Intramolecular oxysulfonylation of alkenes with the insertion of sulfur dioxide under photocatalysis

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Supporting Information

1. General experimental methods (S2).
2. General experimental procedure and characterization data (S2-S10).
3. 1H and 13C NMR spectra of compounds 3, 5 and 7 (S11-S50).
General experimental methods:

Unless otherwise stated, all commercial reagents were used as received. All solvents were dried and distilled according to standard procedures. Flash column chromatography was performed using silica gel (60-Å pore size, 32–63μm, standard grade). Analytical thin–layer chromatography was performed using glass plates pre-coated with 0.25 mm 230–400 mesh silica gel impregnated with a fluorescent indicator (254 nm). Thin layer chromatography plates were visualized by exposure to ultraviolet light. Organic solutions were concentrated on rotary evaporators at ~20 Torr at 25–35°C. Nuclear magnetic resonance (NMR) spectra are recorded in parts per million from internal tetramethylsilane on the δ scale. 1H and 13C NMR spectra were recorded in CDCl3 on a Bruker DRX-400 spectrometer operating at 400 MHz and 100 MHz, respectively. All chemical shift values are quoted in ppm and coupling constants quoted in Hz. High resolution mass spectrometry (HRMS) spectra were obtained on a micrOTOF II Instrument.

General experimental procedure for the reaction of alkenols 1, (DABCO)-{SO2}2, and aryl diazonium tetrafluoroborates 2.

Alkenol 1 (0.2 mmol) was added to a mixture of aryl diazonium tetrafluoroborate 2 (0.3 mmol), DABCO-{SO2}2 (0.4 mmol) and Ir(ppy)3 (2 mol %) in acetonitrile (2.5 mL) under N2 atmosphere. The mixture was stirred under white LED irradiation (35 W) for 12 h. After completion of reaction as indicated by TLC, the solvent was evaporated and the residue was purified directly by flash column chromatography (n-hexane/ethyl acetate = 8:1) to give the corresponding product 3.
2-(((4-Fluorophenyl)sulfonyl)methyl)-2-phenyltetrahydrofuran (3a)

$^1$H NMR (400 MHz, CDCl$_3$): $\delta$ 7.79-7.70 (m, 2H), 7.32-7.16 (m, 5H), 7.11-7.05 (m, 2H), 3.98-3.90 (m, 1H), 3.85 (td, $J = 8.1$, 5.7 Hz, 1H), 3.75-3.64 (m, 2H), 2.72 (dt, $J = 12.5$, 8.2 Hz, 1H), 2.29 (ddd, $J = 12.6$, 7.7, 5.0 Hz, 1H), 2.10-1.99 (m, 1H), 1.84-1.71 (m, 1H); $^{13}$C NMR (100 MHz, CDCl$_3$): $\delta$ 165.4 (d, $^1$J$_{CF} = 255.4$ Hz), 144.0, 137.2, 130.7 (d, $^3$J$_{CF} = 9.5$ Hz), 128.3, 127.3, 125.1, 115.9 (d, $^2$J$_{CF} = 22.6$ Hz), 83.8, 68.1, 65.5, 37.4, 25.1; $^{19}$F NMR (376 MHz, CDCl$_3$): $\delta$ -104.5-104.6 (m, 1F); HRMS (ESI) calcd for C$_{17}$H$_{18}$FO$_3$S$^+$ (M+H$^+$): 321.0955, found: 321.0957.

![Chemical structure of 2-(((4-Fluorophenyl)sulfonyl)methyl)-2-phenyltetrahydrofuran (3a)](image)

2-Phenyl-2-((tosylmethyl)tetrahydrofuran (3b)

$^1$H NMR (400 MHz, CDCl$_3$): $\delta$ 7.64 (d, $J = 8.3$ Hz, 2H), 7.33-7.14 (m, 7H), 3.95 (dd, $J = 15.0$, 7.5 Hz, 1H), 3.84 (td, $J = 8.0$, 5.5 Hz, 1H), 3.69-3.59 (m, 2H), 2.80 (dt, $J = 12.6$, 8.2 Hz, 1H), 2.40 (s, 3H), 2.30 (ddd, $J = 12.5$, 7.7, 4.9 Hz, 1H), 2.10-1.99 (m, 1H), 1.83-1.70 (m, 1H); $^{13}$C NMR (100 MHz, CDCl$_3$): $\delta$ 144.6, 144.0, 138.5, 129.4, 128.3, 127.8, 127.2, 125.2, 84.0, 68.1, 65.5, 36.9, 25.2, 21.6; HRMS (ESI) calcd for C$_{18}$H$_{21}$O$_3$S$^+$ (M+H$^+$): 317.1206, found: 317.1209.

![Chemical structure of 2-Phenyl-2-((tosylmethyl)tetrahydrofuran (3b)](image)

2-Phenyl-2-((phenylsulfonyl)methyl)tetrahydrofuran (3c)

$^1$H NMR (400 MHz, CDCl$_3$): $\delta$ 7.80-7.72 (m, 2H), 7.55 (t, $J = 7.2$, 1.1 Hz, 1H), 7.43 (td, $J = 8.0$, 1.4 Hz, 2H), 7.34-7.15 (m, 4H), 3.98-3.91 (m, 1H), 3.87-3.80 (m, 1H), 3.74-3.63 (m, 2H), 2.85-2.74 (m, 1H), 2.34-2.27 (m, 1H), 2.12-1.99 (m, 1H), 1.84-1.70 (m, 1H); $^{13}$C NMR (100 MHz, CDCl$_3$): $\delta$ 144.4, 141.3, 133.1, 128.8, 128.3, 127.8, 127.3,
125.2, 83.9, 68.1, 65.4, 37.0, 25.2; HRMS (ESI) calcd for C$_{17}$H$_{19}$O$_3$S$^+$ (M+H$^+$): 303.1049, found: 303.1057.

2-(((4-Methoxyphenyl)sulfonyl)methyl)-2-phenyltetrahydrofuran (3d)

$^1$H NMR (400 MHz, CDCl$_3$): $\delta$ 7.67 (d, $J$ = 8.8 Hz, 2H), 7.32-7.22 (m, 4H), 7.21-7.18 (m, 1H), 6.88 (d, $J$ = 8.8 Hz, 2H), 4.00-3.93 (m, 1H), 3.89-3.80 (m, 4H), 3.70-3.60 (m, 2H), 2.78 (dt, $J$ = 12.5, 8.2 Hz, 1H), 2.29 (ddd, $J$ = 12.6, 7.7, 4.9 Hz, 1H), 2.11-1.99 (m, 1H), 1.83-1.70 (m, 1H); $^{13}$C NMR (100 MHz, CDCl$_3$): $\delta$ 163.3, 144.5, 133.0, 130.0, 128.3, 127.2, 125.2, 114.0, 84.0, 68.1, 65.6, 55.6, 37.0, 25.2; HRMS (ESI) calcd for C$_{18}$H$_{21}$O$_4$S$^+$ (M+H$^+$): 333.1155, found: 333.1165.

2-Phenyl-2-(((m-tolylsulfonyl)methyl)tetrahydrofuran (3e)

$^1$H NMR (400 MHz, CDCl$_3$): $\delta$ 7.61-7.52 (m, 1H), 7.49 (s, 1H), 7.37-7.13 (m, 7H), 3.98 (dd, $J$ = 15.0, 7.5 Hz, 1H), 3.85 (td, $J$ = 8.1, 5.5 Hz, 1H), 3.72-3.61 (m, 2H), 2.78 (dt, $J$ = 12.6, 8.2 Hz, 1H), 2.35 (s, 3H), 2.34-2.26 (m, 1H), 2.12-2.00 (m, 1H), 1.84-1.71 (m, 1H); $^{13}$C NMR (100 MHz, CDCl$_3$): $\delta$ 144.3, 141.1, 139.0, 133.9, 128.7, 128.2, 128.2, 127.3, 125.2, 124.9, 84.0, 68.1, 65.5, 37.0, 25.2, 21.2; HRMS (ESI) calcd for C$_{18}$H$_{21}$O$_3$S$^+$ (M+H$^+$): 317.1206, found: 317.1221.

2-(((4-Bromophenyl)sulfonyl)methyl)-2-phenyltetrahydrofuran (3f)
$^1$H NMR (400 MHz, CDCl$_3$): δ 7.62-7.51 (m, 4H), 7.30-7.17 (m, 5H), 3.94 (dd, $J = 15.2$, 7.4 Hz, 1H), 3.85 (td, $J = 8.1$, 5.5 Hz, 1H), 3.74-3.64 (m, 2H), 2.71 (dt, $J = 12.5$, 8.2 Hz, 1H), 2.28 (ddd, $J = 12.6$, 7.7, 4.9 Hz, 1H), 2.09-1.98 (m, 1H), 1.84-1.70 (m, 1H).

$^{13}$C NMR (100 MHz, CDCl$_3$): δ 144.0, 140.2, 132.0, 129.5, 128.3, 127.3, 125.1, 83.8, 68.2, 65.5, 37.5, 25.1; HRMS (ESI) calcd for C$_{17}$H$_{18}$BrO$_3$S$^+$ (M+H$^+$): 381.0155, found: 381.0154.

![Ethyl 4-(((2-phenyltetrahydrofuran-2-yl)methyl)sulfonyl)benzoate (3g)](image)

Ethyl 4-(((2-phenyltetrahydrofuran-2-yl)methyl)sulfonyl)benzoate (3g)

$^1$H NMR (400 MHz, CDCl$_3$): δ 8.09 (d, $J = 8.5$ Hz, 2H), 7.81 (d, $J = 8.5$ Hz, 2H), 7.26-7.17 (m, 5H), 4.42 (q, $J = 7.1$ Hz, 2H), 3.90 (dd, $J = 15.2$, 7.4 Hz, 1H), 3.82 (td, $J = 8.1$, 5.5 Hz, 1H), 3.77-3.67 (m, 2H), 2.75 (dt, $J = 12.5$, 8.2 Hz, 1H), 2.30 (ddd, $J = 12.5$, 7.7, 4.8 Hz, 1H), 2.09-1.98 (m, 1H), 1.83-1.70 (m, 1H), 1.42 (t, $J = 7.1$ Hz, 3H); $^{13}$C NMR (100 MHz, CDCl$_3$): δ 165.2, 145.0, 144.1, 134.5, 129.8, 128.3, 127.9, 127.4, 125.1, 83.8, 68.2, 65.3, 61.7, 37.3, 25.1, 14.3; HRMS (ESI) calcd for C$_{20}$H$_{23}$O$_5$S$^+$ (M+H$^+$): 375.1261, found: 375.1267.

![Methyl 3-(((2-phenyltetrahydrofuran-2-yl)methyl)sulfonyl)benzoate (3h)](image)

Methyl 3-(((2-phenyltetrahydrofuran-2-yl)methyl)sulfonyl)benzoate (3h)

$^1$H NMR (400 MHz, CDCl$_3$): δ 8.39-8.34 (m, 1H), 8.23-8.17 (m, 1H), 7.94-7.87 (m, 1H), 7.51 (t, $J = 7.8$ Hz, 1H), 7.28-7.12 (m, 5H), 4.01-3.88 (m, 4H), 3.83 (td, $J = 8.1$, 5.6 Hz, 1H), 3.78-3.68 (m, 2H), 2.74 (dt, $J = 12.5$, 8.2 Hz, 1H), 2.30 (ddd, $J = 12.6$, 7.7, 4.9 Hz, 1H), 2.11-2.00 (m, 1H), 1.83-1.71 (m, 1H); $^{13}$C NMR (100 MHz, CDCl$_3$): δ 165.4, 143.9, 141.8, 133.9, 131.9, 131.0, 129.2, 129.0, 128.3, 127.3, 125.1, 83.8, 68.2, 65.4, 52.5, 37.4, 25.1; HRMS (ESI) calcd for C$_{19}$H$_{21}$O$_5$S$^+$ (M+H$^+$): 361.1104, found: 361.1118.
2-(((3-Chlorophenyl)sulfonyl)methyl)-2-phenyltetrahydrofuran (3i)

$^1$H NMR (400 MHz, CDCl$_3$): $\delta$ 7.66-7.60 (m, 2H), 7.51-7.47 (m, 1H), 7.36 (t, $J = 7.9$ Hz, 1H), 7.28-7.17 (m, 5H), 3.96 (dd, $J = 15.1$, 7.4 Hz, 1H), 3.86 (td, $J = 8.1$, 5.6 Hz, 1H), 3.76-3.65 (m, 2H), 2.70 (dt, $J = 12.4$, 8.2 Hz, 1H), 2.31 (ddd, $J = 12.6$, 7.7, 5.0 Hz, 1H), 2.11-1.99 (m, 1H), 1.85-1.72 (m, 1H); $^{13}$C NMR (100 MHz, CDCl$_3$): $\delta$ 143.7, 142.8, 134.9, 133.2, 130.1, 128.3, 128.1, 127.5, 126.0, 125.2, 83.8, 68.2, 65.6, 37.5, 25.1; HRMS (ESI) calcd for C$_{17}$H$_{18}$ClO$_3$S$^+$ (M+H$^+$): 337.0660, found: 337.0665.

2-(((2-Chlorophenyl)sulfonyl)methyl)-2-phenyltetrahydrofuran (3j)

$^1$H NMR (400 MHz, CDCl$_3$): $\delta$ 7.87-7.84 (m, 1H), 7.47-7.39 (m, 2H), 7.33-7.24 (m, 3H), 7.20 (t, $J = 7.4$ Hz, 2H), 7.16-7.11 (m, 1H), 4.08 (d, $J = 14.9$ Hz, 1H), 3.93 (d, $J = 14.9$ Hz, 1H), 3.86-3.74 (m, 2H), 2.70 (dt, $J = 12.5$, 8.1 Hz, 1H), 2.31 (ddd, $J = 12.7$, 7.7, 5.2 Hz, 1H), 2.08-1.95 (m, 1H), 1.82-1.69 (m, 1H); $^{13}$C NMR (100 MHz, CDCl$_3$): $\delta$ 143.7, 138.4, 134.1, 132.3, 131.4, 131.2, 128.2, 127.4, 127.0, 125.2, 83.7, 68.1, 63.3, 37.4, 25.1; HRMS (ESI) calcd for C$_{17}$H$_{18}$ClO$_3$S$^+$ (M+H$^+$): 337.0660, found: 337.0669.

2-((Naphthalen-1-ylsulfonyl)methyl)-2-phenyltetrahydrofuran (3k)

$^1$H NMR (400 MHz, CDCl$_3$): $\delta$ 8.61 (d, $J = 8.6$ Hz, 1H), 8.08 (d, $J = 7.4$ Hz, 1H), 8.01 (d, $J = 8.1$ Hz, 1H), 7.90 (d, $J = 7.7$ Hz, 1H), 7.65 (t, $J = 7.7$ Hz, 1H), 7.57 (t, $J = 7.5$ Hz, 1H),
7.45 (t, J = 7.8 Hz, 1H), 7.24-7.18 (m, 2H), 7.17-7.07 (m, 3H), 4.00-3.78 (m, 4H), 2.78 (dt, J = 12.5, 8.1 Hz, 1H), 2.34 (ddd, J = 12.6, 7.7, 5.1 Hz, 1H), 2.12-2.01 (m, 1H), 1.85 - 1.72 (m, 1H); 13C NMR (100 MHz, CDCl3): δ 143.9, 136.0, 134.7, 134.0, 130.2, 129.2, 128.6, 128.5, 128.0, 127.2, 126.7, 125.2, 124.3, 124.0, 84.1, 68.1, 65.0, 37.3, 25.2; HRMS (ESI) calcd for C21H21O3S (M+H+): 353.1206, found: 353.1218.

![Chemical Structure](image)

2-(Thiophen-2-yl)-2-(tosylmethyl)tetrahydrofuran (3I)

1H NMR (400 MHz, CDCl3): δ 7.66 (d, J = 8.3 Hz, 2H), 7.28-7.21 (m, 2H), 7.13 (dd, J = 4.7, 1.4 Hz, 1H), 6.87-6.83 (m, 2H), 3.95-3.84 (m, 2H), 3.77-3.68 (m, 2H), 2.81 (dt, J = 12.7, 8.6 Hz, 1H), 2.47-2.42 (m, 1H), 2.41 (s, 3H), 2.14-2.03 (m, 1H), 2.00-1.88 (m, 1H);

13C NMR (100 MHz, CDCl3): δ 149.5, 144.1, 138.2, 129.5, 127.8, 126.9, 124.9, 123.7, 82.4, 68.2, 65.7, 37.4, 25.6, 21.6; HRMS (ESI) calcd for C16H19O3S2 (M+H+): 323.0770, found: 323.0787.

![Chemical Structure](image)

2-(p-Tolyl)-2-(tosylmethyl)tetrahydrofuran (3m)

1H NMR (400 MHz, CDCl3): δ 7.62 (dd, J = 8.2, 1.5 Hz, 2H), 7.27-7.15 (m, 4H), 7.04 (d, J = 7.2 Hz, 2H), 3.97-3.90 (m, 1H), 3.85-3.79 (m, 1H), 3.69-3.59 (m, 2H), 2.82-2.69 (m, 1H), 2.40 (s, 3H), 2.38-2.20 (m, 4H), 2.10-1.98 (m, 1H), 1.83-1.70 (m, 1H); 13C NMR (100 MHz, CDCl3): δ 143.9, 141.4, 138.5, 136.9, 129.4, 128.9, 127.8, 125.2, 83.9, 68.0, 65.6, 36.8, 25.2, 21.6, 21.0; HRMS (ESI) calcd for C19H23O3S (M+H+): 331.1362, found: 331.1360.
2-(4-Methoxyphenyl)-2-(tosylmethyl)tetrahydrofuran (3n)

\[ \text{H NMR (400 MHz, CDCl}_3\text{): } \delta 7.61 (d, J = 8.2 \text{ Hz}, 2H), 7.21 (t, J = 8.0 \text{ Hz}, 4H), 6.75 (d, J = 8.7 \text{ Hz}, 2H), 3.96-3.89 (m, 1H), 3.81 (td, J = 8.1, 5.5 \text{ Hz}, 1H), 3.77 (s, 3H), 3.67-3.58 (m, 2H), 2.73 (dt, J = 12.5, 8.3 \text{ Hz}, 1H), 2.40 (s, 3H), 2.30 (ddd, J = 12.5, 7.7, 4.8 \text{ Hz}, 1H), 2.09-1.99 (m, 1H), 1.83-1.71 (m, 1H); \]
\[ \text{C NMR (100 MHz, CDCl}_3\text{): } \delta 158.8, 143.9, 138.4, 136.2, 129.4, 127.8, 126.5, 113.5, 83.7, 67.9, 65.7, 55.2, 36.8, 25.2, 21.5; \]
\[ \text{HRMS (ESI) calcd for } C_{19}H_{23}O_4S+ (M+H^+): 347.1312, \text{ found: 347.1316.} \]

2-(3-Methoxyphenyl)-2-(tosylmethyl)tetrahydrofuran (3o)

\[ \text{H NMR (400 MHz, CDCl}_3\text{): } \delta 7.64 (d, J = 8.2 \text{ Hz}, 2H), 7.22 (d, J = 8.1 \text{ Hz}, 2H), 7.16 (t, J = 7.9 \text{ Hz}, 1H), 6.84 (t, J = 4.9 \text{ Hz}, 2H), 6.72 (dd, J = 8.0, 1.9 \text{ Hz}, 1H), 4.00-3.92 (m, 1H), 3.85 (td, J = 8.0, 5.6 \text{ Hz}, 1H), 3.75 (s, 3H), 3.69-3.59 (m, 2H), 2.79 (dt, J = 12.5, 8.2 \text{ Hz}, 1H), 2.40 (s, 3H), 2.28 (ddd, J = 12.5, 7.7, 4.9 \text{ Hz}, 1H), 2.11-2.00 (m, 1H), 1.83-1.71 (m, 1H); \]
\[ \text{C NMR (100 MHz, CDCl}_3\text{): } \delta 159.5, 146.3, 144.0, 138.4, 129.4, 129.3, 127.9, 117.5, 112.5, 111.1, 83.9, 68.2, 65.3, 55.2, 37.0, 25.2, 21.6; \]
\[ \text{HRMS (ESI) calcd for } C_{19}H_{23}O_4S+ (M+H^+): 347.1312, \text{ found: 347.1326.} \]

2-(4-Fluorophenyl)-2-(tosylmethyl)tetrahydrofuran (3p)
$^1$H NMR (400 MHz, CDCl$_3$): $\delta$ 7.61 (d, $J = 8.2$ Hz, 2H), 7.30-7.17 (m, 4H), 6.94-6.87 (m, 2H), 3.94 (dd, $J = 14.9, 7.6$ Hz, 1H), 3.83 (td, $J = 8.1, 5.6$ Hz, 1H), 3.67-3.56 (m, 2H), 2.72 (dt, $J = 12.6, 8.2$ Hz, 1H), 2.41 (s, 3H), 2.28 (ddd, $J = 12.6, 7.7, 5.0$ Hz, 1H), 2.11-1.98 (m, 1H), 1.83-1.70 (m, 1H); $^{13}$C NMR (100 MHz, CDCl$_3$): $\delta$ 162.0 (d, $^1$J$_{CF} = 245.9$ Hz), 144.1, 139.9, 138.3, 129.5, 127.8, 127.1 (d, $^3$J$_{CF} = 8.1$ Hz), 115.0 (d, $^2$J$_{CF} = 21.4$ Hz); 83.6, 68.0, 65.6, 37.2, 25.2, 21.5; $^{19}$F NMR (376 MHz, CDCl$_3$) $\delta$ -115.6 (s, 1F); HRMS (ESI) calcd for C$_{18}$H$_{20}$FO$_3$S + (M+H$^+$): 335.1112, found: 335.1128.

2-(4-Chlorophenyl)-2-(tosylmethyl)tetrahydrofuran (3q)

$^1$H NMR (400 MHz, CDCl$_3$): $\delta$ 7.58 (d, $J = 8.2$ Hz, 2H), 7.28-7.14 (m, 6H), 3.98-3.91 (m, 1H), 3.87-3.79 (m, 1H), 3.69-3.58 (m, 2H), 2.68 (dt, $J = 12.6, 8.1$ Hz, 1H), 2.41 (s, 3H), 2.26 (ddd, $J = 12.6, 7.6, 5.2$ Hz, 1H), 2.10-1.99 (m, 1H), 1.83-1.71 (m, 1H); $^{13}$C NMR (100 MHz, CDCl$_3$): $\delta$ 144.1, 142.5, 138.1, 133.2, 129.4, 128.3, 127.8, 126.8, 83.5, 68.1, 65.4, 37.3, 25.1, 21.6; HRMS (ESI) calcd for C$_{18}$H$_{20}$ClO$_3$S + (M+H$^+$): 351.0816, found: 351.0818.

Methyl 3-(((2-phenyltetrahydrofuran-2-yl)methyl)sulfonyl)thiophene-2-carboxylate (3r)

$^1$H NMR (400 MHz, CDCl$_3$): $\delta$ 7.35-7.30 (m, 2H), 7.29-7.24 (m, 2H), 7.22-7.11 (m, 3H), 4.39 (d, $J = 14.9$ Hz, 1H), 4.13 (d, $J = 14.9$ Hz, 1H), 3.96-3.81 (m, 5H), 2.68 (dt, $J = 12.5, 8.0$ Hz, 1H), 2.29 (ddd, $J = 12.8, 7.7, 5.3$ Hz, 1H), 2.09-1.97 (m, 1H), 1.83-1.71 (m, 1H); $^{13}$C NMR (100 MHz, CDCl$_3$): $\delta$ 160.1, 145.1, 143.7, 133.3, 131.4, 129.0, 128.0, 127.2,
125.2, 83.7, 68.2, 63.9, 52.9, 37.9, 25.0; HRMS (ESI) calcd for C_{17}H_{19}O_{5}S_{2}^{+} (M+H^+): 367.0676, found: 367.0673.

2-Phenyl-2-(tosylmethyl)tetrahydro-2H-pyran (5)

$^1$H NMR (400 MHz, CDCl$_3$): $\delta$ 7.58 (d, $J = 8.3$ Hz, 2H), 7.34-7.25 (m, 4H), 7.24-7.15 (m, 3H), 3.63-3.56 (m, 1H), 3.55-3.41 (m, 2H), 3.36 (td, $J = 11.6$, 2.7 Hz, 1H), 2.58 (dt, $J = 14.0$, 3.4 Hz, 1H), 2.48-2.40 (m, 1H), 2.39 (s, 3H), 1.76-1.59 (m, 2H), 1.54-1.41 (m, 1H), 1.40-1.32 (m, 1H); $^{13}$C NMR (100 MHz, CDCl$_3$): $\delta$ 143.8, 140.6, 138.6, 129.3, 128.6, 127.9, 127.5, 127.0, 76.7, 68.3, 62.6, 31.2, 25.4, 21.5, 19.5; HRMS (ESI) calcd for C$_{19}$H$_{23}$O$_{3}$S$^+$ (M+H$^+$): 331.1362, found: 331.1372.

1-Methyl-1-(tosylmethyl)-1,3-dihydroisobenzofuran (7)

$^1$H NMR (400 MHz, CDCl$_3$): $\delta$ 7.65 (d, $J = 8.2$ Hz, 2H), 7.30-7.19 (m, 4H), 7.14 (dd, $J = 14.3$, 7.4 Hz, 2H), 4.97 (d, $J = 12.4$ Hz, 1H), 4.80 (d, $J = 12.4$ Hz, 1H), 3.62 (d, $J = 14.7$ Hz, 1H), 3.56 (d, $J = 14.7$ Hz, 1H), 2.42 (s, 3H), 1.71 (s, 3H); $^{13}$C NMR (100 MHz, CDCl$_3$): $\delta$ 144.1, 143.0, 138.5, 138.2, 129.5, 128.2, 128.0, 127.6, 121.4, 121.1, 85.4, 71.8, 65.0, 27.5, 21.6; HRMS (ESI) calcd for C$_{17}$H$_{19}$O$_{3}$S$^+$ (M+H$^+$): 303.1049, found: 303.1058.