HIGHLY DIASTEREOSELECTIVE SELF-1,3-DIPOLAR [3+3] CYCLOADDITION OF AZOMETHINE YLIDES PROMOTED BY CESIUM CATALYST

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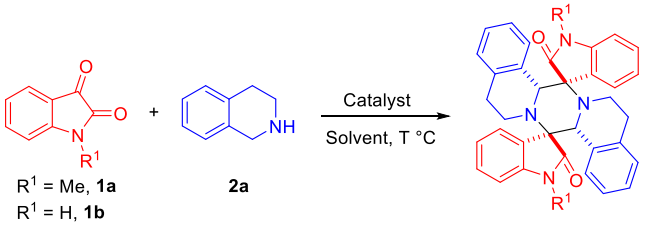
Supporting Information

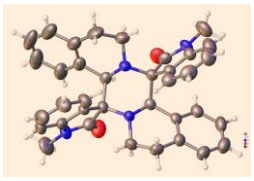
Content

1. General information

All solvents and reagents were obtained from commercial sources and were purified according to standard procedures before use (unless stated otherwise). Column chromatography was performed on silica gel (Qingdao, 300 - 400 mesh) using the indicated eluents. ^{1}H and ^{13}C NMR data were collected on a Varian Mercury 400 MHz or Agilent Mercury 600 MHz NMR spectrometer at room temperature using chloroform-*d* or DMSO-d_6 as a solvent and TMS as an internal standard, and chemical shift (δ) was expressed in parts per million (ppm). ^{1}H and ^{13}C NMR spectra were internally referenced to the proton (^{1}H) of the internal TMS signal at 0.00 ppm or the solvent residue of DMSO-d_6 at 2.50 ppm and the residual carbon nuclei (^{13}C) of the solvent at 77.0 or 39.5 ppm, respectively. The following abbreviations were used in expressing the multiplicity: s = singlet, brs = broad singlet, d = doublet, t = triplet, q = quartet, m = multiplet. High resolution mass spectra (HRMS-ESI) were recorded on a Bruker ESI-QTOF mass spectrometer. The course of the reactions was monitored by thin-layer chromatography (TLC). All reactions that need to be heated were carried out in an oil bath.

2. Optimization of the reaction conditions [a]



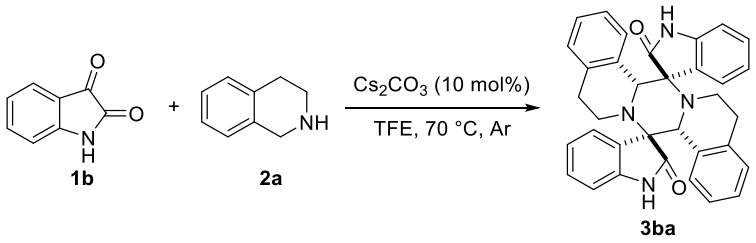


X-ray of **3aa**
CCDC: 2279088

Entry	Solvent	Catalyst	T (℃)	*t* (h)	Yield (%)	dr
1	EtOH	-	50	40	56 (**3aa**)	85/15
2	MeOH	-	50	48	29 (**3aa**)	86/14
3	*i*PrOH	-	50	48	38 (**3aa**)	84/16
4	THF	-	50	48	trace (**3aa**)	-
5	HFIP	-	50	48	24 (**3aa**)	79/21
6	TFE	-	50	16	51 (**3aa**)	90/10
7	TFE	-	60	12	53 (**3aa**)	90/10
8	TFE	-	70	12	61 (**3aa**)	90/10
9	TFE	$Cu(OAc)_2$	70	16	trace (**3aa**)	-
10	TFE	$CuBr_2$	70	16	trace (**3aa**)	-
11	TFE	ZnI_2	70	16	70 (**3aa**)	89/11
12	TFE	AgOAc	70	16	67 (**3aa**)	90/10
13	TFE	AgBr	70	16	55 (**3aa**)	90/10
14	TFE	$FeCl_2$	70	16	61 (**3aa**)	90/10
15	TFE	$CeCl_3$	70	16	70 (**3aa**)	91/9
16	TFE	Cs_2CO_3	70	16	79 (**3aa**)	90/10
17	TFE	Cs_2CO_3	70	16	84 (**3ba**)	>99/1

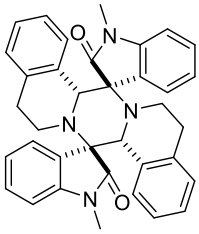
[a] Reaction conditions: **1a** or **1b** (0.20 mmol), **2a** (0.24 mmol), Solvent (2.0 mL). Yields were isolated yields.

3. Experimental procedures and characterizations



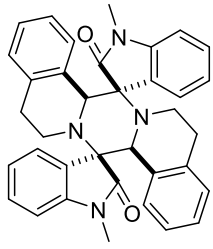
A mixture of **1b** (29.42 mg, 0.2 mmol), **2a** (32.63 mg, 0.2 mmol) and Cs_2CO_3 (8.8 mg, 0.02 mmol) were added in a dried Schlenk tube, then TFE (2 mL) was added under Ar atmosphere, and the reaction system was stirred at 70 ℃. After completion as detected by TLC, about 16 h. The filtrate was concentrated under reduced pressure, purified by flash column chromatography (Petroleum ether/Ethyl acetate = 5/1) to afford corresponding cycloadducts **3ba** (47.6 mg, 84% yield).

(3*S*,8a'*R*,16'*S*,16a'*R*)-1,1''-dimethyl-5',8a',13',16a'-tetrahydro-6'*H*,14'*H*-dispiro[indoline-3,8'-pyrazino[2,1-*a*:5,4-*a*']diisoquinoline-16',3''-indoline]-2,2''-dione (3aa)



White solid, 16 h, 43.6 mg, yield 79%, ^{1}H NMR (600 MHz, Chloroform-*d*) δ 7.90 (dd, *J* = 7.2, 1.2 Hz, 2H), 7.10 (td, *J* = 7.8, 1.2 Hz, 2H), 6.93 – 6.90 (m, 2H), 6.88 – 6.83 (m, 6H), 6.79 – 6.75 (m, 2H), 6.53 (d, *J* = 7.8 Hz, 2H), 6.14 (s, 2H), 3.22 (s, 6H), 2.85 – 2.80 (m, 2H), 2.72 – 2.68 (m, 2H), 2.41 – 2.36 (m, 4H). ^{13}C NMR (150 MHz, Chloroform-*d*) δ 177.2, 143.6, 136.0, 133.2, 129.7, 128.6, 128.1, 126.0, 125.0, 124.9, 124.2, 122.1, 106.9, 74.3, 59.7, 42.2, 30.9, 25.6. HRMS-ESI: Exact mass calcd. for $C_{36}H_{32}N_4O_2Na^+$ $[M + Na]^+$: 575.2423, Found: 575.2440.

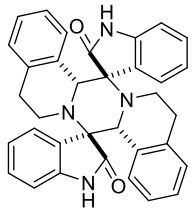
(3S,8a'S,16'S,16a'S)-1,1''-dimethyl-5',8a',13',16a'-tetrahydro-6'H,14'H-dispiro[indoline-3,8'-pyrazino[2,1-a:5,4-a']diisoquinoline-16',3''-indoline]-2,2''-dione (3aa′)



^{1}H NMR (600 MHz, DMSO-d_6) δ 8.12 (d, *J* = 6.6 Hz, 1H), 7.77 (d, *J* = 7.2 Hz, 1H), 7.41 (t, *J* = 7.8 Hz, 1H), 7.16 (t, *J* = 7.8 Hz, 1H), 7.07 – 6.98 (m, 3H), 6.95 – 6.87 (m, 4H), 6.80 – 6.77 (m, 2H), 6.68 – 6.64 (m, 2H), 5.79 (s, 1H), 5.73 (d, *J* = 7.8 Hz, 1H), 5.68 (s, 1H), 3.10 (s, 3H), 2.88 – 2.83 (m, 1H), 2.78 – 2.72 (m, 1H), 2.63 (s, 3H), 2.46 – 2.44 (m, 1H), 2.38 – 2.27 (m, 3H), 2.23 – 2.21 (m, 2H). 13C NMR (150 MHz, Chloroform-*d*) δ 178.1, 175.8, 144.0, 143.1,

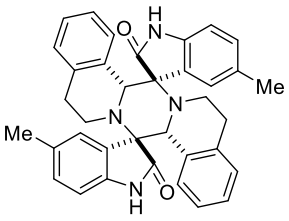
137.9, 136.7, 132.3, 132.0, 129.8, 129.3, 128.5, 128.4, 128.3, 128.2, 126.4, 126.3, 126.0, 126.0, 125.3, 124.7, 124.3, 124.2, 122.4, 122.3, 108.0, 106.5, 75.6, 75.4, 60.8, 60.4, 43.9, 42.1, 31.2, 30.5, 25.6, 25.4. All analytical datas are consistent with literature. [1]

(3*S*,8a'*R*,16'*S*,16a'*R*)-5',8a',13',16a'-tetrahydro-6'*H*,14'*H*-dispiro[indoline-3,8'-pyrazino[2,1-a:5,4-a']diisoquinoline-16',3''-indoline]-2,2''-dione (3ba)



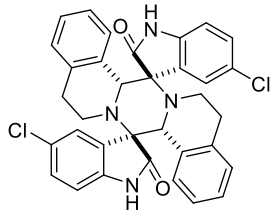
White solid, 16 h, 47.6 mg, yield 84%, ^{1}H NMR (600 MHz, DMSO-d_6) δ 10.55 (s, 2H), 7.69 (d, J = 7.8 Hz, 2H), 6.99 (t, J = 7.8 Hz, 2H), 6.95 – 6.88 (m, 6H), 6.84 – 6.81 (m, 4H), 6.56 (d, J = 7.8 Hz, 2H), 5.87 (s, 2H), 2.71 – 2.66 (m, 2H), 2.52 – 2.48 (m, 2H), 2.44 (d, J = 15.0 Hz, 2H), 2.35 – 2.33 (m, 2H). ^{13}C NMR (150 MHz, DMSO-d_6) δ 179.2, 142.5, 136.2, 133.6, 130.3, 129.1, 128.7, 126.5, 125.8, 125.0, 124.5, 122.0, 109.2, 73.8, 58.9, 42.4, 30.7. HRMS-ESI: Exact mass calcd. for $C_{34}H_{28}N_4O_2Na^+$ [M + Na]$^+$: 574.2104, Found: 574.2098.

(3*S*,8a'*R*,16'*S*,16a'*R*)-5,5''-dimethyl-5',8a',13',16a'-tetrahydro-6'*H*,14'*H*-dispiro[indoline-3,8'-pyrazino[2,1-a:5,4-a']diisoquinoline-16',3''-indoline]-2,2''-dione (3ca)



White solid, 22 h, 45.4 mg, yield 77%, ^{1}H NMR (600 MHz, DMSO-d_6) δ 10.44 (s, 2H), 7.55 (s, 2H), 6.95 – 6.89 (m, 6H), 6.84 (d, J = 6.6 Hz, 2H), 6.79 (d, J = 7.8 Hz, 2H), 6.44 (d, J = 7.8 Hz, 2H), 5.85 (s, 2H), 2.69 – 2.64 (m, 2H), 2.52 – 2.48 (m, 2H), 2.47 – 2.44 (m, 2H), 2.37 – 2.34 (m, 2H), 2.16 (s, 6H). ^{13}C NMR (150 MHz, DMSO-d_6) δ 178.6, 139.7, 135.7, 133.1, 130.0, 129.8, 128.9, 128.2, 126.1, 125.3, 124.7, 124.7, 108.4, 73.5, 58.4, 41.8, 30.3, 20.9. HRMS-ESI: Exact mass calcd. for $C_{36}H_{32}N_4O_2Na^+$ [M + Na]$^+$: 575.2417, Found: 575.2413.

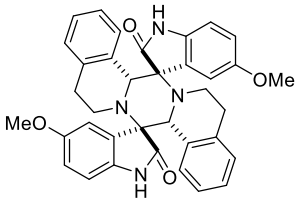
(3*S*,8a'*R*,16'*S*,16a'*R*)-5,5''-dichloro-5',8a',13',16a'-tetrahydro-6'*H*,14'*H*-dispiro[indoline-3,8'-pyrazino[2,1-a:5,4-a']diisoquinoline-16',3''-indoline]-2,2''-dione (3da)



White solid, 22 h, 53.9 mg, yield 86%, ^{1}H NMR (600 MHz, DMSO-d_6) δ 10.76 (s, 2H), 7.59 (d, J = 2.4 Hz, 2H), 7.06 (dd, J = 7.8, 1.8 Hz, 2H), 6.96 – 6.90 (m, 8H), 6.59 (d, J = 8.4 Hz, 2H), 5.83 (s, 2H), 2.67 – 2.62

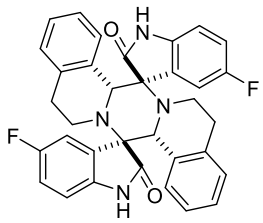
(m, 2H), 2.55 – 2.51 (m, 4H), 2.37 – 2.35 (m, 2H). ^{13}C NMR (150 MHz, DMSO-d_6) δ 178.1, 141.0, 135.5, 132.4, 131.8. 128.7, 128.5, 126.5, 125.6, 125.3, 124.5, 123.6, 110.5, 73.6, 58.5, 42.0, 32.0. HRMS-ESI: Exact mass calcd. for $C_{34}H_{26}N_4O_2Cl_2Na^+$ [M + Na]$^+$: 615.1325, Found: 615.1317.

(3*S*,8a'*R*,16'*S*,16a'*R*)-5,5''-dimethoxy-5',8a',13',16a'-tetrahydro-6'*H*,14'*H*-dispiro[indoline-3,8'-pyrazino[2,1-a:5,4-a']diisoquinoline-16',3''-indoline]-2,2''-dione (3ea)



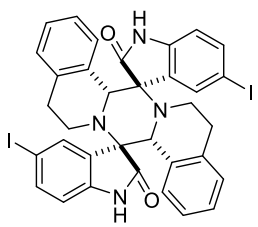
White solid, 18 h, 45.5 mg, yield 76%, ^{1}H NMR (600 MHz, DMSO-d_6) δ 10.41 (s, 2H), 7.31 (d, J = 3.0 Hz, 2H), 7.00 – 6.90 (m, 6H), 6.88 – 6.87 (m, 2H), 6.57 (dd, J = 8.4, 1.8 Hz, 2H), 6.49 (d, J = 7.8 Hz, 2H), 5.85 (s, 2H), 3.62 (s, 6H), 2.71 – 2.66 (m, 2H), 2.51 – 2.46 (m, 4H), 2.36 – 2.33 (m, 2H). ^{13}C NMR (150 MHz, DMSO-d_6) 178.5, 154.3, 135.6, 135.4, 133.1, 131.3, 128.3, 126.2, 125.4, 124.7, 113.5, 110.4, 109.2, 73.6, 58.3, 55.1, 41.9, 30.4. HRMS-ESI: Exact mass calcd. for $C_{36}H_{32}N_4O_4Na^+$ [M + Na]$^+$: 607.2315, Found: 607.2312.

(3*S*,8a'*R*,16'*S*,16a'*R*)-5,5''-difluoro-5',8a',13',16a'-tetrahydro-6'*H*,14'*H*-dispiro[indoline-3,8'-pyrazino[2,1-*a*:5,4-*a*']diisoquinoline-16',3''-indoline]-2,2''-dione (3fa)



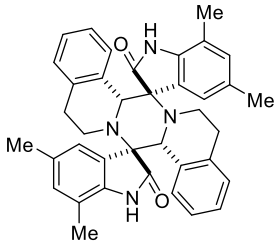
White solid, 19 h, 49.6 mg, yield 83%, ^{1}H NMR (600 MHz, DMSO-d_6) δ 10.65 (s, 2H), 7.38 (dd, J = 7.8, 3.0 Hz, 2H), 6.95 – 6.90 (m, 8H), 6.86 – 6.82 (m, 2H), 6.57 (dd, J = 8.4, 4.2 Hz, 2H), 5.85 (s, 2H), 2.72 – 2.67 (m, 2H), 2.53 – 2.48 (m, 4H), 2.36 – 2.33 (m, 2H). ^{13}C NMR (150 MHz, DMSO-d_6) δ 178.5, 158.4 (d, $^1J_{C\text{-}F}$ = 236.6 Hz), 138.3, 135.6, 132.6, 131.6 (d, $^3J_{C\text{-}F}$ = 8.0 Hz), 128.5, 126.4, 125.6, 124.5, 115.20 (d, $^2J_{C\text{-}F}$ = 23.6 Hz), 111.19 (d, $^2J_{C\text{-}F}$ = 24.1 Hz), 109.76 (d, $^3J_{C\text{-}F}$ = 8.0 Hz), 73.7, 58.4, 42.0, 30.2. HRMS-ESI: Exact mass calcd. for $C_{34}H_{26}N_4O_2F_2Na^+$ [M + Na]$^+$: 583.1916, Found: 583.1910.

(3*S*,8a'*R*,16'*S*,16a'*R*)-5,5''-diiodo-5',8a',13',16a'-tetrahydro-6'*H*,14'*H*-dispiro[indoline-3,8'-pyrazino[2,1-*a*:5,4-*a*']diisoquinoline-16',3''-indoline]-2,2''-dione (3ga)



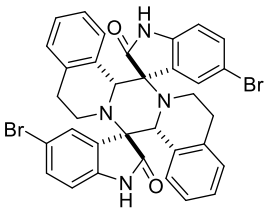
White solid, 17 h, 73.1 mg, yield 87%, ^{1}H NMR (600 MHz, DMSO-d_6) δ 10.72 (s, 2H), 8.00 (d, J = 3.0 Hz, 2H), 7.33 (dd, J = 8.4, 1.8 Hz, 2H), 6.97 – 6.90 (m, 8H), 6.43 (d, J = 8.4 Hz, 2H), 5.78 (s, 2H), 2.64 – 2.59 (m, 2H), 2.55 – 2.54 (m, 4H), 2.36 – 2.33 (m, 2H). ^{13}C NMR (150 MHz, DMSO-d_6) δ 178.0, 141.0, 135.4, 132.3, 131.7, 128.6, 128.4, 126.4, 125.5, 125.2, 124.4, 123.5, 110.4, 73.6, 58.5, 42.0, 30.2. HRMS-ESI: Exact mass calcd. for $C_{34}H_{26}N_4O_2I_2Na^+$ [M + Na]$^+$: 799.0037, Found: 799.0013.

(3*S*,8a'*R*,16'*S*,16a'*R*)-5,5'',7,7''-tetramethyl-5',8a',13',16a'-tetrahydro-6'*H*,14'*H*-dispiro[indoline-3,8'-pyrazino[2,1-*a*:5,4-*a*']diisoquinoline-16',3''-indoline]-2,2''-dione (3ha)



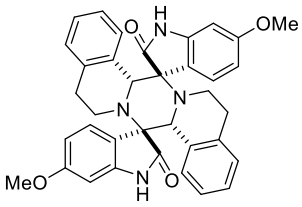
White solid, 24 h, 34.3 mg, yield 56%, ^{1}H NMR (600 MHz, DMSO-d_6) δ 10.46 (s, 2H), 7.31 (s, 2H), 6.90 – 6.84 (m, 6H), 6.78 – 6.77 (m, 2H), 6.55 (s, 2H), 5.80 (s, 2H), 2.64 – 2.56 (m, 2H), 2.47 – 2.37 (m, 4H), 2.31 – 2.29 (m, 2H), 2.06 (s, 6H), 1.93 (s, 6H). ^{13}C NMR (150 MHz, DMSO-d_6) δ 179.2, 138.3, 135.8, 133.3, 130.3, 129.7, 129.7, 128.1, 126.2, 125.1, 124.7, 122.1, 117.5, 73.7, 58.6, 41.9, 30.3, 20.8, 16.1. HRMS-ESI: Exact mass calcd. for $C_{38}H_{36}N_4O_2Na^+$ [M + Na]$^+$: 603.2730, Found: 603.2730.

(3*S*,8a'*R*,16'*S*,16a'*R*)-5,5''-dibromo-5',8a',13',16a'-tetrahydro-6'*H*,14'*H*-dispiro[indoline-3,8'-pyrazino[2,1-a:5,4-*a*']diisoquinoline-16',3''-indoline]-2,2''-dione (3ia)



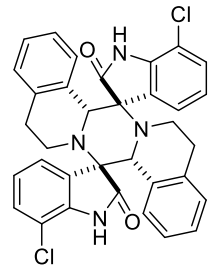
White solid, 24 h, 47.6 mg, yield 66%, ^{1}H NMR (600 MHz, DMSO-d_6) δ 10.75 (s, 2H), 7.57 (d, J = 7.8 Hz, 2H), 7.02 (dd, J = 7.8, 1.8 Hz, 2H), 6.96 – 6.93 (m, 4H), 6.91 – 6.88 (m, 4H), 6.71 (d, J = 1.8 Hz, 2H), 5.83 (s, 2H), 2.70 – 2.65 (m, 2H), 2.48 – 2.44 (m, 4H), 2.33 – 2.31 (m, 2H). ^{13}C NMR (150 MHz, DMSO-d_6) δ 178.5, 143.8, 135.7, 132.6, 129.1, 128.5, 126.4, 125.9, 125.6, 124.4, 124.4, 121.2, 111.7, 73.2, 58.4, 42.0, 30.1. HRMS-ESI: Exact mass calcd. for $C_{34}H_{26}N_4O_2Br_2Na^+$ [M + Na]$^+$: 703.0314, Found: 703.0305.

(3*S*,8a'*R*,16'*S*,16a'*R*)-6,6''-dimethoxy-5',8a',13',16a'-tetrahydro-6'*H*,14'*H*-dispiro[indoline-3,8'-pyrazino[2,1-*a*:5,4-*a*']diisoquinoline-16',3''-indoline]-2,2''-dione (3ja)



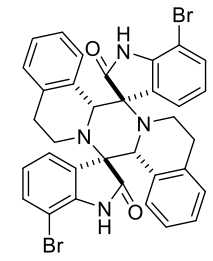
White solid, 24 h, 21.2 mg, yield 36%, ^{1}H NMR (600 MHz, DMSO-d_6) δ 10.48 (s, 2H), 7.53 (d, J = 8.2 Hz, 2H), 6.94 – 6.90 (m, 6H), 6.87 – 6.86 (m, 2H), 6.37 (dd, J = 8.2, 2.4 Hz, 2H), 6.11 (d, J = 2.4 Hz, 2H), 5.82 (s, 2H), 3.62 (s, 6H), 2.69 – 2.64 (m, 2H), 2.48 – 2.43 (m, 4H), 2.36 – 2.34 (m, 2H). ^{13}C NMR (150 MHz, DMSO-d_6) δ 179.3, 159.7, 143.3, 135.8, 133.5, 128.3, 126.0, 125.4, 124.8, 124.6, 121.6, 106.4, 95.6, 73.1, 58.4, 54.9, 41.7, 30.3. HRMS-ESI: Exact mass calcd. for $C_{36}H_{32}N_4O_4Na^+$ [M + Na]$^+$: 607.2316, Found: 607.2313.

(3*S*,8a'*R*,16'*S*,16a'*R*)-7,7''-dichloro-5',8a',13',16a'-tetrahydro-6'*H*,14'*H*-dispiro[indoline-3,8'-pyrazino[2,1-*a*:5,4-*a*']diisoquinoline-16',3''-indoline]-2,2''-dione (3ka)



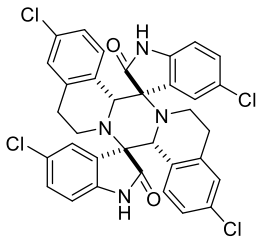
White solid, 18 h, 35.0 mg, yield 56%, ^{1}H NMR (600 MHz, DMSO-d_6) δ 11.04 (s, 2H), 7.63 (dd, J = 7.4, 1.2 Hz, 2H), 7.06 (dd, J = 8.4, 1.2 Hz, 2H), 6.96 – 6.92 (m, 6H), 6.87 – 6.85 (m, 4H), 5.88 (s, 2H), 2.71 – 2.66 (m, 2H), 2.54 – 2.51 (m, 2H), 2.48 – 2.45 (m, 2H), 2.35 – 2.32 (m, 2H). ^{13}C NMR (150 MHz, DMSO-d_6) δ 178.8, 139.6, 135.7, 132.5, 131.6, 128.7, 128.5, 126.5, 125.4, 124.3, 123.0, 122.6, 74.2, 58.7, 48.6, 42.1, 30.1. HRMS-ESI: Exact mass calcd. for $C_{34}H_{36}N_4O_2Cl_2Na^+$ [M + Na]$^+$: 615.1325, Found: 615.1320.

(3*S*,8a'*R*,16'*S*,16a'*R*)-7,7''-dibromo-5',8a',13',16a'-tetrahydro-6'*H*,14'*H*-dispiro[indoline-3,8'-pyrazino[2,1-a:5,4-*a*']diisoquinoline-16',3''-indoline]-2,2''-dione (3la)



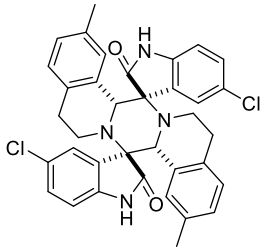
White solid, 17 h, 46.2 mg, yield 64%, ^{1}H NMR (600 MHz, DMSO-d_6) δ 10.92 (s, 2H), 7.66 (d, J = 7.2 Hz, 2H), 7.19 (d, J = 8.4 Hz, 2H), 6.96 – 6.92 (m, 6H), 6.87 – 6.86 (m, 2H), 6.80 (t, J = 7.8 Hz, 2H), 5.87 (s, 2H), 2.71 – 2.66 (m, 2H), 2.53 – 2.51 (m, 2H), 2.48 – 2.45 (m, 2H), 2.35 – 2.32 (m, 2H). ^{13}C NMR (150 MHz, DMSO-d_6) δ 178.7, 141.3, 135.7, 132.5, 131.6, 131.6, 128.5, 126.5, 125.4, 123.4, 123.0, 101.4, 74.4, 58.8, 42.1, 30.1. HRMS-ESI: Exact mass calcd. for $C_{36}H_{32}N_4O_4Na^+$ [M + Na]$^+$: 703.0314, Found: 703.0305.

(3*S*,8a'*R*,16'*S*,16a'*R*)-3',5,5'',11'-tetrachloro-5',8a',13',16a'-tetrahydro-6'*H*,14'*H*-dispiro[indoline-3,8'-pyrazino[2,1-a:5,4-*a*']diisoquinoline-16',3''-indoline]-2,2''-dione (3db)



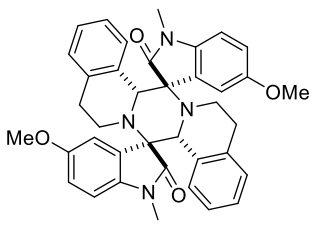
White solid, 17 h, 59.2 mg, yield 85%, ^{1}H NMR (600 MHz, DMSO-d_6) δ 10.83 (s, 2H), 7.58 (d, J = 2.4 Hz, 2H), 7.12 (dd, J = 8.2, 2.4 Hz, 2H), 7.06 – 7.04 (m, 4H), 6.90 (d, J = 8.2 Hz, 2H), 6.65 (d, J = 8.4 Hz, 2H), 5.78 (s, 2H), 2.61 – 2.56 (m, 4H), 2.52 – 2.48 (m, 2H), 2.35 – 2.38 (m, 2H). ^{13}C NMR (150 MHz, DMSO-d_6) δ 177.8, 141.0, 138.1, 131.3, 131.0, 129.0, 128.1, 126.4, 125.8, 125.5, 123.6, 110.8, 73.5, 59.8, 58.3, 20.8, 14.1. HRMS-ESI: Exact mass calcd. for $C_{34}H_{24}N_4O_2Cl_4Na^+$ $[M + Na]^+$: 683.0551, Found: 683.0558.

(3*S*,8a'*R*,16'*S*,16a'*R*)-5,5''-dichloro-2',10'-dimethyl-5',8a',13',16a'-tetrahydro-6'*H*,14'*H*-dispiro[indoline-3,8'-pyrazino[2,1-*a*:5,4-*a*']diisoquinoline-16',3''-indoline]-2,2''-dione (3dc)



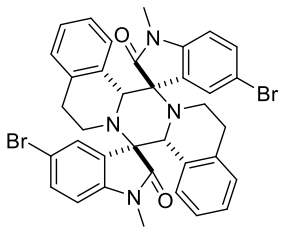
White solid, 26 h, 57.0 mg, yield 87%, ^{1}H NMR (600 MHz, DMSO-d_6) δ 10.76 (s, 2H), 7.56 (s, 2H), 7.06 (d, J = 7.8 Hz, 2H), 6.79 – 6.74 (m, 6H), 6.59 (d, J = 8.4 Hz, 2H), 5.77 (s, 2H), 2.60 – 2.56 (m, 2H), 2.53 – 2.47 (m, 4H), 2.36 – 2.31 (m, 2H), 2.10 (s, 6H). ^{13}C NMR (150 MHz, DMSO-d_6) δ 178.2, 141.1, 134.3, 132.4, 132.2, 131.9, 128.7, 128.2, 127.2, 125.2, 125.0, 123.6, 110.3, 73.7, 58.6, 42.2, 29.7, 14.1. HRMS-ESI: Exact mass calcd. for $C_{36}H_{30}N_4O_2Cl_2Na^+$ $[M + Na]^+$: 643.1638, Found: 643.1638.

(3*S*,8a'*R*,16'*S*,16*a*'*R*)-5,5''-dimethoxy-1,1''-dimethyl-5',8a',13',16a'-tetrahydro-6'*H*,14'*H*-dispiro[indoline-3,8'-pyrazino[2,1-*a*:5,4-*a*']diisoquinoline-16',3''-indoline]-2,2''-dione (3ma)



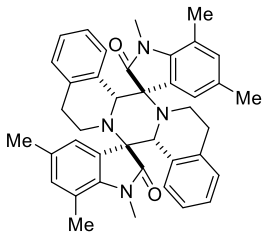
White solid, 24 h, 57.2 mg, yield 88%, 90/10 dr. ^{1}H NMR (600 MHz, Chloroform-*d*) δ 7.57 (d, J = 3.0 Hz, 2H), 6.89 – 6.85 (m, 6H), 6.79 (d, J = 7.2 Hz, 2H), 6.62 (dd, J = 8.4, 3.0 Hz, 2H), 6.44 (d, J = 8.4 Hz, 2H), 6.13 (s, 2H), 3.75 (s, 6H), 3.20 (s, 6H), 2.88 – 2.82 (m, 2H), 2.73 – 2.69 (m, 2H), 2.43 – 2.39 (m, 4H). ^{13}C NMR (150 MHz, Chloroform-*d*) δ 176.8, 155.5, 137.3, 135.8, 133.2, 131.1, 128.2, 126.0, 125.1, 125.0, 113.2, 111.3, 107.2, 74.5, 59.5, 55.7, 42.2, 31.0, 25.7. HRMS-ESI: Exact mass calcd. for $C_{38}H_{36}N_4O_4Na^+$ $[M + Na]^+$: 635.2634, Found: 635.2638.

(3*S*,8a'*R*,16'*S*,16a'*R*)-5,5''-dibromo-1,1''-dimethyl-5',8a',13',16a'-tetrahydro-6'*H*,14'*H*-dispir o[indoline-3,8'-pyrazino[2,1-*a*:5,4-*a*']diisoquinoline-16',3''-indoline]-2,2''-dione (3na)



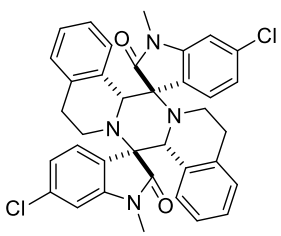
White solid, 17 h, 55.2 mg, yield 84%, 90/10 dr. ^{1}H NMR (600 MHz, Chloroform-*d*) δ 7.94 (d, *J* = 1.8 Hz, 2H), 7.19 (dd, *J* = 8.2, 1.8 Hz, 2H), 6.89 – 6.78 (m, 8H), 6.38 (d, *J* = 8.2 Hz, 2H), 6.07 (s, 2H), 3.17 (s, 6H), 2.85 – 2.79 (m, 2H), 2.70 – 2.66 (m, 2H), 2.44 – 2.36 (m, 4H). ^{13}C NMR (150 MHz, Chloroform-*d*) δ 176.3, 142.6, 135.8, 132.4, 131.5, 131.4, 128.4, 127.2, 126.3, 125.0, 124.8, 114.8, 108.5, 74.5, 59.7, 42.2, 30.7, 25.7. HRMS-ESI: Exact mass calcd. for $C_{36}H_{30}N_4O_2Br_2Na^+$ [M + Na]$^+$: 731.0627, Found: 731.0624.

(3*S*,8a'*R*,16'*S*,16a'*R*)-1,1'',5,5'',7,7''-hexamethyl-5',8a',13',16a'-tetrahydro-6'*H*,14'*H*-dispiro[i ndoline-3,8'-pyrazino[2,1-*a*:5,4-*a*']diisoquinoline-16',3''-indoline]-2,2''-dione (3oa)



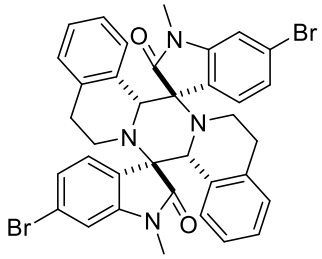
White solid, 23 h, 48.9 mg, yield 79%, 92/8 dr. ^{1}H NMR (600 MHz, Chloroform-*d*) δ 7.73 (s, 2H), 6.88 – 6.82 (m, 8H), 6.75 (d, *J* = 7.8 Hz, 2H), 6.39 (d, *J* = 7.8 Hz, 2H), 6.10 (s, 2H), 3.17 (s, 6H), 2.82 – 2.76 (m, 2H), 2.70 – 2.66 (m, 2H), 2.40 – 2.33 (m, 4H), 2.26 (s, 6H). ^{13}C NMR (150 MHz, Chloroform-*d*) δ 177.0, 141.3, 135.9, 133.2, 131.2, 129.7, 128.7, 128.0, 125.9, 125.1, 125.1, 124.8, 106.5, 74.4, 59.6, 42.1, 30.9, 25.6, 21.2. HRMS-ESI: Exact mass calcd. for $C_{38}H_{36}N_4O_2Na^+$ [M + Na]$^+$: 603.2730, Found: 603.2730.

(3*S*,8a'*R*,16'*S*,16a'*R*)-6,6''-dichloro-1,1''-dimethyl-5',8a',13',16a'-tetrahydro-6'*H*,14'*H*-dispir o[indoline-3,8'-pyrazino[2,1-*a*:5,4-*a*']diisoquinoline-16',3''-indoline]-2,2''-dione (3pa)



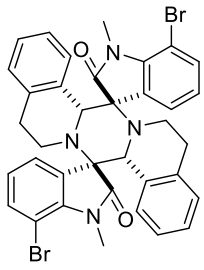
White solid, 23 h, 48.9 mg, yield 79%, 90/10 dr. ^{1}H NMR (600 MHz, Chloroform-*d* -d_6) δ 7.71 (d, *J* = 7.8 Hz, 2H), 6.90 – 6.83 (m, 6H), 6.80 – 6.78 (m, 4H), 6.51 (d, *J* = 1.8 Hz, 2H), 6.07 (s, 2H), 3.17 (s, 6H), 2.77 – 2.71 (m, 2H), 2.66 – 2.62 (m, 2H), 2.38 (dd, *J* = 15.0 Hz, 2H), 2.34 – 2.32 (m, 2H). ^{13}C NMR (150 MHz, Chloroform-*d*) δ 177.5, 139.5, 135.9, 132.8, 132.8, 131.1, 128.4, 126.6, 125.3, 125.0, 123.0, 122.8, 114.7, 60.2, 42.5, 30.9, 29.2. HRMS-ESI: Exact mass calcd. for $C_{36}H_{30}N_4O_2Cl_2Na^+$ [M + Na]$^+$: 645.1638, Found: 645.1636.

(3*S*,8a'*R*,16'*S*,16a'*R*)-6,6''-dibromo-1,1''-dimethyl-5',8a',13',16a'-tetrahydro-6'*H*,14'*H*-dispiro[indoline-3,8'-pyrazino[2,1-*a*:5,4-*a*']diisoquinoline-16',3''-indoline]-2,2''-dione (3qa)



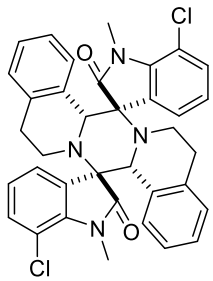
White solid, 23 h, 48.9 mg, yield 69%, 92/8 dr. ^{1}H NMR (600 MHz, Chloroform-*d*) δ 7.67 (d, *J* = 7.8 Hz, 2H), 7.04 (dd, *J* = 7.8, 1.8 Hz, 2H), 6.93 – 6.86 (m, 4H), 6.82 – 6.80 (m, 4H), 6.68 (d, *J* = 1.8 Hz, 2H), 6.08 (s, 2H), 3.19 (s, 6H), 2.78 – 2.72 (m, 2H), 2.68 – 2.64 (m, 2H), 2.42 – 2.39 (m, 2H), 2.36 – 2.33 (m, 2H). ^{13}C NMR (150 MHz, Chloroform-*d*) δ 177.0, 145.2, 135.9, 132.8, 128.8, 128.7, 126.6, 125.5, 125.4, 125.2, 124.9, 122.4, 110.7, 59.7, 42.3, 31.0, 25.9. HRMS-ESI: Exact mass calcd. for $C_{36}H_{30}N_4O_2Br_2Na^+$ [M + Na]$^+$: 731.0627, Found: 731.0614.

(3*S*,8a'*R*,16'*S*,16a'*R*)-7,7''-dibromo-1,1''-dimethyl-5',8a',13',16a'-tetrahydro-6'*H*,14'*H*-dispiro[indoline-3,8'-pyrazino[2,1-*a*:5,4-*a*']diisoquinoline-16',3''-indoline]-2,2''-dione (3ra)



White solid, 23 h, 48.9 mg, yield 79%, 92/8 dr. ^{1}H NMR (600 MHz, Chloroform-*d* -d_6) δ 8.38 (dd, *J* = 7.2, 1.2 Hz, 0.18H), 7.81 (dd, *J* = 7.2, 1.2 Hz, 2H), 7.64 (dd, *J* = 7.2, 1.2 Hz, 0.18H), 7.48 (dd, *J* = 8.2, 1.2 Hz, 0.18H), 7.17 (dd, *J* = 8.2, 1.2 Hz, 2H), 7.00 – 6.95 (m, 0.64H), 6.92 – 6.87 (m, 4H), 6.76 – 6.79 (m, 4H), 6.74 – 6.72 (m, 2H), 6.08 (s, 2H), 3.60 (s, 6H), 3.54 (s, 0.42H), 2.78 – 2.73 (m, 2H), 2.66 – 2.62 (m, 2H), 2.40 – 2.34 (m, 4H). ^{13}C NMR (150 MHz, Chloroform-*d*) δ 177.6, 140.8, 135.7, 134.3, 133.0, 132.7, 128.3, 126.5, 125.2, 124.9, 123.3, 123.1, 101.5, 73.7, 60.1, 42.4, 30.8, 29.3. HRMS-ESI: Exact mass calcd. for $C_{36}H_{30}N_4O_2$ Br_2Na^+ [M + Na]$^+$: 731.0614, Found: 731.0616.

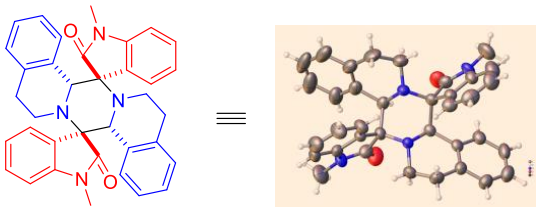
(3*S*,8a'*R*,16'*S*,16a'*R*)-7,7''-dichloro-1,1''-dimethyl-5',8a',13',16a'-tetrahydro-6'*H*,14'*H*-dispiro[indoline-3,8'-pyrazino[2,1-*a*:5,4-*a*']diisoquinoline-16',3''-indoline]-2,2''-dione (3sa)



White solid, 17 h, 56.5 mg, yield 86%, 90/10 dr. ^{1}H NMR (600 MHz, Chloroform-*d* -d_6) δ 7.79 (dd, *J* = 7.2, 1.2 Hz, 2H), 7.01 (dd, *J* = 8.4, 1.2 Hz, 2H), 6.95 – 6.90 (m, 4H), 6.83 – 6.79 (m, 6H), 6.11 (s, 2H), 3.60 (s, 6H),

2.81 – 2.76 (m, 2H), 2.69 – 2.65 (m, 2H), 2.42 – 2.37 (m, 4H). ^{13}C NMR (150 MHz, Chloroform-*d*) δ 177.3, 139.3, 135.7, 132.6, 132.6, 130.9, 128.3, 126.4, 125.1, 124.8, 122.9, 122.6, 114.5, 73.7, 42.3, 30.7, 29.0. HRMS-ESI: Exact mass calcd. for $C_{36}H_{30}N_4O_2Cl_2Na^+$ $[M + Na]^+$: 643.1638, Found: 643.1636.

4. X-Ray analysis



3aa

X-ray of **3aa**
CCDC: 2279088

Crystal data and structure refinement for 2279088

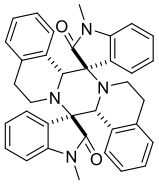
Identification code	exp_11884
Empirical formula	$C_{36}H_{32}N_4O_2$
Formula weight	552.65
Temperature/K	293(2)
Crystal system	monoclinic
Space group	$P2_1/c$
a/Å	8.7064(12)
b/Å	18.067(2)
c/Å	19.310(2)
α/°	90
β/°	99.935(12)
γ/°	90
Volume/Å^3	2992.0(7)
Z	4
ρ_{calc}g/cm^3	1.227
μ/mm^{-1}	0.077
F(000)	1168.0
Crystal size/mm^3	0.16 × 0.14 × 0.08
Radiation	Mo Kα (λ = 0.71073)
2Θ range for data collection/°	4.282 to 48.998
Index ranges	$-10 \leqslant h \leqslant 9$, $-20 \leqslant k \leqslant 21$, $-22 \leqslant l \leqslant 22$
Reflections collected	14168
Independent reflections	4919 [R_{int} = 0.0735, R_{sigma} = 0.1027]
Data/restraints/parameters	4919/0/381
Goodness-of-fit on F^2	0.981
Final R indexes [I>=2σ (I)]	R_1 = 0.0579, wR_2 = 0.1027
Final R indexes [all data]	R_1 = 0.1261, wR_2 = 0.1349
Largest diff. peak/hole / e Å^{-3}	0.20/-0.21

5. References

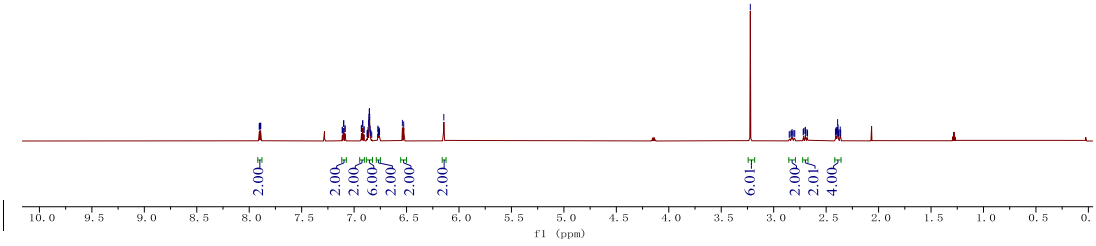
[1] P. J. Xia, Y. H. Sun, J. A. Xiao, Z. F. Zhou, S. S. Wen, Y. Xiong, G. C. Ou, X. Q. Chen and H. Yang, *J. Org. Chem.*, 2015, **80**, 11573-11579.

6. ^{1}H NMR and ^{13}C NMR spectra of compounds

Parameter	Value
1 title	RS-0935-2.1.fid
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDCl3
4 Temperature	298.0
5 Number of Scans	4
6 Acquisition Date	2022-08-25T02:25:28
7 Spectrometer Frequency	600
8 Nucleus	1H



3aa



Parameter	Value
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3 Solvent	CDCl3
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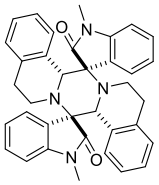
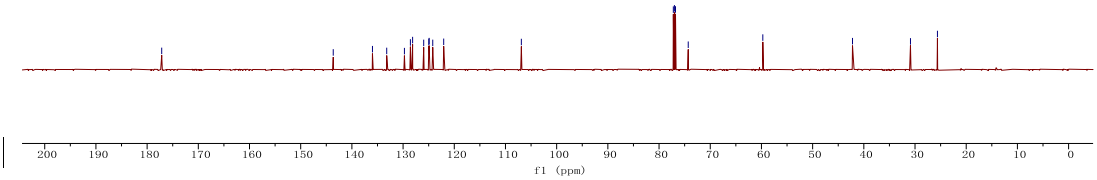
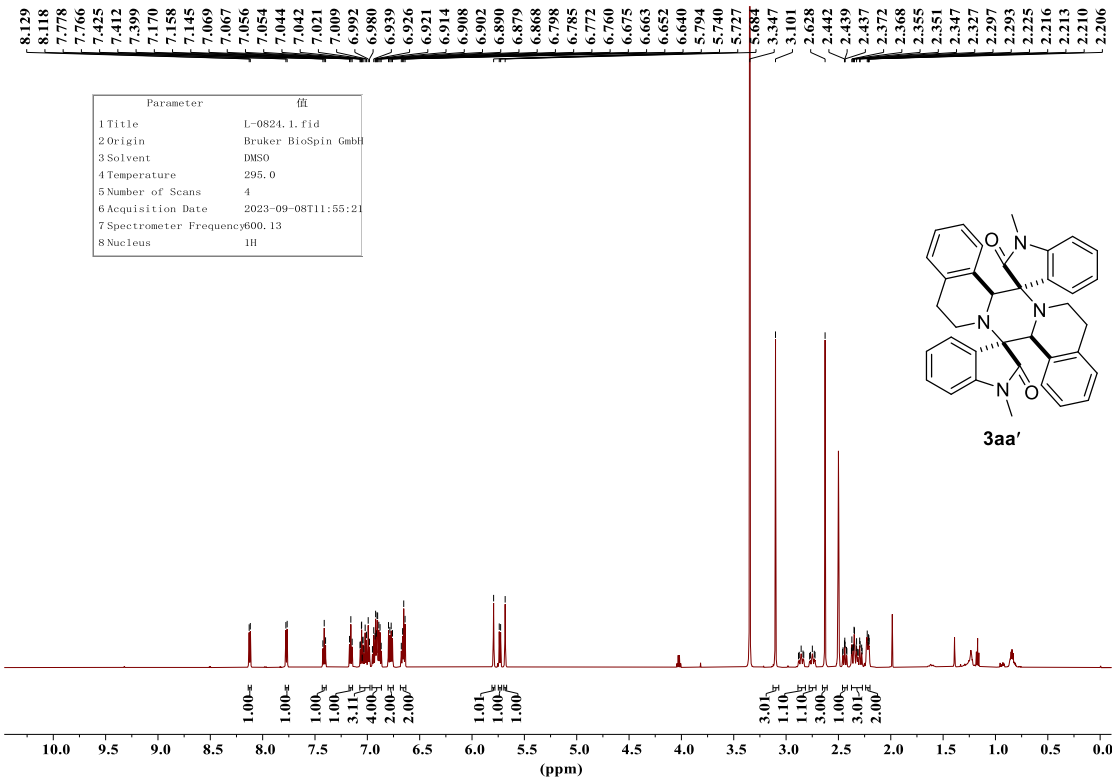
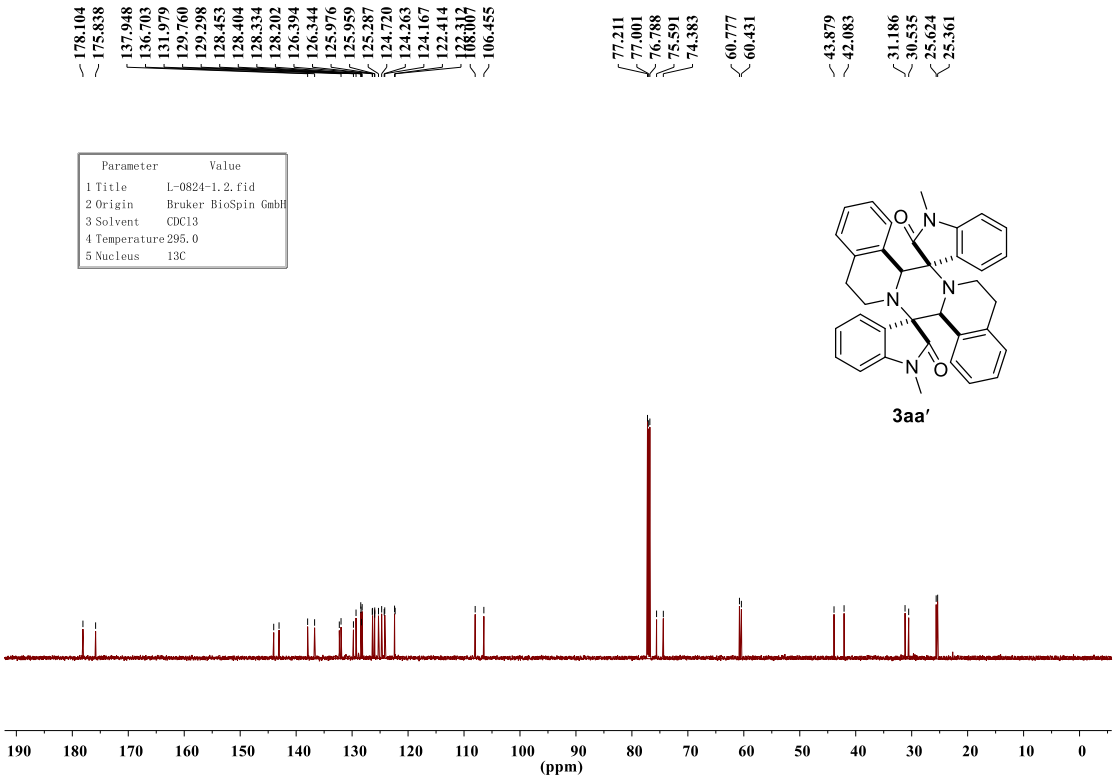
5 Number of Scans	84
6 Acquisition Date	2022-08-25T20:00:38
7 Spectrometer Frequency	151
8 Nucleus	13C



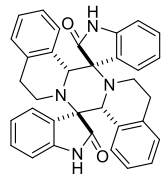
3aa



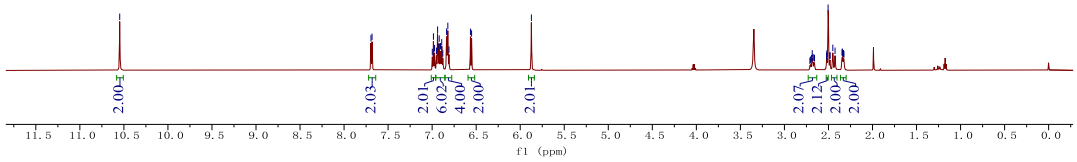

8.129 8.118 7.778 7.766 7.425 7.412 7.399 7.170 7.158 7.145 7.069 7.067 7.056 7.054 7.044 7.042 7.021 7.009 6.992 6.980 6.939 6.926 6.921 6.914 6.908 6.902 6.890 6.879 6.868 6.798 6.785 6.772 6.760 6.675 6.663 6.652 6.640 5.794 5.740 5.727 5.684 3.347 3.101 2.628 2.442 2.439 2.437 2.372 2.368 2.355 2.351 2.347 2.327 2.297 2.293 2.225 2.216 2.213 2.210 2.206
Parameter 值
1 Title L-0824.1.fid
2 Origin Bruker BioSpin GmbH
3 Solvent DMSO
4 Temperature 295.0
5 Number of Scans 4
6 Acquisition Date 2023-09-08T11:55:21
7 Spectrometer Frequency 600.13
8 Nucleus 1H
1.00 1.00 1.00 1.00 3.11 4.00 2.00 2.00 1.01 1.00 1.00 3.01 1.10 1.10 3.00 1.00 3.01 2.00
10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0
(ppm)
3aa′


178.104 175.838 137.948 136.703 131.979 129.760 129.298 128.453 128.404 128.334 128.202 126.394 126.344 125.976 125.959 125.287 124.720 124.263 124.167 122.414 122.312 108.007 106.455
77.211 77.001 76.788 75.591 74.383 60.777 60.431 43.879 42.083 31.186 30.535 25.624 25.361
Parameter Value
1 Title L-0824-1.2.fid
2 Origin Bruker BioSpin GmbH
3 Solvent CDCl3
4 Temperature 295.0
5 Nucleus 13C
190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
(ppm)
3aa′

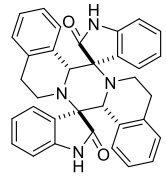
Parameter	Value
1 title	RS-1002(1).1.fid
2 Origin	Bruker BioSpin GmbH
3 Solvent	DMSO
4 Temperature	298.0
5 Number of Scans	4
6 Acquisition Date	2022-11-19T00:02:19
7 Spectrometer Frequency	600
8 Nucleus	1H



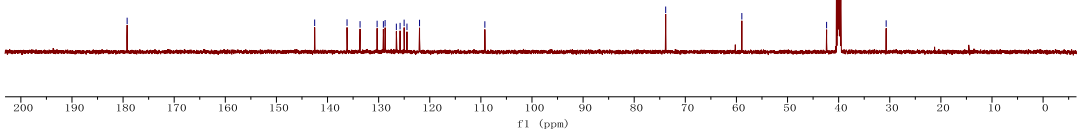
3ba



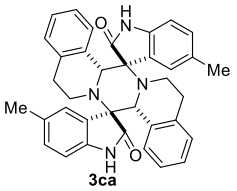
Parameter	Value
1 title	RS-1002(1).2.fid
2 Origin	Bruker BioSpin GmbH
3 Solvent	DMSO
4 Temperature	298.0
5 Number of Scans	300
6 Acquisition Date	2022-11-19T00:17:20
7 Spectrometer Frequency	150
8 Nucleus	13C

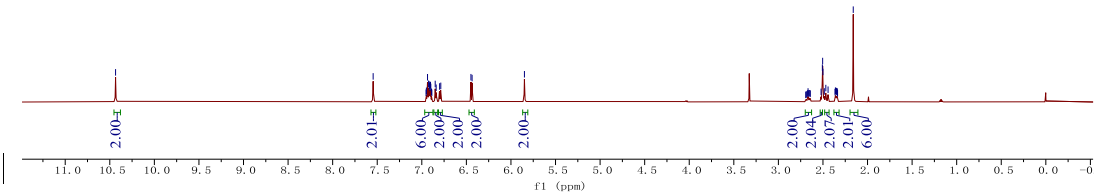


3ba

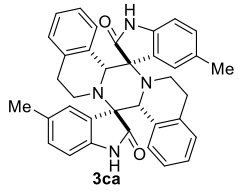


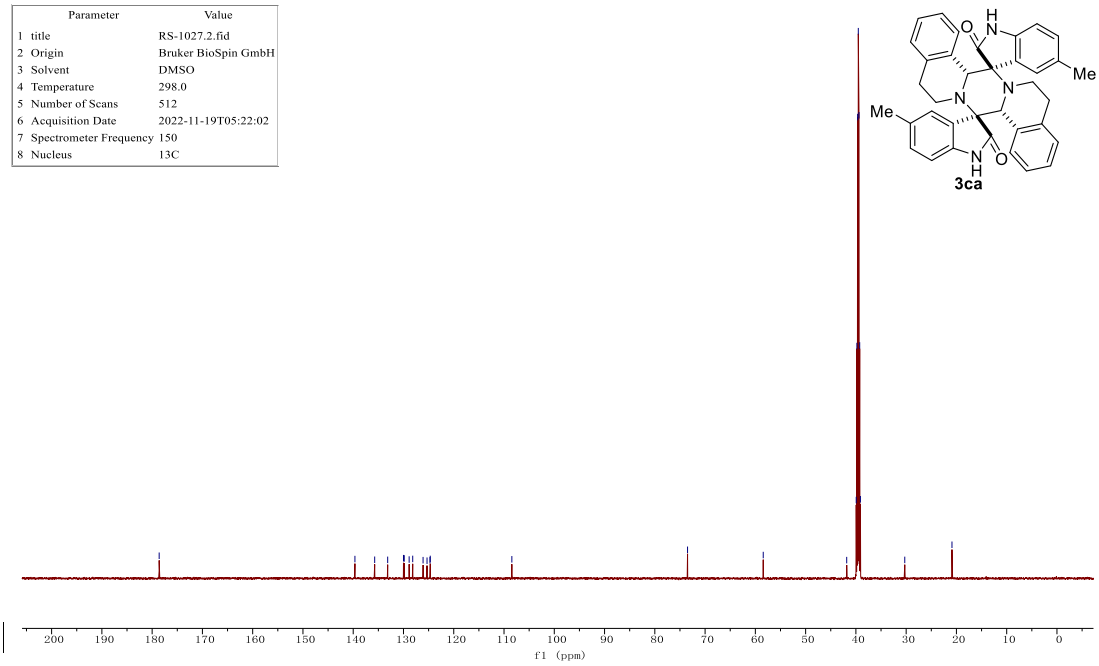
	Parameter	Value
1	title	RS-1027.1.fid
2	Origin	Bruker BioSpin GmbH
3	Solvent	DMSO
4	Temperature	298.0
5	Number of Scans	4
6	Acquisition Date	2022-11-19T04:56:44
7	Spectrometer Frequency	600
8	Nucleus	1H



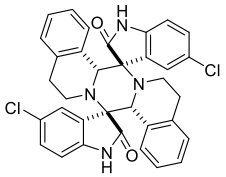


	Parameter	Value
1	title	RS-1027.2.fid
2	Origin	Bruker BioSpin GmbH
3	Solvent	DMSO
4	Temperature	298.0
5	Number of Scans	512
6	Acquisition Date	2022-11-19T05:22:02
7	Spectrometer Frequency	150
8	Nucleus	13C

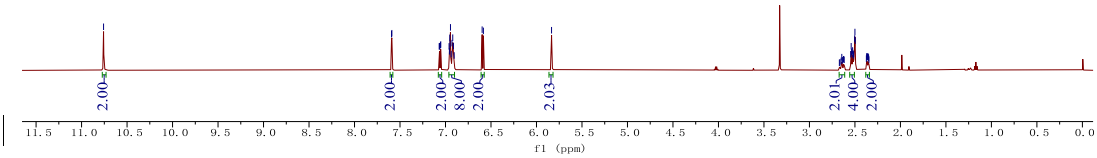




Parameter	Value
1 title	RS-1028.1.fid
2 Origin	Bruker BioSpin GmbH
3 Solvent	DMSO
4 Temperature	298.0
5 Number of Scans	4
6 Acquisition Date	2022-11-18T23:49:11
7 Spectrometer Frequency	600
8 Nucleus	1H

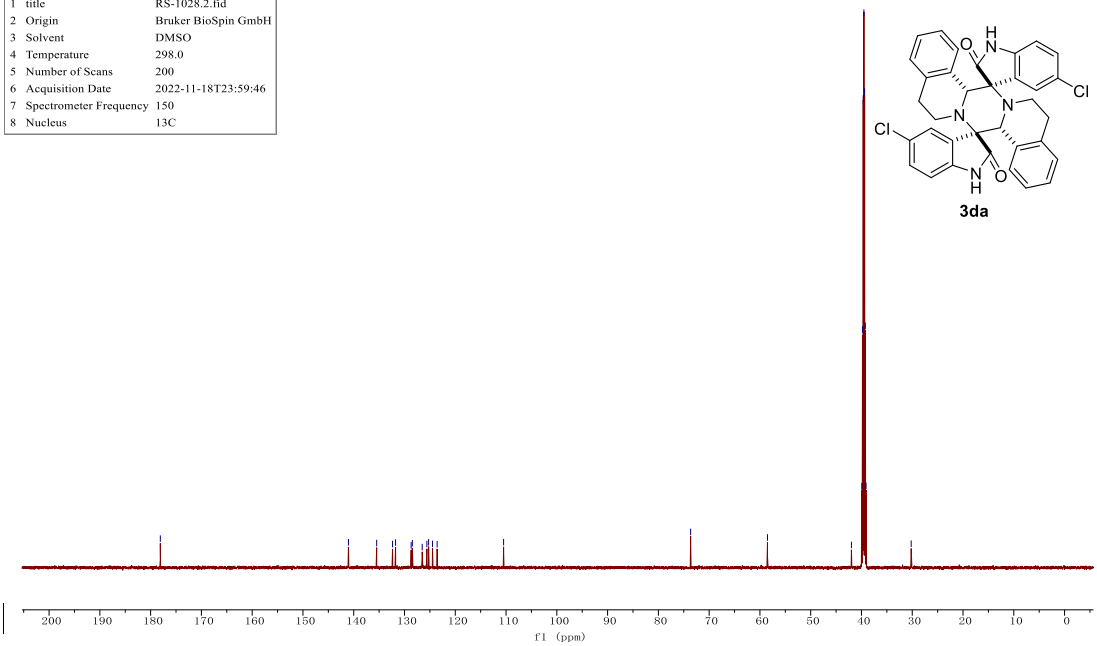


3da

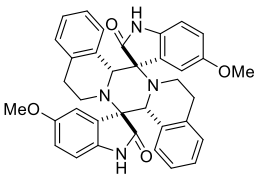


Parameter	Value
1 title	RS-1028.2.fid
2 Origin	Bruker BioSpin GmbH
3 Solvent	DMSO
4 Temperature	298.0
5 Number of Scans	200
6 Acquisition Date	2022-11-18T23:59:46
7 Spectrometer Frequency	150
8 Nucleus	13C

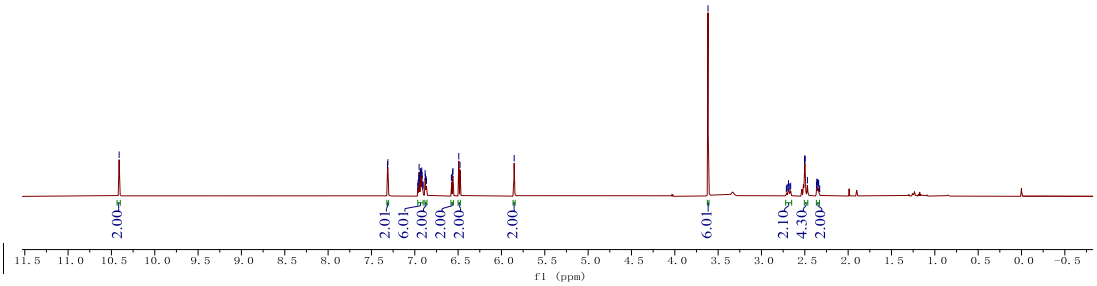
3da



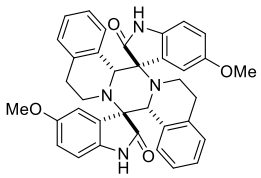
Parameter	Value
1 title	RS-1033.1.fid
2 Origin	Bruker BioSpin GmbH
3 Solvent	DMSO
4 Temperature	298.0
5 Number of Scans	4
6 Acquisition Date	2022-11-19T05:24:29
7 Spectrometer Frequency	600
8 Nucleus	1H



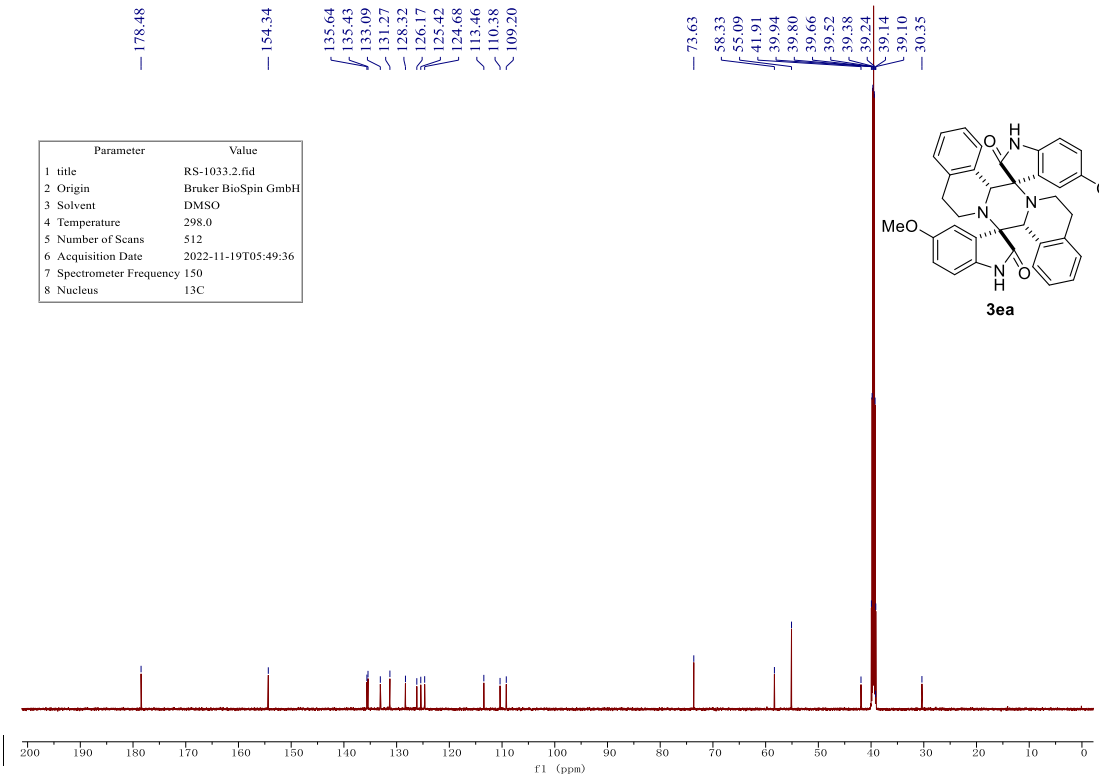
3ea



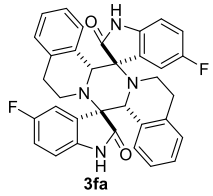
Parameter	Value
1 title	RS-1033.2.fid
2 Origin	Bruker BioSpin GmbH
3 Solvent	DMSO
4 Temperature	298.0
5 Number of Scans	512
6 Acquisition Date	2022-11-19T05:49:36
7 Spectrometer Frequency	150
8 Nucleus	13C



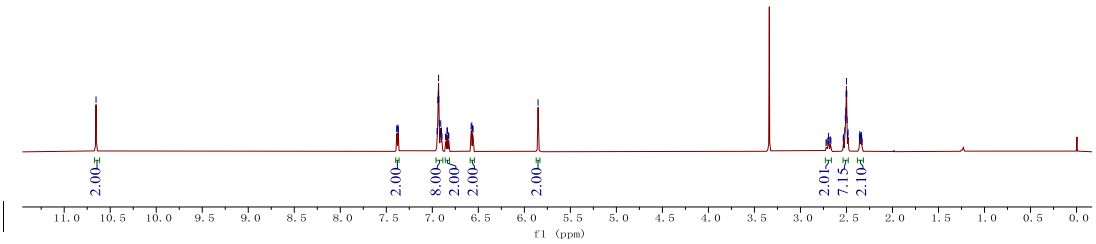
3ea

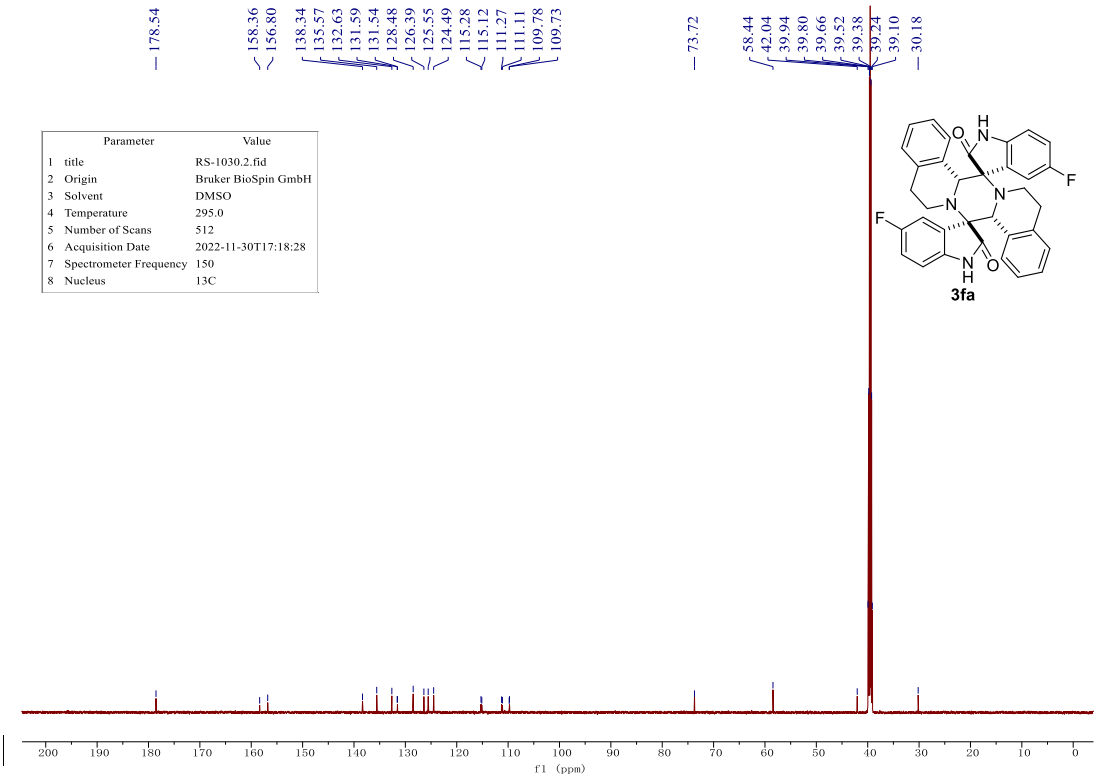


Parameter	Value
1 title	RS-1030.1.fid
2 Origin	Bruker BioSpin GmbH
3 Solvent	DMSO
4 Temperature	295.0
5 Number of Scans	4
6 Acquisition Date	2022-11-30T16:53:19
7 Spectrometer Frequency	600
8 Nucleus	1H



3fa

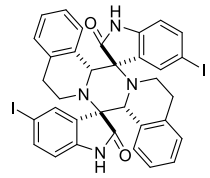




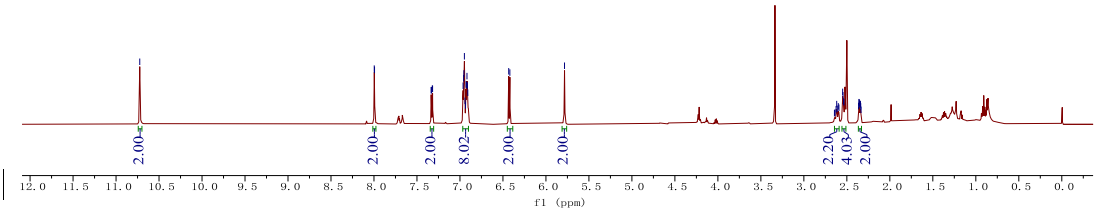
Parameter	Value
1 title	RS-1030.2.fid
2 Origin	Bruker BioSpin GmbH
3 Solvent	DMSO
4 Temperature	295.0
5 Number of Scans	512
6 Acquisition Date	2022-11-30T17:18:28
7 Spectrometer Frequency	150
8 Nucleus	13C

3fa

Parameter	Value
1 title	RS-1037.1.fid
2 Origin	Bruker BioSpin GmbH
3 Solvent	DMSO
4 Temperature	295.0
5 Number of Scans	4
6 Acquisition Date	2022-11-30T13:22:42
7 Spectrometer Frequency	600
8 Nucleus	1H

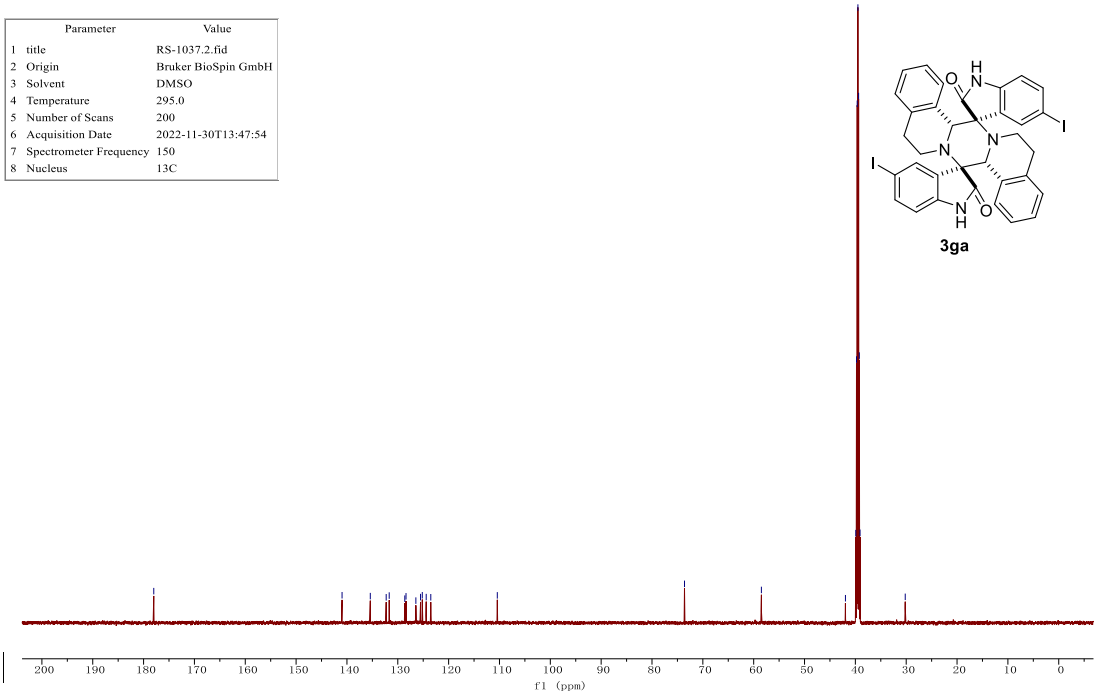


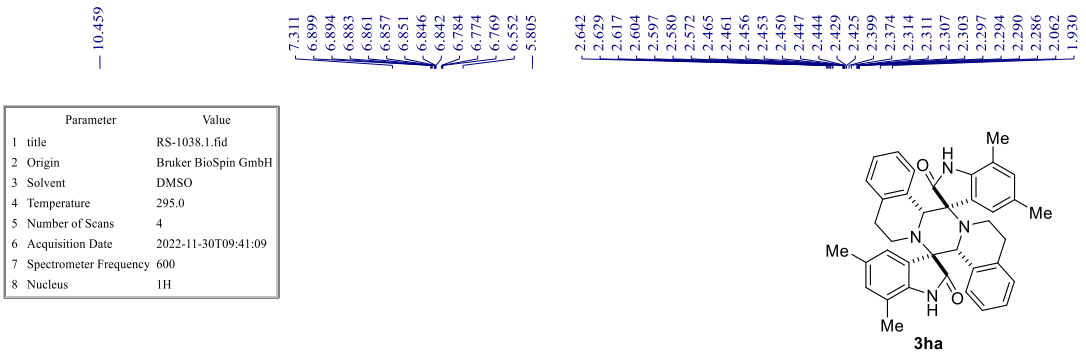
3ga



Parameter	Value
1 title	RS-1037.2.fid
2 Origin	Bruker BioSpin GmbH
3 Solvent	DMSO
4 Temperature	295.0
5 Number of Scans	200
6 Acquisition Date	2022-11-30T13:47:54
7 Spectrometer Frequency	150
8 Nucleus	13C

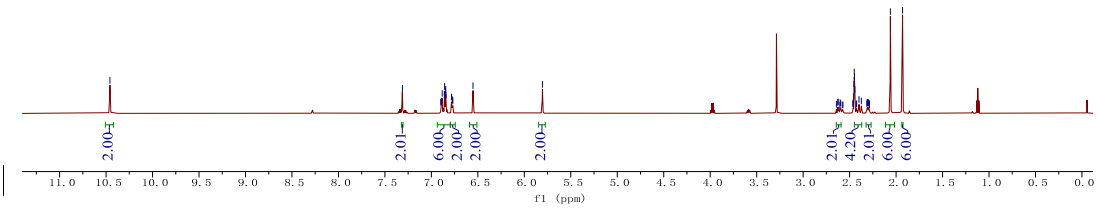
3ga

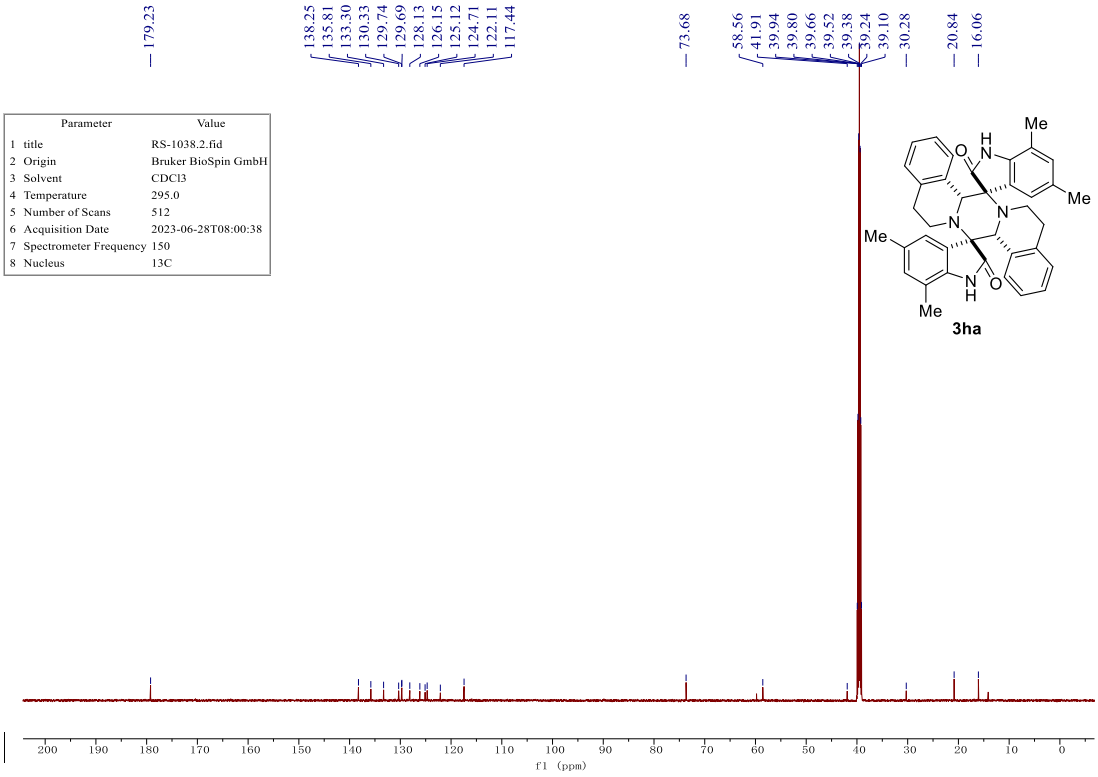




	Parameter	Value
1	title	RS-1038.1.fid
2	Origin	Bruker BioSpin GmbH
3	Solvent	DMSO
4	Temperature	295.0
5	Number of Scans	4
6	Acquisition Date	2022-11-30T09:41:09
7	Spectrometer Frequency	600
8	Nucleus	1H

3ha

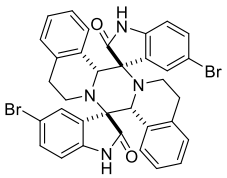




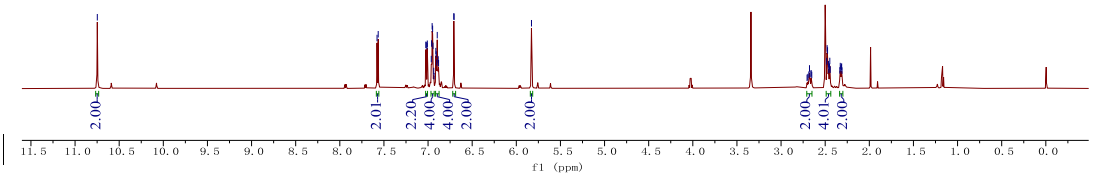
	Parameter	Value
1	title	RS-1038.2.fid
2	Origin	Bruker BioSpin GmbH
3	Solvent	CDCl3
4	Temperature	295.0
5	Number of Scans	512
6	Acquisition Date	2023-06-28T08:00:38
7	Spectrometer Frequency	150
8	Nucleus	13C

3ha

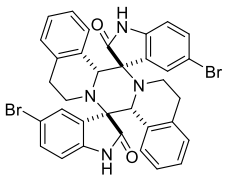
Parameter	Value
1 title	RS-1031.1.fid
2 Origin	Bruker BioSpin GmbH
3 Solvent	DMSO
4 Temperature	295.0
5 Number of Scans	4
6 Acquisition Date	2022-11-30T07:25:24
7 Spectrometer Frequency	600
8 Nucleus	1H



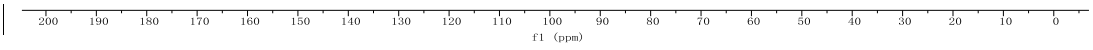
3ia



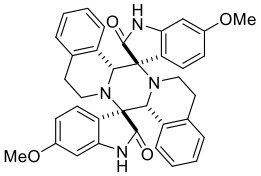
Parameter	Value
1 title	RS-1031.2.fid
2 Origin	Bruker BioSpin GmbH
3 Solvent	DMSO
4 Temperature	295.0
5 Number of Scans	384
6 Acquisition Date	2022-11-30T07:44:29
7 Spectrometer Frequency	150
8 Nucleus	13C



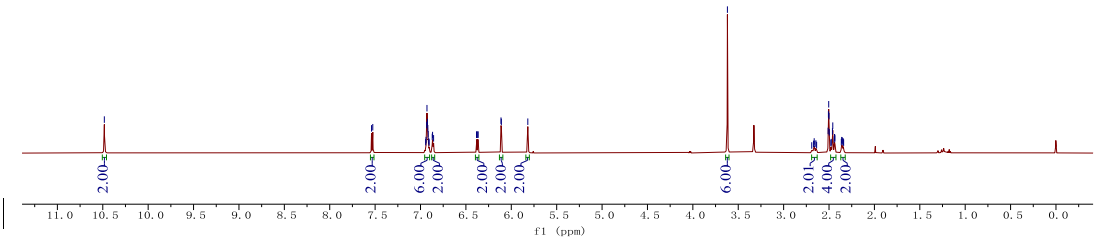
3ia

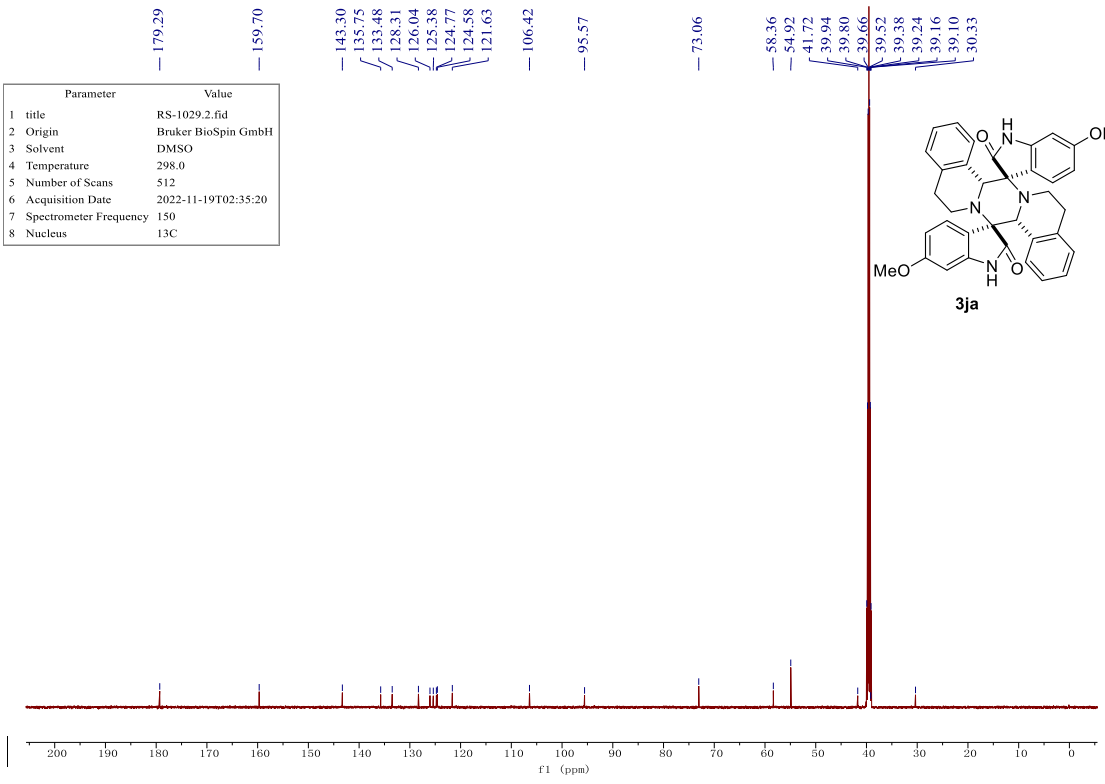


	Parameter	Value
1	title	RS-1029.1.fid
2	Origin	Bruker BioSpin GmbH
3	Solvent	DMSO
4	Temperature	298.0
5	Number of Scans	4
6	Acquisition Date	2022-11-19T02:10:01
7	Spectrometer Frequency	600
8	Nucleus	1H

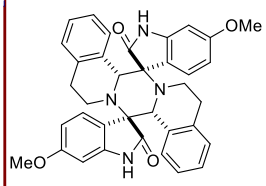


3ja

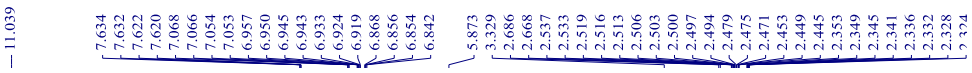




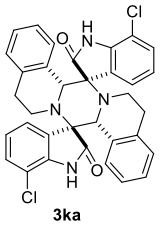
	Parameter	Value
1	title	RS-1029.2.fid
2	Origin	Bruker BioSpin GmbH
3	Solvent	DMSO
4	Temperature	298.0
5	Number of Scans	512
6	Acquisition Date	2022-11-19T02:35:20
7	Spectrometer Frequency	150
8	Nucleus	13C



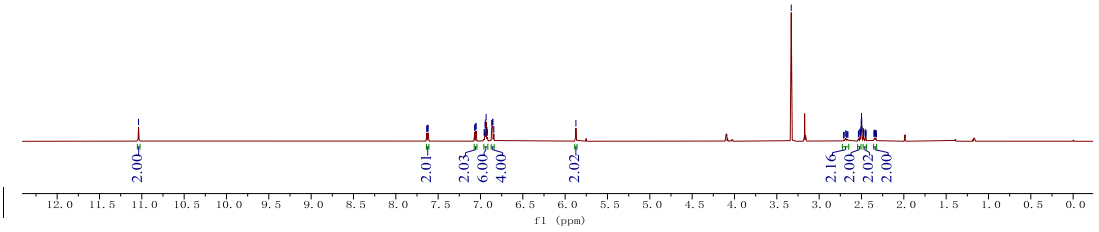
3ja

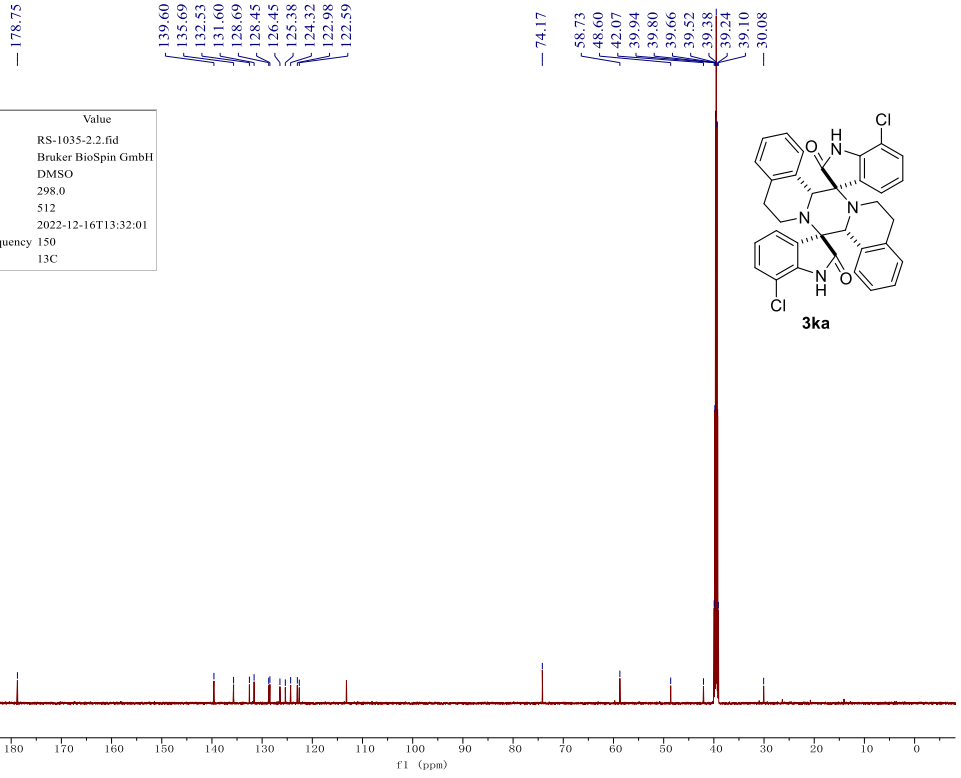


Parameter	Value
1 title	RS-1035-2.1.fid
2 Origin	Bruker BioSpin GmbH
3 Solvent	DMSO
4 Temperature	298.0
5 Number of Scans	4
6 Acquisition Date	2022-12-16T13:06:53
7 Spectrometer Frequency	600
8 Nucleus	1H



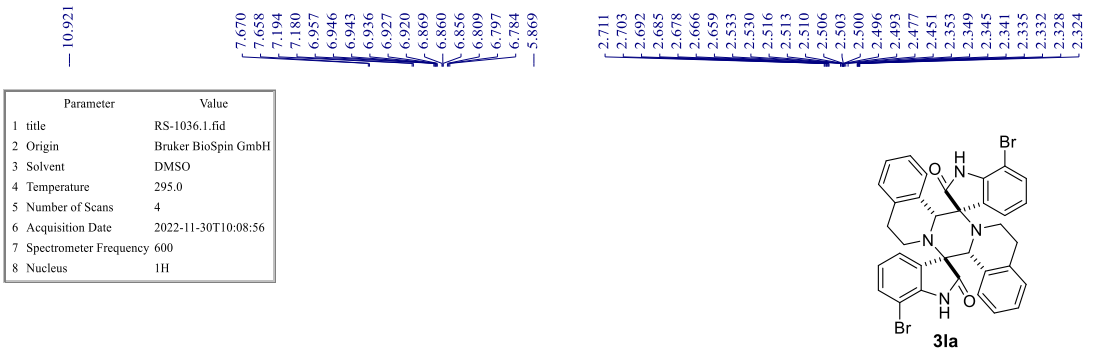
3ka





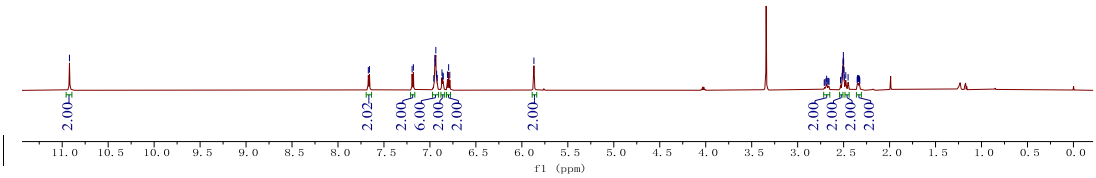
Parameter	Value
1 title	RS-1035-2.2.fid
2 Origin	Bruker BioSpin GmbH
3 Solvent	DMSO
4 Temperature	298.0
5 Number of Scans	512
6 Acquisition Date	2022-12-16T13:32:01
7 Spectrometer Frequency	150
8 Nucleus	13C

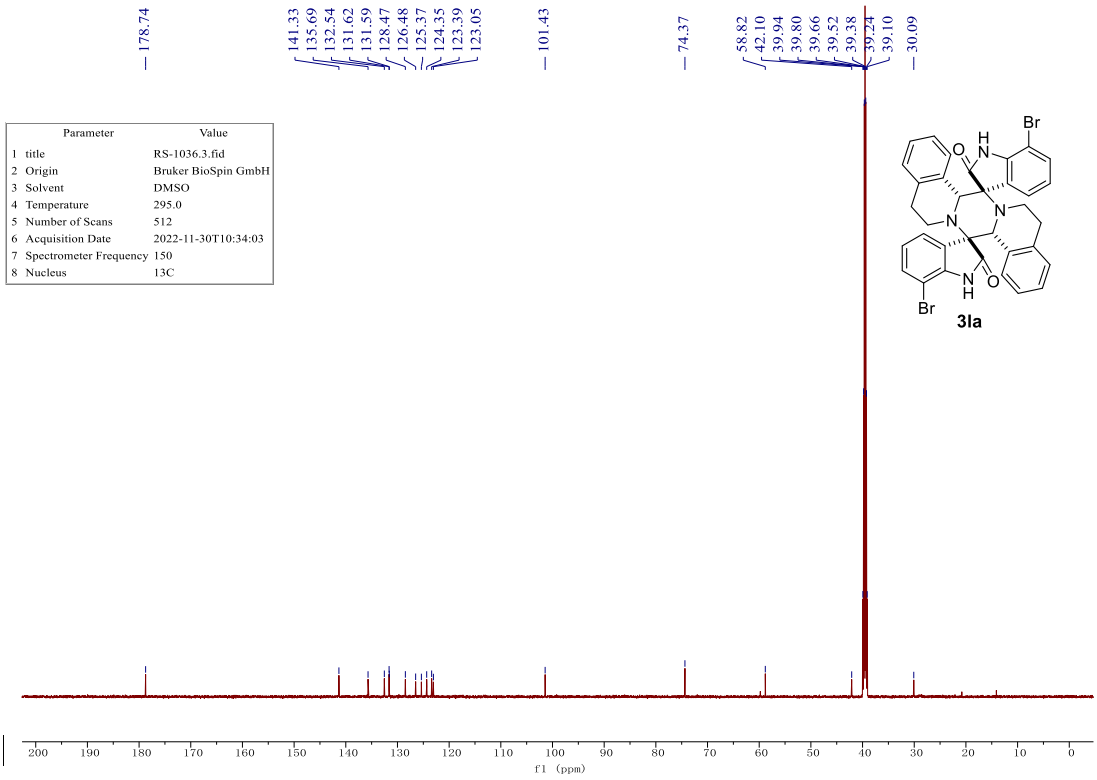
3ka



	Parameter	Value
1	title	RS-1036.1.fid
2	Origin	Bruker BioSpin GmbH
3	Solvent	DMSO
4	Temperature	295.0
5	Number of Scans	4
6	Acquisition Date	2022-11-30T10:08:56
7	Spectrometer Frequency	600
8	Nucleus	1H

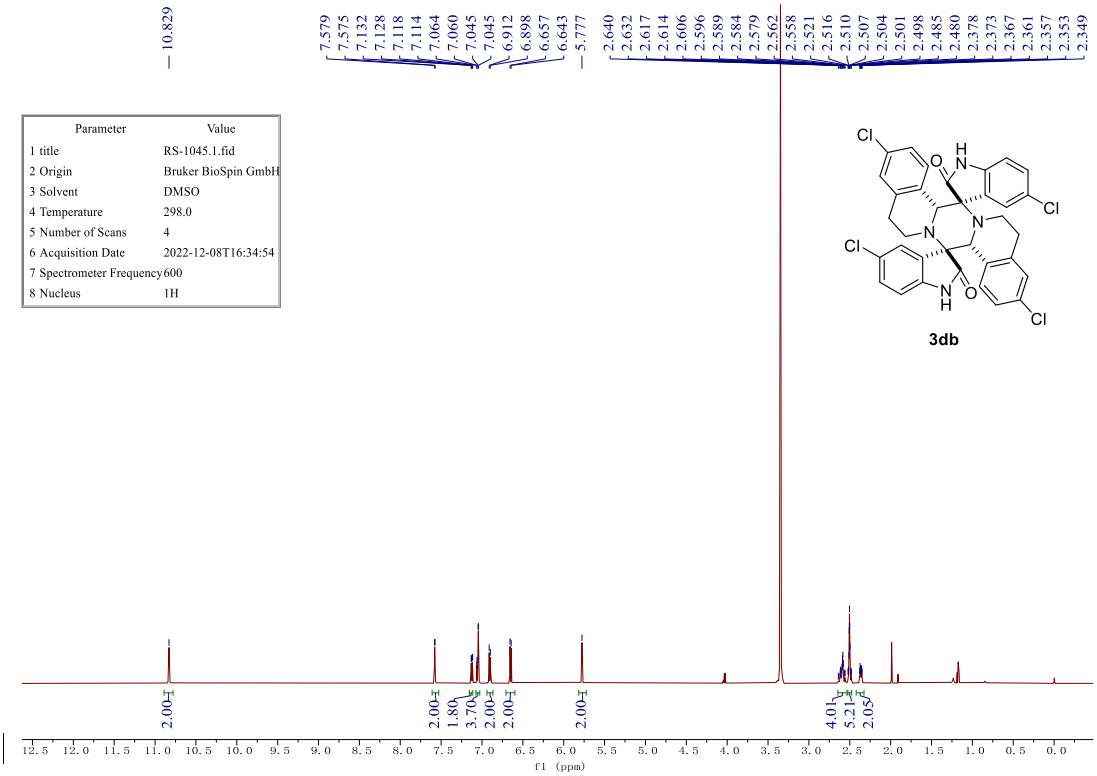
3la

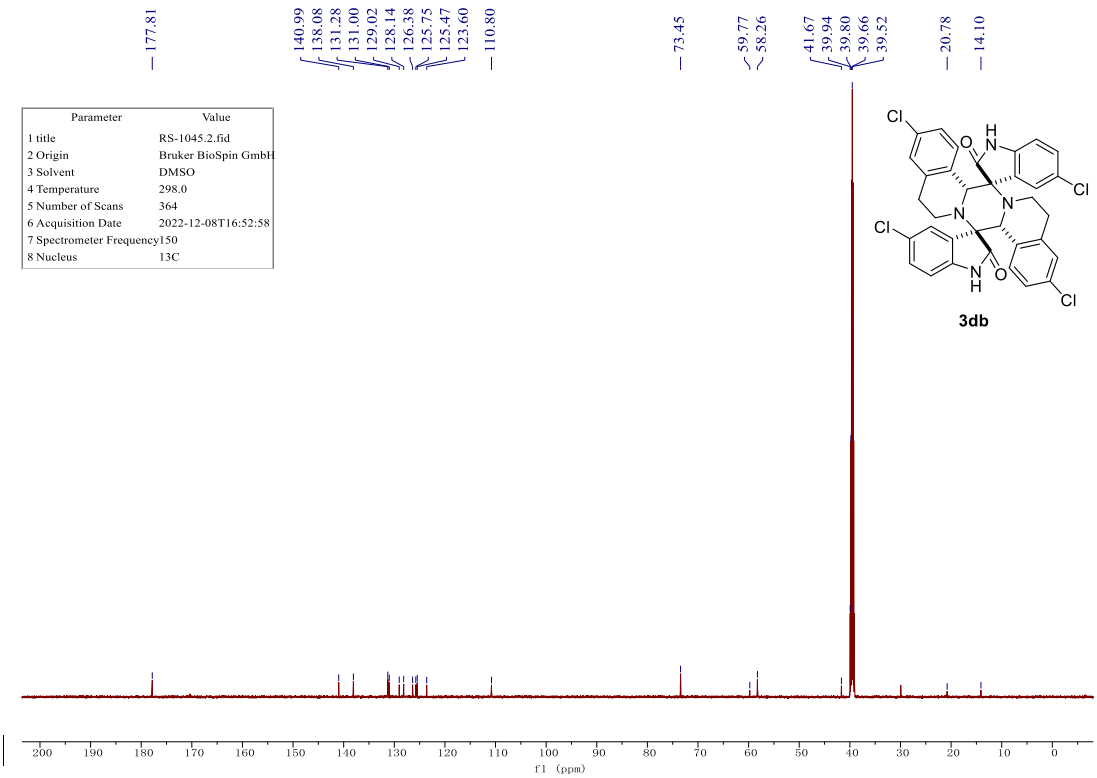


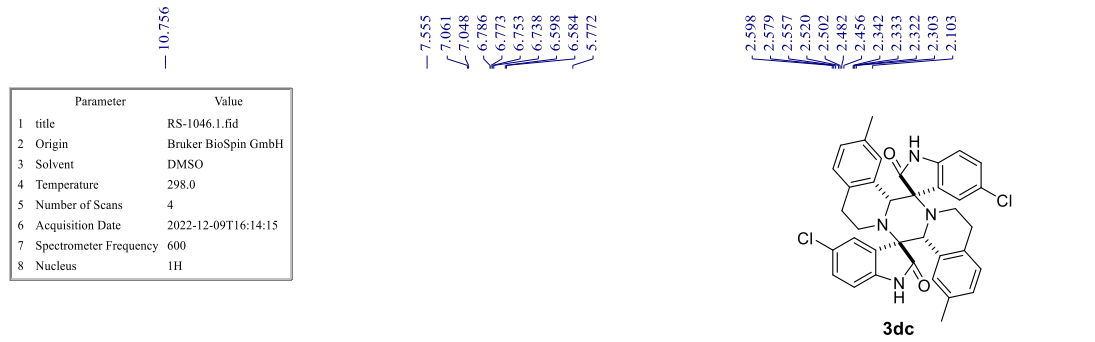


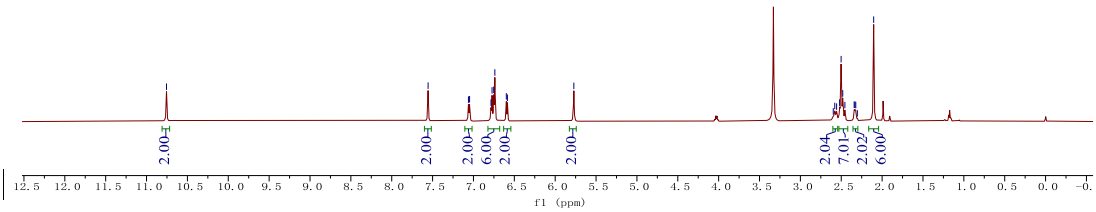
	Parameter	Value
1	title	RS-1036.3.fid
2	Origin	Bruker BioSpin GmbH
3	Solvent	DMSO
4	Temperature	295.0
5	Number of Scans	512
6	Acquisition Date	2022-11-30T10:34:03
7	Spectrometer Frequency	150
8	Nucleus	13C

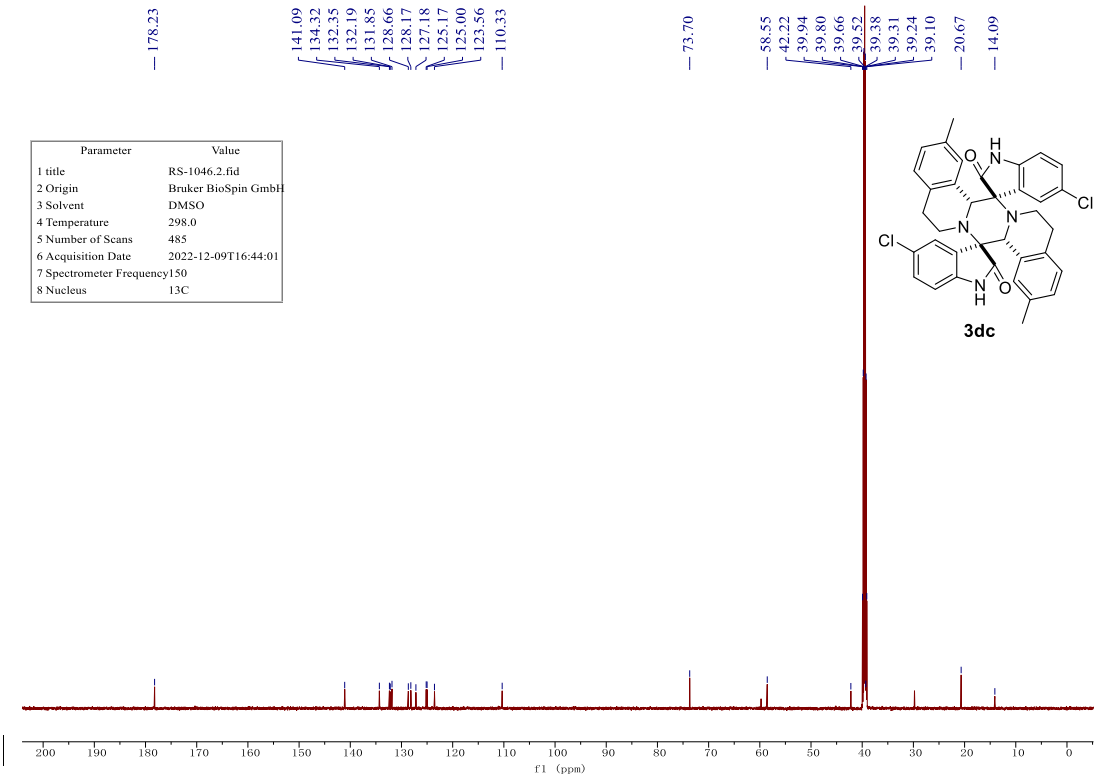
3la


10.829
7.579
7.575
7.132
7.128
7.118
7.114
7.064
7.060
7.045
7.045
6.912
6.898
6.657
6.643
5.777
2.640
2.632
2.617
2.614
2.606
2.596
2.589
2.584
2.579
2.562
2.558
2.521
2.516
2.510
2.507
2.504
2.501
2.498
2.485
2.480
2.378
2.373
2.367
2.361
2.357
2.353
2.349
Parameter Value
1 title RS-1045.1.fid
2 Origin Bruker BioSpin GmbH
3 Solvent DMSO
4 Temperature 298.0
5 Number of Scans 4
6 Acquisition Date 2022-12-08T16:34:54
7 Spectrometer Frequency 600
8 Nucleus 1H
3db
2.00
2.00
1.80
3.70
2.00
2.00
2.00
4.01
5.21
2.05
f1 (ppm)

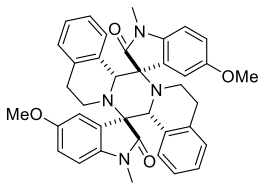

177.81
140.99
138.08
131.28
131.00
129.02
128.14
126.38
125.75
125.47
123.60
110.80
73.45
59.77
58.26
41.67
39.94
39.80
39.66
39.52
20.78
14.10
Parameter Value
1 title RS-1045.2.fid
2 Origin Bruker BioSpin GmbH
3 Solvent DMSO
4 Temperature 298.0
5 Number of Scans 364
6 Acquisition Date 2022-12-08T16:52:58
7 Spectrometer Frequency 150
8 Nucleus 13C
3db
f1 (ppm)


10.756
7.555
7.061
7.048
6.786
6.773
6.753
6.738
6.598
6.584
5.772
2.598
2.579
2.557
2.520
2.502
2.482
2.456
2.342
2.333
2.322
2.303
2.103
Parameter Value
1 title RS-1046.1.fid
2 Origin Bruker BioSpin GmbH
3 Solvent DMSO
4 Temperature 298.0
5 Number of Scans 4
6 Acquisition Date 2022-12-09T16:14:15
7 Spectrometer Frequency 600
8 Nucleus 1H
3dc

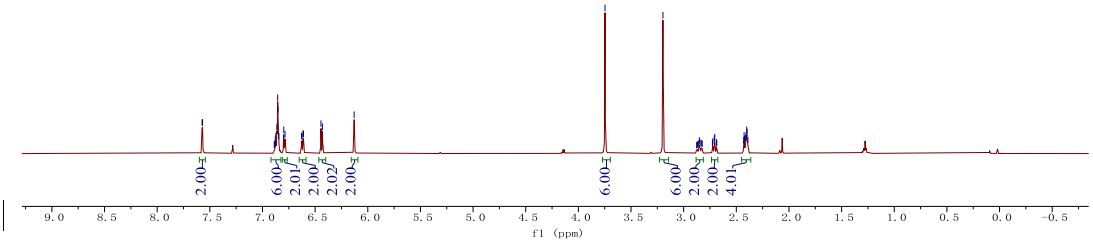

2.00
2.00
2.00
6.00
2.00
2.00
2.04
7.01
2.02
6.00
f1 (ppm)


178.23
141.09
134.32
132.35
132.19
131.85
128.66
128.17
127.18
125.17
125.00
123.56
110.33
73.70
58.55
42.22
39.94
39.80
39.66
39.52
39.38
39.31
39.24
39.10
20.67
14.09
Parameter Value
1 title RS-1046.2.fid
2 Origin Bruker BioSpin GmbH
3 Solvent DMSO
4 Temperature 298.0
5 Number of Scans 485
6 Acquisition Date 2022-12-09T16:44:01
7 Spectrometer Frequency 150
8 Nucleus 13C
3dc
f1 (ppm)

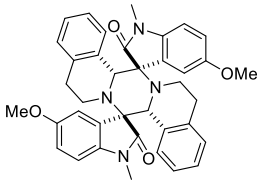
Parameter	Value
1 title	RS-1024-2.1.fid
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDCl3
4 Temperature	295.0
5 Number of Scans	4
6 Acquisition Date	2022-11-16T11:13:05
7 Spectrometer Frequency	600
8 Nucleus	1H



3ma



Parameter	Value
1 title	RS-1024-2(1).2.fid
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDCl3
4 Temperature	298.0
5 Number of Scans	241
6 Acquisition Date	2022-11-18T22:50:35
7 Spectrometer Frequency	150
8 Nucleus	13C



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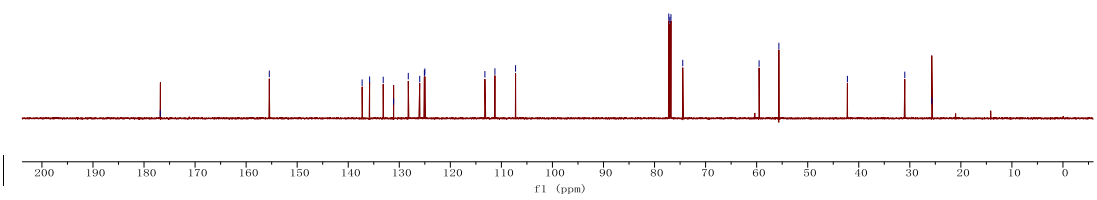
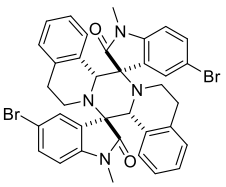
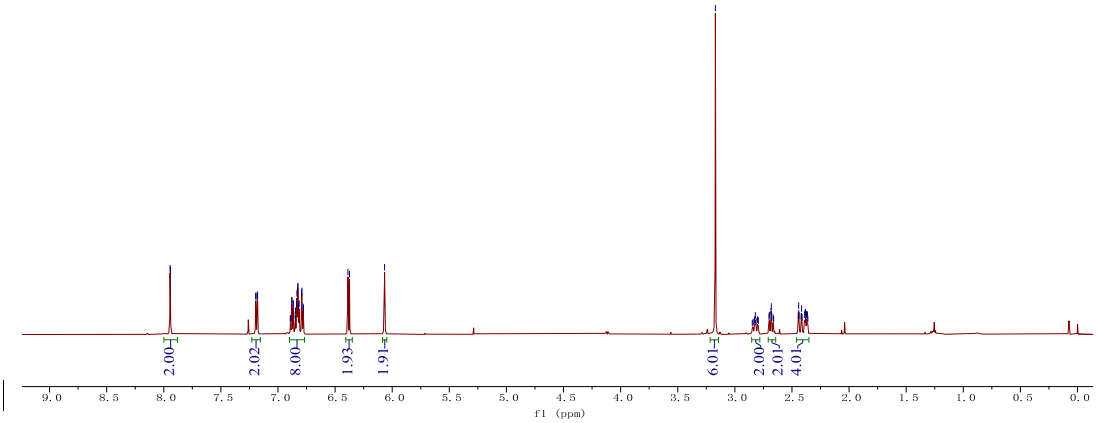


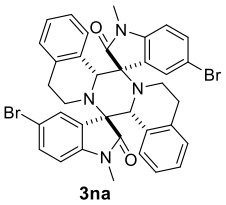
Parameter	Value
1 title	RS-1005-2.1.1.1r
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDCl3
4 Temperature	298.0
5 Number of Scans	4
6 Acquisition Date	2022-11-09T01:00:51
7 Spectrometer Frequency	600
8 Nucleus	1H



3na



Parameter	Value
1 title	RS-1005-2.1.fid
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDCl3
4 Temperature	295.0
5 Number of Scans	366
6 Acquisition Date	2022-11-15T17:28:31
7 Spectrometer Frequency	150
8 Nucleus	13C



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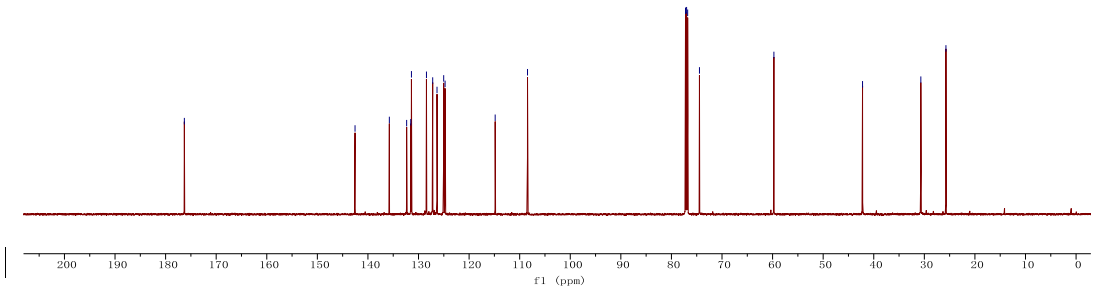
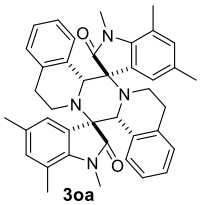


	Parameter	Value
1	title	RS-1004-2.1.fid
2	Origin	Bruker BioSpin GmbH
3	Solvent	CDCl3
4	Temperature	298.0
5	Number of Scans	4
6	Acquisition Date	2022-11-09T01:17:50
7	Spectrometer Frequency	600
8	Nucleus	1H



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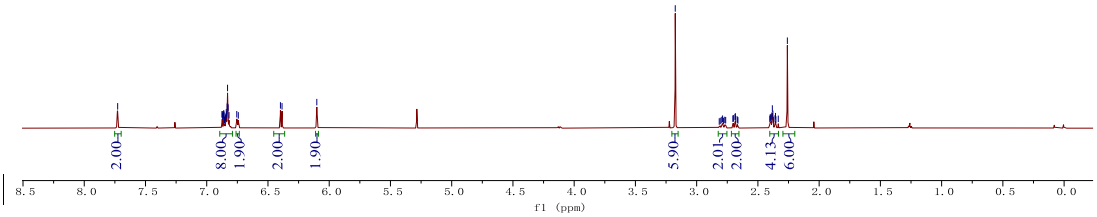
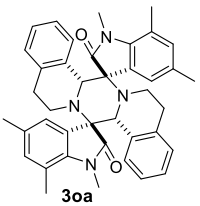
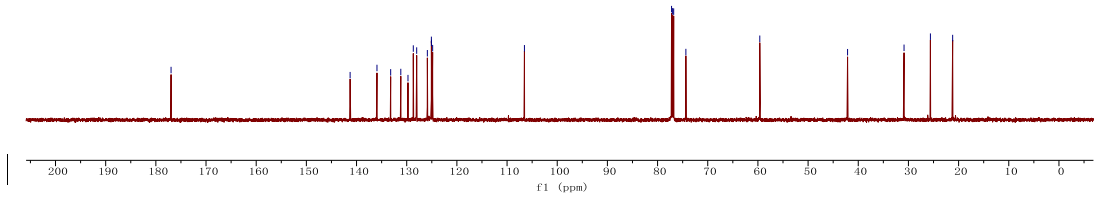


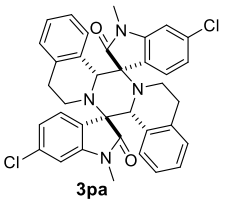
	Parameter	Value
1	title	RS-1004-2.1.fid
2	Origin	Bruker BioSpin GmbH
3	Solvent	CDCl3
4	Temperature	295.1
5	Number of Scans	35
6	Acquisition Date	2022-11-15T17:33:36
7	Spectrometer Frequency	150
8	Nucleus	13C



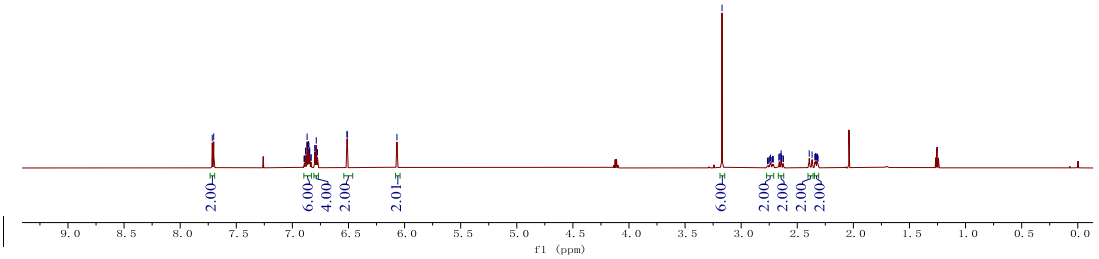
3oa



	Parameter	Value
1	title	RS-1015-2.1.fid
2	Origin	Bruker BioSpin GmbH
3	Solvent	CDCl3
4	Temperature	298.0
5	Number of Scans	4
6	Acquisition Date	2022-11-09T01:03:40
7	Spectrometer Frequency	600
8	Nucleus	1H

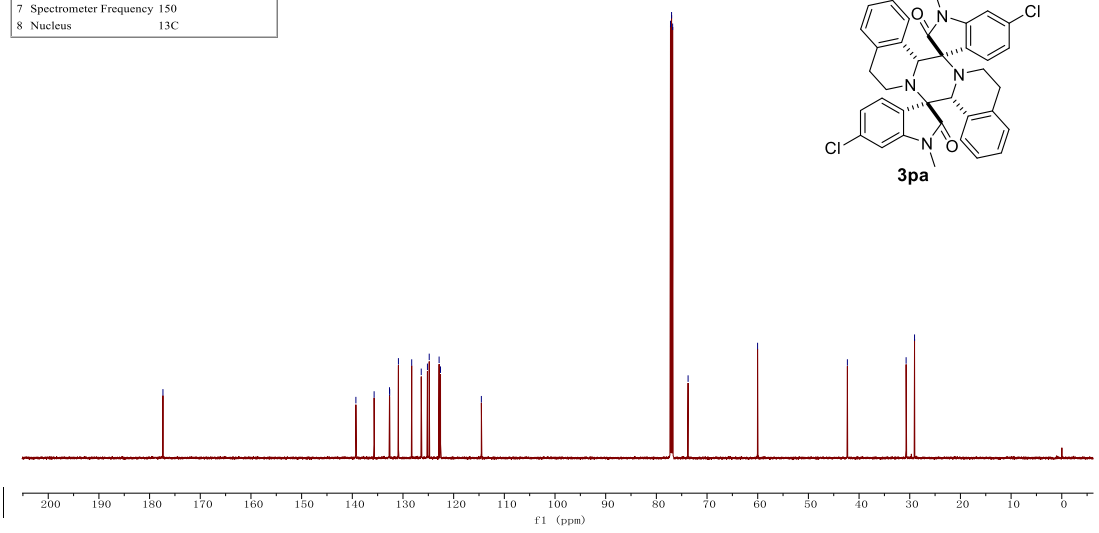


3pa

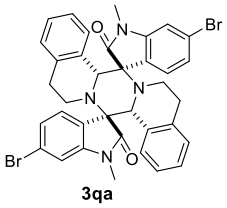


	Parameter	Value
1	title	RS1015.2.fid
2	Origin	Bruker BioSpin GmbH
3	Solvent	CDCl3
4	Temperature	295.0
5	Number of Scans	512
6	Acquisition Date	2023-06-28T11:25:22
7	Spectrometer Frequency	150
8	Nucleus	13C

3pa



Parameter	Value
1 title	RS-1023-2.1.fid
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDCl3
4 Temperature	295.0
5 Number of Scans	4
6 Acquisition Date	2022-11-30T17:21:12
7 Spectrometer Frequency	600
8 Nucleus	1H



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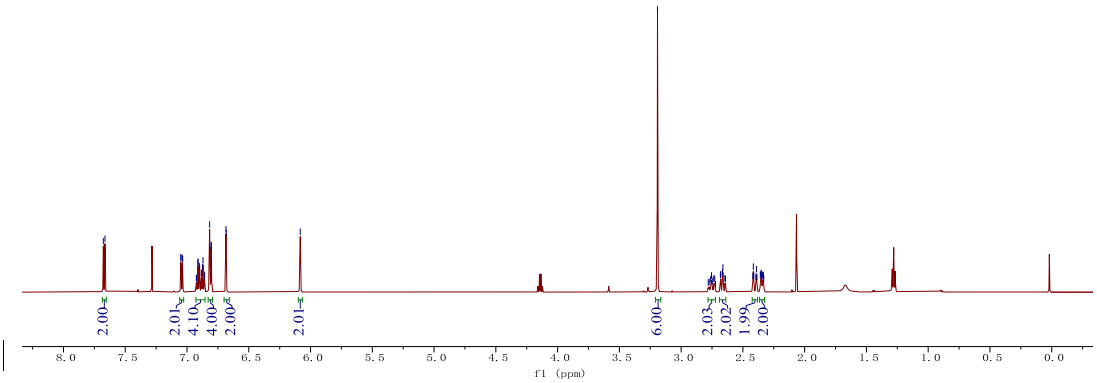
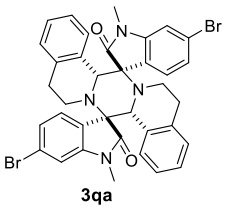


Parameter	Value
1 title	RS-1023(1).3.fid
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDCl3
4 Temperature	298.0
5 Number of Scans	512
6 Acquisition Date	2022-11-19T04:53:54
7 Spectrometer Frequency	150
8 Nucleus	13C



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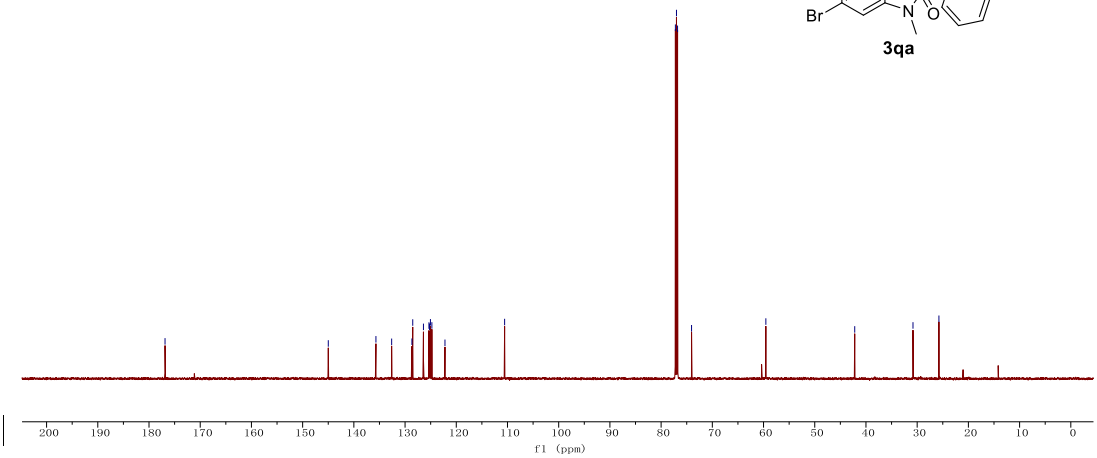
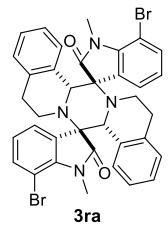


Parameter	Value
1 title	RS-1017.1.fid
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDCl3
4 Temperature	295.0
5 Number of Scans	4
6 Acquisition Date	2022-11-15T01:21:26
7 Spectrometer Frequency	600
8 Nucleus	1H



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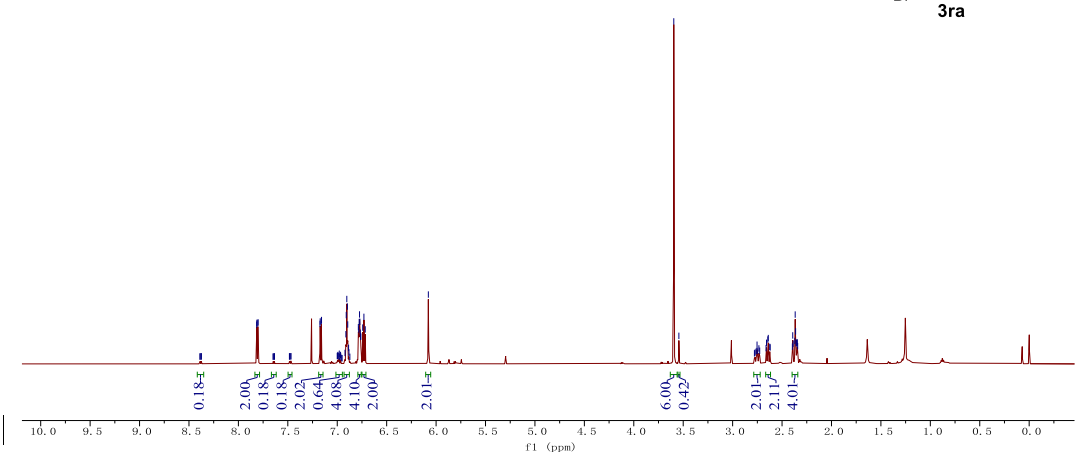
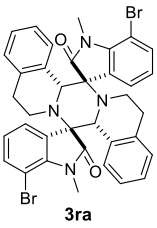


Parameter	Value
1 title	RS-1017-2.2.fid
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDCl3
4 Temperature	295.0
5 Number of Scans	512
6 Acquisition Date	2022-11-16T14:41:21
7 Spectrometer Frequency	150
8 Nucleus	13C



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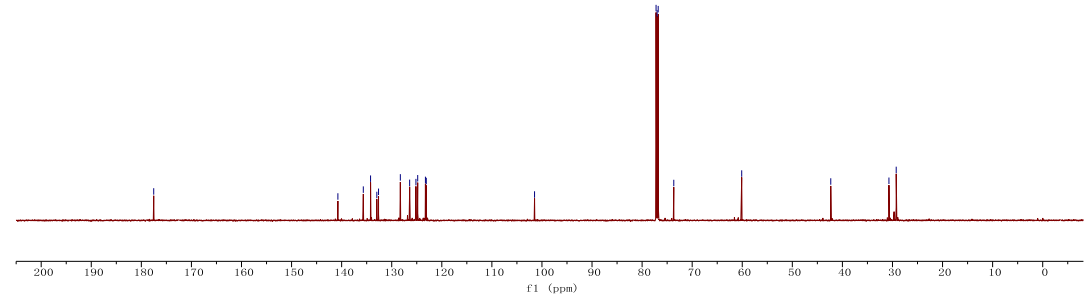
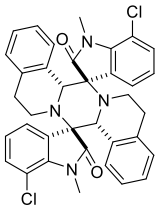
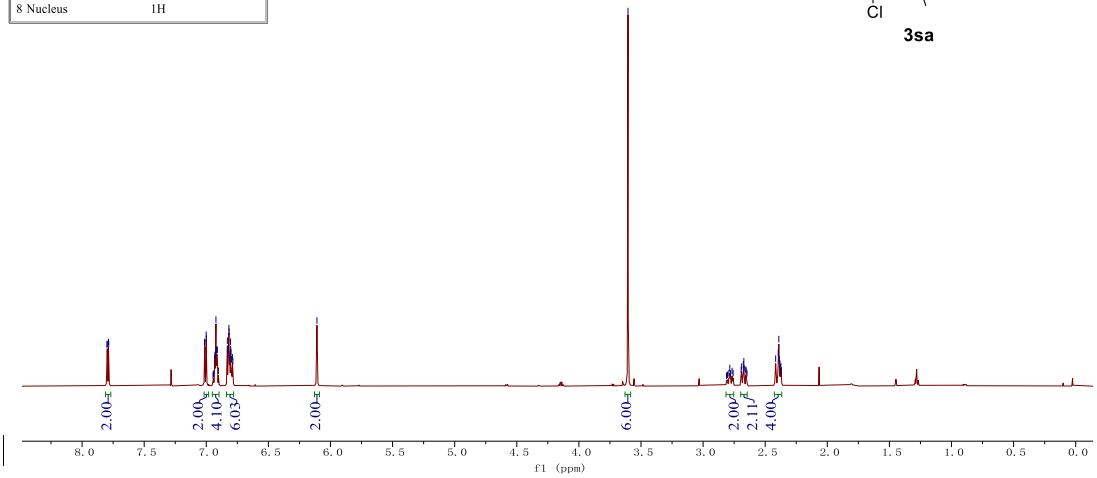


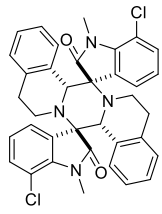
Parameter	Value
1 title	RS-1007-2.1.fid
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDCl3
4 Temperature	295.0
5 Number of Scans	4
6 Acquisition Date	2022-11-15T01:24:12
7 Spectrometer Frequency	600
8 Nucleus	1H



3sa



Parameter	Value
1 title	RS-1007-2.2.fid
2 Origin	Bruker BioSpin GmbH
3 Solvent	CDCl3
4 Temperature	295.0
5 Number of Scans	160
6 Acquisition Date	2022-11-16T14:51:39
7 Spectrometer Frequency	150
8 Nucleus	13C



3sa