# A New Synthesis of *N*-Sulfinylamines by Sulfinylation of *N*-Trimethylsilylamines using Sulfur Dioxide

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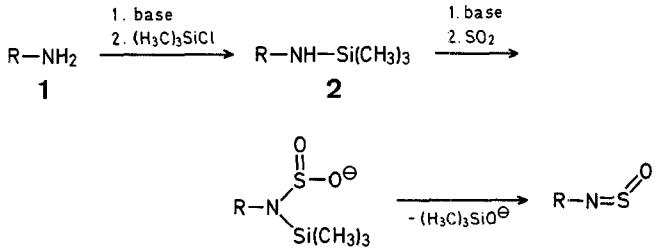
*N*-Sulfinylamines are important, sulfur-centered heterocumulenes of great synthetic utility[1,2,3]. The preparation of these compounds commonly proceeds by reaction of the corresponding amines with thionyl chloride[1,2,3]. Sensitive amines can be converted into their *N*-sulfinyl derivatives by a trans-sulfinylation reaction particularly by means of *N*-sulfinylsulfonamides[1,2]. Recently, Sakai et al.[4] described the preparation of *N*-sulfinylamines by sulfinylation of lithiated amines using sulfur dioxide.

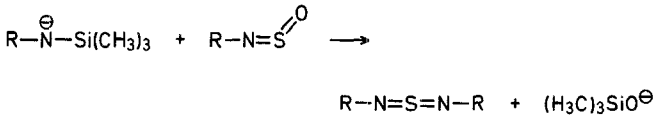
Prompted by our successful synthesis of sulfines (thione *S*-oxides) by alkylidenation of sulfur dioxide using α-silylcarbanions[5], we investigated the nitrogen equivalent of this reaction, viz. the imination of sulfur dioxide by means of *N*-trimethylsilyl-lithioamines. This synthetic approach, which conversely, can be described as the sulfinylation of *N*-trimethylsilylamines is depicted in Scheme **A**.



Scheme **A**

Proton abstraction from silylamines **2** can readily be achieved with *n*-butyllithium in tetrahydrofuran at 0 °C. The resulting anion is then added to a solution containing an excess of sulfur dioxide in tetrahydrofuran at −78 °C. Subsequent removal of solvent at room temperature and distillation of the residue affords pure *N*-sulfinylamine **4**. Yields and physical data are collected in the Table (procedure A).

It is essential that the anion of **2** be added to a solution of an excess of sulfur dioxide. When sulfur dioxide is bubbled through a solution of the anion of **2**, the yield of sulfinylamine **4** decreases drastically as the desired product is admixed with sulfurdiimine **5** as a by-product. Apparently, the side reaction involves the imination of already formed *N*-sulfinylamine **4** with the anion of **2**, according to Scheme **B**. This reaction is similar to the formation of sulfurdiimines from sulfinylamines and lithio-bis[trimethylsilyl]amine, as described by Appel et al.[6].



Scheme **B**

Diimine formation can be avoided by reacting the anion of **2** with an excess of sulfur dioxide. Moreover, it is suggested that an excess of sulfur dioxide may have a beneficial effect[5,7] on the elimination of trimethylsiloxide from intermediate **3**.

Tetrahydrofuran is the solvent of choice for the sulfinylation reaction. By employing ether as solvent, precipitation of lithium salt **3** may occur. This salt could be converted into **4** only by separate treatment with trimethylsilyl chloride.

For the non-hindered silylated anilines **2a–d**, the following modified procedure also led to the sulfinylamines **4a–d**. A solution of silylamine **2** in ether containing one equivalent of pyridine is treated with a large excess of gaseous sulfur dioxide. The trimethylsiloxide fragment was removed by conversion into the volatile hexamethyldisiloxane by adding a slight excess of trimethylsilyl chloride (procedure B, see Table).

Sulfinylation of sulfinamides could not be accomplished by the above method A since *N*-trimethylsilyl-lithiosulfonamides are insoluble in solvents like tetrahydrofuran and 1,2-dimethoxyethane.

It should be noted in the context of this work that sulfinylanilines **4b–c** can also be obtained in good yields by passing sulfur dioxide through a solution of the corresponding aryliminotriphenylphosphorane in tetrahydrofuran. This result confirms Staudinger's earlier observation[8].

The present synthesis of sulfinylamines according to procedure A compares favourably with that reported by Sakai et al.[4] The yields are higher by 30% and the procedure is experimentally less complex. Our procedure A (in some cases also B) gives results comparable with those obtained using the traditional sulfinylation of amines with thionyl chloride.

Solvents and commercial reagents were distilled and dried prior to use. Reagent grade tetrahydrofuran and ether were distilled from lithium aluminium hydride. $^1$H-N.M.R. spectra were recorded at 90 MHz with a Varian E.M. 390 instrument. I.R. spectra were taken on a Perkin Elmer Grating Spectrometer. 6-Methyl-2,4-di-*t*-butylaniline was prepared according to Geuze et al.[9] The *N*-trimethylsilylanilines **2a–f** and **2i** were prepared from the corresponding anilines essentially according to Refs.[10,11] with the exception that for **2c–f** triethylamine was used as the base.

***N*-Trimethylsilylanilines 2g and 2h:**

To a stirred solution of the amine **1** (30 mmol) in dry tetrahydrofuran (60 ml) under nitrogen, a solution of *n*-butyllithium (33 mmol) in hexane (20.6 ml of a 1.6 molar solution) is added gradually at −78 °C. After stirring for 1 h at room temperature, trimethylsilyl chloride (4.6 ml, 1.2 equiv) is added at −78 °C. The mixture is warmed to room temperature and stirred for 15 min, the solvent is evaporated and the residue distilled in vacuo.

*N-Trimethylsilyl-2,6-di-isopropylaniline* (**2g**); yield: 74%; b.p. 72 °C/0.3 torr.

| | | | | |
|---|---|---|---|---|
| $C_{15}H_{27}NSi$ | calc. | C 72.22 | H 10.91 | N 5.61 |
| (249.5) | found | 71.4 | 11.0 | 5.5 |

I.R. (neat): $\nu = 3400$ (N—H); 1254, 840 cm$^{-1}$ [$Si(CH_3)_3$].

$^1$H-N.M.R. ($CDCl_3$/TMS): $\delta = 0.20$ (s, 9H); 1.25 (d, 12H, $J = 7$ Hz); 2.30 (s, 1H); 3.41 (sept, 2H, $J = 6.5$ Hz); 7.03 ppm (s, 3H).

*N-Trimethylsilyl-6-methyl-2,4-di-*t*-butylaniline* (**2h**); yield: 78%; b.p. 85 °C/0.2 torr.

| | | | | |
|---|---|---|---|---|
| $C_{18}H_{33}NSi$ | calc. | C 74.15 | H 11.40 | N 4.80 |
| (291.6) | found | 74.9 | 11.3 | 4.8 |

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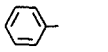
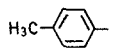
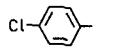
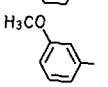
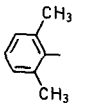
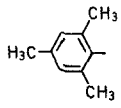
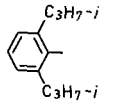
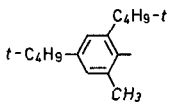
**Table.** *N*-Sulfinylamines **4a–i** prepared

| Product No. | R | Yield [%] by Procedure A | B | m.p. [°C] or b.p. [°C]/torr found | reported | I.R. (neat or KBr) $\nu_{N=S=O}$ [cm$^{-1}$] |
|---|---|---|---|---|---|---|
| **4a** |  | 74 | 69 | 55–60°/11 | 80°/12[12] | 1282, 1160 |
| **4b** |  | 90 | 76 | 47–50°/0.8 | 55°/2[12] | 1282, 1150 |
| **4c** |  | 73 | 65 | 102–106°/12 | 66°/2[12] | 1291, 1170 |
| **4d** |  | 64 | 70 | 69–71°/0.2 | 98°/2[12] | 1288, 1148 |
| **4e** |  | 85 | 0 | 97–100°/15 | 97–100°/15[4] | 1282, 1171 |
| **4f**[a] |  | 85 | — | 86–88°/2.5 | 244–246°/760[13] | 1275, 1185 |
| **4g**[b] |  | 79 | — | 78–80°/0.3 | 82–85°/0.1[14] | 1288, 1177 |
| **4h** |  | 80 | — | 53–55° | 55.5–56.5°[15] | 1272, 1181 |
| **4i** |  | 62 | — | 56–60°/15 | 55–60°/16[4] | 1230, 1120 |

[a] $^1$H-N.M.R. ($CDCl_3$/TMS): $\delta$=2.18 (s, 6H); 2.21 (s, 3H); 6.82 ppm (s, 2H).
[b] $^1$H-N.M.R. ($CDCl_3$/TMS): $\delta$=1.19 (d, 12H, $J$=7 Hz); 2.98 (sept, 2H, $J$=7 Hz); 7.13 ppm (s, 3H).

I.R. (neat): $\nu$=3440 (N—H); 1255, 836 cm$^{-1}$ [$Si(CH_3)_3$].

$^1$H-N.M.R. ($CDCl_3$/TMS): $\delta$=0.21 (s, 9H); 1.29 (s, 9H); 1.41 (s, 9H); 2.27 (s, 3H); 2.90 (s, 1H); 6.95 (d, $J$=2.5 Hz, 1H); 7.15 ppm (d, $J$=2.5 Hz, 1H).

**N-Sulfinylamines 4a–i from 2, using *n*-Butyllithium; General Procedure A:**

A solution of *n*-butyllithium (22 mmol) in hexane (13.75 ml of a 1.6 molar solution) is added gradually to a stirred solution of *N*-trimethylsilylamine **2** (20 mmol) in dry tetrahydrofuran (50 ml) at 0 °C, under nitrogen. After stirring for 1 h at room temperature, the anion of **2** is added to an excess of sulfur dioxide in tetrahydrofuran (50 ml) at −78 °C. This solution is stirred for 1 h at room temperature, after which the solvent is evaporated. Distillation at reduced pressure affords the pure *N*-sulfinylamines **4**.

Compound **4h** is isolated by adding saturated aqueous ammonium chloride (20 ml) to the solution in tetrahydrofuran, drying of the organic layer with magnesium sulfate, evaporation of solvent, and subsequent crystallization from methanol.

**N-Sulfinylamines 4a–d from 2 using Pyridine; General Procedure B:**

Gaseous sulfur dioxide is passed through a solution of *N*-trimethylsilylamine **2** (20 mmol) in ether (50 ml) containing one equiv. of pyridine at room temperature until the yellow colour persists. Then a slight excess of trimethylsilyl chloride is introduced and the mixture is stirred overnight. After filtration to remove pyridinium chloride, removal of solvent and volatiles, followed by distillation of the residue in vacuo gives the sulfinylamines **4a–d**.

The compounds **4** cannot be analyzed by G.L.C., because of their thermal instability and their sensitivity towards moisture at elevated temperatures. With $^1$H-N.M.R. spectrometry, no impurities could be detected.

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[1] G. Kresze, A. Maschke, R. Albrecht, K. Bederke, H. P. Patzschke, H. Smalla, A. Trede, *Angew. Chem.* **74**, 135 (1962); *Angew. Chem. Int. Ed. Engl.* **1**, 89 (1962).
[2] G. Kresze, W. Wucherpfennig, *Angew. Chem.* **79**, 109 (1967); *Angew. Chem. Int. Ed. Engl.* **6**, 149 (1967).
[3] C. R. Johnson in *Comprehensive Organic Chemistry*, D. H. R. Barton, W. D. Ollis, Eds., Vol. 3, D. N. Jones, Ed., Pergamon Press, Oxford, 1979.
[4] S. Sakai, T. Fujinami, K. Komizo, *J. Org. Chem.* **40**, 3291 (1975).
[5] M. van der Leij, P. A. T. W. Porskamp, B. H. M. Lammerink, B. Zwanenburg, *Tetrahedron Lett.* **1978**, 811.
[6] I. Ruppert, V. Bastian, R. Appel, *Chem. Ber.* **108**, 2329 (1975).
[7] T. H. Chan, E. Chang, *J. Org. Chem.* **39**, 3264 (1974).
[8] H. Staudinger, E. Hauser, *Helv. Chim. Acta* **4**, 861 (1921).
[9] J. Geuze, C. Reinard, J. Soeterbroek, P. E. Verkade, H. Visser, B. M. Wepster, *Recl. Trav. Chim. Pays-Bas* **77**, 491 (1958).
[10] H. Anderson, *J. Am. Chem. Soc.* **73**, 5802 (1951).
[11] A. Pierce, *Silylation of Organic Compounds*, Pierce Chemical Company, Rockford, Illinois, 1968.
[12] G. Kresze, A. Maschke, *Chem. Ber.* **94**, 450 (1961).
[13] J. S. Bonham, C. L. Cheng, R. J. W. LeFèvre, G. L. D. Ritchie, *Austr. J. Chem.* **26**, 421 (1973).
[14] M. Davis, T. G. Paproth, L. J. Stephens, *J. Chem. Soc. Perkin Trans. 1* **1973**, 2053.
[15] Y. Inagaki, R. Okazaki, N. Inamoto, *Bull. Chem. Soc. Jpn.* **52**, 1998 (1979).