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Key indicators

Single-crystal X-ray study
 T = 120 K
 Mean $\sigma(C-C)$ = 0.008 Å
 R factor = 0.024
 wR factor = 0.062
 Data-to-parameter ratio = 12.5

For details of how these key indicators were automatically derived from the article, see <http://journals.iucr.org/e>.

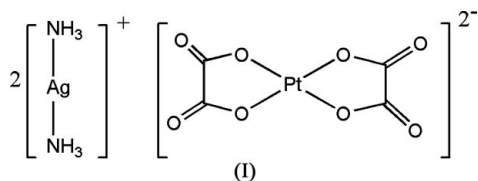
Bis[diamminesilver(I)] dioxalatoplatinate(II)

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In the title compound, $[Ag(NH_3)_2][Pt(C_2O_4)_2]$, the Ag atom is coordinated in an almost linear configuration by two N atoms from two ammine ligands. The Pt atom, located on an inversion centre, is tetracoordinated by four O atoms from two oxalate ions. The silver cations and platinum-centred anions are each stacked separately in a columnar fashion along the *a* axis. In the crystal structure, the cations and anions are further linked together through N—H···O hydrogen bonds, forming a three-dimensional structure.

Comment

There has been considerable interest in linear chain transition metal complexes because of their unusual and highly anisotropic optical, electrical, and magnetic properties. Linear chain platinum complexes are of special interest due to their structure–property relationships and their role as electronic conductors, photosensitizers and photocatalysts for solar photochemical energy conversion (Palmans *et al.*, 1996; Phelps *et al.*, 1976; Reis *et al.*, 1976.). The interaction between platinum(II) centres take place through the d_{z^2} and p_z orbitals of the metal, oriented along the *z* axis. Square-planar complexes of platinum(II) have been shown to display intriguing spectroscopic and luminescence properties. A few impressive examples include the rich polymorphism exhibited by a number of platinum(II) polypyridine complexes in the solid state, with their solid state colours dependent on the extent of metal–metal interactions and the stacking of the polypyridyl ligands (Yam *et al.*, 2002) and, recently, the interesting vapochromic and vapoluminescence properties displayed by a number of double salts of square-planar platinum–palladium and platinum–platinum complexes (Daws *et al.*, 1997). So far, few one-dimensional heterometallic chain compounds supported by platinum–silver interactions have been reported (Oberbeckmann-Winter *et al.*, 2005).



One half-anion and one cation constitute the asymmetric unit of (I) (Fig. 1). The diamminesilver(I) cation has an almost linear structure, with Ag–N bonds of 2.121 (5) and 2.119 (5) Å and an N–Ag–N angle of 172.5 (2)°. The Pt atom, located on an inversion centre, adopts a square-planar geometry, surrounded by four O atoms of two oxalate ions

(Table 1). The dioxalatoplatinate ions stack into perfectly linear one-dimensional chains, with adjacent ions related by translational crystallographic symmetry along the a axis. The $\text{Pt} \cdots \text{Pt}^i$ [symmetry code: (i) $1 + x, y, z$] distance is thus 3.586 (1) Å. The diamminesilver cations also stack in an eclipsed arrangement, forming parallel chains with the same metal–metal distance. The crystal structure is stabilized by hydrogen bonds between the coordinated ammine ligands and the oxalate ions (Table 2). Each N atom donates three H atoms to the carboxylate O atoms of two anion columns, forming a three-dimensional structure (Fig. 2). There are also weak $\text{Pt} \cdots \text{Ag}$ interactions, as seen from the $\text{Pt} \cdots \text{Ag}^{\text{ii}}$ [symmetry code: (ii) $-x, y - \frac{1}{2}, -z + \frac{1}{2}$] intermolecular contacts of 4.071 (1) Å.

Experimental

All reagents and solvents were used as obtained without further purification. Silver nitrate (34 mg, 0.2 mmol) was added to a hot aqueous solution (5 ml) of potassium dioxalatoplatinate (45 mg, 0.1 mmol). The immediately formed precipitate was redissolved by adding a few drops of an ammonia solution (17%). Slow evaporation of the resulting colourless solution yielded pale-yellow crystals in 87% yield. Analysis calculated for $\text{C}_4\text{H}_{12}\text{Ag}_2\text{N}_4\text{O}_8\text{Pt}$: C 7.34, H 1.85, N 8.55%; found: C 7.20, H 2.06, N 8.39%.

Crystal data

$[\text{Ag}(\text{NH}_3)_2]_2 \cdot [\text{Pt}(\text{C}_2\text{O}_4)_2]$	$Z = 2$
$M_r = 655.01$	$D_x = 3.376 \text{ Mg m}^{-3}$
Monoclinic, $P2_1/n$	Mo $K\alpha$ radiation
$a = 3.5857$ (11) Å	$\mu = 13.88 \text{ mm}^{-1}$
$b = 9.014$ (3) Å	$T = 120$ (2) K
$c = 19.936$ (6) Å	Needle, yellow
$\beta = 90.284$ (5)°	$0.36 \times 0.12 \times 0.10 \text{ mm}$
$V = 644.4$ (4) Å ³	

Data collection

Bruker SMART CCD area-detector diffractometer	3232 measured reflections
φ and ω scans	1135 independent reflections
Absorption correction: multi-scan (SADABS; Sheldrick, 1996)	1082 reflections with $I > 2\sigma(I)$
$T_{\min} = 0.082$, $T_{\max} = 0.338$ (expected range = 0.061–0.250)	$R_{\text{int}} = 0.050$
	$\theta_{\text{max}} = 25.0^\circ$

Refinement

Refinement on F^2	$w = 1/[\sigma^2(F_o^2) + (0.0351P)^2 + 1.6017P]$
$R[F^2 > 2\sigma(F^2)] = 0.024$	where $P = (F_o^2 + 2F_c^2)/3$
$wR(F^2) = 0.062$	$(\Delta/\sigma)_{\text{max}} = 0.001$
$S = 1.09$	$\Delta\rho_{\text{max}} = 1.83 \text{ e \AA}^{-3}$
1135 reflections	$\Delta\rho_{\text{min}} = -1.02 \text{ e \AA}^{-3}$
91 parameters	Extinction correction: SHELXL97
H-atom parameters constrained	Extinction coefficient: 0.0040 (5)

Table 1

Selected geometric parameters (Å, °).

C1–O2	1.228 (7)	C2–O3	1.301 (7)
C1–O1	1.300 (7)	O1–Pt	2.011 (4)
C2–O4	1.215 (7)	O3–Pt	2.017 (4)
O1–Pt–O3	97.47 (15)	O1 ⁱ –Pt–O3	82.53 (15)

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

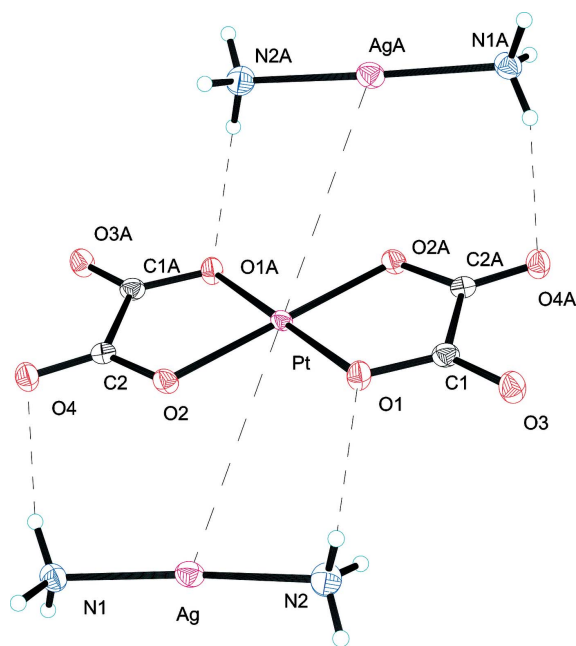


Figure 1

The structure of the title compound, showing the atom-numbering scheme. Displacement ellipsoids are drawn at the 50% probability level and H atoms are shown as small spheres of arbitrary radii. Hydrogen bonds and short metal–metal contacts are shown as dashed lines. [Symmetry code: (A) $-x, 1 - y, 1 - z$].

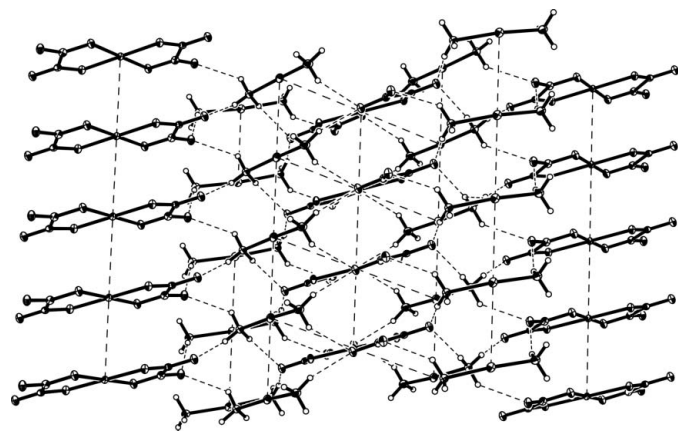


Figure 2

A crystal packing diagram of (I), viewed along a , showing the hydrogen bonds between the cations and anions as dashed lines.

Table 2

Hydrogen-bond geometry (Å, °).

$D-H \cdots A$	$D-H$	$H \cdots A$	$D \cdots A$	$D-H \cdots A$
$\text{N2}-\text{H2C} \cdots \text{O2}^{\text{ii}}$	0.91	2.15	2.988 (7)	153
$\text{N2}-\text{H2B} \cdots \text{O1}^{\text{iii}}$	0.91	2.22	3.112 (6)	165
$\text{N2}-\text{H2A} \cdots \text{O1}^{\text{iv}}$	0.91	2.37	3.053 (7)	132
$\text{N1}-\text{H1C} \cdots \text{O4}^{\text{iv}}$	0.91	2.22	3.077 (6)	157
$\text{N1}-\text{H1B} \cdots \text{O2}^{\text{v}}$	0.91	2.35	3.084 (6)	137
$\text{N1}-\text{H1A} \cdots \text{O4}$	0.91	2.13	2.985 (6)	156

Symmetry codes: (ii) $x + \frac{3}{2}, -y + \frac{1}{2}, z + \frac{1}{2}$; (iii) $-x + \frac{3}{2}, y + \frac{1}{2}, -z + \frac{3}{2}$; (iv) $-x + \frac{1}{2}, y + \frac{1}{2}, -z + \frac{3}{2}$; (v) $-x + 1, -y + 1, -z + 1$.

All H atoms were positioned geometrically and allowed to ride on the N atoms to which they are bonded, with $U_{\text{iso}}(\text{H}) = 1.5U_{\text{eq}}(\text{N})$. The largest electron-density peak and hole lie within 0.9 Å of the Pt atom.

Data collection: *SMART* (Bruker, 1998); cell refinement: *SMART*; data reduction: *SAINT* (Bruker, 1998); program(s) used to solve structure: *SHELXS97* (Sheldrick, 1997a); program(s) used to refine structure: *SHELXL97* (Sheldrick, 1997a); molecular graphics: *SHELXTL* (Sheldrick, 1997b); software used to prepare material for publication: *SHELXTL*.

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