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RING CLEAVAGE OF EPOXIDES WITH THIOANISOLE-CHLORINE COMPLEX: A SIMPLE SYNTHESIS OF α-CHLOROCARBONYL COMPOUNDS

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The reaction of epoxides (1) with thioanisole-chlorine complex (2) produced α-chlorosulfoxonium intermediates (3a and/or 3b), which were quenched with aqNaHCO$_3$ to afford α-chloroalcohols (4a and/or 4b). The intermediate (3a and/or 3b) gave α-chlorocarbonyl compounds (5a and/or 5b) by treatment with triethylamine.

The ring cleavage of epoxides with various kinds of reagents has been a subject of current interest due to their wide applications in organic synthesis. Ring opening of epoxides with methylsulfide-chlorine complexes developed by Corey et al.[1], which transform alcohols to carbonyl compounds, could be one of promising methods applied to epoxide chemistry. Thus we report here a new method for ring cleavage of epoxides and a novel one-step synthesis of α-chlorocarbonyl compounds under mild conditions. The overall synthetic transformation is represented by the scheme I.

The general procedure is described below for the transformation of cyclohexene oxide to 2-chlorocyclohexanol and to 2-chlorocyclohexanone and the results obtained with five different epoxides were summarized in the table I.

To a solution of 2.14g (30.6 mmol) of Cl_2 in 30 ml of CCl_4 was added at -25°C a solution of 3.80g (30.6 mmol) of thioanisole in 15 ml of CH_2Cl_2 under argon. A white precipitate appeared immediately after addition of thioanisole. To the mixture was added a solution of 1.50g (15.3 mmol)of cyclohexene oxide in 20 ml of CH_2Cl_2. (a) The reaction mixture was poured into large excess of saturated aqNaHCO$_3$. The organic layer was dried over Na_2SO_4. Removal of dried solvents under reduced

pressure produced 2-chlorocyclohexanol almost quantitatively (>98%) after purification by silica gel short column. (b) The reaction mixture was further treated with a solution of 6.18g (61.2 mmol) of triethylamine in 20 ml of CH_2Cl_2 at -25°C to -30°C. The cooling bath was removed and after 5 min 120 ml of Et_2O was added. The organic layer was washed with 15 ml of 1% aqHCl and dried over $MgSO_4$. Removal of dried solvents under reduced pressure gave a pale yellow oil which was purified by silica gel short column to give 1.90g (94%) of 2-chlorocyclohexanone. The structures of all products and their ratios were sufficiently analyzed by ir, pmr and mass spectroscopy. Further study on the application of this reaction is in progress.

SCHEME I

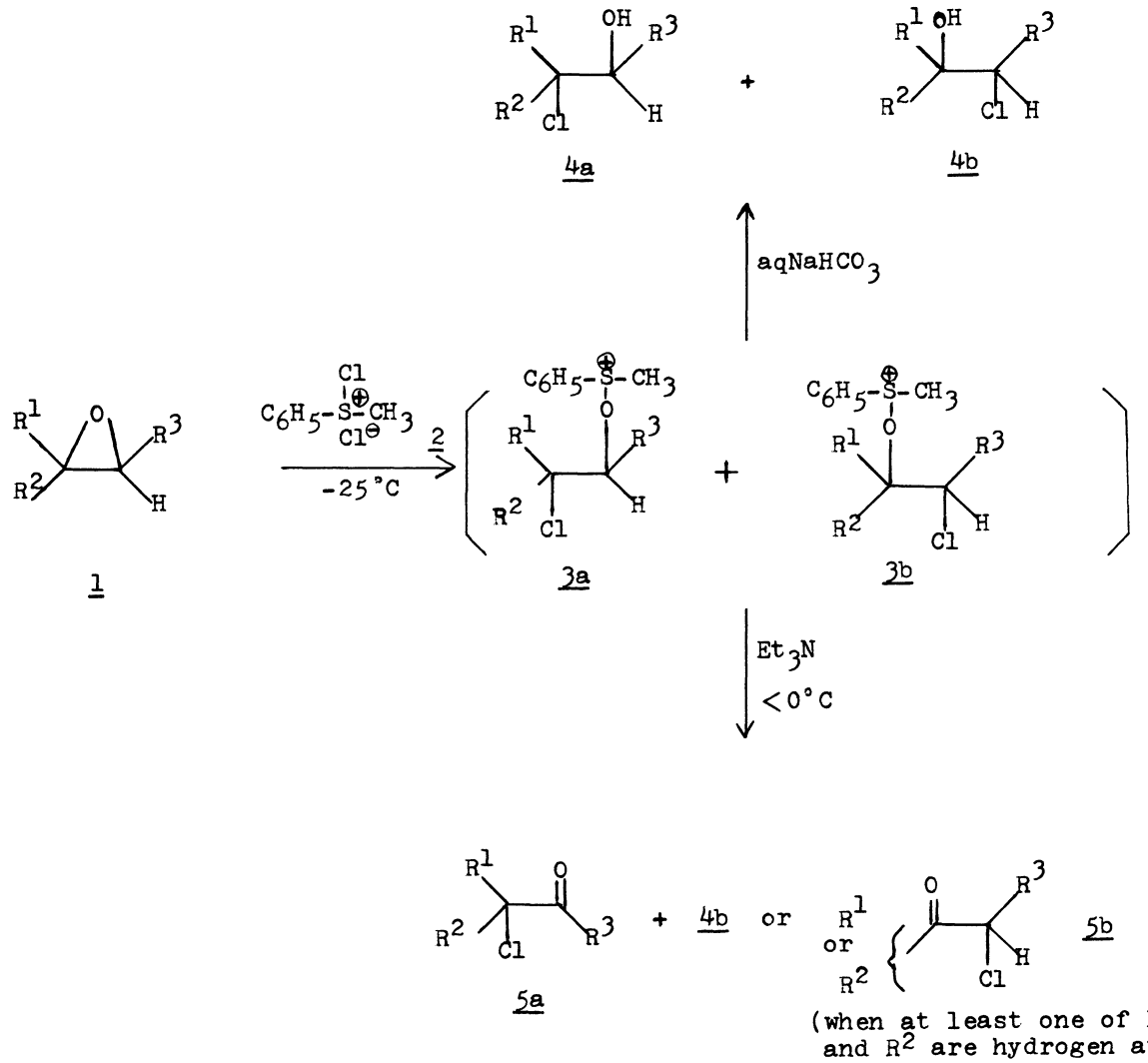
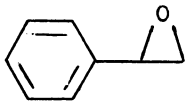
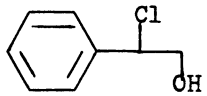
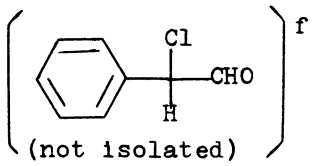
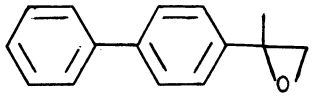
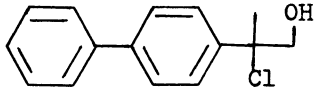
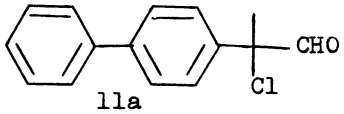
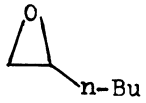
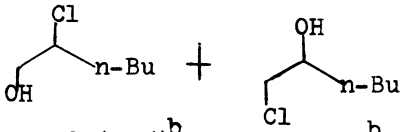
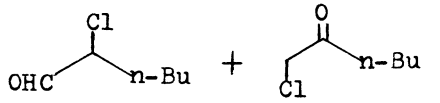
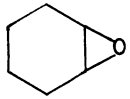
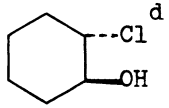
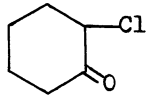
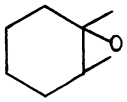
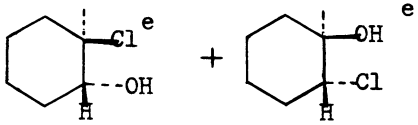
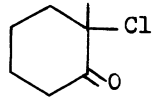


TABLE I α-chloroalcohols and α-chlorocarbonyl compounds from epoxides

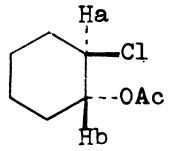
Run	epoxides (1)	α-chloroalcohol (4a) and/or (4b)	(total yield %)[a]	α-chlorocarbonyl compound (5a) and/or (5b)	(total yield %)[a]
1)		 6a	(>95)	 (not isolated)[f]	
2)		 7a	(>98)	 11a	(95)
3)		 8a(27%)[b] 8b(73%)[b]	(>98)	 12a(27%)[g] 12b(73%)[g]	(>95)
4)		 9(9a=9b)	(>98)	 13(13a=13b)	(94)
5)		 10a(50%)[c] 10b(50%)[c]	(>98)	 14a	(46)

a) Isolated yield after purification on silica gel short column.

b) The ratio of 8a and 8b was tentatively estimated from the ratio of α-chlorocarbonyl compounds 12a and 12b.

c) The ratio of 10a and 10b was calculated based on area intensities of their methyl signals of pmr spectrum [10a δ: 1.55_{ppm}(3H, s); 10b δ: 1.27_{ppm}(3H, s)].

d) Trans configuration of 2-chlorocyclohexanol 9 was unambiguously comfirmed with pmr peaks of its acetate 15.



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Ha(axial): 3.86_{ppm}(ddd, J=4.0, 9.0, 10.0 Hz)

Hb(axial): 4.86_{ppm}(ddd, J=5.0, 9.5, 10.0 Hz)

e) Stereochemistry of these two compounds 10a and 10b was tentatively deduced by followings; a) by analogy of run 4), b) by the fact that only two different compounds were quantitatively obtained.

f) Under oxidative condition α-chloroaldehyde $C_6H_5CHClCHO$ expected to be derived from 3a was not obtained, but further chlorinated aldehyde $C_6H_5CCl_2CHO$ was obtained in moderate yield.

g) The ratio was calculated based on area intensities of aldehyde proton [9.3_{ppm} (1H, d)] of 12a and chloromethylene proton [3.89_{ppm}(2H, s)] of 12b.

References

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