Supporting Information

Cu-Mediated Arylselenylation of Aryl Halides with Trifluoromethyl Aryl Selenonium Ylides

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1. General information

All reactions were carried out under a nitrogen atmosphere unless otherwise stated. The NMR spectra were recorded in CDCl$_3$ or CD$_3$COCD$_3$ on a 500 MHz (for $^1$H), 471 MHz (for $^{19}$F), and 126 MHz (for $^{13}$C) spectrometer. All chemical shifts were reported in ppm relative to TMS (0 ppm for $^1$H NMR) and PhOCF$_3$ (58.0 ppm for $^{19}$F NMR) as an internal or external standard, respectively. The coupling constants were reported in Hertz (Hz). The following abbreviations were used to explain the multiplicities: s = singlet, d = doublet, t = triplet, q = quartet, and m = multiplet. The HPLC experiments were carried out on a Wufeng LC-100 II instrument (column: Shodex, C18, 5 μm, 4.6 × 250 mm), and the HPLC yields of the products were determined by using the corresponding pure compounds as the external standards. Melting points were measured and uncorrected. MS experiments were performed on a TOF-Q ESI or EI instrument. Trifluoromethyl aryl selenium ylides (1a-b $^1$ and 1f-j $^1$), dimethyl 2-(phenylselanyl)malonate (4),$^2$ and aryl trifluoromethyl selenoethers$^3$ (starting materials for the synthesis of 1) were synthesized according to the literatures. Solvents were purified according to the literature.$^4$ Other reagents used in the reactions were all purchased from the commercial sources and used without further purification.

2. Screening the optimal reaction conditions for 1b and 2a

Table S1. Reaction of 2a with 1b in the presence of different Cu-catalysts.$^a$

<table>
<thead>
<tr>
<th>Entry</th>
<th>Catalyst</th>
<th>Yield (3b, %)$^b$</th>
<th>Yield (3a', %)$^b$</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CuI</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>CuCl</td>
<td>27</td>
<td>10</td>
</tr>
<tr>
<td>3</td>
<td>CuBr</td>
<td>16</td>
<td>7</td>
</tr>
<tr>
<td>4</td>
<td>CuOAc</td>
<td>54</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>CuSCN</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>CuCN</td>
<td>18</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>CuOTf</td>
<td>40</td>
<td>6</td>
</tr>
<tr>
<td>Entry</td>
<td>Temp. (°C)</td>
<td>Yield (3b, %) &lt;sup&gt;b&lt;/sup&gt;</td>
<td>Yield (3a', %) &lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>-------</td>
<td>---------</td>
<td>-----------------</td>
<td>-----------------</td>
</tr>
<tr>
<td>1</td>
<td>r.t.</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>60</td>
<td>trace</td>
<td>8</td>
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<td>3</td>
<td>80</td>
<td>38</td>
<td>6</td>
</tr>
<tr>
<td>4</td>
<td>100</td>
<td>56</td>
<td>6</td>
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</tbody>
</table>

<sup>a</sup> Reaction condition: a mixture of 2a (0.2 mmol), 1b (0.24 mmol), and CuOAc (0.24 mmol) in DMF (2 mL) was reacted at different temperature for 24 h.  
<sup>b</sup> Yields were determined by HPLC (λ = 253 nm, H<sub>2</sub>O/CH<sub>3</sub>OH = 15:85 (v/v)) using [1,1'-biphenyl]-4-yl(4-nitrophenyl)selane (3b, t<sub>R</sub> = 15.24 min) and 4-(trifluoromethyl)-1,1'-biphenyl (3a', t<sub>R</sub> = 8.54 min) as external standards, respectively.

**Table S3. CuOAc-Catalyzed reaction of 2a with 1b in different solvents.**

<table>
<thead>
<tr>
<th>Entry</th>
<th>Solvent</th>
<th>Yield (3b, %) &lt;sup&gt;b&lt;/sup&gt;</th>
<th>Yield (3a', %) &lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
</table>

<sup>a</sup> Reaction condition: a mixture of 2a (0.2 mmol), 1b (0.2 mmol), and CuOAc (0.24 mmol) in DMF (2 mL) was reacted at 100 °C for 24 h.  
<sup>b</sup> Yields were determined by HPLC (λ = 253 nm, H<sub>2</sub>O/CH<sub>3</sub>OH = 15:85 (v/v)) using [1,1'-biphenyl]-4-yl(4-nitrophenyl)selane (3b, t<sub>R</sub> = 15.24 min) and 4-(trifluoromethyl)-1,1'-biphenyl (3a', t<sub>R</sub> = 8.54 min) as external standards, respectively.
<table>
<thead>
<tr>
<th>Entry</th>
<th>Solvent</th>
<th>Yield (3b, %)</th>
<th>Yield (3a', %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>DMSO</td>
<td>42</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>CH$_3$CN</td>
<td>15</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>DMF</td>
<td><strong>54</strong></td>
<td><strong>3</strong></td>
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</tbody>
</table>

*Reaction condition: a mixture of 2a (0.2 mmol), 1b (0.2 mmol), and Cu (0.2 mmol) in solvent (2 mL) was reacted at 100 °C for 3 h.  
Yields were determined by HPLC ($\lambda = 253$ nm, H$_2$O/CH$_3$OH = 15:85 (v/v)) using [1,1'-biphenyl]-4-yl(4-nitrophenyl)selane (3b, $t_R = 15.24$ min) and 4-(trifluoromethyl)-1,1'-biphenyl (3a', $t_R = 8.54$ min) as external standards, respectively.*
**Table S6.** Reaction of 2a, 1b and CuOAc with different times.\(^a\)

<table>
<thead>
<tr>
<th>Entry</th>
<th>[2a]:[1b]:[Cu]</th>
<th>Yield (3b, %)(^b)</th>
<th>Yield (3a', %)(^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1:1.2:1.2</td>
<td>49</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>1:1.2:2</td>
<td>56</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>1:1.5:1.5</td>
<td>60</td>
<td>12</td>
</tr>
<tr>
<td>4</td>
<td>1:2:2</td>
<td>84, 81(^c)</td>
<td>6</td>
</tr>
<tr>
<td>5(^d)</td>
<td>1:2:2</td>
<td>84</td>
<td>7</td>
</tr>
<tr>
<td>6</td>
<td>1:2:3</td>
<td>62</td>
<td>9</td>
</tr>
<tr>
<td>7</td>
<td>1:2:2.5</td>
<td>59</td>
<td>7</td>
</tr>
<tr>
<td>8</td>
<td>1:2:1.5</td>
<td>56</td>
<td>7</td>
</tr>
<tr>
<td>9</td>
<td>2:1:2</td>
<td>48</td>
<td>7</td>
</tr>
<tr>
<td>10(^e)</td>
<td>1:2:2</td>
<td>14</td>
<td>9</td>
</tr>
<tr>
<td>11(^f)</td>
<td>1:2:2</td>
<td>68</td>
<td>10</td>
</tr>
<tr>
<td>12(^g)</td>
<td>1:2:2</td>
<td>0</td>
<td>trace</td>
</tr>
<tr>
<td>13(^h)</td>
<td>1:2:2</td>
<td>92</td>
<td>4</td>
</tr>
<tr>
<td>14</td>
<td>1:2.5:2.5</td>
<td>72</td>
<td>7</td>
</tr>
<tr>
<td>15</td>
<td>1:3.5:2</td>
<td>58</td>
<td>10</td>
</tr>
</tbody>
</table>

\(^a\) Reaction condition: a mixture of 2a (0.2 mmol), 1b (x equiv), and Cu (y equiv) in DMF (2 mL) was reacted at 100 °C for 3 h.  
\(^b\) Yields were determined by HPLC (λ = 253 nm, H\(_2\)O/CH\(_3\)OH = 15:85 (v/v)) using [1,1'-biphenyl]-4-yl(4-nitrophenyl)selane (3b, \(t_R = 15.24\) min) and 4-(trifluoromethyl)-1,1'-biphenyl (3a', \(t_R = 8.54\) min) as external standards, respectively.  
\(^c\) Isolated yield.  
\(^d\) 6 h.  
\(^e\) CuOAc.  
\(^f\) CuSCN.  
\(^g\) CuOAc, DMSO, 24 h.  
\(^h\) CuOAc, DMSO, 24 h.
### 3. Typical procedures for the synthesis of trifluoromethyl aryl selenium ylide 1

**Procedure A:** In a nitrogen-filled glovebox, an oven-dried flask was charged with p-tolyld trifluoromethyl)selenylation (1.20 g, 5.0 mmol), Rh$_2$(esp)$_2$ (3.8 mg, 0.005 mmol), and CH$_2$Cl$_2$ (40 mL) with stirring. A solution of diazomalonate (0.948 g, 6.0 mmol) in CH$_2$Cl$_2$ (10 mL) was added slowly at room temperature during a period of 30 min. The mixture was heated at 40 °C for 1 h, cooled to room temperature, and concentrated to dryness under the reduced pressure. The residue was purified by column chromatography on silica gel using a mixture of petroleum ether and ethyl acetate (1:1 (v/v)) as eluents to give 0.846 g of 1c as a white solid (91%).

Dimethyl 2-(p-tolyld trifluoromethyl)-λ^4-selanylidene)malonate (1c)
M.p.: 102-103 °C. $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 7.51 (d, $J = 8.1$ Hz, 2H), 7.36 (d, $J = 8.1$ Hz, 2H), 3.70 (s, 6H), 2.43 (s, 3H). $^{19}$F NMR (471 MHz, CDCl$_3$) $\delta$ -45.3 (s, 3F).

$^{13}$C NMR (126 MHz, CDCl$_3$) $\delta$ 166.1, 143.5, 131.3, 128.7, 123.6, 120.5 (q, $J = 357.3$ Hz), 64.9, 51.4, 21.4. IR (KBr): 3077, 3023, 2959, 2851, 1744, 1690, 1649, 1587, 1488, 1440, 1322, 1231, 1210, 1170, 1075, 1056, 1040, 940, 808, 758, 741 cm$^{-1}$. HRMS-ESI (m/z) calcd for C$_{13}$H$_{14}$F$_3$O$_4$Se ([M + H]$^+$): 371.0004; Found: 370.9998.

Dimethyl 2-(phenyl(trifluoromethyl)-$\lambda^4$-selanylidene)malonate (1a)

Light yellow solid (0.801 g, 90%), a mixture of petroleum ether and ethyl acetate (1:1 (v/v)) as eluents for column chromatography. M.p.: 78-80 °C. $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 7.67-7.58 (m, 5H), 3.73 (s, 6H). $^{19}$F NMR (471 MHz, CDCl$_3$) $\delta$ -44.9 (s, 3F).

$^{13}$C NMR (126 MHz, CDCl$_3$) $\delta$ 166.1, 132.5, 130.6, 128.7, 127.0, 120.5 (q, $J = 357.6$ Hz), 64.8, 51.5. IR (KBr): 3090, 3074, 3018, 2960, 2850, 1748, 1697, 1648, 1479, 1440, 1325, 1233, 1205, 1169, 1074, 1055, 999, 941, 759, 741, 685 cm$^{-1}$. HRMS-ESI (m/z) calcd for C$_{12}$H$_{12}$F$_3$O$_4$Se ([M + H]$^+$): 356.9847; Found: 356.9857.

Dimethyl 2-((4-methoxyphenyl)(trifluoromethyl)-$\lambda^4$-selanylidene)malonate (1d)$^1$

Light yellow oil (0.924 g, 96%), a mixture of petroleum ether and ethyl acetate (1:1 (v/v)) as eluents for column chromatography. $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 7.58 (d, $J = 8.9$ Hz, 2H), 7.05 (d, $J = 8.9$ Hz, 2H), 3.86 (s, 3H), 3.70 (s, 6H). $^{19}$F NMR (471 MHz, CDCl$_3$) $\delta$ -45.8 (s, 3F). $^{13}$C NMR (126 MHz, CDCl$_3$) $\delta$ 166.2, 163.1, 131.0, 120.5 (q, $J = 357.7$ Hz), 117.1, 116.1, 65.4, 55.7, 51.4.

Dimethyl 2-((4-chlorophenyl)(trifluoromethyl)-$\lambda^4$-selanylidene)malonate (1e)
White solid (0.317 g, 68%), a mixture of petroleum ether and ethyl acetate (1:1 (v/v)) as eluents for column chromatography. M.p.: 113-115 °C. $^1$H NMR (500 MHz, CDCl$_3$) δ 7.60-7.55 (m, 4H), 3.71 (s, 6H). $^{19}$F NMR (471 MHz, CDCl$_3$) δ -44.7 (s, 3F). $^{13}$C NMR (126 MHz, CDCl$_3$) δ 166.0, 139.5, 130.9, 130.2, 125.1, 120.5 (q, $J = 357.6$ Hz), 65.1, 51.6. IR (KBr): 3098, 3083, 3013, 2994, 2950, 2911, 2843, 1684, 1630, 1439, 1394, 1336, 1239, 1197, 1186, 1161, 1100, 1076, 1005, 813, 764, 737 cm$^{-1}$. HRMS-ESI (m/z) calcd for C$_{12}$H$_{11}$ClF$_3$O$_4$Se ([M + H]$^+$): 390.9458; Found: 390.9452.

Dimethyl 2-((4-cyanophenyl)(trifluoromethyl)-$\lambda^4$-selanylidene)malonate ($1g$)

White solid (0.537 g, 94%), a mixture of petroleum ether and ethyl acetate (1:1 (v/v)) as eluents for column chromatography. M.p.: 125-127 °C. $^1$H NMR (500 MHz, CDCl$_3$) δ 7.86 (d, $J = 8.4$ Hz, 2H), 7.77 (d, $J = 8.4$ Hz, 2H), 3.72 (s, 6H). $^{19}$F NMR (471 MHz, CDCl$_3$) δ -43.6 (s, 3F). $^{13}$C NMR (126 MHz, CDCl$_3$) δ 165.9, 133.8, 130.2, 127.7, 125.7, 121.8, 120.5 (q, $J = 357.5$ Hz), 65.0, 51.6. IR (KBr): 3093, 3071, 2949, 2236, 1678, 1633, 1440, 1326, 1244, 1196, 1187, 1163, 1083, 1053, 1009, 957, 825, 761, 738 cm$^{-1}$. HRMS-ESI (m/z) calcd for C$_{13}$H$_{11}$F$_3$O$_4$Se ([M + H]$^+$): 381.9800; Found: 381.9802.

Procedure B: In a nitrogen-filled glovebox, an oven-dried flask was charged with aryl trifluoromethylselenoether (1 equiv), Rh$_2$(esp)$_2$ (0.1 mol%), and CH$_2$Cl$_2$ with stirring. A solution of diazomalonate (1.2 equiv) in CH$_2$Cl$_2$ was added slowly at room temperature during a period of 30 min. The mixture was heated at 40 °C for 1 h, cooled to room temperature, and concentrated to dryness under the reduced pressure. The residue was purified by crystallization from layering a solution of the crude product in dichloromethane with diethyl ether to afford the desired product ($1b$, $1f$, and $1h$-$j$).

Dimethyl 2-((4-nitrophenyl)(trifluoromethyl)-$\lambda^4$-selanylidene)malonate ($1b$)$^1$
Yellow solid (3.2 g, 80%). M.p.: 113-115 °C. $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 8.42 (d, $J$ = 8.7 Hz, 2H), 7.85 (d, $J$ = 8.7 Hz, 2H), 3.74 (s, 6H). $^{19}$F NMR (471 MHz, CDCl$_3$) $\delta$ -43.5 (s, 3F). $^{13}$C NMR (126 MHz, CDCl$_3$) $\delta$ 165.7, 150.3, 133.7, 130.0, 125.3, 120.5 (q, $J$ = 358.5 Hz), 65.4, 51.8.

Dimethyl 2-([1,1′-biphenyl]-4-yl(trifluoromethyl)-$\lambda^4$-selanylidene)malonate (1f)$^1$

White solid (0.450 g, 52%). M.p.: 122-124 °C. $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 7.77 (d, $J$ = 8.3 Hz, 2H), 7.70 (d, $J$ = 8.3 Hz, 2H), 7.58 (d, $J$ = 7.5 Hz, 2H), 7.48 (t, $J$ = 7.6 Hz, 2H), 7.43 (t, $J$ = 7.2 Hz, 1H), 3.73 (s, 6H). $^{19}$F NMR (471 MHz, CDCl$_3$) $\delta$ -44.9 (s, 3F). $^{13}$C NMR (126 MHz, CDCl$_3$) $\delta$ 166.1, 145.7, 138.9, 129.3, 129.2, 129.1, 128.7, 127.3, 125.4, 120.5 (q, $J$ = 357.0 Hz), 64.9, 51.5.

Dimethyl 2-((3-nitrophenyl)(trifluoromethyl)-$\lambda^4$-selanylidene)malonate (1h)$^1$

Grey solid (0.442 g, 73%). M.p.: 127-129 °C. $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 8.50-8.47 (m, 2H), 7.99 (d, $J$ = 8.1 Hz, 1H), 7.82 (t, $J$ = 8.1 Hz, 1H), 3.74 (s, 6H). $^{19}$F NMR (471 MHz, CDCl$_3$) $\delta$ -43.7 (s, 3F). $^{13}$C NMR (126 MHz, CDCl$_3$) $\delta$ 165.8, 149.1, 134.4, 131.5, 128.9, 127.2, 124.2, 120.5 (q, $J$ = 358.8 Hz), 65.4, 51.8.

Dimethyl 2-((2-nitrophenyl)(trifluoromethyl)-$\lambda^4$-selanylidene)malonate (1i)$^1$

Yellow solid (0.777 g, 53%). M.p.: 116-118 °C. $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 8.52
(dd, J = 7.8, 1.3 Hz, 1H), 7.97 (dd, J = 7.9, 1.3 Hz, 1H), 7.91 (td, J = 7.8, 1.5 Hz, 1H), 7.86 (td, J = 7.9, 1.5 Hz, 1H), 3.70 (s, 6H). $^{19}$F NMR (471 MHz, CDCl$_3$) δ -42.7 (s, 3F). $^{13}$C NMR (126 MHz, CDCl$_3$) δ 166.1, 146.3, 135.7, 133.8, 132.3, 126.7, 122.9, 120.5 (q, J = 357.2 Hz), 65.2, 51.6.

Diethyl 2-((4-nitrophenveny)l(trifluoromethyl)-λ4-selanylidene)malonate (Ij)

Yellow solid (0.483 g, 23%). M.p.: 123-125 °C. $^{1}$H NMR (500 MHz, CDCl$_3$) δ 8.41 (d, J = 8.6 Hz, 2H), 7.86 (d, J = 8.6 Hz, 2H), 4.18 (q, J = 7.1 Hz, 4H), 1.23 (t, J = 7.1 Hz, 6H). $^{19}$F NMR (471 MHz, CDCl$_3$) δ -43.6 (s, 3F). $^{13}$C NMR (126 MHz, CDCl$_3$) δ 165.4, 150.2, 134.0, 130.0, 125.2, 120.5 (q, J = 358.9 Hz), 65.6, 60.7, 14.4. IR (KBr): 3098, 2982, 2953, 1677, 1638, 1601, 1478, 1398, 1373, 1347, 1320, 1233, 1203, 1182, 1088, 1070, 1050, 1007, 849, 764, 739, 708 cm$^{-1}$. HRMS-ESI (m/z) calcd for C$_{12}$H$_{11}$F$_3$NO$_6$Se ([M + H$^+$]): 430.0011; Found: 430.0007.

4. General procedure for the synthesis of diaryl selenides 3

In a nitrogen-filled glovebox, a sealed tube was charged with aryl halides (2, 0.2 mmol), trifluoromethyl aryl selenium ylide (1, 0.4 mmol), CuOAc (48.8 mg, 0.4 mmol), and DMSO (2 mL) with stirring. The mixture was reacted at 100, 120 or 140 °C for 20 h, cooled to room temperature, and diluted with ethyl acetate (60 mL). The organic solution was washed by water (20 × 3 mL), dried over anhydrous Na$_2$SO$_4$, and concentrated to dryness under reduced pressure. The residue was purified by column chromatography on silica gel using petroleum ether or a mixture of petroleum ether and ethyl acetate as eluents to give the title compound (3).

[1,1'-Biphenyl]-4-yl(phenyl)selane (3a)$^5$

White solid (41.5 mg from 100 °C, 67%; 44.6 mg from 120 °C, 72%), petroleum ether as eluent for column chromatography. M.p.: 64-66 °C. $^{1}$H NMR (500 MHz, CDCl$_3$) δ 7.59 (d, J = 7.8 H, 2H), 7.56-7.51 (m, 6H), 7.45 (t, J = 7.4 Hz, 2H), 7.37 (m, 1H), 7.33-7.30 (m, 3H). $^{13}$C NMR (126 MHz, CDCl$_3$) δ 140.4, 140.3, 133.3, 133.1, 131.1,
130.3, 129.4, 128.9, 128.0, 127.5, 127.5, 127.0.

[1, 1′-Biphenyl]-4-yl(4-nitrophenyl)selane (3b)

![Chemical structure](image)

Yellow solid (67.0 mg from 1b, 94%; 39.1 mg from 4-PhC₆H₄Br (140 °C), 55%; 59.7 mg from 1j, 84%), a mixture of petroleum ether and ethyl acetate (40:1 (v/v)) as eluents for column chromatography. M.p.: 95-97 °C. ¹H NMR (500 MHz, CDCl₃) δ 8.06 (d, J = 9.0 Hz, 2H), 7.70 (d, J = 8.4 Hz, 2H), 7.64-7.61 (m, 4H), 7.48 (t, J = 7.5 Hz, 2H), 7.43-7.39 (m, 3H). ¹³C NMR (126 MHz, CDCl₃) δ 146.3, 143.8, 142.4, 139.9, 136.2, 129.9, 129.0, 128.7, 128.0, 127.1, 126.1, 124.0. IR (KBr): 3059, 2924, 1574, 1512, 1474, 1343, 1176, 1107, 1060, 1003, 850, 762, 734, 692 cm⁻¹. HRMS-ESI (m/z) calcd for C₁₈H₁₄NO₂Se ([M + H]+): 356.0184; Found: 356.0178.

(4-Nitrophenyl)(phenyl)selane (3c)⁶

![Chemical structure](image)

Yellow solid (54.2 mg from C₆H₅I, 97%; 39.0 mg from C₆H₅Br (140 °C), 70%), a mixture of petroleum ether and ethyl acetate (80:1 (v/v)) as eluents for column chromatography. M.p.: 56-58 °C. ¹H NMR (500 MHz, CDCl₃) δ 8.03 (d, J = 8.8 Hz, 2H), 7.64 (d, J = 6.8 Hz, 2H), 7.47-7.40 (m, 3H), 7.36 (d, J = 9.0 Hz, 2H). ¹³C NMR (126 MHz, CDCl₃) δ 146.2, 144.0, 135.9, 130.1, 129.7, 129.4, 127.2, 124.0.

(4-Nitrophenyl)(p-tolyl)selane (3d)⁷

![Chemical structure](image)

Yellow solid (49.9 mg from 4-CH₃C₆H₄I, 85%; 34.0 mg from 4-CH₃C₆H₄Br (140 °C), 58%), a mixture of petroleum ether and ethyl acetate (80:1 (v/v)) as eluents for column chromatography. M.p.: 82-84 °C. ¹H NMR (500 MHz, CDCl₃) δ 8.01 (d, J = 8.9 Hz, 2H), 7.53 (d, J = 7.8 Hz, 2H), 7.32 (d, J = 8.9 Hz, 2H), 7.23 (d, J = 7.9, 2H), 2.41 (s, 3H). ¹³C NMR (126 MHz, CDCl₃) δ 146.0, 144.8, 139.8, 136.2, 130.9, 129.2, 123.9, 123.3, 21.3.
(4-Methoxyphenyl)(4-nitrophenyl)selane (3e)

Yellow solid (48.0 mg, 78%; 23.0 mg from 4-MeOC₆H₄Br (140 °C, 20 h), 37%; 32.2 mg from 4-MeOC₆H₄Br (140 °C, 48 h), 52%), a mixture of petroleum ether and ethyl acetate (40:1 (v/v)) as eluents for column chromatography. M.p.: 88-90 °C. ¹H NMR (500 MHz, CDCl₃) δ 8.01 (d, J = 9.0 Hz, 2H), 7.58 (d, J = 8.8 Hz, 2H), 7.28 (d, J = 9.0 Hz, 2H), 6.95 (d, J = 8.9, 2H), 3.86 (s, 3H). ¹³C NMR (126 MHz, CDCl₃) δ 160.9, 145.9, 145.4, 138.2, 128.7, 123.9, 116.8, 115.8, 55.4.

(4-(Benzyloxy)phenyl)(4-nitrophenyl)selane (3f)

Yellow solid (48.4 mg, 63%; 47.7 mg from 4-BnOC₆H₄Br (140 °C), 62%), a mixture of petroleum ether and ethyl acetate (20:1 (v/v)) as eluents for column chromatography. M.p.: 107-109 °C. ¹H NMR (500 MHz, CDCl₃) δ 8.02 (d, J = 8.9 Hz, 2H), 7.58 (d, J = 8.7 Hz, 2H), 7.46 (d, J = 7.1 Hz, 2H), 7.42 (d, J = 7.2 Hz, 2H), 7.36 (t, J = 7.0, 1H), 7.29 (d, J = 9.0 Hz, 2H), 7.03 (d, J = 8.5 Hz, 2H), 5.12 (s, 2H). ¹³C NMR (126 MHz, CDCl₃) δ 160.1, 146.0, 145.3, 138.2, 128.8, 128.7, 128.2, 127.5, 123.9, 117.3, 116.7, 70.2. IR (KBr): 3084, 3063, 3028, 2929, 2876, 2848, 1588, 1573, 1510, 1492, 1359, 1345, 1281, 1242, 1176, 1108, 1079, 1059, 1012, 915, 840, 811, 751, 736, 700, 654 cm⁻¹. HRMS-ESI (m/z) calcd for C₁₉H₁₉N₂O₃Se ([M + NH₄]+): 403.0555; Found: 403.0554.

(4-(Tert-butyl)phenyl)(4-nitrophenyl)selane (3g)

Yellow solid (63.5 mg, 95%; 40.5 mg from 4-t-BuC₆H₄Br (140 °C), 60%), a mixture of petroleum ether and ethyl acetate (40:1 (v/v)) as eluents for column chromatography. M.p.: 66-68 °C. ¹H NMR (500 MHz, CDCl₃) δ 8.03 (d, J = 8.9 Hz,
2H), 7.56 (d, J = 8.6 Hz, 2H), 7.43 (d, J = 8.5 Hz, 2H), 7.35 (d, J = 8.8, 2H), 1.36 (s, 9H). $^{13}$C NMR (126 MHz, CDCl$_3$) δ 152.9, 146.1, 144.4, 135.8, 129.5, 127.2, 123.9, 123.6, 34.8, 31.2. IR (KBr): 3100, 3061, 3027, 2952, 2901, 2867, 2876, 1595, 1575, 1509, 1474, 1398, 1341, 1323, 1176, 1113, 1075, 1061, 1009, 853, 838, 827, 739, 678 cm$^{-1}$. HRMS-ESI (m/z) calcd for C$_{16}$H$_{18}$NO$_2$Se ([M + H$^+$]): 336.0497; Found: 336.0483.

(4-Fluorophenyl)(4-nitrophenyl)selane (3h)$^8$

Yellow solid (41.3 mg, 70%), a mixture of petroleum ether and ethyl acetate (40:1 (v/v)) as eluents for column chromatography. M.p.: 71-73 °C. $^1$H NMR (500 MHz, CDCl$_3$) δ 8.04 (d, J = 9.0 Hz, 2H), 7.64 (m, 2H), 7.32 (d, J = 8.9 Hz, 2H), 7.12 (t, J = 8.7 Hz, 2H). $^{19}$F NMR (471 MHz, CDCl$_3$) δ -110.7 (m, 1F). $^{13}$C NMR (126 MHz, CDCl$_3$) δ 163.6 (d, J = 250.5 Hz), 146.3, 143.1, 137.1, 135.9, 130.3, 129.9, 125.5, 124.1.

(4-Chlorophenyl)(4-nitrophenyl)selane (3i)$^9$

Yellow solid (52.3 mg, 84%), a mixture of petroleum ether and ethyl acetate (40:1 (v/v)) as eluents for column chromatography. M.p.: 82-84 °C. $^1$H NMR (500 MHz, CDCl$_3$) δ 8.04 (d, J = 8.7 Hz, 2H), 7.56 (d, J = 8.5 Hz, 2H), 7.38-7.35 (m, 4H). $^{13}$C NMR (126 MHz, CDCl$_3$) δ 146.4, 143.1, 137.1, 135.9, 130.3, 129.9, 125.5, 124.1.

(4-Bromophenyl)(4-nitrophenyl)selane (3j)

Yellow solid (39.6 mg, 56%), a mixture of petroleum ether and ethyl acetate (40:1 (v/v)) as eluents for column chromatography. M.p.: 97-99 °C. $^1$H NMR (500 MHz, acetone-d$_6$) δ 8.14 (d, J = 8.7 Hz, 2H), 7.65 (d, J = 8.6 Hz, 2H), 7.62 (d, J = 8.6 Hz, 2H), 7.57 (d, J = 8.7 Hz, 2H). $^{13}$C NMR (126 MHz, acetone-d$_6$) δ 146.7, 142.4, 137.3, 133.2, 130.5, 126.7, 124.1, 123.4. IR (KBr): 3088, 3019, 2920, 2840, 1912, 1817,
1645, 1574, 1466, 1341, 1321, 1177, 1109, 1064, 1005, 851, 842, 808, 738, 709, 678 cm$^{-1}$. HRMS-ESI (m/z) calcd for C$_{12}$H$_9$BrNO$_2$Se ([M + H]$^+$): 357.8976; Found: 357.8973.

(4-Nitrophenyl)(4-(trifluoromethyl)phenyl)selane (3k)

Yellow solid (49.6 mg, 71%), a mixture of petroleum ether and ethyl acetate (40:1 (v/v)) as eluents for column chromatography. M.p.: 81-83 °C. $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 8.10 (d, $J$ = 9.0 Hz, 2H), 7.68 (d, $J$ = 8.2 Hz, 2H), 7.62 (d, $J$ = 8.2 Hz, 2H), 7.48 (d, $J$ = 8.9 Hz, 2H). $^{19}$F NMR (471 MHz, CDCl$_3$) $\delta$ -62.9 (s, 3F). $^{13}$C NMR (126 MHz, CDCl$_3$) $\delta$ 146.9, 141.2, 134.7, 133.2, 131.5, 131.0 (q, $J$ = 32.8 Hz), 126.7 (q, $J$ = 3.7 Hz), 124.3, 123.8 (q, $J$ = 272.2 Hz). IR (KBr): 3097, 3068, 2962, 2920, 2850, 1595, 1577, 1475, 1398, 1341, 1324, 1168, 1123, 1100, 1081, 1056, 1016, 1009, 958, 852, 835, 817, 737, 690 cm$^{-1}$. HRMS-ESI (m/z) calcd for C$_{13}$H$_9$F$_3$NO$_2$Se ([M + H]$^+$): 347.9745; Found: 347.9751.

Ethyl 4-((4-nitrophenyl)selanyl)benzoate (3l)

Yellow solid (57.9 mg, 82%; 36.1 mg from 4-EtO$_2$C$_6$H$_5$Br (140 °C), 60%), a mixture of petroleum ether and ethyl acetate (2:1 (v/v)) as eluents for column chromatography. M.p.: 111-113 °C. $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 8.07 (d, $J$ = 8.9 Hz, 2H), 8.01 (d, $J$ = 8.2 Hz, 2H), 7.61 (d, $J$ = 8.3 Hz, 2H), 7.46 (d, $J$ = 8.9 Hz, 2H), 4.39 (q, $J$ = 7.2 Hz, 2H), 1.40 (t, $J$ = 7.3 Hz, 3H). $^{13}$C NMR (126 MHz, CDCl$_3$) $\delta$ 165.9, 146.8, 141.6, 134.3, 134.2, 131.4, 130.8, 130.8, 124.2, 61.3, 14.3. IR (KBr): 3090, 3059, 3038, 2979, 2925, 2909, 2850, 1945, 1817, 1702, 1589, 1575, 1517, 1488, 1474, 1400, 1369, 1349, 1287, 1274, 1184, 1106, 1058, 1011, 852, 760, 739, 688, 683 cm$^{-1}$. HRMS-ESI (m/z) calcd for C$_{15}$H$_{14}$NO$_4$Se ([M + H]$^+$): 352.0083; Found: 352.0078.

1-(4-((4-Nitrophenyl)selanyl)phenyl)ethan-1-one (3m)
Yellow solid (21.0 mg from CuOAc/DMF/20 h, 33%; 31.2 mg from Cu/DMF/3 h, 49%), a mixture of petroleum ether and ethyl acetate (10:1 (v/v)) as eluents for column chromatography. M.p.: 125-127 °C. \(^1\)H NMR (500 MHz, CDCl\(_3\)) \(\delta\) 8.10 (d, \(J = 8.9\) Hz, 2H), 7.92 (d, \(J = 8.4\) Hz, 2H), 7.63 (d, \(J = 8.3\) Hz, 2H), 7.50 (d, \(J = 8.8\) Hz, 2H), 2.62 (s, 3H). \(^1\)C NMR (126 MHz, CDCl\(_3\)) \(\delta\) 197.1, 147.0, 141.1, 137.1, 135.1, 134.1, 131.8, 129.5, 124.2, 26.6. IR (KBr): 3085, 3053, 3003, 2958, 2920, 2849, 1681, 1572, 1514, 1477, 1394, 1344, 1319, 1267, 1181, 1105, 1060, 1008, 957, 852, 827, 737, 682 cm\(^{-1}\). HRMS-ESI (m/z) calcd for C\(_{14}\)H\(_{12}\)NO\(_3\)Se ([M + H\(^+\)]: 321.9977; Found: 321.9983.

\(\text{N,N-Dimethyl-4-((4-nitrophenyl)selanyl)benzamide (3n)}\)

Yellow solid (42.3 mg, 61%), a mixture of petroleum ether and ethyl acetate (2:1 (v/v)) as eluents for column chromatography. M.p.: 97-99 °C. \(^1\)H NMR (500 MHz, CDCl\(_3\)) \(\delta\) 8.04 (d, \(J = 8.9\) Hz, 2H), 7.62 (d, \(J = 8.1\) Hz, 2H), 7.43-7.39 (m, 4H), 3.12 (s, 3H), 3.00 (s, 3H). \(^1\)C NMR (126 MHz, CDCl\(_3\)) \(\delta\) 170.6, 146.5, 142.6, 137.1, 135.3, 135.2, 130.5, 129.4, 128.6, 39.5, 35.4. IR (KBr): 3077, 3043, 2921, 2850, 1790, 1630, 1593, 1574, 1517, 1472, 1404, 1343, 1264, 1085, 1068, 1009, 851, 828, 736 cm\(^{-1}\). HRMS-ESI (m/z) calcd for C\(_{15}\)H\(_{15}\)N\(_2\)O\(_3\)Se ([M + H\(^+\)]: 351.0242; Found: 351.0250.

4-((4-Nitrophenyl)selanyl)benzonitrile (3o)

Yellow solid (27.2 mg from 4-NCC\(_6\)H\(_4\)I, 45%; 32.0 mg from 4-NCC\(_6\)H\(_4\)Br (140 °C), 53%), a mixture of petroleum ether and ethyl acetate (10:1 (v/v)) as eluents for column chromatography. M.p.: 134-136 °C. \(^1\)H NMR (500 MHz, CDCl\(_3\)) \(\delta\) 8.14 (d, \(J = 8.6\) Hz, 2H), 7.62-7.55 (m, 6H). \(^1\)C NMR (126 MHz, CDCl\(_3\)) \(\delta\) 147.4, 139.4, 136.1, 133.7, 133.0, 132.8, 124.5, 118.1, 112.2. IR (KBr): 3091, 3052, 3023, 2922, 2850,
2230, 1921, 1798, 1655, 1596, 1574, 1510, 1481, 1346, 1177, 1104, 1059, 1011, 851, 826, 737, 681, 547 cm⁻¹. HRMS-ESI (m/z) calcd for C₁₃H₁₂N₃O₂Se ([M + NH₄]⁺): 322.0089; Found: 322.0082.

4-((4-Nitrophenyl)selanyl)benzaldehyde (3p)

Yellow solid (53.9 mg, 88%), a mixture of petroleum ether and ethyl acetate (10:1 (v/v)) as eluents for column chromatography. M.p.: 135-137 °C. ¹H NMR (500 MHz, CDCl₃) δ 10.02 (s, 1H), 8.13 (d, J = 8.8 Hz, 2H), 7.84 (d, J = 8.1 Hz, 2H), 7.66 (d, J = 8.1 Hz, 2H), 7.56 (d, J = 8.8 Hz, 2H). ¹³C NMR (126 MHz, CDCl₃) δ 191.1, 147.2, 140.2, 137.5, 136.0, 133.8, 132.4, 130.6, 124.3. IR (KBr): 3090, 3054, 2832, 2736, 1696, 1587, 1564, 1508, 1474, 1384, 1346, 1208, 1168, 1104, 1058, 1010, 852, 836, 737, 680 cm⁻¹. HRMS-ESI (m/z) calcd for C₁₃H₁₀NO₃Se ([M + H⁺): 307.9820; Found: 307.9822.

(4-Nitrophenyl)(o-tolyl)selane (3q)

Yellow solid (50.0 mg, 85%), a mixture of petroleum ether and ethyl acetate (40:1 (v/v)) as eluents for column chromatography. M.p.: 61-63 °C. ¹H NMR (500 MHz, CDCl₃) δ 8.03 (d, J = 8.8 Hz, 2H), 7.65 (d, J = 7.5 Hz, 1H), 7.40-7.38 (m, 2H), 7.28 (d, J = 8.6 Hz, 2H), 7.21 (m, 1H), 2.42 (s, 3H). ¹³C NMR (126 MHz, CDCl₃) δ 146.1, 143.8, 142.4, 137.4, 131.0, 130.2, 129.2, 127.9, 127.4, 124.0, 22.8. IR (KBr): 3087, 3064, 2999, 2957, 2924, 2854, 1594, 1571, 1506, 1475, 1359, 1341, 1317, 1184, 1109, 1064, 1033, 1101, 851, 836, 750, 737, 677 cm⁻¹. HRMS-ESI (m/z) calcd for C₁₃H₁₂NO₂Se ([M + H⁺): 294.0028; Found: 294.0032.

(3-Nitrophenyl)(4-nitrophenyl)selane (3r)

S16
Yellow solid (49.7 mg, 77%), a mixture of petroleum ether and ethyl acetate (40:1 (v/v)) as eluents for column chromatography. M.p.: 120-122 °C. $^1$H NMR (500 MHz, acetone-d$_6$) $\delta$ 8.44 (s, 1H), 8.31 (d, $J = 8.2$ Hz, 1H), 8.17 (d, $J = 8.7$ Hz, 2H), 8.07 (d, $J = 7.8$ Hz, 1H), 7.76 (t, $J = 7.9$ Hz, 1H), 7.70 (d, $J = 8.6$ Hz, 2H). $^{13}$C NMR (126 MHz, acetone-d$_6$) $\delta$ 148.9, 147.2, 140.7, 140.6, 131.8, 131.2, 130.2, 128.9, 124.3, 123.7. IR (KBr): 3093, 3019, 3075, 2919, 2850, 1648, 1596, 1576, 1525, 1476, 1345, 1184, 1109, 1058, 870, 852, 835, 802, 729, 670 cm$^{-1}$. HRMS-ESI (m/z) calcd for C$_{12}$H$_9$N$_2$O$_4$Se ([M + H]$^+$): 324.9722; Found: 324.9724.

Mesityl(4-nitrophenyl)selane (3s)$^{10}$

Yellow solid (53.9 mg, 84%), a mixture of petroleum ether and ethyl acetate (40:1 (v/v)) as eluents for column chromatography. M.p.: 89-91 °C. $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 7.98 (d, $J = 8.9$ Hz, 2H), 7.14 (d, $J = 8.9$ Hz, 2H), 7.06 (s, 2H), 2.42 (s, 6 H), 2.35 (s, 3H). $^{13}$C NMR (126 MHz, CDCl$_3$) $\delta$ 145.7, 144.8, 143.7, 140.3, 129.4, 127.7, 125.1, 124.0, 24.1, 21.1.

Naphthalen-1-yl(4-nitrophenyl)selane (3t)$^{11}$

Yellow solid (51.7 mg, 79%), a mixture of petroleum ether and ethyl acetate (40:1 (v/v)) as eluents for column chromatography. M.p.: 82-84 °C. $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 8.27 (d, $J = 8.0$ Hz, 1H), 8.02 (d, $J = 7.6$ Hz, 2H), 7.96 (d, $J = 8.7$ Hz, 2H), 7.92 (d, $J = 7.6$ Hz, 1H), 7.58-7.49 (m, 3H), 7.23 (d, $J = 8.7$ Hz, 2H). $^{13}$C NMR (126 MHz, CDCl$_3$) $\delta$ 146.1, 143.9, 136.8, 134.6, 134.5, 131.2, 129.1, 128.9, 127.7, 126.8, 126.2, 126.0, 123.9.

4-((4-Nitrophenyl)selanyl)dibenzo[b,d]furan (3u)
Yellow solid (57.6 mg, 78%), a mixture of petroleum ether and ethyl acetate (40:1 (v/v)) as eluents for column chromatography. M.p.: 143-145 °C. $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 8.08 (d, $J = 7.6$ Hz, 1H), 8.02-7.98 (m, 3H), 7.71 (d, $J = 7.5$ Hz, 1H), 7.58 (d, $J = 8.2$ Hz, 1H), 7.49 (t, $J = 7.3$ Hz, 1H), 7.41-7.38 (m, 4H). $^{13}$C NMR (126 MHz, CDCl$_3$) $\delta$ 156.7, 156.0, 146.4, 142.2, 134.7, 129.9, 127.9, 125.2, 124.1, 124.0, 124.0, 123.3, 122.5, 121.1, 112.0, 109.5. IR (KBr): 3101, 3054, 3019, 2835, 1787, 1664, 1593, 1575, 1503, 1475, 1466, 1447, 1408, 1341, 1318, 1260, 1220, 1183, 1142, 1108, 1066, 1031, 1010, 850, 844, 750, 737 cm$^{-1}$. HRMS-ESI (m/z) calcd for C$_{18}$H$_{12}$NO$_3$Se ([M + H]$^+$): 369.9977; Found: 369.9977.

4-((4-Nitrophenyl)selanyl)dibenzo[b,d]thiophene (3v)

Yellow solid (59.9 mg, 78%), a mixture of petroleum ether and ethyl acetate (40:1 (v/v)) as eluents for column chromatography. M.p.: 154-156 °C. $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 8.28 (d, $J = 7.9$ Hz, 1H), 8.17 (m, 1H), 8.00 (d, $J = 8.6$ Hz, 2H), 7.83-7.81 (m, 2H), 7.54-7.48 (m, 3H) 7.33 (d, $J = 8.8$ Hz, 2H). $^{13}$C NMR (126 MHz, CDCl$_3$) $\delta$ 147.3, 146.4, 141.9, 139.3, 136.5, 136.0, 135.2, 129.5, 127.4, 125.7, 124.8, 124.1, 123.1, 122.9, 122.2, 120.3. IR (KBr): 3090, 3060, 2918, 2849, 1642, 1594, 1575, 1509, 1382, 1343, 1246, 1102, 1063, 1045, 1028, 1008, 851, 836, 797, 756, 738, 679 cm$^{-1}$. HRMS-ESI (m/z) calcd for C$_{18}$H$_{12}$NO$_2$SSe ([M + H]$^+$): 385.9748; Found: 385.9755.

[1,1'-Biphenyl]-4-yl($\rho$-tolyl)selane (3w)$^9$
White solid (30.6 mg from 100 °C, 47%; 41.8 mg from 120 °C, 65%), petroleum ether as eluent for column chromatography. M.p.: 98-100 °C. $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 7.58 (d, $J = 8.0$ Hz, 2H), 7.49-7.43 (m, 8H), 7.36 (t, $J = 6.9$ Hz, 1H), 7.15 (d, $J = 7.6$ Hz, 2H), 2.37 (s, 3H). $^{13}$C NMR (126 MHz, CDCl$_3$) $\delta$ 140.5, 139.9, 137.8, 134.0, 132.4, 131.3, 130.3, 128.8, 127.9, 127.4, 127.0, 126.9, 21.2.

[1,1'-Biphenyl]-4-yl(4-methoxyphenyl)selane (3x)$^9$

White solid (17.2 mg from 100 °C, 25%; 37.1 mg from 120 °C, 54%), a mixture of petroleum ether and ethyl acetate (40:1 (v/v)) as eluents for column chromatography. M.p.: 75-77 °C. $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 7.57-7.55 (m, 4H), 7.47-7.40 (m, 6H), 7.34 (t, $J = 7.3$ Hz, 1H), 6.89 (d, $J = 8.7$ Hz, 2H), 3.83 (s, 3H). $^{13}$C NMR (126 MHz, CDCl$_3$) $\delta$ 159.9, 140.5, 139.5, 136.6, 132.4, 131.3, 128.8, 127.8, 127.3, 126.9, 112.0, 115.2, 55.3.

[1,1'-Biphenyl]-4-yl(4-chlorophenyl)selane (3y)$^9$

White solid (55.7 mg, 81%), petroleum ether as eluent for column chromatography. M.p.: 119-121 °C. $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 7.61 (d, $J = 7.8$ Hz, 2H), 7.58-7.54 (m, 4H), 7.50-7.45 (m, 4H), 7.40 (t, $J = 7.5$ Hz, 1H), 7.29 (d, $J = 8.4$ Hz, 2H). $^{13}$C NMR (126 MHz, CDCl$_3$) $\delta$ 140.7, 140.3, 134.2, 133.6, 133.6, 129.7, 129.6, 128.9, 128.2, 127.6, 127.0.

Di([1,1'-biphenyl]-4-yl)selane (3z)$^{12}$
White solid (47.4 mg from 100 °C, 61%; 51.3 mg from 120 °C, 66%), petroleum ether as eluent for column chromatography. M.p.: 177-179 °C. \(^1\)H NMR (500 MHz, CDCl\(_3\)) \(\delta\) 7.61 (d, \(J = 7.6\) Hz, 8H), 7.55 (d, \(J = 7.8\) Hz, 4H), 7.47 (t, \(J = 7.3\) Hz, 4H), 7.38 (t, \(J = 7.3\) Hz, 2H). \(^1^3\)C NMR (126 MHz, CDCl\(_3\)) \(\delta\) 140.4, 140.4, 133.4, 130.2, 128.9, 128.1, 127.5, 127.0.

4-([1,1’-Biphenyl]-4-ylselanyl)benzonitrile (3aa)

White solid (63.6 mg, 95%), a mixture of petroleum ether and ethyl acetate (20:1 (v/v)) as eluents for column chromatography. M.p.: 131-133 °C. \(^1\)H NMR (500 MHz, CDCl\(_3\)) \(\delta\) 7.67 (d, \(J = 8.2\) Hz, 2H), 7.61 (d, \(J = 7.5\) Hz, 4H), 7.49-7.46 (m, 4H). 7.41-7.39 (m, 3H). \(^1^3\)C NMR (126 MHz, CDCl\(_3\)) \(\delta\) 142.1, 140.9, 139.9, 136.0, 132.4, 130.4, 129.0, 128.6, 127.9, 127.1, 126.4, 118.8, 109.8. IR (KBr): 3052, 3028, 2924, 2853, 2227, 1587, 1552, 1481, 1474, 1445, 1391, 1181, 1063, 1016, 1004, 833, 812, 763, 715, 695 cm\(^{-1}\). HRMS-ESI (m/z) calcd for C\(_{19}\)H\(_{14}\)NSe ([M + H]\(^+\)): 336.0286; Found: 336.0285.

[1,1’-Biphenyl]-4-yl(3-nitrophenyl)selane (3ab)

Yellow solid (47.4 mg, 67%), a mixture of petroleum ether and ethyl acetate (40:1 (v/v)) as eluents for column chromatography. M.p.: 95-97 °C. \(^1\)H NMR (500 MHz, CDCl\(_3\)) \(\delta\) 8.27 (m, 1H), 8.07 (dd, \(J = 8.2, 1.0\) Hz, 1H), 7.70 (d, \(J = 7.7\) Hz, 1H), 7.65 (d, \(J = 8.2\) Hz, 2H), 7.61-7.58 (m, 4H), 7.47 (t, \(J = 7.5\) Hz, 2H), 7.43-7.37 (m, 2H). \(^1^3\)C NMR (126 MHz, CDCl\(_3\)) \(\delta\) 148.7, 141.8, 140.0, 137.1, 135.1, 134.8, 129.9, 128.9, 128.6, 127.9, 127.4, 127.1, 125.9, 121.7. IR (KBr): 3098, 3049, 2919, 2855, 1522, 1477, 1346, 1004, 868, 836, 802, 763, 758, 729, 695 cm\(^{-1}\). HRMS-ESI (m/z) calcd for
C_{18}H_{14}NO_{2}Se ([M + H]^+): 356.0184; Found: 356.0188.

[1,1'-Biphenyl]-4-yl(2-nitrophenyl)selane (3ac)

Yellow solid (27.7 mg, 39%), a mixture of petroleum ether and ethyl acetate (40:1 (v/v)) as eluents for column chromatography. M.p.: 121-123 °C. ¹H NMR (500 MHz, CDCl₃) δ 8.34 (dd, J = 8.2, 0.9 Hz, 1H), 7.78 (d, J = 8.1 Hz, 2H), 7.69 (d, J = 8.1 Hz, 2H), 7.66 (d, J = 7.5 Hz, 2H), 7.50 (t, J = 7.4 Hz, 2H), 7.41 (t, J = 7.4 Hz, 1H), 7.34 (t, J = 7.6 Hz, 1H), 7.29 (t, J = 7.4 Hz, 1H), 7.10 (d, J = 8.0 Hz, 1H). ¹³C NMR (126 MHz, CDCl₃) δ 145.7, 142.8, 140.0, 137.8, 136.0, 133.7, 130.3, 129.0, 128.7, 128.0, 127.2, 127.0, 126.1, 125.8. IR (KBr): 3055, 3023, 2963, 2921, 2852, 1732, 1633, 1589, 1568, 1508, 1474, 1448, 1331, 1307, 1169, 1097, 1035, 1006, 875, 851, 830, 758, 724, 693 cm⁻¹. HRMS-ESI (m/z) calcd for C_{18}H_{14}NO_{2}Se ([M + H]^+): 356.0184; Found: 356.0189.

5. Control experiments

5.1. Cu-Mediated reactions of 2a with trifluoromethyl aryl sulfonium ylide and trifluoromethyl aryl selenium ylides under the same conditions.

In a nitrogen-filled glovebox, a sealed tube was charged with 4-iodo-1,1'-biphenyl (2a, 56.0 mg, 0.2 mmol), 1a' or 1a or 1b (0.4 mmol), Cu (25.6 mg, 0.4 mmol), and DMSO or DMF (2 mL) with stirring. The mixture was reacted at 100 °C for 20 h and cooled to room temperature. The yields of 3a' and 4-PhC₆H₄SPh or 3a or 3b were determined by HPLC (λ = 253 nm, H₂O/CH₃OH = 15:85 (v/v)) using 4-(trifluoromethyl)-1,1'-biphenyl (tᵣ = 8.54 min) and [1,1'-biphenyl]-4-yl(phenyl)sulfane (tᵣ = 17.04 min) or [1,1'-biphenyl]-4-yl(phenyl)selane (tᵣ = 18.78 min) or [1,1'-biphenyl]-4-yl(4-nitrophenyl)selane (tᵣ = 15.24 min) as external standards, respectively.
5.2. CuOAc-Mediated reactions of 2a with trifluoromethyl aryl sulfonium ylide and trifluoromethyl aryl selenium ylides under the same conditions.

In a nitrogen-filled glovebox, a sealed tube was charged with 4-iodo-1,1'-biphenyl (2a, 56.0 mg, 0.2 mmol), 1b or 1a or 1a’ (0.4 mmol), CuOAc (48.8 mg, 0.4 mmol), and DMSO or DMF (2 mL) with stirring. The mixture was reacted at 100 °C for 20 h and cooled to room temperature. The yields of 3a’ and 3b or 3a or 4-PhC₆H₄SPh were determined by HPLC (λ = 253 nm, H₂O/CH₃OH = 15:85 (v/v)) using 4-
(trifluoromethyl)-1,1′-biphenyl ($t_R = 8.54$ min) and [1,1′-biphenyl]-4-yl(4-nitrophenyl)selane ($t_R = 15.24$ min) or [1,1′-biphenyl]-4-yl(phenyl)selane ($t_R = 18.78$ min) or [1,1′-biphenyl]-4-yl(phenyl)sulfane ($t_R = 17.04$ min) as external standards, respectively.

The $^{19}$F NMR spectrum of the reaction mixture (equation 8)

29.9 mg of PhOCF$_3$ was added to the reaction mixture as an internal standard. The yield of 4-(trifluoromethyl)-1,1′-biphenyl was calculated to be 5% and that of (4-
nitrophenyl)(trifluoromethyl)selane was found to be 19% based on PhOCF₃ added.

5.3. CuOAc-Mediated decomposition of 1a in the absence of aryl halide.

In a nitrogen-filled glovebox, a sealed tube was charged with dimethyl 2-(phenyl(trifluoromethyl)-\(\lambda^4\)-selanylidene)malonate (1a, 71.2 mg, 0.2 mmol), CuOAc (24.4 mg, 0.2 mmol), and DMSO (2 mL) with stirring. The mixture was reacted at 100 °C for 20 h and cooled to room temperature. 13.2 mg of PhOCF₃ was added as an internal standard and the yield of PhSeCF₃ (6) was measured by \(^{19}\text{F NMR}\) spectroscopy (38%). The reaction mixture was then diluted by ethyl acetate (60 mL). The organic solution was washed with water (20 × 3 mL), dried over anhydrous Na₂SO₄, and concentrated to dryness under reduced pressure. The residue was purified by column chromatography on silica gel using petroleum ether and a mixture of petroleum ether and ethyl acetate (40:1 to 10:1 (v/v)) as eluents to give 12.3 mg of 5 (39%), 4.0 mg of 4 (7%), and 3.5 mg of 7 (13%), respectively.

The \(^{19}\text{F NMR}\) spectrum of the reaction mixture (after addition of 13.2 mg PhOCF₃ and before workup)
1,2-Diphenyldiselenane (5)$^{13}$

![1,2-Diphenyldiselenane](image)

Yellow solid, petroleum ether for column chromatography. $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 7.64 (d, $J = 7.6$ Hz, 4H), 7.31-7.27 (m, 6H). $^{13}$C NMR (126 MHz, CDCl$_3$) $\delta$ 131.5, 130.9, 129.2, 127.7.

Dimethyl 2-(phenylselanylmalonate (4)$^2$

![Dimethyl 2-(phenylselanylmalonate](image)

Yellow oil, a mixture of petroleum ether and ethyl acetate (20:1 (v/v)) as eluents for column chromatography. $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 7.66 (d, $J = 7.2$ Hz, 2H), 7.36 (t, $J = 7.2$ Hz, 1H), 7.32 (t, $J = 7.1$ Hz, 2H), 4.50 (s, 1H), 3.72 (s, 6H). $^{13}$C NMR (126 MHz, CDCl$_3$) $\delta$ 167.6, 135.7, 129.3, 129.2, 127.4, 53.1, 45.8.

Tetramethyl ethene-1,1,2,2-tetracarboxylate (7)$^{14}$

![Tetramethyl ethene-1,1,2,2-tetracarboxylate](image)

Light yellow solid, a mixture of petroleum ether and ethyl acetate (10:1 (v/v)) as eluents for column chromatography. $^1$H NMR (500 MHz, CDCl$_3$) $\delta$ 3.87 (s, 12 H). $^{13}$C NMR (126 MHz, CDCl$_3$) $\delta$ 162.6, 135.4, 53.4.

5.4. CuOAc-Mediated decomposition of 4 in the absence of aryl halide.

![CuOAc-Mediated decomposition of 4](image)

In a nitrogen-filled glovebox, a sealed tube was charged with dimethyl 2-(phenylselanylmalonate (4)$^2$ 57.6 mg, 0.2 mmol), CuOAc (24.4 mg, 0.2 mmol), and DMSO (2 mL) with stirring. The mixture was reacted at 100 °C for 20 h, cooled to room temperature, and diluted with ethyl acetate (60 mL). The organic solution was washed with water (20 × 3 mL), dried over anhydrous Na$_2$SO$_4$, and concentrated to dryness under reduced pressure. The residue was purified by column chromatography.
on silica gel using petroleum ether as eluent to give 17.1 mg of 5 (54%).

5.5. CuOAc-Mediated reactions of 4, 5 and 6 with 2a under the standard conditions.

\[
\begin{align*}
\text{Ph}_2\text{Se} \cdot \text{CO}_2\text{Me} \quad & + \quad \text{Ph} \quad \downarrow \quad \text{CuOAc (2 equiv)} \\
\text{4} \quad (2 \text{ equiv}) \quad & \quad \text{Ph} \quad \text{I} \quad \text{100 °C, 20 h} \\
\text{Ph}_2\text{Se} \cdot \text{Ph} \quad \downarrow \quad \text{3a, 88%}
\end{align*}
\]

In a nitrogen-filled glovebox, a sealed tube was charged with dimethyl 2-(phenylselanyl)malonate (4, 2 115.2 mg, 0.4 mmol), 4-iodo-1,1'-biphenyl (2a, 55.6 mg, 0.2 mmol), CuOAc (48.8 mg, 0.4 mmol), and DMSO (2 mL) with stirring. The mixture was reacted at 100 °C for 20 h and cooled to room temperature. The yield of 3a was determined by HPLC (λ = 253 nm, H₂O/CH₃OH = 15:85 (v/v)) using [1,1'-biphenyl]-4-yl(phenyl)selane (tᵢ = 18.78 min) as an external standard (88%).

\[
\begin{align*}
(\text{PhSe})_2 \quad & + \quad \text{Ph} \quad \downarrow \quad \text{CuOAc (2 equiv)} \\
\text{5} \quad (1 \text{ equiv}) \quad & \quad \text{Ph} \quad \text{I} \quad \text{DMSO, 100 °C, 20 h} \\
\text{Ph}_2\text{Se} \cdot \text{Ph} \quad \downarrow \quad \text{3a, 92%}
\end{align*}
\]

In a nitrogen-filled glovebox, a sealed tube was charged with 1,2-diphenyldiselenane (5, 62.8 mg, 0.2 mmol), 4-iodo-1,1'-biphenyl (2a, 56.0 mg, 0.2 mmol), CuOAc (48.8 mg, 0.4 mmol), and DMSO (2 mL) with stirring. The mixture was reacted at 100 °C for 20 h and cooled to room temperature. The yield of 3a was determined by HPLC (λ = 253 nm, H₂O/CH₃OH = 15:85 (v/v)) using [1,1'-biphenyl]-4-yl(phenyl)selane (tᵢ = 18.78 min) as an external standard (92%).

\[
\begin{align*}
\text{Ph}_2\text{Se} \cdot \text{CF}_3 \quad & + \quad \text{Ph} \quad \downarrow \quad \text{CuOAc (2 equiv)} \\
\text{6} \quad (2 \text{ equiv}) \quad & \quad \text{Ph} \quad \text{I} \quad \text{100 °C, 20 h} \\
\text{Ph}_2\text{Se} \cdot \text{Ph} \quad \downarrow \quad \text{3a, 0%}
\end{align*}
\]

In a nitrogen-filled glovebox, a sealed tube was charged with phenyl(trifluoromethyl)selane (6, 3 90.4 mg, 0.4 mmol), 4-iodo-1,1'-biphenyl (2a, 55.6 mg, 0.2 mmol), CuOAc (48.8 mg, 0.4 mmol), and DMSO (2 mL) with stirring. The mixture was reacted at 100 °C for 20 h and cooled to room temperature. The yield of 3a was determined by HPLC (λ = 253 nm, H₂O/CH₃OH = 15:85 (v/v)) using [1,1'-biphenyl]-4-yl(phenyl)selane (tᵢ = 18.78 min) as an external standard (0%).
5.6. CuOAc-Mediated competitive aryl selenylation and trifluoromethylation.

\[ \text{PhSeCO}_2\text{Me} + \text{PhI} + \text{TMS CF}_3 / \text{CsF} \xrightarrow{\text{CuOAc (2 equiv) DMSO, 100 }^\circ\text{C, 20 h}} \text{PhR}_3 \]

In a nitrogen-filled glovebox, a sealed tube was charged with 4-iodo-1,1'-biphenyl (2a, 56.0 mg, 0.2 mmol), (phenylselanyl)malonate (4, 115.0 mg, 0.4 mmol) CuOAc (48.8 mg, 0.4 mmol), TMSCF\(_3\) (56.8 mg, 0.4 mmol), CsF (60.8 mg, 0.4 mmol), and DMSO (2 mL) with stirring. The mixture was reacted at 100 °C for 20 h and cooled to room temperature. The yields of 3a' (5%) and 3a (92%) were determined by HPLC (λ = 253 nm, H\(_2\)O/CH\(_3\)OH = 15:85 (v/v)) using 4-(trifluoromethyl)-1,1'-biphenyl (t\(_R\) = 8.54 min) and [1,1'-biphenyl]-4-yl(phenyl)selane (t\(_R\) = 18.78 min) as external standards, respectively.

5.7. Cu-Mediated arylselenylation of 2a by 1b in the presence of radical traps.

In a nitrogen-filled glovebox, a sealed tube was charged with 4-iodo-1,1'-biphenyl (2a, 56.0 mg, 0.2 mmol), 1,2-diphenyldiselenane (5, 62.8 mg, 0.2 mmol), CuOAc (48.8 mg, 0.4 mmol), TMSCF\(_3\) (56.8 mg, 0.4 mmol), CsF (60.8 mg, 0.4 mmol), and DMSO (2 mL) with stirring. The mixture was reacted at 100 °C for 20 h and cooled to room temperature. The yields of 3a' (2%) and 3a (97%) were determined by HPLC (λ = 253 nm, H\(_2\)O/CH\(_3\)OH = 15:85 (v/v)) using 4-(trifluoromethyl)-1,1'-biphenyl (t\(_R\) = 8.54 min) and [1,1'-biphenyl]-4-yl(phenyl)selane (t\(_R\) = 18.78 min) as external standards, respectively.

5.7. Cu-Mediated arylselenylation of 2a by 1b in the presence of radical traps.

In a nitrogen-filled glovebox, a sealed tube was charged with 4-iodo-1,1'-biphenyl (2a, 56.0 mg, 0.2 mmol), (phenylselanyl)malonate (4, 115.0 mg, 0.4 mmol) CuOAc (48.8 mg, 0.4 mmol), TMSCF\(_3\) (56.8 mg, 0.4 mmol), CsF (60.8 mg, 0.4 mmol), and DMSO (2 mL) with stirring. The mixture was reacted at 100 °C for 20 h and cooled to room temperature. The yields of 3a' (5%) and 3a (92%) were determined by HPLC (λ = 253 nm, H\(_2\)O/CH\(_3\)OH = 15:85 (v/v)) using 4-(trifluoromethyl)-1,1'-biphenyl (t\(_R\) = 8.54 min) and [1,1'-biphenyl]-4-yl(phenyl)selane (t\(_R\) = 18.78 min) as external standards, respectively.
56.0 mg, 0.2 mmol), 1b (160.4 mg, 0.4 mmol), CuOAc (48.8 mg, 0.4 mmol), 2,2,6,6-
tetramethylpiperidine 1-oxyl (TEMPO, 62.5 mg, 0.4 mmol), and DMSO (2 mL) with
stirring. The mixture was reacted at 100 °C for 20 h and cooled to room temperature.
The yield of 3b (97%) was determined by HPLC using [1,1'-biphenyl]-4-yl(4-
nitrophenyl)selane (t<sub>R</sub> = 15.24 min, λ = 253 nm, H<sub>2</sub>O/CH<sub>3</sub>OH = 15:85 (v/v)) as an
external standard.

The 19F NMR spectrum of the reaction mixture (after addition of 21.3 mg CF<sub>3</sub>CH<sub>2</sub>OH
as an internal standard)

In a nitrogen-filled glovebox, a sealed tube was charged with 4-iodo-1,1'-biphenyl (2a,
56.0 mg, 0.2 mmol), 1b (160.4 mg, 0.4 mmol), CuOAc (48.8 mg, 0.4 mmol), 1,1-
diphenylethylene (72.1 mg, 0.4 mmol), and DMSO (2 mL) with stirring. The mixture
was reacted at 100 °C for 20 h and cooled to room temperature. The yield of 3b (99%)
was determined by HPLC using [1,1'-biphenyl]-4-yl(4-nitrophenyl)selane (t<sub>R</sub> = 15.24
min, \( \lambda = 253 \text{ nm}, \text{H}_2\text{O}/\text{CH}_3\text{OH} = 15:85 \text{ (v/v)} \) as an external standard.

The \(^{19}\text{F}\) NMR spectrum of the reaction mixture (after addition of 29.3 mg PhOCF\(_3\) as an internal standard)

In a nitrogen-filled glovebox, a sealed tube was charged with 4-iodo-1,1'-biphenyl (2a, 56.0 mg, 0.2 mmol), 1b (160.4 mg, 0.4 mmol), CuOAc (48.8 mg, 0.4 mmol), N,N-diallyl-4-methylbenzenesulfonamide (diallyl-PAST, 100.5 mg, 0.4 mmol), and DMSO (2 mL) with stirring. The mixture was reacted at 100 °C for 20 h and cooled to room temperature. The yield of 3b (>99%) was determined by HPLC using [1,1'-biphenyl]-4-yl(4-nitrophenyl)selane (\( t_R = 15.24 \text{ min}, \lambda = 253 \text{ nm}, \text{H}_2\text{O}/\text{CH}_3\text{OH} = 15:85 \text{ (v/v)} \) as an external standard.

The \(^{19}\text{F}\) NMR spectrum of the reaction mixture (after addition of 32.0 mg PhOCF\(_3\) as an internal standard)
Reference


6. The NMR spectra of 1, 3, 4, 5, 6 and 7
$^1$H NMR (500 MHz, CDCl$_3$)

$^{19}$F NMR (471 MHz, CDCl$_3$)
\begin{align*}
\text{\textbf{1a}} \quad \text{\textsuperscript{13}C NMR (126 MHz, CDCl}_3) \quad \text{Se} & \quad \text{CF}_3 \\
\text{MeO}_2\text{C} & \quad \text{CO}_2\text{Me}
\end{align*}

\begin{align*}
\text{\textbf{1b}} \quad \text{\textsuperscript{1}H NMR (500 MHz, CDCl}_3) \quad \text{O}_2\text{N} & \quad \text{Se} & \quad \text{CF}_3 \\
\text{MeO}_2\text{C} & \quad \text{CO}_2\text{Me}
\end{align*}
$^{19}$F NMR (471 MHz, CDCl$_3$)

$^{13}$C NMR (126 MHz, CDCl$_3$)
$\text{SeC}_3\text{F}_3$  \text{MeO}_2\text{C} \text{CO}_2\text{Me}$

$1\text{c}$

$^1\text{H NMR} \ (500 \text{ MHz, } \text{CDCl}_3)$

$\text{SeC}_3\text{F}_3$  \text{MeO}_2\text{C} \text{CO}_2\text{Me}$

$1\text{c}$

$^{19}\text{F NMR} \ (471 \text{ MHz, } \text{CDCl}_3)$
$\text{Se} \text{CF}_3 \text{MeO}_2\text{C} \text{CO}_2\text{Me}
\textbf{1c}$

$1^3\text{C} \text{NMR (126 MHz, CDCl}_3)$

$\text{MeO}_2\text{C} \text{CO}_2\text{Me}
\text{Se} \text{CF}_3
\textbf{1d}$

$1^1\text{H} \text{NMR (500 MHz, CDCl}_3)$
19F NMR (471 MHz, CDCl₃)

13C NMR (126 MHz, CDCl₃)
$^{1}H$ NMR (500 MHz, CDCl$_3$)

$^{19}$F NMR (471 MHz, CDCl$_3$)
**15C NMR (126 MHz, CDCl3)**

**1H NMR (500 MHz, CDCl3)**
$\text{Ph} \quad \text{Se} \quad \text{CF}_3 \\
\text{MeO}_2\text{C} \quad \text{CO}_2\text{Me}$

$1f$

$^{19}\text{F NMR (471 MHz, CDCl}_3)$

$\text{Ph} \quad \text{Se} \quad \text{CF}_3 \\
\text{MeO}_2\text{C} \quad \text{CO}_2\text{Me}$

$1f$

$^{13}\text{C NMR (126 MHz, CDCl}_3)$
$^{1}$H NMR (500 MHz, CDCl$_3$)

$^{19}$F NMR (471 MHz, CDCl$_3$)
$\text{NC-S\textsubscript{2}Se-CF}_3$  
$\text{MeO}_2\text{C-CO}_2\text{Me}$  
$\textbf{1g}$  
\textsuperscript{13}C NMR (126 MHz, CDCl\textsubscript{3})

$\text{O}_2\text{N-S\textsubscript{2}Se-CF}_3$  
$\text{MeO}_2\text{C-CO}_2\text{Me}$  
$\textbf{1h}$  
\textsuperscript{1}H NMR (500 MHz, CDCl\textsubscript{3})
$^{19}\text{F NMR (471 MHz, CDCl}_3\text{)}$

$^{13}\text{C NMR (126 MHz, CDCl}_3\text{)}$
$\text{NO}_2$ $\text{Se}^4 \text{CF}_3$
$\text{MeO}_2\text{C} \text{CO}_2\text{Me}$

$\text{H NMR (500 MHz, CDCl}_3\text{)}$

$\text{NO}_2$ $\text{Se}^4 \text{CF}_3$
$\text{MeO}_2\text{C} \text{CO}_2\text{Me}$

$\text{F NMR (471 MHz, CDCl}_3\text{)}$
$^1$H NMR (500 MHz, CDCl$_3$)

$^{13}$C NMR (126 MHz, CDCl$_3$)
$^{19}\text{F NMR (471 MHz, CDCl$_3$)}$

$^{13}\text{C NMR (126 MHz, CDCl$_3$)}$
$^{1}H$ NMR (500 MHz, CDCl$_3$)

$^{13}C$ NMR (126 MHz, CDCl$_3$)
S48

3b

$^1$H NMR (500 MHz, CDCl$_3$)

3b

$^{13}$C NMR (126 MHz, CDCl$_3$)
**$^{1}$H NMR (500 MHz, CDCl$_3$)**

**$^{13}$C NMR (126 MHz, CDCl$_3$)**
$^1$H NMR (500 MHz, CDCl$_3$)

$^{13}$C NMR (126 MHz, CDCl$_3$)
$^1$H NMR (500 MHz, CDCl$_3$)

$^{13}$C NMR (126 MHz, CDCl$_3$)
$^1$H NMR (500 MHz, CDCl$_3$)

$^{13}$C NMR (126 MHz, CDCl$_3$)
$\text{SeNO}_2$-t-Bu

$3g$

$^1\text{H NMR (500 MHz, CDCl}_3\text{)}$

$\text{SeNO}_2$-t-Bu

$13\text{C NMR (126 MHz, CDCl}_3\text{)}$

$3g$
$^{1}$H NMR (500 MHz, CDCl$_3$)

$^{19}$F NMR (471 MHz, CDCl$_3$)

S54
$^{13}$C NMR (126 MHz, CDCl$_3$)

$^1$H NMR (500 MHz, CDCl$_3$)
$^{13}$C NMR (126 MHz, CDCl$_3$)

$^1$H NMR (500 MHz, acetone-d$_6$)
$^{13}$C NMR (126 MHz, acetone-$d_6$)

$^1$H NMR (500 MHz, CDCl$_3$)

$3j$

Br

$\text{Se} \quad \text{NO}_2$

$3j$

$3k$

F$_3$C

$\text{Se} \quad \text{NO}_2$

$3k$
$^{19}$F NMR (471 MHz, CDCl$_3$)

$^{13}$C NMR (126 MHz, CDCl$_3$)
**1H NMR (500 MHz, CDCl₃)**

![1H NMR spectrum](image)

**13C NMR (126 MHz, CDCl₃)**

![13C NMR spectrum](image)
$3m$

$^1H$ NMR (500 MHz, CDCl$_3$)

$^13C$ NMR (126 MHz, CDCl$_3$)
$^1$H NMR (500 MHz, CDCl$_3$)

$^{13}$C NMR (126 MHz, CDCl$_3$)
$^{1}H$ NMR (500 MHz, CDCl$_3$)

$^{13}C$ NMR (126 MHz, CDCl$_3$)
**$^{1}$H NMR (500 MHz, CDCl$_3$)**

![NMR spectrum for $^{1}$H](image)

**$^{13}$C NMR (126 MHz, CDCl$_3$)**

![NMR spectrum for $^{13}$C](image)
$^{1}H$ NMR (500 MHz, CDCl$_3$)

$^{13}$C NMR (126 MHz, CDCl$_3$)
$^{1}H$ NMR (500 MHz, acetone-$d_{6}$)

$^{13}$C NMR (126 MHz, acetone-$d_{6}$)
\text{\textsuperscript{1}H NMR (500 MHz, CDCl}_3\text{)}

\text{\textsuperscript{13}C NMR (126 MHz, CDCl}_3\text{)}
$^{1}H$ NMR (500 MHz, CDCl$_3$)

$^{13}C$ NMR (126 MHz, CDCl$_3$)
$^{1}H$ NMR (500 MHz, CDCl$_3$)

$^{13}C$ NMR (126 MHz, CDCl$_3$)

$3u$
**1H NMR (500 MHz, CDCl₃)**

**13C NMR (126 MHz, CDCl₃)**
$\text{SePh}_3$  

$\text{H NMR (500 MHz, CDCl}_3\text{)}$

$\text{SePh}_3$  

$\text{13C NMR (126 MHz, CDCl}_3\text{)}$
H NMR (500 MHz, CDCl$_3$)

$^1$H NMR (500 MHz, CDCl$_3$)

$^3$C NMR (126 MHz, CDCl$_3$)

$^13$C NMR (126 MHz, CDCl$_3$)
$\text{Cl}$

\[ \text{Se} \]

\[
\text{3y}
\]

$\text{Ph}$

$\text{1H NMR (500 MHz, CDCl}_3$)

$\text{Se} \quad \text{Ph}$

$\text{3y}$

$\text{Cl}$

$\text{13C NMR (126 MHz, CDCl}_3$)
$^1$H NMR (500 MHz, CDCl$_3$)

$^{13}$C NMR (126 MHz, CDCl$_3$)
**3aa**

$^{1}H$ NMR (500 MHz, CDCl$_3$)

$^{13}C$ NMR (126 MHz, CDCl$_3$)
$^{1}H$ NMR (500 MHz, CDCl$_3$)

$^{13}$C NMR (126 MHz, CDCl$_3$)
$^{1}$H NMR (500 MHz, CDCl$_3$)

$^{13}$C NMR (126 MHz, CDCl$_3$)
$^{1}$H NMR (500 MHz, CDCl$_3$)

$^{13}$C NMR (126 MHz, CDCl$_3$)
(PhSe)$_2$

5

$^1$H NMR (500 MHz, CDCl$_3$)

---

(PhSe)$_2$

5

$^{13}$C NMR (126 MHz, CDCl$_3$)
$\text{SeCF}_3$

**$^1$H NMR (500 MHz, CDCl$_3$)**

- 7.77
- 7.75
- 7.48
- 7.44
- 7.34

**$^1$H NMR (500 MHz, CDCl$_3$)**

- 7.80
- 7.78
- 7.48
- 7.44
- 7.34

$\text{SeCF}_3$

**$^{19}$F NMR (471 MHz, CDCl$_3$)**

- -37.88

$\text{SeCF}_3$

**$^{19}$F NMR (471 MHz, CDCl$_3$)**

- -37.88
**$^{13}$C NMR (126 MHz, CDCl$_3$)**

**$^1$H NMR (500 MHz, CDCl$_3$)**
$\text{MeO}_2\text{C} = \text{CO}_2\text{Me}$

$\text{MeO}_2\text{C} = \text{CO}_2\text{Me}$

$^7\text{H NMR (500 MHz, CDCl}_3\text{)}$

$^1\text{H NMR (500 MHz, CDCl}_3\text{)}$
$^{13}$C NMR (126 MHz, CDCl$_3$)

$^1$H NMR (500 MHz, CDCl$_3$)
$3\mathrm{a'}$

$^{19}\text{F NMR (471 MHz, CDCl}_3\text{)}$

$^{13}\text{C NMR (126 MHz, CDCl}_3\text{)}$