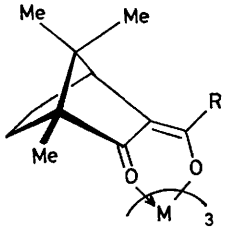
Resolution of Racemic Epoxides on G.l.c. Columns Containing Optically Active Lanthanoid Complexes

By BERNARD T. GOLDING,* PHILIP J. SELLARS, and AH KEE WONG
(*Department of Molecular Sciences, University of Warwick, Coventry* CV4 7AL)

Summary Racemic epoxypropane and 1,2-epoxybutane are resolved on a 2 m g.l.c. column containing the lanthanoid complex (**1**, R = CF_3. M = Eu or Pr) in the stationary phase; (S)-epoxypropane is eluted more slowly than the (*R*)-isomer.

LANTHANOID shift reagents possessing optically active ligands have been used to distinguish proton resonances of enantiomers.[1] We now report the use of such a complex (**1**, R = CF_3, M = Eu or Pr)† as a component of a stationary phase for the resolution by g.l.c. of racemic epoxypropane and 1,2-epoxybutane. It had been suggested[2] that such



(Dimer)

(1)

separations were possible in principle, and indeed columns containing (**1**, R = CF_3, M = Pr, Sm, Tb, Er, or Lu) have been used[2] in order to evaluate 'constants' for the association of oxygen-donor achiral substrates to lanthanoid tris-(β-ketonates). Recently, resolution of racemic 3-methylcyclopentene using dicarbonylrhodium(I) 3-trifluoroacetyl-(1*R*)-camphorate or its enantiomer in the stationary phase has been reported,[3] although retention times on the 200 m capillary column used were extremely long (*ca.* 3 h). This extends the work of Gil-Av and his co-workers who have reported[4] separations of enantiomers (mostly derivatives of amino-acids) on g.l.c. columns containing derivatives of peptides in the stationary phase.

The stationary phase‡ used in our studies consists of a 0·133 M solution of (**1**, R = CF_3, M = Eu or Pr) in squalene deposited (15% w/w) on Chromosorb W HP (100/120 Mesh) contained in a conventional 2 m × 2·2 mm stainless steel column (Perkin-Elmer F-11 instrument). *Effective separation of the enantiomers of epoxypropane was obtained at* 313 K *in* < 10 *min* (see Figure) using N_2 carrier (12·8 ml/min). To confirm that the two peaks observed corresponded to (*R*) and (*S*) forms and not to any possible product formed by reaction of epoxypropane with the column materials, we have also studied the pure enantiomers of (*R*)- and (*S*)-epoxypropane.[5] Each of these samples produced only one peak in the g.l.c. trace, the identity of each component in the racemic mixture being confirmed by co-injections (*cf.* Figure). When (**1**; R = CF_3, M = Eu) is added to epoxypropane in CCl_4, larger shifts are induced in the ^1H n.m.r. spectrum of the (*S*)-isomer. It is this isomer which has the longer retention time on g.l.c. columns containing (**1**, R = CF_3, M = Eu or Pr). Racemic 1,2-epoxybutane is also resolved on these columns, but we have not yet been able to separate racemic 2,3-epoxybutane, 1,2-epoxypentane, or 1,2-epoxyhexane. [(*N.b.* racemic 2,3-epoxybutane is separated from *meso*-2,3-epoxybutane (relative retention times on the Pr column *ca.* 0·5 : 1)].

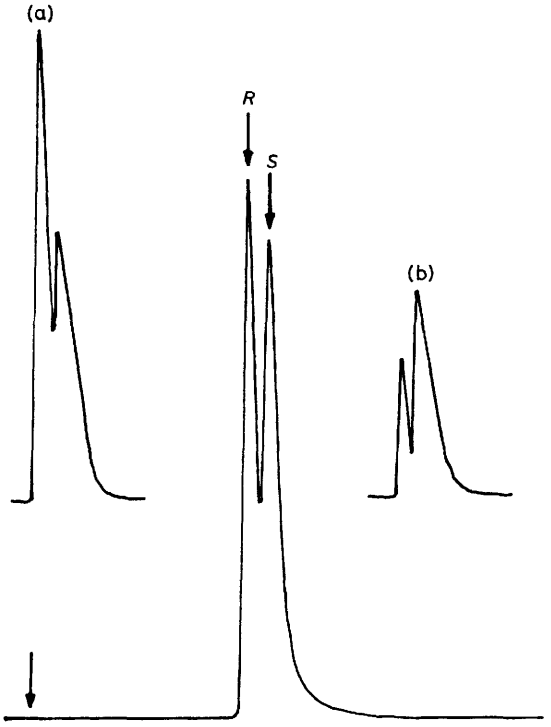


FIGURE. G.l.c. trace of racemic epoxypropane: the peak due to (*R*)-epoxypropane appeared 9 min after injection (↓) [with Eu column, conditions as in text]; inset trace (a) was obtained on co-injecting racemic epoxypropane + (*R*)-epoxypropane; inset trace (b) from racemic epoxypropane + (*S*)-epoxypropane.

The usefulness of complexes (**1**) as chiral shift reagents in n.m.r. spectroscopy is due to the different stabilities of diastereoisomeric adducts formed (*cf.* ref. 1). Lanthanoid shift reagents can exist as monomers, dimers, or mixtures of oligomers depending on the solvent, radius of metal ion and nature of R in (**1**).[6] By exploiting such features, it may well be possible to accentuate energy differences between the diastereoisomeric adducts and so produce chromatographic systems of great versatility.

We thank the S.R.C. for support.

(*Received*, 1*st April* 1977; *Com.* 314.)

† Complexes from commercial sources.

‡ To preserve resolving ability, contact of columns with moisture should be avoided. Conditioning–re-activation was carried out by heating a column overnight at 373 K (nitrogen flow rate 3·7 ml/min) and then for 5 min at 433 K.

[1] M. D. McCreary, D. W. Lewis, D. L. Wernick, and G. M. Whitesides, *J. Amer. Chem. Soc.*, 1974, **96**, 1038; H. L. Goering, J. N. Eikenberry, G. S. Koermer, and C. J. Lattimer, *ibid.*, p. 1493.

[2] B. Feibush, M. F. Richardson, R. E. Sievers, and C. S. Springer, *J. Amer. Chem. Soc.*, 1972, **94**, 6717.

[3] V. Schurig, *Angew Chem. Internat. Edn.*, 1977, **15**, 110.

[4] See *e.g.* R. Charles, U. Beitler, B. Feibush, and E. Gil-Av, *J. Chromatography*, 1975, **112**, 121.

[5] B. T. Golding, D. R. Hall, and S. Sakrikar, *J.C.S. Perkin I*, 1973, 1214.; (*R*)-Epoxypropane was prepared from (*R*)-propane-1,2-diol (P. A. Levene and A. Walti, *Org. Synth.*, 1943, Coll. Vol. 2, p. 545) using the method described (ref. 5) for the (*S*)-isomer.

[6] R. G. Denning, F. J. C. Rossotti, and P. J. Sellars, *J.C.S. Chem. Comm.*, 1973, 381; Ebullioscopic measurements show (**1**, R = CF_3, M = Eu) to exist as dimers in CCl_4 over a wide concentration range. (F. J. C. Rossotti and P. J. Sellars, unpublished results).