Supporting Information

Bench-Stable and Recoverable Palladium(I) Dimer as an Efficient Catalyst for Heck Cross-Coupling

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1. General Experimental Details

All reagents and starting materials were commercially available and used as received. Anhydrous toluene was dried using an Innovative Technology PS-MD-5 solvent purification system. Solvents used in work up and purification were distilled prior to use. Thin layer chromatography (TLC) was performed on Merck Kieselgel 60 F254 aluminium plates with unmodified silica and visualized either under UV light or stained with potassium permanganate. Flash column chromatography was performed with Merck silica gel 60 (35 – 70 mesh).

All $^1$H, $^{13}$C, $^{19}$F and $^{31}$P NMR spectra were recorded on Varian VNMRS 600, Varian VNMRS 400, or Varian Mercury 300 spectrometers at ambient temperature. Chemical shifts (δ) are reported in parts per million (ppm) and were referenced either to residual solvent peak (CDCl$_3$; for $^1$H and $^{13}$C spectra) or trimethyl phosphate O=P(OMe)$_3$ (δ = 3.05 ppm, added as an internal standard for $^{31}$P). Coupling constants (J) are given in Hertz (Hz).

Gas chromatography coupled with mass spectrometry (GC-MS) was performed on an Agilent Technologies 5975 series MSD mass spectrometer under electrospray ionization (EI) mode coupled with an Agilent Technologies 7820A gas chromatograph employing an Agilent 19091s-433 HP-5MS column (30 m × 0.250 μm × 0.250 μm). GC-MS conditions: front inlet mode: split; temperature: 250°C; pressure: 718.4 mbar; total flow: 26.246 mL/min; split ratio: 20 : 1; split flow: 24 mL/min; run time: 25.5 min; oven programme: 60°C for 0.5 min then 10°C/min to 280°C then 280°C for 3 min; flow: 1.2 mL/min.

High-resolution mass spectrometry (HRMS) was performed using a Thermo Scientific LTQ Orbitrap XL spectrometer. Low-resolution masses of known compounds were extracted from their GC-MS chromatograms. IR spectra were recorded on a Spectrum 100 spectrometer with an UATR Diamond/KRS-5 crystal with attenuated total reflectance (ATR). Kugelrohr distillation was performed using a Büchi Glass Oven B-585 Kugelrohr apparatus.

2. General Procedures

**General Procedure for Heck cross-coupling reactions**

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Ar\(^I\) + R\(=\) ester, aryl

\[ \text{Pd(I) iodo dimer 2 \(0.75\) mol\%} \]
\[ \text{DIPEA \(1.1\) eq} \]

\[ \text{toluene, 100°C, 15h} \]

\[ \text{E:Z > 95:5} \]
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Aryl iodide (1.0 eq, 0.2 mmol), acrylate/styrene (1.01 eq, 0.202 mmol), di-iso-propylethylamine (DIPEA, 1.1 eq, 0.22 mmol, 28.4 mg) and Pd(I) iodo dimer 2 (0.75 mol%, 0.0015 mmol, 1.3 mg) were weighed into a 4 mL screw cap vial, purged with Argon and dissolved in anhydrous toluene (1.5 mL). The vial was capped with a PTFE-lined screw cap and sealed with PTFE tape prior to heating to 100°C under stirring using an aluminium heating block outside the glovebox. After 15 h, the reaction mixture was allowed to cool to ambient temperature, was diluted with ethyl acetate (to 20 mL) and excess base was quenched by the addition of aqueous ammonium chloride (20 mL of saturated aqueous solution). The organic phase was separated and the aqueous layer extracted with ethyl acetate (2 x 20 mL). The combined organic layer was dried over magnesium sulfate and the solvent removed under reduced pressure. The obtained crude product was purified by flash column chromatography.
General Procedure for catalyst recovery by Kugelrohr distillation

The Heck cross-coupling was conducted according to the general procedure using 5 mol% 2, 3a (0.4 mmol), 4a (0.404 mmol) and DIPEA (0.44 mmol) in toluene (3 mL) at 100 °C for 3h. The crude product was then subjected to Kugelrohr distillation at 125°C (at 0.3 mbar) for 20 min to yield the cross-coupling product 5aa as the distillate and the dinuclear Pd(I)-catalyst 2 as the remainder.

$^{31}$P NMR of catalyst after recovery ($C_6D_6$):

$^1$H NMR of catalyst after recovery ($C_6D_6$):
3. Compound Characterization Data

**Ethyl cinnamate (5aa)** was obtained after column chromatography (hexane) as a colorless oil (95%).

\[
\text{Rf} = 0.14 \text{ (Hexane).} \quad \text{\textsuperscript{1}H NMR (400 MHz, CDCl}_3): 7.69 (d, J = 16.0 \text{ Hz}, 1H), 7.58 – 7.47 (m, 2H), 7.43 – 7.33 (m, 3H), 6.44 (d, J = 16.0 \text{ Hz}, 1H), 4.27 (q, J = 7.2 \text{ Hz}, 2H), 1.34 (t, J = 7.1 \text{ Hz}, 3H). \quad \text{\textsuperscript{13}C NMR (101 MHz, CDCl}_3): 167.1, 144.7, 134.6, 130.3, 129.0, 128.2, 118.4, 60.6, 14.5. \quad \text{m/z (EI): 175.1 (13%), 176.1 (100%), M}^+ \quad 177.1 (12%), 178.1 (1%). \quad \text{Spectroscopic data are in agreement with those previously reported.}\]

**n-Butyl cinnamate (5ab)** was obtained after column chromatography (hexane) as a yellowish solid (97%).

\[
\text{Rf} = 0.41 \text{ (Hexane).} \quad \text{\textsuperscript{1}H NMR (400 MHz, CDCl}_3): 7.69 (d, J = 16.0 \text{ Hz}, 1H), 7.58 – 7.48 (m, 2H), 7.43 – 7.34 (m, 3H), 6.45 (d, J = 16.0 \text{ Hz}, 1H), 1.69 (ddt, J = 8.9, 7.9, 6.5 Hz, 2H), 1.51 – 1.37 (m, 2H), 0.97 (t, J = 7.4 \text{ Hz}, 3H). \quad \text{\textsuperscript{13}C NMR (101 MHz, CDCl}_3): 167.2, 144.7, 134.6, 130.3, 129.0, 128.2, 118.4, 64.6, 30.9, 19.3, 13.9. \quad \text{m/z (EI): 203.1 (1%), 204.1 (100%), M}^+ \quad 205.1 (14%), 206.1 (1%). \quad \text{Spectroscopic data are in agreement with those previously reported.}\]

**tert-Butyl cinnamate (5ac)** was obtained after column chromatography (hexane) as a yellowish solid (96%).

\[
\text{Rf} = 0.39 \text{ (Hexane).} \quad \text{\textsuperscript{1}H NMR (400 MHz, CDCl}_3): 7.59 (d, J = 16.0 \text{ Hz}, 1H), 7.55 – 7.48 (m, 2H), 7.47 – 7.40 (m, 2H), 7.30 – 7.23 (m, 1H), 7.18 (d, J = 6.0 \text{ Hz}, 2H), 7.09 (d, J = 2.5 \text{ Hz}, 2H), 6.37 (d, J = 16.0 \text{ Hz}, 1H), 1.54 (s, 9H). \quad \text{\textsuperscript{13}C NMR (101 MHz, CDCl}_3): 166.5, 143.7, 134.8, 130.1, 128.9, 128.1, 120.3, 80.6, 28.3. \quad \text{m/z (EI): 204.1 (100%, M}^+) \quad 205.1 (14%), 206.1 (1%). \quad \text{Spectroscopic data are in agreement with those previously reported.}\]

**4-Methylstyrene (5ad)** was obtained after column chromatography (hexane) as a white solid (93%).

\[
\text{Rf} = 0.38 \text{ (Hexane).} \quad \text{\textsuperscript{1}H NMR (400 MHz, CDCl}_3): 7.55 – 7.48 (m, 2H), 7.47 – 7.40 (m, 2H), 7.36 (t, J = 7.7 \text{ Hz}, 2H), 7.30 – 7.23 (m, 1H), 7.18 (d, J = 8.0 \text{ Hz}, 2H), 7.09 (d, J = 2.5 \text{ Hz}, 2H), 2.37 (s, 3H). \quad \text{\textsuperscript{13}C NMR (101 MHz, CDCl}_3): 137.6, 134.7, 129.5, 128.8, 128.7, 127.5, 126.6, 126.5, 21.4. \quad \text{m/z (EI): 187.0 (1%), 188.1 (1%), 189.1 (8%), 190.1 (4%), 191.1 (8%), 192.1 (4%), 193.1 (23%), 194.1 (100%, M}^+) \quad 195.1 (17%), 196.1 (1%). \quad \text{Spectroscopic data are in agreement with those previously reported.}\]

**4-Methoxystyrene (5ae)** was obtained after column chromatography (hexane/EtOAc 20:1) as a white solid (90%).

\[
\text{Rf} = 0.73 \text{ (Hexane/EtOAc 10:1).} \quad \text{\textsuperscript{1}H NMR (400 MHz, CDCl}_3): 7.50 (ddd, J = 14.7, 7.5, 1.8 \text{ Hz}, 4H), 7.37 (t, J = 7.7 \text{ Hz}, 2H), 7.30 – 7.23 (m, 1H), 7.14 – 6.96 (m, 2H), 6.96 – 6.87 (m, 2H), 3.84 (s, 3H). \quad \text{\textsuperscript{13}C NMR (101 MHz, CDCl}_3): 159.4, 137.8, 130.2, 128.8, 128.3, 127.8, 127.3, 126.7, 126.4, 114.2, 55.4. \quad \text{m/z (EI): 209.1 (16%), 210.1 (100%, M}^+) \quad 211.1 (17%), 212.1 (2%). \quad \text{Spectroscopic data are in agreement with those previously reported.}\]
**Styrene (5af)** was obtained after column chromatography (hexane) as a white solid (99%).

\[ \text{Rt} = 0.45 \text{ (Hexane).} \]

**1H NMR** (600 MHz, CDCl₃): 7.57 – 7.52 (m, 4H), 7.39 (t, J = 7.7 Hz, 4H), 7.31 – 7.27 (m, 2H), 7.14 (s, 2H).

**13C NMR** (151 MHz, CDCl₃): 137.4, 128.8, 127.7, 126.6. m/z (EI): 175.1 (1%), 176.1 (11%), 177.1 (8%), 178.1 (64%), 179.1 (100%), 180.1 (100%, M⁺), 181.1 (14%), 182.1 (1%). Spectroscopic data are in agreement with those previously reported.²

**4-Fluorostyrene (5ag)** was obtained after column chromatography (hexane) as a white solid (99%).

\[ \text{Rf} = 0.41 \text{ (Hexane).} \]

**1H NMR** (400 MHz, CDCl₃): 7.54 – 7.43 (m, 4H), 7.39 – 7.32 (m, 2H), 7.29 – 7.24 (m, 1H), 7.12 – 6.97 (m, 4H). **19F NMR** (376 MHz, CDCl₃): -114.18 – -114.36 (m). **13C NMR** (101 MHz, CDCl₃): 162.46 (d, J = 247.5 Hz), 137.29, 133.64 (d, J = 3.7 Hz), 128.84, 128.62 (d, J = 2.4 Hz), 128.11 (d, J = 8.1 Hz), 127.80, 127.60, 126.57, 115.75 (d, J = 21.8 Hz). m/z (EI): 194.1 (6%), 195.1 (4%), 196.1 (44%), 197.1 (70%), 198.1 (100%, M⁺), 199.1 (15%), 200.1 (1%). Spectroscopic data are in agreement with those previously reported.

**tert-Butyl-3-[[1,1’-biphenyl]-4-yl]acrylate (5bc)** was obtained after column chromatography (hexane) as a white solid (98%).

\[ \text{Rt} = 0.43 \text{ (Hexane).} \]

**1H NMR** (600 MHz, CDCl₃): 7.68 – 7.54 (m, 7H), 7.45 (q, J = 9.2, 8.4 Hz, 2H), 7.41 – 7.35 (m, 1H), 6.42 (d, J = 15.9 Hz, 1H), 1.57 (s, 9H).

**13C NMR** (151 MHz, CDCl₃): 166.5, 143.2, 142.8, 140.3, 137.9, 133.7, 129.0, 128.6, 127.9, 127.6, 127.1, 120.2, 80.6, 28.3. m/z (EI): 280.1 (100%, M⁺), 281.2 (26%), 282.0 (4%), 283.0 (2%). Spectroscopic data are in agreement with those previously reported.

**tert-Butyl-3-[(naphthalen-2-yl)acrylate (5cc)** was obtained after column chromatography (hexane) as a white solid (93%).

\[ \text{Rf} = 0.52 \text{ (Hexane/EtOAc 15:1).} \]

**1H NMR** (400 MHz, CDCl₃): 7.92 (s, 1H), 7.85 – 7.74 (m, 4H), 7.66 (d, J = 8.6, 1.7 Hz, 1H), 7.54 – 7.48 (m, 2H), 6.50 (d, J = 15.9 Hz, 1H), 1.57 (s, 9H). **13C NMR** (151 MHz, CDCl₃): 166.5, 143.7, 134.2, 133.4, 132.3, 129.7, 128.7, 128.6, 127.9, 127.6, 127.1, 120.2, 80.6, 28.3. m/z (EI): 253.1 (1%), 254.1 (100%, M⁺), 255.1 (18%), 256.1 (2%). Spectroscopic data are in agreement with those previously reported.

**tert-Butyl-3-(4-methoxyphenyl)acrylate (5dc)** was obtained after column chromatography (hexane/EtOAc 20:1) as a white solid (78%).

\[ \text{Rf} = 0.30 \text{ (Hexane/EtOAc 10:1).} \]

**1H NMR** (400 MHz, CDCl₃): 7.54 (d, J = 15.9 Hz, 1H), 7.45 (d, J = 8.7 Hz, 2H), 6.89 (d, J = 8.8 Hz, 2H), 6.24 (d, J = 15.9 Hz, 1H), 3.83 (s, 3H), 1.53 (s, 9H). **13C NMR** (151 MHz, CDCl₃): 166.8, 161.2, 143.3, 129.7, 127.5, 117.8, 114.4, 80.3, 55.5, 28.4. m/z (EI): 234.1 (100%, M⁺), 235.1 (16%), 236.1 (2%). Spectroscopic data are in agreement with those previously reported.
**tert-Butyl-3-(2-methoxyphenyl)acrylate** (5ec) was obtained after column chromatography (hexane/EtOAc 20:1) as a colorless oil (89%).

\[ R_f = 0.47 \text{ (Hexane/EtOAc 10:1)} \]

**1H NMR** (400 MHz, CDCl₃): 9.1 (d, \( J = 16.1 \text{ Hz, 1H} \)), 7.49 (dd, \( J = 7.7, 1.6 \text{ Hz, 1H} \)), 7.37 – 7.28 (m, 1H), 6.98 – 6.83 (m, 2H), 6.44 (d, \( J = 16.1 \text{ Hz, 1H} \)), 3.87 (s, 3H), 1.54 (s, 9H).

**13C NMR** (101 MHz, CDCl₃): 167.0, 158.3, 139.0, 131.2, 128.9, 123.8, 120.8, 111.2, 80.3, 55.6, 28.4. m/z (EI): 234.1 (100%, M⁺), 235.1 (15%), 236.1 (2%). Spectroscopic data are in agreement with those previously reported.⁶

**tert-Butyl-3-(4-acetylphenyl)acrylate** (5fc) was obtained after column chromatography (hexane/EtOAc 10:1 to 5:1) as an off-white solid (99%).

\[ R_f = 0.29 \text{ (Hexane/EtOAc 5:1)} \]

**1H NMR** (600 MHz, CDCl₃): 7.96 – 7.89 (m, 2H), 7.61 – 7.52 (m, 3H), 6.44 (d, \( J = 16.0 \text{ Hz, 1H} \)), 2.59 (s, 3H), 1.52 (s, 9H).

**13C NMR** (151 MHz, CDCl₃): 197.4, 165.9, 142.1, 139.1, 137.9, 128.9, 128.1, 122.8, 81.0, 28.3. m/z (EI): 246.1 (100%, M⁺), 247.0 (20%), 248.1 (2%). Spectroscopic data are in agreement with those previously reported.⁷

**tert-Butyl-3-(3-formylphenyl)acrylate** (5gc) was obtained after column chromatography (hexane/EtOAc 10:1 to 5:1) as a yellowish oil (96%).

\[ R_f = 0.41 \text{ (Hexane/EtOAc 5:1)} \]

**1H NMR** (600 MHz, CDCl₃): 10.02 (s, 1H), 7.99 (s, 1H), 7.85 (d, \( J = 7.6 \text{ Hz, 1H} \)), 7.33 (td, \( J = 7.9, 5.8 \text{ Hz, 1H} \)), 7.29 – 7.24 (m, 1H), 7.20 (dt, \( J = 9.8, 2.0 \text{ Hz, 1H} \)), 7.05 (ddd, \( J = 8.4, 2.5, 0.8 \text{ Hz, 1H} \)), 6.36 (d, \( J = 16.0 \text{ Hz, 1H} \)), 1.52 (s, 9H).

**13C NMR** (151 MHz, CDCl₃): 191.8, 165.9, 141.9, 137.0, 135.8, 133.6, 130.9, 129.7, 128.8, 81.0, 28.3. m/z (EI): 231.0 (1%), 232.1 (100%, M⁺), 233.0 (16%), 234.0 (2%). Spectroscopic data are in agreement with those previously reported.⁸

**tert-Butyl-3-(3-fluorophenyl)acrylate** (5hc) was obtained after column chromatography (hexane/EtOAc 10:1 to 5:1) as a white solid (88%).

\[ R_f = 0.10 \text{ (Hexane)} \]

**1H NMR** (600 MHz, CDCl₃): 7.53 (d, \( J = 16.0 \text{ Hz, 1H} \)), 7.33 (td, \( J = 7.9, 5.8 \text{ Hz, 1H} \)), 7.29 – 7.24 (m, 1H), 7.20 (dt, \( J = 9.8, 2.0 \text{ Hz, 1H} \)), 7.05 (ddd, \( J = 8.4, 2.5, 0.8 \text{ Hz, 1H} \)), 6.36 (d, \( J = 16.0 \text{ Hz, 1H} \)), 1.53 (s, 9H).

**19F NMR** (564 MHz, CDCl₃): -112.69 – -112.83 (m).

**13C NMR** (151 MHz, CDCl₃): 166.03, 163.11 (d, \( J = 246.2 \text{ Hz} \)), 142.25 (d, \( J = 2.3 \text{ Hz} \)), 137.06 (d, \( J = 7.6 \text{ Hz} \)), 130.47 (d, \( J = 8.3 \text{ Hz} \)), 124.06 (d, \( J = 2.8 \text{ Hz} \)), 121.72, 116.92 (d, \( J = 21.4 \text{ Hz} \)), 114.29 (d, \( J = 21.9 \text{ Hz} \)), 80.92, 28.30. m/z (EI): 222.1 (100%, M⁺), 223.0 (14%), 224.1 (1%). Spectroscopic data are in agreement with those previously reported.⁹

**tert-Butyl-3-(3-cyanophenyl)acrylate** (5ic) was obtained after column chromatography (hexane/EtOAc 10:1 to 5:1) as an off-white solid (81%).

\[ R_f = 0.43 \text{ (Hexane/EtOAc 5:1)} \]

**1H NMR** (600 MHz, CDCl₃): 7.76 (s, 1H), 7.73 – 7.68 (m, 1H), 7.64 – 7.57 (m, 1H), 7.55 – 7.45 (m, 2H), 6.40 (d, \( J = 16.0 \text{ Hz, 1H} \)), 1.52 (s, 9H).

**13C NMR** (151 MHz, CDCl₃): 165.5, 140.8, 136.0, 133.0, 131.9, 131.3, 129.8, 123.0, 118.3, 113.3, 81.2, 28.2. m/z (EI): 229.1 (100%, M⁺), 230.1 (14%), 230.9 (2%). Spectroscopic data are in agreement with those previously reported.¹⁰
**tert-Butyl-3-(pyridin-3-yl)acrylate** (5jc) was obtained after column chromatography (hexane/EtOAc 10:1 to 5:1) as a pale yellow solid (46%).

\[ R_t = 0.09 \] (Hexane/EtOAc 5:1). 1H NMR (600 MHz, CDCl3): 8.66 (d, \( J = 86.7 \) Hz, 2H), 7.81 (d, \( J = 7.9 \) Hz, 1H), 7.56 (d, \( J = 16.1 \) Hz, 1H), 7.31 (d, \( J = 7.4 \) Hz, 1H), 6.43 (d, \( J = 16.1 \) Hz, 1H), 1.53 (s, 9H). 13C NMR (151 MHz, CDCl3): 165.7, 150.8, 149.7, 139.9, 134.3, 123.9, 122.5, 83.4, 81.1, 80.1, 28.3. m/z (EI): 204.0 (4%), 205.1 (100%, M+), 206.1 (17%), 206.9 (5%). Spectroscopic data are in agreement with those previously reported.11

**tert-Butyl-3-(1H-indol-5-yl)acrylate** (5kc) was obtained after column chromatography (hexane/EtOAc 5:1 to 3:1) as a pale yellow oil (71%).

\[ R_f = 0.36 \] (Hexane/EtOAc 3:1). 1H NMR (400 MHz, CDCl3): 8.46 (s, 1H), 7.82 – 7.70 (m, 2H), 7.45 – 7.31 (m, 2H), 7.21 (d, \( J = 3.2 \) Hz, 2H), 6.57 (ddd, \( J = 3.0 \), 2.0, 0.9 Hz, 1H), 6.37 (d, \( J = 15.9 \) Hz, 1H), 1.56 (s, 9H). 13C NMR (101 MHz, CDCl3): 167.3, 145.6, 137.0, 128.2, 126.8, 125.4, 122.3, 121.6, 117.1, 111.7, 103.5, 80.3, 28.4. m/z (EI): 243.1 (100%, M+), 244.1 (16%), 245.0 (2%). Spectroscopic data are in agreement with those previously reported.12

**tert-Butyl-3-(4-aminophenyl)acrylate** (5lc) was obtained after column chromatography (hexane/EtOAc 5:1 to 3:1) as a yellow oil (93%).

\[ R_f = 0.43 \] (Hexane/EtOAc 3:1). 1H NMR (400 MHz, CDCl3): 7.50 (d, \( J = 15.9 \) Hz, 1H), 7.32 (d, \( J = 8.6 \) Hz, 2H), 6.63 (d, \( J = 8.5 \) Hz, 2H), 6.17 (d, \( J = 15.9 \) Hz, 1H), 3.89 (s, 2H), 1.52 (s, 9H). 13C NMR (101 MHz, CDCl3): 167.2, 148.5, 143.9, 129.8, 125.1, 115.9, 115.0, 80.1, 28.4. m/z (EI): 219.1 (100%, M+), 210.1 (15%), 221.1 (1%). Spectroscopic data are in agreement with those previously reported.11

**tert-Butyl-3-(4-chlorophenyl)acrylate** (5nc) was obtained after column chromatography (pure hexane to hexane/EtOAc 20:1) as a white solid (86%).

\[ R_f = 0.49 \] (Hexane/EtOAc 15:1). 1H NMR (400 MHz, CDCl3): 7.52 (d, \( J = 16.0 \) Hz, 1H), 7.47 – 7.38 (m, 2H), 7.38 – 7.30 (m, 2H), 6.33 (d, \( J = 16.0 \) Hz, 1H), 1.53 (s, 9H). 13C NMR (101 MHz, CDCl3): 166.2, 142.2, 135.9, 133.3, 129.2, 120.9, 80.8, 28.3. m/z (EI): 238.0 (100%, M+), 239.0 (16%), 240.0 (36%), 241.0 (5%), 242.0 (1%). Spectroscopic data are in agreement with those previously reported.13

**tert-Butyl-3-((trifluoromethyl)sulfonyl)oxy)phenyl)acrylate** (5mc) was obtained after column chromatography (hexane/EtOAc 20:1) as a colorless oil using either 4-iodophenyl triflate (91%) or 4-bromophenyl triflate (92%).

\[ R_f = 0.41 \] (Hexane/EtOAc 10:1). IR (neat): 2969, 2325, 2095, 1711, 1409, 1165, 993, 866, 720. 1H NMR (400 MHz, CDCl3): 7.58 – 7.49 (m, 3H), 7.29 – 7.22 (m, 2H), 6.34 (d, \( J = 16.0 \) Hz, 1H), 1.51 (s, 9H). 19F NMR (376 MHz, CDCl3): -72.87. 13C NMR (101 MHz, CDCl3): 165.8, 150.2, 141.2, 135.2, 129.7, 122.5, 122.0, 118.85 (q, \( J = 320.9 \) Hz), 81.1, 28.3. m/z (EI): 352.1 (100%, M+), 353.1 (16%), 354.0 (6%), 354.9 (1%). HRMS: m/z [M]+ calcd for C14H15F3O5S: 352.0587; found: 352.0588.
$^1$H NMR (400 MHz, CDCl$_3$):

$^{19}$F NMR (376 MHz, CDCl$_3$):
13C NMR (101 MHz, CDCl3):

![13C NMR spectrum image]

4. References