# Preparation and Reactions of *N*-(Arylthio)-*o*-benzosulfimides

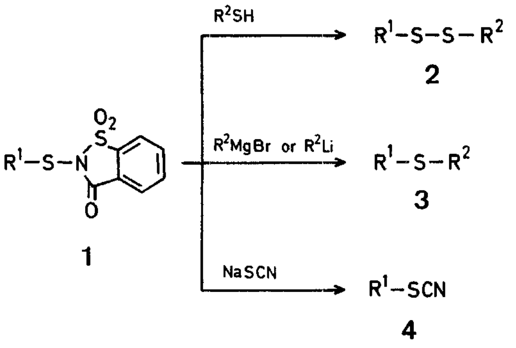
M. Furukawa, T. Suda, A. Tsukamoto, and S. Hayashi

Faculty of Pharmaceutical Sciences, Kumamoto University, Oe-hon Machi, Kumamoto 862, Japan

A variety of sulfenyl-transfer reagents have hitherto been known. Among them, the utility of *N*-(alkylthio- and arylthio-)imides as sulfenyl-transfer reagents toward various nucleophiles has been adequately demonstrated in the last few years[1-10]. We have also found that *N*-(arylthio)-phthalimides act as efficient sulfenylation agents with enamines and with carbanions originated from organometallic compounds to give sulfenyl enamines[11] and unsymmetrical sulfides[12], respectively.

We now wish to report the synthesis of novel sulfenylation reagents, *N*-(arylthio)-*o*-benzosulfimides (**1**), and the reactions with some nucleophilic agents. Compounds **1** were best prepared by treating *o*-benzosulfimides with an equivalent quantity of arenesulfenyl chlorides in dimethylformamide at room temperature under a stream of nitrogen gas. If the reaction is carried out under normal atmospheric pressure, **1** is not obtained successfully, probably due to the facile decomposition by air.

Compounds **1** were found to act as efficient sulfenylation reagents with some nucleophiles. Heating of **1** with an equivalent quantity of thiols in dichloromethane for 10 min to 3 h gave the corresponding disulfides **2**. Treatment of equivalent quantities of **1** and Grignard reagents in benzene for 2 h under reflux and then treatment of the reaction mixture with saturated ammonium chloride solution afforded the corresponding sulfides **3**. Similarly, products **3** were also obtained by heating of **1** with an excess of organolithium compounds in benzene for 3 h. All of these reactions were carried out under nitrogen. The reaction of **1** with sodium cyanide was carried out successfully by vigorous stirring with an excess of sodium cyanide in a mixture of chloroform and water at room temperature to give thiocyanates **4** in comperatively good yields. The results are summarised in the Table.



The structures of all compounds prepared were established by microanalyses, by molecular weight determinations by mass spectrometry, by their spectral data, and, in some cases, by comparison with authentic samples.

**N-(Arylthio)-*o*-benzosulfimides (1); General Procedure:**

A solution of arenesulfenyl chloride (30 mmol) in dimethylformamide (10 ml) was added with stirring to a mixture of *o*-benzosulfimide (30 mmol), triethylamine (30 mmol), and dimethylformamide (20 ml) at room temperature under nitrogen. Stirring was continued for an additional 30 min and then the mixture was poured with stirring into water. Resulting precipitates were collected by filtration and extracted with benzene. The insoluble part was filtered off, the filtrate was poured into petroleum ether, and the crystals formed were collected by filtration.

**Reaction of *N*-(Arylthio)-*o*-benzosulfimides (1) with Thiols; General Procedure:**

A solution of *N*-(arylthio)-*o*-benzosulfimide (10 mmol) and thiol (10 mmol) in dichloromethane (40 ml) was refluxed for 10 min–3 h under a stream of nitrogen. Resulting precipitates were filtered off and the filtrate was evaporated by distillation. The residue was purified by distillation under a reduced pressure to give disulfides **2**.

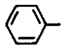
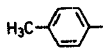
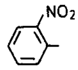
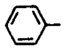
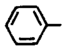
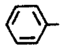
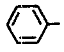
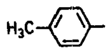
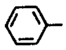
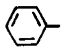
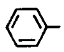
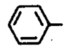
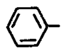
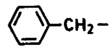
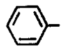
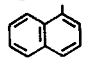
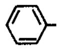
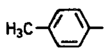
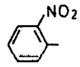
**Reaction of *N*-(Arylthio)-*o*-benzosulfimides (1) with Grignard Reagents; General Procedure:**

A solution of *N*-(arylthio)-*o*-benzosulfimide (15 mmol) in dry benzene (100 ml) was added with stirring to an ethereal Grignard reagent solution prepared from bromide (30 mmol) and magnesium (30 mg-atom) by the usual method under a nitrogen stream. After being heated for 2 h under reflux, the mixture was poured with stirring into a saturated ammonium chloride solution containing pieces of ice. The ether/benzene layer was separated, washed with water, dried over anhydrous sodium sulfate, and evaporated. The residue was distilled under reduced pressure to give sulfides **3**.

**Reaction of *N*-(Arylthio)-*o*-benzosulfimides (1) with Organolithium Compounds; General Procedure:**

A solution of *N*-(arylthio)-*o*-benzosulfimide (15 mmol) in dry benzene (100 ml) was added with stirring under a nitrogen stream

**Table.** *N*-(Arylthio)-*o*-benzosulfimides **1** and Disulfides **2**, Sulfides **3**, and Thiocyanates **4** prepared from **1**

| Compound | $R^1$ | $R^2$ | Yield (%) | m.p. or b.p. |
|---|---|---|---|---|
| **1a** |  | | 49 | m.p. 133–135° (benzene/petroleum ether) |
| **1b** |  | | 59 | m.p. 179–181° (benzene/petroleum ether) |
| **1c** |  | | 88 | m.p. 187–188° (benzene/petroleum ether) |
| **2a** |  | $i$-$C_3H_7$– | 44 | 83°/4 torr |
| **2b** |  | $n$-$C_4H_9$– | 58 | 116°/5 torr |
| **2c** |  |  | 46 | m.p. 61–62° (ethanol) |
| **2d** |  | $i$-$C_3H_7$– | 50 | 62°/3.5 torr |
| **3a** |  | $C_2H_5$ | 53 | 52°/4 torr |
| **3b** |  | $n$-$C_4H_9$– | 56 | 74°/4 torr |
| **3c** |  |  | 50 | 109°/4 torr |
| **3d** |  |  | 57 | 121°/4 torr |
| **3e** |  |  | 73 | 170°/3 torr |
| **4a** |  | | 75 | 72°/2 torr |
| **4b** |  | | 52 | 86°/2 torr |
| **4c** |  | | 76 | m.p. 134–135° (ethanol) |

to a solution of organolithium compound prepared from bromide (30 mmol) and lithium (30 mg-atom) by the usual method. After being heated for 3 h under reflux, the mixture was treated by the same procedure as described above to give sulfides **3**.

**Reaction of *N*-(Arylthio)-*o*-benzosulfimides (1) with Sodium Cyanide; General Procedure:**

A solution of *N*-(arylthio)-*o*-benzosulfimide (10 mmol) in chloroform (200 ml) was added with stirring to a solution of sodium cyanide (12 mmol) in water (30 ml) at room temperature under a stream of nitrogen. Stirring was continued for an additional 1 h, and then the chloroform layer was separated, washed with water, dried over anhydrous sodium sulfate, and evaporated. The residue was purified by distillation under a reduced pressure or recrystallization to give thiocyanates **4**.

Received: November 19, 1974

---

[1] K. S. Boustany, A. B. Sullivan, *Tetrahedron Lett.* **1970**, 3547.

[2] D. N. Harpp, et al., *Tetrahedron Lett.* **1970**, 3551.

[3] D. N. Harpp, T. G. Back, *J. Org. Chem.* **36**, 3828 (1971).

[4] D. H. R. Barton, G. Page, D. A. Widdowson, *Chem. Commun.* **1970**, 1466.

[5] D. N. Harpp, T. G. Back, *Tetrahedron Lett.* **1971**, 4953.

[6] Y. Abe, J. Tsurugi, *Chem. Lett.* **1972**, 441.

[7] T. Mukaiyama, K. Saigo, *Bull. Chem. Soc. Japan* **44**, 3077 (1971).

[8] T. Mukaiyama, S. Kobayashi, T. Kumamoto, *Tetrahedron Lett.* **1970**, 5115.

[9] T. Mukaiyama, S. Kobayashi, K. Kamio, H. Takei, *Chem. Lett.* **1972**, 237.

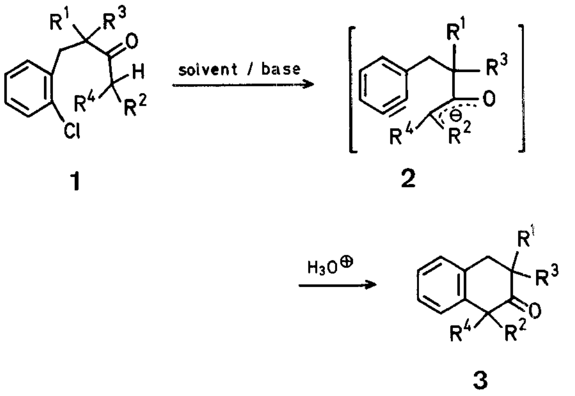
[10] T. Kumamoto, S. Kobayashi, T. Mukaiyama, *Bull. Chem. Soc. Japan* **45**, 866 (1972).

[11] M. Furukawa, Y. Kojima, S. Tsiji, S. Hayashi, *Chem. Pharm. Bull.* **20**, 2738 (1972).

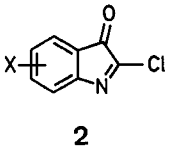
[12] M. Furukawa, T. Suda, S. Hayashi, *Synthesis* **1974**, 282.

## Errata

B. Loubinoux, P. Caubere, *Synthesis* **1974**, 201–203;
The formula scheme (p. 201) should be:

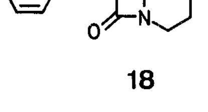


J. Grimshaw, W. J. Begley, *Synthesis* **1974**, 496–498;
The formula **2** in Table 1 (p. 497) should be:



**2**

A. K. Bose, J. C. Kapur, M. S. Manhas, *Synthesis* **1974**, 891–894;
The formula for compound **18** (p. 891) should be:

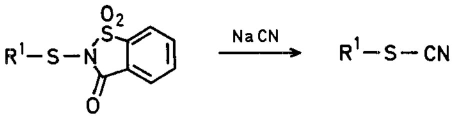


**18**

H. R. Kricheldorf, E. Leppert, *Synthesis* **1975**, 49–50;
The last entry in the first column of the Table (p. 50) should be: *N*-phenyl-*N*-methylimido.

S. Kasina, J. Mematollahi, *Synthesis* **1975**, 162–163;
The name of compound **2** should be:
5,10-dioxo-5*H*,10*H*-diimidazo[3,4-*a*; 3′,4-*d*]pyrazine.

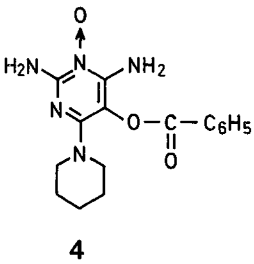
M. Furukawa, T. Suda, A. Tsukamoto, S. Hayashi, *Synthesis* **1975**, 165–167;
The reaction scheme **1**→**4** (p. 166) should be:



**1** **4**

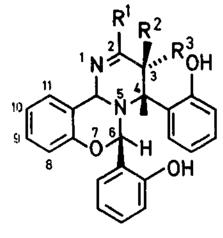
H. Singh, S. Sharma, R. N. Fyer, *Synthesis* **1975**, 325–326;
The name of the title compounds **2** should be:
5-oxobenzimidazo[2,1-*b*][1,3]benzoxazines.

J. M. McCall, R. E. TenBrink, *Synthesis* **1975**, 443–444;
The formula for compound **4** should be:

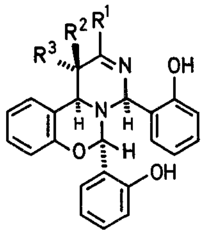


**4**

S. Kambe, T. Takajo, K. Saito, T. Hayashi, A. Sakurai, H. Midorikawa, *Synthesis* **1975**, 802–804;



**6**



**7**

The names for compounds **6** should be:
**6a**: 4,6-Bis[2-hydroxyphenyl]-3,3-dimethyl-3,4-dihydro-11b*H*-pyrimido[1,2-*c*][1,3]benzoxazine
**6b**: 4,6-Bis[2-hydroxyphenyl]-2,3,3-trimethyl-3,4-dihydro-11b*H*-pyrimido[1,2-*c*][1,3]benzoxazine
**6c**: 4,6-Bis[2-hydroxyphenyl]-2-methyl-3-phenyl-3,4-dihydro-11b*H*-pyrimido[1,2-*c*][1,3]benzoxazine

The names for compounds **7** should be:
**7b**: 4,6-Bis[2-hydroxyphenyl]-1,1,2-trimethyl-1,4-dihydro-11b*H*-pyrimido[3,4-*c*][1,3]benzoxazine
**7c**: 4,6-Bis[2-hydroxyphenyl]-1-methyl-2-phenyl-1,4-dihydro-11b*H*-pyrimido[3,4-*c*][1,3]benzoxazine