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Palladium-Catalyzed Regioselective C−H Acylation of Biaryl-2-amines

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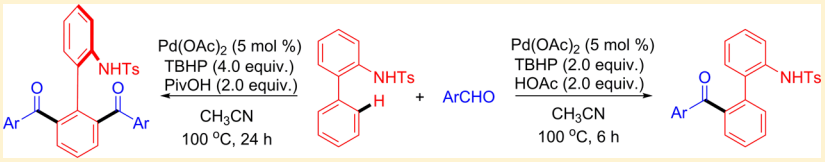
Supporting Information

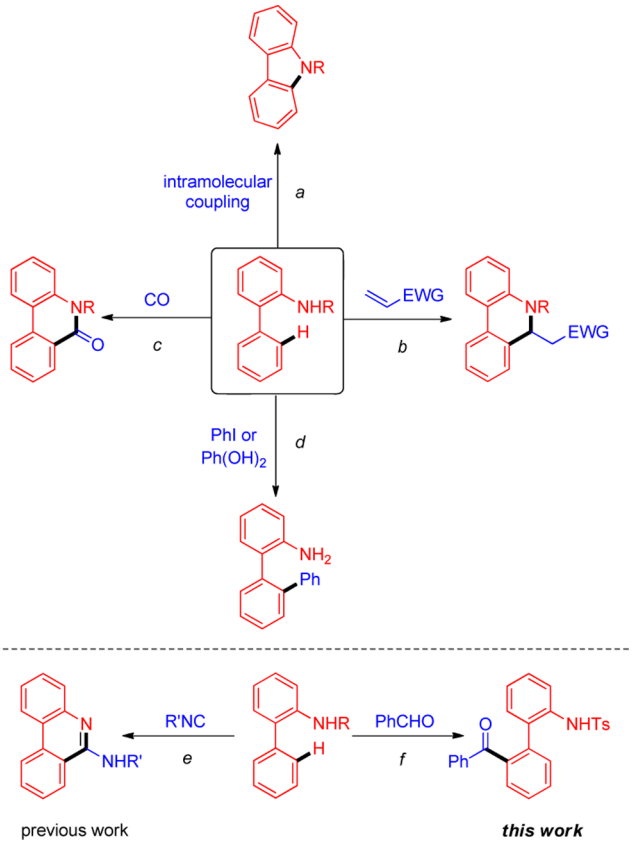


ABSTRACT: A palladium-catalyzed efficient C−H acylation reaction of biaryl-2-amines and aromatic aldehydes is developed. This dehydrogenative cross-coupling protocol could furnish monoacylation and diacylation products in moderate to good yields with a broad substrate scope and good regioselectivity.

INTRODUCTION

Direct selective C−H bond functionalization in organic transformations has emerged as an ideal strategy in synthetic methodology due to its atomic economy and step economy. Transition-metal-catalyzed direct C−H bond functionalization has gained increasing attention in recent years with the development of C−H activation chemistry.[1] It has been successfully used as a powerful tool for the modular, facile synthesis of structurally diversified organic molecules, as well as complex natural products. A variety of directing groups (DGs), such as pyridine,[2] amide,[3] imine,[4] oxime,[5] alkylamine,[6] nitrile,[7] ketone,[8] carboxylic acid,[9] alcohol,[10] aldehyde,[11] ester,[12] triazoene,[13] and oxazoline,[14] etc., have been intensively investigated under palladium, ruthenium, or rhodium catalysis. Remarkable progress has been made on the transition-metal-catalyzed C−H activation of biaryl-2-amines (Scheme 1). For example, in 2005, Buchwald's group[15a] reported a Pd-catalyzed directed C−H bond functionalization and amide arylation to construct substituted carbazoles (Scheme 1a).[15] Domino intermolecular olefination/intramolecular cyclization reactions of biaryl-2-amines and activated olefins have been reported by Miura and others (Scheme 1b).[16] In 2007, Albert's group[17a] successfully constructed phenanthridinones by the reaction of CO with a stoichiometric amount of palladium−biphenyl-2-amine complex. Years later, Chuang's and Zhang's groups described a Pd-catalyzed oxidative insertion of carbon monoxide with biaryl-2-amines through C−H bond activation (Scheme 1c).[17] Moreover, Zhang's group developed an efficient Pd-catalyzed arylation of biaryl-2-amines with aryl iodides or phenylboronic acid to give mono- or diarylated products with good regioselectivity (Scheme 1d).[18] Recently, our group reported a novel $Co(acac)_2$-catalyzed cascade isocyanide insertion with biaryl-2-amines to construct 6-aminophenanthridine derivatives[19] which was achieved by Albert's group[17a] with a stoichiometric amount of palladium−biphenyl-2-amine

Scheme 1. C−H Functionalization of Biaryl-2-amines



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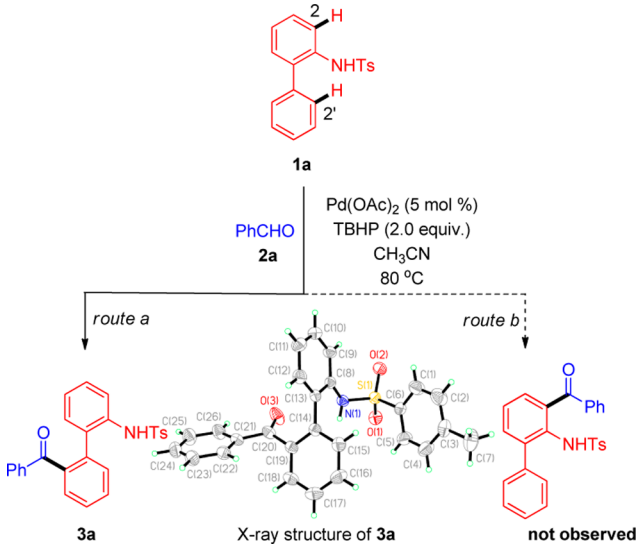
complex (Scheme 1e). Soon after, Jiang's group developed a similar approach for building 6-aminophenanthridines via palladium-catalyzed C−H activation of biaryl-2-amines.[20] As part of our ongoing program on biaryl-2-amines, we describe herein a Pd-catalyzed regioselective C−H acylation[21] reaction of biaryl-2-amines with aromatic aldehydes (Scheme 1f) for the synthesis of diaryl ketone derivatives, which are fundamental building blocks widespread in natural products, pharmaceuticals, and organic functional materials.[22]

RESULTS AND DISCUSSION

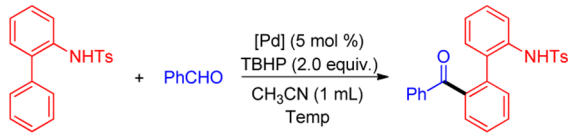
Our study was initiated by treating *N*-([1,1′-biphenyl]-2-yl)-4-methylbenzenesulfonamide (**1a**) with benzaldehyde (**2a**) in the presence of TBHP (2.0 equiv) and $Pd(OAc)_2$ (0.05 mmol) at 80 °C for 24 h. To our delight, *N*-(2′-benzoyl-[1,1′-biphenyl]-2-yl)-4-methylbenzenesulfonamide (**3a**) (Scheme 2, route a)

Scheme 2. C−H Activation at the C2-Position versus C2′-Position



was formed in 58% LC yield. The structure of **3a** was unambiguously established by single- crystal X-ray analysis (Scheme 2). Notably, no C2-acylation product was observed in this reaction (Scheme 2, route b). Inspired by this result, we screened different Pd catalysts, solvents, reaction temperatures, and additives (for details see the Supporting Information). As presented in Table 1, a range of Pd catalysts, such as $Pd(TFA)_2$, $Pd(PPh_3)_4$, $Pd(dba)_2$, and $Pd(PPh_3)_2(OAc)_2$, could promote the reaction smoothly and afford the desired product in 36−57% LC yields (Table 1, entries 2−5). However, $PdCl_2$ gave a bad yield for this transformation (Table 1, entry 6). In further screening the effect of different acids, gratifyingly, good yields were achieved when the amount of HOAc was increased to 2.0 equiv (Table 1, entries 7−9), and PivOH gave a similar yield for this protocol (Table 1, entry 10). However, the yields were reduced when Ph_2PO_2H or L-proline was added (Table 1, entries 11 and 12). Moreover, *p*-TSA, TFA, and $MeSO_3H$ had obvious side effects on the Pd-catalyzed C−H acylation (Table 1, entries 13−15). When the reaction was performed in the presence of $BF_3{\cdot}Et_2O$, the desired product **3a** was obtained in a trace yield (Table 1, entry 16). Notably, this reaction did not work when bases were introduced (Table 1, entries 17−19). It was found that the use of a metal oxidant and ligands both

Table 1. Optimization of the Reaction Conditions[a]



entry	[Pd] (0.05 equiv)	additive (2.0 equiv)	temp (°C)	yield[b] (%)
1	$Pd(OAc)_2$		80	58
2	$Pd(TFA)_2$		80	57
3	$Pd(PPh_3)_2(OAc)_2$		80	36
4	$Pd(PPh_3)_4$		80	53
5	$Pd(dba)_2$		80	54
6	$PdCl_2$		80	trace
7[c]	$Pd(OAc)_2$	HOAc	80	58
8[d]	$Pd(OAc)_2$	HOAc	80	61
9	$Pd(OAc)_2$	HOAc	80	69
10	$Pd(OAc)_2$	PivOH	80	69
11	$Pd(OAc)_2$	Ph_2PO_2H	80	51
12	$Pd(OAc)_2$	L-proline	80	14
13	$Pd(OAc)_2$	*p*-TSA	80	trace
14	$Pd(OAc)_2$	TFA	80	trace
15	$Pd(OAc)_2$	$MeSO_3H$	80	trace
16	$Pd(OAc)_2$	$BF_3{\cdot}Et_2O$	80	trace
17	$Pd(OAc)_2$	Et_3N	80	trace
18	$Pd(OAc)_2$	Na_2CO_3	80	trace
19	$Pd(OAc)_2$	NaOAc	80	trace
20	$Pd(OAc)_2$	$Cu(OAc)_2$	80	trace
21	$Pd(OAc)_2$	AgOAc	80	43
22	$Pd(OAc)_2$	Ag_2CO_3	80	55
23	$Pd(OAc)_2$	PPh_3	80	34
24	$Pd(OAc)_2$	2,2′-bipyridine	80	trace
25	$Pd(OAc)_2$	1,10-Phen	80	trace
26	$Pd(OAc)_2$	HOAc	100	76
27[e]	$Pd(OAc)_2$	HOAc	100	75 (66)[f]

[a]Reaction conditions: **1a** (0.5 mmol), **2a** (1.0 mmol), [Pd] (0.025 mmol), additive (1.0 mmol), TBHP (1.0 mmol), CH_3CN (1 mL), 24 h. [b]The yields were determined by LC analysis using benzophenone as the internal standard. [c]HOAc (0.1 mmol). [d]HOAc (0.5 mmol). [e]Time of 6 h. [f]Isolated yield.

resulted in lower efficiencies (Table 1, entries 20−25). To our delight, when the reaction temprature was increased to 100 °C, the yield improved to 76% (entry 26). Gratifyingly, a satisfactory result was still achieved when the reaction time was decreased to 6 h (Table 1, entry 27).

With the optimal reaction conditions in hand, series amino-directing groups, including NH_2, NHAc, $NH(CF_3CO)$, NHBoc, NHBn, and $NH(MeSO_2)$, were explored. However, many amino-directing groups showed low activity for the reaction except for the $NH(MeSO_2)$ group (Table 2, **3b**). A number of substituted benzenesulfonyls were well tolerated (**3c**−**e**). The protecting group bearing a *p*-OMe substituent on the aromatic ring, for instance, reacted with **2a** smoothly to afford the desired product **3d** in 67% yield. However, NO_2-substituted benzenesulfonyls failed to give the desired products under the identical conditions (Table 2, **3f**).

Next, we investigated the scope of this transformation with different sulfonamides. The Pd-catalyzed regioselective C−H acylation of biaryl-2-amines could react smoothly to afford the desired product **4a** in good yield when C2′-substituted substrates were used. Moreover, halo-substituted biaryl-2-amines were also tolerant in this transformation, affording

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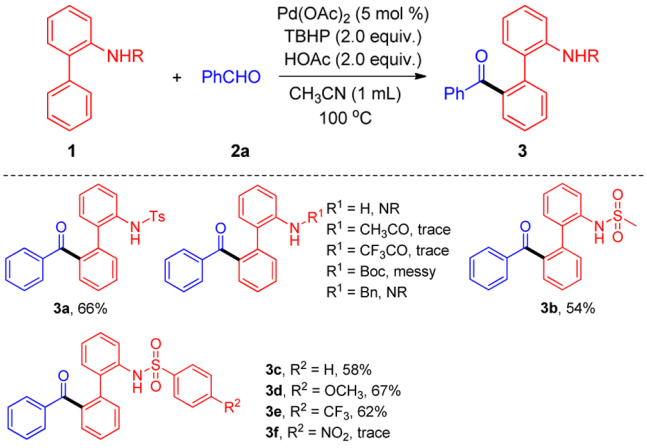
Table 2. Screening of the Directing Groups[a]

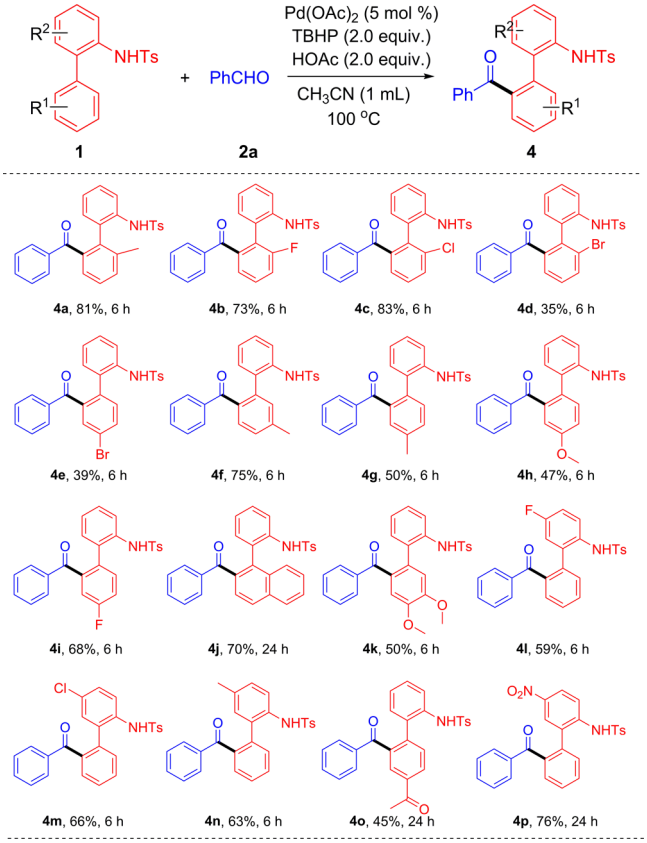


[a]Reaction conditions: **1** (0.5 mmol), **2a** (1.0 mmol), $Pd(OAc)_2$ (0.025 mmol), HOAc (1.0 mmol), TBHP (1.0 mmol), CH_3CN (1 mL), 100 °C,6 h.

halo-substituted products (Table 3, **4b**–**e**) in moderate to good yields. With substrates containing electron-donating groups, the desired products could be obtained in moderate yields (**4f**–**h**, **4k**, 47–75%). Notably, the reaction could be successfully extended to 4-methyl-*N*-(2-naphthalen-1-ylphenyl)-benzenesulfonamide, furnishing the desired product **4j** in 70% yield. Moreover, 4-substituted biaryl-2-amines could also react well and lad to the desired products **4l**, **4m**, and **4n** in 59%, 66%, and 63% yields, respectively. Furthermore, substrates containing electron-withdrawing groups such as acetyl and nitro on the aryl ring of the biaryl-2-amines could also react well and gave the desired products **4o** and **4p** in 45% and 76% yields, respectively.

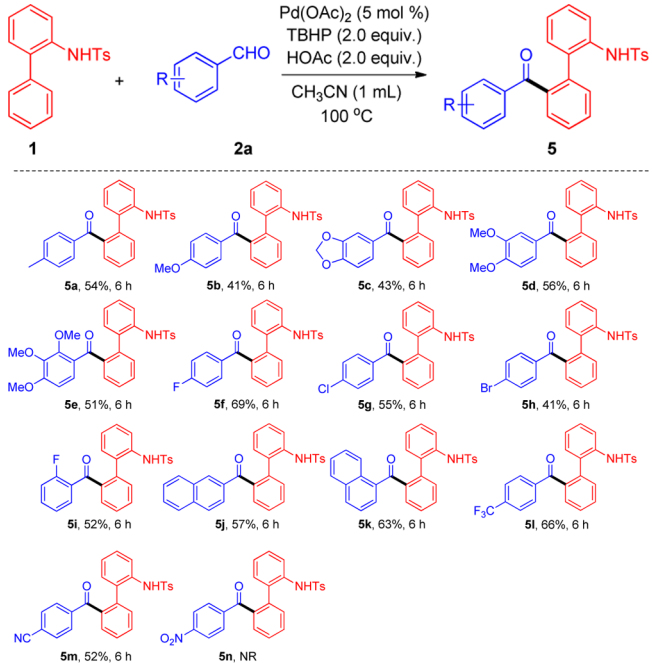
As presented in Table 4, a range of aromatic aldehydes could result in the corresponding C–H acylation products smoothly.

Table 3. Reaction of Various Biaryl-2-amines with Benzaldehyde[a]



[a]Reaction conditions: **1** (0.5 mmol), **2a** (1.0 mmol), $Pd(OAc)_2$ (0.025 mmol), HOAc (1.0 mmol), TBHP (1.0 mmol), CH_3CN (1 mL), 100 °C,6 h.

Table 4. Reaction of Biaryl-2-amine with Various Derivatives[a]



[a]Reaction conditions: **1a** (0.5 mmol), **2** (1.0 mmol), $Pd(OAc)_2$ (0.025 mmol), HOAc (1.0 mmol), TBHP (1.0 mmol), CH_3CN (1 mL), 100 °C, 6 h.

The *para*-position-substituted aldehydes with methyl or methoxy gave the desired products **5a** and **5b** in 54% and 41% yields, respectively. The aromatic aldehydes with more than one substituent on the aromatic ring, such as heliotropin and 3,4-dimethoxy- and 2,3,4-trimethoxybenzaldehydes reacted well and led to **5c**–**e** in 43–56% yields. Moreover, halide-substituted benzaldehydes were also tolerant in this transformation, affording halide-substituted products **5f**–**i** in moderate to good yields. It is noteworthy that naphthyl-substituted aldehydes survived well, generating **5j** and **5k** in 57% and 63% yields, respectively. The reactions of biaryl-2-amine with aromatic aldehydes bearing moderate electron-withdrawing groups (such as CF_3 and CN) on the aromatic ring gave **5l** and **5m** in 66% and 52% yields, respectively. Unfortunately, the presence of a strong electron-withdrawing group such as NO_2 would restrain the reaction.

Subsequently, we turned our attention to construct the diacylated products. After intensive investigation of the reaction conditions, the optimized catalytic system was confirmed: **1a** (0.5 mmol), **2a** (1.5 mmol), $Pd(OAc)_2$ (0.025 mmol), PivOH (1.0 mmol), TBHP (2.0 mmol) in CH_3CN (1 mL), at 100 °C for 24 h. Next, we explored the generality of the diacylation reaction. The results are shown in Table 5. It is similar to the

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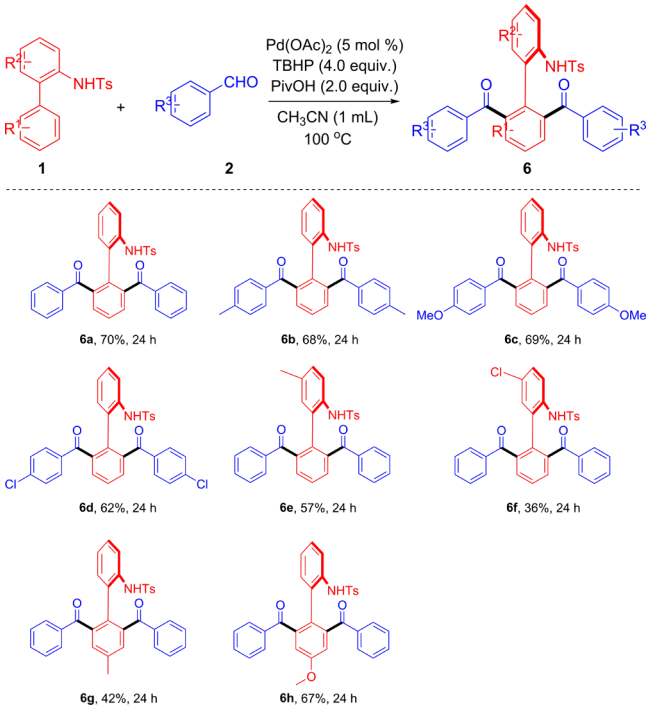
Table 5. Reaction of Biaryl-2-amine with Various Derivatives[a]



[a]Reaction conditions: **1** (0.5 mmol), **2** (1.5 mmol), $Pd(OAc)_2$ (0.025 mmol), PivOH (1.0 mmol), TBHP (2.0 mmol), CH_3CN (1 mL), 100 °C, 24 h.

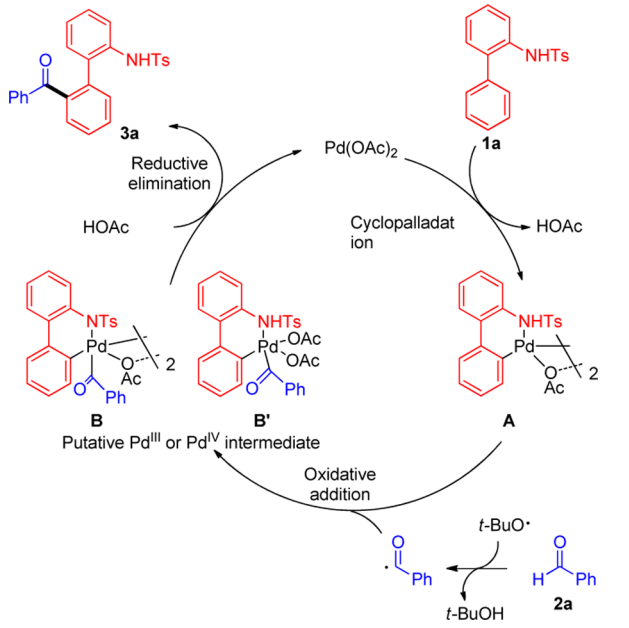
monoacylation transformation; the diacylation of biaryl-2-amines with different aromatic aldehydes could react smoothly to afford the desired products in moderate to good yields (**6a–d**, 62–70%). This diacylation reaction also showed good functional group tolerance toward 4- and 4′-substituted biaryl-2-amines (**6e–h**, 36–67%). Moreover, electron-rich biaryl-2-amines (**6e**, **6g**, and **6h**) display higher efficiency than an electron-deficient one (**6f**).

On the basis of the above results and the reported works,[15−19,21,23] a plausible reaction mechanism for the Pd-catalyzed regioselective C−H acylation reaction is presented in Scheme 3. Initially, $Pd(OAc)_2$ reacts with substrate **1a** by chelation-directed C−H bond activation to afford a six-membered cyclopalladated intermediate (**A**). Then the palladacycle **A** reacts with the benzoyl radical, which is initiated in situ from the benzaldehyde **2a** by TBHP, and generates the dimeric Pd(III)[23a,b] species **B** or reactive Pd(IV)[23c,d] species **B′**. Finally, reductive elimination affords the cross-coupling product **3a**. Meanwhile, the Pd(II) species is regenerated for the next catalytic cycle.

CONCLUSION

In conclusion, we have developed a Pd-catalyzed regioselective C−H acylation reaction of biaryl-2-amines with aromatic aldehydes. This dehydrogenative cross-coupling protocol could furnish mono- and diacylated products in moderate to good yields with a broad substrate scope and good regioselectivity. This transformation only involved two different C−H bonds under oxidative conditions, which was considered an efficient and atom-economical synthetic strategy. Further investigations to understand the mechanism of this reaction and their applications in other organic reactions are ongoing in our laboratory.

Scheme 3. Plausible Mechanism for the Pd-Catalyzed Regioselective C−H Acylation Reaction



EXPERIMENTAL SECTION

General Experimental Information. All the solvents for routine isolation of products and chromatography were reagent grade. Flash chromatography was performed using silica gel (300−400 mesh) with the indicated solvents. Melting points were recorded on an Electrothermal digital melting point apparatus and were uncorrected. IR spectra were recorded on a spectrophotometer using KBr optics. ^1H NMR and ^{13}C NMR spectra were recorded on 300 or 400 MHz (^1H NMR) and 75 or 100 MHz (^{13}C NMR) spectrometers using $CDCl_3$ as the solvent and TMS as the internal standard. The ^1H NMR data are reported as the chemical shift in parts per million, multiplicity (s, singlet; d, doublet; t, triplet; q, quartet; m, multiplet), coupling constant in hertz, and number of protons. High-resolution mass spectra were obtained using a high-resolution ESI-TOF mass spectrometer.

General Procedure for the Construction of 3a. The substrate *N*-([1,1′-biphenyl]-2-yl)-4-methylbenzenesulfonamide (**1a**; 0.5 mmol, 0.1616 g) and $Pd(OAc)_2$ (0.025 mmol, 0.0072 g, 5 mol %) were added to a 25 mL Schlenk tube. The flask was evacuated and backfilled with Ar three times, followed by addition of CH_3CN (1.0 mL), HOAc (1.0 mmol, 0.0601 g), benzaldehyde (**2a**; 1.0 mmol, 0.1060 g), and TBHP (1.0 mmol, 0.1314 g). The mixture was stirred at 100 °C as monitored by TLC. The solution was then quenched by H_2O and extracted with EtOAc, and the combined organic layers were dried over Na_2SO_4, filtered, and evaporated under vacuum. The residue was purified by column chromatography on silica gel (eluent light petroleum ether/ethyl acetate, 5:1, v/v) to afford the desired product *N*-(2′-benzoyl-[1,1′-biphenyl]-2-yl)-4-methylbenzenesulfonamide (**3a**).

General Procedure for the Construction of 6a. The substrate **1a** (0.5 mmol, 0.1616 g), $Pd(OAc)_2$ (0.025 mmol, 0.0072 g, 5 mol %), and PivOH (1.0 mmol, 0.1020 g) were added to a 25 mL Schlenk tube. The flask was evacuated and backfilled with Ar three times, followed by addition of CH_3CN (1.0 mL), **2a** (1.5 mmol, 0.1590 g), and TBHP (2.0 mmol, 0.2628 g). The mixture was stirred at 100 °C as monitored by TLC. The solution was then quenched by H_2O and extracted with EtOAc, and the combined organic layers were dried over Na_2SO_4, filtered, and evaporated under vacuum. The residue was purified by column chromatography on silica gel (eluent light petroleum ether/ethyl acetate, 5:1, v/v) to afford the desired product

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N-(2′,6′-dibenzoyl-[1,1′-biphenyl]-2-yl)-4-methylbenzenesulfonamide (**6a**).

Data for *N*-(2′-benzoyl-[1,1′-biphenyl]-2-yl)-4-methylbenzenesulfonamide (3a): white solid (141 mg, 66%); mp 138−139 °C; IR (neat, ν) 3266, 1660, 1595, 1578, 1449 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.69 (d, J = 7.5 Hz, 2H), 7.55 (t, J = 8.2 Hz, 4H), 7.46 (s, 2H), 7.41 (t, J = 7.6 Hz, 2H), 7.35−7.31 (m, 1H), 7.28−7.19 (m, 4H), 7.03 (d, J = 7.3 Hz, 1H), 6.97 (d, J = 7.2 Hz, 1H), 6.59 (d, J = 7.6 Hz, 1H), 2.47 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ197.4, 142.9, 138.4, 136.7, 136.3, 136.1, 133.9, 133.3, 133.0, 130.5, 129.8, 129.8, 129.7, 129.1, 128.4, 127.9, 127.8, 126.9, 126.7, 124.5, 122.9, 76.9, 76.6, 76.3, 21.1; HRMS (ESI) m/z found 450.1135, calcd for $C_{26}H_{21}NO_3S$ $(M + Na)^+$ 450.1134.

Data for *N*-(2′-benzoyl-[1,1′-biphenyl]-2-yl)-methanesulfonamide (3b): white solid (100 mg, 54%); mp 145−146 °C; IR (neat, ν) 3272, 1651, 1595, 1474 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.76 (d, J = 7.0 Hz, 2H), 7.65 (d, J = 7.5 Hz, 2H), 7.62−7.51 (m, 3H), 7.51−7.40 (m, 3H), 7.34 (s, 1H), 7.09 (s, 2H), 6.85 (s, 1H), 2.97 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 197.0, 138.7, 136.4, 136.3, 134.5, 133.15, 131.8, 130.9, 130.4, 129.9, 129.7, 128.8, 128.4, 128.0, 127.5, 124.2, 120.3, 76.9, 76.6, 76.3, 39.3; HRMS (ESI) m/z found 374.0828, calcd for $C_{20}H_{17}NO_3S$ $(M + Na)^+$ 374.0821.

Data for *N*-(2′-benzoyl-[1,1′-biphenyl]-2-yl)-benzenesulfonamide (3c): white solid (119 mg, 58%); mp 105−106 °C; IR (neat, ν) 3280, 1650, 1594, 1577, 1474 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.82−7.52 (m, 7H), 7.44 (s, 6H), 7.29 (s, 3H), 7.02 (d, J = 32.6 Hz, 2H), 6.50 (d, J = 5.1 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 197.5, 139.6, 138.3, 136.2, 136.1, 133.9, 133.7, 133.1, 132.1, 130.4, 129.9, 129.7, 129.7, 128.5, 128.4, 127.9, 127.7, 126.9, 126.6, 124.8, 123.4, 76.9, 76.6, 76.3; HRMS (ESI) m/z found 436.0975; Calcd for $C_{25}H_{19}NO_3S$ $(M + Na)^+$ 436.0978.

Data for *N*-(2′-benzoyl-[1,1′-biphenyl]-2-yl)-4-methoxybenzenesulfonamide (3d): white solid (148 mg, 67%); mp 145−146 °C; IR (neat, ν) 3260, 1660, 1595, 1576, 1495, 1449 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.66−7.62 (m, 2H), 7.53 (dt, J = 16.2, 5.6 Hz, 4H), 7.41 (t, J = 3.7 Hz, 2H), 7.38−7.30 (m, 3H), 7.23−7.18 (m, 1H), 7.09 (s, 1H), 6.98 (td, J = 7.5, 0.9 Hz, 1H), 6.92 (dd, J = 7.6, 1.5 Hz, 1H), 6.84 (d, J = 8.9 Hz, 2H), 6.61 (d, J = 7.6 Hz, 1H), 3.86 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 197.3, 162.5, 138.4, 136.3, 136.2, 134.0, 133.2, 133.0, 131.3, 130.6, 129.9, 129.8, 129.7, 128.8, 128.4, 127.9, 127.8, 127.0, 124.4, 122.7, 113.6, 76.9, 76.6, 76.3, 55.2; HRMS (ESI) m/z found 466.1088, calcd for $C_{26}H_{21}NO_4S$ $(M + Na)^+$ 466.1083.

Data for *N*-(2′-benzoyl-[1,1′-biphenyl]-2-yl)-4-(trifluoromethyl)benzenesulfonamide (3e): white solid (149 mg, 62%); mp 163−164 °C; IR (neat, ν) 3322, 1647, 1595, 1499 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.79 (s, 1H), 7.65−7.61 (m, 4H), 7.58 (dd, J = 8.3, 4.0 Hz, 3H), 7.53 (t, J = 7.4 Hz, 1H), 7.36 (dt, J = 5.9, 5.3 Hz, 4H), 7.32−7.27 (m, 1H), 7.17 (td, J = 7.5, 1.7 Hz, 1H), 7.08 (td, J = 7.5, 0.9 Hz, 1H), 6.94 (dd, J = 7.6, 1.3 Hz, 1H), 6.39 (d, J = 7.6 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 198.0, 143.4, 137.7, 136.0, 136.0, 134.8, 133.7, 133.4, 133.3, 133.2, 130.2, 129.9, 129.9, 128.7, 128.0, 127.5, 127.0, 125.7, 125.6 (q, J = 271.3 Hz), 125.5 (q, J = 3.6 Hz), 125.2, 76.9, 76.6, 76.2; HRMS (ESI) m/z found 504.0853, calcd for $C_{26}H_{18}F_3NO_3S$ $(M + Na)^+$ 504.0852.

Data for *N*-(2′-benzoyl-6′-methyl-[1,1′-biphenyl]-2-yl)-4-methylbenzenesulfonamide (4a): white solid (178 mg, 81%); mp 133−134 °C; IR (neat, ν) 3266, 1668, 1594, 1578, 1497, 1447 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.75 (dd, J = 18.1, 7.8 Hz, 4H), 7.57 (t, J = 7.2 Hz, 1H), 7.47−7.39 (m, 5H), 7.30 (dd, J = 16.3, 7.3 Hz, 3H), 7.20 (t, J = 7.5 Hz, 1H), 7.08 (s, 1H), 6.97 (t, J = 7.3 Hz, 1H), 6.90 (d, J = 7.2 Hz, 1H), 2.46 (s, 3H), 1.81 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 197.6, 143.0, 139.3, 138.4, 137.3, 136.5, 134.9, 134.7, 132.9, 131.9, 130.3, 129.7, 129.5, 129.2, 128.2, 127.9, 127.2, 126.8, 125.2, 123.8, 120.0, 76.9, 76.6, 76.3, 21.0, 19.4; HRMS (ESI) m/z found 464.1287, calcd for $C_{27}H_{23}NO_3S$ $(M + Na)^+$ 464.1291.

Data for *N*-(2′-benzoyl-6′-fluoro-[1,1′-biphenyl]-2-yl)-4-methylbenzenesulfonamide (4b): white solid (162 mg, 73%); mp 148−149 °C; IR (neat, ν) 3274, 1651, 1596, 1577, 1498, 1448 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.66 (d, J = 7.4 Hz, 2H), 7.61−7.50 (m, 3H), 7.44 (t, J = 10.1 Hz, 2H), 7.37 (t, J = 7.7 Hz, 2H), 7.25−7.08 (m, 6H), 7.02−6.93 (m, 2H), 2.39 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 196.6, 196.5, 159.9 (d, J = 248), 143.4, 141.2, 137.2, 136.4, 135.2, 133.8, 131.0, 130.2, 129.6 (d, J = 8.31 Hz), 129.6 (d, J = 7.5 Hz), 128.5, 127.1, 126.3, 124.9, 124.3 (d, J = 18.0 Hz), 124.0 (d, J = 3.7 Hz), 123.1, 117.9 (d, J = 22.9 Hz), 77.4, 77.1, 76.8, 21.6; HRMS (ESI) m/z found 468.1038, calcd for $C_{26}H_{20}FNO_3S$ $(M + Na)^+$ 468.1040.

Data for *N*-(2′-benzoyl-6′-chloro-[1,1′-biphenyl]-2-yl)-4-methylbenzenesulfonamide (4c): white solid (191 mg, 83%); mp 145−146 °C; IR (neat, ν) 3274, 1651, 1595, 1581, 1499, 1453 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.70 (d, J = 8.2 Hz, 2H), 7.64 (d, J = 7.4 Hz, 2H), 7.53 (t, J = 7.4 Hz, 2H), 7.46−7.33 (m, 5H), 7.18 (dd, J = 17.5, 7.4 Hz, 3H), 6.92 (dd, J = 19.4, 8.6 Hz, 3H), 2.39 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 196.6, 143.6, 141.8, 137.3, 136.3, 135.8, 135.1, 134.7, 133.8, 131.6, 130.6, 130.0, 129.6, 129.4, 129.2, 128.6, 128.5, 127.4, 126.4, 124.2, 120.7, 77.5, 77.1, 76.8, 21.6; HRMS (ESI) m/z found 484.0741, calcd for $C_{26}H_{20}ClNO_3S$ $(M + Na)^+$ 484.0745.

Data for *N*-(2′-benzoyl-6′-bromo-[1,1′-biphenyl]-2-yl)-4-methylbenzenesulfonamide (4d): white solid (88 mg, 35%); mp 160−161 °C; IR (neat, ν) 3283, 1664, 1595, 1581, 1498 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.78 (dd, J = 13.9, 4.8 Hz, 3H), 7.66 (d, J = 7.3 Hz, 2H), 7.56 (t, J = 7.4 Hz, 1H), 7.41 (dd, J = 13.9, 6.8 Hz, 5H), 7.24 (d, J = 8.1 Hz, 2H), 7.22−7.16 (m, 1H), 6.98−6.88 (m, 3H), 2.42 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 197.6, 142.9, 138.4, 137.0, 136.7, 136.4, 134.1, 133.1, 132.9, 130.6, 130.4, 129.9, 129.6, 129.0, 128.3, 128.2, 127.9, 126.7, 124.3, 122.3, 76.9, 76.6, 76.3, 21.1, 20.7; HRMS (ESI) m/z found 506.0405, calcd for $C_{26}H_{20}BrNO_3S$ $(M + H)^+$ 506.0426.

Data for *N*-(2′-benzoyl-4′-bromo-[1,1′-biphenyl]-2-yl)-4-methylbenzenesulfonamide (4e): white solid (98 mg, 39%); mp 166−167 °C; IR (neat, ν) 3236, 1666, 1596, 1582,1503 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.65 (d, J = 7.5 Hz, 2H), 7.55 (dd, J = 11.2, 4.4 Hz, 2H), 7.52−7.46 (m, 3H), 7.43−7.37 (m, 3H), 7.22 (t, J = 9.1 Hz, 3H), 7.15 (s, 1H), 7.03 (t, J = 7.4 Hz, 1H), 6.92 (d, J = 7.5 Hz, 1H), 6.45 (d, J = 8.2 Hz, 1H), 2.46 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 196.0, 143.0, 139.9, 136.8, 135.6, 135.1, 133.8, 133.5, 132.8, 132.7, 132.1, 130.1, 129.7, 129.6, 129.1, 128.8, 128.1, 126.6, 125.0, 124.1, 121.1, 76.9, 76.6, 76.3, 21.1; HRMS (ESI) m/z found 506.0402, calcd for $C_{26}H_{20}BrNO_3S$ $(M + H)^+$ 506.0426.

Data for *N*-(2′-benzoyl-5′-methyl-[1,1′-biphenyl]-2-yl)-4-methylbenzenesulfonamide (4f): white solid (165 mg, 75%); mp 114−115 °C; IR (neat, ν) 3292, 1654, 1596, 1491, 1448 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.63 (d, J = 7.2 Hz, 2H), 7.58 (d, J = 8.0 Hz, 1H), 7.49 (t, J = 9.4 Hz, 3H), 7.34 (dd, J = 16.8, 8.1 Hz, 3H), 7.24−7.11 (m, 5H), 6.99 (t, J = 7.5 Hz, 1H), 6.90 (d, J = 7.4 Hz, 1H), 6.29 (s, 1H), 2.41 (s, 3H), 2.27 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 197.9, 143.2, 140.7, 137.2, 137.1, 136.9, 136.1, 134.5, 134.0, 133.3, 131.7, 130.3, 130.1, 129.5, 128.8, 128.3, 128.1, 127.2, 125.0, 123.3, 77.4, 77.1, 76.8, 21.6, 21.4; HRMS (ESI) m/z found 464.1290, calcd for $C_{27}H_{23}NO_3S$ $(M + Na)^+$ 464.1291.

Data for *N*-(2′-benzoyl-4′-methyl-[1,1′-biphenyl]-2-yl)-4-methylbenzenesulfonamide (4g): white solid (110 mg, 50%); mp 159−160 °C; IR (neat, ν) 3237, 1666, 1595, 1583,1482, 1447 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.64 (d, J = 7.4 Hz, 2H), 7.54−7.46 (m, 4H), 7.35 (t, J = 7.7 Hz, 2H), 7.18 (dd, J = 15.4, 7.5 Hz, 4H), 7.11 (d, J = 10.1 Hz, 2H), 6.96 (t, J = 7.3 Hz, 1H), 6.92−6.87 (m, 1H), 6.46 (d, J = 7.8 Hz, 1H), 2.42 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 197.6, 142.9, 138.4, 137.0, 136.7, 136.4, 134.1, 133.1, 132.9, 130.6, 130.4, 129.9, 129.6, 129.0, 128.3, 128.2, 127.9, 126.7, 124.3, 122.3, 76.9, 76.6, 76.3, 21.1, 20.7; HRMS (ESI) m/z found 464.1287, calcd for $C_{27}H_{23}NO_3S$ $(M + Na)^+$ 464.1291.

Data for *N*-(2′-benzoyl-4′-methoxy-[1,1′-biphenyl]-2-yl)-4-methylbenzenesulfonamide (4h): white solid (107 mg, 47%); mp 149−150 °C; IR (neat, ν) 3243, 1662, 1596, 1582, 1483, 1447 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.64 (d, J = 7.4 Hz, 2H), 7.57−7.43 (m, 4H), 7.35 (t, J = 7.7 Hz, 2H), 7.17 (t, J = 9.7 Hz, 3H), 7.09 (s, 1H), 6.99−6.87 (m, 3H), 6.82 (d, J = 11.0 Hz, 1H), 6.49 (d, J = 8.5

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J. Org. Chem. 2015, 80, 7928−7936

Hz, 1H), 3.84 (s, 3H), 2.42 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 197.6, 158.6, 143.4, 140.1, 137.2, 136.6, 134.7, 133.5, 133.0, 132.2, 130.7, 130.1, 129.5, 128.7, 128.5, 128.4, 127.2, 124.8, 122.7, 116.1, 113.4, 77.4, 77.1, 76.8, 55.6, 21.6; HRMS (ESI) m/z found 480.1236, calcd for $C_{27}H_{23}NO_4S$ $(M + Na)^+$ 480.1240.

Data for *N*-(2′-benzoyl-4′-fluoro-[1,1′-biphenyl]-2-yl)-4-methylbenzenesulfonamide (4i): white solid (151 mg, 68%); mp 166−167 °C; IR (neat, ν) 3271, 1665, 1596, 1578, 1449 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.64 (d, J = 7.5 Hz, 2H), 7.55−7.45 (m, 4H), 7.37 (t, J = 7.5 Hz, 2H), 7.21 (t, J = 8.9 Hz, 3H), 7.10 (d, J = 9.0 Hz, 2H), 6.98 (dd, J = 17.7, 8.2 Hz, 2H), 6.90 (d, J = 7.3 Hz, 1H), 6.53 (dd, J = 8.1, 5.4 Hz, 1H), 2.42 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 196.0, 160.9 (d, J = 249.1 Hz), 143.0, 140.1 (d, J = 6.3 Hz), 136.8, 135.6, 134.1, 133.4, 132.6, 132.5 (d, J = 7.7 Hz), 132.1 (d, J = 3.4 Hz), 130.0, 129.6, 129.0, 128.6, 128.1, 126.7, 124.8, 123.5, 116.7 (d, J = 21 Hz), 114.6 (d, J = 22.8 Hz), 76.9, 76.6, 76.3, 21.1; HRMS (ESI) m/z found 468.1035, calcd for $C_{26}H_{20}FNO_3S$ $(M + Na)^+$ 468.1040.

Data for *N*-(2-(2-benzoylnaphthalen-1-yl)phenyl)-4-methylbenzenesulfonamide (4j): white solid (167 mg, 70%); mp 181−182 °C; IR (neat, ν) 3259, 1655, 1595, 1579, 1496, 1447 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.98−7.92 (m, 2H), 7.80−7.74 (m, 2H), 7.72−7.64 (m, 3H), 7.63−7.58 (m, 2H), 7.47−7.41 (m, 4H), 7.36−7.29 (m, 2H), 7.08 (tdd, J = 9.1, 8.0, 1.2 Hz, 4H), 6.97 (s, 1H), 2.44 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 197.2, 142.7, 136.7, 136.6, 135.9, 134.2, 134.0, 133.3, 133.1, 133.0, 130.9, 130.0, 129.9, 129.0, 128.6, 128.4, 128.0, 127.9, 127.6, 127.5, 126.9, 126.6, 124.8, 123.8, 76.9, 76.6, 76.3, 21.2; HRMS (ESI) m/z found 500.1287, calcd for $C_{30}H_{23}NO_3S$ $(M + Na)^+$ 500.1291.

Data for *N*-(2′-benzoyl-4′,5′-dimethoxy-[1,1′-biphenyl]-2-yl)-4-methylbenzenesulfonamide (4k): white solid (122 mg, 50%); mp 147−148 °C; IR (neat, ν) 3297, 1656, 1595, 1447 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.64 (d, J = 7.3 Hz, 2H), 7.57−7.46 (m, 3H), 7.41 (d, J = 8.1 Hz, 1H), 7.38−7.30 (m, 3H), 7.16 (d, J = 7.8 Hz, 3H), 7.01−6.89 (m, 3H), 6.31 (s, 1H), 3.89 (s, 3H), 3.77 (s, 3H), 2.39 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 196.8, 150.0, 147.4, 142.8, 137.2, 136.9, 134.3, 133.2, 132.7, 130.4, 130.1, 129.6, 128.9, 128.3, 127.8, 126.7, 124.4, 122.4, 113.5, 111.4, 76.9, 76.6, 76.3, 55.8, 55.5, 21.0; HRMS (ESI) m/z found 510.1344, calcd for $C_{28}H_{25}NO_5S$ $(M + Na)^+$ 510.1346.

Data for *N*-(2′-benzoyl-5-fluoro-[1,1′-biphenyl]-2-yl)-4-methylbenzenesulfonamide (4l): white solid (131 mg, 59%); mp 186−187 °C; IR (neat, ν) 3268, 1661, 1595, 1578, 1502, 1447 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.65 (d, J = 7.4 Hz, 2H), 7.51 (dt, J = 8.9, 6.3 Hz, 2H), 7.39 (t, J = 9.1 Hz, 6H), 7.24−7.13 (m, 4H), 6.94 (td, J = 8.6, 2.9 Hz, 1H), 6.65 (dd, J = 8.6, 2.9 Hz, 1H), 6.42 (d, J = 7.6 Hz, 1H), 2.43 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 197.3, 159.3 (d, J = 245.3 Hz), 142.9, 137.8, 136.6, 136.5 (d, J = 8.0 Hz), 136.1, 135.3, 133.3, 130.2, 130.1 (d, J = 3.0 Hz), 129.8, 129.8, 129.1, 128.0, 127.8, 127.1, 126.7, 126.4 (d, J = 8.7 Hz), 116.5 (d, J = 22.9 Hz), 115.2 (d, J = 21.9 Hz), 76.9, 76.6, 76.3, 21.1; HRMS (ESI) m/z found 468.1042, calcd for $C_{26}H_{20}FNO_3S$ $(M + Na)^+$ 468.1040.

Data for *N*-(2′-benzoyl-5-chloro-[1,1′-biphenyl]-2-yl)-4-methylbenzenesulfonamide (4m): white solid (152 mg, 66%); mp 196−197 °C; IR (neat, ν) 3268, 1657, 1594, 1578, 1494 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.70 (d, J = 7.2 Hz, 2H), 7.59 (d, J = 7.5 Hz, 1H), 7.54−7.42 (m, 7H), 7.34−7.29 (m, 1H), 7.25 (dd, J = 13.4, 5.0 Hz, 4H), 6.97 (d, J = 2.4 Hz, 1H), 6.53 (d, J = 7.6 Hz, 1H), 2.48 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 197.1, 143.1, 137.9, 136.5, 136.1, 135.4, 135.1, 133.3, 132.9, 130.4, 130.0, 129.9, 129.8, 129.5, 129.1, 128.4, 128.1, 128.0, 127.3, 126.7, 124.7, 76.9, 76.6, 76.3, 21.1; HRMS (ESI) m/z found 484.0739, calcd for $C_{26}H_{20}ClNO_3S$ $(M + Na)^+$ 484.0745.

Data for *N*-(2′-benzoyl-5-methyl-[1,1′-biphenyl]-2-yl)-4-methylbenzenesulfonamide (4n): white solid (139 mg, 63%); mp 128−129 °C; IR (neat, ν) 3275, 1660, 1595, 1578, 1500, 1449 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.66 (d, J = 7.5 Hz, 2H), 7.52 (d, J = 7.3 Hz, 1H), 7.46 (d, J = 8.1 Hz, 2H), 7.39 (dd, J = 12.2, 5.8 Hz, 5H), 7.29−7.23 (m, 1H), 7.20−7.12 (m, 3H), 7.04 (d, J = 8.0 Hz, 1H), 6.75 (s, 1H), 6.50 (d, J = 7.6 Hz, 1H), 2.44 (s, 3H), 2.18 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 197.5, 142.7, 138.1, 136.8, 136.5, 136.4, 134.5, 133.9, 133.0, 131.3, 130.5, 130.4, 129.7, 129.0, 128.9, 127.9, 127.7, 126.7, 126.6, 123.8, 76.9, 76.6, 76.3, 21.1, 20.2; HRMS (ESI) m/z found 464.1289, calcd for $C_{27}H_{23}NO_3S$ $(M + Na)^+$ 464.1291.

Data for *N*-(4′-acetyl-2′-benzoyl-[1,1′-biphenyl]-2-yl)-4-methylbenzenesulfonamide (4o): white solid (105 mg, 45%); mp 63−64 °C; IR (neat, ν) 3253, 1684, 1662, 1596, 1500 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.01 (d, J = 1.6 Hz, 1H), 7.90 (dd, J = 8.0, 1.8 Hz, 1H), 7.71−7.67 (m, 2H), 7.56 (dd, J = 16.2, 7.8 Hz, 3H), 7.43 (dd, J = 14.2, 6.4 Hz, 3H), 7.28 (td, J = 8.0, 1.5 Hz, 1H), 7.23 (d, J = 8.1 Hz, 2H), 7.16 (s, 1H), 7.08 (td, J = 7.5, 0.9 Hz, 1H), 6.98 (dd, J = 7.6, 1.4 Hz, 1H), 6.80 (d, J = 8.0 Hz, 1H), 2.68 (s, 3H), 2.48 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 196.7, 196.3, 143.1, 141.1, 138.8, 136.7, 135.8, 135.4, 133.6, 133.4, 133.1, 131.1, 129.7, 129.4, 129.1, 129.1, 128.9, 128.1, 128.0, 127.3, 126.7, 125.0, 123.8, 76.9, 76.6, 76.3, 26.2, 21.1; HRMS (ESI) m/z found 470.1417, calcd for $C_{28}H_{23}NO_4S$ $(M + H)^+$ 470.1421.

Data for *N*-(2′-benzoyl-5-nitro-[1,1′-biphenyl]-2-yl)-4-methylbenzenesulfonamide (4p): yellow solid (182 mg, 76%); mp 156−157 °C; IR (neat, ν) 3272, 1662, 1597, 1584, 1494 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.11 (dd, J = 9.1, 2.6 Hz, 1H), 7.88 (d, J = 2.6 Hz, 1H), 7.72 (dd, J = 6.1, 5.0 Hz, 3H), 7.68 (d, J = 8.7 Hz, 2H), 7.60 (t, J = 6.9 Hz, 3H), 7.55−7.50 (m, 1H), 7.45 (t, J = 7.7 Hz, 2H), 7.31 (d, J = 8.0 Hz, 3H), 6.89 (d, J = 7.5 Hz, 1H), 2.48 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 196.4, 144.1, 142.7, 140.6, 138.4, 136.0, 135.6, 134.0, 133.4, 131.9, 130.8, 130.7, 129.7, 129.4, 129.1, 128.3, 128.1, 126.9, 125.1, 123.9, 119.1, 76.9, 76.6, 76.3, 21.2; HRMS (ESI) m/z found 473.1162, calcd for $C_{26}H_{20}N_2O_5S$ $(M + H)^+$ 473.1166.

Data for 4-methyl-*N*-(2′-(4-methylbenzoyl)-[1,1′-biphenyl]-2-yl)benzenesulfonamide (5a): white solid (119 mg, 54%); mp 66−67 °C; IR (neat, ν) 3252, 1650, 1602, 1497 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.48−7.39 (m, 3H), 7.37−7.30 (m, 2H), 7.29−7.20 (m, 3H), 7.15−7.00 (m, 6H), 6.89−6.76 (m, 2H), 6.44−6.28 (m, 1H), 2.31−2.25 (m, 3H), 2.24−2.14 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 197.2, 144.2, 142.9, 138.5, 136.7, 136.0, 133.9, 133.8, 133.7, 130.5, 129.9, 129.8, 129.6, 129.1, 128.7, 128.3, 127.5, 126.9, 126.7, 124.7, 123.3, 77.1, 76.8, 76.5, 21.3, 21.1; HRMS (ESI) m/z found 464.1285, calcd for $C_{27}H_{23}NO_3S$ $(M + Na)^+$ 464.1291.

Data for *N*-(2′-(4-methoxybenzoyl)-[1,1′-biphenyl]-2-yl)-4-methylbenzenesulfonamide (5b): white solid (94 mg, 41%); mp 125−126 °C; IR (neat, ν) 3264, 1650, 1602, 1575, 1497 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.63 (d, J = 8.8 Hz, 2H), 7.51 (d, J = 8.1 Hz, 1H), 7.46 (d, J = 8.2 Hz, 2H), 7.37 (dd, J = 11.1, 6.9 Hz, 3H), 7.22 (d, J = 7.1 Hz, 2H), 7.15 (d, J = 8.1 Hz, 2H), 6.99 (s, 1H), 6.91 (dd, J = 7.6, 1.3 Hz, 1H), 6.83 (d, J = 8.9 Hz, 2H), 6.50 (d, J = 7.6 Hz, 1H), 3.82 (s, 3H), 2.41 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 196.1, 163.5, 142.7, 138.7, 136.8, 135.9, 133.9, 133.7, 132.2, 130.4, 129.7, 129.3, 129.1, 129.0, 128.3, 127.3, 126.8, 126.7, 124.6, 123.3, 113.2, 76.9, 76.6, 76.3, 55.1, 21.1; HRMS (ESI) m/z found 480.1234, calcd for $C_{27}H_{23}NO_4S$ $(M + Na)^+$ 480.1240.

Data for *N*-(2′-(benzo[*d*][1,3]dioxol-5-ylcarbonyl)-[1,1′-biphenyl]-2-yl)-4-methylbenzenesulfonamide (5c): white solid (101 mg, 43%); mp 69−71 °C; IR (neat, ν) 3262, 1650, 1602, 1575, 1497 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.52 (d, J = 8.1 Hz, 1H), 7.46 (d, J = 8.0 Hz, 2H), 7.36 (dd, J = 14.3, 7.3 Hz, 2H), 7.30 (s, 1H), 7.22 (dd, J = 10.7, 5.2 Hz, 2H), 7.15 (dd, J = 8.9, 4.1 Hz, 4H), 6.99 (t, J = 7.4 Hz, 1H), 6.93−6.85 (m, 1H), 6.71 (d, J = 8.1 Hz, 1H), 6.48 (d, J = 7.6 Hz, 1H), 5.98 (d, J = 3.8 Hz, 2H), 2.41 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 195.7, 151.9, 147.6, 142.8, 138.5, 136.8, 135.8, 133.9, 133.6, 130.9, 130.4, 129.7, 129.4, 129.0, 128.4, 127.3, 127.2, 126.8, 126.7, 124.6, 123.3, 108.7, 107.2, 101.5, 76.9, 76.6, 76.3, 21.1; HRMS (ESI) m/z found 494.1035, calcd for $C_{27}H_{21}NO_5S$ $(M + Na)^+$ 494.1033.

Data for *N*-(2′-(3,4-dimethoxybenzoyl)-[1,1′-biphenyl]-2-yl)-4-methylbenzenesulfonamide (5d): white solid (136 mg, 56%); mp 181−182 °C; IR (neat, ν) 3273, 1649, 1601, 1576, 1497, 1439 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.52 (d, J = 8.0 Hz, 1H), 7.44 (d, J = 8.2 Hz, 2H), 7.40−7.34 (m, 3H), 7.32 (s, 1H), 7.25−7.19 (m, 2H), 7.16−7.10 (m, 3H), 6.99 (td, J = 7.5, 0.8 Hz, 1H), 6.91 (dd, J = 7.6, 1.4 Hz, 1H), 6.75 (d, J = 8.4 Hz, 1H), 6.47 (d, J = 7.6 Hz, 1H),

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J. Org. Chem. 2015, 80, 7928−7936

3.88 (s, 3H), 3.84 (s, 3H), 2.40 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 196.6, 153.9, 149.0, 143.2, 139.0, 137.2, 136.4, 134.4, 134.2, 130.9, 130.2, 129.9, 129.7, 129.5, 128.8, 127.8, 127.2, 127.1, 126.4, 125.1, 123.8, 111.1, 109.7, 77.4, 77.1, 76.8, 56.1, 55.9, 21.6; HRMS (ESI) m/z found 510.1349, calcd for $C_{28}H_{25}NO_5S$ (M + Na)$^+$ 510.1346.

Data for 4-methyl-*N*-(2′-(2,3,4-trimethoxybenzoyl)-[1,1′-biphenyl]-2-yl)benzenesulfonamide (5e): white solid (132 mg, 51%); mp 141−142 °C; IR (neat, ν) 3262, 1650, 1602, 1575, 1497 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.57 (d, J = 8.1 Hz, 1H), 7.51 (d, J = 7.9 Hz, 2H), 7.42 (d, J = 3.4 Hz, 2H), 7.32−7.21 (m, 6H), 7.08 (t, J = 7.6 Hz, 2H), 6.67 (d, J = 8.8 Hz, 1H), 6.39 (d, J = 7.5 Hz, 1H), 3.92 (s, 3H), 3.86 (s, 3H), 3.60 (s, 3H), 2.46 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 195.5, 157.4, 152.7, 142.9, 141.5, 141.1, 136.7, 135.3, 133.5, 133.3, 130.5, 130.2, 129.4, 129.0, 128.1, 126.9, 126.9, 126.7, 126.0, 125.0, 124.3, 122.6, 106.7, 76.9, 76.6, 76.3, 60.8, 60.3, 55.7, 21.1; HRMS (ESI) m/z found 540.1445, calcd for $C_{29}H_{27}NO_6S$ (M + Na)$^+$ 540.1451.

Data for *N*-(2′-(4-fluorobenzoyl)-[1,1′-biphenyl]-2-yl)-4-methylbenzenesulfonamide (5f): white solid (153 mg, 69%); mp 122−123 °C; IR (neat, ν) 3354, 1660, 1597, 1498, 1450 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.71 (s, 2H), 7.54 (d, J = 6.3 Hz, 3H), 7.46 (d, J = 10.5 Hz, 2H), 7.36−7.30 (m, 1H), 7.25 (dd, J = 15.5, 7.5 Hz, 3H), 7.16 (s, 1H), 7.11−7.01 (m, 3H), 6.95 (d, J = 6.9 Hz, 1H), 6.60 (d, J = 7.2 Hz, 1H), 2.47 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 195.9, 165.4 (d, J = 254.6 Hz), 143.0, 138.1, 136.6, 136.0, 133.9, 133.1, 132.7 (d, J = 2.6 Hz), 132.3 (d, J = 9.2 Hz), 130.5, 129.9, 129.7, 129.1, 128.5, 127.6, 127.1, 126.7, 124.6, 122.9, 115.1 (d, J = 21.9 Hz), 76.9, 76.6, 76.3, 21.1; HRMS (ESI) m/z found 468.1039, calcd for $C_{26}H_{20}FNO_3S$ (M + Na)$^+$ 468.1040.

Data for *N*-(2′-(4-chlorobenzoyl)-[1,1′-biphenyl]-2-yl)-4-methylbenzenesulfonamide (5g): white solid (127 mg, 55%); mp 149−150 °C; IR (neat, ν) 3352, 1660, 1597, 1583, 1497, 1449 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.57 (d, J = 7.9 Hz, 2H), 7.50 (d, J = 6.9 Hz, 3H), 7.42 (d, J = 11.4 Hz, 2H), 7.31 (d, J = 7.6 Hz, 3H), 7.20 (t, J = 10.8 Hz, 3H), 7.05−6.95 (m, 2H), 6.89 (d, J = 7.1 Hz, 1H), 6.59 (d, J = 7.3 Hz, 1H), 2.42 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 196.1, 143.0, 139.5, 138.0, 136.6, 136.1, 134.7, 133.9, 132.9, 130.9, 130.6, 130.0, 129.7, 129.1, 128.5, 128.2, 127.7, 127.1, 126.7, 124.5, 122.6, 76.9, 76.6, 76.3, 21.1; HRMS (ESI) m/z found 484.0739, calcd for $C_{26}H_{20}ClNO_3S$ (M + Na)$^+$ 484.0745.

Data for *N*-(2′-(4-bromobenzoyl)-[1,1′-biphenyl]-2-yl)-4-methylbenzenesulfonamide (5h): white solid (104 mg, 41%); mp 161−162 °C; IR (neat, ν) 3352, 1661, 1595, 1579, 1497, 1449 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.50 (d, J = 8.4 Hz, 7H), 7.41 (dd, J = 12.2, 7.0 Hz, 2H), 7.31 (t, J = 7.3 Hz, 1H), 7.20 (t, J = 7.4 Hz, 3H), 7.03−6.96 (m, 2H), 6.89 (d, J = 7.4 Hz, 1H), 6.59 (d, J = 7.6 Hz, 1H), 2.42 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 196.3, 143.0, 137.9, 136.6, 136.2, 135.1, 133.9, 132.9, 131.2, 131.0, 130.6, 130.1, 129.7, 129.1, 128.5, 128.3, 127.7, 127.1, 126.7, 124.5, 122.6, 76.9, 76.6, 76.3, 21.1; HRMS (ESI) m/z found 528.0241, calcd for $C_{26}H_{20}BrNO_3S$ (M + Na)$^+$ 528.0239.

Data for *N*-(2′-(2-fluorobenzoyl)-[1,1′-biphenyl]-2-yl)-4-methylbenzenesulfonamide (5i): white solid (116 mg, 52%); mp 99−100 °C; IR (neat, ν) 3268, 1662, 1606, 1578, 1501, 1451 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.60−7.38 (m, 7H), 7.32 (s, 1H), 7.15 (d, J = 39.5 Hz, 4H), 6.96 (s, 3H), 6.71 (s, 1H), 6.54 (s, 1H), 2.42 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 194.1, 160.4 (d, J = 253.4 Hz), 143.2, 139.9, 136.5, 135.6, 134.0 (d, J = 8.8 Hz), 133.9 (d, J = 8.8 Hz), 132.2, 130.6, 130.3, 130.0, 129.1, 128.3, 128.2, 127.6, 126.8, 126.0, 125.9, 124.2, 123.8 (d, J = 3.6 Hz), 121.5, 115.8 (d, J = 21.9 Hz), 76.9, 76.6, 76.3, 21.1; HRMS (ESI) m/z found 468.1037, calcd for $C_{26}H_{20}FNO_3S$ (M + Na)$^+$ 468.1040.

Data for *N*-(2′-(2-naphthoyl)-[1,1′-biphenyl]-2-yl)-4-methylbenzenesulfonamide (5j): white solid (136 mg, 57%); mp 151−152 °C; IR (neat, ν) 3356, 1666, 1499, 1476, 1452 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.09 (s, 1H), 7.83 (dd, J = 12.1, 6.9 Hz, 4H), 7.58 (d, J = 7.8 Hz, 1H), 7.53−7.44 (m, 6H), 7.33 (t, J = 7.1 Hz, 1H), 7.24 (s, 1H), 7.16 (d, J = 7.9 Hz, 3H), 6.97 (s, 2H), 6.61 (d, J = 7.6 Hz, 1H), 2.42 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 197.8, 143.4, 139.0, 137.2, 136.8, 135.7, 134.5, 134.1, 133.9, 133.0, 132.1, 131.1, 130.3, 130.2, 129.7, 129.5, 128.9, 128.9, 128.4, 128.3, 127.8, 127.4, 127.2, 126.9, 125.0, 124.9, 123.4, 77.4, 77.1, 76.8, 21.6; HRMS (ESI) m/z found 500.1290, calcd for $C_{30}H_{23}NO_3S$ (M + Na)$^+$ 500.1291.

Data for *N*-(2′-(1-naphthoyl)-[1,1′-biphenyl]-2-yl)-4-methylbenzenesulfonamide (5k): white solid (150 mg, 63%); mp 163−164 °C; IR (neat, ν) 3257, 1656, 1593, 1501, 1447 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.53−8.38 (m, 1H), 7.91 (d, J = 8.1 Hz, 1H), 7.82 (d, J = 6.9 Hz, 1H), 7.51 (dd, J = 13.2, 5.9 Hz, 5H), 7.42 (dd, J = 13.8, 5.9 Hz, 3H), 7.37−7.29 (m, 2H), 7.19 (d, J = 8.1 Hz, 2H), 7.06 (t, J = 6.9 Hz, 1H), 6.97−6.83 (m, 3H), 6.52 (d, J = 7.5 Hz, 1H), 2.41 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 199.0, 143.0, 140.5, 136.6, 136.6, 134.6, 133.8, 133.2, 133.1, 132.9, 130.6, 130.5, 130.3, 130.3, 129.6, 129.1, 128.9, 128.1, 127.8, 127.5, 127.3, 126.8, 126.1, 125.2, 124.4, 123.5, 122.2, 76.9, 76.6, 76.3, 21.1; HRMS (ESI) m/z found 500.1288, calcd for $C_{30}H_{23}NO_3S$ (M + Na)$^+$ 500.1291.

Data for 4-methyl-*N*-(2′-(4-(trifluoromethyl)benzoyl)-[1,1′-biphenyl]-2-yl)benzenesulfonamide (5l): white solid (163 mg, 66%); mp 58−59 °C; IR (neat, ν) 3270, 1667, 1596, 1498, 1475 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.72 (d, J = 7.9 Hz, 2H), 7.60 (d, J = 8.0 Hz, 2H), 7.52 (d, J = 7.9 Hz, 2H), 7.45 (d, J = 7.3 Hz, 3H), 7.36 (t, J = 6.7 Hz, 1H), 7.20 (d, J = 7.5 Hz, 3H), 6.98 (t, J = 7.3 Hz, 1H), 6.93−6.82 (m, 2H), 6.65 (d, J = 7.5 Hz, 1H), 2.43 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 196.2, 143.1, 139.3, 137.7, 136.5, 136.4, 134.0 (q, J = 32.5 Hz), 132.6, 130.7, 130.5, 129.7, 129.1, 128.6, 128.1, 127.3, 126.8, 126.6, 124.9 (q, J = 3.6 Hz), 124.5, 124.4 (q, J = 271 Hz), 123.0, 122.3, 76.9, 76.6, 76.2, 21.1; HRMS (ESI) m/z found 518.1006, calcd for $C_{27}H_{20}F_3NO_3S$ (M + Na)$^+$ 518.1008.

Data for *N*-(2′-(4-cyanobenzoyl)-[1,1′-biphenyl]-2-yl)-4-methylbenzenesulfonamide (5m): white solid (117 mg, 52%); mp 195−196 °C; IR (neat, ν) 3354, 2227, 1665, 1597, 1498, 1451 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.67 (d, J = 8.4 Hz, 2H), 7.59 (d, J = 8.4 Hz, 2H), 7.52 (d, J = 8.2 Hz, 2H), 7.46 (dd, J = 6.5, 1.0 Hz, 2H), 7.38 (dd, J = 11.0, 5.3 Hz, 2H), 7.24−7.15 (m, 3H), 6.96 (dd, J = 7.4, 0.6 Hz, 1H), 6.89 (dd, J = 7.6, 1.3 Hz, 1H), 6.78 (s, 1H), 6.69 (d, J = 7.5 Hz, 1H), 2.43 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 195.9, 143.3, 139.8, 137.5, 136.4, 136.4, 133.9, 132.2, 131.6, 130.8, 130.7, 129.9, 129.6, 129.2, 128.7, 128.3, 127.5, 126.8, 124.5, 122.0, 117.4, 115.8, 76.9, 76.6, 76.3, 21.1; HRMS (ESI) m/z found 475.1078, calcd for $C_{27}H_{20}N_2O_3S$ (M + Na)$^+$ 475.1087.

Data for *N*-(2′,6′-dibenzoyl-[1,1′-biphenyl]-2-yl)-4-methylbenzenesulfonamide (6a): white solid (186 mg, 70%); mp 164−165 °C; IR (neat, ν) 3262, 1660, 1595, 1579, 1503 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.92 (d, J = 8.2 Hz, 2H), 7.69 (t, J = 3.3 Hz, 7H), 7.56 (t, J = 7.4 Hz, 2H), 7.43 (t, J = 7.7 Hz, 4H), 7.38 (s, 1H), 7.32 (d, J = 8.4 Hz, 2H), 6.95 (s, 1H), 6.93−6.83 (m, 2H), 6.73 (t, J = 7.3 Hz, 1H), 2.44 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 196.9, 143.1, 140.8, 137.2, 136.0, 135.1, 133.5, 133.1, 131.2, 129.4, 129.2, 128.7, 128.0, 127.5, 126.8, 126.2, 122.1, 116.7, 76.9, 76.6, 76.3, 21.1; HRMS (ESI) m/z found 554.1391, calcd for $C_{33}H_{25}NO_4S$ (M + Na)$^+$ 554.1397.

Data for *N*-(2′,6′-bis(4-methylbenzoyl)-[1,1′-biphenyl]-2-yl)-4-methylbenzenesulfonamide (6b): white solid (190 mg, 68%); mp 197−198 °C; IR (neat, ν) 3289, 1668, 1657, 1603, 1571, 1495, 1452 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.93 (d, J = 8.2 Hz, 2H), 7.66−7.59 (m, 7H), 7.44 (s, 1H), 7.32 (d, J = 7.9 Hz, 2H), 7.23 (d, J = 8.0 Hz, 4H), 6.97 (d, J = 7.5 Hz, 1H), 6.88 (t, J = 11.4 Hz, 2H), 6.74 (t, J = 7.3 Hz, 1H), 2.44 (s, 3H), 2.42 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 196.6, 144.2, 143.0, 141.0, 137.4, 135.1, 133.5, 133.3, 131.2, 129.6, 129.2, 129.0, 128.7, 128.6, 127.3, 126.8, 126.4, 122.1, 116.8, 76.9, 76.6, 76.3, 21.3, 21.1; HRMS (ESI) m/z found 582.1708, calcd for $C_{35}H_{29}NO_4S$ (M + Na)$^+$ 582.1710.

Data for *N*-(2′,6′-bis(4-methoxybenzoyl)-[1,1′-biphenyl]-2-yl)-4-methylbenzenesulfonamide (6c): white solid (204 mg, 69%); mp 197−198 °C; IR (neat, ν) 3189, 1668, 1594, 1498 cm^{-1}; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.98 (d, J = 8.3 Hz, 2H), 7.74 (s, 1H), 7.70−7.65 (m, 5H), 7.64−7.60 (m, 2H), 7.34 (d, J = 8.1 Hz, 2H), 6.97 (dd, J = 7.6, 1.3 Hz, 1H), 6.91−6.86 (m, 5H), 6.82 (d, J = 7.4 Hz, 1H), 6.73 (td, J = 7.5, 1.2 Hz, 1H), 3.87 (s, 6H), 2.44 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 195.8, 163.5, 143.0, 141.1, 137.5, 135.1, 132.8, 131.9, 131.3, 129.2, 128.9, 128.6, 127.5, 126.8, 126.4, 122.0, 116.7,

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113.3, 76.9, 76.6, 76.3, 55.1, 21.1; HRMS (ESI) m/z found 614.1602, calcd for $C_{35}H_{29}NO_6S$ $(M + Na)^+$ 614.1608.

Data for *N*-(2′,6′-bis(4-chlorobenzoyl)-[1,1′-biphenyl]-2-yl)-4-methylbenzenesulfonamide (6d): white solid (186 mg, 62%); mp 186−187 °C; IR (neat, ν) 3284, 1668, 1585, 1498, 1453 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.87 (d, J = 8.0 Hz, 2H), 7.68−7.60 (m, 3H), 7.57 (d, J = 8.3 Hz, 4H), 7.31 (dd, J = 13.1, 8.3 Hz, 6H), 7.22 (s, 1H), 6.88 (t, J = 8.1 Hz, 2H), 6.80 (d, J = 8.0 Hz, 1H), 6.71 (t, J = 7.3 Hz, 1H), 2.40 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 195.7, 143.2, 140.4, 139.7, 137.2, 135.0, 134.3, 133.5, 131.1, 130.7, 129.5, 129.3, 128.9, 128.4, 127.7, 126.8, 126.1, 122.4, 117.1, 76.9, 76.6, 76.3, 21.1; HRMS (ESI) m/z found 622.0625, calcd for $C_{33}H_{23}Cl_2NO_4S$ $(M + Na)^+$ 622.0617.

Data for *N*-(2′,6′-dibenzoyl-5-methyl-[1,1′-biphenyl]-2-yl)-4-methylbenzenesulfonamide (6e): white solid (155 mg, 57%); mp 195−196 °C; IR (neat, ν) 3289, 1662, 1594, 1578, 1505, 1446 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.89 (d, J = 8.3 Hz, 2H), 7.68 (t, J = 3.4 Hz, 7H), 7.56 (t, J = 7.4 Hz, 2H), 7.42 (t, J = 7.7 Hz, 4H), 7.30 (dd, J = 9.4, 3.1 Hz, 3H), 6.75−6.66 (m, 3H), 2.44 (s, 3H), 2.00 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 197.0, 142.9, 140.7, 137.3, 136.1, 133.8, 133.0, 132.5, 131.8, 131.7, 129.5, 129.4, 129.2, 129.1, 127.9, 127.3, 126.8, 126.5, 117.1, 76.9, 76.6, 76.3, 21.1, 19.8; HRMS (ESI) m/z found 568.1545, calcd for $C_{34}H_{27}NO_4S$ $(M + Na)^+$ 568.1553.

Data for *N*-(2′,6′-dibenzoyl-5-chloro-[1,1′-biphenyl]-2-yl)-4-methylbenzenesulfonamide (6f): white solid (102 mg, 36%); mp 194−195 °C; IR (neat, ν) 3253, 1673, 1597, 1573, 1491 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.88 (d, J = 8.2 Hz, 2H), 7.70 (d, J = 8.8 Hz, 8H), 7.59 (t, J = 7.4 Hz, 3H), 7.45 (t, J = 7.7 Hz, 5H), 7.32 (d, J = 8.2 Hz, 3H), 6.93 (d, J = 2.0 Hz, 1H), 6.90−6.82 (m, 2H), 2.45 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 196.4, 143.3, 140.6, 136.8, 136.0, 134.0, 133.3, 132.5, 130.7, 129.8, 129.4, 129.3, 128.6, 128.2, 128.1, 127.8, 127.5, 126.9, 118.2, 76.9, 76.6, 76.3, 21.1; HRMS (ESI) m/z found 588.1000, calcd for $C_{33}H_{24}ClNO_4S$ $(M + Na)^+$ 588.1007.

Data for *N*-(2′,6′-dibenzoyl-4′-methyl-[1,1′-biphenyl]-2-yl)-4-methylbenzenesulfonamide (6g): white solid (115 mg, 42%); mp 146−147 °C; IR (neat, ν) 3288, 1664, 1596, 1505, 1448 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.93 (d, J = 8.3 Hz, 2H), 7.71−7.67 (m, 4H), 7.54 (dd, J = 11.7, 4.3 Hz, 2H), 7.49 (s, 2H), 7.42 (dd, J = 9.5, 5.8 Hz, 5H), 7.34−7.31 (m, 2H), 6.94 (dd, J = 7.6, 1.3 Hz, 1H), 6.86 (ddd, J = 17.3, 12.1, 4.3 Hz, 2H), 6.70 (td, J = 7.4, 1.3 Hz, 1H), 2.57 (s, 3H), 2.45 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 197.3, 143.0, 140.8, 137.9, 137.2, 136.1, 135.2, 133.0, 131.4, 130.4, 129.9, 129.7, 129.3, 129.2, 128.6, 128.0, 128.0, 126.8, 125.9, 122.0, 116.4, 76.9, 76.6, 76.3, 21.1, 20.7; HRMS (ESI) m/z found 568.1554, calcd for $C_{34}H_{27}NO_4S$ $(M + Na)^+$ 568.1553.

Data for *N*-(2′,6′-dibenzoyl-4′-methoxy-[1,1′-biphenyl]-2-yl)-4-methylbenzenesulfonamide (6h): white solid (188 mg, 67%); mp 143−144 °C; IR (neat, ν) 3284, 1667, 1596, 1578, 1501, 1450 cm^{-1}; ^1H NMR (400 MHz, $CDCl_3$) δ 7.93 (d, J = 8.3 Hz, 2H), 7.72−7.67 (m, 4H), 7.58−7.52 (m, 2H), 7.42 (t, J = 7.7 Hz, 4H), 7.34 (dd, J = 14.9, 6.8 Hz, 3H), 7.20 (s, 2H), 6.92 (dd, J = 7.6, 1.3 Hz, 1H), 6.83 (ddd, J = 9.4, 7.6, 1.3 Hz, 2H), 6.68 (td, J = 7.4, 1.4 Hz, 1H), 3.96 (s, 3H), 2.45 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 196.7, 158.4, 143.1, 142.1, 137.2, 135.8, 135.4, 133.1, 131.7, 129.3, 129.2, 128.5, 128.0, 126.9, 125.5, 125.0, 122.0, 116.3, 114.8, 76.9, 76.6, 76.3, 55.4, 21.1; HRMS (ESI) m/z found 584.1511, calcd for $C_{34}H_{27}NO_5S$ $(M + Na)^+$ 584.1502.

■ ASSOCIATED CONTENT

Ⓢ Supporting Information

Optimization data tables, ^1H and ^{13}C NMR spectra of all pure products, and CIF files for **3a**. The Supporting Information is available free of charge on the ACS Publications website at DOI: 10.1021/acs.joc.5b00962.

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Notes

The authors declare no competing financial interest.

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