Supplementary Information

Base catalyzed domino reaction between isoindigos and α-alkylidene succinimides—convenient preparation of highly steric bispirooxindoles

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1. General Information

Commercial grade solvent was dried and purified by standard procedures as specified in Purification of Laboratory Chemicals. ^{1}H NMR and ^{13}C NMR spectra were recorded on a Bruker Avance (600 400 and 300MHz for ^{1}H NMR, 150 100 and 75 MHz for ^{13}C NMR) instrument. Data for ^{1}H NMR are reported as chemical shift (ppm, tetramethylsilane as theinternal standard), integration, multiplicity (s = singlet, d =doublet, t = triplet, q = quartet, m = multiplet), coupling con-stant (Hz). Data for^{13}C NMR are reported as chemical shift. High resolution mass spectra were obtained with Thermo Scientific LTQ Orbitrap XL mass spectrometer. Flash column chromatography was carried out using silica gel eluting with ethyl acetate and petroleum ether. Reactions were monitored by TLC and visualized with ultraviolet light. Melting points were recorded on a Buchi Melting Point B-545.

2. General Procedure for the Syntheses of Reactants 1 and 2.

Isoindigos[1] and α-alkylidene[2] were prepared as reported procedures. Unless otherwise noted, materials were purchased from commercial suppliers and used without further purification.

3. General procedure for the synthesis of 3

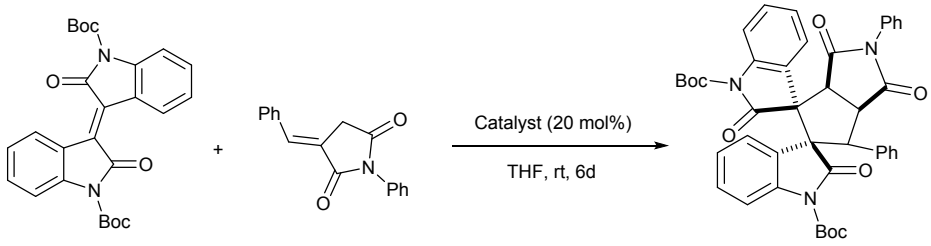
A mixture of 0.1 mmol **1**, 0.12 mmol **2** and 20 mol% Cs_2CO_3 in 1 ml THF was stirred at room temperature. After the reaction was completed by TLC, the crude product was directly purified by silica gel chromatography to give the desired product **3**.

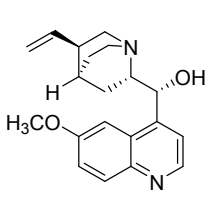
references:

1 Y.-Y. Gui, J. Yang, L.-W. Qi, X. Wang, F. Tian, X.-N. Li,L. Peng and L.-X. Wang, *Org. Biomol. Chem.*, 2015, **13**, 6371.
2. M.Wang, H.-J. Liu, Y.-T. Fan, Y.-Y. Yang, Z.-Y. Jiang, and C.-H Tan* *Chem. Eur. J.,* 2010, **16**, 12534-12537.

4. The data of the products

Scheme 1 catalytic asymmetric synthesis of the product





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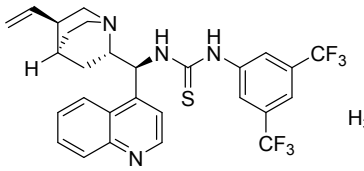

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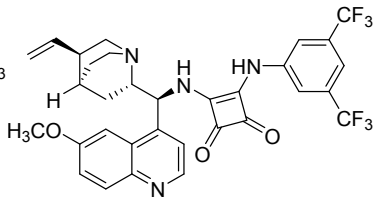

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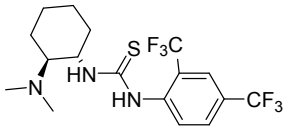

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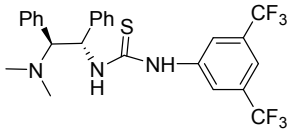
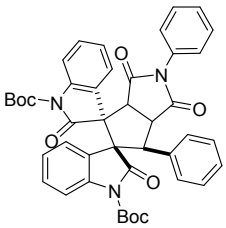


Trace

5. The data of the products

Di-tert-butyl(3R,3a'S,5'S,6a'S)-1',2,2'',3'-tetraoxo-2',6'-diphenyl- 1',2',3',3a',6',6a'-hexahydrodispiro[indoline-3,4'-cyclopenta[c]pyrrole-5',3''-indoline]-1,1''-dicarboxylat (3aa)



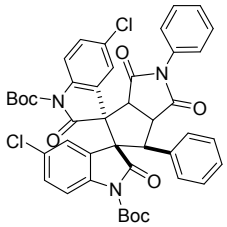
white solid, Mp: 245.1-246.2 °C, 92% yield, dr > 20:1;

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.57-7.52 (m, 3H), 7.48-7.42 (m, 2H), 7.41-7.36 (m, 3H), 7.33 (d, *J* = 8.2 Hz, 1H), 7.22 (d, *J* = 7.6 Hz, 1H), 7.18, *J* = 9.6 Hz, 2H), 7.13 (m *J* = 7.0, 4.3 Hz, 4H), 7.10-7.05 (m, 2H), 4.96 (d, *J* = 9.6 Hz, 1H), 4.77 (t, *J* = 9.8 Hz, 1H), 4.62 (d, *J* = 10.1 Hz, 1H), 1.62 (s, 9H), 1.53 (s, 9H);

^{13}C NMR (100MHz, $CDCl_3$) δ 176.1, 175.3, 175.2, 173.5, 147.9, 147.8, 139.8, 139.8, 134.2, 132.1, 129.9, 129.0, 128.7,128.6, 128.4, 127.7, 127.0, 124.8, 124.4, 124.1, 123.8, 123.6, 122.1, 115.0, 114.9, 84.8, 84.6, 70.6, 62.5, 60.3, 51.4, 51.3, 48.0, 28.1, 28.0;

HRMS (ESI) m/z calcd for $C_{43}H_{39}N_3O_8Na^+$ $(M+Na)^+$ 748.2629, found 748.2627.

Di-tert-butyl(3R,3a'S,5'S,6a'S)-5,5''-dichloro-1',2,2'',3'-tetraoxo-2',6'-diphenyl-1',2',3',3a',6',6a'-hexahydrodispiro[indoline-3,4'-cyclopenta[c]pyrrole-5',3''-indoline]-1,1''-dicarboxylate (3ba)



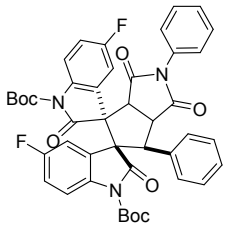
white solid, Mp: 229.1-230.8 ºC, 85% yield, dr > 20:1;

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.63 (d, *J* = 8.8 Hz, 1H), 7.52 (dd, *J* = 6.3, 1.9 Hz, 3H), 7.49-7.44 (m, 3H), 7.38 (dd, *J* = 13.0, 3.5 Hz, 3H), 7.24-7.21 (m, 1H), 7.19-7.13 (m, 5H), 4.91 (d, *J* = 9.5 Hz, 1H), 4.73 (t, *J* = 9.8 Hz, 1H), 4.58 (d, *J* = 10.1 Hz, 1H), 1.66 (s, 9H), 1.58 (s, 9H);

^{13}C NMR (75 MHz, $CDCl_3$) δ 175.7, 174.8, 174.4, 172.5, 147.8, 147.7, 138.4, 138.3, 133.5, 131.9, 130.3, 130.2, 129.1, 129.1, 129.33,128.99, 129.0, 128.7, 128.9,128.5, 128.6, 128.6, 128.1, 126.9, 126.4, 125.2, 124.5, 123.9, 123.7, 116.4, 116.2, 85.7, 85.5, 70.2, 62.0, 51.9, 51.6, 47.8, 28.0, 27.9;

HRMS (ESI) m/z calcd for $C_{43}H_{37}Cl_2N_3O_8Na^+$ $(M+Na)^+$ 816.1849, found 816.1849.

Di-tert-butyl(3R,3a'S,5'S,6a'S)-5,5''-difluoro-1',2,2'',3'-tetraoxo-2',6'-diphenyl-1',2',3',3a',6',6a'-hexahydrodispiro[indoline-3,4'-cyclopenta[c]pyrrole-5',3''-indoline]-1,1''-dicarboxylate (3ca)



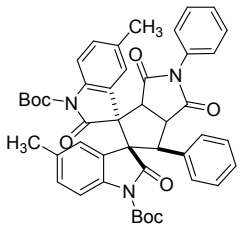
white solid, Mp: 251.7-252.6 ºC, 85% yield, dr > 20:1;

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.65 (dd, *J* = 9.0, 4.6 Hz, 1H), 7.49-7.34 (m, 6H), 7.31-7.27 (m, 2H), 7.17 (s, 5H), 6.92 (m,2H), 4.90 (d, *J* = 9.6 Hz, 1H), 4.74 (t, *J* = 9.8 Hz, 1H), 4.56 (d, *J* = 10.1 Hz, 1H), 1.64 (s, 9H), 1.56 (s, 9H);

^{13}C NMR (100 MHz, $CDCl_3$) δ 175.7, 174.8, 172.9, 161.0 (d, *J* = 18.4 Hz), 147.8(d, *J* = 9.0 Hz), 147.8, 135.8, 134.7 (d, *J* = 223.6 Hz), 133.6, 131.9, 129.1, 128.9, 128.6, 128.1, 126.9, 125.2 (d, *J* = 8.2 Hz), 123.7 (d, *J* = 8.2 Hz), 116.9, 116.8, 116.1, 112.0, 111.8, 111.5, 111.2, 85.5, 85.3, 70.4, 62.2, 51.8, 51.5, 47.9, 27.9,27.8;

HRMS (ESI) m/z calcd for $C_{43}H_{37}F_2N_3O_8Na^+$ $(M+Na)^+$ 784.2440, found 784.2442.

Di-tert-butyl(3R,3a'S,5'S,6a'S)-5,5''-dimethyl-1',2,2'',3'-tetraoxo-2',6'-diphenyl-1',2',3',3a',6',6a'-hexahydrodispiro[indoline-3,4'-cyclopenta[c]pyrrole-5',3''-indoline]-1,1''-dicarboxylate (3da)



white solid, Mp: 247.1-248.3 ºC, 90% yield, dr > 20:1;

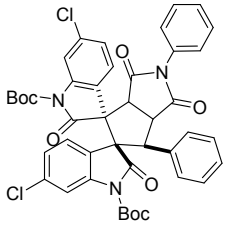
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.44 (d, *J* = 7.4 Hz, 2H), 7.38 (dd, *J* = 8.4, 5.9 Hz, 6H), 7.21 (d, *J* = 8.3 Hz, 1H), 7.14 (dd, *J* = 8.1, 5.3 Hz, 5H), 7.00 (d, *J* = 8.4 Hz, 1H), 6.94 (d, *J* = 8.2 Hz, 1H), 4.95 (d, *J* = 9.5 Hz, 1H), 4.74

(t, 1H), 4.60 (d, *J* = 10.1 Hz, 1H), 2.30 (d, *J* = 5.2 Hz, 6H), 1.62 (s, 9H), 1.53 (s, 9H);

^{13}C NMR (100MHz, $CDCl_3$) δ 176.2, 175.6, 175.3, 173.7, 148.0, 147.9, 137.3, 134.5, 134.5, 134.2, 132.2, 130.4, 130.3, 129.0, 128.7, 128.6, 128.3, 127.6, 127.1, 124.7, 124.3, 123.6, 122.2, 114.6, 114.5, 84.7, 84.4, 77.3, 77.0, 76.7, 70.5, 62.5, 51.5, 51.4, 48.1, 28.1, 28.0, 21.1, 21.1;

HRMS (ESI) m/z calcd for $C_{45}H_{43}N_3O_8Na^+$ $(M+Na)^+$ 776.2942, found 776.2946.

Di-tert-butyl(3R,3a'S,5'S,6a'S)-6,6''-dichloro-1',2,2'',3'-tetraoxo-2',6'-diphenyl-,1',2',3',3a',6',6a'-hexahydrodispiro[indoline-3,4'-cyclopenta[c]pyrrole-5',3''-indoline]-1,1''-dicarboxylate (3ea)



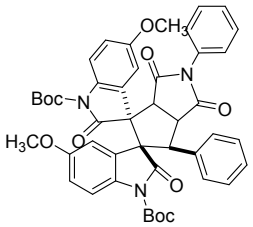
white solid, Mp: 265.2-266.4 ºC, 83% yield, dr > 20:1;

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.54 (d, *J* = 7.1 Hz, 3H), 7.49-7.43 (m, 2H), 7.36 (dd, *J* = 16.9, 7.8 Hz, 4H), 7.22 (m, 2H), 7.15 (t, *J* = 7.6 Hz, 1H), 7.11-7.06 (m, 3H), 6.66 (d, *J* = 8.6 Hz, 2H), 4.90 (d, *J* = 9.6 Hz, 1H), 4.71 (t, *J* = 9.8 Hz, 1H), 4.60 (d, *J* = 10.0 Hz, 1H), 3.69 (s, 3H), 1.62 (s, 9H), 1.54 (s, 9H);

^{13}C NMR (100 MHz, $CDCl_3$) δ175.7, 174.9, 174.8, 173.1, 147.5, 147.3, 140.7, 140.7, 136.11,136.06, 133.5, 131.9, 129.0, 128.7, 128.6, 128.1, 126.9, 125.2, 125.1, 124.7, 124.6, 122.0, 120.3, 116.0, 115.8, 85.7, 85.5, 70.3, 61.9, 52.0, 51.5, 47.8, 28.0, 27.9;

HRMS (ESI) m/z calcd for $C_{43}H_{37}Cl_2N_3O_8Na^+$ $(M+Na)^+$ 816.1849, found 816.1847.

Di-tert-butyl(3R,5'S,6'S)-5,5''-dimethoxy-1',2,2'',3'-tetraoxo-2',6'-diphenyl-1',2',3',3a',6',6a'-hexahydrodispiro[indoline-3,4'-cyclopenta[c]pyrrole-5',3''-indoline]-1,1''-dicarboxylate (3fa)



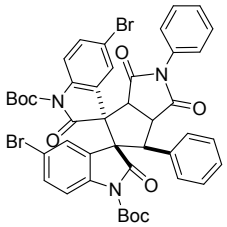
white solid, Mp: 258.2-259.4 ºC, 85% yield, dr > 20:1;

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.46 (m, 3H), 7.38 (d, *J* = 7.8 Hz, 3H), 7.29–7.25 (m, 1H), 7.19 (d, *J* = 3.2 Hz, 2H), 7.16–7.11 (m, 5H), 6.74 (dd, *J* = 8.9, 2.5 Hz, 1H), 6.68 (dd, *J* = 8.9, 2.5 Hz, 1H), 4.94 (d, *J* = 9.5 Hz, 1H), 4.76 (t, *J* = 9.8 Hz, 1H), 4.60 (d, *J* = 10.1 Hz, 1H), 3.79 (s, 3H), 3.77 (s, 3H), 1.61 (s, 9H), 1.52 (s, 9H).

^{13}C NMR (150 MHz, $CDCl_3$) δ 176.1, 175.4, 175.2, 173.7, 157.0, 156.9, 148.0, 147.9, 134.3, 132.9, 132.9, 132.1, 129.0, 128.7, 128.6, 128.4, 127.8, 127.1, 124.7 (s), 123.3, 116.0, 115.9, 115.1, 109.9, 109.4, 84.8, 84.6, 70.8, 62.6, 55.5, 55.3, 51.5, 48.1, 27.9, 27.8.

HRMS (ESI) m/z calcd for $C_{45}H_{43}N_3O_{10}Na^+$ $(M+Na)^+$ 808.2846, found 808.2878.

Di-tert-butyl(3R,5'S,6'S)-5,5''-dibromo-1',2,2'',3'-tetraoxo-2',6'-diphenyl-1',2',3',3a',6',6a'-hexahydrodispiro[indoline-3,4'-cyclopenta[c]pyrrole-5',3''-indoline]-1,1''-dicarboxylate (3ga)



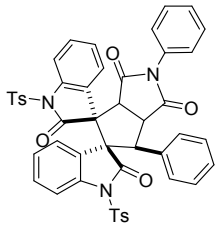
white solid, Mp: 265.2-266.8 ºC, 90 % yield, dr > 20:1;

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.82 (d, *J* = 1.7 Hz, 1H), 7.60 (d, *J* = 1.7 Hz, 1H), 7.45 (d, *J* = 7.8 Hz, 2H), 7.41–7.33 (m, 5H), 7.26 (d, *J* = 5.8 Hz, 1H), 7.23 (d, *J* = 1.7 Hz, 1H), 7.18–7.11 (m, 5H), 4.88 (d, *J* = 9.7 Hz, 1H), 4.71 (t, *J* = 9.9 Hz, 1H), 4.57 (d, *J* = 10.1 Hz, 1H), 1.64 (s, 9H), 1.54 (s, 9H).

^{13}C NMR (150 MHz, $CDCl_3$) δ 175.6, 174.8, 174.8, 173.0, 147.5, 147.3, 140.8, 140.7, 133.4, 131.9, 129.1, 128.7, 128.6, 128.1,127.6, 126.9, 125.5, 124.9, 124.1, 124.1, 122.5, 120.8, 118.7, 85.8, 85.5, 77.5 (s), 77.0, 76.8, 70.3, 61.8, 52.0, 51.5, 47.7, 28.0, 27.9.

HRMS (ESI) m/z calcd for $C_{43}H_{37}Br_2N_3O_8Na^+$ $(M+Na)^+$ 904.0845, found 904.0876.

Di-tert-butyl(3R,3a'S,5'S,6a'S)-5,5''-dimethyl-2',6'-diphenyl-1,1''-ditosyl-6',6a'-dihydrodispiro[indoline-3,4'-cyclopenta[c]pyrrole-5',3''-indoline]-1',2,2'',3'(2'H,3a'H)-tetraone (3ha)



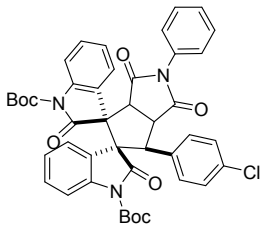
white solid, Mp: 290.1-291.7 ºC, 82% yield, dr > 20:1;

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.79 (d, *J* = 8.2 Hz, 2H), 7.72 (d, *J* = 8.2 Hz, 1H), 7.64 (d, *J* = 8.2 Hz, 2H), 7.58 (d, *J* = 7.3 Hz, 1H), 7.50 (d, *J* = 7.9 Hz, 1H), 7.41 (d, *J* = 7.1 Hz, 3H), 7.36 (d, *J* = 7.7 Hz, 1H), 7.24 (dd, *J* = 12.6, 8.4 Hz, 5H), 7.10 (d, *J* = 7.7 Hz, 2H), 7.04–7.00 (m, 3H), 6.96 (s, 1H), 6.83 (dd, *J* = 14.1, 7.3 Hz, 4H), 4.86 (d, *J* = 9.5 Hz, 1H), 4.54 (t, *J* = 9.8 Hz, 1H), 4.40 (d, *J* = 10.1 Hz, 1H), 2.49 (s, 3H), 2.26 (s, 3H).

^{13}C NMR (150MHz, $CDCl_3$) δ 175.6, 175.5, 173.9, 173.3, 145.9, 145.6, 139.2, 139.0, 134.8, 134.2, 133.1, 131.9, 130.6, 130.5, 129.8, 129.6, 128.7, 128.3, 128.2, 128.0, 127.8, 127.8, 127.4, 126.8, 125.7, 125.5, 124.9, 124.8, 123.7, 121.8, 113.2, 113.04, 69.6, 61.5, 51.8, 51.7, 47.0, 21.7, 21.7;

HRMS (ESI) m/z calcd for $C_{47}H_{35}N_3O_8S_2Na^+$ $(M+Na)^+$ 856.1757, found 856.1759.

Di-tert-butyl(3R,3a'S,5'S,6a'S)-6'-(4-chlorophenyl)-1',2,2'',3'-tetraoxo-2'-phenyl-1',2',3',3a',6',6a'-hexahydrodispiro[indoline-3,4'-cyclopenta[c]pyrrole-5',3''-indoline]-1,1''-dicarboxylate (3ab)



white solid, Mp: 241.4-242.5 ºC, 93% yield, dr > 20:1;

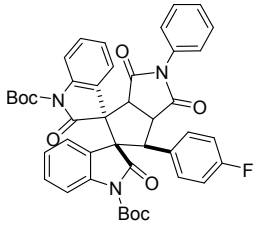
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.54 (t, *J* = 8.0 Hz, 3H), 7.49-7.43 (m, 2H), 7.37 (dd, *J* = 13.5, 6.0 Hz, 4H), 7.21 (ddd, *J* = 11.3, 8.3, 4.1 Hz, 2H), 7.13-7.05 (m, 6H), 4.93 (d, *J* = 9.5 Hz, 1H), 4.71 (t, *J* = 9.8 Hz, 1H),

4.60 (d, *J* = 10.1 Hz, 1H), 1.62 (s, 9H), 1.55 (s, 9H);

^{13}C NMR (100 MHz, $CDCl_3$) δ 175.9, 175.3, 175.0, 173.5, 147.8, 147.6, 139.8, 139.8, 133.8, 132.9, 132.0, 130.1, 130.0, 129.0, 128.7, 128.6, 127.0, 124.8, 124.5, 124.0, 123.7, 123.4, 121.8, 115.0, 115.0, 84.9, 70.5, 62.5, 51.2, 50.7, 48.1, 28.1, 28.0;

HRMS (ESI) m/z calcd for $C_{43}H_{38}ClN_3O_8Na^+$ $(M+Na)^+$ 782.2239, found 782.2243.

Di-tert-butyl(3R,3a'S,5'S,6a'S)-6'-(4-fluorophenyl)-1',2,2'',3'-tetraoxo-2'-phenyl-1',2',3',3a',6',6a'-hexahydrodispiro[indoline-3,4'-cyclopenta[c]pyrrole-5',3''-indoline]-1,1''-dicarboxylate (3ac)



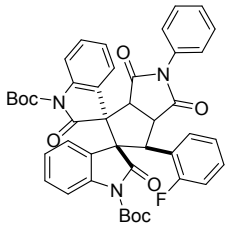
white solid, Mp: 236.6-238.1 ºC, 95% yield, dr > 20:1;

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.53 (d, *J* = 5.9 Hz, 3H), 7.45 (d, *J* = 7.4 Hz, 2H), 7.36 (dd, *J* = 11.3, 8.2 Hz, 4H), 7.24-7.19 (m, 1H), 7.18-7.05 (m, 5H), 6.83 (s, 2H), 4.93 (d, *J* = 9.5 Hz, 1H), 4.71 (t, *J* = 9.8 Hz, 1H), 4.60 (d, *J* = 10.1 Hz, 1H), 1.62 (s, 9H), 1.54 (s, 9H);

^{13}C NMR (100 MHz, $CDCl_3$) δ 176.0, 175.3, 175.1, 173.5, 163.5, 162.3 (d, *J* = 246.6 Hz), 147.8, 147.7, 139.8, 132.0, 130.36 (d, *J* = 8.1 Hz), 130.07 (d, *J* = 8.4 Hz), 129.0, 128.6, 127.0, 124.8, 124.5, 124.0, 123.7, 123.5, 121.9, 115.4, 115.2, 115.0, 84.9, 84.8, 70.6, 62.4, 51.2, 50.7, 48.2, 28.1, 28.0;

HRMS (ESI) m/z calcd for $C_{43}H_{38}FN_3O_8Na^+$ $(M+Na)^+$ 766.2535, found 766.2539.

Di-tert-butyl(3R,3a'S,5'S,6a'S)-6'-(2-fluorophenyl)-1',2,2'',3'-tetraoxo-2'-phenyl-1',2',3',3a',6',6a'-hexahydrodispiro[indoline-3,4'-cyclopenta[c]pyrrole-5',3''-indoline]-1,1''-dicarboxylate (3ad)



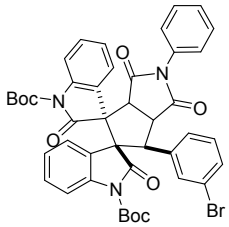
white solid, Mp: 242.9-243.8 ºC, 76 % yield, dr > 20:1;

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.70 (t, *J* = 6.9 Hz, 1H), 7.58 (d, *J* = 7.3 Hz, 1H), 7.56 – 7.52 (m, 2H), 7.46 (t, *J* = 7.6 Hz, 2H), 7.39 (d, *J* = 7.9 Hz, 3H), 7.31–7.19 (m, 3H), 7.11 (m, 4H), 7.04 (t, *J* = 7.6 Hz, 1H), 6.78 (t, *J* = 8.9 Hz, 1H), 5.51 (d, *J* = 9.8 Hz, 1H), 4.69 (t, *J* = 9.9 Hz, 1H), 4.62 (d, *J* = 10.1 Hz, 1H), 1.62 (s, 9H), 1.55 (s, 9H).

^{13}C NMR (150 MHz, $CDCl_3$) δ 175.7, 175.1, 175.1, 173.7, 160.8 (d, *J* = 248.3 Hz), 147.8, 147.7, 139.8, 132.0, 130.0, 129.9,128.9, 128.6, 127.3, 127.0, 125.0,124.2, 124.0, 123.4, 121.7, 115.6, 115.48 (d, *J* = 23.4 Hz), 115.0, 114.38 (s), 84.8, 84.7,70.5, 62.7, 51.2, 48.3, 28.0,27.9;

HRMS (ESI) m/z calcd for $C_{43}H_{38}FN_3O_8Na^+$ $(M+Na)^+$ 766.2535, found 766.2536.

Di-tert-butyl(3R,3a'S,5'S,6a'S)-6'-(3-bromophenyl)-1',2,2'',3'-tetraoxo-2'-phenyl-1',2',3',3a',6',6a'-hexahydrodispiro[indoline-3,4'-cyclopenta[c]pyrrole-5',3''-indoline]-1,1''-dicarboxylate (3ae)



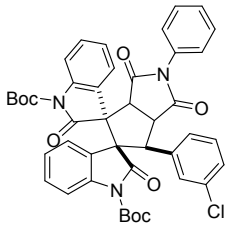
white solid, Mp: 236.1-237.3 ºC, 85% yield, dr > 20:1;

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.54 (dd, *J* = 15.2, 5.3 Hz, 3H), 7.49-7.42 (m, 2H), 7.42-7.35 (m, 5H), 7.29-7.24 (m, 1H), 7.23-7.14 (m, 2H), 7.13-7.04 (m, 3H), 7.00 (d, *J* = 7.8 Hz, 1H), 4.91 (d, *J* = 9.3 Hz, 1H), 4.70 (t, *J* = 9.7 Hz, 1H), 4.61 (d, *J* = 10.1 Hz, 1H), 1.62 (s, 9H), 1.56 (s, 9H);

^{13}C NMR (100 MHz, $CDCl_3$) δ 175.9, 175.2, 175.0, 173.3, 147.9), 147.8, 139.8, 139.8, 131.0, 130.24, 130.0, 129.9, 129.0, 128.7, 127.4, 127.0, 124.8, 124.6, 124.0, 123.7, 123.4, 122.5, 121.7, 115.0, 115.0, 84.9, 70.5, 62.4, 51.2, 50.9, 48.0, 28.1, 28.0;

HRMS (ESI) m/z calcd for $C_{43}H_{38}BrN_3O_8Na^+$ $(M+Na)^+$ 826.1734, found 826.1738.

Di-tert-butyl(3R,3a'S,5'S,6a'S)-6'-(3-chlorophenyl)-1',2,2'',3'-tetraoxo-2'-phenyl-1',2',3',3a',6',6a'-hexahydrodispiro[indoline-3,4'-cyclopenta[c]pyrrole-5',3''-indoline]-1,1''-dicarboxylate (3af)

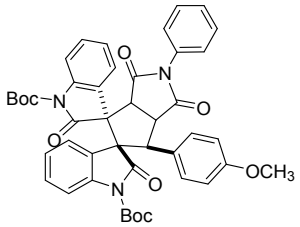


white solid, Mp: 226.4-227.1 ºC, 90% yield, dr > 20:1;

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.57-7.51 (m, 3H), 7.49-7.44 (m, 2H), 7.38 (dd, *J* = 9.7, 3.5 Hz, 4H), 7.23 (dd, *J* = 14.8, 6.2 Hz, 3H), 7.14-7.07 (m, 3H), 7.03 (dd, *J* = 14.7, 7.7 Hz, 2H), 4.92 (d, *J* = 9.4 Hz, 1H), 4.70 (t, *J* = 9.8 Hz, 1H), 4.61 (d, *J* = 10.1 Hz, 1H), 1.62 (s, 9H), 1.56 (s, 9H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 175.9, 175.2, 175.0, 173.3, 147.9, 147.8, 139.8, 139.8, 136.5, 134.2, 132.0, 130.2, 130.0, 129.6, 129.0, 128.8, 128.7, 128.1, 127.0, 126.9, 124.8, 124.6, 124.0, 123.6, 123.4, 121.7, 115.0, 114.9, 84.9, 84.9, 70.4, 62.4, 51.2, 51.0, 48.0, 28.1, 27.9; **HRMS** (ESI) m/z calcd for $C_{43}H_{38}ClN_3O_8Na^+$ $(M+Na)^+$ 782.2239, found 782.2243.

Di-tert-butyl(3R,3a'S,5'S,6a'S)-6'-(4-methoxyphenyl)-1',2,2'',3'-tetraoxo-2'-phenyl-1',2',3',3a',6',6a'-hexahydrodispiro[indoline-3,4'-cyclopenta[c]pyrrole-5',3''-indoline]-1,1''-dicarboxylate (3ag)

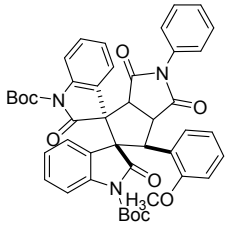


white solid, Mp: 246.2-247.1 ºC, 85% yield, dr > 20:1;

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.54 (d, *J* = 7.1 Hz, 3H), 7.45 (d, *J* = 7.0 Hz, 2H), 7.36 (dd, *J* = 16.9, 7.8 Hz, 4H), 7.21 (s, 1H), 7.15 (s, 1H), 7.12-7.04 (m, 4H), 6.66 (d, *J* = 8.6 Hz, 2H), 4.90 (d, *J* = 9.6 Hz, 1H), 4.71 (t, *J* = 9.8 Hz, 1H), 4.60 (d, *J* = 10.0 Hz, 1H), 3.69 (s, 3H), 1.62 (s, 9H), 1.54 (s, 9H);

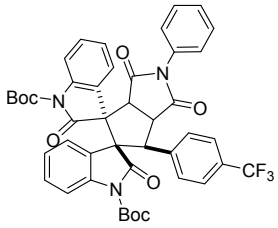
^{13}C NMR (100 MHz, $CDCl_3$) δ 176.1, 175.3, 175.3, 173.7, 159.0, 147.9, 147.8, 139.8, 139.8, 132.1, 129.9, 129.8, 129.0, 128.6, 127.0, 126.1, 124.7, 124.4, 124.0, 123.7, 122.2, 115.0, 114.9, 113.8, 84.8, 84.6, 70.6, 62.4, 55.0, 51.3, 50.9, 48.2, 28.1, 28.0;
HRMS (ESI) m/z calcd for $C_{44}H_{41}N_3O_9Na^+$ $(M+Na)^+$ 778.2735, found 778.2738.

Di-tert-butyl(3R,5'S,6'S)-6'-(2-methoxyphenyl)-1',2,2'',3'-tetraoxo-2'-phenyl-1',2',3',3a',6',6a'-hexahydrodispiro[indoline-3,4'-cyclopenta[c]pyrrole-5',3''-indoline]-1,1''-dicarboxylate(3ah)



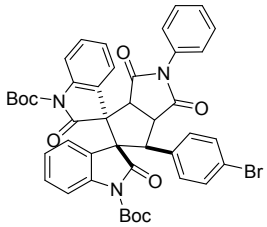
white solid, Mp: 245.8-246.9 ºC, 75% yield, dr > 20:1;
H NMR (400 MHz, $CDCl_3$) δ 7.66 (d, *J* = 7.3 Hz, 1H), 7.58 (dd, *J* = 16.0, 7.4 Hz, 2H), 7.52-7.23 (m, 8H), 7.20 (t, *J* = 7.8 Hz, 1H), 7.08 (dd, *J* = 17.2, 8.3 Hz, 3H), 6.98 (t, *J* = 7.6 Hz, 1H), 6.89 (t, *J* = 7.5 Hz, 1H), 6.56 (d, *J* = 8.1 Hz, 1H), 5.81 (d, *J* = 9.3 Hz, 1H), 4.62 (t, *J* = 7.7 Hz, 1H), 3.44 (s, 3H), 1.61 (s, 9H), 1.54 (s, 9H);
^{13}C NMR (100 MHz, $CDCl_3$) δ 176.1, 175.4, 175.4, 173.9, 157.5, 147.9, 147.8, 139.8, 139.6, 132.2, 129.8, 129.4,129.0, 128.9, 128.7, 128.5, 127.1, 125.5, 124.7, 124.2, 123.9, 123.3, 122.8, 121.6, 120.6, 114.9, 114.1, 110.6, 84.7, 84.4, 70.8, 62.6, 54.9, 51.4, 48.5, 42.0, 28.1, 28.0;
HRMS (ESI) m/z calcd for $C_{44}H_{41}N_3O_9Na^+$ $(M+Na)^+$ 778.2735, found 778.2739.

Di-tert-butyl(3R,3a'S,5'S,6a'S)-1',2,2'',3'-tetraoxo-2'-phenyl-6'-(4(trifluoromethyl)phenyl)-1',2',3',3a',6',6a'-hexahydrodispiro[indoline-3,4'-cyclopenta[c]pyrrole-5',3''-indoline]-1,1''-dicarboxylate (3ai)



white solid, Mp:235.8-236.9 ºC, 92% yield, dr > 20:1;
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.54 (t, *J* = 8.5 Hz, 3H), 7.49-7.44 (m, 2H), 7.43-7.34 (m, 6H), 7.31 (d, *J* = 8.2 Hz, 2H), 7.20 (dd, *J* = 16.8, 8.3 Hz, 2H), 7.11 (dt, *J* = 12.3, 6.3 Hz, 2H), 5.01 (d, *J* = 9.5 Hz, 1H), 4.77 (t, *J* = 9.8 Hz, 1H), 4.62 (d, *J* = 10.1 Hz, 1H), 1.62 (s, 9H), 1.54 (s, 9H);
^{13}C NMR (100 MHz, $CDCl_3$) δ 175.9, 175.2, 174.9, 173.4, 147.8, 147.6, 139.8, 139.7, 138.6, 132.0, 130.24 (d, *J* = 17.5 Hz), 129.1, 128.7, 127.0, 125.3(d, *J* = 164 Hz), 124.9, 124.6, 124.0, 123.7, 123.3, 121.6, 115.1, 85.0, 85.0, 70.4, 62.6, 51.1, 50.8, 48.0, 28.1, 27.9;
HRMS (ESI) m/z calcd for $C_{44}H_{38}F_3N_3O_8Na^+$ $(M+Na)^+$ 816.2503, found 816.2506.

Di-tert-butyl(3R,3a'S,5'S,6a'S)-6'-(4-bromophenyl)-1',2,2'',3'-tetraoxo-2'-phenyl-1',2',3',3a',6',6a'-hexahydrodispiro[indoline-3,4'-cyclopenta[c]pyrrole-5',3''-indoline]-1,1''-dicarboxylate (3aj)



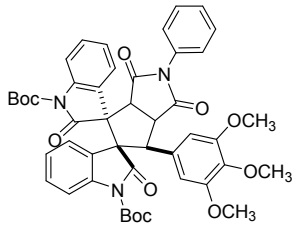
white solid, Mp: 264.2-265.3 ºC, 93% yield, dr > 20:1;

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.53 (t, *J* = 8.4 Hz, 3H), 7.49-7.43 (m, 2H), 7.38 (q, *J* = 6.8 Hz, 4H), 7.29-7.23 (m, 4H), 7.18 (dd, *J* = 13.5, 5.6 Hz, 1H), 7.1-7.05 (m, 3H), 4.91 (d, *J* = 9.5 Hz, 1H), 4.69 (t, *J* = 9.7 Hz, 1H), 4.59 (d, *J* = 10.1 Hz, 1H), 1.62 (s, 9H), 1.55 (s, 9H);

^{13}C NMR (100 MHz, $CDCl_3$) δ 175.9, 175.2, 175.0, 173.5, 147.8, 147.6, 139.8, 139.7, 133.4, 132.0, 131.6, 130.4, 130.2, 130.0, 129.0, 128.7, 127.0, 124.86 (s), 124.55 (s), 124.0, 123.6, 123.4, 122.0, 121.7, 115.0, 84.9, 84.9, 70.4, 62.5, 51.1, 50.7, 48.0, 28.0, 27.9;

HRMS (ESI) m/z calcd for $C_{43}H_{38}BrN_3O_8Na^+$ $(M+Na)^+$ 826.1734, found 826.1739.

Di-tert-butyl(3R,3a'S,5'S,6a'S)-6'-(4-bromophenyl)-1',2,2'',3'-tetraoxo-2'-phenyl-1',2',3',3a',6',6a'-hexahydrodispiro[indoline-3,4'-cyclopenta[c]pyrrole-5',3''-indoline]-1,1''-dicarboxylate (3ak)



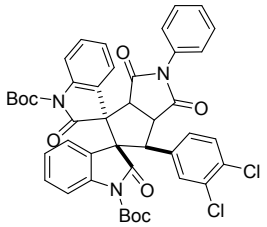
white solid, Mp: 230.1-231.4 ºC, 96% yield, dr > 20:1;

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.54 (s, 3H), 7.46 (d, *J* = 7.0 Hz, 2H), 7.43-7.37 (m, 4H), 7.24- 7.15 (m, 2H), 7.09 (dd, *J* = 16.3, 8.0 Hz, 2H), 6.37 (s, 2H), 4.90 (d, *J* = 9.3 Hz, 1H), 4.70 (t, *J* = 9.5 Hz, 1H), 4.62 (d, *J* = 10.1 Hz, 1H), 3.74 (s, 3H), 3.62 (s, 6H), 1.62 (s, 9H), 1.54 (s, 9H);

^{13}C NMR (150MHz, $CDCl_3$) δ 176.2, 175.5, 175.2, 173.7, 171.1, 152.7, 147.8, 147.7, 139.9, 139.8, 137.2, 132.0, 130.0, 129.9, 129.0, 128.73, 127.0, 126.4, 124.8, 124.3, 124.1, 123.7, 123.5, 122.5, 115.1, 105.3, 84.9, 84.8, 70.5, 62.2, 60.7, 60.3, 56.2, 55.7, 51.7, 51.3, 48.2, 28.6, 28.0, 27.9, 21.0, 14.2;

HRMS (ESI) m/z calcd for $C_{46}H_{45}N_3O_{11}Na^+$ $(M+Na)^+$ 838.2946, found 838.2949.

Di-tert-butyl(3R,5'S,6'S)-6'-(3,4-dichlorophenyl)-1',2,2'',3'-tetraoxo-2'-phenyl-1',2',3',3a',6',6a'-hexahydrodispiro[indoline-3,4'-cyclopenta[c]pyrrole-5',3''-indoline]-1,1''-dicarboxylate (3al)



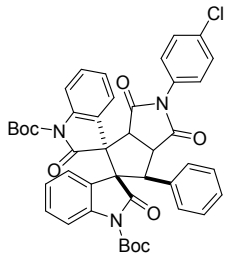
white solid, Mp: 235.6-236.7 ºC, 95% yield, dr > 20:1;

^{1}H NMR (600MHz, $CDCl_3$) δ 7.56 (dd, *J* = 15.5, 7.9 Hz, 5H), 7.29 (dd, *J* = 13.2, 4.5 Hz, 4H), 7.13 (d, *J* = 12.8 Hz, 8H), 4.93 (d, *J* = 9.6 Hz, 1H), 4.77 (t, *J* = 9.7 Hz, 1H), 4.62 (d, *J* = 10.0 Hz, 1H), 1.62 (s, 9H), 1.53 (s, 9H);

^{13}C NMR (150 MHz, $CDCl_3$) δ 175.7, 175.1, 174.8, 173.2, 147.7, 147.5, 139.7, 139.6, 134.7, 132.4, 132.0,

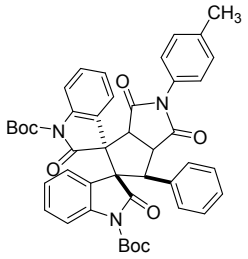
131.8, 130.6, 130.3, 130.1, 129.0, 128.7, 128.0, 126.9, 124.8, 124.6, 123.8, 123.5, 123.1, 121.3, 115.0, 85.0, 84.9, 70.2, 62.40, 50.9 , 50.2 , 48.0 , 28.0, 27.8;
HRMS (ESI) m/z calcd for $C_{43}H_{37}Cl_2N_3O_8Na^+$ $(M+Na)^+$ 816.1849, found 816.1863.

Di-tert-butyl(3R,5'S,6'S)-2'-(4-chlorophenyl)-1',2,2'',3'-tetraoxo-6'-phenyl-1',2',3',3a',6',6a'-hexahydrodispiro[indoline-3,4'-cyclopenta[c]pyrrole-5',3''-indoline]-1,1''-dicarboxylate (3am)



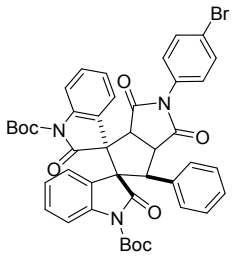
white solid, Mp: 235.1-236.4 ºC, 89% yield, dr > 20:1;
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.54 (d, *J* = 7.1 Hz, 3H), 7.49-7.43 (m, 2H), 7.36 (dd, *J* = 16.9, 7.8 Hz, 4H), 7.22 (dd, *J* = 16.8, 8.9 Hz, 2H), 7.15 (t, *J* = 7.6 Hz, 1H), 7.11-7.06 (m, 3H), 6.66 (d, *J* = 8.6 Hz, 2H), 4.90 (d, *J* = 9.6 Hz, 1H), 4.71 (t, *J* = 9.8 Hz, 1H), 4.60 (d, *J* = 10.0 Hz, 1H), 3.69 (s, 3H), 1.62 (s, 9H), 1.54 (s, 9H);
^{13}C NMR (100MHz, $CDCl_3$) δ 175.9, 175.5, 175.0, 173.5, 147.8, 147.7, 139.8, 134.4, 134.0, 130.6, 130.0, 129.2, 128.6, 128.4, 128.3, 127.8, 124.8, 124.4, 124.1, 123.7, 123.5,122.0, 115.0, 114.9, 84.9, 84.7, 70.6, 62.6, 51.4, 51.2, 48.0, 28.1, 28.0;
HRMS (ESI) m/z calcd for $C_{43}H_{38}ClN_3O_8Na^+$ $(M+Na)^+$ 782.2239, found 782.2243.

Di-tert-butyl(3R,5'S,6'S)-1',2,2'',3'-tetraoxo-6'-phenyl-2'-(p-tolyl)-1',2',3',3a',6',6a'-hexahydrodispiro[indoline-3,4'-cyclopenta[c]pyrrole-5',3''-indoline]-1,1''-dicarboxylate (3an)



white solid, Mp: 246.3-247.1 ºC, 87% yield, dr > 20:1;
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.54 (dd, *J* = 7.2, 3.3 Hz, 3H), 7.32 (s, 1H), 7.26 (s, 4H), 7.20 (d, *J* = 7.6 Hz, 1H), 7.18-7.11 (m, 6H), 7.08 (d, *J* = 7.8 Hz, 2H), 4.95 (d, *J* = 9.5 Hz, 1H), 4.75 (t, *J* = 9.8 Hz, 1H), 4.60 (d, *J* = 10.0 Hz, 1H), 2.37 (s, 3H), 1.62 (s, 9H), 1.53 (s, 9H);
^{13}C NMR (100 MHz, $CDCl_3$) δ 176.2, 175.3, 173.5, 147.9, 147.8, 139.8, 139.7, 138.5, 134.3, 129.9, 129.6, 129.5, 128.7, 128.3, 127.7, 126.8, 124.8, 124.4, 124.1, 123.8, 123.7, 122.1, 115.0, 114.8, 84.7, 84.6, 70.6, 62.5, 51.4, 51.3, 48.0, 28.1, 28.0, 21.2;
HRMS (ESI) m/z calcd for $C_{44}H_{41}N_3O_8Na^+$ $(M+Na)^+$ 762.2785, found 762.2788.

Di-tert-butyl(3R,5'S,6'S)-2'-(4-bromophenyl)-1',2,2'',3'-tetraoxo-6'-phenyl-1',2',3',3a',6',6a'-hexahydrodispiro[indoline-3,4'-cyclopenta[c]pyrrole-5',3''-indoline]-1,1''-dicarboxylate (3ao)



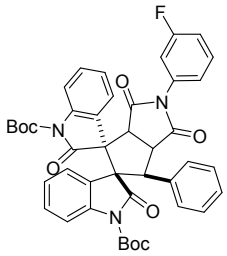
white solid, Mp: 228.4-229.3 ºC, 90% yield, dr > 20:1;

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.56 (dd, *J* = 15.5, 7.9 Hz, 5H), 7.29 (dd, *J* = 13.2, 4.5 Hz, 4H), 7.13 (d, *J* = 12.8 Hz, 8H), 4.93 (d, *J* = 9.6 Hz, 1H), 4.77 (t, *J* = 9.7 Hz, 1H), 4.62 (d, *J* = 10.0 Hz, 1H), 1.62 (s, 9H), 1.53 (s, 9H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 175.8, 175.4, 175.0, 173.4, 147.8, 147.7, 139.7, 133.9, 132.2, 131.0, 130.0, 128.6, 128.4, 127.8, 124.8, 124.4, 124.0, 123.6, 123.4, 122.5, 121.9, 115.0, 114.9, 84.9, 84.7, 70.6, 62.5, 51.3, 51.1 48.0, 28.0, 27.9;

HRMS (ESI) m/z calcd for $C_{43}H_{38}BrN_3O_8Na^+$ $(M+Na)^+$ 826.1734, found 826.1738.

Di-tert-butyl(3R,3a'S,5'S,6a'S)-2'-(3-fluorophenyl))-1',2,2'',3'-tetraoxo-2'-phenyl-1',2',3',3a',6',6a'-hexahydrodispiro[indoline-3,4'-cyclopenta[c]pyrrole-5',3''-indoline]-1,1''-dicarboxylate (3ap)



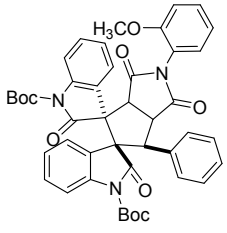
white solid, Mp: 223.1-224.2 ºC, 83% yield, dr > 20:1;

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.55 (t, *J* = 8.1 Hz, 3H), 7.45-7.38 (m, 1H), 7.33 (d, *J* = 8.0 Hz, 1H), 7.26-7.21 (m, 2H), 7.21-7.17 (m, 3H), 7.17-7.12 (m, 6H), 7.09 (dd, *J* = 7.0, 3.4 Hz, 2H), 4.94 (d, *J* = 9.5 Hz, 1H), 4.77 (t, *J* = 9.8 Hz, 1H), 4.62 (d, *J* = 10.1 Hz, 1H), 1.64 (s, 9H), 1.53 (s, 9H);

^{13}C NMR (100 MHz, $CDCl_3$) δ 175.8, 175.4, 174.9, 173.5, 162.67 (d, *J* = 247.2 Hz), 147.9, 147.7, 134.1, 133.4, 130.0, 128.6, 128.4, 127.8, 124.8, 124.4, 124.0, 123.7, 123.5, 122.8, 122.0, 115.8, 115.6, 114.6, 84.9, 84.7, 70.6, 62.6, 51.4, 51.2, 48.0, 28.1 28.0;

HRMS (ESI) m/z calcd for $C_{43}H_{38}FN_3O_8Na^+$ $(M+Na)^+$ 766.2535, found 766.2536.

Di-tert-butyl(3R,3a'S,5'S,6a'S)-6'-(2-methoxyphenyl)-1',2,2'',3'-tetraoxo-2'-phenyl-1',2',3',3a',6',6a'-hexahydrodispiro[indoline-3,4'-cyclopenta[c]pyrrole-5',3''-indoline]-1,1''-dicarboxylate(3aq)



white solid, Mp: 226.1-227.6 ºC, 75% yield, dr > 20:1;

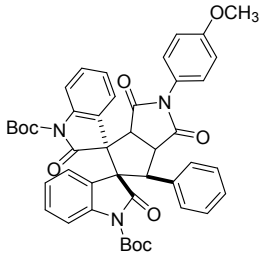
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.55 (t, *J* = 8.9 Hz, 3H), 7.43 (dd, *J* = 7.7, 1.5 Hz, 1H), 7.37-7.31 (m, 2H), 7.21-

7.16 (m, 3H), 7.09 (m, *J* = 12.8, 7.1, 4.9 Hz, 7H), 6.97 (d, *J* = 8.2 Hz, 1H), 4.96 (d, *J* = 9.5 Hz, 1H), 4.80 (t, *J* = 9.8 Hz, 1H), 4.67 (d, *J* = 10.1 Hz, 1H), 3.77 (s, 3H), 1.62 (s, 9H), 1.53 (s, 9H);

^{13}C NMR (100 MHz,$CDCl_3$) δ 175.9,175.3,175.0,173.5,154.8, 147.9,147.8,139.8,139.7, 134.3, 130.4,130.0,129.5, 128.7, 128.3, 127.6, 124.7, 124.4, 124.1, 123.8, 123.7, 122.2, 120.8, 114.9, 114.8, 111.8, 84.7, 84.5, 70.7, 62.4, 55.7, 51.4, 51.3, 48.2, 28.1, 27.9;

HRMS (ESI) m/z calcd for $C_{44}H_{41}N_3O_9Na^+$ $(M+Na)^+$ 778.2735, found 778.2738.

Di-tert-butyl(3R,5'S,6'S)-2'-(4-methoxyphenyl)-1',2,2'',3'-tetraoxo-6'-phenyl-1',2',3',3a',6',6a'-hexahydrodispiro[indoline-3,4'-cyclopenta[c]pyrrole-5',3''-indoline]-1,1''-dicarboxylate (3ar)



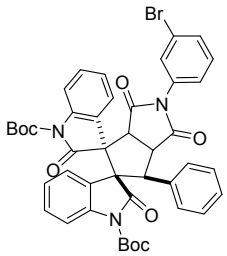
white solid, Mp: 226.1-227.6 ºC, 86% yield, dr > 20:1;

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.57-7.51 (m, 3H), 7.32 (dd, *J* = 13.5, 8.5 Hz, 3H), 7.22-7.06 (m, 9H), 6.96 (d, *J* = 8.9 Hz, 2H), 4.94 (d, *J* = 9.6 Hz, 1H), 4.75 (t, *J* = 9.8 Hz, 1H), 4.60 (d, *J* = 10.0 Hz, 1H), 3.82 (s, 3H), 1.62 (s, 9H), 1.53 (s, 9H);

^{13}C NMR (100 MHz, $CDCl_3$) δ 176.4, 175.5, 175.3, 173.5, 159.5, 147.9, 147.8, 139.8, 139.7, 134.2, 129.9, 128.7, 128.4, 128.2, 127.7, 124.8, 124.4, 124.1, 123.7, 123.6, 122.1, 115.0, 114.8, 114.3, 84.8, 84.6, 70.6, 62.5, 55.4, 51.3, 51.2, 47.9, 28.1, 27.9;

HRMS (ESI) m/z calcd for $C_{44}H_{41}N_3O_9Na^+$ $(M+Na)^+$ 778.2735, found 778.2738.

Di-tert-butyl(3R,3a'S,5'S,6a'S)-6'-(3-bromophenyl)-1',2,2'',3'-tetraoxo-2'-phenyl-1',2',3',3a',6',6a'-hexahydrodispiro[indoline-3,4'-cyclopenta[c]pyrrole-5',3''-indoline]-1,1''-dicarboxylate (3as)



white solid, Mp: 226.1-227.8 ºC, 80% yield, dr > 20:1;

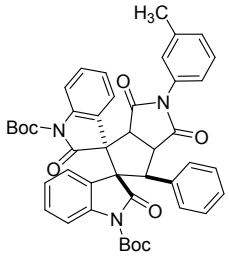
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.55 (dd, *J* = 14.3, 10.0 Hz, 5H), 7.33 (d, *J* = 4.3 Hz, 3H), 7.23 (dd, *J* = 14.4, 6.3 Hz, 2H), 7.18-7.12 (m, 6H), 7.07 (d, *J* = 7.8 Hz, 1H), 4.94 (d, *J* = 9.5 Hz, 1H), 4.76 (t, *J* = 9.8 Hz, 1H), 4.62 (d, *J* = 10.0 Hz, 1H), 1.63 (s, 9H), 1.53 (s, 9H);

^{13}C NMR (100 MHz, $CDCl_3$) δ 175.8, 175.4, 174.9, 173.5, 147.9, 147.7, 139.8, 139.8, 134.1, 133.3, 131.8, 130.2,130.0, 128.6, 128.4, 127.8, 125.8, 124.8, 124.4, 124.0, 123.7, 123.5, 122.3, 122.0, 115.0, 114.9, 84.9, 84.7, 70.6, 62.6, 51.4, 51.2, 48.0, 28.1, 28.0;

HRMS (ESI) m/z calcd for $C_{43}H_{38}BrN_3O_8Na^+$ $(M+Na)^+$ 826.1734, found 826.1738.

Di-tert-butyl(3R,5'S,6'S)-1',2,2'',3'-tetraoxo-6'-phenyl-2'-(m-tolyl)-1',2',3',3a',6',6a'-

hexahydrodispiro[indoline-3,4'-cyclopenta[c]pyrrole-5',3''-indoline]-1,1''-dicarboxylate (3at)



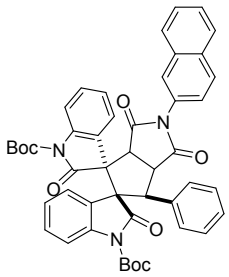
white solid, Mp: 232.2-233.4 ºC, 85% yield, dr > 20:1;

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.56 (dd, *J* = 15.5, 7.9 Hz, 5H), 7.29 (dd, *J* = 13.2, 4.5 Hz, 4H), 7.13 (d, *J* = 12.8 Hz, 8H), 4.93 (d, *J* = 9.6 Hz, 1H), 4.77 (t, *J* = 9.7 Hz, 1H), 4.62 (d, *J* = 10.0 Hz, 1H), 1.62 (s, 9H), 2.39(s,3H), 1.53 (s, 9H);

^{13}C NMR (75 MHz, $CDCl_3$) δ 176.1, 175.2, 139.7, 138.9, 134.1, 129.8, 129.4, 128.7, 128.6, 128.3, 127.6, 127.5, 124.7, 124.3, 124.0, 123.6, 123.5, 122.0, 114.9, 114.8, 84.7, 84.5, 70.5, 62.4, 51.3, 51.2, 47.9, 28.0, 27.9, 21.2;

HRMS (ESI) m/z calcd for $C_{44}H_{41}N_3O_8Na^+$ $(M+Na)^+$ 762.2785, found 762.2788.

Di-tert-butyl(3R,3a'S,5'S,6a'S)-2'-(naphthalen-2-yl)-1',2,2'',3'-tetraoxo-2'-phenyl-1',2',3',3a',6',6a'-hexahydrodispiro[indoline-3,4'-cyclopenta[c]pyrrole-5',3''-indoline]-1,1''-dicarboxylate (3au)



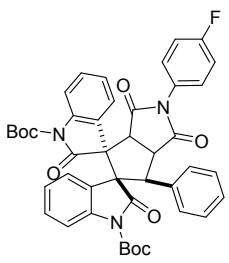
white solid, Mp: 268.1-269.4 ºC, 92% yield, dr 3:1;

^{1}H NMR (600 MHz, $CDCl_3$) δ 7.93 (d, *J* = 8.2 Hz, 1H), 7.89 (dd, *J* = 6.0, 3.4 Hz, 1H), 7.72–7.63 (m, 2H), 7.62 – 7.52 (m, 7H), 7.53–7.47 (m, 3H), 7.36 (d, *J* = 8.0 Hz, 1H), 7.21–7.16 (m, 6H), 7.15–7.09 (m, 8H), 5.06 (d, *J* = 9.5 Hz, 1H), 4.96 (dd, *J* = 10.1, 4.4 Hz, 1H), 4.82 (d, *J* = 10.2 Hz, 1H), 1.65 (s, 9H),1.55 (s, 9H);

^{13}C NMR (150 MHz, $CDCl_3$) δ 176.5, 176.0, 175.5,173.6, 147.9, 147.8, 139.8, 134.2, 134.2, 129.9, 129.7, 129.5, 128.7, 128.4, 127.7, 126.9, 126.8, 126.5, 126.3, 126.1, 125.5, 124.8, 124.4, 124.1, 123.7, 123.5, 122.1, 122.0, 115.0, 114.9, 84.8, 84.7, 70.7, 62.6, 51.4,51.0, 48.3, 28.1, 28.0;

HRMS (ESI) m/z calcd for $C_{47}H_{41}N_3O_8Na^+$ $(M+Na)^+$ 798.2785, found 798.2788.

Di-tert-butyl(3R,3a'S,5'S,6a'S)-6'-(4-fluorophenyl)-1',2,2'',3'-tetraoxo-2'-phenyl-1',2',3',3a',6',6a'-hexahydrodispiro[indoline-3,4'-cyclopenta[c]pyrrole-5',3''-indoline]-1,1''-dicarboxyl (3av)



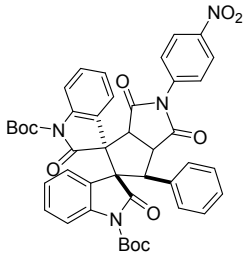
white solid, Mp: 231.1-232.2 ºC, 96% yield, dr > 20:1;

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.54 (d, *J* = 8.0 Hz, 3H), 7.39-7.31 (m, 3H), 7.26-7.20 (m, 3H), 7.17-7.11 (m, 8H), 7.10-7.05 (m, 1H), 4.93 (d, *J* = 9.6 Hz, 1H), 4.77 (t, *J* = 9.8 Hz, 1H), 4.62 (d, *J* = 10.0 Hz, 1H), 1.62 (s, 9H), 1.53 (s, 9H);

^{13}C NMR (100 MHz, $CDCl_3$) δ 176.0, 175.3, 175.1, 173.5, 162.35 (d, *J* = 246.6 Hz), 147.8, 147.7, 139.8, 132.0, 130.36 (d, *J* = 8.1 Hz), 130.07 (d, *J* = 8.4 Hz), 129.0, 128.6, 127.0, 124.8, 124.5, 124.0, 123.7, 123.5, 121.9, 115.4, 115.2, 115.0(d, *J* = 13Hz), 84.9, 84.8, 70.6, 62.4, 51.2, 50.7, 48.2, 28.1, 28.0;

HRMS (ESI) m/z calcd for $C_{43}H_{38}FN_3O_8Na^+$ $(M+Na)^+$ 766.2535, found 766.2537.

Di-tert-butyl(3R,5'S,6'S)-2'-(4-nitrophenyl)-1',2,2'',3'-tetraoxo-6'-phenyl-1',2',3',3a',6',6a'-hexahydrodispiro[indoline-3,4'-cyclopenta[c]pyrrole-5',3''-indoline]-1,1''-dicarboxylate (3aw)



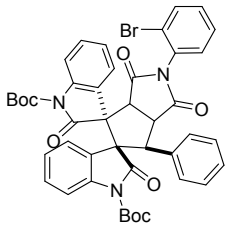
white solid, Mp: 247.1-248.6 ºC, 86% yield, dr > 20:1;

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.33 (d, *J* = 9.0 Hz, 2H), 7.63 (d, *J* = 8.9 Hz, 2H), 7.54 (s, 3H), 7.34 (d, *J* = 8.1 Hz, 1H), 7.26 (s, 3H), 7.16 (s, 7H), 4.93 (d, *J* = 9.6 Hz, 1H), 4.82 (t, *J* = 9.8 Hz, 1H), 4.66 (d, *J* = 10.0 Hz, 1H), 1.62 (s, 9H), 1.54 (s, 9H);

^{13}C NMR (100 MHz, $CDCl_3$) δ 175.4, 174.7, 147.7, 147.7, 147.2, 139.8, 139.7, 137.5, 133.7, 130.1, 128.6, 128.5, 128.0, 127.6, 124.9, 124.5, 124.3, 124.0, 123.6, 123.3, 121.7, 115.1, 115.0, 85.1, 84.8, 70.6, 62.7, 51.4, 51.1, 48.0, 28.0, 27.9;

HRMS (ESI) m/z calcd for $C_{43}H_{38}N_4O_{10}Na^+$ $(M+Na)^+$ 793.2480, found 793.2482.

Di-tert-butyl(3R,5'S,6'S)-2'-(2-bromophenyl)-1',2,2'',3'-tetraoxo-6'-phenyl-1',2',3',3a',6',6a'-hexahydrodispiro[indoline-3,4'-cyclopenta[c]pyrrole-5',3''-indoline]-1,1''-dicarboxylate (3ax)



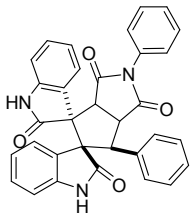
white solid, Mp: 250.1-251.2 ºC, 91% yield, dr > 20:1;

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.66 (dd, *J* = 8.0, 0.9 Hz, 1H), 7.57-7.51 (m, 4H), 7.43 (td, *J* = 7.7, 1.1 Hz, 1H), 7.36 (d, *J* = 8.0 Hz, 1H), 7.30 (dd, *J* = 7.8, 1.4 Hz, 1H), 7.24-7.15 (m, 4H), 7.15-7.06 (m, 5H), 4.97 (d, *J* = 9.4 Hz, 1H), 4.83 (t, *J* = 9.8 Hz, 1H), 4.72 (d, *J* = 10.1 Hz, 1H), 1.63 (s, 9H), 1.54 (s, 9H).

^{13}C NMR (100 MHz, $CDCl_3$) δ 175.6, 175.2, 174.3, 173.4, 147.8, 139.8, 139.8, 134.2, 133.1, 131.8, 130.7, 130.6, 130.0, 128.7, 128.4, 127.8, 124.8, 124.4, 124.1, 123.7, 123.5, 122.2, 122.1, 115.0, 114.9, 84.8, 84.6, 70.7, 62.5, 51.4, 51.2, 48.3, 28.1, 28.0;

HRMS (ESI) m/z calcd for $C_{43}H_{38}BrN_3O_8Na^+$ $(M+Na)^+$ 826.1734, found 826.1737.

(3R,5'S,6'S)-2',6'-diphenyl-6',6a'-dihydrodispiro[indoline-3,4'-cyclopenta[c]pyrrole-5',3''-indoline]-1',2,2'',3'(2'H,3a'H)-tetraone (4)



white solid, Mp: 253.1-254.2 ºC, 91% yield, dr > 20:1;

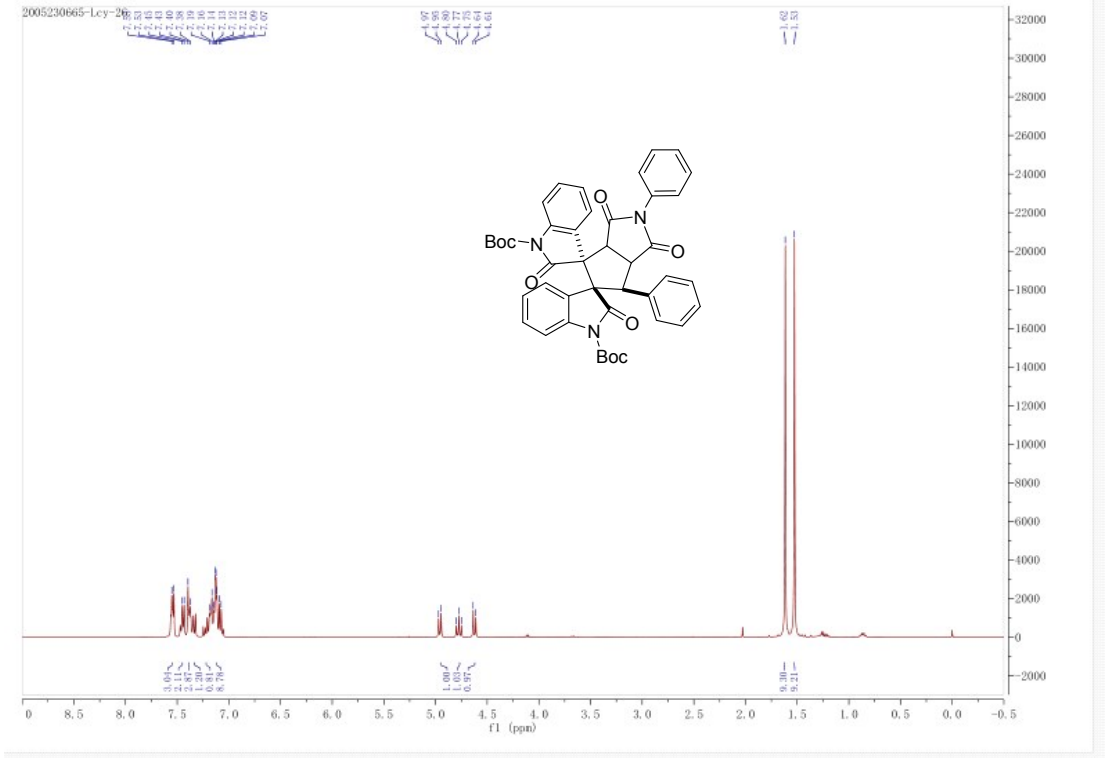
H NMR (400 MHz, DMSO) δ 10.85 (s, 1H), 10.39 (s, 1H), 7.47 m, 5H), 7.28 (d, *J* = 7.6 Hz, 2H), 7.13 (d, *J* = 13.0 Hz, 6H), 7.04 (t, *J* = 7.6 Hz, 1H), 6.96 (q, *J* = 7.0 Hz, 2H), 6.65 (d, *J* = 7.7 Hz, 1H), 6.40 (d, *J* = 7.6 Hz, 1H), 4.88 (d, *J* = 9.6 Hz, 1H), 4.70 (t, *J* = 9.8 Hz, 1H), 4.56 (d, *J* = 9.9 Hz, 1H);

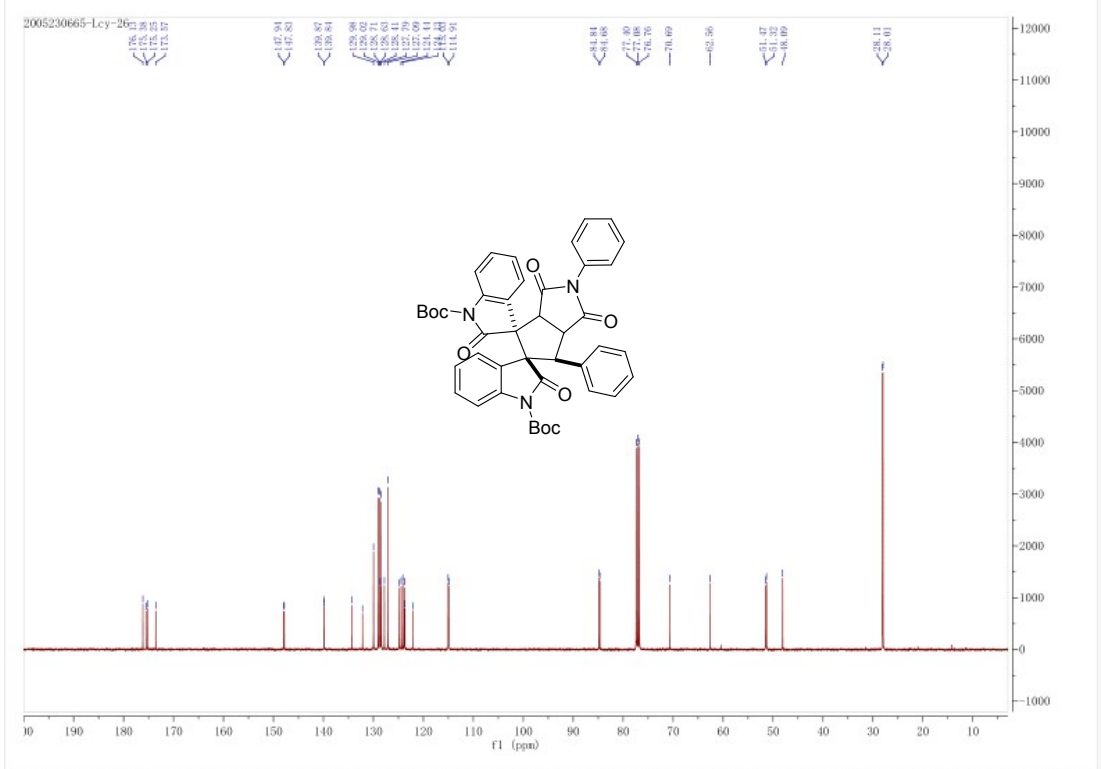
^{13}C NMR (100MHz, DMSO) δ 178.4, 177.6, 176.5, 176.2, 142.7, 142.5, 136.1, 133.0, 129.69, 129.64, 129.3, 128.9, 128.4, 127.8, 127.7, 127.3, 124.9, 124.7, 124.6, 122.6, 122.3, 110.1, 109.7, 69.5, 60.8, 51.8, 51.1, 48.0;

HRMS (ESI) m/z calcd for $C_{33}H_{23}N_3O_4Na^+$ $(M+Na)^+$ 548.1580, found 548.1584.

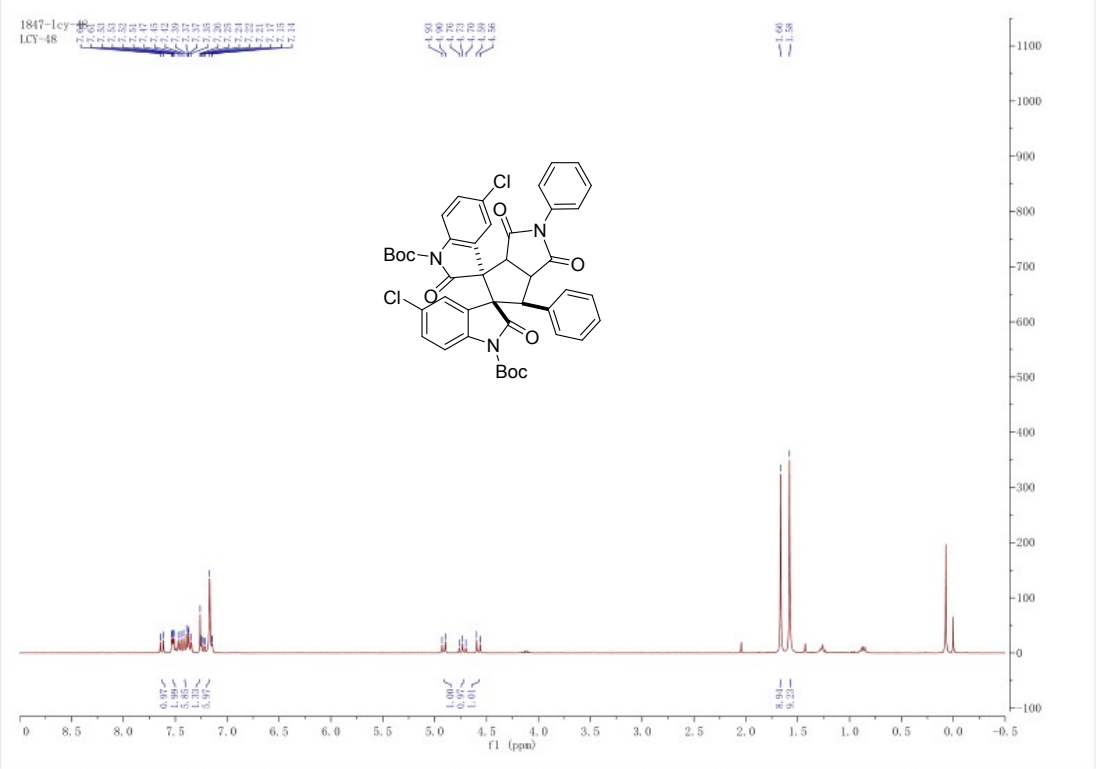
5. The copies of ^{1}H NMR and ^{13}C NMR spectra for compounds

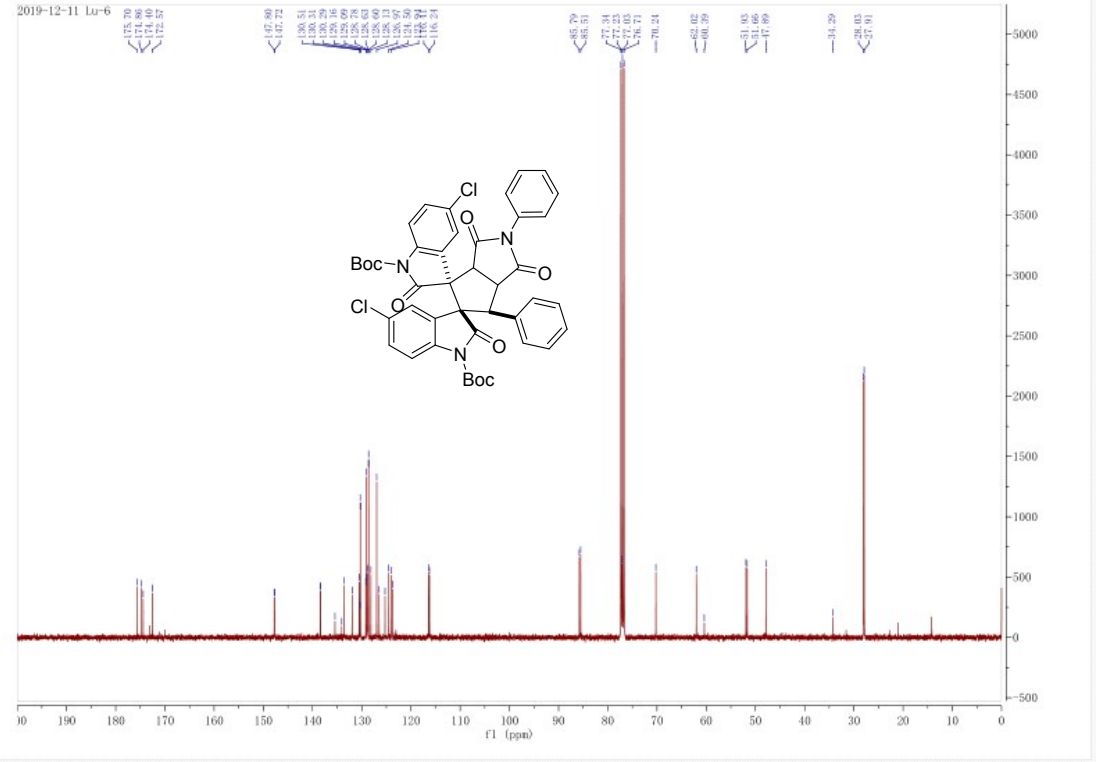
Compound 3aa



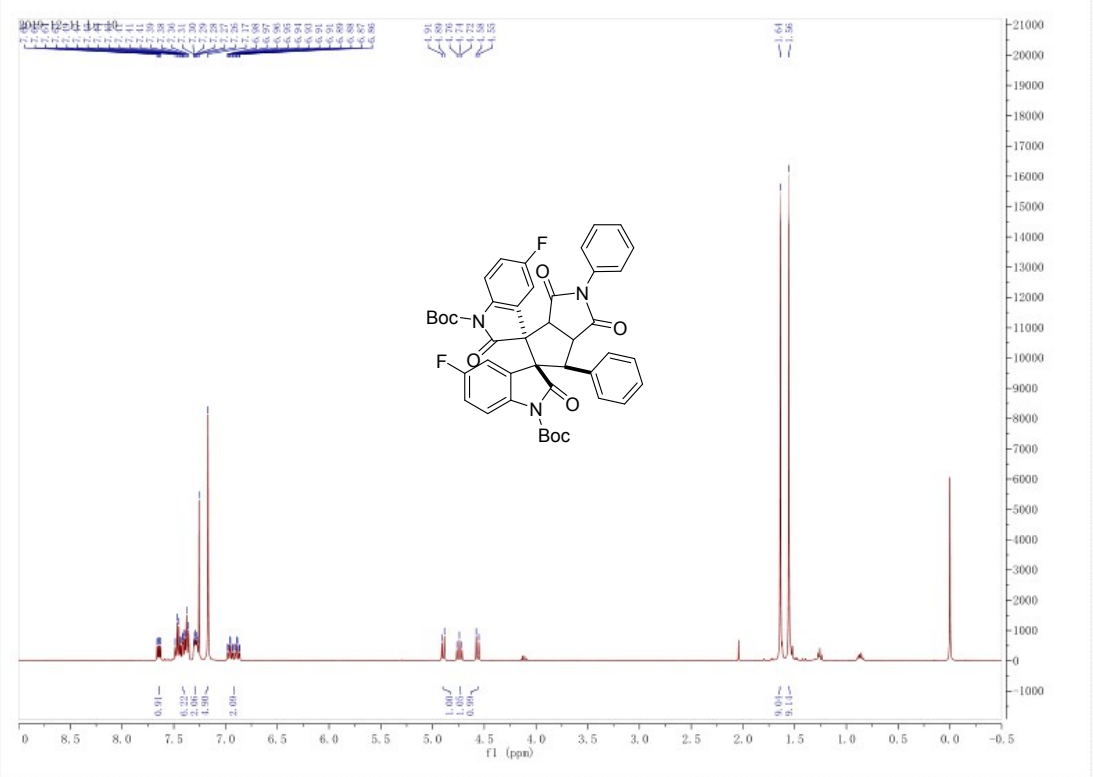


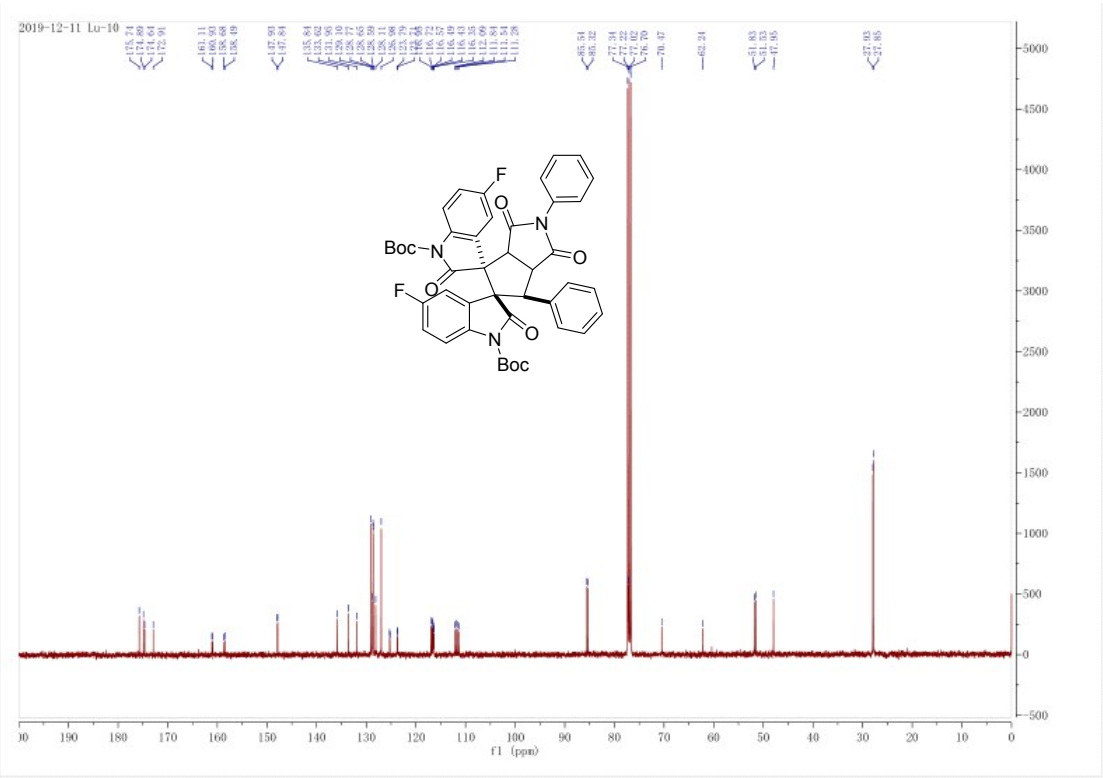
Compound 3ba



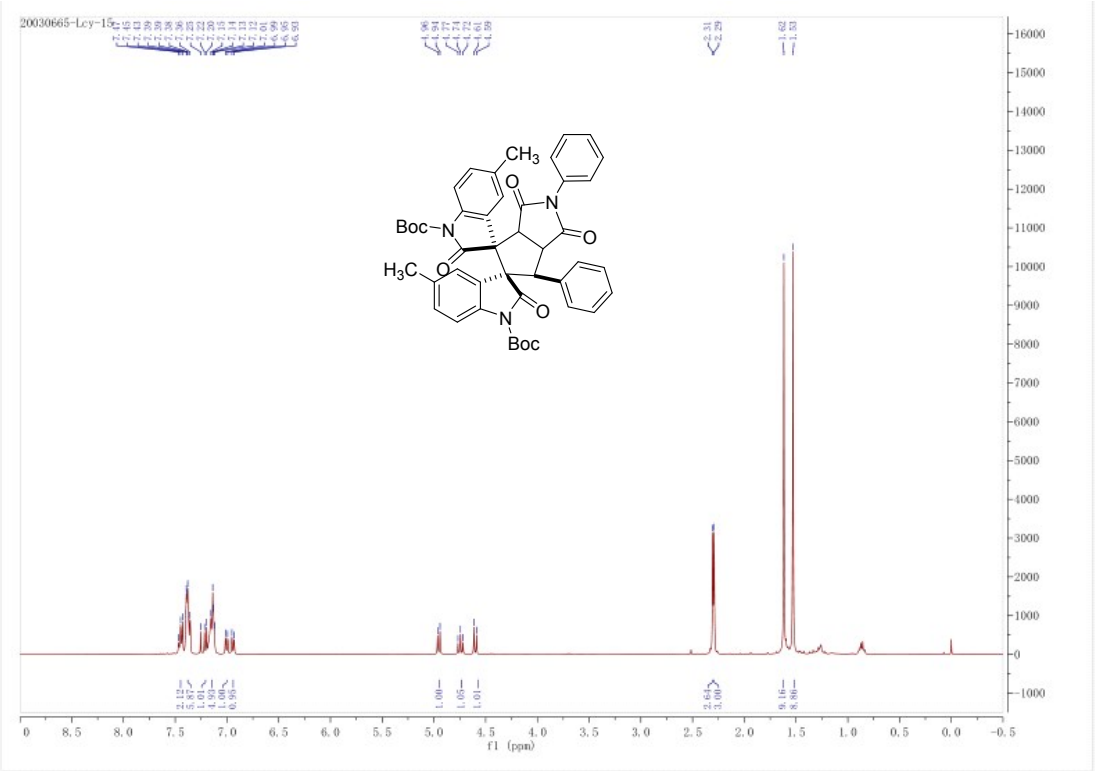


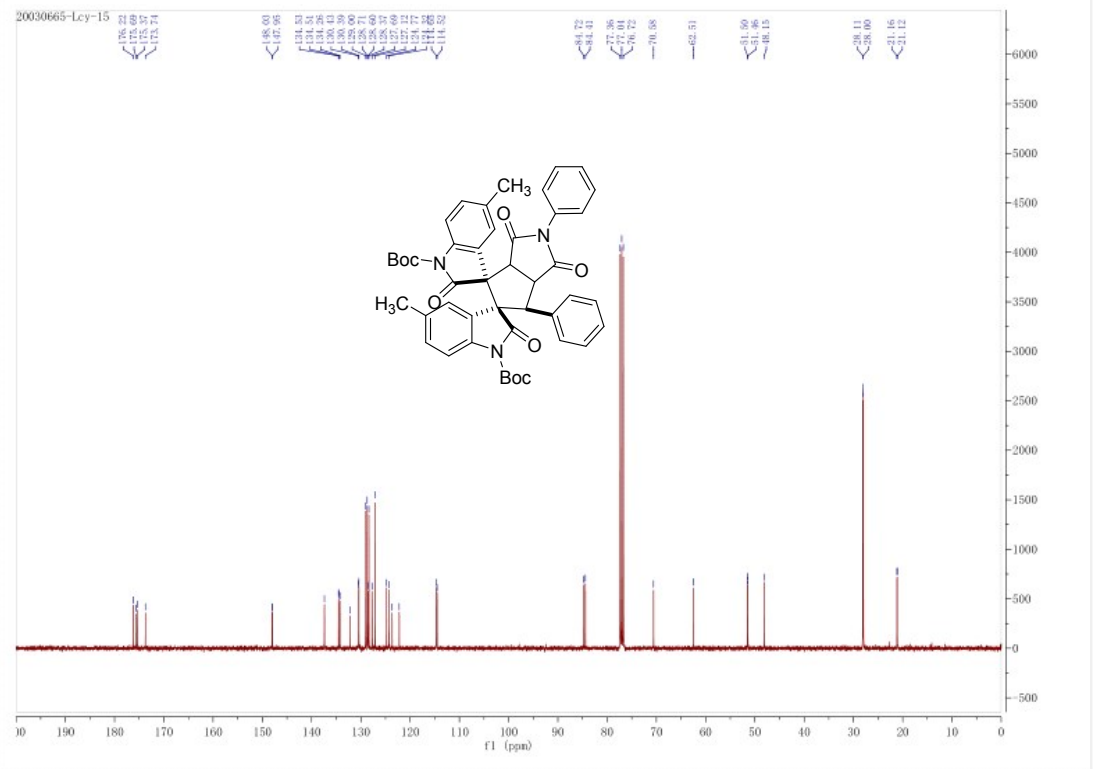
Compound 3ca



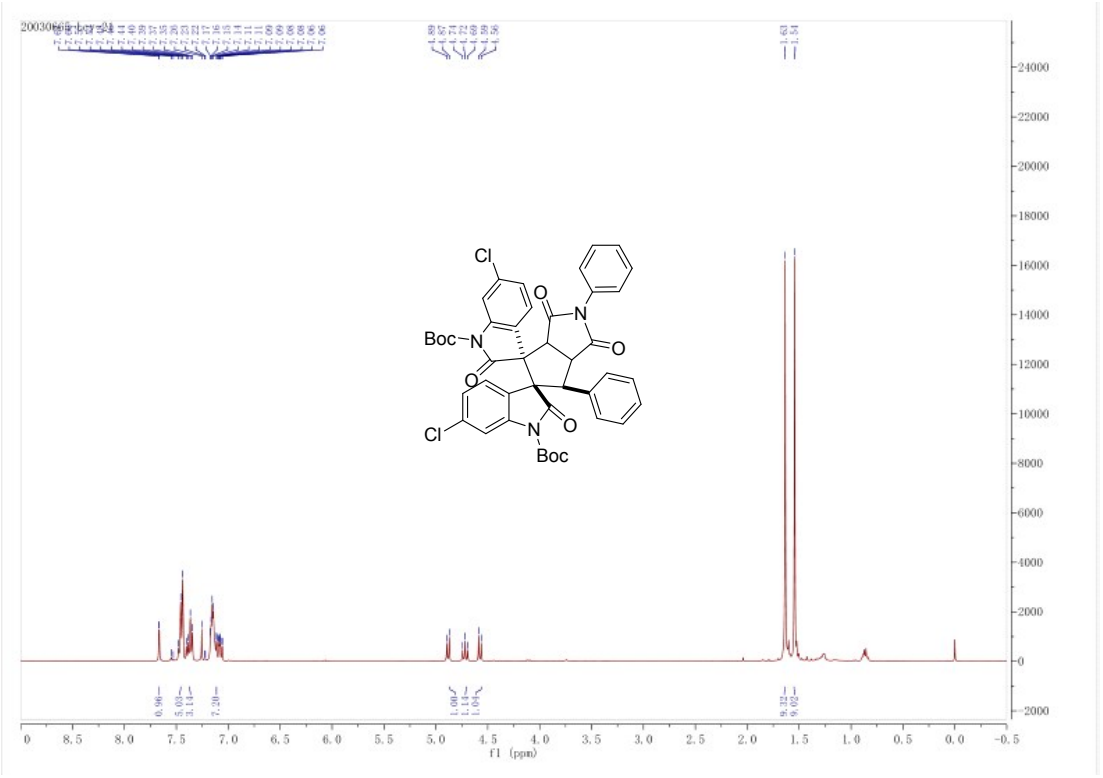


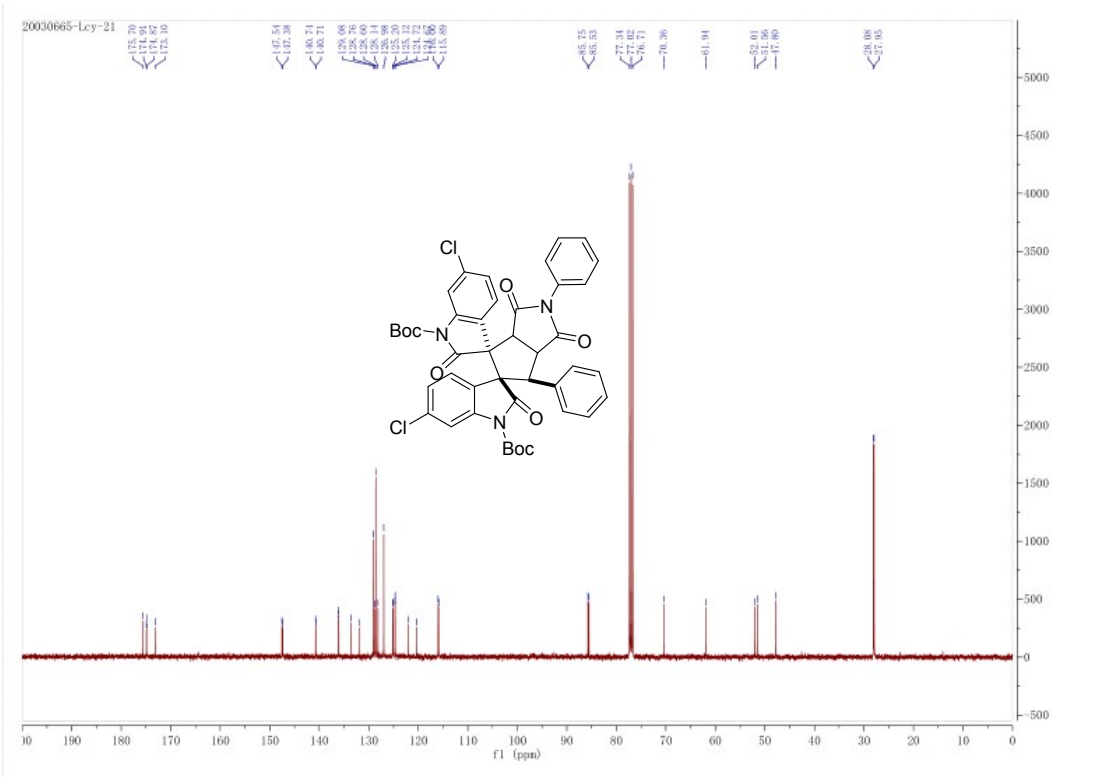
Compound 3da





Compound 3ea





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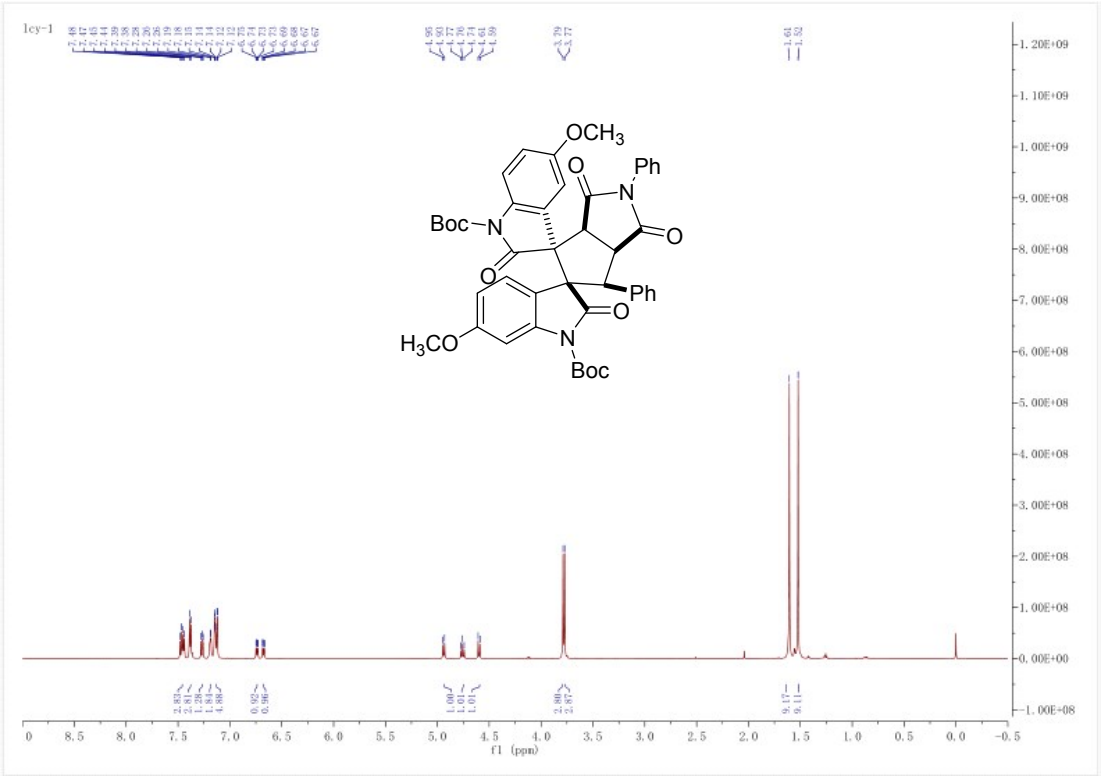
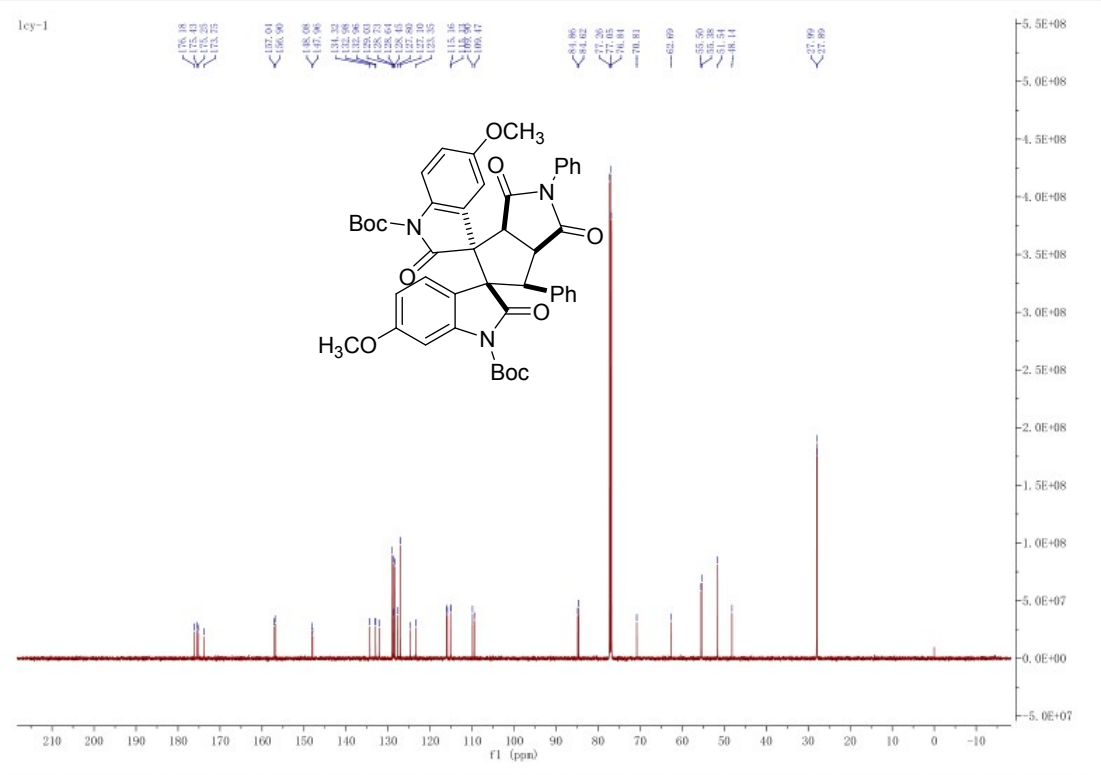
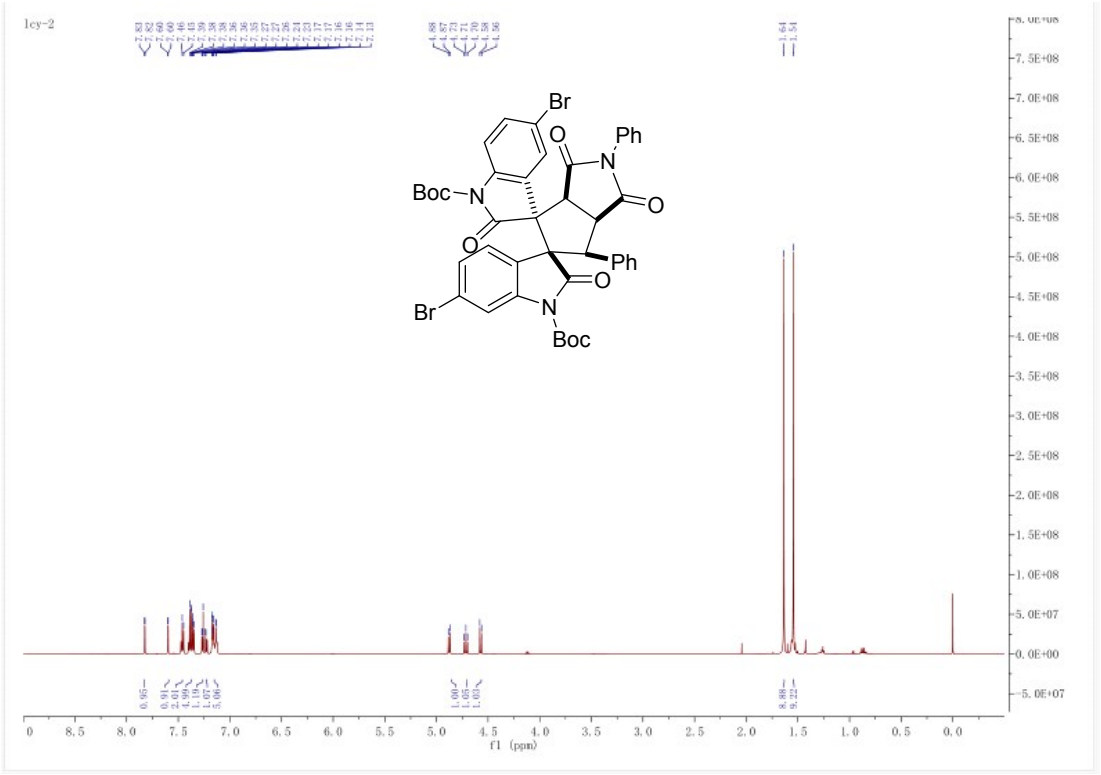
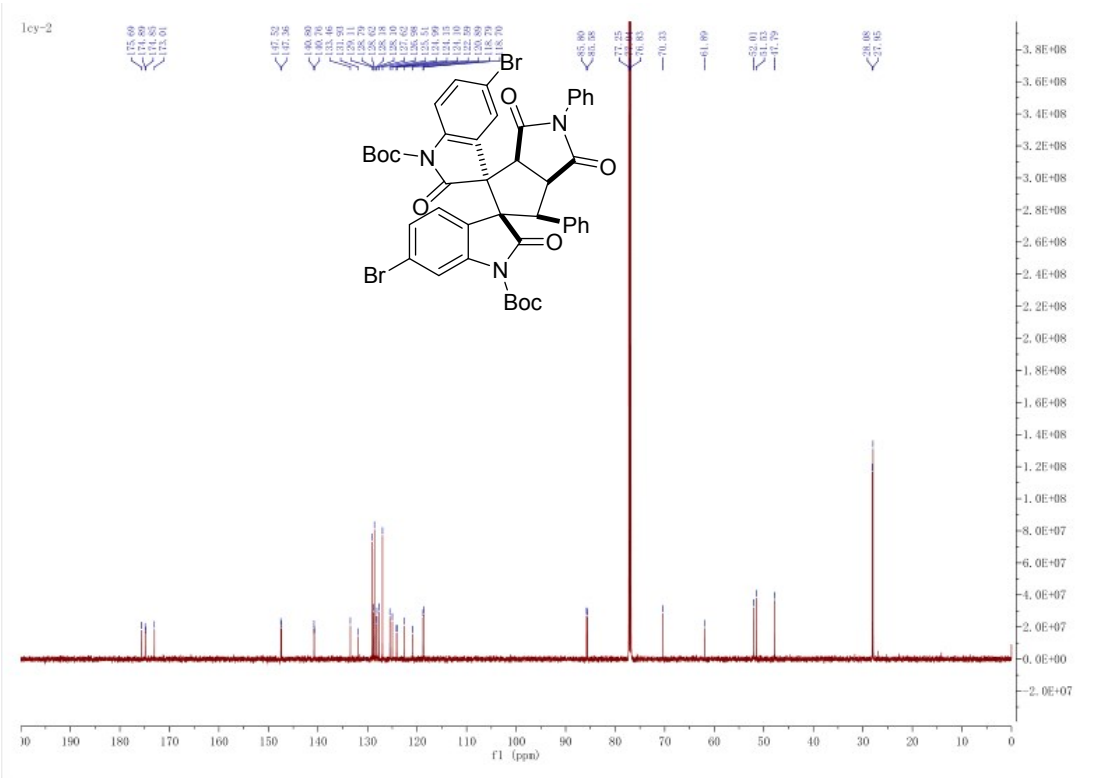


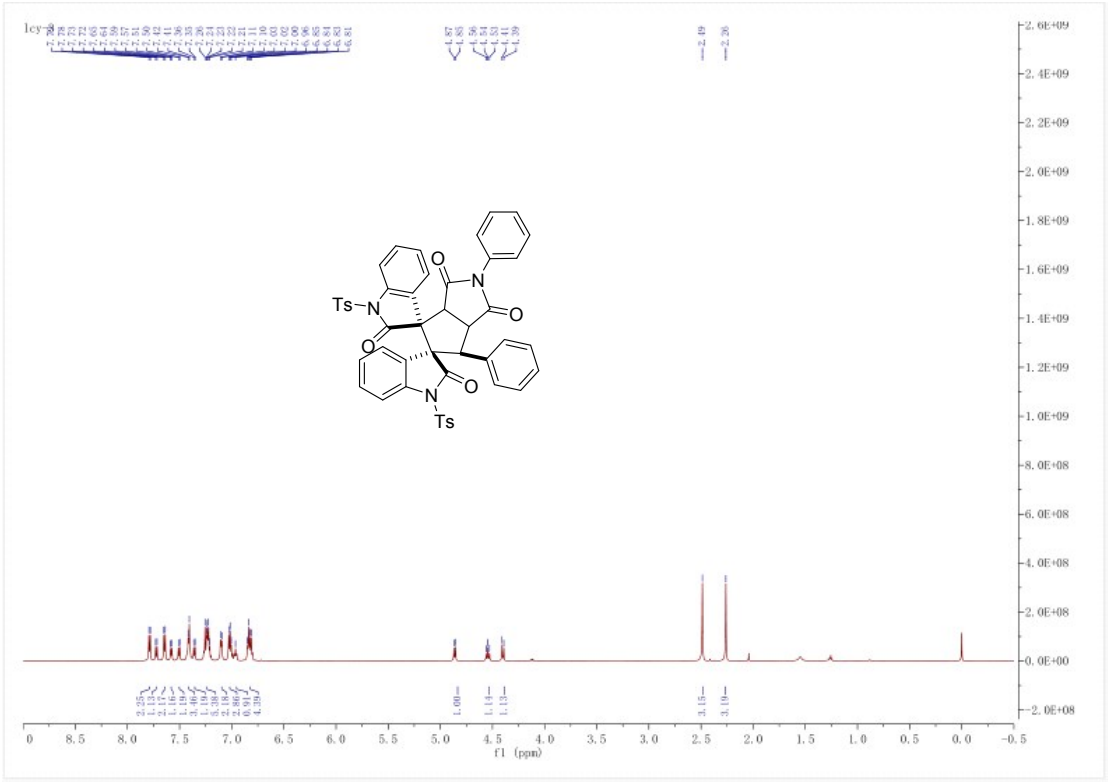


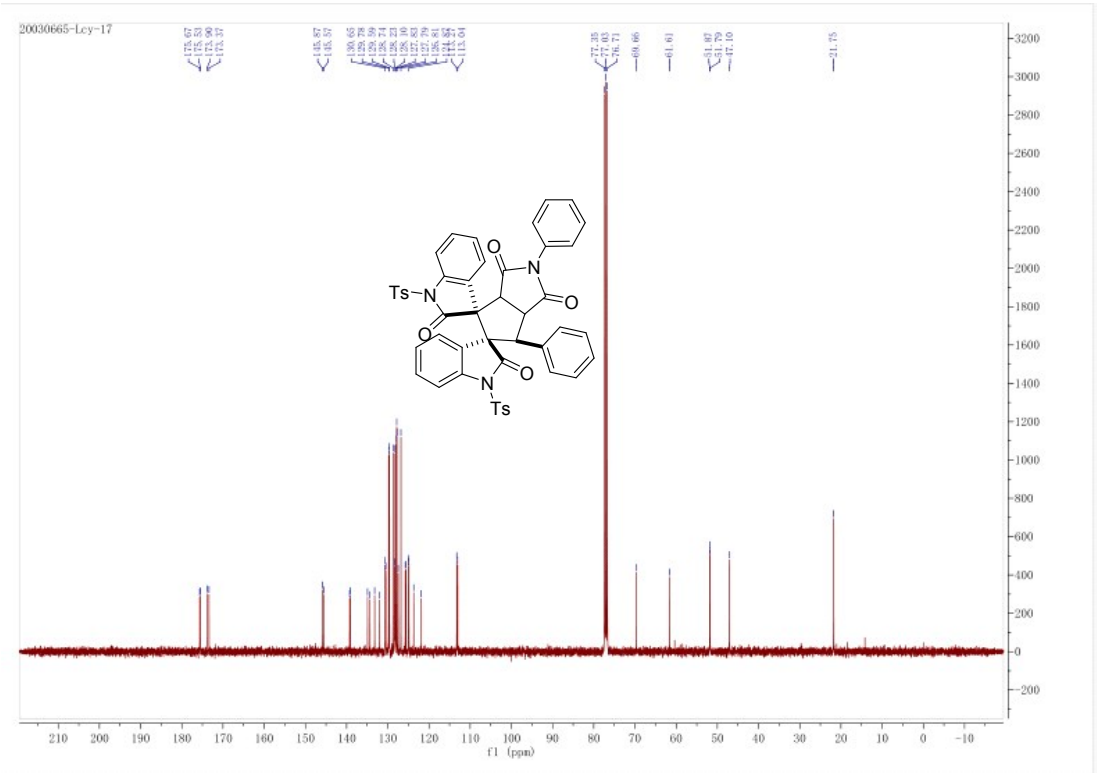
Compound 3ga



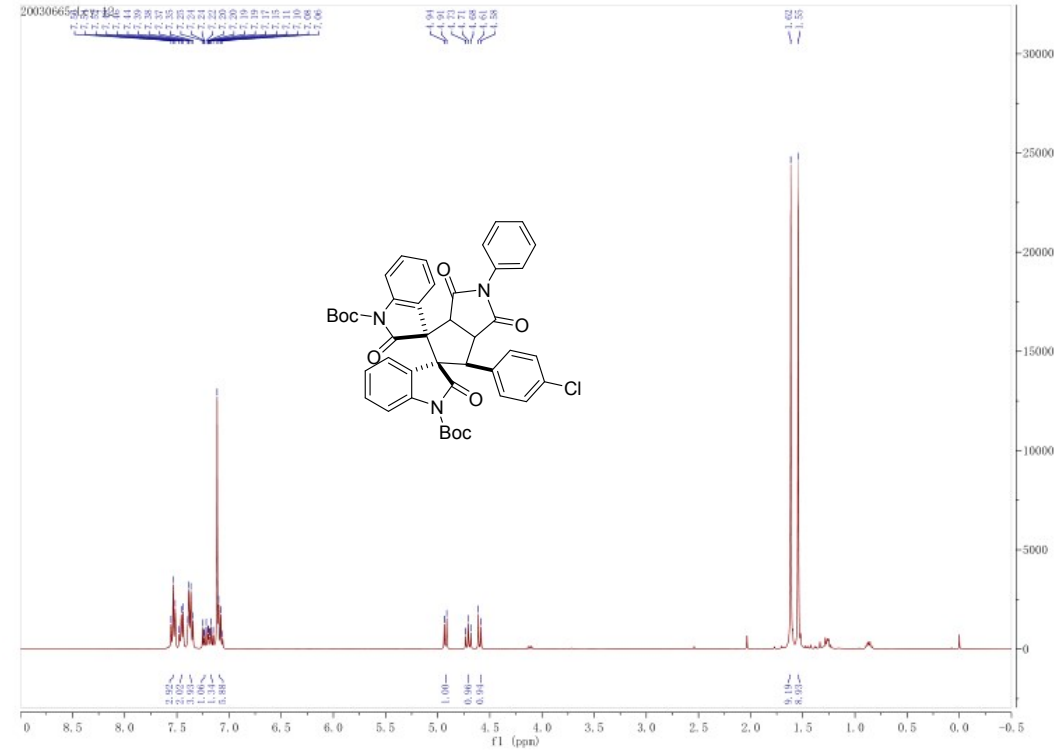


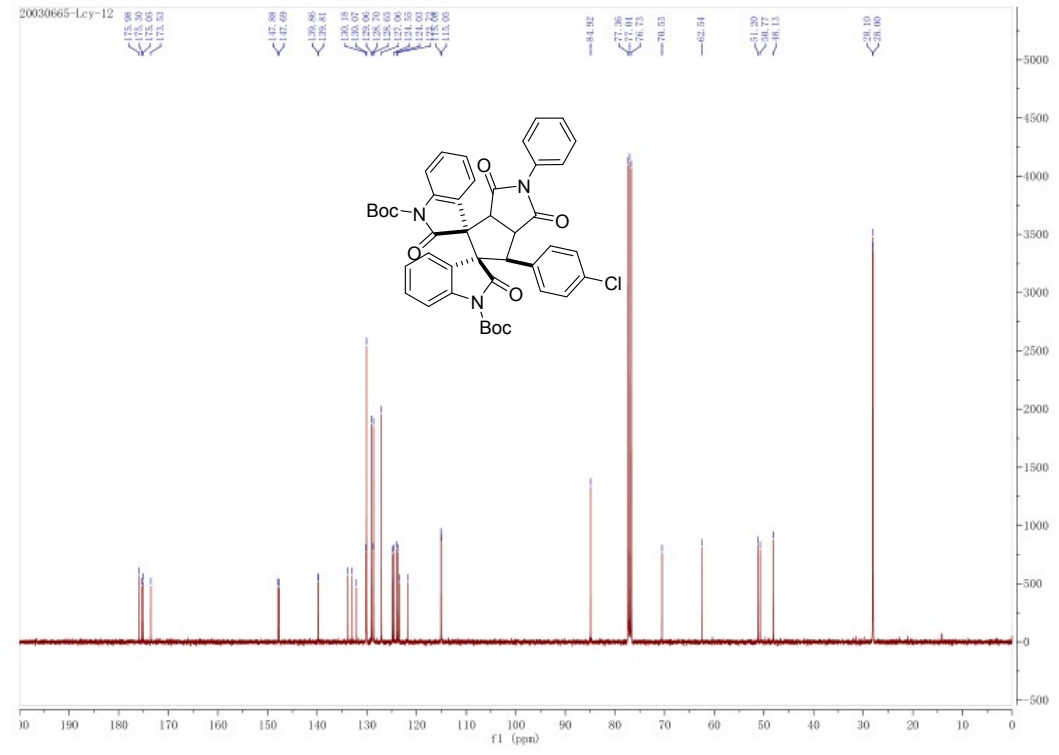
Compound 3ha





Compound 3ab





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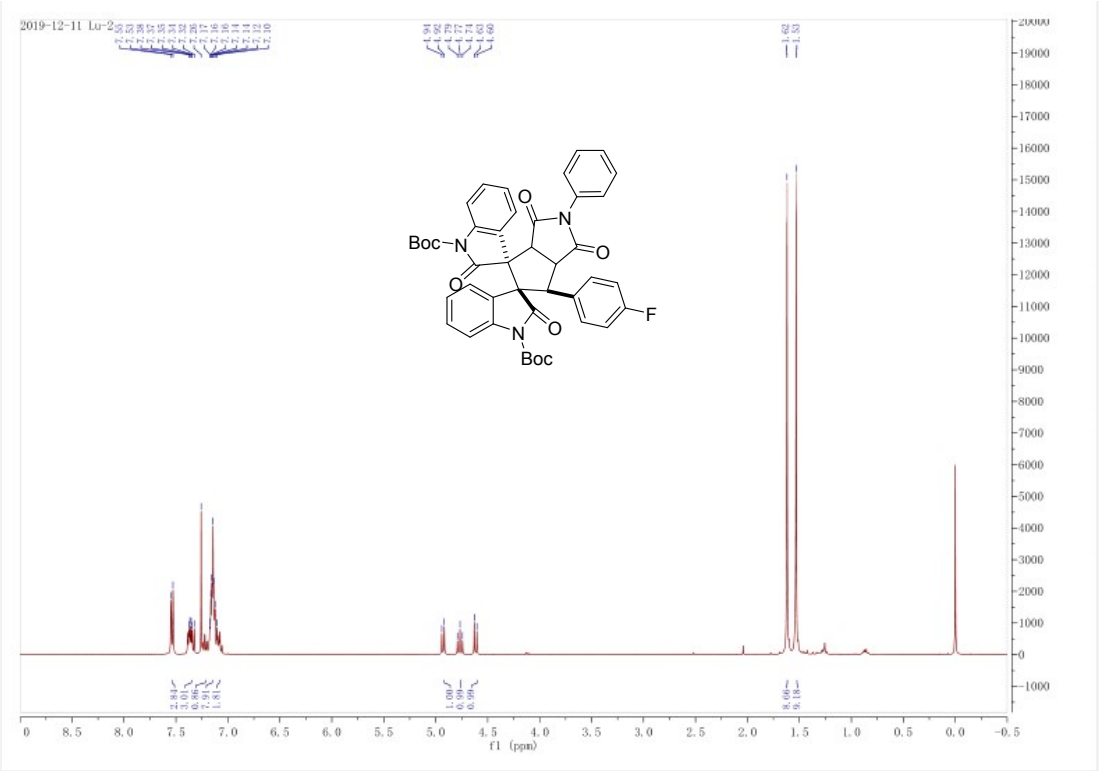

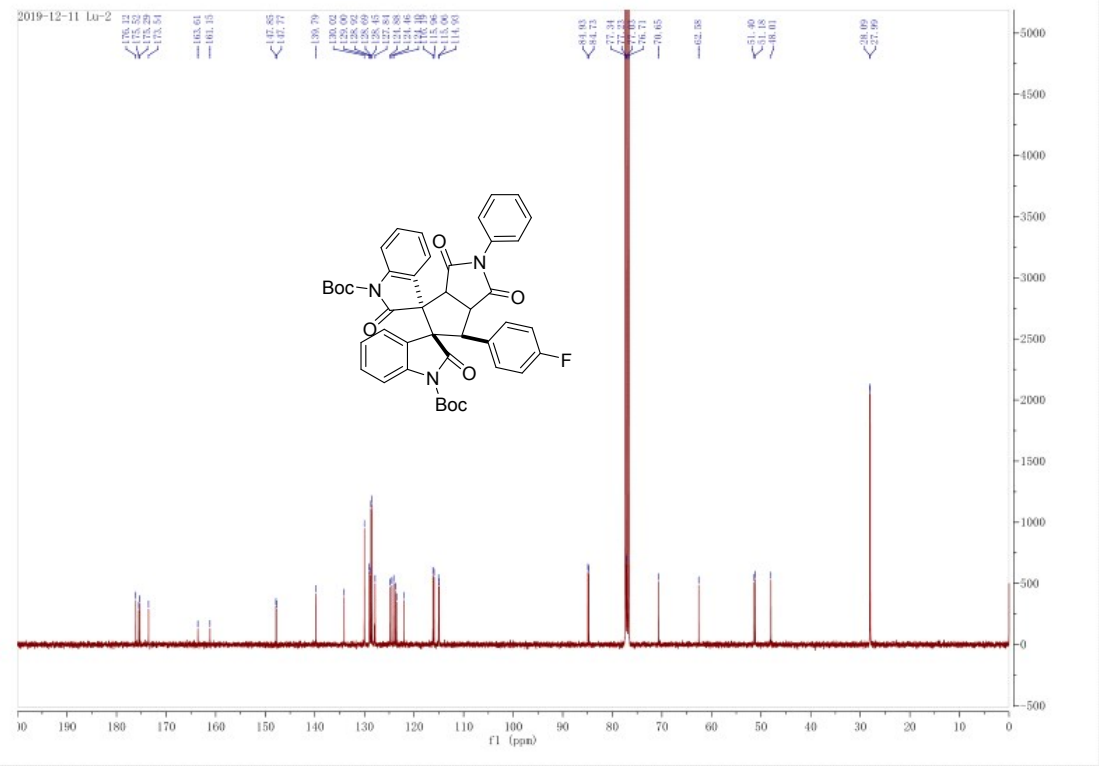

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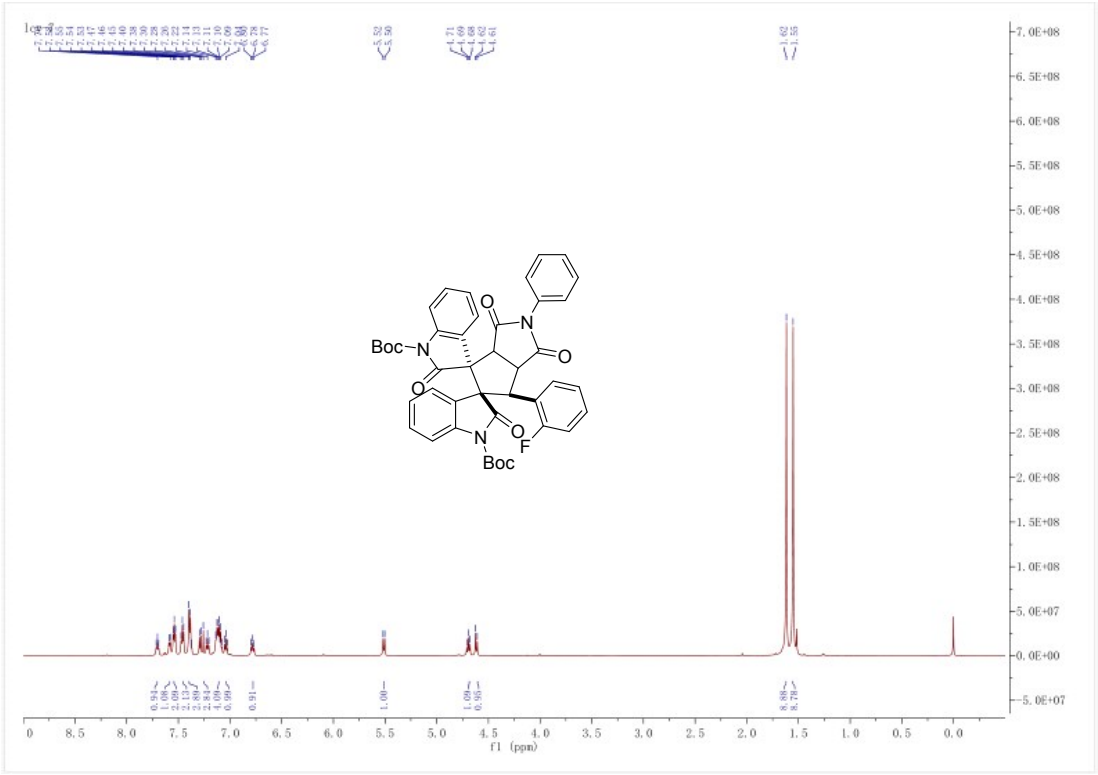
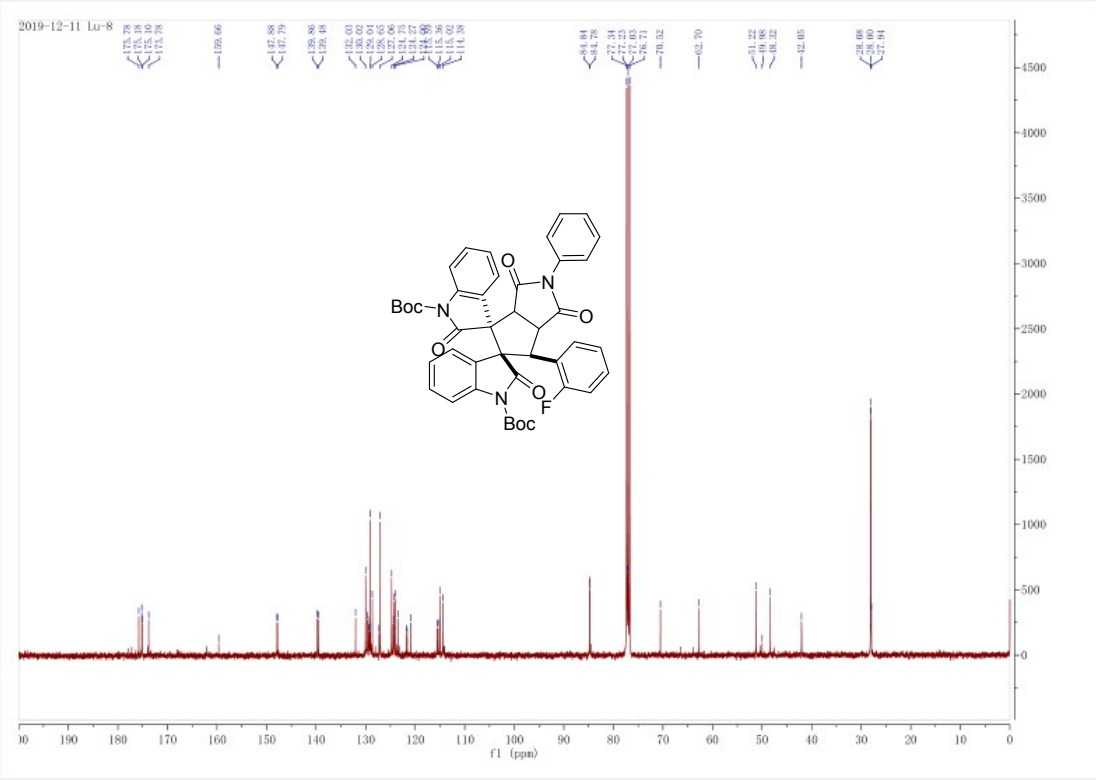
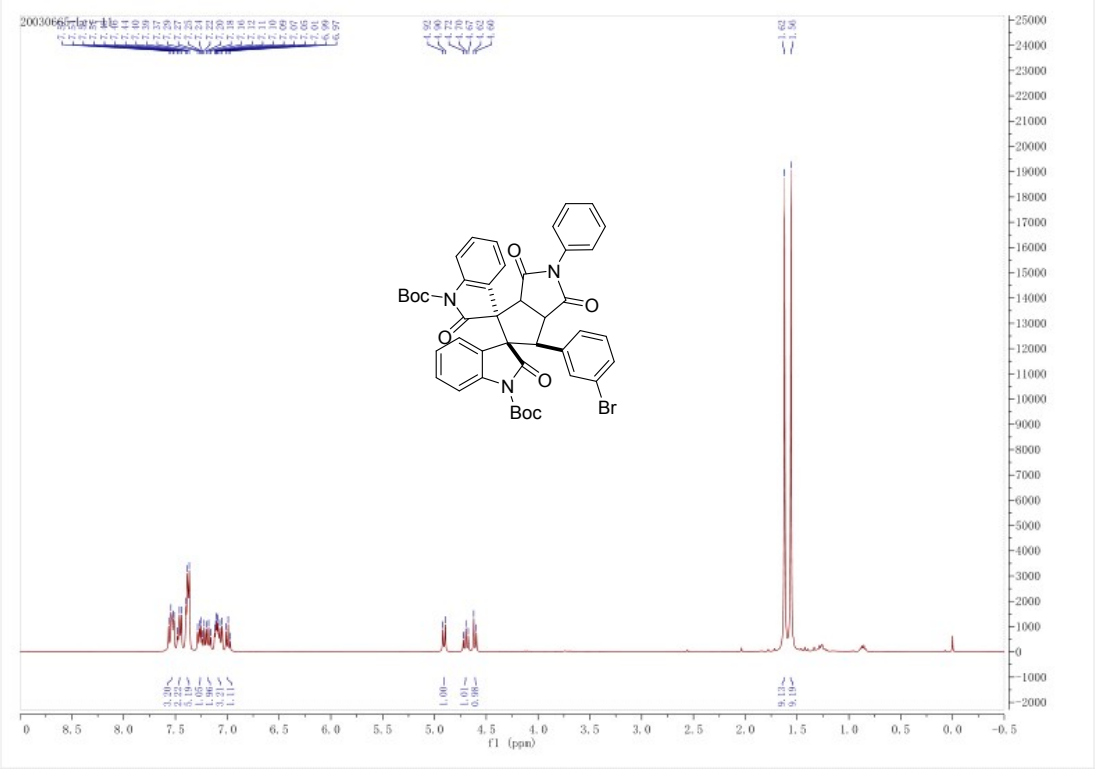
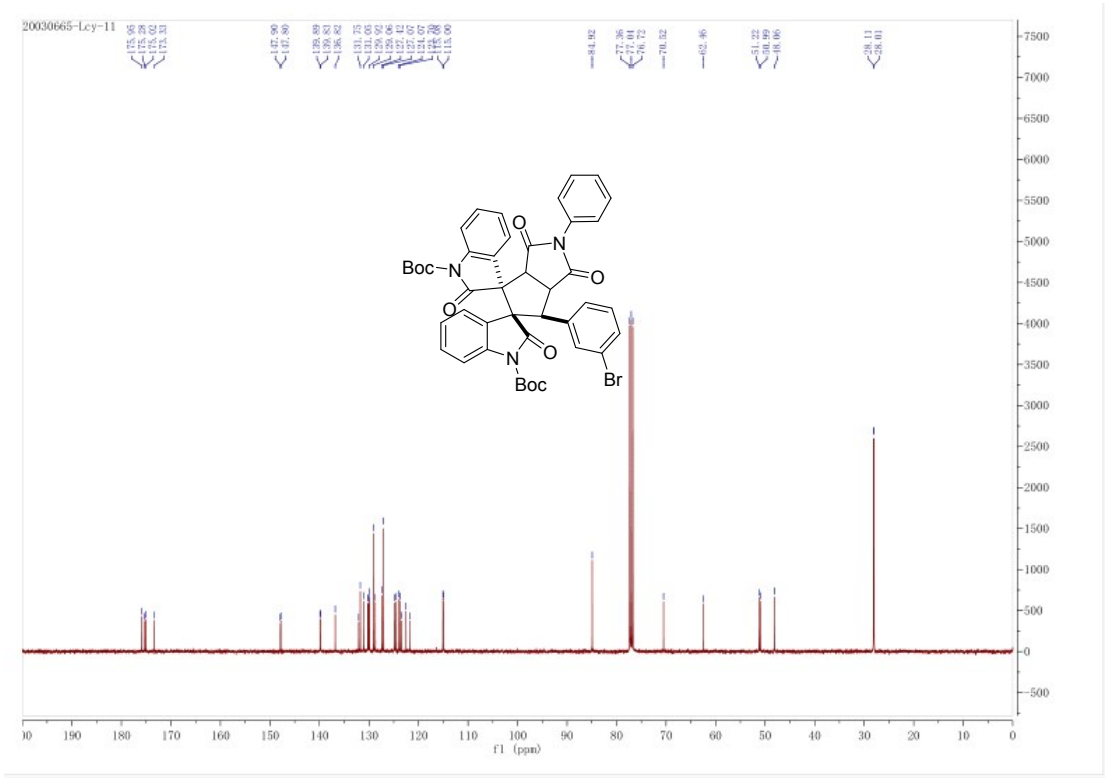




Compound 3ae





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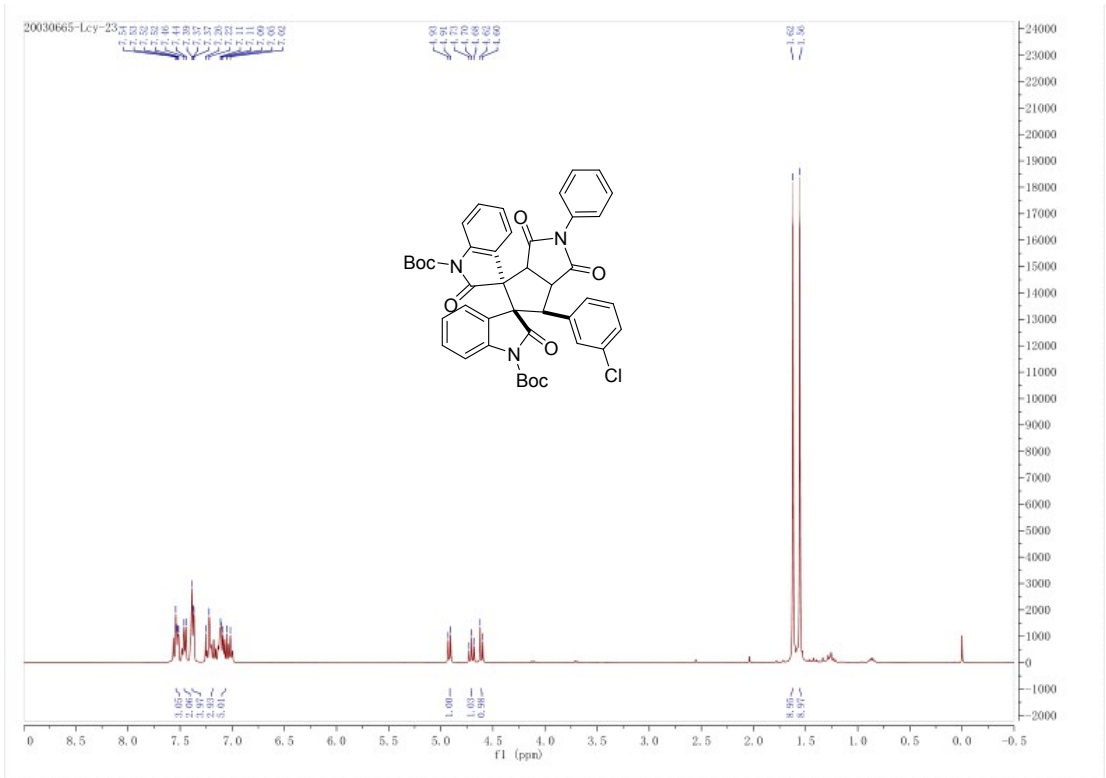
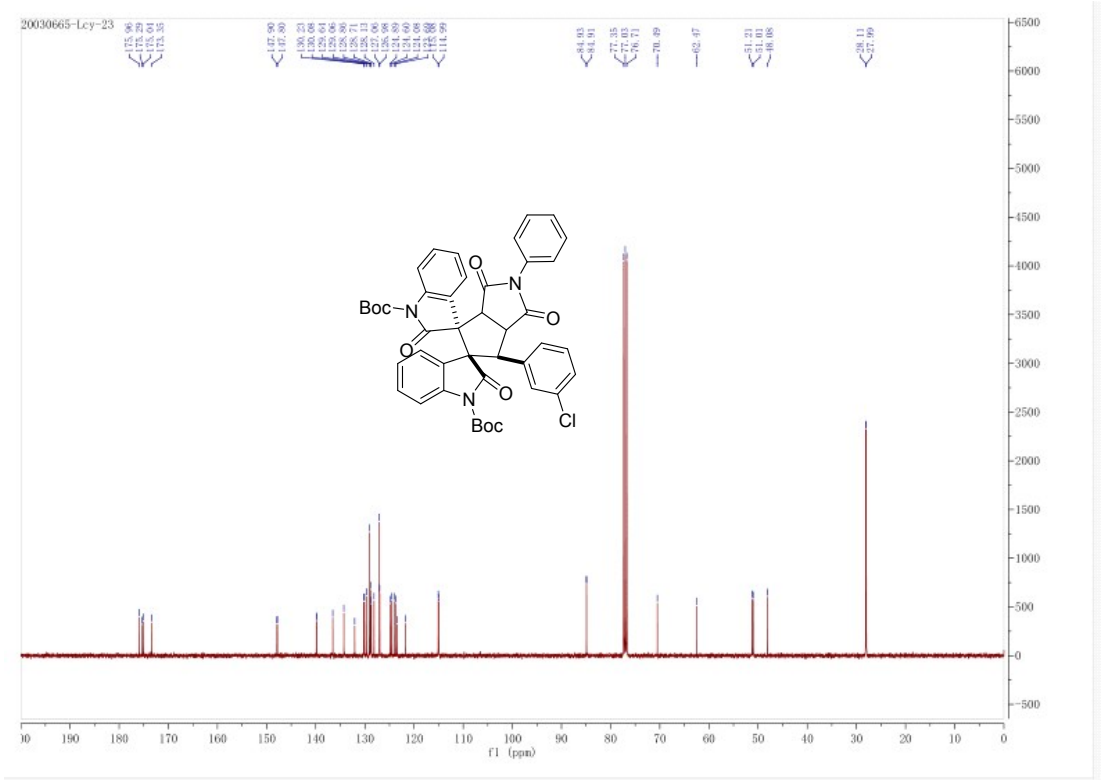
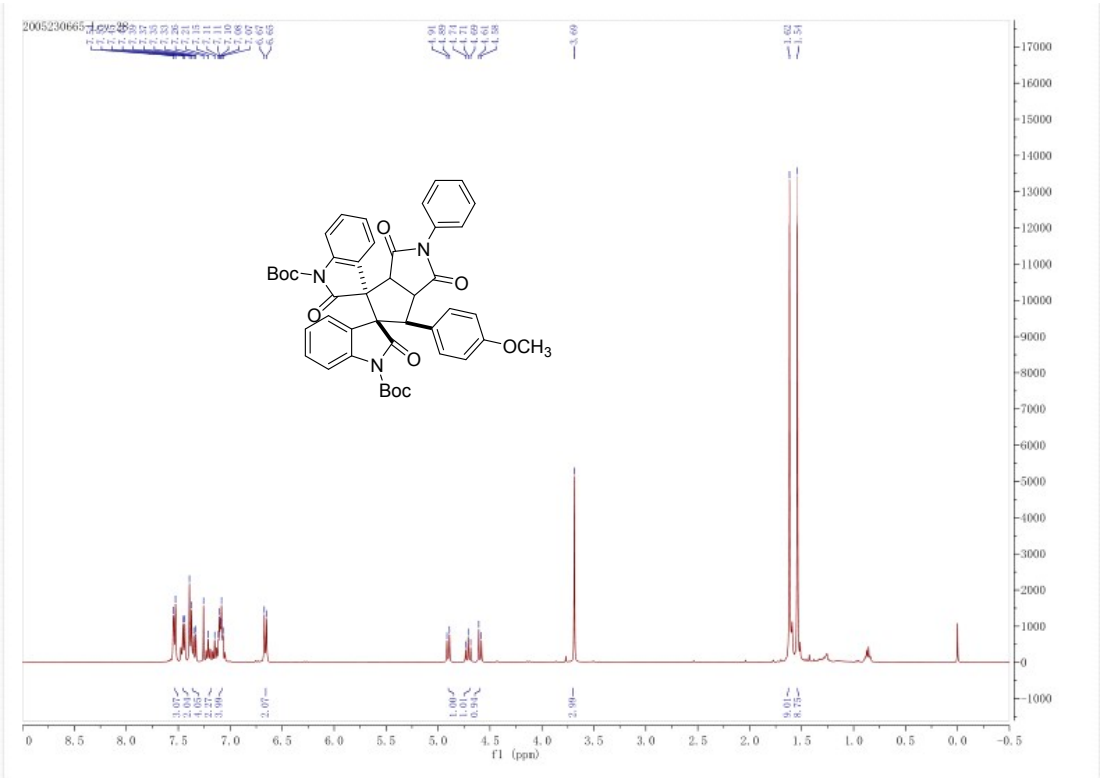
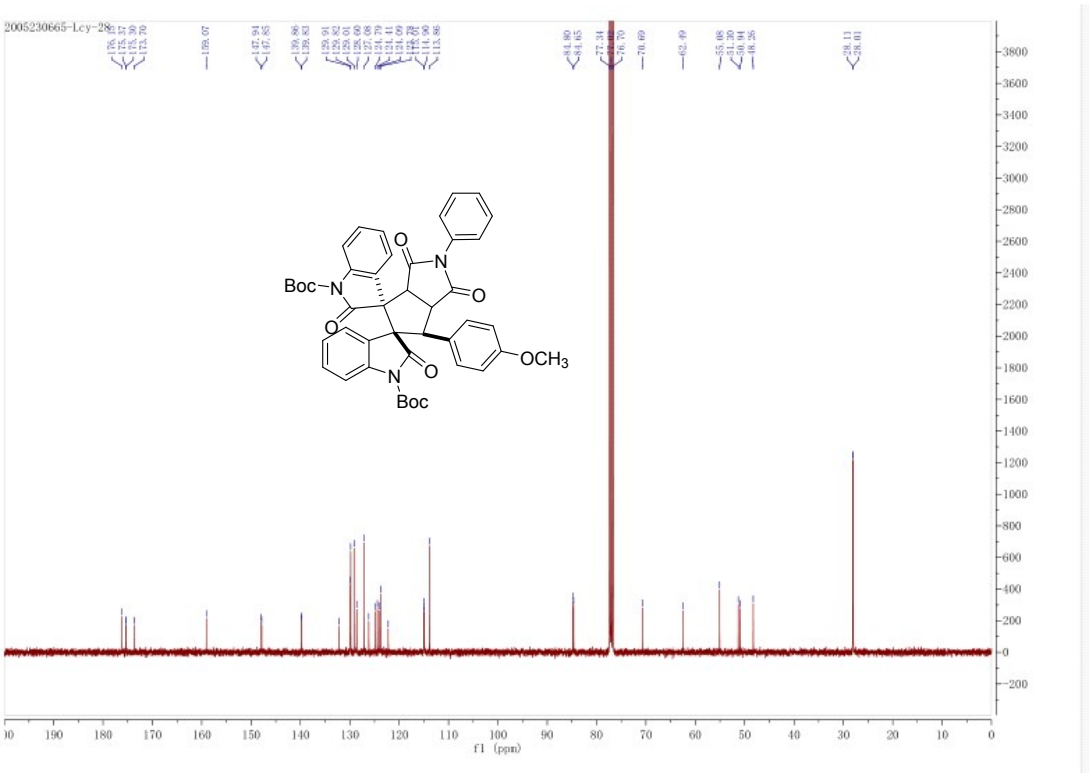


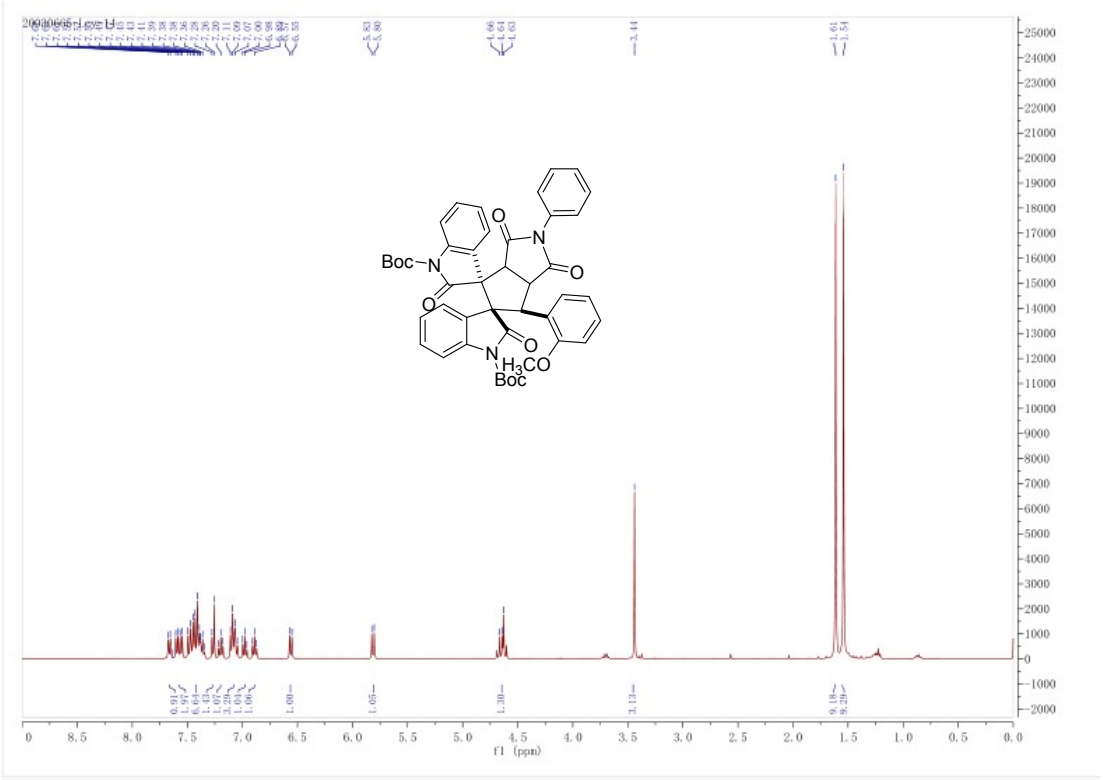


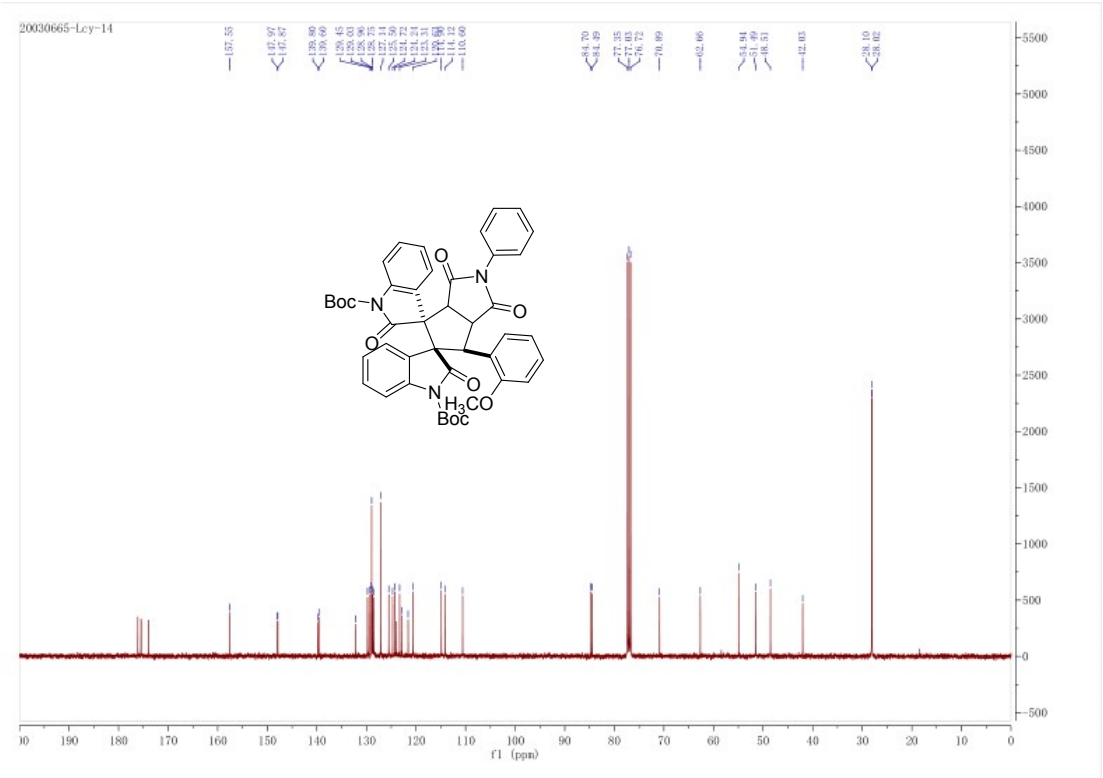
Compound 3ag



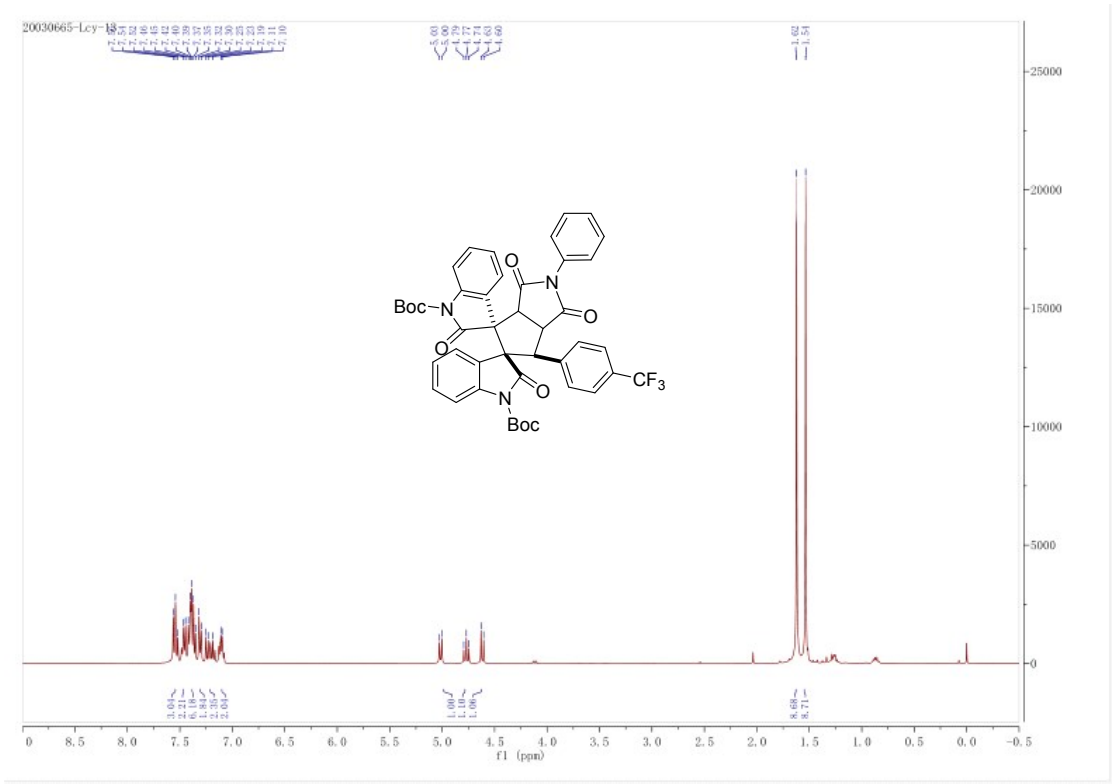


Compound 3ah





Compound 3ai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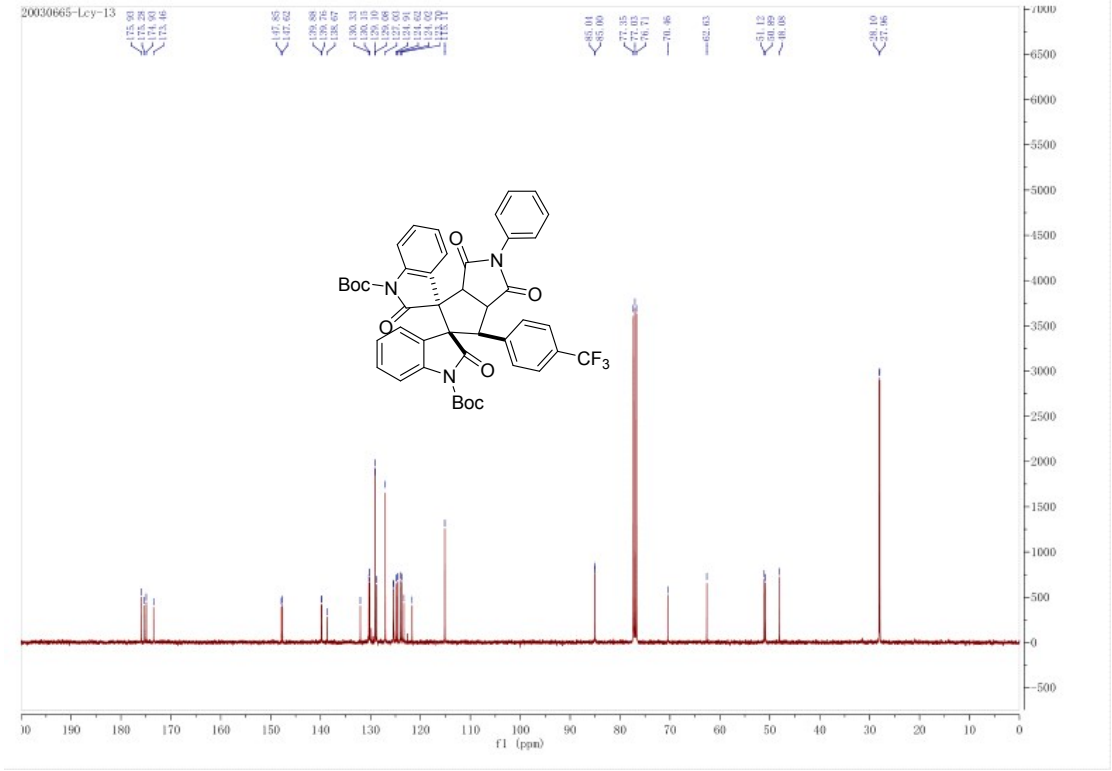
Boc
CF3
f1 (ppm)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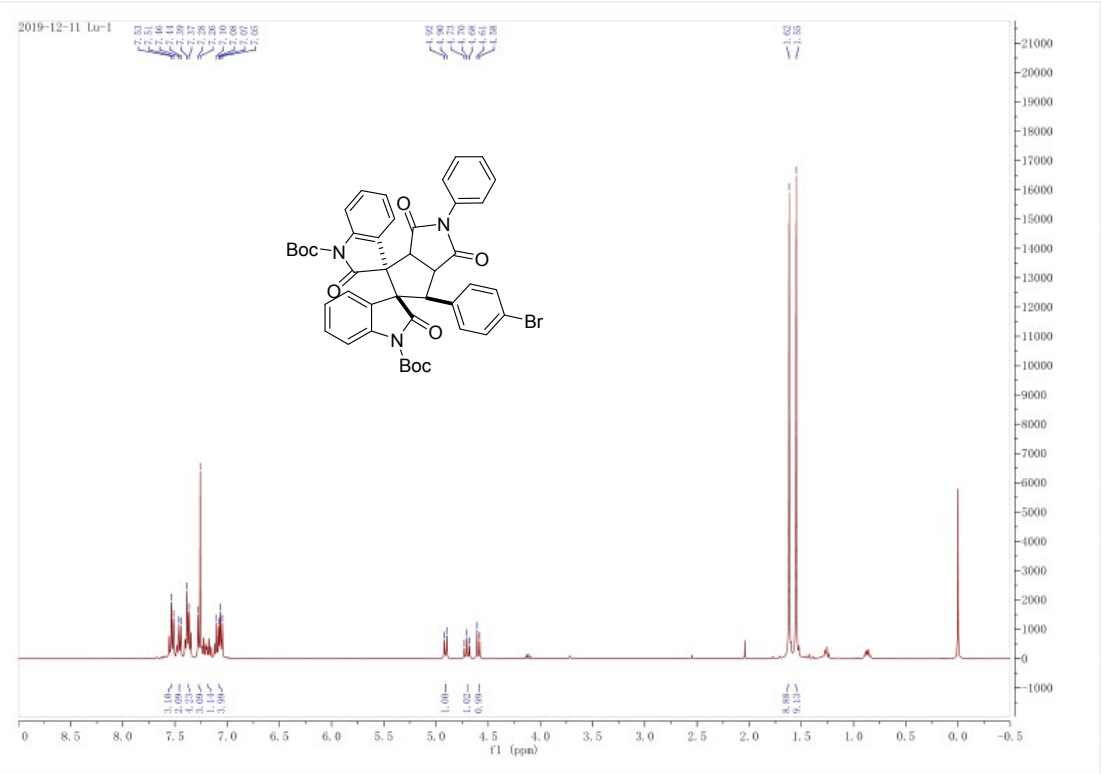
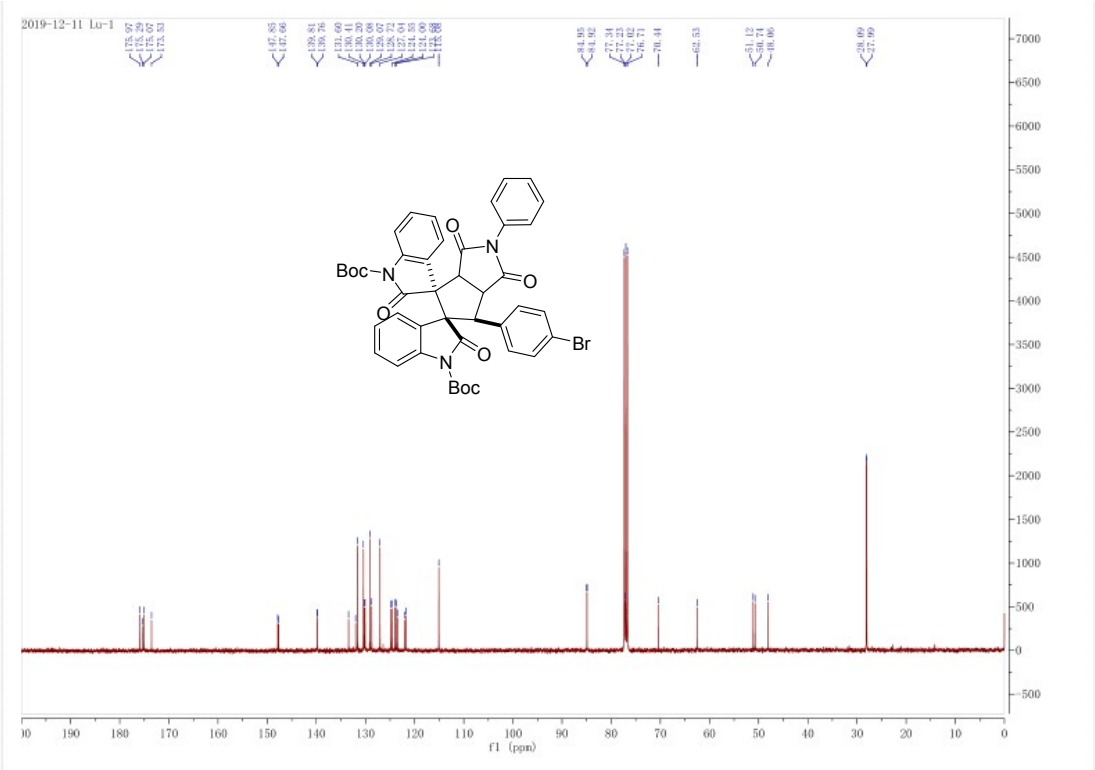
Boc
CF3
f1 (ppm)

Compound 3aj





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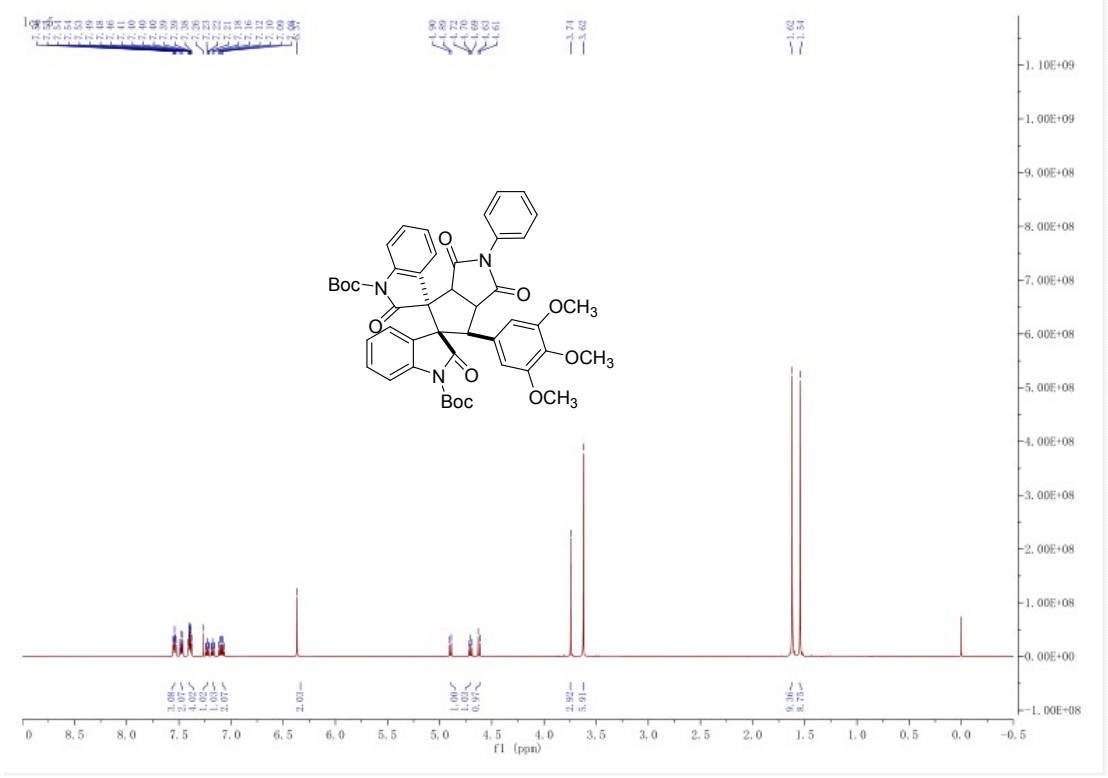

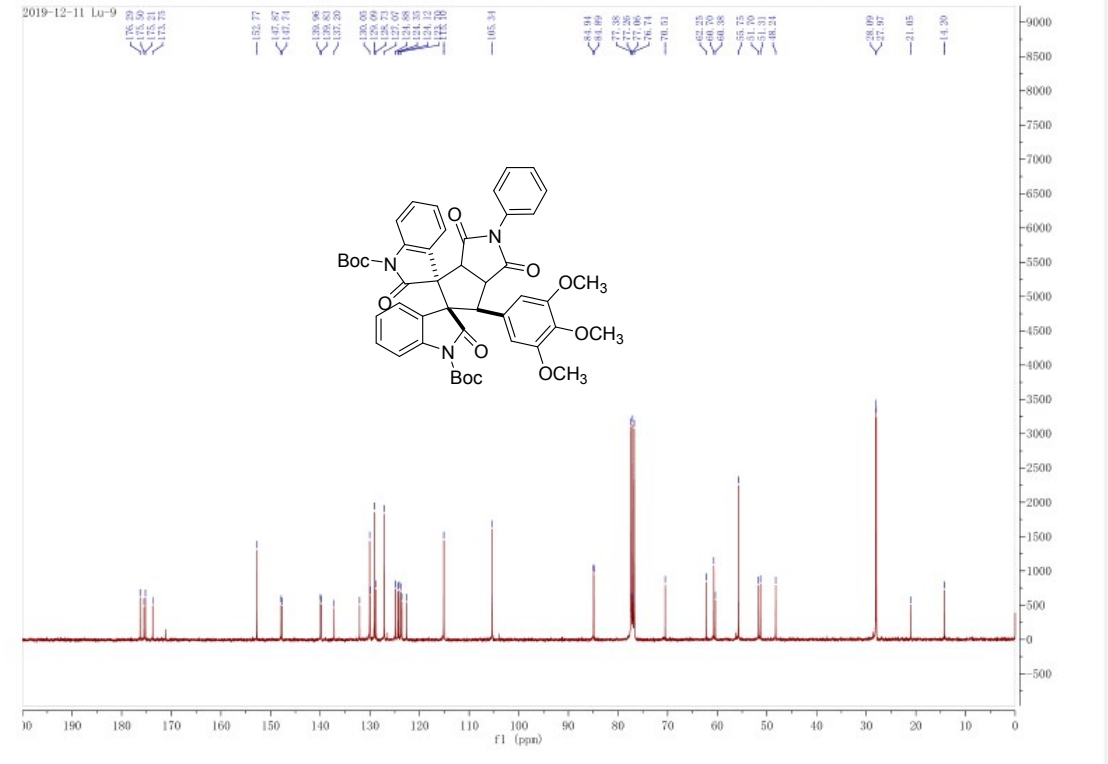

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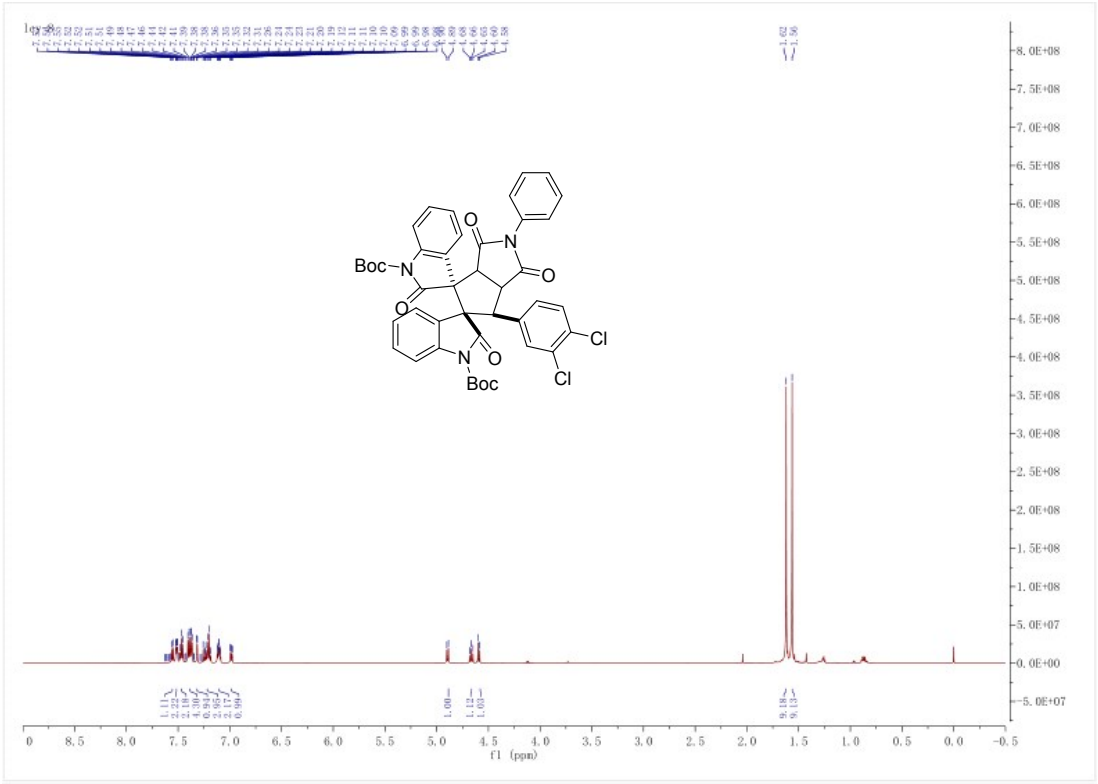

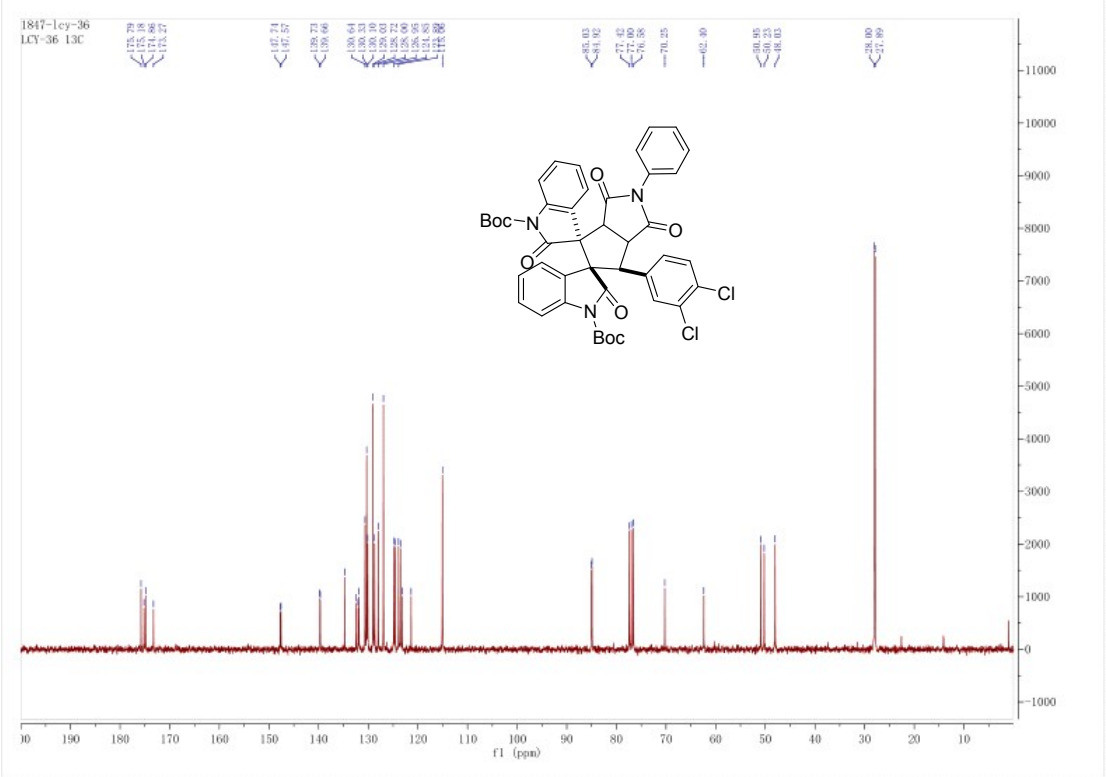

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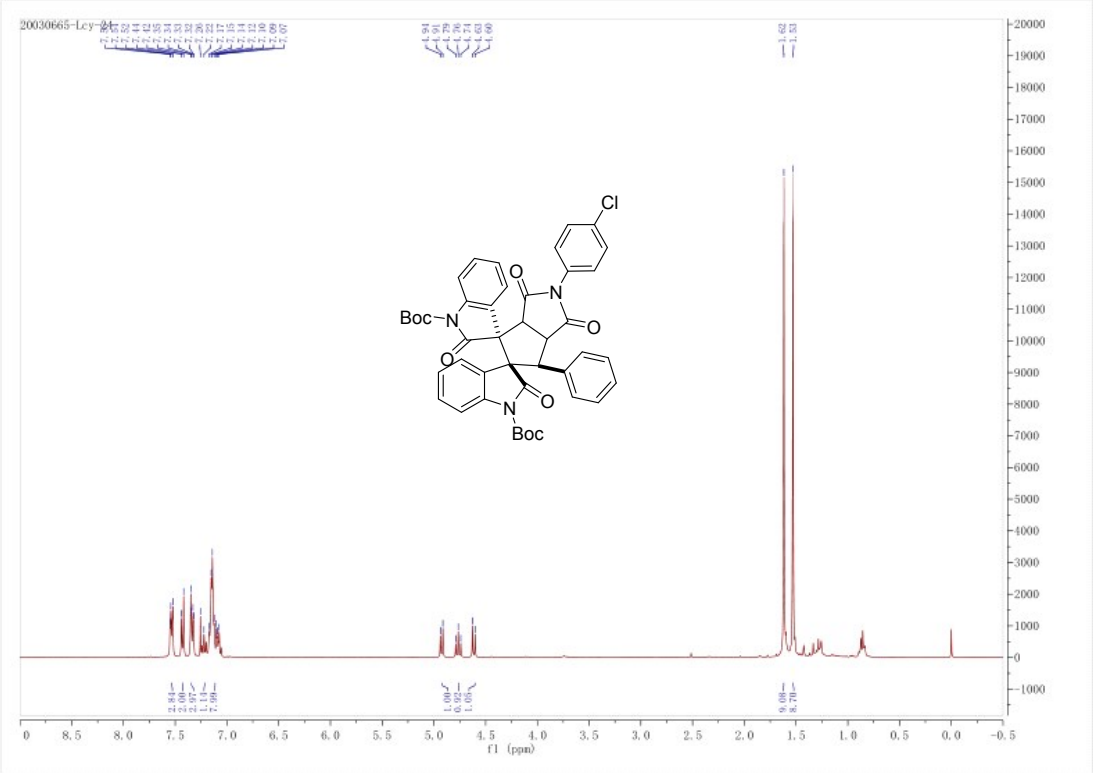

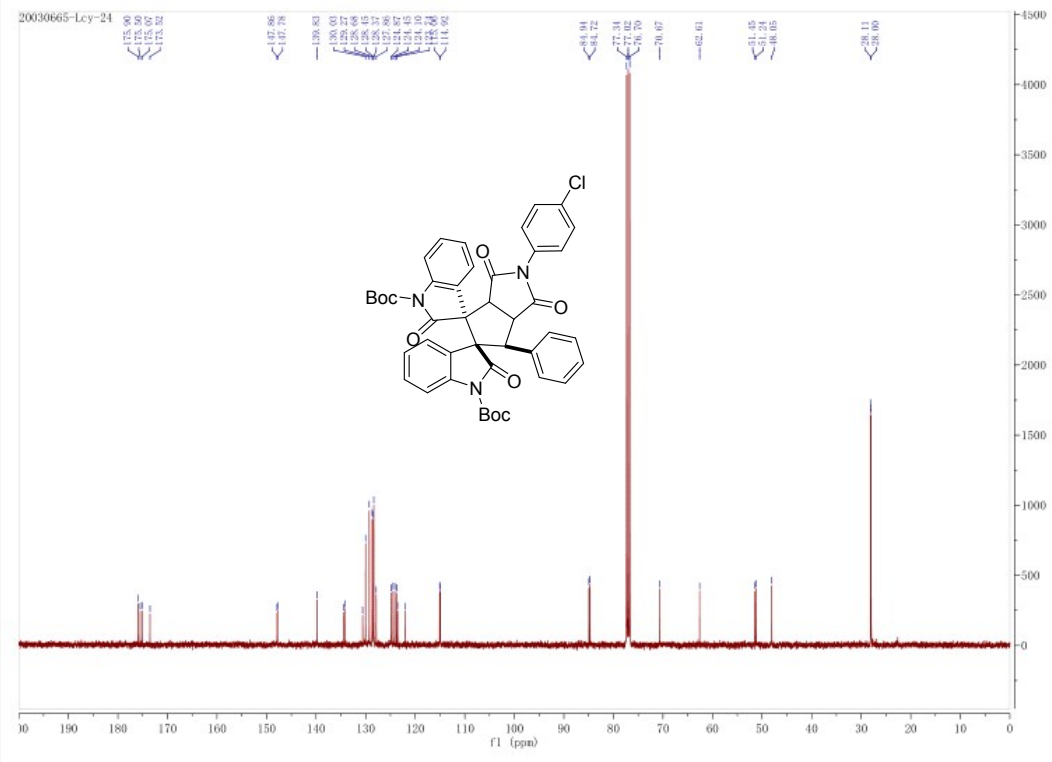

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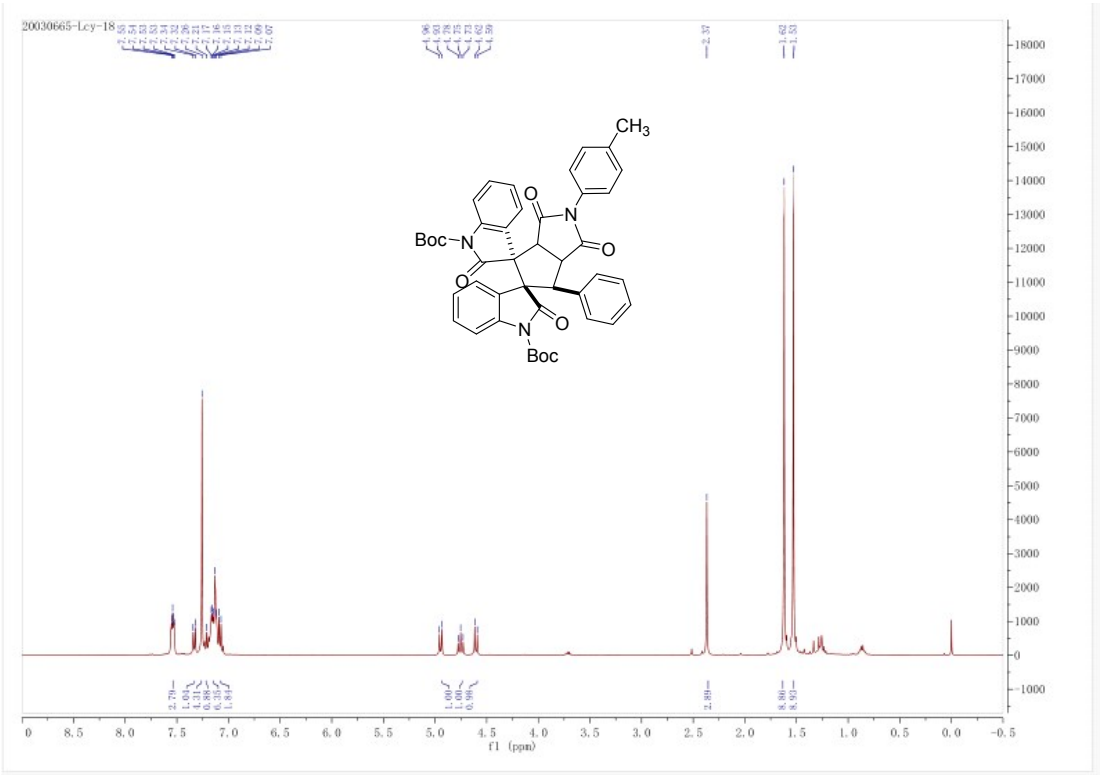

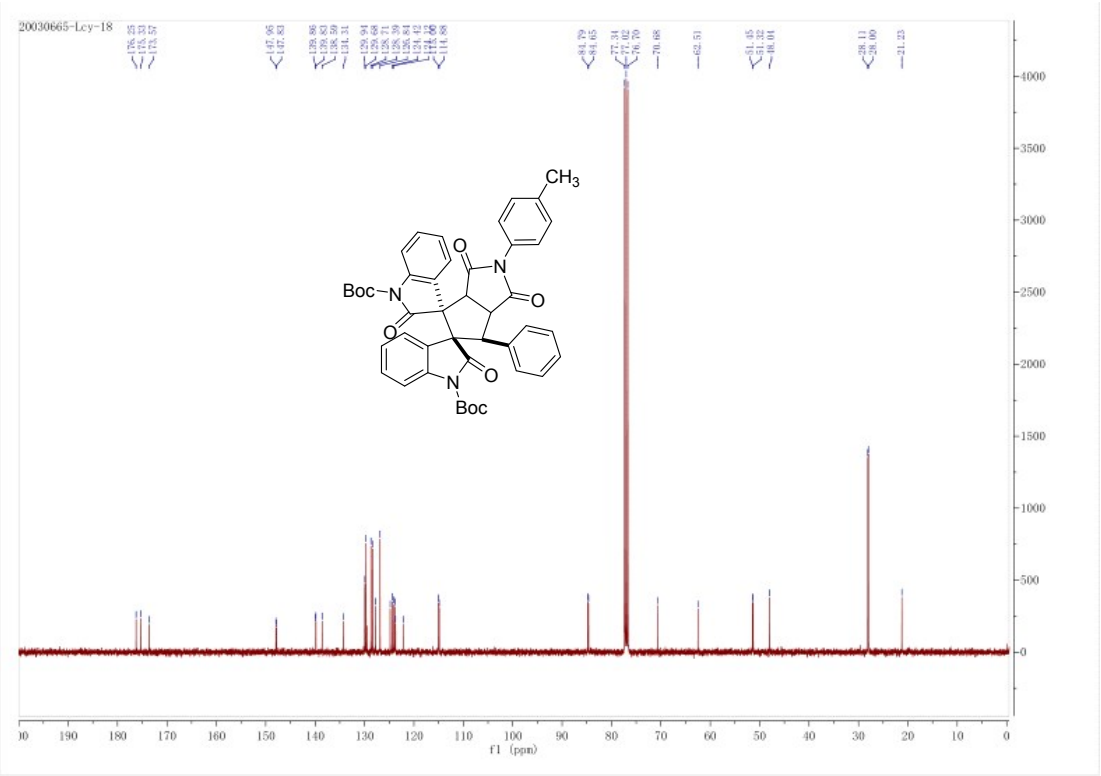

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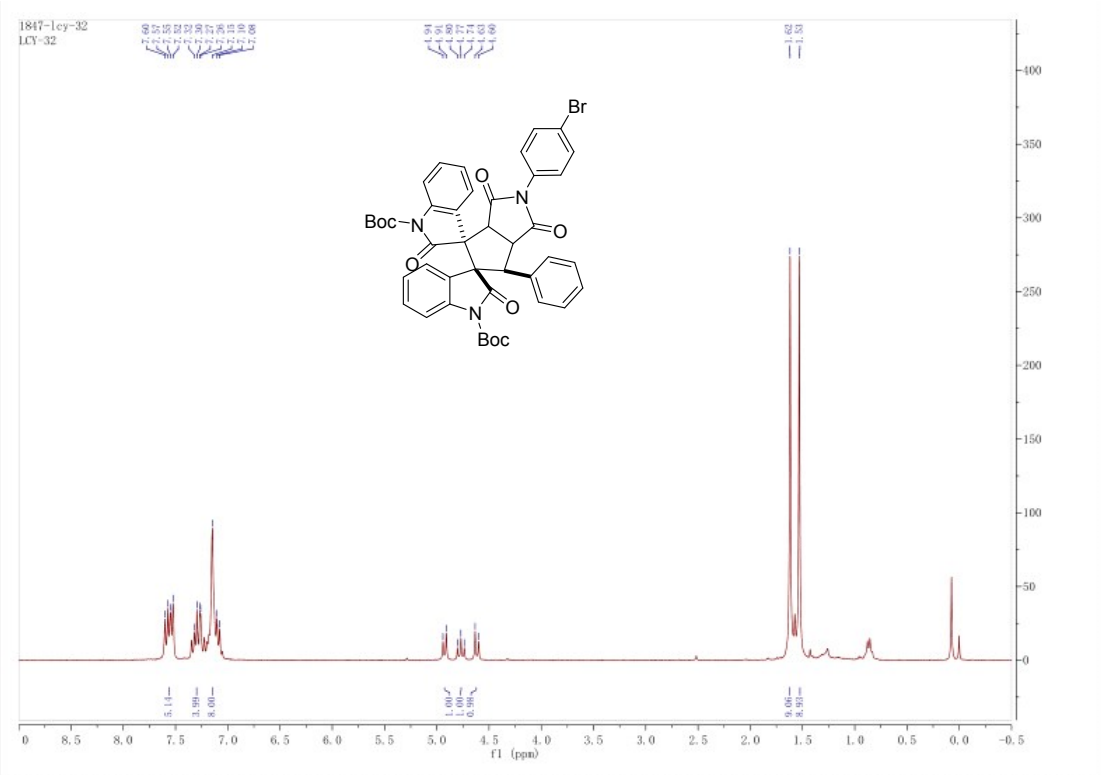
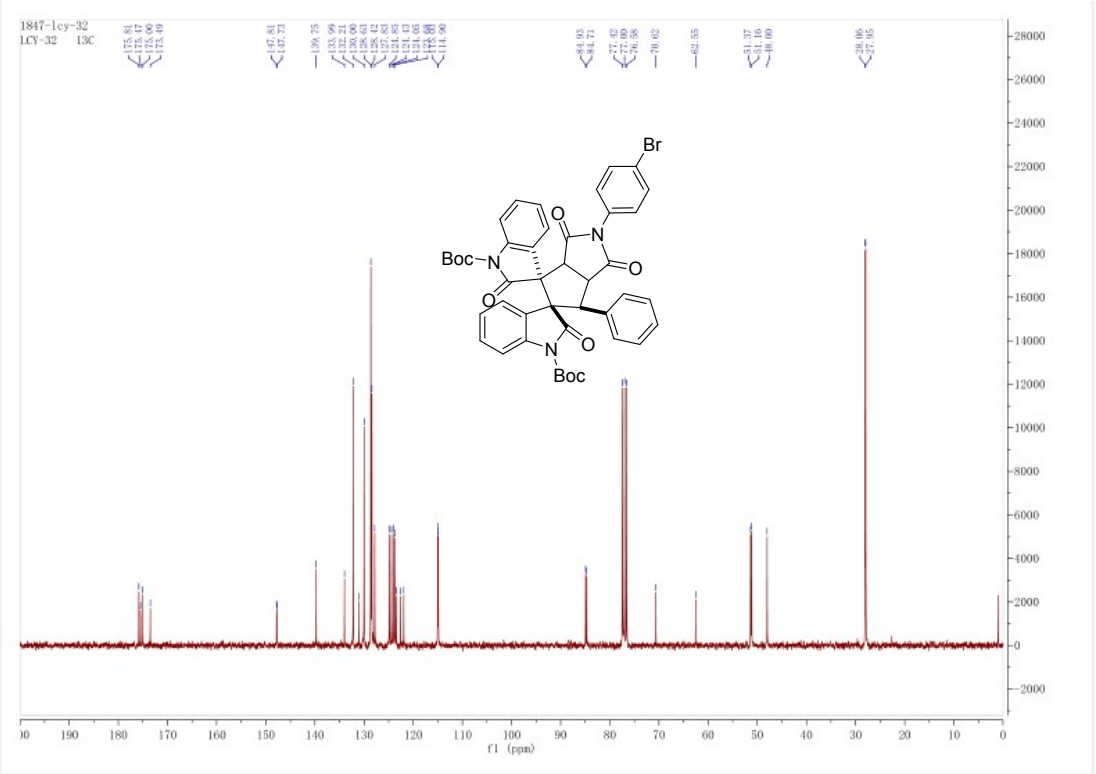
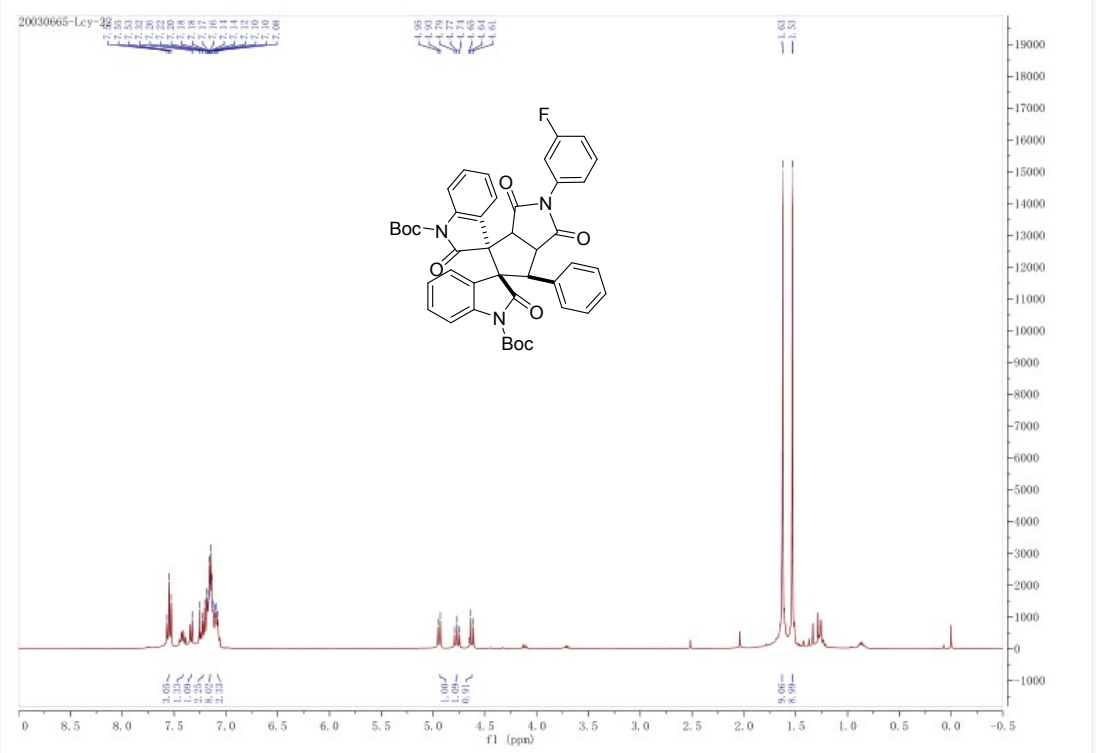
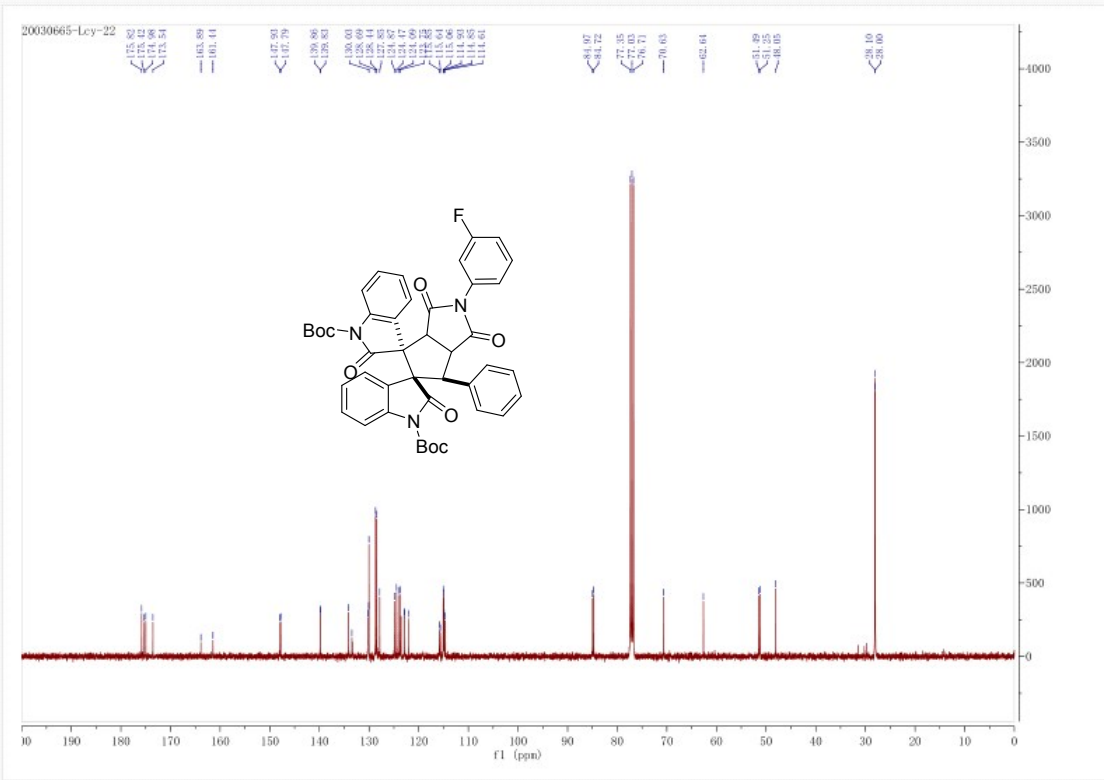


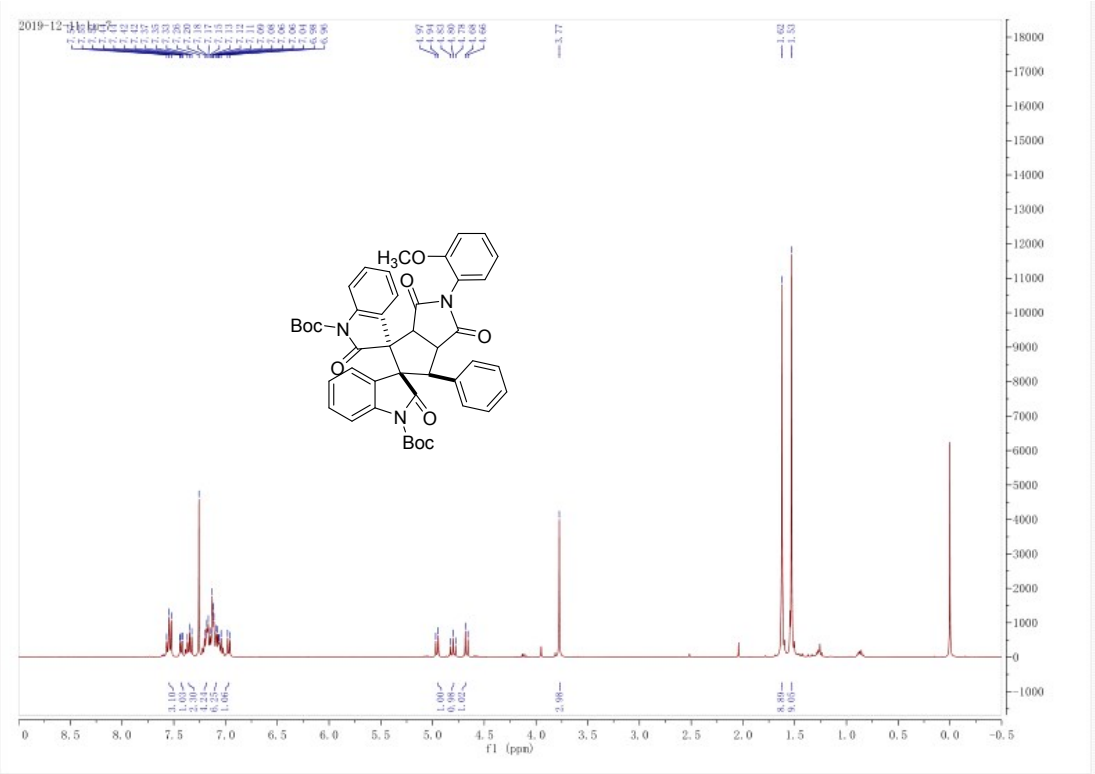


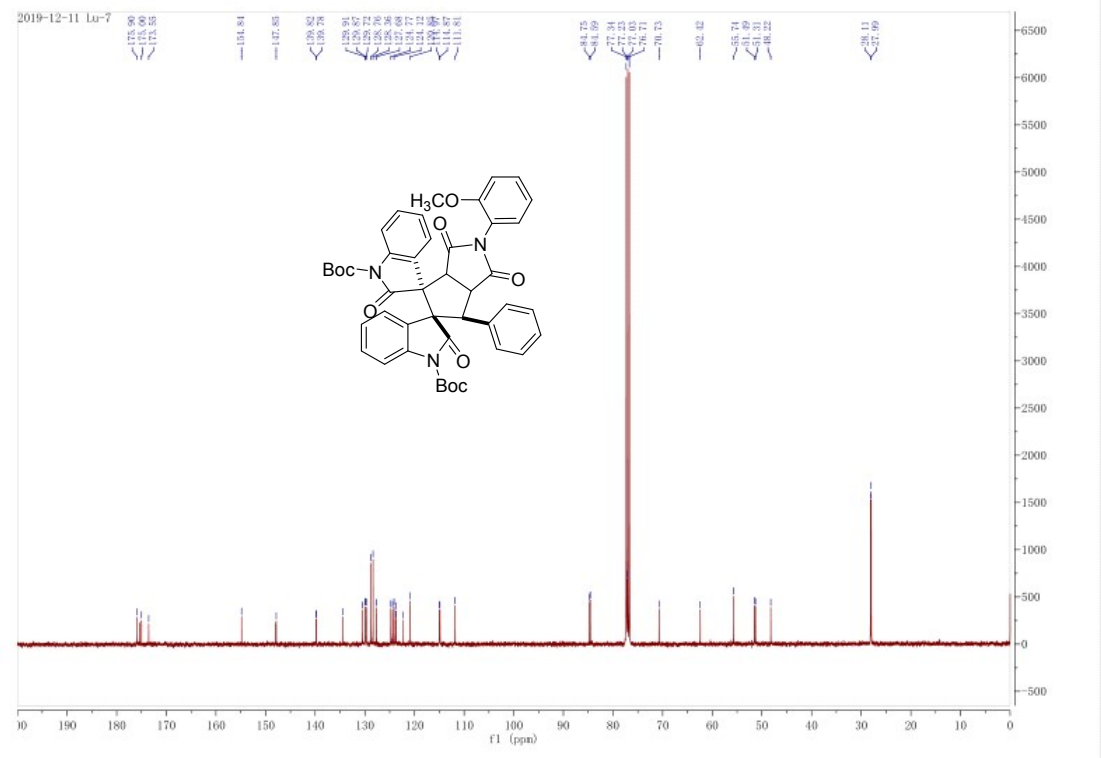
Compound 3ap



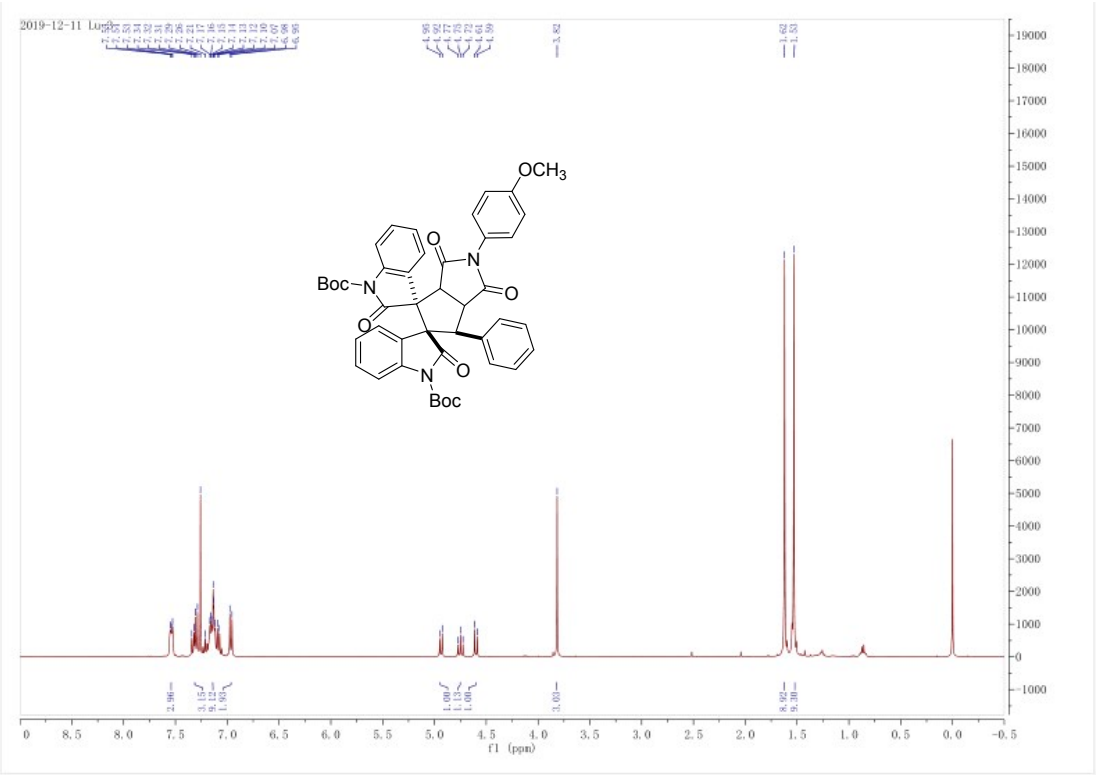


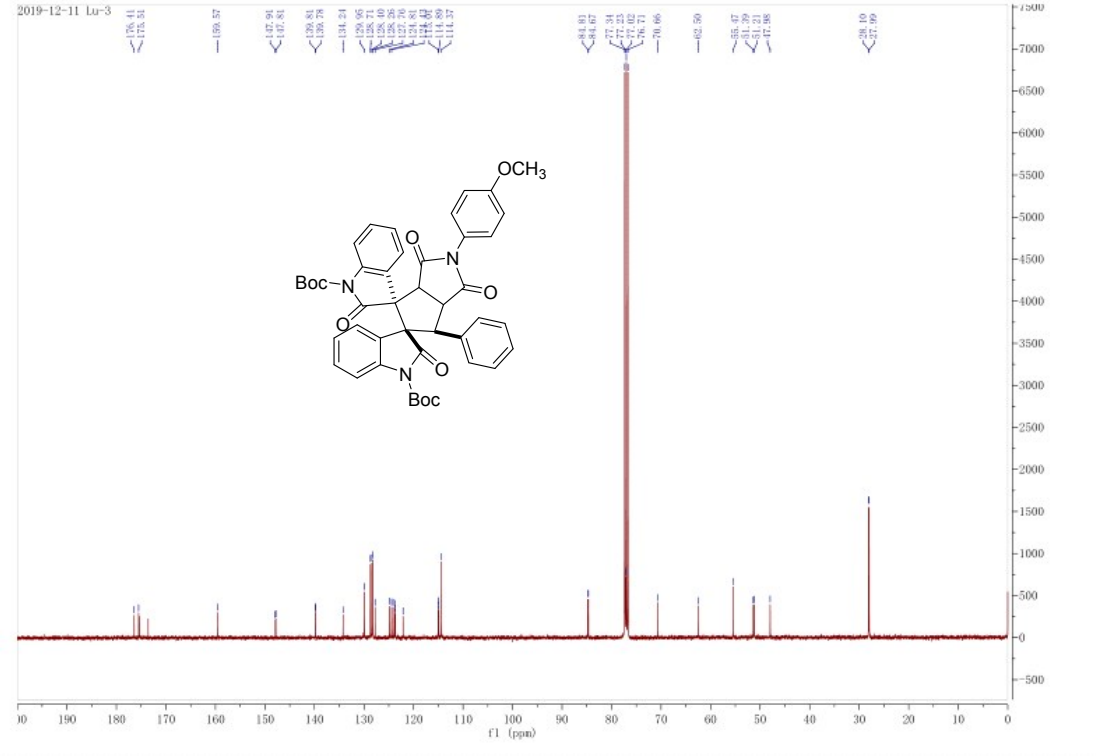
Compound 3aq


H3CO
Boc
N
O
f1 (ppm)

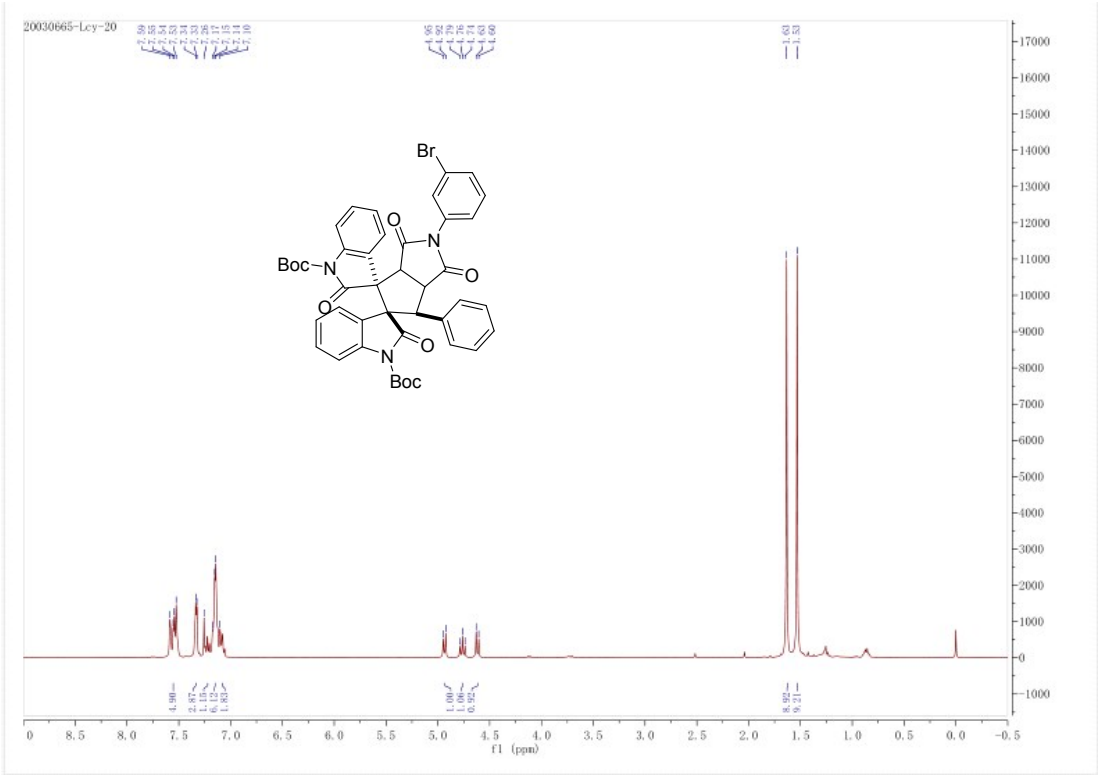

2019-12-11 Lu-7
H3CO
Boc
N
O
f1 (ppm)

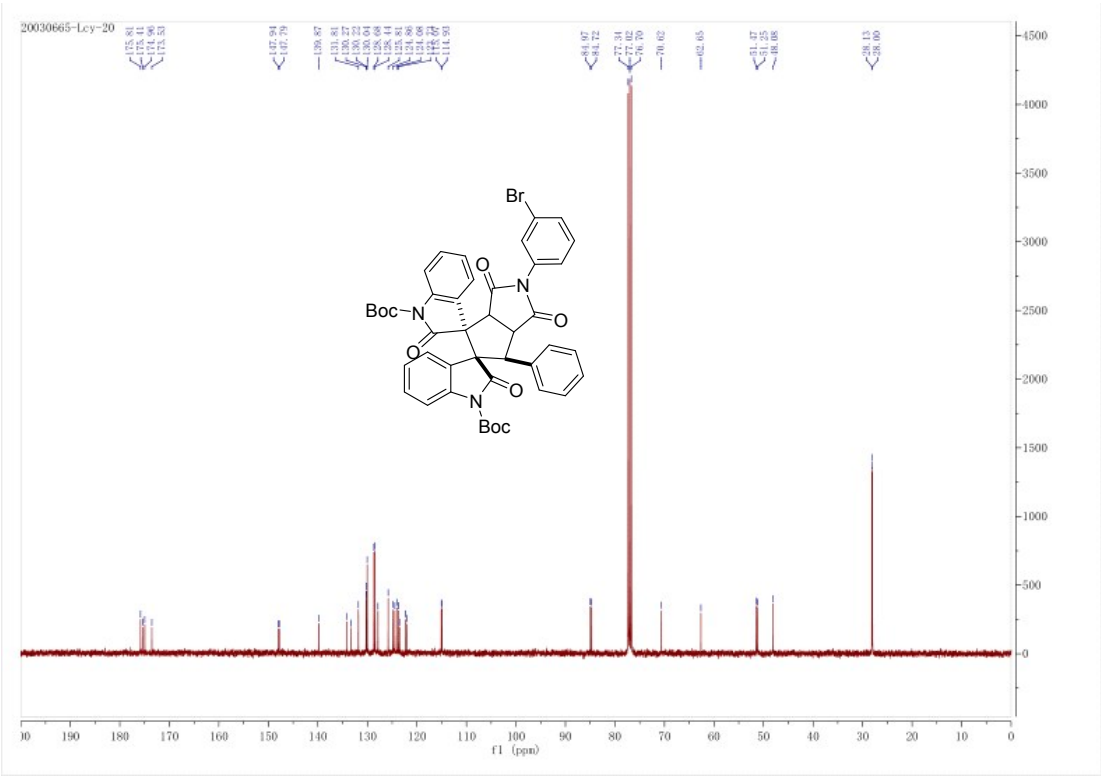
Compound 3ar



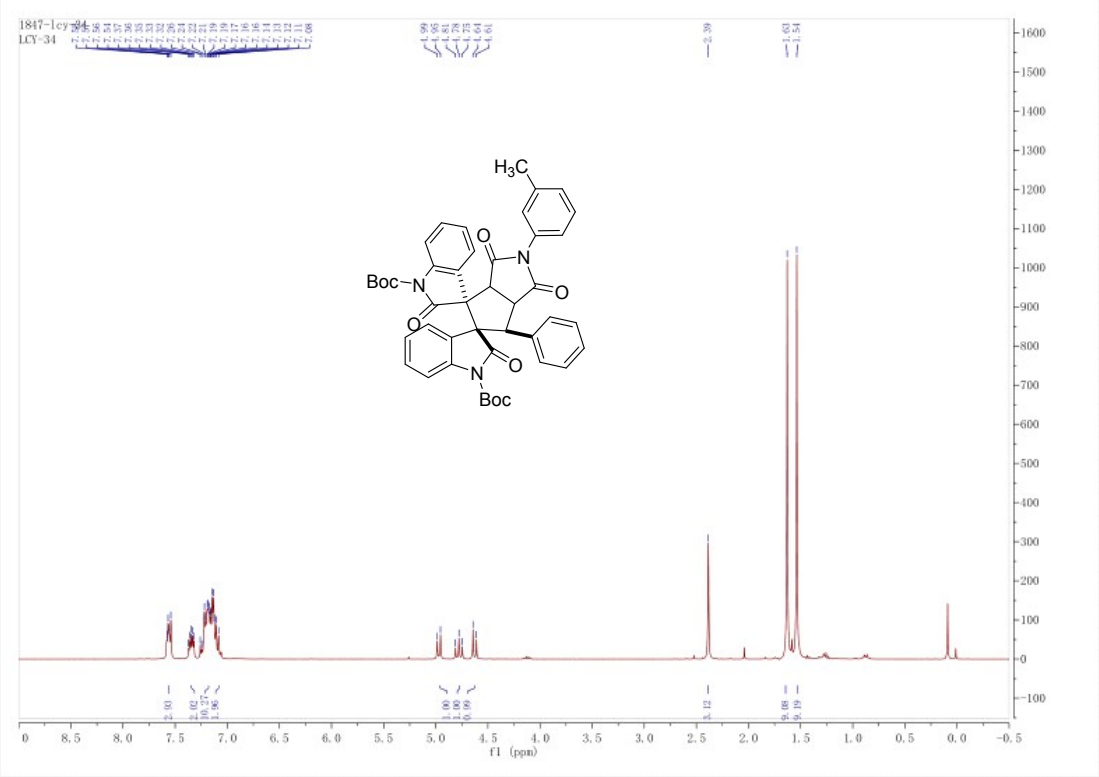


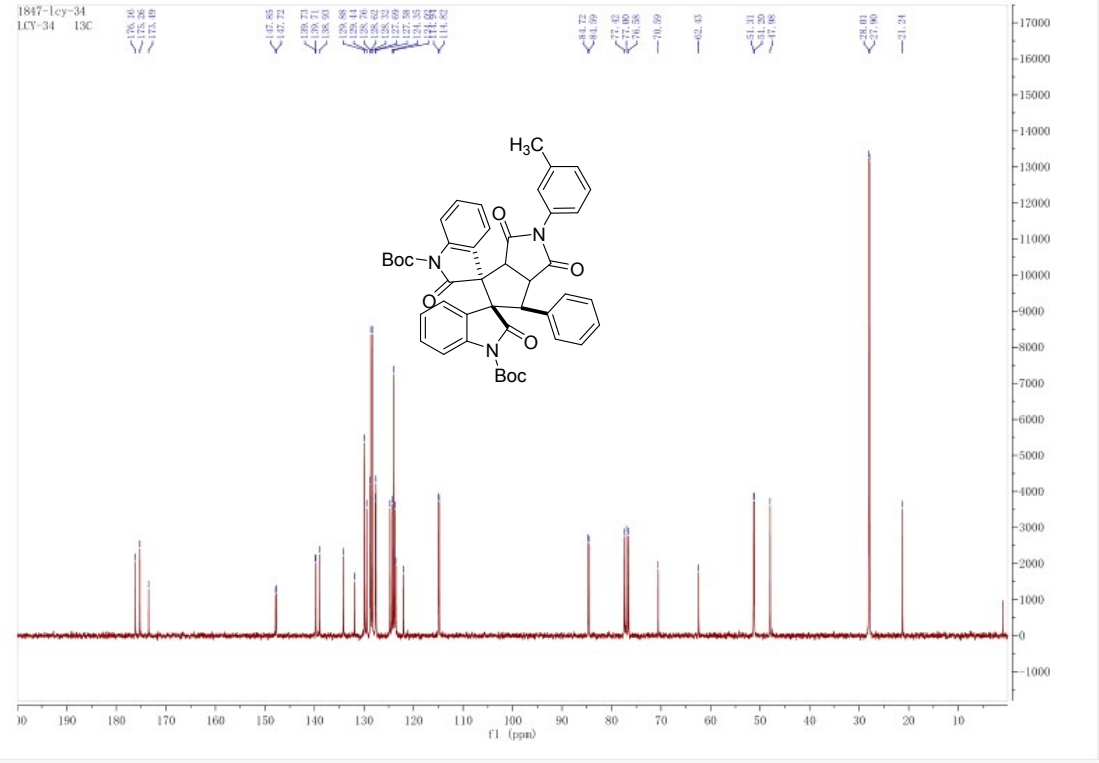
Compound 3as



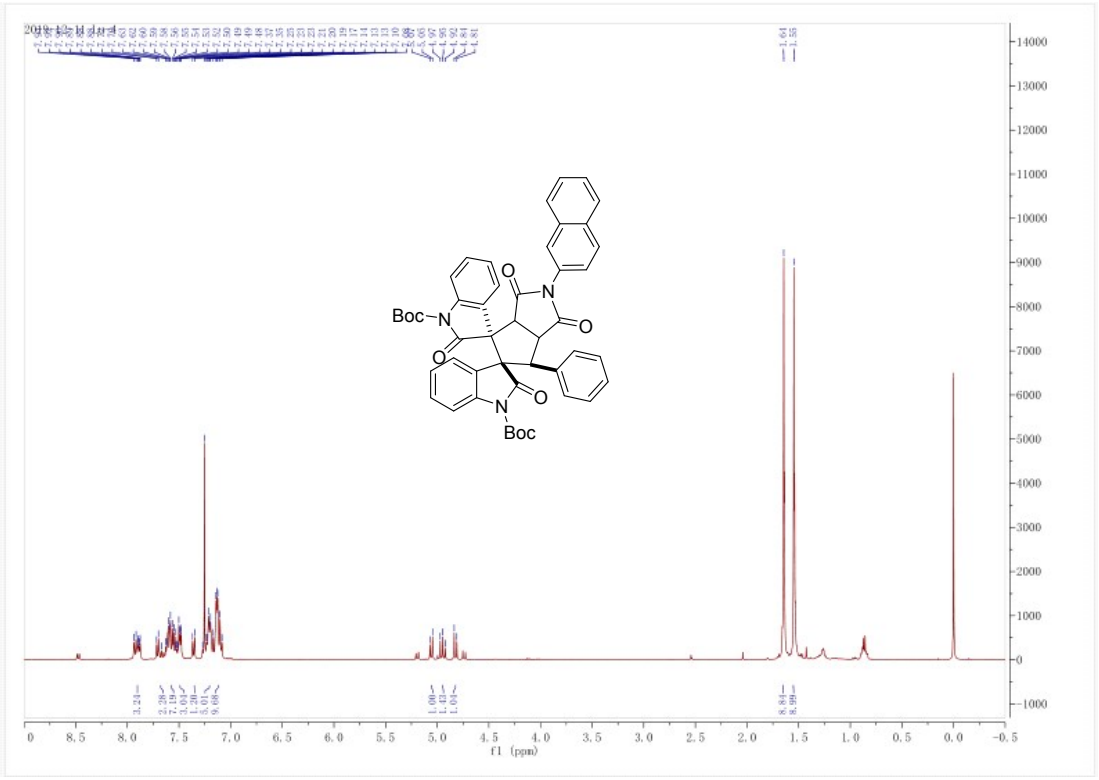


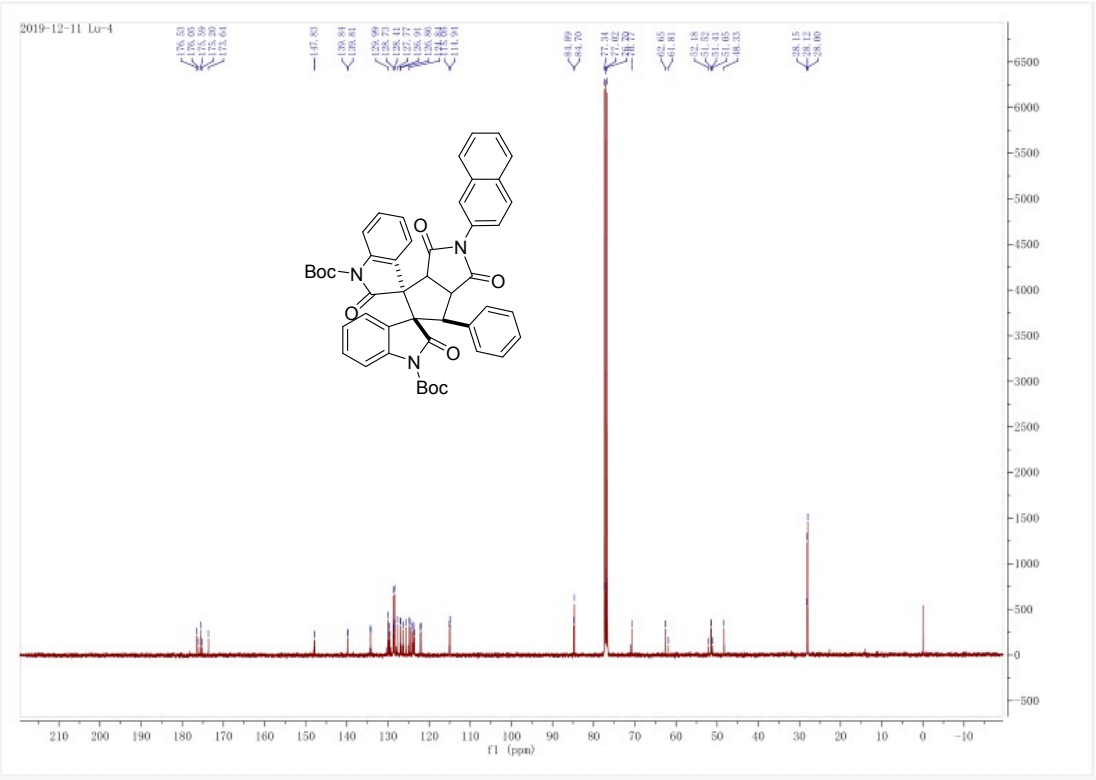
Compound 3at



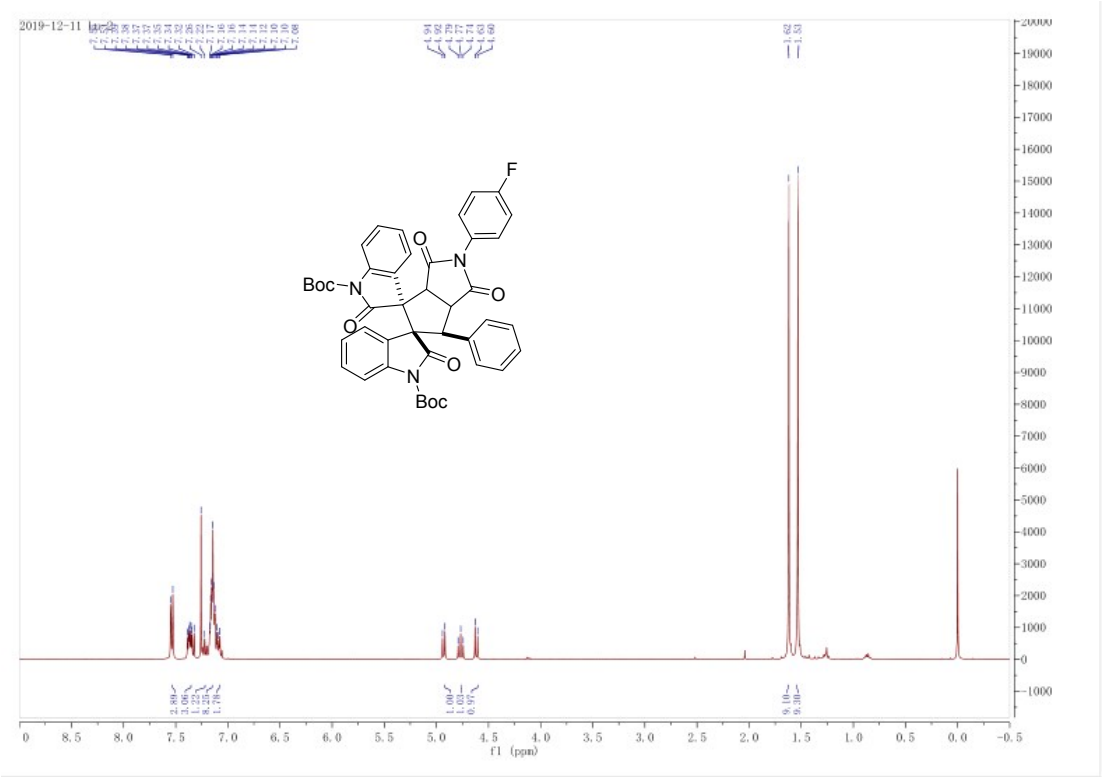


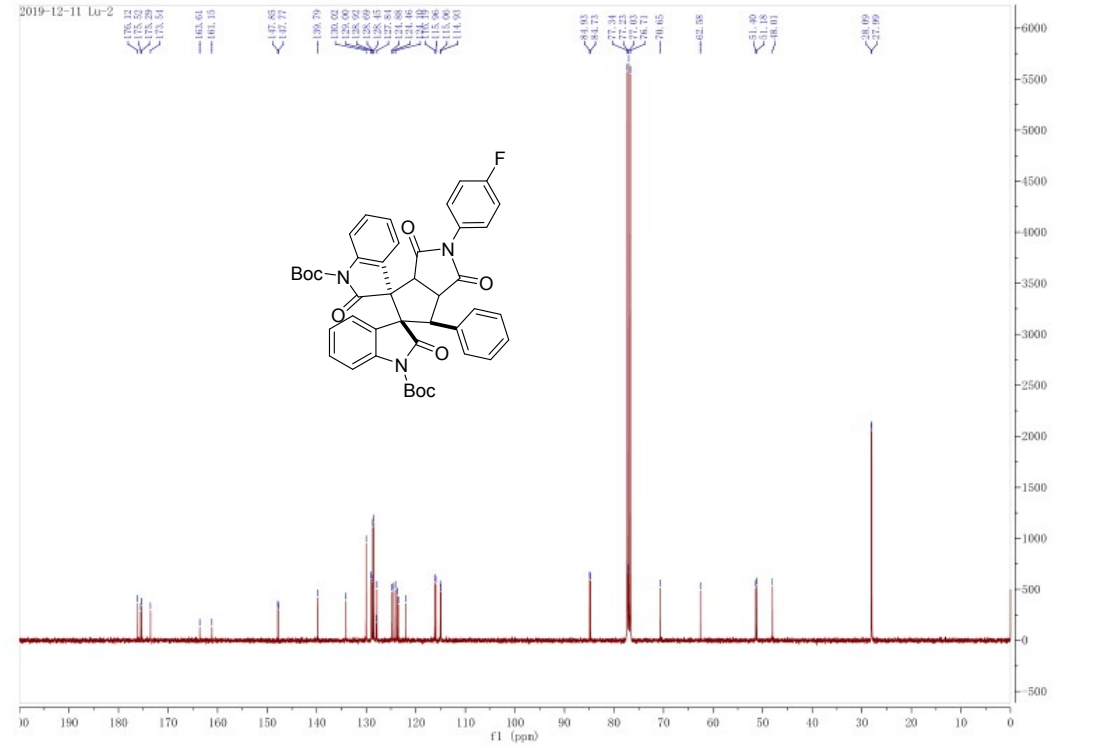
Compound 3au (dr 3:1 mixure)



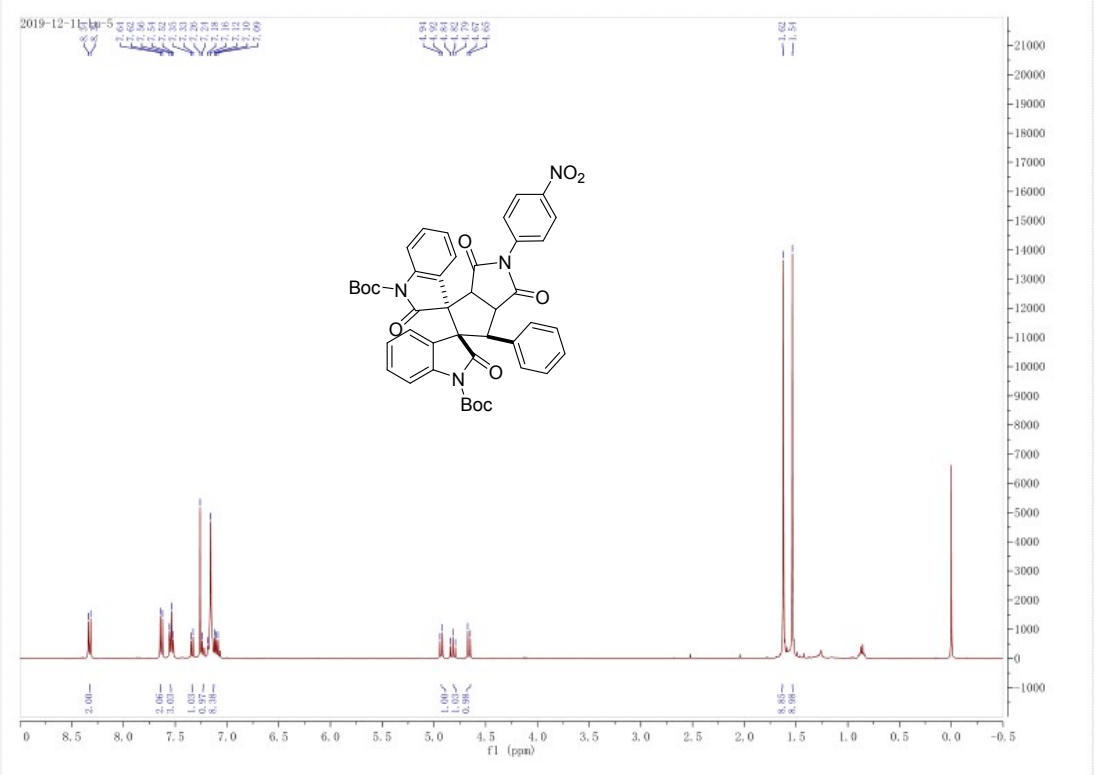


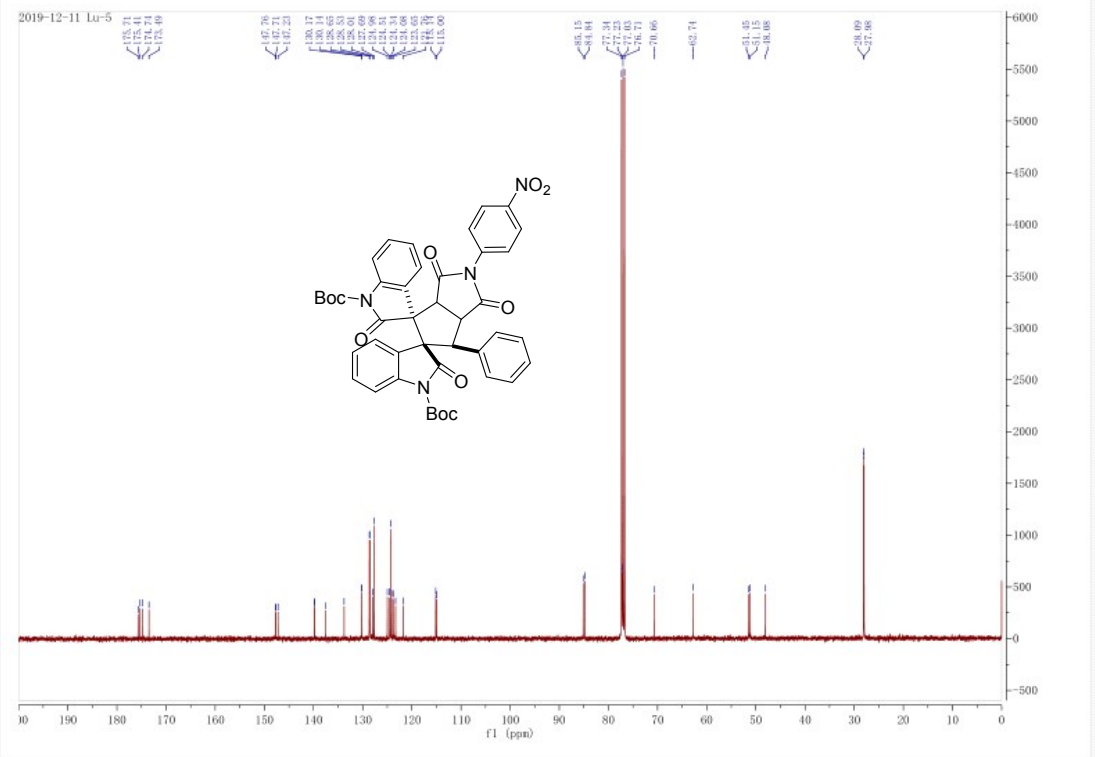
Compound 3av



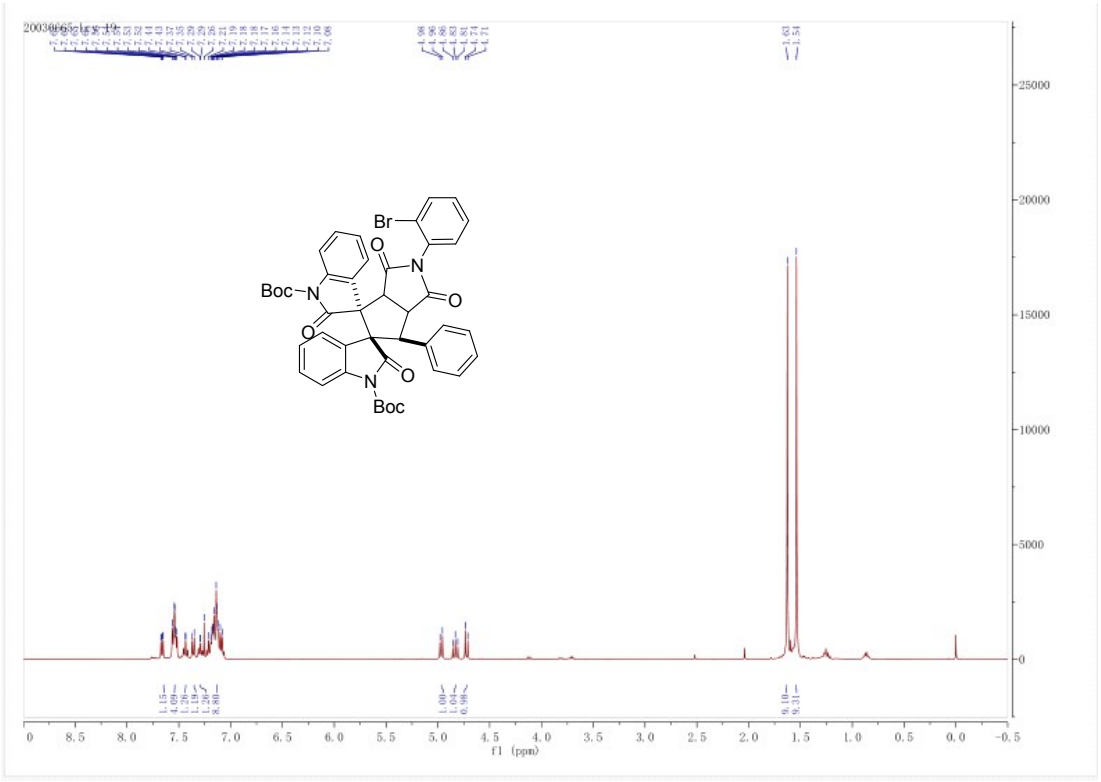


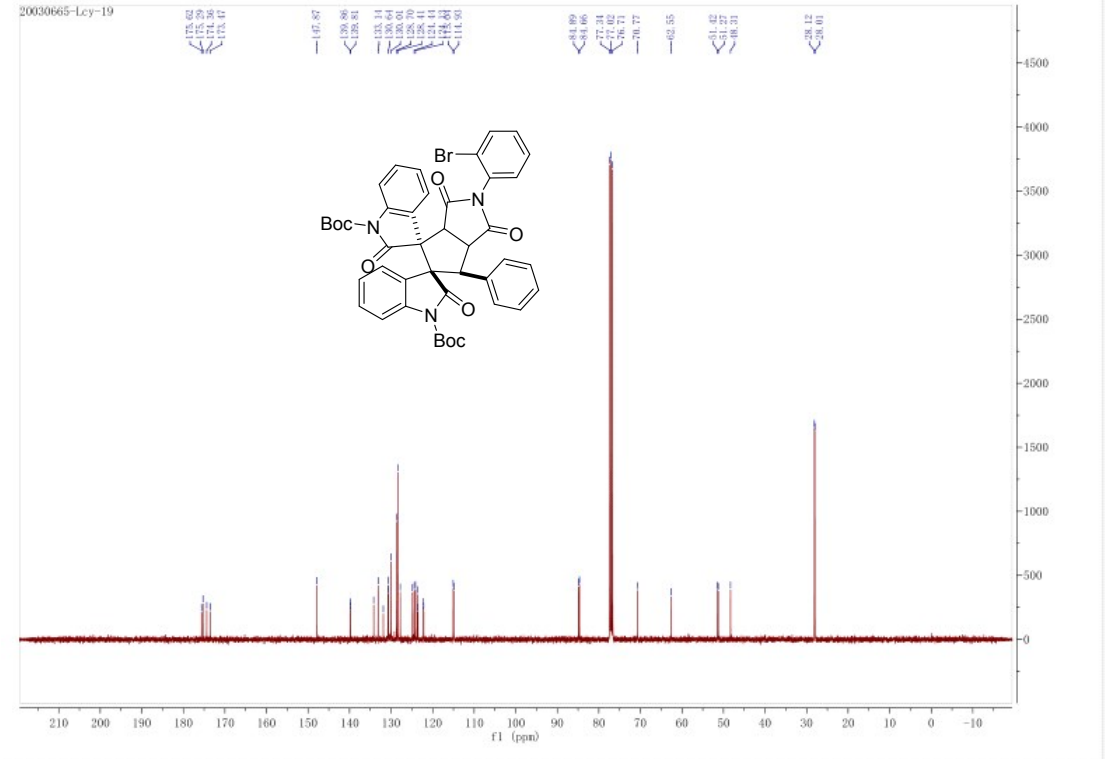
Compound 3aw





Compound 3ax





Compound 4