

# Synthesis, crystal structure and Raman spectrum of $K_2[(Pt_2)(HPO_4)_4(H_2O)_2]$ containing $(Pt_2)^{6+}$ ions

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Key indicators: single-crystal X-ray study;  $T = 123$  K,  $P = 0.0$  kPa; mean  $\sigma(P-O) = 0.005$  Å;  $R$  factor = 0.033;  $wR$  factor = 0.086; data-to-parameter ratio = 21.6.

In the crystal structure of the acid platinum phosphate dipotassium di- $\mu$ -hydrogenphosphato-bis[aquaplatinum(III)]-( $Pt-Pt$ ),  $K_2[(Pt_2)(HPO_4)_4(H_2O)_2]$ , the  $(Pt_2)^{6+}$  dumbbells within the paddle-wheel complex show Pt–Pt distances of 2.4944 (5) and 2.4892 (5) Å. The potassium ions are seven-fold coordinated by hydrogenphosphate groups. In the crystal, O–H...O hydrogen bonds help to establish the packing. The Raman spectrum was recorded.

## Related literature

The structure of the title isotopic sodium compound,  $Na_2[Pt_2(HPO_4)_4(H_2O)_2]$ , was determined by Cotton *et al.* (1982a). For platinum phosphates, see: Wellmann & Liebau (1981). For related compounds containing dinuclear platinum(III), see: Bancroft *et al.* (1984); Baranovskii & Schelokov (1978); Che *et al.* (1982); Cotton & Walton (1982b); Dikareva *et al.* (1982, 1987); Muraveiskaya *et al.* (1974, 1976); Pley & Wickleder (2004a,b, 2005); Stein *et al.* (1983); Woollins & Kelly (1985). For the ternary system Pd/P/O, see: Palkina *et al.* (1978); Panagiotidis *et al.* (2005). For hydrogen bonds, see: Steiner (2002). For the Raman spectra of  $In_3(PO_4)_2$  and  $In_2O(PO_4)$ , see: Thauern & Glaum (2004). For the synthesis, see: Brauer (1978).

## Experimental

### Crystal data

$K_2[(Pt_2)(HPO_4)_4(H_2O)_2]$	$\gamma = 65.528$ (1)°
$M_r = 888.32$	$V = 776.32$ (4) Å <sup>3</sup>
Triclinic, $P\bar{1}$	$Z = 2$
$a = 7.8852$ (2) Å	Mo $K\alpha$ radiation
$b = 7.9657$ (2) Å	$\mu = 19.05$ mm <sup>-1</sup>
$c = 13.7739$ (4) Å	$T = 123$ K
$\alpha = 82.358$ (1)°	$0.24 \times 0.14 \times 0.08$ mm
$\beta = 81.509$ (1)°	

### Data collection

Nonius Kappa CCD diffractometer	18915 measured reflections
Absorption correction: multi-scan (Blessing, 1995)	5589 independent reflections
$T_{\min} = 0.060$ , $T_{\max} = 0.224$	4077 reflections with $I > 2\sigma(I)$
	$R_{\text{int}} = 0.064$

### Refinement

$R[F^2 > 2\sigma(F^2)] = 0.033$	H atoms treated by a mixture of independent and constrained refinement
$wR(F^2) = 0.086$	$\Delta\rho_{\text{max}} = 3.46$ e Å <sup>-3</sup>
$S = 0.98$	$\Delta\rho_{\text{min}} = -2.87$ e Å <sup>-3</sup>
5589 reflections	
259 parameters	
10 restraints	

Table 1

Hydrogen-bond geometry (Å, °).

$D-H\cdots A$	$D-H$	$H\cdots A$	$D\cdots A$	$D-H\cdots A$
O1–H1A...O31 <sup>i</sup>	0.83 (6)	1.73 (6)	2.559 (7)	173 (8)
O1–H1B...O21 <sup>ii</sup>	0.84 (6)	2.09 (4)	2.860 (7)	153 (8)
O14–H14...O31 <sup>iii</sup>	0.83 (2)	1.82 (5)	2.548 (7)	146 (9)
O24–H24...O11 <sup>iv</sup>	0.84 (7)	1.73 (7)	2.562 (7)	177 (9)
O34–H34...O41 <sup>v</sup>	0.83 (6)	1.74 (3)	2.546 (6)	162 (9)
O10–H10A...O41 <sup>vi</sup>	0.86 (2)	1.94 (4)	2.713 (7)	148 (7)
O10–H10B...O11 <sup>vii</sup>	0.86 (2)	1.86 (2)	2.694 (6)	164 (6)
O42–H42...O21 <sup>viii</sup>	0.84 (7)	2.27 (9)	2.475 (7)	94 (6)

Symmetry codes: (i)  $-x, -y + 1, -z + 1$ ; (ii)  $-x + 2, -y, -z + 1$ ; (iii)  $-x, -y, -z + 1$ ; (iv)  $-x + 2, -y - 1, -z + 1$ ; (v)  $-x - 1, -y + 2, -z$ ; (vi)  $-x, -y + 2, -z$ ; (vii)  $-x + 1, -y, -z + 1$ ; (viii)  $-x + 1, -y + 1, -z$ .

Data collection: *COLLECT* (Hooft, 2004); cell refinement: *SCALEPACK* (Otwinowski & Minor, 1997); data reduction: *DENZO* (Otwinowski & Minor 1997) and *SCALEPACK*; program(s) used to solve structure: *SHELXS97* (Sheldrick, 2008); program(s) used to refine structure: *SHELXL97* (Sheldrick, 2008); molecular graphics: *ATOMS* (Dowty, 2006); software used to prepare material for publication: *WinGX* (Farrugia, 1999).

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Supplementary data and figures for this paper are available from the IUCr electronic archives (Reference: ER2058).

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