Supporting Information

Ruthenium-Catalyzed Remote C5-Sulfonation of N-Alkyl-8-Aminoquinolines

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General Remarks

All catalytic reactions were carried out in pre-dried glassware under an argon atmosphere. All solvents were purchased from Energy Chemical, J&K Scientific and used directly without further purification. Substrates 1a and 1d-h were synthesized according to previously described procedures. Other chemicals were obtained from commercial sources and were used without further purification, unless otherwise noted. TLC: Merck TLC Silica gel 60 F254, TLC Aluminum plates. Detection under UV light at 254 nm. Chromatography: Separations were carried out on Qingdao silica gel (60, 0.040-0.063 mm). ^1H-NMR spectra were recorded on a 400 MHz Brucker NMR spectrometer in CDCl3 (all signals are reported in ppm with the internal chloroform signal at 7.26 ppm). ^13C-NMR spectra were recorded with ^1H-decoupling on a 101 or 176 MHz Brucker spectrometer in CDCl3 (all signals are reported in ppm with the internal chloroform signal at 77.16 ppm). Infrared Spectroscopy (IR) were measured on a Bruker FT-IR Alpha device. High-resolution mass spectra (HRMS) were measured on a mass spectrometer (ESI-oa-TOF). Melting points (M. p.) were measured on a melting point with a thermometer and the reported values were uncorrected.

Preparation and Characterization Data for Compounds 1

General Procedure A: Literature procedure was used for the synthesis of 1.[1] Pd(OAc)2 (12.8 mg, 1.9 mol %) and BINAP (35.5 mg, 1.9 mol %) were preheated at 85 °C for 30 min in 5 mL of toluene. The mixture was added to a 50 mL reaction bomb flask containing bromoquinoline (3.0 mmol), tert-butylamine (329.1 mg, 4.5 mmol), and sodium tert-butoxide (403.6 mg, 4.2 mmol) in 10 mL of toluene. The resulting reaction mixture was dark purple and heated at 110 °C for 24 h. The solution was then cooled to room temperature in air, diluted with EA, and washed with H2O and brine. The organic layer was collected, dried over Na2SO4. Removal of solvent in vacuo yielded a dark brown oil, which was purified by flashing through a column of silica with (PE/EA: 20/1) as the eluent to yield the corresponding products.

N-(tert-butyl)-quinolin-8-amine (1a):

The general procedure A was followed using 8-bromoquinoline (624 mg, 3.0 mmol). Purification by column chromatography on silica gel (PE/EA: 20/1) yielded 1a (388 mg, 70%) as a yellow liquid. ^1H-NMR (400 MHz, CDCl3) δ 8.70 (d, J = 1.6 Hz, 1H), 8.03 (d, J = 8.2 Hz, 1H), 7.34 (d, J = 8.0 Hz, 2H), 7.02 (d, J = 8.1 Hz, 1H), 6.95 (d, J = 7.6 Hz, 1H), 6.47 (s, s, 1H), 1.54 (s, 9H). ^13C-NMR (101 MHz, CDCl3) δ 146.6, 143.4, 139.0, 136.2, 129.0, 127.6, 121.3, 113.3, 107.2, 50.7, 29.6. IR (neat): 3373, 2974, 1574, 1526, 1381, 1230, 791 cm⁻¹. HR-MS (ESI) m/z calcd. for C13H16N2 ([M+H]^+): 201.1392, found: 201.1381.
N-(tert-butyl)-3-methylquinolin-8-amine (1d):

The general procedure A was followed using 8-bromo-3-methylquinoline (666 mg, 3.0 mmol). Purification by column chromatography on silica gel (PE/EA: 20/1) yielded 1d (328 mg, 55%) as a yellow liquid. 

$^1$H-NMR (400 MHz, CDCl$_3$) $\delta$ 8.54 (d, $J = 2.1$ Hz, 1H), 7.80 (s, 1H), 7.32 (dd, $J = 7.9$, 7.9 Hz, 1H), 7.01 – 6.86 (m, 2H), 2.48 (s, 3H), 1.53 (s, 9H). 

$^{13}$C-NMR (101 MHz, CDCl$_3$) $\delta$ 148.5, 143.3, 137.4, 135.0, 130.5, 128.8, 127.6, 112.9, 106.6, 50.7, 29.6, 18.7. 

IR (neat): 3373, 2974, 1576, 1521, 1391, 1228, 748 cm$^{-1}$. 

HR-MS (ESI) m/z calcd. for C$_{14}$H$_{19}$N$_2$ ([M+H]$^+$) 215.1548, found: 215.1537.

N-(tert-butyl)-6-methylquinolin-8-amine (1e):

The general procedure A was followed using 8-bromo-6-methylquinoline (666 mg, 3.0 mmol). Purification by column chromatography on silica gel (PE/EA: 20/1) yielded 1e (358 mg, 60%) as a yellow liquid. 

$^1$H-NMR (400 MHz, CDCl$_3$) $\delta$ 8.62 (dd, $J = 4.2$, 1.5 Hz, 1H), 7.94 (dd, $J = 8.2$, 1.1 Hz, 1H), 7.31 (dd, $J = 8.2$, 4.2 Hz, 1H), 6.84 (s, 2H), 2.47 (s, 3H), 1.53 (s, 9H). 

$^{13}$C-NMR (101 MHz, CDCl$_3$) $\delta$ 145.8, 143.0, 137.9, 137.4, 135.5, 129.0, 121.4, 112.6, 109.3, 50.6, 29.6, 22.8. 

IR (neat): 3371, 2925, 2855, 1574, 1528, 1383, 1232, 830 cm$^{-1}$. 

HR-MS (ESI) m/z calcd. for C$_{14}$H$_{19}$N$_2$ ([M+H]$^+$) 215.1548, found: 215.1541.

N-(tert-butyl)-6-(trifluoromethyl)-quinolin-8-amine (1f):

The general procedure A was followed using 8-bromo-6-(trifluoromethyl)-quinoline (828 mg, 3.0 mmol). Purification by column chromatography on silica gel (PE/EA: 10/1) yielded 1f (455 mg, 60%) as a yellow solid. 

M. p.: 71-73 °C. 

$^1$H-NMR (400 MHz, CDCl$_3$) $\delta$ 8.76 (s, 1H), 8.09 (s, 1H), 7.42 (s, 1H), 6.96 (s, 1H), 6.62 (s, 1H), 1.53 (s, 9H). 

$^{13}$C-NMR (101 MHz, CDCl$_3$) $\delta$ 148.4, 143.9, 139.8, 137.2, 129.4 (q, $J_{C\text{-}F}$ = 31.5 Hz), 127.8, 124.6 (d, $J_{C\text{-}F}$ = 272.5 Hz), 122.4, 110.4 (q, $J_{C\text{-}F}$ = 4.7 Hz), 101.6 (d, $J_{C\text{-}F}$ = 3.2 Hz), 50.9, 29.3. 

$^{19}$F-NMR (377 MHz, CDCl$_3$) $\delta$ -63.0 (s). 

IR (neat): 3383, 2965, 2929, 1579, 1523, 1395, 855 cm$^{-1}$. 

HR-MS (ESI) m/z calcd. for C$_{14}$H$_{16}$F$_3$N$_2$ ([M+H]$^+$) 269.1266, found: 269.1260.

N-(tert-butyl)-6-fluoroquinolin-8-amine (1g):
The general procedure A was followed using 8-bromo-6-fluoroquinoline (678 mg, 3.0 mmol). Purification by column chromatography on silica gel (PE/EA: 20/1) yielded 1g (243 mg, 40%) as a yellow solid. **M. p.:** 60-62 °C. \(^{1}H\)-NMR (400 MHz, CDCl\(_3\)) \(\delta\) 8.60 (dd, \(J = 4.2, 1.5\) Hz, 1H), 7.94 (dd, \(J = 8.3, 1.6\) Hz, 1H), 7.34 (dd, \(J = 8.1, 4.1\) Hz, 1H), 6.68 – 6.55 (m, 3H), 1.53 (s, 9H). \(^{13}C\)-NMR (101 MHz, CDCl\(_3\)) \(\delta\) 162.2 (d, \(J_{C-F} = 242.5\) Hz), 145.5 (d, \(J_{C-F} = 2.6\) Hz), 145.1 (d, \(J_{C-F} = 13.9\) Hz), 136.4, 135.7 (d, \(J_{C-F} = 6.0\) Hz), 129.5 (d, \(J_{C-F} = 13.1\) Hz), 122.2, 96.7 (d, \(J_{C-F} = 3-0.9\) Hz), 95.7 (d, \(J_{C-F} = 22.8\) Hz), 50.8, 29.3. \(^{19}F\)-NMR (377 MHz, CDCl\(_3\)) \(\delta\) -110.6 (s). IR (neat): 3369, 2971, 2931, 1576, 1521, 1391, 1224, 834 cm\(^{-1}\). **HR-MS** (ESI) m/z calcd. for C\(_{13}\)H\(_{16}\)FN\(_2\) ([M+H]\(^+\)) 219.1298, found: 219.1288.

\[\text{N-(tert-butyl)-3, 6-dimethylquinolin-8-amine (1h):}\]

The general procedure A was followed using 8-bromo-3,6-dimethylquinoline (708 mg, 3.0 mmol). Purification by column chromatography on silica gel (PE/EA: 10/1) yielded 1h (377 mg, 59%) as a yellow solid. **M. p.:** 49-51 °C. \(^{1}H\)-NMR (400 MHz, CDCl\(_3\)) \(\delta\) 8.46 (d, \(J = 1.9\) Hz, 1H), 7.69 (s, 1H), 6.72 (d, \(J = 3.6\) Hz, 2H), 6.31 (s, 1H), 2.45 (s, 3H), 2.45 (s, 3H), 1.53 (s, 9H). \(^{13}C\)-NMR (101 MHz, CDCl\(_3\)) \(\delta\) 147.6, 142.9, 137.4, 136.3, 134.4, 130.6, 128.8, 112.2, 108.7, 50.7, 29.6, 22.8, 18.7. IR (neat): 3381, 2965, 1574, 1515, 1383, 1230, 789 cm\(^{-1}\). **HR-MS** (ESI) m/z calcd. for C\(_{15}\)H\(_{21}\)N\(_2\) ([M+H]\(^+\)) 229.1705, found: 229.1692.
Table S1: Optimization of Catalytic Reaction Conditions.\textsuperscript{a}

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<th>Entry</th>
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<th>Solvent</th>
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<td>K(_2)CO(_3)</td>
<td>DME</td>
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\textsuperscript{a} Reaction conditions: 1\textsuperscript{a} (0.25 mmol), 2\textsuperscript{a} (0.75 mmol), catalyst (5.0 mol%), base (0.50 mmol), solvent (1.0 ml), 120 °C, 16 h, Ar atomosphere. \textsuperscript{b} Yield of \textsuperscript{1}H-NMR with 1,3,5-trimethoxybenzene as the internal standard. \textsuperscript{c} Isolated yield in parentheses. \textsuperscript{d} 2\textsuperscript{a} (0.50 mmol). \textsuperscript{e} At 110 °C. \textsuperscript{f} At 130 °C. \textsuperscript{g} Catalyst (10.0 mol %).
Preparation and Characterization Data for Compounds 3

General Procedure B:

A 15 mL pressure sealed tube was equipped with a magnetic stir bar and charged with 1 (0.25 mmol), 2 (0.75 mmol), [RuCl$_2$(p-cymene)]$_2$ (7.7 mg, 5.0 mol %), and K$_2$CO$_3$ (69 mg, 0.50 mmol). The tube was degassed three times with argon, followed by the addition of 1.0 mL anhydrous DME. The mixture was allowed to stir at 120°C for 16 h, and then cooled down to room temperature. The reaction solution was diluted with EtOAc and filtered through a short pad of celite. The filtrate was concentrated in vacuo and the resulting residue was purified by column chromatography on silica gel to yield the corresponding products 3.

_N-(tert-butyl)-5-tosylquinolin-8-amine (3aa)_:

General procedure B was followed using _N-(tert-butyl)-quinolin-8-amine_ 1a (50 mg, 0.25 mmol) and 4-methylbenzene-1-sulfonyl chloride 2a (143 mg, 0.75 mmol). Purification by column chromatography on silica gel (PE/EA: 10/1) yielded 3aa (73 mg, 82%) as a pale yellow solid. M. p.: 162-164 °C. $^1$H-NMR (400 MHz, CDCl$_3$) δ 8.85 (d, $J$ = 8.6 Hz, 1H), 8.64 (d, $J$ = 1.6 Hz, 1H), 8.30 (d, $J$ = 8.6 Hz, 1H), 7.79 (d, $J$ = 7.7 Hz, 2H), 7.41 (dd, $J$ = 8.0, 3.6 Hz, 1H), 7.22 (d, $J$ = 7.8 Hz, 3H), 6.87 (d, $J$ = 8.6 Hz, 1H), 2.34 (s, 3H), 1.54 (s, 9H). $^{13}$C-NMR (101 MHz, CDCl$_3$) δ 148.2, 146.7, 143.2, 140.6, 138.0, 133.2, 133.1, 129.7, 126.9, 125.4, 123.1, 118.5, 103.6, 77.5, 76.8, 51.2, 29.2, 21.6. IR (neat): 3357, 3347, 2963, 2927, 2855, 1562, 1379, 1301, 1260, 814, 683 cm$^{-1}$. HR-MS (ESI) m/z calcd. for C$_{20}$H$_{23}$N$_2$O$_2$S ([M+H]$^+$) 355.1480, found: 355.1475.

_N-(tert-pentyl)-5-tosylquinolin-8-amine (3ba)_:

General procedure B was followed using _N-(tert-pentyl)-quinolin-8-amine_ 1b (53 mg, 0.25 mmol) and 4-methylbenzene-1-sulfonyl chloride 2a (143 mg, 0.75 mmol). Purification by column chromatography on silica gel (PE/EA: 10/1) yielded 3ba (63 mg, 68%) as a pale yellow solid. M. p.: 120-122 °C. $^1$H-NMR
(400 MHz, CDCl$_3$) $\delta$ 8.84 (d, $J$ = 7.8 Hz, 1H), 8.64 (d, $J$ = 2.8 Hz, 1H), 8.28 (d, $J$ = 8.7 Hz, 1H), 7.80 (d, $J$ = 8.2 Hz, 2H), 7.41 (dd, $J$ = 8.7, 4.1 Hz, 1H), 7.22 (d, $J$ = 8.1 Hz, 2H), 7.19 (s, 1H), 6.84 (d, $J$ = 8.7 Hz, 1H), 2.34 (s, 3H), 1.89 (q, $J$ = 7.4 Hz, 2H), 1.48 (s, 6H), 0.92 (t, $J$ = 7.5 Hz, 3H).

$^{13}$C-NMR (101 MHz, CDCl$_3$) $\delta$ 148.3, 146.7, 143.2, 140.6, 138.0, 133.3, 133.1, 129.7, 127.0, 125.4, 123.1, 118.4, 103.4, 54.0, 33.2, 27.0, 21.6, 8.6. IR (neat): 3347, 2965, 2920, 2849, 1600, 1562, 1381, 1297, 1132, 814, 681 cm$^{-1}$. HR-MS (ESI) m/z calcd. for C$_{21}$H$_{25}$N$_2$O$_2$S ([M+H]$^+$) 369.1637, found: 369.1624.

$N$-((3s,5s,7s)-adamantan-1-yl)-5-tosylquinolin-8-amine (3ca):

General procedure B was followed using $N$-((3s,5s,7s)-adamantan-1-yl)quinolin-8-amine 1c (69 mg, 0.25 mmol) and 4-methylbenzene-1-sulfonyl chloride 2a (143 mg, 0.75 mmol), and [RuCl$_2$(p-cymene)]$_2$ (15.3 mg, 10.0 mol %). Purification by column chromatography on silica gel (PE/EA: 10/1) yielded 3ca (84 mg, 78%) as a pale yellow solid. M. p.: 215-217 °C. $^1$H-NMR (400 MHz, CDCl$_3$) $\delta$ 8.84 (d, $J$ = 7.8 Hz, 1H), 8.64 (d, $J$ = 2.8 Hz, 1H), 8.28 (d, $J$ = 8.7 Hz, 1H), 7.80 (d, $J$ = 8.2 Hz, 2H), 7.41 (dd, $J$ = 8.7, 4.1 Hz, 1H), 7.22 (d, $J$ = 8.1 Hz, 2H), 7.19 (s, 1H), 6.84 (d, $J$ = 8.7 Hz, 1H), 2.34 (s, 3H), 1.89 (q, $J$ = 7.4 Hz, 2H), 1.48 (s, 6H), 0.92 (t, $J$ = 7.5 Hz, 3H). $^{13}$C-NMR (101 MHz, CDCl$_3$) $\delta$ 148.3, 146.7, 143.2, 140.6, 138.0, 133.3, 133.1, 129.7, 127.0, 125.4, 123.1, 118.4, 103.4, 54.0, 33.2, 27.0, 21.6, 8.6. IR (neat): 3322, 2916, 2849, 1601, 1532, 1385, 1300, 1138, 810, 679 cm$^{-1}$. HR-MS (ESI) m/z calcd. for C$_{26}$H$_{29}$N$_2$O$_2$S ([M+H]$^+$) 433.1950, found: 433.1935.

$N$-(tert-butyl)-3-methyl-5-tosylquinolin-8-amine (3da):

General procedure B was followed using $N$-(tert-butyl)-3-methylquinolin-8-amine 1d (53 mg, 0.25 mmol) and 4-methylbenzene-1-sulfonyl chloride 2a (143 mg, 0.75 mmol). Purification by column chromatography on silica gel (PE/EA: 10/1) yielded 3da (56 mg, 61%) as a pale yellow solid. M. p.: 205-207 °C. $^1$H-NMR (400 MHz, CDCl$_3$) $\delta$ 8.63 (s, 1H), 8.48 (d, $J$ = 1.7 Hz, 1H), 8.26 (d, $J$ = 8.7 Hz, 1H), 7.79 (d, $J$ = 8.2 Hz, 2H), 7.23 (d, $J$ = 8.1 Hz, 2H), 6.82 (d, $J$ = 8.7 Hz, 1H), 2.45 (s, 3H), 2.35 (s, 3H), 1.54 (s, 9H). $^{13}$C-NMR (101 MHz, CDCl$_3$) $\delta$ 148.1, 147.9, 143.3, 140.6, 135.8, 133.3, 132.9, 132.6, 129.7, 126.9, 125.5, 123.0, 118.2, 104.3, 52.0, 41.9, 36.5, 29.7, 21.6. IR (neat): 3367, 2963, 2920, 2849, 1601, 1532, 1385, 1300, 1138, 810, 679 cm$^{-1}$. HR-MS (ESI) m/z calcd. for C$_{21}$H$_{25}$O$_2$S ([M+H]$^+$) 369.1637, found: 369.1624.
1299, 1224, 1138, 816, 687 cm\(^{-1}\). **HR-MS** (ESI) m/z calcd. for C\(_{20}\)H\(_{23}\)N\(_2\)O\(_2\)S ([M+H]\(^{+}\)) 369.1637, found: 369.1624.

**N-(tert-butyl)-6-methyl-5-tosylquinolin-8-amine (3ea):**

General procedure B was followed using **N-(tert-butyl)-6-methylquinolin-8-amine 1e** (53 mg, 0.25 mmol) and 4-methylbenzene-1-sulfonyl chloride **2a** (143 mg, 0.75 mmol). Purification by column chromatography on silica gel (PE/EA: 10/1) yielded **3ea** (57 mg, 62%) as a pale yellow solid. **M. p.**: 154-156 °C. **\(^1\)H-NMR** (400 MHz, CDCl\(_3\)) δ 9.34 (dd, J = 8.9, 1.3 Hz, 1H), 8.59 (dd, J = 4.1, 1.4 Hz, 1H), 7.72 (d, J = 8.3 Hz, 2H), 7.41 (dd, J = 8.9, 4.1 Hz, 1H), 7.21 (d, J = 8.0 Hz, 2H), 6.69 (s, 1H), 2.83 (s, 3H), 2.35 (s, 3H), 1.54 (s, 9H). **\(^{13}\)C-NMR** (101 MHz, CDCl\(_3\)) δ 146.9, 145.6, 144.3, 143.1, 141.9, 136.7, 134.3, 129.7, 127.6, 126.0, 122.9, 116.2, 110.2, 51.3, 29.2, 24.8 (d, J = 1.6 Hz), 21.6 (d, J = 2.0 Hz). **IR** (neat): 3349, 2976, 2929, 2865, 1532, 1366, 1299, 1222, 1148, 812, 679 cm\(^{-1}\). **HR-MS** (ESI) m/z calcd. for C\(_{20}\)H\(_{23}\)N\(_2\)O\(_2\)S ([M+H]\(^{+}\)) 369.1637, found: 369.1632.

**N-(tert-butyl)-5-tosyl-6-(trifluoromethyl)-quinolin-8-amine (3fa):**

General procedure B was followed using **N-(tert-butyl)-6-(trifluoromethyl)-quinolin-8-amine 1f** (67 mg, 0.25 mmol), 4-methylbenzene-1-sulfonyl chloride **2a** (143 mg, 0.75 mmol), and [RuCl\(_2\)(p-cymene)]\(_2\) (15.3 mg, 10.0 mol %). Purification by column chromatography on silica gel (PE/EA: 10/1) yielded **3fa** (55 mg, 52%) as a pale yellow solid. **M. p.**: 172-174 °C. **\(^1\)H-NMR** (400 MHz, CDCl\(_3\)) δ 9.18 (dd, J = 9.0, 1.4 Hz, 1H), 8.69 (dd, J = 4.0, 1.4 Hz, 1H), 7.78 (d, J = 8.3 Hz, 2H), 7.44 (dd, J = 9.0, 4.0 Hz, 2H), 7.28 (s, 1H), 7.23 (d, J = 8.1 Hz, 2H), 2.36 (s, 3H), 1.58 (s, 9H). **\(^{13}\)C-NMR** (101 MHz, CDCl\(_3\)) δ 148.1, 143.4, 141.7, 137.7, 135.9, 133.1 (d, J\(_{C:F}\) = 31.5 Hz), 129.7, 127.5, 126.2, 123.4, 123.4 (d, J\(_{C:F}\) = 275.7 Hz), 117.3, 102.9 (d, J\(_{C:F}\) = 7.9 Hz), 100.1, 51.6, 29.2, 21.6. **\(^{19}\)F-NMR** (377 MHz, CDCl\(_3\)) δ -53.6 (s). **IR** (neat): 3334, 2923, 2851, 1534, 1305, 1220, 1144, 818, 679 cm\(^{-1}\). **HR-MS** (ESI) m/z calcd. for C\(_{21}\)H\(_{22}\)F\(_3\)N\(_2\)O\(_2\)S ([M+H]\(^{+}\)) 423.1354, found: 423.1350.
**N-(tert-buty1)-6-fluoro-5-tosylquinolin-8-amine (3ga):**

General procedure B was followed using *N-(tert-buty1)-6-fluoroquinolin-8-amine* 1g (54 mg, 0.25 mmol) and 4-methylbenzene-1-sulfonyl chloride 2a (143 mg, 0.75 mmol). Purification by column chromatography on silica gel (PE/EA: 10/1) yielded 3ga (73 mg, 70%) as a pale yellow solid. **M. p.:** 147-149 °C. 

**1H-NMR** (400 MHz, CDCl₃) δ 9.56 (dd, *J* = 8.8, 1.5 Hz, 1H), 8.61 (dd, *J* = 4.1, 1.5 Hz, 1H), 7.89 (d, *J* = 8.0 Hz, 2H), 7.52 (dd, *J* = 8.8, 4.1 Hz, 1H), 7.41 (s, 1H), 7.29 – 7.23 (m, 2H), 6.47 (d, *J* = 15.1 Hz, 1H), 2.38 (s, 3H), 1.50 (s, 9H).

**13C-NMR** (101 MHz, CDCl₃) δ 162.6 (d, *J*<sub>C-F</sub> = 255.4 Hz), 149.7 (d, *J*<sub>C-F</sub> = 16.4 Hz), 145.8 (d, *J*<sub>C-F</sub> = 1.8 Hz), 143.6 (s), 141.4 (s), 135.2 (s), 133.4 (d, *J*<sub>C-F</sub> = 6.9 Hz), 129.7 (s), 126.8 (d, *J*<sub>C-F</sub> = 1.7 Hz), 123.9 (s), 105.6 (d, *J*<sub>C-F</sub> = 11.9 Hz), 94.8 (d, *J*<sub>C-F</sub> = 32.3 Hz), 51.4 (s), 29.0 (s), 21.7 (d, *J* = 1.9 Hz).

**19F-NMR** (377 MHz, CDCl₃) δ -95.8 (s).

**IR** (neat): 3332, 2980, 2923, 2872, 1572, 1387, 1303, 1222, 1148, 808, 687 cm⁻¹. 

**HR-MS** (ESI) m/z calcd. for C₂₀H₂₂FN₂O₂S ([M+H]+) 373.1386, found: 373.1380.

**N-(tert-buty1)-3, 6-dimethyl-5-tosylquinolin-8-amine (3ha):**

General procedure B was followed using *N-(tert-buty1)-3,6-dimethylquinolin-8-amine* 1h (57 mg, 0.25 mmol) and 4-methylbenzene-1-sulfonyl chloride 2a (143 mg, 0.75 mmol). Purification by column chromatography on silica gel (PE/EA: 10/1) yielded 3ha (60 mg, 63%) as a pale yellow solid. **M. p.:** 189-191 °C. 

**1H-NMR** (400 MHz, CDCl₃) δ 9.10 (s, 1H), 8.42 (d, *J* = 1.7 Hz, 1H), 7.72 (d, *J* = 8.3 Hz, 2H), 7.21 (d, *J* = 8.1 Hz, 2H), 7.12 (s, 1H), 6.62 (s, 1H), 2.80 (s, 3H), 2.44 (s, 3H), 2.35 (s, 3H), 1.53 (s, 9H). 

**13C-NMR** (101 MHz, CDCl₃) δ 147.5, 147.2, 144.2, 142.9, 142.2, 135.3, 132.8, 132.5, 129.6, 127.4, 126.0, 115.3, 109.2, 51.0, 29.3, 24.8, 21.6, 19.3. 

**IR** (neat): 3355, 2982, 2963, 2923, 1552, 1387, 1303, 1222, 1148, 808, 685 cm⁻¹. **HR-MS** (ESI) m/z calcd. for C₂₀H₂₇N₂O₂S ([M+H]+) 383.1793, found: 383.1794.
N-(5-Tosylquinolin-8-yl)-benzamide (3la):

General procedure B was followed using N-(quinolin-8-yl)-benzamide 1l (62 mg, 0.25 mmol) and 4-methylbenzene-1-sulfonyl chloride 2a (143 mg, 0.75 mmol). Purification by column chromatography on silica gel (PE/EA: 10/1) yielded 3la (24 mg, 24%) as a yellow solid. \textsuperscript{1}H-NMR (400 MHz, CDCl\textsubscript{3}) δ 10.97 (s, 1H), 9.06 (dd, \(J = 17.3, 8.6\) Hz, 2H), 8.88 (s, 1H), 8.55 (d, \(J = 8.3\) Hz, 1H), 8.07 (d, \(J = 7.6\) Hz, 2H), 7.84 (d, \(J = 7.7\) Hz, 2H), 7.59 (dq, \(J = 15.1, 7.4\) Hz, 4H), 7.27 (d, \(J = 7.7\) Hz, 2H), 2.36 (s, 3H). The spectra data are in accordance with those reported in the literature.\textsuperscript{2}

\begin{figure}
\centering
\includegraphics[width=0.8\textwidth]{figure1}
\caption{N-(5-Tosylquinolin-8-yl)-benzamide (3la).}
\end{figure}

N-phenyl-5-tosylquinolin-8-amine (3ma):

General procedure B was followed using N-phenylquinolin-8-amine 1m (55 mg, 0.25 mmol) and 4-methylbenzene-1-sulfonyl chloride 2a (143 mg, 0.75 mmol). Purification by column chromatography on silica gel (PE/EA: 10/1) yielded 3ma (28 mg, 30%) as a pale yellow solid. M. p.: 180-182 °C. \textsuperscript{1}H-NMR (400 MHz, CDCl\textsubscript{3}) δ 8.96 (dd, \(J = 8.7, 1.2\) Hz, 1H), 8.77 (dd, \(J = 4.8, 3.6\) Hz, 2H), 8.35 (d, \(J = 8.5\) Hz, 1H), 7.81 (d, \(J = 8.2\) Hz, 2H), 7.50 (dd, \(J = 8.7, 4.2\) Hz, 1H), 7.47 – 7.37 (m, 4H), 7.35 (d, \(J = 8.6\) Hz, 1H), 7.24 (d, \(J = 8.1\) Hz, 2H), 7.19 (dd, \(J = 7.0\) Hz, 7.0 Hz, 1H), 2.35 (s, 3H). \textsuperscript{13}C-NMR (101 MHz, CDCl\textsubscript{3}) δ 147.6, 146.3, 143.6, 140.2, 139.7, 137.8, 133.3, 133.0, 129.8, 129.8, 127.1, 125.5, 124.7, 123.5, 122.4, 122.3, 104.2, 21.6. IR (neat): 3322, 2923, 2857, 1562, 1517, 1377, 1301, 1146, 820, 683 cm\textsuperscript{-1}. HR-MS (ESI) m/z calcd. for C\textsubscript{22}H\textsubscript{19}N\textsubscript{2}O\textsubscript{2}S ([M+H]\textsuperscript{+}) 375.1167, found: 375.1163.

\begin{figure}
\centering
\includegraphics[width=0.8\textwidth]{figure2}
\caption{N-phenyl-5-tosylquinolin-8-amine (3ma).}
\end{figure}
N-(tert-butyl)-5-(phenylsulfonyl)-quinolin-8-amine (3ab):

General procedure B was followed using N-(tert-butyl)quinolin-8-amine 1a (50 mg, 0.25 mmol) and benzenesulfonyl chloride 2b (132 mg, 0.75 mmol). Purification by column chromatography on silica gel (PE/EA: 10/1) yielded 3ab (57 mg, 67%) as a pale yellow solid. M. p.: 167-169 °C. $^1$H-NMR (400 MHz, CDCl$_3$) δ 8.86 (d, $J = 8.7$ Hz, 1H), 8.68 – 8.62 (m, 1H), 8.32 (d, $J = 8.6$ Hz, 1H), 7.91 (d, $J = 7.4$ Hz, 2H), 7.50 – 7.38 (m, 4H), 6.88 (d, $J = 8.6$ Hz, 1H), 1.55 (s, 9H). $^{13}$C-NMR (101 MHz, CDCl$_3$) δ 148.3, 146.6, 143.5, 137.9, 133.5, 133.3, 132.5, 129.1, 126.9, 125.5, 123.1, 118.1, 103.8, 51.4, 29.1. IR (neat): 3339, 2974, 2965, 2925, 2851, 1562, 1381, 1301, 1218, 1197, 812, 687 cm$^{-1}$. HR-MS (ESI) m/z calcd. for C$_{19}$H$_{21}$N$_2$O$_2$S ([M+H]$^+$) 341.1324, found: 341.1322.

N-(tert-butyl)-5-(m-tolylsulfonyl)-quinolin-8-amine (3ac):

General procedure B was followed using N-(tert-butyl)quinolin-8-amine 1a (50 mg, 0.25 mmol) and 3-methylbenzene-1-sulfonyl chloride 2c (143 mg, 0.75 mmol). Purification by column chromatography on silica gel (PE/EA: 10/1) yielded 3ac (66 mg, 75%) as a pale yellow solid. M. p.: 146-148 °C. $^1$H-NMR (400 MHz, CDCl$_3$) δ 8.86 (d, $J = 8.6$ Hz, 1H), 8.69 (s, 1H), 8.31 (d, $J = 8.6$ Hz, 1H), 2.35 (s, 3H), 1.55 (s, 9H). $^{13}$C-NMR (101 MHz, CDCl$_3$) δ 147.9, 146.6, 139.4, 137.9, 133.4, 129.0, 127.2, 125.6, 124.0, 123.1, 118.4, 103.9, 51.4, 29.2, 21.5. IR (neat): 3339, 2974, 2918, 2869, 1562, 1381, 1281, 1197, 810, 702 cm$^{-1}$. HR-MS (ESI) m/z calcd. for C$_{20}$H$_{23}$N$_2$O$_2$S ([M+H]$^+$) 355.1480, found: 355.1479.

N-(tert-butyl)-5-{{[4-(tert-butyl)-phenyl-sulfonyl]-quinolin}-8-amine (3ad):

General procedure B was followed using N-(tert-butyl)quinolin-8-amine 1a (50 mg, 0.25 mmol) and 4-(tert-butyl)-benzene-1-sulfonyl chloride 2d (175 mg, 0.75 mmol). Purification by column chromatography on silica gel (PE/EA: 20/1) yielded 3ad (74 mg, 75%) as a yellow solid. M. p.: 169-171 °C. $^1$H-NMR (400 MHz, CDCl$_3$) δ 8.92 (d, $J = 8.7$ Hz, 1H), 8.65 (s, 1H), 8.31 (d, $J = 8.6$ Hz, 1H), 7.83 (d, $J = 8.0$ Hz, 2H), 7.43 (d, $J = 8.0$ Hz, 3H), 6.88 (d, $J = 8.6$ Hz, 1H), 1.55 (s, 9H), 1.27 (s, 9H). $^{13}$C-NMR (101 MHz, CDCl$_3$) δ 156.2, 148.0, 146.5, 140.5, 137.8, 133.5, 133.3, 126.8, 126.1, 125.6, 123.1, 118.7, 104.0, 51.4, 35.2, 31.2, 29.1. IR (neat): 3357, 3347, 2963, 2929, 2869, 1564, 1383, 1299, 1218, 1193, 814, 673 cm$^{-1}$. HR-MS (ESI)
m/z calcd. for $\text{C}_{23}\text{H}_{29}\text{N}_{2}\text{O}_{2}\text{S} ([\text{M+H}]^+)$ 397.1950, found: 397.1949.

$N$-(tert-butyl)-5-[(4-(trifluoromethyl)-phenyl]-sulfonyl]-quinolin-8-amine (3ae):

General procedure B was followed using $N$-(tert-butyl)quinolin-8-amine 1a (50 mg, 0.25 mmol), 4-(trifluoromethyl)-benzene-1-sulfonyl chloride 2e (183 mg, 0.75 mmol), and $[\text{RuCl}_2(p\text{-cymene})]_2$ (15.3 mg, 10.0 mol %). Purification by column chromatography on silica gel (PE/EA: 20/1) yielded 3ae (52 mg, 51%) as a pale yellow solid. M. p.: 151-153 °C. $^1\text{H}-\text{NMR}$ (400 MHz, CDCl$_3$) δ 8.87 (d, $J = 8.6$ Hz, 1H), 8.67 (s, 1H), 8.33 (d, $J = 7.9$ Hz, 2H), 7.69 (d, $J = 7.9$ Hz, 2H), 7.50 – 7.43 (m, 1H), 7.40 (s, 1H), 6.92 (d, $J = 8.7$ Hz, 1H), 1.56 (s, 9H). $^{13}\text{C}-\text{NMR}$ (101 MHz, CDCl$_3$) δ 148.8, 147.1, 146.9, 138.0, 134.1 (d, $J_{\text{C-F}} = 3.3$ Hz), 134.1, 132.7, 127.4, 126.3 (q, $J_{\text{C-F}} = 3.7$ Hz), 125.5, 123.4, 123.4 (d, $J_{\text{C-F}} = 272.8$ Hz), 116.6, 103.7, 51.4, 29.1. $^{19}\text{F}-\text{NMR}$ (377 MHz, CDCl$_3$) δ -63.1 (s). IR (neat): 3345, 2967, 2923, 1566, 1387, 1299, 1222, 841, 671 cm$^{-1}$. HR-MS (ESI) m/z calcd. for $\text{C}_{20}\text{H}_{20}\text{F}_{3}\text{N}_{2}\text{O}_{2}\text{S} ([\text{M+H}]^+)$ 409.1198, found: 409.1188.

$N$-(tert-butyl)-5-[(4-fluorophenyl]-sulfonyl]-quinolin-8-amine (3af):

General procedure B was followed using $N$-(tert-butyl)quinolin-8-amine 1a (50 mg, 0.25 mmol), 4-fluorobenzene-1-sulfonyl chloride 2f (146 mg, 0.75 mmol), and $[\text{RuCl}_2(p\text{-cymene})]_2$ (15.3 mg, 10.0 mol %). Purification by column chromatography on silica gel (PE/EA: 15/1) yielded 3af (47mg, 52%) as a pale yellow solid. M. p.: 139-141 °C. $^1\text{H}-\text{NMR}$ (400 MHz, CDCl$_3$) δ 8.82 (dd, $J = 8.7$, 1.3 Hz, 1H), 8.65 (d, $J = 4.1$, 1.3 Hz, 1H), 8.30 (d, $J = 8.7$ Hz, 1H), 7.97 – 7.87 (m, 2H), 7.43 (dd, $J = 8.7$, 4.2 Hz, 1H), 7.29 (s, 1H), 7.10 (dd, $J = 8.6$, 8.6 Hz, 2H), 6.87 (d, $J = 8.7$ Hz, 1H), 1.55 (s, 9H). $^{13}\text{C}-\text{NMR}$ (101 MHz, CDCl$_3$) δ 164.9 (d, $J_{\text{C-F}} = 254.5$ Hz), 148.5, 146.8, 139.7 (d, $J_{\text{C-F}} = 3.2$ Hz), 138.0, 133.5, 132.8, 129.6, 129.5, 125.4, 123.2, 117.6, 116.4, 116.2, 103.6, 51.3, 29.1. $^{19}\text{F}-\text{NMR}$ (377 MHz, CDCl$_3$) δ -105.8 (s). IR (neat): 3353, 2974, 2929, 2869, 1566, 1383, 1220, 1146, 818, 687 cm$^{-1}$. HR-MS (ESI) m/z calcd. for $\text{C}_{19}\text{H}_{20}\text{F}_{3}\text{N}_{2}\text{O}_{2}\text{S} ([\text{M+H}]^+)$ 359.1230, found: 359.1225.
**N-(tert-butyl)-5-[4-chlorophenyl]-sulfonyl]-quinolin-8-amine (3ag):**

General procedure B was followed using \textit{N}-(tert-butyl)quinolin-8-amine 1a (50 mg, 0.25 mmol), 4-chlorobenzene-1-sulfonyl chloride 2g (158 mg, 0.75 mmol), and [RuCl$_2$(p-cymene)]$_2$ (15.3 mg, 10.0 mol%). Purification by column chromatography on silica gel (PE/EA: 15/1) yielded 3ag (42 mg, 45%) as a pale yellow solid. \textbf{M. p.:} 174-176 °C. $^1$H-NMR (400 MHz, CDCl$_3$) $\delta$ 8.82 (d, $J = 8.6$ Hz, 1H), 8.66 (s, 1H), 8.30 (d, $J = 8.5$ Hz, 1H), 7.84 (d, $J = 7.8$ Hz, 2H), 7.42 (dd, $J = 17.5$, 8.2 Hz, 3H), 6.88 (d, $J = 8.6$ Hz, 1H), 1.55 (s, 9H). $^{13}$C-NMR (101 MHz, CDCl$_3$) $\delta$ 148.5, 146.7, 142.1, 139.0, 137.9, 133.7, 133.1, 129.4, 128.4, 125.5, 123.3, 117.5, 103.8, 51.4, 29.2. IR (neat): 3363, 3083, 3059, 2965, 2923, 2853, 1564, 1381, 1309, 1216, 1197, 814, 671 cm$^{-1}$. HR-MS (ESI) m/z calcd. for C$_{19}$H$_{20}$ClN$_2$O$_2$S ([M+H]$^+$) 375.0934, found: 375.0931.

**N-(tert-butyl)-5-(naphthalen-2-ylsulfonyl)-quinolin-8-amine (3ah):**

General procedure B was followed using \textit{N}-(tert-butyl)quinolin-8-amine 1a (50 mg, 0.25 mmol) and naphthalene-2-sulfonyl chloride 2h (170 mg, 0.75 mmol). Purification by column chromatography on silica gel (PE/EA: 10/1) yielded 3ah (49 mg, 50%) as a pale yellow solid. \textbf{M. p.:} 183-185 °C. $^1$H-NMR (400 MHz, CDCl$_3$) $\delta$ 8.94 (d, $J = 8.6$ Hz, 1H), 8.62 (s, 1H), 8.57 (s, 1H), 8.39 (d, $J = 8.4$ Hz, 1H), 7.96 (d, $J = 7.1$ Hz, 1H), 7.85-7.77 (m, $J = 8.8$ Hz, 3H), 7.58 (d, $J = 5.0$ Hz, 2H), 7.40 (d, $J = 8.2$ Hz, 1H), 6.91 (d, $J = 8.5$ Hz, 1H), 1.55 (s, 9H). $^{13}$C-NMR (101 MHz, CDCl$_3$) $\delta$ 148.3, 146.6, 140.4, 137.9, 134.8, 133.4, 133.6, 133.3, 132.3, 129.5, 129.4, 128.8, 128.0, 127.8, 127.5, 125.6, 123.2, 122.5, 118.1, 103.9, 51.4, 29.2. IR (neat): 3339, 2967, 2925, 2851, 1562, 1381, 1297, 1218, 1193, 814, 679 cm$^{-1}$. HR-MS (ESI) m/z calcd. for C$_{23}$H$_{23}$N$_2$O$_2$S ([M+H]$^+$) 391.1480, found: 391.1475.
N-(tert-butyl)-5-(thiophen-2-ylsulfonyl)-quinolin-8-amine (3ai):

General procedure B was followed using N-(tert-butyl)quinolin-8-amine 1a (50 mg, 0.25 mmol) and thiophene-2-sulfonyl chloride 2i (137 mg, 0.75 mmol). Purification by column chromatography on silica gel (PE/EA: 10/1) yielded 3ai (26 mg, 30%) as a yellow solid. M. p.: 163-165 °C. ¹H-NMR (400 MHz, CDCl₃) δ 9.03 (d, J = 8.5 Hz, 1H), 8.68 (s, 1H), 8.28 (d, J = 8.7 Hz, 1H), 7.63 (s, 1H), 7.50 (s, 2H), 6.99 (s, 1H), 6.86 (d, J = 8.4 Hz, 1H), 1.55 (s, 9H). ¹³C-NMR (101 MHz, CDCl₃) δ 148.5, 146.8, 145.8, 138.0, 133.2, 132.1, 131.8, 127.4, 125.4, 123.2, 118.9, 103.6, 51.3, 29.2. IR (neat): 3349, 3094, 2967, 2925, 2853, 1566, 1383, 1313, 1220, 1195, 816, 683 cm⁻¹. HR-MS (ESI) m/z calcd. for C₁₇H₁₉N₂O₂S₂ ([M+H]^+) 347.0888, found: 347.0880.

N-(tert-butyl)-5-(isobutylsulfonyl)-quinolin-8-amine (3aj):

General procedure B was followed using N-(tert-butyl)quinolin-8-amine 1a (50 mg, 0.25 mmol), 2-methylpropane-1-sulfonyl chloride 2j (117 mg, 0.75 mmol), and [RuCl₂(p-cymene)]₂ (15.3 mg, 10.0 mol %). Purification by column chromatography on silica gel (PE/EA: 10/1) yielded 3aj (44 mg, 55%) as a pale yellow solid. M. p.: 154-156 °C. ¹H-NMR (400 MHz, CDCl₃) δ 8.94 (d, J = 8.6 Hz, 1H), 8.73 (d, J = 3.9 Hz, 1H), 8.09 (d, J = 8.6 Hz, 1H), 7.53 (dd, J = 8.6, 4.1 Hz, 1H), 7.25 (s, 1H), 6.85 (d, J = 8.6 Hz, 1H), 3.05 (d, J = 6.7 Hz, 2H), 2.25 (dt, J = 13.5, 6.7 Hz, 1H), 1.56 (s, 9H), 1.03 (d, J = 6.7 Hz, 6H). ¹³C-NMR (101 MHz, CDCl₃) δ 148.2, 146.8, 138.0, 133.5, 132.9, 125.8, 123.3, 117.8, 103.6, 64.7, 51.2, 29.2, 24.4, 23.0. IR (neat): 3396, 3332, 2961, 2874, 1566, 1534, 1389, 1295, 1126, 789 cm⁻¹. HR-MS (ESI) m/z calcd. for C₁₇H₂₅N₂O₂S ([M+H]^+) 321.1637, found: 321.1635.

N-(tert-butyl)-5-(morpholinosulfonyl)-quinolin-8-amine (3ak):

General procedure B was followed using N-(tert-butyl)quinolin-8-amine 1a (50 mg, 0.25 mmol), morpholine-4-sulfonyl chloride 2k (139 mg, 0.75 mmol), and [RuCl₂(p-cymene)]₂ (15.3 mg, 10.0 mol %). Purification by column chromatography on silica gel (PE/EA: 10/1) yielded 3ak (35 mg, 40%) as a pale yellow solid. M. p.: 167-169 °C. ¹H-NMR (400 MHz, CDCl₃) δ 8.96 (dd, J = 8.7, 1.5 Hz, 1H), 8.71 (dd, J = 4.1, 1.5 Hz, 1H), 8.03 (d, J = 8.6 Hz, 1H), 7.49 (dd, J = 8.7, 4.1 Hz, 1H), 6.82 (d, J = 8.7 Hz, 1H), 3.69 (t, 4H), 3.09 (t, 4H), 1.56 (s, 9H). ¹³C-NMR (101 MHz, CDCl₃) δ 148.1, 146.8, 138.0, 134.4, 133.9, 126.0, 123.0, 113.3, 103.3, 76.8, 66.4, 51.2, 45.6, 29.2. IR (neat): 3357, 2971, 2923, 2855, 1568, 1526, 1220, 1150.
816, 720 cm\(^{-1}\). **HR-MS** (ESI) m/z calcd. for C\(_{17}\)H\(_{24}\)N\(_5\)O\(_3\)S([M+H]\(^+\)) 350.1538, found: 350.1527.

**Mechanistic Study**

![Mechanistic Reaction Diagram]

General procedure B was followed using \(1a\) (50 mg, 0.25 mmol), \(2a\) (143 mg, 0.75 mmol), [RuCl\(_2\)(p-cymene)]\(_2\) (7.7 mg, 5.0 mol %), K\(_2\)CO\(_3\) (69 mg, 0.50 mmol), TEMPO (117 mg, 0.75 mmol), and 1.0 mL anhydrous DME. Purification by column chromatography on silica gel (PE/EA: 20/1) recovered 46 mg of \(1a\) (92%), no \(3aa\) was observed.

![Mechanistic Reaction Diagram]

General procedure B was followed using \(1a\) (50 mg, 0.25 mmol), \(2a\) (143 mg, 0.75 mmol), [RuCl\(_2\)(p-cymene)]\(_2\) (7.7 mg, 5.0 mol %), K\(_2\)CO\(_3\) (69 mg, 0.50 mmol), 1,1-Diphenylethylene (225 mg, 1.25 mmol), and 1.0 mL anhydrous DME. Purification by column chromatography on silica gel (PE/EA: 20/1) yielded \(3aa\) (12 mg, 14%) and \(4\) (125 mg, 50%) as a white solid. **\(^1\)H-NMR** (400 MHz, CDCl\(_3\)) \(\delta\) 7.47 (d, \(J = 8.3\) Hz, 2H), 7.36 (m, 2H), 7.35-7.28 (m, 4H), 7.20 (d, \(J = 7.2\) Hz, 2H), 7.15 (d, \(J = 8.0\) Hz, 2H), 7.10 (d, \(J = 7.0\) Hz, 2H), 6.99 (s, 1H), 2.38 (s, 3H). The spectra data are in accordance with those reported in the literature.\(^3\)

![Mechanistic Reaction Diagram]

General procedure B was followed using \(N\)-(tert-butyl)-5-methoxyquinolin-8-amine \(1o\) (57 mg, 0.25 mmol), \(2a\) (143 mg, 0.75 mmol), [RuCl\(_2\)(p-cymene)]\(_2\) (7.7 mg, 5.0 mol %), K\(_2\)CO\(_3\) (69 mg, 0.50 mmol), and 1.0 mL anhydrous DME. Purification by column chromatography on silica gel (PE/EA: 5/1) recovered 51 mg of \(1o\) (88%), no addition product of \(1o\) and \(2a\) was observed.

**Synthesis of Complex 5**

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**Procedure:** In a microwave reaction vial equipped with a magnetic stir bar was added 0.4 mmol of 3aa (dissolved in 2 mL EtOH), followed by 2 mL of 0.2 M HCl. The vial was capped and sealed, then heated in the microwave synthesis apparatus for 30 minutes at 180 °C. After basic aqueous workup (with 2 mL of 3 M NaOH, 1 mL of brine and 2 mL of EA), the organic layers were concentrated under reduced pressure. The residue was purified by flash chromatography on silica gel (PE/EA: 3/1) to afford the product 5 (95 mg, 80%) as a pale yellow solid. **M. p.:** 152-154 °C. **^1H-NMR** (400 MHz, CDCl$_3$) δ 8.88 (dd, $J = 8.7$, 1.5 Hz, 1H), 8.71 (dd, $J = 4.1$, 1.5 Hz, 1H), 8.31 (d, $J = 8.3$ Hz, 1H), 7.78 (d, $J = 8.3$ Hz, 2H), 7.46 – 7.40 (m, 1H), 7.22 (d, $J = 8.1$ Hz, 2H), 6.88 (d, $J = 8.3$ Hz, 1H), 5.66 (s, 2H), 2.34 (s, 3H). **^13C-NMR** (101 MHz, CDCl$_3$) δ 149.9, 147.7, 143.5, 140.3, 137.5, 132.9, 129.8, 127.0, 125.5, 123.3, 121.7, 106.6, 21.6. **IR** (neat): 3436, 3328, 2923, 1617, 1509, 1370, 1281, 1130, 814, 687 cm$^{-1}$. **HR-MS** (ESI) m/z calcd. for C$_{16}$H$_{15}$N$_2$O$_2$S ([M+H]$^+$) 299.0854, found: 299.0859. The spectra data are in accordance with those reported in the literature.\[2\]
References


NMR Spectra

1H-NMR
(400 MHz, CDCl₃)

13C-NMR
(101 MHz, CDCl₃)
$^1$H-NMR
(400 MHz, CDCl₃)

$^{13}$C-NMR
(101 MHz, CDCl₃)
$^{19}$F-NMR (377 MHz, CDCl$_3$)

$^{1}$H-NMR (400 MHz, CDCl$_3$)
$^1$H-NMR 
(400 MHz, CDCl$_3$)

$^{13}$C-NMR 
(101 MHz, CDCl$_3$)
$^{1}H$-NMR
(400 MHz, CDCl$_3$)

$^{13}$C-NMR
(101 MHz, CDCl$_3$)
$^{1}$H-NMR  
($400$ MHz, CDCl$_3$)

$^{13}$C-NMR  
($101$ MHz, CDCl$_3$)
$^1$H-NMR
(400 MHz, CDCl$_3$)

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

$(377 \text{ MHz, CDCl}_3)$

$^{1}\text{H-NMR}$

$(400 \text{ MHz, CDCl}_3)$
$\text{H-NMR}$

(400 MHz, CDCl$_3$)
$^{13}$C-NMR
(101 MHz, CDCl$_3$)
$^1$H-NMR
(400 MHz, CDCl$_3$)

$^{13}$C-NMR
(101 MHz, CDCl$_3$)
$^{1}$H-NMR (400 MHz, CDCl$_3$)

$^{13}$C-NMR (101 MHz, CDCl$_3$)
$^1$H-NMR (400 MHz, CDCl$_3$)

$^{13}$C-NMR (101 MHz, CDCl$_3$)
$^{19}$F-NMR
(377 MHz, CDCl$_3$)

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

(400 MHz, CDCl$_3$)

$^{13}$C-NMR

(101 MHz, CDCl$_3$)
3aj
$^1$H-NMR
(400 MHz, CDCl$_3$)

3aj
$^{13}$C-NMR
(101 MHz, CDCl$_3$)

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