An Efficient Nucleophilic Cleavage of Oxiranes to 1,2-Azido Alcohols†

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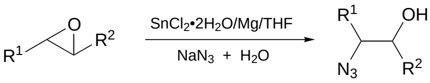
Regioselective ring opening of oxiranes has been induced by the $SnCl_2{\cdot}2H_2O{-}Mg{-}THF/NaN_3{-}H_2O$ system to give the corresponding 1,2-azido alcohols in good yields.

Epoxides are valuable intermediates in organic synthesis because their nucleophilic cleavage leads to 1,2-difunctionalized systems.[1] Preparations of 1,2-azidoalcohols have been reported[2–8] regioselectively through nucleophilic cleavage of oxirane rings. The present work has been undertaken in order to determine the general applicability of the reaction with epoxides, as well as to determine the direction of ring opening for a number of representative symmetrical and unsymmetrical epoxides. In continuation of our earlier studies on applications of metal reagents,[9,10] we have found that $SnCl_2{\cdot}2H_2O{-}Mg/NaN_3{-}H_2O/THF$ is a promising system for regioselective ring opening of oxiranes to the corresponding 1,2-azido alcohols.

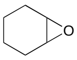
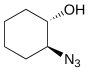
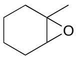
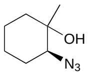
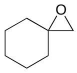
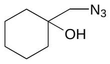
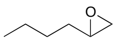
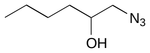
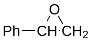
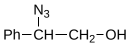
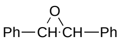
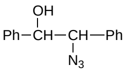
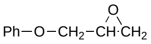
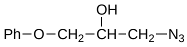


In the system $SnCl_2{\cdot}2H_2O{-}Mg/NaN_3{-}H_2O$ with cyclohexene oxide, azide ion readily attacks the epoxide ring carbon through a bimolecular nucleophilic displacement reaction which proceeds with inversion, to give the azido alcohol. In unsymmetrical epoxides (entries 2, 3, 4 and 7), the ring opening appears preferably at the less substituted carbon, leading to nucleophilic attack occurring predominantly at the sterically less hindered site. In the case of styrene oxide, azide ion attacks exclusively at the secondary carbon atom of the epoxide ring. This interesting observation proves the structure of the corresponding azido alcohol (Table 1, entry 5) from its known reduction product, 2-amino-2-phenylethanol, with the reducing agent $LiAlH_4$. This has been further attributed to the fact that an unsaturated group, *viz.* phenyl, helps to promote the positively charged secondary carbon atom of the epoxide ring, in the presence of a nucleophilic reagent, owing to its high degree of resonance stabilization. The increase in electrophilicity of the oxirane carbon with this system promotes the participation of the azide anion with *trans* stereoselectivity, which is probably due to steric and electronic effects.

The cleavage of oxirane rings has also been tried using $SnCl_2{\cdot}2H_2O{-}NaN_3{-}THF$ alone but the reaction did not occur. However, the use of a stoichiometric amount of magnesium facilitated the reaction. In addition, the possibility exists of active zero-valent tin generated in principle by the reduction of Sn^{II} to Sn^0 in the presence of magnesium effectively inducing nucleophilic attack. The reaction has also been tried with $MgCl_2$ instead of $SnCl_2$ for a longer period but no trace of the required reaction product was obtained.

Owing to the general interest in the smooth and selective cleavage of these compounds, the mild reaction conditions, good yields and some possible synthetic generalization, the $SnCl_2{\cdot}2H_2O{-}Mg{-}THF/NaN_3{-}H_2O$ system will be a useful addition to existing methods.

Table 1 Oxirane ring opening with $SnCl_2{\cdot}2H_2O/Mg/THF/NaN_3{-}H_2O$

Entry	Oxirane	Time (t/h)	Product[a]	Yield (%)[b]	Lit. ref.
1		0.5		85	6, 7, 8
2		0.75		83	11
3		0.5		88	6, 7
4		0.75		70	3
5	 $\mathrm{Ph{-}\overset{O}{CH{\cdot}CH_2}}$	0.5	 $\mathrm{Ph{-}\overset{N_3}{CH}{-}CH_2{-}OH}$	95	6, 7
6	 $\mathrm{Ph{-}\overset{O}{CH{\cdot}CH}{-}Ph}$	1.5	 $\mathrm{Ph{-}\overset{OH}{CH}{-}\underset{N_3}{CH}{-}Ph}$	82	8
7	 $\mathrm{Ph{-}O{-}CH_2{-}\overset{O}{CH{\cdot}CH_2}}$	2	 $\mathrm{Ph{-}O{-}CH_2{-}\overset{OH}{CH}{-}CH_2{-}N_3}$	92	6, 7

[a]All the products were confirmed by spectral data. [b]Total yield of the regioisomers.

Experimental

^1H NMR spectra were recorded in deuteriochloroform on a JEOL FX-90 instrument. IR spectra were recorded on a JASCO FT/IR-5300 instrument in chloroform. Mass spectra were recorded

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*To receive any correspondence.

†This is a **Short Paper** as defined in the Instructions for Authors, Section 5.0 [see *J. Chem. Research (S)*, 1997, Issue 1]; there is therefore no corresponding material in *J. Chem. Research (M)*.

on an MS-30 instrument. TLC and preparative TLC were performed on silica gel (E. Merck).

General Procedure.—To a stirred suspension of $SnCl_2{\cdot}2H_2O$ (442 mg, 2 mmol), Mg powder (36.5 mg, 1.5 mmol) and oxirane (1 mmol) in tetrahydrofuran (5 ml) was added sodium azide (97.5 mg, 1.5 mmol) in H_2O (5 ml) slowly at room temperature. The reaction mixture was stirred for 0.5–2 h. After completion of the reaction (TLC), the resulting mixture was filtered and usual work-up was carried out with dichloromethane. Removal of the organic solvent under reduced pressure followed by purification through preparative chromatography afforded the corresponding 1,2-azido alcohols.

Selected spectral data. Entry 1: δ_H ($CDCl_3$) 1.15–2.20 (8 H, m), 2.95 (1 H, br s), 3.25–3.7 (2 H, m); ν_{max}/cm^{-1} (neat) 3400 (OH), 2100 (N_3). Entry 3: δ_H ($CDCl_3$) 1.25–1.85 (10 H, m), 2.20 (1 H, br s), 3.30 (2 H, s); ν_{max}/cm^{-1} (heat) 3400 (OH), 2100 (N_3). Entry 5: δ_H ($CDCl_3$) 2.33 (1 H, s), 3.95 (2 H, d), 5.00 (1 H, t), 7.45 (5 H, m); ν_{max}/cm^{-1} (neat) 3400 (OH), 2102 (N_3).

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