

## Bis(acridine-*N*)(nitrate-*O,O'*)silver(I)

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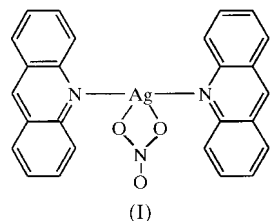
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The title complex,  $[\text{Ag}(\text{NO}_3)(\text{C}_{13}\text{H}_9\text{N})_2]$ , is the first complex of silver and acridine to be reported. The silver coordination is distorted trigonal. The N–Ag–N angle involving the N atoms of the acridine ligands is 145.84 (6)°. The nitrate ion coordinates to silver as an asymmetrically chelating bidentate ligand. The crystal structure consists of neutral complex molecules linked into chains by means of attractive  $\pi$ – $\pi$  interactions among the parallel acridine ligands.

### Comment

Elucidation of the exact structure of adsorbate molecules on a metal surface is a crucial step in some applications of surface-enhanced Raman scattering (SERS) (Moskovits, 1993). Comparison of the vibrational spectra of a metal–adsorbate synthetic complex and the SERS spectra of a molecule adsorbed on a metal surface yields useful information about the orientation of the adsorbate in the SERS system (Vlckova *et al.*, 1993). In our studies, we are dealing with the incorporation of acridine (acr) into Ag–colloid–acridine systems (Michl & Sloufova, 2000). As no structure data for acridine–silver complexes were available, the novel complex  $[\text{Ag}(\text{acr})_2(\text{NO}_3)]$ , (I), was prepared and characterized by X-ray diffraction analysis.



The silver coordination is distorted trigonal. The nitrate ion coordinates to silver as an asymmetrically chelating bidentate ligand; the Ag–O2D and Ag–O3D distances are 2.627 and 2.558 Å, respectively. Defining dummy atom D3 as situated at the centre of gravity of O2D and O3D, the coordination sphere may be defined by D3 and the acridine N1A and N1B atoms. The N1A–Ag–N1B angle is increased from an ideal value of 120° to 145.84 (6)°; angles N1A–Ag–D3 and

N1B–Ag–D3 are decreased to 101.01 and 111.07°, respectively.

Neutral molecules of complex (I) are linked into chains running parallel to [101]. The chains are generated by the

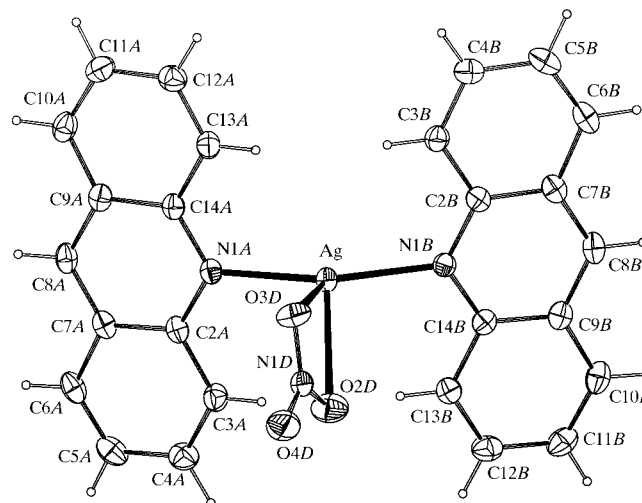


Figure 1

The asymmetric unit of compound (I), showing the atom-numbering scheme. Displacement ellipsoids are drawn at the 50% probability level.

action of inversion centres. Linkage is realised by attractive  $\pi$ – $\pi$  interactions (Desiraju, 1995) among the planar acridine ligands. These interactions are similar to those found between the layers of graphite (Wyckoff, 1965). Acridine molecule A (atoms N1A to C14A) interacts with another acridine molecule A generated by  $(-x+1, -y, -z+2)$ , as shown in Fig. 2. As the two molecules are related by translations and inversion only, the two interacting planar molecules are parallel, the distance between the planes being 3.326 (2) Å.

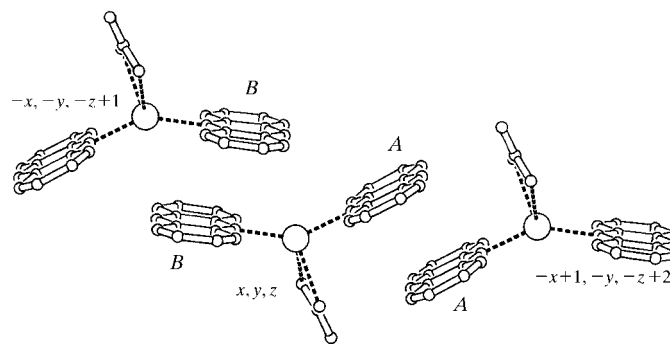


Figure 2

The scheme of  $\pi$ – $\pi$  interactions in compound (I).

Acridine molecule B (atoms N1B to C14B) interacts with another acridine molecule B generated by  $(-x, -y, -z+1)$ . The two molecules are exactly parallel, for the same reasons as discussed above, and the distance between them is 3.343 (3) Å. There are two such [101] chains in the unit cell, which corresponds to two molecules per unit cell.

Examination of the structure with PLATON (Spek, 1990) showed that there are no solvent-accessible voids in the crystal lattice.

The structure of the analogous complex with the same ligands and Cu as the central metal atom has been reported (Kuroda-Sowa *et al.*, 1995).

### Experimental

Yellow–brown crystals of (I) were obtained by mixing a water solution of AgNO<sub>3</sub> (4.2 × 10<sup>−2</sup> M) and a dioxane solution of acridine (4.2 × 10<sup>−2</sup> M) in an equimolar ratio. Crystals of (I) suitable for X-ray analysis appeared over a period of two days. No recrystallization was necessary.

#### Crystal data

[Ag(NO <sub>3</sub> )(C <sub>13</sub> H <sub>9</sub> N) <sub>2</sub> ]	$D_x = 1.711 \text{ Mg m}^{-3}$
$M_r = 528.30$	Mo $K\alpha$ radiation
Triclinic, $P\bar{1}$	Cell parameters from 25 reflections
$a = 9.128 (3) \text{ \AA}$	$\theta = 12\text{--}13^\circ$
$b = 10.096 (2) \text{ \AA}$	$\mu = 1.020 \text{ mm}^{-1}$
$c = 11.763 (2) \text{ \AA}$	$T = 150 (2) \text{ K}$
$\alpha = 108.19 (1)^\circ$	Prism with strongly rounded edges, translucent intense brown
$\beta = 91.93 (2)^\circ$	$0.20 \times 0.15 \times 0.15 \text{ mm}$
$\gamma = 94.23 (2)^\circ$	
$V = 1025.2 (4) \text{ \AA}^3$	
$Z = 2$	

#### Data collection

Enraf–Nonius CAD-4 diffractometer	3593 independent reflections
Background–peak–background scans	3466 reflections with $I > 2\sigma(I)$
Absorption correction: spherical (JANA2000; Petricek & Dusek, 2000)	$\theta_{\text{max}} = 24.98^\circ$
$T_{\text{min}} = 0.793$ , $T_{\text{max}} = 0.797$	$h = 0 \rightarrow 10$
3593 measured reflections	$k = -11 \rightarrow 11$
	$l = -13 \rightarrow 13$
	3 standard reflections
	frequency: 60 min
	intensity decay: none

#### Refinement

Refinement on $F^2$	$w = 1/[\sigma^2(F_o^2) + (0.0269P)^2 + 0.7513P]$
$R[F^2 > 2\sigma(F^2)] = 0.020$	where $P = (F_o^2 + 2F_c^2)/3$
$wR(F^2) = 0.056$	$(\Delta/\sigma)_{\text{max}} = 0.002$
$S = 1.192$	$\Delta\rho_{\text{max}} = 0.58 \text{ e \AA}^{-3}$
3593 reflections	$\Delta\rho_{\text{min}} = -0.72 \text{ e \AA}^{-3}$
335 parameters	Extinction correction: SHELXL97 (Sheldrick, 1997)
H atoms treated by a mixture of independent and constrained refinement	Extinction coefficient: 0.0035 (7)

Data collection was carried out at 150 K, as the crystals decay rapidly under X-rays at room temperature. The H atoms were clearly

**Table 1**

Selected geometric parameters ( $\text{\AA}$ ,  $^\circ$ ).

Ag–N1B	2.216 (2)	Ag–O2D	2.627 (2)
Ag–N1A	2.226 (2)	Ag–O3D	2.558 (2)
N1B–Ag–N1A	145.84 (6)	N1B–Ag–O2D	101.09 (6)
N1B–Ag–O3D	117.72 (6)	N1A–Ag–O2D	103.64 (6)
N1A–Ag–O3D	96.31 (6)		

visible in the difference Fourier maps; they were set to calculated positions and their X–H distances (where X is the relevant heavy atom) and isotropic displacement parameters were refined.

Data collection: CAD-4 Software (Enraf–Nonius, 1989); cell refinement: CAD-4 Software; data reduction: JANA2000 (Petricek & Dusek, 2000); program(s) used to solve structure: SHELXS97 (Sheldrick, 1997); program(s) used to refine structure: SHELXL97 (Sheldrick, 1997); molecular graphics: PLATON (Spek, 1990).

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Supplementary data for this paper are available from the IUCr electronic archives (Reference: AV1049). Services for accessing these data are described at the back of the journal.

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