

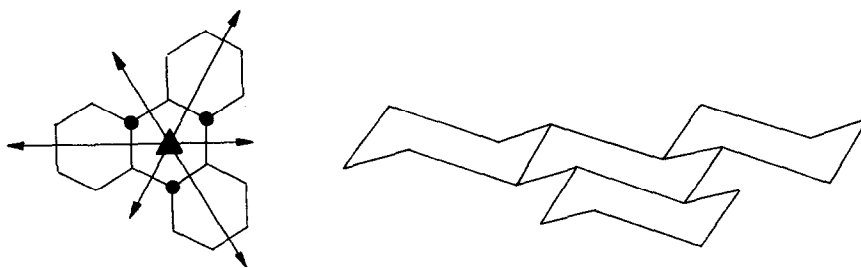
OPTICALLY ACTIVE PERHYDROTRIPHENYLENE:
THE FIRST RESOLUTION OF A D_3 ORGANIC MOLECULE

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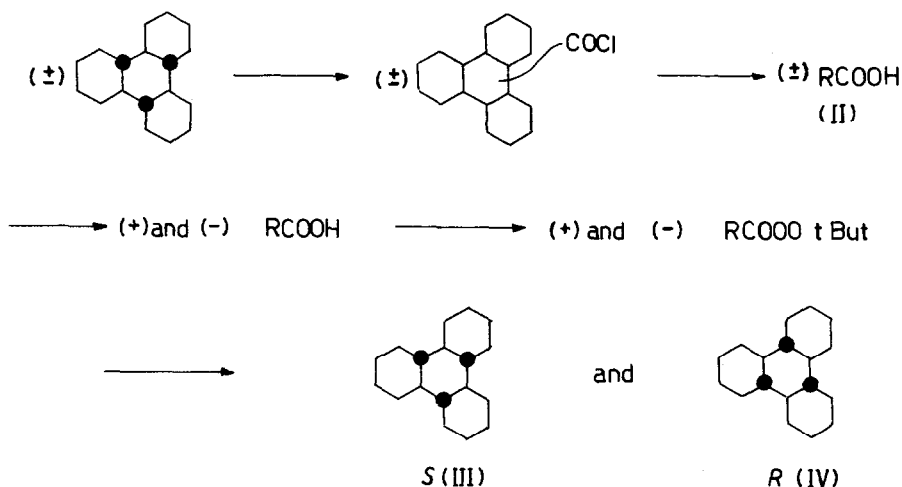
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Some years ago, we synthesized the planar (trans-anti-trans-anti-trans) isomer of perhydrotriphenylene (PHTP) $C_{18}H_{30}$ (I) (1); its structure was subsequently confirmed by the X-ray analysis of one of its inclusion compounds with n-heptane (2). A detailed crystallographic study revealed the great versatility of PHTP as host molecule for the preparation of channel-like inclusion compounds (3), and also showed the possibility of carrying out the conformational analysis of the included molecules (4). In addition, PHTP also exhibits interesting properties in the pure state, particularly from the stereochemical point of view. It belongs to the D_3 symmetry group, which has very seldom been observed in organic chemistry: PHTP possesses one three-fold and three two-fold axes, but no plane of symmetry and therefore it can exist in enantiomorphous forms. Just one rigid conformation exists for each of the two configurational enantiomers, which presumably possess a very high configurational stability. In that, PHTP sharply differs from 1,5,9 trans, trans, trans cyclododecatriene, another organic molecule which in the crystalline state presents a D_3 molecular symmetry (5): in this case, the enantiomers can be easily converted one into another and into other less stable conformers by simple rotation around the C-C bonds.



I

With regard to the resolution of PHTP, a considerable difficulty arises from the low chemical reactivity of this compound, a saturated polycyclic hydrocarbon. Several attempts at resolution, both by physical methods and by introducing into the molecule reactive groups that can be easily eliminated, have been unsuccessful. Finally, we achieved this aim by conversion of PHTP into a carboxylic acid, resolution by classical methods and subsequent decarboxylation, according to the scheme below.



The introduction of the carboxylic group was obtained by reaction of PHTP with oxalyl chloride in boiling CCl_4 promoted by benzoyl peroxide or by UV light (6). The reaction proceeds with rather low conversion and with 20-30% yields, based on reacted PHTP. The acyl chloride was easily separated from unreacted PHTP due to the higher solubility and subsequently hydrolyzed with methylalcoholic potassium hydroxide.

The acid has melting point of 221°C , equivalent weight 292 (calculated 290), elemental analysis: C 78.52%, H 10.51% (calculated for $\text{C}_{19}\text{H}_{30}\text{O}_2$: C 78.57%, H 10.41%). The carboxylic group is likely to be located on the central ring; the NMR spectrum strongly supports this assumption which is based on the higher reactivity of the tertiary carbon atoms in radical reactions.

The resolution of this acid is fairly easy: the less soluble salt was obtained almost quantitatively by treating an ethereal solution of the acid with an ethereal solution of dehydroabietylamine (7, 8) in molar ratio 1:1. After four crystallizations, the rotatory power $[\alpha]_D^{25}$ reached the value of -18.7 . From the solvent of the first pre-

precipitation, the more soluble salt with $[\alpha]_D^{25} = +50$ was obtained. From the less soluble salt the negative acid was obtained, having $[\alpha]_D^{25} = -74.5$ (in benzene). Its melting point is 221°C ; the NMR spectrum is identical with that of the racemic acid.

Decarboxylation was obtained in 45% yield by heating the tert.butyl-per-ester, in the presence of di-iso-propyl-benzene (9, 10). The decarboxylation product was purified by sublimation in vacuo and identified as optically active PHTP on the basis of its I.R. spectrum, identical with that of the racemic compound.

Pure PHTP obtained from the negative acid has $[\alpha]_D^{25} = -100$ (in MEK); a less pure product ($[\alpha]_D^{25} = +70$) was similarly obtained from the positive one. By sublimation and crystallization from MEK, the latter was further enriched up to a rotatory power higher than $+90$.

The melting point of (-)PHTP is $138-140^\circ\text{C}$ (Kofler hot-stage microscope), significantly higher than that of racemic PHTP (128°C). The crystallographic study of optically active PHTP is presently in progress.

With regard to the absolute configuration of the PHTP enantiomers, two problems arise, the first of which concerns the nomenclature. The tertiary carbon atoms of PHTP represent a very particular type of asymmetric carbon atoms, the properties of which were already discussed by us (11): in particular, we observed that their absolute configuration could not be defined by the rules existing at that time (12). A new rule had been suggested by us to fill this gap (11, 13, 14). More recently, Cahn, Ingold and Prelog proposed a "rule for equivalent centers", which inverts our earlier convention, in their new "specification of molecular chirality" (15). From now on, we conform to the use introduced by these authors (15) (the sequence therefore is $\text{CH exo} > \text{CH endo} > \text{CH}_2 > \text{H}$) (see III and IV).

As to the second problem, i.e. the experimental determination of the absolute configuration, we have not yet established any chemical or physical correlation. However, we tried to predict the sign of the optical activity by applying to PHTP the Brewster method (16). In this regard, PHTP can be considered as formed by three 1,2 equatorially disubstituted cyclohexanes. With reference to formula (IV) (enantiomer (R)), the calculation gives a value $[\mathbf{M}]_D = -180$ whereas the experimental value is -246 . Therefore, we temporarily assume this correlation (R as negative enantiomer), which, due to the molecular rigidity, seems highly probable.

As far as we know, PHTP is the first D_3 organic molecule obtained in optically active forms.

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