An Unexpected, Thermal-Ring-Rearrangement of Benzochromenes to Inden-3-yl-naphthols with *p*TsOH

Srinivasarao Yaragorla*, Tabassum Khan

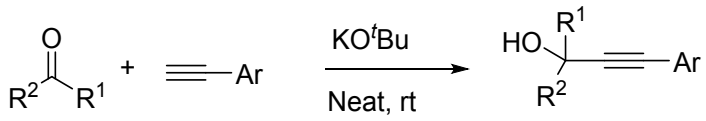
School of Chemistry, University of Hyderabad, P.O. Central University, Gachibowli, Hyderabad, 500046, India.

Table of Contents **Page no**

I. General Information: Unless otherwise noted, all reagents were used as received from commercial suppliers. *p*TsOH, $Ca(OTf)_2$ and Bu_4NPF_6 catalyst were obtained from Sigma-Aldrich and used without further purification. Reactions were performed in flame-dried or oven-dried glassware with magnetic stirring. Reactions were monitored using thin-layer chromatography (TLC) with aluminium sheets silica gel 60 F_{254} from Merck. TLC plates were visualized with UV light (254 nm), iodine treatment or using *p*-anisaldehyde or $KMnO_4$ stain. Column chromatography was carried out using silica gel 60−120 mesh as stationary phase. NMR spectra were recorded at 500 MHz and 400 MHz (^{1}H) and at 125 MHz and 100 MHz (^{13}C), respectively on Avance Bruker spectrometer. Chemical shifts (δ) are reported in ppm, using the residual solvent peak in $CDCl_3$ (^{1}H: δ = 7.26 and ^{13}C: δ = 77.16 ppm) as internal standard, and coupling constants (*J*) are given in Hz. HRMS were recorded using ESI-TOF techniques. Melting points were measured with LABINDIA mepa melting apparatus.

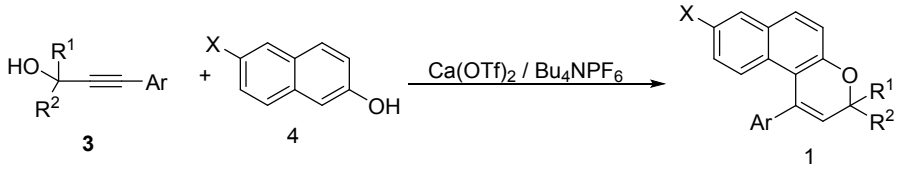
II. General experimental procedures

II.1. General experimental procedure for the synthesis of aryl propargylic alcohol (3)[1]: A mixture of aryl alkyne (1.2 equiv), *t*-BuOK (1.5 equiv) and respective ketone (1 equiv) were placed into a reaction flask at room temperature under nitrogen atmosphere and the mixture was stirred for 2−6h. After completion of the reaction (monitored by TLC), the resulting mixture was quenched with water and extracted into ethyl acetate (thrice). Combined organic layers were washed with brine solution and dried over anhydrous Na_2SO_4 and the solvent was evaporated to obtain the pure compounds **3** in good yield.

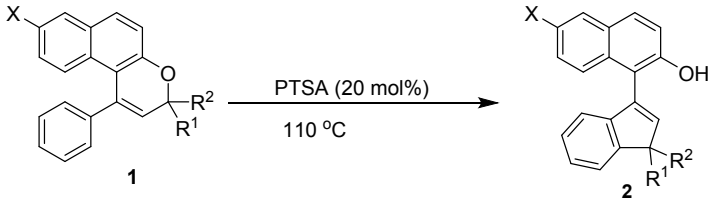


3

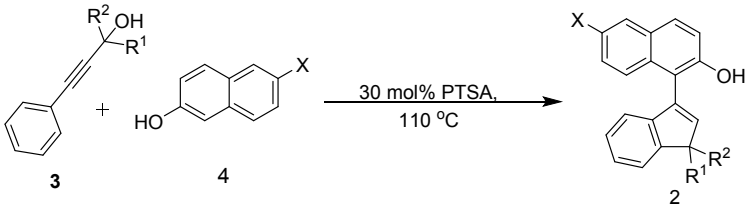
II.2. General experimental procedure for the synthesis of Benzochromene (1)[2]: A mixture of aryl propargylic alcohol **3** (1 equiv) and respective naphthol **4** (1.2 equiv) were heated at 110 °C in presence of $Ca(OTf)_2$ / Bu_4NPF_6 (2 mol% /10 mol%) for 1−2h. After completion of the reaction (monitored by TLC), the crude product was purified by silica gel column chromatography (3−5 % EtOAc in pet ether) to obtain the desired product **1** in good yield.



II.3. General experimental procedure for the synthesis of inden-3-yl-napthols (2) from Benzochromenes (1): Benzochromenes (1 equiv) were treated with PTSA (20 mol%) at 110 °C in solvent free condition for 1.5−3h. After completion of the reaction (monitored by TLC), the crude product was purified by silica gel column chromatography (0−5 % EtOAc in pet ether) to obtain the desired product **2** in moderate to good yield.



II.4. General experimental procedure for the synthesis of inden-3-yl-napthols (2) from aryl propargylic alcohol (3) and naphthol (4): A mixture of aryl propargylic alcohol **3** (1 equiv) and respective naphthol **4** (1.2 equiv) were heated at 110 °C in presence of PTSA (20 mol%) for 3−4h. After completion of the reaction (monitored by TLC), the crude product was purified by silica gel column chromatography (0−5 % EtOAc in pet ether) to obtain the desired product **2** in moderate to good yield.



III. Spectral Data of Synthesized Compounds

1a[2], **1f**[2], **1g**[2], **1i**[2], **1j**[2], **1k**[2], **1m**[2], **1p**[2], **1q**[3], **1t**[3,4], **1v**[2], **8**[5] are reported.

3,3-dimethyl-1-(p-tolyl)-3H-benzo[f]chromene (1b). Following general experimental procedure II.2; white solid, Mp: 159−160 °C; yield: 91% (0.158 g); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.71 (d, J = 10.5 Hz, 2H), 7.22−7.17 (m, 2H), 7.15−7.13 (m, 1H), 7.12−7.08 (m, 3H), 7.07−7.02 (m , 2H), 5.67 (s, 1H), 2.37 (s, 3H), 1.49 (s, 6H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 153.1, 138.7, 137.1, 135.4, 130.3, 130.2 (2), 130.0, 129.2, 128.4, 127.7, 126.5, 125.0, 123.0,

118.9, 116.2, 75.4, 26.5, 21.3 ppm; HRMS (ESI-TOF): *m/z* calculated for $C_{22}H_{20}O$ $[M+H]^+$ 301.1592, found 301.1591.

1-butyl-3,3-dimethyl-3H-benzo[f]chromene (1c). Following general experimental procedure II.2; yellow viscous liquid; yield: 93% (0.148 g); ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.71 (d, J = 8.5 Hz, 2H), 7.18 (d, J = 9.0 Hz, 2H), 7.14−7.09 (m, 4H), 7.04−7.01 (m, 1H), 5.68 (s, 1H), 2.63 (t, J = 7.5 Hz, 2H), 1.64−1.58 (m, 2H), 1.49 (s, 6H), 1.39−1.34 (m, 2H), 0.93 (t, J = 7.5 Hz, 4H) ppm; ^{13}C NMR (125 MHz, $CDCl_3$): δ 153.1, 142.1, 138.9, 135.4, 130.3, 130.2, 130.1 (2), 128.5, 128.4, 127.8, 126.6, 125.0, 123.0, 118.9, 116.3, 75.4, 35.5, 33.7, 26.5, 22.5, 14.1 ppm; HRMS (ESI-TOF): *m/z* calculated for $C_{25}H_{26}O$ $[M+H]^+$ 343.2061, found 343.2061.

1-([1,1'-biphenyl]-4-yl)-3,3-dimethyl-3H-benzo[f]chromene (1d). Following general experimental procedure II.2; pale yellow solid, Mp: 156−157 ^{o}C; yield: 90% (0.139 g); ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.72 (d, J = 8.5 Hz, 2H), 7.62 (dd, J_1 = 1.5, J_2 = 8.5, 2H), 7.54 (d, J = 8.5 Hz, 2H), 7.43 (t, J = 7.5 Hz, 2H), 7.33 (t, J = 7.5 Hz, 1H), 7.26 (d, J = 8.0 Hz, 2H), 7.22−7.18 (m, 3H), 7.07−7.03 (m, 1H), 5.75 (s, 1H), 1.51 (s, 6H) ppm; ^{13}C NMR (125 MHz, $CDCl_3$): δ 153.2, 140.8, 140.7, 140.1, 135.2, 130.7, 130.5, 130.2, 130.0, 128.9, 128.5, 128.3, 127.4, 127.1 (2), 126.5, 125.2, 123.1, 118.9, 116.1, 75.4, 26.5 ppm; HRMS (ESI-TOF): *m/z* calculated for $C_{27}H_{22}O$ $[M+H]^+$ 363.1748, found 363.1751.

1-ethoxy-3,3-dimethyl-3H-benzo[f]chromene (1e). Following general experimental procedure II.2; yellow solid, Mp: 100−101 ^{o}C; yield: 87% (0.142 g); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.72−7.70 (m, 2H), 7.21−7.16 (m, 3H), 7.11−7.03 (m, 3H), 6.83 (dd, J_1 = 2.0 Hz, J_2 = 6.4 Hz, 2H), 5.65 (s, 1H), 4.05 (q, J = 7.2 Hz, 2H), 1.49 (s, 6H), 1.45−1.41 (t, J = 7.2 Hz, 3H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 158.4, 153.1, 135.0, 133.9, 130.3,130.2, 130.1, 129.6, 129.0, 128.4, 126.5, 125.0, 123.0, 118.9, 116.3, 114.4, 75.4, 63.5, 26.5, 15.0 ppm; HRMS (ESI-TOF): *m/z* calculated for $C_{23}H_{22}O_2$ $[M+H]^+$ 331.1697, found 331.1699.

3-hexyl-3-methyl-1-phenyl-3H-benzo[f]chromene (1h). Following general experimental procedure II.2; pale yellow viscous liquid; yield: 89% (0.138 g); ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.70 (d, J = 8.5 Hz, 2H), 7.31−7.29 (m, 3H), 7.21−7.17 (m, 4H), 7.08 (d, J = 8.5 Hz, 1H), 7.03−6.99 (m, 1H), 5.68 (s, 1H), 1.80−1.76 (m, 2H), 1.45 (s, 5H), 1.27−1.24 (m, 6H), 0.86−0.83 (m, 3H) ppm; ^{13}C NMR (125 MHz, $CDCl_3$): δ 153.1, 141.9, 135.7, 130.4, 130.2, 130.0, 128.5, 128.0, 127.3, 126.5, 125.0, 122.9, 118.9, 116.2, 77.7, 39.3, 31.9, 31.7, 29.8, 24.2, 24.0, 22.8, 22.7, 14.2, 14.1 ppm; HRMS (ESI-TOF): *m/z* calculated for $C_{26}H_{28}O$ $[M+H]^+$ 357.2218, found 357.2219.

1-([1,1'-biphenyl]-4-yl)-8-bromo-3,3-dimethyl-3H-benzo[f]chromene (1l). Following general experimental procedure II.2; pale yellow solid, Mp: 167−168 ^{o}C; yield: 91% (0.172 g); ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.87 (d, J = 2.0 Hz, 1H), 7.62 (d, J = 9.0 Hz, 3H), 7.55 (d, J = 8.0 Hz, 2H), 7.43 (t, J = 7.5 Hz, 2H), 7.34 (t, J = 7.0 Hz, 1H), 7.23−7.20 (m, 3H), 7.12−7.10 (m, 1H), 7.05 (d, J = 9.5 Hz, 1H), 5.76 (s, 1H), 1.51 (s, 6H) ppm; ^{13}C NMR (125 MHz, $CDCl_3$): δ 153.5, 140.7, 140.4, 140.2, 134.8, 131.5, 131.0, 130.3, 129.5, 128.9, 128.5, 128.4, 128.3, 128.2, 127.5, 127.2, 127.1, 120.0, 116.9, 116.3, 75.7, 26.5 ppm; HRMS (ESI-TOF): *m/z* calculated for $C_{27}H_{21}BrO$ $[M+H]^+$ 441.0853, found 441.0867.

8-bromo-3,3-dimethyl-1-(p-tolyl)-3H-benzo[f]chromene (1n). Following general experimental procedure II.2; pale yellow solid, Mp: 170−171 °C; yield: 87% (0.193 g); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.85 (d, J = 2.0 Hz, 1H), 7.61 (d, J = 8.8 Hz, 1H), 7.19 (d, J = 8.8 Hz, 1H), 7.13−7.11 (m, 2H), 7.09 (d, J = 2.0 Hz, 1H), 7.06−7.04 (m, 2H), 7.00 (d, J = 9.2 Hz, 1H), 5.68 (s, 1H), 2.37 (s, 3H), 1.48 (s, 6H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 153.3, 138.3, 137.3, 134.9, 131.4, 130.5, 130.2, 129.3 (2), 128.5, 128.2, 127.7, 120.0, 116.8, 116.5, 75.6, 26.5, 21.3, 14.2 ppm; HRMS (ESI-TOF): *m/z* calculated for $C_{22}H_{19}BrO$ $[M+H]^+$ 379.1673, found 379.1690.

8-bromo-3-hexyl-3-methyl-1-phenyl-3H-benzo[f]chromene (1o). Following general experimental procedure II.2; yellow viscous liquid; yield: 78% (0.149 g); ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.85 (d, J = 2.5 Hz, 1H), 7.60 (d, J = 9.0 Hz, 1H), 7.32−7.29 (m, 3H), 7.20 (s, 1H), 7.18−7.15 (m, 2H), 7.08−7.05 (dd, J_1 = 2.0 Hz, J_2 = 9.0 Hz, 1H), 6.93 (d, J = 9.5 Hz, 1H), 5.69 (s, 1H), 1.79−1.75 (m, 2H), 1.44 (s, 4H), 1.27−1.24 (m, 6H), 0.86−0.83 (m, 3H) ppm; ^{13}C NMR (125 MHz, $CDCl_3$): δ 153.4, 141.5, 135.2, 131.4, 130.5, 130.3, 129.4, 128.6, 128.5, 128.2, 128.1, 127.9, 127.5, 120.0, 116.7, 116.4, 78.0, 39.3, 31.8, 29.7, 24.2, 24.0, 22.7, 14.1 ppm; HRMS (ESI-TOF): *m/z* calculated for $C_{26}H_{27}BrO$ $[M+H]^+$ 435.1323, found 435.1323.

8-bromo-1-phenylspiro[benzo[f]chromene-3,1'-cycloheptane (1r). Following general experimental procedure II.2; pale yellow solid, Mp: 134−135 °C; yield: 89% (0.177 g); ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.77 (d, J = 2.0 Hz, 1H), 7.52 (d, J = 11.5 Hz, 1H), 7.25−7.22 (m, 3H), 7.14 (d, J = 9.0 Hz, 1H), 7.10−7.08 (m, 2H), 6.99 (dd, J_1 = 2.0 Hz, J_2 = 9.0 Hz, 1H), 6.85 (d, J = 9.5 Hz, 1H), 5.65 (s, 1H), 2.07−2.02 (m, 2H), 1.82−1.77 (m, 2H), 1.67−1.56 (m, 4H), 1.54−1.51 (m, 2H), 1.44−1.39 (m, 2H) ppm; ^{13}C NMR (125 MHz, $CDCl_3$): δ 153.1, 141.6, 134.4, 131.8, 131.4, 130.3, 129.3, 128.6, 128.5, 128.2, 128.1, 127.9, 127.5, 120.1, 116.8, 116.7, 80.5, 37.9, 29.2, 21.9 ppm; HRMS (ESI-TOF): *m/z* calculated for $C_{25}H_{23}BrO$ $[M+H]^+$ 419.1010, found 419.1011.

8-bromo-1-phenylspiro[benzo[f]chromene-3,1'-cyclooctane] (1s). Following general experimental procedure II.2; pale yellow viscous liquid; yield: 84% (0.162 g); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.77 (d, J = 2.4 Hz, 1H), 7.53 (d, J = 8.8 Hz, 1H), 7.25−7.23 (m, 3H), 7.14 (s, 1H), 7.12−7.08 (m, 2H), 6.99 (dd, J_1 = 2.0 Hz, J_2 = 9.2 Hz, 1H), 6.85 (d, J = 9.2 Hz, 1H), 5.67 (s, 1H), 2.11−2.05 (m, 2H), 1.83−1.77 (m, 2H), 1.71−1.48 (m, 10H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 153.0, 141.6, 134.9, 131.4, 131.0, 129.4, 128.6, 128.5, 128.3, 128.2, 128.0, 127.9, 127.5, 120.0, 116.8, 116.7, 80.2, 32.7, 28.3, 24.8, 21.4 ppm; HRMS (ESI-TOF): *m/z* calculated for $C_{26}H_{25}BrO$ $[M+H]^+$ 433.1166, found 433.1125.

4-phenylspiro[benzo[h]chromene-2,9'-fluorene] (1u). Following general experimental procedure II.2; pale yellow viscous liquid; yield: 76% (0.110 g); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.69 (d, J = 8.8 Hz, 1H), 7.65 (d, J = 8.0 Hz, 1H), 7.55−7.52 (m, 3H), 7.33 (t, J = 4.0 Hz, 6H), 7.26 (t, J = 6.4 Hz, 4H), 7.23−7.18 (m, 1H), 7.17−7.13 (m, 1H), 7.07 (d, J = 8.4 Hz, 1H), 7.00−6.96 (m, 1H), 6.18 (s, 1H) ppm ; ^{13}C NMR (100 MHz, $CDCl_3$): δ 152.7, 144.6, 141.4, 137.3, 130.9, 130.4, 130.2, 129.9, 129.5, 129.3, 128.6, 128.5, 128.4, 128.2, 128.1, 127.7, 127.6, 127.2, 126.6, 125.1, 123.2, 118.8, 116.7, 82.2 ppm; HRMS (ESI-TOF): *m/z* calculated for $C_{31}H_{20}O$ $[M+H]^+$ 409.1592, found 409.1581.

1-(p-tolyl)spiro[benzo[f]chromene-3,1'-cyclohexane] (1w). Following general experimental procedure II.2; pale yellow viscous liquid; yield: 86% (0.137 g); ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.63 (d, J = 8.5 Hz, 2H), 7.16 (s, 1H), 7.132−7.10 (m, 1H), 7.06 (t, J = 8.5 Hz, 1H), 7.03−7.00 (m, 4H), 6.98−6.94 (m, 1H), 5.63 (s, 1H), 2.29 (s, 3H), 1.86 (t, J = 6.0 Hz, 2H), 1.69−1.59 (m, 4H), 1.37−1.34 (m, 1H), 1.22−1.18 (m, 1H), 0.82−0.76 (m, 2H) ppm; ^{13}C NMR (125 MHz, $CDCl_3$): δ 152.9, 139.0, 137.0, 135.6, 130.2, 130.1, 129.6, 129.1, 128.4, 127.8, 126.5, 125.0, 122.9, 118.9, 117.0, 76.4, 34.8, 34.7, 31.7, 25.6, 22.7, 22.0, 21.3, 14.2 ppm; HRMS (ESI-TOF): *m/z* calculated for $C_{25}H_{24}O$ $[M+H]^+$ 341.1905, found 341.1906.

4-phenylspiro[benzo[h]chromene-2,1'-cycloheptane] (1x). Following general experimental procedure II.2; pale yellow viscous liquid; yield: 82% (0.131 g); ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.24−8.22 (m, 1H), 7.66−7.64 (m, 1H), 7.40−7.34 (m, 2H), 7.33−7.29 (m, 5H), 7.21 (d, J = 8.5 Hz, 1H), 7.07 (d, J = 8.5, 1H), 5.58 (s, 1H), 2.23−2.18 (m, 2H), 1.82−1.79 (m, 3H), 1.70−1.66 (m, 2H), 1.56−1.53 (m, 2H), 1.45−1.39 (m, 3H) ppm; ^{13}C NMR (125 MHz, $CDCl_3$): δ 148.7, 138.9, 134.5, 134.4, 128.7, 127.7, 127.6, 126.4, 125.6, 125.4, 123. 5, 122.4, 119.5, 117.1, 81.2, 39.0, 29.4, 21.6 ppm; HRMS (ESI-TOF): *m/z* calculated for $C_{25}H_{24}O$ $[M+H]^+$ 341.1905, found 341.1904.

1-(phenanthren-9-yl)spiro[benzo[f]chromene-3,1'-cyclohexane] (1y). Following general experimental procedure II.2; pale yellow solid, Mp: 212−213 ^{o}C; yield: 93% (0.132 g); ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.60 (t, J = 8.0 Hz, 2H), 7.76 (d, J = 8.0 Hz, 1H), 7.66−7.61 (m, 3H), 7.58−7.49 (m, 3H), 7.43 (t, J = 7.0 Hz, 1H), 7.23−7.17 (m, 2H), 7.13−7.12 (m, 1H), 6.92 (t, J = 7.5 Hz, 1H), 6.60 (t, J = 7.5, 1H), 5.78 (s, 1H), 1.98 (m, 2H), 1.83−1.66 (m, 5H), 1.45−1.38 (m, 3H) ppm; ^{13}C NMR (125 MHz, $CDCl_3$): δ 151.9, 139.1, 134.3, 132.0, 131.9, 131.1, 130.5, 130.4, 130.3, 130.0, 128.7, 128.4, 126.9, 126.8, 126.7 (2), 126.6, 125.8, 124.7, 123.0, 122.9, 122.7, 119.1, 117.7, 76.3, 35.7, 34.1, 25.6, 22.0, 21.9 ppm; HRMS (ESI-TOF): *m/z* calculated for $C_{32}H_{26}O$ $[M+H]^+$ 427.2061, found 427.2061.

1-(1,1-dimethyl-1H-inden-3-yl)naphthalen-2-ol (2a). Following general experimental procedure II.3; yellow solid, Mp: 130−131 ^{o}C; yield: 95% (0.095 g); ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.81 (d, J = 8.8 Hz, 2H), 7.54−7.51 (m, 1H), 7.46 (d, J = 7.6 Hz, 1H), 7.34−7.26 (m, 4H), 7.15 (t, J = 7.2 Hz, 1H), 6.86 (d, J = 8 Hz, 1H), 6.61 (s, 1H), 5.46 (s, 1H), 1.53 (d, J = 8 Hz, 6H) ppm; ^{13}C NMR (125 MHz, $CDCl_3$): δ 153.9, 150.9, 149.1,142.3, 134.5, 133.0, 129.8, 129.0, 128.2, 126.8, 126.5, 126.3, 125.0, 123.4, 121.6, 121.6, 117.4, 114.0, 49.8, 25.0, 24.9 ppm; IR (KBr): $\breve{\upsilon}$ 3519, 2956, 1621, 1166, 750 cm^{-1}; HRMS (ESI-TOF): *m/*z calculated for $C_{21}H_{18}O$ $[M+Na]^+$ 309.1255, found 309.1245.

1-(1,1,6-trimethyl-1H-inden-3-yl)naphthalen-2-ol (2b). Following general experimental procedure II.3; white solid, Mp: 141−142 ^{o}C; yield: 93% (0.093 g); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.82−7.78 (m, 2H), 7.55−7.52 (m, 1H), 7.33−7.26 (m, 4H), 6.97 (d, J = 7.2 Hz, 1H), 6.74 (d, J = 8 Hz, 1H), 6.54 (s, 1H), 5.49 (s, 1H), 2.41 (s, 3H), 1.52 (d, J = 4.8 Hz, 6H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 154.3, 150.9, 148.3, 139.7, 136.3, 134.4, 133.1, 129.7, 129.09, 128.3, 127.6, 126.5, 125.1, 123.5, 122.6, 121.4, 117.4, 114.3, 49.7, 25.2, 25.2, 21.7 ppm; HRMS (ESI-TOF): *m/*z calculated for $C_{22}H_{20}O$ $[M+Na]^+$ 323.1411, found 323.1411.

1-(6-butyl-1,1-dimethyl-1H-inden-3-yl)naphthalen-2-ol (2c). Following general experimental procedure II.3; yellow viscous liquid; yield: 87% (0.087 g); ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.80 (dd, J_1 = 3 Hz, J_2 = 9.5 Hz, 2H), 7.56−7.54 (m, 1H), 7.32−7.30 (m, 2H), 7.27 (d, J = 8.5 Hz, 2H), 6.96 (d, J = 7.5 Hz, 1H), 6.76 (d, J = 7.5 Hz, 1H), 6.54 (s, 1H), 5.48 (s, 1H),2.66 (t, J = 7.5 Hz, 2H), 1.66−1.60 (m, 2H), 1.52 (d, J = 6 Hz, 6H), 1.42−1.37 (m, 2H), 0.94 (t, J = 7.5 Hz, 3H) ppm; ^{13}C NMR (125 MHz, $CDCl_3$): δ 154.2, 150.9, 148.3, 141.5, 139.9, 134.4, 133.1, 129.7, 129.1, 128.3, 127, 126.5, 125.1, 123.4, 121.8, 121.3, 117.4, 114.4, 49.7, 36.1, 34.2, 25.3, 25.1, 22.7, 14.1 ppm; HRMS (ESI-TOF): *m/z* calculated for $C_{25}H_{26}O$ $[M+H]^+$ 343.2061, found 343.2061.

1-(1,1-dimethyl-6-phenyl-1H-inden-3-yl)naphthalen-2-ol (2d). Following general experimental procedure II.3; yellow viscous liquid; yield: 89% (0.089 g); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.71 (d, J = 8.8 Hz, 2H), 7.58 (d, J = 1.2, 1H), 7.53−7.51 (m, 2H), 7.35−7.27 (m, 4H), 7.27−7.18 (m, 4H), 6.82 (d, J = 7.6 Hz, 1H), 6.53 (s, 1H), 5.40 (s, 1H), 1.48 (d, J = 6.4 Hz, 6H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 154.6, 151, 149.5, 141.5, 141.6, 139.7, 134.3, 133, 129.9, 129.1, 128.9, 128.3, 127.4, 127.3, 126.6, 125, 123.5, 121.9, 120.6, 117.4, 114, 50, 25.2, 25.1 ppm; HRMS (ESI-TOF): *m/z* calculated for $C_{27}H_{22}O$ $[M+H]^+$ 363.1748, found 363.1748.

1-(6-ethoxy-1,1-dimethyl-1H-inden-3-yl)naphthalen-2-ol (2e). Following general experimental procedure II.3; colorless viscous liquid; yield: 79% (0.079 g); ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.81−7.78 (m, 2H), 7.56−7.54 (m, 1H), 7.33−7.31 (m, 2H), 7.26 (t, J = 9 Hz, 1H), 7.03 (d, J = 2 Hz, 1H), 6.74 (d, J = 8.5 Hz, 1H), 6.67−6.65 (m, 1H), 6.47 (s, 1H), 5.52 (s, 1H), 4.05 (q, J = 7 Hz, 2H), 1.51 (d, J = 7 Hz, 6H), 1.42 (t, J = 7 Hz, 3H) ppm; ^{13}C NMR (125 MHz, $CDCl_3$): δ 158.6, 156, 150.9, 146.9, 135, 134.2, 133, 129.7, 129.1, 128.3, 126.5, 125.1, 123.4, 122.2, 117.4, 114.3, 112.2, 109.3, 63.9, 49.7, 25.4, 25.3, 15.1 ppm; HRMS (ESI-TOF): *m/z* calculated for $C_{23}H_{22}O_2$ $[M+H]^+$ 331.1697, found 331.1697.

1-(1,1-diphenyl-1H-inden-3-yl)naphthalen-2-ol (2f). Following general experimental procedure II.3; yellow viscous liquid; yield: 53% (0.053 g); ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.74−7.72 (m, 2H), 7.48−7.46 (m, 1H), 7.43 (d, J = 7.5 Hz, 1H), 7.32 (d, J = 7.5 Hz, 2H), 7.27−7.24 (m, 3H), 7.24−7.21 (m, 5H), 7.19−7.17 (m, 3H), 7.15 (d, J = 7.5 Hz, 1H), 7.10 (t, J = 7.5 Hz, 1H), 6.93 (s, 1H), 6.83 (d, J = 7.5 Hz, 1H), 5.24 (s, 1H) ppm; ^{13}C NMR (125 MHz, $CDCl_3$): δ 151.2, 150.9, 147, 143.6, 143.4, 136.2, 133.1, 130.1, 129.1, 128.9, 128.8, 128.4, 127.9, 127.8, 127.6, 127.3, 127.2, 126.9, 126.9, 125.6, 125.1, 123.6, 122.4, 117.5, 113.7, 67.1 ppm; IR (KBr): $\breve{\upsilon}$ 3512, 3056, 1514, 1264, 697 cm^{-1}; HRMS (ESI-TOF): *m/z* calculated for $C_{31}H_{22}O$ $[M+Na]^+$ 433.1568, found 433.1563.

1-(1-methyl-1-phenyl-1H-inden-3-yl)naphthalen-2-ol (2g). Following general experimental procedure II.3; green viscous liquid; yield: 85% (0.085 g); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.83 (t, J = 6.4 Hz, 3H), 7.62−7.56 (m, 3H), 7.44 (d, J = 8.4 Hz, 2H), 7.38−7.31 (m, 13H), 7.28−7.24 (m, 5H), 7.18 (q, J = 3.2 Hz, 2H), 6.97−6.90 (m, 2H), 6.79 (s, 1H), 6.75 (s, 1H), 5.50 (s, 1H), 5.44 (s, 1H), 1.94 (d, J = 6.8 Hz, 6H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 153.8, 151.1, 151.0, 148.9, 148.5, 142.9, 142.6, 135.7, 135.2, 133, 130.1, 130.0, 129.2, 129.1, 129.0, 128.9, 128.4, 127.2, 127.0 (2), 126.9, 126.8, 126.7, 126.6, 126.3, 126.1, 125.1, 125.0, 123.6, 123.4, 123.3,

122.0, 122.0, 117.5, 117.4, 113.8, 57.2, 57.1, 23.9, 23.5 ppm; HRMS (ESI-TOF): *m/z* calculated for $C_{26}H_{20}O$ $[M+Na]^+$ 371.1412, found 371.1410.

1-(1-hexyl-1-methyl-1H-inden-3-yl)naphthalen-2-ol (2h). Following general experimental procedure II.3; white solid, Mp: 104−105 ^oC; yield: 76% (0.076 g); ^1H NMR (500 MHz, $CDCl_3$): δ 7.81 (t, J = 7.0 Hz, 4H), 7.55−7.50 (m, 2H), 7.41 (d, J = 2.5 Hz, 2H), 7.34-7.31 (m, 4H), 7.29−7.27 (m, 3H), 7.25 (d, J = 6.5 Hz, 1H), 7.15 (t, J = 7.5 Hz, 2H), 6.85 (d, J = 2.5 Hz, 1H), 6.83 (d, J = 2.5 Hz, 1H), 6.58 (s, 1H), 6.55 (s, 1H), 5.50 (s, 1H), 5.47 (s, 1H), 1.98−1.89 (m, 4H), 1.55 (s, 2H), 1.51 (d, J = 8.0 Hz, 6H), 1.24−1.22 (m, 14H), 0.85−0.83 (m, 6H) ppm; ^{13}C NMR (125 MHz, $CDCl_3$): δ 153.0, 152.9, 150.9, 147.7, 147.6, 143.1, 135.6, 135.4, 133.0, 129.8, 129.0, 128.2, 126.8 (2), 126.5, 126.4, 126.2, 125.2, 125.0, 123.8, 121.8, 121.7, 121.6, 121.5, 117.4, 117.3, 114.3, 53.7, 38.9, 38.5, 31.8, 31.7, 29.9, 25.5, 25.4, 24.3, 24.2, 22.7, 22.6, 14.1 ppm; IR (KBr): $\breve{\upsilon}$ 3513, 2913, 1594, 1125, 753 cm^{-1}; HRMS (ESI-TOF): *m/z* calculated for $C_{26}H_{28}O$ $[M+H]^+$ 357.2218, found 357.2218.

2-(1,1-dimethyl-1H-inden-3-yl)naphthalen-1-ol (2i). Following general experimental procedure II.3; yellow solid, Mp: 130−131 ^oC; yield: 90% (0.090g); ^1H NMR (500 MHz, $CDCl_3$): δ 7.81 (d, J = 8.5 Hz, 2H), 7.52 (d, J = 2.5 Hz, 1H), 7.47 (d, J = 7.5 Hz, 1H), 7.33−7.24 (m, 4H), 7.15 (t, J = 7.5 Hz, 1H), 6.86 (d, J = 7.5 Hz, 1H), 6.61 (s, 1H), 5.46 (s, 1H), 1.52 (d, J = 6.5 Hz, 6H) ppm; ^{13}C NMR (125 MHz, $CDCl_3$): δ 154.0, 150.9, 149.2, 142.3, 134.5, 133.0, 129.8, 129.0, 128.3, 126.9, 126.5, 126.3, 125.0, 123.5, 121.6, 121.6, 117.4, 114.1, 49.9, 25.1, 25.0 ppm; HRMS (ESI-TOF): *m/z* calculated for $C_{21}H_{18}O$ $[M+Na]^+$ 309.1255, found 309.1258.

2-(1-methyl-1-phenyl-1H-inden-3-yl)naphthalen-1-ol *(2j).* Following general experimental procedure II.3; yellow viscous liquid; yield: 79% (0.079g); ^1H NMR (400 MHz, $CDCl_3$): δ 7.83−7.80 (m, 3H), 7.62−7.55 (m, 3H), 7.50−7.47 (m, 1H), 7.45−7.41 (m, 3H), 7.37 (s, 1H), 7.35 (t, J = 3.6 Hz, 5H), 7.32 (t, J = 5.2 Hz, 4H), 7.28 (d, J = 2.8 Hz, 1H), 7.27−7.23 (m, 3H), 7.20 (d, J = 1.2 Hz, 1H), 7.18−7.14 (m, 3H), 6.92−6.89 (m, 2H), 6.78 (s, 1H), 6.75 (s, 1H), 5.50 (s, 1H), 5.44 (s, 1H), 1.94 (d, J = 5.2 Hz, 6H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 153.8, 153.7, 151.1, 151.0, 148.8, 148.5, 142.9, 142.6, 142.4, 142.3, 135.7, 135.2, 133.0 (2), 130.1, 130 (2), 129.8, 129.2, 129.1 (2), 128.9, 128.8, 128.3 (2), 128.2, 127.8, 127.2 (2), 127.0, 126.9 (2), 126.8, 126.7 (2), 126.6, 126.3, 126.1, 125.1, 124.9, 123.5, 123.4, 123.3, 123.1, 122.9, 122.2, 122.0, 121.9, 119.5, 118.7, 117.5, 117.4, 113.8 (2), 57.2, 57.1, 23.9, 23.5 ppm; HRMS (ESI-TOF): *m/z* calculated for $C_{26}H_{20}O$ $[M+Na]^+$ 371.1412, found 371.1411.

2-(1,1-diphenyl-1H-inden-3-yl)naphthalen-1-ol (2k). Following general experimental procedure II.3; yellow viscous liquid; yield: 58% (0.058g); ^1H NMR (500 MHz, $CDCl_3$): δ 7.83−7.80 (m, 2H), 7.56−7.55 (m, 1H), 7.50 (d, J = 7.5 Hz, 1H), 7.41−7.39 (m, 2H), 7.35−7.33 (m, 3H), 7.32−7.28 (m, 7H), 7.26 (d, J = 4.0 Hz, 1H), 7.24 (t, J = 6.0 Hz, 1H),7.29−7.17 (m, 1H), 7.01 (s, 1H), 6.91 (d, J = 7.5 Hz, 1H), 5.33 (s, 1H) ppm; ^{13}C NMR (125 MHz, $CDCl_3$): δ 151.1, 150.8, 146.9, 143.6,143.3, 143.1, 136.1, 133.0, 130.1, 129.0, 128.8. 128.7,128.5, 128.3, 127.8, 127.7, 127.5, 127.2, 126.8, 126.7, 125.6, 125.0, 123.6, 122.3, 117.5, 113.6, 67.0 ppm; HRMS (ESI-TOF): *m/z* calculated for $C_{31}H_{22}O$ $[M+Na]^+$ 433.1568, found 433.1563.

6-bromo-1-(1,1-dimethyl-6-phenyl-1H-inden-3-yl)naphthalen-2-ol (2l). Following general experimental procedure II.3; white solid, Mp: 177−178 °C; yield: 90% (0.090g).^{1}H NMR (500 MHz,$CDCl_3$): δ 7.97 (d, J = 1.5 Hz, 1H), 7.73−7.68 (m, 2H), 7.61 (d, J = 7 Hz, 2H), 7.45−7.43 (m, 3H), 7.41−7.38 (m, 2H), 7.35−7.29 (m, 2H), 6.88 (d, J = 7.5 Hz, 1H), 6.64 (s, 1H), 5.50 (s, 1H), 1.58 (d, J = 5 Hz, 6H) ppm; ^{13}C NMR (125 MHz, $CDCl_3$): δ 154.6, 151.3, 149.7, 141.6, 141.2, 139.9, 133.8, 131.5, 130.2, 129.8, 128.9(2), 127.4, 127.3, 126.8, 26.2, 121.7, 120.7, 118.6, 117.3, 114.3, 50.1, 25.1(2) ppm; IR (KBr): $\breve{\upsilon}$ 3528, 2958, 1585, 1157, 761cm^{-1}; HRMS (ESI-TOF): *m/z* calculated for $C_{27}H_{21}BrO$ $[M+Na]^+$ 441.0853, found 441.0850.

6-bromo-1-(1,1-dimethyl-1H-inden-3-yl)naphthalen-2-ol (2m). Following general experimental procedure II.3; yellow solid, Mp: 147−148°C; yield: 83% (0.083g); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.95 (s, 1H), 7.70 (d, J = 8.8 Hz, 1H), 7.47−7.26 (m, 5H), 7.15 (t, J = 7.2 Hz, 1H), 6.82 (d, J = 7.6 Hz, 1H), 6.60 (s, 1H), 5.47 (s, 1H), 1.52 (d, J = 3.6 Hz, 6H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 153.9, 151.3, 149.5, 142, 134, 133.4, 131.6, 130.2, 129.8, 128.9, 127, 126.9, 126.5, 121.7, 121.5, 118.6, 117.3, 114.4, 50, 25, 24.9 ppm; HRMS (ESI-TOF): *m/z* calculated for $C_{21}H_{17}BrO$ $[M+Na]^+$ 387.0361, found 387.0361.

6-bromo-1-(1,1,6-trimethyl-1H-inden-3-yl)naphthalen-2-ol (2n). Following general experimental procedure II.3; white solid, Mp: 177−178 °C; yield: 96% (0.096g); ^{1}H NMR (500 MHz,$CDCl_3$): δ 7.95 (d, J = 1.2 Hz, 1H), 7.70 (d, J = 9 Hz, 1H), 7.41−7.35 (m, 2H), 7.29 (t, J = 4.5 Hz, 2H), 6.97 (d, J = 7.5 Hz, 1H), 6.71 (d, J = 7.5, 1H), 6.53 (s, 1H), 5.50 (s, 1H), 2.42 (s, 3H), 1.51 (d, J = 4.5 Hz, 6H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 154.2, 151.2, 148.4, 139.3, 136.4, 133.8, 131.5, 130.1, 129.6, 128.8, 127.6, 126.9, 122.7, 121.2, 118.5, 117.2, 114.5, 49.7, 25.1(2), 21.7 ppm; HRMS (ESI-TOF): *m/z* calculated for $C_{22}H_{19}BrO$ $[M+Na]^+$ 401.0516, found 401.0516.

6-bromo-1-(1-hexyl-1-methyl-1H-inden-3-yl)naphthalen-2-ol (2o). Following general experimental procedure II.3; yellow viscous liquid; yield: 81% (0.081 g); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.97 (d, J = 1.6 Hz, 2H), 7.73 (d, J = 0.8 Hz, 1H), 7.71 (d, J = 0.8 Hz, 1H),7.43−7.36 (m, 7H), 7.31 (d, J = 0.8 Hz, 1H), 7.29 (d, J = 0.8 Hz, 1H), 7.25 (s, 1H), 7.17−7.13 (m, 2H), 7.81(d, J = 2.8 Hz, 1H), 6.80 (d, J = 2.8 Hz, 1H), 6.58 (s, 1H), 6.55 (s, 1H), 5.52 (s, 1H), 5.49 (s, 1H), 1.95−1.91 (m, 2H), 1.57 (s, 5H), 1.50 (d, J = 5.2 Hz, 5H), 1.22 (t, J = 7.5 Hz, 14H), 0.86−0.83 (m, 6H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 152.9 (2), 151.2, 148.0, 147.8, 142.8 (20, 135.0, 134.9, 131.5, 130.1, 129.7 (2), 128.8, 127.0, 126.9 (2), 126.8, 126.3, 121.9, 121.8, 121.4, 121.3, 118.5, 117.2, 114.6, 114.5, 53.8, 38.8, 38.4, 31.8, 31.7, 29.9, 25.5, 25.4, 24.2, 24.1, 22.7, 14.2, 14.1 ppm; HRMS (ESI-TOF): *m/z* calculated for $C_{26}H_{27}BrO$ $[M+Na]^+$ 457.1142, found 457.1141.

1-(spiro[cyclohexane-1,1'-inden]-3'-yl)naphthalen-2-ol (2p). Following general experimental procedure II.3; brown viscous liquid; yield: 93% (0.093 g); ^{1}H NMR (500 MHz, $CDCl_3$,): δ 7.63 (t, J = 5.5 Hz, 2H), 7.40 (d, J = 4 Hz, 1H), 7.31 (d, J = 7 Hz, 1H), 7.16−7.09 (m, 5H), 6.99 (t, J = 7 Hz, 1H), 6.91 (s, 1H), 6.73 (d, J = 7 Hz, 1H), 1.88−1.83 (m, 2H), 1.75 (t, J = 10 Hz, 3H), 1.52−1.47 (m, 3H), 1.42−1.35 (m, 2H) ppm; ^{13}C NMR (125 MHz, $CDCl_3$): δ 154, 150.9, 145.2, 142.4, 135.6, 133, 129.8, 129.6, 129, 128.2, 126.9, 126.5, 126.1, 125.0, 123.4, 122.1, 121.6,

117.4, 114.3, 54.3, 35.1, 35, 26.1, 24.9, 24.8 ppm; HRMS (ESI-TOF): *m/z* calculated for $C_{24}H_{22}O$ $[M+Na]^+$ 349.1568, found 349.1567.

1-(spiro[cycloheptane-1,1'-inden]-3'-yl)naphthalen-2-ol (2q). Following general experimental procedure II.3; green viscous liquid; yield: 91% (0.091 g); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.71 (d, J = 8.4 Hz, 2H), 7.43 (d, J = 7.6 Hz, 2H), 7.25−7.20 (m, 2H), 7.18 −7.12 (m, 2H), 7.06−7.02 (m, 1H), 6.75 (t, J = 5.2 Hz, 2H), 5.39 (s, 1H), 2.00−1.94 (m, 2H), 1.85−1.82 (m, 2H), 1.79−1.68 (m, 8H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 155.6, 150.9, 147.9, 142.0, 134.9, 133.1, 129.8, 129.1, 128.3, 126.9, 126.5, 126.3, 125.1, 123.5, 121.9, 121.6, 117.4, 114.3, 57, 37.3, 37.2, 30.1, 30, 25.9, 25.8 ppm; HRMS (ESI-TOF): *m/z* calculated for $C_{25}H_{24}O$ $[M+Na]^+$ 363.1724, found 363.1727.

6-bromo-1-(spiro[cycloheptane-1,1'-inden]-3'-yl)naphthalen-2-ol (2r): Following general experimental procedure II.3; yellow viscous liquid; yield: 90% (0.090 g); ^{1}H NMR (500 MHz, $CDCl_3$,): δ 7.94 (s, 1H), 7.68 (d, J = 9 Hz, 1H), 7.51 (d, J = 7.5 Hz, 1H), 7.39−7.34 (m, 2H), 7.28−7.23 (m, 2H), 7.12 (t, J = 7.5 Hz, 1H), 6.83 (s, 1H), 6.78 (d, J = 7.5 Hz, 1H), 5.51 (s, 1H), 2.03 (t, J = 13 Hz, 2H), 1.92 (d, J = 5 Hz, 2H), 1.84−1.71 (m, 8H) ppm; ^{13}C NMR (125 MHz, $CDCl_3$): δ 155.5, 151.2, 148.1, 141.6, 134.3, 131.5, 130.1, 129.7, 128.8, 126.9, 126.8, 126.4, 122.0, 121.3, 118.5, 117.2, 114.5, 57.0, 37.2, 37.1, 30.1, 30, 25.8, 25.7 ppm; HRMS (ESI-TOF): *m/z* calculated for $C_{25}H_{23}BrO$ $[M+Na]^+$419.1010, found 419.1010.

6-bromo-1-(spiro[cyclooctane-1,1'-inden]-3'-yl)naphthalen-2-ol (2s). Following general experimental procedure II.3; yellow viscous liquid; yield: 80% (0.080 g); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.87 (s, 1H), 7.61 (d, J = 8.8, 1H), 7.46 (d, J = 8.8, 1H), 7.29 (s, 2H), 7.21−7.15 (m, 3H), 7.09−7.05 (m, 1H), 6.73 (d, J = 6.1 Hz, 1H), 5.40 (s, 1H), 1.84 (s, 5H), 1.77−1.63 (m, 9H) ppm;^{13}C NMR (100 MHz, $CDCl_3$): δ 154.3, 151.2, 148.7, 142.2, 133.9, 131.6, 130.2, 129.7, 129.3, 128.8, 128.7, 128.6, 128.4, 127, 126.9, 122.8, 121.6, 118.5, 117.2, 114.5, 56.9, 32.1, 31.9, 28.9, 28.8, 25.5, 25.3, 25.2 ppm; HRMS (ESI-TOF): *m/z* calculated for $C_{26}H_{25}BrO$ $[M+H]^+$ 433.1166, found 433.1161.

1-(spiro[fluorene-9,1'-inden]-3'-yl)naphthalen-2-ol (2t). Following general experimental procedure II.3; greenish solid, Mp: 114−115 ^{o}C; yield: 77% (0.077 g); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.86−7.80 (m, 5H), 7.47−7.36 (m, 4H), 7.32 (d, J = 4.8 Hz, 1H), 7.27−7.16 (m, 4H), 7.09 (t, J = 7.6 Hz, 1H), 7.04−6.98 (m, 2H), 6.80 (d, J = 7.2 Hz, 1H), 6.47 (s, 1H), 5.65 (s, 1H) ppm; ^{13}C NMR (125 MHz, $CDCl_3$): δ 151.0, 148.9, 144.6, 144.6, 144.5, 142.4, 142.3, 142.0, 139.6, 132.8, 130.2, 129.2, 128.5, 128.3, 128.3, 128.1, 128.0, 127.6, 127.2, 126.8, 125.1, 123.9, 123.7, 123.2, 123.1, 121.8, 120.6, 120.5, 117.6, 113.8, 68.0 ppm; IR (KBr): $\breve{\nu}$ 3504, 3055, 1592, 1196.02, 697 cm^{-1}; HRMS (ESI-TOF): m/z calculated for $C_{31}H_{20}O$ $[M+Na]^+$ 431.1411, found 431.1405.

2-(spiro[fluorene-9,1'-inden]-3'-yl)naphthalen-1-ol (2u). Following general experimental procedure II.3; yellow viscous liquid; yield: 72% (0.072 g); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.86 (d, J = 8.4 Hz, 4H), 7.81 (d, J = 8.4 Hz, 1H), 7.45−7.38 (m, 4H), 7.32 (d, J = 8.8 Hz, 1H), 7.26−7.25 (m, 1H), 7.24 (d, J = 1.2 Hz, 1H), 7.19−7.16 (m, 2H), 7.12−7.08 (m, 1H), 7.03 (d, J = 7.6 Hz, 1H), 6.99 (d, J = 7.6 Hz, 1H), 6.80 (d, J = 7.2 Hz, 1H), 6.48 (s, 1H), 5.66 (s, 1H) ppm;

^{13}C NMR (100 MHz, $CDCl_3$): δ 151, 148.9, 144.6, 144.5, 144.4, 142.4, 142.3, 142.0, 139.5, 132.7, 130.2, 129.2, 128.5, 128.3, 128.3, 128.1, 128.0, 127.6, 127.2, 126.8, 125.1, 123.9, 123.7, 123.2, 123.1, 121.8, 120.6, 120.5, 117.6, 113.8, 68.3 ppm; HRMS (ESI-TOF): *m/z* calculated for $C_{31}H_{20}O$ $[M+Na]^+$ 431.1412, found 431.1377.

2-(spiro[cyclohexane-1,1'-inden]-3'-yl)naphthalen-1-ol (2v). Following general experimental procedure II.3; brown viscous liquid; yield: 74% (0.074 g); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.81 (dd, J_1 = 2.8 Hz, J_2 = 6.4 Hz, 2H), 7.53−7.48 (m, 2H), 7.34−7.23 (m, 4H), 7.15 (td, J_1 = 0.8 Hz, J_2 = 7.6 Hz, 1H), 7.07 (s, 1H), 6.87 (d, J = 7.6 Hz, 1H), 5.48 (s, 1H), 2.06−1.88 (m, 4H), 1.69-1.53 (m, 4H), 1.25 (s, 2H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 154.1, 150.8, 145.3, 142.5, 135.6, 133.0, 129.8, 129.0, 128.3, 127.0, 126.5, 126.1, 125.0, 123.5, 122.1, 121.6, 117.3, 114.3, 54.3, 35.2, 35.0, 25.1, 24.9, 24.9 ppm; HRMS (ESI-TOF): *m/z* calculated for $C_{24}H_{22}O$ $[M+Na]^+$ 349.1568, found 349.1558.

1-(6'-methylspiro[cyclohexane-1,1'-inden]-3'-yl)naphthalen-2-ol (2w). Following general experimental procedure II.3; yellow viscous liquid; yield: 71% (0.071 g); ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.71 (d, J = 3.0 Hz, 2H), 7.46−7.44 (m, 1H), 7.24−7.21 (m, 3H), 7.20 (t, J = 9 Hz, 1H), 6.92 (s, 1H), 6.88 (d, J = 9 Hz, 1H), 6.68 (d, J = 9 Hz, 1H), 5.42 (s, 1H), 2.33 (s, 3H), 1.94−1.92 (m, 2H), 1.86−1.82 (m, 3H), 1.60−1.52 (m, 2H), 1.45 (d, J = 10.5 Hz, 3H) ppm; ^{13}C NMR (125 MHz, $CDCl_3$): δ 154.4, 150.8, 144.3, 139.9, 136.0, 135.5, 133.0, 129.7, 129.0, 128.2, 126.4, 125.1, 123.4, 123.1, 121.3, 114.5, 54.1, 35.3, 35.2, 26.1, 25.0, 24.9, 21.7 ppm; HRMS (ESI-TOF): *m/z* calculated for $C_{25}H_{24}O$ $[M+H]^+$ 341.1905, found 341.1907.

2-(spiro[cycloheptane-1,1'-inden]-3'-yl)naphthalen-1-ol ***(2x).*** Following general experimental procedure II.3; brown viscous liquid; yield: 80% (0.080 g); ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.70 (d, J = 8.5 Hz, 2H), 7.43 (d, J = 7 Hz, 2H), 7.23−7.12 (m, 5H), 7.05−7.02 (m, 2H), 6.76−6.74 (m, 2H), 5.73 (s, 1H), 1.85 (d, J = 8.5 Hz, 2H), 1.78−1.69 (m, 10H) ppm; ^{13}C NMR (125 MHz, $CDCl_3$): δ 155.5, 150.9, 147.8, 142.0, 134.9, 133.0, 129.8, 129.0, 128.2, 126.8, 126.5, 126.3, 125.0, 123.4, 121.9, 121.5, 117.3, 114.2, 57.0, 37.3, 37.2, 30.0 (2), 25.8 (2) ppm; HRMS (ESI-TOF): *m/z* calculated for $C_{25}H_{24}O$ $[M+Na]^+$ 363.1724, found 363.1728.

1-(spiro[cyclohexane-1,1'-cyclopenta[l]phenanthren]-3'-yl)naphthalen-2-ol (2y). Following general experimental procedure II.3; yellow solid, Mp: 193−194 ^{o}C; yield: 78% (0.078 g); ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.72 (d, J = 8 Hz, 1H), 8.59 (d, J = 8.5 Hz, 1H), 8.31 (d, J = 8 Hz, 1H), 7.80 (d, J = 9 Hz, 1H), 7.75 (d, J = 8 Hz, 1H), 7.63−7.60 (m, 1H), 7.57−7.54 (m, 1H), 7.40−7.38 (m, 1H), 7.35−7.32 (m, 3H), 7.27−7.25 (m, 1H), 7.23−7.19 (m, 1H), 7.14−7.11 (m, 1H), 6.97−6.93 (m, 1H), 5.41 (s, 1H), 2.64−2.58 (m, 2H), 1.92 (d, J = 9.5 Hz, 3H), 1.74−1.62 (m, 2H), 1.57−1.42 (m, 3H) ppm; ^{13}C NMR (125 MHz, $CDCl_3$): δ 150.7, 150.2, 147.4, 135.6, 134.9, 133.7, 130.7, 130.6, 129.9, 129.0, 128.3, 128.2, 126.9, 126.7, 126.3, 125.9, 125.5, 125.0, 124.6, 124.0 (2), 123.6, 123.0, 117.7, 117.5, 56.1, 33.9, 33.5, 26.1, 25.3, 25.2 ppm; HRMS (ESI-TOF): *m/z* calculated for $C_{32}H_{26}O$ $[M+H]^+$ 427.2061, found 427.2065.

6-bromo-1-(1,1-diphenyl-1H-inden-3-yl)naphthalen-2-ol (2z). Following general experimental procedure II.3; yellow viscous liquid; yield: 52% (0.030 g); ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.84−7.81 (m, 2H), 7.57−7.55 (m, 1H), 7.51 (d, J = 7.5 Hz, 1H), , 7.40 (d, J = 7.0 Hz, 2H),

7.35−7.32 (m, 2H), 7.31−7.29 (m, 7H), 7.26 (d, J = 4.5 Hz, 1H), 7.25 (s, 1H), 7.20 (t, J = 7.5 Hz, 1H), 7.02 (s, 1H), 6.92 (d, J = 7.5 Hz, 1H), 5.31 (s, 1H) ppm; ^{13}C NMR (125 MHz, $CDCl_3$): δ 151.1, 150.8, 147.0, 143.6, 143.3, 143.2, 136.1, 133.1, 130.1, 129.1, 128.9, 128.7, 128.3, 127.8 (2), 127.5, 127.3, 127.2, 126.8, 126.7, 125.6, 125.0, 123.6, 122.3, 117.5, 113.6, 67.0 ppm; HRMS (ESI-TOF): *m/z* calculated for $C_{31}H_{21}BrO$ $[M+Na]^+$ 511.0673, found 511.0491.

6-bromo-1-(1-methyl-1-phenyl-1H-inden-3-yl)naphthalen-2-ol (2aa). Following general experimental procedure II.4; yellow solid, Mp: 80−81 ^{o}C; yield: 71% (0.036g); ^{1}H NMR (400 MHz, $CDCl_3$): δ 7.98 (s, 2H), 7.30 (dd, J_1 = 2.8 Hz, J_2 = 8.8 Hz, 2H), 7.47−7.25 (m, 20H), 7.22−7.16 (m, 2H), 6.88 (t, J = 1.6 Hz, 1H), 6.86 (d, J = 2.8 Hz, 1H), 6.78 (s, 1H), 6.75 (s, 1H), 5.51 (s, 1H), 5.46 (s, 1H), 1.94 (d, J = 5.2 Hz, 6H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 153.7(2), 151.4, 149.1, 148.7, 142.6, 142.3, 142.2, 142.1, 135.1, 134.6, 131.5 (2), 130.2, 129.9, 129.8, 129(2), 128.8, 127.3, 127.1, 127.0, 126.9(2), 126.8, 126.2, 126.0, 123.5, 123.4, 121.8, 118.6 (2), 117.3, 114.1, 114.0, 57.3, 57.2, 23.8, 23.4 ppm; IR (KBr): $\breve{\upsilon}$ 3504, 3056, 1492, 1138, 696 cm^{-1}; HRMS (ESI-TOF): *m/z* calculated for $C_{26}H_{19}BrO$ $[M+Na]^+$ 449.0516, found 449.0518.

6-bromo-1-(spiro[cyclohexane-1,1'-inden]-3'-yl)naphthalen-2-ol ***(2ab).*** Following general experimental procedure II.4; yellow solid, Mp: 147−148 ^{o}C; yield: 75% (0.0368 g); ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.95 (d, J = 1 Hz, 1H), 7.69 (d, J = 9 Hz, 1H), 7.48 (d, J = 7.5 Hz, 1H), 7.40−7.35 (m, 2H), 7.30−7.26 (m, 2H), 7.16−7.14 (m, 1H), 7.05 (s, 1H), 6.83 (d, J = 7.5 Hz, 1H), 5.49 (s, 1H), 2.05−1.98 (m, 2H), 1.95−1.92 (m, 2H), 1.68−1.51 (m, 6H) ppm; ^{13}C NMR (125 MHz, $CDCl_3$): δ 154.1, 151.2, 145.6, 142.2, 135.1, 131.6, 130.2 (2), 129.7, 128.9, 127.1, 126.9, 126.3,122.2, 121.5, 118.5, 117.3, 114.6, 54.4, 35.1, 35.1, 26.1, 24.9, 24.8 ppm; IR (KBr): $\breve{\upsilon}$ 3496, 2933, 1586,1204, 749 cm^{-1}; HRMS (ESI-TOF): *m/z* calculated for $C_{24}H_{21}BrO$ $[M+Na]^+$ 427.0673, found 427.0668.

6-bromo-1-(spiro[naphthal-9,1'-inden]-3'-yl)naphthalene-2-ol (2ac). Following general experimental procedure II.4; yellow viscous liquid; yield: 72% (0.0415 g); ^{1}H NMR (500 MHz, $CDCl_3$): δ 7.93 (d, J = 2 Hz, 1H), 7.79 (d, J = 8 Hz, 2H), 7.69 (d, J = 9 Hz, 1H), 7.60 (d, J = 9 Hz, 1H), 7.45−7.43 (m, 1H), 7.35 (t, J = 7.5 H, 2H), 7.26 (d, J = 9 Hz, 1H), 7.20−7.11 (m, 4H), 7.06−7.02 (m, 2H), 6.95−6.88 (m, 2H), 7.74 (d, J = 7.5 Hz, 1H), 6.40 (s, 1H), 5.59 (s, 1H) ppm; ^{13}C NMR (125 MHz,$CDCl_3$): δ 151.3, 148.8, 144.4, 144.3, 144.2, 142.4, 142.3, 142.3, 138.9, 131.3, 130.4, 130.3, 130.1, 128.3, 128.4, 128.4, 128.1, 127.7, 127.4, 126.9, 123.8, 123.3, 123.2, 121.6, 120.7, 120.6, 118.7, 117.5, 114.1, 68.3 ppm; HRMS (ESI-TOF): *m/z* calculated for $C_{31}H_{19}BrO$ $[M+Na]^+$ 433.1568, found 433.1563.

3,3-dimethyl-1-(m-tolyl)-3H-benzo[f]chromene (6). Following general experimental procedure II.2; white solid, Mp: 134−135 ^{o}C; yield: 92% (0.16 g); ^{1}H NMR ($CDCl_3$, 500 MHz): δ 7.71 (d, J = 8.5 Hz, 2H), 7.20−7.16 (m, 3H), 7.12 (t, J = 6.0 Hz, 2H), 7.05−7.03 (m, 2H), 6.96 (d, J = 6.5 Hz, 1H), 5.69 (s, 1H), 2.31 (s, 3H), 1.49 (s, 6H) ppm; ^{13}C NMR (125 MHz, $CDCl_3$): δ 153.1, 141.7, 138.1, 135.6, 130.5, 130.4, 130.2, 130.0, 128.5, 128.4, 128.3, 128.1, 126.5, 125.1, 125.0, 123.0, 118.9, 116.2, 75.4, 26.5, 21.5 ppm; HRMS (ESI-TOF): *m/z* calculated for $C_{22}H_{20}O$ $[M+H]^+$ 301.1592, found 301.1591.

1-(1,1,7-trimethyl-1H-inden-3-yl)naphthalen-2-ol and 1-(1,1,5-trimethyl-1H-inden-3-yl)naphthalen-2-ol (6a:6b). Following general experimental procedure II.3; browm viscous liquid; yield: 96% (0.096 g); ^{1}H NMR (500 MHz, $CDCl_3$,): δ 7.82−7.7 (m, 4H), 7.55−7.51 (m, 2H), 7.35−7.26 (m, 7H), 7.10−7.01 (m, 3H), 6.67 (s, 2H), 6.58 (s, 1H), 6.52 (s, 1H), 5.43 (s, 2H), 2.57 (s, 3H), 2.23 (s, 3H), 1.63 (d, J = 7.0 Hz, 6H), 1.52 (d, J = 9.0 Hz, 6H) ppm; ^{13}C NMR (125 MHz,$CDCl_3$): δ 151.2, 150.9, 150.4, 150.3, 149.7, 143.0, 142.5, 136.7, 134.3, 133.8, 133.2, 133.1, 133.0, 129.7, 129.0, 128.7, 128.2, 127.2, 127.0, 126.5, 126.4, 125.0, 123.5, 123.4, 122.1, 121.3, 119.3, 117.3 (2), 114.2 (2), 50.8, 49.5, 25.2, 25.1, 22.5, 22.4, 21.4, 18.9 ppm; HRMS (ESI-TOF): *m/z* calculated for $C_{22}H_{20}O$ $[M+Na]^+$ 323.1411, found 323.1412.

3,3-dimethyl-1-(phenanthren-9-yl)-3H-benzo[f]chromene (7). Following general experimental procedure II.2; yellow solid, Mp: 197−198 ^{o}C; yield: 86% (0.128 g); ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.70 (t, J = 9.0 Hz, 2H), 7.87 (dd, J_1 = 1.5 Hz, J_2 = 8.0 Hz, 1H), 7.75 (s, 1H), 7.73(d, J = 9.5 Hz, 1H), 7.69−7.66 (m, 2H), 7.64−7.59 (m, 2H), 7.56−7.52 (m, 1H), 7.30−7.27 (m, 1H), 7.25 (d, J = 5.0 Hz, 1H), 7.21 (dd, J_1 = 0.5 Hz, J_2 = 9.0 Hz, 1H), 7.04−7.01 (m, 1H), 6.71−6.67 (m, 1H), 5.84 (s, 1H), 1.65 (s, 3H), 1.55 (s, 3H) ppm; ^{13}C NMR (125 MHz, $CDCl_3$): δ 152.2, 139.0, 134.1, 132.4, 131.9, 131.1, 130.6, 130.5, 130.3, 130.0, 128.8, 128.4, 126.9, 126.8, 126.7 (3), 126.6, 125.9, 124.7, 123.0, 122.9, 122.7, 119.1, 116.9, 75.3, 27.5, 25.9 ppm; HRMS (ESI-TOF): *m/z* calculated for $C_{29}H_{22}O$ $[M+H]^+$ 387.1748, found 387.1749.

1-(1,1-dimethyl-1H-cyclopenta[l]phenanthren-3-yl)naphthalen-2-ol (7a). Following general experimental procedure II.3; yellow solid, Mp: 168−169 ^{o}C; yield: 78% (0.078 g); ^{1}H NMR (500 MHz, $CDCl_3$): δ 8.73 (d, J = 8.4 Hz, 1H), 8.61 (d, J = 8 Hz, 1H), 8.17 (d, J = 8.4 Hz, 1H), 7.82 (d, J = 9.2 Hz, 1H), 7.77 (d, J = 8 Hz, 1H), 7.65 (t, J = 6.8 Hz, 1H), 7.58 (t, J = 8.4 Hz, 1H), 7.41 (d, J = 8.4 Hz, 1H), 7.36 (t, J = 8.8 Hz, 1H), 7.30−7.26 (m, 2H), 7.25−7.21 (m, 1H), 7.14 (t, J = 8.0 Hz, 1H), 6.96 (t, J = 8.0 Hz, 1H), 6.72 (s, 1H), 5.44 (s, 1H), 1.72 (s, 3H), 1.68 (s, 3H) ppm; ^{13}C NMR (100 MHz, $CDCl_3$): δ 154.1, 150.7, 147.5, 135.5, 133.7, 133.6, 130.7, 130.4, 129.9, 129.0, 128.4, 128.3, 128.2, 126.9, 126.7, 126.6, 125.9, 125.6, 124.9, 124.6, 124.0, 123.9, 123.7, 123.0, 117.5, 117.3, 51.1, 24.1, 24.0 ppm; HRMS (ESI-TOF): *m/z* calculated for $C_{29}H_{22}O$ $[M+H]^+$ 387.1748, found 387.1749.

References:

(1) S. Chen, F. Yuan, H. Zhao and B. Li, *Res. Chem. Intermed.,* 2013, **39,** 2391.
(2) S. Yaragorla, A. Pareek and R. Dada, *Tet. Lett.,* 2017, **58**, 4642.
(3) J. A. McCubbin, C. Nassar and O. V. Krokhin, *Synthesis,* 2011*,* **19***,* 3152.
(4) R. Hosseinzadeh, M. Mohadjerani, M. J. Ardestanian, M. R. Naimi-jamal and Z. Lasemi, *J. chem. Sci*., 2014, **126**, 1081.
(5) S. Yaragorla and P. L. Saini, *Ind. J. chem.,* 2016, **55B**, 983.

IV. X-ray Data and Crystal Structures

The compounds **2m, 2ab** were further confirmed by Single Crystal X-ray analysis.

X-ray data of Compound 2m:

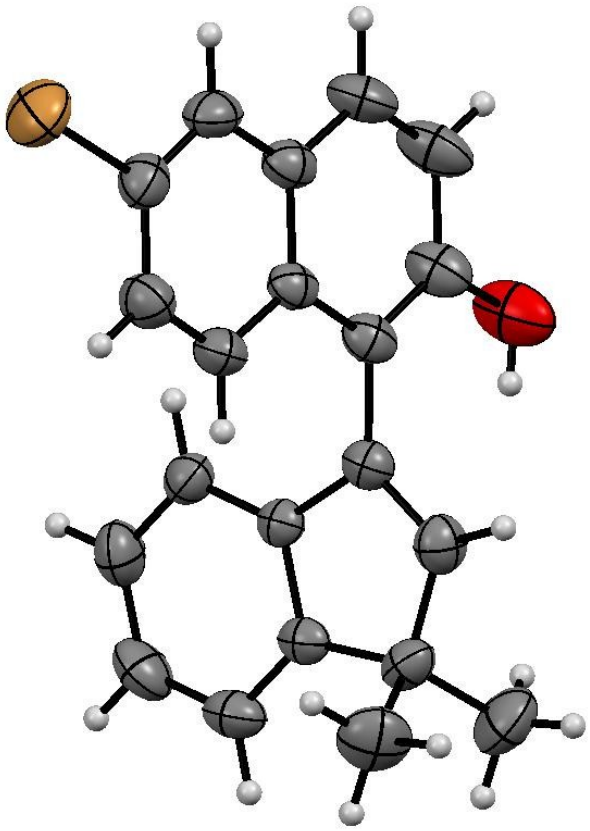


Figure S1. ORTEP representation of compound **2m** and thermal ellipsoids are drawn with 50% probability.

Crystal data and structure refinement for 2m.

Identification code	shelx-97
Empirical formula	$C_{21}H_{17}BrO$
Formula weight	365.25
Temperature	299 (2) K
Wavelength	0.71073 Å

Crystal system	Monoclinic	
Space group	P 21/c	
Unit cell dimensions	a = 12.928 (3) Å	α = 90 °.
	b = 16.007 (4) Å	β = 94.097 (7) °.
	c = 8.3586 (16) Å	γ = 90 °.
Volume	1725.3 (6) $Å^3$	
Z	4	
Density (calculated)	1.406 Mg/m^3	
Absorption coefficient	2.385 mm^{-1}	
F(000)	744	
Crystal size	0.42 x 0.40 x 0.40 mm^3	
Theta range for data collection	2.54 to 27.83 °.	
Index ranges	-16<=h<=16, -20<=k<=20, -10<=l<=10	
Reflections collected	4077	
Independent reflections	2496 [R(int) = 0.0444]	
Max. and min. transmission	0.385 and 0.382	
Refinement method	Full-matrix least-squares on F^2	
restraints / parameters	0 / 210	
Goodness-of-fit on F^2	1.034	
Final R indices [I>2sigma(I)]	R1 = 0.0444, wR2 = 0.0916	
R indices (all data)	R1 = 0.0972, wR2 = 0.1049	

X-ray data of Compound 2ab:

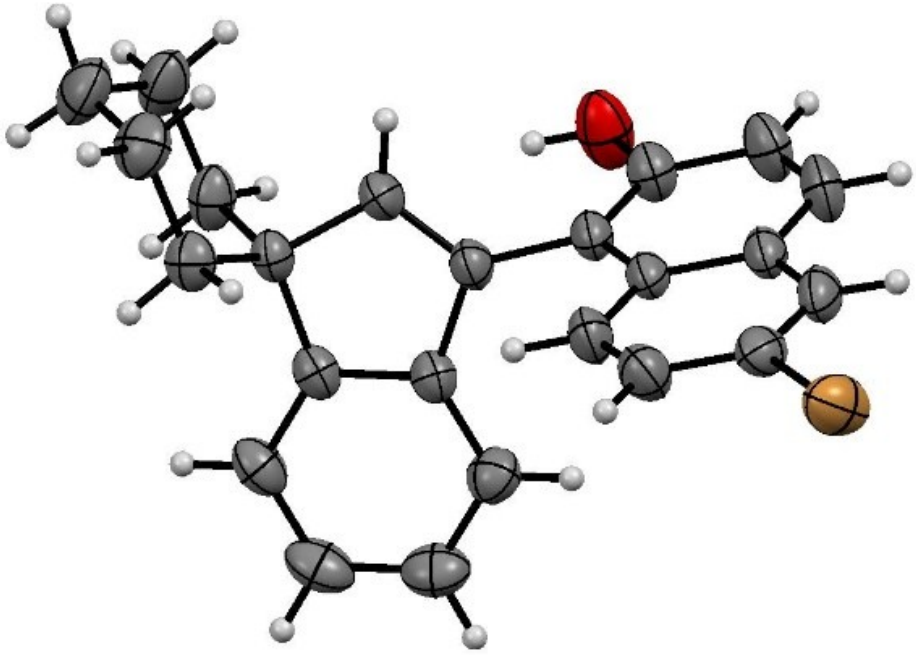


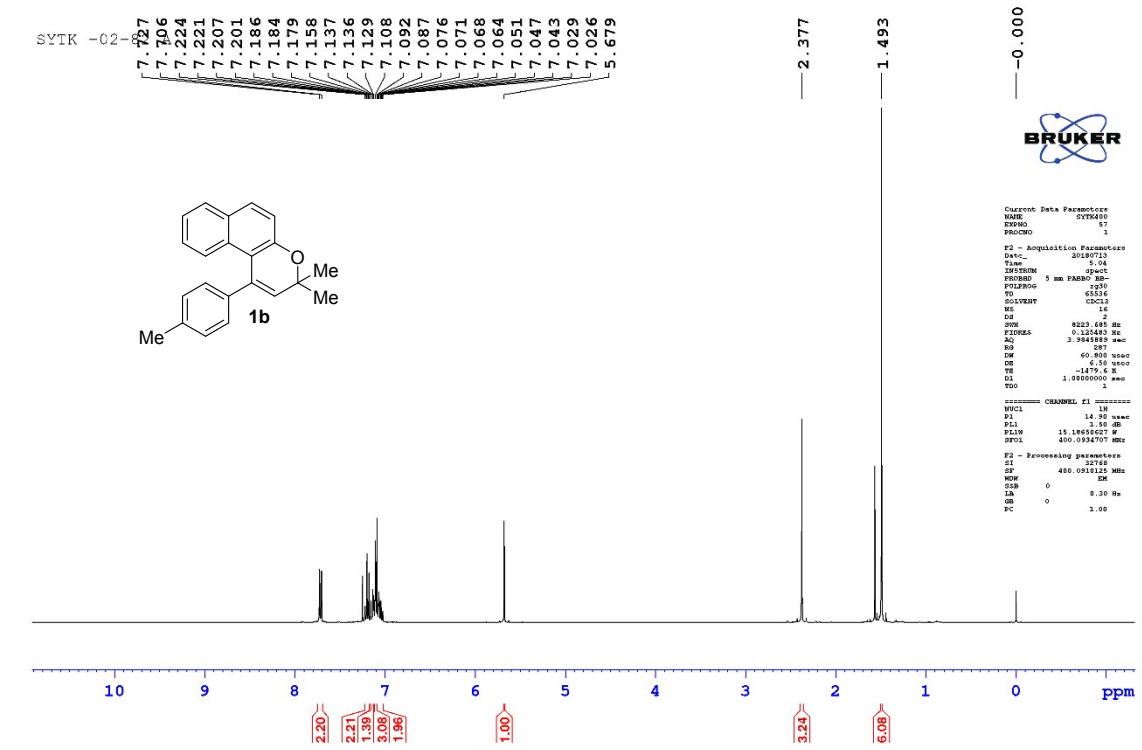
Figure S2. ORTEP representation of compound **2ab** and thermal ellipsoids are drawn with 50% probability.

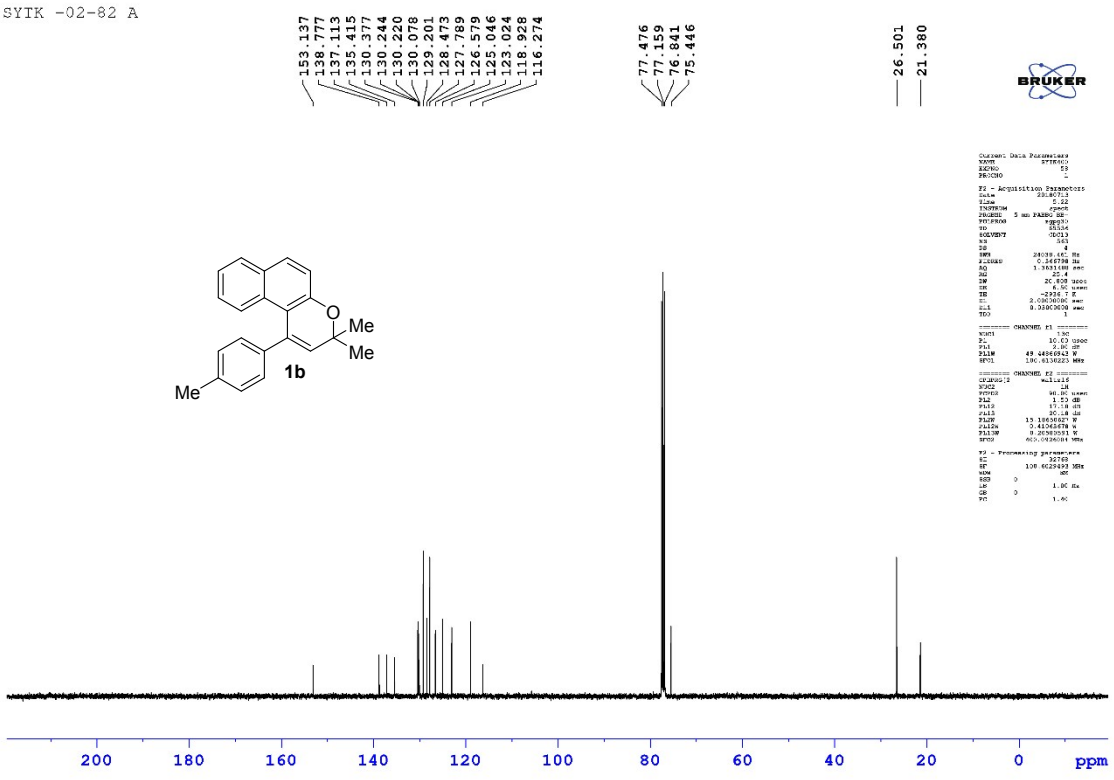
Crystal data and structure refinement for 2ab

Identification code	shelx- 2014/7	
Empirical formula	$C_{24}H_{21}BrO$	
Formula weight	405.32	
Temperature	298 (2) K	
Wavelength	0.71073 Å	
Crystal system	Monoclinic	
Space group	P 21/c	
Unit cell dimensions	a = 11.7077 (18) Å	α = 90 °.
	b = 9.7297 (13) Å	β = 116.691 (8) °.
	c = 18.751 (2) Å	γ = 90 °.
Volume	1908.4 (5) $Å^3$	

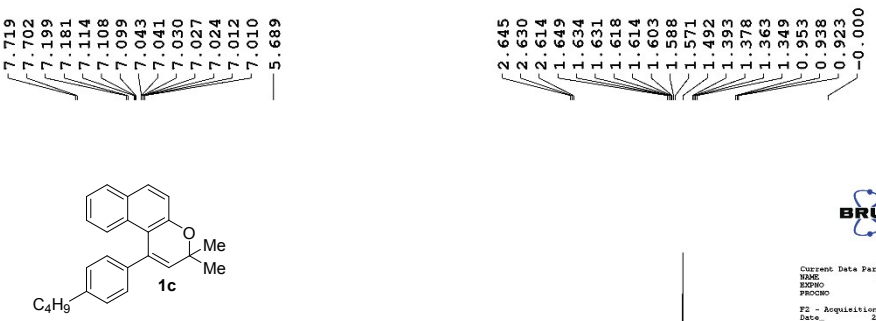
Z	4
Density (calculated)	1.411 Mg/m^3
Absorption coefficient	2.163 mm^{-1}
F(000)	832
Crystal size	0.22 x 0.20 x 0.18 mm^3
Theta range for data collection	2.334 to 30.562 °.
Index ranges	-16<=h<=16, -13<=k<=13, -26<=l<=26
Reflections collected	5813
Independent reflections	4087 [R(int) = 0.0430]
Max. and min. transmission	0.678 and 0.628
Refinement method	Full-matrix least-squares on F^2
restraints / parameters	1 / 239
Goodness-of-fit on F^2	1.030
Final R indices [I>2sigma(I)]	R1 = 0.0430, wR2 = 0.0904
R indices (all data)	R1 = 0.0748, wR2 = 0.1034

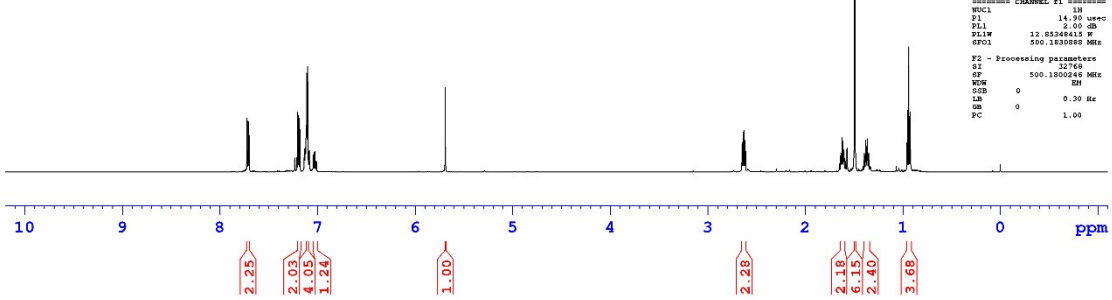
V. Spectral Copies of Synthesized Compounds



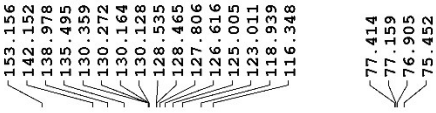


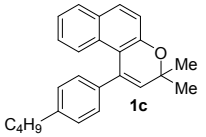
SYTK-02-99-A



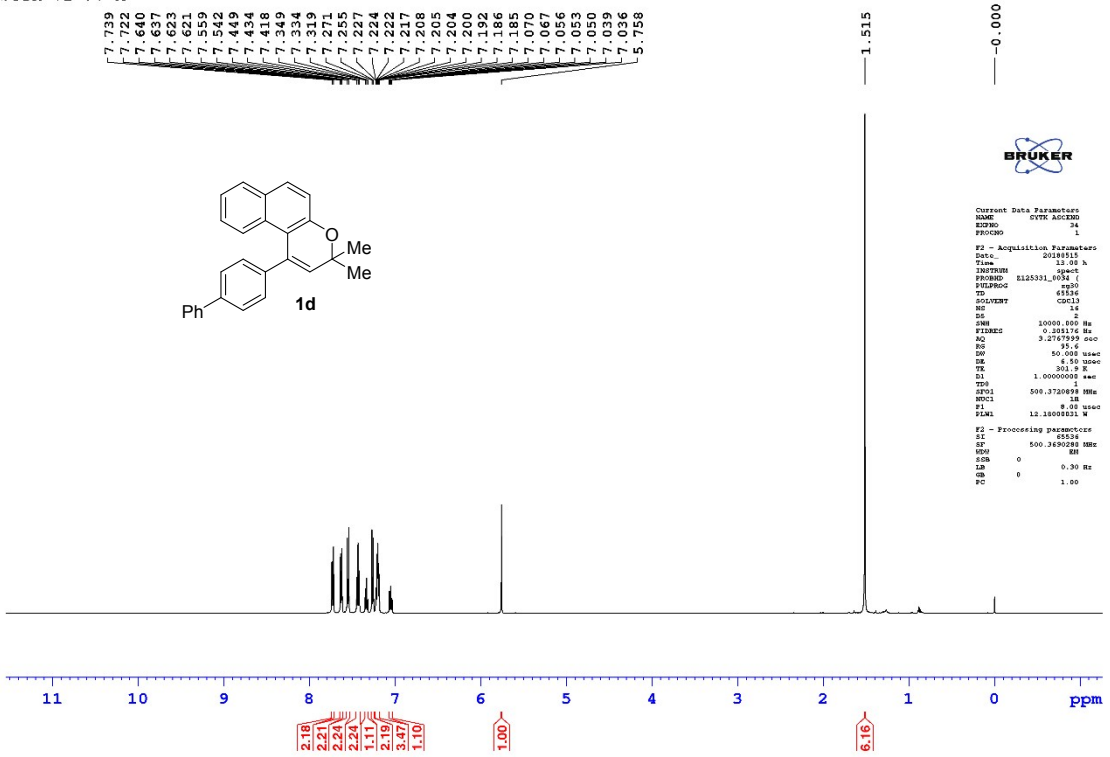


SYTK-02-99-A

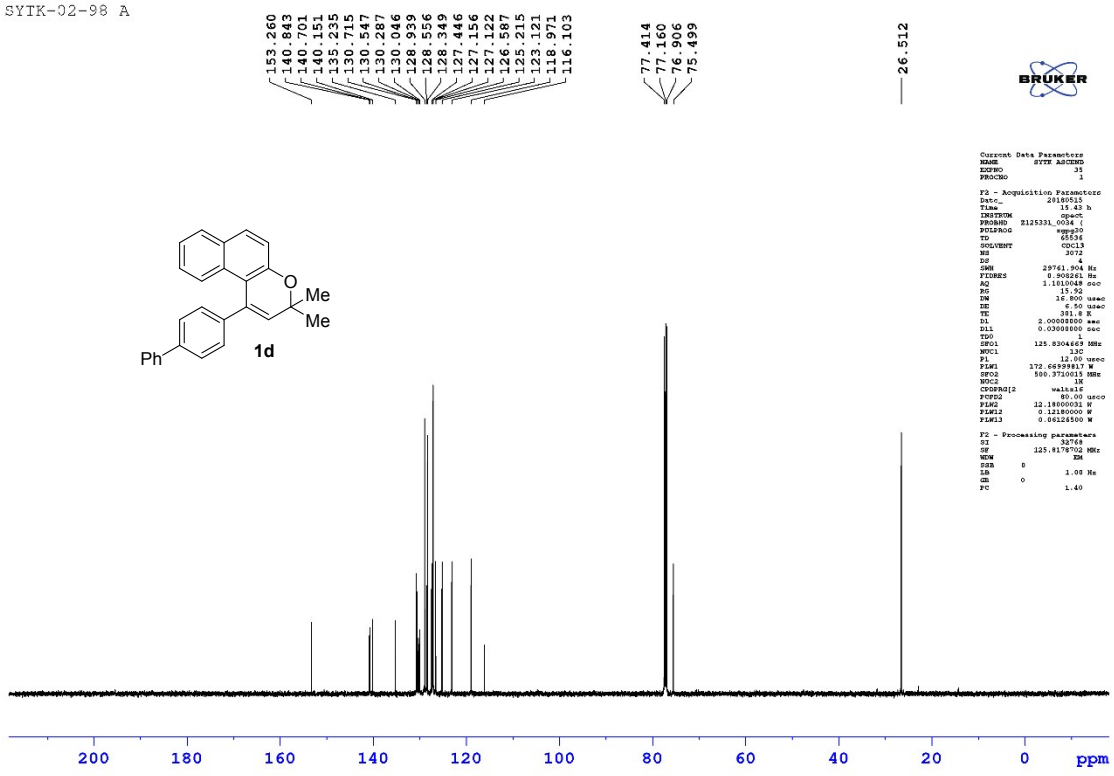




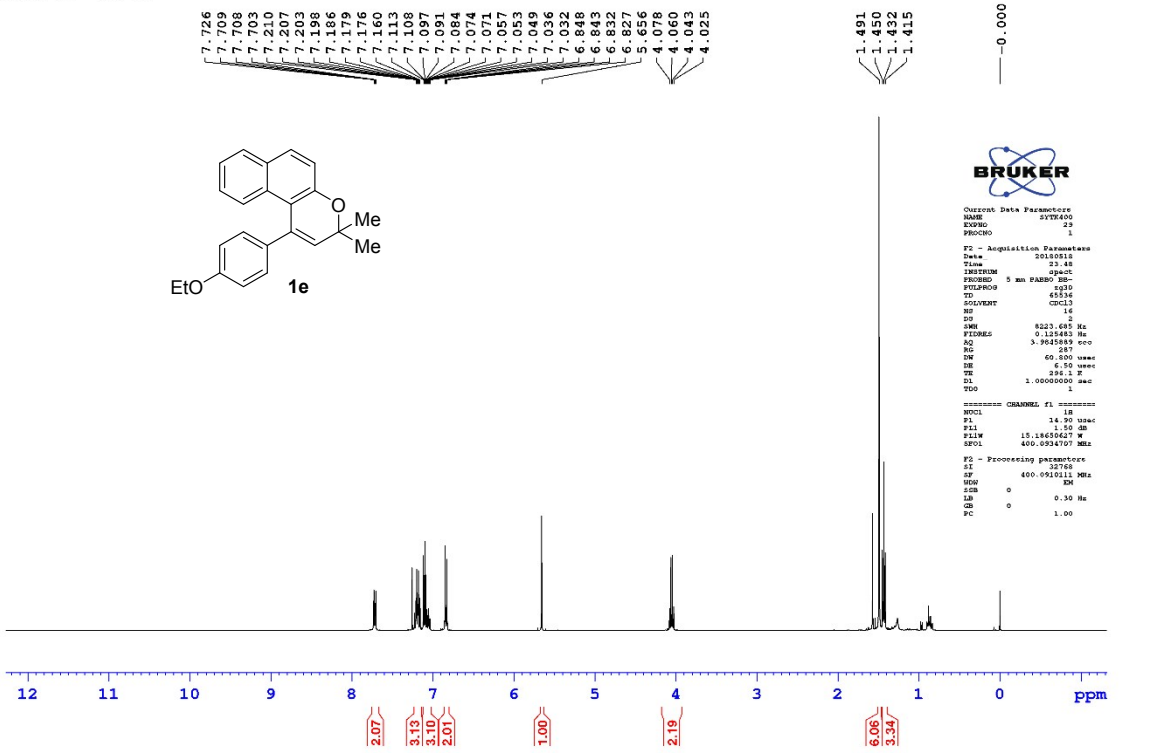
SYTK-02-98 A



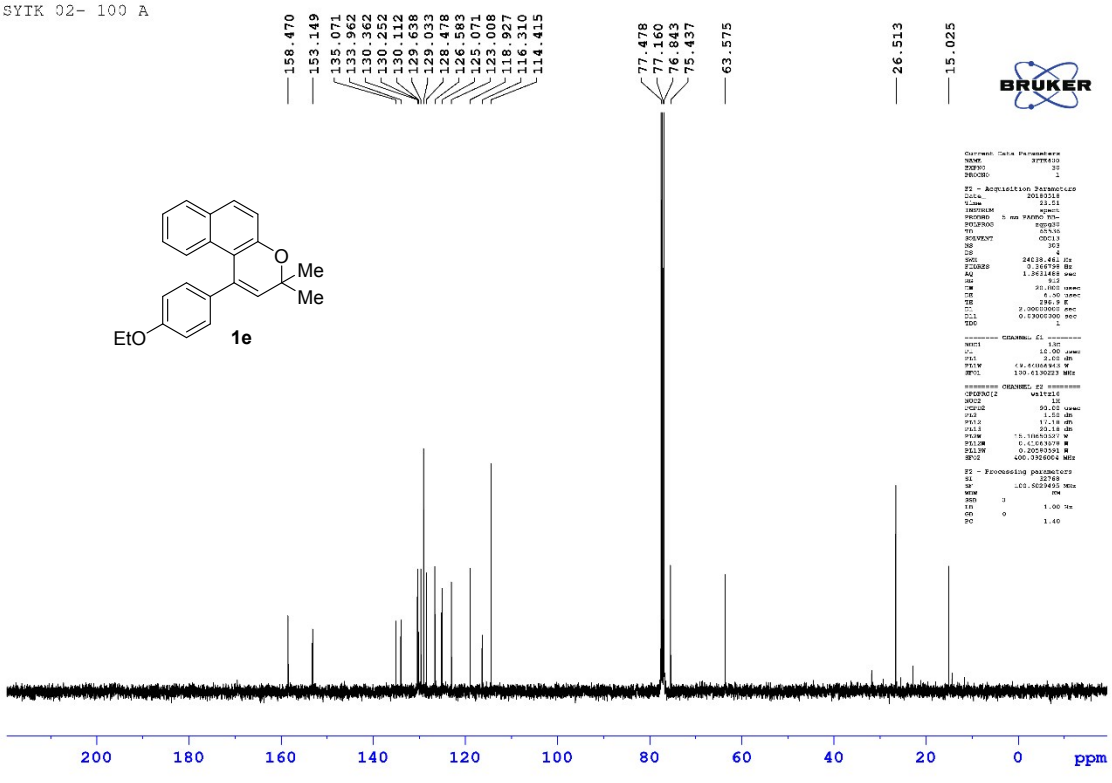
SYTK-02-98 A



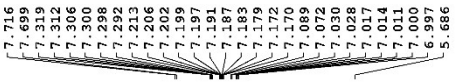
SYTK 02- 100 A

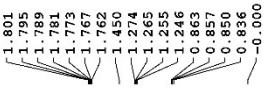


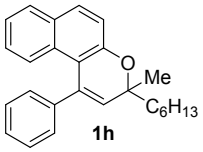
SYTK 02- 100 A

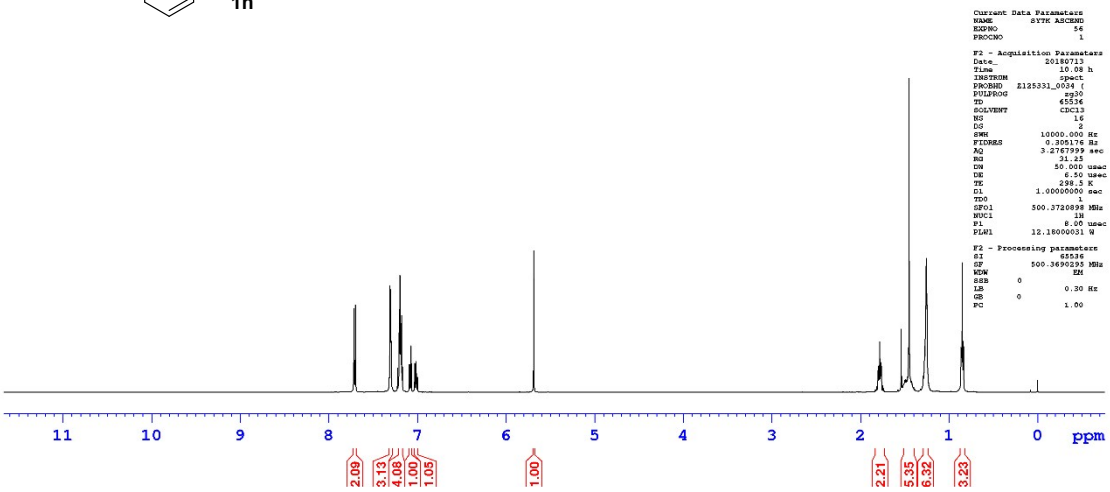


SYTK-02-109 A

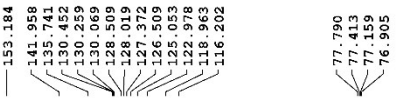


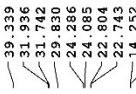


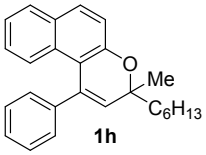


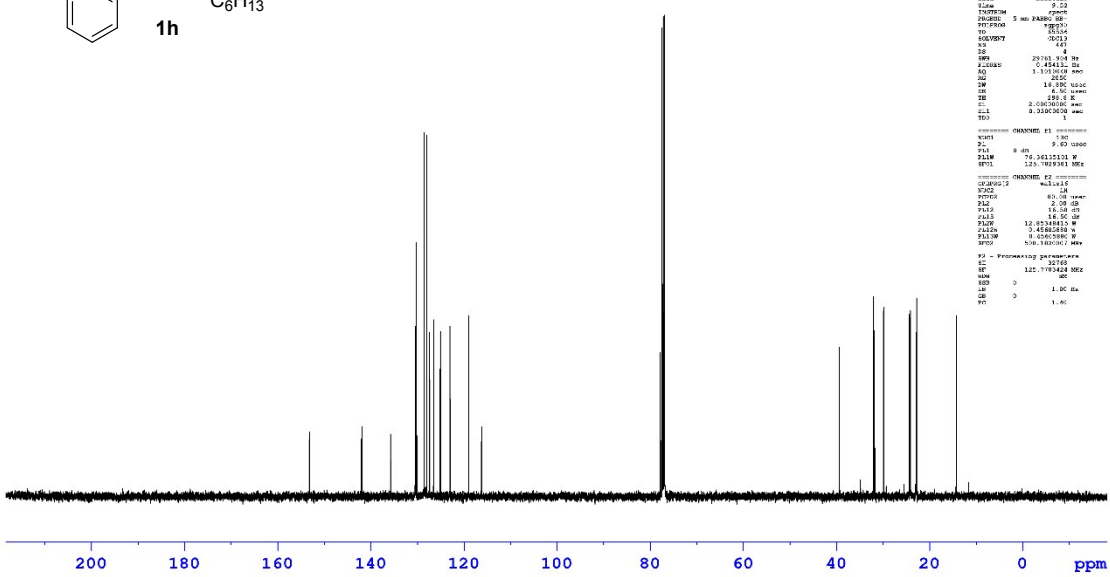


SYTK-02-109 A

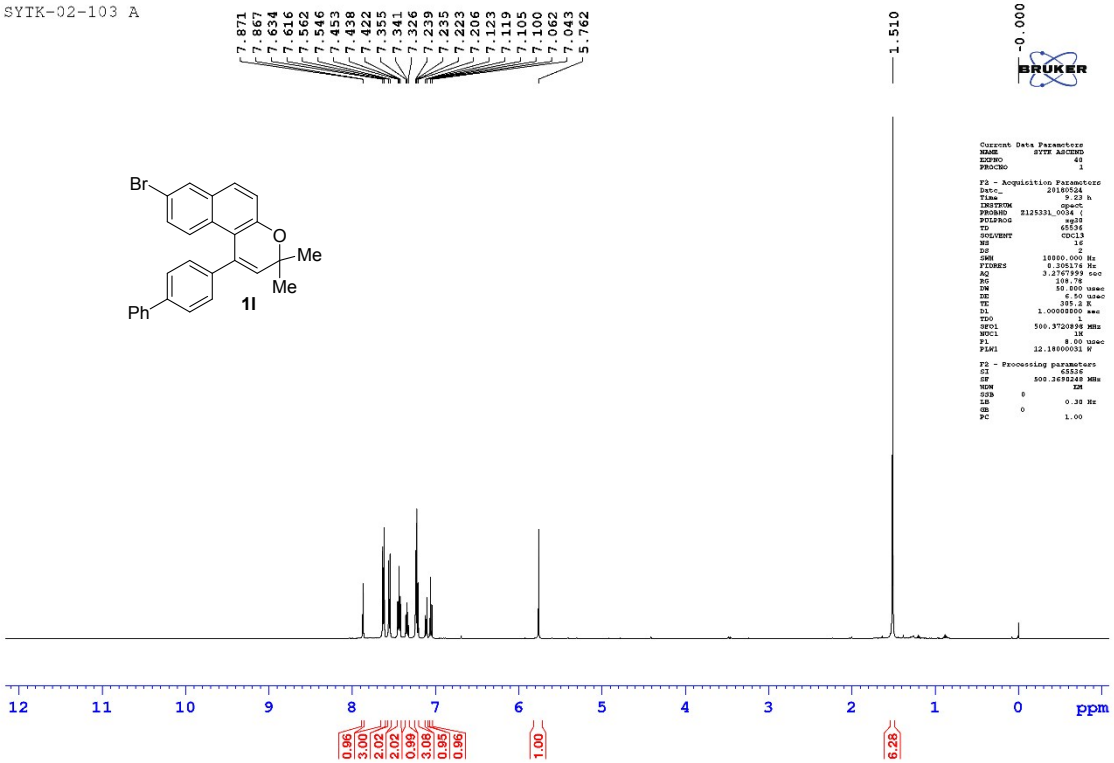




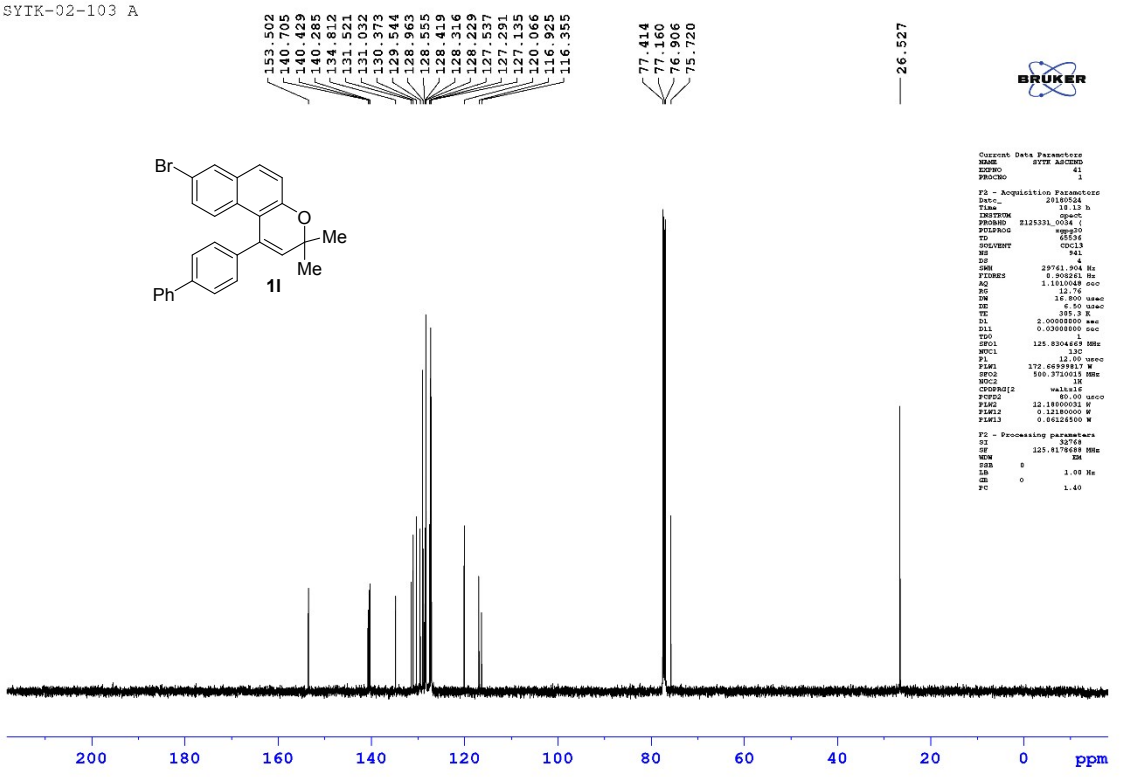




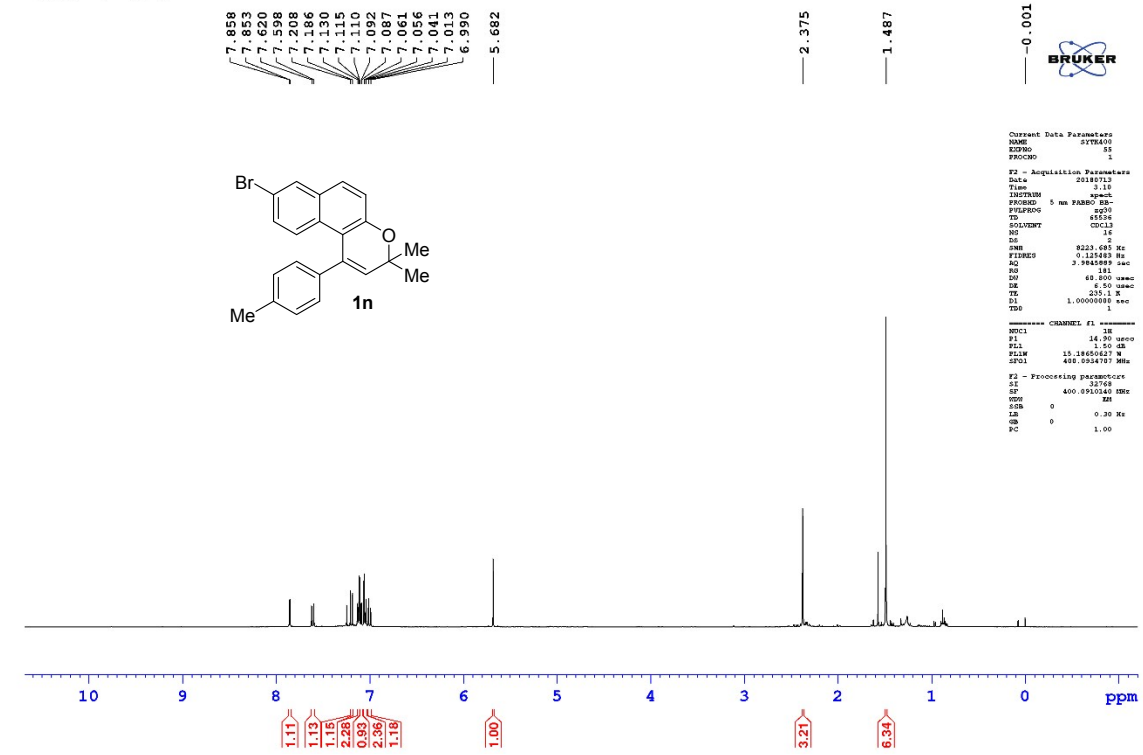
SYTK-02-103 A



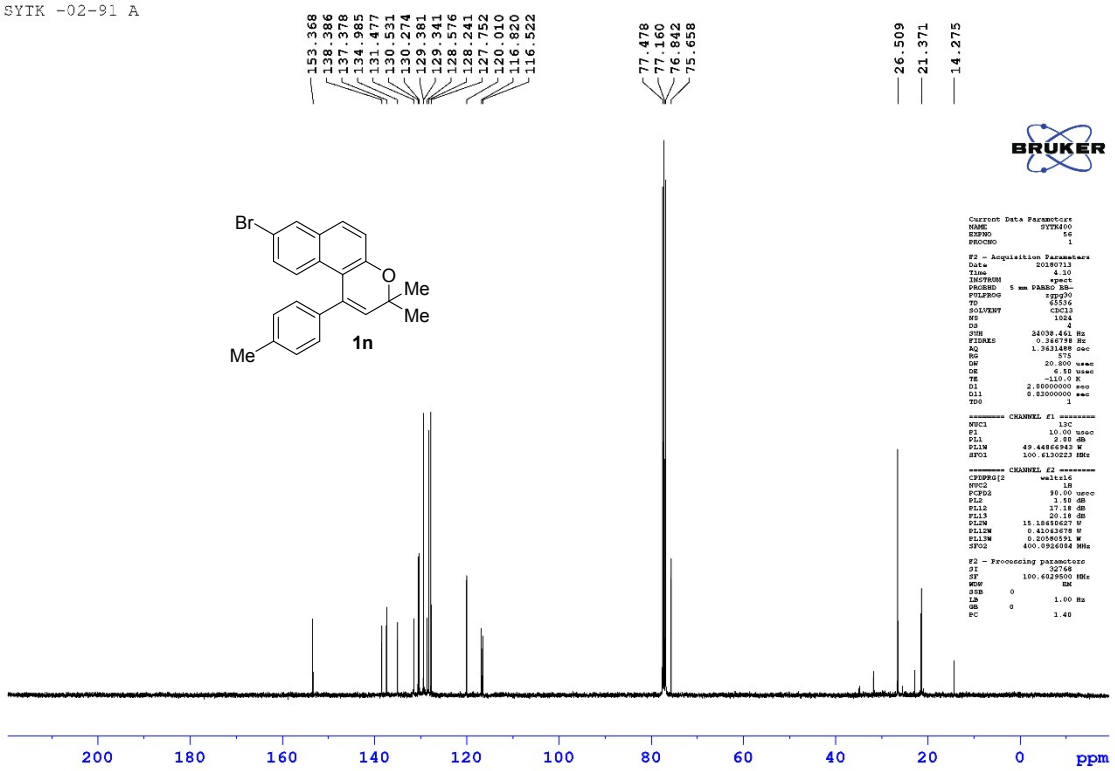
SYTK-02-103 A



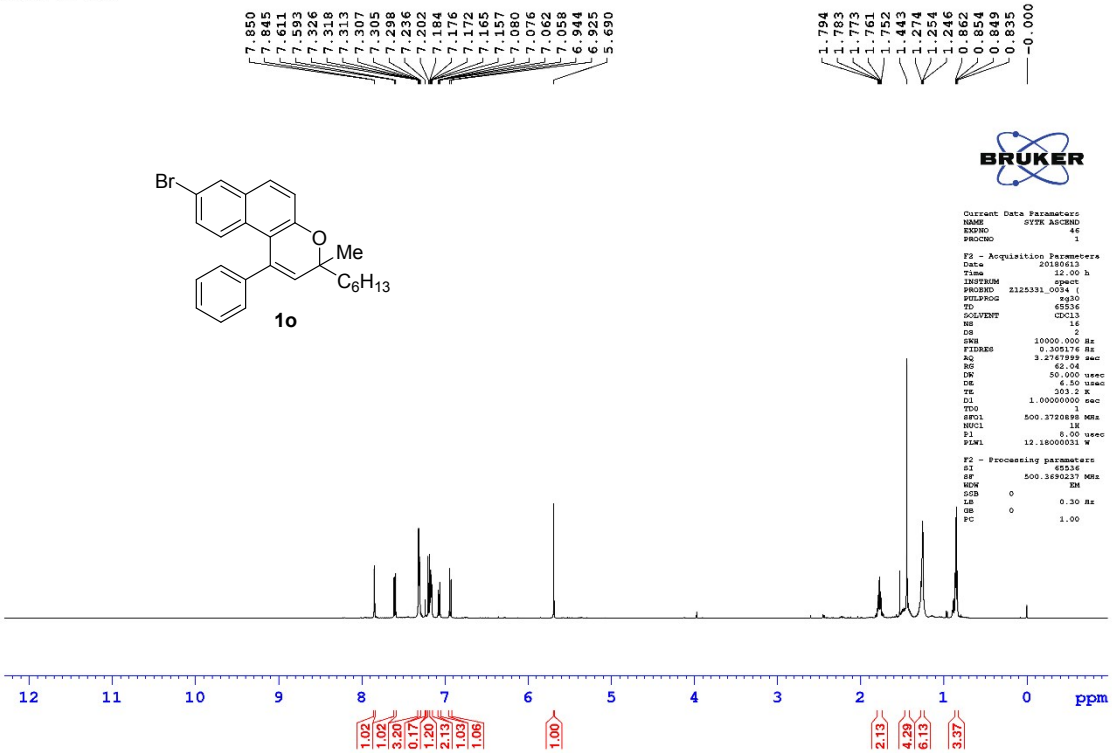
SYTK -02-91 A



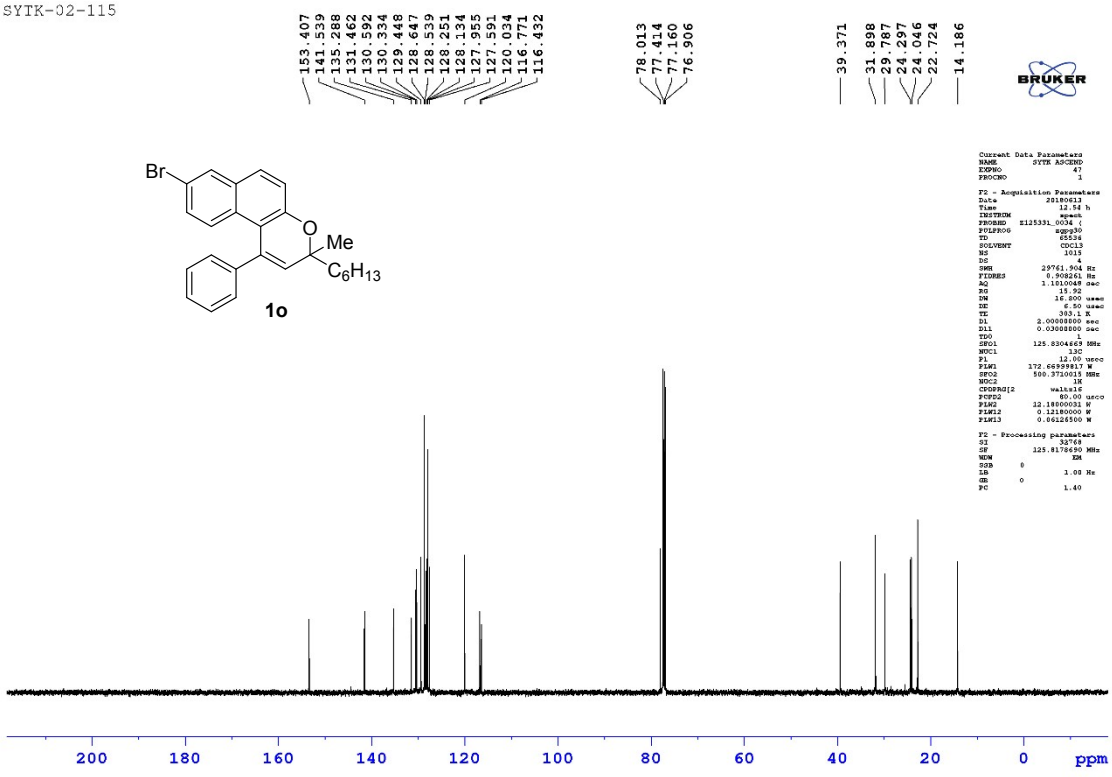
SYTK -02-91 A



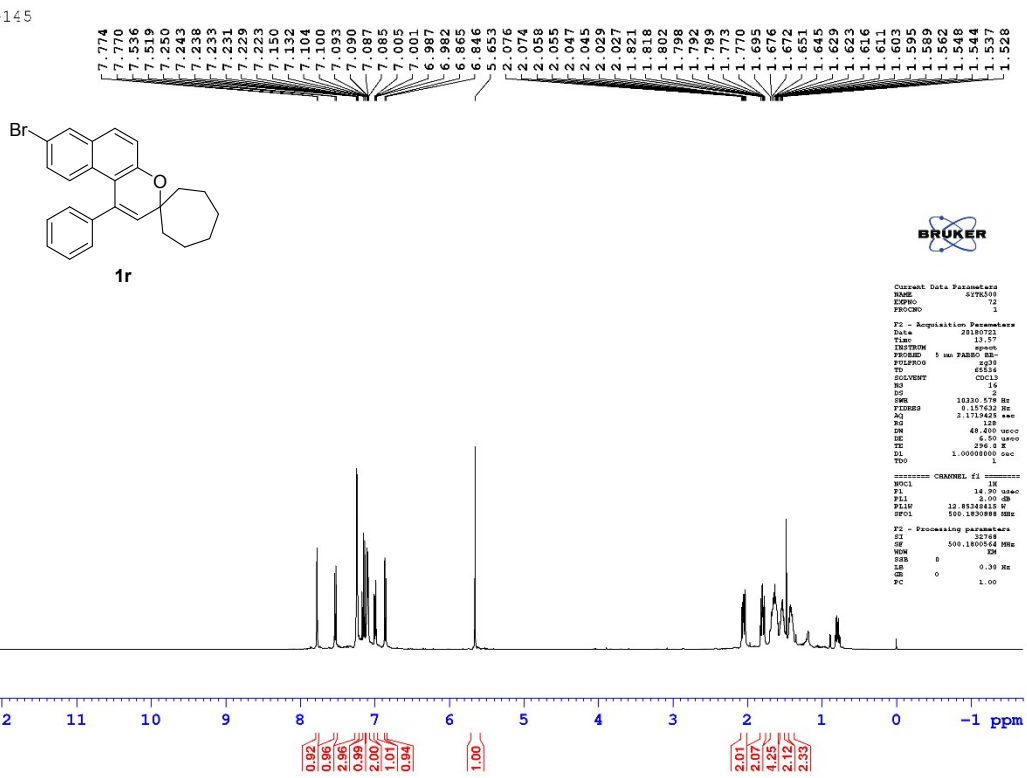
SYTK-02-115



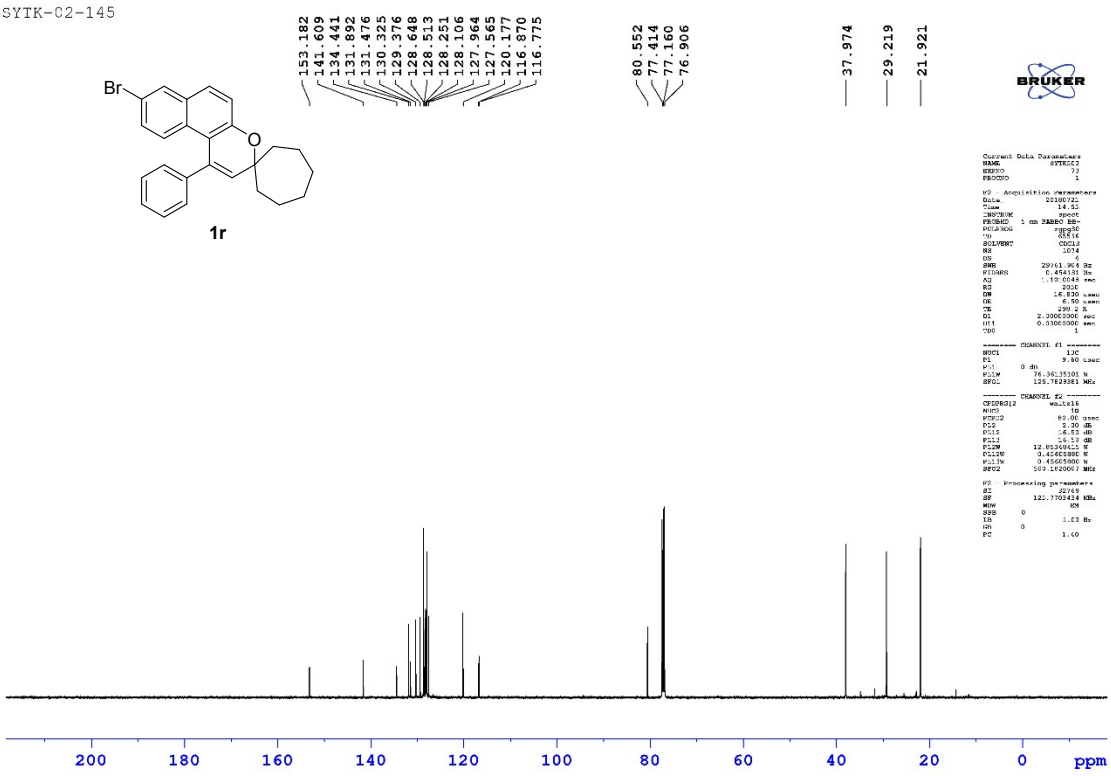
SYTK-02-115



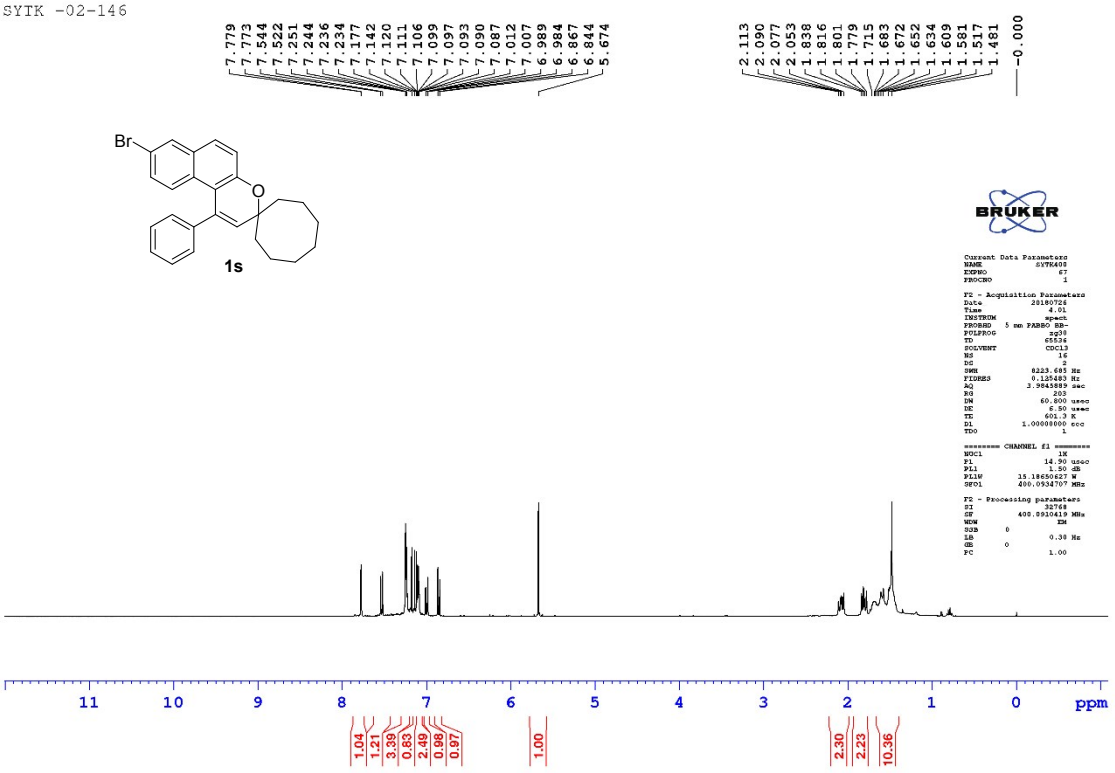
SYTK-02-145



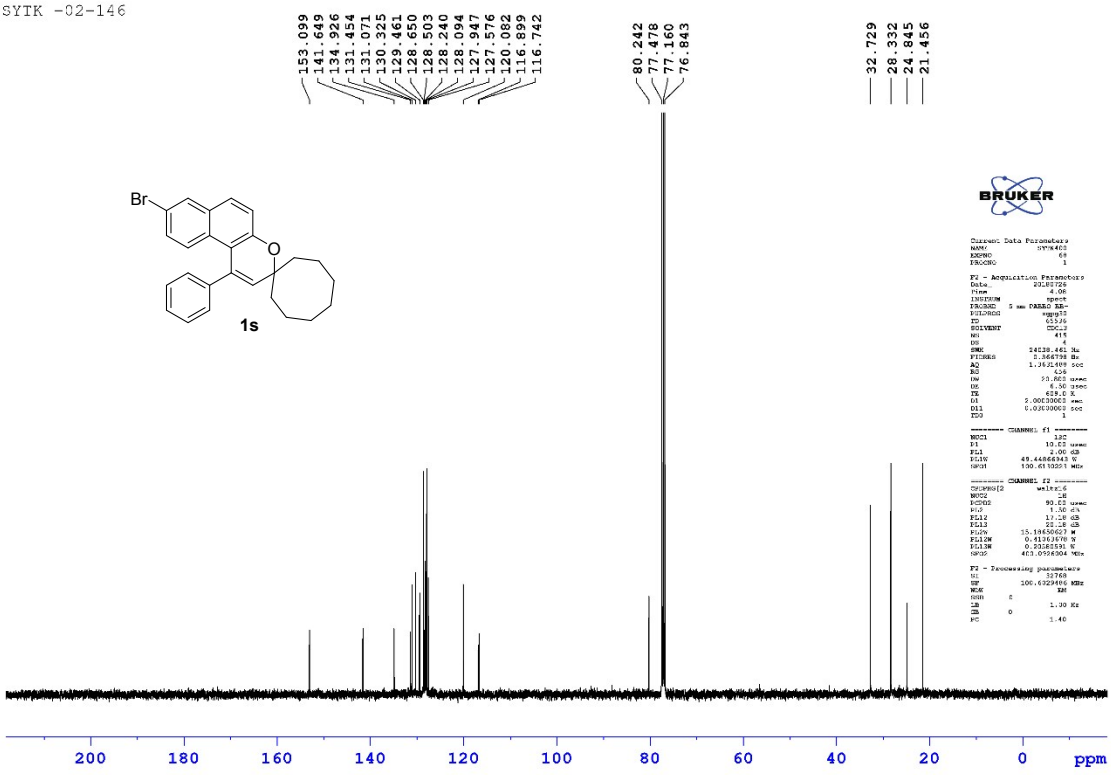
SYTK-02-145



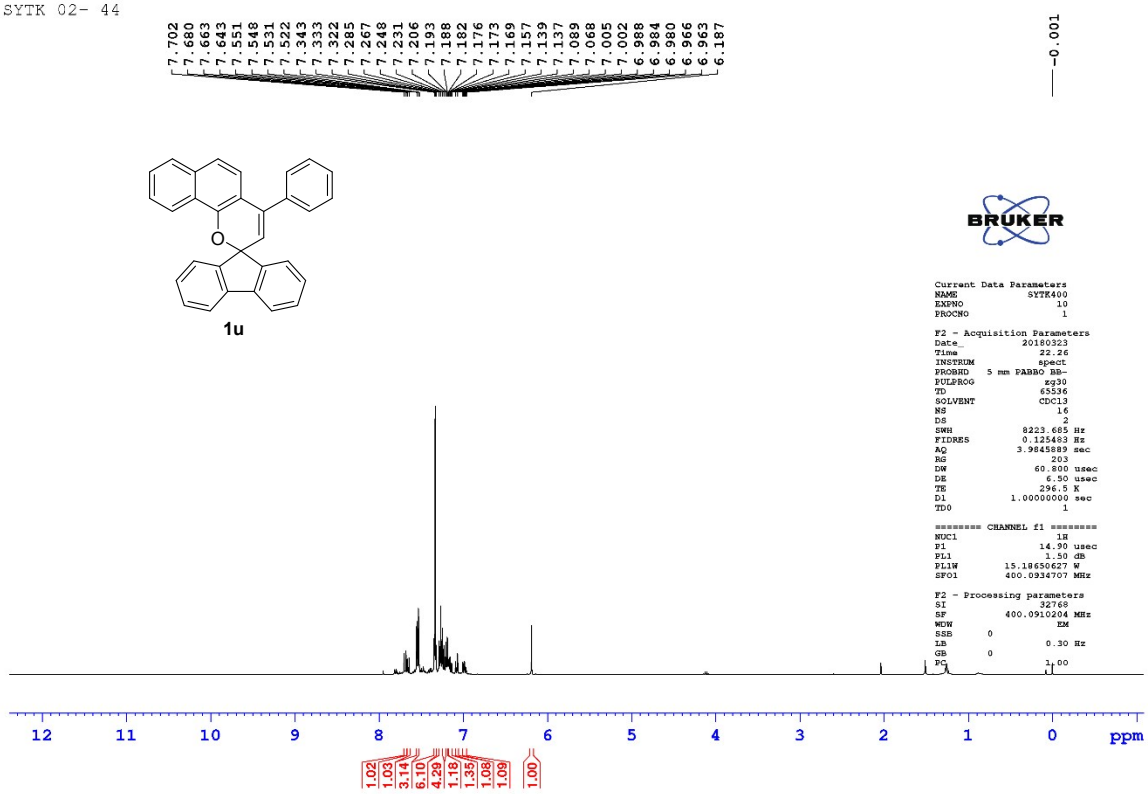
SYTK -02-146



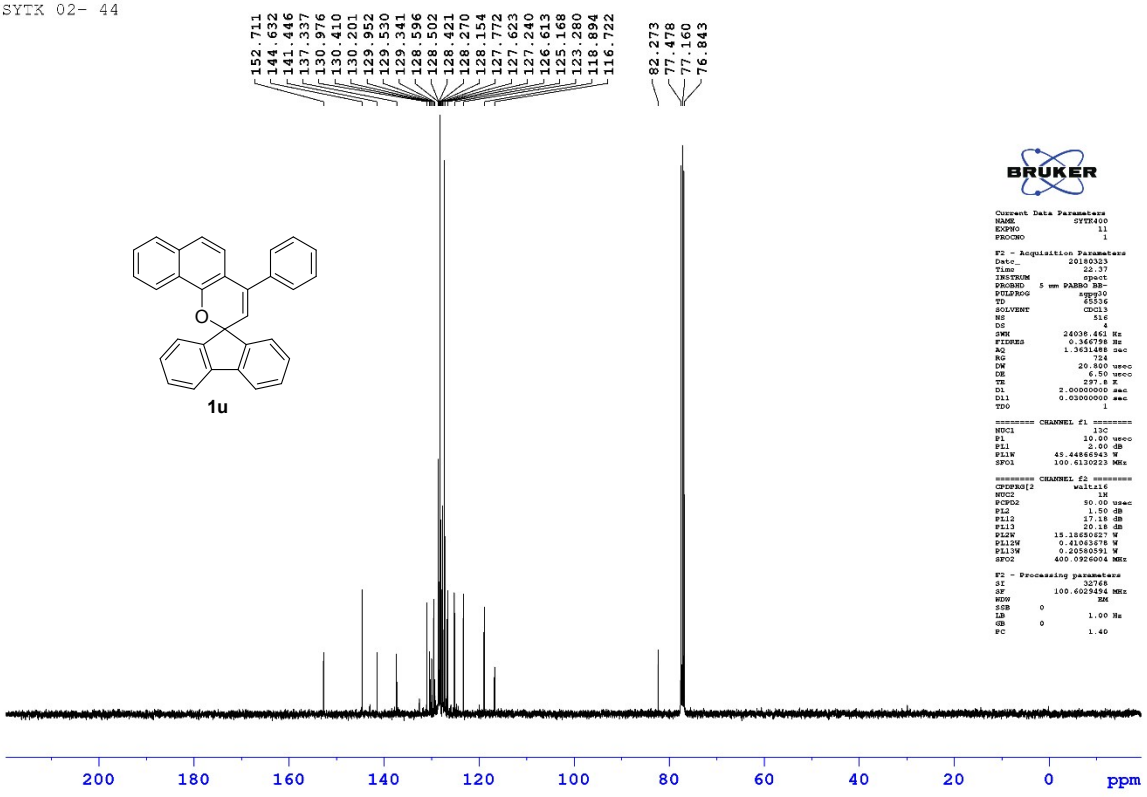
SYTK -02-146



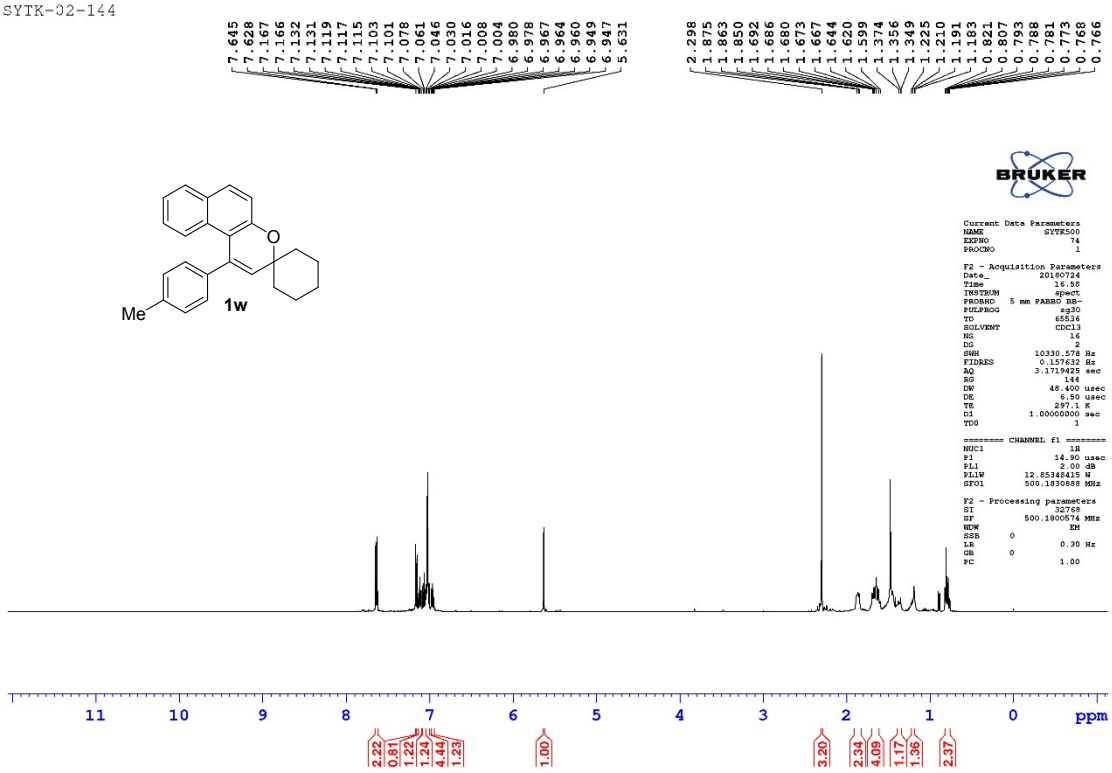
SYTK 02- 44



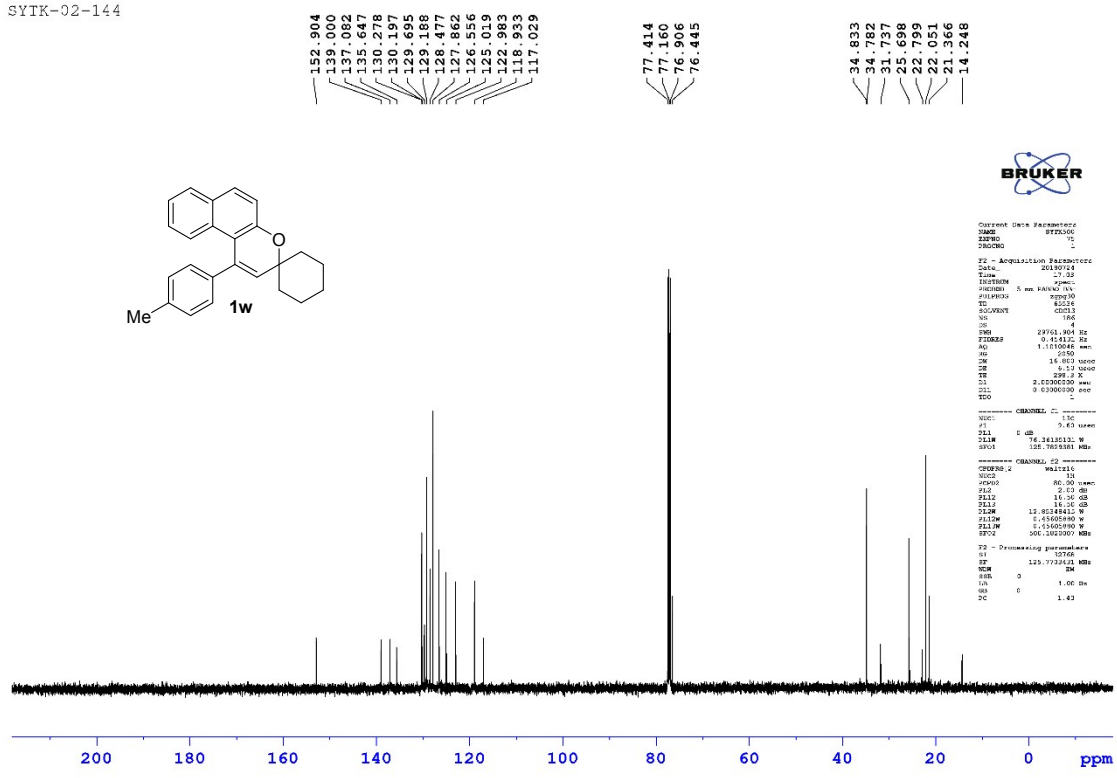
SYTK 02- 44



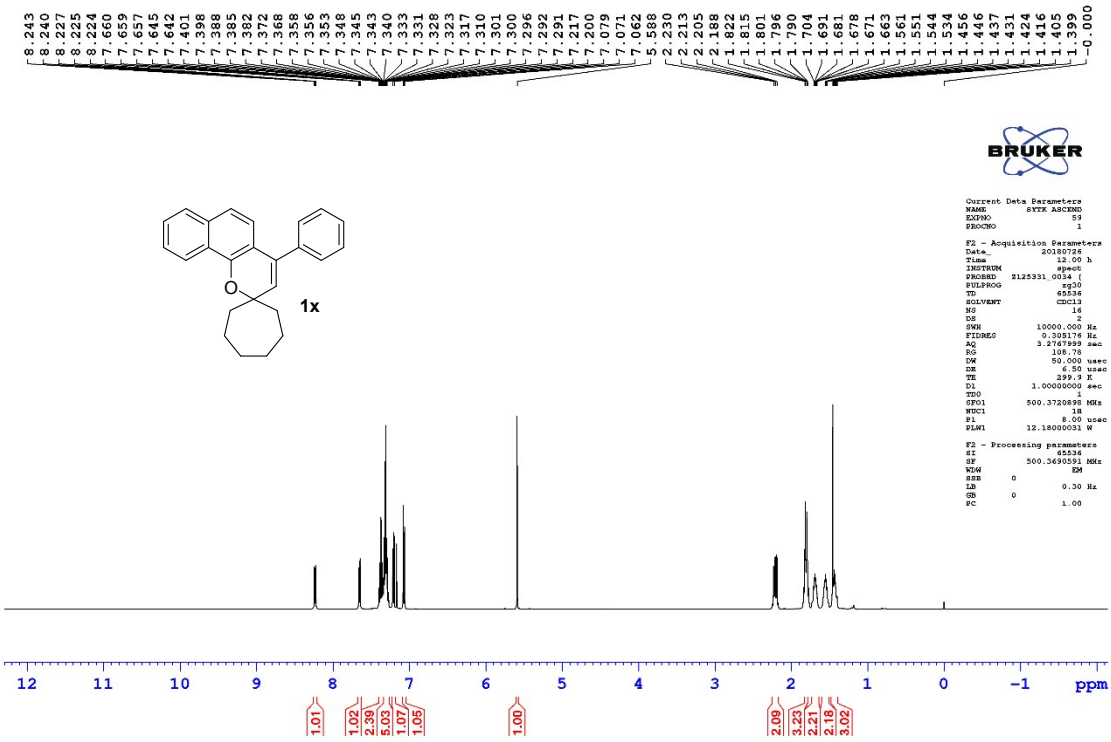
SYTK-02-144



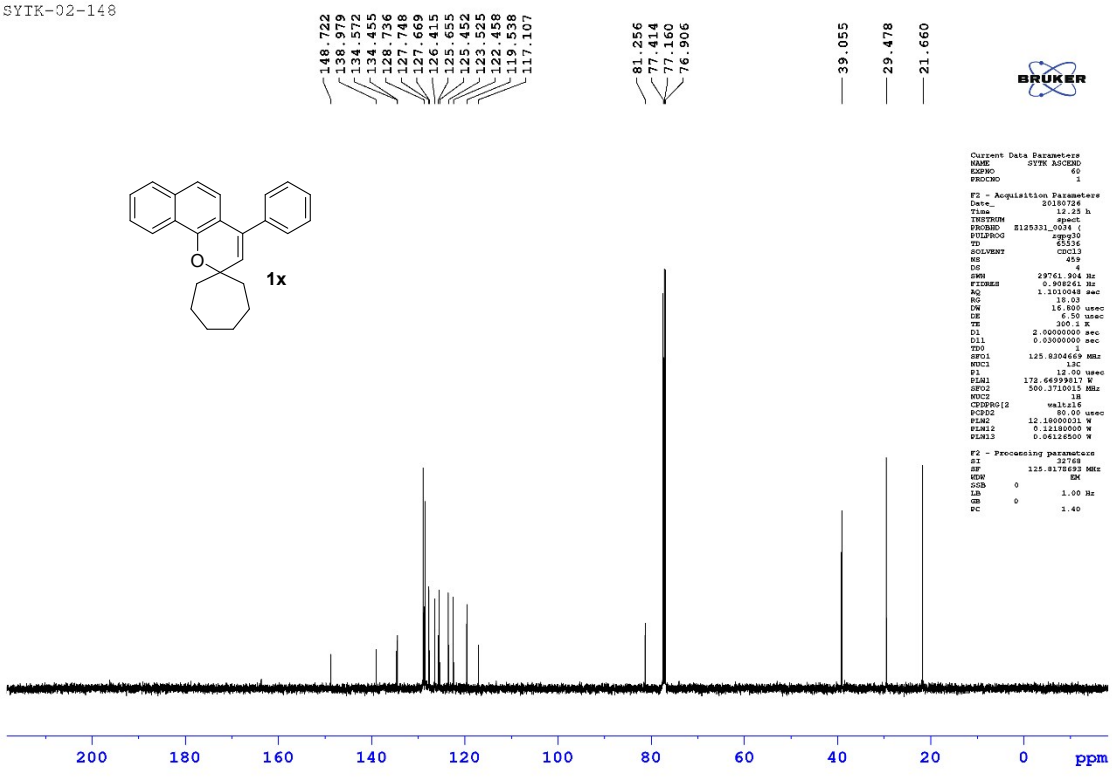
SYTK-02-144



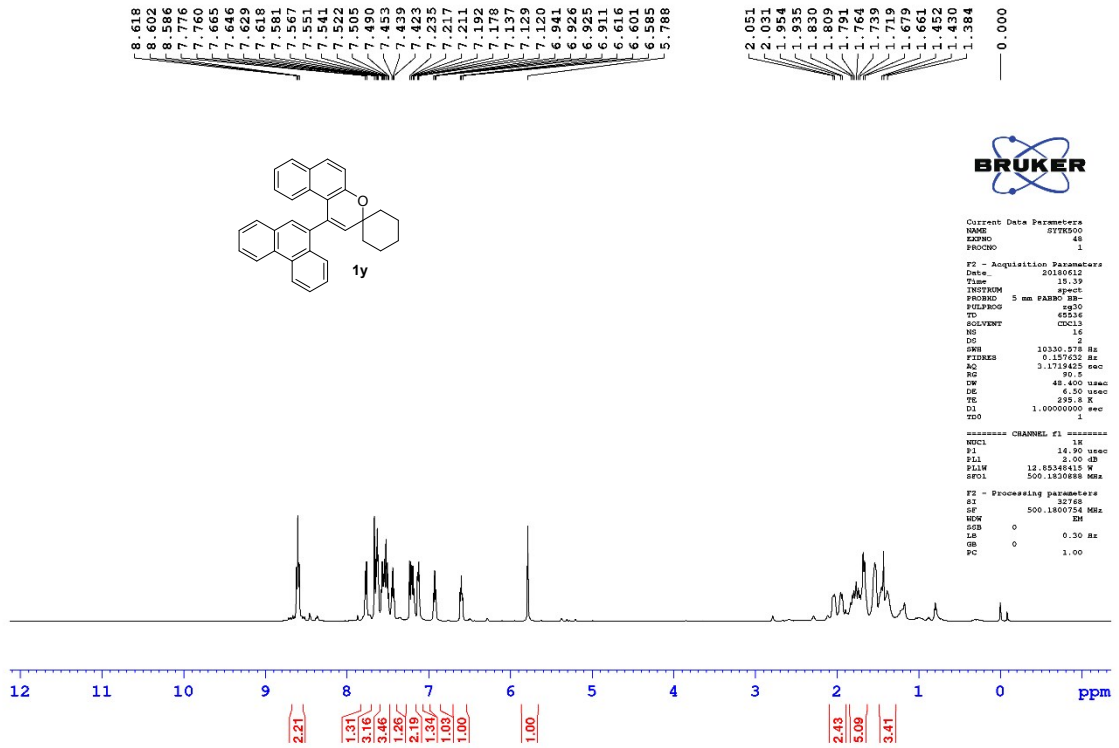
SYTK-02-148



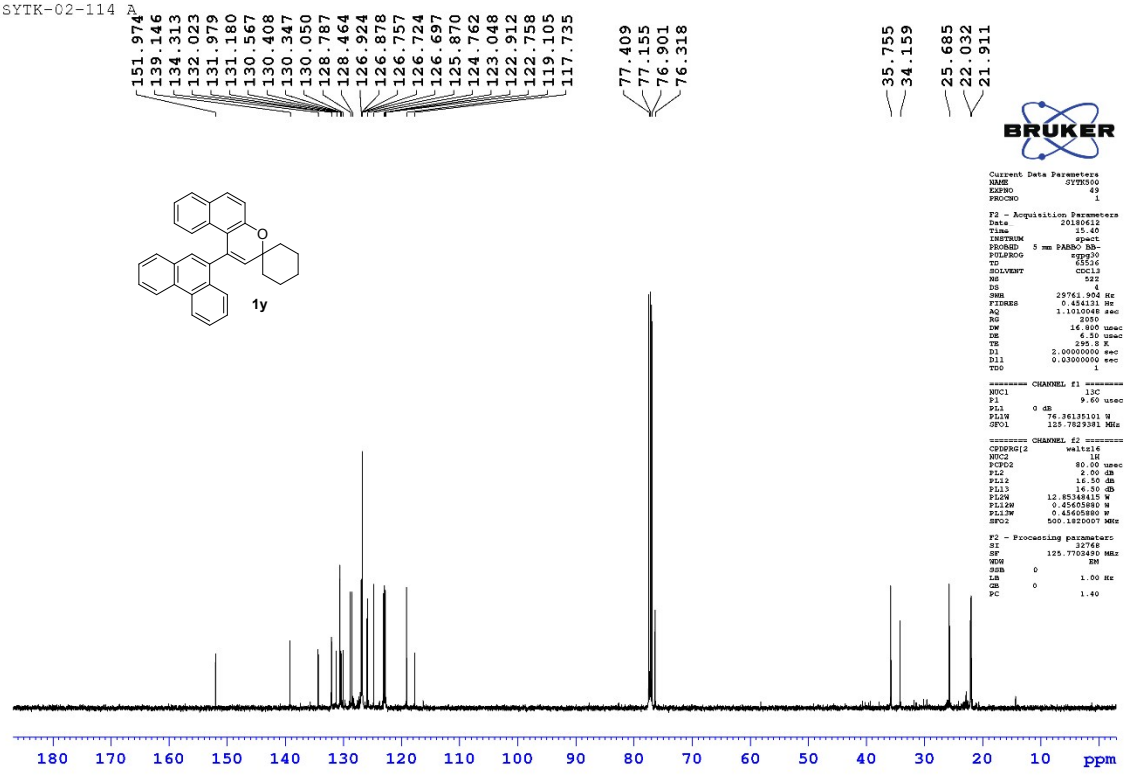
SYTK-02-148

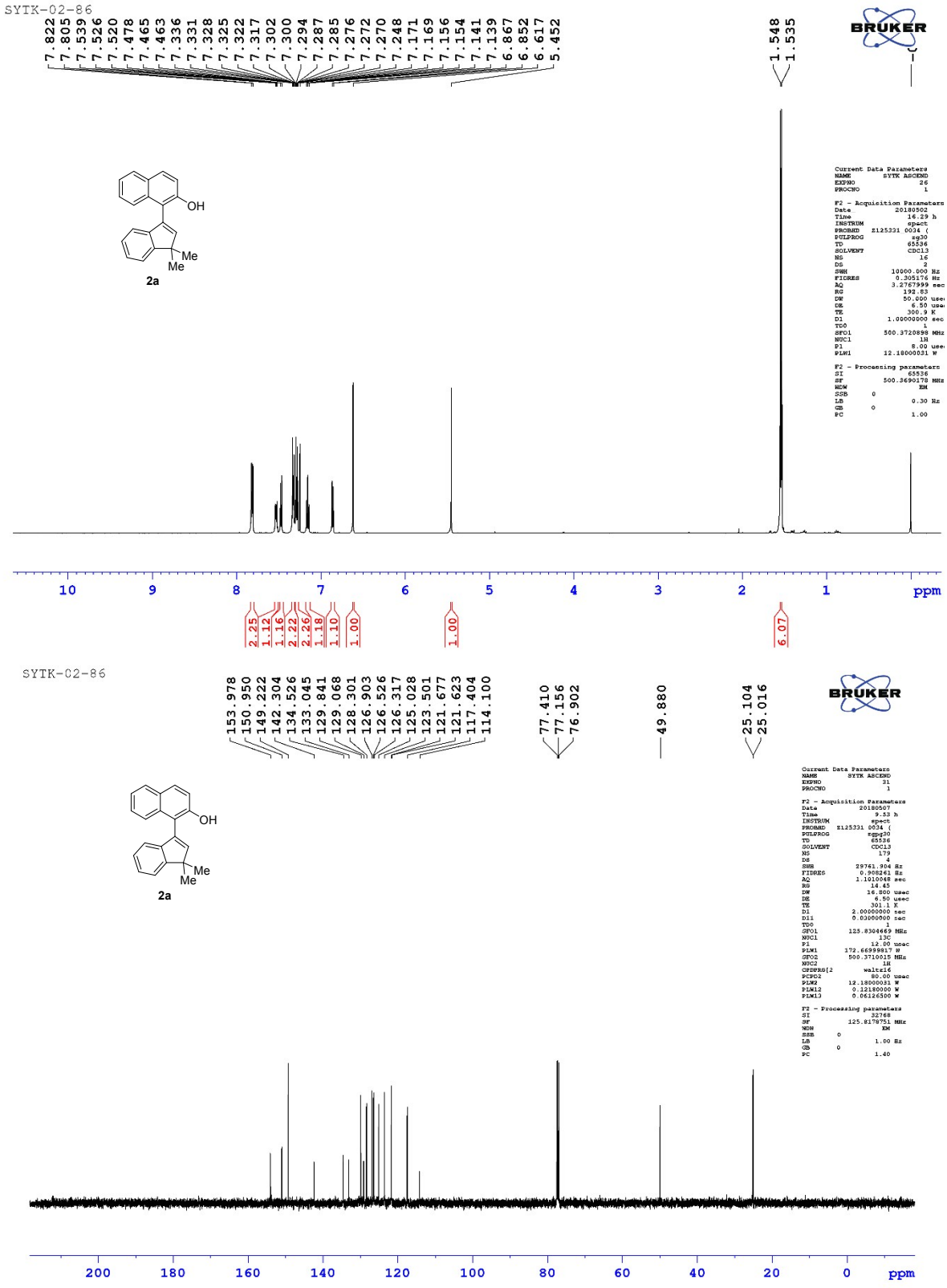


SYTK-02-114 A

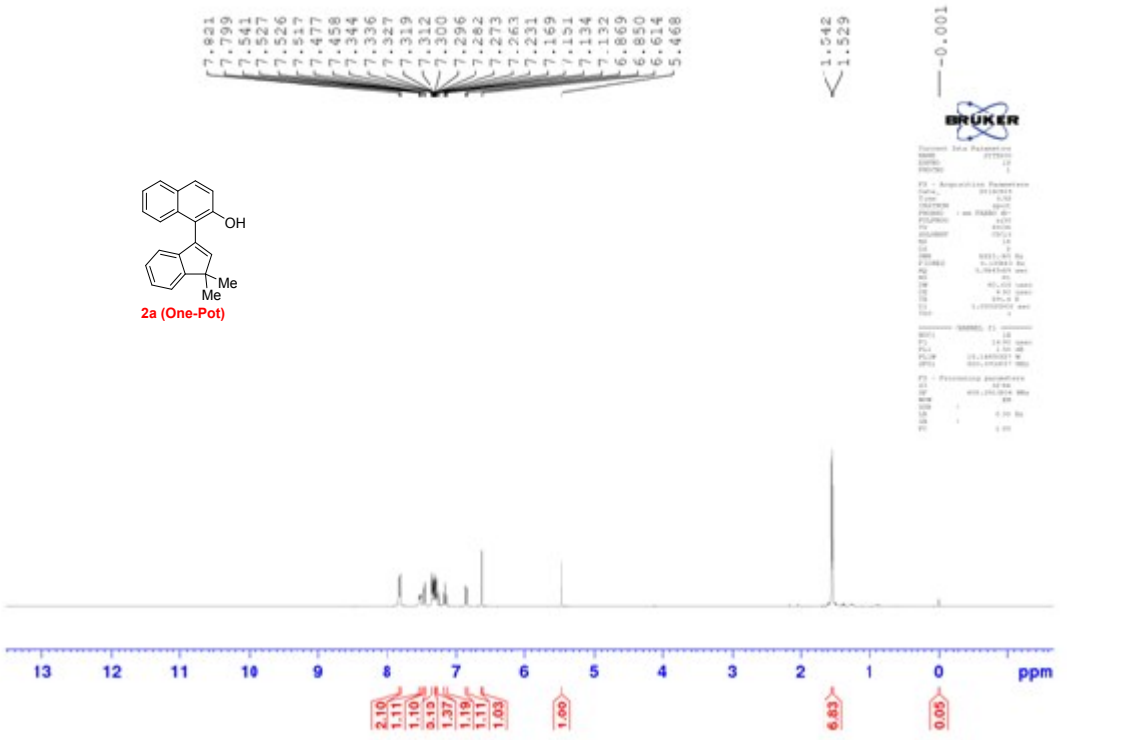


SYTK-02-114 A

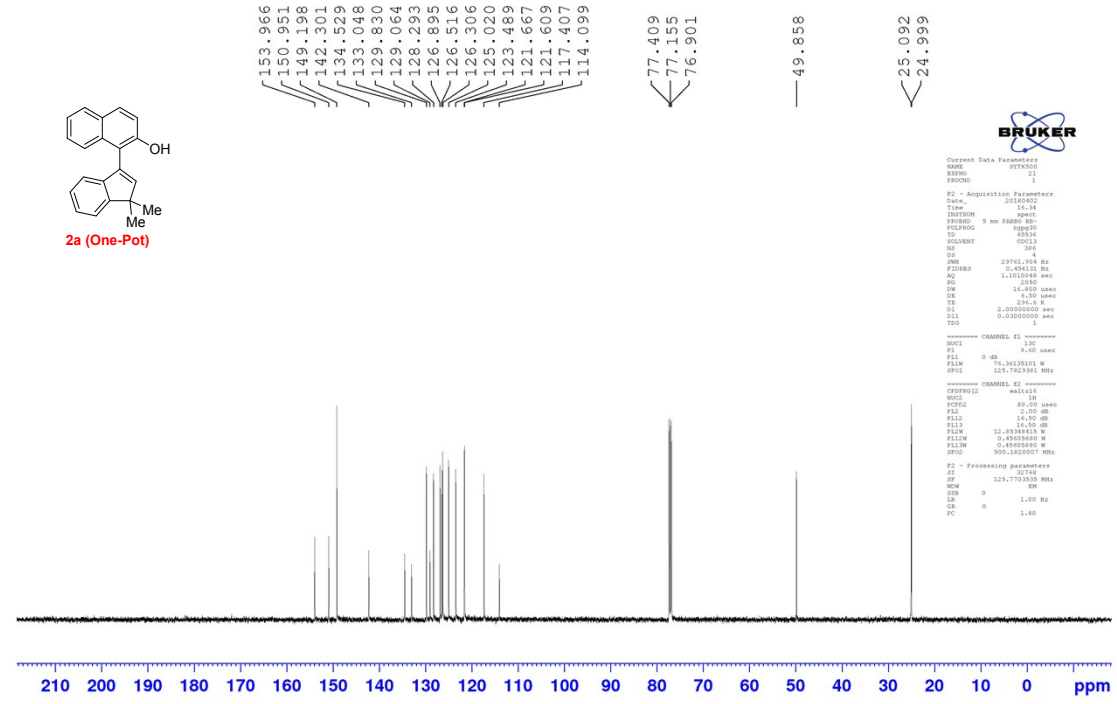



SYTK-02-86
7.822
7.805
7.539
7.526
7.520
7.478
7.465
7.463
7.336
7.331
7.328
7.325
7.322
7.317
7.302
7.300
7.294
7.287
7.285
7.276
7.272
7.270
7.248
7.171
7.169
7.156
7.154
7.141
7.139
6.867
6.852
6.617
5.452
1.548
1.535
BRUKER
OH
Me
Me
2a
Current Data Parameters
NAME SYTK ASCEND
EXPNO 26
PROCNO 1
F2 - Acquisition Parameters
Date 20180502
Time 16.29 h
INSTRUM spect
PROBHD 5125331 0034 (
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
SWH 10000.000 Hz
FIDRES 0.305176 Hz
AQ 3.2767999 sec
RG 192.63
DW 50.000 use
DE 6.50 use
TE 300.9 K
D1 1.00000000 sec
TD0 1
SFO1 500.3720898 MHz
NUC1 1H
P1 8.00 use
PLW1 12.18000031 W
F2 - Processing parameters
SI 65536
SF 500.3690179 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
10
9
8
7
6
5
4
3
2
1
ppm
2.25
1.12
1.16
2.22
2.26
1.18
1.10
1.00
1.00
6.07
SYTK-02-86
153.978
150.950
149.222
142.304
134.526
133.045
129.841
129.068
128.301
126.903
126.526
126.317
125.028
123.501
121.677
121.623
117.404
114.100
77.410
77.156
76.902
49.880
25.104
25.016
BRUKER
OH
Me
Me
2a
Current Data Parameters
NAME SYTK ASCEND
EXPNO 31
PROCNO 1
F2 - Acquisition Parameters
Date 20180507
Time 9.53 h
INSTRUM spect
PROBHD 5125331 0034 (
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 179
DS 4
SWH 29761.904 Hz
FIDRES 0.908261 Hz
AQ 1.1010048 sec
RG 14.45
DW 16.800 usec
DE 6.50 usec
TE 301.1 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1
SFO1 125.8304469 MHz
NUC1 13C
P1 12.00 usec
PLW1 172.66999817 W
SFO2 500.3710015 MHz
NUC2 1H
CPDPRG[2 waltz16
PCPD2 80.00 usec
PLW2 12.18000031 W
PLW12 0.12180000 W
PLW13 0.06126500 W
F2 - Processing parameters
SI 32768
SF 125.8178751 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40
200
180
160
140
120
100
80
60
40
20
0
ppm

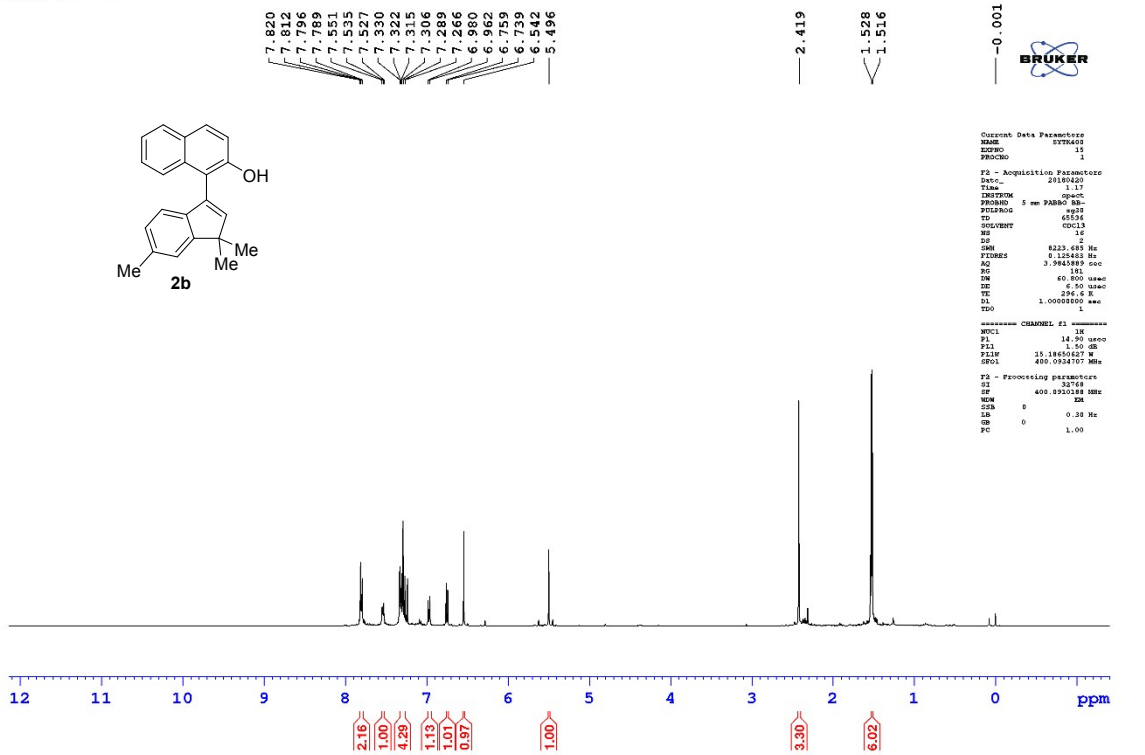
SYTK 02- 60



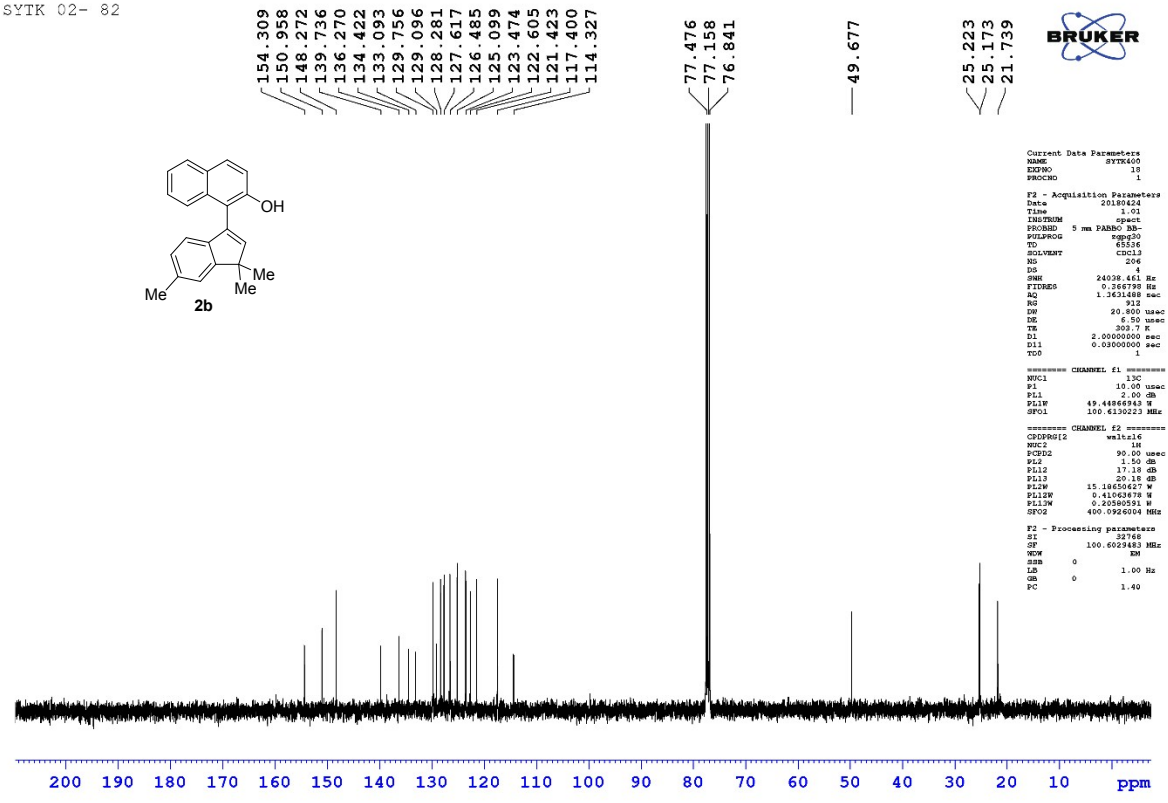
SYTK 02-60



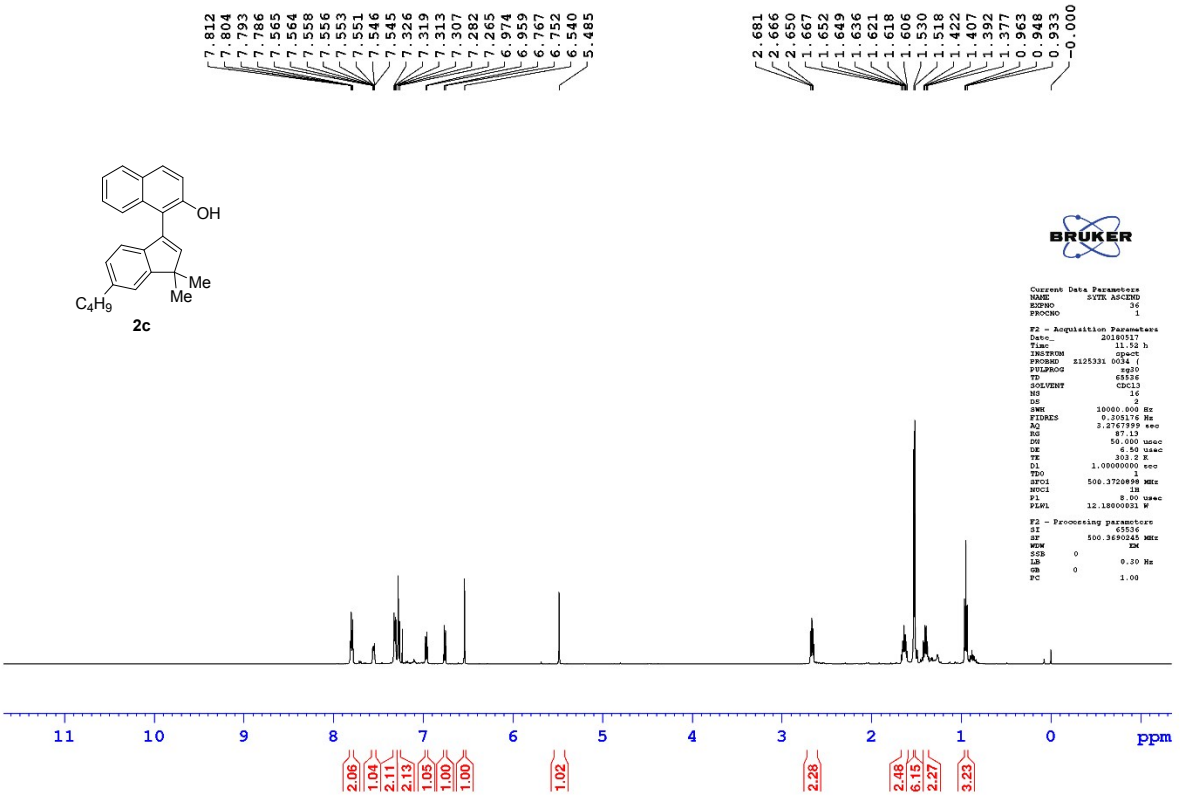
SYTK 02- 82



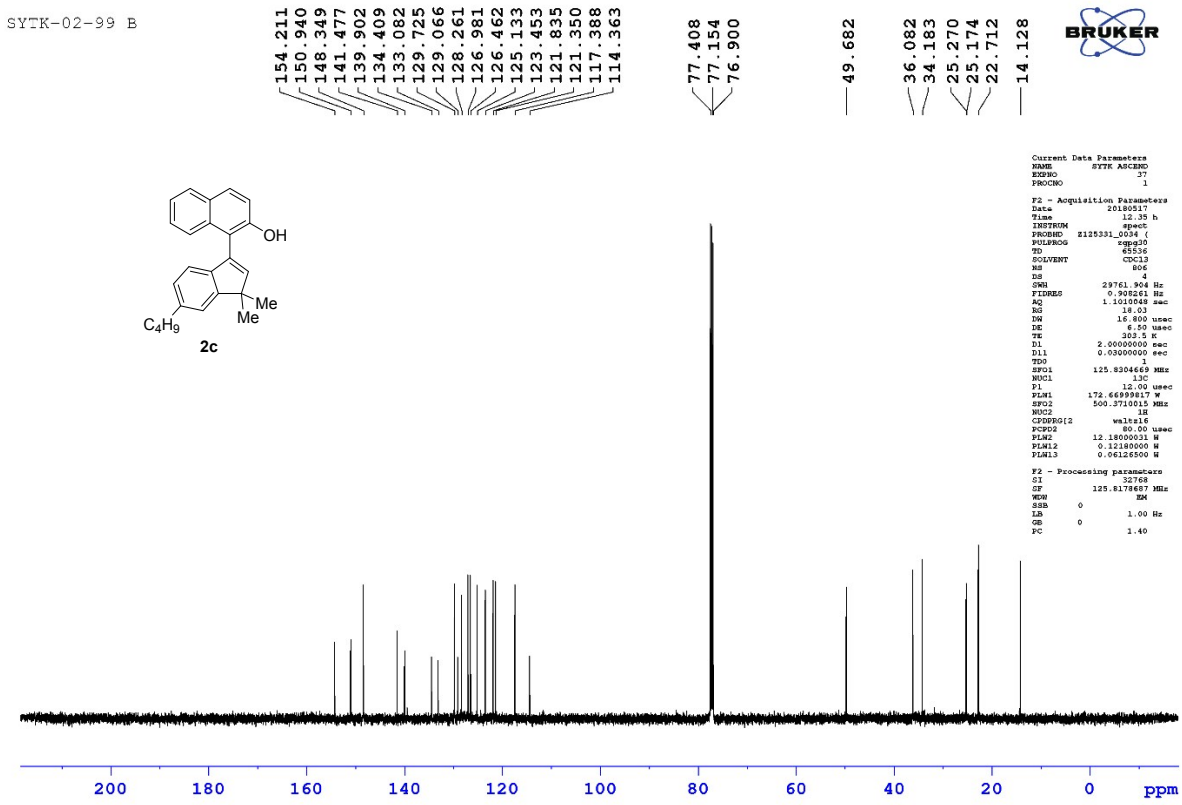
SYTK 02- 82

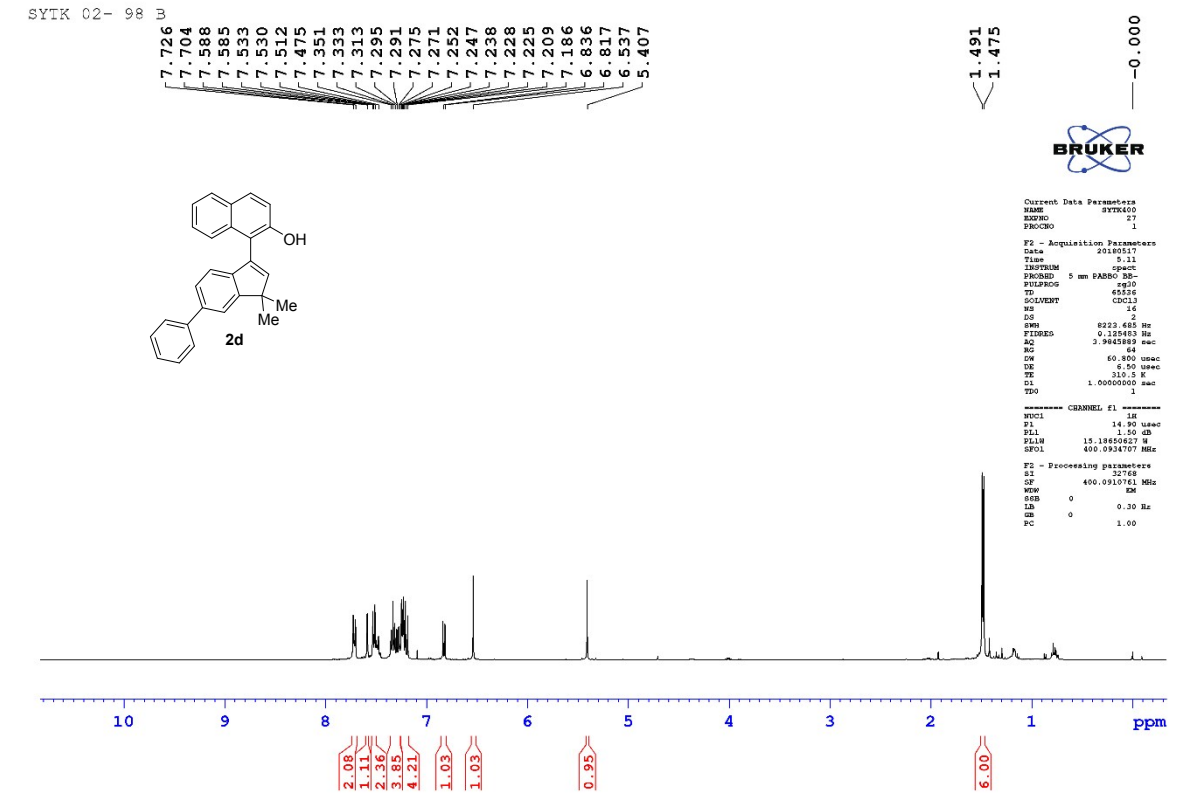


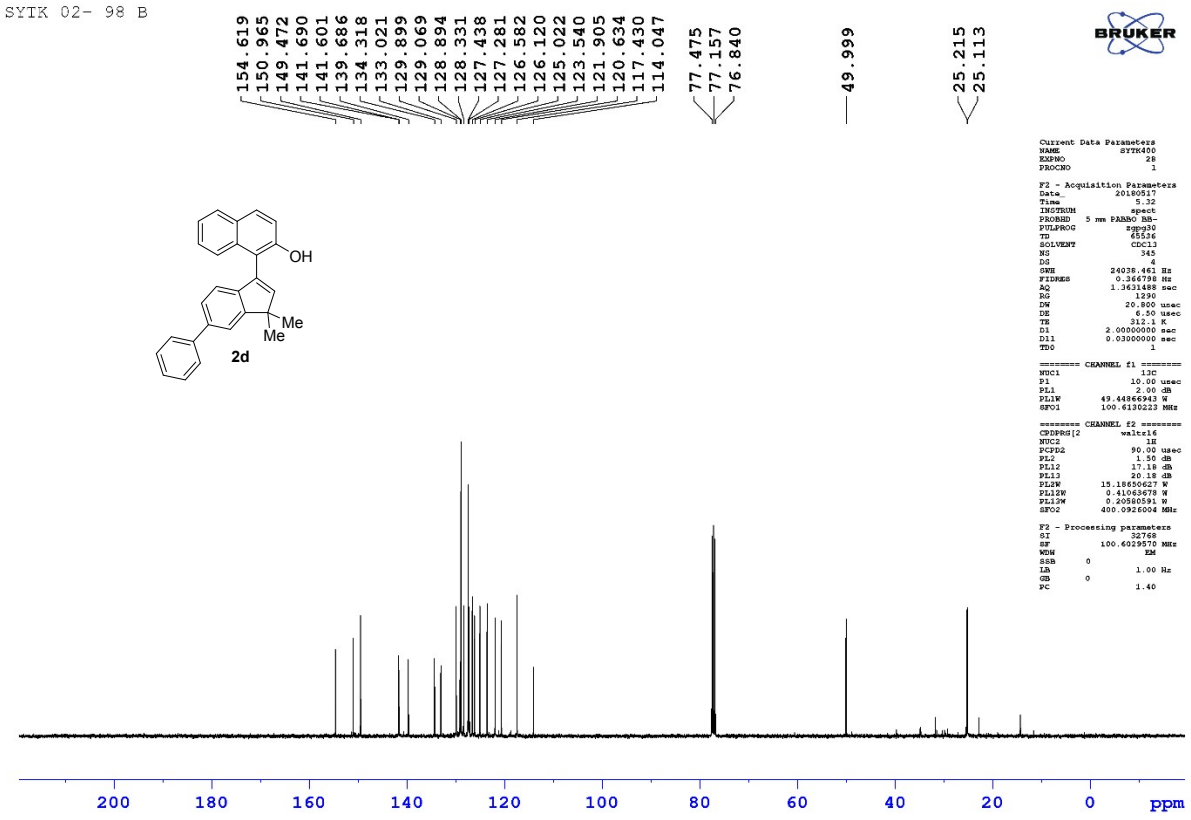
SYTK-02-99 B

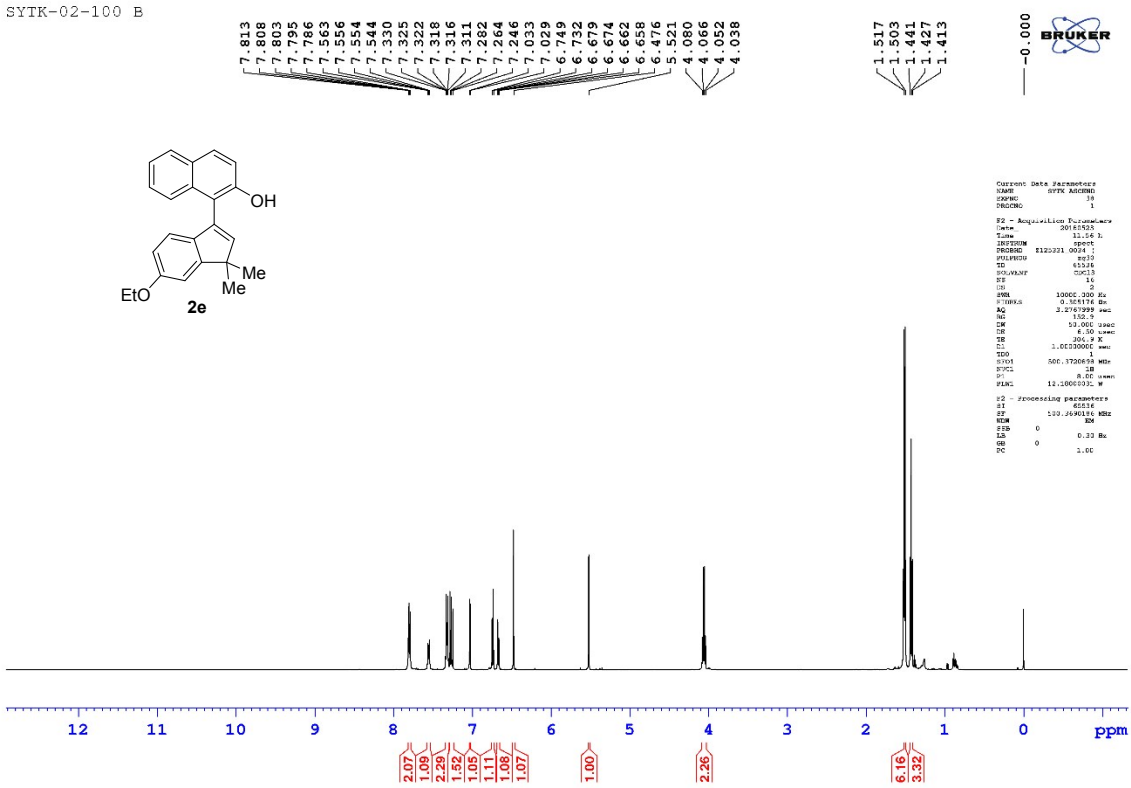


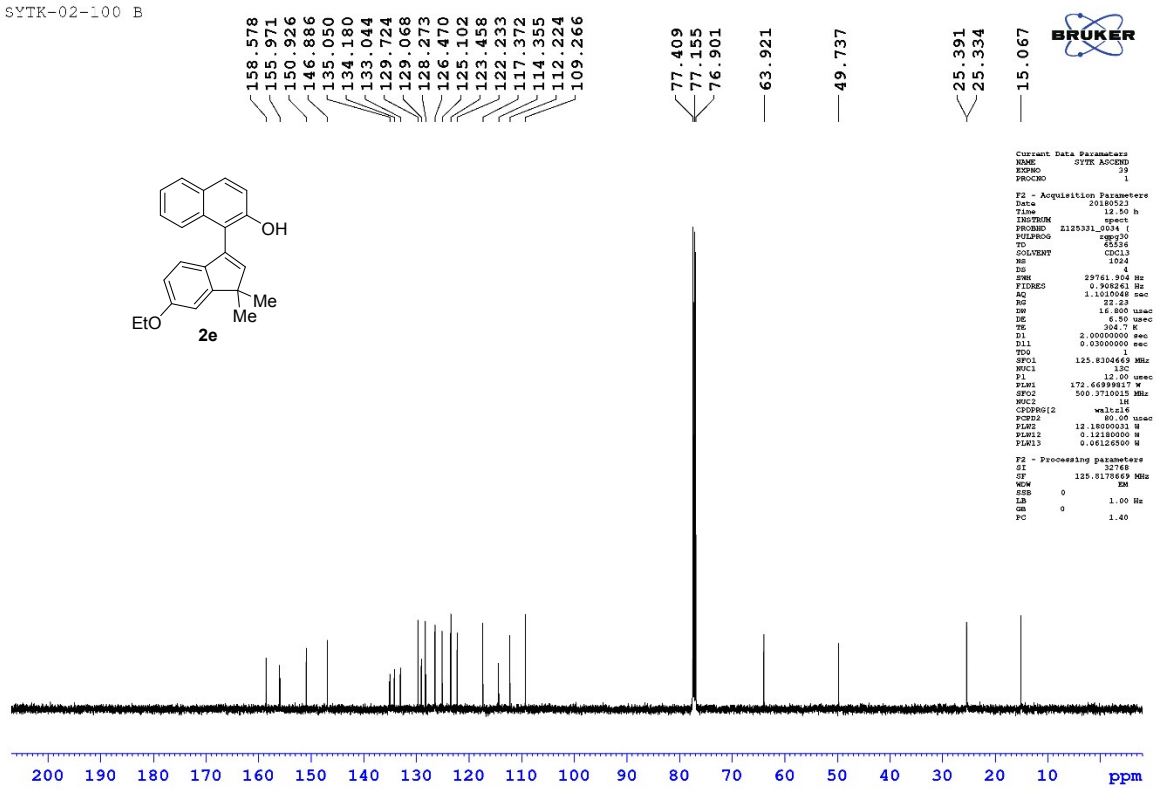
SYTK-02-99 B



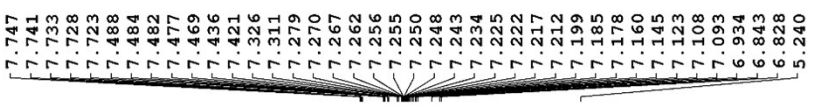

SYTK 02- 98 B
7.726
7.704
7.588
7.585
7.533
7.530
7.512
7.475
7.351
7.333
7.313
7.295
7.291
7.275
7.271
7.252
7.247
7.238
7.228
7.225
7.209
7.186
6.836
6.817
6.537
5.407
1.491
1.475
0.000
BRUKER
OH
Me
Me
2d
Current Data Parameters
NAME SYTK400
EXPNO 27
PROCNO 1
F2 - Acquisition Parameters
Data 20180517
Time 5.11
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
SWH 8223.685 Hz
FIDRES 0.125483 Hz
AQ 3.9845889 sec
RG 64
DW 60.800 usec
DE 6.50 usec
TE 310.5 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 ========
NUC1 1H
P1 14.90 usec
PL1 1.50 dB
PL1W 15.18650627 W
SFO1 400.0934707 MHz
F2 - Processing parameters
SI 32768
SF 400.0910761 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
10
9
8
7
6
5
4
3
2
1
ppm
2.08
1.11
2.36
3.85
4.21
1.03
1.03
0.95
6.00

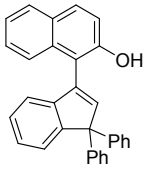

SYTK 02- 98 B
154.619
150.965
149.472
141.690
141.601
139.686
134.318
133.021
129.899
129.069
128.894
128.331
127.438
127.281
126.582
126.120
125.022
123.540
121.905
120.634
117.430
114.047
77.475
77.157
76.840
49.999
25.215
25.113
BRUKER
OH
Me
Me
2d
Current Data Parameters
NAME SYTK400
EXPNO 28
PROCNO 1
F2 - Acquisition Parameters
Data 20180517
Time 5.32
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 345
DS 4
SWH 24038.461 Hz
FIDRES 0.366798 Hz
AQ 1.3631488 sec
RG 1290
DW 20.800 usec
DE 6.50 usec
TE 312.1 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1
======== CHANNEL f1 ========
NUC1 13C
P1 10.00 usec
PL1 2.00 dB
PL1W 49.44866943 W
SFO1 100.6130223 MHz
======== CHANNEL f2 ========
CPDPRG[2 waltz16
NUC2 1H
PCPD2 90.00 usec
PL2 1.50 dB
PL12 17.18 dB
PL13 20.18 dB
PL2W 15.18650627 W
PL12W 0.41063678 W
PL13W 0.20580591 W
SFO2 400.0926004 MHz
F2 - Processing parameters
SI 32768
SF 100.6029570 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40
200
180
160
140
120
100
80
60
40
20
0
ppm


SYTK-02-100 B
7.813
7.808
7.803
7.795
7.786
7.563
7.556
7.554
7.544
7.330
7.325
7.322
7.318
7.316
7.311
7.282
7.264
7.246
7.033
7.029
6.749
6.732
6.679
6.674
6.662
6.658
6.476
5.521
4.080
4.066
4.052
4.038
1.517
1.503
1.441
1.427
1.413
0.000
BRUKER
OH
Me
Me
EtO
2e
12
11
10
9
8
7
6
5
4
3
2
1
0
ppm
2.07
1.09
2.29
1.52
1.05
1.11
1.08
1.07
1.00
2.26
6.16
3.32

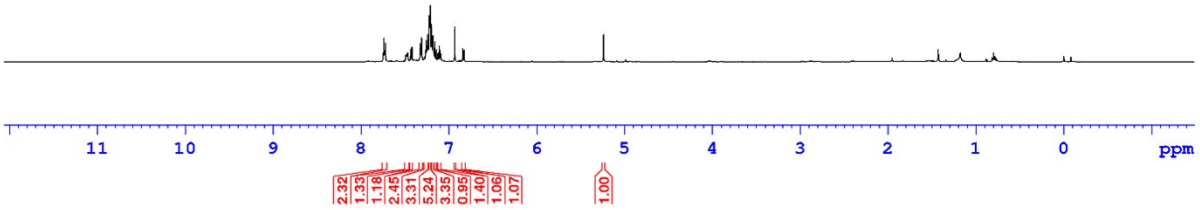

SYTK-02-100 B
158.578
155.971
150.926
146.886
135.050
134.180
133.044
129.724
129.068
128.273
126.470
125.102
123.458
122.233
117.372
114.355
112.224
109.266
77.409
77.155
76.901
63.921
49.737
25.391
25.334
15.067
BRUKER
OH
Me
Me
EtO
2e
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
ppm

SYTK-02-104 B

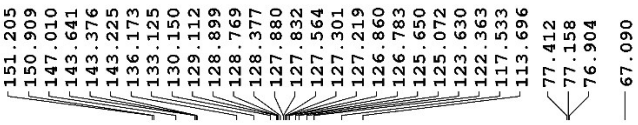


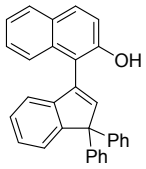


2f

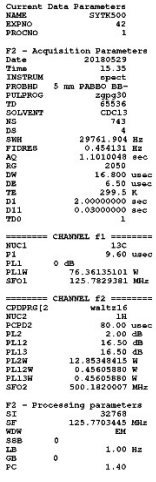


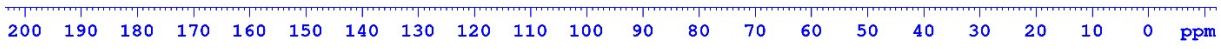
SYTK-02-104 B



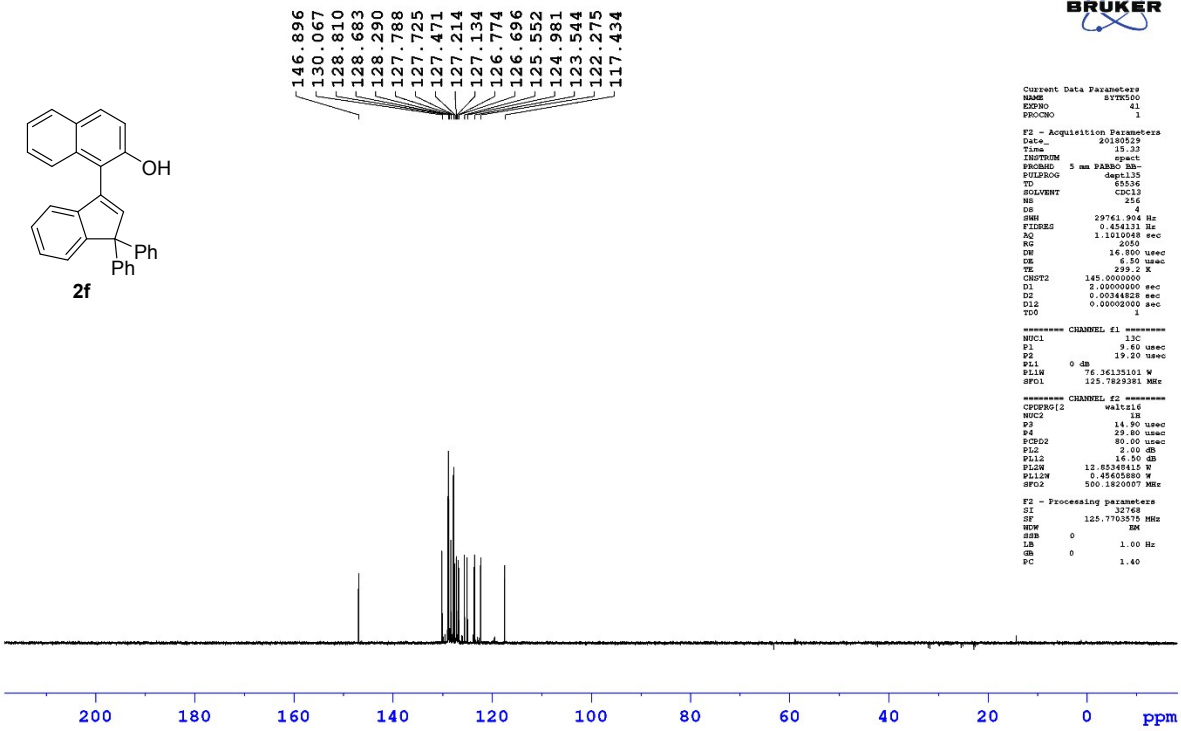


2f



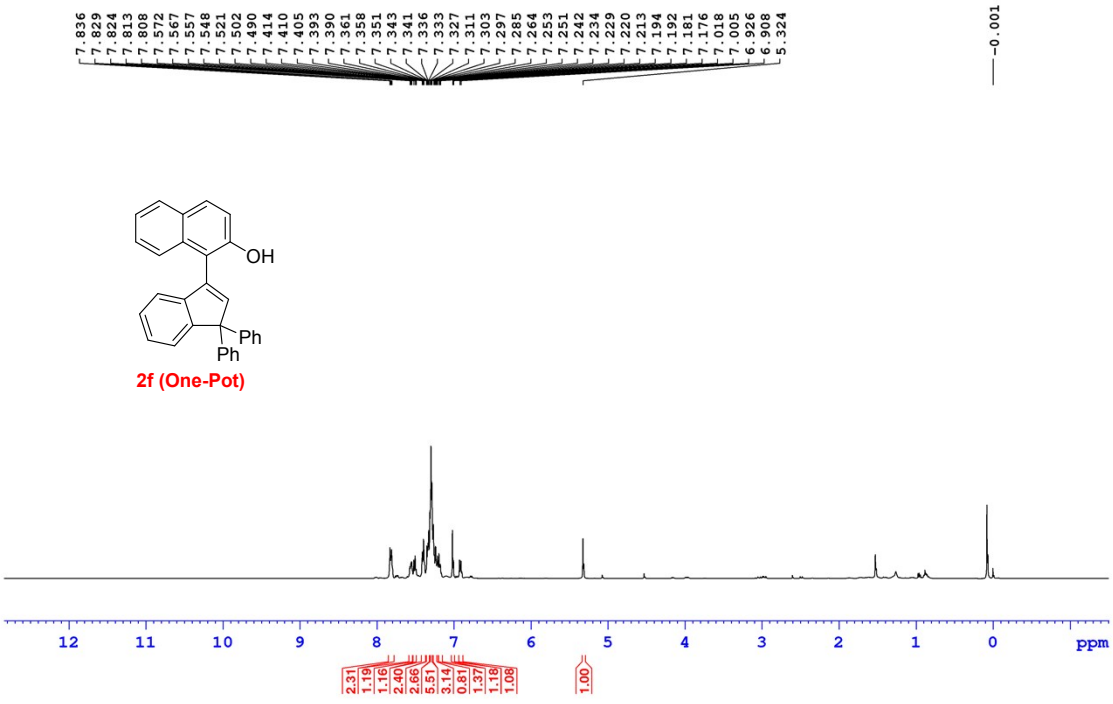


SYTK-02-104 B

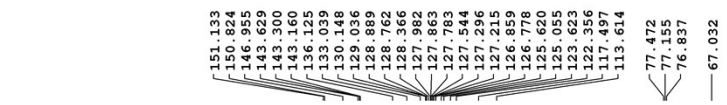


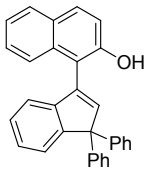

```
Current Data Parameters
NAME                  SYTK500
EXPNO                      41
PROCNO                      1

F2 - Acquisition Parameters
Date_               20180529
Time                   15.22
INSTRUM                spect
PROBHD    5 mm PABBO BA-
PULPROG             deptl35
TD                     65536
SOLVENT                CDCl3
NS                       256
DS                         4
SWH                29761.904 Hz
FIDRES                 0.454131 Hz
AQ                 1.1010048 sec
RG                      2050
DW                    16.800 usec
DE                     6.50 usec
TE                    299.2 K
CNST2              145.0000000
D1                   2.00000000 sec
D2                   0.00344828 sec
D12                  0.00002000 sec
TD0                         1

======== CHANNEL f1 ========
NUC1                      13C
P1                       9.60 usec
P2                      19.20 usec
PL1          0 dB
PL1W              76.36135101 W
SFO1             125.7829381 MHz

======== CHANNEL f2 ========
CPDPRG[2                waltz16
NUC2                        1H
P3                      14.90 usec
P4                      29.80 usec
PCPD2                   80.00 usec
PL2                       2.00 dB
PL12                     16.50 dB
PL2W              12.85349411 W
PL12W              0.45605880 W
SFO2             500.1820007 MHz

F2 - Processing parameters
SI                        32768
SF                125.7703575 MHz
WDW                          EM
SSB          0
LB                        1.00 Hz
GB           0
PC                        1.40
```

SYTK-02-105

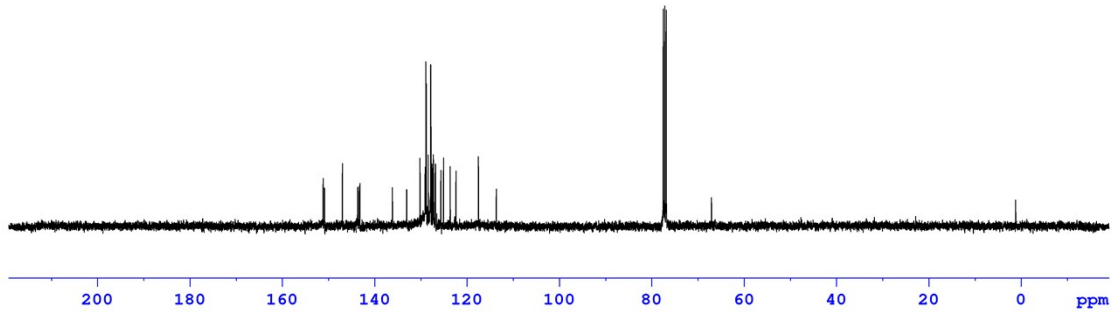


SYTK-02-105

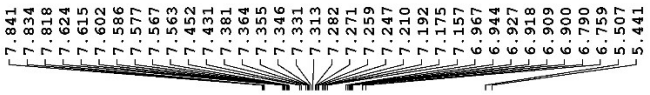


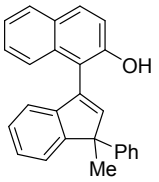


2f (One-Pot)



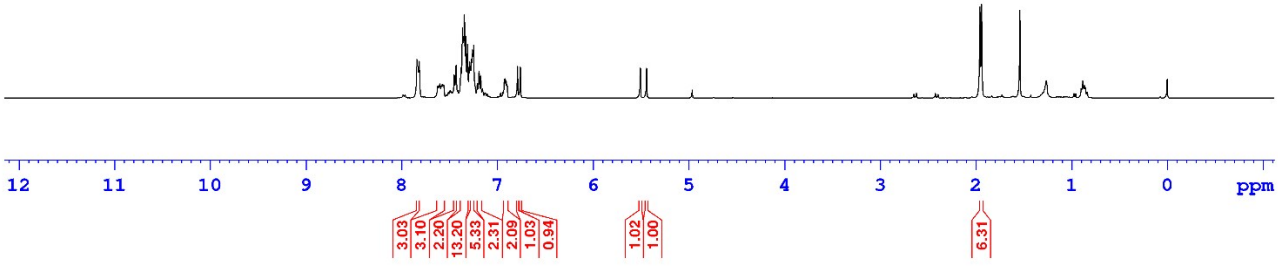
SYAP-3-103b1



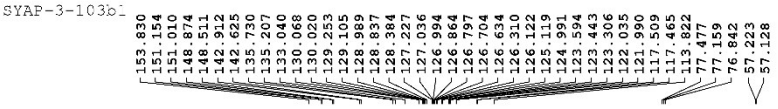


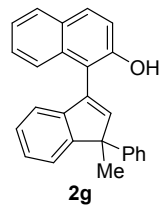
2g


```
Current Data Parameters
NAME          SYAP STUDENT
EXPNO                  142
PROCNO                   1

F2 - Acquisition Parameters
Date_              20190410
Time                  11.02
INSTRUM                spect
PROBHD   5 mm BBI 1H/D-
PULPROG                zg30
TD                    65536
SOLVENT               CDCl3
NS                       16
DS                        2
SWH               8278.146 Hz
FIDRES            0.126314 Hz
AQ                3.9583745 sec
RG                      128
DW                 60.400 usec
DE                  6.50 usec
TE                 297.6 K
D1              1.00000000 sec
TD0                      1

======== CHANNEL f1 ========
NUC1                    1H
P1                   9.20 usec
PL1                 -1.00 dB
PLW1           10.73012138 W
SFO1          400.1324710 MHz

F2 - Processing parameters
SI                      32768
SF            400.1300159 MHz
WDW                     EM
SSB                  0
LB                   0.30 Hz
GB                   0
PC                   1.00
```



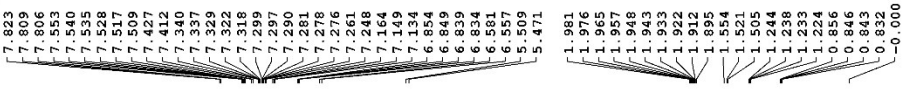
SYAP-3-103b1

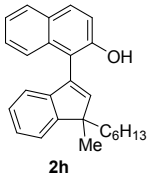




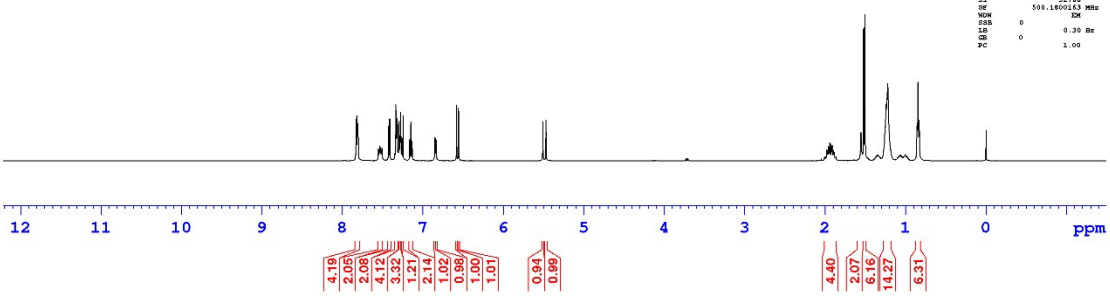
2g

SYTK-02-109 B

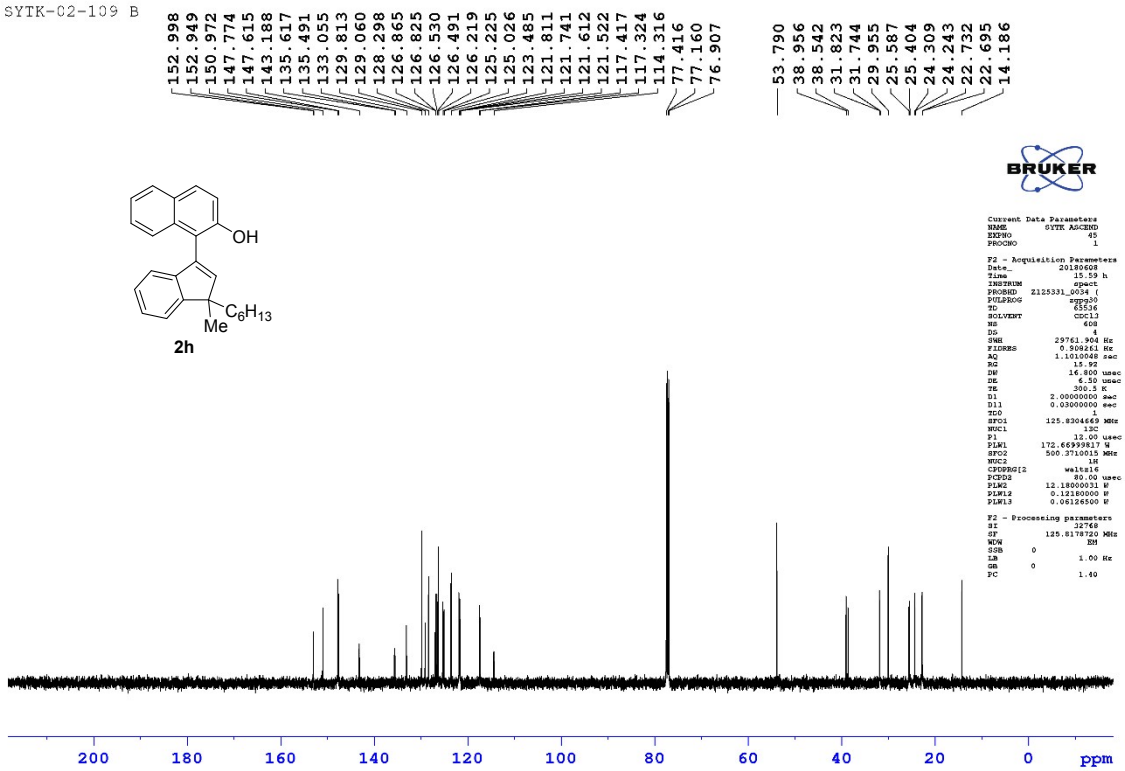




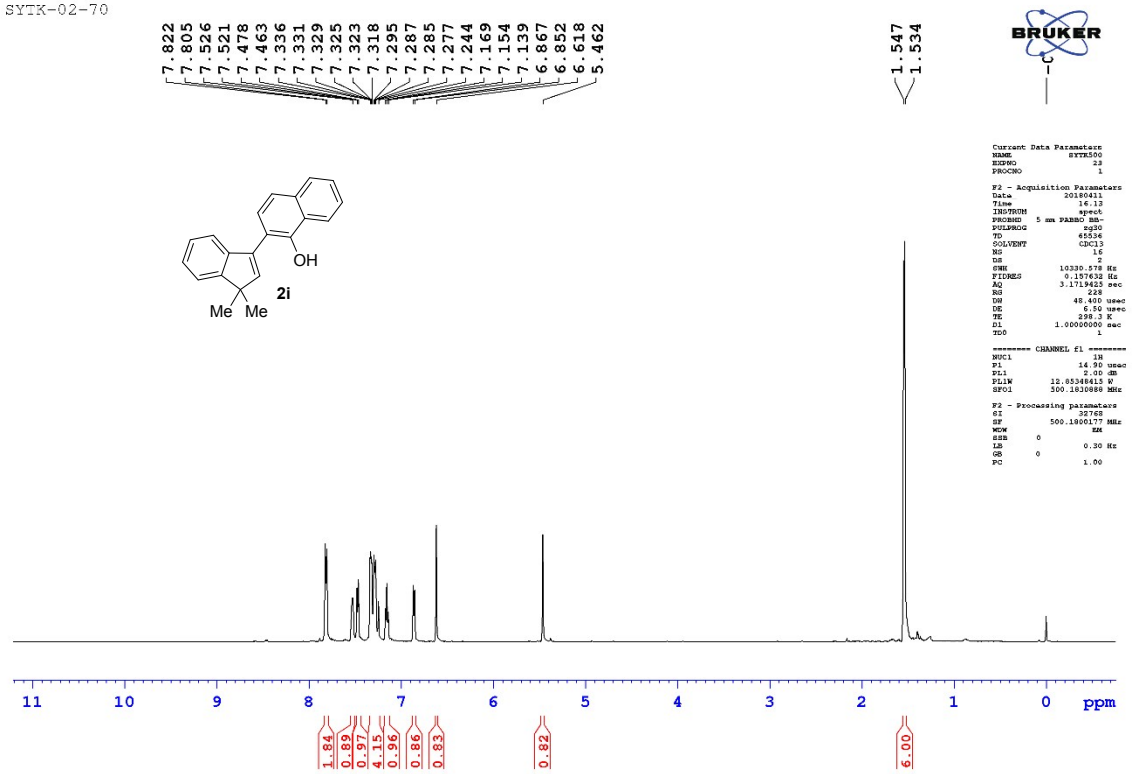
2h



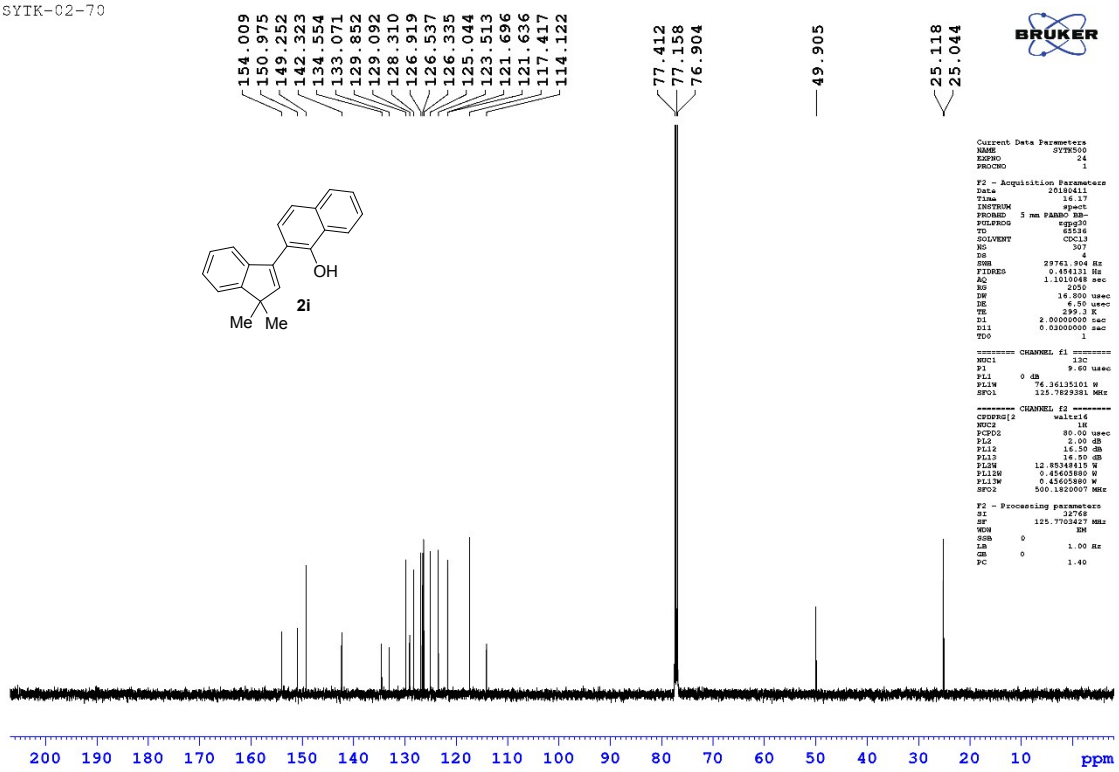
SYTK-02-109 B



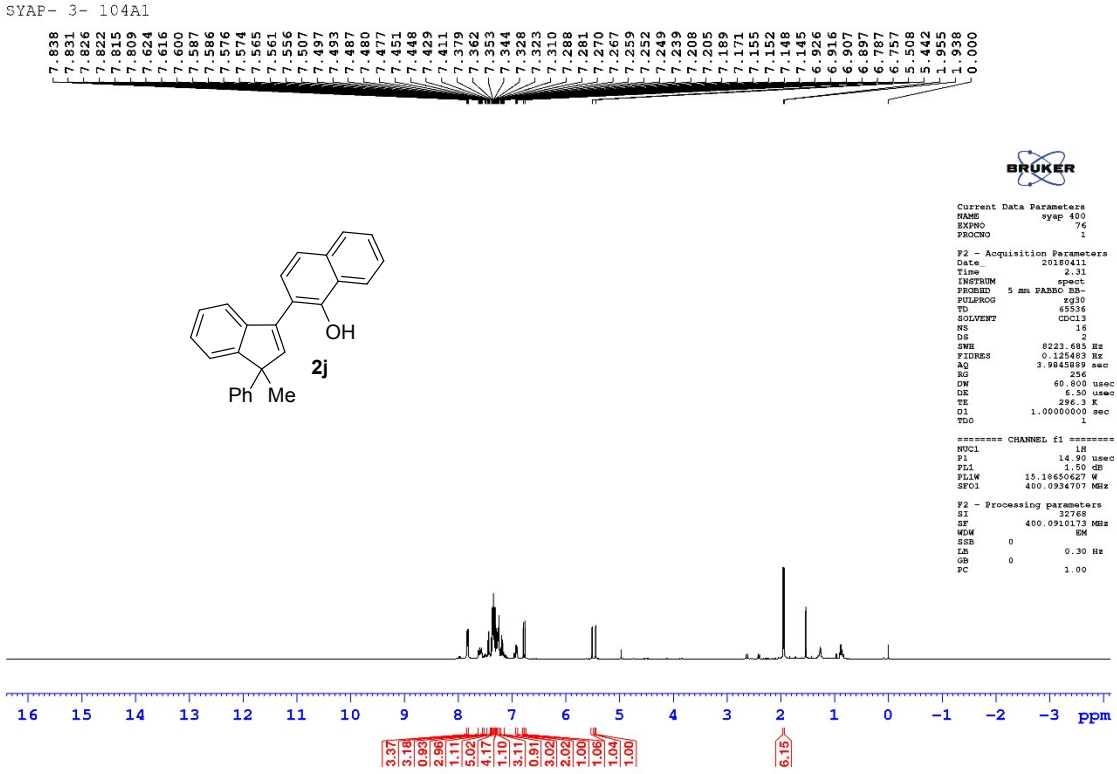
SYTK-02-70



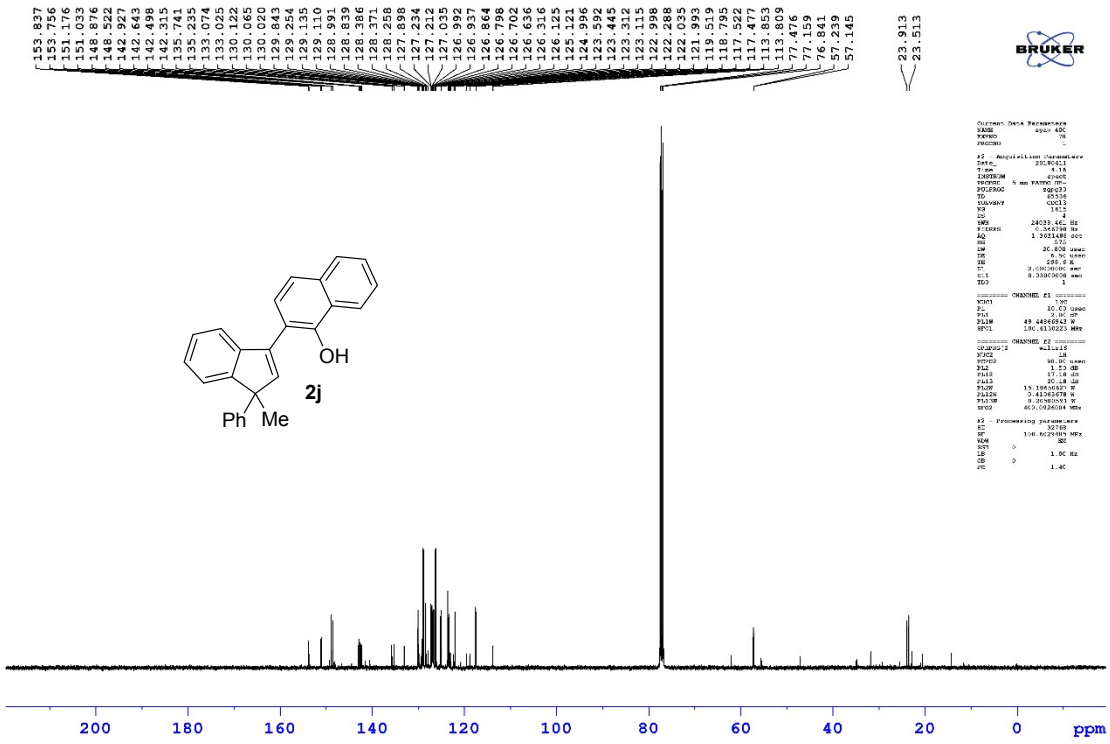
SYTK-02-70



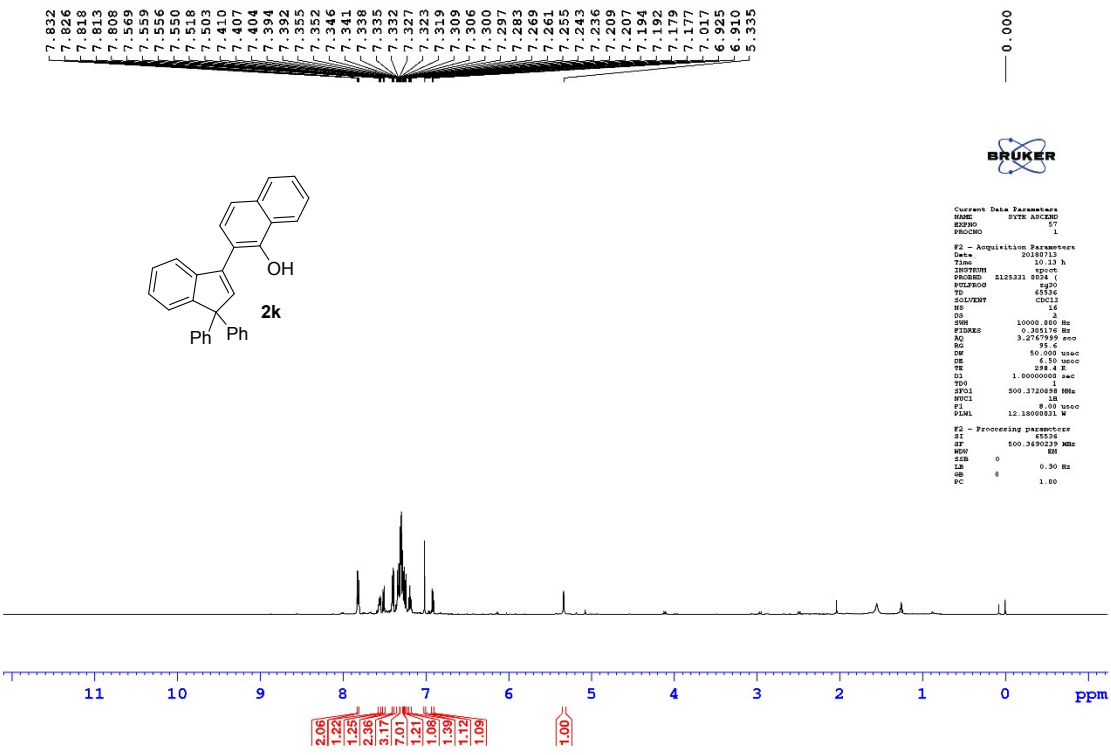
SYAP- 3- 104A1



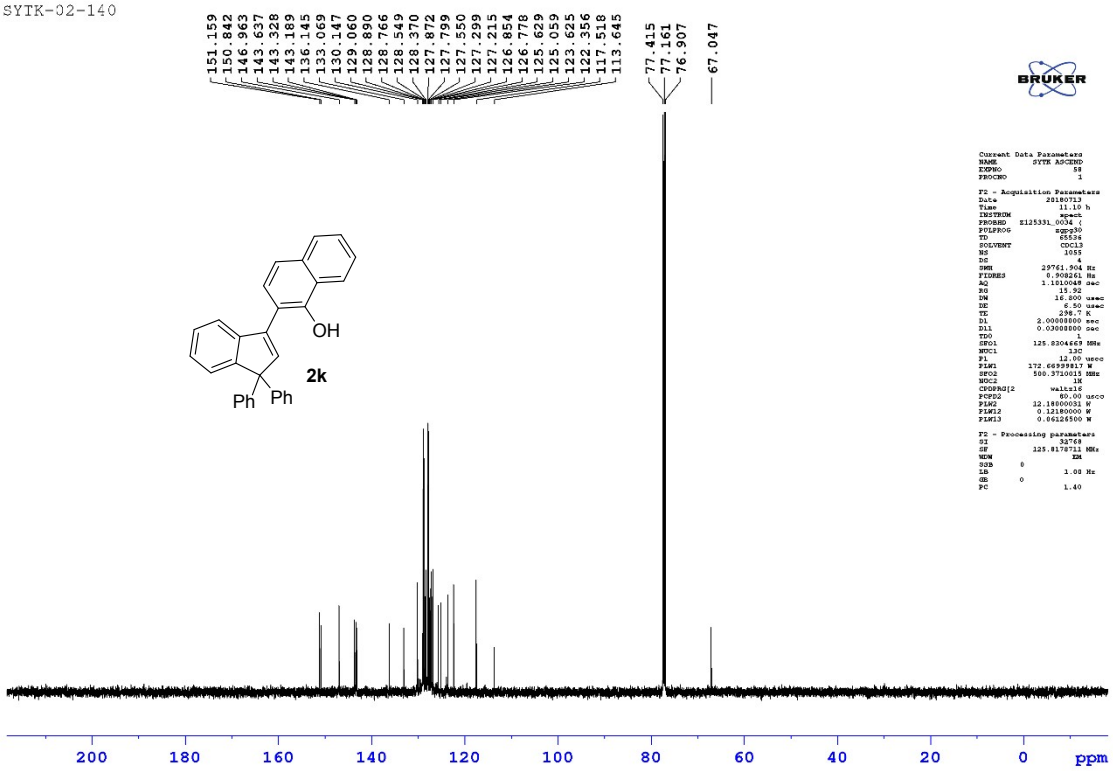
SYAP- 3- 104A1



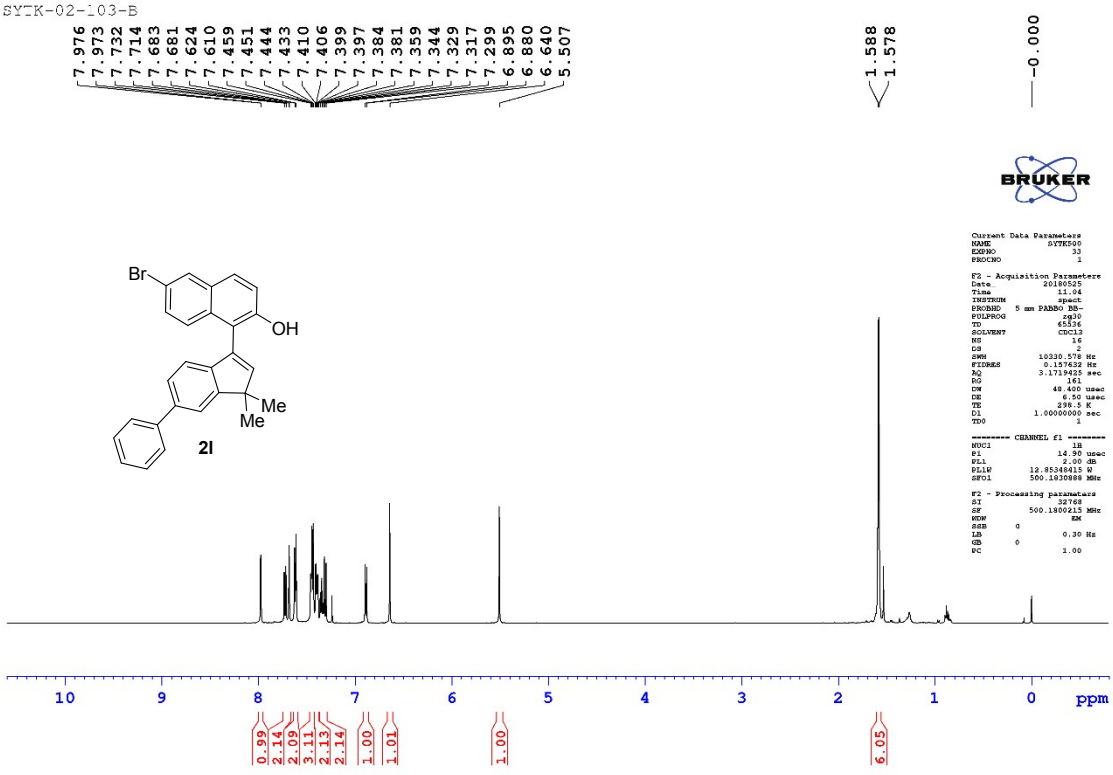
SYTK-02-140



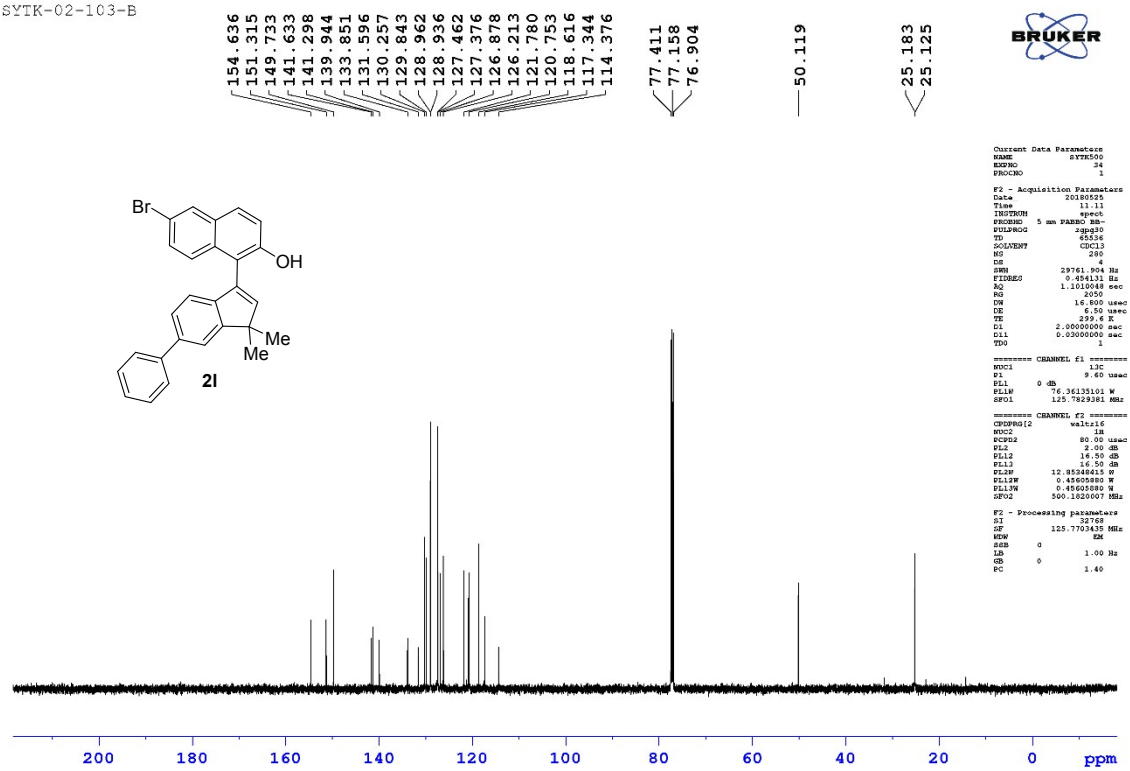
SYTK-02-140



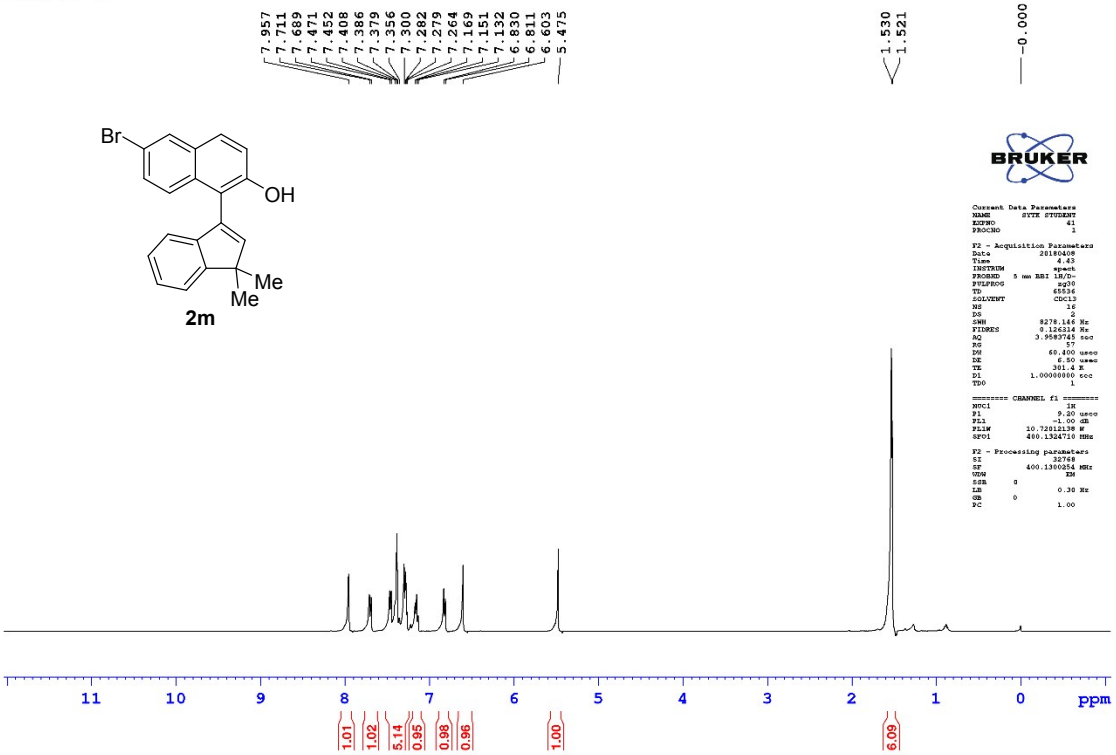
SYTK-02-103-B



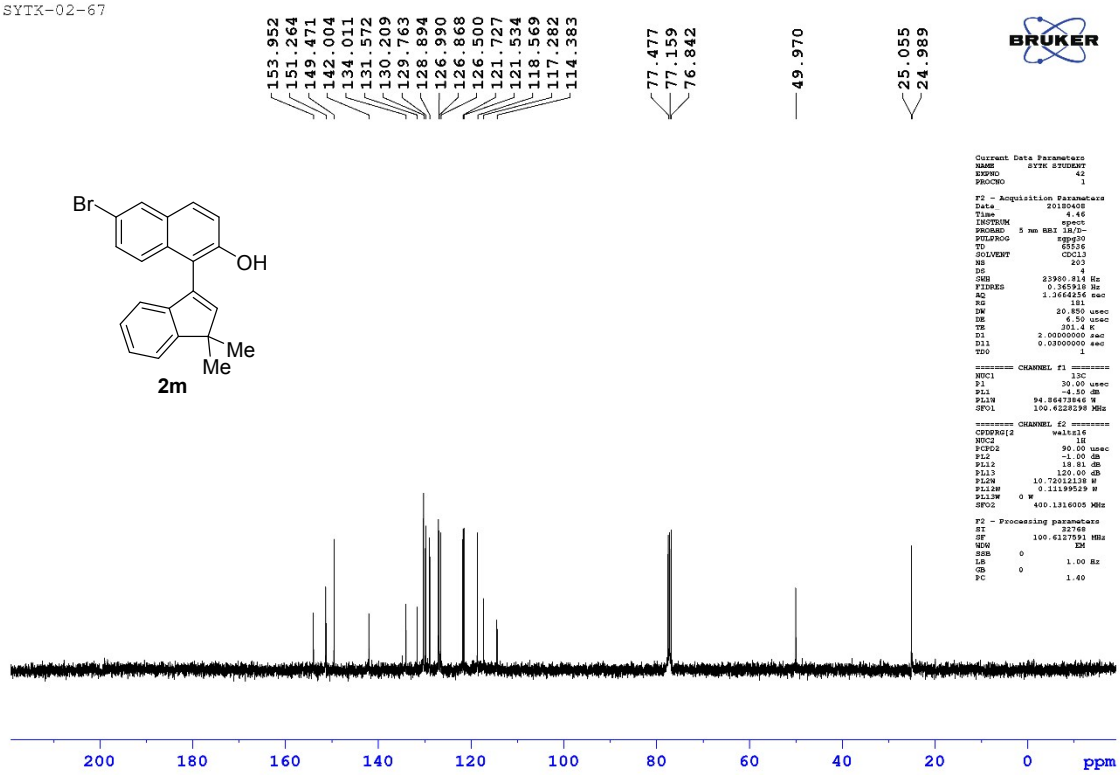
SYTK-02-103-B



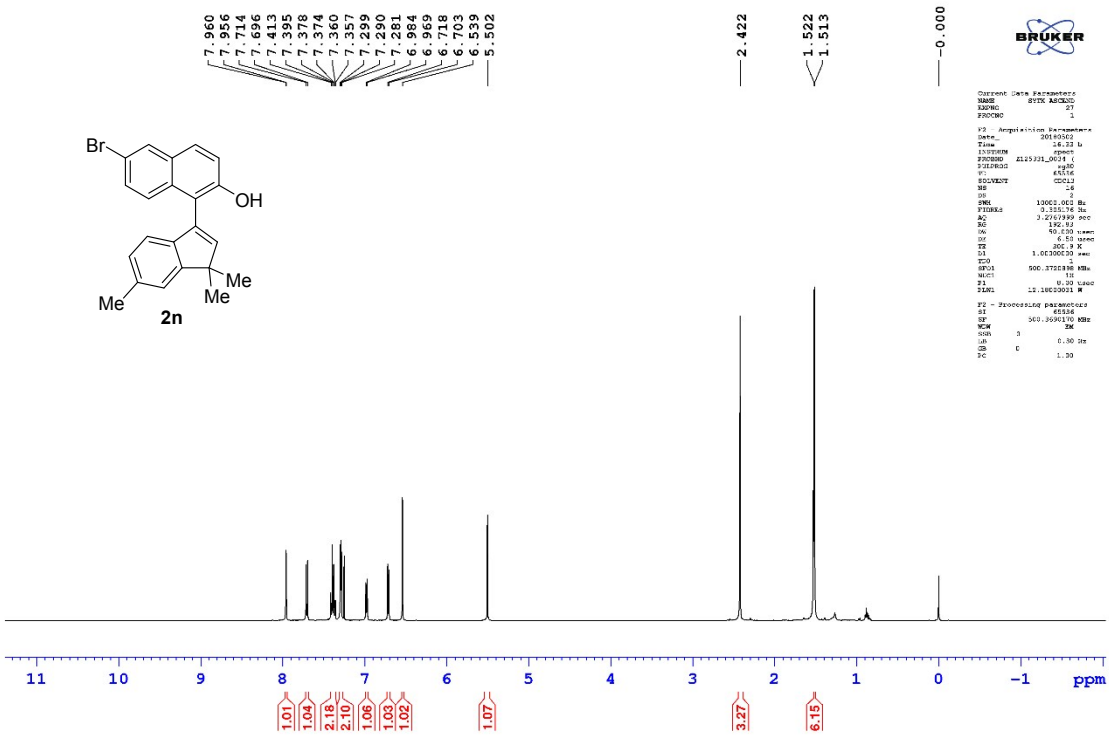
SYTK-02-67



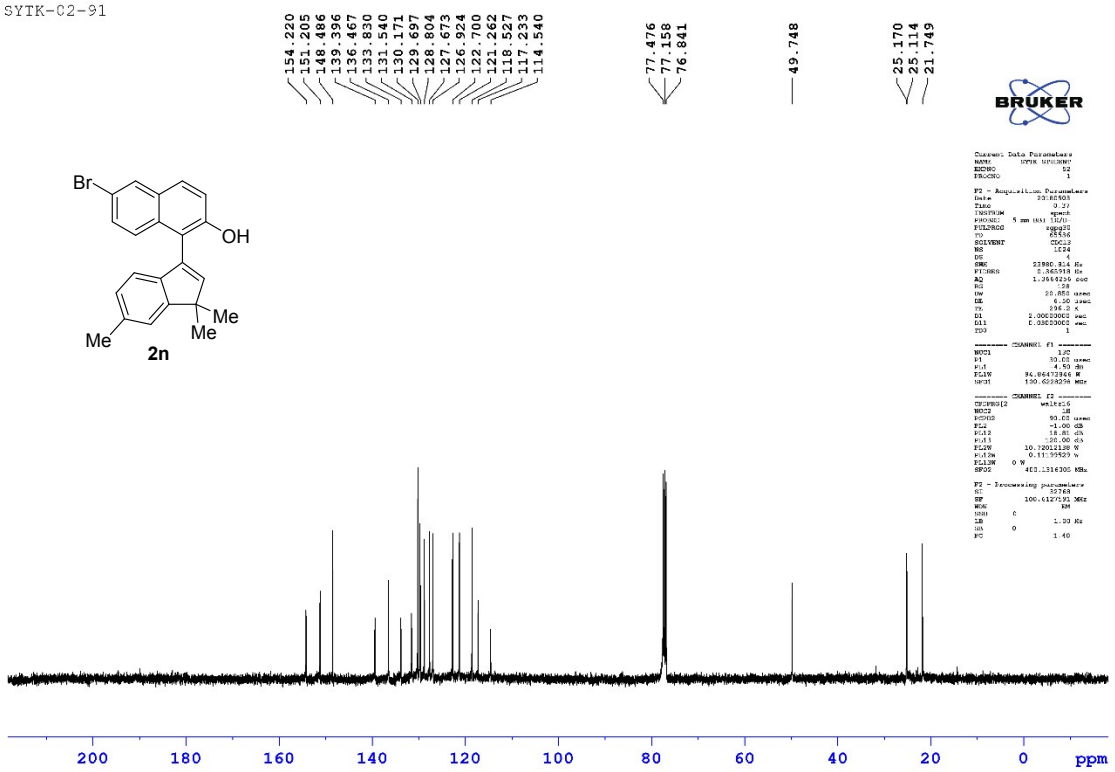
SYTK-02-67



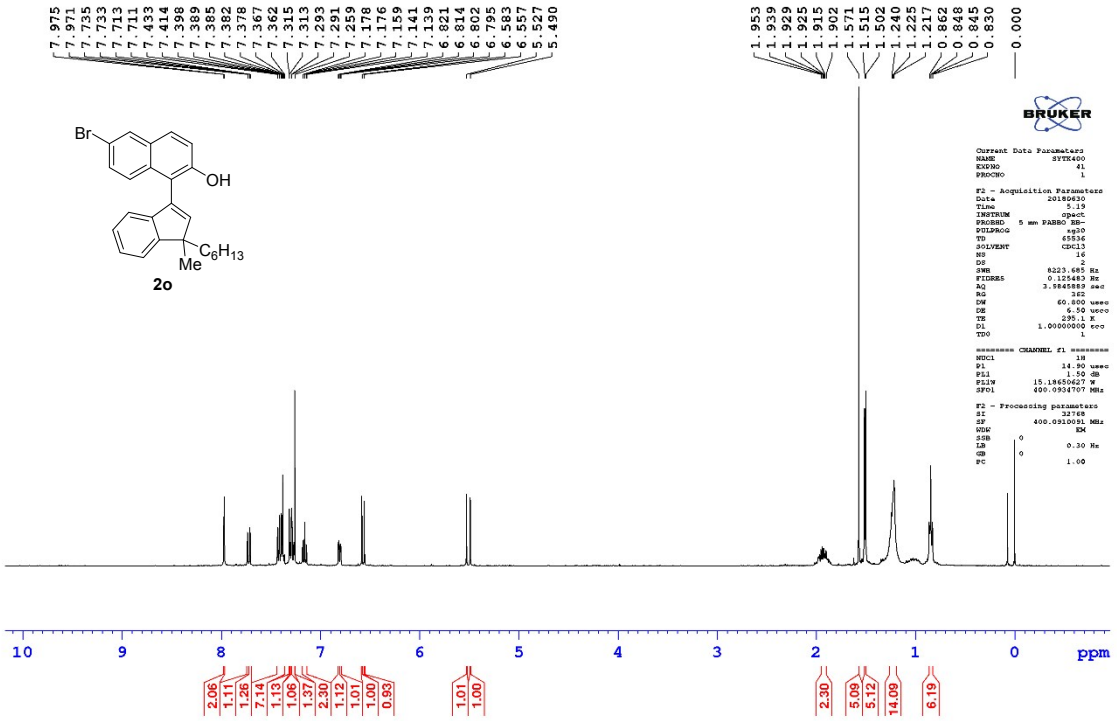
SYTK-02-91



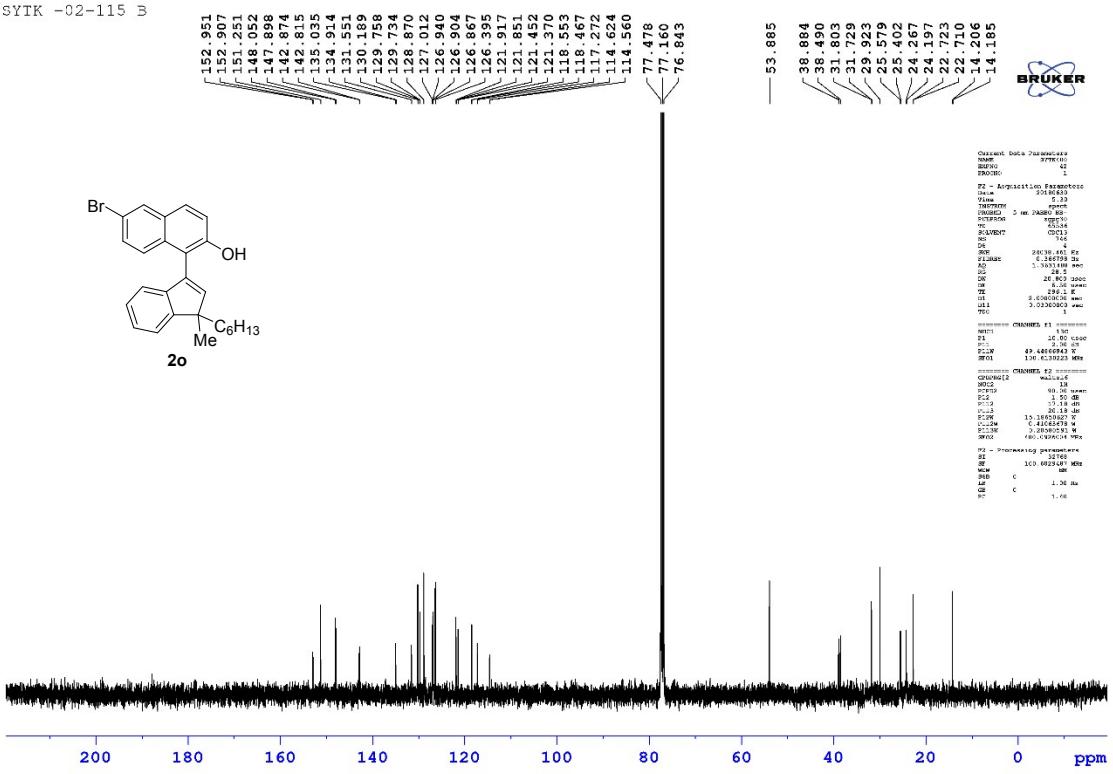
SYTK-02-91



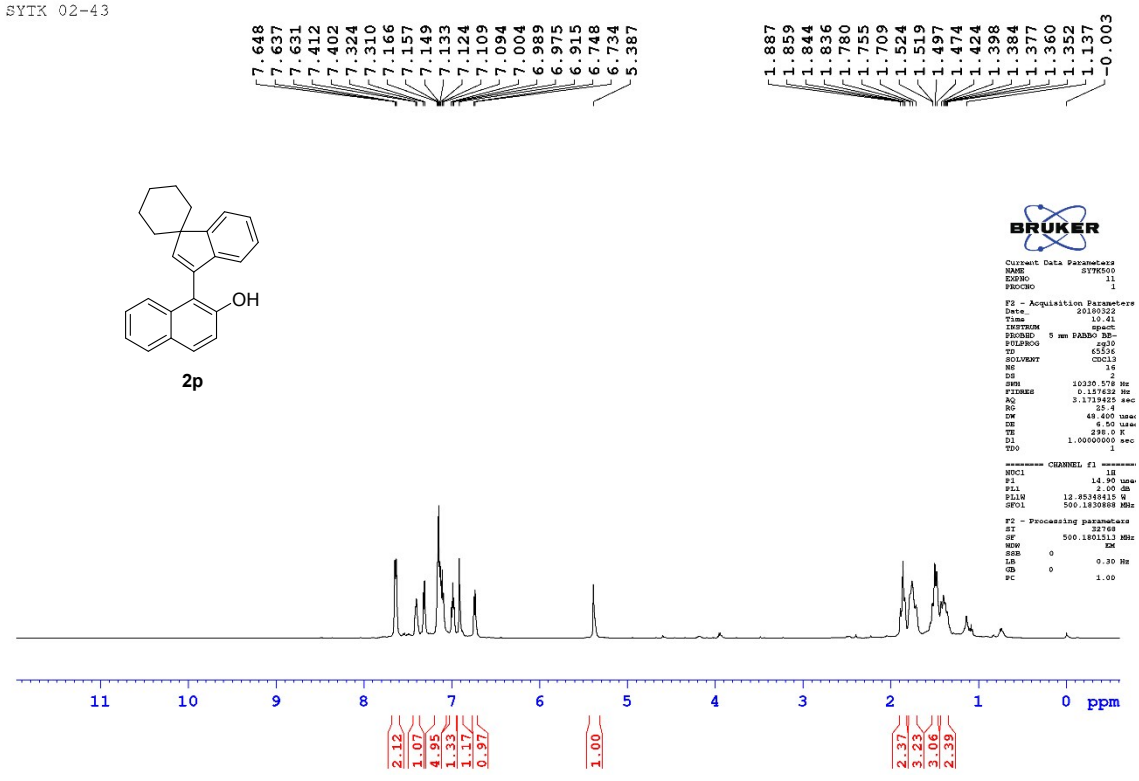
SYTK -02-115 B



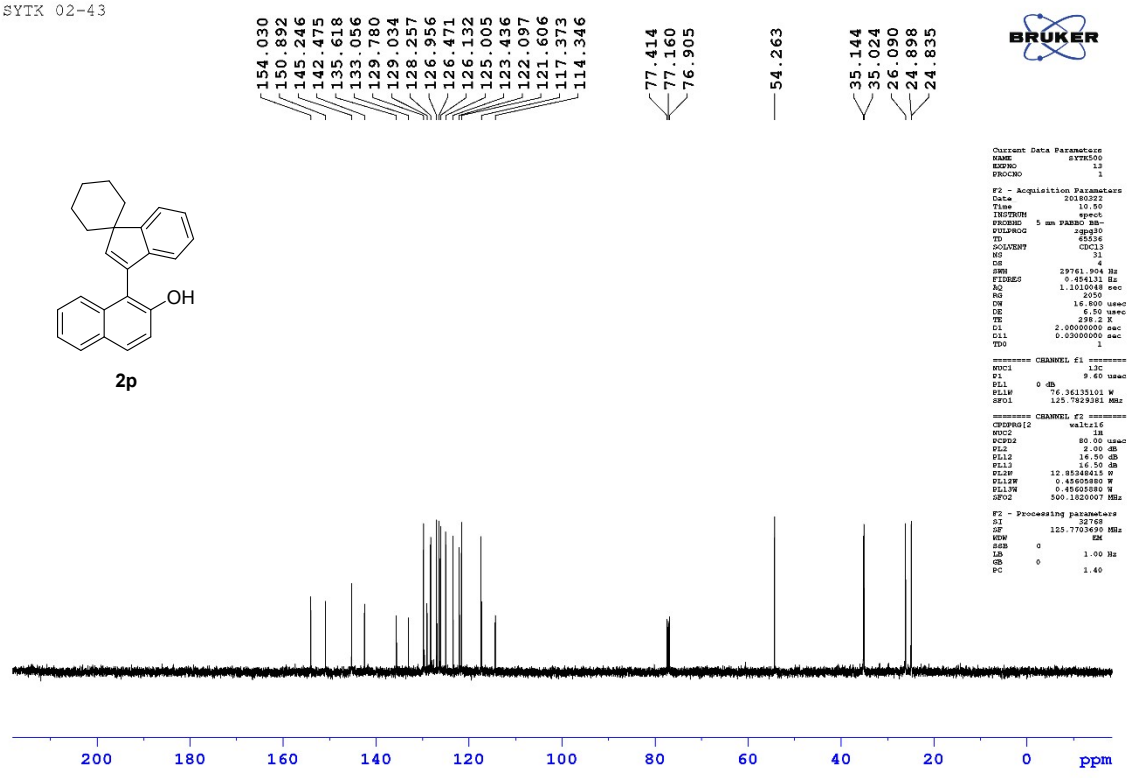
SYTK -02-115 B



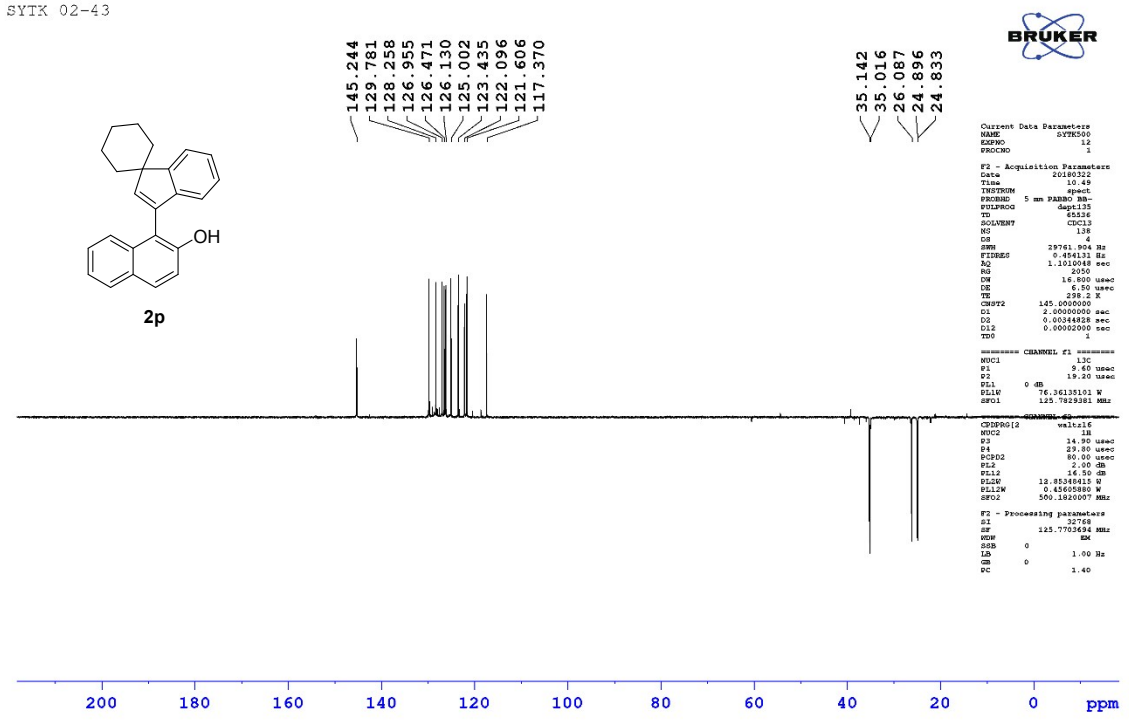
SYTK 02-43



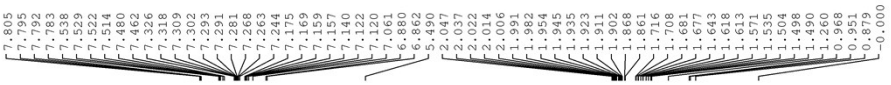
SYTK 02-43

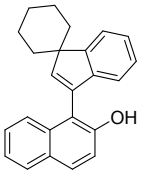


SYTK 02-43

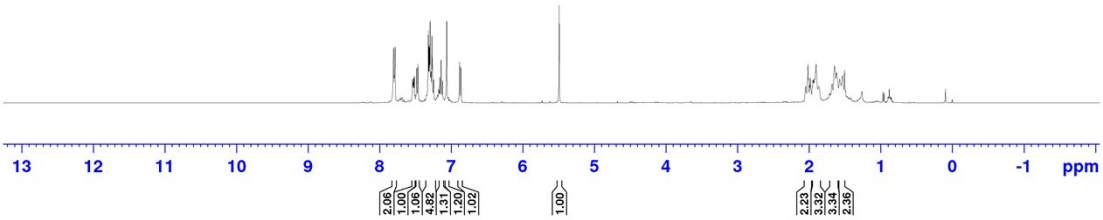


SYTK-02-45

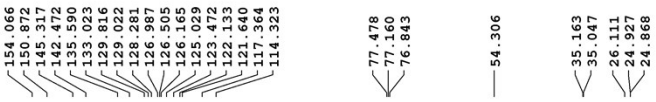


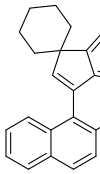


2p (one-Pot)

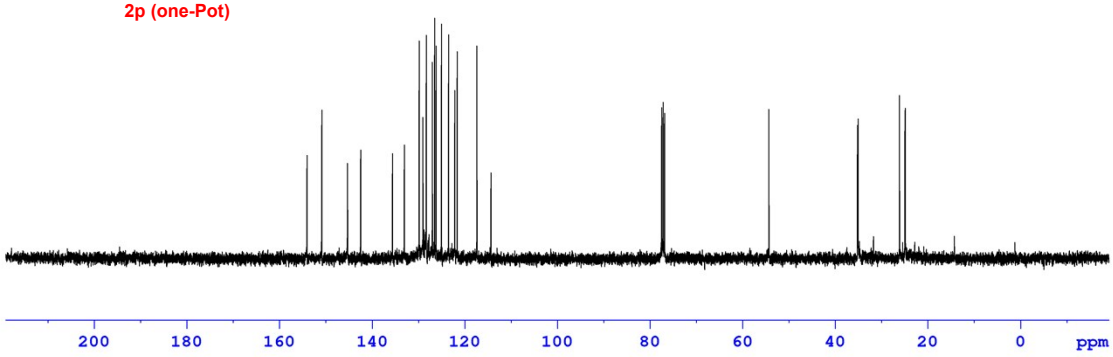


SYTK-02-45

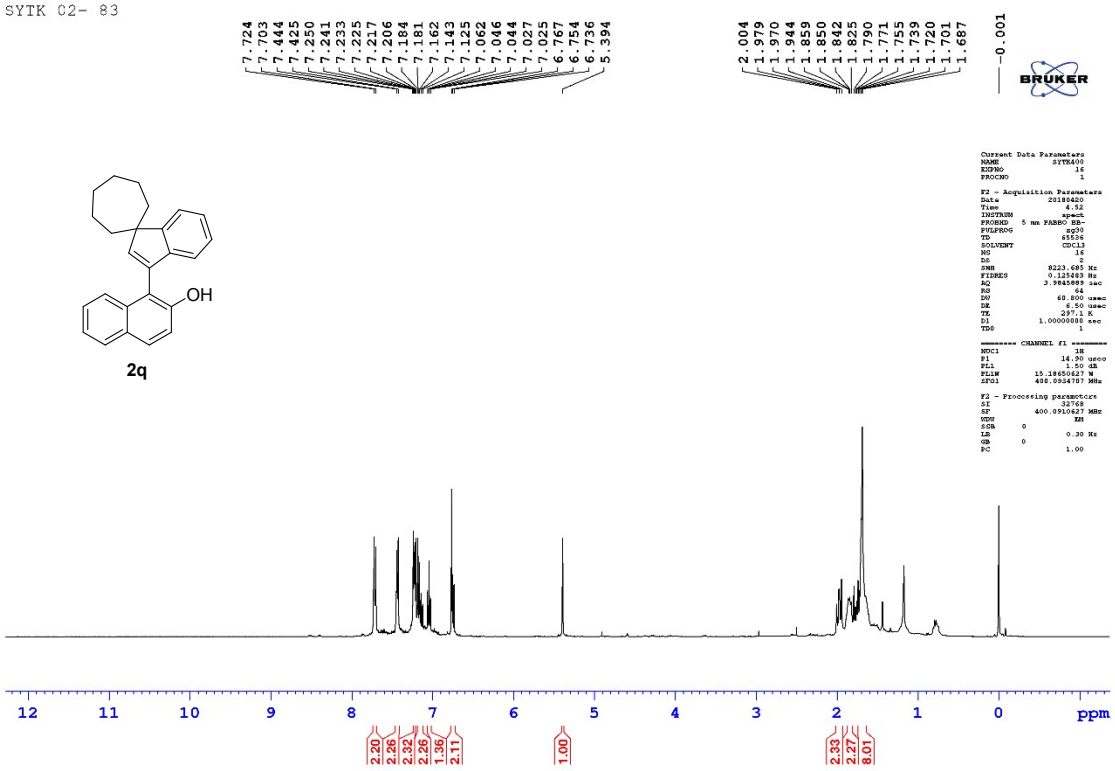




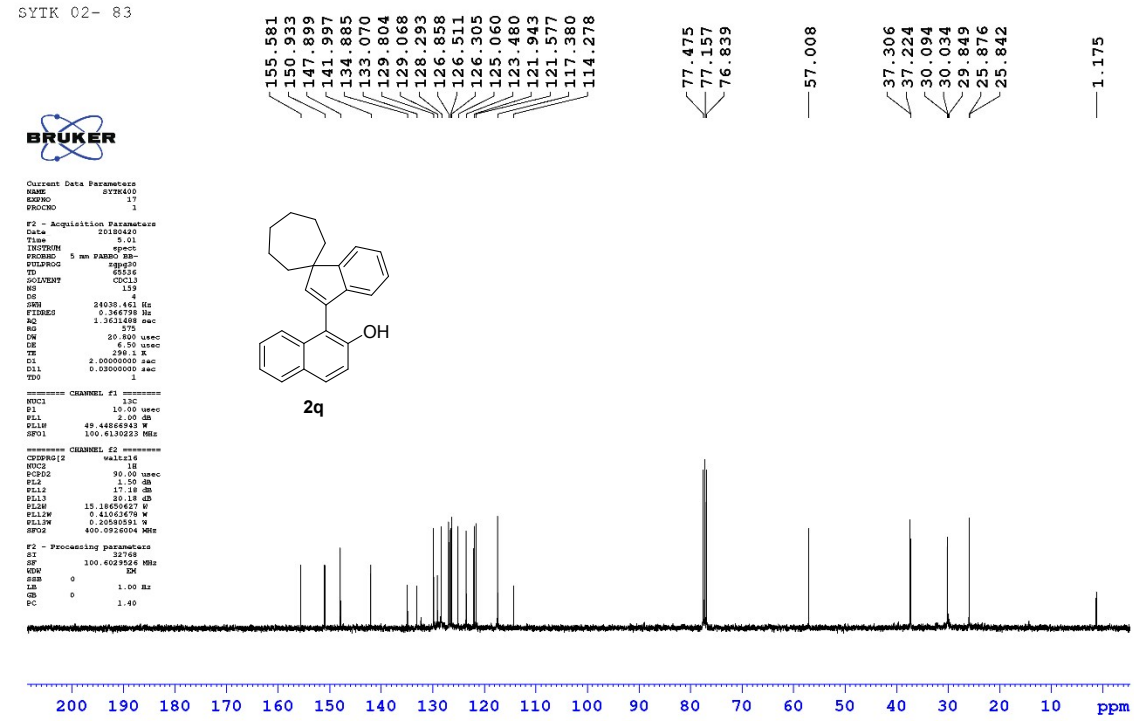
2p (one-Pot)



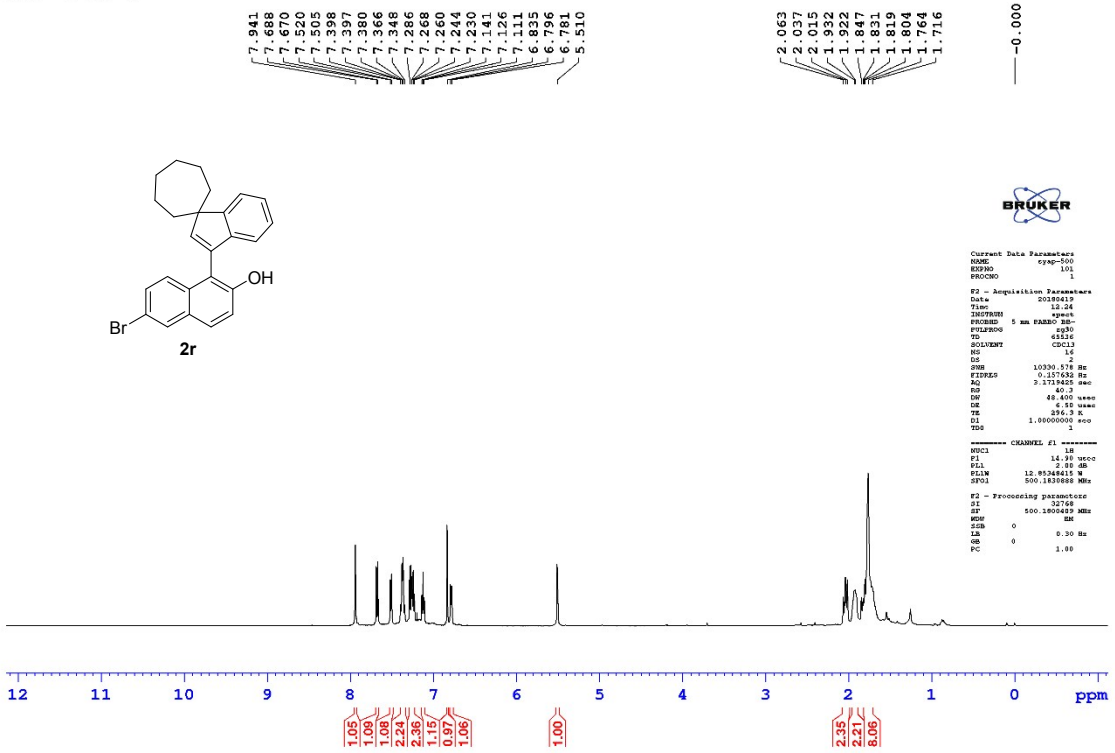
SYTK 02- 83



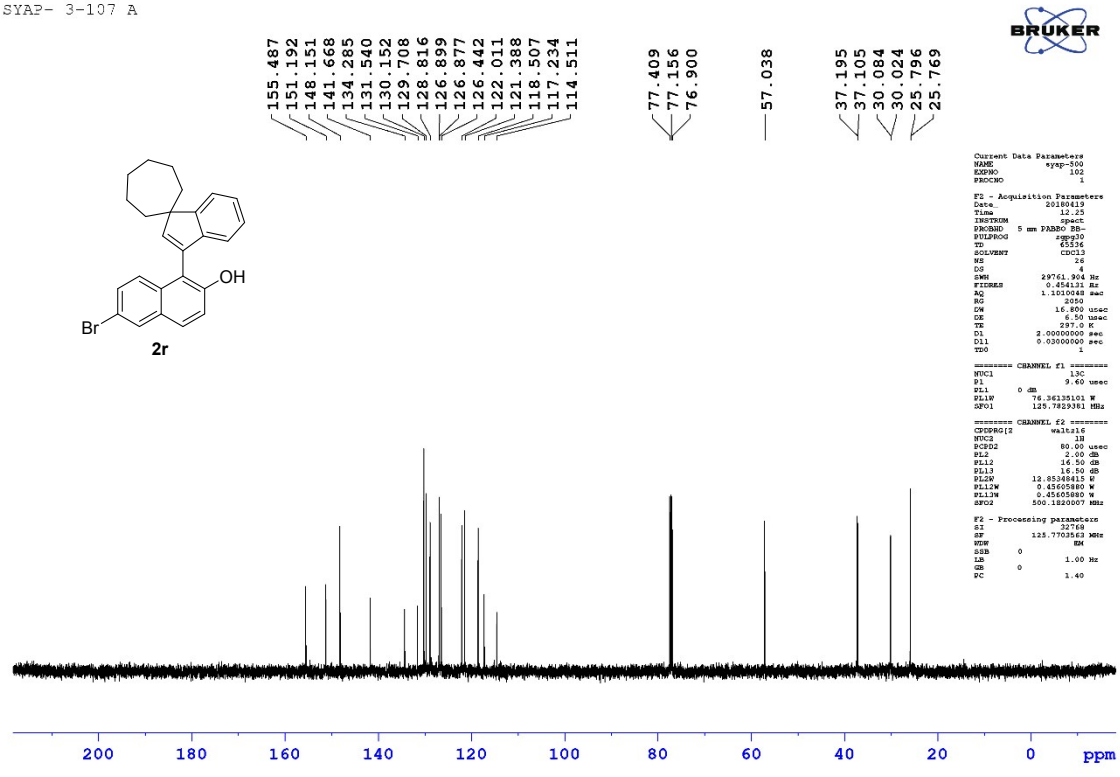
SYTK 02- 83

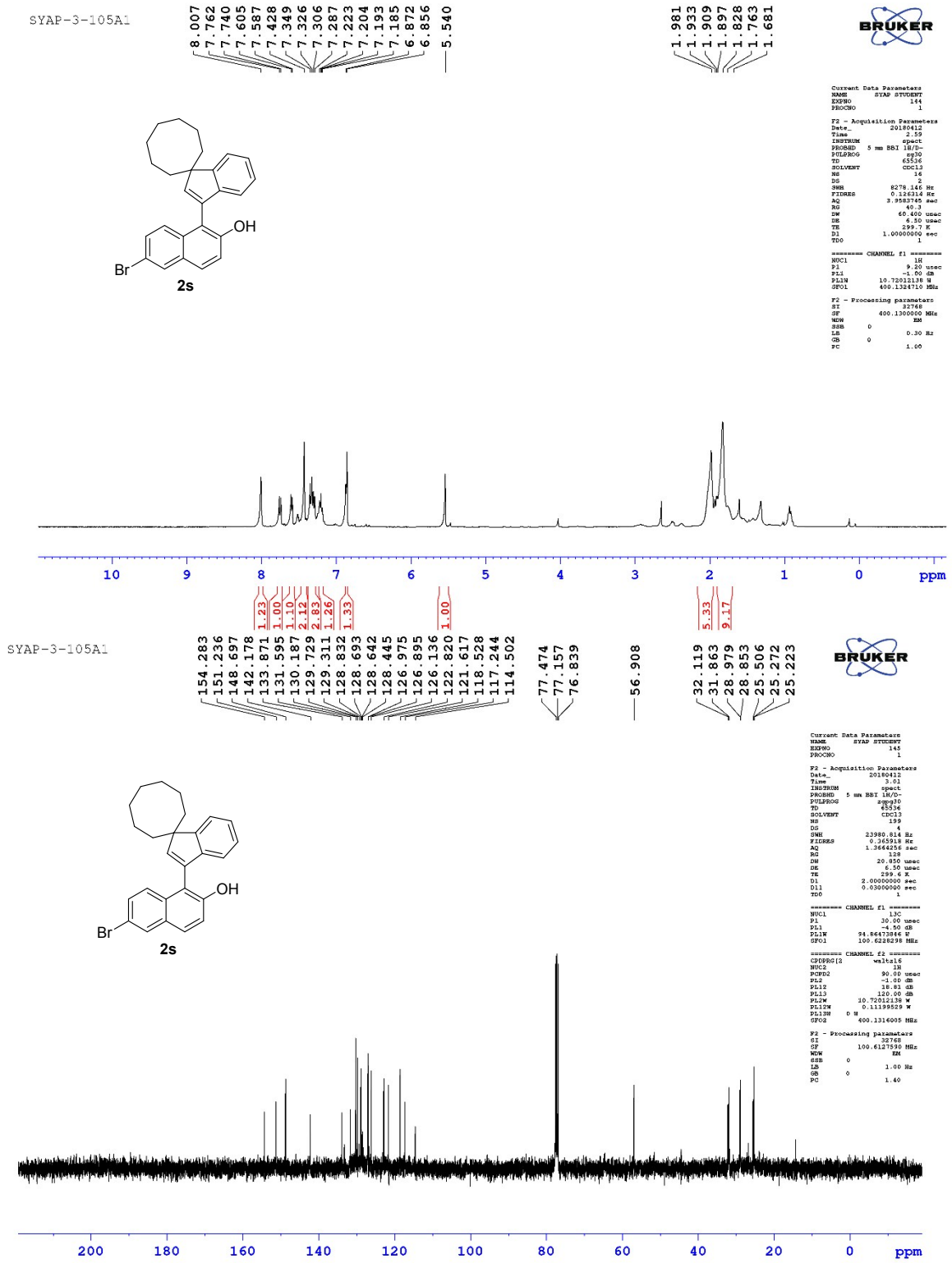


SYAP- 3-107 A

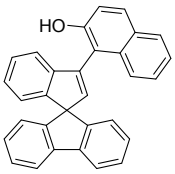


SYAP- 3-107 A

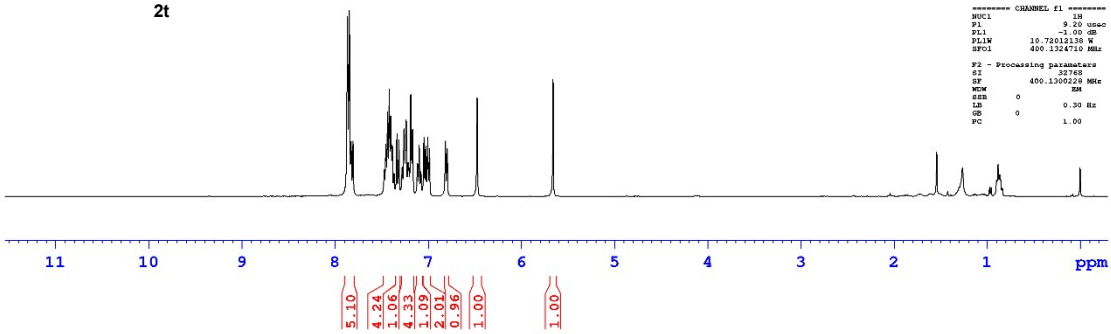



SYAP-3-105A1
8.007
7.762
7.740
7.605
7.587
7.428
7.349
7.326
7.306
7.287
7.223
7.204
7.193
7.185
6.872
6.856
5.540
1.981
1.933
1.909
1.897
1.828
1.763
1.681
BRUKER
OH
Br
2s
Current Data Parameters
NAME SYAP STUDENT
EXPNO 144
PROCNO 1
F2 - Acquisition Parameters
Date_ 20180412
Time 2.59
INSTRUM spect
PROBHD 5 mm BBI 1H/D-
PULPROG zg30
TD 65536
SOLVENT CDCl3
NS 16
DS 2
SWH 8278.146 Hz
FIDRES 0.126314 Hz
AQ 3.9583745 sec
RG 40.3
DW 60.400 usec
DE 6.50 usec
TE 299.7 K
D1 1.00000000 sec
TD0 1
======== CHANNEL f1 ========
NUC1 1H
P1 9.20 usec
PL1 -1.00 dB
PL1W 10.72012138 W
SFO1 400.1324710 MHz
F2 - Processing parameters
SI 32768
SF 400.1300000 MHz
WDW EM
SSB 0
LB 0.30 Hz
GB 0
PC 1.00
10
9
8
7
6
5
4
3
2
1
0
ppm
1.23
1.00
1.10
2.12
2.83
1.26
1.33
1.00
5.33
9.17
SYAP-3-105A1
154.283
151.236
148.697
142.178
133.871
131.595
130.187
129.729
129.311
128.832
128.693
128.642
128.445
126.975
126.895
126.136
122.820
121.617
118.528
117.244
114.502
77.474
77.157
76.839
56.908
32.119
31.863
28.979
28.853
25.506
25.272
25.223
BRUKER
OH
Br
2s
Current Data Parameters
NAME SYAP STUDENT
EXPNO 145
PROCNO 1
F2 - Acquisition Parameters
Date_ 20180412
Time 3.01
INSTRUM spect
PROBHD 5 mm BBI 1H/D-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 199
DS 4
SWH 23980.814 Hz
FIDRES 0.365918 Hz
AQ 1.3664256 sec
RG 128
DW 20.850 usec
DE 6.50 usec
TE 299.6 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1
======== CHANNEL f1 ========
NUC1 13C
P1 30.00 usec
PL1 -4.50 dB
PL1W 94.86473846 W
SFO1 100.6228298 MHz
======== CHANNEL f2 ========
CPDPRG[2 waltz16
NUC2 1H
PCPD2 90.00 usec
PL2 -1.00 dB
PL12 18.81 dB
PL13 120.00 dB
PL2W 10.72012138 W
PL12W 0.11199529 W
PL13W 0 W
SFO2 400.1316005 MHz
F2 - Processing parameters
SI 32768
SF 100.6127590 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40
200
180
160
140
120
100
80
60
40
20
0
ppm

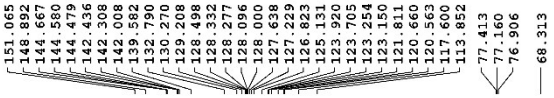
SYjs-46

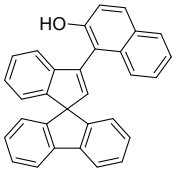


2t

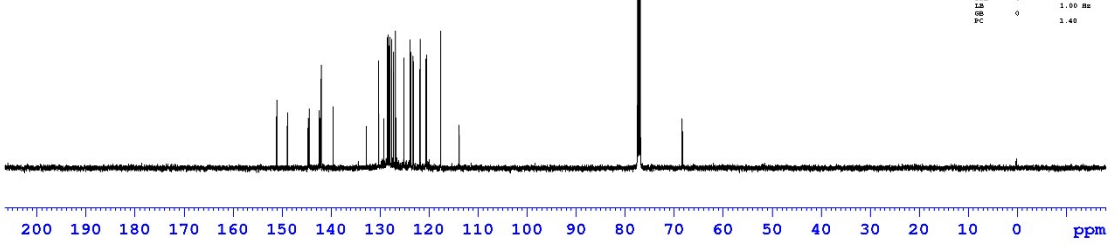


SYJS-46

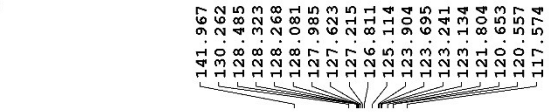


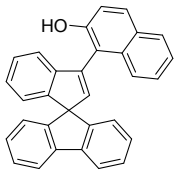


2t

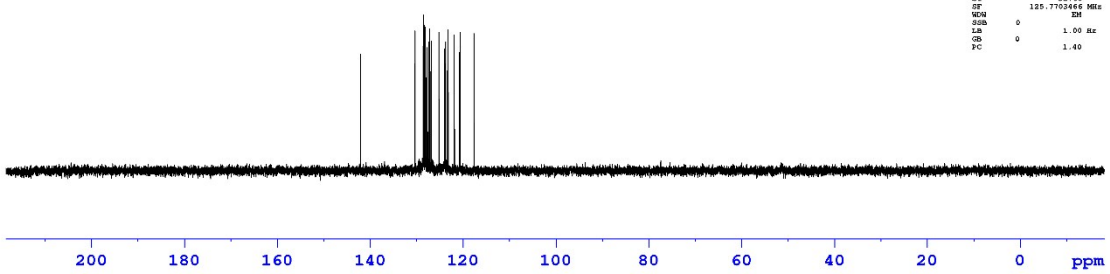


SYJS-46

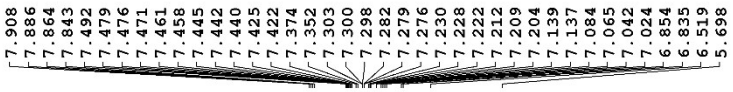


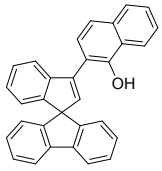


2t

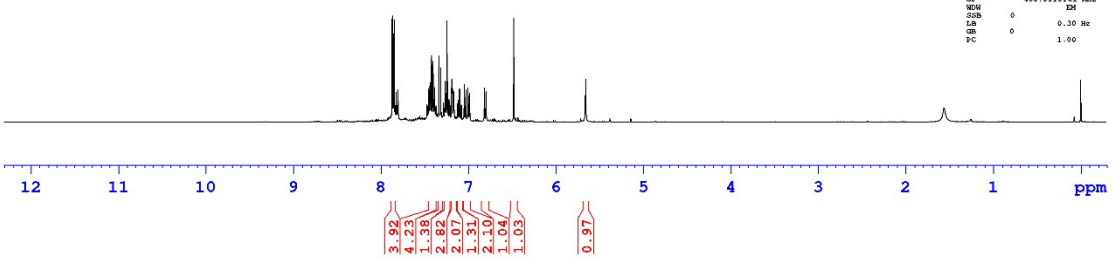


SYJS-70

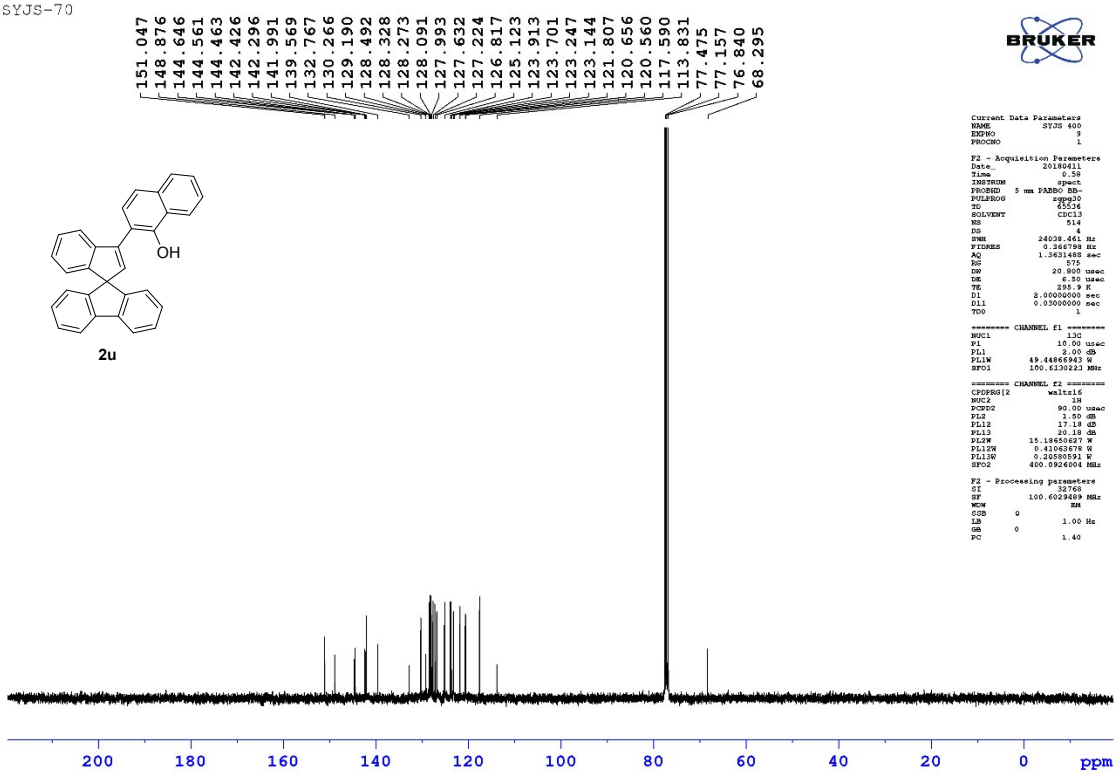




2u

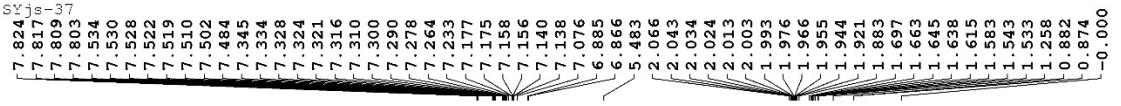


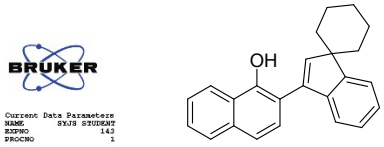
SYJS-70



2u

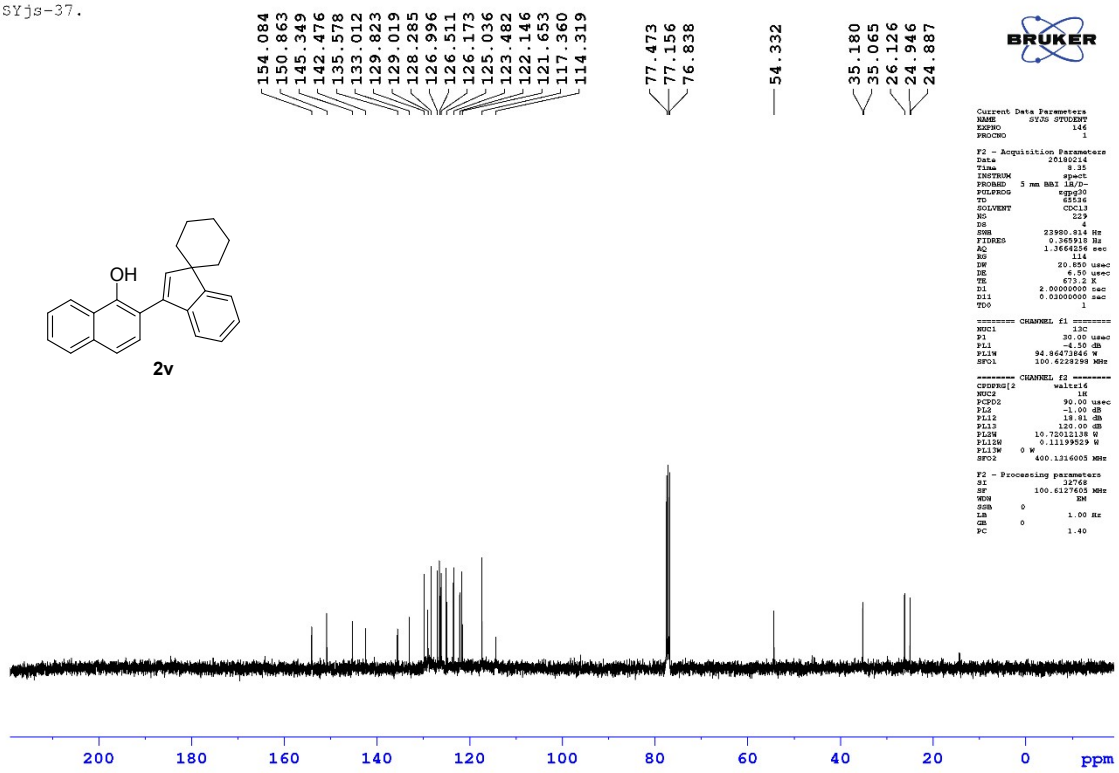
SYjs-37



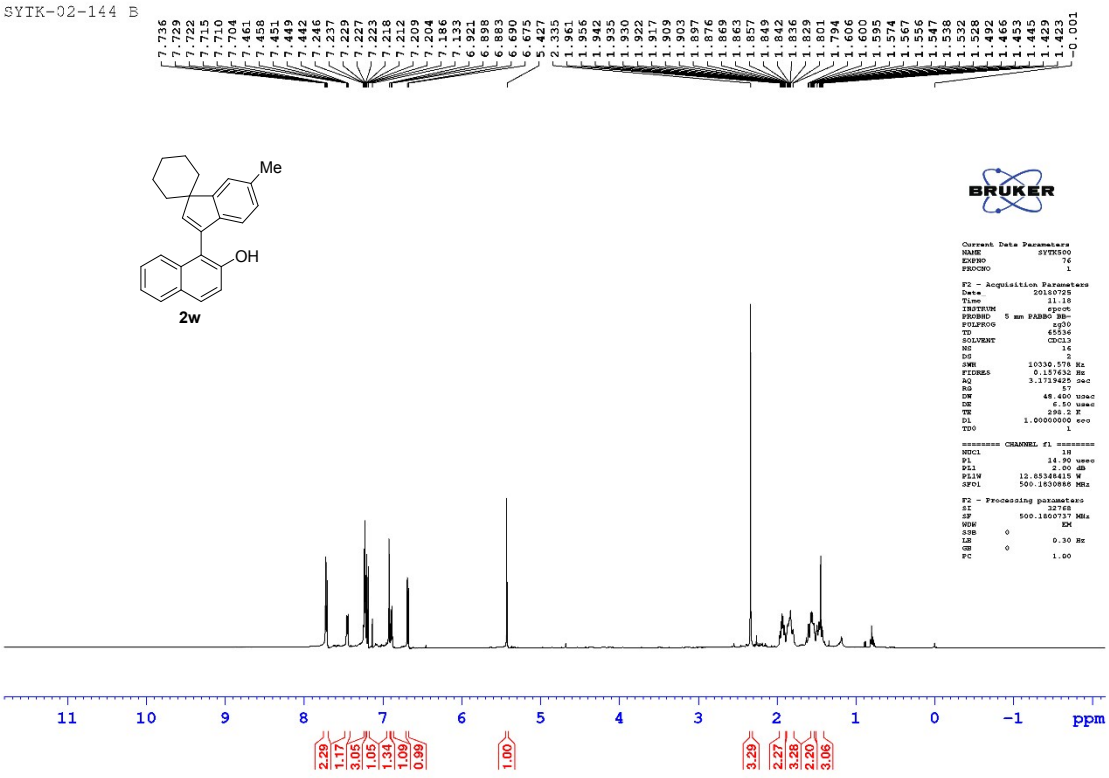


2v

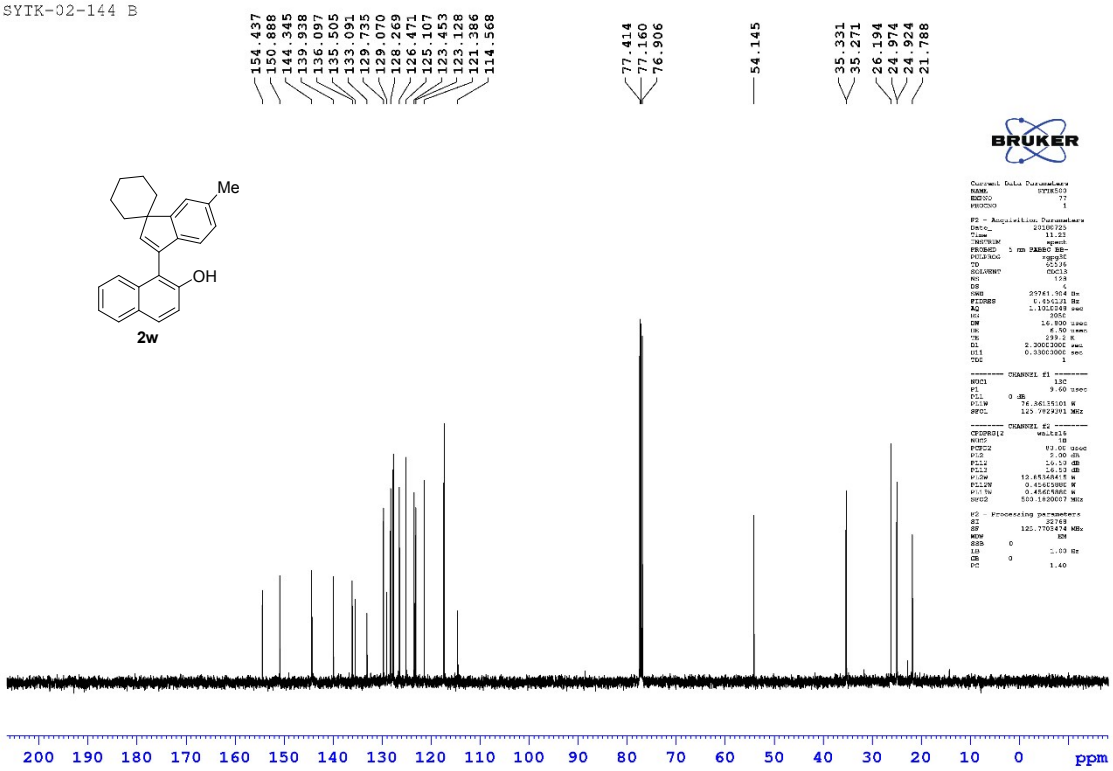
SYjs-37.



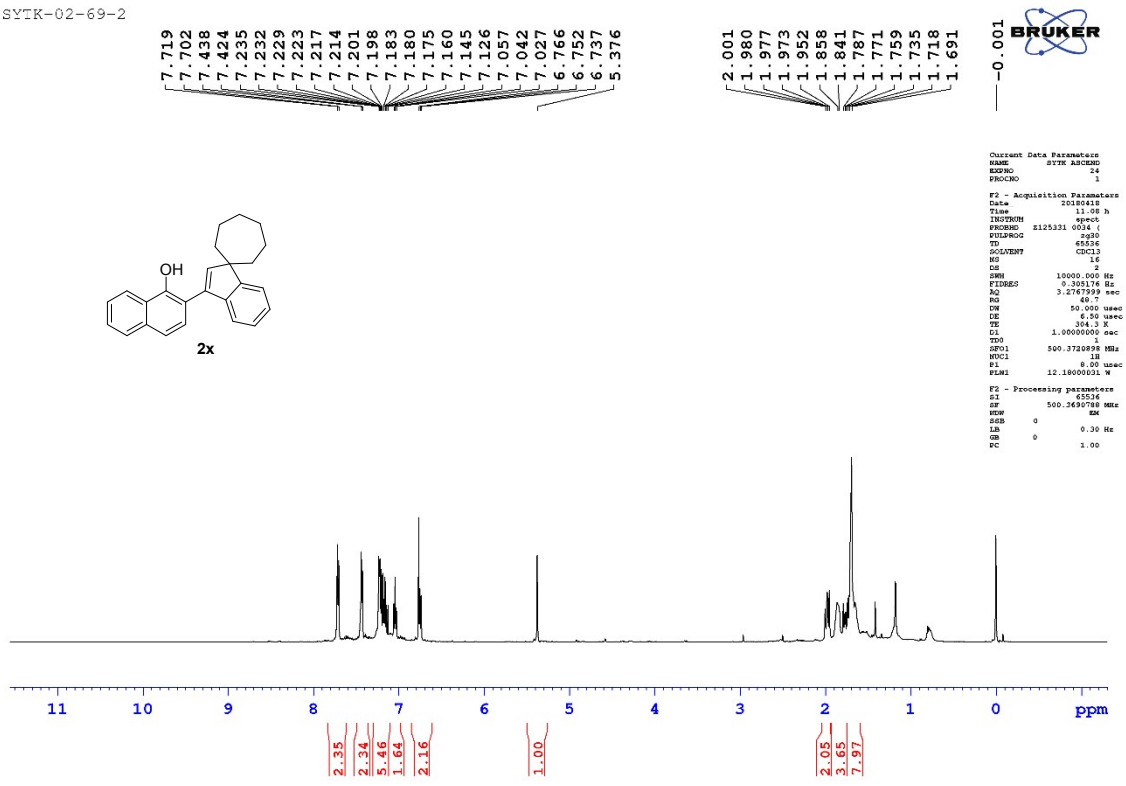
SYTK-02-144 B



SYTK-02-144 B

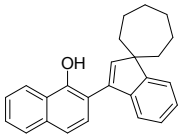


SYTK-02-69-2

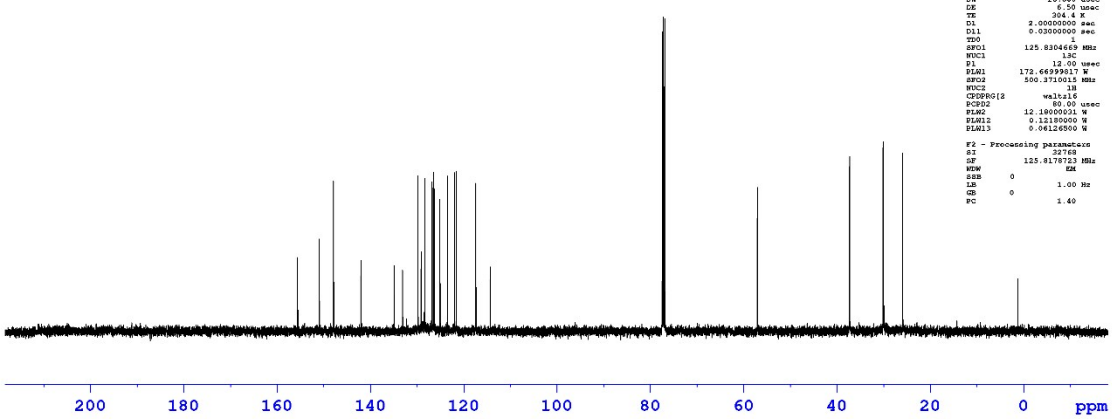


SYTK-02-69-2

155.591
150.948
147.893
142.002
134.910
133.090
129.803
129.088
128.295
126.860
126.513
126.312
125.063
123.481
121.943
121.581
117.388
114.296
77.412
77.158
76.904
57.023
37.322
37.250
30.083
30.024
25.894
25.860
1.170

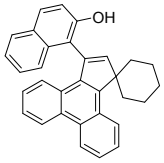


2x

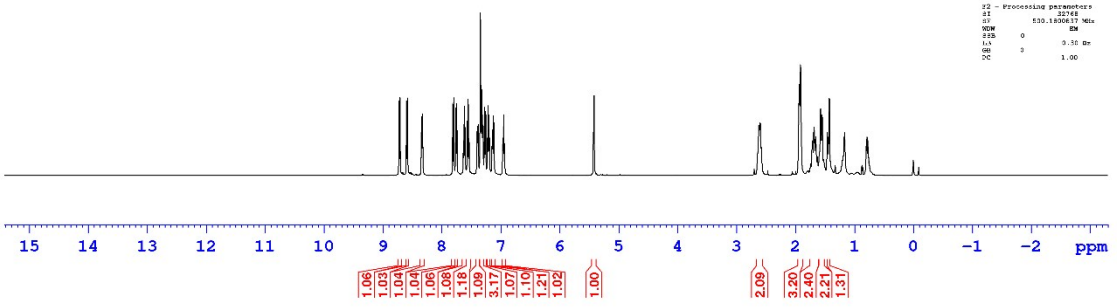


SYTK-02-114 B

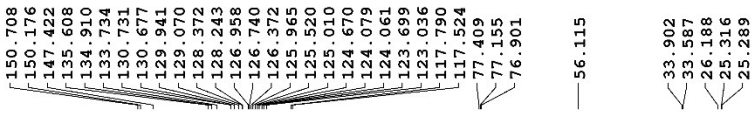
8.727
8.711
8.600
8.583
8.344
8.328
7.815
7.797
7.763
7.747
7.634
7.620
7.604
7.570
7.554
7.539
7.401
7.397
7.384
7.383
7.352
7.347
7.345
7.338
7.322
7.307
7.301
7.283
7.276
7.273
7.266
7.259
7.255
7.226
7.213
7.198
7.197
7.145
7.131
7.129
7.113
6.968
6.966
6.951
6.937
6.935
5.422
5.416
2.638
2.622
2.612
2.604
2.598
2.586
2.578
1.935
1.914
1.742
1.715
1.687
1.654
1.627
1.573
1.548
1.458
1.424
0.000

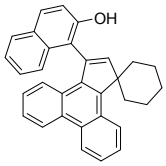


2y

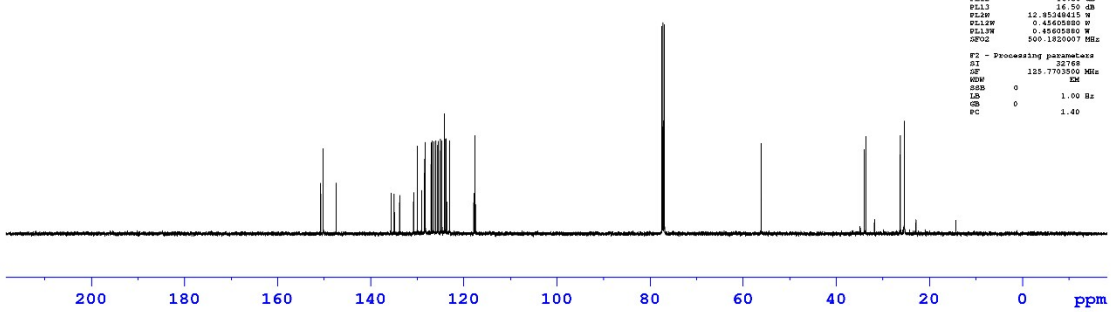


SYTK-02-114 B

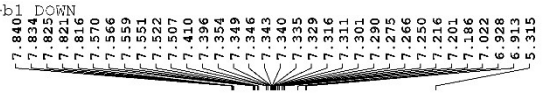


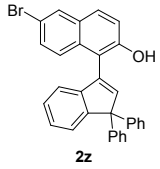


2y

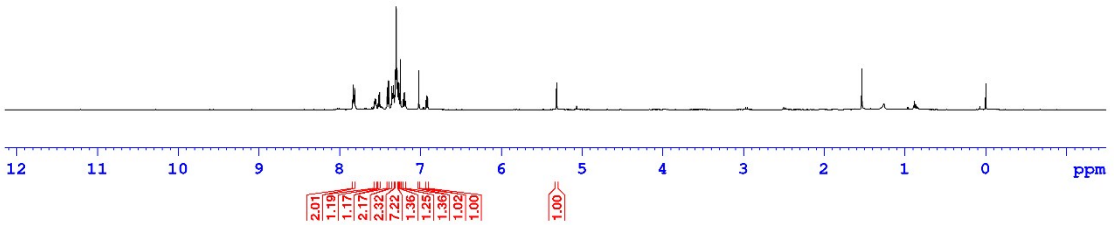


SYAP- 3-105-b1 DOWN

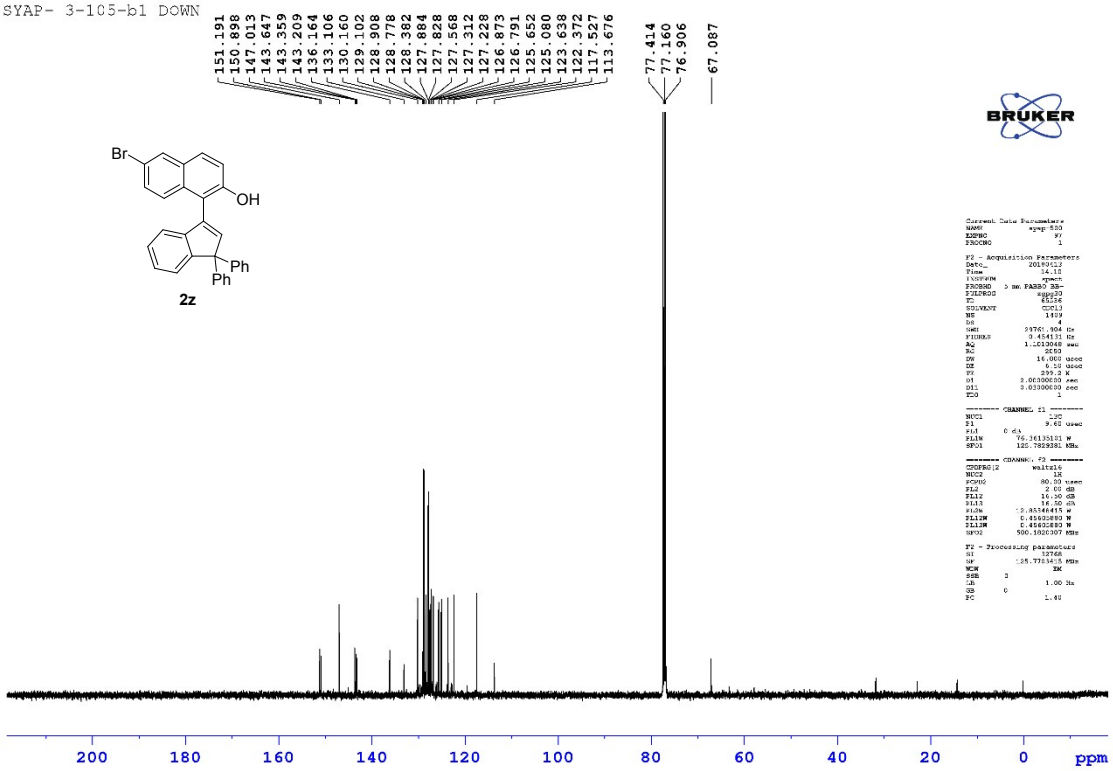




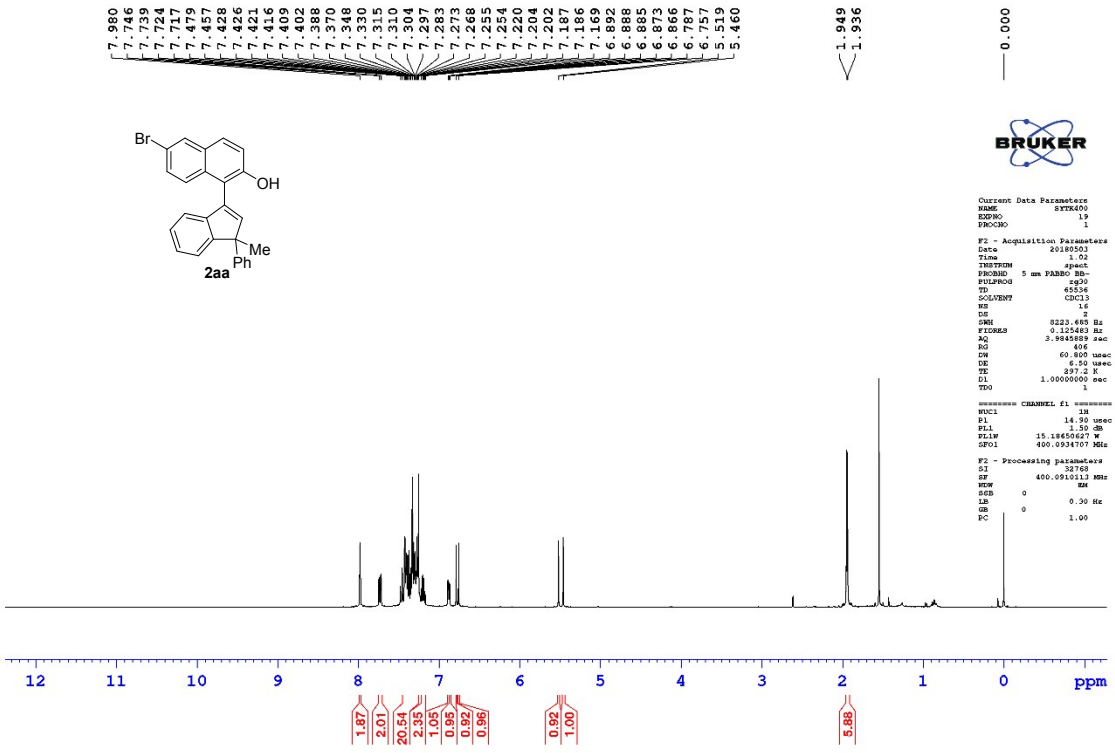
2z



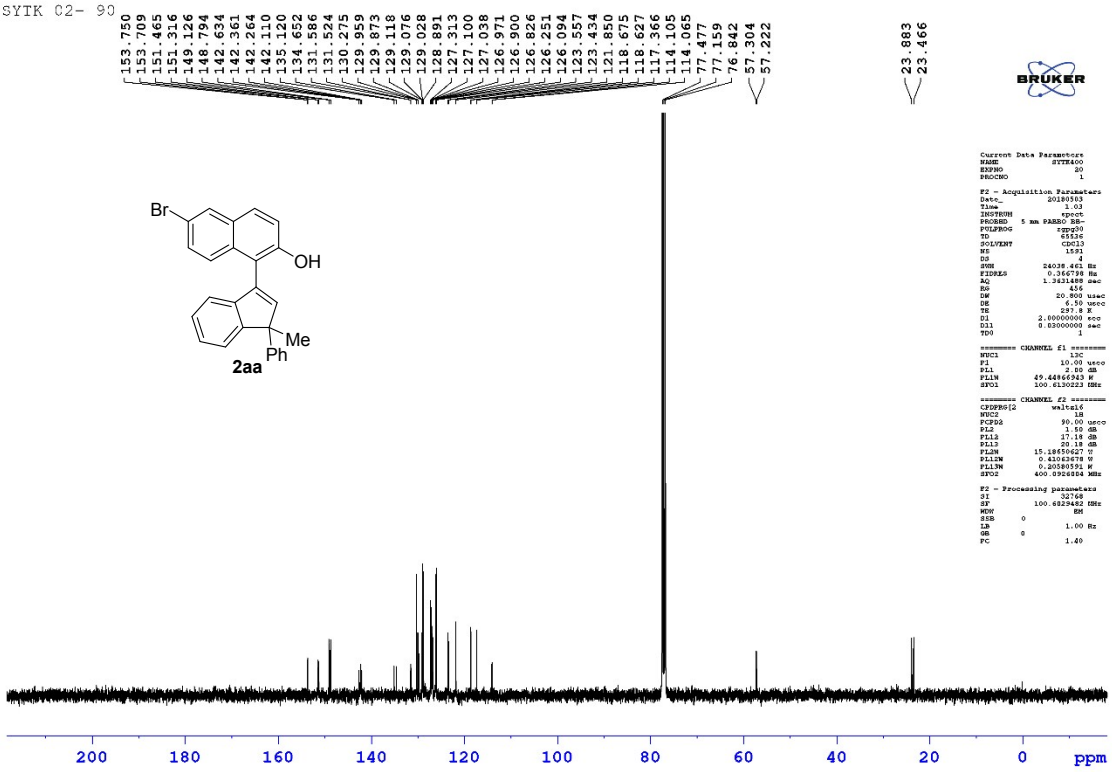
SYAP- 3-105-b1 DOWN



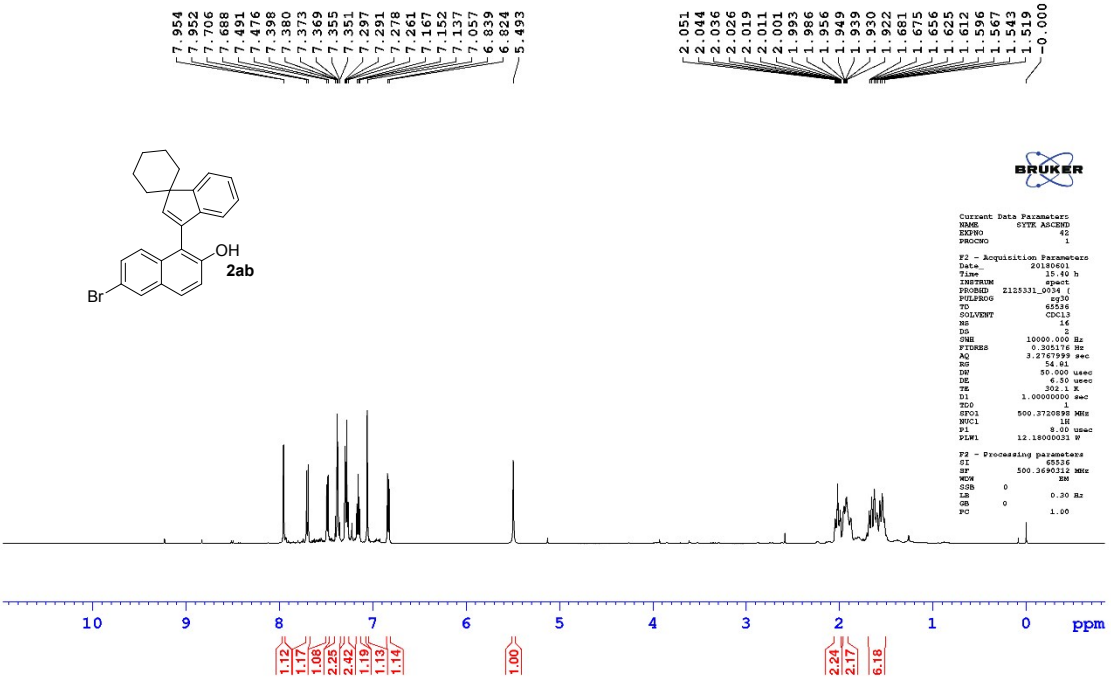
SYTK 02- 90



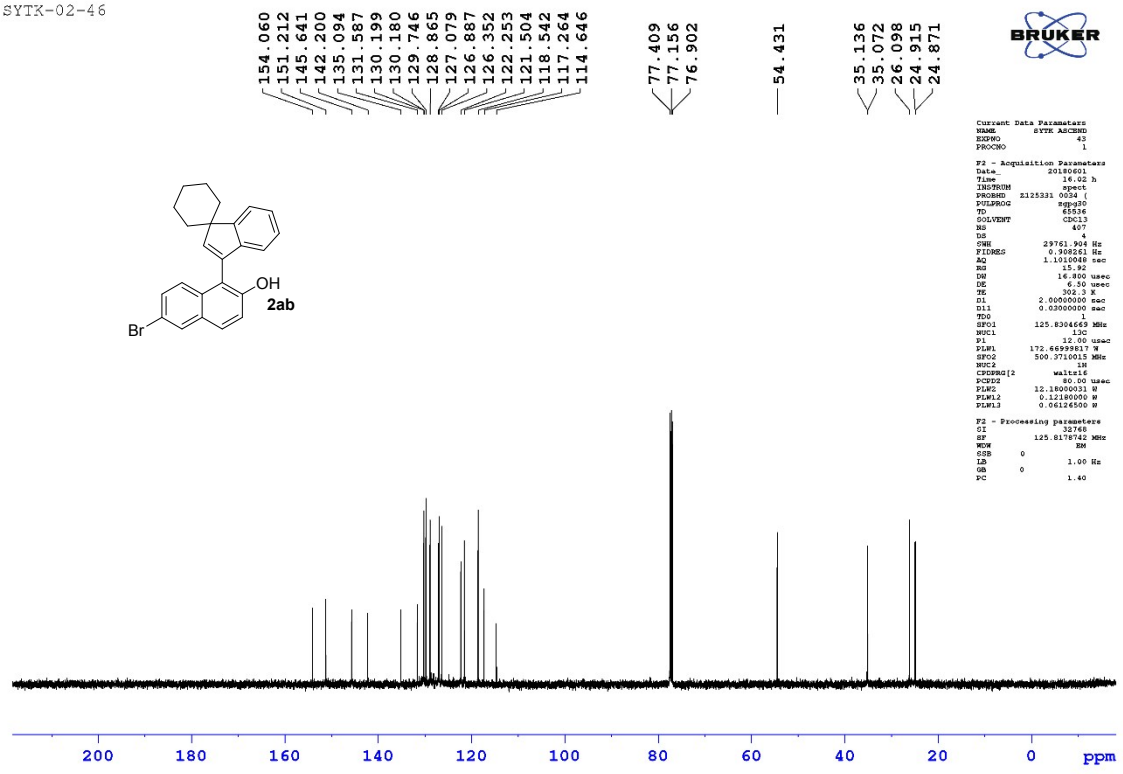
SYTK 02- 99



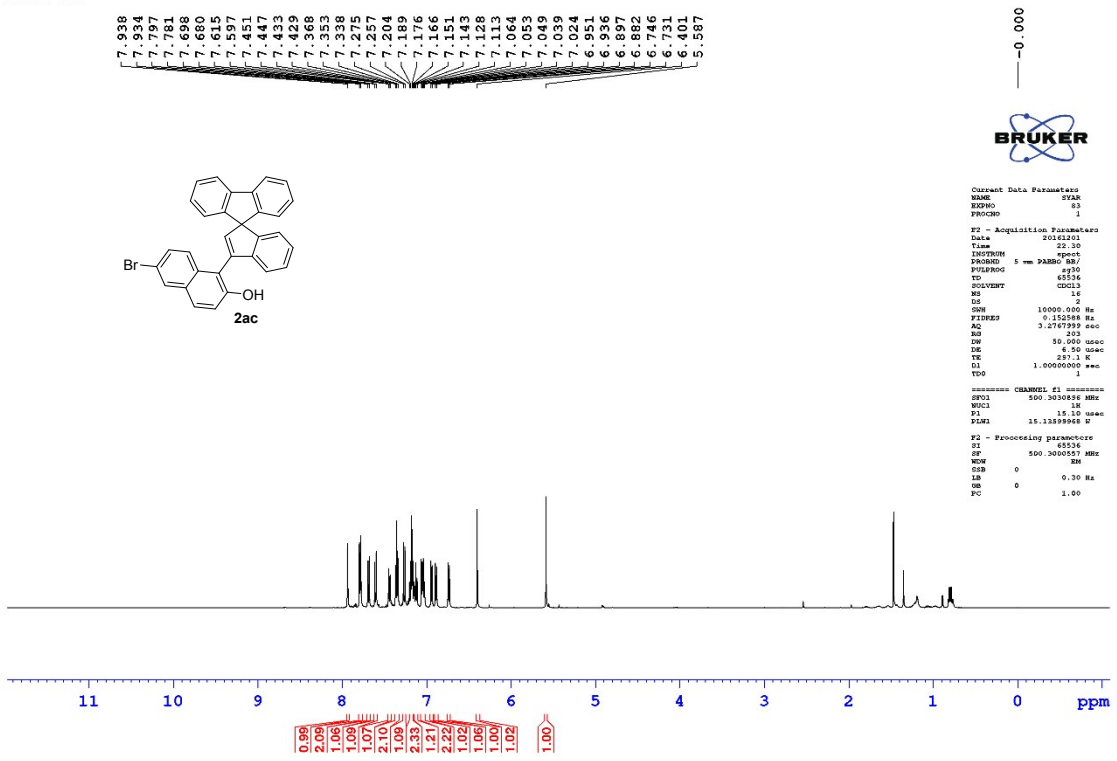
SYTK-02-46



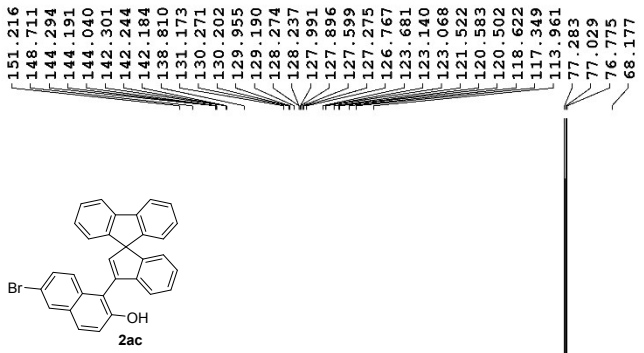
SYTK-02-46



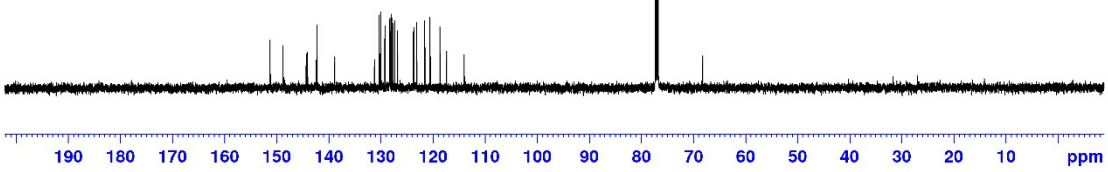
SYAR-120



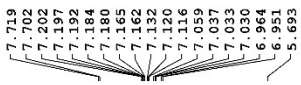
SYAR-12C

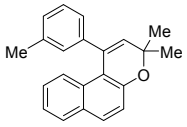


2ac

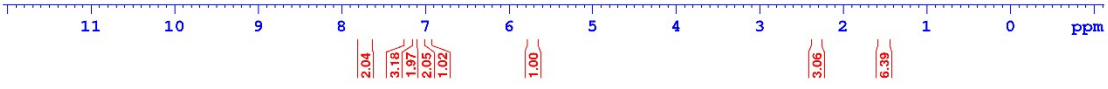


SYTK-02-93 A

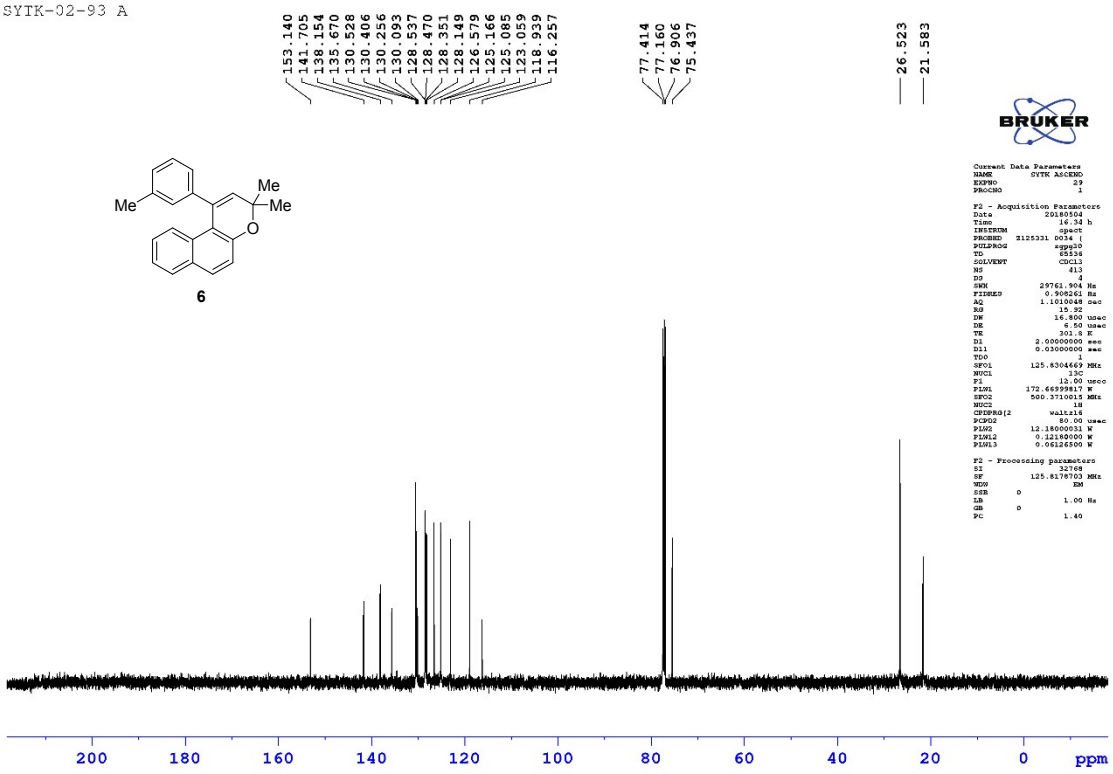




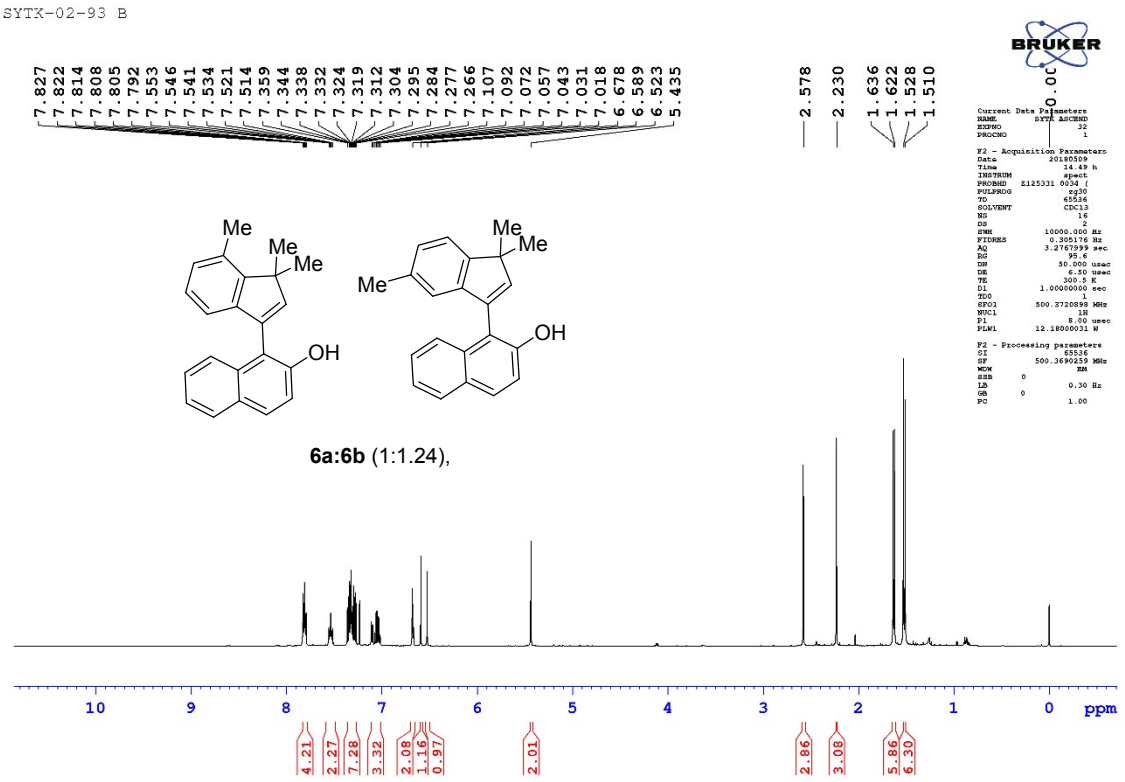
6



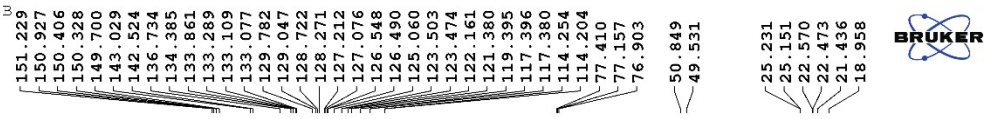
SYTK-02-93 A

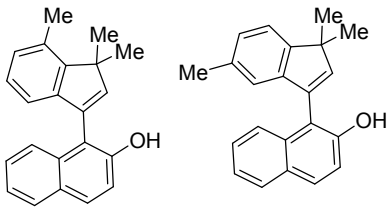


SYTK-02-93 B



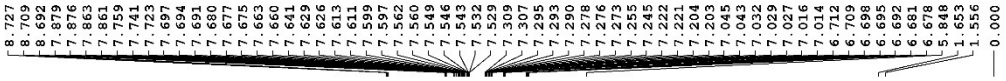
SYTK-02-93 B

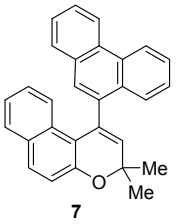




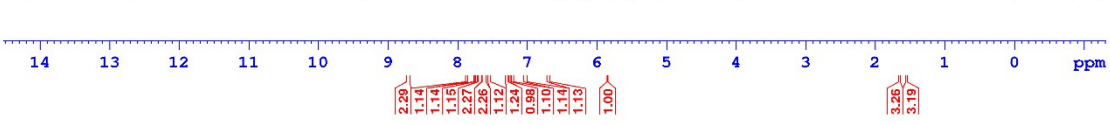
6a:6b (1:1.24),

SYTK-02-129 A

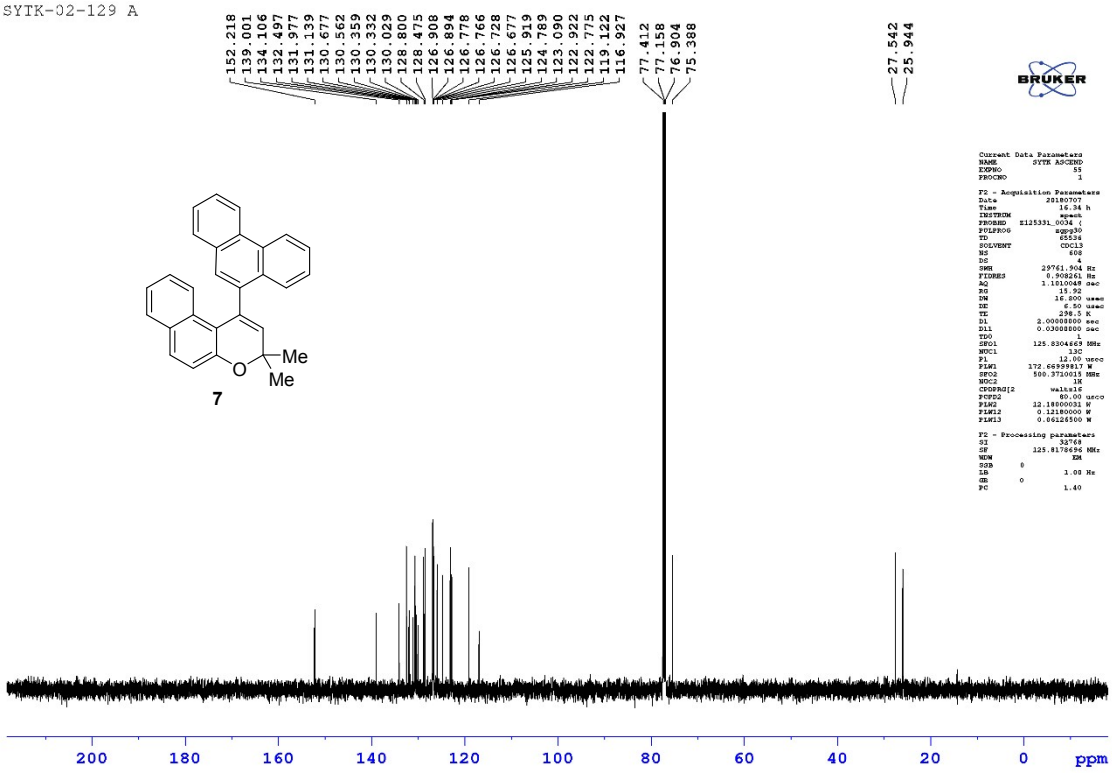




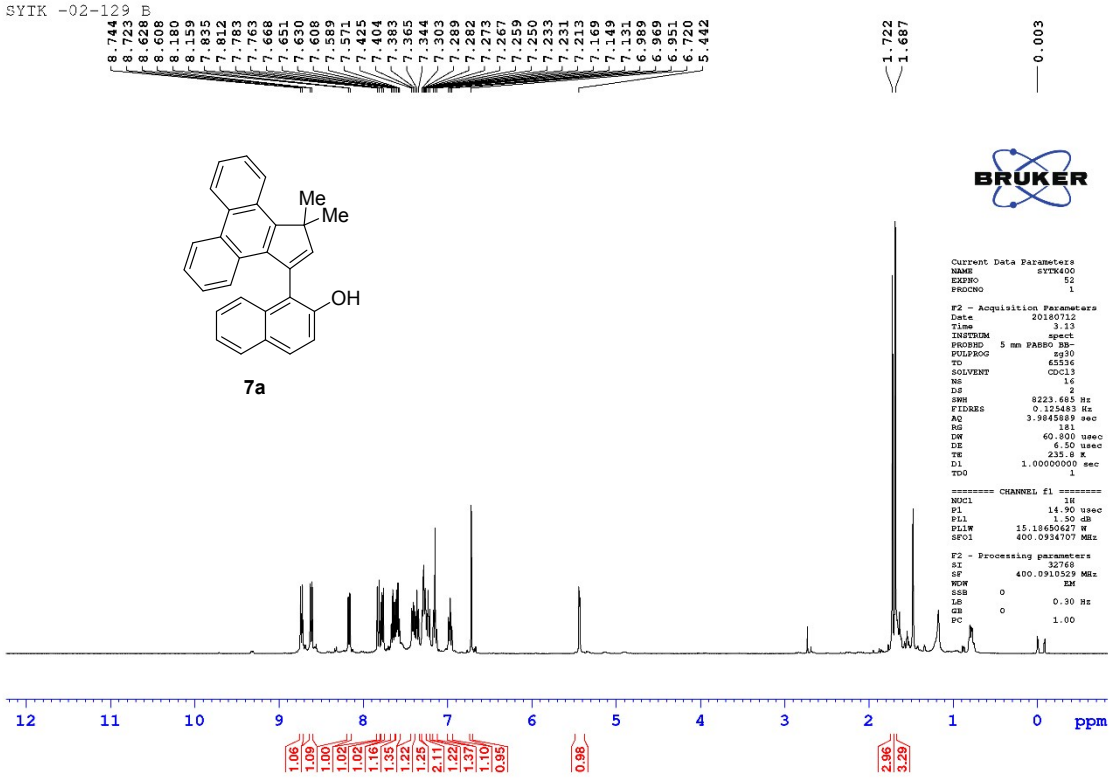
7



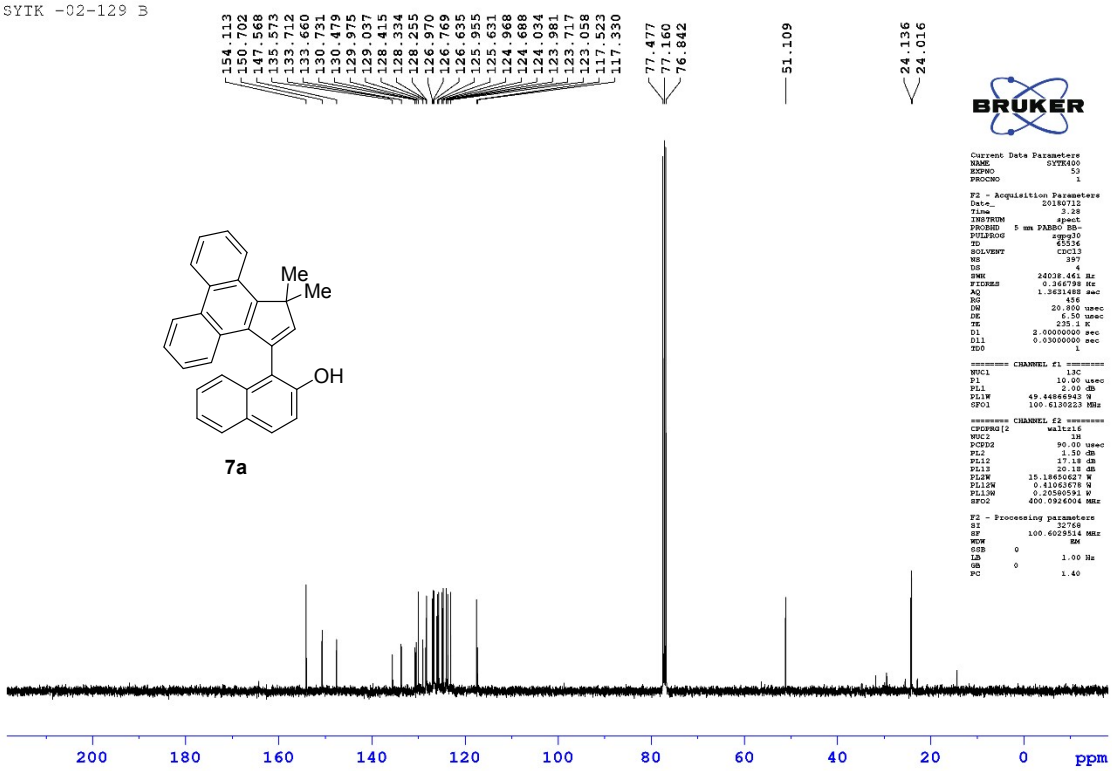
SYTK-02-129 A



SYTK -02-129 B



SYTK -02-129 B


154.113
150.702
147.568
135.573
133.712
133.660
130.731
130.479
129.975
129.037
128.415
128.334
128.255
126.970
126.769
126.635
125.955
125.631
124.968
124.688
124.034
123.981
123.717
123.058
117.523
117.330
77.477
77.160
76.842
51.109
24.136
24.016
Me
Me
OH
7a
BRUKER
Current Data Parameters
NAME SYTK400
EXPNO 53
PROCNO 1
F2 - Acquisition Parameters
Date_ 20180712
Time 3.28
INSTRUM spect
PROBHD 5 mm PABBO BB-
PULPROG zgpg30
TD 65536
SOLVENT CDCl3
NS 397
DS 4
SWH 24038.461 Hz
FIDRES 0.366798 Hz
AQ 1.3631488 sec
RG 456
DW 20.800 usec
DE 6.50 usec
TE 235.1 K
D1 2.00000000 sec
D11 0.03000000 sec
TD0 1
======== CHANNEL f1 ========
NUC1 13C
P1 10.00 usec
PL1 2.00 dB
PL1W 49.44866943 W
SFO1 100.6130223 MHz
======== CHANNEL f2 ========
CPDPRG[2 waltz16
NUC2 1H
PCPD2 90.00 usec
PL2 1.50 dB
PL12 17.18 dB
PL13 20.18 dB
PL2W 15.18650627 W
PL12W 0.41062678 W
PL13W 0.20580591 W
SFO2 400.0926004 MHz
F2 - Processing parameters
SI 32768
SF 100.6029514 MHz
WDW EM
SSB 0
LB 1.00 Hz
GB 0
PC 1.40
200
180
160
140
120
100
80
60
40
20
0
ppm