Supporting Information

Metal free access to amide compounds via peroxide-mediated N=N double bond cleavage of azobenzenes

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1. General experimental details

$^1$H NMR and $^{13}$C NMR spectra were recorded at 400 MHz and 100 MHz, respectively using tetramethylsilane as an internal reference. Chemical shifts ($\delta$) and coupling constants ($J$) were expressed in parts per million and hertz, respectively. Melting points were uncorrected. High Resolution Mass spectra (HRMS) were performed on an ESI-TOF spectrometer. All reagents were obtained from commercial sources and used without further purification except as indicated below: DCE and benzaldehyde were purified according to the Purification of Laboratory Chemicals book, and azobenzenes were prepared according to the literature procedure.

1.1 Optimization study for the reaction of azobenzene with benzyl amine

Reaction conditions: 1a (0.25 mmol), 3a (0.5 mmol), oxidant (4.0 equiv), additive, solvent (1.0 mL), 24 h, air.

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<th>Entry</th>
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<th>Additive</th>
<th>Solvent</th>
<th>T ($^\circ$C)</th>
<th>Yield (%)$^b$</th>
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$^a$Reaction conditions: 1a (0.25 mmol), 3a (0.5 mmol), oxidant (4.0 equiv), additive, solvent (1.0 mL), 24 h, air. $^b$Isolated yield.

1.2 General procedure for preparation of azobenzenes: Arylamine (1.0 mmol), CuBr (4.2 mg, 0.03 mmol), pyridine (8.7 mg, 0.09 mmol), and toluene (4 mL) were added together. The mixture was stirred at 60 $^\circ$C under air for 20 h, then cooled down to room temperature. The mixture was evaporated under vacuum. The corresponding azobenzene was isolated by silica gel column chromatography with a petroleum ether/ethyl acetate mixture as eluent.
1.3 Typical procedure for TBHP-mediated reaction of aldehydes or benzyl amines with azobenzenes:
The mixture of azobenzenes 1 (0.25 mmol), aldehydes 2 (0.25 mmol) (or benzyl amines 3 (0.5 mmol)),
TBHP (1.0 mmol) and DCE (1 mL) were added into a sealed tube. After being stirred vigorously at 120 °C
for 24 h, the mixture was evaporated under vacuum. The corresponding product was isolated by silica gel
column chromatography with a petroleum ether/ethyl acetate mixture as eluent.

1.4 The GC-MS and HRMS spectra about the reaction mixture.
The mixture of azobenzene 1a (0.25 mmol), benzaldehyde 2a (0.25 mmol), TBHP (1.0 mmol) and DCE (1
mL) were added into a sealed tube. After being stirred vigorously at 120 °C for 24 h, part of the mixture was
analyzed by GC-MS and HRMS, respectively.
The by-product azoxybenzene was detected by HRMS spectrum of reaction mixture:

![HRMS spectrum of the reaction mixture](image1)

Figure S1. The HRMS spectrum of the reaction mixture

The corresponding GC-MS spectra about the by-product nitrobenzene was shown in
Figure 2 and Figure 3.

![GC-MS spectra from the reaction mixture which was carried out for 24 h](image2)

Figure S2. The GC-MS spectra from the reaction mixture which was carried out for 24 h

![GC-MS spectra of nitrobenzene](image3)

Figure S3. The GC-MS spectra of nitrobenzene
2. Experimental characterization data for products

*N*-phenylbenzamide (4a)

White solid. 40 mg, 81% yield. $^1$H NMR (400 MHz, CDCl$_3$): $\delta$ 7.88 (d, $J$ = 7.2 Hz, 2H), 7.80 (s, 1H), 7.65 (d, $J$ = 7.6 Hz, 2H), 7.59-7.47 (m, 3H), 7.38 (t, $J$ = 7.6 Hz, 2H), 7.16 (t, $J$ = 7.6 Hz, 1H). $^{13}$C NMR (100 MHz, CDCl$_3$): $\delta$ 165.8, 137.9, 135.0, 131.9, 129.1, 128.8, 127.0, 124.6, 120.2. HRMS (ESI-TOF) m/z: [M + H]$^+$ Calcd for C$_{13}$H$_{12}$NO 198.0919; Found 198.0930

*N*-(_o_-tolyl)benzamide (4b)

White solid. 25 mg, 47% yield. $^1$H NMR (400 MHz, CDCl$_3$): $\delta$ 8.02 (d, $J$ = 7.6 Hz, 1H), 7.97 (d, $J$ = 7.2 Hz, 2H), 7.78 (s, 1H), 7.67-7.55 (m, 3H), 7.37-7.30 (m, 2H), 7.20 (t, $J$ = 7.6 Hz, 1H), 2.42 (s, 3H). $^{13}$C NMR (100 MHz, CDCl$_3$): $\delta$ 165.8, 134.7, 134.0, 132.6, 130.8, 129.5, 127.8, 126.0, 125.9, 124.4, 122.0, 16.8. HRMS (ESI-TOF) m/z: [M + H]$^+$ Calcd for C$_{14}$H$_{14}$NO 212.1075; Found 212.1066

*N*-(_m_-tolyl)benzamide (4c)

White solid. 37 mg, 70% yield. $^1$H NMR (400 MHz, CDCl$_3$): $\delta$ 8.11 (d, $J$ = 6.8 Hz, 1H), 7.93 (s, 1H), 7.85 (d, $J$ = 7.2 Hz, 2H), 7.63-7.39 (m, 4H), 7.23 (t, $J$ = 8.0 Hz, 1H), 6.96 (d, $J$ = 7.2 Hz, 1H), 2.34 (s, 3H). $^{13}$C NMR (100 MHz, CDCl$_3$): $\delta$ 165.9, 139.0, 137.8, 135.0, 133.7, 131.8, 130.2, 128.5, 127.1, 125.4, 121.0, 117.4, 21.5. HRMS (ESI-TOF) m/z: [M + H]$^+$ Calcd for C$_{14}$H$_{14}$NO 212.1075; Found 212.1067

*N*-(_p_-tolyl)benzamide (4d)

White solid. 38 mg, 72% yield. $^1$H NMR (400 MHz, CDCl$_3$): $\delta$ 8.12 (d, $J$ = 7.2 Hz, 1H), 7.86 (d, $J$ = 6.8 Hz, 2H), 7.80 (s, 1H), 7.54-7.45 (m, 4H), 7.18 (d, $J$ = 8.0 Hz, 2H), 2.34 (s, 3H). $^{13}$C NMR (100 MHz, CDCl$_3$): $\delta$ 165.7, 135.4, 135.1, 134.2, 131.7, 129.6, 128.7, 127.0, 120.4, 20.9. HRMS (ESI-TOF) m/z: [M + H]$^+$ Calcd for C$_{14}$H$_{14}$NO 212.1075; Found 212.1078

*N*-(4-methoxyphenyl)benzamide (4e)

Pale yellow solid. 24 mg, 41% yield. $^1$H NMR (400 MHz, CDCl$_3$): $\delta$ 7.86 (d, $J$ = 7.2 Hz, 2H), 7.56-7.51 (m,
3H), 7.47 (t, J = 7.6 Hz, 2H), 6.90 (d, J = 8.8 Hz, 2H), 3.81 (s, 3H). $^{13}$C NMR (100 MHz, CDCl$_3$): δ 165.7, 135.6, 135.0, 131.7, 131.0, 128.7, 128.4, 127.0, 122.1, 114.2, 55.5. HRMS (ESI-TOF) m/z: [M + H]$^+$ Calcld for C$_7$H$_5$NO$_2$ 228.1025; Found 228.1024

$N$-(4-fluorophenyl)benzamide (4f)$^2$

![4-fluorophenylbenzamide](image)

Pale yellow solid. 34 mg, 64% yield. $^1$H NMR (400 MHz, CDCl$_3$): δ 8.11 (d, J = 7.2 Hz, 1H), 7.87 (d, J = 7.2 Hz, 2H), 7.84 (s, 1H), 7.52-7.47 (m, 4H), 7.07 (t, J = 8.4 Hz, 2H). $^{13}$C NMR (100 MHz, CDCl$_3$): δ 165.7, 160.8, 158.3, 134.7, 133.6, 131.9, 130.2, 128.8, 128.5, 127.0, 122.1 (J = 7.7 Hz), 115.9, 115.7. HRMS (ESI-TOF) m/z: [M - H]$^-$ Calcld for C$_8$H$_7$FNO 214.0668; Found 214.0661

$N$-(4-chlorophenyl)benzamide (4g)$^2$

![4-chlorophenylbenzamide](image)

Pale yellow solid. 43 mg, 75% yield. $^1$H NMR (400 MHz, CDCl$_3$): δ 8.11 (d, J = 7.2 Hz, 1H), 7.86 (d, J = 7.2 Hz, 2H), 7.83 (bs, 1H), 7.53-7.46 (m, 4H), 7.34 (d, J = 8.8 Hz, 2H). $^{13}$C NMR (100 MHz, CDCl$_3$): δ 165.7, 136.5, 134.6, 132.1, 130.2, 129.6, 129.1, 128.9, 127.0, 121.4. HRMS (ESI-TOF) m/z: [M + H]$^+$ Calcld for C$_8$H$_7$ClNO 232.0529; Found 232.0513

$N$-(4-bromophenyl)benzamide (4h)$^3$

![4-bromophenylbenzamide](image)

Pale yellow solid. 62 mg, 91% yield. $^1$H NMR (400 MHz, CDCl$_3$): δ 8.12 (d, J = 7.2 Hz, 1H), 7.86 (d, J = 7.2 Hz, 1H), 7.82 (s, 1H), 7.58-7.47 (m, 7H). $^{13}$C NMR (100 MHz, CDCl$_3$): δ 162.6, 134.6, 133.7, 132.1, 132.0, 128.9, 127.0, 121.7, 117.2. HRMS (ESI-TOF) m/z: [M - H]$^-$ Calcld for C$_8$H$_7$BrNO 273.9868; Found 273.9833

$N$-(3-chlorophenyl)benzamide (4i)$^3$

![3-chlorophenylbenzamide](image)

Pale yellow solid. 33 mg, 57% yield. $^1$H NMR (400 MHz, CDCl$_3$): δ 8.11 (d, J = 7.2 Hz, 1H), 8.04 (s, 1H), 7.77-7.75 (m, 1H), 7.50-7.42 (m, 5H), 7.28-7.23 (m, 1H), 7.13-7.09 (m, 1H). $^{13}$C NMR (100 MHz, CDCl$_3$): δ 165.9, 139.1, 134.7, 134.5, 132.1, 130.0, 128.8, 127.1, 124.6, 120.4, 118.3. HRMS (ESI-TOF) m/z: [M + H]$^+$ Calcld for C$_8$H$_7$ClNO 232.0529; Found 232.0523

$N$-(3-bromophenyl)benzamide (4j)$^3$

![3-bromophenylbenzamide](image)
White solid. 40 mg, 58% yield. $^1$H NMR (400 MHz, CDCl$_3$): $\delta$ 8.03 (s, 1H), 7.91-7.82 (m, 3H), 7.54 (t, $J$ = 7.2 Hz, 2H), 7.45 (t, $J$ = 7.2 Hz, 2H), 7.28-7.17 (m, 2H). $^{13}$C NMR (100 MHz, CDCl$_3$): $\delta$ 165.9, 139.2, 134.5, 132.1, 130.3, 128.5, 127.6, 127.1, 123.2, 122.7, 118.8. HRMS (ESI-TOF) m/z: [M + H]$^+$ Calcd for C$_{13}$H$_{14}$BrNO 276.0024; Found 276.0021

**ethyl 4-benzamidobenzoate (4k)**

White solid. 55 mg, 82% yield. $^1$H NMR (400 MHz, CDCl$_3$): $\delta$ 8.27 (s, 1H), 8.03 (d, $J$ = 8.8 Hz, 2H), 7.87 (d, $J$ = 7.2 Hz, 2H), 7.75 (d, $J$ = 8.8 Hz, 2H), 7.57-7.53 (m, 1H), 7.45 (t, $J$ = 7.2 Hz, 2H), 4.35 (q, $J$ = 7.2 Hz, 2H), 1.39 (t, $J$ = 7.2 Hz, 3H). $^{13}$C NMR (100 MHz, CDCl$_3$): $\delta$ 166.2, 166.0, 142.2, 134.5, 132.2, 130.8, 128.8, 127.1, 126.1, 119.3, 60.9, 14.4. HRMS (ESI-TOF) m/z: [M + H]$^+$ Calcd for C$_{16}$H$_{16}$NO$_2$ 270.1130; Found 270.1129

**N-(4-(trifluoromethoxy)phenyl)benzamide (4l)**

White solid. 49 mg, 70% yield. mp: 176-178 °C. $^1$H NMR (400 MHz, CDCl$_3$): $\delta$ 8.11 (d, $J$ = 6.8 Hz, 1H), 7.87 (d, $J$ = 7.2 Hz, 2H), 7.61-7.46 (m, 4H), 7.23 (d, $J$ = 8.4 Hz, 2H). $^{13}$C NMR (100 MHz, CDCl$_3$): $\delta$ 165.8, 136.5, 134.5, 133.7, 132.1, 130.2, 128.9, 128.5, 127.0, 121.9, 121.3. HRMS (ESI-TOF) m/z: [M - H]$^-$ Calcd for C$_{16}$H$_{14}$F$_3$NO$_2$ 280.0585; Found 280.0573

**N-(2,4-dimethylphenyl)benzamide (4m)**

Pale yellow solid. 16 mg, 29% yield. $^1$H NMR (400 MHz, CDCl$_3$): $\delta$ 8.13 (d, $J$ = 7.2 Hz, 2H), 7.89 (d, $J$ = 6.8 Hz, 1H), 7.63-7.46 (m, 5H), 7.12-7.02 (m, 1H), 2.32 (s, 3H), 2.30 (s, 3H). $^{13}$C NMR (100 MHz, CDCl$_3$): $\delta$ 172.1, 139.1, 133.8, 131.8, 131.3, 130.2, 129.4, 128.8, 128.5, 127.4, 127.3, 20.9, 17.8. HRMS (ESI-TOF) m/z: [M + H]$^+$ Calcd for C$_{13}$H$_{16}$NO 226.1232; Found 226.1226

**2-methyl-N-phenylbenzamide (4n)**

White solid. 30 mg, 57% yield. $^1$H NMR (400 MHz, CDCl$_3$): $\delta$ 7.61 (d, $J$ = 8.0 Hz, 2H), 7.46-7.32 (m, 4H), 7.27-7.22 (m, 3H), 7.14 (d, $J$ = 7.2 Hz, 1H), 2.48 (s, 3H). $^{13}$C NMR (100 MHz, CDCl$_3$): $\delta$ 168.2, 138.0, 136.4, 131.3, 130.3, 129.1, 126.6, 125.9, 124.6, 119.9, 19.8. HRMS (ESI-TOF) m/z: [M + H]$^+$ Calcd for C$_{14}$H$_{14}$NO
3-methyl-N-phenylbenzamide (4o)²

Pale yellow solid. 38 mg, 72% yield. ¹H NMR (400 MHz, CDCl₃): δ 7.85 (bs, 1H), 7.69-7.63 (m, 3H), 7.39-7.35 (m, 5H), 7.15 (t, J = 7.2 Hz, 1H), 2.42 (s, 3H). ¹³C NMR (100 MHz, CDCl₃): δ 165.9, 138.7, 138.3, 135.0, 132.6, 129.1, 128.7, 127.8, 124.5, 123.9, 120.2, 21.4. HRMS (ESI-TOF) m/z: [M + H]⁺ Calcd for C₁₄H₁₄NO 212.1075; Found 212.1079

4-methyl-N-phenylbenzamide (4p)²

White solid. 36 mg, 68% yield. ¹H NMR (400 MHz, CDCl₃): δ 7.84 (s, 1H), 7.76 (d, J = 8.0 Hz, 2H), 7.64 (d, J = 7.6 Hz, 2H), 7.36 (t, J = 8.0 Hz, 2H), 7.29-7.26 (m, 2H), 7.14 (t, J = 7.6 Hz, 1H), 2.42 (s, 3H). ¹³C NMR (100 MHz, CDCl₃): δ 165.6, 142.4, 138.0, 132.1, 129.4, 129.1, 124.4, 120.2, 21.5. HRMS (ESI-TOF) m/z: [M + Na]⁺ Calcd for C₁₄H₁₃NNaO 234.0895; Found 234.0893

2-methoxy-N-phenylbenzamide (4q)⁵

White solid. 26 mg, 46% yield. ¹H NMR (400 MHz, CDCl₃): δ 9.81 (s, 1H), 8.31-8.27 (m, 1H), 7.68 (d, J = 8.0 Hz, 2H), 7.50-7.47 (m, 1H), 7.36 (t, J = 8.0 Hz, 2H), 7.16-7.12 (m, 2H), 7.03 (d, J = 8.0 Hz, 1H), 4.05 (s, 3H). ¹³C NMR (100 MHz, CDCl₃): δ 163.2, 157.2, 138.4, 133.3, 132.5, 129.0, 124.2, 121.7, 120.4, 111.5, 56.2. HRMS (ESI-TOF) m/z: [M + H]⁺ Calcd for C₁₄H₁₄NO₂ 228.1025; Found 228.1022

3-methoxy-N-phenylbenzamide (4r)²

White solid. 36 mg, 64% yield. ¹H NMR (400 MHz, CDCl₃): δ 7.87 (s, 1H), 7.76 (d, J = 8.0 Hz, 2H), 7.64 (d, J = 8.0 Hz, 2H), 7.40-7.35 (m, 1H), 7.15 (t, J = 7.6 Hz, 1H), 7.09-7.07 (m, 1H), 3.86 (s, 3H). ¹³C NMR (100 MHz, CDCl₃): δ 165.6, 159.9, 137.9, 136.5, 129.8, 129.1, 124.6, 120.2, 118.7, 118.0, 112.5, 55.5. HRMS (ESI-TOF) m/z: [M + H]⁺ Calcd for C₁₄H₁₄NO₂ 228.1025; Found 228.1022

4-methoxy-N-phenylbenzamide (4s)²
White solid. 38 mg, 66% yield. $^1$H NMR (400 MHz, CDCl$_3$): δ 7.84 (d, $J = 8.8$ Hz, 2H), 7.80 (s, 1H), 7.63 (d, $J = 7.6$ Hz, 2H), 7.36 (t, $J = 7.6$ Hz, 2H), 7.13 (t, $J = 7.6$ Hz, 1H), 6.97 (d, $J = 8.8$ Hz, 2H), 3.87 (s, 3H). $^{13}$C NMR (100 MHz, CDCl$_3$): δ 165.2, 162.5, 138.1, 129.1, 129.0, 127.1, 124.3, 120.1, 114.0, 55.5. HRMS (ESI-TOF) m/z: [M + H]$^+$ Calcd for C$_{14}$H$_{14}$NO$_2$: 228.1025; Found 228.1029

4-(dimethylamino)-N-phenylbenzamide (4t)$^5$

White solid. 25 mg, 43% yield. $^1$H NMR (400 MHz, CDCl$_3$): δ 7.78 (d, $J = 8.8$ Hz, 2H), 7.73 (s, 1H), 7.63 (d, $J = 7.6$ Hz, 2H), 7.35 (t, $J = 7.6$ Hz, 2H), 7.25-7.23 (m, 2H), 7.13-7.08 (m, 1H), 3.05 (s, 6H). $^{13}$C NMR (100 MHz, CDCl$_3$): δ 165.6, 153.8, 138.5, 132.0, 131.4, 129.0, 128.6, 124.5, 123.9, 111.2, 40.1. HRMS (ESI-TOF) m/z: [M + H]$^+$ Calcd for C$_{15}$H$_{17}$N$_2$O: 241.1341; Found 241.1346

4-fluoro-N-phenylbenzamide (4u)$^3$

Pale yellow solid. 22 mg, 41% yield. $^1$H NMR (400 MHz, CDCl$_3$): δ 7.91-7.87 (m, 2H), 7.77 (s, 1H), 7.62 (d, $J = 8.0$ Hz, 2H), 7.38 (t, $J = 8.0$ Hz, 2H), 7.17 (t, $J = 8.4$ Hz, 3H). $^{13}$C NMR (100 MHz, CDCl$_3$): δ 166.2, 164.7, 163.7, 137.7, 131.2, 130.5 ($J = 2.1$ Hz), 129.4 ($J = 8.9$ Hz), 129.2, 124.7, 120.2, 115.9 ($J = 21.8$ Hz). HRMS (ESI-TOF) m/z: [M + H]$^+$ Calcd for C$_{13}$H$_{11}$FNO: 216.0825; Found 216.0819

4-chloro-N-phenylbenzamide (4v)$^3$

White solid. 31 mg, 53% yield. $^1$H NMR (400 MHz, CDCl$_3$): δ 7.82 (d, $J = 8.4$ Hz, 2H), 7.77 (s, 1H), 7.63 (d, $J = 8.0$ Hz, 2H), 7.47 (d, $J = 8.4$ Hz, 2H), 7.38 (t, $J = 8.0$ Hz, 2H), 7.17 (t, $J = 7.6$ Hz, 1H). $^{13}$C NMR (100 MHz, CDCl$_3$): δ 164.6, 138.2, 137.6, 133.3, 129.2, 129.1, 128.5, 124.8, 120.2. HRMS (ESI-TOF) m/z: [M + H]$^+$ Calcd for C$_{13}$H$_{11}$ClNO: 232.0529; Found 232.0531

4-bromo-N-phenylbenzamide (4w)$^2$
White soild. 27 mg, 39% yield. $^1$H NMR (400 MHz, CDCl$_3$): $\delta$ 7.75 (d, $J$ = 8.8 Hz, 2H), 7.65-7.61 (m, 4H), 7.38 (t, $J$ = 7.6 Hz, 2H), 7.17 (t, $J$ = 7.6 Hz, 1H). $^{13}$C NMR (100 MHz, CDCl$_3$): $\delta$ 163.7, 136.6, 132.8, 131.0, 128.1, 127.6, 125.6, 123.8, 119.2. HRMS (ESI-TOF) m/z: [M + Na]$^+$ Calcd for C$_{13}$H$_9$BrNNaO 297.9843; Found 297.9829

3-fluoro-N-phenylbenzamide (4x)$^2$

White soild. 42 mg, 79% yield. $^1$H NMR (400 MHz, CDCl$_3$): $\delta$ 7.85 (bs, 1H), 7.65-7.57 (m, 4H), 7.49-7.43 (m, 1H), 7.40-7.35 (m, 2H), 7.28-7.22 (m, 1H), 7.17 (t, $J$ = 7.6 Hz, 1H). $^{13}$C NMR (100 MHz, CDCl$_3$): $\delta$ 164.4, 164.1, 161.6, 137.6, 137.2 ($J$ = 6.8 Hz), 130.5 ($J$ = 7.9 Hz), 129.2, 124.9, 122.4, 120.3, 118.9 ($J$ = 21.1 Hz), 114.6 ($J$ = 22.9 Hz). HRMS (ESI-TOF) m/z: [M + H]$^+$ Calcd for C$_{10}$H$_9$FNO 216.0825; Found 216.0831

4-nitro-N-phenylbenzamide (4y)$^5$

White soild. 24 mg, 40% yield. $^1$H NMR (400 MHz, CDCl$_3$): $\delta$ 7.99 (d, $J$ = 8.4 Hz, 2H), 7.82 (s, 1H), 7.77 (d, $J$ = 8.0 Hz, 2H), 7.65 (d, $J$ = 8.0 Hz, 2H), 7.40 (t, $J$ = 7.6 Hz, 2H), 7.20 (t, $J$ = 7.6 Hz, 1H). $^{13}$C NMR (100 MHz, CDCl$_3$): $\delta$ 163.2, 149.3, 140.7, 137.4, 129.2, 127.5, 125.9, 125.1, 120.3. HRMS (ESI-TOF) m/z: [M - H]$^-$ Calcd for C$_{10}$H$_7$N$_2$O, 241.0613; Found 241.0591

N-phenyl-4-(trifluoromethyl)benzamide (4z)$^6$

White soild. 28 mg, 43% yield. $^1$H NMR (400 MHz, CDCl$_3$): $\delta$ 8.36 (d, $J$ = 8.4 Hz, 2H), 8.05 (d, $J$ = 8.8 Hz, 2H), 7.82 (s, 1H), 7.64 (d, $J$ = 8.0 Hz, 2H), 7.41 (t, $J$ = 8.0 Hz, 2H), 7.21 (t, $J$ = 8.4 Hz, 1H). $^{13}$C NMR (100 MHz, CDCl$_3$): $\delta$ 164.3, 139.2, 133.5, 131.5, 128.3, 127.2, 124.3, 123.7, 123.0, 120.5. HRMS (ESI-TOF) m/z: [M - H]$^-$ Calcd for C$_{13}$H$_9$F$_3$NO 264.0636; Found 264.0615

4-cyano-N-phenylbenzamide (4aa)$^7$

White soild. 21 mg, 38% yield. $^1$H NMR (400 MHz, CDCl$_3$): $\delta$ 7.97 (d, $J$ = 8.4 Hz, 2H), 7.91 (s, 1H), 7.78 (d, $J$ = 8.4 Hz, 2H), 7.63 (d, $J$ = 8.0 Hz, 2H), 7.39 (t, $J$ = 7.6 Hz, 2H), 7.20 (t, $J$ = 7.6 Hz, 1H). $^{13}$C NMR (100 MHz, CDCl$_3$): $\delta$ 163.9, 138.9, 137.3, 132.6, 129.2, 127.8, 125.3, 120.4, 117.9, 115.4. HRMS (ESI-TOF) m/z: [M + H]$^+$ Calcd for C$_{13}$H$_9$N$_2$O 223.0871; Found 223.0876
N-phenyl-2-(trifluoromethyl)benzamide (4ab)\(^2\)

![N-phenyl-2-(trifluoromethyl)benzamide](image)

White solid. 28 mg, 43% yield. \(^1\)H NMR (400 MHz, CDCl\(_3\)): \(\delta\) 7.75 (d, \(J = 7.6\) Hz, 1H), 7.67-7.56 (m, 5H), 7.51 (s, 1H), 7.38 (t, \(J = 7.6\) Hz, 2H), 7.19 (t, \(J = 7.6\) Hz, 1H). \(^13\)C NMR (100 MHz, CDCl\(_3\)): \(\delta\) 165.7, 137.4, 135.8, 132.2, 130.9, 130.2, 129.2, 128.6, 126.5 (\(J = 4.9\) Hz), 125.1, 120.3. HRMS (ESI-TOF) m/z: [M + Na]\(^+\) Calcd for C\(_{14}\)H\(_{10}\)FNaO 288.0612; Found 288.0605

N-phenylcyclohexanecarboxamide (4ac)\(^9\)

![N-phenylcyclohexanecarboxamide](image)

White solid. 17 mg, 34% yield. \(^1\)H NMR (400 MHz, CDCl\(_3\)): \(\delta\) 7.52 (d, \(J = 8.0\) Hz, 2H), 7.31 (t, \(J = 8.0\) Hz, 2H), 7.09 (t, \(J = 7.6\) Hz, 1H), 2.27-2.20 (m, 1H), 1.85-1.65 (m, 5H), 1.57-1.43 (m, 5H). \(^13\)C NMR (100 MHz, CDCl\(_3\)): \(\delta\) 174.5, 138.1, 128.9, 124.1, 119.8, 46.6, 29.7, 25.7, 25.3. HRMS (ESI-TOF) m/z: [M + H]\(^+\) Calcd for C\(_{13}\)H\(_{18}\)NO 204.1388; Found 204.1386

N-phenylfuran-2-carboxamide (4ad)\(^9\)

![N-phenylfuran-2-carboxamide](image)

Brown solid. 18 mg, 38% yield. \(^1\)H NMR (400 MHz, CDCl\(_3\)): \(\delta\) 8.08 (s, 1H), 7.66 (d, \(J = 7.6\) Hz, 2H), 7.52 (s, 1H), 7.37 (t, \(J = 7.6\) Hz, 2H), 7.26-7.24 (m, 1H), 7.15 (t, \(J = 7.6\) Hz, 1H), 6.58-6.56 (m, 1H). \(^13\)C NMR (100 MHz, CDCl\(_3\)): \(\delta\) 155.0, 146.8, 143.1, 136.3, 128.1, 123.5, 118.9, 114.3, 111.6. HRMS (ESI-TOF) m/z: [M + H]\(^+\) Calcd for C\(_{11}\)H\(_{10}\)NO, 188.0712; Found 188.0719

N-phenylbutyramide (4ae)\(^9\)

![N-phenylbutyramide](image)

White solid. 19 mg, 47% yield. \(^1\)H NMR (400 MHz, CDCl\(_3\)): \(\delta\) 7.52 (d, \(J = 8.0\) Hz, 2H), 7.46 (s, 1H), 7.30 (t, \(J = 7.6\) Hz, 2H), 7.09 (t, \(J = 7.6\) Hz, 1H), 2.33 (t, \(J = 7.6\) Hz, 2H), 1.79-1.72 (m, 2H), 0.99 (t, \(J = 7.6\) Hz, 3H). \(^13\)C NMR (100 MHz, CDCl\(_3\)): \(\delta\) 171.5, 137.9, 128.9, 124.2, 119.9, 39.7, 19.1, 13.8. HRMS (ESI-TOF) m/z: [M + H]\(^+\) Calcd for C\(_{10}\)H\(_{10}\)NO, 164.1075; Found 164.1083

2-fluoro-N-phenylbenzamide (4af)\(^2\)

![2-fluoro-N-phenylbenzamide](image)

White solid. 31 mg, 57% yield. \(^1\)H NMR (400 MHz, CDCl\(_3\)): \(\delta\) 8.47 (bs, 1H), 8.20-8.15 (m, 1H), 7.66 (d, \(J =

S10
7.6 Hz, 2H), 7.54-7.51 (m, 1H), 7.40-7.29 (m, 3H), 7.21-7.14 (m, 2H). $^{13}$C NMR (100 MHz, CDCl$_3$): δ 161.6, 161.3, 159.2, 137.7, 133.8 ($J$ = 9.4 Hz), 132.3, 129.1, 125.1, 124.8, 121.3 ($J$ = 11.2 Hz), 120.5, 116.1 ($J$ = 24.9 Hz). HRMS (ESI-TOF) m/z: [M + H]$^+$ Calcd for C$_{13}$H$_{11}$FNO 216.0825; Found 216.0818
3. References

4. NMR spectra

4a
$4q$
4ab
4ac