

## Supporting Information

### **Copper-Catalyzed Dimerization Fragmentation Cyclization Reactions of (E)-1-En-4-yn-3-ols as an Versatile Approach for the Synthesis of Multisubstituted 1H-Cyclopenta[b]naphthalenes**

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#### Table of Contents

<b>1</b>	<b>General Remarks</b>	<b>S2</b>
<b>2</b>	<b>General Procedure 1</b>	<b>S2</b>
<b>3</b>	<b>Characterization Data of 1a-1s</b>	<b>S2-S6</b>
<b>4</b>	<b>General Procedure 2</b>	<b>S6</b>
<b>5</b>	<b>Characterization Data of 2a-2s</b>	<b>S6-S11</b>
<b>6</b>	<b>General Procedure and Characterization Data of 3n.</b>	<b>S12</b>
<b>7</b>	<b>Crystallographic data of 1a</b>	<b>S13-S14</b>
<b>8</b>	<b><sup>1</sup>H NMR and <sup>13</sup>C NMR Spectra for Compounds 1a-1s</b>	<b>S15-S52</b>
<b>9</b>	<b><sup>1</sup>H NMR and <sup>13</sup>C NMR Spectra for Products 2a-2s</b>	<b>S53-S90</b>
<b>10</b>	<b><sup>1</sup>H NMR and <sup>13</sup>C NMR Spectra for Compound 3n</b>	<b>S91- S92</b>

## General Remarks

Column chromatography was carried out on silica gel.  $^1\text{H}$  NMR spectra were recorded on 400 MHz in  $\text{CDCl}_3$  and  $^{13}\text{C}$  NMR spectra were recorded on 100 MHz in  $\text{CDCl}_3$  using TMS as internal standard. IR spectra were recorded on a FT-IR spectrometer and only major peaks are reported in  $\text{cm}^{-1}$ . Melting points were determined on a microscopic apparatus and were uncorrected. All new compounds were further characterized by element analysis; copies of their  $^1\text{H}$  NMR and  $^{13}\text{C}$  NMR spectra are provided.

## General Procedure 1: Synthesis of 1,3,5-triaryls -1-en-4-yn-3-ol

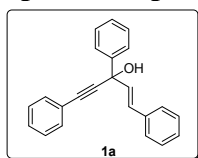
1,3,5-triaryls -1-en-4-yn-3-ol was prepared according to the literature<sup>1</sup>

## References

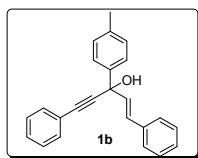
Shao-Hua Wang, Yong-Qiang Tu, *J. Org. Chem.* **2006**, 71, 4343-4345

General Procedure for dimerization fragmentation Cycloisomerization Reaction of (E)-1-en-4-yn-3-ol

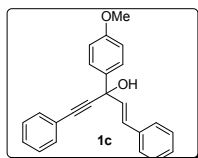
## Spectroscopic Data for Substrates 1



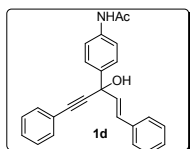
$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  7.75-7.75 (m, 2H), 7.50-7.48 (m, 2H), 7.47-7.33 (m, 4H), 7.28-7.22 (m, 7H), 7.01-6.97 (d,  $J = 16$  Hz, 2H), 6.99-6.93 (d,  $J = 16$  Hz, 2H), 3.19 (brs, 1H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$  ppm):  $\delta$  143.6, 136.3, 133.1, 132.2, 132.0, 129.2, 128.8, 128.7, 128.5, 128.5, 128.1, 128.1, 127.1, 126.1, 122.5, 90.2, 87.6, 73.39. IR (neat,  $\text{cm}^{-1}$ ): 2867, 1594, 1432, 1220, 1021, 732. Anal. Calcd for  $\text{C}_{23}\text{H}_{18}\text{O}$ : C, 89.00; H, 5.85. Found: C, 89.09; H, 5.81.



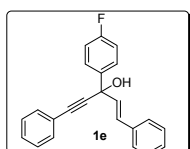
$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  7.70 (d,  $J = 8.4$  Hz, 2H), 7.25-7.60 (m, 12H), 7.06 (d,  $J = 16$  Hz, 1H), 6.52 (d,  $J = 16$  Hz, 1H), 2.85 (brs, 1H), 2.42 (s, 3H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  140.5, 137.6, 136.1, 133.0, 131.7, 129.0, 128.80, 128.4, 128.2, 127.8, 126.8, 125.7, 122.4, 90.1, 87.2, 73.0, 21.0. IR (neat,  $\text{cm}^{-1}$ ): 2862, 1548, 1401, 1236, 1031, 698. Anal. Calcd for  $\text{C}_{24}\text{H}_{20}\text{O}$ : C, 88.85; H, 6.21. Found: C, 88.93; H, 6.16.



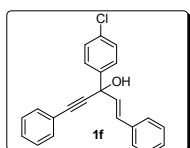
$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):  $\delta$  7.77-7.76 (m, 2H), 7.75-7.60 (m, 2H), 7.50-7.48 (m, 2H), 7.41-7.30 (m, 6H), 7.09-7.05 (d,  $J = 16$  Hz, 1H), 7.00-6.98 (m, 2H), 6.57-6.53 (d,  $J = 16$  Hz, 1H), 3.85 (s, 3H), 3.22 (brs, 1H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  159.1, 136.1, 135.6, 133.0, 131.7, 128.7, 128.537, 128.4, 128.3, 128.2, 127.1, 126.8, 122.3, 113.6, 90.1, 87.2, 72.7, 55.2. IR (neat,  $\text{cm}^{-1}$ ): 2912, 1521, 1392, 1190, 1019, 765. Anal. Calcd for  $\text{C}_{24}\text{H}_{20}\text{O}_2$ : C, 84.68; H, 5.92. Found: C, 84.59; H, 5.88.



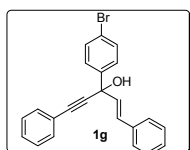
$^1\text{H}$  NMR (400 MHz, Acetone):  $\delta$  9.25 (s, 1H), 7.83-7.70 (m, 1H), 7.56-7.07 (m, 3H), 7.56-7.54 (m, 2H), 7.50-7.45 (m, 2H), 7.40-7.39 (m, 3H), 7.35-7.31 (m, 2H), 7.26-7.24 (m, 2H), 7.04-7.00 (d,  $J$  = 16 Hz, 1H), 6.57-6.53 (d,  $J$  = 16 Hz, 1H), 5.62 (brs, 1H), 2.10 (s, 3H);  $^{13}\text{C}$  NMR (100 MHz, Acetone, ppm):  $\delta$  168.1, 143.4, 139.4, 138.9, 136.7, 134.4, 131.5, 128.6, 127.7, 126.7, 126.3, 122.9, 118.8, 91.4, 86.1, 72.1, 23.4. IR (neat,  $\text{cm}^{-1}$ ): 3059, 2989, 1498, 1384, 1179, 1002, 796. Anal. Calcd for  $\text{C}_{25}\text{H}_{21}\text{NO}_2$ : C, 81.72; H, 5.76; N, 3.81. Found: C, 81.61; H, 5.78, N, 3.86.



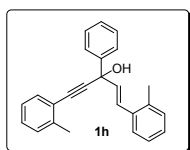
$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  7.80-7.79 (m, 2H), 7.61-7.58 (m, 2H), 7.49-7.46 (m, 2H), 7.42-7.31 (m, 5H), 7.15-7.11 (t,  $J$  = 8 Hz, 2H), 7.03 (d,  $J$  = 16 Hz, 1H), 6.47 (d,  $J$  = 16 Hz, 1H), 3.28 (brs, 1H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  163.7, 161.3, 139.4, 139.4, 136.1, 132.9, 131.9, 129.4, 128.9, 128.7, 128.5, 128.2, 127.9, 127.9, 127.1, 122.3, 115.4, 115.2, 89.9, 87.8, 72.9. IR (neat,  $\text{cm}^{-1}$ ): 3021, 1708, 1472, 1079, 1019, 765. Anal. Calcd for  $\text{C}_{23}\text{H}_{17}\text{OF}$ : C, 84.12; H, 5.22. Found: C, 84.21; H, 5.26.



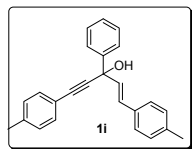
$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  8.08-8.07 (d,  $J$  = 1.6 Hz, 1H), 7.63-7.61 (m, 2H), 7.61-7.50 (m, 3H), 7.42-7.31 (m, 9H), 7.19-7.15 (d,  $J$  = 16 Hz, 1H), 6.72-6.69 (d,  $J$  = 16 Hz, 1H), 3.61 (brs, 1H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  139.7, 136.0, 132.2, 131.6, 131.2, 130.4, 129.5, 129.1, 128.5, 128.1, 127.4, 126.8, 126.8, 122.3, 88.9, 86.9, 72.0. IR (neat,  $\text{cm}^{-1}$ ): 3026, 1721, 1452, 1076, 1032, 785. Anal. Calcd for  $\text{C}_{23}\text{H}_{17}\text{OCl}$ : C, 80.11; H, 4.97. Found: C, 80.18; H, 4.96.



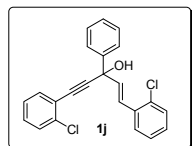
$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  7.64-7.62 (d,  $J$  = 8.4 Hz, 1H), 7.47-7.45 (m, 2H), 7.38-7.34 (m, 7H), 7.22-7.16 (m, 3H), 6.97-6.93 (d,  $J$  = 16 Hz, 1H), 6.39-6.35 (d,  $J$  = 16 Hz, 1H), 3.40 (brs, 1H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  141.9, 135.8, 133.6, 132.4, 131.7, 129.5, 128.7, 128.6, 128.5, 128.4, 128.3, 128.3, 128.0, 127.3, 126.9, 122.0, 89.5, 87.7, 72.7. IR (neat,  $\text{cm}^{-1}$ ): 3054, 1703, 1439, 1055, 1022, 799. Anal. Calcd for  $\text{C}_{23}\text{H}_{17}\text{OBr}$ : C, 70.96; H, 4.40. Found: C, 71.01; H, 4.46.



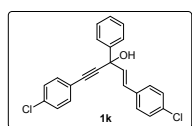
$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  7.82-7.80 (d,  $J = 8.4$  Hz, 1H), 7.50-7.45 (m, 4H), 7.38-7.35 (m, 3H), 7.21-7.16 (m, 4H), 7.06-7.02 (d,  $J = 16$  Hz, 1H), 6.49-6.45 (d,  $J = 16$  Hz, 1H), 2.81 (brs, 1H), 2.42 (s, 3H), 2.38 (s, 3H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  143.5, 138.7, 137.7, 133.3, 131.9, 131.6, 131.6, 129.2, 129.0, 129.7, 128.9, 128.5, 128.3, 127.8, 126.8, 126.7, 125.8, 119.2, 89.3, 87.6, 73.3, 21.4, 21.2. IR (neat,  $\text{cm}^{-1}$ ): 2985, 1717, 1398, 1025, 985, 785. Anal. Calcd for  $\text{C}_{25}\text{H}_{22}\text{O}$ : C, 88.72; H, 6.55. Found: C, 88.65; H, 6.59.



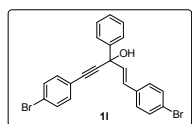
$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  7.85-7.83 (d,  $J = 15.6$  Hz, 1H), 7.51-7.37 (m, 7H), 7.22-7.18 (m, 4H), 7.09-7.05 (d,  $J = 15.6$  Hz, 1H), 6.51-6.48 (d,  $J = 15.6$  Hz, 1H), 2.93 (brs, 1H), 2.43 (s, 3H), 2.40 (s, 3H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  143.5, 138.8, 137.7, 133.3, 131.9, 131.6, 129.2, 129.0, 128.9, 128.4, 127.8, 126.8, 125.8, 119.2, 89.3, 87.6, 73.3, 21.5, 21.2. IR (neat,  $\text{cm}^{-1}$ ): 3015, 1720, 1418, 1025, 985, 735. Anal. Calcd for  $\text{C}_{25}\text{H}_{22}\text{O}$ : C, 88.72; H, 6.55. Found: C, 88.69; H, 6.51.



$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  7.85-7.83 (d,  $J = 7.6$  Hz, 2H), 7.54-7.54 (d,  $J = 1.6$  Hz, 1H), 7.53-7.37 (m, 4H), 7.36-7.35 (m, 2H), 7.30-7.23 (m, 4H), 6.96-6.92 (d,  $J = 15.6$  Hz, 1H), 6.501-6.46 (d,  $J = 15.6$  Hz, 1H), 3.20 (brs, 1H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  142.9, 138.0, 134.6, 134.3, 134.1, 131.7, 130.0, 129.8, 129.7, 129.1, 128.6, 128.3, 128.0, 127.9, 126.8, 125.8, 125.2, 123.9, 91.0, 86.2, 73.1. IR (neat,  $\text{cm}^{-1}$ ): 3038, 1761, 1432, 1001, 962, 712. Anal. Calcd for  $\text{C}_{23}\text{H}_{16}\text{OCl}_2$ : C, 72.83; H, 4.25. Found: C, 72.79; H, 4.21.

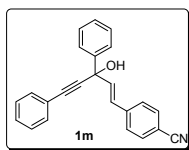


$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  7.87-7.85 (d,  $J = 4.8$  Hz, 1H), 7.48-7.45 (m, 2H), 7.37-7.35 (m, 3H), 7.28-7.24 (m, 4H), 7.21-7.19 (m, 1H), 7.02-6.98 (d,  $J = 16$  Hz, 1H), 6.50-6.46 (d,  $J = 16$  Hz, 1H), 3.40 (brs, 1H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  138.5, 135.835, 134.215, 133.1, 131.6, 130.8, 129.9, 128.7, 128.5, 128.4, 128.2, 128.1, 126.9, 122.1, 88.5, 87.1, 71.6. IR (neat,  $\text{cm}^{-1}$ ): 3031, 1758, 1429, 1012, 965, 694. Anal. Calcd for  $\text{C}_{23}\text{H}_{16}\text{OCl}_2$ : C, 72.83; H, 4.25. Found: C, 72.76; H, 4.28.

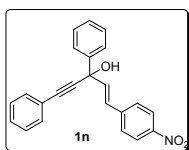


$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  7.77-7.73 (m, 2H), 7.51-7.49 (m, 3H), 7.46-7.40 (m, 6H), 7.29-7.27 (d,  $J = 8.8$  Hz, 2H), 6.94-6.90 (d,  $J = 16$  Hz, 1H), 6.47-6.43 (d,  $J = 16$  Hz, 1H), 2.85 (brs, 1H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  142.9, 135.0, 133.3, 133.3, 133.0, 131.7, 131.7, 128.6, 128.5, 128.3, 128.1, 125.9, 125.8, 123.2, 121.9, 121.2, 90.8, 86.6, 73.2. IR (neat,  $\text{cm}^{-1}$ ): 3029, 1765,

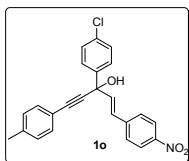
1398, 1003, 945, 672. Anal. Calcd for C<sub>23</sub>H<sub>16</sub>OBr<sub>2</sub>: C, 59.00; H, 3.44. Found: C, 58.95; H, 3.38.



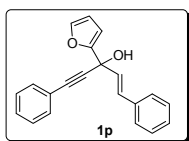
<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>, ppm): δ 7.80-7.79 (d, *J* = 4.4, 2H), 7.56-7.54 (d, *J* = 7.6 Hz, 4H), 7.46-7.38 (m, 8H), 7.05-7.01 (d, *J* = 15.6 Hz, 1H), 6.62-6.58 (d, *J* = 15.6 Hz, 1H), 3.45 (brs, 1H); <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>, ppm): δ 142.7, 140.6, 136.5, 132.1, 131.6, 128.7, 128.4, 128.3, 128.1, 127.2, 126.9, 125.7, 121.9, 118.7, 110.7, 89.2, 87.7, 72.8. IR (neat, cm<sup>-1</sup>): 3023, 1708, 1426, 1003, 672. Anal. Calcd for C<sub>24</sub>H<sub>17</sub>NO: C, 85.94; H, 5.11; N, 4.18. Found: C, 85.89; H, 5.17; N, 4.23.



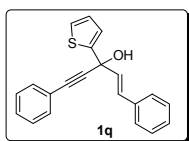
<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>, ppm): δ 8.17-8.15 (d, *J* = 8.4, 2H), 7.80-7.76 (m, 2H), 7.57-7.52 (m, 4H), 7.46-7.42 (m, 2H), 7.38-7.35 (m, 4H), 7.09-7.05 (d, *J* = 15.6 Hz, 1H), 6.54-6.61 (d, *J* = 15.6 Hz, 1H), 3.20 (brs, 1H); <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>, ppm): δ 147.0, 142.7, 142.8, 137.4, 131.7, 128.9, 128.7, 128.6, 128.4, 128.3, 127.4, 126.6, 125.8, 123.8, 121.9, 89.1, 87.9, 73.0. IR (neat, cm<sup>-1</sup>): 3029, 1740, 1471, 1203, 1075, 672. Anal. Calcd for C<sub>23</sub>H<sub>17</sub>NO<sub>3</sub>: C, 77.73; H, 4.82; N, 3.94. Found: C, 77.69; H, 4.85; N, 3.89.



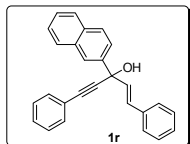
<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>, ppm): δ 8.22(s, 1H), 8.09-8.06 (m, 1H), 7.70-7.68 (d, *J* = 8.8 Hz, 3H), 7.48-7.36 (m, 5H), 7.18-7.16 (d, *J* = 8 Hz, 4H), 7.04-7.00 (d, *J* = 15.6 Hz, 1H), 6.56-6.52 (d, *J* = 15.6 Hz, 1H), 3.26 (brs, 1H), 2.38(s, 3H); <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>, ppm): δ 148.3, 141.4, 139.2, 137.7, 135.6, 133.9, 132.7, 131.6, 129.4, 129.1, 128.9, 128.6, 127.3, 126.7, 122.5, 121.4, 118.6, 88.3, 88.1, 72.5, 21.5. IR (neat, cm<sup>-1</sup>): 3062, 1801, 1462, 1185, 1023, 705. Anal. Calcd for C<sub>24</sub>H<sub>18</sub>ClNO<sub>3</sub>: C, 71.38; H, 4.49; N, 3.47. Found: C, 71.26; H, 4.52; N, 3.41.



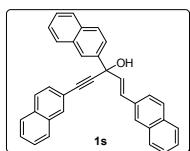
<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>, ppm): δ 7.59-7.57 (m, 2H), 7.51-7.49 (d, *J* = 3.6 Hz, 3H), 7.39-7.30 (m, 6H), 7.13-7.09 (d, *J* = 16 Hz, 1H), 6.68-6.64 (d, *J* = 16 Hz, 1H), 6.59-6.58 (d, *J* = 3.2 Hz, 1H), 6.42-6.40 (m, 1H), 3.55 (brs, 1H); <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>, ppm): δ 154.5, 142.9, 135.9, 131.9, 131.8, 131.8, 130.8, 129.2, 128.7, 128.5, 128.5, 128.3, 128.0, 126.9, 125.8, 122.0, 110.3, 107.1, 87.7, 86.5, 68.5. IR (neat, cm<sup>-1</sup>): 3012, 1719, 1401, 1064, 962, 691. Anal. Calcd for C<sub>21</sub>H<sub>16</sub>O<sub>2</sub>: C, 83.98; H, 5.37. Found: C, 83.95; H, 5.41.



$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  7.64-7.63 (m, 2H), 7.62-7.53 (m, 2H), 7.51-7.34 (m, 8H), 7.19-7.13 (d,  $J = 15.6$  Hz, 1H), 7.08-7.06 (m, 1H), 6.68-6.65 (d,  $J = 15.6$  Hz, 1H), 3.31 (brs, 1H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  148.4, 135.8, 131.8, 131.7, 129.4, 128.7, 128.5, 128.3, 128.90, 126.9, 126.7, 125.8, 124.8, 121.9, 89.2, 86.7, 70.4. IR (neat,  $\text{cm}^{-1}$ ): 3009, 1703, 1415, 1035, 978, 645. Anal. Calcd for  $\text{C}_{21}\text{H}_{16}\text{OS}$ : C, 79.71; H, 5.10. Found: C, 79.65; H, 5.11.

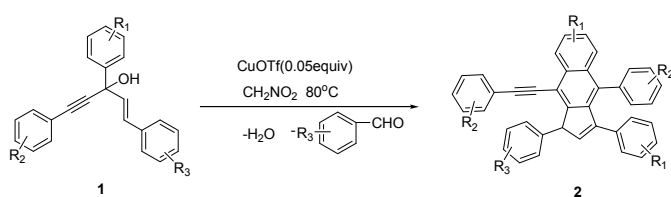


$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  8.31(s, 1H), 7.95-7.91 (m, 4H), 7.64-7.62(m, 2H), 7.61-7.54 (m, 2H), 7.49-7.47 (m, 2H), 7.42-7.27 (m, 6H), 7.16-7.12 (d,  $J = 15.6$  Hz, 1H), 6.63-6.59 (d,  $J = 15.6$  Hz, 1H), 3.07 (brs, 1H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  140.7, 136.2, 133.2, 133.1, 132.8, 131.9, 129.6, 128.8, 128.7, 128.5, 128.5, 128.4, 128.1, 127.7, 127.1, 126.4, 126.3, 124.4, 124.4, 122.4, 90.0, 87.8, 73.5. IR (neat,  $\text{cm}^{-1}$ ): 2975, 1707, 1385, 1015, 979, 765. Anal. Calcd for  $\text{C}_{27}\text{H}_{20}\text{O}$ : C, 89.97; H, 5.59. Found: C, 90.03; H, 5.61.



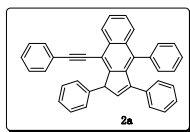
$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  8.71(s, 1H), 8.07-8.05(m, 1H), 7.89-7.87(m, 1H), 7.78-7.76 (m, 2H), 7.70-7.64 (m, 7H), 7.50-7.41 (m, 1H), 7.40-7.28 (m, 9H), 7.20-7.16 (d,  $J = 16$  Hz, 1H), 6.78-6.74 (d,  $J = 16$  Hz, 1H), 2.95 (brs, 1H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  138.0, 134.7, 133.6, 133.5, 133.2, 133.0, 132.9, 132.8, 131.7, 131.0, 130.3, 129.6, 128.8, 128.3, 128.2, 128.0, 128.0, 127.8, 127.7, 127.6, 127.2, 126.8, 126.7, 126.5, 126.3, 126.0, 125.6, 125.5, 125.0, 124.1, 123.8, 119.7, 90.9, 88.4, 73.2. IR (neat,  $\text{cm}^{-1}$ ): 2965, 1718, 1379, 1020, 962, 755. Anal. Calcd for  $\text{C}_{35}\text{H}_{24}\text{O}$ : C, 91.27; H, 5.25. Found: C, 91.23; H, 5.29.

## General Procedure 1: Synthesis of 1H-cyclopenta[b]naphthalenes

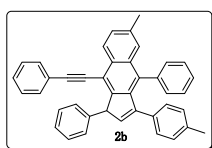


To a solution of 1,3,5-triaryls -1-en-4-yn-3-ol derivatives **1** (0.50 mmol) in  $\text{CH}_3\text{NO}_2$  (5.0 mL) was added 5 mmol%  $\text{CuOTf}$  at 80 °C under Ar. When the reaction was considered complete as determined by TLC analysis, the reaction mixture was quenched by addition of saturated aqueous  $\text{NH}_4\text{Cl}$  and diluted with ethyl ether (40 mL), washed with water, saturated brine, dried over  $\text{Na}_2\text{SO}_4$  and evaporated under reduced pressure. The residue was purified by chromatography on silica gel to afford corresponding 1H-cyclopenta[b]naphthalenes **2a-2s**.

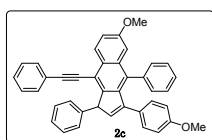
## Spectroscopic Data for Products 2a-2s



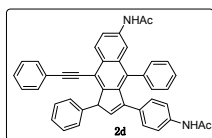
$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  8.39-8.37 (d,  $J=12.8$  Hz, 1H), 7.65-7.64 (m, 1H), 7.45-7.44 (m, 1H), 7.43-7.16 (m, 9H), 7.10-7.06 (m, 4H), 7.05-7.04 (m, 2H), 6.98-6.85 (m, 2H), 6.84-6.74 (m, 2H), 6.51-6.50 (d,  $J=2.4$ Hz, 1H), 5.04-5.03(d,  $J=2.4$ Hz, 1H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  149.2, 143.9, 142.4, 140.3, 138.1, 135.9, 135.0, 133.7, 132.3, 132.2, 132.0, 131.7, 131.5, 131.2, 131.1, 130.3, 129.4, 129.3, 128.8, 128.5, 128.5, 128.3, 127.7, 127.6, 127.6, 127.2, 127.1, 126.8, 126.7, 125.6, 123.0, 116.5, 99.5, 85.0, 55.0. IR (neat,  $\text{cm}^{-1}$ ): 3062, 1708, 1592, 1076, 755. Anal. Calcd for  $\text{C}_{39}\text{H}_{26}$ : C, 94.70; H, 5.30. Found: C, 94.76; H, 5.25.



$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  8.48-8.46 (m, 1H), 7.67 (s, 1H), 7.56-7.32 (m, 11H), 7.27-7.12 (m, 4H), 6.85-6.79 (m, 4H), 6.56-6.55 (d,  $J=2.4$ Hz, 1H), 5.04-5.03 (d,  $J=2.4$ Hz, 1H), 2.35 (s, 3H), 2.20 (s, 3H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  148.5, 145.3, 141.0, 139.7, 139.0, 136.9, 135.5, 135.3, 134.0, 132.9, 132.6, 131.5, 131.3, 131.2, 130.2, 128.6, 128.4, 128.3, 128.2, 128.1, 128.0, 127.6, 127.2, 126.5, 126.4, 125.8, 125.7, 123.5, 116.1, 98.7, 85.9, 54.9, 21.8, 21.1. IR (neat,  $\text{cm}^{-1}$ ): 2923, 1693, 1445, 820, 735. Anal. Calcd for  $\text{C}_{41}\text{H}_{30}$ : C, 94.21; H, 5.79. Found: C, 94.28; H, 5.71.

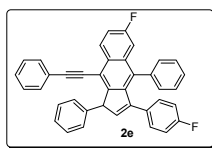


$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  8.43-8.41(d,  $J=9.2$  Hz, 1H), 7.37-7.22 (m, 12H), 7.16-7.02 (m, 6H), 6.84-6.82 (d,  $J=8.8$  Hz, 9H), 6.05 (s, 1H), 5.08-5.07 (d,  $J=2.4$  Hz, 1H), 3.76 (s, 3H), 3.71 (s, 3H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  157.7, 147.3, 144.8, 141.3, 140.1, 139.1, 136.9, 134.1, 132.1, 131.4, 131.2, 131.1, 129.4, 129.1, 128.5, 128.4, 128.4, 128.2, 127.4, 127.3, 127.3, 126.7, 126.5, 123.5, 117.5, 112.7, 106.1, 98.7, 85.9, 55.2, 55.1, 54.8. IR (neat,  $\text{cm}^{-1}$ ): 2926, 1598, 1498, 1071, 755, 696. Anal. Calcd for  $\text{C}_{41}\text{H}_{30}\text{O}_2$ : C, 88.78; H, 5.45. Found: C, 88.71; H, 5.39.

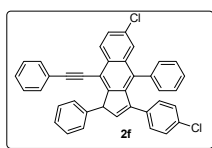


$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  8.45-8.43 (d,  $J=8.8$  Hz, 1H), 7.94-7.91(m, 1H), 7.60 (s, 2H), 7.37-7.26 (m, 9H), 7.12-7.00 (m, 6H), 7.00-6.88 (m, 5H), 6.53-6.52 (d,  $J=2$  Hz, 1H), 5.08 (d,  $J=2.4$  Hz, 1H), 2.07 (s, 6H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  168.5, 148.5, 145.2, 141.9, 140.0, 138.8, 136.8, 136.6, 136.02 133.2, 132.5, 131.5, 131.2, 131.2, 129.1, 128.6, 128.5, 128.3, 128.3, 128.1, 127.4, 127.4, 127.1, 127.0, 126.9, 126.7, 126.0, 123.4, 120.0, 116.2, 115.6, 99.1, 85.6, 55.0, 29.7. IR (neat,  $\text{cm}^{-1}$ ): 2924, 1654, 1486, 1073, 755, 697. Anal. Calcd for  $\text{C}_{43}\text{H}_{32}\text{ON}_2$ : C,

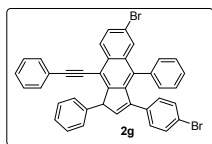
84.84; H, 5.30; N, 4.60. Found: C, 84.81; H, 5.30; N, 4.52.



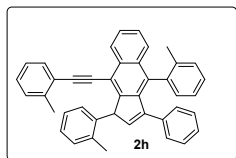
$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  8.54-8.50 (m, 1H), 7.47-7.32 (m, 12H), 7.23-7.21 (m, 1H), 7.16-7.13 (m, 3H), 7.07-7.05 (m, 1H), 6.90-6.88 (m, 2H), 6.86-6.64 (m, 2H), 6.57-6.56 (d,  $J=2$  Hz, 1H), 5.11-5.10 (d,  $J=1.6$  Hz, 1H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  162.6, 162.3, 160.1, 159.9, 148.4, 144.1, 142.3, 140.3, 138.4, 136.2, 134.2, 134.1, 132.6, 132.6, 132.5, 132.4, 131.7, 131.5, 131.1, 131.0, 130.7, 129.7, 129.7, 128.9, 128.8, 128.6, 128.5, 128.4, 128.3, 128.3, 127.9, 127.7, 127.6, 127.5, 127.2, 126.9, 126.8, 123.2, 116.5, 115.9, 115.6, 114.1, 114.0, 113.9, 113.8, 110.6, 110.4, 99.4, 85.3, 55.0. IR (neat,  $\text{cm}^{-1}$ ): 2926, 1614, 1508, 1248, 71034, 697. Anal. Calcd for  $\text{C}_{39}\text{H}_{24}\text{F}_2$ : C, 88.28; H, 4.56. Found: C, 88.31; H, 4.61.



$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  8.29-8.26 (d,  $J=8.8$  Hz, 1H), 7.545-7.540 (d,  $J=2$  Hz, 1H), 7.34-7.31 (m, 1H), 7.31-7.16 (m, 5H), 7.13-7.07 (m, 7H), 6.97-6.95 (m, 3H), 6.94-6.93 (m, 1H), 6.76-6.74 (d,  $J=8$  Hz, 2H), 6.64-6.62 (d,  $J=8$  Hz, 2H), 6.383-6.378 (d,  $J=2$  Hz, 2H), 4.915-4.91 (d,  $J=2$  Hz, 1H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  149.2, 143.9, 142.4, 140.3, 138.1, 135.9, 135.0, 133.7, 132.3, 132.2, 132.1, 131.5, 131.1, 131.1, 130.3, 129.3, 128.5, 128.5, 128.5, 128.2, 127.6, 127.6, 127.6, 127.2, 126.8, 126.8, 126.7, 125.6, 123.1, 116.5, 99.6, 85.1, 55.1. IR (neat,  $\text{cm}^{-1}$ ): 3056, 1458, 1377, 1248, 756, 697. Anal. Calcd for  $\text{C}_{39}\text{H}_{24}\text{Cl}_2$ : C, 83.12; H, 4.29. Found: C, 83.15; H, 4.21.



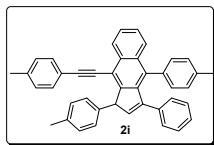
$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  8.40-8.38 (d,  $J=8.8$  Hz, 1H), 7.90 (s, 1H), 7.66-7.63 (m, 1H), 7.63-7.25 (m, 11H), 7.17-7.02 (m, 5H), 6.64-6.62 (d,  $J=8.4$  Hz, 2H), 6.57-6.56 (d,  $J=2$  Hz, 2H), 5.09-5.08 (d,  $J=2$  Hz, 1H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  149.4, 143.9, 142.3, 140.2, 138.0, 135.8, 135.5, 134.1, 132.2, 131.5, 131.1, 131.1, 130.5, 130.2, 129.6, 129.3, 128.8, 128.6, 128.5, 128.5, 128.4, 128.3, 127.7, 127.6, 127.6, 127.2, 126.8, 123.1, 120.6, 120.2, 116.6, 99.7, 85.0, 55.1. IR (neat,  $\text{cm}^{-1}$ ): 3023, 1599, 1490, 1027, 732, 696. Anal. Calcd for  $\text{C}_{39}\text{H}_{24}\text{Br}_2$ : C, 71.80; H, 3.71. Found: C, 71.86; H, 3.68.



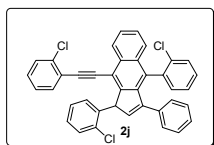
$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  8.51-8.49 (d,  $J=8$  Hz, 1H), 7.80-7.78 (d,  $J=8.4$  Hz, 1H), 7.57-7.53 (m, 1H), 7.41-7.30 (m, 2H), 7.23-7.19 (m, 4H), 7.14-7.12 (m, 2H), 7.04-6.84 (m, 9H), 6.52-6.51 (d,  $J=2.4$  Hz, 2H), 5.09-5.08 (d,  $J=2.4$  Hz, 1H), 2.42 (s, 3H), 2.36 (s, 3H), 2.29 (s, 3H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  149.6, 145.1, 141.4, 139.8, 138.3, 137.0, 136.3, 136.1, 135.6,



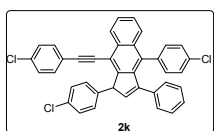
133.7, 133.0, 132.7, 131.9, 131.6, 131.4, 131.1, 131.0, 129.1, 129.0, 128.8, 128.5, 128.3, 128.2, 128.0, 127.8, 127.8, 126.9, 126.8, 125.8, 125.7, 125.7, 125.4, 120.5, 116.2, 99.1, 85.2, 54.6, 21.6, 21.1, 21.09. IR (neat,  $\text{cm}^{-1}$ ): 2924, 1600, 1488, 1092, 755, 700. Anal. Calcd for  $\text{C}_{42}\text{H}_{32}$ : C, 93.99; H, 6.01. Found: C, 94.05; H, 6.07.



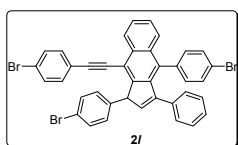
$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ , ppm): 8.47-8.45 (d,  $J=8.4$  Hz, 1H), 7.59-7.75 (m, 1H), 7.47-7.44(m, 1H), 7.38-7.36(m, 2H), 7.26-7.23 (m, 4H), 7.19-7.17(m, 1H), 7.10-6.87 (m, 9H), 6.57 (s, 1H), 5.12 (s, 1H), 2.46 (s, 3H), 2.41 (s, 3H), 2.34 (s, 3H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  149.4, 145.2, 141.4, 139.6, 138.2, 137.0, 136.3, 136.0, 135.7, 133.7, 133.7, 133.0, 132.8, 131.9, 131.5, 131.4, 131.1, 131.0, 129.0, 129.0, 128.5, 128.2, 127.8, 127.8, 126.9, 126.8, 125.8, 125.7, 125.4, 120.5, 116.2, 99.2, 54.6, 21.5, 21.13, 21.1. IR (neat,  $\text{cm}^{-1}$ ): 3026, 1617, 1446, 1027, 819, 732. Anal. Calcd for  $\text{C}_{42}\text{H}_{32}$ : C, 93.99; H, 6.01. Found: C, 93.94; H, 5.95.



$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  8.47-8.45(d,  $J=8$  Hz, 1H), 7.70-7.67(m, 1H), 7.67-7.59 (m, 1H), 7.57-7.46(m, 1H), 7.44-7.30 (m, 6H), 7.13-7.00 (m, 9H), 6.97-6.93 (m, 2H), 6.51-6.50 (d,  $J=1.6$  Hz, 2H), 5.04-5.03 (d,  $J=2$  Hz, 1H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  148.7, 145.5, 140.7, 139.4, 138.2, 136.2, 134.2, 133.4, 132.5, 132.0, 131.8, 131.4, 131.4, 131.3, 129.8, 129.5, 129.3, 129.2, 128.7, 128.6, 127.9, 127.3, 127.2, 127.1, 126.4, 126.3, 125.8, 124.7, 116.4, 98.0, 86.4, 54.5. IR (neat,  $\text{cm}^{-1}$ ): 2924, 1600, 1488, 1092, 825, 700. Anal. Calcd for  $\text{C}_{39}\text{H}_{23}\text{Cl}_3$ : C, 78.34; H, 3.88. Found: C, 78.39; H, 3.92.

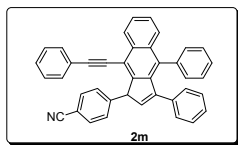


$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  8.45-8.43 (d,  $J=8.4$  Hz, 1H), 7.70-7.68 (d,  $J=8.4$  Hz, 1H), 7.60-7.57(m, 1H), 7.46-7.42 (m, 2H), 7.30-7.26(m, 5H), 7.20-7.13 (m, 2H), 7.02-6.95 (m, 5H), 6.87-6.85 (m, 2H), 6.50-6.49 (d,  $J=2$  Hz, 2H), 5.05-5.04 (d,  $J=2$  Hz, 1H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  148.8, 145.3, 140.9, 139.6, 137.2, 136.3, 134.9, 134.5, 133.1, 132.6, 132.6, 132.5, 132.4, 132.1, 131.8, 130.8, 129.8, 128.9, 128.7, 128.6, 128.6, 128.3, 128.2, 127.4, 127.34, 127.3, 126.5, 126.3, 126.3, 126.2, 125.8, 121.6, 116.3, 98.3, 86.3, 54.2. IR (neat,  $\text{cm}^{-1}$ ): 2854, 1644, 1446, 1074, 756, 698. Anal. Calcd for  $\text{C}_{39}\text{H}_{23}\text{Cl}_3$ : C, 78.34; H, 3.88. Found: C, 78.29; H, 3.91.

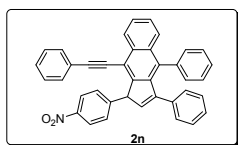


$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  8.44-8.42 (d,  $J=8.4$  Hz, 1H), 7.70-7.68 (m,  $J=8.8$  Hz, 1H), 7.59-7.51(m, 3H), 7.42-7.40 (m, 3H), 7.20-7.13 (m, 7H), 7.00-6.97 (m, 3H), 6.90-6.84 (m, 3H), 6.49-6.48 (d,  $J=2.4$  Hz, 2H), 5.03-5.02 (d,  $J=2$  Hz, 1H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$

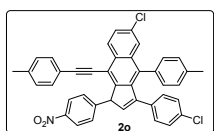
148.7, 145.4, 140.8, 139.6, 137.8, 136.3, 135.4, 132.9, 132.8, 132.7, 132.5, 132.1, 131.8, 131.7, 131.6, 131.5, 130.4, 130.3, 130.2, 128.2, 127.4, 126.5, 126.3, 126.3, 126.2, 125.8, 122.8, 122.0, 121.4, 120.4, 116.4, 98.4, 86.5, 54.4. IR (neat,  $\text{cm}^{-1}$ ): 3026, 1598, 1491, 1028, 760, 696. Anal. Calcd for  $\text{C}_{39}\text{H}_{23}\text{Br}_3$ : C, 64.05; H, 3.17. Found: C, 64.01; H, 3.23.



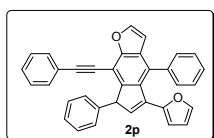
$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  8.50-8.48 (d,  $J=8.4$  Hz, 1H), 7.75-7.73 (d,  $J=8.4$  Hz, 1H), 7.60-7.56 (m, 3H), 7.46-7.36 (m, 8H), 7.15-7.00 (m, 5H), 7.00-6.89 (m, 4H), 6.47-6.46 (d,  $J=2.4$  Hz, 2H), 5.14-5.13 (d,  $J=2.4$  Hz, 1H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  148.0, 146.7, 145.1, 139.7, 139.0, 136.4, 133.9, 133.0, 132.3, 132.0, 131.3, 131.2, 129.4, 128.7, 128.5, 128.1, 127.4, 127.3, 127.2, 127.1, 127.0, 125.9, 123.0, 119.0, 116.6, 110.4, 99.5, 85.4, 54.8. IR (neat,  $\text{cm}^{-1}$ ): 2854, 1460, 1376, 1073, 757, 696. Anal. Calcd for  $\text{C}_{40}\text{H}_{25}\text{N}$ : C, 92.46; H, 4.85; N, 2.70. Found: C, 92.41; H, 4.81; N, 2.63.



$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  8.52-8.50 (d,  $J=8.4$  Hz, 1H), 8.18-8.16 (d,  $J=8.4$  Hz, 2H), 7.77-7.75 (m, 1H), 7.59-7.57 (m, 1H), 7.47-7.38 (m, 8H), 7.17-7.00 (m, 6H), 6.99-6.90 (m, 4H), 6.48-6.47 (d,  $J=2$  Hz, 2H), 5.19-5.18 (d,  $J=2$  Hz, 1H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  148.0, 147.3, 146.9, 146.9, 139.5, 138.9, 136.3, 134.0, 133.1, 132.0, 131.3, 131.2, 131.2, 129.4, 128.7, 128.5, 128.1, 127.4, 127.4, 127.3, 127.1, 127.0, 126.4, 125.9, 123.7, 123.0, 116.7, 99.5, 85.5, 54.5. IR (neat,  $\text{cm}^{-1}$ ): 2924, 1489, 1312, 1028, 803, 724. Anal. Calcd for  $\text{C}_{39}\text{H}_{25}\text{NO}_2$ : C, 86.80; H, 4.67; N, 2.60. Found: C, 86.72; H, 4.76; N, 2.52.

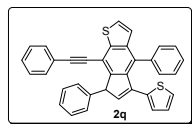


$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  8.42-8.41 (d,  $J=8.4$  Hz, 1H), 8.21-8.22 (m, 1H), 8.11-8.10 (d,  $J=1.2$  Hz, 1H), 7.76-7.61 (m, 1H), 7.61-7.40 (m, 1H), 7.35-7.34 (m, 4H), 7.24-7.22 (m, 1H), 7.18-7.16 (m, 4H), 6.99-6.92 (m, 5H), 6.89-6.77 (m, 3H), 6.50-6.49 (d,  $J=2.4$  Hz, 1H), 5.15-5.18 (d,  $J=2.4$  Hz, 1H), 2.40 (s, 3H), 2.38 (s, 3H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  148.4, 147.7, 145.7, 141.0, 140.1, 139.9, 139.2, 137.6, 134.7, 134.5, 134.2, 134.0, 133.0, 132.6, 132.4, 132.3, 131.2, 131.0, 130.9, 130.4, 129.4, 129.2, 129.1, 128.60, 128.3, 127.6, 127.0, 125.8, 123.8, 122.0, 119.5, 116.7, 100.3, 84.1, 54.4, 21.5, 21.1. IR (neat,  $\text{cm}^{-1}$ ): 2924, 1710, 1261, 1030, 802, 697. Anal. Calcd for  $\text{C}_{41}\text{H}_{27}\text{Cl}_2\text{NO}_2$ : C, 77.36; H, 4.28; N, 2.20. Found: C, 77.32; H, 4.21; N, 2.23.

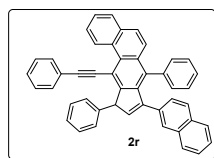


$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ , ppm): 7.34-7.28 (m, 14H), 7.23-7.18 (m, 4H), 7.00-6.98 (m, 1H), 6.67-6.66 (d,  $J=2.4$  Hz, 2H), 6.59-6.57 (m, 1H), 6.30-6.28 (m, 1H), 5.03-5.028 (d,  $J=2.4$  Hz, 1H);

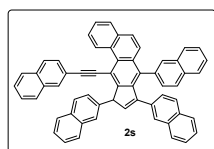
$^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  147.7, 142.2, 139.3, 138.1, 137.8, 137.4, 131.7, 131.6, 130.0, 130.0, 128.7, 128.5, 128.2, 127.4, 127.0, 126.8, 126.6, 125.9, 124.5, 123.8, 123.1, 113.4, 98.3, 85.1, 54.7. IR (neat,  $\text{cm}^{-1}$ ): 2922, 1489, 1260, 1094, 800, 694. Anal. Calcd for  $\text{C}_{35}\text{H}_{22}\text{O}_2$ : C, 88.58; H, 4.67. Found: C, 88.71; H, 4.69.



$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ , ppm): 7.365-7.25 (m, 14H), 7.22-7.18 (m, 4H), 6.99-6.98 (d,  $J=4.4$  Hz, 2H), 6.66-6.65 (d,  $J=2$  Hz, 2H), 6.58-6.56 (m, 1H), 6.29-6.28 (d,  $J=3.2$  Hz, 1H), 5.02-5.01 (d,  $J=2$  Hz, 1H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  147.6, 142.2, 140.7, 139.3, 138.1, 137.9, 137.8, 137.4, 131.7, 131.6, 131.6, 130.0, 128.7, 128.4, 128.2, 127.4, 126.9, 126.9, 126.8, 126.6, 125.9, 124.5, 123.8, 123.0, 113.4, 98.3, 85.1 54.7. IR (neat,  $\text{cm}^{-1}$ ): 2960, 1447, 1226, 1029, 862, 731. Anal. Calcd for  $\text{C}_{35}\text{H}_{22}\text{S}_2$ : C, 82.97; H, 4.38. Found: C, 82.89; H, 4.41.

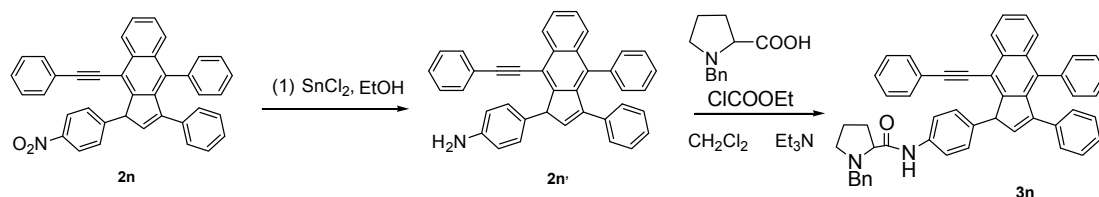


$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  8.60-8.58 (m, 1H), 7.88-7.86 (d,  $J=8.4$  Hz, 2H), 7.78-7.76 (d,  $J=8.4$  Hz, 2H), 7.67-7.66 (m, 1H), 7.48-7.33 (m, 16H), 7.27-7.26 (m, 1H), 7.17-7.16 (m, 1H), 7.07-7.06 (d,  $J=7.2$  Hz, 1H), 7.00-6.96 (m, 1H), 6.89 (s, 1H), 6.83-6.81 (m, 1H), 6.72 (s, 1H), 6.64 (s, 1H), 5.17-5.16 (d,  $J=1.6$  Hz, 1H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  149.2, 145.7, 142.4, 141.4, 140.0, 138.3, 135.7, 134.5, 133.7, 132.6, 132.1, 131.5, 128.6, 128.5, 128.3, 128.2, 127.7, 127.3, 126.9, 126.7, 126.7, 126.4, 125.6, 125.4, 125.3, 124.7, 124.4, 123.4, 117.2, 99.1, 86.2, 54.8. IR (neat,  $\text{cm}^{-1}$ ): 3079, 1598, 1491, 1073, 760, 696. Anal. Calcd for  $\text{C}_{47}\text{H}_{30}$ : C, 94.92; H, 5.08. Found: C, 94.96; H, 5.05.



$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  8.58-8.56 (d,  $J=8$  Hz, 1H), 8.05 (s, 1H), 7.87-7.77 (m, 7H), 7.69-7.62 (m, 1H), 7.60-7.40 (m, 16H), 7.40-7.25 (m, 2H), 6.90-6.87 (m, 2H), 6.62-6.57 (m, 4H), 5.34-5.33 (d,  $J=2$  Hz, 1H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  149.2, 145.6, 141.2, 136.4, 133.8, 132.9, 132.8, 132.7, 132.6, 132.3, 132.0, 131.4, 129.1, 128.3, 128.2, 127.9, 127.8, 127.8, 127.8, 127.7, 127.6, 127.7, 127.4, 126.9, 126.8, 126.8, 126.7, 126.6, 126.4, 126.1, 126.0, 126.0, 125.7, 125.65, 125.6, 125.5, 120.5, 116.7, 99.7, 85.9, 55.3. IR (neat,  $\text{cm}^{-1}$ ): 3058, 1642, 1449, 1028, 911, 760. Anal. Calcd for  $\text{C}_{47}\text{H}_{30}$ : C, 95.13; H, 4.87. Found: C, 95.02; H, 4.93.

## Typical Procedure for **3n** Synthesis and Characterization Data of **3n**



To a solution of **2n** (1.07 g 2 mmol) in  $\text{EtOH}$  (20 mL) was added 2eq  $\text{SnCl}_2$  at  $50^\circ\text{C}$ . When the reaction was considered complete as determined by TLC analysis, the reaction mixture was quenched by addition 20 %  $\text{NaOH}$  and diluted with ethyl ether (40 mL), washed with water, saturated brine, dried over  $\text{Na}_2\text{SO}_4$  and evaporated under reduced pressure. The residue was purified by chromatography on silica gel to afford corresponding compounds **2n'** (773 mg, yield 76 %).

1-benzyloxycarbonylpyrrolidine-2-carboxylic acid (307 mg, 1.5 mmol) was dissolved in  $\text{CH}_2\text{Cl}_2$  (10 ml) and cooled to  $-15^\circ\text{C}$ .  $\text{Et}_3\text{N}$  was added (151 mg, 1.5 mmol), followed by ethyl chloroformate (162 mg, 1.5 mmol). The suspension was stirred for 30 min, then the **2n'** (509 mg, 1 mmol) was added and stirring was continued for 6 h. the reaction mixture was quenched by addition of water and diluted with  $\text{CH}_2\text{Cl}_2$  (100 mL), washed with water, saturated brine, dried over  $\text{Na}_2\text{SO}_4$  and evaporated under reduced pressure. The residue was purified by chromatography on silica gel to afford corresponding compounds **3n** (591 mg, yield 85 %).

$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  9.40-9.38 (d,  $J=8.8$  Hz, 1H), 8.48-8.46 (d,  $J=8$  Hz, 1H), 7.69-7.67 (d,  $J=8.4$  Hz, 1H), 7.53-7.41 (m, 5H), 7.37-7.21 (m, 12H), 7.10-6.85 (m, 10H), 6.46-6.45 (d,  $J=2$  Hz, 1H), 5.06-5.05 (d,  $J=2$  Hz, 1H), 3.92-3.89 (m, 1H), 3.57-3.53 (m, 1H), 3.33-3.29 (m, 1H), 3.10-3.08 (m, 1H), 2.45-2.40 (m, 1H), 2.30-3.24 (m, 1H), 2.02-1.98 (m, 1H), 1.78-1.72 (m, 3H);  $^{13}\text{C}$  NMR (100 MHz,  $\text{CDCl}_3$ , ppm):  $\delta$  172.6, 149.4, 145.4, 141.5, 139.4, 138.5, 138.4, 136.9, 136.7, 136.4, 134.4, 133.3, 132.9, 132.0, 131.6, 131.58, 131.3, 131.2, 129.2, 128.7, 128.67, 128.3, 128.2, 127.5, 127.3, 126.8, 126.9, 126.0, 125.9, 119.5, 116.4, 99.3, 85.8, 68.0, 60.1, 54.5, 54.1, 30.8, 24.3. IR (neat,  $\text{cm}^{-1}$ ): 3062, 1708, 1592, 1076, 761, 732. Anal. Calcd for  $\text{C}_{51}\text{H}_{40}\text{N}_2\text{O}$ : C, 87.90; H, 5.79; N, 4.02. Found: C, 87.82; H, 5.76; N, 4.07.

## Crystallographic data of 1a

### Datablock: p-1

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Bond precision: C-C = 0.0120 Å Wavelength=0.71073

Cell: a=11.398(5) b=12.638(5) c=20.547(11)  
alpha=107.151(12) beta=96.768(12) gamma=103.674(8)

Temperature: 296 K

	Calculated	Reported
Volume	2691(2)	2691(2)
Space group	P -1	P-1
Hall group	-P 1	?
Moiety formula	C39 H26	?
Sum formula	C39 H26	C78 H52
Mr	494.60	989.20
Dx, g cm <sup>-3</sup>	1.221	1.221
Z	4	2
Mu (mm <sup>-1</sup> )	0.069	0.069
F000	1040.0	1040.0
F000'	1040.38	
h, k, lmax	13, 15, 24	13, 15, 24
Nref	10016	9828
Tmin, Tmax	0.976, 0.979	0.976, 0.979
Tmin'	0.976	
Correction method=	MULTI-SCAN	
Data completeness=	0.981	Theta(max)= 25.500
R(reflections)=	0.1369( 5522)	wR2(reflections)= 0.4315( 9828)
S =	1.052	Npar= 704

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PLATON version of 22/10/2010; check.def file version of 11/10/2010

Datablock p-1 - ellipsoid plot

