

catena-Poly[[di- μ -benzoato- κ^4 O:O'-disilver(I)]- μ -*N,N'*-bis(2-fluorobenzylidene)butane-1,4-diamine- κ^2 N:N']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

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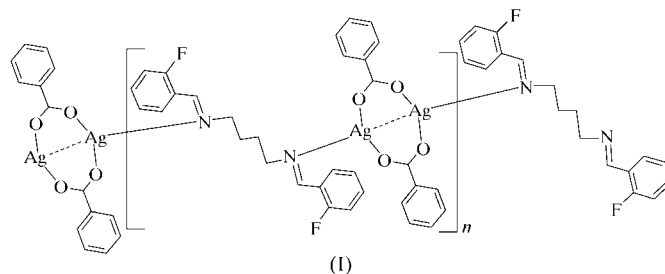
The title complex, $[\text{Ag}_2(\text{C}_7\text{H}_5\text{O}_2)_2(\text{C}_{18}\text{H}_{18}\text{F}_2\text{N}_2)]_n$, is a dinuclear silver(I) compound with one inversion centre between pairs of Ag atoms and another at the mid-point of the central C—C bond in the butane-1,4-diamine moiety. Each of the smallest repeat units consists of two silver(I) cations, two benzoate anions and one *N,N'*-bis(2-fluorobenzylidene)-butane-1,4-diamine Schiff base ligand. Each Ag^I ion is three-coordinated in a trigonal configuration by two O atoms from two benzoate anions and one N atom from a Schiff base ligand. The di- μ -benzoato-disilver(I) moieties are linked by the bridging Schiff base ligand, giving zigzag polymeric chains with an $[-\text{Ag}\cdots\text{Ag}-\text{N}-\text{C}-\text{C}-\text{C}-\text{C}-\text{N}-]_n$ backbone running along the *b* axis.

Comment

Transition metal compounds containing Schiff base ligands have been of great interest for many years (Yamada, 1999; Chang *et al.*, 1998; Chaturvedl, 1977; Archer & Wang, 1990). These compounds play an important role in the development of coordination chemistry related to catalysis and enzymatic reactions, magnetism and molecular architectures (Costamagna *et al.*, 1992; Bhatia *et al.*, 1981). 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) and the construction of a wide variety of network topologies has been achieved through ligand design and the use of different counter-anions. Owing to the flexible coordination sphere of Ag^I, coordination numbers from two to six are all possible, and because of 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).

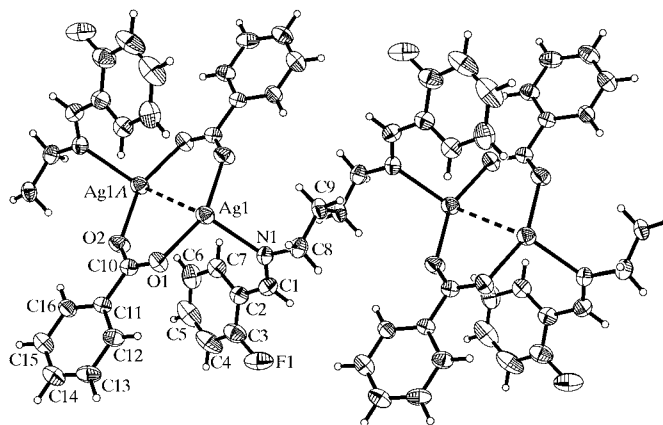
Our work is aimed at obtaining multidimensional metal complexes. On the basis of the above-mentioned considerations, we designed and synthesized the flexible biden-

tate ligand *N,N'*-bis(2-fluorobenzylidene)butane-1,4-diamine (BFBD), which offers advantages over rigid ligands in that it can adopt a different coordination mode according to the geometric needs of the coordination environment of the transition metal ion. Silver(I) is a good candidate for a trigonal coordination geometry. We report here an interesting one-dimensional infinite chain structure formed by the reaction of the BFBD ligand with silver(I) benzoate.



The title complex, (I), is a polymeric compound with one inversion centre between pairs of Ag atoms and another at the mid-point of the central C—C bond in the butane-1,4-diamine moiety (Fig. 1). The smallest repeat unit of the complex contains a BFBD-(Ag^I)₂ cation and two benzoate anions. Each Ag^I ion is three-coordinated in a trigonal configuration by two O atoms belonging to two benzoate anions and one N atom of a Schiff base ligand. Atom Ag1 lies 0.100 (6) Å out of the plane defined by the three donor atoms [O1/N1/O2[‡]; symmetry code: (i) 1 - *x*, 2 - *y*, 1 - *z*]. The benzoate anion bridges two silver(I) ions related by the inversion centre. The distance between the two silver ions [3.051 (2) Å] is shorter than the sum of the van der Waals radii of two Ag atoms (3.44 Å) and is comparable to the value of 3.035 (2) Å observed in a silver complex with weak Ag⋯Ag interactions (Zhu, Shao *et al.*, 2003), indicating the existence of similar interactions in (I).

The Ag1—N1 bond length [2.417 (7) Å; Table 1] is comparable to the value of 2.397 (3) Å observed in another Schiff base-silver(I) complex (Fei *et al.*, 2000), and the average Ag—O bond length in (I) [2.216 (6) Å] is essentially the same

**Figure 1**

The structure of (I), showing the atom-numbering scheme. Displacement ellipsoids are drawn at the 30% probability level. The atom labelled with the suffix *A* is at the symmetry position (1 - *x*, 2 - *y*, 1 - *z*).

as the value of 2.210 (4) Å observed in a silver(I)–carboxylate complex (Zhu, Zhang *et al.*, 2003). The O1–Ag1–O2ⁱ bond angle [153.9 (3)°] is larger than the other two bond angles about atom Ag1, *viz.* N1–Ag1–O2ⁱ [103.8 (2)°] and N1–Ag1–O1 [101.6 (2)°], apparently as a result of the Ag···Ag interactions. The Ag···Ag interactions also flatten the eight-membered Ag1/O1/C10/O2/Ag1ⁱ/O1ⁱ/C10ⁱ/O2ⁱ ring. The diagonal distance between atoms C10 and C10ⁱ [5.439 (9) Å] is much longer than the diagonal distance between Ag1 and Ag1ⁱ [3.051 (2) Å]. The mean deviation of the eight-membered ring from the combined mean plane is 0.109 (7) Å.

The bridging BFBD ligand adopts a *trans* configuration and coordinates to two Ag atoms belonging to two different repeat units. The C1=N1 bond length [1.287 (10) Å] conforms to the value for a double bond, while the C8–N1 bond length [1.472 (10) Å] conforms to the value for a single bond.

In the crystal structure, the linking of the dibenzoatodisilver(I) moieties by the bridging Schiff base ligand results in zigzag polymeric chains with an [–Ag···Ag–N–C–C–C–C–N–]_n backbone running along the *b* axis. The molecules stack along the *a* axis with no short intermolecular contacts (< 3.2 Å).

Experimental

For the preparation of the title compound, *N,N'*-bis(2-fluorobenzylidene)butane-1,4-diamine (0.1 mmol, 30.0 mg) and silver(I) benzoate (0.2 mmol, 45.8 mg) were dissolved in a 30% ammonia solution (10 ml) with stirring. The mixture was stirred at room temperature for 20 min and then filtered. The filtrate was allowed to stand in air for 17 d, during which time about three-quarters of the original solvent volume evaporated and colourless block-shaped crystals formed at the bottom of the vessel. The crystals were isolated, washed three times with water and dried in a vacuum desiccator using anhydrous CaCl₂ (pure product yield 68.7%). Analysis found: C 50.5, H 3.7, N 3.8%; calculated for C₁₆H₁₄AgFNO₂: C 50.7, H 3.7, N 3.7%.

Crystal data

[Ag ₂ (C ₇ H ₅ O ₂) ₂ (C ₁₈ H ₁₈ F ₂ N ₂) ₂]	Z = 1
<i>M_r</i> = 758.30	<i>D_x</i> = 1.724 Mg m ⁻³
Triclinic, <i>P</i> $\bar{1}$	Mo K α radiation
<i>a</i> = 5.703 (3) Å	Cell parameters from 1624 reflections
<i>b</i> = 10.313 (5) Å	θ = 2.6–23.4°
<i>c</i> = 12.805 (6) Å	μ = 1.39 mm ⁻¹
α = 86.978 (6)°	<i>T</i> = 293 (2) K
β = 84.452 (7)°	Block, colourless
γ = 77.115 (7)°	0.27 × 0.22 × 0.15 mm
<i>V</i> = 730.4 (6) Å ³	

Table 1

Selected geometric parameters (Å, °).

Ag1–O2 ⁱ	2.206 (6)	Ag1–Ag1 ⁱ	3.051 (2)
Ag1–O1	2.227 (5)	N1–C1	1.287 (10)
Ag1–N1	2.417 (7)	N1–C8	1.472 (10)
O2 ⁱ –Ag1–O1	153.9 (3)	O1–Ag1–N1	101.6 (2)
O2 ⁱ –Ag1–N1	103.8 (2)		

Symmetry code: (i) 1 – *x*, 2 – *y*, 1 – *z*.

Data collection

Bruker SMART CCD area-detector diffractometer	2524 independent reflections
ω scans	1952 reflections with <i>I</i> > 2 σ (<i>I</i>)
Absorption correction: multi-scan (<i>SADABS</i> ; Sheldrick, 1996)	<i>R</i> _{int} = 0.047
<i>T</i> _{min} = 0.705, <i>T</i> _{max} = 0.818	θ _{max} = 25.0°
3880 measured reflections	<i>h</i> = –6 → 4
	<i>k</i> = –10 → 12
	<i>l</i> = –14 → 15

Refinement

Refinement on <i>F</i> ²	H-atom parameters constrained
$R[F^2 > 2\sigma(F^2)] = 0.080$	$w = 1/[\sigma^2(F_o^2) + (0.1604P)^2]$
$wR(F^2) = 0.215$	where $P = (F_o^2 + 2F_c^2)/3$
<i>S</i> = 0.98	(Δ/σ) _{max} < 0.001
2524 reflections	$\Delta\rho_{max} = 1.86 \text{ e } \text{Å}^{-3}$
190 parameters	$\Delta\rho_{min} = -1.84 \text{ e } \text{Å}^{-3}$

All H atoms were placed in idealized positions and allowed to ride on their parent atoms, with C–H distances of 0.93–0.97 Å and with *U*_{iso}(H) = 1.2*U*_{eq}(C).

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

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Supplementary data for this paper are available from the IUCr electronic archives (Reference: SQ1176). Services for accessing these data are described at the back of the journal.

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