

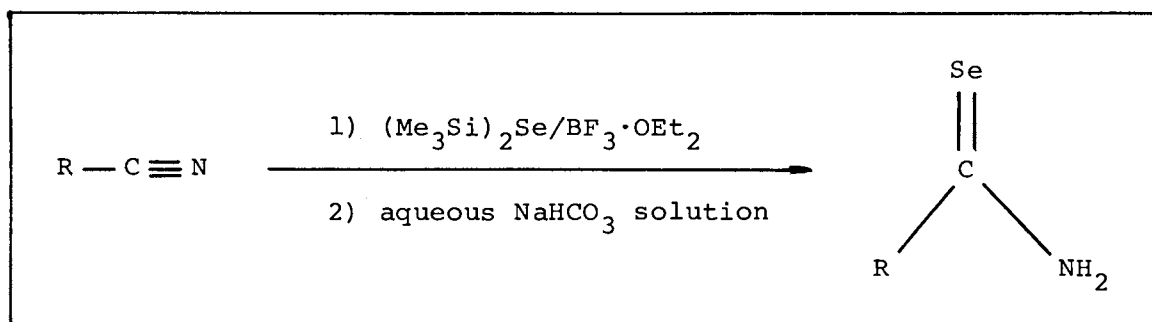
A Novel Synthesis of Primary Selenoamides from Nitriles by  
the Treatment of Bis(trimethylsilyl) Selenide and  $\text{BF}_3 \cdot \text{OEt}_2$

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Reaction of nitriles with  $(\text{Me}_3\text{Si})_2\text{Se}$  in the presence of  $\text{BF}_3 \cdot \text{OEt}_2$  afforded the corresponding primary selenoamides in moderate yields. A selenourea and a selenothiocarbamate were also prepared in a similar manner from the corresponding cyanamide and thiocyanate.

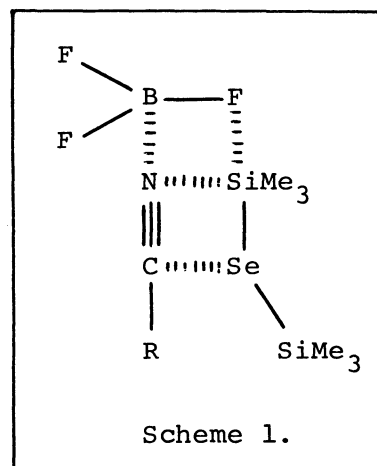
Among the organic compounds possessing a selenocarbonyl group, primary selenoamides are regarded as novel intermediates for several types of nitrogen- and selenium-containing heterocycles.<sup>1-5)</sup> However, only a few methods for the preparation of primary selenoamides have been reported<sup>6-12)</sup> owing to their lability toward bases and oxidants. Thus, a more effective synthesis of primary selenoamides possessing various substituents would be achieved under mild and non-basic reaction conditions. In the previous paper we described<sup>13)</sup> a preparation of 2,4,6-trisubstituted 1,3,5-triselenanes via selenoaldehydes from the corresponding aldehydes by the use of  $(\text{Me}_3\text{Si})_2\text{Se}-\text{BF}_3 \cdot \text{OEt}_2$  system and showed the novel utility for the selenating reagent of this system. In this paper we would like to describe a new method for the synthesis of primary selenoamides, a selenourea, and a selenothiocarbamate from the corresponding nitriles and their analogues by the treatment with  $(\text{Me}_3\text{Si})_2\text{Se}$  and  $\text{BF}_3 \cdot \text{OEt}_2$ .



A typical procedure in the preparation of selenobenzamide is described as follows. To a  $\text{CH}_2\text{Cl}_2$  solution of benzonitrile, 0.86 equiv. of  $(\text{Me}_3\text{Si})_2\text{Se}$  and 2.2 equiv. of  $\text{BF}_3 \cdot \text{OEt}_2$  were added under nitrogen atmosphere, and the solution was heated to  $60^\circ\text{C}$  for 8 h in a sealed tube. The reaction mixture was then quenched with aqueous  $\text{NaHCO}_3$  solution; after the usual work-up and purification by  $\text{SiO}_2$  column chromatography, the resulting selenobenzamide was isolated as air-sensitive yellow needles in 66% yield.

In most cases no by-products except for the starting nitriles were obtained. This procedure was applied successfully to various nitriles possessing not only aromatic but also aliphatic substituents. However, *N,N*-dimethylcyanamide **1** gave three by-products besides *N,N*-dimethylselenourea **2** and the starting material **1**. The products were purified by  $\text{SiO}_2$  column chromatography, and their structures were confirmed to be **3**, **4**, and **5** on the basis of physical data including  $^1\text{H}$  NMR, IR, MS, and elemental analyses.<sup>14)</sup> It was plausible that the by-products, **3** and **4**, were generated via the further condensation or oxidative dimerization<sup>15)</sup> of selenourea by the reaction of  $\text{BF}_3 \cdot \text{OEt}_2$ . These results are shown in Table 1.

When  $\text{SnCl}_4$  or  $\text{TiCl}_4$  was used in place of  $\text{BF}_3 \cdot \text{OEt}_2$ , selenoamides were obtained in rather low yields, indicating that  $\text{BF}_3 \cdot \text{OEt}_2$  was necessary for the reaction. Acceleration of the reaction by  $\text{BF}_3 \cdot \text{OEt}_2$  was presumably caused by the coordination to the nitrile nitrogen as well as the trimethylsilyl group as shown in Scheme 1.

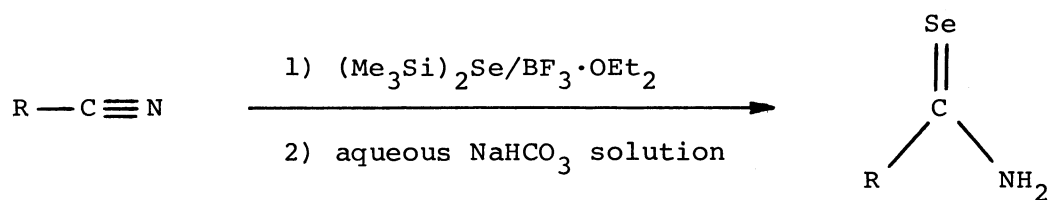


In these reactions, several points are worth noting: (1)  $(\text{Me}_3\text{Si})_2\text{Se}$  reacted as a stable synthetic equivalent of hydrogen selenide by the assistance of  $\text{BF}_3 \cdot \text{OEt}_2$ . (2) Not only aromatic but also aliphatic nitriles afforded primary selenoamides in moderate yields under mild reaction conditions. (3) A cyanamide and a thiocyanate were also converted into the corresponding selenourea and selenothiocarbamate.

Conclusively, the combination of  $(\text{Me}_3\text{Si})_2\text{Se}$  and  $\text{BF}_3 \cdot \text{OEt}_2$  provided a novel and convenient synthetic method for primary selenoamides possessing various substituents.

Preparation of other selenocarbonyl compounds using the  $(\text{Me}_3\text{Si})_2\text{Se}$ - $\text{BF}_3 \cdot \text{OEt}_2$  combination as well as the synthesis of selenium-containing heterocycles from primary selenoamides is now in progress in our laboratory.

Table 1. Synthesis of Selenoamides by the Treatment of Cyano Compounds  
with  $(\text{Me}_3\text{Si})_2\text{Se}$  in the Presence of  $\text{BF}_3 \cdot \text{OEt}_2$



R	$(\text{Me}_3\text{Si})_2\text{Se}$ /equiv.	$\text{BF}_3 \cdot \text{OEt}_2$ /equiv.	Solvent	Temp/°C	Time/h	Yield/% <sup>a)</sup>
$\text{C}_6\text{H}_5$	1.0	-	$\text{CH}_2\text{Cl}_2$	60 <sup>b)</sup>	12	0
$\text{C}_6\text{H}_5$	0.86	2.2	$\text{CH}_2\text{Cl}_2$	60 <sup>b)</sup>	8	66
$\text{C}_6\text{H}_5$	0.80	2.2	$\text{C}_6\text{H}_6$	60	12	43
4- $\text{CH}_3\text{C}_6\text{H}_4$ <sup>16)</sup>	1.2	1.2	$\text{CDCl}_3$	reflux	2	60
4- $\text{CH}_3\text{OC}_6\text{H}_4$	1.3	1.3	$\text{CH}_2\text{Cl}_2$	reflux	23	40
4- $\text{ClC}_6\text{H}_4$	0.8	2.2	$\text{C}_6\text{H}_6$	60	40	35
$\text{CH}_3$	10 mmol	21 mmol	$\text{CH}_3\text{CN}$ <sup>c)</sup>	40	40	21
$\text{CH}_3\text{CH}_2\text{CH}_2$	1.1	1.2	$\text{CH}_2\text{Cl}_2$	60 <sup>b)</sup>	8	79
$\text{CH}_3(\text{CH}_2)_3\text{CH}_2$	1.2	2.4	$\text{CHCl}_3$	reflux	3	50
$\text{CH}_3(\text{CH}_2)_5\text{CH}_2$	1.2	1.2	$\text{CHCl}_3$	reflux	2	50
$\text{CH}_3(\text{CH}_2)_9\text{CH}_2$	1.2	1.2	$\text{CHCl}_3$	reflux	9	49
$\text{C}_6\text{H}_5\text{CH}_2\text{S}$	1.2	1.2	$\text{CH}_2\text{Cl}_2$	r.t.	72	59
$(\text{CH}_3)_2\text{N}$	1.2	1.2	$\text{CH}_2\text{Cl}_2$	reflux	9	23 <sup>d)</sup>

a) Isolated yield. b) In a sealed tube. c) 3 ml. d) In the reaction with N,N-dimethylcyanamide 1, three by-products, 1,1-dimethyl-2-(dimethylselenocarbamoyl)guanidine 3, 3,5-bis(dimethylamino)-1,2,4-selenadiazole 4, and 2,4,6-tris(dimethylamino)-1,3,5-triazine 5 were obtained in 9, 21, and 17% yields, respectively.

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- 14) 3 : Colorless needles, mp 122-122.5 °C (Et<sub>2</sub>O), MS(m/e) ; 222(M<sup>+</sup>, bp), 220(M<sup>+</sup>, 71%), 178(M<sup>+</sup>-NMe<sub>2</sub>, 36%), IR(KBr) ; 3300, 3040, 2900, 1610, 1545, 1485, 1425, 1403, 1380, 1345, 1260, 1208, 1108, 1050, 1003, 730 cm<sup>-1</sup>, <sup>1</sup>H NMR(CDCl<sub>3</sub>) ; δ 3.03(6H, s), 3.22(3H, s), 3.51(3H, s), 7.47 (2H, br.s), Found ; C, 32.43, H, 6.40, N, 26.05%, Calcd for C<sub>6</sub>H<sub>14</sub>N<sub>4</sub>Se ; C, 32.58, H, 6.38, N, 25.33%.  
4 : Colorless needles, mp 49-50 °C (Hexane), MS(m/e) ; 220(M<sup>+</sup>, 99%), 218(M<sup>+</sup>, 84%), 176(M<sup>+</sup>-NMe<sub>2</sub>, 98%), 148(M<sup>+</sup>-Me<sub>2</sub>NCN, bp), 70(Me<sub>2</sub>NCN, 97%), IR(KBr) ; 2910, 2850, 1590, 1510, 1370, 1330, 1250, 1190, 1110, 1050, 1020, 850 cm<sup>-1</sup>, <sup>1</sup>H NMR(CDCl<sub>3</sub>) ; δ 3.08(6H, s), 3.11(6H, s).
- 15) 3,5-Bis(dimethylamino)-1,2,4-selenadiazole 4 was obtained in 31% yield by the treatment of N,N-dimethylselenourea 2 with 1.1 equiv. of I<sub>2</sub> in MeOH at 0 °C for 10 min followed by the work-up using NH<sub>4</sub>OH solution.
- 16) Although a new signal (δ 0.45 ppm) tentatively assigned to be a trimethylsilyl group of N,N-bis(trimethylsilyl)-4-methylselenobenzamide was observed in the <sup>1</sup>H NMR spectrum of the reaction mixture, the structure of the intermediate was not confirmed from the result.

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