0957-4166/93 $6.00+.00

Chromatographic Resolution of a C2-symmetric Spirosulfurane: 1,1'Spirobi[3H-2,1-benzoxathiol]-3,3'-dione

Stig Allenmark* and Sofia Claeson

Department of Organic Chemistry, University of Gothenburg,
S-41296 Gothenburg, Sweden

Abstract: The enantiomers of a diaryldiacyloxyspirosulfurane, 1,1'spirobi[3H-2,1-benzoxathiol]-3,3'-dione, have been obtained via direct resolution of the racemate by chiral liquid chromatography and further characterized by chiroptical methods.

Spirosulfuranes constitute a class of hypervalent (10-S-4) sulfur compounds possessing a trigonal bipyramid stucture,[1] and which may exhibit chirality due to molecular dissymmetry. A series of diaryl-diacyloxyspirosulfuranes, available from *bis*-carboxy-substituted, diarylsulfides or -sulfoxides, have been studied by Kapovits et al.[2-5] It has been shown recently[5] that these compounds are readily hydrolyzed to their parent sulfoxides and that the stability decreases with increasing electron density at the sulfur atom and on increasing the size of the spirorings from 5- to 6-membered.

When these spirosulfuranes are generated from achiral, symmetric sulfoxides by dehydration, a chiral, C2-symmetric structure results, as represented by **I**, synthetically available from o,o'-di-carboxy-substituted, symmetric diarylsulfides or -sulfoxides.

To date, no member of this interesting group of spirosulfuranes seems to have been obtained in optically active form, however. This paper describes the liquid chromatographic separation and further characterization of the enantiomers of the parent spirosulfurane **Ia** (X = H).

I
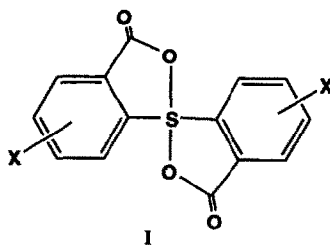
Racemic **Ia** was synthesized by cyclization of bis(2-carboxyphenyl) sulfoxide with the use of acetyl chloride in pyridine as described previously.[3] The compound (m.p. 318-319°C (d.), lit.[2] 305-307 °C) gave two well separated groups of ^{1}H NMR signals, centered around 7.818 and 8.195 ppm, respectively. The ^{13}C NMR signals were found at 128.8, 129.3, 129.7, 134.2, 135.6, 141.3 and 167.3 ppm.[6]

A 2D NMR spectrum with the use of a pulsed field gradient[7] gave the result in Fig. 1, showing the unsubstituted aromatic ring positions.
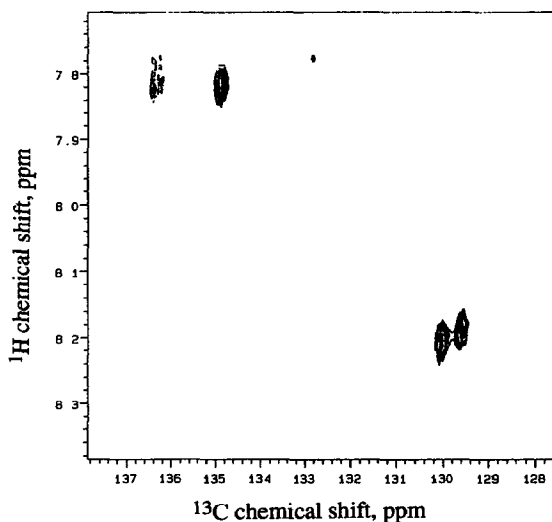
Fig. 1. A 2D ge-HMQC NMR spectrum of Ia.

Fig. 2 shows the two enantiomers of **Ia** as extremely well resolved peaks in an analytical scale chromatogram obtained by the use of chiral liquid chromatography.[8] It seems likely that the rigid structure of **Ia** makes hydrogen bond interaction with the chiral stationary phase much more favourable for one of the enantiomers.
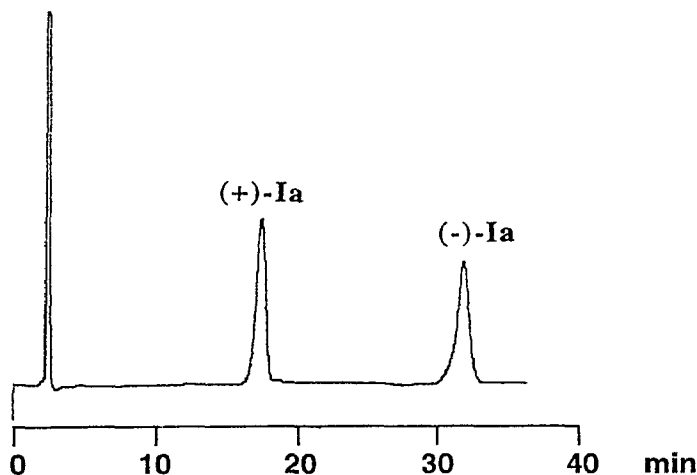

Fig. 2. Chromatogram showing the separated enantiomers of Ia. Mobile phase 2% 2-propanol in
hexane; α = 1.96.

The three-dimensional structures of the enantiomers as obtained from energy minimization using a semiempirical AM1 method[10] is shown in Fig. 3. The third equatorial position is occupied by the lone-pair at the sulfur atom. The calculated structures reveal a slight distortion of the bipyramidal configuration, in complete agreement with the previously obtained X-ray data of the racemate.[1,4]
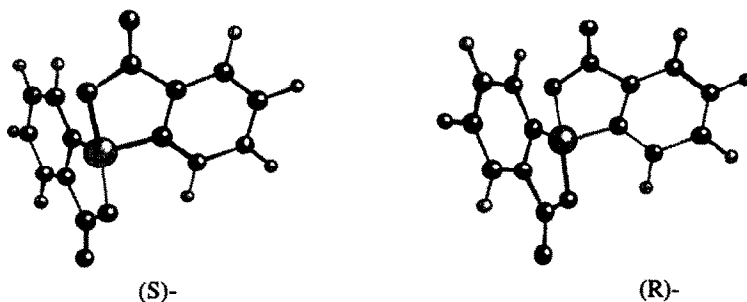
(S)-   (R)-

Fig. 3. Stereoprojections of the enantiomers of **Ia**

The elution order was established by on-line polarimetric detection.[11] A semipreparative separation by repeated injections and collection of the respective peaks eluted from the column, gave a few mg of each enantiomer, permitting further characterization by means of polarimetry and CD. The enantiomers showed specific rotations of $[\alpha]_{436} = \pm 91.7$ (MeCN, c. 0.05) and $[\alpha]_{546} = \pm 27.3$ (MeCN, c. 0.05), respectively. The (+)-enantiomer was consistently the first eluted in the phase systems used. The CD spectra[12] are shown in Fig. 4. A molecular ellipticity $[\theta] = 3.13 \times 10^5$ deg M^{-1} cm^{-1} was found for the $\pi \rightarrow \pi^*$ transition at $\lambda = 237$ nm.

The spirosulfurane was easily hydrolyzed by small amounts of water in the more polar solvents used. Recrystallization of the enantiomers was therefore carried out in anhydrous solvents.
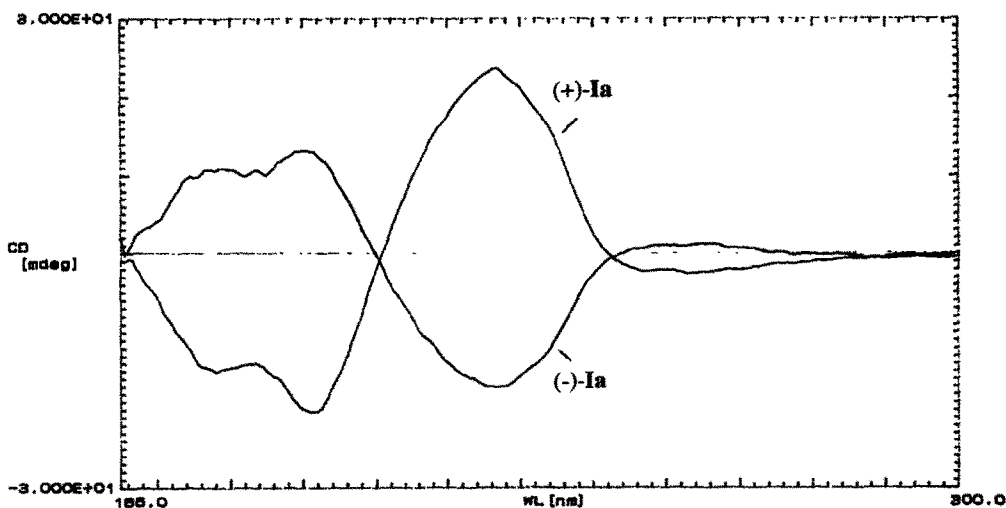

Fig. 4. CD spectra of the (+)- and (-)-forms of **Ia**

The absolute configurations of the separated enantiomers have not yet been determined. However, work directed towards the preparation of a single crystal, suitable for an X-ray crystallographic structure determination of (+)-**Ia** with the use of the anomalous dispersion effect (Bijvoet-technique), is now in progress in our laboratory.

Acknowledgements

References and Notes

1. A. Kálmán, K. Sasvári and I. Kapovits, *Acta Crystallogr.* **1973**, *B29*, 355.

2. I. Kapovits, J. Rábai, F. Ruff and Á. Kucsman, *Tetrahedron* **1979**, *35*, 1869.

3. I. Kapovits, J. Rábai, F. Ruff, Á. Kucsman and B. Tanács, *Tetrahedron* **1979**, *35*, 1875.

4. I. Kapovits, J. Rábai, D. Szabó, K. Czakó, Á. Kucsman, G. Argay, V. Fülöp, A. Kálmán, T. Koritsánszky and L. Párkányi, *J. Chem. Soc., Perkin Trans. 2* **1993**, 847.

5. E. Vass, F. Ruff, I. Kapovits, J. Rábai and D. Szabó, *J. Chem. Soc., Perkin Trans. 2* **1993**, 855.

6. Spectra were recorded in $CDCl_3$ with a 400 MHz Varian VXR-400 spectrometer. The chemical shifts were measured from TMS as internal reference.

7. J. Ruiz-Cabello, G.W. Uuister, C.T.W. Moonen, P. van Gelderen, J.S. Cohen and P.C. van Zijl, *J. Magn. Reson.* **1992**, *100*, 282.
   A Varian Unity 500 MHz spectrometer, equipped with a pulsed field gradient triple resonance probe, was used. The spectrum was recorded in $CDCl_3$ using 32 transients and a HMQC (Varian) pulse sequence.

8. The chromatographic resolutions were performed on a 4.6 mm ID x 200 mm analytical column containing a Kromasil-based chiral sorbent available from EKA Nobel AB, Bohus, Sweden. The mobile phase systems used were hexane + 2-10% of 2-propanol and hexane + 20-30% of dioxane. UV detection at 225 nm.

9. The capacity ratio, k', is defined as: $k' = (V_R - V_0)/V_0$, where V_R and V_0 denote the retention volume and void volume, respectively. The separation factor, α, is given by the ratio: k_2'/k_1', where the subscripts 1 and 2 refer to the first and last eluted enantiomer, respectively.

10. M.J.S. Dewar, E.G. Zoebish, E.F. Healy and J.J.P. Stewart, *J. Am. Chem. Soc.* **1985**, *107*, 3902. Our calculations were performed on a VAX 3100 computer.

11. The instrument used was an ACS Chiramonitor diode laser -based polarimetric detector, operating at an 800 nm wavelength and equipped with a 20 µl microcell.

12. The CD spectra were recorded in acetonitrile with a JASCO mod. 720 spectropolarimeter using a quartz cell of 0.2 mm pathlength and a 38 µM concentration. The enantiomeric purity of (+)-**Ia** was higher than that of (-)-**Ia**, hence the difference in amplitude between the two curves.