EurJOC
European Journal of Organic Chemistry

Chemistry Europe
European Chemical Societies Publishing

Accepted Article

Title: Direct C-S Bond Functionalization of Benzyl Mercaptan

Authors: Khokan Choudhuri, Milan Pramanik, and Prasenjit Mal

To be cited as: *Eur. J. Org. Chem.* 10.1002/ejoc.202000521

Link to VoR: https://doi.org/10.1002/ejoc.202000521

WILEY-VCH

FULL PAPER WILEY-VCH

Direct C-S Bond Functionalization of Benzyl Mercaptan

Khokan Choudhuri,[a] Milan Pramanik[a] and Prasenjit Mal*[a]

[a] Mr. K. Choudhuri, Mr. M. Pramanik, Dr. P. Mal
School of Chemical Sciences, National Institute of Science Education and Research (NISER), HBNI, Bhubaneswar, PO Bhimpur-Padanpur, Via Jatni, District Khurda, Odisha 752050, India
E-mail: pmal@niser.ac.in
https://www.niser.ac.in/users/pmal#profile-main

Supporting information for this article is given via a link at the end of the document

Abstract: Cleavage of a C-S bond of benzyl mercaptan led to formation of a new C-C bond during (*Z*)-selective alkenylation of nitriles using 1,10-phenanthroline as organocatalyst and ^{t}BuOK as a base. Also, we have shown that the cascaded functionalization of benzylic C-S and aryl-halide bonds could be done in one pot. ^{1}H NMR study and kinetic experiments also helped to establish the mechanism of the reaction.

Introduction

α,β-Unsaturated diphenylacrylonitrile skeleton is present in central cores of many drug molecules,[1] and found to have potent activities like anticancer,[2] antimicrobial,[3] antioxidant,[4] antitumor,[5] spasmolytic,[6] cytotoxic,[7] etc. They are also used as organic lighting-emitting diodes (OLEDs)[8] and provide key building block in many synthetic transformations.[9] The classical approach for the synthesis of α,β-unsaturated diphenylacrylonitrile from benzyl alcohol and benzyl cyanide involves metal catalysis (Figure 1a),[10] which makes the process unappealing in medicinal or pharmaceutical industries due to high toxicity issues and formation of unwanted side product.

Functionalization of more than one kind of bonds in one pot can be the state of art practice in synthetic organic chemistry. The chemical transformations *via* multiple bond functionalization in a cascaded manner can thus be important to mimic multistep reactions.[11] Among the functionalization of benzylic C-S and aryl-halide bonds, C-S bond functionalization is an important aspects in biological systems because, breaking of C-S bonds is well known in the replication of DNA.[12] Sulfur center in mercaptan can acts as either nucleophile or electrophile depending upon reaction environment. In addition, mercaptans are prone to get oxidized to disulfides.[13] Moreover, the mercaptans are readily accessible to be utilized as thiyl source for the formation of various kinds of C-S bonds.[14] The C-S bond cleavage of unbiased benzyl mercaptans and the utilization of them as benzyl synthon is extremely challenging and remain possibly unexplored in organic synthesis. Few examples on C-C,[15] C- Si,[16] C-O,[17] C-B[18] bond formation reactions are documented in literature *via* breaking of the respective pre-functionalized C-S bonds. In general, UV light[17] or metal catalysts like Rh[19] and Pd[18] are used to functionalize the C-S bond on pre-functionalized mercaptans. Herein, the approach towards metal free base mediated alkenylation of nitrile *via* C-S bond functionalization of benzyl mercaptan (Figure 1b) can have potential application in the pharmaceutical industry or in the green synthesis of fine chemicals. To the best of our knowledge, no report is available in the literature for the synthesis of stereoselective *α,β*-unsaturated diphenylacrylonitrile derivatives from mercaptan as benzyl synthon source *via* C-S bond cleavage. In addition, cascaded C-S and C-X (X= Cl, F) bond functionalization led to thiolated-diphenylacrylonitrile derivatives. These compounds are mostly used as radiation curing photosensitive initiator. The C-F bond is relatively less reactive nature and therefore difficult to functionalize due to high bond energy.[20] So, development of cascaded C-S and C-X (X = F, Cl) bond functionalization might be helpful in organic synthesis.

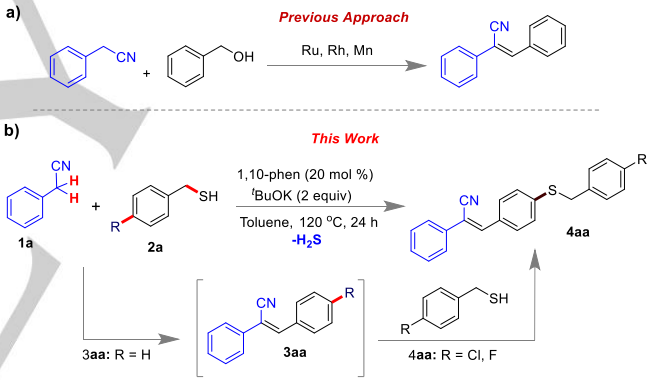


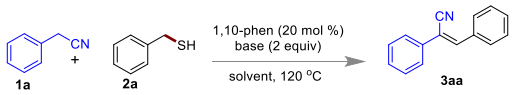
Figure 1. a) Known approach for *α*-olefination of nitriles using benzyl alcohol b) Our approach for alkenylation of nitrile through the breaking and reforming of C-S bond from benzyl mercaptan.

Results and Discussion

Before aryl-halide bond activations reactions, we have optimized the reaction sequence for the synthesis of diphenylacrylonitrile from benzyl cyanide (**1a**) and benzyl mercaptan (**2a**) using ^{t}BuOK and 1,10-phenanthroline (1,10-phen) (Table 1). The reactions were performed at 120 ºC and under open atmosphere. The compounds **1a** and **2a** smoothly reacted to afford the diphenylacrylonitrile (**3aa**) in 90% yield in presence of ^{t}BuOK and 1,10-phen within 24 h in benzene (entry 1). Varying the ratio of ^{t}BuOK and 1,10-phen led to inferior results (entries 2-3). Use of bases other than ^{t}BuOK was also not giving encouraging results (entries 4-6). This can be attributed to strong σ-donor and π-accepter ability of 1,10-phen,[21] to bind potassium(I) ion. Solvents other than toluene were also ineffective to have better yield of **3aa** (entries 7-12). Notablely, yield was reduced to 62 % when 1.5 equiv of benzyl mercaptan was used (entry 13). Upon lowering temperature than 120 ºC did not have any better impact (entry 14). Very poor yield **3aa** (28%) was observed in absence

of 1,10-phen (entry 15). However, no product could be detected in absence of ^{t}BuOK (entry 16) and in inert atmosphere (entry 17). However 82% yield of **3aa** was observed when reaction time was reduced to 18 h (entry 18). Finally, the most suitable condition was found to be using ^{t}BuOK (2 equiv) and 1,10-phen (0.2 equiv) in toluene (entry 10).

Table 1. Optimization Method.[a]



entry	base (equiv)	1,10-phen (mol %)	solvent	yield (%)[a]
1	^{t}BuOK (2.0)	0.2	benzene	90
2	^{t}BuOK (1.0)	0.2	benzene	75
3	^{t}BuOK (2.0)	0.1	benzene	40
4	^{t}BuOLi (2.0)	0.2	benzene	12
5	^{t}BuONa (2.0)	0.2	benzene	38
6	KOH (2.0)	0.2	benzene	0
7	^{t}BuOK (2.0)	0.2	DMF	17
8	^{t}BuOK (2.0)	0.2	DCE	15
9	^{t}BuOK (2.0)	0.2	EtOH	50
10	^{t}BuOK (2.0)	0.2	toluene	96
11	^{t}BuOK (2.0)	0.2	DMSO	--
12	^{t}BuOK (2.0)	0.2	xylene	91
13	^{t}BuOK (2.0)	0.2	toluene	62[b]
14	^{t}BuOK (2.0)	0.2	toluene	67[c]
15	^{t}BuOK (2.0)	--	toluene	28
16	--	0.2	toluene	0
17	^{t}BuOK (2.0)	0.2	toluene	0[d]
18	^{t}BuOK (2.0)	0.2	toluene	82[e]

Reaction Condition: **1a** (0.517 mmol), **2a** (1.034 mmol), 1,10-Phenanthroline (0.103 mmol), ^{t}BuOK (1.034 mmol) in toluene for 24 h. [a]Isolated yield; [b]1.5 equiv **2a** was used; [c]100 °C, 24 h, [d]N_2 atmosphere, [e]After 18 h.

Using the optimized reaction condition, substrate scope for the synthesis of α,β-diphenylacrylonitrile derivatives are shown in Figure 2. Reactions involving both electron donating (-Me, -OMe, -napthyl) and halide groups (-Cl, -F, -Br) at phenyl acetonitriles led to excellent yields (80-96%) of the products **3aa**-**3ha**. Similarly, **3db**, **3cc**, **3fc**, **3dc** and **3dd** were isolated in 82%, 84%, 71%, 95% and 93% yields, respectively. However, no product formation was observed with nitrile derivatives with electron withdrawing -NO_2 or -CN substituted phenyl groups (**3ic**, **3jc**). Possibly, after proton abstraction, phenyl acetonitrile led to benzylic anion intermediate which was not nucleophilic enough for condensation reaction due to –R effect of the -NO_2 or –CN groups. Furthermore, the versatility of the reaction was explored using heterocyclic coupling partners (both in aryl mercaptan and nitrile substrates). 2-Furfurylthiol reacted with substituted phenyl acetonitrile to produce **3hf**, **3df** and **3kf** in 82%, 94% and 81% yields, respectively. Similarly, 2-thenylmercaptan led to **3dg** and **3kg** in 76% and 74% yields, respectively. 2-Thiopheneacetonitrile also reacted with benzyl cyanide and yielded **3ka** in 85% yield. Likewise, we have extended our methodology towards *in situ* cascaded C-S and C-X (X = Cl, F) bond functionalization reaction *via* ipso substitution having halo substituted benzyl mercaptans (Figure 3). Under the standard condition benzyl mercaptan containing halides (X = -F, -Cl) at para position, selectively resulted in (*Z*)-selective thiolated-diphenylacrylonitrile derivatives. Fluorine substituted benzyl mercaptans also led to the products **4bh**, **4dh** and **4kh**, in good yields (73%, 67% and 50%, respectively) *via* C-F bond activation.[22] In addition, chloro substituted benzyl mercaptan provided **4ae** and **4ge,** in 65% and 74% yield, respectively. Mixture of products **3be** and **4be** was obtained in (3:4) ratio with 36% and 48% yield, respectively, when *p*-tolylacetonitrile was taken as one of the coupling partners. However, 2-chloro-4-fluoro phenylacetonitrile mainly delivered the para selective C-F bond activated product **4lc** in 36% yield.

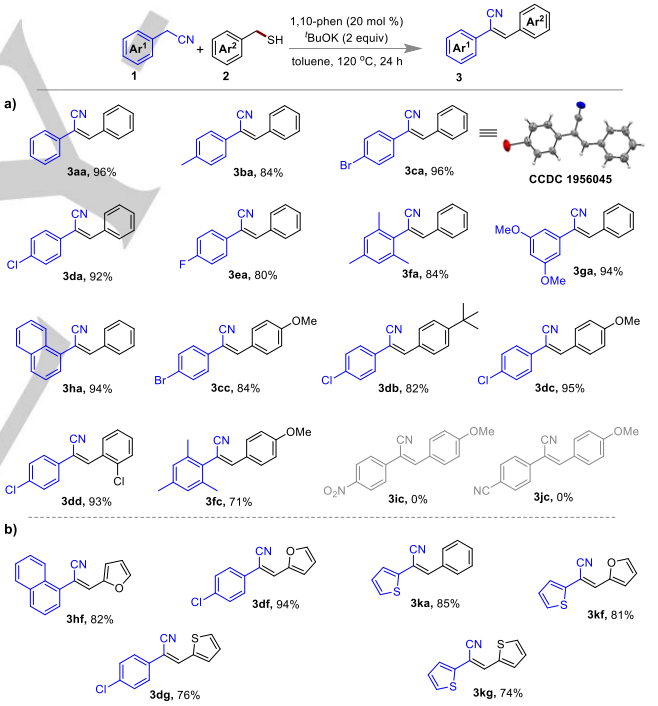


Figure 2. Substrate scope for the substituted 1,2-diphenylacrylonitrile synthesis. a) C-C Coupling reaction using different kinds of benzyl cyanides and mercaptans. b) C-C bond synthesis using heterocyclic coupling partner. **3ca:** CCDC 1956045.

Next, we have investigated the mechanism of the reaction using the support from control experiments shown in Figure 4. Radical pathway was initially anticipated,[23] because 1,10-phenanthroline and ^{t}BuOK are known to produce ^{t}BuO· *via* single electron transfer pathway.[24] However, the use of stoichiometric amount of radical scavengers like 2,2,6,6-tetramethyl-1-piperidinyloxy (TEMPO) or butylated hydroxytoluene (BHT) during the reaction under standard condition shown to have non-involvement of any radical pathway (Figure 4a). In presence of

base, the benzyl mercaptan generally produces 1,2-dibenzyldisulfane. As expected, 85% yield of **3aa** was isolated, when 1,2-dibenzyldisulfane was employed under optimized condition (Figure 4b). A kinetic isotopic effect was also measured and found to be K_H/K_D = 3.75 (Figure 4c). This indicates that the benzylic C(sp3)–H bond was actively participating to form a stable benzyl carbanionic intermediate during the reaction. Contrastingly, 2-phenylethane-1-thiol and phenyl acetonitrile under standard condition did not furnish any products (Figure 4d). This result indicated that stability of benzylic carbanion is an important factor for the reactions to proceed. In addition, reaction of **3de** with **2h** led to the formation of **4dh** in 68 % yield (Figure 4e). This fact confirms that the α,β-diphenylacrylonitrile might be the intermediate for the formation of *ipso* substituted product **4dh** *via* cascaded C-S and C-X bond functionalization reaction. Also, in absence of phenyl acetonitile, 87% yield of 1,2 dibenzyldisulfane was isolated (Figure 4f).[25] **4dh:** CCDC 1956046.

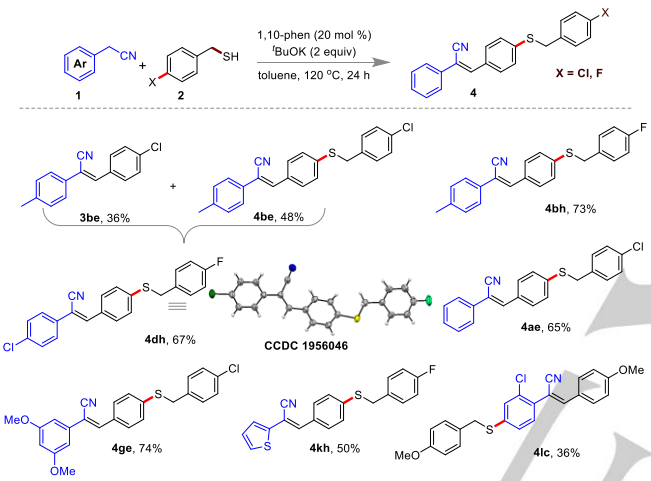


Figure 3. Scope of cascaded C-S and C-X (X = -F, -Cl) bond activation reaction.

A plausible mechanism for the cascaded benzylic C-S and aryl-halide bond functionalization has been proposed in Figure 5. Literature report[26] suggested that K^+ ion from inorganic salt ^{t}BuOK and 1,10-phen might have a reliable interaction with toluene *via* π-π stacking and cation-π interaction[27] to form a stable complex **5** in which the counter anion of ^{t}BuOK could be available for acidic H-abstraction (Figure 5a). Following, complex **5** under the treatment with **2a** in presence of aerial dioxygen led to intermediate **2aa**. Further, with the help of complex **5**, disulfides expected to get converted to a stable benzyl carbanion intermediate **2aa'** (Figure 5c). Under standard condition, benzyl carbanion intermediate **2aa'** is expected to produce thiobenzaldehyde[28] **6** and the intermediate **7** (Figure 5c). Following, carbanion intermediate **1a'** generated from phenyl acetonitrile **1a** (Figure 5b) was coupled with thiobenzaldehyde **6** to provide intermediate **8**. Finally, release of H_2S (turned the led-acetate paper into black, supporting information, Scheme S2) from **8** could lead to formation of **3aa** through E2 elimination. On the other hand compound **9** having F/Cl atom underwent *ipso* substitution by benzyl thiolate to produce compound **4ah**. ^{1}H NMR studies also supported for the formation of complex **5** (Figure 6) from 1,10-phen and ^{t}BuOK in toluene-d_8 (Figure 6b). A new peak at 5.1 ppm suggested a strong H-bonding between C(sp^3)-H of toluene and oxygen atom of ^{t}BuOK.

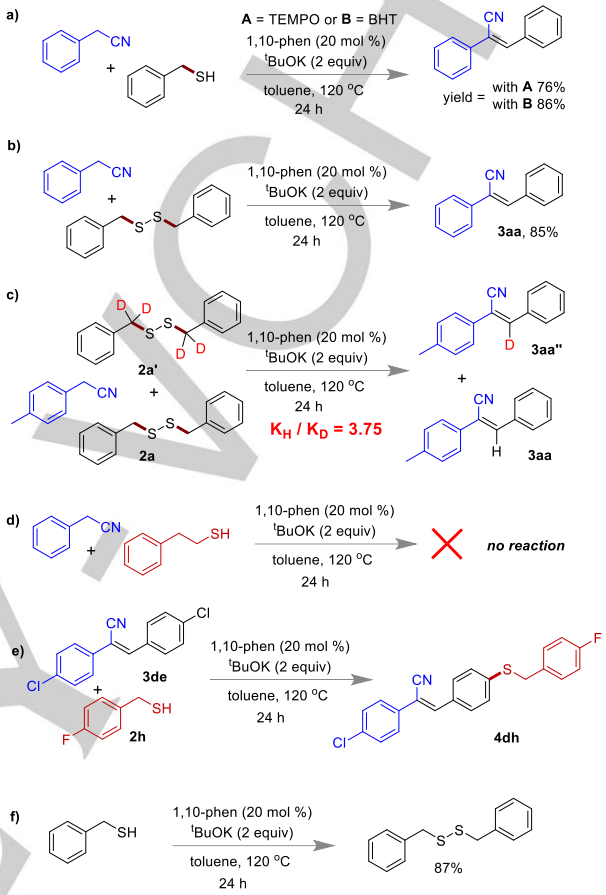


Figure 4. Control experiments.

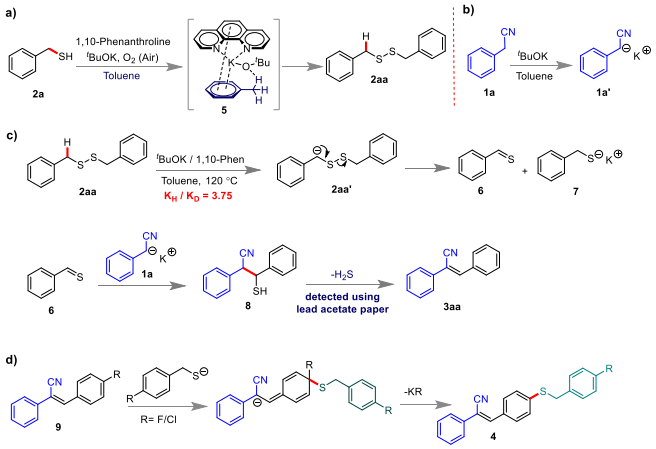


Figure 5. Plausible mechanism of the reaction. a) Activation of base by 1,10-phen. b) Generation of benzyl carbocation intermediate from disulfane. c) C-C bond formation reaction. d) *Ipso*-substitution and C-S coupling reaction.

The cascaded C-S and C-X (X = Cl, F) bond functionalization reactions were truly controlled by electronic effect. For aromatic

nucleophilic substitution reactions, stability of the sigma complexes are crucial. Therefore, fluorine substituted phenyl acetonitrile derivatives were unable to results in *ipso* substitution of C-F bonds and 2-(4-fluorophenyl)acetonitrile led to the formation of **3ea**. However, methyl group is an electron donating group due to hyperconjugation effect which may cause destabilization of the sigma complexes. Hence, mixture of products **3be** and **4be** was obtained in (3:4) ratio with 36% and 48% yield for the *p*-tolylacetonitrile system. On the other hand, for 2-(4-chlorophenyl)acetonitrile the –R effect by the Cl group operative and **4ae** was obtained as the only product.

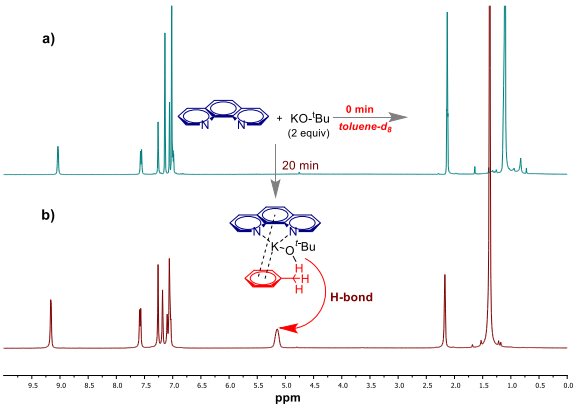


Figure 6. Possible interaction between the phenanthroline, ^{t}BuOK and the solvent molecule. a) ^{1}H-NMR spectra of 1,10-phenanthroline and ^{t}BuOK in toluene-d_8 after 0 min. b) ^{1}H-NMR spectra of 1,10-Phenanthroline and ^{t}BuOK after 15 min heating at 120 °C.

Conclusion

In conclusion, we have shown that using 1,10-phenanthroline as organocatalyst and ^{t}BuOK as base, cascaded activation of multiple bonds like benzylic C-S and aryl-halide could be possible in one pot. Overall, by the cleavage of C-S bond of benzyl mercaptans resulted in the formation of (*Z*)-selective *α*,*β*-unsaturated diphenylacrylonitriles in presence of phenyl acetonitriles. Also, synthesis of thiolated diphenylacrylonitriles derivatives were achieved from the same reaction pot by *ipso* substitution in diphenylacrylonitriles when para substituted halogen containing benzyl mercaptans were used. Thus expected that the current methodology will be highly appealing in organic synthesis, pharmaceutical chemistry and drug discovery.

Experimental Section

Instrumentation and Chemicals

All the chemicals were purchase from the commercially available source and used as received. All the reactions were carried out at 120 °C in open atmosphere. Column chromatography purification was performed using silica gel (Mesh 230-400) and ethyl acetate/hexane as an eluent unless otherwise specified. TLC was performed on Merck silica gel 60 F_{254} aluminum plate and visualized with UV lamp. ^{1}H and ^{13}C NMR spectra of the compounds were recorded on 400 and 700 MHz spectrometer at 25 °C. The chemical shift value (δ, ppm) were reported with respect to the residual chloroform (7.26 for ^{1}H and 77.16 ppm for ^{13}C) and DMSO-d_6 (2.50 for ^{1}H and 39.520 ppm for ^{13}C). Infrared (IR) spectra were recorded in wave number (cm^{-1}). Digital melting point apparatus were used to record the melting point of the compound. High resolution mass spectroscopy (HR-ESIMS) was recorded on ESI-TOF (Time-of-flight) mass spectroscopy.

Synthesis

General procedure for the preparation of diphenylacrylonitrile. To a stirred solution of 1,10-Phenanthroline (19 mg, 0.103 mmol) and ^{t}BuOK (116 mg, 1.034 mmol) in toluene, benzyl cyanide (60 µL, 0.517 mmol) and benzyl mercaptan (121 µL, 1.034 mmol) were added. Then the resulting mixture was allowed to stir at 120 °C for 24 h under open atmosphere. After that the solution was concentrated under vacuum, diluted with CH_2Cl_2 and washed with brine solution. Then the organic layer was dried over anhydrous sodium sulphate and purified through silica gel column chromatography using *n*-hexane and ethyl acetate solvent mixture as an eluent to afford the product.

KIE Experiment. To a stirred solution of 1,10-phenanthroline (0.021 mg, 0.114 mmol) and tBuOK (0.129 mg, 1.150 mmol) in toluene, benzyl cyanide (0.076 mg, 0.574 mmol), 1,2-dibenzyldisulfane (0.070 mg, 0.287 mmol) and 1,2-bis(phenylmethyl-d2)disulfane (0.071 mg, 0.287 mmol) were added. Then the resulting mixture was allowed to stir at 120 oC for 24 h under open atmosphere. After that the solution was concentrated under vacuum, diluted with CH2Cl2 and washed with brine solution. Then the organic layer was dried over anhydrous sodium sulfate and purified through silica gel column chromatography using n-hexane and ethyl acetate solvent mixture as an eluent to afford the mixture of (3aa and 3aa') product. After that, KH / KD ratio was calculated from NMR analysis and found to be KH / KD 3.75.

Preparation of 1,2-bis(phenylmethyl-d2)disulfane.

We prepared the 1,2-bis(phenylmethyl-d2)disulfane using the standard procedure[29] by the two step sequence described in details.

Preparation of 1,1-[D2]Phenylmethanethiol acetate. Thioacetic acid (12.03 mmol) and ZnI_2 (2.405 mmol) were added to a solution of phenylmethan-d2-ol (4.81 mmol) in dichloroethane. Then the solution was refluxed for 1 h to complete the reaction. After that the resulting solution was diluted with CH_2Cl_2 and washed with water, purified over silica-gel column chromatography to afford **13** as yellow color oil. ^{1}H NMR (400 MHz, CDCl3) δ 7.62 – 6.93 (m, 5H), 2.35 (s, 3H).

Preparation of Di-(1,1-[D2]Phenylmethyl) disulfide: To a room temperature solution of 13 in methanol, 0.25 mL conc. HCl was added and the resulting solution was refluxed for 14 h. After that, the solution was cooled to room temperature. Following, 5% solution of I_2 in methanol was added and stirred for 30 min. After completion of the reaction, saturated $Na_2S_2O_3$ was added to remove the excess amount of I_2 and the organic layer was separated. Then the crude mixture was purified over silica gel column chromatography using *n*-hexane and ethyl acetate solvent mixture to afford the product 14. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.36 – 7.26 (m, 8H), 7.25 – 7.24 (m, 1H), 7.24 – 7.22 (m, 1H).

(Z)-2,3-Diphenylacrylonitrile (3aa). R_f = 0.6 (5% ethyl acetate in hexane); White solid; yield 96% (102 mg); mp 80 - 82 °C (lit.[30] 86-87 °C); ^{1}H NMR (700 MHz, DMSO-d_6) δ 8.05 (s, 1H), 7.94 (d, *J* = 7.6 Hz, 2H), 7.77 (d, *J* = 7.6 Hz, 2H), 7.57 – 7.49 (m, 5H), 7.46 (t, *J* = 7.2 Hz, 1H); ^{13}C NMR (175 MHz, DMSO) δ 143.1, 133.8, 133.79, 130.7, 129.4, 129.3, 129.2, 129.0, 125.9, 118.0, 110.4.

(Z)-3-Phenyl-2-(p-tolyl)acrylonitrile (3ba). R_f = 0.62 (5% ethyl acetate in hexane); White solid; yield 84% (84 mg); mp 62 - 64 °C (lit.[31] 73-74 °C); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.88 (d, *J* = 7.0 Hz, 2H), 7.58 (d, *J* = 8.2 Hz, 2H), 7.50 (s, 1H), 7.49 – 7.40 (m, 3H), 7.25 (d, *J* = 8.2 Hz, 2H),

2.40 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 141.4, 139.6, 134.0, 131.8, 130.5, 129.9, 129.3, 129.1, 126.0, 118.2, 111.8, 21.4.

(Z)-2-(4-Bromophenyl)-3-phenylacrylonitrile (3ca). R_f = 0.6 (5% ethyl acetate in hexane); White solid; yield 96% (84 mg); mp 105-107 ºC (lit.[32] 135-137 ºC); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.92 – 7.85 (m, 2H), 7.60 – 7.52 (m, 5H), 7.51 – 7.44 (m, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 142.8, 133.6, 133.6, 132.4, 131.0, 129.5, 129.2, 127.6, 123.6, 117.8, 110.8.

(Z)-2-(4-Chlorophenyl)-3-phenylacrylonitrile (3da). R_f = 0.5 (5% ethyl acetate in hexane); White solid; yield 92% (110 mg); mp 117-119 ºC (lit.[33] 121-122 ºC); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.93 – 7.85 (m, 2H), 7.61 (d, *J* = 8.6 Hz, 2H), 7.52 (s, 1H), 7.50 – 7.44 (m, 3H), 7.42 (d, *J* = 8.6 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 142.7, 135.4, 133.6, 133.1, 130.9, 129.5, 129.4, 129.2, 127.4, 117.8, 110.7.

(Z)-2-(4-Fluorophenyl)-3-phenylacrylonitrile (3ea). R_f = 0.48 (5% ethyl acetate in hexane); White solid; yield 80% (89 mg); mp 85-87 ºC (lit.[34] 88-89 ºC);^{1}H NMR (400 MHz, $CDCl_3$) δ 7.91 – 7.84 (m, 2H), 7.66 (dd, *J* = 8.8, 5.2 Hz, 2H), 7.52 – 7.42 (m, 4H), 7.15 (t, *J* = 8.6 Hz, 2H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 163.4 (d, $^1J_{CF}$ = 248 Hz), 142.3 (d, $^4J_{CF}$ = 1.8 Hz), 133.7, 130.84, 130.78, 129.3 (d, $^2J_{CF}$ = 21.2 Hz), 128.0 (d, $^3J_{CF}$ = 8.3 Hz), 118.0, 116.4, 116.2, 110.8.

(Z)-2-Mesityl-3-phenylacrylonitrile (3fa). R_f = 0.4 (5% ethyl acetate in hexane); Colorless liquid; yield 84% (78 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.38 (s, 1H), 7.32 – 7.25 (m, 1H), 7.19 (t, *J* = 7.6 Hz, 2H), 6.99 (d, *J* = 7.6 Hz, 2H), 6.94 (s, 2H), 2.33 (s, 3H), 2.20 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 147.6, 145.6, 139.1, 136.2, 134.2, 130.4, 129.5, 129.3, 128.9, 119.7, 112.2, 21.3, 19.8; IR (KBr) ῡ = 3017, 2921, 2205, 1610, 1448, 1217 cm^{-1}; HRMS (ESI-TOF) calcd for $C_{18}H_{17}N$ (M +H)$^+$ 248.1434, found 248.1415.

(Z)-2-(3,5-dimethoxyphenyl)-3-phenylacrylonitrile (3ga).[35] R_f = 0.2 (5% ethyl acetate in hexane); Off white solid; yield 94% (84 mg); mp 68-70. ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.88 (d, *J* = 6.8 Hz, 2H), 7.53 (s, 1H), 7.51 – 7.41 (m, 3H), 6.81 (d, *J* = 2.2 Hz, 2H), 6.50 (t, *J* = 2.2 Hz, 1H), 3.85 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.2, 142.7, 136.5, 133.6, 130.6, 129.4, 129.0, 118.0, 111.6, 104.3, 101.3, 55.6; HRMS (ESI-TOF) calcd for $C_{17}H_{15}NO_2$ (M +H)$^+$ 266.1176, found 266.1185.

(Z)-2-(Naphthalen-1-yl)-3-phenylacrylonitrile (3ha).[10a] R_f = 0.2 (5% ethyl acetate in hexane); Colorless liquid; yield 94% (86 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.20 (d, *J* = 8.0 Hz, 1H), 7.97 (d, *J* = 7.6 Hz, 2H), 7.93 (d, *J* = 8.2 Hz, 2H), 7.63 – 7.56 (m, 3H), 7.55 – 7.50 (m, 4H), 7.36 (s, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 148.0, 134.0, 133.8, 133.7, 130.9, 130.9, 130.0, 129.4, 129.2, 128.9, 127.4, 127.2, 126.6, 125.5, 124.7, 118.7, 110.0.

(Z)-3-(4-(tert-Butyl)phenyl)-2-(4-chlorophenyl) acrylonitrile (3db). R_f = 0.65 (5% ethyl acetate in hexane); Light yellow solid; yield 82% (95 mg); mp 182-184 ºC; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.84 (d, *J* = 8.6 Hz, 2H), 7.60 (d, *J* = 8.6 Hz, 2H), 7.52 – 7.46 (m, 3H), 7.41 (d, *J* = 8.6 Hz, 2H), 1.35 (s, 9H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 154.7, 142.6, 135.2, 133.3, 130.9, 129.4 (x2), 127.3, 126.2, 118.1, 109.6, 35.2, 31.3; IR (KBr) ῡ = 2976, 2958, 2359, 2339, 2220, 1402 cm^{-1}; HRMS (ESI-TOF) calcd for $C_{19}H_{18}NCl$ (M +Na)$^+$ 318.1020, found 318.1005.

(Z)-2-(4-Bromophenyl)-3-(4-methoxyphenyl) acrylonitrile (3cc). R_f = 0.35 (5% ethyl acetate in hexane); Light yellow solid; yield 84% (81 mg); mp 128-130 ºC; ^{1}H NMR (700 MHz, $CDCl_3$) δ 7.88 (d, *J* = 8.8 Hz, 2H), 7.56 (d, *J* = 8.6 Hz, 2H), 7.52 (d, *J* = 8.6 Hz, 2H), 7.45 (s, 1H), 6.98 (d, *J* = 8.6 Hz, 2H), 3.88 (s, 3H); ^{13}C NMR (175 MHz, $CDCl_3$) δ 161.8, 142.4, 134.0, 132.3, 131.5, 127.4, 126.4, 123.0, 118.3, 114.6, 107.7, 55.6; IR (KBr) ῡ = 2923, 2852, 2359, 2214, 1511, 1273; HRMS (ESI-TOF) calcd for $C_{16}H_{12}NOBr$ (M +Na)$^+$ 335.9994, found 335.9995.

(Z)-3-(4-Chlorophenyl)-2-(*p*-tolyl)acrylonitrile (3be). R_f = 0.4 (5% ethyl acetate in hexane); Off white solid; yield 36% (40 mg); mp 118-120 ºC (lit.[36] 119-120 ºC); ^{1}H NMR (700 MHz, DMSO) δ 8.01 (s, 1H), 7.94 (d, *J* = 8.6 Hz, 2H), 7.66 (d, *J* = 8.2 Hz, 2H), 7.62 (d, *J* = 8.6 Hz, 2H), 7.33 (d, *J* = 8.2 Hz, 2H), 2.36 (s, 3H); ^{13}C NMR (175 MHz, DMSO) δ 140.4, 139.3, 134.9, 132.7, 130.8, 130.7, 129.8, 129.1, 125.7, 117.7, 110.9, 20.8.

(Z)-3-(2-Chlorophenyl)-2-(4-chlorophenyl)acrylonitrile (3dd). R_f = 0.5 (5% ethyl acetate in hexane); White solid; yield 93% (110 mg); mp 110-112 ºC (lit.[37] 109-110 ºC); ^{1}H NMR (700 MHz, DMSO) δ 8.13 (s, 1H), 7.96 (dd, *J* = 7.0, 1.8 Hz, 1H), 7.81 (d, *J* = 8.6 Hz, 2H), 7.67 – 7.63 (m, 1H), 7.61 (d, *J* = 8.6 Hz, 2H), 7.57 – 7.51 (m, 2H); ^{13}C NMR (175 MHz, DMSO) δ 140.2, 134.5, 133.4, 132.3, 131.9, 131.8, 129.8, 129.8, 129.4, 127.9, 127.6, 116.7, 113.8.

(Z)-2-Mesityl-3-(4-methoxyphenyl)acrylonitrile (3fc). R_f = 0.15 (5% ethyl acetate in hexane); Colorless liquid; yield 71% (74 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.32 (s, 1H), 6.94 (s, 2H), 6.93 – 6.88 (m, 2H), 6.71 (d, *J* = 8.8 Hz, 2H), 3.76 (s, 3H), 2.33 (s, 3H), 2.20 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.1, 144.9, 138.8, 136.3, 131.2, 129.2, 128.9, 127.0, 120.0, 114.2, 109.1, 55.3, 21.2, 19.7; IR (KBr) ῡ = 2961, 2811, 2248, 1931, 1661, 1154 cm^{-1}; HRMS (ESI-TOF) calcd for $C_{19}H_{19}NO$ (M +H)$^+$ 278.1539, found 278.1548.

(Z)-2-(4-Chlorophenyl)-3-(4-methoxyphenyl) acrylonitrile (3dc). R_f = 0.2 (5% ethyl acetate in hexane); Off white solid; yield 95% (100 mg); mp 118-120 ºC (lit.[33] 128-129 ºC); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.88 (d, *J* = 8.8 Hz, 2H), 7.58 (d, *J* = 8.6 Hz, 2H), 7.44 (s, 1H), 7.40 (d, *J* = 8.6 Hz, 2H), 6.99 (d, *J* = 8.8 Hz, 2H), 3.88 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.6, 142.2, 134.7, 133.4, 131.3, 129.2, 127.0, 126.3, 118.2, 114.5, 107.5, 55.5.

(Z)-3-(Furan-2-yl)-2-(naphthalen-1-yl)acrylonitrile (3hf): R_f = 0.4 (5% ethyl acetate in hexane); Yellow color liquid; yield 82% (72 mg); ^{1}H NMR (400 MHz, $CDCl_3$) δ 8.20 (d, *J* = 8.2 Hz, 1H), 7.91 (d, *J* = 7.6 Hz, 2H), 7.64 (d, *J* = 1.2 Hz, 1H), 7.62 – 7.46 (m, 4H), 7.24 (d, *J* = 3.6 Hz, 1H), 7.21 (s, 1H), 6.62 (dd, *J* = 3.4, 1.6 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 150.1, 145.1, 134.1, 134.0, 132.9, 130.9, 130.0, 128.9, 127.4, 127.2, 126.6, 125.5, 124.7, 118.7, 115.5, 112.9, 106.3; IR (KBr) ῡ = 3141, 3058, 2924, 2207, 1614, 1471, 1248 cm^{-1}; HRMS (ESI-TOF) calcd for $C_{17}H_{11}NO$ (M +Na)$^+$ 268.0733, found 268.0732.

(Z)-2-(4-Chlorophenyl)-3-(furan-2-yl)acrylonitrile (3df). R_f = 0.25 (5% ethyl acetate in hexane); Brown solid; yield 94% (85 mg); mp 74-76 ºC (lit.[33] 80-88 ºC); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.61 (d, *J* = 1.6 Hz, 1H), 7.57 (d, *J* = 8.6 Hz, 2H), 7.40 (d, *J* = 8.6 Hz, 2H), 7.36 (s, 1H), 7.21 (d, *J* = 3.6 Hz, 1H), 6.59 (dd, *J* = 3.6, 1.6 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 149.9, 145.2, 135.1, 132.2, 129.3, 128.2, 126.8, 117.5, 115.7, 112.9, 106.4.

(E)-3-Phenyl-2-(thiophen-2-yl)acrylonitrile (3ka). R_f = 0.4 (5% ethyl acetate in hexane); Yellow solid; yield 85% (100 mg); mp 78-80 ºC (lit.[38] 76-77 ºC); ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.85 (d, *J* = 6.4 Hz, 2H), 7.49 – 7.42 (m, 3H), 7.40 – 7.37 (m, 2H), 7.31 (d, *J* = 5.2 Hz, 1H), 7.08 (dd, *J* = 5.2, 3.8 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 139.8, 139.3, 133.5, 130.7, 129.3, 129.1, 128.3, 127.4, 126.4, 117.0, 106.3.

(E)-3-(Furan-2-yl)-2-(thiophen-2-yl)acrylonitrile (3kf): R_f = 0.4 (5% ethyl acetate in hexane); Yellow solid; yield 81% (92 mg); mp 84-86 ºC; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.59 (d, *J* = 1.2 Hz, 1H), 7.35 (d, *J* = 3.6 Hz, 1H), 7.29 (d, *J* = 5.2 Hz, 1H), 7.19 (s, 1H), 7.10 (d, *J* = 3.6 Hz, 1H), 7.06 (dd, *J* = 5.2, 3.6 Hz, 1H), 6.57 (dd, *J* = 3.6, 1.6 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 149.8, 145.1, 138.8, 128.4, 127.2, 126.2, 125.9, 116.8, 115.3, 113.0, 102.6; IR (KBr) ῡ = 3115, 2923, 2853, 2216, 1609, 1468, 1225, 745; HRMS (ESI-TOF) calcd for $C_{11}H_{17}NOS$ (M +H)$^+$ 202.0321, found 202.0332.

(Z)-2-(4-Chlorophenyl)-3-(thiophen-2-yl)acrylonitrile (3dg). R_f = 0.4 (5% ethyl acetate in hexane); Yellow solid; yield 76% (80 mg); mp 115-117 ºC (lit.[33] 135-136 ºC); ^{1}H NMR (700 MHz, DMSO-d_6) δ 8.36 (s, 1H), 7.95 (d, *J* = 4.8 Hz, 1H), 7.78 (d, *J* = 3.4 Hz, 1H), 7.75 (d, *J* = 8.6 Hz, 2H), 7.58 (d, *J* = 8.6 Hz, 2H), 7.28 (dd, *J* = 4.9, 3.8 Hz, 1H); ^{13}C NMR (175 MHz, DMSO-d_6) δ 137.4, 136.3, 135.0, 133.5, 132.3, 132.0, 129.2, 128.1, 127.2, 117.8, 104.9.

(E)-2,3-Di(thiophen-2-yl)acrylonitrile (3kg). R_f = 0.35 (5% ethyl acetate in hexane); Yellow solid; yield 74% (90 mg); mp 130-132 ºC (lit.[38] 130-131 ºC); ^{1}H NMR (700 MHz, DMSO-d_6) δ 8.04 (s, 1H), 7.90 (d, *J* = 5.0 Hz, 1H), 7.75 (d, *J* = 3.5 Hz, 1H), 7.66 (dd, *J* = 5.0, 0.9 Hz, 1H), 7.39 (dd, *J* = 3.5, 0.8 Hz, 1H), 7.25 (dd, *J* = 5.0, 3.8 Hz, 1H), 7.16 (dd, *J* = 5.0, 3.8 Hz, 1H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 138.7, 137.6, 132.1, 132.1, 130.0, 128.2, 127.9, 127.0, 125.9, 117.0, 103.2; IR (KBr) ῡ = 3097, 3081, 2185, 1545, 1430, 750, 713; HRMS (ESI-TOF) calcd for $C_{11}H_7NS_2$ (M +Na)$^+$ 239.9912, found 239.9916.

(Z)-3-(4-((4-Chlorobenzyl)thio)phenyl)-2-(*p*-tolyl) acrylonitrile (4be). R_f = 0.3 (5% ethyl acetate in hexane); White solid; yield 48% (80 mg); mp 114-116 ºC; ^{1}H NMR (700 MHz, DMSO-d_6) δ 7.92 (s, 1H), 7.85 (d, *J* = 8.2 Hz, 2H), 7.63 (d, *J* = 8.0 Hz, 2H), 7.47 (d, *J* = 8.2 Hz, 2H), 7.44 (d, *J* = 8.2 Hz, 2H), 7.37 (d, *J* = 8.2 Hz, 2H), 7.32 (d, *J* = 8.0 Hz, 2H), 4.36 (s, 2H), 2.35 (s, 3H); ^{13}C NMR (175 MHz, DMSO-d_6) δ 141.0, 139.6, 138.9, 136.3, 131.8, 131.1, 130.9, 130.7, 129.7, 129.5, 128.4, 127.3, 125.6, 118.1, 109.2, 34.7, 20.7; IR (KBr) ῡ = 3026, 2923, 2853, 2212, 1588, 1512, 1491, 746 cm^{-1}; HRMS (ESI-TOF) calcd for $C_{23}H_{18}NSCl$ (M +Na)$^+$ 398.0741, found 398.0731.

(Z)-3-(4-((4-Fluorobenzyl)thio)phenyl)-2-(p-tolyl) acrylonitrile (4bh). R_f = 0.3 (5% ethyl acetate in hexane); Off white solid; yield 73% (115 mg); mp 120-122 ºC; ^{1}H NMR (700 MHz, DMSO-d_6) δ 7.91 (s, 1H), 7.85 (d, *J* = 8.4 Hz, 2H), 7.63 (d, *J* = 8.0 Hz, 2H), 7.49 – 7.42 (m, 4H), 7.31 (d, *J* = 8.0 Hz, 2H), 7.14 (t, *J* = 8.8 Hz, 2H), 4.35 (s, 2H), 2.35 (s, 3H); ^{13}C NMR (175 MHz, DMSO-d_6) δ 161.3 (d, $^1J_{CF}$ = 243.3 Hz), 141.0, 139.9, 138.9, 133.3 (d, $^4J_{CF}$ = 2.9 Hz), 131.1, 130.8, 130.8, 129.7, 129.5, 127.3, 125.5, 118.1, 115.2 (d, $^2J_{CF}$ = 21.3 Hz), 109.1, 34.7, 20.7; IR (KBr) ῡ = 2923, 2853, 2211, 1600, 1510, 754; HRMS (ESI-TOF) calcd for $C_{23}H_{18}NSF$ (M +Na)$^+$ 382.1036, found 382.1034.

(Z)-3-(4-((4-Chlorobenzyl)thio)phenyl)-2-(3,5-dimethoxyphenyl)acrylonitrile (4ge). R_f = 0.15 (5% ethyl acetate in hexane); Light yellow solid; yield 74% (106 mg); mp 98-104 ºC; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.76 (d, *J* = 8.4 Hz, 2H), 7.41 (s, 1H), 7.30 (d, *J* = 8.4 Hz, 2H), 7.26 (s, 3H), 7.24 (s, 1H), 6.76 (d, *J* = 2.2 Hz, 2H), 6.46 (t, *J* = 2.1 Hz, 1H), 4.13 (s, 2H), 3.82 (s, 6H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.4, 141.8, 140.3, 136.6, 135.3, 133.4, 131.3, 130.2, 129.9, 129.0, 128.5, 118.2, 111.1, 104.4, 101.4, 55.7, 37.3; IR (KBr) ῡ = 2925, 2852, 2211, 1598, 1491, 1206, 737 cm^{-1}; HRMS (ESI-TOF) calcd for $C_{24}H_{20}NO_2SCl$ (M +Na)$^+$ 444.0795, found 444.0770.

(Z)-2-(4-Chlorophenyl)-3-(4-((4-fluorobenzyl)thio)phenyl)acrylonitrile (4dh). R_f = 0.3 (5% ethyl acetate in hexane); Light yellow solid; yield 67% (100 mg); mp 160-162 ºC; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.78 (d, *J* = 8.4 Hz, 2H), 7.59 (d, *J* = 8.4 Hz, 2H), 7.45 – 7.39 (m, 3H), 7.37 – 7.27 (m, 4H), 7.00 (t, *J* = 8.6 Hz, 2H), 4.18 (s, 2H); 13C NMR (100 MHz, CDCl3) δ 162.2 (d, $^1J_{CF}$ = 246.2 Hz), 141.6, 140.7, 135.2, 133.0, 132.2 (d, $^4J_{CF}$ = 3.2 Hz), 130.9, 130.4 (d, $^3J_{CF}$ = 8.1 Hz), 129.7, 129.3, 128.3, 127.2, 117.8, 115.6 (d, $^2J_{CF}$ = 21.6 Hz), 109.7, 37.0; ^{19}F NMR (376 MHz, CDCl3) δ -114.8; IR (KBr) ῡ = 3049, 2922, 2853, 2210, 1697, 1592, 755; HRMS (ESI-TOF) calcd for $C_{22}H_{15}NSClF$ (M +Na)$^+$ 402.0490, found 402.0484.

(Z)-3-(4-((4-Chlorobenzyl)thio)phenyl)-2-phenylacrylonitrile (4ae). R_f = 0.3 (5% ethyl acetate in hexane); Yellow solid; yield 65% (120 mg); mp 109-111 ºC; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.79 (d, *J* = 8.4 Hz, 2H), 7.66 (d, *J* = 7.4 Hz, 2H), 7.48 – 7.38 (m, 4H), 7.33 (d, *J* = 8.4 Hz, 2H), 7.29 – 7.26 (m, 4H), 4.16 (s, 2H); ^{13}C NMR (175 MHz, DMSO-d_6) δ 142.2, 139.9, 136.3, 133.9, 131.8, 130.8, 130.7, 129.6, 129.2, 129.2, 128.5, 127.3, 125.7, 118.1, 109.2, 34.7; IR (KBr) ῡ = 2954, 2923, 2853, 2185, 1605, 1409, 697; HRMS (ESI-TOF) calcd for $C_{22}H_{16}NSCl$ (M)$^+$ 361.0686, found 361.0717.

(E)-3-(4-((4-Fluorobenzyl)thio)phenyl)-2-(thiophen-2-yl)acrylonitrile (4kh). R_f = 0.2 (5% ethyl acetate in hexane); Yellow solid; yield 50% (98 mg); mp 90-92 ºC; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.75 (d, *J* = 8.4 Hz, 2H), 7.37 (d, *J* = 3.5 Hz, 1H), 7.35 – 7.26 (m, 6H), 7.10 – 7.04 (m, 1H), 7.00 (t, *J* = 8.6 Hz, 2H), 4.17 (s, 2H); ^{13}C NMR (175 MHz, $CDCl_3$) δ 162.3 (d, $^1J_{CF}$ = 246.2 Hz), 142.8, 140.4, 139.4, 138.9, 132.4 (d, $^4J_{CF}$ = 3.2 Hz), 131.0 (s), 130.5 (d, $^3J_{CF}$ = 8.1 Hz), 129.6, 128.5, 128.3, 127.3, 126.3, 117.1, 115.7 (d, $^2J_{CF}$ = 21.6 Hz), 105.6, 37.2; IR (KBr) ῡ = 2923, 2853, 2216, 1583, 1507, 1275, 848, 751 cm^{-1}; HRMS (ESI-TOF) calcd for $C_{20}H_{14}NS_2F$ (M +H)$^+$ 352.0624, found 352.0612.

(Z)-2-(2-Chloro-4-((4-methoxybenzyl)thio)phenyl)-3-(4-methoxyphenyl)acrylonitrile (4ic). R_f = 0.2 (5% ethyl acetate in hexane); Light yellow solid; yield 36% (54 mg); mp 108-110 ºC; ^{1}H NMR (400 MHz, $CDCl_3$) δ 7.83 (d, *J* = 8.8 Hz, 2H), 7.31 (d, *J* = 1.6 Hz, 1H), 7.27 – 7.19 (m, 3H), 7.17 – 7.09 (m, 2H), 6.93 (d, *J* = 8.8 Hz, 2H), 6.81 (d, *J* = 8.8 Hz, 2H), 4.09 (s, 2H), 3.83 (s, 3H), 3.76 (s, 3H); ^{13}C NMR (100 MHz, $CDCl_3$) δ 161.8, 159.1, 147.6, 140.0, 133.3, 132.0, 131.3, 130.8, 130.0, 129.6, 128.2, 127.2, 126.0, 117.9, 114.4, 114.1, 105.4, 55.5, 55.3, 37.6; IR (KBr) ῡ = 2954, 2925, 2853, 2125, 1608, 1250, 1177, 738 cm^{-1}; HRMS (ESI-TOF) calcd for $C_{24}H_{20}NO_2SCl$ (M +Na)$^+$ 444.0795, found 444.0798.

Acknowledgements

We thank CSIR for funding (Project No. 02(0338)/18/EMR-II dated 24-04-2018). K.C. and M.P. thank NISER for fellowship.

Keywords: Benzylic C-S bond functionalization • Cascaded Reactions • Organocatalysis • 1,10-Phenanthroline-^{t}BuOK • (*Z*)-Selective alkenylation

[1] F. F. Fleming, L. Yao, P. C. Ravikumar, L. Funk, B. C. Shook, *J. Med. Chem.* **2010**, *53*, 7902-7917.

[2] J. Ma, J. Li, Y. S. Tian, *Bioorg. Med. Chem. Lett.* **2017**, *27*, 81-85.

[3] M. S. Alam, Y. J. Nam, D. U. Lee, *Eur. J. Med. Chem.* **2013**, *69*, 790-797.

[4] M. De Rosa, L. Lu, E. Zamaratski, N. Szałaj, S. Cao, H. Wadensten, L. Lenhammar, J. Gising, A. K. Roos, D. L. Huseby, R. Larsson, P. E. Andrén, D. Hughes, P. Brandt, S. L. Mowbray, A. Karlén, *Biorg. Med. Chem.* **2017**, *25*, 897-911.

[5] M. Hranjec, G. Pavlović, M. Marjanović, M. Kralj, G. Karminski-Zamola, *Eur. J. Med. Chem.* **2010**, *45*, 2405-2417.

[6] S. Naruto, H. Mizuta, T. Yoshida, H. Uno, K. Kawashima, T. Kadokawa, H. Nishimura, *Chem. Pharm. Bull.* **1983**, *31*, 2023-2032.

[7] F. Sączewski, P. Reszka, M. Gdaniec, R. Grünert, P. J. Bednarski, *J. Med. Chem.* **2004**, *47*, 3438-3449.

[8] W. Wen, Z.-F. Shi, X.-P. Cao, N.-S. Xu, *Dyes Pigments* **2016**, *132*, 282-290.

[9] F. F. Fleming, Q. Wang, *Chem. Rev.* **2003**, *103*, 2035-2078.

[10] a) S. Chakraborty, U. K. Das, Y. Ben-David, D. Milstein, *J. Am. Chem. Soc.* **2017**, *139*, 11710-11713; b) J. Li, Y. Liu, W. Tang, D. Xue, C. Li, J. Xiao, C. Wang, *Chem. Eur. J.* **2017**, *23*, 14445-14449.

[11] a) J.-N. Zhu, W.-K. Wang, Y. Zhu, Y.-Q. Hu, S.-Y. Zhao, *Org. Lett.* **2019**, *21*, 6270-6274; b) K. Seth, S. Raha Roy, A. K. Chakraborti, *Chem. Commun.* **2016**, *52*, 922-925.

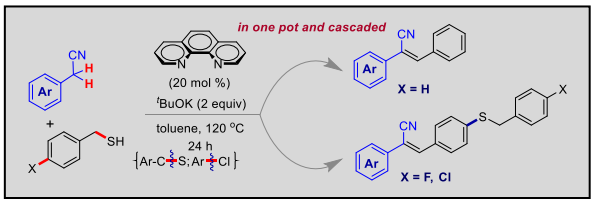
[12] J. Liang, Z. Wang, X. He, J. Li, X. Zhou, Z. Deng, *Nucleic Acids Res.* **2007**, *35*, 2944-2954.

[13] a) Y. Liu, H. Wang, C. Wang, J.-P. Wan, C. Wen, *RSC Adv.* **2013**, *3*, 21369-21372; b) S.-S. Wu, C.-T. Feng, D. Hu, Y.-K. Huang, Z. Li, Z.-G.

Luo, S.-T. Ma, *Org. Biomol. Chem.* **2017**, *15*, 1680-1685; c) H. Huang, J. Ash, J. Y. Kang, *Org. Biomol. Chem.* **2018**, *16*, 4236-4242.
[14] a) E. L. Tyson, M. S. Ament, T. P. Yoon, *J. Org. Chem.* **2013**, *78*, 2046-2050; b) K. Choudhuri, T. K. Achar, P. Mal, *Adv. Synth. Catal.* **2017**, *359*, 3566-3576; c) K. Choudhuri, S. Maiti, P. Mal, *Adv. Synth. Catal.* **2019**, *361*, 1092-1101.
[15] M. Lanzi, J. Merad, D. V. Boyarskaya, G. Maestri, C. Allain, G. Masson, *Org. Lett.* **2018**, *20*, 5247-5250.
[16] Y. M. Lin, G. P. Lu, R. K. Wang, W. B. Yi, *Org. Lett.* **2017**, *19*, 1100-1103.
[17] R.-Z. Mao, F. Guo, D.-C. Xiong, Q. Li, J. Duan, X.-S. Ye, *Org. Lett.* **2015**, *17*, 5606-5609.
[18] M. Bhanuchandra, A. Baralle, S. Otsuka, K. Nogi, H. Yorimitsu, A. Osuka, *Org. Lett.* **2016**, *18*, 2966-2969.
[19] Y. Uetake, T. Niwa, T. Hosoya, *Org. Lett.* **2016**, *18*, 2758-2761.
[20] H. Amii, K. Uneyama, *Chem. Rev.* **2009**, *109*, 2119-2183.
[21] S. R. Maqsood, N. Islam, S. Bashir, B. Khan, A. H. Pandith, *J. Coord. Chem.* **2013**, *66*, 2308-2315.
[22] a) J. J. Gair, R. L. Grey, S. Giroux, M. A. Brodney, *Org. Lett.* **2019**, *21*, 2482-2487; b) T. Stahl, H. F. T. Klare, M. Oestreich, *ACS Catal.* **2013**, *3*, 1578-1587.
[23] A. Studer, D. P. Curran, *Nat. Chem.* **2014**, *6*, 765-773.
[24] H. Zhang, R. Shi, A. Ding, L. Lu, B. Chen, A. Lei, *Angew. Chem. Int. Ed.* **2012**, *51*, 12542-12545.
[25] W.-L. Dong, G.-Y. Huang, Z.-M. Li, W.-G. Zhao, *Phosphorus Sulfur Silicon Relat. Elem.* **2009**, *184*, 2058-2065.
[26] a) M. Patil, *J. Org. Chem.* **2016**, *81*, 632-639; b) C.-L. Sun, H. Li, D.-G. Yu, M. Yu, X. Zhou, X.-Y. Lu, K. Huang, S.-F. Zheng, B.-J. Li, Z.-J. Shi, *Nat. Chem.* **2010**, *2*, 1044.
[27] D. A. Dougherty, *Acc. Chem. Res.* **2013**, *46*, 885-893.
[28] J. Zhang, M. Qiao, L. Chen, Y. Dong, C. Jiao, S. Liao, Y. Wu, *Org. Chem. Front.* **2019**, *6*, 2844-2849.
[29] R. Amorati, P. T. Lynett, L. Valgimigli, D. A. Pratt, *Chem. Eur. J.* **2012**, *18*, 6370-6379.
[30] C. R. Hauser, W. R. Brasen, *J. Am. Chem. Soc.* **1956**, *78*, 494-497.
[31] K. Hohenlohe-Oehringen, *Monatshefte für Chemie und verwandte Teile anderer Wissenschaften* **1958**, *89*, 479-488.
[32] Y. Yue, J. Kang, M. Yu, *Dyes Pigments* **2009**, *83*, 72-80.
[33] S. S. Kulp, C. B. Caldwell, *J. Org. Chem.* **1980**, *45*, 171-173.
[34] S. S. Al-Shihry, *Molecules* **2004**, *9*, 658-665.
[35] H. Ishitani, Y. Saito, Y. Nakamura, W.-J. Yoo, S. Kobayashi, *Asian J. Org. Chem.* **2018**, *7*, 2061-2064.
[36] J.-J. Li, J. Ma, Y.-B. Xin, Z.-S. Quan, Y.-S. Tian, *Chem. Biol. Drug Des.* **2018**, *92*, 1419-1428.
[37] J.-L. Han, S.-J. Zhi, L.-Y. Wang, Y. Pan, G. Li, *Eur. J. Org. Chem.* **2007**, 1332-1337.
[38] B. F. Crowe, F. F. Nord, *J. Org. Chem.* **1950**, *15*, 1177-1183.

10.1002/ejoc.202000521

C-S Bond Activation



Using 1,10-phenanthroline as organocatalyst and ^{t}BuOK as base, cascaded activation of three different bonds like C(sp^3)-H, benzylic C-S and aryl-halide could be achievable in one pot.