Supporting Information

Palladium-Catalyzed Synthesis of Isoindoloquinazolinones via Dicarbonylation of 1,2-Dibromoarenes

Jianbin Chen, Helfried Neumann, Matthias Beller and Xiao-Feng Wu *

Leibniz-Institut für Katalyse an der Universität Rostock e.V. Albert-Einstein-Str. 29a, 18059 Rostock, Germany E-mail: xiao-feng.wu@catalysis.de

Table of Contents

1. General Considerations

Nuclear Magnetic Resonance spectra were recorded on Bruker Avance 300 and Bruker ARX 400 spectrometers. All ^{1}H NMR experiments were reported in δ units, parts per million (ppm), and were measured relative to residual chloroform (7.26 ppm) or DMSO (2.5 ppm) in the deuterated solvent. All ^{13}C NMR spectra were reported in ppm relative to deuterochloroform (77.0 ppm) or DMSO-d_6 (39.5 ppm) and all were obtained with ^{1}H decoupling. All coupling constants *J*, were reported in Hz. The following abbreviations were used to describe peak splitting patterns when appropriate: s = singlet, d = doublet, t = triplet, dd = doublet of doublet, m = multiplet and br s = broad singlet. All measurements were carried out at room temperature unless otherwise stated. Electron impact (EI) mass spectra were recorded on AMD 402 mass spectrometer (70 eV). High resolution mass spectra (HRMS) were recorded on Agilent 6210. The data were given as mass units per charge (m/z). Gas chromatography analysis was performed on an Agilent HP-5890 instrument with a FID detector and HP-5 capillary column (polydimethylsiloxane with 5 % phenyl groups, 30 m, 0.32 mm i.d., 0.25 μm film thickness) using argon as carrier gas. The products were isolated from the reaction mixture by column chromatography on silica gel 60, 0.063-0.2 mm, 70-230 mesh (Merck).

2. Materials

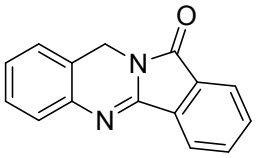
DMA (anhydrous, 99.8 %) was purchased from Sigma-Aldrich and degassed with Argon before used. All Chemicals were commercial available and were used without further purification unless otherwised noted.

3. General Procedure for the Synthesis of Isoindoloquinazolinone

The reaction was carried out in a Parr Instruments 4560 series 300 ml autoclave containing an alloy plate with wells for five 12 ml Wheaton vials. $Pd(OAc)_2$ (2 mol %), $BuPAd_2$ (6 mol %) and a stirring bar were placed in each vials, which were then capped with a septum equipped a inlet needle and flushed with argon 3 times. Then, Et_3N (3.0 equiv.), *o*-dibromobenzene (0.5 mmol, 1 equiv.) and DMA (2 mL) were injected *via* syringe under argon. The vial (or several vials) was placed in an autoclave under argon atmosphere. After flushing the autoclave three times with CO, a pressure of 10 bars of CO was adjusted at ambient temperature. The reaction was performed for 16h at 120 ^{o}C. After the reaction completed, the autoclave was cooled down with ice water to room temperature and the pressure was released carefully. The solution was extracted 3-5 times with ethyl acetate form saturated brine and dried with Mg_2SO_4. After evaporation of the organic solvent the residue was adsorbed on silica gel and the crude product was purified by column chromatography using EA/pentane (1:10-1:2) as eluent.

4. Characterization Data of Products

Isoindolo[1,2-*b*]quinazolin-12(10*H*)-one[1]



^{1}H NMR (300 MHz, $CDCl_3$) δ 7.96 – 7.88 (m, 1H), 7.82 – 7.72 (m, 1H), 7.65 – 7.47 (m, 2H), 7.35 (dd, *J* = 7.8, 1.4 Hz, 1H), 7.25 – 7.15 (m, 1H), 7.11 (td, *J* = 7.4, 1.4 Hz, 1H), 7.07 – 7.00 (m, 1H), 4.83 (s, 2H).

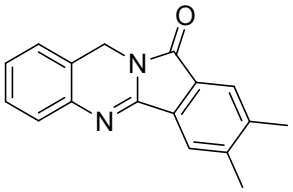
^{13}C NMR (75 MHz, $CDCl_3$) δ 166.8, 148.8, 140.2, 134.4, 132.8, 132.0, 130.4, 128.7, 128.0, 127.6, 126,8, 123.0, 122.1, 121.2, 40.6.

GC-MS (EI, 70eV): m/z [M^+-H] (%) 233 (100), 205 (9), 102 (10), 77 (8).

HRMS (EI) [M^+-H]: calcd. For $C_{15}H_9ON_2$: 233.07094; found: 233.07079.

HRMS (ESI): calcd. for $[M+H]^+$, $C_{15}H_{11}ON_2$: 235.08659; found: 235.08659.

2,3-Dimethylisoindolo[1,2-b]quinazolin-12(10H)-one

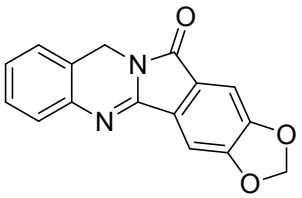


^{1}H NMR (300 MHz, $CDCl_3$) δ 7.67 (s, 1H), 7.51 (s, 1H), 7.33 (dd, *J* = 7.8, 1.4 Hz, 1H), 7.25 – 7.15 (m, 1H), 7.10 (td, *J* = 7.4, 1.4 Hz, 1H), 7.03 (dd, *J* = 7.6, 1.6 Hz, 1H), 4.79 (s, 2H), 2.30 (s, 3H), 2.29 (s, 3H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 167.2, 149.2, 142.5, 141.6, 140.4, 132.3, 128.6, 128.3, 127.8, 127.3, 126.8, 123.9, 123.0, 121.3, 40.5, 20.4.

HRMS (ESI): calcd. for $[M+H]^+$, $C_{17}H_{15}ON_2$: 263.11789; found: 263.11777.

[1,3]Dioxolo[4',5':5,6]isoindolo[1,2-*b*]quinazolin-12(10*H*)-one



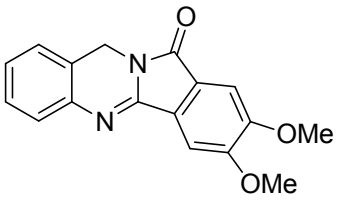
^{1}H NMR (300 MHz, $CDCl_3$) δ 7.52 – 7.38 (m, 2H), 7.36 – 7.28 (m, 1H), 7.26 – 7.13 (m, 3H), 6.15 (s, 2H), 4.93 (s, 2H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 166.5, 152.1, 151.4, 148.8, 140.4, 130.2, 128.7, 128.0, 127.5, 126.9, 125.7, 121.3, 103.3, 102.6, 102.6, 40.7.

GC-MS (EI, 70 eV): m/z (%) = 277 ([M-H]$^+$, 100), 138 (9).

HRMS (ESI): calcd. for $[M+H]^+$, $C_{16}H_{11}O_3N_2$: 279.07642; found: 279.07665.

2,3-Dimethoxyisoindolo[1,2-*b*]quinazolin-12(10*H*)-one



^{1}H NMR (300 MHz, $CDCl_3$) δ 7.50 – 7.36 (m, 2H), 7.35 – 7.23 (m, 2H), 7.17 (dd, *J* =7.4, 1.6 Hz, 2H), 4.87 (s, 2H),3.03 (s, 3H), 2.94 (s, 3H).

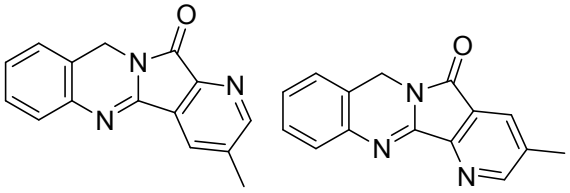
^{13}C NMR (75 MHz, $CDCl_3$) δ 170.4, 166.7, 152.9, 152.3, 148.8, 140.1, 128.3, 127.6, 127.4, 127.1, 126.6, 123.2, 121.1, 104.5, 103.8, 56.2, 56.1, 40.3.

GC-MS (EI, 70 eV): m/z (%) = 293 ($[M-H]^+$, 100), 277 (18).

HRMS (ESI): calcd. for $[M+H]^+$, $C_{17}H_{15}O_3N_2$: 295.10772; found: 295.10801.

3-Methylpyrido[3',2':3,4]pyrrolo[2,1-*b*]quinazolin-12(10*H*)-one

3-Methylpyrido[2',3':3,4]pyrrolo[2,1-*b*]quinazolin-5(7*H*)-one



1.3:1

^{1}H NMR (300 MHz, $CDCl_3$) selected signal for the main products.δ 8.64 – 8.60 (m, 1H), 8.02 – 7.96 (m, 1H), 7.31 (dd, *J* = 7.8, 1.5 Hz, 1H), 7.12 (td, *J* = 7.3, 1.9 Hz, 2H), 7.05 (d, *J* = 1.6 Hz, 1H), 4.86 (s, 2H), 2.81 – 1.94 (m, 3H).

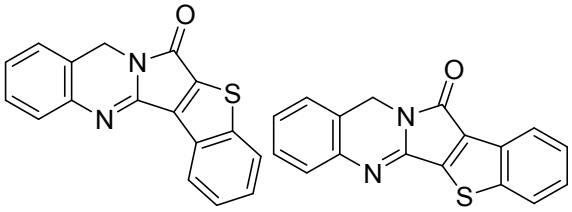
^{13}C NMR (75 MHz, $CDCl_3$) δ 164.6, 164. 6, 154.8, 154.3, 151.0, 147.1, 147.0, 146.1, 139.8, 139.6, 137.1, 136.5, 130.9, 129.9, 129.3, 129.0, 128.7, 128.7, 128.1, 128.0, 127.9, 126.8, 126.6, 125.2, 121.4, 121.0, 40.5, 40.4, 19.0.

GC-MS (EI, 70 eV): m/z (%) = 248 ($[M-H]^+$, 100), 220 (9).

HRMS (ESI): calcd. for $[M+H]^+$, $C_{15}H_{12}ON_3$: 250.09749; found: 250.0975. calcd. for $[M+Na]^+$, $C_{15}H_{11}ON_3Na$: 272.07943; found: 272.07934.

Benzo[4',5']thieno[3',2':3,4]pyrrolo[2,1-*b*]quinazolin-6(8*H*)-one

Benzo[4',5']thieno[2',3':3,4]pyrrolo[2,1-*b*]quinazolin-13(11*H*)-one



2.3:1

^{1}H NMR (300 MHz, $CDCl_3$) selected signal for the main products δ 8.30 (dt, *J* = 8.1, 1.0 Hz, 1H), 7.87 – 7.74 (m, 2H), 7.51 – 7.33 (m, 2H), 7.30 – 7.00 (m, 3H), 4.81 (s, 2H).

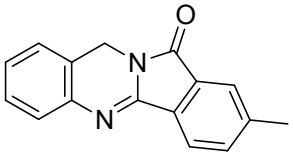
^{13}C NMR (75 MHz, $CDCl_3$) selected signal for the main products δ 162.5, 146.6, 145.9, 140.2, 140.2, 138.2, 131.0, 128.9, 128.8, 128.7, 127.9, 127.2, 126.9, 126.2, 124.4, 123.9, 121.5.

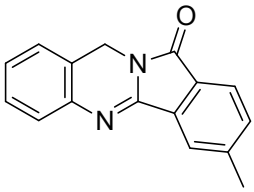
GC-MS (EI, 70 eV): m/z (%) = 289 ([M-H]$^+$, 100), 261 (9), 130 (11).

HRMS (ESI): calcd. for [M+H]$^+$, $C_{17}H_{11}SN_2$: 291.05866; found: 291.05853.

2-Methylisoindolo[1,2-*b*]quinazolin-12(10*H*)-one

3-Methylisoindolo[1,2-*b*]quinazolin-12(10*H*)-one





1:1

^{1}H NMR (300 MHz, $CDCl_3$) δ 7.88 (d, *J* = 7.7 Hz, 1H), 7.81 (s, 1H), 7.73 (d, *J* = 7.7 Hz, 1H), 7.65 (d, *J* = 1.5 Hz, 1H), 7.52 – 7.39 (m, 4H), 7.36 – 7.24 (m, 2H), 7.19 (tt, *J* = 7.3, 1.4 Hz, 2H), 7.12 (dd, *J* = 7.3, 1.8 Hz, 2H), 4.91 (s, 4H), 2.49-2.48 (m, 6H).

^{13}C NMR (75 MHz, $CDCl_3$) δ 167.0, 166.9, 149.1, 149.0, 143.9, 143.0, 140.3, 134.7, 133.7, 132.8, 131.8, 130.7, 130.1, 128.7, 128.0, 127.9, 127.9, 127.5, 127.4, 126.8, 126.8, 125.4, 123.5, 122.9, 122.6, 122.0, 121.3, 121.2, 40.6, 21.9, 21.9.

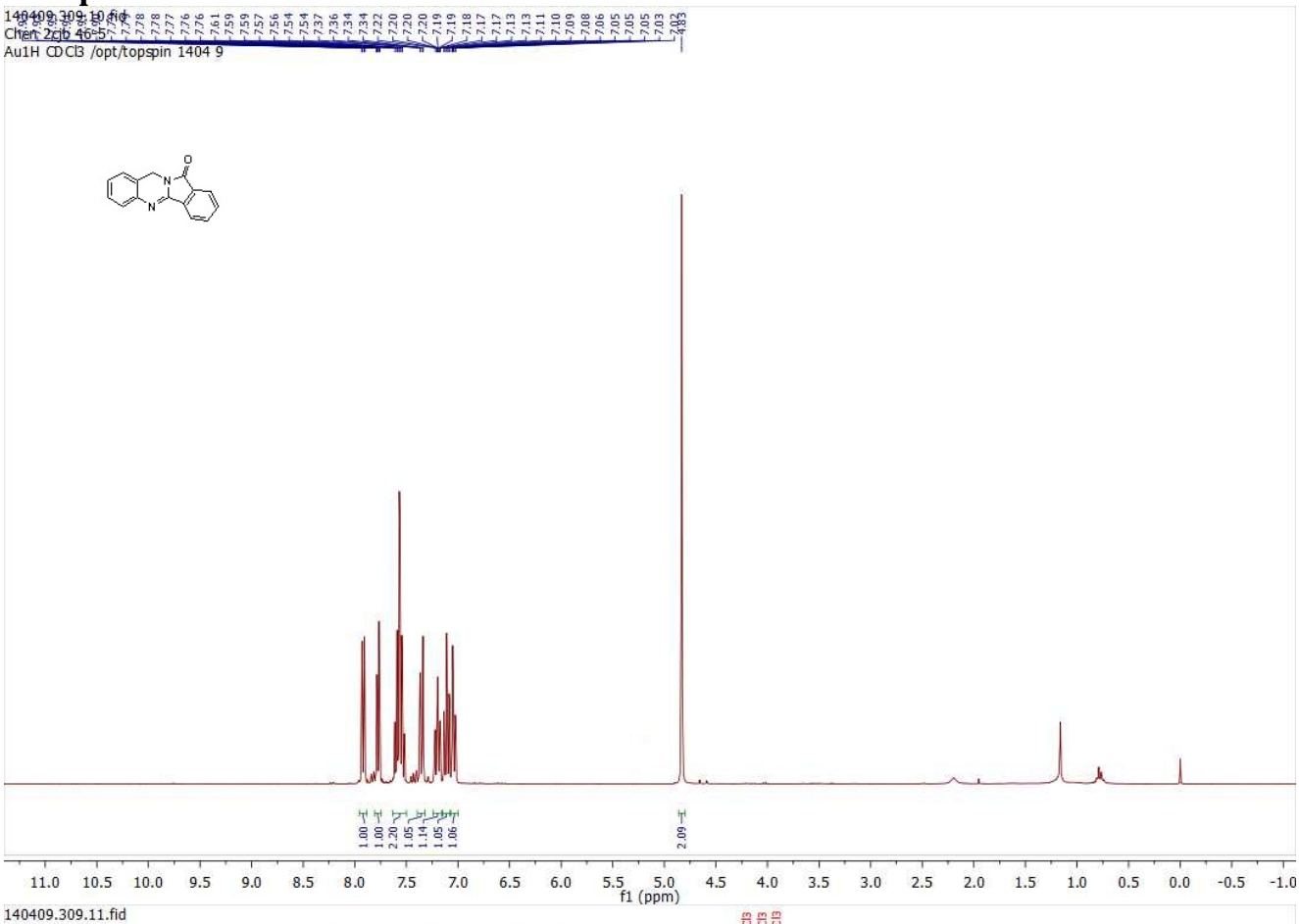
GC-MS (EI, 70 eV): m/z (%) = 247 ([M-H]+, 100), 219 (6).

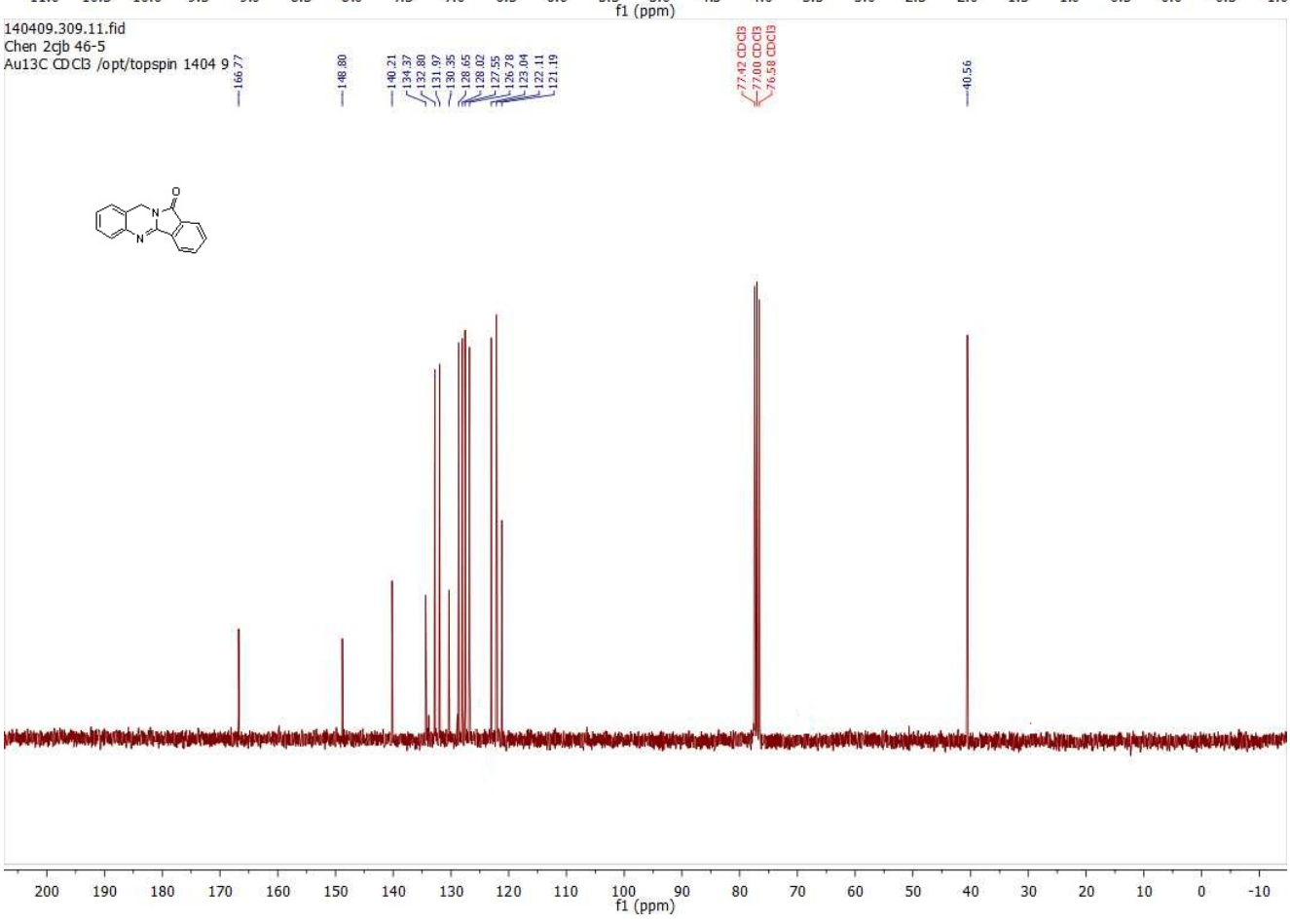
HRMS (ESI): calcd. for [M+H]+, C16H13ON2: 249.10224; found: 249.10266.

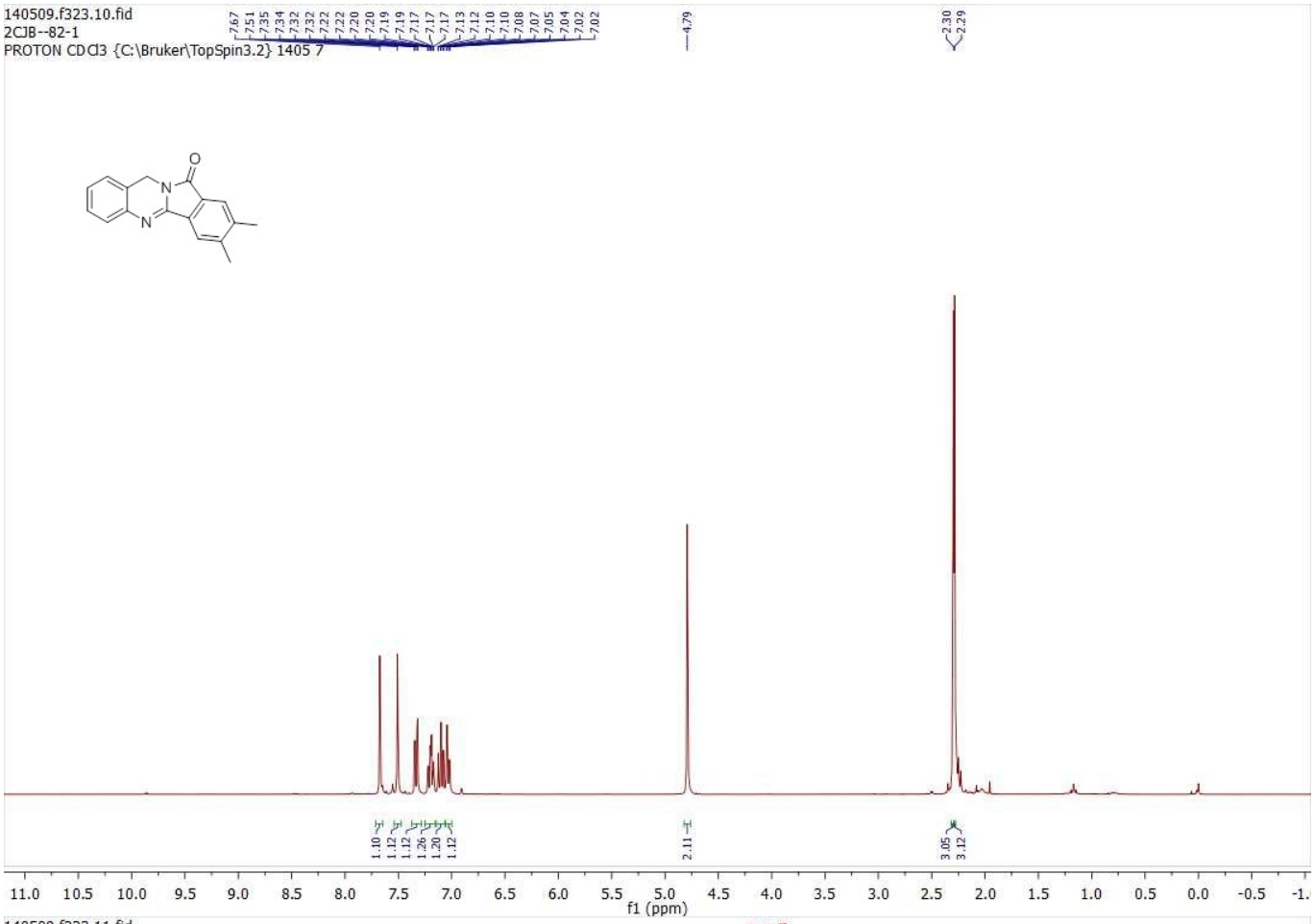
5. References

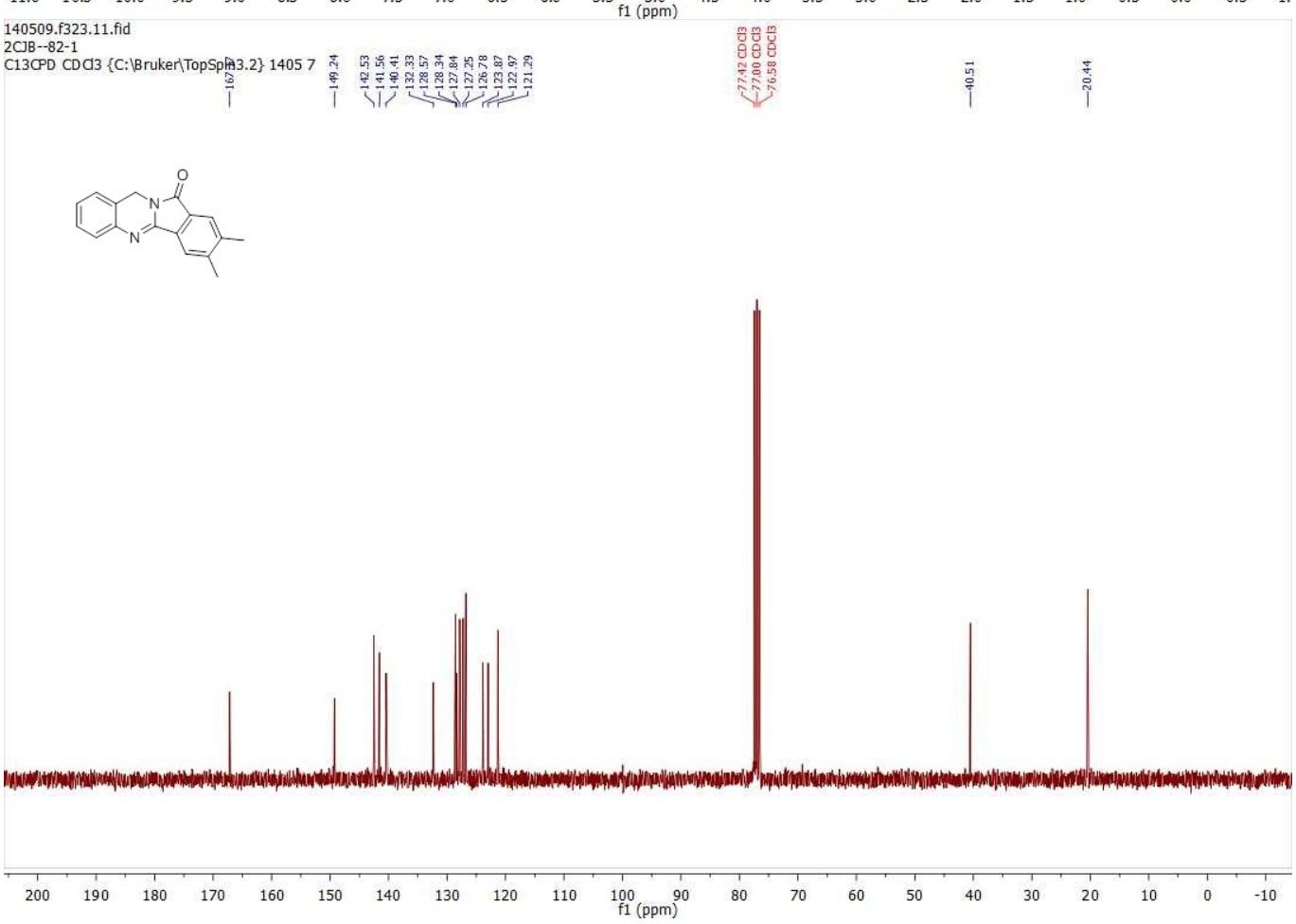
[1] M.-C. Tseng, P.-Y. Lai, L. Shi, H.-Y. Li, M.-J. Tseng,Y.-H. Chu *Tetrahedron* **2014**, *70*, 2629-2633.

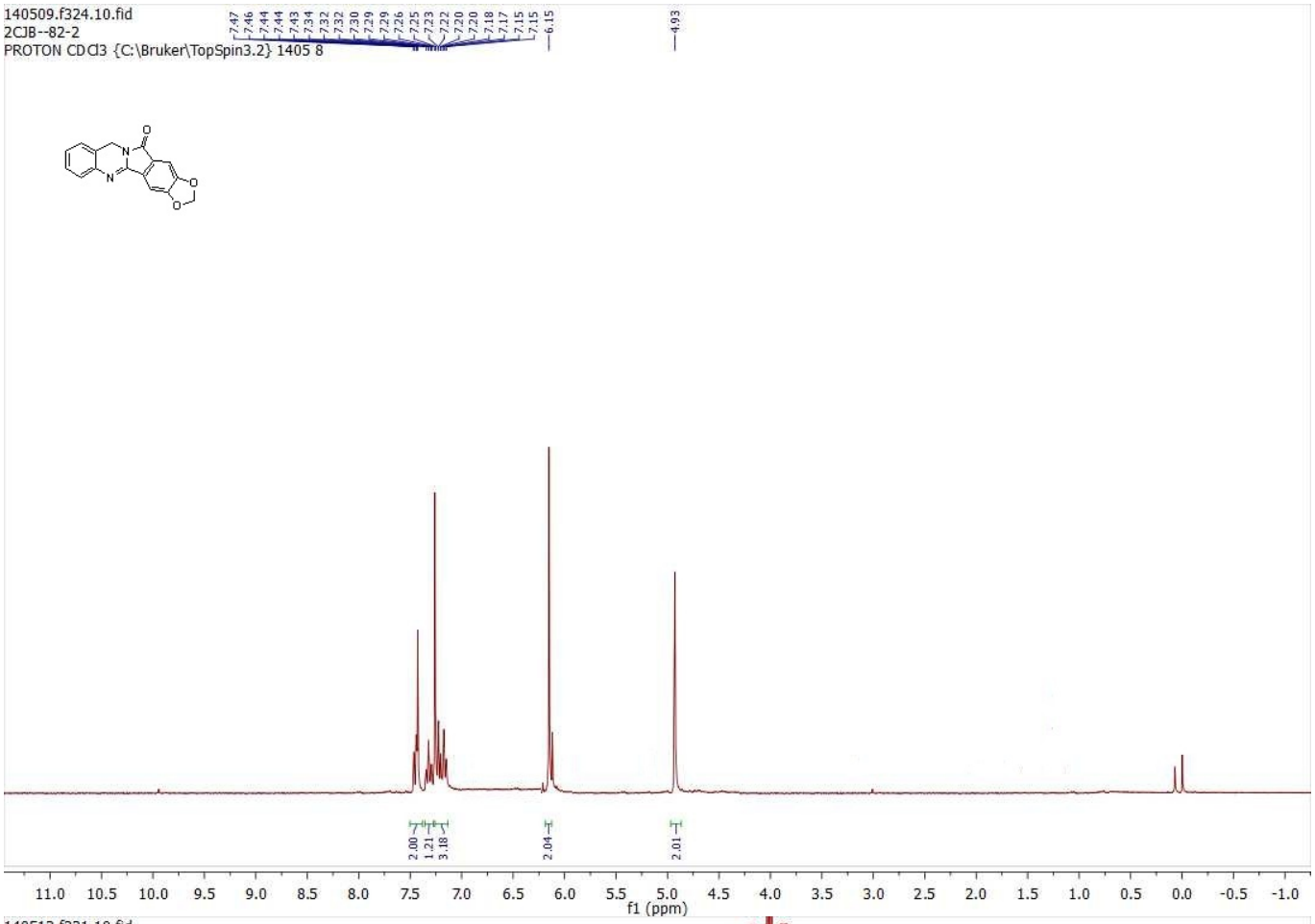
6. Copies of the Products ^{1}H NMR and ^{13}C NMR

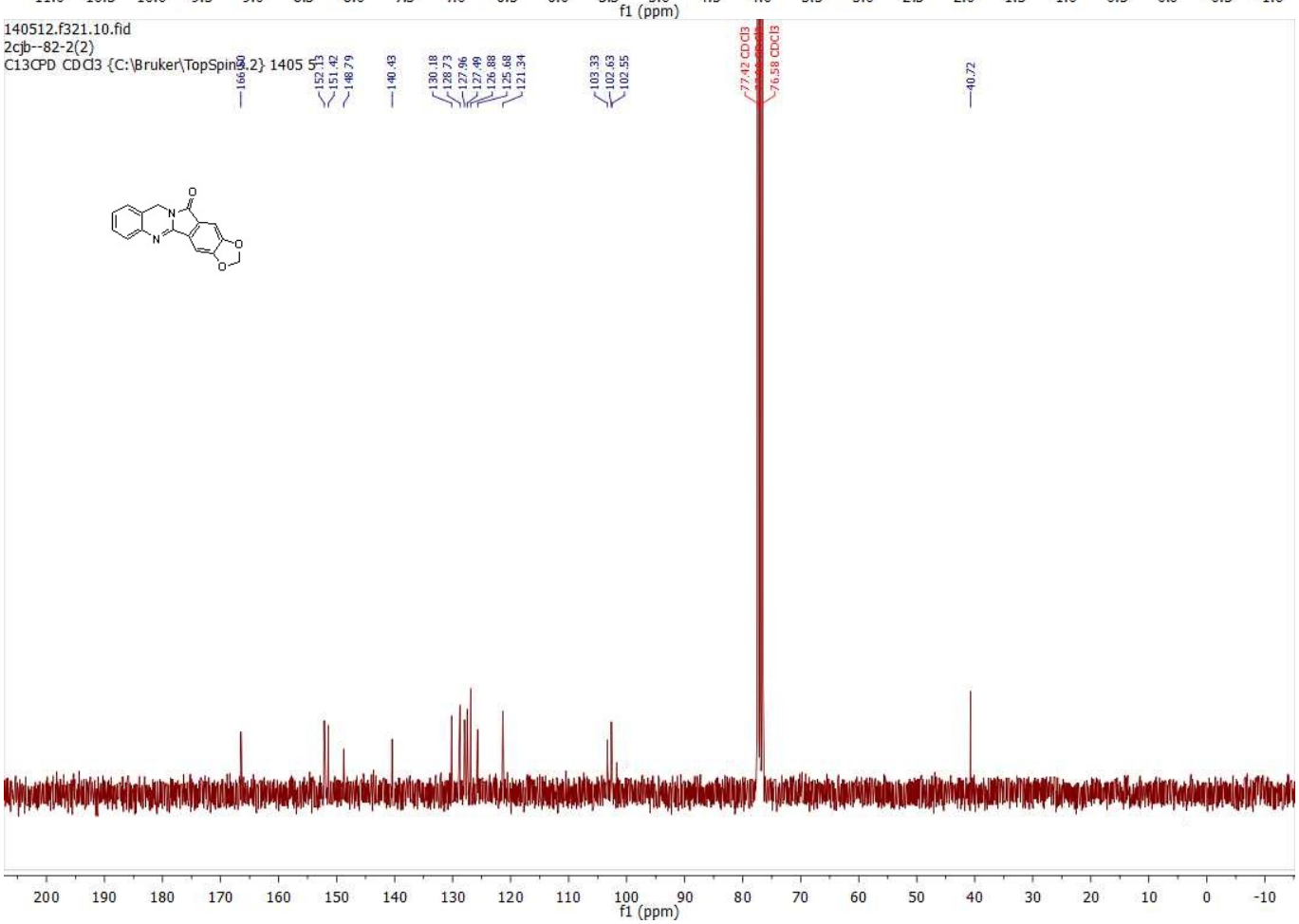


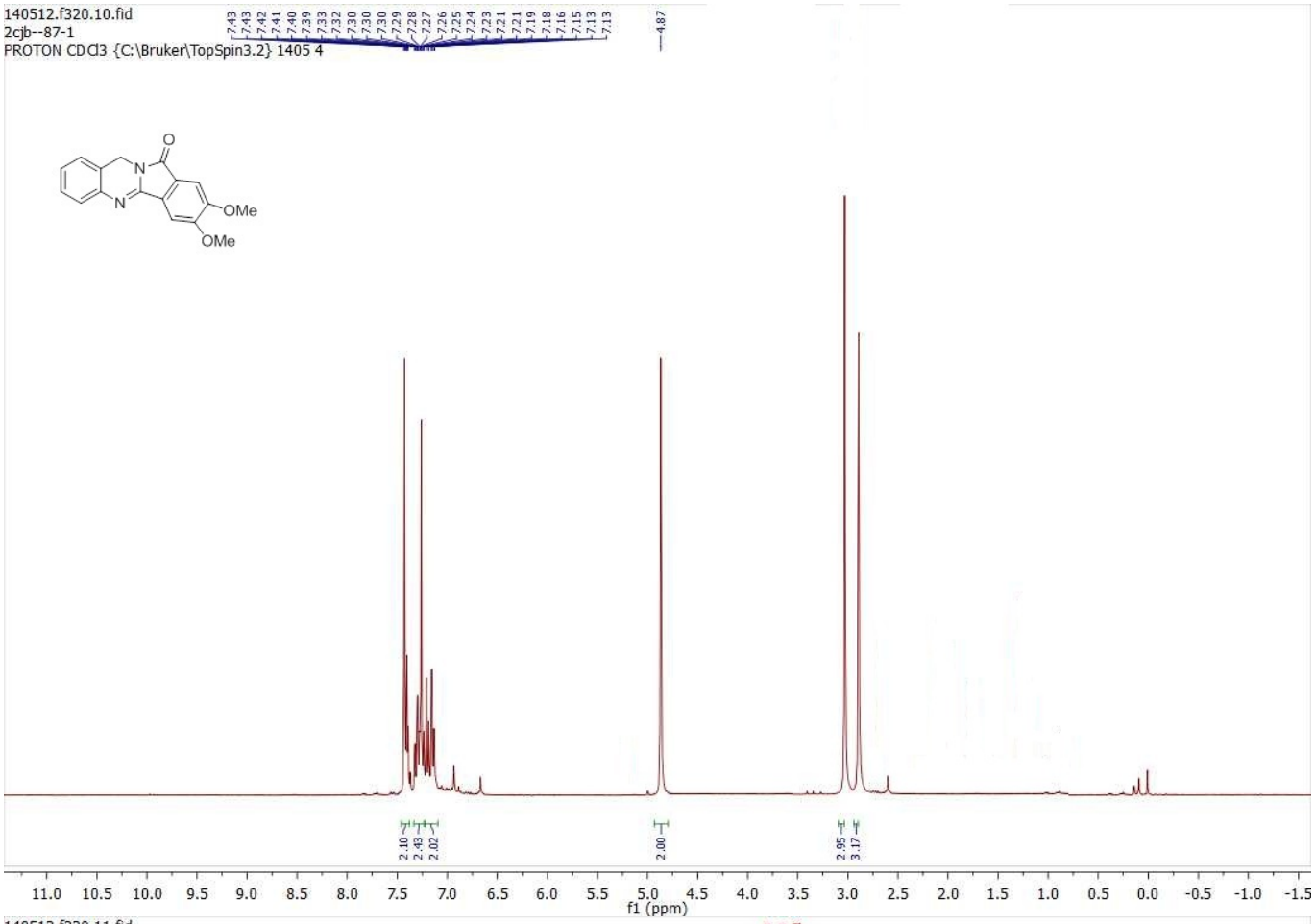


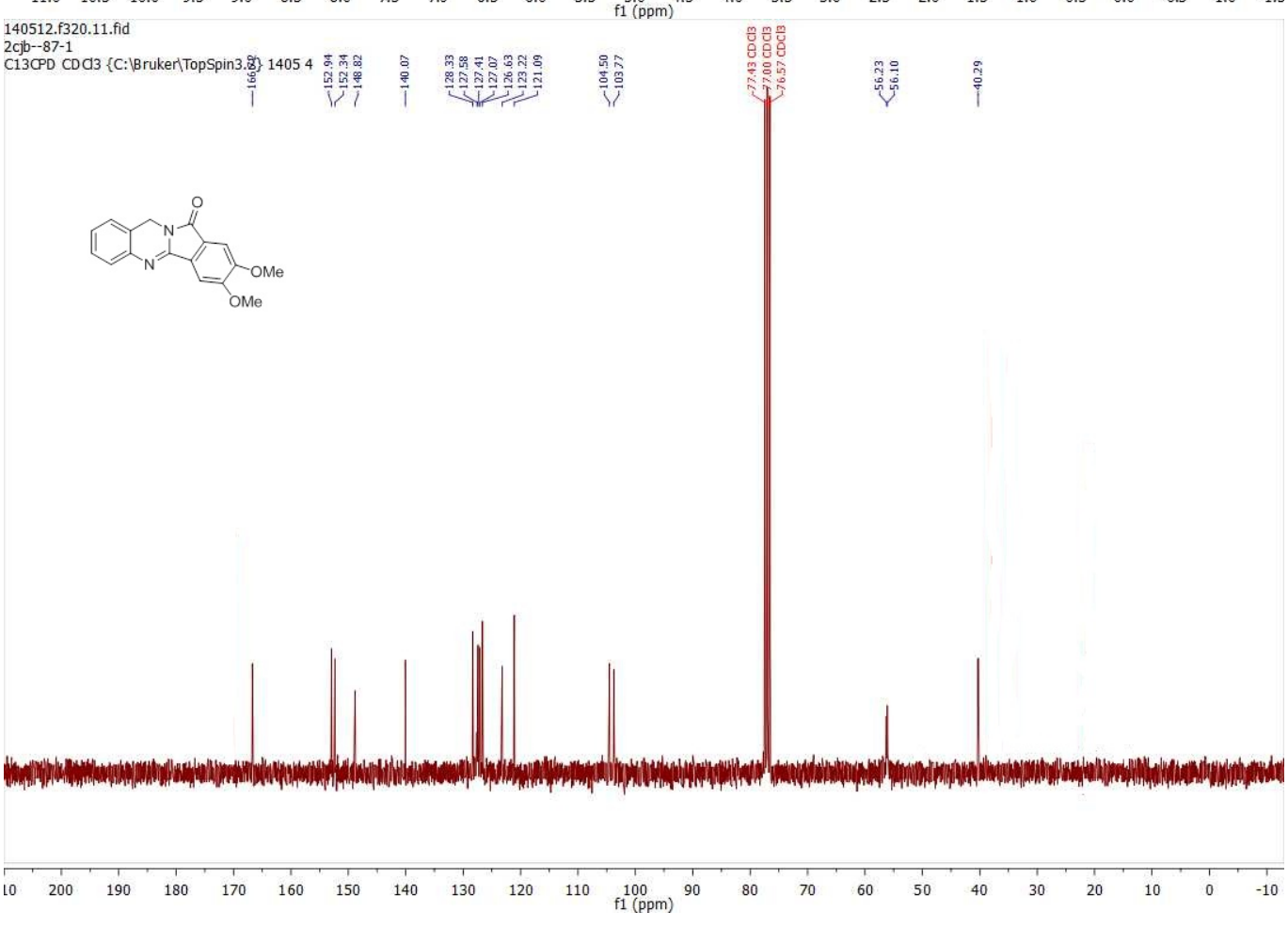

140509.f323.10.fid
2CJB--82-1
PROTON CDCl3 {C:\Bruker\TopSpin3.2} 1405 7
7.67
7.51
7.35
7.34
7.32
7.32
7.22
7.22
7.20
7.20
7.19
7.19
7.17
7.17
7.17
7.13
7.12
7.10
7.10
7.08
7.07
7.05
7.04
7.02
7.02
4.79
2.30
2.29
O
N
N
1.10
1.12
1.12
1.26
1.20
1.12
2.11
3.05
3.12
11.0
10.5
10.0
9.5
9.0
8.5
8.0
7.5
7.0
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
-0.5
f1 (ppm)

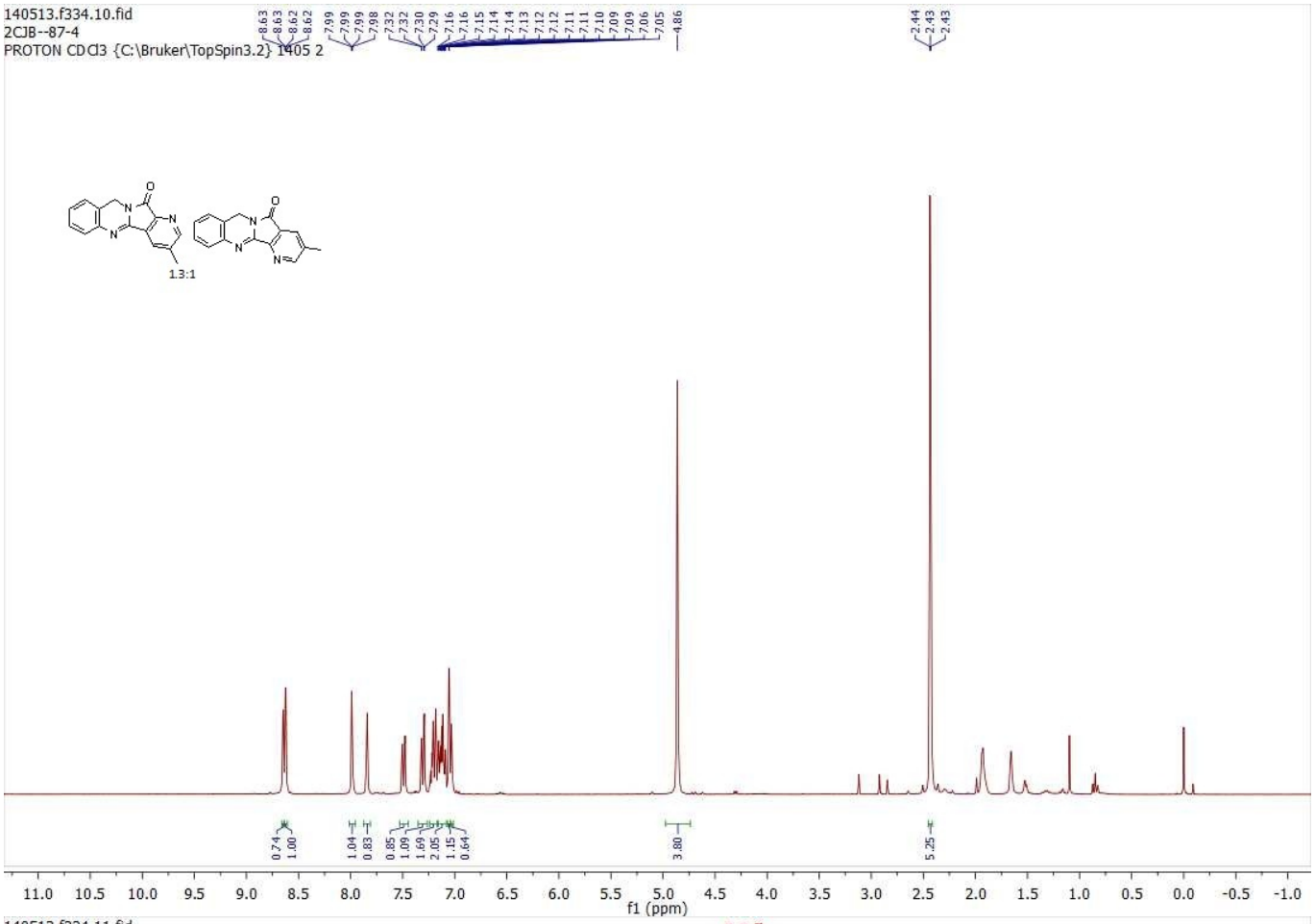

140509.f323.11.fid
2CJB--82-1
C13CPD CDCl3 {C:\Bruker\TopSpin3.2} 1405 7
167.73
149.24
142.53
141.56
140.41
132.33
128.57
128.34
127.84
127.25
126.78
123.87
122.97
121.29
77.42 CDCl3
77.00 CDCl3
76.58 CDCl3
40.51
20.44
O
N
N
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
-10
f1 (ppm)

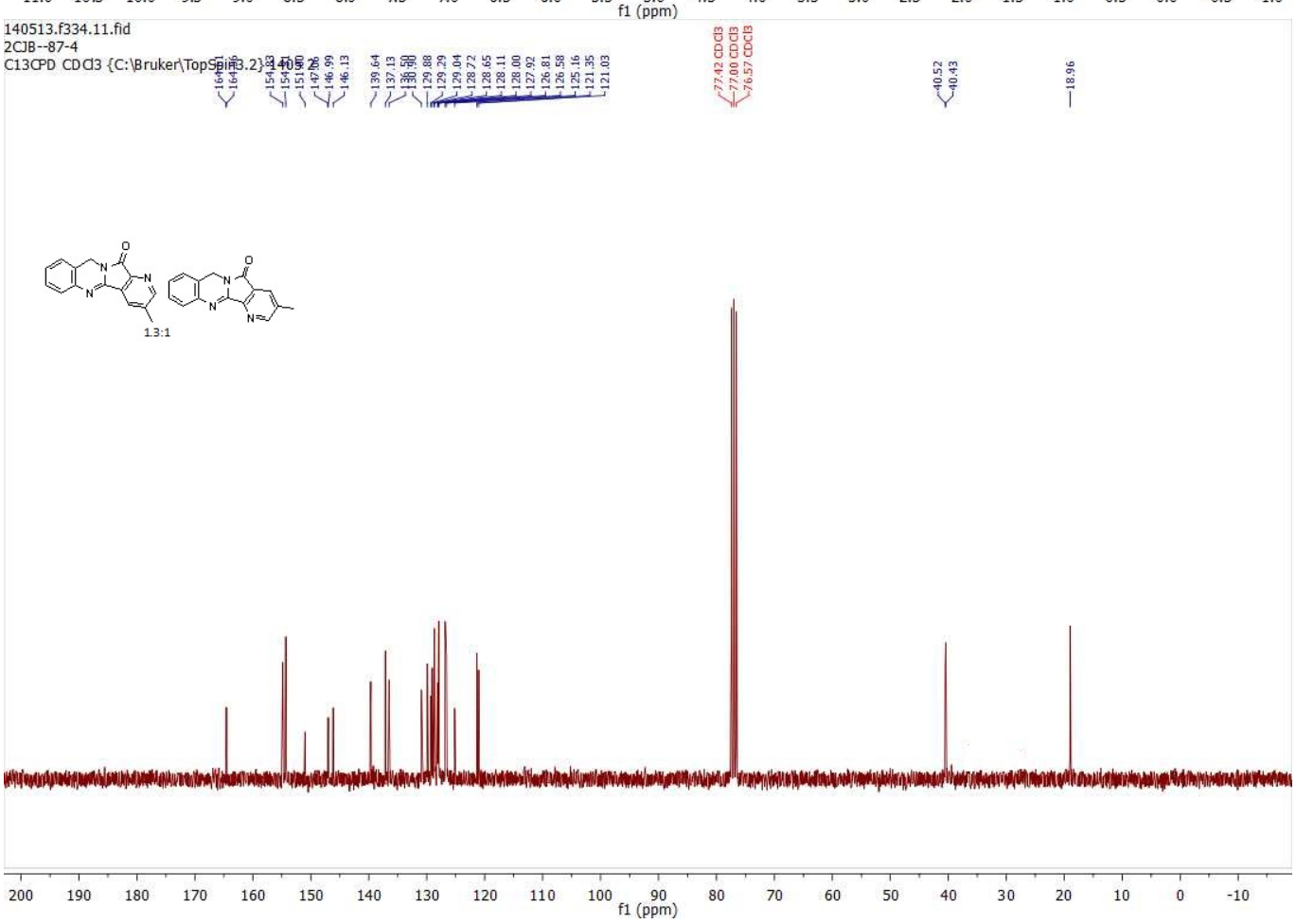

140509.f324.10.fid
2CJB--82-2
PROTON CDCl3 {C:\Bruker\TopSpin3.2} 1405 8
7.47
7.46
7.44
7.44
7.44
7.43
7.34
7.32
7.32
7.30
7.29
7.29
7.26
7.25
7.23
7.22
7.20
7.20
7.18
7.17
7.15
7.15
6.15
4.93
2.00
1.21
3.18
2.04
2.01
11.0 10.5 10.0 9.5 9.0 8.5 8.0 7.5 7.0 6.5 6.0 5.5 5.0 4.5 4.0 3.5 3.0 2.5 2.0 1.5 1.0 0.5 0.0 -0.5 -1.0
f1 (ppm)

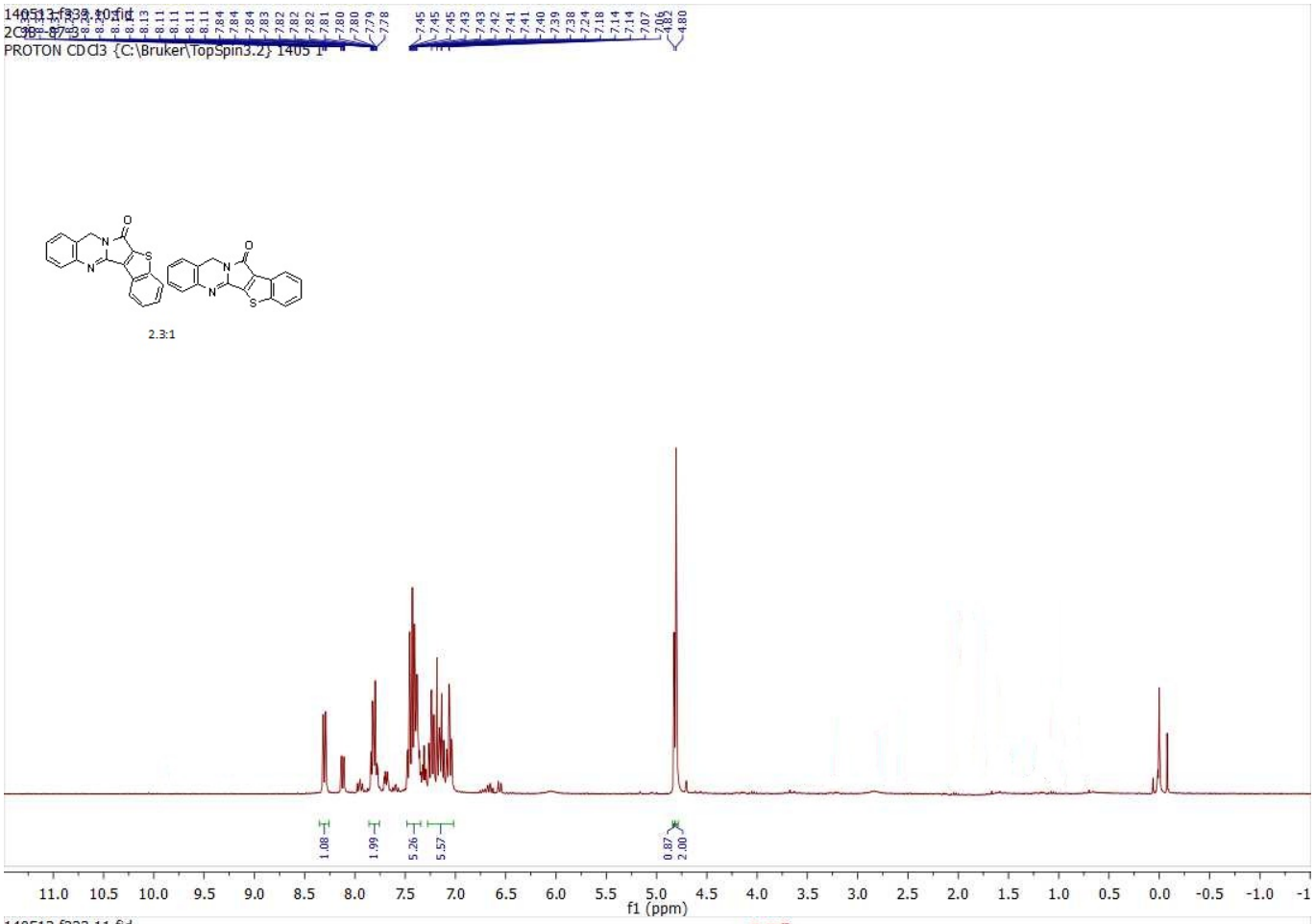

140512.f321.10.fid
2cjb--82-2(2)
C13CPD CDCl3 {C:\Bruker\TopSpin3.2} 1405 5
166.
152.
151.42
148.79
140.43
130.18
128.73
127.96
127.49
126.88
125.68
121.34
103.33
102.63
102.55
77.42 CDCl3
76.58 CDCl3
40.72
200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 -10
f1 (ppm)

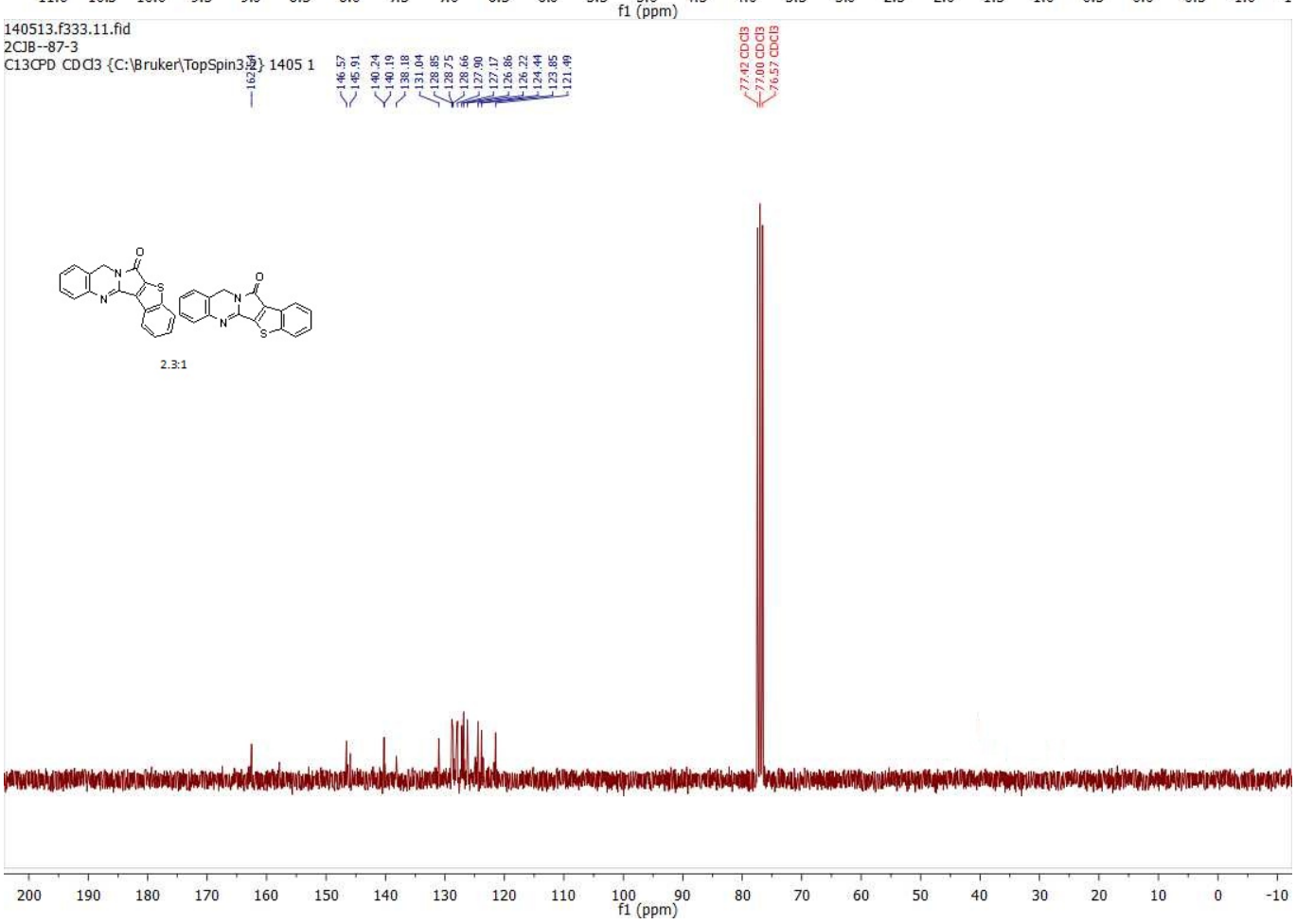

140512.f320.10.fid
2cjb--87-1
PROTON CDCl3 {C:\Bruker\TopSpin3.2} 1405 4
OMe
OMe
f1 (ppm)

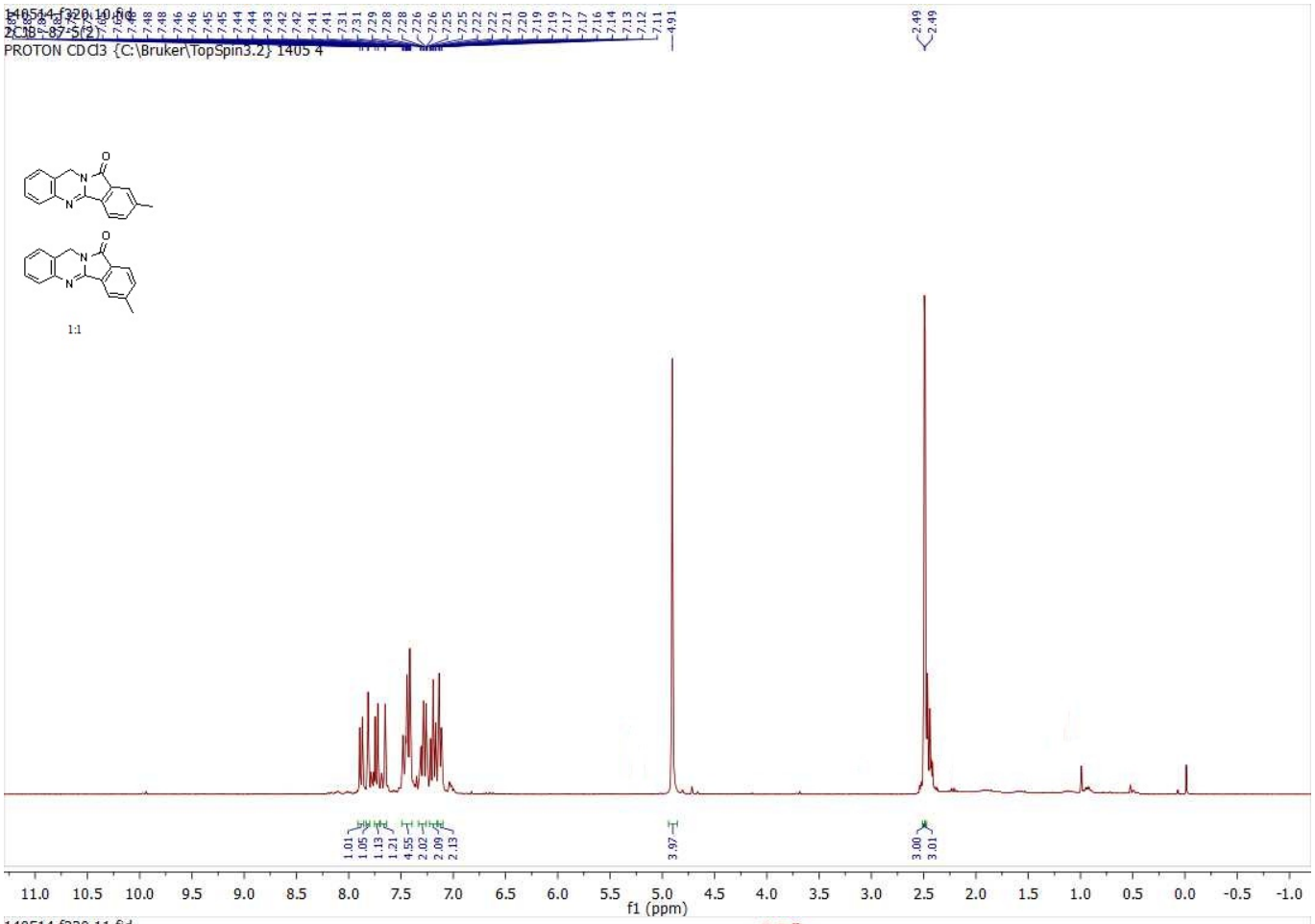

140512.f320.11.fid
2cjb--87-1
C13CPD CDCl3 {C:\Bruker\TopSpin3.2} 1405 4
OMe
OMe
f1 (ppm)

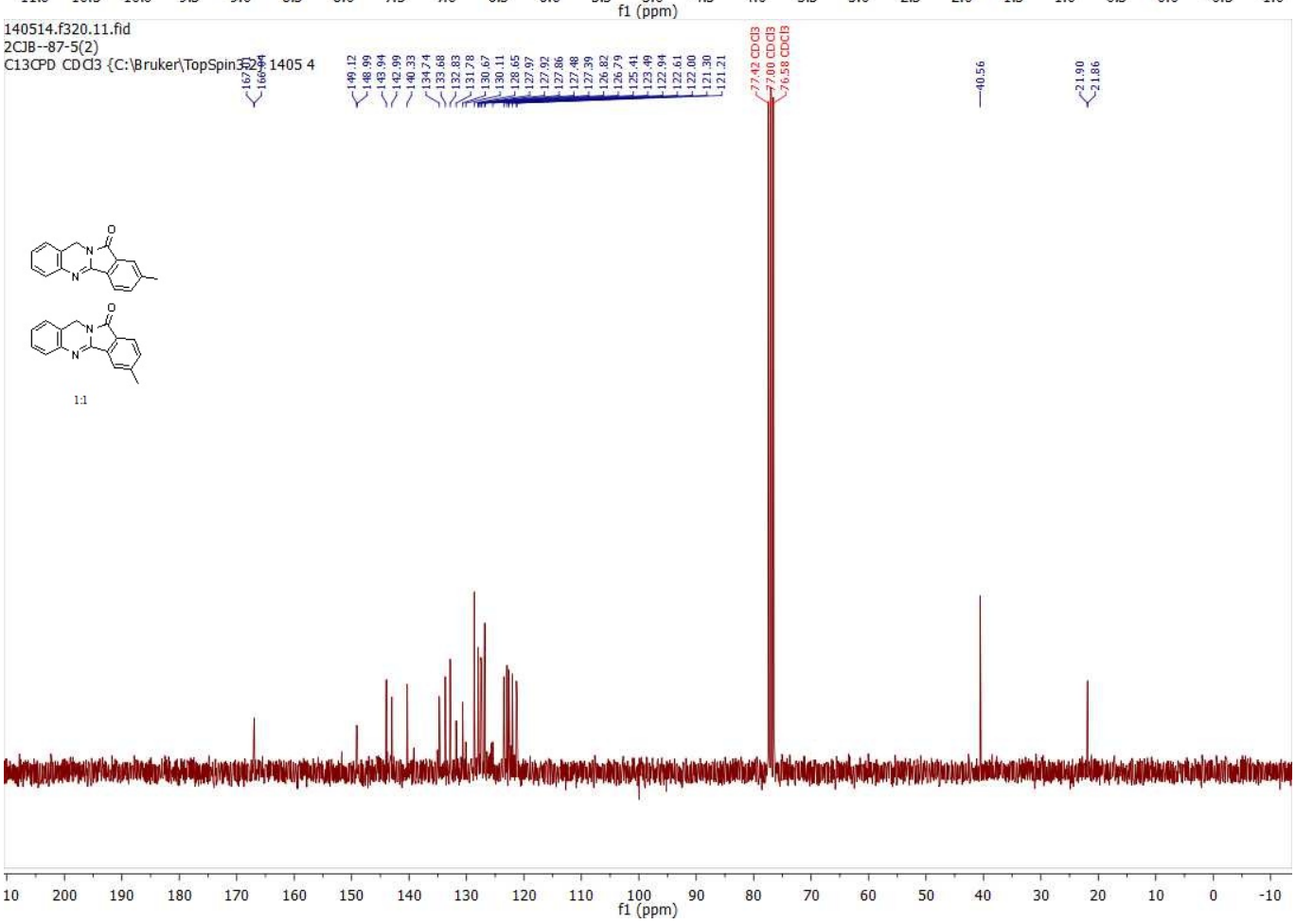

140513.f334.10.fid
2CJB--87-4
PROTON CDCl3 {C:\Bruker\TopSpin3.2} 1405 2
1.3:1
f1 (ppm)


140513.f334.11.fid
2CJB--87-4
C13CPD CDCl3 {C:\Bruker\TopSpin3.2} 1405 2
1.3:1
f1 (ppm)


140513.f333.11.fid
2CJB--87-3
PROTON CDCl3 {C:\Bruker\TopSpin3.2} 1405 1
2.3:1
1.08
1.99
5.26
5.57
0.87
2.00
f1 (ppm)


140513.f333.11.fid
2CJB--87-3
C13CPD CDCl3 {C:\Bruker\TopSpin3.2} 1405 1
162.84
146.57
145.91
140.24
140.19
138.18
131.04
128.85
128.75
128.66
127.90
127.17
126.86
126.22
124.44
123.85
121.49
77.42 CDCl3
77.00 CDCl3
76.57 CDCl3
2.3:1
f1 (ppm)


140514.f320.10.fid
2CJB--87-5(2)
PROTON CDCl3 {C:\Bruker\TopSpin3.2} 1405 4
1:1
f1 (ppm)


140514.f320.11.fid
2CJB--87-5(2)
C13CPD CDCl3 {C:\Bruker\TopSpin3.2} 1405 4
1:1
f1 (ppm)