Supporting Information

Aerobic Oxidative α-Arylation of Furans with Boronic Acids via Pd(II)-Catalyzed C–C Bond Cleavage of Primary Furfuryl Alcohols: Sustainable Access to Arylfurans

Guanghao Huang, Lin Lu, Huanfeng Jiang and Biaolin Yin*

Key Laboratory of Functional Molecular Engineering of Guangdong Province,
School of Chemistry and Chemical Engineering, South China University of Technology,
Guangzhou 510640, P. R. China

E-mail: blyin@scut.edu.cn
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1 General experimental details

All chemicals and solvents were purchased from commercial vendors and used without further purification unless otherwise noted. Analytical TLC was performed with silica gel 60 F254 plates. Column chromatography was performed on silica gel 200-300 mesh and using appropriate solvents as eluent. Melting points were determined using a Stuart SMP10 melting point apparatus. NMR spectra were recorded on a Bruker AV-400 spectrometer (1H NMR at 400 MHz and 13C NMR at 100 MHz). Proton chemical shifts were referenced relative to tetramethylsilane proton signals at δ = 0.00 ppm. Carbon chemical shifts were referenced relative to CDCl3 at δ = 77.16 ppm. Data for 1H NMR are reported as follows: chemical shift (ppm), multiplicity (s = singlet, d = doublet, t = triplet, q = quartet, m = multiplet, dd = double doublet, dt = double triplet, dq = double quartet, br = broad), coupling constants (Hz), integration. Data for 13C NMR are reported in chemical shift (ppm). Infrared spectra (IR) recorded as KBr disks on a Bruker Tensor 27 FT/IR spectrometer are reported in cm⁻¹. ESI technique was used for the high resolution mass (HRMS) measurements.
2 Synthesis of the starting materials

(5-Phenylfuran-2-yl)methanol (1a)

The syntheses of 1a have been reported previously. Analytical data were consistent with previously reported data. Yellow solid (2.34 g, 85% over two steps). $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.69 – 7.64 (m, 2H), 7.42 – 7.34 (m, 2H), 7.28 – 7.23 (m, 1H), 6.59 (d, $J = 3.3$ Hz, 1H), 6.37 (d, $J = 3.3$ Hz, 1H), 4.66 (s, 2H), 1.83 (br, 1H). $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 154.2, 153.7, 130.8, 128.8, 127.6, 124.0, 110.1, 105.8, 57.8.

(5-(p-Tolyl)furan-2-yl)methanol (1b)

Compound 1b was prepared in the same manner of 1a, except that 4-tolylboronic acid was used instead of phenylboronic acid. Analytical data were consistent with previously reported data. White solid (0.82 g, 94% over two steps). $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.56 (d, $J = 8.0$ Hz, 2H), 7.18 (d, $J = 7.9$ Hz, 2H), 6.53 (d, $J = 3.2$ Hz, 1H), 6.35 (d, $J = 3.2$ Hz, 1H), 4.65 (s, 2H), 2.35 (s, 3H), 1.89 (br, 1H). $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 154.4, 153.3, 137.5, 129.5, 128.1, 123.9, 110.1, 105.1, 57.8, 21.4.

(5-(4-Methoxyphenyl)furan-2-yl)methanol (1c)

Compound 1c was prepared in the same manner of 1a, except that 4-methoxyphenylboronic acid was used instead of phenylboronic acid. Analytical data were consistent with previously reported data. White solid (0.91 g, 94% over two steps). $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.58 (d, $J = 8.8$ Hz, 2H), 6.90 (d, $J = 8.8$ Hz, 2H), 6.44 (d, $J = 3.2$ Hz, 1H), 6.33 (d, $J = 3.2$ Hz, 1H), 4.62 (s, 2H), 3.81 (s, 3H), 2.10 (br, 1H). $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 159.2, 154.2, 153.0, 125.4, 123.9, 114.2, 110.1, 104.2, 57.7, 55.4.

(5-(4-Fluorophenyl)furan-2-yl)methanol (1d)
The syntheses of 1d have been reported previously. Analytical data were consistent with previously reported data. Yellow solid (0.21 g, 24%). $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.66 – 7.58 (m, 2H), 7.09 – 7.02 (m, 2H), 6.51 (d, $J = 3.3$ Hz, 1H), 6.35 (d, $J = 3.3$ Hz, 1H), 4.64 (s, 2H), 2.05 (br, 1H). $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 162.3 (d, $J_{CF} = 24.56$ Hz), 153.7, 153.3, 127.2 (d, $J_{CF} = 3.3$ Hz), 125.7 (d, $J_{CF} = 8.0$ Hz), 115.8 (d, $J_{CF} = 21.8$ Hz), 110.1, 105.5 (d, $J_{CF} = 1.3$ Hz), 57.7. $^{19}$F NMR (376 MHz, CDCl$_3$) $\delta$ -114.12.

(5-(4-Nitrophenyl)furan-2-yl)methanol (1e)

The syntheses of 1e have been reported previously. Analytical data were consistent with previously reported data. Yellow solid (0.18 g, 17%). $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 8.24 (d, $J = 8.8$ Hz, 2H), 7.78 (d, $J = 8.8$ Hz, 2H), 6.83 (d, $J = 3.3$ Hz, 1H), 6.46 (d, $J = 3.3$ Hz, 1H), 4.71 (s, 2H), 1.84 (br, 1H). $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 156.0, 151.8, 146.6, 136.4, 124.5, 124.1, 110.7, 109.9, 57.7.

(5-(Thiophen-2-yl)furan-2-yl)methanol (1f)

Compound 1f was prepared in the same manner of 1a, except that 2-thiopheneboronic acid was used instead of phenylboronic acid. White solid (0.32 g, 39% over two steps). $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.26 – 7.24 (m, 1H), 7.23 – 7.19 (m, 1H), 7.02 (dd, $J = 5.0$, 3.7 Hz, 1H), 6.43 (d, $J = 3.3$ Hz, 1H), 6.33 (d, $J = 3.3$ Hz, 1H), 4.62 (s, 2H), 1.97 (br, 1H). $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 153.3, 149.6, 133.7, 127.7, 124.4, 122.9, 110.1, 105.9, 57.6. IR (film) 3312, 3048, 2925, 1651, 1423, 1197, 1012, 845, 785 cm$^{-1}$. HRMS (ESI) $m/z$ Calcd for C$_9$H$_8$NaO$_2$S [M+Na]$^+$: 203.0137, found: 203.0136.

(5-Methylfuran-2-yl)methanol (1g)
The syntheses of 1g have been reported previously.\textsuperscript{4} Analytical data were consistent with previously reported data.\textsuperscript{4} Yellow oil (0.93 g, 84%). \textsuperscript{1}H NMR (400 MHz, CDCl\textsubscript{3}) $\delta$ 6.15 (d, $J = 3.0$ Hz, 1H), 5.90 (d, $J = 3.0$ Hz, 1H), 4.52 (s, 2H), 2.28 (s, 3H), 2.13 (br, 1H). \textsuperscript{13}C NMR (100 MHz, CDCl\textsubscript{3}) $\delta$ 152.5, 152.4, 108.8, 106.3, 57.5, 13.6.

(5-Ethylfuran-2-yl)methanol (1h)

The syntheses of 1h have been reported previously.\textsuperscript{2} Analytical data were consistent with previously reported data.\textsuperscript{2} Yellow oil (0.72 g, 34% over two steps). \textsuperscript{1}H NMR (400 MHz, CDCl\textsubscript{3}) $\delta$ 6.15 (d, $J = 2.8$ Hz, 1H), 5.91 (br, 1H), 4.51 (s, 2H), 2.67–2.50 (m, 3H), 1.22 (t, $J = 7.6$ Hz, 3H). \textsuperscript{13}C NMR (100 MHz, CDCl\textsubscript{3}) $\delta$ 158.1, 152.3, 108.5, 104.7, 57.4, 21.4, 12.1.

Methyl 5-(hydroxymethyl)furan-2-carboxylate (1j)

To a DMSO solution of potassium hydroxide (100 mg potassium hydroxide in 5 mL DMSO) was added 5-(hydroxymethyl)furan-2-carboxylic acid (0.38 g, 2.7 mmol). After stirring at room temperature for 5 min, methyl iodide (0.25 g, 1.8 mmol) was added and the mixture stirred for 5 h. Water (30 mL) was added very carefully and the mixture was extracted with EtOAc (3 × 20 mL). The combined organic layers were dried over Na\textsubscript{2}SO\textsubscript{4} and concentrated in vacuo, and then was purified by silica gel chromatography (petroleum ether/EtOAc =5:1) to give the title compound 1j (0.23 g, 80 %) as a yellow oil. \textsuperscript{1}H NMR (400 MHz, CDCl\textsubscript{3}) $\delta$ 7.12 (d, $J = 3.4$ Hz, 1H), 6.41 (d, $J = 3.4$ Hz, 1H), 4.66 (s, 2H), 3.88 (s, 3H), 2.97 (br, 1H). \textsuperscript{13}C NMR (100 MHz, CDCl\textsubscript{3}) $\delta$ 159.4, 158.7, 143.9, 119.1, 109.5, 57.5, 52.1. Analytical data were consistent with previously reported data.\textsuperscript{5}

1-(5-Phenylfuran-2-yl)ethan-1-ol (1k)

The syntheses of 1k have been reported previously.\textsuperscript{6} Analytical data were consistent with previously reported data.\textsuperscript{6} Yellow oil (0.44 g, 96%). \textsuperscript{1}H NMR (400 MHz, CDCl\textsubscript{3}) $\delta$ 7.66 (d, $J = 7.8$ Hz, 2H), 7.37 (t, $J = 7.6$ Hz, 2H), 7.25 (t, $J = 7.4$ Hz, 1H), 6.58 (d, $J = 3.2$ Hz, 1H), 6.31 (d, $J =
= 3.2 Hz, 1H), 4.99 – 4.87 (m, 1H), 2.10 (br, 1H), 1.59 (d, J = 6.6 Hz, 3H). $^{13}$C NMR (100 MHz, CDCl$_3$) δ 157.3, 153.4, 130.9, 128.8, 127.5, 123.8, 107.4, 105.6, 63.9, 21.5.

1-(5-Phenylfuran-2-yl)propan-1-ol (II)

[Chemical structure image]

Compound II was prepared in the same manner of 1k, except that ethylmagnesium bromide was used instead of methylmagnesium bromide.$^6$ Yellow oil (0.47 g, 88%). $^1$H NMR (400 MHz, CDCl$_3$) δ 7.65 (d, J = 7.4 Hz, 2H), 7.36 (t, J = 7.7 Hz, 2H), 7.24 (t, J = 7.4 Hz, 1H), 6.58 (d, J = 3.3 Hz, 1H), 6.31 (d, J = 3.3 Hz, 1H), 4.65 (t, J = 6.7 Hz, 1H), 2.09 – 1.84 (m, 3H), 0.99 (t, J = 7.4 Hz, 3H); $^{13}$C NMR (100 MHz, CDCl$_3$) δ 156.4, 153.4, 130.9, 128.8, 127.4, 123.8, 108.2, 105.6, 69.5, 28.8, 10.1. IR (film) 3353, 3068, 2969, 1605, 1455, 1381, 1018, 759 cm$^{-1}$. HRMS (ESI) m/z Calcd for C$_{13}$H$_{14}$NaO$_2$ [M+Na]$^+$: 225.0886, found: 225.0887.

2-Methyl-1-(5-phenylfuran-2-yl)propan-1-ol (1m)

[Chemical structure image]

Compound 1m was prepared in the same manner of 1k, except that iso-propylmagnesium bromide was used instead of methylmagnesium bromide.$^6$ Yellow oil (0.38 g, 61%). $^1$H NMR (400 MHz, CDCl$_3$) δ 7.66 – 7.61 (m, 2H), 7.36 (t, J = 7.7 Hz, 2H), 7.23 (t, J = 7.4 Hz, 1H), 6.58 (d, J = 3.3 Hz, 1H), 6.30 (d, J = 3.3 Hz, 1H), 4.42 (d, J = 6.9 Hz, 1H), 2.17 (m, 1H), 2.05 (br, 1H), 1.05 (d, J = 6.8 Hz, 3H), 0.92 (d, J = 6.8 Hz, 3H). $^{13}$C NMR (100 MHz, CDCl$_3$) δ 155.9, 153.3, 131.0, 128.8, 127.4, 123.8, 108.8, 105.6, 73.8, 33.5, 18.9, 18.4. IR (film) 3446, 3021, 2961, 2843, 1611, 1543, 1353, 1019, 759 cm$^{-1}$. HRMS (ESI) m/z Calcd for C$_{14}$H$_{16}$NaO$_3$ [M+Na]$^+$: 239.1043, found: 239.1046.

2,2-Dimethyl-1-(5-phenylfuran-2-yl)propan-1-ol (1n)

[Chemical structure image]

Compound 1n was prepared in the same manner of 1k, except that tert-butylmagnesium chloride was used instead of methylmagnesium bromide.$^6$ Yellow oil (0.27 g, 41%). $^1$H NMR (400 MHz, CDCl$_3$) δ 7.63 (d, J = 7.4 Hz, 2H), 7.36 (t, J = 7.7 Hz, 2H), 7.23 (t, J = 7.4 Hz, 1H), 6.58 (d, J = 3.3 Hz, 1H), 6.29 (d, J = 3.3 Hz, 1H), 4.41 (s, 1H), 2.04 (br, 1H), 1.01 (s, 9H). $^{13}$C NMR (100
MHz, CDCl$_3$) $\delta$ 155.6, 153.0, 131.0, 128.8, 127.3, 123.7, 109.4, 105.5, 76.7, 35.8, 26.0. IR (film) 3447, 3063, 2957, 1650, 1542, 1383, 1204, 1014, 760 cm$^{-1}$. HRMS (ESI) m/z Calcd for C$_{15}$H$_{14}$NaO$_2$ [M+Na]$^+$: 253.1199, found: 253.1196.

2-(5-Phenylfuran-2-yl)propan-2-ol (1o)

Compounds 1o were prepared by additions of 5-lithio-2-phenylfuran, prepared by deprotonation of 2-phenylfuran with n-BuLi, to acetone.$^7$ Yellow oil (0.44 g, 62%). $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.65 (d, $J = 8.0$ Hz, 2H), 7.36 (t, $J = 7.4$ Hz, 2H), 7.24 (t, $J = 7.0$ Hz, 1H), 6.55 (d, $J = 3.1$ Hz, 1H), 6.26 (d, $J = 3.1$ Hz, 1H), 2.16 (br, 1H), 1.64 (s, 6H). $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 159.9, 153.0, 131.0, 128.8, 127.4, 123.8, 105.9, 105.6, 69.1, 28.9. IR (film) 3337, 3068, 2976, 1607, 1453, 1206, 1024, 759 cm$^{-1}$. HRMS (ESI) m/z Calcd for C$_{13}$H$_{14}$NaO$_2$ [M+Na]$^+$: 225.0886, found: 225.0884.

2-(Methoxymethyl)-5-phenylfuran (1p)

To a suspension of sodium hydride (60% in mineral oil, 0.19 g, 4.4 mmol) in 10 mL of anhydrous THF under N$_2$ was carefully added a solution of (5-phenylfuran-2-yl)methanol (1a, 0.5 g, 2.9 mmol) in 5 mL of anhydrous THF. After stirring at room temperature for 5 min, methyl iodide (0.82 g, 5.8 mmol) was added and the mixture stirred for 12 h. Water (15 mL) was added very carefully and the mixture concentrated in vacuo to remove the THF. The remaining aqueous mixture was extracted with EtOAc (3 $\times$ 30 mL). The combined organic layers were dried over Na$_2$SO$_4$ and concentrated in vacuo, and then was purified by silica gel chromatography (petroleum ether/EtOAc =20:1) to give the title compound 1p (0.48 g, 93 %) as a red oil. $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.67 (d, $J = 8.1$ Hz, 2H), 7.36 (t, $J = 7.7$ Hz, 2H), 7.24 (t, $J = 7.3$ Hz, 1H), 6.59 (d, $J = 3.3$ Hz, 1H), 6.39 (d, $J = 3.3$ Hz, 1H), 4.44 (s, 2H), 3.39 (s, 3H). $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 154.4, 151.4, 130.9, 128.7, 127.5, 124.0, 111.6, 105.7, 66.6, 57.9. Analytical data were consistent with previously reported data.$^8
3 General procedure for the synthesis of arylfurans 3

General procedure: 1 (0.5 mmol) was added to an 25-mL dried Schlenk tube charged with aryl boronic acids (1.25 mmol), Pd(OAc)$_2$ (5 mol %, 5.6 mg), L$^7$ (12 mol %, 11.0 mg ), KF (1.0 mmol, 58.0 mg), and 1,2-dichloroethane (1.5 mL). The mixture was stirred at 70 °C for 15 h under O$_2$ atmosphere (in balloon), and then was cooled down to room temperature. The resultant mixture was evaporated in vacuum and further isolated by flash chromatography on silica gel with petroleum ether to give the pure product 3.
4 Data for arylfurans 3

2,5-Diphenylfuran (3a)

White solid (76.1 mg, 69%), mp: 86-87 °C. \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.74 – 7.68 (m, 4H), 7.40 – 7.32 (m, 4H), 7.26 – 7.19 (m, 2H), 6.68 (s, 2H). \(^13\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 153.5, 130.9, 128.9, 127.5, 123.9, 107.4. IR (film) 3039, 1602, 1534, 1474, 1270, 1018, 794 cm\(^{-1}\). HRMS (ESI) \(m/z\) Calcd for C\(_{16}\)H\(_{13}\)O [M+H]\(^+\): 221.0961, found: 221.0963.

2-Phenyl-5-(m-tolyl)furan (3b)

White solid (80.5 mg, 68%), mp: 82-83 °C. \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.73 (d, \(J = 7.5\) Hz, 2H), 7.61 – 7.50 (m, 2H), 7.38 (t, \(J = 7.7\) Hz, 2H), 7.32 – 7.21 (m, 2H), 7.07 (d, \(J = 7.4\) Hz, 1H), 6.77 – 6.64 (m, 2H), 2.39 (s, 3H). \(^13\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 153.7, 153.4, 138.4, 131.0, 130.8, 128.8, 128.7, 128.3, 127.4, 124.5, 123.8, 121.0, 107.3, 107.2, 21.6. IR (film) 3046, 2959, 1602, 1533, 1478, 1271, 1022, 772 cm\(^{-1}\). HRMS (ESI) \(m/z\) Calcd for C\(_{17}\)H\(_{15}\)O [M+H]\(^+\): 235.1117, found: 235.1115.

2-Phenyl-5-(p-tolyl)furan (3c)

White solid (73.8 mg, 64%), mp: 109-110 °C. \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.75 – 7.70 (m, 2H), 7.62 (d, \(J = 8.2\) Hz, 2H), 7.38 (t, \(J = 7.7\) Hz, 2H), 7.24 (t, \(J = 7.4\) Hz, 1H), 7.19 (d, \(J = 8.2\) Hz, 2H), 6.70 (d, \(J = 3.5\) Hz, 1H), 6.65 (d, \(J = 3.5\) Hz, 1H), 2.35 (s, 3H). \(^13\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 153.8, 153.1, 137.3, 131.0, 129.5, 128.8, 128.3, 127.3, 123.8, 123.8, 107.3, 106.6, 21.4. IR (film) 3027, 2926, 1595, 1482, 1273, 1021, 791 cm\(^{-1}\). HRMS (ESI) \(m/z\) Calcd for C\(_{17}\)H\(_{15}\)O [M+H]\(^+\): 235.1117, found: 235.1113.

2-(3-Methoxyphenyl)-5-phenylfuran (3d)
White solid (86.6 mg, 70%). mp: 83-84 °C. \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.71 (d, \(J = 7.7\) Hz, 2H), 7.36 (t, \(J = 7.6\) Hz, 2H), 7.33 – 7.19 (m, 4H), 6.79 (d, \(J = 7.6\) Hz, 1H), 6.68 (br, 2H), 3.81 (s, 3H). \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 160.0, 153.4, 153.2, 132.1, 130.8, 129.9, 128.8, 127.5, 123.8, 116.5, 113.0, 109.4, 107.7, 107.3, 55.3. IR (film) 3122, 3067, 2956, 1596, 1476, 1284, 1219, 1031, 840, 766 cm\(^{-1}\). HRMS (ESI) \(m/z\) Calcd for C\(_{17}\)H\(_{15}\)O\(_2\) [M+H]\(^+\): 251.1067, found: 251.1065.

2-(4-Methoxyphenyl)-5-phenylfuran (3e)

White solid (81.8 mg, 66%), mp: 121-122 °C. \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.71 (d, \(J = 7.6\) Hz, 2H), 7.65 (d, \(J = 8.5\) Hz, 2H), 7.37 (t, \(J = 7.5\) Hz, 2H), 7.23 (t, \(J = 7.4\) Hz, 1H), 6.92 (d, \(J = 8.5\) Hz, 2H), 6.68 (d, \(J = 3.3\) Hz, 1H), 6.56 (d, \(J = 3.3\) Hz, 1H), 3.80 (s, 3H). \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 159.2, 153.6, 152.8, 131.0, 128.8, 127.2, 125.3, 124.0, 123.7, 114.3, 107.3, 105.8, 55.4. IR (film) 3123, 2961, 1607, 1533, 1490, 1246, 1023, 830, 756 cm\(^{-1}\). HRMS (ESI) \(m/z\) Calcd for C\(_{17}\)H\(_{14}\)O\(_2\) [M]+: 250.0988, found: 250.0993.

2-(4-(tert-Butyl)phenyl)-5-phenylfuran (3f)

White solid (82.0 mg, 60%), mp: 105-107 °C. \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.73 (d, \(J = 7.6\) Hz, 2H), 7.66 (d, \(J = 8.4\) Hz, 2H), 7.44 – 7.34 (m, 4H), 7.24 (t, \(J = 7.4\) Hz, 1H), 6.70 (d, \(J = 3.4\) Hz, 1H), 6.66 (d, \(J = 3.4\) Hz, 1H), 1.33 (s, 9H). \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 153.7, 153.1, 150.6, 131.0, 128.8, 128.2, 127.3, 125.8, 123.8, 123.7, 107.3, 106.8, 34.8, 31.4. IR (film) 3118, 2964, 1604, 1490, 1408, 1269, 1022, 831, 795 cm\(^{-1}\). HRMS (ESI) \(m/z\) Calcd for C\(_{20}\)H\(_{21}\)O [M+H]\(^+\): 277.1587, found: 277.1586.

2-Phenyl-5-(o-toly)furan (3g)

White solid (35.7 mg, 31%), mp: 49-51 °C. \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.78 (d, \(J = 7.4\) Hz, 1H), 7.73 (d, \(J = 7.5\) Hz, 2H), 7.39 (t, \(J = 7.5\) Hz, 2H), 7.30 – 7.19 (m, 4H), 6.77 – 6.72 (m, 1H), 6.64 – 6.60 (m, 1H), 2.56 (s, 3H). \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 153.2, 153.1, 134.6, 131.4, 130.9, 130.2, 128.9, 127.6, 127.4, 127.0, 126.2, 123.8, 110.8, 107.1, 22.2. IR (film) 3064, 2962,
1604, 1481, 1204, 1029, 831, 791 cm\(^{-1}\). HRMS (ESI) \textit{m/z} Calcd for C\(_{17}\)H\(_{15}\)O [M+H]\(^{+}\): 235.1117, found: 235.1113.

\textbf{2-(3,5-Dimethylphenyl)-5-phenylfuran (3h)}

White solid (88.6 mg, 71%), mp: 62-63 °C. \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta 7.72\) (d, \(J = 7.7\) Hz, 2H), 7.41 – 7.32 (m, 4H), 7.22 (t, \(J = 7.0\) Hz, 1H), 6.88 (s, 1H), 6.69 – 6.66 (m, 1H), 6.66 – 6.64 (m, 1H), 2.34 (s, 6H). \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta 153.8, 153.2, 138.3, 131.0, 130.8, 129.3, 128.8, 127.3, 123.8, 121.7, 107.3, 107.1, 21.5. IR (film) 3034, 2920, 1602, 1533, 1475, 1273, 1026, 849, 794 cm\(^{-1}\). HRMS (ESI) \textit{m/z} Calcd for C\(_{18}\)H\(_{17}\)O [M+H]\(^{+}\): 249.1274, found: 249.1280.

\textbf{2-(3,5-Dimethoxyphenyl)-5-phenylfuran (3i)}

White solid (91.9 mg, 66%), mp: 63-64 °C. \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta 7.71\) (d, \(J = 7.7\) Hz, 2H), 7.37 (t, \(J = 7.5\) Hz, 2H), 7.24 (t, \(J = 7.3\) Hz, 1H), 6.89 (s, 2H), 6.68 (s, 2H), 6.38 (s, 1H), 3.81 (s, 6H). \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta 161.2, 153.4, 153.2, 132.5, 130.7, 128.8, 127.5, 123.8, 107.9, 107.3, 102.0, 99.7, 55.4. IR (film) 3119, 3070, 2948, 1603, 1470, 1210, 1058, 838, 795 cm\(^{-1}\). HRMS (ESI) \textit{m/z} Calcd for C\(_{18}\)H\(_{12}\)O\(_3\) [M+H]\(^{+}\): 281.1172, found: 281.1176.

\textbf{2-(4-Fluorophenyl)-5-phenylfuran (3j)}

White solid (65.2 mg, 55%), mp: 108-109 °C. \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta 7.73 – 7.62\) (m, 4H), 7.37 (t, \(J = 7.7\) Hz, 2H), 7.24 (t, \(J = 7.3\) Hz, 1H), 7.05 (t, \(J = 8.6\) Hz, 2H), 6.67 (d, \(J = 3.4\) Hz, 1H), 6.60 (d, \(J = 3.4\) Hz, 1H). \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta 162.2\) (d, \(J_{C-H} = 245.5\) Hz), 153.5, 152.6, 130.8, 128.8, 127.5, 127.3 (d, \(J_{C-H} = 3.2\) Hz), 125.5 (d, \(J_{C-H} = 8.0\) Hz), 123.8, 115.8 (d, \(J_{C-H} = 21.8\) Hz), 107.3, 107.0 (d, \(J_{C-H} = 1.3\) Hz). \(^{19}\)F NMR (376 MHz, CDCl\(_3\)) \(\delta -114.1.\) IR (film) 3125, 3071, 1611, 1483, 1229, 1019, 836, 793 cm\(^{-1}\). HRMS (ESI) \textit{m/z} Calcd for C\(_{18}\)H\(_{12}\)FO [M+H]\(^{+}\): 239.0867, found: 239.0862.
2-(4-Bromophenyl)-5-phenylfuran (3k)

White solid (85.6 mg, 58%), mp: 128-129 °C. $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.69 (d, $J = 7.9$ Hz, 2H), 7.54 (d, $J = 8.5$ Hz, 2H), 7.47 (d, $J = 8.5$ Hz, 2H), 7.37 (t, $J = 7.6$ Hz, 2H), 7.25 (t, $J = 7.4$ Hz, 1H), 6.67 (br, 2H). $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 153.8, 152.4, 133.1, 130.7, 129.4, 129.1, 128.9, 127.7, 125.0, 123.9, 107.8, 107.4. IR (film) 3126, 3073, 1527, 1464, 1016, 826, 791 cm$^{-1}$. HRMS (ESI) m/z Calcd for C$_{16}$H$_{12}$BrO [M+H]$^+$: 299.0066, found: 299.0066.

2-(4-Chlorophenyl)-5-phenylfuran (3l)

White solid (42.1 mg, 33%), mp: 126-128 °C. $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.72 (d, $J = 7.5$ Hz, 2H), 7.64 (d, $J = 8.5$ Hz, 2H), 7.40 (t, $J = 7.7$ Hz, 2H), 7.35 (d, $J = 8.5$ Hz, 2H), 7.27 (t, $J = 7.4$ Hz, 1H), 6.71 (d, $J = 3.5$ Hz, 1H), 6.70 (d, $J = 3.5$ Hz, 1H). $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 153.8, 152.4, 133.1, 130.7, 129.4, 129.1, 128.9, 127.7, 125.0, 123.9, 107.8, 107.4. IR (film) 3081, 1527, 1472, 1103, 1019, 831, 793 cm$^{-1}$. HRMS (ESI) m/z Calcd for C$_{16}$H$_{12}$ClO [M+H]$^+$: 255.0571, found: 255.0550.

Ethyl 4-(5-phenylfuran-2-yl)benzoate (3m)

Yellow solid (64.1 mg, 44%), mp: 86-88 °C. $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 8.10 – 8.04 (m, 2H), 7.75 (t, $J = 7.9$ Hz, 4H), 7.41 (t, $J = 7.7$ Hz, 2H), 7.29 (t, $J = 7.4$ Hz, 1H), 6.84 (d, $J = 3.5$ Hz, 1H), 6.75 (d, $J = 3.5$ Hz, 1H), 4.38 (q, $J = 7.1$ Hz, 2H), 1.40 (t, $J = 7.1$ Hz, 3H). $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 166.4, 154.5, 152.4, 134.6, 130.5, 130.2, 129.6, 128.9, 127.9, 124.0, 123.3, 109.6, 107.6, 61.1, 14.5. IR (film) 3124, 2976, 1708, 1605, 1465, 1269, 1020, 854, 760 cm$^{-1}$. HRMS (ESI) m/z Calcd for C$_{19}$H$_{17}$O$_3$ [M+H]$^+$: 293.1172, found: 293.1170.

2-Phenyl-5-(4-(trifluoromethyl)phenyl)furan (3n)

513
White solid (30.2 mg, 21%), mp: 133-135 °C. $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.80 (d, $J = 8.2$ Hz, 2H), 7.75 (d, $J = 7.9$ Hz, 2H), 7.63 (d, $J = 8.2$ Hz, 2H), 7.42 (t, $J = 7.6$ Hz, 2H), 7.30 (t, $J = 7.1$ Hz, 1H), 6.83 (d, $J = 3.4$ Hz, 1H), 6.75 (d, $J = 3.4$ Hz, 1H). $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 154.6, 151.9, 134.0, 130.5, 129.0 (q, $J_{C-H} = 32.3$ Hz), 128.9, 128.0, 125.9 (q, $J_{C-H} = 3.8$ Hz), 124.4 (q, $J_{C-H} = 270.2$ Hz), 124.1, 123.8, 109.4, 107.5. $^{19}$F NMR (376 MHz, CDCl$_3$) $\delta$ -62.4. IR (film) 3124, 1608, 1527, 1330, 1163, 843, 795 cm$^{-1}$. HRMS (ESI) $m/z$ Calcd for C$_{17}$H$_{12}$F$_3$O [M+H]$^+$: 289.0835, found: 289.0832.

4-(5-Phenylfuran-2-yl)benzaldehyde (3o)

Yellow solid (21.5 mg, 18%), mp: 110-112 °C. $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 9.97 (s, 1H), 7.88 (d, $J = 8.3$ Hz, 2H), 7.84 (d, $J = 8.3$ Hz, 2H), 7.75 (d, $J = 7.7$ Hz, 2H), 7.42 (t, $J = 7.7$ Hz, 2H), 7.30 (t, $J = 7.3$ Hz, 1H), 6.90 (d, $J = 3.5$ Hz, 1H), 6.76 (d, $J = 3.5$ Hz, 1H). $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 191.6, 155.1, 151.9, 136.0, 134.9, 130.5, 130.3, 128.9, 128.1, 124.1, 123.8, 110.6, 107.8. IR (film) 3124, 2733, 1692, 1599, 1212, 1021, 832, 798 cm$^{-1}$. HRMS (ESI) $m/z$ Calcd for C$_{17}$H$_{13}$O$_2$ [M+H]$^+$: 249.0910, found: 249.0908.

4-(5-Phenylfuran-2-yl)benzonitrile (3p)

Yellow solid (10.8 mg, 9%), mp: 122-125 °C. $^1$H NMR (400 MHz, CDCl$_3$) $\delta$ 7.80 (d, $J = 8.4$ Hz, 2H), 7.75 (d, $J = 7.7$ Hz, 2H), 7.67 (d, $J = 8.4$ Hz, 2H), 7.43 (t, $J = 7.6$ Hz, 2H), 7.32 (t, $J = 7.4$ Hz, 1H), 6.90 (d, $J = 3.5$ Hz, 1H), 6.78 (d, $J = 3.5$ Hz, 1H). $^{13}$C NMR (100 MHz, CDCl$_3$) $\delta$ 155.2, 151.4, 134.6, 132.8, 130.2, 129.0, 128.3, 124.2, 123.9, 119.2, 110.6, 110.2, 107.8. IR (film) 3118, 2219, 1526, 1464, 1270, 1016, 837, 794 cm$^{-1}$. HRMS (ESI) $m/z$ Calcd for C$_{17}$H$_{13}$NNaO [M+Na]$^+$: 268.0733, found: 268.0740.

2-(Naphthalen-1-yl)-5-phenylfuran (3r)
White solid (38.1 mg, 29%), mp: 40-42 °C. \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 8.51 (d, \(J = 8.2\) Hz, 1H), 7.90 – 7.85 (m, 1H), 7.81 (dd, \(J = 6.9, 6.1\) Hz, 2H), 7.77 (d, \(J = 7.5\) Hz, 2H), 7.57 – 7.47 (m, 3H), 7.40 (t, \(J = 7.7\) Hz, 2H), 7.26 (t, \(J = 7.4\) Hz, 1H), 6.82 (d, \(J = 3.4\) Hz, 1H), 6.79 (d, \(J = 3.4\) Hz, 1H). \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 153.9, 153.1, 134.1, 131.0, 130.4, 128.9, 128.7, 128.6, 127.5, 126.8, 126.2, 126.1, 125.7, 125.5, 123.9, 111.6, 107.1. IR (film) 3051, 1601, 1516, 1482, 1392, 1203, 1027, 782 cm\(^{-1}\). HRMS (ESI) \(m/z\) Calcd for C\(_{38}\)H\(_{29}\)O [M+H]\(^+\): 271.1117, found: 271.1121.

2-(Naphthalen-2-yl)-5-phenylfuran (3s)

![Structure of 2-(Naphthalen-2-yl)-5-phenylfuran](image1)

White solid (68.5 mg, 52%), mp: 136-137 °C. \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 8.21 (s, 1H), 7.92 – 7.76 (m, 6H), 7.53 – 7.39 (m, 4H), 7.29 (t, \(J = 7.3\) Hz, 1H), 6.86 (d, \(J = 3.3\) Hz, 1H), 6.78 (d, \(J = 3.3\) Hz, 1H). \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 153.8, 153.6, 133.7, 132.8, 130.9, 128.9, 128.6, 128.3, 128.2, 127.9, 127.6, 126.7, 126.0, 124.0, 122.4, 122.1, 108.1, 107.6. IR (film) 3121, 1601, 1526, 1463, 1269, 1017, 791 cm\(^{-1}\). HRMS (ESI) \(m/z\) Calcd for C\(_{20}\)H\(_{15}\)O [M+H]\(^+\): 271.1117, found: 271.1115.

2-(3,5-Dimethylphenyl)-5-(p-tolyl)furan (3t)

![Structure of 2-(3,5-Dimethylphenyl)-5-(p-tolyl)furan](image2)

White solid (99.0 mg, 76%), mp: 123-124 °C. \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 7.66 – 7.59 (m, 2H), 7.35 (s, 2H), 7.18 (d, \(J = 7.0\) Hz, 2H), 6.88 (s, 1H), 6.71 – 6.58 (m, 2H), 2.34 (br, 9H). \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 153.5, 153.4, 138.3, 137.2, 130.8, 129.5, 129.1, 128.3, 123.8, 121.6, 107.1, 106.6, 21.5, 21.4. IR (film) 3119, 2920, 1602, 1492, 1209, 1022, 833, 779 cm\(^{-1}\). HRMS (ESI) \(m/z\) Calcd for C\(_{19}\)H\(_{19}\)O [M+H]\(^+\): 263.1430, found: 263.1429.

2-(3,5-Dimethylphenyl)-5-(4-methoxyphenyl)furan (3u)

![Structure of 2-(3,5-Dimethylphenyl)-5-(4-methoxyphenyl)furan](image3)


White solid (113.1 mg, 82%), mp: 107-108 °C. \( ^1H \) NMR (400 MHz, CDCl\(_3\)) \( \delta \) 7.65 (d, \( J = 8.7 \) Hz, 2H), 7.34 (s, 2H), 6.91 (d, \( J = 8.7 \) Hz, 2H), 6.88 (s, 1H), 6.65 (d, \( J = 3.4 \) Hz, 1H), 6.55 (d, \( J = 3.4 \) Hz, 1H), 3.79 (s, 3H), 2.34 (s, 6H).

\[ \text{13}^C \text{ NMR (100 MHz, CDCl}_3\text{) } \delta \text{ 159.1, 153.3, 138.3, 130.9, 129.0, 125.2, 124.1, 121.5, 114.3, 107.1, 105.7, 55.4, 21.5}. \]

IR (film) 3126, 2953, 1604, 1491, 1291, 1030, 836, 781 cm\(^{-1}\).

HRMS (ESI) \text{m/z Calcd for C}_{19}H_{19}O_2 [M+H]+: 279.1380, found: 279.1378.

2-(3,5-Dimethylphenyl)-5-(4-fluorophenyl)furan (3v)

![Diagram of 2-(3,5-Dimethylphenyl)-5-(4-fluorophenyl)furan (3v)]

White solid (82.3 mg, 62%), mp: 91-93 °C. \( ^1H \) NMR (400 MHz, CDCl\(_3\)) \( \delta \) 7.71–7.64 (m, 2H), 7.33 (s, 2H), 7.10–7.03 (m, 2H), 6.89 (s, 1H), 6.65 (d, \( J = 3.4 \) Hz, 1H), 6.60 (d, \( J = 3.4 \) Hz, 1H), 2.34 (s, 6H). \( \text{13}^C \text{ NMR (100 MHz, CDCl}_3\text{) } \delta \text{ 162.2 (d, } J_{\text{C-H}} = 245.5 \text{ Hz)}\), 153.9, 152.4, 138.4, 130.7, 129.4, 127.4 (d, \( J_{\text{C-H}} = 3.3 \) Hz), 125.5 (d, \( J_{\text{C-H}} = 8.0 \) Hz), 121.7, 115.8 (d, \( J_{\text{C-H}} = 21.8 \) Hz), 107.1, 107.0, 21.5; IR (film) 3115, 2919, 1605, 1494, 1233, 1024, 848, 790 cm\(^{-1}\). HRMS (ESI) \text{m/z Calcd for C}_{18}H_{13}FO [M]: 266.1107, found: 266.1105.

2-(3,5-Dimethylphenyl)-5-(4-nitrophenyl)furan (3w)

![Diagram of 2-(3,5-Dimethylphenyl)-5-(4-nitrophenyl)furan (3w)]

Yellow solid (94.0 mg, 63%), mp: 141-143 °C. \( ^1H \) NMR (400 MHz, CDCl\(_3\)) \( \delta \) 8.20 (d, \( J = 8.8 \) Hz, 2H), 7.77 (d, \( J = 8.8 \) Hz, 2H), 7.34 (s, 2H), 6.95 (s, 1H), 6.89 (d, \( J = 3.5 \) Hz, 1H), 6.72 (d, \( J = 3.5 \) Hz, 1H), 2.37 (s, 6H). \( \text{13}^C \text{ NMR (100 MHz, CDCl}_3\text{) } \delta \text{ 156.1, 150.8, 146.2, 138.5, 136.4, 130.2, 129.9, 124.4, 123.7, 122.0, 111.5, 107.8, 21.5}. \)

IR (film) 3113, 2919, 2842, 1596, 1464, 1335, 1027, 847, 782 cm\(^{-1}\). HRMS (ESI) \text{m/z Calcd for C}_{18}H_{18}NNaO_3 [M+Na]+: 316.0944, found: 316.0949.

2-(3,5-Dimethylphenyl)-5-(thiophen-2-yl)furan (3x)

![Diagram of 2-(3,5-Dimethylphenyl)-5-(thiophen-2-yl)furan (3x)]

White solid (113.1 mg, 82%), mp: 107-108 °C. \( ^1H \) NMR (400 MHz, CDCl\(_3\)) \( \delta \) 7.65 (d, \( J = 8.7 \) Hz, 2H), 7.34 (s, 2H), 6.91 (d, \( J = 8.7 \) Hz, 2H), 6.88 (s, 1H), 6.65 (d, \( J = 3.4 \) Hz, 1H), 6.55 (d, \( J = 3.4 \) Hz, 1H), 3.79 (s, 3H), 2.34 (s, 6H). \( \text{13}^C \text{ NMR (100 MHz, CDCl}_3\text{) } \delta \text{ 159.1, 153.3, 138.3, 130.9, 129.0, 125.2, 124.1, 121.5, 114.3, 107.1, 105.7, 55.4, 21.5}. \)

IR (film) 3126, 2953, 1604, 1491, 1291, 1030, 836, 781 cm\(^{-1}\). HRMS (ESI) \text{m/z Calcd for C}_{19}H_{19}O_2 [M+H]+: 279.1380, found: 279.1378.
White solid (59.2 mg, 47%). ¹H NMR (400 MHz, CDCl₃) δ 7.32 (s, 2H), 7.30 (d, J = 3.5 Hz, 1H), 7.19 (d, J = 5.0 Hz, 1H), 7.02 (dd, J = 5.0, 3.5 Hz, 1H), 6.89 (s, 1H), 6.63 (d, J = 3.4 Hz, 1H), 6.53 (d, J = 3.4 Hz, 1H), 2.34 (s, 6H). ¹³C NMR (100 MHz, CDCl₃) δ 153.4, 148.9, 138.3, 134.0, 129.4, 127.8, 124.1, 121.7, 107.3, 107.1, 21.5. IR (film) 3121, 2917, 1605, 1493, 1386, 1016, 846, 780 cm⁻¹. HRMS (ESI) m/z Calcd for C₁₆H₁₄O₅S [M⁺]: 254.0765, found: 254.0759.

2-(3,5-Dimethylphenyl)-5-methylfuran (3y)

Yellow oil (39.9 mg, 43%). ¹H NMR (400 MHz, CDCl₃) δ 7.25 (s, 2H), 6.84 (s, 1H), 6.48 (d, J = 3.1 Hz, 1H), 6.01 (d, J = 3.1 Hz, 1H), 2.34 (s, 3H), 2.31 (s, 6H). ¹³C NMR (100 MHz, CDCl₃) δ 152.7, 151.7, 138.2, 131.2, 128.7, 121.3, 107.7, 105.7, 21.5, 13.8. IR (film) 3110, 2920, 1600, 1451, 1381, 1212, 1023, 845, 780 cm⁻¹. HRMS (ESI) m/z Calcd for C₁₃H₁₃O [M+H]⁺: 187.1117, found: 187.1115.

2-(3,5-Dimethylphenyl)-5-ethylfuran (3z)

Yellow oil (26.9 mg, 27%). ¹H NMR (400 MHz, CDCl₃) δ 7.25 (s, 2H), 6.83 (s, 1H), 6.48 (d, J = 3.2 Hz, 1H), 6.01 (d, J = 3.2 Hz, 1H), 2.69 (q, J = 7.5 Hz, 2H), 2.30 (s, 6H), 1.26 (t, J = 7.6 Hz, 3H). ¹³C NMR (100 MHz, CDCl₃) δ 157.5, 152.6, 138.1, 131.3, 128.7, 121.3, 106.1, 105.5, 21.6, 21.4, 12.3. IR (film) 3108, 2926, 1602, 1551, 1376, 1203, 1014, 846, 781 cm⁻¹. HRMS (ESI) m/z Calcd for C₁₄H₁₇O [M+H]⁺: 201.1274, found: 201.1273.
5 Data for 4 and 5

5-Phenylfuran-2-carbaldehyde (4)

\[
\text{\includegraphics[width=0.2\textwidth]{5-phenylfuran-2-carbaldehyde.png}}
\]

Yellow oil (4.8 mg, 5%). \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 9.63 (s, 1H), 7.80 (d, \(J = 7.2\) Hz, 2H), 7.46 – 7.35 (m, 3H), 7.31 (d, \(J = 3.7\) Hz, 1H), 6.82 (d, \(J = 3.7\) Hz, 1H). \(^{13}\)C NMR (100 MHz, CDCl\(_3\)) \(\delta\) 177.2, 159.4, 152.0, 129.7, 128.9, 125.3, 107.7. Analytical data were consistent with previously reported data.\(^9\)

5-Phenylfuran-2-carboxylic acid (5)

\[
\text{\includegraphics[width=0.2\textwidth]{5-phenylfuran-2-carboxylic-acid.png}}
\]

Compounds 5 were prepared by hydrolysis of methyl 5-phenylfuran-2-carboxylate, prepared by Suzuki coupling of methyl 5-bromofuran-2-carboxylate with phenylboronic acid. White solid (117.0 mg, 70%). \(^1\)H NMR (400 MHz, CDCl\(_3\)) \(\delta\) 8.45 (s, 1H), 7.81 (d, \(J = 7.7\) Hz, 2H), 7.50 – 7.32 (m, 4H), 6.78 (d, \(J = 3.5\) Hz, 1H). \(^{13}\)C NMR (101 MHz, CDCl\(_3\)) \(\delta\) 163.6, 158.9, 143.0, 129.4, 129.4, 129.0, 125.2, 122.3, 107.4. Analytical data were consistent with previously reported data.\(^10\)
6 Full list of references


7  NMR charts of starting materials

1H NMR spectrum of 1a

13C NMR spectrum of 1a
$^{1}H$ NMR spectrum of 1b

$^{13}C$ NMR spectrum of 1b
$^{1}$H NMR spectrum of 1c

$^{13}$C NMR spectrum of 1c
$^1$H NMR spectrum of 1d

$^{13}$C NMR spectrum of 1d
\( ^{19}\text{F NMR spectrum of 1d} \)

\( ^{1}\text{H NMR spectrum of 1e} \)
$^{13}$C NMR spectrum of 1e

$^1$H NMR spectrum of 1f
$^{13}$C NMR spectrum of 1f

$^1$H NMR spectrum of 1g
\[^{13}\text{C} \text{NMR spectrum of 1g}\]

\[^{1}\text{H} \text{NMR spectrum of 1h}\]
$\text{C NMR spectrum of 1j}$

$\text{H NMR spectrum of 1k}$
$^{13}$C NMR spectrum of 1k

$^1$H NMR spectrum of 11
$^{13}$C NMR spectrum of 1I

$^1$H NMR spectrum of 1m
$^{13}$C NMR spectrum of 1m

$^1$H NMR spectrum of 1n
$^{13}$C NMR spectrum of 1n

$^1$H NMR spectrum of 1o
$^{13}$C NMR spectrum of 1o

$^1$H NMR spectrum of 1p
$^{13}$C NMR spectrum of 1p
NMR charts of arylfurans 3

$^1$H NMR spectrum of 3a

$^{13}$C NMR spectrum of 3a
$^1$H NMR spectrum of 3b

$^{13}$C NMR spectrum of 3b
$\text{H NMR spectrum of 3c}$

$\text{C NMR spectrum of 3c}$
$^1$H NMR spectrum of 3d

$^{13}$C NMR spectrum of 3d
$^1$H NMR spectrum of 3e

$^{13}$C NMR spectrum of 3e
$^{1}$H NMR spectrum of 3f

$^{13}$C NMR spectrum of 3f
$^1$H NMR spectrum of 3g

$^{13}$C NMR spectrum of 3g
$^{1}$H NMR spectrum of 3h

$^{13}$C NMR spectrum of 3h
$^1$H NMR spectrum of 3i

$^{13}$C NMR spectrum of 3i
$^{1}$H NMR spectrum of 3j

$^{13}$C NMR spectrum of 3j
$^{19}$F NMR spectrum of 3j

$^1$H NMR spectrum of 3k
$^{13}$C NMR spectrum of 3k

$^1$H NMR spectrum of 3l
$^{13}$C NMR spectrum of 3l

$^1$H NMR spectrum of 3m
$^{13}$C NMR spectrum of 3m

$^1$H NMR spectrum of 3n
$^{13}$C NMR spectrum of $3n$

$^{19}$F NMR spectrum of $3n$
$^1$H NMR spectrum of 3o

$^{13}$C NMR spectrum of 3o
$^1$H NMR spectrum of 3p

$^{13}$C NMR spectrum of 3p
$^1$H NMR spectrum of 3r

$^{13}$C NMR spectrum of 3r
$^1$H NMR spectrum of 3s

$^{13}$C NMR spectrum of 3s
$^{1\text{H}}$ NMR spectrum of 3t

$^{13\text{C}}$ NMR spectrum of 3t
$^1$H NMR spectrum of 3u

$^{13}$C NMR spectrum of 3u
$^1$H NMR spectrum of 3v

$^{13}$C NMR spectrum of 3v
$^{19}\text{F NMR spectrum of 3v}$

$^1\text{H NMR spectrum of 3w}$
$\text{C NMR spectrum of } 3w$

$\text{H NMR spectrum of } 3x$
$^{13}$C NMR spectrum of 3x

$^1$H NMR spectrum of 3y
$^{13}$C NMR spectrum of 3y

$^1$H NMR spectrum of 3z
$^{13}$C NMR spectrum of $3z$