Supporting Information

Palladium-Catalyzed Selective Aminoamidation and Aminocyanation of Alkenes Using Isonitrile as Amide and Cyanide Sources

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General Information

$^1$H and $^{13}$C NMR spectra were recorded on BRUKER DRX/400 spectrometer using CDCl$_3$ as solvent and TMS as an internal standard. Gas chromatograph mass spectra were obtained with a SHIMADZU model GCMS/QP5000 spectrometer. IR spectra were obtained as potassium bromide pellets or as liquid films between two potassium bromide pellets with a Brucker Vector 22 spectrometer. TLC was performed using commercially prepared 100/400 mesh silica gel plates (GF254), and visualization was effected at 254 nm. High resolution exact mass measurements (HR-MS) were performed on a TOF spectrometer.
Optimization Study

Table 1. Optimization of the reaction conditions.$^a$

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<th>Entry</th>
<th>Catalyst</th>
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<th>Solvent</th>
<th>Additive</th>
<th>Yield (%) $^b$</th>
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<td></td>
<td></td>
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<td>68  20</td>
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</table>

$^a$ The reaction conditions are optimized for the conversion of 1a to 3a. The table lists the catalyst, oxidant, solvent, additive, and yield of the product. The values in parentheses indicate the yield in a different solvent.

$^b$ Yields are in percentage and are determined by GC analysis.

$^c$ Additional optimization study in a different solvent.

$^d$ The reaction was carried out under an atmosphere of oxygen.

$^e$ The reaction was carried out without a catalyst.

$^f$ The reaction was carried out with a different additive.

$^g$ The reaction was carried out under an elevated temperature.

$^h$ The reaction was carried out with a different solvent.

$^i$ The reaction was carried out with a different oxidant.
Reaction conditions: unless otherwise noted, all reactions were performed with 1a (0.3 mmol), 2a (0.36 mmol), catalyst (10 mol %), base (0.6 mmol), and oxidant (0.3 mmol) in solvent (2.0 mL) at 100 °C for 10 h, DCE = 1,2- dichloroethane. DMF = N,N-dimethylformamide. DABCO = 1,4-diazabicyclo[2.2.2]octane. \(^a\)Yields and conversions analyzed by GC/MS are based on 1a. \(^c\)isolated yield. \(^d\)20 mol% Cu(TFA)\(_2\) and O\(_2\) balloon was used. \(^e\)The reaction was carried out at 110 °C. \(^f\)The reaction was carried out at 90 °C. \(^h\)Reaction performed at 130 °C. \(^i\)20 mol% Pd(TFA)\(_2\) was used. \(^j\)2 equiv isonitrile was used.

**Synthesis of Starting Materials**

Starting materials S2a-r: Into a flame-dried Schlenk-flask were introduced S1 (10.0 mmol, 1.0 equiv), allylbromide (0.87 mL, 10.0 mmol, 1.0 equiv), K\(_2\)CO\(_3\) (3.3 g, 24 mmol, 2.4 equiv) and DMF (25 mL). The flask was equipped with a stopper and the reaction mixture heated to 70 °C over night. The mixture was allowed to cool down to room temperature and washed with water (10 mL). The aqueous phase was extracted with diethyl ether (3 × 20 mL). The combined organic layers were washed with brine, dried and concentrated to provide the crude N-allylaniline.

Starting materials S3a-r\(^i\): Into a flame-dried Schlenk-flask were introduced S1 (8.0 mmol, 1.0 equiv), BF\(_3\)OEt\(_2\) (8.0 mmol, 1.0 equiv) and xylene (4 mL). The flask was
sealed and heated to 160 °C overnight. The reaction was allowed to cool down and treated with saturated aqueous K$_2$CO$_3$ solution (10 mL). The organic phase was separated and the aqueous phase was extracted with diethyl ether (3 × 20 mL). The organic layers were combined, dried over MgSO$_4$ and concentrated to provide the crude product. Purification was carried out by column chromatography (silica gel, hexanes/EtOAc, 9/1, v/v).

**Starting materials 1a-r**: To an oven dried 50 mL round bottom flask containing the solution of the amine (5.0 mmol) in pyridine (10 mL), the reaction mixture was cooled to 0 °C and acyl chlorides and acid anhydrides (7.5 mmol) were added slowly. Then the mixture was stirred at room temperature for 12 h. Upon completion, the reaction mixture was washed with saturated NaCl for three times and extracted with ethyl acetate (3 × 10 mL), and the organic layers were combined, dried over anhydrous MgSO$_4$. The organic layer was then concentrated under vacuum, and the residue was separated by silica gel column chromatography (hexanes/EtOAc) to give N-sulfonyl-2-aminobiaryls.

**Starting materials 1u**: The method for the synthesis of the known sulfonamide 1u was the same as the method previously described except for replacing 3-bromoprop-1-ene with 3-bromo-2-methylprop-1-ene.
Starting materials 1s3,4:

![C6H5BrCN](image)

To a 100 mL round-bottomed flask was added n-BuMgBr (10 mL, 1.2 M in THF, 12 mmol) and n-BuLi (15 mL, 1.6 M in hexanes, 24 mmol) at 0 °C in THF (20 mL), and stirred for 10-15 min. The mixture was then cooled down to -78 °C and 2-bromobenzonitrile (1.82 g, 10 mmol) in THF (20 mL) was added dropwise. It was then allowed to stir at -78 °C for 1 h. Meanwhile, CuCN (269.6 mg, 3.01 mmol) and LiCl (254.3 mg, 6.00 mmol) in THF (3 mL) were added to a 15 mL round-bottomed flask and stirred at room temperature until all solids were dissolved and the mixture turned to blue color. The resulting CuCN·2LiCl solution and allyl bromide (3.5 mL, 40 mmol) were then added onto the reaction mixture at -78 °C, respectively. After 1 h stirring, the reaction mixture was then quenched with saturated aqueous NH₄Cl at room temperature. Organic materials were then extracted three times with 50 mL of Et₂O. The organic phase was washed with water and brine, and dried over MgSO₄. After filtration, the solvent was evaporated to give crude mixture, which was purified by Kugelrohr distillation to provide 1f (0.93 g, 6.49 mmol) as a colorless oil for 65% yield.

![C6H5CN](image)

A solution of 2-allylbenzonitrile (2.92 g, 0.020 mol, 1 equiv) in diethyl ether (10 mL)
was transferred via cannula over 2 mins to a Schlenk containing a lithium aluminum hydride (2.50 g, 0.063 mol, 3.2 equiv) suspension in diethyl ether (90 mL) at 0 ºC, allowing for venting of the formed gas. After stirring for 1 h at 0 ºC, the reaction mixture was carefully quenched via the dropwise addition of water (6 mL), 2M KOH (6 mL), and water (6 mL) at 0 ºC. Upon quench, the resulting suspension was brought to ambient temperature, then filtered through a Whatman filter paper and rinsed with diethyl ether (700 mL). The resulting filtrate was concentrated and the crude product thus obtained was purified by silica gel flash column chromatography (2/2/96 methanol/triethylamine/dichloromethane) to provide the desired amine as a pink oil after concentration under high vacuum (< 1 Torr) for 1 h (2.67 g, 0.018 mol, 91%). Rf = 0.42 (2/2/96 methanol/triethylamine/dichloromethane).

Starting materials 1t5:

\[
\begin{align*}
\text{Ph} & \quad \text{CN} \\
\text{Ph} & \quad \text{NH}_2
\end{align*}
\]

**N-(2,2-Diphenylpent-4-enyl)-4-methylbenzamide.** Sodium hydride (0.630 g, 21.00 mmol) was suspended in 20 mL of DMF and diphenylacetonitrile (3.86 g, 20.00 mmol) (dissolved in 6 mL of DMF) was added. The reaction was allowed to stir for 1 h. The reaction mixture was cooled to 0 ºC and allyl bromide (1.861 mL, 22.00 mmol) was added. The reaction mixture was allowed to stir overnight. The reaction mixture was poured over an ice/water mixture (100 mL). The aqueous layer was extracted with benzene (3 × 50 mL). Then the combined organic layer was washed with water, dried over MgSO₄, and concentrated under reduced pressure. The reaction mixture
was carried on without further purification. LAH (1.594 g, mmol) was suspended in 50 mL of Et₂O and the crude product from the previous step was added. The reaction was allowed to stir for two hours and then quenched with 50 mL of 1M NaOH. Reaction mixture was filtered through celite and the celite was rinsed with Et₂O (2 × 10 mL). Reaction mixture was concentrated under reduced pressure and 2,2-diphenylpent-4-en-1-amine was carried on without further purification.

**Experimental Procedures for 3a-3z:**

\[
\begin{array}{c}
\text{R}_2\text{N} + \text{R}_3\text{N} + \text{R}_1\text{Pd(TFA)}_2 (10 \text{ mol} \%) + \text{Cu(TFA)}_2 (1.0 \text{ equiv}) + \text{DABCO} (2 \text{ equiv}) \rightarrow \text{R}_1\text{R}_2\text{O} (n=0,1)\\
\end{array}
\]

To the mixture of 1 (0.3 mmol), Pd(TFA)₂ (10 mol %) and Cu(TFA)₂ (1.0 equiv) in toluene (2.0 mL) solvent, TFA (2.0 equiv) were added successively. After stirred for 5 min at room temperature, isocyanide 2 (1.2 equiv) was added, and then the mixture was stirred at 100 °C for 10 h. After cooling to room temperature, the mixture was extracted by ethyl acetate (3 × 10 mL). The organic layer was washed with brine, and dried with anhydrous MgSO₄, filtered and concentrated under reduced pressure, and the residue was isolated by silica gel column chromatography, eluted with petroleum ether/ethyl acetate to give the pure product 3.
Experimental Procedures for 4a-4e:

To the mixture of 1 (0.3 mmol), Pd(TFA)$_2$ (10 mol %) and Cu(TFA)$_2$ (1.0 equiv) in toluene (2.0 mL) solvent was added TFA (1.0 equiv) dropwise. After stirred for 5 min at room temperature, isocyanide 2 (1.2 equiv) was added, and then the mixture was stirred at 100 °C for 10 h. After cooling to room temperature, the mixture was extracted by ethyl acetate (3 × 10 mL). The organic layer was washed with saturated aqueous NaHCO$_3$ solution, and dried over anhydrous MgSO$_4$, filtered and concentrated under reduced pressure. The residue was isolated by silica gel column chromatography, eluted with petroleum ether/ethyl acetate to give the pure product 4.


Analysis Data for Compounds 3a-3zd, 4a-4e, 5-7

*N-(tert-butyl)-2-(1-tosyldinolidin-2-yl)acetamide (3a)*: Grey solid; mp 89-91 °C. IR (KBr): 3690, 3308, 2898, 1673, 1530, 1463, 1323, 1124, 816, 742; ¹H NMR (400 MHz, CDCl₃) δ 7.64 (d, J = 8.0 Hz, 1H), 7.52 (d, J = 7.6 Hz, 2H), 7.19-7.13 (m, 3H), 7.01-6.97 (m, 2H), 5.56 (br. s, 1H), 4.68-4.30 (m, 1H), 2.91-2.84 (m, 1H), 2.80-2.75 (m, 1H), 2.71-2.66 (m, 1H), 2.55-2.49 (m, 1H), 2.32 (s, 1H), 1.22 (s, 3H); ¹³C NMR (100 MHz, CDCl₃) δ 169.0, 144.1, 141.2, 134.4, 131.9, 129.7, 127.7, 127.2, 125.4, 124.9, 117.1, 59.5, 51.4, 44.1, 34.0, 28.6, 21.5. HRMS (ESI) m/z: calcd for C₂₁H₂₇N₂O₃S+, 387.1737; found, 387.1741.

*N-(tert-butyl)-2-(5-methyl-1-tosyldinolidin-2-yl)acetamide (3b)*: Yellow solid; mp 94-96 °C. IR (KBr): 3697, 3312, 2970, 1663, 1541, 1488, 1351, 1164, 816, 752; ¹H NMR (400 MHz, CDCl₃) δ 7.50 (d, J = 7.2 Hz, 3H), 7.13 (d, J = 7.6 Hz, 2H), 6.97 (d, J = 8.0 Hz, 1H), 6.81 (s, 1H), 5.58 (br. s, 1H), 4.50-4.45 (m, 1H), 2.83-2.77 (m, 1H), 2.70-2.63 (m, 2H), 2.51-2.46 (m, 1H), 2.32 (s, 3H), 2.23 (s, 3H), 1.23 (s, 9H); ¹³C NMR (100 MHz, CDCl₃) δ 169.0, 138.8, 134.7, 134.3, 132.0, 129.6, 128.3, 127.2, 125.9, 117.0, 59.6, 51.3, 44.0, 34.0, 28.6, 21.5, 20.9. HRMS (ESI) m/z: calcd for C₂₂H₂₉N₂O₃S⁺, 401.1893; found, 401.1901.

*N-(tert-butyl)-2-(5-methoxy-1-tosyldinolidin-2-yl)acetamide (3c)*:
Yellow solid; mp 102-104 °C. IR (KBr): 3667, 3319, 2968, 1662, 1538, 1486, 1352, 1164, 1032, 813, 741; 1H NMR (400 MHz, CDCl3) δ 7.47-7.42 (m, 3H), 7.09 (d, J = 8.0 Hz, 1H), 6.67 (d, J = 8.4 Hz, 1H), 6.51 (s, 1H), 5.80 (br. s, 1H), 4.46-4.45 (m, 1H), 3.67 (s, 3H), 2.72-2.56 (m, 3H), 2.46-2.40 (m, 1H), 2.28 (s, 3H), 1.21 (s, 9H).; 13C NMR (100 MHz, CDCl3) δ 169.1, 157.6, 144.0, 134.4, 134.1, 129.6, 127.2, 118.4, 113.1, 110.8, 59.8, 55.5, 51.3, 43.8, 34.3, 28.6, 21.5. HRMS (ESI) m/z: calcd for C22H29N2O4S+, 417.1843; found, 417.1849.

\[
\text{N-(tert-butyl)-2-(5-isopropyl-1-tosylindolin-2-yl)acetamide (3d):}
\]
Yellow solid; mp 140-142 °C. IR (KBr): 3683, 3317, 2964, 1661, 1541, 1353, 1164, 819, 750; 1H NMR (400 MHz, CDCl3) δ 7.47 (d, J = 8.0 Hz, 3H), 7.08 (d, J = 8.0 Hz, 2H), 6.97 (d, J = 8.4 Hz, 1H), 6.82 (s, 1H), 5.77 (br. s, 1H), 4.48-4.44 (m, 1H), 2.82-2.72 (m, 2H), 2.68-2.60 (m, 2H), 2.49-2.44 (m, 1H), 2.27 (s, 3H), 1.17 (s, 9H), 1.11 (d, J = 6.8 Hz, 6H); 13C NMR (100 MHz, CDCl3) δ 169.1, 145.8, 144.0, 139.0, 134.4, 131.9, 129.6, 127.1, 125.8, 123.3, 116.8, 59.6, 51.2, 44.0, 34.0, 33.6, 28.5, 24.1, 24.0, 21.5. HRMS (ESI) m/z: calcd for C24H33N2O3S+, 429.2206; found, 429.2214.

\[
\text{N-(tert-butyl)-2-(5-fluoro-1-tosylindolin-2-yl)acetamide (3e):}
\]
Yellow oil. IR (KBr): 3695, 3309, 3080, 2974, 1730, 1548, 1481, 1356, 1166, 816, 668; 1H NMR (400 MHz, CDCl3) δ 7.56-7.47 (m, 3H), 7.19-7.13 (m, 2H), 6.85 (t, J = 8.0 Hz, 1H), 6.69 (d, J =
7.6 Hz, 1H), 5.64 (br. s, 1H), 4.51 (s, 1H), 2.80-2.64 (m, 3H), 2.50-2.45 (m, 1H), 2.32 (s, 3H), 1.23 (s, 9H); $^{13}$C NMR (100 MHz, CDCl$_3$) δ 168.8, 160.3 (d, $J = 221.1$ Hz), 144.3, 137.2 (d, $J = 1.7$ Hz), 134.3 (d, $J = 8.8$ Hz), 134.0, 129.7, 127.2, 118.2 (d, $J = 8.6$ Hz), 114.4 (d, $J = 23.2$ Hz), 112.5 (d, $J = 23.6$ Hz), 60.0, 51.4, 43.8, 34.1, 28.6, 21.5. HRMS (ESI) m/z: calcd for C$_{21}$H$_{25}$FN$_2$NaO$_3$S$^+$, 427.1462; found, 427.1469.

$N$-(tert-butyl)-2-(5-chloro-1-tosylindolin-2-yl)acetamide (3f):

Brown solid; mp 148-150 °C. IR (KBr): 3672, 3319, 2970, 1660, 1596, 1470, 1355, 1167, 816, 717; $^1$H NMR (400 MHz, CDCl$_3$) δ 7.48 (d, $J = 8.4$ Hz, 3H), 7.13 (d, $J = 8.0$ Hz, 2H), 7.08 (d, $J = 8.8$ Hz, 1H), 6.94 (s, 1H), 5.79 (br. s, 1H), 4.51-4.49 (m, 1H), 2.86-2.79 (m, 1H), 2.72-2.67 (m, 2H), 2.50-2.44 (m, 1H), 2.30 (s, 3H), 1.22 (s, 9H); $^{13}$C NMR (100 MHz, CDCl$_3$) δ 168.9, 144.4, 139.9, 134.0, 133.8, 130.0, 129.8, 127.7, 127.1, 125.5, 117.8, 59.9, 51.5, 43.7, 34.0, 28.6, 21.5. HRMS (ESI) m/z: calcd for C$_{21}$H$_{26}$ClN$_2$O$_3$S$^+$, 421.1347; found, 421.1353.

2-(5-bromo-1-tosyl-2,3-dihydro-1H-inden-2-yl)-$N$-(tert-butyl)acetamide (3g):

Yellow solid; mp 142-144 °C. IR (KBr): 3686, 3313, 1712, 1582, 1268, 1165, 755; $^1$H NMR (400 MHz, CDCl$_3$) δ 7.58-7.45 (m, 3H), 7.29 (d, $J = 5.6$ Hz, 1H), 7.20-7.15 (m, 3H), 5.73 (br. s, 1H), 4.57-4.52 (m, 1H), 2.93-2.66 (m, 3H), 2.56-2.49 (m, 1H), 2.36 (s, 3H), 1.28 (s, 9H); $^{13}$C NMR (100 MHz, CDCl$_3$) δ 168.8, 144.4, 134.1, 134.1, 130.7, 129.8, 128.4, 127.1, 118.2,
117.6, 59.8, 51.4, 43.8, 33.9, 28.6, 21.5. HRMS (ESI) m/z: calcd for C_{21}H_{26}BrN_{2}O_{3}S^{+}, 465.0842; found, 465.0848.

\[
\text{N-(tert-butyl)-2-(5-cyano-1-tosylindolin-2-yl)acetamide (3h):}
\]
Brownish solid; mp 157-159 °C. IR (KBr): 3679, 3326, 2971, 2226, 1664, 1537, 1357, 1167, 743, 667; \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.70 (d, \(J = 8.4\) Hz, 1H), 7.61 (d, \(J = 8.0\) Hz, 2H), 7.48 (d, \(J = 8.4\) Hz, 1H), 7.31 (s, 1H), 7.24 (d, \(J = 8.0\) Hz, 2H), 5.84 (br. s, 1H), 4.67-4.60 (m, 1H), 3.10-3.04 (m, 1H), 2.97-2.92 (m, 1H), 2.87-2.83 (m, 1H), 2.60-2.54 (m, 1H), 2.37 (s, 3H), 1.29 (s, 9H); \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 168.6, 145.4, 144.9, 134.1, 132.6, 132.5, 130.0, 129.1, 126.9, 118.8, 116.1, 107.4, 60.0, 51.4, 43.7, 33.8, 28.6, 21.5. HRMS (ESI) m/z: calcd for C_{22}H_{25}N_{3}NaO_{3}S^{+}, 434.1509; found, 434.1514.

\[
\text{N-(tert-butyl)-2-(7-fluoro-1-tosylindolin-2-yl)acetamide (3i):}
\]
Pale yellow oil. IR (KBr): 3692, 3302, 3115, 1722, 1553, 1168, 955, 675; \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.46 (d, \(J = 7.6\) Hz, 2H), 7.14 (d, \(J = 8.0\) Hz, 2H), 7.06-7.01 (m, 1H), 6.97-6.92 (m, 1H), 6.81 (d, \(J = 7.2\) Hz, 0H), 5.70 (br. s, 1H), 4.70-4.66 (m, 1H), 2.53-2.42 (m, 3H), 2.34 (s, 3H), 2.31-2.27 (m, 1H), 1.23 (s, 9H); \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 168.6, 154.5 (d, \(J = 253.6\) Hz), 144.4, 138.5 (d, \(J = 1.4\) Hz), 134.3, 129.7, 128.2 (d, \(J = 10.1\) Hz), 127.7 (d, \(J = 6.8\) Hz), 127.6, 121.0 (d, \(J = 3.5\) Hz), 115.9 (d, \(J = 20.2\) Hz), 61.7, 51.4, 42.9,34.3, 28.6, 21.6. HRMS (ESI) m/z: calcd for
Yellow solid; mp 98-100 °C. IR (KBr): 3695, 3301, 3114, 1725, 1546, 1493, 1356, 1165, 979, 865; 

\[ \text{N-(tert-butyl)-2-(6-fluoro-1-tosylindolin-2-yl)acetamide (3j)}: \]

\[ ^1H \text{ NMR (400 MHz, CDCl}_3\] \[ ] \[ \delta 7.54 (d, J = 8.0 Hz, 2H), 7.33 (d, J = 10.0 Hz, 1H), 7.16 (d, J = 8.0 Hz, 2H), 6.93-6.89 (m, 1H), 6.68-6.63 (m, 1H), 5.71 (br. s, 1H), 4.55-4.51 (m, 1H), 2.89-2.83 (m, 1H), 2.76-2.69 (m, 2H), 2.55-2.49 (m, 1H), 2.32 (s, 3H), 1.24 (s, 9H); \]

\[ ^{13}C \text{ NMR (100 MHz, CDCl}_3\] \[ ] \[ \delta 168.9, 162.5 (d, J = 242.0 Hz), 144.5, 142.5 (d, J = 11.6 Hz), 134.2, 129.8, 127.1, 126.9 (d, J = 2.6 Hz), 125.9 (d, J = 9.6 Hz), 111.4 (d, J = 22.5 Hz), 104.7 (d, J = 27.8 Hz), 60.5, 51.5, 43.9, 33.5, 28.6, 21.5. HRMS (ESI) m/z: calcd for C\[21\]H\[26\]F\[2\]N\[2\]O\[3\]S, 405.1643; found, 405.1651.

Yellow solid; mp 151-153 °C. IR (KBr): 3693, 3315, 2972, 1661, 1538, 1343, 1158, 979, 759; 

\[ ^1H \text{ NMR (400 MHz, CDCl}_3\] \[ ] \[ \delta 7.38 (d, J = 8.4 Hz, 1H), 7.15-7.12 (m, 2H), 7.03-7.00 (m, 1H), 5.61 (br. s, 1H), 4.60-4.55 (m, 1H), 3.48-3.42 (m, 1H), 3.03-2.99 (m, 1H), 2.78 (s, 3H), 2.72-2.67 (m, 1H), 2.52-2.46 (m, 1H), 1.21 (s, 9H); \]

\[ ^{13}C \text{ NMR (100 MHz, CDCl}_3\] \[ ] \[ \delta 168.8, 141.1, 131.0, 128.0, 125.6, 124.7, 115.5, 60.0, 51.3, 44.3, 35.3, 34.4, 28.6. HRMS (ESI) m/z: calcd for C\[15\]H\[22\]N\[2\]NaO\[3\]S, 333.1243; found, 333.1250.
2-(1-acetylindolin-2-yl)-N-(tert-butyl)acetamide (3l): Yellow solid;

mp 162-164 °C. IR (KBr): 3662, 3323, 2972, 1654, 1545, 1477, 1400, 942, 751; \(^1\)H NMR (400 MHz, (CD\(_3\))\(_2\)C=O) \(\delta\) 8.04 (s, 1H), 7.21 (d, J = 6.8 Hz, 1H), 7.16-7.12 (m, 1H), 7.01-6.97 (m, 1H), 4.82 (br. s, 1H), 3.30 (d, J = 7.2 Hz, 1H), 2.95 (s, 1H), 2.84 (d, J = 16.0 Hz, 1H), 2.52-2.33 (m, 2H), 2.25 (s, 3H), 1.31 (s, 9H); \(^13\)C NMR (100 MHz, (CD\(_3\))\(_2\)C=O) \(\delta\) 169.6, 168.6, 143.3, 131.7, 127.8, 125.9, 124.2, 118.2, 58.9, 51.4, 42.6, 34.9, 29.0, 23.5. HRMS (ESI) m/z: calcd for C\(_{16}\)H\(_{23}\)N\(_2\)O\(_2\)^+ , 275.1754; found, 275.1759.

2-(1-benzoylindolin-2-yl)-N-(tert-butyl)acetamide (3m): Yellow solid;

mp 172-174 °C. IR (KBr): 3693, 3323, 2971, 1646, 1480, 1393, 926, 753; \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.45-7.35 (m, 6H), 7.15 (d, J = 7.2 Hz, 1H), 6.92-6.89 (m, 2H), 5.72 (br. s, 1H), 4.92 (s, 1H), 3.39-3.32 (m, 1H), 2.99 (d, J = 16.4 Hz, 1H), 2.56 (s, 1H), 2.25-2.19 (m, 1H), 1.21 (s, 9H); \(^13\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 169.1, 168.7, 141.4, 136.4, 131.7, 130.6, 128.8, 127.2, 126.9, 125.7, 124.0, 116.2, 58.9, 51.2, 41.2, 33.6, 28.7. HRMS (ESI) m/z: calcd for C\(_{21}\)H\(_{22}\)N\(_2\)NaO\(_2\)^+, 359.1730; found, 359.1737.
tert-butyl 2-(2-(tert-butylamino)-2-oxoethyl)indoline-1-carboxylate

(3n): Yellow solid; mp 129-131 °C. IR (KBr): 3662, 3323, 2975, 1754, 1477, 942, 751; \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.56 (s, 1H), 7.14-7.10 (m, 2H), 6.91 (t, \(J = 7.2\) Hz, 1H), 5.42 (br. s, 1H), 4.72-4.67 (m, 1H), 3.36-3.29 (m, 1H), 2.95 (d, \(J = 15.2\) Hz, 1H), 2.66-2.62 (m, 1H), 2.27-2.22 (m, 1H), 1.55 (s, 9H), 1.26 (s, 9H); \(^13\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 169.4, 152.3, 141.7, 130.2, 127.4, 125.2, 122.8, 115.3, 81.4, 57.1, 41.9, 33.4, 28.8, 28.5. HRMS (ESI) m/z: calcd for C\(_{19}\)H\(_{29}\)N\(_2\)O\(_3\), 333.2173; found, 333.2179.

\[ \text{N-(tert-butyl)-2-(1-((4-methoxyphenyl)sulfonyl)indolin-2-yl)acetamide (3o):} \] Yellow solid; mp 153-155 °C. IR (KBr): 3694, 3308, 2972, 1722, 1539, 1352, 1160, 1024, 835; \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.60 (d, \(J = 8.0\) Hz, 1H), 7.54 (d, \(J = 8.8\) Hz, 2H), 7.15 (t, \(J = 7.2\) Hz, 1H), 7.00-6.95 (m, 2H), 6.78 (d, \(J = 8.8\) Hz, 2H), 5.67 (br. s, 1H), 4.51-4.46 (m, 1H), 3.75 (s, 3H), 2.90-2.82 (m, 1H), 2.74-2.65 (m, 2H), 2.52-2.46 (m, 1H), 1.21 (s, 9H); \(^13\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 169.0, 163.3, 141.3, 131.9, 129.2, 128.9, 127.7, 125.4, 124.9, 117.1, 114.2, 59.5, 55.5, 51.3, 44.0, 34.1, 28.6. HRMS (ESI) m/z: calcd for C\(_{21}\)H\(_{27}\)N\(_2\)O\(_4\)S\(^+\), 403.1686; found, 403.1682.
**N-(tert-butyl)-2-(1-(4-(trifluoromethyl)phenyl)indolin-2-yl)acetamide (3p):** White solid; mp 137-138 °C. IR (KBr): 3661, 3322, 2972, 1662, 1537, 1324, 1172, 842, 715; $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.76 (d, $\ J = 8.0$ Hz, 2H), 7.61-7.59 (m, 3H), 7.17 (t, $\ J = 6.8$ Hz, 1H), 7.03-6.98 (m, 2H), 5.65 (br. s, 1H), 4.56-4.51 (m, 1H), 2.91-2.84 (m, 1H), 2.77-2.70 (m, 2H), 2.50-2.45 (m, 1H), 1.23 (s, 9H); $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 168.8, 140.8, 140.5, 134.8 (q, $\ J = 32.7$ Hz), 131.7, 127.9, 127.6, 126.2 (q, $\ J = 3.5$ Hz), 125.7, 125.3, 123.1 (q, $\ J = 271.2$ Hz), 116.8, 59.8, 51.4, 43.8, 34.1, 28.6. HRMS (ESI) m/z: calcld for C$_{21}$H$_{24}$F$_3$N$_2$O$_3$S$,^{+}$ 441.1454; found, 441.1457.

**N-(tert-butyl)-2-(1-(mesitylsulfonyl)indolin-2-yl)acetamide (3q):** Yellow solid; mp 126-128 °C. IR (KBr): 3693, 3321, 2972, 1660, 1541, 1338, 1158, 1045, 750, 663; $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.07 (d, $\ J = 7.2$ Hz, 1H), 7.01-6.85 (m, 5H), 5.81 (br. s, 1H), 4.60 (d, $\ J = 1.6$ Hz, 1H), 3.26-3.20 (m, 1H), 2.99 (d, $\ J = 16.0$ Hz, 1H), 2.59-2.54 (m, 1H), 2.52 (s, 6H), 2.46-2.42 (m, 1H), 2.23 (s, 3H), 1.10 (s, 9H); $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 168.6, 143.1, 141.8, 140.3, 132.8, 132.3, 130.3, 127.4, 125.6, 123.4, 114.1, 59.3, 51.2, 43.2, 33.5, 28.3, 22.9,
21.0. HRMS (ESI) m/z: caled for C_{23}H_{31}N_{2}O_{3}S^{+}, 415.2050; found, 415.2048.

\[ \text{N}-(\text{tert-butyl})-2-(1-(\text{naphthalen-1-ylsulfonyl})\text{indolin-2-yl})\text{acetamide} \]

(3r): Yellow solid; mp 158-160 °C. IR (KBr): 3693, 3313, 2972, 1663, 1538, 1350, 1164, 753,
660; \(^1\)H NMR (400 MHz, CDCl\(_3\)) \( \delta \) 8.27 (s, 1H), 7.82 (d, \( J = 8.4 \) Hz, 1H), 7.77-7.68 (m, 3H),
7.56-7.50 (m, 3H), 7.18 (t, \( J = 6.8 \) Hz, 1H), 6.98-6.94 (m, 2H), 5.76 (br. s, 1H), 4.65-4.61 (m, 1H),
2.84-2.69 (m, 3H), 2.56-2.50 (m, 1H), 1.23 (s, 9H); \(^1\)C NMR (100 MHz, CDCl\(_3\)) \( \delta \) 169.0, 141.1,
135.0, 134.4, 132.0, 131.8, 129.3, 128.9, 128.7, 127.8, 127.6, 125.5, 125.0, 122.1, 117.0,
59.7, 51.4, 44.0, 34.1, 28.6. HRMS (ESI) m/z: caled for C_{24}H_{27}N_{2}O_{3}S^{+}, 423.1737; found,
423.1745.

\[ \text{N}-(\text{tert-butyl})-2-(2-(\text{methylsulfonyl})-1,2,3,4-tetrahydroisoquinolin-3-yl)\text{acetamide} \]

(3s): Yellow oil. IR (KBr): 3689, 3316, 2972, 1661, 1538, 1343, 1158, 979, 759;
\(^1\)H NMR (400 MHz, CDCl\(_3\)) \( \delta \) 7.17-7.06 (m, 4H), 5.63 (br. s, 1H), 4.60 (d, \( J = 8.4 \) Hz, 1H),
4.38-4.34 (m, 1H), 4.25 (d, \( J = 16.8 \) Hz, 1H), 3.14-3.08 (m, 1H), 2.79-2.74 (m, 1H), 2.64 (s, 3H),
2.45-2.40 (m, 1H), 2.28-2.23 (m, 1H), 1.28 (s, 9H); \(^1\)C NMR (100 MHz, CDCl\(_3\)) \( \delta \) 169.2, 132.9,
132.3, 129.3, 127.6, 126.7, 125.8, 51.4, 50.3, 43.8, 41.2, 38.4, 32.9, 28.7. HRMS (ESI) m/z: caled
for C_{16}H_{23}N_{2}O_{3}S^{+}, 325.1580; found, 325.1584.
**N-(tert-butyl)-2-(2-methyl-1-tosylindolin-2-yl)acetamide (3t):**

Grey solid; mp 89-91 °C. IR (KBr): 3403.9, 2960.3, 2355.7, 1661.8, 1343.0, 1013.2, 577.0; \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.74 (d, \(J = 8.4\) Hz, 2H), 7.31 (d, \(J = 7.6\) Hz, 1H), 7.19 (d, \(J = 7.2\) Hz, 2H), 7.01 (d, \(J = 6.8\) Hz, 2H), 6.85 (t, \(J = 7.2\) Hz, 1H), 5.89 (s, 1H), 3.78 (d, \(J = 16.0\) Hz, 1H), 3.04 (d, \(J = 13.6\) Hz, 1H), 2.89 (d, \(J = 16.4\) Hz, 1H), 2.37 (d, \(J = 13.2\) Hz, 1H), 2.32 (s, 3H), 1.60 (s, 3H), 1.18 (s, 3H), 1.05 (s, 9H); \(^1^3\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 168.8, 143.9, 141.9, 138.4, 129.7, 128.7, 127.4, 126.8, 125.2, 123.1, 113.4, 70.9, 51.2, 49.6, 42.4, 28.2, 27.9, 21.5. HRMS (ESI) m/z: calcd for C\(_{22}\)H\(_{29}\)N\(_2\)O\(_3\)S\(^+\), 401.1893; found, 401.1895.

**N-(tert-butyl)-2-(4,4-diphenyl-1-tosylpyrrolidin-2-yl)acetamide (3u):**

White solid; mp 99-101 °C. IR (KBr): 3387.5, 3057.0, 2968.2, 1663.4, 1532.2, 1339.4, 1159.0, 706.2, 663.2; \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.51 (d, \(J = 8.0\) Hz, 2H), 7.19 (d, \(J = 4.4\) Hz, 4H), 7.11-7.05 (m, 3H), 7.00 (s, 5H), 5.58 (br. s, 1H), 4.32 (d, \(J = 10.8\) Hz, 1H), 4.05-3.97 (m, 1H), 3.73 (d, \(J = 10.4\) Hz, 1H), 2.87-2.76 (m, 2H), 2.57-2.52 (m, 1H), 2.29 (s, 3H), 2.12-2.06 (m, 1H), 1.29 (s, 9H). \(^1^3\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 169.9, 145.5, 144.3, 143.3, 133.6, 129.7, 128.6, 127.3, 126.7, 126.5, 126.2, 59.0, 56.9, 52.3, 51.1, 43.2, 42.7, 28.8, 21.5. HRMS (ESI) m/z: calcd for C\(_{29}\)H\(_{33}\)N\(_2\)O\(_3\)S\(^+\), 491.2363; found, 491.2369.
**N-(tert-butyl)-2-(2-methyl-4,4-diphenyl-1-tosylpyrrolidin-2-yl)acetamide (3v):** White solid; mp 167-168 °C. IR (KBr): 3722.4, 2971.3, 2355.4, 1634.4, 1327.0, 1052.1, 663.6; \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.75 (d, \(J = 8.0\) Hz, 2H), 7.29 – 7.25 (m, 4H), 7.21 (t, \(J = 7.2\) Hz, 2H), 7.14 – 7.09 (m, 4H), 7.03 (s, 2H), 5.49 (s, 1H), 4.15 (d, \(J = 10.0\) Hz, 1H), 3.79 (d, \(J = 10.8\) Hz, 1H), 3.59 (d, \(J = 13.2\) Hz, 1H), 2.77 (d, \(J = 13.6\) Hz, 1H), 2.57 (d, \(J = 13.2\) Hz, 1H), 2.42 (s, 3H), 2.26 (d, \(J = 10.0\) Hz, 1H), 1.35 (s, 3H), 1.30 (s, 9H). \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 169.7, 145.2, 143.2, 137.6, 129.6, 128.6, 128.4, 127.6, 126.9, 126.5, 126.4, 66.9, 56.8, 51.4, 51.2, 49.7, 48.7, 28.6, 27.0, 21.5. HRMS (ESI) m/z: calcd for C\(_{30}\)H\(_{37}\)N\(_2\)O\(_3\)S\(_3\), 505.2519; found, 505.2519.

**N-butyl-2-(2-methyl-4,4-diphenyl-1-tosylpyrrolidin-2-yl)acetamide (3w):** White solid; mp 122-124 °C. IR (KBr): 3382.4, 2930.5, 2356.4, 1645.1, 1329.2, 1154.2, 664.0; \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.74 (d, \(J = 7.6\) Hz, 2H), 7.30 – 7.26 (m, 4H), 7.22 (t, \(J = 7.2\) Hz, 2H), 7.12 (d, \(J = 5.6\) Hz, 4H), 7.05 (d, \(J = 6.8\) Hz, 2H), 5.68 (d, \(J = 4.4\) Hz, 1H), 4.19 (d, \(J = 10.4\) Hz, 1H), 3.74 (d, \(J = 10.0\) Hz, 1H), 3.59 (d, \(J = 13.2\) Hz, 1H), 3.22 – 3.06 (m, 2H), 2.88 (d, \(J = 14.0\) Hz, 1H), 2.57 (d, \(J = 13.2\) Hz, 1H), 2.43 (s, 3H), 2.27 (d, \(J = 13.6\) Hz, 1H), 1.45 – 1.40 (m, 2H), 1.36 (s, 3H), 1.34 – 1.23 (m, 3H), 0.89 (t, \(J = 7.2\) Hz, 3H). \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 170.1, 145.3, 145.1, 143.3, 137.4, 129.6, 128.6, 128.5, 127.6, 126.9, 126.5, 126.4, 126.4, 66.7, 56.6, 51.4, 49.9, 47.6, 39.1, 31.5, 26.9, 21.5, 20.1, 13.8. HRMS (ESI) m/z: calcd for C\(_{30}\)H\(_{37}\)N\(_2\)O\(_3\)S\(_3\), 505.2519; found, 505.2517.
**N-cyclohexyl-2-(2-methyl-4,4-diphenyl-1-tosylpyrrolidin-2-yl)acetamide (3x):**
Brown solid; mp 156-158 °C. IR (KBr): 3709.9, 2929.5, 2355.58, 1672.3, 1150.9, 1052.6, 697.6; 1H NMR (400 MHz, CDCl₃) δ 7.74 (d, J = 7.6 Hz, 2H), 7.31 – 7.21 (m, 6H), 7.16 – 7.12 (m, 4H), 7.04 (d, J = 6.4 Hz, 2H), 5.44 (d, J = 7.6 Hz, 1H), 4.20 (d, J = 10.0 Hz, 1H), 3.73 (d, J = 10.0 Hz, 1H), 3.57 (d, J = 13.2 Hz, 1H), 2.82 (d, J = 14.0 Hz, 1H), 2.55 (d, J = 13.2 Hz, 1H), 2.44 (s, 3H), 2.24 (d, J = 13.6 Hz, 1H), 1.85 (s, 3H), 1.67 – 1.57 (m, 3H), 1.35 (s, 3H), 1.28 (d, J = 15.6 Hz, 2H), 1.18 – 1.05 (m, 3H). 13C NMR (100 MHz, CDCl₃) δ 169.2, 145.3, 145.1, 143.3, 137.5, 129.6, 128.6, 128.5, 127.6, 126.9, 126.5, 126.4, 66.7, 56.7, 51.3, 49.7, 48.3, 47.8, 33.0, 32.9, 27.0, 25.5, 24.9, 24.9, 21.5. HRMS (ESI) m/z: calcd for C₃₂H₃₈N₂NaO₃S⁺, 553.2495; found, 553.2504.

**N-(tert-butyl)-2-(2-tosyl-2-azaspiro[4.5][decan-3-yl]acetamide (3y):**
Yellow oil; IR (KBr): 3381.6, 2927.3, 1654.8, 1540.5, 1157.1, 661.9; 1H NMR (400 MHz, CDCl₃) δ 7.74 (d, J = 7.6 Hz, 1H), 7.33 (d, J = 7.6 Hz, 1H), 6.12 (s, 0H), 3.73 (d, J = 7.6 Hz, 0H), 3.28 (d, J = 10.8 Hz, 1H), 3.09 (d, J = 10.8 Hz, 1H), 2.74 (d, J = 14.0 Hz, 1H), 2.65 – 2.60 (m, 1H), 2.42 (s, 3H), 1.88 – 1.83 (m, 1H), 1.76 – 1.71 (m, 1H), 1.37 (s, 9H), 1.27 – 1.15 (m, 8H), 0.69 – 0.64 (m, 1H), 0.49 – 0.46 (m, 1H). 13C NMR (100 MHz, CDCl₃) δ 169.9, 143.6, 133.7, 129.6, 127.5, 56.7, 51.0, 43.2, 40.7, 36.3, 33.6, 28.7, 25.7, 23.6, 22.6, 21.5. HRMS (ESI) m/z: calcd for C₂₂H₃₈N₂O₃S⁺, 407.2363; found, 407.2361.
\( N\)-(tert-butyl)-2-(4,4-dimethyl-1-tosylpyrrolidin-2-yl)acetamide (3z):

Light yellow solid; mp 118-120 °C. IR (KBr): 3133.0, 2964.5, 2355.6, 1667.7, 1399.9, 1046.3, 661.4; \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.74 (d, \(J = 7.6\) Hz, 2H), 7.33 (d, \(J = 8.0\) Hz, 2H), 6.04 (s, 1H), 3.79 (q, \(J = 7.5\) Hz, 1H), 3.16 (d, \(J = 10.4\) Hz, 1H), 3.08 (d, \(J = 10.4\) Hz, 1H), 2.74 (d, \(J = 14.0\) Hz, 1H), 2.66 – 2.60 (m, 1H), 2.43 (s, 3H), 1.86 – 1.74 (m, 2H), 1.37 (s, 9H), 1.00 (s, 3H), 0.37 (s, 3H). \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 169.8, 143.6, 133.9, 129.7, 127.6, 61.9, 57.42 (s, 3H), 51.1, 45.7, 43.2, 36.8, 28.7, 26.2, 25.5, 21.5. HRMS (ESI) m/z: calcd for C\(_{19}\)H\(_{31}\)N\(_2\)O\(_3\)S\(^+\), 367.2050; found, 367.2045.

\( N\)-butyl-2-(1-tosylindolin-2-yl)acetamide (3za):

Yellow solid; mp 106-108 °C. IR (KBr): 3690, 3304, 2953, 1722, 1551, 1351, 1164, 966, 756, 576; \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.61 (d, \(J = 8.0\) Hz, 1H), 7.50 (d, \(J = 8.0\) Hz, 2H), 7.17-7.11 (m, 3H), 7.09-6.95 (m, 2H), 5.98 (br. s, 1H), 4.55-4.48 (m, 1H), 4.32-3.07 (m, 2H), 2.88-2.69 (m, 3H), 2.54-2.48 (m, 1H), 2.30 (s, 3H), 1.42-1.35 (m, 2H), 1.31-1.20 (m, 2H), 0.86 (t, \(J = 7.2\) Hz, 3H); \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 169.7, 144.2, 141.1, 134.3, 131.8, 129.7, 127.7, 127.1, 125.3, 124.9, 117.2, 59.5, 43.2, 39.3, 34.3, 31.5, 21.5, 20.1, 13.7. HRMS (ESI) m/z: calcd for C\(_{21}\)H\(_{26}\)N\(_2\)NaO\(_3\)S\(^+\), 409.1556; found, 409.1565.
2-(1-tosylindolin-2-yl)-N-(2,4,4-trimethylpentan-2-yl)acetamide (3zb): Green solid; mp 130-132 °C. IR (KBr): 3694, 3311, 2956, 1665, 1540, 1353, 1164, 754, 665; \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.61 (d, \(J = 8.0\) Hz, 1H), 7.50 (d, \(J = 8.0\) Hz, 2H), 7.17-6.11 (m, 3H), 6.99-6.95 (m, 2H), 5.63 (br. s, 1H), 4.52-4.48 (m, 1H), 2.89-2.83 (m, 1H), 2.74-2.68 (m, 2H), 2.50-2.44 (m, 1H), 2.30 (s, 3H), 1.71 (d, \(J = 14.8\) Hz, 1H), 1.57 (d, \(J = 14.8\) Hz, 1H), 1.27 (d, \(J = 5.6\) Hz, 6H), 0.96 (s, 9H); \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 168.8, 144.1, 141.2, 134.3, 131.9, 129.7, 127.7, 127.1, 125.4, 124.9, 117.1, 59.5, 55.3, 51.6, 44.3, 34.2, 31.6, 31.5, 29.1, 28.9, 21.5. HRMS (ESI) m/z: calcd for C\(_{25}\)H\(_{35}\)N\(_2\)O\(_3\)S\(_3\)+, 443.2363; found, 443.2371.

N-cyclohexyl-2-(1-tosylindolin-2-yl)acetamide (3zc): Yellow solid; mp 173-175 °C. IR (KBr): 3692, 3299, 2931, 2855, 1544, 1351, 1165, 1096, 754; \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.59 (d, \(J = 8.0\) Hz, 1H), 7.49 (d, \(J = 7.6\) Hz, 2H), 7.15-7.10 (m, 3H), 6.97-6.94 (m, 2H), 5.88 (br. s, 1H), 4.52-4.48 (m, 1H), 3.69-3.61 (m, 1H), 2.87-2.80 (m, 1H), 2.75-2.69 (m, 2H), 2.53-2.47 (m, 1H), 2.29 (s, 3H), 1.86 (d, \(J = 8.8\) Hz, 1H), 1.67-1.51 (m, 4H), 1.32-1.21 (m, 2H), 1.13-0.90 (m, 3H); \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 168.7, 144.2, 141.1, 134.3, 131.8, 129.7, 127.7, 127.1, 125.3, 124.9, 117.2, 59.5, 48.3, 43.3, 34.2, 32.9, 25.5, 24.9, 21.5. HRMS (ESI) m/z: calcd for C\(_{24}\)H\(_{28}\)N\(_2\)NaO\(_3\)S\(_3\)+, 435.1713; found, 435.1722.
2-(1-(methylsulfonyl)indolin-2-yl)-N-(2,4,4-trimethylpentan-2-yl)acetamide (3zd): Yellow solid; mp 99-101 °C. IR (KBr): 3684, 3328, 2955, 1661, 1538, 1346, 1159, 979, 758; ^1H NMR (400 MHz, CDCl$_3$) $\delta$ 7.36 (d, $J = 8.0$ Hz, 1H), 7.12 (t, $J = 7.2$ Hz, 2H), 7.00 (t, $J = 7.6$ Hz, 1H), 5.62 (br. s, 1H), 4.59-4.53 (m, 1H), 2.99-2.94 (m, 1H), 2.76 (s, 2H), 2.74-2.69 (m, 1H), 2.49-2.43 (m, 1H), 1.62 (q, $J_1 = J_2 = 14.8$ Hz, 2H), 1.25 (d, $J = 6.4$ Hz, 6H), 0.93 (s, 9H); ^13C NMR (100 MHz, CDCl$_3$) δ 168.7, 141.1, 131.0, 128.0, 125.6, 124.7, 115.5, 59.9, 55.3, 51.5, 44.5, 35.3, 34.6, 31.6, 31.4, 29.1, 28.9. HRMS (ESI) m/z: calcd for C$_{19}$H$_{31}$N$_2$O$_3$S, 367.2050; found, 367.2058.

2-(1-tosylindolin-2-yl)acetonitrile (4a):
Yellow oil. IR (KBr): 2923.8, 2249.7, 1472.1, 1353.3, 1165.8, 1097.5, 756.1, 666.6; ^1H NMR (400 MHz, CDCl$_3$) $\delta$ 7.67 (d, $J = 8.4$ Hz, 1H), 7.56 (d, $J = 7.6$ Hz, 2H), 7.26 (s, 1H), 7.20 (d, $J = 8.0$ Hz, 2H), 7.09-7.06 (m, 2H), 4.48-4.44 (m, 1H), 3.07-2.97 (m, 2H), 2.84-2.74 (m, 2H), 2.37 (s, 3H). ^13C NMR (100 MHz, CDCl$_3$) δ 144.6, 140.5, 134.2, 129.9, 129.8, 128.4, 127.1, 125.4, 125.3, 117.0, 116.7, 58.0, 33.9, 25.5, 21.6. HRMS (ESI) m/z: calcd for C$_{17}$H$_{16}$N$_2$O$_2$S$^+$, 335.0825; found, 335.0830.

2-(5-methoxy-1-tosylindolin-2-yl)acetonitrile (4b):
Yellow oil. IR (KBr): 2932.7, 2250.6, 1601.9, 1485.4, 1353.3, 1166.6, 1033.9, 750.3, 669.3; ^1H
NMR (400 MHz, CDCl$_3$) $\delta$ 7.55 (d, $J = 8.8$ Hz, 1H), 7.49 (d, $J = 8.0$ Hz, 2H), 7.17 (d, $J = 7.6$ Hz, 2H), 6.77 (d, $J = 8.8$ Hz, 1H), 6.61 (s, 1H), 4.44-4.40 (m, 1H), 3.74 (s, 3H), 2.91-2.84 (m, 2H), 2.76-2.66 (m, 2H), 2.35 (s, 3H). $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 157.9, 144.5, 133.9, 133.7, 131.9, 129.8, 127.1, 118.4, 116.7, 113.7, 110.9, 58.4, 55.6, 34.0, 25.3, 21.6. HRMS (ESI) m/z: calcd for C$_{18}$H$_{18}$N$_2$NaO$_3$S$^+$, 365.0930; found, 365.0936.

**2-(5-isopropyl-1-tosylindolin-2-yl)acetonitrile (4c):**

Yellow solid; mp 50-52 °C. IR (KBr): 2959.4, 2250.7, 1486.0, 1354.1, 1165.6, 752.0, 667.4, 587.1; $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.53 (d, $J = 8.0$ Hz, 3H), 7.17 (d, $J = 8.0$ Hz, 2H), 7.17 (d, $J = 7.6$ Hz, 2H), 7.07 (d, $J = 8.4$ Hz, 1H), 6.92 (s, 1H), 4.43-4.39 (m, 1H), 3.00-2.92 (m, 2H), 2.86-2.70 (m, 3H), 2.34 (s, 3H). $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 146.3, 144.5, 138.3, 134.2, 129.8, 129.8, 127.1, 126.5, 123.3, 116.8, 58.2, 34.0, 33.7, 25.4, 24.1, 24.0, 21.6. HRMS (ESI) m/z: calcd for C$_{20}$H$_{22}$N$_2$NaO$_2$S$^+$, 377.1294; found, 377.1298.

**2-(5-fluoro-1-tosylindolin-2-yl)acetonitrile (4d):**

Yellow oil. IR (KBr): 2923.6, 2250.8, 1481.6, 1354.9, 1167.0, 753.0; $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.60-7.57 (m, 1H), 7.50 (d, $J = 7.2$ Hz, 2H), 7.18 (d, $J = 7.6$ Hz, 2H), 6.92 (d, $J = 8.8$ Hz, 1H), 6.76 (d, $J = 8.0$ Hz, 1H), 4.46-4.42 (m, 1H), 2.97-2.88 (m, 2H), 2.79-2.71 (m, 2H), 2.34 (s, 3H). $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 160.6 (d, $J = 242.9$ Hz), 144.8, 136.6, 133.8, 132.2 (d, $J = 8.8$ Hz), 130.0, 127.1, 118.3 (d, $J = 8.7$ Hz), 116.5, 115.2 (d, $J = 23.5$ Hz), 112.6 (d, $J = 24.2$ Hz). HRMS (ESI) m/z:
calcd for C$_{17}$H$_{16}$FN$_2$O$_2$S$^+$, 331.0911; found, 331.0909.

2-(1-((4-(trifluoromethyl)phenyl)sulfonyl)indolin-2-yl)acetonitrile (4e):

Yellow oil. IR (KBr): 2924.4, 2249.1, 1323.3, 1170.0, 841, 3, 752.8; $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.75 (d, $J$ = 7.6 Hz, 2H), 7.61 (d, $J$ = 8.4 Hz, 3H), 7.23-7.19 (m, 1H), 7.05-7.00 (m, 1H), 4.40 (s, 1H), 3.02-2.88 (m, 2H), 2.80-2.70 (m, 1H); $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 140.7, 139.8, 135.2 (q, $J$ = 33.1 Hz), 129.6, 128.7, 127.6, 126.4 (q, $J$ = 3.4 Hz), 125.9, 125.7, 123.0 (q, $J$ = 271.3 Hz), 116.8, 116.3, 58.2, 33.9, 25.5. HRMS (ESI) m/z: calcd for C$_{17}$H$_{13}$F$_3$N$_2$NaO$_2$S$^+$, 389.0542; found, 389.0543.

2-methyl-1-tosyl-1H-indole (5):

Brown oil; IR (KBr): 2970.6, 2359.1, 1632.4, 1173.8, 1053.1, 696.2; $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 8.07 (d, $J$ = 7.6 Hz, 1H), 7.58 (d, $J$ = 6.4 Hz, 2H), 7.31 (d, $J$ = 6.0 Hz, 1H), 7.14 (d, $J$ = 22.0 Hz, 4H), 6.25 (s, 1H), 2.52 (s, 3H), 2.25 (s, 3H); $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 144.7, 137.4, 136.4, 129.9, 126.3, 123.7, 123.4, 120.0, 114.5, 109.6, 21.5, 15.7. LR-MS (EI, 70 eV): m/z = 285, 207, 155, 132.

2-(indolin-2-yl)acetamide (6): Brown oil; IR (KBr): 3443.1, 2964.9,
2356.8, 1665.8, 1116.6, 752.8; \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.05 (d, \(J = 7.2\) Hz, 1H), 7.00 (t, \(J = 7.6\) Hz, 1H), 6.69 (t, \(J = 7.2\) Hz, 1H), 6.60 (d, \(J = 7.6\) Hz, 1H), 5.85 (d, \(J = 56.8\) Hz, 2H), 4.265 – 4.19 (m, 1H), 3.16 (dd, \(J = 15.6, 8.4\) Hz, 1H), 2.68 (dd, \(J = 15.3, 7.8\) Hz, 1H), 2.52 – 2.45 (m, 2H);

\(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 173.9, 150.4, 128.2, 127.5, 124.7, 119.0, 109.6, 56.2, 41.6, 35.7.

HRMS (ESI) m/z: calecd for C\(_{10}\)H\(_{13}\)N\(_2\)O\(_1\)^+, 177.1022; found, 177.1026.

(E)-N-(tert-butyl)-4-(2-(4-methylphenylsulfonamido)phenyl)but-3-enamide (7): To a stirred solution of 3a (38.6 mg, 0.1 mmol) in EtOH (2.0 mL) was added KOH (15.1 mg, 268.1 umol). The reaction proceeded at a reflux for 4h before EtOH was removed by rotary evaporation. The remained mixture was extracted with EtOAc, the combined organic layers were washed with H\(_2\)O and brine and dried over anhydrous Na\(_2\)SO\(_4\), evaporated in a vacuo. The residue was purified by column chromatography on a silica gel PE/EtOAc to provide 7 in 95 % yield as a yellow oil: IR (KBr): 3133.1, 2357.5, 1649.9, 1401.2, 1051.6, 664.8; \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.61 – 7.58 (m, 3H), 7.34 (d, \(J = 7.2\) Hz, 1H), 7.17 (d, \(J = 8.0\) Hz, 2H), 7.11 – 7.05 (m, 2H), 7.02 (d, \(J = 7.2\) Hz, 1H), 6.56 (d, \(J = 16.0\) Hz, 1H), 6.07 – 6.00 (m, 1H), 5.80 (s, 1H), 2.96 (d, \(J = 7.6\) Hz, 2H), 2.34 (s, 3H), 1.29 (s, 9H); \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 170.3, 143.7, 136.5, 133.3, 133.2, 129.6, 129.4, 128.1, 127.3, 127.0, 126.7, 126.3, 125.6, 51.4, 42.1, 28.7, 21.5. HRMS (ESI) m/z: calecd for C\(_{21}\)H\(_{27}\)N\(_2\)O\(_3\)S\(^+\), 387.1737; found, 387.1734.
NMR Spectra for Compounds 3a-3zd, 4a-4e, 5-7

\[N-(\text{tert-butyl})-2-(\text{tosylindolin-2-yl})\text{acetamide (3a)}\]
N-(tert-butyl)-2-(5-methyl-1-tosylindolin-2-yl)acetamide (3b)
$N$-(tert-butyl)-2-(5-methoxy-1-tosylindolin-2-yl)acetamide (3c)
N-(tert-butyl)-2-(5-isopropyl-1-tosylindolin-2-yl)acetamide (3d)
\(N-(\text{tert-butyl})-2-\text{(5-fluoro-1-tosylindolin-2-yl)acetamide (3e)}\)
$N$-(tert-butyl)-2-(5-chloro-1-tosylindolin-2-yl)acetamide (3f)
2-(5-bromo-1-tosyl-2,3-dihydro-1H-inden-2-yl)-N-(tert-butyl)acetamide (3g)
N-(tert-butyl)-2-(5-cyano-1-tosylindolin-2-yl)acetamide (3h)
\[ \text{N-([\text{tert-butyl}]2-(7-fluoro-1-tosylindolin-2-yl)acetamide (3i)} \]
\[ N-(\text{tert-butyl})-2-(6\text{-fluoro-1-tosylindolin-2-yl})\text{acetamide (3j)} \]
$N$-(tert-buty)-2-(1-(methylsulfonyl)indolin-2-yl)acetamide (3k)
2-(1-acetyindolin-2-yl)-N-(tert-butyl)acetamide (3l)
2-(1-benzoylindolin-2-yl)-N-(tert-butyl)acetamide (3m)
tert-butyl 2-(2-(tert-butylamino)-2-oxoethyl)indoline-1-carboxylate (3n)
N-(tert-butyl)-2-(1-((4-methoxyphenyl)sulfonyl)indolin-2-yl)acetamide (3o)
\[ N-(\text{tert}-\text{butyl})-2-(1-(4-(\text{trifluoromethyl})\text{phenyl})\text{indolin-2-yl})\text{acetamide (3p)}} \]
$N$-(tert-butyl)-2-(1-(mesitylsulfonyl)indolin-2-yl)acetamide (3q)
N-(tert-butyl)-2-(1-(naphthalen-1-ylsulfonyl)indolin-2-yl)acetamide (3r)
$N$-(tert-butyl)-2-(2-(methylsulfonyl)-1,2,3,4-tetrahydroisoquinolin-3-yl)acetamide (3s)
$N$-(tert-butyl)-2-(2-methyl-1-tosylindolin-2-yl)acetamide (3t)
$N$-(tert-butyl)-2-(4,4-diphenyl-1-tosylpyrrolidin-2-yl)acetamide (3u)
N-(tert-butyl)-2-(2-methyl-4,4-diphenyl-1-tosylpyrrolidin-2-yl)acetamide (3v)
N-butyl-2-(2-methyl-4,4-diphenyl-1-tosylpyrrolidin-2-yl)acetamide (3w)
$N$-cyclohexyl-2-(2-methyl-4,4-diphenyl-1-tosylpyrrolidin-2-yl)acetamide (3x)
$N$-(tert-butyl)-2-(2-tosyl-2-azaspiro[4.5]decan-3-yl)acetamide (3y)
N-(tert-butyl)-2-(4,4-dimethyl-1-tosylpyrrolidin-2-yl)acetamide (3z)
N-butyl-2-(1-tosylindolin-2-yl)acetamide (3za)
2-(1-tosylindolin-2-yl)-N-(2,4,4-trimethylpentan-2-yl)acetamide (3zb)
N-cyclohexyl-2-(1-tosylindolin-2-yl)acetamide (3zc)
2-(1-(methylsulfonyl)indolin-2-yl)-N-(2,4,4-trimethylpentan-2-yl)acetamide (3zd)
2-(1-tosylindolin-2-yl)acetonitrile (4a)
2-(5-methoxy-1-tosylindolin-2-yl)acetonitrile (4b)
2-(5-isopropyl-1-tosylindolin-2-yl)acetonitrile (4c)
2-(5-fluoro-1-tosylindolin-2-yl)acetonitrile (4d)
2-(1-((4-(trifluoromethyl)phenyl)sulfonyl)indolin-2-yl)acetonitrile (4e)
2-methyl-1-tosyl-1H-indole (5)
2-(indolin-2-yl)acetamide (6)
(E)-N-(tert-butyl)-4-(2-(4-methylphenylsulfonamido)phenyl)but-3-enamide (7)
NOE Spectra for Compound (E)-N-(tert-butyl)-4-(2-(4-methylphenylsulfonamido)phenyl)but-3-enamide (7)
MS Spectra for Compounds 3a and 3a-$^{18}$O

MS Spectra for Compounds 3a:

Chemical Formula: C$_{21}$H$_{26}$N$_2$O$_3$S
Exact Mass: 386.1664

MS Spectra for Compounds 3a-$^{18}$O:
Chemical Formula: $\text{C}_{21}\text{H}_{26}\text{N}_{2}\text{O}_{2}^{16}\text{O}$

Exact Mass: 388.1707