Bis[μ-bis(diphenylphosphino)amine-κP:P']-bis[acetonitrilesilver(I)] tris(cis-1,2-dicyano-ethylene-1,2-dithiolate)molybdate(IV)

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The reaction between the metal diphosphine $[Ag_2(dppa)_2](BF_4)_2$ [dppa is bis(diphenylphosphino)amine, $C_{24}H_{21}N_2P_2$] and the metal thiolate $[Bu_4N]_2[Mo(mnt)_3]$ (mnt is cis-1,2-dicyanoethylene-1,2-dithiolate, $C_4N_2S_2$) gave the title compound, $[Ag_2(dppa)_2(MeCN)_2][Mo(mnt)_3]$. The Ag···Ag distance of 2.9501 (13) Å is shorter than the sum of van der Waals radii for two Ag atoms, indicating a weak metal–metal contact in the complex. The cation lies on an inversion centre and the anion lies on a twofold axis.

## Comment

Interest in the metal complexes of diphosphine compounds has grown rapidly in recent years (Yam *et al.*, 1998). We are interested in the design of photoluminescent heterometallic cluster complexes by self-assembly between two metal components, one with potential bridging donors and the other with substitutable or vacant coordination sites (Xu *et al.*, 2002). Thus, the reaction between $[Bu_4N]_2[Mo(mnt)_3]$ (mnt is cis-1,2-dicyanoethylene-1,2-dithiolate), with potential bridging sulfur donors, and $[Ag_2(dppa)_2]^{2+}$ [dppa is bis(diphenylphosphino)amine], with vacant coordination sites, was expected to afford an Ag–Mo heteronuclear species. However, the only isolated product of the reaction between $[Bu_4N]_2[Mo(mnt)_3]$ and $[Ag_2(dppa)_2](BF_4)_2$ was the title compound $[Ag_2(dppa)_2(MeCN)_2][Mo(mnt)_3]$, (I), in which

(I)
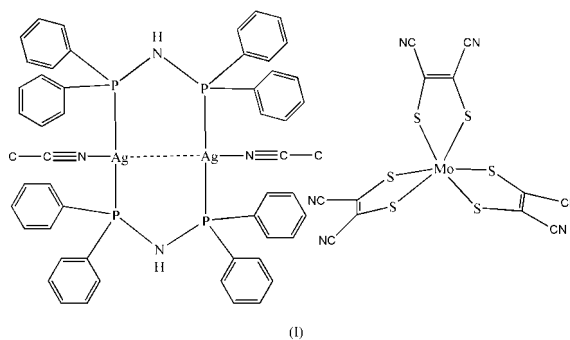
$[Mo(mnt)_3]^{2-}$ acts only as an anion. A perspective drawing of the complex with the atomic numbering scheme is depicted in Fig. 1 and selected bonding parameters are presented in Table 1. The Ag[I] atoms are located in a distorted triangular-planar environment of a P_2N chromophore and the Ag···Ag distance [2.9501 (13) Å] is shorter than the sum of the van der Waals radii of two Ag atoms, indicating a weak metal–metal contact; the two Ag atoms are bridged by P—N—P groups of two dppa molecules. The Mo atom is located in an octahedral environment of six S atoms, and the Mo—S distances [2.382 (2)–2.385 (2) Å] are similar to those observed in $[Ph_4As]_2[Mo(mnt)_3]$ (Brown & Stiefel, 1973).
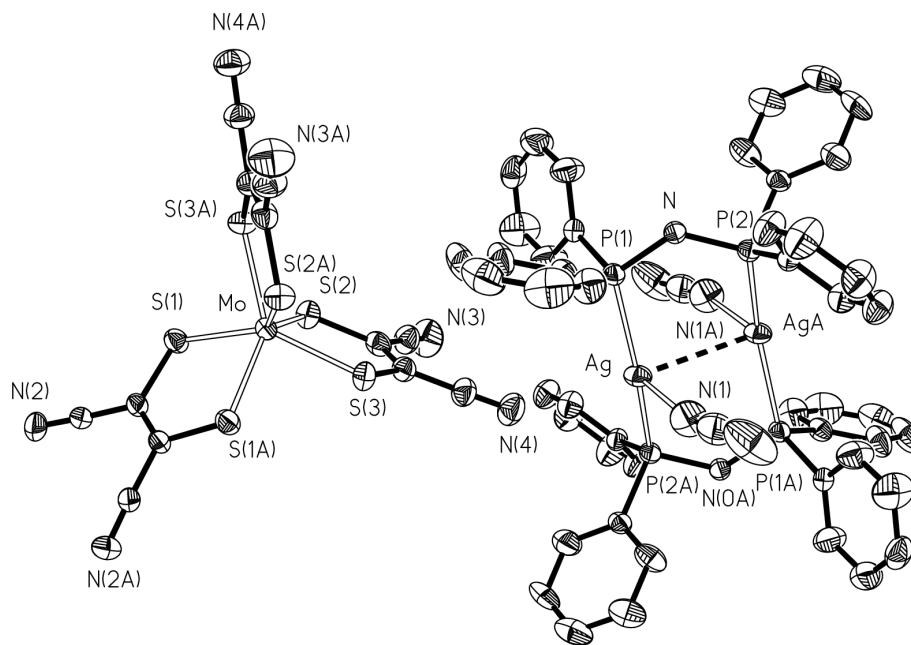
Figure 1
A view of the title complex with the atomic numbering scheme; symmetry-related atoms have a suffix *A*. Displacement ellipsoids are drawn at the 30% probability level. H atoms have been omitted for clarity.

Experimental

The starting materials [Bu$_4$N]$_2$[Mo(mnt)$_3$] (Stiefel *et al.*, 1970) and [Ag$_2$(dppa)$_2$](BF$_4$)$_2$ (Sekabange *et al.*, 2002) were prepared according to the reported procedures. The reaction between equimolar qualitities of [Ag$_2$(dppa)$_2$](BF$_4$)$_2$ and [Bu$_4$N]$_2$[Mo(mnt)$_3$] was carried out in dichloromethane under anaerobic conditions for 1 d, after which the solvent was removed *in vacuo* and the residue was extracted with acetonitrile. Well-shaped dark-green crystals suitable for X-ray diffraction analysis were grown by slow diffusion of diethyl ether into the acetonitrile solution.

Crystal data

[Ag$_2$(C$_{24}$H$_{21}$N$_2$P$_2$)$_2$(C$_2$H$_3$N)$_2$]-[Mo(C$_4$N$_2$S$_2$)$_3$]	D_x = 1.517 Mg m^{-3}
M_r = 1585.1	Mo $K\alpha$ radiation
Orthorhombic, *Pbcn*	Cell parameters from 5955
a = 17.181 (3) Å	reflections
b = 15.313 (3) Å	θ = 1.5–25.1°
c = 26.386 (5) Å	μ = 1.06 mm^{-1}
V = 6942 (2) Å^3	T = 293 (2) K
Z = 4	Prism, dark green
	0.36 × 0.34 × 0.28 mm

Data collection

Siemens SMART CCD diffractometer	6143 independent reflections
ω scans	3749 reflections with $I > 2\sigma(I)$
Absorption correction: multi-scan (*SADABS*; Sheldrick, 1996)	R_{int} = 0.080
T_{min} = 0.729, T_{max} = 1.000	θ_{max} = 25.1°
19 737 measured reflections	$h = -13 \rightarrow 20$
	$k = -18 \rightarrow 17$
	$l = -31 \rightarrow 21$

Refinement

Refinement on F^2	$w = 1/[\sigma^2(F_o^2) + (0.0205P)^2 + 30.6018P]$
$R[F^2 > 2\sigma(F^2)]$ = 0.063	where $P = (F_o^2 + 2F_c^2)/3$
$wR(F^2)$ = 0.135	$(\Delta/\sigma)_{max}$ = 0.001
S = 1.17	$\Delta\rho_{max}$ = 0.40 e Å^{-3}
6143 reflections	$\Delta\rho_{min}$ = -0.55 e Å^{-3}
393 parameters	
H-atom parameters constrained	

Table 1
Selected geometric parameters (Å, °).

Mo—S2	2.382 (2)	Ag···Ag^i	2.9501 (13)
Mo—S1	2.384 (2)	P1—N	1.677 (6)
Mo—S3	2.385 (2)	P2—N	1.688 (6)
Ag—P1	2.434 (2)	P2—Ag^i	2.430 (2)
Ag—N1	2.457 (9)	N1—C1	1.111 (13)
S2^{ii}—Mo—S2	141.21 (11)	P1—Ag—N1	99.9 (2)
S2^{ii}—Mo—S1	130.07 (8)	P2^i—Ag···Ag^i	88.65 (5)
S2—Mo—S1	81.88 (7)	P1—Ag···Ag^i	88.52 (5)
S2—Mo—S1^{ii}	130.07 (8)	N1—Ag···Ag^i	84.5 (2)
S1—Mo—S1^{ii}	81.70 (10)	N—P1—Ag	114.0 (2)
S2^{ii}—Mo—S3	81.93 (8)	C21—P1—Ag	115.5 (3)
S2—Mo—S3	81.54 (7)	C11—P1—Ag	112.9 (3)
S1—Mo—S3	141.35 (8)	N—P2—Ag^i	114.0 (2)
S1^{ii}—Mo—S3	82.77 (7)	C41—P2—Ag^i	112.2 (2)
S2^{ii}—Mo—S3^{ii}	81.54 (7)	C31—P2—Ag^i	116.7 (3)
S3—Mo—S3^{ii}	128.69 (11)	P1—N—P2	125.9 (3)
P2^i—Ag—P1	156.48 (7)	C1—N1—Ag	168.3 (10)
P2^i—Ag—N1	103.0 (2)		

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

The positions of the H atoms were generated geometrically (C—H fixed at 0.96 Å); these atoms were assigned isotropic displacement parameters and allowed to ride on their respective parent C atoms in the refinement.

Data collection: *SMART* (Siemens, 1994); cell refinement: *SMART* and *SAINT* (Siemens, 1994); data reduction: *XPREP* (Siemens, 1994); program(s) used to solve structure: *SHELXTL* (Siemens, 1994); program(s) used to refine structure: *SHELXTL*; molecular graphics: *SHELXTL*; software used to prepare material for publication: *SHELXTL*.

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