

## Supporting Information

for

### Regioselective Magnesiations of Functionalized Arenes and Heteroarenes using $\text{TMP}_2\text{Mg}$ in Hydrocarbons

A. Hess, N. Alandini, H. C. Guelen, J. P. Prohaska, P. Knochel

Ludwig-Maximilians-Universität München

Department Chemie

Butenandtstrasse 5-13, Haus F, 81377 München (Germany)

E-mail: paul.knochel@cup.uni-muenchen.de

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## 1. General Information

All reactions were carried out under argon or nitrogen atmosphere in glassware dried with a heat gun (650 °C) under high vacuum (<1 mbar). Syringes which were used to transfer anhydrous solvents or reagents were purged thrice with argon or nitrogen prior to use. Indicated yields are isolated yields of compounds estimated to be >95% pure as determined by <sup>1</sup>H-NMR (25 °C) and capillary GC. Unless otherwise indicated, all reagents were obtained from commercial sources.

### Solvents

Toluene was continuously refluxed and freshly distilled from sodium under nitrogen and stored over molecular sieves. THF was continuously refluxed and freshly distilled from sodium benzophenone ketyl under nitrogen and stored over molecular sieves. Solvents for flash column chromatography were distilled prior to use.

### Chromatography

Flash column chromatography was performed using SiO<sub>2</sub> 60 (0.040-0.063 mm, 230-400 mesh ASTM) from Merck. Thin layer chromatography (TLC) was performed using aluminum plates covered with SiO<sub>2</sub> (Merck 60, F-254). Spots were visualized under UV light.

### Analytical Data

<sup>1</sup>H-NMR and <sup>13</sup>C-NMR spectra were recorded on VARIAN Mercury 200, BRUKER ARX 300, VARIAN VXR 400 S and BRUKER AMX 600 instruments. Chemical shifts are reported as values in ppm relative to tetramethylsilane. CDCl<sub>3</sub> peaks were set to 7.26 ppm in <sup>1</sup>H NMR and 77.16 ppm in <sup>13</sup>C NMR experiments. The following abbreviations were used to characterize

signal multiplicities: s (singlet), d (doublet), dd (doublet of doublets), t (triplet), q (quartet), hept (heptet) as well as m (multiplet).

**Mass spectroscopy:** High resolution (HRMS) and low resolution (MS) spectra were recorded on a FINNIGAN MAT 95Q instrument. Electron impact ionization (EI) was conducted with an ionization energy of 70 eV. For coupled gas chromatography/mass spectrometry, a HEWLETT-PACKARD HP 6890/MSD 5973 GC/MS system was used. Molecular fragments are reported starting at a relative intensity of 10-20%.

## 2. Reagents

All reagents were obtained from commercial sources and used without further purification unless otherwise stated.

***n*Bu<sub>2</sub>Mg** solution in hexanes was purchased from Albemarle and the concentration was determined by iodometric titration.

**TMP<sub>2</sub>Mg**: A dry and argon-flushed Schlenk-flask equipped with a stirring bar and a septum, was charged with 2,2,6,6-Tetramethylpiperidine (3.44 mL, 20.2 mmol, 2.02 equiv). Then *n*Bu<sub>2</sub>Mg (13.5 mL, 10 mmol, 0.74 M in hexane, 1.00 equiv) was added dropwise at 0 °C. The resulting cloudy mixture was refluxed for 6 h. The resulting yellow solution was titrated (benzoic acid and 4-(phenylazo)diphenylamine as indicator, 0.65-0.70 M, 95% yield) prior use.

**CuCN·2LiCl**: A CuCN·2LiCl solution (1.00 M) was prepared by drying CuCN (80.0 mmol, 7.17 g) and LiCl (160 mmol, 6.77 g) in a Schlenk-flask under vacuum at 140 °C for 12 h. After cooling, dry THF (80 mL) was added and stirring was continued until the salts were dissolved.<sup>1</sup>

**ZnCl<sub>2</sub>**: A ZnCl<sub>2</sub> solution (1.00 M) was prepared by drying ZnCl<sub>2</sub> (200 mmol, 27.3 g) in a Schlenk-flask under vacuum at 140 °C for 5 h. After cooling, dry THF (200 mL) was added and stirring continued until the salt was dissolved.

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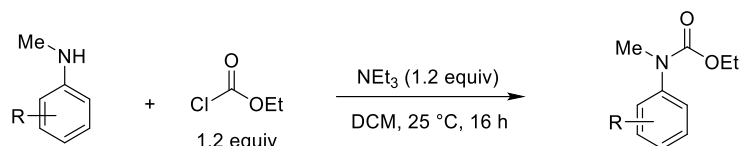
<sup>1</sup> P. Knochel, M. C. P. Yeh, S. C. Berk, J. Talbert, *J. Org. Chem.* **1988**, 53, 2390-2392.

### 3. Typical Procedures

**Typical Procedure 1 (TP1):** Regioselective metalation and functionalization of arenes and heteroarenes using  $\text{TMP}_2\text{Mg}$

A dry and argon flushed Schlenk-tube, equipped with a magnetic stirring bar and a septum, was charged with the corresponding substrate (1.0 equiv) in dry toluene (0.5 M solution). The resulting solution was stirred at indicated temperature and  $\text{TMP}_2\text{Mg}$  (1.1 equiv) was added dropwise. The completion of the metalation was checked by GC-analysis of reaction aliquots quenched with iodine, using undecane as internal standard. Subsequent reactions with electrophiles were carried out under the indicated conditions. After complete conversion, the mixture was quenched with sat. aq.  $\text{NH}_4\text{Cl}$  solution and extracted with ethyl acetate (3 x 10 mL). The combined organic extracts were dried over  $\text{MgSO}_4$ , filtered and concentrated. Purification of the crude product by flash column chromatography using an indicated eluent afforded the corresponding title compounds.

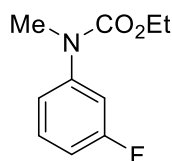
**Typical Procedure 2 (TP2):** Preparation of aryl carbamate derivatives



A dry and argon flushed Schlenk-tube, equipped with a magnetic stirring bar and a septum, was charged with the corresponding aniline (20.0 mmol, 1.0 equiv) and subsequently dissolved in dry DCM (25 mL).  $\text{NEt}_3$  (24.0 mmol, 1.2 equiv) and ethyl chloroformate (24.0 mmol, 1.2 equiv) were added at 0 °C and the reaction mixture was allowed to warm up to room temperature and stirred for 16 h. The mixture was quenched with brine (20 mL) and extracted with ethyl acetate (3 x 30 mL). The combined organic extracts were dried over  $\text{MgSO}_4$ , filtered and concentrated *in vacuo*. The crude products were purified by flash column chromatography.

## 4. Starting Materials

### Ethyl (3-fluorophenyl)(methyl)carbamate (**5h**)



Ethyl (3-fluorophenyl)(methyl)carbamate (**5h**) was prepared according to **TP 2** using 3-fluoro-N-methylaniline. The crude product was purified by flash column chromatography (silica gel, pentane/EtOAc = 6:1) affording the desired compound as a colorless oil (**5h**, 3.15 g, 16 mmol, 80% yield).

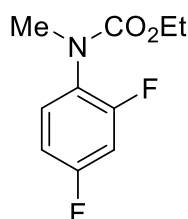
**<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>):** δ (ppm) = 7.33 – 7.21 (m, 1H), 7.07 – 6.97 (m, 2H), 6.94 – 6.86 (m, 1H), 4.18 (q, *J* = 7.1 Hz, 2H), 3.30 (s, 3H), 1.25 (t, *J* = 7.1 Hz, 3H).

**<sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>):** δ (ppm) = 162.6 (d, *J* = 245.8 Hz), 155.4, 144.9 (d, *J* = 9.9 Hz), 129.7 (d, *J* = 9.3 Hz), 120.8, 112.9 (d, *J* = 24.0 Hz), 112.6 (d, *J* = 21.1 Hz), 62.0, 37.4, 14.6.

**MS (EI, 70 eV):** *m/z* (%) = 197 (36), 169 (18), 138 (52), 125 (40), 124 (100), 122 (11), 97 (23), 96 (11), 95 (10), 77 (10), 75 (10).

**HRMS (EI):** for C<sub>10</sub>H<sub>12</sub>FNO<sub>2</sub>: calc. [M<sup>+</sup>]: 197.0852; found: 197.0843.

### Ethyl (2-fluoro-4-fluorophenyl)(methyl)carbamate (**5i**)



Ethyl (2-fluoro-4-fluorophenyl)(methyl)carbamate (**5i**) was prepared according to **TP 2** using 2-fluoro-4-fluoro-N-methylaniline. The crude product was purified by flash column chromatography (silica gel, pentane/EtOAc = 6:1) affording the desired compound as a colorless oil (**5i**, 3.25 g, 15.2 mmol, 76% yield).

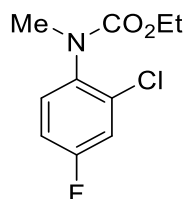
**<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>):** δ (ppm) = 7.20 (s, 1H), 6.94 – 6.77 (m, 2H), 4.31 – 4.01 (m, 2H), 3.22 (s, 3H), 1.42 – 1.07 (m, 3H). Rotamers.

**<sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>)** δ (ppm) = 162.6 (d, *J* = 11.4 Hz), 160.1 (d, *J* = 11.2 Hz), 155.6, 129.7, 111.4 (dd, *J* = 22.3, 3.8 Hz), 104.8 (t, *J* = 25.4 Hz), 62.0, 37.5, 14.5.

**MS (EI, 70 eV):** *m/z* (%) = 215 (13), 156 (58), 143 (52), 142 (100), 140 (13), 123 (11), 95 (13).

**HRMS (EI):** for C<sub>10</sub>H<sub>11</sub>F<sub>2</sub>NO<sub>2</sub>: calc. [*M*+]: 215.0758; found: 215.0748.

### Ethyl (2-chloro-4-fluorophenyl)(methyl)carbamate (**5j**)



Ethyl (2-chloro-4-fluorophenyl)(methyl)carbamate (**5j**) was prepared according to **TP 2** using 2-chloro-4-fluoro-N-methylaniline. The crude product was purified by flash column chromatography (silica gel, pentane/EtOAc = 6:1) affording the desired compound as a colorless oil (**5j**, 3.85 g, 16.6 mmol, 83% yield).

**<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>):** δ (ppm) = 7.31 – 7.14 (m, 2H), 6.99 (ddd, *J* = 8.8, 7.8, 2.9 Hz, 1H), 4.26 – 4.00 (m, 2H), 3.18 (s, 3H), 1.13 (t, *J* = 7.1 Hz, 3H). Rotamers.

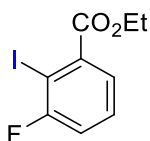
**<sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>)** δ (ppm) = 161.2 (d, *J* = 250.2 Hz), 155.6, 136.8 (d, *J* = 4.0 Hz), 133.8 (d, *J* = 10.8 Hz), 130.3 (d, *J* = 9.3 Hz), 117.4 (d, *J* = 25.7 Hz), 114.8 (d, *J* = 22.0 Hz), 61.9, 37.0, 14.6.

**MS (EI, 70 eV):** *m/z* (%) = 196 (27), 172 (10), 158 (58), 123 (14), 122 (15), 95 (13).

**HRMS (EI):** for C<sub>10</sub>H<sub>12</sub>ClFNO<sub>2</sub>: calc. [*M*+]: 232.0535; found: 232.0531.

## 5. Preparation of compounds

### Ethyl 3-fluoro-2-iodobenzoate (**9a**)



According to **TP 1**, to a solution of ethyl 3-fluorobenzoate (**5a**, 74  $\mu$ L, 0.5 mmol, 1.0 equiv) in toluene (1 mL) was added  $\text{TMP}_2\text{Mg}$  (0.55 mmol, 1.1 equiv) at  $-20\text{ }^\circ\text{C}$  and the reaction mixture was stirred for 1 h. The resulting arylmagnesium was then cooled to  $0\text{ }^\circ\text{C}$  and iodine (153 mg, 0.60 mmol, 1.2 equiv) dissolved in THF (1 mL) was added dropwise and the reaction mixture was stirred for 1 h. Purification of the crude product by flash column chromatography (silica gel, pentane/EtOAc = 98:2) afforded the title compound as a colorless oil (**9a**, 261 mg, 0.45 mmol, 89% yield).

**$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 7.53 (ddd,  $J$  = 7.7, 1.5, 0.7 Hz, 1H), 7.35 (td,  $J$  = 8.0, 5.3 Hz, 1H), 7.17 (td,  $J$  = 8.0, 1.5 Hz, 1H), 4.41 (q,  $J$  = 7.1 Hz, 2H), 1.41 (t,  $J$  = 7.1 Hz, 3H).

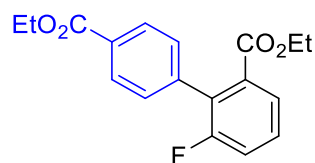
**$^{13}\text{C}$  NMR (101 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 166.0 (d,  $J$  = 2.7 Hz), 162.2 (d,  $J$  = 245.0 Hz), 138.1 (d,  $J$  = 1.6 Hz), 129.7 (d,  $J$  = 8.2 Hz), 126.3 (d,  $J$  = 3.3 Hz), 118.0 (d,  $J$  = 25.4 Hz), 82.7 (d,  $J$  = 27.2 Hz), 62.0, 14.2.

**MS (EI, 70 eV):**  $m/z$  (%) = 265 (49), 248 (96), 220 (29), 126 (98), 94 (100), 93 (13), 92 (11), 75 (21), 74 (33), 68 (32), 50 (10).

**HRMS (EI):** for  $\text{C}_9\text{H}_8\text{FIO}_2$ : calc.  $[\text{M}^+]$ : 293.9553; found: 293.9547.



## Diethyl 6-fluoro-(1,1'-biphenyl)-2,4'-dicarboxylate (**9b**)



According to **TP 1**, to a solution of ethyl 3-fluorobenzoate (**5a**, 74  $\mu$ L, 0.5 mmol, 1.0 equiv) in toluene (1 mL) was added  $\text{TMP}_2\text{Mg}$  (0.55 mmol, 1.1 equiv) at  $-20\text{ }^\circ\text{C}$ . After 10 min, the resulting arylmagnesium was transmetalated with a  $\text{ZnCl}_2$  solution (1.2 mL, 1.00 M in THF, 2.40 equiv) at  $0\text{ }^\circ\text{C}$  for 30 min. A dry and argon-flushed Schlenk-tube, equipped with a magnetic stirring bar and a septum was charged with  $\text{Pd}(\text{dba})_2$  (9 mg, 3 mol%) and TFP (7 mg, 6 mol%) and ethyl 4-iodobenzoate (70  $\mu$ L, 0.415 mmol, 0.83 equiv). The freshly prepared arylzinc reagent was added and the reaction mixture was placed in an oil bath at  $55\text{ }^\circ\text{C}$  for 16 h. Purification of the crude product by flash column chromatography (silica gel, pentane/diethyl ether = 9:1) afforded the title compound as a yellow oil (**9b**, 107 mg, 0.34 mmol, 82% yield).

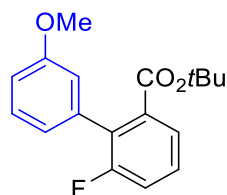
**$^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 8.10 (d,  $J = 8.4$  Hz, 2H), 7.71 (dd,  $J = 7.9, 0.7$  Hz, 1H), 7.43 (td,  $J = 8.0, 5.2$  Hz, 1H), 7.37 (d,  $J = 7.8$  Hz, 2H), 7.30 (ddd,  $J = 9.4, 8.3, 1.3$  Hz, 1H), 4.40 (q,  $J = 7.1$  Hz, 2H), 4.05 (q,  $J = 7.1$  Hz, 2H), 1.41 (t,  $J = 7.1$  Hz, 3H), 0.97 (t,  $J = 7.1$  Hz, 3H).

**$^{13}\text{C NMR}$  (101 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 166.9 (d,  $J = 3.5$  Hz), 166.5, 159.5 (d,  $J = 246.9$  Hz), 139.1, 133.3 (d,  $J = 2.5$  Hz), 130.2, 129.7, 129.4, 129.3, 129.2, 128.9, 127.2, 125.7 (d,  $J = 3.6$  Hz), 119.0 (d,  $J = 23.2$  Hz), 61.3, 61.1, 14.4, 13.7.

**MS (EI, 70 eV):**  $m/z$  (%) = 271 (28), 243 (17), 199 (19), 170 (17), 75 (17), 73 (100).

**HRMS (EI):** for  $\text{C}_{18}\text{H}_{17}\text{FO}_4$ : calc.  $[\text{M}^+]$ : 316.1111; found: 316.1103.

***tert*-Butyl 6-fluoro-3'-methoxy-[1,1'-biphenyl]-2-carboxylate (**9c**)**



According to **TP 1**, to a solution of *tert*-butyl 3-fluorobenzoate (**5b**, 98 mg, 0.5 mmol, 1.0 equiv) in toluene (1 mL) was added  $\text{TMP}_2\text{Mg}$  (0.55 mmol, 1.1 equiv) at 25 °C. After 10 min, the resulting arylmagnesium with transmetalated with a  $\text{ZnCl}_2$  solution (1.2 mL, 1.00 M in THF, 2.40 equiv) at 0 °C for 30 min. A dry and argon-flushed Schlenk-tube, equipped with a magnetic stirring bar and a septum was charged with  $\text{Pd}(\text{dba})_2$  (9 mg, 3 mol%) and TFP (7 mg, 6 mol%) and 3-iodoanisole (56  $\mu\text{L}$ , 0.415 mmol, 0.83 equiv). The freshly prepared arylzinc reagent was added and the reaction mixture was placed in an oil bath at 55 °C for 16 h. Purification of the crude product by flash column chromatography (silica gel, pentane/diethyl ether = 95:5) afforded the title compound as a yellow oil (**9c**, 94 mg, 0.31 mmol, 74% yield).

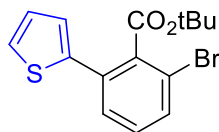
**$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 7.57 (d,  $J$  = 5.8 Hz, 1H), 7.40 – 7.36 (m, 1H), 7.35 – 7.30 (m, 1H), 7.27 – 7.20 (m, 1H), 6.94 (ddd,  $J$  = 8.4, 2.6, 1.0 Hz, 1H), 6.91 – 6.88 (m, 1H), 6.85 (s, 1H), 3.81 (s, 3H), 1.22 (s, 9H).

**$^{13}\text{C}$  NMR (101 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 167.0 (d,  $J$  = 3.4 Hz), 159.7 (d,  $J$  = 246 Hz), 159.4, 135.9, 135.8 (d,  $J$  = 2.5 Hz), 129.3, 129.1, 128.9 (d,  $J$  = 8.6 Hz), 125.2 (d,  $J$  = 3.5 Hz), 122.2, 118.3 (d,  $J$  = 23.5 Hz), 115.0, 113.7, 81.9, 55.4, 27.6.

**MS (EI, 70 eV):**  $m/z$  (%) = 247 (14), 246 (100), 245 (15), 229 (37), 202 (15), 186 (19), 172 (13), 171 (11), 170 (20), 159 (10), 157 (25).

**HRMS (EI):** for  $\text{C}_{18}\text{H}_{19}\text{FO}_3$ : calc.  $[\text{M}^+]$ : 302.1318; found: 302.1312.

***tert*-Butyl 2-bromo-6-(thiophen-2-yl)benzoate (9d)**



According to **TP 1**, to a solution of *tert*-butyl 2-bromobenzoate (**5c**, 129 mg, 0.5 mmol, 1.0 equiv) in toluene (1 mL) was added  $\text{TMP}_2\text{Mg}$  (0.55 mmol, 1.1 equiv) at 40 °C. After 10 min, the resulting arylmagnesium was transmetalated with a  $\text{ZnCl}_2$  solution (1.2 mL, 1.00 M in THF, 2.40 equiv) at 0 °C for 30 min. A dry and argon-flushed Schlenk-tube, equipped with a magnetic stirring bar and a septum was charged with  $\text{Pd}(\text{dba})_2$  (9 mg, 3 mol%) and TFP (7 mg, 6 mol%) and 2-iodothiophene (42  $\mu\text{L}$ , 0.415 mmol, 0.83 equiv). The freshly prepared arylzinc reagent was added and the reaction mixture was placed in an oil bath at 55 °C for 16 h. Purification of the crude product by flash column chromatography (silica gel, pentane/diethyl ether = 100:1) afforded the title compound as a white solid (**9d**, 101 mg, 0.30 mmol, 71% yield).

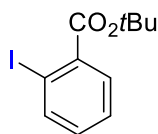
**$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 7.54 (dd,  $J$  = 8.0, 1.1 Hz, 1H), 7.39 (dd,  $J$  = 7.8, 1.1 Hz, 1H), 7.36 (dd,  $J$  = 5.1, 1.2 Hz, 1H), 7.24 (t,  $J$  = 7.9 Hz, 1H), 7.17 (dd,  $J$  = 3.6, 1.2 Hz, 1H), 7.05 (dd,  $J$  = 5.1, 3.6 Hz, 1H), 1.43 (s, 9H).

**$^{13}\text{C}$  NMR (101 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 166.5, 140.1, 136.8, 133.8, 132.0, 129.9, 129.3, 127.6, 127.4, 126.5, 119.7, 83.3, 27.9.

**MS (EI, 70 eV):**  $m/z$  (%) = 284 (14), 283 (100), 282 (11), 281 (97), 266 (27), 264 (27), 250 (22), 248 (23), 158 (33), 115 (10), 114 (11), 57 (27), 40 (15).

**HRMS (EI):** for  $\text{C}_{15}\text{H}_{15}\text{BrO}_2\text{S}$ : calc.  $[M^+]$ : 337.9976; found: 337.9970.

### ***tert*-Butyl 2-iodobenzoate (9e)**



According to **TP 1**, to a solution of *tert*-butylbenzoate (**5d**, 89  $\mu$ L, 0.5 mmol, 1.0 equiv) in toluene (1 mL) was added  $\text{TMP}_2\text{Mg}$  (0.55 mmol, 1.1 equiv) at 25  $^\circ\text{C}$ . The reaction mixture was heated to 50  $^\circ\text{C}$  and stirred for 30 min. The resulting arylmagnesium was then cooled to 0  $^\circ\text{C}$  and iodine (153 mg, 0.60 mmol, 1.2 equiv) dissolved in THF (1 mL) was added dropwise and the reaction mixture was stirred for 1 h. Purification of the crude product by flash column chromatography (silica gel, pentane/diethyl ether = 98:2) afforded the title compound as a pale yellow oil (**9e**, 88 mg, 0.29 mmol, 58% yield).

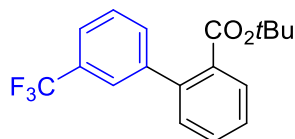
**$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 7.94 (dd,  $J$  = 7.9, 1.2 Hz, 1H), 7.68 (dd,  $J$  = 7.7, 1.7 Hz, 1H), 7.37 (td,  $J$  = 7.5, 1.2 Hz, 1H), 7.10 (td,  $J$  = 7.6, 1.7 Hz, 1H), 1.62 (s, 9H).

**$^{13}\text{C}$  NMR (101 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) =  $\delta$  166.3, 141.0, 137.5, 132.1, 130.6, 127.9, 93.6, 82.81, 28.3.

**MS (EI, 70 eV):**  $m/z$  (%) = 247 (100), 230 (56).

**HRMS (EI):** for  $\text{C}_{11}\text{H}_{13}\text{IO}_2$ : calc.  $[\text{M}^+]$ : 303.9960; found: 303.9955.

***tert*-Butyl 3'-(trifluoromethyl)-[1,1'-biphenyl]-2-carboxylate (9f)**



According to **TP 1**, to a solution of *tert*-butylbenzoate (**5d**, 89  $\mu$ L, 0.5 mmol, 1.0 equiv) in toluene (1 mL) was added  $\text{TMP}_2\text{Mg}$  (0.55 mmol, 1.1 equiv) at 50  $^\circ\text{C}$ . After 30 min, the resulting arylmagnesium with transmetalated with a  $\text{ZnCl}_2$  solution (1.2 mL, 1.00 M in THF, 2.40 equiv) at 0  $^\circ\text{C}$  for 30 min. A dry and argon-flushed Schlenk-tube, equipped with a magnetic stirring bar and a septum was charged with  $\text{Pd}(\text{dppf})\text{Cl}_2$  (15 mg, 2 mol%) and 1-iodo-3-(trifluoromethyl)benzene (60  $\mu$ L, 0.415 mmol, 0.83 equiv). The freshly prepared arylzinc reagent was added and the reaction mixture was placed in an oil bath at 55  $^\circ\text{C}$  for 16 h. Purification of the crude product by flash column chromatography (silica gel, pentane/diethyl ether = 10:1) afforded the title compound as a yellow oil (**9f**, 80 mg, 0.25 mmol, 60% yield).

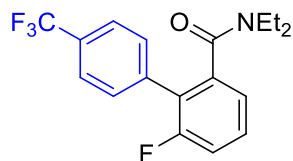
**$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 7.87 (dd,  $J$  = 7.7, 1.5 Hz, 1H), 7.63 (d,  $J$  = 6.2 Hz, 1H), 7.58 (s, 1H), 7.56 – 7.49 (m, 3H), 7.45 (td,  $J$  = 7.6, 1.4 Hz, 1H), 7.31 (dd,  $J$  = 7.6, 1.4 Hz, 1H), 1.25 (s, 9H).

**$^{13}\text{C}$  NMR (101 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 167.5, 142.9, 140.8, 132.8, 131.9, 131.0, 130.5, 130.3 (q,  $J$  = 30.5 Hz), 130.1, 128.5, 127.8, 125.5 (q,  $J$  = 3.9 Hz), 124.2 (q,  $J$  = 272 Hz), 123.7 (q,  $J$  = 3.8 Hz), 81.6, 27.6.

**MS (EI, 70 eV):**  $m/z$  (%) = 267 (10), 266 (77), 282 (11), 265 (53), 250 (15), 249 (100), 229 (60), 201 (63), 152 (17).

**HRMS (EI):** for  $\text{C}_{18}\text{H}_{17}\text{F}_3\text{O}_2$ : calc.  $[\text{M}^+]$ : 322.1181; found: 322.1175.

### ***N,N*-Diethyl-6-fluoro-4'-(trifluoromethyl)-[1,1'-biphenyl]-2-carboxamide (9g)**



According to **TP 1**, to a solution of *N,N*-diethyl-3-fluorobenzamide (**5e**, 98 mg, 0.5 mmol, 1.0 equiv.) in toluene (1 mL) was added  $\text{TMP}_2\text{Mg}$  (0.55 mmol, 1.1 equiv) at 25 °C. After 10 min, the resulting arylmagnesium was transmetalated with a  $\text{ZnCl}_2$  solution (1.2 mL, 1.00 M in THF, 2.40 equiv) at 0 °C for 30 min. A dry and argon-flushed Schlenk-tube, equipped with a magnetic stirring bar and a septum was charged with  $\text{Pd}(\text{dba})_2$  (9 mg, 3 mol%), TFP (7 mg, 6 mol%) and 1-iodo-4-(trifluoromethyl)benzene (61  $\mu\text{L}$ , 0.415 mmol, 0.83 equiv). The freshly prepared arylzinc reagent was added and the reaction mixture was placed in an oil bath at 55 °C for 16 h. Purification of the crude product by flash column chromatography (silica gel, pentane/diethyl ether = 1:1) afforded the title compound as a white solid (**9g**, 122 mg, 0.36 mmol, 88% yield).

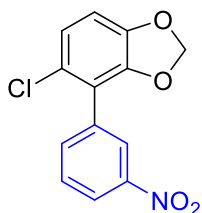
**$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 7.64 (d,  $J$  = 8.1 Hz, 2H), 7.56 (d,  $J$  = 8.5 Hz, 2H), 7.44 – 7.37 (m, 1H), 7.21 – 7.14 (m, 2H), 3.78 – 2.58 (m, 4H), 0.83 (t,  $J$  = 7.1 Hz, 3H), 0.74 (t,  $J$  = 7.1 Hz, 3H).

**$^{13}\text{C}$  NMR (101 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) =  $\delta$  168.1, 158.9 (d,  $J$  = 249.0 Hz), 138.8 (d,  $J$  = 1.9 Hz), 136.3 (d,  $J$  = 1.5 Hz), 130.2, 130.1, 129.9 (q,  $J$  = 8.6 Hz), 124.8 (q,  $J$  = 3.8 Hz), 124.5 (d,  $J$  = 16.5 Hz), 123.8 (q,  $J$  = 270 Hz), 122.1 (d,  $J$  = 3.7 Hz), 116.0 (d,  $J$  = 22.9 Hz), 115.9 (d,  $J$  = 21.7 Hz), 113.4 (d,  $J$  = 22.7 Hz), 42.1, 38.0, 13.3, 11.4.

**MS (EI, 70 eV):**  $m/z$  (%) = 339 (13), 338 (67), 318 (11), 268 (15), 267 (100), 219 (45), 194 (18), 170 (35).

**HRMS (EI):** for  $\text{C}_{18}\text{H}_{17}\text{F}_4\text{NO}$ : calc.  $[\text{M}^+]$ : 339.1246; found: 339.1193.

### 5-Chloro-4-(3-nitrophenyl)benzo-1,3-dioxole (9h)



According to **TP 1**, to a solution of 5-chlorobenzo-1,3-dioxole (**5f**, 58  $\mu$ L, 0.5 mmol, 1.0 equiv) in toluene (1 mL) was added  $\text{TMP}_2\text{Mg}$  (0.55 mmol, 1.1 equiv) at 60  $^\circ\text{C}$ . After one hour, the resulting arylmagnesium with transmetalated with a  $\text{ZnCl}_2$  solution (1.2 mL, 1.00 M in THF, 2.40 equiv) at 0  $^\circ\text{C}$  for 30 min. A dry and argon-flushed Schlenk-tube, equipped with a magnetic stirring bar and a septum was charged with  $\text{Pd}(\text{dba})_2$  (9 mg, 3 mol%) and TFP (7 mg, 6 mol%) and 1-Iodo-3-nitrobenzene (103 mg, 0.415 mmol, 0.83 equiv). The freshly prepared arylzinc reagent was added and the reaction mixture was placed in an oil bath at 55  $^\circ\text{C}$  for 16 h. Purification of the crude product by flash column chromatography (silica gel, pentane/diethyl ether = 99:1) afforded the title compound as a white solid (**9h**, 88 mg, 0.32 mmol, 76% yield).

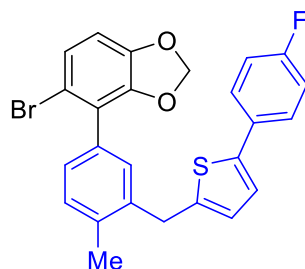
**$^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 8.37 (t,  $J = 2.0$  Hz, 1H), 8.26 (ddd,  $J = 8.1, 2.3, 1.0$  Hz, 1H), 7.82 (d,  $J = 7.7$  Hz, 1H), 7.63 (t,  $J = 8.0$  Hz, 1H), 7.26 (s, 1H), 7.01 (d,  $J = 8.3$  Hz, 1H), 6.80 (d,  $J = 8.4$  Hz, 1H), 6.02 (s, 2H).

**$^{13}\text{C NMR}$  (101 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 148.1, 146.6, 146.5, 136.4, 134.6, 129.1, 125.3, 124.8, 123.1, 122.8, 120.1, 108.9, 102.1.

**MS (EI, 70 eV):**  $m/z$  (%) = 279 (31), 278 (14), 277 (100), 276 (24), 260 (12), 230 (17), 175 (22), 173 (71), 168 (21), 139 (25), 138 (29), 137 (22).

**HRMS (EI):** for  $\text{C}_{13}\text{H}_8\text{ClNO}_4$ : calc.  $[\text{M}^+]$ : 277.0142; found: 277.0137.

**5-Bromo-4-(3-((5-(4-fluorophenyl)thiophen-2-yl)methyl)-4-methylphenyl)benzo-1,3-dioxole (9i)**



According to **TP 1**, to a solution of 5-bromo-1,3-benzodioxole (**5g**, 60  $\mu$ L, 0.5 mmol, 1.0 equiv) in toluene (1 mL) was added  $\text{TMP}_2\text{Mg}$  (0.55 mmol, 1.1 equiv) at 60  $^\circ\text{C}$ . After 30 min, the resulting arylmagnesium with transmetalated with a  $\text{ZnCl}_2$  solution (1.2 mL, 1.00 M in THF, 2.40 equiv) at 0  $^\circ\text{C}$  for 30 min. A dry and argon-flushed Schlenk-tube, equipped with a magnetic stirring bar and a septum was charged with  $\text{Pd}(\text{dba})_2$  (9 mg, 3 mol%), TFP (7 mg, 6 mol%) and 2-(4-fluorophenyl)-5-(5-iodo-2-methylbenzyl)thiophene (169 mg, 0.415 mmol, 0.83 equiv). The freshly prepared arylzinc reagent was added and the reaction mixture was placed in an oil bath at 55  $^\circ\text{C}$  for 16 h. Purification of the crude product by flash column chromatography (silica gel, hexane/EtOAc = 20:1) afforded the title compound as a white solid (**9i**, 138 mg, 0.29 mmol, 69% yield).

**$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 7.53 – 7.46 (m, 2H), 7.36 – 7.25 (m, 3H), 7.17 (d,  $J$  = 8.3 Hz, 1H), 7.09 – 7.00 (m, 3H), 6.73 (d,  $J$  = 3.6 Hz, 1H), 6.70 (d,  $J$  = 8.3 Hz, 1H), 5.96 (s, 2H), 4.19 (s, 2H), 2.39 (s, 3H).

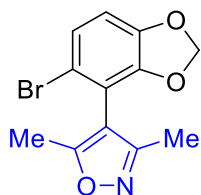
**$^{13}\text{C}$  NMR (101 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 162.1 (d,  $J$  = 246.5 Hz), 147.0, 146.5, 143.1, 141.6, 138.1, 136.7, 132.6, 131.2, 131.0 (d,  $J$  = 3.3 Hz), 130.4, 128.4, 127.2 (d,  $J$  = 7.9 Hz), 126.3, 125.7, 124.5, 122.8 (d,  $J$  = 1.3 Hz), 115.8 (d,  $J$  = 21.7 Hz), 114.6, 108.6, 101.7, 34.2, 19.5.

**MS (EI, 70 eV):**  $m/z$  (%) = 483 (13), 482 (50), 481 (12), 480 (49), 304 (14), 303 (90), 302 (15), 301 (91), 223 (15), 207 (20), 195 (57), 192 (11), 191 (100), 189 (10), 178 (11), 167 (13), 165 (25), 152 (20), 139 (16), 133 (17).

**HRMS (EI):** for  $\text{C}_{25}\text{H}_{18}\text{BrFO}_2\text{S}$ : calc.  $[\text{M}^+]$ : 480.0195; found: 480.0189.



#### 4-(5-Bromobenzo-1,3-dioxol-4-yl)-3,5-dimethylisoxazole (**9j**)



According to **TP 1**, to a solution of 5-bromo-1,3-benzodioxole (**5g**, 60  $\mu$ L, 0.5 mmol, 1.0 equiv) in toluene (1 mL) was added  $\text{TMP}_2\text{Mg}$  (0.55 mmol, 1.1 equiv) at 60  $^\circ\text{C}$ . After 30 min, the resulting arylmagnesium was transmetalated with a  $\text{ZnCl}_2$  solution (1.2 mL, 1.00 M in THF, 2.40 equiv) at 0  $^\circ\text{C}$  for 30 min. A dry and argon-flushed Schlenk-tube, equipped with a magnetic stirring bar and a septum was charged with  $\text{Pd}(\text{dba})_2$  (9 mg, 3 mol%), TFP (7 mg, 6 mol%) and 4-iodo-3,5-dimethylisoxazole (93 mg, 0.415 mmol, 0.83 equiv). The freshly prepared arylzinc reagent was added and the reaction mixture was placed in an oil bath at 55  $^\circ\text{C}$  for 16 h. Purification of the crude product by flash column chromatography (silica gel, pentane/diethyl ether = 9:1) afforded the title compound as a white solid (**9j**, 74 mg, 0.25 mmol, 60% yield).

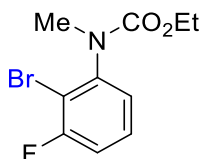
**$^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 7.15 (d,  $J$  = 8.3 Hz, 1H), 6.74 (d,  $J$  = 8.3 Hz, 1H), 5.99 (q,  $J$  = 1.3 Hz, 2H), 2.30 (s, 3H), 2.18 (s, 3H).

**$^{13}\text{C NMR}$  (101 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 167.3, 159.5, 147.6, 147.0, 125.6, 116.2, 113.3, 110.6, 109.7, 101.9, 12.12, 10.8.

**MS (EI, 70 eV):**  $m/z$  (%) = 297 (12), 296 (94), 295 (12), 294 (100), 253 (20), 251 (21), 216 (22), 213 (80), 212 (14), 211 (82), 210 (14), 201 (37), 200 (15), 188 (13), 175 (11), 154 (14), 152 (14), 147 (29), 146 (10), 119 (16), 18 (10), 91 (24), 89 (22).

**HRMS (EI):** for  $\text{C}_{12}\text{H}_{10}\text{BrNO}_3$ : calc.  $[\text{M}^+]$ : 294.9844; found: 294.9839.

### Ethyl (3-fluoro-2-bromophenyl)(methyl)carbamate (**9k**)



According to **TP 1**, to a solution of ethyl (3-fluorophenyl)(methyl)carbamate (**5h**, 98 mg, 0.5 mmol, 1.0 equiv) in toluene (1 mL) was added  $\text{TMP}_2\text{Mg}$  (0.55 mmol, 1.1 equiv) at 0 °C. After 1 h, 1,2-dibromotetrachloroethane (195 mg, 0.60 mmol, 1.2 equiv) dissolved in THF (1 mL) was added dropwise to the resulting arylmagnesium at 0 °C and the reaction mixture was warmed up to room temperature and stirred for an additional 2 h. Purification of the crude product by flash column chromatography (silica gel, pentane/diethyl ether = 8:1) afforded the title compound as a pale yellow solid (**9k**, 86 mg, 0.31 mmol, 62% yield).

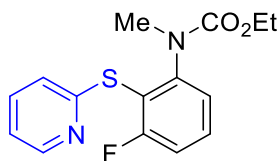
**$^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 7.35 – 7.28 (m, 1H), 7.13 – 6.96 (m, 2H), 4.30 – 3.39 (m, 2H), 3.18 (s, 3H), 1.14 (t,  $J = 7.1$  Hz, 3H). rotamers.

**$^{13}\text{C NMR}$  (101 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) =  $\delta$  159.9 (d,  $J = 248.4$  Hz), 155.4, 144.0, 128.8 (d,  $J = 9.1$  Hz), 124.8 (d,  $J = 3.2$  Hz), 115.5 (d,  $J = 22.6$  Hz), 111.1 (d,  $J = 20.3$  Hz), 62.1, 37.1, 14.7.

**MS (EI, 70 eV):**  $m/z$  (%) = 203 (18), 201 (18), 196 (23), 168 (100), 136 (10), 123 (14), 122 (16).

**HRMS (EI):** for  $\text{C}_{10}\text{H}_{12}\text{BrFNO}_2$ : calc.  $[\text{M}^+]$ : 276.0030; found: 276.0029.

### Ethyl (3-fluoro-2-(pyridin-2-ylthio)phenyl)(methyl)carbamate (**9l**)



According to **TP 1**, to a solution of ethyl (3-fluorophenyl)(methyl)carbamate (**5h**, 98 mg, 0.5 mmol, 1.0 equiv) in toluene (1 mL) was added  $\text{TMP}_2\text{Mg}$  (0.55 mmol, 1.1 equiv) at 0 °C. After 1 h, 2,2'-dipyridyldisulfide (165 mg, 0.75 mmol, 1.5 equiv) dissolved in toluene (1 mL) was added dropwise to the resulting arylmagnesium at 0 °C and the reaction mixture was warmed up to room temperature and stirred for an additional 2 h. Purification of the crude product by flash column chromatography (silica gel, pentane/diethyl ether = 4:1) afforded the title compound as a pale yellow solid (**9l**, 85 mg, 0.27 mmol, 55% yield).

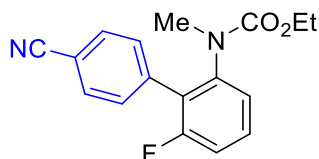
**$^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 8.35 (ddd,  $J$  = 4.9, 1.9, 0.9 Hz, 1H), 7.51 – 7.41 (m, 2H), 7.19 – 7.13 (m, 2H), 7.03 – 6.93 (m, 2H), 4.00 (q,  $J$  = 7.0 Hz, 2H), 3.17 (s, 3H), 1.07 (t,  $J$  = 7.1 Hz, 3H). rotamers.

**$^{13}\text{C NMR}$  (101 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 163.5 (d,  $J$  = 250.1 Hz), 158.4, 155.5, 149.6, 136.5, 131.4 (d,  $J$  = 9.8 Hz), 124.3, 120.9, 120.2, 118.45 (d,  $J$  = 18.3 Hz), 115.3 (d,  $J$  = 23.5 Hz), 61.9, 37.9, 14.6.

**MS (EI, 70 eV):**  $m/z$  (%) = 306 (15), 273 (29), 260 (10), 233 (16), 232 (11), 215 (10), 213 (11), 205 (11), 204 (100), 201 (50), 199 (12), 186 (10), 168 (14), 154 (49), 80 (29).

**HRMS (EI):** for  $\text{C}_{15}\text{H}_{15}\text{FN}_2\text{O}_2\text{S}$ : calc.  $[M^+]$ : 306.0838; found: 306.0831.

### Ethyl (4'-cyano-6-fluoro-(1,1'-biphenyl)-2-yl)(methyl)carbamate (**9m**)



According to **TP 1**, to a solution of ethyl (3-fluorophenyl)(methyl)carbamate (**5h**, 197 mg, 0.5 mmol, 1.0 equiv) in toluene (1 mL) was added  $\text{TMP}_2\text{Mg}$  (0.55 mmol, 1.1 equiv) at 0 °C. After 1 h, the resulting arylmagnesium was transmetalated with a  $\text{ZnCl}_2$  solution (1.2 mL, 1.00 M in THF, 2.40 equiv) at 0 °C for 30 min. A dry and argon-flushed Schlenk-tube, equipped with a magnetic stirring bar and a septum was charged with  $\text{Pd}(\text{dba})_2$  (9 mg, 3 mol%), TFP (7 mg, 6 mol%) and 4-iodobenzonitrile (95 mg, 0.415 mmol, 0.83 equiv). The freshly prepared arylzinc reagent was added and the reaction mixture was placed in an oil bath at 55 °C for 16 h. Purification of the crude product by flash column chromatography (silica gel, pentane/EtOAc = 4:1) afforded the title compound as a colorless oil (**9m**, 83 mg, 0.28 mmol, 67% yield).

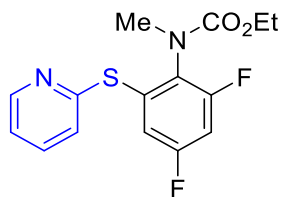
**$^1\text{H}$  NMR (600 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 7.71 (d,  $J$  = 8.0 Hz, 2H), 7.49 – 7.34 (m, 3H), 7.21 – 7.05 (m, 2H), 4.15 – 3.86 (m, 2H), 2.96 (s, 3H), 1.07 (t,  $J$  = 7.1 Hz, 3H). rotamers.

**$^{13}\text{C}$  NMR (101 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 159.8 (d,  $J$  = 248.4 Hz), 155.2, 142.5, 137.5, 132.2, 132.1, 130.6, 130.5, 130.1, 126.4 (d,  $J$  = 15.4 Hz), 124.1, 118.7, 115.1 (d,  $J$  = 22.7 Hz), 112.0, 62.0, 38.0, 14.7.

**MS (EI, 70 eV):**  $m/z$  (%) = 298 (36), 253 (10), 239 (10), 226 (15), 225 (100), 224 (17), 223 (40), 210 (72), 198 (13), 195 (11), 182 (11).

**HRMS (EI):** for  $\text{C}_{17}\text{H}_{15}\text{FN}_2\text{O}_2$ : calc.  $[M^+]$ : 298.1118; found: 298.1111.

### Ethyl (2,4-difluoro-6-(pyridin-2-ylthio)phenyl)(methyl)carbamate (**9n**)



According to **TP 1**, to a solution of ethyl (2-fluoro-4-fluorophenyl)(methyl)carbamate (**5i**, 108 mg, 0.5 mmol, 1.0 equiv) in toluene (1 mL) was added  $\text{TMP}_2\text{Mg}$  (0.55 mmol, 1.1 equiv) at 25 °C. After 10 min, 2,2'-dipyridyldisulfide (165 mg, 0.75 mmol, 1.5 equiv) dissolved in toluene (1 mL) was added dropwise to the resulting arylmagnesium at 0 °C and the reaction mixture was warmed up to room temperature and stirred for an additional 2 h. Purification of the crude product by flash column chromatography (silica gel, pentane/EtOAc = 4:1) afforded the title compound as a yellow oil (**9n**, 144 mg, 0.44 mmol, 89% yield).

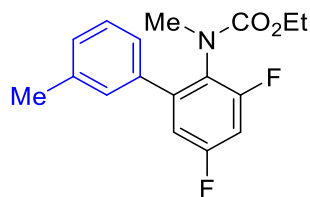
**$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 8.36 (ddd,  $J$  = 4.8, 1.9, 1.0 Hz, 1H), 7.64 – 7.58 (m, 1H), 7.55 – 7.48 (m, 1H), 7.44 – 7.29 (m, 1H), 7.07 – 6.96 (m, 2H), 4.11 (s, 2H), 3.24 (s, 3H), 1.13 (s, 3H). Rotamers.

**$^{13}\text{C}$  NMR (151 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 161.7 (dd,  $J$  = 250.7, 3.4 Hz), 158.9, 158.7 (dd,  $J$  = 253.0, 4.8 Hz), 157.3, 155.4, 149.6 (d,  $J$  = 26.1 Hz), 137.5, 136.8, 121.1, 120.8, 120.4, 119.68, 111.6 (dd,  $J$  = 24.2, 4.1 Hz), 108.1 (t,  $J$  = 22.2 Hz), 62.1, 37.4, 14.5.

**MS (EI, 70 eV):**  $m/z$  (%) = 223 (11), 222 (100), 78 (30), 73 (10).

**HRMS (EI):** for  $\text{C}_{15}\text{H}_{14}\text{F}_2\text{N}_2\text{O}_2\text{S}$ : calc.  $[M^+]$ : 324.0744; found: 324.0738.

### Ethyl (3,5-difluoro-3'-methyl-[1,1'-biphenyl]-2-yl)(methyl)carbamate (**9o**)



According to **TP 1**, to a solution of ethyl (2-fluoro-4-fluorophenyl)(methyl)carbamate (**5i**, 108 mg, 0.5 mmol, 1.0 equiv) in toluene (1 mL) was added  $\text{TMP}_2\text{Mg}$  (0.55 mmol, 1.1 equiv) at 25 °C. After 10 min, the resulting arylmagnesium was transmetalated with a  $\text{ZnCl}_2$  solution (1.2 mL, 1.00 M in THF, 2.40 equiv) at 0 °C for 30 min. A dry and argon-flushed Schlenk-tube, equipped with a magnetic stirring bar and a septum was charged with  $\text{Pd}(\text{dba})_2$  (9 mg, 3 mol%), TFP (7 mg, 6 mol%) and 3-iodotoluene (53  $\mu\text{L}$ , 0.415 mmol, 0.83 equiv). The freshly prepared arylzinc reagent was added and the reaction mixture was placed in an oil bath at 55 °C for 16 h. Purification of the crude product by flash column chromatography (silica gel, pentane/EtOAc = 4:1) afforded the title compound as a colorless oil (**9o**, 75 mg, 0.31 mmol, 59% yield).

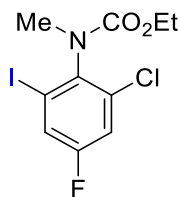
**$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 7.36 (t,  $J$  = 7.6 Hz, 1H), 7.29 – 7.20 (m, 4H), 6.97 (td,  $J$  = 8.9, 1.8 Hz, 1H), 4.17 – 4.07 (m, 2H), 3.25 (s, 3H), 2.41 (s, 3H), 1.26 (t,  $J$  = 7.1 Hz, 3H). Rotamers.

**$^{13}\text{C}$  NMR (101 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 171.3, 158.5 (dd,  $J$  = 248.6, 6.4 Hz), 156.7, 155.8, 138.1, 131.0, 129.4, 128.7, 128.3, 127.9, 127.4, 119.6 (t,  $J$  = 19.2 Hz), 111.5 (dd,  $J$  = 24.1, 4.0 Hz), 62.1, 37.6 (d,  $J$  = 1.8 Hz), 21.5, 14.7.

**MS (EI, 70 eV):**  $m/z$  (%) = 305 (18), 246 (12), 233 (16), 232 (18), 61 (16), 44 (13), 42 (100).

**HRMS (EI):** for  $\text{C}_{17}\text{H}_{17}\text{F}_2\text{NO}_2$ : calc.  $[M^+]$ : 305.1227; found: 305.1222.

### Ethyl (2-chloro-4-fluoro-6-iodophenyl)(methyl)carbamate (**9p**)



According to **TP 1**, to a solution of ethyl (2-chloro-4-fluorophenyl)(methyl)carbamate (**5j**, 116 mg, 0.5 mmol, 1.0 equiv) in toluene (1 mL) was added  $\text{TMP}_2\text{Mg}$  (0.55 mmol, 1.1 equiv) at 25 °C. After 10 min, iodine (153 mg, 0.60 mmol, 1.2 equiv) dissolved in THF (1 mL) was added dropwise at 0 °C to the resulting arylmagnesium and the reaction mixture was stirred for 1 h. Purification of the crude product by flash column chromatography (silica gel, pentane/EtOAc = 9:1) afforded the title compound as a pale yellow oil (**9p**, 130 mg, 0.38 mmol, 76% yield).

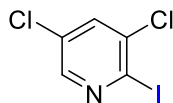
**$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 7.34 – 7.20 (m, 1H), 7.00 (dd,  $J$  = 8.8, 7.0 Hz, 1H), 4.34 – 3.94 (m, 2H), 3.17 (d,  $J$  = 1.8 Hz, 3H), 1.12 (t,  $J$  = 7.1 Hz, 3H). Rotamers.

**$^{13}\text{C}$  NMR (101 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 161.6 (d,  $J$  = 248.0 Hz), 155.4, 139.2 (d,  $J$  = 3.7 Hz), 137.2, 130.1 (d,  $J$  = 8.8 Hz), 114.2 (d,  $J$  = 25.6 Hz), 88.3 (d,  $J$  = 28.7 Hz), 62.2, 36.9, 14.7.

**MS (EI, 70 eV):**  $m/z$  (%) = 321 (15), 60 (13), 45 (13), 43 (100), 232 (11), 215 (10), 213 (11), 205 (11), 204 (100), 201 (50), 199 (12), 186 (10), 168 (14), 154 (49), 80 (29).

**HRMS (EI):** for  $\text{C}_{10}\text{H}_{10}\text{ClFINO}_2$ : calc.  $[M^+]$ : 356.9429; found: 356.9438.

### 3,5-Dichloro-2-iodopyridine (10a)



According to **TP 1**, to a solution of 3,5-dichloropyridine (**6a**, 74 mg, 0.50 mmol, 1.0 equiv) in toluene (1 mL) was added  $\text{TMP}_2\text{Mg}$  (0.55 mmol, 1.1 equiv) at 25 °C. After 10 min, the reaction mixture was cooled to 0 °C and iodine (153 mg, 0.60 mmol, 1.2 equiv) dissolved in THF (1 mL) was added dropwise and the reaction mixture was stirred for 1 h. Purification of the crude product by flash column chromatography (silica gel, pentane/diethyl ether = 95:5) afforded the title compound as a pale yellow solid (**10a**, 116 mg, 0.425 mmol, 86% yield).

**$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 8.26 (d,  $J$  = 2.3 Hz, 1H), 7.67 (d,  $J$  = 2.3 Hz, 1H).

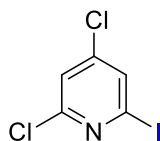
**$^{13}\text{C}$  NMR (101 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 147.1, 138.8, 135.9, 132.1, 118.4.

**MS (EI, 70 eV):**  $m/z$  (%) = 276 (10), 274 (63), 272 (100), 165 (15), 163 (23), 147 (43), 145 (65), 126 (17), 111 (13), 109 (39).

**HRMS (EI):** for  $\text{C}_5\text{H}_2\text{Cl}_2\text{IN}$ : calc.  $[M^+]$ : 272.8609; found: 272.8604.



## 2,4-Dichloro-6-iodopyridine (**10b**)



According to **TP 1**, to a solution of 2,4-dichloropyridine (**6b**, 54  $\mu$ L, 0.50 mmol, 1.0 equiv) in toluene (1 mL) was added  $\text{TMP}_2\text{Mg}$  (0.55 mmol, 1.1 equiv) at 25  $^\circ\text{C}$ . After 10 min, the reaction mixture was cooled to 0  $^\circ\text{C}$  and iodine (254 mg, 1.0 mmol, 2 equiv.) dissolved in THF (1 mL) was added dropwise and the reaction mixture was stirred for 1 h. Purification of the crude product by flash column chromatography (silica gel, pentane/diethyl ether = 99:1) afforded the title compound as a pale yellow solid (**10b**, 109 mg, 0.4 mmol, 80% yield).

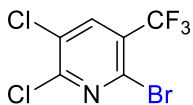
**$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 7.70 (d,  $J$  = 1.5 Hz, 1H), 7.34 (d,  $J$  = 1.5 Hz, 1H).

**$^{13}\text{C}$  NMR (101 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 151.1, 145.9, 133.6, 123.9, 115.3.

**MS (EI, 70 eV):**  $m/z$  (%) = 274 (13), 272 (21), 163 (13), 149 (10), 147 (64), 145 (100), 127 (15), 126 (15), 111 (19), 109 (56), 75 (10).

**HRMS (EI):** for  $\text{C}_5\text{H}_2\text{Cl}_2\text{IN}$ : calc.  $[M^+]$ : 272.8609; found: 272.8603.

## 2-Bromo-5,6-dichloro-3-(trifluoromethyl)pyridine (10c)



According to **TP 1**, to a solution of 2,3-dichloro-5-(trifluoromethyl)pyridine (**6c**, 107 mg, 0.50 mmol, 1.0 equiv) in toluene (1 mL) was added  $\text{TMP}_2\text{Mg}$  (0.55 mmol, 1.1 equiv) at 25 °C. After 10 min, 1,2-dibromotetrachloroethane (227 mg, 0.70 mmol, 1.4 equiv) dissolved in THF (1 mL) was added dropwise to the resulting arylmagnesium at 0 °C and the reaction mixture was warmed up to room temperature and stirred for an additional 2 h. Purification of the crude product by flash column chromatography (silica gel, pentane/EtOAc 98:2 ) afforded the title compound as a yellow solid (**10c**, 131 mg, 0.33 mmol, 89% yield).

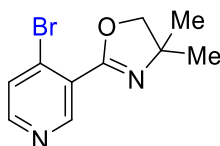
**$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 8.02 (s, 1H).

**$^{13}\text{C}$  NMR (101 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 151.4, 138.4 (q,  $J$  = 5.1 Hz), 135.6, 130.3, 127.9 (q,  $J$  = 34.1 Hz), 121.4 (q,  $J$  = 273.5 Hz).

**MS (EI, 70 eV):**  $m/z$  (%) = 296 (31), 294 (71), 292 (45), 215 (63), 213 (100), 144 (10), 84 (17), 68 (12).

**HRMS (EI):** for  $\text{C}_6\text{HBrCl}_2\text{F}_3\text{N}$ : calc.  $[\text{M}^+]$ : 292.8622; found: 292.8614.

## 2-(4-Bromopyridin-3-yl)-4,4-dimethyl-4,5-dihydrooxazole (10d)



According to **TP 1**, to a solution of 4,4-dimethyl-2-(pyridin-3-yl)-4,5-dihydrooxazole (**6d**, 88 mg, 0.50 mmol, 1.0 equiv) in toluene (1 mL) was added  $\text{TMP}_2\text{Mg}$  (0.55 mmol, 1.1 equiv) at 25 °C. After 10 min, 1,2-dibromotetrachloroethane (227 mg, 0.70 mmol, 1.4 equiv) dissolved in THF (1 mL) was added dropwise to the resulting arylmagnesium at 0 °C and the reaction mixture was warmed up to room temperature and stirred for an additional 2 h. Purification of the crude product by flash column chromatography (silica gel, pentane/EtOAc 1:1 ) afforded the title compound as a yellow solid (**10d**, 85 mg, 0.33 mmol, 68% yield).

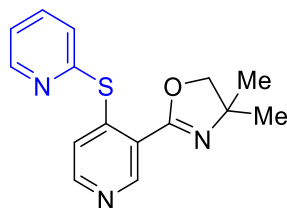
**$^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 8.84 (d,  $J$  = 0.5 Hz, 1H), 8.42 (d,  $J$  = 5.4 Hz, 1H), 7.58 (dd,  $J$  = 5.4, 0.5 Hz, 1H), 4.16 (s, 2H), 1.43 (s, 6H).

**$^{13}\text{C NMR}$  (101 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 159.4, 151.4, 151.3, 132.5, 128.5, 126.7, 79.5, 68.5, 28.3.

**MS (EI, 70 eV):**  $m/z$  (%) = 240 (88), 238 (91), 225 (22), 223 (22), 212 (44), 210 (44), 185 (45), 183 (16), 182 (100), 103 (23), 76 (17).

**HRMS (EI):** for  $\text{C}_{10}\text{H}_{11}\text{ON}_2\text{Br}$ : calc.  $[\text{M}^+]$ : 254.0055; found: 254.0051.

#### 4,4-Dimethyl-2-(4-(pyridin-2-ylthio)pyridin-3-yl)-4,5-dihydrooxazole (10e)



According to **TP 1**, to a solution of 4,4-dimethyl-2-(pyridin-3-yl)-4,5-dihydrooxazole (**6d**, 35 mg, 0.20 mmol, 1.0 equiv) in toluene (0.4 mL) was added  $\text{TMP}_2\text{Mg}$  (0.22 mmol, 1.1 equiv) at 25 °C. After 10 min, 2,2'-dipyridyldisulfide (66 mg, 0.30 mmol, 1.5 equiv) dissolved in toluene (0.5 mL) was added dropwise to the resulting arylmagnesium at 0 °C and the reaction mixture was warmed up to room temperature and stirred for an additional 2 h. Purification of the crude product by flash column chromatography (silica gel, EtOAc 100%) afforded the title compound as a yellow solid (**10e**, 41 mg, 0.14 mmol, 72% yield).

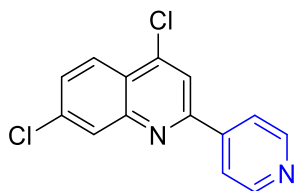
**$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 8.90 (s, 1H), 8.67 (ddd,  $J$  = 4.8, 2.0, 0.9 Hz, 1H), 8.31 (d,  $J$  = 5.5 Hz, 1H), 7.75 (td,  $J$  = 7.7, 1.9 Hz, 1H), 7.65 – 7.58 (m, 1H), 7.32 (ddd,  $J$  = 7.5, 4.8, 1.2 Hz, 1H), 6.86 (dd,  $J$  = 5.6, 0.6 Hz, 1H), 4.09 (s, 2H), 1.41 (s, 6H).

**$^{13}\text{C}$  NMR (101 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 159.1, 154.4, 151.3, 150.3, 150.2, 149.3, 137.8, 129.6, 123.5, 121.8, 121.7, 78.8, 77.4, 68.8, 28.5.

**MS (EI, 70 eV):**  $m/z$  (%) = 208 (10), 207 (100), 153 (11), 78 (10).

**HRMS (EI):** for  $\text{C}_{15}\text{H}_{15}\text{N}_3\text{OS}$ : calc.  $[\text{M}^+]$ : 285.0936; found: 285.0930.

#### 4,7-Dichloro-2-(pyridin-4-yl)quinoline (10f)



According to **TP 1**, to a solution of 4,7-dichloroquinoline (**6e**, 99 mg, 0.50 mmol, 1.0 equiv) in toluene (1 mL) was added  $\text{TMP}_2\text{Mg}$  (0.55 mmol, 1.1 equiv) at 25 °C. After 30 min, the resulting arylmagnesium was transmetalated with a  $\text{ZnCl}_2$  solution (4.8 mL, 1.00 M in THF, 2.40 equiv) at 0 °C for 30 min. A dry and argon-flushed Schlenk-tube, equipped with a magnetic stirring bar and a septum was charged with  $\text{Pd}(\text{dba})_2$  (9 mg, 3 mol%), TFP (7 mg, 6 mol%) and 4-iodopyridine (85 mg, 0.415 mmol, 0.83 equiv). The freshly prepared arylzinc reagent was added and the reaction mixture was placed in an oil bath at 55 °C for 16 h. Purification of the crude product by flash column chromatography (silica gel, pentane/EtOAc = 8:1) afforded the title compound as a white solid (**10f**, 84 mg, 0.30 mmol, 74% yield).

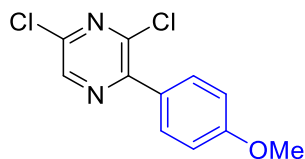
**$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 8.79 – 8.76 (m, 2H), 8.73 (d,  $J$  = 4.7 Hz, 1H), 8.28 (d,  $J$  = 9.1 Hz, 1H), 7.76 (d,  $J$  = 9.1 Hz, 1H), 7.52 (d,  $J$  = 4.6 Hz, 1H), 7.35 – 7.29 (m, 2H).

**$^{13}\text{C}$  NMR (101 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 150.9, 149.7, 147.9, 144.9, 142.9, 136.9, 135.3, 129.3, 125.7, 125.6, 125.5, 121.6.

**MS (EI, 70 eV):**  $m/z$  (%) = 276 (10), 274 (64), 272 (100), 239 (22), 106 (12).

**HRMS (EI):** for  $\text{C}_{14}\text{H}_7\text{Cl}_2\text{N}_2$ : calc.  $[M^+]$ : 272.9986; found: 272.9978.

### 3,5-Dichloro-2-(4-methoxyphenyl)pyrazine (10g)



According to **TP 1**, to a solution of 2,6-dichloropyrazine (**6f**, 75 mg, 0.50 mmol, 1.0 equiv) in toluene (1 mL) was added  $\text{TMP}_2\text{Mg}$  (0.55 mmol, 1.1 equiv) at 0 °C. After 10 min, the resulting arylmagnesium was transmetalated with a  $\text{ZnCl}_2$  solution (1.2 mL, 1.00 M in THF, 2.40 equiv) at 0 °C for 30 min. A dry and argon-flushed Schlenk-tube, equipped with a magnetic stirring bar and a septum was charged with  $\text{Pd}(\text{dba})_2$  (9 mg, 3 mol%) and TFP (7 mg, 6 mol%) and 4-iodoanisole (97 mg, 0.42 mmol, 0.83 equiv). The freshly prepared arylzinc reagent was added and the reaction mixture was placed in an oil bath at 55 °C for 16 h. Purification of the crude product by flash column chromatography (silica gel, pentane/EtOAc = 15:1) afforded the title compound as a white solid (**10g**, 89 mg, 0.30 mmol, 73% yield).

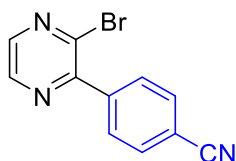
**$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 8.56 (s, 1H), 7.80 (d,  $J$  = 8.9 Hz, 2H), 7.02 (d,  $J$  = 8.9 Hz, 2H), 3.88 (s, 3H).

**$^{13}\text{C}$  NMR (101 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 161.1, 151.0, 145.2, 144.6, 141.9, 131.2, 113.9, 55.6.

**MS (EI, 70 eV):**  $m/z$  (%) = 257 (110), 286 (10), 256 (64), 255 (12), 254 (100), 219 (31), 210 (11), 44 (14), 43 (12).

**HRMS (EI):** for  $\text{C}_{11}\text{H}_8\text{O}_1\text{N}_2\text{Cl}_2$ : calc.  $[\text{M}^+]$ : 254.0014; found: 254.0015.

#### 4-(Benzoxazol-2-yl)benzonitrile (10h)



According to **TP 1**, to a solution of 2-bromopyridine (**6g**, 18  $\mu$ L, 0.2 mmol, 1.0 equiv) in toluene (1 mL) was added  $\text{TMP}_2\text{Mg}$  (0.22 mmol, 1.1 equiv) at  $-25\text{ }^\circ\text{C}$ . After 2 min, the resulting arylmagnesium was transmetalated with a  $\text{ZnCl}_2$  solution (0.48 mL, 1.00 M in THF, 2.40 equiv) at  $0\text{ }^\circ\text{C}$  for 30 min. A dry and argon-flushed Schlenk-tube, equipped with a magnetic stirring bar and a septum was charged with  $\text{Pd}(\text{dba})_2$  (4 mg, 3 mol%) and TFP (3 mg, 6 mol%) and 4-iodobenzonitrile (39 mg, 0.17 mmol, 0.83 equiv). The freshly prepared arylzinc reagent was added and the reaction mixture was placed in an oil bath at  $55\text{ }^\circ\text{C}$  for 16 h. Purification of the crude product by flash column chromatography (silica gel, pentane/EtOAc = 4:1) afforded the title compound as a white solid (**10h**, 32 mg, 0.12 mmol, 73% yield).

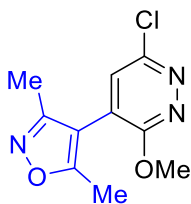
**$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 8.64 (d,  $J = 2.4$  Hz, 1H), 8.40 (d,  $J = 2.4$  Hz, 1H), 7.90 (d,  $J = 8.6$  Hz, 2H), 7.80 (d,  $J = 8.6$  Hz, 2H).

**$^{13}\text{C}$  NMR (101 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) =  $\delta$  153.6, 143.5, 142.6, 141.5, 139.7, 132.0, 130.3, 118.4, 113.4.

**MS (EI, 70 eV):**  $m/z$  (%) = 260 (25), 258 (25), 181 (12), 180 (100), 153 (35), 129 (17).

**HRMS (EI):** for  $\text{C}_{11}\text{H}_6\text{BrN}_3$ : calc.  $[\text{M}^+]$ : 258.9745; found: 258.9739.

#### 4-(6-Chloro-3-methoxypyridazin-4-yl)-3,5-dimethylisoxazole (10i)



According to **TP 1**, to a solution of 3-chloro-6-methoxypyridazine (**6h**, 72 mg, 0.50 mmol, 1.0 equiv) in toluene (1 mL) was added  $\text{TMP}_2\text{Mg}$  (0.55 mmol, 1.1 equiv) at 0 °C. After 5 min, the resulting arylmagnesium with transmetalated with a  $\text{ZnCl}_2$  solution (1.2 mL, 1.00 M in THF, 2.40 equiv) at 0 °C for 30 min. A dry and argon-flushed Schlenk-tube, equipped with a magnetic stirring bar and a septum was charged with  $\text{Pd}(\text{dba})_2$  (9 mg, 3 mol%) and TFP (7 mg, 6 mol%) and 4-iodo-3,5-dimethylisoxazole (93 mg, 0.42 mmol, 0.83 equiv). The freshly prepared arylzinc reagent was added and the reaction mixture was placed in an oil bath at 55 °C for 16 h. Purification of the crude product by flash column chromatography (silica gel, pentane/EtOAc = 2:1) afforded the title compound as a white solid (**10i**, 60 mg, 0.25 mmol, 60% yield).

**$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 7.23 (s, 1H), 4.13 (s, 3H), 2.37 (s, 3H), 2.21 (s, 3H).

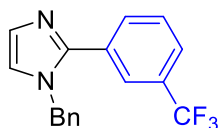
**$^{13}\text{C}$  NMR (101 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 168.4, 162.0, 158.7, 151.0, 130.2, 123.4, 108.6, 55.6, 12.2, 10.9.

**MS (EI, 70 eV):**  $m/z$  (%) = 226 (31), 224 (100), 198 (23), 196 (16), 182 (28), 182 (17), 169 (12), 158 (16), 157 (16), 156 (50), 155 (53), 130 (11), 128 (33).

**HRMS (EI):** for  $\text{C}_{10}\text{H}_{10}\text{O}_2\text{N}_3\text{Cl}$ : calc.  $[M^+]$ : 239.0462; found: 239.0455.



### 1-Benzyl-2-(3-(trifluoromethyl)phenyl)-1H-imidazole (**10j**)



According to **TP 1**, to a solution of 1-benzylimidazole (**6i**, 79 mg, 0.5 mmol, 1.0 equiv) in toluene (1 mL) was added  $\text{TMP}_2\text{Mg}$  (0.55 mmol, 1.1 equiv) at 0 °C. After 30 min, the resulting arylmagnesium with transmetalated with a  $\text{ZnCl}_2$  solution (1.2 mL, 1.00 M in THF, 2.40 equiv) at 0 °C for 30 min. A dry and argon-flushed Schlenk-tube, equipped with a magnetic stirring bar and a septum was charged with  $\text{Pd}(\text{dba})_2$  (9 mg, 3 mol%) and TFP (7 mg, 6 mol%) and 1-iodo-3-(trifluoromethyl)benzene (60  $\mu\text{L}$ , 0.415 mmol, 0.83 equiv). The freshly prepared arylzinc reagent was added and the reaction mixture was placed in an oil bath at 55 °C for 16 h. Purification of the crude product by flash column chromatography (silica gel, pentane/EtOAc = 1:1) afforded the title compound as a colorless oil (**10j**, 80 mg, 0.26 mmol, 64% yield).

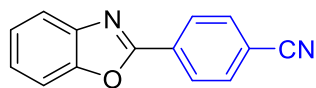
**$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) =  $\delta$  7.84 (s, 1H), 7.71 (d,  $J$  = 7.8 Hz, 1H), 7.62 (d,  $J$  = 7.8 Hz, 1H), 7.49 (t,  $J$  = 7.8 Hz, 1H), 7.39 – 7.28 (m, 3H), 7.21 (d,  $J$  = 1.3 Hz, 1H), 7.12 – 7.05 (m, 2H), 7.03 (d,  $J$  = 1.3 Hz, 1H), 5.21 (s, 2H).

**$^{13}\text{C}$  NMR (101 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) =  $\delta$  146.6, 136.5, 131.7, 131.7, 131.3, 131.1 (q,  $J$  = 32.6 Hz), 129.3, 129.1, 128.2, 126.5, 125.7 (q,  $J$  = 3.8 Hz), 125.4 (q,  $J$  = 3.7 Hz), 123.8 (q,  $J$  = 272.5 Hz) 122.2, 50.6.

**MS (EI, 70 eV):**  $m/z$  (%) = 302 (23), 91 (100).

**HRMS (EI):** for  $\text{C}_{17}\text{H}_{13}\text{N}_2\text{F}_3$ : calc.  $[\text{M}^+]$ : 302.1031; found: 302.1024.

#### 4-(Benzoxazol-2-yl)benzonitrile (**10k**)



According to **TP 1**, to a solution of benzoxazole (**6j**, 60 mg, 0.5 mmol, 1.0 equiv) in toluene (1 mL) was added  $\text{TMP}_2\text{Mg}$  (0.55 mmol, 1.1 equiv) at  $-40\text{ }^\circ\text{C}$ . After 10 min, the resulting arylmagnesium with transmetalated with a  $\text{ZnCl}_2$  solution (1.2 mL, 1.00 M in THF, 2.40 equiv) at  $0\text{ }^\circ\text{C}$  for 30 min. A dry and argon-flushed Schlenk-tube, equipped with a magnetic stirring bar and a septum was charged with  $\text{Pd}(\text{dba})_2$  (9 mg, 3 mol%) and TFP (7 mg, 6 mol%) and 4-iodobenzonitrile (95 mg, 0.415 mmol, 0.83 equiv). The freshly prepared arylzinc reagent was added and the reaction mixture was placed in an oil bath at  $55\text{ }^\circ\text{C}$  for 16 h. Purification of the crude product by flash column chromatography (silica gel, pentane/EtOAc = 1:1) afforded the title compound as a white solid (**10k**, 66 mg, 0.30 mmol, 72% yield).

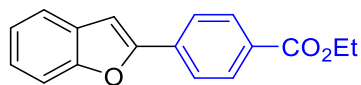
**$^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 8.31 (d,  $J$  = 8.5 Hz, 2H), 7.77 (d,  $J$  = 8.6 Hz, 3H), 7.63 – 7.53 (m, 1H), 7.47 – 7.33 (m, 2H).

**$^{13}\text{C NMR}$  (101 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) =  $\delta$  160.9, 150.9, 141.9, 132.7, 131.1, 127.9, 126.2, 125.1, 120.6, 118.2, 114.7, 110.9.

**MS (EI, 70 eV):**  $m/z$  (%) = 221 (15), 220 (100), 192 (20).

**HRMS (EI):** for  $\text{C}_{14}\text{H}_8\text{N}_2\text{O}$ : calc.  $[\text{M}^+]$ : 220.0637; found: 220.0631.

### Ethyl 4-(benzofuran-2-yl)benzoate (**10l**)



According to **TP 1**, to a solution of benzofuran (**6k**, 55  $\mu$ L, 0.5 mmol, 1.0 equiv) in toluene (1 mL) was added  $\text{TMP}_2\text{Mg}$  (0.55 mmol, 1.1 equiv) at  $-20\text{ }^\circ\text{C}$ . After 10 min, the resulting arylmagnesium with transmetalated with a  $\text{ZnCl}_2$  solution (1.2 mL, 1.00 M in THF, 2.40 equiv) at  $0\text{ }^\circ\text{C}$  for 30 min. A dry and argon-flushed Schlenk-tube, equipped with a magnetic stirring bar and a septum was charged with  $\text{Pd}(\text{dba})_2$  (9 mg, 3 mol%) and TFP (7 mg, 6 mol%) and ethyl 4-iodobenzoate (70  $\mu$ L, 0.415 mmol, 0.83 equiv). The freshly prepared arylzinc reagent was added and the reaction mixture was placed in an oil bath at  $55\text{ }^\circ\text{C}$  for 16 h. Purification of the crude product by flash column chromatography (silica gel, pentane/diethyl ether = 9:1) afforded the title compound as a yellow oil (**10l**, 93 mg, 0.35 mmol, 84% yield).

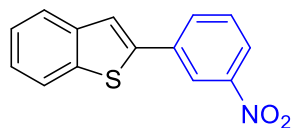
**$^1\text{H}$  NMR (400 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 8.12 (d,  $J$  = 8.5 Hz, 2H), 7.92 (d,  $J$  = 8.5 Hz, 2H), 7.61 (ddd,  $J$  = 7.8, 1.3, 0.7 Hz, 1H), 7.55 (dq,  $J$  = 8.2, 0.9 Hz, 1H), 7.33 (ddd,  $J$  = 8.3, 7.2, 1.3 Hz, 1H), 7.29 – 7.23 (m, 1H), 7.15 (d,  $J$  = 0.9 Hz, 1H), 4.41 (q,  $J$  = 7.2 Hz, 2H), 1.42 (t,  $J$  = 7.2 Hz, 3H).

**$^{13}\text{C}$  NMR (151 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 166.3, 155.3, 154.8, 134.5, 130.2, 130.1, 129.0, 125.2, 124.7, 123.3, 121.4, 111.5, 103.5, 61.2, 14.5.

**MS (EI, 70 eV):**  $m/z$  (%) = 266 (100), 239 (14), 238 (89), 222 (14), 221 (93), 193 (28), 166 (13), 165 (99), 164 (31), 163 (33), 139 (13).

**HRMS (EI):** for  $\text{C}_{17}\text{H}_{14}\text{O}_3$ : calc.  $[\text{M}^+]$ : 266.0943; found: 266.0937.

## 2-(3-Nitrophenyl)benzo[b]thiophene (10m)



According to **TP 1**, to a solution of benzo[b]thiophene (**6I**, 67 mg, 0.5 mmol, 1.0 equiv) in toluene (1 mL) was added  $\text{TMP}_2\text{Mg}$  (0.55 mmol, 1.1 equiv) at 65 °C. After one hour, the resulting arylmagnesium was transmetalated with a  $\text{ZnCl}_2$  solution (1.2 mL, 1.00 M in THF, 2.40 equiv) at 0 °C for 30 min. A dry and argon-flushed Schlenk-tube, equipped with a magnetic stirring bar and a septum was charged with  $\text{Pd}(\text{dba})_2$  (9 mg, 3 mol%) and TFP (7 mg, 6 mol%) and 1-iodo-3-nitrobenzene (100 mg, 0.415 mmol, 0.83 equiv). The freshly prepared arylzinc reagent was added and the reaction mixture was placed in an oil bath at 55 °C for 16 h. Purification of the crude product by flash column chromatography (silica gel, pentane/EtOAc = 9:1) afforded the title compound as a yellow solid (**10m**, 69 mg, 0.27 mmol, 66% yield).

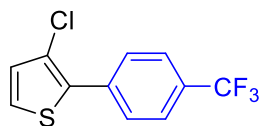
**$^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 8.56 (t,  $J$  = 2.0 Hz, 1H), 8.18 (ddd,  $J$  = 8.2, 2.3, 1.0 Hz, 1H), 8.02 – 7.98 (m, 1H), 7.88 – 7.80 (m, 2H), 7.68 (s, 1H), 7.60 (t,  $J$  = 8.0 Hz, 1H), 7.44 – 7.34 (m, 2H).

**$^{13}\text{C NMR}$  (101 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 148.8, 141.2, 140.4, 139.8, 136.2, 132.2, 130.1, 125.4, 125.1, 124.2, 122.8, 122.5, 121.5, 121.1.

**MS (EI, 70 eV):**  $m/z$  (%) = 256 (12), 255 (79), 209 (17), 208 (84), 197 (13), 166 (13), 165 (100), 164 (21), 163 (35), 139 (13).

**HRMS (EI):** for  $\text{C}_{14}\text{H}_9\text{NO}_2\text{S}$ : calc.  $[M^+]$ : 255.0354; found: 255.0349.

### 3-Chloro-2-(4-(trifluoromethyl)phenyl)thiophene (10n)



According to **TP 1**, to a solution of 3-chlorothiophene (**6m**, 371  $\mu$ L, 4 mmol, 1.0 equiv) in toluene (1 mL) was added  $\text{TMP}_2\text{Mg}$  (4.4 mmol, 1.1 equiv) at 60  $^\circ\text{C}$ . After 30 min, the resulting arylmagnesium was transmetalated with a  $\text{ZnCl}_2$  solution (9.6 mL, 1.00 M in THF, 2.40 equiv) at 0  $^\circ\text{C}$  for 30 min. A dry and argon-flushed Schlenk-tube, equipped with a magnetic stirring bar and a septum was charged with  $\text{Pd}(\text{dba})_2$  (69 mg, 3 mol%) and TFP (56 mg, 6 mol%) and 1-iodo-4-(trifluoromethyl)benzene (0.5 mL, 3.32 mmol, 0.83 equiv). The freshly prepared arylzinc reagent was added and the reaction mixture was placed in an oil bath at 55  $^\circ\text{C}$  for 16 h. Purification of the crude product by flash column chromatography (silica gel, pentane/EtOAc = 1:1) afforded the title compound as a white solid (**10n**, 698 mg, 2.65 mmol, 80% yield).

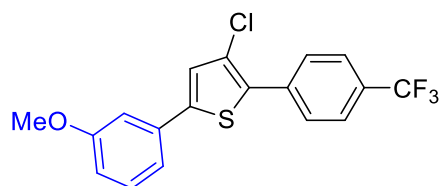
**$^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 7.79 (d,  $J$  = 8.1 Hz, 2H), 7.69 (d,  $J$  = 8.4 Hz, 2H), 7.34 (d,  $J$  = 5.4 Hz, 1H), 7.04 (d,  $J$  = 5.4 Hz, 1H).

**$^{13}\text{C NMR}$  (101 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) =  $\delta$  135.8, 135.7, 134.5, 130.0 (d,  $J$  = 32.7 Hz), 129.6, 128.9, 125.6 (q,  $J$  = 3.8 Hz), 124.9, 122.5, 123.7 (q,  $J$  = 204.1 Hz), 120.5.

**MS (EI, 70 eV):**  $m/z$  (%) = 263 (35), 261 (100), 207 (20), 183 (28), 182 (12).

**HRMS (EI):** for  $\text{C}_{11}\text{H}_6\text{ClF}_3\text{S}$ : calc.  $[M^+]$ : 261.9831; found: 261.9827.

### 3-Chloro-5-(3-methoxyphenyl)-2-(4-(trifluoromethyl)phenyl)thiophene (10o)



According to **TP 1**, to a solution of 3-Chloro-2-(4-(trifluoromethyl)phenyl)thiophene (**10n**, 52 mg, 0.2 mmol, 1.0 equiv) in toluene (0.4 mL) was added  $\text{TMP}_2\text{Mg}$  (0.22 mmol, 1.1 equiv) at 40 °C. After 30 min, the resulting arylmagnesium was transmetalated with a  $\text{ZnCl}_2$  solution (0.48 mL, 1.00 M in THF, 2.40 equiv) at 0 °C for 30 min. A dry and argon-flushed Schlenk-tube, equipped with a magnetic stirring bar and a septum was charged with  $\text{Pd}(\text{dba})_2$  (4 mg, 3 mol%) and TFP (3 mg, 6 mol%) and 1-iodo-3-methoxybenzene (18  $\mu\text{L}$ , 0.14 mmol, 0.7 equiv). The freshly prepared arylzinc reagent was added and the reaction mixture was placed in an oil bath at 55 °C for 16 h. Purification of the crude product by flash column chromatography (silica gel, hexane 100%) afforded the title compound as a yellow oil (**10o**, 33 mg, 0.09 mmol, 65% yield).

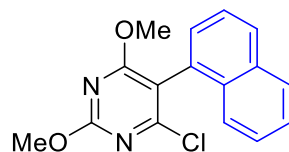
**$^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 7.84 (d,  $J$  = 7.5 Hz, 2H), 7.69 (d,  $J$  = 8.5 Hz, 2H), 7.38 – 7.29 (m, 1H), 7.23 (s, 1H), 7.18 (ddd,  $J$  = 7.7, 1.7, 0.9 Hz, 1H), 7.11 (dd,  $J$  = 2.5, 1.7 Hz, 1H), 6.90 (ddd,  $J$  = 8.3, 2.5, 0.9 Hz, 1H), 3.87 (s, 3H).

**$^{13}\text{C NMR}$  (101 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 146.6, 136.5, 131.8, 131.4, 131.1 (q,  $J$  = 32.6 Hz), 129.3, 129.2, 128.2, 126.5, 125.8 (q,  $J$  = 3.8 Hz), 125.5 (q,  $J$  = 3.7 Hz), 123.8 (q,  $J$  = 272.5 Hz), 122.3, 50.6.

**MS (EI, 70 eV):**  $m/z$  (%) = 370 (35), 369 (19), 368 (100), 325 (22), 304 (17).

**HRMS (EI):** for  $\text{C}_{18}\text{H}_{12}\text{OCIF}_3\text{S}$ : calc.  $[\text{M}^+]$ : 368.0249; found: 368.0244.

#### 4-Chloro-2,6-dimethoxy-5-(naphthalen-1-yl)pyrimidine (**11b**)



According to **TP 1**, to a solution of 4-chloro-2,6-dimethoxypyrimidine (**11a**, 349.6 mg, 2 mmol, 1.0 equiv) in toluene (1 mL) was added  $\text{TMP}_2\text{Mg}$  (2.2 mmol, 1.1 equiv) at 0 °C. After 30 min, the resulting arylmagnesium with transmetalated with a  $\text{ZnCl}_2$  solution (4.8 mL, 1.00 M in THF, 2.40 equiv) at 0 °C for 30 min. A dry and argon-flushed Schlenk-tube, equipped with a magnetic stirring bar and a septum was charged with  $\text{Pd}(\text{dba})_2$  (35 mg, 3 mol%) and TFP (28 mg, 6 mol%) and 1-iodonaphthalene (243  $\mu\text{L}$ , 1.66 mmol, 0.83 equiv). The freshly prepared arylzinc reagent was added and the reaction mixture was placed in an oil bath at 55 °C for 16 h. Purification of the crude product by flash column chromatography (silica gel, pentane/diethyl ether = 6:1) afforded the title compound as a white solid (**11b**, 418 mg, 1.39 mmol, 84% yield).

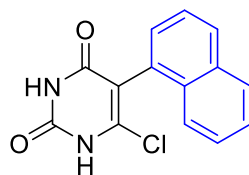
**$^1\text{H NMR}$  (400 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 7.96 – 7.90 (m, 2H), 7.58 – 7.42 (m, 4H), 7.36 (dd,  $J$  = 7.0, 1.2 Hz, 1H), 4.10 (s, 3H), 3.87 (s, 3H).

**$^{13}\text{C NMR}$  (101 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 170.4, 163.8, 160.9, 133.6, 131.7, 129.8, 129.0, 128.6, 128.38, 126.5, 126.1, 125.4, 124.8, 112.5, 55.5, 55.0.

**MS (EI, 70 eV):**  $m/z$  (%) = 302 (31), 301 (16), 300 (100), 299 (31), 285 (15), 271 (16), 270 (16), 265 (37), 250 (41), 235 (28), 233 (16), 220 (24), 207 (32), 206 (29), 205 (15), 193 (31), 192 (15), 191 (19), 180 (28), 179 (24), 178 (23), 165 (44), 164 (68), 152 (21), 139 (19), 137 (15).

**HRMS (EI):** for  $\text{C}_{16}\text{H}_{13}\text{O}_2\text{N}_2\text{Cl}$ : calc.  $[M^+]$ : 300.0666; found: 300.0658.

### 6-Chloro-5-(naphthalen-1-yl)pyrimidine-2,4(1H,3H)-dione (**11c**)



The title compound was prepared according to a literature procedure.<sup>2</sup> A dry and argon flushed 25 mL round-bottom-flask, equipped with a magnetic stirring bar and a septum, was charged with 4-Chloro-2,6-dimethoxy-5-(naphthalen-1-yl) pyrimidine (**11b**, 0.25 mmol), concentrated hydrochloric acid (0.5 mL), THF (0.4 mL), and dioxane (0.4 mL). The resulting mixture was heated to reflux. After 2 h, the reaction mixture was allowed to cool down and half of the volume was removed by evaporation. Water (2 mL) was then added and the mixture was boiled for 1-2 min. After refrigerating for 2 h, the crystals were filtered and washed with water and diethyl ether. The title compound was obtained as a white powder (**11c**, 50 mg, 0.18 mmol, 74% yield).

**<sup>1</sup>H NMR (400 MHz, (CD<sub>3</sub>)<sub>2</sub>SO):** δ (ppm) = 12.25 (s, 1H), 11.54 (s, 1H), 7.99 – 7.92 (m, 2H), 7.74 (dd, *J* = 8.2, 1.5 Hz, 1H), 7.60 – 7.45 (m, 3H), 7.39 (dd, *J* = 7.1, 1.3 Hz, 1H).

**<sup>13</sup>C NMR (101 MHz, (CD<sub>3</sub>)<sub>2</sub>SO):** δ (ppm) = 162.95, 150.5, 143.9, 133.7, 132.4, 130.4, 129.4, 128.9, 128.7, 126.8, 126.4, 125.9, 125.6, 110.7.

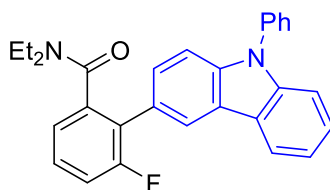
**MS (EI, 70 eV):** *m/z* (%) = 302 (31), 301 (16), 300 (100), 299 (31), 285 (15), 271 (16), 270 (16), 265 (37), 250 (41), 235 (28), 233 (16), 220 (24), 207 (32), 206 (29), 205 (15), 193 (31), 192 (15), 191 (19), 180 (28), 179 (24), 178 (23), 165 (44), 164 (68), 152 (21), 139 (19), 137 (15).

**HRMS (EI):** for C<sub>14</sub>H<sub>9</sub>ClN<sub>2</sub>O<sub>2</sub>: calc. [*M*+]: 272.0353; found: 272.0340.

<sup>2</sup> R. Nencka, I. Votruba, H. Hřebabeký, P. Jansa, E. Tloušťová, K. Masojídková, A. Holý, *J. Med. Chem.* **2007**, 50, 24, 6016-6023.



### **N,N-Diethyl-3-fluoro-2-(9-phenyl-9H-carbazol-3-yl)benzamide (11d)**



According to **TP 1**, to a solution of *N,N*-diethyl-3-fluorobenzamide (**5e**, 390 mg, 2 mmol, 1.0 equiv.) in toluene (4 mL) was added  $\text{TMP}_2\text{Mg}$  (2.2 mmol, 1.1 equiv) at 25 °C. After 10 min, the resulting arylmagnesium with transmetalated with a  $\text{ZnCl}_2$  solution (4.8 mL, 1.00 M in THF, 2.40 equiv) at 0 °C for 30 min. A dry and argon-flushed Schlenk-tube, equipped with a magnetic stirring bar and a septum was charged with  $\text{Pd}(\text{dba})_2$  (35 mg, 3 mol%), TFP (28 mg, 6 mol%) and 3-iodo-9-phenyl-9H-carbazole (612 mg, 1.66 mmol, 0.83 equiv). The freshly prepared arylzinc reagent was added and the reaction mixture was placed in an oil bath at 55 °C for 16 h. Purification of the crude product by flash column chromatography (silica gel, pentane/EtOAc = 1:1) afforded the title compound as a white solid (**11d**, 651 mg, 1.49 mmol, 90% yield).

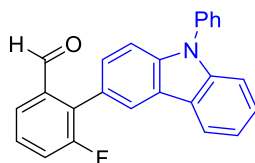
**$^1\text{H}$  NMR (600 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 8.22 (s, 1H), 8.14 (d,  $J$  = 7.8 Hz, 1H), 7.64 – 7.54 (m, 4H), 7.53 – 7.46 (m, 2H), 7.44 – 7.40 (m, 3H), 7.38 (td,  $J$  = 8.1, 5.1 Hz, 1H), 7.31 – 7.27 (m, 1H), 7.24 – 7.18 (m, 2H), 3.69 (dq,  $J$  = 14.1, 7.1 Hz, 1H), 3.11 (dq,  $J$  = 14.3, 7.2 Hz, 1H), 2.88 (dq,  $J$  = 14.0, 7.0 Hz, 1H), 2.69 (dq,  $J$  = 14.1, 7.0 Hz, 1H), 0.81 (t,  $J$  = 7.1 Hz, 3H), 0.70 (t,  $J$  = 7.1 Hz, 3H).

**$^{13}\text{C}$  NMR (151 MHz,  $\text{CDCl}_3$ ):**  $\delta$  (ppm) = 169.22 (d,  $J$  = 3.0 Hz), 159.58 (d,  $J$  = 247.0 Hz), 141.2, 140.5, 139.5, 137.4, 129.9, 128.9 (d,  $J$  = 8.6 Hz), 127.9 (d,  $J$  = 1.7 Hz), 127.6, 127.0, 126.9 (d,  $J$  = 16.5 Hz), 126.1, 124.3, 123.3, 123.2, 122.5 (d,  $J$  = 3.7 Hz), 121.8 (d,  $J$  = 1.5 Hz), 120.5, 120.1, 116.1 (d,  $J$  = 23.3 Hz), 109.8, 109.4, 42.4, 38.3, 13.6, 11.9.

**MS (EI, 70 eV):**  $m/z$  (%) = 437 (27), 436 (100), 435 (14), 365 (33), 364 (57), 363 (11), 336 (10), 335 (15), 257 (12), 181 (23), 72 (10).

**HRMS (EI):** for  $\text{C}_{29}\text{H}_{25}\text{FN}_2\text{O}$ : calc.  $[\text{M}^+]$ : 436.1951; found: 436.1945.

### 3-Fluoro-2-(9-phenyl-9H-carbazol-3-yl)benzaldehyde (11e)



The title compound was prepared according to a literature procedure.<sup>3</sup> A dry and argon flushed Schlenk-tube, equipped with a magnetic stirring bar and a septum, was charged with Cp<sub>2</sub>Zr(H)Cl (77 mg, 0.30 mmol, 1.5 equiv). A solution of N,N-diethyl-3-fluoro-2-(9-phenyl-9H-carbazol-3-yl)benzamide (**11d**, 87 mg, 0.2 mmol, 1.0 equiv) in dry THF (1 mL) was added and the reaction mixture was stirred for 30 min at 25 °C. Purification by short path flash column chromatography (silica gel, ihexane/EtOAc = 4:1) afforded the title compound as a yellow oil (**11e**, 59 mg, 0.16 mmol, 81% yield).

**<sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>):** δ (ppm) = 9.92 (d, *J* = 0.8 Hz, 1H), 8.18 – 8.07 (m, 2H), 7.89 (dd, *J* = 7.6, 1.4 Hz, 1H), 7.69 – 7.57 (m, 4H), 7.55 – 7.39 (m, 7H), 7.33 (ddd, *J* = 8.0, 5.3, 2.9 Hz, 1H).

**<sup>13</sup>C NMR (101 MHz, CDCl<sub>3</sub>):** δ (ppm) = δ 191.68 (d, *J* = 3.9 Hz), 160.10 (d, *J* = 247.2 Hz), 141.4, 140.8, 137.3, 136.2 (d, *J* = 2.4 Hz), 133.8 (d, *J* = 16.5 Hz), 130.0, 128.7 (d, *J* = 7.8 Hz), 128.6, 127.8, 127.2, 126.6, 123.4, 123.2 (d, *J* = 3.6 Hz), 123.0, 122.9, 121.6, 120.8 (d, *J* = 23.2 Hz), 120.5, 120.4, 110.1, 109.7.

**MS (EI, 70 eV):** *m/z* (%) = 366 (26), 365 (100), 364 (15), 338 (14), 337 (55), 336 (52), 335 (19), 311 (26), 259 (10), 258 (17), 241 (10), 157 (10).

**HRMS (EI):** for C<sub>25</sub>H<sub>16</sub>FNO: calc. [M<sup>+</sup>]: 365.1216; found: 365.1213

<sup>3</sup> J. M. White, A. R. Tunoori, G. I. Georg, *J. Am. Chem. Soc.* **2000**, *122*, 11995-11996.

## 6. NMR Spectra

