

## Partial Resolution of Sulphoxides *via* Cyclodextrin Inclusion Compounds

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**Summary** Chiral sulphoxides have been partially resolved by stereospecific inclusion into cyclodextrins.

CHIRAL sulphoxides, without acidic or basic functional groups, have not, as yet, been resolved, with the exception of ethyl *p*-tolyl sulphoxide (which has been resolved by means of platinum complexes containing optically active  $\alpha$ -methylbenzylamine).<sup>1</sup> Although optically active sul-

phoxides can be readily obtained through Andersen synthesis,<sup>2</sup> the method fails for sulphoxides containing substituents which react faster than the methoxy-sulphinyl group with the Grignard reagent.

We report here a simple method of partial resolution of sulphoxides by stereospecific inclusion into cyclodextrins. The use of cyclodextrins as resolving agents for some chiral carbon compounds was reported by one of us<sup>3</sup> several years ago.

Stereospecific inclusion of R<sup>1</sup>-SO-R<sup>2</sup> in  $\beta$ -cyclodextrin (CD)

Sulphoxide					Optical purity (%) <sup>b</sup>	Absolute configura- tion	Molar ratio of sulphoxide and $\beta$ -(CD) in the complexes <sup>c</sup>
No.	R <sup>1</sup>	R <sup>2</sup>	$[\alpha]_{589}$	( <i>c</i> , solvent <sup>a</sup> )			
(I)	PhCH <sub>2</sub>	Me	-8.5	(2.08, eth.)	8.0	S	1:1
(II)	PhCH <sub>2</sub>	Et	+5.0	(2.00, chl.)	4.7	S	1:1
(III)	PhCH <sub>2</sub>	Pr <sup>n</sup>	+2.0	(1.20, eth.)	—	—	1:1
(IV)	PhCH <sub>2</sub>	Pr <sup>i</sup>	—	—	—	—	1:1
(V)	PhCH <sub>2</sub>	Bu <sup>n</sup>	+1.2	(5.05, eth.)	6.3	R	1:1
(VI)	PhCH <sub>2</sub>	Bu <sup>i</sup>	+6.4	(3.82 chl.)	—	—	4:3
(VII)	PhCH <sub>2</sub>	Bu <sup>t</sup>	+45.0	(4.05, eth.)	14.5	R	4:3
(VIII)	<i>p</i> -Me-C <sub>6</sub> H <sub>4</sub>	Me	+11.5	(2.77, eth.)	8.1	R	1:1
(IX)	<i>p</i> -Me-C <sub>6</sub> H <sub>4</sub>	Et	+10.1	(2.30, act.)	5.3	R	1:1
(X)	Ph	Me	+6.5	(2.29, eth.)	4.4	R	1:1

<sup>a</sup> eth. = ethanol, chl. = chloroform, act. = acetone. <sup>b</sup> Optical purities were calculated based on the literature data [K. Mislow, M. M. Green, and M. Raban, *J. Amer. Chem. Soc.*, 1965, **87**, 2761; K. Mislow, M. M. Green, P. Lauer, J. T. Melillo, T. Simmons, and A. L. Ternay, *J. Amer. Chem. Soc.*, 1965, **87**, 1958; U. Folli, D. Jarossi, F. Montanari, and G. Torre, *J. Chem. Soc., (C)*, 1968, 1317].  
<sup>c</sup> Based on elemental analyses.

We applied the standard procedure and added the sulphoxides (I—X) in 5-molar excess to a 1.5% solution of  $\beta$ -cyclodextrin in water. After few days the inclusion compounds formed were filtered off, dried, and analysed. Decomposition of the inclusion compounds by trichloroethylene-water at 60° released the sulphoxides into the organic layer, which was dried and evaporated. Recovered sulphoxides were chromatographed on an Al<sub>2</sub>O<sub>3</sub> column. The optical rotations, optical purities, absolute configuration of the included sulphoxides, and the composition of the inclusion complexes are given in the Table.

Inclusion of sulphoxides into  $\beta$ -cyclodextrin is stereospecific (see Table). All the sulphoxides examined,

except (IV), were optically active. Optical purities can be increased by repeating the inclusion process or by fractional crystallization of the solid, partially resolved sulphoxides. Thus, after the second inclusion procedure the optical rotation of (+)-(VIII),  $[\alpha]_{589} + 11.5^\circ$ , (opt. purity 8.1%) was increased to  $[\alpha]_{589} + 16.10^\circ$  (opt. purity 11.4%) and four fractional crystallizations of (+)-(VIII),  $[\alpha]_D + 11.5^\circ$ , from light petroleum (b.p. 60—80°) afforded (+)-(VIII),  $[\alpha]_{589} + 100.8^\circ$ , (optical purity 71.5%).

It is of interest that in most cases the sulphoxides with *R*-configuration are preferentially included into  $\beta$ -cyclodextrin.

(Received, December 14th, 1970; Com. 2161.)

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<sup>3</sup> F. Cramer and W. Dietsche, *Chem. Ber.*, 1959, **92**, 378.