CHEMISTRY LETTERS, pp. 79-82, 1990.

Facile Synthesis of α-Chlorosulfoxide Using the N,N'-Dichloro-p-toluenesulfonamide

Yong Hae KIM,* Sang Chul LIM, Hyoung Rae KIM, and Dae Chul YOON
Department of Chemistry,
Korea Advanced Institute of Science and Technology,
P.O. Box 150, Cheongyang-Ni, Seoul, Korea

Various unsymmetrical and symmetrical diakyl sulfoxides or alkyl aryl sulfoxides reacted with N,N'-dichloro-p-toluenesulfonamide to yield the corresponding α-chlorosulfoxide in excellent yields under mild and neutral conditions in high regioselectivity of monochlorination at α-position of sulfoxides.

α-Halosulfoxides have become useful in the various organic syntheses [1)] and a number of methods for the synthesis of α-chlorosulfoxides have been reported. Sulfuryl chloride[2)] gives reasonable results in the chlorination of sulfoxide in the absence of base. Most chlorinating reagents, such as nitrosyl chloride,[3)] p-toluenesulfonyl chloride,[4)] iodobenzene dichloride,[5)] t-butyl hypochlorite,[6)] chlorine,[7)] and N-chlorosuccinimide[8)] need organic or inorganic bases to avoid the Pummerer-type rearrangements[9)] giving α-substituted sulfides instead of α-substituted sulfoxides. In this paper, we wish to report a new and general synthesis of α-chlorosulfoxides: various unsymmetrical and symmetrical dialkyl sulfoxides or alkyl aryl sulfoxides reacted with N,N'-dichloro-p-toluenesulfonamide (N,N'-dichloramine-T)[10)] in the absence of base to yield the corresponding α-chlorosulfoxides in excellent yields under mild conditions and with high

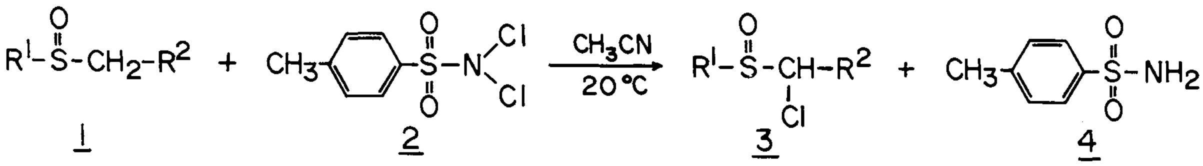
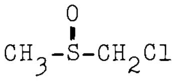
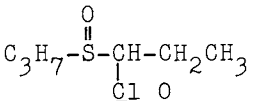
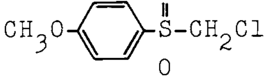
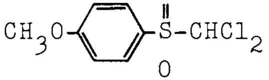
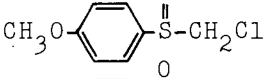
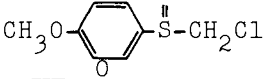
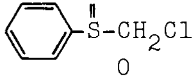
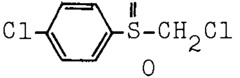
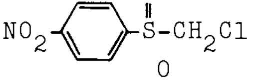
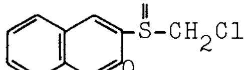
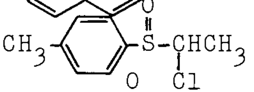
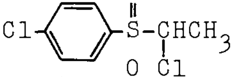
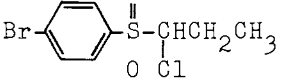
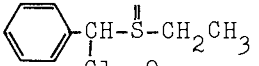
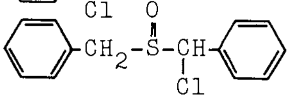


Table 1. α-Chlorination of Sulfoxides (R^1-S(O)-R^2) with N,N'-Dichloramine-T(2)

Run	R^1	R^2	Solvent	Ratio of 1 / 2	Time min	Products	Yield[a)] %
1	CH_3	CH_3	CH_3CN	2	10	 $CH_3\text{-}\overset{O}{S}\text{-}CH_2Cl$	80[b)]
2	C_3H_7	C_3H_7	CH_3CN	2	10	 $C_3H_7\text{-}\overset{O}{S}\text{-}\underset{Cl}{CH}\text{-}CH_2CH_3$	94[b)]
3	p-CH_3O-C_6H_4	CH_3	CH_3CN	2	5		98
4	p-CH_3O-C_6H_4	CH_3	CH_3CN	1	15		87
5	p-CH_3O-C_6H_4	CH_3	CH_2Cl_2	2	60		71
6	p-CH_3O-C_6H_4	CH_3	C_6H_6	2	60		66
7	C_6H_5	CH_3	CH_3CN	2	5		91
8	p-Cl-C_6H_4	CH_3	CH_3CN	2	5		95[b)]
9	p-NO_2-C_6H_4	CH_3	CH_3CN	2	10		92
10	$C_{10}H_7$	CH_3	CH_3CN	2	5		93
11	p-CH_3-C_6H_4	C_2H_5	CH_3CN	2	5		93
12	p-Cl-C_6H_4	C_2H_5	CH_3CN	2	5		91
13	p-Br-C_6H_4	C_3H_7	CH_3CN	2	5		89
14	C_6H_5-CH_2	C_2H_5	CH_3CN	2	5		81
15	C_6H_5-CH_2	CH_2-C_6H_5	CH_3CN	2	5		70

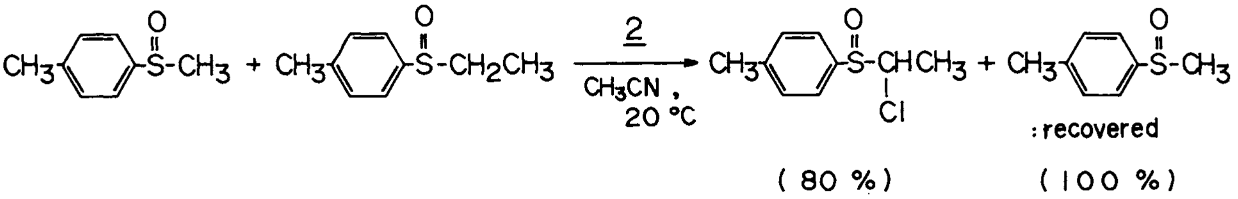
a) Isolated yields. b) Determined by ^1H MNR spectrum.

selectivity of monochlorination at α-position of sulfoxides.

In a typical experiment, a solution of 2 (60 mg, 0.25 mmol) in acetonitrile (3 ml) was added dropwise into a solution of p-methoxyphenyl methyl sulfoxide

(85 mg, 0.5 mmol) in acetonitrile (3 ml) with stirring at 20 °C under nitrogen atmosphere. After being stirred for 5 min, the reaction mixture was concentrated under reduced pressure to give a mixture of chloromethyl p-methoxyphenyl sulfoxide and p-toluenesulfonamide, which were separated by preparative TLC (Silica gel, Merck, 60 GF_{254}, Et_2O : hexane = 5 : 1, V/V) to give a pure product (100 mg, 90%), ^1H NMR ($CDCl_3$) δ 3.88 (s, 3H), 4.40 (s, 2H), 7.23 (q, 4H) ; IR (KBr) $\nu_{s=o}$ 1045 cm^{-1}. Other α-chlorosulfoxides were isolated by preparative TLC or column chromatography (Silica gel, Merck, Kieselgel 60, 70-230 mesh, 1 cm x 20 cm, Et_2O : hexane = 1 :1, V/V) and identified by comparing their IR, ^1H NMR, and mp with those of authentic samples. The results are summarized in Table 1. The new chlorination method using 2 shows several merits comparing with the previous reported methods. 2 do not need a base because p-toluenesulfonamide formed during the reaction prevents decomposition of the sulfinyl group with the concurrently generated hydrogen chloride. Both two chlorine atoms of 2 could be used to chlorinate the sulfoxide, so that only half equivalent amount of reagent for sulfoxides is needed to monochlorination of α-position of sulfoxides to obtain almost quantitative yields with no formation of by-product for short reaction time within 10 min. It is easy to control the exact amount of 2 for the monochlorination by weighing the reagent.

To check the solvent effects, α-chlorination of p-methoxyphenyl methyl sulfoxide using 2 was carried out in CH_3CN, CH_2Cl_2, and benzene. Among the three solvents, acetonitrile showed the best result (CH_3CN : 98%, Run 3 ; CH_2Cl_2 : 71%, Run 5 ; benzene : 66%, Run 6 in Table 1). The monochlorinated sulfoxide are significantly less reactive toward 2 than their precursor's sulfoxides. Thus monochlorination seems to occur first and then dichlorination in stepwise. For example, the best yield (98%) of chloromethyl p-methoxyphenyl sulfoxide was produced by using half equimolar amount of 2, but when equivalent amount of 2 was used 87% of dichloromethyl p-methoxyphenyl sulfoxide was obtained (Run 4 in Table 1). In order to see a selectivity in chlorination at α-position of two alkyl groups, a mixture of ethyl p-tolyl sulfoxide and methyl p-tolyl sulfoxide was treated with the half equimolar amount of 2, only α-chloroethyl p-tolyl sulfoxide (80%) was obtained: no evidence for the formation of chloromethyl p-tolyl sulfoxide could be observed by ^1H NMR spectrum of the total crude reaction mixture, which shows high selectivity in the α-chlorination of alkylsulfoxides with 2 as shown below.



When benzyl ethyl sulfoxide (Run 14) was reacted with 2, only α-chlorobenzyl ethyl sulfoxide was obtained (81%) where formation of benzyl chloroethyl sulfoxide was not observed. The reaction is simple and work-up is easy and the commercially available 2 can be handled more conveniently than other known reagents. The reaction mechanism is being investigated.

This work was supported by Korea Science and Engineering Foundation.

References

1) T. Durst and K.C. Tin, Tetraheron Lett., 27, 2369 (1970); D.F. Tavares, R.E. Estep, and M. Blezard, ibid., 27, 2373 (1970); T. Durst, J. Am. Chem. Soc., 91, 1034 (1969); G. Tsuchihashi and K. Ogura, Bull. Chem. Soc. Jpn., 45, 2023 (1972).
2) K.C. Tin and T. Durst, Tetrahedron Lett., 27, 4643 (1970).
3) R.N. Loeppky and D.C.K. Chang, Tetrahedron Lett., 25, 5415 (1968).
4) M. Hojo and Z. Yoshida, J. Am. Chem. Soc., 90, 4496 (1968).
5) M. Cinquini, S. Colonna, and F. Montanari, J. Chem. Soc., Perkin Trans. 1, 1972, 1883.
6) S. Iriuchijima and G. Tsuchihashi, Tetrahedron Lett., 26, 5259 (1969).
7) G. Tsuchihashi and S. Iriuchijima, Bull. Chem. Soc. Jpn., 43, 2271 (1970).
8) K. Ogura, J. Imaizumi, H. Iida, and G. Tsuchihashi, Chem. Lett., 1980, 1587.
9) T. Durst, Adv. Org. Chem., 6, 285 (1969) and references therein.
10) R.W. Heinzelman and D. Swern, Synthesis, 1976, 731.

(Received October 2, 1989)