

catena-Poly[[silver(I)- μ -ethane-1,2-diamine- $\kappa^2N:N'$] trifluoromethanesulfonate]Zhong-Lu You^{a,b} and Hai-Liang Zhu^{a*}^aDepartment of Chemistry, Fuyang Normal College, Fuyang, Anhui 236041, People's Republic of China, and ^bDepartment of Chemistry, Lanzhou University, Lanzhou 730000, People's Republic of China

Correspondence e-mail: hailiang_zhu@163.com

Received 11 August 2004

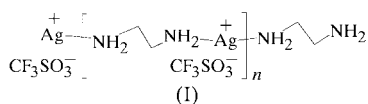
Accepted 24 August 2004

Online 25 September 2004

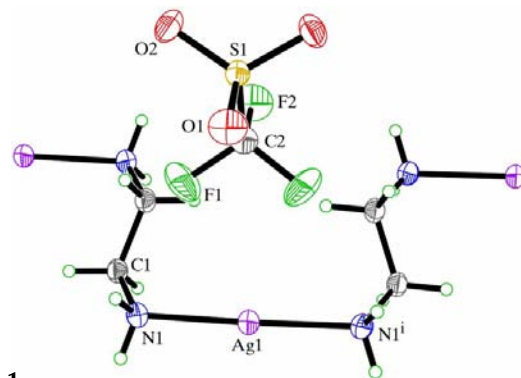
The title complex, $[\{\text{Ag}(\text{C}_2\text{H}_8\text{N}_2)\}(\text{CF}_3\text{SO}_3)]_n$, is a mononuclear silver(I) compound. The Ag^{I} atom lies on a mirror plane and is bicoordinated in a linear configuration by two N atoms from two ethane-1,2-diamine ligands, giving zigzag polymeric chains with an $[-\text{Ag}-\text{N}-\text{C}-\text{C}-\text{N}-]_n$ backbone running along the b axis. These chains are interconnected by $\text{N}-\text{H}\cdots\text{O}$ hydrogen bonds involving the trifluoromethanesulfonate anions (which also lie on mirror planes), forming a three-dimensional network.

Comment

Inorganic supramolecular chemistry, and in particular the construction of polymeric coordination networks, is an extremely topical area of research (Xu *et al.*, 2001; Yaghi & Li, 1996). The construction of a wide variety of network topologies has been achieved through ligand design and the use of different counter-anions. The balance between the formation of different structures is often subtle. Factors which affect the topology of coordination polymers include not only the highly influential forces of metal and ligand coordination preferences, but also anion-based interactions. The latter factor is particularly notable in Ag^{I} coordination polymers (Blake *et al.*, 2000; Melcer *et al.*, 2001). Owing to the flexible coordination sphere of Ag^{I} , coordination numbers from 2 to 6 are all possible and, due to the relatively weak nature of many Ag^{I} -ligand interactions, such compounds are particularly susceptible to the influence of weaker supramolecular forces (Khlobystov *et al.*, 2001).



Recently, we have reported a polynuclear Ag^{I} complex, (II), with ethane-1,2-diamine as the ligand and 3-fluorobenzoate as the counter-anion, *viz.* *catena*-poly[[silver(I)- μ -ethane-1,2-diamine- $\kappa^2N:N'$] 3-fluorobenzoate monohydrate] (You *et al.*,

**Figure 1**

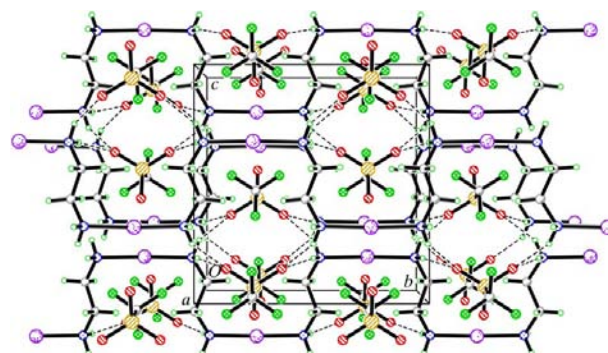
The structure of (I), showing the atom-numbering scheme. Displacement ellipsoids are drawn at the 30% probability level and H atoms are shown as small spheres of arbitrary radii. [Symmetry code: (i) $x, \frac{3}{2} - y, z$.]

2004). In order to study the effects of the counter-anion in the construction of silver(I) coordination polymers, the structure of the title compound, (I), is reported here.

Complex (I) is a polymeric ethane-1,2-diamine- Ag^{I} compound (Fig. 1). The smallest repeat unit for the complex contains an ethane-1,2-diamine- Ag^{I} cation and a trifluoromethanesulfonate anion, where the $\text{Ag}1$ atom and the $\text{O}1-\text{S}1-\text{C}2-\text{F}2$ moiety of the anion lie on a mirror plane and the ethane-1,2-diamine ligand has a centre of symmetry. The Ag^{I} atom is in a linear coordination environment and is bicoordinated by two N atoms of ethane-1,2-diamine ligands, the $\text{N}1-\text{Ag}1-\text{N}1^{\text{i}}$ bond angle being $177.86(15)^\circ$ [symmetry code: (i) $x, \frac{3}{2} - y, z$; Table 1].

In the crystal packing of (I), the ethane-1,2-diamine- Ag^{I} polymer forms a zigzag chain along the b axis and the trifluoromethanesulfonate anions are located between these chains. The sulfonate ends connect the chains *via* $\text{N}-\text{H}\cdots\text{O}$ hydrogen bonds (Table 2), forming a three-dimensional structure (Fig. 2).

The $\text{Ag}-\text{N}$ bond length in (I) [$2.143(4) \text{ \AA}$] is comparable with the average value of $2.138(2) \text{ \AA}$ in (II). The coordination geometry around the Ag atom in (II) is also linear but slightly distorted, with an $\text{N}-\text{Ag}-\text{N}$ bond angle of $170.50(11)^\circ$. This may be due to weak interactions between the solvate water molecule and the Ag atom in (II), with an $\text{Ag}\cdots\text{OW}$ distance of $2.610(3) \text{ \AA}$, which inclines the Ag^{I} atom towards the solvate water molecule.

**Figure 2**

The crystal packing of (I), viewed along the a axis. Broken lines indicate $\text{N}-\text{H}\cdots\text{O}$ hydrogen bonds.

In (I), two O atoms of the trifluoromethanesulfonate anion contribute to intermolecular N—H···O hydrogen bonds, which results in the two ethane-1,2-diamine ligands being located on the same side of the N—Ag—N axis and adopting the *trans* form to minimize steric effects (Fig. 2). However, in (II), the ethane-1,2-diamine ligand shows the *gauche* form, with a C—N—N—C torsion angle of $-74.1(4)^\circ$, and the 3-fluorobenzoate anion is located near the two N atoms of the ethane-1,2-diamine ligand. In (II), a nine-membered ring is formed through N—H···O hydrogen bonds involving the carboxylate group of the anion.

Experimental

Silver trifluoromethanesulfonate (0.1 mmol, 25.7 mg) and ethane-1,2-diamine (0.1 mmol, 6.0 mg) were dissolved in an ammonia solution (10 ml, 30%). The mixture was stirred for about 10 min at room temperature to obtain a clear colourless solution. The resulting solution was kept in the dark and, after slow evaporation of the solvent over a period of 5 d, crystals of (I) were isolated, washed three times with water and dried in a vacuum desiccator using anhydrous CaCl_2 (yield 61%). Elemental analysis, calculated: C 11.4, H 2.5, N 8.8%; found: C 11.3, H 2.5, N 8.9%.

Crystal data

$[\text{Ag}(\text{C}_2\text{H}_8\text{N}_2)](\text{CF}_3\text{SO}_3)$	Mo $K\alpha$ radiation
$M_r = 317.04$	Cell parameters from 2334 reflections
Orthorhombic, <i>Pnma</i>	$\theta = 2.8\text{--}28.0^\circ$
$a = 8.711(11) \text{ \AA}$	$\mu = 2.51 \text{ mm}^{-1}$
$b = 10.050(13) \text{ \AA}$	$T = 298(2) \text{ K}$
$c = 10.224(13) \text{ \AA}$	Block, colourless
$V = 895(2) \text{ \AA}^3$	$0.21 \times 0.10 \times 0.08 \text{ mm}$
$Z = 4$	
$D_x = 2.353 \text{ Mg m}^{-3}$	

Data collection

Bruker SMART CCD area-detector diffractometer	1025 independent reflections
ω scans	972 reflections with $I > 2\sigma(I)$
Absorption correction: multi-scan (SADABS; Sheldrick, 1996)	$R_{\text{int}} = 0.029$
$T_{\text{min}} = 0.621$, $T_{\text{max}} = 0.824$	$\theta_{\text{max}} = 27.0^\circ$
4585 measured reflections	$h = -11 \rightarrow 11$
	$k = -12 \rightarrow 10$
	$l = -8 \rightarrow 13$

Refinement

Refinement on F^2	$w = 1/[\sigma^2(F_o^2) + (0.0314P)^2 + 1.0534P]$
$R[F^2 > 2\sigma(F^2)] = 0.033$	where $P = (F_o^2 + 2F_c^2)/3$
$wR(F^2) = 0.076$	$(\Delta/\sigma)_{\text{max}} < 0.001$
$S = 1.19$	$\Delta\rho_{\text{max}} = 0.88 \text{ e \AA}^{-3}$
1025 reflections	$\Delta\rho_{\text{min}} = -0.57 \text{ e \AA}^{-3}$
67 parameters	
H-atom parameters constrained	

All H atoms were placed in geometrically idealized positions and constrained to ride on their parent atoms, with N—H = 0.90 Å and C—H = 0.96 Å, and $U_{\text{iso}}(\text{H}) = 0.08 \text{ \AA}^2$.

Table 1

Selected geometric parameters (Å, °).

Ag1—N1	2.143 (4)		
N1 ⁱ —Ag1—N1	177.86 (15)		
N1—C1—C1 ⁱⁱ —N1 ⁱⁱ	−180.0	O2—S1—C2—F2	59.74 (14)
O2—S1—C2—F1	−60.1 (4)	O1—S1—C2—F1	60.2 (3)

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

Table 2

Hydrogen-bonding geometry (Å, °).

$D\text{—}H\cdots A$	$D\text{—}H$	$H\cdots A$	$D\cdots A$	$D\text{—}H\cdots A$
N1—H1B···O2 ⁱ	0.90	2.30	3.126 (5)	152
N1—H1A···O2 ⁱⁱ	0.90	2.20	3.043 (5)	156

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

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.

The authors thank the Education Office of Anhui Province, People's Republic of China, for research grant No. 2004kj300zd.

Supplementary data for this paper are available from the IUCr electronic archives (Reference: OB1200). Services for accessing these data are described at the back of the journal.

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