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Iodine(III)-Mediated Tandem Oxidative Cyclization for Construction of 2-Nitrobenzo[*b*]furans

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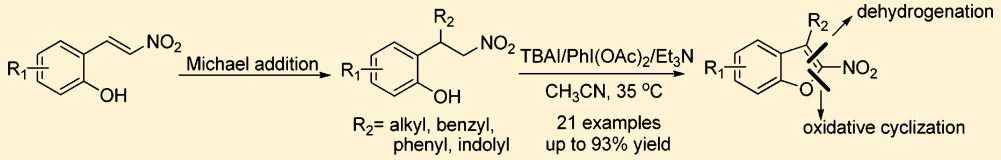
Supporting Information



ABSTRACT: Various 3-alkyl-2-nitrobenzo[*b*]furans were synthesized from common intermediate 2-(2-nitroethyl)phenols via a hypervalent iodine-induced oxidative cyclization, with good to excellent yields. This facile route is able to efficiently functionalize 2-nitrobenzo[*b*]furans, which are difficult to obtain by classical methods.

Synthesis of benzo[*b*]furans has drawn extensive and enduring attention because of their ubiquitous and varied biological activities.[1,2] In particular, the synthesis of 3-alkyl-2-nitrobenzo[*b*]furans is the subject of intense investigation because the nitro group has a significant effect on the biological activity and often manifests changes in chemical and physical properties.[3] Unfortunately, as Figure 1 indicates, the synthetic methods are not well-developed. The condensation of bromonitromethane and *ortho*-hydroxylated aromatic aldehydes is generally used to prepare 2-nitrobenzofurans, but not for the preparation of 3-substituted 2-nitrobenzofurans (Figure 1, route a).[3c] Direct nitration methods (Figure 1, route b) present major disadvantages of poor regioselectivity and low yield.[4] An improved method was reported that 2-trimethylstannylated benzo[*b*]furan can be converted to 2-nitrobenzo[*b*]furan upon treatment with tetranitromethane, but prefunctionalization of the benzo[*b*]furan was needed (Figure 1, route c).[5] Very recently, Wunderlich et al. reported an alternative approach by reaction of diorganozinc compounds bearing a nitro group with an alkyl halide. The reaction was catalyzed by $(tmp)_2Zn{\cdot}2MgCl_2{\cdot}2LiCl$ and highly toxic regent CuCN·2LiCl (Figure 1, route d).[6] Thus, the development of new methods for efficient construction of 3-alkyl-2-nitrobenzo[*b*]furans is quite desirable. In this paper, we report a facile synthesis of 3-alkyl-2-nitrobenzo[*b*]furans via tandem iodine(III)-induced oxidative cyclization and subsequent dehydrogenation.

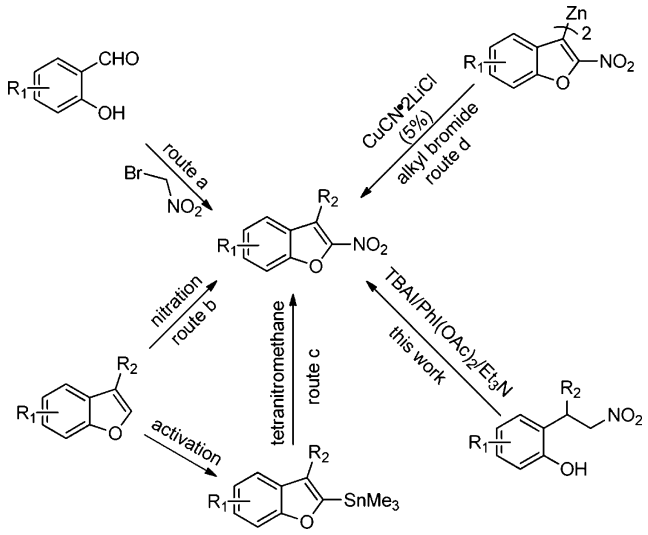


Figure 1. Methods for the synthesis of 2-nitrobenzo[*b*]furans.

In the past decades, the chemistry of hypervalent iodine organic compounds has experienced explosive developments.[7] In particular, aryl-λ^3-iodanes (iodine in the oxidation state +III) have been established as cheap and nontoxic alternatives to transition metals in oxidative C−H bond activations.[8,9] Inspired by the metal-free oxidative C−H activation approaches, we proposed that the desired 3-alkyl-2-nitrobenzo[*b*]furan products could be obtained by hypervalent iodine through the intramolecular cyclization and subsequent dehydrogenation of 2-(2-nitroethyl)phenols. The substituents at the 3-position of 2-nitrobenzo[*b*]furans are able to be easily introduced by the well-known Michael addition of a nucleophilic reagent to a nitroolefin (Scheme 1).[10]

In our initial studies, we chose the 2-(2-nitroethyl)phenol **1a** (prepared by Michael addition of the corresponding

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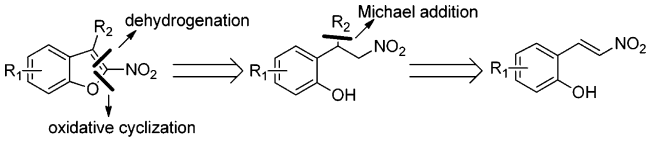
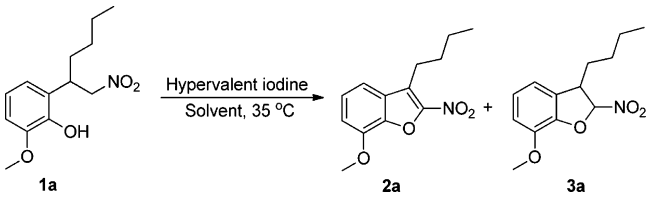
Scheme 1. Synthetic Route for 2-Nitrobenzo[*b*]furan Formation



nucleophilic reagent to 2-nitrovinylbenzene) as a model substrate to examine whether the substrate **1a** could be converted into the corresponding nitrobenzofuran **2a** (Table 1). Reaction was carried out in CH_3CN at 35 °C in the presence of 1 equiv of $PhI(OAc)_2$ as the oxidant (Table 1, entry 1). However, none of the desired product was observed; the majority of the starting material **1a** remained. To generate a more reactive hypervalent iodine species, 1 equiv of tetrabutylammonium iodide (TBAI) was added.[11] After an initial screen of typical aryl-λ^3-iodanes ($PhI(OAc)_2$ (PIDA), $PhI(OCOCF_3)_2$ (PIFA), and PhI(OH)(OTs) (HTIB)) as oxidants (Table 1, entries 2–4), we found that the combination of TBAI with $PhI(OAc)_2$ successfully produced **2a** in 30% yield (Table 1, entry 2) while a 2-nitro-2,3-dihydrobenzofuran product **3a** was also isolated in 26% yield. With exposure of substrate **1a** to 2.5 equiv of $PhI(OAc)_2$ and 3 equiv of TBAI in CH_3CN for 30 min, the yields of **2a** and **3a** were increased to 55 and 30%, respectively (Table 1, entry 5). It is hypothesized that the required excess of $PhI(OAc)_2$ and moderate yield is most likely the result of the generation of unreactive I_2.[12] Motivated by the synthetic potential of the possible method, we further employed conditions that generated in situ catalytically active species of hypervalent iodine reagents through the combination of TBAI with *tert*-butyl hydroperoxide (TBHP) or H_2O_2.[13] However, the desired reaction failed to take place; instead, *trans*-2-nitro-2,3-dihydrobenzofuran **3a** was selectively obtained in excellent yield (Table 1, entries 6 and 7). Stereochemical assignment of the obtained compound was based on the ^1H NMR coupling constants. The coupling constants of the isolated product **3a** were measured to be 1.4 Hz, matching the values of known *trans*-isomers (J = 1.0–2.0 Hz).[14] In the case of the corresponding *syn*-isomers, J values are known to be in the range of 6.5–8.0 Hz. Consequently, the *trans*-isomer was obtained exclusively, but these tested conditions lack a dehydrogenation step.

Table 1. Screening of the Reaction Conditions



				yield (%)[a]	
entry	TBAI/hypervalent iodine (equiv)[b]	solvent	additive	**2a**	**3a**
1	PIDA (1)	CH_3CN		0	0
2	TBAI/PIDA (1:1)	CH_3CN		30	26
3	TBAI/PIFA (1:1)	CH_3CN		trace	0
4	TBAI/HTIB (1:1)	CH_3CN		trace	0
5	TBAI/PIDA (2.5:3.0)	CH_3CN		55	30
6[c]	TBAI/TBHP (0.1:1)	CH_3CN		0	94
7	TBAI/H_2O_2 (0.1:1)	CH_3CN		0	95
8	TBAI/PIDA (2.5:3.0)	CH_3CN	NaOAc	71	20
9	TBAI/PIDA (2.5:3.0)	CH_3CN	K_2CO_3	65	10
10	TBAI/PIDA (2.5:3.0)	CH_3CN	*t*-BuOK	67	12
11	**TBAI/PIDA (2.5:3.0)**	**CH_3CN**	**Et_3N**	**91**	**<5**
12	TBAI/PIDA (2.5:3.0)	CH_3CN	AcOH	8	18
13	TBAI/PIDA (2.5:3.0)	THF	Et_3N	88	8
14	TBAI/PIDA (2.5:3.0)	CH_2Cl_2	Et_3N	76	10
15	TBAI/PIDA (2.5:3.0)	CH_3OH	Et_3N	0	0
16	TBAI/PIDA (2.5:3.0)	H_2O	Et_3N	0	0
17	TBAI/PIDA (2.5:3.0)	dioxane	Et_3N	86	6

[a]Isolated yields after silica gel chromatography. [b]Relative to amount of **1a**. [c]The reaction was carried out at 80 °C.

Surprisingly, when a base such as NaOAc, K_2CO_3, *t*-BuOK, or, in particular, Et_3N (Table 1, entries 8–11) was added to the reaction mixture, the yield of **2a** was significantly increased to 91%. Addition of acetic acid resulted in a nearly complete loss of reactivity (Table 1, entry 12). It is assumed that the base promoted the deprotonation of the nitroalkane at the α-position to form the corresponding resonance-stabilized anion and neutralized the acetic acid produced in the reaction.

The effect of solvents on the model reaction was further examined. Among the solvents tested, in addition to CH_3CN, CH_2Cl_2 and dioxane are also acceptable while H_2O and MeOH are not (Table 1, entries 13–17).

Under the optimized reaction conditions, the scope and generality of the reaction were systematically investigated. The results listed in Table 2 demonstrate that the corresponding target products were obtained in good to excellent yields for most substrates. It was observed that substrate **1d**, without any substitution at the position of R_2, produced the 2-nitrobenzofuran **2d** in 91% yield by this method. To check the effect of R_2 substituents, various substrates bearing different substituted aliphatic (Table 2, **2a–2c**, **2e–2o**) and aromatic (Table 2, **2p–2s**) motifs at this position were converted to the desired products **2** in satisfactory yields. These results also show that when R_2 was a bulkier benzyl group (Table 2, **2h–2o**) or phenyl (Table 2, **2p–2s**), the reaction yields were slightly reduced.

To obtain further insights into the reaction mechanism, compound **3a** was treated with the combination of $PhI(OAc)_2$ (1 equiv)/TBAI (1 equiv)/Et_3N (1 equiv) under the same conditions, and it could be converted smoothly into product **2a** in 90% yield (Scheme 2). This suggested that the oxidation system of $PhI(OAc)_2$/TBAI played an important role for dehydrogenation of **3a**.

On the basis of this observation and the literature evidence,[12] a plausible reaction pathway for the $PhI(OAc)_2/Bu_4NI$-mediated tandem oxidative cyclization is formulated in Scheme 3. It is assumed that $PhI(OAc)_2$ initially reacts with TBAI to give a halide-exchanged halonium species **A**. Under basic conditions, deprotonation of the nitroalkane at the α-position forms the corresponding resonance-stabilized anion **B**. Anion **B** with the generated highly reactive iodine species **A** forms an α-hyperiodination intermediate **C**, which is ready to undergo an intramolecular attack on the α-position of the nitro group by the oxygen atom to give 3-alkyl-2-nitro-2,3-dihydrobenzofuran **D** accompanied by reductive elimination of PhI. Following a second α-hyperiodination and subsequent reductive elimination, 3-alkyl-2-nitrobenzofuran is finally formed.

A valuable benefit of this tandem reaction is shown by its application to highly functionalized molecules such as a coumarin derivative and an indole derivative (Scheme 4). 3,3-

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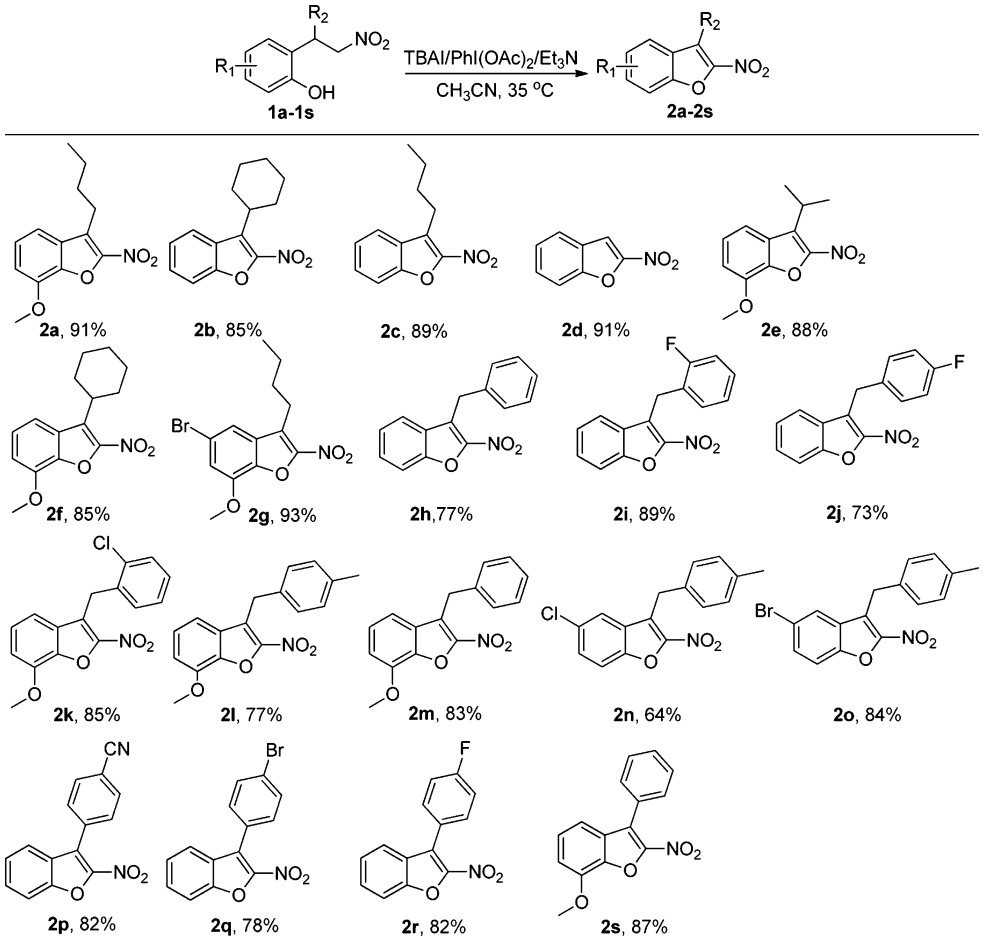
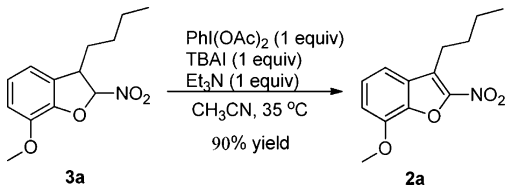
Table 2. Synthesis of 3-Alkyl-2-nitrobenzo[*b*]furans by Iodine(III)-Mediated Tandem Oxidative Cyclization[a]



[a]All reactions were run under the following conditions, unless otherwise indicated: substrates **1** (1.0 mmol), $PhI(OAc)_2$ (3.0 mmol), TBAI (2.5 mmol), Et_3N (2.0 mmol) at 35 °C in CH_3CN (3 mL) under argon atmosphere. Yield of analytically pure product.

Scheme 2. Control Experiment



Linked hybrid molecules of indole and benzofuran pharmacophores were obtained for the first time (Scheme 4, **2t**). From coumain substrate **4**, designed furocoumarin **2u** was obtained in two steps in moderate yield. These results illustrate that indole and coumarin, involving an α,β-unsaturated system and an ester bond, tolerate a mild $TBAI/PhI(OAc)_2/Et_3N$ system. The coumarin ring and indole, present in natural products and displaying interesting pharmacological properties, have intrigued medicinal chemists to explore and synthesize their analogues for use as drugs. The diversity shown by our synthetic route may lead to interesting derivatives and biological activity.

CONCLUSION

In conclusion, we have presented a highly efficient and practical protocol for synthesis of 3-alkyl-2-nitrobenzo[*b*]furans by iodine(III)-mediated tandem oxidative cyclization. In this transformation, various 2-nitrobenzo[*b*]furan derivatives were efficiently converted into 3-substituted 2-nitrobenzo[*b*]furans in good to excellent yields. The present process could facilitate the synthetic applications of nitro-containing building blocks.

EXPERIMENTAL SECTION

Preparation of Substrates 1a–1c, 1e–1h, 1l–1o, and 1s. Three milliliters of Grignard reagent (1.0 M solution in THF) was slowly added to corresponding 2-nitroethene (1.0 mmol) in 20 mL of anhydrous THF at −30 °C under argon atmosphere. After 30 min, an ice-cold 5% aqueous HCl (15 mL) was then added to the reaction solution and stirred for 30 min. The reaction mixture was extracted with ethyl acetate and dried over $MgSO_4$. The solvent was evaporated to give the crude product. Further purification was achieved by column chromatography on silica gel (ethyl acetate/petroleum).

2-Methoxy-6-(1-nitrohexan-2-yl)phenol (1a): Colorless oil, 197 mg, 78% yield; ^{1}H NMR (300 MHz, acetone) δ 7.64 (s, 1H), 6.88–6.85 (m, 1H), 6.79–6.76 (m, 2H), 4.88–4.72 (m, 2H), 3.85–3.78 (m, 4H), 1.93–1.62 (m, 2H), 1.37–1.14 (m, 4H), 0.83 (t, J = 6.8 Hz, 3H); ^{13}C NMR (150 MHz, acetone) δ 148.2, 145.3, 126.4, 121.5, 120.1, 110.7, 80.0, 56.2, 40.0, 31.9, 30.0, 23.1, 14.1; HRMS (ESI-TOF) calcd for $C_{13}H_{19}NO_4Na$ $[M + Na]^+$ (276.1206), found 276.1217.

2-(1-Cyclohexyl-2-nitroethyl)phenol (1b): Colorless oil, 174 mg, 70% yield; ^{1}H NMR (300 MHz, acetone) δ 8.48 (s, 1H), 7.12–7.05 (m, 3H), 6.84 (d, J = 8.0 Hz, 1H), 6.78 (t, J = 7.4 Hz, 1H), 5.03–4.88 (m, 2H), 3.58 (m, 1H), 1.96–0.93 (m, 11H); ^{13}C NMR (150 MHz, acetone) δ 156.1, 130.6, 128.7, 126.5, 120.3, 116.3, 116.2, 78.3,

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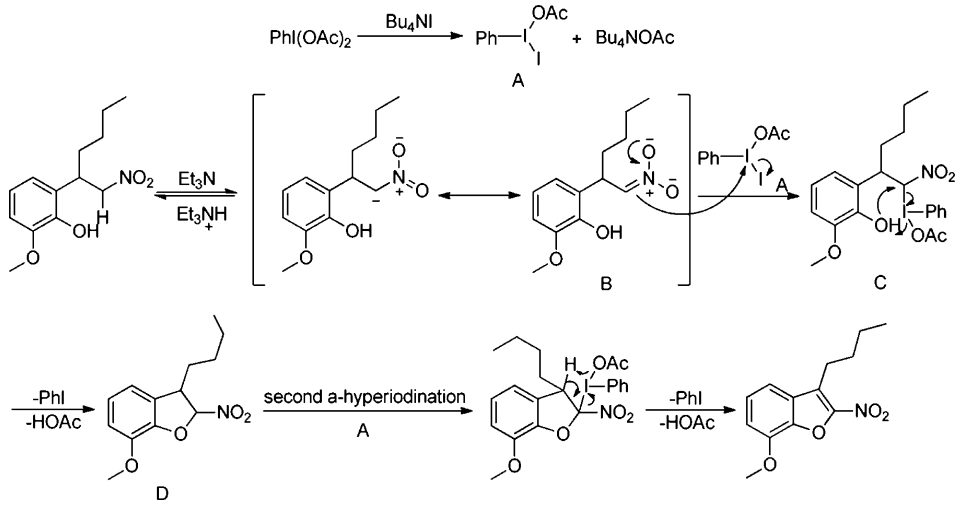
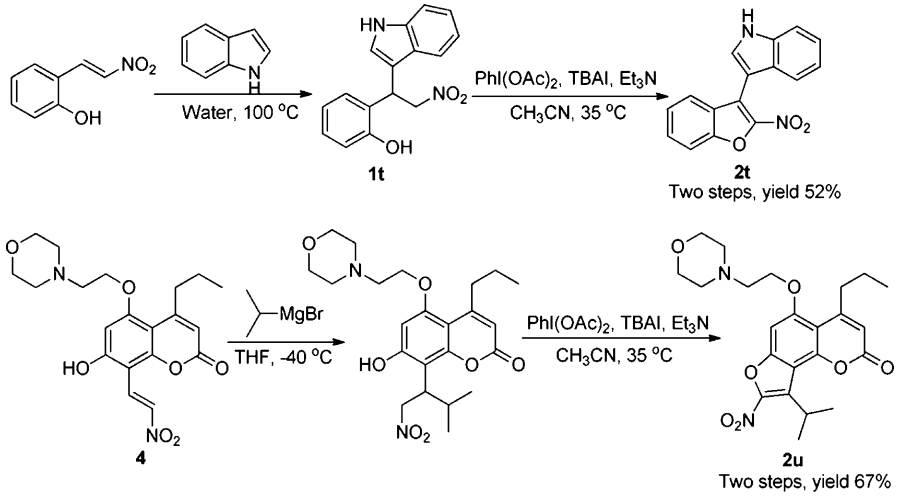
Scheme 3. Proposed Mechanistic Pathway



Scheme 4. Application for Synthesis of More Complex Molecules



46.4, 40.3, 31.7, 31.6, 27.0, 26.9, 26.8; HRMS (ESI-TOF) calcd for $C_{14}H_{19}NO_3Na$ $[M + Na]^+$ (272.1257), found 272.1250.

2-(1-Nitrohexan-2-yl)phenol (1c): Colorless oil, 167 mg, 75% yield; ^1H NMR (300 MHz, acetone) δ 8.56 (s, 1H), 7.16 (d, J = 7.8 Hz, 1H), 7.08 (t, J = 7.8 Hz, 1H), 6.87 (d, J = 8.1 Hz, 1H), 6.81 (t, J = 7.5 Hz, 1H), 4.86 (dd, J = 12.2, 8.1 Hz, 1H), 4.75 (dd, J = 12.2, 7.1 Hz, 1H), 3.88−3.72 (m, 1H), 1.81−1.90 (m, 1H), 1.80−1.62 (m, 1H), 1.36−1.16 (m, 4H), 0.83 (t, J = 6.9 Hz, 3H); ^{13}C NMR (150 MHz, acetone) δ 156.0, 129.8, 128.8, 126.7, 120.5, 116.4, 80.0, 40.2, 31.8, 29.9, 23.1, 14.1; HRMS (ESI-TOF) calcd for $C_{12}H_{17}NO_3Na$ $[M + Na]^+$ (246.1101), found 246.1113.

2-Methoxy-6-(3-methyl-1-nitrobutan-2-yl)phenol (1e): Colorless oil, 206 mg, 86% yield; ^1H NMR (300 MHz, acetone) δ 7.58 (s, 1H), 6.86−6.82 (m, 1H), 6.76−6.74 (m, 2H), 5.02−4.87 (m, 2H), 3.83 (s, 3H), 3.58−3.53 (m, 1H), 2.18−2.10 (m, 1H), 1.04 (d, J = 6.7 Hz, 3H), 0.81 (d, J = 6.7 Hz, 3H); ^{13}C NMR (150 MHz, acetone) δ 148.1, 145.3, 126.3, 122.1, 120.0, 110.6, 78.4, 56.2, 46.9, 30.8, 21.2, 20.8; HRMS (ESI-TOF) calcd for $C_{12}H_{17}NO_4Na$ $[M + Na]^+$ (262.1050), found 262.1060.

2-(1-Cyclohexyl-2-nitroethyl)-6-methoxyphenol (1f): Colorless oil, 229 mg, 82% yield; ^1H NMR (300 MHz, acetone) δ 7.55 (s, 1H), 6.83−6.78 (m, 1H), 6.71−6.67 (m, 2H), 4.93−4.88 (m, 2H), 3.79 (s, 3H), 3.60−3.53(m, 1H), 1.95−0.83 (m, 11H); ^{13}C NMR (150 MHz, acetone) δ 148.1, 145.4, 126.1, 122.3, 119.4, 110.6, 78.3, 56.2, 46.1, 40.3, 31.71, 31.65, 30.0, 26.9, 26.8; HRMS (ESI-TOF) calcd for $C_{15}H_{21}NO_4Na$ $[M + Na]^+$ (302.1363), found 302.1369.

4-Bromo-2-methoxy-6-(1-nitrohexan-2-yl)phenol (1g): Colorless oil, 265 mg, 80% yield; ^1H NMR (300 MHz, acetone) δ 7.99 (s, 1H), 7.01 (d, J = 1.9 Hz, 2H), 6.98 (d, J = 1.9 Hz, 1H), 4.92−4.75 (m, 2H), 3.94−3.72 (m, 4H), 1.77−1.65 (m, 2H), 1.37−1.13 (m, 4H), 0.84 (t, J = 7.0 Hz, 3H); ^{13}C NMR (150 MHz, acetone) δ 149.2, 144.9, 128.6, 124.0, 114.1, 111.4, 79.6, 56.6, 39.7, 31.9, 30.3, 23.1, 14.1; HRMS (ESI-TOF) calcd for $C_{13}H_{18}BrNO_4Na$ $[M + Na]^+$ (354.0311), found 354.0325.

2-(1-Nitro-3-phenylpropan-2-yl)phenol (1h): Colorless oil, 198 mg, 77% yield; ^1H NMR (300 MHz, DMSO) δ 9.59 (s, 1H), 7.26−6.97 (m, 7H), 6.76 (d, J = 7.5 Hz, 1H), 6.67 (t, J = 7.4 Hz, 1H), 4.92 (dd, J = 12.5, 9.0 Hz, 1H), 4.70 (dd, J = 12.5, 6.1 Hz, 1H), 4.02−3.89 (m, 1H), 3.02 (dd, J = 13.6, 8.2 Hz, 1H), 2.90 (dd, J = 13.6, 7.1 Hz, 1H); ^{13}C NMR (150 MHz, acetone) δ 155.1, 139.0, 128.9, 128.7, 128.2, 128.0, 126.1, 125.1, 118.9, 115.3, 78.3, 40.5, 37.1; HRMS (ESI-TOF) calcd for $C_{15}H_{15}NO_3Na$ $[M + Na]^+$ (280.0944), found 280.0957.

2-Methoxy-6-(1-nitro-3-*p*-tolylpropan-2-yl)phenol (1l): Colorless oil, 262 mg, 87% yield; ^1H NMR (300 MHz, acetone) δ 7.72 (s, 1H), 7.09−7.01 (m, 4H), 6.83 (dd, J = 6.5, 2.9 Hz, 1H), 6.75−6.69 (m, 2H), 4.96 (dd, J = 12.5, 8.9 Hz, 1H), 4.71 (dd, J = 12.5, 6.1 Hz, 1H), 4.15−4.03 (m, 1H), 3.82 (s, 3H), 3.13 (dd, J = 13.7, 8.0 Hz, 1H), 2.98 (dd, J = 13.7, 7.5 Hz, 1H), 2.25 (s, 3H); ^{13}C NMR (150 MHz, acetone) δ 148.2, 145.2, 136.9, 136.4, 129.8, 129.7, 126.1, 121.7, 120.0, 110.9, 78.8, 56.2, 42.4, 37.8, 21.0; HRMS (ESI-TOF) calcd for $C_{17}H_{19}NO_4Na$ $[M + Na]^+$ (324.1206), found 324.1216.

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2-Methoxy-6-(1-nitro-3-phenylpropan-2-yl)phenol (1m): Colorless oil, 470 mg, two steps, yield 82%; ^{1}H NMR (300 MHz, acetone) δ 7.75 (s, 1H), 7.27−7.15 (m, 5H), 6.86−6.82 (m, 1H), 6.74−6.69 (m, 2H), 4.98 (dd, J = 12.5, 8.9 Hz, 1H), 4.74 (dd, J = 12.5, 6.2 Hz, 1H), 4.17−4.04 (m, 1H), 3.82 (s, 3H), 3.17 (dd, J = 13.7, 8.1 Hz, 1H), 3.03 (dd, J = 13.6, 7.3 Hz, 1H); ^{13}C NMR (150 MHz, acetone) δ 148.2, 145.2, 140.0, 129.9, 129.1, 127.1, 126.0, 121.7, 120.0, 111.0, 78.8, 56.2, 42.4, 38.2; HRMS (ESI-TOF) calcd for $C_{16}H_{17}NO_4Na$ [M + Na]$^+$ (310.1050), found 310.1058.

4-Chloro-2-(1-nitro-3-*p*-tolylpropan-2-yl)phenol (1n): Colorless oil, 427 mg, two steps, yield 70%; ^{1}H NMR (300 MHz, acetone) δ 8.95 (s, 1H), 7.16 (d, J = 2.4 Hz, 1H), 7.12−7.01 (m, 5H), 6.86 (d, J = 8.6 Hz, 1H), 5.00 (dd, J = 12.6, 9.1 Hz, 1H), 4.74 (dd, J = 12.6, 5.9 Hz, 1H), 4.13−4.01 (m, 1H), 3.12 (dd, J = 13.7, 8.0 Hz, 1H), 3.00 (dd, J = 13.7, 7.5 Hz, 1H), 2.25 (s, 3H); ^{13}C NMR (150 MHz, acetone) δ 154.9, 136.6, 136.5, 129.80, 129.77, 128.8, 128.7, 124.6, 117.8, 78.5, 42.3, 37.7, 20.9; HRMS (ESI-TOF) calcd for $C_{16}H_{16}ClNO_3Na$ [M + Na]$^+$ (328.0711), found 328.0704.

4-Bromo-2-(1-nitro-3-*p*-tolylpropan-2-yl)phenol (1o): Colorless oil, 290 mg, 83% yield; ^{1}H NMR (300 MHz, acetone) δ 8.98 (s, 1H), 7.29 (d, J = 2.4 Hz, 1H), 7.20 (dd, J = 8.6, 2.5 Hz, 1H), 7.11−7.03 (m, 4H), 6.82 (d, J = 8.6 Hz, 1H), 5.00 (dd, J = 12.7, 9.1 Hz, 1H), 4.74 (dd, J = 12.7, 5.9 Hz, 1H), 4.13−4.00 (m, 1H), 3.12 (dd, J = 13.7, 7.9 Hz, 1H), 3.00 (dd, J = 13.7, 7.6 Hz, 1H), 2.25 (s, 3H); ^{13}C NMR (150 MHz, acetone) δ 155.5, 136.7, 132.8, 131.8, 129.9, 129.4, 118.5, 112.0, 78.6, 42.4, 37.8, 21.1; HRMS (ESI-TOF) calcd for $C_{16}H_{16}BrNO_3Na$ [M + Na]$^+$ (372.0206), found 372.0209.

2-Methoxy-6-(2-nitro-1-phenylethyl)phenol (1s): Colorless oil, 205 mg, 75% yield; ^{1}H NMR (300 MHz, acetone) δ 7.83 (s, 1H), 7.46−7.39 (m, 2H), 7.35−7.27 (m, 2H), 7.26−7.19 (m, 1H), 6.91−6.84 (m, 2H), 6.81−6.75 (m, 1H), 5.35−5.21 (m, 3H), 3.83 (s, 3H); ^{13}C NMR (126 MHz, acetone) δ 147.48, 143.92, 139.90, 128.48, 128.02, 126.96, 125.89, 120.00, 119.32, 110.18, 77.65, 55.44, 43.08; HRMS (ESI-TOF) calcd for $C_{15}H_{15}NO_4Na$ [M + Na]$^+$ (296.0893), found 296.0895.

Preparation of Substrates 1p−1r. The Grignard reaction is the same as above for the preparation of substrates **1a**−**1c**, **1e**−**1o**, and **1s**. Subsequent deprotection of the methyl group was processed as previously described in ref 15.

4-(1-(2-Hydroxyphenyl)-2-nitroethyl)benzonitrile (1p): Colorless oil, 180 mg, two steps, yield 67%; ^{1}H NMR (300 MHz, acetone) δ 8.84 (s, 1H), 7.74 (d, J = 8.2 Hz, 2H), 7.65 (d, J = 8.3 Hz, 2H), 7.30 (d, J = 7.7 Hz, 1H), 7.13 (t, J = 7.8 Hz, 1H), 6.92−6.82 (m, 2H), 5.40−5.31 (m, 3H); ^{13}C NMR (150 MHz, acetone) δ 155.5, 146.5, 133.1, 129.2, 126.1, 120.9, 116.6, 111.6, 77.8, 44.3; HRMS (ESI-TOF) calcd for $C_{15}H_{12}N_2O_3Na$ [M + Na]$^+$ (291.0740), found 291.0737.

2-(1-(4-Bromophenyl)-2-nitroethyl)phenol (1q): Colorless oil, 185 mg, two steps, yield 58%; ^{1}H NMR (300 MHz, acetone) δ 8.77 (s, 1H), 7.50 (d, J = 8.4 Hz, 2H), 7.39 (d, J = 8.5 Hz, 2H), 7.25 (d, J = 7.7 Hz, 1H), 7.11 (td, J = 8.1, 1.5 Hz, 1H), 6.92−6.78 (m, 2H), 5.26 (s, 3H); ^{13}C NMR (150 MHz, acetone) δ 155.4, 140.2, 132.3, 131.1, 129.3, 129.1, 126.6, 121.2, 120.8, 116.5, 78.2, 43.7; HRMS (ESI-TOF) calcd for $C_{14}H_{12}BrNO_3Na$ [M + Na]$^+$ (343.9893), found 343.9898.

2-(1-(4-Fluorophenyl)-2-nitroethyl)phenol (1r): Colorless oil, 175 mg, two steps, yield 67%; ^{1}H NMR (300 MHz, acetone) δ 8.75 (s, 1H), 7.49−7.43 (m, 2H), 7.25 (d, J = 7.7 Hz, 1H), 7.14−7.04 (m, 3H), 6.89 (d, J = 7.8 Hz, 1H), 6.83 (t, J = 7.8 Hz, 1H), 5.29−5.24 (m, 3H); ^{13}C NMR (150 MHz, acetone) δ 162.6 (d, J = 246.0 Hz), 155.4, 136.9, 130.8 (d, J = 8.1 Hz), 129.3, 129.1, 127.0, 120.7, 116.5, 116.4, 116.0 (d, J = 20.7 Hz), 78.6, 43.4; HRMS (ESI-TOF) calcd for $C_{14}H_{12}FNO_3Na$ [M + Na]$^+$ (284.0693), found 284.0685.

Preparation of Substrates 1i−1k.[16] Magnesium powder (4.0 mmol) and nitroalkene (2.0 mmol) were placed and stirred at 0 °C. The reaction was monitored by TLC. After the reaction was completed, saturated NH_4Cl (10 mL) was slowly poured into the reaction mixture. The mixture was extracted with ethyl acetate (3 × 10 mL). The organic layer was separated, dried over $MgSO_4$, and evaporated under reduced pressure. The crude residue was subjected to column chromatography (silica gel, ethyl acetate/petroleum) to gain pure product. Subsequent deprotection of methyl group was processed as previously described in ref 15.

2-(1-(2-Fluorophenyl)-3-nitropropan-2-yl)phenol (1i): Colorless oil, 407 mg, two steps, yield 74%; ^{1}H NMR (300 MHz, acetone) δ 8.66 (s, 1H), 7.25−7.12 (m, 2H), 7.12−6.96 (m, 4H), 6.84 (d, J = 7.9 Hz, 1H), 6.73 (t, J = 7.5 Hz, 1H), 5.04 (dd, J = 12.5, 8.7 Hz, 1H), 4.81 (dd, J = 12.6, 6.3 Hz, 1H), 4.17−4.04 (m, 1H), 3.26−3.11 (m, 2H); ^{13}C NMR (150 MHz, acetone) δ 162.1 (d, J = 243.0), 156.0, 132.4 (d, J = 5.0 Hz), 130.3, 129.20 (d, J = 8.1 Hz), 129.19, 126.8 (d, J = 15.3 Hz), 125.9, 124.9, 120.5, 116.4, 115.8, 78.9, 41.7, 31.4 (d, J = 22.0 Hz); HRMS (ESI-TOF) calcd for $C_{15}H_{14}FNO_3Na$ [M + Na]$^+$ (298.0850), found 298.0862.

2-(1-(4-Fluorophenyl)-3-nitropropan-2-yl)phenol (1j): Colorless oil, 434 mg, two steps, yield 79%; ^{1}H NMR (300 MHz, acetone) δ 8.65 (s, 1H), 7.21−7.14 (m, 2H), 7.05 (t, J = 7.2 Hz, 2H), 6.96 (t, J = 8.8 Hz, 2H), 6.85 (d, J = 7.6 Hz, 1H), 6.73 (t, J = 7.5 Hz, 1H), 4.99 (dd, J = 12.5, 8.7 Hz, 1H), 4.79 (dd, J = 12.5, 6.4 Hz, 1H), 4.11−3.97 (m, 1H), 3.17 (dd, J = 13.6, 8.4 Hz, 1H), 3.05 (dd, J = 13.7, 6.9 Hz, 1H); ^{13}C NMR (150 MHz, acetone) δ 162.3 (d, J = 240.0 Hz), 156.0 (d, J = 2.8 Hz), 136.1, 131.6 (d, J = 7.2 Hz), 130.2, 129.1, 126.0, 120.5, 116.4, 115.6 (d, J = 22.0 Hz), 78.9, 42.8, 37.3; HRMS (ESI-TOF) calcd for $C_{15}H_{14}FNO_3Na$ [M + Na]$^+$ (298.0850), found 298.0861.

2-(1-(2-Chlorophenyl)-3-nitropropan-2-yl)-6-methoxyphenol (1k): Colorless oil, 462 mg, two steps, yield 72%; ^{1}H NMR (300 MHz, acetone) δ 7.76 (s, 1H), 7.36 (d, J = 7.5 Hz, 1H), 7.22−7.10 (m, 3H), 6.86−6.79 (m, 1H), 6.73−6.68 (m, 2H), 5.06 (dd, J = 12.5, 8.8 Hz, 1H), 4.81 (dd, J = 12.5, 6.3 Hz, 1H), 4.25−4.13 (m, 1H), 3.82 (s, 4H), 3.27 (d, J = 7.7 Hz, 2H); ^{13}C NMR (150 MHz, acetone) δ 148.2, 145.4, 137.5, 134.7, 132.3, 130.2, 129.0, 127.7, 125.5, 122.1, 120.0, 111.2, 78.8, 56.2, 41.2, 35.8; HRMS (ESI-TOF) calcd for $C_{16}H_{16}ClNO_4Na$ [M + Na]$^+$ (344.0660), found 344.0665.

Preparation of Substrate 1d. Cmopound **1d** was synthesized following known procedure.[17]

2-(2-Nitroethyl)phenol (1d): Colorless oil, 155 mg, 93% yield; ^{1}H NMR (300 MHz, acetone) δ 8.61 (s, 1H), 7.15−7.06 (m, 2H), 6.87 (d, J = 8.0 Hz, 1H), 6.78 (t, J = 7.4 Hz, 1H), 4.76 (t, J = 7.2 Hz, 2H), 3.29 (t, J = 7.2 Hz, 2H); ^{13}C NMR (150 MHz, acetone) δ 156.1, 131.5, 129.2, 123.4, 120.5, 115.9, 75.4; HRMS (ESI-TOF) calcd for $C_8H_9NO_3Na$ [M + Na]$^+$ (190.0475), found 190.0481.

Preparation of Substrate 1t. Cmopound **1t** was synthesized following known procedure.[18]

2-(1-(1*H*-Indol-3-yl)-2-nitroethyl)phenol (1t): Colorless solid, 203 mg, 72% yield; ^{1}H NMR (300 MHz, acetone) δ 10.21 (s, 1H), 8.85 (s, 1H), 7.55 (d, J = 7.9 Hz, 1H), 7.41−7.36 (m, 2H), 7.18 (dd, J = 7.6, 1.5 Hz, 1H), 7.12−7.03 (m, 2H), 7.02−6.88 (m, 2H), 6.74 (td, J = 7.5, 1.1 Hz, 1H), 5.63 (t, J = 8.0 Hz, 1H), 5.20 (dd, J = 8.0, 1.4 Hz, 2H); ^{13}C NMR (150 MHz, acetone) δ 155.5, 129.9, 128.9, 127.7, 127.2, 123.3, 122.5, 120.5, 119.7, 119.5, 116.3, 114.5, 112.2, 78.9, 36.0; HRMS (ESI-TOF) calcd for $C_{16}H_{15}N_2O_3$ [M + H]$^+$ (283.1077), found 283.1085; mp 71−73 °C [lit.[18] 72−74 °C].

General Experimental Procedure for Construction of 3-Alkyl-2-nitrobenzo[*b*]furans. The mixture of 2-(2-nitroethyl)-phenol **1a** (253 mg, 1.0 mmol), $PhI(OAc)_2$ (966 mg, 3.0 mmol), and Et_3N (278 μL, 2.0 mmol) in CH_3CN (10 mL) was treated with Bu_4NI (923 mg, 2.5 mmol). The reaction was allowed to stir at 35 °C for 30 min. Upon completion as shown by TLC, the reaction mixture was washed with saturated $Na_2S_2O_3$ (20 mL) and extracted using ethyl acetate (25 mL × 3). The organic layer was dried over $MgSO_4$ and concentrated in vacuo. The residue was purified by column chromatography on silica gel (ethyl acetate/petroleum) to provide corresponding 3-alkyl-2-nitrobenzo[*b*]furan **2a** in 91% yield. Compound **3a** was obtained by the reaction above in the absence of Et_3N (Table 1, entry 2).

3-Butyl-7-methoxy-2-nitrobenzofuran (2a): Light yellow solid, 226 mg, 91% yield; ^{1}H NMR (400 MHz, acetone) δ 7.46 (d, J = 7.9 Hz, 1H), 7.38 (t, J = 8.0 Hz, 1H), 7.24 (d, J = 7.8 Hz, 1H), 4.04 (s, 3H), 3.21−3.12 (t, J = 7.8 Hz, 2H), 1.78−1.67 (m, 2H), 1.50−1.39 (m, 2H), 0.95 (t, J = 7.4 Hz, 3H); ^{13}C NMR (125 MHz, acetone) δ 146.7, 142.0, 130.1, 126.4, 125.5, 115.0, 112.4, 56.6, 31.8, 24.7, 23.3,

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14.1; HRMS (ESI-TOF) calcd for $C_{13}H_{16}NO_4$ $[M + H]^+$ (250.1074), found 250.1082; mp 100−101 °C.

(2*RS*,3*RS*)-3-Butyl-7-methoxy-2-nitro-2,3-dihydrobenzofuran (3a): Colorless oil, 75 mg, 30% yield; ^{1}H NMR (300 MHz, acetone) δ 7.08−6.90 (m, 3H), 6.34 (d, J = 1.4 Hz, 1H), 3.91 (s, 3H), 3.78 (t, J = 7.1 Hz, 1H), 1.85−1.73 (m, 2H), 1.58−1.35 (m, 4H), 0.93 (t, J = 7.2 Hz, 3H); ^{13}C NMR (150 MHz, acetone) δ 146.8, 145.6, 130.0, 124.7, 117.3, 114.0, 111.3, 56.6, 51.5, 34.8, 29.1, 23.0, 14.1; HRMS (ESI-TOF) calcd for $C_{13}H_{17}NO_4Na$ $[M + Na]^+$ (274.1050), found 274.1044.

3-Cyclohexyl-2-nitrobenzofuran (2b): Light yellow solid, 208 mg, 85% yield; ^{1}H NMR (600 MHz, acetone) δ 8.06 (d, J = 7.8 Hz, 1H), 7.69−7.64 (m, 2H), 7.44 (td, J = 7.4, 1.2 Hz, 1H), 3.81 (tt, J = 12.0, 3.0 Hz, 1H), 2.01−1.98 (m,3H), 1.95−1.83 (m, 4H), 1.82−1.80 (m, 1H), 1.50−1.41 (m, 3H); ^{13}C NMR (150 MHz, acetone) δ 152.6, 130.7, 128.5, 127.2, 125.6, 125.3, 113.3, 36.8, 31.9, 27.2, 26.4; HRMS (ESI-TOF) calcd for $C_{14}H_{16}NO_3$ $[M + H]^+$ (246.1125), found 246.1126; mp 88−90 °C.

3-Butyl-2-nitrobenzofuran (2c): Light yellow solid, 195 mg, 89% yield; ^{1}H NMR (300 MHz, acetone) δ 7.95 (d, J = 8.1 Hz, 1H), 7.71−7.63 (m, 2H), 7.45−7.50 (m, 1H), 3.20 (t, J = 7.5 Hz, 2H), 1.82−1.68 (m, 2H), 1.46 (dq, J = 14.8, 7.4 Hz, 2H), 0.95 (t, J = 7.3 Hz, 3H); ^{13}C NMR (150 MHz, acetone) δ 152.4, 131.2, 128.5, 125.6, 125.3, 123.8, 113.1, 31.8, 24.5, 23.3, 14.1; HRMS (ESI-TOF) calcd for $C_{12}H_{14}NO_3$ $[M + H]^+$ (220.0968), found 220.0964; mp 55−56 °C.

2-Nitrobenzofuran (2d): Light yellow solid, 148 mg, 91% yield; ^{1}H NMR (300 MHz, acetone) δ 8.00−7.90 (m, 2H), 7.78−7.66 (m, 2H), 7.50 (t, J = 7.5 Hz, 1H); ^{13}C NMR (150 MHz, acetone) δ 154.2, 130.9, 127.0, 126.2, 125.3, 113.3, 108.3; HRMS (ESI-TOF) calcd for $C_8H_6NO_3$ $[M + H]^+$ (164.0342), found 164.0343; mp 132−133 °C [lit.[14] 135 °C].

3-Isopropyl-7-methoxy-2-nitrobenzofuran (2e): Light yellow solid, 207 mg, 88% yield; ^{1}H NMR (300 MHz, acetone) δ 7.62 (d, J = 8.1 Hz, 1H), 7.37 (t, J = 8.1 Hz, 1H), 7.24 (d, J = 7.5 Hz, 1H), 4.16−4.05 (m, 1H), 4.03 (s, 3H), 1.50 (d, J = 7.1 Hz, 6H); ^{13}C NMR (150 MHz, acetone) δ 147.0, 142.3, 129.7, 128.5, 126.1, 116.5, 111.9, 56.5, 26.5, 21.4; HRMS (ESI-TOF) calcd for $C_{12}H_{14}NO_4$ $[M + H]^+$ (236.0917), found 236.0920; mp 76−77 °C.

3-Cyclohexyl-7-methoxy-2-nitrobenzofuran (2f): Light yellow solid, 234 mg, 85% yield; ^{1}H NMR (300 MHz, acetone) δ 7.67 (d, J = 8.1 Hz, 1H), 7.36 (t, J = 8.1 Hz, 1H), 7.22 (d, J = 8.0 Hz, 1H), 4.03 (s, 3H), 3.82−3.75 (m, 1H), 2.04−1.80 (m, 8H), 1.52−1.44 (m, 2H); ^{13}C NMR (150 MHz, acetone) δ 147.0, 142.4, 128.79, 128.77, 126.1, 116.9, 111.9, 56.6, 36.91, 31.88, 27.3, 26.5; HRMS (ESI-TOF) calcd for $C_{15}H_{18}NO_4$ $[M + H]^+$ (276.1230), found 276.1235; mp 75−77 °C.

5-Bromo-3-butyl-7-methoxy-2-nitrobenzofuran (2g): Light yellow solid, 304 mg, 93% yield; ^{1}H NMR (300 MHz, acetone) δ 7.67 (s, 1H), 7.36 (s, 1H), 4.08 (s, 3H), 3.16 (t, J = 7.5 Hz, 1H), 1.78−1.66 (m, 2H), 1.52−1.40 (m, 2H), 0.95 (t, J = 7.5 Hz, 3H); ^{13}C NMR (150 MHz, acetone) δ 147.3, 140.9, 131.2, 124.7, 118.4, 117.5, 115.7, 57.2, 31.7, 24.6, 23.3, 14.1; HRMS (ESI-TOF) calcd for $C_{13}H_{15}BrNO_4$ $[M + H]^+$ (328.0179), found 328.0184; mp 74−75 °C.

3-Benzyl-2-nitrobenzofuran (2h): Light yellow solid, 195 mg, 77% yield; ^{1}H NMR (300 MHz, acetone) δ 7.83 (d, J = 8.1 Hz, 1H), 7.74−7.64 (m, 2H), 7.47−7.38 (m, 3H), 7.33−7.18 (m, 3H), 4.64 (s, 2H); ^{13}C NMR (150 MHz, acetone) δ 152.5, 138.5, 131.2, 129.55, 129.52, 125.5, 128.3, 127.6, 125.8, 124.2, 123.1, 113.2, 30.6; HRMS (ESI-TOF) calcd for $C_{15}H_{12}NO_3$ $[M + H]^+$ (254.0812), found 254.0811; mp 104−105 °C.

3-(2-Fluorobenzyl)-2-nitrobenzofuran (2i): Light yellow solid, 241 mg, 89% yield; ^{1}H NMR (300 MHz, acetone) δ 7.79−7.66 (m, 3H), 7.44 (t, J = 7.0 Hz, 1H), 7.39−7.27 (m, 2H), 7.18−7.07 (m, 2H). 4.65 (s, 2H); ^{13}C NMR (150 MHz, acetone) δ 161.8 (d, J = 244.0 Hz), 152.5, 131.6 (d, J = 3.6 Hz), 131.3, 129.8 (d, J = 7.4 Hz), 128.2, 125.8, 125.4 (d, J = 3.8 Hz), 125.3 (d, J = 14.7 Hz), 123.9, 121.7, 116.1 (d, J = 22.0 Hz), 113.2, 24.0 (d, J= 5.0 Hz); HRMS (ESI-TOF) calcd for $C_{15}H_{11}FNO_3$ $[M + H]^+$ (272.0717), found 272.0724; mp 107−108 °C.

3-(4-Fluorobenzyl)-2-nitrobenzofuran (2j): Light yellow solid, 198 mg, 73% yield; ^{1}H NMR (300 MHz, acetone) δ 7.84 (d, J = 8.0 Hz, 1H), 7.74−7.65 (m, 2H), 7.51−7.41 (m, 3H), 7.06 (t, J = 7.8 Hz, 2H), 4.63 (s, 2H); ^{13}C NMR (150 MHz, acetone) δ 162.6 (d, J = 242.9 Hz), 152.5, 134.6, 131.4, 131.3 (d, J = 7.5 Hz), 128.2, 125.8, 124.1, 122.9, 116.1 (d, J = 21.0 Hz), 113.2; HRMS (ESI-TOF) calcd for $C_{15}H_{11}FNO_3$ $[M + H]^+$ (272.0717), found 272.0723; mp 112−113 °C.

3-(2-Chlorobenzyl)-7-methoxy-2-nitrobenzofuran (2k): Light yellow solid, 269 mg, 85% yield; ^{1}H NMR (300 MHz, acetone) δ 7.48 (d, J = 7.4 Hz, 1H), 7.34−7.20 (m, 5H), 7.10 (dd, J = 7.7, 1.0 Hz, 1H), 4.71 (s, 2H), 4.05 (s, 3H); ^{13}C NMR (150 MHz, acetone) δ 146.8, 142.2, 135.9, 134.6, 131.2, 130.4, 129.8, 129.5, 128.2, 126.7, 121.6, 115.1, 112.4, 56.6, 28.9; HRMS (ESI-TOF) calcd for $C_{16}H_{13}ClNO_4$ $[M + H]^+$ (318.0528), found 318.0524; mp 129−130 °C.

7-Methoxy-3-(4-methylbenzyl)-2-nitrobenzofuran (2l): Light yellow solid, 228 mg, 77% yield; ^{1}H NMR (300 MHz, acetone) δ 7.35−7.34 (m, 2H), 7.28−7.20 (m, 3H), 7.10 (d, J = 7.8 Hz, 2H), 4.55 (s, 2H), 4.04 (s, 3H), 2.26 (s, 3H); ^{13}C NMR (150 MHz, acetone) δ 146.7, 142.2, 137.0, 135.4, 130.1, 129.9, 129.4, 126.5, 123.6, 115.4, 112.4, 56.6, 30.3, 20.9; HRMS (ESI-TOF) calcd for $C_{17}H_{16}NO_4$ $[M + H]^+$ (298.1074), found 298.1072; mp 148−149 °C.

3-Benzyl-7-methoxy-2-nitrobenzofuran (2m): Light yellow solid, 235 mg, 83% yield; ^{1}H NMR (300 MHz, acetone) δ 7.20−6.94 (m, 7H), 4.33 (s, 2H), 3.77 (s, 3H); ^{13}C NMR (150 MHz, acetone) δ 146.7, 142.2, 138.5, 129.9, 129.51, 129.48, 127.6, 126.6, 123.3, 115.4, 112.4, 56.6, 30.7; HRMS (ESI-TOF) calcd for $C_{16}H_{14}NO_4$ $[M + H]^+$ (284.0917), found 284.0920; mp 109−110 °C.

5-Chloro-3-(4-methylbenzyl)-2-nitrobenzofuran (2n): Light yellow solid, 193 mg, 64% yield; ^{1}H NMR (300 MHz, acetone) δ 7.82 (d, J = 1.4 Hz, 1H), 7.76 (d, J = 8.7 Hz, 1H), 7.67 (d, J = 9.0 Hz, 1H), 7.29 (d, J = 7.9 Hz, 2H), 7.12 (d, J = 8.0 Hz, 2H), 4.58 (s, 2H), 2.27 (s, 3H); ^{13}C NMR (150 MHz, acetone) δ 150.9, 137.2, 135.1, 131.3, 130.9, 130.2, 129.8, 129.5, 123.5, 122.7, 115.0, 20.9; HRMS (ESI-TOF) calcd for $C_{16}H_{13}ClNO_3$ $[M + H]^+$ (302.0578), found 302.0572; mp 129−130 °C.

5-Bromo-3-(4-methylbenzyl)-2-nitrobenzofuran (2o): Light yellow solid, 290 mg, 84% yield; ^{1}H NMR (300 MHz, acetone) δ 7.98 (d, J = 1.9 Hz, 1H), 7.81 (dd, J = 8.9, 1.8 Hz, 1H), 7.71 (d, J = 8.9 Hz, 1H), 7.29 (d, J = 7.9 Hz, 2H), 7.12 (d, J = 7.8 Hz, 2H), 4.58 (s, 2H), 2.27 (s, 3H); ^{13}C NMR (150 MHz, acetone) δ 151.2, 137.2, 135.1, 134.0, 130.3, 130.2, 129.5, 126.7, 122.5, 118.2, 115.3, 30.1, 20.9; HRMS (ESI-TOF) calcd for $C_{16}H_{13}BrNO_3$ $[M + H]^+$ (346.0073), found 346.0076; mp 135−136 °C.

4-(2-Nitrobenzofuran-3-yl)benzonitrile (2p): Light yellow solid, 298 mg, 82% yield; ^{1}H NMR (300 MHz, acetone) δ 8.03 (d, J = 8.2 Hz, 2H), 7.96 (d, J = 8.3 Hz, 2H), 7.86−7.75 (m, 2H), 7.72 (d, J = 8.1 Hz, 1H), 7.55 (t, J = 7.4 Hz, 1H); ^{13}C NMR (150 MHz, acetone) δ 152.5, 134.5, 133.2, 131.9, 131.5, 127.9, 126.6, 123.8, 121.0, 119.0, 113.8, 113.4; HRMS (ESI-TOF) calcd for $C_{15}H_9N_2O_3$ $[M + H]^+$ (265.0608), found 265.0612; mp 197−198 °C.

3-(4-Bromophenyl)-2-nitrobenzofuran (2q): Light yellow solid, 247 mg, 78% yield; ^{1}H NMR (300 MHz, acetone) δ 7.84−7.66 (m, 7H), 7.53 (dt, J = 7.0, 1.5 Hz, 1H); ^{13}C NMR (150 MHz, acetone) δ 152.4, 132.8, 132.7, 132.6, 131.4, 128.7, 128.1, 126.4, 124.1, 124.0, 121.6, 113.3; HRMS (ESI-TOF) calcd for $C_{14}H_9BrNO_3$ $[M + H]^+$ (317.9760), found 317.9762; mp 140−141 °C.

3-(4-Fluorophenyl)-2-nitrobenzofuran (2r): Light yellow solid, 211 mg, 82% yield; ^{1}H NMR (300 MHz, acetone) δ 7.83−7.70 (m, 5H), 7.53 (t, J = 7.4 Hz, 1H), 7.38 (t, J = 7.6 Hz, 2H); ^{13}C NMR (150 MHz, acetone) δ 164.1 (d, J = 246.0 Hz), 152.4, 133.2 (d, J = 8.6 Hz), 131.4, 128.4, 126.3, 125.7, 124.1, 121.9, 116.4 (d, J = 20.7 Hz), 113.3; HRMS (ESI-TOF) calcd for $C_{14}H_9FNO_3$ $[M + H]^+$ (258.0561), found 258.0559; mp 167−168 °C.

7-Methoxy-2-nitro-3-phenylbenzofuran (2s): Light yellow solid, 234 mg, 87% yield; ^{1}H NMR (300 MHz, acetone) δ 7.71 (dd, J = 7.8, 1.7 Hz, 2H), 7.63−7.54 (m, 3H), 7.42 (t, J = 8.0 Hz, 1H), 7.31 (d, J = 7.3 Hz, 1H), 7.22 (dd, J = 8.0, 0.9 Hz, 1H), 4.09 (s, 3H); ^{13}C NMR (125 MHz, acetone) δ 146.8, 142.1, 130.8, 130.2, 130.0, 129.6, 129.4, 127.0, 123.0, 115.3, 112.5, 56.7; HRMS (ESI-TOF) calcd for $C_{15}H_{12}NO_4$ $[M + H]^+$ (270.0761), found 270.0759; mp 156−157 °C.

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3-(2-Nitrobenzofuran-3-yl)-*1H*-indole (2t): Red solid, 200 mg, 72% yield; ^{1}H NMR (300 MHz, acetone) δ 11.04 (s, 1H), 8.06 (d, J = 2.7 Hz, 1H), 7.87 (d, J = 8.0 Hz, 1H), 7.83−7.69 (m, 2H), 7.61 (d, J = 8.2 Hz, 1H), 7.52−7.43 (m, 2H), 7.26 (td, J = 7.6, 0.9 Hz, 1H), 7.14 (td, J = 7.4, 0.9 Hz, 1H); ^{13}C NMR (150 MHz, acetone) δ 152.7, 137.6, 131.2, 129.5, 128.5, 126.9, 125.6, 125.2, 123.2, 121.4, 121.0, 118.4, 113.2, 113.1, 104.0; HRMS (ESI-TOF) calcd for $C_{16}H_{11}N_2O_3$ $[M + H]^+$ (279.0764), found 279.0773; mp 177−178 °C.

9-Isopropyl-5-(2-morpholinoethoxy)-8-nitro-4-propyl-2*H*-furo[2,3-h]chromen-2-one (2u): Light yellow solid, 297 mg, two steps, 67% yield; ^{1}H NMR (500 MHz, acetone) δ 7.28 (s, 1H), 6.23 (s, 1H), 4.45−4.37 (m, 3H), 3.64 (t, J = 4.0 Hz, 4H), 3.14 (t, J = 7.5 Hz, 2H), 2.93 (t, J = 7.5 Hz, 2H), 2.56 (t, J = 4.0 Hz, 4H), 1.77−1.69 (m, 2H), 1.53 (d, J = 7.0 Hz, 6H), 1.04 (t, J = 7.5 Hz, 3H); ^{13}C NMR (125 MHz, acetone) δ 160.8, 159.4, 158.9, 155.1, 152.6, 131.1, 113.7, 110.3, 108.6, 92.7, 67.9, 67.4, 57.8, 54.6, 39.5, 25.5, 23.7, 20.4, 14.2; HRMS (ESI-TOF) calcd for $C_{23}H_{29}N_2O_7$ $[M + H]^+$ (445.1969), found 445.1966; mp 158−160 °C.

■ ASSOCIATED CONTENT

Ⓢ Supporting Information

^{1}H and ^{13}C NMR spectra for all new compounds. This material is available free of charge via the Internet at http://pubs.acs.org.

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Notes

The authors declare no competing financial interest.

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