

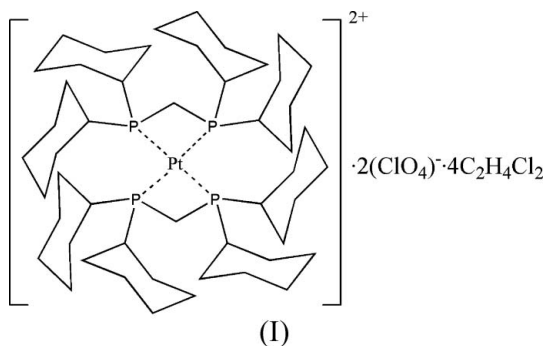
Chen Yong,<sup>a,b</sup> Zhao Xi-Juan<sup>a,b</sup>  
and Fu Wen-Fu<sup>a,b,c\*</sup><sup>a</sup>Technical Institute of Physics and Chemistry,  
Chinese Academy of Sciences, Beijing 100080,  
People's Republic of China, <sup>b</sup>Graduate  
University of the Chinese Academy of Sciences,  
Beijing 100039, People's Republic of China,  
and <sup>c</sup>College of Chemistry and Chemical  
Engineering, Yunnan Normal University,  
Kunming 650092, People's Republic of China

Correspondence e-mail: dongli@mail.ipc.ac.cn

## Key indicators

Single-crystal X-ray study  
 $T = 294$  K  
Mean  $\sigma(\text{C}-\text{C}) = 0.008$  Å  
Disorder in solvent or counterion  
 $R$  factor = 0.032  
 $wR$  factor = 0.082  
Data-to-parameter ratio = 14.8For details of how these key indicators were  
automatically derived from the article, see  
<http://journals.iucr.org/e>.Bis[bis(dicyclohexylphosphino)methane- $\kappa^2P,P'$ ]-  
platinum(II) bis(perchlorate) 1,2-dichloroethane  
tetrasolvateIn the centrosymmetric title complex,  $[\text{Pt}(\text{C}_{25}\text{H}_{46}\text{P}_2)_2]-(\text{ClO}_4)_2 \cdot 4\text{C}_2\text{H}_4\text{Cl}_2$ , the Pt atom is four-coordinated by P atoms in a distorted square-planar coordination geometry and the bis(dicyclohexylphosphino)methane ligands form two planar four-membered chelate rings.Received 8 August 2006  
Accepted 26 September 2006

## Comment

Heterodinuclear  $d^8-d^{10}$  metal complexes containing  $d^8$  Pt<sup>II</sup>, Pd<sup>II</sup> or Ni<sup>II</sup> and  $d^{10}$  Au<sup>I</sup>, Ag<sup>I</sup> or Cu<sup>I</sup> ions with a bridging ligand have attracted considerable attention due to their diverse structures and rich photoluminescent properties (Yip *et al.*, 1991, 1993, 1994; Pettijohn *et al.*, 1998; Crespo *et al.*, 2000). Generally, these Pt complexes are synthesized from a highly active intermediate, for example  $[\text{Pt}(\text{dppm})_2]^{2+}$  and  $[\text{Pt}(\text{dcpm})_2]^{2+}$ , where dppm is bis(diphenylphosphino)methane and dcpm is bis(dicyclohexylphosphino)methane (Cooper *et al.*, 1984; Xia *et al.*, 2003). We report here the title complex,  $[\text{Pt}(\text{dcpm})_2](\text{ClO}_4)_2 \cdot 4\text{ClCH}_2\text{CH}_2\text{Cl}$ , (I).The structure of the  $[\text{Pt}(\text{dcpm})_2]^{2+}$  cation in (I) is centrosymmetric, with the Pt atom within a  $P_4$  donor set defined by two symmetrically chelating diphosphine ligands (Fig. 1). In the dcpm chelate rings, the Pt–P bond lengths are slightly different from each other [Pt1–P1 = 2.3450 (9) Å and Pt1–P2 = 2.3558 (9) Å]. These values are essentially identical to those found in  $[\text{Pt}(\text{dppm})_2]^{2+}$  [2.321 (3) and 2.333 (9) Å]. The P1–Pt1–P2 bond angle is 71.68 (3)°, which is larger than that found in  $[\text{Pt}(\text{dppm})_2]^{2+}$  [70.46 (3)°], due to steric repulsion.In the crystal packing, some C–H...O interactions are present, involving H atoms of the cyclohexyl rings and O atoms of the  $\text{ClO}_4^-$  anion (Table 1).

## Experimental

Dcpm (Acros, 97%) and  $\text{K}_2\text{PtCl}_4$  (Kunming Institute of Precious Metals, 98%) were obtained commercially. Solvents were distilled

using standard techniques and were saturated with nitrogen before use. A mixture of  $K_2PtCl_4$  (41.5 mg, 0.1 mmol) and dcpm (81.7 mg, 0.2 mmol) in ethanol (20 ml) was stirred for 8 h at room temperature under an atmosphere of  $N_2$ , and then reduced to 5 ml. Addition of diethyl ether (20 ml) gave a yellow solid, which was filtered off and washed with water and diethyl ether. Recrystallization by diffusion of diethyl ether into a 1,2-dichloroethane solution yielded pale-yellow crystals of (I) suitable for X-ray diffraction.

## Crystal data

$[Pt(C_{25}H_{46}P_2)_2](ClO_4)_2 \cdot 4C_2H_4Cl_2$	$V = 1822.5 (4) \text{ \AA}^3$
$M_r = 1606.91$	$Z = 1$
Triclinic, $P\bar{1}$	$D_x = 1.464 \text{ Mg m}^{-3}$
$a = 11.9213 (15) \text{ \AA}$	Mo $K\alpha$ radiation
$b = 13.7673 (16) \text{ \AA}$	$\mu = 2.43 \text{ mm}^{-1}$
$c = 13.9489 (16) \text{ \AA}$	$T = 294 (2) \text{ K}$
$\alpha = 109.137 (2)^\circ$	Block, pale yellow
$\beta = 112.534 (2)^\circ$	$0.22 \times 0.20 \times 0.20 \text{ mm}$
$\gamma = 103.398 (2)^\circ$	

## Data collection

Bruker SMART CCD area-detector diffractometer	9358 measured reflections
$\varphi$ and $\omega$ scans	6377 independent reflections
Absorption correction: multi-scan (SADABS; Bruker, 2000)	6254 reflections with $I > 2\sigma(I)$
$T_{\min} = 0.602$ , $T_{\max} = 0.623$	$R_{\text{int}} = 0.020$
	$\theta_{\text{max}} = 25.0^\circ$

## Refinement

Refinement on $F^2$	$w = 1/[\sigma^2(F_o^2) + (0.0452P)^2 + 2.2251P]$
$R[F^2 > 2\sigma(F^2)] = 0.033$	where $P = (F_o^2 + 2F_c^2)/3$
$wR(F^2) = 0.082$	$(\Delta/\sigma)_{\text{max}} = 0.003$
$S = 1.02$	$\Delta\rho_{\text{max}} = 1.25 \text{ e \AA}^{-3}$
6377 reflections	$\Delta\rho_{\text{min}} = -1.10 \text{ e \AA}^{-3}$
432 parameters	
H-atom parameters constrained	

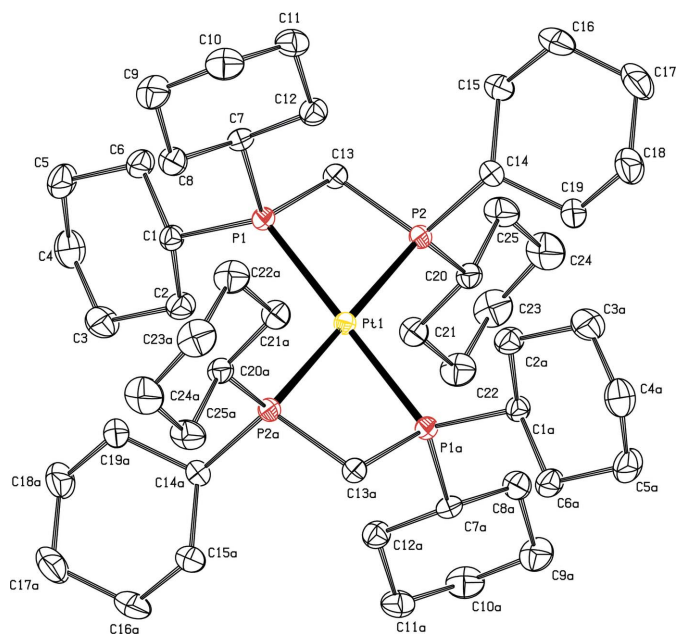
**Table 1**

Hydrogen-bond geometry ( $\text{\AA}$ ,  $^\circ$ ).

$D-H \cdots A$	$D-H$	$H \cdots A$	$D \cdots A$	$D-H \cdots A$
$C7-H7 \cdots O2$	0.98	2.56	3.502 (7)	161
$C13-H13B \cdots O3^i$	0.97	2.38	3.346 (8)	171
$C27-H27A \cdots O1$	0.97	2.54	3.421 (19)	151

Symmetry code: (i)  $-x + 1, -y, -z + 1$ .

All H atoms were placed in calculated positions. The H atoms were then refined as riding, with C–H distances of 0.97  $\text{\AA}$  and with  $U_{\text{iso}}(\text{H}) = 1.2U_{\text{eq}}(\text{C})$ . During the structure refinement, a region of electron density was identified as a highly disordered molecule of 1,2-dichloroethane. In the final structure model, the 1,2-dichloroethane molecule was disordered over two positions. The bond distances in the minor component were restrained to the corresponding bond distances in the major component. The site occupancy factors were refined to 1.78 (1) ( $C26-C12$ ,  $C27-C13$ ,  $C26-C14$  and  $C26-C14$ ) and 1.52 (1) ( $C26-C27$ ,  $C28-C29$ ,  $C26'-C27'$  and  $C28'-C29'$ ) and fixed in subsequent refinement cycles. The highest peak is located within 1.03  $\text{\AA}$  of atom C14, and the deepest hole is 1.07  $\text{\AA}$  from the same atom.



**Figure 1**

The molecular structure of the cation of (I). Displacement ellipsoids are drawn at the 30% probability level. H atoms have been omitted for clarity. [Symmetry code: (a)  $-x + 2, -y, -z + 1$ ]

Data collection: SMART (Bruker, 2000); cell refinement: SAINT (Bruker, 2000); data reduction: SAINT; program(s) used to solve structure: SHELXTL (Bruker, 2000); program(s) used to refine structure: SHELXTL; molecular graphics: SHELXTL; software used to prepare material for publication: SHELXTL.

The authors are grateful to the State Key Project (grant No. 2005CCA06800) for financial support. We also thank the Foundation for NSFC/RGC Joint Research (grant No. 50418010).

## References

- Bruker (2000). SMART, SAINT, SHELXTL and SADABS. Bruker AXS Inc., Madison, Wisconsin, USA.
- Cooper, G. R., Hutton, A. T., Langrick, C. R., McEwan, D. M., Pringle, P. G. & Shaw, B. L. (1984). *J. Chem. Soc. Dalton Trans.* pp. 855–862.
- Crespo, O., Laguna, A., Fernández, E. J., López-de-Luzuriaga, J. M., Jones, P. G., Teichert, M., Monge, M., Pykkö, P., Runeberg, N., Schütz, M. & Werner, H. (2000). *Inorg. Chem.* **39**, 4786–4792.
- Pettijohn, C. N., Jochowitz, E. B., Chuong, B., Nagle, J. K. & Vogler, A. (1998). *Coord. Chem. Rev.* **171**, 85–92.
- Xia, B.-H., Zhang, H.-X., Che, C.-M., Leung, K.-H., Phillips, D. L., Zhu, N. & Zhou, Z.-Y. (2003). *J. Am. Chem. Soc.* **125**, 10362–10374.
- Yip, H.-K., Che, C.-M. & Peng, S.-M. (1991). *J. Chem. Soc. Chem. Commun.* pp. 1626–1628.
- Yip, H.-K., Lin, H.-M., Cheung, K.-K., Che, C.-M. & Wang, Y. (1994). *Inorg. Chem.* **33**, 1644–1651.
- Yip, H.-K., Lin, H.-M., Wang, Y. & Che, C.-M. (1993). *J. Chem. Soc. Dalton Trans.* pp. 2939–2944.