

## *trans*-Di- $\mu$ -bromo-bis[bromo(triethylphosphine- $\kappa$ P)platinum(II)]

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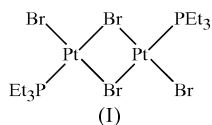
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The title compound,  $[\text{Pt}_2\text{Br}_4(\text{C}_6\text{H}_{15}\text{P})_2]$ , is a centrosymmetric dinuclear platinum(II) complex consisting of two square-planar platinum centres connected by two bridging Br atoms.

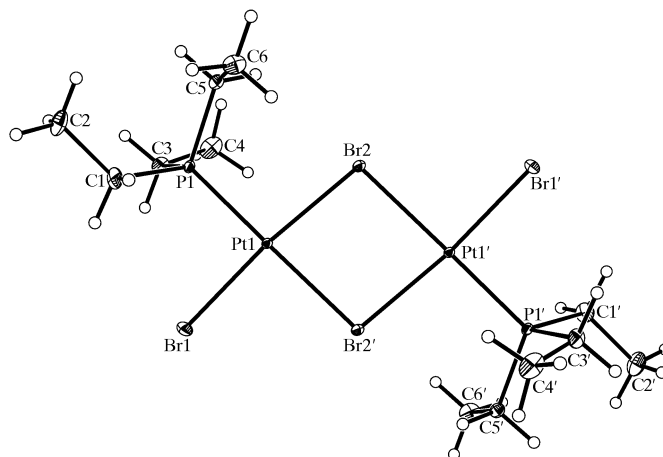
### Comment

Bridged chloride complexes of the form  $[\text{PtCl}_2(\text{PR}_3)]_2$  have been used extensively as starting materials in the synthesis of mononuclear platinum–phosphine complexes, which are formed through cleavage of the bridging Pt–Cl bond (Chatt & Venanzi, 1955; Meidine & Nixon, 1988; Dillon & Goodwin, 1992, 1994). Similar synthetic methodology can also be applied to bromide analogues (Cornet, 2002). However, while the crystal structures of the chloro-bridged complexes  $[\text{PtCl}_2(\text{PMe}_3)]_2$ ,  $[\text{PtCl}_2(\text{PEt}_3)]_2$  and  $[\text{PtCl}_2(\text{PPr}_3)]_2$  are known (Boag & Ravetz, 1996; Blake *et al.*, 1989; Black *et al.*, 1969), structures of complexes exhibiting the central heavy-atom skeleton  $[\text{PtCl}_2\text{P}]_2$  are surprisingly rare, with only a handful known (Simms *et al.*, 1987; Copley *et al.*, 2000).

The title complex, (I), was prepared by the  $\text{CHCl}_2$ -mediated reaction of equimolar quantities of  $\text{PtBr}_2$  and  $[\text{PtBr}_2(\text{PEt}_3)]_2$ . Given the rarity of crystal structures containing the  $[\text{PtCl}_2\text{P}]_2$  fragment, it is unsurprising that (I) is the first structure to be reported containing the  $[\text{PtBr}_2\text{P}]_2$  motif.



The chloride complexes  $[\text{PtCl}_2(\text{PR}_3)]_2$  (where  $R = \text{CH}_3$ ,  $\text{C}_2\text{H}_5$  and  $\text{C}_3\text{H}_7$ ) and the title compound are closely related, and all four complexes possess an inversion centre in the middle of the dimer, with the  $\text{PR}_3$  ligands in a *trans* geometry (Fig. 1). In addition, all four structures are asymmetric around the bridging halide ligands, but this asymmetry is reduced in (I) with respect to the chloride complexes (Table 1). This degree of asymmetry in (I) is presumably due to the relative positions of the Cl, Br and P atoms in the *trans* influence series and the increased ionic radius of the bromide ligand. These



**Figure 1**

A view of (I), with selected atoms labelled. Symmetry equivalents related by  $(\frac{1}{2} - x, \frac{1}{2} - y, 1 - z)$  are also shown and are indicated by primes. Displacement ellipsoids for the non-H atoms are drawn at the 50% probability level.

factors also appear to reduce the effect bridging has on the bond lengths, since the bonds to the bridging Br atoms are only 0.023 and 0.122 Å longer than those to the terminal Br atoms, compared with averages of 0.033 and 0.146 Å in  $[\text{PtCl}_2(\text{PR}_3)]_2$  (where  $R = \text{CH}_3$ ,  $\text{C}_2\text{H}_5$  and  $\text{C}_3\text{H}_7$ ; Boag & Ravetz, 1996; Blake *et al.*, 1989; Black *et al.*, 1969, respectively).

### Experimental

$\text{PtBr}_2$  (1.48 g, 4.2 mmol) in PhCN (10 ml) was heated to 373 K to give a bright-orange solution and a yellow precipitate on cooling [*cis*- $[\text{PtBr}_2(\text{PhCN})_2]$ , yield 81%].  $\text{PEt}_3$  (1.75 g, 2.18 ml, 14.8 mmol) was then added to a solution of  $[\text{PtBr}_2(\text{PhCN})_2]$  (1.77 g, 3.15 mmol) in  $\text{CH}_2\text{Cl}_2$  (15 ml) and the mixture stirred for 3 h. Evaporation of the solvent produced a white solid [*cis*- $[\text{PtBr}_2(\text{PEt}_3)]_2$ , yield 83%], some of which (1.45 g, 2.45 mmol) was added to a solution of  $\text{PtBr}_2$  (1.03 g, 2.9 mmol) in  $(\text{CHCl}_2)_2$  and heated to 423 K for 4 h. The yellow crystals of (I) obtained on cooling were recrystallized from  $\text{CH}_2\text{Cl}_2$  (yield 79%). Analysis calculated for  $\text{C}_{12}\text{H}_{30}\text{Br}_4\text{P}_2\text{Pt}_2$ : C 15.23, H 3.20%; found: C 15.27, H 3.23%.  $^{31}\text{P}$  NMR ( $\text{CDCl}_3$ ):  $\delta$  10.9 (singlet with Pt satellites,  $^1J_{\text{P-Pt}} = 3701$  Hz,  $^3J_{\text{P-Pt}} = 24.4$  Hz,  $^4J_{\text{P-P}} = 1.6$  Hz). The AA'XX' part of the spectrum was insufficiently resolved for  $^2J_{\text{Pt-Pt}}$  to be evaluated (Kiffen *et al.*, 1975).

### Crystal data

$[\text{Pt}_2\text{Br}_4(\text{C}_6\text{H}_{15}\text{P})_2]$   
 $M_r = 946.12$   
 Monoclinic,  $C2/c$   
 $a = 26.522$  (6) Å  
 $b = 6.8720$  (13) Å  
 $c = 13.811$  (4) Å  
 $\beta = 120.930$  (7)°  
 $V = 2159.3$  (9) Å<sup>3</sup>  
 $Z = 4$

$D_x = 2.910$  Mg m<sup>-3</sup>  
 Mo  $K\alpha$  radiation  
 Cell parameters from 7378 reflections  
 $\theta = 1.9$ – $30.6$ °  
 $\mu = 20.48$  mm<sup>-1</sup>  
 $T = 120$  (2) K  
 Block, clear intense orange  
 0.20 × 0.10 × 0.10 mm

### Data collection

Bruker SMART CCD 1K area-detector diffractometer  
 $\omega$  scans  
 Absorption correction: multi-scan (SADABS; Bruker, 1998)  
 $T_{\text{min}} = 0.058$ ,  $T_{\text{max}} = 0.129$   
 10 540 measured reflections

2355 independent reflections  
 2158 reflections with  $I > 2\sigma(I)$   
 $R_{\text{int}} = 0.036$   
 $\theta_{\text{max}} = 27.0$ °  
 $h = -32 \rightarrow 33$   
 $k = -8 \rightarrow 8$   
 $l = -17 \rightarrow 17$

## Refinement

Refinement on  $F^2$  $R[F^2 > 2\sigma(F^2)] = 0.020$  $wR(F^2) = 0.046$  $S = 1.11$ 

2355 reflections

94 parameters

H-atom parameters constrained

$$w = 1/[\sigma^2(F_o^2) + (0.0168P)^2 + 10.3265P]$$

$$\text{where } P = (F_o^2 + 2F_c^2)/3$$

$$(\Delta/\sigma)_{\max} = 0.001$$

$$\Delta\rho_{\max} = 0.85 \text{ e } \text{\AA}^{-3}$$

$$\Delta\rho_{\min} = -1.75 \text{ e } \text{\AA}^{-3}$$

graphics: *SHELXTL* (Sheldrick, 1997b); software used to prepare material for publication: *SHELXTL*.

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Supplementary data for this paper are available from the IUCr electronic archives (Reference: HJ1034). Services for accessing these data are described at the back of the journal.

**Table 1**

Selected geometric parameters ( $\text{\AA}$ ,  $^\circ$ ) for (I) and the related chloro complexes  $[\text{PtCl}_2(\text{PMe}_3)_2]$ ,  $[\text{PtCl}_2(\text{PET}_3)_2]$  and  $[\text{PtCl}_2(\text{PPr}_3)_2]$  (Hal = Cl or Br).

	$[\text{PtCl}_2(\text{PMe}_3)_2]$	$[\text{PtCl}_2(\text{PET}_3)_2]$	$[\text{PtCl}_2(\text{PPr}_3)_2]$	(I)
Pt–P	2.205 (3)	2.212 (3)	2.230 (9)	2.2266 (11)
Pt–Hal <sub>terminal</sub>	2.281 (3)	2.282 (3)	2.279 (9)	2.4229 (7)
Pt–Hal <sub>bridging</sub>	2.309 (3)	2.318 (3)	2.315 (8)	2.4455 (7)
	2.423 (3)	2.431 (3)	2.425 (8)	2.5451 (6)
Pt–Hal–Pt	96.19 (10)	96.48 (10)	96.4 (3)	96.17 (2)
Hal–Pt–Hal	83.81 (10)	83.52 (9)	83.6 (2)	83.83 (2)

All H atoms were placed geometrically and refined using a riding model ( $\text{C–H} = 0.98$  and  $0.99 \text{ \AA}$ ), with their  $U_{\text{iso}}(\text{H})$  values fixed at 1.2 or 1.5 times  $U_{\text{eq}}$  of the parent C atom. Although there are difference density holes larger than  $1 \text{ e } \text{\AA}^{-3}$ , they are within  $1 \text{ \AA}$  of the Pt atom.

Data collection: *SMART-NT* (Bruker, 1998); cell refinement: *SMART-NT*; data reduction: *SAINT-NT* (Bruker, 1998); program(s) used to solve structure: *SHELXS97* (Sheldrick, 1997a); program(s) used to refine structure: *SHELXS97* (Sheldrick, 1997a); molecular

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