# cis-Dichloro(2-morpholinoethylamine-κ^2N,N')-platinum(II)

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The diamine ligand in the title compound, [PtCl$_2$(C$_6$H$_{14}$N$_2$O)], chelates to platinum, which adopts a square-planar geometry. Adjacent molecules are linked by an N—H⋯O hydrogen bond, forming a chain running along [101].

Comment

The crystal structures of a large number of square-planar dichloroplatinum(II) complexes of amine ligands have been reported, as noted from the Cambridge Structural Database (Allen 2002; Version 5.27, December 2005 update). These structural studies are part of the attempt to understand the anticancer activity of diamminedichloroplatinum(II) and its close analogues. Among the complexes studied are several containing the chelating ligand 1,2-diaminoethane as well as its N-substituted derivatives, e.g. N,N-dimethylethane-1,2-diamine (Melanson et al., 1987) and N-(2-hydroxy-ethyl)ethane-1,2-diamine (Davies et al., 2002). The chelating nature of the 1,2-diaminoethane portion of these ligands ensures a cis configuration; in the present study, the 2-morpholinoethylamine chelate also ensures such a geometry in the title platinum dichloride adduct, (I) (Fig. 1). The compound forms a hydrogen-bonded chain (Table 2 and Fig. 2) in which the amine group uses one H atom to serve as a donor to the O atom of the morpholinyl ring of an adjacent molecule. Its other H atom engages in interactions with the Cl atoms of adjacent molecules, these weaker interactions (Table 2) giving rise to a three-dimensional framework structure.

(I)
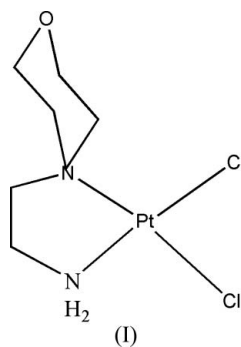
The 2-morpholinoethylamine ligand has been shown to chelate in the nickel isothiocyanate (Laskar et al., 2001), nickel dicyanamide (Konar et al., 2005) and dicopper diperchlorate oxalate (Mukherjee et al., 2001) complexes. The crystal structures of the salts ammonium ethylmorpholinium tetrachlorocuprate(II) (Battaglia et al., 1982) and ammonium ethylmorpholinium tetrachloromercurate(II) (Vozzosi et al., 1984) have also been reported.

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Experimental

Potassium tetrachloroplatinate(II) (1.25 g, 0.003 mmol) was dissolved in water (25 ml) along with potassium chloride (3 g, 0.018 mmol). To the solution was added a solution of 2-morpholinoethylamine (0.39 g, 0.003 mmol) in water (10 ml). The mixture set aside for the formation of yellow crystals. The product was washed with water followed by ethanol, and was isolated in nearly quantitative yield. The compound was analysed for its Pt content: calculated 49.23%; found 49.76%.

Crystal data

[PtCl$_2$(C$_6$H$_{14}$N$_2$O)]	$Z = 8$
$M_r = 396.18$	$D_x = 2.566$ Mg m^{-3}
Monoclinic, $C2/c$	Mo $K\alpha$ radiation
$a = 16.365$ (2) Å	$\mu = 14.16$ mm^{-1}
$b = 12.584$ (2) Å	$T = 295$ (2) K
$c = 10.775$ (2) Å	Block, yellow
$\beta = 112.459$ (2)°	$0.28 \times 0.25 \times 0.20$ mm
$V = 2050.7$ (6) Å^3	

Data collection

Bruker APEX-II area-detector diffractometer	5839 measured reflections
φ and ω scans	2245 independent reflections
Absorption correction: multi-scan (SADABS; Sheldrick, 1996)	1651 reflections with $I > 2\sigma(I)$
$T_{min} = 0.027$, $T_{max} = 0.059$	$R_{int} = 0.041$
	$\theta_{max} = 27.3°$

Refinement

Refinement on F^2	H-atom parameters constrained
$R[F^2 > 2\sigma(F^2)] = 0.029$	$w = 1/[\sigma^2(F_o^2) + (0.0282P)^2]$
$wR(F^2) = 0.067$	where $P = (F_o^2 + 2F_c^2)/3$
$S = 0.96$	$(\Delta/\sigma)_{max} = 0.001$
2245 reflections	$\Delta\rho_{max} = 0.72$ e Å^{-3}
109 parameters	$\Delta\rho_{min} = -1.94$ e Å^{-3}

Table 1
Selected geometric parameters (Å, °).

Pt1—N1	2.018 (6)	Pt1—Cl1	2.304 (2)
Pt1—N2	2.075 (5)	Pt1—Cl2	2.303 (2)
N1—Pt1—N2	84.8 (2)	N2—Pt1—Cl1	93.0 (2)
N1—Pt1—Cl1	177.4 (2)	N2—Pt1—Cl2	175.1 (2)
N1—Pt1—Cl2	90.4 (2)	Cl1—Pt1—Cl2	91.80 (9)

Table 2
Hydrogen-bond geometry (Å, °).

D—H$\cdots A$	D—H	H$\cdots A$	$D\cdots A$	D—H$\cdots A$
N1—H11$\cdots$O1^i	0.86	2.19	2.972 (7)	152
N1—H12$\cdots$Cl1^{ii}	0.86	2.55	3.284 (6)	145
N1—H12$\cdots$Cl2^{ii}	0.86	2.81	3.458 (7)	134

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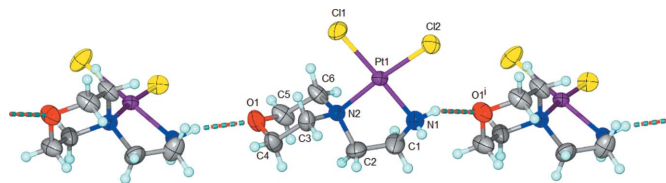

Figure 1
Three molecules of (I), showing displacement ellipsoids drawn at the 50% probability level and H atoms as spheres of arbitrary radii. The dashed lines represent the N—H$\cdots$O hydrogen bonds. [Symmetry code: (i) $\frac{1}{2} + x$, $\frac{1}{2} - y$, $\frac{1}{2} + z$.]

The H atoms were treated as riding atoms, with C—H = 0.93–0.98 Å and N—H = 0.86 Å, and with U_{iso}(H) = 1.2U_{eq}(C,N). Although $\mu*d$ is larger than 3, the structure has refined smoothly with the multi-scan absorption correction. There are no large peaks/holes in the final difference Fourier map. Moreover, the crystal did not have clearly defined faces for a face-indexing absorption correction

Data collection: *APEXII* (Bruker, 2004); cell refinement: *SAINT* (Bruker, 2004); data reduction: *SAINT*; program(s) used to solve structure: *SHELXS97* (Sheldrick, 1997); program(s) used to refine structure: *SHELXL97* (Sheldrick, 1997); molecular graphics: *X-SEED* (Barbour, 2001); software used to prepare material for publication: *SHELXL97*.

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