

Regioselective Ring Cleavage of Phenyl- or/and Alkyl- Substituted Epoxides with *Al*-Methanesulfonyldiisobutylalane

Jin Soon Cha* and Seung Jin Park

Department of Chemistry, Yeungnam University, Gyongsan 712-749, Korea. *E-mail: jscha@yu.ac.kr

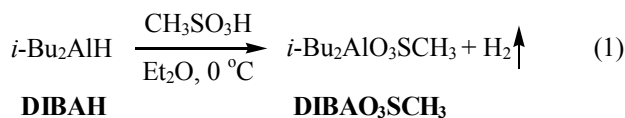
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In the previous communication,¹ we reported that *Al*-fluoro-diisobutylalane readily attacks both phenyl- or/and alkyl- substituted epoxides to produce the regioselectively ring-opened reduction products through the Meerwein-Ponndorf-Verley (MPV) type reaction mechanism. In the course of our successive efforts to devise new unique MPV type reagents,² we found *Al*-methanesulfonyldiisobutylalane (DIBAO₃SCH₃), a new MPV type reagent, reacts readily with both aromatic and aliphatic epoxides to produce the corresponding alcohols in an essentially perfect regioselectivity. This paper described such a regioselective MPV type reduction of epoxides.

Results and Discussion

The reagent, DIBAO₃SCH₃, can be prepared by a simple reaction of diisobutylaluminum hydride (DIBAH) and an equivalent of methanesulfonic acid in Et₂O at 0 °C (Eq. 1).



As summarized in Table 1, DIBAO₃SCH₃ reduced both aromatic and aliphatic epoxides examined in Et₂O in 48 h at 25 °C. The regioselectivities shown in these reactions of one alkyl- or phenyl- substituted epoxides such as 1,2-epoxybutane and styrene oxide are extraordinary. The reagent attacked only the more hindered site of epoxy ring to produce the corresponding primary alcohol as a sole product. These results clearly indicate that the reaction proceeds through trapping of β-hydrogen from isobutyl group of the reagent at the site best able to accommodate a carbocation. Such interpretation was further confirmed by the results obtained from the reaction of more substituted epoxides such as 2,3-epoxy-2-methylbutane and α-methylstyrene oxide: the products are 3-methyl-2-butanol and 2-phenyl-1-propanol, respectively. Again, the selectivities are perfects.

Particularly interesting example is the reaction of *trans*-β-methylstyrene oxide. Thus, the reaction yielded only 1-phenyl-2-propanol as a sole product showing 100% selectivity. It is quite surprising that the reagent discriminates between the phenyl- and alkyl- group substituted carbon sites.

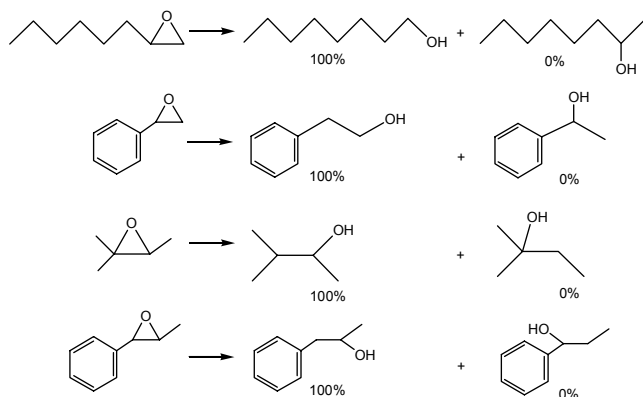
Preliminary experiments revealed that the reagent is extremely mild toward other organic functional groups except for simple carbonyl compounds. Therefore, this reagent should find an

Table 1. Reaction of Epoxides with DIBAO₃SCH₃ in Et₂O at 25 °C.

Epoxides	Time (h)	Conversion (%) ^b	Product	Purity (%) ^b
1,2-epoxybutane	6	79	1-butanol	100
	24	92		100
	48	99		100
1,2-epoxyoctane	6	75	1-octanol	100
	24	90		100
	48	100		100
2,3-epoxy-2-methylbutane	6	72	3-methyl-2-butanol	100
	24	88		100
	72	95		100
	120	98		100
styrene oxide	6	95	2-phenylethanol	100
	24	100 ^c		100
α-methylstyrene oxide	3	93	2-phenyl-1-propanol	100
	6	98		100
	24	100		100
<i>trans</i> -β-methylstyrene oxide	3	89	2-phenyl-2-propanol	100
	6	100		100

^aTen% excess reagent utilized; 0.5 M concentration. ^bDetermined by GC using a suitable internal standard. ^cSeventy four% of 2-phenylethanol was isolated from the 40 mmol scale reaction.

application in the selective reduction of organic functionalities. The further systematic investigation on the general reducing characteristics of the reagent is underway.



Experimental Section

All reactions and manipulations of air- and moisture-sensitive material were carried out using standard techniques for handling air-sensitive materials.³ Et₂O was dried over sodium-benzophenone ketyl and distilled. All liquid materials were transferred by using hypodermic syringes.

Preparation of DIBAO₃SCH₃. Into an oven-dried, 100 mL flask with a sidearm with a downward-directed, water-cooled condenser leading to a mercury bubbler, 11 g of diisobutylaluminum hydride (DIBAH, 75 mmol) was injected and diluted with Et₂O to be 2.0 M. The flask was maintained at 0 °C using a water bath. To this was added 15 mL of a 5.0 M solution of methanesulfonic acid (75 mmol) in Et₂O dropwise. After the complete evolution of hydrogen gas, the solution was diluted with Et₂O to be 1.5 M. The ²⁷Al NMR spectrum of the solution showed a broad singlet centered at δ = 23.7 ppm relative to Al(H₂O)₆³⁺.

Reduction of Epoxides. The following procedure is illustrative. Into a 50 mL flask with a sidearm equipped with a condenser

leading to a mercury bubbler, 0.60 g of styrene oxide (5 mmol), 6.0 mL of Et₂O, tridecane (2 mmol) as an internal standard, and 3.7 mL of a 1.5 M DIBAO₃SCH₃ (5.5 mmol) in Et₂O were injected. Then the flask was immersed into a water bath and the mixture was maintained at 25 °C. At the appropriate reaction periods (3, 6, and 24 h) an aliquot of the reaction mixture was withdrawn and quenched with water. The aqueous phase was saturated with K₂CO₃ and the organic phase was dried over anhydrous MgSO₄. GC analysis of the organic layer revealed the presence of 2-phenylethanol as a sole product in a yield of 95% at 6 h-period and 100% at 24 h-period.

Isolation of Products. The following procedure is representative for isolation of product alcohols on distillation. In the assembly previously described was placed 4.81 g of styrene oxide (40 mmol) in 20 mL of Et₂O and the solution was maintained in a circulating bath at 25 °C. Into the solution was injected 29.5 mL of a stock solution of DIBAO₃SCH₃ (44 mmol) in Et₂O with stirring and the reaction mixture was stirred for 24 hrs. The mixture was then quenched with 3 N HCl. The aqueous layer was saturated with NaCl. The separated organic layer was dried over anhydrous MgSO₄. The solvent was distilled out under reduced pressure and a careful fractional distillation gave 3.62 g (74% yield) of essentially pure 2-phenylethanol. The product was further confirmed by GC-Mass spectrometer.

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