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A new preparation of *cis*-*N*-sulfonylaziridines from *N*-sulfonylaldimines using trimethylsilyldiazomethane†

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Abstract

Trimethylsilyldiazomethane smoothly reacts with *N*-sulfonylaldimines to give 2-substituted *N*-sulfonyl-3-trimethylsilylaziridines in good yields with high *cis* selectivity.

Keywords: trimethylsilyldiazomethane; *N*-sulfonylaldimine; *N*-sulfonylaziridine.

Aziridines are useful building blocks in organic synthesis, and a variety of methods for the preparation of aziridines have been reported.[1] However, the most attractive approach is either 1,2-addition of carbon to a carbon–nitrogen double bond[2] and 1,2-addition of nitrogen to a carbon–carbon double bond.[3]

We have already demonstrated that trimethylsilyldiazomethane ($TMSCHN_2$) is very useful as a reagent for the introduction of a C-1 unit.[4] For instance, $TMSCHN_2$ smoothly reacts with electron-deficient olefins such as tetracyanoethylene and benzylidenecyanoacetate to give silylcyclopropanes.[5] Our continued interest in the use of $TMSCHN_2$ as a C-1 unit introducer has led us to investigate the aziridination of *N*-sulfonylaldimines, electron-deficient imines, with $TMSCHN_2$. During the course of our work, two examples of the Lewis acid-catalyzed aziridination of α-imino esters using $TMSCHN_2$ were reported.[6]

We have found that $TMSCHN_2$ smoothly reacts with *N*-sulfonylaldimines (**1**) in refluxing toluene to give 2-substituted *N*-sulfonyl-3-trimethylsilylaziridines (**2**) in good yields with high *cis* selectivity.[7] In many cases, small amounts of *C*-methylated *N*-sulfonylimines (**3**) were formed as byproducts (Scheme 1).

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† Dedicated to Professor Harry Wasserman on the occasion of his 80th birthday.

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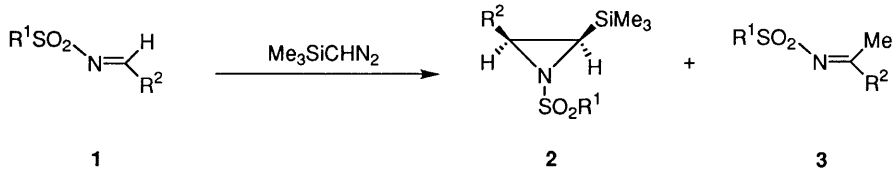


1 2 3

Scheme 1.

A typical experimental procedure is as follows (entry 4 in Table 1): A mixture of **1d**[8] (144 mg, 0.5 mmol) and $TMSCHN_2$ (1.67 M in hexane, 0.45 ml, 0.75 mmol) in dry toluene (5 ml) was stirred at reflux for 7 h. After removal of the solvent in vacuo, the residue was purified by column chromatography on silica gel (EtOAc:hexane = 1:6) to give **2d** (159 mg, 85%) and **3d** (15 mg, 10%).

The results are summarized in Table 1. The sulfonyl moiety of the imines **1** affected both the yield and the stereoselectivity (entries 1–5). Among those examined, the mesitylenesulfonyl group as a substituent gave the best result (entry 4). Various mesitylenesulfonylaldimines (**1f–n**)

Table 1
Preparation of *cis*-*N*-sulfonylaziridines **2**[a]

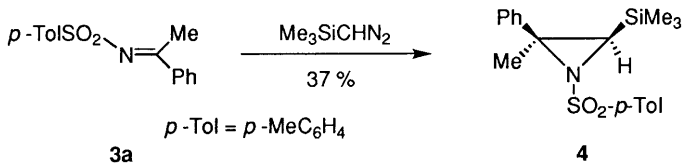
Entry	Compound no.	R^1 time (h)	R^2	Reaction	Yield (%)[b]	
					2	**3**
1	**a**	*p*-MeC_6H_4	Ph[c]	3	75 (*cis* only)	10
2	**b**	*p*-$NO_2C_6H_4$	Ph[c]	1	45 (*cis*/*trans* = 91/6)[d]	18
3	**c**	*p*-$MeOC_6H_4$	Ph[c]	4.5	80 (*cis*/*trans* = 94/6)[d]	10
4	**d**	2,4,6-$Me_3C_6H_2$	Ph[e]	7	85 (*cis* only)	10
5	**e**	Benzyl	Ph[c]	1	65 (*cis*/*trans* = 87/13)[d]	–
6	**f**	2,4,6-$Me_3C_6H_2$	*p*-ClC_6H_4[e]	5	81 (*cis* only)	(9)[d]
7	**g**	2,4,6-$Me_3C_6H_2$	*p*-$NO_2C_6H_4$[e]	5	78 (*cis* only)	12
8	**h**	2,4,6-$Me_3C_6H_2$	*p*-$MeOC_6H_4$[e]	24	76 (*cis* only)	(10)[d]
9	**i**	2,4,6-$Me_3C_6H_2$	2-Naphthyl[e]	9	76 (*cis* only)	(10)[d]
10	**j**	2,4,6-$Me_3C_6H_2$	2-Furyl[e]	2	82[f] (*cis* only)	–
11	**k**	2,4,6-$Me_3C_6H_2$	3-Pyridyl[e]	2	59 (*cis* only)	–
12	**l**	2,4,6-$Me_3C_6H_2$	Styryl[e]	2	12 (*cis* only)	–
13	**m**	2,4,6-$Me_3C_6H_2$	Phenethyl[e]	1	60 (*cis* only)	30
14	**n**	2,4,6-$Me_3C_6H_2$	*n*-Pentyl[e]	1	65 (*cis* only)	20
15	**o**	(1*R*)-10-Camphor	Ph[c]	4	88 (*cis* only) (de = 0%)	–

[a] All new compounds gave satisfactory spectral data and elemental analysis (or HRMS data).
[b] Isolated yield.
[c] $TMSCHN_2$ (1.2 equiv.) was used.
[d] Determined by ^1H NMR.
[e] $TMSCHN_2$ (1.5 equiv.) was used.
[f] The compound **2j** was very unstable under column chromatography conditions, so it was isolated by recrystallization (hexane).

derived from aromatic, heteroaromatic, and aliphatic aldehydes smoothly underwent the reaction with $TMSCHN_2$ to give the *cis*-aziridines (**2f–n**) in high to moderate yields (entries 4, 6–14). Although (1*R*)-10-camphorsulfonylaldimine (**1o**) also gave the *cis*-aziridine (**2o**) in high yield, no diastereoselectivity was observed.

The trimethylsilyl group of **2** can be easily removed with tetrabutylammonium fluoride (TBAF) to give the 2-substituted *N*-sulfonylaziridines.[9]

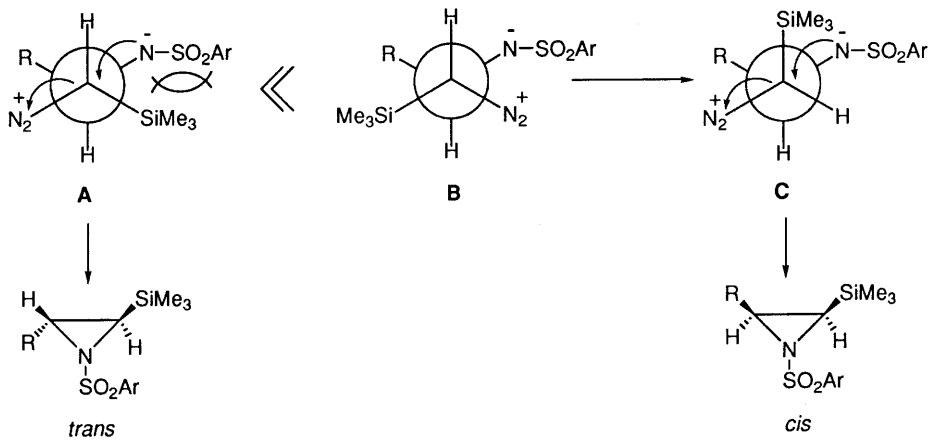
Furthermore, the reaction of the *N*-sulfonylketimine (**3a**) with $TMSCHN_2$ also proceeded to give the aziridine **4**, but a very long reaction time (30 h) was required and yet the yield was low[10] (Scheme 2).



Scheme 2.

In contrast to the Jørgensen's aziridination[6] in which significant quantities of the *trans* isomers were produced by the Lewis acid catalyzed reaction, the exclusive formation of the *cis* isomers was observed without use of Lewis acids in our case.

The high *cis*-selectivity of the reaction could be explained by steric hindrance between the trimethylsilyl and the bulkier arylsulfonyl groups in the first formed betain intermediates **A** and **B**, in which the latter would lead to a minimum steric hindrance and afford the *cis*-aziridine with expulsion of nitrogen after rotation to the intermediate **C** (Scheme 3).



Scheme 3.

In conclusion, compared to the Lewis acid-catalyzed aziridination of α-imino esters using $TMSCHN_2$,[6] the present method makes possible the simple, high-yield, and high stereoselective conversion of *N*-sulfonylaldimines to *cis*-*N*-sulfonylaziridines, and will provide an added flexibility in the aziridine synthesis.

Acknowledgements

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References

1. (a) Kemp, J. E. G. In *Comprehensive Organic Synthesis*; Trost, B. M.; Fleming, I., Eds.; Pergamon: Oxford, 1991; Vol. 7, p. 469. (b) Tanner D. *Angew. Chem., Int. Ed. Engl.* **1994**, *33*, 599. (c) Pearson, W. H.; Lian, B. W.; Bergmeier, S. C. In *Comprehensive Heterocyclic Chemistry II*; Padwa, A., Ed.; Pergamon: Oxford, 1996; Vol. 1A, p. 1.
2. (a) Xie, W.; Fang, J.; Li, J.; Wang, P. G. *Tetrahedron* **1999**, *55*, 12929. (b) Mohan, J. M.; Uphade, B. S.; Choudhary, V. R.; Ravindranathan, T.; Sudalai, A. *Chem. Commun.* **1997**, 1429. (c) Rasmussen, K. G.; Jørgensen, K. A. *J. Chem. Soc., Chem. Commun.* **1995**, 1401. (d) Casarrubios, L.; Pérez, J. A.; Brookhart, M.; Templeton, J. L. *J. Org. Chem.* **1996**, *61*, 8358. (e) Ha, H.-J.; Kang, K.-H.; Suh, J.-M.; Ahn, Y.-G. *Tetrahedron Lett.* **1996**, *37*, 7069. (f) Antilla, J. C.; Wulff, W. D. *J. Am. Chem. Soc.* **1999**, *121*, 5099.
3. (a) Jeong, J. U.; Tao, B.; Sagasser, I.; Henniges, H.; Sharpless, K. B. *J. Am. Chem. Soc.* **1998**, *120*, 6844. (b) Ando, T.; Kano, D.; Minakata, S.; Ryu, I.; Komatsu, M. *Tetrahedron* **1998**, *54*, 13485. (c) Södergren, M. J.; Alonso, D. A.; Bedekar, A. V.; Andersson, P. G. *Tetrahedron Lett.* **1997**, *38*, 6897. (d) Evans, D. A.; Faul, M. M.; Bilodeau, M. T. *J. Am. Chem. Soc.* **1994**, *116*, 2742. (e) Li, Z.; Conser, K. R.; Jacobsen, E. N. *J. Am. Chem. Soc.* **1993**, *115*, 5326. (f) Evans, D. A.; Faul, M. M.; Bilodeau, M. T. *J. Org. Chem.* **1991**, *56*, 6744.
4. For reviews, see (a) Shioiri, T.; Aoyama, T. *J. Synth. Org. Chem. Jpn.* **1986**, *44*, 149. (b) Anderson, R.; Anderson, S. B. In *Advances in Silicon Chemistry*; Larson, G. L., Ed.; JAI Press: Greenwich, CT, 1991; Vol. 1, p. 303. (c) Shioiri, T.; Aoyama, T. In *Advances in the Use of Synthons in Organic Chemistry*; Dondoni, A., Ed.; JAI Press: London, 1993; Vol. 1, p. 51. (d) Shioiri, T.; Aoyama, T. In *Encyclopedia of Reagents for Organic Synthesis*; Paquette, L. A., Ed.; John Wiley: Chichester, 1995; Vol. 7, p. 5248.
5. Aoyama, T.; Iwamoto, Y.; Nishigaki, S.; Shioiri, T. *Chem. Pharm. Bull.* **1989**, *37*, 253.
6. Juhl, K.; Hazell, R. G.; Jørgensen, K. A. *J. Chem. Soc., Perkin Trans. 1* **1999**, 2293.
7. The stereochemistry of **2** was determined by NOE experiments and coupling constants[11] between C-2 and C-3 protons.
8. *N*-Sulfonylaldimines **1** used were prepared according to the reported methods, for compounds **1a**–**e** see, Davis, F. A.; Lamendola Jr., J.; Nadir, U.; Kluger, E. W.; Sedergran, T. C.; Panunto, T. W.; Billmers, R.; Jenkins Jr., R.; Turchi, I. J.; Watson, W. H.; Chen, J. S.; Kimura, M. *J. Am. Chem. Soc.* **1980**, *102*, 2000; for compounds **1f**–**l** and **1o**; Love, B. E.; Raje, P. S.; Williams II, T. C. *Synlett* **1994**, 493; for compounds **1m**, **n**; Chemla, F.; Hebbe, V.; Normant, J.-F. *Synthesis* **2000**, 75.
9. For example, the aziridine **2d** (112 mg, 0.3 mmol) was treated with TBAF·3H_2O (114 mg, 0.36 mmol) in THF (5 ml) at 0°C for 3 h to give *N*-mesitylenesulfonyl-2-phenylaziridine (75 mg, 83%).
10. The starting ketimine **3a** was recovered in 48% yield.
11. Tanner, D.; He, H. M.; Somfai, P. *Tetrahedron* **1992**, *48*, 6069.