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AgSCF3/Na2S2O8 Promoted Trifluoromethylthiolation-Cyclization of o-Propargyl Arylazides/o-Alkynyl Benzylazides: Synthesis of SCF3-Substituted Quinolines and Isoquinolines

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$AgSCF_3/Na_2S_2O_8$ Promoted Trifluoromethylthiolation-Cyclization of *o*-Propargyl Arylazides/*o*-Alkynyl Benzylazides: Synthesis of SCF_3-Substituted Quinolines and Isoquinolines

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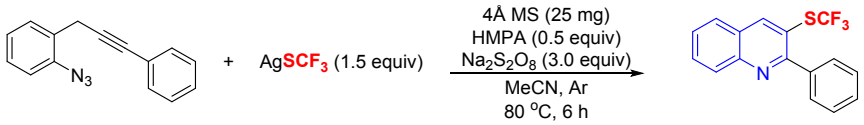
ABSTRACT: A $AgSCF_3/Na_2S_2O_8$ promoted trifluoromethylthiolation/cascade cyclization of *o*-propargyl arylazides (or *o*-alkynyl benzylazides) triggered by a carbon–carbon triple bond is reported. This strategy provides the synthesis of valuable SCF_3-substituted quinoline and isoquinoline systems via the construction s of one $C(sp^2)$–SCF_3 bond and one C–N bond within one process.



· 44 wokrable examples · Broad substrate scope · Yield up to 89%

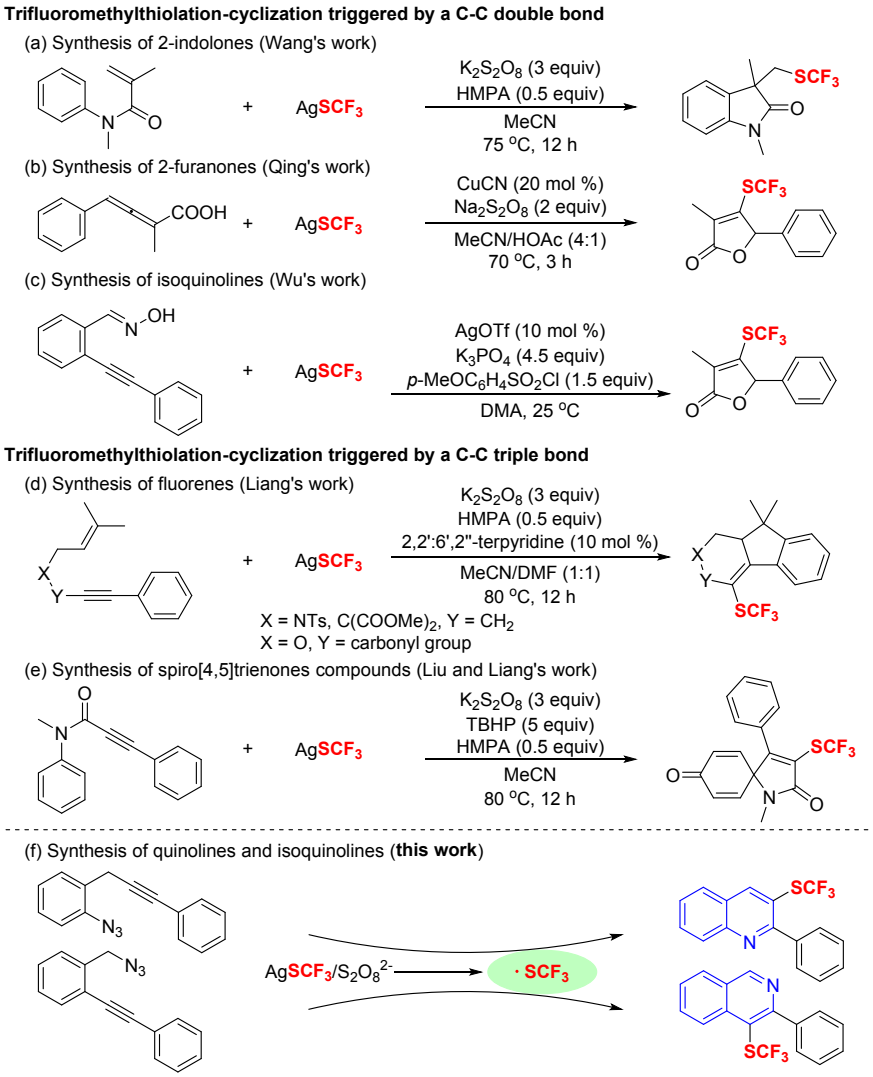
■ INTRODUCTION

Owing to the fulfilling bioactivities of fluorine-containing compounds, organofluorine chemistry research has achieved increasing and diversifying applications in drug development, pesticide chemistry, and material technology.[1] The trifluoromethylthio group (SCF_3) has held a remarkable position for its high metabolic stability, electronegativity and lipophilicity with great acceleration in absorption rate and membrane permeability in bioavailability.[2] Due to the complicated operations, highly toxic reagents, and poor selectivity in the traditional synthetic methods of trifluoromethylthiolation,[3] adequate evolutions are acquired in the exploitation of varieties of new reagents.[4] With the persistent efforts of Billard,[5] Shen,[6] and Qing[2e,2f,7] et al., various electrophilic trifluoromethylthiolation reagents[8] have been exploited. Nevertheless, limited efforts were devoted to an efficient construction of a cyclic system during the direct trifluoromethylthiolation process. In a subsequent study, $AgSCF_3$ has presented as a significant straightforward reagent[9] for trifluoromethylthiolation-cyclization reaction in a radical[10] or anion pathway.[11] In 2014, the Wang

group first demonstrated the synthesis of SCF_3-containing oxindoles through Ag-promoted aryltrifluoromethylthiolation/cyclization of alkenes including a unique SCF_3 radical pathway (Scheme 1a).[10a] Qing reported a copper-mediated trifluoromethylthiolation/cyclization of 2,3-allenoic acids in the past year (Scheme 1b).[7e] Soon afterwards, the Wu group presented a facile assembly of trifluoromethylthio-substituted isoquinolines in the presence of silver(I) salt and base.[11b] For the addition of radical onto triple bonds with more difficulties, Liang and co-workers disclosed the first $AgSCF_3$-promoted trifluoromethylthiolation/cyclization of 1,6-enynes including a radical course, generating a polycyclic fluorene cyclic system efficiently (Scheme 1d).[10f] Soon afterwards, a variety of trifluoromethylthio-substituted spiro[4,5]trienones were synthesized by Liu and co-workers from activated alkynes through a trifluoromethylthiolation/dearomatization process (Scheme 1e).[10h] Still, the development of a direct construction of most common heterocyclic scaffold with the simultaneous incorporation of a trifluoromethylthio group is driven by an increasing desire in organofluorine chemistry.

Quinoline and isoquinoline have become identified as numerous pharmacological, toxicological, or physiological activities in synthetic chemistry and pharmaceutical analysis.[12] Such compounds are also significant scaffold structure and precious intermediates found in various ligands, natural products and pharmaceutically active molecules.[13] The efficient construction for quinoline and isoquinoline has been a hot and classical concern in organic methodology research.[13] As is well known, radical cascaded cyclization strategy has become an ingenious approach for constructing heterocyclic molecules for combining multi-step reactions into one synthetic operation.[14] Given our present interest in fluorine-[10f,11d] or sulfur-containing[15] groups incorporation, and the persistent anticipation towards new routes to the crucial scaffold for bioactive molecules,[11d,16] we designed a $AgSCF_3/Na_2S_2O_8$ promoted cascade cyclization of *o*-propargyl arylazides (or *o*-alkynyl benzylazides). In this paper, a series of trifluoromethylthio-substituted quinolines and isoquinolines system were constructed within a single step via direct trifluoromethylthiolation-cyclization reaction (Scheme 1f).

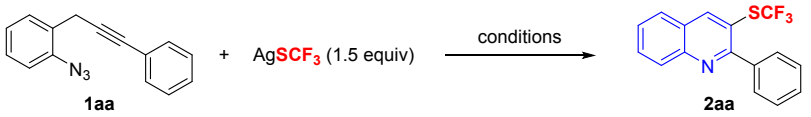
Scheme 1. Previous Works on Direct Trifluoromethylthiolation-Cyclization Strategies and Our New Anticipation towards Trifluoromethylthio-substituted Quinolines and Isoquinolines



■ RESULTS AND DISCUSSION

Our initial attempt to obtain trifluoromethylthio-substituted quinoline **2aa** began by using starting material **1aa** (0.2 mmol), $AgSCF_3$ (1.5 equiv), and $K_2S_2O_8$ (3.0 equiv) in the presence of HMPA (50 mol %) in acetonitrile under argon at 80 °C for 6 h. Delightedly, the expected product **2aa** was obtained in a yield of 55% with over 25% of **1aa** recovered simultaneously (Table 1, entry 1). Prolonging the reaction time gave a slightly lower yield of 52% for product **2aa** (entry 2). The survey on solvents indicated that MeCN was the best choice (entries 3–5). And the screen of oxidants gave a higher yield of 63% with the addition of 3.0 equiv of $Na_2S_2O_8$ (entries 6–10). The replacement of HMPA or a higher temperature was unable to give a better result (entries 11–12). Subsequently, the addition of 4Å molecular sieve (25 mg) proved to be highly efficient as 83% of product **2aa** was isolated and no **1aa** remained unreacted (entries 13–18). The control experiments presented that argon and base were necessary (entries 19–20).

Table 1. Reaction Conditions Optimization [a]



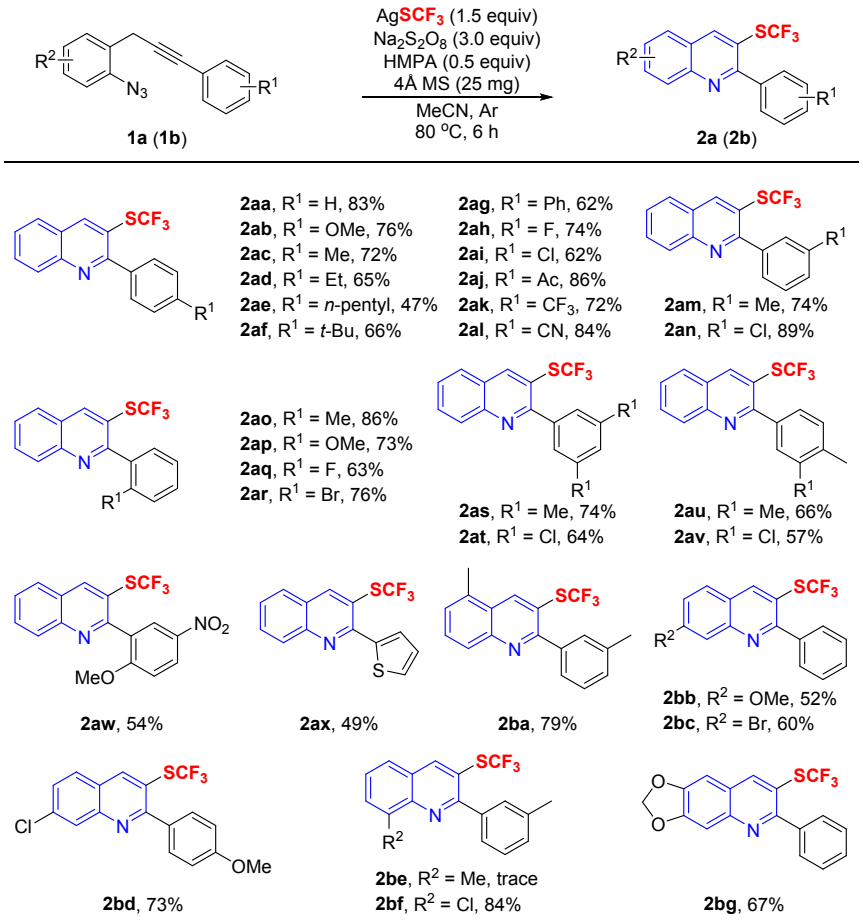
entry	solvent	oxidant (equiv)	additive (20 mol %)	yield (%)[b]
1[c]	MeCN	$K_2S_2O_8$ (3.0)		55
2[d]	MeCN	$Na_2S_2O_8$ (3.0)		52
3	DMF	$K_2S_2O_8$ (3.0)		23
4	DMSO	$K_2S_2O_8$ (3.0)		39
5	dioxane	$K_2S_2O_8$ (3.0)		trace
6	MeCN	$Na_2S_2O_8$ (3.0)		63
7	MeCN	$(NH_4)_2S_2O_8$ (3.0)		47
8	MeCN	oxone (3.0)		trace
9	MeCN	$PhI(OAc)_2$ (3.0)		0
10	MeCN	$Na_2S_2O_8$ (2.5)		47
11[e]	MeCN	$Na_2S_2O_8$ (3.0)		33
12[f]	MeCN	$Na_2S_2O_8$ (3.0)		43
13	MeCN	$Na_2S_2O_8$ (3.0)	1,10-phen	38
14	MeCN	$Na_2S_2O_8$ (3.0)	2,2':6',2"-terpyridine	33
15	MeCN	$Na_2S_2O_8$ (3.0)	TBAI	68
16	MeCN	$Na_2S_2O_8$ (3.0)	SDS	44
17	MeCN	$Na_2S_2O_8$ (3.0)	13X M.S. (25 mg)	74
18	**MeCN**	**$Na_2S_2O_8$ (3.0)**	**4Å M.S. (25 mg)**	**83**
19[g]	MeCN	$Na_2S_2O_8$ (3.0)	4Å M.S. (25 mg)	29
20[h]	MeCN	$Na_2S_2O_8$ (3.0)	4Å M.S. (25 mg)	39

[a]Unless otherwise noted, the reactions were conducted with **1aa** (0.2 mmol), $AgSCF_3$ (1.5 equiv), oxidant (3.0 equiv), HMPA (0.5 equiv), and additive (20 mol %) or molecular sieve (25 mg) in anhydrous solvent (2 mL) under an argon atmosphere at 80 °C for 6 h. [b]Isolated products yields are given. [c]Over 25% of **1aa** was recovered. [d]This reaction was performed for 10 h with over 25% of **1aa** recovered. [e]DBU (0.5 equiv) was used instead of HMPA. [f]This reaction was performed at 100 °C. [g]Without HMPA. [h]This reaction was performed under an air atmosphere. SDS = Sodium dodecyl sulfate.

To investigate the scope of this trifluoromethylthiolation-cyclization transformation, various substituted *o*-propargyl arylazides were synthesized. The corresponding trifluoromethylthio-substituted quinolines (**2aa**–**2ax** and **2ba**–**2bg**) could be isolated smoothly (Scheme 2). Both electron-rich (**1aa**–**1af**) and -insufficient (**1ag**–**1al**) groups of R^1 on the *para*-position of phenyl group showed good compatibility with this transformation.

The substrate with a large long-chain/branched alkyl group (*n*-pentyl/*t*-Bu group) or a strong electron-withdrawing group (CF_3 or CN) were tolerated generating the corresponding products in 47% to 84% yields (**2ae**, **2af**, **2ak** and **2al**). The substrates with a *meta*- (**1am** and **1an**) or *ortho*- (**1ao** and **1ar**) substituent group worked smoothly as well. The *ortho*-position steric effect exerted little influence on this transformation. The developed reaction conditions could also be applied to multisubstituted substrates (**2as**–**2aw**). Notably, the substrate with an electron-withdrawing (nitro group, **1aw**) or a heterocyclic group (2-thienyl group, **1ax**) proceeded smoothly in this transformation as well. Subsequently, several substrates contained distinct substituents of R^2 (**1ba**–**1bg**) were prepared to explore the reaction scope. In general, substituents for various electronic effects showed good compatibilities in this reaction system. Product **2be** contained an *ortho*-methyl group was identified in a trace yield for *ortho*-substituent steric effect. When the methyl group was replaced by a chlorine atom, the corresponding product **2bf** was isolated in 84% yield. The substrates contained a strong electron-donating group (**1bg**) was tolerated and gave the corresponding trifluoromethylthio-substituted quinoline product **2bg** in 67% yield. The construction of product **2aa** was confirmed by X-ray crystal structure analysis (see the Supporting Information (SI)).

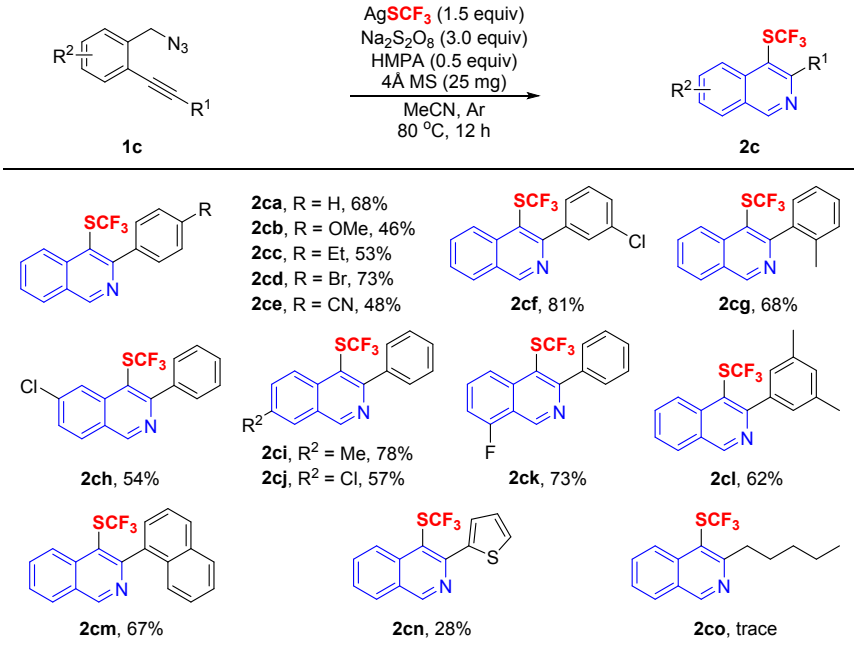
Scheme 2. Synthesis of Trifluoromethylthio-substituted Quinolines 2a and 2b[a]



[a]Unless otherwise noted, all reactions were performed with **1a**/**1b** (0.2 mmol), $AgSCF_3$ (1.5 equiv), $Na_2S_2O_8$ (3.0 equiv), HMPA (0.5 equiv), and 4Å molecular sieve (25 mg) in anhydrous MeCN (2 mL) at 80 °C under an argon atmosphere for 6 h. Isolated products yields are given.

Stimulated by the above result, a series of *o*-alkynyl benzylazides were synthesized to explore the reaction scope further. Satisfactorily, as presented in Scheme 3, our expected trifluoromethylthio-substituted isoquinolines (**2ca**–**2cn**) were isolated in moderate to good yields by prolonging the reaction time to 12 h. In this portion, more by-products came under observation by TLC analyses, which might be due to the insufficiently selective addition of SCF_3 radical onto the carbon–carbon triple bond of the substrate. Generally, this transformation has the similar electronic and steric effects with *o*-propargyl arylazide substrates. Remarkably, the substrate with a heterocyclic group (2-thienyl, **1cn**) or a multiple-ring group (1-naphthyl group, **1cm**) also worked smoothly. The substrate with an alkyl (**1co**) was unable to afford the respect product. The construction of **2ca** was identified by X-ray crystal structure analysis as well (see the SI).

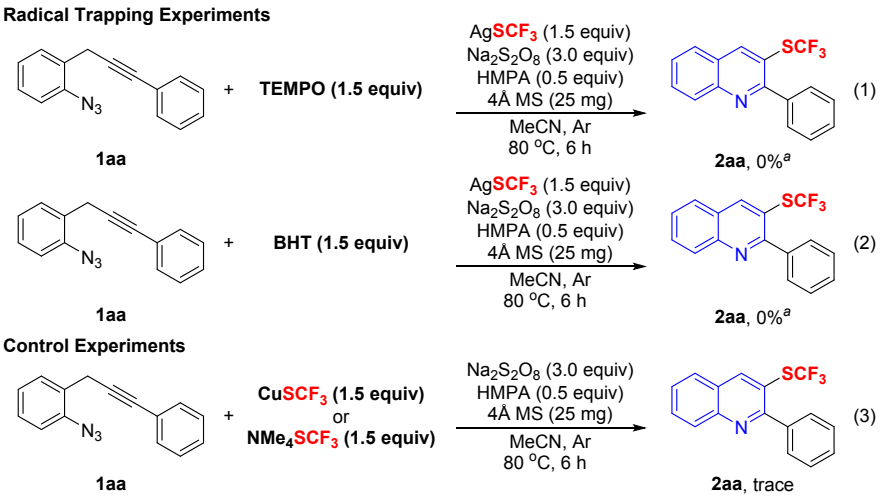
Scheme 3. Synthesis of Trifluoromethylthio-substituted Isoquinolines 2c[a]



[a]Unless otherwise noted, all reactions were performed with **1c** (0.2 mmol), $AgSCF_3$ (1.5 equiv), $Na_2S_2O_8$ (3.0 equiv), HMPA (0.5 equiv), and 4Å molecular sieve (25 mg) in anhydrous MeCN (2 mL) at 80 °C under an argon atmosphere for 12 h. Isolated products yields are given.

Some necessary inhibition experiments were conducted carefully in order to explore the reaction mechanism (Scheme 4). The reaction was completely inhibited with the addition of BHT (2,6-di-tert-butyl-4-methylphenol) or TEMPO (2,2,6,6-tetramethylpiperidine-1-oxyl), which verified our hypothesis that this transformation went through a radical process. Silver salts also proved to have significant effect in the reaction system, since other SCF_3 sources ($CuSCF_3$ or NMe_4SCF_3) failed to give the corresponding products.

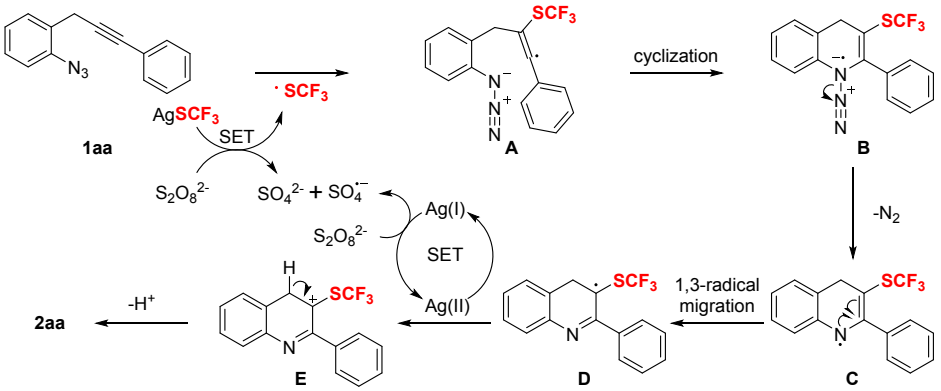
Scheme 4. Exploration Experiments for Mechanism



[a]Over 80% of substrate **1aa** was recovered.

According to the precedent literature[10] and the above control experiments, a plausible mechanism is depicted in Scheme 5. The oxidation of $AgSCF_3$ by $Na_2S_2O_8$ gives the $SCF_3\cdot$ radical, which is added to the carbon-carbon triple bond of substrate **1** to give intermediate **A**. Intermediate **A** goes through the subsequent 6-*endo*-dig cyclization process to generate radical anion intermediate **B**, which then releases a molar of nitrogen to give nitrogen radical intermediate **C**. An 1,3-radical migration of intermediate **C** affords carbon radical intermediate **D**, which undergoes another SET process from intermediate **D** to Ag(II) species to generate product **2**.

Scheme 5. Plausible Reaction Mechanism



To sum up, we presented a $AgSCF_3/Na_2S_2O_8$-promoted cascade cyclization of *o*-propargyl arylazides (*o*-alkynyl benzylazides) to synthesize a series of trifluoromethylthio-substituted quinoline (isoquinoline) derivatives. This transformation occurred smoothly in moderate to excellent yields with one C(sp^2)–N bond and C(sp^2)–SCF_3 bond concurrently constructed. According to the control experiment, a radical pathway triggered by a carbon–carbon triple was involved in this reaction process. So, some particular functional groups (nitro, cyan, and trifluoromethyl groups) could be applied and were unaffected by strong electronic effect.

■ EXPERIMENTAL SECTION

General Experimental Information. Silica gel (200-300 mesh) was used in column chromatography. ^{1}H NMR spectra were recorded on 400 or 600 MHz in $CDCl_3$ or d-acetone and chemical shifts (ppm) were recorded with tetramethylsilane (TMS) as the internal reference standard. ^{13}C{1H} NMR spectra were recorded on 100 or 150 MHz in $CDCl_3$ or d-acetone, ^{19}F spectra were recorded on 376 MHz in $CDCl_3$ ($CFCl_3$ as outside standard and low field is positive). Multiplicities are given as: s (singlet), d (doublet), t (triplet), dd (doublet of doublets), dq (doublet of quartets), q

(quartet) or m (multiplet). IR spectra were recorded on a FT-IR spectrometer and only major peaks are reported in cm^{-1}. HR-MS was obtained using a Q-Orbitrap (for compounds **1**) or Q-TOF (for compounds **2**) instrument equipped with ESI source. The copies of ^{1}H NMR, $^{13}C\{1H\}$ NMR, and ^{19}F NMR spectra of all compounds are provided in the Supporting Information. Room temperature is 23–25 °C. THF was distilled immediately before use from Na/benzophenone. Acetonitrile was distilled from CaH_2 and stored in a dryer before use. Other commercially available reagents and solvents were used directly.

General Procedures for Preparation of Starting Materials. For the synthesis of **1aa** (This procedure could not be used for the synthesis of substrate **1aj**, **1al**, **1aw** and **1ax**. Please see **Scheme S1** in the Supporting Information): NaN_3 (6.5 g, 100 mmol, 2.0 equiv) was added into a stirred solution of 2-nitrobenzaldehyde **A** (7.56 g, 50 mmol) in HMPA (150 mL). The reaction mixture was allowed to stir at 50 °C for 72 h. After completion of the reaction determined by TLC, the reaction mixture was quenched by addition of an aqueous saturated solution of NH_4Cl (150 mL) and extracted with methyl *tert*-butyl ether (3×150 mL). The organic layers were combined to be washed with brine and dried over Na_2SO_4 for 20 min. Then the solution would be concentrated under reduced pressure. The obtained residue would be further purified by flash column chromatography (silica gel, petroleum ether/ethyl acetate, 500:1) to give 2-azidobenzaldehyde **B** (96%, 7.06 g, 48 mmol).

n-BuLi (2.5 M, 5.8 mL, 1.2 equiv) was added dropwise via a syringe to a stirred solution of phenylacetylene (1.71 g, 12 mmol, 1.4 equiv) in dry THF (30 mL) under argon at -78 °C. The reaction mixture was allowed to stir for 10 min. Then, the solution of 2-azidobenzaldehyde **B** (1.47 g, 10 mmol) in THF was added at -78 °C. The reaction mixture was allowed to stir for 10 min at room temperature (Note: prolonging the reaction time would lead to an obvious yield decrease for this reaction). After the completion of the reaction determined by TLC, the reaction mixture was quenched by an aqueous saturated solution of NH_4Cl (30 mL) and extracted with ethyl acetate (2×50 mL). The organic layers were combined to be washed with brine and dried over Na_2SO_4 for 20 min. Then the solution would be concentrated under reduced pressure. The obtained residue would be further purified by flash column chromatography (silica gel, petroleum ether/ethyl acetate, 4:1) to give 1-(2-azidophenyl)-3-phenylprop-2-yn-1-ol **C** (79%, 2.36 g, 9.48 mmol).

Triethylsilane (872 mg, 7.5 mmol, 1.5 equiv) and 2,2,2-trifluoroacetic acid (855 mg, 7.5 mmol,

1.5 equiv) were sequentially added to a stirred solution of 1-(2-azidophenyl)-3-phenylprop-2-yn-1-ol **C** (1.25 g, 5 mmol) in dichloromethane (30 mL) at 0 °C. The mixture was allowed to stir over night at room temperature. After the completion of the reaction determined by TLC, the reaction mixture was quenched an aqueous saturated solution of $NaHCO_3$ (30 mL) and extracted with dichloromethane (2×50 mL). The organic layers were combined to be washed with brine and dried over Na_2SO_4 for 20 min. Then the solution would be concentrated under reduced pressure. The obtained residue would be further purified by flash column chromatography (silica gel, petroleum ether/ethyl acetate, 50:1) to give 1-azido-2-(3-phenylprop-2-yn-1-yl)benzene **1aa** (70%, 816.6 mg, 3.5 mmol).

For the synthesis of **1aw** (This procedure was also used for the synthesis of substrate **1aj**, **1al** and **1ax**. Please see **Scheme S2** in the Supporting Information): Ethynylmagnesium bromide (0.5 mol/L in THF, 45 mL, 1.5 equiv) was added dropwise into a stirred solution of 2-azidobenzaldehyde **B** (2.21 g, 15 mmol) in THF (35 mL) under argon. The mixture was allowed to stir at room temperature for 4 h. After the completion of the reaction determined by TLC, the reaction mixture was quenched by addition of an aqueous saturated solution of NH_4Cl (35 mL) and extracted with ethyl acetate (2×70 mL). The organic layers were combined to be washed with brine and dried over Na_2SO_4 for 20 min. Then the solution would be concentrated under reduced pressure. The resulting material 1-(2-azidophenyl)prop-2-yn-1-ol **D** (95%, 2.47 g, 14.3 mmol) was directly used for the next step without further purification**.**

$Pd(PPh_3)_2Cl_2$ (56.2 mg, 0.08 mmol, 1 mol %) and CuI (30.5 mg, 0.16 mmol, 2 mol %) were sequentially added to a stirred solution of 1-(2-azidophenyl)prop-2-yn-1-ol **D** (1.39 g, 8 mmol) in triethylamine (40 mL) under argon at room temperature. The mixture was allowed to stir for 10 min. Then 2-iodo-1-methoxy-4-nitrobenzene (2.68 g, 9.6 mmol, 1.2 equiv) was added. The mixture was allowed to stir overnight. An aqueous saturated solution of NH_4Cl (40 mL) was poured into the resulting mixture and the mixture was extracted with ethyl acetate (2×50 mL). The organic layers were combined to be washed with brine and dried over Na_2SO_4 for 20 min. Then the solution would be concentrated under reduced pressure. The obtained residue would be further purified by flash column chromatography (silica gel, petroleum ether/ethyl acetate, 2:1) to give 1-(2-azidophenyl)-3-(2-methoxy-5-nitrophenyl)prop-2-yn-1-ol **E** (95%, 2.46 g, 7.6 mmol).

Substrate 2-(3-(2-azidophenyl)prop-1-yn-1-yl)-1-methoxy-4-nitroben zene **1aw** (68%) was

synthesized via the similar preparation procedure of substrate **1aa**.

For the synthesis of **1ca** (Please see **Scheme S3** in the Supporting Information): $Pd(PPh_3)_2Cl_2$ (210.6 mg, 0.3 mmol, 1 mol %) and CuI (114.3 mg, 0. 6 mmol, 2 mol %) were sequentially added to a stirred solution of phenylacetylene (3.68 g, 36 mmol, 1.2 equiv) in triethylamine (100 mL) under argon at room temperature. The mixture was allowed to stir for 10 min. Then (2-iodophenyl)methanol **F** (7.02 g, 30 mmol) was added. The mixture was allowed to stir overnight. An aqueous saturated solution of NH_4Cl (80 mL) was poured into the resulting mixture and the mixture was extracted with ethyl acetate (2×150 mL). The organic layers were combined to be washed with brine and dried over Na_2SO_4 for 20 min. Then the solution would be concentrated under reduced pressure. The obtained residue would be further purified by flash column chromatography (silica gel, petroleum ether/ethyl acetate/triethylamine, 100:25:1) to give (2-(phenylethynyl)phenyl)methanol **G** (99%, 6.19 g, 29.7 mmol).

DBU (1.98 g, 13 mmol, 1.3 equiv) and diphenyl phosphoryl azide (1.65 g, 6 mmol, 1.2 equiv) were sequentially added portion-wise to a solution of (2-(phenylethynyl)phenyl)methanol **G** (1.05 g, 5 mmol) in toluene (25 mL) at room temperature. The mixture was allowed to stir overnight. After the completion of the reaction determined by TLC analysis, the reaction mixture was extracted with ethyl acetate (2×30 mL). The organic layers were combined to be washed with brine and dried over Na_2SO_4 for 20 min. Then the solution would be concentrated under reduced pressure. The obtained residue would be further purified by flash column chromatography (silica gel, petroleum ether/ethyl acetate, 10:1) to give 1-(azidomethyl)-2-(phenylethynyl)benzene **1ca** (83 %, 4.2 mmol, 0.97 g).

General Procedure for the Synthesis of Products. For the synthesis of **2aa** (Please see **Scheme S4** in the Supporting Information): $Na_2S_2O_8$ (142.9 mg, 0.6 mmol, 3.0 equiv), $AgSCF_3$ (62.7 mg, 0.3 mmol, 1.5 equiv) and 4Å molecular sieve (25 mg) were sequentially added an oven-dried tube charged with 1-azido-2-(3-phenylprop-2-yn-1-yl) benzene (**1aa**; 46.7 mg, 0.2 mmol). The tube was evacuated and backfilled with argon (repeated three times). And then, HMPA (17.4 μL, 0.5 eq) and anhydrous MeCN (2 mL) were added via syringe. The resulting mixture was allowed to stir at 80 °C for 6 h, and then extracted with ethyl ether (2×20 mL), washed with a saturated aqueous solution of saturated brine, dried over Na_2SO_4, and evaporated under reduced pressure. The residue was further purified by chromatography on silica gel (petroleum ether/ethyl

acetate/triethylamine, 100:30:1) to afford the product 2-phenyl-3-((trifluoromethyl)thio)quinoline (**2aa**) in 83% yield.

Scale-up experiment. When the reaction system was scaled up to gram scale (1.0 g of **1aa** was added) under the optimal conditions, the corresponding product **2aa** was isolated in 67% (0.88 g). for 12h.

1-azido-2-(3-(4-methoxyphenyl)prop-2-yn-1-yl)benzene (1ab): yellow oil; 0.87 g; 66%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 7.60 (d, J = 6.8 Hz, 1H), 7.39−7.37 (m, 2H), 7.29 (t, J = 7.6 Hz, 1H), 7.15−7.12 (m, 2H), 6.83−6.81 (m, 2H), 3.78 (s, 3H), 3.72 (s, 2H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 159.2, 137.5, 133.0, 129.6, 128.2, 128.0, 124.9, 117.8, 115.6, 113.8, 85.0, 82.8, 55.2, 21.2. HRMS (ESI/Q-Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{16}H_{14}N_3O$ 264.1131; Found 264.1131 (0 ppm).

1-azido-2-(3-(p-tolyl)prop-2-yn-1-yl)benzene (1ac): yellow oil; 0.73 g; 59%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 7.62−7.60 (m, 1H), 7.34 (d, J = 8.0 Hz, 2H), 7.30 (t, J = 7.6 Hz, 1H), 7.16−7.13 (m, 2H), 7.10 (d, J = 8.0 Hz, 2H), 3.73 (s, 2H), 2.34 (s, 3H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 137.9, 137.6, 131.5, 129.7, 129.0, 128.1, 128.0, 124.9, 120.4, 117.9, 85.8, 83.1, 21.4, 21.2. HRMS (ESI/Q-Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{16}H_{14}N_3$ 248.1182; Found 248.1182 (0 ppm).

1-azido-2-(3-(4-ethylphenyl)prop-2-yn-1-yl)benzene (1ad): yellow oil; 0.67 g; 51%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 7.62 (d, J = 7.6 Hz, 1H), 7.37 (d, J = 8.0 Hz, 2H), 7.32−7.28 (m, 1H), 7.15 (dd, J = 8.8 Hz 4.0 Hz, 4H), 3.73 (s, 2H), 2.63 (q, J = 7.6 Hz, 2H), 1.22 (t, J = 7.6 Hz, 3H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 144.2, 137.6, 131.6, 129.6, 128.1, 128.0, 127.8, 124.9, 120.7, 117.8, 85.8, 83.1, 76.9, 28.8, 21.2, 15.4. HRMS (ESI/Q-Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{17}H_{16}N_3$ 262.1339; Found 262.1340 (0.4 ppm).

1-azido-2-(3-(4-pentylphenyl)prop-2-yn-1-yl)benzene (1ae): yellow oil; 0.65 g; 43%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 7.60 (dd, J = 7.6 Hz 0.8 Hz, 1H), 7.36 (s, J = 8.0 Hz, 2H), 7.27 (t, J = 7.6 Hz, 1H), 7.14−7.08 (m, 4H), 3.72 (s, 2H), 3.58−3.55 (m, 2H), 1.62−1.55 (m, 2H), 1.34−1.26 (m, 4H), 0.91−0.86 (m, 3H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 142.9, 137.5, 131.5, 129.6, 128.3, 128.1, 128.0, 124.8, 120.6, 117.7, 85.8, 83.2, 35.8, 31.4, 30.9, 22.5, 21.2, 14.0. HRMS (ESI/Q-Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{20}H_{22}N_3$ 304.1808; Found 304.1808 (0 ppm).

4-(3-(2-azidophenyl)prop-1-yn-1-yl)-1,1'-biphenyl (1ag): yellow solid; 0.90 g; 58%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 7.61 (d, J = 7.2 Hz, 1H), 7.55 (d, J = 7.2 Hz, 2H), 7.51 (s, 4H), 7.40 (t, J

= 7.6 Hz, 2H), 7.33−7.26 (m, 2H), 7.15−7.10 (m, 2H), 3.74 (s, 2H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 140.5, 140.3, 137.6, 132.0, 129.6, 128.8, 128.1, 127.9, 127.5, 126.9, 126.9, 124.9, 122.4, 117.8, 87.3, 82.9, 21.2. HRMS (ESI/Q-Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{21}H_{16}N_3$ 310.1339; Found 310.1340 (0.3 ppm).

1-azido-2-(3-(4-fluorophenyl)prop-2-yn-1-yl)benzene (1ah): yellow oil; 0.97 g; 77%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 7.58−7.56 (m, 1H), 7.44−7.39 (m, 2H), 7.30 (dt, J = 8.0 Hz 1.2 Hz, 1H), 7.16−7.12 (m, 2H), 7.01−6.96 (m, 2H), 3.71 (s, 2H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 162.2 (d, ^1J = 247 Hz, 1C), 137.6, 133.4 (d, ^3J = 8 Hz, 1C), 129.6, 128.1, 127.9, 124.9, 119.6 (d, ^4J = 4 Hz, 1C), 117.9, 115.4 (d, ^2J = 22 Hz, 1C), 86.3 (d, ^5J = 1 Hz, 1C), 81.8, 21.1; ^{19}F NMR (376 MHz, $CDCl_3$) δ ppm -112.03 (s, 1F). HRMS (ESI/Q-Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{15}H_{11}FN_3$ 252.0932; Found 252.0932 (0 ppm).

1-(4-(3-(2-azidophenyl)prop-1-yn-1-yl)phenyl)ethan-1-one (1aj): yellow solid; 1.05 g; 76%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 7.87 (d, J = 8.4 Hz, 2H), 7.56 (d, J = 7.2 Hz, 1H), 7.51 (d, J = 8.0 Hz, 2H), 7.31 (t, J = 7.6 Hz, 1H), 7.14 (t, J = 8.4 Hz, 2H), 3.75 (s, 2H), 2.57 (s, 3H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 197.2, 137.6, 135.9, 131.7, 129.5, 128.4, 128.2, 128.1, 127.3, 124.9, 117.9, 90.4, 82.2, 26.5, 21.2. HRMS (ESI/Q-Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{17}H_{14}N_3O$ 276.1131; Found 276.1133 (0.7 ppm).

1-azido-2-(3-(4-(trifluoromethyl)phenyl)prop-2-yn-1-yl)benzene (1ak): yellow solid; 1.07 g; 71%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 7.56−7.52 (m, 5H), 7.30 (t, J = 7.6 Hz, 1H), 7.14 (t, J = 7.6 Hz, 2H), 3.74 (s, 2H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 137.7, 131.9, 129.6 (q, J = 32 Hz, 1C), 129.6, 128.3, 127.4, 127.4, 127.4, 125.3, 125.1 (q, J = 4 Hz, 1C), 124.9, 122.6, 117.9, 89.5, 81.7, 21.2; ^{19}F NMR (376 MHz, $CDCl_3$) δ ppm -63.14 (s, 3F). HRMS (ESI/Q-Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{16}H_{11}F_3N_3$ 302.0900; Found 302.0898 (0.7 ppm).

4-(3-(2-azidophenyl)prop-1-yn-1-yl)benzonitrile (1al): yellow solid; 0.68 g; 53%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 7.57 (d, J = 8.4 Hz, 2H), 7.53−7.50 (m, 3H), 7.33 (t, J = 7.2 Hz, 1H), 7.17−7.14 (m, 2H), 3.76 (s, 2H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 137.7, 132.1, 131.9, 129.5, 128.5, 128.4, 127.1, 124.9, 118.5, 118.0, 111.2, 91.8, 81.4, 21.2. HRMS (ESI/Q-Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{16}H_{11}N_4$ 259.0978; Found 259.0978 (0 ppm).

1-azido-2-(3-(3-chlorophenyl)prop-2-yn-1-yl)benzene (1an): yellow oil; 0.84 g; 63%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 7.54 (d, J = 7.6 Hz, 1H), 7.41 (d, J = 0.8 Hz, 1H), 7.31−7.23 (m, 3H),

7.20−7.10 (m, 3H), 3.71 (s, 2H); $^{13}C\{1H\}$ NMR (100 MHz, $CDCl_3$) δ ppm 137.6, 134.0, 131.5, 129.7, 129.5, 129.4, 128.1, 128.1, 127.5, 125.2, 124.9, 117.8, 88.1, 81.6, 21.1. HRMS (ESI/Q-Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{15}H_{11}ClN_3$ 268.0636; Found 268.0635 (0.4 ppm).

1-azido-2-(3-(o-tolyl)prop-2-yn-1-yl)benzene (1ao): yellow oil; 0.89 g; 72%; ^1H NMR (400 MHz, $CDCl_3$) δ ppm 7.63 (d, J = 7.2 Hz, 1H), 7.42 (d, J = 7.6 Hz, 1H), 7.31 (t, J = 7.2 Hz, 1H), 7.19−7.11 (m, 5H), 3.79 (s, 2H), 2.44 (s, 3H); $^{13}C\{1H\}$ NMR (100 MHz, $CDCl_3$) δ ppm 140.1, 137.6, 132.0, 129.6, 129.3, 128.2, 128.1, 127.8, 125.5, 124.9, 123.3, 117.9, 90.5, 81.9, 21.4, 20.8. HRMS (ESI/Q-Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{16}H_{14}N_3$ 248.1182; Found 248.1182 (0 ppm).

1-azido-2-(3-(2-methoxyphenyl)prop-2-yn-1-yl)benzene (1ap): yellow oil; 0.84 g; 64%; ^1H NMR (400 MHz, $CDCl_3$) δ ppm 7.71 (d, J = 7.6 Hz, 1H), 7.43 (dd, J = 7.6 Hz 1.6 Hz, 1H), 7.31−7.24 (m, 2H), 7.15 (t, J = 7.6 Hz, 2H), 6.89 (dd, J = 13.6 Hz 7.6 Hz, 2H), 3.89 (s, 3H), 3.81 (s, 2H); $^{13}C\{1H\}$ NMR (100 MHz, $CDCl_3$) δ ppm 160.0, 137.5, 133.6, 129.7, 129.3, 128.1, 127.9, 124.9, 120.4, 117.7, 112.6, 110.5, 90.7, 79.4, 55.8, 21.5. HRMS (ESI/Q-Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{16}H_{14}N_3O$ 264.1131; Found 264.1132 (0.4 ppm).

1-azido-2-(3-(2-fluorophenyl)prop-2-yn-1-yl)benzene (1aq): yellow oil; 0.85 g; 68%; ^1H NMR (400 MHz, $CDCl_3$) δ ppm 7.63 (d, J = 7.6 Hz, 1H), 7.44 (dt, J = 7.6 Hz 1.6 Hz, 1H), 7.33−7.24 (m, 2H), 7.18−7.14 (m, 2H), 7.09−7.04 (m, 2H), 3.79 (s, 2H); $^{13}C\{1H\}$ NMR (100 MHz, $CDCl_3$) δ ppm 162.9 (d, ^1J = 249 Hz, 1C), 137.6, 133.6 (d, ^3J = 2 Hz, 1C), 129.6, 129.5 (d, ^3J = 8 Hz, 1C), 128.1, 127.6, 125.0, 123.8 (d, ^4J = 4 Hz, 1C), 117.8, 115.4 (d, ^2J = 21 Hz, 1C), 112.0 (d, ^2J = 15 Hz, 1C) , 92.1 (d, ^5J = 247 Hz, 3C), 76.4, 21.4; ^{19}F NMR (376 MHz, $CDCl_3$) δ ppm -111.00 (s, 1F). HRMS (ESI/Q-Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{15}H_{11}FN_3$ 252.0932; Found 252.0932 (0 ppm).

1-azido-2-(3-(2-bromophenyl)prop-2-yn-1-yl)benzene (1ar): yellow oil; 1.09 g; 70%; ^1H NMR (400 MHz, $CDCl_3$) δ ppm 7.71 (d, J = 7.6 Hz, 1H), 7.55 (d, J = 8.0 Hz, 1H), 7.47−7.45 (m, 1H), 7.29 (t, J = 7.6 Hz, 1H), 7.22 (t, J = 7.6 Hz, 1H), 7.16−7.10 (m, 3H), 3.79 (s, 2H); $^{13}C\{1H\}$ NMR (100 MHz, $CDCl_3$) δ ppm 137.5, 133.4, 132.3, 129.7, 129.0, 128.1, 127.5, 126.9, 125.6, 125.5, 124.9, 117.8, 91.6, 81.7, 21.4. HRMS (ESI/Q-Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{15}H_{11}BrN_3$ 312.0131; Found 312.0129 (0.6 ppm).

1-(3-(2-azidophenyl)prop-1-yn-1-yl)-3,5-dimethylbenzene (1as): yellow oil; 0.73 g; 56%; ^1H NMR (400 MHz, $CDCl_3$) δ ppm 7.59 (d, J = 8.0 Hz, 1H), 7.25 (t, J = 7.6 Hz, 1H), 7.10 (dd, J = 16.0 Hz 8.0 Hz, 4H), 6.89 (s, 1H), 3.70 (s, 2H), 2.25 (s, 6H); $^{13}C\{1H\}$ NMR (100 MHz, $CDCl_3$) δ ppm

137.7, 137.5, 129.7, 129.5, 129.3, 128.0, 127.9, 124.8, 123.1, 117.7, 85.7, 83.3, 21.1, 21.0. HRMS (ESI/Q-Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{17}H_{16}N_3$ 262.1339; Found 262.1340 (0.4 ppm).

1-(3-(2-azidophenyl)prop-1-yn-1-yl)-3,5-dichlorobenzene (1at): yellow solid; 1.09 g; 72%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 7.50 (d, J = 7.6 Hz, 1H), 7.35−7.23 (m, 4H), 7.16−7.13 (m, 2H), 3.71 (s, 2H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 137.7, 134.7, 129.8, 129.5, 128.3, 128.2, 127.2, 126.3, 124.9, 117.9, 89.6, 80.4, 21.1. HRMS (ESI/Q-Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{15}H_{10}Cl_2N_3$ 302.0246; Found 302.0245 (0.3 ppm).

4-(3-(2-azidophenyl)prop-1-yn-1-yl)-1,2-dimethylbenzene (1au): yellow oil; 0.88 g; 67%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 7.60 (d, J = 7.6 Hz, 1H), 7.29−7.23 (m, 2H), 7.20−7.09 (m, 1H), 7.03 (d, J = 7.6 Hz, 2H), 3.71 (s, 1H), 2.22 (s, 3H), 2.20 (s, 3H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 137.5, 136.6, 136.5, 132.7, 129.6, 129.5, 129.0, 128.2, 128.0, 124.8, 120.7, 117.7, 85.5, 83.2, 21.2, 19.6, 19.5. HRMS (ESI/Q-Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{17}H_{16}N_3$ 262.1339; Found 262.1338 (0.4 ppm).

4-(3-(2-azidophenyl)prop-1-yn-1-yl)-2-chloro-1-methylbenzene (1av): yellow solid; 0.83 g; 59%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 7.54 (d, J = 7.6 Hz, 1H), 7.40 (s, 1H), 7.26 (t, J = 7.6 Hz, 1H), 7.20 (d, J = 8.0 Hz, 1H), 7.10 (dd, J = 16.8 Hz 8.0 Hz, 3H), 3.69 (s, 2H), 2.31 (s, 3H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 137.5, 136.0, 134.0, 131.9, 130.6, 129.7, 129.5, 128.1, 127.7, 124.8, 122.5, 117.8, 87.1, 81.7, 21.1, 19.9. HRMS (ESI/Q-Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{16}H_{13}ClN_3$ 282.0793; Found 282.0793 (0 ppm).

2-(3-(2-azidophenyl)prop-1-yn-1-yl)-1-methoxy-4-nitrobenzene (1aw): yellow solid; 1.22 g; 79%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 8.28 (d, J = 2.8 Hz, 1H), 8.16 (dd, J = 9.2 Hz 6.8 Hz, 1H), 7.63 (d, J = 7.2 Hz, 1H), 7.32 (t, J = 7.6 Hz, 1H), 7.17 (t, J = 8.4 Hz, 2H), 6.92 (d, J = 9.2 Hz, 1H), 3.98 (s, 1H), 3.80 (s, 2H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 164.6, 140.9, 137.6, 129.6, 129.0, 128.2, 127.3, 125.2, 124.9, 117.9, 113.8, 110.1, 93.0, 77.0, 56.5, 21.4. HRMS (ESI/Q-Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{16}H_{13}N_4O_3$ 309.0982; Found 309.0981 (0.3 ppm).

2-(3-(2-azidophenyl)prop-1-yn-1-yl)thiophene (1ax): light red oil; 0.49 g; 41%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 7.53 (d, J = 7.2 Hz, 1H), 7.26 (t, J = 7.6 Hz, 1H), 7.15 (d, J = 4.8 Hz, 2H), 7.10 (dd, J = 12.4 Hz 8.4 Hz, 2H), 6.92−6.90 (m, 1H), 3.72 (s, 2H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 137.5, 131.4, 129.6, 128.1, 127.5, 126.7, 126.3, 124.8, 123.5, 117.8, 90.7, 76.1, 21.4. HRMS (ESI/Q-Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{13}H_{10}N_3S$ 240.0590; Found 240.0585 (2.1 ppm).

1-azido-3-methyl-2-(3-(m-tolyl)prop-2-yn-1-yl)benzene (1ba): yellow oil; 0.95 g; 73%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 7.16−7.07 (m, 4H), 7.00 (d, J = 7.6 Hz, 1H), 6.96−6.92 (m, 2H), 3.68 (s, 2H), 2.41 (s, 3H), 2.23 (s, 3H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 138.8, 137.8, 137.6, 132.1, 128.6, 128.5, 127.9, 127.7, 126.9, 126.7, 123.4, 115.8, 86.4, 80.4, 21.0, 19.5, 17.8. HRMS (ESI/Q-Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{17}H_{16}N_3$ 262.1339; Found 262.1339 (0 ppm).

2-azido-4-methoxy-1-(3-phenylprop-2-yn-1-yl)benzene (1bb): yellow oil; 0.74 g; 56%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 7.48−7.42 (m, 3H), 7.27 (t, J = 2.8 Hz, 3H), 6.69−6.67 (m, 2H), 3.79 (m, 3H), 3.66 (s, 2H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 159.5, 138.3, 131.6, 130.4, 128.2, 127.8, 123.6, 120.2, 110.1, 104.0, 87.1, 82.6, 55.4, 20.4. HRMS (ESI/Q-Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{16}H_{14}N_3O$ 264.1131; Found 264.1129 (0.8 ppm).

2-azido-4-bromo-1-(3-phenylprop-2-yn-1-yl)benzene (1bc): yellow oil; 1.05 g; 67%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 7.55 (d, J = 8.4 Hz, 1H), 7.43 (t, J = 1.6 Hz, 2H), 7.29−7.27 (m, 3H), 6.82−6.71 (m, 1H), 6.70 (s, 1H), 3.67 (s, 2H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 139.9, 138.9, 131.6, 130.7, 128.2, 127.9, 124.6, 123.3, 115.2, 108.5, 86.2, 83.2, 20.7. HRMS (ESI/Q-Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{15}H_{11}BrN_3$ 312.0131; Found 312.0131 (0 ppm).

2-azido-4-chloro-1-(3-(4-methoxyphenyl)prop-2-yn-1-yl)benzene (1bd): yellow solid; 0.80 g; 54%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 7.54 (d, J = 8.4 Hz, 1H), 7.35 (d, J = 8.4 Hz, 2H), 6.79 (d, J = 8.0 Hz, 3H), 6.66 (s, 1H), 3.74 (s, 3H), 3.63 (s, 2H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 159.2, 139.7, 138.8, 132.8, 130.6, 124.8, 115.4, 115.1, 113.7, 108.4, 84.5, 83.0, 55.0, 20.7. HRMS (ESI/Q-Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{16}H_{13}ClN_3O$ 298.0742; Found 298.0742 (0 ppm).

2-azido-1-methyl-3-(3-(m-tolyl)prop-2-yn-1-yl)benzene (1be): yellow oil; 0.76 g; 58%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 7.40 (d, J = 6.8 Hz, 1H), 7.25 (d, J = 9.6 Hz, 2H), 7.15 (t, J = 7.6 Hz, 1H), 7.10−7.04 (m, 3H), 3.81 (s, 2H), 2.40 (s, 3H), 2.28 (s, 3H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 137.8, 136.2, 132.5, 132.2, 130.8, 130.0, 128.7, 128.7, 128.1, 127.3, 126.0, 123.3, 86.4, 83.0, 22.4, 21.1, 17.9. HRMS (ESI/Q-Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{17}H_{16}N_3$ 262.1339; Found 262.1339 (0 ppm).

2-azido-1-chloro-3-(3-(m-tolyl)prop-2-yn-1-yl)benzene (1bf): yellow oil; 0.87 g; 62%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 7.47 (d, J = 7.6 Hz, 1H), 7.26−7.23 (m, 3H), 7.17 (t, J = 7.6 Hz, 1H), 7.07 (t, J = 8.0 Hz, 2H), 3.79 (m, 2H), 2.30 (s, 3H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 137.9, 134.2, 132.4, 132.2, 129.4, 129.1, 128.8, 128.6, 128.1, 127.8, 126.3, 123.0, 85.6, 83.5, 22.6, 21.2.

HRMS (ESI/Q-Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{16}H_{13}ClN_3$ 282.0793; Found 282.0792 (0.4 ppm).

5-azido-6-(3-phenylprop-2-yn-1-yl)benzo[d][1,3]dioxole (1bg): yellow solid; 0.73 g; 53%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 7.43 (t, J = 3.6 Hz, 2H), 7.28 (d, J = 2.4 Hz, 3H), 7.07 (s, 1H), 6.64 (s, 1H), 5.94 (s, 2H), 3.65 (s, 2H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 147.3, 144.9, 131.6, 130.3, 128.2, 127.9, 123.4, 121.0, 109.4, 101.6, 99.1, 86.8, 82.8, 20.9. HRMS (ESI/Q-Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{16}H_{12}N_3O_2$ 278.0924; Found 278.0922 (0.7 ppm).

1-(azidomethyl)-2-((4-ethylphenyl)ethynyl)benzene (1cc): light yellow oil; 1.08 g; 83%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 7.55−7.53 (m, 1H), 7.46 (d, J = 8.0 Hz, 2H), 7.35 (d, J = 7.2 Hz, 1H), 7.32−7.25 (m, 2H), 7.16 (d, J = 8.0 Hz, 2H), 4.57 (m, 2H), 2.63 (q, J = 7.6 Hz, 2H), 1.22 (t, J = 7.6 Hz, 3H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 145.0, 137.0, 132.3, 131.5, 128.4, 128.4, 128.1, 127.9, 123.0, 119.9, 94.8, 85.9, 53.2, 28.8, 15.3. HRMS (ESI/Q-Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{17}H_{16}N_3$ 262.1339; Found 262.1339 (0 ppm).

1-(azidomethyl)-2-((4-bromophenyl)ethynyl)benzene (1cd): light yellow oil; 1.19 g; 76%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 7.54 (d, J = 7.2 Hz, 1H), 7.46 (d, J = 8.4 Hz, 2H), 7.38−7.28 (m, 5H), 4.55 (s, 2H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 137.1, 132.9, 132.4, 131.6, 128.9, 128.5, 128.2, 122.8, 122.4, 121.7, 93.3, 87.7, 53.2. HRMS (ESI/Q-Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{15}H_{11}BrN_3$ 312.0131; Found 312.0129 (0.6 ppm).

4-((2-(azidomethyl)phenyl)ethynyl)benzonitrile (1ce): light yellow oil; 0.94 g; 73%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 7.64−7.58 (m, 5H), 7.41 (d, J = 4.0 Hz, 2H), 7.38−7.33 (m, 1H), 4.58 (m, 2H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 137.3, 132.6, 131.9, 131.9, 129.5, 128.7, 128.3, 127.5, 121.7, 118.3, 111.7, 92.5, 90.7, 53.1. HRMS (ESI/Q-Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{16}H_{11}N_4$ 259.0978; Found 259.0978 (0 ppm).

2-(azidomethyl)-4-methyl-1-(phenylethynyl)benzene (1ci): light yellow oil; 1.06 g; 86%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 7.53−7.52 (m, 2H), 7.45 (d, J = 7.6 Hz, 1H), 7.32 (d, J = 3.2 Hz, 3H), 7.17 (s, 1H), 7.10 (d, J = 7.6 Hz, 1H), 4.54 (s, 2H), 2.35 (s, 3H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 138.9, 136.9, 132.2, 131.4, 129.2, 128.9, 128.3, 128.3, 123.0, 119.7, 93.7, 86.7, 53.2, 21.4. HRMS (ESI/Q-Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{16}H_{14}N_3$ 248.1182; Found 248.1183 (0.4 ppm).

2-(azidomethyl)-1-fluoro-3-(phenylethynyl)benzene (1ck): light yellow oil; 0.93 g; 74%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 7.56−7.54 (m, 2H), 7.38−7.35 (m, 4H), 7.28 (dt, J = 8.0 Hz 5.6 Hz,

1H), 7.08 (t, J = 8.8 Hz, 1H), 4.61 (s, 2H); $^{13}C\{1H\}$ NMR (100 MHz, $CDCl_3$) δ ppm 161.19 (d, ^1J = 247 Hz, 1C), 131.6, 130.0 (d, ^3J = 9 Hz, 1C), 128.9, 128.4, 128.2 (d, ^4J = 3 Hz, 1C), 125.8 (d, ^3J = 5 Hz, 1C), 124.2 (d, ^2J = 17 Hz, 1C), 122.3, 115.9 (d, ^2J = 22 Hz, 1C), 94.9, 85.6 (d, ^5J = 4 Hz, 1C), 46.3 (d, ^3J = 3 Hz, 1C); ^{19}F NMR (376 MHz, $CDCl_3$) δ ppm -116.21 (t, J = 7.1 Hz, 1F). HRMS (ESI/Q-Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{15}H_{11}FN_3$ 252.0932; Found 252.0929 (1.2 ppm).

1-((2-(azidomethyl)phenyl)ethynyl)-3,5-dimethylbenzene (1cl): light yellow oil; 1.14 g; 87%; ^1H NMR (400 MHz, $CDCl_3$) δ ppm 7.55−7.53 (m, 1H), 7.37−7.26 (m, 3H), 7.17 (s, 2H), 6.96 (s, 1H), 4.58 (s, 2H), 2.30 (s, 6H); $^{13}C\{1H\}$ NMR (100 MHz, $CDCl_3$) δ ppm 137.9, 137.0, 132.3, 130.5, 129.2, 128.5, 128.4, 128.1, 122.9, 122.4, 95.0, 85.8, 53.2, 21.0. HRMS (ESI/Q-Orbitrap) m/z: $[M + H]^+$ Calcd for $C_{17}H_{16}N_3$ 262.1339; Found 262.1338 (0.4 ppm).

2-phenyl-3-((trifluoromethyl)thio)quinoline (2aa): white solid; 50.7 mg; 83%; ^1H NMR (400 MHz, $CDCl_3$) δ ppm 8.66 (s, 1H), 8.19 (d, J = 8.0 Hz, 1H), 7.90 (d, J = 7.2 Hz, 1H), 7.84−7.81 (m, 1H), 7.62 (d, J = 6.0 Hz, 3H), 7.50 (d, J = 4.4 Hz, 3H); $^{13}C\{1H\}$ NMR (150 MHz, $CDCl_3$) δ ppm 161.9, 148.1 ,145.9, 139.3, 131.7, 129.6, 129.6, 129.2 (q, J = 308 Hz, 1C, S**C**F_3), 128.8, 128.1, 127.6, 127.6, 127.1, 118.0 (J = 2 Hz, 1C, **C**-SCF_3, quartet peak should be obtained, however, doublet peak was observed due to the low resolution of NMR machine); ^{19}F NMR (376 MHz, $CDCl_3$) δ ppm -42.43 (s, 3F). IR (neat, cm^{-1}): 3060, 2925, 1772, 1614, 1576, 1549, 1481, 1443, 1400, 1369, 1114, 962, 918, 866, 790, 758, 723, 699, 604; HRMS (ESI/Q-TOF) m/z: $[M + Na]^+$ Calcd for $C_{16}H_{10}F_3NNaS$ 328.0378; Found 328.0384 (1.8 ppm).

2-(4-methoxyphenyl)-3-((trifluoromethyl)thio)quinoline (2ab): yellow solid; 51.0 mg; 76%; ^1H NMR (400 MHz, $CDCl_3$) δ ppm 8.62 (s, 1H), 8.18−8.13 (m, 2H), 7.87 (d, J = 8.4 Hz, 1H), 7.84−7.79 (m, 1H), 7.62−7.59 (m, 2H), 7.06−7.02 (m, 2H), 3.88 (s, 3H); $^{13}C\{1H\}$ NMR (100 MHz, $CDCl_3$) δ ppm 160.2, 148.1, 145.8, 136.6, 131.6, 131.2, 129.5, 129.2 (q, J = 308 Hz, 1C, S**C**F_3), 127.6, 126.9, 125.9, 118.0 (J = 1 Hz, 1C, **C**-SCF_3, quartet peak should be obtained, however, doublet peak was observed due to the low resolution of NMR machine), 114.2, 113.6, 55.3; ^{19}F NMR (376 MHz, $CDCl_3$) δ ppm -42.46 (s, 3F). IR (neat, cm^{-1}): 2959, 2926, 2596, 1605, 1548, 1508, 1452, 1370, 1290, 1250, 1177, 1114, 1028, 964, 920, 833, 788, 758, 615; HRMS (ESI/Q-TOF) m/z: $[M + H]^+$ Calcd for $C_{17}H_{13}F_3NOS$ 336.0664; Found 336.067 (3.6 ppm).

2-(p-tolyl)-3-((trifluoromethyl)thio)quinoline (2ac): yellow solid; 46.0 mg; 72%; ^1H NMR (400 MHz, $CDCl_3$) δ ppm 8.62 (s, 1H), 8.17 (d, J = 8.4 Hz, 1H), 7.86 (d, J = 8.0 Hz, 1H), 7.82−7.78 (m,

1H), 7.59 (t, J = 7.6 Hz, 1H), 7.53 (d, J = 8.0 Hz, 2H), 7.31 (d, J = 8.0 Hz, 2H), 2.43 (s, 3H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 161.8, 148.1, 145.6, 138.8, 136.5, 131.6, 129.5, 129.5, 129.2 (q, J = 307 Hz, 1C, S**C**F_3), 128.8, 127.6, 127.4, 126.9, 124.8, 118.0 (J = 2 Hz, 1C, **C**-SCF_3, quartet peak should be obtained, however, doublet peak was observed due to the low resolution of NMR machine), 21.3; ^{19}F NMR (376 MHz, $CDCl_3$) δ ppm -42.39 (s, 3F). IR (neat, cm^{-1}): 3738, 1844, 1613, 1479, 1399, 1370, 1184, 1128, 966, 824, 786, 754, 608; HRMS (ESI/Q-TOF) m/z: $[M + H]^+$ Calcd for $C_{17}H_{13}F_3NS$ 320.0715; Found 320.0722 (2.2 ppm).

2-(4-ethylphenyl)-3-((trifluoromethyl)thio)quinoline (2ad): yellow solid; 43.3 mg; 65%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 8.60 (s, 1H), 8.17 (d, J = 8.8 Hz, 1H), 7.82 (d, J = 8.0 Hz, 1H), 7.76 (t, J = 8.8 Hz, 1H), 7.55 (t, J = 8.0 Hz, 3H), 7.32 (d, J = 8.0 Hz, 2H), 2.72 (q, J = 7.6 Hz, 2H), 1.28 (d, J = 7.6 Hz, 3H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 161.7, 148.0, 145.5, 145.0, 136.7, 131.5, 129.6, 129.5, 129.2 (q, J = 308 Hz, 1C, S**C**F_3), 127.6, 127.5, 127.3, 126.9, 117.9 (J = 2 Hz, 1C, **C**-SCF_3, quartet peak should be obtained, however, doublet peak was observed due to the low resolution of NMR machine), 28.7, 15.4; ^{19}F NMR (376 MHz, $CDCl_3$) δ ppm -42.32 (s, 3F). IR (neat, cm^{-1}): 3039, 2932, 2872, 1913, 1717, 1689, 1614, 1575, 1549, 1484, 1458, 1401, 1369, 1294, 1155, 1108, 1021, 970, 916, 869, 836, 792, 759, 619; HRMS (ESI/Q-TOF) m/z: $[M + H]^+$ Calcd for $C_{18}H_{15}F_3NS$ 334.0872; Found 334.0876 (1.2 ppm).

2-(4-pentylphenyl)-3-((trifluoromethyl)thio)quinoline (2ae): yellow solid; 35.3 mg; 47%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 8.63 (s, 1H), 8.18 (d, J = 8.4 Hz, 1H), 7.88 (d, J = 8.0 Hz, 1H), 7.83−7.79 (m, 1H), 7.63−7.59 (m, 1H), 7.54 (d, J = 8.4 Hz, 2H), 7.31 (d, J = 8.0 Hz, 2H), 2.69 (t, J = 8.0 Hz, 2H), 1.71−1.64 (m, 2H), 1.37−1.34 (m, 4H), 0.93−0.88 (m, 3H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 161.9, 148.1, 145.5, 143.8, 136.6, 131.6, 129.5, 129.2 (q, J = 308 Hz, 1C, S**C**F_3), 128.2, 127.6, 127.4, 127.0, 118.1 (J = 2 Hz, 1C, **C**-SCF_3, quartet peak should be obtained, however, doublet peak was observed due to the low resolution of NMR machine), 35.8, 31.5, 31.0, 22.6, 14.0; ^{19}F NMR (376 MHz, $CDCl_3$) δ ppm -42.38 (s, 3F). IR (neat, cm^{-1}): 3059, 2924, 1740, 1616, 1554, 1481, 1433, 1399, 1370, 1109, 1027, 973, 920, 864, 792, 757; HRMS (ESI/Q-TOF) m/z: $[M + H]^+$ Calcd for $C_{21}H_{21}F_3NS$ 376.1341; Found 376.1349 (2.1 ppm).

2-(4-(tert-butyl)phenyl)-3-((trifluoromethyl)thio)quinoline (2af): light yellow solid; 47.7 mg; 66%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 8.63 (s, 1H), 8.17 (d, J = 8.4 Hz, 1H), 7.87 (d, J = 8.0 Hz, 1H), 7.83−7.78 (m, 1H), 7.59 (dd, J = 13.6 Hz 8.0 Hz, 3H), 7.52 (d, J = 8.4 Hz, 2H), 1.38 (s, 9H);

$^{13}C\{1H\}$ NMR (100 MHz, $CDCl_3$) δ ppm 161.7, 151.9, 148.1, 145.4, 136.4, 131.6, 129.5, 129.3, 129.2 (q, J = 307 Hz, 1C, S**C**F_3), 127.6, 127.4, 127.0, 125.6, 125.1, 118.0 (q, J = 2 Hz, 1C, S**C**F_3), 34.7, 31.3; ^{19}F NMR (376 MHz, $CDCl_3$) δ ppm -42.30 (s, 3F). IR (neat, cm^{-1}): 3053, 2963, 1786, 1664, 1611, 1550, 1479, 1400, 1368, 1268, 1115, 1019, 970, 836, 790, 756, 610; HRMS (ESI/Q-TOF) m/z: $[M + H]^+$ Calcd for $C_{20}H_{19}F_3NS$ 362.1185; Found 362.1193 (2.2 ppm).

2-([1,1'-biphenyl]-4-yl)-3-((trifluoromethyl)thio)quinoline (2ag): yellow solid; 47.3 mg; 62%; ^1H NMR (400 MHz, $CDCl_3$) δ ppm 8.66 (s, 1H), 8.20 (d, J = 8.4 Hz, 1H), 7.89 (d, J = 8.0 Hz, 1H), 7.85−7.81 (m, 1H), 7.73 (m, 4H), 7.67 (d, J = 7.2 Hz, 2H), 7.62 (t, J = 8.0 Hz, 1H), 7.47 (t, J = 7.6 Hz, 2H), 7.37 (t, J = 7.6 Hz, 1H); $^{13}C\{1H\}$ NMR (100 MHz, $CDCl_3$) δ ppm 161.5, 148.1, 146.0, 141.7, 140.6, 138.2, 131.8, 130.1, 129.5, 129.2 (q, J = 307 Hz, 1C, S**C**F_3), 128.8, 127.6, 127.5, 127.2, 127.0, 126.9, 117.8 (J = 2 Hz, 1C, **C**-SCF_3, quartet peak should be obtained, however, doublet peak was observed due to the low resolution of NMR machine); ^{19}F NMR (376 MHz, $CDCl_3$) δ ppm -42.33 (s, 3F). IR (neat, cm^{-1}): 3057, 2852, 1923, 1611, 1481, 1398, 1201, 1146, 1126, 1101, 966, 910, 846, 762, 733, 692; HRMS (ESI/Q-TOF) m/z: $[M + H]^+$ Calcd for $C_{22}H_{15}F_3NS$ 382.0872; Found 382.0881 (2.4 ppm).

2-(4-fluorophenyl)-3-((trifluoromethyl)thio)quinoline (2ah): yellow solid; 47.8 mg; 74%; ^1H NMR (400 MHz, $CDCl_3$) δ ppm 8.66 (s, 1H), 8.17 (d, J = 8.4 Hz, 1H), 7.90 (d, J = 8.0 Hz, 1H), 7.86−7.82 (m, 1H), 7.63 (dd, J = 8.8 Hz 5.6 Hz, 3H), 7.19 (t, J = 8.8 Hz, 2H); $^{13}C\{1H\}$ NMR (100 MHz, $CDCl_3$) δ ppm 163.2 (d, ^1J = 247 Hz, 1C), 160.9, 148.1, 146.4, 135.4 (d, ^4J = 3 Hz, 1C), 131.9, 131.7 (d, ^3J = 8 Hz, 1C), 129.5, 129.1 (q, J = 308 Hz, 1C, S**C**F_3), 127.6 (d, ^2J = 13 Hz, 1C), 127.1, 117.7 (J = 2 Hz, 1C, **C**-SCF_3, quartet peak should be obtained, however, doublet peak was observed due to the low resolution of NMR machine), 115.2, 115.0; ^{19}F NMR (376 MHz, $CDCl_3$) δ ppm -42.52 (s, 3F), -112.86—112.94 (m, 1F). IR (neat, cm^{-1}): 3624, 3057, 2925, 1780, 1601, 1549, 1513, 1482, 1404, 1369, 1229, 1155, 1115, 970, 841, 787, 759, 607; HRMS (ESI/Q-TOF) m/z: $[M + Na]^+$ Calcd for $C_{16}H_9F_4NNaS$ 346.0284; Found 346.0287 (0.9 ppm).

2-(4-chlorophenyl)-3-((trifluoromethyl)thio)quinoline (2ai): yellow solid; 42.1 mg; 62%; ^1H NMR (400 MHz, $CDCl_3$) δ ppm 8.66 (s, 1H), 8.17 (d, J = 8.4 Hz, 1H), 7.89 (d, J = 8.0 Hz, 1H), 7.83 (t, J = 7.6 Hz, 1H), 7.65−7.58 (m, 3H), 7.48 (d, J = 7.6 Hz, 2H); $^{13}C\{1H\}$ NMR (100 MHz, $CDCl_3$) δ ppm 160.8, 148.1, 146.5, 137.7, 135.1, 132.0, 131.1, 129.5, 129.0 (q, J = 308 Hz, 1C, S**C**F_3), 128.3, 127.8, 127.7, 127.1, 117.5 (J = 2 Hz, 1C, **C**-SCF_3, quartet peak should be obtained,

however, doublet peak was observed due to the low resolution of NMR machine); ^{19}F NMR (376 MHz, $CDCl_3$) δ ppm -42.49 (s, 3F). IR (neat, cm^{-1}): 3059, 2924, 1785, 1484, 1402, 1298, 1115, 1015, 968, 833, 787, 755; HRMS (ESI/Q-TOF) m/z: $[M + Na]^+$ Calcd for $C_{16}H_9ClF_3NNaS$ 361.9989; Found 361.9995 (1.7 ppm).

1-(4-(3-((trifluoromethyl)thio)quinolin-2-yl)phenyl)ethan-1-one (2aj): yellow solid; 59.8 mg; 86%; ^{1}H NMR (400 MHz, acetone) δ ppm 8.99 (s, 1H), 8.17 (dd, J = 13.2 Hz 8.8 Hz, 4H), 7.99−7.95 (m, 1H), 7.87 (d, J = 8.4 Hz, 1H), 7.78 (t, J = 7.6 Hz, 1H), 2.69 (s, 3H); ^{13}C{1H} NMR (100 MHz, acetone) δ ppm 197.7, 162.0, 149.3, 148.2, 144.9, 138.3, 133.2, 131.2, 130.5 (J = 307 Hz, 1C, **C**-SCF_3, quartet peak should be obtained, however, due to the poor solubility of this compound in each solvent, the insufficient acquisition time lead to doublet peak presented in ^{13}C{1H} NMR spectrum), 130.4, 129.1, 129.0, 128.6, 128.3, 117.9 (J = 1 Hz, 1C, **C**-SCF_3, quartet peak should be obtained, however, doublet peak was observed due to the low resolution of NMR machine), 26.9; ^{19}F NMR (376 MHz, $CDCl_3$) δ ppm -43.92 (s, 3F). IR (neat, cm^{-1}): 3049, 2918, 2777, 1819, 1672, 1608, 1485, 1398, 1359, 1270, 1150, 1110, 960, 834, 794, 760, 732, 654, 610; HRMS (ESI/Q-TOF) m/z: $[M + Na]^+$ Calcd for $C_{18}H_{12}F_3NNaOS$ 370.0484; Found 370.0492 (2.2 ppm).

2-(4-(trifluoromethyl)phenyl)-3-((trifluoromethyl)thio)quinoline (2ak): yellow solid; 53.8 mg; 72%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 8.70 (s, 1H), 8.19 (d, J = 8.4 Hz, 1H), 7.93 (d, J = 8.4 Hz, 1H), 7.88−7.84 (m, 1H), 7.77 (s, 4H), 7.67 (t, J = 7.6 Hz, 1H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 160.7, 148.2, 146.9, 142.8, 132.2, 130.8 (q, J = 33 Hz, 1C, **C**-CF_3), 130.2, 129.6, 129.0 (q, J = 308 Hz, 1C, S**C**F_3), 128.0, 127.7, 127.3, 125.1 (q, J = 4 Hz, 1C, **C**-C-CF_3), 124.1 (q, J = 271 Hz, 1C, **C**F_3), 117.3 (J = 3 Hz, 1C, **C**-SCF_3, quartet peak should be obtained, however, doublet peak was observed due to the low resolution of NMR machine); ^{19}F NMR (376 MHz, $CDCl_3$) δ ppm -42.54 (s, 3F). IR (neat, cm^{-1}): 2645, 1617, 1485, 1406, 1330, 1154, 1121, 1020, 972, 847, 792, 760, 619; HRMS (ESI/Q-TOF) m/z: $[M + Na]^+$ Calcd for $C_{17}H_9F_6NNaS$ 396.0252; Found 396.0259 (1.8 ppm).

4-(3-((trifluoromethyl)thio)quinolin-2-yl)benzonitrile (2al): dark yellow solid; 55.5 mg; 84%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 8.72 (s, 1H), 8.19 (d, J = 8.4 Hz, 1H), 7.95 (d, J = 8.0 Hz, 1H), 7.89 (t, J = 7.6 Hz, 1H), 7.79 (dd, J = 12.4 Hz 8.4 Hz, 4H), 7.70 (t, J = 7.6 Hz, 1H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 160.0, 148.1, 147.2, 143.6, 132.3, 131.8, 130.5, 129.5, 128.9 (q, J = 308 Hz, 1C, S**C**F_3), 128.2, 127.8, 127.3, 118.5, 116.9 (J = 2 Hz, 1C, **C**-SCF_3, quartet peak should be

obtained, however, doublet peak was observed due to the low resolution of NMR machine), 112.5; ^{19}F NMR (376 MHz, $CDCl_3$) δ ppm -42.54 (s, 3F). IR (neat, cm^{-1}): 3057, 2708, 1817, 1612, 1483, 1371, 1329, 1114, 970, 844, 790, 755; HRMS (ESI/Q-TOF) m/z: $[M + Na]^+$ Calcd for $C_{17}H_9F_3N_2NaS$ 353.0331; Found 353.0341 (2.8 ppm).

2-(m-tolyl)-3-((trifluoromethyl)thio)quinoline (2am): yellow liquid; 47.3 mg; 74%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 8.63 (s, 1H), 8.19 (d, J = 8.4 Hz, 1H), 7.88 (d, J = 8.0 Hz, 1H), 7.83−7.79 (m, 1H), 7.61 (t, J = 7.6 Hz, 1H), 7.43 (s, 1H), 7.39−7.36 (m, 2H), 7.29 (d, J = 7.2 Hz, 1H), 2.44 (s, 3H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 162.0, 147.9, 145.4, 139.2, 137.9, 131.6, 130.1, 129.6, 129.5, 129.2 (q, J = 308 Hz, 1C, S**C**F_3), 127.9, 127.6, 127.5, 127.0, 126.7, 118.1 (J = 2 Hz, 1C, **C**-SCF_3, quartet peak should be obtained, however, doublet peak was observed due to the low resolution of NMR machine), 21.5; ^{19}F NMR (376 MHz, $CDCl_3$) δ ppm -42.34 (s, 3F). IR (neat, cm^{-1}): 3055, 2924, 1614, 1577, 1550, 1483, 1451, 1399, 1370, 1118, 978, 917, 837, 781, 755, 728, 700; HRMS (ESI/Q-TOF) m/z: $[M + H]^+$ Calcd for $C_{17}H_{13}F_3NS$ 320.0715; Found 320.0721 (1.9 ppm).

2-(3-chlorophenyl)-3-((trifluoromethyl)thio)quinoline (2an): light yellow solid; 60.5 mg; 89%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 8.67 (s, 1H), 8.18 (d, J = 8.4 Hz, 1H), 7.91 (d, J = 8.4 Hz, 1H), 7.95 (d, J = 7.6 Hz, 1H), 7.66 (d, J = 12.4 Hz, 2H), 7.51 (d, J = 7.2 Hz, 1H), 7.47−7.41 (m, 2H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 160.5, 148.1, 146.5, 141.0, 134.1, 132.0, 129.8, 129.6, 129.3, 129.0 (q, J = 308 Hz, 1C, S**C**F_3), 129.0, 127.9, 127.9, 127.7, 127.2, 117.5 (J = 2 Hz, 1C, **C**-SCF_3, quartet peak should be obtained, however, doublet peak was observed due to the low resolution of NMR machine); ^{19}F NMR (376 MHz, $CDCl_3$) δ ppm -42.44 (s, 3F). IR (neat, cm^{-1}): 3422, 3063, 2926, 2855, 1942, 1784, 1616, 1574, 1482, 1370, 1302, 1258, 1107, 981, 891, 783, 756, 727, 692; HRMS (ESI/Q-TOF) m/z: $[M + Na]^+$ Calcd for $C_{16}H_9ClF_3NNaS$ 361.9989; Found 361.9999 (2.8 ppm).

2-(o-tolyl)-3-((trifluoromethyl)thio)quinoline (2ao): yellow liquid; 54.9 mg; 86%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 8.63 (s, 1H), 8.19 (d, J = 8.0 Hz, 1H), 7.90 (d, J = 8.0 Hz, 1H), 7.82 (t, J = 7.6 Hz, 1H), 7.63 (t, J = 7.2 Hz, 1H), 7.39−7.36 (m, 1H), 7.32−7.24 (m, 3H), 2.14 (s, 3H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 162.2, 147.8, 144.4, 138.9, 135.8, 131.6, 130.2, 129.4, 129.2 (q, J = 308 Hz, 1C, S**C**F_3), 129.1, 128.8, 127.6, 127.5, 127.1, 125.6, 119.3 (**C**-SCF_3, quartet peak should be obtained, however, single peak was observed due to the low resolution of NMR machine), 19.5; ^{19}F NMR (376 MHz, $CDCl_3$) δ ppm -41.97 (s, 3F). IR (neat, cm^{-1}): 3703, 3403, 3060, 2926, 1842,

1614, 1577, 1484, 1454, 1399, 1370, 1296, 1109, 970, 864, 758; HRMS (ESI/Q-TOF) m/z: $[M + H]^+$ Calcd for $C_{17}H_{13}F_3NS$ 320.0715; Found 320.0724 (2.8 ppm).

2-(2-methoxyphenyl)-3-((trifluoromethyl)thio)quinoline (2ap): yellow solid; 49.0 mg; 73%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 8.59 (s, 1H), 8.19 (d, J = 8.4 Hz, 1H), 7.87 (d, J = 8.4 Hz, 1H), 7.81−7.76 (m, 1H), 7.59 (t, J = 7.6 Hz, 1H), 7.52 (dd, J = 7.6 Hz 1.6 Hz, 1H), 7.48−7.44 (m, 1H), 7.15−7.12 (m, 1H), 6.97 (d, J = 8.4 Hz, 1H), 3.76 (s, 3H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 160.3, 156.5, 148.4, 144.4, 131.2, 130.6, 130.5, 129.6 (q, J = 307 Hz, 1C, S**C**F_3), 129.5, 128.8, 127.7, 127.3, 127.1, 121.1, 120.2 (J = 2 Hz, 1C, **C**-SCF_3, quartet peak should be obtained, however, doublet peak was observed due to the low resolution of NMR machine), 110.3, 55.2; ^{19}F NMR (376 MHz, $CDCl_3$) δ ppm -42.67 (s, 3F). IR (neat, cm^{-1}): 3412, 3060, 2936, 2838, 1785, 1603, 1552, 1490, 1463, 1437, 1398, 1370, 1292, 1256, 1110, 1024, 973, 921, 754; HRMS (ESI/Q-TOF) m/z: $[M + H]^+$ Calcd for $C_{17}H_{13}F_3NOS$ 336.0664; Found 336.0671 (2.1 ppm).

2-(2-fluorophenyl)-3-((trifluoromethyl)thio)quinoline (2aq): yellow liquid; 40.7 mg; 63%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 8.67 (s, 1H), 8.20 (d, J = 8.4 Hz, 1H), 7.92 (d, J = 8.4 Hz, 1H), 7.86−7.82 (m, 1H), 7.67−7.63 (m, 1H), 7.58 (t, J = 7.6 Hz, 1H), 7.48 (dd, J = 13.6 Hz 7.6 Hz, 1H), 7.32 (t, J = 7.6 Hz, 1H), 7.18 (t, J = 9.2 Hz, 1H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 159.7 (d, ^1J = 308 Hz, 1C), 158.1, 148.4, 146.1, 131.9, 131.2 (d, ^3J = 3 Hz, 1C), 131.1 (d, ^3J = 9 Hz, 1C), 129.6, 129.2 (q, J = 307 Hz, 1C, S**C**F_3), 127.9, 127.8, 127.6 (d, ^2J = 15 Hz, 1C), 127.3, 124.4 (d, ^4J = 3 Hz, 1C), 119.0 (J = 2 Hz, 1C, **C**-SCF_3, quartet peak should be obtained, however, doublet peak was observed due to the low resolution of NMR machine), 115.4 (d, ^2J = 22 Hz, 1C); ^{19}F NMR (376 MHz, $CDCl_3$) δ ppm -42.85 (d, J = 3 Hz, 3F), -115.31 (d, J = 3 Hz, 1F). IR (neat, cm^{-1}): 3680, 3063, 2926, 1798, 1617, 1580, 1554, 1486, 1454, 1400, 1371, 1287, 1249, 1213, 1159, 1108, 975, 862, 822, 788, 758; HRMS (ESI/Q-TOF) m/z: $[M + Na]^+$ Calcd for $C_{16}H_9F_4NNaS$ 346.0284; Found 346.0294 (2.9 ppm).

2-(2-bromophenyl)-3-((trifluoromethyl)thio)quinoline (2ar): yellow solid; 58.4 mg; 76%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 8.67 (s, 1H), 8.21−8.19 (m, 1H), 7.93 (t, J = 8.0 Hz, 1H), 7.87−7.82 (m, 1H), 7.68−7.64 (m, 2H), 7.51−7.45 (m, 2H); 7.36−7.32 (m, 1H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 161.7, 148.0, 146.0, 140.4, 131.8, 130.9, 130.2, 129.6, 129.2 (q, J = 308 Hz, 1C, S**C**F_3), 127.9, 127.8, 127.5, 127.4, 123.0, 119.0 (J = 2 Hz, 1C, **C**-SCF_3, quartet peak should be obtained, however, doublet peak was observed due to the low resolution of NMR machine); ^{19}F

NMR (376 MHz, $CDCl_3$) δ ppm -42.46 (s, 3F). IR (neat, cm^{-1}): 3059, 2926, 1618, 1572, 1554, 1481, 1433, 1399, 1370, 1284, 1108, 1026, 973, 922, 864, 792, 757; HRMS (ESI/Q-TOF) m/z: $[M + Na]^+$ Calcd for $C_{16}H_9BrF_3NNaS$ 405.9483; Found 405.9489 (1.5 ppm).

2-(3,5-dimethylphenyl)-3-((trifluoromethyl)thio)quinoline (2as): yellow solid; 49.3 mg; 74%; ^1H NMR (400 MHz, $CDCl_3$) δ ppm 8.62 (s, 1H), 8.18 (d, J = 8.4 Hz, 1H), 7.87 (d, J = 8.4 Hz, 1H), 7.83−7.79 (m, 1H), 7.63−7.59 (m, 1H), 7.19 (s, 2H), 7.11 (s, 1H), 2.40 (s, 6H); $^{13}C\{1H\}$ NMR (100 MHz, $CDCl_3$) δ ppm 162.1, 147.9, 145.0, 139.2, 137.6, 131.5, 130.5, 129.5, 129.2 (q, J = 308 Hz, 1C, S**C**F_3), 127.6, 127.4, 127.2, 127.0, 118.3 (J = 2 Hz, 1C, **C**-SCF_3, quartet peak should be obtained, however, doublet peak was observed due to the low resolution of NMR machine), 21.4; ^{19}F NMR (376 MHz, $CDCl_3$) δ ppm -42.27 (s, 3F). IR (neat, cm^{-1}): 3153, 2921, 1715, 1603, 1481, 1451, 1399, 1371, 1297, 1205, 1157, 1107, 1013, 976, 915, 854, 789, 756, 732, 699; HRMS (ESI/Q-TOF) m/z: $[M + H]^+$ Calcd for $C_{18}H_{15}F_3NS$ 334.0872; Found 334.0879 (2.1 ppm).

2-(3,5-dichlorophenyl)-3-((trifluoromethyl)thio)quinoline (2at): yellow liquid; 47.9 mg; 64%; ^1H NMR (400 MHz, $CDCl_3$) δ ppm 8.69 (s, 1H), 8.18 (d, J = 8.4 Hz, 1H), 7.93−7.86 (m, 2H), 7.68 (t, J = 7.6 Hz, 1H), 7.53 (d, J = 1.6 Hz, 2H), 7.48 (s, 1H); $^{13}C\{1H\}$ NMR (100 MHz, $CDCl_3$) δ ppm 159.2, 148.0, 147.0, 142.0, 134.7, 132.3, 129.6, 128.9, 128.9 (q, J = 308 Hz, 1C, S**C**F_3), 128.3, 128.2, 127.7, 127.3, 117.1 (J = 1 Hz, 1C, **C**-SCF_3, quartet peak should be obtained, however, doublet peak was observed due to the low resolution of NMR machine); ^{19}F NMR (376 MHz, $CDCl_3$) δ ppm -42.35 (s, 3F). IR (neat, cm^{-1}): 2959, 2869, 1857, 1558, 1483, 1408, 1369, 1262, 1119, 963, 852, 806, 785, 754, 728, 685; HRMS (ESI/Q-TOF) m/z: $[M + Na]^+$ Calcd for $C_{16}H_8Cl_2F_3NNaS$ 395.9599; Found 395.9609 (2.5 ppm).

2-(3,4-dimethylphenyl)-3-((trifluoromethyl)thio)quinoline (2au): yellow solid; 44.0 mg; 66%; ^1H NMR (400 MHz, $CDCl_3$) δ ppm 8.62 (s, 1H), 8.17 (d, J = 8.4 Hz, 1H), 7.87 (d, J = 8.4 Hz, 1H), 7.82−7.79 (m, 1H), 7.60 (t, J = 7.6 Hz, 1H), 7.40 (s, 1H), 7.33 (d, J = 7.6 Hz, 1H), 7.25 (d, J = 7.2 Hz, 1H), 2.35 (s, 3H), 2.34 (s, 3H); $^{13}C\{1H\}$ NMR (100 MHz, $CDCl_3$) δ ppm 161.9, 148.0, 145.2, 137.5, 136.9, 136.5, 131.5, 130.6, 129.5, 129.3, 129.2 (q, J = 308 Hz, 1C, S**C**F_3), 127.6, 127.3, 127.0, 126.9 118.2 (q, J = 2 Hz, 1C, **C**-SCF_3), 19.9, 19.7; ^{19}F NMR (376 MHz, $CDCl_3$) δ ppm -42.31 (s, 3F). IR (neat, cm^{-1}): 2923, 1714, 1616, 1576, 1550, 1481, 1450, 1402, 1370, 1263, 1107, 1003, 979, 824, 787, 754, 617; HRMS (ESI/Q-TOF) m/z: $[M + Na]^+$ Calcd for $C_{18}H_{14}F_3NNaS$ 356.0691; Found 356.0700 (2.5 ppm).

2-(3-chloro-4-methylphenyl)-3-((trifluoromethyl)thio)quinoline (2av): yellow solid; 40.3 mg; 57%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 8.65 (s, 1H), 8.17 (d, J = 8.4 Hz, 1H), 7.89 (d, J = 8.4 Hz, 1H), 7.83 (t, J = 8.0 Hz, 1H), 7.63 (t, J = 7.6 Hz, 2H), 7.43 (d, J = 7.6 Hz, 1H), 7.35 (d, J = 8.0 Hz, 1H), 2.46 (s, 3H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 160.4, 148.1, 146.3, 138.4, 136.8, 134.2, 131.9, 130.5, 130.2, 129.5, 129.1 (q, J = 308 Hz, 1C, S**C**F_3), 127.9, 127.7, 127.6, 127.1, 117.6 (J = 1 Hz, 1C, **C**-SCF_3, quartet peak should be obtained, however, doublet peak was observed due to the low resolution of NMR machine), 20.0; ^{19}F NMR (376 MHz, $CDCl_3$) δ ppm -42.42 (s, 3F). IR (neat, cm^{-1}): 3060, 2959, 2926, 1765, 1616, 1577, 1549, 1482, 1447, 1400, 1370, 1256, 1107, 978, 901, 826, 788, 754, 698, 620; HRMS (ESI/Q-TOF) m/z: $[M + H]^+$ Calcd for $C_{17}H_{12}ClF_3NS$ 354.0326; Found 354.0337 (3.1 ppm).

2-(2-methoxy-5-nitrophenyl)-3-((trifluoromethyl)thio)quinoline (2aw): yellow solid; 41.1 mg; 54%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 8.66 (s, 1H), 8.45−8.39 (m, 2H), 8.19 (d, J = 8.4 Hz, 1H), 7.95 (d, J = 8.0 Hz, 1H), 7.87 (dd, J = 8.4 Hz 7.6 Hz, 1H), 7.69 (t, J = 7.6 Hz, 1H), 7.08 (d, J = 9.2 Hz, 1H), 3.90 (s, 3H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 161.5, 158.0, 148.4, 145.6, 141.7, 131.9, 130.0, 129.5, 129.2 (J = 307 Hz, 1C, S**C**F_3), 128.0, 127.8, 127.4, 126.7, 126.7, 120.9 (J = 1 Hz, 1C, **C**-SCF_3, quartet peak should be obtained, however, doublet peak was observed due to the low resolution of NMR machine), 110.5, 56.2; ^{19}F NMR (376 MHz, $CDCl_3$) δ ppm -42.74 (s, 3F). IR (neat, cm^{-1}): 2926, 2850, 1732, 1613, 1587, 1521, 1490, 1462, 1428, 1343, 1270, 1109, 1070, 1020, 988, 909, 865, 825, 794, 754, 734, 637; HRMS (ESI/Q-TOF) m/z: $[M + Na]^+$ Calcd for $C_{17}H_{11}F_3N_2O_3NaS$ 403.0335; Found 403.0346 (2.7 ppm).

2-(thiophen-2-yl)-3-((trifluoromethyl)thio)quinoline (2ax): dark yellow solid; 30.5 mg; 49%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 8.57 (s, 1H), 8.14−8.09 (m, 2H), 7.81−7.77 (m, 2H), 7.57−7.51 (m, 2H), 7.16 (dd, J = 5.2 Hz 4.0 Hz, 1H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 154.0, 148.2, 148.2, 142.9, 132.0, 130.5, 129.6, 129.3 (q, J = 308 Hz, 1C, S**C**F_3), 129.2, 127.7, 127.5, 127.4, 126.5, 115.6 (q, J = 2 Hz, 1C, **C**-SCF_3); ^{19}F NMR (376 MHz, $CDCl_3$) δ ppm -42.55 (s, 3F). IR (neat, cm^{-1}): 3069, 2924, 1616, 1574, 1547, 1482, 1424, 1372, 1310, 1243, 1106, 851, 783, 752, 708; HRMS (ESI/Q-TOF) m/z: $[M + Na]^+$ Calcd for $C_{14}H_8F_3NNaS_2$ 333.9942; Found 333.9948 (1.8 ppm).

Characterization Data of 2ba−2bd and 2bf−2bg

5-methyl-2-(m-tolyl)-3-((trifluoromethyl)thio)quinoline (2ba): yellow solid; 52.7 mg; 79%; ^{1}H

NMR (400 MHz, $CDCl_3$) δ ppm 8.79 (s, 1H), 8.02 (d, J = 8.4 Hz, 1H), 7.69−7.65 (m, 1H), 7.45 (s, 1H), 7.41−7.35 (m, 3H), 7.28 (d, J = 7.6 Hz, 1H), 2.72 (s, 3H), 2.44 (s, 3H); $^{13}C\{1H\}$ NMR (100 MHz, $CDCl_3$) δ ppm 161.6, 148.4, 142.5, 139.2, 137.8, 134.7, 131.4, 130.1, 129.5, 129.2 (q, J = 308 Hz, 1C, S**C**F_3), 127.8, 127.8, 127.7, 126.7, 126.5, 117.4 (q, J = 1 Hz, 1C, **C**-SCF_3), 21.4, 18.4; ^{19}F NMR (376 MHz, $CDCl_3$) δ ppm -42.49 (s, 3F). IR (neat, cm^{-1}): 3036, 2949, 2924, 1945, 1582, 1555, 1468, 1379, 1285, 1110, 1062, 986, 916, 810, 793, 758, 727, 697, 640; HRMS (ESI/Q-TOF) m/z: $[M + H]^+$ Calcd for $C_{18}H_{15}F_3NS$ 334.0872; Found 334.0875 (0.9 ppm).

7-methoxy-2-phenyl-3-((trifluoromethyl)thio)quinoline (2bb): yellow solid; 34.9 mg; 52%; ^1H NMR (400 MHz, $CDCl_3$) δ ppm 8.54 (s, 1H), 7.76 (d, J = 8.8 Hz, 1H), 7.61 (d, J = 6.4 Hz, 2H), 7.51−7.48 (m, 4H), 7.28−7.25 (m, 1H), 3.95 (s, 3H); $^{13}C\{1H\}$ NMR (100 MHz, $CDCl_3$) δ ppm 162.7, 162.6, 150.2, 146.0, 139.6, 129.6, 129.2 (q, J = 308 Hz, 1C, S**C**F_3), 128.7, 128.7, 128.0, 122.4, 121.0, 114.7 (J = 2 Hz, 1C, **C**-SCF_3, quartet peak should be obtained, however, doublet peak was observed due to the low resolution of NMR machine), 107.3, 55.7; ^{19}F NMR (376 MHz, $CDCl_3$) δ ppm -42.92 (s, 3F). IR (neat, cm^{-1}): 3011, 2959, 2934, 2855, 1712, 1621, 1486, 1448, 1400, 1379, 1329, 1284, 1219, 1158, 1107, 1027, 974, 920, 851, 817, 752, 698, 640; HRMS (ESI/Q-TOF) m/z: $[M + Na]^+$ Calcd for $C_{17}H_{12}F_3NONaS$ 358.0484; Found 358.0487 (0.8 ppm).

7-bromo-2-phenyl-3-((trifluoromethyl)thio)quinoline (2bc): yellow solid; 46.1 mg; 60%; ^1H NMR (400 MHz, $CDCl_3$) δ ppm 8.59 (s, 1H), 7.87−7.82 (m, 2H), 7.62−7.60 (m, 2H), 7.50 (dd, J = 5.2 Hz 2.0 Hz, 3H), 7.25 (dd, J = 6.8 Hz 2.4 Hz, 1H); $^{13}C\{1H\}$ NMR (100 MHz, $CDCl_3$) δ ppm 163.1, 148.8, 145.7, 144.1, 139.1, 129.5, 129.4, 129.1 (q, J = 308 Hz, 1C, S**C**F_3), 129.0, 128.1, 124.6, 120.9, 117.1 (J = 1 Hz, 1C, **C**-SCF_3, quartet peak should be obtained, however, doublet peak was observed due to the low resolution of NMR machine), 117.0; ^{19}F NMR (376 MHz, $CDCl_3$) δ ppm -42.52 (s, 3F). IR (neat, cm^{-1}): 3060, 2925, 1615, 1580, 1483, 1430, 1375, 1332, 1287, 1251, 1105, 974, 865, 814, 758, 698; HRMS (ESI/Q-TOF) m/z: $[M + H]^+$ Calcd for $C_{16}H_{10}BrF_3NS$ 383.9664; Found 383.9672 (2.1 ppm).

7-chloro-2-(4-methoxyphenyl)-3-((trifluoromethyl)thio)quinoline (2bd): yellow solid; 54.0 mg; 73%; ^1H NMR (400 MHz, $CDCl_3$) δ ppm 8.56 (s, 1H), 7.85−7.80 (m, 2H), 7.60 (d, J = 8.4 Hz, 2H), 7.23 (dd, J = 8.8 Hz 2.4 Hz, 1H), 7.03 (d, J = 8.4 Hz, 2H), 3.89 (s, 3H); $^{13}C\{1H\}$ NMR (100 MHz, $CDCl_3$) δ ppm 162.5, 160.3, 148.9, 145.6, 143.9, 131.5, 131.2, 129.4, 129.2 (q, J = 309 Hz, 1C, S**C**F_3), 124.4, 120.7, 117.1 (J = 1 Hz, 1C, **C**-SCF_3, quartet peak should be obtained, however,

doublet peak was observed due to the low resolution of NMR machine), 117.0, 113.6, 55.3; ^{19}F NMR (376 MHz, $CDCl_3$) δ ppm -42.56 (s, 3F). IR (neat, cm^{-1}): 2926, 2842, 1609, 1577, 1514, 1484, 1419, 1375, 1329, 1293, 1251, 1155, 1106, 1032, 972, 835, 779; HRMS (ESI/Q-TOF) m/z: $[M + H]^+$ Calcd for $C_{17}H_{12}ClF_3NOS$ 370.0275; Found 370.0284 (2.4 ppm).

8-chloro-2-(m-tolyl)-3-((trifluoromethyl)thio)quinoline (2bf): yellow solid; 59.4 mg; 84%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 8.63 (s, 1H), 7.91 (dd, J = 7.6 Hz 1.2 Hz, 1H), 7.81−7.79 (m, 1H), 7.54−7.47 (m, 3H), 7.39 (t, J = 7.6 Hz, 1H), 7.30 (d, J = 7.2 Hz, 1H), 2.46 (s, 3H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 162.0, 145.1, 144.2, 138.7, 137.8, 133.9, 131.5, 130.6, 130.0, 129.1 (q, J = 308 Hz, 1C, S**C**F_3), 128.1, 127.9, 127.4, 127.1, 126.6, 119.5 (q, J = 2 Hz, 1C, **C**-SCF_3), 21.5; ^{19}F NMR (376 MHz, $CDCl_3$) δ ppm -42.11 (s, 3F). IR (neat, cm^{-1}): 3051, 2924, 2513, 1703, 1541, 1460, 1400, 1364, 1263, 1110, 1011, 764, 700; HRMS (ESI/Q-TOF) m/z: $[M + Na]^+$ Calcd for $C_{17}H_{11}ClF_3NNaS$ 376.0145; Found 376.0154 (2.4 ppm).

6-phenyl-7-((trifluoromethyl)thio)-[1,3]dioxolo[4,5-g]quinoline (2bg): white solid; 46.8 mg; 67%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 8.41 (s, 1H), 7.59 (d, J = 6.4 Hz, 2H), 7.50−7.44 (m, 4H), 7.10 (s, 1H), 6.15 (s, 2H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 160.3, 152.6, 148.7, 147.1, 144.5, 139.5, 129.7, 129.2 (q, J = 308 Hz, 1C, S**C**F_3), 128.6, 128.0, 124.4, 115.5 (J = 2 Hz, 1C, **C**-SCF_3, quartet peak should be obtained, however, doublet peak was observed due to the low resolution of NMR machine), 105.9, 102.3, 102.2; ^{19}F NMR (376 MHz, $CDCl_3$) δ ppm -42.75 (s, 3F). IR (neat, cm^{-1}): 3061, 2912, 2783, 1953, 1882, 1641, 1614, 1573, 1461, 1418, 1381, 1321, 1265, 1229, 1160, 1105, 1037, 976, 939, 856, 783, 758, 699, 612; HRMS (ESI/Q-TOF) m/z: $[M + Na]^+$ Calcd for $C_{17}H_{10}F_3NO_2NaS$ 372.0277; Found 372.0286 (2.4 ppm).

3-phenyl-4-((trifluoromethyl)thio)isoquinoline (2ca): white solid; 41.5 mg; 68%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 8.65 (s, 1H), 8.19 (d, J = 8.4 Hz, 1H), 7.89 (d, J = 7.6 Hz, 1H), 7.82 (d, J = 7.6 Hz, 1H), 7.62 (s, 3H), 7.50 (d, J = 4.8 Hz, 3H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 161.9, 148.1, 145.9, 139.3, 131.7, 129.6, 129.6, 129.2 (q, J = 308 Hz, 1C, S**C**F_3), 128.8, 128.1, 127.6, 127.6, 127.1, 117.9 (J = 2 Hz, 1C, **C**-SCF_3, quartet peak should be obtained, however, doublet peak was observed due to the low resolution of NMR machine); ^{19}F NMR (376 MHz, $CDCl_3$) δ ppm -42.42 (s, 3F). IR (neat, cm^{-1}): 3053, 2925, 2865, 1616, 1497, 1450, 1321, 1239, 1171, 1120, 1103, 1035, 1022, 954, 847, 754, 728, 714, 699, 654; HRMS (ESI/Q-TOF) m/z: $[M + H]^+$ Calcd for $C_{16}H_{11}F_3NS$ 306.0559; Found 306.0566 (2.3 ppm).

3-(4-methoxyphenyl)-4-((trifluoromethyl)thio)isoquinoline (2cb): white solid; 30.8 mg; 46%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 9.38 (s, 1H), 8.61 (d, J = 8.4 Hz, 1H), 8.04 (d, J = 8.0 Hz, 1H), 7.90−7.86 (m, 1H), 7.69 (t, J = 7.6 Hz, 1H), 7.59 (d, J = 8.8 Hz, 2H), 7.02 (d, J = 4.4 Hz, 2H), 3.88 (s, 3H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 160.6, 159.8, 154.8, 139.4, 132.6, 132.1, 131.7, 129.3 (q, J = 310 Hz, 1C, S**C**F_3), 128.0, 127.9, 127.7, 125.8, 114.2 (J = 2 Hz, 1C, **C**-SCF_3, quartet peak should be obtained, however, doublet peak was observed due to the low resolution of NMR machine), 113.3, 55.3; ^{19}F NMR (376 MHz, $CDCl_3$) δ ppm -41.52 (s, 3F). IR (neat, cm^{-1}): 3005, 2957, 2928, 1886, 1725, 1609, 1575, 1552, 1514, 1439, 1414, 1344, 1291, 1249, 1128, 1102, 1032, 974, 834, 793, 757, 693, 637; HRMS (ESI/Q-TOF) m/z: $[M + H]^+$ Calcd for $C_{17}H_{13}F_3NOS$ 336.0664; Found 336.0672 (2.4 ppm).

3-(4-ethylphenyl)-4-((trifluoromethyl)thio)isoquinoline (2cc): yellow solid; 35.3 mg; 53%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 9.39 (s, 1H), 8.61 (d, J = 8.4 Hz, 1H), 8.05 (d, J = 8.4 Hz, 1H), 7.90−7.86 (m, 1H), 7.11−7.67 (m, 1H), 7.54 (d, J = 8.0 Hz, 2H), 7.32 (d, J = 8.0 Hz, 2H), 2.74 (q, J = 7.6 Hz, 2H), 1.30 (t, J = 7.6 Hz, 3H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 161.1, 154.8, 144.5, 139.3, 137.6, 132.1, 130.2, 129.2 (q, J = 309 Hz, 1C, S**C**F_3), 128.0, 128.0, 127.7, 127.4, 125.8, 114.4 (J = 2 Hz, 1C, **C**-SCF_3, quartet peak should be obtained, however, doublet peak was observed due to the low resolution of NMR machine), 28.7, 15.4; ^{19}F NMR (376 MHz, $CDCl_3$) δ ppm -41.41 (s, 3F). IR (neat, cm^{-1}): 3027, 2965, 2931, 1712, 1616, 1552, 1441, 1412, 1247, 1129, 1102, 1023, 974, 834, 757; HRMS (ESI/Q-TOF) m/z: $[M + Na]^+$ Calcd for $C_{18}H_{14}F_3NNaS$ 356.0691; Found 356.0697 (1.7 ppm).

3-(4-bromophenyl)-4-((trifluoromethyl)thio)isoquinoline (2cd): white solid; 56.1 mg; 73%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 9.40 (s, 1H), 8.61 (d, J = 8.4 Hz, 1H), 8.07 (d, J = 8.4 Hz, 1H), 7.91 (t, J = 7.6 Hz, 1H), 7.29 (t, J = 7.6 Hz, 1H), 7.62 (d, J = 8.0 Hz, 2H), 7.50 (d, J = 8.0 Hz, 2H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 159.7, 155.0, 139.1, 139.1, 132.4, 131.9, 131.0, 129.1 (q, J = 309 Hz, 1C, S**C**F_3), 128.2, 128.1, 128.1, 125.8, 122.9, 114.8 (J = 1 Hz, 1C, **C**-SCF_3, quartet peak should be obtained, however, doublet peak was observed due to the low resolution of NMR machine); ^{19}F NMR (376 MHz, $CDCl_3$) δ ppm -41.39 (s, 3F). IR (neat, cm^{-1}): 2924, 1618, 1572, 1489, 1440, 1375, 1246, 1131, 1102, 1011, 977, 862, 827, 791, 757; HRMS (ESI/Q-TOF) m/z: $[M + Na]^+$ Calcd for $C_{16}H_9BrF_3NNaS$ 405.9483; Found 405.9494 (2.7 ppm).

4-(4-((trifluoromethyl)thio)isoquinolin-3-yl)benzonitrile (2ce): yellow solid; 31.7 mg; 48%; ^{1}H

NMR (400 MHz, $CDCl_3$) δ ppm 9.44 (s, 1H), 8.64 (d, J = 8.4 Hz, 1H), 8.12 (d, J = 8.0 Hz, 1H), 7.96 (t, J = 7.6 Hz, 1H), 7.79 (d, J = 7.6 Hz, 3H), 7.74 (d, J = 8.0 Hz, 2H); $^{13}C\{1H\}$ NMR (100 MHz, $CDCl_3$) δ ppm 158.8, 155.3, 144.6, 139.0, 132.7, 131.7, 131.0, 128.9 (q, J = 310 Hz, 1C, S**C**F_3), 128.6, 128.4, 128.2, 125.7, 118.7, 115.2 (J = 2 Hz, 1C, **C**-SCF_3, quartet peak should be obtained, however, doublet peak was observed due to the low resolution of NMR machine), 112.1; ^{19}F NMR (376 MHz, $CDCl_3$) δ ppm -41.35 (s, 3F). IR (neat, cm^{-1}): 3408, 3064, 2925, 2854, 1923, 1725, 1617, 1554, 1441, 1410, 1376, 1294, 1248, 1131, 1101, 1022, 976, 911, 839, 793, 758, 734; HRMS (ESI/Q-TOF) m/z: $[M + H]^+$ Calcd for $C_{17}H_{10}F_3N_2S$ 331.0511; Found 331.0522 (3.2 ppm).

3-(3-chlorophenyl)-4-((trifluoromethyl)thio)isoquinoline (2cf): yellow solid; 55.0 mg; 81%; ^1H NMR (400 MHz, $CDCl_3$) δ ppm 9.40 (s, 1H), 8.62 (d, J = 8.4 Hz, 1H), 8.07 (d, J = 8.0 Hz, 1H), 7.93−7.90 (m, 1H), 7.74 (t, J = 7.6 Hz, 1H), 7.62 (s, 1H), 7.51−7.49 (m, 1H), 7.42 (dd, J = 14.0 Hz 7.6Hz, 2H); $^{13}C\{1H\}$ NMR (100 MHz, $CDCl_3$) δ ppm 159.4, 155.0, 141.8, 139.1, 133.8, 132.4, 130.3, 129.1, 129.1 (q, J = 310 Hz, 1C, S**C**F_3), 128.5, 128.4, 128.3, 128.2, 128.1, 125.8, 115.0 (**C**-SCF_3, quartet peak should be obtained, however, single peak was observed due to the low resolution of NMR machine); ^{19}F NMR (376 MHz, $CDCl_3$) δ ppm -41.32 (s, 3F). IR (neat, cm^{-1}): 3067, 2926, 2854, 1942, 1616, 1553, 1486, 1439, 1411, 1376, 1342, 1248, 1211, 1131, 1102, 978, 883, 760, 708, 689; HRMS (ESI/Q-TOF) m/z: $[M + Na]^+$ Calcd for $C_{16}H_9ClF_3NNaS$ 361.9989; Found 361.9997 (2.2 ppm).

3-(o-tolyl)-4-((trifluoromethyl)thio)isoquinoline (2cg): yellow solid; 43.4 mg; 68%; ^1H NMR (400 MHz, $CDCl_3$) δ ppm 9.42 (s, 1H), 8.60 (d, J = 8.4 Hz, 1H), 8.07 (d, J = 8.0 Hz, 1H), 7.90 (t, J = 8.0 Hz, 1H), 7.20 (t, J = 7.6 Hz, 1H), 7.38−7.24 (m, 4H), 2.12 (m, 3H); $^{13}C\{1H\}$ NMR (100 MHz, $CDCl_3$) δ ppm 161.5, 154.9, 139.8, 138.9, 135.9, 132.2, 130.0, 129.8, 129.2 (q, J = 309 Hz, 1C, S**C**F_3), 128.4, 128.1, 128.1, 127.9, 125.6, 125.2, 115.8 (J = 1 Hz, 1C, **C**-SCF_3, quartet peak should be obtained, however, doublet peak was observed due to the low resolution of NMR machine), 19.6; ^{19}F NMR (376 MHz, $CDCl_3$) δ ppm -40.81 (s, 3F). IR (neat, cm^{-1}): 3063, 3024, 2957, 2926, 1728, 1618, 1555, 1485, 1444, 1413, 1376, 1290, 1248, 1130, 1102, 1044, 976, 938, 868, 758, 728; HRMS (ESI/Q-TOF) m/z: $[M + H]^+$ Calcd for $C_{17}H_{13}F_3NS$ 320.0715; Found 320.0721 (1.9 ppm).

6-chloro-3-phenyl-4-((trifluoromethyl)thio)isoquinoline (2ch): yellow solid; 36.7 mg; 54%; ^1H NMR (400 MHz, $CDCl_3$) δ ppm 9.38 (s, 1H), 8.61 (s, 1H), 8.01 (d, J = 8.8 Hz, 1H), 7.66 (d, J = 8.4 Hz, 1H), 7.59 (d, J = 7.2 Hz, 2H), 7.50−7.45 (m, 3H); $^{13}C\{1H\}$ NMR (100 MHz, $CDCl_3$) δ ppm

162.0, 154.5, 140.2, 139.8, 139.1, 133.7, 130.1, 129.7, 129.20 (q, J = 309 Hz, 1C, S**C**F_3), 129.1, 128.6, 127.9, 126.2, 125.0, 124.4, 113.7 (J = 1 Hz, 1C, **C**-SCF_3, quartet peak should be obtained, however, doublet peak was observed due to the low resolution of NMR machine); ^{19}F NMR (376 MHz, $CDCl_3$) δ ppm -41.46 (s, 3F). IR (neat, cm^{-1}): 2926, 2514, 1716, 1609, 1569, 1475, 1415, 1376, 1242, 1132, 1103, 980, 815, 758, 698, 636; HRMS (ESI/Q-TOF) m/z: $[M + Na]^+$ Calcd for $C_{16}H_9ClF_3NNaS$ 361.9989; Found 361.9989 (1.9 ppm).

7-methyl-3-phenyl-4-((trifluoromethyl)thio)isoquinoline (2ci): yellow solid; 49.8 mg; 78%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 9.32 (s, 1H), 8.50 (d, J = 8.8 Hz, 1H), 7.83 (s, 1H), 7.73 (dd, J = 8.8 Hz 1.2 Hz, 1H), 7.59 (d, J = 6.4 Hz, 2H), 7.50−7.42 (m, 3H), 2.6 (s, 3H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 160.2, 154.3, 140.3, 138.1, 137.5, 134.5, 130.2, 129.2 (q, J = 310 Hz, 1C, S**C**F_3), 128.3, 128.2, 127.8, 126.8, 125.6, 114.5 (J = 2 Hz, 1C, **C**-SCF_3, quartet peak should be obtained, however, doublet peak was observed due to the low resolution of NMR machine), 21.5; ^{19}F NMR (376 MHz, $CDCl_3$) δ ppm -41.45 (s, 3F). IR (neat, cm^{-1}): 3439, 3206, 2923, 2857, 1712, 1558, 1425, 1244, 1132, 1105, 1030, 979, 827, 760, 706; HRMS (ESI/Q-TOF) m/z: $[M + H]^+$ Calcd for $C_{17}H_{13}F_3NS$ 320.0715; Found 320.0722 (1.8 ppm).

7-chloro-3-phenyl-4-((trifluoromethyl)thio)isoquinoline (2cj): yellow solid; 38.7 mg; 57%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 9.32 (s, 1H), 8.55(d, J = 8.8 Hz, 1H), 8.02(s, 1H), 7.80 (d, J = 6.0 Hz, 1H), 7.60 (d, J = 4.8 Hz, 2H), 7.50−7.47 (m, 3H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 161.2, 153.8, 139.7, 137.6, 133.9, 133.0, 130.1, 129.0 (q, J = 310 Hz, 1C, S**C**F_3), 128.5, 128.5, 127.9, 127.8, 126.6, 114.7 (**C**-SCF_3, quartet peak should be obtained, however, single peak was observed due to the low resolution of NMR machine); ^{19}F NMR (376 MHz, $CDCl_3$) δ ppm -41.37 (s, 3F). IR (neat, cm^{-1}): 3057, 2624, 1713, 1547, 1386, 1241, 1152, 1106, 976, 940, 881, 837, 754, 698; HRMS (ESI/Q-TOF) m/z: $[M + Na]^+$ Calcd for $C_{16}H_9ClF_3NNaS$ 361.9989; Found 361.9999 (2.8 ppm).

8-fluoro-3-phenyl-4-((trifluoromethyl)thio)isoquinoline (2ck): light yellow solid; 47.2 mg; 73%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 9.70 (s, 1H), 8.39 (d, J = 8.4 Hz, 1H), 7.80 (dd, J = 14.0 Hz 8.0 Hz, 1H), 7.61 (d, J = 6.8 Hz, 2H), 7.51−7.44 (m, 3H), 7.32 (t, J = 8.8 Hz, 1H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 161.9, 159.2 (d, ^1J = 256 Hz, 1C), 148.6 (d, ^3J = 6 Hz, 1C), 140.5 (d, ^4J = 2 Hz, 1C), 139.9, 132.4 (d, ^3J = 9 Hz, 1C), 130.1, 129.1 (q, J = 310 Hz, 1C, S**C**F_3), 128.6, 127.9, 121.8 (d, ^3J = 5 Hz, 1C), 118.6 (d, ^2J = 16 Hz, 1C), 114.4 (J = 2 Hz, 1C, **C**-SCF_3), 111.7 (d, ^2J = 19

Hz, 1C); ^{19}F NMR (376 MHz, $CDCl_3$) δ ppm -41.36 (s, 3F), -122.33−-122.38 (m, 1F). IR (neat, cm^{-1}): 3614, 3067, 2923, 2853, 1628, 1566, 1447, 1408, 1377, 1238, 1169, 1126, 1107, 1033, 967, 907, 816, 776, 700, 608; HRMS (ESI/Q-TOF) m/z: $[M + H]^+$ Calcd for $C_{16}H_{10}F_4NS$ 324.0465; Found 324.0471 (1.9 ppm).

3-(3,5-dimethylphenyl)-4-((trifluoromethyl)thio)isoquinoline (2cl): yellow solid; 41.3 mg; 62%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 9.39 (s, 1H), 8.61 (d, J = 8.4 Hz, 1H), 8.05 (d, J = 8.0 Hz, 1H), 7.90−7.86 (m, 1H), 7.70 (t, J = 7.6 Hz, 1H), 7.20 (s, 2H), 7.09 (s, 1H), 2.40 (s, 6H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 161.4, 154.7, 140.1, 139.2, 137.3, 132.1, 130.0, 129.3 (q, J = 309 Hz, 1C, S**C**F_3), 128.0, 128.0, 127.8, 127.8, 125.8, 114.6 (J = 1 Hz, 1C, **C**-SCF_3, quartet peak should be obtained, however, doublet peak was observed due to the low resolution of NMR machine), 21.3; ^{19}F NMR (376 MHz, $CDCl_3$) δ ppm -41.24 (s, 3F). IR (neat, cm^{-1}): 2953, 2922, 2859, 1719, 1612, 1554, 1483, 1443, 1376, 1294, 1256, 1129, 1104, 1028, 978, 852, 793, 757; HRMS (ESI/Q-TOF) m/z: $[M + H]^+$ Calcd for $C_{18}H_{15}F_3NS$ 334.0872; Found 334.0878 (1.8 ppm).

3-(naphthalen-1-yl)-4-((trifluoromethyl)thio)isoquinoline (2cm): white solid; 47.6 mg; 67%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 9.47 (s, 1H), 8.62 (d, J = 8.8 Hz, 1H), 8.07 (d, J = 8.0 Hz, 1H), 7.97−7.88 (m, 3H), 7.71 (t, J = 7.6 Hz, 1H), 7.59 (t, J = 7.6 Hz, 1H), 7.53 (d, J = 6.8 Hz, 1H), 7.48−7.45 (m, 1H), 7.38−7.31 (m, 2H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 160.5, 155.0, 138.8, 137.7, 133.4, 132.3, 131.8, 129.0 (q, J = 310 Hz, 1C, S**C**F_3), 128.8, 128.3, 128.3, 128.1, 128.1, 127.9, 126.4, 125.8, 125.7, 125.2, 124.9, 117.0 (J = 2 Hz, 1C, **C**-SCF_3, quartet peak should be obtained, however, doublet peak was observed due to the low resolution of NMR machine); ^{19}F NMR (376 MHz, $CDCl_3$) δ ppm -40.98 (s, 3F). IR (neat, cm^{-1}): 3055, 2927, 1928, 1721, 1618, 1555, 1484, 1387, 1339, 1294, 1247, 1129, 1103, 1026, 969, 909, 860, 758, 733, 649 HRMS (ESI/Q-TOF) m/z: $[M + H]^+$ Calcd for $C_{20}H_{13}F_3NS$ 356.0715; Found 356.0724 (2.5 ppm).

3-(thiophen-2-yl)-4-((trifluoromethyl)thio)isoquinoline (2cn): red solid; 17.4 mg; 28%; ^{1}H NMR (400 MHz, $CDCl_3$) δ ppm 9.31 (s, 1H), 8.60 (d, J = 8.4 Hz, 1H), 8.26 (d, J = 7.2 Hz, 1H), 7.99 (d, J = 8.0 Hz, 1H), 7.85 (t, J = 7.2 Hz, 1H), 7.65 (t, J = 7.2 Hz, 1H), 7.54−7.53 (m, 1H), 7.18 (dd, J = 4.8 Hz 4.0 Hz, 1H); ^{13}C{1H} NMR (100 MHz, $CDCl_3$) δ ppm 154.9, 152.6, 143.4, 139.7, 132.3, 130.9, 129.7, 129.3 (q, J = 310 Hz, 1C, S**C**F_3), 128.0, 127.7, 127.6, 125.8, 111.3 (**C**-SCF_3, quartet peak should be obtained, however, single peak was observed due to the low resolution of NMR machine); ^{19}F NMR (376 MHz, $CDCl_3$) δ ppm -41.04 (s, 3F). IR (neat, cm^{-1}): 3091, 2922,

1729, 1614, 1576, 1551, 1438, 1360, 1246, 1226, 1168, 1126, 1096, 966, 840, 786, 757, 701; HRMS (ESI/Q-TOF) m/z: $[M + H]^+$ Calcd for $C_{14}H_9F_3NS_2$ 312.0123; Found 312.0132 (2.9 ppm).

■ ASSOCIATED CONTENT

Supporting Information

The Supporting Information is available free of charge on the ACS Publications website.

Crystallographic data and copies of the ^1H, ^{13}C and ^{19}F NMR spectra (PDF)

X-ray data for **2aa** (CIF)

X-ray data for **2ca** (CIF)

Accession Codes

CCDC 1887232 and 1887231 contains the supplementary crystallographic data for this paper.

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Notes

The authors declare no competing financial interest.

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