Synthesis of Substituted 2-Imino-1,3-benzodithioles

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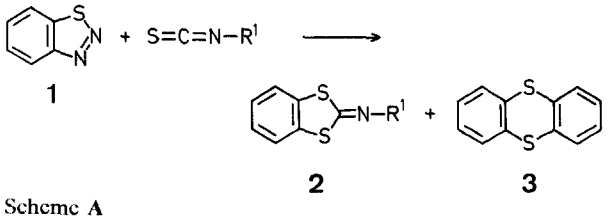
N-Substituted 2-imino-1,3-benzodithioles **2** have previously been prepared by thermal decomposition of 1,2,3-benzothiadiazole (**1**) in the presence of isothiocyanates[1] as shown in Scheme **A**.



1 **2** **3**

Scheme **A**

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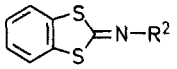
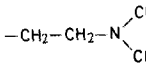
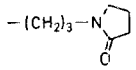
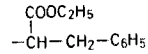
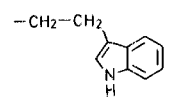
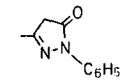
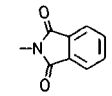
Table 1. 2-Imino-1,3-benzodithioles prepared

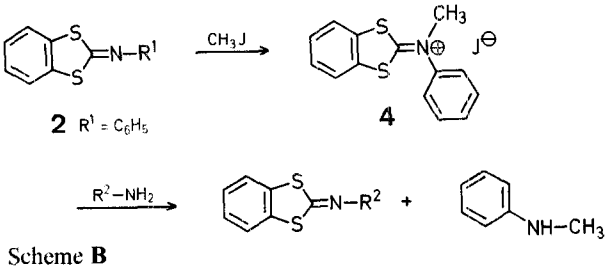


Entry No.	R^2	Yield [%]	m.p.	Solvent system for chromatography	Molecular formula[a]	I.R. (KBr) ν_{max} [cm^{-1}]	^{1}H-N.M.R. ($CDCl_3$) δ [ppm]
1		51	70–72°	$CHCl_3/CH_3OH$ (9:1)	$C_{11}H_{14}N_2S_2$ (238.4)	1595, 1450, 1430	2.30 (s, 3H); 2.32 (s, 3H); 2.68 (t, 2H); 3.35 (t, 2H); 7.25 (m, 4H)
2		28	110–112°	—[b]	$C_{14}H_{16}N_2S_2$ (276.4)	1600, 1496, 1430	1.70 (m, 5H); 2.80 (m, 4H); 3.20 (m, 2H); 7.20 (m, 4H)
3		41	101–104°	—[b]	$C_{14}H_{16}N_2OS_2$ (292.42)	1670, 1580, 1450, 1430	2.00 (m, 4H); 2.39 (t, 2H); 3.25 (t, 2H); 3.40 (t, 4H); 7.25 (m, 4H)
4	—OH	51	130–133°	*n*-C_5H_{12}/C_6H_6 (1:4)	$C_7H_5NOS_2$ (183.2)	1580, 1445, 1435	7.25 (m, 4H); 8.25 (m, 1H)
5	$-CH_2-COOC_2H_5$	75	88–89°	CH_2Cl_2	$C_{11}H_{11}NO_2S_2$ (253.3)	1750, 1585, 1440, 1430	1.30 (t, 3H); 4.02 (s, 2H); 4.26 (q, 2H); 7.30 (m, 4H)
6		32	oil	CH_2Cl_2	$C_{17}H_{15}NO_2S_2$ (329.4)	1735, 1585, 1440, 1426[c]	3.20 (d, 1H); 3.25 (d, 1H); 3.72 (s, 3H); 4.02 (m, 1H); 7.27 (m, 9H)
7	$-NH-C_3H_7-n$	80	35–37°	*n*-C_5H_{12}/CH_2Cl_2 (1:1)	$C_{10}H_{12}N_2S_2$ (224.3)	1568, 1548, 1440, 1427	0.95 (t, 3H); 1.65 (m, 2H); 3.17 (t, 2H); 3.92 (m, 1H); 7.28 (m, 4H)
8	$-NH-C_6H_5$	84	161–162°	—[b]	$C_{13}H_{10}N_2S_2$ (258.4)	3310, 1595, 1443, 1427	7.20 (m, 9H); 8.95 (s, 1H)[d]
9		76	149–149.5°	—[b]	$C_{17}H_{14}N_2S_2$ (310.4)	3400, 1582, 1444, 1420	3.20 (t, 2H); 3.60 (t, 2H); 7.20 (m, 8H); 7.70 (m, 1H); 8.00 (m, 1H)
10		32	136–138°	*n*-C_5H_{12}/CH_2Cl_2 (4:1)	$C_{10}H_6N_2S_3$ (250.4)	1570, 1520, 1440, 1410	7.20 (d, 1H); 7.50 (m, 4H); 7.80 (d, 1H)
11		42	122–124°	—[b]	$C_{11}H_{10}N_2OS_2$ (250.3)	1700, 1576, 1542, 1450, 1442	2.30 (m, 4H); 3.65 (t, 2H); 7.27 (m, 4H)
12		36	148–150°	—[b]	$C_{10}H_8N_2S_3$ (252.4)	1570, 1510, 1450, 1435	3.40 (t, 2H); 4.34 (t, 2H); 7.40 (m, 4H)
13		34	246–249°	—[b]	$C_{16}H_{11}N_3OS_2$ (325.4)	1617, 1560, 1535, 1500, 1460, 1438	5.76 (s, 2H); 7.40 (m, 6H); 8.00 (m, 3H)[d]
14		19	185–187°	—[b]	$C_{15}H_8N_2O_2S_2$ (312.4)	1740, 1575, 1520, 1472, 1454, 1440	7.22 (m, 4H); 7.80 (m, 4H)
15[e]		49	146–149°	—[b]	$C_{10}H_8N_2OS_3$ (268.4)	1685, 1580, 1540, 1458, 1440	3.32 (t, 2H); 3.80 (t, 2H); 7.25 (m, 4H)
16	$-CH_2-$ 	81	64–64.5°	—[b]	$C_{12}H_9NOS_2$ (247.3)	1580, 1557, 1500, 1442, 1430	4.37 (s, 2H); 6.30 (s, 2H); 7.30 (m, 5H)
17	$-(CH_2)_3-COOCH_3$	35	78–80°	CH_2Cl_2	$C_{12}H_{13}NO_2S_2$ (267.4)	1730, 1575, 1550, 1450, 1430	2.10 (m, 2H); 2.46 (t, 2H); 3.25 (t, 2H); 3.70 (s, 3H); 7.27 (m, 4H)
18		64	295–300°	—[b]	$C_{10}H_6N_2OS_4$ (298.4)	1667, 1610, 1557, 1500, 1425	

[a] The microanalyses for all products were in satisfactory agreement with the calculated values (C ±0.29, H ±0.28, N ±0.29, S 0.3)
[b] Product purified by recrystallization. [c] Neat. [d] In DMSO-d_6.

This method is of limited general preparative value because reaction conditions are severe and there is concomitant formation of thianthrene (**3**). We have found that new iminobenzodithioles can be prepared from the quaternary salt **4** by an addition-elimination reaction with a large variety of primary amines as shown in Scheme **B**.

The quaternary compound **4** can be prepared directly from **1** on a large scale in about 30% overall yield.



2 $R^1 = C_6H_5$ **4**

Scheme **B**

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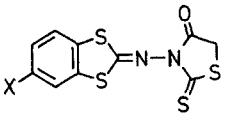
These new reaction conditions allow incorporation of a wide variety of different functional groups into R^2 (Table 1) and, as the *N*-methylaniline by-product is easily removed by an acid wash procedure, purification of the benzodithiole products is relatively simple. Substituents on the aromatic ring are also tolerated although electron-withdrawing functions lead to lower yields (Table 2). Primary amines must be more basic than *N*-methylaniline in order to react successfully with **4**.

Table 2. 5-Substituted 2-Imino-1,3-benzodithioles prepared



Entry No.	X	Yield [%]	m.p.	Molecular formula[a]	I.R. (KBr) ν_{max} [cm^{-1}]
18	H	64	295–300°	see Table 1	
19	Cl	42	312–314°	$C_{10}H_5ClN_2OS_4$ (332.9)	1690, 1564, 1520, 1445, 1430
20[b]	CF_3	24	285–288°	$C_{11}H_5F_3N_2OS_4$ (366.4)	1690, 1595, 1565, 1520, 1396
21	NO_2	35	315–316°	$C_{10}H_5N_3O_3S_4$ (343.4)	1690, 1570, 1525, 1390
22	OCH_3	68	254–255°	$C_{11}H_8N_2O_2S_4$ (328.5)	1690, 1597, 1520

[a] The microanalyses for all products were in satisfactory agreement with the calculated values (C ±0.22, H ±0.12, N ±0.26, S ±0.28, Cl ±0.08).

[b] ^{1}H-N.M.R. (DMSO-d_6): δ = 6.00 (s, 2H); 8.2 ppm (m, 3H).

N-(1,3-Benzodithiol-2-ylidene)-N-methylbenzaminium Iodide (4):
A mixture of 1,2,3-benzothiadiazole[3] (100 g, 0.735 mol) and phenyl isothiocyanate (700 g, 5.18 mol) is heated at 220° under nitrogen for 5 h. The excess phenyl isothiocyanate is removed in vacuo and the resultant black residue extracted with hot hexane. Concentration gives a 50/50 mixture (140 g) of **2** (R^1 = phenyl) and **3**. The crude material is mixed with benzene (500 ml) and methyl iodide (250 ml) and heated at reflux for 96 h. The solid which separated is filtered and washed with acetonitrile followed by ether to give **4**; yield: 85 g (22 %); m.p. 220–230° dec. (from acetonitrile).

$C_{14}H_{12}NS_2J$	calc.	C 43.69	H 3.14	N 3.64	S 16.65	J 32.64
(385.3)	found	43.64	3.26	3.69	16.44	33.02

2-Imino-1,3-benzodithioles; General Procedure:
A mixture of **4** (30 mmol), the amine or amine hydrochloride from Table 1 (30 mmol), and anhydrous sodium carbonate (*15 mmol, 30 mmol if amine hydrochloride is used*) in dimethylformamide is heated under nitrogen at 120° for 2 h. The resultant mixture is poured into chilled water, allowed to stand in the cold for 1–2 h, and extracted with benzene. The combined extracts are washed with water, brine, dried over sodium sulfate, and concentrated in vacuo to yield the crude product. The product is purified by recrystallization or column chromatography.

All of the compounds listed in Table 1 were synthesized by the above method. In many cases the compounds crystallized directly after work-up but in others purification by column chromatography on silica gel was necessary. Solvent systems used for compound elution were pentane/dichloromethane, dichloromethane/ethyl acetate, or methanol/dichloromethane mixtures.

The compounds in Table 2 were synthesized in the same way except that different quaternary starting materials were used in examples 19–22. These quaternary compounds were synthesized using the method described for the synthesis of **4** from the appropriately substituted 1,2,3-benzothiadiazoles. The 1,2,3-benzothiadiazoles were prepared by diazotization[2] of the appropriate substituted *o*-mercaptoaniline[3,4,5].

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