Supporting Information

A Convenient Access to Allylic Triflones with Allenes and Triflyl chloride in the Presence of (EtO)$_2$P(O)H

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General remark

$^1$H NMR, and $^{13}$C NMR spectra were recorded on Bruker 400M and Mercury 300M in CDCl$_3$. All $^1$H NMR and $^{13}$C NMR chemical shifts were given as $\delta$ value (ppm) with reference to tetramethylsilane (TMS) as an internal standard. All compounds were further characterized by HRMS; copies of their $^1$H NMR and $^{13}$C NMR spectra were provided. Products were purified by flash chromatography on 200–300 mesh silica gels. All melting points were determined without correction. All reactions were carried out under argon atmosphere in oven-dried glassware, unless otherwise noted. Tetrahydrofuran (THF) was distilled prior to use and stored over activated molecular sieves. All reagents were purchased commercially and used as received, unless otherwise noted.

Table S1. Optimization of reaction conditions

<table>
<thead>
<tr>
<th>Entry</th>
<th>Additive (equiv)</th>
<th>Solvent</th>
<th>Temp. (°C)</th>
<th>Yield (%)</th>
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<tr>
<td>1</td>
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<td>MeCN</td>
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General procedure for the GC-MS experiment

Figure S1

Figure S2
General procedure for synthesis of substituted allenes[^1-3]

\[
\begin{align*}
R^1R^2 & \xrightarrow{\text{Ph}_3P\text{CH}_3\text{Br}^- t-\text{BuOK}} \xrightarrow{\text{CHBr}_3 \text{TEBAC}} \xrightarrow{\text{NaOH/H}_2\text{O,DCM}} \equiv R^1R^2 \\
\text{I} & \text{II} & \text{III} \\
R^1=\text{alkyl,aryl} & R^2=\text{aryl} \\
\end{align*}
\]

**Step 1:** In an oven dried flask, methyl triphenylphosphonium bromide (1.2 equiv.) was taken and to this abs. THF (1.6 mL/mmol) was added. The suspension was cooled to 0 °C, t-BuOK (1.2 equiv.) was added and the resulting yellow suspension was stirred at 0 °C for 45 min. To this suspension, a solution of ketone I (1.0 equiv., 10.0 mmol) in THF (0.7 mL/mmol) was added dropwise and the resulting mixture was warmed gradually to rt. and stirred at rt for 16 h. Reaction mixture was concentrated under reduced pressure and filtered over Celite®. The filtrate was concentrated under reduced pressure to afford yellow oil. Purification by column chromatography over silica gel (200-300 mesh) using petroleumether as eluent afforded II.

**Step 2:** To a solution of alkene II (1.0 equiv.), bromoform (1.6 equiv.), TEBAC (0.85 mol%) in dichloromethane (4 mL/mmol II), was added dropwise a solution of 50% NaOH (2.86mL/mmol II) and left stirring at 30-35 °C until full conversion was observed by TLC (1-3days). Water and DCM were added. The aqueous phase was extracted with DCM (30 mL × 3). The combined organic phases were washed with saturated NaCl solution, dried over Na₂SO₄ and the solvent removed under reduced pressure. The reaction mixture was purified by flash column chromatography using hexanes as eluent afforded III.

**Step 3:** EtMgBr (2.0 M in THF, 1.5 equiv, 7.6 mL) was added dropwise to a solution
of III (10 mmol) in dry THF (20 ml) under nitrogen atmosphere at room temperature. The resulting mixture was allowed to stir at room temperature for an additional 30 minutes. Then the reaction was quenched by saturated NH₄Cl solution (30 ml), and extracted with petroleum ether (30 mL × 3). The combined organic layers was washed with brine (30 mL × 3), and dried with anhydrous Na₂SO₄. After removing the solvent under reduced pressure, the crude product was purified by flash column chromatography on silica gel afforded 1a-1y, 1ab.

**Typical Procedure for the Cross-Coupling of N-Tosylhydrazones and Terminal Alkynes**[^4]

\[
\begin{align*}
\begin{array}{c}
\text{Cul (20 %), LiO} & \\
\text{Bu (3.5 equiv)} & \\
\text{dioxane, 1h}
\end{array}
\end{align*}
\]

Under a nitrogen atmosphere, ethynylbenzene (1020.0 mg, 10.0 mmol) was added to a mixture of Cul (382.5 mg, 2.0 mmol), LitOBu (2.8 g, 35.0 mmol), and the N-tosylhydrazone A (6.0 g, 22.0 mmol) in 1,4-dioxane (50 mL). The solution was stirred at 90 °C for 1 h, and the progress of the reaction was monitored by TLC. Upon completion of the reaction, the mixture was cooled to room temperature and was filtered through a short silica gel column eluting with EtOAc. The solvent was removed in vacuum to leave a crude mixture, which was purified by column chromatography on silica gel (eluting with petroleum ether) to afford pure 1z as a colorless oil.

**General procedure for the synthesis of allylic triflones:**

\[
\begin{align*}
\begin{array}{c}
\text{Ph} & \\
\text{1a} & \\
\text{CF₃SO₂Cl} & \\
\text{2a}
\end{array}
\end{align*}
\]

A mixture of buta-2,3-dien-2-ylbenzene 1a (1 equiv, 0.3 mmol), trifluoromethyl sulfonyl chloride 2a (3.0 equiv, 0.9 mmol), diethyl phosphate (2.0 equiv, 0.6 mmol), toluene (2 mL) were stirred at 100 °C under air atmosphere for 8 h (TLC monitored).
Upon completion of the reaction, the reaction mixture was cooled to room temperature. The solvent was evaporated in vacuo and the crude product was purified by column chromatography, eluting with petroleum ether/EtOAc (20:1) to afford the desired product \((E)-(4-((\text{trifluoromethyl})\text{sulfonyl})\text{but-2-en-2-yl})\text{benzene 3aa}.

**The data of products:**

\[
\text{buta-2,3-dien-2-ylbenzene (1a)}^{[5-9]}
\]

Yellow oil (702.0 mg, 54% yield). \(^1\)H NMR (400 MHz, CDCl\(_3\), ppm): \(\delta = 7.41-7.39\) (d, \(J = 8.0\) Hz, 2 H), 7.33-7.29 (m, 2 H), 7.21-7.17 (m, 1 H), 5.02-5.00 (m, 2 H), 2.10-2.08 (t, \(J = 3.2\) Hz, 3 H); \(^{13}\)C NMR (100 MHz, CDCl\(_3\), ppm): \(\delta = 209.0, 136.7, 128.3, 126.6, 125.7, 99.8, 77.1, 16.7.\n
\[
\text{1-(buta-2,3-dien-2-yl)-4-methylbenzene (1b)}^{[5, 8]}
\]

Yellow oil (720.0 mg, 50% yield). \(^1\)H NMR (400 MHz, CDCl\(_3\), ppm): \(\delta = 7.29-7.27\) (d, \(J = 8.0\) Hz, 2 H), 7.13-7.11 (d, \(J = 8.0\) Hz, 2 H), 5.00-4.97 (m, 2 H), 2.32 (s, 3 H), 2.07-2.06 (t, \(J = 3.2\) Hz, 3 H); \(^{13}\)C NMR (100 MHz, CDCl\(_3\), ppm): \(\delta = 208.8, 136.3, 133.7, 129.1, 125.6, 99.6, 76.8, 21.1, 16.8.\n
\[
\text{1-(buta-2,3-dien-2-yl)-2-methoxybenzene (1c)}^{[8-11]}
\]

Yellow oil (768.0 mg, 48% yield). \(^1\)H NMR (400 MHz, CDCl\(_3\), ppm): \(\delta = 7.24-7.21\) (m, 2 H), 6.95-6.87 (m, 2 H), 4.80-4.78 (m, 2 H), 3.84 (s, 3 H), 2.10-2.08 (t, \(J = 3.2\) Hz, 3 H); \(^{13}\)C NMR (100 MHz, CDCl\(_3\), ppm): \(\delta = 209.2, 156.9, 129.2, 128.2, 127.2, 120.7, 111.3, 97.8, 73.6, 55.5, 19.2.\
1-(buta-2,3-dien-2-yl)-4-methoxybenzene (1d) $^{5,8,11}$
Yellow oil (816.0 mg, 51% yield). $^1$H NMR (400 MHz, CDCl$_3$, ppm): $\delta$ = 7.35-7.32 (d, $J$ = 8.8 Hz, 2 H), 6.88-6.85 (m, 2 H), 5.01-5.00 (m, 2 H), 3.80 (s, 3 H), 2.08-2.07 (t, $J$ = 3.2 Hz, 3 H); $^{13}$C NMR (100 MHz, CDCl$_3$, ppm): $\delta$ = 208.6, 158.5, 129.0, 126.8, 113.8, 110.7, 99.3, 76.9, 55.3, 16.9.

1-(buta-2,3-dien-2-yl)-4-ethoxybenzene (1e) $^8$
Yellow solid (713.4 mg, 41% yield), mp: 49-51 $^\circ$C. $^1$H NMR (400 MHz, CDCl$_3$, ppm): $\delta$ = 7.32-7.29 (m, 2 H), 6.87-6.83 (m, 2 H), 5.00-4.98 (m, 2 H), 4.04-3.99 (m, 2 H), 2.07-2.05 (t, $J$ = 3.2 Hz, 3 H), 1.42-1.38 (t, $J$ = 3.2 Hz, 3 H); $^{13}$C NMR (100 MHz, CDCl$_3$, ppm): $\delta$ = 208.6, 157.8, 128.8, 126.7, 114.4, 99.3, 76.8, 63.4, 16.9, 14.9.

4-(buta-2,3-dien-2-yl)-1,2-dimethylbenzene (1f) $^8$
Yellow oil (695.2 mg, 44% yield). $^1$H NMR (400 MHz, CDCl$_3$, ppm): $\delta$ = 7.20 (s, 1 H), 7.17-7.06 (m, 2 H), 5.00-4.98 (m, 2 H), 2.25 (s, 3 H), 2.23 (s, 3 H), 2.07-2.06 (t, $J$ = 3.2 Hz, 3 H); $^{13}$C NMR (100 MHz, CDCl$_3$, ppm): $\delta$ = 208.8, 136.4, 135.0, 134.2, 129.7, 127.0, 123.1, 99.7, 76.8, 19.9, 19.4, 16.8.

4-(buta-2,3-dien-2-yl)-1,2-dimethoxybenzene (1g) $^{10}$
Yellow oil (950.0 mg, 50% yield). $^1$H NMR (400 MHz, CDCl$_3$, ppm): $\delta$ = 6.98-6.97 (d, $J$ = 2.0 Hz, 1 H), 6.91-6.89 (d, $J$ = 8.8 Hz, 1 H), 6.82-6.80 (d, $J$ = 8.4 Hz, 1 H),
5.02-5.00 (m, 2 H), 3.87 (s, 3 H), 3.85 (s, 3 H), 2.08-2.06 (t, $J = 3.2$ Hz, 3 H); $^{13}$C
NMR (100 MHz, CDCl$_3$, ppm): $\delta = 208.7$, 148.9, 148.2, 129.4, 117.7, 111.0, 109.3,
99.7, 77.1, 55.9, 55.8, 16.9.

4-(buta-2,3-dien-2-yl)-1,1'-biphenyl (1h)$^{[8]}$
white solid (824.0 mg, 40% yield), mp: 84-86 $^\circ$C. $^1$H NMR (400 MHz, CDCl$_3$, ppm):
$\delta = 7.60-7.55$ (m, 4 H), 7.48-7.40 (m, 4 H), 7.34-7.30 (m, 1 H), 5.06-5.04 (m, 2 H),
2.13-2.11 (t, $J = 3.2$ Hz, 3 H); $^{13}$C NMR (100 MHz, CDCl$_3$, ppm): $\delta = 209.2$, 140.8,
139.4, 135.8, 128.8, 127.2, 127.1, 127.0, 126.1, 99.6, 77.4, 16.7.

1-(buta-2,3-dien-2-yl)-4-fluorobenzene (1i)$^{[5, 8]}$
colorless oil (710.4 mg, 48% yield). $^1$H NMR (400 MHz, CDCl$_3$, ppm): $\delta = 7.36-7.32$
(m, 2 H), 7.02-6.97 (m, 2 H), 5.01-5.00 (d, $J = 4.0$ Hz, 2 H), 2.07-2.05 (t, $J=3.2$ Hz, 3 H);
$^{13}$C NMR (100 MHz, CDCl$_3$, ppm): $\delta = 208.8$ ($J = 2$ Hz, 1 C), 163.0 ($J = 244$ Hz,
1 C), 132.7 ($J = 3$ Hz, 1 C), 127.2 ($J = 8$ Hz, 2 C), 115.3 ($J = 21$ Hz, 2 C), 99.0, 77.4,
16.8.

1-(buta-2,3-dien-2-yl)-4-chlorobenzene (1j)$^{[5, 8]}$
Yellow oil (623.2 mg, 38% yield). $^1$H NMR (400 MHz, CDCl$_3$, ppm): $\delta = 7.33-7.25$
(m, 4 H), 5.04-5.02 (m, 2 H), 2.08-2.06 (t, $J = 3.2$ Hz, 3 H); $^{13}$C NMR (100 MHz,
CDCl$_3$, ppm): $\delta = 208.9$, 135.2, 132.2, 128.4, 126.9, 99.0, 77.3, 16.6.
1-bromo-4-(buta-2,3-dien-2-yl)benzene (1k) [5, 8-9, 11]
Yellow solid (728.0 mg, 35% yield), mp: 54-56 °C. \(^1\)H NMR (400 MHz, CDCl\(_3\), ppm):
\[\delta = 7.45-7.42 (d, J = 8.8 \text{ Hz}, 2 \text{ H}), 7.28-7.26 (d, J = 8.8 \text{ Hz}, 2 \text{ H}), 5.04-5.02 (m, 2 \text{ H}), 2.08-2.06 (t, J = 3.2 \text{ Hz}, 3 \text{ H});\]
\(^1^3\)C NMR (100 MHz, CDCl\(_3\), ppm):
\[\delta = 208.9, 135.8, 131.3, 127.3, 120.4, 99.1, 77.4, 16.6.\]

5-(buta-2,3-dien-2-yl)benzo[d][1,3]dioxole (1l) [5]
Yellow oil (1131.0 mg, 65% yield). \(^1\)H NMR (400 MHz, CDCl\(_3\), ppm):
\[\delta = 6.99-6.93 (m, 1 \text{ H}), 6.83-6.74 (m, 2 \text{ H}), 5.96-5.90 (m, 2 \text{ H}), 5.05-4.98 (m, 2 \text{ H}), 2.04-2.03 (t, J = 3.2 \text{ Hz}, 3 \text{ H});\]
\(^1^3\)C NMR (100 MHz, CDCl\(_3\), ppm):
\[\delta = 208.6, 147.8, 146.4, 130.8, 118.7, 108.0, 106.4, 101.0, 99.6, 77.0, 17.0.\]

2-(buta-2,3-dien-2-yl)naphthalene (1m) [5, 6, 8, 9, 11, 13]
Yellow solid (918.0 mg, 51% yield), mp: 59-61 °C. \(^1\)H NMR (400 MHz, CDCl\(_3\), ppm):
\[\delta = 7.82-7.78 (m, 2 \text{ H}), 7.77-7.72 (m, 2 \text{ H}), 7.65-7.63 (m, 1 \text{ H}), 7.48-7.40 (m, 2 \text{ H}), 5.12-5.10 (m, 2 \text{ H}), 2.22-2.21 (t, J = 3.2 \text{ Hz}, 3 \text{ H});\]
\(^1^3\)C NMR (100 MHz, CDCl\(_3\), ppm):
\[\delta = 209.7, 134.1, 133.6, 132.3, 128.0, 127.7, 127.6, 126.1, 125.6, 124.9, 123.3, 100.1, 77.3, 16.8.\]

Propa-1,2-diene-1,1-diyl dibenzene (1n) [6-9, 13]
Yellow oil (1152.0 mg, 60% yield). \(^1\)H NMR (400 MHz, CDCl\(_3\), ppm):
\[\delta = 7.38-7.32\]
(m, 8 H), 7.29-7.25 (m, 2 H), 5.26 (s, 2 H); $^{13}$C NMR (100 MHz, CDCl$_3$, ppm): $\delta =$ 209.9, 136.3, 128.5, 127.3, 109.2, 78.1.

1-methyl-4-(1-phenylproa-1,2-dien-1-yl)benzene (1o) $^{[5,6,8]}$
Yellow oil (1071.2 mg, 52% yield). $^1$H NMR (300 MHz, CDCl$_3$, ppm): $\delta =$ 7.38-7.31 (m, 4 H), 7.27-7.24 (m, 3 H), 7.17-7.14 (m, 2 H), 5.24 (s, 2 H), 2.36 (s, 3 H); $^{13}$C NMR (75 MHz, CDCl$_3$, ppm): $\delta =$ 209.7, 137.0, 136.3, 133.2, 129.1, 128.4, 128.3, 127.1, 108.9, 78.0, 21.2.

1-methoxy-4-(1-phenylproa-1,2-dien-1-yl)benzene (1p) $^{[7,12]}$
Yellow solid (1021.2 mg, 46% yield), mp: 90-91 °C. $^1$H NMR (400 MHz, CDCl$_3$, ppm): $\delta =$ 7.40-7.34 (m, 4 H), 7.32-7.27 (m, 3 H), 6.92-6.88 (m, 2 H), 5.26 (s, 2 H), 3.83 (s, 3 H); $^{13}$C NMR (100 MHz, CDCl$_3$, ppm): $\delta =$ 209.6, 158.9, 136.5, 129.5, 128.3, 127.1, 113.8, 108.6, 77.9, 55.3.

1,2-dimethyl-4-(1-phenylproa-1,2-dien-1-yl)benzene (1q) $^{[7,8]}$
Yellow solid (990.0 mg, 45% yield), mp: 94-96 °C. $^1$H NMR (300 MHz, CDCl$_3$, ppm): $\delta =$ 7.39-7.31 (m, 4 H), 7.29-7.26 (m, 1 H), 7.14-7.13 (m, 1 H), 7.11-7.05 (m, 2 H), 5.24 (s, 2 H), 2.27 (s, 3 H), 2.25 (s, 3 H); $^{13}$C NMR (75 MHz, CDCl$_3$, ppm): $\delta =$ 209.7, 136.6, 136.4, 135.7, 133.6, 129.7, 129.5, 128.4, 128.3, 127.1, 125.8, 108.9, 77.8, 19.8, 19.5.
4-(1-phenylpropa-1,2-dien-1-yl)-1,1'-biphenyl (1r) \[7\]
Yellow solid (964.8 mg, 36% yield), mp: 99-101 °C. \(^1\)H NMR (300 MHz, CDCl\(_3\), ppm): \(\delta = 7.58-7.54\) (m, 4 H), 7.43-7.34 (m, 10 H), 5.26 (s, 2 H); \(^{13}\)C NMR (75 MHz, CDCl\(_3\), ppm): \(\delta = 209.9, 140.6, 140.0, 136.1, 135.1, 128.7, 128.4, 127.3, 127.1, 127.0, 108.9, 77.4\).

1-chloro-4-(1-phenylpropa-1,2-dienyl)benzene (1s) \[6-8, 19\]
Yellow solid (904.0 mg, 40% yield), mp: 115-117 °C. \(^1\)H NMR (400 MHz, CDCl\(_3\), ppm): \(\delta = 7.36-7.22\) (m, 9 H), 5.26 (s, 2 H); \(^{13}\)C NMR (100 MHz, CDCl\(_3\), ppm): \(\delta = 209.8, 135.9, 134.9, 133.0, 129.7, 128.6, 128.5, 128.4, 127.5, 108.4, 78.5\).

1-bromo-4-(1-phenylpropa-1,2-dien-1-yl)benzene (1t) \[20\]
Yellow solid (1053.0 mg, 39% yield), mp: 110-112 °C. \(^1\)H NMR (400 MHz, CDCl\(_3\), ppm): \(\delta = 7.46-7.44\) (d, \(J = 8.4\) Hz, 2 H), 7.35-7.31 (m, 4 H), 7.30-7.28 (m, 1 H), 7.23-7.21 (m, \(J = 8.4\) Hz, 2H), 5.26 (s, 2 H); \(^{13}\)C NMR (100 MHz, CDCl\(_3\), ppm): \(\delta = 209.7, 135.7, 135.3, 131.5, 130.0, 128.5, 128.3, 127.4, 121.1, 108.4, 78.5\).

4,4'-(propa-1,2-diene-1,1-diyl)bis(methylbenzene) (1u) \[7, 21\]
Colorless solid (1320.0 mg, 60% yield), mp: 92-94 °C. \(^1\)H NMR (400 MHz, CDCl\(_3\),
ppm): $\delta = 7.26-7.24$ (d, $J = 8.0$ Hz, 4 H), 7.15-7.13 (d, $J = 8.0$ Hz, 4 H), 5.21 (s, 2 H), 2.34 (s, 6 H); $^{13}$C NMR (100 MHz, CDCl$_3$, ppm): $\delta = 209.6$, 136.9, 133.4, 129.1, 128.3, 108.8, 77.8, 21.1.

1-fluoro-4-(1-(4-methoxyphenyl)propa-1,2-dien-1-yl)benzene (1v)
Yellow solid (1608.0 mg, 67% yield), mp: 97-98 °C. $^1$H NMR (400 MHz, CDCl$_3$, ppm): $\delta = 7.33-7.30$ (m, 2 H), 7.27-7.23 (m, 2 H), 7.05-7.00 (m, 2 H), 6.90-6.88 (m, 2 H), 5.23 (s, 2 H), 3.81 (s, 3 H); $^{13}$C NMR (100 MHz, CDCl$_3$, ppm): $\delta = 209.5$, 163.2-160.8 (d, $J = 245.0$ Hz, 1C), 159.0, 132.5-132.4 (d, $J = 3.0$ Hz, 1C), 130.0-129.8 (d, $J = 8.0$ Hz, 1C), 128.2, 115.4-115.1 (d, $J = 84.0$ Hz, 1C), 113.9, 107.8, 78.1, 55.3. C$_{16}$H$_{14}$FO [M+H]$^+$ 241.1023; found: 241.1026.

propa-1,2-dien-1-ylbenzene (1w) $^{[13]}$
Yellow oil (777.2 mg, 67% yield). $^1$H NMR (400 MHz, CDCl$_3$, ppm): $\delta = 7.33-7.30$ (m, 4 H), 7.23-7.17 (m, 1 H), 6.18-6.15 (t, $J = 6.8$ Hz, 1 H), 5.15-5.14 (d, $J = 6.8$ Hz, 2H); $^{13}$C NMR (100 MHz, CDCl$_3$, ppm): $\delta = 209.8$, 139.9, 128.6, 126.9, 126.7, 94.0, 78.9.

penta-1,2-dien-3-ylbenzene (1x) $^{[5, 6, 8, 14]}$
Yellow oil (878.4 mg, 61% yield). $^1$H NMR (400 MHz, CDCl$_3$, ppm): $\delta = 7.42-7.40$ (d, $J = 7.6$ Hz, 2 H), 7.33-7.29 (m, 2 H), 7.25-7.17 (m, 1 H), 5.10-5.09 (t, $J = 3.6$ Hz, 2 H), 2.46-2.39 (m, 2 H), 1.17-1.13 (t, $J = 3.2$ Hz, 3 H); $^{13}$C NMR (100 MHz, CDCl$_3$, ppm): $\delta = 208.4$, 136.6, 128.4, 126.6, 125.9, 106.7, 78.8, 22.4, 12.5.
(1-cyclopropylpropa-1,2-dien-1-yl)benzene (1y) [5, 8, 15, 16]
Yellow oil (546.0 mg, 35% yield). $^1$H NMR (400 MHz, CDCl$_3$, ppm): $\delta$ = 7.59-7.57 (m, 2 H), 7.35-7.32 (m, 2 H), 7.23-7.19 (m, 1 H), 5.10-5.09 (d, $J$ = 2.8 Hz, 2 H), 1.60-1.52 (m, 1 H), 0.89-0.85 (m, 2 H), 0.57-0.53 (m, 2 H); $^{13}$C NMR (100 MHz, CDCl$_3$, ppm): $\delta$ = 207.9, 136.8, 128.3, 126.8, 126.2, 108.3, 79.3, 10.4, 6.9.

1,3-diphenylpropa-1,2-diene (1z) [8, 13, 17]
colorless oil (960.0 mg, 50% yield). $^1$H NMR (300 MHz, CDCl$_3$, ppm): $\delta$ = 7.12-7.37 (m, 10 H), 6.60 (s, 2 H); $^{13}$C NMR (75 MHz, CDCl$_3$, ppm): $\delta$ = 207.8, 133.6, 128.7, 127.3, 127.0, 98.4.

buta-2,3-dien-1-ylbenzene (1ab) [18-21]
colorless oil (650.0 mg, 50% yield). $^1$H NMR (400 MHz, CDCl$_3$, ppm): $\delta$ = 7.42-7.21 (m, 5 H), 5.33 (m, 1 H), 4.76 (m, 2 H), 3.41 (m, 2 H); $^{13}$C NMR (75 MHz, CDCl$_3$, ppm): $\delta$ = 209.4, 140.7, 128.9, 128.8, 126.6, 90.0, 75.5, 35.5.

(E)-(4-((trifluoromethyl)sulfonyl)but-2-en-2-yl)benzene (3aa)
Yellow solid (59.4 mg, 75% yield), mp: 35-37 °C. $^1$H NMR (400 MHz, CDCl$_3$, ppm): $\delta$ = 7.42-7.31 (m, 5 H), 5.78-5.74 (m, 1 H), 4.20-4.18 (d, $J$ = 8.0 Hz, 2 H), 2.19 (s, 3 H); $^{13}$C NMR (100 MHz, CDCl$_3$, ppm): $\delta$ = 147.9, 141.6, 128.5, 128.4, 126.0, 119.7 (q, $J$ = 327.0 Hz, 1C), 108.0, 50.7, 16.9; HRMS calcd for C$_{11}$H$_{12}$F$_3$O$_2$S [M+H]$^+$ 265.0505; found: 265.0511.
(E)-1-methyl-4-((trifluoromethyl)sulfonyl)but-2-en-2-yl)benzene (3ba)
Yellow solid (59.2 mg, 71% yield), mp: 48-50 °C. $^1$H NMR (400 MHz, CDCl$_3$, ppm):
$\delta$ = 7.32-7.30 (d, $J$ = 8.0 Hz, 2 H), 7.18-7.16 (d, $J$ = 8.0 Hz, 2 H), 5.76-5.72 (m, 1 H),
4.19-4.17 (d, $J$ = 8.0 Hz, 2 H), 2.36 (s, 3 H), 2.17 (s, 3 H); $^{13}$C NMR (100 MHz,
CDCl$_3$, ppm): $\delta$ = 147.7, 138.7, 138.5, 129.2, 125.9, 119.7 (q, $J$ = 327.0 Hz, 1C),
107.1, 50.8, 21.1, 16.9; HRMS calcd for $C_{12}H_{14}F_3O_2S$ [M+H]$^+$ 279.0661; found: 279.0653.

(3ca)
Yellow oil (37.9 mg, 43% yield). $^1$H NMR (400 MHz, CDCl$_3$, ppm): $\delta$ = 7.31-7.27 (m, 1 H),
7.14-7.11 (m, 1 H), 6.95-6.88 (m, 2 H), 5.55-5.51 (m, 1 H), 4.17-4.15 (d, $J$ = 8.0 Hz, 2 H),
3.81 (s, 3 H), 2.12 (s, 3 H); $^{13}$C NMR (100 MHz, CDCl$_3$, ppm): $\delta$ = 156.3,
148.1, 132.3, 129.3, 129.2, 120.7, 119.7 (q, $J$ = 326.0 Hz, 1C), 110.9, 110.1, 55.4,
50.5, 17.9; HRMS calcd for $C_{12}H_{14}F_3O_3S$ [M+H]$^+$ 295.0574; found: 295.0580.

(3da)
Yellow solid (70.6 mg, 80% yield), mp: 76-78 °C. $^1$H NMR (300 MHz, CDCl$_3$, ppm):
$\delta$ = 7.39-7.34 (m, 2 H), 6.90-6.87 (m, 2 H), 5.72-5.67 (m, 1 H), 4.20-4.17 (m, 2 H),
3.82 (s, 3 H), 2.16 (s, 3 H); $^{13}$C NMR (75 MHz, CDCl$_3$, ppm): $\delta$ = 159.9, 147.2, 133.9,
127.2, 119.7 (q, $J$ = 326.3 Hz, 1C), 113.8, 106.1, 55.3, 50.8, 16.8; HRMS calcd for
$C_{12}H_{14}F_3O_3S$ [M+H]$^+$ 295.0574; found: 295.0570.

(3ea)
(E)-1-ethoxy-4-((trifluoromethyl)sulfonyl)but-2-en-2-yl)benzene

14
Yellow solid (64.7 mg, 70% yield), mp: 70-72 °C. $^1$H NMR (400 MHz, CDCl$_3$, ppm): $\delta = 7.37$-$7.33$ (m, 2 H), 6.90-$6.85$ (m, 2 H), 5.71-$5.67$ (m, 1 H), 4.19-$4.17$ (d, $J = 8.0$ Hz, 2 H), 4.07-$4.02$ (m, 2 H), 2.16 (s, 3 H), 1.44-$1.40$ (m, 3 H); $^{13}$C NMR (100 MHz, CDCl$_3$, ppm): $\delta = 159.3$, 147.2, 133.8, 127.2, 119.8 (q, $J = 327.0$ Hz, 1C), 114.4, 106.0, 63.5, 50.8, 16.8, 14.8; HRMS calcd for C$_{13}$H$_{16}$F$_3$O$_3$S [M+H]$^+$ 309.0767; found: 309.0770.

(\textit{E})-1,2-dimethyl-4-(4-((trifluoromethyl)sulfonyl)but-2-en-2-yl)benzene (3fa)

Yellow solid (63.1 mg, 72% yield), mp: 50-52 °C. $^1$H NMR (400 MHz, CDCl$_3$, ppm): $\delta = 7.18$ (s, 1 H), 7.16-7.10 (m, 2 H), 5.75-$5.71$ (m, 1 H), 4.19-$4.17$ (d, $J = 8.0$ Hz, 2 H), 2.28 (s, 3 H), 2.27 (s, 3 H), 2.16 (s, 3 H); $^{13}$C NMR (100 MHz, CDCl$_3$, ppm): $\delta = 147.8$, 139.2, 137.2, 136.7, 129.7, 127.3, 123.5, 119.8 (q, $J = 327.0$ Hz, 1C), 106.9, 50.8, 19.9, 19.5, 16.9; HRMS calcd for C$_{13}$H$_{16}$F$_3$O$_2$S [M+H]$^+$ 293.0818; found: 293.0825.

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\end{center}

Yellow oil (58.3 mg, 60% yield). $^1$H NMR (400 MHz, CDCl$_3$, ppm): $\delta = 7.01$-$6.98$ (m, 1 H), 6.93-$6.92$ (d, $J = 2.0$ Hz, 1 H), 6.86-$6.84$ (d, $J = 8.8$ Hz, 1 H), 5.73-$5.69$ (t, $J = 7.6$ Hz, 1 H), 4.20-$4.18$ (d, $J = 8.0$ Hz, 2 H), 3.91 (s, 3 H), 3.90 (s, 3 H), 2.18 (s, 3 H); $^{13}$C NMR (100 MHz, CDCl$_3$, ppm): $\delta = 149.6$, 148.9, 147.6, 134.4, 119.8 (q, $J = 326.0$ Hz, 1C), 118.8, 111.0, 109.3, 106.4, 56.0, 50.8, 17.1; HRMS calcd for C$_{13}$H$_{16}$F$_3$O$_4$S [M+H]$^+$ 325.0716; found: 325.0720.

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\end{center}

(\textit{E})-1,2-dimethoxy-4-(4-((trifluoromethyl)sulfonyl)but-2-en-2-yl)benzene (3ga)

Yellow solid (74.5 mg, 73% yield), mp: 136-139 °C. $^1$H NMR (400 MHz, CDCl$_3$,
ppm): $\delta = 7.61$-$7.58$ (m, 4 H), $7.50$-$7.43$ (m, 4 H), $7.38$-$7.34$ (m, 1 H), $5.85$-$5.81$ (m, 1 H), 4.23-4.21 (d, $J = 8.0$ Hz, 2 H), 2.22 (s, 3 H); $^{13}$C NMR (100 MHz, CDCl$_3$, ppm): $\delta = 147.4$, 141.4, 140.4, 140.3, 128.9, 127.6, 127.2, 127.0, 126.5, 119.8 (q, $J = 326.0$ Hz, 1C), 107.9, 50.8, 16.9; HRMS calcd for C$_{17}$H$_{16}$F$_3$O$_2$S [M+H]$^+$ 341.0818; found: 341.0824.

(E)-1-fluoro-4-((trifluoromethyl)sulfonyl)but-2-en-2-yl)benzene (3ia)
Yellow solid (42.3 mg, 50% yield), mp: 40-42 °C. $^1$H NMR (400 MHz, CDCl$_3$, ppm): $\delta = 7.41$-$7.36$ (m, 2 H), 7.08-7.02 (m, 2 H), 5.74-5.70 (m, 1 H), 4.20-4.18 (d, $J = 8.0$ Hz, 2 H), 2.18 (s, 3 H); $^{13}$C NMR (100 MHz, CDCl$_3$, ppm): $\delta = 146.9$, 137.6-137.5 (d, $J = 4.0$ Hz, 1C), 127.8-127.7 (d, $J = 8.0$ Hz, 1C), 119.6 (q, $J = 327.0$ Hz, 1C), 115.5-115.3 (d, $J = 21.0$ Hz, 1C), 107.9, 50.5, 17.1; HRMS calcd for C$_{11}$H$_{11}$F$_3$O$_2$S [M+H]$^+$ 283.0411; found: 283.0408.

Cl
(E)-1-chloro-4-((trifluoromethyl)sulfonyl)but-2-en-2-yl)benzene (3ja)
Yellow solid (38.4 mg, 43% yield), mp: 34-36 °C. $^1$H NMR (400 MHz, CDCl$_3$, ppm): $\delta = 7.34$ (s, 4 H), 5.77-5.73 (m, 1 H), 4.19-4.17 (d, $J = 8.0$ Hz, 2 H), 2.17 (s, 3 H); $^{13}$C NMR (100 MHz, CDCl$_3$, ppm): $\delta = 146.8$, 140.0, 134.5, 128.7, 127.4, 119.7 (q, $J = 327.0$ Hz, 1C), 108.6, 50.6, 16.9; HRMS calcd for C$_{11}$H$_{11}$ClF$_3$O$_2$S [M+H]$^+$ 299.0115; found: 299.0120.

Br
(E)-1-bromo-4-((trifluoromethyl)sulfonyl)but-2-en-2-yl)benzene (3ka)
Yellow solid (41.0 mg, 40% yield), mp: 28-30 °C. $^1$H NMR (300 MHz, CDCl$_3$, ppm): $\delta = 7.51$-7.48 (d, $J = 8.4$ Hz, 2 H), 7.30-7.27 (m, 8.7 Hz, 2 H), 5.79-5.73 (m, 1 H), 4.21-4.18 (d, $J = 8.1$ Hz, 2 H), 2.18 (s, 3 H); $^{13}$C NMR (75 MHz, CDCl$_3$, ppm): $\delta = 140.3$, 131.6, 127.6, 122.6, 108.5, 50.5, 16.9; HRMS calcd for C$_{11}$H$_{11}$BrF$_3$O$_2$S
(E)-5-(4-((trifluoromethyl)sulfonyl)but-2-en-2-yl)benzo[d][1,3]dioxole (3la)
Yellow oil (48.0 mg, 52% yield). $^1$H NMR (400 MHz, CDCl$_3$, ppm): $\delta$ = 6.91-6.89 (m, 2 H), 6.80-6.77 (m, 1 H), 5.97 (s, 2 H), 5.69-5.65 (t, $J$ = 8.0 Hz, 1 H), 4.18-4.16 (d, $J$ = 8.0 Hz, 2 H), 2.14 (s, 3 H); $^{13}$C NMR (100 MHz, CDCl$_3$, ppm): $\delta$ = 147.8, 147.3, 135.8, 119.9, 119.7 (q, $J$ = 326.0 Hz, 1 C), 108.1, 106.8, 106.5, 101.3, 100.8, 50.7, 17.0; HRMS calcd for C$_{12}$H$_{12}$F$_3$O$_4$S [M+H]$^+$ 309.0403; found: 309.0400.

(E)-2-(4-((trifluoromethyl)sulfonyl)but-2-en-2-yl)naphthalene (3ma)
Yellow solid (52.8 mg, 56% yield), mp: 98-100 °C. $^1$H NMR (400 MHz, CDCl$_3$, ppm): $\delta$ = 7.87-7.81 (m, 4 H), 7.56-7.53 (m, 1 H), 7.52-7.47 (m, 2 H), 5.93-5.89 (m, 1 H), 4.26-4.24 (d, $J$ = 8.0 Hz, 2 H), 2.30 (s, 3 H); $^{13}$C NMR (100 MHz, CDCl$_3$, ppm): $\delta$ = 147.7, 138.8, 133.2, 128.3, 128.2, 127.6, 126.5, 126.4, 125.2, 123.9, 119.8 (q, $J$ = 327.0 Hz, 1 C), 108.4, 50.8, 16.9; HRMS calcd for C$_{15}$H$_{14}$F$_3$O$_2$S [M+H]$^+$ 315.0661; found: 315.0669.

(3-((trifluoromethyl)sulfonyl)prop-1-ene-1,1-diyl)dibenzene (3na)
Yellow oil (79.2 mg, 81% yield). $^1$H NMR (400 MHz, CDCl$_3$, ppm): $\delta$ = 7.46-7.41 (m, 3 H), 7.34-7.31 (m, 3 H), 7.28-7.24 (m, 2 H), 7.23-7.20 (m, 2 H), 6.14-6.10 (m, 1 H), 4.11-4.09 (d, $J$ = 7.6 Hz, 2 H); $^{13}$C NMR (100 MHz, CDCl$_3$, ppm): $\delta$ = 152.6, 140.3, 137.3, 129.4, 128.8, 128.7, 128.5, 128.4, 127.7, 108.9, 51.8; HRMS calcd for C$_{16}$H$_{14}$F$_3$O$_2$S [M+H]$^+$ 327.0661; found: 327.0655.
(E/Z)-1-methyl-4-(1-phenyl-3-((trifluoromethyl)sulfonyl)prop-1-en-1-yl)benzene (3oa)

Colorless oil (71.4 mg, 70% yield). (E/Z = 61/39) ¹H NMR (400 MHz, CDCl₃, ppm):
δ = 7.45-7.09 (m, 9 H, Ar), 6.10-6.06 (m, 1 H), 4.09-4.07 (d, J = 8.0 Hz, 2 H), 2.35 (s, 3 H); δ = 7.45-7.09 (m, 9 H, Ar), 6.10-6.06 (m, 1 H), 4.13-4.11 (d, J = 8.0 Hz, 2 H), 2.40 (s, 3 H); ¹³C NMR (100 MHz, CDCl₃, ppm): δ = 152.7, 152.5, 140.6, 138.9, 138.4, 137.5, 137.4, 134.3, 129.5, 129.4, 129.3, 129.1, 128.7, 128.4, 128.3, 127.7, 127.6, 119.5 (q, J = 326.0 Hz, 1C), 108.9, 107.9, 51.9, 21.3, 21.2; HRMS calcd for C₁₇H₁₆F₃O₂S [M+H]⁺ 341.0818; found: 341.0822.

(E/Z)-1-methoxy-4-(1-phenyl-3-((trifluoromethyl)sulfonyl)prop-1-en-1-yl)benzene (3pa)

Colorless oil (65.1 mg, 61% yield). (E/Z = 72/28) ¹H NMR (400 MHz, CDCl₃, ppm):
δ = 7.45-6.82 (m, 9 H, Ar), 6.07-6.01 (m, 1 H), 4.08-4.06 (d, J = 8.0 Hz, 2 H), 3.80 (s, 3 H); δ = 7.45-6.82 (m, 9 H, Ar), 6.07-6.01 (m, 1 H), 4.15-4.13 (d, J = 8.0 Hz, 2 H), 3.85 (s, 3 H); ¹³C NMR (100 MHz, CDCl₃, ppm): δ = 160.1, 159.7, 152.5, 152.1, 140.8, 137.5, 132.8, 130.8, 129.5, 129.4, 129.0, 128.7, 128.4, 128.3, 127.8, 119.5 (q, J = 327.0 Hz, 1 C), 114.1, 113.7, 108.4, 106.7, 55.3, 51.9; HRMS calcd for C₁₇H₁₆F₃O₃S [M+H]⁺ 357.0767; found: 357.0759.

(E/Z)-1,2-dimethyl-4-(1-phenyl-3-((trifluoromethyl)sulfonyl)prop-1-en-1-yl)benzene (3qa)

Colorless oil (66.9 mg, 63% yield). (E/Z = 65/35) ¹H NMR (300 MHz, CDCl₃, ppm):
δ = 7.45-6.93 (m, 8 H, Ar), 6.09-6.04 (m, 1 H), 4.09-4.07 (d, J = 8.0 Hz, 2H), 2.25 (s, 3H), 2.22 (s, 3H); 7.45-6.93 (m, 8 H, Ar), 6.09-6.04 (m, 1 H), 4.14-4.12 (d, J = 7.6 Hz, 2H), 2.30 (s, 3H), 2.27 (s, 3H); ¹³C NMR (100 MHz, CDCl₃, ppm): δ = 152.7, 152.6, 140.6, 137.9, 137.6, 137.5, 137.1, 137.0, 136.7, 134.7, 130.4, 129.9, 129.6, 129.4,
128.7, 128.6, 128.4, 128.3, 127.7, 126.8, 126.8, 125.2, 119.5 (q, $J = 326.0$ Hz, 1C),
108.5, 107.7, 52.0, 51.8, 19.8, 19.7, 19.6, 19.5; HRMS calcd for C$_{18}$H$_{18}$F$_3$O$_2$S [M+H]$^+$
355.0974; found: 355.0982.

(E/Z)-4-(1-phenyl-3-((trifluoromethyl)sulfonyl)prop-1-en-1-yl)-1,1'-biphenyl (3ra)

Colorless oil (69.9 mg, 58% yield). (E/Z = 65/35) $^1$H NMR (400 MHz, CDCl$_3$, ppm):
$\delta = 7.67$-7.26 (m, 14 H, Ar), 6.20-6.12 (m, 1 H), 4.13-4.11 (d, $J = 7.6$ Hz, 2H); 7.67-
7.26 (m, 14 H, Ar), 6.20-6.12 (m, 1 H), 4.18-4.16 (d, $J = 8.0$ Hz, 2H); $^{13}$C NMR (100
MHz, CDCl$_3$, ppm): $\delta = 152.4$, 152.2, 141.6, 141.3, 140.4, 140.2, 140.1, 139.1, 137.2,
136.2, 129.9 129.4, 128.9, 128.8, 128.6, 128.5, 128.1, 127.8, 127.7, 127.6, 127.4,
127.1, 127.0, 126.9, 119.5 (q, $J = 326.0$ Hz, 1C), 108.9, 108.7, 51.8; HRMS calcd for C$_{22}$H$_{18}$F$_3$O$_2$S [M+H]$^+$
403.0974; found: 403.0977.

(E/Z)-1-chloro-4-(1-phenyl-3-((trifluoromethyl)sulfonyl)prop-1-en-1-yl)benzene
(3sa)

Colorless oil (44.3 mg, 41% yield). (E/Z = 50/50) $^1$H NMR (400 MHz, CDCl$_3$, ppm):
$\delta = 7.67$-7.25 (m, 9 H, Ar), 6.20-6.12 (m, 1 H), 4.13-4.11 (m, 2 H); 7.67-7.25 (m, 9 H,
Ar), 6.20-6.12 (m, 1 H), 4.18-4.16 (m, 2 H); $^{13}$C NMR (100 MHz, CDCl$_3$, ppm): $\delta =
152.4$, 152.2, 141.6, 141.3, 140.4, 140.2, 140.1, 139.1, 137.2, 136.2, 129.9, 128.9, 128.8,
128.6, 128.5, 128.1, 127.8, 127.7, 127.6, 127.4, 127.1, 127.0, 126.9, 119.5 (q, $J = 326.0$
Hz, 1C), 108.9, 108.7, 51.8; HRMS calcd for C$_{16}$H$_{13}$ClF$_3$O$_2$S [M+H]$^+$
361.0272; found: 361.0266.

(E/Z)-1-bromo-4-(1-phenyl-3-((trifluoromethyl)sulfonyl)prop-1-en-1-yl)benzene
(3ta)

Colorless oil (48.4 mg, 40% yield). (E/Z = 49/51) $^1$H NMR (400 MHz, CDCl$_3$, ppm):
δ = 7.60-7.10 (m, 9 H, Ar), 6.15-6.09 (m, 1 H), 4.07-4.06 (m, 2 H); 7.60-7.10 (m, 9 H, Ar), 6.15-6.09 (m, 1 H), 4.09-4.08 (m, 2 H); 13C NMR (75 MHz, CDCl3, ppm): δ = 151.7, 151.6, 139.8, 139.2, 136.7, 136.1, 132.2, 132.1, 131.6, 131.1, 129.3, 129.2, 129.1, 128.9, 128.8, 128.5, 127.6, 123.1, 122.9, 109.4, 109.2, 51.7; HRMS calcd for C16H13BrF3O2S [M+H]+ 404.9766; found: 404.9473.

![4,4'-((3-((trifluoromethyl)sulfonyl)prop-1-ene-1,1-diyl)bis(methylbenzene) (3ua)](image)

4,4′-((3-((trifluoromethyl)sulfonyl)prop-1-ene-1,1-diyl)bis(methylbenzene) (3ua)
Colorless oil (73.3 mg, 69% yield). 1H NMR (300 MHz, CDCl3, ppm): δ = 7.24-7.21 (d, J = 6.9 Hz, 2 H), 7.17-7.07 (m, 6 H), 6.07-6.02 (m, 1 H), 4.11-4.09 (d, J = 7.8 Hz, 2 H), 2.40 (s, 3 H), 2.34 (s, 3 H); 13C NMR (75 MHz, CDCl3, ppm): δ = 152.5, 138.8, 138.3, 137.7, 134.4, 129.4, 129.3, 129.0, 127.6, 119.5 (q, J = 326.3 Hz, 1C), 107.6, 51.9, 21.2, 21.1; HRMS calcd for C18H18F3O2S [M+H]+ 355.0974; found: 355.0966.

![OMe](image)

(E/Z)-1-fluoro-4-(1-(4-methoxyphenyl)-3-((trifluoromethyl)sulfonyl)prop-1-en-1-yl)benzene (3va)
Colorless oil (56.1 mg, 50% yield). (E/Z = 65/35) 1H NMR (300 MHz, CDCl3, ppm): δ = 7.24-7.10 (m, 5 H), 7.07-6.93 (m, 2 H), 6.87-6.81 (m, 1 H), 6.05-6.00 (m, 1 H), 4.14-4.05 (m, 2 H), 3.86-3.81 (m, 3 H); 13C NMR (75 MHz, CDCl3, ppm): δ = 164.6, 164.3, 161.0, 160.2, 159.7, 151.4, 151.3, 133.4, 133.3, 132.7, 131.3, 131.2, 130.7, 129.6, 129.5, 129.2, 128.9, 119.5 (q, J = 326.3 Hz, 1C), 116.0, 115.7, 115.4, 115.2, 114.2, 113.8, 108.2, 106.9, 55.3, 51.8; HRMS calcd for C17H15F4O3S [M+H]+ 375.0673; found: 375.0678.
(E)-(1-((trifluoromethyl)sulfonyl)pent-2-en-2-yl)benzene (5aa)
Yellow oil (33.4 mg, 40% yield). $^1$H NMR (400 MHz, CDCl$_3$, ppm): $\delta = 7.40$-$7.37$ (m, 2 H), 7.33-$7.29$ (m, 2 H), 7.26-$7.23$ (m, 1 H), 5.79-$5.75$ (m, 1 H), 3.62-$3.59$ (t, $J = 7.2$ Hz, 1 H), 2.71-$2.66$ (m, 2H), 2.06 (d, $J = 1.2$ Hz, 3 H); $^{13}$C NMR (100 MHz, CDCl$_3$, ppm): $\delta = 143.4$, 138.0, 128.3, 127.1, 125.8, 123.6, 44.2, 32.3, 16.2; HRMS calcd for C$_{12}$H$_{14}$F$_3$O$_2$S [M+H]$^+$ 279.0661; found: 279.0655.

References
3ma