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ASYMMETRIC SYNTHESIS OF OPTICALLY ACTIVE SELENONIUM YLIDE.

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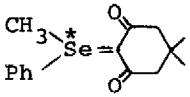
Syntheses and stereochemical properties of optically active trivalent sulfur compounds have been extensively investigated.1) Recently, an optically active tetravalent sulfurane was prepared by Martin.2) Meanwhile, among the corresponding tri- and tetravalent selenium compound an attempt was made to resolve an optically active selenoxide by fractional recrystallization of the mixed diastereoisomers but was unsuccessful.3) Neither optically active selenonium ylide nor the imide has ever been prepared, although a first example of optically inactive selenonium ylide was reported in 1935,4) while an optically inactive imide was also synthesized only recently.5)

In this communication, we wish to report the first example of a successful synthesis of some optically active selenonium ylides by asymmetric induction. We reported previously a simple and convenient procedure to synthesize selenonium ylides by treating the corresponding selenoxide with active methylene compounds.6) This procedure was applied for the synthesis of optically active selenonium ylides.

An equimolar mixture of methyl phenyl selenoxide and 10-d-camphorsulfonic acid was dissolved in dry $CHCl_3$ containing anhydrous sodium sulfate, and then, an equimolar amount of dimedone was added into the solution at room temperature. After 12 hr the reaction mixture was filtered and the filtrate was concentrated by a rotary evaporator. The resulting residue was fractionated further by preparative TLC on Kieselgel GF_{254} using $CHCl_3$-MeOH as eluent. The fraction containing selenonium ylide was extracted with $CHCl_3$-MeOH, filtered and evaporated (yield: 47.9%). The optical activity of the colorless crystalline ylide7) was determined in $CHCl_3$ at 20°C without further recrystallization in order to avoid any further fractionation which might take place during the subsequent work up.



$[\alpha]_D^{20} = -0.44°$ (c= 1.8)

mp= 124-126°C

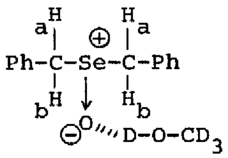
Likewise, various selenonium ylides were obtained by treating the corresponding selenoxides with an active methylene compound, i.e., 1,3-diketocyclohexane, in the presence of 10-d-camphorsulfonic acid and are listed in Table I.

Table I. Specific Rotatory Powers of Various Selenonium Ylides Obtained by the Reaction of the Corresponding Selenoxide with 1,3-Diketocyclohexane in the Presence of 10-d-Camphorsulfonic Acid in $CHCl_3$ at Room Temperature.

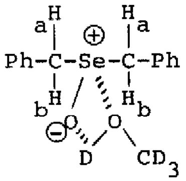
R_1-Se(O)-R_2		chem. yield(%)	$[\alpha]_D^{20}$	c	mp °C
Ph	CH_3	54.1	-0.96	1.9	123.5-124
o-CH_3O-C_6H_4	CH_3	96.8	-2.8	2.8	147-148
α-Np	CH_3	88.7	+0.91	2.9	162-164
Mesityl	CH_3	25.9	+4.9	1.7	oil
Ph	CH_2Ph	0.0	-	-	-

Failure to obtain the phenyl benzyl selenonium ylide is probably due to the Pummerer type reaction between the selenoxide and the sulfonic acid.

The effects of solvent and reaction temperature on the asymmetric induction in the reaction of o-methoxyphenyl methyl selenoxide with 1,3-diketocyclohexane are shown in Table II. Apparently the amount of asymmetric induction depends on the polarity of the solvent,excepting THF, while no asymmetric induction occurred in such a hydrolytic solvent as methanol. A corollary of this observation with methanol may be found in that NMR proton signals of dibenzyl selenoxide in CD_3OD (3.85-4.12 ppm; double-doublet) are markedly different from those in $CDCl_3$ (4.02 ppm; s).[8] There must be a strong interaction between the selenoxide and CD_3OD such as (I) or (II).



(I)



(II)

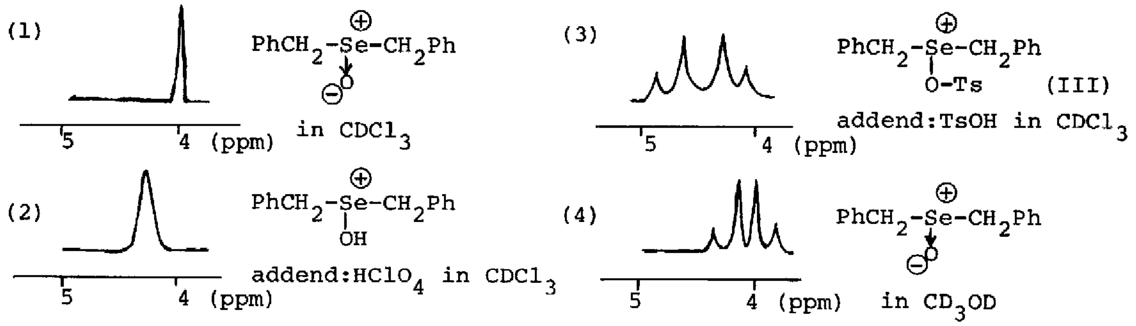
Table II. Solvent and Temperature Effects on the Reaction of o-Methoxyphenyl Methyl Selenoxide with 1,3-Diketocyclohexane Containing Equimolar Amount of 10-d-Camphorsulfonic Acid.

solvent	chem. yield(%)	$[\alpha]_D^{20}$	c	mp °C
THF[a)]	76.4	-1.3	2.2	143-144
CH_2Cl_2[a)]	81.8	-2.1	2.5	145-146.5
CH_3COCH_3[a)]	82.2	-1.4	1.8	147.5-149
CH_3CN[a)]	75.6	-0.83	2.4	149.5-151
MeOH[a)]	46.8	0.0	1.9	140-141.5
$CHCl_3$[b)]	55.2	-9.7	2.4	147.5-148

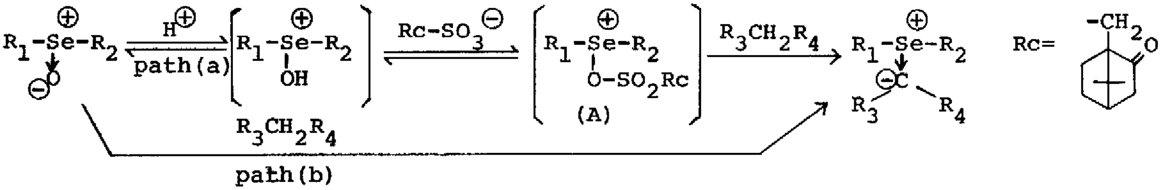
a) and b) reactions were carried out at room temperature and -40°C respectively.

Meanwhile, although no splitting of the signal was noticed in $CDCl_3$ containing perchloric acid or sulfuric acid as shown in scheme I, some splitting was observed in the presence of p-toluenesulfonic acid or 10-d-camphorsulfonic acid. Thus the selenoxide is not merely protonated but forms such a salt as (III) in the presence of these sulfonic acids.[3)] The strong interaction between the selenoxide and methanol undoubtedly prevent the participation of a chiral entity, i.e., 10-d-camphorsulfonic acid, for the asymmetric induction.

Scheme I. NMR Spectra of Dibenzyl Selenoxide under Acidic Conditions (p-TsOH, $HClO_4$, and H_2SO_4) in $CDCl_3$ and CD_3OD at Room Temperature.



When the reaction was carried out at a lower temperature(-40°C), the optical yield was raised. A more effective induction is usually accomplished when the transition state of the reaction system becomes more rigid in a less polar solvent at a lower temperature. This asymmetric synthesis of optically active selenonium ylides is very likely to involve the formation of a diastereoisomeric oxoselenonium salts(A) which is formed by the attack of 10-d-camphorsulfonate on the protonated selenoxide.



Direct reaction of selenoxide with active methylene compound without formation of the salts(A) apparently diminishes as the mol ratio of sulfonic acid increases from 1:1 to 1:1.5 as shown in Table III, as one can see the increase of the optical rotation.

Table III. Specific Rotatory Powers of the Selenonium Ylide Obtained from the Reaction of o-Methoxyphenyl Methyl Selenoxide with 1,3-Diketocyclohexane Containing Various Amount of 10-d-Camphorsulfonic Acid in $CHCl_3$ at Room Temperature.

selenoxide:acid (mol ratio)	chem. yield(%)	$[\alpha]_D^{20}$	c	mp °C of ylide
1 : 1	96.8	-2.8	2.8	147-148
1 : 1.5	81.7	-3.9	3.3	143-144
1 : 2.0	83.3	-3.7	3.3	139-141

Further attempt to prepare the optically active selenoxide and selenonium imide is now in progress in our laboratory.

References

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