Supporting Information

Delineating Physical Organic Parameters in Site-Selective C–H Functionalization of Indoles

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I. General Methods

Unless otherwise stated, all commercial reagents were used without additional purification. Analytical thin layer chromatography (TLC) was performed on Merck pre-coated silica gel 60 F254 plates. Visualization on TLC was achieved by the use of UV light (254 nm) or treatment with acidic anisaldehyde stain followed by heating. Column chromatography was undertaken on silica gel (400-630 mesh) using a proper eluent system. ¹H NMR was recorded on Agilent Technologies DD2 (600 MHz), Bruker Avance 400 (400 MHz) or Bruker Avance 300 (300 MHz). Chemical shifts were quoted in parts per million (ppm) referenced to the appropriate solvent peak. The following abbreviations were used to describe peak splitting patterns when appropriate: br (broad), s (singlet), d (doublet), t (triplet), hept (heptet), dd (doublet of doublet), td (triplet of doublet), m (multiplet). Coupling constants, J, were reported in hertz unit (Hz). ¹³C NMR was recorded on Agilent Technologies DD2 (150 MHz), Bruker Avance 400 (100 MHz) or Bruker Avance 300 (75 MHz) and was fully decoupled by broad band proton decoupling. Chemical shifts were reported in ppm referenced to the appropriate solvent peak. ¹⁹F NMR was recorded on Agilent Technologies DD2 (564 MHz), Bruker Avance 400 (376 MHz). Infrared (IR) spectra were recorded on Bruker Alpha FT-IR Spectrometer. Frequencies are given in reciprocal centimeters (cm⁻¹) and only selected absorbance is reported. High resolution mass spectra were obtained from the Korea Basic Science Institute (Daegu) by using EI method. X-ray diffraction data was collected on a Bruker SMART APEX II coated with Paraton-N oil under a stream of N₂ (g) at 120 K. Melting point was measured with Buchi Melting Point M-565. If necessary, regioemic ratios were measured by using a high performance liquid chromatography from Shimadzu with a binary mobile phase gradient (Hx/THF = 8:2 or 9:1) elution (0.8 mL/min) and a Chiral-pak IA-3 or ID-3. Photodiode array (PDA) detection was monitored at 254 nm.

Safety Statement

No unexpected or unusually high safety hazards were encountered in these methods. Although tosyl azide is one of the more stable azide compounds, it is still regarded as a potential explosive and should be carefully stored at -30 °C.
II. Procedures for the Preparation of Starting Materials

1. General Procedure for the Preparation of N-Protected Indoles\textsuperscript{S1}

To a solution of indoles (2.5 mmol), 4-(dimethylamino)pyridine (31 mg, 0.25 mmol) and triethylamine (0.52 mL, 3.8 mmol) in dry 1,2-dichloroethane (10 mL) was added acyl chloride (3.0 mmol) dropwise at 0 °C. The reaction mixture was stirred at 80°C for overnight. After the reaction was cooled to room temperature, the solvent was removed under reduced pressure and the residue was partitioned between EtOAc and brine. The organic layer was collected, and the aqueous layer was extracted by EtOAc for two times. The combined organic layers were dried over Na\textsubscript{2}SO\textsubscript{4}, filtered, and concentrated under reduced pressure. The residue was purified by chromatography on silica gel (n-hexane/EtOAc) to give the desired N-protected indoles.

**1-Acetyl-4-fluoroindole**

White solid; \textbf{m.p.} 50 – 52 °C; \textbf{\textsuperscript{1}H NMR} (600 MHz, CDCl\textsubscript{3}) \(\delta\) 8.21 (d, \(J = 8.2\) Hz, 1H), 7.37 (d, \(J = 3.7\) Hz, 1H), 7.31 – 7.22 (m, 1H), 6.98 – 6.92 (m, 1H), 6.73 (d, \(J = 3.7\) Hz, 1H), 2.62 (s, 3H); \textbf{\textsuperscript{13}C NMR} (150 MHz, CDCl\textsubscript{3}) \(\delta\) 168.8, 155.7 (d, \(J = 248.0\) Hz), 137.7 (d, \(J = 9.2\) Hz), 126.1 (d, \(J = 7.2\) Hz), 125.3, 119.3 (d, \(J = 21.9\) Hz), 112.8, 109.2 (d, \(J = 18.4\) Hz), 104.8, 24.1; \textbf{\textsuperscript{19}F NMR} (564 MHz, CDCl\textsubscript{3}) \(\delta\) -122.0; \textbf{IR} (cm\textsuperscript{-1}) 3150, 3129, 1692, 1485, 1432, 1268, 1210, 1038, 922, 735, 674, 594; \textbf{High Resolution MS} (EI): Calculated for C\textsubscript{10}H\textsubscript{8}FNO [M]\textsuperscript{+}: 177.0590, Found: 177.0588.

2. Synthesis of Deuterated Indole\textsuperscript{S2,S3}

For kinetic studies, deuterated indole substrate was synthesized according to the reported procedures.

3. Preparation of Silver Carboxylates\textsuperscript{S4-6}

**General Procedure 1 (GPI)**

Acid (20.9 mmol) was added to a solution of NaOH (724 mg, 18.1 mmol) in H\textsubscript{2}O (10 mL) in 50 mL beaker equipped with a magnetic stir bar. After stirring at room temperature for 15 min, a solution of AgNO\textsubscript{3} (2.56 g, 15.1 mmol) in H\textsubscript{2}O (10 mL) was added dropwise and stirring was continued for
additional 15 min. The product was collected on a filter and then washed with water (20 mL x 2) and hexane (20 mL x 2), respectively. Subsequent drying under reduced pressure afforded the silver carboxylate.

**General Procedure 2 (GP2)**

Ag₂O (0.69 g, 3.0 mmol) was added to a 50% aqueous solution of acid (7.0 mmol) in 20 mL vial equipped with a magnetic stir bar. During the reaction, white precipitate appeared which was collected on a filter and then washed with water (20 mL x 2). Subsequent drying under reduced pressure afforded the silver carboxylate.

**Silver 2,2,2-triphenylacetate (GP1)**

![Silver 2,2,2-triphenylacetate](image)

White solid; m.p. 215 – 217 °C; ¹H NMR (600 MHz, DMSO-d₆) δ 7.24 – 7.10 (m, 15H); ¹³C NMR (150 MHz, DMSO-d₆) δ 177.6, 146.4 (3C), 130.4 (6C), 127.0 (6C), 125.6 (3C), 69.2; IR (cm⁻¹) 3010, 1561, 1541, 1484, 1441, 1330, 744, 697, 671.

**Silver 2-(3,4-dimethoxyphenyl)acetate (GP1)**

![Silver 2-(3,4-dimethoxyphenyl)acetate](image)

White solid; m.p. 185 – 187 °C; ¹H NMR (400 MHz, DMSO-d₆) δ 6.87 – 6.78 (m, 2H), 6.73 (dd, J = 8.1, 1.9 Hz, 1H), 3.70 (s, 3H), 3.69 (s, 3H), 3.39 (s, 2H); ¹³C NMR (100 MHz, DMSO-d₆) δ 175.5, 148.4, 147.1, 130.7, 121.2, 113.3, 111.7, 55.7, 55.5, 43.6; IR (cm⁻¹) 2985, 1508, 1382, 1244, 1181, 1026, 813, 792, 704, 521.

**Silver 2-(4-methoxyphenyl)acetate (GP1)**

![Silver 2-(4-methoxyphenyl)acetate](image)

White solid; m.p. 206 – 208 °C; ¹H NMR (400 MHz, CDCl₃) δ 7.15 (d, J = 8.0 Hz, 2H), 6.81 (d, J = 8.0 Hz, 2H), 3.40 (s, 2H); ¹³C NMR (100 MHz, CDCl₃) δ 175.1, 157.5, 153.0 (2C), 129.8, 113.3 (2C), 55.0, 42.7; IR (cm⁻¹) 2983, 1611, 1506, 1390, 1244, 1181, 1026, 813, 792, 704, 521.
Silver 2-(4-chlorophenyl)acetate (GP1)
Grey solid; m.p. 231 – 233 °C; \(^1\text{H NMR}\) (600 MHz, DMSO-\(d_6\)) \(\delta\) 7.29 (d, \(J = 8.4\) Hz, 2H), 7.25 (d, \(J = 8.5\) Hz, 2H), 3.45 (s, 2H); \(^{13}\text{C NMR}\) (150 MHz, DMSO-\(d_6\)) \(\delta\) 174.6, 137.3, 131.1 (2C), 130.3, 127.7 (2C), 43.2; \(\text{IR}\) (cm\(^{-1}\)) 1532, 1489, 1367, 1087, 1015, 856, 807, 754, 736, 676.

Silver 2-(4-nitrophenyl)acetate (GP1)
White solid; m.p. 243 – 245 °C; \(^1\text{H NMR}\) (400 MHz, DMSO-\(d_6\)) \(\delta\) 8.11 (d, \(J = 8.7\) Hz, 2H), 7.50 (d, \(J = 8.7\) Hz, 2H), 3.61 (s, 2H); \(^{13}\text{C NMR}\) (100 MHz, DMSO-\(d_6\)) \(\delta\) 173.7, 146.7, 145.8, 130.6 (2C), 123.1 (2C), 43.8; \(\text{IR}\) (cm\(^{-1}\)) 1523, 1378, 1345, 1308, 1110, 849, 823, 732, 722.

Silver 2,2-dichloroacetate (GP1)
Grey solid; m.p. 210 – 212 °C; \(^1\text{H NMR}\) (600 MHz, DMSO-\(d_6\)) \(\delta\) 6.18 (s, 1H); \(^{13}\text{C NMR}\) (150 MHz, DMSO-\(d_6\)) \(\delta\) 166.3, 70.1; \(\text{IR}\) (cm\(^{-1}\)) 3007, 1594, 1568, 1367, 1201, 816, 713, 660.

Silver 2-fluoroacetate (GP2)
White solid; m.p. 246 – 248 °C; \(^1\text{H NMR}\) (600 MHz, DMSO-\(d_6\)) \(\delta\) 4.64 (d, \(J = 49.3\) Hz, 2H); \(^{13}\text{C NMR}\) (150 MHz, DMSO-\(d_6\)) \(\delta\) 171.6, 80.32 (d, \(J = 180.4\) Hz); \(^{19}\text{F NMR}\) (564 MHz, DMSO-\(d_6\)) \(\delta\) 32.4 (t, \(J = 49.3\) Hz); \(\text{IR}\) (cm\(^{-1}\)) 2959, 1539, 1406, 1323, 1045, 933, 690, 585, 554.

Silver 2,2-difluoroacetate (GP2)
White solid; m.p. 251 – 253 °C; \(^1\text{H NMR}\) (600 MHz, DMSO-\(d_6\)) \(\delta\) 5.85 (t, \(J = 55.7\) Hz, 1H); \(^{13}\text{C NMR}\) (150 MHz, DMSO-\(d_6\)) \(\delta\) 165.8, 110.1 (t, \(J = 248.8\) Hz); \(^{19}\text{F NMR}\) (564 MHz, DMSO-\(d_6\)) \(\delta\) -121.5 (d, \(J = 55.7\) Hz); \(\text{IR}\) (cm\(^{-1}\)) 1582, 1448, 1320, 1112, 1045, 949, 814, 593.
Silver 4-bromo-2,3,5,6-tetrafluorobenzoate (GP1)

White solid; m.p. 244 – 246 °C; $^{19}$F NMR (564 MHz, DMSO-$d_6$) δ -134.5 (m), -141.8 (m); $^{13}$C NMR (100 MHz, DMSO-$d_6$) 160.5, 144.1 (dddd, $J = 245.5, 16.8, 3.8, 2.3$ Hz), 142.0 (dddd, $J = 245.2, 14.1, 9.3, 3.8$ Hz), 122.64 – 121.84 (m), 97.29 – 96.62 (m); IR (cm$^{-1}$) 1634, 1551, 1470, 1360, 973, 836, 804, 748, 691, 474.

4. General Procedure for the Preparation of Sulfonyl Azides$^{57}$

\[
\text{RSO}_2\text{Cl} + \text{NaN}_3 \xrightarrow{\text{Acetone/H}_2\text{O (2:1)}} \text{RSO}_2\text{N}_3
\]

To a solution of sodium azide (1.0 g, 15 mmol) in water (5 mL) was added dropwise a solution of sulfonyl chloride (10 mmol) in acetone (10 mL) at 0 °C. The reaction mixture was allowed to stir at room temperature for overnight and the acetone was removed under reduced pressure. Water was added, and the reaction mixture was extracted with EtOAc for three times. The combined organic layers were dried over MgSO$_4$, and concentrated under reduced pressure. The crude product can be used without any further purification.

5. Preparation of IrCp*(CF$_3$CO$_2$)$_2$\textsuperscript{58}

Pentamethylcyclopentadienyl iridium bistrifluoroacetate complex was synthesized according to the reported procedures.
III. Procedure for the Optimization Study

1. Procedure for Reaction Optimization

To a screw capped vial with a spinvane triangular-shaped Teflon spinbar were added \( N \)-acylindole (0.20 mmol), \( p \)-toluenesulfonyl azide (34 \( \mu \)L, 0.22 mmol), catalyst, and additive in 1,2-dichloroethane (0.5 mL) under Ar-purged conditions. The reaction mixture was stirred in a pre-heated oil bath or a heating block at the 40 °C for 12 h. The reaction mixture was cooled to room temperature and then washed with EtOAc. The solvents were removed under reduced pressure and the crude yield and regiomeric ratios were measured by \(^1\)H NMR using dibromomethane as an internal standard or by HPLC using quinoline as an internal standard in case the regiomeric ratio exceeds 19:1.

Table S1. Directing Groups and Silver Carboxylates Screen

| entry | \( R^1 \) | \( R^2 \) | 1\(^{st} \) trial yield (%) (C7 / C2) | 2\(^{nd} \) trial yield (%) (C7 / C2) | average yield (%) (C7-product) | average yield (%) (C2-product) | ratio (C7:C2) | measured \( \Delta G^i \) (kcal/mol) |
|-------|---------|---------|---------------------------------|---------------------------------|-------------------------------|-------------------------------|---------------|------------------|
| 1     | Me      | Me      | 47.0 / 34.0                     | 48.0 / 36.0                     | 47.5                          | 35.0                          | 1.4 : 1       | 0.19             |
| 2     | Me      | CH\(_2\)F | 19.0 / 55.3                    | 21.6 / 58.3                    | 20.3                          | 56.8                          | 1 : 2.8       | -0.64           |
| 3     | Me      | CHF\(_2\) | 6.0 / 76.0                     | 6.0 / 71.0                     | 6.0                           | 73.5                          | 1 : 12.3      | -1.56           |
| 4     | Me      | CF\(_3\) | 1.4 / 83.8                     | 1.2 / 77.1                     | 1.3                           | 80.5                          | 1 : 61.9      | -2.57           |
| 5     | Me      | Et      | 54.0 / 37.0                    | 49.0 / 31.0                    | 51.5                          | 34.0                          | 1.5 : 1       | 0.26            |
| 6     | Me      | \( i \)Pr | 50.0 / 31.0                    | 51.0 / 31.0                    | 50.5                          | 31.0                          | 1.6 : 1       | 0.30            |
| 7     | Me      | \( i \)Bu | 50.0 / 21.0                    | 52.0 / 21.0                    | 51.5                          | 21.0                          | 2.5 : 1       | 0.56            |
| 8     | Me      | CH\(_2\)Ph | 41.0 / 46.0                    | 40.0 / 44.0                    | 40.5                          | 45.0                          | 1 : 1.1       | -0.07           |
| 9     | Me      | CH(\(Ph\))\(_2\) | 33.0 / 45.0                  | 33.0 / 48.0                    | 33.0                          | 46.5                          | 1 : 1.4       | -0.21           |
| 10    | Me      | C(\(Ph\))\(_3\) | 34.0 / 48.5                  | 33.0 / 46.0                    | 33.5                          | 47.3                          | 1 : 1.4       | -0.21           |
| 11    | Me      | \( \text{MeO} \)\(_2\) | 38.0 / 41.5                    | 39.0 / 38.0                    | 38.5                          | 39.8                          | 1 : 1.0       | -0.02           |
| 12    | Me      | \( \text{MeO} \)\(_2\) | 41.0 / 43.5                    | 40.0 / 46.0                    | 40.5                          | 44.8                          | 1 : 1.1       | -0.06           |
| 13    | Me      | Cl \(_2\) | 38.0 / 43.0                    | 39.0 / 47.5                    | 38.5                          | 45.3                          | 1 : 1.2       | -0.10           |

S7
|   |   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|---|
| Me | O2N | 37.0 / 51.0 | 36.0 / 49.0 | 36.5 | 50.0 | 1 : 1.4 | -0.20 |
| Me | CH2Cl | 21.5 / 57.0 | 23.0 / 57.0 | 22.3 | 57.0 | 1 : 2.6 | -0.58 |
| Me | CHCl3 | 5.8 / 77.8 | 5.7 / 76.6 | 5.8 | 77.2 | 1 : 13.3 | -1.61 |
| Me | C2F6 | 1.1 / 81.7 | 1.1 / 79.0 | 1.1 | 80.4 | 1 : 73.1 | -2.67 |
| Et | Me | 53.0 / 28.0 | 53.0 / 28.0 | 53.0 | 28.0 | 1.9 : 1 | 0.40 |
| Et | CHF2 | 9.0 / 72.0 | 9.0 / 73.0 | 9.0 | 72.5 | 1 : 8.1 | -1.30 |
| Et | CF3 | 2.9 / 67.2 | 3.1 / 68.3 | 3.0 | 67.8 | 1 : 22.6 | -1.94 |
| Et | tBu | 64.0 / 22.0 | 62.0 / 17.0 | 63.0 | 19.5 | 3.2 : 1 | 0.73 |
| Et | CHCl3 | 9.8 / 74.0 | 9.3 / 71.0 | 9.6 | 72.5 | 1 : 7.6 | -1.26 |
| Pr | Me | 55.0 / 21.0 | 53.0 / 21.0 | 54.0 | 21.0 | 2.6 : 1 | 0.59 |
| Pr | CHF2 | 31.5 / 50.3 | 32.7 / 48.0 | 32.1 | 49.2 | 1 : 1.5 | -0.27 |
| Pr | CF3 | 9.5 / 71.0 | 10.9 / 71.8 | 10.2 | 71.4 | 1 : 7.0 | -1.21 |
| Pr | tBu | 4.8 / 73.0 | 5.6 / 73.6 | 5.2 | 73.3 | 1 : 14.1 | -1.65 |
| Pr | CHCl3 | 71.9 / 19.0 | 71.4 / 16.0 | 71.7 | 17.5 | 4.1 : 1 | 0.88 |
| tBu | CHF2 | 12.8 / 70.0 | 10.8 / 68.0 | 11.8 | 69.0 | 1 : 5.8 | -1.10 |
| tBu | C2F6 | 5.0 / 78.0 | 5.0 / 78.0 | 5.0 | 78.0 | 1 : 15.6 | -1.71 |
| tBu | CHCl3 | 88.0 / 5.0 | 86.0 / 5.0 | 87.0 | 5.0 | 17.4 : 1 | 1.78 |
| tBu | CHF2 | 65.0 / 24.0 | 65.0 / 25.0 | 65.0 | 24.5 | 2.7 : 1 | 0.61 |
| tBu | CF3 | 48.0 / 38.0 | 48.0 / 36.5 | 48.0 | 37.3 | 1.3 : 1 | 0.16 |
| tBu | C2F6 | 45.0 / 38.3 | 45.4 / 39.3 | 45.2 | 38.8 | 1.2 : 1 | 0.10 |
| tBu | CHCl3 | 69.0 / 27.0 | 68.5 / 24.8 | 68.8 | 25.9 | 2.7 : 1 | 0.61 |
| CF2H | Me | n.d. / n.d. | n.d. / n.d. | n.d. | n.d. | - | - |
| CF3 | Me | n.d. / n.d. | n.d. / n.d. | n.d. | n.d. | - | - |
| Cy | Me | 53.0 / 26.0 | 55.0 / 18.5 | 54.0 | 22.3 | 2.4 : 1 | 0.55 |
| Pr | Me | 55.0 / 27.0 | 56.0 / 29.8 | 55.5 | 28.4 | 2.0 : 1 | 0.41 |
| Me | (4-CF3)C6H4 | 26.3 / 43.3 | 28.5 / 53.7 | 27.4 | 48.5 | 1 : 1.8 | -0.36 |
| Me | (4-NO2)C6H4 | 30.0 / 50.5 | 25.1 / 50.1 | 27.6 | 50.3 | 1 : 1.8 | -0.38 |
| Me | (4-F)C6H4 | 18.0 / 44.8 | 22.2 / 43.4 | 20.1 | 44.1 | 1 : 2.2 | -0.49 |
| Me | (4-Cl)C6H4 | 21.3 / 42.5 | 18.2 / 46.8 | 19.8 | 44.7 | 1 : 2.3 | -0.51 |
| Ph | Me | 20.0 / 47.9 | 14.0 / 45.3 | 17.0 | 46.6 | 1 : 2.7 | -0.63 |
| Me | (4-Br)C6F5 | 12.3 / 75.6 | 12.6 / 75.0 | 12.5 | 75.3 | 1 : 6.0 | -1.12 |

*Standard reaction conditions: N-acylindole (0.20 mmol), p-toluenesulfonyl azide (0.22 mmol, 1.1 equiv.), catalyst, and additives in 1.2-DCE (0.5 mL) at 40 °C for 12 h. Ratios, determined by 1H NMR or HPLC analysis of the crude reaction mixture versus internal standard, are averaged over two experimental runs. n.d.= not detected.
**N-(1-Propionyl-1H-indol-2-yl)-4-methylbenzenesulfonamide** (Scheme 2 and Figure 3)

[Separation condition (HPLC): Chiral-pak ID-3, Hx/THF=9:1, 0.8 mL/min, 254 nm]

![Structure](image)

Brown solid; **m.p.** 145 – 147 °C; **^1H NMR** (400 MHz, DMSO-<sub>d6</sub>) δ 10.60 (s, 1H), 8.13 (d, J = 8.4 Hz, 1H), 7.65 (d, J = 8.1 Hz, 2H), 7.45 (d, J = 7.7 Hz, 1H), 7.42 (d, J = 8.0 Hz, 2H), 7.28 (t, J = 7.7 Hz, 1H), 7.18 (t, J = 7.4 Hz, 1H), 5.93 (s, 1H), 3.18 (q, J = 7.2 Hz, 2H), 2.40 (s, 3H), 1.17 (t, J = 7.2 Hz, 3H); **^13C NMR** (150 MHz, DMSO-<sub>d6</sub>) δ 174.9, 144.2, 136.3, 134.7, 131.1, 130.2 (2C), 127.5 (2C), 127.2, 125.2, 123.6, 121.0, 115.8, 105.2, 32.1, 21.5, 9.3; **IR** (cm<sup>-1</sup>) 3206, 2986, 2920, 1717, 1622, 1592, 1354, 1309, 1150, 1132, 1086, 740, 667, 546; **High Resolution MS** (EI): Calculated for C<sub>18</sub>H<sub>18</sub>N<sub>2</sub>O<sub>3</sub>S [M]<sup>+</sup>: 342.1038, Found: 342.1036.

**N-(1-Isobutyryl-1H-indol-2-yl)-4-methylbenzenesulfonamide** (Scheme 2 and Figure 3)

![Structure](image)

White solid; **m.p.** 126 – 128 °C; **^1H NMR** (400 MHz, DMSO-<sub>d6</sub>) δ 10.73 (s, 1H), 7.97 (d, J = 8.4 Hz, 1H), 7.60 (d, J = 8.3 Hz, 2H), 7.45 (d, J = 7.5 Hz, 1H), 7.40 (d, J = 8.1 Hz, 2H), 7.29 – 7.23 (m, 1H), 7.20 – 7.10 (m, 1H), 5.91 (s, 1H), 4.00 (hept, J = 6.8 Hz, 1H), 2.39 (s, 3H), 1.15 (d, J = 6.8 Hz, 6H); **^13C NMR** (150 MHz, DMSO-<sub>d6</sub>) δ 178.2, 143.8, 135.4, 134.6, 130.5, 129.8 (2C), 127.0 (2C), 126.7, 124.6, 122.9, 120.5, 114.5, 104.0, 35.3, 21.1, 18.7 (2C); **IR** (cm<sup>-1</sup>) 3371, 2972, 2870, 1713, 1629, 1595, 1462, 1310, 1150, 1075, 757, 665, 548; **High Resolution MS** (EI): Calculated for C<sub>19</sub>H<sub>20</sub>N<sub>2</sub>O<sub>3</sub>S [M]<sup>+</sup>: 356.1195, Found: 356.1192.

**N-(1-Butyryl-1H-indol-7-yl)-4-methylbenzenesulfonamide** (Figure 3)

![Structure](image)

White solid; **m.p.** 115 – 117 °C; **^1H NMR** (300 MHz, CDCl<sub>3</sub>) δ 10.49 (s, 1H), 7.56 – 7.46 (m, 2H), 7.42 (d, J = 8.2 Hz, 2H), 7.36 – 7.23 (m, 3H), 7.09 (d, J = 8.0 Hz, 3H), 6.60 (d, J = 3.9 Hz, 1H), 2.76 (t, J = 7.4 Hz, 2H), 1.79 (h, J = 7.3 Hz, 3H), 1.05 (t, J = 7.4 Hz, 3H); **^13C NMR** (75 MHz, CDCl<sub>3</sub>) δ 173.8, 144.0, 137.0, 133.7, 129.6 (2C), 128.5, 127.3 (2C), 126.9, 126.0, 125.7, 120.6, 118.6, 110.8, 38.7, 21.5, 18.7, 13.8; **IR** (cm<sup>-1</sup>) 3067, 2970, 1686, 1330, 1202, 1160, 1087, 798, 774, 699, 558, 534; **High Resolution MS** (EI): Calculated for C<sub>19</sub>H<sub>20</sub>N<sub>2</sub>O<sub>3</sub>S [M]<sup>+</sup>: 356.1195, Found: 356.1195.
**N-(1-Butyryl-1H-indol-2-yl)-4-methylbenzenesulfonamide** (Figure 3)

White solid; m.p. 119 – 121 °C; \(^1\)H NMR (300 MHz, DMSO-\(d_6\)) \(\delta\) 10.62 (s, 1H), 8.11 (d, \(J = 8.3\) Hz, 1H), 7.64 (d, \(J = 8.3\) Hz, 1H), 7.50 – 7.38 (m, 2H), 7.32 – 7.24 (m, 3H), 7.22 – 7.14 (m, 1H), 5.93 (s, 1H), 3.13 (t, \(J = 7.2\) Hz, 2H), 2.40 (s, 3H), 1.69 (h, \(J = 7.3\) Hz, 2H), 0.93 (t, \(J = 7.4\) Hz, 3H); \(^{13}\)C NMR (75 MHz, DMSO-\(d_6\)) \(\delta\) 173.7, 143.8, 135.9, 134.3, 130.6, 129.8 (2C), 127.0 (2C), 126.8, 124.8, 123.2, 120.6, 115.3, 104.8, 40.0, 21.1, 17.8, 13.5; IR (cm\(^{-1}\)) 3050, 2963, 2929, 1718, 1626, 1593, 1314, 1280, 1071, 837, 754, 546; High Resolution MS (EI): Calculated for C\(_{19}\)H\(_{20}\)N\(_2\)O\(_3\)S [M]**: 356.1195, Found: 356.1192.

**N-(1-Cyclohexanecarbonyl-1H-indol-2-yl)-4-methylbenzenesulfonamide** (Figure 3)

Yellow solid; m.p. 120 – 122 °C; \(^1\)H NMR (600 MHz, DMSO-\(d_6\)) \(\delta\) 10.69 (s, 1H), 7.96 (d, \(J = 8.3\) Hz, 1H), 7.60 (d, \(J = 8.0\) Hz, 2H), 7.45 – 7.36 (m, 3H), 7.24 (t, \(J = 7.6\) Hz, 1H), 7.14 (t, \(J = 7.4\) Hz, 1H), 5.87 (s, 1H), 3.73 (m, 1H), 2.38 (s, 3H), 1.93 – 1.70 (m, 4H), 1.50 – 1.10 (m, 6H); \(^{13}\)C NMR (150 MHz, DMSO-\(d_6\)) \(\delta\) 176.9, 143.8, 135.7, 134.5, 130.4, 129.8 (2C), 127.0 (2C), 126.6, 124.6, 122.9, 120.5, 114.6, 104.1, 44.6, 28.7 (2C), 25.3, 25.1 (2C), 21.0; IR (cm\(^{-1}\)) 2928, 2853, 1717, 1628, 1595, 1463, 1314, 1279, 1153, 1073, 854, 778, 755, 549; High Resolution MS (EI): Calculated for C\(_{22}\)H\(_{24}\)N\(_2\)O\(_3\)S [M]**: 396.1508, Found: 396.1509.

**N-(1-Pivaloylindolin-2-ylidene)-4-methylbenzenesulfonamide** (Figure 3)

White solid; m.p. 200 – 202 °C; \(^1\)H NMR (600 MHz, CD\(_2\)Cl\(_2\)) \(\delta\) 7.80 (d, \(J = 8.2\) Hz, 2H), 7.37 (d, \(J = 7.4\) Hz, 1H), 7.32 (d, \(J = 8.0\) Hz, 2H), 7.30 – 7.24 (m, 1H), 7.19 – 7.09 (m, 1H), 6.89 (d, \(J = 8.0\) Hz, 1H), 4.32 (s, 2H), 2.42 (s, 3H), 1.31 (s, 9H); \(^{13}\)C NMR (150 MHz, CD\(_2\)Cl\(_2\)) \(\delta\) 185.2, 169.5, 144.1, 142.1, 139.1, 130.0 (2C), 128.6, 127.2 (2C), 127.0, 125.4, 124.8, 111.7, 44.6, 36.7, 27.6 (3C), 21.8; IR (cm\(^{-1}\)) 3062, 2954, 2834, 1590, 1299, 1143, 1087, 774, 669, 544; High Resolution MS (EI): Calculated for C\(_{20}\)H\(_{22}\)N\(_2\)O\(_3\)S [M]**: 370.1351, Found: 370.1351.
2. HPLC Calibration for Yield Determination

Preparation of HPLC Samples
Following the above procedure, to the crude residue was added internal standard (quinoline, 24 μL, 0.20 mmol), and the resulting mixture was then reconstituted in HPLC grade THF (10 mL). After sonication, an aliquot (100 μL) of this mixture was diluted with hexane/THF solution (1.6:1, 900 μL) to a concentration of approximately ~2.0 mM, and this solution was analyzed by HPLC to determine yield; typical HPLC traces are shown in Figure S1.

Construction of Calibration Curves
The regiomeric ratios exceeding ratio of 19:1 were obtained by HPLC. UV response area (λ = 254 nm) relative to quinoline as internal standard was determined for all components of the model reaction system, and calibration curves across 6 concentrations were generated for each. Reaction samples during optimization were analyzed within the linear range at a concentration of ~2.0 mM.
Figure S1. Sample HPLC trace of reaction used to determine yield; the internal standard and each regioisomer are identified on the traces (up: Table S1, entry 17, down: Table S1, entry 21).
Figure S2. Calibration curves of N-acetylindole and regioisomeric products.
Figure S3. Calibration curves of N-propionylindole and regioisomeric products.
3. Further Optimizations for Improved Catalytic Reaction

To afford high yields of 4, further studies were conducted according to the above general procedure (page S7). The crude yield was measured by $^1$H NMR using dibromomethane as an internal standard.

**Table S2. Optimization of the Reaction Condition**

| entry | catalytic system (mol %) | additives (mol %) | yield (%) |
|-------|--------------------------|-------------------|-----------|
| 1     | [IrCp*Cl$_2$]$_2$ (5) / AgNTf$_2$ (20) | -                  | n.d       |
| 2     | [IrCp*Cl$_2$]$_2$ (5) / AgNTf$_2$ (10) | AgOTFA (20)       | 78        |
| 3     | [IrCp*Cl$_2$]$_2$ (5) / AgNTf$_2$ (10) | NaOTFA (20)       | 61        |
| 4     | [IrCp*Cl$_2$]$_2$ (5) / AgNTf$_2$ (10) | LiOTFA (20)       | 55        |
| 5     | [IrCp*Cl$_2$]$_2$ (5) / AgNTf$_2$ (10) | Cu(OTFA)$_2$ (20) | <5        |
| 6     | [IrCp*Cl$_2$]$_2$ (5) / NaNTf$_2$ (10) | AgOTFA (20)       | 87        |
| 7     | IrCp*(OTFA)$_2$ (10) | AgNTf$_2$ (10)    | 75        |
| 8     | IrCp*(OTFA)$_2$ (10) | NaNTf$_2$ (10)    | 93        |
| 9     | IrCp*(OTFA)$_2$ (10) | -                  | 10        |
| 10    | -                        | NaNTf$_2$ (10)    | n.d       |

*aStandard reaction conditions: $N$-acetylindole 1 (23 μL, 0.20 mmol), 2 (34 μL, 0.22 mmol, 1.1 equiv.), catalyst, and additives in 1,2-DCE (0.5 mL) at 40 °C for 12 h.*
IV. Experimental Procedures of Mechanistic Studies

1. Preparation of Iridacycle

A solution of N-acetylindole (1, 70 μL, 0.50 mmol), [IrCp*Cl₂]₂ (0.20 g, 0.25 mmol), lithium carbonate (37 mg, 0.50 mmol), and silver trifluoroacetate (0.11 g, 0.50 mmol) in 1,2-dichloroethane (2.5 mL) was stirred for 12 h at 50°C under argon atmosphere. Another portion of silver trifluoroacetate (0.11 g, 0.50 mmol) was added and the mixture was allowed to stir for additional 12 h at 50°C. The resulting crude mixture was filtered through a pad of celite washing with 1,2-dichloroethane (15 mL), and concentrated under reduced pressure. The crude mixture was reconstituted in methylene chloride (1.0 mL) for the preparation of concentrated solution, then eluting with a solution of hexane/EtOAc (2:1) on preparative thin layer chromatography silica plate. After repeating the elution three times, the yellowish silica containing the product was collected and then washed with EtOAc. The filtrate was dried under reduced pressure to give the desired iridacycle as a yellow solid.

Iridacycle (Scheme 3, 5) Yellow solid (153 mg, 51%); m.p. 165 – 167 °C; ¹H NMR (600 MHz, CD₂Cl₂) δ 7.50 (d, J = 8.1 Hz, 1H), 7.42 (d, J = 7.5 Hz, 1H), 7.24 – 7.18 (m, 1H), 7.12 – 7.06 (m, 1H), 6.59 (s, 1H), 2.91 (s, 3H), 1.73 (s, 15H); ¹³C NMR (150 MHz, CD₂Cl₂) δ 179.3, 162.3, 161.9 (q, J = 35.4 Hz), 137.6, 136.0, 124.9, 122.3, 120.0, 115.9 (q, J = 291.8 Hz), 113.9, 112.8, 87.5 (5C), 21.9, 9.9 (5C); ¹⁹F NMR (564 MHz, CD₂Cl₂) δ -75.0; IR (cm⁻¹) 2919, 1705, 1693, 1553, 1476, 1179, 1129, 1021, 753, 720; High Resolution MS (EI): Calculated for C₂₀H₂₃IrNO⁺ [M-CO₂CF₃]⁺: 486.1403, Found: 486.1401.

2. Stoichiometric Amidation of Iridacycle with Tosyl Azide

To a J-Young NMR tube were added Iridacycle (5, 60 mg, 0.10 mmol), p-toluenesulfonyl azide (17 μL, 0.11 mmol) and methylene chloride-d₂ (0.5 mL) under argon atmosphere. The NMR tube was gently shaken and kept at 25 °C. The reaction progress was followed by ¹H and ¹⁹F NMR spectroscopy until complete conversion to Ir-Amido complex was reached (approximately for 12 h). The crude yield of 6
(71%) was measured by $^1$H NMR spectroscopy using CH$_2$Br$_2$ as an internal standard. The reaction mixture was then quenched by hydrochloric acid in methanol solution. Organic solvents were removed under reduced pressure and the residue was purified by chromatography on silica gel with hexane/EtOAc as an eluent to give the desired amidated product (4, 61%).

**Ir-Amido Complex (Scheme 3, 6)**

After confirming the complete conversion to Ir-Amido complex, the reaction mixture was transferred to the 10 mL vial and additional 0.2 mL of methylene chloride-$d_2$ was used to rinse the vial. Then, the solvent was reduced to a minimal volume. Crystals suitable for X-ray analysis were grown by layering pentane on top of a concentrated solution of the metal species in methylene chloride-$d_2$ at -30 °C.

Yellow solid; $^1$H NMR (600 MHz, CD$_2$Cl$_2$) $\delta$ 7.74 (d, $J = 8.0$ Hz, 2H), 7.34 (d, $J = 7.7$ Hz, 1H), 7.27 (d, $J = 8.3$ Hz, 1H), 7.18 (t, $J = 7.6$ Hz, 1H), 7.11 – 7.05 (m, 3H), 6.81 (s, 1H), 2.80 (s, 3H), 2.28 (s, 3H), 1.56 (s, 15H); $^13$C NMR (150 MHz, CD$_2$Cl$_2$) $\delta$ 176.3, 161.9 (q, $J = 35.8$ Hz) 142.5, 141.9, 140.1, 132.5, 132.3, 129.2 (2C), 128.4 (2C), 125.7, 123.2, 120.7, 116.6 (q, $J = 291.0$ Hz), 114.5, 99.0, 85.4 (5C), 28.0, 21.6, 9.9 (5C); $^{19}$F NMR (564 MHz, CD$_2$Cl$_2$) $\delta$ -74.6; **High Resolution MS (EI):** Calculated for C$_{27}$H$_{30}$IrN$_2$O$_3$S [M-CO$_2$CF$_3$]$^+$: 655.1601, Found: 655.1608.

3. **Catalytic C–H Amidation Reaction using Iridacycle**

To an oven-dried screw capped vial equipped with a spinvane triangular-shaped Teflon stirbar were added N-acetylindole (1, 23 µL, 0.20 mmol), p-toluenesulfonyl azide (2, 31 µL, 0.20 mmol), Iridacycle (5, 12 mg, 0.020 mmol, 10 mol %), NaNTf$_2$ (6.1 mg, 0.020 mmol, 10 mol %) and 1,2-dichloroethane (0.5 mL) under argon atmosphere. The reaction mixture was stirred in a pre-heated oil bath at 40 °C for 16 h. The reaction mixture was filtered through a pad of celite with EtOAc (10 mL x 3) and concentrated under reduced pressure. The crude yield of 4 (60%) and 3 (<5%) were measured by $^1$H NMR spectroscopy using CH$_2$Br$_2$ as an internal standard.
4. Deuterium Labeling Test: Intermolecular Competition Test

To an oven-dried screw capped vial equipped with a spinvane triangular-shaped Teflon stirbar were added \( p \)-toluenesulfonyl azide (31 \( \mu \)L, 0.20 mmol), IrCp*(OTFA)\(_2\) (4.4 mg, 0.0080 mmol, 4 mol \%), NaNTf\(_2\) (2.4 mg, 0.0080 mmol, 4 mol \%), and 1,2-dichloroethane (0.5 mL) under argon atmosphere. The reaction mixture was stirred in a preheated oil bath at 40 °C for 10 min and then \( N \)-acetyl-3-methylindole (17 mg, 0.10 mmol) and \( N \)-acetyl-3-methylindole-\( d_2 \) (18 mg, 0.10 mmol) were added. After the mixture was further stirred in an oil bath at 40 °C for 7 min, it was cooled to -78 °C for 5 min, filtered through a plug of silica and then washed with cold ethyl acetate. Organic solvents were removed under reduced pressure and the crude mixture was further purified by silica gel column chromatography with n-hexane/EtOAc as an eluent to recover the starting material and the desired amidated product. KIE value (\( P_H/P_D = 3.69 \)) was determined by the ratio of desired product.

Figure S4. \(^1\)H NMR of starting material: Deuterated \( N \)-acetyl-3-methylindole (Scheme 3)
Figure S5. $^1$H NMR of intermolecular competition test: recovering starting material (Scheme 3)

Figure S6. $^1$H NMR of intermolecular competition test: amidated product (Scheme 3)
5. Deuterium Kinetic Isotope Effect: Initial Rate Comparison Test

To a J-Young NMR tube were added N-acetyl-3-methylindole (17 mg, 0.10 mmol) or N-acetyl-3-methylindole-\(d_n\) (18 mg, 0.10 mmol), IrCp*(OTFA)\(2\) (4.4 mg, 0.0080 mmol, 4 mol %), NaNTf\(2\) (2.4 mg, 0.0080 mmol, 4 mol %), 1,2-dibromethane as an internal standard (14 \(\mu\)L, 0.20 mmol) and methylene chloride-\(d_2\) (0.5 mL) under argon atmosphere. The NMR tube was gently shaken and allowed to cool at -78 °C for 15 min. \(p\)-toluenesulfonyl azide (31 \(\mu\)L, 0.20 mmol) was added, and the NMR tube was again shaken to insure through mixing of the reagents and started to measure its conversion over 10 min with a 1 min interval at the 40 °C (NMR probe temperature). KIE value (\(k_H/k_D = 1.8\)) was determined by comparing the relative initial rates.

**Figure S7.** Initial rate of N-acetyl-3-methylindole (red diamond) and N-acetyl-3-methylindole-\(d_n\) (blue diamond)
6. Reversibility Test and Initial Rate Comparison Test with N-Acetylindole

**Reversibility Test**

To an oven-dried screw capped vial equipped with a spinvane triangular-shaped Teflon stirbar were added p-toluenesulfonyl azide (31 μL, 0.20 mmol), IrCp*(OTFA)₂ (4.4 mg, 0.0080 mmol, 4 mol %), NaNTf₂ (2.4 mg, 0.0080 mmol, 4 mol %), and 1,2-dichloroethane (0.5 mL) under argon atmosphere. The reaction mixture was stirred in a preheated oil bath at 40 °C for 10 min and then N-acetylindole (16 mg, 0.10 mmol) and N-acetyl-2-deutrio-indole (16 mg, 0.10 mmol) were added. After the mixture was further stirred in an oil bath at 40 °C for 5 min, it was cooled to -78 °C for 5 min, filtered through a plug of silica and then washed with cold ethyl acetate. Organic solvents were removed under reduced pressure and the crude mixture was further purified by silica gel column chromatography with n-hexane/EtOAc as an eluent to recover the starting material and the amidated product.

![Figure S8. 1H NMR of intermolecular competition test: recovering starting material.](image)
**Initial Rate Comparison Test**

To an oven-dried screw capped vial equipped with a spinnane triangular-shaped Teflon stirbar were added N-acetylindole (32 mg, 0.20 mmol) or N-acetyl-2-deutero-indole\(^{33}\) (32 mg, 0.20 mmol), \(p\)-toluenesulfonyl azide (31 μL, 0.20 mmol), IrCp*(OTFA)\(_2\) (11 mg, 0.020 mmol, 10 mol %), NaNTf\(_2\) (6.1 mg, 0.020 mmol, 10 mol %), 1,2-dibromomethane as an internal standard (14 μL, 0.20 mmol) and methylene chloride (0.5 mL) under argon atmosphere. The reaction mixture was stirred in a preheated oil bath at 25 °C. For each 20 min, 10 μL of the reaction mixture was transferred to NMR tube and diluted with DMSO-\(d_6\), analyzed by \(^1\)H NMR spectroscopy. The initial reaction rate was obtained by plotting the six points to obtain KIE value to be 1.5.
**Figure S10.** Initial rate of $N$-acetylindole (red diamond) and $N$-acetyl-2-deuterio-indole (blue diamond)
V. Procedure for the Ir-Catalyzed C–H Amination with Azides

![Chemical structure](image)

To a screw capped vial with a spinnve triangular-shaped Teflon stir bar were added indole (0.20 mmol), azide (0.22 mmol), IrCp*(OTFA)_2 (11 mg, 0.020 mmol, 10 mol %), and NaNTf_2 (6.1 mg, 0.020 mmol, 10 mol %) in 1,2-dichloroethane (0.5 mL) under atmospheric conditions. The reaction mixture was stirred at the indicated temperature for 16 h, filtered through a pad of celite and then washed with EtOAc (10 mL x 3). Organic solvents were removed under reduced pressure and the residue was purified by chromatography on silica gel (n-hexane/EtOAc) to give the desired product.

N-(1-Acetyl-1H-indol-2-yl)-4-methylbenzenesulfonylamine (Scheme 2–4 and Figure 2–3, 4)

[Separation condition (HPLC): Chiral-pak IA-3, Hx/THF=4:1, 0.8 mL/min, 254 nm]

White solid (56 mg, 85%); m.p. 170 – 172 °C; ^1H NMR (600 MHz, DMSO-d_6) δ 10.62 (s, 1H), 8.17 (d, J = 8.4 Hz, 1H), 7.66 (d, J = 7.8 Hz, 2H), 7.46 (d, J = 7.8 Hz, 1H), 7.43 (d, J = 7.9 Hz, 2H), 7.31 – 7.27 (m, 1H), 7.21 – 7.17 (m, 1H), 5.93 (s, 1H), 2.76 (s, 3H), 2.40 (s, 3H); ^13C NMR (150 MHz, DMSO-d_6) δ 170.3, 143.8, 135.9, 132.5, 132.4, 130.7, 129.8 (2C), 127.1 (2C), 126.8, 124.9, 123.3, 120.6, 115.6, 105.0, 27.1, 21.1; IR (cm⁻¹) 3140, 2917, 1719, 1629, 1596, 1313, 1252, 1146, 1087, 765, 595, 546; High Resolution MS (EI): Calculated for C_{17}H_{16}N_2O_3S [M]^+: 328.0882, Found: 328.0883.

N-(1-Acetyl-5-methyl-1H-indol-2-yl)-4-methylbenzenesulfonylamine (Scheme 4, 7)

Yellow solid (58 mg, 84%); m.p. 189 – 191 °C; ^1H NMR (600 MHz, DMSO-d_6) δ 10.54 (s, 1H), 8.05 (d, J = 8.5 Hz, 1H), 7.65 (d, J = 7.8 Hz, 2H), 7.42 (d, J = 7.8 Hz, 2H), 7.23 (s, 1H), 7.10 (d, J = 8.3 Hz, 1H), 5.85 (s, 1H), 2.73 (s, 3H), 2.40 (s, 3H), 2.31 (s, 3H); ^13C NMR (150 MHz, DMSO-d_6) δ 170.3, 143.8, 135.9, 132.5, 132.4, 130.7, 129.8 (2C), 127.1 (2C), 127.0, 126.1, 120.3, 115.4, 105.0, 26.9, 21.1, 20.8; IR (cm⁻¹) 3048, 2917, 1702, 1624, 1311, 1151, 1086, 779, 685, 595, 546; High Resolution MS (EI): Calculated for C_{18}H_{18}N_2O_3S [M]^+: 342.1038, Found: 342.1040.
N-(1-Acetyl-5-methoxy-1H-indol-2-yl)-4-methylbenzenesulfonamide (Scheme 4, 8)

Yellow solid (57 mg, 80%); m.p. 176 – 178 °C; $^1$H NMR (600 MHz, DMSO-$d_6$) δ 10.57 (s, 1H), 8.07 (d, $J = 9.1$ Hz, 1H), 7.67 (d, $J = 8.0$ Hz, 2H), 7.44 (d, $J = 7.9$ Hz, 2H), 7.00 (s, 1H), 6.89 (d, $J = 9.0$ Hz, 1H), 5.88 (s, 1H), 3.73 (s, 3H), 2.73 (s, 3H), 2.41 (s, 3H); $^{13}$C NMR (150 MHz, DMSO-$d_6$) δ 170.1, 155.7, 143.8, 136.1, 131.1, 129.8 (2C), 128.9, 127.8, 127.0 (2C), 116.7, 113.4, 105.1, 103.1, 55.2, 26.8, 21.1; IR (cm$^{-1}$) 3133, 2916, 2845, 1710, 1613, 1304, 1147, 1085, 1021, 780, 542; High Resolution MS (EI): Calculated for C$_{18}$H$_{18}$N$_2$O$_3$S [M]$^+$: 358.0987, Found: 358.0990.

N-(1-Acetyl-5-fluoro-1H-indol-2-yl)-4-methylbenzenesulfonamide (Scheme 4, 9)

Yellow solid (33 mg, 48%); m.p. 144 – 146 °C; $^1$H NMR (400 MHz, DMSO-$d_6$) δ 10.71 (s, 1H), 8.17 (dd, $J = 9.2$, 4.8 Hz, 1H), 7.66 (d, $J = 8.3$ Hz, 2H), 7.44 (d, $J = 8.0$ Hz, 2H), 7.30 (dd, $J = 9.0$, 2.7 Hz, 1H), 7.13 (td, $J = 9.3$, 2.8 Hz, 1H), 5.95 (s, 1H), 2.75 (s, 3H), 2.41 (s, 3H); $^{13}$C NMR (100 MHz, DMSO-$d_6$) δ 170.6, 159.8 (d, $J = 237.7$ Hz), 144.0, 135.9, 132.4, 130.9, 130.0 (2C), 128.1 (d, $J = 10.4$ Hz), 127.1 (2C), 117.3 (d, $J = 8.9$ Hz), 112.6 (d, $J = 24.7$ Hz), 106.3 (d, $J = 24.2$ Hz), 104.7 (d, $J = 3.7$ Hz), 27.0, 21.2; $^{19}$F NMR (376 MHz, DMSO-$d_6$) δ -119.2; IR (cm$^{-1}$) 3136, 2920, 1705, 1634, 1604, 1478, 1293, 1145, 1086, 779, 572, 545; High Resolution MS (EI): Calculated for C$_{17}$H$_{15}$FN$_2$O$_3$S [M]$^+$: 346.0787, Found: 346.0785.

N-(1-Acetyl-5-chloro-1H-indol-2-yl)-4-methylbenzenesulfonamide (Scheme 4, 10)

Brown solid (36 mg, 50%); m.p. 167 – 169 °C; $^1$H NMR (600 MHz, DMSO-$d_6$) δ 10.70 (s, 1H), 8.14 (d, $J = 9.0$ Hz, 1H), 7.65 (d, $J = 7.9$ Hz, 2H), 7.57 (s, 1H), 7.43 (d, $J = 7.9$ Hz, 2H), 7.31 (d, $J = 8.9$ Hz, 1H), 5.93 (s, 1H), 2.75 (s, 3H), 2.40 (s, 3H); $^{13}$C NMR (150 MHz, DMSO-$d_6$) δ 170.5, 143.9, 135.7, 132.7, 132.2, 129.8 (2C), 128.3, 127.6, 127.0 (2C), 124.6, 119.9, 117.1, 104.0, 26.9, 21.1; IR (cm$^{-1}$) 2929, 2849, 1710, 1624, 1293, 1147, 1087, 778, 541, 523; High Resolution MS (EI): Calculated for C$_{17}$H$_{15}$ClN$_2$O$_3$S [M]$^+$: 362.0492, Found: 362.0489.

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N-(1-Acetyl-5-bromo-1H-indol-2-yl)-4-methylbenzenesulfonamide (Scheme 4, 11)

Brown solid (37 mg, 46%); m.p. 192 – 194 °C; 1H NMR (600 MHz, DMSO-d6) δ 10.70 (s, 1H), 8.09 (d, J = 8.9 Hz, 1H), 7.71 (d, J = 2.1 Hz, 1H), 7.64 (d, J = 8.1 Hz, 2H), 7.45 – 7.40 (m, 3H), 5.93 (s, 1H), 2.75 (s, 3H), 2.40 (s, 3H); 13C NMR (150 MHz, DMSO-d6) δ 170.6, 143.9, 135.7, 133.0, 132.0, 129.8 (2C), 128.8, 127.3, 127.0 (2C), 122.9, 117.5, 115.7, 103.9, 27.0, 21.1; IR (cm⁻¹) 3054, 2920, 1712, 1625, 1292, 1146, 1087, 778, 701, 541; High Resolution MS (EI): Calculated for C17H15BrN2O3S [M]+: 405.9987, Found: 405.9989.

N-(1-Acetyl-4-methyl-1H-indol-2-yl)-4-methylbenzenesulfonamide (Scheme 4, 12)

Yellow solid (58 mg, 80%); m.p. 192 – 194 °C; 1H NMR (600 MHz, DMSO-d6) δ 10.55 (s, 1H), 7.98 (d, J = 8.4 Hz, 1H), 7.65 (d, J = 8.1 Hz, 2H), 7.43 (d, J = 7.9 Hz, 2H), 7.24 – 7.12 (m, 1H), 7.01 (d, J = 7.4 Hz, 1H), 5.91 (s, 1H), 2.72 (s, 3H), 2.41 (s, 3H), 2.28 (s, 3H); 13C NMR (150 MHz, DMSO-d6) δ 170.5, 143.8, 135.9, 134.1, 130.2, 129.7 (2C), 129.3, 127.1 (2C), 126.3, 124.9, 123.7, 113.2, 103.6, 27.0, 21.0, 17.9; IR (cm⁻¹) 3142, 2913, 1712, 1633, 1591, 1312, 1233, 1148, 1082, 867, 747, 550; High Resolution MS (EI): Calculated for C18H18N2O3S [M]+: 342.1038, Found: 342.1040.

N-(1-Acetyl-4-fluoro-1H-indol-2-yl)-4-methylbenzenesulfonamide (Scheme 4, 13)

Yellow solid (31 mg, 45%); m.p. 161 – 163 °C; 1H NMR (400 MHz, DMSO-d6) δ 10.75 (s, 1H), 7.98 (d, J = 8.4 Hz, 1H), 7.66 (d, J = 8.3 Hz, 2H), 7.43 (d, J = 8.0 Hz, 2H), 7.34 – 7.23 (m, 1H), 7.04 (dd, J = 9.9, 8.1 Hz, 1H), 5.89 (s, 1H), 2.76 (s, 3H), 2.40 (s, 3H); 13C NMR (150 MHz, DMSO-d6) δ 170.8, 155.2 (d, J = 245.6 Hz), 144.0, 136.2 (d, J = 9.2 Hz), 135.7, 131.5, 129.9 (2C), 127.1 (2C), 125.9 (d, J = 7.1 Hz), 115.5 (d, J = 22.0 Hz), 112.2 (d, J = 3.5 Hz), 108.7 (d, J = 17.9 Hz), 99.4, 27.0, 21.1; 19F NMR (376 MHz, DMSO-d6) δ -122.5; IR (cm⁻¹) 3111, 2921, 1592, 1463, 1237, 1147, 1089, 752, 656, 544; High Resolution MS (EI): Calculated for C17H15FN2O3S [M]+: 346.0787, Found: 346.0784.
**N-(1-Acetyl-4-chloro-1H-indol-2-yl)-4-methylbenzenesulfonamide** (Scheme 4, 14)

Yellow solid (46 mg, 64%); **m.p.** 140 – 142 °C; **$^1$H NMR** (400 MHz, DMSO-$d_6$) δ 10.79 (s, 1H), 8.20 – 8.05 (m, 1H), 7.67 (d, $J$ = 8.0 Hz, 2H), 7.44 (d, $J$ = 8.0 Hz, 2H), 7.32 – 7.28 (m, 2H), 5.87 (s, 1H), 2.76 (s, 3H), 2.41 (s, 3H); **$^{13}$C NMR** (100 MHz, DMSO-$d_6$) δ 170.7, 144.0, 135.6, 134.8, 132.1, 129.8 (2C), 127.1 (2C), 125.8, 125.3, 124.1, 123.0, 114.5, 101.5, 27.0, 21.1; **IR** (cm$^{-1}$) 3147, 2912, 1720, 1631, 1444, 1315, 1244, 1144, 1086, 822, 785, 716, 548; **High Resolution MS** (EI): Calculated for C$_{17}$H$_{15}$ClN$_2$O$_3$ [M]$^+$: 362.0492, Found: 362.0493.

**N-(1-Acetyl-4-bromo-1H-indol-2-yl)-4-methylbenzenesulfonamide** (Scheme 4, 15)

Brown solid (35 mg, 43%); **m.p.** 130 – 132 °C; **$^1$H NMR** (600 MHz, DMSO-$d_6$) δ 10.78 (s, 1H), 8.14 (d, $J$ = 8.4 Hz, 1H), 7.66 (d, $J$ = 8.3 Hz, 2H), 7.52 – 7.36 (m, 3H), 7.23 (t, $J$ = 8.1 Hz, 1H), 5.78 (s, 1H), 2.76 (s, 3H), 2.40 (s, 3H); **$^{13}$C NMR** (150 MHz, DMSO-$d_6$) δ 170.7, 144.0, 135.5, 134.4, 132.1, 129.8 (2C), 127.2, 127.1 (2C), 126.1, 126.0, 114.9, 113.1, 103.3, 27.0, 21.0; **IR** (cm$^{-1}$) 3090, 2940, 1723, 1596, 1578, 1267, 1137, 1087, 776, 546; **High Resolution MS** (EI): Calculated for C$_{17}$H$_{15}$BrN$_2$O$_3$ [M]$^+$: 405.9987, Found: 405.9985.

**N-(1-Acetyl-6-methyl-1H-indol-2-yl)-4-methylbenzenesulfonamide** (Scheme 4, 16)

Brown solid (34 mg, 50%); **m.p.** 168 – 170 °C; **$^1$H NMR** (600 MHz, DMSO-$d_6$) δ 10.51 (s, 1H), 8.01 (s, 1H), 7.64 (d, $J$ = 7.4 Hz, 2H), 7.42 (d, $J$ = 7.7 Hz, 2H), 7.33 (d, $J$ = 7.9 Hz, 1H), 7.03 (d, $J$ = 8.0 Hz, 1H), 5.87 (s, 1H), 2.73 (s, 3H), 2.41 (s, 3H), 2.39 (s, 3H); **$^{13}$C NMR** (150 MHz, DMSO-$d_6$) δ 170.5, 143.7, 136.0, 134.7, 134.4, 123.0, 129.8 (2C), 127.0 (2C), 124.6, 124.5, 120.2, 115.7, 105.3, 27.0, 21.7, 21.1; **IR** (cm$^{-1}$) 3061, 2921, 1712, 1632, 1599, 1322, 1144, 1084, 756, 541; **High Resolution MS** (EI): Calculated for C$_{18}$H$_{18}$N$_2$O$_3$S [M]$^+$: 342.1038, Found: 342.1040.
**N-(1-Acetyl-6-fluoro-1H-indol-2-yl)-4-methylbenzenesulfonamide (Scheme 4, 17)**

White solid (42 mg, 61%); **m.p.** 165 – 167 °C; **1H NMR** (600 MHz, DMSO-\(d_6\)) \(\delta\) 10.62 (s, 1H), 7.95 (d, \(J = 11.0\) Hz, 1H), 7.66 (d, \(J = 8.1\) Hz, 2H), 7.52 – 7.47 (m, 1H), 7.43 (d, \(J = 7.8\) Hz, 2H), 7.15 – 7.02 (m, 1H), 5.95 (s, 1H), 2.76 (s, 3H), 2.41 (s, 3H); **13C NMR** (150 MHz, CD\(_2\)Cl\(_2\)) \(\delta\) 170.6, 160.4 (d, \(J = 238.1\) Hz), 143.8, 135.9, 134.3 (d, \(J = 13.1\) Hz), 131.0 (d, \(J = 3.8\) Hz), 129.8 (2C), 127.0 (2C), 123.3, 121.9 (d, \(J = 9.9\) Hz), 111.4 (d, \(J = 23.8\) Hz), 105.3, 102.7 (d, \(J = 29.0\) Hz), 26.88, 21.05; **19F NMR** (564 MHz, DMSO-\(d_6\)) \(\delta\) -116.2 (td, \(J = 10.1, 5.7\) Hz); **IR** (cm\(^{-1}\)) 3142, 2919, 1718, 1640, 1597, 1279, 1151, 1106, 883, 810, 761, 683, 548; **High Resolution MS** (EI): Calculated for C\(_{17}\)H\(_{15}\)FN\(_2\)O\(_5\)S [M]\(^+\): 346.0787, Found: 346.0789.

**N-(1-Acetyl-3-methyl-1H-indol-2-yl)-4-methylbenzenesulfonamide (Scheme 4, 18)**

White solid (58 mg, 85%); **m.p.** 166 – 168 °C; **1H NMR** (600 MHz, CD\(_2\)Cl\(_2\)) \(\delta\) 8.19 (s, 1H), 7.54 (d, \(J = 6.7\) Hz, 1H), 7.49 (d, \(J = 8.1\) Hz, 1H), 7.46 (d, \(J = 8.1\) Hz, 2H), 7.35 – 7.25 (m, 2H), 7.19 (d, \(J = 8.0\) Hz, 2H), 2.38 (s, 3H), 2.30 (s, 3H), 2.22 (s, 3H); **13C NMR** (150 MHz, CD\(_2\)Cl\(_2\)) \(\delta\) 170.9, 144.4, 135.8, 133.1, 129.4 (2C), 129.2, 128.0, 127.4 (2C), 125.1, 123.2, 119.8, 117.0, 113.7, 26.4, 21.2, 8.5; **IR** (cm\(^{-1}\)) 3239, 2919, 1638, 1451, 1368, 1302, 1162, 814, 732, 673, 554; **High Resolution MS** (EI): Calculated for C\(_{18}\)H\(_{16}\)N\(_2\)O\(_5\)S [M]\(^+\): 342.1038, Found: 342.1036.

**Methyl 3-[1-acetyl-2-{(4-methylphenyl)sulfonamido}-1H-indol-3-yl]-2-[(t-\text{butoxy carbonyl})amino]propanoate (Scheme 4, 19)**

White solid (38 mg, 36%); **m.p.** 165 – 167 °C; **1H NMR** (600 MHz, CD\(_2\)Cl\(_2\)) \(\delta\) 8.32 (s, 1H), 7.70 (d, \(J = 8.3\) Hz, 1H), 7.56 (d, \(J = 7.5\) Hz, 1H), 7.48 (d, \(J = 7.9\) Hz, 2H), 7.34 (t, \(J = 7.5\) Hz, 1H), 7.29 (t, \(J = 7.4\) Hz, 1H), 7.22 (d, \(J = 7.8\) Hz, 2H), 5.35 (s, 1H), 4.55 (q, \(J = 7.2\) Hz, 1H), 3.72 (s, 3H), 3.00 (m, 2H), 2.48 – 2.29 (m, 6H), 1.37 (s, 9H); **13C NMR** (150 MHz, CD\(_2\)Cl\(_2\)) 173.0, 171.7, 155.8, 145.3, 135.9, 134.1, 130.2 (2C), 129.8, 128.6, 128.1 (2C), 125.9, 123.9, 120.3, 115.8, 114.8, 80.5, 78.1, 53.0, 28.5 (3C), 27.2, 26.7, 21.9; **IR** (cm\(^{-1}\)) 3371, 3256, 2971, 2920, 1688, 1521, 1343, 1163, 680, 532; **High Resolution MS** (EI): Calculated for C\(_{26}\)H\(_{31}\)N\(_2\)O\(_5\)S [M]\(^+\): 529.1883, Found: 529.1881.
**N-(1-Acetyl-1H-indol-2-yl)-benzenesulfonamide (Scheme 4, 20)**

Yellow solid (53 mg, 84%); **m.p.** 138 – 140 °C; **¹H NMR** (600 MHz, DMSO-$_d_6$) δ 10.69 (s, 1H), 8.17 (d, $J = 8.4$ Hz, 1H), 7.78 (d, $J = 7.0$ Hz, 2H), 7.74 – 7.70 (m, 1H), 7.67 – 7.60 (m, 2H), 7.45 (d, $J = 7.7$ Hz, 1H), 7.33 – 7.26 (m, 1H), 7.23 – 7.14 (m, 1H), 5.91 (s, 1H), 2.75 (s, 3H); **¹³C NMR** (150 MHz, DMSO-$_d_6$) δ 170.5, 138.8, 134.3, 133.4, 130.5, 129.4 (2C), 127.0 (2C), 126.8, 125.0, 123.3, 120.6, 115.6, 105.2, 27.0; **IR** (cm$^{-1}$) 3126, 2919, 1706, 1625, 1310, 1251, 1144, 759, 570, 543; **High Resolution MS** (EI): Calculated for C$_{16}$H$_{14}$N$_2$O$_3$S $[M]^+$: 314.0725, Found: 314.0723.

**N-(1-Acetyl-1H-indol-2-yl)-4-methoxybenzenesulfonamide (Scheme 4, 21)**

Brown solid (52 mg, 75%); **m.p.** 160 – 162 °C; **¹H NMR** (400 MHz, DMSO-$_d_6$) δ 10.53 (s, 1H), 8.17 (d, $J = 8.3$ Hz, 1H), 7.70 (d, $J = 8.8$ Hz, 2H), 7.47 (d, $J = 7.7$ Hz, 1H), 7.32 – 7.26 (m, 1H), 7.22 – 7.17 (m, 1H), 7.14 (d, $J = 8.7$ Hz, 2H), 5.93 (s, 1H), 3.85 (s, 3H), 2.76 (s, 3H); **¹³C NMR** (100 MHz, DMSO-$_d_6$) δ 170.7, 162.9, 134.4, 131.0, 130.3, 129.4 (2C), 126.9, 125.0, 123.4, 120.7, 115.7, 114.6 (2C), 105.1, 55.8, 27.2; **IR** (cm$^{-1}$) 3219, 3002, 1677, 1574, 1450, 1367, 1306, 1243, 1148, 1024, 771, 667, 547; **High Resolution MS** (EI): Calculated for C$_{17}$H$_{16}$N$_2$O$_4$S $[M]^+$: 344.0831, Found: 344.0829.

**N-(1-Acetyl-1H-indol-2-yl)-4-chlorobenzenesulfonamide (Scheme 4, 22)**

White solid (59 mg, 85%); **m.p.** 164 – 166 °C; **¹H NMR** (600 MHz, DMSO-$_d_6$) δ 10.81 (s, 1H), 8.17 (d, $J = 8.4$ Hz, 1H), 7.78 (d, $J = 8.2$ Hz, 2H), 7.71 (d, $J = 8.3$ Hz, 2H), 7.48 (d, $J = 7.7$ Hz, 1H), 7.33 – 7.27 (m, 1H), 7.22 – 7.16 (m, 1H), 5.99 (s, 1H), 2.76 (s, 3H); **¹³C NMR** (150 MHz, DMSO-$_d_6$) δ 170.5, 138.3, 137.6, 134.4, 130.3, 129.6 (2C), 129.0 (2C), 126.8, 125.1, 123.4, 120.7, 115.7, 105.5, 27.1; **IR** (cm$^{-1}$) 3089, 2956, 1711, 1624, 1594, 1465, 1314, 1277, 1172, 1148, 1083, 787, 753, 543; **High Resolution MS** (EI): Calculated for C$_{16}$H$_{15}$ClN$_2$O$_3$S $[M]^+$: 348.0335, Found: 348.0332.
**N-(1-Acetyl-1H-indol-2-yl)-4-bromobenzensulfonamide (Scheme 4, 23)**

Brown solid (66 mg, 84%); m.p. 165 – 167 °C; $^1$H NMR (600 MHz, DMSO-$d_6$) $\delta$ 10.82 (s, 1H), 8.17 (d, $J = 8.4$ Hz, 1H), 7.85 (d, $J = 7.6$ Hz, 2H), 7.70 (d, $J = 8.0$ Hz, 2H), 7.48 (d, $J = 7.8$ Hz, 1H), 7.33 – 7.26 (m, 1H), 7.21 – 7.18 (m, 1H), 6.00 (s, 1H), 2.76 (s, 3H); $^{13}$C NMR (150 MHz, DMSO-$d_6$) $\delta$ 170.4, 138.0, 134.4, 132.5 (2C), 130.2, 129.0 (2C), 127.4, 126.8, 125.1, 123.4, 120.7, 115.6, 105.5, 27.1; IR (cm$^{-1}$) 3087, 1704, 1625, 1594, 1465, 1315, 1146, 1082, 783, 584, 543; High Resolution MS (EI): Calculated for C$_{16}$H$_{13}$BrN$_2$O$_3$S [M]$^+$: 391.9830, Found: 391.9829.

**N-(1-Acetyl-1H-indol-2-yl)-4-(trifluoromethyl)benzenesulfonamide (Scheme 4, 24)**

White solid (66 mg, 86%); m.p. 155 – 157 °C; $^1$H NMR (600 MHz, DMSO-$d_6$) $\delta$ 10.99 (s, 1H), 8.18 (d, $J = 8.4$ Hz, 1H), 8.00 (d, $J = 8.4$ Hz, 2H), 7.47 (d, $J = 7.7$ Hz, 1H), 7.32 – 7.27 (m, 1H), 7.23 – 7.18 (m, 1H), 6.02 (s, 1H), 2.76 (s, 3H); $^{13}$C NMR (150 MHz, DMSO-$d_6$) $\delta$ 170.3, 142.7, 134.4, 133.0 (q, $J = 32.3$ Hz), 130.0, 128.0 (2C), 126.7, 126.7 (q, $J = 3.3$ Hz, 2C), 125.1, 124.3 (q, $J = 273.0$ Hz), 123.4, 120.7, 115.6, 105.6, 27.0; $^{19}$F NMR (564 MHz, DMSO-$d_6$) $\delta$ -61.69; IR (cm$^{-1}$) 3127, 1718, 1620, 1592, 1319, 1148, 1061, 760, 583, 539; High Resolution MS (EI): Calculated for C$_{17}$H$_{13}$F$_3$N$_2$O$_3$S [M]$^+$: 382.0599, Found: 382.0601.

**N-(1-Acetyl-1H-indol-2-yl)naphthalene-1-sulfonamide (Scheme 4, 25)**

White solid (64 mg, 88%); m.p. 150 – 152 °C; $^1$H NMR (600 MHz, DMSO-$d_6$) $\delta$ 10.92 (s, 1H), 8.66 (d, $J = 8.2$ Hz, 1H), 8.31 (d, $J = 8.4$ Hz, 2H), 8.16 (d, $J = 8.0$ Hz, 1H), 8.14 (d, $J = 8.5$ Hz, 1H), 8.07 (d, $J = 7.3$ Hz, 1H), 7.77 – 7.68 (m, 2H), 7.66 – 7.58 (m, 1H), 7.33 (d, $J = 7.8$ Hz, 1H), 7.29 – 7.24 (m, 1H), 7.17 – 7.12 (m, 1H), 5.66 (s, 1H), 2.75 (s, 3H); $^{13}$C NMR (150 MHz, DMSO-$d_6$) $\delta$ 170.4, 134.8, 134.3, 133.9, 133.8, 130.0, 129.9, 129.3, 128.3, 127.3, 127.2, 126.7, 125.1, 124.6, 124.2, 123.4, 120.6, 115.6, 106.0, 27.0; IR (cm$^{-1}$) 3055, 2931, 1640, 1460, 1311, 1171, 1102, 853, 756, 686, 581, 501; High Resolution MS (EI): Calculated for C$_{20}$H$_{16}$N$_2$O$_3$S [M]$^+$: 364.0882, Found: 364.0883.
**N-(1-Acetyl-1H-indol-2-yl)methanesulfonamide (Scheme 4, 26)**

Brown solid (43 mg, 86%); **m.p.** 138 – 140 °C; **^1H NMR** (400 MHz, DMSO-d$_6$) δ 10.14 (s, 1H), 8.21 (d, $J$ = 8.3 Hz, 1H), 7.59 (d, $J$ = 7.6 Hz, 1H), 7.35 – 7.30 (m, 1H), 7.30 – 7.24 (m, 1H), 6.77 (s, 1H), 3.19 (s, 3H), 2.75 (s, 3H); **^13C NMR** (100 MHz, DMSO-d$_6$) δ 170.7, 134.5, 131.4, 127.2, 124.9, 123.5, 120.6, 115.8, 105.4, 39.4, 27.2; **IR (cm$^{-1}$)** 3015, 2934, 1704, 1638, 1281, 1130, 776, 581, 502; **High Resolution MS (EI):** Calculated for C$_{11}$H$_{12}$N$_2$O$_3$S [M]$^+$: 252.0569, Found: 252.0569.

**N-(1-Acetyl-1H-indol-2-yl)butane-1-sulfonamide (Scheme 4, 27)**

White solid (48 mg, 82%); **m.p.** 107 – 109 °C; **^1H NMR** (400 MHz, DMSO-d$_6$) δ 10.16 (s, 1H), 8.20 (d, $J$ = 8.3 Hz, 1H), 7.59 (d, $J$ = 7.9 Hz, 1H), 7.37 – 7.29 (m, 1H), 7.29 – 7.22 (m, 1H), 6.72 (s, 1H), 3.31 – 3.23 (m, 2H), 2.76 (s, 3H), 1.80 – 1.72 (m, 2H), 1.53 – 1.35 (m, 2H), 0.92 (t, $J$ = 7.3 Hz, 3H); **^13C NMR** (100 MHz, DMSO-d$_6$) δ 170.8, 134.4, 131.1, 127.2, 124.9, 123.5, 120.6, 115.8, 105.6, 50.5, 27.2, 25.1, 20.8, 13.6; **IR (cm$^{-1}$)** 2958, 2874, 1713, 1639, 1598, 1464, 1319, 1133, 853, 755, 507; **High Resolution MS (EI):** Calculated for C$_{14}$H$_{18}$N$_2$O$_3$S [M]$^+$: 294.1038, Found: 294.1041.

**N-(1-Acetyl-1H-indol-2-yl)-1-phenylmethanesulfonamide (Scheme 4, 28)**

White solid (51 mg, 78%); **m.p.** 154 – 156 °C; **^1H NMR** (600 MHz, DMSO-d$_6$) δ 10.11 (s, 1H), 8.18 (d, $J$ = 8.3 Hz, 1H), 7.59 (d, $J$ = 7.6 Hz, 1H), 7.46 (d, $J$ = 7.1 Hz, 2H), 7.43 – 7.37 (m, 3H), 7.35 – 7.31 (m, 1H), 7.29 – 7.25 (m, 1H), 6.76 (s, 1H), 4.65 (s, 2H), 2.71 (s, 3H); **^13C NMR** (150 MHz, DMSO-d$_6$) δ 170.8, 134.3, 131.1, 131.1 (2C), 129.2, 128.5 (2C), 128.4, 127.3, 124.9, 123.5, 120.6, 115.8, 105.4, 57.2, 27.0; **IR (cm$^{-1}$)** 2959, 2918, 1697, 1630, 1594, 1311, 1145, 1123, 808, 764, 696, 540, 499; **High Resolution MS (EI):** Calculated for C$_{17}$H$_{16}$N$_2$O$_3$S [M]$^+$: 328.0882, Found: 328.0883.
VI. Procedure for the Ir-Catalyzed C–H Olefination with Acrylates

1. Procedure for Reaction Optimization

To a seal tube with an oval-shaped Teflon spinbar were added N-acetylindole (32 mg, 0.20 mmol), methyl acrylate (91 μL, 1.0 mmol), [Ir\(\text{Cp}^*\text{Cl}_2\)]_2 (8.0 mg, 0.010 mmol, 5 mol %), AgNTf₂ (15.5 mg, 0.040 mmol, 20 mol %) and copper carboxylate (0.42 mmol) in methylene chloride (1.5 mL) under Ar-purged conditions. The reaction mixture was stirred in a pre-heated oil bath or a heating block at the 80 °C for 36 h. The reaction mixture was cooled to room temperature, filtered through a plug of celite and 3M aqueous NH₃ solution was added. The two layers were separated, and the aqueous layer was extracted with methylene chloride (10 mL x 3). The combined organic layers were dried over MgSO₄, filtered, and concentrated under reduced pressure. The crude yield and regiemonic ratios were measured by \(^1\)H NMR using dibromomethane as an internal standard.

Table S3. Copper Carboxylates Screen

| entry | Cu carboxylate | \begin{tabular}{l} yield (\%) \\ \(\text{C2-products}\) \end{tabular} | \begin{tabular}{l} yield (\%) \\ \(\text{C7-products}\) \end{tabular} | \begin{tabular}{l} ratio \\ \(\text{C2:}\text{C7}\) \end{tabular} |
|-------|----------------|---------------------------------|---------------------------------|---------------------------------|
| 1     | Cu(OAc)$_2$    | 23                              | 28                              | 1:1.2                           |
| 2     | Cu(OPiv)$_2$   | 22                              | 42                              | 1:1.9                           |
| 3     | Cu(OTFA)$_2$   | 66                              | 5                               | 13.2:1                          |
2. Further Optimizations for Improved Catalytic Reaction

To afford high yields of 29, further studies were conducted according to the above general procedure. The crude yield was measured by $^1$H NMR using dibromomethane as an internal standard.

**Table S4. Optimization of the Reaction Condition**

| entry | catalytic system (mol %) | additives (mol %) | solvent       | yield (%) |
|-------|--------------------------|-------------------|---------------|-----------|
| 1     | [IrCp*Cl$_2$]$_2$ (5) / AgNTf$_2$ (20) | -                  | CH$_2$Cl$_2$  | n.d       |
| 2     | [IrCp*Cl$_2$]$_2$ (5) / AgNTf$_2$ (10) | AgOTFA (20)       | CH$_2$Cl$_2$  | 18        |
| 3     | [IrCp*Cl$_2$]$_2$ (5) / AgNTf$_2$ (20) | Cu(OTFA)$_2$ (210) | CH$_2$Cl$_2$  | 66        |
| 4     | [IrCp*Cl$_2$]$_2$ (5) / AgNTf$_2$ (20) | Cu(OTFA)$_2$ (210) | 1,2-DCE       | 46        |
| 5     | [IrCp*Cl$_2$]$_2$ (5) / NaNTf$_2$ (20) | Cu(OTFA)$_2$ (210) | CH$_2$Cl$_2$  | 82        |
| 6     | [IrCp*Cl$_2$]$_2$ (5) / NaNTf$_2$ (20) | -                  | CH$_2$Cl$_2$  | n.d       |
| 7     | -                        | Cu(OTFA)$_2$ (210) | CH$_2$Cl$_2$  | n.d       |

*Standard reaction conditions: N-acetylindole (23 μL, 0.20 mmol), methyl acrylate (91 μL, 1.0 mmol, 5.0 equiv.), catalyst, and additives in solvent (1.5 mL) at 80 °C for 36 h.

3. General Procedure for the Ir-Catalyzed C–H Olefination with Acrylates

To a seal tube with a oval-shaped spinbar were added N-acetylindole (32 mg, 0.20 mmol), acrylate (1.0 mmol), [IrCp*Cl$_2$]$_2$ (8.0 mg, 0.010 mmol, 5 mol %), NaNTf$_2$ (12.1 mg, 0.040 mmol, 20 mol %) and copper trifluoroacetate (121.6 mg, 0.42 mmol) in methylene chloride (1.5 mL) under Ar-purged conditions. The reaction mixture was stirred in a pre-heated oil bath at the 80 °C for 36 h. The reaction mixture was cooled to room temperature, filtered through a plug of celite and 3M aqueous NH$_3$ solution was added. The two layers were seperated, and the aqueous layer was extracted with methylene chloride (10 mL x 3). The combined organic layers were dried over MgSO$_4$, filtered, and concentrated under reduced pressure. The crude yield and regiemonic ratios were measured by $^1$H NMR using dibromomethane as an internal standard, and the residue was purified by chromatography on silica gel.
to give the desired product.

**Methyl (E)-3-(1-acetyl-1H-indol-2-yl)acrylate (Scheme 5, 29)**

White solid (39 mg, 80%); **m.p.** 89 – 91 °C; **1H NMR** (400 MHz, CD2Cl2) δ 8.04 (d, J = 15.7 Hz, 1H), 7.94 (d, J = 8.4 Hz, 1H), 7.59 (d, J = 7.7 Hz, 1H), 7.37 (t, J = 7.7 Hz, 1H), 7.28 (t, J = 7.4 Hz, 1H), 6.98 (s, 1H), 6.38 (d, J = 15.7 Hz, 1H), 3.79 (s, 3H), 2.73 (s, 3H); **13C NMR** (100 MHz, CD2Cl2) δ 170.2, 166.7, 137.3, 136.3, 129.2, 125.9, 123.7, 121.5, 119.4, 115.1, 111.7, 51.7, 27.4; **IR** (cm⁻¹) 2946, 1693, 1623, 1440, 1369, 1300, 1271, 1198, 1145, 1005, 838, 759; **High Resolution MS (EI):** Calculated for C14H13NO3 [M]+: 243.0895, Found: 243.0895.

**Ethyl (E)-3-(1-acetyl-1H-indol-2-yl)acrylate (Scheme 5, 30)**

Yellow solid (36 mg, 70%); **m.p.** 95 – 96 °C; **1H NMR** (400 MHz, CD2Cl2) δ 8.05 – 8.00 (m, 1H), 7.96 (d, J = 8.5 Hz, 1H), 7.60 (d, J = 7.8 Hz, 1H), 7.37 (ddd, J = 8.5, 7.3, 1.3 Hz, 1H), 7.32 – 7.22 (m, 1H), 6.98 (s, 1H), 6.38 (d, J = 15.7 Hz, 1H), 4.25 (q, J = 7.1 Hz, 2H), 2.73 (s, 3H), 1.33 (t, J = 7.1 Hz, 3H); **13C NMR** (100 MHz, CD2Cl2) δ 170.6, 166.6, 137.6, 136.7, 136.1, 129.5, 126.2, 124.0, 121.8, 120.3, 115.4, 111.9, 61.0, 27.8, 14.5; **IR** (cm⁻¹) 2981, 1698, 1474, 1368, 1294, 1116, 1025, 745; **High Resolution MS (EI):** Calculated for C15H15NO3 [M]+: 257.1052, Found: 257.1051.

**Benzyl (E)-3-(1-acetyl-1H-indol-2-yl)acrylate (Scheme 5, 31)**

Orange oil (53 mg, 83%); **1H NMR** (600 MHz, CD2Cl2) δ 8.10 (d, J = 15.7 Hz, 1H), 7.95 (d, J = 8.4 Hz, 1H), 7.60 (d, J = 7.7 Hz, 1H), 7.39 (m, 6H), 7.29 (t, J = 7.4 Hz, 1H), 7.00 (s, 1H), 6.44 (d, J = 15.8 Hz, 1H), 5.26 (s, 2H), 2.74 (s, 3H); **13C NMR** (150 MHz, CD2Cl2) δ 170.6, 166.5, 137.7, 136.8, 136.7, 136.6, 129.6, 128.9 (2C), 128.6, 128.6 (2C), 126.3, 124.1, 122.0, 119.8, 115.5, 112.2, 66.8, 27.8; **IR** (cm⁻¹) 3054, 1702, 1456, 1371, 1300, 1264, 1211, 1164, 1026, 731, 639; **High Resolution MS (EI):** Calculated for C20H17NO3 [M]+: 319.1208, Found: 319.1207.
VII. DFT Calculations

1. Computational Details

All DFT calculations were carried out with Gaussian09 quantum chemical package.\textsuperscript{59} For transition state analysis, geometry optimizations were performed with M06 functional and the 6-31G** basis set. The iridium atom was represented using the Los Alamos LANL2DZ basis set,\textsuperscript{510} which includes relativistic effective core potentials. For those structures having various conformations, the most stable conformer was searched and utilized. Vibrational frequency calculations were carried out at the same level of theory as the geometry optimizations. The single-point calculations of the optimized geometries were performed with M06 functional and triple-zeta quality of basis set including Stuttgart/Dresden basis set (SDD) for iridium and 6-311+G** basis set for other atoms. We obtained solvation energies using the optimized gas phase structures with SMD model.\textsuperscript{511} Solvation calculations were carried out with the same level of single-point calculations employing the dielectric constants of $\varepsilon = 10.125$ for dichloroethane. Graphical structures are visualized with CYLview.\textsuperscript{512}

To interrogate stereoelectronic properties of acid additives for multivariate analysis, geometries of carboxylic acids were fully optimized with M06-2X functional\textsuperscript{513} and a triple zeta potential basis set (jun-cc-pVTZ),\textsuperscript{514} which was chosen based on the evaluation of the M06-2X functional for organic molecules with triple zeta quality basis sets resulting in quantitative correlations.\textsuperscript{515} Natural bond orbital (NBO) charge was calculated from the same level of theory utilizing version 3.0 embedded in Gaussian09.\textsuperscript{516} Sterimol values were collected using Molecular Modeling Pro\textsuperscript{®}.\textsuperscript{517} Interrogated parameters are listed in Table S5 and Table S6.

\begin{table}[h]
\centering
\begin{tabular}{|c|c|c|c|c|c|c|c|c|}
\hline
entry & R & NBO Charge & & & & IR Frequency & Sterimol Values & \\
& & NBO\textsubscript{O} & NBO\textsubscript{OH} & NBO\textsubscript{C} & NBO\textsubscript{OAvg} & $\nu$\textsubscript{C=O} & I\textsubscript{C=O} & L & B\textsubscript{1} & B\textsubscript{2} \\
\hline
1 & 'Bu & -0.61 & -0.72 & 0.83 & -0.66 & 1859.18 & 330.32 & 4.27 & 2.93 & 3.34 \\
2 & 'Pr & -0.61 & -0.71 & 0.82 & -0.66 & 1862.15 & 318.39 & 4.31 & 2.07 & 3.35 \\
3 & Et & -0.61 & -0.71 & 0.82 & -0.66 & 1867.49 & 317.65 & 4.34 & 1.74 & 3.32 \\
4 & Me & -0.60 & -0.71 & 0.81 & -0.65 & 1874.00 & 369.93 & 3.03 & 1.70 & 2.20 \\
5 & CH\textsubscript{2}Ph & -0.60 & -0.71 & 0.83 & -0.65 & 1864.76 & 348.53 & 4.34 & 1.70 & 6.10 \\
6 & CH(Ph)\textsubscript{2} & -0.61 & -0.70 & 0.85 & -0.65 & 1861.20 & 237.87 & 5.71 & 2.16 & 6.02 \\
7 & C(Ph)\textsubscript{3} & -0.60 & -0.70 & 0.86 & -0.65 & 1848.38 & 299.13 & 5.42 & 4.26 & 6.19 \\
\hline
\end{tabular}
\caption{Physical organic parameters for carboxylic acids}
\end{table}
Table S6. Sterimol values for substituents on directing groups

| R               | L      | B₁     | B₅     |
|-----------------|--------|--------|--------|
| Me              | 3.031  | 1.700  | 2.197  |
| Et              | 4.339  | 1.744  | 3.315  |
| Pr              | 5.211  | 1.746  | 3.532  |
| iPr             | 4.305  | 2.068  | 3.348  |
| Cy              | 6.363  | 2.071  | 3.690  |
| tBu             | 4.275  | 2.928  | 3.344  |
VIII. Statistical Modeling

Using MATLAB student version R2014a, a script used to develop multivariate linear regression models was edited from a literature procedure. Parameters used in the model were normalized using the formula: $X_{\text{norm}} = (X - \mu)/\sigma$, where $X_{\text{norm}}$ is the normalized parameter, $X$ is the parameter, $\mu$ is the mean, and $\sigma$ is the standard deviation. Unless otherwise noted, parameters in this section are normalized ones.

According to Curtin-Hammett principle, the relative rate of formation of competing products (X and Y) is logarithmically related to the difference in transition state energies, represented by the measured $\Delta\Delta G^\ddagger$ (eq S1), where $R$ is the gas constant and $T$ is temperature. To derive measured $\Delta\Delta G^\ddagger$ values, product ratios resulting from differences in selectivity were obtained experimentally. Using stepwise linear regression in Matlab®, a mathematical model was developed relating the identified steric and electronic parameters, represented by A, B, and C, to the predicted $\Delta\Delta G^\ddagger$ (eq S2). Thus, the predicted $\Delta\Delta G^\ddagger$ values can be compared with the measured $\Delta\Delta G^\ddagger$ values obtained from experimental results. This correlation is possible in cases where all of the compared product ratios are the result of a similar mechanism of product determination. A good correlation between the two indicates that the structural parameters included in the equation may adequately approximate the effects leading to the measured $\Delta\Delta G^\ddagger$.

$$\Delta\Delta G^\ddagger_{\text{predicted}} = \alpha A + \beta B + \gamma C \quad (S2)$$

1. Univariate Regression Models of the C–H Amidation Reaction with N-Acylindole

Table S7. Measured $\Delta\Delta G^\ddagger$ and Sterimol $B_1^{DG}$ values for directing group variations

| DG | C7.C2  | $\Delta\Delta G^\ddagger$ | $B_1^{DG}$ |
|----|--------|--------------------------|------------|
| Me | 1.36   | 0.190                    | 1.700      |
| Et | 1.89   | 0.397                    | 1.744      |
| Pr | 2.57   | 0.588                    | 2.068      |
| Cy | 2.43   | 0.552                    | 2.071      |
| np | 1.93   | 0.410                    | 1.746      |

$^{a}$ $\Delta\Delta G^\ddagger$ is reported in kcal/mol. $^{b}$ Calculated by $\Delta\Delta G^\ddagger = -RT \ln([C2]/[C7])$ at 40 °C. $^{c}$ Parameter is not normalized, since only a single variable was used.
Figure S11. Univariate Regression Model with Directing Group $B_{1}^{DG}$ values

2. Univariate Regression Models of the C–H Amidation Reaction with $N$-Acetylimidole

Table S8. Measured $\Delta\Delta G^\dagger$ and Sterimol $B_5$ values for carboxylate variations (data for Figure 2, left).\textsuperscript{a}

| R         | 3:4 | $\Delta\Delta G^\dagger$ measured$^b$ | $B_5^c$ |
|-----------|-----|---------------------------------------|---------|
| $^i$Bu    | 2.5:1 | 0.558                                 | 3.344   |
| $^i$Pr    | 1.6:1 | 0.304                                 | 3.348   |
| Et        | 1.5:1 | 0.258                                 | 3.315   |
| Me        | 1.4:1 | 0.190                                 | 2.197   |
| CH$_2$Ph  | 1:1.1 | -0.066                                | 6.099   |
| CH(Ph)$_2$| 1:1.4 | -0.213                                | 6.020   |
| C(Ph)$_3$ | 1:1.4 | -0.215                                | 6.189   |
| MeO       | 1:1.0 | -0.021                                | 8.243   |
| MeO       | 1:1.1 | -0.063                                | 7.486   |
| Cl        | 1:1.2 | -0.101                                | 8.324   |
| O$_2$N     | 1:1.4 | -0.196                                | 7.674   |
| CH$_2$Cl  | 1:2.6 | -0.584                                | 3.363   |
| CH$_2$F   | 1:2.8 | -0.640                                | 2.747   |
| CHCl$_2$  | 1:13.3 | -1.611                              | 3.437   |
| CHF$_3$   | 1:12.3 | -1.559                              | 2.742   |
| CF$_3$    | 1:61.9 | -2.568                              | 2.720   |
| C$_2$F$_5$ | 1:73.1 | -2.671                              | 3.816   |
| (4-CF$_3$)C$_6$H$_4$ | 1:1.8 | -0.355                              | 3.231   |
| (4-NO$_2$)C$_6$H$_4$ | 1:1.8 | -0.375                              | 3.227   |
| (4-F)C$_6$H$_4$ | 1:2.2 | -0.489                              | 3.226   |
| (4-Cl)C$_6$H$_4$ | 1:2.3 | -0.508                              | 3.230   |
| Ph        | 1:2.7 | -0.629                              | 3.235   |
Table S9. Measured, predicted, and leave-one-out (LOO) predicted $\Delta \Delta G^\ddagger$ versus $NBO_{\text{Avg}}$ for carboxylate variations (data for Figure 2, right).\(^a\)

$\Delta \Delta G^\ddagger = -48.3 - 34.57 \text{ NBO}_{\text{Avg}}$

| R | $\Delta \Delta G^\ddagger$ measured\(^b\) | $\text{NBO}_{\text{Avg}}$\(^c\) | $\Delta \Delta G^\ddagger$ predicted\(^c\) | $\Delta \Delta G^\ddagger$ LOO predicted |
|---|---|---|---|---|
| tBu | 2.5:1 | 0.558 | -0.661 | 0.301 | 0.274 |
| iPr | 1.6:1 | 0.304 | -0.660 | 0.228 | 0.221 |
| Et | 1.5:1 | 0.258 | -0.657 | 0.107 | 0.095 |
| Me | 1.4:1 | 0.190 | -0.655 | -0.013 | 0.027 |
| CH$_2$Ph | 1:1.1 | -0.066 | -0.655 | -0.013 | -0.010 |
| CH(Ph)$_2$ | 1:1.4 | -0.213 | -0.652 | -0.158 | -0.155 |
| C(Ph)$_3$ | 1:1.4 | -0.215 | -0.652 | -0.158 | -0.155 |
| OMe | 1:1:1 | -0.063 | -0.655 | 0.011 | 0.013 |
| Cl | 1:1.2 | -0.101 | -0.652 | -0.134 | -0.136 |
| O$_2$N | 1:1.4 | -0.196 | -0.648 | -0.327 | -0.334 |
| CH$_2$Cl | 1:2.6 | -0.584 | -0.637 | -0.883 | -0.899 |
| CH$_2$F | 1:2.8 | -0.640 | -0.638 | -0.835 | -0.845 |
| CHCl$_2$ | 1:13.3 | -1.611 | -0.624 | -1.487 | -1.472 |
| CHF$_2$ | 1:12.3 | -1.559 | -0.620 | -1.680 | -1.698 |
| CF$_3$ | 1:61.9 | -2.568 | -0.606 | -2.380 | -2.308 |
| C$_2$F$_5$ | 1:73.1 | -2.671 | -0.607 | -2.332 | -2.208 |
| (4-CF$_3$)C$_6$H$_4$ | 1:1.8 | -0.355 | -0.647 | -0.376 | -0.377 |
| (4-NO$_2$)C$_6$H$_4$ | 1:1.8 | -0.375 | -0.643 | -0.569 | -0.578 |
| (4-F)C$_6$H$_4$ | 1:2.2 | -0.489 | -0.654 | -0.062 | -0.034 |
| (4-Cl)C$_6$H$_4$ | 1:2.3 | -0.508 | -0.651 | -0.182 | -0.164 |
| Ph | 1:2.7 | -0.629 | -0.653 | -0.086 | -0.052 |
| (4-Br)C$_6$F$_4$ | 1:6.0 | -1.120 | -0.621 | -1.656 | -1.735 |

\(^a\) $\Delta \Delta G^\ddagger$ is reported in kcal/mol. \(^b\) Calculated by $\Delta \Delta G^\ddagger = -RT \ln(4/3)$ at 40 °C. \(^c\) Parameter is not normalized, since only a single variable was used.
### Table S10

Measured, predicted, and leave-one-out (LOO) predicted ΔΔ\(G^\ddagger\) versus NBO=O for carboxylate variations.\(^a\)

\[
\Delta \Delta G^\ddagger = -21.50 - 35.59 \text{ NBO=O}
\]

| R       | 3:4 measured\(^b\) | NBO=O\(^c\) | ΔΔ\(G^\ddagger\) predicted\(^d\) | ΔΔ\(G^\ddagger\) LOO predicted |
|---------|-------------------|-------------|-------------------------------|-------------------------------|
| tBu     | 2.5:1             | -0.558     | 0.507                         | 0.105                         |
| iPr     | 1.6:1             | -0.610     | 0.212                         | 0.092                         |
| Et      | 1.5:1             | -0.607     | 0.105                         | 0.092                         |
| Me      | 1.4:1             | -0.600     | -0.144                        | -0.164                        |
| \(CH_2\)Ph | 1:1.1          | -0.603     | -0.037                        | -0.035                        |
| \(CH(Ph)\)_2 | 1:1.4       | -0.606     | 0.070                         | 0.092                         |
| \(C(Ph)\)_3 | 1:1.4      | -0.600     | -0.144                        | -0.140                        |
| Cl\(_2\)N | 1:1.0            | -0.601     | -0.108                        | -0.114                        |
| Me\(_2\)O | 1:1.1           | -0.605     | 0.034                         | 0.041                         |
| \(Cl\)       | 1:1.2            | -0.602     | -0.073                        | -0.071                        |
| \(O_2N\)N | 1:1.4            | -0.596     | -0.286                        | -0.291                        |
| \(CH_2\)Cl | 1:2.6            | -0.569     | -0.358                        | -0.358                        |
| \(CH_2\)F | 1:2.8            | -0.568     | -0.571                        | -0.580                        |
| \(CHCl\)2 | 1:13.3           | -0.568     | -0.037                        | -0.006                        |
| \(CHF\)2 | 1:12.3           | -0.566     | -0.144                        | -0.122                        |
| \(CF_3\) | 1:61.9           | -0.539     | -0.073                        | -0.037                        |
| \(C_2\)F\(_5\) | 1:73.1     | -0.543     | -1.568                        | -1.631                        |
| \((4-CF_3)\)C\(_6\)H\(_4\) | 1:1.8 | -0.594 | -1.247 | -1.306 |
| \((4-NO_2)\)C\(_6\)H\(_4\) | 1:1.8 | -0.588 | -1.283 | -1.343 |
| \((4-F)\)C\(_6\)H\(_4\) | 1:2.2 | -0.603 | -1.283 | -1.252 |
| \((4-Cl)\)C\(_6\)H\(_4\) | 1:2.3 | -0.600 | -1.354 | -1.333 |
| Ph      | 1:2.7            | -0.602     | -2.315                        | -2.215                        |
| \((4-Br)\)C\(_6\)F\(_4\) | 1:6.0 | -0.560 | -2.173 | -2.009 |

\(^a\)ΔΔ\(G^\ddagger\) is reported in kcal/mol. \(^b\)Calculated by ΔΔ\(G^\ddagger\) = -RT ln(4/3) at 40 °C. \(^c\)Parameter is not normalized, since only a single variable was used.
Figure S12. Univariate regression models with NBO_{O} (a) and NBO_{AVG} (b)

As discussed in the main text, utilization of NBO charges of carbonyl oxygen (NBO_{O}) also gave correlative model (in the case of acetic acid derivatives), as shown in Figure S12a. However, R^2 value (0.89) is slightly lower than that with averaged NBO charges in Figure S12b (R^2 = 0.97). This lowered accuracy is attributed to overestimated carbonyl charges in the case of fluoroacetic acid and chloroacetic acid, as highlighted in Figure S13. This is because the most stable conformer was only considered to measure the charges: it may cause inaccurate results if substituent contains highly inductive group, such as halogen atoms. Indeed, as shown in Figure S13a and Figure S13b, NBO_{O} values were highly dependent on the choice of conformer. For example, NBO_{O} value was -0.568 when fluoro substituent is proximal to carbonyl oxygen, but the value significantly decreased to -0.600 when another conformer was considered.

Figure S13. Calculated NBO charges of fluoroacetic acid (a, b) and chloroacetic acid conformers (c, d).
Interestingly, however, average charge values of two carboxylic oxygens were almost unchanged regardless of conformations, and more negative value was obtained (−0.64) with fluoroacetic acid. The same tendency was also observed with chloroacetic acid, as shown in Figure S13c and Figure S13d. The series of analysis enabled us to rationalize the effectiveness of $NBO_{Avg}$ in describing carboxylate additives.

3. Multivariate Regression Models of C–H Amidation Reactions

\[
\begin{align*}
\text{NMe}_2 + \text{CO}_2 & \rightarrow \text{MeCN} + \text{O}_2 \\
\text{R}^1 \text{O} & \rightarrow \text{R}^1 \text{N} \equiv \text{C} \equiv \text{R}^2 \\
\text{R}^2 \text{SF}_4 & \rightarrow \text{R}^2 \text{N} \equiv \text{C} \equiv \text{R}^2
\end{align*}
\]

(a) Training Set

| R² | R¹ | Me | Et | iPr | tBu |
|----|----|----|----|-----|-----|
| Me | 1:4:1 | 1:2:8 | 1:1:2.3 | 1:6:1.9 | 1:2:1 |
| Et | 1:9:1 | 1:2:0 | 1:8:1 | 1:2:2.6 |
| iPr | 2:6:1 | 1:1:5 | 1:7:0 | 1:1:4.1 |
| tBu | 17:4:1 | 2:7:1 | 1:3:1 |

(b) Validation Set

| R² | R¹ | Me | Et | iPr | tBu |
|----|----|----|----|-----|-----|
| Me | 2:0:1 | 1:5:1 | 1:6:1 | 2:5:1 | 1:1:1 |
| Et | 1:25:2 | 3:2:1 | 4:1:1 |
| iPr | 1:15:6 | |

Figure S14. Full list of training and validation sets used for statistical modeling. *C7:C2 ratio.
Table S11. Measured and predicted ΔΔ\textit{G}‡ for the training set (data for Figure 3).\textsuperscript{a}

\[ \Delta \Delta \text{G}^\ddagger = -0.333 - 0.975 \text{NBO}_{\text{Oavg}} + 0.735 \text{BG}^\ddagger \]

| R          | DG | C7:2 | \(\Delta \Delta \text{G}^\ddagger\) measured\textsuperscript{b} | \(\Delta \Delta \text{G}^\ddagger\) predicted |
|------------|----|------|-------------------------------------------------|------------------------------------------|
| CH\(_3\)   | Me | 1.4:1 | 0.190                                           | 0.146                                    |
| CH\(_2\)F | Me | 1.2:8 | -0.640                                          | -0.699                                   |
| CHF\(_2\) | Me | 1:12.3 | -1.559                                          | -1.569                                   |
| CF\(_3\)  | Me | 1.61:9 | -2.568                                          | -2.290                                   |
| CH\(_3\)  | Et | 1.9:1 | 0.397                                           | 0.229                                    |
| CH\(_2\)F | Et | 1:2.0 | -0.426                                          | -0.616                                   |
| CHF\(_2\) | Et | 1:8:1 | -1.298                                          | -1.486                                   |
| CF\(_3\)  | Et | 1:22.6 | -1.940                                          | -2.207                                   |
| CH\(_3\)  | \(\text{Pr}\) | 2:6:1 | 0.588                                           | 0.835                                    |
| CH\(_2\)F | \(\text{Pr}\) | 1:1.5 | -0.266                                          | -0.010                                   |
| CHF\(_2\) | \(\text{Pr}\) | 1:7:0 | -1.211                                          | -0.880                                   |
| CF\(_3\)  | \(\text{Pr}\) | 1:14:1 | -1.647                                          | -1.601                                   |
| CH\(_3\)  | \(\text{Bu}\) | 17.4:1 | 1.778                                           | 1.602                                    |
| CHF\(_2\) | \(\text{Bu}\) | 2.7:1 | 0.612                                           | 0.732                                    |
| CF\(_3\)  | \(\text{Bu}\) | 1.3:1 | 0.157                                           | 0.012                                    |
| C\(_2\)F\(_5\) | \(\text{Bu}\) | 1:2:1 | 0.095                                           | 0.061                                    |

\textsuperscript{a}ΔΔ\textit{G}‡ is reported in kcal/mol. \textsuperscript{b}Calculated by \(\Delta \Delta \text{G}^\ddagger = -RT \ln([\text{C2}]/[\text{C7}])\) at 40 °C.

RMS error 0.207  
R\(^2\) 0.972  
Adjusted R\(^2\) 0.967  
F-stat 223

Table S12. Measured and predicted ΔΔ\textit{G}‡ for the validation set (data for Figure 3).\textsuperscript{a}

| R          | DG | C7:2 | \(\Delta \Delta \text{G}^\ddagger\) measured\textsuperscript{b} | \(\Delta \Delta \text{G}^\ddagger\) predicted |
|------------|----|------|-------------------------------------------------|------------------------------------------|
| Et         | Me | 1.5:1 | 0.258                                           | 0.270                                    |
| \(\text{Pr}\) | Me | 1.6:1 | 0.304                                           | 0.395                                    |
| \(\text{Bu}\) | Me | 2.5:1 | 0.558                                           | 0.469                                    |
| CH\(_3\)Ph | Me | 1:1:1 | -0.066                                          | 0.146                                    |
| C\(_2\)F\(_5\) | Me | 1:73:1 | -2.671                                          | -2.240                                   |
| CH(Ph)\(_2\) | Me | 1:1:4 | -0.213                                          | -0.003                                   |
| C(Ph)\(_3\) | Me | 1:1:4 | -0.215                                          | -0.003                                   |
| \(\text{Me}\) 2Cl | Me | 1:1:2 | -0.101                                          | 0.022                                    |
| \(\text{Me}\)O | Me | 1:1:1 | -0.063                                          | 0.171                                    |
$$\Delta \Delta G^\circ$$ is reported in kcal/mol. $^b$Calculated by $\Delta \Delta G^\circ = -RT \ln([\text{C2}]/[\text{C7}])$ at 40 °C.

|                  | Me     | Me     | CH$_2$Cl | Me     | 1.2.6 | -0.584 | -0.749 |
|------------------|--------|--------|----------|--------|-------|--------|--------|
|                  | CHCl$_2$ | Me     | 1:13.3   | -1.611 | -1.370 |
|                  | C$_2$F$_5$ | Et     | 1:25.2   | -2.008 | -2.157 |
| $^i$Bu           | Et     | 3:2:1  | 0.730    | 0.552  |
| $^t$Bu           | $^t$Pr | 4:1:1  | 0.878    | 1.158  |
| C$_2$F$_5$       | $^t$Pr | 1:15.6 | -1.710   | -1.551 |
| CHCl$_2$         | $^t$Pr | 1:5.8  | -1.099   | -0.681 |
| CHCl$_2$         | Et     | 1:7.6  | -1.258   | -1.287 |
| CHCl$_2$         | $^t$Bu | 2:7:1  | 0.608    | 0.931  |
| (4-CF$_3$)C$_6$H$_4$ | Me     | 1:1.8  | -0.355   | -0.227 |
| (4-NO$_2$)C$_6$H$_4$ | Me     | 1:1.8  | -0.375   | -0.426 |
| (4-F)C$_6$H$_4$   | Me     | 1:2.2  | -0.489   | 0.096  |
| (4-Cl)C$_6$H$_4$  | Me     | 1:2.3  | -0.508   | -0.028 |
| Ph               | Me     | 1:2.7  | -0.629   | 0.072  |
| (4-Br)C$_6$F$_4$  | Me     | 1:6.0  | -1.120   | -1.544 |
| CH$_3$           | Cy     | 2.4:1  | 0.552    | 0.841  |
| CH$_3$           | Pr     | 2.0:1  | 0.410    | 0.232  |
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Appendix I

Spectral Copies of $^1\text{H}$, $^{13}\text{C}$ and $^{19}\text{F}$ NMR of Compounds Obtained in this Study
1-Acetyl-4-fluoroindole

![Chemical Structure]

S48
Silver (2,2,2-triphenyl)acetate
Silver 2-(3,4-dimethoxyphenyl)acetate

\[
\text{MeO} - \text{C} = \text{O} \quad \text{MeO}
\]

- 175.60
- 148.37
- 137.73
- 121.22
- 113.32
- 111.72
- 55.46
- 43.56

S51
Silver 2-(4-methoxyphenyl)acetate
Silver 2-(4-chlorophenyl)acetate
Silver 2-(4-nitrophenyl)acetate
Silver 2,2-dichloroacetate
Silver fluoroacetate
Silver 2,2-fluoroacetate
Silver 4-bromo-2,3,5,6-tetrafluorobenzoate
$N$-(1-Propionyl-1$H$-indol-2-yl)-4-methylbenzenesulfonamide (Scheme 2 and Figure 3)
N-(1-Isobutyryl-1H-indol-2-yl)-4-methylbenzenesulfonamide (Scheme 2 and Figure 3)
N-(1-Butyryl-1H-indol-7-yl)-4-methylbenzenesulfonamide (Figure 3)
N-(1-Butyryl-1H-indol-2-yl)-4-methylbenzenesulfonamide (Figure 3)
N-(1-Cyclohexanecarbonyl-1H-indol-2-yl)-4-methylbenzenesulfonamide (Figure 3)
$N$-(1-Pivaloylindolin-2-ylidene)-4-methylbenzenesulfonamide (Figure 3)
Iridacycle (Scheme 3, 5)
Ir-Amido Complex (Scheme 3, 6)
$N$-(1-Acetyl-$1H$-indol-2-yl)-4-methylbenzenesulfonamide (Scheme 2–4 and Figure 2–3, 4)
N-(1-Acetyl-5-methyl-1H-indol-2-yl)-4-methylbenzenesulfonamide (Scheme 4, 7)
N-(1-Acetyl-5-methoxy-1H-indol-2-yl)-4-methylbenzenesulfonamide (Scheme 4, 8)
N-(1-Acetyl-5-fluoro-1H-indol-2-yl)-4-methylbenzenesulfonamide (Scheme 4, 9)

\[ \text{Scheme 4, 9} \]
N-(1-Acetyl-5-chloro-1H-indol-2-yl)-4-methylbenzenesulfonamide (Scheme 4, 10)
N-(1-Acetyl-5-bromo-1H-indol-2-yl)-4-methylbenzenesulfonamide (Scheme 4, 11)
N-(1-Acetyl-4-methyl-1H-indol-2-yl)-4-methylbenzenesulfonamide (Scheme 4, 12)
N-(1-Acetyl-4-fluoro-1H-indol-2-yl)-4-methylbenzenesulfonamide (Scheme 4, 13)
**N-(1-Acetyl-4-chloro-1H-indol-2-yl)-4-methylbenzenesulfonamide (Scheme 4, 14)**

![Chemical Structure](image)

**1H-NMR Spectra**

- Chemical Shifts (ppm):
  - 8.12
  - 8.11
  - 7.68
  - 7.45
  - 7.31
  - 7.30
  - 6.87
  - 2.76
  - 2.41

- peak assignments (ppm):
  - 0.85
  - 1.04
  - 2.02
  - 3.12
  - 3.03
  - 4.06
  - 6.06
  - 7.06
  - 8.06
  - 9.06

- Resonance frequencies:
  - 170.69
  - 145.04
  - 135.59
  - 129.39
  - 125.80
  - 124.10
  - 122.95
  - 124.52
  - 101.92
  - 25.98
  - 21.05
N-(1-Acetyl-4-bromo-1H-indol-2-yl)-4-methylbenzenesulfonamide (Scheme 4, 15)
N-(1-Acetyl-6-methyl-1H-indol-2-yl)-4-methylbenzenesulfonamide (Scheme 4, 16)
N-(1-Acetyl-6-fluoro-1H-indol-2-yl)-4-methylbenzenesulfonamide (Scheme 4, 17)
N-(1-Acetyl-3-methyl-1H-indol-2-yl)-4-methylbenzenesulfonamide (Scheme 4, 18)
Methyl 3-(1-acetyl-2-((4-methylphenyl)sulfonamido)-1H-indol-3-yl)-2-((tert-butoxycarbonyl)amino)propanoate (Scheme 4, 19)
N-(1-Acetyl-1H-indol-2-yl)-benzenesulfonamide (Scheme 4, 20)
\[ N-(1-\text{Acetyl}-1H-\text{indol-2-yl})-4-\text{methoxybenzenesulfonamide} \] (Scheme 4, 21)
$N$-(1-Acetyl-$1H$-indol-2-yl)-4-chlorobenzenesulfonamide (Scheme 4, 22)
N-(1-Acetyl-1H-indol-2-yl)-4-bromobenzenesulfonamide (Scheme 4, 23)
N-(1-Acetyl-1H-indol-2-yl)-4-(trifluoromethyl)benzenesulfonamide (Scheme 4, 24)
N-(1-Acetyl-1H-indol-2-yl)naphthalene-1-sulfonamide (Scheme 4, 25)
N-(1-Acetyl-1H-indol-2-yl)methanesulfonamide (Scheme 4, 26)
N-(1-Acetyl-1H-indol-2-yl)butane-1-sulfonamide (Scheme 4, 27)
$N$-(1-Acetyl-$1H$-indol-2-yl)-1-phenylmethanesulfonamide (Scheme 4, 28)
Methyl (E)-3-(1-acetyl-1H-indol-2-yl)acrylate (Scheme 5, 29)
Ethyl (E)-3-(1-acetyl-1H-indol-2-yl)acrylate (Scheme 5, 30)
Benzyl (E)-3-(1-acetyl-1H-indol-2-yl)acrylate (Scheme 5, 31)
Appendix II

Crystallographic Data for 5, 6 and 18
Crystallographic data of 5 (Scheme 3)
Table S13. Crystal data and structure refinement for 5.

| Property                          | Value                                      |
|-----------------------------------|--------------------------------------------|
| Identification code               | No1sqd                                     |
| Empirical formula                 | C_{22}H_{23}F_{3}IrN_{3}O_{3}              |
| Formula weight                    | 598.61                                     |
| Temperature                       | 223(2) K                                   |
| Wavelength                        | 0.71073 Å                                  |
| Crystal system                    | Triclinic                                  |
| Space group                       | P-1                                        |
| Unit cell dimensions              | a = 9.2770(3) Å                            |
|                                  | b = 9.4109(4) Å                            |
|                                  | c = 15.3550(7) Å                           |
| Volume                            | 1197.89(8) Å                               |
| Z                                 | 2                                          |
| Density (calculated)              | 1.660 Mg/m³                                |
| Absorption coefficient            | 5.616 mm⁻¹                                 |
| F(000)                            | 580                                        |
| Crystal size                      | 0.21 x 0.18 x 0.12 mm³                     |
| Theta range for data collection   | 2.36 to 28.38°                             |
| Index ranges                      | -12<=h<=12, -12<=k<=12, -20<=l<=20          |
| Reflections collected             | 35085                                      |
| Independent reflections           | 5981 [R(int) = 0.0736]                     |
| Completeness to theta = 28.38°    | 99.6 %                                     |
| Absorption correction             | Semi-empirical from equivalents            |
| Max. and min. transmission        | 0.5522 and 0.3851                          |
| Refinement method                 | Full-matrix least-squares on F²            |
| Data / restraints / parameters    | 5981 / 0 / 277                             |
| Goodness-of-fit on F²             | 1.013                                      |
| Final R indices [I>2sigma(I)]     | R1 = 0.0264, wR2 = 0.0533                   |
| R indices (all data)              | R1 = 0.0352, wR2 = 0.0554                   |
| Largest diff. peak and hole       | 1.221 and -0.795 e.Å⁻³                     |
Table S14. Atomic coordinates (x 10^4) and equivalent isotropic displacement parameters (Å^2 x 10^3) for 5. U(eq) is defined as one third of the trace of the orthogonalized U[ij] tensor.

|     | x         | y         | z         | U(eq) |
|-----|-----------|-----------|-----------|-------|
| Ir(1)| 9607(1)   | 7147(1)   | 3229(1)   | 28(1) |
| C(1)| 8681(3)   | 6459(4)   | 1823(2)   | 29(1) |
| C(2)| 8770(4)   | 5566(4)   | 1046(2)   | 36(1) |
| C(3)| 7718(4)   | 5654(4)   | 219(2)    | 38(1) |
| C(4)| 7334(4)   | 4943(5)   | -734(2)   | 49(1) |
| C(5)| 6225(5)   | 5277(5)   | -1354(3)  | 57(1) |
| C(6)| 5489(5)   | 6278(5)   | -1049(3)  | 56(1) |
| C(7)| 5835(4)   | 6993(5)   | -109(3)   | 47(1) |
| C(8)| 6963(4)   | 6672(4)   | 518(2)    | 34(1) |
| N(1)| 7565(3)   | 7190(3)   | 1506(2)   | 29(1) |
| C(9)| 7254(3)   | 8134(4)   | 2159(2)   | 31(1) |
| C(10)| 6132(4)  | 8955(5)   | 1929(3)   | 46(1) |
| O(1)| 7950(2)   | 8324(2)   | 3800(3)   | 39(1) |
| C(11)| 11061(4)| 5958(4)   | 3800(3)   | 39(1) |
| C(12)| 11230(4)| 7237(4)   | 4573(2)   | 35(1) |
| C(13)| 9738(4)  | 7080(4)   | 4683(2)   | 33(1) |
| C(14)| 8591(4)  | 5691(4)   | 3979(2)   | 38(1) |
| C(15)| 9417(4)  | 4962(4)   | 3473(2)   | 41(1) |
| C(16)| 12365(5)| 5587(6)   | 3496(3)   | 63(1) |
| C(17)| 12739(4)| 8528(5)   | 5114(3)   | 52(1) |
| C(18)| 9334(5)  | 8150(5)   | 5374(3)   | 47(1) |
| C(19)| 6878(4)  | 5110(5)   | 3899(3)   | 59(1) |
| C(20)| 8718(6)  | 3425(4)   | 2743(3)   | 65(1) |
| O(2)| 10981(2) | 9208(2)   | 3053(2)   | 32(1) |
| C(21)| 12247(4)| 9393(4)   | 2856(3)   | 39(1) |
| O(3)| 12909(4) | 8497(4)   | 2664(3)   | 81(1) |
| C(22)| 13056(4)| 11086(4)  | 2896(3)   | 47(1) |
| F(1)| 13768(3) | 11962(3)  | 3795(2)   | 79(1) |
| F(2)| 12071(3) | 11746(3)  | 2545(2)   | 71(1) |
| F(3)| 14171(3) | 11266(3)  | 2490(2)   | 81(1) |
Table S15. Bond lengths [Å] and angles [°] for 5.

| Bond                  | Length [Å] |
|-----------------------|------------|
| Ir(1)-C(1)            | 2.017(3)   |
| Ir(1)-O(2)            | 2.108(2)   |
| Ir(1)-C(14)           | 2.124(3)   |
| Ir(1)-C(15)           | 2.131(3)   |
| Ir(1)-C(11)           | 2.132(3)   |
| Ir(1)-O(1)            | 2.140(2)   |
| Ir(1)-C(13)           | 2.223(3)   |
| Ir(1)-C(12)           | 2.224(3)   |
| C(1)-C(2)             | 1.347(4)   |
| C(1)-N(1)             | 1.444(4)   |
| C(2)-C(3)             | 1.443(5)   |
| C(2)-H(2)             | 0.9400     |
| C(3)-C(4)             | 1.394(5)   |
| C(3)-C(8)             | 1.403(5)   |
| C(4)-C(5)             | 1.383(6)   |
| C(4)-H(4)             | 0.9400     |
| C(5)-C(6)             | 1.380(6)   |
| C(5)-H(5)             | 0.9400     |
| C(6)-C(7)             | 1.382(5)   |
| C(6)-H(6)             | 0.9400     |
| C(7)-C(8)             | 1.393(5)   |
| C(7)-H(7)             | 0.9400     |
| C(8)-N(1)             | 1.415(4)   |
| N(1)-C(9)             | 1.341(4)   |
| C(9)-O(1)             | 1.255(4)   |
| C(9)-C(10)            | 1.482(4)   |
| C(10)-H(10A)          | 0.9700     |
| C(10)-H(10B)          | 0.9700     |
| C(10)-H(10C)          | 0.9700     |
| C(11)-C(15)           | 1.451(5)   |
| C(11)-C(12)           | 1.451(5)   |
| C(11)-C(16)           | 1.496(5)   |
| C(12)-C(13)           | 1.404(5)   |
| C(12)-C(17)           | 1.489(5)   |
C(13)-C(14)  1.455(4)
C(13)-C(18)  1.497(5)
C(14)-C(15)  1.421(5)
C(14)-C(19)  1.494(5)
C(15)-C(20)  1.497(5)
C(16)-H(16A)  0.9700
C(16)-H(16B)  0.9700
C(16)-H(16C)  0.9700
C(17)-H(17A)  0.9700
C(17)-H(17B)  0.9700
C(17)-H(17C)  0.9700
C(18)-H(18A)  0.9700
C(18)-H(18B)  0.9700
C(18)-H(18C)  0.9700
C(19)-H(19A)  0.9700
C(19)-H(19B)  0.9700
C(19)-H(19C)  0.9700
C(20)-H(20A)  0.9700
C(20)-H(20B)  0.9700
C(20)-H(20C)  0.9700
O(2)-C(21)  1.254(4)
C(21)-O(3)  1.204(4)
C(21)-C(22)  1.539(5)
C(22)-F(3)  1.315(4)
C(22)-F(2)  1.318(4)
C(22)-F(1)  1.352(5)
C(1)-Ir(1)-O(2)  85.47(11)
C(1)-Ir(1)-C(14)  117.59(13)
O(2)-Ir(1)-C(14)  156.16(12)
C(1)-Ir(1)-C(15)  99.67(13)
O(2)-Ir(1)-C(15)  149.35(12)
C(14)-Ir(1)-C(15)  39.01(14)
C(1)-Ir(1)-C(11)  115.88(13)
O(2)-Ir(1)-C(11)  110.96(12)
C(14)-Ir(1)-C(11)  66.11(14)
C(15)-Ir(1)-C(11)  39.80(14)
\begin{align*}
C(1)-Ir(1)-O(1) & \quad 77.40(10) \\
O(2)-Ir(1)-O(1) & \quad 78.10(8) \\
C(14)-Ir(1)-O(1) & \quad 100.01(11) \\
C(15)-Ir(1)-O(1) & \quad 132.56(12) \\
C(11)-Ir(1)-O(1) & \quad 163.77(11) \\
C(1)-Ir(1)-C(13) & \quad 156.16(13) \\
O(2)-Ir(1)-C(13) & \quad 117.39(10) \\
C(14)-Ir(1)-C(13) & \quad 39.02(12) \\
C(15)-Ir(1)-C(13) & \quad 64.59(12) \\
C(11)-Ir(1)-C(13) & \quad 64.34(13) \\
O(1)-Ir(1)-C(13) & \quad 99.68(10) \\
C(1)-Ir(1)-C(12) & \quad 153.93(13) \\
O(2)-Ir(1)-C(12) & \quad 98.03(11) \\
C(14)-Ir(1)-C(12) & \quad 64.28(13) \\
C(15)-Ir(1)-C(12) & \quad 64.75(12) \\
C(11)-Ir(1)-C(12) & \quad 38.86(13) \\
O(1)-Ir(1)-C(12) & \quad 128.65(10) \\
C(13)-Ir(1)-C(12) & \quad 36.80(12) \\
C(2)-C(1)-N(1) & \quad 106.0(3) \\
C(2)-C(1)-Ir(1) & \quad 141.9(3) \\
N(1)-C(1)-Ir(1) & \quad 112.1(2) \\
C(1)-C(2)-C(3) & \quad 110.7(3) \\
C(1)-C(2)-H(2) & \quad 124.6 \\
C(3)-C(2)-H(2) & \quad 124.6 \\
C(4)-C(3)-C(8) & \quad 119.1(3) \\
C(4)-C(3)-C(2) & \quad 133.7(3) \\
C(8)-C(3)-C(2) & \quad 107.2(3) \\
C(5)-C(4)-C(3) & \quad 118.6(4) \\
C(5)-C(4)-H(4) & \quad 120.7 \\
C(3)-C(4)-H(4) & \quad 120.7 \\
C(6)-C(5)-C(4) & \quad 121.6(4) \\
C(6)-C(5)-H(5) & \quad 119.2 \\
C(4)-C(5)-H(5) & \quad 119.2 \\
C(5)-C(6)-C(7) & \quad 121.3(4) \\
C(5)-C(6)-H(6) & \quad 119.4 \\
C(7)-C(6)-H(6) & \quad 119.4
\end{align*}
C(6)-C(7)-C(8) 117.3(4)
C(6)-C(7)-H(7) 121.3
C(8)-C(7)-H(7) 121.3
C(7)-C(8)-C(3) 122.1(3)
C(7)-C(8)-N(1) 131.4(3)
C(3)-C(8)-N(1) 106.4(3)
C(9)-N(1)-C(8) 132.9(3)
C(9)-N(1)-C(1) 117.5(3)
C(8)-N(1)-C(1) 109.6(2)
O(1)-C(9)-N(1) 118.0(3)
O(1)-C(9)-C(10) 119.1(3)
N(1)-C(9)-C(10) 123.0(3)
C(9)-C(10)-H(10A) 109.5
C(9)-C(10)-H(10B) 109.5
H(10A)-C(10)-H(10B) 109.5
C(9)-C(10)-H(10C) 109.5
H(10A)-C(10)-H(10C) 109.5
H(10B)-C(10)-H(10C) 109.5
C(9)-O(1)-Ir(1) 114.98(19)
C(15)-C(11)-C(12) 107.0(3)
C(15)-C(11)-C(16) 125.6(4)
C(12)-C(11)-C(16) 126.7(4)
C(15)-C(11)-Ir(1) 70.07(18)
C(12)-C(11)-Ir(1) 74.00(19)
C(16)-C(11)-Ir(1) 128.4(3)
C(13)-C(12)-C(11) 108.7(3)
C(13)-C(12)-C(17) 126.7(3)
C(11)-C(12)-C(17) 124.6(3)
C(13)-C(12)-Ir(1) 71.56(18)
C(11)-C(12)-Ir(1) 67.14(18)
C(17)-C(12)-Ir(1) 124.8(2)
C(12)-C(13)-C(14) 108.1(3)
C(12)-C(13)-C(18) 127.5(3)
C(14)-C(13)-C(18) 124.3(3)
C(12)-C(13)-Ir(1) 71.64(19)
C(14)-C(13)-Ir(1) 66.81(18)
C(18)-C(13)-Ir(1) 125.6(2)
C(15)-C(14)-C(13) 108.1(3)
C(15)-C(14)-C(19) 127.9(3)
C(13)-C(14)-C(19) 123.7(4)
C(15)-C(14)-Ir(1) 70.8(2)
C(13)-C(14)-Ir(1) 74.17(19)
C(19)-C(14)-Ir(1) 125.5(3)
C(14)-C(15)-C(11) 107.8(3)
C(14)-C(15)-C(20) 126.0(4)
C(11)-C(15)-C(20) 126.1(4)
C(14)-C(15)-Ir(1) 70.22(19)
C(11)-C(15)-Ir(1) 70.13(18)
C(20)-C(15)-Ir(1) 126.0(3)
C(11)-C(16)-H(16A) 109.5
C(11)-C(16)-H(16B) 109.5
H(16A)-C(16)-H(16B) 109.5
C(11)-C(16)-H(16C) 109.5
H(16A)-C(16)-H(16C) 109.5
H(16B)-C(16)-H(16C) 109.5
C(12)-C(17)-H(17A) 109.5
C(12)-C(17)-H(17B) 109.5
H(17A)-C(17)-H(17B) 109.5
C(12)-C(17)-H(17C) 109.5
H(17A)-C(17)-H(17C) 109.5
H(17B)-C(17)-H(17C) 109.5
C(13)-C(18)-H(18A) 109.5
C(13)-C(18)-H(18B) 109.5
H(18A)-C(18)-H(18B) 109.5
C(13)-C(18)-H(18C) 109.5
H(18A)-C(18)-H(18C) 109.5
H(18B)-C(18)-H(18C) 109.5
C(14)-C(19)-H(19A) 109.5
C(14)-C(19)-H(19B) 109.5
H(19A)-C(19)-H(19B) 109.5
C(14)-C(19)-H(19C) 109.5
H(19A)-C(19)-H(19C) 109.5

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H(19B)-C(19)-H(19C) 109.5
C(15)-C(20)-H(20A) 109.5
C(15)-C(20)-H(20B) 109.5
H(20A)-C(20)-H(20B) 109.5
C(15)-C(20)-H(20C) 109.5
H(20A)-C(20)-H(20C) 109.5
H(20B)-C(20)-H(20C) 109.5
C(21)-O(2)-Ir(1) 124.7(2)
O(3)-C(21)-O(2) 131.2(4)
O(3)-C(21)-C(22) 117.3(3)
O(2)-C(21)-C(22) 111.5(3)
F(3)-C(22)-F(2) 108.4(3)
F(3)-C(22)-F(1) 106.0(3)
F(2)-C(22)-F(1) 104.5(3)
F(3)-C(22)-C(21) 113.3(3)
F(2)-C(22)-C(21) 113.9(3)
F(1)-C(22)-C(21) 110.1(3)

Symmetry transformations used to generate equivalent atoms:
Table S16. Anisotropic displacement parameters ($\AA^2 \times 10^3$) for 5. The anisotropic displacement factor exponent takes the form: 

$$-2\pi^2 [h^2 a^* U^{11} + ... + 2hk a^* b^* U^{12}]$$

|      | $U^{11}$ | $U^{22}$ | $U^{33}$ | $U^{23}$ | $U^{13}$ | $U^{12}$ |
|------|----------|----------|----------|----------|----------|----------|
| Ir(1)| 29(1)    | 25(1)    | 25(1)    | 4(1)     | 6(1)     | 7(1)     |
| C(1) | 26(2)    | 29(2)    | 29(2)    | 5(1)     | 7(1)     | 7(1)     |
| C(2) | 35(2)    | 39(2)    | 33(2)    | 3(1)     | 12(1)    | 14(2)    |
| C(3) | 31(2)    | 44(2)    | 30(2)    | 6(2)     | 11(1)    | 3(2)     |
| C(4) | 43(2)    | 63(3)    | 29(2)    | 0(2)     | 15(2)    | 5(2)     |
| C(5) | 47(2)    | 78(3)    | 25(2)    | 6(2)     | 9(2)     | -3(2)    |
| C(6) | 46(2)    | 75(3)    | 33(2)    | 21(2)    | 2(2)     | 5(2)     |
| C(7) | 45(2)    | 58(2)    | 36(2)    | 18(2)    | 7(2)     | 18(2)    |
| C(8) | 31(2)    | 37(2)    | 26(2)    | 7(1)     | 8(1)     | 2(1)     |
| N(1) | 29(1)    | 31(1)    | 25(1)    | 8(1)     | 8(1)     | 9(1)     |
| C(9) | 25(2)    | 31(2)    | 33(2)    | 7(1)     | 9(1)     | 4(1)     |
| C(10)| 45(2)    | 51(2)    | 45(2)    | 13(2)    | 11(2)    | 25(2)    |
| O(1) | 27(1)    | 32(1)    | 30(1)    | 3(1)     | 9(1)     | 10(1)    |
| C(11)| 48(2)    | 44(2)    | 38(2)    | 20(2)    | 16(2)    | 26(2)    |
| C(12)| 37(2)    | 35(2)    | 32(2)    | 12(1)    | 3(1)     | 13(2)    |
| C(13)| 39(2)    | 30(2)    | 28(2)    | 9(1)     | 6(1)     | 11(1)    |
| C(14)| 39(2)    | 33(2)    | 37(2)    | 14(2)    | 6(2)     | 4(2)     |
| C(15)| 58(2)    | 26(2)    | 32(2)    | 10(1)    | 7(2)     | 10(2)    |
| C(16)| 80(3)    | 79(3)    | 67(3)    | 35(3)    | 39(2)    | 59(3)    |
| C(17)| 37(2)    | 51(2)    | 51(2)    | 14(2)    | -3(2)    | 7(2)     |
| C(18)| 63(2)    | 49(2)    | 38(2)    | 13(2)    | 23(2)    | 25(2)    |
| C(19)| 44(2)    | 59(3)    | 58(3)    | 26(2)    | 9(2)     | -6(2)    |
| C(20)| 104(4)   | 30(2)    | 41(2)    | 2(2)     | 2(2)     | 19(2)    |
| O(2) | 31(1)    | 30(1)    | 37(1)    | 10(1)    | 14(1)    | 10(1)    |
| C(21)| 34(2)    | 36(2)    | 51(2)    | 16(2)    | 15(2)    | 15(2)    |
| O(3) | 77(2)    | 58(2)    | 158(4)   | 56(2)    | 81(2)    | 43(2)    |
| C(22)| 41(2)    | 42(2)    | 64(3)    | 19(2)    | 25(2)    | 12(2)    |
| F(1) | 56(2)    | 61(2)    | 86(2)    | 1(2)     | 13(1)    | -8(1)    |
| F(2) | 72(2)    | 52(2)    | 108(2)   | 44(2)    | 33(2)    | 30(1)    |
| F(3) | 78(2)    | 63(2)    | 133(3)   | 44(2)    | 76(2)    | 23(1)    |
Table S17. Hydrogen coordinates (x 10^4) and isotropic displacement parameters (Å^2x 10^3) for 5.

|     | x   | y   | z   | U(eq) |
|-----|-----|-----|-----|-------|
| H(2)| 9428| 4967| 1043| 44    |
| H(4)| 7819| 4252|-951 | 59    |
| H(5)| 5965| 4810|-1999| 69    |
| H(6)| 4739| 6478|-1490| 67    |
| H(7)| 5329| 7669| 100 | 56    |
| H(10A)| 6090| 9581| 2502| 68    |
| H(10B)| 5090| 8205| 1580| 68    |
| H(10C)| 6482| 9615| 1555| 68    |
| H(16A)| 13150| 6533| 3512| 95    |
| H(16B)| 11939| 4895| 2864| 95    |
| H(16C)| 12853| 5090| 3914| 95    |
| H(17A)| 12526| 9481| 5287| 78    |
| H(17B)| 13442| 8640| 4734| 78    |
| H(17C)| 13232| 8305| 5675| 78    |
| H(18A)| 9043| 7649| 5832| 71    |
| H(18B)| 8455| 8405| 5050| 71    |
| H(18C)| 10242| 9089| 5688| 71    |
| H(19A)| 6291| 4370| 3289| 89    |
| H(19B)| 6492| 5970| 3972| 89    |
| H(19C)| 6738| 4612| 4382| 89    |
| H(20A)| 8696| 2609| 3043| 97    |
| H(20B)| 9354| 3384| 2325| 97    |
| H(20C)| 7650| 3285| 2389| 97    |
**Table S18.** Torsion angles [°] for 5.

| Bond                  | Torsion Angle |
|-----------------------|---------------|
| O(2)-Ir(1)-C(1)-C(2) | 101.1(4)      |
| C(14)-Ir(1)-C(1)-C(2)| -85.2(4)      |
| C(15)-Ir(1)-C(1)-C(2)| -48.4(4)      |
| C(11)-Ir(1)-C(1)-C(2)| -10.0(5)      |
| O(1)-Ir(1)-C(1)-C(2) | 179.9(4)      |
| C(13)-Ir(1)-C(1)-C(2)| -94.6(5)      |
| C(12)-Ir(1)-C(1)-C(2)|  2.1(6)       |
| O(2)-Ir(1)-C(1)-N(1) | -75.9(2)      |
| C(14)-Ir(1)-C(1)-N(1)|  97.7(2)      |
| C(15)-Ir(1)-C(1)-N(1)| 134.6(2)      |
| C(11)-Ir(1)-C(1)-N(1)| 173.0(2)      |
| O(1)-Ir(1)-C(1)-N(1) |  2.9(2)       |
| C(13)-Ir(1)-C(1)-N(1)|  88.3(3)      |
| C(12)-Ir(1)-C(1)-N(1)| -174.9(2)     |
| N(1)-C(1)-C(2)-C(3)  |  -1.3(4)      |
| Ir(1)-C(1)-C(2)-C(3) | -178.4(3)     |
| C(1)-C(2)-C(3)-C(4)  | -177.9(4)     |
| C(1)-C(2)-C(3)-C(8)  |   0.6(4)      |
| C(8)-C(3)-C(4)-C(5)  |   0.4(5)      |
| C(2)-C(3)-C(4)-C(5)  | 178.8(4)      |
| C(3)-C(4)-C(5)-C(6)  |  -0.6(6)      |
| C(4)-C(5)-C(6)-C(7)  |   0.1(6)      |
| C(5)-C(6)-C(7)-C(8)  |   0.5(6)      |
| C(6)-C(7)-C(8)-C(3)  |  -0.7(5)      |
| C(6)-C(7)-C(8)-N(1)  | -179.3(3)     |
| C(4)-C(3)-C(8)-C(7)  |   0.2(5)      |
| C(2)-C(3)-C(8)-C(7)  | -178.5(3)     |
| C(4)-C(3)-C(8)-N(1)  | 179.2(3)      |
| C(2)-C(3)-C(8)-N(1)  |   0.4(4)      |
| C(7)-C(8)-N(1)-C(9)  |   0.5(6)      |
| C(3)-C(8)-N(1)-C(9)  | -178.3(3)     |
| C(7)-C(8)-N(1)-C(1)  | 177.6(4)      |
| C(3)-C(8)-N(1)-C(1)  |  -1.2(4)      |
| C(2)-C(1)-N(1)-C(9)  | 179.1(3)      |
| Bond                      | Distance (Å) |
|---------------------------|---------------|
| Ir(1)-C(1)-N(1)-C(9)     | -2.7(3)       |
| C(2)-C(1)-N(1)-C(8)      | 1.6(4)        |
| Ir(1)-C(1)-N(1)-C(8)     | 179.7(2)      |
| C(8)-N(1)-C(9)-O(1)      | 177.0(3)      |
| C(1)-N(1)-C(9)-O(1)      | 0.1(4)        |
| C(8)-N(1)-C(9)-C(10)     | -3.0(6)       |
| C(1)-N(1)-C(9)-C(10)     | -179.9(3)     |
| N(1)-C(9)-O(1)-Ir(1)     | 2.5(4)        |
| C(10)-C(9)-O(1)-Ir(1)    | -177.5(2)     |
| C(1)-Ir(1)-O(1)-C(9)     | -3.1(2)       |
| O(2)-Ir(1)-O(1)-C(9)     | 84.9(2)       |
| C(14)-Ir(1)-O(1)-C(9)    | -119.4(2)     |
| C(15)-Ir(1)-O(1)-C(9)    | -94.7(2)      |
| C(11)-Ir(1)-O(1)-C(9)    | -149.4(4)     |
| C(13)-Ir(1)-O(1)-C(9)    | -159.0(2)     |
| C(12)-Ir(1)-O(1)-C(9)    | 175.7(2)      |
| C(1)-Ir(1)-C(11)-C(15)   | -73.1(2)      |
| O(2)-Ir(1)-C(11)-C(15)   | -168.37(18)   |
| C(14)-Ir(1)-C(11)-C(15)  | 37.3(2)       |
| O(1)-Ir(1)-C(11)-C(15)   | 69.9(5)       |
| C(13)-Ir(1)-C(11)-C(15)  | 80.4(2)       |
| C(12)-Ir(1)-C(11)-C(15)  | 115.3(3)      |
| C(1)-Ir(1)-C(11)-C(12)   | 171.56(19)    |
| O(2)-Ir(1)-C(11)-C(12)   | 76.3(2)       |
| C(14)-Ir(1)-C(11)-C(12)  | -78.1(2)      |
| C(15)-Ir(1)-C(11)-C(12)  | -115.3(3)     |
| O(1)-Ir(1)-C(11)-C(12)   | -45.4(5)      |
| C(13)-Ir(1)-C(11)-C(12)  | -34.95(19)    |
| C(1)-Ir(1)-C(11)-C(16)   | 47.0(4)       |
| O(2)-Ir(1)-C(11)-C(16)   | -48.2(4)      |
| C(14)-Ir(1)-C(11)-C(16)  | 157.4(4)      |
| C(15)-Ir(1)-C(11)-C(16)  | 120.2(5)      |
| O(1)-Ir(1)-C(11)-C(16)   | -169.9(3)     |
| C(13)-Ir(1)-C(11)-C(16)  | -159.5(4)     |
| C(12)-Ir(1)-C(11)-C(16)  | -124.5(5)     |
| C(15)-C(11)-C(12)-C(13)  | -3.0(4)       |
| Bond                        | Angle (°)  |
|-----------------------------|------------|
| C(16)-C(11)-C(12)-C(13)    | -174.0(3)  |
| Ir(1)-C(11)-C(12)-C(13)    | 59.7(2)    |
| C(15)-C(11)-C(12)-C(17)    | 179.8(3)   |
| C(16)-C(11)-C(12)-C(17)    | 8.8(6)     |
| Ir(1)-C(11)-C(12)-C(17)    | -117.5(3)  |
| C(15)-C(11)-C(12)-Ir(1)    | -62.7(2)   |
| C(16)-C(11)-C(12)-Ir(1)    | 126.4(4)   |
| C(1)-Ir(1)-C(12)-C(13)     | -137.9(3)  |
| O(2)-Ir(1)-C(12)-C(13)     | 125.93(18) |
| C(14)-Ir(1)-C(12)-C(13)    | -37.27(19) |
| C(15)-Ir(1)-C(12)-C(13)    | -80.7(2)   |
| C(11)-Ir(1)-C(12)-C(13)    | -120.5(3)  |
| O(1)-Ir(1)-C(12)-C(13)     | 44.8(2)    |
| C(1)-Ir(1)-C(12)-C(11)     | -17.5(4)   |
| O(2)-Ir(1)-C(12)-C(11)     | -113.6(2)  |
| C(14)-Ir(1)-C(12)-C(11)    | 83.2(2)    |
| C(15)-Ir(1)-C(12)-C(11)    | 39.8(2)    |
| O(1)-Ir(1)-C(12)-C(11)     | 165.24(18) |
| C(13)-Ir(1)-C(12)-C(11)    | 120.5(3)   |
| C(1)-Ir(1)-C(12)-C(17)     | 99.7(4)    |
| O(2)-Ir(1)-C(12)-C(17)     | 3.6(3)     |
| C(14)-Ir(1)-C(12)-C(17)    | -159.6(3)  |
| C(15)-Ir(1)-C(12)-C(17)    | 156.9(4)   |
| C(11)-Ir(1)-C(12)-C(17)    | 117.2(4)   |
| O(1)-Ir(1)-C(12)-C(17)     | -77.6(3)   |
| C(13)-Ir(1)-C(12)-C(17)    | -122.4(4)  |
| C(11)-C(12)-C(13)-C(14)    | 0.0(4)     |
| C(17)-C(12)-C(13)-C(14)    | 177.1(3)   |
| Ir(1)-C(12)-C(13)-C(14)    | 57.0(2)    |
| C(11)-C(12)-C(13)-C(18)    | -178.3(3)  |
| C(17)-C(12)-C(13)-C(18)    | -1.1(6)    |
| Ir(1)-C(12)-C(13)-C(18)    | -121.3(3)  |
| C(11)-C(12)-C(13)-Ir(1)    | -57.0(2)   |
| C(17)-C(12)-C(13)-Ir(1)    | 120.1(3)   |
| C(1)-Ir(1)-C(13)-C(12)     | 133.2(3)   |
| O(2)-Ir(1)-C(13)-C(12)     | -64.6(2)   |
C(14)-Ir(1)-C(13)-C(12)  119.9(3)
C(15)-Ir(1)-C(13)-C(12)  81.2(2)
C(11)-Ir(1)-C(13)-C(12)  36.9(2)
O(1)-Ir(1)-C(13)-C(12)  -146.08(18)
C(1)-Ir(1)-C(13)-C(14)  13.3(4)
O(2)-Ir(1)-C(13)-C(14)  175.52(17)
C(15)-Ir(1)-C(13)-C(14)  -38.7(2)
C(11)-Ir(1)-C(13)-C(14)  -83.1(2)
O(1)-Ir(1)-C(13)-C(14)  94.00(19)
C(12)-Ir(1)-C(13)-C(14)  -119.9(3)
C(1)-Ir(1)-C(13)-C(18)  -103.3(4)
O(2)-Ir(1)-C(13)-C(18)  58.9(3)
C(14)-Ir(1)-C(13)-C(18)  -116.6(4)
C(15)-Ir(1)-C(13)-C(18)  -155.3(3)
C(11)-Ir(1)-C(13)-C(18)  160.3(3)
O(1)-Ir(1)-C(13)-C(18)  -22.6(3)
C(12)-Ir(1)-C(13)-C(18)  123.5(4)
C(12)-C(13)-C(14)-C(15)  3.1(4)
C(18)-C(13)-C(14)-C(15)  -178.6(3)
Ir(1)-C(13)-C(14)-C(15)  63.1(2)
C(12)-C(13)-C(14)-C(19)  177.7(3)
C(18)-C(13)-C(14)-C(19)  -4.0(5)
Ir(1)-C(13)-C(14)-C(19)  -122.4(4)
C(12)-C(13)-C(14)-Ir(1)  -59.9(2)
C(18)-C(13)-C(14)-Ir(1)  118.4(3)
C(1)-Ir(1)-C(14)-C(15)  69.9(2)
O(2)-Ir(1)-C(14)-C(15)  -126.0(3)
C(11)-Ir(1)-C(14)-C(15)  -38.0(2)
O(1)-Ir(1)-C(14)-C(15)  150.82(19)
C(13)-Ir(1)-C(14)-C(15)  -116.1(3)
C(12)-Ir(1)-C(14)-C(15)  -80.9(2)
C(1)-Ir(1)-C(14)-C(13)  -173.98(17)
O(2)-Ir(1)-C(14)-C(13)  -9.9(4)
C(15)-Ir(1)-C(14)-C(13)  116.1(3)
C(11)-Ir(1)-C(14)-C(13)  78.1(2)
O(1)-Ir(1)-C(14)-C(13)  -93.05(18)
| Bond                  | Distance (Å) |
|----------------------|--------------|
| C(12)-Ir(1)-C(14)-C(13) | 35.19(18)    |
| C(1)-Ir(1)-C(14)-C(19)  | -53.5(4)     |
| O(2)-Ir(1)-C(14)-C(19)  | 110.6(4)     |
| C(15)-Ir(1)-C(14)-C(19) | -123.4(4)    |
| C(11)-Ir(1)-C(14)-C(19) | -161.4(4)    |
| O(1)-Ir(1)-C(14)-C(19)  | 27.4(4)      |
| C(13)-Ir(1)-C(14)-C(19) | 120.5(4)     |
| C(12)-Ir(1)-C(14)-C(19) | 155.7(4)     |
| C(13)-C(14)-C(15)-C(11) | -5.0(4)      |
| C(19)-C(14)-C(15)-C(11) | -179.2(3)    |
| Ir(1)-C(14)-C(15)-C(11) | 60.3(2)      |
| C(13)-C(14)-C(15)-C(20) | 174.0(3)     |
| C(19)-C(14)-C(15)-C(20) | -0.2(6)      |
| Ir(1)-C(14)-C(15)-C(20) | -120.7(4)    |
| C(13)-C(14)-C(15)-Ir(1) | -65.3(2)     |
| C(19)-C(14)-C(15)-Ir(1) | 120.5(4)     |
| C(12)-C(11)-C(15)-C(14) | 5.0(4)       |
| C(16)-C(11)-C(15)-C(14) | 176.0(3)     |
| Ir(1)-C(11)-C(15)-C(14) | -60.4(2)     |
| C(12)-C(11)-C(15)-C(20) | -174.1(3)    |
| C(16)-C(11)-C(15)-C(20) | -3.0(6)      |
| Ir(1)-C(11)-C(15)-C(20) | 120.6(4)     |
| C(12)-C(11)-C(15)-Ir(1) | 65.3(2)      |
| C(16)-C(11)-C(15)-Ir(1) | -123.6(4)    |
| C(1)-Ir(1)-C(15)-C(14)  | -122.4(2)    |
| O(2)-Ir(1)-C(15)-C(14)  | 140.1(2)     |
| C(11)-Ir(1)-C(15)-C(14) | 118.4(3)     |
| O(1)-Ir(1)-C(15)-C(14)  | -40.7(2)     |
| C(13)-Ir(1)-C(15)-C(14) | 38.74(19)    |
| C(12)-Ir(1)-C(15)-C(14) | 79.6(2)      |
| C(1)-Ir(1)-C(15)-C(11)  | 119.1(2)     |
| O(2)-Ir(1)-C(15)-C(11)  | 21.7(3)      |
| C(14)-Ir(1)-C(15)-C(11) | -118.4(3)    |
| O(1)-Ir(1)-C(15)-C(11)  | -159.13(17)  |
| C(13)-Ir(1)-C(15)-C(11) | -79.7(2)     |
| C(12)-Ir(1)-C(15)-C(11) | -38.8(2)     |
| Bond                  | Angle (°) |
|-----------------------|-----------|
| C(1)-Ir(1)-C(15)-C(20) | -1.7(4)   |
| O(2)-Ir(1)-C(15)-C(20) | -99.2(4)  |
| C(14)-Ir(1)-C(15)-C(20) | 120.7(4)  |
| C(11)-Ir(1)-C(15)-C(20) | -120.8(5) |
| O(1)-Ir(1)-C(15)-C(20) | 80.1(4)   |
| C(13)-Ir(1)-C(15)-C(20) | 159.5(4)  |
| C(12)-Ir(1)-C(15)-C(20) | -159.6(4) |
| C(1)-Ir(1)-O(2)-C(21)   | -83.4(3)  |
| C(14)-Ir(1)-O(2)-C(21)   | 110.7(4)  |
| C(15)-Ir(1)-O(2)-C(21)   | 18.0(4)   |
| C(11)-Ir(1)-O(2)-C(21)   | 32.6(3)   |
| O(1)-Ir(1)-O(2)-C(21)    | -161.4(3) |
| C(13)-Ir(1)-O(2)-C(21)   | 103.7(3)  |
| C(12)-Ir(1)-O(2)-C(21)   | 70.6(3)   |
| Ir(1)-O(2)-C(21)-O(3)    | 5.6(6)    |
| Ir(1)-O(2)-C(21)-C(22)   | -173.0(2) |
| O(3)-C(21)-C(22)-F(3)    | 16.1(6)   |
| O(2)-C(21)-C(22)-F(3)    | -165.1(3) |
| O(3)-C(21)-C(22)-F(2)    | 140.6(4)  |
| O(2)-C(21)-C(22)-F(2)    | -40.6(5)  |
| O(3)-C(21)-C(22)-F(1)    | -102.4(4) |
| O(2)-C(21)-C(22)-F(1)    | 76.5(4)   |

Symmetry transformations used to generate equivalent atoms:
Crystallographic data of 6 (Scheme 3)
Table S19. Crystal data and structure refinement for 6.

| Property                           | Value                                      |
|------------------------------------|--------------------------------------------|
| Identification code                | p1_a                                       |
| Empirical formula                  | C29H30F3IrN2O5S                           |
| Formula weight                     | 767.81                                     |
| Temperature                        | 426(2) K                                   |
| Wavelength                         | 0.71073 Å                                  |
| Crystal system                     | Triclinic                                  |
| Space group                        | P-1                                        |
| Unit cell dimensions               | a = 9.6211(3) Å, b = 10.9933(4) Å, c = 14.5750(4) Å |
|                                   | α = 81.373(2)°, β = 79.858(2)°, γ = 67.962(2)° |
| Volume                             | 1400.64(8) Å³                             |
| Z                                  | 2                                          |
| Density (calculated)               | 1.821 Mg/m³                                |
| Absorption coefficient             | 4.904 mm⁻¹                                 |
| F(000)                             | 756                                        |
| Crystal size                       | 0.210 x 0.160 x 0.110 mm³                  |
| Theta range for data collection    | 2.852 to 27.971°.                         |
| Index ranges                       | -12 <= h <= 12, -14 <= k <= 14, -19 <= l <= 19 |
| Reflections collected              | 128466                                     |
| Independent reflections            | 6734 [R(int) = 0.0487]                     |
| Completeness to theta = 25.242°    | 99.8 %                                     |
| Absorption correction              | Semi-empirical from equivalents           |
| Max. and min. transmission         | 0.7456 and 0.5084                          |
| Refinement method                  | Full-matrix least-squares on F²           |
| Data / restraints / parameters     | 6734 / 0 / 380                             |
| Goodness-of-fit on F²              | 1.122                                      |
| Final R indices [I>2σ(I)]          | R1 = 0.0232, wR2 = 0.0574                  |
| R indices (all data)               | R1 = 0.0263, wR2 = 0.0597                  |
| Extinction coefficient             | n/a                                        |
| Largest diff. peak and hole        | 2.039 and -1.022 e.Å⁻³                    |
**Table S20.** Atomic coordinates ($\times 10^4$) and equivalent isotropic displacement parameters ($\AA^2 \times 10^3$) for 6. U(eq) is defined as one third of the trace of the orthogonalized $U_{ij}$ tensor.

|       | x      | y      | z      | U(eq) |
|-------|--------|--------|--------|-------|
| Ir(1) | 3066(1)| 2600(1)| 7630(1)| 14(1) |
| C(1)  | 3112(4)| 879(3) | 8540(2)| 20(1) |
| C(2)  | 2407(4)| 892(3) | 7734(2)| 20(1) |
| C(3)  | 1109(3)| 2074(3)| 7698(2)| 21(1) |
| C(4)  | 974(3) | 2797(3)| 8481(2)| 20(1) |
| C(5)  | 2194(3)| 2043(3)| 9006(2)| 19(1) |
| C(6)  | 4411(4)| -226(3)| 8904(3)| 28(1) |
| C(7)  | 2935(4)| -158(3)| 7072(3)| 26(1) |
| C(8)  | 69(4)  | 2487(4)| 6979(3)| 33(1) |
| C(9)  | -282(4)| 4048(4)| 8727(2)| 27(1) |
| C(10)| 2506(4)| 2425(4)| 9873(2)| 25(1) |
| C(11)| 6069(3)| 4861(3)| 7392(2)| 17(1) |
| C(12)| 5959(4)| 4843(3)| 6453(2)| 23(1) |
| C(13)| 6222(4)| 5813(3)| 5801(2)| 25(1) |
| C(14)| 6588(4)| 6808(3)| 6073(2)| 23(1) |
| C(15)| 6854(5)| 7858(4)| 5356(3)| 32(1) |
| C(16)| 6668(4)| 6821(3)| 7015(2)| 23(1) |
| C(17)| 6397(4)| 5856(3)| 7683(2)| 21(1) |
| C(18)| 6009(4)| 1112(3)| 6503(2)| 21(1) |
| C(19)| 7252(4)| 1194(4)| 5681(3)| 27(1) |
| C(20)| 1763(3)| 5456(3)| 6799(2)| 18(1) |
| C(21)| 947(4) | 6427(4)| 6059(2)| 30(1) |
| C(22)| 1017(3)| 7134(3)| 7957(2)| 19(1) |
| C(23)| -211(4)| 8183(3)| 7660(2)| 23(1) |
| C(24)| -738(4)| 9315(3)| 8143(3)| 28(1) |
| C(25)| -75(4) | 9378(3)| 8891(3)| 30(1) |
| C(26)| 1104(4)| 8300(4)| 9217(3)| 29(1) |
| C(27)| 1643(4)| 7162(3)| 8747(2)| 22(1) |
| C(28)| 2794(4)| 5905(3)| 8930(2)| 22(1) |
| C(29)| 2915(3)| 5128(3)| 8262(2)| 16(1) |
| F(1) | 7846(4)| 2048(3)| 5776(2)| 58(1) |
| Element | N(1)  | N(2)  | O(1)  | O(2)  | O(3)  | O(4)  | O(5)  | S(1)  | F(3)  | F(2)  | F(4)  | F(5)  |
|---------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
|         | 3940(3) | 1830(3) | 6572(2) | 5802(3) | 4888(2) | 6249(3) | 2346(2) | 5662(1) | 8524(5) | 6818(6) | 6661(9) | 8227(7) |
|         | 3884(2) | 5865(2) | 2346(2) | 3881(2) | 2199(2) | 77(2)  | 4282(2) | 3629(1) | 60(5)  | 1210(7) | 1851(8) | 84(6)  |
|         | 8071(2) | 7622(2) | 7913(2) | 9120(2) | 6540(2) | 6984(2) | 6629(2) | 8204(1) | 5760(3) | 4901(3) | 4863(6) | 5403(5) |
|         | 17(1)  | 16(1)  | 22(1)  | 24(1)  | 19(1)  | 29(1)  | 18(1)  | 16(1)  | 31(1)  | 38(1)  | 61(2)  | 53(1)  |
Table S21. Bond lengths [Å] and angles [°] for 6.

| Bond                  | Length [Å]  |
|-----------------------|-------------|
| Ir(1)-O(3)            | 2.108(2)    |
| Ir(1)-N(1)            | 2.114(2)    |
| Ir(1)-C(4)            | 2.124(3)    |
| Ir(1)-C(5)            | 2.128(3)    |
| Ir(1)-C(1)            | 2.132(3)    |
| Ir(1)-O(5)            | 2.148(2)    |
| Ir(1)-C(3)            | 2.149(3)    |
| Ir(1)-C(2)            | 2.172(3)    |
| C(1)-C(5)             | 1.443(4)    |
| C(1)-C(2)             | 1.451(4)    |
| C(1)-C(6)             | 1.490(4)    |
| C(2)-C(3)             | 1.427(5)    |
| C(2)-C(7)             | 1.498(4)    |
| C(3)-C(4)             | 1.447(5)    |
| C(3)-C(8)             | 1.481(5)    |
| C(4)-C(5)             | 1.431(4)    |
| C(4)-C(9)             | 1.493(4)    |
| C(5)-C(10)            | 1.499(4)    |
| C(6)-H(6A)            | 0.9600      |
| C(6)-H(6B)            | 0.9600      |
| C(6)-H(6C)            | 0.9600      |
| C(7)-H(7A)            | 0.9600      |
| C(7)-H(7B)            | 0.9600      |
| C(7)-H(7C)            | 0.9600      |
| C(8)-H(8A)            | 0.9600      |
| C(8)-H(8B)            | 0.9600      |
| C(8)-H(8C)            | 0.9600      |
| C(9)-H(9A)            | 0.9600      |
| C(9)-H(9B)            | 0.9600      |
| C(9)-H(9C)            | 0.9600      |
| C(10)-H(10A)          | 0.9600      |
| C(10)-H(10B)          | 0.9600      |
| C(10)-H(10C)          | 0.9600      |
| C(11)-C(17)           | 1.386(4)    |
| Bond                  | Distance (Å) |
|----------------------|--------------|
| C(11)-C(12)          | 1.394(4)     |
| C(11)-S(1)           | 1.773(3)     |
| C(12)-C(13)          | 1.385(5)     |
| C(12)-H(12)          | 0.9300       |
| C(13)-C(14)          | 1.395(5)     |
| C(13)-H(13)          | 0.9300       |
| C(14)-C(16)          | 1.391(5)     |
| C(14)-C(15)          | 1.502(5)     |
| C(15)-H(15A)         | 0.9600       |
| C(15)-H(15B)         | 0.9600       |
| C(15)-H(15C)         | 0.9600       |
| C(16)-C(17)          | 1.397(5)     |
| C(16)-H(16)          | 0.9300       |
| C(17)-H(17)          | 0.9300       |
| C(18)-O(4)           | 1.208(4)     |
| C(18)-O(3)           | 1.275(4)     |
| C(18)-C(19)          | 1.555(4)     |
| C(19)-F(5)           | 1.299(7)     |
| C(19)-F(2)           | 1.274(6)     |
| C(19)-F(1)           | 1.302(4)     |
| C(19)-F(3)           | 1.388(6)     |
| C(19)-F(4)           | 1.393(9)     |
| C(20)-O(5)           | 1.242(4)     |
| C(20)-N(2)           | 1.361(4)     |
| C(20)-C(21)          | 1.499(4)     |
| C(21)-H(21A)         | 0.9600       |
| C(21)-H(21B)         | 0.9600       |
| C(21)-H(21C)         | 0.9600       |
| C(22)-C(23)          | 1.386(4)     |
| C(22)-C(27)          | 1.399(5)     |
| C(22)-N(2)           | 1.431(4)     |
| C(23)-C(24)          | 1.401(5)     |
| C(23)-H(23)          | 0.9300       |
| C(24)-C(25)          | 1.380(6)     |
| C(24)-H(24)          | 0.9300       |
| C(25)-C(26)          | 1.388(5)     |
| Bond                  | Length   |
|-----------------------|----------|
| C(25)-H(25)           | 0.9300   |
| C(26)-C(27)           | 1.396(4) |
| C(26)-H(26)           | 0.9300   |
| C(27)-C(28)           | 1.432(4) |
| C(28)-C(29)           | 1.351(4) |
| C(28)-H(28)           | 0.9300   |
| C(29)-N(1)            | 1.388(4) |
| C(29)-N(2)            | 1.449(4) |
| N(1)-S(1)             | 1.615(3) |
| O(1)-S(1)             | 1.435(2) |
| O(2)-S(1)             | 1.442(2) |
| O(3)-Ir(1)-N(1)       | 87.38(9) |
| O(3)-Ir(1)-C(4)       | 164.23(11)|
| N(1)-Ir(1)-C(4)       | 107.45(11)|
| O(3)-Ir(1)-C(5)       | 147.57(10)|
| N(1)-Ir(1)-C(5)       | 94.43(11) |
| C(4)-Ir(1)-C(5)       | 39.32(12) |
| O(3)-Ir(1)-C(1)       | 112.04(10)|
| N(1)-Ir(1)-C(1)       | 117.10(11) |
| C(4)-Ir(1)-C(1)       | 66.46(12) |
| C(5)-Ir(1)-C(1)       | 39.61(12) |
| O(3)-Ir(1)-O(5)       | 77.01(8)  |
| N(1)-Ir(1)-O(5)       | 78.80(9)  |
| C(4)-Ir(1)-O(5)       | 100.17(10)|
| C(5)-Ir(1)-O(5)       | 135.13(10)|
| C(1)-Ir(1)-O(5)       | 161.15(11)|
| O(3)-Ir(1)-C(3)       | 124.78(11)|
| N(1)-Ir(1)-C(3)       | 145.57(11)|
| C(4)-Ir(1)-C(3)       | 39.57(12) |
| C(5)-Ir(1)-C(3)       | 65.68(12) |
| C(1)-Ir(1)-C(3)       | 65.70(12) |
| O(5)-Ir(1)-C(3)       | 95.49(11) |
| O(3)-Ir(1)-C(2)       | 102.53(10)|
| N(1)-Ir(1)-C(2)       | 156.45(11)|
| C(4)-Ir(1)-C(2)       | 65.88(12) |
| C(5)-Ir(1)-C(2)       | 65.78(12)|
C(1)-Ir(1)-C(2) 39.38(12)
O(5)-Ir(1)-C(2) 124.02(10)
C(3)-Ir(1)-C(2) 38.55(12)
C(5)-C(1)-C(2) 107.6(3)
C(5)-C(1)-C(6) 125.5(3)
C(2)-C(1)-C(6) 126.3(3)
C(5)-C(1)-Ir(1) 70.03(17)
C(2)-C(1)-Ir(1) 71.81(17)
C(6)-C(1)-Ir(1) 130.3(2)
C(3)-C(2)-C(1) 107.6(3)
C(3)-C(2)-C(7) 126.3(3)
C(1)-C(2)-C(7) 126.1(3)
C(3)-C(2)-Ir(1) 69.84(17)
C(1)-C(2)-Ir(1) 68.81(17)
C(7)-C(2)-Ir(1) 127.5(2)
C(2)-C(3)-C(4) 108.8(3)
C(2)-C(3)-C(8) 125.5(3)
C(4)-C(3)-C(8) 125.7(3)
C(2)-C(3)-Ir(1) 71.61(17)
C(4)-C(3)-Ir(1) 69.28(17)
C(8)-C(3)-Ir(1) 125.4(2)
C(5)-C(4)-C(3) 107.4(3)
C(5)-C(4)-C(9) 126.8(3)
C(3)-C(4)-C(9) 125.7(3)
C(5)-C(4)-Ir(1) 70.48(17)
C(3)-C(4)-Ir(1) 71.15(17)
C(9)-C(4)-Ir(1) 127.1(2)
C(4)-C(5)-C(1) 108.5(3)
C(4)-C(5)-C(10) 125.8(3)
C(1)-C(5)-C(10) 125.7(3)
C(4)-C(5)-Ir(1) 70.20(17)
C(1)-C(5)-Ir(1) 70.36(17)
C(10)-C(5)-Ir(1) 123.4(2)
C(1)-C(6)-H(6A) 109.5
C(1)-C(6)-H(6B) 109.5
H(6A)-C(6)-H(6B) 109.5
C(1)-C(6)-H(6C) 109.5
H(6A)-C(6)-H(6C) 109.5
H(6B)-C(6)-H(6C) 109.5
C(2)-C(7)-H(7A) 109.5
C(2)-C(7)-H(7B) 109.5
H(7A)-C(7)-H(7B) 109.5
C(2)-C(7)-H(7C) 109.5
H(7A)-C(7)-H(7C) 109.5
H(7B)-C(7)-H(7C) 109.5
C(3)-C(8)-H(8A) 109.5
C(3)-C(8)-H(8B) 109.5
H(8A)-C(8)-H(8B) 109.5
C(3)-C(8)-H(8C) 109.5
H(8A)-C(8)-H(8C) 109.5
H(8B)-C(8)-H(8C) 109.5
C(4)-C(9)-H(9A) 109.5
C(4)-C(9)-H(9B) 109.5
H(9A)-C(9)-H(9B) 109.5
C(4)-C(9)-H(9C) 109.5
H(9A)-C(9)-H(9C) 109.5
H(9B)-C(9)-H(9C) 109.5
C(5)-C(10)-H(10A) 109.5
C(5)-C(10)-H(10B) 109.5
H(10A)-C(10)-H(10B) 109.5
C(5)-C(10)-H(10C) 109.5
H(10A)-C(10)-H(10C) 109.5
H(10B)-C(10)-H(10C) 109.5
C(17)-C(11)-C(12) 120.9(3)
C(17)-C(11)-S(1) 121.4(2)
C(12)-C(11)-S(1) 117.7(2)
C(13)-C(12)-C(11) 119.5(3)
C(13)-C(12)-H(12) 120.3
C(11)-C(12)-H(12) 120.3
C(12)-C(13)-C(14) 120.8(3)
C(12)-C(13)-H(13) 119.6
C(14)-C(13)-H(13) 119.6
C(16)-C(14)-C(13) 118.9(3)
C(16)-C(14)-C(15) 121.2(3)
C(13)-C(14)-C(15) 119.9(3)
C(14)-C(15)-H(15A) 109.5
C(14)-C(15)-H(15B) 109.5
H(15A)-C(15)-H(15B) 109.5
C(14)-C(15)-H(15C) 109.5
H(15A)-C(15)-H(15C) 109.5
C(14)-C(16)-C(17) 121.1(3)
C(14)-C(16)-H(16) 119.4
C(17)-C(16)-H(16) 119.4
C(11)-C(17)-C(16) 118.9(3)
C(11)-C(17)-H(17) 120.6
C(16)-C(17)-H(17) 120.6
O(4)-C(18)-O(3) 131.5(3)
O(4)-C(18)-C(19) 117.1(3)
O(3)-C(18)-C(19) 111.4(3)
F(5)-C(19)-F(2) 79.8(5)
F(5)-C(19)-F(1) 114.4(4)
F(2)-C(19)-F(1) 119.1(4)
F(5)-C(19)-F(3) 26.8(3)
F(2)-C(19)-F(3) 106.5(4)
F(1)-C(19)-F(3) 98.3(3)
F(5)-C(19)-F(4) 102.7(5)
F(2)-C(19)-F(4) 28.2(4)
F(1)-C(19)-F(4) 94.5(4)
F(3)-C(19)-F(4) 127.2(5)
F(5)-C(19)-C(18) 116.8(4)
F(2)-C(19)-C(18) 110.3(3)
F(1)-C(19)-C(18) 112.8(3)
F(3)-C(19)-C(18) 108.5(3)
F(4)-C(19)-C(18) 112.9(4)
O(5)-C(20)-N(2) 122.6(3)
O(5)-C(20)-C(21) 117.1(3)
N(2)-C(20)-C(21) 120.3(3)
C(20)-C(21)-H(21A) 109.5
C(20)-C(21)-H(21B) 109.5
H(21A)-C(21)-H(21B) 109.5
C(20)-C(21)-H(21C) 109.5
H(21A)-C(21)-H(21C) 109.5
H(21B)-C(21)-H(21C) 109.5
C(23)-C(22)-C(27) 121.6(3)
C(23)-C(22)-N(2) 131.6(3)
C(27)-C(22)-N(2) 106.8(3)
C(22)-C(23)-C(24) 117.3(3)
C(22)-C(23)-H(23) 121.3
C(24)-C(23)-H(23) 121.3
C(25)-C(24)-C(23) 121.4(3)
C(25)-C(24)-H(24) 119.3
C(23)-C(24)-H(24) 119.3
C(24)-C(25)-C(26) 121.0(3)
C(24)-C(25)-H(25) 119.5
C(26)-C(25)-H(25) 119.5
C(25)-C(26)-C(27) 118.4(3)
C(25)-C(26)-H(26) 120.8
C(27)-C(26)-H(26) 120.8
C(26)-C(27)-C(22) 120.1(3)
C(26)-C(27)-C(28) 131.1(3)
C(22)-C(27)-C(28) 108.8(3)
C(29)-C(28)-C(27) 108.6(3)
C(29)-C(28)-H(28) 125.7
C(27)-C(28)-H(28) 125.7
C(28)-C(29)-N(1) 131.4(3)
C(28)-C(29)-N(2) 108.6(3)
N(1)-C(29)-N(2) 119.7(3)
C(29)-N(1)-S(1) 114.6(2)
C(29)-N(1)-Ir(1) 116.50(19)
S(1)-N(1)-Ir(1) 128.87(14)
C(20)-N(2)-C(22) 127.6(3)
C(20)-N(2)-C(29) 124.8(2)
C(22)-N(2)-C(29) 107.1(2)
| Bond                  | Value   |
|----------------------|---------|
| C(18)-O(3)-Ir(1)     | 124.1(2)|
| C(20)-O(5)-Ir(1)     | 126.5(2)|
| O(1)-S(1)-O(2)       | 116.5(4)|
| O(1)-S(1)-N(1)       | 107.0(4)|
| O(2)-S(1)-N(1)       | 112.9(4)|
| O(1)-S(1)-C(11)      | 110.1(4)|
| O(2)-S(1)-C(11)      | 107.2(5)|
| N(1)-S(1)-C(11)      | 102.0(4)|

Symmetry transformations used to generate equivalent atoms:
Table S22. Anisotropic displacement parameters (Å$^2 \times 10^3$) for 6. The anisotropic displacement factor exponent takes the form: $-2\pi^2 [ \ h^2 \ a^* a^* U^{11} + \ldots + 2 \ h \ k \ a^* b^* U^{12} ]$

|     | $U^{11}$ | $U^{22}$ | $U^{33}$ | $U^{23}$ | $U^{13}$ | $U^{12}$ |
|-----|----------|----------|----------|----------|----------|----------|
| Ir(1)| 13(1)    | 14(1)    | 16(1)    | -2(1)    | -1(1)    | -6(1)    |
| C(1) | 23(2)    | 16(1)    | 21(1)    | 2(1)     | -2(1)    | -9(1)    |
| C(2) | 22(2)    | 21(2)    | 23(2)    | -1(1)    | -1(1)    | -14(1)   |
| C(3) | 16(1)    | 27(2)    | 24(2)    | -2(1)    | 0(1)     | -14(1)   |
| C(4) | 17(1)    | 21(2)    | 22(1)    | 1(1)     | 2(1)     | -8(1)    |
| C(5) | 19(1)    | 19(1)    | 19(1)    | 1(1)     | 0(1)     | -8(1)    |
| C(6) | 30(2)    | 19(2)    | 29(2)    | 2(1)     | -6(1)    | -4(1)    |
| C(7) | 30(2)    | 26(2)    | 31(2)    | -8(1)    | -2(1)    | -17(1)   |
| C(8) | 33(2)    | 43(2)    | 28(2)    | -2(2)    | -1(1)    | -22(2)   |
| C(9) | 18(2)    | 29(2)    | 26(2)    | -2(1)    | 3(1)     | -2(1)    |
| C(10)| 30(2)    | 28(2)    | 18(1)    | -2(1)    | -3(1)    | -10(1)   |
| C(11)| 13(1)    | 14(1)    | 24(1)    | -2(1)    | -2(1)    | -5(1)    |
| C(12)| 26(2)    | 22(2)    | 23(2)    | -6(1)    | -1(1)    | -11(1)   |
| C(13)| 31(2)    | 24(2)    | 22(2)    | -4(1)    | -1(1)    | -13(1)   |
| C(14)| 21(2)    | 20(2)    | 30(2)    | -3(1)    | 0(1)     | -9(1)    |
| C(15)| 39(2)    | 28(2)    | 33(2)    | 2(1)     | -5(2)    | -19(2)   |
| C(16)| 22(2)    | 18(2)    | 32(2)    | -4(1)    | -4(1)    | -10(1)   |
| C(17)| 19(1)    | 19(1)    | 27(2)    | -5(1)    | -6(1)    | -6(1)    |
| C(18)| 19(1)    | 23(2)    | 26(2)    | -11(1)   | 2(1)     | -12(1)   |
| C(19)| 20(2)    | 28(2)    | 34(2)    | -13(1)   | 7(1)     | -10(1)   |
| C(20)| 15(1)    | 20(1)    | 18(1)    | -1(1)    | 1(1)     | -7(1)    |
| C(21)| 37(2)    | 25(2)    | 22(2)    | 1(1)     | -6(1)    | -3(2)    |
| C(22)| 19(1)    | 14(1)    | 25(2)    | -4(1)    | 2(1)     | -7(1)    |
| C(23)| 20(2)    | 18(2)    | 29(2)    | -2(1)    | -1(1)    | -5(1)    |
| C(24)| 23(2)    | 15(2)    | 38(2)    | -3(1)    | 4(1)     | -2(1)    |
| C(25)| 33(2)    | 17(2)    | 35(2)    | -11(1)   | 6(2)     | -6(1)    |
| C(26)| 31(2)    | 24(2)    | 31(2)    | -13(1)   | 2(1)     | -9(1)    |
| C(27)| 21(2)    | 20(2)    | 25(2)    | -6(1)    | 2(1)     | -8(1)    |
| C(28)| 20(2)    | 22(2)    | 23(2)    | -7(1)    | -2(1)    | -7(1)    |
| C(29)| 13(1)    | 16(1)    | 20(1)    | -2(1)    | -1(1)    | -5(1)    |
| F(1) | 69(2)    | 74(2)    | 54(2)    | -31(2)   | 28(1)    | -60(2)   |
|    |    |    |    |    |    |    |    |
|----|----|----|----|----|----|----|----|
| N(1) | 14(1) | 16(1) | 22(1) | -5(1) | -2(1) | -6(1) |
| N(2) | 15(1) | 12(1) | 22(1) | -3(1) | -2(1) | -3(1) |
| O(1) | 18(1) | 15(1) | 33(1) | -4(1) | -6(1) | -3(1) |
| O(2) | 25(1) | 26(1) | 22(1) | -3(1) | -10(1) | -9(1) |
| O(3) | 17(1) | 19(1) | 21(1) | -6(1) | 2(1) | -7(1) |
| O(4) | 26(1) | 17(1) | 41(1) | -6(1) | 1(1) | -7(1) |
| O(5) | 21(1) | 16(1) | 18(1) | -3(1) | -3(1) | -6(1) |
| S(1) | 14(1) | 15(1) | 20(1) | -3(1) | -4(1) | -4(1) |
| F(2) | 39(3) | 76(4) | 11(2) | -18(2) | 9(2) | -33(3) |
Table S23. Hydrogen coordinates (x $10^4$) and isotropic displacement parameters ($\text{Å}^2 x 10^3$) for 6.

|   | x     | y     | z     | U(eq) |
|---|-------|-------|-------|-------|
| H(6A) | 4048 | -678 | 9453 | 41    |
| H(6B) | 5112 | 117  | 9060 | 41    |
| H(6C) | 4908 | -830 | 8434 | 41    |
| H(7A) | 2458 | -792 | 7293 | 40    |
| H(7B) | 4013 | -588 | 7037 | 40    |
| H(7C) | 2673 | 234  | 6462 | 40    |
| H(8A) | 567  | 2030 | 6433 | 49    |
| H(8B) | -218 | 3420 | 6816 | 49    |
| H(8C) | -818 | 2279 | 7223 | 49    |
| H(9A) | -1131| 3851 | 9069 | 41    |
| H(9B) | -574 | 4598 | 8164 | 41    |
| H(9C) | 53   | 4501 | 9106 | 41    |
| H(10A)| 2066 | 3365 | 9883 | 38    |
| H(10B)| 3578 | 2141 | 9874 | 38    |
| H(10C)| 2072 | 2013 | 10415| 38    |
| H(12) | 5711 | 4186 | 6267 | 27    |
| H(13) | 6153 | 5801 | 5174 | 30    |
| H(15A)| 5980 | 8653 | 5397 | 48    |
| H(15B)| 7036 | 7569 | 4742 | 48    |
| H(15C)| 7718 | 8024 | 5470 | 48    |
| H(16) | 6905 | 7484 | 7203 | 28    |
| H(17) | 6436 | 5880 | 8313 | 25    |
| H(21A)| 1319 | 6077 | 5461 | 45    |
| H(21B)| 1114 | 7238 | 6041 | 45    |
| H(21C)| -117 | 6588 | 6200 | 45    |
| H(23) | -667 | 8137 | 7160 | 28    |
| H(24) | -1553| 10039| 7954 | 34    |
| H(25) | -422 | 10155| 9182 | 36    |
| H(26) | 1524 | 8336 | 9736 | 35    |
| H(28) | 3363 | 5665 | 9425 | 26    |
Table S24. Torsion angles [°] for 6.

| Torsion angle (°) | Value       |
|-------------------|-------------|
| C(5)-C(1)-C(2)-C(3) | 1.9(3)     |
| C(6)-C(1)-C(2)-C(3) | 173.6(3)   |
| Ir(1)-C(1)-C(2)-C(3) | -59.3(2)  |
| C(5)-C(1)-C(2)-C(7) | -177.1(3)  |
| C(6)-C(1)-C(2)-C(7) | -5.4(5)    |
| Ir(1)-C(1)-C(2)-C(7) | 121.7(3)   |
| C(5)-C(1)-C(2)-Ir(1) | 61.2(2)    |
| C(6)-C(1)-C(2)-Ir(1) | -127.1(3)  |
| C(1)-C(2)-C(3)-C(4) | 0.9(3)     |
| C(7)-C(2)-C(3)-C(8) | 178.1(3)   |
| Ir(1)-C(2)-C(3)-C(4) | -59.5(2)   |
| C(1)-C(2)-C(3)-C(8) | 179.4(3)   |
| C(7)-C(2)-C(3)-C(8) | -1.6(5)    |
| Ir(1)-C(2)-C(3)-C(8) | 120.8(3)   |
| C(1)-C(2)-C(3)-Ir(1) | 58.6(2)    |
| C(7)-C(2)-C(3)-Ir(1) | -122.4(3)  |
| C(2)-C(3)-C(4)-C(5) | -0.5(3)    |
| C(8)-C(3)-C(4)-C(5) | 179.2(3)   |
| Ir(1)-C(3)-C(4)-C(5) | -61.5(2)   |
| C(2)-C(3)-C(4)-C(9) | -176.3(3)  |
| C(8)-C(3)-C(4)-C(9) | 3.3(5)     |
| Ir(1)-C(3)-C(4)-C(9) | 122.7(3)   |
| C(2)-C(3)-C(4)-Ir(1) | 61.0(2)    |
| C(8)-C(3)-C(4)-Ir(1) | -119.3(3)  |
| C(3)-C(4)-C(5)-C(1) | 1.7(3)     |
| C(9)-C(4)-C(5)-C(1) | 177.5(3)   |
| Ir(1)-C(4)-C(5)-C(1) | -50.2(2)   |
| C(3)-C(4)-C(5)-C(10) | 179.4(3)   |
| C(9)-C(4)-C(5)-C(10) | -4.9(5)    |
| Ir(1)-C(4)-C(5)-C(10) | 117.5(3)   |
| C(3)-C(4)-C(5)-Ir(1) | 61.9(2)    |
| C(9)-C(4)-C(5)-Ir(1) | -122.3(3)  |
| C(2)-C(1)-C(5)-C(4) | -2.3(3)    |
| C(6)-C(1)-C(5)-C(4) | -174.0(3)  |
Ir(1)-C(1)-C(5)-C(4)  60.1(2)
C(2)-C(1)-C(5)-C(10) -179.9(3)
C(6)-C(1)-C(5)-C(10)  8.3(5)
Ir(1)-C(1)-C(5)-C(10) -117.6(3)
C(2)-C(1)-C(5)-Ir(1) -62.4(2)
C(6)-C(1)-C(5)-Ir(1)  125.9(3)
C(17)-C(11)-C(12)-C(13)  1.8(5)
S(1)-C(11)-C(12)-C(13)  178.0(3)
C(11)-C(12)-C(13)-C(14)  -0.3(5)
C(12)-C(13)-C(14)-C(16)  -0.8(5)
C(12)-C(13)-C(14)-C(15) -179.4(3)
C(13)-C(14)-C(16)-C(17)  0.4(5)
C(15)-C(14)-C(16)-C(17)  179.0(3)
C(12)-C(11)-C(17)-C(16) -2.1(5)
S(1)-C(11)-C(17)-C(16) -178.2(2)
C(14)-C(16)-C(17)-C(11)  1.0(5)
O(4)-C(18)-C(19)-F(5)  19.1(6)
O(3)-C(18)-C(19)-F(5) -160.9(4)
O(4)-C(18)-C(19)-F(2)  107.7(5)
O(3)-C(18)-C(19)-F(2) -72.3(5)
O(4)-C(18)-C(19)-F(1) -116.4(4)
O(3)-C(18)-C(19)-F(1)  63.6(4)
O(4)-C(18)-C(19)-F(3) -8.6(5)
O(3)-C(18)-C(19)-F(3)  171.4(3)
O(4)-C(18)-C(19)-F(4)  137.9(5)
O(3)-C(18)-C(19)-F(4) -42.1(5)
C(27)-C(22)-C(23)-C(24)  4.4(5)
N(2)-C(22)-C(23)-C(24) -179.3(3)
C(22)-C(23)-C(24)-C(25) -0.8(5)
C(23)-C(24)-C(25)-C(26) -2.6(6)
C(24)-C(25)-C(26)-C(27)  2.4(5)
C(25)-C(26)-C(27)-C(22)  1.2(5)
C(25)-C(26)-C(27)-C(28) -178.0(3)
C(23)-C(22)-C(27)-C(26) -4.6(5)
N(2)-C(22)-C(27)-C(26)  178.2(3)
C(23)-C(22)-C(27)-C(28)  174.7(3)

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| Bond                  | Angle (deg) |
|----------------------|-------------|
| N(2)-C(22)-C(27)-C(28) | -2.4(3)     |
| C(26)-C(27)-C(28)-C(29) | -179.1(4)  |
| C(22)-C(27)-C(28)-C(29) | 1.7(4)      |
| C(27)-C(28)-C(29)-N(1)  | 173.1(3)    |
| C(27)-C(28)-C(29)-N(2)  | -0.2(3)     |
| C(28)-C(29)-N(1)-S(1)   | -38.6(4)    |
| C(27)-C(29)-N(1)-S(1)   | 134.1(2)    |
| C(28)-C(29)-N(1)-Ir(1)  | 142.4(3)    |
| N(2)-C(29)-N(1)-Ir(1)   | -44.9(3)    |
| O(5)-C(20)-N(2)-C(22)   | -169.4(3)   |
| C(21)-C(20)-N(2)-C(22)  | 9.7(5)      |
| O(5)-C(20)-N(2)-C(29)   | 19.6(5)     |
| C(21)-C(20)-N(2)-C(29)  | -161.2(3)   |
| C(23)-C(22)-N(2)-C(20)  | 13.3(5)     |
| C(27)-C(22)-N(2)-C(20)  | -170.0(3)   |
| C(23)-C(22)-N(2)-C(29)  | -174.5(3)   |
| N(2)-C(20)-N(2)-C(29)   | 2.3(3)      |
| C(28)-C(29)-N(2)-C(20)  | 171.2(3)    |
| N(1)-C(29)-N(2)-C(20)   | -3.0(4)     |
| C(28)-C(29)-N(2)-C(22)  | -1.3(3)     |
| N(1)-C(29)-N(2)-C(22)   | -175.5(3)   |
| O(4)-C(18)-O(3)-Ir(1)   | 7.3(5)      |
| C(19)-C(18)-O(3)-Ir(1)  | -172.74(19) |
| N(2)-C(20)-O(5)-Ir(1)   | 16.5(4)     |
| C(21)-C(20)-O(5)-Ir(1)  | -162.7(2)   |
| C(29)-N(1)-S(1)-O(1)    | -175.8(2)   |
| Ir(1)-N(1)-S(1)-O(1)    | 3.1(2)      |
| C(29)-N(1)-S(1)-O(2)    | 54.7(3)     |
| Ir(1)-N(1)-S(1)-O(2)    | -126.47(18) |
| C(29)-N(1)-S(1)-C(11)   | -60.1(2)    |
| Ir(1)-N(1)-S(1)-C(11)   | 118.74(19)  |
| C(17)-C(11)-S(1)-O(1)   | -129.6(3)   |
| C(12)-C(11)-S(1)-O(1)   | 54.2(3)     |
| C(17)-C(11)-S(1)-O(2)   | -1.9(3)     |
| C(12)-C(11)-S(1)-O(2)   | -178.1(2)   |
| C(17)-C(11)-S(1)-N(1)   | 117.1(3)    |
Symmetry transformations used to generate equivalent atoms:

Table S25. Hydrogen bonds for 6. [Å and °].

| D-H...A          | d(D-H) | d(H...A) | d(D...A) | <(DHA) |
|------------------|--------|----------|----------|--------|
| C(28)-H(28)...O(2)#1 | 0.93   | 2.57     | 3.428(4) | 153.5  |
| C(28)-H(28)...O(2)  | 0.93   | 2.45     | 2.944(4) | 113.5  |
| C(12)-H(12)...O(3)  | 0.93   | 2.55     | 3.409(4) | 154.5  |
| C(12)-H(12)...F(1)   | 0.93   | 2.57     | 3.132(4) | 119.1  |

Symmetry transformations used to generate equivalent atoms:

#1 -x+1,-y+1,-z+2
Crystallographic data of 18 (Scheme 4)
**Table S26.** Crystal data and structure refinement for 18

| Property                                      | Value                                      |
|-----------------------------------------------|--------------------------------------------|
| Identification code                           | No1                                        |
| Empirical formula                             | C₁₈H₁₈N₂O₃S                               |
| Formula weight                                 | 342.40                                     |
| Temperature                                    | 223(2) K                                   |
| Wavelength                                     | 0.71073 Å                                  |
| Crystal system                                 | Monoclinic                                 |
| Space group                                    | P2₁/c                                      |
| Unit cell dimensions                          | a = 17.1548(8) Å, b = 5.2806(2) Å, c = 18.3203(8) Å |
|                                               | α = 90°, β = 97.2991(19)°, γ = 90°.        |
| Volume                                         | 1646.14(12) Å³                            |
| Z                                              | 4                                          |
| Density (calculated)                          | 1.382 Mg/m³                                |
| Absorption coefficient                        | 0.216 mm⁻¹                                 |
| F(000)                                        | 720                                        |
| Crystal size                                   | 0.210 x 0.150 x 0.100 mm³                  |
| Theta range for data collection               | 2.242 to 28.355°.                         |
| Index ranges                                   | -22<=h<=22, -7<=k<=7, -24<=l<=24            |
| Reflections collected                         | 71612                                      |
| Independent reflections                       | 4095 [R(int) = 0.0654]                     |
| Completeness to theta = 25.242°               | 100.0 %                                    |
| Absorption correction                         | Bruker SADABS                              |
| Max. and min. transmission                    | 0.7457 and 0.7134                          |
| Refinement method                             | Full-matrix least-squares on F²            |
| Data / restraints / parameters                 | 4095 / 0 / 220                             |
| Goodness-of-fit on F²                          | 1.044                                      |
| Final R indices [I>2sigma(I)]                 | R1 = 0.0454, wR2 = 0.1096                  |
| R indices (all data)                           | R1 = 0.0693, wR2 = 0.1230                  |
| Extinction coefficient                         | n/a                                        |
| Largest diff. peak and hole                    | 0.368 and -0.364 e.Å⁻³                    |
Table S27. Atomic coordinates ($\times 10^4$) and equivalent isotropic displacement parameters ($\text{Å}^2 \times 10^3$) for 18. U(eq) is defined as one third of the trace of the orthogonalized $U_{ij}$ tensor.

|     | x     | y     | z     | U(eq) |
|-----|-------|-------|-------|-------|
| N(1)| 1335(1)| 5357(3)| 1071(1)| 33(1) |
| C(1)| 1889(1)| 7355(3)| 1114(1)| 32(1) |
| C(2)| 2099(1)| 7867(3)| 443(1) | 35(1) |
| C(3)| 1669(1)| 6157(3)| -64(1) | 34(1) |
| C(4)| 1654(1)| 5815(4)| -823(1)| 44(1) |
| C(5)| 1188(1)| 3931(4)| -1161(1)| 51(1) |
| C(6)| 734(1) | 2397(4)| -763(1)| 49(1) |
| C(7)| 740(1) | 2689(4)| -13(1) | 42(1) |
| C(8)| 1217(1)| 4575(3)| 330(1) | 33(1) |
| C(9)| 950(1) | 4324(3)| 1634(1)| 37(1) |
| C(10)| 832(1)| 5957(4)| 2278(1)| 44(1) |
| O(1)| 704(1) | 2183(3)| 1571(1)| 55(1) |
| N(2)| 2215(1)| 8304(3)| 1805(1)| 37(1) |
| S(1)| 2941(1)| 6747(1)| 2268(1)| 39(1) |
| O(2)| 2738(1)| 4118(3)| 2202(1)| 49(1) |
| O(3)| 3077(1)| 7916(3)| 2973(1)| 56(1) |
| C(11)| 3781(1)| 7191(3)| 1825(1)| 37(1) |
| C(12)| 3977(1)| 5431(4)| 1321(1)| 46(1) |
| C(13)| 4661(1)| 5740(5)| 1004(1)| 54(1) |
| C(14)| 5152(1)| 7792(5)| 1177(1)| 52(1) |
| C(15)| 4935(1)| 9546(4)| 1672(1)| 51(1) |
| C(16)| 4260(1)| 9281(4)| 1998(1)| 46(1) |
| C(17)| 5908(2)| 8068(7)| 851(2) | 82(1) |
| C(18)| 2676(1)| 9797(4)| 258(1) | 49(1) |
Table S28. Bond lengths [Å] and angles [°] for 18.

| Bond                  | Length  |
|-----------------------|---------|
| N(1)-C(9)             | 1.404(2) |
| N(1)-C(8)             | 1.409(2) |
| N(1)-C(1)             | 1.416(2) |
| C(1)-C(2)             | 1.351(2) |
| C(1)-N(2)             | 1.411(2) |
| C(2)-C(3)             | 1.431(3) |
| C(2)-C(18)            | 1.489(3) |
| C(3)-C(4)             | 1.399(3) |
| C(3)-C(8)             | 1.401(2) |
| C(4)-C(5)             | 1.374(3) |
| C(4)-H(4)             | 0.9400  |
| C(5)-C(6)             | 1.393(3) |
| C(5)-H(5)             | 0.9400  |
| C(6)-C(7)             | 1.380(3) |
| C(6)-H(6)             | 0.9400  |
| C(7)-C(8)             | 1.387(3) |
| C(7)-H(7)             | 0.9400  |
| C(9)-O(1)             | 1.208(2) |
| C(9)-C(10)            | 1.495(3) |
| C(10)-H(10A)          | 0.9700  |
| C(10)-H(10B)          | 0.9700  |
| C(10)-H(10C)          | 0.9700  |
| N(2)-S(1)             | 1.6359(16) |
| N(2)-H(2N)            | 0.8700  |
| S(1)-O(3)             | 1.4239(15) |
| S(1)-O(2)             | 1.4324(15) |
| S(1)-C(11)            | 1.757(2) |
| C(11)-C(12)           | 1.381(3) |
| C(11)-C(16)           | 1.389(3) |
| C(12)-C(13)           | 1.383(3) |
| C(12)-H(12)           | 0.9400  |
| C(13)-C(14)           | 1.384(3) |
| C(13)-H(13)           | 0.9400  |
| C(14)-C(15)           | 1.380(3) |
C(14)-C(17) 1.502(3)
C(15)-C(16) 1.376(3)
C(15)-H(15) 0.9400
C(16)-H(16) 0.9400
C(17)-H(17A) 0.9700
C(17)-H(17B) 0.9700
C(17)-H(17C) 0.9700
C(18)-H(18A) 0.9700
C(18)-H(18B) 0.9700
C(18)-H(18C) 0.9700

C(9)-N(1)-C(8) 124.78(15)
C(9)-N(1)-C(1) 128.61(15)
C(8)-N(1)-C(1) 106.59(14)
C(2)-C(1)-N(2) 128.69(16)
C(2)-C(1)-N(1) 110.68(15)
N(2)-C(1)-N(1) 120.09(15)
C(1)-C(2)-C(3) 106.81(15)
C(1)-C(2)-C(18) 127.27(18)
C(3)-C(2)-C(18) 125.92(17)
C(4)-C(3)-C(8) 119.57(17)
C(4)-C(3)-C(2) 132.00(17)
C(8)-C(3)-C(2) 108.39(15)
C(5)-C(4)-C(3) 118.54(18)
C(5)-C(4)-H(4) 120.7
C(3)-C(4)-H(4) 120.7
C(4)-C(5)-C(6) 121.11(19)
C(4)-C(5)-H(5) 119.4
C(6)-C(5)-H(5) 119.4
C(7)-C(6)-C(5) 121.50(19)
C(7)-C(6)-H(6) 119.2
C(5)-C(6)-H(6) 119.2
C(6)-C(7)-C(8) 117.41(18)
C(6)-C(7)-H(7) 121.3
C(8)-C(7)-H(7) 121.3
C(7)-C(8)-C(3) 121.86(17)
| Bond                  | Angle (°)       |
|-----------------------|----------------|
| C(7)-C(8)-N(1)        | 130.65(16)     |
| C(3)-C(8)-N(1)        | 107.46(15)     |
| O(1)-C(9)-N(1)        | 119.02(17)     |
| O(1)-C(9)-C(10)       | 122.34(17)     |
| N(1)-C(9)-C(10)       | 118.60(16)     |
| C(9)-C(10)-H(10A)     | 109.5          |
| C(9)-C(10)-H(10B)     | 109.5          |
| H(10A)-C(10)-H(10B)   | 109.5          |
| C(9)-C(10)-H(10C)     | 109.5          |
| H(10A)-C(10)-H(10C)   | 109.5          |
| H(10B)-C(10)-H(10C)   | 109.5          |
| C(1)-N(2)-S(1)        | 118.42(12)     |
| C(1)-N(2)-H(2N)       | 120.8          |
| S(1)-N(2)-H(2N)       | 120.8          |
| O(3)-S(1)-O(2)        | 120.42(10)     |
| O(3)-S(1)-N(2)        | 106.17(9)      |
| O(2)-S(1)-N(2)        | 106.43(8)      |
| O(3)-S(1)-C(11)       | 108.18(9)      |
| O(2)-S(1)-C(11)       | 107.16(9)      |
| N(2)-S(1)-C(11)       | 107.95(8)      |
| C(12)-C(11)-C(16)     | 120.04(18)     |
| C(12)-C(11)-S(1)      | 120.19(14)     |
| C(16)-C(11)-S(1)      | 119.75(15)     |
| C(11)-C(12)-C(13)     | 119.49(19)     |
| C(11)-C(12)-H(12)     | 120.3          |
| C(13)-C(12)-H(12)     | 120.3          |
| C(12)-C(13)-C(14)     | 121.4(2)       |
| C(12)-C(13)-H(13)     | 119.3          |
| C(14)-C(13)-H(13)     | 119.3          |
| C(15)-C(14)-C(13)     | 117.9(2)       |
| C(15)-C(14)-C(17)     | 121.0(2)       |
| C(13)-C(14)-C(17)     | 121.1(2)       |
| C(16)-C(15)-C(14)     | 122.01(19)     |
| C(16)-C(15)-H(15)     | 119.0          |
| C(14)-C(15)-H(15)     | 119.0          |
| C(15)-C(16)-C(11)     | 119.2(2)       |
C(15)-C(16)-H(16)  120.4
C(11)-C(16)-H(16)  120.4
C(14)-C(17)-H(17A)  109.5
C(14)-C(17)-H(17B)  109.5
H(17A)-C(17)-H(17B)  109.5
C(14)-C(17)-H(17C)  109.5
H(17A)-C(17)-H(17C)  109.5
H(17B)-C(17)-H(17C)  109.5
C(2)-C(18)-H(18A)  109.5
C(2)-C(18)-H(18B)  109.5
H(18A)-C(18)-H(18B)  109.5
C(2)-C(18)-H(18C)  109.5
H(18A)-C(18)-H(18C)  109.5
H(18B)-C(18)-H(18C)  109.5

Symmetry transformations used to generate equivalent atoms:
**Table S29.** Anisotropic displacement parameters (Å² x 10³) for 18. The anisotropic displacement factor exponent takes the form: -$2\pi^2 [ h^2 a^* 2 U_{11} + \ldots + 2 h k a^* b^* U_{12} ]$

|       | U¹¹ | U²² | U³³ | U²³ | U¹³ | U¹² |
|-------|-----|-----|-----|-----|-----|-----|
| N(1)  | 35(1)| 31(1)| 34(1)| 3(1)| 8(1)| -4(1) |
| C(1)  | 33(1)| 28(1)| 35(1)| 3(1)| 3(1)| 0(1)  |
| C(2)  | 34(1)| 33(1)| 38(1)| 8(1)| 4(1)| -2(1) |
| C(3)  | 36(1)| 33(1)| 35(1)| 5(1)| 6(1)| 2(1)  |
| C(4)  | 50(1)| 47(1)| 36(1)| 9(1)| 9(1)| 0(1)  |
| C(5)  | 69(1)| 52(1)| 33(1)| -1(1)| 4(1)| 1(1)  |
| C(6)  | 57(1)| 44(1)| 44(1)| -4(1)| -2(1)| -7(1) |
| C(7)  | 45(1)| 38(1)| 44(1)| 1(1)| 6(1)| -7(1) |
| C(8)  | 35(1)| 31(1)| 34(1)| 3(1)| 7(1)| 1(1)  |
| C(9)  | 39(1)| 34(1)| 41(1)| 6(1)| 12(1)| 1(1) |
| C(10) | 49(1)| 46(1)| 39(1)| 4(1)| 16(1)| 1(1) |
| O(1)  | 76(1)| 37(1)| 57(1)| 4(1)| 29(1)| -12(1) |
| N(2)  | 39(1)| 33(1)| 38(1)| -1(1)| 2(1)| 2(1)  |
| S(1)  | 40(1)| 42(1)| 35(1)| 5(1)| 2(1)| 0(1)  |
| O(2)  | 46(1)| 41(1)| 60(1)| 15(1)| 7(1)| -1(1) |
| O(3)  | 57(1)| 74(1)| 34(1)| -2(1)| 1(1)| 4(1)  |
| C(11) | 36(1)| 38(1)| 34(1)| 3(1)| -3(1)| -4(1) |
| C(12) | 49(1)| 43(1)| 44(1)| -6(1)| 5(1)| -13(1) |
| C(13) | 58(1)| 60(1)| 46(1)| -8(1)| 14(1)| -10(1) |
| C(14) | 46(1)| 68(1)| 40(1)| 6(1)| 2(1)| -16(1) |
| C(15) | 49(1)| 53(1)| 48(1)| 3(1)| -6(1)| -19(1) |
| C(16) | 52(1)| 42(1)| 41(1)| -4(1)| -5(1)| -6(1)  |
| C(17) | 64(2)| 119(3)| 66(2)| -6(2)| 22(1)| -34(2) |
| C(18) | 46(1)| 49(1)| 53(1)| 16(1)| 5(1)| -13(1) |
Table S30. Hydrogen coordinates (\( \times 10^4 \)) and isotropic displacement parameters (Å\(^2\)x 10\(^3\)) for 18.

|     | x    | y    | z    | U(eq) |
|-----|------|------|------|-------|
| H(4) | 1956 | 6851 | -1096| 53    |
| H(5) | 1175 | 3673 | -1670| 62    |
| H(6) | 416  | 1134 | -1009| 59    |
| H(7) | 433  | 1651 | 254  | 51    |
| H(10A)|354|5454|2470|66    |
| H(10B)|791|7714|2123|66    |
| H(10C)|1276|5763|2658|66    |
| H(2N)|2035|9684|1982|44    |
| H(12)|3648|4034|1194|55    |
| H(13)|4795|4532| 665 |65    |
| H(15)|5257|10965|1789|62    |
| H(16)|4125|10499|2335|55    |
| H(17A)|5815|9037| 399 |123   |
| H(17B)|6107|6404| 747 |123   |
| H(17C)|6292|8939|1198|123   |
| H(18A)|2834|10848| 685 |74    |
| H(18B)|2436|10847| -144|74    |
| H(18C)|3133|8953| 111 |74    |
Table S31. Torsion angles [°] for 18.

| Torsion Angle                  | Torsion Angle (°) |
|--------------------------------|-------------------|
| C(9)-N(1)-C(1)-C(2)           | -177.34(17)       |
| C(8)-N(1)-C(1)-C(2)           | 1.38(19)          |
| C(9)-N(1)-C(1)-N(2)           | 10.3(3)           |
| C(8)-N(1)-C(1)-N(2)           | -170.94(15)       |
| N(2)-C(1)-C(2)-C(3)           | 171.64(17)        |
| N(1)-C(1)-C(2)-C(3)           | 0.2(2)            |
| N(2)-C(1)-C(2)-C(18)          | -7.3(3)           |
| N(1)-C(1)-C(2)-C(18)          | -178.83(18)       |
| C(1)-C(2)-C(3)-C(4)           | -179.5(2)         |
| C(18)-C(2)-C(3)-C(4)          | -0.5(3)           |
| C(1)-C(2)-C(3)-C(8)           | -1.7(2)           |
| C(18)-C(2)-C(3)-C(8)          | 177.34(18)        |
| C(8)-C(3)-C(4)-C(5)           | 0.4(3)            |
| C(2)-C(3)-C(4)-C(5)           | 178.1(2)          |
| C(3)-C(4)-C(5)-C(6)           | 0.4(3)            |
| C(4)-C(5)-C(6)-C(7)           | -0.6(3)           |
| C(5)-C(6)-C(7)-C(8)           | 0.0(3)            |
| C(6)-C(7)-C(8)-C(3)           | 0.9(3)            |
| C(6)-C(7)-C(8)-N(1)           | 178.60(19)        |
| C(4)-C(3)-C(8)-C(7)           | -1.1(3)           |
| C(2)-C(3)-C(8)-C(7)           | -179.30(17)       |
| C(4)-C(3)-C(8)-N(1)           | -179.30(16)       |
| C(2)-C(3)-C(8)-N(1)           | 2.5(2)            |
| C(9)-N(1)-C(8)-C(7)           | -1.6(3)           |
| C(1)-N(1)-C(8)-C(7)           | 179.65(19)        |
| C(9)-N(1)-C(8)-C(3)           | 176.41(16)        |
| C(1)-N(1)-C(8)-C(3)           | -2.37(19)         |
| C(8)-N(1)-C(9)-O(1)           | 25.4(3)           |
| C(1)-N(1)-C(9)-O(1)           | -156.14(18)       |
| C(8)-N(1)-C(9)-C(10)          | -152.32(17)       |
| C(1)-N(1)-C(9)-C(10)          | 26.2(3)           |
| C(2)-C(1)-N(2)-S(1)           | -90.1(2)          |
| N(1)-C(1)-N(2)-S(1)           | 80.69(19)         |
| C(1)-N(2)-S(1)-O(3)           | -172.27(14)       |
| Bond                  | Torsion Angle |
|----------------------|---------------|
| C(1)-N(2)-S(1)-O(2)  | -42.84(16)    |
| C(1)-N(2)-S(1)-C(11) | 71.92(15)     |
| O(3)-S(1)-C(11)-C(12)| 150.59(16)    |
| O(2)-S(1)-C(11)-C(12)| 19.36(18)     |
| N(2)-S(1)-C(11)-C(12)| -94.92(17)    |
| O(3)-S(1)-C(11)-C(16)| -27.57(18)    |
| O(2)-S(1)-C(11)-C(16)| -158.80(15)   |
| N(2)-S(1)-C(11)-C(16)| 86.92(16)     |
| C(16)-C(11)-C(12)-C(13)| 1.4(3) |
| S(1)-C(11)-C(12)-C(13)| -176.72(16)  |
| C(11)-C(12)-C(13)-C(14)| -0.6(3) |
| C(12)-C(13)-C(14)-C(15)| -0.7(3) |
| C(12)-C(13)-C(14)-C(17)| 177.9(2) |
| C(13)-C(14)-C(15)-C(16)| 1.0(3) |
| C(17)-C(14)-C(15)-C(16)| -177.5(2) |
| C(14)-C(15)-C(16)-C(11)| -0.2(3) |
| C(12)-C(11)-C(16)-C(15)| -1.1(3) |
| S(1)-C(11)-C(16)-C(15)| 177.10(15) |

Symmetry transformations used to generate equivalent atoms:
Appendix III

Cartesian Coordinates of DFT-Optimized Structures
**F12COOH**

\( E(\text{RM62X}) = -922.1792271 \)

# of negative frequency = 0

| C | 0.3803 | -0.0800 | -0.0030 |
| H | 0.5819 | 0.0450 | 0.0119 |
| F | 0.3929 | -1.4462 | 0.8167 |
| O | 0.2249 | 0.3180 | 0.0028 |
| H | 0.2113 | -0.0689 | 0.0036 |
| F | 0.8829 | 0.0050 | 0.0112 |

**FCH2COOH**

\( E(\text{RM62X}) = -1148.2893769 \)

# of negative frequency = 0

| C | 0.2505 | -0.8027 | -0.0027 |
| H | 0.1730 | 0.0126 | 0.0014 |
| F | 0.2092 | -1.4362 | 0.8167 |
| Cl | 1.7890 | 0.0750 | 0.0051 |
| C | 0.2146 | 0.0497 | 0.0176 |
| O | 0.9240 | 1.3180 | 0.0028 |
| H | 0.0663 | -0.0689 | 0.0036 |
| F | 0.8158 | 0.0050 | 0.0112 |

**CICH2COOH**

\( E(\text{RM62X}) = -574.6466997 \)

# of negative frequency = 0

| C | 0.0556 | 0.0169 | 0.0000 |
| H | 0.0355 | -0.0406 | 0.0000 |
| C | 0.5136 | 0.0022 | 0.0000 |
| H | 0.7892 | -0.3146 | 0.8877 |
| F | 1.8443 | 0.1505 | 0.0000 |

**OMe**

\( E(\text{RM62X}) = -689.16744820 \)

# of negative frequency = 0

| C | -0.6960 | 1.3118 | 0.0000 |
| H | -1.5694 | -0.7116 | -0.0005 |
| F | -2.3713 | -0.7117 | 0.0005 |

**MeO**

\( E(\text{RM62X}) = -919.73968979 \)

# of negative frequency = 0

| C | -2.1288 | 0.2389 | 0.0000 |
| H | -2.9410 | -0.1401 | -0.0005 |
| Element | C  | C  | F  |
|---------|----|----|----|
| **F₂CHCO₂H** | | | |
| **E(RM062X) = -427.58077207** | | | |
| # of negative frequency = 0 | | | |
| C | 0.69764 | 0.44409 | 0.02342 |
| C | -0.79716 | 0.11911 | 0.00544 |
| H | 0.85032 | 1.51999 | 0.08170 |
| F | 1.27642 | -0.03841 | -1.09506 |
| O | -1.64022 | 0.96502 | 0.04390 |
| O | -1.01496 | -1.19106 | -0.05568 |
| H | -1.97102 | -1.34040 | -0.06310 |
| **Cl₂CHCO₂H** | | | |
| **E(RM062X) = -328.32739466** | | | |
| # of negative frequency = 0 | | | |
| C | 0.24417 | -0.00381 | -0.52854 |
| C | -1.21743 | -0.00880 | -0.10868 |
| Cl | 1.05105 | 1.46843 | 0.05125 |
| H | 0.27586 | 0.00118 | -1.61003 |
| Cl | 1.05184 | -1.46591 | 0.04452 |
| O | -2.10384 | 0.00941 | -0.91041 |
| O | -1.37838 | -0.01063 | 1.21150 |
| H | -2.32757 | -0.00655 | 1.39658 |
| **CF₃CO₂H** | | | |
| **E(RM062X) = -526.84516538** | | | |
| # of negative frequency = 0 | | | |
| C | -0.59874 | 0.00113 | 0.00011 |
| C | 0.93690 | -0.16219 | 0.00133 |
| F | -1.18849 | -1.17993 | -0.00537 |
| F | -0.98854 | 0.60026 | -1.07701 |
| F | -0.99169 | 0.67129 | 1.08124 |
| O | 1.48290 | -1.21820 | -0.00223 |
| O | 1.51858 | 1.03276 | 0.00030 |
| H | 2.47775 | 0.90539 | 0.00113 |
| **C₂F₅CO₂H** | | | |
| **E(RM062X) = -764.65696724** | | | |
| # of negative frequency = 0 | | | |
| C | 0.21289 | -0.51296 | 0.00031 |
| C | 1.41817 | 0.44596 | -0.00060 |
| F | 0.26815 | -1.29345 | -1.08771 |
| C | -1.14699 | 0.20860 | -0.00021 |
| F | 0.26826 | -1.29183 | 1.08953 |
| O | 1.32482 | 1.63359 | 0.00052 |
| O | 2.54530 | -0.25580 | -0.00071 |
| H | 3.29168 | 0.36844 | -0.00032 |
| F | -1.27410 | 0.96338 | -1.08333 |
| F | -1.27503 | 0.96410 | 1.08232 |
| F | -2.11548 | -0.70135 | -0.00027 |