Electronic Supplementary Information

for

Pd-Catalyzed 1, 2-Diarylation of Vinylarenes at Ambient Temperature

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1. **General information.** $^1$H NMR and $^{13}$C NMR spectra were recorded at ambient temperature using 500 MHz spectrometers. The data are reported as follows: chemical shift in ppm from internal tetramethylsilane on the $\delta$ scale, multiplicity (br = broad, s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet), coupling constants (Hz) and integration. High-resolution mass spectra were obtained by peak matching. All reactions were carried out under an atmosphere of nitrogen in glassware, which had been oven-dried. All reagents and solvents were purchased from commercial suppliers and used without further purification. Unless otherwise stated, all experiments were conducted in a Schlenk tube under N$_2$ atmosphere. Reactions were monitored by TLC or GC-MS analysis. Flash column chromatography was performed over silica gel (200-300 mesh).
2. **Optimization of experimental conditions**

Table S1. Condition Screening.\(^{a}\)

<table>
<thead>
<tr>
<th>entry</th>
<th>base (2 equiv)</th>
<th>solvent (1 mL)</th>
<th>temp (°C)</th>
<th>GC yield (%)(^{b})</th>
</tr>
</thead>
<tbody>
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<td>1</td>
<td>Na(_2)CO(_3)</td>
<td>t-Amy-OH</td>
<td>60</td>
<td>59</td>
</tr>
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<td>K(_2)CO(_3)</td>
<td>t-Amy-OH</td>
<td>60</td>
<td>67</td>
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<tr>
<td>3</td>
<td>Cs(_2)CO(_3)</td>
<td>t-Amy-OH</td>
<td>60</td>
<td>70</td>
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<td>KF</td>
<td>t-Amy-OH</td>
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<td>5</td>
<td>NaOAc</td>
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<td>60</td>
<td>trace</td>
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<tr>
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<td>K(_3)PO(_4)</td>
<td>t-Amy-OH</td>
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<td>64</td>
</tr>
<tr>
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<td>59</td>
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<td>KH(_2)PO(_4)</td>
<td>t-Amy-OH</td>
<td>60</td>
<td>58</td>
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<td>9</td>
<td>CsF</td>
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<td>60</td>
<td>trace</td>
</tr>
<tr>
<td>10(^{c})</td>
<td>Cs(_2)CO(_3)</td>
<td>t-Amy-OH</td>
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<td>trace</td>
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</tr>
<tr>
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<td>Cs(_2)CO(_3)</td>
<td>EA</td>
<td>RT</td>
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\(^{a}\) Reaction conditions: all reactions were ran on 0.2 mmol scale with respect to 1\(a\).

\(^{b}\) Yields determined by GC, by utilizing dodecane as internal standard, figures in brackets represent separation yield. t-Amy-OH = tert-amyl alcohol. [c] under air.

**byproducts**
Table S1. Base screening.\(^a\)

<table>
<thead>
<tr>
<th>entry</th>
<th>1a (equiv)</th>
<th>2a (equiv)</th>
<th>Pd (equiv)</th>
<th>base (equiv)</th>
<th>solvent (1 mL)</th>
<th>temp (°C)</th>
<th>yield (%)(^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>1.0</td>
<td>1.5</td>
<td>0.05</td>
<td>Cs(_2)CO(_3) 2.0</td>
<td>t-Amy-OH</td>
<td>rt</td>
<td>81</td>
</tr>
<tr>
<td>22</td>
<td>1.0</td>
<td>1.1</td>
<td>0.05</td>
<td>Cs(_2)CO(_3) 2.0</td>
<td>t-Amy-OH</td>
<td>rt</td>
<td>64</td>
</tr>
<tr>
<td>23</td>
<td>1.0</td>
<td>1.2</td>
<td>0.05</td>
<td>Cs(_2)CO(_3) 2.0</td>
<td>t-Amy-OH</td>
<td>rt</td>
<td>80 (70)</td>
</tr>
<tr>
<td>24</td>
<td>1.0</td>
<td>1.2</td>
<td>0.05</td>
<td>Cs(_2)CO(_3) 1.5</td>
<td>t-Amy-OH</td>
<td>rt</td>
<td>73</td>
</tr>
<tr>
<td>25</td>
<td>1.0</td>
<td>1.2</td>
<td>0.05</td>
<td>Cs(_2)CO(_3) 1.2</td>
<td>t-Amy-OH</td>
<td>rt</td>
<td>77</td>
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<td>26</td>
<td>1.0</td>
<td>1.2</td>
<td>0.05</td>
<td>Cs(_2)CO(_3) 1.0</td>
<td>t-Amy-OH</td>
<td>rt</td>
<td>68</td>
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<tr>
<td>27</td>
<td>1.0</td>
<td>1.2</td>
<td>0.05</td>
<td>Li(_2)CO(_3) 1.2</td>
<td>t-Amy-OH</td>
<td>rt</td>
<td>92 (82)</td>
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<tr>
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<td>1.2</td>
<td>0.05</td>
<td>Li(_2)CO(_3) 1.2</td>
<td>t-Amy-OH</td>
<td>rt</td>
<td>88 (79)</td>
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<tr>
<td>29</td>
<td>1.0</td>
<td>1.2</td>
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<td>Li(_2)CO(_3) 1.2</td>
<td>t-Amy-OH</td>
<td>rt</td>
<td>84</td>
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<tr>
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<td>1.0</td>
<td>1.2</td>
<td>0.03</td>
<td>Li(_2)CO(_3) 1.2</td>
<td>t-Amy-OH</td>
<td>rt</td>
<td>70</td>
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<tr>
<td>31</td>
<td>1.0</td>
<td>1.2</td>
<td>0.01</td>
<td>Li(_2)CO(_3) 1.2</td>
<td>t-Amy-OH</td>
<td>rt</td>
<td>30</td>
</tr>
</tbody>
</table>

\(\text{[a]}\) Reaction conditions: all reactions were run on 0.2 mmol scale with respect to 1a. \(\text{[b]}\) Yields determined by GC by utilizing dodecane as internal standard, figures in brackets represent separation yield. t-Amy-OH = tert-amyl alcohol.

3. General procedure for 1,2-diaroylation of vinylnaphthalene derivatives.

To a 25 mL Schlenk tube, under a nitrogen atmosphere, was added 0.20 mmol of 2-vinylnaphthalene (1a) followed by 0.20 mmol of 4-fluorophenyl diazonium tetrafluoroborate (2a) (1.0 equiv), 0.24 mmol of p-tolylboronic acid (3a) (1.2 equiv), 0.01 mmol of Pd\(_2\)(dba)\(_3\) (0.05 equiv), 0.24 mmol of lithium carbonate (1.2 equiv), in 1.0 mL of t-Amy-OH. The Schlenk tube was sealed and stirred at rt. After 12 h, the reaction mixture was extracted water/Et\(_2\)O. Then the organic layers were dried with Na\(_2\)SO\(_4\), and concentrated to dryness. The crude product was purified by silica gel chromatography (silica gel, PE: EA = 120:1 – 80:1, v/v) to afford the product 4aaa as a slight yellow solid.
2-(2-(4-fluorophenyl)-1-(p-tolyl)ethyl)naphthalene (4aaa). The optimized procedure was followed by using 30.8 mg of 2-vinyl naphthalene (1a) (0.20 mmol), 42.0 mg of 4-fluorophenyl diazonium tetrafluoroborate (2a) (0.20 mmol), 36.5 mg of (4-methoxyphenyl) boronic acid (3b) (0.24 mmol), 9.2 mg of Pd$_2$(dba)$_3$ (0.01 mmol), 17.8 mg of lithium carbonate (0.24 mmol) and 1 mL of t-Amy-OH and stirred at rt. After 12 h, the reaction mixture was extracted water/EtOAc. Then the organic layers were dried with Na$_2$SO$_4$ and concentrated to dryness. The crude product was purified by silica gel chromatography (silica gel, PE: EtOAc = 100:1, v/v) to afford 56.2 mg of the product as a slightly yellow solid (82%). $^1$H NMR (500 MHz, CDCl$_3$) δ 7.78 (t, $J$ = 7.8 Hz, 2H), 7.74 (d, $J$ = 8.5 Hz, 1H), 7.65 (s, 1H), 7.48 – 7.41 (m, 2H), 7.31 (d, $J$ = 8.5 Hz, 1H), 7.14–7.09 (m, 2H), 6.85 (t, $J$ = 8.4 Hz, 2H), 6.81 (d, $J$ = 8.7 Hz, 2H), 6.30 (t, $J$ = 8.4 Hz, 2H), 6.27 (s, 3H). $^{13}$C NMR (125 MHz, CDCl$_3$) δ 161.2 (d, $J$ = 242.1 Hz), 158.0, 142.0, 136.1, 135.9 (d, $J$ = 3.2 Hz), 133.4, 132.1, 130.4 (d, $J$ = 7.7 Hz), 129.0, 128.0, 127.7, 127.5, 126.8, 125.9 (d, $J$ = 8.5 Hz), 125.4, 114.9, 114.7, 52.4, 41.2. $^{19}$F NMR (471 MHz, CDCl$_3$) δ -117.4. HRMS (EI) m/z: calcd for: C$_{25}$H$_{21}$FO: 340.1627; Found: 340.1633.

2-(2-(4-fluorophenyl)-1-(4-methoxyphenyl)ethyl) naphthalene (4aab). The optimized procedure was followed by using 30.8 mg of 2-vinyl naphthalene (1a) (0.20 mmol), 42.0 mg of 4-fluorophenyl diazonium tetrafluoroborate (2a) (0.20 mmol), 36.5 mg of (4-methoxyphenyl) boronic acid (3b) (0.24 mmol), 9.2 mg of Pd$_2$(dba)$_3$ (0.01 mmol), 17.8 mg of lithium carbonate (0.24 mmol) and 1 mL of t-Amy-OH and stirred at rt. After 12 h, the reaction mixture was extracted water/EtOAc. Then the organic layers were dried with Na$_2$SO$_4$ and concentrated to dryness. The crude product was purified by silica gel chromatography (silica gel, PE: EtOAc = 50:1, v/v) to afford 51.9 mg of the product as a bronzing oil (73%). $^1$H NMR (500 MHz, CDCl$_3$) δ 7.78 (t, $J$ = 7.8 Hz, 2H), 7.74 (d, $J$ = 8.5 Hz, 1H), 7.65 (s, 1H), 7.48 – 7.41 (m, 2H), 7.31 (d, $J$ = 8.5 Hz, 1H), 7.14–7.09 (m, 2H), 6.85 (t, $J$ = 8.4 Hz, 2H), 6.81 (d, $J$ = 8.7 Hz, 2H), 6.30 (t, $J$ = 8.4 Hz, 2H), 6.27 (s, 3H). $^{13}$C NMR (125 MHz, CDCl$_3$) δ 161.2 (d, $J$ = 242.1 Hz), 158.0, 142.0, 136.1, 135.9 (d, $J$ = 3.2 Hz), 133.4, 132.1, 130.4 (d, $J$ = 7.7 Hz), 129.0, 128.0, 127.7, 127.5, 126.8, 125.9 (d, $J$ = 8.5 Hz), 125.4, 114.9, 114.7, 52.4, 41.2. $^{19}$F NMR (471 MHz, CDCl$_3$) δ -117.4. HRMS (EI) m/z: calcd for: C$_{25}$H$_{21}$FO: 356.1576; Found: 356.1569.
2-(1-(4-chlorophenyl)-2-(4-fluorophenyl)ethyl)naphthalene (4aac). The optimized procedure was followed by using 30.8 mg of 2-vinyl naphthalene (1a) (0.20 mmol), 42.0 mg of 4-fluorophenyl diazonium tetrafluoroborate (2a) (0.20 mmol), 37.5 mg of (4-chlorophenyl)boronic acid (3c) (0.24 mmol), 9.2 mg of Pd₂dba₂ (0.01 mmol), 17.8 mg of lithium carbonate (0.24 mmol) and 1 mL of t-Amy-OH and stirred at rt. After 12 h, the reaction mixture was extracted water/EA. Then the organic layers were dried with Na₂SO₄, and concentrated to dryness. The crude product was purified by silica gel chromatography (silica gel, PE: EA = 80:1, v/v) to afford 51.9 mg of the product as a slight yellow solid (70%). ^1H NMR (500 MHz, CDCl₃) δ 7.79 (dd, J = 8.8, 7.9 Hz, 2H), 7.75 (d, J = 8.5 Hz, 1H), 7.65 (s, 1H), 7.50 – 7.43 (m, 2H), 7.28 (dd, J = 8.5, 1.4 Hz, 1H), 7.23 (d, J = 8.4 Hz, 2H), 7.14 (t, J = 7.5 Hz, 2H), 6.96 (dt, J = 8.1, 5.9 Hz, 2H), 6.87 (t, J = 8.7 Hz, 2H), 4.32 (t, J = 7.8 Hz, 1H), 3.46 (dd, J = 13.6, 7.4 Hz, 1H), 3.36 (dd, J = 13.6, 8.3 Hz, 1H). ^13C NMR (125 MHz, CDCl₃) δ 161.3 (d, J = 242.4 Hz), 142.5, 141.1, 135.4 (d, J = 3.2 Hz), 133.4, 132.2, 132.1, 130.4 (d, J = 7.8 Hz), 129.5, 128.5, 128.2, 127.7, 127.6, 126.6, 126.0 (d, J = 18.0 Hz), 125.7, 115.0, 114.9, 52.6, 41.0. ^19F NMR (471 MHz, CDCl₃) δ -117.0. HRMS (EI) m/z: calcd for: C₂₄H₁₈ClF: 360.1081; Found: 360.1085.

2-(2-(4-fluorophenyl)-1-(4-propylphenyl)ethyl)naphthalene (4aad). The optimized procedure was followed by using 30.8 mg of 2-vinyl naphthalene (1a) (0.20 mmol), 42.0 mg of 4-fluorophenyl diazonium tetrafluoroborate (2a) (0.20 mmol), 39.4 mg of (4-propylphenyl)boronic acid (3d) (0.24 mmol), 9.2 mg of Pd₂dba₂ (0.01 mmol), 17.8 mg of lithium carbonate (0.24 mmol) and 1 mL of t-Amy-OH and stirred at rt. After 12 h, the reaction mixture was extracted water/EA. Then the organic layers were dried with Na₂SO₄, and concentrated to dryness. The crude product was purified by silica gel chromatography (silica gel, PE: EA = 80:1, v/v) to afford 52.5 mg of the product as a slight yellow solid (71%). ^1H NMR (500 MHz, CDCl₃) δ 7.81 (t, J = 7.5 Hz, 2H), 7.77 (d, J = 8.6 Hz, 1H), 7.68 (s, 1H), 7.50 – 7.43 (m, 2H), 7.37 (d, J = 8.5 Hz, 1H), 7.19 (d, J = 7.5 Hz, 2H), 7.12 (d, J = 7.3 Hz, 2H), 7.02 – 6.96 (m, 2H), 6.88 (t, J = 8.2 Hz, 2H), 4.35 (t, J = 7.8 Hz, 1H), 3.52 – 3.40 (m, 2H), 2.58 (t, J = 7.6 Hz, 2H), 1.70 – 1.61 (m, 2H), 0.97 (t, J = 7.3 Hz, 3H). ^13C NMR (125 MHz, CDCl₃) δ 161.2 (d, J = 242.0 Hz), 141.8, 141.3, 140.6, 135.9 (d, J = 3.1 Hz), 133.4, 132.1, 130.4 (d, J = 7.8 Hz), 128.5, 128.0, 127.8, 127.7, 127.5, 126.8, 126.0 (d, J = 23.4 Hz), 125.4, 114.9, 114.7, 52.9, 41.1, 37.6, 24.5, 13.8. ^19F NMR (471 MHz, CDCl₃) δ -117.5. HRMS (EI) m/z: calcd for: C₂₇H₂₅F: 368.1940; Found: 368.1937.
2-(1-(3,5-dimethylphenyl)-2-(4-fluorophenyl)ethyl)naphthalene (4aae). The optimized procedure was followed by using 30.8 mg of 2-vinylnaphthalene (1a) (0.20 mmol), 42.0 mg of 4-fluorophenyldiazonium tetrafluoroborate (2a) (0.20 mmol), 39.4 mg of (3, 5-dimethylphenyl)boronic acid (3e) (0.24 mmol), 9.2 mg of Pd₂dba₃ (0.01 mmol), 17.8 mg of lithium carbonate (0.24 mmol) and 1 mL of t-Amy-OH and stirred at rt. After 12 h, the reaction mixture was extracted water/EA. Then the organic layers were dried with Na₂SO₄, and concentrated to dryness. The crude product was purified by silica gel chromatography (silica gel, PE: EA = 100:1, v/v) to afford 54.4 mg of the product as a yellow oil (77%). ¹H NMR (500 MHz, CDCl₃) δ 7.78 (dd, J = 8.8, 7.1 Hz, 2H), 7.74 (d, J = 8.5 Hz, 1H), 7.64 (s, 1H), 7.48–7.41 (m, 2H), 7.34 (dd, J = 8.5, 1.7 Hz, 1H), 7.01 – 6.95 (m, 2H), 6.89 (s, 2H), 6.85 (dd, J = 11.9, 5.5 Hz, 3H), 4.28 (t, J = 7.8 Hz, 1H), 3.48–3.39 (m, 2H), 2.28 (s, 6H). ¹³C NMR (125 MHz, CDCl₃) δ 161.2 (d, J = 242.0 Hz), 144.1, 141.7, 137.8, 136.0 (d, J = 3.2 Hz), 133.4, 132.1, 130.4 (d, J = 7.8 Hz), 128.0 (d, J = 6.4 Hz), 127.7, 127.5, 126.8, 126.2, 125.9, 125.4, 114.9, 114.7, 53.2, 41.1, 21.4. ¹⁹F NMR (471 MHz, CDCl₃) δ -117.6. HRMS (EI) m/z: calcd for: C₂₆H₂₃F: 354.1784; Found: 354.1790.

2-(1-(2-bromophenyl)-2-(4-fluorophenyl)ethyl)naphthalene (4aaf). The optimized procedure was followed by using 30.8 mg of 2-vinylnaphthalene (1a) (0.20 mmol), 42.0 mg of 4-fluorophenyldiazonium tetrafluoroborate (2a) (0.20 mmol), 48.0 mg of (2-bromophenyl)boronic acid (3f) (0.24 mmol), 9.2 mg of Pd₂dba₃ (0.01 mmol), 17.8 mg of lithium carbonate (0.24 mmol) and 1 mL of t-Amy-OH and stirred at rt. After 12 h, the reaction mixture was extracted water/EA. Then the organic layers were dried with Na₂SO₄, and concentrated to dryness. The crude product was purified by silica gel chromatography (silica gel, PE: EA = 100:1, v/v) to afford 54.4 mg of the product as a slight bronzing solid (62%). ¹H NMR (500 MHz, CDCl₃) δ 7.80 (dd, J = 7.9, 6.6 Hz, 2H), 7.76 (d, J = 8.5 Hz, 1H), 7.72 (s, 1H), 7.55 (dd, J = 8.0, 1.1 Hz, 1H), 7.50–7.43 (m, 2H), 7.41 (dd, J = 7.8, 1.5 Hz, 1H), 7.36 (dd, J = 8.5, 1.7 Hz, 1H), 7.32–7.27 (m, 1H), 7.07 (dd, J = 11.1, 5.5 Hz, 3H), 6.92–6.85 (m, 2H), 4.99 (t, J = 7.8 Hz, 1H), 3.43 (qd, J = 13.9, 7.8 Hz, 2H). ¹³C NMR (125 MHz, CDCl₃) δ 161.3 (d, J = 242.4 Hz), 143.1, 139.9, 135.2 (d, J = 3.2 Hz), 133.3, 133.0, 132.2, 130.4 (d, J = 7.8 Hz), 129.2, 127.9 (d, J = 4.5 Hz), 127.8, 127.6 (d, J = 1.4 Hz), 127.1, 126.6, 126.0, 125.6, 125.3, 115.0, 114.8, 51.0, 40.7. ¹⁹F NMR (471 MHz, CDCl₃) δ -117.1. HRMS (EI) m/z: calcd for: C₂₄H₁₈BrF: 404.0576; Found: 404.0580.
The optimized procedure was followed by using 30.8 mg of 2-vinlnaphthalene (1a) (0.20 mmol), 42.0 mg of 4-fluorophenyl diazonium tetrafluoroborate (2a) (0.20 mmol), 32.6 mg of (2-tolylphenyl)boronic acid (3g) (0.24 mmol), 9.2 mg of Pd₂(dba)₃ (0.01 mmol), 17.8 mg of lithium carbonate (0.24 mmol) and 1 mL of t-Amy-OH and stirred at rt. After 12 h, the reaction mixture was extracted water/EA. Then the organic layers were dried with Na₂SO₄, and concentrated to dryness. The crude product was purified by silica gel chromatography (silica gel, PE: EA = 100:1, v/v) to afford 54.4 mg of the product as a yellow solid (76%). ¹H NMR (500 MHz, CDCl₃) δ 7.79 – 7.76 (m, 1H), 7.74 – 7.71 (m, 1H), 7.70 (d, J = 8.5 Hz, 1H), 7.54 (s, 1H), 7.46 – 7.40 (m, 3H), 7.22 (ddd, J = 9.6, 8.5, 4.5 Hz, 2H), 7.14 (td, J = 7.4, 1.2 Hz, 1H), 7.09 (d, J = 6.7 Hz, 1H), 6.96 – 6.90 (m, 2H), 6.85 (t, J = 8.7 Hz, 2H), 4.52 (t, J = 7.7 Hz, 1H), 3.45 – 3.36 (m, 2H), 2.14 (s, 3H). ¹³C NMR (125 MHz, CDCl₃) δ 161.3 (d, J = 241.1 Hz), 142.1, 141.1, 136.4, 135.9 (d, J = 3.2 Hz), 133.3, 132.0, 130.5 (d, J = 2.5 Hz), 130.4, 127.8, 127.7, 127.5, 127.1 (d, J = 5.2 Hz), 126.4, 126.3, 126.1, 125.9, 125.4, 114.9, 114.7, 48.9, 41.5, 19.8. ¹⁹F NMR (471 MHz, CDCl₃) δ -117.3. HRMS (EI) m/z: calcd for: C₂₅H₂₁F: 340.1627; Found: 340.1614.

2-(2-(4-fluorophenyl)-1-phenylethyl)naphthalene (4aah). The optimized procedure was followed by using 30.8 mg of 2-vinlnaphthalene (1a) (0.20 mmol), 42.0 mg of 4-fluorophenyl diazonium tetrafluoroborate (2a) (0.20 mmol), 29.3 mg of boronic acid (3h) (0.24 mmol), 9.2 mg of Pd₂(dba)₃ (0.01 mmol), 17.8 mg of lithium carbonate (0.24 mmol) and 1 mL of t-Amy-OH and stirred at rt. After 12 h, the reaction mixture was extracted water/EA. Then the organic layers were dried with Na₂SO₄, and concentrated to dryness. The crude product was purified by silica gel chromatography (silica gel, PE: EA = 100:1, v/v) to afford 44.5 mg of the product as a yellow oil (68%). ¹H NMR (500 MHz, CDCl₃) δ 7.81 (t, J = 7.3 Hz, 2H), 7.77 (d, J = 8.5 Hz, 1H), 7.69 (s, 1H), 7.50 – 7.43 (m, 2H), 7.35 (dd, J = 8.5, 1.6 Hz, 1H), 7.32 – 7.28 (m, 2H), 7.27 (dd, J = 6.6, 1.2 Hz, 2H), 7.24 – 7.19 (m, 1H), 7.02 – 6.96 (m, 2H), 6.87 (dd, J = 12.1, 5.2 Hz, 2H), 4.38 (t, J = 7.8 Hz, 1H), 3.47 (qd, J = 13.7, 7.9 Hz, 2H). ¹³C NMR (125 MHz, CDCl₃) δ 161.6 (d, J = 242.3 Hz), 144.0, 141.6, 135.8 (d, J = 3.2 Hz), 133.4, 132.1, 130.4 (d, J = 7.8 Hz), 128.4, 128.1, 128.0, 127.7, 127.5, 126.8, 126.3, 126.0 (d, J = 12.9 Hz), 125.5, 114.9, 114.7, 53.3, 41.0. ¹⁹F NMR (471 MHz, CDCl₃) δ -117.4. HRMS (EI) m/z: calcd for: C₂₅H₂₁F: 326.1471; Found: 326.1459.
2-(2-(4-fluorophenyl)-1-(4-(trifluoromethyl)phenyl)ethyl)naphthalene (4aai). The optimized procedure was followed by using 30.8 mg of 2-vinyl naphthalene (1a) (0.20 mmol), 42.0 mg of 4-fluorophenyl diazonium tetrafluoroborate (2a) (0.20 mmol), 45.6 mg of (4-(trifluoromethyl)phenyl)boronic acid (3i) (0.24 mmol), 9.2 mg of Pd\textsubscript{2}(dba)\textsubscript{3} (0.01 mmol), 17.8 mg of lithium carbonate (0.24 mmol) and 1 mL of t-Amy-OH and stirred at rt. After 12 h, the reaction mixture was extracted water/Et\textsubscript{2}O. Then the organic layers were dried with Na\textsubscript{2}SO\textsubscript{4}, and concentrated to dryness. The crude product was purified by silica gel chromatography (silica gel, PE: EA = 80:1, v/v) to afford 49.5 mg of the product as a bronzing solid (63%). \textsuperscript{1}H NMR (500 MHz, CDCl\textsubscript{3}) \(\delta\) 7.83 (ddd, \(J = 15.3, 9.3, 5.2\) Hz, 2H), 7.77 (d, \(J = 8.6\) Hz, 1H), 7.68 (s, 1H), 7.51 (dd, \(J = 8.4, 1.8\) Hz, 1H), 7.00 – 6.95 (m, 2H), 6.91 – 6.84 (m, 2H), 4.41 (t, \(J = 7.8\) Hz, 1H), 3.51 (dd, \(J = 13.7, 7.6\) Hz, 1H), 3.41 (dd, \(J = 13.7, 8.1\) Hz, 1H). \textsuperscript{13}C NMR (125 MHz, CDCl\textsubscript{3}) \(\delta\) 161.3 (d, \(J = 242.9\) Hz), 148.1, 140.5, 135.1 (d, \(J = 3.3\) Hz), 133.4, 132.3, 130.4 (d, \(J = 7.9\) Hz), 128.4, 128.3, 127.7, 127.6, 126.5, 126.2 (d, \(J = 5.7\) Hz), 125.8, 125.3 (q, \(J = 3.7\) Hz), 115.1, 115.0, 53.1, 40.8. \textsuperscript{19}F NMR (471 MHz, CDCl\textsubscript{3}) \(\delta\) -62.3, -116.9. HRMS, m/z: calcd for: C\textsubscript{25}H\textsubscript{18}F\textsubscript{4}: 394.1345; Found: 394.1335.

2-(1,2-bis(4-fluorophenyl)ethyl)naphthalene (4aaj). The optimized procedure was followed by using 30.8 mg of 2-vinyl naphthalene (1a) (0.20 mmol), 42.0 mg of 4-fluorophenyl diazonium tetrafluoroborate (2a) (0.20 mmol), 33.6 mg of (4-fluorophenyl)boronic acid (3j) (0.24 mmol), 9.2 mg of Pd\textsubscript{2}(dba)\textsubscript{3} (0.01 mmol), 17.8 mg of lithium carbonate (0.24 mmol) and 1 mL of t-Amy-OH and stirred at rt. After 12 h, the reaction mixture was extracted water/EA. Then the organic layers were dried with Na\textsubscript{2}SO\textsubscript{4}, and concentrated to dryness. The crude product was purified by silica gel chromatography (silica gel, PE: EA = 100:1, v/v) to afford 55.1 mg of the product as a yellow solid (80%). \textsuperscript{1}H NMR (500 MHz, CDCl\textsubscript{3}) \(\delta\) 7.79 (t, \(J = 7.7\) Hz, 2H), 7.75 (d, \(J = 8.6\) Hz, 1H), 7.66 (s, 1H), 7.46 (p, \(J = 6.9\) Hz, 2H), 7.30 (d, \(J = 8.5\) Hz, 1H), 7.16 (dd, \(J = 7.2, 5.5\) Hz, 2H), 7.00 – 6.91 (m, 4H), 6.96 – 6.83 (m, 2H), 4.33 (t, \(J = 7.8\) Hz, 1H), 3.46 (dd, \(J = 13.6, 7.4\) Hz, 1H), 3.37 (dd, \(J = 13.6, 8.2\) Hz, 1H). \textsuperscript{13}C NMR (125 MHz, CDCl\textsubscript{3}) \(\delta\) 161.4 (d, \(J = 251.6\) Hz), 161.4 (d, \(J = 233.9\) Hz), 148.1, 141.4, 139.7 (d, \(J = 3.2\) Hz), 135.6 (d, \(J = 3.1\) Hz), 133.4, 132.2, 130.4 (d, \(J = 7.9\) Hz), 129.5 (d, \(J = 7.8\) Hz), 128.1, 127.7 (d, \(J = 19.2\) Hz), 126.7, 126.0 (d, \(J = 18.4\) Hz), 125.6, 115.3, 115.1, 115.0, 114.8, 53.1, 40.8. \textsuperscript{19}F NMR (471 MHz, CDCl\textsubscript{3}) \(\delta\) -116.7, -117.2. HRMS (EI) m/z: calcd for: C\textsubscript{24}H\textsubscript{18}F\textsubscript{2}: 344.1377; Found: 344.1385.
2-(1-(4-(tert-butyl)phenyl)-2-(4-fluorophenyl)ethyl)naphthalene (4aak). The optimized procedure was followed by using 30.8 mg of 2-vinylnaphthalene (1a) (0.20 mmol), 42.0 mg of 4-fluorophenyl diazonium tetrafluoroborate (2a) (0.20 mmol), 42.7 mg of (4-(tert-butyl)phenyl)boronic acid (3k) (0.24 mmol), 9.2 mg of Pd$_2$(dba)$_3$ (0.01 mmol), 17.8 mg of lithium carbonate (0.24 mmol) and 1 mL of t-Amy-OH and stirred at rt. After 12 h, the reaction mixture was extracted water/EA. Then the organic layers were dried with Na$_2$SO$_4$, and concentrated to dryness. The crude product was purified by silica gel chromatography (silica gel, PE: EA = 100:1, v/v) to afford 66.5 mg of the product as a slight yellow solid (87%). $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 7.76 (dd, $J_{ab} = 19.9, 9.8$ Hz, 3H), 7.63 (s, 1H), 7.47–7.40 (m, 2H), 7.34 (d, $J_{ab} = 8.5$ Hz, 1H), 7.32–7.28 (m, 2H), 7.21 (d, $J = 8.2$ Hz, 2H), 6.99–6.94 (m, 2H), 6.84 (t, $J = 8.7$ Hz, 2H), 4.33 (t, $J = 7.7$ Hz, 1H), 3.44 (d, $J = 7.8$ Hz, 2H), 1.30 (s, 9H). $^{13}$C NMR (125 MHz, CDCl$_3$) $\delta$ 161.2 (d, $J_{ab} = 241.9$ Hz), 149.1, 141.6, 141.1, 136.0 (d, $J_{ab} = 3.2$ Hz), 133.4, 132.1, 130.4 (d, $J_{ab} = 7.8$ Hz), 128.0, 127.7, 127.5, 126.8, 126.3, 125.9, 125.4, 125.3, 114.9, 114.7, 52.9, 41.1, 34.3, 31.3. $^{19}$F NMR (471 MHz, CDCl$_3$) $\delta$ -117.5. HRMS (EI) $m/z$: calcd for: C$_{28}$H$_{27}$F: 382.2097; Found: 382.2106.

ethyl 4-(2-(4-fluorophenyl)-1-(naphthalen-2-yl)ethyl)benzoate (4aal). The optimized procedure was followed by using 30.8 mg of 2-vinylnaphthalene (1a) (0.20 mmol), 42.0 mg of 4-fluorophenyl diazonium tetrafluoroborate (2a) (0.20 mmol), 46.6 mg of (4-ethoxycarbonyl)phenylboronic acid (3l) (0.24 mmol), 9.2 mg of Pd$_2$(dba)$_3$ (0.01 mmol), 17.8 mg of lithium carbonate (0.24 mmol) and 1 mL of t-Amy-OH and stirred at rt. After 12 h, the reaction mixture was extracted water/EA. Then the organic layers were dried with Na$_2$SO$_4$, and concentrated to dryness. The crude product was purified by silica gel chromatography (silica gel, PE: EA = 100:1, v/v) to afford 43.1 mg of the product as a yellow solid (54%). $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 7.95 (d, $J = 7.3$ Hz, 2H), 7.79 (t, $J = 7.2$ Hz, 2H), 7.75 (d, $J = 8.5$ Hz, 1H), 7.68 (s, 1H), 7.50–7.43 (m, 2H), 7.29 (d, $J = 7.3$ Hz, 3H), 6.97 (dd, $J = 8.2, 5.6$ Hz, 2H), 6.86 (t, $J = 8.4$ Hz, 2H), 4.41 (t, $J = 7.8$ Hz, 1H), 4.36 (q, $J = 6.8$ Hz, 2H), 3.50 (dd, $J = 13.7, 7.4$ Hz, 1H), 3.42 (dd, $J = 13.7, 8.3$ Hz, 1H), 1.38 (t, $J = 7.1$ Hz, 3H). $^{13}$C NMR (125 MHz, CDCl$_3$) $\delta$ 166.4, 161.3 (d, $J = 242.6$ Hz), 149.1, 140.8, 135.3 (d, $J = 3.2$ Hz), 133.4, 132.2, 130.4 (d, $J = 7.8$ Hz), 129.7, 128.7, 128.2 (d, $J = 4.9$ Hz), 127.7, 127.6, 126.6, 126.1 (d, $J = 2.8$ Hz), 125.7, 115.0, 114.9, 60.8,
$^{19}$F NMR (471 MHz, CDCl$_3$) $\delta$ -117.0. HRMS (EI) m/z: calcld for: C$_{27}$H$_{23}$FO$_2$: 398.1682; Found: 398.1680.

2,2'-(2-(p-tolyl)ethane-1,1-diyl)dinaphthalene (4abm). The optimized procedure was followed by using 30.8 mg of 2-vinylnaphthalene (1a) (0.20 mmol), 41.2 mg of 4-tolyl diazonium tetrafluoroborate (2b) (0.20 mmol), 41.3 mg of naphthalen-2-ylboronic acid (3m) (0.24 mmol), 9.2 mg of Pd$_2$(dba)$_3$ (0.01 mmol), 17.8 mg of lithium carbonate (0.24 mmol) and 1 mL of $t$-Amy-OH and stirred at rt. After 12 h, the reaction mixture was extracted water/EtOAC. Then the organic layers were dried with Na$_2$SO$_4$, and concentrated to dryness. The crude product was purified by silica gel chromatography (silica gel, PE: EtOAC = 100:0, v/v) to afford 38.9 mg of the product as a colourless solid (52%). $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 7.78 (dd, $J$ = 7.6, 1.7 Hz, 4H), 7.74 – 7.71 (m, 4H), 7.47 – 7.40 (m, 4H), 7.38 (dd, $J$ = 8.6, 1.6 Hz, 2H), 6.97 (s, 4H), 4.57 (t, $J$ = 7.7 Hz, 1H), 3.55 (d, $J$ = 7.7 Hz, 2H), 2.25 (s, 3H). $^{13}$C NMR (125 MHz, CDCl$_3$) $\delta$ 141.9, 137.0, 135.3, 133.4, 132.1, 128.9, 128.0, 127.8, 127.5, 127.0, 126.2, 125.9, 125.4, 53.1, 41.3, 21.0. HRMS (EI) m/z: calcld for: C$_{29}$H$_{24}$O: 372.1878; Found: 372.1951.

(E)-2-(4-phenyl-1-(p-tolyl)but-3-en-2-yl)naphthalene (4abn). The optimized procedure was followed by using 30.8 mg of 2-vinylnaphthalene (1a) (0.20 mmol), 41.2 mg of 4-tolyl diazonium tetrafluoroborate (2b) (0.20 mmol), 35.5 mg of (E)-styrylboronic acid (3n) (0.24 mmol), 9.2 mg of Pd$_2$(dba)$_3$ (0.01 mmol), 17.8 mg of lithium carbonate (0.24 mmol) and 1 mL of $t$-Amy-OH and stirred at rt. After 12 h, the reaction mixture was extracted water/EtOAC. Then the organic layers were dried with Na$_2$SO$_4$, and concentrated to dryness. The crude product was purified by silica gel chromatography (silica gel, PE: EtOAC = 100:0, v/v) to afford 32.1 mg of the product as a colourless solid (46%). $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 7.80 (dd, $J$ = 16.3, 7.8 Hz, 3H), 7.66 (s, 1H), 7.48 – 7.43 (m, 2H), 7.41 (d, $J$ = 8.4 Hz, 1H), 7.30 (dd, $J$ = 16.3, 7.3 Hz, 4H), 7.19 (t, $J$ = 7.1 Hz, 1H), 7.02 (s, 4H), 6.50 (dd, $J$ = 15.9, 7.3 Hz, 1H), 6.33 (d, $J$ = 15.9 Hz, 1H), 3.90 (q, $J$ = 7.4 Hz, 1H), 3.20 (d, $J$ = 7.4 Hz, 2H), 2.28 (s, 3H). $^{13}$C NMR (125 MHz, CDCl$_3$) $\delta$ 141.3, 137.5, 136.8, 135.4, 133.6, 133.4, 132.3, 130.2, 129.1, 128.9, 128.5, 128.0, 127.7, 127.6, 127.1, 126.6, 126.2, 126.2, 125.9, 125.4, 51.0, 42.1, 21.0. HRMS (EI) m/z: calcld for: C$_{29}$H$_{24}$O: 348.1878; Found: 348.1951.
4-(1-(naphthalen-2-yl)-2-(p-tolyl)ethyl)dibenzo[b,d]furan(4abo). The optimized procedure was followed by using 30.8 mg of 2-vinylnaphthalene (1a) (0.20 mmol), 41.2 mg of 4-tolyl diazonium tetrafluoroborate (2b) (0.20 mmol), 50.9 mg of dibenzo[b,d]furan-4-ylboronic acid (3o) (0.24 mmol), 9.2 mg of Pd$_2$(dba)$_3$ (0.01 mmol), 17.8 mg of lithium carbonate (0.24 mmol) and 1 mL of t-Amy-OH and stirred at rt. After 12 h, the reaction mixture was extracted with water/EA. Then the organic layers were dried with Na$_2$SO$_4$, and concentrated to dryness. The crude product was purified by silica gel chromatography (silica gel, PE: EA = 100:1, v/v) to afford 37.9 mg of the product as a colourless solid (46%). $^1$H NMR (500 MHz, CDCl$_3$) δ 7.92 (d, $J$ = 7.6 Hz, 1H), 7.85 (s, 1H), 7.81 – 7.73 (m, 4H), 7.60 – 7.54 (m, 2H), 7.42 (dqd, $J$ = 13.9, 6.8, 1.1 Hz, 4H), 7.31 (dt, $J$ = 15.1, 7.5 Hz, 2H), 7.06 (d, $J$ = 7.9 Hz, 2H), 6.96 (d, $J$ = 7.9 Hz, 2H), 5.11 (t, $J$ = 7.8 Hz, 1H), 3.69 (dd, $J$ = 14.0, 7.5 Hz, 1H), 3.63 (dd, $J$ = 14.0, 8.2 Hz, 1H), 2.23 (s, 3H). $^{13}$C NMR (125 MHz, CDCl$_3$) δ 156.0, 154.2, 140.8, 137.0, 135.3, 133.4, 132.2, 128.8, 128.8, 128.7, 128.5, 127.8, 127.5, 126.9, 126.9, 126.5, 125.9, 125.9, 125.4, 124.5, 124.1, 122.8, 122.5, 120.6, 118.6, 111.7, 47.3, 40.4, 21.0. HRMS (EI) m/z: calcd for: C$_{31}$H$_{24}$O: 412.1827; Found: 412.1900.

2-(2-(3-bromophenyl)-1-(p-tolyl)ethyl)naphthalene (4aca). The optimized procedure was followed by using 30.8 mg of 2-vinylnaphthalene (1a) (0.20 mmol), 59.8 mg of 3-bromophenyldiazonium tetrafluoroborate (2c) (0.20 mmol), 32.6 mg of p-tolylboronic acid (3a) (0.24 mmol), 9.2 mg of Pd$_2$(dba)$_3$ (0.01 mmol), 17.8 mg of lithium carbonate (0.24 mmol) and 1 mL of t-Amy-OH and stirred at rt. After 12 h, the reaction mixture was extracted with water/EA. Then the organic layers were dried with Na$_2$SO$_4$, and concentrated to dryness. The crude product was purified by silica gel chromatography (silica gel, PE: EA = 100:1, v/v) to afford 58.6 mg of the product as a brown oil (73%). $^1$H NMR (500 MHz, CDCl$_3$) δ 7.80 – 7.76 (m, 2H), 7.74 (d, $J$ = 7.6 Hz, 1H), 7.66 (s, 1H), 7.47 – 7.41 (m, 2H), 7.32 (dd, $J$ = 8.5, 1.8 Hz, 1H), 7.26 (d, $J$ = 7.0 Hz, 2H), 7.13 (d, $J$ = 8.1 Hz, 2H), 7.08 (d, $J$ = 8.0 Hz, 2H), 7.00 (t, $J$ = 8.0 Hz, 1H), 6.91 (d, $J$ = 7.6 Hz, 1H), 4.35 (t, $J$ = 7.8 Hz, 1H), 3.42 (qd, $J$ = 13.7, 7.9 Hz, 2H), 2.30 (s, 3H). $^{13}$C NMR (125 MHz, CDCl$_3$) δ 142.6, 141.6, 140.8, 135.9, 133.4, 132.1, 132.0, 129.6, 129.1, 129.0, 128.0, 127.9, 127.7, 127.5, 126.7, 125.9, 125.9, 125.4, 122.10, 52.4, 41.5, 21.0. HRMS (EI) m/z: calcd for: C$_{25}$H$_{21}$Br: 400.0827; Found: 400.0824.
2-(2-(2-fluorophenyl)-1-(p-tolyl)ethyl)naphthalene (4ada). The optimized procedure was followed by using 30.8 mg of 2-vinylnaphthalene (1a) (0.20 mmol), 42.0 mg of 2-fluorophenylidiazonium tetrafluoroborate (2d) (0.20 mmol), 32.6 mg of p-tolyboronic acid (3a) (0.24 mmol), 9.2 mg of Pd_2(dba)_3 (0.01 mmol), 17.8 mg of lithium carbonate (0.24 mmol) and 1 mL of t-Amy-OH and stirred at rt. After 12 h, the reaction mixture was extracted water/EA. Then the organic layers were dried with Na_2SO_4, and concentrated to dryness. The crude product was purified by silica gel chromatography (silica gel, PE: EA = 100:1, v/v) to afford 38.2 mg of the product as a yellow oil (57%). ^1H NMR (500 MHz, CDCl_3) δ 7.80 – 7.75 (m, 2H), 7.74 (d, J = 8.5 Hz, 1H), 7.69 (s, 1H), 7.47 – 7.40 (m, 2H), 7.36 (dd, J = 8.5, 1.8 Hz, 1H), 7.17 (d, J = 8.1 Hz, 2H), 7.13 – 7.06 (m, 3H), 6.96 (td, J = 9.3, 2.5 Hz, 2H), 6.88 (td, J = 7.5, 1.1 Hz, 1H), 4.47 (t, J = 7.9 Hz, 1H), 3.55 – 3.43 (m, 2H), 2.31 (s, 3H). ^13C NMR (125 MHz, CDCl_3) δ 161.2 (d, J = 243.1 Hz), 141.8, 141.0, 135.8, 133.4, 132.1, 131.2 (d, J = 4.9 Hz), 129.0, 127.9 (d, J = 2.1 Hz), 127.6 (d, J = 28.8 Hz), 127.6 (d, J = 8.1 Hz), 127.0 (d, J = 15.3 Hz), 126.8, 126.0, 125.8, 125.3, 123.6 (d, J = 3.5 Hz), 115.1, 114.9, 51.1, 35.0, 21.0. ^19F NMR (471 MHz, CDCl_3) δ -118.1. HRMS (EI) m/z: calcd for: C_{25}H_{21}F: 340.1627; Found: 340.1634.

2-(2-(3-fluorophenyl)-1-(p-tolyl)ethyl)naphthalene (4aea). The optimized procedure was followed by using 30.8 mg of 2-vinylnaphthalene (1a) (0.20 mmol), 42.0 mg of 3-fluorophenylidiazonium tetrafluoroborate (2e) (0.20 mmol), 32.6 mg of p-tolyboronic acid (3a) (0.24 mmol), 9.2 mg of Pd_2(dba)_3 (0.01 mmol), 17.8 mg of lithium carbonate (0.24 mmol) and 1 mL of t-Amy-OH and stirred at rt. After 12 h, the reaction mixture was extracted water/EA. Then the organic layers were dried with Na_2SO_4, and concentrated to dryness. The crude product was purified by silica gel chromatography (silica gel, PE: EA = 100:1, v/v) to afford 45.1 mg of the product as a yellow oil (67%). ^1H NMR (500 MHz, CDCl_3) δ 7.78 (t, J = 7.1 Hz, 2H), 7.74 (d, J = 8.5 Hz, 1H), 7.67 (s, 1H), 7.48 – 7.41 (m, 2H), 7.34 (dd, J = 8.5, 1.8 Hz, 1H), 7.18 – 7.11 (m, 3H), 7.09 (d, J = 8.0 Hz, 2H), 7.00 – 6.82 (m, 2H), 6.81 – 6.77 (m, 1H), 4.38 (t, J = 7.8 Hz, 1H), 3.47 (qd, J = 13.7, 7.8 Hz, 2H), 2.31 (s, 3H). ^13C NMR (125 MHz, CDCl_3) δ 162.6 (d, J = 243.5 Hz), 142.9 (d, J = 7.3 Hz), 141.7, 140.9, 135.9, 133.4, 132.1, 129.4 (d, J = 8.4 Hz), 129.1, 128.0, 127.9, 127.7, 127.5, 126.7, 125.9 (d, J = 2.9 Hz), 125.4, 124.7 (d, J = 2.7 Hz), 115.9, 115.7, 112.9, 112.7, 52.4, 41.6, 21.0. ^19F NMR (471 MHz, CDCl_3) δ -113.9. HRMS (EI) m/z: calcd for: C_{25}H_{21}F: 340.1627; Found: 340.1626.
2-(2-(4-chlorophenyl)-1-(p-tolyl)ethyl)naphthalene (4afa). The optimized procedure was followed by using 30.8 mg of 2-vinylnaphthalene (1a) (0.20 mmol), 45.4 mg of 4-chlorophenyl diazonium tetrafluoroborate (2f) (0.20 mmol), 32.6 mg of p-tolylboronic acid (3a) (0.24 mmol), 9.2 mg of Pd$_2$(dba)$_3$ (0.01 mmol), 17.8 mg of lithium carbonate (0.24 mmol) and 1 mL of t-Amy-OH and stirred at rt. After 12 h, the reaction mixture was extracted water/EA. Then the organic layers were dried with Na$_2$SO$_4$, and concentrated to dryness. The crude product was purified by silica gel chromatography (silica gel, PE: EA = 100:1, v/v) to afford 56.2 mg of the product as a slight yellow oil (79%). $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 7.79 (t, $J = 7.6$ Hz, 2H), 7.75 (d, $J = 8.5$ Hz, 1H), 7.66 (s, 1H), 7.48 – 7.42 (m, 2H), 7.33 (dd, $J = 8.5$, 1.8 Hz, 1H), 7.15 (d, $J = 8.3$ Hz, 4H), 7.09 (d, $J = 8.0$ Hz, 2H), 6.97 (d, $J = 8.4$ Hz, 2H), 4.39 (t, $J = 7.8$ Hz, 1H), 3.49 – 3.39 (m, 2H), 2.32 (s, 3H). $^{13}$C NMR (125 MHz, CDCl$_3$) $\delta$ 141.7, 140.9, 138.8, 135.9, 133.4, 132.1, 131.6, 130.4, 129.1, 128.2, 128.0, 127.9, 127.7, 127.53, 126.7, 126.0, 126.0, 125.4, 52.6, 41.3, 21.0. HRMS (EI) m/z: calcd for: C$_{25}$H$_{21}$Cl: 356.1332; Found: 356.1343.

2-(2-(o-tolyl)-1-(p-tolyl)ethyl)naphthalene (4aga). The optimized procedure was followed by using 30.8 mg of 2-vinyl naphthalene (1a) (0.20 mmol), 41.2 mg of o-tolyl diazonium tetrafluoroborate (2g) (0.20 mmol), 32.6 mg of p-tolylboronic acid (3a) (0.24 mmol), 9.2 mg of Pd$_2$(dba)$_3$ (0.01 mmol), 17.8 mg of lithium carbonate (0.24 mmol) and 1 mL of t-Amy-OH and stirred at rt. After 12 h, the reaction mixture was extracted water/EA. Then the organic layers were dried with Na$_2$SO$_4$, and concentrated to dryness. The crude product was purified by silica gel chromatography (silica gel, PE: EA = 100:1, v/v) to afford 50.6 mg of the product as a slight yellow oil (76%). $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 7.80 – 7.76 (m, 2H), 7.74 (d, $J = 8.5$ Hz, 1H), 7.66 (s, 1H), 7.47 – 7.41 (m, 2H), 7.33 (dd, $J = 8.5$, 1.7 Hz, 1H), 7.13 (t, $J = 7.3$ Hz, 2H), 7.07 (ddd, $J = 9.5$, 8.6, 3.1 Hz, 4H), 6.97 (t, $J = 6.6$ Hz, 1H), 6.89 (d, $J = 7.3$ Hz, 1H), 4.39 (t, $J = 7.5$ Hz, 1H), 3.51 – 3.41 (m, 2H), 2.32 (s, 3H), 2.22 (s, 3H). $^{13}$C NMR (125 MHz, CDCl$_3$) $\delta$ 142.2, 141.4, 138.4, 136.3, 135.7, 133.4, 132.1, 123.0, 129.7, 129.0, 128.0, 127.9, 127.7, 127.5, 127.0, 126.0, 125.9, 125.8, 125.5, 125.3, 51.3, 39.1, 21.0, 19.5. HRMS (EI) m/z: calcd for: C$_{26}$H$_{24}$: 336.1878; Found: 336.1867.
2-(2-(4-ethylphenyl)-1-(p-tolyl)ethyl)naphthalene (4aha). The optimized procedure was followed by using 30.8 mg of 2-vinylnaphthalene (1a) (0.20 mmol), 44.0 mg of 4-ethylphenyldiazonium tetrafluoroborate (2h) (0.20 mmol), 32.6 mg of p-tolylboronic acid (3a) (0.24 mmol), 9.2 mg of Pd$_2$(dba)$_3$ (0.01 mmol), 17.8 mg of lithium carbonate (0.24 mmol) and 1 mL of t-Amy-OH and stirred at rt. After 12 h, the reaction mixture was extracted water/EA. Then the organic layers were dried with Na$_2$SO$_4$, and concentrated to dryness. The crude product was purified by silica gel chromatography (silica gel, PE: EA = 100:1, v/v) to afford 47.6 mg of the product as a yellow oil (68%). $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 7.78 (t, $J = 6.9$ Hz, 2H), 7.74 (d, $J = 8.5$ Hz, 2H), 7.68 (s, 1H), 7.47 – 7.41 (m, 2H), 7.36 (dd, $J = 8.5, 1.7$ Hz, 1H), 7.18 (d, $J = 8.1$ Hz, 2H), 7.09 (d, $J = 7.9$ Hz, 2H), 7.01 (q, $J = 8.3$ Hz, 4H), 4.40 (t, $J = 7.7$ Hz, 1H), 3.50 – 3.40 (m, 2H), 2.58 (q, $J = 8.5$ Hz, 4H), 2.31 (s, 3H), 2.20 (s, 3H), 2.04 (t, $J = 7.6$ Hz, 3H). $^{13}$C NMR (125 MHz, CDCl$_3$) $\delta$ 142.2, 141.6, 141.5, 137.4, 135.6, 133.4, 132.1, 129.0, 128.9, 128.0, 127.9, 127.5, 127.5, 126.9, 126.0, 125.8, 125.3, 52.6, 41.5, 28.4, 21.0, 15.5. HRMS (EI) m/z: calcd for: C$_{27}$H$_{26}$: 350.2035; Found: 350.2030.

2-(2-(4-isopropylphenyl)-1-(p-tolyl)ethyl)naphthalene (4aia). The optimized procedure was followed by using 30.8 mg of 2-vinylnaphthalene (1a) (0.20 mmol), 50.4 mg of 4-isopropylphenyldiazonium tetrafluoroborate (2i) (0.20 mmol), 32.6 mg of p-tolylboronic acid (3a) (0.24 mmol), 9.2 mg of Pd$_2$(dba)$_3$ (0.01 mmol), 17.8 mg of lithium carbonate (0.24 mmol) and 1 mL of t-Amy-OH and stirred at rt. After 12 h, the reaction mixture was extracted water/EA. Then the organic layers were dried with Na$_2$SO$_4$, and concentrated to dryness. The crude product was purified by silica gel chromatography (silica gel, PE: EA = 100:1, v/v) to afford 43.1 mg of the product as a slight yellow oil (59%). $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 7.77 (t, $J = 7.7$ Hz, 2H), 7.73 (d, $J = 8.5$ Hz, 1H), 7.67 (s, 1H), 7.43 (dq, $J = 6.9$, 5.5 Hz, 2H), 7.36 (dd, $J = 8.5, 1.5$ Hz, 1H), 7.18 (d, $J = 8.0$ Hz, 2H), 7.09 (d, $J = 7.9$ Hz, 2H), 7.04 (d, $J = 8.0$ Hz, 2H), 7.00 (d, $J = 8.0$ Hz, 2H), 4.40 (t, $J = 7.7$ Hz, 1H), 3.50 – 3.40 (m, 2H), 2.93 – 2.76 (m, 1H), 2.31 (s, 3H), 2.12 (d, $J = 6.9$ Hz, 6H). $^{13}$C NMR (125 MHz, CDCl$_3$) $\delta$ 146.3, 142.3, 141.6, 137.6, 135.6, 133.4, 132.1, 129.0, 128.9, 128.0, 127.9, 127.7, 127.5, 126.9, 126.1, 126.0, 125.8, 125.3, 52.6, 41.4, 33.6, 24.0, 24.0, 21.0. HRMS (EI) m/z: calcd for: C$_{28}$H$_{28}$: 364.2191; Found: 364.2199.
2-(2-(tert-butyl)phenyl)-1-(p-tolyl)ethyl)naphthalene (4aja). The optimized procedure was followed by using 30.8 mg of 2-vinyl naphthalene (1a) (0.20 mmol), 49.6 mg of 4-(tert-butyl)phenyldiazonium tetrafluoroborate (2j) (0.20 mmol), 32.6 mg of p-tolylboronic acid (3a) (0.24 mmol), 9.2 mg of Pd₂(dba)₃ (0.01 mmol), 17.8 mg of lithium carbonate (0.24 mmol) and 1 mL of t-Amy-OH and stirred at rt. After 12 h, the reaction mixture was extracted water/EA. Then the organic layers were dried with Na₂SO₄, and concentrated to dryness. The crude product was purified by silica gel chromatography (silica gel, PE: EA = 100:1, v/v) to afford 57.5 mg of the product as a yellow oil (76%). 

1H NMR (500 MHz, CDCl₃) δ 7.78 (dd, J = 8.9, 7.4 Hz, 2H), 7.74 (d, J = 8.5 Hz, 1H), 7.68 (s, 1H), 7.47 – 7.41 (m, 2H), 7.37 (dd, J = 8.5, 1.5 Hz, 1H), 7.23 – 7.17 (m, 4H), 7.10 (d, J = 8.0 Hz, 2H), 7.02 (d, J = 8.1 Hz, 2H), 4.42 (t, J = 7.7 Hz, 1H), 3.51 – 3.42 (m, 2H), 2.32 (s, 3H), 1.29 (s, 9H). 13C NMR (125 MHz, CDCl₃) δ 148.6, 142.3, 141.6, 137.2, 135.6, 133.5, 132.1, 129.1, 128.6, 128.0, 127.9, 127.7, 127.5, 126.9, 126.1, 125.8, 125.3, 125.0, 52.5, 41.3, 34.3, 31.4, 21.0. HRMS (EI) m/z: calcd for: C₂₉H₃₀: 378.2348; Found: 378.2346.

2-(2-phenyl-1-(p-tolyl)ethyl)naphthalene (4aka). The optimized procedure was followed by using 30.8 mg of 2-vinyl naphthalene (1a) (0.20 mmol), 38.4 mg of phenyldiazonium tetrafluoroborate (2k) (0.20 mmol), 32.6 mg of p-tolylboronic acid (3a) (0.24 mmol), 9.2 mg of Pd₂(dba)₃ (0.01 mmol), 17.8 mg of lithium carbonate (0.24 mmol) and 1 mL of t-Amy-OH and stirred at rt. After 12 h, the reaction mixture was extracted water/EA. Then the organic layers were dried with Na₂SO₄, and concentrated to dryness. The crude product was purified by silica gel chromatography (silica gel, PE: EA = 100:1, v/v) to afford 49.0 mg of the product as a slight yellow oil (76%). 

1H NMR (500 MHz, CDCl₃) δ 7.79 (dd, J = 8.0, 7.0 Hz, 2H), 7.74 (d, J = 8.5 Hz, 1H), 7.68 (s, 1H), 7.48 – 7.41 (m, 2H), 7.36 (dd, J = 8.5, 1.8 Hz, 1H), 7.22 – 7.16 (m, 4H), 7.16 – 7.12 (m, 1H), 7.09 (t, J = 8.2 Hz, 4H), 4.41 (t, J = 7.8 Hz, 1H), 3.54 – 3.44 (m, 2H), 2.32 (s, 3H). 13C NMR (125 MHz, CDCl₃) δ 142.1, 141.3, 140.3, 135.6, 133.4, 132.0, 129.0, 129.0, 129.0, 128.0, 127.9, 127.7, 127.5, 126.9, 126.0, 125.8, 125.5, 52.6, 41.9, 21.0. HRMS (EI) m/z: calcd for: C₂₅H₂₅: 322.1722; Found: 322.1727.
**2-(2-(4-methoxyphenyl)-1-(p-tolyl)ethyl)naphthalene (4ala).** The optimized procedure was followed by using 30.8 mg of 2-vinylnaphthalene (1a) (0.20 mmol), 44.4 mg of 4-methoxyphenyl diazonium tetrafluoroborate (2l) (0.20 mmol), 32.6 mg of p-tolylboronic acid (3a) (0.24 mmol), 9.2 mg of Pd$_2$(dba)$_3$ (0.01 mmol), 17.8 mg of lithium carbonate (0.24 mmol) and 1 mL of t-Amy-OH and stirred at rt. After 12 h, the reaction mixture was extracted water/EA. Then the organic layers were dried with Na$_2$SO$_4$, and concentrated to dryness. The crude product was purified by silica gel chromatography (silica gel, PE: EA = 50:1, v/v) to afford 48.2 mg of the product as a slight yellow solid (69%). $^1$H NMR (500 MHz, CDCl$_3$) δ 7.83 – 7.79 (m, 2H), 7.77 (d, $J = 8.5$ Hz, 1H), 7.70 (s, 1H), 7.50 – 7.43 (m, 2H), 7.38 (dd, $J = 8.5$, 1.4 Hz, 1H), 7.20 (d, $J = 8.0$ Hz, 2H), 7.12 (d, $J = 8.1$ Hz, 2H), 7.00 (d, $J = 8.5$ Hz, 2H), 6.76 (d, $J = 8.6$ Hz, 2H), 4.38 (t, $J = 7.7$ Hz, 1H), 3.77 (s, 3H), 3.50 – 3.39 (m, 2H), 2.34 (s, 3H). $^{13}$C NMR (125 MHz, CDCl$_3$) δ 157.7, 142.2, 141.4, 135.6, 133.5, 132.4, 132.1, 129.9, 129.0, 128.0, 127.9, 127.8, 127.5, 126.9, 126.1, 125.8, 125.3, 113.5, 55.1, 53.0, 41.1, 21.0. HRMS (EI) m/z: calcd for: C$_{26}$H$_{24}$O: 352.1827; Found: 352.1833.

**2-(2-(4-nitrophenyl)-1-(p-tolyl)ethyl)naphthalene (4ama).** The optimized procedure was followed by using 30.8 mg of 2-vinylnaphthalene (1a) (0.20 mmol), 47.4 mg of 4-nitrophenyl diazonium tetrafluoroborate (2m) (0.20 mmol), 32.6 mg of p-tolylboronic acid (3a) (0.24 mmol), 9.2 mg of Pd$_2$(dba)$_3$ (0.01 mmol), 17.8 mg of lithium carbonate (0.24 mmol) and 1 mL of t-Amy-OH and stirred at rt. After 12 h, the reaction mixture was extracted water/EA. Then the organic layers were dried with Na$_2$SO$_4$, and concentrated to dryness. The crude product was purified by silica gel chromatography (silica gel, PE: EA = 40:1, v/v) to afford 44.5 mg of the product as a yellow oil (61%). $^1$H NMR (500 MHz, CDCl$_3$) δ 8.04 – 8.02 (m, 1H), 8.02 – 8.00 (m, 1H), 7.80 – 7.74 (m, 3H), 7.65 (s, 1H), 7.49 – 7.42 (m, 2H), 7.32 (dd, $J = 8.5$, 1.8 Hz, 1H), 7.17 (d, $J = 8.7$ Hz, 2H), 7.13 (d, $J = 8.2$ Hz, 2H), 7.09 (d, $J = 8.0$ Hz, 2H), 4.38 (t, $J = 7.9$ Hz, 1H), 3.61 – 3.51 (m, 2H), 2.31 (s, 3H). $^{13}$C NMR (125 MHz, CDCl$_3$) δ 148.2, 146.3, 141.1, 140.2, 136.2, 133.3, 132.2, 129.8, 129.2, 128.2, 127.8, 127.7, 127.5, 126.4, 126.1, 125.9, 125.6, 123.3, 52.3, 41.7, 21.0. HRMS (EI) m/z: calcd for: C$_{26}$H$_{21}$NO$_2$: 367.1572; Found: 367.1575.
1-(4-(naphthalen-2-yl)-2-(p-tolyl)ethyl)phenyl)ethan-1-one (4ana). The optimized procedure was followed by using 30.8 mg of 2-vinylnaphthalene (1a) (0.20 mmol), 50.2 mg of 4-acetylphenonediazonium tetrafluoroborate (2n) (0.20 mmol), 32.6 mg of p-tolylboronic acid (3a) (0.24 mmol), 9.2 mg of Pd$_2$(dba)$_3$ (0.01 mmol), 17.8 mg of lithium carbonate (0.24 mmol) and 1 mL of t-Amy-OH and stirred at 50 oC. After 12 h, the reaction mixture was extracted water/EtOAc. Then the organic layers were dried with Na$_2$SO$_4$, and concentrated to dryness. The crude product was purified by silica gel chromatography (silica gel, PE: EA = 40:1, v/v) to afford 30.5 mg of the product as a brown oil (42%). $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 7.76 (ddd, $J$ = 9.3, 6.0, 4.0 Hz, 4H), 7.73 (d, $J$ = 8.6 Hz, 1H), 7.65 (s, 1H), 7.43 (ddd, $J$ = 5.4, 4.6, 1.5 Hz, 2H), 7.32 (dd, $J$ = 8.5, 1.6 Hz, 1H), 7.13 (d, $J$ = 8.3 Hz, 4H), 7.07 (d, $J$ = 8.1 Hz, 2H), 4.39 (t, $J$ = 7.8 Hz, 1H), 3.56 – 3.47 (m, 2H), 2.53 (s, 3H), 2.30 (s, 3H). $^{13}$C NMR (125 MHz, CDCl$_3$) $\delta$ 197.9, 146.1, 141.6, 140.8, 136.0, 135.1, 133.4, 132.2, 129.2, 128.9, 128.4, 128.3, 128.1, 127.9, 127.7, 127.5, 126.7, 126.0, 125.45, 52.3, 41.9, 26.5, 21.0. HRMS (EI) m/z: calcd for: C$_{27}$H$_{24}$O: 364.1827; Found: 364.1831.

2-bromo-6-(2-(4-fluorophenyl)-1-(p-tolyl)ethyl)naphthalene (4baa). The optimized procedure was followed by using 46.4 mg of 2-bromo-6-vinylnaphthalene (1b) (0.20 mmol), 42.0 mg of 4-fluorophenylediazonium tetrafluoroborate (2a) (0.20 mmol), 32.6 mg of p-tolylboronic acid (3a) (0.24 mmol), 9.2 mg of Pd$_2$(dba)$_3$ (0.01 mmol), 17.8 mg of lithium carbonate (0.24 mmol) and 1 mL of t-Amy-OH and stirred at rt. After 12 h, the reaction mixture was extracted water/EtOAc. Then the organic layers were dried with Na$_2$SO$_4$, and concentrated to dryness. The crude product was purified by silica gel chromatography (silica gel, PE: EA = 100:1, v/v) to afford 55.6 mg of the product as a slight yellow solid (67%). $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 7.94 (d, $J$ = 1.7 Hz, 1H), 7.63 (dd, $J$ = 8.5, 5.9 Hz, 2H), 7.59 (s, 1H), 7.51 (dd, $J$ = 8.8, 1.9 Hz, 1H), 7.34 (dd, $J$ = 8.6, 1.7 Hz, 1H), 7.13 (d, $J$ = 8.1 Hz, 2H), 7.09 (d, $J$ = 8.5, 5.5 Hz, 2H), 6.85 (t, $J$ = 8.7 Hz, 2H), 4.30 (t, $J$ = 7.8 Hz, 1H), 3.41 (d, $J$ = 7.8 Hz, 2H), 2.31 (s, 3H). $^{13}$C NMR (125 MHz, CDCl$_3$) $\delta$ 161.2 (d, $J$ = 242.2 Hz), 142.4, 140.7, 136.0, 135.7 (d, $J$ = 3.2 Hz), 133.2, 131.8, 130.4 (d, $J$ = 7.8 Hz), 129.5, 129.3 (d, $J$ = 13.2 Hz), 129.2, 127.9, 127.8, 127.1, 126.0, 119.3, 114.9, 114.8, 52.8, 41.0, 21.0. $^{19}$F NMR (471 MHz, CDCl$_3$) $\delta$ -117.2. HRMS (EI) m/z: calcd for: C$_{25}$H$_{20}$BrF: 418.0732; Found: 418.0727.
2-fluoro-6-(2-(4-fluorophenyl)-1-(p-tolyl)ethyl)naphthalene (4caa). The optimized procedure was followed by using 17.2 mg of 2-fluoro-6-vinynaphthalene (1c) (0.10 mmol), 21.0 mg of 4-fluorophenyl diazonium tetrafluoroborate (2a) (0.10 mmol), 16.3 mg of p-tolylboronic acid (3a) (0.12 mmol), 4.6 mg of Pd₂(dba)₃ (0.005 mmol), 8.9 mg of lithium carbonate (0.12 mmol) and 0.5 mL of t-Amy-OH and stirred at rt. After 12 h, the reaction mixture was extracted water/EA. Then the organic layers were dried with Na₂SO₄, and concentrated to dryness. The crude product was purified by silica gel chromatography (silica gel, PE: EA = 100:1, v/v) to afford 23.1 mg of the product as a slight yellow solid (65%).¹H NMR (500 MHz, CDCl₃) δ 7.73 (dd, J = 9.0, 5.6 Hz, 1H), 7.66 (d, J = 8.5 Hz, 1H), 7.61 (s, 1H), 7.38 (dd, J = 9.8, 2.5 Hz, 1H), 7.33 (d, J = 8.5 Hz, 1H), 7.22 (td, J = 8.7, 2.6 Hz, 1H), 7.12 (d, J = 8.1 Hz, 2H), 7.08 (d, J = 8.1 Hz, 2H), 6.96 (dd, J = 8.5, 5.5 Hz, 2H), 6.84 (t, J = 8.7 Hz, 2H), 4.29 (t, J = 7.8 Hz, 1H), 3.44 – 3.36 (m, 2H), 2.30 (s, 3H).

¹³C NMR (125 MHz, CDCl₃) δ 161.3 (d, J = 242.3 Hz), 160.4 (d, J = 243.8 Hz), 141.2, 140.9, 135.9, 135.8 (d, J = 3.2 Hz), 132.7 (d, J = 9.1 Hz), 130.4, 130.4 (d, J = 7.8 Hz), 130.3, 130.0 (d, J = 8.9 Hz), 129.1, 127.9, 127.8, 127.4 (d, J = 5.3 Hz), 126.0, 116.2 (d, J = 25.3 Hz), 114.9 (d, J = 21.1 Hz), 110.6 (d, J = 20.3 Hz), 52.7, 41.1, 21.0.

¹⁹F NMR (471 MHz, CDCl₃) δ -115.5, -117.3.

HRMS (EI) m/z: calcd for: C₂₅H₂₀F₂: 358.1533; Found: 358.1536.

2-(2-(4-fluorophenyl)-1-(p-tolyl)ethyl)-6-methoxynaphthalene (4daa). The optimized procedure was followed by using 36.8 mg of 2-methoxy-6-vinynaphthalene (1d) (0.20 mmol), 42.0 mg of 4-fluorophenyl diazonium tetrafluoroborate (2a) (0.20 mmol), 32.6 mg of p-tolylboronic acid (3a) (0.24 mmol), 9.2 mg of Pd₂(dba)₃ (0.01 mmol), 17.8 mg of lithium carbonate (0.24 mmol) and 1 mL of t-Amy-OH and stirred at rt. After 12 h, the reaction mixture was extracted water/EA. Then the organic layers were dried with Na₂SO₄, and concentrated to dryness. The crude product was purified by silica gel chromatography (silica gel, PE: EA = 40:1, v/v) to afford 47.0 mg of the product as a field gray solid (63%).¹H NMR (500 MHz, CDCl₃) δ 7.65 (dd, J = 12.9, 8.7 Hz, 2H), 7.57 (s, 1H), 7.29 (dd, J = 8.4, 1.5 Hz, 1H), 7.15 – 7.12 (m, 3H), 7.08 (d, J = 8.2 Hz, 3H), 6.97 (dd, J = 8.3, 5.6 Hz, 2H), 6.85 (t, J = 8.7 Hz, 2H), 4.29 (t, J = 7.8 Hz, 1H), 3.91 (s, 3H), 3.46 – 3.36 (m, 2H), 2.31 (s, 3H).¹³C NMR (125 MHz, CDCl₃) δ 161.2 (d, J = 242.8 Hz), 157.4, 141.3, 139.6, 136.0 (d, J = 3.1 Hz), 135.7, 133.1, 130.4 (d, J = 7.8 Hz), 129.1 (d, J = 16.5 Hz), 128.9, 127.9, 127.3, 126.9, 125.9, 118.7, 114.9, 114.7, 105.8, 55.3, 52.7, 41.2, 21.0.

¹⁹F NMR (471 MHz, CDCl₃) δ -115.5. HRMS (EI) m/z: calcd for: C₂₆H₂₃FO: 370.1733; Found: 370.1737.
1-(2-(4-fluorophenyl)-1-(p-tolyl)ethyl)naphthalene (4eaa). The optimized procedure was followed by using 30.8 mg of 1-vinylnaphthalene (1e) (0.20 mmol), 42.0 mg of 4-fluorophenyl diazonium tetrafluoroborate (2a) (0.20 mmol), 32.6 mg of p-tolylboronic acid (3a) (0.24 mmol), 17.8 mg of lithium carbonate (0.24 mmol) and 1 mL of t-Amy-OH and stirred at rt. After 12 h, the reaction mixture was extracted water/EA. Then the organic layers were dried with Na$_2$SO$_4$, and concentrated to dryness. The crude product was purified by silica gel chromatography (silica gel, PE: EA = 100:1, v/v) to afford 51.7 mg of the product as a yellow oil (76%). $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 8.05 (d, $J$ = 9.0 Hz, 1H), 7.85 – 7.81 (m, 1H), 7.75 (d, $J$ = 8.1 Hz, 1H), 7.58 (d, $J$ = 7.1 Hz, 1H), 7.49 (t, $J$ = 7.7 Hz, 1H), 7.42 (p, $J$ = 6.9 Hz, 2H), 7.01 (ddd, $J$ = 13.8, 12.7, 6.8 Hz, 6H), 6.86 (t, $J$ = 8.4 Hz, 2H), 4.98 – 4.91 (m, 1H), 3.50 (dd, $J$ = 13.8, 6.3 Hz, 1H), 3.41 (dd, $J$ = 13.8, 9.0 Hz, 1H), 2.27 (s, 3H).

$^{13}$C NMR (125 MHz, CDCl$_3$) $\delta$ 161.3 (d, $J$ = 242.1 Hz), 140.8, 140.0, 136.0 (d, $J$ = 3.1 Hz), 135.7, 134.0, 131.7, 130.4 (d, $J$ = 7.8 Hz), 129.0, 128.8, 128.1, 127.1, 125.9, 125.3 (d, $J$ = 4.0 Hz), 124.4, 123.6, 114.9, 114.7, 47.9, 41.8, 21.0. $^{19}$F NMR (471 MHz, CDCl$_3$) $\delta$ -117.4. HRMS (EI) m/z: calcd for: C$_{25}$H$_{21}$F: 340.1627; Found: 340.1621.

5-(2-(4-fluorophenyl)-1-(p-tolyl)ethyl)benzo[b]thiophene (4faa). The optimized procedure was followed by using 16.0 mg of 5-vinylbenzo[b]thiophene (1f) (0.10 mmol), 21.0 mg of 4-fluorophenyl diazonium tetrafluoroborate (2a) (0.10 mmol), 16.3 mg of p-tolylboronic acid (3a) (0.12 mmol), 4.6 mg of Pd$_2$(dba)$_3$ (0.005 mmol), 8.9 mg of lithium carbonate (0.12 mmol) and 1 mL of t-Amy-OH and stirred at rt. After 12 h, the reaction mixture was extracted water/EA. Then the organic layers were dried with Na$_2$SO$_4$, and concentrated to dryness. The crude product was purified by silica gel chromatography (silica gel, PE: EA = 80:1, v/v) to afford 14.9 mg of the product as a slight yellow solid (44%). $^1$HNMR (500 MHz, CDCl$_3$) $\delta$ 7.74 (d, $J$ = 8.4 Hz, 1H), 7.63 (d, $J$ = 1.6 Hz, 1H), 7.40 (d, $J$ = 5.4 Hz, 1H), 7.25 (d, $J$ = 5.4 Hz, 1H), 7.17 (dd, $J$ = 8.4, 1.7 Hz, 1H), 7.12 (d, $J$ = 8.1 Hz, 2H), 7.07 (d, $J$ = 8.0 Hz, 2H), 6.98 – 6.93 (m, 2H), 6.87 – 6.81 (m, 2H), 4.27 (t, $J$ = 7.8 Hz, 1H), 3.38 (d, $J$ = 7.8 Hz, 2H), 2.29 (s, 3H). $^{13}$C NMR (125 MHz, CDCl$_3$) $\delta$ 161.2 (d, $J$ = 242.0 Hz), 141.4, 140.7, 139.8, 137.9, 136.0 (d, $J$ = 3.2 Hz), 135.8, 130.4 (d, $J$ = 7.8 Hz), 129.1, 127.8, 126.5, 124.9, 123.8, 122.4 (d, $J$ = 24.2 Hz), 114.9, 114.7, 52.7, 41.4, 21.0.
**F NMR (471 MHz, CDCl₃) δ -117.5. HRMS (EI) m/z: calcd for: C₂₃H₁₉FS: 346.1191; Found: 346.1189.**

3-[(2-(p-tolyl)-1-(4-(trifluoromethyl)phenyl)ethyl)benzo[b]thiophene (4gbi). The optimized procedure was followed by using 32.0 mg of 3-vinylbenzo[b]thiophene (1g) (0.20 mmol), 41.2 mg of p-tolylidiazonium tetrafluoroborate (2b) (0.20 mmol), (4-(trifluoromethyl)phenyl)boronic acid (3i) (0.24 mmol), 9.2 mg of Pd₂(dbacha)₃ (0.01 mmol), 17.8 mg of lithium carbonate (0.024 mmol) and 1.0 mL of t-AmOH and stirred at rt. After 12 h, the reaction mixture was extracted water/EA. Then the organic layers were dried with Na₂SO₄, and concentrated to dryness. The crude product was purified by silica gel chromatography (silica gel, PE: EA = 20:1, v/v) to afford 43 mg of the product as a light yellow oil (55%).

**1H NMR (500 MHz, CDCl₃) δ 7.85 (d, J = 7.9 Hz, 1H), 7.52 (d, J = 8.0 Hz, 1H), 7.46 (d, J = 8.1 Hz, 2H), 7.38 (s, 1H), 7.31 – 7.26 (m, 1H), 7.20 (d, J = 8.1 Hz, 2H), 4.61 (dd, J = 9.3, 5.9 Hz, 1H), 3.57 (dd, J = 13.6, 9.4 Hz, 1H), 2.30 (s, 3H).**

**13C NMR (125 MHz, CDCl₃) δ 147.0, 140.5, 138.3, 138.0, 136.0, 135.8, 129.0, 128.8, 128.3, 127.8 (q, J = 75.8, 43.5 Hz), 128.4, 125.3 (q, J = 3.7 Hz), 124.4, 124.0, 122.9, 122.2, 122.0, 47.1, 41.8, 21.0.**

19F NMR (471 MHz, CDCl₃) δ -62.3.

**HRMS (EI) m/z: calcd for: C₂₄H₁₉F₃S: 396.1160; Found: 396.1161.**

2-(2-(4-fluorophenyl)-1-(p-tolyl)ethyl)anthracene (4haa). The optimized procedure was followed by using 20.4 mg of 2-vinylanthracene (1h) (0.10 mmol), 21.0 mg of 4-fluoro[2-[1,2,3]triazoniumentafluoroborate (2a) (0.10 mmol), 16.3 mg of p-tolylboronic acid (3a) (0.12 mmol), 4.6 mg of Pd₂(dbacha)₃ (0.005 mmol), 8.9 mg of lithium carbonate (0.12 mmol) and 0.5 mL of t-AmOH and stirred at rt. After 12 h, the reaction mixture was extracted water/EA. Then the organic layers were dried with Na₂SO₄, and concentrated to dryness. The crude product was purified by silica gel chromatography (silica gel, PE: EA = 100:1, v/v) to afford 29 mg of the product as a brown solid (74%).

**1H NMR (500 MHz, CDCl₃) δ 8.35 (s, 1H), 8.34 (s, 1H), 7.98 (dd, J = 9.2, 3.4 Hz, 2H), 7.89 (d, J = 8.8 Hz, 1H), 7.78 (s, 1H), 7.47 – 7.44 (m, 2H), 7.29 (dd, J = 8.8, 1.7 Hz, 1H), 7.16 (d, J = 8.1 Hz, 2H), 7.10 (s, 1H), 7.09 (s, 1H), 6.99 (d, J = 3.2 Hz, 1H), 6.98 (s, 1H), 6.85 (d, J = 8.8 Hz, 2H), 4.33 (t, J = 7.8 Hz, 1H), 3.49 (dd, J = 13.7, 7.8 Hz, 1H), 3.42 (dd, J = 13.7, 7.8 Hz, 1H), 3.42 (dd, J = 13.7, 7.8 Hz, 1H), 3.42 (dd, J = 13.7, 7.8 Hz, 1H).**
= 13.7, 7.7 Hz, 1H), 2.31 (s, 3H). $^{13}$C NMR (125 MHz, CDCl$_3$) δ 161.2 (d, $J = 242.1$ Hz), 141.1, 140.7, 135.9 (d, $J = 2.9$ Hz), 131.8, 131.7, 131.5, 130.6, 130.4 (d, $J = 7.8$ Hz), 129.1, 129.0, 128.8 (d, $J = 15.6$ Hz), 128.3, 128.1, 128.1, 128.0, 126.8, 125.9, 125.6, 125.3, 125.1, 114.9, 114.8, 53.0, 40.8, 21.0. $^{19}$F NMR (471 MHz, CDCl$_3$) δ -117.4. HRMS (EI) m/z: calcd for: C$_{29}$H$_{23}$F: 390.1784; Found: 390.1787.

9-(2-(4-fluorophenyl)-1-(p-tolyl)ethyl)phenanthrene (4iaa). The optimized procedure was followed by using 40.8 mg of 9-vinylphenanthrene (1i) (0.20 mmol), 42.0 mg of 4-fluorophenyldiazonium tetrafluoroborate (2a) (0.20 mmol), 32.6 mg of p-tolylboronic acid (3a) (0.24 mmol), 9.2 mg of Pd$_2$(dba)$_3$ (0.01 mmol), 17.8 mg of lithium carbonate (0.24 mmol) and 1 mL of t-Amy-OH and stirred at rt. After 12 h, the reaction mixture was extracted water/EtOAc. Then the organic layers were dried with Na$_2$SO$_4$, and concentrated to dryness. The crude product was purified by silica gel chromatography (silica gel, PE: EtOAc = 100:1, v/v) to afford 56.2 mg of the product as a slight yellow solid (72%). $^1$H NMR (500 MHz, CDCl$_3$) δ 8.73 (d, $J = 8.1$ Hz, 1H), 8.68 (d, $J = 7.5$ Hz, 1H), 8.12 (d, $J = 8.1$ Hz, 1H), 7.94 (d, $J = 8.1$ Hz, 2H), 7.07 (d, $J = 8.1$ Hz, 2H), 4.94 (dd, $J = 9.1$, 5.9 Hz, 1H), 3.62 (dd, $J = 13.7$, 5.9 Hz, 1H), 3.45 (dd, $J = 13.7$, 9.2 Hz, 1H), 2.28 (s, 3H). $^{13}$C NMR (125 MHz, CDCl$_3$) δ 161.3 (d, $J = 242.1$ Hz), 140.4, 137.9, 136.0 (d, $J = 3.2$ Hz), 135.8, 131.5, 131.1, 130.9, 130.5 (d, $J = 7.8$ Hz), 129.7, 129.0, 128.5, 128.1, 126.6 (d, $J = 9.8$ Hz), 126.4, 126.1, 125.2, 124.5, 123.1, 122.4, 114.9, 114.8, 48.2, 41.9, 21.0. $^{19}$F NMR (471 MHz, CDCl$_3$) δ -117.4. HRMS (EI) m/z: calcd for: C$_{29}$H$_{23}$F: 390.1784; Found: 390.1787.

2-(1-(4-fluorophenyl)-2-(p-tolyl)propan-2-yl)naphthalene (4kaa). The optimized procedure was followed by using 16.8 mg of 2-(prop-1-en-2-yl)naphthalene (1k) (0.10 mmol), 21.0 mg of 4-fluorophenyldiazonium tetrafluoroborate (2a) (0.10 mmol), 16.3 mg of p-tolylboronic acid (3a) (0.12 mmol), 4.6 mg of Pd$_2$(dba)$_3$ (0.005 mmol), 8.9 mg of lithium carbonate (0.12 mmol) and 0.5 mL of t-Amy-OH and stirred at rt. After 12 h, the reaction mixture was extracted water/EtOAc. Then the organic layers were dried with Na$_2$SO$_4$, and concentrated to dryness. The crude product was purified by silica gel chromatography (silica gel, PE: EA = 100:1, v/v) to afford 25.0 mg of the product as a slight yellow solid (70%). $^1$H NMR (500 MHz, CDCl$_3$) δ 7.80 (t, $J = 8.7$ Hz, 2H),
2-(1-(p-tolyl)-2-(4-(trifluoromethyl)phenyl)propan-2-yl)naphthalene (4kbi). The optimized procedure was followed by using 33.6 mg of 2-(prop-1-en-2-yl)naphthalene (1k) (0.20 mmol), 41.2 mg of p-tolyl diazonium tetrafluoroborate (2b) (0.20 mmol), 45.6 mg of (4-(trifluoromethyl)phenyl)boronic acid (3i) (0.24 mmol) and 1.0 mL of t-Amy-OH and stirred at rt. After 12 h, the reaction mixture was extracted water/EA. Then the organic layers were dried with Na₂SO₄, and concentrated to dryness. The crude product was purified by silica gel chromatography (silica gel, PE: EA = 200:1, v/v) to afford 66.1 mg of the product as a slight yellow oil (82%). ^1H NMR (500 MHz, CDCl₃) δ 7.83 (dd, J = 8.8, 5.6 Hz, 2H), 7.75 (d, J = 9.4 Hz, 2H), 7.54 – 7.48 (m, 4H), 7.31 (d, J = 8.2 Hz, 2H), 7.17 (dd, J = 8.6, 1.9 Hz, 1H), 6.88 (d, J = 7.8 Hz, 2H), 6.52 (d, J = 7.9 Hz, 2H), 3.58 (d, J = 12.8 Hz, 1H), 3.51 (d, J = 12.6 Hz, 1H), 2.26 (s, 3H), 1.68 (s, 3H). ^13C NMR (125 MHz, CDCl₃) δ 153.2, 145.7, 135.7, 134.1, 133.0, 131.9, 130.5, 128.2, 128.0, 127.7, 127.4, 127.2, 126.1, 125.8, 125.6 (q, J = 272.3 Hz), 125.1, 124.8 (q, J = 3.7 Hz), 47.5, 46.8, 26.8, 20.9. ^19F NMR (471 MHz, CDCl₃) δ -62.2. HRMS (EI) m/z: calcd for: C_{27}H_{23}F_3: 404.1752; Found: 404.1749.

2-(1-(4-nitrophenyl)-2-(p-tolyl)propan-2-yl)naphthalene (4kma). The optimized procedure was followed by using 33.6 mg of 2-(prop-1-en-2-yl)naphthalene (1k) (0.20 mmol), 47.4 mg of 4-nitrophenyl diazonium tetrafluoroborate (2m) (0.20 mmol), 32.6 mg of p-tolylboronic acid (3a) (0.24 mmol) and 1 mL of t-Amy-OH and stirred at rt. After 12 h, the reaction mixture was extracted water/EA. Then the organic layers were dried with Na₂SO₄, and concentrated to dryness. The crude product was purified by silica gel chromatography (silica gel, PE: EA = 40:1, v/v) to afford 40.6 mg of the product as a slight yellow oil (53%). ^1H NMR (500 MHz, CDCl₃) δ 7.89 (d, J = 8.6 Hz, 2H), 7.82
2-(1-(4-chlorophenyl)-2-(p-tolyl)propan-2-yl)naphthalene (4kfa). The optimized procedure was followed by using 33.6 mg of 2-(prop-1-en-2-yl)naphthalene (1k) (0.20 mmol), 45.4 mg of 4-chlorophenyl diazonium tetrafluoroborate (2f) (0.20 mmol), 32.6 mg of p-tolylboronic acid (3a) (0.24 mmol), 9.2 mg of Pd$_2$(dba)$_3$ (0.01 mmol), 17.8 mg of lithium carbonate (0.24 mmol) and 1 mL of t-Amy-OH and stirred at rt. After 12 h, the reaction mixture was extracted water/EA. Then the organic layers were dried with Na$_2$SO$_4$, and concentrated to dryness. The crude product was purified by silica gel chromatography (silica gel, PE: EA = 100:1, v/v) to afford 26.1 mg of the product as a slight yellow oil (35%). $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 7.79–7.75 (m, 1H), 7.72 (d, $J$ = 8.7 Hz, 1H), 7.68 (s, 1H), 7.50–7.46 (m, 2H), 7.18 (dd, $J$ = 8.6, 1.7 Hz, 1H), 7.06 (q, $J$ = 8.3 Hz, 4H), 6.76 (d, $J$ = 8.6 Hz, 2H), 3.62 (q, $J$ = 12.3 Hz, 2H), 2.33 (s, 3H), 1.56 (s, 3H). $^{13}$C NMR (125 MHz, CDCl$_3$) $\delta$ 146.4, 146.2, 145.9, 145.7, 144.9, 135.7, 131.7, 131.3, 128.7, 127.9, 127.7, 127.4, 127.3, 127.1, 126.0, 125.7, 124.6, 122.4, 47.2, 47.0, 26.8, 20.8. HRMS (EI) m/z: calcd for: C$_{26}$H$_{23}$NO$_2$: 381.1729; Found: 381.1732.

2,2'-2-(4-(trifluoromethyl)phenyl)propane-1,2-diyl)dinaphthalene (4koi). The optimized procedure was followed by using 33.6 mg of 2-(prop-1-en-2-yl)naphthalene (1k) (0.20 mmol), 48.4 mg of 2-naphthalenediazonium tetrafluoroborate (2o) (0.20 mmol), 45.6 mg of (4-(trifluoromethyl)phenyl)boronic acid (3i) (0.24 mmol), 9.2 mg of Pd$_2$(dba)$_3$ (0.01 mmol), 17.8 mg of lithium carbonate (0.24 mmol) and 1 mL of t-Amy-OH and stirred at rt. After further 12 h, the reaction mixture was extracted water/EA. Then the organic layers were dried with Na$_2$SO$_4$, and concentrated to dryness. The crude product was purified by silica gel chromatography (silica gel, PE: EA = 200:1, v/v) to afford 70.8 mg of the product as a slight yellow oil (80%). $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 7.88–7.84 (m, 1H), 7.80 (dt, $J$ = 12.8, 6.1 Hz, 3H), 7.75 (dd, $J$ = 5.6, 3.7 Hz, 1H), 7.62–7.58 (m, 1H), 7.52 (dt, $J$ = 12.3, 8.6 Hz, 5H), 7.44–7.40 (m, 2H), 7.32 (d, $J$ = 8.2 Hz, 2H), 7.23–7.18 (m, 2H), 6.62 (dd, $J$ = 8.4, 1.5 Hz, 1H), 3.78 (d, $J$ = 12.5 Hz, 1H), 3.71 (d, $J$ = 8.2 Hz, 2H).
12.5 Hz, 1H), 1.73 (s, 3H). $^{13}$C NMR (126 MHz, CDCl$_3$) δ 153.0, 145.6, 135.0, 133.0, 132.0, 131.9, 129.4, 129.0, 128.3, 128.1, 127.8, 127.4, 127.2, 126.7, 126.1, 125.9, 125.8 (q, $J = 213.8$ Hz), 125.7, 125.4, 125.1, 124.8 (q, $J = 3.6$ Hz), 47.8, 47.5, 26.8. $^{19}$F NMR (471 MHz, CDCl$_3$) δ -62.2. HRMS (EI) m/z: calcd for: C$_{30}$H$_{23}$F$_3$: 440.1752; Found: 440.1747.

2-(1-(p-tolyl)-2-(4-(trifluoromethyl)phenyl)butan-2-yl)naphthalene (4lbi). The optimized procedure was followed by using 36.4 mg of 2-(but-1-en-2-yl)naphthalene (1l) (0.20 mmol), 41.2 mg of p-tolyldiazonium tetrafluoroborate (2b) (0.20 mmol), 45.6 mg of (4-(trifluoromethyl)phenyl)boronic acid (3i) (0.24 mmol), 9.2 mg of Pd$_2$(dba)$_3$ (0.01 mmol), 17.8 mg of lithium carbonate (0.24 mmol) and 1 mL of t-Amy-OH and stirred at rt. After further 12 h, the reaction mixture was extracted water/EA. Then the organic layers were dried with Na$_2$SO$_4$, and concentrated to dryness. The crude product was purified by silica gel chromatography (silica gel, PE: EA = 100:1, v/v) to afford 41.1 mg of the product as a slight yellow oil (49%). $^1$H NMR (500 MHz, CDCl$_3$) δ 7.81 (dd, $J = 6.4, 2.8$ Hz, 2H), 7.75 – 7.70 (m, 2H), 7.52 – 7.46 (m, 4H), 7.22 (d, $J = 8.2$ Hz, 2H), 7.07 (dd, $J = 8.7, 1.8$ Hz, 1H), 6.85 (d, $J = 7.8$ Hz, 2H), 6.43 (d, $J = 7.9$ Hz, 2H), 3.55 (d, $J = 12.8$ Hz, 1H), 3.43 (d, $J = 12.8$ Hz, 1H), 2.24 (s, 3H), 2.18 – 2.06 (m, 2H), 0.79 (t, $J = 7.3$ Hz, 3H). $^{13}$C NMR (125 MHz, CDCl$_3$) δ 152.4, 144.7, 135.7, 134.0, 132.9, 131.9, 130.2, 128.9, 128.2, 128.1, 127.7, 127.4, 126.7 (q, $J = 294.9$ Hz), 126.0 (d, $J = 2.2$ Hz), 125.8, 124.6 (q, $J = 3.6$ Hz), 123.2, 51.2, 42.1, 28.4, 21.0, 8.9. $^{19}$F NMR (471 MHz, CDCl$_3$) δ -62.2. HRMS (EI) m/z: calcd for: C$_{28}$H$_{25}$F$_3$: 418.1908; Found: 418.1905.

2-methoxy-6-(1-(p-tolyl)-2-(4-(trifluoromethyl)phenyl)propan-2-yl)naphthalene (4mbi). The optimized procedure was followed by using 39.8 mg of 2-methoxy-6-(prop-1-en-2-yl)naphthalene (1m) (0.20 mmol), 41.2 mg of p-tolyldiazonium tetrafluoroborate (2b) (0.20 mmol), 45.6 mg of (4-(trifluoromethyl)phenyl)boronic acid (3i) (0.24 mmol), 9.2 mg of Pd$_2$(dba)$_3$ (0.01 mmol), 17.8 mg of lithium carbonate (0.24 mmol) and 1 mL of t-Amy-OH and stirred at rt. After further 12 h, the reaction mixture was extracted water/EA. Then the organic layers were dried with Na$_2$SO$_4$, and concentrated to dryness. The crude product was purified by silica gel chromatography (silica gel, PE: EA = 100:1, v/v) to afford 51.2 mg of the product as a pale yellow oil (59%). $^1$H NMR (500 MHz, CDCl$_3$) δ 7.70 (d, $J = 8.9$ Hz, 1H), 7.67 – 7.63 (m, 2H), 7.52 (dd, $J = 13.2, 8.4$ Hz, 2H), 7.30 (t, $J = 7.2$ Hz, 2H), 7.18 – 7.15 (m, 1H), 7.12 (d, $J = 6.7$ Hz, 2H), 6.87 (d, $J = 7.8$ Hz, 2H), 3.60 (s, 3H), 3.57 (d, $J = 6.4$ Hz, 3H), 3.38 (d, $J = 6.4$ Hz, 3H), 3.35 (d, $J = 6.4$ Hz, 3H), 3.00 (s, 3H), 2.89 (s, 3H), 2.85 (s, 3H), 2.18 (s, 3H), 2.17 (s, 3H), 1.30 (s, 3H), 1.29 (s, 3H), 1.28 (s, 3H), 0.89 (t, $J = 7.2$ Hz, 3H). $^{13}$C NMR (125 MHz, CDCl$_3$) δ 152.4, 144.7, 135.7, 134.0, 132.9, 131.9, 130.2, 128.9, 128.2, 128.1, 127.7, 127.4, 126.7 (q, $J = 294.9$ Hz), 126.0 (d, $J = 2.2$ Hz), 125.8, 124.6 (q, $J = 3.6$ Hz), 123.2, 51.2, 42.1, 28.4, 21.0, 8.9. $^{19}$F NMR (471 MHz, CDCl$_3$) δ -62.2. HRMS (EI) m/z: calcd for: C$_{28}$H$_{25}$F$_3$: 418.1908; Found: 418.1905.
6.50 (d, $J = 7.8$ Hz, 2H), 3.93 (s, 3H), 3.58 – 3.45 (m, 2H), 2.25 (s, 3H), 1.64 (s, 3H). $^{13}$C NMR (125 MHz, CDCl$_3$) $\delta$ 157.7, 153.4, 143.4, 135.6, 134.2, 132.9, 130.9, 130.5, 129.6, 129.0 (d, $J = 32.3$Hz), 128.4, 128.2, 128.2, 127.7, 126.6, 124.9, 124.74 (q, $J = 3.7$ Hz), 118.7, 105.5, 55.3, 47.3, 46.9, 26.8, 20.9. $^{19}$F NMR (471 MHz, CDCl$_3$) $\delta$ -62.2. HRMS (EI) m/z: calcd for: C$_{28}$H$_{25}$F$_3$O: 434.1858; Found: 434.1857.

2-(1-(p-tolyl)-2-(4-(trifluoromethyl)phenyl)propan-2-yl)benzo[b]thiophene (4nbi). The optimized procedure was followed by using 34.8 mg of 2-(prop-1-en-2-yl)benzo[b]thiophene (1n) (0.20 mmol), 41.2 mg of p-toluidinium tetrafluoroborate (2b) (0.20 mmol), 45.6 mg of (4-(trifluoromethyl)phenyl)boronic acid (3i) (0.24 mmol), 9.2 mg of Pd$_2$(dba)$_3$ (0.01 mmol), 17.8 mg of lithium carbonate (0.24 mmol) and 1 mL of t-Amy-OH and stirred at rt. After further 12 h, the reaction mixture was extracted water/EA. Then the organic layers were dried with Na$_2$SO$_4$, and concentrated to dryness. The crude product was purified by silica gel chromatography (silica gel, PE: EA = 100:1, v/v) to afford 44.4 mg of the product as a yellow oil (54%). $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 7.76 (dd, $J = 7.8$, 3.5 Hz, 1H), 7.71 (d, $J = 7.8$ Hz, 1H), 7.56 (dd, $J = 15.1$, 8.3 Hz, 2H), 7.42 (d, $J = 9.6$ Hz, 1H), 7.40 – 7.33 (m, 2H), 7.11 (d, $J = 11.6$ Hz, 1H), 6.90 (dd, $J = 33.8$, 7.9 Hz, 2H), 6.63 (d, $J = 7.9$ Hz, 2H), 3.55 (dt, $J = 24.6$, 8.5 Hz, 2H), 2.28 (s, 3H), 1.72 (s, 3H), $^{13}$C NMR (125 MHz, CDCl$_3$) $\delta$ 155.1, 151.3, 139.4, 136.1, 133.5, 130.8, 130.4, 128.4, 127.7, 127.6, 124.9 (q, $J = 3.7$ Hz), 124.2, 124.0, 123.3, 122.2, 122.1, 120.8, 48.2, 46.5, 27.4, 21.0. $^{19}$F NMR (471 MHz, CDCl$_3$) $\delta$ -62.3. HRMS (EI) m/z: calcd for: C$_{25}$H$_{21}$F$_3$S: 410.1316; Found: 410.1326.

• 1-(tert-butyl)-4-(1-(4-methoxyphenyl)-2-(4-nitrophenyl)ethyl)benzene (4omb). The procedure was followed by using 474 mg of p-nitrophenyldiazonium tetrafluoroborate (2m) (2.0 mmol), 365mg of (4-methoxyphenyl)boronic acid (3b) (2.4 mmol), 46 mg of Pd$_2$(dba)$_3$ (0.05 mmol), 178 mg of lithium carbonate (2.4 mmol), 160 mg of 1-(tert-butyl)-4-vinylbenzene (1o) (1mmol) and 6 mL of t-Amy-OH and stirred at 40°C. After further 12 h, the reaction mixture was extracted water/EA. Then the organic layers were dried with Na$_2$SO$_4$, and concentrated to dryness. The crude product was purified by silica gel chromatography (silica gel, PE: EA = 100:3, v/v) to afford 60.5 mg of the product with byproduct (mb) as a yellow solid (7% analyzed by NMR). HRMS (EI) m/z: calcd for: C$_{25}$H$_{27}$NO$_3$: 389.1991; Found: 389.1996.

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2-(vinyl-2,2-d_2)naphthalene (1a-D_2). The operation process was on the basis of reference 2. The desired product was got as a white solid (39%, 71% D). And the determination of the rates of deuteriation was based on the peak area of ^1H NMR of the corresponding 1H. ^1H NMR (500 MHz, CDCl_3) δ 7.88–7.83 (m, 3H), 7.80 (s, 1H), 7.69 (dd, J = 8.5, 1.5 Hz, 1H), 7.54–7.47 (m, 2H), 6.97–6.91 (m, 1H), 5.96–5.90 (m, 0.29H), 5.39 (dd, J = 10.9, 7.4 Hz, 0.29H). ^13C NMR (125 MHz, CDCl_3) δ 136.8 (dd, J = 13.7, 10.9 Hz), 134.9, 133.5, 133.1, 128.1, 128.0, 127.6, 126.3, 126.2, 125.9, 123.1, 114.1.

2-(2-(4-fluorophenyl)-1-(p-tolyl)ethyl-2,2-d_2)naphthalene (4aaa-D_2). The optimized procedure was followed by using 31.2 mg of 2-(vinyl-2,2-d_2)naphthalene 1a-D_2 (0.20 mmol), 42.0 mg of 4-fluorophenyl diazonium tetrafluoroborate (2a) (0.20 mmol), 32.6 mg of p-tolylboronic acid (3a) (0.24 mmol), 9.2 mg of Pd_2(dba)_3 (0.01 mmol), 17.8 mg of lithium carbonate (0.24 mmol) and 1 mL of t-Amy-OH and stirred at rt. After 12 h, the reaction mixture was extracted water/EA. Then the organic layers were dried with Na_2SO_4, and concentrated to dryness. The crude product was purified by silica gel chromatography (silica gel, PE: EA = 100:1, v/v) to afford 41.1 mg of the product as a yellowish oil (60%, 2x71% D). ^1H NMR (500 MHz, CDCl_3) δ 7.78 (dd, J = 8.6, 7.3 Hz, 2H), 7.74 (d, J = 8.5 Hz, 1H), 7.65 (s, 1H), 7.45 (pd, J = 6.8, 1.4 Hz, 2H), 7.33 (dd, J = 8.5, 1.3 Hz, 1H), 7.14 (d, J = 8.0 Hz, 2H), 7.09 (d, J = 8.0 Hz, 2H), 7.00–6.95 (m, 2H), 6.91–6.80 (m, 2H), 4.37–4.29 (m, 1H), 3.48–3.38 (m, 0.58H), 2.31 (s, 3H). ^13C NMR (125 MHz, CDCl_3) δ 161.2 (d, J = 243.4 Hz), 141.8, 141.0, 135.8, 133.4, 132.1, 130.4 (d, J = 7.8 Hz), 129.1, 127.96 (d, J = 8.4 Hz), 127.7, 127.5, 126.8, 125.9 (d, J = 10.7 Hz), 125.4, 114.9, 114.7, 52.8, 52.7, 21.0. ^19F NMR (471 MHz, CDCl_3) δ -117.4. HRMS (El) m/z: calcd for: C_{25}H_{19}D_{2}F:342.1753; Found: 342.1762.
(E)-2-(4-fluorostyryl)naphthalene (5). The optimized procedure was followed by using 303 mg of 2-vinylnaphthalene (1a) (2.0 mmol), 420 mg of 4-fluorophenyldiazonium tetrafluoroborate (2a) (2.0 mmol), 394 mg of (4-propylphenyl)boronic acid (3d) (2.4 mmol), 91.5 mg of Pd$_2$(dba)$_3$ (0.1 mmol), 178 mg of lithium carbonate (2.4 mmol) and 8 mL of t-Amy-OH and stirred at rt. After 12 h, the reaction mixture was extracted water/EA. Then the organic layers were dried with Na$_2$SO$_4$, and concentrated to dryness. The crude product was purified by silica gel chromatography (silica gel, PE: EA = 100:1, v/v) to afford 446 mg of the product as a slight yellow solid (62%) along with 10% of the byproduct (6) as a slight yellow oil and 14% of Heck-type product (5) as a white solid. $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 7.84 (dd, $J$ = 8.4, 4.1 Hz, 4H), 7.73 (dd, $J$ = 8.6, 1.7 Hz, 1H), 7.55 – 7.51 (m, 2H), 7.47 (ddd, $J$ = 8.3, 7.2, 1.5 Hz, 2H), 7.20 (s, 2H), 7.12 – 7.06 (m, 2H). $^{13}$C NMR (125 MHz, CDCl$_3$) $\delta$ 162.3 (d, $J$ = 246.3 Hz), 134.6, 133.7, 133.5 (d, $J$ = 3.4 Hz), 133.0, 128.5 (d, $J$ = 2.4 Hz), 128.3, 128.0, 128.0, 127.7 (d, $J$ = 9.2 Hz), 126.6, 126.4, 125.9, 123.4, 115.7, 115.6.

2-(1-(4-chlorophenyl)ethyl)naphthalene (6). $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 7.80 (d, $J$ = 8.2 Hz, 2H), 7.75 (d, $J$ = 8.5 Hz, 1H), 7.68 (s, 1H), 7.46 (ddd, $J$ = 9.3, 6.9, 1.4 Hz, 2H), 7.29 – 7.26 (m, 2H), 7.26 – 7.25 (m, 1H), 7.21 – 7.16 (m, 2H), 4.29 (q, $J$ = 7.2 Hz, 1H), 1.72 (d, $J$ = 7.2 Hz, 3H). $^{13}$C NMR (125 MHz, CDCl$_3$) $\delta$ 144.7, 143.2, 133.5, 132.1, 131.8, 129.1, 128.5, 128.1, 127.7, 127.6, 126.6, 126.1, 125.5, 125.3, 44.2, 21.7.
4. Preliminary mechanistic studies

The reaction (eq a) was carried out under the optimized conditions with the D-labeled 2-vinyl naphthalene 1a-D₂ (71% D). Subsequently, the compound 4aaa-D₂ was isolated as a yellow oil in 60% yield with 71% D. By deuterium label experiments, we found that the deuterium ratio of β was almost no change, and the α was no deuterium replacement.

In the process of optimizing conditions, we found the Heck byproduct and hydroarylation byproduct were detected, so we prepared these two products accordingly and subjected them to the standard conditions (compounds 5 and 6 in eq b and eq c), no corresponding desired products were detected. These results suggested that the above two byproducts were not key intermediates for this transformation.

To understand the mechanism of this transformation, a scale-up reaction was conducted with 2 mmol of 1a with 2a and 3c under the standard condition, the corresponding desired product 4aac was obtained in 62% yield along with 10% of 2-(1-(4-chlorophenyl)ethyl)naphthalene (6) and 14% of Heck-type product 5 (eq d), and the structures of both 5 and 6 were verified by corresponding spectroscopic analysis.
5. NMR spectroscopic data

2-(2-(4-fluorophenyl)-1-(p-tolyl)ethyl)naphthalene (4aaa)
2-(2-(4-fluorophenyl)-1-(4-methoxyphenyl)ethyl)naphthalene (4aab)
2-(1-(4-chlorophenyl)-2-(4-fluorophenyl)ethyl)naphthalene (4aac)
2-(2-(4-fluorophenyl)-1-(4-propylphenyl)ethyl)naphthalene (4aad)
2-(1-(3,5-dimethylphenyl)-2-(4-fluorophenyl)ethyl)naphthalene (4aae)
2-(1-(2-bromophenyl)-2-(4-fluorophenyl)ethyl)naphthalene (4aaf)
2-(2-(4-fluorophenyl)-1-(o-toly)ethyl)naphthalene (4aag)
2-(2-(4-fluorophenyl)-1-phenylethyl)naphthalene (4aah)
2-(2-(4-fluorophenyl)-1-(4-(trifluoromethyl)phenyl)ethyl)naphthalene (4aai)
2-(1,2-bis(4-fluorophenyl)ethyl)naphthalene (4aa)

![Chemical Structure](image)

![NMR Spectra](image)
2-(1-(4-(tert-butyl)phenyl)-2-(4-fluorophenyl)ethyl)naphthalene (4aak)
ethyl 4-(2-(4-fluorophenyl)-1-(naphthalen-2-yl)ethyl)benzoate (4aal)
2,2’-(2-(p-tolyl)ethane-1,1-diyl)dinaphthalene (4abm)
(E)-2-(4-phenyl-1-(p-tolyl)but-3-en-2-yl)naphthalene(4abn)
4-(1-(naphtalen-2-yl)-2-(p-tolyl)ethyl)dibenzo[b,d]furan(4abo)
2-(2-(2-fluorophenyl)-1-(p-tolyl)ethyl)naphthalene (4ada)
2-(2-(3-fluorophenyl)-1-(p-tolyl)ethyl)naphthalene (4aea)
2-(2-(4-chlorophenyl)-1-(p-tolyl)ethyl)naphthalene (4afa)
2-(2-(o-tolyl)-1-(p-tolyl)ethyl)naphthalene (4aga)
2-(2-(4-ethylphenyl)-1-(p-tolyl)ethyl)naphthalene (4aha)
2-(2-(4-isopropylphenyl)-1-(p-tolyl)ethyl)naphthalene (4aia)
2-(2-(4-(tert-butyl)phenyl)-1-(p-tolyl)ethyl)naphthalene (4aja)
2-(2-phenyl-1-(p-tolyl)ethyl)naphthalene (4aka)
2-(2-(4-methoxyphenyl)-1-\((p\)-tolyl\)ethyl\)naphthalene (4ala)
2-(2-(4-nitrophenyl)-1-(p-tolyl)ethyl)naphthalene (4ama)
1-(4-(2-(naphthalen-2-yl)-2-(p-tolyl)ethyl)phenyl)ethan-1-one (4ana)
2-bromo-6-(2-(4-fluorophenyl)-1-(p-tolyl)ethyl)naphthalene (4baa)
4baa
2-fluoro-6-((2-(4-fluorophenyl)-1-(p-tolyl)ethyl)naphthalene (4caa)
2-(2-(4-fluorophenyl)-1-(p-tolyl)ethyl)-6-methoxynaphthalene (4daa)
1-(2-(4-fluorophenyl)-1-(p-tolyl)ethyl)naphthalene (4eaa)
5-(2-(4-fluorophenyl)-1-(p-tolyl)ethyl)benzo[b]thiophene (4faa)
3-(2-(p-tolyl)-1-(4-(trifluoromethyl)phenyl)ethyl)benzo[b]thiophene (4gbi).
2-(2-(4-fluorophenyl)-1-(p-tolyl)ethyl)anthracene (4haa)
9-(2-(4-fluorophenyl)-1-(p-tolyl)ethyl)phenanthrene (4iaa)
2-(1-(4-fluorophenyl)-2-(p-tolyl)propan-2-yl)naphthalene (4kaa)
2-(1-(p-tolyl)-2-(4-(trifluoromethyl)phenyl)propan-2-yl)naphthalene (4kbi)
2-(1-(4-nitrophenyl)-2-(p-tolyl)propan-2-yl)naphthalene (4kma)
2-(1-(4-chlorophenyl)-2-(p-tolyl)propan-2-yl)naphthalene (4kfa)
2,2'(2-(4-(trifluoromethyl)phenyl)propane-1,2-diyl)dinaphthalene (4koi)
2-((1-(p-tolyl)-2-(4-(trifluoromethyl)phenyl)butan-2-yl)naphthalene (4ibi)
2-methoxy-6-(1-(p-tolyl)-2-(4-(trifluoromethyl)phenyl)propan-2-yl)naphthalene (4mbi)
2-(1-p-tolyl)-2-(4-(trifluoromethyl)phenyl)propan-2-yl)benzo[b]thiophene (4nbi)
1-(tert-butyl)-4-(1-(4-methoxyphenyl)-2-(4-nitrophenyl)ethyl)benzene (4omb)
2-(vinyl-2,2-d$_2$)naphthalene (1a-D$_2$)
2-(2-(4-fluorophenyl)-1-(p-tolyl)ethyl-2,2-$d_2$)naphthalene (4aaa-$D_2$)
(E)-2-(4-fluorostyryl)naphthalene (5)
2-(1-(4-chlorophenyl)ethyl)naphthalene (6)
6. References


