Room temperature HFIP/Ag-Promoted Palladium-Catalyzed C–H Functionalization of Benzothiazole with Iodoarenes.

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1. General remarks: C, H and N analyses were carried out locally. NMR data (^{1}H or ^{13}C) were recorded locally on 400spectrometer in IIT Bombay. HRMS analyses were performed locally. The ionization mechanism used was electrospray in positive and negative ion full scan mode using acetonitrile as solvent and nitrogen gas for desolvation. All, commercially available chemicals were purchased from commercial sources and were used without further purification. All the solvents were dried by standard methods before use.

2. Representative Procedure:

A) General procedure:

A clean and dry Schlenk tube was subjected to vacuum degassing and nitrogen flushing for 5 min. A clean dry stir bar was dropped into the tube and it was set over a magnetic stirrer with nitrogen atmosphere was maintained inside the tube. (under nitrogen atmosphere)
The components were added as follows: $Pd(OAc)_2$ (1.0 mol%, 2.2 mg), Ag_2O (1.0 mmol., 231 mg), NaOAc (0.5 mmol., 41 mg), iodoarenes (1.0 mmol.) with (then) hexaflouro-2- propanol was added (2.0 mL), followed by benzothiazole (1.0 mmol.). After a final nitrogen flushing of 5 min, the tube was sealed using teflon tape. The reaction mixture was allowed to stir at room temperature (30 ^oC) for 12 hr. After this the reaction mixture was filtered through a short silica gel filter and washing it with ethyl acetate with the filtrate transferred and subsequently concentrated on a rotary evaporator under vacuum. Purification of the crude was performed using column chromatography with silica gel of 60 Å mesh size.

B) Sequential HFIP-promoted iodination/Pd-catalyzed C—H functionalization strategy.

1) Iodination of arene to aryl iodide (9a-b):
In a clean and oven dried round bottom flask, arene (1.0 mmol.) is treated with I_2 (0.6 mmol., 151 mg), $PhI(OAc)_2$ (1.1 mmol., 354 mg) and the mixture is grinded using a mortar and pestle at room temperature for 0.5 hr. The semi-solid product slowly solidified, and the formed product was confirmed by GC- MS (EI). The obtained product was next transferred to another clean flask by using 1.0 mL hexaflouro-2- propanol and was directly used for the next catalytic step without purification[1].
3) Product 9(a-b) was prepared according to the general procedure.

C) Synthesis of PMX 610 analog (antitumor agent) (12).

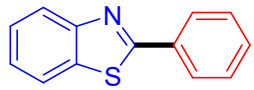
1) Alkylation with methyl iodide:
In a clean and oven dried round bottom flask, catechol (1.0 mmol., 110 mg), MeI (3.0 mmol., 425 mg) and K_2CO_3 (4.0 mmol., 552 mg) were mixed in acetone (6.0 mL) and stirred at room temperature for 12 hr. Product formed was purified by column chromatography and isolated in 95% yield[2].

2) Iodination:
Product isolated from step (1) is treated with I_2 (0.6 mmol., 151 mg), $PhI(OAc)_2$ (1.1 mmol., 354 mg) and the mixture is grinded using a mortar and pestle at room temperature for 0.5 hr. The semi-solid product slowly solidified and was product confirmed by GC- MS (EI). Formed product was next transferred by using 1.0 mL hexaflouro-2- propanol and was directly used for the next catalytic step without purification[1].
3) Product (PMX 610 Analog) was prepared according to the general procedure (231 mg, 80% yield) and was obtained as a semi-solid.

D) Synthesis of CJM 126 analog (15).

1) In a clean and oven dried Schlenk tube, N- phenylacetamide (1.0 mmol., 135 mg) and N-iodosuccinimide (1.0 mmol., 224 mg) are mixed and hexaflouro-2- propanol (2.0 mL) was added to this mixture. The reaction mixture was stirred at room temperature for 2 hr. The product was purified and isolated by column chromatography (253 mg, 97% yield)[3].
2) Product (**15)** was prepared according to the general procedure (171 mg, 64% yield) and obtained as a brown solid.

3. Characterization data for substituted benzothiazoles:



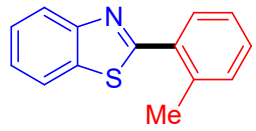
2-phenylbenzo[*d*]thiazole (3a)

Product **3a** was prepared according to the general procedure (194 mg, 92% yield) and obtained as a solid.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.15 – 8.06 (m, 3H), 7.94 – 7.87 (m, 1H), 7.55 – 7.46 (m, 4H), 7.39 (ddd, *J* = 1.2, 7.2, 8.2 Hz, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 168.1, 154.2, 135.1, 133.7, 131.0, 129.1, 127.6, 126.4, 125.3, 123.3, 121.7

HRMS: ESI, $(M+H)^+$ m/z= 212.0538 calcd. for $(C_{13}H_9NS+H)^+$, found: 212.0537.



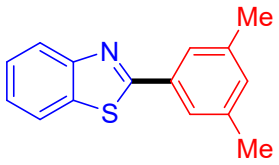
2-(*o*-tolyl)benzo[*d*]thiazole (3b)

Product **3b** was prepared according to the general procedure (180 mg, 80% yield) and obtained as a solid.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.12 (dd, *J* = 1.1, 8.2 Hz, 1H), 7.94 (dd, *J* = 1.1, 7.9 Hz, 1H), 7.77 (dd, *J* = 1.4, 7.6 Hz, 1H), 7.52 (ddd, *J* = 1.3, 7.4, 8.8 Hz, 1H), 7.45 – 7.38 (m, 2H), 7.33 (ddd, *J* = 1.9, 7.9, 14.4 Hz, 2H), 2.67 (s, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 168.1, 153.9, 137.3, 135.7, 133.2, 131.6, 130.6, 130.1, 126.2, 126.2, 125.2, 123.5, 121.4, 21.4.

HRMS: ESI, $(M+H)^+$ m/z= 226.0698 calcd. for $(C_{14}H_{11}NS+H)^+$, found: 226.0697.



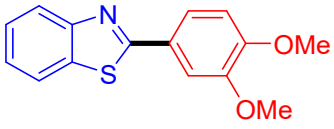
2-(3,5-dimethylphenyl)benzo[*d*]thiazole (3c)

Product **3c** was prepared according to the general procedure (193 mg, 81% yield) and obtained as a solid.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.11 – 8.05 (m, 1H), 7.90 (dd, *J* = 1.3, 8.0 Hz, 1H), 7.72 (d, *J* = 1.7 Hz, 2H), 7.49 (ddd, *J* = 1.3, 7.2, 8.3 Hz, 1H), 7.38 (ddd, *J* = 1.2, 7.2, 8.2 Hz, 1H), 7.16 – 7.11 (m, 1H), 2.42 (s, 6H).

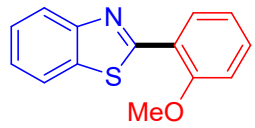
^{13}C NMR (101 MHz, $CDCl_3$) δ 154.2, 138.8, 133.5, 132.8, 126.3, 125.4, 125.1, 123.2, 121.7, 29.8, 21.3.

HRMS: ESI, $(M+H)^+$ m/z= 240.0855 calcd. for $(C_{15}H_{13}NS+H)^+$, found: 240.0855.



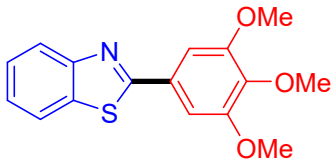
2-(3,4-dimethoxyphenyl)benzo[*d*]thiazole (3d)

Product **3d** was prepared according to the general procedure (227 mg, 84% yield) and obtained as a solid.
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.03 (dt, *J* = 0.8, 8.2 Hz, 1H), 7.87 (dd, *J* = 1.2, 8.0 Hz, 1H), 7.71 (d, *J* = 2.1 Hz, 1H), 7.59 (dd, *J* = 2.1, 8.4 Hz, 1H), 7.47 (ddd, *J* = 1.3, 7.2, 8.2 Hz, 1H), 7.35 (td, *J* = 1.2, 7.6 Hz, 1H), 6.94 (d, *J* = 8.4 Hz, 1H), 4.02 (s, 3H), 3.95 (s, 3H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 168.0, 154.2, 151.7, 149.4, 135.0, 126.8, 126.3, 125.0, 122.9, 121.6,121.2, 111.1, 109.9, 56.2, 56.1.
HRMS: ESI, $(M+H)^+$ m/z= 272.0750 calcd. for $(C_{15}H_{13}NO_2S+H)^+$, found: 272.0749.



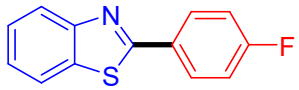
2-(2-methoxyphenyl)benzo[*d*]thiazole (3e)

Product **3e** was prepared according to the general procedure (197 mg, 87% yield) and obtained as a solid.
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.54 (dd, *J* = 1.8, 7.9 Hz, 1H), 8.10 (dt, *J* = 0.9, 8.2 Hz, 1H), 7.93 (dt, *J* = 0.9, 8.0 Hz, 1H), 7.48 (dddd, *J* = 1.5, 7.2, 8.9, 12.8 Hz, 2H), 7.37 (ddd, *J* = 1.1, 7.2, 8.2 Hz, 1H), 7.18 – 7.10 (m, 1H), 7.07 (dd, *J* = 1.1, 8.4 Hz, 1H), 4.06 (s, 3H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 163.2, 157.3, 152.3, 136.2, 131.8, 129.6, 126.0, 124.7, 122.9, 122.4, 121.3, 121.3, 111.8, 55.8.
HRMS: ESI, $(M+Na)^+$ m/z= 264.0453 calcd. for $(C_{14}H_{11}NOS+Na)^+$, found: 264.0453.



2-(3,4,5-trimethoxyphenyl)benzo[*d*]thiazole (3f)

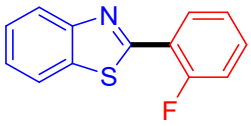
Product **3f** was prepared according to the general procedure (252 mg, 84% yield) and obtained as a solid.
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.05 (dt, *J* = 0.9, 8.1 Hz, 1H), 7.92 – 7.85 (m, 1H), 7.49 (ddd, *J* = 1.3, 7.2, 8.3 Hz, 1H), 7.38 (ddd, *J* = 1.2, 7.2, 8.2 Hz, 1H), 7.33 (s, 2H), 3.98 (s, 6H), 3.92 (s, 3H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 167.9, 154.2, 153.7, 140.8, 135.1, 129.2, 126.4, 125.2, 123.2, 121.6, 104.9, 61.1, 56.5.
HRMS: ESI, $(M+Na)^+$ m/z= 324.0666 calcd. for $(C_{16}H_{15}NO_3S+Na)^+$, found: 324.0665.



2-(4-fluorophenyl)benzo[*d*]thiazole (3g)

Product **3g** was prepared according to the general procedure (196 mg, 86% yield) and obtained as a solid.
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.13 – 8.03 (m, 3H), 7.89 (d, *J* = 7.9 Hz, 1H), 7.49 (ddd, *J* = 1.3, 7.1, 8.3 Hz, 1H), 7.43 – 7.34 (m, 1H), 7.18 (t, *J* = 8.6 Hz, 2H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 166.8,164.5(d, J_{CF}=252.5Hz), 154.2, 135.1, 130.1(d, J_{CF}=3.0Hz), 129.6(d, J_{CF}=9.0Hz), 126.5, 125.3, 123.3, 121.7, 116.2(d, J_{CF}=22.2Hz).
^{19}F NMR (376 MHz, $CDCl_3$) δ -108.9.

HRMS: ESI, $(M+H)^+$ m/z= 230.0434 calcd. for $(C_{13}H_8FNS+H)^+$, found: 230.0433.



2-(2-fluorophenyl)benzo[*d*]thiazole (3h)

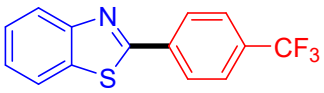
Product **3h** was prepared according to the general procedure (185 mg, 81% yield) and obtained as a solid.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.42 (td, J = 1.8, 7.7 Hz, 1H), 8.13 (dt, J = 0.9, 8.2 Hz, 1H), 7.94 (dt, J = 0.9, 8.0 Hz, 1H), 7.56 – 7.37 (m, 3H), 7.37 – 7.28 (m, 1H), 7.24 (ddd, J = 1.2, 8.3, 11.2 Hz, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 161.2(d, J_{CF} = 6.06Hz), 160.6(d, J_{CF} = 254.5Hz), 152.6, 135.8, 161.2(d, J_{CF} = 8.0Hz), 132.2(d, J_{CF} = 9.09Hz), 129.8(d, J_{CF} = 3.0Hz), 126.4, 125.4, 124.8 (d, J_{CF} = 4.0Hz), 123.4, 121.5(d, J_{CF} = 11.1Hz), 116.5(d, J_{CF} = 22.2Hz).

^{19}F NMR (376 MHz, $CDCl_3$) δ -111.9.

HRMS: ESI, $(M+H)^+$ m/z= 230.0436 calcd. for $(C_{13}H_8FNS+H)^+$, found: 230.0435.



2-(4-(trifluoromethyl)phenyl)benzo[*d*]thiazole (3i)

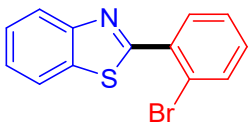
Product **3i** was prepared according to the general procedure (212 mg, 76% yield) and obtained as a solid.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.23 – 8.17 (m, 2H), 8.11 (dt, J = 0.9, 8.2 Hz, 1H), 7.96 – 7.89 (m, 1H), 7.75 (d, J = 8.2 Hz, 2H), 7.53 (ddd, J = 1.3, 7.2, 8.3 Hz, 1H), 7.43 (td, J = 1.2, 7.6 Hz, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 166.0, 154.0, 136.7, 135.2, 132.4(q, J_{CF} = 33.3Hz), 127.7, 126.6, 126.0(q, J_{CF} = 4.0Hz), 125.8, 123.8(q, J_{CF} = 273.7Hz), 123.6, 121.7.

^{19}F NMR (376 MHz, $CDCl_3$) δ -62.8.

HRMS: ESI, $(M+H)^+$ m/z= 279.0300 calcd. for $(C_{14}H_8F_3NS+H)^+$, found: 280.0398.



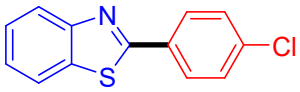
2-(2-bromophenyl)benzo[*d*]thiazole (3j)

Product **3j** was prepared according to the general procedure (227 mg, 79% yield) and obtained as a solid.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.15 (dd, J = 1.0, 8.2 Hz, 1H), 8.02 – 7.92 (m, 2H), 7.74 (dd, J = 1.2, 8.0 Hz, 1H), 7.53 (ddd, J = 1.3, 7.2, 8.2 Hz, 1H),7.44 (tdd, J = 1.2, 2.5, 7.1 Hz, 2H), 7.33 (td, J = 1.8, 7.7 Hz, 1H)

^{13}C NMR (101 MHz, $CDCl_3$) δ 165.7, 152.8, 136.2, 134.6, 134.2, 132.2, 131.3, 127.7,126.4, 125.6, 123.7, 122.2, 121.5.

HRMS: ESI, $(M+H)^+$ m/z= 291.9615 calcd. for $(C_{13}H_8BrNS+H)^+$, found: 291.9615.



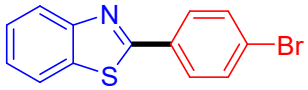
2-(4-chlorophenyl)benzo[*d*]thiazole (3k)

Product **3k** was prepared according to the general procedure (220 mg, 90% yield) and obtained as a solid.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.10 – 8.03 (m, 1H), 8.05 – 7.98 (m, 2H), 7.90 (dd, J = 1.3, 8.0 Hz, 1H), 7.54 – 7.45 (m, 2H), 7.45 (d, J = 1.8 Hz, 1H), 7.44 – 7.35 (m, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 166.7, 154.2, 137.1, 135.1, 132.2, 129.4, 128.8, 126.6, 125.5, 123.4, 121.7.

HRMS: ESI, $(M+H)^+$ m/z= 246.0146 calcd. for $(C_{13}H_8ClNS+H)^+$, found: 246.0145.



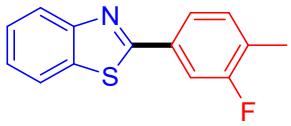
2-(4-bromophenyl)benzo[*d*]thiazole (3l)

Product **3l** was prepared according to the general procedure (256 mg, 89% yield) and obtained as a solid.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.07 (d, J = 8.2 Hz, 1H), 7.98 – 7.91 (m, 2H), 7.92 – 7.87 (m, 1H), 7.66 – 7.57 (m, 2H), 7.50 (tt, J = 1.5, 8.4 Hz, 1H), 7.40 (td, J = 1.9, 7.5 Hz, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 166.8, 154.1, 135.1, 132.6, 132.3, 129.0, 126.6, 125.5, 125.5, 123.4, 121.7.

HRMS: ESI, $(M+H)^+$ m/z= 291.9613 calcd. for $(C_{13}H_8BrNS+H)^+$, found: 291.9613.



2-(3-fluoro-4-methylphenyl)benzo[*d*]thiazole (3m)

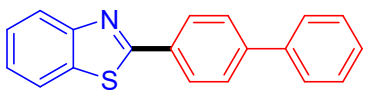
Product **3m** was prepared according to the general procedure (206 mg, 85% yield) and obtained as a solid.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.13 – 8.03 (m, 1H), 7.97 – 7.85 (m, 1H), 7.81 – 7.70 (m, 2H), 7.49 (ddd, J = 1.3, 7.2, 8.3 Hz, 1H), 7.38 (ddd, J = 1.2, 7.2, 8.2 Hz, 1H), 7.34 – 7.24 (m, 1H), 2.34 (d, J = 2.0 Hz, 3H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 166.8(d, J_{CF}=3.0Hz), 161.6(d, J_{CF}=246.4Hz), 154.1, 135.1, 133.2(d, J_{CF}=8.0Hz), 132.1(d, J_{CF}=5.0Hz), 128.2(d, J_{CF}=18.1Hz), 126.5, 125.4, 123.3, 123.1(d, J_{CF}=3.0Hz), 121.7, 114.0(d, J_{CF}=25.2Hz), 14.8(d, J_{CF}=3.0Hz).

^{19}F NMR (376 MHz, $CDCl_3$) δ -116.3.

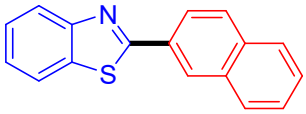
HRMS: ESI, $(M+H)^+$ m/z= 244.0598 calcd. for $(C_{14}H_{10}FNS+H)^+$, found: 244.0598.



2-([1,1'-biphenyl]-4-yl)benzo[*d*]thiazole (5a)

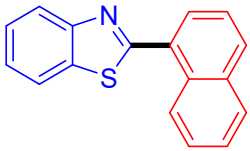
Product **5a** was prepared according to the general procedure (238 mg, 83% yield) and obtained as a solid.

^{1}H NMR (400 MHz, $CDCl_3$) δ 8.21 – 8.14 (m, 2H), 8.10 (dt, *J* = 0.8, 8.2 Hz, 1H), 7.95 – 7.88 (m, 1H), 7.77 – 7.69 (m, 2H), 7.72 – 7.62 (m, 2H), 7.50 (dddd, *J* = 1.5, 6.7, 7.9, 10.7 Hz, 3H), 7.40 (ddt, *J* = 1.3, 7.3, 8.2 Hz, 2H)
^{13}C NMR (101 MHz, $CDCl_3$) δ 167.8, 154.3, 143.8, 140.1, 135.2, 132.6, 129.0, 128.1, 128.0, 127.7, 127.2, 126.4, 125.3, 123.3, 121.7, 77.4, 77.1, 76.8.
HRMS: ESI, $(M+Na)^+$ m/z= 310.0662 calcd. for $(C_{19}H_{13}NS+Na)^+$, found: 310.0661.



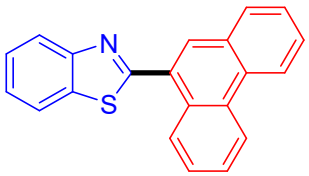
2-(naphthalen-2-yl)benzo[*d*]thiazole (5b)

Product **5b** was prepared according to the general procedure (221 mg, 85% yield) and obtained as a solid.
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.59 – 8.54 (m, 1H), 8.21 (dd, *J* = 1.8, 8.5 Hz, 1H), 8.13 (dt, *J* = 0.9, 8.2 Hz, 1H), 8.01 – 7.90 (m, 3H), 7.90 – 7.83 (m, 1H), 7.60 – 7.52 (m, 1H), 7.56 – 7.47 (m, 1H), 7.40 (ddd, *J* = 1.2, 7.2, 8.3 Hz, 1H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 168.2, 154.3, 135.2, 134.7, 133.3, 131.1, 128.9, 127.9, 127.7, 127.5, 126.9, 126.5, 125.3, 124.5, 123.3, 121.7.
HRMS: ESI, $(M+H)^+$ m/z= 262.0691 calcd. for $(C_{17}H_{11}NS+H)^+$, found: 262.0691.



2-(naphthalen-1-yl)benzo[*d*]thiazole (5c)

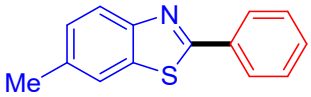
Product **5c** was prepared according to the general procedure (229 mg, 88% yield) and obtained as a solid.
^{1}H NMR (400 MHz, $CDCl_3$) δ 9.00 (dd, *J* = 3.3, 8.7 Hz, 1H), 8.25 (dt, *J* = 1.7, 8.2 Hz, 1H), 8.03 – 7.91 (m, 4H), 7.65 (ddt, *J* = 1.3, 6.9, 8.4 Hz, 1H), 7.62 – 7.53 (m, 3H), 7.50 – 7.42 (m, 1H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 167.7, 154.2, 135.5, 134.1, 131.1, 130.9, 130.7, 129.4, 128.5, 127.7, 126.6, 126.3, 126.0, 125.3, 125.0, 123.6, 121.4.
HRMS: ESI, $(M+Na)^+$ m/z= 284.0501 calcd. for $(C_{17}H_{11}NS+Na)^+$, found: 284.0501.



2-(phenanthren-9-yl)benzo[*d*]thiazole (5d)

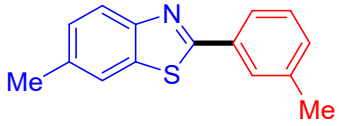
Product **5d** was prepared according to the general procedure (245 mg, 79% yield) and obtained as a solid.
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.96 – 8.90 (m, 1H), 8.79 (dd, *J* = 1.6, 8.0 Hz, 1H), 8.73 (d, *J* = 8.3 Hz, 1H), 8.25 – 8.18 (m, 2H), 8.03 – 7.94 (m, 2H), 7.74 (ddd, *J* = 1.6, 6.8, 8.0 Hz, 2H), 7.70 (ddd, *J* = 1.6, 7.0, 8.4 Hz, 1H), 7.65 (ddd, *J* = 1.2, 7.0, 8.1 Hz, 1H), 7.58 (ddd, *J* = 1.3, 7.2, 8.3 Hz, 1H), 7.48 (ddd, *J* = 1.3, 7.2, 8.3 Hz, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 167.7, 154.2, 135.5, 131.3, 131.1, 130.9, 130.8, 129.9, 129.5, 129.3, 128.3, 127.5, 127.3, 127.2, 126.8, 126.4, 125.5, 123.7, 123.0, 122.8, 121.5.
HRMS: ESI, $(M+H)^+$ m/z= 312.0844 calcd. for $(C_{21}H_{13}NS+H)^+$, found: 312.0844.



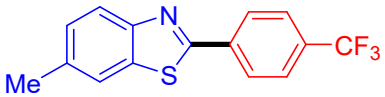
6-methyl-2-phenylbenzo[*d*]thiazole (7a)

Product 7**a** was prepared according to the general procedure (193 mg, 86% yield) and obtained as a solid.
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.13 – 8.03 (m, 2H), 7.96 (d, J = 8.3 Hz, 1H), 7.68 (d, J = 1.7 Hz, 1H), 7.48 (qd, J = 1.7, 3.8 Hz, 3H), 7.30 (dd, J = 1.7, 8.3 Hz, 1H), 2.49 (s, 3H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 167.1, 152.3, 135.4, 135.3, 133.8, 130.8, 129.0, 128.0, 127.5, 122.8, 121.4, 21.6.
HRMS: ESI, $(M+H)^+$ m/z= 226.0694 calcd. for $(C_{14}H_{11}NS+H)^+$, found: 226.0694.



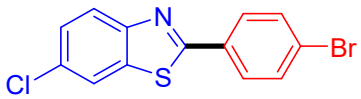
6-methyl-2-(*m*-tolyl)benzo[*d*]thiazole (7b)

Product **7b** was prepared according to the general procedure (193 mg, 81% yield) and obtained as a solid.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.98 – 7.90 (m, 2H), 7.85 (dt, J = 1.6, 7.8 Hz, 1H), 7.68 (d, J = 1.9 Hz, 1H), 7.37 (t, J = 7.6 Hz, 1H), 7.33 – 7.25 (m, 2H), 2.50 (s, 3H), 2.45 (s, 3H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 167.4, 152.3, 138.9, 135.4, 135.3, 133.7, 131.7, 129.1, 129.0, 128.0, 124.8, 122.7, 121.4, 21.6, 21.4.
HRMS: ESI, $(M+H)^+$ m/z= 240.0851 calcd. for $(C_{15}H_{13}NS+H)^+$, found: 240.0851.



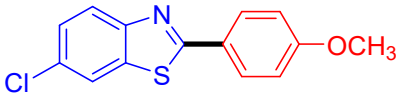
6-methyl-2-(4-(trifluoromethyl)phenyl)benzo[*d*]thiazole (7c)

Product **7c** was prepared according to the general procedure (213 mg, 73% yield) and obtained as a solid.
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.18 (d, J = 8.1 Hz, 2H), 7.98 (d, J = 8.4 Hz, 1H), 7.77 – 7.66 (m, 3H), 7.37 – 7.30 (m, 1H),2.51 (s, 3H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 165.0, 152.2, 136.9, 136.1, 132.4, 132.0, 128.3, 127.6, 125.9(q, J_{CF}=4.0Hz), 123.8(q, J_{CF}=273.7Hz), 123.1, 121.4, 21.6.
HRMS: ESI, $(M+H)^+$ m/z= 294.0560 calcd. for $(C_{15}H_{10}F_3NS+H)^+$, found: 294.0559.



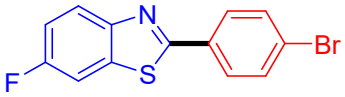
2-(4-bromophenyl)-6-chlorobenzo[*d*]thiazole (7d)

Product **7d** was prepared according to the general procedure (259 mg, 80% yield) and obtained as a solid.
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.03 – 7.92 (m, 3H), 7.86 (d, J = 2.1 Hz, 1H), 7.45 (ddt, J = 2.6, 6.5, 9.0 Hz, 3H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 167.2, 152.7, 137.5, 136.3, 131.8, 131.4, 129.5, 128.8, 127.4, 124.1, 121.4.
HRMS: ESI, $(M+H)^+$ m/z= 325.9219 calcd. for $(C_{13}H_7BrClNS+H)^+$, found: 325.9219.



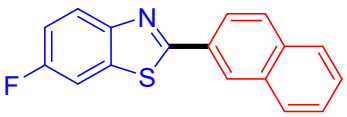
6-chloro-2-(4-methoxyphenyl)benzo[*d*]thiazole (7e)

Product **7e** was prepared according to the general procedure (217 mg, 79% yield) and obtained as a solid.
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.50 (dd, J = 1.8, 7.9 Hz, 1H), 7.98 (d, J = 8.7 Hz, 1H), 7.88 (d, J = 2.1 Hz, 1H), 7.51 – 7.40 (m, 2H), 7.18 – 7.10 (m, 1H), 7.07 (dd, J = 1.1, 8.4 Hz, 1H), 4.06 (d, J = 1.4 Hz, 3H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 163.7, 157.3, 150.8, 137.5, 132.2, 130.4, 129.5, 126.8, 123.6, 122.0, 121.3, 120.8, 111.8, 55.8
HRMS: ESI, $(M+H)^+$ m/z= 276.0249 calcd. for $(C_{14}H_{10}ClNOS+H)^+$, found: 276.0249.



2-(4-bromophenyl)-6-fluorobenzo[*d*]thiazole (7f)

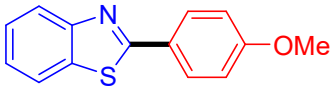
Product **7f** was prepared according to the general procedure (217 mg, 79% yield) and obtained as a solid.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.98 (dd, J = 4.8, 9.0 Hz, 1H), 7.92 – 7.84 (m, 2H), 7.64 – 7.56 (m, 2H), 7.60 – 7.51 (m, 1H), 7.22 (td, J = 2.6, 8.9 Hz, 1H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 166.5(d, J_{CF}=3.0Hz), 160.7(d, J_{CF}=246.4Hz), 150.8(d, J_{CF}=1.0Hz), 136.0(d, J_{CF}=11.1Hz), 132.3, 128.8, 125.6, 124.3(d, J_{CF}=9.0Hz), 115.2(d, J_{CF}=25.2Hz), 107.9(d, J_{CF}=27.2Hz).
^{19}F NMR (376 MHz, $CDCl_3$) δ -115.21.
HRMS: ESI, $(M+H)^+$ m/z= 309.9517 calcd. for $(C_{13}H_7BrFNS+H)^+$, found: 309.9516.



6-fluoro-2-(naphthalen-2-yl)benzo[*d*]thiazole (7g)

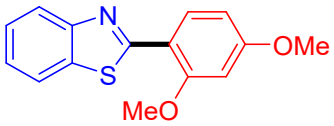
Product **7g** was prepared according to the general procedure (192 mg, 69% yield) and obtained as a solid.
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.93 (dq, J = 0.9, 8.7 Hz, 1H), 8.13 (dd, J = 4.8, 8.9 Hz, 1H), 8.00 (dd, J = 1.2, 8.3 Hz, 1H), 7.92 (ddd, J = 1.5, 7.7, 8.4 Hz, 2H), 7.69 – 7.61 (m, 2H), 7.61 – 7.52 (m, 2H), 7.29 (td, J = 2.6, 8.9 Hz, 1H).

^{13}C NMR (101 MHz, $CDCl_3$) δ 167.4(d, J_{CF}=3.0Hz), 160.7(d, J_{CF}=246.4Hz), 150.9(d, J_{CF}=2.0Hz), 136.5(d, J_{CF}=6.0Hz), 134.1, 131.3, 130.6, 130.6, 129.5, 128.6, 127.8, 126.7, 125.9, 125.1, 124.6(d, J_{CF}=9.0Hz), 115.0(d, J_{CF}=25.0Hz), 107.7(d, J_{CF}=27.0Hz).
^{19}F NMR (376 MHz, $CDCl_3$) δ -115.7.
HRMS: ESI, $(M+H)^+$ m/z= 280.0592 calcd. for $(C_{17}H_{10}FNS+H)^+$, found: 280.0591.



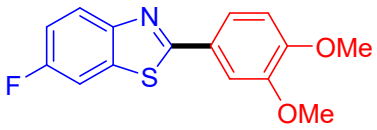
2-(4-methoxyphenyl)benzo[*d*]thiazole (9a)

Product **9a** was prepared according to the general procedure (187 mg, 78% yield) and obtained as a solid.
^{1}H NMR (400 MHz, $CDCl_3$) δ 7.99 – 7.85 (m, 3H), 7.82 – 7.74 (m, 1H), 7.38 (ddd, J = 1.3, 7.2, 8.3 Hz, 1H), 7.26 (ddd, J = 1.2, 7.2, 8.2 Hz, 1H), 6.95 – 6.87 (m, 2H), 3.78 (s, 3H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 168.0, 162.0, 154.3, 134.9, 129.2, 126.5, 126.3, 124.9, 122.9, 121.6, 114.5, 55.5.
HRMS: ESI, $(M+H)^+$ m/z= 242.0647 calcd. for $(C_{14}H_{11}NOS+H)^+$, found: 242.0646.



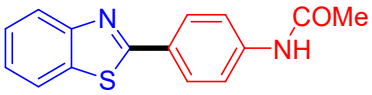
2-(2,4-dimethoxyphenyl)benzo[*d*]thiazole (9b)

Product **9b** was prepared according to the general procedure (203 mg, 75% yield) and obtained as a solid.
^{1}H NMR (400 MHz, $CDCl_3$) δ 8.46 (d, J = 8.8 Hz, 1H), 8.04 (dt, J = 1.0, 8.2 Hz, 1H), 7.90 (ddd, J = 0.7, 1.3, 8.0 Hz, 1H), 7.50 – 7.42 (m, 1H), 7.33 (ddd, J = 1.2, 7.2, 8.1 Hz, 1H), 6.67 (dd, J = 2.4, 8.8 Hz, 1H), 6.59 (d, J = 2.4 Hz, 1H), 4.04 (s, 3H), 3.89 (s, 3H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 163.4, 163.0, 158.7, 152.3, 135.7, 130.9, 126.9, 125.9, 124.2, 122.4, 121.2, 115.8, 106.0, 98.6, 55.8.
HRMS: ESI, $(M+H)^+$ m/z= 272.0741 calcd. for $(C_{15}H_{13}NO_2S+H)^+$, found: 272.0741.



2-(3,4-dimethoxyphenyl)-6-fluorobenzo[*d*]thiazole (PMX 610 Analog)(12)

^{1}H NMR (400 MHz, $CDCl_3$) δ 7.96 (dd, J = 4.8, 8.9 Hz, 1H), 7.67 (d, J = 2.0 Hz, 1H), 7.61 – 7.52 (m, 2H), 7.20 (td, J = 2.6, 8.9 Hz, 1H), 6.95 (d, J = 8.3 Hz, 1H), 4.02 (s, 3H), 3.96 (s, 3H).
^{13}C NMR (101 MHz, $CDCl_3$) δ 167.6(d, J_{CF}=3.0Hz), 160.3(d, J_{CF}=246.4Hz), 150.9, 150.7(d, J_{CF}=1.0Hz), 149.4, 135.8(d, J_{CF}=12.1Hz), 126.4, 123.6(d, J_{CF}=9.0Hz), 121.0, 114.7(d, J_{CF}=25.2Hz), 111.0, 109.6, 107.7(d, J_{CF}=27.2Hz), 56.1, 56.0.
HRMS: ESI, $(M+H)^+$ m/z= 290.0650 calcd. for $(C_{15}H_{12}FNO_2S+H)^+$, found: 290.0650.



***N*-(4-(benzo[*d*]thiazol-2-yl)phenyl)acetamide (15)**

^{1}H NMR (400 MHz, DMSO) δ 10.29 (s, 1H), 8.12 – 7.99 (m, 2H), 8.04 – 7.97 (m, 2H), 7.80 – 7.72 (m, 2H), 7.52 (ddd, *J* = 1.3, 7.2, 8.3 Hz, 1H), 7.42 (ddd, *J* = 1.2, 7.2, 8.3 Hz, 1H), 2.09 (s, 3H).
^{13}C NMR (101 MHz, DMSO) δ 169.1, 167.2, 153.7, 142.2, 134.4, 128.1, 127.6, 126.7, 125.4, 122.7, 122.4, 119.4, 119.3, 24.2.
HRMS: ESI, $(M+H)^+$ m/z= 268.0700 calcd. for $(C_{15}H_{12}NO_2S+H)^+$, found: 269.0737.

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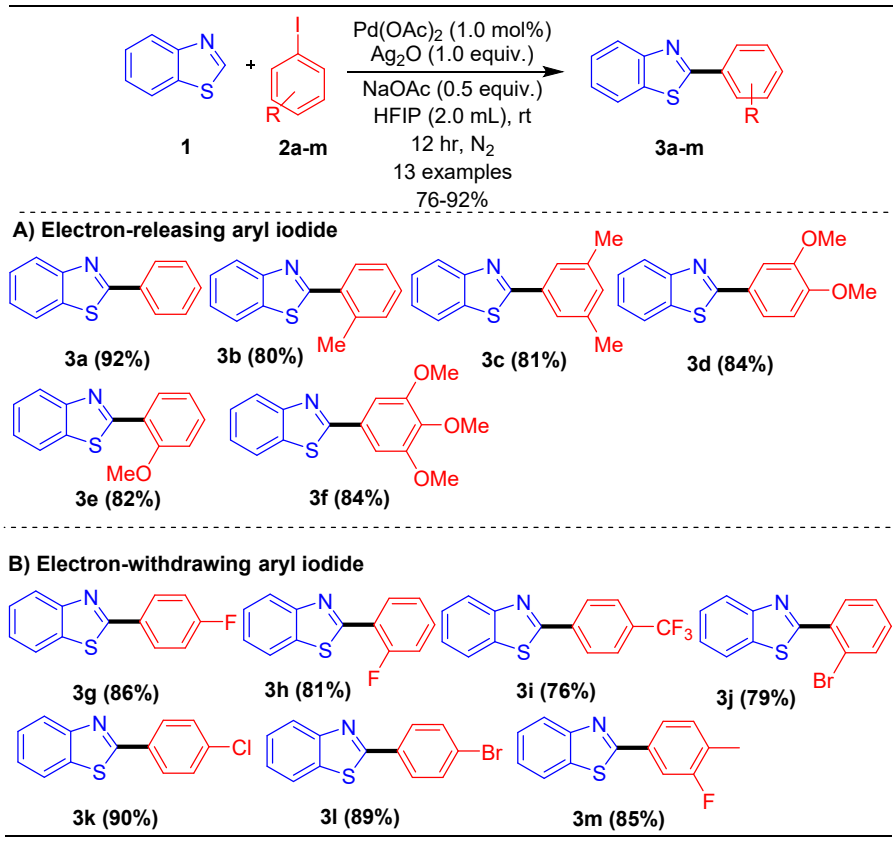
1) Karade, N. N.; Tiwari, G. B.; Huple, D. B.; Siddiqui, T. A. J. *J. Chem. Res.*2006, 366-368.
2) Kim, Heon; Kim, Yoosik; Kharbash, Raisa; Kwon, Se Hyun; Chang, Yeongrae; Jang.Photopolymer composition, hologram recording medium, optical element, and holog. recording method. WO 2020122678 A1, 2020.
3) Ren-Jin Tang.:Thierry Milcent.:Benoit."Crousse, Regioselective Halogenation of Arenes and Heterocycles in Hexafluoroisopropanol. *J. Org. Chem.* 2018, 83, 2, 930–938.

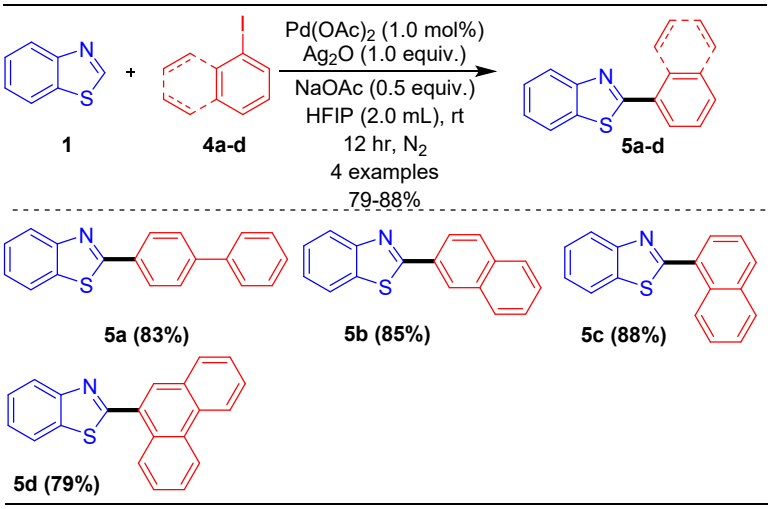
Schemes with footnotes

Scheme 2: Substrate scope for room temperature C—H functionalization of benzothiazoles.[a]



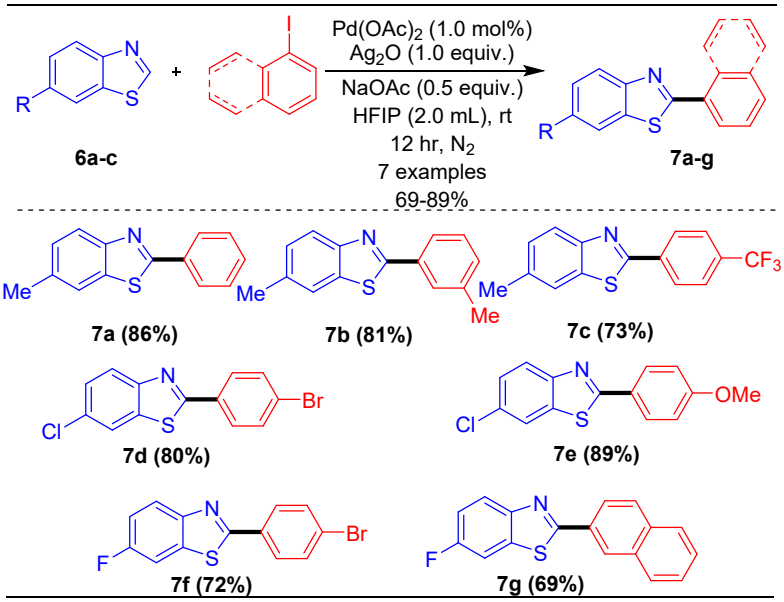
[a]$Pd(OAc)_2$ (1.0 mol%), Ag_2O (1.0 mmol), Base (0.5 mmol), iodoarenes (1.0 mmol) in hexaflouro-2- propanol (2.0 mL), followed by benzothiazole (1.0 mmol) and reaction stirred at 30 °C (rt) for 12 hr.

Scheme 3: Room temperature C–H functionalization of benzothiazoles using polyaromatics.[a]



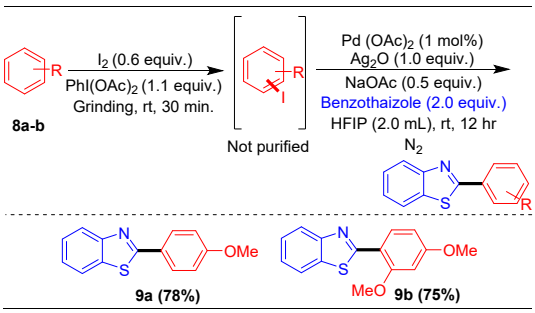
[a] $Pd(OAc)_2$ (1.0 mol%), Ag_2O (1.0 mmol), Base (0.5 mmol), iodoarenes (1.0 mmol) in hexaflouro-2- propanol (2.0 mL), followed by benzothiazole (1.0 mmol) and reaction stirred at 30 °C (rt) for 12 hr.

Scheme 4: Substrate scope for room temperature C—H functionalization of substituted benzothiazoles.[a]



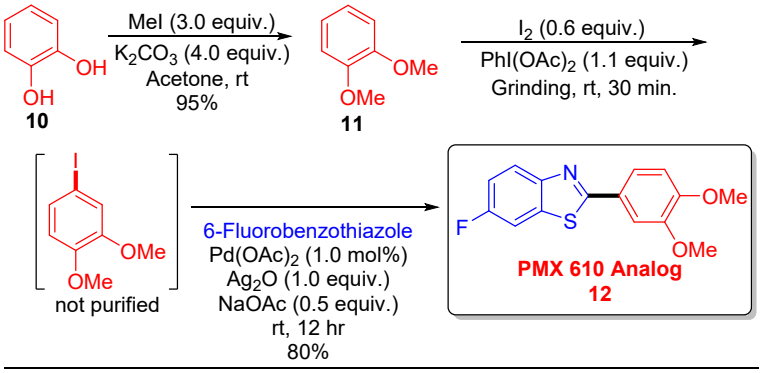
[a] $Pd(OAc)_2$ (1.0 mol%), Ag_2O (1.0 mmol), Base (0.5 mmol), iodoarenes (1.0 mmol) in hexaflouro-2- propanol (2.0 mL), followed by substituted benzothiazole (1.0 mmol) and reaction stirred at 30 °C (rt) for 12 hr.

Scheme 5: Sequential HFIP-promoted iodination/Pd-catalyzed C—H functionalization strategy.[a,b]



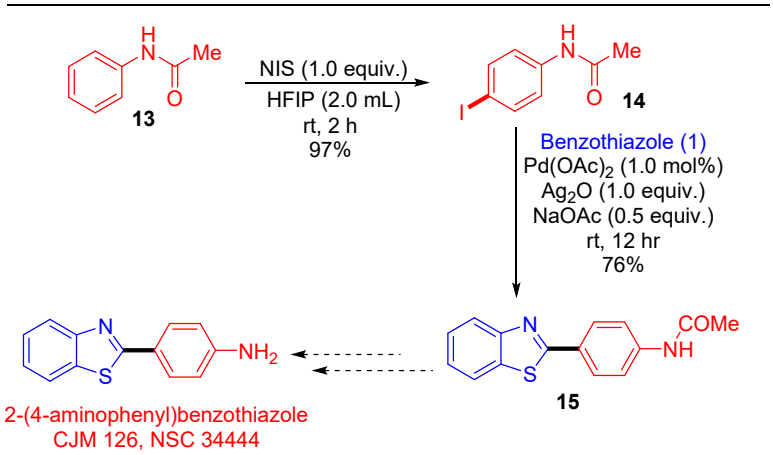
[a] arene (1.0 mmol), $PhI(OAc)_2$ (1.1 mmol), I_2 (0.6 mmol), grinding at 30°C (rt) for 30 mins, without purification solid transferred to the next process; [b] $Pd(OAc)_2$ (1.0 mol%), Ag_2O (1.0 mmol), Base (0.5 mmol), iodoarenes (1.0 mmol) in hexaflouro-2- propanol (2.0 mL), followed by benzothiazole (1.0 mmol) and reaction stirred at 30 °C (rt) for 12 hr.

Scheme 6: Synthesis of PMX 610 analog (antitumor agent).[a,b,c]



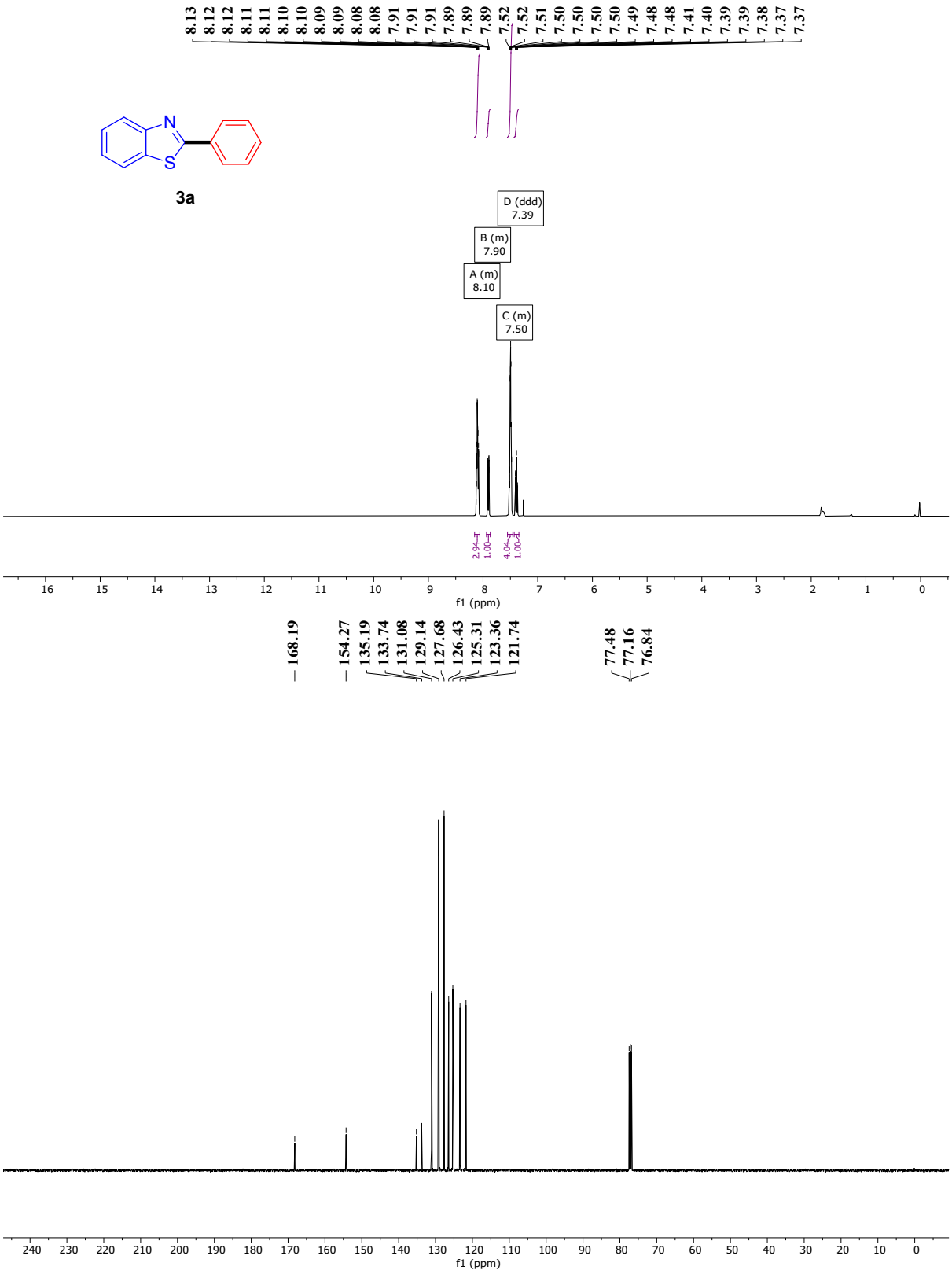
[a] catechol (1.0 mmol), MeI (3.0 mmol), K_2CO_3 (4.0 mmol), acetone (6.0 mL) stirrer at 30 °C (rt) for 12 hr. product isolated by column chromatography; [b] arene (1.0 mmol), $PhI(OAc)_2$ (1.1 mmol), I_2 (0.6 mmol), grinding at 30 °C (rt) for 30 mins, without purification solid transferred to the next process; [a] $Pd(OAc)_2$ (1.0 mol%), Ag_2O (1.0 mmol), Base (0.5 mmol), iodoarenes (1.0 mmol) in hexaflouro-2- propanol (2.0 mL), followed by benzothiazole (1.0 mmol) and reaction stirred at 30 °C (rt) for 12 hr (isolated yields).

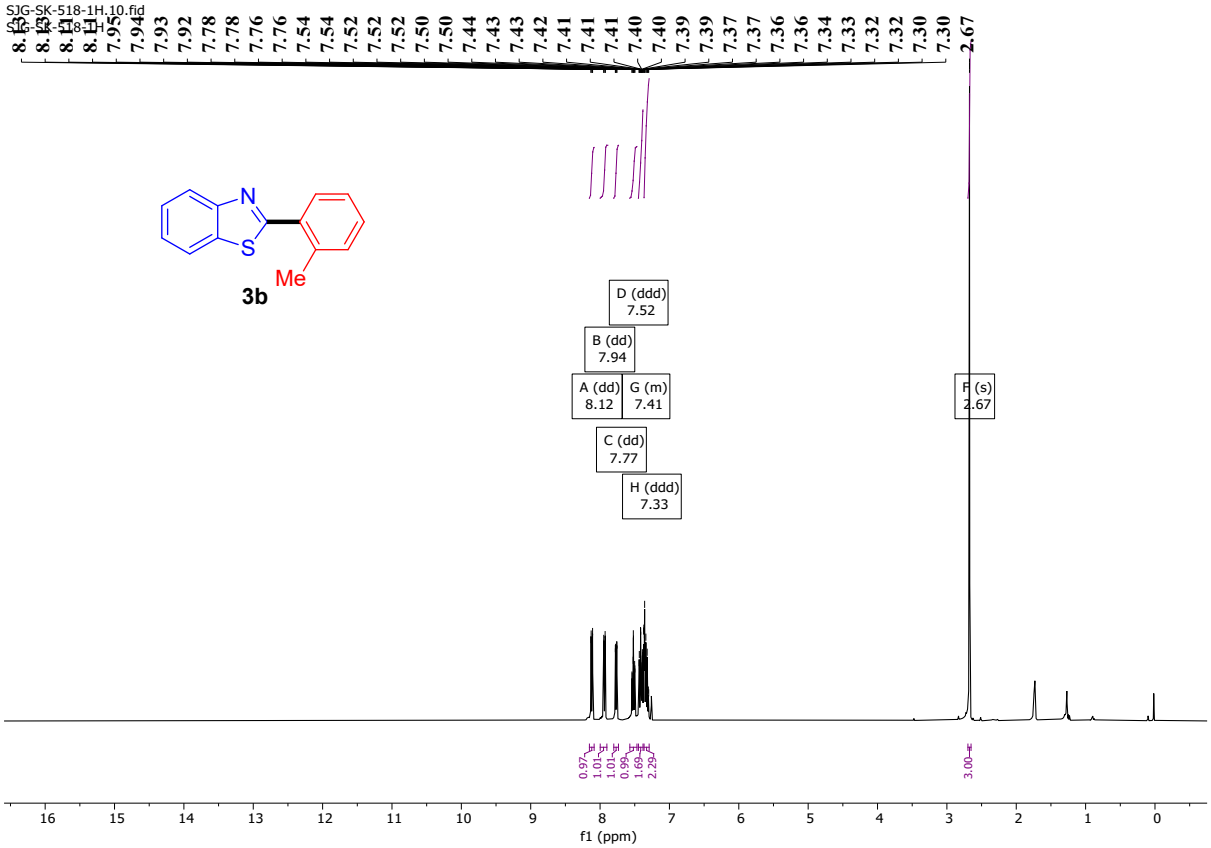
Scheme 7: Synthesis of CJM126 precursor (NSC 3444).[a,b]

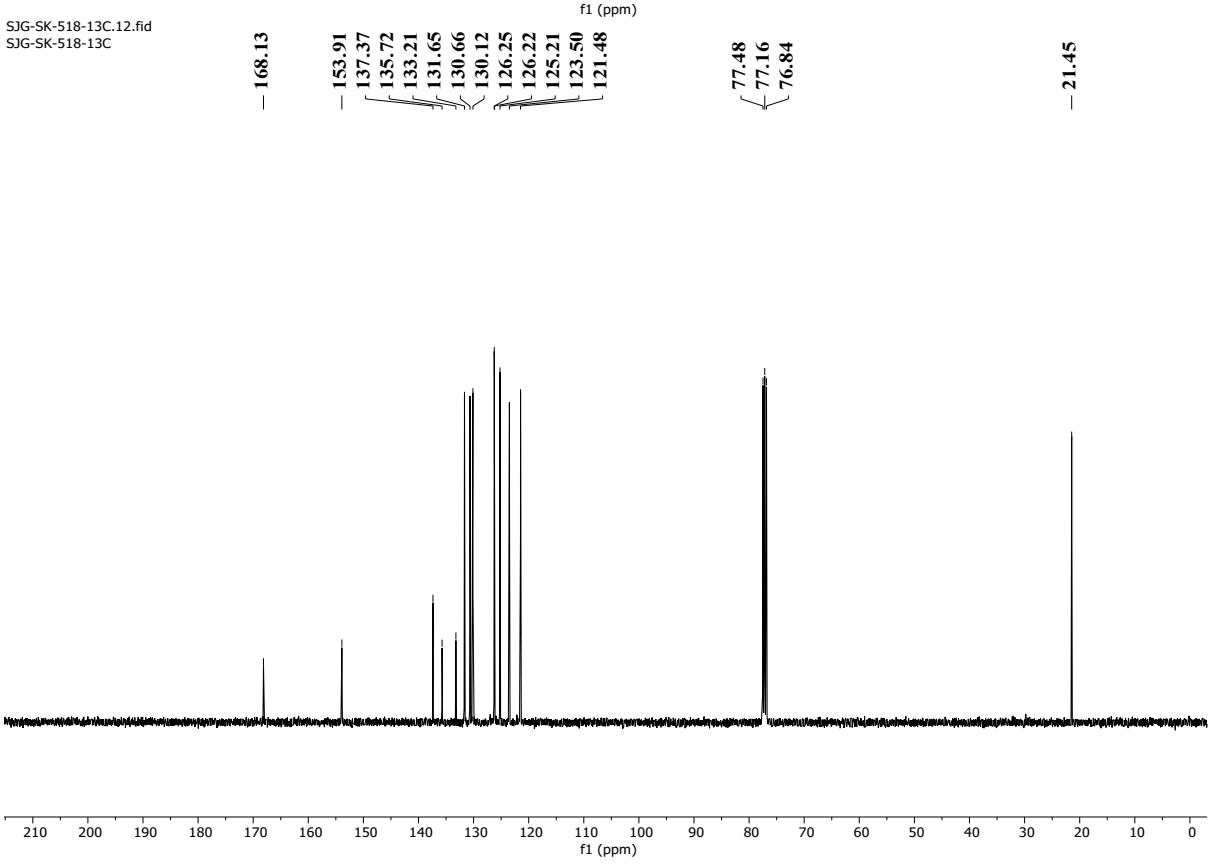


[b] acetanalide (1.0 mmol), NIS (1.0 mmol), HFIP (2.0 mL) added and reaction stirred at 30 °C (rt) for 2 hr, product isolated by column chromatography; [a] $Pd(OAc)_2$ (1.0 mol%), Ag_2O (0.97 mmol), Base (0.5 mmol), 4-iodoacetanilide (0.97 mmol) in hexaflouro-2-propanol (2.0 mL), followed by benzothiazole (0.97 mmol) and reaction stirred at 30 °C (rt) for 12 hr (isolated yields).

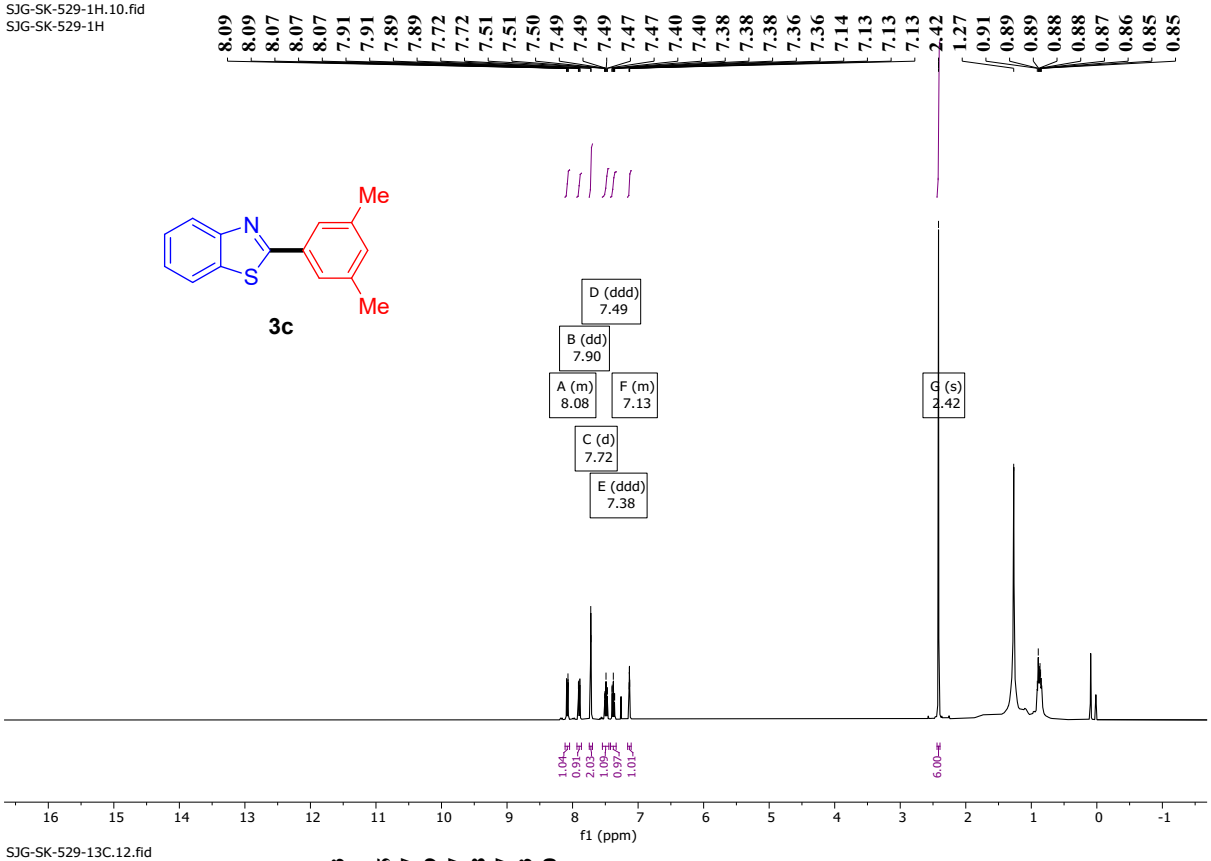
4. ^{1}H NMR,^{13}C NMR and ^{19}F NMR Spectra



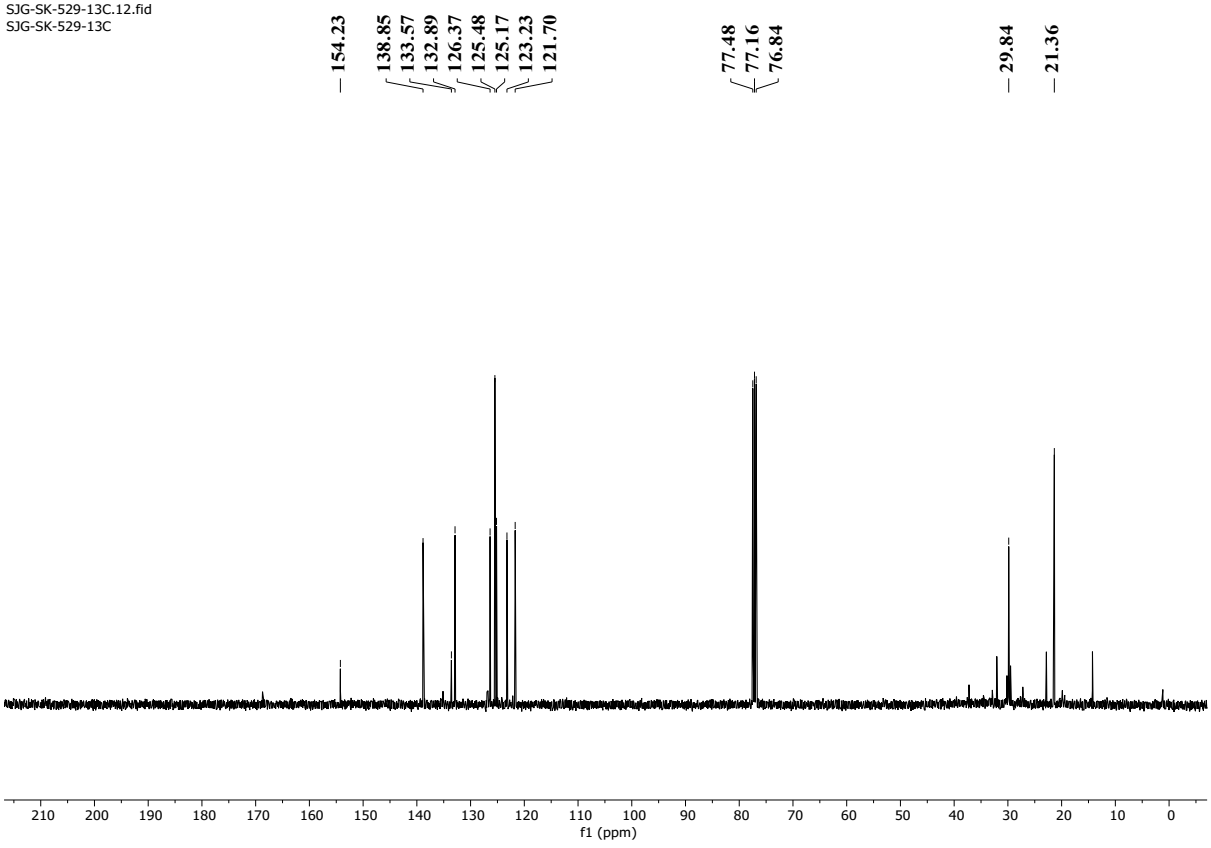

SJG-SK-518-1H.10.fid
8.13
8.12
8.11
7.95
7.94
7.93
7.92
7.78
7.78
7.76
7.76
7.54
7.54
7.52
7.52
7.52
7.50
7.50
7.44
7.43
7.43
7.42
7.41
7.41
7.41
7.40
7.40
7.39
7.39
7.37
7.37
7.36
7.36
7.34
7.33
7.32
7.32
7.30
7.30
2.67
N
S
Me
3b
D (ddd) 7.52
B (dd) 7.94
A (dd) 8.12
G (m) 7.41
C (dd) 7.77
H (ddd) 7.33
F (s) 2.67
0.97
1.01
1.01
0.99
1.68
2.29
3.00
16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
f1 (ppm)

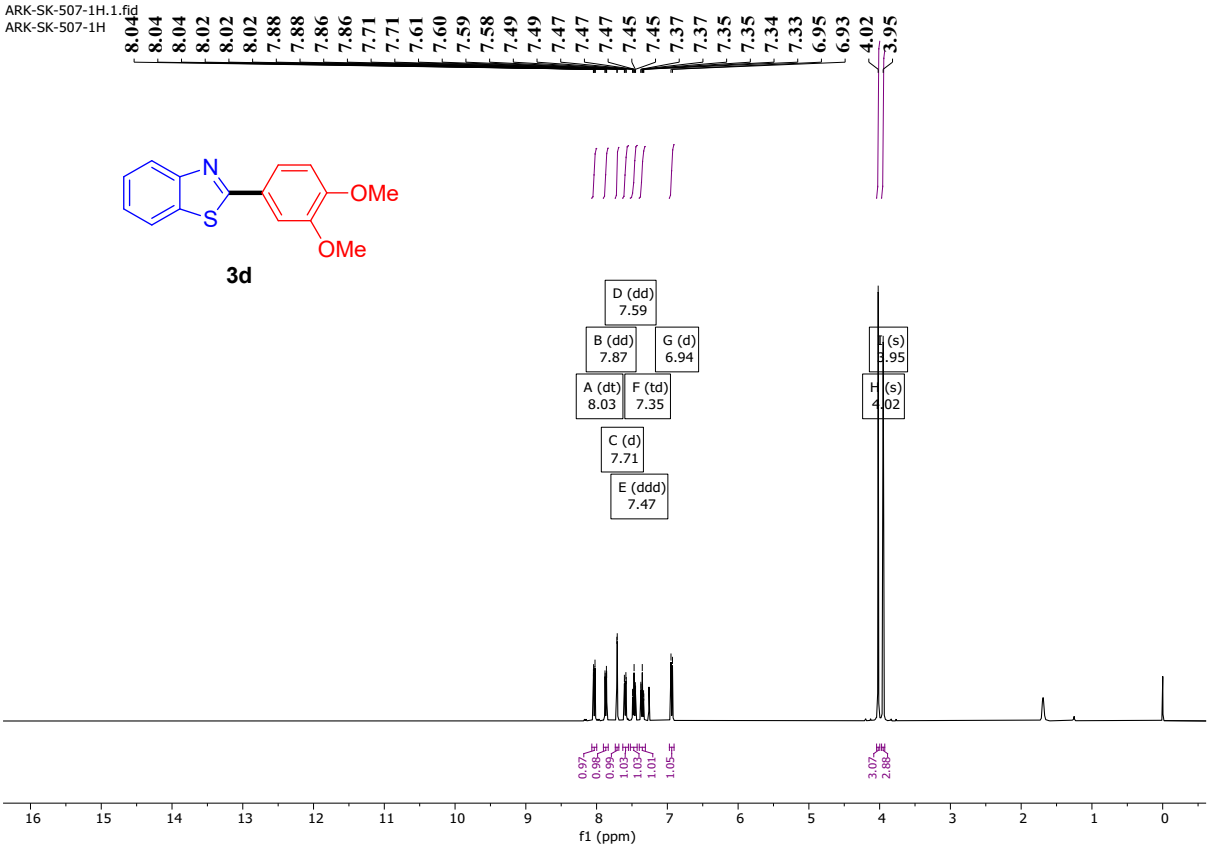

SJG-SK-518-13C.12.fid
SJG-SK-518-13C
168.13
153.91
137.37
135.72
133.21
131.65
130.66
130.12
126.25
126.22
125.21
123.50
121.48
77.48
77.16
76.84
21.45
210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)

SJG-SK-529-1H.10.fid
SJG-SK-529-1H



SJG-SK-529-13C.12.fid
SJG-SK-529-13C




ARK-SK-507-1H.1.fid
ARK-SK-507-1H
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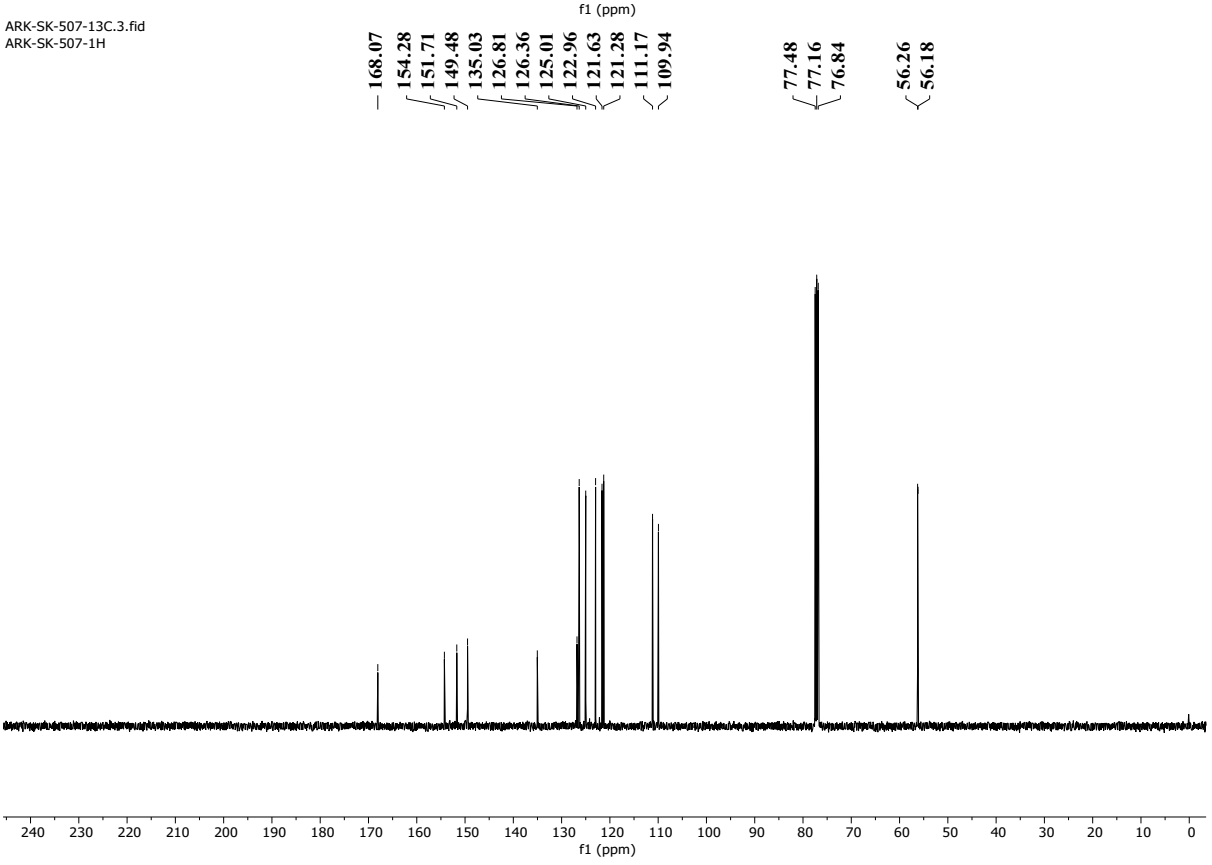
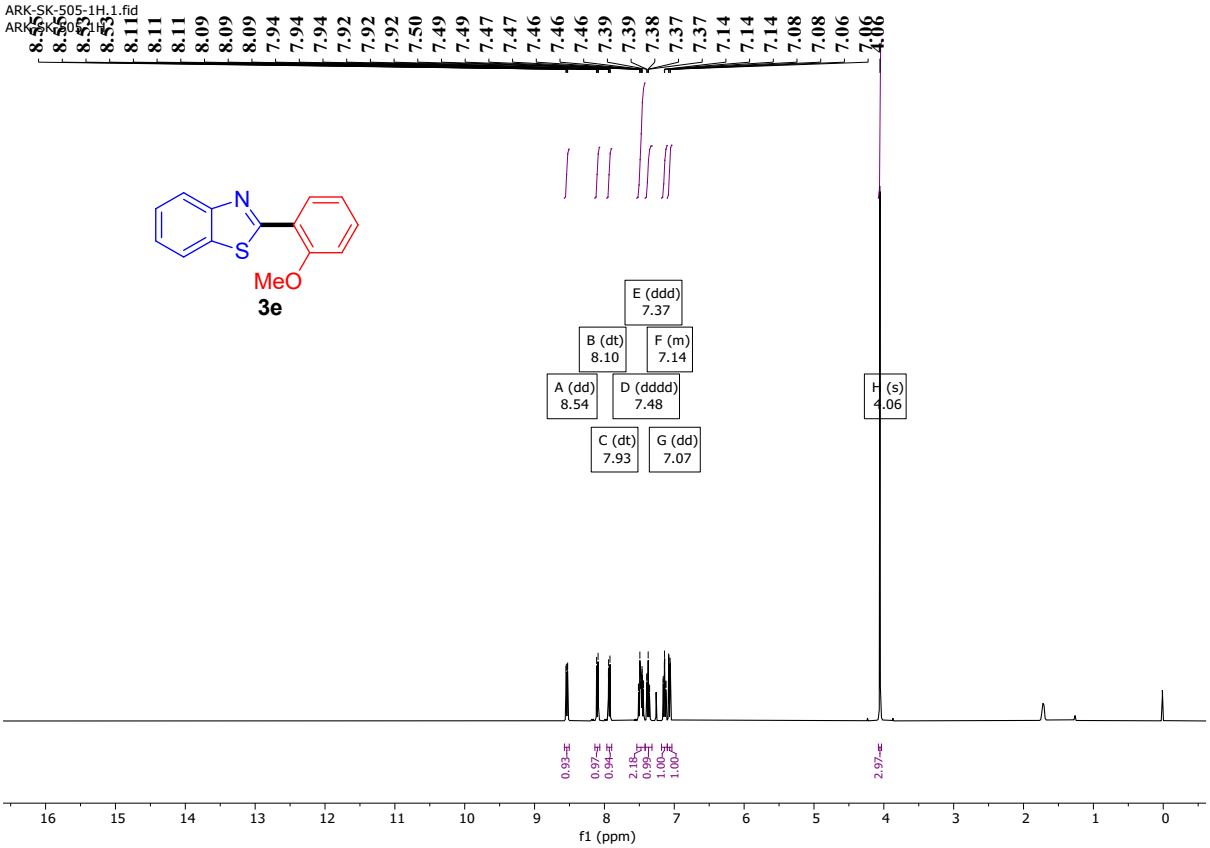
N
S
OMe
OMe
3d
D (dd) 7.59
B (dd) 7.87
G (d) 6.94
I (s) 3.95
A (dt) 8.03
F (td) 7.35
H (s) 4.02
C (d) 7.71
E (ddd) 7.47
0.97 0.98 0.99 1.03 1.03 1.01 1.05 3.07 2.86
16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
f1 (ppm)


ARK-SK-507-13C.3.fid
ARK-SK-507-1H
168.07 154.28 151.71 149.48 135.03 126.81 126.36 125.01 122.96 121.63 121.28 111.17 109.94
77.48 77.16 76.84
56.26 56.18
240 230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


ARK-SK-505-1H.1.fid
ARK-SK-505-1H
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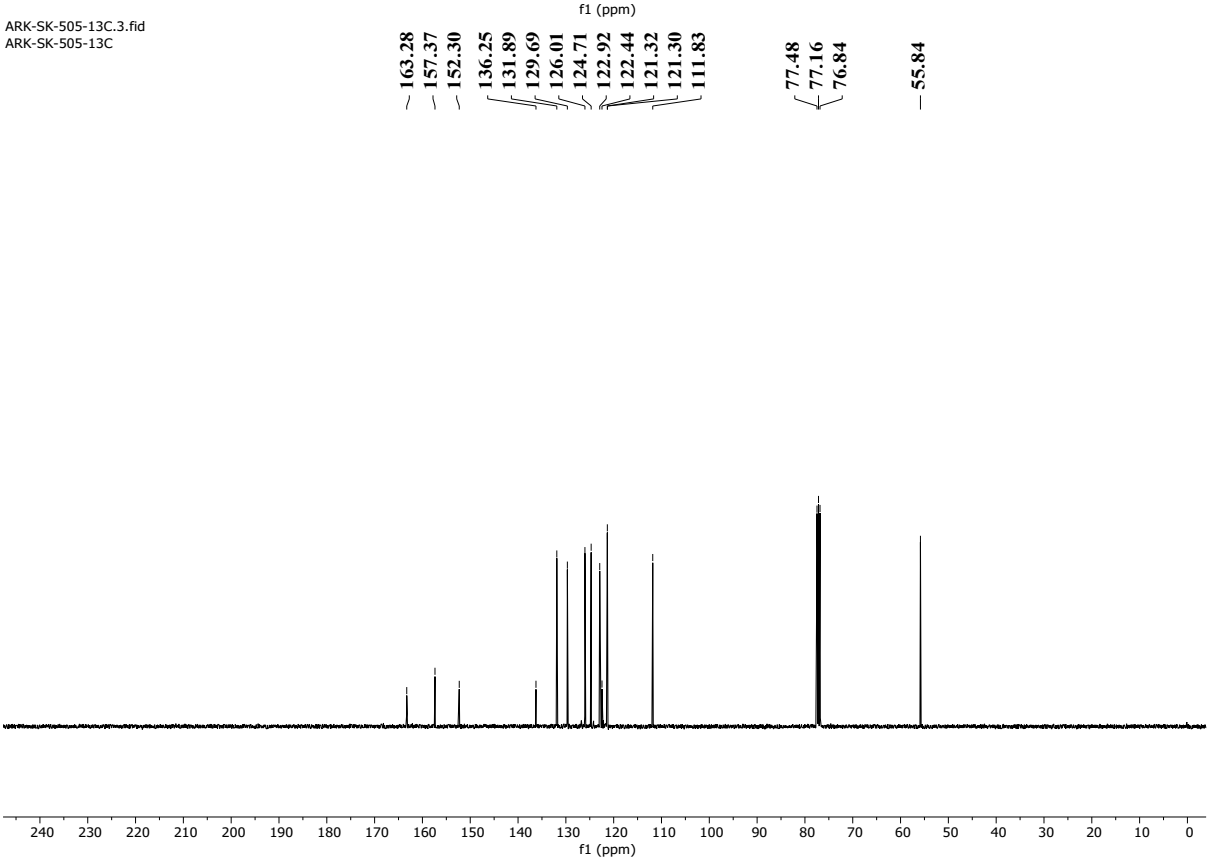
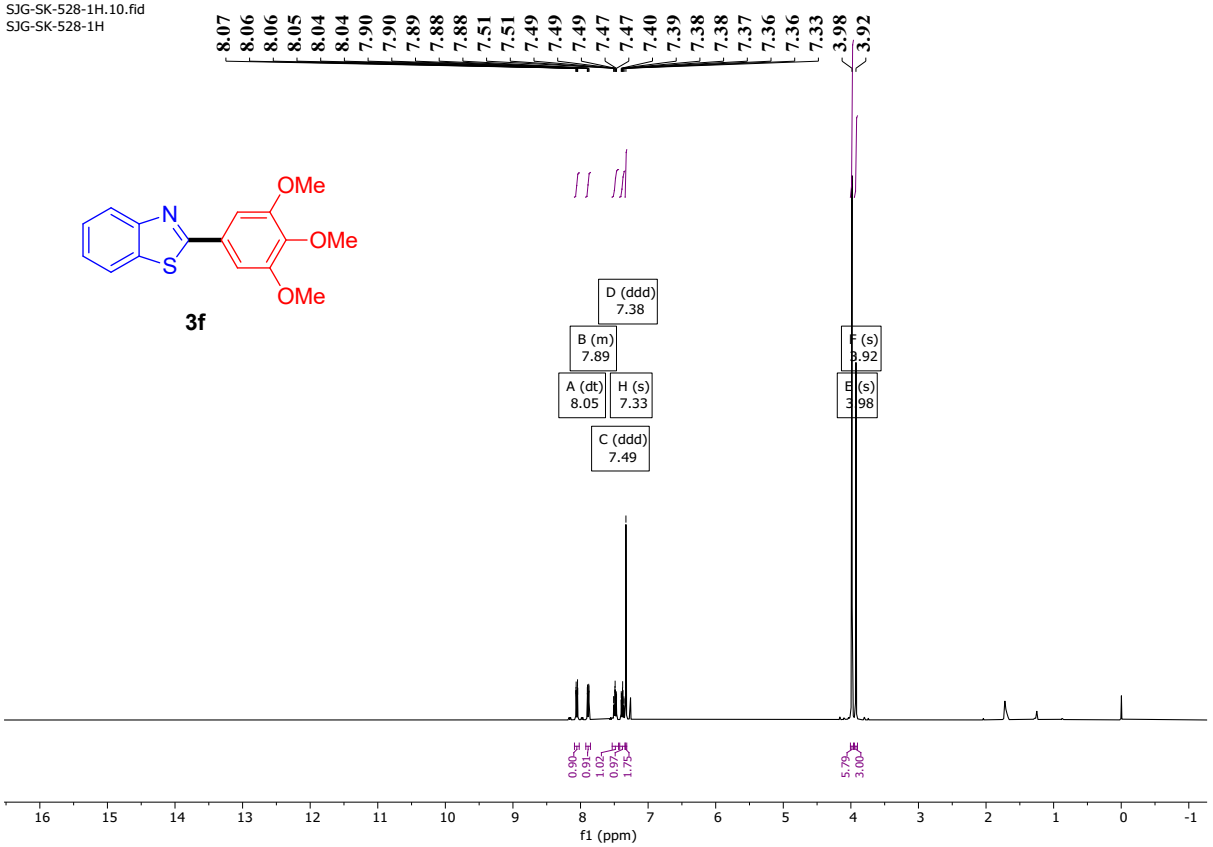
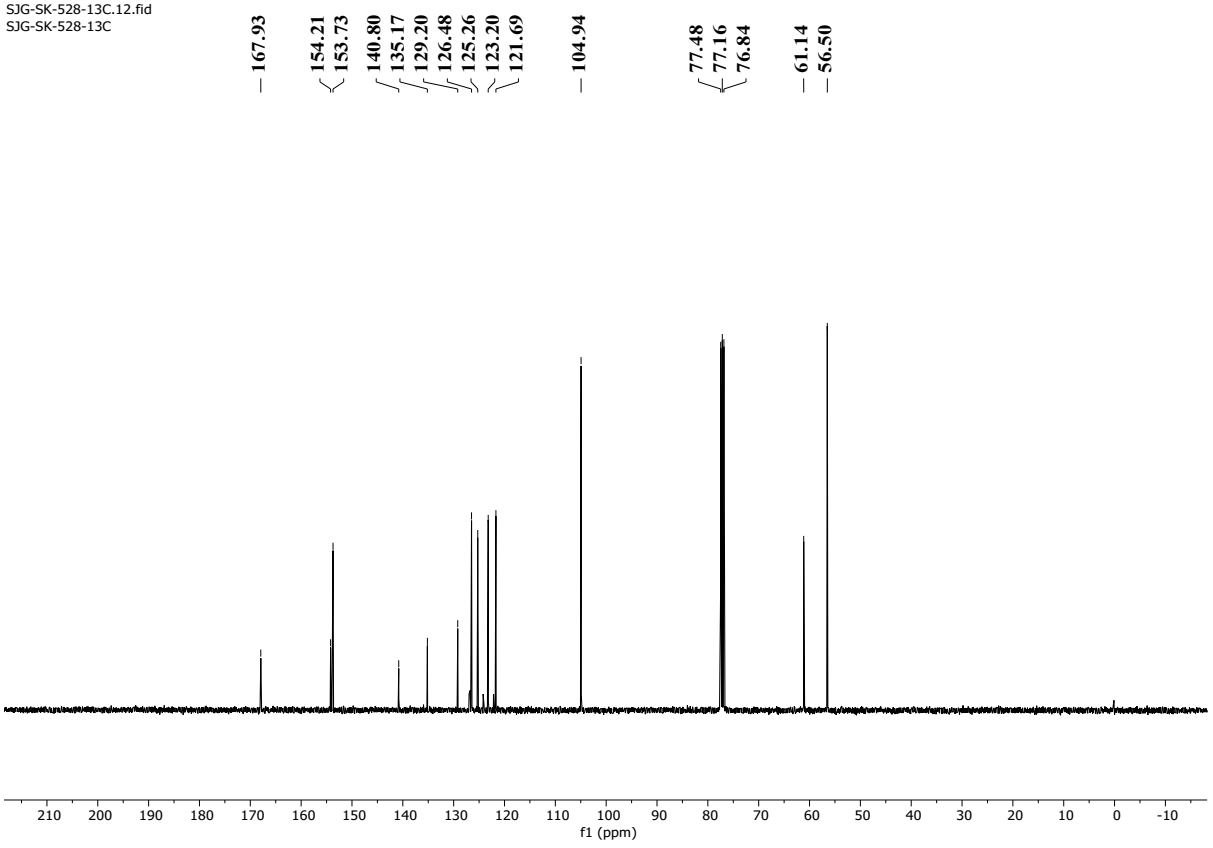
8.54
8.11
8.11
8.11
8.09
8.09
8.09
7.94
7.94
7.94
7.92
7.92
7.92
7.50
7.49
7.49
7.47
7.47
7.46
7.46
7.46
7.39
7.39
7.38
7.37
7.37
7.14
7.14
7.14
7.08
7.08
7.06
7.06
4.06
N
S
MeO
3e
E (ddd)
7.37
B (dt)
8.10
F (m)
7.14
A (dd)
8.54
D (dddd)
7.48
H (s)
4.06
C (dt)
7.93
G (dd)
7.07
0.93
0.97
0.94
2.18
0.99
1.00
1.00
2.97
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
f1 (ppm)


ARK-SK-505-13C.3.fid
ARK-SK-505-13C
163.28
157.37
152.30
136.25
131.89
129.69
126.01
124.71
122.92
122.44
121.32
121.30
111.83
77.48
77.16
76.84
55.84
240
230
220
210
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
f1 (ppm)

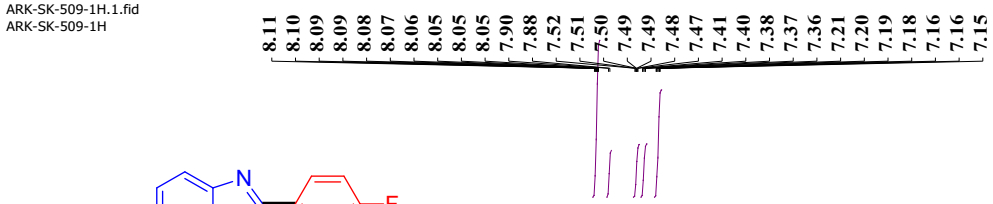
SJG-SK-528-1H.10.fid
SJG-SK-528-1H

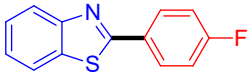


SJG-SK-528-13C.12.fid
SJG-SK-528-13C

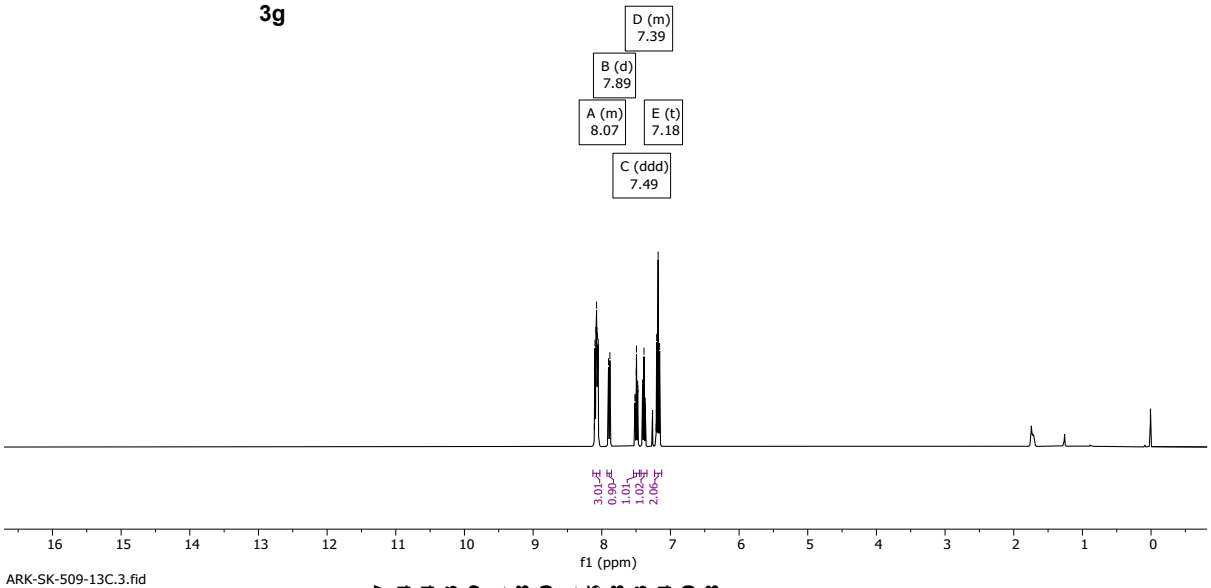


ARK-SK-509-1H.1.fid
ARK-SK-509-1H

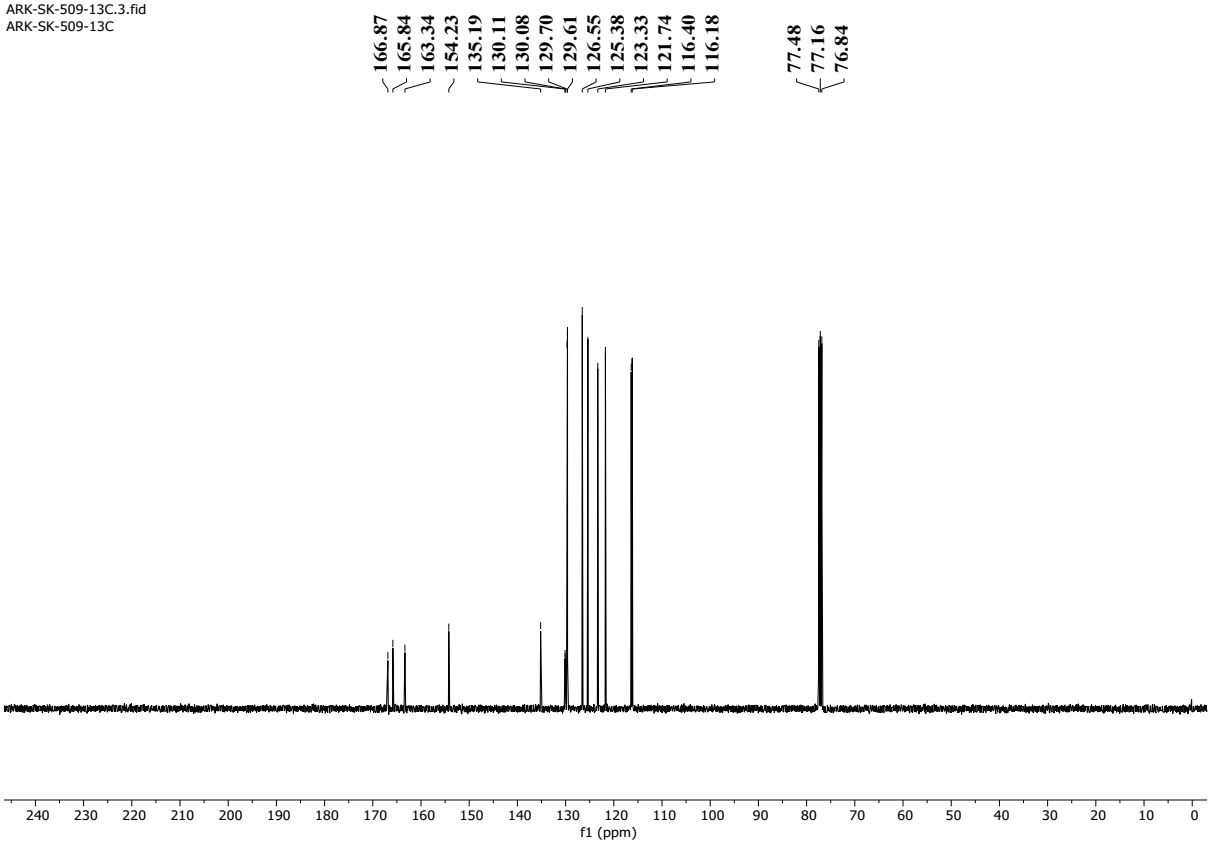




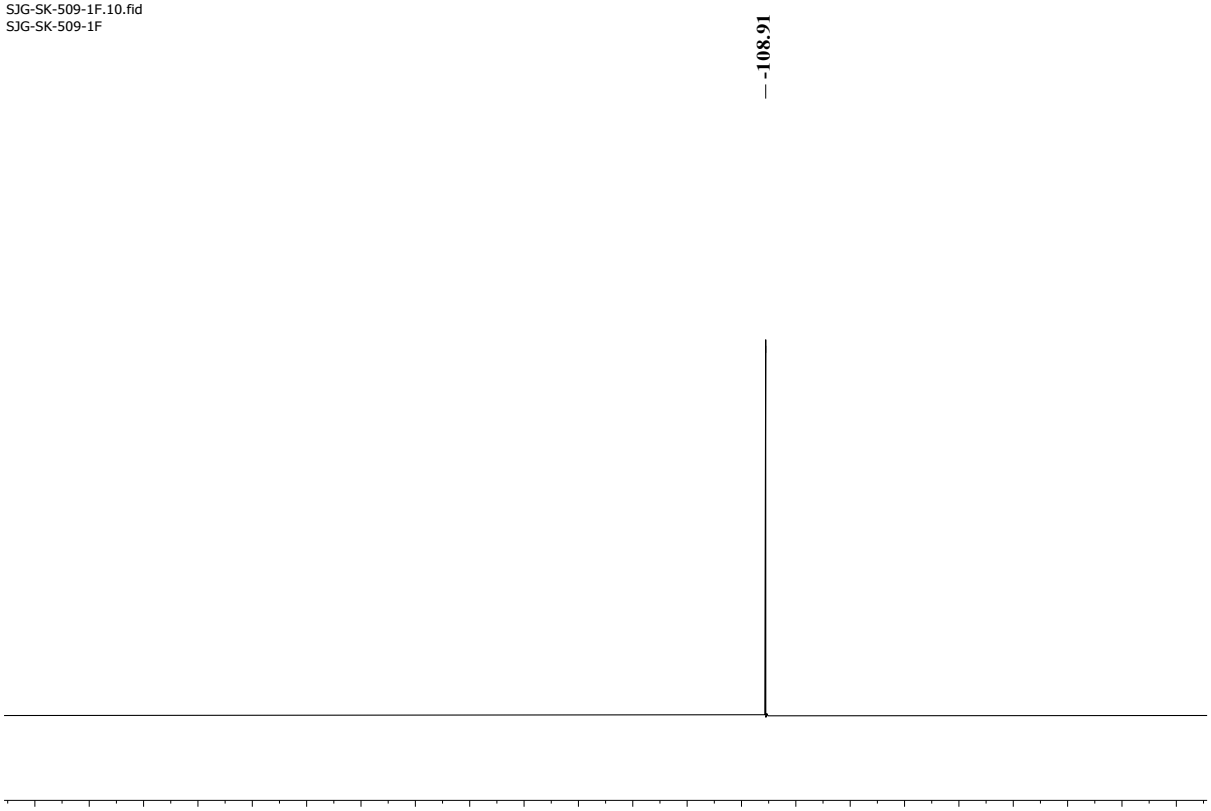
3g



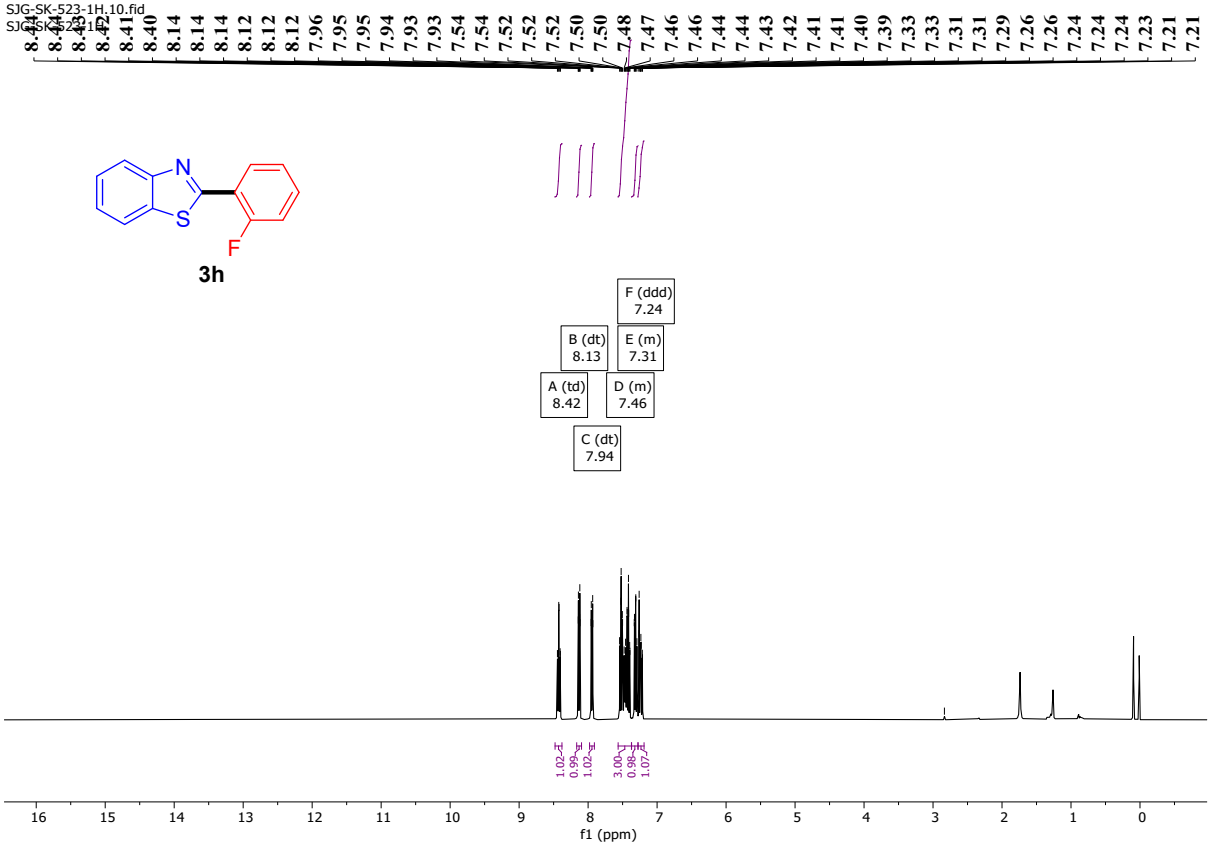
ARK-SK-509-13C.3.fid
ARK-SK-509-13C



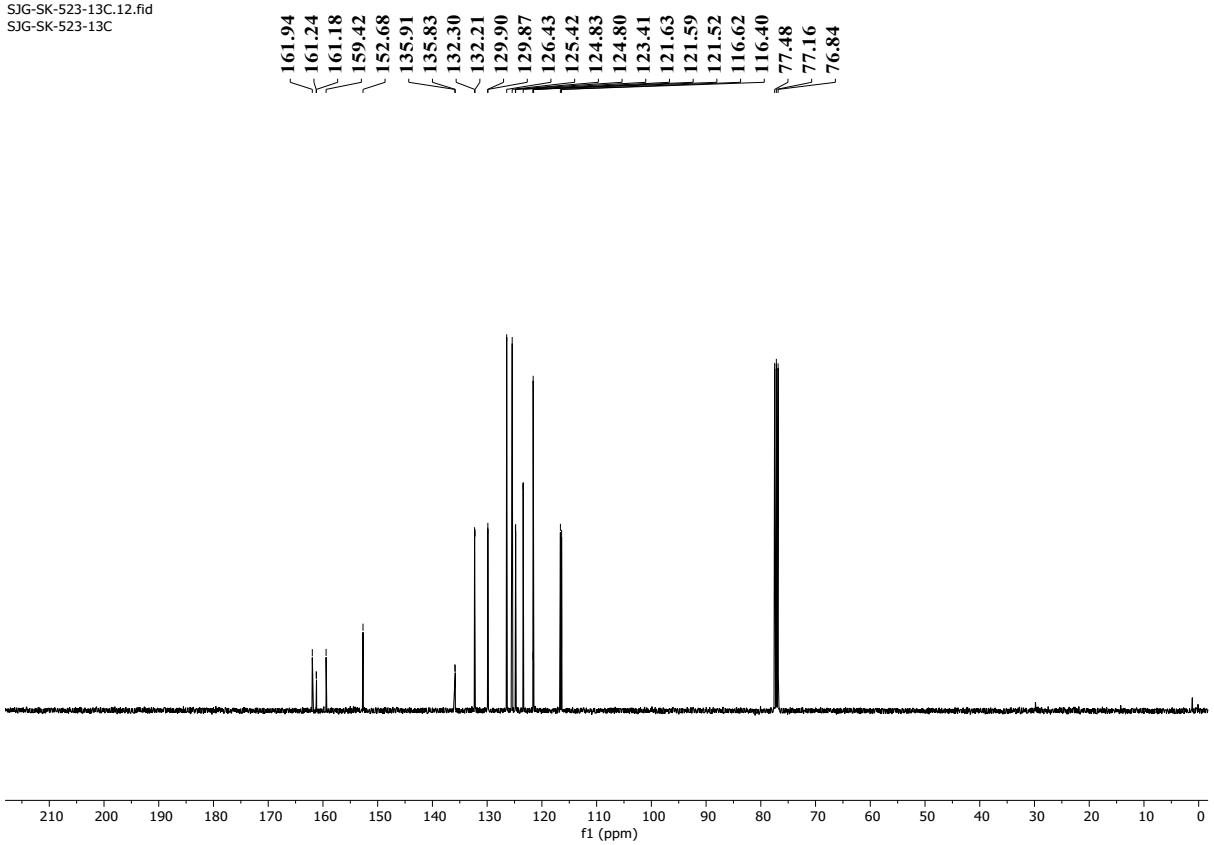
SJG-SK-509-1F.10.fid
SJG-SK-509-1F



SJG-SK-523-1H.10.fid
SJG-SK-523-1H



SJG-SK-523-13C.12.fid
SJG-SK-523-13C



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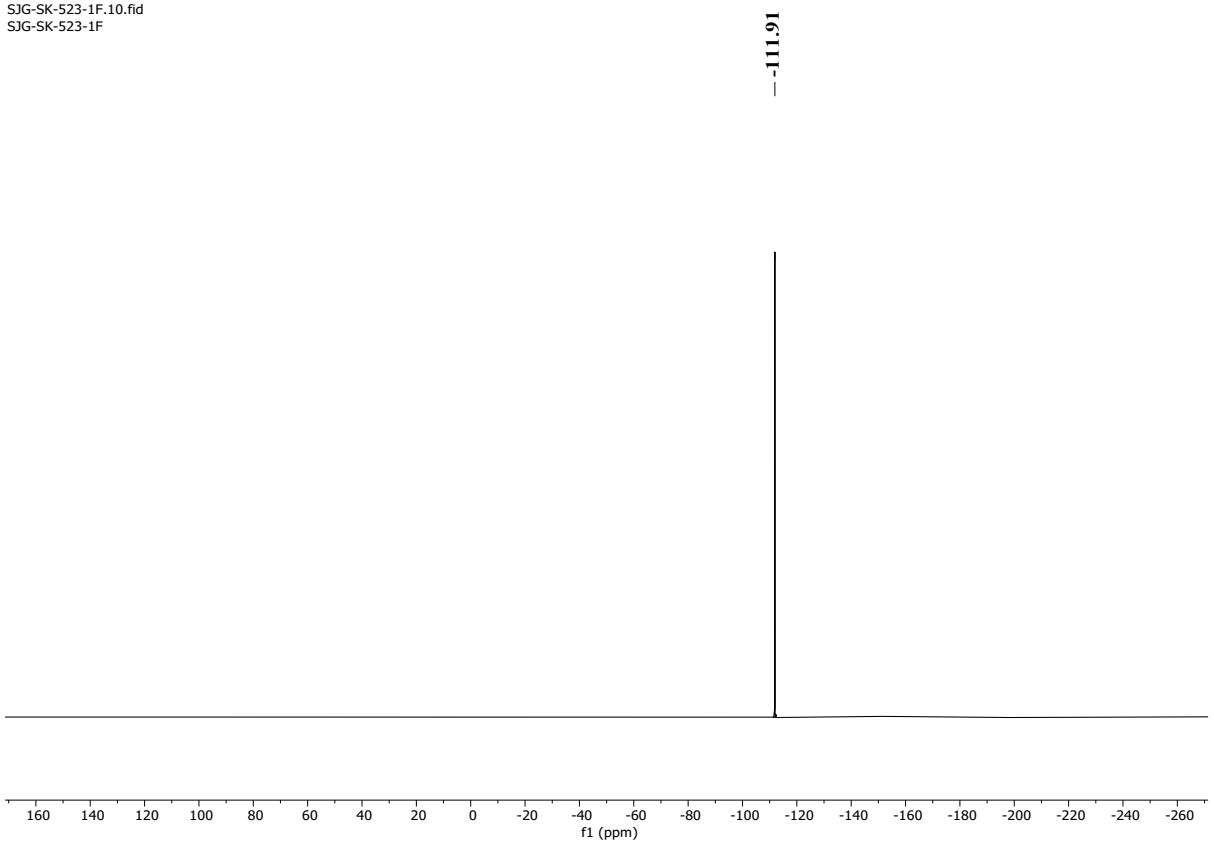
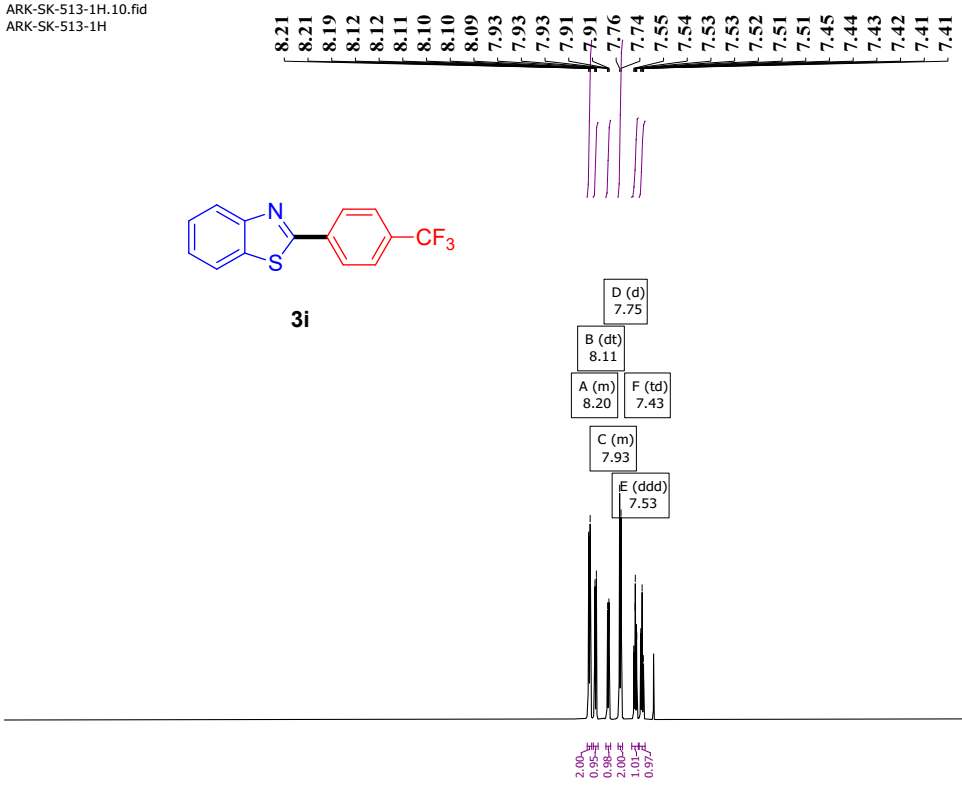
SJG-SK-523-1F

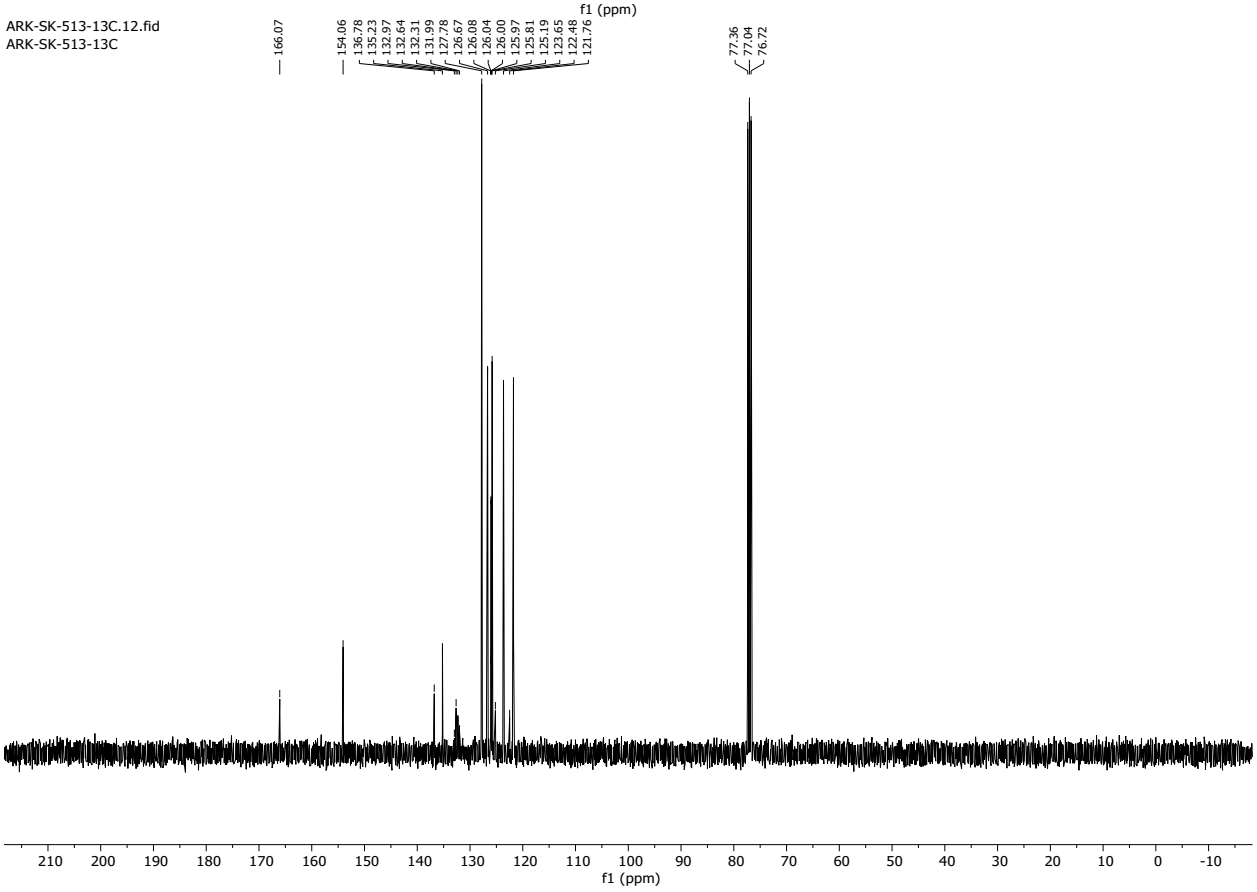


ARK-SK-513-1H.10.fid
ARK-SK-513-1H

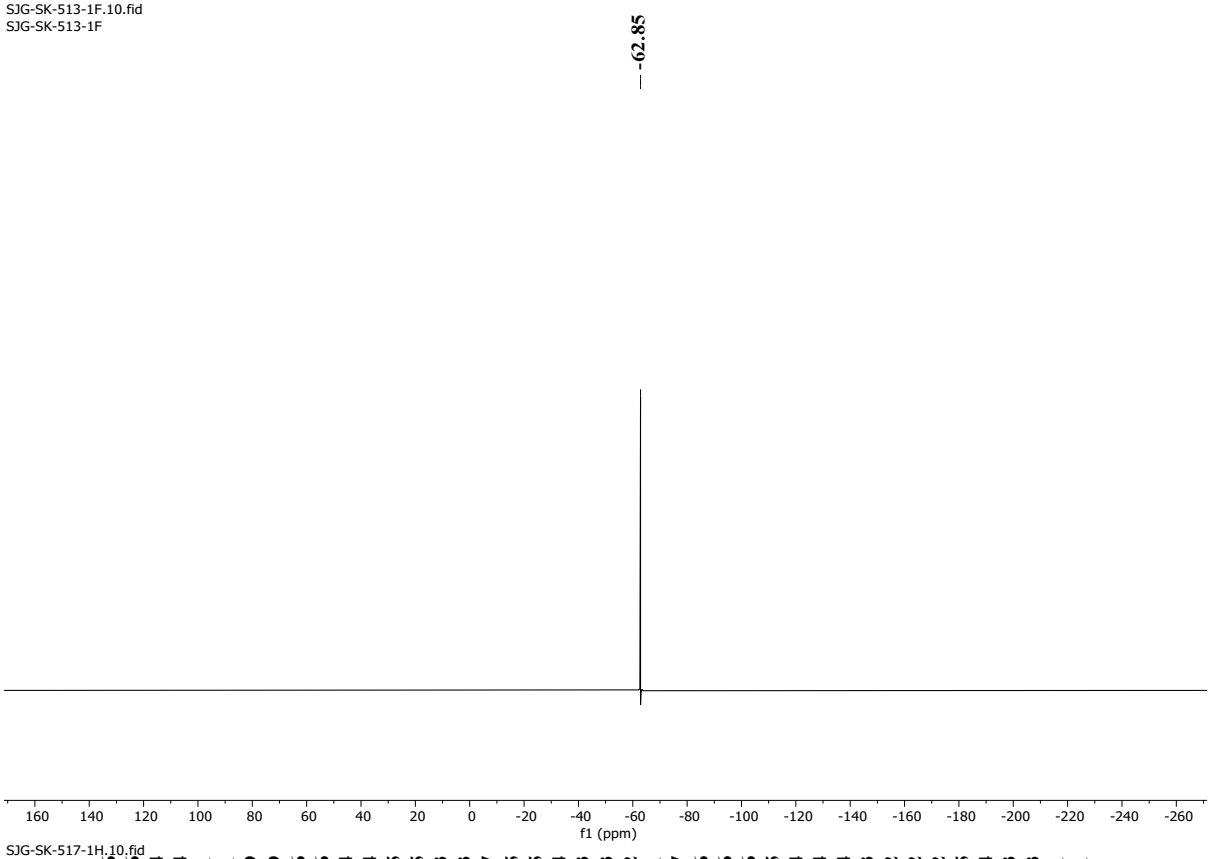


3i

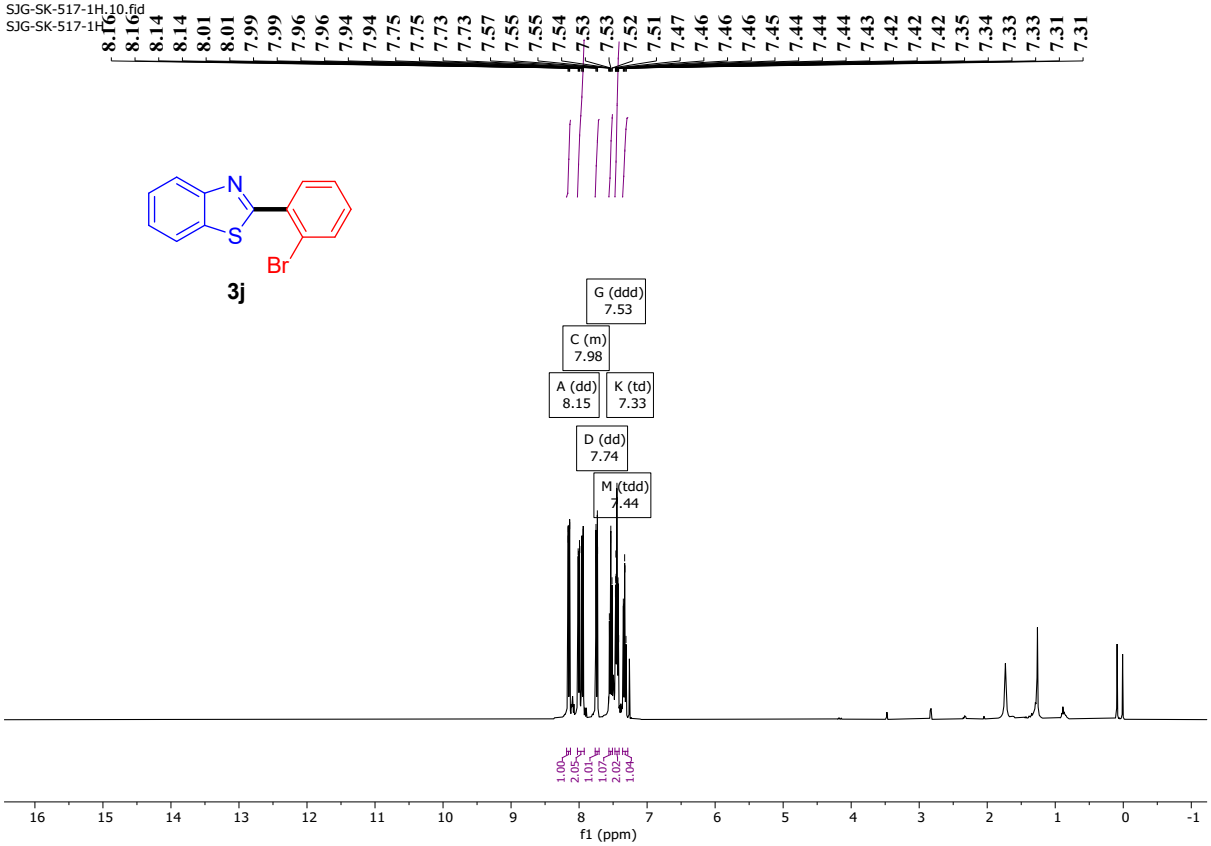
ARK-SK-513-13C.12.fid
ARK-SK-513-13C



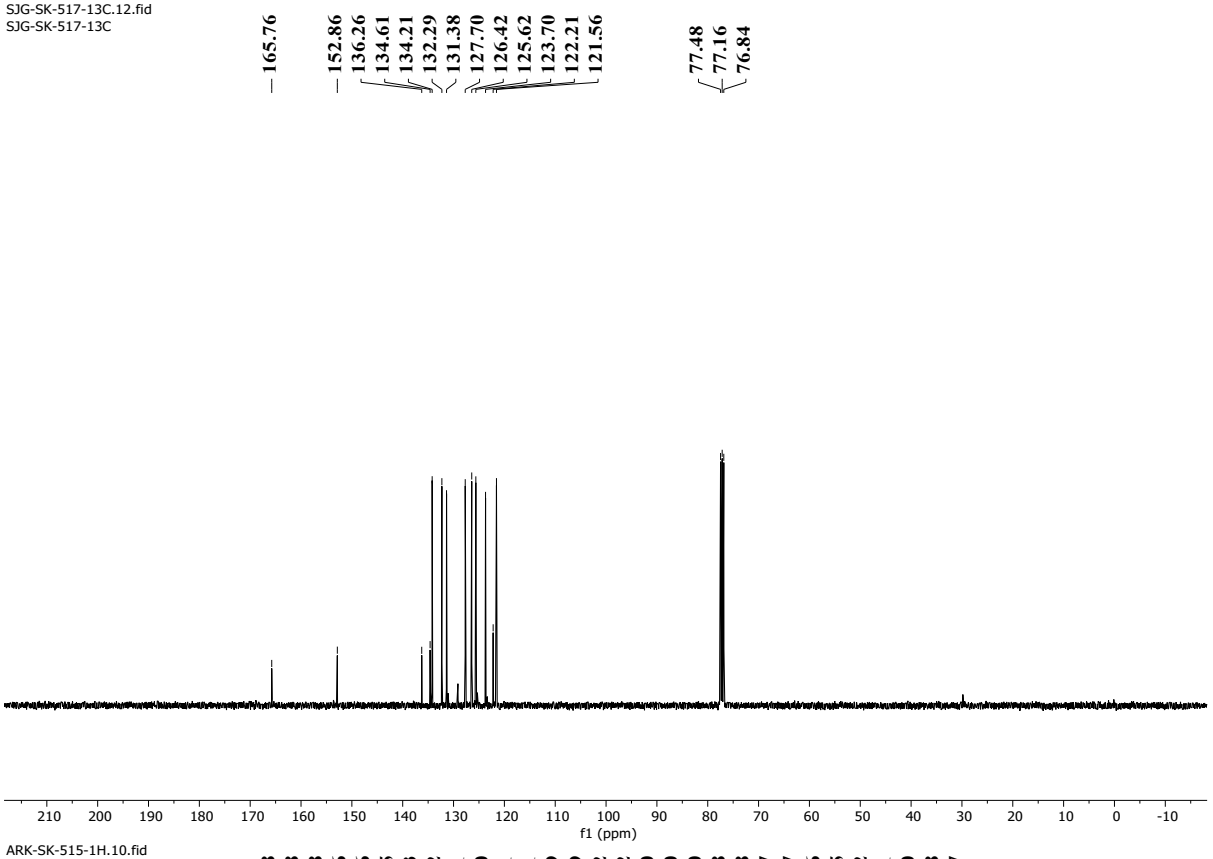
SJG-SK-513-1F.10.fid
SJG-SK-513-1F



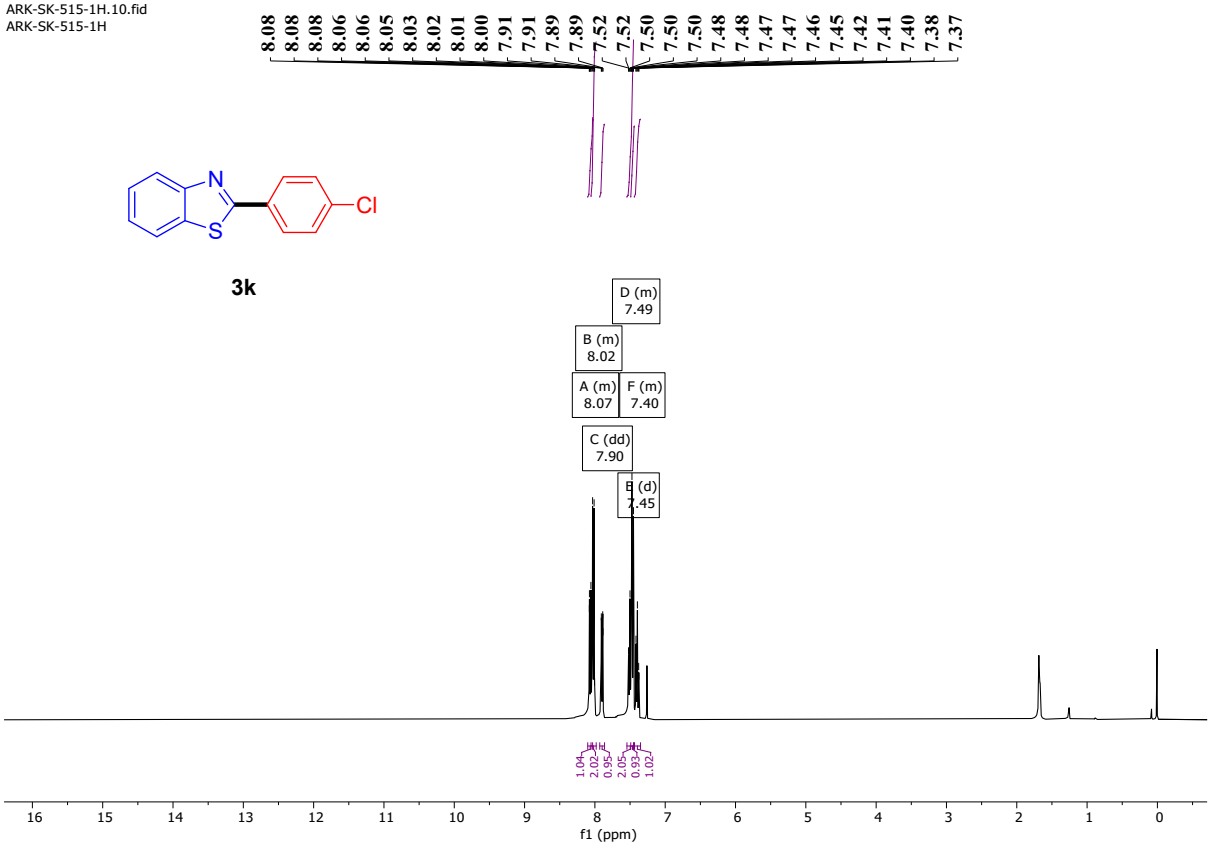
SJG-SK-517-1H.10.fid
SJG-SK-517-1H



SJG-SK-517-13C.12.fid
SJG-SK-517-13C

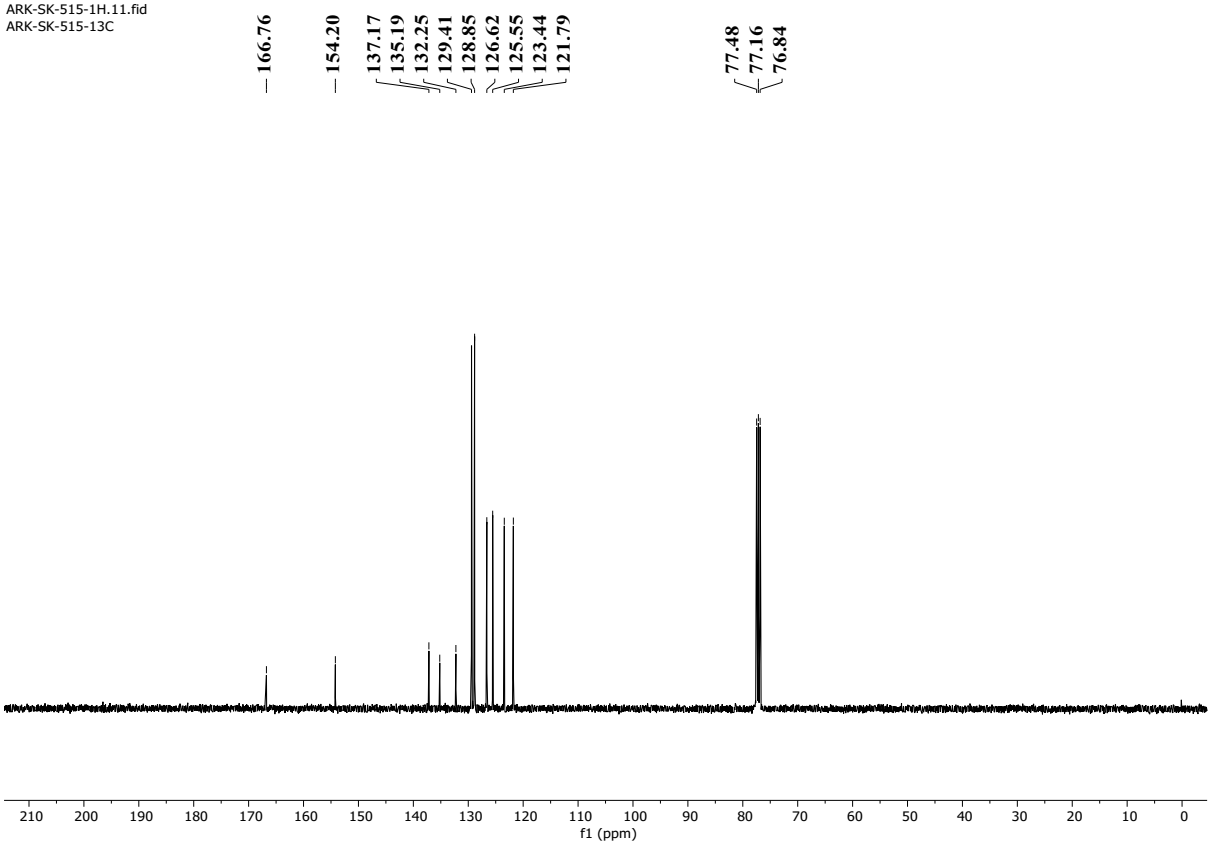


ARK-SK-515-1H.10.fid
ARK-SK-515-1H

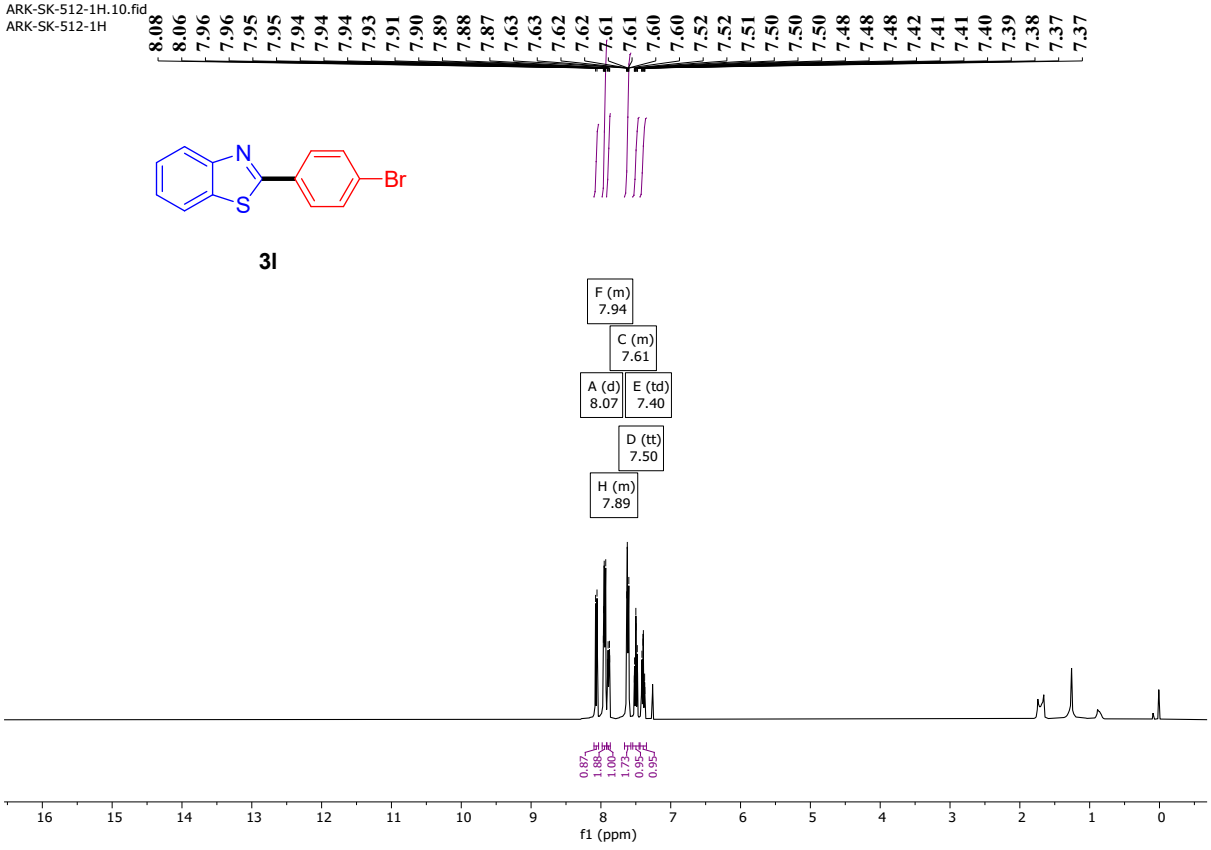


3k

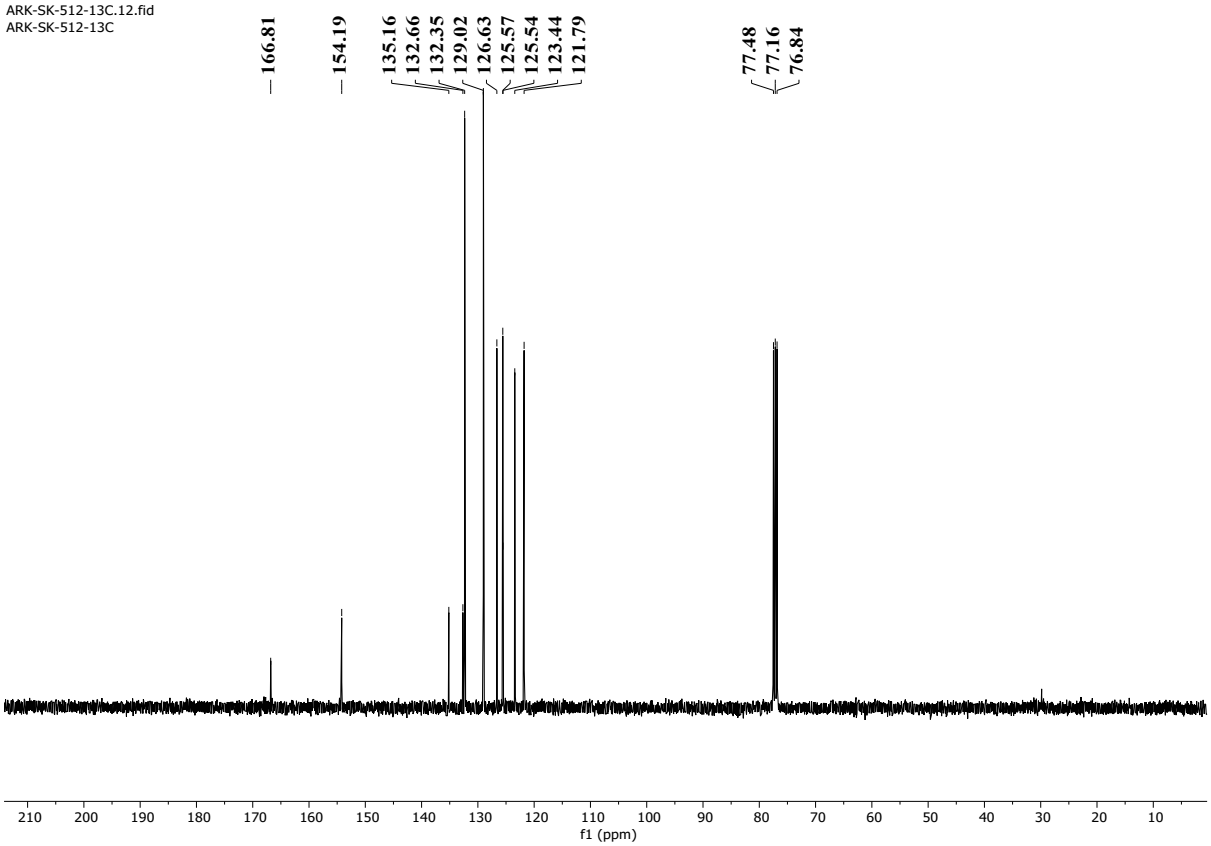
ARK-SK-515-1H.11.fid
ARK-SK-515-13C

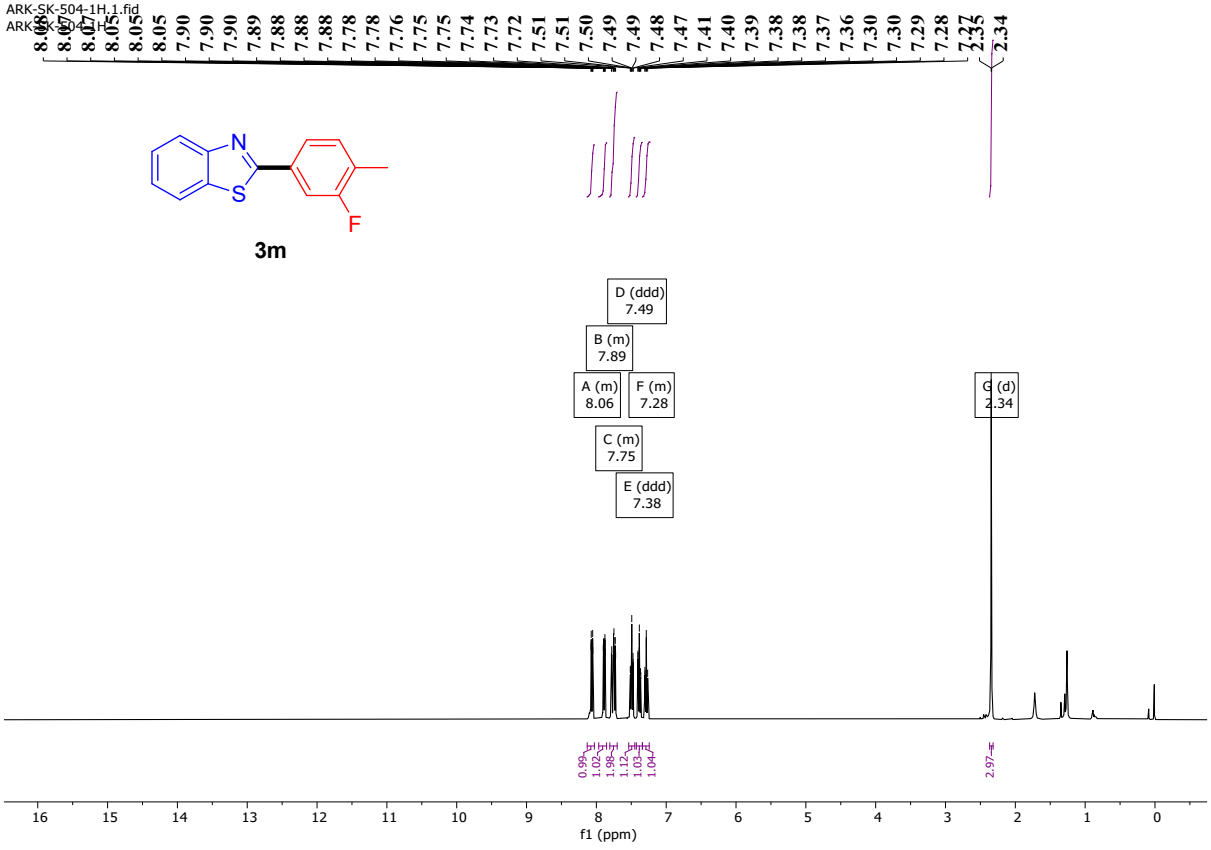


ARK-SK-512-1H.10.fid
ARK-SK-512-1H

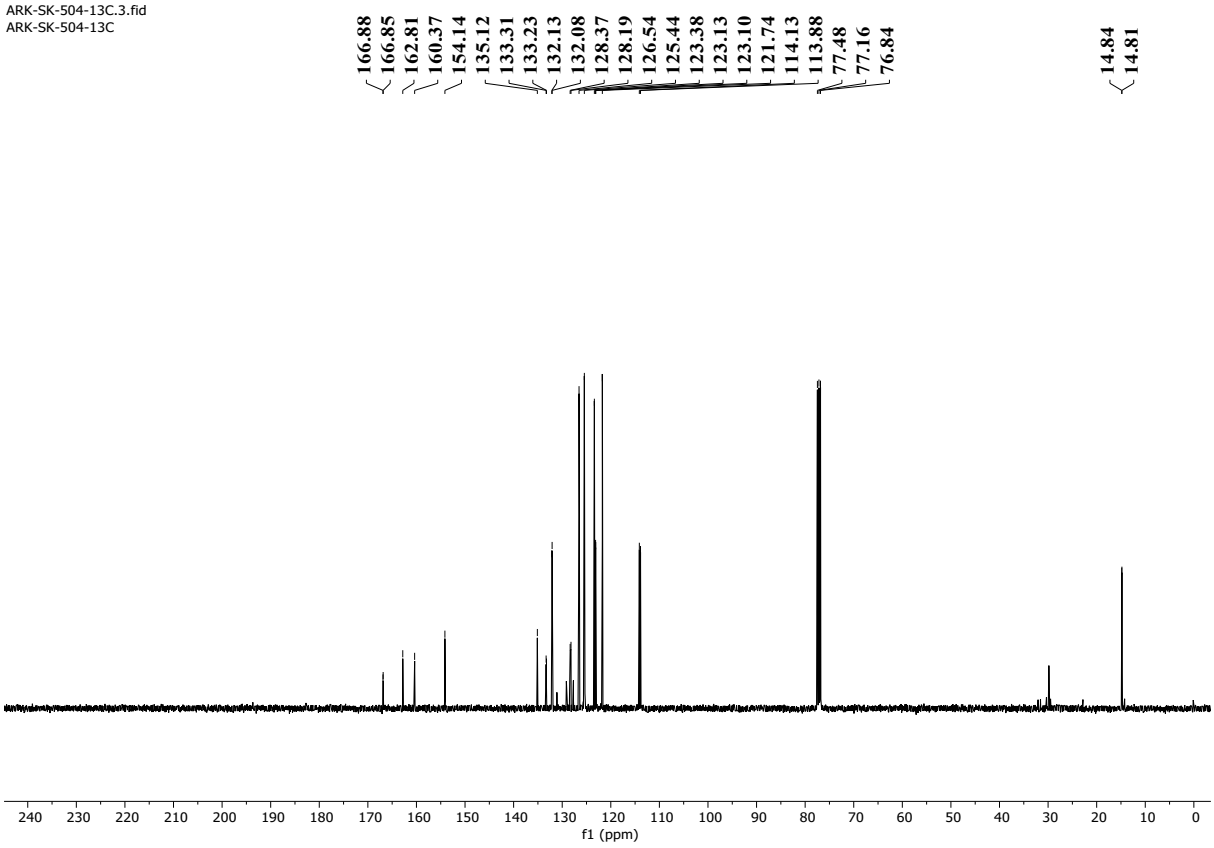


3l

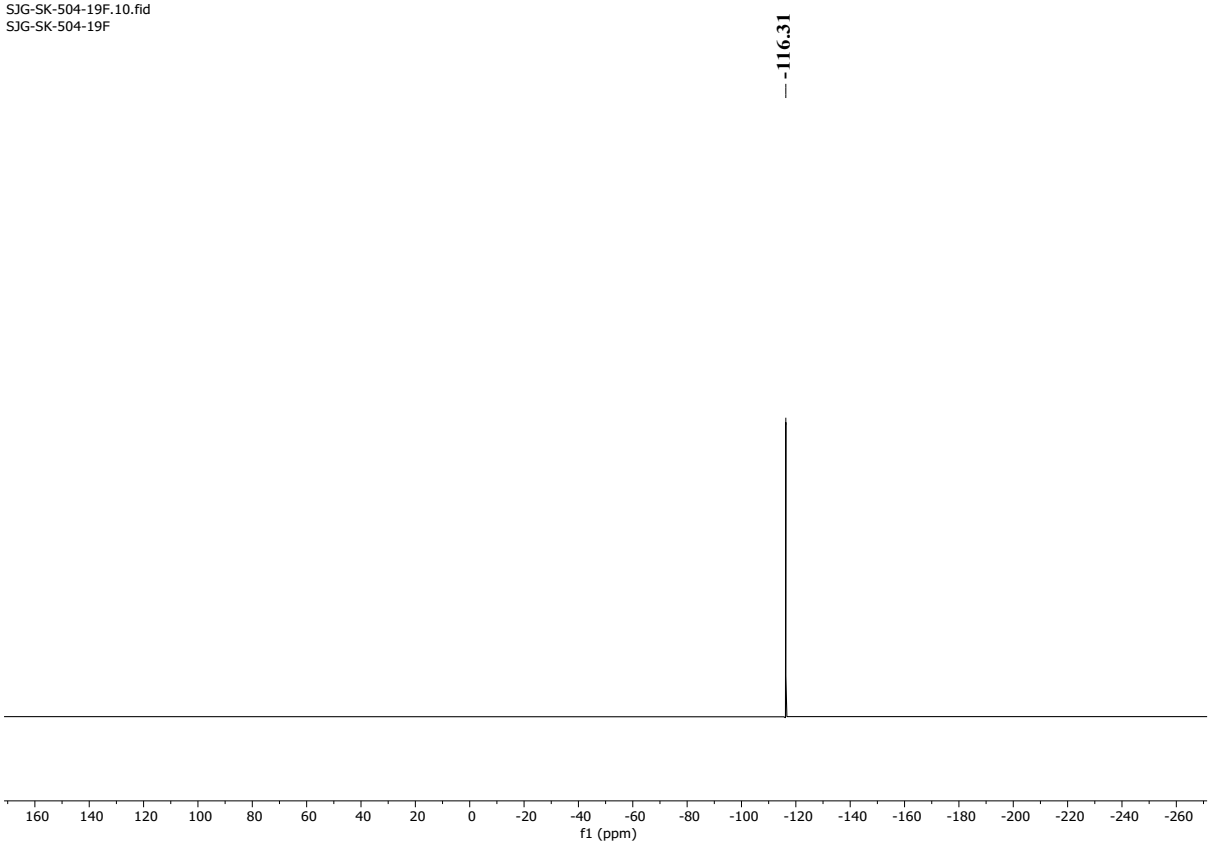

ARK-SK-512-13C.12.fid
ARK-SK-512-13C
166.81
154.19
135.16
132.66
132.35
129.02
126.63
125.57
125.54
123.44
121.79
77.48
77.16
76.84
f1 (ppm)

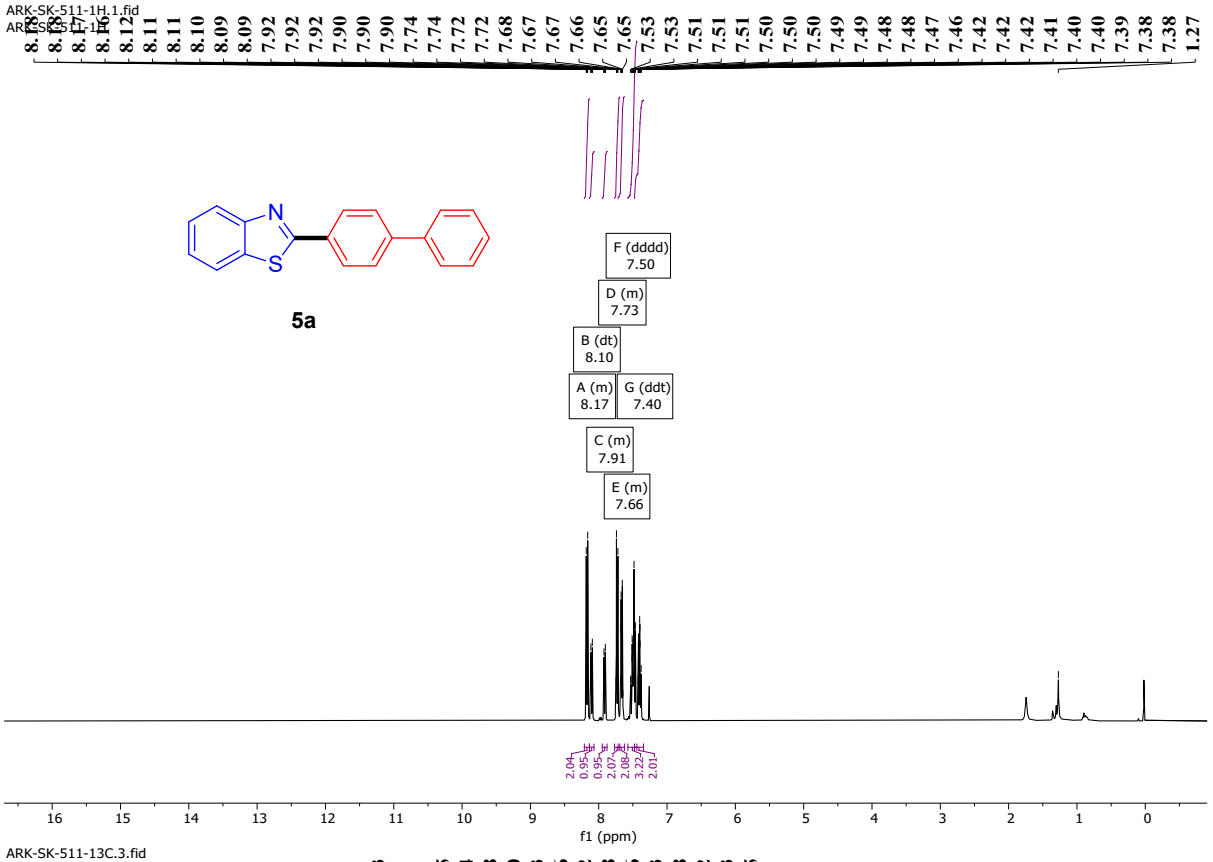

ARK-SK-504-1H.1.fid
ARK-SK-504-1H
8.06
7.90
7.89
7.88
7.78
7.76
7.75
7.74
7.73
7.72
7.51
7.50
7.49
7.48
7.47
7.41
7.40
7.39
7.38
7.37
7.36
7.30
7.29
7.28
2.35
2.34
N
S
F
3m
D (ddd)
7.49
B (m)
7.89
A (m)
8.06
F (m)
7.28
C (m)
7.75
E (ddd)
7.38
G (d)
2.34
0.99
1.02
1.98
1.12
1.03
1.04
2.97
f1 (ppm)

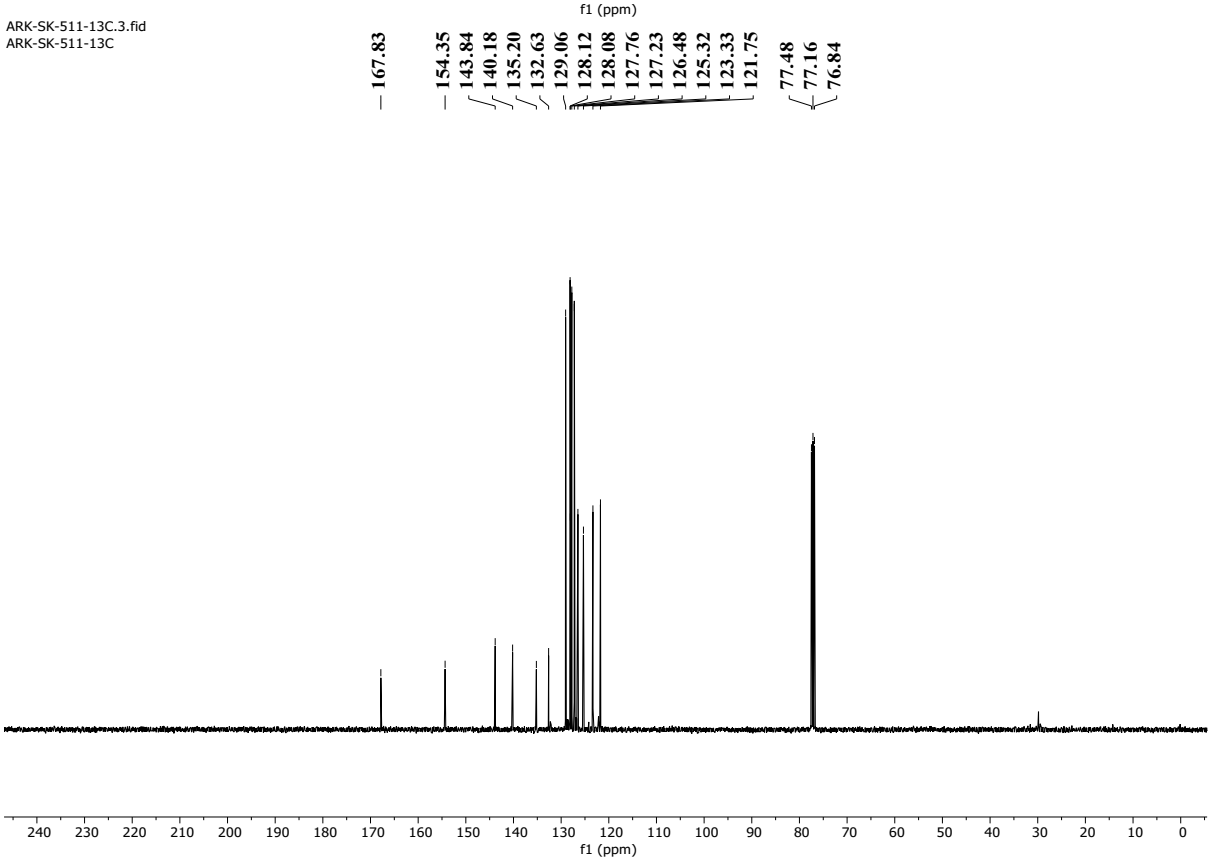
ARK-SK-504-13C.3.fid
ARK-SK-504-13C

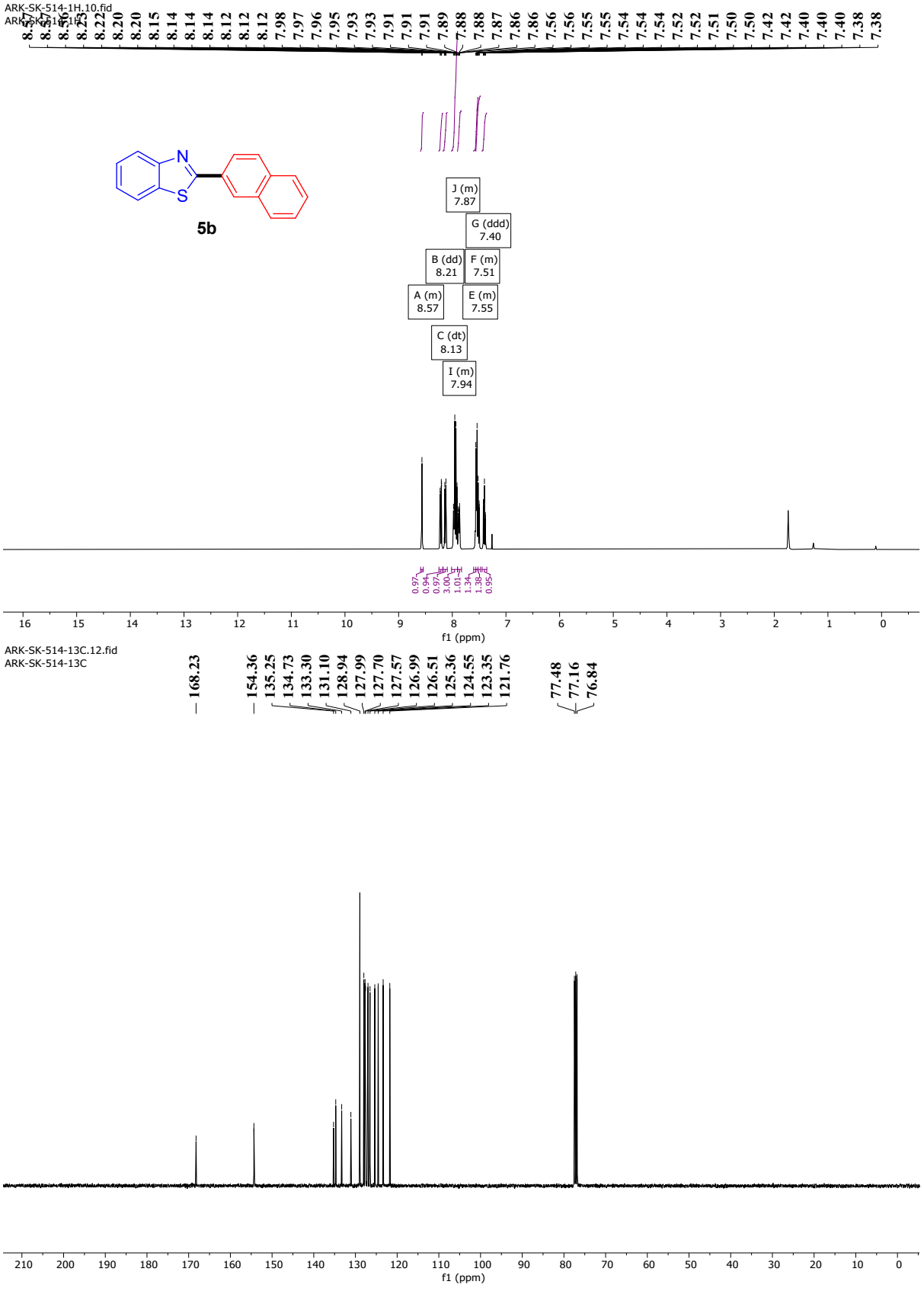


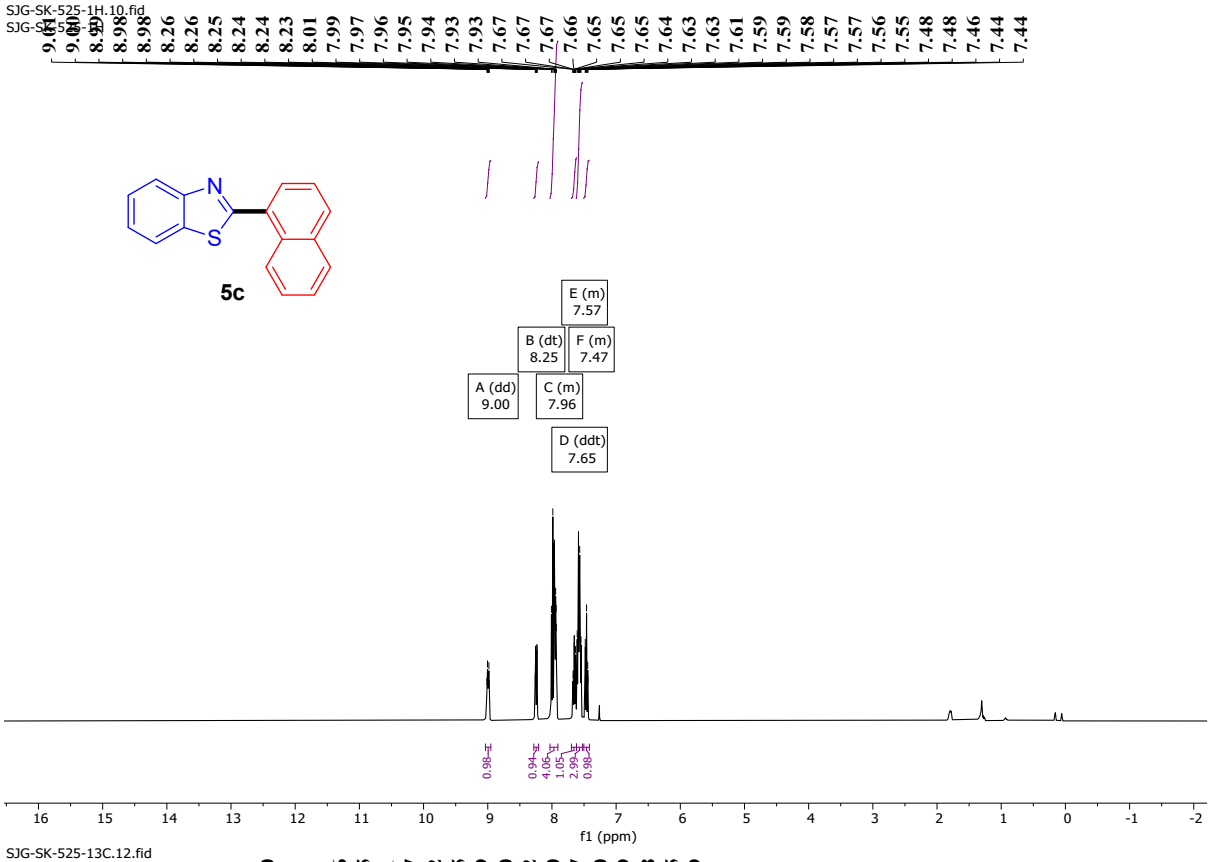
SJG-SK-504-19F.10.fid
SJG-SK-504-19F




ARK-SK-511-1H.1.fid
ARK-SK-511-1H
8.22
8.22
8.19
8.12
8.11
8.11
8.10
8.09
8.09
7.92
7.92
7.90
7.90
7.90
7.74
7.74
7.72
7.72
7.68
7.67
7.67
7.66
7.65
7.65
7.53
7.53
7.51
7.51
7.51
7.50
7.50
7.50
7.49
7.49
7.48
7.48
7.47
7.46
7.42
7.42
7.42
7.41
7.40
7.40
7.39
7.38
7.38
1.27
N
S
5a
F (dddd) 7.50
D (m) 7.73
B (dt) 8.10
A (m) 8.17
G (ddt) 7.40
C (m) 7.91
E (m) 7.66
2.04
0.95
0.95
2.07
2.08
3.22
2.01
16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
f1 (ppm)


ARK-SK-511-13C.3.fid
ARK-SK-511-13C
167.83
154.35
143.84
140.18
135.20
132.63
129.06
128.12
128.08
127.76
127.23
126.48
125.32
123.33
121.75
77.48
77.16
76.84
240 230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0
f1 (ppm)


ARK-SK-514-1H.10.fid
ARK-SK-514-1H
8.25 8.22 8.20 8.20 8.15 8.14 8.14 8.14 8.12 8.12 8.12 7.98 7.97 7.96 7.95 7.93 7.93 7.91 7.91 7.91 7.89 7.88 7.88 7.87 7.86 7.86 7.56 7.56 7.55 7.55 7.54 7.54 7.54 7.52 7.52 7.51 7.50 7.50 7.42 7.42 7.40 7.40 7.38 7.38
N
S
5b
J (m) 7.87
G (ddd) 7.40
B (dd) 8.21
F (m) 7.51
A (m) 8.57
E (m) 7.55
C (dt) 8.13
I (m) 7.94
0.97 0.94 0.97 3.00 1.01 1.34 1.38 0.95
f1 (ppm)
ARK-SK-514-13C.12.fid
ARK-SK-514-13C
168.23 154.36 135.25 134.73 133.30 131.10 128.94 127.99 127.70 127.57 126.99 126.51 125.36 124.55 123.35 121.76 77.48 77.16 76.84
f1 (ppm)


SJG-SK-525-1H.10.fid
SJG-SK-525-1H
9.00
8.99
8.98
8.26
8.25
8.24
8.23
8.01
7.99
7.97
7.96
7.95
7.94
7.93
7.67
7.66
7.65
7.64
7.63
7.61
7.59
7.58
7.57
7.56
7.55
7.48
7.46
7.44
N
S
5c
E (m) 7.57
B (dt) 8.25
F (m) 7.47
A (dd) 9.00
C (m) 7.96
D (ddt) 7.65
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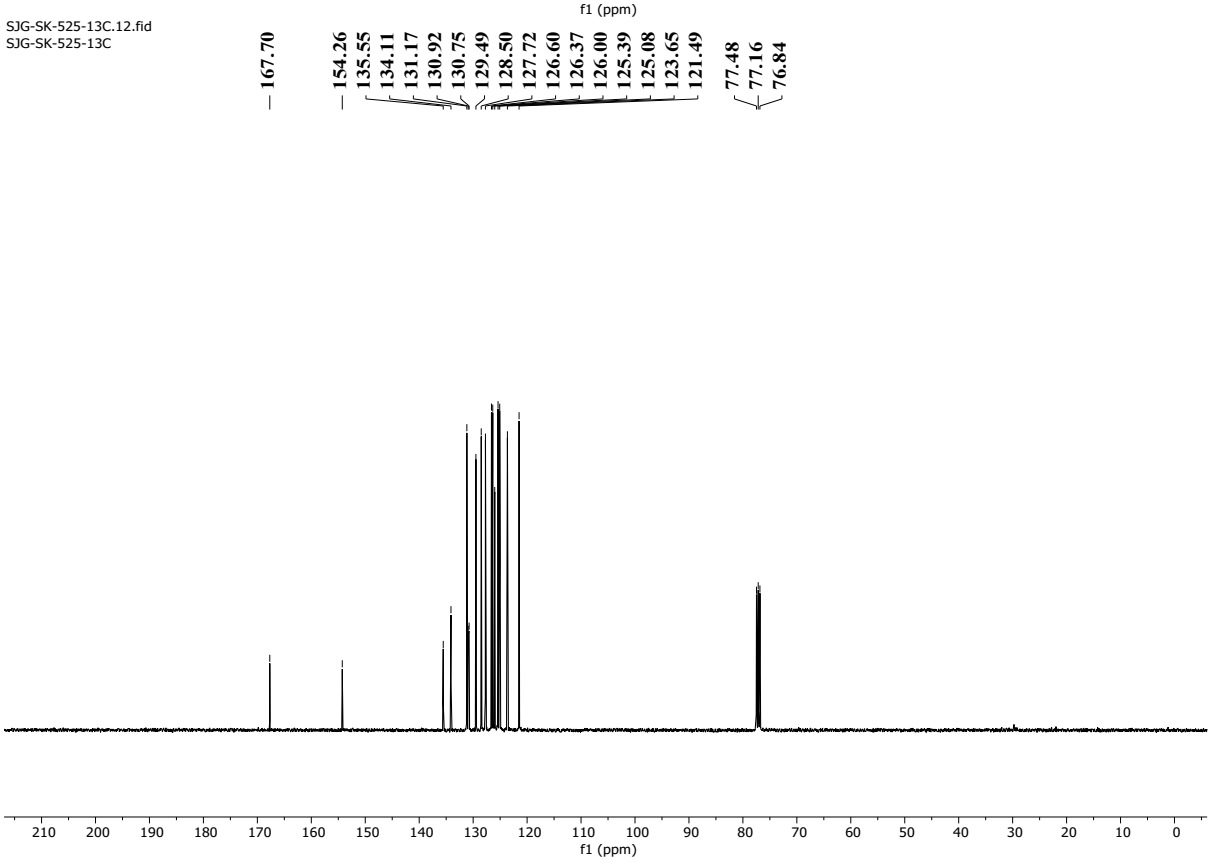
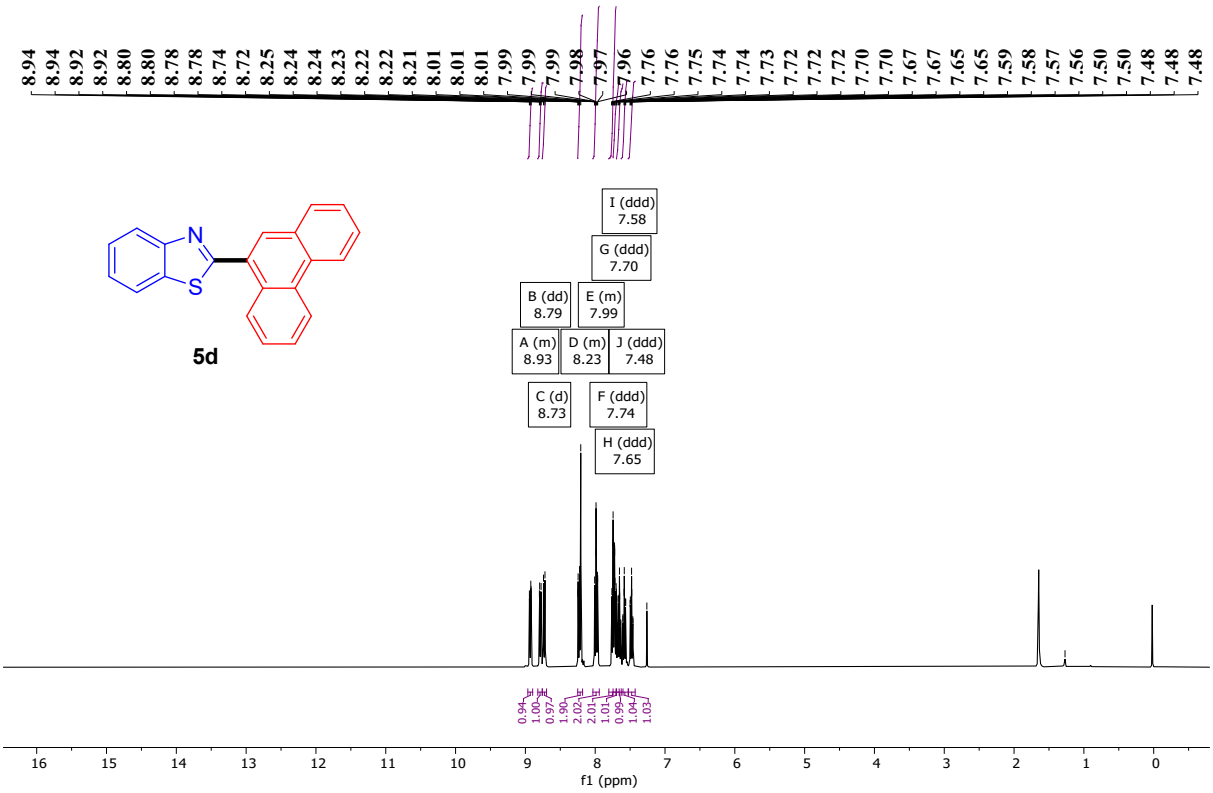
0.94
4.06
1.05
2.99
0.98
f1 (ppm)


SJG-SK-525-13C.12.fid
SJG-SK-525-13C
167.70
154.26
135.55
134.11
131.17
130.92
130.75
129.49
128.50
127.72
126.60
126.37
126.00
125.39
125.08
123.65
121.49
77.48
77.16
76.84
f1 (ppm)

ARK-SK-510-1H.1.fid
ARK-SK-510-1H



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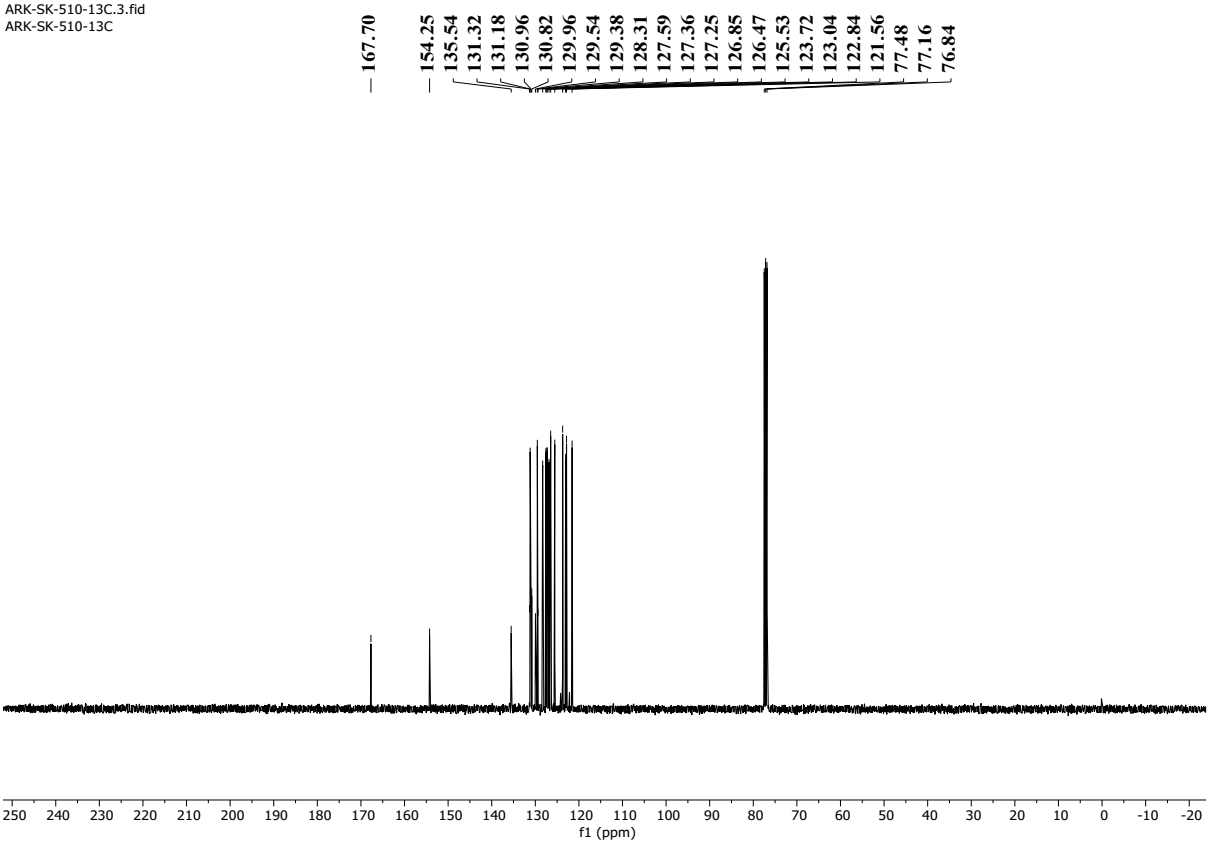
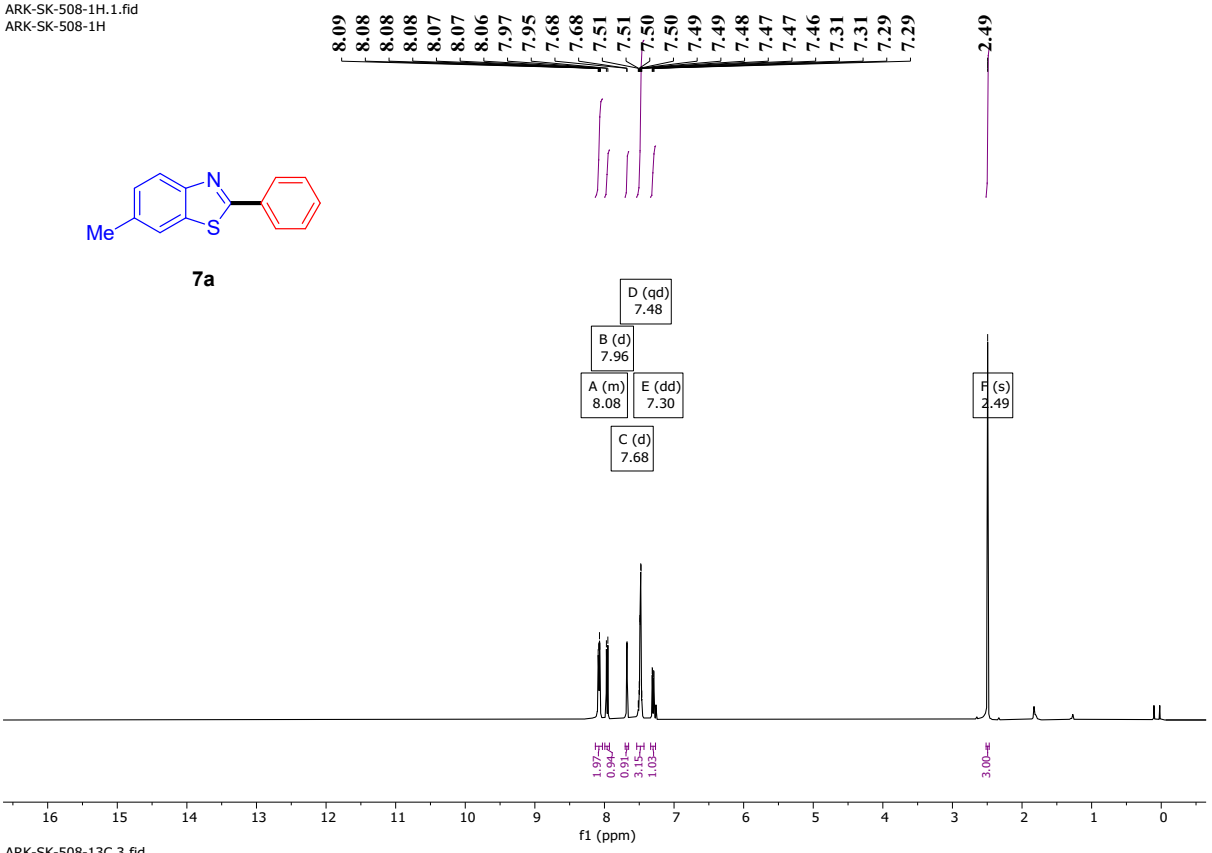
ARK-SK-510-13C



ARK-SK-508-1H.1.fid
ARK-SK-508-1H



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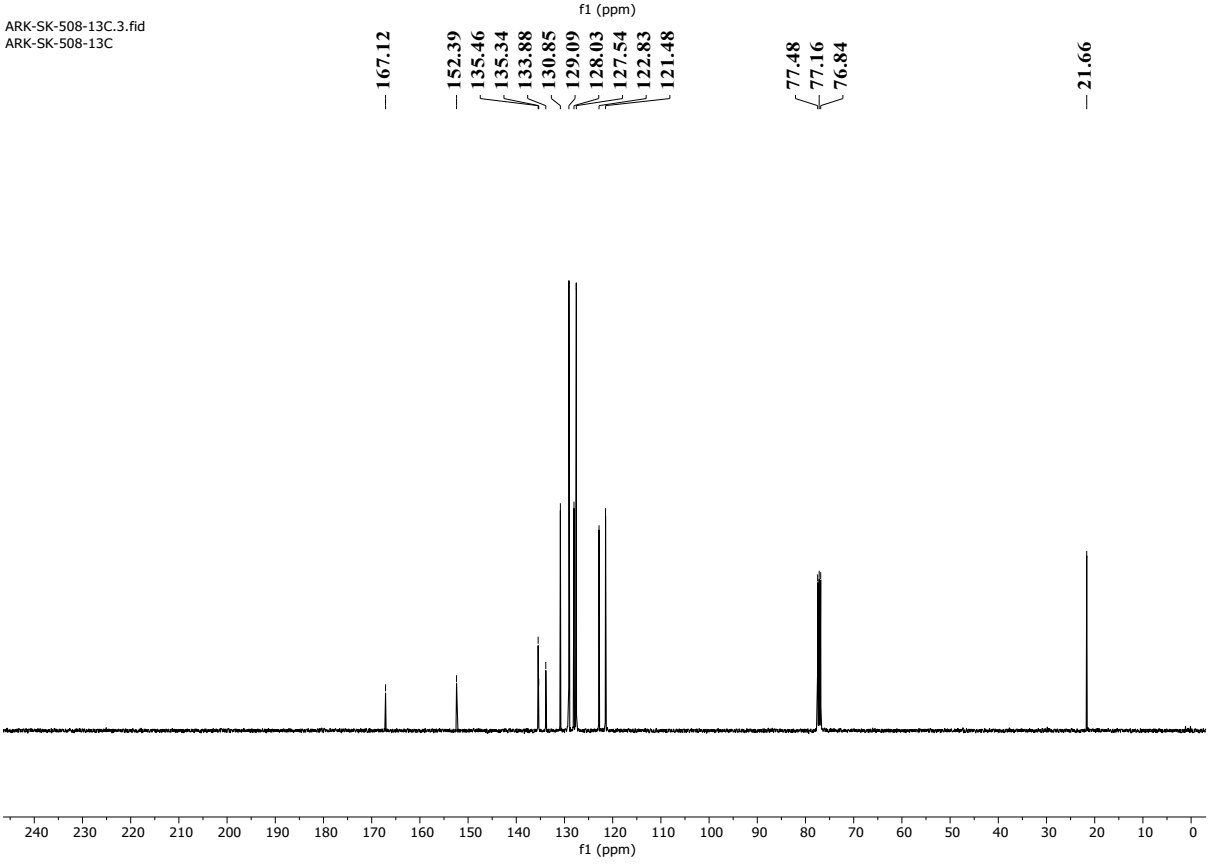
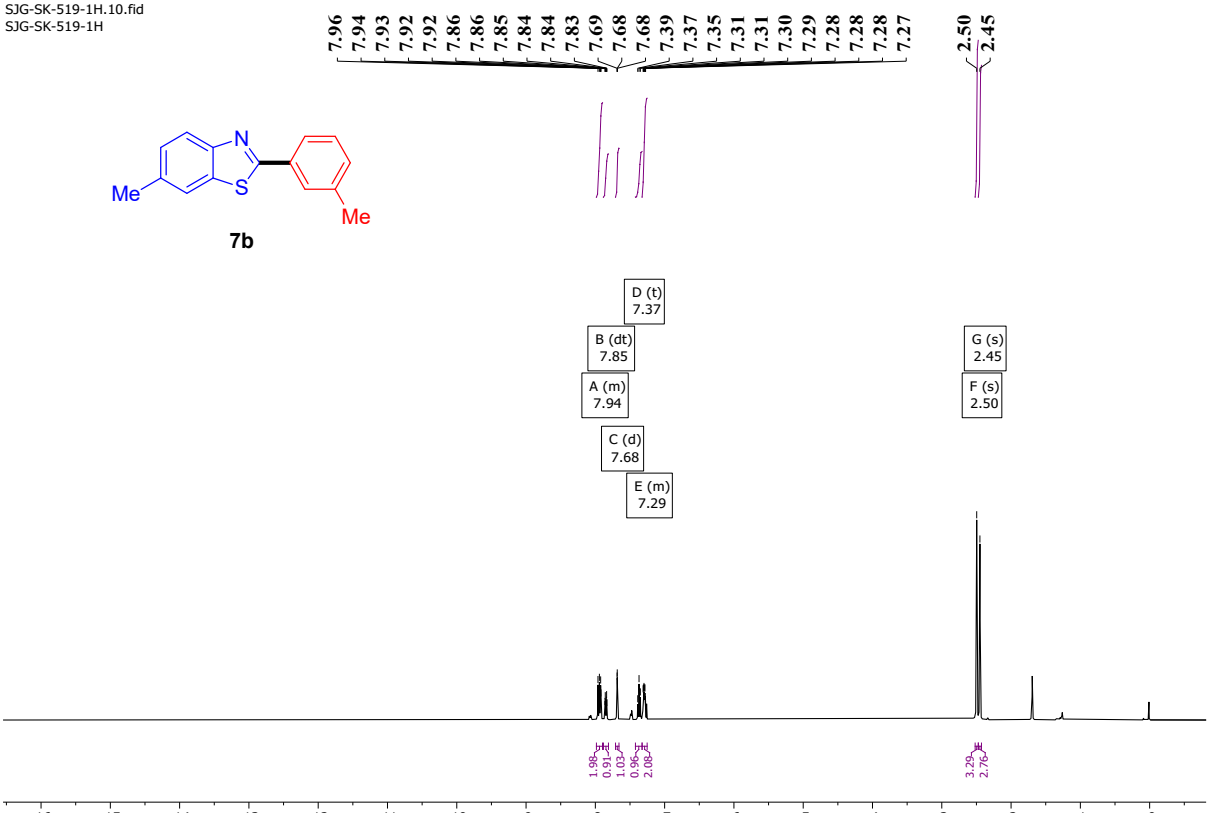
ARK-SK-508-13C.3.fid
ARK-SK-508-13C

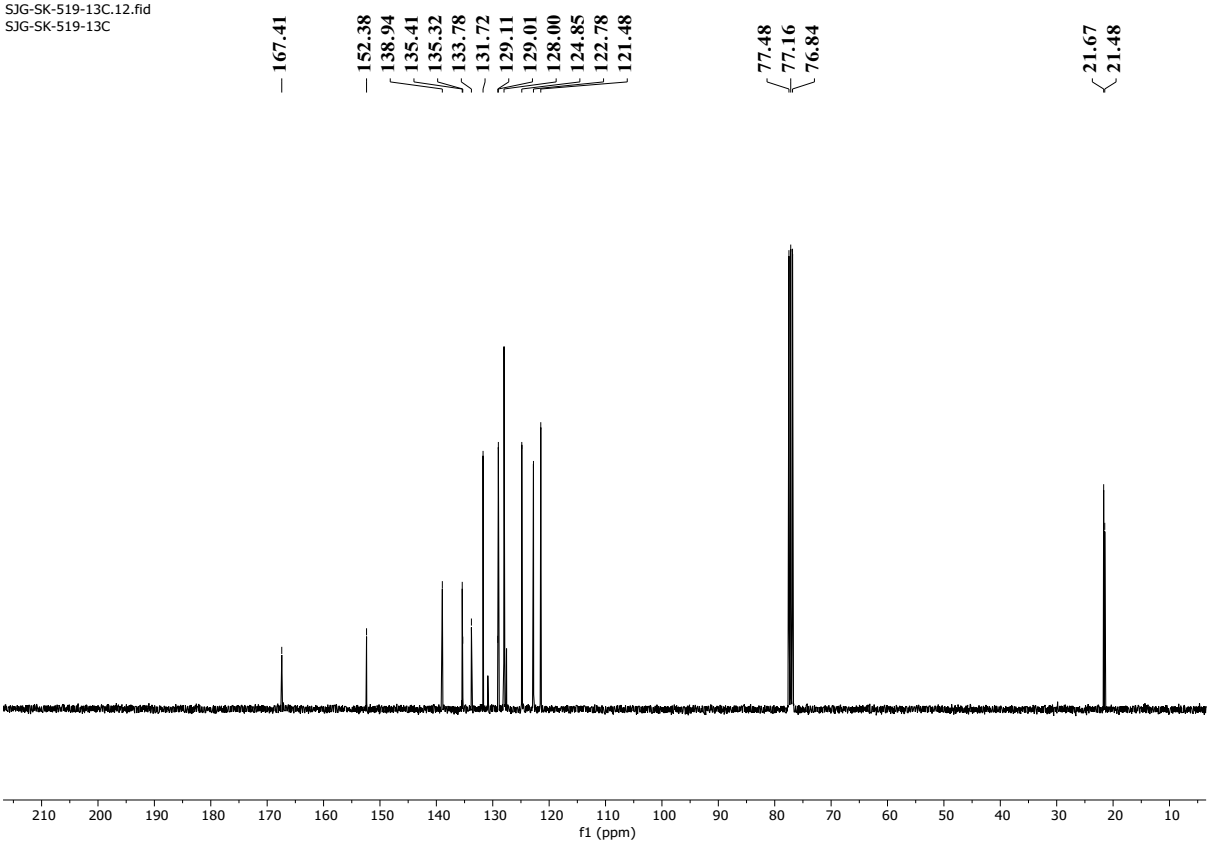


SJG-SK-519-1H.10.fid
SJG-SK-519-1H

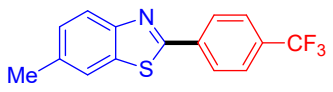


7b

SJG-SK-519-13C.12.fid
SJG-SK-519-13C



SJG-SK-521-1H.10.fid
SJG-SK-521-1H



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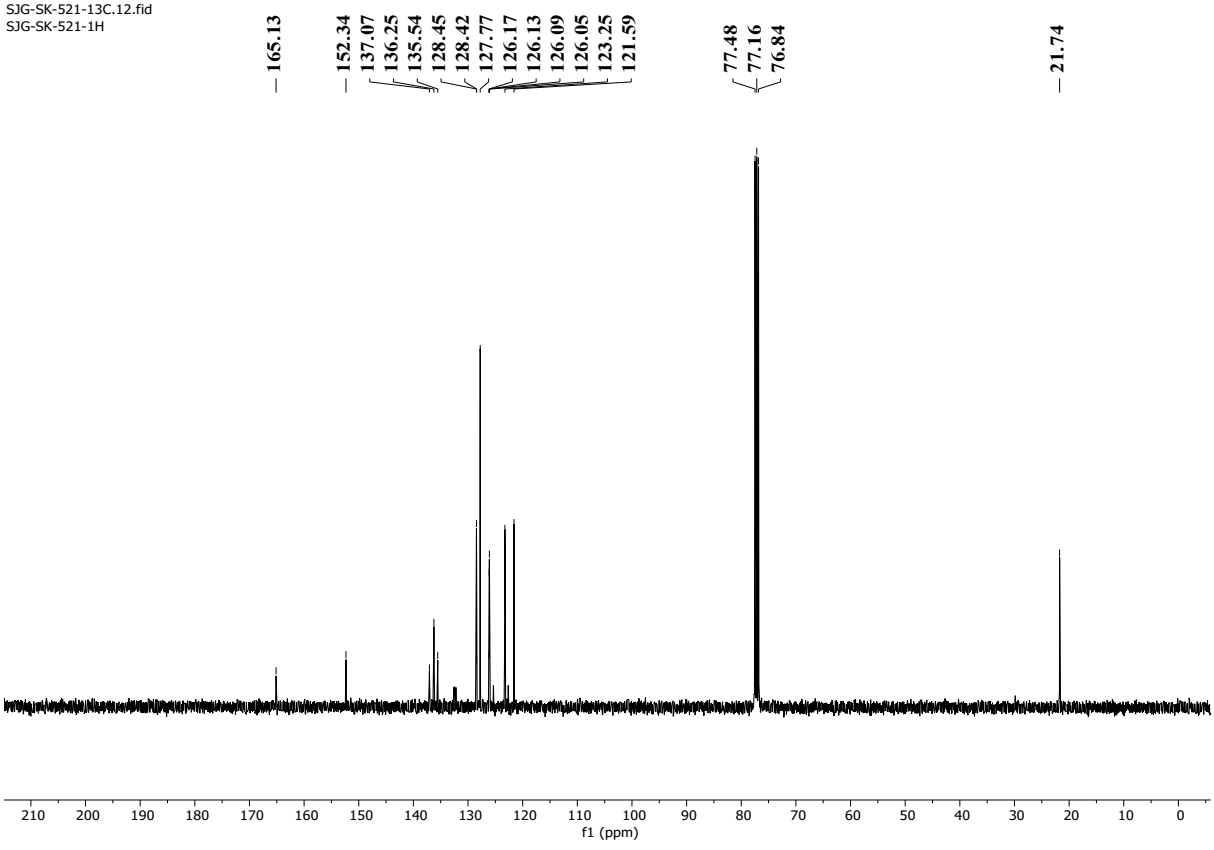
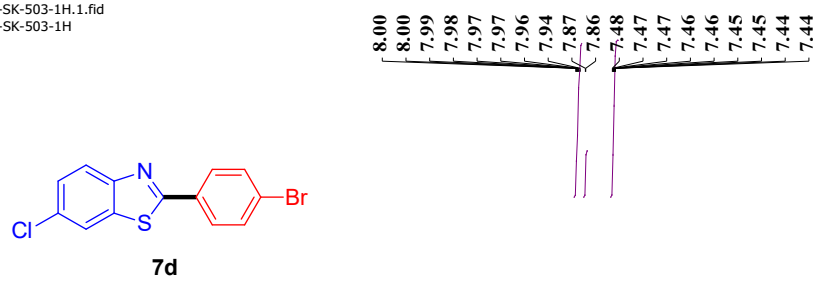
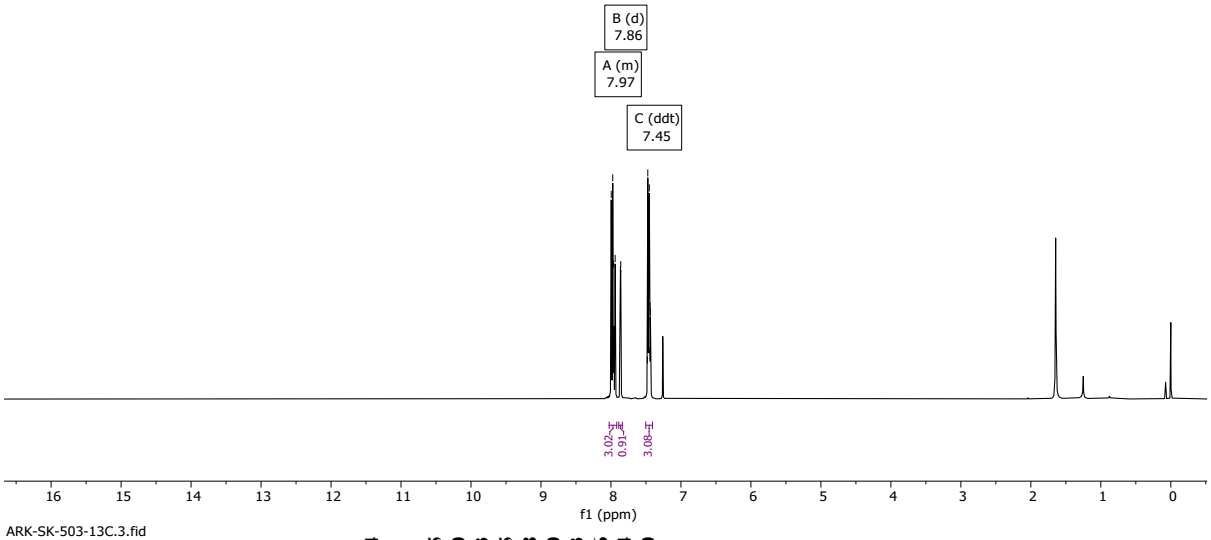
SJG-SK-521-13C.12.fid
SJG-SK-521-1H



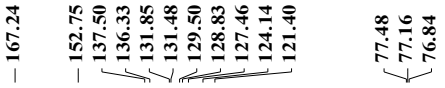
ARK-SK-503-1H.1.fid
ARK-SK-503-1H

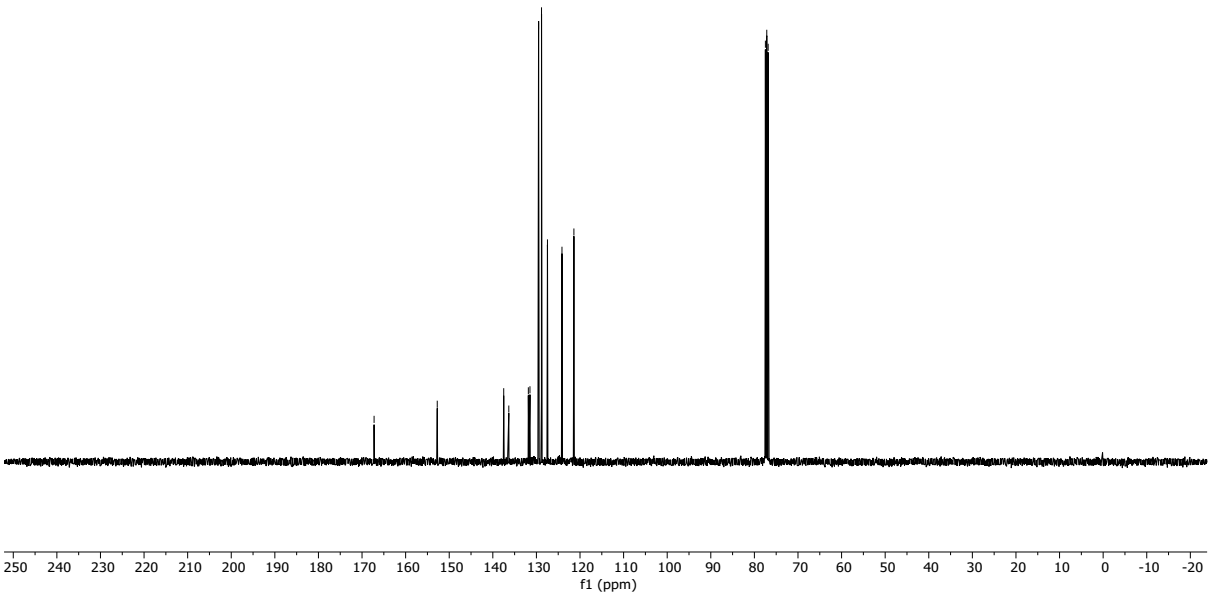


7d

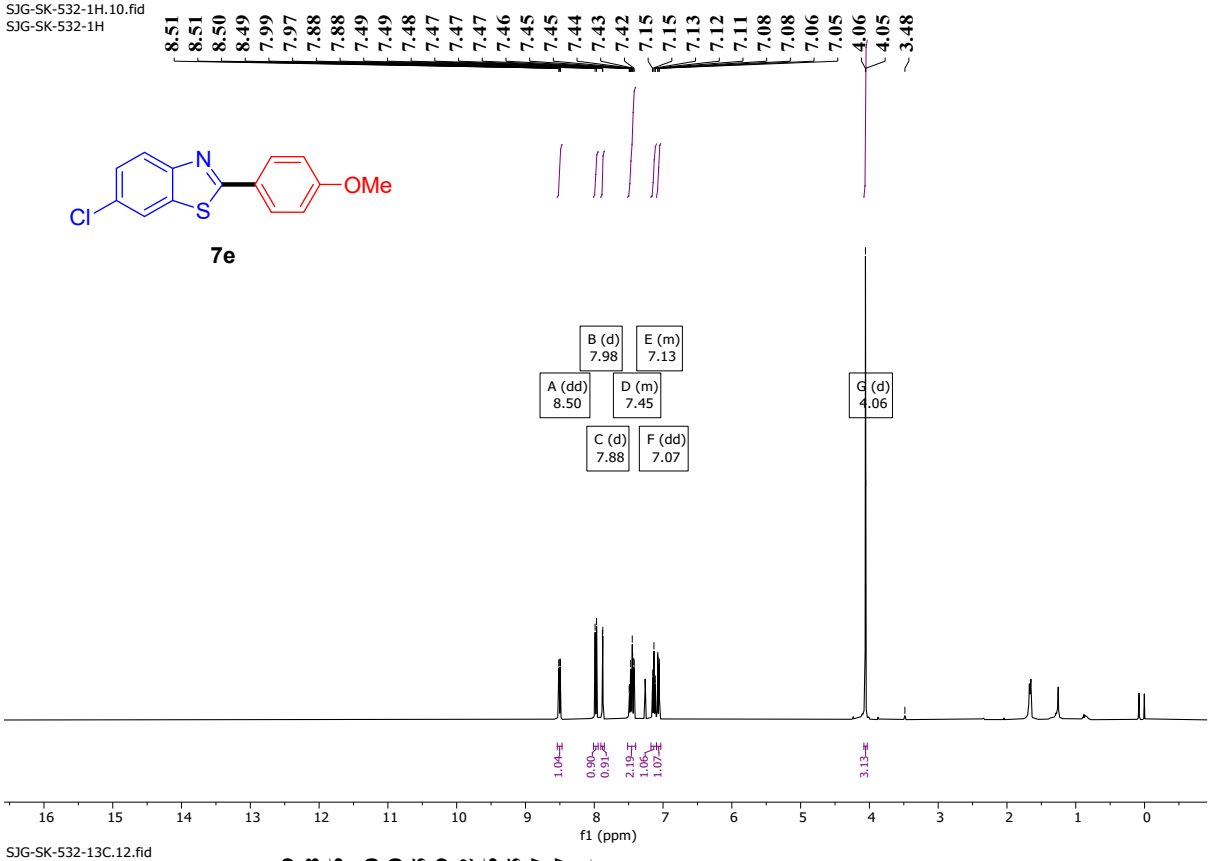


ARK-SK-503-13C.3.fid
ARK-SK-503-13C



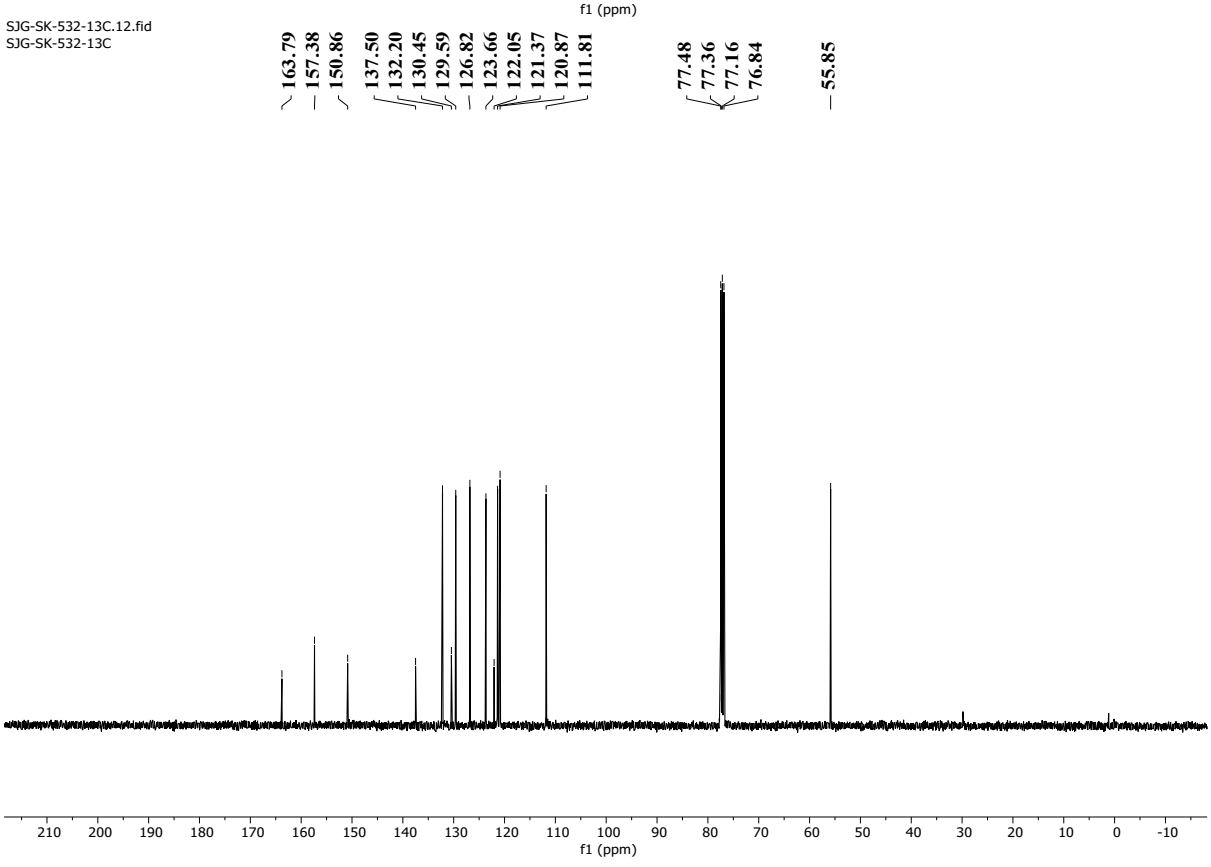


SJG-SK-532-1H.10.fid
SJG-SK-532-1H

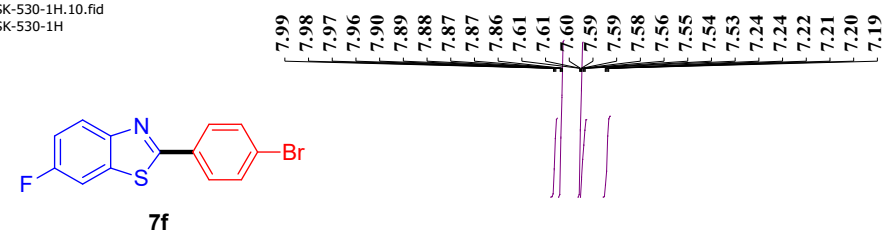


7e

SJG-SK-532-13C.12.fid
SJG-SK-532-13C



SJG-SK-530-1H.10.fid
SJG-SK-530-1H



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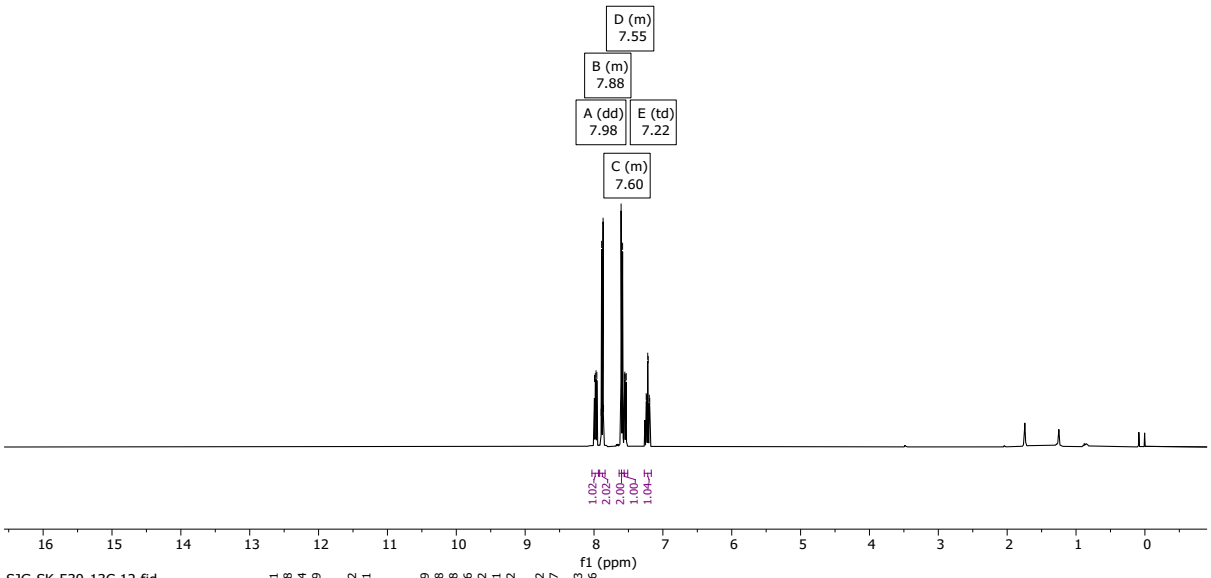
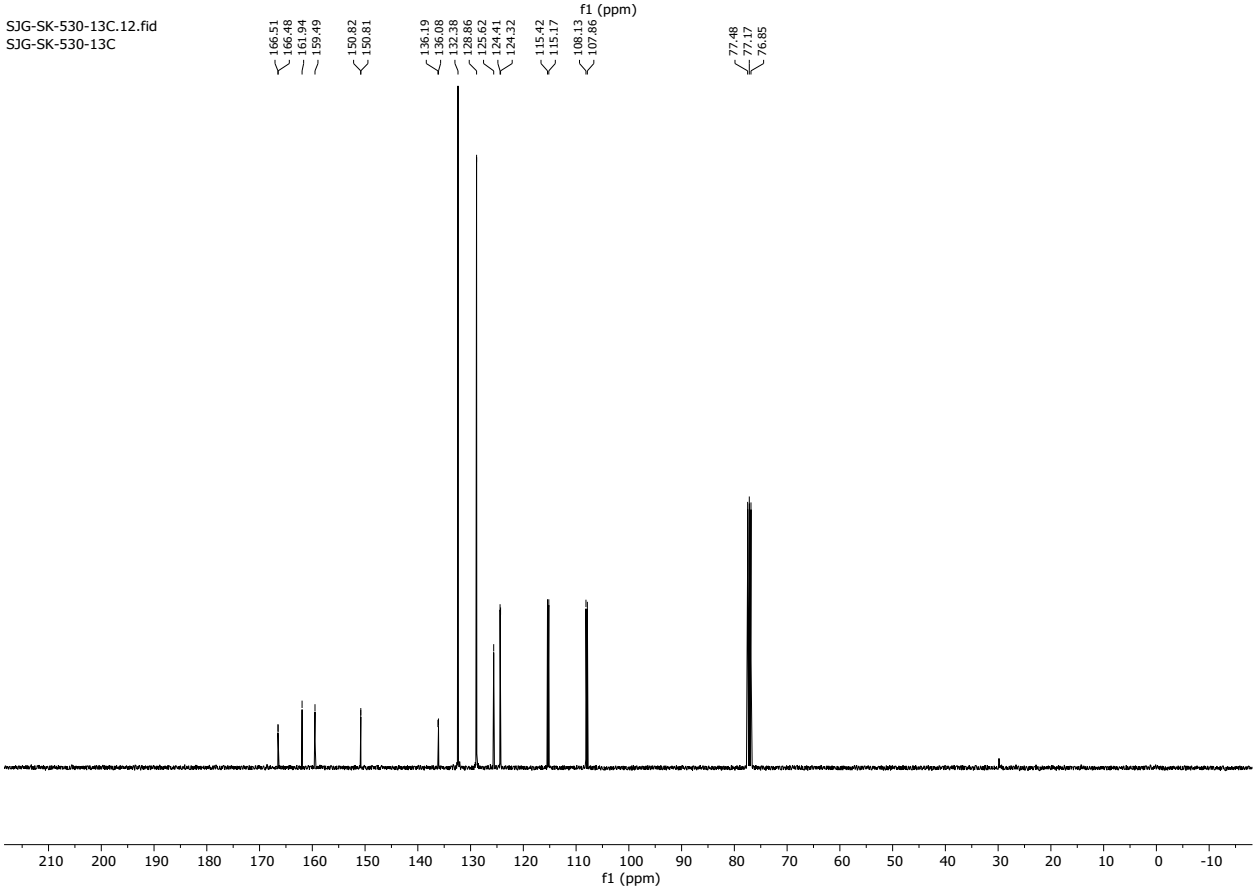


SJG-SK-530-13C.12.fid
SJG-SK-530-13C



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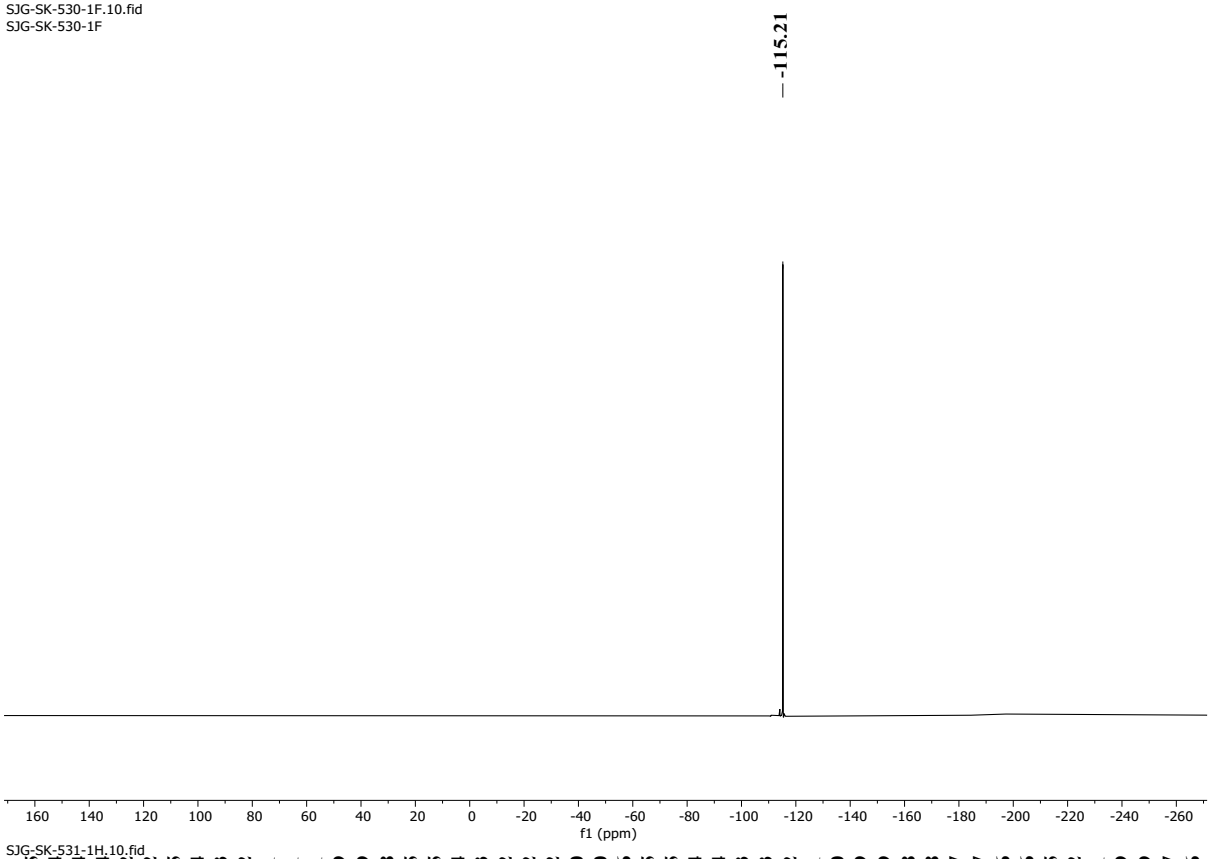
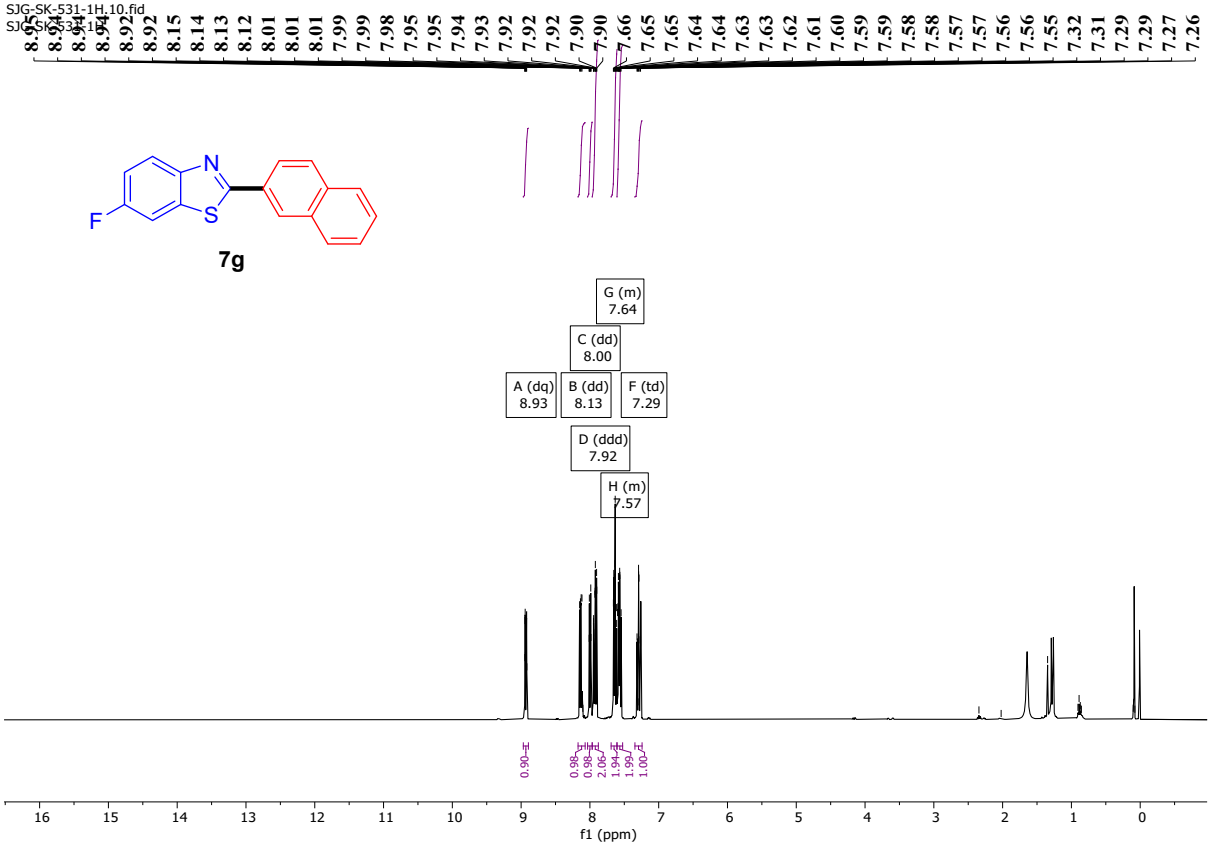
SJG-SK-530-1F

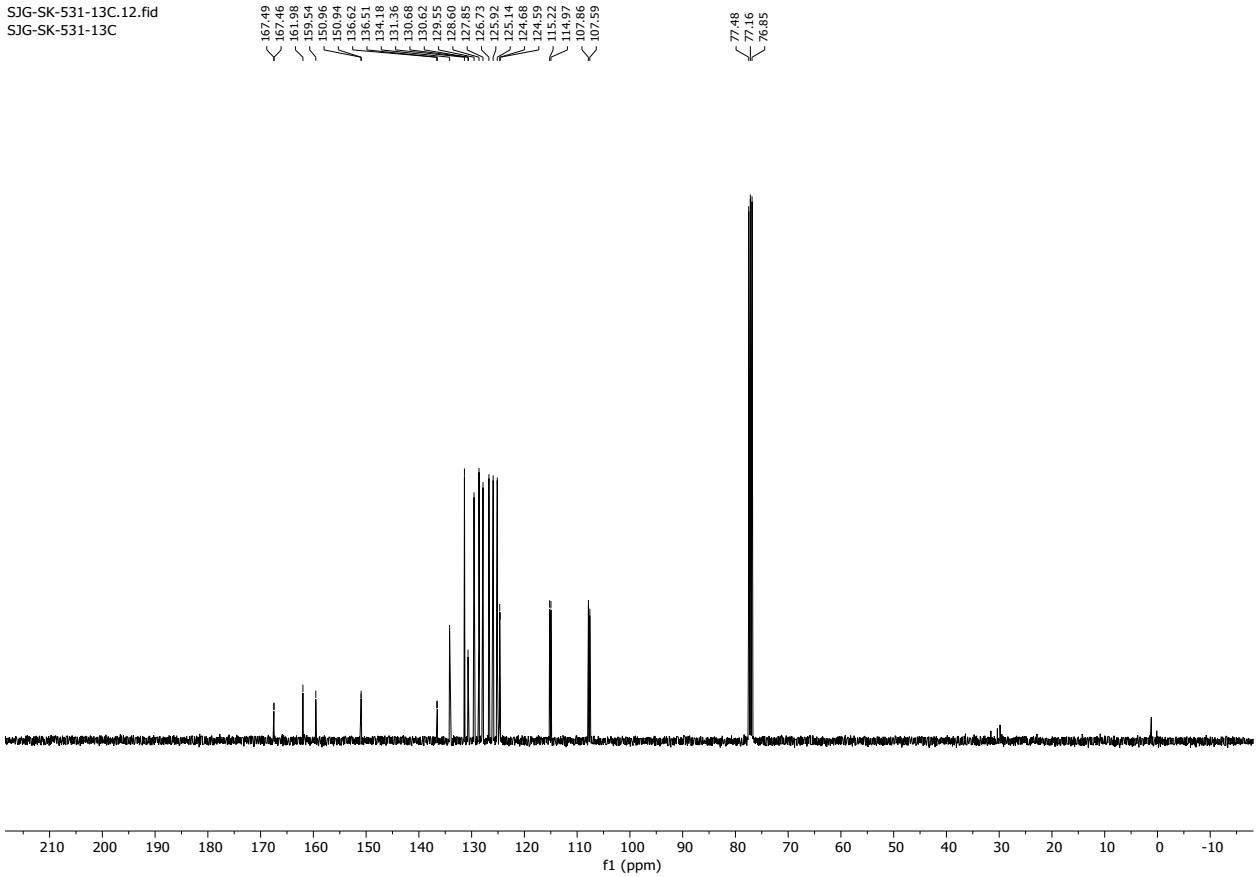


SJG-SK-531-1H.10.fid
SJG-SK-531-1H

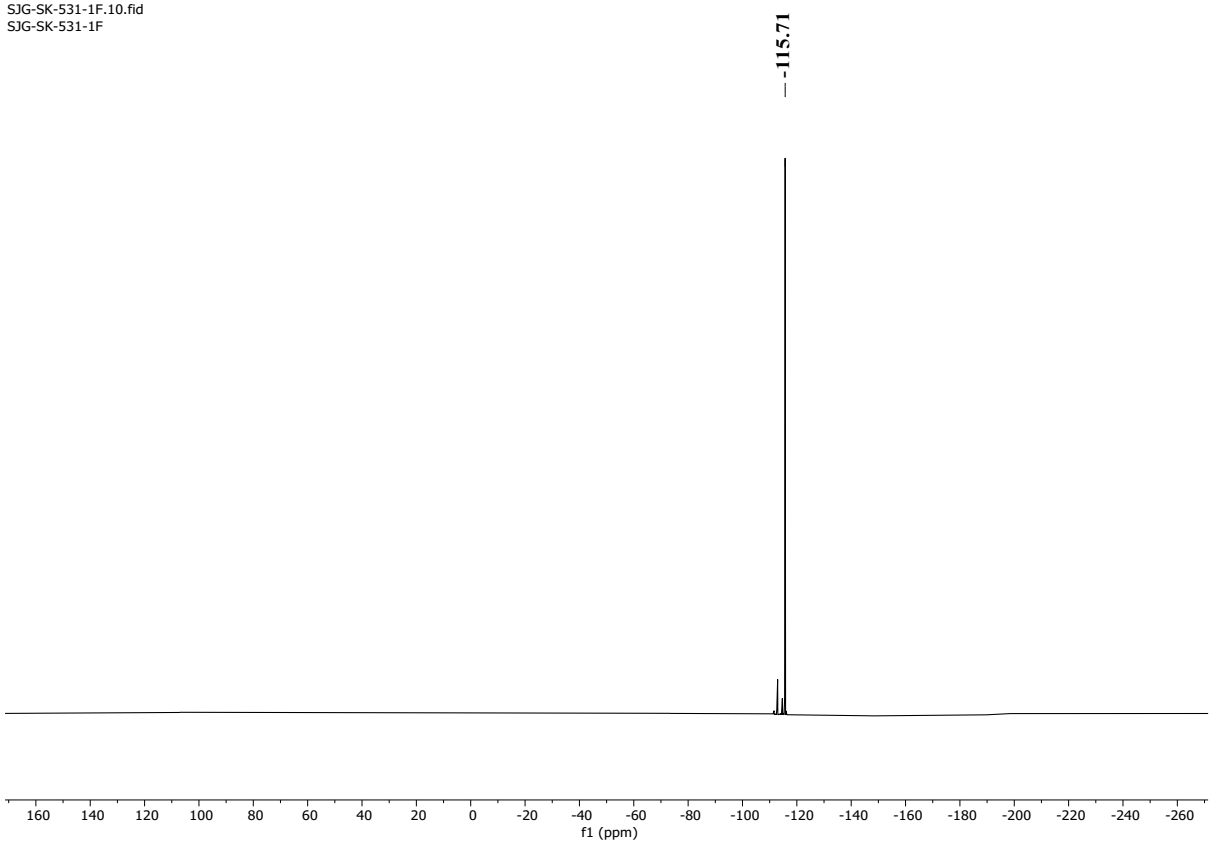


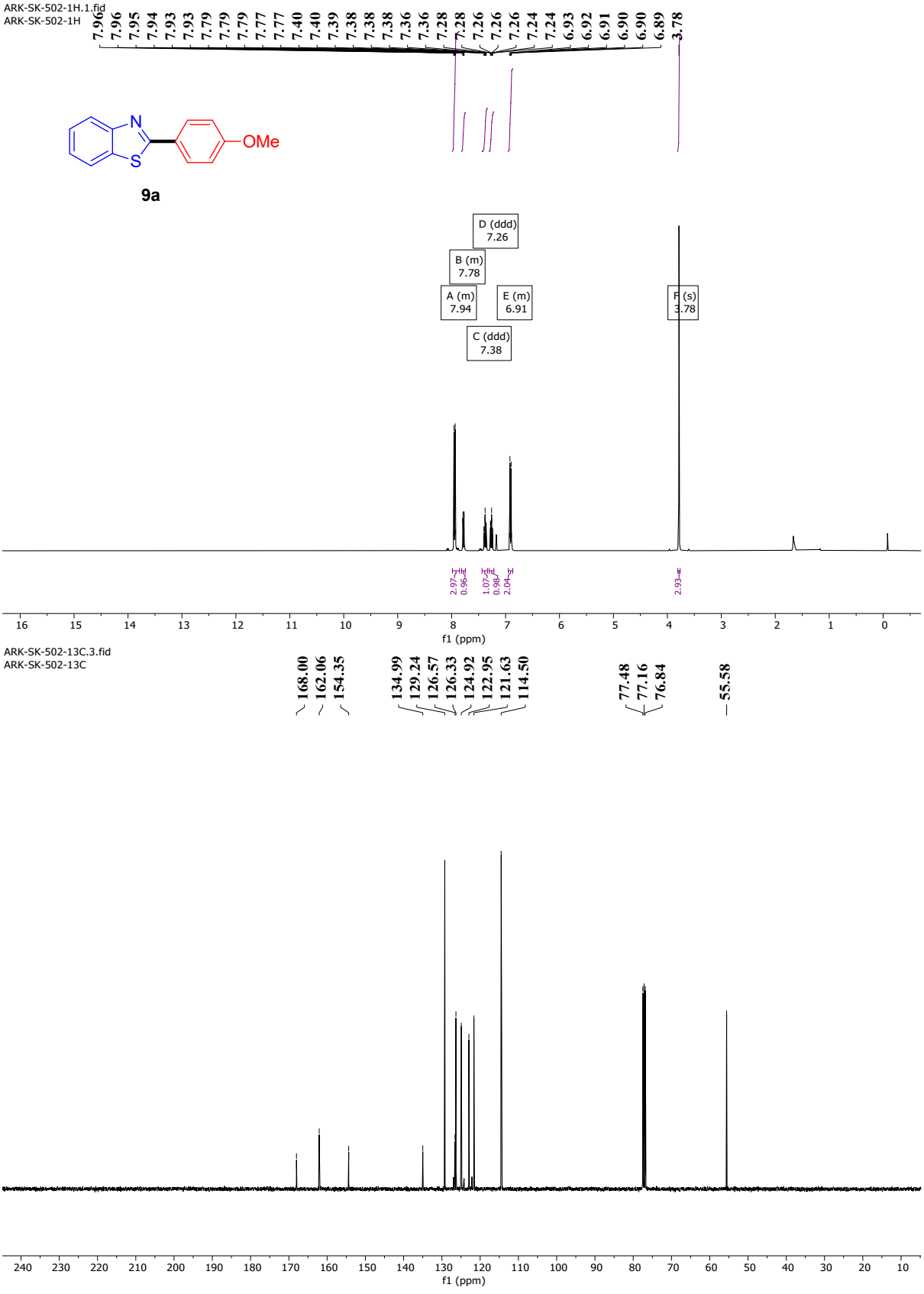
7g

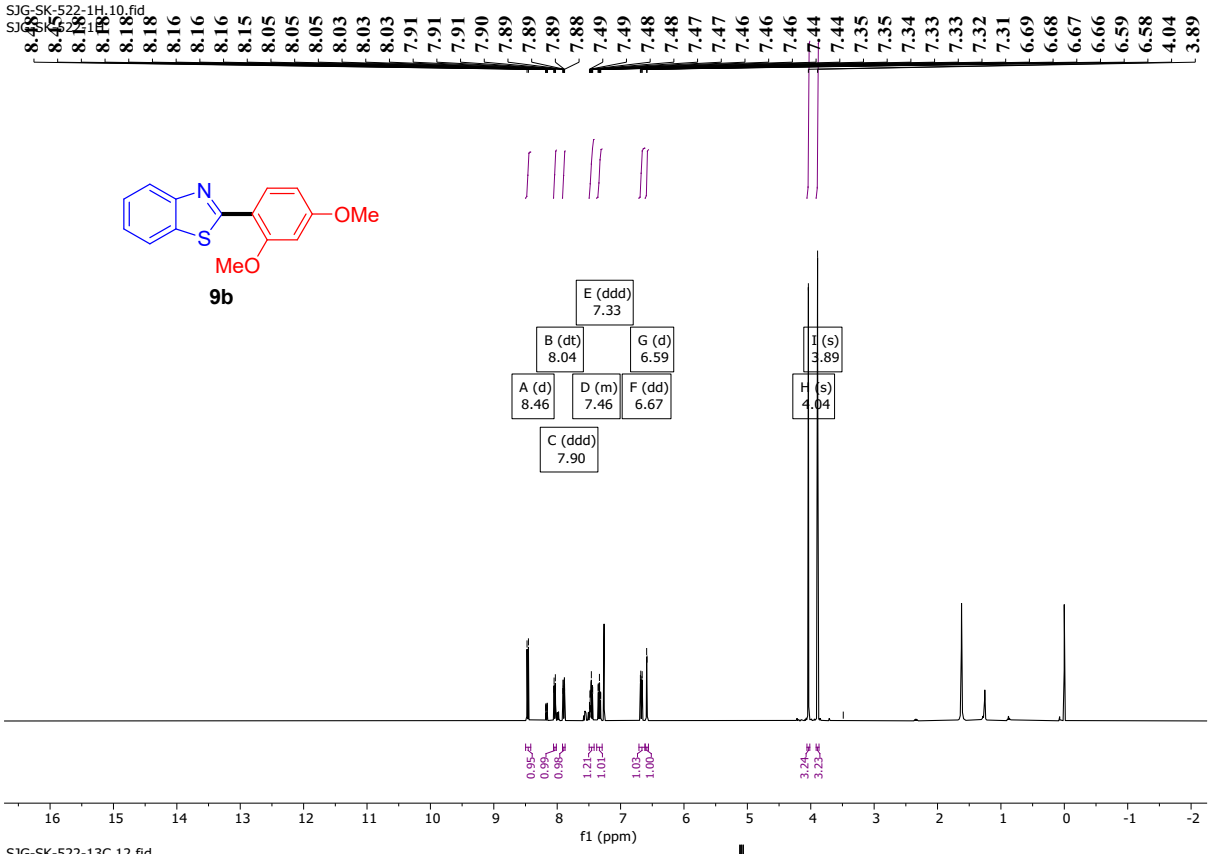
SJG-SK-531-13C.12.fid
SJG-SK-531-13C

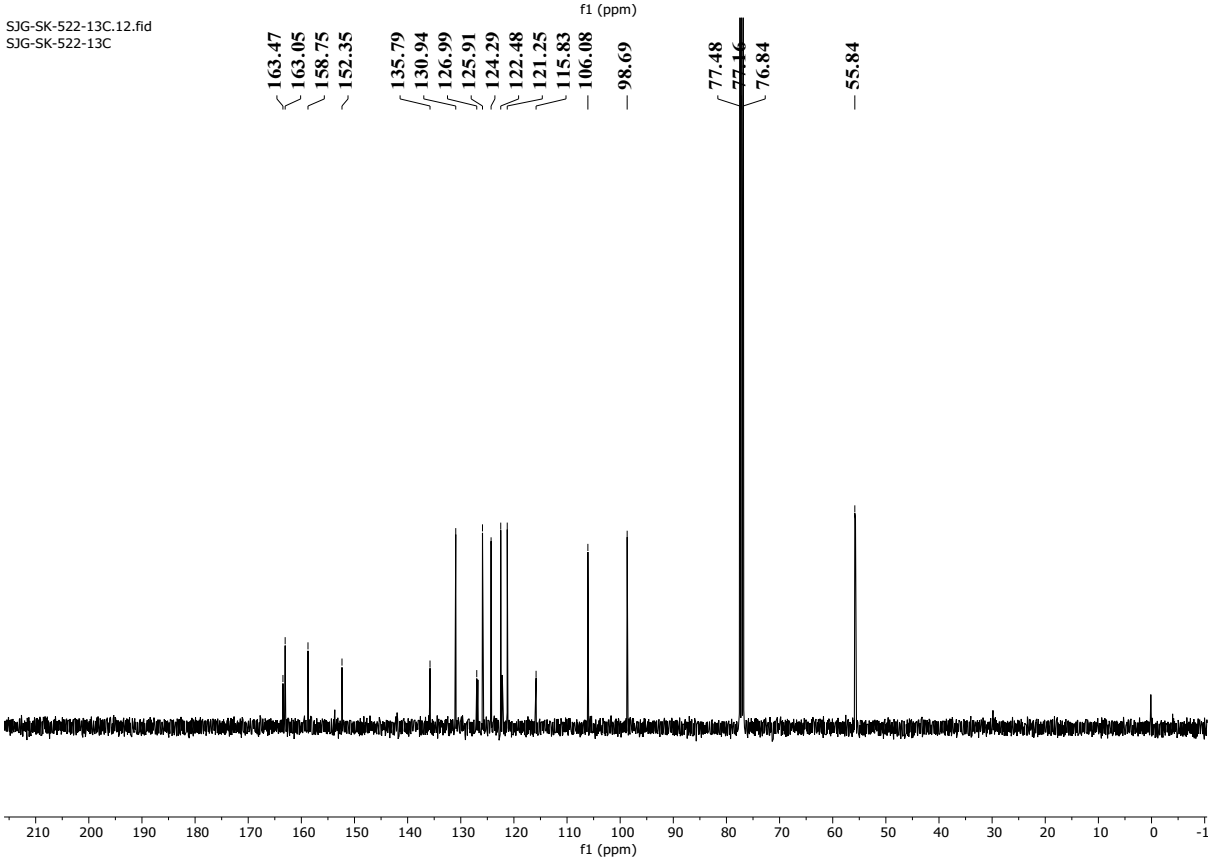


SJG-SK-531-1F.10.fid
SJG-SK-531-1F

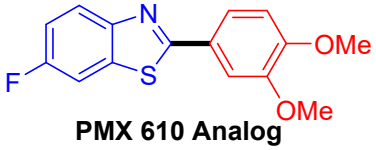



ARK-SK-502-1H.1.fid
ARK-SK-502-1H
7.96 7.96 7.95 7.94 7.93 7.93 7.79 7.79 7.79 7.77 7.77 7.40 7.40 7.39 7.38 7.38 7.38 7.36 7.36 7.28 7.28 7.26 7.26 7.26 7.24 7.24 6.93 6.92 6.91 6.90 6.90 6.89 3.78
N
S
OMe
9a
D (ddd) 7.26
B (m) 7.78
A (m) 7.94
E (m) 6.91
C (ddd) 7.38
F (s) 3.78
2.97
0.96
1.07
0.96
2.04
2.93
f1 (ppm)
ARK-SK-502-13C.3.fid
ARK-SK-502-13C
168.00 162.06 154.35 134.99 129.24 126.57 126.33 124.92 122.95 121.63 114.50 77.48 77.16 76.84 55.58
f1 (ppm)


SJG-SK-522-1H.10.fid
SJG-SK-522-1H
8.46 8.46 8.22 8.18 8.18 8.16 8.16 8.16 8.15 8.05 8.05 8.05 8.03 8.03 8.03 7.91 7.91 7.91 7.90 7.89 7.89 7.89 7.88 7.49 7.49 7.48 7.48 7.47 7.47 7.46 7.46 7.46 7.44 7.44 7.35 7.35 7.34 7.33 7.33 7.32 7.31 6.69 6.68 6.67 6.66 6.59 6.58 4.04 3.89
N
S
OMe
MeO
9b
E (ddd) 7.33
B (dt) 8.04
G (d) 6.59
I (s) 3.89
A (d) 8.46
D (m) 7.46
F (dd) 6.67
H (s) 4.04
C (ddd) 7.90
0.95
0.99
0.98
1.21
1.01
1.03
1.00
3.24
3.23
f1 (ppm)

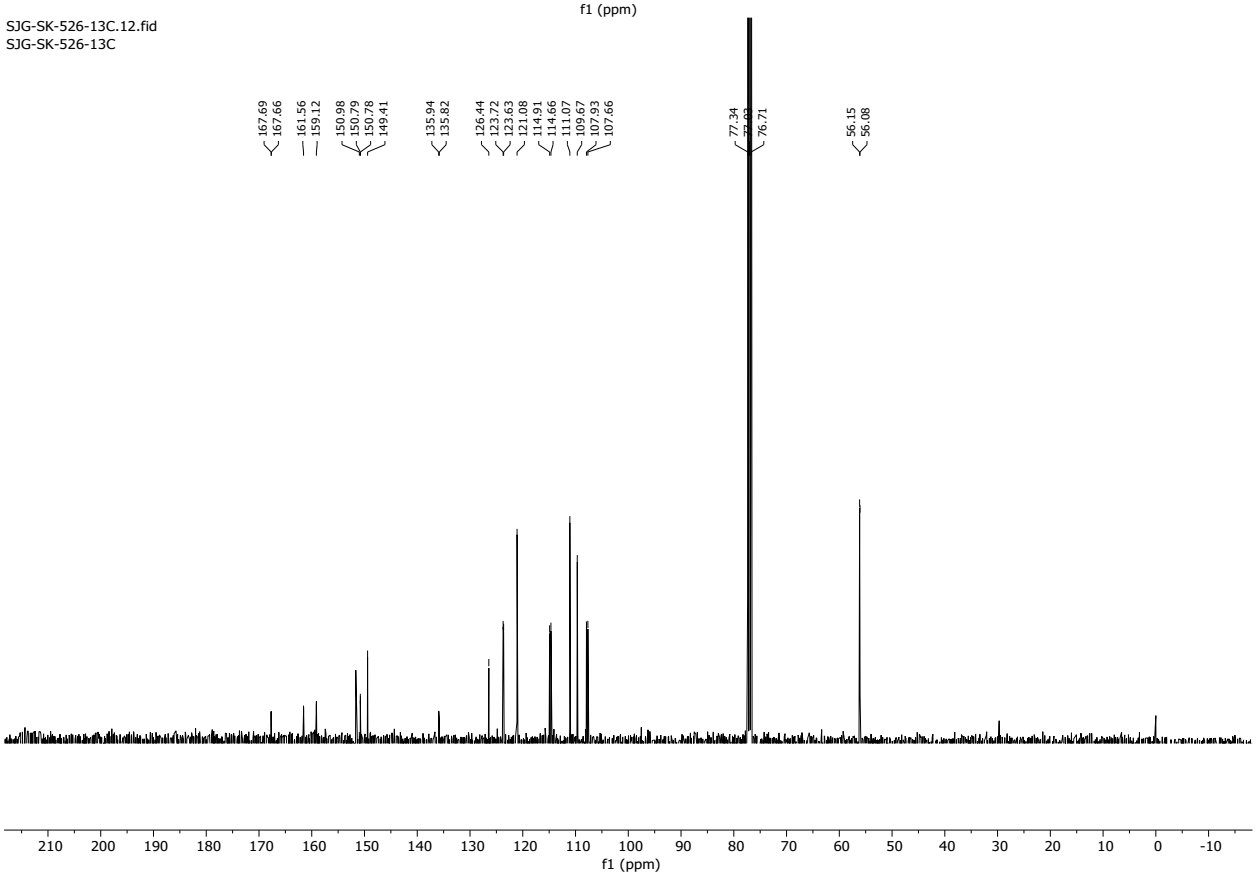

SJG-SK-522-13C.12.fid
SJG-SK-522-13C
163.47 163.05 158.75 152.35 135.79 130.94 126.99 125.91 124.29 122.48 121.25 115.83 106.08 98.69 77.48 77.16 76.84 55.84
f1 (ppm)

SJG-SK-526-1H.10.fid
SJG-SK-526-1H

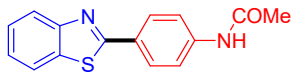


PMX 610 Analog 12

SJG-SK-526-13C.12.fid
SJG-SK-526-13C

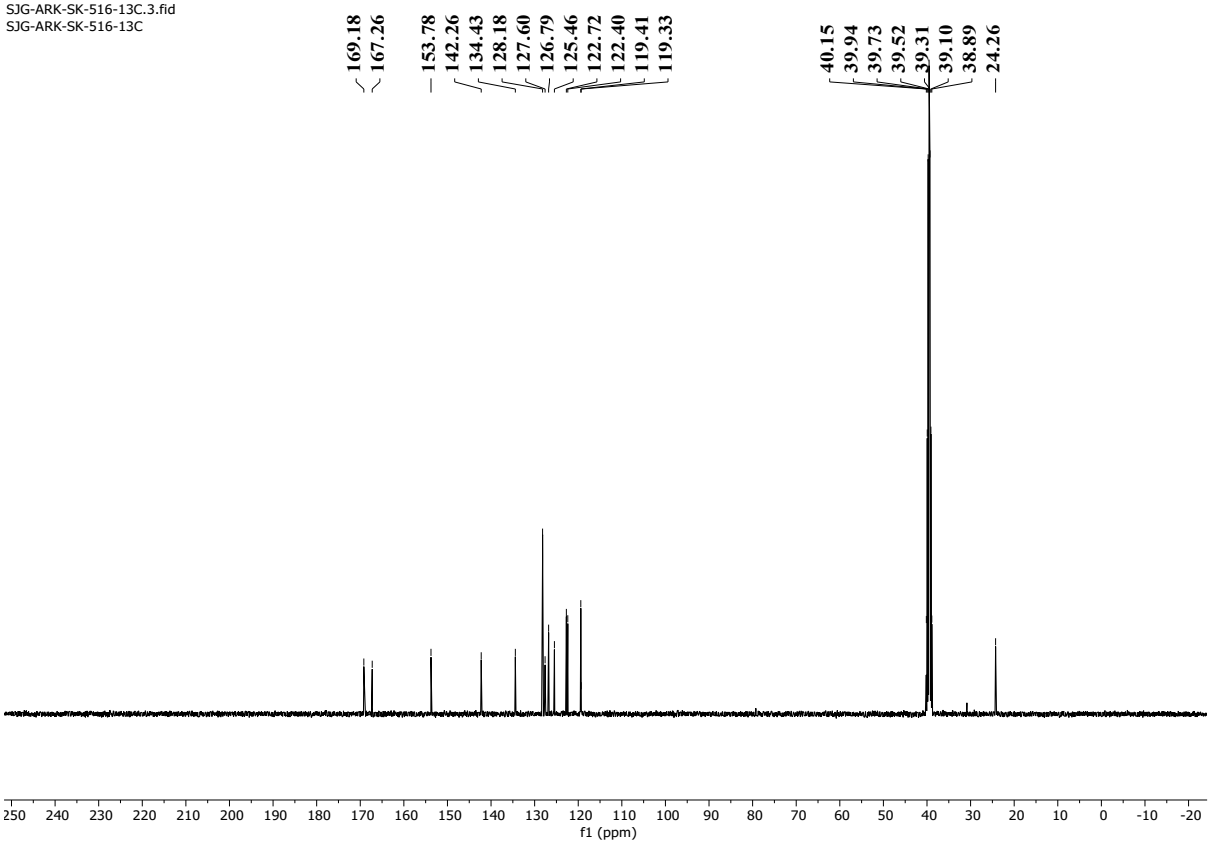


SJG-ARK-SK-516-1H.1.fid
SJG-ARK-SK-516-1H

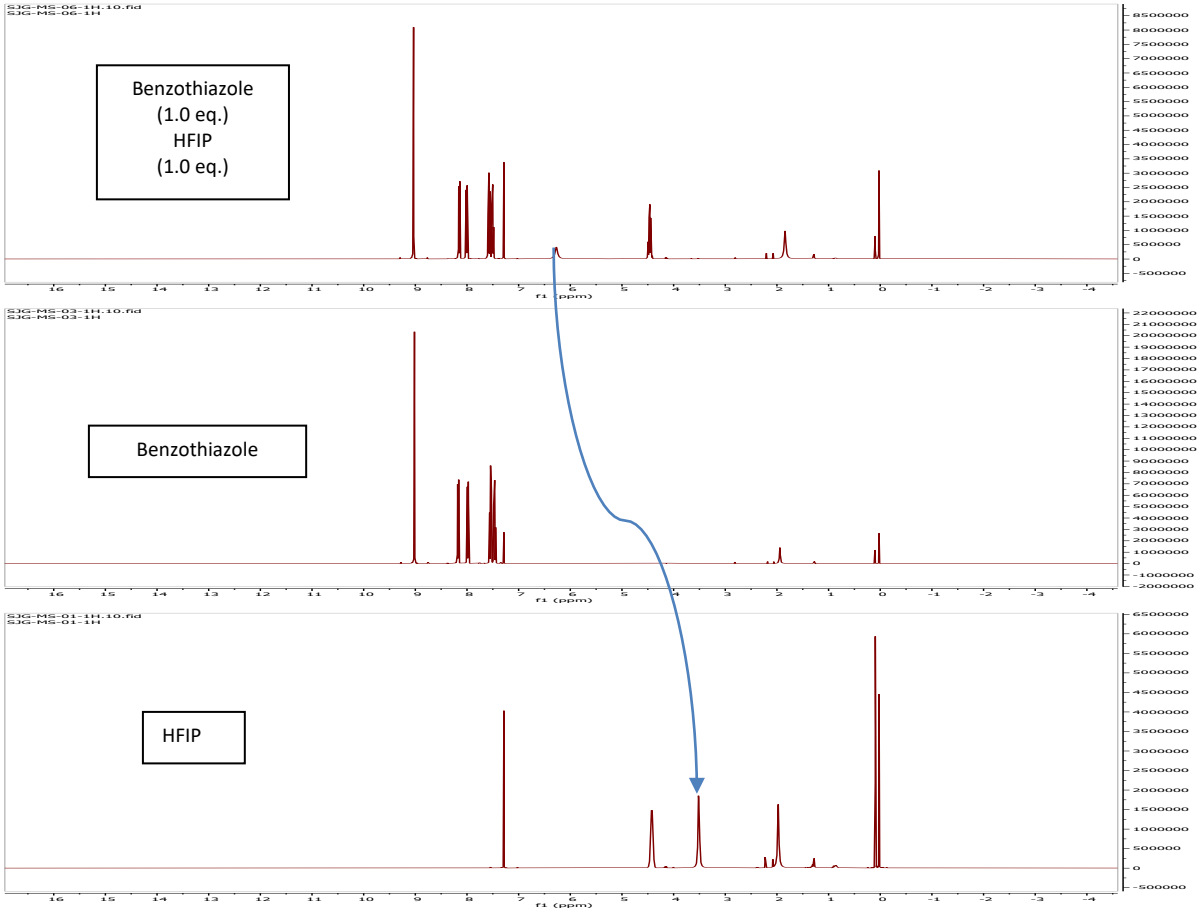


15

SJG-ARK-SK-516-13C.3.fid
SJG-ARK-SK-516-13C

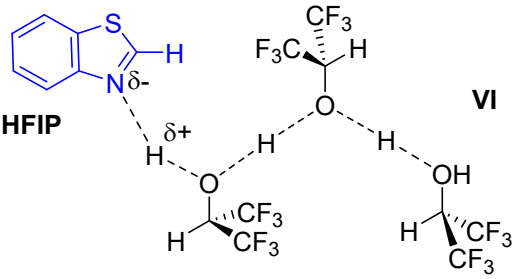


1. ^{1}H NMR of Benzothiazole, HFIP and binary mixture.



The most significant changes found in ^{1}H NMR, for the binary mixture compared to the individual species, are the downfield shift (de-shielded) of the O-H proton, from a chemical shift value of δ 3.52 ppm to 6.27 ppm (Δδ = 2.75).

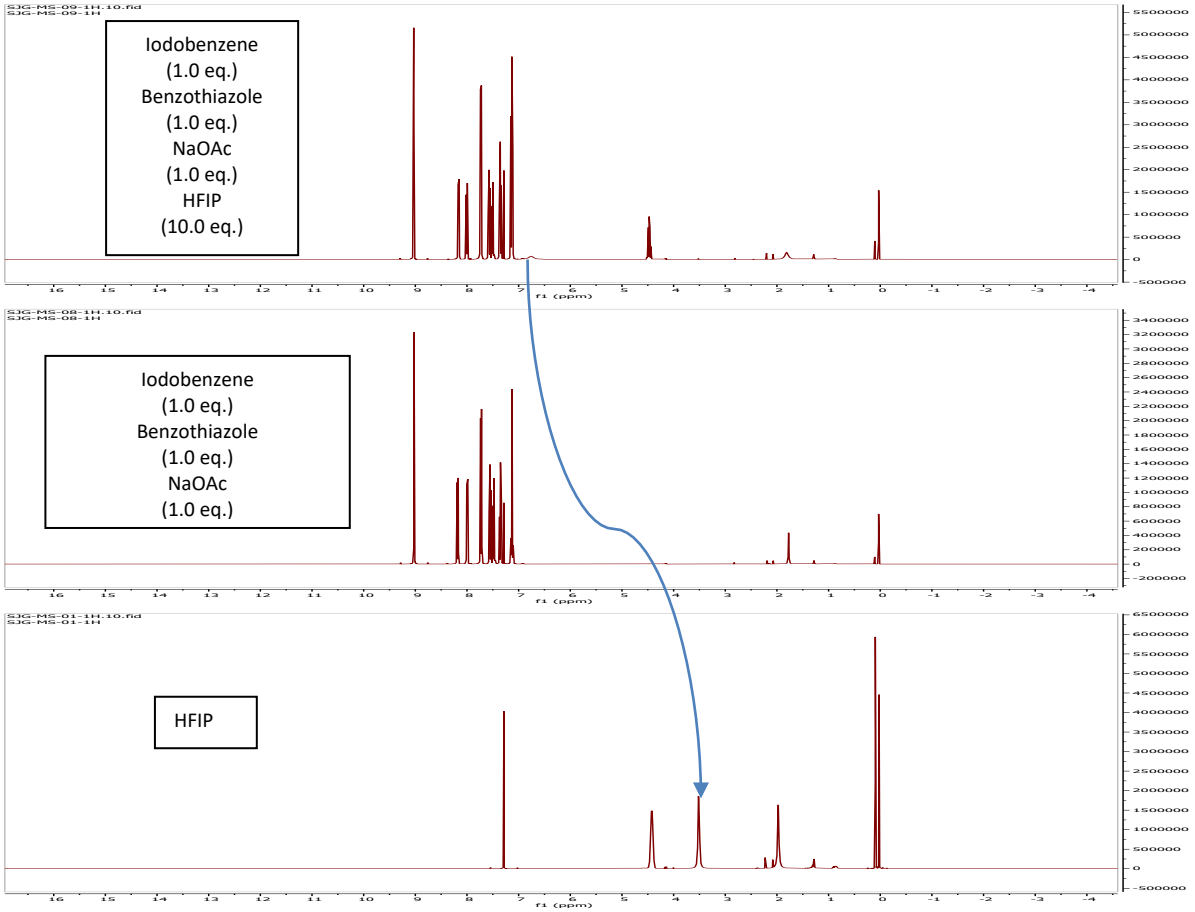
Possible role of HFIP



VI

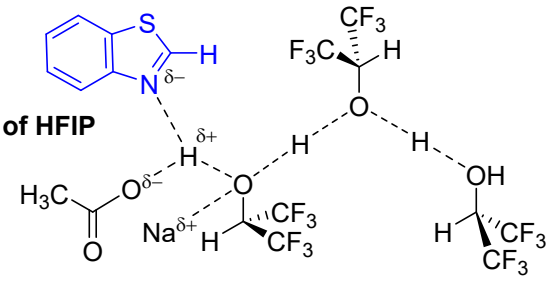
These data support a H-bonding between the nitrogen atom of the benzothiazole and the exceptionally good hydrogen bond donor HFIP.

2. ^{1}H NMR of HFIP, mixture of: a) Iodobenzene+Benzothiazole+NaOAc+HFIP, b) Iodobenzene+Benzothiazole+NaOAc c) only HFIP



The most significant changes found in ^{1}H NMR, for the mixture containing HFIP compared to the one without HFIP, are the downfield shift (deshieled) of the OH, from a frequency of δ 3.52 to 6.84 ppm (Δδ = 3.32).

Possible role of HFIP



These data follows a similar trend like the binary mixtures and support a H-bonding between the benzothiazole and the sodium acetate with the hydrogen bond donor HFIP.