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# *catena*-Poly[[(*p*-toluenesulfonato-$\kappa O$)-silver(I)]-$\mu$-1,3-bis(pyridin-4-yl)propane-$\kappa^2N:N'$]

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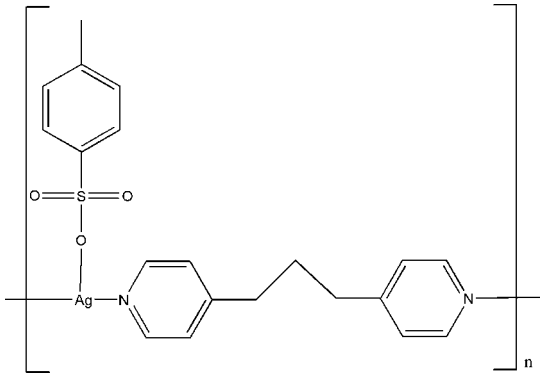
Key indicators: single-crystal X-ray study; $T$ = 293 K; mean $\sigma$(C–C) = 0.005 Å; $R$ factor = 0.030; $wR$ factor = 0.075; data-to-parameter ratio = 14.1.

In the title compound, $[Ag(C_7H_7O_3S)(C_{13}H_{14}N_2)]_n$, the $Ag^I$ ion is coordinated in a T-shape by two N atoms from two symmetry-related 1,3-bis(pyridin-4-yl)propane ligands and one O atom from a *p*-toluenesulfonate ligand, forming a one-dimensional zigzag chain along [001]. In the crystal, weak C—H···O hydrogen bonds and weak Ag···Ag interactions [3.2628 (5) Å] are observed.

## Related literature

For potential applications of compounds with metal-organic framework structures, see: Horike *et al.* (2008); Liu *et al.* (2010); Lu *et al.* (2006); Li *et al.* (1999). For coordination polymers of 1,3-bis(pyridin-4-yl)propane (bpp), see: Carlucci *et al.* (2002). For mixed ligands of aromatic or aliphatic carboxylates and bpp, see: Yang *et al.* (2009); Jin *et al.* (2009); Zhang *et al.* (2009); Luo *et al.* (2011). For silver(I) sulfonate complexes, see: Wu *et al.* (2011); Smith *et al.* (1998) For similar systems with Ag···Ag interactions, see: Li *et al.* (2005). For a similar synthetic procedure, see: Li *et al.* (2006).




## Experimental

### Crystal data

$[Ag(C_7H_7O_3S)(C_{13}H_{14}N_2)]$
$M_r$ = 477.33
Monoclinic, $P2_1/n$
$a$ = 10.8061 (3) Å
$b$ = 9.9466 (3) Å
$c$ = 18.4288 (5) Å
$\beta$ = 98.230 (3)°
$V$ = 1960.40 (10) Å$^3$
$Z$ = 4
Mo $K\alpha$ radiation
$\mu$ = 1.16 mm$^{-1}$
$T$ = 293 K
0.52 × 0.47 × 0.36 mm

### Data collection

Agilent Xcalibur Eos Gemini diffractometer
Absorption correction: multi-scan (*CrysAlis PRO*; Agilent, 2010)
$T_{min}$ = 0.553, $T_{max}$ = 0.659
11169 measured reflections
3450 independent reflections
2834 reflections with $I > 2\sigma(I)$
$R_{int}$ = 0.030

### Refinement

$R[F^2 > 2\sigma(F^2)]$ = 0.030
$wR(F^2)$ = 0.075
$S$ = 0.94
3450 reflections
245 parameters
H-atom parameters constrained
$\Delta\rho_{max}$ = 0.63 e Å$^{-3}$
$\Delta\rho_{min}$ = −0.55 e Å$^{-3}$

**Table 1**
Selected bond lengths (Å).

| | | | |
|---|---|---|---|
| N1—Ag1$^{i}$ | 2.155 (2) | O3—Ag1 | 2.645 (2) |
| N2—Ag1 | 2.162 (2) | | |

Symmetry code: (i) $x+\frac{1}{2}, -y+\frac{3}{2}, z-\frac{1}{2}$.

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

| $D$—H···$A$ | $D$—H | H···$A$ | $D$···$A$ | $D$—H···$A$ |
|---|---|---|---|---|
| C14—H14$B$···O2$^{ii}$ | 0.97 | 2.56 | 3.533 (4) | 178 |
| C12—H12···O1$^{i}$ | 0.93 | 2.58 | 3.332 (4) | 138 |
| C8—H8···O3$^{iii}$ | 0.93 | 2.46 | 3.305 (4) | 151 |

Symmetry codes: (i) $x+\frac{1}{2}, -y+\frac{3}{2}, z-\frac{1}{2}$; (ii) $-x+\frac{3}{2}, y+\frac{1}{2}, -z+\frac{1}{2}$; (iii) $-x+\frac{5}{2}, y+\frac{1}{2}, -z+\frac{1}{2}$.

Data collection: *CrysAlis PRO* (Agilent, 2010); cell refinement: *CrysAlis PRO*; data reduction: *CrysAlis PRO*; program(s) used to solve structure: *SHELXS97* (Sheldrick, 2008); program(s) used to refine structure: *SHELXL97* (Sheldrick, 2008); molecular graphics: *SHELXTL* (Sheldrick, 2008) and *DIAMOND* (Brandenburg & Putz, 2004); software used to prepare material for publication: *SHELXL97*.

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Supplementary data and figures for this paper are available from the IUCr electronic archives (Reference: LH5431).

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# supplementary materials

*Acta Cryst.* (2012). E**68**, m611–m612 [doi:10.1107/S1600536812015218]

## *catena*-Poly[[(*p*-toluenesulfonato-$\kappa O$)silver(I)]-$\mu$-1,3-bis(pyridin-4-yl)propane-$\kappa^2N:N'$]

**Feng Ma, Dai-Bao Wei and Zhi-Min Cao**

### Comment

The design and synthesis of metal-organic frameworks (MOFs) have attracted considerable attention in recent years,not only for their intriguing structural diversity, but also because of their potential applications in the area of catalysis (Horike *et al.*, 2008), ion exchange (Liu *et al.*, 2010), magnetism, photochemistry (Lu *et al.*, 2006), and porous materials (Li *et al.*, 1999).

The reactions of silver salts with 1,3-bis(pyridin-4-yl)propane (bpp) have already afforded intresting coordination polymers with distinct structural motifs (Carlucci *et al.*, 2002). Moreover, the combination of Ag cations with mixed ligands of aromatic (Yang *et al.*, 2009; Jin *et al.*, 2009; Zhang *et al.*, 2009) or aliphatic (Luo *et al.*, 2011) carboxylates and bpp can allow the formation of MOFs possessing fascinating architectures and novel topologies. In terms of silver(I) sulfonate complexes, many nitrogen-based secondary ligands such as pyrazine (Pyr) (Li *et al.*, 2005), hexamethylenetetramine (hmt) (Wu *et al.*, 2011), pyridine (py) (Smith *et al.*, 1998) and their analogues or derivatives were exploited as secondary ligands to synthesize new metal organic frameworks. Here we report a novel one-dimensional polymer $[Ag(C_7H_7O_3S)(C_{13}H_{14}N_2)]_n$ assembled by mixed ligands of p-toluenesulfonate and bpp with silver nitrate.

The asymmetric unit of the title compound (I) and symmetry related atoms are shown in Fig. 1. The $Ag^I$ cation is coordinated by two N atoms from two symmetry related bpp ligands one O atom from one p-toluenesulfonate ligand. The Ag—O and Ag—N bonds are comparable to those in the literature (Li *et al.*, 2005). As shown in Fig. 2, there are weak Ag···Ag interactions (3.2628 (5)Å) which are shorter than the sum van der Waals radii for Ag···Ag [3.40Å]. Compound (I) is a one-dimensional coordination polymer formed by bpp ligands and Ag cations, with tos ligands as the side chains in which bpp ligands exhibit the TG (Carlucci *et al.*, 2002) conformation and the N···N separation is 8.6746 (2)Å. The weak Ag ···Ag interactions bridge the undulating 1-D chains to form 2-D layers (Fig .2), which are further linked into a three-dimensional network via weak C—H···O hydrogen bonds.

### Experimental

A solution of bpp and tos in 8 ml methanol and 2 ml water was slowly added to a solution of $AgNO_3$(0.1668 g) in 8 ml water. A white suspension formed immediately. An aqueous $NH_3$ solution (25%) was dropped into the mixture to give a clear solution. The resultant colorless filtrate (pH=9.0) was allowed to evaporate slowly at room temperature. After one week, colorless block crystals were obtained in 52.87% yield (based on Ag). Elemental analysis for (I) (%): calculated: C 50.3, H 4.4, N 5.9, O 10.1, S 6.7. Found C49.94, H 4.452, N 5.969, O 10.123, S 7.013.

### Refinement

All H atoms were positioned geometrically and refined using a riding model with C—H = 0.93–0.98 Å and with $U_{iso}$(H) = 1.2(1.5 for methyl groups) times $U_{eq}$(C).

### Computing details

Data collection: *CrysAlis PRO* (Agilent, 2010); cell refinement: *CrysAlis PRO* (Agilent, 2010); data reduction: *CrysAlis PRO* (Agilent, 2010); program(s) used to solve structure: *SHELXS97* (Sheldrick, 2008); program(s) used to refine structure: *SHELXL97* (Sheldrick, 2008); molecular graphics: *SHELXTL* (Sheldrick, 2008) and *DIAMOND* (Brandenburg & Putz, 2004); software used to prepare material for publication: *SHELXL97* (Sheldrick, 2008).

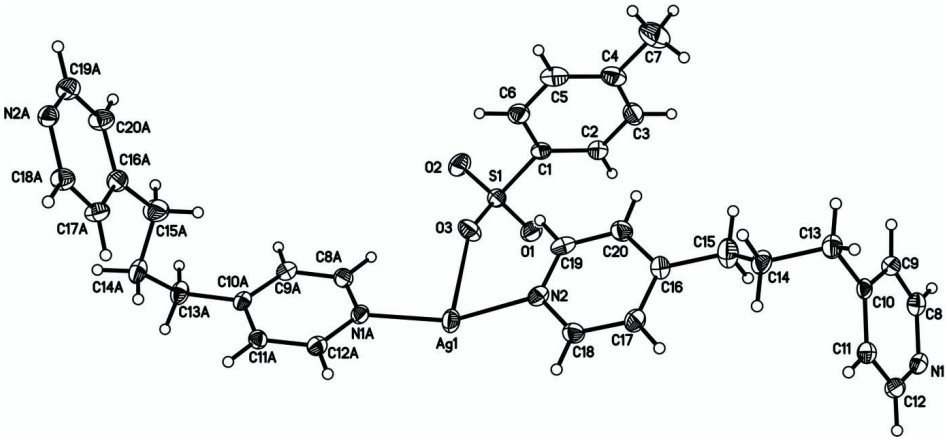


**Figure 1**

The molecular structure of (I), with 50% probability displacement ellipsoids for non-H atoms. Atoms labeled with capital "A" were generated through the symmetry operation ($x$ - 1/2, -$y$ + 3/2, $z$ + 1/2).

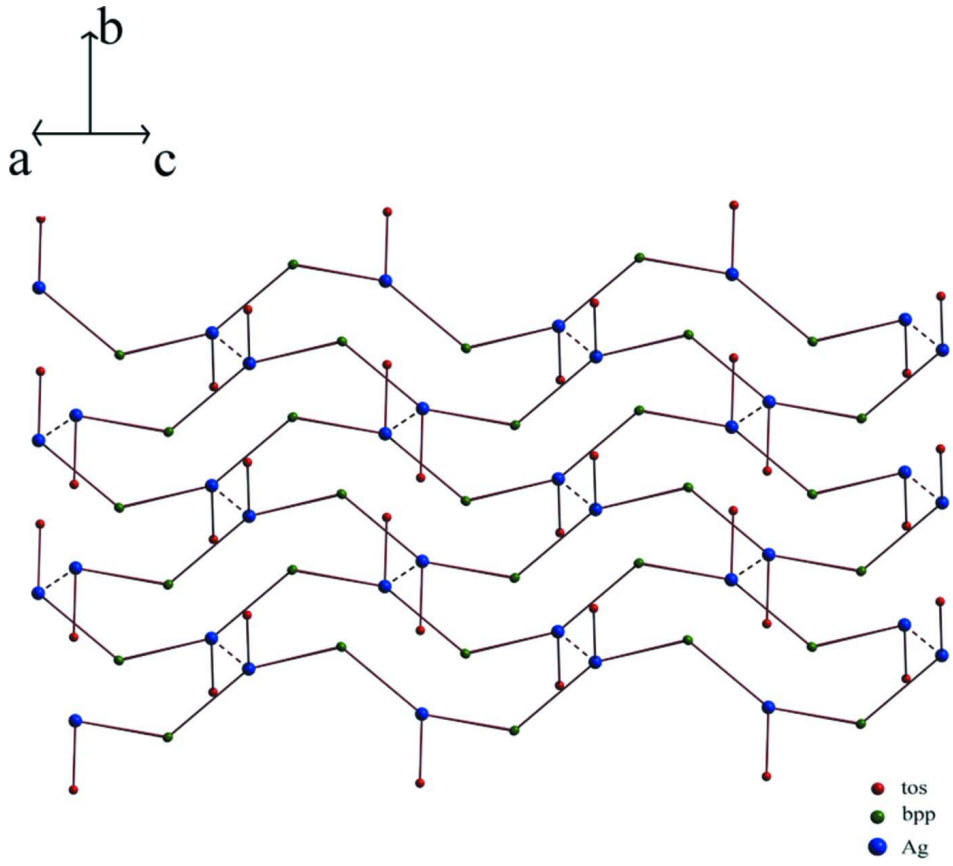


**Figure 2**

Part of the crystal structure. Tos and bpp ligands have been simplified by replacing molecules with their centroids (dummy atoms). Dashed lines indicate weak Ag···Ag interactions.

**catena-Poly[[(*p*-toluenesulfonato-κ*O*)silver(I)]- μ-1,3-bis(pyridin-4-yl)propane-κ²*N*:*N*′]**

*Crystal data*

$[Ag(C_7H_7O_3S)(C_{13}H_{14}N_2)]$
$M_r$ = 477.33
Monoclinic, $P2_1/n$
Hall symbol: -P 2yn
$a$ = 10.8061 (3) Å
$b$ = 9.9466 (3) Å
$c$ = 18.4288 (5) Å
$\beta$ = 98.230 (3)°
$V$ = 1960.40 (10) Å$^3$
$Z$ = 4
$F(000)$ = 968
$D_x$ = 1.617 Mg m$^{-3}$
Mo $K\alpha$ radiation, $\lambda$ = 0.7107 Å
Cell parameters from 4048 reflections
$\theta$ = 2.8–28.9°
$\mu$ = 1.16 mm$^{-1}$
$T$ = 293 K
Block, colorless
0.52 × 0.47 × 0.36 mm

*Data collection*

Agilent Xcalibur Eos Gemini diffractometer
Radiation source: Enhance (Mo) X-ray Source′
Graphite monochromator
$\varphi$ and $\omega$ scans
Absorption correction: multi-scan (*CrysAlis PRO*; Agilent, 2010)
$T_{min}$ = 0.553, $T_{max}$ = 0.659
11169 measured reflections
3450 independent reflections
2834 reflections with $I > 2\sigma(I)$

$R_{int}$ = 0.030
$\theta_{max}$ = 25.0°, $\theta_{min}$ = 2.8°
$h$ = −12→12
$k$ = −11→11
$l$ = −21→21

*Refinement*

Refinement on $F^2$
Least-squares matrix: full
$R[F^2 > 2\sigma(F^2)]$ = 0.030
$wR(F^2)$ = 0.075
$S$ = 0.94
3450 reflections
245 parameters
0 restraints
Primary atom site location: structure-invariant direct methods
Secondary atom site location: difference Fourier map
Hydrogen site location: inferred from neighbouring sites
H-atom parameters constrained
$w = 1/[\sigma^2(F_o^2) + (0.032P)^2 + 1.9473P]$ where $P = (F_o^2 + 2F_c^2)/3$
$(\Delta/\sigma)_{max}$ = 0.001
$\Delta\rho_{max}$ = 0.63 e Å$^{-3}$
$\Delta\rho_{min}$ = −0.55 e Å$^{-3}$
Extinction correction: *SHELXL*
Extinction coefficient: 0.0029 (3)

*Special details*

**Geometry**. All e.s.d.'s (except the e.s.d. in the dihedral angle between two l.s. planes) are estimated using the full covariance matrix. The cell e.s.d.'s are taken into account individually in the estimation of e.s.d.'s in distances, angles and torsion angles; correlations between e.s.d.'s in cell parameters are only used when they are defined by crystal symmetry. An approximate (isotropic) treatment of cell e.s.d.'s is used for estimating e.s.d.'s involving l.s. planes.

**Refinement**. Refinement of $F^2$ against ALL reflections. The weighted *R*-factor *wR* and goodness of fit *S* are based on $F^2$, conventional *R*-factors *R* are based on *F*, with *F* set to zero for negative $F^2$. The threshold expression of $F^2 > \sigma(F^2)$ is used only for calculating *R*-factors(gt) *etc*. and is not relevant to the choice of reflections for refinement. *R*-factors based on $F^2$ are statistically about twice as large as those based on *F*, and *R*- factors based on ALL data will be even larger.

*Fractional atomic coordinates and isotropic or equivalent isotropic displacement parameters (Å$^2$)*

| | *x* | *y* | *z* | $U_{iso}$*/$U_{eq}$ |
|---|---|---|---|---|
| C1 | 0.6485 (3) | 0.3186 (3) | 0.37306 (16) | 0.0409 (7) |
| C2 | 0.5674 (3) | 0.2730 (3) | 0.41963 (17) | 0.0461 (8) |
| H2 | 0.5350 | 0.3328 | 0.4508 | 0.055* |
| C3 | 0.5348 (3) | 0.1389 (4) | 0.4196 (2) | 0.0555 (9) |
| H3 | 0.4799 | 0.1099 | 0.4509 | 0.067* |
| C4 | 0.5814 (3) | 0.0464 (4) | 0.3743 (2) | 0.0560 (9) |
| C5 | 0.6608 (3) | 0.0938 (4) | 0.3271 (2) | 0.0594 (10) |
| H5 | 0.6920 | 0.0341 | 0.2953 | 0.071* |
| C6 | 0.6943 (3) | 0.2273 (4) | 0.32633 (18) | 0.0503 (8) |
| H6 | 0.7479 | 0.2566 | 0.2944 | 0.060* |
| C7 | 0.5484 (4) | −0.1011 (4) | 0.3759 (3) | 0.0888 (14) |
| H7A | 0.5897 | −0.1488 | 0.3410 | 0.133* |
| H7B | 0.4596 | −0.1117 | 0.3637 | 0.133* |
| H7C | 0.5750 | −0.1364 | 0.4241 | 0.133* |
| C8 | 1.4014 (3) | 1.0844 (3) | 0.16123 (17) | 0.0428 (8) |
| H8 | 1.4868 | 1.0709 | 0.1622 | 0.051* |
| C9 | 1.3610 (3) | 1.1564 (3) | 0.21756 (16) | 0.0397 (7) |
| H9 | 1.4190 | 1.1919 | 0.2548 | 0.048* |
| C10 | 1.2347 (3) | 1.1757 (3) | 0.21868 (15) | 0.0341 (7) |
| C11 | 1.1536 (3) | 1.1223 (3) | 0.16073 (16) | 0.0367 (7) |
| H11 | 1.0678 | 1.1325 | 0.1593 | 0.044* |

| | | | | |
|---|---|---|---|---|
| C12 | 1.1999 (3) | 1.0545 (3) | 0.10545 (17) | 0.0399 (7) |
| H12 | 1.1438 | 1.0216 | 0.0665 | 0.048* |
| C13 | 1.1866 (3) | 1.2496 (3) | 0.28054 (17) | 0.0463 (8) |
| H13A | 1.1419 | 1.3292 | 0.2610 | 0.056* |
| H13B | 1.2573 | 1.2789 | 0.3155 | 0.056* |
| C14 | 1.0998 (3) | 1.1642 (3) | 0.32062 (17) | 0.0482 (8) |
| H14A | 1.0670 | 1.2188 | 0.3571 | 0.058* |
| H14B | 1.0297 | 1.1331 | 0.2858 | 0.058* |
| C15 | 1.1673 (3) | 1.0460 (4) | 0.3572 (2) | 0.0637 (10) |
| H15A | 1.2369 | 1.0792 | 0.3916 | 0.076* |
| H15B | 1.2021 | 0.9947 | 0.3201 | 0.076* |
| C16 | 1.0919 (3) | 0.9508 (3) | 0.39783 (17) | 0.0437 (7) |
| C17 | 0.9734 (3) | 0.9066 (3) | 0.36888 (18) | 0.0476 (8) |
| H17 | 0.9342 | 0.9404 | 0.3244 | 0.057* |
| H18 | 0.8344 | 0.7824 | 0.3862 | 0.057* |
| H19 | 1.1140 | 0.7734 | 0.5447 | 0.057* |
| C18 | 0.9136 (3) | 0.8116 (3) | 0.40651 (17) | 0.0444 (8) |
| C19 | 1.0775 (3) | 0.8061 (3) | 0.49934 (17) | 0.0488 (8) |
| C20 | 1.1415 (3) | 0.8990 (3) | 0.46477 (18) | 0.0496 (8) |
| H20 | 1.2198 | 0.9276 | 0.4869 | 0.060* |
| N1 | 1.3229 (2) | 1.0335 (2) | 0.10532 (13) | 0.0381 (6) |
| N2 | 0.9650 (2) | 0.7598 (2) | 0.47099 (13) | 0.0405 (6) |
| O1 | 0.6460 (2) | 0.5548 (2) | 0.43292 (12) | 0.0563 (6) |
| O2 | 0.6561 (2) | 0.5423 (3) | 0.30278 (13) | 0.0676 (7) |
| O3 | 0.8348 (2) | 0.4792 (2) | 0.39088 (14) | 0.0605 (6) |
| S1 | 0.69972 (7) | 0.48821 (8) | 0.37467 (4) | 0.0449 (2) |
| Ag1 | 0.88538 (2) | 0.59100 (3) | 0.521998 (14) | 0.05157 (12) |

*Atomic displacement parameters (Å²)*

| | $U^{11}$ | $U^{22}$ | $U^{33}$ | $U^{12}$ | $U^{13}$ | $U^{23}$ |
|---|---|---|---|---|---|---|
| C1 | 0.0369 (16) | 0.0487 (19) | 0.0340 (16) | −0.0031 (14) | −0.0054 (13) | 0.0006 (15) |
| C2 | 0.0455 (18) | 0.0487 (19) | 0.0433 (19) | −0.0037 (15) | 0.0037 (15) | −0.0019 (16) |
| C3 | 0.050 (2) | 0.059 (2) | 0.057 (2) | −0.0110 (17) | 0.0033 (17) | 0.0091 (19) |
| C4 | 0.050 (2) | 0.053 (2) | 0.060 (2) | −0.0068 (17) | −0.0107 (18) | −0.0034 (19) |
| C5 | 0.054 (2) | 0.062 (2) | 0.058 (2) | 0.0060 (18) | −0.0060 (18) | −0.0189 (19) |
| C6 | 0.0407 (18) | 0.063 (2) | 0.0458 (19) | −0.0025 (16) | 0.0026 (15) | −0.0042 (17) |
| C7 | 0.097 (3) | 0.056 (3) | 0.110 (4) | −0.018 (2) | 0.003 (3) | −0.011 (2) |
| C8 | 0.0400 (17) | 0.0460 (18) | 0.0442 (19) | 0.0039 (14) | 0.0117 (15) | 0.0086 (15) |
| C9 | 0.0445 (18) | 0.0393 (17) | 0.0344 (16) | −0.0052 (14) | 0.0030 (14) | 0.0018 (14) |
| C10 | 0.0501 (18) | 0.0226 (14) | 0.0316 (15) | −0.0035 (13) | 0.0127 (13) | 0.0041 (12) |
| C11 | 0.0380 (16) | 0.0343 (16) | 0.0388 (17) | 0.0026 (13) | 0.0089 (14) | 0.0025 (13) |
| C12 | 0.0430 (18) | 0.0404 (17) | 0.0356 (17) | −0.0005 (14) | 0.0039 (13) | −0.0004 (14) |
| C13 | 0.065 (2) | 0.0344 (17) | 0.0440 (18) | −0.0016 (15) | 0.0219 (16) | −0.0040 (15) |
| C14 | 0.065 (2) | 0.0439 (19) | 0.0401 (18) | −0.0010 (16) | 0.0228 (16) | −0.0050 (15) |
| C15 | 0.053 (2) | 0.074 (3) | 0.066 (2) | −0.0001 (19) | 0.0129 (18) | 0.026 (2) |
| C16 | 0.0435 (18) | 0.0434 (18) | 0.0454 (19) | −0.0012 (15) | 0.0108 (15) | 0.0054 (15) |
| C17 | 0.052 (2) | 0.050 (2) | 0.0389 (18) | 0.0011 (16) | 0.0008 (15) | 0.0124 (15) |
| C18 | 0.0397 (17) | 0.0474 (19) | 0.0441 (19) | −0.0037 (15) | −0.0006 (14) | 0.0012 (16) |
| C19 | 0.057 (2) | 0.053 (2) | 0.0336 (17) | −0.0044 (17) | −0.0048 (15) | 0.0093 (16) |

| | | | | | | |
|---|---|---|---|---|---|---|
| C20 | 0.0428 (18) | 0.056 (2) | 0.047 (2) | −0.0088 (16) | −0.0048 (15) | 0.0068 (16) |
| N1 | 0.0487 (15) | 0.0344 (13) | 0.0325 (14) | 0.0042 (12) | 0.0108 (12) | 0.0028 (11) |
| N2 | 0.0493 (15) | 0.0390 (14) | 0.0334 (14) | −0.0046 (12) | 0.0064 (12) | 0.0024 (12) |
| O1 | 0.0720 (16) | 0.0508 (14) | 0.0460 (14) | −0.0014 (12) | 0.0079 (12) | −0.0029 (11) |
| O2 | 0.0875 (18) | 0.0722 (17) | 0.0398 (14) | −0.0038 (14) | −0.0025 (12) | 0.0167 (13) |
| O3 | 0.0428 (13) | 0.0628 (15) | 0.0735 (17) | −0.0153 (11) | 0.0002 (12) | 0.0014 (14) |
| S1 | 0.0475 (5) | 0.0484 (5) | 0.0371 (4) | −0.0078 (4) | 0.0002 (3) | 0.0058 (4) |
| Ag1 | 0.0679 (2) | 0.04608 (18) | 0.04440 (18) | −0.00999 (12) | 0.02079 (13) | 0.00570 (12) |

*Geometric parameters (Å, º)*

| | | | |
|---|---|---|---|
| C1—C2 | 1.388 (4) | C13—H13A | 0.9700 |
| C1—C6 | 1.390 (4) | C13—H13B | 0.9700 |
| C1—S1 | 1.775 (3) | C14—C15 | 1.493 (5) |
| C2—C3 | 1.379 (5) | C14—H14A | 0.9700 |
| C2—H2 | 0.9300 | C14—H14B | 0.9700 |
| C3—C4 | 1.385 (5) | C15—C16 | 1.515 (4) |
| C3—H3 | 0.9300 | C15—H15A | 0.9700 |
| C4—C5 | 1.389 (5) | C15—H15B | 0.9700 |
| C4—C7 | 1.511 (5) | C16—C20 | 1.373 (4) |
| C5—C6 | 1.377 (5) | C16—C17 | 1.387 (4) |
| C5—H5 | 0.9300 | C17—C18 | 1.385 (4) |
| C6—H6 | 0.9300 | C17—H17 | 0.9300 |
| C7—H7A | 0.9600 | C18—N2 | 1.341 (4) |
| C7—H7B | 0.9600 | C18—H18 | 0.9295 |
| C7—H7C | 0.9600 | C19—N2 | 1.334 (4) |
| C8—N1 | 1.338 (4) | C19—C20 | 1.365 (4) |
| C8—C9 | 1.382 (4) | C19—H19 | 0.9301 |
| C8—H8 | 0.9300 | C20—H20 | 0.9300 |
| C9—C10 | 1.381 (4) | N1—Ag1$^{i}$ | 2.155 (2) |
| C9—H9 | 0.9300 | N2—Ag1 | 2.162 (2) |
| C10—C11 | 1.386 (4) | O1—S1 | 1.451 (2) |
| C10—C13 | 1.510 (4) | O2—S1 | 1.445 (2) |
| C11—C12 | 1.374 (4) | O3—S1 | 1.451 (2) |
| C11—H11 | 0.9300 | O3—Ag1 | 2.645 (2) |
| C12—N1 | 1.346 (4) | Ag1—N1$^{ii}$ | 2.155 (2) |
| C12—H12 | 0.9300 | Ag1—Ag1$^{iii}$ | 3.2628 (5) |
| C13—C14 | 1.532 (4) | | |

| | | | |
|---|---|---|---|
| C2—C1—C6 | 118.8 (3) | C15—C14—C13 | 111.2 (3) |
| C2—C1—S1 | 121.6 (2) | C15—C14—H14A | 109.4 |
| C6—C1—S1 | 119.5 (2) | C13—C14—H14A | 109.4 |
| C3—C2—C1 | 120.0 (3) | C15—C14—H14B | 109.4 |
| C3—C2—H2 | 120.0 | C13—C14—H14B | 109.4 |
| C1—C2—H2 | 120.0 | H14A—C14—H14B | 108.0 |
| C2—C3—C4 | 121.9 (3) | C14—C15—C16 | 116.9 (3) |
| C2—C3—H3 | 119.1 | C14—C15—H15A | 108.1 |
| C4—C3—H3 | 119.1 | C16—C15—H15A | 108.1 |
| C3—C4—C5 | 117.5 (3) | C14—C15—H15B | 108.1 |
| C3—C4—C7 | 121.8 (4) | C16—C15—H15B | 108.1 |

| | | | |
|---|---|---|---|
| C5—C4—C7 | 120.7 (4) | H15A—C15—H15B | 107.3 |
| C6—C5—C4 | 121.4 (3) | C20—C16—C17 | 116.5 (3) |
| C6—C5—H5 | 119.3 | C20—C16—C15 | 120.7 (3) |
| C4—C5—H5 | 119.3 | C17—C16—C15 | 122.7 (3) |
| C5—C6—C1 | 120.4 (3) | C18—C17—C16 | 119.7 (3) |
| C5—C6—H6 | 119.8 | C18—C17—H17 | 120.2 |
| C1—C6—H6 | 119.8 | C16—C17—H17 | 120.2 |
| C4—C7—H7A | 109.5 | N2—C18—C17 | 122.8 (3) |
| C4—C7—H7B | 109.5 | N2—C18—H18 | 118.5 |
| H7A—C7—H7B | 109.5 | C17—C18—H18 | 118.7 |
| C4—C7—H7C | 109.5 | N2—C19—C20 | 123.0 (3) |
| H7A—C7—H7C | 109.5 | N2—C19—H19 | 118.5 |
| H7B—C7—H7C | 109.5 | C20—C19—H19 | 118.5 |
| N1—C8—C9 | 122.7 (3) | C19—C20—C16 | 121.0 (3) |
| N1—C8—H8 | 118.6 | C19—C20—H20 | 119.5 |
| C9—C8—H8 | 118.6 | C16—C20—H20 | 119.5 |
| C10—C9—C8 | 120.1 (3) | C8—N1—C12 | 117.3 (3) |
| C10—C9—H9 | 119.9 | C8—N1—Ag1$^{i}$ | 122.5 (2) |
| C8—C9—H9 | 119.9 | C12—N1—Ag1$^{i}$ | 120.1 (2) |
| C9—C10—C11 | 116.9 (3) | C19—N2—C18 | 117.0 (3) |
| C9—C10—C13 | 121.8 (3) | C19—N2—Ag1 | 119.6 (2) |
| C11—C10—C13 | 121.3 (3) | C18—N2—Ag1 | 122.9 (2) |
| C12—C11—C10 | 120.1 (3) | O2—S1—O3 | 113.49 (15) |
| C12—C11—H11 | 119.9 | O2—S1—O1 | 113.29 (15) |
| C10—C11—H11 | 119.9 | O3—S1—O1 | 111.93 (15) |
| N1—C12—C11 | 122.8 (3) | O2—S1—C1 | 106.18 (14) |
| N1—C12—H12 | 118.6 | O3—S1—C1 | 104.30 (14) |
| C11—C12—H12 | 118.6 | O1—S1—C1 | 106.81 (14) |
| C10—C13—C14 | 113.2 (2) | N1$^{ii}$—Ag1—N2 | 160.18 (9) |
| C10—C13—H13A | 108.9 | N1$^{ii}$—Ag1—Ag1$^{iii}$ | 100.65 (7) |
| C14—C13—H13A | 108.9 | N2—Ag1—Ag1$^{iii}$ | 87.67 (6) |
| C10—C13—H13B | 108.9 | N1$^{ii}$—Ag1—O3 | 111.38 (8) |
| C14—C13—H13B | 108.9 | N2—Ag1—O3 | 88.42 (8) |
| H13A—C13—H13B | 107.7 | | |

Symmetry codes: (i) $x+1/2, -y+3/2, z-1/2$; (ii) $x-1/2, -y+3/2, z+1/2$; (iii) $-x+2, -y+1, -z+1$.

*Hydrogen-bond geometry (Å, º)*

| *D*—H···*A* | *D*—H | H···*A* | *D*···*A* | *D*—H···*A* |
|---|---|---|---|---|
| C14—H14*B*···O2$^{iv}$ | 0.97 | 2.56 | 3.533 (4) | 178 |
| C12—H12···O1$^{i}$ | 0.93 | 2.58 | 3.332 (4) | 138 |
| C8—H8···O3$^{v}$ | 0.93 | 2.46 | 3.305 (4) | 151 |

Symmetry codes: (i) $x+1/2, -y+3/2, z-1/2$; (iv) $-x+3/2, y+1/2, -z+1/2$; (v) $-x+5/2, y+1/2, -z+1/2$.