# Hypervalent Iodine Mediated Oxidative Cyclization of *o*-Hydroxystilbenes into Benzo- and Naphthofurans

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**Abstract:** A new and convenient metal-free cyclization of *ortho*-hydroxystilbenes into 2-arylbenzofurans and 2-arylnaphthofurans mediated by hypervalent iodine reagents is described. The cyclization products are isolated in good to excellent yields using stoichiometric (diacetoxyiodo)benzene in acetonitrile.

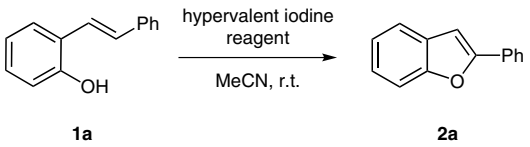
**Key words:** benzofurans, cyclization, hypervalent iodine reagents, naphthofurans, stilbenes

Benzofuran scaffolds are basic structural motifs found in various naturally occurring biologically active compounds.[1] Additionally, several natural products with a naphthofuran core such as (+)-heritol[2] and (±)-laevigatin[3] possess interesting pharmacological and cytotoxic properties. A number of synthetic benzofurans have been reported to have diverse pharmacological activities. These compounds can act as 5-lipoxygenase inhibitors,[4] as angiotensin II inhibitors,[5] calcium entry blockers,[6] or possess antifungal,[7] antibacterial,[8] antimicrobial,[9] or acetylcholinesterase inhibitor activity.[10]

Numerous synthetic approaches have been published for the synthesis of benzofurans, but most of these are associated with transition-metal-catalyzed annulation reactions of prefunctionalized substrates which were typically synthesized by Heck or Sonogashira coupling reactions.[11] There are few synthetic methodologies available in this area which do not require transition metals; these include the [3,3]-sigmatropic rearrangement of *N*-trifluoroacetylene-hydroxylamines,[12] cycloaddition of arynes with iodonium ylids[13] and cyclization of *o*-stilbenes using iodine with potassium carbonate as the base.[14] The synthesis of benzofurans has also been achieved by intramolecular photochemical Wittig reaction of functionalized phosphonium bromides.[15]

Hypervalent iodine compounds have been recognized as very promising reagents in synthetic organic chemistry.[16] Their low toxicity, favorable safety profiles, easy handling, and environmentally friendly nature make them attractive as reagents for metal-free transformations. Our research group has developed different oxidative cyclization reactions using hypervalent iodine reagents.[17]

Herein, we report a convenient procedure for the cyclization of a series of *ortho*-hydroxystilbenes **1** into the corresponding 2-arylbenzofurans **2** using (diacetoxyiodo)benzene [PhI(OAc)$_2$] in good to excellent yields under mild reaction conditions. The synthesis of precursors **1** was achieved by palladium-catalyzed Heck reactions of 2-iodophenol and various functionalized styrenes in 69–89% yield.[18] Initially, optimal reaction conditions and reagents for the hypervalent iodine mediated cyclization were established using (*E*)-2-styrylphenol (**1a**) as a model substrate. The cyclizations were performed in acetonitrile using one equivalent of [bis(trifluoroacetoxy)iodo]benzene at room temperature under an argon atmosphere. The isolated product was characterized as 2-phenylbenzofuran (**2a**) as shown in Scheme 1.




**1a** **2a**

**Scheme 1** Cyclization of **1a** using different hypervalent iodine reagents

In order to further optimize the reaction conditions, different cyclic and acyclic hypervalent iodine reagents were investigated (Table 1). The cyclized product **2a** was obtained in 69% yield with [bis(trifluoroacetoxy)iodo]benzene (Table 1, entry 1), while the yield was increased up to 77% by using the less reactive (diacetoxyiodo)benzene (Table 1, entry 2). The same reaction was carried out using Koser's reagent [PhI(OH)OTs], but the reaction product **2a** was isolated in only 67% yield (Table 1, entry 3). The fully fluorinated and more soluble reagent [bis(trifluoroacetoxy)iodo]pentafluorobenzene[19] was also used, but **2a** was obtained in only 59% yield (Table 1, entry 4). It appeared that more reactive hypervalent iodine compounds were less efficient in this transformation. This was also demonstrated with the in situ synthesis and use of a reactive bistriflate (Table 1, entry 5) which led to benzofuran **2a** in only 59% yield. The reaction product was observed only in trace amount when using iodosylbenzene (PhIO). Furthermore, the reaction did not occur with the cyclic hypervalent iodine(V) reagent, 1-hydroxy-1,2-benziodoxol-3-(1*H*)-one 1-oxide (IBX) (Table 1, entry 7).

In addition, different polar and non-polar solvents were investigated in the cyclization of **1a** using (diacetoxyiodo)benzene as shown in Table 2. The cyclization reaction proceeded well in polar and aprotic solvents such as acetonitrile and dichloromethane (Table 2, entries 1 and 3).

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**Table 1** Different Hypervalent Iodine Compounds Used for the Cyclization of **1a**

| Entry | Oxidant | Time (h) | Yield of **2a** (%) |
|---|---|---|---|
| 1 | $PhI(OCOCF_3)_2$ | 1 | 69 |
| 2 | $PhI(OAc)_2$ | 1 | 77 |
| 3 | PhI(OH)OTs | 2 | 67 |
| 4 | $C_6F_5I(OCOCF_3)_2$ | 1 | 59 |
| 5 | $PhI(OSO_2CF_3)_2$ | 1 | 59 |
| 6 | PhIO | 15 | trace |
| 7 | IBX | 15 | 0 |

The reaction also occurred in polar and protic solvents such as diethyl ether, tetrahydrofuran and methanol, but the cyclic product **2a** was obtained in lower yields (Table 2, entries 2, 4 and 5). The cyclized product **2a** was observed only in trace amount in the non-polar and aprotic solvent toluene (Table 2, entry 6). One equivalent of (diacetoxyiodo)benzene with a reaction time of two hours in acetonitrile was found to be optimal conditions for the cyclization of **1a** into benzofuran **2a**.

**Table 2** Different Solvents Investigated for the Cyclization of **1a** Using (Diacetoxyiodo)benzene

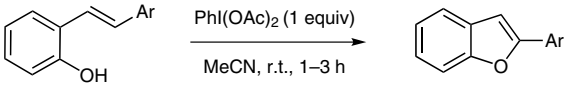
| Entry | Solvent | Time (h) | Yield of **2a** (%) |
|---|---|---|---|
| 1 | MeCN | 1 | 77 |
| 2 | THF | 15 | 27 |
| 3 | $CH_2Cl_2$ | 1 | 65 |
| 4 | $Et_2O$ | 15 | 38 |
| 5 | MeOH | 15 | 46 |
| 6 | toluene | 15 | trace |

Employing these optimal reaction conditions, a series of 2-hydroxystilbenes **1b–k** was successfully cyclized to yield the benzofuran products **2b–k** in 68–87% yield as shown in Table 3.

The cyclization reactions occurred smoothly with substrates **1** having both electron-donating and electron-withdrawing group bearing aromatic substituents and the products were isolated in good to excellent yields (Table 3). The products were obtained in higher yields when electron-donating groups were present on the aromatic substituent of the starting material (Table 3, entries 7–10). All the reaction products were fully characterized by spectroscopic analysis.

After the synthesis of 2-arylbenzofurans **2**, our efforts were directed toward the cyclization of (*E*)-2-styrylnaphthols **3**. The starting materials **3a–c** were prepared by palladium-catalyzed Heck reactions of 1-bromonaphthalen-2-ol and the appropriate styrenes in 48–56% yields. Compounds **3a–c** were cyclized into 2-naphthofurans **4a–c** by using one equivalent of (diacetoxyiodo)benzene under the same reaction conditions employed for the synthesis of compounds **2**. Products **4a–c** were isolated in 88–95% yields (Table 4) and were fully characterized by spectroscopic analysis.

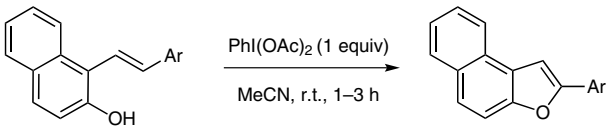
**Table 3** Cyclization of (*E*)-2-Hydroxystilbenes **1a–k**




**1** **2**

| Entry | Substrate | Ar | Time (h) | Yield of **2** (%) |
|---|---|---|---|---|
| 1 | **1a** | Ph | 2 | 77 |
| 2 | **1b** | $4\text{-}ClC_6H_4$ | 2 | 79 |
| 3 | **1c** | $3\text{-}ClC_6H_4$ | 2 | 77 |
| 4 | **1d** | $2\text{-}ClC_6H_4$ | 2 | 74 |
| 5 | **1e** | $3\text{-}FC_6H_4$ | 3 | 68 |
| 6 | **1f** | $3\text{-}O_2NC_6H_4$ | 3 | 69 |
| 7 | **1g** | $4\text{-}MeOC_6H_4$ | 1 | 87 |
| 8 | **1h** | $4\text{-}MeC_6H_4$ | 2 | 79 |
| 9 | **1i** | $3\text{-}MeC_6H_4$ | 2 | 83 |
| 10 | **1j** | $2\text{-}MeC_6H_4$ | 1 | 86 |
| 11 | **1k** | 2-pyridyl | 3 | 79 |

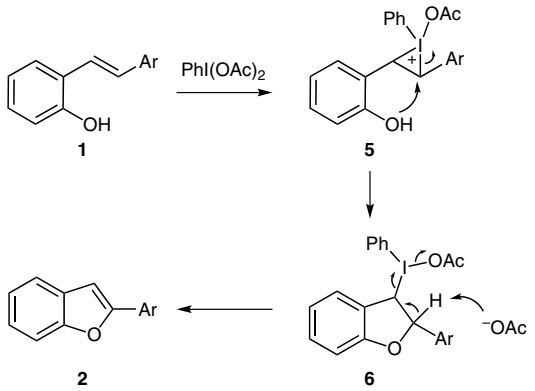
**Table 4** Cyclization of (*E*)-1-Styryl-2-naphthols **3a–c**




**3** **4**

| Entry | Substrate | Ar | Time (h) | Yield of **4** (%) |
|---|---|---|---|---|
| 1 | **3a** | Ph | 2 | 88 |
| 2 | **3b** | $4\text{-}ClC_6H_4$ | 3 | 91 |
| 3 | **3c** | $3\text{-}MeOC_6H_4$ | 1 | 95 |

A proposed mechanism for the hypervalent iodine induced oxidative cyclization of stilbenes **1** into benzofurans **2** is shown in Scheme 2. According to this mechanism, the electrophilic iodine activates the double bond of stilbene **1** forming a three-membered iodonium intermediate **5**. This undergoes intramolecular reaction with the phenolic oxygen atom leading to intermediate **6**. Finally, elimination of the hypervalent iodine then gives product **2**.




**Scheme 2** Proposed mechanism for the cyclization of stilbenes **1**

In summary, we have demonstrated an alternative approach for the synthesis of 2-arylbenzofurans and 2-arylnaphthofurans via oxidative cyclization of *o*-hydroxystilbenes using (diacetoxyiodo)benzene as the oxidant. Our method to synthesize these scaffolds is very simple, economical and metal-free. Further studies on the wider scope of this approach are currently in progress.

All experiments were performed under an inert atmosphere of argon or nitrogen. Dry THF was used from a solvent purification system while acetonitrile of HPLC grade was used and dried over molecular sieves (4 Å). All other purchased chemicals were used without further purification. All reactions were monitored by thin-layer chromatography performed on pre-coated Merck sheets of silica gel 60. Flash column chromatography was performed with silica gel 60 (Merck, 230–400 mesh). Eluting solvents are indicated in the text. Melting points were obtained in open capillary tubes using a MP–Gallenkamp apparatus. Infrared spectra were recorded on a JASCO FT/IR-660 Plus spectrophotometer. $^1$H NMR and $^{13}$C NMR spectra were recorded on an AV-400 Bruker instrument at 400 and 100 MHz, respectively, using the solvents indicated. A DRX-500 Bruker instrument was used in some cases [$^1$H (500 MHz) and $^{13}$C (125 MHz)]. HRMS was performed using a LTQ ORBITRAP XL spectrometer under the conditions of electron impact (EI), electrospray (ES) or chemical ionization (CI).

**(*E*)-2-Styrylphenols 1a–k and (*E*)-1-Styrylnaphthols 3a–c; General Procedure**

(*E*)-2-Styrylphenols and (*E*)-1-styrylnaphthols were prepared according to the reported procedure.[18] A mixture of 2-iodophenol (0.438 g, 2.0 mmol) [or 1-bromonaphthol (0.446 g, 2.0 mmol)], the styrene derivative (2.6 mmol), $Et_3N$ (0.640 mL, 4.6 mmol), $Pd(OAc)_2$ (0.013 g, 0.06 mmol) and $PPh_3$ (0.038 g, 0.07 mmol) was heated at reflux temperature (80 °C) for 3–7 h. After completion of the reaction, ice-cold $H_2O$ (10 mL) was added and the mixture was acidified using aq HCl (1 M) with stirring to dissolve the solids. The mixture was extracted with EtOAc (3 × 10 mL) and the combined organic layer dried over $MgSO_4$, filtered and evaporated in vacuo. Finally, the crude residue was purified by column chromatography (hexane–$CH_2Cl_2$, 1:4).

**(*E*)-2-Styrylphenol (1a)[20]**

Yield: 0.286 g, 1.46 mmol (73%); yellow solid; mp 142–144 °C; $R_f$ = 0.4 ($CH_2Cl_2$).

$^1$H NMR (400 MHz, $CDCl_3$): δ = 4.99 (br s, 1 H, OH), 6.81 (dd, $J_1$ = 1.2 Hz, $J_2$ = 8.0 Hz, 1 H, ArH), 6.96 (dt, $J_1$ = 0.8 Hz, $J_2$ = 7.6 Hz, 1 H, ArH), 7.12 (d, $J$ = 16.4 Hz, 1 H, CH), 7.15 (dt, $J_1$ = 1.6 Hz, $J_2$ = 8.0 Hz, 1 H, ArH), 7.26 (tt, $J_1$ = 1.6 Hz, $J_2$ = 8.0 Hz, 1 H, ArH), 7.37 (d, $J$ = 16.4 Hz, 1 H, CH), 7.33–7.39 (m, 2 H, ArH), 7.54 (td, $J_1$ = 2.0 Hz, $J_2$ = 8.0 Hz, 3 H, ArH).

$^{13}$C NMR (125 MHz, $CDCl_3$): δ = 115.9, 121.2, 123.1, 124.7, 126.6, 127.3, 127.6, 128.7, 130.3, 137.6, 153.0.

**(*E*)-2-(4-Chlorostyryl)phenol (1b)[21]**

Yield: 0.363 g, 1.58 mmol (79%); yellow solid; mp 124–126 °C; $R_f$ = 0.4 ($CH_2Cl_2$).

IR (KBr): 3060, 3030, 1600, 1581, 1498, 1486, 1454, 1323, 1250, 1191, 1170, 1085, 1009, 975, 964, 815, 746 cm$^{-1}$.

$^1$H NMR (400 MHz, $CDCl_3$): δ = 4.98 (s, 1 H, OH), 6.82 (dd, $J_1$ = 1.2 Hz, $J_2$ = 8.0 Hz, 1 H, ArH), 6.99 (t, $J$ = 7.6 Hz, 1 H, ArH), 7.10 (d, $J$ = 16.4 Hz, 1 H, CH), 7.18 (dt, $J_1$ = 1.6 Hz, $J_2$ = 8.0 Hz, 1 H, ArH), 7.33–7.39 (m, 3 H, CH, ArH), 7.48 (td, $J_1$ = 2.0 Hz, $J_2$ = 8.8 Hz, 2 H, ArH), 7.55 (dd, $J_1$ = 1.4 Hz, $J_2$ = 7.8 Hz, 1 H, ArH).

$^{13}$C NMR (125 MHz, $CDCl_3$): δ = 116.0, 121.3, 123.7, 124.4, 127.3, 127.7, 128.7, 128.8, 128.9, 133.2, 136.2, 153.0.

HRMS (APCI): *m*/*z* [M]$^+$ calcd for $C_{14}H_{12}OCl$: 231.0571; found 231.0567.

**(*E*)-2-(3-Chlorostyryl)phenol (1c)**

Yield: 0.368 g, 1.60 mmol (80%); yellow solid; mp 82–84 °C; $R_f$ = 0.4 ($CH_2Cl_2$).

IR (KBr): 3264, 3065, 1633, 1604, 1590, 1661, 1470, 1455, 1328, 1291, 1236, 1094, 1077, 958, 908, 875, 796, 776, 748, 677 cm$^{-1}$.

$^1$H NMR (500 MHz, $CDCl_3$): δ = 5.01 (br s, 1 H, OH), 6.83 (dd, $J_1$ = 1.0 Hz, $J_2$ = 8.0 Hz, 1 H, ArH), 6.99 (t, $J$ = 7.5 Hz, 1 H, ArH), 7.09 (d, $J$ = 16.5 Hz, 1 H, CH), 7.19 (dt, $J_1$ = 1.5 Hz, $J_2$ = 8.0 Hz, 1 H, ArH), 7.24–7.26 (m, 1 H, ArH), 7.30 (t, $J$ = 7.5 Hz, 1 H, ArH), 7.41 (d, $J$ = 16.5 Hz, 1 H, CH), 7.41 (d, $J$ = 7.5 Hz, 1 H, ArH), 7.53–7.57 (m, 2 H, ArH).

$^{13}$C NMR (125 MHz, $CDCl_3$): δ = 116.0, 121.3, 124.3, 124.6, 124.8, 126.4, 127.4, 127.5, 128.6, 129.1, 129.8, 134.7, 139.6, 153.1.

HRMS (APCI): *m*/*z* [M]$^+$ calcd for $C_{14}H_{12}OCl$: 231.0571; found 231.0568.

**(*E*)-2-(2-Chlorostyryl)phenol (1d)**

Yield: 0.345 g, 1.50 mmol (75%); yellow solid; mp 138–140 °C; $R_f$ = 0.4 ($CH_2Cl_2$).

IR (KBr): 3048, 1620, 1599, 1581, 1491, 1467, 1445, 1330, 1295, 1245, 1085, 1193, 1172, 1123, 1088, 1048, 1034, 974, 849, 753, 734, 705 cm$^{-1}$.

$^1$H NMR (500 MHz, $CDCl_3$): δ = 5.01 (br s, 1 H, OH), 6.84 (dd, $J_1$ = 1.0 Hz, $J_2$ = 8.0 Hz, 1 H, ArH), 7.01 (t, $J$ = 7.5 Hz, 1 H, ArH), 7.17–7.24 (m, 2 H, ArH), 7.29 (t, $J$ = 7.5 Hz, 1 H, ArH), 7.39 (d, $J$ = 16.5 Hz, 1 H, CH), 7.39 (dd, $J_1$ = 1.5 Hz, $J_2$ = 8.0 Hz, 1 H, ArH), 7.56 (d, $J$ = 16.5 Hz, 1 H, CH), 7.61 (dd, $J_1$ = 1.5 Hz, $J_2$ = 8.0 Hz, 1 H, ArH), 7.75 (dd, $J_1$ = 1.5 Hz, $J_2$ = 8.0 Hz, 1 H, ArH).

$^{13}$C NMR (125 MHz, $CDCl_3$): δ = 116.0, 121.3, 124.5, 125.7, 126.1, 126.6, 126.9, 127.6, 128.5, 129.1, 129.8, 133.4, 135.8, 153.1.

HRMS (APCI): *m*/*z* [M]$^+$ calcd for $C_{14}H_{12}OCl$: 231.0571; found 231.0568.

**(*E*)-2-(3-Fluorostyryl)phenol (1e)[22]**

Yield: 0.306 g, 1.46 mmol (73%); yellow solid; mp 94–96 °C; $R_f$ = 0.4 ($CH_2Cl_2$).

$^1$H NMR (400 MHz, $CDCl_3$): δ = 4.98 (br s, 1 H, OH), 6.78 (dd, $J_1$ = 1.2 Hz, $J_2$ = 8.0 Hz, 1 H, ArH), 6.93–6.99 (m, 2 H, ArH), 7.10 (d, $J$ = 16.4 Hz, 1 H, CH), 7.17 (dt, $J_1$ = 1.6 Hz, $J_2$ = 7.6 Hz, 1 H, ArH), 7.22–7.34 (m, 3 H, ArH), 7.39 (d, $J$ = 16.4 Hz, 1 H, CH), 7.53 (dd, $J_1$ = 1.4 Hz, $J_2$ = 7.8 Hz, 1 H, ArH).

$^{13}$C NMR (100 MHz, $CDCl_3$): δ = 113.3 (d, $J$ = 21.4 Hz), 114.8 (d, $J$ = 21.3 Hz), 116.4, 121.7, 122.9 (d, $J$ = 2.6 Hz), 124.6, 124.8, 127.4, 129.1 (d, $J$ = 2.7 Hz), 129.5, 130.5 (d, $J$ = 8.4 Hz), 140.5 (d, $J$ = 7.8 Hz), 153.5, 163.6 (d, $J$ = 243.6 Hz).

**(*E*)-2-(3-Nitrostyryl)phenol (1f)**
Yield: 0.428 g, 1.78 mmol (89%); yellow solid; mp 152–154 °C; $R_f$ = 0.2 ($CH_2Cl_2$).

IR (KBr): 3069, 3041, 1601, 1587, 1571, 1522, 1500, 1457, 1349, 1254, 1203, 1090, 1075, 981, 973, 964, 897, 832, 800, 752, 739, 723, 686 $cm^{-1}$.

$^1H$ NMR (400 MHz, $CDCl_3$): δ = 5.03 (br s, 1 H, OH), 6.81 (d, *J* = 8.0 Hz, 1 H, ArH), 6.98 (t, *J* = 7.6 Hz, 1 H, ArH), 7.19 (d, *J* = 16.4 Hz, 1 H, CH), 7.20 (d, *J* = 7.6 Hz, 1 H, ArH), 7.49–7.57 (m, 3 H, CH, ArH), 7.82 (d, *J* = 7.6 Hz, 1 H, ArH), 8.09 (ddd, $J_1$ = 1.2 Hz, $J_2$ = 1.2 Hz, $J_3$ = 8.0 Hz, 1 H, ArH), 8.38 (t, *J* = 1.6 Hz, 1 H, ArH).

$^{13}C$ NMR (100 MHz, $CDCl_3$): δ = 116.5, 121.4, 121.8, 122.4, 124.1, 126.7, 127.5, 127.9, 129.9, 130.0, 132.7, 140.0, 149.1, 153.7.

HRMS (APCI): *m*/*z* $[M]^+$ calcd for $C_{14}H_{12}O_3N$: 242.0812; found 242.0809.

**(*E*)-2-(4-Methoxystyryl)phenol (1g)[22]**
Yield: 0.312 g, 1.38 mmol (69%); light-yellow solid; mp 144–146 °C; $R_f$ = 0.2 ($CH_2Cl_2$).

$^1H$ NMR (400 MHz, $CDCl_3$): δ = 3.86 (s, 3 H, $OCH_3$), 5.08 (br s, 1 H, OH), 6.83 (d, *J* = 8.0 Hz, 1 H, ArH), 6.93 (d, *J* = 8.8 Hz, 2 H, ArH), 6.97 (t, *J* = 7.6 Hz, 1 H, ArH), 7.09 (d, *J* = 16.4 Hz, 1 H, CH), 7.16 (dt, $J_1$ = 1.6 Hz, $J_2$ = 7.6 Hz, 1 H, ArH), 7.26 (d, *J* = 16.4 Hz, 1 H, CH), 7.50 (d, *J* = 8.4 Hz, 2 H, ArH), 7.53 (dd, $J_1$ = 1.2 Hz, $J_2$ = 7.6 Hz, 1 H, ArH).

$^{13}C$ NMR (100 MHz, $CDCl_3$): δ = 55.8, 114.5, 116.3, 121.2, 121.6, 125.4, 127.5, 128.2, 128.7, 130.2, 130.8, 153.2, 159.7.

**(*E*)-2-(4-Methylstyryl)phenol (1h)[21]**
Yield: 0.332 g, 1.58 mmol (79%); light-yellow solid; mp 128–130 °C; $R_f$ = 0.4 ($CH_2Cl_2$).

$^1H$ NMR (400 MHz, $CDCl_3$): δ = 2.39 (s, 3 H, $CH_3$), 4.98 (br s, 1 H, OH), 6.83 (d, *J* = 8.0 Hz, 1 H, ArH), 6.98 (t, *J* = 7.4 Hz, 1 H, ArH), 7.12 (d, *J* = 16.4 Hz, 1 H, CH), 7.16 (dd, $J_1$ = 1.6 Hz, $J_2$ = 8.0 Hz, 1 H, ArH), 7.20 (d, *J* = 8.0 Hz, 2 H, ArH), 7.34 (d, *J* = 16.4 Hz, 1 H, CH), 7.46 (d, *J* = 8.0 Hz, 2 H, ArH), 7.55 (d, *J* = 7.6 Hz, 1 H, ArH).

$^{13}C$ NMR (100 MHz, $CDCl_3$): δ = 21.7, 116.3, 121.6, 122.3, 125.2, 126.9, 127.6, 128.9, 129.8, 130.6, 135.2, 138.0, 153.3.

HRMS (APCI): *m*/*z* $[M]^+$ calcd for $C_{15}H_{15}O$: 211.1117; found 211.1112.

**(*E*)-2-(3-Methylstyryl)phenol (1i)**
Yield: 0.319 g, 1.58 mmol (79%); colorless solid; mp 118–120 °C; $R_f$ = 0.4 ($CH_2Cl_2$).

IR (KBr): 3018, 2924, 1623, 1600, 1584, 1454, 1267, 1248, 1201, 1186, 1170, 1088, 1042, 972, 852, 808, 752, 732 $cm^{-1}$.

$^1H$ NMR (400 MHz, $CDCl_3$): δ = 2.41 (s, 3 H, $CH_3$), 5.00 (br s, 1 H, OH), 6.84 (d, *J* = 8.0 Hz, 1 H, ArH), 6.99 (t, *J* = 7.4 Hz, 1 H, ArH), 7.11 (d, *J* = 8.0 Hz, 1 H, ArH), 7.13 (d, *J* = 16.4 Hz, 1 H, CH), 7.18 (dt, $J_1$ = 1.6 Hz, $J_2$ = 8.0 Hz, 1 H, ArH), 7.29 (d, *J* = 16.0 Hz, 1 H, CH), 7.36–7.41 (m, 3 H, ArH), 7.55 (d, *J* = 7.6 Hz, 1 H, ArH).

$^{13}C$ NMR (100 MHz, $CDCl_3$): δ = 21.9, 116.4, 121.6, 123.1, 124.2, 125.2, 127.6, 127.7, 128.9, 129.0, 129.1, 130.7, 137.9, 138.7, 153.3.

HRMS (APCI): *m*/*z* $[M]^+$ calcd for $C_{15}H_{15}O$: 211.1117; found 211.1111.

**(*E*)-2-(2-Methylstyryl)phenol (1j)**
Yield: 0.340 g, 1.62 mmol (81%); colorless solid; mp 126–128 °C; $R_f$ = 0.4 ($CH_2Cl_2$).

IR (KBr): 3017, 2924, 1600, 1584, 1498, 1454, 1330, 1267, 1247, 1200, 1185, 1170, 1088, 971, 851, 808, 751, 731 $cm^{-1}$.

$^1H$ NMR (400 MHz, $CDCl_3$): δ = 2.46 (s, 3 H, $CH_3$), 4.98 (br s, 1 H, OH), 6.85 (d, *J* = 8.0 Hz, 1 H, ArH), 7.00 (t, *J* = 7.6 Hz, 1 H, ArH), 7.17–7.27 (m, 5 H, CH, ArH), 7.38 (d, *J* = 16.0 Hz, 1 H, CH), 7.56 (d, *J* = 7.6 Hz, 1 H, ArH), 7.66 (d, *J* = 7.6 Hz, 1 H, ArH).

$^{13}C$ NMR (100 MHz, $CDCl_3$): δ = 20.4, 116.4, 121.6, 124.7, 125.4, 125.9, 126.7, 127.8, 128.0, 128.7, 129.1, 130.8, 136.2, 137.0, 153.4.

HRMS (APCI): *m*/*z* $[M]^+$ calcd for $C_{15}H_{15}O$: 211.1117; found 211.1111.

**(*E*)-2-[2-(Pyridin-2-yl)ethenyl]phenol (1k)**
Yield: 0.272 g, 1.38 mmol (69%); yellow solid; mp 142–144 °C; $R_f$ = 0.2 ($CH_2Cl_2$–MeOH, 99:1).

IR (KBr): 3051, 2925, 2708, 1626, 1592, 1561, 1503, 1467, 1054, 1436, 1386, 1328, 1300, 1242, 1156, 1088, 1004, 967, 769, 757, 745 $cm^{-1}$.

$^1H$ NMR (400 MHz, $CDCl_3$): δ = 6.86 (dt, $J_1$ = 0.8 Hz, $J_2$ = 7.6 Hz, 1 H, ArH), 6.90 (d, *J* = 8.0 Hz, 1 H, ArH), 7.13 (dt, $J_1$ = 1.6 Hz, $J_2$ = 7.6 Hz, 1 H, ArH), 7.21 (ddd, $J_1$ = 1.0 Hz, $J_2$ = 5.0 Hz, $J_3$ = 7.6 Hz, 1 H, ArH), 7.45 (dd, $J_1$ = 1.6 Hz, $J_2$ = 7.6 Hz, 1 H, ArH), 7.61 (d, *J* = 8.0 Hz, 1 H, ArH), 7.72 (dd, $J_1$ = 1.8 Hz, $J_2$ = 7.8 Hz, 1 H, ArH), 7.79 (d, *J* = 2.0 Hz, 2 H, ArH), 8.66 (d, *J* = 4.8 Hz, 1 H, ArH), 10.60 (br s, 1 H, OH).

$^{13}C$ NMR (100 MHz, $CDCl_3$): δ = 117.0, 120.0, 121.6, 122.3, 124.3, 128.3, 129.8, 130.0, 131.6, 137.7, 148.5, 156.7, 157.7.

HRMS (APCI): *m*/*z* $[M]^+$ calcd for $C_{13}H_{12}ON$: 198.0913; found 198.0909.

**(*E*)-1-Styrylnaphth-2-ol (3a)**
Yield: 0.236 g, 0.96 mmol (48%); yellow oil; $R_f$ = 0.4 (hexane–$CH_2Cl_2$, 1:1).

IR (KBr): 3049, 3017, 1627, 1600, 1583, 1497, 1487, 1454, 1329, 1253, 1194, 1087, 1072, 967, 846, 787, 751, 721, 690 $cm^{-1}$.

$^1H$ NMR (400 MHz, $CDCl_3$): δ = 5.88 (br s, 1 H, OH), 7.05 (d, *J* = 16.8 Hz, 1 H, CH), 7.24 (d, *J* = 9.2 Hz, 1 H, ArH), 7.35–7.40 (m, 2 H, ArH), 7.42–7.50 (m, 4 H, CH, ArH), 7.61 (d, *J* = 7.2 Hz, 2 H, ArH), 7.74 (d, *J* = 8.8 Hz, 1 H, ArH), 7.80 (d, *J* = 8.0 Hz, 1 H, ArH), 7.91 (d, *J* = 8.4 Hz, 1 H, ArH).

$^{13}C$ NMR (100 MHz, $CDCl_3$): δ = 117.1, 118.1, 122.5, 124.0, 124.1, 127.0, 127.1, 128.8, 129.31, 129.34, 129.9, 133.3, 136.4, 137.0, 151.1.

HRMS (APCI): *m*/*z* $[M - H]^+$ calcd for $C_{18}H_{13}O$: 245.0961; found 245.0954.

**(*E*)-1-(4-Chlorostyryl)naphthalen-2-ol (3b)**
Yield: 0.285 g, 1.02 mmol (51%); yellow solid; mp 162–164 °C; $R_f$ = 0.4 (hexane–$CH_2Cl_2$, 1:1).

IR (KBr): 3062, 1619, 1595, 1516, 1488, 1463, 1390, 1267, 1254, 1215, 1187, 1129, 1096, 1086, 1011, 989, 950, 806, 775, 741 $cm^{-1}$.

$^1H$ NMR (400 MHz, $CDCl_3$): δ = 5.76 (br s, 1 H, OH), 7.01 (d, *J* = 16.8 Hz, 1 H, CH), 7.22 (d, *J* = 8.8 Hz, 1 H, ArH), 7.36 (d, *J* = 6.8 Hz, 1 H, ArH), 7.40 (d, *J* = 8.8 Hz, 2 H, ArH), 7.47 (d, *J* = 7.2 Hz, 1 H, ArH), 7.47 (d, *J* = 16.8 Hz, 1 H, CH), 7.53 (d, *J* = 8.4 Hz, 2 H, ArH), 7.74 (d, *J* = 8.8 Hz, 1 H, ArH), 7.80 (d, *J* = 7.6 Hz, 1 H, ArH), 7.90 (d, *J* = 8.4 Hz, 1 H, ArH).

$^{13}C$ NMR (100 MHz, $CDCl_3$): δ = 116.8, 118.1, 123.2, 124.0, 124.1, 127.2, 128.2, 128.9, 129.3, 129.5, 130.0, 133.2, 134.5, 135.0, 135.5, 151.1.

HRMS (APCI): *m*/*z* $[M - H]^+$ calcd for $C_{18}H_{12}OCl$: 279.0571; found 279.0589.

**(*E*)-1-(4-Methoxystyryl)naphthalen-2-ol (3c)**
Yield: 0.309 g, 1.12 mmol (56%); yellow solid; mp 156–158 °C; $R_f$ = 0.2 (hexane–$CH_2Cl_2$, 1:1).

IR (KBr): 3371, 3038, 2980, 2939, 1602, 1585, 1508, 1456, 1350, 1259, 1230, 1172, 1091, 1017, 970, 959, 846, 817, 800, 750 $cm^{-1}$.

$^1H$ NMR (400 MHz, $CDCl_3$): δ = 3.87 (s, 3 H, $OCH_3$), 5.90 (br s, 1 H, OH), 6.96 (d, *J* = 8.2 Hz, 2 H, ArH), 6.97 (d, *J* = 15.8 Hz, 1 H, CH), 7.24 (d, *J* = 8.8 Hz, 1 H, ArH), 7.28 (d, *J* = 16.8 Hz, 1 H, CH), 7.36 (t, *J* = 7.6 Hz, 1 H, ArH), 7.47 (t, *J* = 7.6 Hz, 1 H, ArH), 7.54 (d, *J* = 8.4 Hz, 2 H, ArH), 7.72 (d, *J* = 8.8 Hz, 1 H, ArH), 7.79 (d, *J* = 8.0 Hz, 1 H, ArH), 7.90 (d, *J* = 8.4 Hz, 1 H, ArH).

$^{13}C$ NMR (100 MHz, $CDCl_3$): δ = 55.9, 114.7, 117.4, 118.1, 120.1, 123.9, 124.2, 127.0, 128.3, 128.8, 129.3, 129.6, 129.8, 133.4, 136.0, 151.0, 160.3.

HRMS (APCI): *m*/*z* $[M - H]^+$ calcd for $C_{19}H_{15}O_2$: 275.1067; found 275.1062.

**Cyclization of (*E*)-2-Styrylphenols 1a–k and (*E*)-1-Styrylnaphthols 3a–c; General Procedure**

(*E*)-2-Styrylphenol **1** or (*E*)-1-styrylnaphthol **3** (0.2 mmol) was added to a soln of $PhI(OAc)_2$ (0.064 g, 0.2 mmol) in MeCN (4 mL) under Ar at r.t. and the mixture stirred at the same temperature for 1–3 h. After completion of the reaction, the solvent was evaporated under reduced pressure and the residue purified immediately by column chromatography (hexane).

**2-Phenylbenzofuran (2a)[9,14,23]**

Yield: 0.03 g, 0.154 mmol (77%); colorless solid; mp 118–120 °C; $R_f$ = 0.3 (hexane).

$^1H$ NMR (400 MHz, $CDCl_3$): δ = 6.96 (s, 1 H, ArH), 7.14–7.23 (m, 2 H, ArH), 7.28 (t, *J* = 7.6 Hz, 1 H, ArH), 7.38 (t, *J* = 7.6 Hz, 2 H, ArH), 7.45 (d, *J* = 8.4 Hz, 1 H, ArH), 7.52 (d, *J* = 7.6 Hz, 1 H, ArH), 7.80 (d, *J* = 7.6 Hz, 2 H, ArH).

$^{13}C$ NMR (125 MHz, $CDCl_3$): δ = 101.3, 111.2, 120.9, 122.9, 124.3, 125.0, 128.5, 128.8, 129.2, 130.5, 154.9, 155.0.

**2-(4-Chlorophenyl)benzofuran (2b)[14,15]**

Yield: 0.036 g, 0.158 mmol (79%); colorless solid; mp 150–152 °C; $R_f$ = 0.4 (hexane).

$^1H$ NMR (400 MHz, $CDCl_3$): δ = 7.04 (s, 1 H, ArH), 7.27 (t, *J* = 7.2 Hz, 1 H, ArH), 7.33 (dt, $J_1$ = 1.2 Hz, $J_2$ = 8.0 Hz, 1 H, ArH), 7.44 (d, *J* = 8.4 Hz, 2 H, ArH), 7.54 (d, *J* = 7.6 Hz, 1 H, ArH), 7.61 (d, *J* = 7.6 Hz, 1 H, ArH), 7.82 (d, *J* = 8.8 Hz, 2 H, ArH).

$^{13}C$ NMR (125 MHz, $CDCl_3$): δ = 102.2, 111.6, 121.4, 123.5, 125.0, 126.6, 129.4, 129.5, 134.7, 155.2, 155.3.

**2-(3-Chlorophenyl)benzofuran (2c)[24]**

Yield: 0.035 g, 0.154 mmol (77%); colorless solid; mp 96–98 °C; $R_f$ = 0.4 (hexane).

$^1H$ NMR (500 MHz, $CDCl_3$): δ = 7.07 (s, 1 H, ArH), 7.26–7.29 (m, 1 H, ArH), 7.32–7.35 (m, 2 H, ArH), 7.40 (t, *J* = 8.0 Hz, 1 H, ArH), 7.56 (d, *J* = 8.0 Hz, 1 H, ArH), 7.62 (dd, $J_1$ = 0.5 Hz, $J_2$ = 7.5 Hz, 1 H, ArH), 7.76 (td, $J_1$ = 1.2 Hz, $J_2$ = 8.0 Hz, 1 H, ArH), 7.89 (t, *J* = 1.8 Hz, 1 H, ArH).

$^{13}C$ NMR (125 MHz, $CDCl_3$): δ = 100.5, 109.4, 119.3, 121.1, 121.3, 122.9, 123.1, 126.6, 127.1, 128.2, 130.4, 133.0, 152.5, 153.1.

**2-(2-Chlorophenyl)benzofuran (2d)[25]**

Yield: 0.034 g, 0.148 mmol (74%); colorless solid; mp 48–50 °C; $R_f$ = 0.4 (hexane).

$^1H$ NMR (500 MHz, $CDCl_3$): δ = 7.27–7.42 (m, 4 H, ArH), 7.53 (dd, $J_1$ = 1.0 Hz, $J_2$ = 8.0 Hz, 1 H, ArH), 7.56–7.58 (m, 2 H, ArH), 7.67 (d, *J* = 8.0 Hz, 1 H, ArH), 8.09 (dd, $J_1$ = 1.5 Hz, $J_2$ = 8.0 Hz, 1 H, ArH).

$^{13}C$ NMR (125 MHz, $CDCl_3$): δ = 107.4, 111.1, 121.5, 123.0, 124.9, 127.0, 129.01, 129.04, 129.1 (2 C), 130.9, 131.4, 152.0, 154.2.

**2-(3-Fluorophenyl)benzofuran (2e)[26]**

Yield: 0.029 g, 0.136 mmol (68%); colorless solid; mp 78–80 °C; $R_f$ = 0.4 (hexane).

$^1H$ NMR (400 MHz, $CDCl_3$): δ = 6.96 (ddt, $J_1$ = 0.6 Hz, $J_2$ = 2.6 Hz, $J_3$ = 8.8 Hz, 1 H, ArH), 6.97 (s, 1 H, ArH), 7.25 (dt, $J_1$ = 0.8 Hz, $J_2$ = 7.6 Hz, 1 H, ArH), 7.32 (dt, $J_1$ = 1.2 Hz, $J_2$ = 7.6 Hz, 1 H, ArH), 7.41 (ddd, $J_1$ = 2.4 Hz, $J_2$ = 5.6 Hz, $J_3$ = 8.0 Hz, 1 H, ArH), 7.52–7.66 (m, 4 H, ArH).

$^{13}C$ NMR (100 MHz, $CDCl_3$): δ = 102.8, 111.7, 112.2 (d, *J* = 23.4 Hz), 115.8 (d, *J* = 21.3 Hz), 121.0 (d, *J* = 2.8 Hz), 121.6, 123.6, 125.2, 129.4, 130.8 (d, *J* = 8.1 Hz), 133.0 (d, *J* = 8.6 Hz), 155.0 (d, *J* = 2.8 Hz), 155.3, 163.6 (d, *J* = 243.8 Hz).

**2-(3-Nitrophenyl)benzofuran (2f)[27]**

Yield: 0.033 g, 0.138 mmol (69%); colorless solid; mp 136–138 °C; $R_f$ = 0.4 (hexane–$CH_2Cl_2$, 1:1).

$^1H$ NMR (400 MHz, $CDCl_3$): δ = 7.20 (s, 1 H, ArH), 7.29 (d, *J* = 7.6 Hz, 1 H, ArH), 7.36 (dt, $J_1$ = 1.2 Hz, $J_2$ = 8.0 Hz, 1 H, ArH), 7.57 (d, *J* = 8.4 Hz, 1 H, ArH), 7.62 (d, *J* = 8.4 Hz, 1 H, ArH), 7.64 (d, *J* = 7.6 Hz, 1 H, ArH), 8.15–8.21 (m, 2 H, ArH), 8.71 (t, *J* = 1.2 Hz, 1 H, ArH).

$^{13}C$ NMR (100 MHz, $CDCl_3$): δ = 104.0, 111.9, 120.1, 121.9, 123.3, 123.9, 125.8, 129.1, 130.3, 130.7, 132.6, 149.2, 153.6, 155.5.

**2-(4-Methoxyphenyl)benzofuran (2g)[23,28]**

Yield: 0.038 g, 0.174 mmol (87%); colorless solid; mp 148–150 °C; $R_f$ = 0.4 (hexane–$CH_2Cl_2$, 1:1).

$^1H$ NMR (400 MHz, $CDCl_3$): δ = 3.89 (s, 3 H, $OCH_3$), 6.92 (s, 1 H, ArH), 7.01 (d, *J* = 8.8 Hz, 2 H, ArH), 7.23–7.31 (m, 2 H, ArH), 7.54 (d, *J* = 7.6 Hz, 1 H, ArH), 7.59 (dd, $J_1$ = 1.6 Hz, $J_2$ = 8.8 Hz, 1 H, ArH), 7.83 (d, *J* = 8.8 Hz, 2 H, ArH).

$^{13}C$ NMR (100 MHz, $CDCl_3$): δ = 55.8, 100.1, 111.5, 114.7, 121.0, 123.3, 123.8, 124.2, 126.9, 129.9, 155.1, 156.5, 160.4.

**2-(4-Methylphenyl)benzofuran (2h)[23]**

Yield: 0.032 g, 0.158 mmol (79%); colorless solid; mp 122–124 °C; $R_f$ = 0.3 (hexane).

$^1H$ NMR (400 MHz, $CDCl_3$): δ = 2.43 (s, 3 H, $CH_3$), 7.01 (s, 1 H, ArH), 7.23–7.32 (m, 4 H, ArH), 7.55 (d, *J* = 8.0 Hz, 1 H, ArH), 7.60 (dd, $J_1$ = 1.2 Hz, $J_2$ = 8.8 Hz, 1 H, ArH), 7.80 (d, *J* = 8.0 Hz, 2 H, ArH).

$^{13}C$ NMR (100 MHz, $CDCl_3$): δ = 21.9, 101.0, 111.5, 121.2, 123.3, 124.4, 125.3, 128.2, 129.8, 129.9, 139.1, 155.2, 156.6.

**2-(3-Methylphenyl)benzofuran (2i)[23,29]**

Yield: 0.034 g, 0.166 mmol (83%); colorless solid; mp 76–78 °C; $R_f$ = 0.3 (hexane).

$^1H$ NMR (400 MHz, $CDCl_3$): δ = 2.44 (s, 3 H, $CH_3$), 7.02 (s, 1 H, ArH), 7.18 (d, *J* = 7.6 Hz, 1 H, ArH), 7.21–7.31 (m, 2 H, ArH), 7.35 (d, *J* = 7.6 Hz, 1 H, ArH), 7.53 (d, *J* = 8.0 Hz, 1 H, ArH), 7.59 (dd, $J_1$ = 1.2 Hz, $J_2$ = 8.0 Hz, 1 H, ArH), 7.68 (d, *J* = 7.6 Hz, 1 H, ArH), 7.71 (s, 1 H, ArH).

$^{13}C$ NMR (100 MHz, $CDCl_3$): δ = 22.0, 101.6, 111.6, 121.3, 122.6, 123.3, 124.6, 126.0, 129.2, 129.7, 129.8, 130.8, 138.9, 155.3, 156.5.

**2-(2-Methylphenyl)benzofuran (2j)[30]**

Yield: 0.036 g, 0.172 mmol (86%); colorless oil; $R_f$ = 0.3 (hexane).

$^1H$ NMR (400 MHz, $CDCl_3$): δ = 2.60 (s, 3 H, $CH_3$), 6.91 (s, 1 H, ArH), 7.25 (t, *J* = 7.6 Hz, 1 H, ArH), 7.29–7.35 (m, 4 H, ArH), 7.54 (d, *J* = 8.0 Hz, 1 H, ArH), 7.62 (d, *J* = 7.2 Hz, 1 H, ArH), 7.87 (d, *J* = 8.0 Hz, 1 H, ArH).

$^{13}C$ NMR (100 MHz, $CDCl_3$): δ = 22.4, 105.6, 111.5, 121.4, 123.3, 124.7, 126.6, 128.6, 128.9, 129.6, 130.3, 131.7, 136.3, 154.8, 156.0.

**2-(Benzofuran-2-yl)pyridine (2k)[31]**

Yield: 0.031 g, 0.158 mmol (79%); colorless solid; mp 90–92 °C; $R_f$ = 0.2 ($CH_2Cl_2$).

$^1H$ NMR (400 MHz, $CDCl_3$): δ = 7.23–7.28 (m, 2 H, ArH), 7.34 (dt, $J_1$ = 1.2 Hz, $J_2$ = 7.6 Hz, 1 H, ArH), 7.44 (s, 1 H, ArH), 7.57 (d,

$J$ = 8.0 Hz, 1 H, ArH), 7.65 (d, $J$ = 8.0 Hz, 1 H, ArH), 7.78 (dt, $J_1$ = 1.6 Hz, $J_2$ = 7.8 Hz, 1 H, ArH), 7.91 (d, $J$ = 7.6 Hz, 1 H, ArH), 8.67 (d, $J$ = 4.4 Hz, 1 H, ArH).

$^{13}$C NMR (125 MHz, $CDCl_3$): δ = 105.2, 112.0, 120.3, 122.1, 123.4, 123.6, 125.6, 129.3, 137.2, 149.7, 150.3, 155.5, 155.7.

**2-Phenylnaphtho[2,1-*b*]furan (4a)[14,32]**
Yield: 0.042 g, 0.176 mmol (88%); colorless solid; mp 144–146 °C; $R_f$ = 0.3 (hexane).

$^1$H NMR (400 MHz, $CDCl_3$): δ = 7.36 (t, $J$ = 7.4 Hz, 1 H, ArH), 7.48 (t, $J$ = 7.6 Hz, 3 H, ArH), 7.54 (s, 1 H, ArH), 7.61 (dt. $J_1$ = 1.2 Hz, $J_2$ = 7.6 Hz, 1 H, ArH), 7.70 (d, $J$ = 8.8 Hz, 1 H, ArH), 7.74 (d, $J$ = 9.2 Hz, 1 H, ArH), 7.95 (d, $J$ = 7.4 Hz, 3 H, ArH), 8.18 (d, $J$ = 8.0 Hz, 1 H, ArH).

$^{13}$C NMR (125 MHz, $CDCl_3$): δ = 100.9, 112.8, 123.9, 124.9, 125.0, 125.1, 125.6, 126.7, 128.0, 128.7, 129.2, 129.3, 130.9, 131.1, 152.8, 155.8.

**2-(4-Chlorophenyl)naphtho[2,1-*b*]furan (4b)[14]**
Yield: 0.051 g, 0.182 mmol (91%); colorless solid; mp 154–156 °C; $R_f$ = 0.4 (hexane).

$^1$H NMR (400 MHz, $CDCl_3$): δ = 7.47 (t, $J$ = 8.4 Hz, 2 H, ArH), 7.51 (dt, $J_1$ = 1.2 Hz, $J_2$ = 8.0 Hz, 1 H, ArH), 7.52 (s, 1 H, ArH), 7.60 (dt, $J_1$ = 1.2 Hz, $J_2$ = 8.0 Hz, 1 H, ArH), 7.68 (d, $J$ = 8.8 Hz, 1 H, ArH), 7.74 (d, $J$ = 8.8 Hz, 1 H, ArH), 7.86 (d, $J$ = 8.8 Hz, 2 H, ArH), 7.96 (d, $J$ = 8.4 Hz, 1 H, ArH), 8.16 (d, $J$ = 8.4 Hz, 1 H, ArH).

$^{13}$C NMR (100 MHz, $CDCl_3$): δ = 101.4, 112.7, 123.9, 124.9, 125.2, 126.0, 126.3, 126.8, 128.0, 129.3, 129.5, 130.9, 134.4, 152.9, 154.7.

**2-(4-Methoxyphenyl)naphtho[2,1-*b*]furan (4c)[14]**
Yield: 0.052 g, 0.190 mmol (95%); colorless solid; mp 110–112 °C; $R_f$ = 0.4 (hexane–$CH_2Cl_2$, 1:1).

$^1$H NMR (400 MHz, $CDCl_3$): δ = 3.87 (s, 3 H, OMe), 7.01 (d, $J$ = 8.8 Hz, 2 H, ArH), 7.39 (s, 1 H, ArH), 7.50 (dt, $J_1$ = 1.2 Hz, $J_2$ = 8.0 Hz, 1 H, ArH), 7.59 (dt, $J_1$ = 1.2 Hz, $J_2$ = 8.0 Hz, 1 H, ArH), 7.68 (d, $J$ = 9.2 Hz, 1 H, ArH), 7.71 (d, $J$ = 9.2 Hz, 1 H, ArH), 7.86 (d, $J$ = 8.8 Hz, 2 H, ArH), 7.95 (d, $J$ = 8.0 Hz, 1 H, ArH), 8.16 (dd, $J_1$ = 0.6 Hz, $J_2$ = 8.2 Hz, 1 H, ArH).

$^{13}$C NMR (125 MHz, $CDCl_3$): δ = 55.8, 99.3, 112.7, 114.8, 123.9, 124.0, 124.9, 125.0, 125.2, 126.5, 126.6, 127.9, 129.2, 130.9, 152.5, 156.0, 160.2.

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