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TETRAHEDRON: *ASYMMETRY*

Resolution and determination of the absolute configuration of 3,3′4,4′-tetramethyl-1,1′-diphosphaferrocene-2-carboxylic acid

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Abstract—(±)-3,3′4,4′-Tetramethyl-1,1′-diphosphaferrocene-2-carboxylic acid **1** was resolved via diastereomeric salts with brucine. The (*R*)-absolute configuration of (+)-**1** was determined by X-ray crystallography.

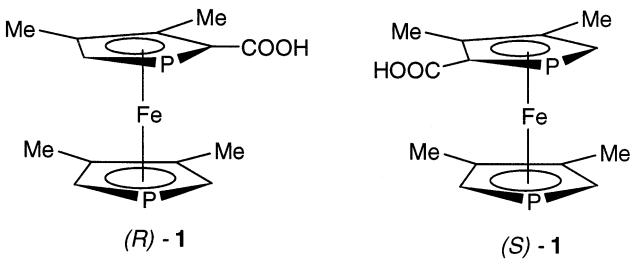
1. Introduction

Planar chiral group 15-heteroferrocenes have attracted considerable attention as ligands in asymmetric catalysis.[1] There are reports on the resolution of planar chiral azaferrocenes,[2,3] phosphaferrocenes[4,5] and of one 1,1′-diphosphaferrocene.[6] The latter system seems especially interesting because it is readily available, stable and has varied coordination chemistry (including bidentate binding to metal centres).[7–10] On this basis we recently initiated a research program directed toward the development of synthetic methods for enantiomerically pure derivatives of 1.1′-diphosphaferrocene.

The acid **1** displays some solubility in water (particularly in the deprotonated form under weakly basic conditions) and therefore could be interesting as a ligand for reactions carried out in aqueous media. Furthermore, the presence of the carboxylic function in **1** was expected to enable classical resolution via diastereomeric salts or amides formed with a homochiral amine. In this communication we report the successful resolution of racemic **1** via the separation of diastereomeric salts with brucine and the determination of the absolute configuration of one of the separated enantiomers (+)-**1** by X-ray crystallography.[11]

2. Results and discussion

In the first attempts to resolve (±)-**1**, diastereomeric amides were formed by coupling with (*S*)-α-phenylethylamine, these amides were easily separated by column chromatography.[12] We assigned the absolute configuration of the amides on the basis of ^{1}H NMR data



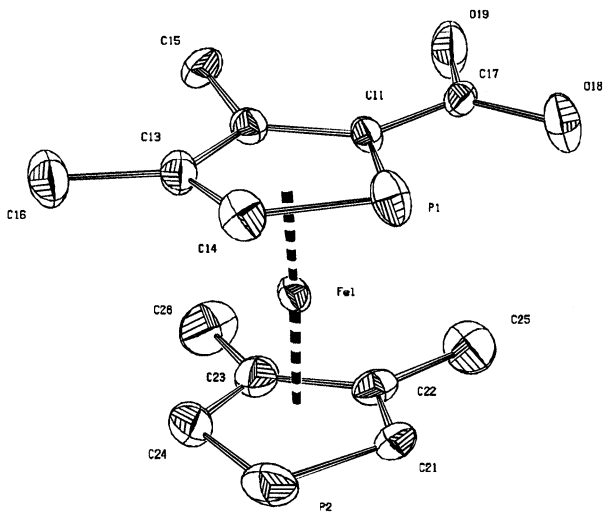


Fig. 1. ORTEP drawing of molecule (+)-**1**. Displacement ellipsoids are shown at 50% probability level. Hydrogen atoms are omitted for clarity.

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Table 1. Crystal data for (+)-**1**

Molecular formula	$C_{13}H_{16}P_2O_2Fe$
Molecular weight	322.05
Crystal description, size (mm)	Dark red prism, $0.25\times0.25\times0.35$
Crystal system	Monoclinic
Space group	$P2_1$
a (Å)	14.235(3)
b (Å)	13.460(1)
c (Å)	15.046(1)
β (°)	107.11(1)
V (Å^3)	2758.5(6)
Z	8
d_x (g cm^{-3})	1.551
$F(000)$	1328
μ (cm^{-1})	108.89
T (K)	293(2)
Max θ (°)	66.06
hkl ranges	−16 16; −15 15; −17 17
No. of reflections measured	25495
No. of independent reflections	9416
R_{int}	0.0644
Refinement type	F^2
Hydrogen atoms	Mixed
No. of parameters refined	707
Flack parameter	−0.020(4)
Reflections/parameters	13
wR_2	0.0958
R_1	0.0420
No. of reflections used	5564
Criterion	$>2\sigma(I)$
GOF	1.117
Difference peak/hole (e Å^{-3})	0.391/−0.658

supported by molecular modeling.[12] However, our attempts to hydrolyse the diastereomeric amides to obtain enantiomers of **1** met with failure.

We therefore turned to the use of diastereomeric salt separation for the resolution of **1** using homochiral brucine as the resolving agent. This proved successful, with the (+)-**1**-brucine diastereomeric salt precipitating from the mixture. The free acid (+)-**1** was liberated from its diastereomeric salt by agitation with dilute hydrochloric acid and straightforward dichloromethane extraction.

To confirm the enantiomeric purity and absolute configuration of the acid (+)-**1**, the diastereomeric amide was formed from coupling with (*S*)-α-phenylethylamine[12] to afford, according to ^{1}H NMR, the pure (*S*,*R*)-diastereomeric amide. Indicating that the (+)-**1** obtained from the resolution process with brucine was contaminated with only a very low level ($<\sim1\%$) of the opposite enantiomer.

X-Ray quality crystals of (+)-**1** were grown from layered dichloromethane–hexane and the structure is represented in Fig. 1. Crystal data are listed in Table 1.

According to Ganter's suggestions[4] concerning the applicability of the CIP rules to phosphaferrocenes, the absolute configuration of the molecule is (*R*). This is in agreement with the configuration deduced from ^{1}H NMR data of the amide formed with (*S*)-α-phenylethylamine,[12] confirming our previous assignments.

3. Experimental

(±)-**1** (483 mg, 1.5 mmol) and brucine (650 mg, 1.7 mmol) were dissolved in hot methanol (75 mL) and the resultant solution was stirred at 4°C for 72 h. The crystals formed were collected by filtration, dried and dissolved in dichloromethane. This solution was shaken with 2 M aq. HCl, the organic layer separated, dried and evaporated to dryness. The procedure was repeated once more to give (+)-**1** (176 mg, 73%), $[\alpha]_{546}^{20}=+23$ ($c=1$, $CHCl_3$). Analogous workup of the mother liquors gave (−)-**1** (216 mg, 89%).

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References

1. Fu, G. C. *Acc. Chem. Res.* **2000**, *33*, 412–420.
2. Hodous, B. L.; Ruble, J. C.; Fu, G. C. *J. Am. Chem. Soc.* **1999**, *121*, 2637–2638.
3. Lo, M. M.-C.; Fu, G. C. *J. Am. Chem. Soc.* **1998**, *120*, 10270–10271.
4. Ganter, C.; Brassat, L.; Ganter, G. *Tetrahedron: Asymmetry* **1997**, *8*, 2607–2611.
5. Qiao, S.; Fu, G. C. *J. Org. Chem.* **1998**, *63*, 4168–4169.
6. Qiao, S.; Hoic, D. A.; Fu, G. C. *Organometallics* **1998**, *17*, 773–774.
7. Deschamps, B.; Mathey, F.; Fischer, J.; Nelson, J. H. *Inorg. Chem.* **1984**, *23*, 3455–3462.
8. Atwood, D. A.; Cowley, A. H.; Dennis, S. M. *Inorg. Chem.* **1993**, *32*, 1527–1528.
9. Zakrzewski, J.; Kłys, A.; Bukowska-Strzyżewska, M.; Tosik, A. *Organometallics* **1998**, *17*, 5880–5886.
10. Sava, X.; Ricard, L.; Mathey, F.; Le Floch, P. *Organometallics* **2000**, *19*, 4899–4903.
11. De Lauzon, G.; Deschamps, B.; Mathey, F. *New J. Chem.* **1980**, *4*, 683.
12. Kłys, A.; Nazarski, R. B.; Zakrzewski, J. *J. Organomet. Chem.*, accepted.