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ARTICLE

Nickel-catalyzed synthesis of diarylsulfides and sulfones via C–H bond functionalization of arylamides†

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The direct sulfenylation and sulfonylation of (sp^2)C−H bonds of benzamide derivatives were achieved using a Ni catalyst with the aid of an 8-aminoquinoline moiety as a bidentate directing group. These protocols represent a convenient route to the formation of valuable diaryl sulfides and sulfones in moderate to excellent yields.

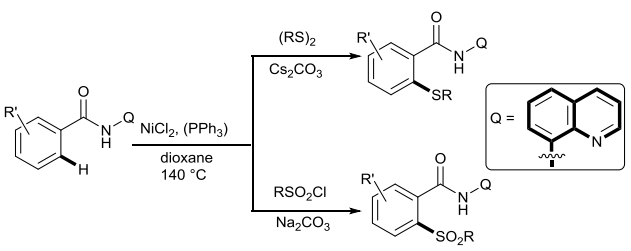
Introduction

Diaryl sulfides and derivatives thereof are ubiquitous structural motifs that are found in numerous biologically active natural products, pharmaceuticals, functional materials, and metal complexes.[1] Among the various synthetic routes to the diaryl sulfides, the transition metal mediated cross-coupling of Ar−X (X = Cl, Br, I, OTf) or Ar−$B(OH)_2$ with aryl thiols or their metal salts (ArSM) is one of the most useful methods and is a powerful tool for preparing diaryl sulfides.[2] Diaryl sulfones, an oxidized family of sulfides, can also be prepared by metal catalyzed coupling reactions between arylsulfonyl chlorides or arylsulfinic acid salts and an appropriate aryl halide or boronic acid.[3] Although these traditional coupling reactions are effective for constructing various C−S bonds, prefunctionalized substrates such as aryl halides and aryl metal reagents are required, and this can often restrict potential applications of these reactions.

In recent years, transition metal catalyzed C–H functionalization reactions have received considerable attention as straightforward transformations for the synthesis of valuable products from simple starting materials in an inherently benign fashion, minimizing wastes in atom-economic ways.[4] However, the formation of C–S bonds through transition metal catalyzed C–H bond cleavage[5-9] has been less studied than the formation of the corresponding C–C, C–N, and C–O bonds.[10-18a,b]

The direct sulfenylation of C−H bonds of arenes to give the corresponding C−S bonds has been achieved via the use of Cu,[6] Rh,[7] or Pd[8] catalytic systems. Most recently, the Cu-catalyzed sulfenylation of benzamides by thiols using a stoichiometric amount of a Ag salt as the oxidant[6d] and the Pd-catalyzed sulfenylation[8b-d] of C–H bonds have been reported. In these reactions, various sulfur-containing sources, including diaryl disulfides, thiols, and 1-(phenylthio)pyrrolidine-2,5-dione have been studied, in efforts to achieve C–H bond sulfenylation.[8a] For the synthesis of sulfones via C–H bond cleavage, Dong[9a] and Frost[9b] independently reported on the sulfonylation of the C-2 and C-3 position of phenylpyridines by sulfonyl chlorides using Pd and Ru catalysts, respectively. Very recently, Wu and coworkers reported on the use of a Cu catalytic system in the C2-sulfonylation of quinoline *N*-oxides.[9c]

Since the first example of the Pd-catalyzed C–C bond formation of benzamide derivatives with the aid of an 8-aminoquinoline moiety as a bidentate directing group was reported by Daugulis,[10,11] various groups have successfully developed carbon-carbon and carbon-heteroatom bond forming reactions by the use of the bidentate directing group using different transition metal catalysts such as Ni,[12] Pd,[8b,c,e,10,13] Cu,[6c,d,14] Ru,[15] and Fe[16]. In recent years, Ni complexes have been shown to be powerful catalysts for inert (sp^2)C–H and (sp^3)C–H bond functionalization with the advantages of high catalytic efficiency and good functional group tolerance. However, Ni-catalyzed C–H bond functionalizations have been limited to C–C bond formation reactions. To date, only the cross-coupling reactions of azoles with aryl esters,[17] alkylation,[12a,d] and arylation[12g] of (sp^2)C–H bonds of aromatic amides, and alkylation[12c] and arylation[12b,e,f] of (sp^3)C−H bonds of aliphatic amides have been achieved. With this background in mind, we investigated direct C–H sulfenylation and sulfonylation with diaryl disulfides and sulfonyl chlorides. In a continuation of our studies in the area of C–H bond functionalization and carbon-chalcogen bond forming reactions,[8d,18] we herein report the first examples of C–H bond sulfenylation and sulfonylation of aromatic rings catalyzed by Ni using an 8-aminoquinoline as a removable bidentate directing group (Scheme 1).[14c,19]

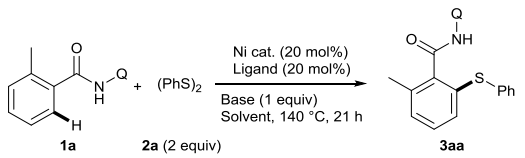


Scheme 1 C–H bond sulfenylation and sulfonylation reactions

Results and discussion

Initially, the reaction of *N*-(2-methylbenzoyl)-8-aminoquinoline (**1a**) with diphenyl disulfide (**2a**) was chosen as a model reaction to optimize the reaction conditions, and results are summarized in Table 1. With the combination of $NiCl_2$ and PPh_3 (20 mol%), we examined the effects of bases and solvents. In the absence of base, only 10% yield of desired sulfenylated product **3aa** was obtained by $NiCl_2$ and PPh_3 catalytic system (entry 1). Among the bases employed, Cs_2CO_3 gave the best results (entries 2-6), giving rise to desired product **3aa** in 85% yield. The structure of **3aa** was confirmed by an X-ray crystallographic analysis (Fig 1a).[20] 1,4-Dioxane was found to be the best solvent and DMF, DMSO, and DCE resulted in somewhat lower yields (entries 7-9). In the absence of the PPh_3, yield of the product slightly dropped to 68% (entry 10) but the use of 3 equiv of PPh_3 did not improve the yield (entry 11). This may suggests that Ni intermediates are ligated by the aminoquinoline directing group. Indeed, bidentate ligands, 2,2'-bipyridine, dppe, and dppp, affected the sulfenylation reaction (entries 12-14). In the absence of Ni catalyst, no reaction took place at all (entry 15).

Table 1. Optimization of nickel-catalyzed sulfenylation of C–H bond of benzamide[a]

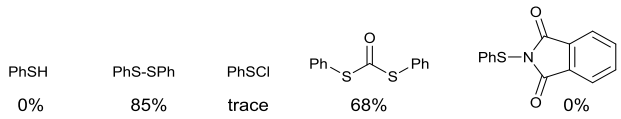


1a **2a** (2 equiv) **3aa**

Entry	Catalyst	Ligand	Base	Solvent	Yield[b] (%)
1	$NiCl_2$	PPh_3	–	Dioxane	10
2	$NiCl_2$	PPh_3	K_3PO_4	Dioxane	59
3	$NiCl_2$	PPh_3	Na_2CO_3	Dioxane	65
4	$NiCl_2$	PPh_3	NaOMe	Dioxane	61
5	$NiCl_2$	PPh_3	K_2CO_3	Dioxane	75
6	$NiCl_2$	PPh_3	Cs_2CO_3	Dioxane	85
7	$NiCl_2$	PPh_3	Cs_2CO_3	DMF	70
8	$NiCl_2$	PPh_3	Cs_2CO_3	DMSO	74
9	$NiCl_2$	PPh_3	Cs_2CO_3	DCE	69
10	$NiCl_2$	–	Cs_2CO_3	Dioxane	68
11	$NiCl_2(PPh_3)_2$	PPh_3	Cs_2CO_3	Dioxane	79
12	$NiCl_2$	bpy	Cs_2CO_3	Dioxane	7
13	$NiCl_2$(dppe)	–	Cs_2CO_3	Dioxane	13
14	$NiCl_2$(dppp)	–	Cs_2CO_3	Dioxane	40
15	–	–	Cs_2CO_3	Dioxane	N.D.

[a] Reaction conditions: **1a** (0.25 mmol), **2a** (0.5 mmol), Ni catalyst (20 mol%), PPh_3 (20 mol%), base (1.0 mmol), and solvent (1.0 mL), 21 h, 140 °C. [b] Isolated yields.

Then, we tested several sulfur sources having PhS moiety under the optimized conditions as indicated in Table 1, entry 6 (Scheme 2). Among these sulfur sources, diphenyl disulfide and *S*,*S*'-diphenyl carbonodithioate gave the desired products in 85% and 68% yields, respectively. On the other hand, benzenethiol as well as phenylsulfenyl chloride were not effective for the present catalytic system. The reaction employing *N*-(phenylthio)phthalimide gave no desired product. Due to easy accessibility of diaryl disulfides, we chose diaryl disulfides as the best sulfenylating reagents.



Scheme 2. Yield of **3aa** from various sulfur sources for C–H bond sulfenylation of **1a**.

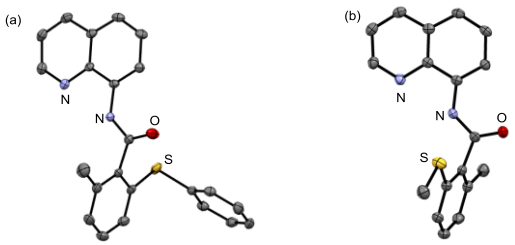
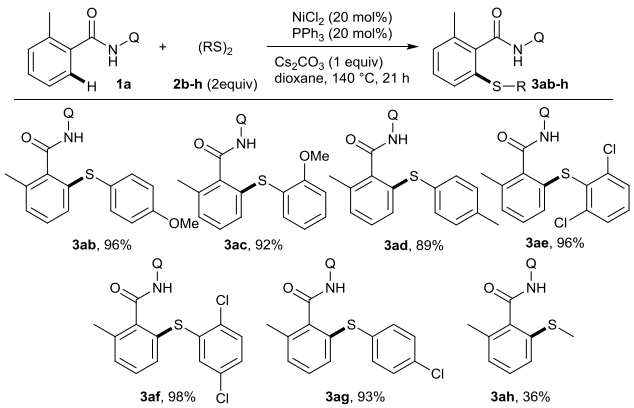


Fig. 1. ORTEP drawing of **3aa** (a) and **3ah** (b) with thermal ellipsoids at the 50% probability level. H atoms are omitted for clarity

As shown in Table 2, the reaction of **1a** with diaryl disulfides carrying an electron-donating or -withdrawing group(s) gave the desired coupling products in excellent yields (**3ab**-**3ag**). The reaction of **1a** with dimethyl disulfide (**2h**) gave the desired product **3ah**[20] in 36% yield (Fig 1b).

Table 2 Ni-catalyzed C–H sulfenylation of a 2-methylbenzamide

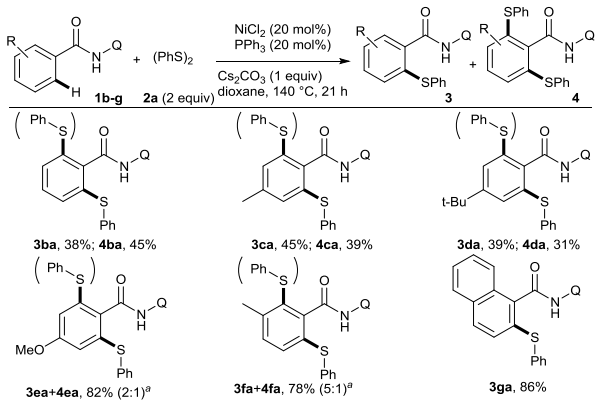


The unsubstituted benzamide **1b** and *p*-substituted benzamides **1c**-**e**, which contains two *ortho*-C–H bonds, underwent sulfenylation to give an approximately 1:1 mixture of mono- and disulfenylated products (**3** and **4**) in good overall yields under the same conditions (Table 3). *m*-Methylbenzamide was predominantly sulfenylated at the relatively less hindered position to afford a mixture of mono- and disulfenylated products, **3fa** and **4fa**, in a 5:1 ratio. The reaction of naphthamide **1g** gave only the 2-sulfenylated product **3ga** in 86% yield.

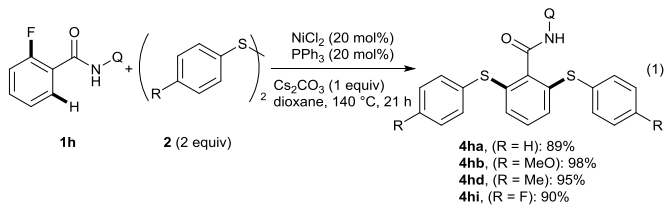
When *N*-(2-fluorobenzoyl)-8-aminoquinoline (**1h**) was reacted with various diphenyl disulfide derivatives, sulfenylation took place at the both the *ortho*-position via concomitant C–H and C–F bond cleavage to give the disulfenylated products **4** in excellent yields (eq 1). Although

the mechanism of the C–F bond sulfenylation is not clear at this moment, it may proceed via S_NAr reaction.

Table 3 Ni-catalyzed C–H sulfenylation of *m*- or *p*-substituted benzamides and 1-naphthamide

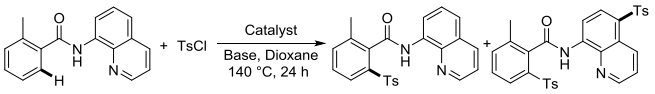


[a] An inseparable mixture of **3** and **4** was obtained. Ratio was determined by ^{1}H NMR.



After the successful C–H bond sulfenylation of amide derivatives, we next turned our attention to aromatic C–H bond sulfonylation using sulfonyl chlorides as the coupling partner. During course of the revision of the manuscript, a similar catalytic system has been reported.[21] Initially, the reaction of 2-methyl-*N*-(quinolin-8-yl)benzamide (**1a**) with tosyl chloride (**5a**) was chosen as a model reaction and conducted under the optimized conditions of the sulfenylation reaction; however, the reaction did not take place. We thus optimized the reaction conditions and results are shown in Table 4. The desired sulfonylated product **6aa** was obtained in 61% yield accompanied by a trace amount of the disulfonylated product **7aa**, when the reaction was conducted at 140 °C for 24 h using 50 mol% $NiCl_2$ in the presence of Na_2CO_3 (2.0 equiv) as a base (entry 4). Replacement of Na_2CO_3 with Cs_2CO_3 or K_2CO_3 resulted in no reaction (entries 1 and 3) and K_3PO_4 gave the corresponding product in only a trace amount (entry 2). Lowering catalyst loading led decreasing of the yield of **6aa** (entry 5); however, 100 mol% of $NiCl_2$ did not improve the yield (entry 6). The addition of PPh_3 dropped the yield of sulfonylated product (entry 7). Both Ni catalyst and base were essential to attain the sulfonylation and no reaction took place without either catalyst or base (entries 8-9). Among various solvents tested, dioxane gave the best results. $PdCl_2(PhCN)_2$ showed unsatisfactory catalytic activity and simple Pd chloride was completely ineffective (entries 10-11). Catalytic procedures in recent reports for C–H bond sulfonylation by using Pd,[9a] Cu,[9c] and Ru[9b] were ineffective to provide the desired cross-coupling products (entries 12-14). The structures of the products **6aa** and **7aa** were confirmed by X-ray crystallographic analyses (Fig 2).[20]

Table 4. Sulfonylation of C–H bond of benzamide **1a**[a]



Entry	Catalyst (mol%)	Base	Yield[b] (%)
1	$NiCl_2$ (50)	Cs_2CO_3	N.D.
2	$NiCl_2$ (50)	K_3PO_4	Trace
3	$NiCl_2$ (50)	K_2CO_3	N.D.
4	$NiCl_2$ (50)	Na_2CO_3	61
5	$NiCl_2$ (30)	Na_2CO_3	44
6	$NiCl_2$ (100)	Na_2CO_3	56
7	$NiCl_2/PPh_3$ (20)	Na_2CO_3	19
8	$NiCl_2$ (50)	–	N.D.
9	–	Na_2CO_3	N.D.
10	$PdCl_2(PhCN)$ (10)	Na_2CO_3	31
11	$PdCl_2$ (10)	Na_2CO_3	N.D.
12[c]	$PdCl_2(CH_3CN)_2$ (50)	K_2CO_3	Trace
13[d]	CuI (10)	K_2CO_3	N.D.
14[e]	$[Ru(p\text{-cymene})Cl_2]_2$ (5)	K_2CO_3	N.D.

[a] Reaction conditions: **1a** (0.25 mmol), sulfonyl chloride **5a** (0.75 mmol), catalyst, base (2.0 mmol), solvent (1.0 mL), 24 h, 140 °C. [b] Isolated yields. [c] In toluene. [d] In dichloroethane. [e] In acetonitrile.

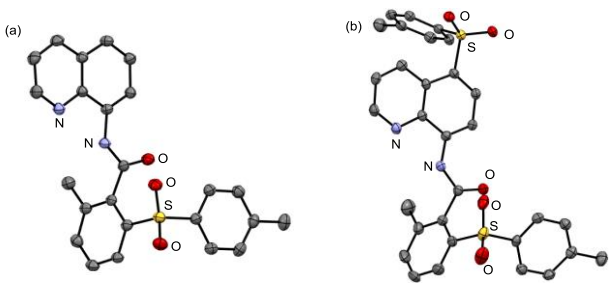
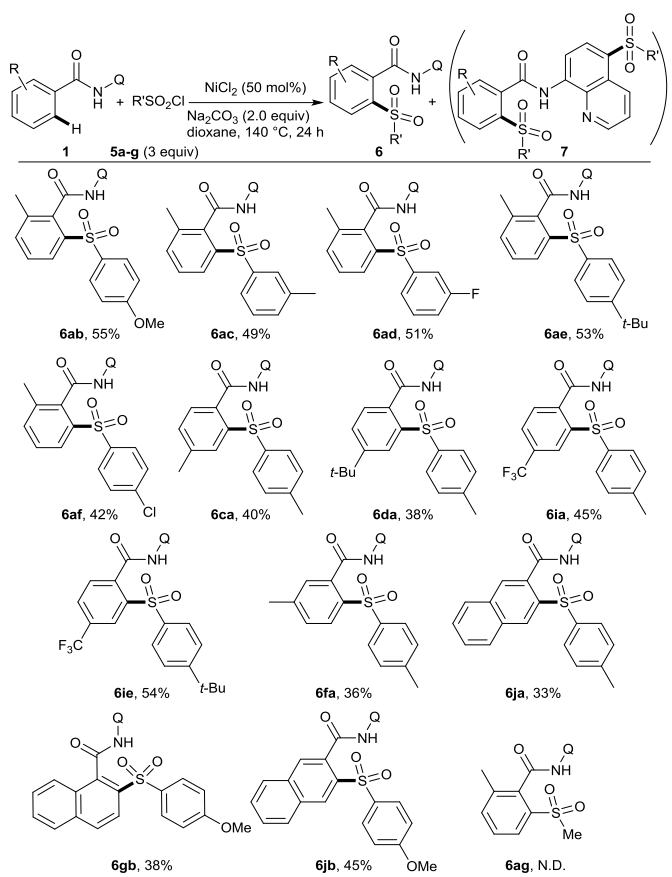


Fig. 2. ORTEP drawing of **6aa** (a) and **7aa** (b) with thermal ellipsoids at the 50% probability level. H atoms are omitted for clarity

Under these optimized conditions, we investigated various benzamides and aryl sulfonyl chlorides in the reaction, as shown in Table 5. In all cases, the mono sulfonylated products **6** were obtained as the major products, accompanied by the formation of a trace amount of disulfonylation products **7**. The reaction of an *ortho*-methylbenzamide **1a** with sulfonyl chlorides possessing an electron-donating or an electron-withdrawing group afforded the desired products **6ab**-**6af** in 42% to 61% yields. *para*-Substituted benzamide derivatives **1c**,**d**,**i** gave the desired products **6ca**,**da**,**ia**,**ie** in moderate yields. In either cases, no disulfonylation at their *ortho*-positions took place, even when 5 equiv of the sulfonyl chloride was used. When a *meta*-substituted benzamide derivative was reacted with TsCl (**5a**), the reaction took place selectively at the less hindered position to give the coupling product **6fa** in 36% yield. The reaction of 1- and 2-naphthamides proceeded at the 2- and 3-positions, respectively, to give the desired products **6gb**,**ja**,**jb** in 33% to 45% yields. MsCl (**5g**) did not afford the

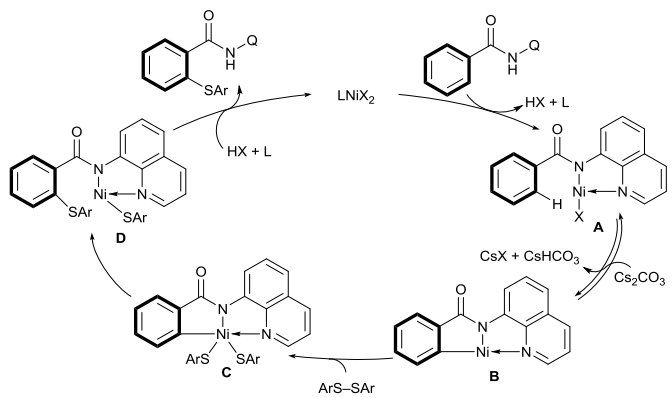
coupling product **6ag** under the same conditions, probably due to the thermal decomposition of **5g**.[9a]

Table 5 Ni-mediated C–H bond sulfonylation



[a] Less than 2% of **7** was observed in each reaction.

A possible catalytic cycle for the reaction is shown in Scheme 3. The coordination of quinoline to the Ni center and subsequent deprotonation of the amide N–H leads to the formation of intermediate **A**, which gives rise to the intermediate **B** via cyclometalation by the aid of Cs_2CO_3.[12] The oxidative addition of intermediate **B** to diaryl disulfides[22] affords the Ni(IV) intermediate **C**, which simultaneously undergoes reductive elimination followed by protonation to afford the desired products with the regeneration of Ni(II) to complete the catalytic cycle.



Scheme 3. A possible catalytic cycle

Conclusions

In conclusion, we report herein the first example of the Ni-catalyzed C(sp^2)–H bond sulfenylation and sulfonylation of benzamide derivatives. The present Ni-catalyzed system would be useful as an alternative or a supplementary method to the currently used methods for preparing diaryl sulfides and diaryl sulfones having various substituents from readily available precursors.

Experimental

General methods

^{1}H and ^{13}C NMR spectra were recorded with a JEOL JNM-Alice 400 (400 MHz and 100 MHz, respectively) spectrometer. All ^{1}H NMR chemical shifts were reported in ppm relative to internal references of tetramethylsilane at δ 0.00. All ^{13}C NMR chemical shifts were reported in ppm relative to carbon resonance in chloroform-d_1 at δ 77.00. Conventional mass spectra were recorded with a JEOL JMS-T100TD spectrometer (DART) using a time-of-flight mass spectrometer. High resolution mass spectra were recorded with a JEOL JMS-DX303HF spectrometer (EI) using a double focusing magnetic sector mass spectrometer. Melting points were measured using Stanford Research Systems OptiMelt MPA 100. X-ray crystallographic analyses were carried out using a Rigaku R-AXIS RAPID Imaging Plate diffractometer with Cu-Kα for **3aa**, **6aa**, and **7aa** and with Mo-Kα for **3ah**. The structures of **3aa**, **3ah**, **6aa**, and **7aa** were solved by direct methods (SHELX97[23]). The structure was refined on F^2 by full-matrix least-squares method using SHELXL-97.[23] Non-hydrogen atoms were anisotropically refined. Hydrogen atoms were included in the refinement on calculated positions riding on their carrier atoms. Catalysts, benzoyl chloride derivatives, 8-aminoquinoline, and diaryl disulfides were purchased from Tokyo Chemical Industry Company and Sigma Aldrich Company. Dehydrated solvents (Wako Pure Chemical Industries) were purchased and used as received.

General procedure for the preparation of amide substrates

8-Aminoquinoline (3.0 g, 21 mmol) and *N*,*N*-dimethyl-4-aminopyridine (80 mg, 0.65 mmol) were placed in a 100 mL two-necked flask, and the flask was flushed with nitrogen. Dichloromethane (20 mL) and Et_3N (3.3 mL, 24 mmol) were added and the resulting solution was cooled to 0 °C. To this solution benzoyl chloride derivatives (20 mmol) was added drop wise. The resulting mixture was stirred at room temperature for 15 h. The mixture was quenched with water and the products were extracted with dichloromethane. The combined organic layer was dried over sodium sulfate and concentrated to give benzamide derivatives.

2-Methyl-*N*-(quinolin-8-yl)benzamide (1a).[14c] ^{1}H NMR (400 MHz, $CDCl_3$): δ = 10.22 (br s, 1H), 8.95 (d, *J* = 7.2 Hz, 1H), 8.78 (dd, *J* = 4.0, 1.2 Hz, 1H), 8.18 (dd, *J* = 8.4, 1.6 Hz,

1H), 7.69 (d, *J* = 7.6 Hz, 1H), 7.62-7.54 (m, 2H), 7.47-7.38 (m, 2H), 7.34-7.26 (m, 2H), 2.60 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 168.2, 148.2, 138.6, 136.7, 136.6, 136.3, 134.7, 131.3, 130.3, 128.0, 127.4, 127.2, 126.0, 121.7, 121.6, 116.5, 20.2; MS (DART): *m/z* 263 $[M+H]^+$.

***N*-(Quinolin-8-yl)benzamide (1b).**[16c] ^{1}H NMR (400 MHz, $CDCl_3$): δ = 10.76 (br s, 1H), 8.95 (dd, *J* = 7.2, 1.2 Hz, 1H), 8.86 (dd, *J* = 8.4, 1.6 Hz, 1H), 8.20 (dd, *J* = 8.0, 2.0 Hz, 1H), 8.11-8.08 (m, 2H), 7.62-7.53 (m, 5H), 7.49 (dd, *J* = 8.4, 2.0 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 165.5, 148.3, 138.8, 136.4, 134.6, 131.8, 128.8, 128.0, 127.5, 127.3, 121.7, 116.5; MS (DART): *m/z* 249 $[M+H]^+$.

4-Methyl-*N*-(quinolin-8-yl)benzamide (1c).[16c] ^{1}H NMR (400 MHz, $CDCl_3$): δ = 10.73 (br s, 1H), 8.94 (d, *J* = 8.0 Hz, 1H), 8.85 (d, *J* = 4.0 Hz, 1H), 8.18 (d, *J* = 8.4 Hz, 1H), 7.99 (d, *J* = 7.6 Hz, 2H), 7.61-7.46 (m, 3H), 7.35 (d, *J* = 8.0 Hz, 2H), 2.46 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 165.4, 148.2, 142.3, 138.8, 136.4, 134.7, 132.3, 129.4, 128.0, 127.5, 127.3, 121.6, 121.5, 116.4, 21.5; MS (DART): *m/z* 263 $[M+H]^+$.

4-(*tert*-Butyl)-*N*-(quinolin-8-yl)benzamide (1d).[14c] ^{1}H NMR (400 MHz, $CDCl_3$): δ = 10.74 (br s, 1H), 8.94 (dd, *J* = 7.6, 1.2 Hz, 1H), 8.84 (dd, *J* = 4.4, 1.2 Hz, 1H), 8.18 (dd, *J* = 8.4, 1.2 Hz, 1H), 8.03 (d, *J* = 8.8 Hz, 2H), 7.61-7.52 (m, 4H), 7.47 (dd, *J* = 8.0, 4.0 Hz, 1H), 1.38 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 165.5, 155.3, 148.2, 138.8, 136.4, 134.7, 132.3, 128.0, 127.5, 127.1, 125.7, 121.6, 121.5, 116.4, 35.0, 31.8; MS (DART): *m/z* 305 $[M+H]^+$.

4-Methoxy-*N*-(quinolin-8-yl)benzamide (1e).[16c] ^{1}H NMR (400 MHz, $CDCl_3$): δ = 10.69 (br s, 1H), 8.93 (dd, *J* = 7.6, 1.2 Hz, 1H), 8.85 (dd, *J* = 4.0, 1.2 Hz, 1H), 8.19 (dd, *J* = 8.0, 1.6 Hz, 1H), 8.06 (t, *J* = 2.4 Hz, 2H), 7.61-7.46 (m, 3H), 7.06-7.02 (m, 2H), 3.90 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 165.0, 162.5, 148.2, 138.7, 136.4, 134.7, 129.2, 128.0, 127.5, 127.4, 121.6, 121.4, 116.3, 114.0, 55.5; MS (DART): *m/z* 279 $[M+H]^+$.

3-Methyl-*N*-(quinolin-8-yl)benzamide (1f).[16c] ^{1}H NMR (400 MHz, $CDCl_3$): δ = 10.72 (br s, 1H), 8.95 (dd, *J* = 7.2, 1.2 Hz, 1H), 8.86 (dd, *J* = 4.0, 1.2 Hz, 1H), 8.19 (dd, *J* = 8.4, 1.2 Hz, 1H), 7.89 (d, *J* = 8.0 Hz, 2H), 7.62-7.53 (m, 2H), 7.50-7.38 (m, 3H), 2.49 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 165.7, 148.3, 138.8, 138.7, 136.4, 135.1, 134.6, 132.6, 128.6, 128.1, 128.0, 127.5, 124.2, 121.7, 121.6, 116.5, 21.5; MS (DART): *m/z* 263 $[M+H]^+$.

***N*-(Quinolin-8-yl)-1-naphthamide (1g).** ^{1}H NMR (400 MHz, $CDCl_3$): δ = 10.43 (br s, 1H), 9.06 (d, *J* = 7.6 Hz, 1H), 8.75 (dd, *J* = 4.0, 1.2 Hz, 1H), 8.54 (d, *J* = 8.4 Hz, 1H), 8.20 (dd, *J* = 8.4, 1.2 Hz, 1H), 8.01 (d, *J* = 8.0 Hz, 1H), 7.93 (d, *J* = 7.2 Hz, 2H), 7.67-7.55 (m, 5H), 7.46 (dd, *J* = 8.4, 4.4 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 167.7, 148.3, 138.6, 136.4, 134.8, 134.6, 133.9, 131.1, 130.3, 128.4, 128.0, 127.4, 127.3, 126.5, 125.6, 125.5, 124.9, 121.9, 121.7, 116.7; MS (DART): *m/z* 299 $[M+H]^+$.

2-Fluoro-*N*-(quinolin-8-yl)benzamide (1h). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 11.16 (br d, *J* = 12.0 Hz, 1H), 8.98 (dd, *J* = 7.2, 1.6 Hz, 1H), 8.88 (dd, *J* = 8.0, 1.6 Hz, 1H), 8.25-8.17 (m, 2H), 7.61-7.51 (m, 3H), 7.48 (dd, *J* = 8.0, 4.0 Hz, 1H), 7.35-7.31 (m, 1H), 7.26-7.22 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 161.8, 161.64, 161.60, 159.3, 148.5, 138.8, 136.3, 134.8, 133.6, 133.5, 132.02, 132.00, 128.0, 127.4, 124.9, 124.8, 122.1, 122.04, 122.00, 121.7, 117.2, 116.4, 116.2; MS (DART): *m/z* 267 $[M+H]^+$.

4-Trifluoromethyl-*N*-(quinolin-8-yl)benzamide (1i). ^{1}H NMR (400 MHz, $CDCl_3$): δ = 10.79 (br s, 1H), 8.92 (dd, *J* = 7.6, 1.6 Hz, 1H), 8.85 (dd, *J* = 4.0, 1.6 Hz, 1H), 8.22-8.18 (m, 3H), 7.82 (d, *J* = 8.4 Hz, 2H), 7.63-7.56 (m, 2H), 7.50 (dd, *J* = 8.0, 4.0 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 164.0, 148.4, 138.7, 138.4, 136.5, 134.1, 133.6, 133.3, 128.0, 127.7, 127.4, 125.90, 125.87, 125.83, 125.80, 122.2, 121.8, 116.7.

***N*-(Quinolin-8-yl)-2-naphthamide (1j).**[14c] ^{1}H NMR (400 MHz, $CDCl_3$): δ = 10.90 (br s, 1H), 9.00 (dd, *J* = 7.6, 1.2 Hz, 1H), 8.89 (dd, *J* = 4.0, 1.6 Hz, 1H), 8.60 (s, 1H), 8.18 (dd, *J* = 8.0, 1.2 Hz, 1H), 8.14 (dd, *J* = 7.6, 1.2 Hz, 1H), 8.05-7.99 (m, 2H), 7.92-7.91 (m, 1H), 7.64-7.54 (m, 4H), 7.48 (dd, *J* = 8.0, 4.4 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 165.5, 148.3, 138.8, 136.4, 134.9, 134.6, 132.7, 132.3, 129.2, 128.7, 128.0, 127.83, 127.77, 127.5, 126.8, 123.7, 121.7, 116.6; MS (DART): *m/z* 299 $[M+H]^+$.

General procedure for Ni-catalyzed sulfenylation of amides with diaryl disulfides

To an oven-dried 5 mL screw-capped vial, benzamide derivative (1.0 mmol), diaryl disulfides (2.0 mmol), $NiCl_2$ (20 mol %), PPh_3 (20 mol%), Cs_2CO_3 (1.0 equiv), and dioxane (1 mL) were added in a glove box. The mixture was stirred for 21 h at 140 °C followed by cooling. The resulting mixture was filtered through a celite pad and concentrated *in vacuo*. The residue was purified by column chromatography on silica gel to afford the desired products.

6-Methyl-2-(phenylsulfanyl)-*N*-(quinolin-8-yl)benzamide (3aa).[6c] Following general procedure, the title compound was purified by flash column chromatography on silica gel (hexane/EtOAc = 20:1) to yield **3aa** in 85% yield as a solid. Single crystals of **3aa** suitable for X-ray crystallography were obtained by recrystallization from toluene: mp 152-153 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ = 9.94 (br s, 1H), 8.97 (d, *J* = 7.2 Hz, 1H), 8.68 (dd, *J* = 4.0, 1.2 Hz, 1H), 8.15 (d, *J* = 8.4 Hz, 1H), 7.61-7.53 (m, 2H), 7.42 (dd, *J* = 8.4, 4.0 Hz, 1H), 7.32-7.34 (m, 2H), 7.28-7.12 (m, 6H), 2.48 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 166.9, 148.1, 140.1, 138.5, 136.2, 136.1, 135.6, 134.3, 133.0, 131.3, 130.4, 129.7, 129.6, 129.1, 127.9, 127.4, 127.1, 121.9, 121.6, 116.9, 19.6; MS (DART): *m/z* 371 $[M+H]^+$; HRMS (EI): *m/z* $[M]^+$ Calcd for $C_{23}H_{18}N_2O_2S$ 370.1140; Found 370.1141; X-ray data for **3aa** (CCDC 1023625): *M* = 370.47, colorless, monoclinic, $P2_1/n$ (#14), *a* = 16.1194(3) Å, *b* = 8.0643(2) Å, *c* = 16.6212(3) Å, *β* = 118.7846(7)°, *V* = 1893.64(6) Å^3, *Z* = 4, D_{calcd} = 1.299 g/cm^3, T = –150(2) °C, R_1 (wR_2) = 0.0412 (0.1013).

2-(4-Methoxyphenylsulfanyl)-6-methyl-*N*-(quinolin-8-yl)benzamide (3ab). Following general procedure, the title compound was purified by flash column chromatography on silica gel (hexane/EtOAc = 20:1) to yield **3ab** in 96% yield as a white solid: mp 138-139 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ =

9.97 (br s, 1H), 9.00 (dd, *J* = 7.2, 1.6 Hz, 1H), 8.73 (dd, *J* = 8.0, 1.6 Hz, 1H), 8.17 (d, *J* = 8.4 Hz, 1H), 7.63-7.55 (m, 2H), 7.45-7.42 (m, 1H), 7.38 (d, *J* = 8.4 Hz, 2H), 7.19 (t, *J* = 8.0 Hz, 1H), 7.11 (d, *J* = 7.6 Hz, 1H), 7.01 (d, *J* = 7.6 Hz, 1H), 6.77 (d, *J* = 8.4 Hz, 2H), 3.73 (s, 3H), 2.45 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 167.1, 159.7, 148.2, 138.5, 138.2, 136.3, 135.8, 135.7, 135.2, 134.3, 129.5, 128.4, 128.0, 127.4, 124.6, 121.9, 121.6, 116.9, 114.8, 55.2, 19.5; MS (DART): *m/z* 401 $[M+H]^+$; HRMS (EI): *m/z* $[M]^+$ Calcd for $C_{24}H_{20}N_2O_2S$ 400.1245; Found 400.1250.

2-(2-Methoxyphenylsulfanyl)-6-methyl-*N*-(quinolin-8-yl)benzamide (3ac). Following general procedure, the title compound was purified by flash column chromatography on silica gel (hexane/EtOAc = 20:1) to yield **3ac** in 92% yield as a white solid: mp 189-190 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ = 9.98 (br s, 1H), 8.97 (dd, *J* = 7.6, 1.2 Hz, 1H), 8.67 (dd, *J* = 8.0, 1.2 Hz, 1H), 8.13 (dd, *J* = 8.0, 1.6 Hz, 1H), 7.59-7.52 (m, 2H), 7.39 (dd, *J* = 8.0, 4.0 Hz, 1H), 7.26-7.13 (m, 5H), 6.85 (t, *J* = 7.2 Hz, 1H), 6.73 (d, *J* = 8.0 Hz, 1H), 3.66 (s, 3H), 2.47 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 167.0, 157.4, 148.0, 140.3, 138.4, 136.2, 136.1, 134.4, 132.2, 132.1, 130.5, 129.52, 129.46, 128.4, 127.8, 127.3, 124.1, 121.8, 121.5, 121.2, 116.8, 110.8, 55.6, 19.6; MS (DART): *m/z* 401 $[M+H]^+$; HRMS (EI): *m/z* $[M]^+$ Calcd for $C_{24}H_{20}N_2O_2S$ 400.1245; Found 400.1243.

6-Methyl-2-(4-methylphenylsulfanyl)-*N*-(quinolin-8-yl)-benzamide (3ad). Following general procedure, the title compound was purified by flash column chromatography on silica gel (hexane/EtOAc = 20:1) to yield **3ad** in 89% yield as a white solid: mp 133-134 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ = 9.95 (br s, 1H), 8.99 (dd, *J* = 7.2, 1.2 Hz, 1H), 8.69 (dd, *J* = 4.0, 1.2 Hz, 1H), 8.14 (dd, *J* = 8.4, 1.6 Hz, 1H), 7.60-7.52 (m, 2H), 7.41 (dd, *J* = 8.4, 4.0 Hz, 1H), 7.28-7.19 (m, 3H), 7.13 (t, *J* = 8.4 Hz, 2H), 7.01 (d, *J* = 8.0 Hz, 2H), 2.46 (s, 3H), 2.23 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 167.0, 148.1, 139.1, 138.4, 137.5, 136.2, 135.9, 134.29, 134.26, 132.4, 131.2, 129.9, 129.5, 129.2, 128.9, 127.9, 127.4, 121.9, 121.5, 116.8, 21.0, 19.5; MS (DART): *m/z* 385 $[M+H]^+$; HRMS (EI): *m/z* $[M]^+$ Calcd for $C_{24}H_{20}N_2OS$ 384.1296; Found 384.1298.

2-(2,6-Dichlorophenylsulfanyl)-6-methyl-*N*-(quinolin-8-yl)benzamide (3ae). Following general procedure, the title compound was purified by flash column chromatography on silica gel (hexane/EtOAc = 20:1) to yield **3ae** in 96% yield as a white solid: mp 170-171 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ = 10.16 (br s, 1H), 9.00 (d, *J* = 7.6 Hz, 1H), 8.75 (d, *J* = 4.0 Hz, 1H), 8.17 (d, *J* = 8.4 Hz, 1H), 7.63-7.55 (m, 2H), 7.45 (dd, *J* = 8.0, 4.0 Hz, 1H), 7.35 (d, *J* = 8.0 Hz, 2H), 7.20-7.09 (m, 3H), 6.72 (d, *J* = 7.6 Hz, 1H), 2.47 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 166.7, 148.2, 141.6, 138.5, 137.2, 136.3, 136.0, 134.4, 133.5, 131.7, 130.5, 129.5, 128.8, 128.3, 128.0, 127.4, 125.4, 122.0, 121.6, 116.8, 19.6; MS (DART): *m/z* 439 $[M+H]^+$; HRMS (EI): *m/z* $[M]^+$ Calcd for $C_{23}H_{16}Cl_2N_2OS$ 438.0360; Found 438.0359.

2-(2,5-Dichlorophenylsulfanyl)-6-methyl-*N*-(quinolin-8-yl)benzamide (3af). Following general procedure, the title compound was purified by flash column chromatography on silica gel (hexane/EtOAc = 20:1) to yield **3af** in 98% yield as a white solid: mp 132-133 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ = 9.86 (br s, 1H), 8.91 (dd, *J* = 7.6, 1.6 Hz, 1H), 8.66 (d, *J* = 3.2 Hz, 1H), 8.14 (d, *J* = 7.6 Hz, 1H), 7.59-7.52 (m, 2H), 7.41-7.37 (m, 4H), 7.08-6.94 (m, 3H), 2.51 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 166.4, 148.1, 142.3, 138.7, 138.3, 137.0, 136.2, 134.0, 133.1, 132.8, 131.6, 131.0, 130.3, 130.2, 129.3, 128.5, 127.8, 127.3, 127.0, 122.0, 121.6, 116.8, 19.7; MS (DART): *m/z* 439 $[M+H]^+$; HRMS (EI): *m/z* $[M]^+$ Calcd for $C_{23}H_{16}Cl_2N_2OS$ 438.0360; Found 438.0358.

2-(4-Chlorophenylsulfanyl)-6-methyl-*N*-(quinolin-8-yl)benzamide (3ag). Following general procedure, the title compound was purified by flash column chromatography on silica gel (hexane/EtOAc = 20:1) to yield **3ag** in 93% yield as a white solid: mp 118-119 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ = 9.84 (br s, 1H), 8.94 (dd, *J* = 7.2, 1.2 Hz, 1H), 8.65 (dd, *J* = 4.4, 1.6 Hz, 1H), 8.14 (dd, *J* = 8.4, 1.6 Hz, 1H), 7.59-7.52 (m, 2H), 7.41 (dd, *J* = 8.0, 4.4 Hz, 1H), 7.31-7.17 (m, 5H), 7.11-7.08 (m, 2H), 2.47 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 166.7, 148.2, 140.8, 138.3, 136.4, 136.2, 134.8, 134.1, 132.9, 131.9, 131.8, 131.3, 130.3, 129.8, 129.1, 127.9, 127.3, 122.0, 121.6, 116.8, 19.6; MS (DART): *m/z* 405$[M+H]^+$; HRMS (EI): *m/z* $[M]^+$ Calcd for $C_{23}H_{17}ClN_2OS$ 404.0750; Found: 404.0751.

6-Methyl-2-(methylsulfanyl)-*N*-(quinolin-8-yl)benzamide (3ah). Following general procedure, the title compound was purified by flash column chromatography on silica gel (hexane/EtOAc = 20:1) to yield **3ah** in 36% yield as an orange solid. Single crystals of **3ah** suitable for X-ray crystallography were obtained by recrystallization from toluene: mp 96-97 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ = 9.99 (br s, 1H), 9.02 (dd, *J* = 8.0, 1.6 Hz, 1H), 8.75 (dd, *J* = 4.0, 1.6 Hz, 1H), 8.18 (dd, *J* = 8.4, 2.0 Hz, 1H), 7.63-7.55 (m, 2H), 7.44 (dd, *J* = 8.0, 4.0 Hz, 1H), 7.33-7.24 (m, 2H), 7.11 (d, *J* = 7.2 Hz, 1H), 2.47 (s, 3H), 2.44 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 167.2, 148.3, 138.5, 138.2, 136.3, 135.6, 135.5, 134.3, 129.5, 128.0, 127.8, 127.4, 125.5, 122.0, 121.6, 116.9, 19.4, 17.4; MS (DART): *m/z* 309 $[M+H]^+$; HRMS (EI): *m/z* $[M]^+$ Calcd for $C_{18}H_{16}N_2OS$ 308.0983; Found 308.0985; Anal. Calcd for $[C_{18}H_{16}N_2OS]$: C, 70.10; H, 5.23; N, 9.08. Found: C, 70.05; H, 5.15; N, 8.99; X-ray data for **3ah** (CCDC 1030338): *M* = 308.40, colorless, monoclinic, $P2_1/c$ (#14), *a* = 7.2995(4) Å, *b* = 8.9313(4) Å, *c* = 23.2132(12) Å, *β* = 90.8321(17)°, *V* = 1513.20(14) Å^3, *Z* = 4, D_{calcd} = 1.354 g/cm^3, T = –150(2) °C, R_1 (wR_2) = 0.0400 (0.0889).

2-(Phenylsulfanyl)-*N*-(quinolin-8-yl)benzamide (3ba). Following general procedure, the title compound was purified by flash column chromatography on silica gel (hexane/EtOAc = 20:1) to give **3ba** and **4ba** in 38% and 45% yields, respectively: mp 111-112 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ = 10.53 (br s, 1H), 8.93 (d, *J* = 7.2 Hz, 1H), 8.75 (t, *J* = 2.0 Hz, 1H), 8.15 (dd, *J* = 8.0, 1.2 Hz, 1H), 7.81-7.79 (m, 1H), 7.59-7.41 (m, 5H), 7.31-7.24 (m, 5H), 7.17-7.15 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 166.2, 148.2, 138.6, 137.4, 136.3, 135.8, 134.5, 134.1, 133.4, 130.9, 130.6, 129.4, 128.2, 128.0, 127.9, 127.4, 126.2, 121.8, 121.6, 116.7; MS (DART): *m/z* 357 $[M+H]^+$; HRMS (EI): *m/z* $[M]^+$ Calcd for $C_{22}H_{16}N_2OS$ 356.0983; Found 356.0984.

4-Methyl-2-(phenylsulfanyl)-*N*-(quinolin-8-yl)benzamide (3ca). Following general procedure, the title compound was purified by flash column chromatography on silica gel (hexane/EtOAc = 20:1) to give **3ca** and **4ca** in 45% and 39% yields, respectively: ^{1}H NMR (400 MHz, $CDCl_3$): δ = 10.57 (br s, 1H), 8.92 (dd, *J* = 7.2, 1.2 Hz, 1H), 8.76 (dd, *J* = 4.0, 1.6 Hz, 1H), 8.17 (dd, *J* = 8.4, 1.6 Hz, 1H), 7.73 (d, *J* = 7.6 Hz, 1H), 7.59-7.52 (m, 2H), 7.46-7.42 (m, 3H), 7.32-7.24 (m, 3H), 7.13 (d, *J* = 8.0 Hz, 1H), 7.02 (s, 1H), 2.29 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 166.3, 148.2, 141.4, 138.7, 136.8, 136.3, 134.7, 134.5, 133.5, 132.9, 131.6, 129.3, 128.5, 127.9, 127.8, 127.4, 127.3, 121.7, 121.6, 116.7, 21.4; MS (DART): *m/z* 371 $[M+H]^+$; HRMS (EI): *m/z* $[M]^+$ Calcd for $C_{23}H_{18}N_2OS$ 370.1140; Found 370.1137.

4-Methyl-2,6-bis(phenylsulfanyl)-*N*-(quinolin-8-yl)benzamide (4ca). mp 145-146 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ = 10.00 (br s, 1H), 8.95 (dd, *J* = 7.6, 1.2 Hz, 1H), 8.66 (dd, *J* = 8.4, 1.2 Hz, 1H), 8.13 (dd, *J* = 8.0, 1.2 Hz, 1H), 7.58-7.50 (m, 2H), 7.41-7.38 (m, 5H), 7.25-7.16 (m, 6H), 7.00 (s, 2H), 2.19 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 165.4, 148.0, 140.5, 138.4, 138.2, 136.1, 134.9, 134.8, 134.3, 132.0, 131.5, 129.2, 127.8, 127.5, 127.4, 121.8, 121.4, 116.9, 21.2; MS (DART): *m/z* 479 $[M+H]^+$.

4-(*tert*-Butyl)-2-(phenylsulfanyl)-*N*-(quinolin-8-yl)benzamide (3da). Following general procedure, the title compound was purified by flash column chromatography on silica gel (hexane/EtOAc = 20:1) to give **3da** and **4da** in 39% and 31% yields, respectively: mp 72-73 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ = 10.57 (br s, 1H), 8.92 (dd, *J* = 7.6, 1.6 Hz, 1H), 8.75 (dd, *J* = 4.0, 1.6 Hz, 1H), 8.15 (dd, *J* = 8.4, 1.2 Hz, 1H), 7.78 (d, *J* = 8.0 Hz, 1H), 7.58-7.50 (m, 2H), 7.45-7.42 (m, 3H), 7.35-7.23 (m, 5H), 1.21 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 166.2, 154.3, 148.2, 138.7, 136.5, 136.3, 134.70, 134.67, 133.4, 132.9, 129.2, 128.45, 128.36, 127.9, 127.8, 127.4, 123.6, 121.7, 121.6, 116.7, 34.9, 30.9; MS (DART): *m/z* 413 $[M+H]^+$; HRMS (EI): *m/z* $[M]^+$ Calcd for $C_{26}H_{24}N_2OS$ 412.1609; Found 412.1608.

4-(*tert*-Butyl)-2,6-bis(phenylsulfanyl)-*N*-(quinolin-8-yl)benzamide (4da). mp 155-156 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ = 9.97 (br s, 1H), 8.94 (d, *J* = 7.6 Hz, 1H), 8.65-8.64 (m, 1H), 8.13 (d, *J* = 8.4 Hz, 1H), 7.58-7.51 (m, 2H), 7.41-7.36 (m, 5H), 7.26-7.15 (m, 8H), 1.14 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 165.4, 153.4, 148.0, 138.4, 138.2, 136.1, 134.9, 134.5, 134.3, 131.8, 129.1, 128.4, 127.8, 127.40, 127.38, 121.8, 121.4, 116.9, 34.9, 30.8; MS (DART): *m/z* 521 $[M+H]^+$; HRMS (EI): *m/z* $[M]^+$ Calcd for $C_{32}H_{28}N_2OS_2$ 520.1643; Found 520.1645.

5-Methyl-2-(phenylsulfanyl)-*N*-(quinolin-8-yl)benzamide (3ea:4ea). Following general procedure, the title compound was purified by flash column chromatography on silica gel (hexane/EtOAc = 20:1) to give **3ea** and **4ea** as an inseparable mixture in 82% of combined yield with 2:1 ratio (determined by ^{1}H NMR): ^{1}H NMR (400 MHz, $CDCl_3$): δ = (major product **3ea**) 10.08 (s, 1H), 8.96 (dd, *J* = 7.6, 1.2 Hz, 1H), 8.69 (dd, *J* = 4.4, 1.6 Hz, 1H), 8.13 (dd, *J* = 8.4, 1.2 Hz, 1H), 7.58-7.7.20 (m, 10H), 6.59 (s, 1H), 3.58 (s, 3H): (minor product **4ea**) 10.59 (s, 1H), 8.93 (d, *J* = 7.2 Hz, 1H), 8.77 (dd, *J* = 4.0, 2.0 Hz, 1H), 8.15 (dd, *J* = 8.4, 1.2 Hz, 1H), 7.82 (d, *J* = 8.8 Hz, 2H), 7.58-7.7.20 (m, 13H), 6.78-6.82 (m, 1H), 6.60 (s, 2H), 3.68 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 165.8, 165.2, 161.4, 160.1, 148.1, 148.0, 140.8, 138.6, 138.4, 137.3, 136.3, 136.1, 134.7, 134.3, 134.1, 133.9, 133.5, 132.7, 132.2, 130.0, 129.5, 139.3, 128.4, 127.93, 127.90, 127.9, 127.40, 127.39, 127.3, 121.8, 121.54, 121.46, 116.8, 116.6, 115.2, 115.0, 111.1, 55.28, 55.22.

5-Methyl-2-(phenylsulfanyl)-*N*-(quinolin-8-yl)benzamide (3fa:4fa). Following general procedure, the title compound was purified by flash column chromatography on silica gel (hexane/EtOAc = 20:1) to give **3fa** and **4fa** as an inseparable mixture in 78% of combined yield with 5:1 ratio (determined by ^{1}H NMR): ^{1}H NMR (400 MHz, $CDCl_3$): δ = (major product **3fa**) 10.51 (br s, 1H), 8.95-8.89 (m, 1H), 8.72 (dd, *J* = 4.4, 1.2 Hz, 1H), 8.14 (dd, *J* = 8.4, 1.2 Hz, 1H), 7.62-7.10 (m, 11H), 2.40 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 166.4, 165.7, 148.1, 147.8, 143.3, 138.6, 138.3, 137.2, 137.1, 136.7, 136.2, 136.0, 135.4, 135.3, 134.5, 134.2, 133.9, 132.3, 132.1, 132.0, 131.8, 131.6, 129.9, 129.20, 129.17, 128.9, 127.9, 127.7, 127.6, 127.37, 127.35, 127.30, 125.6, 121.8, 121.7, 121.5, 121.3, 116.8, 116.7, 21.0, 20.9.

2-(Phenylsulfanyl)-*N*-(quinolin-8-yl)-1-naphthamide (3ga). Following general procedure, the title compound was purified by flash column chromatography on silica gel (hexane/EtOAc = 20:1) to give **3ga** in 86% yield: mp 180-181 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ = 10.22 (br s, 1H), 9.11 (dd, *J* = 7.6, 1.2 Hz, 1H), 8.63 (dd, *J* = 4.0, 1.2 Hz, 1H), 8.16 (dd, *J* = 8.4, 1.6 Hz, 1H), 8.06-8.04 (m, 1H), 7.87-7.81 (m, 2H), 7.66-7.50 (m, 4H), 7.42-7.38 (m, 4H), 7.26-7.17 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 166.5, 148.2, 138.4, 137.4, 136.2, 135.4, 134.4, 132.4, 131.5, 130.7, 130.6, 130.1, 129.3, 129.2, 128.1, 127.9, 127.7, 127.4, 127.2, 126.8, 125.2, 122.1, 121.6, 117.0; MS (DART): *m/z* 407 $[M+H]^+$; HRMS (EI): *m/z* $[M]^+$ Calcd for $C_{26}H_{18}N_2OS$ 406.1140; Found 406.1143.

2,6-Bis(phenylsulfanyl)-*N*-(quinolin-8-yl)benzamide (4ha). Following general procedure, the title compound was purified by flash column chromatography on silica gel (hexane/EtOAc = 20:1) to yield **4ha** in 89% yield as an orange solid: ^{1}H NMR (400 MHz, $CDCl_3$): δ = 10.06 (br s, 1H), 8.97 (d, *J* = 6.8 Hz, 1H), 8.67 (dd, *J* = 4.4, 1.2 Hz, 1H), 8.12 (dd, *J* = 8.4, 1.2 Hz, 1H), 7.58-7.50 (m, 2H), 7.41-7.37 (m, 5H), 7.26-7.10 (m, 9H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 165.2, 148.0, 139.8, 138.4, 136.2, 135.6, 134.2, 134.1, 132.5, 130.1, 130.0, 129.3, 127.83, 127.75, 127.4, 122.0, 121.5, 116.9; MS (DART): *m/z* 465 $[M+H]^+$; HRMS (EI): *m/z* $[M]^+$ Calcd for $C_{28}H_{20}N_2OS_2$ 464.1017; Found 464.1014.

2,6-Bis(4-methoxyphenylsulfanyl)-*N*-(quinolin-8-yl)benzamide (4hb). Following general procedure, the title compound was purified by flash column chromatography on silica gel (hexane/EtOAc = 20:1) to yield **4hb** in 98% yield as an orange solid: mp 131-132 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ = 10.09 (br s, 1H), 9.04 (dd, *J* = 7.2, 1.2 Hz, 1H), 8.75 (dd, *J* = 4.0, 1.2 Hz, 1H), 8.17 (dd, *J* = 8.4, 1.2 Hz, 1H), 7.62-7.54 (m, 2H), 7.45-7.40 (m, 5H), 7.07 (t, *J* = 8.0 Hz, 1H), 6.88 (d, *J* = 7.6 Hz, 2H), 6.80 (d, *J* = 8.8 Hz, 4H), 3.73 (s, 6H); ^{13}C NMR

(100 MHz, $CDCl_3$): δ = 165.3, 160.0, 148.1, 138.5, 137.6, 136.6, 136.2, 135.9, 134.3, 129.7, 127.9, 127.5, 127.1, 123.5, 122.0, 121.5, 117.0, 114.9, 55.2; MS (DART): *m/z* 525 $[M+H]^+$; HRMS (EI): *m/z* $[M]^+$ Calcd for $C_{30}H_{24}N_2O_3S_2$ 524.1228; Found 524.1230.

2,6-Bis(4-methylphenylsulfanyl)-*N*-(quinolin-8-yl)benzamide (4hd). Following general procedure, the title compound was purified by flash column chromatography on silica gel (hexane/EtOAc = 20:1) to yield **4hd** in 95% yield as an orange solid: mp 120-121 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ = 10.05 (br s, 1H), 9.01 (dd, *J* = 8.0, 1.6 Hz, 1H), 8.69 (dd, *J* = 4.0, 1.2 Hz, 1H), 8.15 (dd, *J* = 8.4, 1.6 Hz, 1H), 7.59-7.50 (m, 2H), 7.42 (dd, *J* = 8.0, 4.0 Hz, 1H), 7.41-7.32 (m, 4H), 7.12-6.99 (m, 7H), 2.25 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 165.3, 148.0, 138.4, 138.3, 138.2, 136.6, 136.2, 134.2, 133.4, 130.1, 129.8, 128.6, 127.9, 127.4, 121.9, 121.5, 117.0, 21.1; MS (DART): *m/z* 493 $[M+H]^+$; HRMS (EI): *m/z* $[M]^+$ Calcd for $C_{30}H_{24}N_2OS_2$ 492.1330; Found 492.1327.

2,6-Bis(4-fluorophenylsulfanyl)-*N*-(quinolin-8-yl)benzamide (4hi). Following general procedure, the title compound was purified by flash column chromatography on silica gel (hexane/EtOAc = 20:1) to give **4hi** in 90% yield as an orange solid: mp 135-136 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ = 10.00 (br s, 1H), 8.98 (dd, *J* = 7.6, 1.6 Hz, 1H), 8.71 (dd, *J* = 4.0, 1.6 Hz, 1H), 8.17 (dd, *J* = 8.0, 1.6 Hz, 1H), 7.62-7.55 (m, 2H), 7.46-7.40 (m, 5H), 7.21-7.17 (m, 1H), 7.07 (d, *J* = 7.2 Hz, 2H), 6.96-6.92 (m, 4H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 165.0, 163.9, 161.4, 148.1, 139.1, 138.4, 136.3, 136.1, 135.2, 135.1, 134.0, 130.1, 129.6, 129.1, 129.0, 127.9, 127.4, 122.2, 121.6, 117.0, 116.6, 116.4; MS (DART): *m/z* 501 $[M+H]^+$; HRMS (EI): *m/z* $[M]^+$ Calcd for $C_{28}H_{18}F_2N_2OS_2$ 500.0829; Found 500.0827.

General procedure for Ni-mediated sulfonylation of amides with arylsulfonyl chlorides

To an oven-dried 5 mL screw-capped vial, benzamide derivative (1.0 mmol), aryl sulfonyl chloride (3.0 mmol), $NiCl_2$ (50 mol %), Na_2CO_3 (2.0 equiv), and dioxane (1 mL) were added in a glove box. The mixture was stirred for 24 h at 140 °C followed by cooling. The resulting mixture was filtered through a celite pad and concentrated *in vacuo*. The residue was purified by column chromatography on silica gel to afford the desired products.

6-Methyl-*N*-(quinolin-8-yl)-2-tosylbenzamide (6aa). Following general procedure, the title compound was purified by flash column chromatography on silica gel (hexane/EtOAc = 10:2) to yield **6aa** in 61% yield as a solid accompanied by **7aa**. Single crystals of **6aa** and **7aa** suitable for X-ray crystallography were obtained by recrystallization from toluene: mp 232-233 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ = 9.89 (br s, 1H), 8.95 (dd, *J* = 7.6, 1.6 Hz, 1H), 8.70 (dd, *J* = 4.4, 1.6 Hz, 1H), 8.18 (dd, *J* = 8.0, 1.6 Hz, 1H), 8.04-8.00 (m, 1H), 7.83 (d, *J* = 8.4 Hz, 2H), 7.65-7.57 (m, 2H), 7.49 (d, *J* = 5.2 Hz, 2H), 7.45 (dd, *J* = 8.0, 4.0 Hz, 1H), 7.15 (d, *J* = 8.0 Hz, 2H), 2.45 (s, 3H), 2.30 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 165.3, 148.2, 144.1, 138.7, 138.4, 138.3, 137.2, 136.29, 136.25, 135.5, 134.3, 129.6, 129.5, 128.2, 128.0, 127.4, 127.0, 122.1, 121.6, 117.0, 21.5, 19.3; MS (DART): *m/z* 417 $[M+H]^+$; HRMS (EI): *m/z* $[M]^+$ Calcd for $C_{24}H_{20}N_2O_3S$ 416.1195; Found 416.1198; X-ray data for **6aa** (CCDC 1023627): *M* = 416.49, colorless, triclinic, *P*-1 (#2), *a* = 7.8422(2) Å, *b* = 10.5048(2) Å, *c* = 12.7128(3) Å, α = 98.844(1)°, β = 95.249(1)°, γ = 107.102(1)°, *V* = 978.68(4) Å^3, *Z* = 2, D_{calcd} = 1.413 g/cm^3, T = –150(2) °C, R_1 (*wR*$_2$) = 0.0438 (0.1903).

6-Methyl-2-tosyl-*N*-(5-tosylquinolin-8-yl)benzamide (7aa). mp 276-277 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ = 10.19 (br s, 1H), 9.06 (dd, *J* = 8.4, 2.8 Hz, 2H), 8.74 (dd, *J* = 4.0, 1.2 Hz, 1H), 8.60 (d, *J* = 8.4 Hz, 1H), 8.06-7.96 (m, 1H), 7.86-7.82 (m, 4H), 7.55-7.48 (m, 3H), 7.29-7.21 (m, 4H), 2.43 (s, 3H), 2.37 (s, 3H), 2.34 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 166.2, 148.7, 144.4, 144.2, 139.5, 138.9, 138.18, 138.15, 137.0, 135.6, 135.5, 133.4, 132.0, 129.9, 129.7, 128.1, 127.3, 127.2, 124.2, 123.3, 114.8, 21.6, 21.5, 19.3; MS (DART): *m/z* 571 $[M+H]^+$; HRMS (EI): *m/z* $[M]^+$ Calcd for $C_{31}H_{26}N_2O_5S_2$ 570.1283; Found 570.1286; X-ray data for **7aa** (CCDC 1023628): *M* = 570.68, colorless, triclinic, *P*-1 (#2), *a* = 10.2496(2) Å, *b* = 10.7814(2) Å, *c* = 13.5184(3) Å, α = 65.784(1)°, β = 78.651(1)°, γ = 89.847(2)°, *V* = 1330.66(5) Å^3, *Z* = 2, D_{calcd} = 1.424 g/cm^3, T = –150(2) °C, R_1 (*wR*$_2$) = 0.0403 (0.1212).

2-(4-Methoxybenzenesulfonyl)-6-methyl-*N*-(quinolin-8-yl)benzamide (6ab). Following general procedure, the title compound was purified by flash column chromatography on silica gel (hexane/EtOAc = 10:3) to yield **6ab** in 55% yield as a solid: mp 201-202 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ = 9.89 (br s, 1H), 8.96 (dd, *J* = 7.2, 1.6 Hz, 1H), 8.69 (dd, *J* = 4.0, 1.6 Hz, 1H), 8.17 (dd, *J* = 8.0, 1.6 Hz, 1H), 8.03-8.00 (m, 1H), 7.90-7.87 (m, 2H), 7.64-7.56 (m, 2H), 7.48-7.47 (m, 2H), 7.43 (dd, *J* = 8.4, 4.4 Hz, 1H), 6.83-6.79 (m, 2H), 3.73 (s, 3H), 2.44 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 165.4, 163.2, 148.2, 139.0, 138.3, 137.1, 136.2, 136.1, 135.3, 134.2, 132.7, 130.3, 129.5, 127.9, 127.3, 126.8, 122.1, 121.6, 116.9, 114.1, 55.4, 19.3; MS (DART): *m/z* 433 $[M+H]^+$; HRMS (EI): *m/z* $[M]^+$ Calcd for $C_{24}H_{20}N_2O_4S$ 432.1144; Found 432.1142.

6-Methyl-2-(3-methylbenzenesulfonyl)-*N*-(quinolin-8-yl)benzamide (6ac). Following general procedure, the title compound was purified by flash column chromatography on silica gel (hexane/EtOAc = 10:2) to yield **6ac** in 49% yield as a solid: mp 188-189 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ = 9.84 (br s, 1H), 8.95 (dd, *J* = 7.2, 1.2 Hz, 1H), 8.67 (dd, *J* = 8.0, 1.2 Hz, 1H), 8.17 (dd, *J* = 8.4, 1.6 Hz, 1H), 8.06-8.03 (m, 1H), 7.73-7.70 (m, 2H), 7.64-7.57 (m, 2H), 7.51-7.50 (m, 2H), 7.43 (dd, *J* = 8.4, 4.0 Hz, 1H), 7.26-7.41 (m, 2H), 2.45 (s, 3H), 2.16 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 165.1, 148.2, 140.9, 139.1, 138.4, 138.3, 137.3, 136.3, 136.2, 135.5, 134.2, 133.9, 129.5, 128.8, 128.2, 127.9, 127.4, 127.1, 125.2, 122.2, 121.6, 117.0, 21.1, 19.3; MS (DART): *m/z* 417 $[M+H]^+$; HRMS (EI): *m/z* $[M]^+$ Calcd for $C_{24}H_{20}N_2O_3S$ 416.1195; Found 416.1197.

2-(3-Fluorobenzenesulfonyl)-6-methyl-*N*-(quinolin-8-yl)benzamide (6ad). Following general procedure, the title compound was purified by flash column chromatography on silica gel (hexane/EtOAc = 10:2) to yield **6ad** in 51% yield as a

solid: mp 165-166 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ = 9.92 (br s, 1H), 8.95 (dd, *J* = 7.2, 1.2 Hz, 1H), 8.71 (dd, *J* = 4.0, 1.6 Hz, 1H), 8.19 (dd, *J* = 8.4, 1.6 Hz, 1H), 8.03 (dd, *J* = 6.8, 2.8 Hz, 1H), 7.79-7.76 (m, 1H), 7.70-7.58 (m, 3H), 7.54-7.52 (m, 2H), 7.45 (dd, *J* = 8.4, 4.0 Hz, 1H), 7.40-7.35 (m, 1H), 7.19-7.14 (m, 1H), 2.47 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 165.2, 163.5, 160.9, 148.3, 143.4, 143.3, 138.4, 137.8, 137.5, 136.6, 136.3, 136.1, 134.1, 130.83, 130.75, 129.7, 128.0, 127.4, 127.3, 124.0, 122.3, 121.7, 120.6, 120.4, 117.0, 115.6, 115.4, 19.3; MS (DART): *m/z* 421 $[M+H]^+$; HRMS (EI): *m/z* $[M]^+$ Calcd for $C_{23}H_{17}FN_2O_3S$ 420.0944; Found 420.0942.

2-(4-(*tert*-Butyl)benzenesulfonyl)-6-methyl-*N*-(quinolin-8-yl)benzamide (6ae). Following general procedure, the title compound was purified by flash column chromatography on silica gel (hexane/EtOAc = 10:2) to yield **6ae** in 53% yield as a solid: mp 215-216 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ = 9.93 (br s, 1H), 8.96 (dd, *J* = 7.6, 1.2 Hz, 1H), 8.72 (d, *J* = 4.0 Hz, 1H), 8.19 (d, *J* = 8.0 Hz, 1H), 8.04 (t, *J* = 4.0 Hz, 1H), 7.91-7.88 (m, 2H), 7.66-7.50 (m, 2H), 7.50 (d, *J* = 4.4 Hz, 2H), 7.46-7.44 (m, 1H), 7.41-7.38 (m, 2H), 2.46 (s, 3H), 1.25 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 165.5, 157.0, 148.3, 138.9, 138.5, 138.3, 137.2, 136.4, 136.3, 135.5, 134.3, 129.6, 128.1, 128.0, 127.4, 127.1, 126.1, 122.2, 121.7, 117.1, 35.1, 31.0, 19.4; MS (DART): *m/z* 459 $[M+H]^+$; HRMS (EI): *m/z* $[M]^+$ Calcd for $C_{27}H_{26}N_2O_3S$ 458.1664; Found 458.1667.

2-(4-Chlorobenzenesulfonyl)-6-methyl-*N*-(quinolin-8-yl)benzamide (6af). Following general procedure, the title compound was purified by flash column chromatography on silica gel (hexane/EtOAc = 10:2) to yield **6af** in 42% yield as a solid: mp 210-211 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ = 10.06 (br s, 1H), 8.84 (dd, *J* = 6.0, 2.8 Hz, 1H), 8.75 (dd, *J* = 4.4, 1.6 Hz, 1H), 8.19 (dd, *J* = 8.4, 2.0 Hz, 1H), 8.15 (d, *J* = 8.4 Hz, 1H), 7.85 (d, *J* = 8.4 Hz, 2H), 7.61-7.58 (m, 4H), 7.47 (dd, *J* = 8.4, 4.0 Hz, 1H), 7.20 (d, *J* = 8.4 Hz, 2H), 2.31 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 164.1, 148.4, 144.6, 140.0, 138.4, 137.6, 137.5, 136.3, 134.1, 131.2, 130.4, 129.7, 128.9, 128.4, 127.9, 127.3, 122.5, 121.8, 117.1, 21.6; MS (DART): *m/z* 437 $[M+H]^+$; HRMS (EI): *m/z* $[M]^+$ Calcd for $C_{23}H_{17}ClN_2O_3S$ 436.0648; Found 436.0647.

4-Methyl-*N*-(quinolin-8-yl)-2-tosylbenzamide (6ca). Following general procedure, the title compound was purified by flash column chromatography on silica gel (hexane/EtOAc = 10:2) to yield **6ca** in 40% yield as a solid: mp 191-192 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ = 10.02 (br s, 1H), 8.86 (dd, *J* = 7.2, 1.6 Hz, 1H), 8.72 (dd, *J* = 4.0, 1.2 Hz, 1H), 8.17 (dd, *J* = 8.4, 1.2 Hz, 1H), 8.03 (s, 1H), 7.88 (d, *J* = 8.4 Hz, 2H), 7.62-7.52 (m, 3H), 7.46-7.42 (m, 2H), 7.19 (d, *J* = 8.0 Hz, 2H), 2.48 (s, 3H), 2.30 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 165.8, 148.2, 144.1, 140.9, 138.7, 138.4, 138.1, 136.2, 134.44, 134.41, 134.0, 129.9, 129.5, 128.7, 128.3, 127.9, 127.3, 122.1, 121.6, 116.9, 21.5, 21.3; MS (DART): *m/z* 417 $[M+H]^+$; HRMS (EI): *m/z* $[M]^+$ Calcd for $C_{24}H_{20}N_2O_3S$ 416.1195; Found 416.1193.

4-(*tert*-Butyl)-*N*-(quinolin-8-yl)-2-tosylbenzamide (6da). Following general procedure, the title compound was purified by flash column chromatography on silica gel (hexane/EtOAc = 10:2) to yield **6da** in 38% yield as a solid: mp 200-201 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ = 10.03 (br s, 1H), 8.86 (dd, *J* = 7.2, 1.6 Hz, 1H), 8.72 (dd, *J* = 4.0, 1.6 Hz, 1H), 8.25 (d, *J* = 2.0 Hz, 1H), 8.17 (dd, *J* = 8.4, 2.0 Hz, 1H), 7.85 (d, *J* = 8.4 Hz, 2H), 7.69-7.66 (m, 1H), 7.62-7.55 (m, 3H), 7.44 (dd, *J* = 8.4, 4.0 Hz, 1H), 7.18 (d, *J* = 8.4 Hz, 2H), 2.29 (s, 3H), 1.39 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 165.8, 154.1, 148.2, 144.0, 138.6, 138.4, 138.2, 136.2, 134.43, 134.39, 130.4, 129.5, 128.7, 128.3, 127.9, 127.3, 126.4, 122.1, 121.6 116.9, 35.2, 31.0, 21.5; MS (DART): *m/z* 459 $[M+H]^+$; HRMS (EI): *m/z* $[M]^+$ Calcd for $C_{27}H_{26}N_2O_3S$ 458.1664; Found 458.1666.

4-(Trifluoromethyl)-*N*-(quinolin-8-yl)-2-tosylbenzamide (6ia). Following general procedure, the title compound was purified by flash column chromatography on silica gel (hexane/EtOAc = 10:2) to yield **6ia** in 45% yield as a solid: mp 115-116 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ = 10.12 (br s, 1H), 8.85 (dd, *J* = 6.0, 2.8 Hz, 1H), 8.74 (dd, *J* = 4.4, 1.6 Hz, 1H), 8.49 (s, 1H), 8.20 (dd, *J* = 8.4, 2.0 Hz, 1H), 7.92-7.87 (m, 3H), 7.78 (d, *J* = 7.6 Hz, 1H), 7.63-7.61 (m, 2H), 7.47 (dd, *J* = 8.4, 4.4 Hz, 1H), 7.23 (d, *J* = 8.4 Hz, 2H), 2.32 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 164.3, 148.4, 145.0, 140.4, 140.0, 138.3, 137.0, 136.3, 134.1, 130.3, 129.8, 129.6, 128.6, 128.0, 127.3, 126.8, 122.6, 121.8, 117.1, 21.6; MS (DART): *m/z* 471 $[M+H]^+$; HRMS (EI): *m/z* $[M]^+$ Calcd for $C_{24}H_{17}F_3N_2O_3S$ 470.0912; Found 470.0913.

2-(4-(*tert*-Butyl)benzenesulfonyl)-4-(trifluoromethyl)-*N*-(quinolin-8-yl)benzamide (6ie). Following general procedure, the title compound was purified by flash column chromatography on silica gel (hexane/EtOAc = 10:2) to yield **6ie** in 54% yield as a solid: mp 203-204 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ = 10.15 (br s, 1H), 8.86 (dd, *J* = 6.0, 3.2 Hz, 1H), 8.74 (dd, *J* = 4.0, 1.6 Hz, 1H), 8.49 (s, 1H), 8.20 (dd, *J* = 8.4, 1.2 Hz, 1H), 7.94 (d, *J* = 8.0 Hz, 2H), 7.92 (d, *J* = 9.2 Hz, 1H), 7.78 (d, *J* = 8.0 Hz, 1H), 7.63-7.61 (m, 2H), 7.48-7.45 (m, 3H), 1.26 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 164.4, 157.8, 148.5, 140.5, 140.0, 138.4, 136.9, 136.4, 134.1, 132.8, 130.2, 129.6, 128.5, 128.0, 127.3, 126.93, 126.90, 126.3, 122.7, 121.9, 117.2, 35.2, 30.9; MS (DART): *m/z* 513 $[M+H]^+$; HRMS (EI): *m/z* $[M]^+$ Calcd for $C_{27}H_{23}F_3N_2O_3S$ 512.1381; Found 512.1385.

5-Methyl-*N*-(quinolin-8-yl)-2-tosylbenzamide (6fa). Following general procedure, the title compound was purified by flash column chromatography on silica gel (hexane/EtOAc = 10:2) to yield **6fa** in 36% yield as a solid: mp 239-240 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ = 10.03 (br s, 1H), 8.88 (dd, *J* = 7.6, 1.6 Hz, 1H), 8.73 (dd, *J* = 4.4, 1.6 Hz, 1H), 8.18 (dd, *J* = 8.4, 1.6 Hz, 1H), 8.08 (d, *J* = 7.6 Hz, 1H), 7.85 (d, *J* = 8.0 Hz, 2H), 7.63-7.56 (m, 2H), 7.46-7.40 (m, 3H), 7.17 (d, *J* = 7.6 Hz, 2H), 2.44 (s, 3H), 2.30 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 165.8, 148.3, 144.6, 144.0, 138.4, 138.3, 137.0, 136.3, 136.0, 134.4, 130.8, 129.7, 129.5, 129.3, 128.2, 127.9, 127.3, 122.2, 121.6, 117.0, 21.5, 21.4; MS (DART): *m/z* 417 $[M+H]^+$; HRMS (EI): *m/z* $[M]^+$ Calcd for $C_{24}H_{20}N_2O_3S$ 416.1195; Found 416.1194.

***N*-(Quinolin-8-yl)-3-tosyl-2-naphthamide (6ja).** Following general procedure, the title compound was purified by flash column chromatography on silica gel (hexane/EtOAc =

10:2) to yield **6ja** in 33% yield as a solid: mp 261-262 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ = 10.13 (br s, 1H), 8.90 (dd, *J* = 7.2, 1.2 Hz, 1H), 8.87 (s, 1H), 8.71 (dd, *J* = 4.0, 1.2 Hz, 1H), 8.19 (dd, *J* = 8.0, 1.6 Hz, 1H), 8.13 (s, 1H), 8.08-8.06 (m, 1H), 7.95-7.88 (m, 3H), 7.72-7.68 (m, 2H), 7.65-7.57 (m, 2H), 7.45 (dd, *J* = 8.4, 4.0 Hz, 1H), 7.17 (d, *J* = 8.0 Hz, 2H), 2.27 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 165.6, 148.2, 144.0, 138.4, 138.2, 136.2, 136.1, 134.5, 134.4, 132.8, 132.4, 131.8, 129.9, 129.4, 129.3, 129.0, 128.6, 128.4, 128.2, 127.9, 127.3, 122.1, 121.6, 116.9, 21.5; MS (DART): *m/z* 453 $[M+H]^+$; HRMS (EI): *m/z* $[M]^+$ Calcd for $C_{27}H_{20}N_2O_3S$ 452.1195; Found 452.1197.

2-(4-Methoxybenzenesulfonyl)-*N*-(quinolin-8-yl)-1-naphthamide (6gb). Following general procedure, the title compound was purified by flash column chromatography on silica gel (hexane/EtOAc = 10:2) to yield **6gb** in 38% yield as a solid: mp 152-153 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ = 10.16 (s, 1H), 9.13 (dd, *J* = 7.6, 1.2 Hz, 1H), 8.64-8.63 (m, 1H), 8.18 (d, *J* = 8.4 Hz, 1H), 8.13-8.07 (m, 2H), 8.03-7.98 (m, 3H), 7.91 (d, *J* = 7.6 Hz, 1H), 7.70-7.60 (m, 4H), 7.41 (dd, *J* = 8.0, 4.4 Hz, 1H), 6.86 (d, *J* = 9.2 Hz, 2H), 3.75 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 165.2, 163.4, 148.2, 138.4, 136.2, 135.5, 135.4, 135.0, 134.4, 132.8, 130.44, 130.41, 130.1, 129.2, 128.4, 128.1, 128.0, 127.4, 126.7, 123.8, 122.3, 121.7, 117.1, 114.3, 55.5; MS (DART): *m/z* 469 $[M+H]^+$; HRMS (EI): *m/z* $[M]^+$ Calcd for $C_{27}H_{20}N_2O_4S$ 468.1144; Found 468.1141.

3-(4-Methoxybenzenesulfonyl)-*N*-(quinolin-8-yl)-2-naphthamide (6jb). Following general procedure, the title compound was purified by flash column chromatography on silica gel (hexane/EtOAc = 10:2) to yield **6jb** in 45% yield as a solid: mp 217-218 °C; ^{1}H NMR (400 MHz, $CDCl_3$): δ = 10.13 (br s, 1H), 8.92 (dd, *J* = 7.2, 1.2 Hz, 1H), 8.84 (s, 1H), 8.71 (dd, *J* = 4.0, 1.6 Hz, 1H), 8.18 (dd, *J* = 8.0, 1.6 Hz, 1H), 8.12 (s, 1H), 8.07-8.04 (m, 1H), 7.97-7.92 (m, 3H), 7.72-7.68 (m, 2H), 7.65-7.57 (m, 2H), 7.44 (dd, *J* = 8.4, 4.0 Hz, 1H), 6.83 (dd, *J* = 6.8, 2.0 Hz, 2H), 3.71 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$): δ = 165.8, 163.2, 148.3, 138.4, 136.5, 136.2, 134.6, 134.3, 132.8, 132.6, 132.4, 131.6, 130.7, 129.8, 129.3, 129.0, 128.6, 128.2, 127.9, 127.3, 122.1, 121.7, 116.9, 114.0, 55.4; MS (DART): *m/z* 469 $[M+H]^+$; HRMS (EI): *m/z* $[M]^+$ Calcd for $C_{27}H_{20}N_2O_4S$ 468.1144; Found 468.1145.

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Notes and references

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