2-[(—)-Camphor-10-ylsulphonyl]-3-(nitrophenyl)oxaziridine: a New Chiral Oxidizing Agent

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Summary [(—)-Camphor-10-ylsulphonyl-3-(nitrophenyl)-oxaziridine (**2**) is a new type of optically active oxidizing agent which, unlike chiral peroxy acids, has fixed geometry and chiral centres which are essentially one bond removed from the electrophilic oxaziridine oxygen atom.

OPTICALLY active sulphoxides are useful for stereochemical studies of organic sulphur compounds.[1] They are also important in organic synthesis[1,2] and as chiral aprotic solvents.[3] A number of naturally occurring, optically active sulphoxides have been reported.[1b] The procedure developed by Andersen[1a] and extended by Mislow,[1e,4] namely the reaction of an organometallic reagent with an optically active sulphinate ester, is generally used to prepare these chiral sulphoxides. When this procedure cannot be used,[1b,c] oxidation with a chiral peroxy acid is employed.[5,6] Although optical yields are low (*i.e.*, 0—3%) the large rotations for sulphinyl compounds and the fact that oxidation is often the only source of these compounds makes this procedure of some significance.[5]

Lack of control of transition state geometry is believed to be responsible for the low asymmetric bias observed in these chiral oxidations.[4] In contrast to chiral peroxy acids, an optically active 2-sulphonyl-3-aryloxaziridine would be an oxidizing agent with well defined geometry and with the electrophilic oxygen atom one bond removed from the chiral centres (nitrogen and carbon) of the reagent. We recently reported the selective oxidation of sulphides and disulphides to sulphoxides and thiosulphinates by 2-arylsulphonyl-3-aryloxaziridines.[7] The proposed mechanism for oxidation by this reagent is similar to that postulated for peroxy acids.

The optically active sulphonimides (**1a** and **b**),† were prepared in 60—70% yield by heating (—)-camphor-10-sulphonamide[8] with the diethyl acetals of 3- and 4-nitrobenzaldehyde at 130—170 °C (see Scheme). Oxidation of (**1a** and **b**) as previously described[9] gave the oxaziridines (**2a** and **b**), as mixtures of diastereoisomers. Crystallization from ether afforded (**2a** and **b**) in the diastereoisomeric ratio of 66:33 (33% optically pure).†‡ Several crystalliza-

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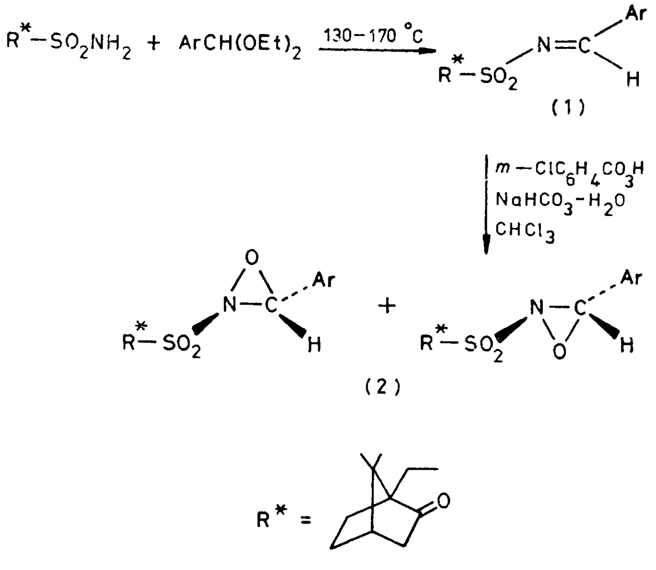
† Satisfactory elemental analyses were obtained for all new compounds. (**1a**) m.p. 156—157 °C; $[\alpha]_D^{20}$ +21·47° (*c* 0·81, $CHCl_3$); (**1b**) m.p. 106—108 °C; $[\alpha]_D^{20}$ +10·91° (*c* 14·4, $CHCl_3$); (**2a**), m.p. 142—143 °C (decomp.); 33% optically pure: $[\alpha]_D^{20}$ −40·40° (*c* 1·98, $CHCl_3$); 68% optically pure: $[\alpha]_D^{20}$ −71·43° (*c* 1·12, $CHCl_3$); (**2b**), m.p. 117—118 °C (decomp.); 33% optically pure: $[\alpha]_D^{20}$ −94·7° (*c* 4·44, $CHCl_3$).

‡ The diastereoisomer ratios were determined by integration of the two methylene protons ($-CH_2SO_2-$) appearing as two pairs of doublets for each diastereoisomer. For (**2a**), the major diastereoisomer had doublets centred at δ 3·85 (*J* 15 Hz) and 3·33 (*J* 15 Hz); minor isomer 3·95 (*J* 15 Hz) and 3·27 (*J* 15 Hz). For (**2b**) the major diastereoisomer had doublets centred at δ 3·87 (*J* 15 Hz) and 3·36 (*J* 15 Hz); minor isomer δ 3·97 (*J* 15 Hz) and 3·27 (*J* 15 Hz).

TABLE. Oxidation of sulphides with 2-[(−)-camphorsulphon-10-yl]-3-aryloxaziridines (**2**) in chloroform.

Oxaziridine (optical purity)[a]	Temp °C	Sulphoxide data: Rotation (%e.e.) [%e.e. (corr.)[b]] configuration		
		PhS(O)Me[c]	p-MeC$_6$H$_4$S(O)Me[d]	PhS(O)Bu^t)[e]
(**2a**) (33%)	25	+2·31° (1·6) [4·8] *R*	+1·89° (1·3) [3·9] *R*	−3·89° (2·0) [6·0] *S*
(33%)	−50	+4·14° (2·8) [8·4] *R*	+6·51° (4·5) [13·5] *R*	−2·72° (1·6) [4·8] *S*
(68%)	25		+5·50° (3·8) [5·6] *R*	−5·50° (3·2) [9·6] *S*
(**2b**) (33%)	25		+2·17° (1·5) [4·5] *R*	
(33%)	−50		+5·43° (3·7) [11·1] *R*	

[a] See footnote ‡. [b] Corrected for 100% optical purity of oxaziridine. [c] (0·4, EtOH); %e.e. based on the value of +146·2° (EtOH) reported in ref. 6. [d] (*c* 1·0, acetone); %e.e. based on the value +145·5° (acetone) reported in ref. 4. [e] (*c* 9·0, CHCl$_3$) %e.e. based on the value −174·6° reported in ref. 6. Oxidations were performed at least twice and the results averaged.



SCHEME

a; Ar = 4-O$_2$NC$_6$H$_4$
b; Ar = 3-O$_2$NC$_6$H$_4$

tions of (**2a**) from ether increased the diastereoisomeric ratio to 84:16 (68% optically pure).

Thioanisole, methyl *p*-tolyl sulphide, and t-butyl phenyl sulphide were oxidised by dropwise addition of (**2a** and **b**) in chloroform.[7] The sulphoxides were isolated by vacuum distillation or chromatography (silica gel) in 80—85% yields. The sulphonimides (**1a** and **b**), were isolated in > 90% yield and recycled (Scheme).

The results of these asymmetric oxidations (Table) reveal that the optical purity of the sulphoxides is 1·3—2·0 times better than that obtained in similar oxidations using (+)-monoperoxycamphoric acid,[4,5] when corrected for temperature variations and oxaziridine purity.§ As predicted by the transition state model of Montanari, *et al.*[6] t-butyl phenyl sulphoxide had the opposite configuration to that of methyl *p*-tolyl and phenyl sulphoxides (Table). A lower temperature also increased the enantiomeric excess.¶

Our results suggest that the relationship of the electrophilic oxygen to the chiral centres of the reagent as well as restricted geometry of the oxidizing agent are important in achieving higher asymmetric induction using chiral peroxy compounds. The fact that the asymmetric bias for oxidations using (**2**) was not higher may well imply that the angle of attack of the sulphur atom on the oxygen in (**2**) is of significance. Nevertheless, the ease of preparation of 2-[(−)-camphor-10-ylsulphonyl)-3-aryloxaziridines (**2**) suggest that this new chiral oxidizing agent will be of synthetic utility. Choice of appropriate substituents in the oxaziridine is expected to increase the extent of asymmetric induction.

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§ The assumption is made that as the optical purity of (**2a** and **b**) increases so will the optical purity of the sulphoxide. Support for this assumption is the increase in %e.e., observed for methyl *p*-tolyl sulphoxide and t-butyl phenyl sulphoxide using (**2a**) of 33 and 68% optical purity. The values of 1·3—2·0 times better than similar oxidations using (+)-monoperoxycamphoric acid are probably minimum values (see Table).

¶ It is unclear why lowering the temperature for oxidation of t-butyl phenyl sulphide had little effect on the %e.e. of the corresponding sulphoxides.

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