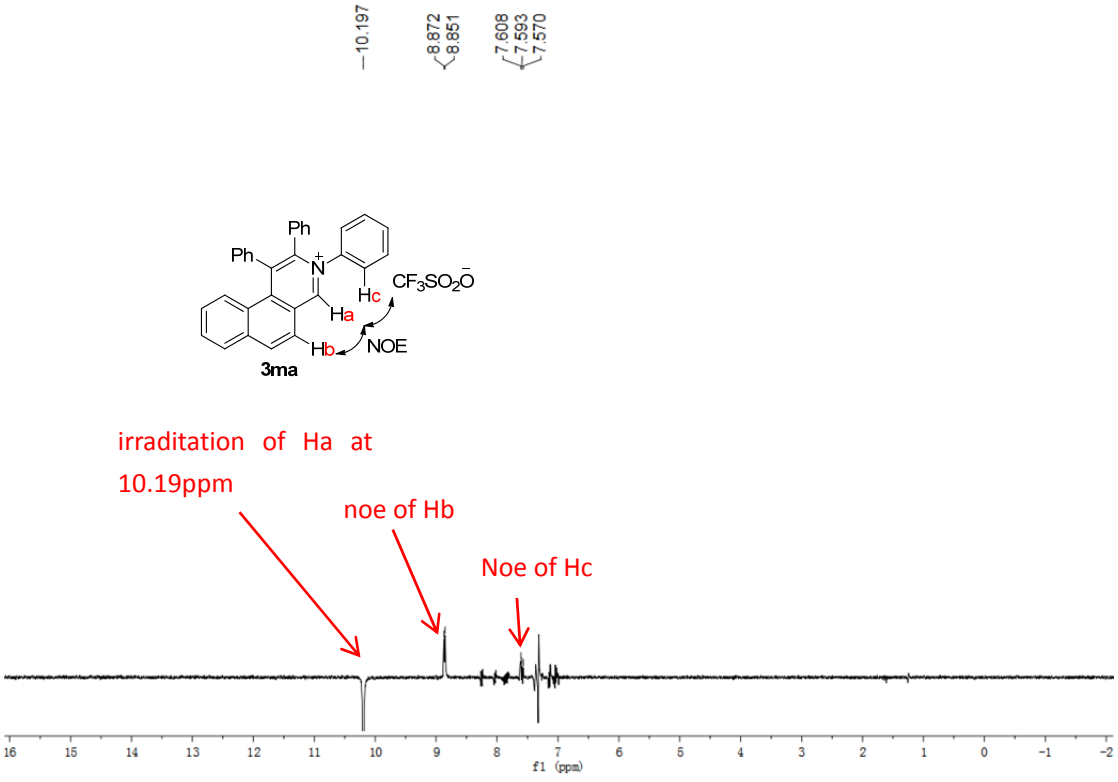

9.687
7.509
7.501
7.493
7.453
7.432
7.336
7.332
7.269
7.247
7.173
7.164
7.123
7.112
7.063
7.045
6.960
6.944
4.068
3.379
Ph
Ph
Ph
O
O
CF3SO2O
3ka
1.00
2.03
1.07
3.05
1.41
1.98
2.98
2.32
3.02
3.18
3.00
f1 (ppm)
152.308
149.880
145.555
145.095
142.575
137.745
137.055
131.450
131.232
130.324
129.754
129.465
129.451
128.812
127.547
127.138
126.923
126.853
122.303
120.963
120.086
119.113
110.286
77.372
77.257
77.054
76.736
57.074
56.844
f1 (ppm)

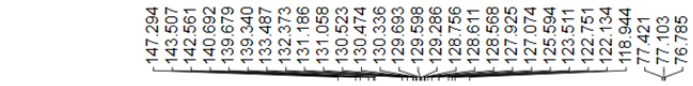

Single peak
3la'
Single peak
3la
Ha
Hb
S
S
The single peaks indicate the other isomer is 3la'
Hb
Ha
noe of Hc
Hc
Ha
Noe of Ha
3la
NOE
Hb
irradiation of Hb at 8.42ppm
f1 (ppm)

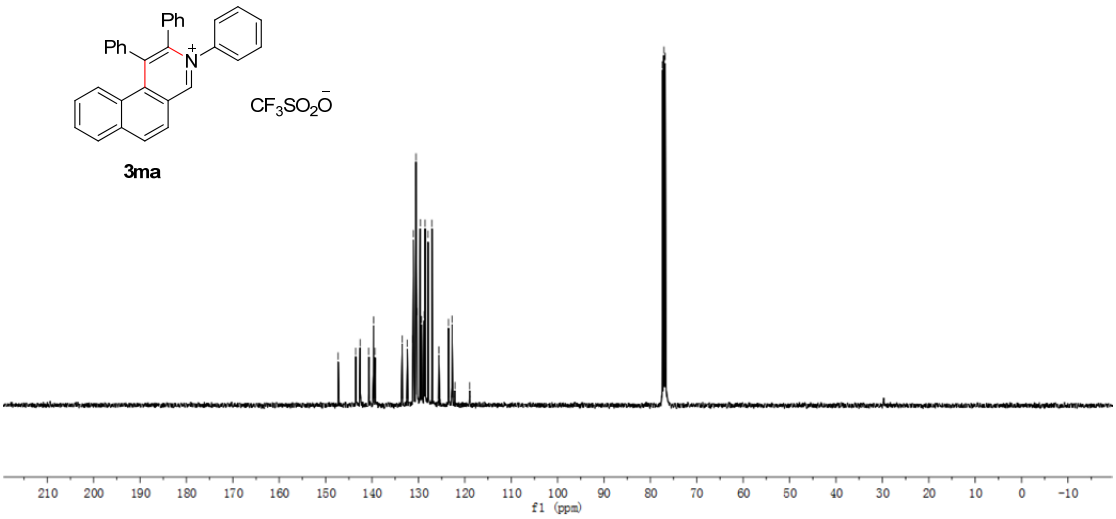

155.409
151.375
143.754
142.118
141.887
131.303
130.271
130.085
129.516
129.039
127.806
127.554
126.842
115.988
103.695
77.366
77.252
77.048
76.731
Ph
Ph
Ph
N
O
O
CF3SO2O
3la
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

3ma

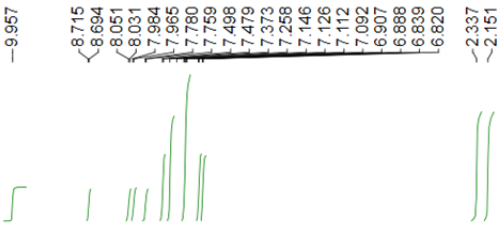

10.181
8.856
8.837
8.259
8.236
8.039
8.020
7.870
7.851
7.837
7.818
7.624
7.615
7.592
7.569
7.373
7.366
7.318
7.263
7.151
7.134
7.063
7.042
7.024
7.007
Ph
Ph
N
Hc
Ha
Hb
CF3SO2O
NOE
3ma
Ha
Hb
Hc
f1 (ppm)

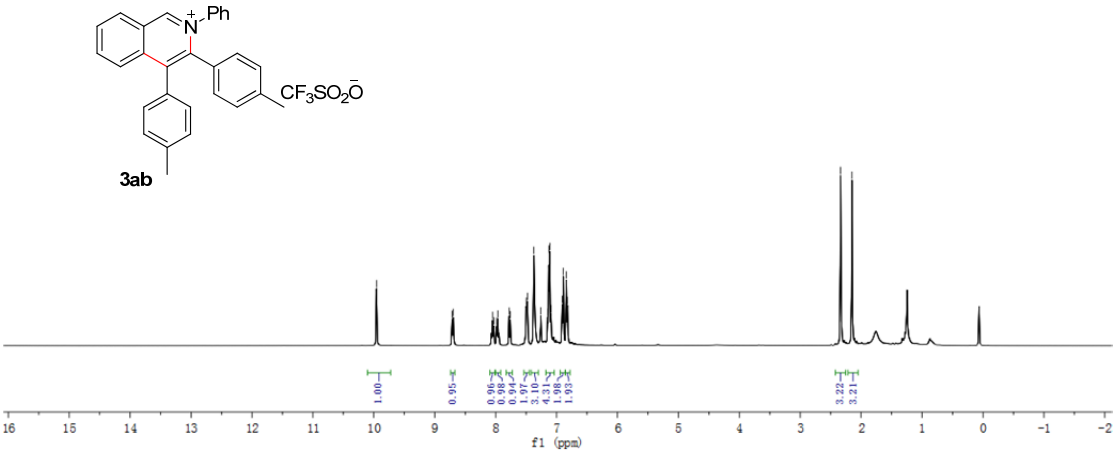

10.197
8.872
8.851
7.608
7.593
7.570
Ph
Ph
N
Hc
Ha
Hb
CF3SO2O
NOE
3ma
irraditation of Ha at 10.19ppm
noe of Hb
Noe of Hc
f1 (ppm)

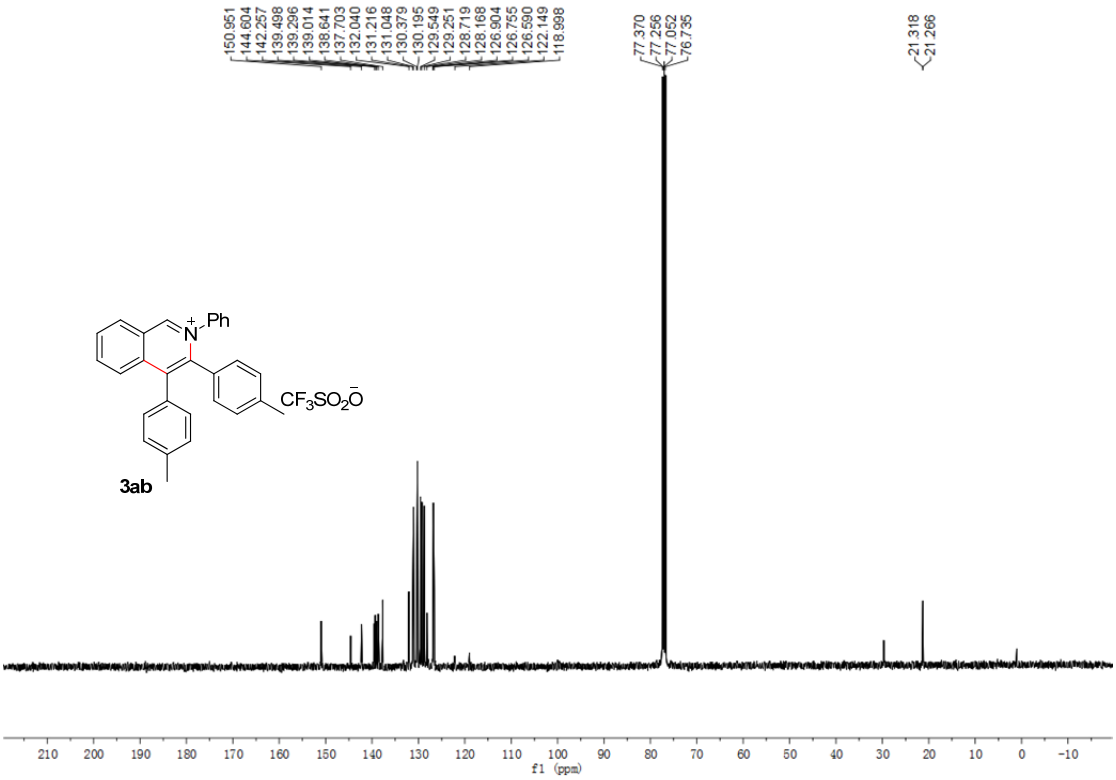

147.294
143.507
142.561
140.692
139.679
139.340
133.487
132.373
131.186
131.058
130.523
130.474
130.336
129.693
129.598
129.286
128.756
128.611
128.568
127.925
127.074
125.594
123.511
122.751
122.134
118.944
77.421
77.103
76.785


Ph
Ph
N
CF3SO2O
3ma
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

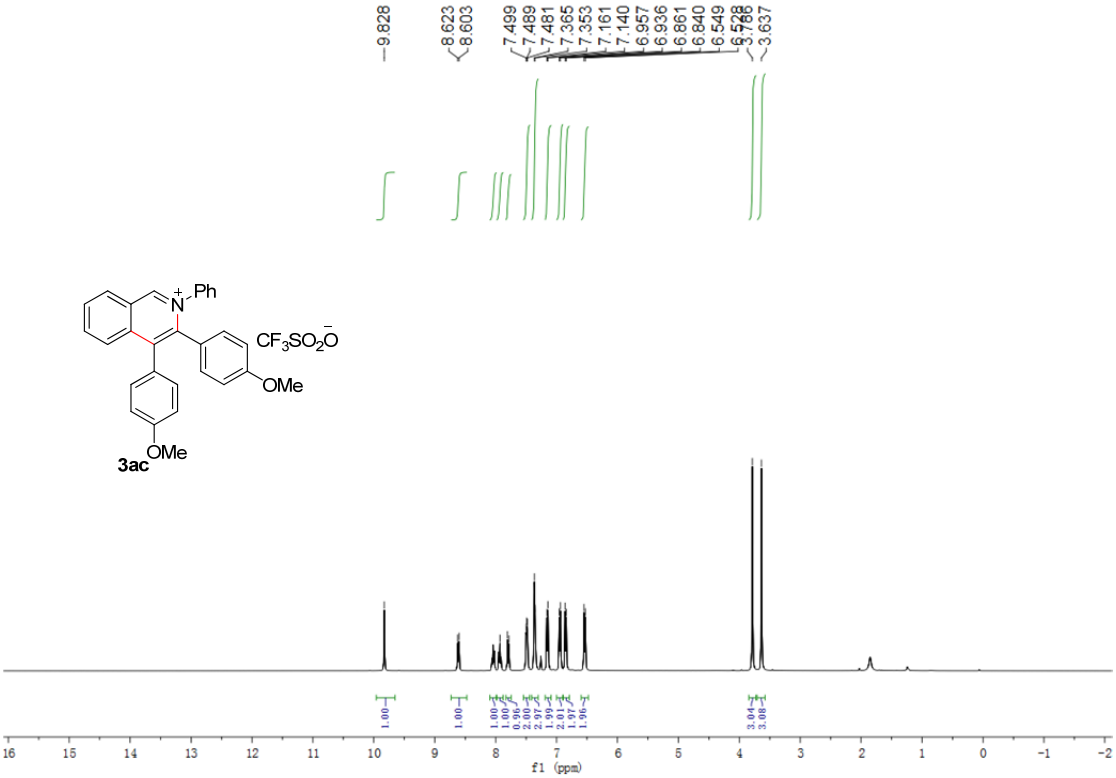
3ab

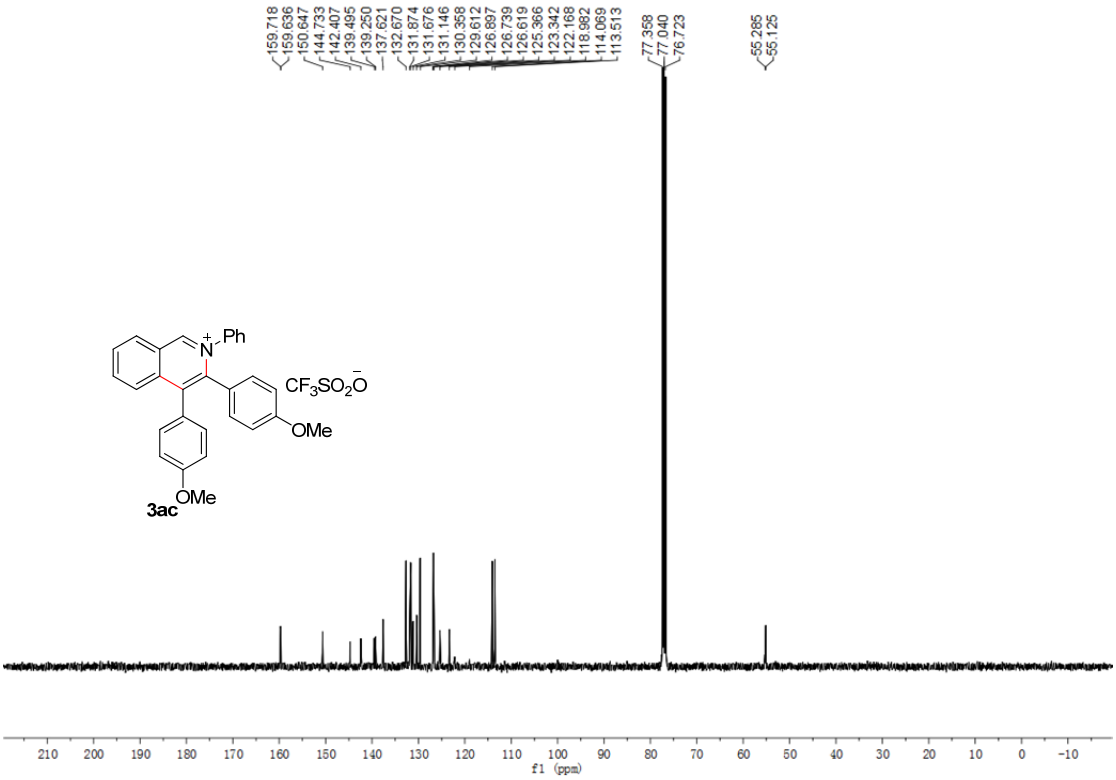

9.957
8.715
8.694
8.051
8.031
7.984
7.965
7.780
7.759
7.498
7.479
7.373
7.258
7.146
7.126
7.112
7.092
6.907
6.888
6.839
6.820
2.337
2.151


Ph
N
CF3SO2O
3ab
1.00
0.95
0.96
0.98
0.94
1.97
3.10
4.13
1.98
1.93
3.22
3.21
16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 -1 -2
f1 (ppm)

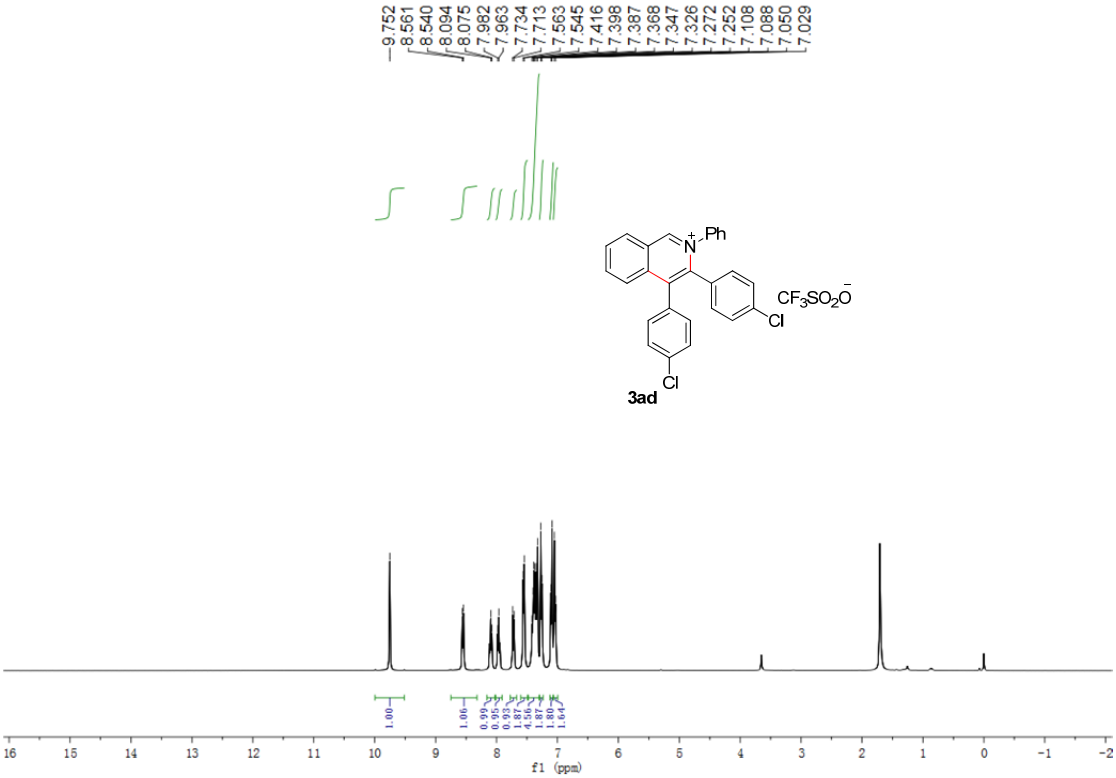

150.951
144.604
142.257
139.498
139.296
139.014
138.641
137.703
132.040
131.216
131.048
130.379
130.195
129.549
129.251
128.719
128.168
126.904
126.755
126.590
122.149
118.998
77.370
77.256
77.052
76.735
21.318
21.266
Ph
N
CF3SO2O
3ab
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

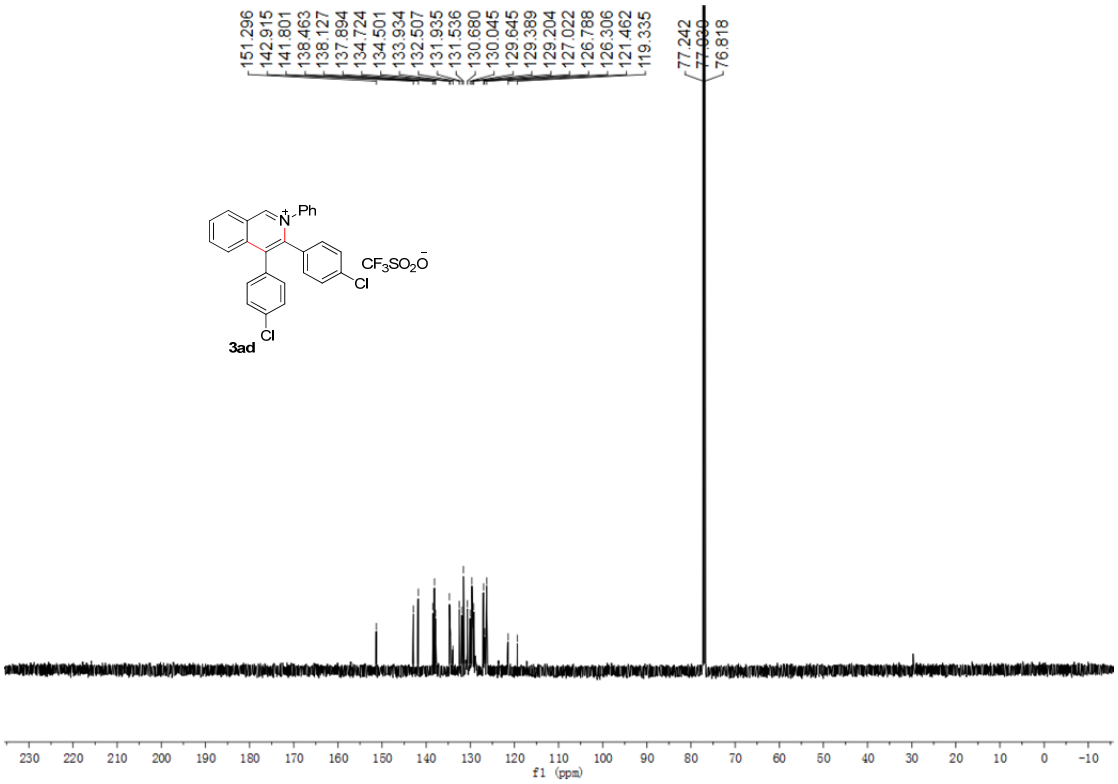
3ac


9.828
8.623
8.603
7.499
7.489
7.481
7.365
7.353
7.161
7.140
6.957
6.936
6.861
6.840
6.549
6.528
3.786
3.637
Ph
N
CF3SO2O
OMe
OMe
3ac
1.00
1.00
1.00
1.00
0.96
2.00
2.97
1.91
2.01
1.97
1.96
3.04
3.08
16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 -1 -2
f1 (ppm)

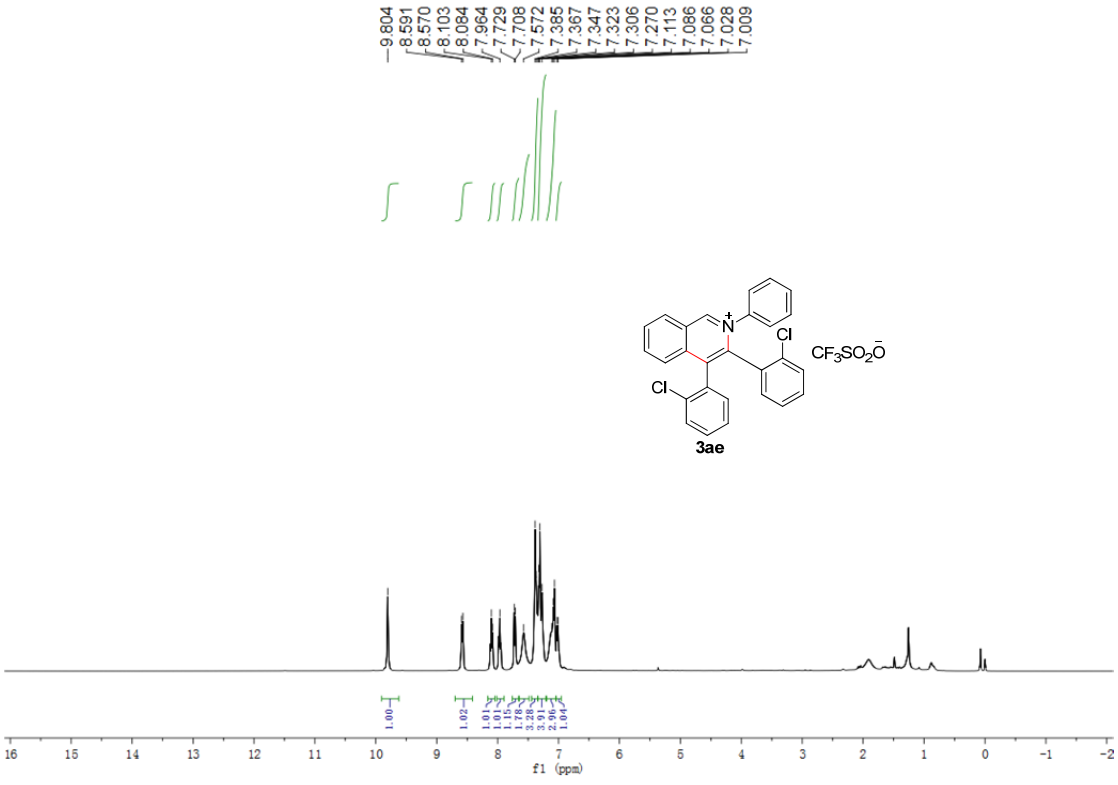

159.718
159.636
150.647
144.733
142.407
139.495
139.250
137.621
132.670
131.874
131.676
131.146
130.358
129.612
126.897
126.739
126.619
125.366
123.342
122.168
118.982
114.069
113.513
77.358
77.040
76.723
55.285
55.125
Ph
N
CF3SO2O
OMe
OMe
3ac
f1 (ppm)

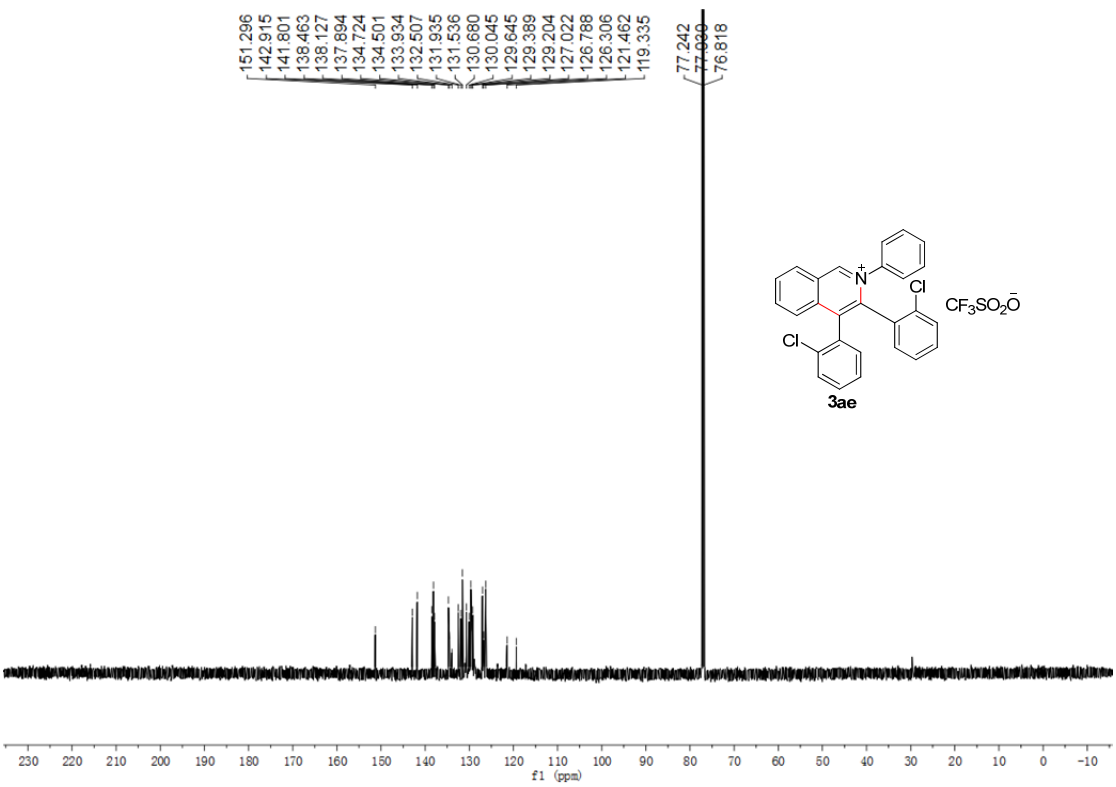
3ad


9.752
8.561
8.540
8.094
8.075
7.982
7.963
7.734
7.713
7.563
7.545
7.416
7.398
7.387
7.368
7.347
7.326
7.272
7.252
7.108
7.088
7.050
7.029
Ph
N
CF3SO2O
Cl
Cl
3ad
1.00
1.06
f1 (ppm)

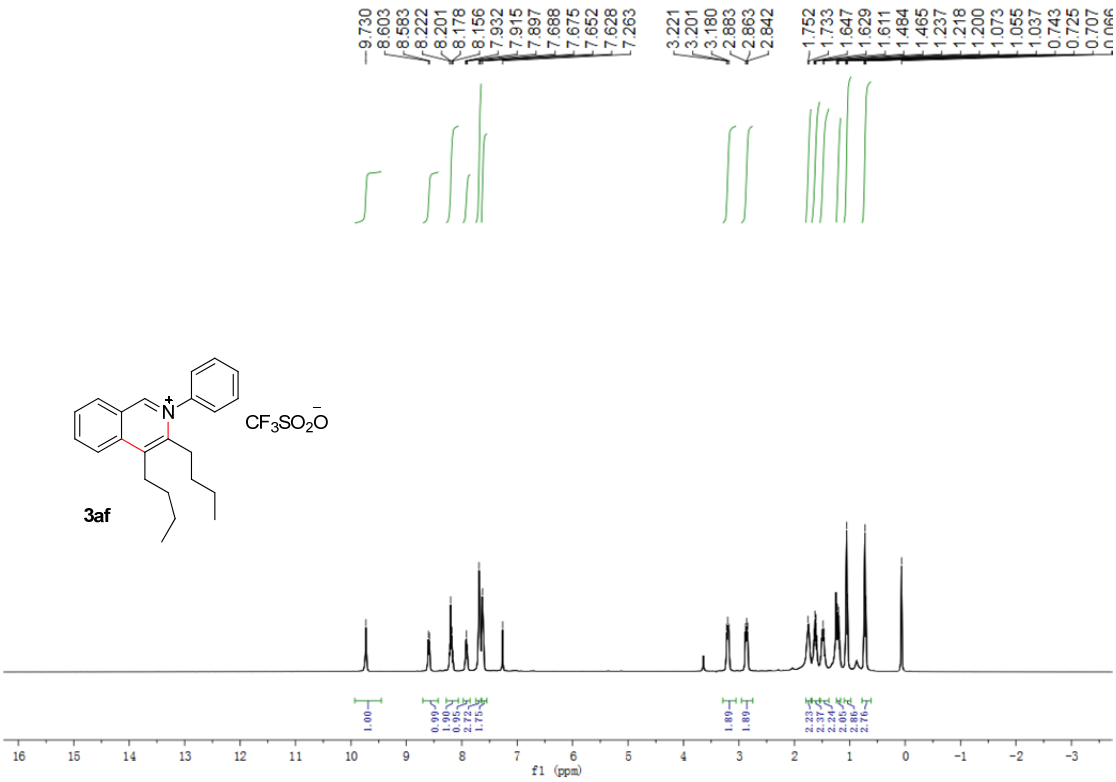

151.296
142.915
141.801
138.463
138.127
137.894
134.724
134.501
133.934
132.507
131.935
131.536
130.680
130.045
129.645
129.389
129.204
127.022
126.788
126.306
121.462
119.335
77.242
77.000
76.818
Ph
CF3SO2O
Cl
Cl
3ad
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

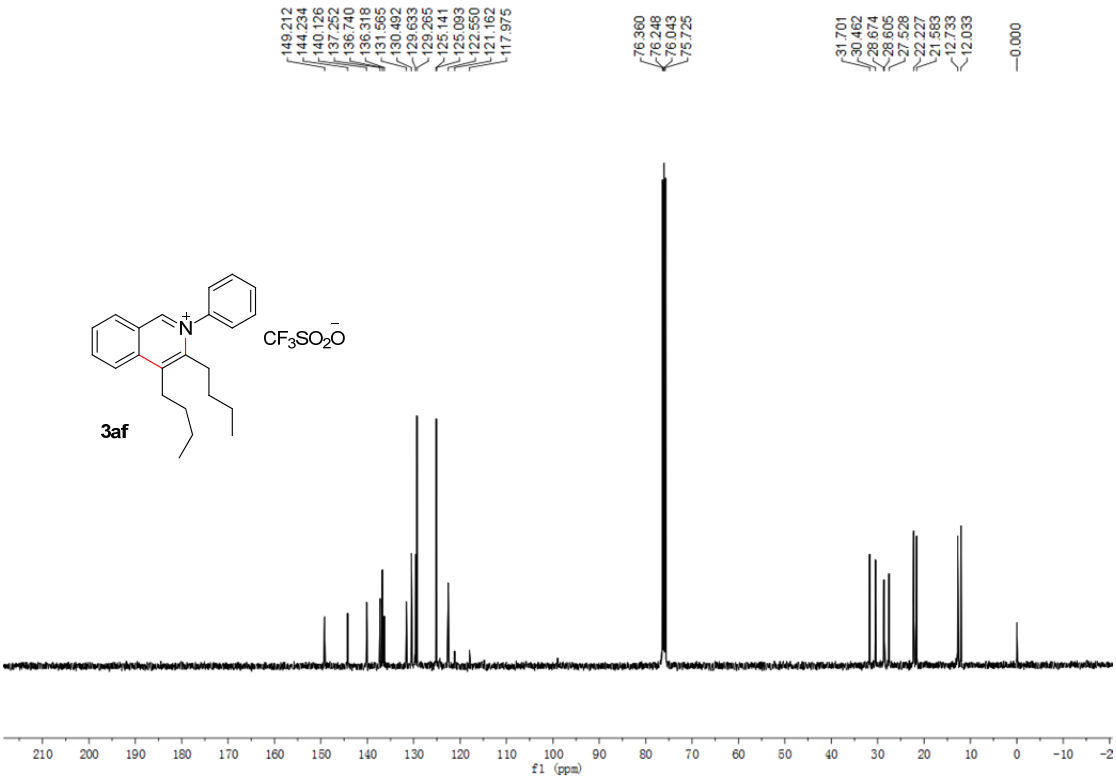
3ae


9.804
8.591
8.570
8.103
8.084
7.964
7.729
7.708
7.572
7.385
7.367
7.347
7.323
7.306
7.270
7.113
7.086
7.066
7.028
7.009
Cl
CF3SO2O
Cl
3ae
1.00
1.02
16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 -1 -2
f1 (ppm)

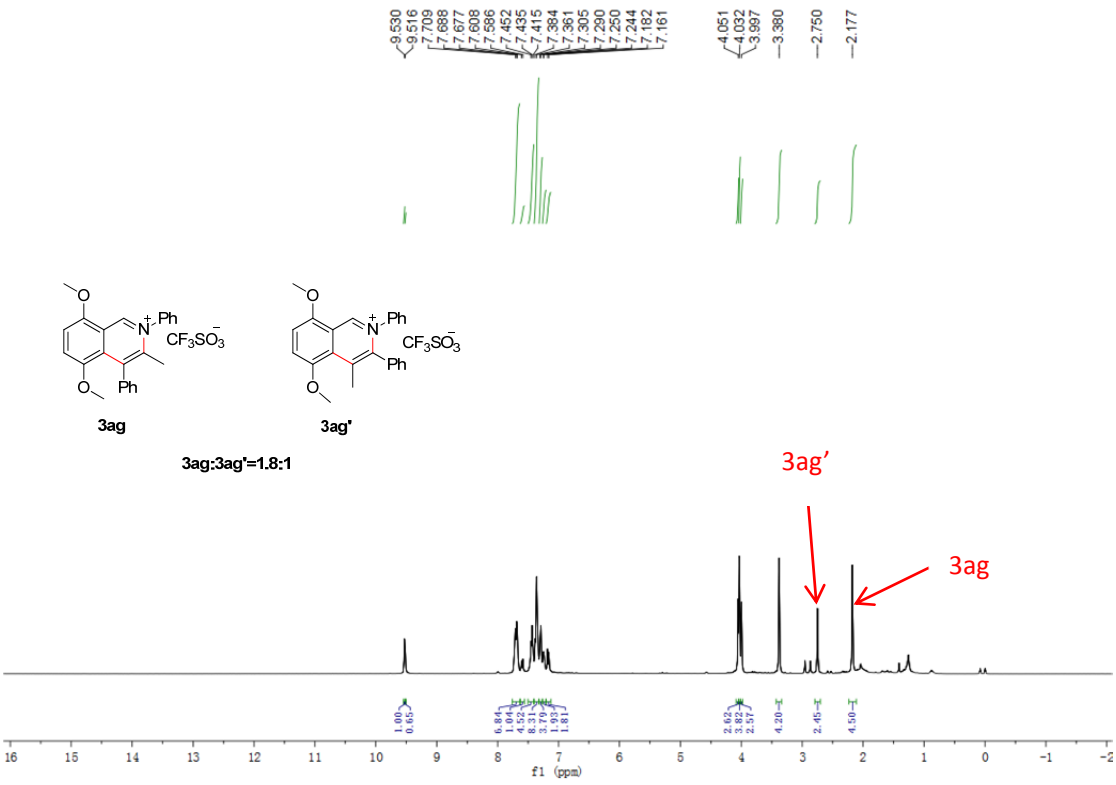

151.296
142.915
141.801
138.463
138.127
137.894
134.724
134.501
133.934
132.507
131.935
131.536
130.680
130.045
129.645
129.389
129.204
127.022
126.788
126.306
121.462
119.335
77.242
77.000
76.818
Cl
Cl
$CF_3SO_2O^-$
3ae
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

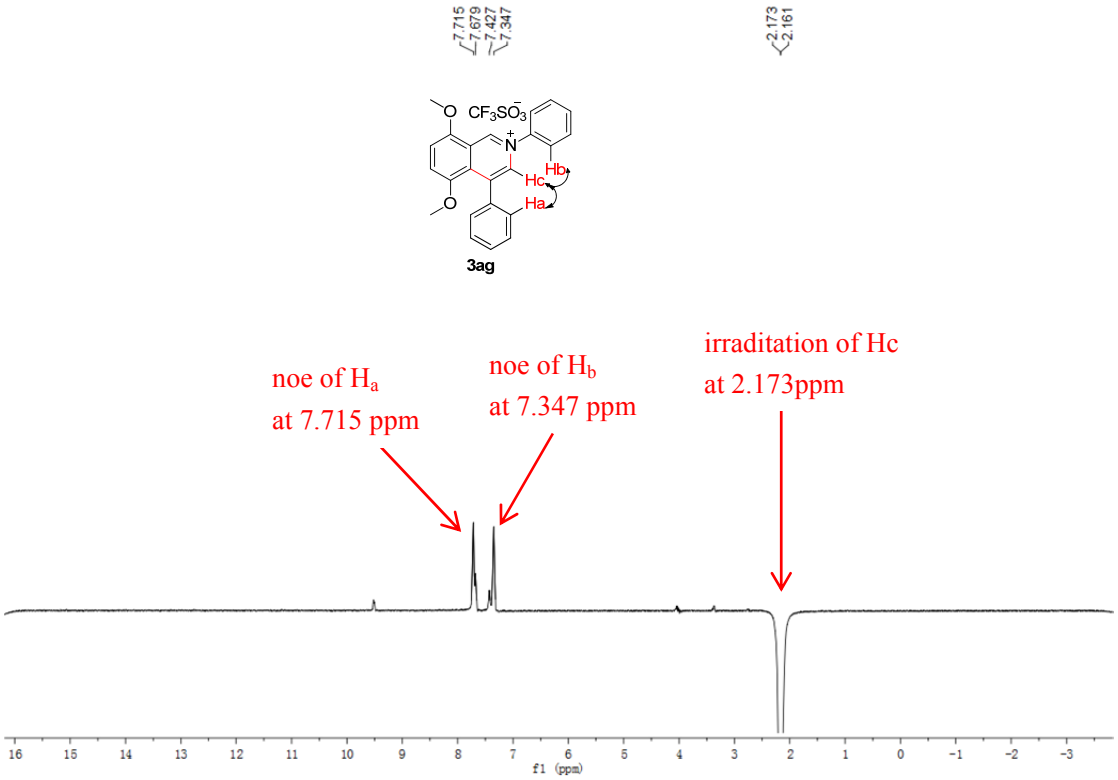
3af


9.730
8.603
8.583
8.222
8.201
8.178
8.156
7.932
7.915
7.897
7.688
7.675
7.652
7.628
7.263
3.221
3.201
3.180
2.883
2.863
2.842
1.752
1.733
1.647
1.629
1.611
1.484
1.465
1.237
1.218
1.200
1.073
1.055
1.037
0.743
0.725
0.707
$CF_3SO_2O^-$
3af
16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 -1 -2 -3
f1 (ppm)


149.212
144.234
140.126
137.252
136.740
136.318
131.565
130.492
129.633
129.265
125.141
125.093
122.550
121.162
117.975
76.360
76.248
76.043
75.725
31.701
30.462
28.674
28.605
27.528
22.227
21.583
12.733
12.033
0.000
CF3SO2O
3af
f1 (ppm)

3ag:3ag’


9.530
9.516
7.709
7.688
7.677
7.608
7.586
7.452
7.435
7.415
7.384
7.361
7.305
7.290
7.250
7.244
7.182
7.161
4.051
4.032
3.997
3.380
2.750
2.177
Ph
CF3SO3
Ph
3ag
3ag'
3ag:3ag'=1.8:1
3ag’
3ag
f1 (ppm)


7.715
7.679
7.427
7.347
2.173
2.161
CF3SO3
N
Hb
Hc
Ha
O
O
3ag
noe of Ha
at 7.715 ppm
noe of Hb
at 7.347 ppm
irraditation of Hc
at 2.173ppm
16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0 -1 -2 -3
f1 (ppm)