

Convenient and Efficient Synthesis of Functionalized 2-Sulfenylindoles

Abstract: A simple, efficient, and practical sulfonylation at the C2 position of *N*-tosylindoles under mild conditions was developed. The designed transformation is based on the reaction of *N*-tosylindoles with BuLi and *S*-alkyl and *S*-aryl thiotosylates to produce 2-sulfenylindoles in moderate to high yields. The presence of additional hydroxy, carboxy, or amino functionalities did not disturb the formation of products.

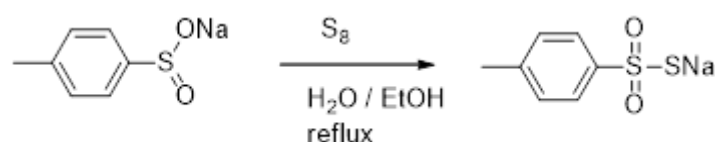
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1. General Information

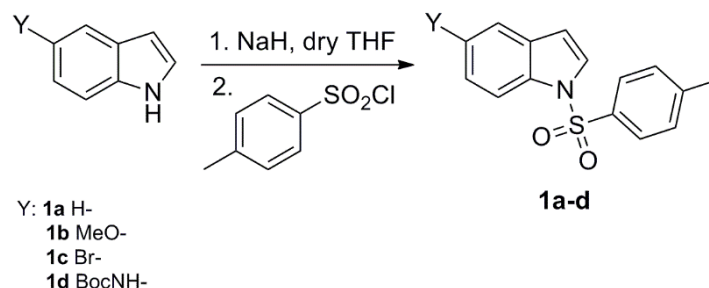
All 1-[(4-methylphenyl)sulfonyl]indoles (**1a–d**) were obtained from indole, 5-methoxyindole, 5-bromoindole, and 5-aminoindole, respectively. Sodium hydride and *p*-toluenesulfonyl chloride were purchased from Merck. All bromides required for preparation thiotosylates **3** were purchased from ProChimia. 5,5-Dimethyl-2-thioxo-1,3,2-dioxaphosphorinane-2-disulfanyl derivatives [RSC *Adv.*, **2016**, 6, 105449–105453] **2** and thiotosylates [Eur. J. Org. Chem. **2018**, 6333–6337] **3** were prepared by the literature methods. Sodium 4-methylbenzenesulfonothioate was obtained from sodium 4-methylbenzenesulfinate purchased from Merck. *N,N,N',N'*-tetramethylethylenediamine (TMEDA) is available from Merck. Tetrahydrofuran was pre-dried over KOH pellets and distilled. Subsequently, THF was dried by heating under reflux over potassium in the presence of benzophenone as an indicator and distilled. TLC was performed with silica gel Polygram SIL G/UV254. Column chromatography was performed using silica gel 60 (230–400 mesh, Merck). NMR spectra were recorded on Bruker 400 MHz spectrometers. The residual solvent peak was used as the internal reference (CDCl₃: δ = 7.26 ppm for ¹H, δ = 77.0 ppm for ¹³C). IR spectra were recorded on Nicolet Is50 Ft-IR spectrometer by ATR method. Melting points were measured with a Gallenkamp 7936B apparatus.

2. Typical Procedure for the Preparation of Sodium 4-methylbenzenesulfonothioate



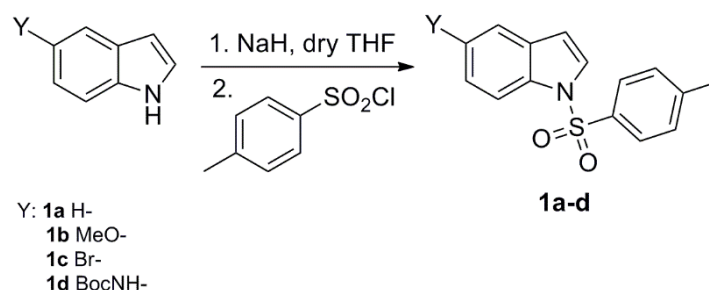
To a stirred solution of sodium 4-methylbenzenesulfinate (112 mmol) in H₂O/EtOH (100 mL/100 mL) was added sulfur (122 mmol). Mixture was warmed to reflux for 8 h. Then residual sulfur was removed by filtration. Filtrate was evaporated. The wet solid was dried under vacuum for 9 h at room temperature to provide 18.8 g (80%) of sodium 4-methylbenzenesulfonotioate (procedure from L. Wang, D.L.J. Clive, *Org. Synth.* 2013, **90**, 10–24).

3. General Procedure for the Preparation of Thiotosylates Derivatives 3 and Representative Analytical Data



To a stirred solution of alkyl bromide (1 eq) in acetonitrile (20 mL) was added sodium 4-methylbenzene-sulfonotioate (1.1 eq). Reaction was stirred for 3 h under reflux. Then mixture was slowly cooled to room temperature and stirred overnight. After evaporation of the solvent under reduced pressure, the residue was dissolved in Et₂O and washed with water, dried over MgSO₄, filtered and concentrated under vacuum. The products were purified by column chromatography (procedure from J. Doroszuk, M. Musiejuk, Ł. Ponikiewski, D. Witt, *Eur. J. Org. Chem.* **2018**, 6333–6337, doi:10.1002/ejoc.201801181).

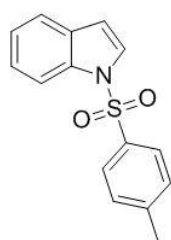
4. General Procedure for the Preparation of 1-[(4-methylphenyl)sulfonyl]indoles (1a-d) and Representative Analytical Data



To a stirred, cooled to 0 °C suspension of NaH (1.5 mmol) in dry THF (5 mL) was added dropwise a solution of indole (1 mmol) in dry THF (5 mL). Mixture was stirred at 0 °C for 15 min. Then the solution of *p*-toluenesulfonyl chloride (1.1 mmol) in dry THF (5 mL) was added slowly. Mixture was warm to room temperature and stirred overnight. Then reaction mixture was diluted with EtOAc (25 mL) and washed with water (10 mL), dried over MgSO₄, filtered and concentrated under vacuum. The product was purified by column chromatography.

1-[(4-methylphenyl)sulfonyl]-1H-indole 1a

Chromatography: Petroleum ether-toluene (4:1), *R_f* = 0.3, a yellow solid mp: 84.6–85.2 °C, yield: 0.219 g (81%):

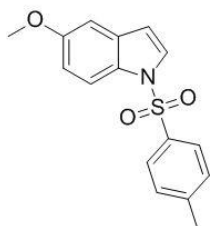


¹H NMR (400 MHz, CDCl₃) δ 8.01 (d, *J* = 9.1 Hz, 1H), 7.79 (d, *J* = 8.4 Hz, 2H), 7.59 (d, *J* = 3.7 Hz, 1H), 7.55 (d, *J* = 7.8 Hz, 1H), 7.35–7.31 (m, 1H), 7.25 (dd, *J* = 6.0, 1.7 Hz, 2H), 7.24–7.22 (m, 1H), 6.68 (d, *J* = 3.7 Hz, 1H), 2.36 (s, 3H).

¹³C NMR (101 MHz, CDCl₃) δ 144.9, 135.4, 134.9, 130.8, 129.9, 126.8, 126.3, 124.5, 123.3, 121.4, 113.5, 109.0, 21.6; signals: 13 expected, 13 observed.

5-methoxy-1-[(4-methylphenyl)sulfonyl]-1H-indole 1b

Chromatography: Toluene, *R_f* = 0.4, a white solid mp: 108.3–108.6 °C, yield: 0.262 g (87%):



¹H NMR (400 MHz, CDCl₃) δ 7.92–7.88 (m, 1H), 7.77–7.73 (m, 2H), 7.54 (d, *J* = 3.6 Hz, 1H), 7.23 (dd, *J* = 8.6, 0.6 Hz, 2H), 6.99–6.93 (m, 2H), 6.60 (dd, *J* = 3.6, 0.7 Hz, 1H), 3.83 (s, 3H), 2.35 (s, 3H).

¹³C NMR (101 MHz, CDCl₃) δ 156.4, 144.8, 135.3, 131.8, 129.8, 129.6, 127.1, 126.7, 114.4, 113.7, 109.2, 103.6, 55.6, 21.5; signals: 14 expected, 14 observed

5-bromo-1-[(4-methylphenyl)sulfonyl]-1H-indole 1c

Chromatography: Petroleum ether-Dichloromethane (4:1), *R_f* = 0.3, a white solid mp: 133.2–133.5 °C, yield: 0.318 g (91%):

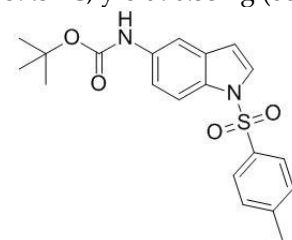


¹H NMR (400 MHz, CDCl₃) δ 7.88 (d, *J* = 8.8 Hz, 1H), 7.78–7.74 (m, 2H), 7.68 (d, *J* = 1.7 Hz, 1H), 7.58 (d, *J* = 3.7 Hz, 1H), 7.44–7.40 (m, 1H), 7.25 (dd, *J* = 8.6, 0.6 Hz, 2H), 6.61 (dd, *J* = 3.7, 0.7 Hz, 1H), 2.37 (s, 3H).

¹³C NMR (101 MHz, CDCl₃) δ 145.3, 135.0, 133.5, 132.5, 130, 127.6, 127.5, 126.8, 124.0, 116.8, 115, 108.3, 21.6; signals: 13 expected, 13 observed.

5-[(1,1-dimethylethoxy)carbonylamino]-1-[(4-methylphenyl)sulfonyl]-1H-indole 1d

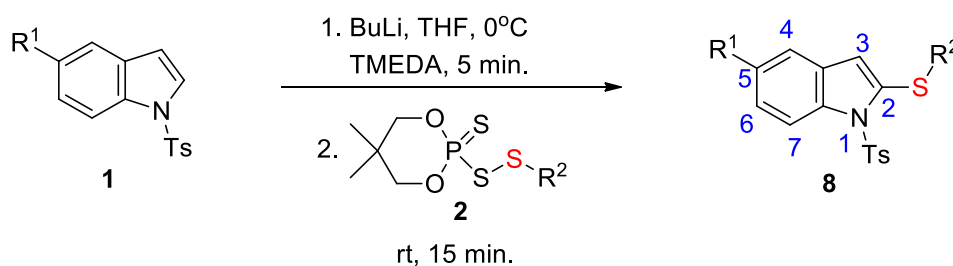
Chromatography: Petroleum ether-Dichloromethane (4:1), *R_f* = 0.2, a white solid mp: 138.9–139.3 °C, yield: 0.332 g (86%)



¹H NMR (400 MHz, CDCl₃) δ 8.21 (s, 1H), 7.71 (s, 1H), 7.29 (d, *J* = 4.3 Hz, 2H), 7.20–7.11 (m, 2H), 6.50 (s, 2H), 1.57 (s, 12H).

¹³C NMR (101 MHz, CDCl₃) δ 153.1, 144.9, 135.2, 134.2, 131.5, 131.2, 129.8, 127.2, 126.7, 116.9, 113.9, 111.3, 109.4, 80.5, 28.4, 21.5; signals: 16 expected, 16 observed.

5. General Procedure for the Preparation of 2-sulfenyl-1-[(4-methylphenyl)sulfonyl]-1H-indoles 8 from Phosphorodithioate Disulfanyl Derivatives 2



To a stirred, cooled to 0 °C solution of indole **1a–d** (1 mmol) and *N,N,N',N'*-tetramethylethane-1,2-diamine (1 mmol) in dry THF (5 mL) was added dropwise *n*-BuLi (2.5 M in hexane; 1 mmol*). Mixture was stirred in 0 °C for 5 min. Then the solution of phosphorodithioate disulfanyl derivative **2** (1 mmol) in dry THF (5 mL) was added. Reaction was warmed to room temperature and stirred for 15 min. Mixture was diluted with Et₂O (30 mL) and washed with water (10 mL), dried over MgSO₄, filtered and concentrated under vacuum. The products were purified by column chromatography.

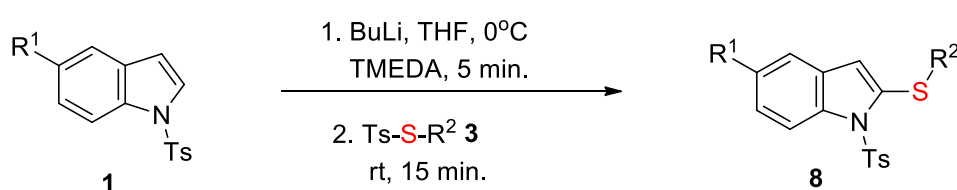
*in case of indole **1d** (1 mmol), *n*-BuLi (2 mmol) must be added

Table S1. Reaction of indoles **1** with phosphorodithioate disulfanyl derivatives **2**.

Entry	R ¹	R ²	Yield ^b [%]
1	H 1a	CH ₃ (CH ₂) ₁₁ –	72 8a
2		C ₆ H ₅ –	94 8b
3		CH ₂ =CH(CH ₂) ₉ –	78 8c
4		CH ₃ (CH ₂) ₉ –	78 8d
5		4–CH ₃ –C ₆ H ₄ –	86 8e
6		H ₃ COOC(CH ₂) ₁₀ –	75 8f
7		HO(CH ₂) ₁₁ –	67 8g
8		4–CN–C ₆ H ₄ –CH ₂ –	65 8h
9		C ₆ H ₅ CH ₂ –	87 8i
10	CH ₃ O– 1b	CH ₂ =CH(CH ₂) ₉ –	71 8j
11		CH ₃ (CH ₂) ₉ –	81 8k
12		4–CH ₃ –C ₆ H ₄ –	86 8l
13		H ₃ COOC(CH ₂) ₁₀ –	72 8m
14		HO(CH ₂) ₁₁ –	78 8n
15		4–CN–C ₆ H ₄ –CH ₂ –	72 8o
16		C ₆ H ₅ CH ₂ –	82 8p
17		CH ₂ =CH(CH ₂) ₉ –	69 8r
18	Br– 1c	CH ₃ (CH ₂) ₉ –	84 8s
19		4–CH ₃ –C ₆ H ₄ –	91 8t
20		H ₃ COOC(CH ₂) ₁₀ –	79 8u
21		HO(CH ₂) ₁₁ –	76 8w
22		4–CN–C ₆ H ₄ –CH ₂ –	69 8x
23		C ₆ H ₅ CH ₂ –	85 8y
24	(CH ₃) ₃ COC(O)NH– 1d	CH ₂ =CH(CH ₂) ₉ –	65 8z
25		CH ₃ (CH ₂) ₉ –	68 8aa
26		4–CH ₃ –C ₆ H ₄ –	72 8ab
27		H ₃ COOC(CH ₂) ₁₀ –	65 8ac
28		HO(CH ₂) ₁₁ –	71 8ad
29		4–CN–C ₆ H ₄ –CH ₂ –	66 8ae
30		C ₆ H ₅ CH ₂ –	78 8af

^b isolated yields

6. General Procedure for the Preparation of 2-sulfenyl-1-[(4-methylphenyl)sulfonyl]-1*H*-indoles **8** from Thiotosylates **3** and Representative Analytical Data



To a stirred, cooled to 0 °C solution of indole **1a–d** (1 mmol) and *N,N,N',N'*-tetramethylethane-1,2-diamine (1 mmol) in dry THF (5 mL) was added dropwise *n*-BuLi (2.5 M in hexane; 1 mmol*). Mixture was stirred in 0 °C for 5 min. Then the solution of thiotosylates **3** (1 mmol) in dry THF (5 mL) was added. Reaction was warmed to room temperature and stirred for 15 min. Mixture was diluted with Et₂O (30 mL) and washed with water (10 mL), dried over MgSO₄, filtered and concentrated under vacuum. The products were purified by column chromatography. *in case of indole **1d** (1 mmol), *n*-BuLi (2 mmol) must be added

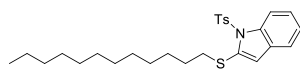
Table S2. Reaction of indoles **1** with thiotosylates **3**.

Entry	R ¹	R ²	Yield ^b [%]
1	H	CH ₃ (CH ₂) ₁₁ –	83 8a
2		C ₆ H ₅ –	92 8b
3		CH ₂ =CH(CH ₂) ₉ –	81 8c
4		CH ₃ (CH ₂) ₉ –	82 8d
5		4–CH ₃ –C ₆ H ₄ –	82 8e
6		H ₃ COOC(CH ₂) ₁₀ –	69 8f
7		HO(CH ₂) ₁₁ –	68 8g
8		4–CN–C ₆ H ₄ –CH ₂ –	69 8h
9		C ₆ H ₅ CH ₂ –	85 8i
10	CH ₃ O–	CH ₂ =CH(CH ₂) ₉ –	78 8j
11		CH ₃ (CH ₂) ₉ –	81 8k
12		4–CH ₃ –C ₆ H ₄ –	82 8l
13		H ₃ COOC(CH ₂) ₁₀ –	67 8m
14		HO(CH ₂) ₁₁ –	76 8n
15		4–CN–C ₆ H ₄ –CH ₂ –	68 8o
16		C ₆ H ₅ CH ₂ –	82 8p
17		CH ₂ =CH(CH ₂) ₉ –	74 8r
18		CH ₃ (CH ₂) ₉ –	83 8s
19	Br–	4–CH ₃ –C ₆ H ₄ –	86 3t
20		H ₃ COOC(CH ₂) ₁₀ –	78 8u
21		HO(CH ₂) ₁₁ –	76 8w
22		4–CN–C ₆ H ₄ –CH ₂ –	68 8x
23		C ₆ H ₅ CH ₂ –	84 8y
24		CH ₂ =CH(CH ₂) ₉ –	70 8z
25		CH ₃ (CH ₂) ₉ –	79 8aa
26		4–CH ₃ –C ₆ H ₄ –	71 8ab
27		H ₃ COOC(CH ₂) ₁₀ –	62 8ac
28	(CH ₃) ₃ COC(O)NH–	HO(CH ₂) ₁₁ –	69 8ad
29		4–CN–C ₆ H ₄ –CH ₂ –	63 8ae
30		C ₆ H ₅ CH ₂ –	78 8af

^b isolated yields

2-(Dodec-1-ylsulfanyl)-1-[(4-methylphenyl)sulfonyl]-1H-indole **8a**

Chromatography: Petroleum ether (PE)-Toluene (T) (1:2), *R_f* = 0.5, a yellowish oil, yield: 0.340 g (72%) (Table S1); 0.392 g (83%) (Table S2).



¹H NMR (400 MHz, CDCl₃) δ 8.26–8.20 (m, 1H), 7.89–7.80 (m, 2H), 7.46–7.35 (m, 1H), 7.32–7.19 (m, 4H), 6.50 (d, *J* = 0.5 Hz, 1H), 2.96 (t, *J* = 7.4 Hz, 2H), 2.36 (s, 3H), 1.75–1.64 (m, 2H), 1.49–1.40 (m, 2H), 1.37–1.24 (m, 16H), 0.92 (t, *J* = 6.8 Hz, 3H).

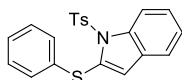
¹³C NMR (101 MHz, CDCl₃) δ 144.8, 137.8, 135.6, 135.0, 130.0, 129.6, 127.1, 124.0, 123.6, 119.5, 114.7, 111.7, 35.1, 31.9, 29.7, 29.6, 29.6, 29.5, 29.4, 29.2, 28.9, 28.4, 22.7, 21.6, 14.1; signals: 25 expected, 25 observed.

IR (ATR) 2924 (w), 2852 (w), 1441 (m), 1373 (m), 1174 (s), 1088 (m), 677 (s), 580 (s), 542 (s).

HRMS (ESI): *m/z* [M + H]⁺ calcd for C₂₇H₃₈NO₂S₂: 472.2338; found: 472.2342

2-[Phenylsulfanyl]-1-[(4-methylphenyl)sulfonyl]-1H-indole 8b

Chromatography: Toluene, *R_f* = 0.4, a white solid mp: 110–112 °C, yield: 0.357 g (94%) (Table S1); 0.349 g (92%) (Table S2).



¹H NMR (400 MHz, CDCl₃) δ 8.26 (d, *J* = 8.4 Hz, 1H), 7.86 (d, *J* = 8.4 Hz, 2H), 7.57 (dd, *J* = 15.7, 5.7 Hz, 1H), 7.40–7.32 (m, 2H), 7.33–7.29 (m, 5H), 7.21 (d, *J* = 8.0 Hz, 2H), 6.47 (d, *J* = 0.6 Hz, 1H), 2.37 (s, 3H).

¹³C NMR (101 MHz, CDCl₃) δ 144.9, 135.6, 131.3, 129.9, 129.6, 127.9, 127.2, 126.8, 124.7, 124.5, 123.7, 120.1, 115.4, 114.8, 113.5, 109.0, 21.6; signals: 17 expected and observed.

IR (ATR) 1444 (m), 1363 (s), 1171 (s), 1084 (m), 1005 (m), 796 (m), 752 (s), 681(s), 586 (s), 538 (s).

HRMS (ESI): *m/z* [M + H]⁺ calcd for C₂₁H₁₈NO₂S₂: 380.0773; found: 380.0776.

2-(Undec-10-en-1-ylsulfanyl)-1-[(4-methylphenyl)sulfonyl]-1H-indole 8c

Chromatography: PE-CH₂Cl₂ (4:1), *R_f* = 0.5, a yellow solid mp: 62.7–63.2 °C, yield: 0.355 g (78%) (Table S1); 0.369 g (81%) (Table S2).



¹H NMR (400 MHz, CDCl₃) δ 8.23 (dd, *J* = 8.3, 0.9 Hz, 1H), 7.87–7.83 (m, 2H), 7.40 (ddd, *J* = 7.6, 1.4, 0.7 Hz, 1H), 7.31–7.18 (m, 4H), 6.50 (d, *J* = 0.7 Hz, 1H), 5.84 (dd, *J* = 17.0, 10.2 Hz, 1H), 5.05–4.94 (m, 2H), 2.96 (t, *J* = 7.4 Hz, 2H), 2.36 (s, 3H), 2.11–2.03 (m, 2H), 1.69 (dt, *J* = 15.0, 7.3 Hz, 2H), 1.49–1.25 (m, 12H).

¹³C NMR (101 MHz, CDCl₃) δ 144.8, 139.2, 137.8, 135.6, 135.0, 130.0, 129.6, 129.0, 128.2, 127.1, 125.3, 124.0, 123.6, 119.5, 114.7, 114.2, 111.7, 35.1, 33.8, 29.4, 29.1, 28.9, 28.4, 21.6; signals: 24 observed, 24 expected.

IR (ATR) 2921 (w), 2848 (w), 1441 (m), 1371 (m), 1165 (m), 1088 (m), 746 (s), 683 (s), 584 (s), 538 (s)

HRMS (ESI): *m/z* [M + H]⁺ calcd for C₂₆H₃₄NO₂S₂: 456.2025; found: 456.2029.

2-(Dec-1-ylsulfanyl)-1-[(4-methylphenyl)sulfonyl]-1H-indole 8d

Chromatography: PE-T (1:2), *R_f* = 0.5, a yellowish oil, yield: 0.346 g (78%) (Table S1); 0.364 g (82%) (Table S2).



¹H NMR (400 MHz, CDCl₃) δ 8.27–8.19 (m, 1H), 7.88–7.81 (m, 2H), 7.45–7.36 (m, 1H), 7.32–7.19 (m, 4H), 6.50 (d, *J* = 0.5 Hz, 1H), 2.96 (t, *J* = 7.4 Hz, 2H), 2.36 (s, 3H), 1.74–1.65 (m, 2H), 1.49–1.40 (m, 2H), 1.38–1.23 (m, 12H), 0.92 (t, *J* = 6.8 Hz, 3H).

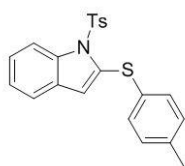
¹³C NMR (101 MHz, CDCl₃) δ 144.8, 137.8, 135.6, 135.0, 130.0, 129.6, 127.1, 124.0, 123.6, 119.5, 114.6, 111.6, 35.1, 31.9, 29.6, 29.5, 29.3, 29.2, 28.9, 28.4, 22.7, 21.6, 14.1; signals: 23 expected, 23 observed.

IR (ATR) 2924 (w), 2852 (w), 1441 (m), 1373 (m), 1174 (s), 1088 (m), 677 (s), 580 (s), 542 (s).

HRMS (ESI): m/z [M + H]⁺ calcd for C₂₅H₃₄NO₂S₂: 444.2025; found: 444.2023.

2-[(4-Methylphenyl)sulfanyl]-1-[(4-methylphenyl)sulfonyl]-1H-indole 8e

Chromatography: T, R_f = 0.4, a white solid mp: 112.6–113.9 °C, yield: 0.338 g (86%) (Table S1); 0.323 g (82%) (Table S2).



¹H NMR (400 MHz, CDCl₃) δ 8.24 (d, J = 8.4 Hz, 1H), 7.90 (d, J = 8.4 Hz, 2H), 7.35–7.27 (m, 4H), 7.24–7.15 (m, 5H), 6.21 (d, J = 0.7 Hz, 1H), 2.40 (s, 3H), 2.36 (s, 3H)

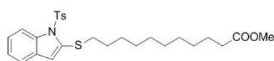
¹³C NMR (101 MHz, CDCl₃) δ 144.9, 138.6, 137.9, 135.6, 135.2, 132.6, 130.2, 129.7, 129.7, 129.7, 127.2, 124.3, 123.6, 119.8, 114.7, 113.5, 21.6, 21.2; signals: 18 expected and observed.

IR (ATR) 1444 (m), 1363 (s), 1171 (s), 1084 (m), 1005 (m), 796 (m), 752 (s), 681(s), 586 (s), 538 (s).

HRMS (ESI): m/z [M + H]⁺ calcd for C₂₂H₂₀NO₂S₂: 394.0930; found: 394.0933.

2-(10-Methoxycarbonyldodec-1-ylsulfanyl)-1-[(4-methylphenyl)sulfonyl]-1H-indole 8f

Chromatography: PE-CHCl₃ (4:1), R_f = 0.2, a waxy solid, yield: 0.376 g (75%) (Table S1); 0.346 g (69%) (Table S2).



¹H NMR (400 MHz, CDCl₃) δ 8.24–8.20 (m, 1H), 7.86–7.82 (m, 2H), 7.41–7.38 (m, 1H), 7.30–7.19 (m, 4H), 6.49 (t, J = 2.4 Hz, 1H), 3.69 (s, 3H), 2.95 (t, J = 7.4 Hz, 2H), 2.35 (s, 3H), 1.71–1.59 (m, 2H), 1.48–1.23 (m, 16H).

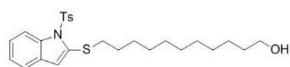
¹³C NMR (101 MHz, CDCl₃) δ 174.3, 144.8, 137.8, 135.6, 135, 130, 129.6, 127.1, 124.0, 123.6, 119.5, 114.6, 111.7, 51.5, 35.1, 34.1, 29.4, 29.4, 29.2, 29.1, 28.9, 28.4, 25, 21.6; signals: 24 observed and expected.

IR (ATR) 2920 (w), 2848 (w), 1736 (s), 1441 (m), 1365 (s), 1167 (s), 1090 (s), 744 (s), 584 (s), 540 (s)

HRMS (ESI): m/z [M + H]⁺ calcd for C₂₇H₃₆NO₄S₂: 502.2080; found: 502.2083.

2-(11-Hydroxydodec-1-ylsulfanyl)-1-[(4-methylphenyl)sulfonyl]-1H-indole 8g

Chromatography: CHCl₃, R_f = 0.2, a waxy solid, yield: 0.317 g (67%) (Table S1); 0.322 g (68%) (Table S2).



¹H NMR (400 MHz, CDCl₃) δ 8.24–8.21 (m, 1H), 7.85 (d, J = 8.4 Hz, 2H), 7.42–7.38 (m, 1H), 7.24 (ddd, J = 8.9, 8.5, 1.3 Hz, 4H), 6.50 (d, J = 0.6 Hz, 1H), 3.66 (t, J = 6.6 Hz, 2H), 2.96 (t, J = 7.4 Hz, 2H), 2.36 (s, 3H), 1.48–1.21 (m, 18H).

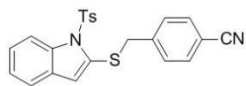
¹³C NMR (101 MHz, CDCl₃) δ 144.8, 137.8, 135.6, 135, 129.6, 128.2, 127.1, 124.1, 123.6, 119.5, 114.7, 111.8, 63.1, 35.1, 32.8, 29.6, 29.5, 29.5, 29.4, 29.2, 28.9, 28.4, 25.7, 21.6; signals: 24 expected and observed.

IR (ATR) 3593 (w), 2922 (m), 2846 (m), 1442 (s), 1361 (s), 1167 (s), 1090 (s), 744 (s), 685 (s), 584 (s), 538 (s)

HRMS (ESI): m/z [M + H]⁺ calcd for C₂₆H₃₆NO₃S₂: 474.2131; found: 474.2129.

2-[(4-Cyanobenzyl)sulfanyl]-1-[(4-methylphenyl)sulfonyl]-1H-indole 8h

Chromatography: toluene, $R_f = 0.2$, a red solid mp: 148.1–150.0 °C, yield: 0.272 g (65%) (Table S1); 0.289 g (69%) (Table S2).



^1H NMR (400 MHz, CDCl_3) δ 8.29 (dd, $J = 8.4, 0.8$ Hz, 1H), 7.85–7.81 (m, 2H), 7.57–7.54 (m, 2H), 7.40–7.34 (m, 3H), 7.29–7.24 (m, 2H), 7.22 (d, $J = 8.2$ Hz, 2H), 6.46 (d, $J = 0.6$ Hz, 1H), 4.23 (s, 2H), 2.37 (s, 3H).

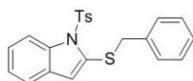
^{13}C NMR (101 MHz, CDCl_3) δ 145.1, 142.4, 138.4, 135.5, 132.3, 130.9, 129.8, 129.7, 129.1, 127.1, 125.3, 123.9, 120.4, 118.7, 117.5, 115.0, 111.1, 40.5, 21.6; signals: 19 expected and observed.

IR (ATR) 2922(w), 2227 (m), 1437 (m), 1371 (s), 1169 (s), 1088 (s), 748 (s), 673 (s), 579 (s), 536 (s)

HRMS (ESI): m/z $[\text{M} + \text{H}]^+$ calcd for $\text{C}_{23}\text{H}_{19}\text{N}_2\text{O}_2\text{S}_2$: 419.0882; found: 419.0888.

2-(Benzylsulfanyl)-1-[(4-methylphenyl)sulfonyl]-1H-indole 8i

Chromatography: toluene, $R_f = 0.3$, a waxy yellow solid, yield: 0.342 g (87%) (Table S1); 0.334 g (85%) (Table S2).



^1H NMR (400 MHz, CDCl_3) δ 8.26 (d, $J = 8.4$ Hz, 1H), 7.85 (d, $J = 8.4$ Hz, 2H), 7.57 (dd, $J = 15.7, 5.7$ Hz, 1H), 7.39–7.33 (m, 2H), 7.33–7.29 (m, 5H), 7.21 (d, $J = 8.0$ Hz, 2H), 6.47 (d, $J = 0.6$ Hz, 1H), 4.19 (s, 2H), 2.37 (s, 3H).

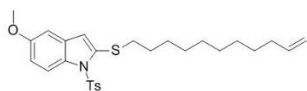
^{13}C NMR (101 MHz, CDCl_3) δ 144.9, 138.0, 136.3, 135.7, 133.2, 129.9, 129.6, 129.1, 128.5, 127.4, 127.2, 124.6, 123.6, 120, 114.8, 114.7, 40.6, 21.6; 18 expected and observed.

IR (ATR) 2924 (w), 1597 (w), 1442 (m), 1367 (s), 1169 (s), 1119 (s), 1088 (s), 748 (s), 677 (s), 575 (s), 536 (s)

HRMS (ESI): m/z $[\text{M} + \text{H}]^+$ calcd for $\text{C}_{22}\text{H}_{20}\text{NO}_2\text{S}_2$: 394.0930; found: 394.0933.

2-(Undec-10-en-1-ylsulfanyl)-5-methoxy-1-[(4-methylphenyl)sulfonyl]-1H-indole 8j

Chromatography: toluene, $R_f = 0.4$, a white solid mp: 45.6–46.3 °C, yield: 0.345 g (71%) (Table S1); 0.379 g (78%) (Table S2).



^1H NMR (400 MHz, CDCl_3) δ 8.11 (d, $J = 9.1$ Hz, 1H), 7.81 (d, $J = 8.4$ Hz, 2H), 7.20 (d, $J = 8.0$ Hz, 2H), 6.85 (d, $J = 2.5$ Hz, 2H), 6.44–6.41 (m, 1H), 5.89–5.78 (m, 1H), 5.05–4.93 (m, 2H), 3.83 (s, 3H), 2.95 (t, $J = 7.4$ Hz, 2H), 2.36 (s, 3H), 1.47–1.26 (m, 16H).

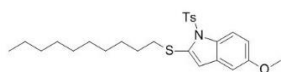
^{13}C NMR (101 MHz, CDCl_3) δ 156.7, 145.0, 139.1, 135.7, 132.5, 131.0, 129.8, 129.6, 127.1, 124.4, 115.6, 114.6, 111.9, 102.2, 55.6, 35.1, 33.9, 31.9, 29.5, 29.3, 28.9, 28.5, 28.4, 21.6; signals: 25 expected, 24 observed.

IR (ATR) 2924 (m), 2850 (m), 1604 (w), 1456 (m), 1427 (m), 1375 (m), 1213 (m), 1151 (s), 1034 (m), 812 (m), 671 (s), 602 (s), 540 (s)

HRMS (ESI): m/z $[\text{M} + \text{H}]^+$ calcd for $\text{C}_{27}\text{H}_{36}\text{NO}_3\text{S}_2$: 486.2131; found: 486.2135.

2-(Dec-1-ylsulfanyl)-5-methoxy-1-[(4-methylphenyl)sulfonyl]-1H-indole 8k

Chromatography: toluene, $R_f = 0.4$, a yellow oil, yield: 0.384 g (81%) (Table S1); 0.384 g (81%) (Table S2).



¹H NMR (400 MHz, CDCl₃) δ 8.11 (d, *J* = 9.1 Hz, 1H), 7.81 (d, *J* = 8.4 Hz, 2H), 7.20 (d, *J* = 8.0 Hz, 2H), 6.93–6.83 (m, 2H), 6.43 (d, *J* = 0.5 Hz, 1H), 3.83 (s, 3H), 2.95 (t, *J* = 7.4 Hz, 2H), 2.36 (s, 3H), 1.73–1.62 (m, 2H), 1.41–1.23 (m, 16H), 0.93–0.89 (m, 3H).

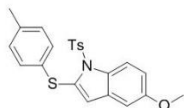
¹³C NMR (101 MHz, CDCl₃) δ 156.6, 144.7, 135.7, 132.5, 131.0, 129.8, 129.6, 127.1, 115.6, 112.6, 111.9, 102.2, 55.8, 35.1, 31.9, 29.5, 29.3, 28.9, 28.5, 28.4, 25.6, 22.7, 21.6, 14.1; signals: 24 expected and observed.

IR (ATR) 2952 (w), 2924 (m), 2848 (w), 1597 (w), 1458 (m), 1435 (m), 1369 (m), 1213 (s), 1178 (s), 1153 (s), 814 (s), 669 (s), 600 (s), 542 (s)

HRMS (ESI): *m/z* [M + H]⁺ calcd for C₂₆H₃₆NO₃S₂: 474.2131; found: 474.2134.

2-(4-Methylphenylsulfanyl)-5-methoxy-1-[(4-methylphenyl)sulfonyl]-1H-indole 8l

Chromatography: toluene, *R_f* = 0.4, a yellow oil, yield: 0.364 g (86%) (Table S1); 0.347 g (82%) (Table S2).



¹H NMR (400 MHz, CDCl₃) δ 8.11 (d, *J* = 9.1 Hz, 1H), 7.87–7.83 (m, 2H), 7.34–7.30 (m, 2H), 7.19 (dd, *J* = 19.8, 8.0 Hz, 4H), 6.89 (dd, *J* = 9.1, 2.6 Hz, 1H), 6.76 (d, *J* = 2.5 Hz, 1H), 6.12 (d, *J* = 0.6 Hz, 1H), 3.80 (s, 3H), 2.38 (s, 3H), 2.37 (s, 3H).

¹³C NMR (101 MHz, CDCl₃) δ 157.6, 144.9, 138.6, 137.9, 135.6, 135.2, 132.6, 130.2, 129.7, 129.7, 127.2, 124.3, 123.6, 119.8, 114.7, 113.5, 55.8, 21.6, 21.2; signals: 19 expected and observed.

IR (ATR) 2921 (w), 1604 (w), 1456 (w), 1429 (m), 1365 (s), 1211 (s), 1176 (s), 1149 (s), 1110 (m), 1083 (m), 1033 (s), 811 (s), 670 (s), 597 (s), 538 (s)

HRMS (ESI): *m/z* [M + H]⁺ calcd for C₂₃H₂₂NO₃S₂: 424.1036; found: 424.1040

2-(10-Methoxycarbonyldec-1-ylsulfanyl)-5-methoxy-1-[(4-methylphenyl)sulfonyl]-1H-indole 8m

Chromatography: T-PE (1:4), *R_f* = 0.4, a waxy solid, yield: 0.383 g (72%) (Table S1); 0.356 g (67%) (Table S2).



¹H NMR (400 MHz, CDCl₃) δ 8.11 (d, *J* = 9.1 Hz, 1H), 7.81 (d, *J* = 8.4 Hz, 2H), 7.20 (d, *J* = 7.9 Hz, 2H), 6.91–6.84 (m, 2H), 6.43 (s, 1H), 3.83 (s, 3H), 3.69 (s, 3H), 2.95 (t, *J* = 7.4 Hz, 2H), 2.35 (s, 3H), 1.72–1.62 (m, 4H), 1.47–1.26 (m, 14H).

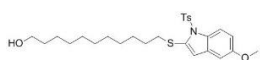
¹³C NMR (101 MHz, CDCl₃) δ 174.3, 156.6, 144.7, 135.5, 132.5, 131.0, 129.6, 129.4, 127.1, 115.7, 112.6, 112.4, 102.2, 55.6, 51.5, 35.1, 34.1, 29.4, 29.4, 29.2, 29.1, 28.9, 28.4, 25.0, 21.6; signals: 26 expected, 25 observed.

IR (ATR) 2925 (m), 2852 (w), 1734 (m), 1456 (m), 1433 (m), 1369 (m), 1173 (s), 1149 (s), 1090 (m), 1032 (m), 671 (s), 592 (s), 538 (s)

HRMS (ESI): *m/z* [M + H]⁺ calcd for C₂₈H₃₈NO₅S₂: 532.2186; found: 532.2187.

2-(11-Hydroxyundec-1-ylsulfanyl)-5-methoxy-1-[(4-methylphenyl)sulfonyl]-1H-indole 8n

Chromatography: CHCl₃, *R_f* = 0.3, a yellow oil, yield: 0.393 g (78%) (Table S1); 0.383 g (76%) (Table S2).

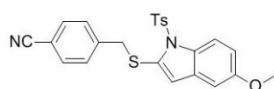


¹H NMR (400 MHz, CDCl₃) δ 8.10 (d, *J* = 9.1 Hz, 1H), 7.80 (d, *J* = 8.4 Hz, 2H), 7.20 (d, *J* = 8.0 Hz, 2H), 6.91–6.83 (m, 2H), 6.43 (d, *J* = 0.5 Hz, 1H), 3.83 (s, 3H), 3.66 (t, *J* = 6.6 Hz, 2H), 2.95 (t, *J* = 7.4 Hz, 2H), 2.35 (s, 3H), 1.47–1.23 (m, 18H).

¹³C NMR (101 MHz, CDCl₃) δ 156.6, 144.7, 135.6, 135.5, 132.5, 131.0, 129.6, 127.1, 115.7, 112.6, 112.0, 102.2, 63.1, 55.6, 35.1, 32.8, 29.6, 29.5, 29.5, 29.4, 29.1, 28.8, 28.4, 25.7, 21.6; signals: 25 expected and observed.
IR (ATR) 3583 (w), 2924 (s), 2850 (s), 1599 (m), 1456 (s), 1358 (m), 1176 (s), 1151 (s), 1086 (s), 1034 (s), 816 (s), 673 (s), 602 (s), 540 (s)
HRMS (ESI): m/z [M + H]⁺ calcd for C₂₇H₃₈NO₄S₂: 504.2237; found: 504.2241.

2-[(4-Cyanobenzyl)sulfanyl]-5-methoxy-1-[(4-methylphenyl)sulfonyl]-1H-indole 8o

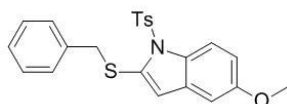
Chromatography: toluene, R_f = 0.2, a red solid mp: 116.1–117.7 °C, yield: 0.323 g (72%) (Table S1); 0.305 g (68%) (Table S2).



¹H NMR (400 MHz, CDCl₃) δ 8.17 (d, J = 9.2 Hz, 1H), 7.79 (d, J = 8.4 Hz, 2H), 7.60–7.50 (m, 2H), 7.31–7.25 (m, 4H), 6.98–6.97 (m, 1H), 6.80 (d, J = 2.6 Hz, 1H), 6.37 (s, 1H), 4.22 (s, 2H), 3.83 (s, 3H), 2.37 (s, 3H).
¹³C NMR (101 MHz, CDCl₃) δ 156.7, 144.7, 142.4, 138.4, 135.5, 132.3, 130.9, 129.7, 129.1, 127.1, 125.3, 123.9, 120.4, 118.7, 117.5, 115.0, 111.1, 55.8, 40.5, 21.6; signals: 20 expected and observed.
IR (ATR) 3302 (w), 2924 (w), 2225 (w), 1658 (w), 1435 (m), 1367 (m), 1161 (s), 1028 (s), 671 (s), 567 (s), 542 (s)
HRMS (ESI): m/z [M + H]⁺ calcd for C₂₄H₂₁N₂O₃S₂: 449.0988; found: 449.0992.

2-(Benzylsulfanyl)-5-methoxy-1-[(4-methylphenyl)sulfonyl]-1H-indole 8p

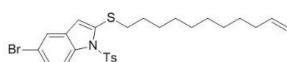
Chromatography: T-PE (1:4), R_f = 0.3, a yellowish solid; mp: 116.1–117.7 °C, yield: 0.347 g (82%) (Table S1); 0.347 g (82%) (Table S2).



¹H NMR (400 MHz, CDCl₃) δ 8.14 (d, J = 9.1 Hz, 1H), 7.81 (d, J = 8.4 Hz, 2H), 7.32–7.28 (m, 5H), 7.21–7.19 (m, 2H), 6.93 (dd, J = 9.1, 2.6 Hz, 1H), 6.81 (d, J = 2.5 Hz, 1H), 6.39 (d, J = 0.6 Hz, 1H), 4.19 (s, 2H), 3.82 (s, 3H), 2.36 (s, 3H).
¹³C NMR (101 MHz, CDCl₃) δ 156.7, 144.7, 142.4, 138.4, 135.5, 132.3, 130.9, 129.7, 129.1, 127.1, 125.3, 123.9, 120.4, 118.7, 117.5, 115.0, 55.8, 40.5, 21.6; signals: 19 expected and observed.
IR (ATR) 2922 (w), 2224 (w), 1593 (w), 1504 (w), 1437 (m), 1371 (s), 1169 (s), 795 (s), 665 (s), 592 (s), 540 (s)
HRMS (ESI): m/z [M + H]⁺ calcd for C₂₃H₂₂NO₃S₂: 424.1036; found: 424.1035.

2-(Undec-10-en-1-ylsulfanyl)-5-bromo-1-[(4-methylphenyl)sulfonyl]-1H-indole 8r

Chromatography: T-PE (1:4), R_f = 0.3, a waxy solid, yield: 0.369 g (69%) (Table S1); 0.396 g (74%) (Table S2).

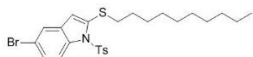


¹H NMR (400 MHz, CDCl₃) δ 8.08 (d, J = 8.9 Hz, 1H), 7.84–7.81 (m, 2H), 7.51 (d, J = 1.7 Hz, 1H), 7.38–7.32 (m, 1H), 7.25–7.22 (m, 2H), 6.38 (d, J = 0.6 Hz, 1H), 5.84 (ddt, J = 16.9, 10.2, 6.7 Hz, 1H), 5.05–4.94 (m, 2H), 2.95 (t, J = 7.4 Hz, 2H), 2.38 (s, 3H), 2.10–1.95 (m, 2H), 1.75–1.60 (m, 2H), 1.49–1.27 (m, 12H).
¹³C NMR (101 MHz, CDCl₃) δ 145.2, 139.2, 137.1, 136.4, 135.2, 131.7, 129.7, 127.1, 126.6, 122, 117.1, 115.9, 114.2, 109.5, 35.1, 34.8, 34.8, 29.4, 29.1, 29.1, 28.9, 28.9, 28.3, 21.6; signals: 24 observed and expected.
IR (ATR) 2925 (m), 2852 (m), 1595 (w), 1435 (m), 1373 (s), 1223 (m), 1173 (s), 1088 (m), 910 (m), 804 (m), 706 (s), 665 (s), 592 (s), 540 (s)

HRMS (ESI): m/z $[M + H]^+$ calcd for $C_{26}H_{33}BrNO_2S_2$: 534.1131; found: 534.1136.

2-(Dec-1-ylsulfanyl)-5-bromo-1-[(4-methylphenyl)sulfonyl]-1H-indole 8s

Chromatography: T-PE (1:4), R_f = 0.3, a yellow oil, yield: 0.439 g (84%) (Table S1); 0.434 g (83%) (Table S2).



1H NMR (400 MHz, $CDCl_3$) δ 8.08 (d, J = 8.9 Hz, 1H), 7.85–7.80 (m, 2H), 7.51 (d, J = 1.9 Hz, 1H), 7.38–7.32 (m, 1H), 7.25–7.21 (m, 2H), 6.38 (d, J = 0.5 Hz, 1H), 2.95 (t, J = 7.4 Hz, 2H), 2.38 (s, 3H), 1.72–1.60 (m, 2H), 1.49–1.24 (m, 14H), 0.91 (t, J = 7.1 Hz, 3H).

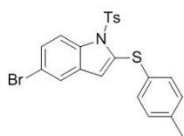
^{13}C NMR (101 MHz, $CDCl_3$) δ 145.2, 137.2, 136.4, 135.2, 131.7, 129.7, 127.2, 126.6, 122.0, 117.1, 115.9, 109.5, 34.8, 31.9, 29.6, 29.5, 29.3, 29.2, 28.9, 28.3, 22.7, 21.3, 14.1; signals: 23 expected and observed.

IR (ATR) 2943 (w), 2922 (m), 2852 (m), 1595 (w), 1437 (m), 1375 (s), 1171 (s), 1090 (s), 800 (m), 706 (s), 663 (s), 590 (s), 540 (s)

HRMS (ESI): m/z $[M + H]^+$ calcd for $C_{25}H_{33}BrNO_2S_2$: 522.1131; found: 522.1132.

2-(4-Methylphenylsulfanyl)-5-bromo-1-[(4-methylphenyl)sulfonyl]-1H-indole 8t

Chromatography: PE-DCM (4:1), R_f = 0.4, a waxy solid, yield: 0.430 g (91%) (Table S1); 0.406 g (86%) (Table S2).



1H NMR (400 MHz, $CDCl_3$) δ 8.07 (d, J = 8.9 Hz, 1H), 7.88 (d, J = 8.4 Hz, 2H), 7.40 (d, J = 1.9 Hz, 1H), 7.36 (d, J = 2.0 Hz, 1H), 7.35–7.32 (m, 2H), 7.25 (d, J = 8.0 Hz, 2H), 7.19 (d, J = 7.9 Hz, 2H), 5.99 (d, J = 0.6 Hz, 1H), 2.40 (s, 3H), 2.39 (s, 3H).

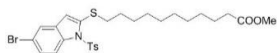
^{13}C NMR (101 MHz, $CDCl_3$) δ 145.3, 139.3, 137.9, 136.4, 135.2, 133.3, 131.5, 130.1, 129.8, 128.6, 127.2, 126.7, 122.2, 117.1, 115.9, 111.0, 21.7, 21.3; signals: 18 expected and observed.

IR (ATR) 1595 (w), 1439 (m), 1367 (m), 1169 (s), 1173 (m), 1086 (m), 804 (m), 665 (s), 598 (s), 540 (s)

HRMS (ESI): m/z $[M + H]^+$ calcd for $C_{22}H_{19}BrNO_2S_2$: 472.0035; found: 472.0037.

2-(10-Methoxycarbonyldec-1-ylsulfanyl)-5-bromo-1-[(4-methylphenyl)sulfonyl]-1H-indole 8u

Chromatography: T, R_f = 0.4, a waxy solid, yield: 0.459 g (79%) (Table S1); 0.453 g (78%) (Table S2).



1H NMR (400 MHz, $CDCl_3$) δ 8.08 (d, J = 8.9 Hz, 1H), 7.82 (dd, J = 8.4, 1.7 Hz, 2H), 7.51 (d, J = 2.0 Hz, 1H), 7.38–7.32 (m, 1H), 7.23 (d, J = 8.1 Hz, 2H), 6.38 (s, 1H), 3.69 (s, 3H), 2.95 (t, J = 7.4 Hz, 2H), 2.38 (s, 3H), 2.33 (t, J = 7.5 Hz, 2H), 1.68–1.50 (m, 4H), 1.48–1.26 (m, 12H).

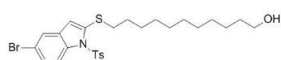
^{13}C NMR (101 MHz, $CDCl_3$) δ 174.3, 145.2, 137.1, 136.4, 135.2, 131.7, 129.7, 127.1, 126.6, 122.0, 117.1, 115.9, 109.6, 51.5, 34.8, 34.1, 29.4, 29.4, 29.2, 29.1, 28.9, 28.3, 24.9, 21.6; signals: 25 expected, 24 observed.

IR (ATR) 2925 (m), 2852 (m), 1734 (s), 1437 (s), 1367 (s), 1169 (s), 708 (s), 663 (s), 582 (s), 540 (s)

HRMS (ESI): m/z $[M + H]^+$ calcd for $C_{27}H_{35}BrNO_4S_2$: 580.1185; found: 580.1181.

2-(11-Hydroxyundec-1-ylsulfanyl)-5-bromo-1-[(4-methylphenyl)sulfonyl]-1H-indole 8w

Chromatography: CHCl_3 , $R_f = 0.3$, a waxy solid, yield: 0.420 g (76%) (Table S1); 0.420 g (76%) (Table S2).



^1H NMR (400 MHz, CDCl_3) δ 8.08 (d, $J = 8.9$ Hz, 1H), 7.82 (d, $J = 8.4$ Hz, 2H), 7.51 (d, $J = 1.7$ Hz, 1H), 7.38–7.32 (m, 1H), 7.23 (d, $J = 8.0$ Hz, 2H), 6.38 (d, $J = 0.6$ Hz, 1H), 3.67 (t, $J = 6.6$ Hz, 2H), 2.95 (t, $J = 7.4$ Hz, 2H), 2.38 (s, 3H), 1.75–1.60 (m, 2H), 1.48–1.21 (m, 16H).

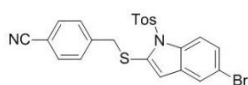
^{13}C NMR (101 MHz, CDCl_3) δ 145.2, 137.1, 136.4, 135.2, 131.7, 129.7, 127.1, 126.6, 122.0, 117.1, 115.9, 109.6, 63.1, 34.8, 32.8, 29.6, 29.5, 29.5, 29.4, 29.1, 28.9, 28.3, 25.7, 21.6; signals: 24 expected and observed.

IR (ATR) 3359 (w), 2916 (s), 2850 (s), 1441 (s), 1379 (s), 1169 (s), 1092 (s), 806 (m), 706 (s), 665 (s), 579 (s), 536 (s)

HRMS (ESI): m/z $[\text{M} + \text{H}]^+$ calcd for $\text{C}_{26}\text{H}_{35}\text{BrNO}_3\text{S}_2$: 552.1236; found: 552.1238.

2-[(4-Cyanobenzyl)sulfanyl]-5-bromo-1-[(4-methylphenyl)sulfonyl]-1H-indole 8x

Chromatography: PE- CHCl_3 (4:1), $R_f = 0.5$, a waxy solid, yield: 0.343 g (69%) (Table S1); 0.338 g (68%) (Table S2).



^1H NMR (400 MHz, CDCl_3) δ 8.15 (d, $J = 9.0$ Hz, 1H), 7.80 (d, $J = 8.4$ Hz, 2H), 7.57 (d, $J = 8.4$ Hz, 2H), 7.51 (d, $J = 1.7$ Hz, 1H), 7.45–7.41 (m, 1H), 7.37 (d, $J = 8.4$ Hz, 2H), 7.24 (d, $J = 8.0$ Hz, 2H), 6.36 (d, $J = 0.6$ Hz, 1H), 4.23 (s, 2H), 2.39 (s, 3H).

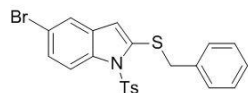
^{13}C NMR (101 MHz, CDCl_3) δ 145.1, 142.4, 138.4, 135.5, 132.3, 130.9, 129.8, 129.7, 129.1, 127.1, 125.3, 123.9, 120.4, 118.7, 117.5, 115.0, 111.1, 40.5, 21.6; signals: 19 expected and observed.

IR (ATR) 2922 (w), 2224 (w), 1593 (w), 1504 (w), 1437 (m), 1371 (s), 1169 (s), 795 (s), 665 (s), 592 (s), 540 (s) cm^{-1}

HRMS (ESI): m/z $[\text{M} + \text{H}]^+$ calcd for $\text{C}_{23}\text{H}_{18}\text{BrN}_2\text{O}_2\text{S}_2$: 496.9988; found: 496.9991.

2-(Benzylsulfanyl)-5-bromo-1-[(4-methylphenyl)sulfonyl]-1H-indole 8y

Chromatography: PE- CHCl_3 (2:1), $R_f = 0.3$, a waxy solid, yield: 0.402 g (85%) (Table S1); 0.397 g (84%) (Table S2).



^1H NMR (400 MHz, CDCl_3) δ 8.12 (d, $J = 8.9$ Hz, 1H), 7.82 (d, $J = 8.4$ Hz, 2H), 7.49 (d, $J = 1.8$ Hz, 1H), 7.38–7.34 (m, 1H), 7.33–7.29 (m, 5H), 7.23 (d, $J = 8.1$ Hz, 2H), 6.36 (d, $J = 0.6$ Hz, 1H), 4.18 (s, 2H), 2.38 (s, 3H).

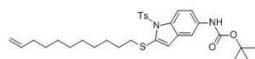
^{13}C NMR (101 MHz, CDCl_3) δ 144.9, 138.0, 136.3, 135.7, 133.2, 129.9, 129.6, 129.1, 128.5, 127.4, 124.6, 123.6, 120.0, 118.2, 117.6, 114.7, 40.6, 21.6; 18 expected and observed.

IR (ATR) 2922 (w), 1593 (w), 1439 (m), 1371 (s), 1167 (s), 1084 (m), 802 (s), 696 (s), 667 (s), 596 (s), 579 (s), 536 (s) cm^{-1}

HRMS (ESI): m/z $[\text{M} + \text{H}]^+$ calcd for $\text{C}_{22}\text{H}_{19}\text{BrNO}_2\text{S}_2$: 472.0035; found: 472.0043.

2-(Undec-10-en-1-ylsulfanyl)-5-[[[(1,1-dimethylethoxy)carbonyl]amino]-1-[(4-methylphenyl)sulfonyl]-1H-indole 8z

Chromatography: PE- CHCl_3 (2:1), $R_f = 0.5$, a waxy solid, yield: 0.371 g (65%) (Table S1); 0.400 g (70%) (Table S2).



¹H NMR (400 MHz, CDCl₃) δ 8.10 (d, *J* = 8.9 Hz, 1H), 7.79 (d, *J* = 8.4 Hz, 2H), 7.59 (s, 1H), 7.19 (d, *J* = 8.2 Hz, 2H), 7.15–7.07 (m, 1H), 6.54 (brs, 1H), 6.41 (s, 1H), 5.86–5.81 (m, 1H), 4.97–4.91 (m, 2H), 2.93 (t, *J* = 7.4 Hz, 2H), 2.35 (s, 3H), 2.10–1.95 (m, 2H), 1.60–1.52 (m, 2H), 1.54 (s, 9H), 1.48–1.20 (m, 12H).

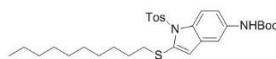
¹³C NMR (101 MHz, CDCl₃) δ 156.5, 145.1, 141.0, 140.1, 135.2, 133.0, 131.0, 129.9, 128.1, 127.2, 124.1, 119.6, 115.4, 113.6, 109.1, 81.9, 38.4, 32.8, 29.4, 28.7, 28.1, 27.1, 25.7, 21.6; signals: 27 expected, 25 observed.

IR (ATR) 2915 (m), 2850 (m), 1440 (s), 1378 (s), 1166 (s), 700 (s), 665 (s), 578 (s), 536 (s) cm⁻¹

HRMS (ESI): *m/z* [M + H]⁺ calcd for C₃₁H₄₃N₂O₄S₂: 571.2659; found: 571.2664.

2-(Dec-1-ylsulfanyl)-5-[[[(1,1-dimethylethoxy)carbonyl]amino]-1-[(4-methylphenyl)sulfonyl]-1H-indole 8aa

Chromatography: PE-CHCl₃ (2:1), *R_f* = 0.3, a waxy solid, yield: 0.380 g (68%) (Table S1); 0.441 g (79%) (Table S2).



¹H NMR (400 MHz, CDCl₃) δ 8.10 (d, *J* = 8.9 Hz, 1H), 7.79 (d, *J* = 8.4 Hz, 2H), 7.59 (d, *J* = 3.7 Hz, 1H), 7.21–7.19 (m, 2H), 7.15–7.07 (m, 1H), 6.51 (s, 1H), 6.42 (s, 1H), 2.93 (t, *J* = 7.4 Hz, 2H), 2.36 (s, 3H), 1.71–1.61 (m, 2H), 1.54 (s, 9H), 1.48–1.19 (m, 14H), 0.91 (t, *J* = 6.8 Hz, 3H).

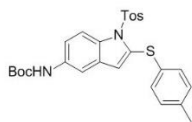
¹³C NMR (101 MHz, CDCl₃) δ 156.5, 145.1, 141.0, 135.2, 133.0, 131.0, 129.9, 129.3, 126.9, 124.1, 119.6, 113.6, 109.1, 81.9, 38.4, 34.8, 31.9, 29.5, 29.3, 28.9, 28.3, 22.7, 21.3, 14.1; signals: 26 expected, 24 observed

IR (ATR) 3365 (w), 2924 (m), 2852 (m), 1720 (s), 1537 (m), 1454 (s), 1365 (s), 1160 (s), 806 (s), 675 (s), 584 (s), 542 (s)

HRMS (ESI): *m/z* [M + H]⁺ calcd for C₃₀H₄₃N₂O₄S₂: 559.2659; found: 559.2663.

2-(4-Methylphenylsulfanyl)-5-[[[(1,1-dimethylethoxy)carbonyl]amino]-1-[(4-methylphenyl)sulfonyl]-1H-indole 8ab

Chromatography: Toluene, *R_f* = 0.3, a waxy solid, yield: 0.366 g (72%) (Table S1); 0.361 g (71%) (Table S2).



¹H NMR (400 MHz, CDCl₃) δ 7.89 (d, *J* = 8.8 Hz, 1H), 7.76 (d, *J* = 8.4 Hz, 2H), 7.57 (d, *J* = 3.7 Hz, 1H), 7.35–6.95 (m, 7H), 6.47 (brs, 1H), 6.12 (d, *J* = 0.6 Hz, 1H), 2.38 (s, 3H), 2.37 (s, 3H), 1.53 (s, 9H).

¹³C NMR (101 MHz, CDCl₃) δ 156.1, 145.1, 141.2, 137.9, 135.2, 134.9, 133.1, 130.9, 129.9, 127.6, 127.1, 126.8, 123.7, 115.2, 113.5, 109.1, 82.5, 28.1, 21.6, 21.2; signals: 21 expected, 20 observed.

IR (ATR) 2924 (w), 2364 (w), 1705 (w), 1452 (m), 1365 (m), 1155 (s), 808 (s), 671 (s), 582 (s), 542 (s)

HRMS (ESI): *m/z* [M + H]⁺ calcd for C₂₇H₂₉N₂O₄S₂: 509.1563; found: 509.1569.

2-(10-Methoxycarbonyldec-1-ylsulfanyl)-5-[[[(1,1-dimethylethoxy)carbonyl]amino]-1-[(4-methylphenyl)sulfonyl]-1H-indole 8ac

Chromatography: toluene, *R_f* = 0.1, a yellowish oil, yield: 0.401 g (65%) (Table S1); 0.382 g (62%) (Table S2).

¹H NMR (400 MHz, CDCl₃) δ 7.93 (d, *J* = 8.8 Hz, 1H), 7.76 (d, *J* = 8.4 Hz, 2H), 7.57 (d, *J* = 3.7 Hz, 1H), 7.38 (s, 1H), 7.22 (d, *J* = 8.1 Hz, 2H), 7.21–7.17 (m, 1H), 6.62 (d, *J* = 4.2 Hz, 1H), 3.67 (s, 3H), 2.81 (t, *J* = 7.3 Hz, 2H), 2.34 (s, 3H), 2.33 (t, *J* = 7.5 Hz, 2H), 1.70–1.50 (m, 4H), 1.48 (s, 9H), 1.47–1.20 (m, 12H).



¹³C NMR (101 MHz, CDCl₃) δ 174.3, 156.5, 145.1, 141.0, 135.2, 133.0, 131.0, 129.9, 128.1, 126.9, 124.1, 119.6, 113.6, 109.1, 81.9, 52.3, 38.4, 31.9, 29.5, 29.3, 28.9, 28.9, 28.3, 27.9, 22.7, 21.3; signals: 28 expected, 26 observed

IR (ATR) 2924 (m), 2364 (m), 1705 (s), 1734 (s), 1437 (s), 1367 (s), 1155 (s), 808 (s), 671 (s), 582 (s), 542 (s)

HRMS (ESI): *m/z* [M + H]⁺ calcd for C₃₂H₄₅N₂O₆S₂: 617.2714; found: 617.2711.

2-((11-Hydroxyundec-1-yl)sulfanyl)-5-((1,1-dimethylethoxy)carbonylamino)-1-((4-methylphenyl)sulfonyl)-1H-indole 8ad

Chromatography: chloroform, *R_f* = 0.1, a yellowish oil, yield: 0.418 g (71%) (Table S1); 0.406 g (69%) (Table S2).

¹H NMR (400 MHz, CDCl₃) δ 7.94 (d, *J* = 8.8 Hz, 1H), 7.77 (d, *J* = 8.4 Hz, 2H), 7.58 (d, *J* = 3.7 Hz, 1H), 7.39 (s, 1H), 7.24 (d, *J* = 8.0 Hz, 2H), 7.18–7.15 (m, 1H), 6.64 (d, *J* = 4.2 Hz, 1H), 3.67 (t, *J* = 6.6 Hz, 2H), 2.83 (t, *J* = 7.4 Hz, 2H), 2.37 (s, 3H), 1.70–1.50 (m, 4H), 1.47 (s, 9H), 1.38–1.25 (m, 14H).



¹³C NMR (101 MHz, CDCl₃) δ 156.5, 145.1, 141.0, 135.2, 133.0, 131.0, 129.9, 128.1, 127.2, 124.1, 119.6, 113.6, 109.1, 81.9, 63.1, 38.4, 32.8, 29.6, 29.4, 29.2, 29.2, 28.7, 28.1, 27.1, 25.7, 21.6; signals: 27 expected, 26 observed.

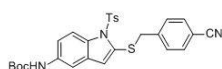
IR (ATR) 2924 (m), 2364 (m), 1705 (s), 1734 (s), 1437 (s), 1169 (s), 1092 (s), 806 (m), 706 (s), 665 (s), 579 (s), 536 (s)

HRMS (ESI): *m/z* [M + H]⁺ calcd for C₃₁H₄₅N₂O₅S₂: 589.2764; found: 589.2762.

2-((4-Cyanobenzyl)sulfanyl)-5-((1,1-dimethylethoxy)carbonylamino)-1-((4-methylphenyl)sulfonyl)-1H-indole 8ae

Chromatography: toluene, *R_f* = 0.2, a yellowish oil, yield: 0.352 g (66%) (Table S1); 0.336 g (63%) (Table S2).

¹H NMR (400 MHz, CDCl₃) δ 8.15 (d, *J* = 9.0 Hz, 1H), 7.80 (d, *J* = 8.4 Hz, 2H), 7.57 (d, *J* = 8.4 Hz, 2H), 7.51 (d, *J* = 1.7 Hz, 1H), 7.44–7.41 (m, 1H), 7.37 (d, *J* = 8.4 Hz, 2H), 7.24 (d, *J* = 8.0 Hz, 2H), 6.36 (d, *J* = 0.6 Hz, 1H), 4.23 (s, 2H), 2.39 (s, 3H), 1.47 (s, 9H).



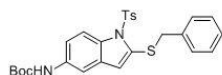
¹³C NMR (101 MHz, CDCl₃) δ 156.1, 145.1, 142.1, 137.9, 135.2, 134.9, 133.1, 130.9, 129.9, 129.8, 127.6, 126.8, 123.7, 120.0, 117.5, 116.4, 113.5, 109.1, 82.5, 40.0, 28.1, 21.2; signals: 22 expected and observed.

IR (ATR) 3325 (w), 2922 (w), 2850 (w), 2225 (w), 1689 (m), 1595 (m), 1529 (m), 1456 (s), 1369 (m), 1160 (s), 904 (m), 850 (m), 731 (s), 671 (s), 582 (s), 544 (s) cm⁻¹

HRMS (ESI): *m/z* [M + H]⁺ calcd for C₂₈H₂₈N₃O₄S₂: 534.1516; found: 534.1521.

2-(Benzylsulfanyl)-5-[[[(1,1-dimethylethoxy)carbonyl]amino]-1-[(4-methylphenyl)sulfonyl]-1H-indole 8af

Chromatography: PE-DCM (4:1), R_f = 0.2, a yellowish oil, yield: 0.397 g (78%) (Table S1); 0.396 g (78%) (Table S2).



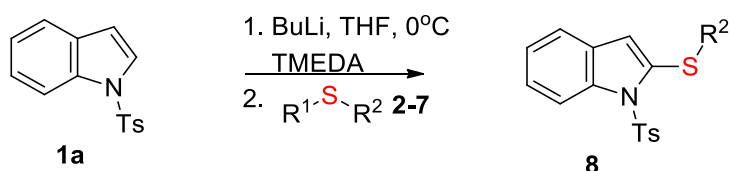
^1H NMR (400 MHz, CDCl_3) δ 8.14 (d, J = 9.0 Hz, 1H), 7.79 (d, J = 8.4 Hz, 2H), 7.35–7.25 (m, 5H), 7.21–7.18 (m, 2H), 7.09–6.95 (m, 1H), 6.51 (s, 1H), 6.38 (s, 1H), 4.18 (s, 2H), 2.37 (s, 3H), 1.54 (s, 9H).

^{13}C NMR (101 MHz, CDCl_3) δ 156.1, 144.9, 136.3, 135.4, 134.4, 134.2, 130.4, 129.6, 129.1, 128.6, 128.5, 128.0, 127.5, 127.1, 127.1, 115.2, 114.7, 82.5, 40.4, 28.4, 21.6; signals: 21 expected and observed.

IR (ATR) 3325 (w), 2921 (w), 1691 (w), 1452 (m), 1367 (m), 1155 (s), 1087 (m), 810 (w), 700 (m), 671 (s), 582 (s), 541 (s) cm^{-1}

HRMS (ESI): m/z $[\text{M} + \text{H}]^+$ calcd for $\text{C}_{27}\text{H}_{29}\text{N}_2\text{O}_4\text{S}_2$: 509.1563; found: 509.1566.

7. General Procedure for the Preparation of 2-(dodecyl-1-sulfenyl)-1-[(4-methylphenyl)sulfonyl]-1H-indole 8a and Representative Analytical Data



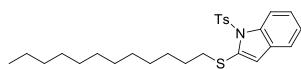
To a stirred, cooled to 0 °C solution of indole **1a** (1 mmol) and *N,N,N',N'*-tetramethylethane-1,2-diamine (1 mmol) in dry THF (5 mL) was added dropwise *n*-BuLi (2.5 M in hexane; 1 mmol). Mixture was stirred in 0 °C for 5 min. After that, the solution of thioalkylating agents **2–7** (1 mmol) in dry THF (5 mL) was added. Reaction was warmed to room temperature and stirred for 15 min. Mixture was diluted in Et_2O and washed with water, dried over MgSO_4 , filtered and concentrated under vacuum. The products were purified by column chromatography.

Lp.	R^1	R^2	Yield ^b [%]
1	(2a)	$\text{CH}_3(\text{CH}_2)_{11}-$	8a (72)
2	(3a)	$\text{CH}_3(\text{CH}_2)_{11}-$	8a (83)
3	(2b) $\text{CH}_3(\text{CH}_2)_{11}\text{S}-$	$\text{CH}_3(\text{CH}_2)_{11}-$	8a (72)
4	(2d)	$\text{CH}_3(\text{CH}_2)_{11}-$	8a (55)
5	(2e)	$\text{CH}_3(\text{CH}_2)_{11}-$	8a (53)
6	(2f) $\text{C}_6\text{H}_5\text{S}$	C_6H_5-	8b (95)

^b isolated yields

2-(Dodec-1-ylsulfanyl)-1-[(4-methylphenyl)sulfonyl]-1H-indole 8a

Chromatography: Petroleum ether (PE)-Toluene (T) (1:2), R_f = 0.5, a yellowish oil, yield: 0.392 g (83%).



^1H NMR (400 MHz, CDCl_3) δ 8.26–8.20 (m, 1H), 7.89–7.80 (m, 2H), 7.46–7.35 (m, 1H), 7.32–7.19 (m, 4H), 6.50 (d, J = 0.5 Hz, 1H), 2.96 (t, J = 7.4 Hz, 2H), 2.36 (s, 3H), 1.75–1.64 (m, 2H), 1.49–1.40 (m, 2H), 1.37–1.24 (m, 16H), 0.92 (t, J = 6.8 Hz, 3H).

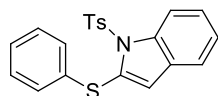
^{13}C NMR (101 MHz, CDCl_3) δ 144.8, 137.8, 135.6, 135.0, 130.0, 129.6, 127.1, 124.0, 123.6, 119.5, 114.7, 111.7, 35.1, 31.9, 29.7, 29.6, 29.6, 29.5, 29.4, 29.2, 28.9, 28.4, 22.7, 21.6, 14.1; signals: 25 expected and 25 observed.

IR (ATR) 2924 (w), 2852 (w), 1441 (m), 1373 (m), 1174 (s), 1088 (m), 677 (s), 580 (s), 542 (s)

HRMS (ESI): m/z $[\text{M} + \text{H}]^+$ calcd for $\text{C}_{27}\text{H}_{38}\text{NO}_2\text{S}_2$: 472.2338; found: 472.2342.

2-[Phenylsulfanyl]-1-[(4-methylphenyl)sulfonyl]-1H-indole 8b

Chromatography: Toluene, R_f = 0.4, a white solid mp: 110–112 °C, yield: 0.349 g (92%).



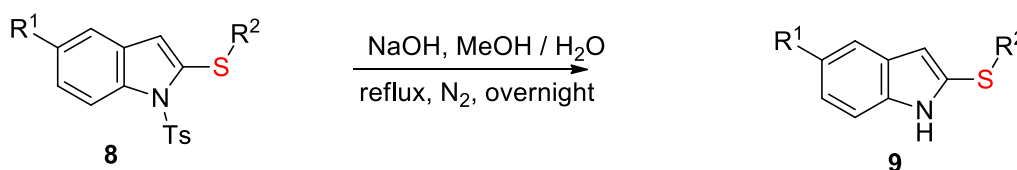
^1H NMR (400 MHz, CDCl_3) δ 8.26 (d, J = 8.4 Hz, 1H), 7.86 (d, J = 8.4 Hz, 2H), 7.57 (dd, J = 15.7, 5.7 Hz, 1H), 7.40–7.32 (m, 2H), 7.33–7.29 (m, 5H), 7.21 (d, J = 8.0 Hz, 2H), 6.47 (d, J = 0.6 Hz, 1H), 2.37 (s, 3H).

^{13}C NMR (101 MHz, CDCl_3) δ 144.9, 135.6, 131.3, 129.9, 129.6, 127.9, 127.2, 126.8, 124.7, 124.5, 123.7, 120.1, 115.4, 114.8, 113.5, 109.0, 21.6, signals: 17 expected and observed.

IR (ATR) 1444 (m), 1363 (s), 1171 (s), 1084 (m), 1005 (m), 796 (m), 752 (s), 681(s), 586 (s), 538 (s)

HRMS (ESI): m/z $[\text{M} + \text{H}]^+$ calcd for $\text{C}_{21}\text{H}_{18}\text{NO}_2\text{S}_2$: 380.0773; found: 380.0776.

8. General Procedure for Preparation of 2-sulfenyl-1H-indoles 9c and 9k and Representative Analytical Data



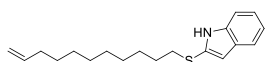
9c R^1 = -H, R^2 = $-(\text{CH}_2)_9\text{CH}=\text{CH}_2$ 96%

9k R^1 = -OMe, R^2 = $-(\text{CH}_2)_9\text{CH}_3$ 94%

A solution of NaOH (2M, 3 mL) was added to a stirring solution of 2-sulfenyl-1-[(4-methylphenyl)sulfonyl]-1H-indole **8c** or **8k** (1.48 mmol) in methanol (10 mL) and the resulting mixture was refluxed under nitrogen overnight. The reaction mixture was concentrated under reduce pressure and extracted with diethyl ether (30 mL), organic layer was washed with brine (10 mL). The combined organic layer was dried over anhydrous MgSO_4 and concentrated under reduce pressure. The crude product was purified by silica gel column chromatography.

2-(Undec-10-en-1-ylsulfanyl)-1H-indole 9c

Chromatography: PE-DCM (4:1), R_f = 0.5, a yellowish oil, yield: 0.428 g (96%).



^1H NMR (400 MHz, CDCl_3) δ 8.28–8.20 (m, 1H), 7.98 (s, 1H), 7.45–7.35 (m, 1H), 7.30–7.10 (m, 2H), 6.50 (d, $J = 0.7$ Hz, 1H), 5.60–5.87 (m, 1H), 5.05–4.94 (m, 2H), 2.96 (t, $J = 7.4$ Hz, 2H), 2.11–2.03 (m, 2H), 1.72–1.60 (m, 2H), 1.49–1.25 (m, 12H).

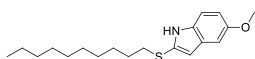
^{13}C NMR (101 MHz, CDCl_3) δ 139.2, 137.8, 135.0, 129.6, 124.0, 123.6, 119.5, 114.6, 114.2, 111.6, 35.1, 33.8, 31.9, 29.6, 29.5, 29.3, 29.2, 28.9, 28.4, signals: 19 expected and observed.

IR (ATR) 2921 (w), 2848 (w), 1441 (m), 1371 (m), 1165 (m), 1088 (m), 746 (s), 683 (s), 584 (s), 538 (s)

HRMS (ESI): m/z $[\text{M} + \text{H}]^+$ calcd for $\text{C}_{19}\text{H}_{28}\text{NS}$: 302.1937; found: 302.1940.

2-(Dec-1-ylsulfany)-5-methoxy-1H-indole 9k

Chromatography: PE-DCM (4:1), $R_f = 0.5$, a yellowish oil, yield: 0.444g (94%).



^1H NMR (400 MHz, CDCl_3) δ 7.97 (brs, 1H), 7.23 (d, $J = 8.8$ Hz, 1H), 7.03 (d, $J = 2.4$ Hz, 1H), 6.87–6.85 (m, 1H), 6.57–6.55 (m, 1H), 3.86 (s, 3H), 2.83 (t, $J = 7.5$ Hz, 2H), 1.67–1.56 (m, 2H), 1.44–1.23 (m, 14H), 0.90 (t, $J = 6.9$ Hz, 3H)

^{13}C NMR (101 MHz, CDCl_3) δ 156.3, 132.1, 129.7, 127.1, 112.8, 111.2, 108.3, 101.6, 55.8, 36.8, 31.9, 29.9, 29.5, 29.5, 29.3, 29.2, 28.6, 22.7, 14.1; signals: 19 expected and observed.

IR (ATR) 3396 (w), 2921 (s), 2850 (s), 1620 (s), 1430 (s), 1214 (s), 1160 (s), 1035 (s), 752 (s) cm^{-1}

HRMS (ESI): m/z $[\text{M} + \text{H}]^+$ calcd for $\text{C}_{19}\text{H}_{30}\text{NOS}$: 320.2043; found: 320.2041.

