Cu(OTf)$_2$-Mediated C(sp$^2$)–H Arylsulfenylation of Enamides via the Insertion of Sulfur Dioxide

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General information.

All reactions were carried out in oven dried Schlenk tubes under nitrogen atmosphere. All of Enamides were prepared as reported in the reference.\textsuperscript{1} DABSO was prepared according to the reported method.\textsuperscript{2} And diazonium salts were freshly prepared according to the literature.\textsuperscript{3} Cu(OTf)\textsubscript{2} and dry 1,2-dichloroethane(DCE) were purchased from Energy Chemical. Isopropanol was purchased from Greagent. All reactions were using undistilled solvent, without the need of precautions to exclude air and moisture. All the temperatures are referred to the bath temperature. Melting points were recorded on an Electrothermal digital melting point apparatus.\textsuperscript{1}H, \textsuperscript{19}F, \textsuperscript{13}C NMR spectra were recorded in CDCl\textsubscript{3} on Bruker Avance 400 MHz spectrometers. High resolution mass spectra (HRMS) were obtained using a commercial apparatus (ESI Source). NMR spectra were taken using TMS (\textsuperscript{1}H, \(\delta = 0\)), CDCl\textsubscript{3} (\textsuperscript{1}H, \(\delta = 7.26\)), and CDCl\textsubscript{3} (\textsuperscript{13}C, CPD \(\delta = 77.0\)) as the internal standards, respectively. Column chromatography was generally performed on silica gel (300-400 mesh) and reactions were monitored by thin layer chromatography (TLC) using UV light to visualize the course of the reactions.

General procedures for the synthesis of (E)-vinyl sulfone derivatives 3

Enamides 1 (0.3 mmol), diazonium salts 2 (0.45 mmol, 1.5 equiv.), DABSO (0.45 mmol, 1.5 equiv.), and Cu(OTf)\textsubscript{2} (0.36 mmol, 1.2 equiv.) were added sequentially into Schlenk tube under nitrogen. Then mixed solvent (DCE/PrOH = 5/1, 1.5 mL) was added rapidly by syringe. The resulting mixture was allowed to stir at 50 °C in the oil bath for 12 hours as monitored by TLC. Upon completion, solvent was removed under vacuum and the residue was purified by flash silica gel column chromatography using petroleum ether/ethyl acetate as eluent to afford pure products 3.
General procedures for the synthesis of (E)-vinyl sulfone derivatives 3ma

Enamide 1m (0.5 mmol), diazonium salt 2a (0.75 mmol, 1.5 equiv.), DABSO (0.75 mmol, 1.5 equiv.), and Cu(OTf)$_2$ (0.60 mmol, 1.2 equiv.) were added sequentially into Schlenk tube under nitrogen. Then mixed solvent (DCE/PrOH = 5/1, 2.5 mL) was added rapidly by syringe. The resulting mixture was allowed to stir at 50 °C in the oil bath for 12 hours as monitored by TLC. Upon completion, solvent was removed under vacuum and the residue was purified by flash silica gel column chromatography using petroleum ether/ethyl acetate as eluent to afford pure products 3ma.

Table S1. Optimization of Cu(II)-sources$^a$

<table>
<thead>
<tr>
<th>Entry</th>
<th>[Cu]</th>
<th>NMR yield of 3aa$^b$ (%)</th>
<th>Recovery of 1a$^b$(%)</th>
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<tbody>
<tr>
<td>1</td>
<td>----</td>
<td>16</td>
<td>60</td>
</tr>
<tr>
<td>2</td>
<td>Cu(OTf)$_2$</td>
<td>49</td>
<td>36</td>
</tr>
<tr>
<td>3</td>
<td>Cu(OAc)$_2$</td>
<td>32</td>
<td>42</td>
</tr>
<tr>
<td>4</td>
<td>Cu(acac)$_2$</td>
<td>18</td>
<td>50</td>
</tr>
<tr>
<td>5</td>
<td>CuBr$_2$</td>
<td>16</td>
<td>51</td>
</tr>
<tr>
<td>6</td>
<td>CuCl$_2$</td>
<td>10</td>
<td>67</td>
</tr>
<tr>
<td>7</td>
<td>CuF$_2$</td>
<td>21</td>
<td>64</td>
</tr>
<tr>
<td>8</td>
<td>CuO</td>
<td>13</td>
<td>68</td>
</tr>
</tbody>
</table>

$^a$ Reaction conditions: enamide 1a (0.2 mmol), diazonium salt 2a (0.3 mmol, 1.5 equiv.), DABSO (0.3 mmol, 1.5 equiv.), and Cu(II)-sources (0.2 mmol, 1.0 equiv.) in DCE (1.0 mL) at 80 °C for 12 h under nitrogen. $^b$ Determined by NMR analysis of the crude reaction mixture by using mesitylene as an internal standard.
Table S2. Effect of solvents

<table>
<thead>
<tr>
<th>Entry</th>
<th>Solvent</th>
<th>NMR yield of 3aa(^b) (%)</th>
<th>Recovery of 1a(^b) (%)</th>
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<tbody>
<tr>
<td>1</td>
<td>DCE</td>
<td>49</td>
<td>36</td>
</tr>
<tr>
<td>2</td>
<td>MeCN</td>
<td>12</td>
<td>66</td>
</tr>
<tr>
<td>3</td>
<td>1,4-dioxane</td>
<td>46</td>
<td>46</td>
</tr>
<tr>
<td>4</td>
<td>Toluene</td>
<td>48</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>DMSO(^c)</td>
<td>trace</td>
<td>62</td>
</tr>
<tr>
<td>6</td>
<td>DMF(^d)</td>
<td>28</td>
<td>44</td>
</tr>
<tr>
<td>7</td>
<td>EtOH</td>
<td>36</td>
<td>0</td>
</tr>
<tr>
<td>8</td>
<td>MeOH</td>
<td>46</td>
<td>0</td>
</tr>
<tr>
<td>9</td>
<td>CHCl(_3)</td>
<td>15</td>
<td>46</td>
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</tbody>
</table>

\(^a\) Reaction conditions: enamide 1a (0.2 mmol), diazonium salt 2a (0.3 mmol, 1.5 equiv.), DABSO (0.3 mmol, 1.5 equiv.), and Cu(OTf)\(_2\) (0.2 mmol, 1.0 equiv.) in solvent (1.0 mL) at 80 °C for 12 h under nitrogen. \(^b\) Determined by NMR analysis of the crude reaction mixture by using mesitylene as an internal standard. \(^c\) DMSO = dimethyl sulfoxide. \(^d\) DMF = N,N-dimethylformamide.

Table S3. Effect of the loading of Cu(II)-sources

<table>
<thead>
<tr>
<th>Entry</th>
<th>Cu(OTf)(_2) (equiv)</th>
<th>NMR yield of 3aa(^b) (%)</th>
<th>Recovery of 1a(^b) (%)</th>
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<tbody>
<tr>
<td>1</td>
<td>0.5</td>
<td>41</td>
<td>37</td>
</tr>
<tr>
<td>2</td>
<td>1.0</td>
<td>49</td>
<td>36</td>
</tr>
<tr>
<td>3</td>
<td>1.2</td>
<td>54</td>
<td>25</td>
</tr>
<tr>
<td>4</td>
<td>1.5</td>
<td>35</td>
<td>23</td>
</tr>
</tbody>
</table>

\(^a\) Reaction conditions: enamide 1a (0.2 mmol), diazonium salt 2a (0.3 mmol, 1.5 equiv.), DABSO (0.3 mmol, 1.5 equiv.), and Cu(OTf)\(_2\) in DCE (1.0 mL) at 80 °C for 12 h under nitrogen. \(^b\) Determined by NMR analysis of the crude reaction mixture by using mesitylene as an internal standard.
Table S4. Optimization of mixed solvents and temperature$^{a}$

<table>
<thead>
<tr>
<th>Entry</th>
<th>DCE/ROH</th>
<th>$t$ ($^\circ$C)</th>
<th>NMR yield of 3aa$^b$ (%)</th>
<th>Recovery of 1a$^b$ (%)</th>
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<tbody>
<tr>
<td>1</td>
<td>DCE/MeOH = 3/1</td>
<td>80</td>
<td>31</td>
<td>0</td>
</tr>
<tr>
<td>2</td>
<td>DCE/EtOH = 3/1</td>
<td>80</td>
<td>48</td>
<td>0</td>
</tr>
<tr>
<td>3</td>
<td>DCE/PrOH = 3/1</td>
<td>80</td>
<td>67</td>
<td>0</td>
</tr>
<tr>
<td>4</td>
<td>DCE/BuOH = 3/1</td>
<td>80</td>
<td>57</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>DCE/PrOH = 5/1</td>
<td>80</td>
<td>72</td>
<td>0</td>
</tr>
<tr>
<td>6</td>
<td>DCE/PrOH = 5/1</td>
<td>100</td>
<td>51</td>
<td>0</td>
</tr>
<tr>
<td>7</td>
<td>DCE/PrOH = 5/1</td>
<td>70</td>
<td>74</td>
<td>0</td>
</tr>
<tr>
<td>8</td>
<td>DCE/PrOH = 5/1</td>
<td>60</td>
<td>80</td>
<td>0</td>
</tr>
<tr>
<td>9</td>
<td>DCE/PrOH = 5/1</td>
<td>50</td>
<td>90</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>DCE/PrOH = 5/1</td>
<td>40</td>
<td>71</td>
<td>9</td>
</tr>
</tbody>
</table>

$^{a}$ Reaction conditions: enamide 1a (0.2 mmol), diazonium salt 2a (0.3 mmol, 1.5 equiv.), DABSO (0.3 mmol, 1.5 equiv.), and Cu(OTf)$_2$ (0.24 mmol, 1.2 equiv.) in a mixed solvent (1.0 mL) for 12 h under nitrogen. $^{b}$ Determined by NMR analysis of the crude reaction mixture by using mesitylene as an internal standard.
Mechanistic studies

1) Trapping experiment with 2,2,6,6-tetramethylpiperidin-1-oxyl (TEMPO)*

\[
\text{Entry} \quad \text{Additive (equiv.)} \quad \text{NMR yield of 3aa}^b (\%) \\
1 \quad \text{---} \quad 90 \\
2 \quad \text{TEMPO (2.0)} \quad 45 \\
3 \quad \text{TEMPO (3.0)} \quad \text{Trace}
\]

* Reaction conditions: enamide 1a (0.2 mmol), diazonium salt 2a (0.3 mmol, 1.5 equiv.), DABSO (0.3 mmol, 1.5 equiv.), Cu(OTf)₂ (0.24 mmol, 1.2 equiv.), and TEMPO in a mixed solvent (DCE/iPrOH = 5/1, 1.0 mL) at 50 °C for 12 h under nitrogen. * Determined by NMR analysis of the crude reaction mixture by using mesitylene as an internal standard.

2) Trapping experiment with ethene-1,1-diyl dibenzene (7)*

\[
\text{Entry} \quad \text{Cu(OTf)₂ (equiv.)} \quad \text{NMR yield of 3ba}^b (\%) \quad \text{NMR yield of 8}^b (\%) \quad \text{NMR yield of 8'}^b (\%)
\]

<table>
<thead>
<tr>
<th>Entry</th>
<th>Cu(OTf)₂ (equiv.)</th>
<th>NMR yield of 3ba^b (%)</th>
<th>NMR yield of 8^b (%)</th>
<th>NMR yield of 8'^b (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.2</td>
<td>48</td>
<td>69</td>
<td>9</td>
</tr>
<tr>
<td>2</td>
<td>0</td>
<td>trace</td>
<td>trace</td>
<td>9</td>
</tr>
</tbody>
</table>

* Reaction conditions: enamide 1b (0.2 mmol), ethene-1,1-diyl dibenzene 7 (0.2 mmol), diazonium salt 2a (0.3 mmol, 1.5 equiv.), DABSO (0.3 mmol, 1.5 equiv.), Cu(OTf)₂ in a mixed solvent (DCE/iPrOH = 5/1, 1.0 mL) at 50 °C for 12 h under nitrogen. * Determined by NMR analysis of the crude reaction mixture by using mesitylene as an internal standard.
3) Poison reaction of catalyst with 1,4-Diaza[2.2.2]bicyclooctane (DABCO)\(^a\)

\[
\begin{align*}
\text{Enamide } 1a (0.2 \text{ mmol}), \text{ diazonium salts } 2a (0.3 \text{ mmol, 1.5 equiv.}), \text{ DABSO (0.3 mmol, 1.5 equiv.), Cu(OTf)}_2 (0.24 \text{ mmol, 1.2 equiv.) and DABCO (0.3 mmol, 1.5 equiv.) were added sequentially into Schlenk tube under nitrogen. Then mixed solvent (DCE/iPrOH = 5/1, 1.5 mL) was added rapidly by syringe. Then, the resulting mixture was allowed to stir at 50 °C in the oil bath for 12 hours. Then, the resulting mixture was filtered through a short column of silica gel eluted with ethyl acetate and concentrated. Subsequently, determined by NMR analysis of the crude reaction mixture by using mesitylene as an internal standard.}
\end{align*}
\]

4) Intermolecular kinetic isotopic effect (KIE) study

\[
\begin{align*}
\text{Enamide } 1a (0.115 \text{ mmol), } 1a-d_2 (0.185 \text{ mmol) were added sequentially into Schlenk tube under nitrogen. Then mixed solvent(DCE/iPrOH = 5/1, 1.5 mL) was added rapidly by syringe. The resulting mixture was allowed to stir at 0 °C for 5 minutes. The product was isolated through thin-layer chromatography(petroleum ether/ethyl acetate = 2/1 as developing solvent) to afford crude mixture (Yield ~ 4%) as white solid. The KIE value (K_{H}/K_{D} = 0.79) was determined from the } ^1\text{H-NMR.}
\end{align*}
\]
Gram-scale experiment

Enamide 1a (1.13 g, 4.5 mmol), diazonium salt 2a (6.75 mmol, 1.5 equiv.), DABSO (6.75 mmol, 1.5 equiv.), and Cu(OTf)$_2$ (5.4 mmol, 1.2 equiv.) were added sequentially into Schlenk tube under nitrogen. Then mixed solvent (DCE/iPrOH = 5/1, 22.5 mL) was added rapidly by syringe. The resulting mixture was allowed to stir at 50 °C in the oil bath for 12 hours as monitored by TLC. Upon completion, solvent was removed under vacuum and the residue was purified by flash silica gel column chromatography using petroleum ether/ethyl acetate as eluent to afford pure products 3aa (1.47 g, Yield = 83%).

Derivatization reactions
The palladium-catalyzed coupling reaction$^5$

(E)-N-(2-bromobenzyl)-N-(1-phenyl-2-(phenylsulfonyl)vinyl)acetamide 3ma (0.2 mmol), Pd(OAc)$_2$ (0.02 mmol), PPh$_3$ (0.04 mmol) were added sequentially into a flask Schlenk tube under nitrogen. Then triethylamine (0.4 mmol) and DMF were added by syringe. Then, the resulting mixture was allowed to stir at 120 °C in the oil bath for 24 hours as monitored by TLC. Upon completion, solvent was removed under vacuum and the residue was purified by flash silica gel column chromatography using petroleum ether/ethyl acetate as eluent to afford pure products 5.
Hydrolyzation of 3aa

(E)-N-benzyl-N-(1-phenyl-2-(phenylsulfonyl)vinyl)acetamide 3aa (0.3 mmol) was added into a tube. Then THF (1 mL) and concentrated hydrochloric acid (1 mL) were added sequentially by syringe. The resulting mixture was stirred at room temperature for 12 hours as monitored by TLC. Upon completion, solvent was removed under vacuum and the residue was purified by flash silica gel column chromatography using petroleum ether/ethyl acetate as eluent to afford pure products 6.

References


Characterization data for products

*(E)-N-benzyl-N-(1-phenyl-2-(phenylsulfonyl)vinyl)acetamide* (3aa): Yield = 87%. White solid. m.p. = 116.2 – 117.1 °C. $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.57 – 7.46 (m, 4H, ArH), 7.43 – 7.30 (m, 6H, ArH), 7.29 – 7.24 (m, 3H, ArH), 7.13 – 7.05 (m, 2H, ArH), 6.22 (s, 1H, C=CH), 4.50 (s, 2H, CH$_2$), 2.00 (s, 3H, CH$_3$) ppm. $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 170.0, 151.7, 140.7, 136.2, 133.3, 131.9, 131.3, 130.0, 128.9, 128.6, 128.5, 128.4, 128.3, 127.7, 127.2, 50.1, 23.0 ppm. HRMS m/z: calcd for C$_{23}$H$_{22}$NO$_3$S$^+$ [M+H]$^+$ 392.1315, found: 392.1335.

*(E)-N-benzyl-N-(1-phenyl-2-tosylvinyl)acetamide* (3ab): Yield = 88%. White solid. m.p. = 125.5 – 126.0 °C. $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.50 (t, $J$ = 7.3 Hz, 1H, ArH), 7.44 – 7.31 (m, 6H, ArH), 7.29 – 7.24 (m, 3H, ArH), 7.17 (d, $J$ = 8.1 Hz, 2H, ArH), 7.12 – 7.05 (m, 2H, ArH), 6.19 (s, 1H, C=CH), 4.49 (s, 2H, CH$_2$), 2.39 (s, 3H, CH$_3$), 2.00 (s, 3H, CH$_3$) ppm. $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 170.0, 151.3, 144.3, 137.8, 136.3, 131.9, 131.3, 130.1, 129.5, 128.9, 128.6, 128.4, 128.3, 127.7, 127.3, 50.0, 23.0, 21.5 ppm. HRMS m/z: calcd for C$_{24}$H$_{24}$NO$_3$S$^+$ [M+H]$^+$ 406.1471, found: 406.1479.
\[(E)\text{-}N\text{-}benzyl\text{-}N\text{-}(2\text{-}((4\text{-}(\text{tert-buty|l})\text{phenyl})\text{sulfonyl})\text{-}1\text{-}phenylvinyl)acetamide (3ac)}:\]
Yield = 85%. Faint yellow solid. m.p. = 112.0 – 113.6 °C. \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.55 – 7.43 (m, 3H, ArH), 7.42 – 7.30 (m, 6H, ArH), 7.29 – 7.21 (m, 3H, ArH), 7.16 – 7.02 (m, 2H, ArH), 6.20 (s, 1H, C=CH), 4.50 (s, 2H, CH\(_2\)), 2.02 (s, 3H, CH\(_3\)), 1.30 (s, 9H, C(CH\(_3\))\(_3\)). ppm. \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 170.0, 157.2, 151.1, 137.5, 136.3, 132.1, 131.2, 130.0, 129.0, 128.6, 128.5, 128.3, 127.7, 127.2, 125.9, 50.2, 35.1, 30.9, 23.0 ppm. HRMS m/z: calcd for C\(_{27}\)H\(_{30}\)NO\(_3\)S\(_3\) \([\text{M+H}]^+\) 448.1941, found: 448.1948.

\[(E)\text{-}N\text{-}benzyl\text{-}N\text{-}(2\text{-}((4\text{-}(\text{methoxyphenyl})\text{sulfonyl})\text{-}1\text{-}phenylvinyl)acetamide (3ad)}:\]
Yield = 88%. White solid. m.p. = 144.8 – 145.8 °C. \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.53 – 7.47 (m, 1H, ArH), 7.47 – 7.32 (m, 6H, ArH), 7.28 – 7.24 (m, 3H, ArH), 7.12 – 7.06 (m, 2H, ArH), 6.85 – 6.80 (m, 2H, ArH), 6.21 (s, 1H, C=CH), 4.49 (s, 2H, CH\(_2\)), 3.83 (s, 3H, OCH\(_3\)), 2.01 (s, 3H, CH\(_3\)). ppm. \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 170.0, 163.4, 150.9, 136.3, 132.3, 132.0, 131.3, 130.1, 129.5, 129.4, 128.6, 128.5, 128.3, 127.7, 114.1, 55.6, 50.0, 23.0 ppm. HRMS m/z: calcd for C\(_{24}\)H\(_{24}\)NO\(_3\)S\(_3\) \([\text{M+H}]^+\) 422.1421, found: 422.1431.

\[(E)\text{-}N\text{-}benzyl\text{-}N\text{-}(2\text{-}((4\text{-}(\text{benzyloxy)phenyl})\text{sulfonyl})\text{-}1\text{-}phenylvinyl)acetamide (3ae)}:\]
Yield = 88%. White solid. m.p. = 115.9 – 117.7 °C. \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.50 – 7.29 (m, 12H, ArH), 7.28 – 7.22 (m, 3H, ArH), 7.13 – 7.05 (m, 2H, ArH), 6.88 (d, \(J = 8.9\) Hz, 2H, ArH), 6.20 (s, 1H, C=CH), 5.09 (s, 2H, OCH\(_2\)), 4.49 (s, 2H, CH\(_2\)), 2.00 (s, 3H, CH\(_3\)). ppm. \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 170.0, 162.4, 150.9, 136.3, 135.6, 132.5, 132.0, 131.2, 130.1, 129.5, 129.4, 128.7, 128.6, 128.5, 128.4, 128.3, 127.7, 114.1, 55.6, 50.0, 23.0 ppm. HRMS m/z: calcd for C\(_{24}\)H\(_{24}\)NO\(_3\)S\(_3\) \([\text{M+H}]^+\) 422.1431, found: 422.1431.
128.3, 127.7, 127.4, 115.0, 70.3, 50.1, 23.0 ppm. HRMS m/z: calcd for C_{30}H_{28}NO_{4}S^+ [M+H]^+ 498.1734, found: 498.1755.

(E)-N-benzyl-N-(2-((4-hydroxyphenyl)sulfonyl)-1-phenylvinyl)acetamide (3af): Yield = 50%. White solid. m.p. = 159.8 – 161.7 °C. $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.54 – 7.45 (m, 2H, ArH+OH), 7.43 – 7.33 (m, 6H, ArH), 7.31 – 7.23 (m, 3H, ArH), 7.14 – 7.05 (m, 2H, ArH), 6.75 (d, $J$ = 8.7 Hz, 2H, ArH), 6.19 (s, 1H, C=CH), 4.49 (s, 2H, CH$_2$), 2.00 (s, 3H, CH$_3$) ppm. $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 170.9, 161.2, 150.4, 135.8, 131.6, 131.5, 131.1, 130.1, 129.9, 129.7, 128.7, 128.4, 127.9, 115.9, 50.3, 22.8 ppm. HRMS m/z: calcd for C$_{23}$H$_{22}$NO$_4$S$^+$ [M+H]$^+$ 408.1264, found: 408.1236.

(E)-4-((2-(N-benzylacetamido)-2-phenylvinyl)sulfonyl)phenyl acetate (3ag): Yield = 54%. Faint yellow solid. m.p. = 110.4 – 112.1 °C. $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.53 – 7.46 (m, 3H, ArH), 7.39 (t, $J$ = 8.0 Hz, 2H, ArH), 7.33 – 7.24 (m, 5H, ArH), 7.13 – 7.05 (m, 4H, ArH), 6.23 (s, 1H, C=CH), 4.53 (s, 2H, CH$_2$), 2.32 (s, 3H,CH$_3$), 2.02 (s, 3H, CH$_3$) ppm. $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 170.1, 168.3, 154.3, 151.9, 137.9, 136.2, 132.0, 131.4, 130.0, 128.9, 128.7, 128.43, 128.38, 128.3, 127.8, 122.2, 50.3, 23.2, 21.1 ppm. HRMS m/z: calcd for C$_{25}$H$_{24}$NO$_5$S$^+$ [M+H]$^+$ 450.1370, found: 450.1351.
(E)-N-benzyl-N-(2-((2-methylthiophenyl)sulfonyl)-1-phenylvinyl)acetamide (3ah): Yield = 70%. (E/Z = 88:12). Yellow viscous liquid. $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.90 [d, $J = 8.0$ Hz, 0.13H, ArH of (Z)-isomer], 7.61 – 7.53 [m, 1H, ArH + 0.13H of (Z)-isomer], 7.48 – 7.42 (m, 2H, ArH), 7.39 – 7.29 [m, 4H, ArH + 0.65H ArH of (Z)-isomer], 7.28 – 7.22 (m, 4H, ArH), 7.16 – 7.06 [m, 3H, ArH + 1.04H ArH and C=CH of (Z)-isomer], 6.49 (s, 1H, C=CH), 5.05 [d, $J = 16.0$ Hz, 0.13H one of proton of CH$_2$ of (Z)-isomer], 4.60 (s, 2H, CH$_2$), 4.36 [d, $J = 16.0$ Hz, 0.13H one of proton of CH$_2$ of (Z)-isomer], 2.65 [s, 0.39H, SCH$_3$ of (Z)-isomer], 2.45 (s, 3H, SCH$_3$), 2.07 (s, 3H, CH$_3$), 1.78 [s, 0.39H, CH$_3$ of (Z)-isomer] ppm. $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 170.4, 152.5, 139.5, 137.6, 136.6, 133.4, 132.4, 131.1, 129.9, 128.5, 128.23, 128.19, 127.5, 126.8, 126.2, 124.6, 50.7, 23.1, 16.1 ppm. HRMS m/z: calcd for C$_{24}$H$_{24}$NO$_3$S$_2^+$ [M+H]$^+$ 438.1192, found: 438.1198.

(E)-N-benzyl-N-(2-((2-iodophenyl)sulfonyl)-1-phenylvinyl)acetamide (3ai): Yield = 48%. Light yellow solid. m.p. = 90.3 – 92.1 ºC. $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 8.00 (d, $J = 7.8$ Hz, 1H, ArH), 7.69 (d, $J = 7.9$ Hz, 1H, ArH), 7.42 (t, $J = 7.2$ Hz, 1H, ArH), 7.38 – 7.22 (m, 8H, ArH), 7.20 – 7.09 (m, 3H, ArH), 6.56 (s, 1H, C=CH), 4.72 (s, 2H, CH$_2$), 2.10 (s, 3H, CH$_3$) ppm. $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 170.4, 152.5, 139.5, 137.6, 136.6, 133.4, 132.4, 131.1, 130.7, 129.8, 128.8, 128.3, 128.2, 127.8, 127.7, 124.9, 92.6, 51.1, 23.8 ppm. HRMS m/z: calcd for C$_{23}$H$_{21}$INO$_3$S$^+$ [M+H]$^+$ 518.0281, found: 518.0307.
(E)-N-benzyl-N-(2-((4-bromophenyl)sulfonyl)-1-phenylvinyl)acetamide (3aj): Yield = 92%. Light yellow solid. m.p. = 128.6 – 129.1 °C. $^1$H NMR (400 MHz, CDCl$_3$) δ 7.54 – 7.45 (m, 3H, ArH), 7.39 (t, $J$ = 7.6 Hz, 2H, ArH), 7.34 – 7.24 (m, 7H, ArH), 7.14 – 7.05 (m, 2H, ArH), 6.23 (s, 1H, C=CH), 4.54 (s, 2H, CH$_2$), 2.02 (s, 3H, CH$_3$) ppm. $^{13}$C NMR (100 MHz, CDCl$_3$) δ 170.1, 152.3, 139.8, 136.2, 132.1, 132.0, 131.4, 130.0, 128.8, 128.7, 128.5, 128.4, 128.3, 127.8, 127.8, 127.0, 126.1, 23.2 ppm. HRMS m/z: calcd for C$_{23}$H$_{21}$BrNO$_3$S$^+$ [M+H]$^+$ 470.0420, found: 470.0422, C$_{23}$H$_{21}$S$^{31}$BrNO$_3$S$^+$ [M+H]$^+$472.0400, found: 472.0403.

(3ak): Yield = 72%. Light yellow solid. m.p. = 107.5 – 108.0 °C. $^1$H NMR (400 MHz, CDCl$_3$) δ 7.67 (d, $J$ = 7.5 Hz, 1H, ArH), 7.48 – 7.40 (m, 3H, ArH), 7.36 – 7.20 (m, 8H, ArH), 7.15 – 7.06 (m, 2H, ArH), 6.47 (s, 1H, C=CH), 4.64 (s, 2H, CH$_2$), 2.12 (s, 3H, CH$_3$) ppm. $^{13}$C NMR (100 MHz, CDCl$_3$) δ 170.4, 153.4, 138.5, 136.4, 134.3, 132.3, 132.2, 131.5, 131.1, 130.7, 129.7, 128.6, 128.2, 127.9, 127.7, 127.0, 126.1, 51.0, 23.4 ppm. HRMS m/z: calcd for C$_{23}$H$_{21}$ClNO$_3$S$^+$ [M+H]$^+$ 426.0925, found: 426.0927, C$_{23}$H$_{21}$S$^{37}$ClNO$_3$S$^+$ [M+H]$^+$ 428.0896, found: 428.0898.
(E)-N-benzyl-N-(2-((4-fluorophenyl)sulfonyl)-1-phenylvinyl)acetamide  (3al):
Yield = 85%. Light yellow solid. m.p. = 96.4 – 97.7 °C. 1H NMR (400 MHz, CDCl3) δ 7.54 – 7.44 (m, 3H, ArH), 7.39 (t, J = 8.0 Hz, 2H, ArH), 7.34 – 7.24 (m, 5H, ArH), 7.14 – 7.07 (m, 2H, ArH), 7.01 (t, J = 8.5 Hz, 2H, ArH), 6.25 (s, 1H, C=CH), 4.53 (s, 2H, CH2), 2.02 (s, 3H, CH3) ppm. 13C NMR (100 MHz, CDCl3) δ 170.0, 165.30 (d, J = -256.4 Hz), 151.9, 136.77 (d, J = 3.0 Hz), 136.2, 132.0, 131.4, 130.12 (d, J = 9.6 Hz), 130.0, 128.6, 128.40, 128.36, 128.3, 127.8, 116.10 (d, J = 22.6 Hz), 50.3, 23.2 ppm. 19F NMR (376 MHz, CDCl3) δ -103.59 ppm. HRMS m/z: calcd for C23H21FNO5S+ [M+H]+ 410.1221, found: 410.1225.

(3am):
Yield = 70%. m.p. = 150.2 – 152.0 °C. Light yellow solid. 1H NMR (400 MHz, CDCl3) δ 7.58 (d, J = 8.2 Hz, 2H, ArH), 7.53 – 7.45 (m, 3H, ArH), 7.42 – 7.28 (m, 5H, ArH), 7.23 (d, J = 7.8 Hz, 2H, ArH), 7.14 – 7.05 (m, 2H, ArH), 6.31 (s, 1H, C=CH), 4.59 (s, 2H, CH2), 2.00 (s, 3H, CH3) ppm. 13C NMR (100 MHz, CDCl3) δ 170.3, 153.3, 144.9, 136.0, 132.4, 132.0, 131.5, 130.0, 128.7, 128.5, 128.2, 127.9, 127.8, 126.4, 117.0, 116.6, 50.6, 23.5 ppm. HRMS m/z: calcd for C24H21N2O5S+ [M+H]+ 417.1267, found: 417.1245.
(E)-N-benzyl-N-(2-((4-nitrophenyl)sulfonyl)-1-phenylvinyl)acetamide (3an): Yield = 46%. Yellow solid. m.p. = 125.9 – 127.0 °C. ^1H NMR (400 MHz, CDCl₃) δ 8.12 (d, J = 8.8 Hz, 2H, ArH), 7.61 – 7.47 (m, 3H, ArH), 7.41 – 7.28 (m, 5H, ArH), 7.27 – 7.19 (m, 2H, ArH), 7.15 – 7.08 (m, 2H, ArH), 6.34 (s, 1H, C=CH), 4.60 (s, 2H, CH₂), 2.01 (s, 3H, CH₃) ppm. ^13C NMR (100 MHz, CDCl₃) δ 170.4, 153.6, 150.0, 146.4, 136.0, 132.0, 131.6, 130.0, 128.8, 128.6, 128.5, 128.1, 127.9, 126.2, 123.8, 50.7, 23.6 ppm. HRMS m/z: calcd for C_{23}H_{21}N_{2}O_{5}S^+ [M+H]^+ 437.1166, found: 437.1169.

ethyl (E)-4-((2-(N-benzylacetamido)-2-phenylvinyl)sulfonyl)benzoate (3ao): Yield = 58%. Light yellow solid. m.p. = 78.6 – 80.1 °C. ^1H NMR (400 MHz, CDCl₃) δ 8.00 (d, J = 8.4 Hz, 2H, ArH), 7.57 – 7.48 (m, 3H, ArH), 7.39 (t, J = 7.7 Hz, 2H, ArH), 7.33 – 7.24 (m, 5H, ArH), 7.13 – 7.05 (m, 2H, ArH), 6.25 (s, 1H, C=CH), 4.53 (s, 2H, CH₂), 4.41 (q, J = 7.1 Hz, 2H, CH₂), 2.00 (s, 3H, CH₃), 1.41 (t, J = 7.1 Hz, 3H, CH₃) ppm. ^13C NMR (100 MHz, CDCl₃) δ 170.1, 164.9, 152.8, 144.5, 136.1, 134.6, 131.9, 131.5, 130.0, 129.9, 128.7, 128.4, 128.3, 127.8, 127.4, 127.3, 61.8, 50.3, 23.2, 14.2. HRMS m/z: calcd for C_{26}H_{26}NO_{5}S^+ [M+H]^+ 464.1526, found: 464.1533.
(E)-N-(2-((4-acetylphenyl)sulfonyl)-1-phenylvinyl)-N-benzylacetamide (3ap):
Yield = 61%. Light yellow solid. m.p. = 125.1 – 125.6 °C. 
$^1$H NMR (400 MHz, CDCl$_3$) \( \delta \) 7.89 (d, \( J = 8.5 \) Hz, 2H, ArH), 7.56 (d, \( J = 8.4 \) Hz, 2H, ArH), 7.51 (t, \( J = 7.4 \) Hz, 1H, ArH), 7.38 (t, \( J = 7.7 \) Hz, 2H, ArH), 7.33 – 7.25 (m, 5H, ArH), 7.13 – 7.05 (m, 2H, ArH), 6.26 (s, 1H, C=CH), 4.53 (s, 2H, CH$_2$), 2.62 (s, 3H, CH$_3$), 2.01 (s, 3H, CH$_3$) ppm. 
$^{13}$C NMR (100 MHz, CDCl$_3$) \( \delta \) 196.6, 170.1, 152.8, 144.6, 140.2, 136.1, 131.5, 131.0, 128.7, 128.6, 128.4, 128.3, 127.8, 127.6, 127.3, 50.4, 26.9, 23.2 ppm. HRMS m/z: calcd for C$_{25}$H$_{24}$NO$_4$S$^+$ [M+H]$^+$ 434.1421, found: 434.1434.

(3aq):
Yield = 80%. Yellow solid. m.p. = 133.4 -134.2 °C. $^1$H NMR (400 MHz, CDCl$_3$) \( \delta \) 7.76 – 7.68 (m, 4H, ArH), 7.65 (t, \( J = 7.4 \) Hz, 1H, ArH), 7.57 (d, \( J = 8.3 \) Hz, 2H, ArH), 7.55 – 7.47 (m, 3H, ArH), 7.39 (t, \( J = 7.7 \) Hz, 2H, ArH), 7.34 – 7.26 (m, 5H, ArH), 7.16 – 7.08 (m, 2H, ArH), 6.31 (s, 1H, C=CH), 4.56 (s, 2H, CH$_2$), 2.04 (s, 3H, CH$_3$) ppm. $^{13}$C NMR (100 MHz, CDCl$_3$) \( \delta \) 195.0, 170.2, 152.7, 143.7, 141.6, 136.3, 136.2, 133.3, 132.1, 131.5, 130.1, 130.03, 129.97, 128.7, 128.5, 128.4, 128.3, 127.8, 127.6, 127.5, 127.2, 50.5, 23.1 ppm. HRMS m/z: calcd for C$_{30}$H$_{26}$NO$_4$S$^+$ [M+H]$^+$ 496.1577, found: 496.1599.

(3ar):
Yield = 73%. Light yellow solid. m.p. = 121.1 – 121.7 °C. $^1$H NMR (400 MHz, CDCl$_3$) \( \delta \) 8.47 – 8.36 (m, 1H, ArH), 8.02 (d, \( J = 8.2 \) Hz, 1H, ArH), 7.96 – 7.88 (m, 2H, ArH), 7.63 - 7.55 (m, 2H, ArH), 7.48 (t, \( J = 7.2 \) Hz, 1H, ArH), 7.41 – 7.30 (m, 5H, ArH), 7.23 – 7.14 (m, 3H, ArH), 7.02 – 6.94 (m, 2H, ArH), 6.33 (s, 1H, C=CH), 4.48 (s, 2H,
CH$_2$), 1.83 (s, 3H, CH$_3$) ppm. $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 170.0, 152.0, 136.3, 135.4, 134.8, 133.9, 132.1, 131.3, 130.0, 129.7, 129.1, 128.5, 128.41, 128.39, 128.23, 128.16, 127.6, 126.9, 124.24 124.18, 50.6, 23.0 ppm. HRMS m/z: calcd for C$_{27}$H$_{24}$NO$_3$S$^+$[M+H]$^+$ 442.1471, found: 442.1486.

(E)-N-benzyl-N-(2-(naphthalen-2-ylsulfonyl)-1-phenylvinyl)acetamide (3as): Yield = 69%. Light yellow solid. m.p. = 130.3 – 131.5 °C. $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.98 (s, 1H, ArH), 7.89 – 7.82 (m, 2H, ArH), 7.78 (d, $J$ = 8.1 Hz, 1H, ArH), 7.67 – 7.62 (m, 1H, ArH), 7.61 – 7.56 (m, 1H, ArH), 7.53 (dd, $J$ = 8.7, 1.8 Hz, 1H, ArH), 7.50 – 7.42 (m, 1H, ArH), 7.31 – 7.29 (m, 4H, ArH), 7.25 – 7.21 (m, 3H, ArH), 7.11 – 7.04 (m, 2H, ArH), 6.30 (s, 1H, C=CH), 4.50 (s, 2H, CH$_2$), 1.99 (s, 3H, CH$_3$) ppm. $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 170.1, 151.9, 137.3, 136.3, 134.9, 132.0, 131.8, 131.4, 130.1, 129.3, 129.25, 129.22, 128.60, 128.57, 128.4, 128.3, 127.8, 127.7, 127.6, 122.0, 50.3, 23.1 ppm. HRMS m/z: calcd for C$_{27}$H$_{24}$NO$_3$S$^+$[M+H]$^+$ 442.1471, found: 442.1486.

methyl (E)-3-((2-(N-benzylacetamido)-2-phenylvinyl)sulfonyl)thiophene-2-carboxylate (3at): Yield = 26%. Light brown solid. m.p. = 91.6 – 92.1 °C. $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.46 (t, $J$ = 7.1 Hz, 1H, ArH), 7.42 – 7.32 (m, 3H, ArH), 7.31 – 7.17 (m, 6H, ArH), 7.15 – 7.07 (m, 2H, ArH), 6.82 (s, 1H, C=CH), 4.63 (s, 2H, CH$_2$), 3.88 (s, 3H, CH$_3$), 2.12 (s, 3H, CH$_3$) ppm. $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 170.5, 159.6, 152.8, 145.3, 136.6, 133.8, 132.7, 131.1, 130.5, 129.8, 129.6, 128.5, 128.24, 128.18, 127.5, 127.3, 53.0, 50.7, 23.3. HRMS m/z: calcd for C$_{23}$H$_{22}$NO$_3$S$_2$$^+$[M+H]$^+$ 456.0934, found: 456.0929.
(E)-N-benzyl-N-(2-(phenylsulfonyl)-1-(p-tolyl)vinyl)acetamide (3ba): Yield = 90%. White Solid. m.p. = 130.7 – 132.3 °C. ^1H NMR (400 MHz, CDCl_3) δ 7.59 – 7.50 (m, 3H, ArH), 7.39 (t, J = 7.7 Hz, 2H, ArH), 7.30 – 7.18 (m, 7H, ArH), 7.12 – 7.06 (m, 2H, ArH), 6.12 (s, 1H, C=CH), 4.50 (s, 2H, CH_2), 2.42 (s, 3H, CH_3), 1.97 (s, 3H, CH_3) ppm. ^13C NMR (100 MHz, CDCl_3) δ 170.0, 151.8, 142.0, 140.9, 136.3, 133.2, 130.1, 129.1, 129.0, 129.0, 128.9, 128.55, 128.48, 127.71, 127.67, 127.2, 50.2, 23.0, 21.5 ppm. HRMS m/z: calcd for C_{24}H_{24}NO_3S^+ [M+H]^+ 406.1471, found: 406.1486.

(E)-N-(1-([1,1'-biphenyl]-4-yl)-2-(phenylsulfonyl)vinyl)-N-benzylacetamide (3ca): Yield = 93%. Yellow viscous oil. ^1H NMR (400 MHz, CDCl_3) δ 7.67 – 7.47 (m, 10H, ArH), 7.40 (quint, J = 8.0 Hz, 5H, ArH), 7.30 – 7.25 (m, 2H, ArH), 7.14 – 7.08 (m, 2H, ArH), 6.22 (s, 1H, C=CH), 4.56 (s, 2H, CH_2), 2.03 (s, 3H, CH_3) ppm. ^13C NMR (100 MHz, CDCl_3) δ 170.1, 151.4, 144.2, 140.7, 139.6, 136.3, 133.3, 130.7, 130.6, 128.94, 128.92, 128.6, 128.5, 128.4, 128.1, 127.8, 127.3, 127.1, 126.9, 50.3, 23.1 ppm. HRMS m/z: calcd for C_{29}H_{26}NO_3S^+ [M+H]^+ 468.1628, found: 468.1637.
**(E)-N-benzyl-N-(2-(phenylsulfonyl)-1-(4-(trifluoromethyl)phenyl)vinyl)acetamide (3da):** Yield = 87%. White solid. m.p. = 136.2 – 136.7 °C. \( ^1 \)H NMR (400 MHz, CDCl\(_3\)) \( \delta \) 7.63 (d, \( J = 8.0 \) Hz, 2H, ArH), 7.59 – 7.50 (m, 3H, ArH), 7.46 – 7.36 (m, 4H, ArH), 7.32 – 7.25 (m, 3H, ArH), 7.11 – 7.02 (m, 2H, ArH), 6.32 (s, 1H, C=CH), 4.52 (s, 2H, CH\(_2\)), 2.03 (s, 3H, CH\(_3\)) ppm. \( ^{13} \)C NMR (100 MHz, CDCl\(_3\)) \( \delta \) 169.9, 149.9, 140.4, 135.9, 135.7, 133.6, 132.8 (q, \( J = 33.0 \) Hz), 130.4, 129.7, 129.1, 128.7, 128.3, 127.9, 127.2, 125.2 (q, \( J = 271.0 \) Hz), 50.3, 23.0 ppm. \( ^{19} \)F NMR (376 MHz, CDCl\(_3\)) \( \delta \) -62.93 ppm. HRMS m/z: calcd for C\(_{24}\)H\(_{21}\)F\(_3\)NO\(_3\)S\(^+\) [M+H]\(^+\) 460.1189, found: 460.1180.

![Chemical structure of (E)-N-benzyl-N-(2-(phenylsulfonyl)-1-(4-(trifluoromethyl)phenyl)vinyl)acetamide](image)

**ethyl (E)-4-(1-(N-benzylacetamido)-2-(phenylsulfonyl)vinyl)benzoate (3ea):** Yield = 92%. Light yellow solid. M. P. = 91.5 – 93.2 °C. \( ^1 \)H NMR (400 MHz, CDCl\(_3\)) \( \delta \) 8.06 (d, \( J = 8.3 \) Hz, 2H, ArH), 7.60 – 7.52 (m, 3H, ArH), 7.44 – 7.36 (m, 4H, ArH), 7.31 – 7.22 (m, 3H, ArH), 7.09 – 7.02 (m, 2H, ArH), 6.27 (s, 1H, C=CH), 4.50 (s, 2H, CH\(_2\)), 4.43 (q, \( J = 7.1 \) Hz, 2H, CH\(_2\)), 2.01 (s, 3H, CH\(_3\)), 1.43 (t, \( J = 7.2 \) Hz, 3H, CH\(_3\)) ppm. \( ^{13} \)C NMR (100 MHz, CDCl\(_3\)) \( \delta \) 169.9, 165.6, 150.5, 140.6, 136.2, 136.0, 133.5, 132.8, 130.0, 129.4, 129.3, 129.1, 128.7, 128.3, 127.9, 127.3, 61.4, 50.2, 23.0, 14.3 ppm. HRMS m/z: calcd for C\(_{26}\)H\(_{26}\)NO\(_5\)S\(^+\) [M+H]\(^+\) 464.1526, found: 464.1515.

![Chemical structure of ethyl (E)-4-(1-(N-benzylacetamido)-2-(phenylsulfonyl)vinyl)benzoate](image)

**(E)-N-benzyl-N-(1-(2-fluorophenyl)-2-(phenylsulfonyl)vinyl)acetamide (3fa):** Yield = 90%. White solid. m.p. = 105.8 – 107.0 °C. \( ^1 \)H NMR (400 MHz, CDCl\(_3\)) \( \delta \) 7.62 – 7.53 (m, 3H, ArH), 7.52 – 7.38 (m, 3H, ArH), 7.34 – 7.17 (m, 5H, ArH), 7.09 – 6.95 (m, 3H, ArH), 6.33 (s, 1H, C=CH), 4.50 (s, 2H, CH\(_2\)), 2.09 (s, 3H, CH\(_3\)) ppm. \( ^{13} \)C NMR (100 MHz, CDCl\(_3\)) \( \delta \) 170.0, 161.1, 158.7, 146.6, 140.4, 136.2, 133.5, 133.05, 132.96, 129.0, 128.7 (d, \( J = -224.0 \) Hz), 128.5, 128.0, 127.3, 123.8 (d, \( J = 4.0 \) Hz), 119.7 (d, \( J = 14.0 \) Hz), 115.7 (d, \( J = 21.0 \) Hz), 49.6, 22.7 ppm. \( ^{19} \)F NMR (376 MHz, CDCl\(_3\)) \( \delta \) -62.93 ppm. HRMS m/z: calcd for C\(_{24}\)H\(_{21}\)F\(_3\)NO\(_3\)S\(^+\) [M+H]\(^+\) 460.1189, found: 460.1180.
MHz, CDCl₃) δ -111.94 ppm. HRMS m/z: calcd for C₂₃H₂₁FNO₃S⁺ [M+H]⁺ 410.1221, found: 410.1239.

(E)-N-benzyl-N-(1-(4-fluorophenyl)-2-(phenylsulfonyl)vinyl)acetamide (3ga):
Yield = 87%. White solid. m.p. = 119.5 – 120.3 °C. ¹H NMR (400 MHz, CDCl₃) δ 7.59 – 7.51 (m, 3H, ArH), 7.42 (t, J = 7.7 Hz, 2H, ArH), 7.33 (dd, J = 8.5, 5.3 Hz, 2H, ArH), 7.29 – 7.24 (m, 3H, ArH), 7.13 – 7.02 (m, 4H, ArH), 6.20 (s, 1H, C=CH), 4.51 (s, 2H, CH₂), 1.98 (s, 3H, CH₃) ppm. ¹³C NMR (100 MHz, CDCl₃) δ 170.0, 164.4 (d, J = -252.0 Hz), 150.5, 140.6, 136.1, 133.5, 132.3 (d, J = 9.0 Hz), 129.0, 128.7, 128.42, 128.39, 128.0 (d, J = 4.0 Hz), 127.8, 127.2, 115.6 (d, J = 22.0 Hz), 50.2, 23.0 ppm. ¹⁹F NMR (376 MHz, CDCl₃) δ -107.25 ppm. HRMS m/z: calcd for C₂₃H₂₁FNO₃S⁺ [M+H]⁺ 410.1222, found: 410.1222.

(E)-N-benzyl-N-(1-(3-chlorophenyl)-2-(phenylsulfonyl)vinyl)acetamide (3ha):
Yield = 94%. Light yellow solid. m.p. = 137.4 – 137.7 °C. ¹H NMR (400 MHz, CDCl₃) δ 7.59 – 7.52 (m, 3H, ArH), 7.48 – 7.38 (m, 3H, ArH), 7.34 (t, J = 7.8 Hz, 1H, ArH), 7.30 – 7.24 (m, 4H, ArH), 7.14 (s, 1H, ArH), 7.10 – 7.04 (m, 2H, ArH), 6.26 (s, 1H, C=CH), 4.51 (s, 2H, CH₂), 2.03 (s, 3H, CH₃) ppm. ¹³C NMR (100 MHz, CDCl₃) δ 169.9, 150.0, 140.5, 136.0, 134.4, 133.7, 133.5, 131.2, 129.6, 129.4, 129.3, 129.0, 128.7, 128.6, 128.3, 127.9, 127.3, 50.2, 23.0 ppm. HRMS m/z: calcd for C₂₃H₂₁ClNO₃S⁺ [M+H]⁺ 426.0925, found: 426.0928, C₂₃H₂₁ClNO₃S⁺ [M+H]⁺ 428.0896, found: 428.0899.
(E)-N-benzyl-N-(1-(4-bromophenyl)-2-(phenylsulfonyl)vinyl)acetamide (3ia): Yield = 95%. Light yellow solid. m.p. = 144.5 – 144.8 °C. $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.59 – 7.51 (m, 5H, ArH), 7.46 – 7.39 (m, 2H, ArH), 7.30 – 7.24 (m, 3H, ArH), 7.22 – 7.17 (m, 2H, ArH), 7.09 – 7.03 (m, 2H, ArH), 6.21 (s, 1H, C=CH), 4.51 (s, 2H, CH$_2$), 1.98 (s, 3H, CH$_3$) ppm. $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 169.9, 150.4, 140.6, 136.0, 133.5, 131.6, 131.5, 130.9, 129.1, 128.75, 128.68, 128.4, 127.9, 127.2, 126.1, 50.2, 23.0 ppm. HRMS m/z: calcd for C$_{23}$H$_{21}$BrNO$_3$S$^+$ [M+H]$^+$ 470.0420, found: 470.0406, C$_{23}$H$_{21}$81BrNO$_3$S$^+$ [M+H]$^+$ 472.0400, found: 472.0391.

(3ja):

(3ja):

(E)-N-benzyl-N-(1-(2-methoxyphenyl)-2-(phenylsulfonyl)vinyl)acetamide (3ja): Yield = 85%. White solid. m.p. = 129.4 – 129.8 °C. $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.56 – 7.43 (m, 3H, ArH), 7.42 – 7.29 (m, 3H, ArH), 7.26 – 7.17 (m, 4H, ArH), 7.09 - 6.94 (m, 3H, ArH), 6.63 (d, J = 8.3 Hz, 1H, ArH), 6.36 (s, 1H, C=CH), 4.45 (s, 2H, CH$_2$), 3.48 (s, 3H, OCH$_3$), 2.18 (s, 3H, CH$_3$) ppm. $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 170.5, 157.0, 150.7, 140.7, 136.7, 133.5, 132.8, 132.5, 129.4, 128.5, 128.3, 128.0, 127.35, 127.28, 120.02, 119.96, 110.3, 54.9, 49.2, 22.8 ppm. HRMS m/z: calcd for C$_{24}$H$_{24}$NO$_3$S$^+$ [M+H]$^+$ 422.1421, found: 422.1426.

(E)-N-benzyl-N-(1-(naphthalen-2-yl)-2-(phenylsulfonyl)vinyl)acetamide (3ka):
Yield = 93%. Light yellow solid. m.p. = 165.1 – 165.6 °C. \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.93 – 7.76 (m, 4H, ArH), 7.64 – 7.54 (m, 2H, ArH), 7.52 – 7.43 (m, 3H, ArH), 7.32 – 7.23 (m, 6H, ArH), 7.15 – 7.06 (m, 2H, ArH), 6.31 (s, 1H, C=CH), 4.54 (s, 2H, CH\(_2\)), 2.06 (s, 3H, CH\(_3\)) ppm. \(^13\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 170.1, 151.8, 140.7, 136.3, 134.3, 133.2, 132.2, 131.4, 129.2, 128.82, 128.79, 128.6, 128.5, 128.2, 128.0, 127.8, 127.7, 127.2, 127.0, 125.5, 50.3, 23.1 ppm. HRMS m/z: calcd for C\(_{27}\)H\(_{24}\)NO\(_3\)S\(^+\) [M+H]\(^+\) 442.1471, found: 442.1465.

\((E)-N\text{-benzyl-}N\text{-}(2\text{-}(phenylsulfonyl)-1\text{-}(thiophen-2-yl)vinyl)acetamide (3la)\): Yield = 81%, \((E/Z = 84/16)\). Light yellow solid. \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.81 \([d, J = 3.8\text{ Hz, 1H, ArH} + 0.19\text{H, ArH of (Z)-isomer}], 7.70 – 7.53 (m, 4H, ArH + 0.57H ArH of (Z)-isomer), 7.41 \(t, J = 7.8\text{ Hz, 2H, ArH}\), 7.35 – 7.20 (m, 3H, ArH +1.33H ArH of (Z)-isomer), 7.19 – 7.09 (m, 3H, ArH), 6.81 \(t, J = 6.0\text{ Hz, 0.19H, ArH of (Z)-isomer}\), 6.71 \[s, 0.19H, C=CH of (Z)-isomer\], 6.64 \(d, J = 4.0\text{ Hz, 0.19H, ArH of (Z)-isomer}\), 6.07 \(s, 1H, C=CH\), 5.33 \[d, J = 14.2\text{ Hz, 0.2H, one proton of CH}_2\ of (Z)-isomer\], 4.61 \(s, 2H\), 4.52 \[d, J = 14.2\text{ Hz, 0.2H, one proton of CH}_2\ of (Z)-isomer\], 1.96 \(s, 3H, CH_3\), 1.71 \[s, 0.57H, CH_3\ of (Z)-isomer\]. \(^13\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 169.7, 144.2, 140.4, 136.2, 135.2, 134.5, 133.5, 131.7, 129.0, 128.9, 128.6, 128.3, 127.9, 127.2, 50.7, 22.5 ppm. HRMS m/z: calcd for C\(_{21}\)H\(_{20}\)NO\(_3\)S\(^+\) [M+H]\(^+\) 398.0879, found: 398.0883.

\((E)-N\text{-}(2\text{-bromobenzyl})\text{-}N\text{-}(1\text{-phenyl-2-(phenylsulfonyl)vinyl)acetamide (3ma)\): Yield = 87%. Light yellow solid. m.p. = 90.5 – 91.2 °C. \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.63 – 7.20 (m, 12H, ArH), 7.18 – 6.98 (m, 2H, ArH), 6.42 \(s, 1H, C=CH\), 4.67 \(s, 2H, CH_2\), 2.04 \(s, 3H, CH_3\) ppm. \(^13\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 169.7, 144.2, 140.4, 136.2, 135.2, 134.5, 133.5, 131.7, 129.0, 128.9, 128.6, 128.3, 127.9, 127.2, 50.4, 23.1 ppm. C\(_{23}\)H\(_{21}\)BrNO\(_3\)S\(^+\) [M+H]\(^+\) 470.0421, found: 470.0421, C\(_{23}\)H\(_{21}\)\(^{81}\)BrNO\(_3\)S\(^+\) [M+H]\(^+\) 472.0400, found: 472.0403.
1-(3-phenyl-4-(phenylsulfonyl)isoquinolin-2(1H)-yl)ethan-1-one 5: Yield = 64%. White solid. m.p. = 184.0 – 184.3°C. $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 8.08 (d, $J = 7.8$ Hz, 1H, ArH), 7.58 - 7.45 (m, 5H, ArH), 7.43 – 7.18 (m, 8H, ArH), 4.83 (s, 2H, CH$_2$), 1.40 (s, 3H, CH$_3$). $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 171.5, 148.7, 142.0, 134.8, 133.2, 132.4, 131.9, 131.1, 129.1, 128.3, 128.33, 128.30, 128.2, 127.5, 127.0, 126.0, 125.0, 46.9, 24.9. HRMS m/z: calcd for C$_{23}$H$_{20}$NO$_3$S$^+$ [M+H]$^+$ 390.1178, found: 390.1158.

1-phenyl-2-(phenylsulfonyl)ethan-1-one 6: Yield = 95%. White solid. m.p. = 95.0 – 95.4 °C. $^1$H NMR (401 MHz, CDCl$_3$) $\delta$ 7.98 – 7.86 (m, 4H, ArH), 7.69 – 7.58 (m, 2H, ArH), 7.58 – 7.51 (m, 2H, ArH), 7.50 – 7.44 (m, 2H, ArH), 4.74 (s, 2H, CH$_2$) ppm. $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 187.9, 138.6, 135.6, 134.3, 134.2, 129.2, 129.1, 128.8, 128.5, 63.3 ppm. HRMS m/z: calcd for C$_{14}$H$_{13}$O$_3$S$^+$ [M+H]$^+$ 261.0580, found: 261.0584.
$^{1}\text{H}$, $^{19}\text{F}$ and $^{13}\text{C}$ NMR spectra of products 

$(E)-N$-benzyl-$N$-(1-phenyl-2-(phenylsulfonyl)vinyl)acetamide (3aa)
(E)-N-benzyl-N-(1-phenyl-2-tosylvinyl)acetamide (3ab)
(E)-N-benzyl-N-(2-((4-tert-buty1)phenyl)sulfonyl)-1-phenylvinylacetamide (3ac)
(E)-N-benzyl-N-(2-((4-methoxyphenyl)sulfonyl)-1-phenylvinyl)acetamide (3ad)
(E)-N-benzyl-N-(2-((4-(benzyloxy)phenyl)sulfonyl)-1-phenylvinyl)acetamide (3ae)
(E)-N-benzyl-N-(2-((4-hydroxyphenyl)sulfonyl)-1-phenylvinyl)acetamide (3af)
(E)-4-((2-(N-benzylacetamido)-2-phenylvinyl)sulfonyl)phenyl acetate (3ag)
(E)-N-benzyl-N-(2-((2-methylthiophenyl)sulfonyl)-1-phenylvinyl)acetamide (3ah)
(E)-N-benzyl-N-(2-((2-iodophenyl)sulfonyl)-1-phenylvinyl)acetamide (3ai)
(E)-N-benzyl-N-(2-((2-chlorophenyl)sulfonyl)-1-phenylvinyl)acetamide (3ak)
(E)-N-benzyl-N-(2-((4-fluorophenyl)sulfonyl)-1-phenylvinyl)acetamide (3al)
(E)-N-benzyl-N-(2-((4-cyanophenyl)sulfonyl)-1-phenylvinyl)acetamide (3am)
(E)-N-benzyl-N-(2-((4-nitrophenyl)sulfonyl)-1-phenylvinyl)acetamide (3an):
ethyl (E)-4-((2-(N-benzylacetamido)-2-phenylvinyl)sulfonyl)benzoate (3ao)
(E)-N-(2-((4-acetylphenyl)sulfonyl)-1-phenylvinyl)-N-benzylacetamide (3ap)
(E)-N-(2-((4-benzoylphenyl)sulfonyl)-1-phenylvinyl)-N-benzylacetamide (3aq)
(E)-N-benzyl-N-(2-(naphthalen-1-ylsulfonyl)-1-phenylvinyl)acetamide (3ar)
(E)-N-benzyl-N-(2-(naphthalen-2-ylsulfonyl)-1-phenylvinyl)acetamide (3as)
Methyl-(E)-3-((2-(N-benzylacetamido)-2-phenylvinyl)sulfonyl)thiophene-2-carboxylate (3at)
(E)-N-benzyl-1-phenylsulfonyl-1-arylvinylacetamide (3ba)
(E)-N-(1-[(1,1'-biphenyl)-4-yl]-2-(phenylsulfonyl)vinyl)-N-benzylacetamide (3ca)
(E)-N-benzyl-N-(2-(phenylsulfonyl)-1-(4-(trifluoromethyl)phenyl)vinyl)acetamide (3da)
ethyl (E)-4-(1-(N-benzylacetamido)-2-(phenylsulfonyl)vinyl)benzoate (3ea)
(E)-N-benzyl-N-(1-(2-fluorophenyl)-2-(phenylsulfonyl)vinyl)acetamide (3fa)
(E)-N-benzyl-N-(1-(4-fluorophenyl)-2-(phenylsulfonyl)vinyl)acetamide (3ga)
(E)-N-benzyl-N-(1-(3-chlorophenyl)-2-(phenylsulfonyl)vinyl)acetamide (3ha)
(E)-N-benzyl-N-(1-(4-bromophenyl)-2-(phenylsulfonyl)vinyl)acetamide (3ia)
(E)-N-benzyl-N-(1-(2-methoxyphenyl)-2-(phenylsulfonyl)vinyl)acetamide (3ja)
\[(E)-N\text{-}\text{benzyl-}N\text{-}1(\text{naphthalen-2-yl})\text{-}2(\text{phenylsulfonyl})\text{vinyl})\text{acetamide (3ka)}\]
(E)-N-benzyl-N-(2-(phenylsulfonyl)-1-(thiophen-2-yl)vinyl)acetamide (3la)
(E)-N-(2-bromobenzyl)-N-(1-phenyl-2-(phenylsulfonyl)vinyl)acetamide (3ma)
1-(3-phenyl-4-(phenylsulfonyl)isoquinolin-2(1H)-yl)ethan-1-one 5
1-phenyl-2-(phenylsulfonyl)ethan-1-one 6