Metal-Free Synthesis of 2-Substituted (N, O, C) Benzothiazoles via an Intramolecular C−S Bond Formation

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Received December 8, 2009

An efficient, economical, and convenient method was developed for the preparation of 2-substituted (N, O, C) benzothiazoles from *N*′-substituted-*N*-(2-halophenyl)thioureas, *O*′-substituted-*N*-(2-halophenyl) carbamothioates, or *N*-(2-halophenyl) thioamides via a base-promoted cyclization in dioxane without any transition metal. A one-pot variant combining the synthesis of the thiourea and the cyclization was also demonstrated. High yields were obtained, and a variety of functional groups were tolerated under these conditions. Transition-metal-free, mild reactive conditions, wide application scope, and shorter reaction times make this method superior to the reported methods for the synthesis of 2-substituted benzothiazoles and suitable for combinatorial format.

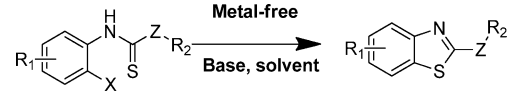
Introduction

In synthetic organic reactions, the scope and application of organosulfur chemistry have increased tremendously since sulfur-containing groups serve as an important auxiliary function in synthetic sequences.[1] And the formation of C−S bonds is one of the most useful and fundamental reactions since it represents a key step in the synthesis of complex molecules. Transition metal-mediated cross-coupling of prefunctionalized substrates is one of the most important synthetic tools for constructing the C−S bonds.[2] Among the various cross-coupling types, *S*-arylation has been a subject of particular interest in recent years. In 1980, Migita et al.[3] first reported the cross-coupling of aryl halides with thiols in the presence of $Pd(PPh_3)_4$ as the catalyst and NaO*t*Bu as a base in ethanol at reflux or dimethyl sulfoxide (DMSO) at 90 °C. Palladium-,[3,4] nickel-,[5] copper-,[6] cobalt-,[7] and iron-[8] based catalytic systems have been studied later by other groups. However, transition metal-based protocols, although successful, usually have some inherent limitations such as moisture sensitivity, costly metal catalysts, and environmental toxicity. Moreover, their separation from polar reaction products, which is of particular importance for the synthesis of pharmaceutical fine chemicals because of their residual toxicity in the target compounds, is a central issue to consider.

Benzothiazoles are a considerably important class of heterocycles in the medicinal area because of their broad range of biological activities.[9] Two common approaches are applied for the construction of 2-substituted benzothiazoles. The first approach used various oxidants, including Jacobson's and Hugershoff's methods via oxidative cyclization of thiobenzanilides.[10] However, using stoichiometric or excess amounts of toxic reagents, such as bromine or metals, is a major drawback of these methods, and low functional group tolerance also have disadvantages. Synthesized via palladium- or copper-catalyzed cyclization of *ortho*-halobenzo-thioureas,[11] or directly functionalized aromatic C−H bonds to construct C−S bonds,[12] provided another access to benzothiazoles. However, these reactions still require large amount of catalyst (typically 1 mol % to 20 mol %) to promote the transformation efficiently. Very recently, the intramolecular nucleophilic aromatic substitution of *o*-halothiobenzanilides (INASOB) promoted by a base was reported by some groups.[13] However, these catalyst-free methods could produce the 2-(alkyl)arylbenzothiazoles only. So there is an urgent need to develop less expensive and easily available catalyst systems for these important heterocycles.

As a part of our ongoing efforts devoted to the synthesis of key core blocks in natural products[14] and the development of environmentally benign processes,[15] we required an efficient method to generate a 2-substituted (N, O, C) benzothiazole based scaffold, with a hope of finding more active hits or leads for our particular biological assays. In this paper, we have developed a novel base-promoted cyclization of *ortho*-haloaryl precursors **1** through a C−S bond formation process, leading to a broad range of 2-substituted benzothiazoles **2** (Scheme 1). Yields were generally good to high for this cyclization, and good functional group tolerance was observed using our catalyst

Scheme 1. Synthesis of 2-Substituted Benzothiazoles via a Base-Promoted Cyclization



1 X = I, Br; Z = N, C, O — **2**

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10.1021/cc9001839
Published on Web 04/09/2010

Scheme 2. Synthesis of Cyclization Precursors **1** from *ortho*-Haloaryl Isothiocyanates **3**

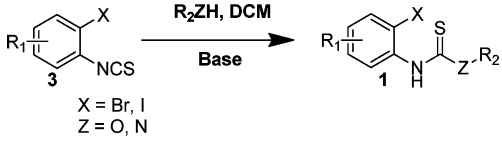
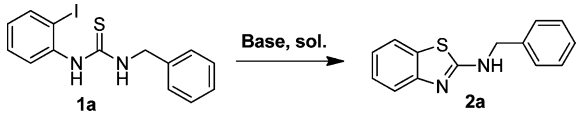


Table 1. Optimization of the Reaction Conditions[a]



entry	base	solvent	time (h)	temperature (°C)	yield of **2a** (%)[b]
1	Na_2CO_3	DME	2	130	45
2	K_2CO_3	DME	2	130	79
3	NaOH	DME	2	130	10
4	Cs_2CO_3	DME	2	130	84
5	DBU	DME	2	130	30
6	Cs_2CO_3	dioxane	2	130	89
7	Cs_2CO_3	DMF	2	130	85
8	Cs_2CO_3	DMSO	2	130	81
9	Cs_2CO_3	toluene	2	130	85
10	Cs_2CO_3	NMP	2	130	78
11	Cs_2CO_3	dioxane	1	130	65
12	Cs_2CO_3	dioxane	0.5	130	35
13	Cs_2CO_3	dioxane	2	140	79
14	Cs_2CO_3	dioxane	2	100	Trace
15	Cs_2CO_3[c]	dioxane	2	130	65

[a] Reaction conditions: **1a** (0.2 mmol), base (0.4 mmol), solvent (2 mL). [b] Yield of isolated products. [c] 0.2 mmol Cs_2CO_3 was used as the base.

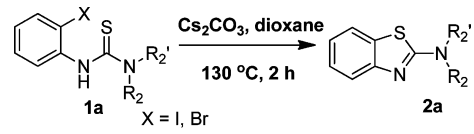
system. Indeed, the method developed here represents a rare example of C—S bond formation under transition metal-free reaction conditions with competitive yields when compared with its catalyzed versions.[3−8]

Results and Discussion

The requisite cyclization precursors *N*′-substituted-*N*-(2-halophenyl)ureas or *O*′-substituted-*N*-(2-halophenyl) carbamothioate **1** are readily synthesized from *ortho*-haloaryl isothiocyanates **3**[9b,16] through reactions with base and different kinds of amines and alcohols in dichloromethane (Scheme 2). The desired products were obtained in less than 20 min, in quantitative yields. The *N*-(2-halophenyl) thioamides are readily synthesized according to the relevant literature.[17]

1-Benzyl-3-(2-iodophenyl)thiourea **1a** was first used as a model substrate to optimize the reaction conditions, including different bases, various solvents, reaction temperatures, and reaction times. The results are shown in Table 1. Intramolecular cyclization of **1a** was investigated using 1,2-dimethoxyethane (DME) as the solvent, at 130 °C for 2 h with various bases, including inorganic bases Na_2CO_3, K_2CO_3, NaOH, Cs_2CO_3, and organic base 1,8-diazabicyclo[5.4.0]undec-7-ene (DBU). Good conversion of **1a** to *N*-benzylbenzothiazol-2-amine **2a** was observed with K_2CO_3 and Cs_2CO_3, with Cs_2CO_3 being superior in 84% yield (Table 1, entries 1−5). Encouraged by this result, we further examined this reaction using Cs_2CO_3 as the base. Dioxane proved to be best among an array of solvents tested (Table 1, entries 5−10). Reduced reaction time led to a significant decrease in reaction yields (Table 1, entries 11 and 12) and no improvement was observed when the temperature was further increased or decreased (Table 1, entries 13 and 14). Essentially, no satisfactory results were obtained when a smaller amount of Cs_2CO_3 was used in this cyclization (Table 1, entry 15). In these cases, only *N*-benzylbenzothiazol-2-amine **2a** resulting from cyclization through C—S bond formation was observed, with no evidence for the formation of 1-benzyl-1*H*-benzoimidazole-2(3*H*)-thione that would form from cyclization through the nitrogen atom.[18]

Table 2. Synthesis of 2-Amino-Benzothiazoles via a Base-Promoted Cyclization[a]

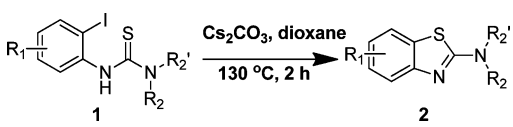


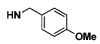
Entry	NR_2R_2'	Product	Yield (%)[b]	Entry	NR_2R_2'	Product	Yield (%)[b]
1		**2a**	89/67[c]	9		**2i**	65[d]
2		**2b**	91/66[c]	10		**2j**	82
3		**2c**	88/56[c]	11		**2k**	89
4		**2d**	90	12		**2l**	91/64[c]
5		**2e**	84	13		**2m**	92
6		**2f**	83/63[c]	14		**2n**	90
7		**2g**	80	15		**2o**	91
8		**2h**	25/60[d]	16		**2p**	92

[a] Reaction conditions: **1** (0.2 mmol), base (0.4 mmol), dioxane (2 mL), 130 °C, 2 h, X = I. [b] Yield of isolated products. [c] X = Br, at 140 °C. [d] Reaction time prolonged to 10 h.

After determining the optimized conditions (1.0 equiv of *ortho*-haloaryl precursors **1**, 2.0 equiv of Cs_2CO_3, in dioxane at 130 °C for 2 h), we next examined the generality of the process. First, we demonstrated that a variety of *N*′-substituted-*N*-(2-halophenyl)thioureas, including primary and secondary *N*′-substituted ureas could provide the desired products **2a**−**2p** in moderate to good yields (56−92%) (Table 2, entries 1−16). We were pleased to find that the electronic nature of the benzylamine seems to have little influence on the reaction, which is evident from the fact that both the electron-rich (Table 2, entries 2−4) and the electron-deficient (Table 2, entries 5 and 6) benzylamines gave satisfactory results. Comparatively, desired product could be obtained in low yield (25%) by reacting 1-(2-iodophenyl)-3-phenyl-thiourea **1h** under essentially the same conditions as above, prolonging the reation time to 10 h to give a moderate yield (60%). Moreover, under the optimized conditions, **1g** and **1i** selected for this study gave strong evidence to suggest that this base-promoted coupling reaction tolerates *N*′-heterocyclic groups **2g** and **2i** (Table 2, entries 7 and 9). In the case of *N*,*N*′,*N*′-trisubstituted thioureas, excellent yields (>89%) were obtained under these base-promoted coupling reaction conditions (Table 2, entries 11−16), which was consistent with the order reported previously.[11d] It is noteworthy that the coupling of **1n** furnished the expected product **2n** in 90% isolated yield, in

Table 3. Synthesis of Various 2-Amino-Benzothiazoles[a]



Entry	R_1	NR_2R_2'	Product	Yield(%)[b]
1	4-F		**2q**	89
2	5-Cl		**2r**	81
3	5-OMe		**2s**	85
4	4-F		**2t**	85
5	5Cl		**2u**	82
6	5-OMe		**2v**	84
7	4-CF_3		**2w**	86
8	4-F		**2x**	93
9	5-Cl		**2y**	89
10	5-OMe		**2z**	91
11	5-CF3		**2aa**	91

[a] Reaction conditions: **1** (0.2 mmol), Cs_2CO_3 (0.4 mmol), dioxane (2 mL), 130 °C, 2 h. [b] Yield of isolated products.

which the ester group was well tolerated during the reaction (Table 2, entry 14). The reaction also works with *ortho*-bromoaryl precursors, giving somewhat lower yields than the reactions from the *ortho*-iodoaryl precursors (Table 2, entries 1, 2, 3, 6, and 12).

Prompted by the successful synthesis of 2-amino-benzothiazoles **2a**−**2p**, we then investigated the scope of the process with respect to the aryl substitutents of *N*′-substituted-*N*-(2-halophenyl)thioureas. We found that both the electron-donating methoxy substituent and the electron-withdrawing fluoro or trifluoromethyl groups could be readily incorporated, and good yields of the desired products **2q-2aa** were obtained (Table 3, entries 1−11).

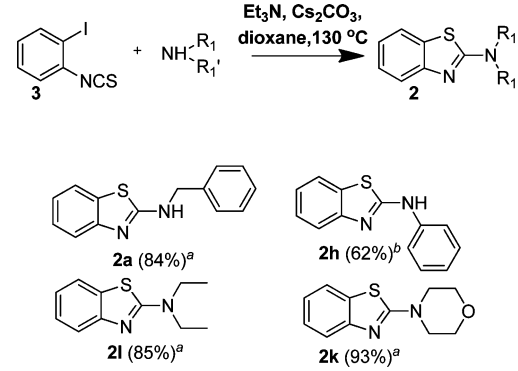
During the preparation of this manuscript, Li et al. reported a direct strategy to 2-aminobenzothiazoles via an iron-catalyzed tandem reaction from 2-halobenzenamines with isothiocyanates.[19] To our delight, results for the application of our metal free conditions in one pot for various substrates (*N*′-aryl, alkyl and benzyl) were also obtained in moderate to good yields (Scheme 3).

Finally, we focused our attention on employing *O*′-substituted-*N*-(2-halophenyl) carbamothioate and *N*-(2-halophenyl) thioamides as the substrates. In these cases, the base-promoted coupling reaction proceeded smoothly at 80 and 115 °C, respectively. Under these reaction conditions, a number of 2-substituted (aryl, alkyl, and ether) precursors **1** were applied, and they all gave the corresponding 2-substituted-benzothiazoles **2** in good yields (**2ab**-**2ah**), thereby providing an alternative route for the synthesis of these heterocyclic compounds (Schemes 4).

Conclusion

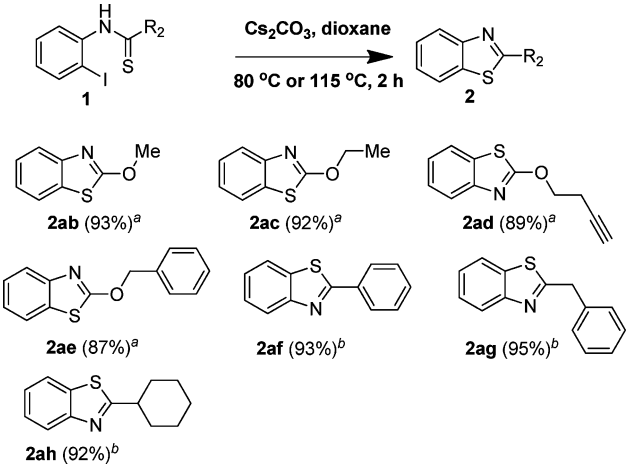
In conclusion, we have developed a novel protocol for the elaboration of 2-substituted (N, O, C) benzothiazoles via a base-promoted intramolecular C−S bond coupling cyclization without any transition metal. This method enables the use of a wide range of *ortho*-haloaryl isothiocyanates and amines or alcohols to assemble various products in moderate to good yields. In this regard, this approach would be particularly suitable for library synthesis in drug discovery efforts.

Scheme 3. Tandem Reaction in One Pot



[a] Reagent and conditions: **3** (0.1 mmol), benylamine (0.1 mmol), and Et_3N (0.2 mmol) in dioxane (2 mL), rt, 5 min; then Cs_2CO_3 (0.2 mmol) was added, the vial was sealed and heated at 130 °C for 2 h. [b] Reaction time prolonged to 10 h.

Scheme 4. Synthesis of Various 2-Substituted Benzothiazoles



[a] Reaction conditions: **1** (0.2 mmol), Cs_2CO_3 (0.4 mmol), dioxane (2 mL), 80 °C, 2 h. [b] Reaction conditions: **1** (0.2 mmol), Cs_2CO_3 (0.4 mmol), dioxane (2 mL), 115 °C, 2 h.

Experimental Section

General Procedure for Synthesis of *N*′-substituted-*N*-(2-halo-phenyl)thioureas (Method 1) and *O*′-substituted-*N*-(2-halophenyl) Carbamothioate (Method 2). Method 1. To a solution of amine (0.5 mmol) and triethylamine (TEA) (0.5 mmol) in CH_2Cl_2 (5 mL) at room temperature (rt), *ortho*-haloaryl isothiocyanates **3** (0.5 mmol) was added. The reaction was monitored with thin-layer chromatography (TLC), and then the reaction mixture was concentrated in vacuo. The desired products were obtained in high yields and purity without further purification.

Method 2. To a solution of alcohol (0.5 mmol) and NaH (0.5 mmol) in CH_2Cl_2 (5 mL) at 0 °C, *ortho*-haloaryl isothiocyanate **3** (0.5 mmol) was added dropwise. After the starting materials were completely reacted, the reaction mixture was diluted with CH_2Cl_2, washed with water, and saturated brine, and dried with anhydrous Na_2SO_4. The solvent was evaporated under reduced pressure, and the

residue was purified by flash column chromatography (petroleum ether/ethyl acetate = 20/1) to yield the expected product.

General Procedure for Synthesis of 2-Substituted Benzothiazoles 2. To a solution of *N*′-substituted-*N*-(2-halophenyl) thiourea (0.5 mmol) in dioxane (2 mL), Cs_2CO_3 (1.0 mmol) was added. The vial was sealed, and this mixture was then heated in an oil bath and stirred at 130 °C for 2 h (for *C*′ and *O*′-substituted at 115 and 80 °C, respectively). The cold mixture was diluted with CH_2Cl_2, washed with water, and brine, and dried with anhydrous Na_2SO_4. The solvent was then concentrated in vacuum. The residue was purified by flash column chromatography to yield the expected products **2a**−**2ah**.

General Procedure for the Tandem Reaction in One Pot. To a solution of 1-iodo-2-isothiocyanatobenzene **3** (0.1 mmol) and amine (0.1 mmol) in dioxane (2 mL), TEA (0.2 mmol) was added. After being stirred at rt for 5 min, Cs_2CO_3 (0.2 mmol) was added, then the vial was sealed and the mixture was heated in an oil bath and stirred at 130 °C for 2 h. The cold mixture was diluted with CH_2Cl_2, washed with water, and brine, and dried with anhydrous Na_2SO_4 and concentrated in vacuum. The residue was purified by flash column chromatography to yield the expected products.

***N*-benzylbenzothiazol-2-amine (2a).** Compound **2a** was obtained as a white solid after the purification by flash chromatography (petroleum ether/ethyl acetate = 8/1). ^{1}H NMR (300 MHz, $CDCl_3$, ppm) δ 4.64 (s, 2H), 7.08 (t, J = 7.2 Hz, 1H), 7.25−7.28 (m, 1H), 7.30−7.40 (m, 5H), 7.43 (d, J = 3.9 Hz, 1H), 7.58 (d, J = 4.5 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 49.4, 118.8, 120.8, 121.5, 125.9, 127.6, 127.8, 128.8(2ArCH), 130.3(2ArCH), 137.4, 152.2, 167.7; EI-MS *m*/*z* (M^+) 240; EI-HRMS calcd. For $C_{14}H_{12}N_2S$ (M^+) calcd. 240.0721, found 240.0719.

***N*-(4-methoxybenzyl)benzothiazol-2-amine (2b).** Compound **2b** was obtained as a white solid after the purification by flash chromatography (petroleum ether/ethyl acetate = 8/1). ^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 3.80 (s, 3H), 4.56 (s, 2H), 6.88 (d, J = 8.4 Hz, 2H), 7.09 (t, J = 6.4 Hz, 1H), 7.27 (t, J = 6.8 Hz, 1H), 7.31 (d, J = 8.4 Hz, 2H), 7.50 (d, J = 8 Hz, 1H), 7.57 (dd, J = 7.6 Hz, 0.4 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 48.9, 55.3, 114.2(2ArCH), 118.7, 120.9, 121.7, 126.1, 129.1, 129.2, 130.0(2ArCH), 151.6, 159.3, 167.4; EI-MS *m*/*z* (M^+) 270; EI-HRMS calcd. For $C_{15}H_{14}N_2OS$ (M^+) 270.0827, found 270.0832.

***N*-(3-methoxybenzyl)benzothiazol-2-amine (2c).** Compound **2c** was obtained as a white solid after the purification by flash chromatography (petroleum ether/ethyl acetate = 8/1). ^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 3.78 (s, 3H), 4.59 (s, 2H), 6.85 (dd, J = 8 Hz, 2 Hz, 1H), 6.94 (s, 1H), 6.97 (d, J = 7.6 Hz, 1H), 7.13 (t, J = 8 Hz, 1H), 7.27 (t, J = 8 Hz, 1H), 7.32 (d, J = 8 Hz, 1H), 7.49 (d, J = 8 Hz, 1H), 7.55 (dd, J = 8 Hz, 0.8 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 49.7, 55.2, 113.1, 113.5, 117.7, 119.8, 121.1, 122.3, 126.6, 128.2, 129.9, 138.0, 148.6, 160.0, 168.3; EI-MS *m*/*z* (M^+) 270; EI-HRMS calcd. For $C_{15}H_{14}N_2OS$ (M^+) 270.0827, found 270.0832.

***N*-(2-methoxybenzyl)benzothiazol-2-amine (2d).** Compound **2d** was obtained as a white solid after the purification by flash chromatography (petroleum ether/ethyl acetate = 8/1). ^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 3.87 (s, 3H), 4.59 (s, 2H), 6.90 (d, J = 8.8 Hz, 1H), 6.94 (d, J = 7.2 Hz, 1H), 7.09 (t, J = 7.6 Hz, 1H), 7.29 (t, J = 7.6 Hz, 1H), 7.35 (d, J = 7.6 Hz. 1H), 7.51 (d, J = 8 Hz, 1H), 7.56 (d, J = 7.6 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 45.8, 55.3, 110.4, 118.1, 120.5, 120.9, 121.9, 124.9, 126.2, 129.0, 129.4, 129.5, 150.0, 157.5, 168.0; EI-MS *m*/*z* (M^+) 270; EI-HRMS calcd. For $C_{15}H_{14}N_2OS$ (M^+) 270.0827, found 270.0832.

***N*-(3-(trifluoromethyl)benzyl)benzothiazol-2-amine (2e).** Compound **2e** was obtained as a white solid after the purification by flash chromatography (petroleum ether/ethyl acetate = 8/1). ^{1}H NMR (300 MHz, $CDCl_3$, ppm) δ 4.73 (s, 2H), 7.12 (t, J = 7.5 Hz, 1H), 7.31 (t, J = 7.5 Hz, 1H), 7.46−7.66 (m, 6H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 48.7, 119.0, 120.9, 122.0, 124.35, and 124.39 (J_{C-F}, 3.7 Hz), 124.70 and 124.73 (J_{C-F}, 3.5 Hz), 126.2, 129.3, 130.2, 130.9, 138.5, 151.7, 167.1; EI-MS *m*/*z* (M^+) 308; EI-HRMS calcd. For $C_{15}H_{11}F_3N_2S$ (M^+) 308.0595, found 308.0586.

***N*-(4-fluorobenzyl)benzothiazol-2-amine (2f).** Compound **2f** was obtained as a white solid after the purification by flash chromatography (petroleum ether/ethyl acetate = 8/1). ^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 4.61 (s, 2H), 7.04 (td, J = 6.8,Hz, 2 Hz, 2H), 7.10 (td, J = 8 Hz, 1.6 Hz, 1H), 7.29 (td, J = 8 Hz, 0.9 Hz, 1H), 7.35−7.39 (m, 2H), 7.49 (dd, J = 8 Hz, 0.4 Hz, 1H), 7.58 (dd, J = 8 Hz, 0.8 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ48.6, 115.59, and 115.80 (2ArCH, J_{C-F}, 21.4 Hz), 118.9, 120.9, 121.8, 126.1, 129.33, and 129.41 (2ArCH, J_{C-F}, 8.1 Hz), 130.2, 133.1, 151.8, 161.16, and 163.61 (J_{C-F}, 245 Hz), 167.3; EI-MS *m*/*z* (M^+) 258; EI-HRMS calcd. For $C_{14}H_{11}FN_2S$ (M^+) 258.0627, found 258.0624.

***N*-(pyridin-4-ylmethyl)benzothiazol-2-amine (2g).** Compound **2g** was obtained as a white solid after the purification by flash chromatography (petroleum ether/ethyl acetate = 8/1). ^{1}H NMR (300 MHz, $CDCl_3$, ppm) δ 4.71 (s, 2H), 7.12 (t, J = 7.5 Hz, 1H), 7.28−7.34 (m, 3H), 7.51 (d, J = 8.4 Hz, 1H), 7.59 (d, 7.5 Hz), 8.58 (br, 2H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 47.8, 119.1, 120.9, 122.1, 122.2(2ArCH), 126.2, 130.3, 147.0, 150.0, 151.8(2ArCH), 167.1; EI-MS *m*/*z* (M^+) 241; EI-HRMS calcd. For $C_{13}H_{11}N_3S$ (M^+) 241.0674, found 241.0683.

***N*-phenylbenzothiazol-2-amine (2h).** Compound **2h** was obtained as a white solid after the purification by flash chromatography (petroleum ether/ethyl acetate = 8/1). ^{1}H NMR (300 MHz, $CDCl_3$, ppm) δ 7.14−7.20 (m, 2H), 7.34 (t, J = 7.2 Hz, 1H), 7.39−7.44 (m, 2H), 7.52 (d, J = 8.1 Hz, 2H), 7.60 (d, J = 7.8 Hz, 1H), 7.64 (d, J = 7.8 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 119.4, 120.2(2ArCH), 120.8, 122.4, 124.4, 126.1, 129.6, 129.9(2ArCH), 139.8, 151.3, 164.6; EI-MS *m*/*z* (M^+) 226; EI-HRMS calcd. For $C_{13}H_{10}N_2S$ (M^+) 226.0565, found 226.0568.

***N*-(thiazol-2-yl)benzothiazol-2-amine (2i).** Compound **2i** was obtained as a yellow solid after the purification by flash chromatography (petroleum ether/ethyl acetate = 8/1). ^{1}H NMR (300 MHz, DMSO-d_6, ppm) δ 7.12 (d, J = 3.6 Hz,1H), 7.20 (td, J = 7.5 Hz, 1.2 Hz, 1H), 7.43 (d, J = 3.6 Hz, 1H), 7.58 (d, J = 8.1 Hz, 1H), 7.84 (d, J = 7.5 Hz, 1H), 12.46 (br, 1H); ^{13}C NMR (100 MHz, DMSO-d_6, ppm) δ 111.7,

121.8, 122.6(2ArCH), 126.2, 130.3, 161.6; ESI-MS *m/z* $[M+H]^+$ 234; HRMS (ESI) calcd for $C_{10}H_8N_3S_2$ $[M+H]^+$ 234.0160 found 234.0165.

***N*-butylbenzothiazol-2-amine (2j).** Compound **2j** was obtained as a white solid after the purification by flash chromatography (petroleum ether/ethyl acetate = 8/1). ^{1}H NMR (300 MHz, $CDCl_3$, ppm) δ 0.96 (t, J = 7.2 Hz, 3H), 1.37−1.48 (m, 2H), 1.61−1.73 (m, 2H), 3.41 (t, J = 7.2 Hz, 2H), 7.07 (t, J = 7.8 Hz, 1H), 7.29 (t, J = 7.5 Hz, 1H), 7.52 (d, J = 8.1 Hz, 1H), 7.59 (d, J = 7.8 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 13.7, 20.0, 31.6, 45.4, 118.5, 120.8, 121.3, 125.9, 130.2, 152.4, 168.0; EI-MS *m/z* (M^+) 206; EI-HRMS calcd. For $C_{11}H_{14}N_2S$ (M^+) 206.0878, found 206.0883.

***N*,*N*-diethylbenzothiazol-2-amine (2k).** Compound **2k** was obtained as a white solid after the purification by flash chromatography (petroleum ether/ethyl acetate = 8/1). ^{1}H NMR (300 MHz, $CDCl_3$, ppm) δ 1.29 (t, J = 7.2 Hz, 6H), 3.57 (q, J = 7.2 Hz, 4H), 7.02 (td, J = 7.8 Hz, 1.2 Hz, 1H), 7.26 (td, J = 7.5 Hz, 1.2 Hz, 1H), 7.53 (d, J = 7.8 Hz, 1H), 7.57 (dd, J = 7.5 Hz, 0.9 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 12.8($2CH_3$), 45.3($2CH_2$), 118.5, 120.5, 120.7, 125.8, 130.6, 153.3, 167.3; EI-MS *m/z* (M^+) 206; EI-HRMS calcd. For $C_{11}H_{14}N_2S$ (M^+) 206.0878, found 206.0881.

4-(Benzothiazol-2-yl)morpholine (2l). Compound **2l** was obtained as a white solid after the purification by flash chromatography (petroleum ether/ethyl acetate =1/1). ^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 3.62 (t, J = 4.8 Hz, 4H), 3.84 (t, J = 4.8 Hz, 4H), 7.10 (dd, J = 8.4 Hz, 0.8 Hz, 1H), 7.31 (dd, J = 8.4 Hz, 0.8 Hz, 1H), 7.57 (d, J = 8 Hz, 1H), 7.61 (d, J = 7.6 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ48.5($2CH_2$), 66.2($2CH_2$), 119.3, 120.8, 121.7, 126.1, 130.6, 152.5; EI-MS *m/z* (M^+) 220; EI-HRMS calcd. For $C_{11}H_{12}N_2OS$ (M^+) 220.0670, found 220.0668.

2-(Piperidin-1-yl)benzothiazole (2m). Compound **2m** was obtained as a white solid after the purification by flash chromatography (petroleum ether/ethyl acetate = 8/1). ^{1}H NMR (300 MHz, $CDCl_3$, ppm) δ 1.69 (br, 6H), 3.59 (br, 4H), 7.04 (dd, J = 7.8 Hz, 1.2 Hz, 1H), 7.27 (dd, J = 7.8 Hz, 0.9 Hz, 1H), 7.53 (dd, J = 8.1 Hz, 0.6 Hz, 1H), 7.57 (dd, J = 7.8 Hz, 0.6 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 24.2, 25.3($2CH_2$), 49.6($2CH_2$), 118.7, 120.5, 121.0, 125.8, 130.6, 152.9, 168.9; EI-MS *m/z* (M^+) 218; EI-HRMS calcd. For $C_{12}H_{14}N_2S$ (M^+) 218.0878, found 218.0871.

Ethyl 1-(Benzothiazol-2-yl)piperidine-4-carboxylate (2n). Compound **2n** was obtained as a white solid after the purification by flash chromatography (petroleum ether/ethyl acetate = 8/1). ^{1}H NMR (300 MHz, $CDCl_3$, ppm) δ 1.27 (t, J = 7.2 Hz, 3H), 1.82−1.92 (m, 2H), 2.02−2.07 (m, 2H), 2.53−2.58 (m, 1H), 3.19−3.28 (m, 2H), 4.05−4.13 (m, 2H), 4.16 (q, J = 7.2 Hz, 2H), 7.07 (td, J = 7.8 Hz, 0.9 Hz, 1H), 7.29 (td, J = 7.5 Hz, 1.5 Hz, 1H), 7.55 (d, J = 8.1 Hz, 1H), 7.59 (d, J = 7.8 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 14.1, 27.4($2CH_2$), 40.8, 47.9($2CH_2$), 60.6, 118.9, 120.6, 121.3, 125.9, 130.7, 152.7, 168.6, 174.0; EI-MS *m/z* (M^+) 290; EI-HRMS calcd. For $C_{15}H_{18}N_2O_2S$ (M^+) 290.1089, found 290.1082.

2-(4-Phenylpiperazin-1-yl)benzothiazole (2o). Compound **2o** was obtained as a white solid after the purification by flash chromatography (petroleum ether/ethyl acetate = 8/1). ^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 3.33 (t, J = 5.2 Hz, 4H), 3.81 (t, J = 5.2 Hz, 4H), 6.93 (t, J = 7.2 Hz, 1H), 6.98 (d, J = 8 Hz, 2H), 7.10 (td, J = 8 Hz, 1.2 Hz, 1H), 7.30−7.34 (m, 3H), 7.58 (d, J = 8 Hz, 1H), 7.62 (dd, J = 8 Hz, 0.8 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 48.3($2CH_2$), 49.1($2CH_2$), 116.9(2ArCH), 119.2, 120.7, 120.8, 121.6, 126.1, 129.3(2ArCH), 130.7, 151.0, 152.6, 168.7; EI-MS *m/z* (M^+) 295; EI-HRMS calcd. For $C_{17}H_{17}N_3S$ (M^+) 295.1143, found 295.1135.

2-(Pyrrolidin-1-yl)benzothiazole (2p). Compound **2p** was obtained as a white solid after the purification by flash chromatography (petroleum ether/ethyl acetate = 8/1). ^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 2.07−2.09 (m, 4H), 3.57−3.61 (m, 4H), 7.04 (dd, J = 8 Hz, 1.2 Hz, 1H), 7.28 (dd, J = 8 Hz, 1.2 Hz, 1H), 7.58 (d, J = 8 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 25.6($2CH_2$), 49.5($2CH_2$), 118.6, 120.6(2ArCH), 125.9, 130.6, 153.1, 165.4; EI-MS *m/z* (M^+) 204; EI-HRMS calcd. For $C_{11}H_{12}N_2S$ (M^+) 204.0721, found 204.0724.

***N*-benzyl-6-fluorobenzo[*d*]thiazol-2-amine (2q).** Compound **2q** was obtained as a white solid after the purification by flash chromatography (petroleum ether/ethyl acetate = 8/1). ^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 4.63 (s, 2H), 5.67 (br, 1H), 7.02 (td, J = 9.2 Hz, 2.8 Hz, 1H), 7.28 (dd, J = 8 Hz, 2.4 Hz, 1H), 7.30−7.41 (m, 5H), 7.44 (dd, J = 8.8 Hz, 4.8 Hz, 1H; ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 49.3, 107.44, and 107.71 (J_{C-F}, 25.4 Hz), 113.51 and 113.75 (J_{C-F}, 23.6 Hz), 119.39 and 119.48 (J_{C-F}, 8.6 Hz), 127.7(2ArCH), 128.0, 128.9(2ArCH), 131.15 and 131.25 (J_{C-F}, 10.9 Hz), 137.3, 148.7, 157.1 and 159.5(J_{C-F}, 238.7 Hz), 166.6; EI-MS *m/z* (M+) 258; EI-HRMS calcd. For $C_{14}H_{11}FN_2S$ (M+) 258.0627, found 258.0628.

Ethyl 4-(2-Methyl-3-oxo-2*H*-1,4-benzoxazin-4(3*H*)-yl)-benzoate (2r). Compound **2r** was obtained as a white solid after the purification by flash chromatography (petroleum ether/ethyl acetate = 8/1). ^{1}H NMR (300 MHz, $CDCl_3$, ppm) δ 4.63 (s, 2H), 7.06 (dd, J = 8.4 Hz, 1.8 Hz, 1H), 7.31−7.42 (m, 5H), 7.46 (d, J = 4.2 Hz, 1H), 7.48 (d, J = 1.8 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 49.4, 119.0, 121.4, 121.8, 127.5, 127.7, 128.0, 128.7, 128.9, 131.9(2ArCH), 137.0, 153.3, 168.5; EI-MS *m/z* (M^+) 274; EI-HRMS calcd. For $C_{14}H_{11}ClN_2S$ (M^+) 274.0331, found 274.0333.

***N*-benzyl-5-methoxybenzothiazol-2-amine (2s).** Compound **2s** was obtained as a white solid after the purification by flash chromatography (petroleum ether/ethyl acetate = 8/1). ^{1}H NMR (300 MHz, $CDCl_3$, ppm) δ 3.76 (s, 3H), 4.61 (s, 2H), 6.71 (dd, J = 8.4 Hz, 2.1 Hz, 1H), 7.04 (d, J = 2.4 Hz, 1H), 7.30−7.42 (m, 6H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 49.4, 55.4, 103.0, 110.1, 121.0, 121.4, 127.5(2ArCH), 127.8, 128.7(2ArCH), 137.3, 153.0, 159.0, 169.5; EI-MS *m/z* (M^+) 270; EI-HRMS calcd. For $C_{15}H_{14}N_2OS$ (M^+) 270.0827, found 270.0830.

6-Fluoro-*N*-(4-methoxybenzyl)benzothiazol-2-amine (2t). Compound **2t** was obtained as a white solid after the purification by flash chromatography (petroleum ether/ethyl acetate = 8/1). ^{1}H NMR (300 MHz, $CDCl_3$, ppm) δ 3.81 (s, 3H), 4.55 (s, 2H), 5.66 (br, 1H), 6.90 (d, J = 8.7 Hz, 2H), 7.01 (td, J = 9 Hz, 2.4 Hz, 1H), 7.26 (d, J = 2.4 Hz, 1H),

7.32 (d, $J = 8.7$ Hz, 2H), 7.43 (dd, $J = 8.4$ Hz, 4.8 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 48.8, 55.3, 107.42, and 107.69 (J_{C-F}, 26.9 Hz), 113.47 and 113.71 (J_{C-F}, 23.6 Hz), 114.2(2ArCH), 119.31 and 119.40 (J_{C-F}, 8.7 Hz), 129.1(2ArCH), 129.2, 131.1, 148.7, 157.07, and 159.35 (J_{C-F}, 227.1 Hz), 159.5, 166.6; EI-MS m/z (M^+) 288; EI-HRMS calcd. For $C_{15}H_{13}FN_2OS$ (M^+) 288.0733, found 288.0731.

5-Chloro-*N*-(4-methoxybenzyl)benzothiazol-2-amine (2u). Compound **2u** was obtained as a white solid after the purification by flash chromatography (petroleum ether/ethyl acetate = 8/1). ^{1}H NMR (300 MHz, $CDCl_3$, ppm) δ 3.81 (s, 3H), 4.54 (s, 2H), 6.90 (d, $J = 8.7$ Hz, 2H), 7.04 (dd, $J = 8.4$ Hz, 1.8 Hz, 1H), 7.32 (d, $J = 8.4$ Hz, 2H), 7.39 (d, $J = 2.1$ Hz, 1H), 7.45 (d, $J = 8.4$ Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 49.2, 55.3, 114.3(2ArCH), 118.6, 121.4, 121.8, 128.0, 128.6, 129.1(2ArCH), 131.9, 152.7, 159.4, 169.4; EI-MS m/z (M^+) 304; EI-HRMS calcd. For $C_{15}H_{13}ClN_2OS$ (M^+) 304.0437, found 304.0425.

5-Methoxy-*N*-(4-methoxybenzyl)benzothiazol-2-amine (2v). Compound **2v** was obtained as a white solid after the purification by flash chromatography (petroleum ether/ethyl acetate = 8/1). ^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 3.81 (s, 3H), 3.83 (s, 3H), 4.55 (s, 2H), 5.73 (br, 1H), 6.72 (dd, $J = 8.7$ Hz, 2.4 Hz, 1H), 6.89 (dt, $J = 8.7$ Hz, 2.7 Hz, 2H), 7.10 (d, $J = 2.1$ Hz, 1H), 7.31 (dt, $J = 8.7$ Hz, 3 Hz, 2H), 7.42 (d, $J = 9$ Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 48.8, 55.3, 55.5, 103.4, 110.1, 114.2(2ArCH), 121.0, 121.9, 129.1(2ArCH), 129.4, 153.5, 159.0, 159.3, 168.5; EI-MS m/z (M^+) 300; EI-HRMS calcd. For $C_{16}H_{16}N_2O_2S$ (M^+) 300.0932, found 300.0927.

***N*-(4-methoxybenzyl)-6-(trifluoromethyl)benzothiazol-2-amine (2w).** Compound **2w** was obtained as a white solid after the purification by flash chromatography (petroleum ether/ethyl acetate = 8/1). ^{1}H NMR (300 MHz, $CDCl_3$, ppm) δ 3.50 (s, 1H), 3.81 (s, 3H), 4.58 (s, 2H), 6.90 (d, $J = 8.4$ Hz, 2H), 7.32 (d, $J = 9$ Hz, 2H), 7.51−7.52 (m, 2H), 7.84 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 49.0, 55.3, 114.3(2ArCH), 118.28 and 118.57 (J_{C-F}, 29.6 Hz), 123.12 and 123.29 (2ArCH, J_{C-F}, 16 Hz), 128.7, 129.1(2ArCH), 130.5, 154.7, 159.5, 169.2; EI-MS m/z (M^+) 338; EI-HRMS calcd. For $C_{16}H_{13}F_3N_2OS$ (M^+) 338.0701, found 338.0703.

4-(6-Fluorobenzothiazol-2-yl)morpholine (2x). Compound **2x** was obtained as a white solid after the purification by flash chromatography (petroleum ether/ethyl acetate = 8/1). ^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 3.58−3.61 (m, 4H), 3.82−3.86 (m, 4H), 7.03 (td, $J = 9.3$ Hz, 2.4 Hz, 1H), 7.32 (dd, $J = 7.8$ Hz, 2.7 Hz, 1H), 7.49 (dd, $J = 9$ Hz, 2.1 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 48.4($2CH_2$), 66.2($2CH_2$), 107.36 and 107.63 (J_{C-F}, 26.8 Hz), 113.66 and 113.90 (J_{C-F}, 23.8 Hz), 119.69 and 119.78 (J_{C-F}, 8.8 Hz), 128.8, 148.9, 157.02, and 159.41 (J_{C-F}, 238.2 Hz), 159.4, 168.6; EI-MS m/z (M^+) 238; EI-HRMS calcd. For $C_{11}H_{11}FN_2OS$ (M^+) 238.0576, found 238.0568.

4-(5-Chlorobenzo[*d*]thiazol-2-yl)morpholine (2y). Compound **2y** was obtained as a white solid after the purification by flash chromatography (petroleum ether/ethyl acetate = 8/1). ^{1}H NMR (400 MHz, $CDCl_3$, ppm) δ 3.61 (t, $J = 4.8$ Hz, 4H), 3.82 (t, $J = 4.8$ Hz, 4H), 7.05 (dd, $J = 8.8$ Hz, 2 Hz, 1H), 7.48 (d, $J = 8.4$ Hz, 1H), 7.53 (d, $J = 2$ Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 48.4($2CH_2$), 66.1($2CH_2$), 119.2, 121.3, 121.7, 128.7, 131.9, 153.5, 170.0; EI-MS m/z (M^+) 254; EI-HRMS calcd. For $C_{11}H_{11}ClN_2OS$ (M^+) 254.0281, found 254.0289.

4-(5-Methoxybenzothiazol-2-yl)morpholine (2z). Compound **2z** was obtained as a white solid after the purification by flash chromatography (petroleum ether/ethyl acetate = 8/1). ^{1}H NMR (300 MHz, $CDCl_3$, ppm) δ 3.60 (t, $J = 5.1$ Hz, 4H), 3.81−3.84 (m, 7H), 6.73 (dd, $J = 8.7$ Hz, 2.7 Hz, 1H), 7.14 (d, $J = 2.1$ Hz, 1H), 7.45 (d, $J = 8.7$ Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 48.3($2CH_2$), 55.4($2CH_2$), 66.1, 103.3, 110.3, 120.9, 121.9, 153.5, 159.0, 170.2; EI-MS m/z (M^+) 250; EI-HRMS calcd. For $C_{12}H_{14}N_2O_2S$ (M^+) 250.0776, found 250.0776.

4-(6-(Trifluoromethyl)benzothiazol-2-yl)morpholine (2aa). Compound **2aa** was obtained as a white solid after the purification by flash chromatography (petroleum ether/ethyl acetate = 8/1). ^{1}H NMR (300 MHz, $CDCl_3$, ppm) δ 3.65 (t, $J = 4.5$ Hz, 4H), 3.84 (t, $J = 4.8$ Hz, 4H), 7.54 (d, $J = 9.3$ Hz, 1H), 7.59 (d, $J = 8.4$ Hz, 1H), 7.87 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 48.4($2CH_2$), 66.1($2CH_2$), 118.19 and 118.23 (J_{C-F}, 4.1 Hz), 119.0, 123.33, and 123.36 (J_{C-F}, 3.2 Hz), 123.13 and 128.53 (J_{C-F}, 539.8 Hz), 123.68 and 125.83 (J_{C-F}, 214.9 Hz), 130.6, 155.1, 170.5; EI-MS m/z (M^+) 288; EI-HRMS calcd. For $C_{12}H_{11}F_3N_2OS$ (M^+) 288.0544, found 288.0549.

2-Methoxybenzothiazole (2ab). Compound **2ab** was obtained as a colorless oil after the purification by flash chromatography (petroleum ether/ethyl acetate = 20/1). ^{1}H NMR (300 MHz, $CDCl_3$, ppm) δ 4.20 (s, 3H), 7.23 (dd, $J = 8.1$ Hz, 0.9 Hz, 1H), 7.37 (dd, $J = 8.1$ Hz, 0.9 Hz, 1H), 7.63 (dd, $J = 7.8$ Hz, 0.6 Hz, 1H), 7.71(d, $J = 8.1$ Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 58.4, 120.7, 121.2, 123.4, 125.9, 149.2, 173.4; EI-MS m/z (M^+) 165; EI-HRMS calcd. For C_8H_7NOS (M^+) 165.0248, found 165.0232.

2-Ethoxybenzothiazole (2ac). Compound **2ac** was obtained as a colorless oil after the purification by flash chromatography (petroleum ether/ethyl acetate = 20/1). ^{1}H NMR (300 MHz, $CDCl_3$, ppm) δ 1.49 (t, $J = 7.2$ Hz, 3H), 4.63 (q, $J = 7.2$ Hz, 2H), 7.22 (t, $J = 7.5$ Hz, 1H), 7.36 (t, $J = 7.8$ Hz, 1H), 7.63 (d, $J = 7.5$ Hz, 1H), 7.69 (d, $J = 7.8$ Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ14.4, 67.9, 120.7, 121.2, 123.3, 125.9, 131.8, 149.4, 172.9; EI-MS m/z (M^+) 179; EI-HRMS calcd. For C_9H_9NOS (M^+) 179.0405, found 179.0410.

2-(But-3-yn-1-yloxy)benzothiazole (2ad). Compound **2ad** was obtained as a white solid after the purification by flash chromatography (petroleum ether/ethyl acetate = 20/1). ^{1}H NMR (300 MHz, $CDCl_3$, ppm) δ 2.06 (t, $J = 2.8$ Hz, 1H), 2.78 (td, $J = 6.8$ Hz, 2.8 Hz, 2H), 4.67 (t, $J = 6.8$ Hz, 2H), 7.23 (td, $J = 8.4$ Hz, 0.8 Hz, 1H), 7.37 (td, $J = 8.4$ Hz, 0.8 Hz, 1H), 7.64(d, $J = 8$ Hz, 1H), 7.68(d, $J = 8$ Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 19.1, 69.1, 70.3, 79.6, 120.9, 121.3, 123.6, 126.0, 131.9, 149.2, 172.3; EI-MS m/z (M^+) 203; EI-HRMS calcd. For $C_{11}H_9NOS$ (M^+) 203.0405, found 203.0397.

2-(Benzyloxy)benzothiazole (2ae). Compound **2ae** was obtained as a colorless oil after the purification by flash

chromatography (petroleum ether/ethyl acetate = 20/1). ^{1}H NMR (300 MHz, $CDCl_3$, ppm) δ 5.61 (s, 2H), 7.22−7.46 (m, 5H), 7.50−7.53 (m, 2H), 7.66 (dd, J = 7.8 Hz, 0.9 Hz, 1H), 7.74 (dd, J = 8.1 Hz, 0.9 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 73.3, 120.8, 121.3, 123.6, 126.0, 128.5(2ArCH), 128.6(2ArCH), 129.4, 132.0, 135.2, 149.2, 172.7; EI-MS m/z (M^+) 241; EI-HRMS calcd. For $C_{14}H_{11}NOS$ (M^+) 241.0561, found 241.0559.

2-Phenylbenzothiazole (2af). Compound **2af** was obtained as a colorless oil after the purification by flash chromatography (petroleum ether/ethyl acetate = 20/1). ^{1}H NMR (300 MHz, $CDCl_3$, ppm) δ 7.40 (t, J = 7.8 Hz, 1H), 7.48−7.54 (m, 4H), 7.92 (d, J = 8.1 Hz, 1H), 8.08−8.13 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 121.6, 123.2, 125.2, 126.3, 127.5(2ArCH), 129.0(2ArCH), 131.0, 133.6, 135.0, 154.1, 168.1; ESI-MS m/z $[M+H]^+$ 212; HRMS (ESI) calcd for $C_{13}H_{10}NS$ $[M+H]^+$ 212.0534 found 212.0549.

2-Benzylbenzothiazole (2ag). Compound **2ag** was obtained as a colorless oil after the purification by flash chromatography (petroleum ether/ethyl acetate = 20/1). ^{1}H NMR (300 MHz, $CDCl_3$, ppm) δ 4.46 (s, 2H), 7.30−7.39 (m, 6), 7.46 (t, J = 7.8 Hz, 1H), 7.79 (d, J = 8.1 Hz, 1H), 8.02 (d, J = 7.8 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 40.6, 121.5, 122.7, 124.8, 125.9, 127.3, 128.8(2ArCH), 129.1(2ArCH), 135.6, 137.1, 153.2, 171.1; ESI-MS m/z $[M+H]^+$ 226; HRMS (ESI) calcd for $C_{14}H_{12}NS$ $[M+H]^+$ 226.0690 found 226.0674.

2-Cyclohexylbenzothiazole (2ah). Compound **2ah** was obtained as a colorless oil after the purification by flash chromatography (petroleum ether/ethyl acetate = 20/1). ^{1}H NMR (300 MHz, $CDCl_3$, ppm) δ 1.24−1.52 (m, 3H), 1.58−1.71 (m, 2H), 1.73−1.79 (m, 1H), 1.86−1.92 (m, 2H), 2.18−2.23 (m, 2H), 3.06−3.15 (m, 1H), 7.32 (td, J = 7.5 Hz, 1.2 Hz,1H, 7.43 (td, J = 7.5 Hz, 1.2 Hz, 1H), 7.83 (dd, J = 7.8 Hz, 1.5 Hz, 1H), 7.97 (m, 1H); ^{13}C NMR (100 MHz, $CDCl_3$, ppm) δ 25.7, 26.0($2CH_2$), 33.4($2CH_2$), 43.4, 121.5, 122.5, 124.4, 125.7, 134.5, 153.0, 177.6 ESI-MS m/z $[M+H]^+$ 218; HRMS (ESI) calcd for $C_{13}H_{16}NS$ $[M+H]^+$ 218.1003 found 218.1010.

Acknowledgment. We gratefully acknowledge financial support from the National Natural Science Foundation of China (Grants 20721003 and 20872153), State Key Program of Basic Research of China (2009CB918502) and the 863 Hi-Tech Program of China (Grants 2006AA020602 and 2006AA01A124).

Supporting Information Available. Part of the experimental details, general information, and ^{1}H and ^{13}C NMR spectra for all products. This material is available free of charge via the Internet at http://pubs.acs.org.

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CC9001839