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A [3+2]–[4+2]–[3+2] Cycloaddition Sequence of Isoquinolinium Ylide

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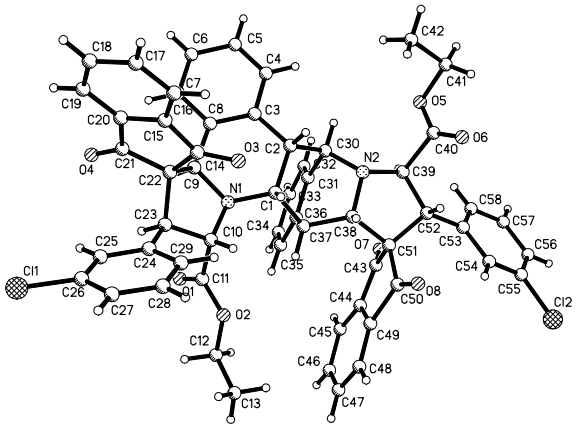


Figure s1 Crystal structure of compound **2o**

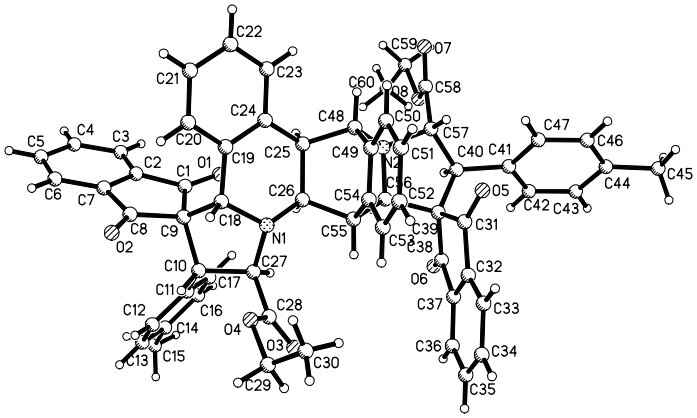


Figure s2 Crystal structure of compound **2p**

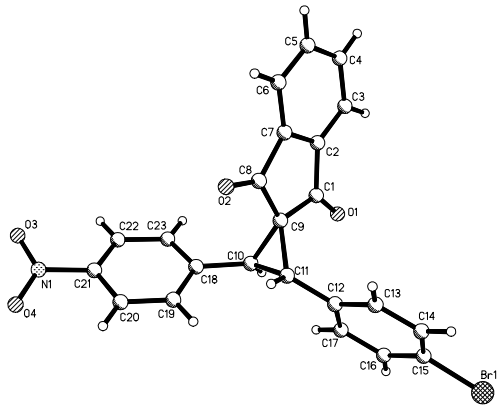


Figure s3 Crystal structure of compound **3b**

General procedure for three-component reaction: A mixture of *N*-alkoxycarbonylmethyl- or *N*-phenacylisoquinolinium salt (0.5 mmol), aromatic aldehyde (0.5 mmol), indan-1,3-dione (0.5 mmol), and triethylamine (0.6 mmol) in ethanol (10.0 mL) was stirred at room temperature for 10 h. The solvent was removed by rotatory evaporation at reduced pressure. The residue was subjected to column chromatography with a mixture of light petroleum and ethyl acetate (V/V = 1:3) to give the pure product.

(4b'*R[1],6'*R**,7'*R**,17'*S**,18'*R**)-Dimethyl 6',18'-diphenyl-1,1'',3,3''-tetraoxo-1,1'',3,3'',4b',6',7',8a',9',14a'-decahydro-14'*H*- dispiro[indene-2,5'-[14,9][1,2]epipyrrolobenzo[*b*]pyrrolo[1,2-*f*]phenanthridine-19',2''-indene]-7',17'-dicarboxylate (2a)**: white solid, 70%, m.p. 190 – 192 ℃; ^{1}H NMR (600 MHz, DMSO-d_6) δ: 8.08 (d, *J* = 7.2 Hz, 1H, ArH), 7.97 – 7.93 (m, 2H, ArH), 7.84 (d, *J* = 7.2 Hz, 1H, ArH), 7.75 (t, *J* = 7.2 Hz, 1H, ArH), 7.64 (t, *J* = 7.2 Hz, 1H, ArH), 7.54 (d, *J* = 7.2 Hz, 1H, ArH), 7.39 – 7.37 (m, 2H, ArH), 7.16 – 7.12 (m, 1H, ArH), 7.10 – 7.08 (m, 3H, ArH), 7.07 – 7.06 (m, 2H, ArH), 7.05 – 7.02 (m, 3H, ArH), 7.01 – 6.98 (m, 2H, ArH), 6.85 (d, *J* = 7.2 Hz, 2H, ArH), 6.79 (d, *J* = 6.6 Hz, 1H, ArH), 6.56 (t, *J* = 7.2 Hz, 1H, ArH), 6.46 (d, *J* = 7.2 Hz, 1H, ArH), 6.16 (d, *J* = 7.8 Hz, 1H, ArH), 4.53 (d, *J* = 9.0 Hz, 1H, CH), 4.40 – 4.38 (m, 2H, CH), 4.36 – 4.32 (m, 2H, CH), 4.29 – 4.26 (m, 2H, CH), 4.21 (d, *J* = 9.0 Hz, 1H, CH), 3.75 (s, 3H, OCH_3), 3.70 – 3.67 (m, 1H, CH), 3.26 (s, 3H, OCH_3), 2.89 – 2.87 (m, 1H, CH); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 200.5, 199.9, 199.2, 195.3, 173.9, 172.5, 143.5, 142.7, 142.3, 141.3, 136.5, 135.7, 135.6, 135.2, 135.0, 134.9, 134.2, 133.5, 132.8, 128.8, 128.7, 128.6, 128.5, 128.4, 128.3, 127.8, 127.7, 127.6, 127.2, 127.1, 126.8, 126.5, 125.7, 124.9, 124.8, 123.3, 122.9, 122.3, 122.2, 73.7, 72.1, 70.3, 68.2, 67.7, 66.3, 63.7, 61.6, 56.9, 52.3, 51.9, 51.7, 43.7, 42.9; IR (KBr) υ: 2952, 2843, 1737, 1702, 1561, 1416, 1331, 762, 702 cm^{-1}; HRMS (ESI) Calcd. for $C_{56}H_{43}N_2O_8$ ([M+H]$^+$): 871.3014, Found: 871.3007.

(4b'*R,6'*R**,7'*R**,17'*S**,18'*R**)-Dimethyl 6',18'-di(m-methylphenyl)-1,1'',3,3''-tetraoxo-1,1'',3,3'',4b',6',7',8a',9',14a'-decahydro-14'*H*- dispiro[indene-2,5'-[14,9][1,2]epipyrrolobenzo[*b*]pyrrolo[1,2-*f*] phenanthridine-19',2''-indene]-7',17'-dicarboxylate (2b)**: white solid, 67%, m.p. 203 – 204 ℃; ^{1}H NMR (400 MHz, DMSO-d_6) δ: 8.08 (d, *J* = 6.4 Hz, 1H, ArH), 7.99 – 7.92 (m, 2H, ArH), 7.84 (d, *J* = 8.0 Hz, 1H, ArH), 7.77 – 7.73 (m, 1H, ArH), 7.66 – 7.63 (m, 1H, ArH), 7.54 (d, *J* = 6.4 Hz, 1H, ArH), 7.41 – 7.36 (m, 2H, ArH), 7.09 – 7.04 (m, 2H, ArH), 7.01 – 6.98 (m, 2H, ArH), 6.92 – 6.86 (m, 3H, ArH), 6.84 – 6.81 (m, 2H, ArH), 6.79 – 6.78 (m, 1H, ArH), 6.65 – 6.64 (m, 2H, ArH), 6.57 – 6.55 (m, 1H, ArH), 6.45 – 6.43 (m, 1H, ArH), 6.15 (d, *J* = 7.6 Hz, 1H, ArH), 4.51 (d, *J* = 8.8 Hz, 1H, CH), 4.40 – 4.32 (m, 4H, CH), 4.25 – 4.23 (m, 1H, CH), 4.22 – 4.18 (m, 2H, CH), 3.75 (s, 3H, OCH_3), 3.71 – 3.69 (m, 1H, CH), 3.24 (s, 3H, OCH_3), 2.87 – 2.85 (m, 1H, CH), 2.09 (s, 3H, CH_3), 2.05 (s, 3H, CH_3); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 200.6, 200.0, 199.2, 195.3, 174.0, 172.5, 143.6, 142.7, 142.4, 141.3, 137.9, 137.3, 136.5, 135.7, 135.1, 134.9, 134.8, 134.1, 133.4, 132.8, 129.4, 129.3, 128.8, 128.4, 128.3, 128.2, 127.9, 127.7, 127.6, 127.1, 126.7, 126.5, 125.8, 125.7, 125.6, 124.9, 124.8, 123.3, 122.9, 122.3, 122.2, 73.8, 72.2, 70.4, 68.2, 67.7, 66.3, 63.8, 61.6, 56.9, 52.3, 51.9, 51.6, 43.7, 43.0, 21.2(2C);

[1] The superscript asterisk (*) indicates the related configuration here and hereinafter.

IR (KBr) υ: 2953, 1735, 1702, 1416, 1333 cm^{-1}; HRMS (ESI) Calcd. for $C_{58}H_{47}N_2O_8$ ($[M+H]^+$): 899.3327, Found: 899.3325.

(4b'*R,6'*R**,7'*R**,17'*S**,18'*R**)-Dimethyl 6',18'-di(*m*-methoxyphenyl)-1,1'',3,3''-tetraoxo-1,1'',3,3'',4b',6',7',8a',9',14a'-decahydro-14'*H*-dispiro[indene-2,5'-[14,9][1,2]epipyrrolobenzo[*b*]pyrrolo[1,2-*f*]phenanthridine-19',2''-indene]-7',17'-dicarboxylate (2c)**: white solid, 81%, m.p. 194 – 196 ℃; ^{1}H NMR (600 MHz, DMSO-d_6) δ: 8.09 (d, *J* = 7.2 Hz, 1H, ArH), 7.99 – 7.94 (m, 2H, ArH), 7.85 (d, *J* = 7.8 Hz, 1H, ArH), 7.77 – 7.75 (m, 1H, ArH), 7.67 – 7.64 (m, 1H, ArH), 7.55 (d, *J* = 7.2 Hz, 1H, ArH), 7.41 (d, *J* = 7.8 Hz, 1H, ArH), 7.37 (d, *J* = 7.8 Hz, 1H, ArH), 7.08 – 7.00 (m, 3H, ArH), 6.99 – 6.95 (m, 2H, ArH), 6.78 (d, *J* = 6.6 Hz, 1H, ArH), 6.65 – 6.63 (m, 2H, ArH), 6.61 – 6.59 (m, 1H, ArH), 6.57 – 6.56 (m, 1H, ArH), 6.55 – 6.54 (m, 1H, ArH), 6.46 (d, *J* = 7.2 Hz, 1H, ArH), 6.40 (d, *J* = 7.8 Hz, 1H, ArH), 6.35 – 6.33 (m, 1H, ArH), 6.15 (d, *J* = 7.8 Hz, 1H, ArH), 4.54 (d, *J* = 8.4 Hz, 1H, CH), 4.38 – 4.36 (m, 2H, CH), 4.33 – 4.32 (m, 1H, CH), 4.31 – 4.29 (m, 1H, CH), 4.24 – 4.22 (m, 2H, CH), 4.19 – 4.17 (m, 1H, CH), 3.78 (s, 3H, OCH_3), 3.70 – 3.68 (m, 1H, CH), 3.58 (s, 3H, OCH_3), 3.52 (s, 3H, OCH_3), 3.27 (s, 3H, OCH_3), 2.89 – 2.87 (m, 1H, CH); ^{13}C NMR (150 MHz, $CDCl_3$) δ: 200.5, 199.9, 199.3, 195.2, 174.0, 172.5, 159.3, 158.9, 143.6, 142.8, 142.4, 141.4, 136.5, 135.8, 135.6, 135.3, 135.2, 135.0, 134.9, 132.9, 129.4, 128.8, 128.8, 128.3, 127.7, 127.2, 126.8, 126.6, 125.8, 125.0, 124.9, 123.4, 123.0, 122.4, 122.3, 120.9, 114.4, 114.0, 113.4, 112.5, 73.8, 72.0, 70.4, 68.1, 67.6, 66.3, 63.7, 61.7, 56.9, 55.0, 54.9, 52.4, 51.7, 43.7, 42.9; IR (KBr) υ: 2954, 2853, 1737, 1700, 1639, 1416, 1332, 855, 763, 652 cm^{-1}; HRMS (ESI) Calcd. for $C_{58}H_{47}N_2O_{10}$ ($[M+H]^+$): 931.3225, Found: 931.3229.

(4b'*R,6'*R**,7'*R**,17'*S**,18'*R**)-Dimethyl 6',18'-di(*m*-chlorophenyl)-1,1'',3,3''-tetraoxo-1,1'',3,3'',4b',6',7',8a',9',14a'-decahydro-14'*H*-dispiro[indene-2,5'-[14,9][1,2]epipyrrolobenzo[*b*]pyrrolo[1,2-*f*]phenanthridine-19',2''-indene]-7',17'-dicarboxylate (2d)**: white solid, 69%, m.p. 198 – 201 ℃; ^{1}H NMR (600 MHz, DMSO-d_6) δ: 8.10 – 8.09 (m, 1H, ArH), 7.80 – 7.78 (m, 2H, ArH), 7.87 – 7.86 (m, 1H, ArH), 7.78 – 7.76 (m, 1H, ArH), 7.67 – 7.65 (m, 1H, ArH), 7.57 – 7.56 (m, 1H, ArH), 7.42 – 7.38 (m, 2H, ArH), 7.22 – 7.20 (m, 1H, ArH), 7.16 – 7.15 (m, 2H, ArH), 7.13 – 7.11 (m, 2H, ArH), 7.08 – 7.06 (m, 3H, ArH), 7.00 – 6.98 (m, 1H, ArH), 6.86 – 6.81 (m, 3H, ArH), 6.57 – 6.55 (m, 1H, ArH), 6.47 – 6.45 (m, 1H, ArH), 6.17 – 6.16 (m, 1H, ArH), 4.68 (d, *J* = 8.4 Hz, 1H, CH), 4.43 – 4.41 (m, 2H, CH), 4.34 – 4.32 (m, 2H, CH), 4.29 (d, *J* = 7.8 Hz, 1H, CH), 4.25 – 4.21 (m, 2H, CH), 3.77 (s, 3H, OCH_3), 3.69 – 3.67 (m, 1H, CH), 3.29 (s, 3H, OCH_3), 2.94 – 2.92 (m, 1H, CH); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 200.0, 199.3, 199.0, 195.1, 173.5, 172.1, 143.5, 142.5, 142.3, 141.2, 136.5, 136.4, 135.9, 135.7, 135.5, 135.4, 135.2, 135.1, 134.1, 133.6, 132.7, 129.7, 129.1, 128.8, 128.4, 128.3, 127.9, 127.6, 127.5, 127.3, 127.0, 126.9, 126.8, 126.6, 125.7, 125.0, 124.9, 123.4, 123.1, 122.5, 122.3, 73.8, 72.1, 70.4, 68.5, 67.6, 66.1, 63.7, 61.5, 56.1, 52.4, 51.8, 51.2, 43.6, 42.9; IR (KBr) υ: 2950, 2853, 1739, 1702, 1433, 1355, 789, 761, 694 cm^{-1}; HRMS (ESI) Calcd. for $C_{56}H_{41}Cl_2N_2O_8$ ($[M+H]^+$): 939.2234, Found: 939.2221.

(4b'*R,6'*R**,7'*R**,17'*S**,18'*R**)-Dimethyl 6',18'-di(*p*-methylphenyl)-1,1'',3,3''-tetraoxo-1,1'',3,**

3'',4b',6',7',8a',9',14a'-decahydro-14'*H*-dispiro[indene-2,5'-[14,9][1,2]epipyrrolobenzo[*b*]pyrrolo[1,2-*f*]phenanthridine-19',2''-indene]-7',17'-dicarboxylate (2e): white solid, 76%, m.p. 189 – 191 ℃; ^{1}H NMR (600 MHz, DMSO-d_6) δ: 8.07 (d, *J* = 6.6 Hz, 1H, ArH), 7.96 – 7.94 (m, 2H, ArH), 7.84 (d, *J* = 7.2 Hz, 1H, ArH), 7.76 – 7.74 (m, 1H, ArH), 7.66 – 7.63 (m, 1H, ArH), 7.54 (d, *J* = 7.2 Hz, 1H, ArH), 7.39 (d, *J* = 7.8 Hz, 1H, ArH), 7.36 (d, *J* = 8.4 Hz, 1H, ArH), 7.08 – 7.03 (m, 2H, ArH), 7.00 – 6.95 (m, 3H, ArH), 6.91 – 6.90 (m, 2H, ArH), 6.85 – 6.83 (m, 2H, ArH), 6.77 (d, *J* = 7.2 Hz, 1H, ArH), 6.74 – 6.73 (m, 2H, ArH), 6.56 – 6.53 (m, 1H, ArH), 6.45 (d, *J* = 6.6 Hz, 1H, ArH), 6.14 (d, *J* = 7.2 Hz, 1H, ArH), 4.49 (d, *J* = 9.0 Hz, 1H, CH), 4.36 – 4.35 (m, 2H, CH), 4.34 – 4.32 (m, 2H, CH), 4.23 – 4.21 (m, 2H, CH), 4.19 – 4.17 (m, 1H, CH), 3.74 (s, 3H, OCH_3), 3.69 (d, *J* = 7.8 Hz, 1H, CH), 3.24 (s, 3H, OCH_3), 2.85 – 2.83 (m, 1H, CH), 2.11 (s, 3H, CH_3), 2.06 (s, 3H, CH_3); ^{13}C NMR (100 MHz, DMSO-d_6) δ: 200.6, 200.0, 199.3, 195.4, 174.0, 172.6, 143.7, 142.8, 142.5, 141.4, 137.2, 136.6, 135.7, 135.6, 135.1, 134.9, 134.8, 133.0, 131.2, 130.4, 129.1, 128.9, 128.6, 128.5, 128.4, 128.3, 127.7, 127.1, 126.7, 126.5, 125.7, 125.0, 124.8, 123.4, 122.9, 122.4, 122.3, 73.8, 72.2, 70.4, 68.2, 67.8, 66.5, 63.7, 61.8, 56.6, 52.2, 51.7, 51.6, 43.8, 43.0, 20.8(2C); IR (KBr) υ: 2950, 2846, 1730, 1702, 1639, 1416, 1352, 799, 760, 655 cm^{-1}; HRMS (ESI) Calcd. for $C_{58}H_{47}N_2O_8$ ([M+H]$^+$): 899.3327, Found: 899.3320.

(4b'*R,6'*R**,7'*R**,17'*S**,18'*R**)-Dimethyl 6',18'-di(*p*-methoxyphenyl)-1,1'',3,3''-tetraoxo-1,1'',3,3'',4b',6',7',8a',9',14a'-decahydro-14'*H*-dispiro[indene-2,5'-[14,9][1,2]epipyrrolobenzo[*b*]pyrrolo[1,2-*f*]phenanthridine-19',2''-indene]-7',17'-dicarboxylate (2f)**: white solid, 71%, m.p. 182 – 185 ℃; ^{1}H NMR (600 MHz, DMSO-d_6) δ: 8.06 – 8.05 (m, 1H, ArH), 7.97 – 7.95 (m, 2H, ArH), 7.84 – 7.83 (m, 1H, ArH), 7.77 – 7.75 (m, 1H, ArH), 7.66 – 7.64 (m, 1H, ArH), 7.56 – 7.55 (m, 1H, ArH), 7.42 – 7.36 (m, 2H, ArH), 7.08 – 7.06 (m, 2H, ArH), 7.00 – 6.96 (m, 3H, ArH), 6.78 – 7.77 (m, 3H, ArH), 6.66 – 6.65 (m, 2H, ArH), 6.61 (m, 2H, ArH), 6.55 – 6.54 (m, 1H, ArH), 6.46 – 6.45 (m, 1H, ArH), 6.15 – 6.14 (m, 1H, ArH), 4.46 – 4.45 (m, 1H, CH), 4.35 (m, 2H, CH), 4.32 – 4.29 (m, 2H, CH), 4.22 – 4.18 (m, 3H, CH), 3.74 (s, 3H, OCH_3), 3.70 (d, *J* = 7.8 Hz, 1H, CH), 3.58 (s, 3H, OCH_3), 3.55 (s, 3H, OCH_3), 3.24 (s, 3H, OCH_3), 2.84 (m, 1H, CH); ^{13}C NMR (100 MHz, DMSO-d_6) δ: 200.7, 200.0, 199.5, 195.5, 174.0, 172.6, 158.9, 158.5, 143.7, 142.8, 142.5, 141.4, 136.6, 135.8, 135.7, 135.2, 134.9, 134.8, 132.9, 129.9, 129.8, 129.7, 129.6, 129.0, 128.3, 127.7, 127.0, 126.8, 126.6, 126.1, 125.7, 125.4, 124.9, 124.8, 123.3, 122.9, 122.4, 122.3, 113.7, 113.6, 113.2, 73.9, 72.1, 70.2, 68.0, 67.8, 66.6, 63.6, 61.8, 56.4, 55.0, 54.9, 52.2, 51.7, 51.6, 43.8, 43.0; IR (KBr) υ: 2952, 2902, 2839, 1739, 1702, 1640, 1433, 1349, 1305, 816, 759, 653 cm^{-1}; HRMS (ESI) Calcd. for $C_{58}H_{46}N_2NaO_{10}$ ([M+Na]$^+$): 953.3045, Found: 953.3042.

(4b'*R,6'*R**,7'*R**,17'*S**,18'*R**)-Dimethyl 6',18'-di(*p*-chlorophenyl)-1,1'',3,3''-tetraoxo-1,1'',3,3'',4b',6',7',8a',9',14a'-decahydro-14'*H*-dispiro[indene-2,5'-[14,9][1,2]epipyrrolobenzo[*b*]pyrrolo[1,2-*f*]phenanthridine-19',2''-indene]-7',17'-dicarboxylate (2g)**: white solid, 64%, m.p. 187 – 189 ℃; ^{1}H NMR (600 MHz, DMSO-d_6) δ: 8.07 (d, *J* = 7.2 Hz, 1H, ArH), 7.98 – 7.96 (m, 2H, ArH), 7.85 (d, *J* = 7.2 Hz, 1H, ArH), 7.78 – 7.76 – 7.75 (m, 1H, ArH), 7.67 – 7.65 (m, 1H, ArH), 7.56 (d, *J* = 6.6 Hz, 1H, ArH), 7.41 – 7.37 (m, 2H, ArH), 7.

22 – 7.18 (m, 2H, ArH), 7.14 – 7.13 (m, 4H, ArH), 7.08 – 7.05 (m, 2H, ArH), 7.00 – 6.98 (m, 1H, ArH), 6.88 (d, *J* = 7.8 Hz, 2H, ArH), 6.79 (d, *J* = 6.0 Hz, 1H, ArH), 6.57 – 6.54 (m, 1H, ArH), 6.46 (d, *J* = 6.0 Hz, 1H, ArH), 6.16 (d, *J* = 7.2 Hz, 1H, ArH), 4.59 (d, *J* = 8.4 Hz, 1H, CH), 4.41 – 4.39 (m, 2H, CH), 4.32 – 4.31 (m, 2H, CH), 4.28 (d, *J* = 8.4 Hz, 1H, CH), 4.23 – 4.21 (m, 2H, CH), 3.75 (s, 3H, OCH_3), 3.68 (d, *J* = 10.8 Hz, 1H, CH), 3.28 (s, 3H, OCH_3), 2.90 (m, 1H, CH); ^{13}C NMR (100 MHz, DMSO-*d*$_6$) δ: 200.1, 199.5, 199.1, 195.2, 173.6, 172.3, 143.5, 142.6, 142.3, 141.2, 136.4, 135.9, 1 35.5, 135.4, 135.2, 135.1, 133.5, 133.0, 132.8, 132.7, 132.0, 130.2, 129.9, 128.5, 128.4, 12 8.3, 128.0, 127.6, 127.2, 126.9, 126.6, 125.7, 125.0, 124.9, 123.4, 123.0, 122.4, 122.3, 73. 8, 72.1, 70.3, 68.4, 67.6, 66.2, 63.7, 61.6, 56.0, 52.3, 51.7, 51.2, 43.6, 42.9; IR (KBr) υ: 2946, 2889, 1733, 1702, 1640, 1415, 1351, 792, 712, 653 cm^{-1}; HRMS (ESI) Calcd. for $C_{56}H_{41}Cl_2N_2O_8$ ($[M+H]^+$): 939.2234, Found: 939.2228.

(4b'*R,6'*R**,7'*R**,17'*S**,18'*R**)-Dimethyl 6',18'-di(*p*-bromophenyl)-1,1'',3,3''-tetraoxo-1,1'',3, 3'',4b',6',7',8a',9',14a'-decahydro-14'*H*-dispiro[indene-2,5'-[14,9][1,2]epipyrrolobenzo[*b*]pyr rolo[1,2-*f*]phenanthridine-19',2''-indene]-7',17'-dicarboxylate (2h)**: white solid, 73%, m.p. 203 – 206 ℃; ^1H NMR (600 MHz, DMSO-*d*$_6$) δ: 8.08 (d, *J* = 7.2 Hz, 1H, ArH), 8.00 – 7.95 (m, 2H, ArH), 7.85 (d, *J* = 7.2 Hz, 1H, ArH), 7.79 – 7.76 – 7.75 (m, 1H, ArH), 7.68 – 7.65 (m, 1H, ArH), 7.56 (d, *J* = 7.2 Hz, 1H, ArH), 7.41 (d, *J* = 7.2 Hz, 1H, Ar H), 7.37 (d, *J* = 7.8 Hz, 1H, ArH), 7.33 – 7.32 (m, 2H, ArH), 7.27 (d, *J* = 8.4 Hz, 2H, ArH), 7.08 – 7.04 (m, 4H, ArH), 7.00 – 6.98 (m, 1H, ArH), 6.83 – 6.81 (m, 1H, ArH), 6.81 – 6.79 – 6.78 (m, 2H, ArH), 6.56 – 6.54 (m, 1H, ArH), 6.46 (d, *J* = 7.2 Hz, 1H, ArH), 6.15 (d, *J* = 7.8 Hz, 1H, ArH), 4.59 (d, *J* = 9.0 Hz, 1H, CH), 4.41 – 4.39 (m, 2 H, CH), 4.33 – 4.31 (m, 2H, CH), 4.26 (d, *J* = 8.4 Hz, 1H, CH), 4.23 – 4.19 (m, 2H, CH), 3.75 (s, 3H, OCH_3), 3.68 – 3.66 (m, 1H, CH), 3.27 (s, 3H, OCH_3), 2.90 – 2.89 (m, 1H, CH); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 200.1, 199.5, 199.1, 195.2, 173.6, 172.2, 143. 5, 142.6, 142.3, 141.2, 136.4, 136.0, 135.4, 135.2, 135.1, 133.3, 132.6, 132.5, 131.5, 131.0, 130.5, 130.3, 128.4, 128.3, 127.6, 127.2, 126.9, 126.6, 125.7, 125.0, 124.9, 123.4, 123.0, 122.5, 122.4, 121.7, 121.2, 73.7, 72.0, 70.4, 68.5, 67.6, 66.2, 63.7, 61.6, 56.0, 52.4, 51.7, 51.2, 43.6, 42.9; IR (KBr) υ: 3099, 2950, 2925, 2902, 1736, 1701, 1640, 1413, 1352, 808, 761, 724, 677 cm^{-1}; HRMS (ESI) Calcd. for $C_{56}H_{41}Br_2N_2O_8$ ($[M+H]^+$): 1027.1220, Found: 1027.1222.

(4b'*R,6'*R**,7'*R**,17'*S**,18'*R**)-Dimethyl 6',18'-di(*p*-nitrophenyl)-1,1'',3,3''-tetraoxo-1,1'',3,3 '',4b',6',7',8a',9',14a'-decahydro-14'*H*-dispiro[indene-2,5'-[14,9][1,2]epipyrrolobenzo[*b*]pyrr olo[1,2-*f*]phenanthridine-19',2''-indene]-7',17'-dicarboxylate (2i)**: white solid, 74%, m.p. 1 69 – 172 ℃; ^1H NMR (600 MHz, DMSO-*d*$_6$) δ: 8.09 (d, *J* = 7.2 Hz, 1H, ArH), 8.01 – 7.98 (m, 3H, ArH), 7.96 – 7.95 (m, 3H, ArH), 7.87 (d, *J* = 7.2 Hz, 1H, ArH), 7.79 – 7. 76 (m, 1H, ArH), 7.66 – 7.64 (m, 1H, ArH), 7.55 (d, *J* = 7.2 Hz, 1H, ArH), 7.45 (d, *J* = 7.8 Hz, 2H, ArH), 7.39 (d, *J* = 7.8 Hz, 2H, ArH), 7.16 (d, *J* = 8.4 Hz, 2H, ArH), 7.0 9 – 7.06 (m, 2H, ArH), 7.01 – 6.98 (m, 1H, ArH), 6.83 (d, *J* = 6.6 Hz, 1H, ArH), 6.56 – 6.54 (m, 1H, ArH), 6.47 – 6.46 (m, 1H, ArH), 6.17 (d, *J* = 7.8 Hz, 1H, ArH), 4.77 (d, *J* = 8.4 Hz, 1H, CH), 4.50 – 4.48 (m, 1H, CH), 4.46 – 4.43 (m, 3H, CH), 4.35 – 4. 34 (m, 2H, CH), 4.29 (d, *J* = 9.0 Hz, 1H, CH), 3.77 (s, 3H, OCH_3), 3.69 – 3.68 (m, 1

H, CH), 3.30 (s, 3H, OCH_3), 2.98 – 2.96 (m, 1H, CH); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 199.5, 199.0, 198.9, 194.9, 173.2, 171.9, 147.3, 146.9, 143.4, 142.2, 142.1, 141.3, 141.0, 136.3, 136.2, 135.7, 135.5, 135.4, 135.1, 132.5, 129.8, 129.7, 129.6, 128.4, 127.9, 127.6, 127.5, 127.1, 126.8, 125.8, 125.0, 123.6, 123.2, 123.0, 122.6, 122.4, 73.7, 72.3, 70.6, 68.9, 67.8, 66.0, 63.7, 61.6, 55.7, 51.9, 51.9, 51.0, 43.5, 42.9, 29.6; IR (KBr) υ: 2954, 2857, 1741, 1697, 1416, 1348, 851, 766, 699 cm^{-1}; HRMS (ESI) Calcd. for $C_{56}H_{40}N_4NaO_{12}$ ($[M+Na]^+$): 983.2535, Found: 983.2554.

(4b'*R,6'*R**,7'*R**,17'*S**,18'*R**)-Diethyl 6',18'-diphenyl-1,1'',3,3''-tetraoxo-1,1'',3,3'',4b',6',7',8a',9',14a'-decahydro-14'*H*-dispiro[indene-2,5'-[14,9][1,2]epipyrrolobenzo[*b*]pyrrolo[1,2-*f*]phenanthridine-19',2''-indene]-7',17'-dicarboxylate (2j)**: white solid, 77%, m.p. 166 – 168 ℃; ^1H NMR (600 MHz, DMSO-d_6) δ: 8.05 (d, *J* = 7.2 Hz, 1H, ArH), 7.95 – 7.90 (m, 2H, ArH), 7.84 (d, *J* = 7.2 Hz, 1H, ArH), 7.76 – 7.74 (m, 1H, ArH), 7.65 – 7.62 (m, 1H, ArH), 7.51 (d, *J* = 7.8 Hz, 1H, ArH), 7.39 (d, *J* = 7.8 Hz, 1H, ArH), 7.33 (d, *J* = 8.4 Hz, 1H, ArH), 7.12 – 7.11 (m, 1H, ArH), 7.10 – 7.08 (m, 3H, ArH), 7.07 – 7.03 (m, 4H, ArH), 7.02 – 6.99 (m, 3H, ArH), 6.83 (d, *J* = 7.2 Hz, 2H, ArH), 6.81 – 6.79 (m, 1H, ArH), 6.57 – 6.54 (m, 1H, ArH), 6.51 – 6.50 (m, 1H, ArH), 6.16 (d, *J* = 7.8 Hz, 1H, ArH), 4.53 (d, *J* = 9.0 Hz, 1H, CH), 4.44 – 4.42 (m, 2H, CH), 4.37 – 4.35 (m, 2H, CH), 4.28 – 4.26 (m, 1H, CH), 4.24 – 4.20 (m, 3H, CH), 4.19 – 4.15 (m, 1H, CH), 3.85 – 3.81 (m, 1H, CH), 3.77 – 3.72 (m, 2H, CH), 2.93 – 2.92 (m, 1H, CH), 1.19 (t, *J* = 7.2 Hz, 3H, CH_3), 0.73 (t, *J* = 7.2 Hz, 3H, CH_3); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 200.6, 200.1, 199.3, 195.5, 173.7, 172.0, 143.5, 142.7, 142.4, 141.3, 136.6, 135.9, 135.8, 135.2, 135.1, 135.0, 134.4, 133.5, 133.0, 129.0, 128.9, 128.6, 128.4, 128.3, 127.8, 127.7, 127.6, 127.2, 127.1, 126.8, 126.6, 125.7, 125.0, 124.8, 123.3, 122.9, 122.4, 122.3, 73.9, 72.2, 70.3, 68.3, 67.5, 66.4, 63.7, 61.7, 60.9, 60.8, 57.2, 52.4, 43.9, 43.0, 14.1, 13.9; IR (KBr) υ: 2981, 2902, 1739, 1701, 1415, 1333, 761, 700 cm^{-1}; HRMS (ESI) Calcd. for $C_{58}H_{47}N_2O_8$ ($[M+H]^+$): 899.3327, Found: 899.3346.

(4b'*R,6'*R**,7'*R**,17'*S**,18'*R**)-Diethyl 6',18'-di(*o*-chlorophenyl)-1,1'',3,3''-tetraoxo-1,1'',3,3'',4b',6',7',8a',9',14a'-decahydro-14'*H*-dispiro[indene-2,5'-[14,9][1,2]epipyrrolobenzo[*b*]pyrrolo[1,2-*f*]phenanthridine-19',2''-indene]-7',17'-dicarboxylate (2k)**: white solid, 59%, m.p. 187 – 189 ℃; ^1H NMR (600 MHz, DMSO-d_6) δ: 8.05 (d, *J* = 7.8 Hz, 1H, ArH), 8.03 – 8.00 (m, 1H, ArH), 7.98 – 7.95 (m, 1H, ArH), 7.90 (d, *J* = 7.8 Hz, 1H, ArH), 7.86 (d, *J* = 7.8 Hz, 1H, ArH), 7.79 – 7.77 (m, 1H, ArH), 7.72 (d, *J* = 7.2 Hz, 1H, ArH), 7.68 – 7.66 (m, 1H, ArH), 7.58 (d, *J* = 7.8 Hz, 1H, ArH), 7.56 – 7.53 (m, 1H, ArH), 7.43 (d, *J* = 7.8 Hz, 1H, ArH), 7.38 – 7.36 (m, 3H, ArH), 7.25 – 7.23 (m, 1H, ArH), 7.13 (d, *J* = 7.8 Hz, 1H, ArH), 7.11 – 7.06 (m, 3H, ArH), 7.04 – 7.03 (m, 1H, ArH), 6.83 (d, *J* = 7.2 Hz, 1H, ArH), 6.62 – 6.60 (m, 1H, ArH), 6.49 (d, *J* = 7.8 Hz, 1H, ArH), 6.23 (d, *J* = 7.8 Hz, 1H, ArH), 4.95 (d, *J* = 7.8 Hz, 1H, CH), 4.60 – 4.58 (m, 1H, CH), 4.50 – 4.49 (m, 1H, CH), 4.48 – 4.40 (m, 3H, CH), 4.27 (d, *J* = 7.8 Hz, 1H, CH), 4.07 – 4.03 (m, 1H, CH), 3.95 (d, *J* = 8.4 Hz, 1H, CH), 3.87 – 3.84 (m, 3H, CH), 3.80 – 3.77 (m, 1H, CH), 2.93 – 2.92 (m, 1H, CH), 0.77 (t, *J* = 7.2 Hz, 3H, CH_3), 0.75 (t, *J* = 7.2 Hz, 3H, CH_3); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 199.7, 199.6, 198.7, 196.7, 172.9, 171.2, 142.4, 142.3, 142.0, 141.2, 136.2, 135.8, 135.7, 135.3, 135.2, 134.7, 134.6, 133.1, 133.0, 1

30.9, 129.8, 129.4, 128.8, 128.7, 128.6, 128.5, 128.4, 127.8, 127.2, 127.1, 126.8, 126.7, 125.8, 125.0, 124.9, 123.5, 122.9, 122.6, 122.2, 75.9, 71.9, 69.1, 68.9, 68.4, 63.7, 63.4, 61.5, 60.9, 60.2, 53.0, 49.8, 43.2, 43.1, 13.8, 13.6; IR (KBr) υ: 2984, 1740, 1700, 1640, 1415, 1338, 761, 638 cm^{-1}; HRMS (ESI) Calcd. for $C_{58}H_{45}Cl_2N_2O_8$ ($[M+H]^+$): 967.2547, Found: 967.2559.

(4b'*R,6'*R**,7'*R**,17'*S**,18'*R**)-Diethyl 6',18'-di(*o*-bromophenyl)-1,1'',3,3''-tetraoxo-1,1'',3,3'',4b',6',7',8a',9',14a'-decahydro-14'*H*-dispiro[indene-2,5'-[14,9][1,2]epipyrrolobenzo[*b*]pyrrolo[1,2-*f*]phenanthridine-19',2''-indene]-7',17'-dicarboxylate (2l)**: white solid, 58%, m.p. 200 – 202 ℃; ^{1}H NMR (600 MHz, DMSO-d_6) δ: 8.20 – 8.19 (m, 1H, ArH), 8.01 – 7.96 (m, 2H, ArH), 7.90 – 7.85 (m, 2H, ArH), 7.79 – 7.77 (m, 1H, ArH), 7.72 – 7.68 (m, 2H, ArH), 7.59 – 7.52 (m, 3H, ArH),7.45 – 7.44 (m, 1H, ArH), 7.39 – 7.38 (m, 1H, ArH), 7.32 – 7.27 (m, 3H, ArH), 7.10 – 7.05 (m, 3H, ArH), 7.00 – 6.97 (m, 1H, ArH), 6.83 – 6.82 (m, 1H, ArH), 6.62 (m, 1H, ArH), 6.49 – 6.48 (m, 1H, ArH), 6.23 – 6.22 (m, 1H, ArH), 4.96 – 4.94 (m, 1H, CH), 4.58 – 4.57 (m, 1H, CH), 4.51 – 4.49 (m, 1H, CH), 4.44 – 4.43 (m, 1H, CH), 4.40 – 4.36 (m, 2H, CH), 4.27 – 4.26 (m, 1H, CH), 4.05 (m, 1H, CH), 3.98 – 3.96 (m, 1H, CH), 3.87 – 3.85 (m, 3H, CH), 3.81 – 3.78 (m, 1H, CH), 2.89 – 2.88 (m, 1H, CH), 0.77 – 0.76 (m, 6H, CH_3); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 199.7, 199.6, 198.7, 196.7, 172.8, 171.1, 142.5, 142.3, 141.9, 141.3, 136.8, 136.2, 135.8, 135.7, 135.2, 134.9, 133.1, 132.9, 132.1, 131.1, 129.9, 128.8, 128.7, 128.6, 128.4, 127.8, 127.5, 127.2, 126.8, 126.7, 126.0, 125.8, 125.4, 125.0, 124.9, 123.5, 122.9, 122.6, 122.2, 76.4, 72.0, 69.1, 68.9, 68.5, 63.8, 63.5, 61.5, 60.9, 60.2, 55.8, 52.8, 43.2, 43.1, 13.8, 13.6; IR (KBr) υ: 2980, 2867, 1741, 1702, 1641, 1416, 1333, 760, 728 cm^{-1}; HRMS (ESI) Calcd. for $C_{58}H_{45}Br_2N_2O_8$ ($[M+H]^+$): 1055.1540, Found: 1055.1533.

(4b'*R,6'*R**,7'*R**,17'*S**,18'*R**)-Diethyl 6',18'-di(*m*-methylphenyl)-1,1'',3,3''-tetraoxo-1,1'',3,3'',4b',6',7',8a',9',14a'-decahydro-14'*H*-dispiro[indene-2,5'-[14,9][1,2]epipyrrolobenzo[*b*]pyrrolo[1,2-*f*]phenanthridine-19',2''-indene]-7',17'-dicarboxylate (2m)**: white solid, 62%, m.p. 184 – 186 ℃; ^{1}H NMR (400 MHz, DMSO-d_6) δ: 8.07 – 8.05 (m, 1H, ArH), 7.96 – 7.90 (m, 2H, ArH), 7.84 (d, *J* = 7.6 Hz, 1H, ArH), 7.77 – 7.73 (m, 1H, ArH), 7.66 – 7.62 (m, 1H, ArH), 7.52 – 7.50 (m, 1H, ArH), 7.40 (d, *J* = 7.6 Hz, 1H, ArH), 7.33 (d, *J* = 7.6 Hz, 1H, ArH), 7.07 – 7.05 (m, 2H, ArH), 7.01 – 6.98 (m, 2H, ArH), 6.91 (m, 1H, ArH), 6.89 – 6.86 (m, 3H, ArH), 6.83 – 6.79 (m, 2H, ArH), 6.64 – 6.62 (m, 2H, ArH), 6.57 – 6.53 (m, 1H, ArH), 6.49 – 6.47 (m, 1H, ArH), 6.15 (d, *J* = 7.6 Hz, 1H, ArH), 4.50 (d, *J* = 9.2 Hz, 1H, CH), 4.43 – 4.41 (m, 2H, CH), 4.37 – 4.34 (m, 2H, CH), 4.24 (m, 1H, CH), 4.22 – 4.17 (m, 4H, CH), 3.86 – 3.80 (m, 1H, CH), 3.76 – 3.71 (m, 2H, CH), 2.91 – 2.90 (m, 1H, CH), 2.10 (s, 3H, CH_3), 2.05 (s, 3H, CH_3), 1.20 (t, *J* = 7.2 Hz, 3H, CH_3), 0.72 (t, *J* = 7.2 Hz, 3H, CH_3); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 200.6, 200.1, 199.3, 195.4, 173.7, 172.0, 143.5, 142.7, 142.4, 141.3, 137.8, 137.2, 136.7, 135.8, 135.7, 135.1, 134.9, 134.2, 133.4, 133.0, 129.5, 129.3, 128.9, 128.3, 128.2, 128.1, 127.8, 127.6, 127.5, 127.0, 126.7, 126.5, 125.9, 125.7, 125.6, 124.9, 124.7, 123.2, 122.8, 122.3, 122.2, 74.0, 72.2, 70.3, 68.3, 67.4, 66.4, 63.7, 61.7, 60.8, 60.7, 57.2, 52.4, 43.8, 43.0, 21.3, 21.2, 14.1, 13.8; IR (KBr) υ: 2983, 2857, 1732, 1701, 1639, 1415, 1352, 853, 758, 692 cm^{-1}; HRMS (ESI) Calcd. for $C_{60}H_{51}N_2O_8$ ($[M+H]^+$): 927.3640, Found: 927.3654.

(4b'*R,6'*R**,7'*R**,17'*S**,18'*R**)-Diethyl 6',18'-di(*m*-methoxyphenyl)-1,1'',3,3''-tetraoxo-1,1'',3,3'',4b',6',7',8a',9',14a'-decahydro-14'*H*-dispiro[indene-2,5'-[14,9][1,2]epipyrrolobenzo[*b*]pyrrolo[1,2-*f*]phenanthridine-19',2''-indene]-7',17'-dicarboxylate (2n)**: white solid, 75%, m.p. 186 – 189 ℃; ^{1}H NMR (600 MHz, DMSO-d_6) δ: 8.06 (d, *J* = 7.8 Hz, 1H, ArH), 7.96 – 7.91 (m, 2H, ArH), 7.85 (d, *J* = 7.8 Hz, 1H, ArH), 7.77 – 7.75 (m, 1H, ArH), 7.67 – 7.64 (m, 1H, ArH), 7.52 (d, *J* = 7.2 Hz, 1H, ArH), 7.41 (d, *J* = 7.8 Hz, 1H, ArH), 7.32 (d, *J* = 8.4 Hz, 1H, ArH), 7.06 – 7.04 (m, 2H, ArH), 7.02 – 7.01 (m, 1H, ArH), 7.00 – 6.98 (m, 1H, ArH), 6.95 (d, *J* = 7.8 Hz, 1H, ArH), 6.80 – 6.78 (m, 1H, ArH), 6.71 – 6.68 (m, 1H, ArH), 6.64 (d, *J* = 8.4 Hz, 2H, ArH), 6.59 – 6.58 (m, 1H, ArH), 6.56 – 6.54 (m, 1H, ArH), 6.50 – 6.49 (m, 1H, ArH), 6.39 (d, *J* = 7.8 Hz, 1H, ArH), 6.33 – 6.32 (m, 1H, ArH), 6.15 (d, *J* = 7.8 Hz, 1H, ArH), 4.53 (d, *J* = 8.4 Hz, 1H, CH), 4.41 – 4.40 (m, 2H, CH), 4.35 – 4.34 (m, 1H, CH), 4.32 – 4.30 (m, 1H, CH), 4.28 – 4.22 (m, 2H, CH), 4.21 – 4.19 (m, 2H, CH), 3.88 – 3.82 (m, 1H, CH), 3.78 – 3.73 (m, 1H, CH), 3.72 – 3.70 (m, 1H, CH), 3.61 – 3.59 (m, 1H, CH), 3.58 (s, 3H, OCH_3), 3.51 (s, 3 H, OCH_3), 2.92 – 2.91 (m, 1H, CH), 1.22 (t, *J* = 7.2 Hz, 3H, CH_3), 0.75 (t, *J* = 7.2 Hz, 3H, CH_3); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 200.5, 200.0, 199.3, 195.3, 173.6, 171.9, 159.3, 158.9, 143.6, 142.8, 142.7, 141.4, 136.7, 136.0, 135.8, 135.7, 135.2, 135.1, 134.9, 134.8, 133.1, 129.3, 129.0, 128.7, 128.3, 127.6, 127.1, 126.7, 126.6, 125.7, 124.9, 124.8, 123.3, 122.9, 122.4, 122.3, 121.1, 121.0, 114.5, 113.9, 113.4, 112.6, 73.9, 72.0, 70.4, 68.1, 67.4, 66.4, 63.6, 61.9, 60.9, 60.8, 57.2, 55.0, 54.9, 52.2, 43.9, 43.0, 14.2, 13.9; IR (KBr) υ: 2986, 2934, 2851, 1732, 1702, 1455, 1353, 780, 760, 692 cm^{-1}; HRMS (ESI) Calcd. for $C_{60}H_{51}N_2O_{10}$ ([M+H]$^+$): 959.3538, Found: 959.3548.

(4b'*R,6'*R**,7'*R**,17'*S**,18'*R**)-Diethyl 6',18'-di(*m*-chlorophenyl)-1,1'',3,3''-tetraoxo-1,1'',3,3'',4b',6',7',8a',9',14a'-decahydro-14'*H*-dispiro[indene-2,5'-[14,9][1,2]epipyrrolobenzo[*b*]pyrrolo[1,2-*f*]phenanthridine-19',2''-indene]-7',17'-dicarboxylate (2o)**: white solid, 73%, m.p. 181 – 183 ℃; ^{1}H NMR (400 MHz, DMSO-d_6) δ: 8.06 – 8.04 (m, 1H, ArH), 7.95 – 7.90 (m, 2H, ArH), 7.84 (d, *J* = 7.6 Hz, 1H, ArH), 7.77 – 7.73 (m, 1H, ArH), 7.66 – 7.62 (m, 1H, ArH), 7.52 – 7.50 (m, 1H, ArH), 7.49 (d, *J* = 7.6 Hz, 1H, ArH), 7.32 (d, *J* = 8.0 Hz, 1H, ArH), 7.21 – 7.20 (m, 1H, ArH), 7.14 – 7.12 (m, 2H, ArH), 7.10 – 7.07 (m, 2H, ArH), 7.05 – 7.02 (m, 3H, ArH), 6.99 – 6.95 (m, 1H, ArH), 6.84 – 6.83 (m, 1H, ArH), 6.82 – 6.80 (m, 2H, ArH), 6.55 – 6.51 (m, 1H, ArH), 6.49 – 6.47 (m, 1H, ArH), 6.14 (d, *J* = 7.6 Hz, 1H, ArH), 4.65 (d, *J* = 8.8 Hz, 1H, CH), 4.45 – 4.43 (m, 2H, CH), 4.33 – 4.31 (m, 2H, CH), 4.27 – 4.15 (m, 5H, CH), 3.91 – 3.82 (m, 1H, CH), 3.80 – 3.72 (m, 1H, CH), 3.68 – 3.66 (m, 1H, CH), 2.95 – 2.94 (m, 1H, CH), 1.17 (t, *J* = 7.2 Hz, 3H, CH_3), 0.72 (t, *J* = 7.2 Hz, 3H, CH_3); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 200.0, 199.5, 199.0, 195.2, 173.3, 171.6, 143.5, 142.7, 142.4, 141.3, 136.7, 135.9, 135.8, 135.6, 135.3, 135.1, 135.0, 134.1, 133.6, 132.9, 129.6, 129.0, 128.9, 128.8, 128.6, 128.3, 127.9, 127.6, 127.4, 127.3, 127.2, 126.9, 126.8, 126.7, 125.7, 125.0, 124.9, 123.4, 123.1, 122.5, 122.4, 74.0, 72.1, 70.4, 68.5, 67.4, 66.2, 63.7, 61.8, 61.0, 60.9, 56.4, 51.7, 43.8, 43.0, 14.1, 13.9; IR (KBr) υ: 2898, 2867, 1736, 1702, 1639, 1418, 1357, 791, 761, 717, 695 cm^{-1}; HRMS (ESI) Calcd. for $C_{58}H_{44}Cl_2N_2NaO_8$ ([M+Na]$^+$): 989.2367, Found: 989.2361.

(4b'*R,6'*R**,7'*R**,17'*S**,18'*R**)-Diethyl 6',18'-di(*p*-methylphenyl)-1,1'',3,3''-tetraoxo-1,1'',3,3''-4b',6',7',8a',9',14a'-decahydro-14'*H*-dispiro[indene-2,5'-[14,9][1,2]epipyrrolobenzo[*b*]pyrrolo[1,2-*f*]phenanthridine-19',2''-indene]-7',17'-dicarboxylate (2p)**: white solid, 79%, m.p. 185 – 187 ℃; ^{1}H NMR (600 MHz, DMSO-d_6) δ: 8.04 (d, *J* = 7.2 Hz, 1H, ArH), 7.95 – 7.90 (m, 2H, ArH), 7.83 (d, *J* = 7.2 Hz, 1H, ArH), 7.76 – 7.74 – 7.73 (m, 1H, ArH), 7.66 – 7.63 (m, 1H, ArH), 7.51 (d, *J* = 7.2 Hz, 1H, ArH), 7.40 (d, *J* = 7.8 Hz, 1H, ArH), 7.32 (d, *J* = 7.8 Hz, 1H, ArH), 7.06 – 7.04 (m, 2H, ArH), 7.00 – 6.96 (m, 3H, ArH), 6.91 (d, *J* = 7.8 Hz, 2H, ArH), 6.83 (d, *J* = 7.8 Hz, 2H, ArH), 6.80 – 6.78 (m, 1H, ArH), 6.72 (d, *J* = 7.8 Hz, 2H, ArH), 6.56 – 6.53 (m, 1H, ArH), 6.49 – 6.48 (m, 1H, ArH), 6.15 (d, *J* = 7.8 Hz, 1H, ArH), 4.48 (d, *J* = 9.0 Hz, 1H, CH), 4.41 (d, *J* = 12.0 Hz, 2H, CH), 4.34 – 4.32 (m, 2H, CH), 4.26 – 4.22 (m, 2H, CH), 4.19 – 4.15 (m, 3H, CH), 3.84 – 3.79 (m, 1H, CH), 3.76 – 3.70 (m, 2H, CH), 2.90 – 2.89 (m, 1H, CH), 2.08 (s, 3H, CH_3), 2.08 (s, 3H, CH_3), 1.20 (t, *J* = 7.2 Hz, 3H, CH_3), 0.72 (t, *J* = 7.2 Hz, 3H, CH_3); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 200.6, 200.1, 199.4, 195.5, 173.7, 172.0, 143.7, 142.8, 142.5, 141.4, 137.1, 136.7, 136.6, 135.9, 135.7, 135.1, 134.9, 134.8, 133.1, 131.3, 130.4, 129.1, 129.0, 128.7, 128.5, 128.3, 127.6, 127.0, 126.7, 126.5, 125.7, 124.9, 124.7, 123.3, 122.9, 122.3, 122.2, 74.0, 72.2, 70.4, 68.3, 67.6, 66.5, 63.6, 61.8, 60.8, 60.7, 56.9, 52.2, 43.9, 43.0, 20.9, 20.8, 14.8, 13.9; IR (KBr) υ: 2978, 1738, 1704, 1418, 1330, 802, 758 cm^{-1}; HRMS (ESI) Calcd. for $C_{60}H_{51}N_2O_8$ ([M+H]$^+$): 927.3640, Found: 927.3658.

(4b'*R,6'*R**,7'*R**,17'*S**,18'*R**)-Diethyl 6',18'-di(*p*-methoxyphenyl)-1,1'',3,3''-tetraoxo-1,1'',3,3''-4b',6',7',8a',9',14a'-decahydro-14'*H*-dispiro[indene-2,5'-[14,9][1,2]epipyrrolobenzo[*b*]pyrrolo[1,2-*f*]phenanthridine-19',2''-indene]-7',17'-dicarboxylate (2q)**: white solid, 80%, m.p. 186 – 189 ℃; ^{1}H NMR (400 MHz, DMSO-d_6) δ: 8.05 – 8.03 (m, 1H, ArH), 7.95 – 7.90 (m, 2H, ArH), 7.84 (d, *J* = 7.6 Hz, 1H, ArH), 7.77 – 7.74 (m, 1H, ArH), 7.67 – 7.63 (m, 1H, ArH), 7.53 – 7.51 (m, 1H, ArH), 7.41 (d, *J* = 7.6 Hz, 1H, ArH), 7.32 (d, *J* = 8.0 Hz, 1H, ArH), 7.07 – 7.05 (m, 2H, ArH), 7.02 – 6.97 (m, 3H, ArH), 6.80 – 6.75 (m, 3H, ArH), 6.66 (d, *J* = 7.2 Hz, 2H, ArH), 6.60 – 6.53 (m, 3H, ArH), 6.50 – 6.48 (m, 1H, ArH), 6.15 (d, *J* = 7.6 Hz, 1H, ArH), 4.45 (d, *J* = 8.8 Hz, 1H, CH), 4.40 – 4.38 (m, 2H, CH), 4.33 – 4.29 (m, 2H, CH), 4.25 – 4.14 (m, 5H, CH), 3.86 – 3.78 (m, 1H, CH), 3.75 – 3.70 (m, 2H, CH), 3.58 (s, 3H, OCH_3), 3.55 (s, 3H, OCH_3), 2.89 – 2.88 (m, 1H, CH), 1.19 (t, *J* = 7.2 Hz, 3H, CH_3), 0.72 (t, *J* = 7.2 Hz, 3H, CH_3); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 200.7, 200.1, 199.5, 195.6, 173.7, 172.0, 158.8, 158.5, 143.6, 142.9, 142.5, 141.4, 136.7, 135.9, 135.7, 135.1, 134.9, 134.8, 133.1, 130.0, 129.7, 129.2, 128.3, 127.6, 127.0, 126.7, 126.5, 126.2, 125.6, 125.4, 124.9, 124.8, 123.2, 122.8, 122.3, 122.2, 113.7, 113.1, 74.1, 72.2, 70.2, 68.0, 67.6, 66.7, 63.6, 61.9, 60.8, 60.7, 56.7, 55.0, 54.9, 52.1, 44.0, 43.0, 14.2, 13.9; IR (KBr) υ: 3001, 2935, 2906, 1738, 1701, 1640, 1461, 1417, 1351, 805, 758 cm^{-1}; HRMS (ESI) Calcd. for $C_{60}H_{51}N_2O_{10}$ ([M+H]$^+$): 959.3538, Found: 959.3548.

(4b'*R,6'*R**,7'*R**,17'*S**,18'*R**)-Diethyl 6',18'-di(*p*-chlorophenyl)-1,1'',3,3''-tetraoxo-1,1'',3,3''-4b',6',7',8a',9',14a'-decahydro-14'*H*-dispiro[indene-2,5'-[14,9][1,2]epipyrrolobenzo[*b*]pyrrolo[1,2-*f*]phenanthridine-19',2''-indene]-7',17'-dicarboxylate (2r)**: white solid, 82%, m.p. 183 – 185 ℃; ^{1}H NMR (400 MHz, DMSO-d_6) δ: 8.06 – 8.04 (m, 1H, ArH), 7.98 – 7.91

(m, 2H, ArH), 7.85 (d, *J* = 7.6 Hz, 1H, ArH), 7.79 – 7.75 (m, 1H, ArH), 7.68 – 7.64 (m, 1H, ArH), 7.54 – 7.52 (m, 1H, ArH), 7.41 (d, *J* = 7.6 Hz, 1H, ArH), 7.33 (d, *J* = 8.0 Hz, 1H, ArH), 7.21 – 7.19 (m, 2H, ArH), 7.16 – 7.14 (m, 3H, ArH), 7.12 (m, 1H, ArH), 7.07 – 7.05 (m, 2H, ArH), 7.01 – 6.98 (m, 1H, ArH), 6.88 – 6.85 (m, 2H, ArH), 6.82 – 6.80 (m, 1H, ArH), 6.57 – 6.53 (m, 1H, ArH), 6.51 – 6.48 (m, 1H, ArH), 6.16 (d, *J* = 7.6 Hz, 1H, ArH), 4.58 (d, *J* = 8.8 Hz, 1H, CH), 4.45 – 4.44 (m, 2H, CH), 4.34 – 4.32 (m, 2H, CH), 4.27 (d, *J* = 8.8 Hz, 1H, CH), 4.25 – 4.22 (m, 2H, CH), 4.21 – 4.19 (m, 1H, CH), 4.18 – 4.15 (m, 1H, CH), 3.88 – 3.84 (m, 1H, CH), 3.78 – 3.74 (m, 1H, CH), 3.71 – 3.68 (m, 1H, CH), 2.94 – 2.93 (m, 1H, CH), 1.20 (t, *J* = 7.2 Hz, 3H, CH_3), 0.73 (t, *J* = 7.2 Hz, 3H, CH_3); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 200.2, 199.7, 199.2, 195.3, 173.7, 171.7, 143.5, 142.7, 142.4, 141.2, 136.6, 136.0, 135.6, 135.4, 135.2, 135.1, 133.5, 133.0, 132.9, 132.1, 130.3, 130.0, 128.7, 128.5, 128.3, 128.0, 127.6, 127.2, 126.8, 126.6, 125.7, 125.0, 124.8, 123.4, 123.0, 122.4, 122.3, 73.9, 72.1, 70.4, 68.4, 67.5, 66.4, 63.7, 61.8, 61.0, 60.9, 56.3, 51.7, 43.9, 43.0, 14.2, 13.9; IR (KBr) υ: 2925, 1736, 1702, 1415, 1345 cm^{-1}; HRMS (ESI) Calcd. for $C_{58}H_{45}Cl_2N_2O_8$ ($[M+H]^+$): 967.2547 Found: 967.2554.

(4b'*R,6'*R**,7'*R**,17'*S**,18'*R**)-Diethyl 6',18'-di(*p*-bromophenyl)-1,1'',3,3''-tetraoxo-1,1'',3,3'',4b',6',7',8a',9',14a'-decahydro-14'*H*-dispiro[indene-2,5'-[14,9][1,2]epipyrrolobenzo[*b*]pyrrolo[1,2-*f*]phenanthridine-19',2''-indene]-7',17'-dicarboxylate (2s)**: white solid, 74%, m.p. 190 – 192 ℃; ^1H NMR (600 MHz, DMSO-d_6) δ: 8.01 – 7.99 (m, 1H, ArH), 7.96 – 7.93 (m, 3H, ArH), 7.83 – 7.81 (m, 1H, ArH), 7.67 – 7.64 (m, 1H, ArH), 7.58 – 7.57 (m, 1H, ArH), 7.50 (d, *J* = 7.2 Hz, 1H, ArH), 7.47 – 7.45 (m, 2H, ArH), 7.33 – 7.30 (m, 2H, ArH), 7.27 (d, *J* = 8.4 Hz, 2H, ArH), 7.21 (d, *J* = 8.4 Hz, 2H, ArH), 7.06 – 7.04 (m, 1H, ArH), 7.03 – 7.01 (m, 2H, ArH), 6.90 (d, *J* = 7.2 Hz, 1H, ArH), 6.79 – 6.77 (m, 1H, ArH), 6.70 – 6.68 (m, 2H, ArH), 6.59 (d, *J* = 7.8 Hz, 1H, ArH), 5.07 – 5.05 (m, 1H, CH), 4.60 – 4.58 (m, 1H, CH), 4.53 – 4.52 (m, 1H, CH), 4.40 – 4.37 (m, 2H, CH), 4.18 (d, *J* = 11.4 Hz, 1H, CH), 4.13 – 4.07 (m, 1H, CH), 4.00 – 3.94 (m, 1H, CH), 3.91 – 3.84 (m, 3H, CH), 3.67 – 3.65 (m, 1H, CH), 2.88 (d, *J* = 10.8 Hz, 1H, CH), 2.80 – 2.79 (m, 1H, CH), 1.08 (t, *J* = 7.2 Hz, 3H, CH_3), 1.04 (t, *J* = 7.2 Hz, 3H, CH_3); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 200.2, 199.7, 199.1, 196.1, 173.1, 170.9, 143.3, 142.6, 142.5, 141.6, 139.5, 136.8, 135.6, 135.7, 135.4, 135.3, 134.9, 134.1, 134.0, 133.2, 131.5, 130.9, 130.5, 130.3, 128.9, 127.8, 127.5, 127.2, 127.1, 127.0, 125.5, 125.0, 124.6, 123.2, 122.8, 122.6, 122.4, 121.6, 75.5, 72.9, 70.7, 67.5, 66.5(2C), 61.5, 61.3, 61.1, 60.8, 57.0, 50.1, 43.5, 40.5, 14.2, 13.9; IR (KBr) υ: 2980, 1740, 1701, 1640, 1415, 1344 cm^{-1}; HRMS (ESI) Calcd. for $C_{58}H_{45}Br_2N_2O_8$ ($[M+H]^+$): 1055.1540, Found: 1055.1533.

(4b'*R,6'*R**,7'*R**,17'*S**,18'*R**)-Di(*tert*-butyl) 6',18'-diphenyl-1,1'',3,3''-tetraoxo-1,1'',3,3'',4b',6',7',8a',9',14a'-decahydro-14'*H*- dispiro[indene-2,5'-[14,9][1,2]epipyrrolobenzo[*b*]pyrrolo[1,2-*f*]phenanthridine-19',2''-indene]-7',17'-dicarboxylate (2t)**: white solid, 53%, m.p. 180 – 182 ℃; ^1H NMR (600 MHz, $CDCl_3$) δ: 7.92 – 7.91 (m, 1H, ArH), 7.73 – 7.70 (m, 3H, ArH), 7.54 – 7.53 (m, 2H, ArH), 7.45 (t, *J* = 7.2 Hz, 1H, ArH), 7.35 (d, *J* = 7.2 Hz, 1H, ArH), 7.29 – 7.28 (m, 1H, ArH), 7.11 – 7.08 (m, 4H, ArH), 7.05 (t, *J* = 6.0 Hz, 2H, ArH), 7.02 – 7.00 (m, 2H, ArH), 6.96 – 6.92 (m, 5H, ArH), 6.80 – 6.76 (m, 2H, ArH),

6.44 (t, *J* = 6.6 Hz, 1H, ArH), 6.17 – 6.16 (m, 1H, ArH), 4.59 – 4.48 (m, 3H, CH), 4.44 – 4.36 (m, 3H, CH), 4.19 – 4.06 (m, 3H, CH), 2.84 – 2.82 (m, 1H, CH), 1.38 (s, 9H, $3CH_3$), 1.05 (s, 9H, $3CH_3$); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 200.5, 200.1, 199.2, 195.5, 173.2, 171.1, 143.7, 142.9, 142.5, 141.3, 136.8, 135.9, 135.7, 135.1, 134.8, 134.7, 134.4, 134.1, 133.2, 129.4, 129.0, 128.7, 128.6, 128.1, 127.7, 127.6, 127.4, 126.9, 126.8, 126.7, 126.5, 125.5, 124.8, 124.7, 123.3, 122.8, 122.3, 122.2, 81.0, 80.7, 74.8, 71.8, 70.6, 67.9, 67.6, 67.0, 63.5, 62.1, 57.8, 52.3, 44.1, 42.8, 28.0, 27.6; IR (KBr) υ: 3032, 2976, 2923, 2868, 1736, 1703, 1594, 1491, 1459, 1362, 1252, 1148, 1045, 971, 928, 843, 760 cm^{-1}; HR MS (ESI) Calcd. for $C_{62}H_{55}N_2O_8$ ($[M+H]^+$): 955.3953, Found: 955.3966.

(4b'*R,6'*R**,7'*R**,17'*S**,18'*R**)-Di(*tert*-butyl) 6',18'-di(*p*-methoxyphenyl)-1,1'',3,3''-tetraoxo-1,1'',3,3'',4b',6',7',8a',9',14a'-decahydro-14'*H*-dispiro[indene-2,5'-[14,9][1,2]epipyrrolobenzo[*b*]pyrrolo[1,2-*f*]phenanthridine-19',2''-indene]-7',17'-dicarboxylate (2u)**: white solid, 61%, m.p. 173 – 175 ℃; ^1H NMR (400 MHz, DMSO-d_6) δ: 8.02 – 8.00 (m, 1H, ArH), 7.94 – 7.88 (m, 2H, ArH), 7.83 (d, *J* = 7.6 Hz, 1H, ArH), 7.75 (t, *J* = 7.2 Hz, 1H, ArH), 7.66 (t, *J* = 7.2 Hz, 1H, ArH), 7.53 – 7.51 (m, 1H, ArH), 7.44 (d, *J* = 7.6 Hz, 1H, ArH), 7.26 (d, *J* = 8.0 Hz, 1H, ArH), 7.07 – 7.05 (m, 2H, ArH), 7.02 (d, *J* = 7.2 Hz, 1H, ArH), 6.99 – 6.96 (m, 2H, ArH), 6.77 – 6.73 (m, 3H, ArH), 6.67 – 6.65 (m, 2H, ArH), 6.61 – 6.58 (m, 3H, ArH), 6.54 (t, *J* = 8.0 Hz, 1H, ArH), 6.12 (d, *J* = 7.6 Hz, 1H, ArH), 4.41 – 4.40 (m, 1H, CH), 4.35 – 4.33 (m, 2H, CH), 4.27 (d, *J* = 9.2 Hz, 1H, CH), 4.20 (d, *J* = 11.8 Hz, 1H, CH), 4.10 – 4.07 (m, 2H, CH), 4.04 – 4.02 (m, 1H, CH), 3.72 (d, *J* = 9.6 Hz, 1H, CH), 3.57 (s, 3H, OCH_3), 3.54 (s, 3H, OCH_3), 2.77 – 2.76 (m, 1H, CH), 1.42 (s, 9H, $3CH_3$), 1.00 (s, 9H, $3CH_3$); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 200.8, 200.3, 199.6, 195.8, 173.4, 171.3, 158.7, 158.3, 143.7, 142.9, 142.5, 141.3, 136.8, 135.9, 135.8, 135.2, 134.9, 134.8, 133.2, 130.2, 129.7, 129.4, 128.6, 127.7, 126.9, 126.6, 126.5, 126.3, 126.0, 125.5, 124.8, 124.7, 123.3, 122.8, 122.4, 122.3, 113.5, 113.0, 81.1, 80.7, 75.1, 71.8, 70.3, 67.8, 67.6, 67.1, 63.5, 62.0, 57.3, 55.0, 54.9, 51.9, 44.1, 42.7, 28.0, 27.7; IR (KBr) υ: 2972, 2931, 1736, 1703, 1602, 1513, 1460, 1363, 1251, 1149, 1036, 958, 837, 758 cm^{-1}; HRMS (ESI) Calcd. for $C_{64}H_{59}N_2O_{10}$ ($[M+H]^+$): 1015.4164, Found: 1015.4251.

(4b'*R,6'*R**,7'*R**,17'*S**,18'*R**)-Di(*tert*-butyl) 6',18'-di(*p*-chlorophenyl)-1,1'',3,3''-tetraoxo-1,1'',3,3'',4b',6',7',8a',9',14a'-decahydro-14'*H*-dispiro[indene-2,5'-[14,9][1,2]epipyrrolobenzo[*b*]pyrrolo[1,2-*f*]phenanthridine-19',2''-indene]-7',17'-dicarboxylate (2v)**: white solid, 56%, m.p. 188 – 190 ℃; ^1H NMR (400 MHz, $CDCl_3$) δ: 7.92 – 7.90 (m, 1H, ArH), 7.74 – 7.71 (m, 3H, ArH), 7.58 – 7.53 (m, 2H, ArH), 7.47 (t, *J* = 7.2 Hz, 1H, ArH), 7.35 (d, *J* = 8.0 Hz, 1H, ArH), 7.27 – 7.25 (m, 1H, ArH), 7.12 – 7.10 (m, 2H, ArH), 7.06 – 7.02 (m, 4H, ArH), 6.98 – 6.95 (m, 4H, ArH), 6.91 (t, *J* = 8.0 Hz, 1H, ArH), 6.78 – 6.74 (m, 2H, ArH), 6.42 (d, *J* = 7.2 Hz, 1H, ArH), 6.14 (d, *J* = 7.6 Hz, 1H, ArH), 4.57 – 4.56 (m, 1H, CH), 4.50 – 4.49 (m, 1H, CH), 4.43 (d, *J* = 11.6 Hz, 2H, CH), 4.32 – 4.28 (m, 2H, CH), 4.16 (d, *J* = 9.6 Hz, 1H, CH),4.07 – 4.02 (m, 2H, CH), 2.77 – 2.76 (m, 1H, CH), 1.40 (s, 9H, $3CH_3$), 1.08 (s, 9H, $3CH_3$); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 200.2, 199.8, 199.2, 195.4, 173.0, 170.8, 143.6, 142.7, 142.4, 141.2, 136.7, 135.9, 135.7, 135.3, 135.1, 135.0, 133.4, 133.1, 132.8, 132.7, 130.4, 130.0, 129.0, 128.6, 128.4, 127.8, 127.6, 127.0, 126.7, 126.6, 125.5, 124.9, 124.7, 123.4, 122.9, 122.4, 122.3, 81.3, 81.0, 74.8, 71.7, 70.5,

68.1, 67.6, 66.9, 63.5, 62.0, 56.9, 51.6, 44.1, 42.8, 28.0, 27.7; IR (KBr) υ: 2972, 2928, 1 736, 1704, 1596, 1491, 1461, 1361, 1252, 1149, 1100, 1046, 1018, 972, 838, 760, 716 c m^{-1}; HRMS (ESI) Calcd. for $C_{62}H_{53}Cl_2N_2O_8$ ($[M+H]^+$): 1023.3173, Found: 1023.3188.

(4b'*R,6'*R**,7'*R**,17'*S**,18'*R**)-7',17'-Dibenzoyl-6',18'-diphenyl-1,1'',3,3''-tetraoxo-1,1'',3,3'',4b',6',7',8a',9',14a'-decahydro-14'*H*-dispiro[indene-2,5'-[14,9][1,2]epipyrrolobenzo[*b*]pyrrolo[1,2-*f*]phenanthridine-19',2''-indene]-dicarboxylate (2w)**: white solid, 34%, m.p. 181 – 183 ℃; ^{1}H NMR (600 MHz, DMSO-d_6) δ: 8.16 (d, *J* = 7.8 Hz, 2H, ArH), 7.93 – 7.90 (m, 1H, ArH), 7.89 – 7.88 (m, 1H, ArH), 7.87 – 7.86 (m, 2H, ArH), 7.83 (d, *J* = 7.8 Hz, 1H, ArH), 7.78 – 7.76 (m, 2H, ArH), 7.74 – 7.73 (m, 1H, ArH), 7.70 – 7.68 (m, 2H, ArH), 7.63 – 7.61 (m, 1H, ArH), 7.50 – 7.47 (m, 1H, ArH), 7.41 – 7.39 (m, 1H, ArH), 7.25 – 7.23 (m, 3H, ArH), 7.20 – 7.19 (m, 2H, ArH), 7.11 – 7.06 (m, 4H, ArH), 7.03 (d, *J* = 7.8 Hz, 1H, ArH), 6.99 – 6.96 (m, 1H, ArH), 6.91 – 6.90 (m, 4H, ArH), 6.86 – 6.84 (m, 1H, ArH), 6.79 (d, *J* = 7.2 Hz, 1H, ArH), 6.76 – 6.74 (m, 2H, ArH), 6.54 – 6.52 (m, 1H, ArH), 6.21 (d, *J* = 7.8 Hz, 1H, ArH), 5.93 (d, *J* = 7.2 Hz, 1H, CH), 5.56 (d, *J* = 9.0 Hz, 1H, CH), 5.10 (d, *J* = 11.4 Hz, 1H, CH), 4.58 – 4.57 (m, 1H, CH), 4.53 – 4.52 (m, 1H, CH), 4.49 – 4.47 (m, 1H, CH), 4.39 (d, *J* = 11.4 Hz, 1H, CH), 4.37 (d, *J* = 8.4 Hz, 1H, CH), 4.12 – 4.11 (m, 1H, CH), 3.62 (d, *J* = 7.8 Hz, 1H, CH); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 202.2, 200.3, 200.2, 199.7, 199.6, 195.4, 143.2, 142.8, 142.5, 141.0, 137.3, 136.6, 136.4, 135.6, 135.5, 135.1, 135.0, 134.8, 134.1, 133.1, 133.0, 132.9, 132.7, 129.0, 128.9, 128.8, 128.7, 128.6, 128.5, 128.4, 128.1, 127.7, 127.6, 127.4, 127.1, 127.0, 126.8, 126.6, 125.3, 125.0, 124.8, 124.7, 123.0, 122.8, 122.7, 122.4, 122.3, 75.6, 72.6, 70.1, 68.9, 68.5, 67.6, 64.3, 61.8, 58.3, 53.6, 44.6, 43.1; IR (KBr) υ: 2949, 2855, 1735, 1698, 761, 730, 700, 661 cm^{-1}; HRMS (ESI) Calcd. for $C_{66}H_{47}N_2O_6$ ($[M+H]^+$): 963.3429, Found: 963.3431.

(4b'*R,6'*R**,7'*R**,17'*S**,18'*R**)-7',17'-Dibenzoyl-6',18'-di(4-methylphenyl)-1,1'',3,3''-tetraoxo-1,1'',3,3'',4b',6',7',8a',9',14a'-decahydro-14'*H*-dispiro[indene-2,5'-[14,9][1,2]epipyrrolobenzo[*b*]pyrrolo[1,2-*f*]phenanthridine-19',2''-indene]-dicarboxylate (2x)**: white solid, 30%, m.p. 172 – 175 ℃; ^{1}H NMR (600 MHz, DMSO-d_6) δ: 7.93 – 7.92 (m, 1H, ArH), 7.80 – 7.78 (m, 3H, ArH), 7.75 – 7.73 (m, 2H, ArH), 7.70 – 7.69 (m, 1H, ArH), 7.63 – 7.61 (m, 1H, ArH), 7.50 – 7.48 (m, 6H, ArH), 7.34 – 7.33 (m, 2H, ArH), 7.30 – 7.28 (m, 3H, ArH), 7.24 (m, 2H, ArH), 7.07 – 7.03 (m, 3H, ArH), 6.83 – 6.82 (m, 2H, ArH), 6.68 – 6.67 (m, 3H, ArH), 6.62 – 6.61 (m, 2H, ArH), 6.51 – 6.50 (m, 2H, ArH), 6.46 – 6.45 (m, 1H, ArH), 5.46 – 5.42 (m, 2H, CH), 4.69 (d, *J* = 11.4 Hz, 1H, CH), 4.50 – 4.49 (m, 1H, CH), 4.39 (d, *J* = 7.8 Hz, 1H, CH), 4.35 – 4.34 (m, 1H, CH), 3.91 (d, *J* = 10.2 Hz, 1H, CH), 3.84 (d, *J* = 9.6 Hz, 1H, CH), 2.95 (d, *J* = 10.8 Hz, 1H, CH), 2.29 – 2.27 (m, 1H, CH), 2.01 (s, 3H, CH_3), 1.94 (s, 3H, CH_3); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 201.3, 201.1, 200.4, 200.1, 199.1, 195.8, 143.0, 142.7, 142.6, 141.2, 138.9, 137.3, 136.9, 136.4, 135.9, 135.5, 135.2, 135.1, 134.4, 133.8, 132.9, 131.8, 131.0, 129.9, 129.1, 128.9, 128.7, 128.6, 128.5, 128.4, 128.3, 128.2, 127.9, 127.6, 127.4, 127.3, 126.9, 126.6, 125.3, 125.2, 124.8, 122.9, 122.7, 122.5, 122.2, 73.4, 73.2, 70.1, 67.4, 65.5, 65.4, 62.0, 61.8, 58.2, 52.4, 45.1, 39.7, 20.8, 20.7; IR (KBr) υ: 2919, 2900, 1739, 1699, 1640, 1415, 1348, 844, 785, 761, 732, 669 cm^{-1}; HRMS (ESI) Calcd. for $C_{68}H_{50}N_2NaO_6$ ($[M+Na]^+$): 1013.3560, Found: 1013.3558.

(2*R,3*R**)-2-(4-Nitrophenyl)-3-(*p*-tolyl)spiro[cyclopropane-1,2'-indene]-1',3'-dione** (**3a**): white solid, 61%, m.p. 152 – 154 ℃;^{1}H NMR (600 MHz, DMSO-d_6) δ: 8.17 (d, *J* = 7.8 Hz, 2H,

ArH), 7.90 – 7.84 (m, 4H, ArH), 7.76 (d, *J* = 7.8 Hz, 2H, ArH), 7.32 (d, *J* = 7.2 Hz, 2H, ArH), 7.13 (d, *J* = 6.6 Hz, 2H, ArH), 4.27 (d, *J* = 8.4 Hz, 1H, CH), 4.16 (d, *J* = 8.4 Hz, 1H, CH), 2.30 (s, 3H, CH_3); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 195.2, 194.7, 147.3, 142.0, 141.9, 141.6, 138.0, 135.1, 135.0, 130.2, 129.7, 129.2, 129.0, 123.5, 122.7, 122.6, 48.3, 43.5, 41.4, 21.2; IR (KBr) υ: 3046, 2920, 2858, 1737, 1702, 1599, 1517, 1445, 1403, 1348, 0288, 1213, 1181, 1157, 1110, 1076, 1039, 1013, 981, 885, 854, 813, 748, 694 cm^{-1}; HRMS (ESI) Calcd. for $C_{24}H_{17}NNaO_8$ ([M+Na]$^+$): 406.1050, Found: 406.1061.

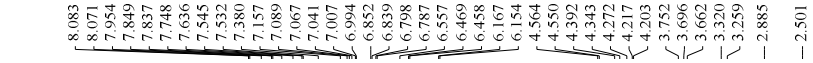
(2*R,3*R**)-2-(4-Bromophenyl)-3-(4-nitrophenyl)spiro[cyclopropane-1,2'-indene]-1',3'-dione (3b):** white solid, 57%, m.p. 195 – 198 ℃; ^{1}H NMR (600 MHz, DMSO-d_6) δ: 8.17 (d, *J* = 8.4 Hz, 2H, ArH), 7.91 – 7.90 (m, 2H, ArH), 7.85 – 7.84 (m, 2H, ArH), 7.77 (d, *J* = 8.4 Hz, 2H, ArH), 7.52 (d, *J* = 8.4 Hz, 2H, ArH), 7.44 (d, *J* = 7.8 Hz, 2H, ArH), 4.27 (d, *J* = 9.0 Hz, 1H, CH), 4.19 (d, *J* = 9.0 Hz, 1H, CH); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 194.8, 194.5, 147.4, 142.0, 141.9, 141.0, 135.3, 135.2, 131.9, 131.6, 130.8, 130.1, 123.5, 122.8, 122.7, 122.3, 48.0, 42.4, 41.3; IR (KBr) υ: 3072, 2945, 2848, 1734, 1703, 1598, 1515, 1490, 1448, 1397, 1344, 1286, 1216, 1181, 1155, 1108, 1078, 1043, 1009, 971, 882, 845, 812, 747, 697 cm^{-1}; HRMS (ESI) Calcd. for $C_{23}H_{15}BrNO_4$ ([M+H]$^+$): 448.0179, Found: 448.0185.

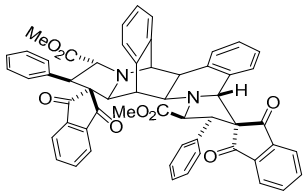
(2*R,3*R**)-2-(4-Chlorophenyl)-3-(4-nitrophenyl)spiro[cyclopropane-1,2'-indene]-1',3'-dione (3c)**: white solid, 75%, m.p. 161 – 163 ℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.22 – 8.20 (m, 2H, ArH), 7.89 – 7.84 (m, 2H, ArH), 7.82 – 7.79 (m, 2H, ArH), 7.57 – 7.55 (m, 2H, ArH), 7.35 – 7.30 (m, 4H, ArH), 4.14 (d, *J* = 8.8 Hz, 1H, CH), 4.10 (d, *J* = 8.8 Hz, 1H, CH); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 194.9, 194.5, 147.4, 142.0, 141.9, 141.0, 135.3, 135.2, 134.1, 131.3, 130.4, 130.1, 128.6, 123.5, 122.8, 122.7, 48.0, 42.3, 41.3; IR (KBr) υ: 3080, 1735, 1701, 1598, 1519, 1492, 1445, 1401, 1347, 1288, 1219, 1154, 1085, 1039, 1012, 850, 751, 695 cm^{-1}; HRMS (ESI) Calcd. for $C_{23}H_{15}ClNO_4$ ([M+H]$^+$): 404.0684, Found: 404.0687.

(2*R,3*R**)-2,3-Bis(4-nitrophenyl)spiro[cyclopropane-1,2'-indene]-1',3'-dione** (**3d**): white solid, 53%, m.p. 178 – 180 ℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.24 – 8.21 (m, 4H, ArH), 7.90 – 7.87 (m, 2H, ArH), 7.85 – 7.82 (m, 2H, ArH), 7.60 – 7.56 (m, 4H, ArH), 4.18 (s, 2H, CH); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 194.3, 147.5, 141.9, 140.4, 135.6, 130.1, 123.6, 123.0, 47.9, 41.3; IR (KBr) υ: 3080, 2851, 1736, 1697, 1599, 1515, 1404, 1347, 1288, 1214, 1180, 1108, 1079, 1037, 1013, 977, 890, 855, 812, 746, 696 cm^{-1}; HRMS (ESI) Calcd. for $C_{23}H_{15}N_2O_6$ ([M+H]$^+$): 415.0925, Found: 415.0923.

(2*R,3*R**)-2-(3-Methoxyphenyl)-3-(4-nitrophenyl)spiro[cyclopropane-1,2'-indene]-1',3'-dion e** (**3e**): white solid, 58%, m.p. 164 – 166 ℃; ^{1}H NMR (400 MHz, $CDCl_3$) δ: 8.21 (d, *J* = 8.8 Hz, 2H, ArH), 7.89 – 7.84 (m, 2H, ArH), 7.81 – 7.78 (m, 2H, ArH), 7.57 (d, *J* = 8.4 Hz, 2H, ArH), 7.28 (t, *J* = 8.0 Hz, 1H, ArH), 6.97 (d, *J* = 8.0 Hz, 1H, ArH), 6.92 – 6.91 (m, 1H, ArH), 6.88 – 6.85 (m, 1H, ArH), 4.17 (d, *J* = 9.6 Hz, 1H, CH), 4.13 (d, *J* = 9.6 Hz, 1H, CH), 3.80 (s, 3H, OCH_3); ^{13}C NMR (100 MHz, $CDCl_3$) δ: 195.2, 194.5, 159.5, 147.4, 142.1, 141.8, 141.4, 135.2, 135.1, 134.3, 130.2, 129.4, 123.5, 122.8, 122.7, 121.4, 115.0, 113.4, 55.2, 48.2, 43.4, 41.5; IR (KBr) υ: 3072, 3006, 2940, 2838, 1740, 1703, 1597, 1511, 1460, 1429, 1346, 1282, 1207, 1168, 1087, 1039, 1012, 987, 880, 854, 791, 747, 694 cm^{-1}; HRMS (ESI) Calcd. for $C_{24}H_{18}NO_5$ ([M+H]$^+$): 400.1179,

Found: 400.1184.





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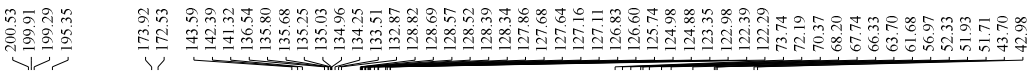
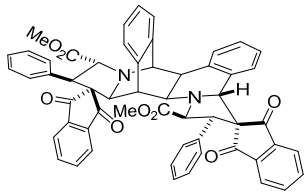
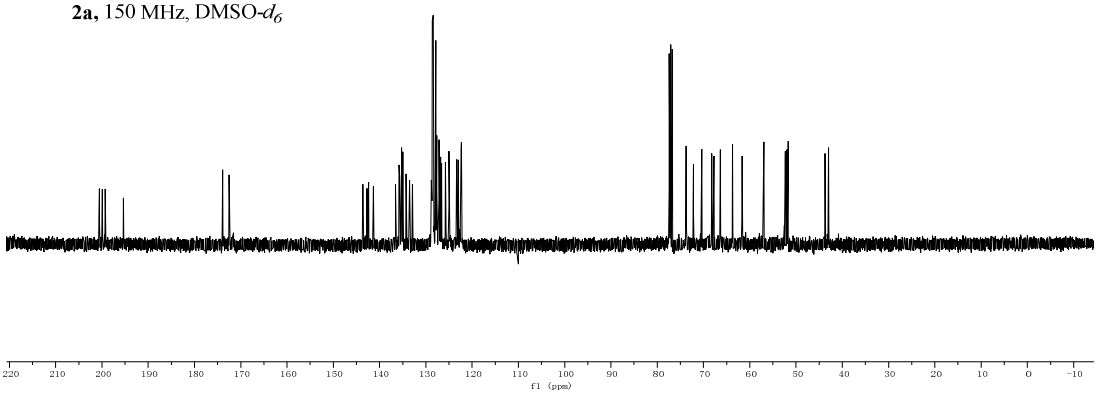
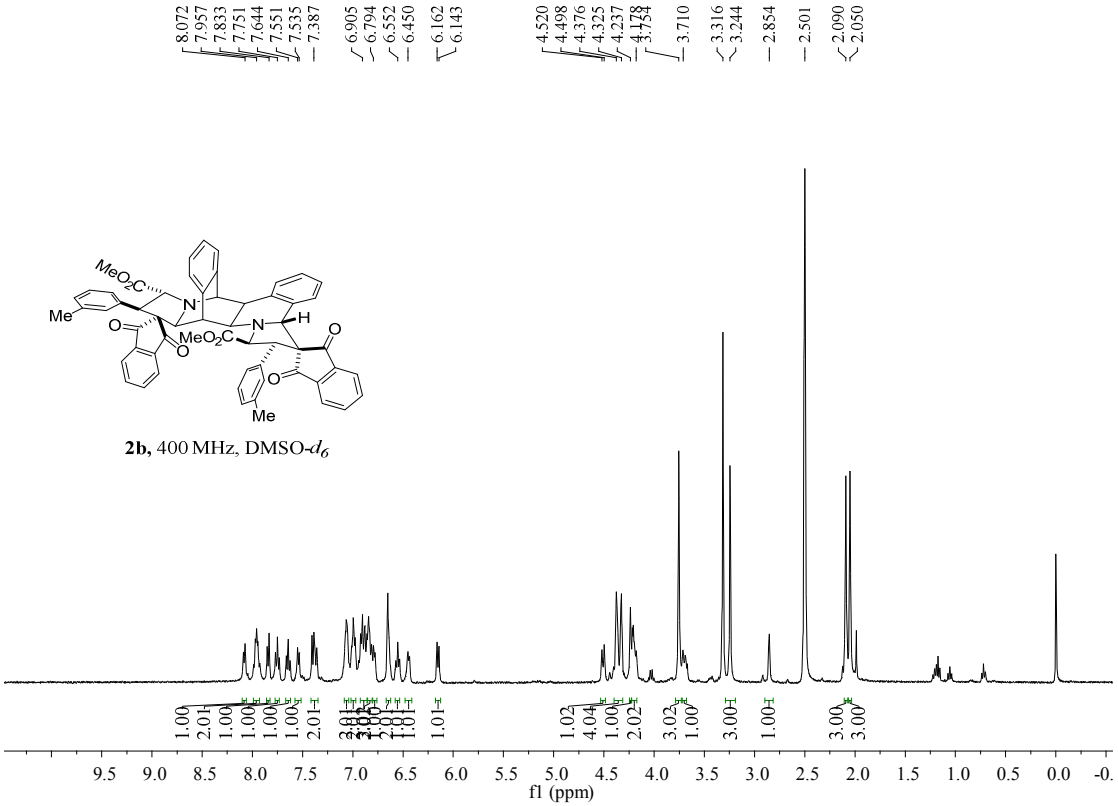


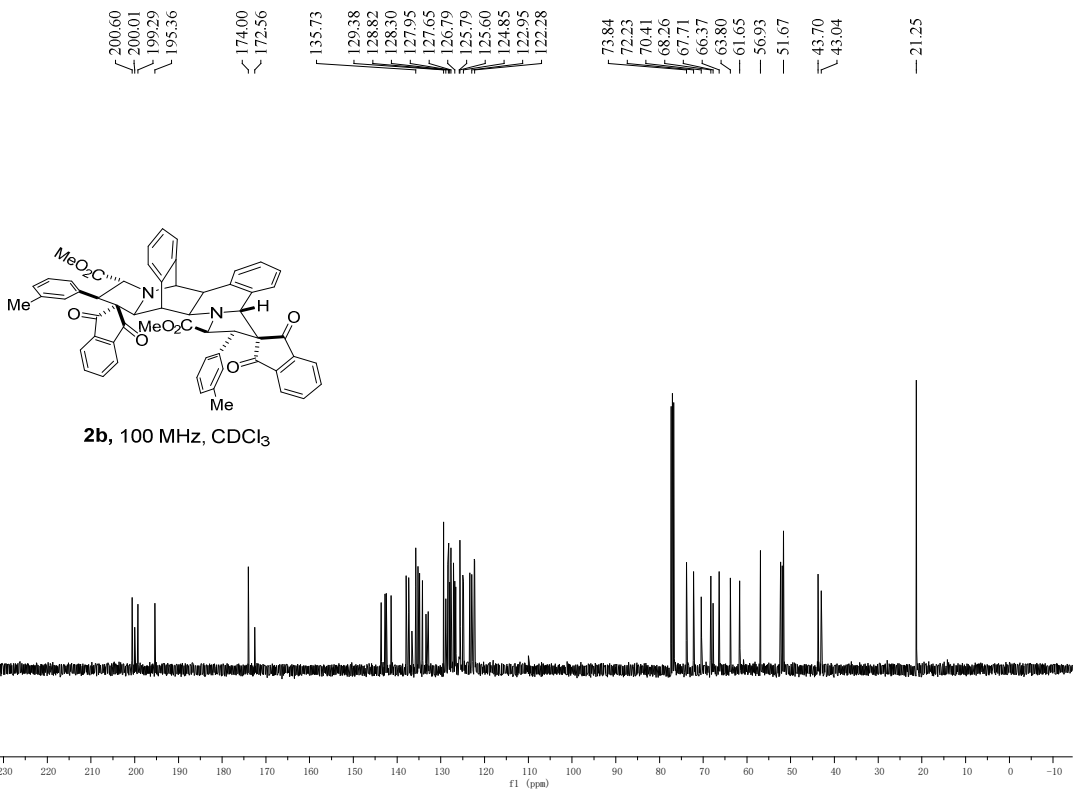


2a, 150 MHz, DMSO-d_6

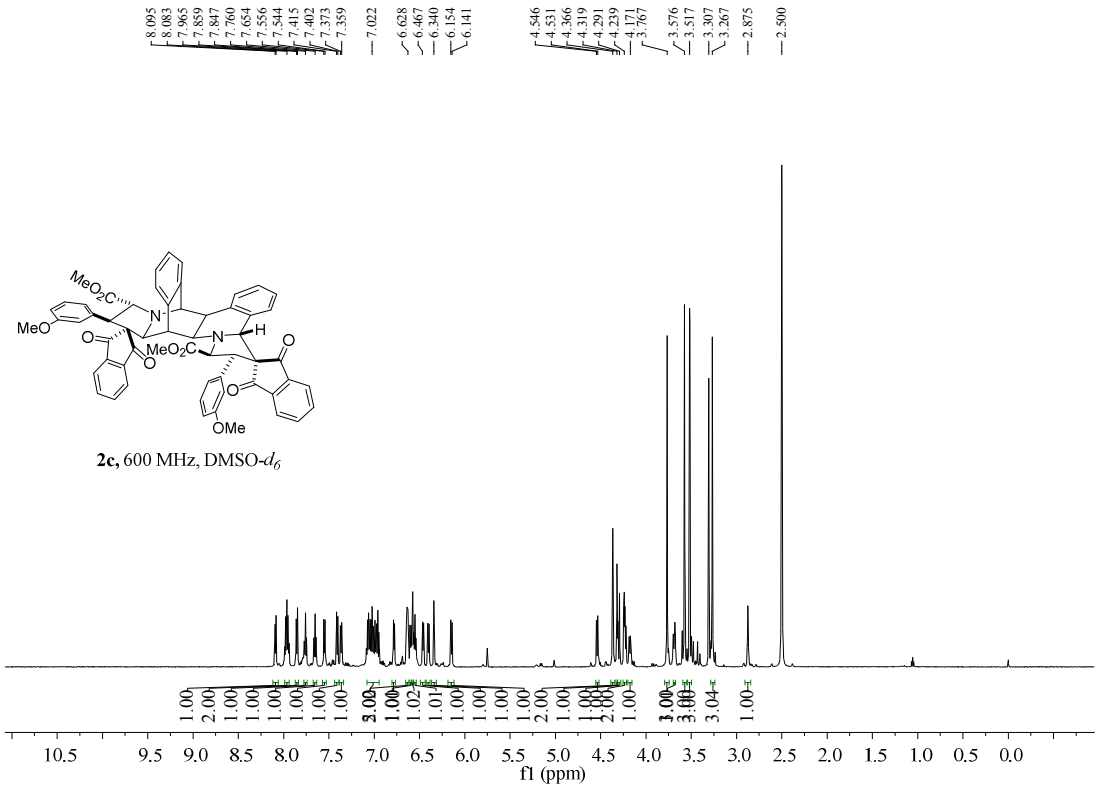




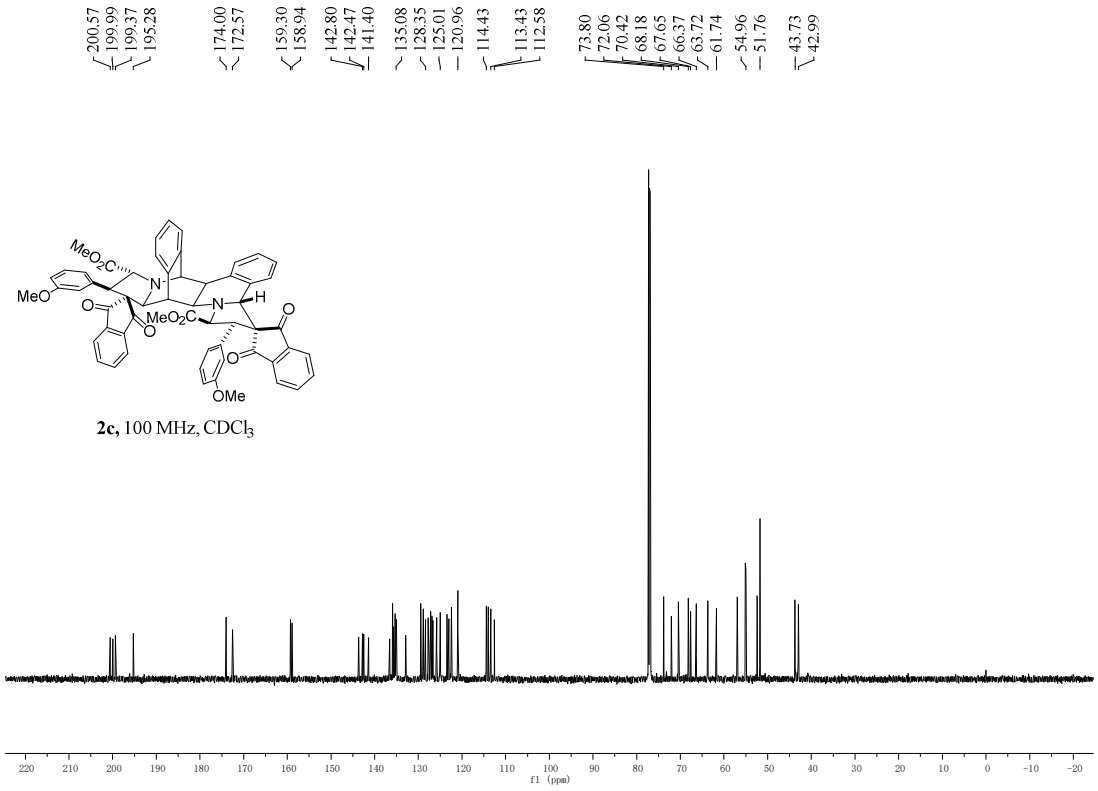
2b, 400 MHz, DMSO-d_6



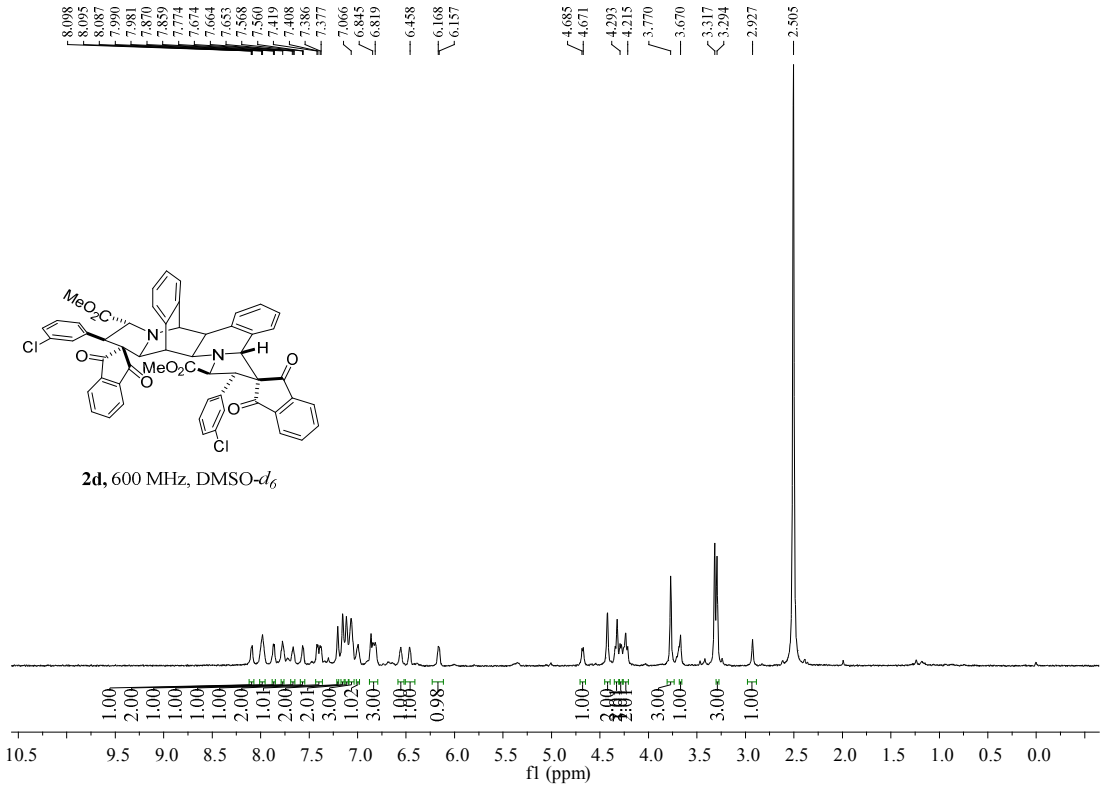
2b, 100 MHz, $CDCl_3$



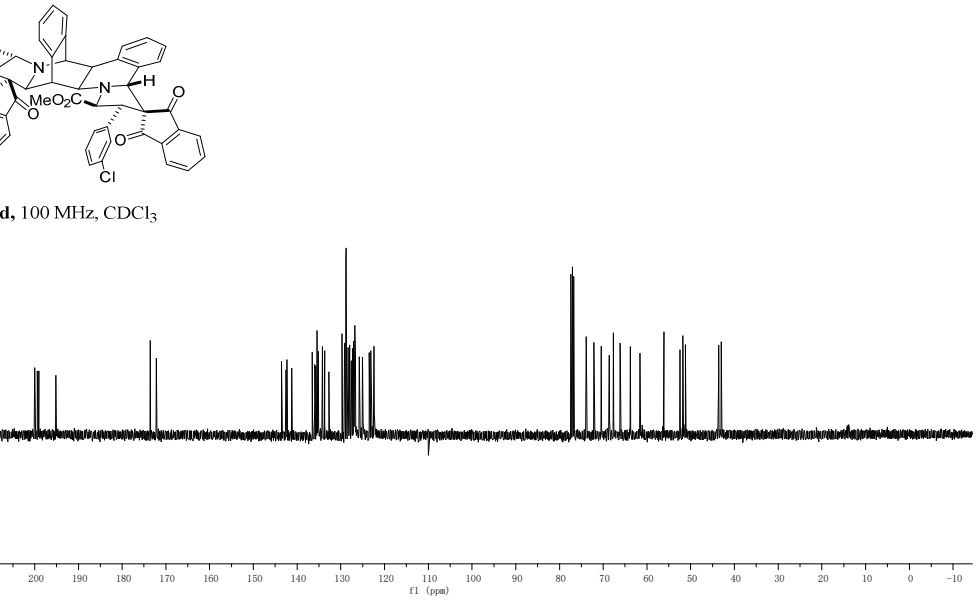
2c, 600 MHz, DMSO-d_6



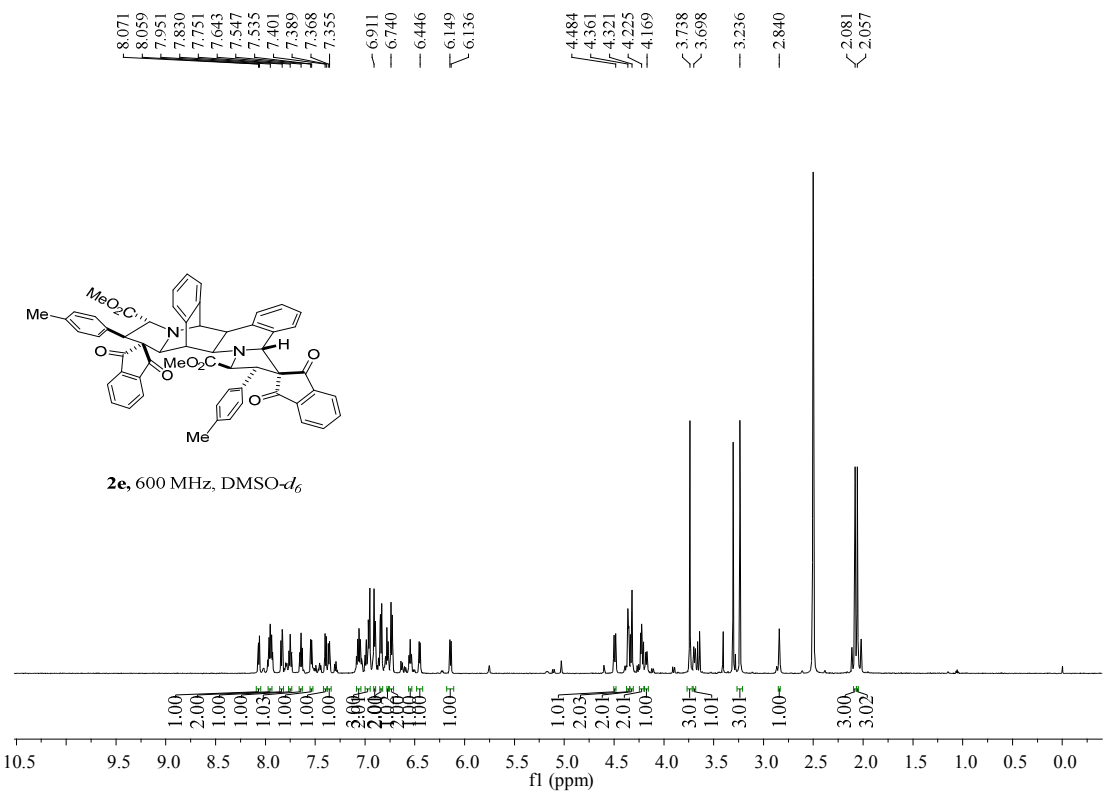
2c, 100 MHz, $CDCl_3$

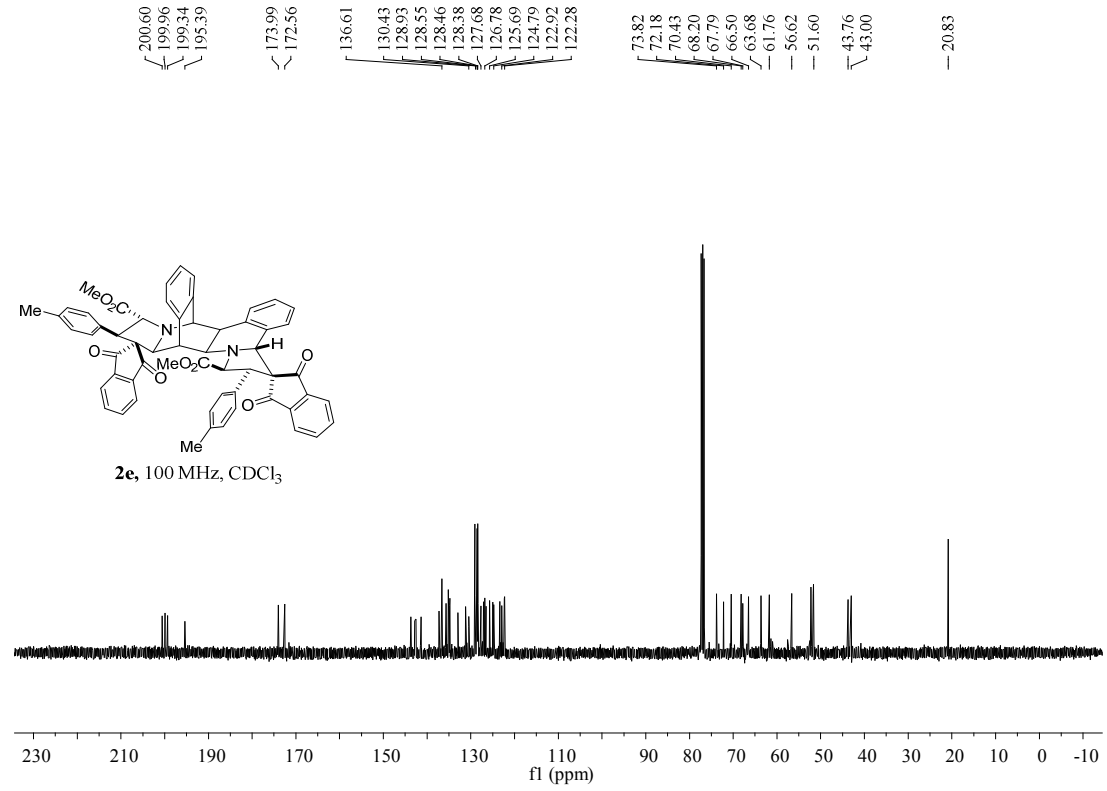


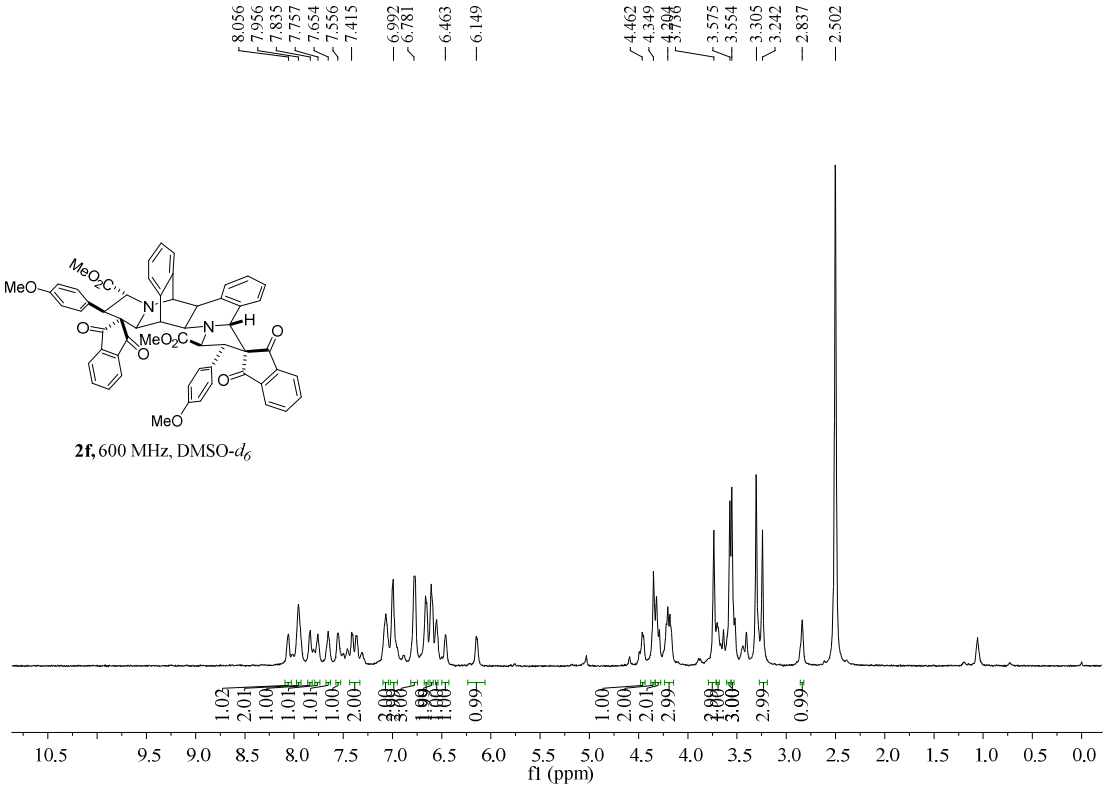
2d, 600 MHz, DMSO-d_6



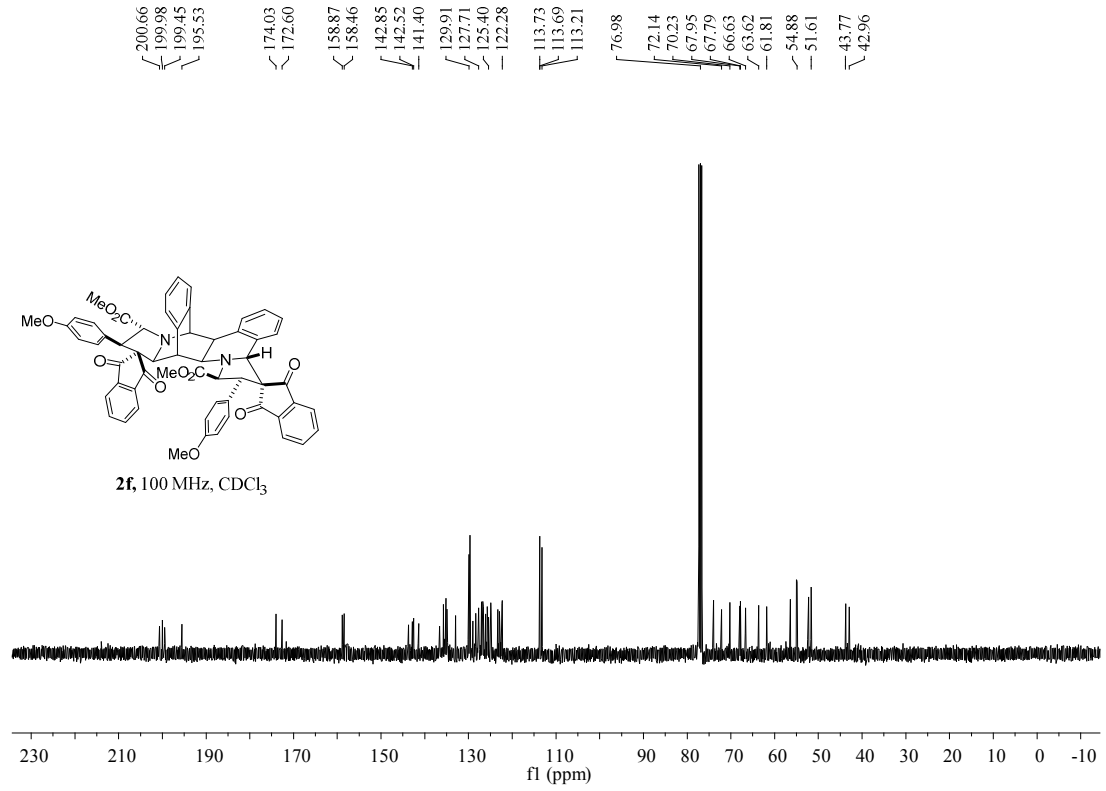
2d, 100 MHz, $CDCl_3$


8.071
8.059
7.951
7.830
7.751
7.643
7.547
7.535
7.401
7.389
7.368
7.355
6.911
6.740
6.446
6.149
6.136
4.484
4.361
4.321
4.225
4.169
3.738
3.698
3.236
2.840
2.081
2.057
Me
MeO2C
N
H
O
MeO2C
O
O
O
Me
2e, 600 MHz, DMSO-d6
1.00
2.00
1.00
1.03
1.00
1.00
1.00
3.00
2.00
1.02
1.00
1.00
1.01
2.03
2.01
2.01
1.00
3.01
1.01
3.01
1.00
3.00
3.02
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

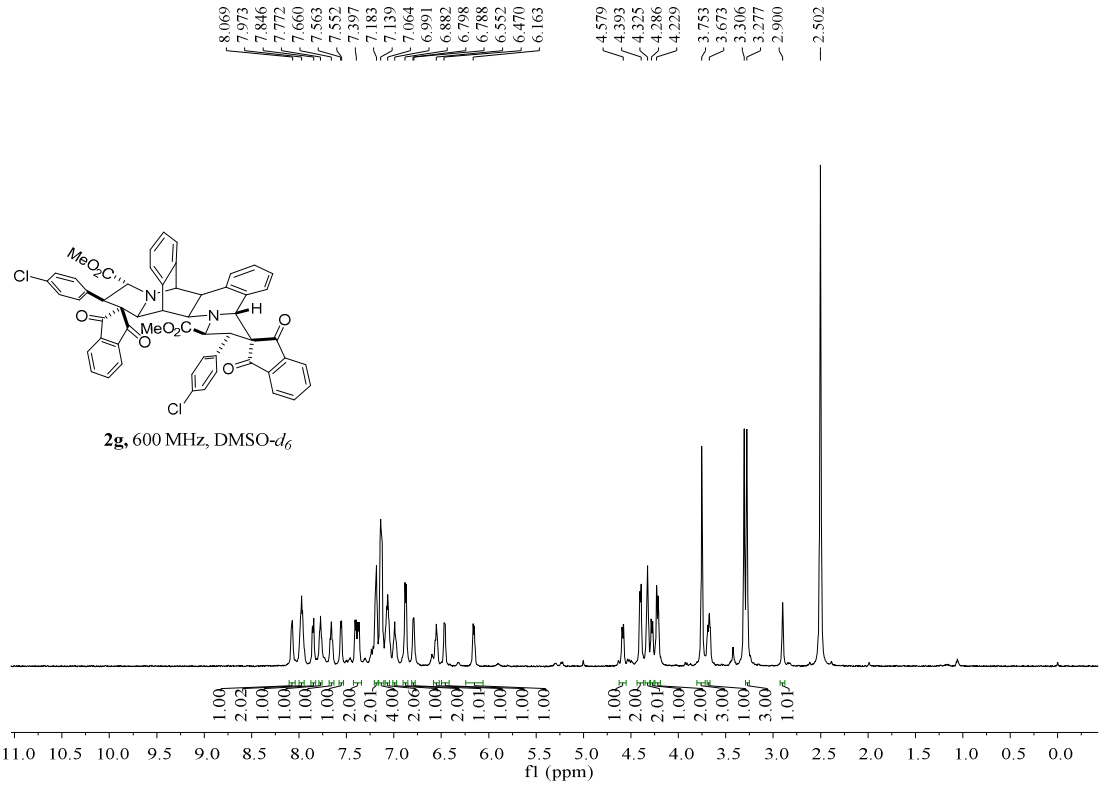

200.60
199.96
199.34
195.39
173.99
172.56
136.61
130.43
128.93
128.55
128.46
128.38
127.68
126.78
125.69
124.79
122.92
122.28
73.82
72.18
70.43
68.20
67.79
66.50
63.68
61.76
56.62
51.60
43.76
43.00
20.83
Me
MeO2C
N
H
O
MeO2C
O
O
O
Me
2e, 100 MHz, CDCl3
230
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)



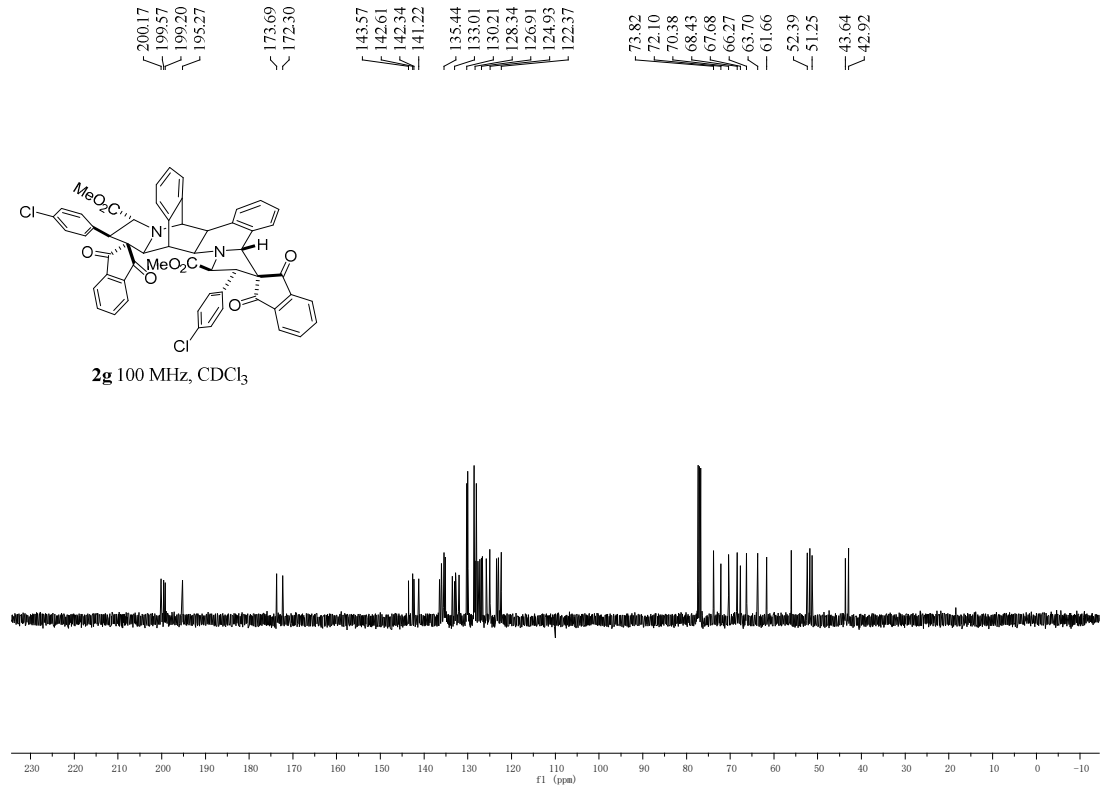
2f, 600 MHz, DMSO-d_6



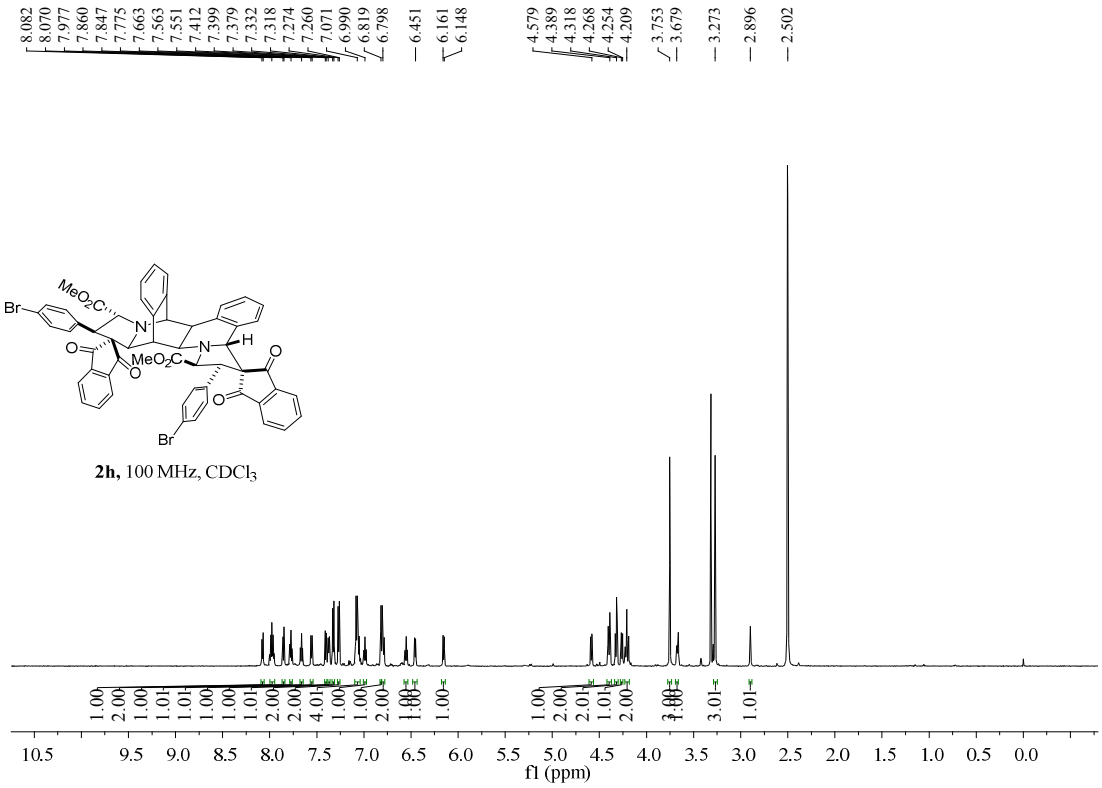
2f, 100 MHz, $CDCl_3$



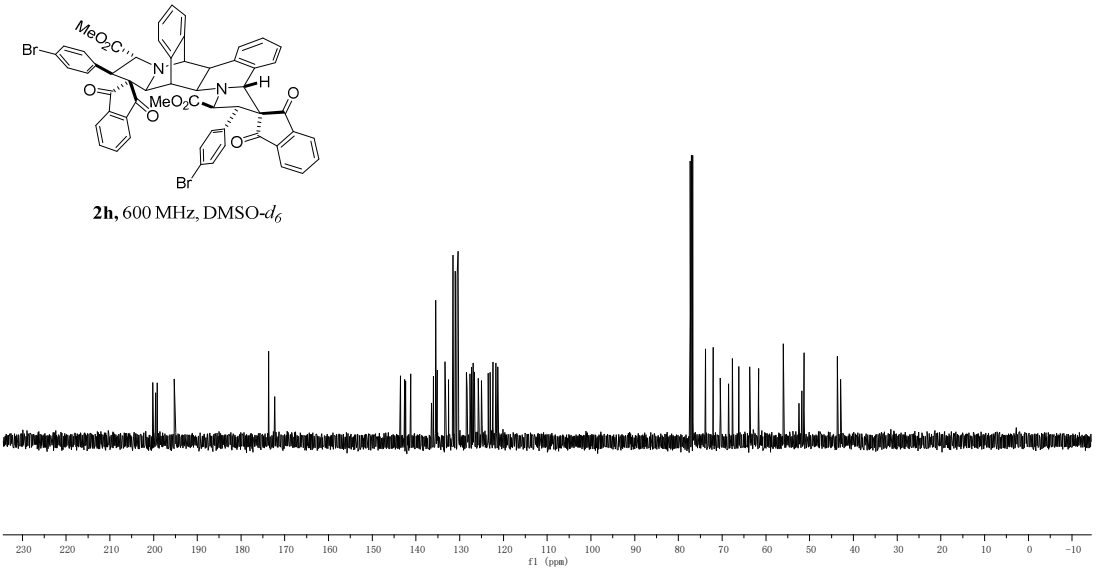
2g, 600 MHz, DMSO-d_6



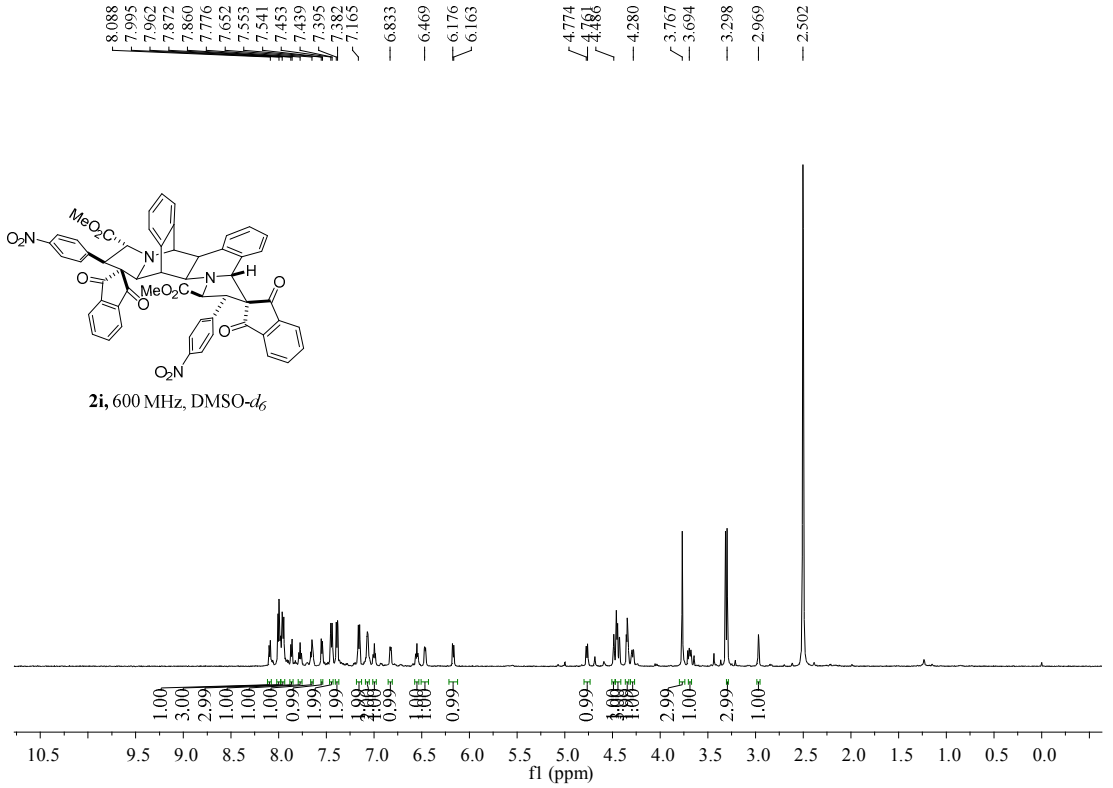
2g 100 MHz, $CDCl_3$



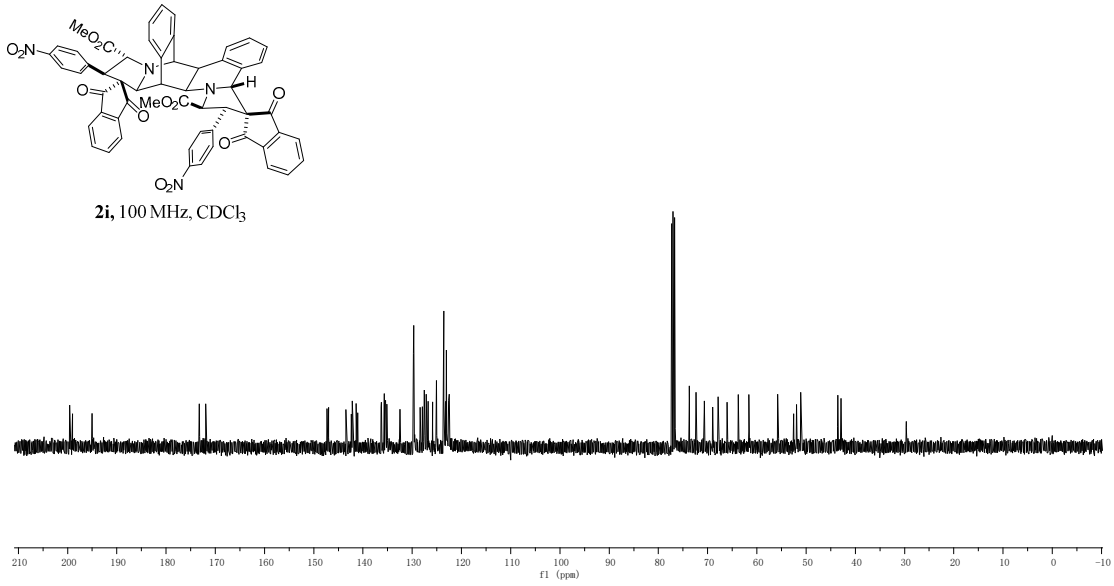
2h, 100 MHz, $CDCl_3$



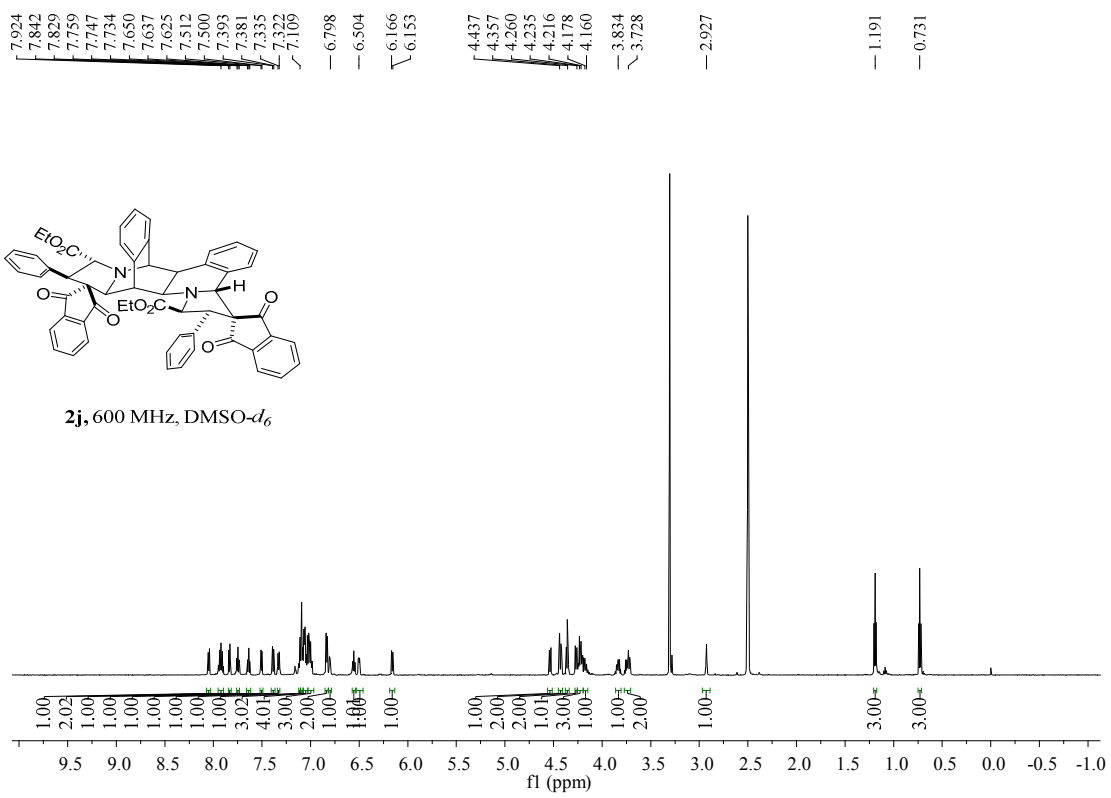
2h, 600 MHz, DMSO-d_6



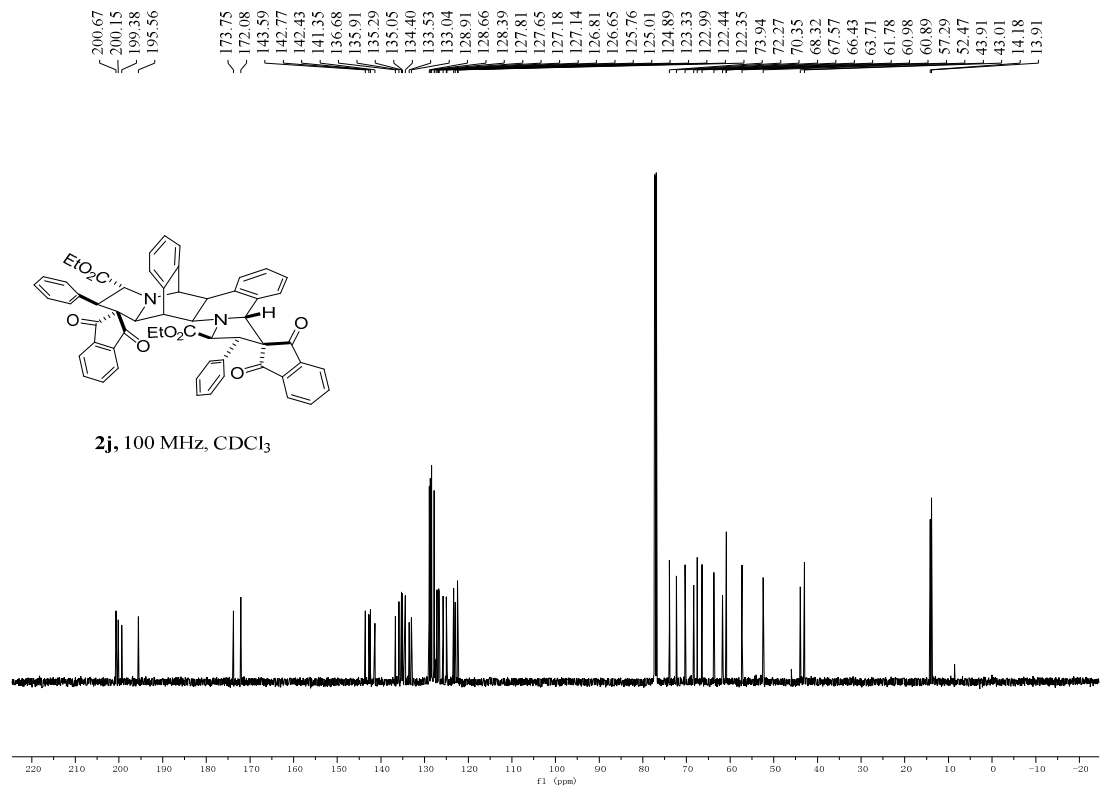
2i, 600 MHz, DMSO-d_6



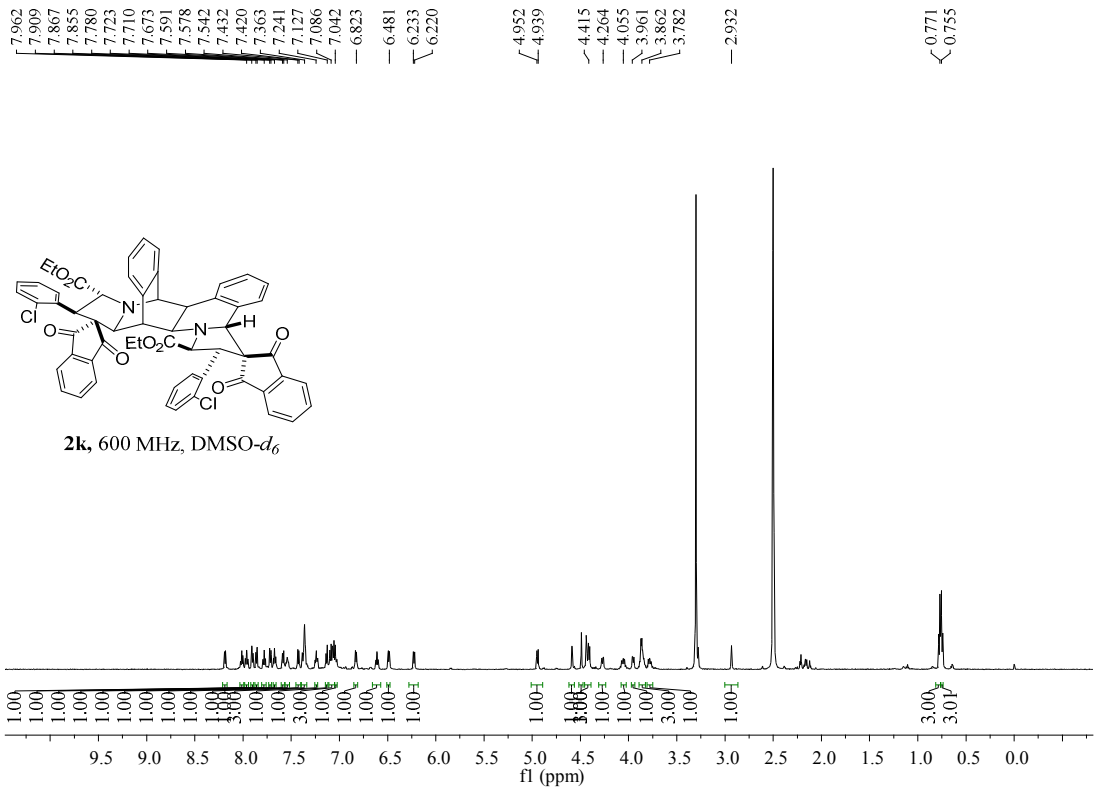
2i, 100 MHz, $CDCl_3$



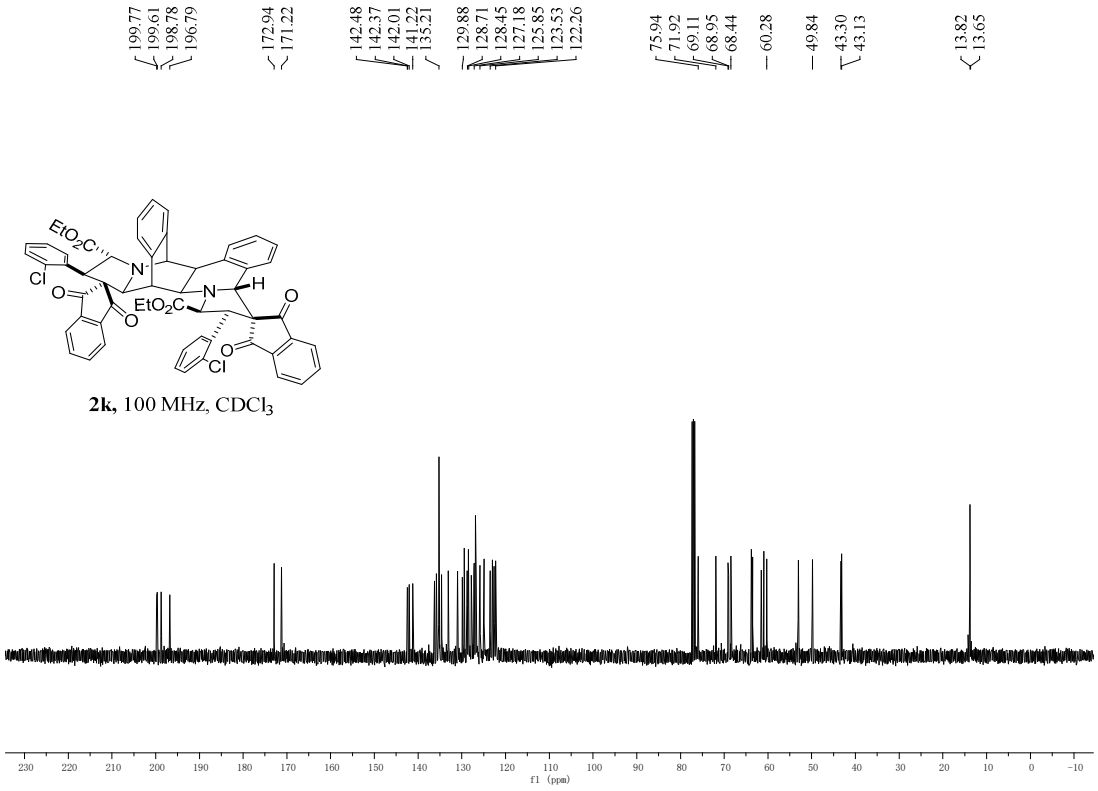
2j, 600 MHz, DMSO-d_6



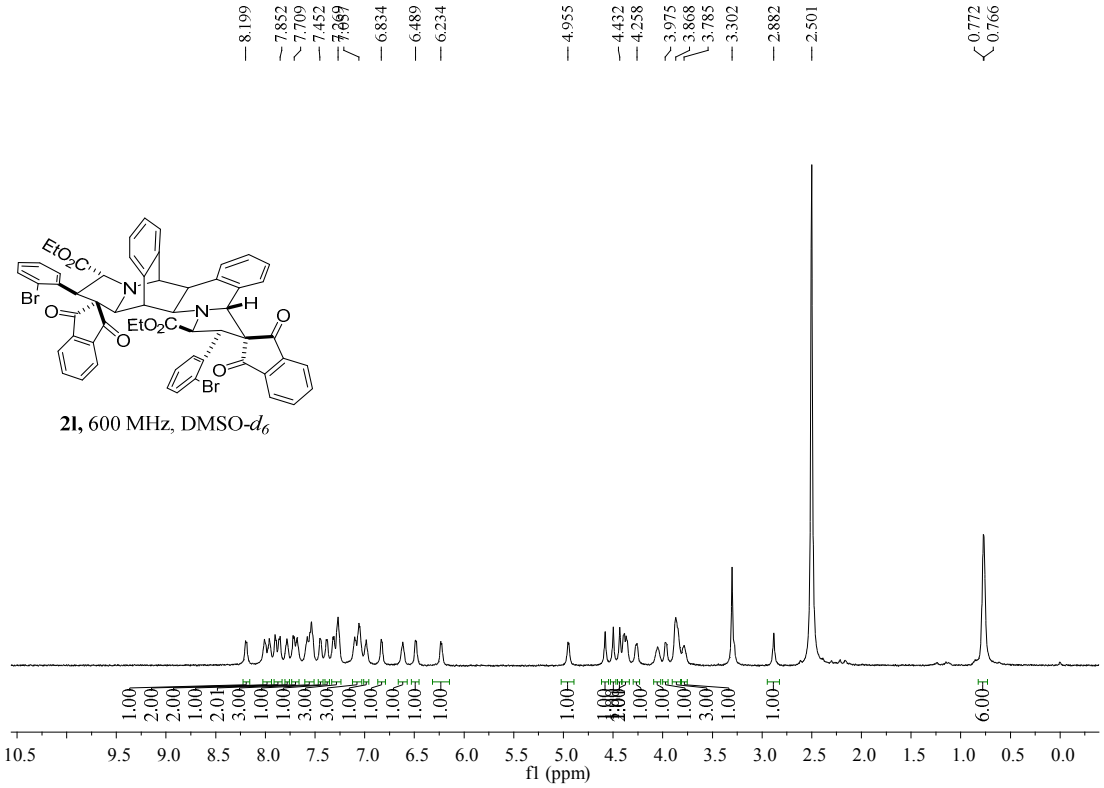
2j, 100 MHz, $CDCl_3$



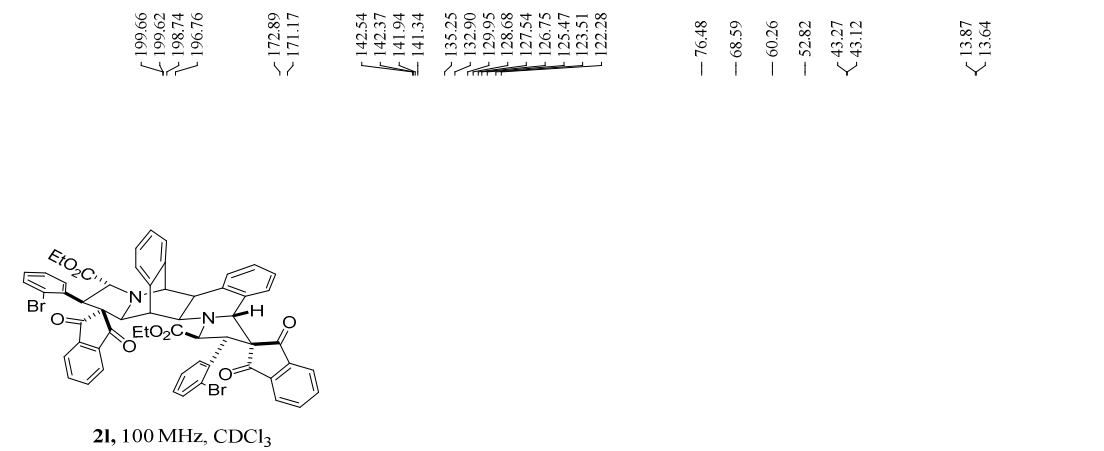
2k, 600 MHz, DMSO-d_6



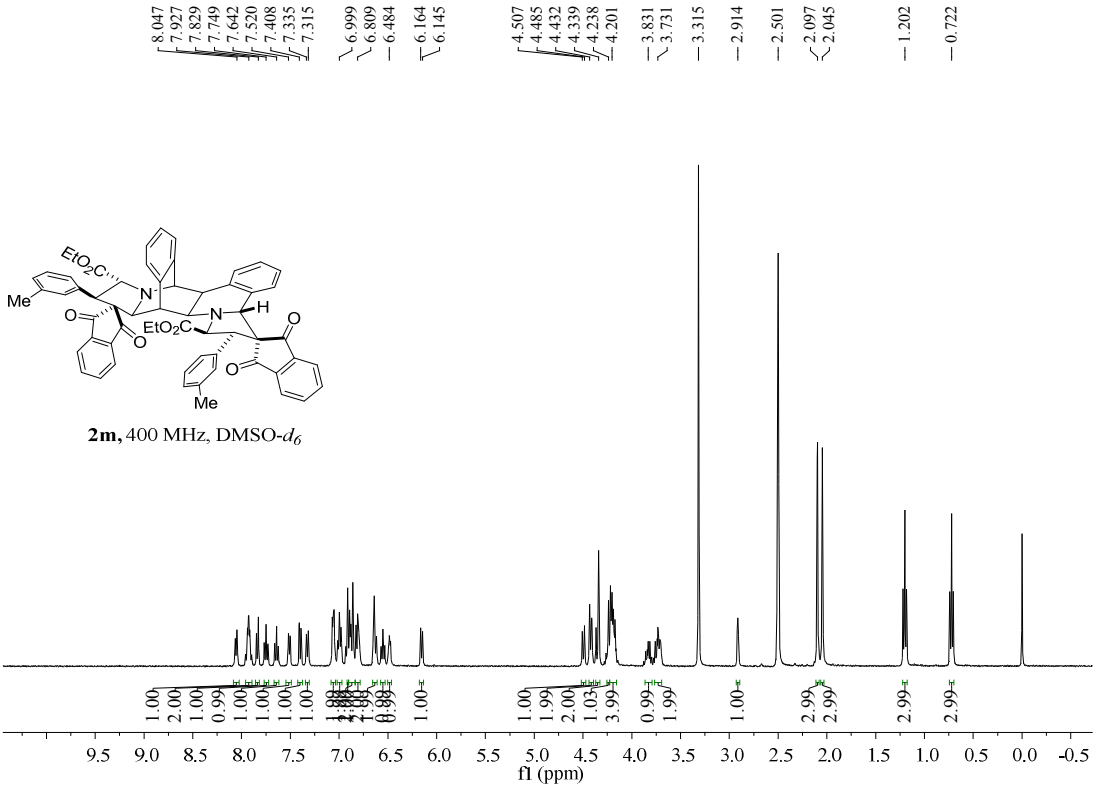
2k, 100 MHz, $CDCl_3$



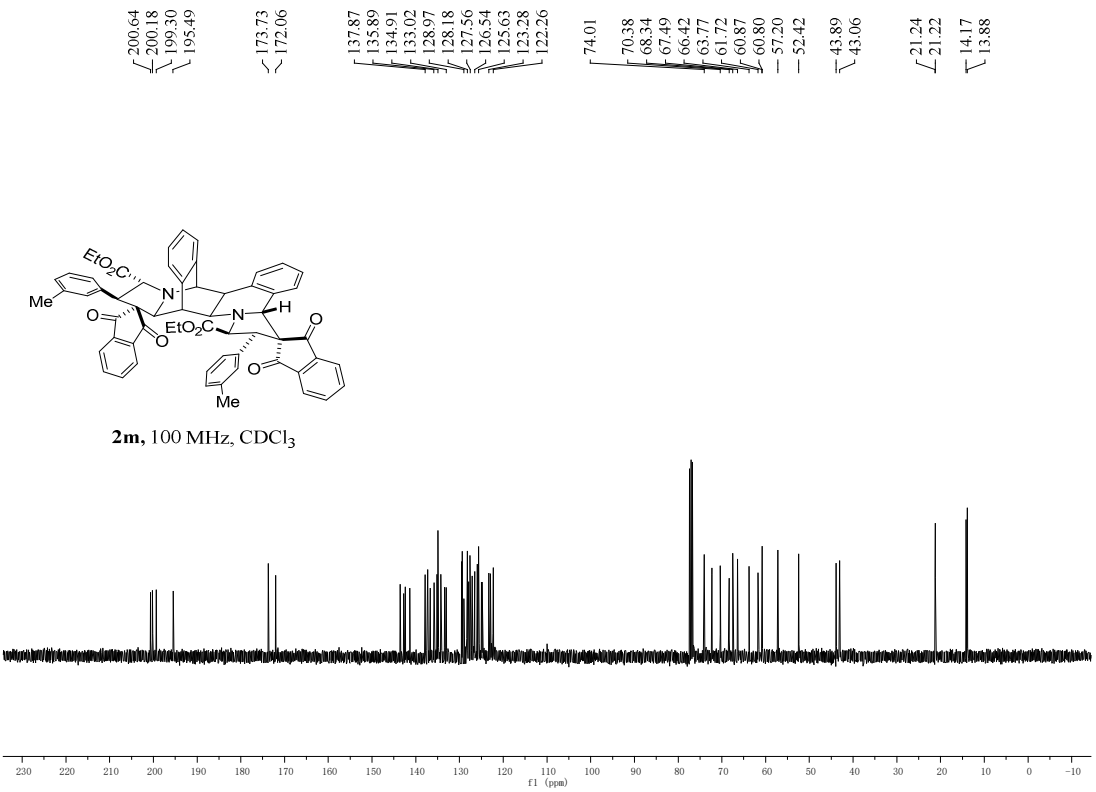
2l, 600 MHz, DMSO-d_6



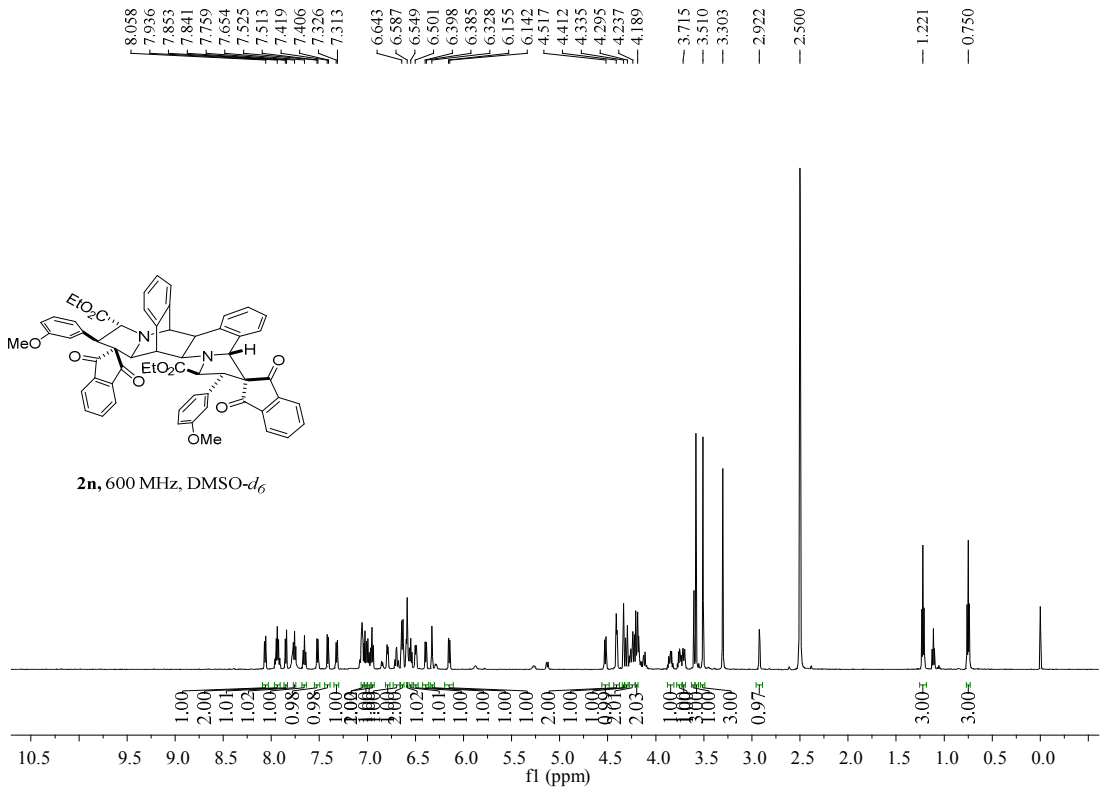
2l, 100 MHz, $CDCl_3$



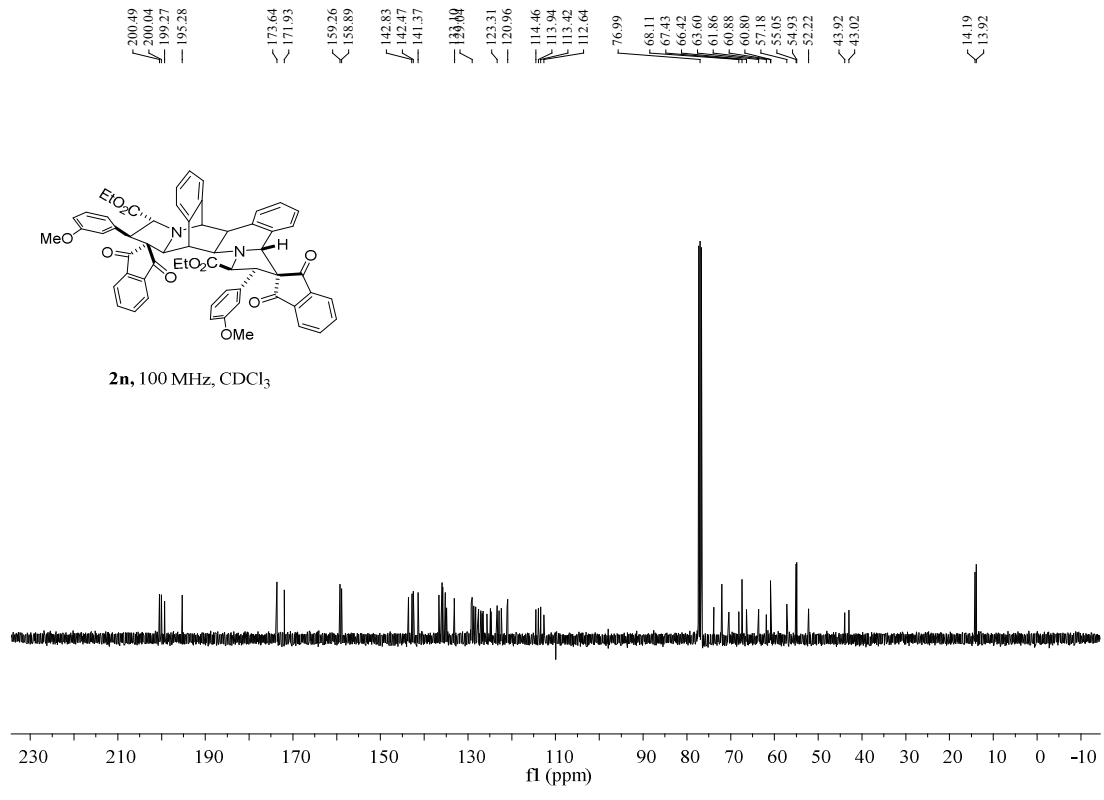
2m, 400 MHz, DMSO-d_6



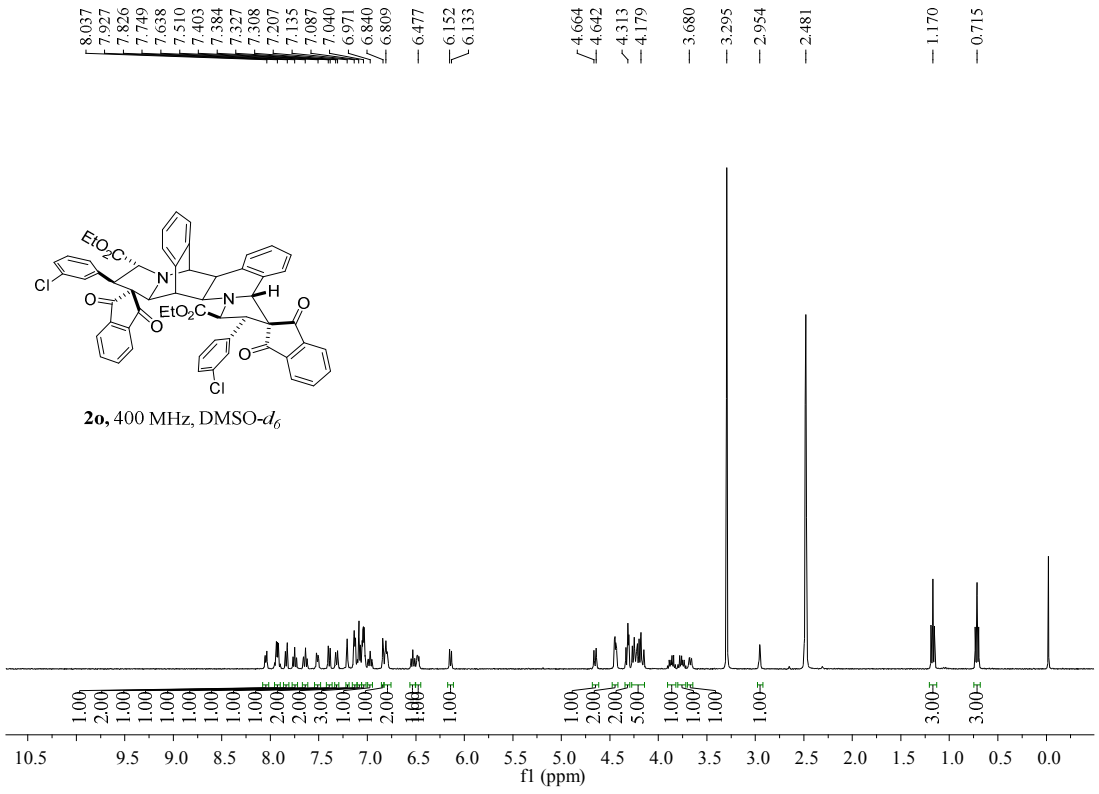
2m, 100 MHz, $CDCl_3$



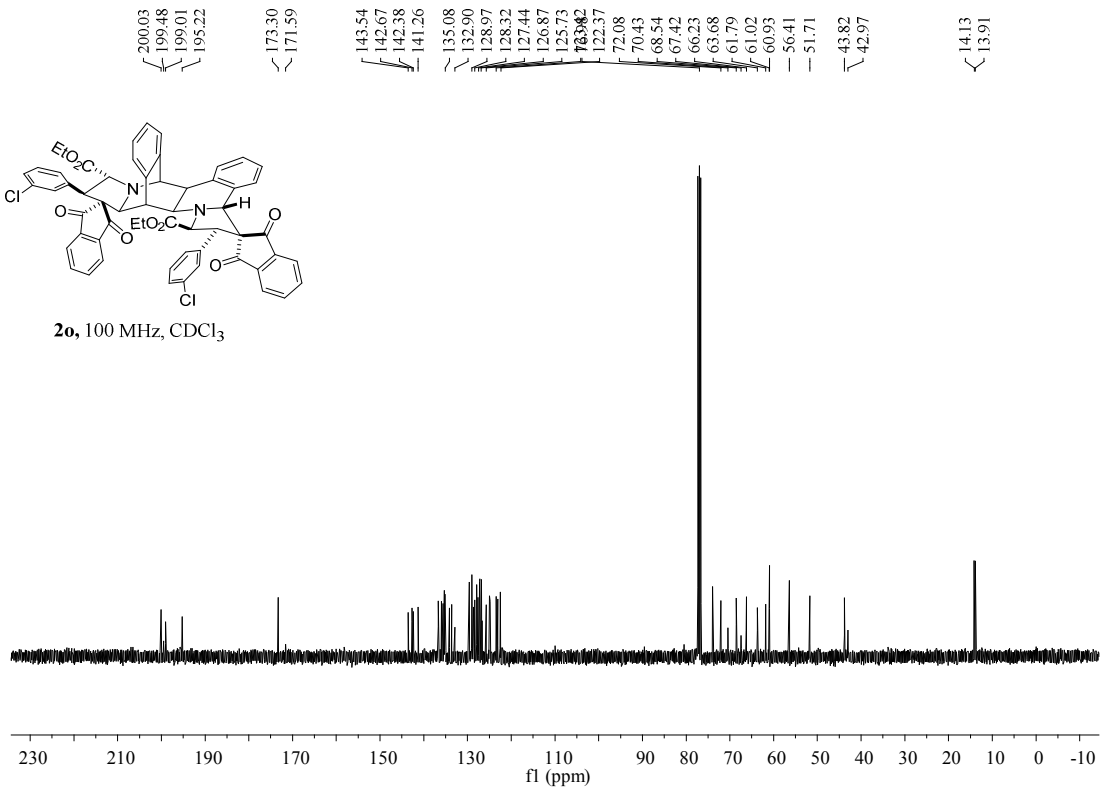
2n, 600 MHz, DMSO-d_6



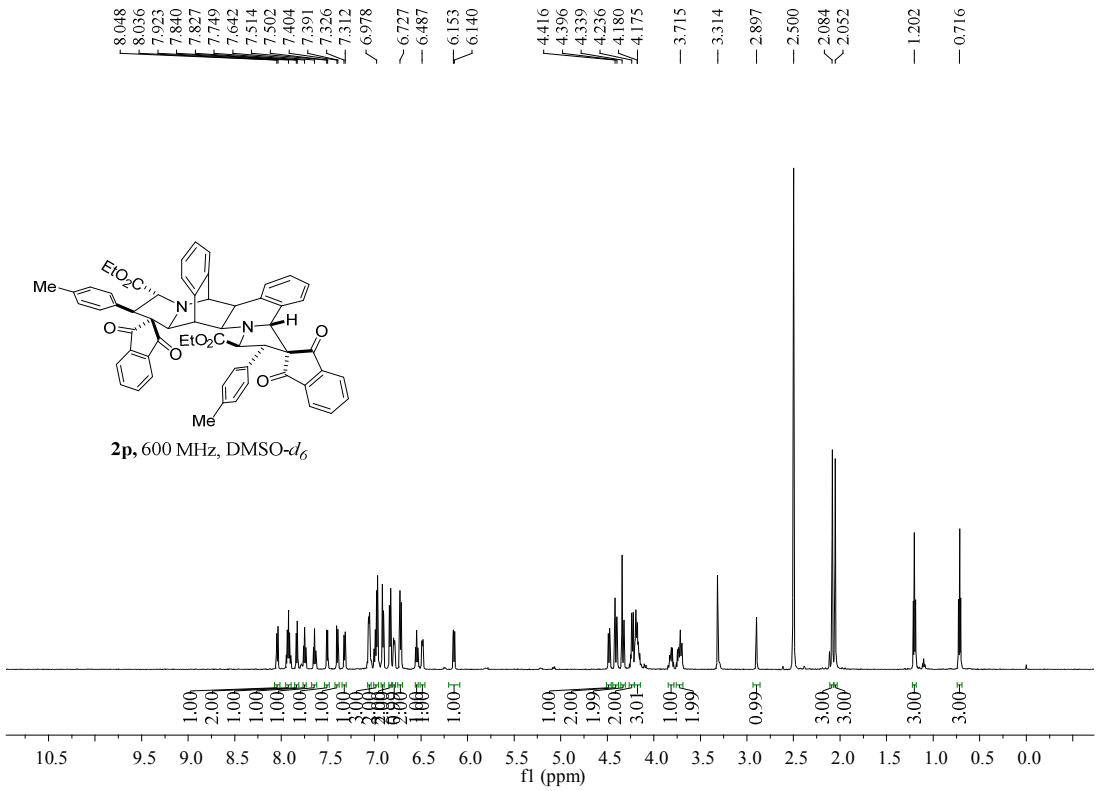
2n, 100 MHz, $CDCl_3$

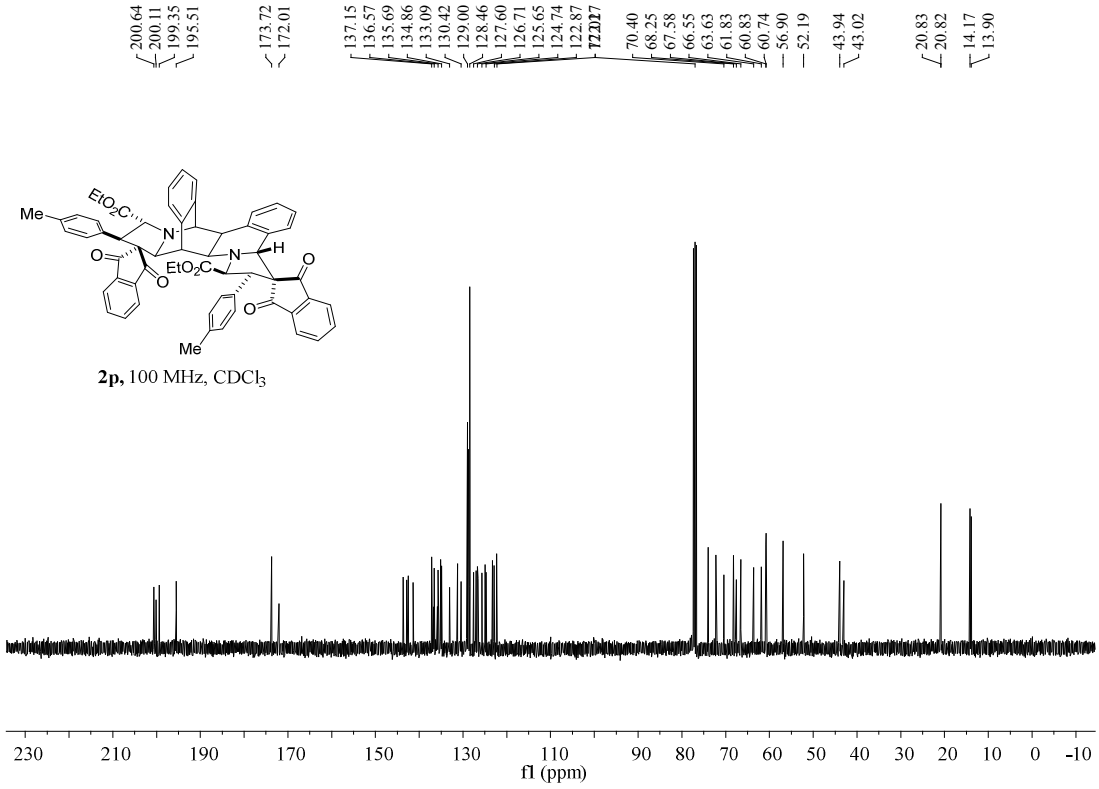


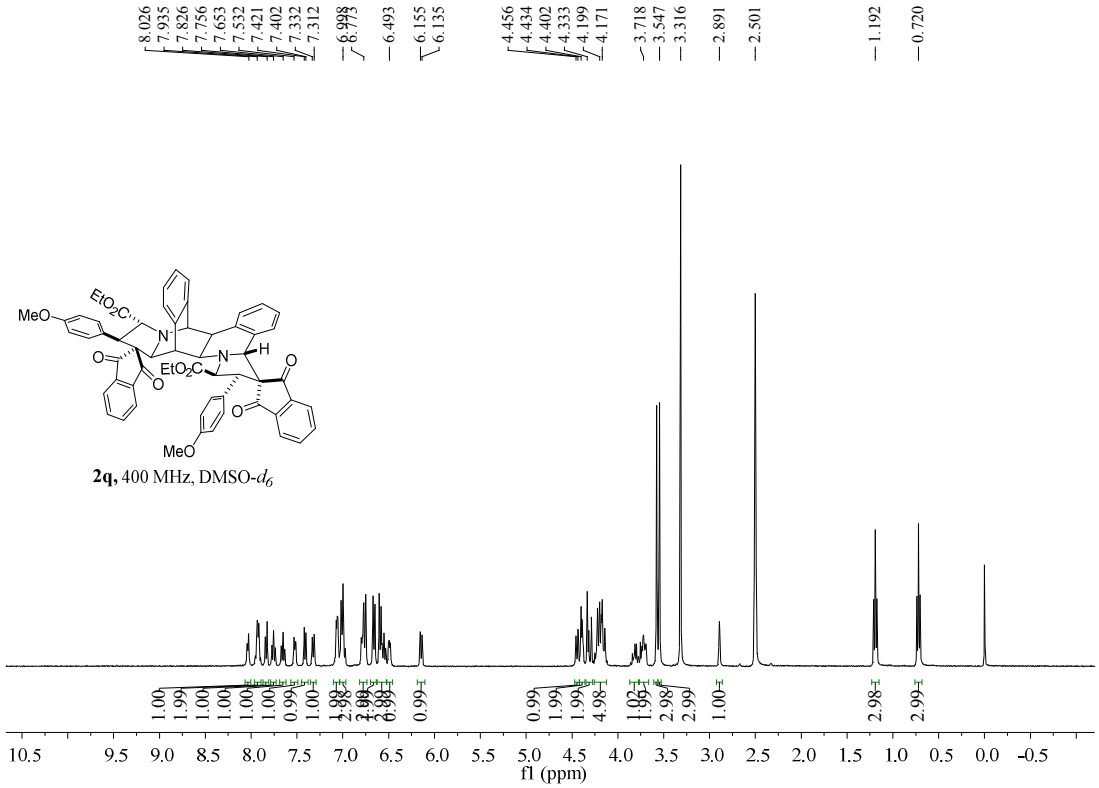
2o, 400 MHz, DMSO-d_6

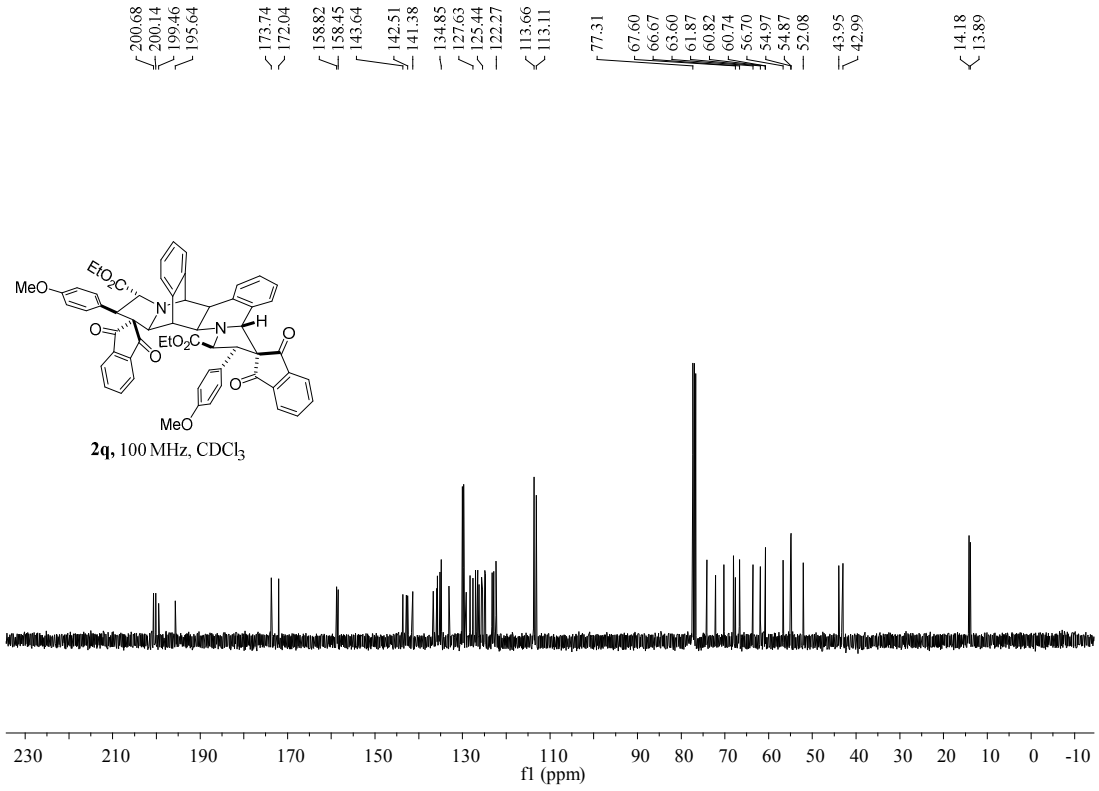


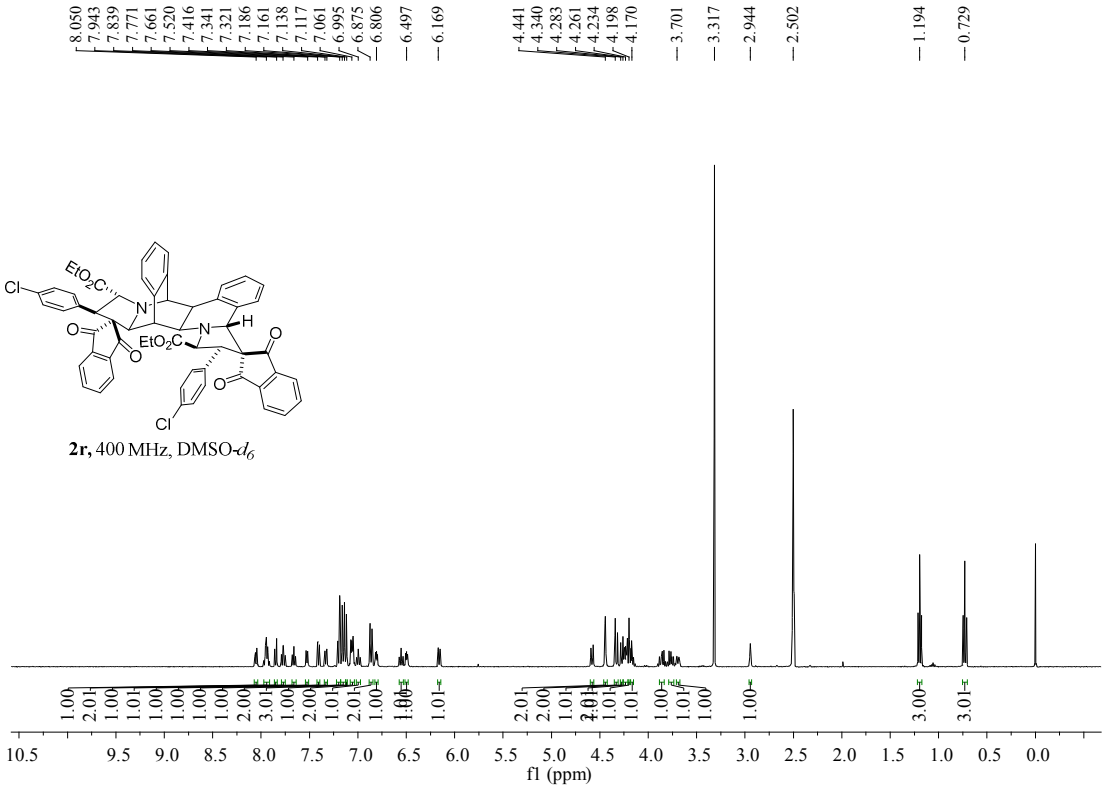
2o, 100 MHz, $CDCl_3$


8.048
8.036
7.923
7.840
7.827
7.749
7.642
7.514
7.502
7.404
7.391
7.326
7.312
6.978
6.727
6.487
6.153
6.140
4.416
4.396
4.339
4.236
4.180
4.175
3.715
3.314
2.897
2.500
2.084
2.052
1.202
0.716
Me
EtO2C
N
H
O
Me
2p, 600 MHz, DMSO-d6
f1 (ppm)

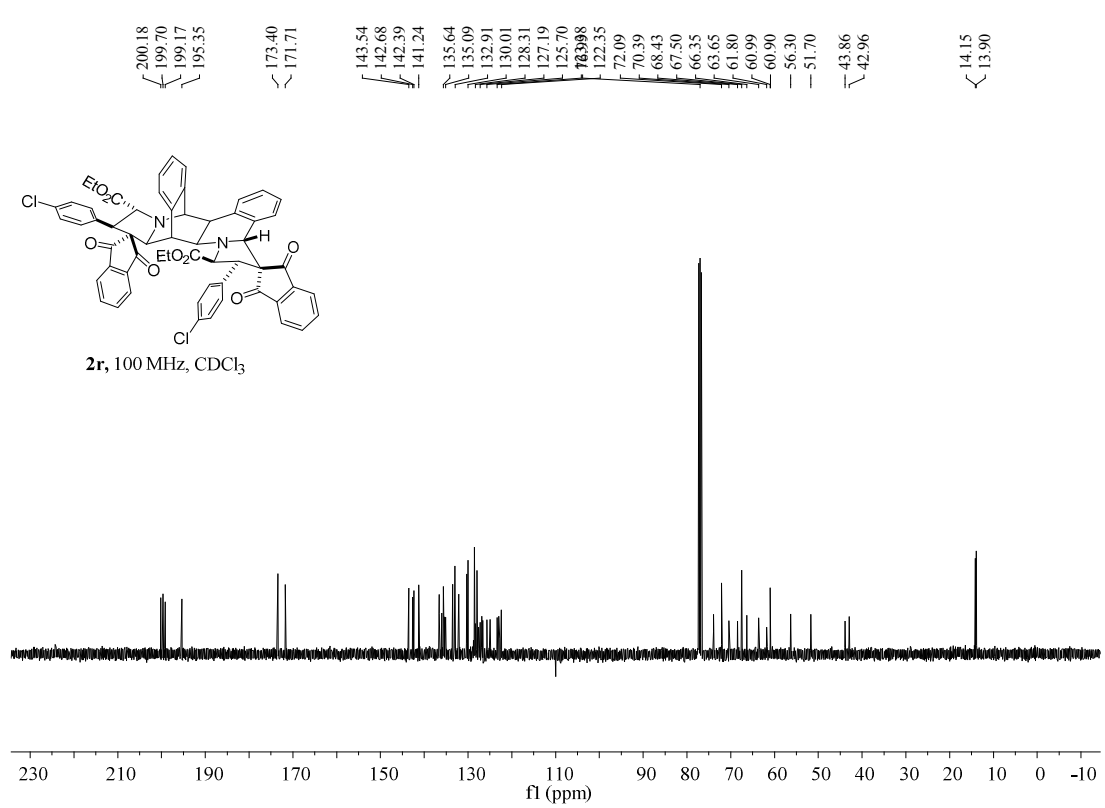

200.64
200.11
199.35
195.51
173.72
172.01
137.15
136.57
135.69
134.86
133.09
130.42
129.00
128.46
127.60
126.71
125.65
124.74
122.87
70.40
68.25
67.58
66.55
63.63
61.83
60.83
60.74
56.90
52.19
43.94
43.02
20.83
20.82
14.17
13.90
Me
EtO2C
N
H
O
Me
2p, 100 MHz, CDCl3
f1 (ppm)


8.026
7.935
7.826
7.756
7.653
7.532
7.421
7.402
7.332
7.312
6.998
6.773
6.493
6.155
6.135
4.456
4.434
4.402
4.333
4.199
4.171
3.718
3.547
3.316
2.891
2.501
1.192
0.720
MeO
EtO2C
N
H
O
MeO
2q, 400 MHz, DMSO-d6
f1 (ppm)

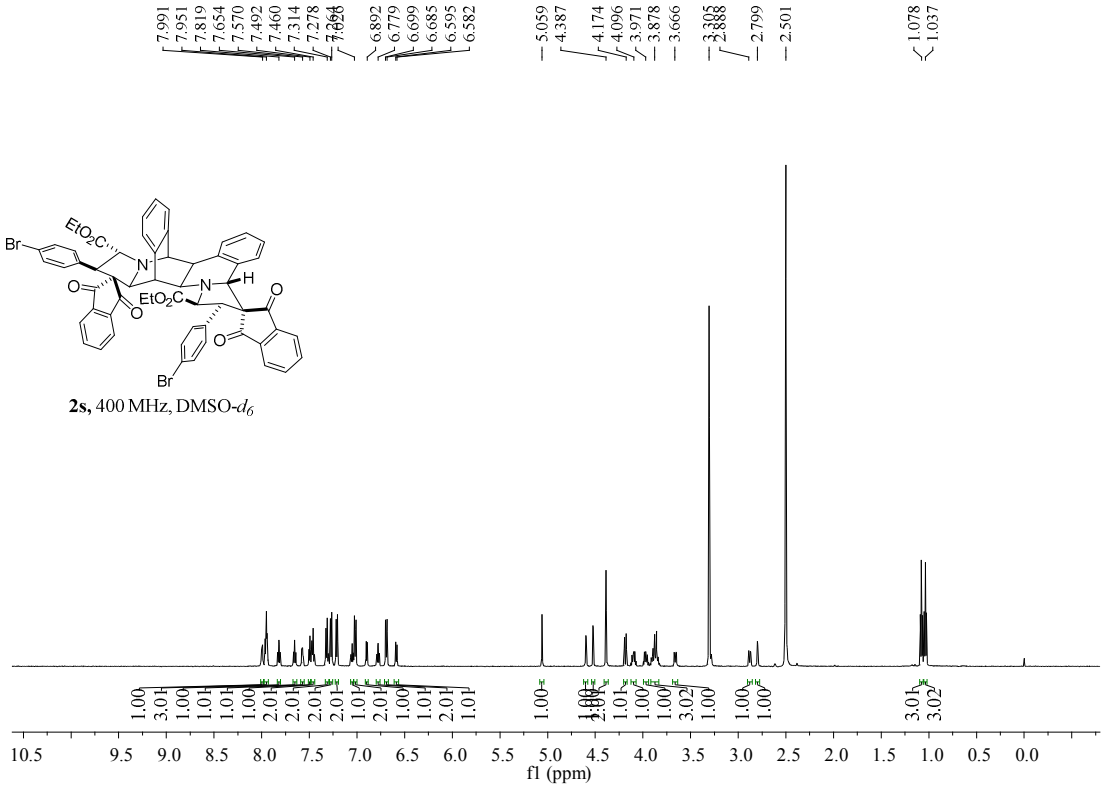

200.68
200.14
199.46
193.64
173.74
172.04
158.82
158.45
143.64
142.51
141.38
134.85
127.63
125.44
122.27
113.66
113.11
77.31
67.60
66.67
63.60
61.87
60.82
60.74
56.70
54.97
54.87
52.08
43.95
42.99
14.18
13.89
MeO
EtO2C
N
H
O
MeO
2q, 100 MHz, CDCl3
f1 (ppm)



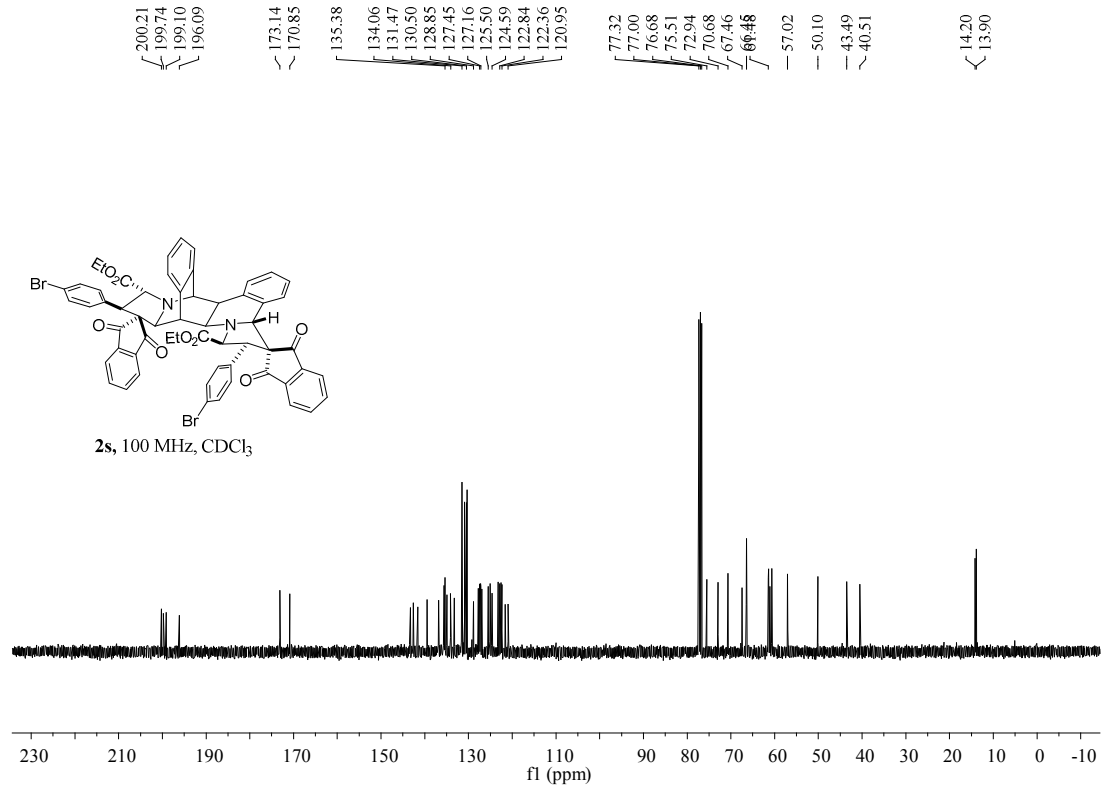
2r, 400 MHz, DMSO-d_6



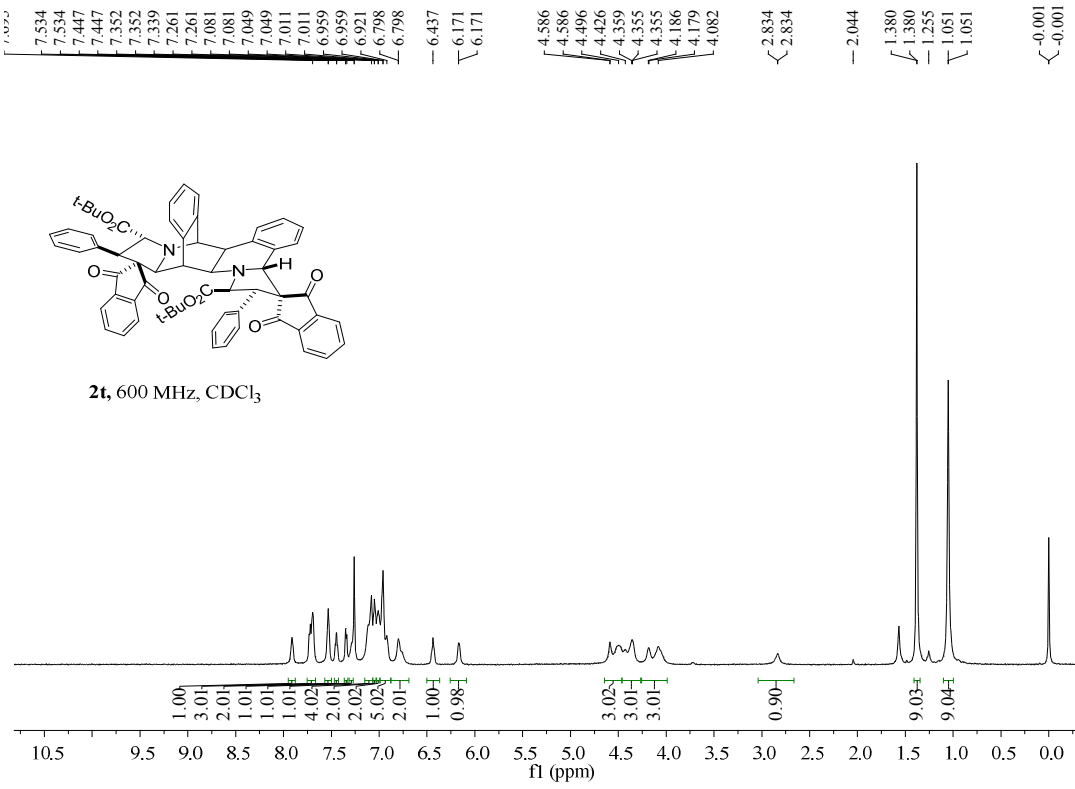
2r, 100 MHz, $CDCl_3$



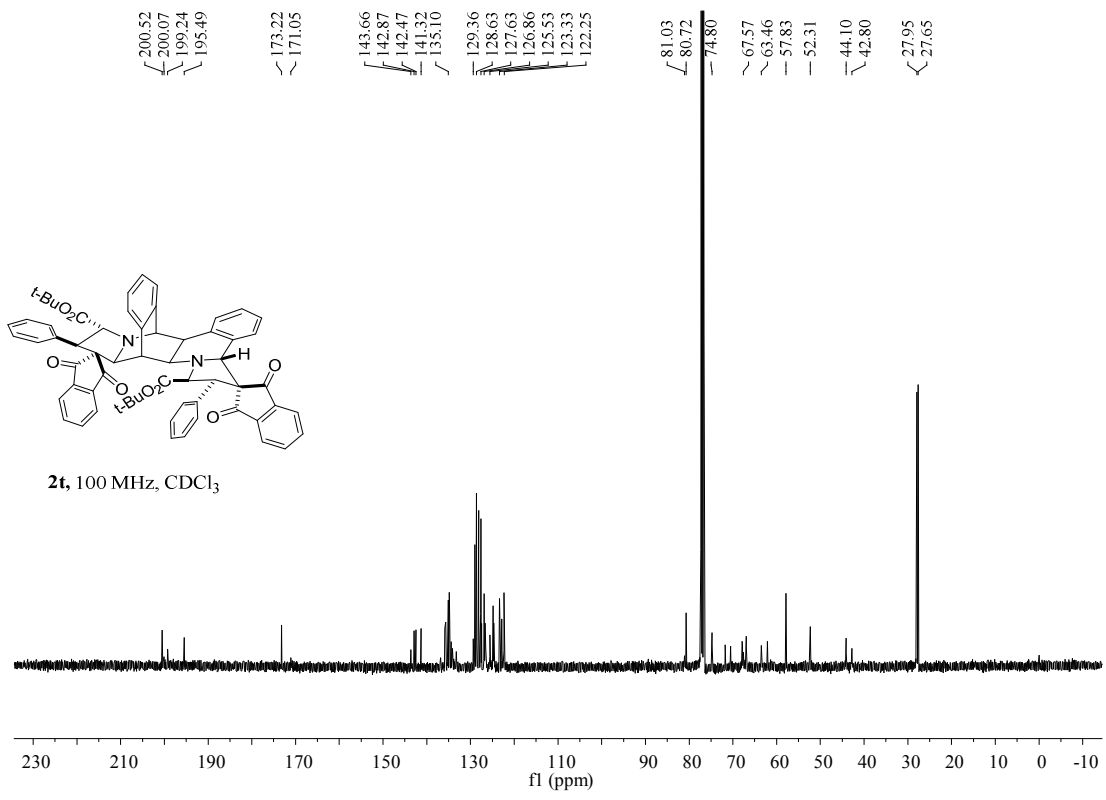
2s, 400 MHz, DMSO-d_6



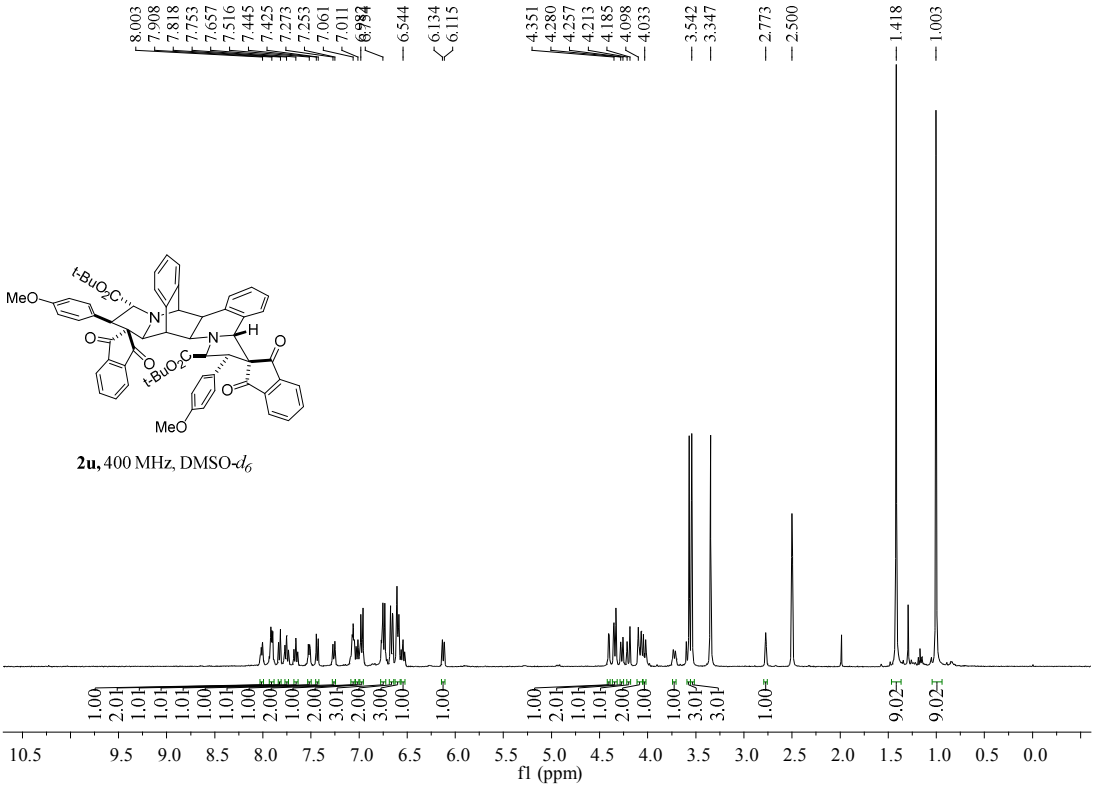
2s, 100 MHz, $CDCl_3$



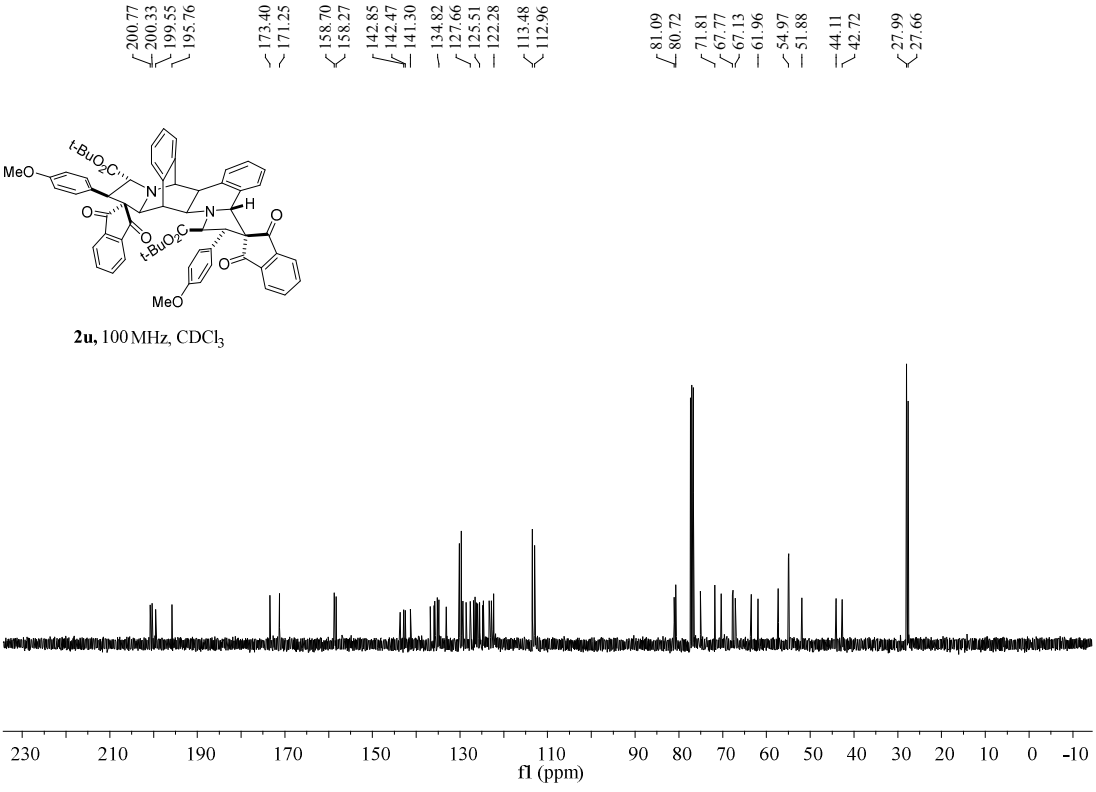
2t, 600 MHz, $CDCl_3$



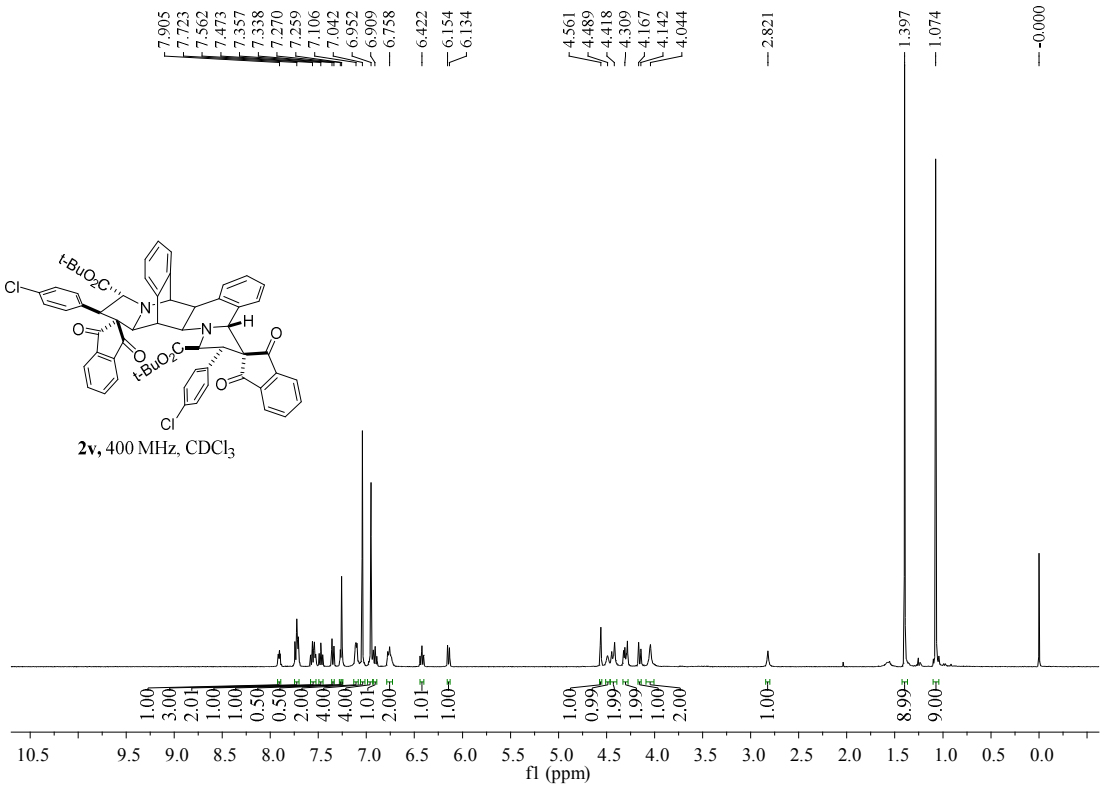
2t, 100 MHz, $CDCl_3$

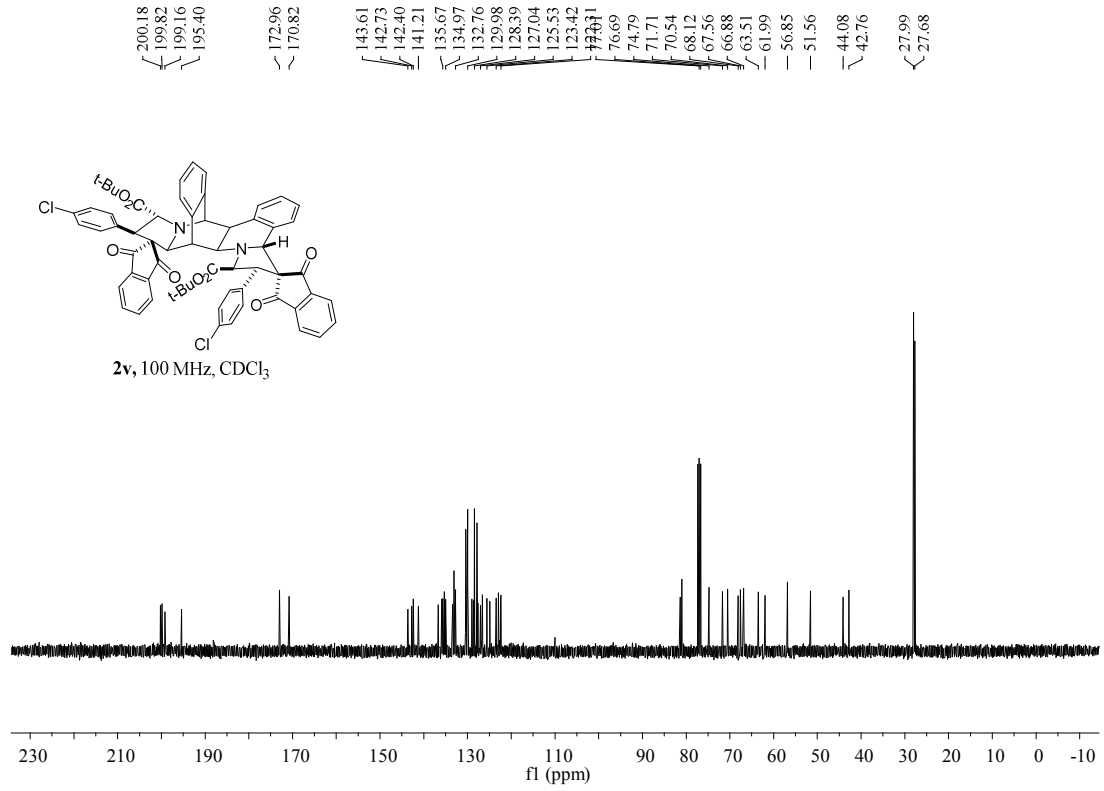


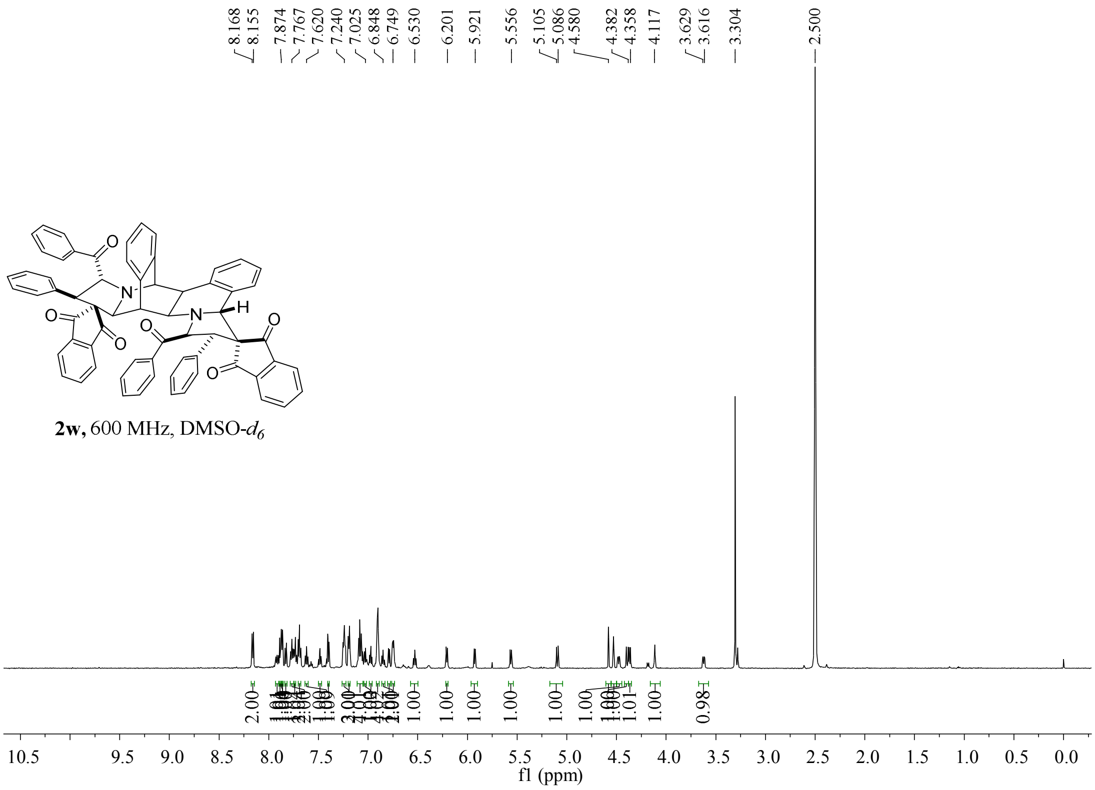
2u, 400 MHz, DMSO-d_6



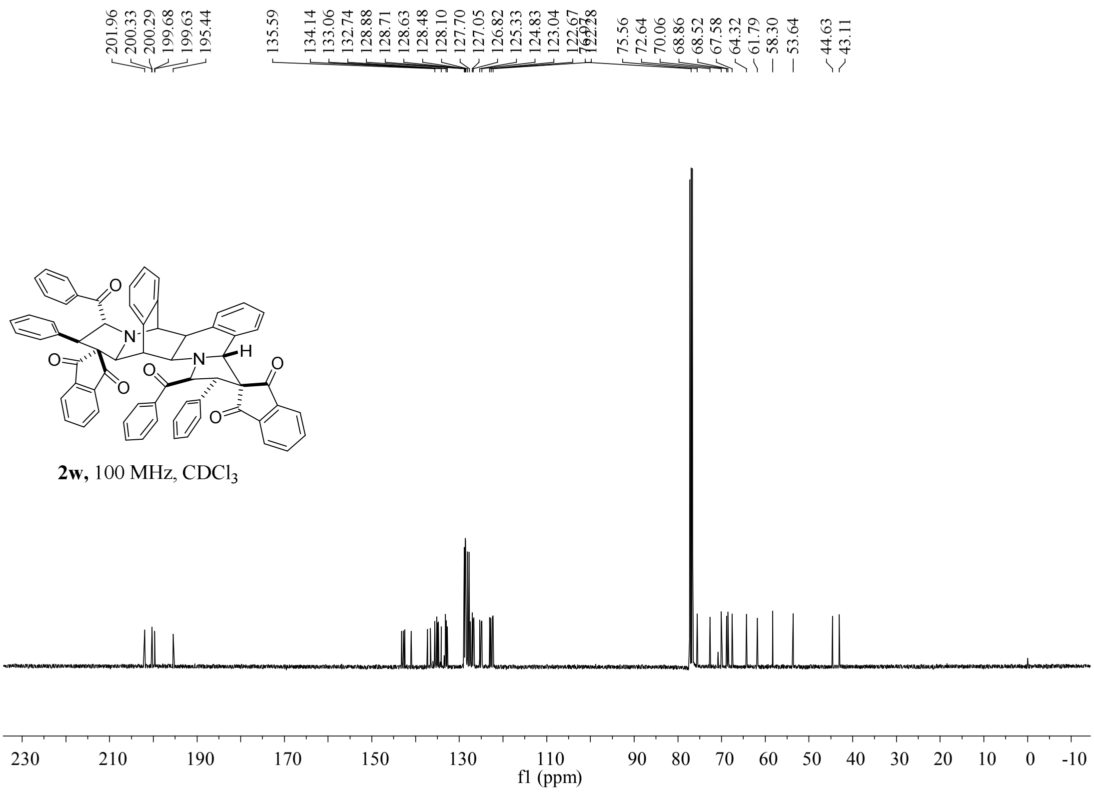
2u, 100 MHz, $CDCl_3$


7.905
7.723
7.562
7.473
7.357
7.338
7.270
7.259
7.106
7.042
6.952
6.909
6.758
6.422
6.154
6.134
4.561
4.489
4.418
4.309
4.167
4.142
4.044
2.821
1.397
1.074
0.000
t-BuO2C
Cl
N
H
O
t-BuO2C
Cl
2v, 400 MHz, CDCl3
1.00
3.00
2.01
1.00
1.00
0.50
0.50
2.00
4.00
4.00
1.01
2.00
1.01
1.00
1.00
0.99
1.99
1.99
1.00
2.00
1.00
8.99
9.00
10.5
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
f1 (ppm)

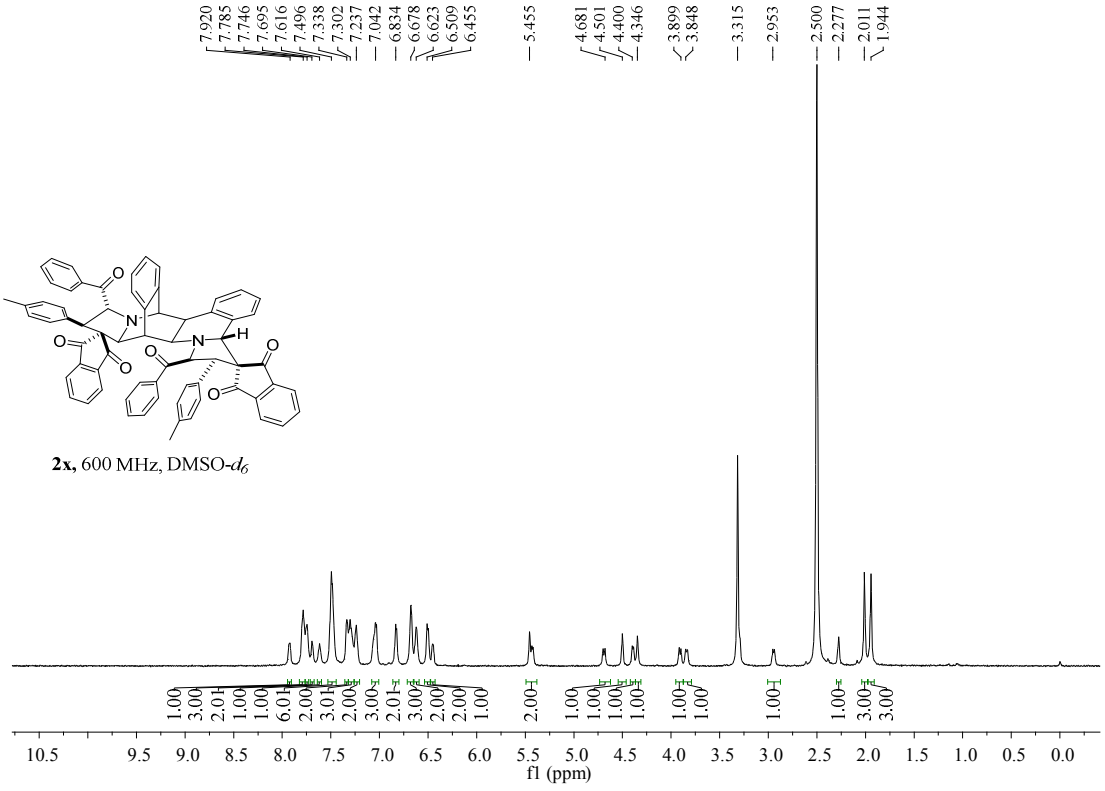

200.18
199.82
199.16
195.40
172.96
170.82
143.61
142.73
142.40
141.21
135.67
134.97
132.76
129.98
128.39
127.04
125.53
123.42
76.69
74.79
71.71
70.54
68.12
67.56
66.88
63.51
61.99
56.85
51.56
44.08
42.76
27.99
27.68
t-BuO2C
Cl
N
H
O
t-BuO2C
Cl
2v, 100 MHz, CDCl3
230
210
190
170
150
130
110
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)



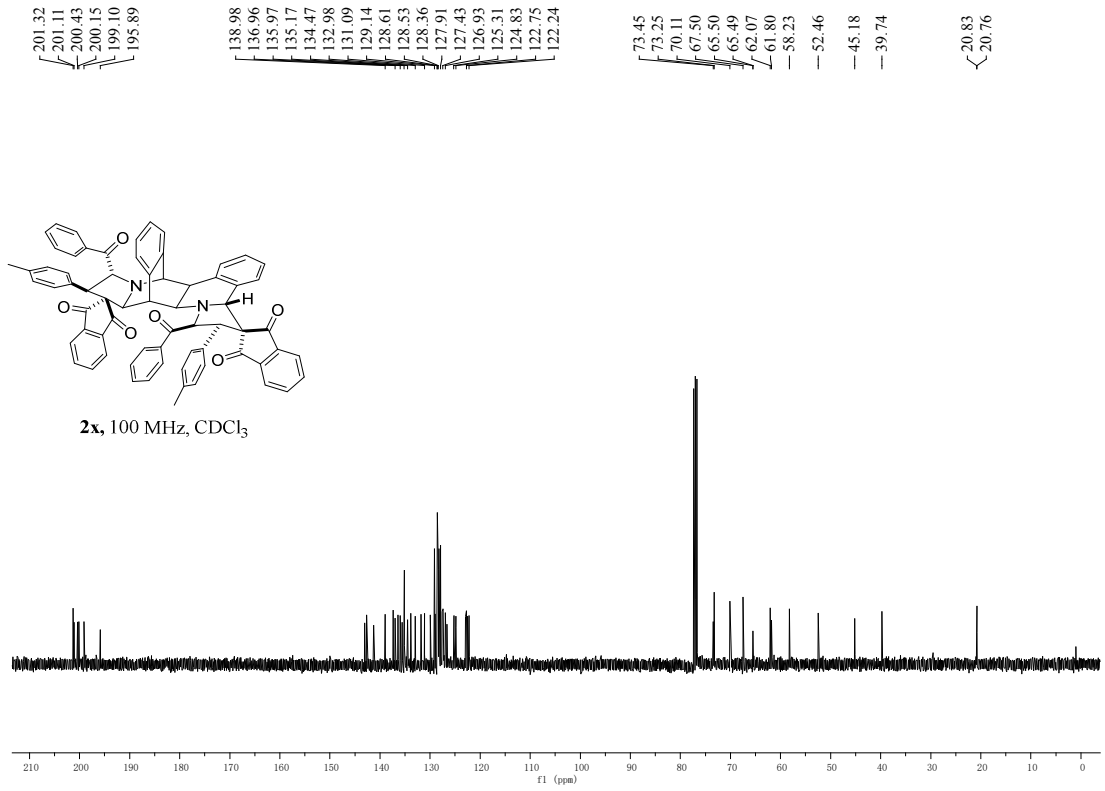
2w, 600 MHz, DMSO-d_6



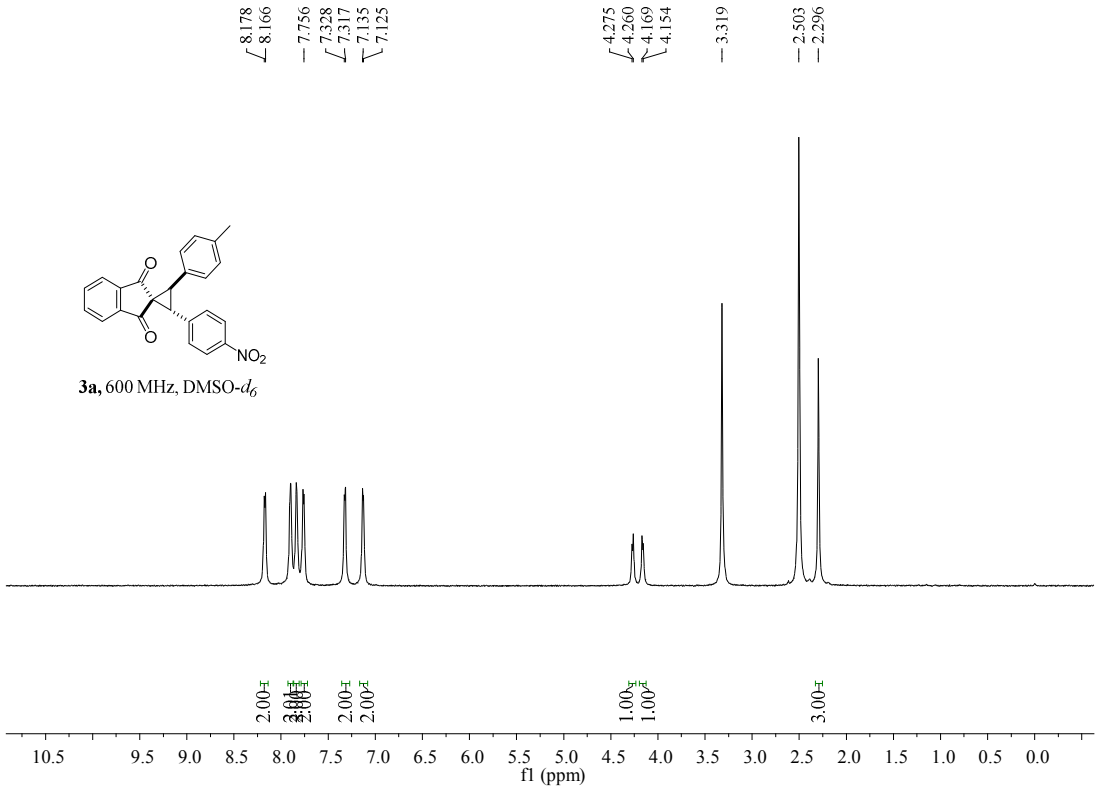
2w, 100 MHz, $CDCl_3$



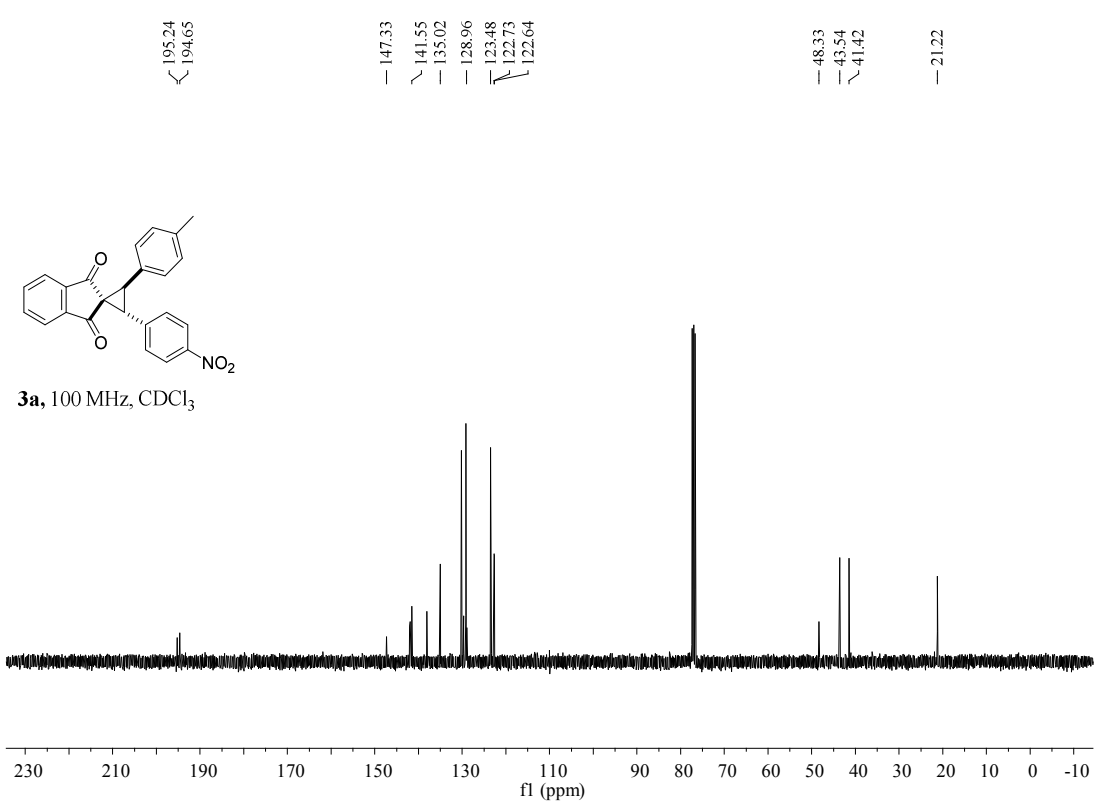
2x, 600 MHz, DMSO-d_6



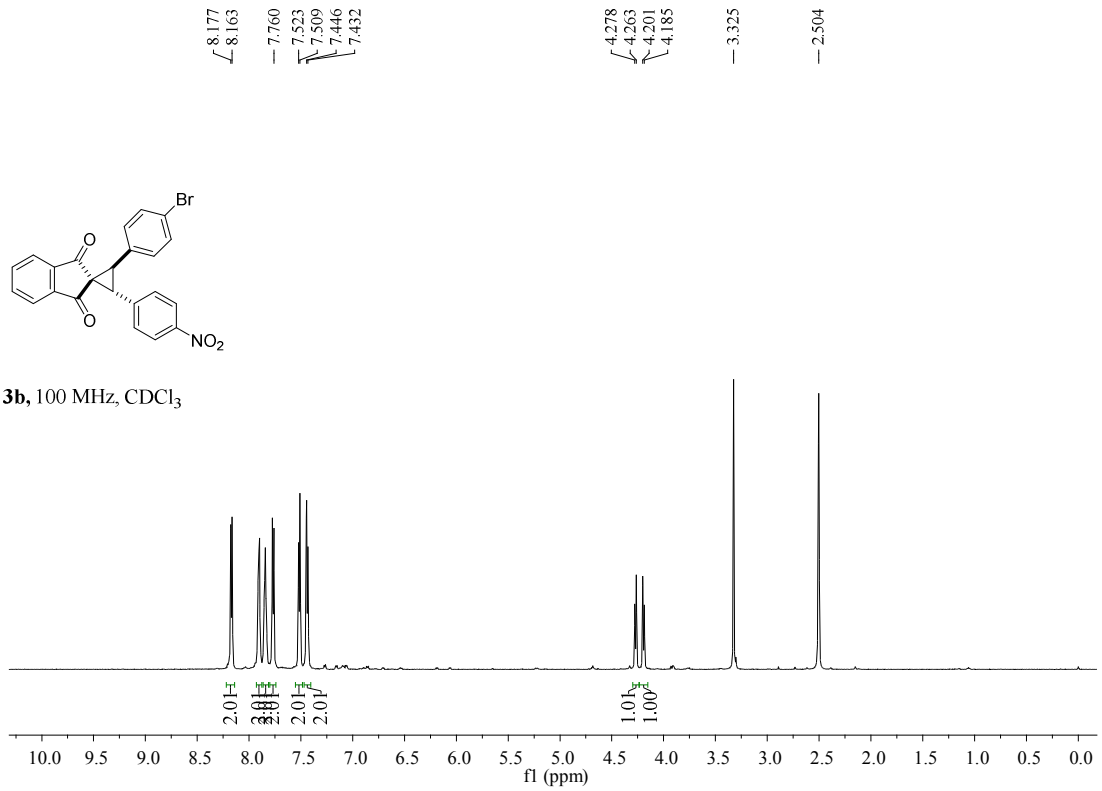
2x, 100 MHz, $CDCl_3$



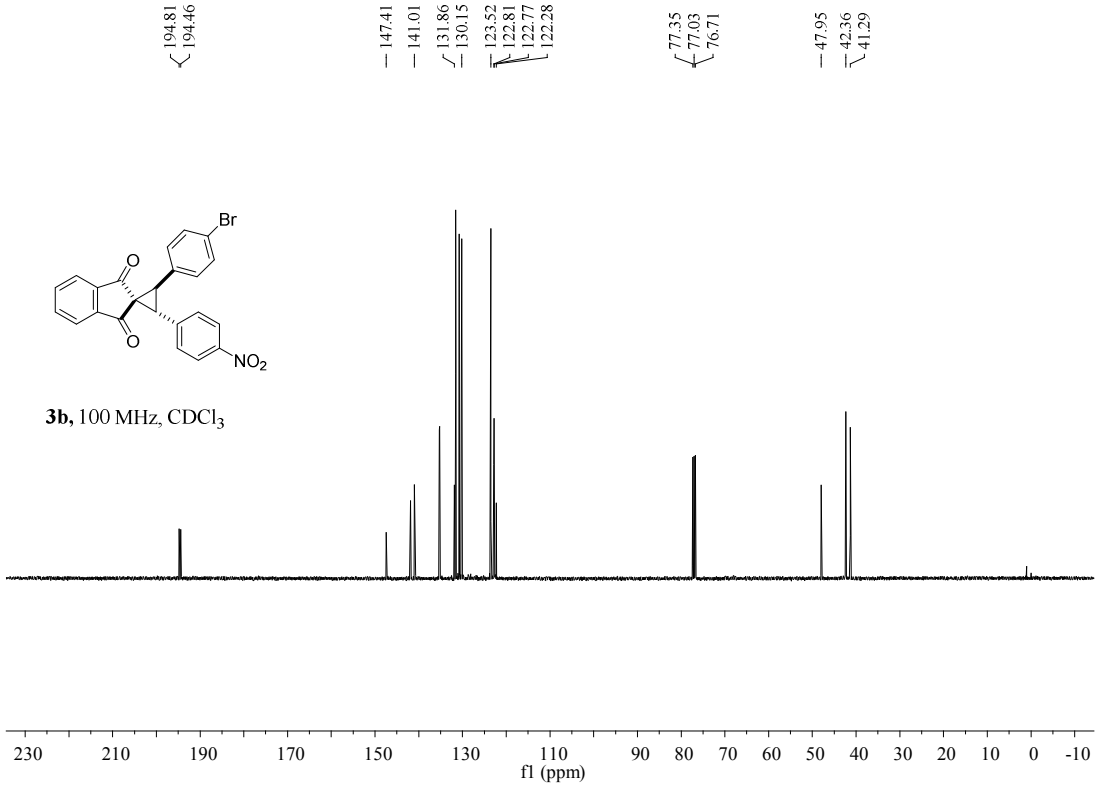
3a, 600 MHz, DMSO-d_6



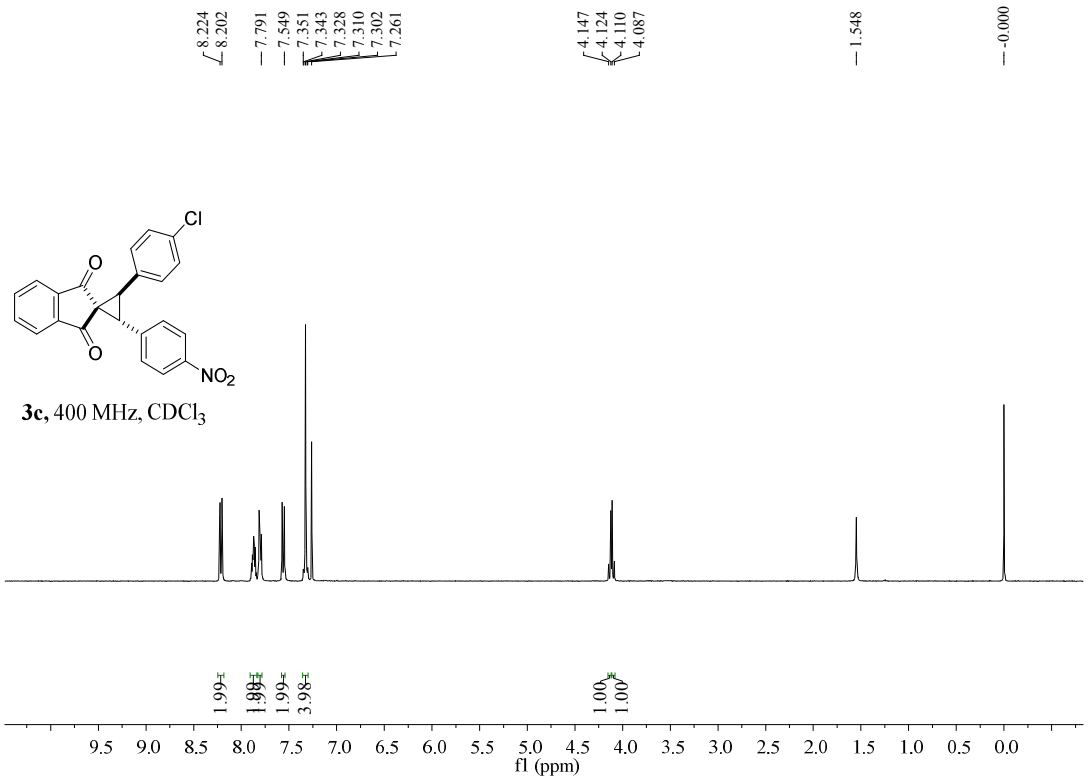
3a, 100 MHz, $CDCl_3$



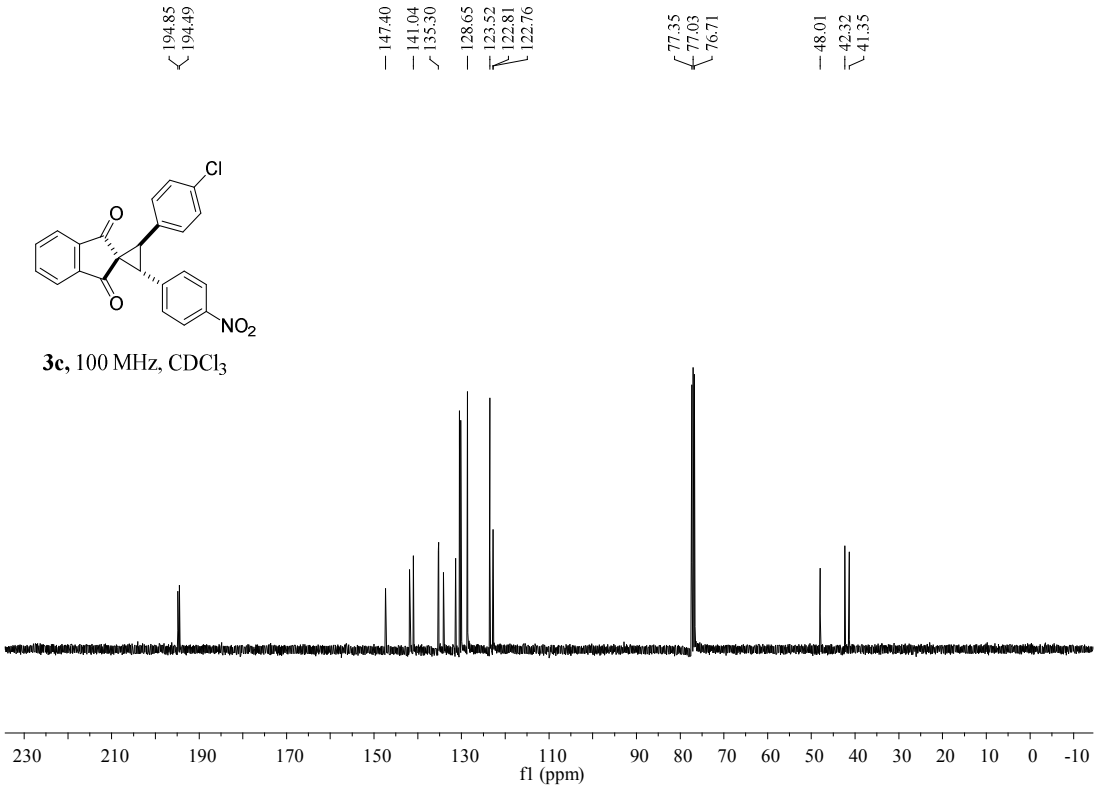
3b, 100 MHz, $CDCl_3$



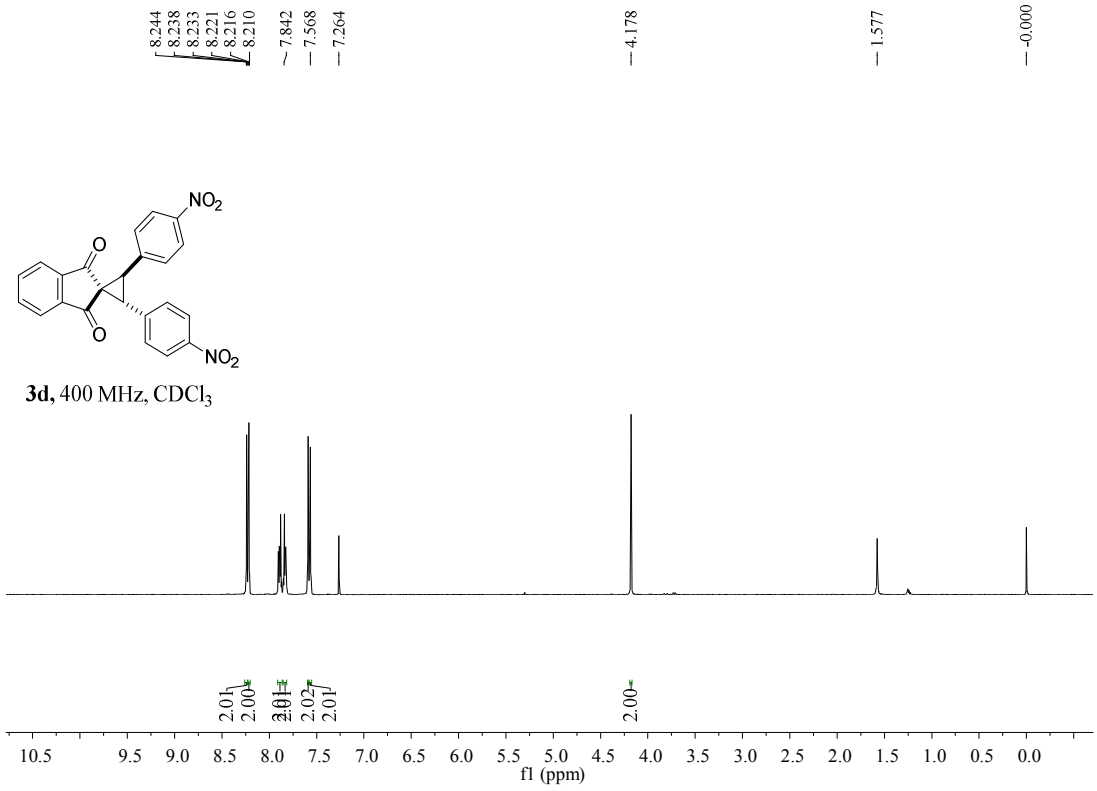
3b, 100 MHz, $CDCl_3$

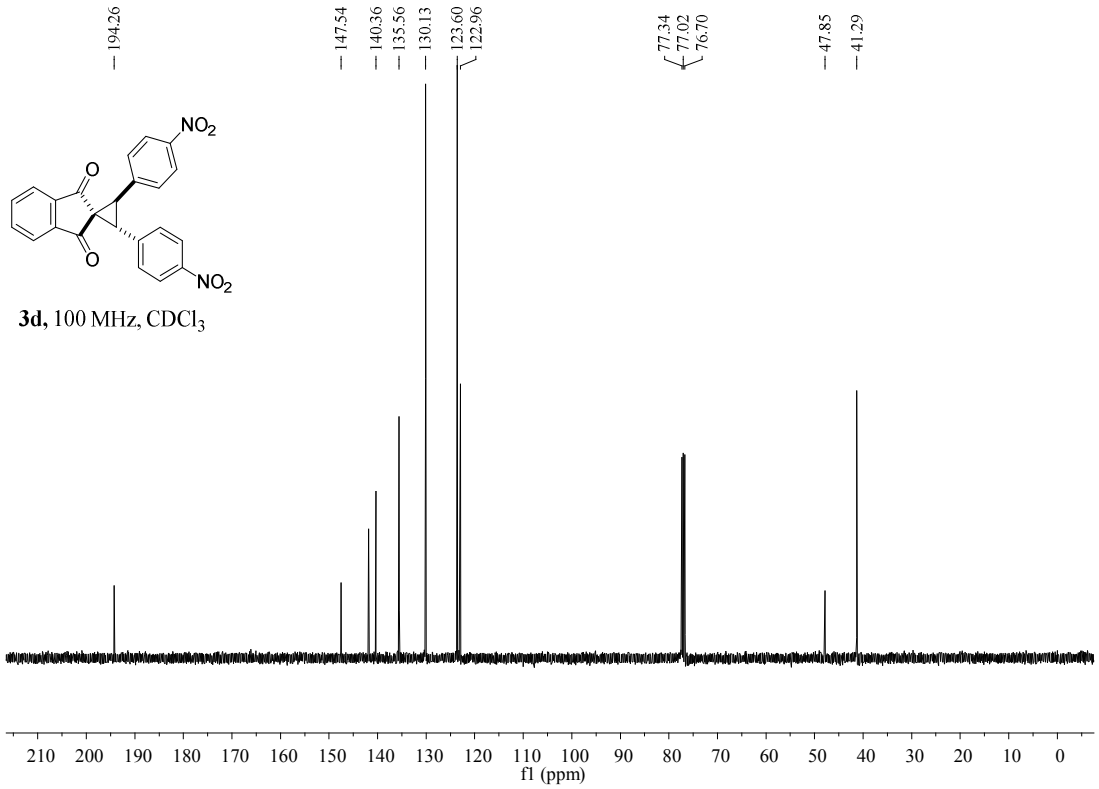


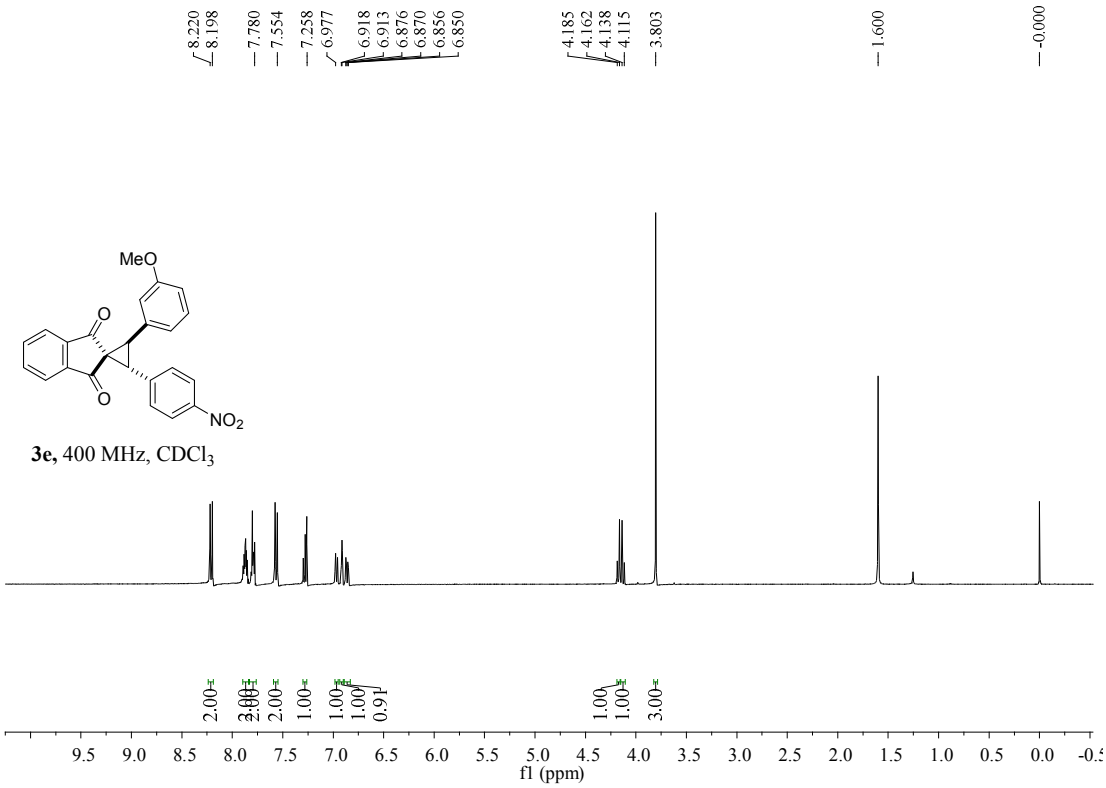
3c, 400 MHz, $CDCl_3$



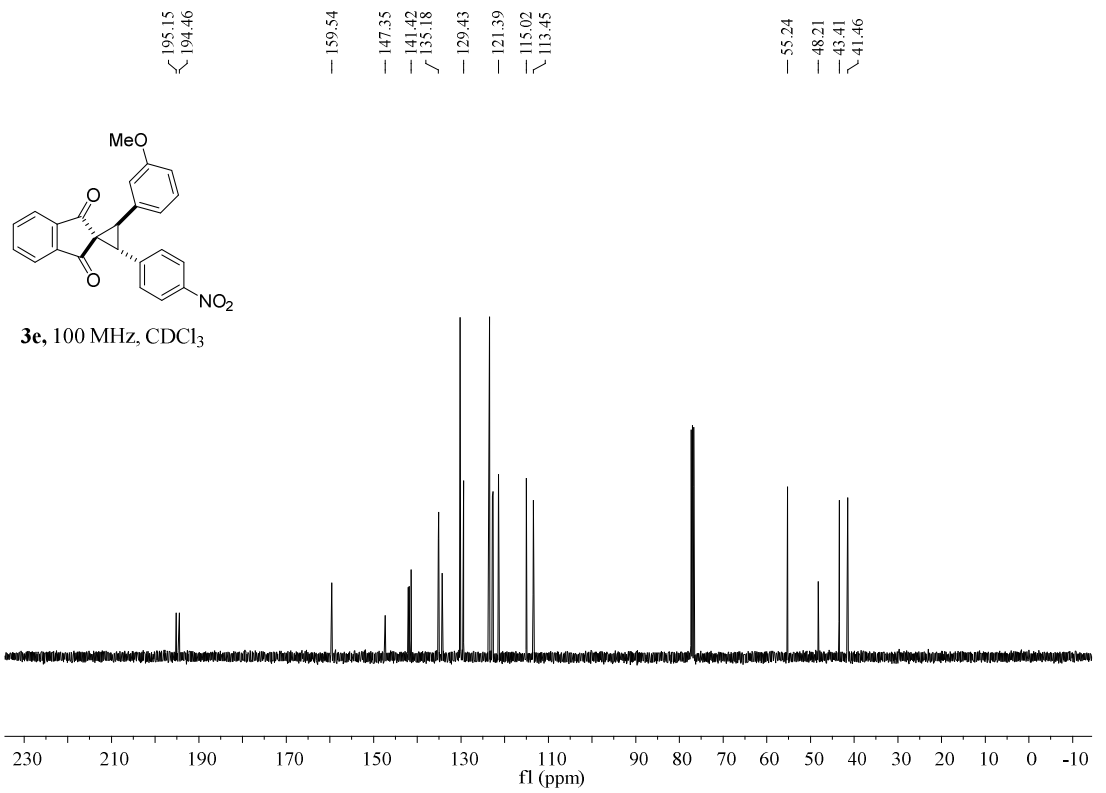
3c, 100 MHz, $CDCl_3$


8.244
8.238
8.233
8.221
8.216
8.210
7.842
7.568
7.264
4.178
1.577
0.000
NO2
O
O
NO2
3d, 400 MHz, CDCl3
2.01
2.00
2.01
2.01
2.02
2.01
2.00
10.5 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
f1 (ppm)


194.26
147.54
140.36
135.56
130.13
123.60
122.96
77.34
77.02
76.70
47.85
41.29
NO2
O
O
NO2
3d, 100 MHz, CDCl3
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)



3e, 400 MHz, $CDCl_3$



3e, 100 MHz, $CDCl_3$