Selective C(sp²)–H bond functionalization of olefins via visible-light-induced photoredox-quinuclidine dual catalysis

Xin-Tao Gu, Long-Hai Li, Yin Wei* and Min Shi*

State Key Laboratory of Organometallic Chemistry, Center for Excellence in Molecular Synthesis, Shanghai Institute of Organic Chemistry, Chinese Academy of Sciences, 345 Ling-Ling Lu, Shanghai, 200032, China. weiyin@sioc.ac.cn, mshi@mail.sioc.ac.cn.

Content
1. General Remarks .................................................................S2
2. Optimization of Reaction Conditions .......................................................S3
3. Procedures for Preparation of Reactants ..................................................S4
4. General Procedure of Migration Reactions .............................................S6
5. Scale-up Synthesis of 2h ..................................................................S7
6. Radical Trapping Experiment ..............................................................S9
7. Stern-Volmer Quenching Studies .........................................................S10
8. Unsuccessful Heterocycles Scaffolds ....................................................S11
9. Characterization and Spectra Charts ....................................................S12
10. Reaction Setup ........................................................................S118
11. References ............................................................................S119
1. General Remarks

$^1$H NMR spectra were recorded on Agilent-400, Varian Mercury-400 and Bruker-400 spectrometers for solution in CDCl$_3$ with tetramethylsilane (TMS) as an internal standard; coupling constants J are given in Hz. $^{13}$C NMR spectra were recorded on Agilent-400, Varian Mercury-400 and Bruker-400 spectrophotometers with complete proton decoupling spectrophotometers (CDCl$_3$: 77.0 ppm). The reference of $^{19}$F NMR (376 MHz) spectra is trichlorofluoromethane (δ ppm 0). Mass and HRMS spectra were recorded by ESI, EI or FI method. Organic solvents used were dried by standard methods when necessary. Infrared spectra were recorded on a Perkin-Elmer PE-983 spectrometer with absorption in cm$^{-1}$. Melting points were determined on a digital melting point apparatus and temperatures were uncorrected. Commercially obtained reagents were used without further purification. All these reactions were monitored by TLC with silica gel coated plates. Flash column chromatography was carried out using silica gel at increased pressure.
### 2. Optimization of Reaction Conditions

**Table S1 Optimization of reaction conditions**

<table>
<thead>
<tr>
<th>Entry</th>
<th>Oxidant</th>
<th>Base</th>
<th>Light wavelength</th>
<th>Photocatalyst</th>
<th>Yield (%)&lt;sup&gt;6&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PIDA</td>
<td>K&lt;sub&gt;2&lt;/sub&gt;HPO&lt;sub&gt;4&lt;/sub&gt;</td>
<td>450 nm</td>
<td>Ir[dpF(CF&lt;sub&gt;3&lt;/sub&gt;)ppy]&lt;sub&gt;2&lt;/sub&gt;(dtbbpy)PF&lt;sub&gt;6&lt;/sub&gt;</td>
<td>62</td>
</tr>
<tr>
<td>2</td>
<td>PIFA</td>
<td>K&lt;sub&gt;2&lt;/sub&gt;HPO&lt;sub&gt;4&lt;/sub&gt;</td>
<td>450 nm</td>
<td>Ir[dpF(CF&lt;sub&gt;3&lt;/sub&gt;)ppy]&lt;sub&gt;2&lt;/sub&gt;(dtbbpy)PF&lt;sub&gt;6&lt;/sub&gt;</td>
<td>N.R.</td>
</tr>
<tr>
<td>3</td>
<td>CAN</td>
<td>K&lt;sub&gt;2&lt;/sub&gt;HPO&lt;sub&gt;4&lt;/sub&gt;</td>
<td>450 nm</td>
<td>Ir[dpF(CF&lt;sub&gt;3&lt;/sub&gt;)ppy]&lt;sub&gt;2&lt;/sub&gt;(dtbbpy)PF&lt;sub&gt;6&lt;/sub&gt;</td>
<td>16</td>
</tr>
<tr>
<td>4</td>
<td>1,4-Benzooquinone</td>
<td>K&lt;sub&gt;2&lt;/sub&gt;HPO&lt;sub&gt;4&lt;/sub&gt;</td>
<td>450 nm</td>
<td>Ir[dpF(CF&lt;sub&gt;3&lt;/sub&gt;)ppy]&lt;sub&gt;2&lt;/sub&gt;(dtbbpy)PF&lt;sub&gt;6&lt;/sub&gt;</td>
<td>N.R.</td>
</tr>
<tr>
<td>5</td>
<td>Dess-Martin</td>
<td>K&lt;sub&gt;2&lt;/sub&gt;HPO&lt;sub&gt;4&lt;/sub&gt;</td>
<td>450 nm</td>
<td>Ir[dpF(CF&lt;sub&gt;3&lt;/sub&gt;)ppy]&lt;sub&gt;2&lt;/sub&gt;(dtbbpy)PF&lt;sub&gt;6&lt;/sub&gt;</td>
<td>47</td>
</tr>
<tr>
<td>6</td>
<td>K&lt;sub&gt;2&lt;/sub&gt;S&lt;sub&gt;2&lt;/sub&gt;O&lt;sub&gt;8&lt;/sub&gt;</td>
<td>K&lt;sub&gt;2&lt;/sub&gt;HPO&lt;sub&gt;4&lt;/sub&gt;</td>
<td>450 nm</td>
<td>Ir[dpF(CF&lt;sub&gt;3&lt;/sub&gt;)ppy]&lt;sub&gt;2&lt;/sub&gt;(dtbbpy)PF&lt;sub&gt;6&lt;/sub&gt;</td>
<td>N.R.</td>
</tr>
<tr>
<td>7</td>
<td>LPO</td>
<td>K&lt;sub&gt;2&lt;/sub&gt;HPO&lt;sub&gt;4&lt;/sub&gt;</td>
<td>450 nm</td>
<td>Ir[dpF(CF&lt;sub&gt;3&lt;/sub&gt;)ppy]&lt;sub&gt;2&lt;/sub&gt;(dtbbpy)PF&lt;sub&gt;6&lt;/sub&gt;</td>
<td>N.R.</td>
</tr>
<tr>
<td>8</td>
<td>Di-tert-butyl peroxide</td>
<td>K&lt;sub&gt;2&lt;/sub&gt;HPO&lt;sub&gt;4&lt;/sub&gt;</td>
<td>450 nm</td>
<td>Ir[dpF(CF&lt;sub&gt;3&lt;/sub&gt;)ppy]&lt;sub&gt;2&lt;/sub&gt;(dtbbpy)PF&lt;sub&gt;6&lt;/sub&gt;</td>
<td>N.R.</td>
</tr>
<tr>
<td>9</td>
<td>PIDA</td>
<td>K&lt;sub&gt;2&lt;/sub&gt;HPO&lt;sub&gt;4&lt;/sub&gt;</td>
<td>450 nm</td>
<td>4CzIPN</td>
<td>68</td>
</tr>
<tr>
<td>10</td>
<td>PIDA</td>
<td>K&lt;sub&gt;2&lt;/sub&gt;P&lt;sub&gt;4&lt;/sub&gt;</td>
<td>450 nm</td>
<td>4CzIPN</td>
<td>28</td>
</tr>
<tr>
<td>11</td>
<td>PIDA</td>
<td>BTMG</td>
<td>450 nm</td>
<td>4CzIPN</td>
<td>N.R.</td>
</tr>
<tr>
<td>12</td>
<td>PIDA</td>
<td>K&lt;sub&gt;2&lt;/sub&gt;HPO&lt;sub&gt;4&lt;/sub&gt;</td>
<td>395 nm</td>
<td>4CzIPN</td>
<td>59</td>
</tr>
<tr>
<td>13</td>
<td>PIDA</td>
<td>K&lt;sub&gt;2&lt;/sub&gt;HPO&lt;sub&gt;4&lt;/sub&gt;</td>
<td>395 nm</td>
<td>Ir[dpF(CF&lt;sub&gt;3&lt;/sub&gt;)ppy]&lt;sub&gt;2&lt;/sub&gt;(dtbbpy)PF&lt;sub&gt;6&lt;/sub&gt;</td>
<td>78</td>
</tr>
<tr>
<td>14&lt;sup&gt;c&lt;/sup&gt;</td>
<td>PIDA</td>
<td>K&lt;sub&gt;2&lt;/sub&gt;HPO&lt;sub&gt;4&lt;/sub&gt;</td>
<td>395 nm</td>
<td>Ir[dpF(CF&lt;sub&gt;3&lt;/sub&gt;)ppy]&lt;sub&gt;2&lt;/sub&gt;(dtbbpy)PF&lt;sub&gt;6&lt;/sub&gt;</td>
<td>71</td>
</tr>
<tr>
<td>15</td>
<td>PIDA</td>
<td>K&lt;sub&gt;2&lt;/sub&gt;P&lt;sub&gt;4&lt;/sub&gt;</td>
<td>395 nm</td>
<td>Ir[dpF(CF&lt;sub&gt;3&lt;/sub&gt;)ppy]&lt;sub&gt;2&lt;/sub&gt;(dtbbpy)PF&lt;sub&gt;6&lt;/sub&gt;</td>
<td>21</td>
</tr>
<tr>
<td>16</td>
<td>O&lt;sub&gt;2&lt;/sub&gt;</td>
<td>K&lt;sub&gt;2&lt;/sub&gt;HPO&lt;sub&gt;4&lt;/sub&gt;</td>
<td>395 nm</td>
<td>Ir[dpF(CF&lt;sub&gt;3&lt;/sub&gt;)ppy]&lt;sub&gt;2&lt;/sub&gt;(dtbbpy)PF&lt;sub&gt;6&lt;/sub&gt;</td>
<td>29</td>
</tr>
<tr>
<td>17</td>
<td>H&lt;sub&gt;2&lt;/sub&gt;O&lt;sub&gt;2&lt;/sub&gt; (aq)</td>
<td>K&lt;sub&gt;2&lt;/sub&gt;HPO&lt;sub&gt;4&lt;/sub&gt;</td>
<td>395 nm</td>
<td>Ir[dpF(CF&lt;sub&gt;3&lt;/sub&gt;)ppy]&lt;sub&gt;2&lt;/sub&gt;(dtbbpy)PF&lt;sub&gt;6&lt;/sub&gt;</td>
<td>N.R.</td>
</tr>
<tr>
<td>18&lt;sup&gt;e&lt;/sup&gt;</td>
<td>PIDA</td>
<td>K&lt;sub&gt;2&lt;/sub&gt;HPO&lt;sub&gt;4&lt;/sub&gt;</td>
<td>\</td>
<td>Ir[dpF(CF&lt;sub&gt;3&lt;/sub&gt;)ppy]&lt;sub&gt;2&lt;/sub&gt;(dtbbpy)PF&lt;sub&gt;6&lt;/sub&gt;</td>
<td>N.R.</td>
</tr>
<tr>
<td>19&lt;sup&gt;f&lt;/sup&gt;</td>
<td>PIDA</td>
<td>K&lt;sub&gt;2&lt;/sub&gt;HPO&lt;sub&gt;4&lt;/sub&gt;</td>
<td>395 nm</td>
<td>\</td>
<td>N.R.</td>
</tr>
<tr>
<td>20&lt;sup&gt;g&lt;/sup&gt;</td>
<td>PIDA</td>
<td>K&lt;sub&gt;2&lt;/sub&gt;HPO&lt;sub&gt;4&lt;/sub&gt;</td>
<td>395 nm</td>
<td>Ir[dpF(CF&lt;sub&gt;3&lt;/sub&gt;)ppy]&lt;sub&gt;2&lt;/sub&gt;(dtbbpy)PF&lt;sub&gt;6&lt;/sub&gt;</td>
<td>N.R.</td>
</tr>
</tbody>
</table>

<sup>a</sup>Reaction conditions: 1a (0.2 mmol, 1.0 equiv.), photocatalyst (2 mol%), Base (0.8 mmol, 4.0 equiv.), quinuclidine (0.1 mmol, 0.5 equiv.), MeCN (8.0 mL), LEDs light (30 W), rt, 12 h. <sup>b</sup>Isolated yield in 0.2 mmol scale. <sup>c</sup>No reaction. <sup>d</sup>Base (0.6 mmol, 3.0 equiv.). <sup>e</sup>Reaction was conducted in the absence of light source. <sup>f</sup>Reaction was conducted in the absence of the photocatalyst. <sup>g</sup>MeCN with water (5 %) as the co-solvent.
3. Procedures for Preparation of Reactants

General Procedure A for the Synthesis of Starting Material:

\[
R^1O \quad X \quad N \quad R'^n \quad \text{MgCl} (3.0 \text{ equiv.}) \quad \text{THF, 0 °C, 6 h} \quad R^2O \quad X \quad N \quad R'^n \quad 1a\text{-}1u, 1y, 1ad\text{-}1ah
\]

To an oven-dried 100 mL double neck round bottom flask, vinyl magnesium bromide (3.0 mmol, 3.0 equiv.) was added dropwise to a solution of ketone (1.0 mmol, 1.0 equiv.) in dry THF (0.20 M) under N\textsubscript{2} atmosphere at 0 °C. The resulting mixture was warmed gradually to room temperature and stirred for 6-8 h. After completion of the reaction, the reaction was quenched with a saturated NH\textsubscript{4}Cl solution, extracted with EtOAc and dried over anhydrous Na\textsubscript{2}SO\textsubscript{4} before it was purified on a silica gel column chromatography using an eluent of PE/EtOAc (v/v) to afford the desired product.

General Procedure B for the Synthesis of Starting Material:

\[
R^1O \quad X \quad N \quad R'^n \quad \text{+ n-BuLi (1.5 equiv.)} \quad \text{THF, 12 h, -78 °C to rt} \quad R^2O \quad X \quad N \quad R'^n \quad 1v\text{-}1x, 1z\text{-}1ac
\]

To an oven-dried 100 mL double neck round bottom flask was added heterocycle such as benzo[d]thiazole or benzo[d]oxazole (1.5 mmol 1.5 equiv.) in dry THF (0.50 M) under N\textsubscript{2} atmosphere and cooled to -78 °C. n-BuLi (1.5 mmol, 1.5 equiv., 2.50 M in hexane) was added dropwise to this solution at -78 °C. After the addition was complete, the solution was kept stirring at the same temperature until complete the lithiation. To this stirred solution was added a solution of ketone (1.0 mmol 1.0 equiv.) in dry THF (0.50 M) at -78 °C and the resulting mixture was stirred continuously at this temperature for 1-3 h. Next, the reaction temperature was gradually increased to room temperature and stirred for another 8-10 h. After the reaction completion, the reaction was quenched with saturated NH\textsubscript{4}Cl solution, extracted with EtOAc and dried over anhydrous Na\textsubscript{2}SO\textsubscript{4}.
before it was purified on a silica gel column chromatography using an eluent of PE/EtOAc (v/v) to afford the desired product.
4. General Procedure of Migration Reactions

An oven-dried 20.0 mL sealed tube equipped with a teflon septum cap and a magnetic stir bar was charged with the photocatalyst (0.004 mmol, 0.02 equiv., Ir[dF(CF₃)ppy]₂(dtbbpy)PF₆), quinuclidine (0.1 mmol, 0.5 equiv.), powdered K₂HPO₄ (0.8 mmol 4.0 equiv.) and the corresponding starting materials 1a-1ah (0.2 mmol). Then, 8.0 mL of degassed CH₃CN was added via a syringe and the oxidant PIDA (0.4 mmol 2.0 equiv.) was added. The reaction tube was sealed with a teflon septum cap. Then, the vail was placed in 395 nm light from a 30 W LEDs strip at room temperature (a fan was employed to maintain this temperature). After the indicated time period, the reaction mixture was treated with water and extracted with ethyl acetate. The organic layer was separated, dried over anhydrous Na₂SO₄ and the solvent was evaporated in vacuo and the crude mixture was purified by a silica gel flash column chromatography (eluent: petroleum ether / ethyl acetate) to afford the products in up to 81% yield.
5. Scale-up Synthesis of 2h

An oven-dried 250.0 mL sealed tube equipped with a teflon septum cap and a magnetic stir bar was charged with the photocatalyst (0.06 mmol, 0.02 equiv., Ir[dF(CF$_3$)ppy]$_2$(dtbbpy)PF$_6$), quinuclidine (1.5 mmol, 0.5 equiv.), powdered K$_2$HPO$_4$ (12 mmol 4.0 equiv.) and the starting material 1h (3.0 mmol, 1.1 g). Then, 120.0 mL of degassed CH$_3$CN was added via a syringe and the oxidant PIDA (6.0 mmol 2.0 equiv.) was added. The reaction tube was sealed with a teflon septum cap. Then, the vail was placed in 395 nm light from a 30 W LEDs strip at room temperature (a fan was employed to maintain this temperature). After 18 h, the reaction mixture was treated with water and extracted with ethyl acetate. The organic layer was separated, dried over anhydrous Na$_2$SO$_4$ and the solvent was evaporated in vacuo and the crude mixture was purified by a silica gel flash column chromatography (eluent: petroleum ether / ethyl acetate = 20 / 1) to afford the product 2h in 27% yield (292.1 mg).

An oven-dried 100.0 mL sealed tube equipped with a teflon septum cap and a magnetic stir bar was charged with the photocatalyst (0.03 mmol, 0.02 equiv., Ir[dF(CF$_3$)ppy]$_2$(dtbbpy)PF$_6$), quinuclidine (0.75 mmol, 0.5 equiv.), powdered K$_2$HPO$_4$ (6 mmol 4.0 equiv.) and the starting material 1h (1.5 mmol, 544.5 mg). Then, 60.0 mL of degassed CH$_3$CN was added via a syringe and the oxidant PIDA (3.0 mmol 2.0 equiv.) was added. The reaction tube was sealed with a teflon septum cap. Then, the vail was placed in 395 nm light from a 30 W LEDs strip at room temperature.
(a fan was employed to maintain this temperature). After 18 h, the reaction mixture was treated with water and extracted with ethyl acetate. The organic layer was separated, dried over anhydrous Na$_2$SO$_4$ and the solvent was evaporated in vacuo and the crude mixture was purified by a silica gel flash column chromatography (eluent: petroleum ether / ethyl acetate = 20 / 1) to afford the product 2h in 53% yield (287.1 mg).
6. Radical Trapping Experiment

An oven-dried 20.0 mL sealed tube equipped with a teflon septum cap and a magnetic stir bar was charged with the photocatalyst (0.004 mmol, 0.02 equiv., Ir[dF(CF$_3$)ppy]$_2$(dtbbpy)PF$_6$), quinuclidine (0.1 mmol, 0.5 equiv.), powdered K$_2$HPO$_4$ (0.8 mmol 4.0 equiv.), TEMPO (0.4 mmol, 2.0 equiv.) and the starting material 1a (0.2 mmol). Then, 8.0 mL of degassed CH$_3$CN was added via a syringe and the oxidant PIDA (0.4 mmol 2.0 equiv.) was added. The reaction tube was sealed with a teflon septum cap. Then, the vail was placed in 395 nm light from a 30 W LEDs strip at room temperature (a fan was employed to maintain this temperature). After the indicated time period, the reaction mixture was treated with water and extracted with ethyl acetate. The organic layer was separated, dried over anhydrous Na$_2$SO$_4$ and the solvent was evaporated in vacuo and the crude mixture was detected by MS spectroscopy. The resultant quinuclidinium radical cation trapped by TEMPO was successfully detected by MS spectroscopy.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>267.24301</td>
<td>9524.71</td>
<td>14.20</td>
<td>C$<em>{16}$H$</em>{31}$N$_2$O</td>
<td>267.24309</td>
<td>-0.08</td>
<td>-0.32</td>
<td>2.5</td>
</tr>
</tbody>
</table>
7. Stern-Volmer Quenching Studies

The measurements were performed using a 0.2 mM solution of photocatalyst Ir[dF(CF₃)ppy]₂(dtbbpy)PF₆ in 2.0 mL of degassed CH₃CN with varying concentrations of a quencher. The samples were excited at 400 nm and emission intensity was recorded from 450 nm to 575 nm for Ir[dF(CF₃)ppy]₂(dtbbpy)PF₆. Experiments showed that the excited state Ir[dF(CF₃)ppy]₂(dtbbpy)PF₆⁺ was quenched by quinuclidine instead of 1a.

**Figure S1.** Ir[dF(CF₃)ppy]₂(dtbbpy)PF₆ emission quenching with quinuclidine.
8. Unsuccessful Heterocycles Scaffolds
9. Characterization and Spectra Charts

**Compound 1a**: Yield: 230.1 mg, 78%; A white solid; This is a known compound and its spectroscopic data are consistent with those reported in the literature;\(^1\) \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.99 (d, \(J = 8.0\) Hz, 1H), 7.81 (d, \(J = 8.0\) Hz, 1H), 7.72 – 7.60 (m, 2H), 7.52 – 7.42 (m, 1H), 7.39 – 7.29 (m, 3H), 7.29 – 7.23 (m, 1H), 5.94 – 5.75 (m, 1H), 5.07 – 4.90 (m, 2H), 4.00 (br, 1H), 2.71 – 2.45 (m, 2H), 2.32 – 2.08 (m, 2H); \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 178.1, 152.6, 143.7, 138.1, 135.7, 128.4, 127.6, 126.0, 125.5, 125.0, 123.1, 121.7, 115.2, 79.0, 41.5, 28.1.
**Compound 1b**: Yield: 250.3 mg, 81%; A white solid; This is a known compound and its spectroscopic data are consistent with those reported in the literature;\(^1\) \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.96 (d, \(J = 8.1\) Hz, 1H), 7.76 (d, \(J = 8.1\) Hz, 1H), 7.62 – 7.50 (m, 2H), 7.45 – 7.35 (m, 1H), 7.35 – 7.26 (m, 1H), 7.13 (d, \(J = 7.9\) Hz, 2H), 5.92 – 5.75 (m, 1H), 5.06 – 4.89 (m, 2H), 4.10 (br, 1H), 2.62 – 2.47 (m, 2H), 2.28 (s, 3H), 2.22 – 2.08 (m, 2H); \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 178.4, 152.6, 140.8, 138.1, 137.2, 135.6, 129.0, 125.9, 125.4, 124.9, 123.0, 121.6, 115.0, 78.8, 41.4, 28.0, 20.9.
$^1$H NMR (CDCl$_3$, 400 MHz, TMS)

$^{13}$C NMR (CDCl$_3$, 100 MHz, TMS)
**Compound 1c**: Yield: 245.9 mg, 78%; A white solid; Mp: 79 - 81 °C; isolated by column chromatography on silica gel (PE/EtOAc = 10:1, R<sub>f</sub> = 0.3); <sup>1</sup>H NMR (400 MHz, CDCl<sub>3</sub>) δ 7.96 (d, J = 8.1 Hz, 1H), 7.76 (d, J = 8.1 Hz, 1H), 7.57 (d, J = 7.7 Hz, 2H), 7.39 (t, J = 7.6 Hz, 1H), 7.28 (t, J = 7.6 Hz, 1H), 7.20 – 7.14 (m, 2H), 5.92 – 5.75 (m, 1H), 5.04 – 4.90 (m, 2H), 4.10 (br, 1H), 2.63 – 2.49 (m, 4H), 2.25 – 2.07 (m, 2H), 1.18 (t, J = 7.7 Hz, 3H); <sup>13</sup>C NMR (100 MHz, CDCl<sub>3</sub>) δ 178.4, 152.6, 143.5, 141.0, 138.1, 135.6, 127.8, 125.8, 125.4, 124.8, 123.0, 121.6, 115.0, 78.8, 41.4, 28.3, 28.0, 15.3; IR (neat): ν 3418, 2961, 1636, 1508, 1440, 1302, 1247, 1075, 911, 839, 757, 728 cm<sup>-1</sup>; HRMS (ESI+) Calcd. for C<sub>20</sub>H<sub>22</sub>NOS [M+H]<sup>+</sup>: 324.1417, found: 324.1409.
**Compound 1d**: Yield: 242.2 mg, 69%; A white solid; This is a known compound and its spectroscopic data are consistent with those reported in the literature;\(^2\) \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 8.00 – 7.95 (m, 1H), 7.81 – 7.75 (m, 1H), 7.63 – 7.56 (m, 2H), 7.44 – 7.38 (m, 1H), 7.38 – 7.33 (m, 2H), 7.32 – 7.26 (m, 1H), 5.92 – 5.78 (m, 1H), 5.07 – 4.90 (m, 2H), 4.04 (br, 1H), 2.63 – 2.46 (m, 2H), 2.25 – 2.07 (m, 2H), 1.27 (s, 9H); \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 178.4, 152.7, 150.4, 140.8, 138.2, 135.6, 125.9, 125.3, 125.2, 124.9, 123.0, 121.6, 115.0, 78.9, 41.5, 34.4, 31.2, 28.1.
Compound 1e: Yield: 209.7 mg, 67%; A white solid; This is a known compound and its spectroscopic data are consistent with those reported in the literature;\textsuperscript{1} \textsuperscript{1}H NMR (400 MHz, CDCl\textsubscript{3}) \( \delta \) 7.97 (d, \( J = 8.1 \) Hz, 1H), 7.78 (d, \( J = 8.1 \) Hz, 1H), 7.72 – 7.57 (m, 2H), 7.41 (t, \( J = 7.6 \) Hz, 1H), 7.30 (t, \( J = 7.6 \) Hz, 1H), 7.00 (t, \( J = 8.7 \) Hz, 2H), 5.92 – 5.76 (m, 1H), 5.06 – 4.88 (m, 2H), 4.17 (s, 1H), 2.60 – 2.46 (m, 2H), 2.20 – 2.10 (m, 2H); \textsuperscript{13}C NMR (100 MHz, CDCl\textsubscript{3}) \( \delta \) 178.0, 162.1 (d, \( J = 245.2 \) Hz), 152.6, 139.5 (d, \( J = 3.1 \) Hz), 137.9, 135.5, 127.4 (d, \( J = 7.9 \) Hz), 126.0, 125.0, 123.0, 121.6, 115.3, 115.1 (d, \( J =21.0 \) Hz), 78.6, 41.6, 28.0. \textsuperscript{19}F NMR (376 MHz, CDCl\textsubscript{3}) \( \delta \) -114.8.
Compound 1f: Yield: 194.1 mg, 59%; A white solid; This is a known compound and its spectroscopic data are consistent with those reported in the literature; $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.97 (d, $J$ = 8.1 Hz, 1H), 7.79 (d, $J$ = 8.1 Hz, 1H), 7.65 – 7.56 (m, 2H), 7.46 – 7.38 (m, 1H), 7.36 – 7.24 (m, 3H), 5.92 – 5.75 (m, 1H), 5.07 – 4.89 (m, 2H), 4.16 (br, 1H), 2.60 – 2.43 (m, 2H), 2.21 – 2.07 (m, 2H); $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 177.6, 152.6, 142.2, 137.8, 135.5, 133.5, 128.4, 127.0, 126.0, 125.1, 123.1, 121.7, 115.4, 78.7, 41.5, 28.0.
**Compound 1g**: Yield: 309.6 mg, 83%; A white solid; This is a known compound and its spectroscopic data are consistent with those reported in the literature; $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.97 (d, $J$ = 8.0 Hz, 1H), 7.79 (d, $J$ = 8.0 Hz, 1H), 7.61 – 7.51 (m, 2H), 7.49 – 7.39 (m, 3H), 7.36 – 7.28 (m, 1H), 5.90 – 5.72 (m, 1H), 5.05 – 4.90 (m, 2H), 4.14 (s, 1H), 2.60 – 2.44 (m, 2H), 2.19 – 2.08 (m, 2H); $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 177.5, 152.5, 142.7, 137.8, 135.4, 131.4, 127.4, 126.1, 125.1, 123.1, 121.7, 121.7, 115.4, 78.7, 41.4, 28.0.
**Compound 1h**: Yield: 279.5 mg, 77%; A white solid; This is a known compound and its spectroscopic data are consistent with those reported in the literature;\(^1\) \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.99 (d, \(J = 8.1\) Hz, 1H), 7.82 (t, \(J = 8.5\) Hz, 3H), 7.60 (d, \(J = 8.1\) Hz, 2H), 7.44 (t, \(J = 7.7\) Hz, 1H), 7.33 (t, \(J = 7.7\) Hz, 1H), 5.92 – 5.78 (m, 1H), 5.06 – 4.95 (m, 2H), 4.23 (br, 1H), 2.63 – 2.51 (m, 2H), 2.21 – 2.10 (m, 2H); \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 177.2, 152.6, 147.5, 137.7, 135.5, 129.8 (q, \(J = 32.2\) Hz), 126.2, 126.0, 125.3 (q, \(J = 3.7\) Hz), 125.2, 124.0 (q, \(J = 270.4\) Hz), 123.1, 121.7, 115.6, 78.9, 41.6, 28.0; \(^{19}\)F NMR (376 MHz, CDCl\(_3\)) \(\delta\) -62.5.
Compound 1i: Yield: 295.6 mg, 78%; A white solid; This is a known compound and its spectroscopic data are consistent with those reported in the literature: $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.98 (d, $J = 8.0$ Hz, 1H), 7.80 (d, $J = 8.0$ Hz, 1H), 7.72 (d, $J = 8.4$ Hz, 2H), 7.43 (t, $J = 7.6$ Hz, 1H), 7.32 (t, $J = 7.6$ Hz, 1H), 7.18 (d, $J = 8.4$ Hz, 2H), 5.90 – 5.77 (m, 1H), 5.05 – 4.93 (m, 2H), 4.22 (br, 1H), 2.63 – 2.46 (m, 2H), 2.22 – 2.12 (m, 2H); $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 177.6, 152.6, 148.6, 148.5, 142.3, 137.8, 135.5, 127.2, 126.1, 125.2, 123.1, 121.7, 120.6, 120.4 (q, $J = 255.5$ Hz), 115.4, 78.7, 41.6, 28.0; $^{19}$F NMR (376 MHz, CDCl$_3$) $\delta$ -57.8.
**Compound 1j:** Yield: 250.3 mg, 77%; A white solid; This is a known compound and its spectroscopic data are consistent with those reported in the literature;\(^1\) \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.98 (d, \(J = 8.1\) Hz, 1H), 7.80 (d, \(J = 8.1\) Hz, 1H), 7.57 (d, \(J = 8.9\) Hz, 2H), 7.43 (t, \(J = 7.5\) Hz, 1H), 7.32 (t, \(J = 7.5\) Hz, 1H), 6.89 – 6.83 (m, 2H), 5.96 – 5.75 (m, 1H), 5.07 – 4.89 (m, 2H), 3.98 (br, 1H), 3.76 (s, 3H), 2.63 – 2.45 (m, 2H), 2.27 – 2.07 (m, 2H); \(^1^3\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 178.5, 158.9, 152.6, 138.1, 135.9, 135.6, 126.8, 125.9, 124.9, 123.0, 121.6, 115.1, 113.7, 78.6, 55.2, 41.5, 28.1.
Compound 1k: Yield: 326.5 mg, 88%; A white solid; This is a known compound and its spectroscopic data are consistent with those reported in the literature; $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.88 (d, $J = 8.1$ Hz, 1H), 7.70 – 7.58 (m, 3H), 7.48 – 7.39 (m, 4H), 7.33 – 7.23 (m, 3H), 7.22 – 7.13 (m, 2H), 5.87 – 5.64 (m, 1H), 4.97 – 4.81 (m, 2H), 4.02 (s, 1H), 2.55 – 2.43 (m, 2H), 2.14 – 2.02 (m, 2H); $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 178.2, 152.6, 142.7, 140.3, 140.3, 138.0, 135.5, 128.6, 127.2, 127.0, 126.9, 126.0, 125.9, 124.9, 123.0, 121.6, 115.1, 78.9, 41.4, 28.0.
**Compound 1**: Yield: 156.8 mg, 49%; A white solid; This is a known compound and its spectroscopic data are consistent with those reported in the literature;\(^1\) \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.99 (d, \(J = 8.2\) Hz, 1H), 7.88 – 7.78 (m, 3H), 7.61 (d, \(J = 8.2\) Hz, 2H), 7.46 (t, \(J = 7.7\) Hz, 1H), 7.36 (t, \(J = 7.7\) Hz, 1H), 5.91 – 5.76 (m, 1H), 5.10 – 4.93 (m, 2H), 4.21 (s, 1H), 2.63 – 2.50 (m, 2H), 2.22 – 2.06 (m, 2H); \(^13\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 176.7, 152.6, 148.8, 137.5, 135.4, 132.1, 126.4, 126.2, 125.3, 123.1, 121.7, 118.6, 115.7, 111.2, 78.9, 41.5, 27.9.
Compound 1m: Yield: 228.7 mg, 74%; A white solid; This is a known compound and its spectroscopic data are consistent with those reported in the literature;\textsuperscript{1} \textsuperscript{1}H NMR (400 MHz, CDCl\textsubscript{3}) \(\delta\) 7.97 (d, \(J = 8.1\) Hz, 1H), 7.76 (d, \(J = 8.1\) Hz, 1H), 7.52 – 7.48 (m, 1H), 7.48 – 7.36 (m, 2H), 7.33 – 7.26 (m, 1H), 7.23 – 7.17 (m, 1H), 7.05 (d, \(J = 7.5\) Hz, 1H), 6.00 – 5.63 (m, 1H), 5.25 – 4.79 (m, 2H), 4.10 (br, 1H), 2.71 – 2.42 (m, 2H), 2.31 (s, 3H), 2.26 – 2.06 (m, 2H); \textsuperscript{13}C NMR (100 MHz, CDCl\textsubscript{3}) \(\delta\) 178.3, 152.6, 143.6, 138.1, 138.0, 135.6, 128.3, 128.2, 126.1, 125.9, 124.9, 123.0, 122.5, 121.6, 115.0, 78.9, 41.4, 28.0, 21.6.
$^1$H NMR (CDCl$_3$, 400 MHz, TMS)

$^{13}$C NMR (CDCl$_3$, 100 MHz, TMS)
**Compound 1n**: Yield: 241.0 mg, 77%; A white solid; Mp: 86 - 88 °C; isolated by column chromatography on silica gel (PE/EtOAc = 10:1, Rf = 0.3); \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.98 (d, \(J = 8.1\) Hz, 1H), 7.80 (d, \(J = 8.1\) Hz, 1H), 7.44 (d, \(J = 8.4\) Hz, 3H), 7.35 – 7.24 (m, 2H), 6.99 – 6.87 (m, 1H), 5.91 – 5.77 (m, 1H), 5.06 – 4.92 (m, 2H), 4.18 (br, 1H), 2.60 – 2.48 (m, 2H), 2.19 – 2.11 (m, 2H); \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 177.4, 162.3 (d, \(J = 244.4\) Hz), 152.5, 146.3 (d, \(J = 6.9\) Hz), 137.8, 135.5, 129.8 (d, \(J = 8.0\) Hz), 126.1, 125.1, 123.1, 121.7, 121.1 (d, \(J = 2.9\) Hz), 115.4, 114.5 (d, \(J = 22.1\) Hz), 112.9 (d, \(J = 23.1\) Hz), 78.7, 41.5, 28.0; \(^{19}\)F NMR (376 MHz, CDCl\(_3\)) \(\delta\) -112.1; IR (neat): \(\nu\) 3444, 3073, 2912, 1588, 1436, 1239, 911, 858, 757, 728, 707 cm\(^{-1}\); HRMS (ESI\(^+\)) Calcd. for C\(_{18}\)H\(_{17}\)NOFS [M+H]\(^+\): 314.1009, found: 314.1004.
$^{13}$C NMR (CDCl$_3$, 100 MHz, TMS)

$^{19}$F NMR (CDCl$_3$, 376 MHz)
**Compound 10**: Yield: 256.6 mg, 78%; A white solid; This is a known compound and its spectroscopic data are consistent with those reported in the literature;\(^2\) \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.97 (d, \(J = 8.1\) Hz, 1H), 7.77 (d, \(J = 8.1\) Hz, 1H), 7.75 – 7.70 (m, 1H), 7.57 – 7.50 (m, 1H), 7.41 (t, \(J = 7.6\) Hz, 1H), 7.30 (t, \(J = 7.6\) Hz, 1H), 7.25 – 7.18 (m, 2H), 5.90 – 5.74 (m, 1H), 5.05 – 4.90 (m, 2H), 4.28 (s, 1H), 2.60 – 2.46 (m, 2H), 2.18 – 2.09 (m, 2H); \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 177.4, 152.5, 145.7, 137.7, 135.4, 134.3, 129.6, 127.7, 126.0, 125.8, 125.1, 123.8, 123.0, 121.6, 115.4, 78.6, 41.4, 27.9.
**Compound 1p**: Yield: 216.3 mg, 58%; A white solid; Mp: 106 – 108 °C; isolated by column chromatography on silica gel (PE/EtOAc = 10:1, Rf = 0.3); $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.97 (d, $J$ = 8.1 Hz, 1H), 7.92 – 7.86 (m, 1H), 7.77 (d, $J$ = 8.1 Hz, 1H), 7.61 – 7.56 (m, 1H), 7.44 – 7.39 (m, 1H), 7.38 – 7.34 (m, 1H), 7.33 – 7.28 (m, 1H), 7.16 (t, $J$ = 7.9 Hz, 1H), 5.88 – 5.76 (m, 1H), 5.06 – 4.93 (m, 2H), 4.25 (br, 1H), 2.58 – 2.45 (m, 2H), 2.18 – 2.10 (m, 2H); $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 177.3, 152.5, 145.9, 137.7, 135.4, 130.6, 129.8, 128.7, 126.0, 125.1, 124.2, 123.1, 122.6, 121.6, 115.4, 78.5, 41.5, 27.9; IR (neat): $\nu$ 3431, 3076, 2914, 1641, 1539, 1312, 1075, 997, 910, 787, 757, 728, 702 cm$^{-1}$; HRMS (ESI+) Calcd. for C$_{18}$H$_{17}$NOSBr [M+H]$^+$: 374.0209, found: 374.0211.
**Compound 1q:** Yield: 225.9 mg, 73%; A white solid; This is a known compound and its spectroscopic data are consistent with those reported in the literature; \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.97 (d, \(J = 8.0\) Hz, 1H), 7.73 (d, \(J = 7.6\) Hz, 1H), 7.70 – 7.65 (m, 1H), 7.44 – 7.36 (m, 1H), 7.34 – 7.26 (m, 1H), 7.26 – 7.18 (m, 2H), 7.13 – 7.04 (m, 1H), 5.86 – 5.73 (m, 1H), 5.04 – 4.97 (m, 1H), 4.95 – 4.87 (m, 1H), 4.10 (br, 1H), 2.70 – 2.60 (m, 1H), 2.60 – 2.48 (m, 1H), 2.25 – 2.19 (m, 1H), 2.18 (s, 3H), 2.13 – 2.02 (m, 1H); \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 178.1, 151.9, 140.9, 138.0, 137.4, 135.8, 132.5, 128.2, 126.3, 125.9, 125.6, 125.0, 123.1, 121.6, 114.8, 78.7, 40.5, 27.9, 21.5.
**Compound 1r**: Yield: 200.3 mg, 64%; A white solid; Mp: 79 - 81 °C; isolated by column chromatography on silica gel (PE/EtOAc = 10:1, Rf = 0.3); $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.97 (d, $J = 8.1$ Hz, 1H), 7.79 (d, $J = 8.1$ Hz, 1H), 7.77 – 7.71 (m, 1H), 7.41 (t, $J = 7.6$ Hz, 1H), 7.35 – 7.23 (m, 2H), 7.14 (t, $J = 7.6$ Hz, 1H), 7.04 – 6.97 (m, 1H), 5.91 – 5.76 (m, 1H), 5.04 – 4.90 (m, 2H), 4.44 (br, 1H), 2.73 – 2.54 (m, 2H), 2.20 – 2.12 (m, 2H); $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 176.6, 159.9 (d, $J = 245.3$ Hz), 151.9, 137.9, 135.6, 130.7 (d, $J = 10.9$ Hz), 129.9 (d, $J = 8.9$ Hz), 128.1 (d, $J = 3.5$ Hz), 126.0, 125.1, 124.2 (d, $J = 3.4$ Hz), 123.1, 121.6, 116.2 (d, $J = 23.5$ Hz), 114.9, 77.3, 39.9 (d, $J = 4.0$ Hz), 28.0; $^{19}$F NMR (376 MHz, CDCl$_3$) $\delta$ -110.5; IR (neat): ν 3209, 2922, 1644, 1550, 1445, 1199, 1186, 906, 840, 768, 696 cm$^{-1}$; HRMS (ESI+) Calcd. for C$_{18}$H$_{17}$NOFS [M+H]$^+$: 314.1009, found: 314.1010.
**Compound 1s**: Yield: 180.9 mg, 56%; A white solid; Mp: 99 - 101 °C; isolated by column chromatography on silica gel (PE/EtOAc = 10:1, R_f = 0.3); ^1^H NMR (400 MHz, CDCl_3) δ 7.84 (dd, J = 7.7, 1.5 Hz, 1H), 7.50 (td, J = 7.5, 1.5 Hz, 1H), 7.42 – 7.34 (m, 4H), 7.31 – 7.24 (m, 2H), 7.21 – 7.16 (m, 1H), 3.49 (s, 3H), 1.59 – 1.53 (m, 2H), 1.20 – 1.12 (m, 2H); ^13^C NMR (100 MHz, CDCl_3) δ 168.4, 142.0, 140.6, 131.4, 131.3, 131.2, 129.8, 129.7, 128.0, 127.0, 126.61, 126.56, 123.9, 51.8, 5.3, 1.9; IR (neat): ν 3439, 3042, 1654, 1639, 1456, 1435, 1304, 1242, 1072, 913, 757, 727 cm⁻¹; HRMS (ESI+) Calcd. for C_{20}H_{21}N0NaS [M+Na]^+: 346.1236, found: 346.1233.
**Compound 1t:** Yield: 228.7 mg, 63%; A white solid; Mp: 104 - 106 °C; isolated by column chromatography on silica gel (PE/EtOAc = 10:1, R_f = 0.3); 

\({}^1\)H NMR (400 MHz, CDCl₃) \(\delta 7.94 (d, J = 8.0\ \text{Hz}, 1\text{H}), 7.81 (d, J = 8.4\ \text{Hz}, 1\text{H}), 7.74 (d, J = 8.0\ \text{Hz}, 1\text{H}), 7.43 - 7.36 (m, 1\text{H}), 7.34 - 7.26 (m, 3\text{H}), 5.84 - 5.72 (m, 1\text{H}), 5.02 - 4.82 (m, 2\text{H}), 4.24 (s, 1\text{H}), 2.95 - 2.77 (m, 1\text{H}), 2.68 - 2.55 (m, 1\text{H}), 2.25 - 2.11 (m, 1\text{H}), 2.04 - 1.88 (m, 1\text{H}); \n
\(^{13}\)C NMR (101 MHz, CDCl₃) \(\delta 176.4, 152.1, 139.0, 137.6, 135.2, 134.5, 133.1, 130.8, 129.6, 126.9, 125.9, 125.3, 123.3, 121.6, 115.0, 77.8, 38.2, 27.8; IR (neat): \(\nu 3214, 3110, 2919, 1637, 1491, 1445, 1167, 1123, 998, 914, 839, 774, 745, 710\ \text{cm}^{-1};\) HRMS (ESI+) Calcd. for \(\text{C}_{18}\text{H}_{16}\text{NOSCl}_2\ [\text{M+H}]^+: 364.0324,\) found: 364.0332.
**Compound 1u**: Yield: 153.5 mg, 51%; A white solid; This is a known compound and its spectroscopic data are consistent with those reported in the literature;\(^1\) \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.97 (d, \(J = 8.3\) Hz, 1H), 7.79 (d, \(J = 8.2\) Hz, 1H), 7.47 – 7.38 (m, 1H), 7.37 – 7.26 (m, 1H), 7.20 (d, \(J = 5.0\) Hz, 1H), 7.16 – 7.08 (m, 1H), 7.01 – 6.86 (m, 1H), 5.89 – 5.76 (m, 1H), 5.05 – 4.89 (m, 2H), 4.60 – 4.44 (br, 1H), 2.63 – 2.45 (m, 2H), 2.36 – 2.20 (m, 1H), 2.20 – 2.08 (m, 1H); \(^13\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 177.0, 152.3, 149.2, 137.7, 135.6, 126.9, 126.0, 125.2, 125.1, 124.1, 123.1, 121.7, 115.2, 77.7, 42.7, 28.0.
**Compound 1v**: Yield: 126.4 mg, 42%; A white solid; This is a known compound and its spectroscopic data are consistent with those reported in the literature;\(^1\) \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 8.00 (d, \(J = 8.0\) Hz, 1H), 7.88 (d, \(J = 8.0\) Hz, 1H), 7.48 (t, \(J = 8.0\) Hz, 1H), 7.38 (t, \(J = 8.0\) Hz, 1H), 5.87 – 5.69 (m, 1H), 5.00 – 4.87 (m, 2H), 3.43 (br, 1H), 2.22 – 2.10 (m, 2H), 2.08 – 2.00 (m, 2H), 1.82 – 1.63 (m, 5H), 1.43 – 1.37 (m, 1H), 1.27 – 1.10 (m, 5H); \(^1\)\(^3\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 178.4, 152.3, 138.3, 135.4, 126.0, 124.8, 122.8, 121.7, 114.9, 80.4, 48.6, 38.8, 27.9, 27.1, 26.5, 26.42, 26.38, 26.2.


**Compound 1w**: Yield: 156.8 mg, 57%; A colorless oil; This is a known compound and its spectroscopic data are consistent with those reported in the literature;\(^2\) \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 8.01 (d, \(J = 8.1\) Hz, 1H), 7.87 (d, \(J = 8.1\) Hz, 1H), 7.46 (t, \(J = 7.6\) Hz, 1H), 7.37 (t, \(J = 7.6\) Hz, 1H), 5.87 – 5.73 (m, 1H), 5.00 – 4.86 (m, 2H), 3.71 (br, 1H), 2.29 – 2.20 (m, 1H), 2.18 – 2.05 (m, 2H), 1.73 – 1.61 (m, 1H), 1.07 (s, 9H); \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 177.0, 152.1, 138.5, 135.6, 125.8, 124.8, 122.8, 121.4, 115.0, 82.5, 39.0, 35.3, 28.2, 25.6.
$^1$H NMR (CDCl$_3$, 400 MHz, TMS)

$^1$C NMR (CDCl$_3$, 100 MHz, TMS)
**Compound 1x**: Yield: 146.3 mg, 45%; A white solid; This is a known compound and its spectroscopic data are consistent with those reported in the literature;\(^1\) \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.86 (d, \(J = 8.8\) Hz, 1H), 7.71 – 7.61 (m, 2H), 7.40 – 7.30 (m, 2H), 7.29 – 7.21 (m, 2H), 7.03 (dd, \(J = 8.8, 2.4\) Hz, 1H), 5.94 – 5.72 (m, 1H), 5.08 – 4.98 (m, 1H), 4.98 – 4.91 (m, 1H), 4.03 (br, 1H), 3.81 (s, 3H), 2.63 – 2.48 (m, 2H), 2.22 – 2.10 (m, 2H); \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 175.5, 157.4, 147.0, 143.8, 138.1, 136.9, 128.3, 127.5, 125.5, 123.5, 115.3, 115.1, 104.1, 78.8, 55.7, 41.5, 28.1.
**Compound 1y:** Yield: 180.9 mg, 55%; A white solid; This is a known compound and its spectroscopic data are consistent with those reported in the literature;\(^1\) \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.96 – 7.90 (m, 1H), 7.69 – 7.64 (m, 2H), 7.63 – 7.58 (m, 1H), 7.36 – 7.29 (m, 2H), 7.27 – 7.20 (m, 2H), 5.89 – 5.77 (m, 1H), 5.05 – 4.97 (m, 1H), 4.97 – 4.92 (m, 1H), 4.07 (br, 1H), 2.65 – 2.50 (m, 2H), 2.21 – 2.06 (m, 2H). \(^1\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 180.4, 153.6, 143.3, 137.9, 133.7, 131.8, 128.4, 127.7, 125.4, 125.3, 122.8, 122.3, 115.3, 79.0, 41.3, 28.0.
**Compound 1z**: Yield: 270.9 mg, 79%; A white solid; Mp: 106 - 108 °C; isolated by column chromatography on silica gel (PE/EtOAc = 10:1, R_f = 0.3); ^1H NMR (400 MHz, CDCl_3) δ 8.05 – 7.95 (m, 1H), 7.54 (d, J = 8.0 Hz, 2H), 7.47 (d, J = 8.4 Hz, 1H), 7.33 – 7.18 (m, 3H), 7.16 – 7.08 (m, 1H), 5.80 – 5.65 (m, 1H), 4.97 – 4.79 (m, 2H), 3.88 (s, 1H), 2.51 – 2.34 (m, 2H), 2.11 – 1.98 (m, 2H); ^13C NMR (100 MHz, CDCl_3) δ 180.2, 153.9, 143.3, 137.9, 134.2, 128.4, 128.0, 127.7, 125.9, 125.4, 124.1, 122.6, 119.5, 115.3, 79.1, 41.3, 28.0; IR (neat): ν 3452, 3058, 2906, 1583, 1493, 1446, 1433, 1068, 1053, 909, 899, 869, 797, 763, 698 cm⁻¹; HRMS (ESI+) Calcd. for C_{18}H_{17}NOSBr [M+H]^+: 374.0209, found: 374.0197.
Compound 1aa: Yield: 265.7 mg, 43%; A white solid; Mp: 126 - 128 °C; isolated by column chromatography on silica gel (PE/EtOAc = 2:1, R_f = 0.4); \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.85 – 7.79 (m, 4H), 7.78 – 7.72 (m, 2H), 7.69 – 7.58 (m, 2H), 7.40 – 7.27 (m, 7H), 6.97 – 6.92 (m, 1H), 5.96 – 5.77 (m, 1H), 5.06 – 4.90 (m, 2H), 3.71 (br, 1H), 2.60 – 2.52 (m, 2H), 2.47 (s, 6H), 2.22 – 2.11 (m, 2H); \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 180.4, 153.2, 145.1, 143.2, 137.9, 137.7, 136.4, 132.3, 129.6, 128.6, 128.5, 127.9, 127.8, 126.2, 125.4, 121.9, 115.4, 79.1, 41.3, 28.0, 21.7; IR (neat): \(\nu\) 2986, 2922, 1596, 1447, 1377, 1188, 1167, 1084, 979, 919, 861, 811, 732, 701, 674, 658 cm\(^{-1}\); HRMS (ESI+) Calcd. for C\(_{32}\)H\(_{31}\)N\(_2\)O\(_3\)S\(_3\) [M+H]\(^+\): 619.1389, found: 619.1381.
**Compound 1ab:** Yield: 245.5 mg, 88%; A white solid; This is a known compound and its spectroscopic data are consistent with those reported in the literature;\(^1\) \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.71 – 7.65 (m, 1H), 7.64 – 7.59 (m, 2H), 7.48 – 7.42 (m, 1H), 7.36 – 7.20 (m, 5H), 5.87 – 5.72 (m, 1H), 5.02 – 4.87 (m, 2H), 4.56 (br, 1H), 2.63 – 2.51 (m, 1H), 2.50 – 2.40 (m, 1H), 2.28 – 2.16 (m, 1H), 2.17 – 2.06 (m, 1H); \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 168.9, 151.0, 142.6, 140.1, 137.7, 128.3, 127.7, 125.2, 125.1, 124.5, 120.1, 114.8, 110.8, 75.8, 40.1, 27.8.

---

---
Compound 1ac: Yield: 263.7 mg, 90%; A white solid; Mp: 106 - 108 °C; isolated by column chromatography on silica gel (PE/EtOAc = 10:1, Rf = 0.4); $^1$H NMR (400 MHz, CDCl$_3$) δ 7.63 – 7.58 (m, 2H), 7.43 – 7.39 (m, 1H), 7.34 – 7.29 (m, 3H), 7.27 – 7.21 (m, 1H), 7.10 – 7.05 (m, 1H), 5.87 – 5.73 (m, 1H), 5.01 – 4.88 (m, 2H), 4.46 (br, 1H), 2.59 – 2.51 (m, 1H), 2.49 – 2.41 (m, 1H), 2.40 (s, 3H), 2.26 – 2.17 (m, 1H), 2.14 – 2.04 (m, 1H). $^{13}$C NMR (100 MHz, CDCl$_3$) δ 169.0, 149.3, 142.8, 140.3, 137.8, 134.3, 128.3, 127.7, 126.1, 125.3, 119.9, 114.7, 110.1, 75.8, 40.2, 27.9, 21.3; IR (neat): ν 3214, 2925, 1503, 1482, 1393, 1317, 1133, 1092, 1064, 1007, 912, 878, 816, 754, 725, 655 cm$^{-1}$; HRMS (ESI+) Calcd. for C$_{19}$H$_{19}$NO$_2$Na [M+Na]$^+$: 316.1308, found: 316.1304.
**Compound 1ad**: Yield: 247.3 mg, 79%; A white solid; Mp: 116 - 118 °C; isolated by column chromatography on silica gel (PE/EtOAc = 10:1, Rf = 0.4); $^1$H NMR (400 MHz, CDCl$_3$) δ 7.66 – 7.55 (m, 3H), 7.41 – 7.31 (m, 3H), 7.31 – 7.23 (m, 2H), 5.87 – 5.72 (m, 1H), 5.02 – 4.88 (m, 2H), 4.37 (br, 1H), 2.57 – 2.49 (m, 1H), 2.49 – 2.39 (m, 1H), 2.24 – 2.14 (m, 1H), 2.13 – 2.02 (m, 1H); $^{13}$C NMR (100 MHz, CDCl$_3$) δ 170.3, 149.6, 142.3, 141.3, 137.6, 130.1, 128.5, 127.9, 125.5, 125.2, 120.1, 115.0, 111.6, 75.9, 40.1, 27.8; IR (neat): υ 3402, 2922, 1646, 1557, 1449, 1255, 1137, 1071, 1057, 919, 873, 800, 724, 696 cm$^{-1}$; HRMS (ESI+) Calcd. for C$_{18}$H$_{17}$NO$_2$Cl [M+H]$: 314.0942,$ found: 314.094.
**Compound 1ae**: Yield: 203.5 mg, 78%; A white solid; Mp: 95 - 97 °C; isolated by column chromatography on silica gel (PE/EtOAc = 10:1, Rf = 0.4); $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.84 (d, $J$ = 8.1 Hz, 1H), 7.63 (d, $J$ = 8.1 Hz, 1H), 7.43 (d, $J$ = 7.9 Hz, 2H), 7.27 (t, $J$ = 7.6 Hz, 1H), 7.15 (t, $J$ = 7.6 Hz, 1H), 7.01 (d, $J$ = 7.9 Hz, 2H), 5.70 – 5.53 (m, 1H), 4.92 – 4.75 (m, 2H), 3.97 (br, 1H), 2.37 – 2.28 (m, 2H), 2.16 (s, 3H), 2.00 – 1.91 (m, 2H), 1.43 – 1.31 (m, 2H); $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 178.7, 152.5, 140.9, 138.2, 137.1, 135.5, 129.0, 125.8, 125.4, 124.8, 122.9, 121.5, 114.8, 78.7, 41.8, 33.6, 22.7, 20.9; IR (neat): $\nu$ 3441, 3063, 2917, 1639, 1509, 1437, 1312, 1084, 991, 908, 813, 757, 728 cm$^{-1}$; HRMS (ESI+) Calcd. for C$_{20}$H$_{21}$NONaS [M+Na]$^+$: 346.1236, found: 346.1234.
**Compound 1af**: Yield: 252.6 mg, 67%; A white solid; Mp: 111 - 113 °C; isolated by column chromatography on silica gel (PE/EtOAc = 10:1, R$_f$ = 0.4); $^1$H NMR (400 MHz, CDCl$_3$) δ 7.98 (d, $J$ = 8.2 Hz, 1H), 7.87 – 7.77 (m, 3H), 7.59 (d, $J$ = 8.2 Hz, 2H), 7.44 (t, $J$ = 7.7 Hz, 1H), 7.33 (t, $J$ = 7.7 Hz, 1H), 5.80 – 5.66 (m, 1H), 5.06 – 4.89 (m, 2H), 4.18 (s, 1H), 2.46 (t, $J$ = 8.2 Hz, 2H), 2.15 – 2.03 (m, 2H), 1.56 – 1.37 (m, 2H); $^{13}$C NMR (100 MHz, CDCl$_3$) δ 177.3, 152.5, 147.7, 138.0, 135.5, 129.7 (q, $J$ = 32.3 Hz), 126.2, 126.0, 125.3, 125.3, 125.3, 125.2, 124.0 (q, $J$ = 270.2 Hz), 123.1, 121.7, 115.2, 78.7, 42.0, 33.5, 22.6; $^{19}$F NMR (376 MHz, CDCl$_3$) δ -62.5; IR (neat): ν 3332, 1610, 1403, 1323, 1163, 1067, 1016, 913, 847, 758, 729 cm$^{-1}$; HRMS (ESI+) Calcd. for C$_{20}$H$_{19}$NOF$_3$S [M+H]$^+$: 378.1134, found: 378.1129.
**Compound 1ag**: Yield: 206.5 mg, 77%; A yellow solid; This is a known compound and its spectroscopic data are consistent with those reported in the literature;\(^1\) \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 8.02 (d, \(J = 8.1\) Hz, 1H), 7.85 (d, \(J = 8.1\) Hz, 1H), 7.60 – 7.53 (m, 2H), 7.50 – 7.44 (m, 1H), 7.40 – 7.29 (m, 4H), 6.77 – 6.66 (m, 1H), 5.57 – 5.39 (m, 2H), 3.87 (br, 1H); \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 176.9, 152.7, 143.2, 141.0, 135.5, 128.5, 128.2, 126.4, 126.1, 125.2, 123.2, 121.7, 115.7, 79.1.
Compound 1ah: Yield: 227.5 mg, 81%; A yellow solid; This is a known compound and its spectroscopic data are consistent with those reported in the literature;\(^1\) \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 8.00 (d, \(J = 8.1\) Hz, 1H), 7.77 (d, \(J = 8.1\) Hz, 1H), 7.75 – 7.66 (m, 2H), 7.41 (t, \(J = 7.7\) Hz, 1H), 7.35 – 7.21 (m, 4H), 5.81 – 5.64 (m, 1H), 5.29 – 5.13 (m, 2H), 3.80 (br, 1H), 3.48 – 3.37 (m, 1H), 3.15 – 3.02 (m, 1H); \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 177.9, 153.0, 143.3, 135.5, 132.4, 128.3, 127.6, 125.8, 125.4, 124.8, 123.0, 121.6, 121.1, 77.7, 47.1.
**Compound 2a:** Yield: 45.6 mg, 78%; A yellow solid; Mp: 77 - 79 °C; isolated by column chromatography on silica gel (PE/EtOAc = 10:1, R_f = 0.4); \(^1\)H NMR (400 MHz, CDCl\(_3\) ) \(\delta\) 8.02 – 8.00 (m, 3H), 7.84 (d, \(J = 7.9\) Hz, 1H), 7.61 – 7.52 (m, 1H), 7.51 – 7.48 (m, 3H), 7.42 – 7.40 (m, 1H), 6.00 (s, 1H), 5.62 (s, 1H), 3.40 (t, \(J = 7.5\) Hz, 2H), 3.17 (t, \(J = 7.5\) Hz, 2H). \(^{13}\)C NMR (100 MHz, CDCl\(_3\) ) \(\delta\) 199.4, 168.6, 153.8, 142.5, 136.8, 134.7, 133.0, 128.6, 128.2, 126.1, 125.5, 123.3, 121.4, 120.4, 37.9, 28.9; IR (neat): \(\nu\) 2962, 2926, 1682, 1596, 1448, 1311, 1206, 973, 759, 743 cm\(^{-1}\);

\(^1\)HRMS (ESI+): Calcd. for C\(_{18}\)H\(_{16}\)NOS [M+H]\(^+\): 294.0947, found: 294.0940.
**Compound 2b**: Yield: 46.1 mg, 75%; A yellow solid; Mp: 88 - 90 °C; isolated by column chromatography on silica gel (PE/EtOAc = 10:1, R_f = 0.4); $^1$H NMR (400 MHz, CDCl$_3$) δ 8.01 (d, $J$ = 8.0 Hz, 1H), 7.91 (d, $J$ = 7.9 Hz, 2H), 7.85 (d, $J$ = 8.0 Hz, 1H), 7.49 – 7.43 (m, 1H), 7.42 – 7.35 (m, 1H), 7.26 – 7.21 (m, 2H), 5.99 (s, 1H), 5.61 (s, 1H), 3.36 (t, $J$ = 7.5 Hz, 2H), 3.16 (t, $J$ = 7.5 Hz, 2H), 2.40 (s, 3H); $^{13}$C NMR (100 MHz, CDCl$_3$) δ 199.0, 168.7, 153.5, 143.8, 142.4, 134.6, 134.4, 129.2, 128.3, 126.1, 125.5, 123.3, 121.4, 120.5, 37.7, 29.0, 21.6; IR (neat): ν 3318, 1674, 1456, 1434, 1198, 1123, 928, 887, 765, 738 cm$^{-1}$; HRMS (ESI+) Calcd. for C$_{19}$H$_{18}$NOS [M+H]$^+$: 308.1104, found: 308.1100.
**Compound 2c:** Yield: 51.1 mg, 81%; A white solid; Mp: 89 - 91 °C; isolated by column chromatography on silica gel (PE/EtOAc = 10:1, Rf = 0.4); \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 8.03 – 7.99 (m, 1H), 7.93 (d, \(J = 8.1\) Hz, 2H), 7.86 – 7.82 (m, 1H), 7.48 – 7.43 (m, 1H), 7.40 – 7.35 (m, 1H), 7.27 (d, \(J = 8.1\) Hz, 2H), 5.98 (s, 1H), 5.61 (s, 1H), 3.42 – 3.31 (m, 2H), 3.21 – 3.08 (m, 2H), 2.69 (q, \(J = 7.6\) Hz, 2H), 1.25 (t, \(J = 7.6\) Hz, 3H); \(^1^3\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 199.0, 168.6, 153.7, 150.0, 142.5, 134.7, 134.6, 128.4, 128.0, 126.1, 125.5, 123.3, 121.4, 120.4, 37.7, 29.0, 28.9, 15.2; IR (neat): \(\nu\) 2964, 2929, 1677, 1605, 1514, 1455, 1412, 1180, 1051, 906, 759, 729 cm\(^{-1}\); HRMS (ESI+) Calcd. for C\(_{20}\)H\(_{20}\)NOS [M+H]\(^+\): 322.1260, found: 322.1261.
**Compound 2d**: Yield: 54.4 mg, 78%; A white solid; Mp: 88 - 90 °C; isolated by column chromatography on silica gel (PE/EtOAc = 10:1, Rf = 0.4); \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 8.01 (d, \(J = 8.1\) Hz, 1H), 7.95 (d, \(J = 8.1\) Hz, 2H), 7.84 (d, \(J = 7.9\) Hz, 1H), 7.49 – 7.43 (m, 3H), 7.40 – 7.34 (m, 1H), 5.99 (s, 1H), 5.61 (s, 1H), 3.37 (t, \(J = 7.5\) Hz, 2H), 3.16 (t, \(J = 7.5\) Hz, 2H), 1.33 (s, 9H); \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 199.0, 168.6, 156.7, 153.7, 142.5, 134.7, 134.3, 128.1, 126.1, 125.5, 123.3, 121.4, 120.4, 37.7, 35.1, 31.1, 29.0; IR (neat): ν 2962, 1678, 1604, 1486, 1107, 907, 842, 759, 728 cm\(^{-1}\); HRMS (ESI+) Calcd. for C\(_{22}\)H\(_{24}\)NOS [M+H]\(^+\): 350.1573, found: 350.1569.
**Compound 2e:** Yield: 39.7 mg, 64%; A white solid; Mp: 86 - 88 °C; isolated by column chromatography on silica gel (PE/EtOAc = 10:1, Rf = 0.4); $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 8.07 – 7.98 (m, 3H), 7.84 (d, $J$ = 7.9 Hz, 1H), 7.46 (t, $J$ = 7.8 Hz, 1H), 7.38 (t, $J$ = 7.8 Hz, 1H), 7.11 (t, $J$ = 8.5 Hz, 2H), 5.98 (s, 1H), 5.61 (s, 1H), 3.36 (t, $J$ = 7.5 Hz, 2H), 3.15 (t, $J$ = 7.5 Hz, 2H); $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 197.7, 168.5, 165.7 (d, $J$ = 253.4 Hz), 153.7, 142.3, 134.7, 133.2, 130.8 (d, $J$ = 9.8 Hz), 126.1, 125.5, 123.3, 121.4, 120.6, 115.6 (d, $J$ = 21.0 Hz), 37.8, 29.0; $^{19}$F NMR (376 MHz, CDCl$_3$) $\delta$ -105.4; IR (neat): $\nu$ 1681, 1595, 1505, 1312, 1252, 840, 756, 727 cm$^{-1}$; HRMS (ESI+) Calcd. for C$_{18}$H$_{15}$NOFS [M+H]$^+$: 312.0853, found: 312.0849.
**Compound 2f:** Yield: 39.2 mg, 60%; A yellow solid; Mp: 95 - 97 °C; isolated by column chromatography on silica gel (PE/EtOAc = 10:1, Rf = 0.4); $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 8.02 (d, $J$ = 7.9 Hz, 1H), 7.99 - 7.93 (m, 2H), 7.85 (d, $J$ = 7.9 Hz, 1H), 7.49 - 7.37 (m, 4H), 6.00 (s, 1H), 5.62 (s, 1H), 3.36 (t, $J$ = 7.5 Hz, 2H), 3.16 (t, $J$ = 7.5 Hz, 2H); $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 198.1, 168.5, 153.5, 142.2, 139.5, 135.1, 134.6, 129.6, 128.9, 126.2, 125.6, 123.3, 121.5, 120.8, 37.9, 29.0; IR (neat): v 2966, 1712, 1489, 1440, 1338, 1161, 1038, 754, 694, 655 cm$^{-1}$; HRMS (ESI+) Calcd. for C$_{18}$H$_{15}$NOSCl [M+H]$^+$: 328.0557, found: 328.0552.
**Compound 2g:** Yield: 33.3 mg, 45%; A white solid; Mp: 114 - 116 °C; isolated by column chromatography on silica gel (PE/EtOAc = 10:1, R_f = 0.4); ^1H NMR (400 MHz, CDCl_3) δ 8.02 – 7.97 (m, 1H), 7.91 – 7.83 (m, 3H), 7.62 – 7.56 (m, 2H), 7.50 – 7.44 (m, 1H), 7.41 – 7.36 (m, 1H), 5.98 (s, 1H), 5.61 (s, 1H), 3.35 (t, J = 7.5 Hz, 2H), 3.15 (t, J = 7.5 Hz, 2H); ^13C NMR (100 MHz, CDCl_3) δ 198.3, 168.4, 153.7, 142.3, 135.5, 134.6, 131.9, 129.7, 128.2, 126.1, 125.6, 123.3, 121.4, 120.6, 37.9, 29.0; IR (neat): v 2844, 1711, 1598, 1346, 1165, 1023, 1014, 816, 663 cm^{-1}; HRMS (ESI+) Calcd. for C_{18}H_{15}NOSBr [M+H]^+: 372.0052, found: 372.0059.
Compound 2h: Yield: 52.7 mg, 73%; A white solid; Mp: 111 - 113 °C; isolated by column chromatography on silica gel (PE/EtOAc = 10:1, Rf = 0.4); $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 8.03 (d, $J$ = 8.0 Hz, 2H), 7.92 (d, $J$ = 8.0 Hz, 1H), 7.76 (d, $J$ = 8.0 Hz, 1H), 7.63 (d, $J$ = 8.0 Hz, 2H), 7.38 (t, $J$ = 7.6 Hz, 1H), 7.30 (t, $J$ = 7.6 Hz, 1H), 5.90 (s, 1H), 5.55 (s, 1H), 3.34 (t, $J$ = 7.4 Hz, 2H), 3.09 (t, $J$ = 7.4 Hz, 2H); $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 198.3, 168.4, 153.6, 142.1, 139.4, 139.4, 134.6, 134.3 (q, $J$ = 32.4 Hz), 128.5, 126.2, 125.6 (q, $J$ = 3.7 Hz), 125.6, 123.6 (q, $J$ = 271.2 Hz), 123.3, 121.4, 120.8, 38.2, 28.9; $^{19}$F NMR (376 MHz, CDCl$_3$) $\delta$ -63.1; IR (neat): v 2918, 2849, 1714, 1151, 1338, 1161, 1094, 1023, 836, 664 cm$^{-1}$; HRMS (ESI+) Calcd. for C$_{19}$H$_{15}$NOF$_3$S [M+H]$^+$: 362.0821, found: 362.0812.
**Compound 2i:** Yield: 36.2 mg, 48%; A white solid; Mp: 87 - 89 °C; isolated by column chromatography on silica gel (PE/EtOAc = 10:1, Rf = 0.4); $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 8.07 (d, $J$ = 8.4 Hz, 2H), 8.00 (d, $J$ = 8.0 Hz, 1H), 7.85 (d, $J$ = 8.0 Hz, 1H), 7.47 (t, $J$ = 7.5 Hz, 1H), 7.38 (t, $J$ = 7.5 Hz, 1H), 7.27 (d, $J$ = 8.4 Hz, 2H), 5.98 (s, 1H), 5.62 (s, 1H), 3.38 (t, $J$ = 7.5 Hz, 2H), 3.16 (t, $J$ = 7.5 Hz, 2H); $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 197.8, 168.4, 153.7, 152.6, 142.3, 135.0, 134.6, 130.2, 126.1, 125.6, 123.3, 121.4, 120.7, 120.4, 120.3 (q, $J$ = 257.1 Hz), 38.0, 28.9; $^{19}$F NMR (376 MHz, CDCl$_3$) $\delta$ -57.6; IR (neat): $\nu$ 1684, 1601, 1505, 1308, 1284, 1164, 988, 937, 758, 731 cm$^{-1}$; HRMS (ESI+) Calcd. for C$_{19}$H$_{15}$NO$_2$S [M+H]$^+$: 378.0770, found: 378.0766.
**Compound 2j**: Yield: 36.1 mg, 56%; A white solid; Mp: 93 - 95 °C; isolated by column chromatography on silica gel (PE/EtOAc = 10:1, Rf = 0.4); \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 8.08 – 7.95 (m, 3H), 7.85 (d, \(J = 8.2\) Hz, 1H), 7.51 – 7.42 (m, 1H), 7.41 – 7.34 (m, 1H), 6.96 – 6.89 (m, 2H), 5.99 (s, 1H), 5.61 (s, 1H), 3.86 (s, 3H), 3.33 (t, \(J = 7.5\) Hz, 2H), 3.15 (t, \(J = 7.5\) Hz, 2H); \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 197.9, 168.7, 163.4, 153.6, 142.5, 134.6, 130.4, 129.9, 126.1, 125.5, 123.3, 121.4, 120.5, 113.7, 55.4, 37.5, 29.1; IR (neat): ν 2927, 1671, 1597, 1510, 1418, 1258, 1112, 1024, 906, 825, 761, 729 cm\(^{-1}\); HRMS (ESI+) Calcd. for C\(_{19}\)H\(_{18}\)NO\(_2\)S [M+H]\(^+\): 324.1053, found: 324.1046.
**Compound 2k:** Yield: 45.0 mg, 61%; A white solid; Mp: 93 - 95 °C; isolated by column chromatography on silica gel (PE/EtOAc = 10:1, \( R_f = 0.4 \)); \(^1\)H NMR (400 MHz, CDCl\(_3\)) \( \delta \) 8.12 - 8.07 (m, 2H), 8.02 (d, \( J = 8.1 \) Hz, 1H), 7.86 (d, \( J = 8.1 \) Hz, 1H), 7.71 - 7.66 (m, 2H), 7.64 - 7.60 (m, 2H), 7.49 - 7.44 (m, 3H), 7.43 - 7.36 (m, 2H), 6.00 (s, 1H), 5.64 (s, 1H), 3.43 (t, \( J = 7.4 \) Hz, 2H), 3.19 (t, \( J = 7.4 \) Hz, 2H); \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \( \delta \) 199.0, 168.6, 153.7, 145.7, 142.4, 139.9, 135.5, 134.7, 128.9, 128.8, 128.2, 127.3, 127.2, 126.1, 125.5, 123.3, 121.4, 120.5, 37.9, 29.0; IR (neat): \( \nu \) 2924, 1678, 1603, 1487, 1252, 1031, 1006, 754, 728 cm\(^{-1}\); HRMS (ESI+) Calcd. for C\(_{24}\)H\(_{20}\)NOS [M+H]\(^+\): 370.1260, found: 370.1267.
**Compound 2l**: Yield: 39.4 mg, 62%; A white solid; Mp: 126 - 128 °C; isolated by column chromatography on silica gel (PE/EtOAc = 10:1, Rf = 0.4); $^1$H NMR (400 MHz, CDCl$_3$) δ 8.10 (d, $J$ = 8.0 Hz, 2H), 7.99 (d, $J$ = 8.2 Hz, 1H), 7.85 (d, $J$ = 8.0 Hz, 1H), 7.76 (d, $J$ = 8.2 Hz, 2H), 7.47 (t, $J$ = 7.7 Hz, 1H), 7.39 (t, $J$ = 7.7 Hz, 1H), 5.99 (s, 1H), 5.64 (s, 1H), 3.41 (t, $J$ = 7.5 Hz, 2H), 3.16 (t, $J$ = 7.5 Hz, 2H); $^{13}$C NMR (100 MHz, CDCl$_3$) δ 198.0, 168.3, 153.5, 142.0, 139.7, 134.6, 132.5, 128.6, 126.2, 125.7, 123.3, 121.5, 121.0, 117.9, 116.3, 38.3, 28.9; IR (neat): ν 3033, 2231, 1687, 1423, 1090, 1030, 1010, 842, 760, 729 cm$^{-1}$; HRMS (ESI+) Calcd. for C$_{19}$H$_{15}$N$_2$OS [M+H]$^+$: 319.0899, found: 319.0898.
Compound 2m: Yield: 38.7 mg, 63%; A yellow oil; isolated by column chromatography on silica gel (PE/EtOAc = 10:1, Rf = 0.4); ¹H NMR (400 MHz, CDCl₃) δ 8.03 (d, J = 8.1 Hz, 1H), 7.85 (d, J = 8.1 Hz, 1H), 7.83 – 7.77 (m, 2H), 7.50 – 7.44 (m, 1H), 7.42 – 7.30 (m, 3H), 6.01 (s, 1H), 5.63 (s, 1H), 3.38 (t, J = 7.5 Hz, 2H), 3.16 (t, J = 7.5 Hz, 2H), 2.40 (s, 3H); ¹³C NMR (100 MHz, CDCl₃) δ 199.5, 168.7, 153.4, 142.3, 138.3, 136.8, 134.6, 133.8, 128.7, 128.4, 126.2, 125.6, 125.4, 123.3, 121.4, 120.7, 37.9, 29.0, 21.3; IR (neat): v 3062, 1679, 1505, 1491, 1456, 1246, 1241, 991, 762, 758 cm⁻¹; HRMS (ESI+) Calcd. for C₁₉H₁₈NOS [M+H]⁺: 308.1104, found: 308.1098.
**Compound 2n**: Yield: 41.7 mg, 67%; A yellow oil; isolated by column chromatography on silica gel (PE/EtOAc = 10:1, R_f = 0.4); \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 8.02 (d, \(J = 8.1\) Hz, 1H), 7.84 (d, \(J = 8.1\) Hz, 1H), 7.82 – 7.70 (m, 2H), 7.49 – 7.35 (m, 3H), 7.28 – 7.21 (m, 1H), 5.98 (s, 1H), 5.62 (s, 1H), 3.37 (t, \(J = 7.5\) Hz, 2H), 3.15 (t, \(J = 7.5\) Hz, 2H); \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 198.1, 168.4, 162.9 (d, \(J = 246.3\) Hz), 153.7, 142.2, 138.8 (d, \(J = 6.2\) Hz), 134.6, 130.2 (d, \(J = 7.5\) Hz), 126.1, 125.6, 123.9 (d, \(J = 3.1\) Hz), 123.3, 121.4, 120.6, 120.0 (d, \(J = 21.3\) Hz), 115.0 (d, \(J = 22.1\) Hz), 38.1, 29.0; \(^{19}\)F NMR (376 MHz, CDCl\(_3\)) \(\delta\) -111.9; IR (neat): \(\nu\) 2918, 1685, 1586, 1437, 1241, 1150, 908, 758, 728, 679 cm\(^{-1}\); HRMS (ESI+) Calcd. for C\(_{18}\)H\(_{15}\)NOFS \([\text{M+H}]^+:\) 312.0853, found: 312.0845.
$^{13}$C NMR (CDCl$_3$, 100 MHz, TMS)

$^{19}$F NMR (CDCl$_3$, 376 MHz)
**Compound 2o:** Yield: 49.7 mg, 76%; A white solid; Mp: 93 - 95 °C; isolated by column chromatography on silica gel (PE/EtOAc = 10:1, R_f = 0.4); \( ^1 \)H NMR (400 MHz, CDCl\(_3\) ) \( \delta \) 8.05 – 8.02 (m, 1H), 8.01 (s, 1H), 7.90 – 7.87 (m, 1H), 7.86 – 7.83 (m, 1H), 7.54 – 7.51 (m, 1H), 7.49 – 7.44 (m, 1H), 7.41 – 7.37 (m, 2H), 5.98 (s, 1H), 5.62 (s, 1H), 3.36 (t, \( J = 7.5 \) Hz, 2H), 3.15 (t, \( J = 7.5 \) Hz, 2H); \( ^{13} \)C NMR (100 MHz, CDCl\(_3\) ) \( \delta \) 198.1, 168.4, 153.7, 142.3, 138.3, 134.9, 134.7, 133.0, 129.9, 128.4, 126.3, 126.1, 125.6, 123.4, 121.4, 120.7, 38.1, 29.0; IR (neat): \( \nu \) 3064, 2921, 1685, 1570, 1456, 1202, 997, 905, 758, 728, 678 cm\(^{-1}\); HRMS (ESI\(^+\)) Calcd. for C\(_{18}\)H\(_{15}\)NOSCl [M+H\(^+\)]: 328.0557, found: 328.0549.
Compound 2p: Yield: 59.2 mg, 80%; A white solid; Mp: 106 - 108 °C; isolated by column chromatography on silica gel (PE/EtOAc = 10:1, Rf = 0.4); ¹H NMR (400 MHz, CDCl₃) δ 8.16 (s, 1H), 8.03 (d, J = 8.0 Hz, 1H), 7.93 (d, J = 7.9 Hz, 1H), 7.85 (d, J = 7.9 Hz, 1H), 7.67 (d, J = 8.0 Hz, 1H), 7.49 – 7.43 (m, 1H), 7.41 – 7.36 (m, 1H), 7.35 – 7.30 (m, 1H), 5.98 (s, 1H), 5.62 (s, 1H), 3.36 (t, J = 7.5 Hz, 2H), 3.15 (t, J = 7.5 Hz, 2H); ¹³C NMR (100 MHz, CDCl₃) δ 198.0, 168.4, 153.7, 142.2, 138.5, 135.9, 134.7, 131.3, 130.2, 126.7, 126.1, 125.6, 123.4, 123.0, 121.4, 120.7, 38.1, 29.0; IR (neat): ν 3062, 2922, 1683, 1565, 1456, 1200, 995, 906, 758, 728, 677 cm⁻¹; HRMS (ESI+) Calcd. for C₁₈H₁₄NOSBr [M+H]⁺: 372.0052, found: 372.0061.
**Compound 2q**: Yield: 24.6 mg, 40%; A yellow oil; isolated by column chromatography on silica gel (PE/EtOAc = 10:1, R<sub>f</sub> = 0.4); \(^1\)H NMR (400 MHz, CDCl<sub>3</sub>) \(\delta\) 8.04 – 7.97 (m, 1H), 7.86 – 7.80 (m, 1H), 7.68 (d, \(J = 7.7\) Hz, 1H), 7.48 – 7.42 (m, 1H), 7.40 – 7.32 (m, 2H), 7.28 – 7.19 (m, 2H), 5.98 (s, 1H), 5.59 (s, 1H), 3.31 (t, \(J = 7.4\) Hz, 2H), 3.14 (t, \(J = 7.4\) Hz, 2H), 2.52 (s, 3H); \(^{13}\)C NMR (100 MHz, CDCl<sub>3</sub>) \(\delta\) 203.2, 168.6, 153.6, 142.4, 138.2, 137.7, 134.6, 131.9, 131.3, 128.6, 126.1, 125.6, 125.5, 123.3, 121.4, 120.4, 40.4, 28.9, 21.4; IR (neat): ν 2925, 1679, 1569, 1455, 1242, 1211, 973, 907, 758, 728 cm<sup>-1</sup>; HRMS (ESI+) Calcd. for C<sub>19</sub>H<sub>18</sub>NOS [M+H]<sup>+</sup>: 308.1104, found: 308.1105.
Compound 2r: Yield: 24.6 mg, 40%; A yellow oil; isolated by column chromatography on silica gel (PE/EtOAc = 10:1, R_f = 0.4); ¹H NMR (400 MHz, CDCl₃) δ 8.03 – 7.96 (m, 1H), 7.89 (td, J = 7.5, 1.8 Hz, 1H), 7.86 – 7.80 (m, 1H), 7.53 – 7.47 (m, 1H), 7.47 – 7.41 (m, 1H), 7.36 (t, J = 7.5 Hz, 1H), 7.22 (t, J = 7.5 Hz, 1H), 7.15 – 7.07 (m, 1H), 6.00 (s, 1H), 5.59 (s, 1H), 3.40 (td, J = 7.3, 3.0 Hz, 2H), 3.16 (t, J = 7.3 Hz, 2H); ¹³C NMR (100 MHz, CDCl₃) δ 197.5 (d, J = 4.0 Hz), 168.6, 161.9 (d, J = 253.1 Hz), 153.7, 142.3, 134.7, 134.5 (d, J = 8.8 Hz), 130.6 (d, J = 5.3 Hz), 126.0, 125.6 (d, J = 12.9 Hz), 125.4, 124.4 (d, J = 3.8 Hz), 123.3, 121.4, 120.2, 116.6 (d, J = 23.1 Hz), 42.4 (d, J = 7.4 Hz), 28.3 (d, J = 2.1 Hz); ¹⁹F NMR (376 MHz, CDCl₃) δ -109.3; IR (neat): ν 2922, 1682, 1607,
1479, 1450, 1210, 1151, 1102, 985, 906, 756, 728 cm\(^{-1}\); HRMS (ESI+) Calcd. for C\(_{18}\)H\(_{15}\)NOFS [M+H]\(^+\): 312.0853, found: 312.0849.
Compound 2s: Yield: 49.4 mg, 77%; A white solid;Mp: 81 – 83 °C; isolated by column chromatography on silica gel (PE/EtOAc = 10:1, Rf = 0.4); ¹H NMR (400 MHz, CDCl₃) δ 8.02 (d, J = 8.0 Hz, 1H), 7.85 (d, J = 8.0 Hz, 1H), 7.64 – 7.57 (m, 2H), 7.49 – 7.43 (m, 1H), 7.41 – 7.35 (m, 1H), 7.22 – 7.15 (m, 1H), 5.99 (s, 1H), 5.61 (s, 1H), 3.36 (t, J = 7.5 Hz, 2H), 3.15 (t, J = 7.5 Hz, 2H), 2.35 (s, 6H); ¹³C NMR (100 MHz, CDCl₃) δ 199.7, 168.7, 153.7, 142.5, 138.2, 136.9, 134.7, 126.1, 125.9, 125.5, 123.3, 121.4, 120.4, 37.9, 29.0, 21.2; IR (neat): ν 2917, 1681, 1604, 1485, 1313, 1180, 1157, 906, 759, 729 cm⁻¹; HRMS (ESI+) Calcd. for C₂₀H₂₀NOS [M+H]+: 322.1260, found: 322.1259.
**Compound 2t**: Yield: 30.3 mg, 42%; A white solid; Mp: 102 - 104 °C; isolated by column chromatography on silica gel (PE/EtOAc = 10:1, R_f = 0.4); ^1H NMR (400 MHz, CDCl_3) δ 8.04 – 7.98 (m, 1H), 7.88 – 7.81 (m, 1H), 7.50 – 7.43 (m, 2H), 7.42 (d, J = 2.0 Hz, 1H), 7.40 – 7.35 (m, 1H), 7.31 – 7.26 (m, 1H), 5.99 (s, 1H), 5.60 (s, 1H), 3.35 (t, J = 7.4 Hz, 2H), 3.14 (t, J = 7.4 Hz, 2H); ^13C NMR (100 MHz, CDCl_3) δ 200.9, 168.4, 153.5, 141.8, 137.4, 137.3, 134.6, 132.2, 130.5, 130.3, 127.3, 126.2, 125.6, 123.3, 121.4, 120.8, 41.7, 28.6; IR (neat): ν 2924, 1687, 1581, 1406, 1104, 906, 820, 758, 728 cm\(^{-1}\); HRMS (ESI+) Calcd. for C\(_{18}\)H\(_{14}\)NOSCl\(_2\) [M+H]^+: 362.0167, found: 362.0172.
Compound 2u: Yield: 31.1 mg, 52%; A yellow oil; isolated by column chromatography on silica gel (PE/EtOAc = 10:1, Rf = 0.4); H NMR (400 MHz, CDCl3) δ 8.01 (d, J = 8.1 Hz, 1H), 7.85 (d, J = 8.1 Hz, 1H), 7.79 – 7.74 (m, 1H), 7.65 – 7.58 (m, 1H), 7.51 – 7.42 (m, 1H), 7.41 – 7.34 (m, 1H), 7.16 – 7.06 (m, 1H), 5.98 (s, 1H), 5.62 (s, 1H), 3.32 (t, J = 7.5 Hz, 2H), 3.17 (t, J = 7.5 Hz, 2H); C NMR (100 MHz, CDCl3) δ 192.3, 168.5, 153.6, 144.2, 142.1, 134.7, 133.6, 132.1, 128.0, 126.1, 125.5, 123.3, 121.4, 120.7, 38.5, 29.2; IR (neat): ν 2918, 2849, 1656, 1436, 1413, 1231, 1062, 853, 759, 721 cm⁻¹; HRMS (ESI+) Calcd. for C16H14NOS2 [M+H]⁺: 300.0511, found: 300.0509.
**Compound 2v:** Yield: 40.7 mg, 68%; A yellow oil; isolated by column chromatography on silica gel (PE/EtOAc = 10:1, Rf = 0.4); $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 8.00 (d, $J$ = 8.0 Hz, 1H), 7.84 (d, $J$ = 8.0 Hz, 1H), 7.46 (t, $J$ = 8.0 Hz, 1H), 7.37 (t, $J$ = 8.0 Hz, 1H), 5.95 (s, 1H), 5.53 (s, 1H), 2.98 (t, $J$ = 7.4 Hz, 2H), 2.84 (t, $J$ = 7.4 Hz, 2H), 2.39 – 2.30 (m, 1H), 1.86 – 1.81 (m, 2H), 1.79 – 1.73 (m, 2H), 1.68 – 1.61 (m, 1H), 1.40 – 1.27 (m, 3H), 1.27 – 1.12 (m, 3H); $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 213.0, 168.7, 153.5, 142.4, 134.6, 126.1, 125.5, 123.3, 121.4, 120.3, 50.8, 39.5, 28.4, 28.2, 25.8, 25.6; IR (neat): $\nu$ 2927, 2851, 1703, 1513, 1448, 1314, 1241, 991, 910, 759, 729 cm$^{-1}$; HRMS (ESI$^+$) Calcd. for C$_{18}$H$_{22}$NOS [M+H]+: 300.1417, found: 300.1412.
Compound 2w: Yield: 26.8 mg, 49%; A colorless oil; isolated by column chromatography on silica gel (PE/EtOAc = 10:1, Rf = 0.4); $^1$H NMR (400 MHz, CDCl$_3$) δ 8.00 (d, $J = 8.1$ Hz, 1H), 7.84 (d, $J = 8.1$ Hz, 1H), 7.45 (t, $J = 7.6$ Hz, 1H), 7.37 (t, $J = 7.6$ Hz, 1H), 5.95 (s, 1H), 5.54 (s, 1H), 2.98 (t, $J = 7.2$ Hz, 2H), 2.89 (t, $J = 7.2$ Hz, 2H), 1.13 (s, 9H); $^{13}$C NMR (100 MHz, CDCl$_3$) δ 214.8, 168.6, 153.7, 142.6, 134.7, 126.0, 125.4, 123.3, 121.4, 120.2, 44.1, 35.6, 28.6, 26.3; IR (neat): ν 2966, 1701, 1478, 1457, 1365, 1241, 1082, 989, 905, 759, 729 cm$^{-1}$; HRMS (ESI+) Calcd. for C$_{16}$H$_{20}$NOS [M+H]$^+$: 274.1260, found: 274.1264.
**Compound 2x**: Yield: 30.4 mg, 47%; A yellow solid; Mp: 85 - 87 °C; isolated by column chromatography on silica gel (PE/EtOAc = 10:1, R_f = 0.4); \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 8.01 (d, \(J = 7.7\) Hz, 2H), 7.88 (d, \(J = 9.0\) Hz, 1H), 7.58 – 7.52 (m, 1H), 7.48 – 7.42 (m, 2H), 7.31 – 7.28 (m, 1H), 7.09 – 7.03 (m, 1H), 5.90 (s, 1H), 5.56 (s, 1H), 3.88 (s, 3H), 3.38 (t, \(J = 7.5\) Hz, 2H), 3.14 (t, \(J = 7.5\) Hz, 2H); \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 199.3, 166.2, 158.1, 147.9, 142.2, 136.8, 136.0, 133.0, 128.6, 128.2, 123.8, 119.8, 115.5, 104.0, 55.8, 37.9, 28.9; IR (neat): \(\nu\) 2061, 1682, 1585, 1478, 1248, 1072, 1058, 985, 808, 788, 713 cm\(^{-1}\); HRMS (ESI+) Calcd. for C\(_{19}\)H\(_{18}\)NO\(_2\)S [M+H]\(^+\): 324.1053, found: 324.1051.
**Compound 2y**: Yield: 46.4 mg, 71%; A yellow solid; Mp: 98 - 100 °C; isolated by column chromatography on silica gel (PE/EtOAc = 10:1, R_f = 0.4); ^1H NMR (400 MHz, CDCl_3) δ 8.04 – 7.97 (m, 3H), 7.77 – 7.72 (m, 1H), 7.59 – 7.53 (m, 1H), 7.49 – 7.44 (m, 2H), 7.38 – 7.33 (m, 1H), 6.00 (s, 1H), 5.64 (s, 1H), 3.39 (t, J = 7.4 Hz, 2H), 3.15 (t, J = 7.4 Hz, 2H); ^13C NMR (100 MHz, CDCl_3) δ 199.2, 170.5, 154.6, 142.3, 136.8, 133.1, 133.0, 132.1, 128.6, 128.1, 126.0, 123.2, 122.1, 121.1, 37.7, 28.8; IR (neat): ν 2985, 2901, 1678, 1595, 1428, 1321, 1296, 1029, 1065, 931, 806, 704 cm⁻¹; HRMS (ESI+) Calcd. for C_{18}H_{15}NOSCl [M+H]^+: 328.0557, found: 328.0559.
**Compound 2z**: Yield: 37.9 mg, 51%; A white solid; Mp: 108 - 110 °C; isolated by column chromatography on silica gel (PE/EtOAc = 10:1, R_f = 0.4); \(^1\)H NMR (400 MHz, CDCl\(_3\)) δ 8.18 – 8.13 (m, 1H), 8.02 – 7.97 (m, 2H), 7.74 – 7.68 (m, 1H), 7.59 – 7.54 (m, 1H), 7.50 – 7.44 (m, 3H), 6.00 (s, 1H), 5.65 (s, 1H), 3.38 (t, \(J = 7.5\) Hz, 2H), 3.15 (t, \(J = 7.4\) Hz, 2H); \(^13\)C NMR (100 MHz, CDCl\(_3\)) δ 199.2, 170.2, 154.9, 142.3, 136.8, 133.5, 133.1, 128.6, 128.1, 126.2, 122.5, 121.2, 119.6, 37.7, 28.8; IR (neat): \(\nu\) 2988, 1680, 1578, 1427, 1106, 1066, 1054, 803, 745, 683 cm\(^{-1}\); HRMS (ESI+) Calcd. for C\(_{18}\)H\(_{15}\)NOSBr [M+H]\(^+\): 372.0052, found: 372.0043.
**Compound 2aa**: Yield: 81.3 mg, 66%; A white solid; Mp: 128 - 130 °C; isolated by column chromatography on silica gel (PE/EtOAc = 2:1, Rf = 0.4); \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 8.04 – 7.98 (m, 2H), 7.84 (d, \(J = 8.1\) Hz, 4H), 7.80 – 7.78 (m, 1H), 7.73 – 7.68 (m, 1H), 7.59 – 7.53 (m, 1H), 7.49 – 7.43 (m, 2H), 7.34 (d, \(J = 8.1\) Hz, 4H), 7.03 – 6.99 (m, 1H), 6.00 (s, 1H), 5.67 (s, 1H), 3.38 (t, \(J = 7.5\) Hz, 2H), 3.14 (t, \(J = 7.5\) Hz, 2H), 2.46 (s, 6H); \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 199.2, 170.4, 154.1, 145.1, 142.3, 136.8, 136.7, 136.5, 133.1, 132.5, 129.7, 128.6, 128.4, 128.1, 126.4, 121.6, 121.4, 37.7, 28.7, 21.7; IR (neat): \(\nu\) 2327, 1686, 1600, 1379, 1257, 1207, 1167, 1007,
942, 857, 760, 660 cm\(^{-1}\); HRMS (ESI+) Calcd. for C\(_{32}\)H\(_{29}\)N\(_2\)O\(_5\)S\(_3\) [M+H]\(^+\): 617.1233, found: 617.1239.
**Compound 2ab**: Yield: 38.2 mg, 69%; A white solid; Mp: 82 - 84 °C; isolated by column chromatography on silica gel (PE/EtOAc = 10:1, Rf = 0.4); $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 8.05 – 7.95 (m, 2H), 7.77 – 7.70 (m, 1H), 7.58 – 7.50 (m, 2H), 7.48 – 7.42 (m, 2H), 7.37 – 7.30 (m, 2H), 6.33 (s, 1H), 5.71 (s, 1H), 3.42 (t, $J = 7.4$ Hz, 2H), 3.11 (t, $J = 7.4$ Hz, 2H); $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 199.0, 162.9, 150.4, 141.8, 136.8, 135.2, 133.1, 128.6, 128.1, 125.4, 124.4, 122.0, 120.2, 110.5, 37.7, 27.6; IR (neat): ν 2987, 1682, 1537, 1454, 1248, 1209, 1100, 1057, 1001, 787, 739, 730, 687 cm$^{-1}$; HRMS (ESI+) Calcd. for C$_{18}$H$_{16}$NO$_2$ [M+H]$^+$: 278.1176, found: 278.1174.
$^1$H NMR (CDCl$_3$, 400 MHz, TMS)

$^{13}$C NMR (CDCl$_3$, 100 MHz, TMS)
Compound 2ac: Yield: 39.6 mg, 68%; A white solid; Mp: 102 - 104 °C; isolated by column chromatography on silica gel (PE/EtOAc = 10:1, Rf = 0.4); $^1$H NMR (400 MHz, CDCl$_3$) δ 8.05 – 7.94 (m, 2H), 7.58 – 7.49 (m, 2H), 7.49 – 7.42 (m, 2H), 7.40 – 7.34 (m, 1H), 7.17 – 7.12 (m, 1H), 6.29 (s, 1H), 5.68 (s, 1H), 3.40 (t, $J$ = 7.5 Hz, 2H), 3.10 (t, $J$ = 7.5 Hz, 2H), 2.46 (s, 3H). $^{13}$C NMR (100 MHz, CDCl$_3$) δ 199.0, 163.0, 148.7, 142.0, 136.9, 135.4, 134.2, 133.0, 128.6, 128.1, 126.5, 121.6, 120.1, 109.8, 37.8, 27.7, 21.5; $^{13}$C NMR DEPT 135 (100 MHz, CDCl$_3$) δ 133.0, 128.6, 128.1, 126.6, 121.7, 120.0, 109.8, 37.7, 27.6, 21.5; IR (neat): ν 2999, 1489, 1447, 1346, 1165, 1024, 830, 760, 701, 665 cm$^{-1}$; HRMS (ESI+) Calcd. for C$_{19}$H$_{18}$NO$_2$ [M+H]$^+$: 292.1332, found: 292.1336.
**Compound 2ad**: Yield: 44.2 mg, 71%; A white solid; Mp: 132 - 134 °C; isolated by column chromatography on silica gel (PE/EtOAc = 10:1, Rf = 0.4); \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.92 (d, \(J = 7.6\) Hz, 2H), 7.64 (s, 1H), 7.49 (t, \(J = 7.4\) Hz, 1H), 7.42 – 7.32 (m, 3H), 7.27 – 7.21 (m, 1H), 6.26 (s, 1H), 5.67 (s, 1H), 3.33 (t, \(J = 7.5\) Hz, 2H), 3.02 (t, \(J = 7.5\) Hz, 2H); \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 198.9, 164.2, 149.0, 143.0, 136.8, 135.0, 133.1, 129.8, 128.6, 128.1, 125.7, 122.8, 120.2, 111.2, 37.6, 27.5; IR (neat): \(\nu\) 2972, 1712, 1514, 1340, 1162, 1092, 752, 697, 655 cm\(^{-1}\); HRMS (ESI+) Calcd. for C\(_{18}\)H\(_{13}\)NO\(_2\)Cl [M+H]\(^+\): 312.0786, found: 312.0794.
Compound 2ae: Yield: 37.2 mg, 58%; A white solid; Mp: 89 - 91 °C; isolated by column chromatography on silica gel (PE/EtOAc = 10:1, Rf = 0.4); ^1H NMR (400 MHz, CDCl₃) δ 7.99 (d, J = 8.2 Hz, 1H), 7.88 – 7.81 (m, 3H), 7.48 – 7.42 (m, 1H), 7.40 – 7.33 (m, 1H), 7.23 (d, J = 8.0 Hz, 2H), 6.00 (s, 1H), 5.55 (s, 1H), 3.06 (t, J = 7.5 Hz, 2H), 2.83 (t, J = 7.5 Hz, 2H), 2.40 (s, 3H), 2.12 (p, J = 7.5 Hz, 2H); ^13C NMR (100 MHz, CDCl₃) δ 199.6, 169.1, 153.6, 143.7, 142.8, 134.6, 134.5, 129.2, 128.1, 126.1, 125.4, 123.2, 121.4, 119.8, 37.7, 33.1, 22.8, 21.6; IR (neat): ν 2921, 1678, 1605, 1406, 1275, 1179, 976, 806, 759, 729 cm⁻¹; HRMS (ESI+) Calcd. for C₂₆H₂₆NO₄ [M+H]⁺: 416.1856, found: 416.1863.
**Compound 2af**: Yield: 44.2 mg, 59%; A white solid; Mp: 119 - 121 °C; isolated by column chromatography on silica gel (PE/EtOAc = 10:1, R_t = 0.4); ^1H NMR (400 MHz, CDCl_3) δ 7.96 (d, J = 8.2 Hz, 2H), 7.90 (d, J = 8.2 Hz, 1H), 7.80 – 7.75 (m, 1H), 7.62 (d, J = 8.2 Hz, 2H), 7.42 – 7.35 (m, 1H), 7.34 – 7.27 (m, 1H), 5.95 (s, 1H), 5.50 (s, 1H), 3.04 (t, J = 7.3 Hz, 2H), 2.79 (t, J = 7.3 Hz, 2H), 2.08 (p, J = 7.3 Hz, 2H); ^13C NMR (100 MHz, CDCl_3) δ 198.8, 169.0, 153.3, 142.6, 139.6, 134.5, 134.2 (q, J = 36.6 Hz), 128.3, 126.2, 125.6 (q, J = 3.7 Hz), 125.6, 123.6 (q, J = 272.6 Hz), 123.2, 121.4, 120.2, 38.0, 33.0, 22.6; ^19F NMR (376 MHz, CDCl_3) δ -63.1; IR (neat): ν 1689, 1510, 1409, 1322, 1123, 1064, 826, 759, 729 cm⁻¹; HRMS (ESI+) Calcd. for C_{20}H_{17}NOF_3S [M+H]^+: 376.0976, found: 376.0974.
10. Reaction Setup

Figure S2. Reaction setup for synthesis.

As depicted in the pictures, the reactions were carried out in oven-dried sealed tubes. Each reaction setup is equipped with two fans to maintain the reaction temperature.
11. References
