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# Tetrakis(2,2′-bipyridine)-1$\kappa^4N,N'$;-4$\kappa^4N,N'$-hexa-$\mu$-iodido-1:2$\kappa^4I$:$I$;-2:3$\kappa^4I$:$I$;3:4$\kappa^4I$:$I$-1,4-dicadmium(II)-2,3-disilver(I)

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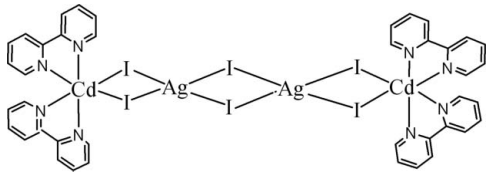
Key indicators: single-crystal X-ray study; $T$ = 293 K; mean $\sigma$(C–C) = 0.013 Å; $R$ factor = 0.044; $wR$ factor = 0.121; data-to-parameter ratio = 23.5.

The centrosymmetric title compound, $[Ag_2Cd_2I_6(C_{10}H_8N_2)_4]$, was synthesized by the reaction of $CdI_2$, $KAgI_2$ and 2,2′-bipyridine in dimethylformamide. The crystal structure contains an $Ag_2I_6$ chain and Cd(2,2′-bipyridine)$_2$ units; the four 2,2′-bipyridine ligands are positioned at the ends of the molecule and $\mu_2$-iodo bridges link two Cd(2,2′-bipyridine)-$I_2$Ag units. The Cd atom exhibits a distorted octahedral geometry.

## Related literature

For related literature, see: Li *et al.* (2006); Cheetham (1994); Estienne (1986); Helgsson & Jagner (1991); Jones (1992); Meyer (1963); Niu *et al.* (2004); Rutherford (1998); Wu *et al.* (2003); Yaghi *et al.* (1998).




## Experimental

### Crystal data

$[Ag_2Cd_2I_6(C_{10}H_8N_2)_4]$
$M_r$ = 1826.68
Monoclinic, $P2_1/n$
$a$ = 8.9170 (6) Å
$b$ = 21.5098 (15) Å
$c$ = 12.8527 (9) Å
$\beta$ = 94.374 (4)°
$V$ = 2458.0 (3) Å$^3$
$Z$ = 2
Mo $K\alpha$ radiation
$\mu$ = 5.44 mm$^{-1}$
$T$ = 293 (2) K
0.20 × 0.15 × 0.15 mm

### Data collection

Bruker SMART APEX CCD diffractometer
Absorption correction: none
14678 measured reflections
6188 independent reflections
4890 reflections with $I > 2\sigma(I)$
$R_{int}$ = 0.045

### Refinement

$R[F^2 > 2\sigma(F^2)]$ = 0.044
$wR(F^2)$ = 0.121
$S$ = 1.00
6188 reflections
263 parameters
H-atom parameters constrained
$\Delta\rho_{max}$ = 1.19 e Å$^{-3}$
$\Delta\rho_{min}$ = −1.02 e Å$^{-3}$

**Table 1**
Selected geometric parameters (Å, °).

| | | | |
|---|---|---|---|
| Cd1—N1 | 2.407 (6) | Cd1—I1 | 2.9368 (6) |
| Cd1—N2 | 2.331 (5) | I2—Ag1 | 2.9058 (8) |
| Cd1—N3 | 2.339 (4) | I3—Ag1 | 2.8036 (7) |
| Cd1—N4 | 2.399 (5) | I1—Ag1 | 2.8784 (7) |
| Cd1—I2 | 2.8352 (6) | | |
| N2—Cd1—N3 | 155.03 (18) | N4—Cd1—I1 | 86.86 (12) |
| N2—Cd1—N4 | 90.75 (18) | I2—Cd1—I1 | 96.217 (17) |
| N3—Cd1—N4 | 69.61 (17) | Ag1—I3—Ag1$^{i}$ | 70.08 (2) |
| N2—Cd1—N1 | 69.7 (2) | I3—Ag1—I1 | 109.69 (2) |
| N3—Cd1—N1 | 92.37 (19) | I3—Ag1—I2 | 118.40 (2) |
| N4—Cd1—N1 | 84.32 (17) | I1—Ag1—I2 | 95.96 (2) |
| N4—Cd1—I2 | 171.04 (13) | | |

Symmetry code: (i) $-x+2, -y, -z+1$.

Data collection: *SMART* (Bruker, 2001); cell refinement: *SMART*; data reduction: *SAINT-Plus* (Bruker, 2001); 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 and figures for this paper are available from the IUCr electronic archives (Reference: KP2139).

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# supplementary materials

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# Tetrakis(2,2'-bipyridine)-1$\kappa^4N,N'$;4$\kappa^4N,N'$-hexa-$\mu$-iodido-1:2$\kappa^4I:I$;2:3$\kappa^4I:I$;3:4$\kappa^4I:I$-1,4-dicadmium(II)-2,3-disilver(I)

**Y.-S. Jiang, H.-G. Yao, L.-J. Zou and Y.-L. An**

## Comment

Divers and useful physcial properties as well as large structural varitey have prompted the recent surge in design and synthesis of new hybrid organic-inorganic materials·These materials have attracted much attention of chemists and physicists, not due to variety of intriguing structure topologies, but also for their potential application in catalysis, materials science, medicine, magntochemistry, and optical materials (Cheetham, 1994; Yaghi *et al.*, 1998; Wu *et al.*, 2003; Niu *et al.*, 2004). Among the various families of hybrid functional materials, silver(I) halides occupy an important role (Li *et al.*, 2006; Rutherford, 1998). Up to now the structure of silver(I) halides containing $Ag_2I_4$, $Ag_3I_6$, $Ag_4I_6$, and $Ag_4I_8$ anions exhibit isolated anions, one-dimensional infinite chains, two- and three-dimensional frameworks (Meyer, 1963; Estienne, 1986; Helgsson & Jagner, 1991; Jones, 1992). In this paper we report the synthesis and structure of a new one-dimensional organic-inorganic hybrid compound $Ag_2I_6[Cd(2,2'\text{-bipyridine})_2]_2$.

The structure of the compound contains an one-dimensional $Ag_2I_6$ chain: the six iodide atoms acting as bridges between the silver atoms (Fig. 1). Ag atoms are in a tetraherdal arrangement where $AgI_4$ tetrahedra share all corners with the neighbouring metal atoms (Figs.1 and 2). The Ag—I distances range from 2.8036 (7)Å to 2.9058 (8) Å, while the Ag—I—Ag angle is 70.08 (2)°,and the I—Ag—I angles range from 95.96 (2)° to 118.40 (2)° (Table 1). In $Ag_2I_6$ the Ag···Ag separation is 3.2260 (11) Å. Cd(II) reveals a distorted octahedral geometry with two 2,2'-bipyridine ligands and two iodide atoms (Fig. 1). The Cd—I distances range from 2.8352 (6)Å to 2.9368 (6) Å, whereas Cd—N are in the range from 2.331 (5)Å to 2.407 (6) Å. The N—Cd—N angles range from 69.61 (17)° to 155.03 (18)°, I—Cd—I is 96.217 (17)°, and the N—Cd—I angles are from 86.86 (12)° to 171.04 (13)° (Table 1). $Ag_2I_6$ links adjacent Cd centres into the chains.

## Experimental

$KAgI_2$ was prepared by dropping excessive KI/DMF solution into $AgNO_3$/DMF solution·The title compound was synthesized by $CdI_2$(0.074 g) and 2,2'-bipyridine (0.015 g) dissolved in DMF (2.5 ml) followed by dropping the $KAgI_2$(4 ml) solution·The mixture was stirred for 2 m and then filtered off. The filtrate was kept at room temperature for five days and the deep-brown block crystals were obtained. Crystals were washed with ethanol and then with water.

## Refinement

H atoms were positioned geometrically with C—H = 0.93Å and allowed to ride during subsequent refinement with $U_{iso}$(H)=1.2$U_{eq}$(C).

## Figures

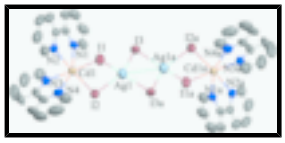

Fig. 1. The molecular structure of (I) with the atom-labelling scheme and displacement ellipsoids drawn at the 30% probability level. Symmetry codes: (i) −*x* + 2, −*y*, −*z* + 1. H atoms have been omitted.

## Tetrakis(2,2-bipyridine)-1κ$^4$*N*,*N*';4κ$^4$*N*,*N*'- hexa-μ-iodido-1:2κ$^4$*I*:I;2:3κ$^4$*I*:I;3:4κ$^4$*I*:I– 1,4-dicadmium(II)-2,3-disilver(I)(Ag—Ag)

*Crystal data*

| | |
|---|---|
| $[Ag_2Cd_2I_6(C_{10}H_8N_2)_4]$ | $F_{000}$ = 1672 |
| $M_r$ = 1826.68 | $D_x$ = 2.468 Mg m$^{-3}$ |
| Monoclinic, $P2_1/n$ | Mo $K\alpha$ radiation<br>λ = 0.71073 Å |
| $a$ = 8.9170 (6) Å | Cell parameters from 6188 reflections |
| $b$ = 21.5098 (15) Å | θ = 2.5–26.3º |
| $c$ = 12.8527 (9) Å | μ = 5.44 mm$^{-1}$ |
| β = 94.374 (4)º | $T$ = 293 (2) K |
| $V$ = 2458.0 (3) Å$^3$ | Block, brown |
| $Z$ = 2 | 0.20 × 0.15 × 0.15 mm |

*Data collection*

| | |
|---|---|
| Bruker SMART APEXII CCD diffractometer | 4890 reflections with $I > 2\sigma(I)$ |
| Radiation source: fine-focus sealed tube | $R_{int}$ = 0.045 |
| Monochromator: graphite | $\theta_{max}$ = 28.5º |
| $T$ = 293(2) K | $\theta_{min}$ = 2.5º |
| φ and ω scans | $h$ = −11→11 |
| Absorption correction: none | $k$ = −25→28 |
| 14678 measured reflections | $l$ = −17→17 |
| 6188 independent reflections | |

*Refinement*

| | |
|---|---|
| Refinement on $F^2$ | Hydrogen site location: inferred from neighbouring sites |
| Least-squares matrix: full | H-atom parameters constrained |
| $R[F^2 > 2\sigma(F^2)]$ = 0.044 | $w = 1/[\sigma^2(F_o^2) + (0.0653P)^2 + 1.6703P]$<br>where $P = (F_o^2 + 2F_c^2)/3$ |
| $wR(F^2)$ = 0.121 | $(\Delta/\sigma)_{max}$ = 0.001 |
| $S$ = 1.00 | $\Delta\rho_{max}$ = 1.19 e Å$^{-3}$ |
| 6188 reflections | $\Delta\rho_{min}$ = −1.02 e Å$^{-3}$ |

263 parameters

Primary atom site location: structure-invariant direct methods

Secondary atom site location: difference Fourier map

Extinction correction: SHELXL97 (Sheldrick, 1997), $Fc^*=kFc[1+0.001xFc^2\lambda^3/\sin(2\theta)]^{-1/4}$

Extinction coefficient: 0.0073 (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* | $U_{iso}$*/$U_{eq}$ |
|---|---|---|---|---|
| Cd1 | 0.82840 (5) | 0.162316 (19) | 0.20025 (3) | 0.04285 (13) |
| I1 | 0.68673 (5) | 0.04486 (2) | 0.25574 (3) | 0.06171 (15) |
| I2 | 0.98594 (5) | 0.18259 (2) | 0.39736 (3) | 0.05907 (15) |
| I3 | 0.80925 (5) | 0.01176 (2) | 0.60922 (3) | 0.05752 (15) |
| Ag1 | 0.92118 (7) | 0.05126 (3) | 0.42222 (4) | 0.06661 (17) |
| N1 | 0.8859 (7) | 0.2636 (3) | 0.1342 (4) | 0.0571 (13) |
| N2 | 0.6309 (6) | 0.2308 (3) | 0.2223 (4) | 0.0583 (14) |
| N3 | 1.0127 (5) | 0.1145 (2) | 0.1076 (4) | 0.0456 (11) |
| N4 | 0.7331 (6) | 0.1421 (2) | 0.0239 (4) | 0.0494 (11) |
| C1 | 0.7836 (9) | 0.3074 (3) | 0.1394 (5) | 0.0608 (18) |
| C2 | 0.8089 (12) | 0.3669 (4) | 0.1002 (7) | 0.087 (3) |
| H2A | 0.7350 | 0.3973 | 0.1027 | 0.104* |
| C3 | 0.9371 (15) | 0.3803 (5) | 0.0595 (9) | 0.111 (4) |
| H3A | 0.9542 | 0.4203 | 0.0354 | 0.134* |
| C4 | 1.0433 (14) | 0.3358 (5) | 0.0530 (8) | 0.099 (3) |
| H4A | 1.1337 | 0.3442 | 0.0243 | 0.118* |
| C5 | 1.0125 (10) | 0.2774 (4) | 0.0907 (6) | 0.078 (2) |
| H5A | 1.0838 | 0.2462 | 0.0854 | 0.094* |
| C6 | 0.6409 (8) | 0.2892 (3) | 0.1866 (5) | 0.0616 (18) |
| C7 | 0.5247 (13) | 0.3303 (5) | 0.1890 (7) | 0.095 (3) |
| H7A | 0.5325 | 0.3705 | 0.1634 | 0.113* |
| C8 | 0.3968 (15) | 0.3105 (6) | 0.2302 (9) | 0.108 (4) |
| H8A | 0.3153 | 0.3374 | 0.2310 | 0.129* |
| C9 | 0.3850 (10) | 0.2524 (7) | 0.2702 (8) | 0.106 (4) |
| H9A | 0.2980 | 0.2396 | 0.2996 | 0.128* |
| C10 | 0.5080 (9) | 0.2125 (5) | 0.2658 (7) | 0.080 (2) |
| H10A | 0.5037 | 0.1727 | 0.2937 | 0.096* |
| C11 | 0.5951 (8) | 0.1549 (4) | −0.0136 (5) | 0.0624 (17) |

| | | | | |
|---|---|---|---|---|
| H11A | 0.5384 | 0.1823 | 0.0234 | 0.075* |
| C12 | 0.5298 (9) | 0.1296 (4) | −0.1058 (6) | 0.072 (2) |
| H12A | 0.4315 | 0.1392 | −0.1297 | 0.086* |
| C13 | 0.6148 (10) | 0.0904 (4) | −0.1598 (5) | 0.073 (2) |
| H13A | 0.5751 | 0.0727 | −0.2219 | 0.087* |
| C14 | 0.7597 (9) | 0.0772 (4) | −0.1222 (5) | 0.0649 (18) |
| H14A | 0.8182 | 0.0499 | −0.1579 | 0.078* |
| C15 | 0.8172 (7) | 0.1048 (3) | −0.0312 (4) | 0.0465 (13) |
| C16 | 1.1535 (7) | 0.1061 (3) | 0.1497 (6) | 0.0584 (15) |
| H16A | 1.1784 | 0.1189 | 0.2179 | 0.070* |
| C17 | 1.2614 (9) | 0.0791 (4) | 0.0943 (7) | 0.071 (2) |
| H17A | 1.3587 | 0.0741 | 0.1247 | 0.086* |
| C18 | 1.2264 (9) | 0.0599 (4) | −0.0041 (7) | 0.074 (2) |
| H18A | 1.2998 | 0.0416 | −0.0417 | 0.089* |
| C19 | 1.0838 (9) | 0.0669 (3) | −0.0490 (6) | 0.068 (2) |
| H19A | 1.0582 | 0.0532 | −0.1167 | 0.081* |
| C20 | 0.9763 (7) | 0.0957 (3) | 0.0103 (4) | 0.0483 (13) |

*Atomic displacement parameters (Å$^2$)*

| | $U^{11}$ | $U^{22}$ | $U^{33}$ | $U^{12}$ | $U^{13}$ | $U^{23}$ |
|---|---|---|---|---|---|---|
| Cd1 | 0.0466 (2) | 0.0396 (2) | 0.0428 (2) | 0.00666 (17) | 0.00627 (16) | −0.00090 (15) |
| I2 | 0.0791 (3) | 0.0469 (3) | 0.0492 (2) | −0.0079 (2) | −0.00834 (19) | −0.00098 (16) |
| I3 | 0.0673 (3) | 0.0548 (3) | 0.0524 (2) | 0.0105 (2) | 0.01750 (19) | −0.00039 (17) |
| I1 | 0.0624 (3) | 0.0576 (3) | 0.0635 (3) | −0.0183 (2) | −0.0058 (2) | 0.00984 (19) |
| Ag1 | 0.0715 (4) | 0.0658 (4) | 0.0631 (3) | 0.0075 (3) | 0.0083 (3) | 0.0091 (2) |
| N3 | 0.048 (3) | 0.041 (3) | 0.050 (2) | 0.006 (2) | 0.016 (2) | 0.0011 (19) |
| N4 | 0.058 (3) | 0.048 (3) | 0.043 (2) | 0.002 (2) | 0.006 (2) | 0.005 (2) |
| N2 | 0.045 (3) | 0.072 (4) | 0.057 (3) | 0.015 (3) | 0.000 (2) | −0.011 (3) |
| N1 | 0.070 (3) | 0.044 (3) | 0.056 (3) | 0.002 (3) | −0.004 (3) | 0.002 (2) |
| C15 | 0.063 (4) | 0.036 (3) | 0.041 (2) | −0.011 (3) | 0.010 (2) | 0.002 (2) |
| C6 | 0.074 (4) | 0.051 (4) | 0.056 (3) | 0.025 (3) | −0.017 (3) | −0.021 (3) |
| C20 | 0.059 (3) | 0.037 (3) | 0.052 (3) | −0.003 (3) | 0.024 (3) | 0.003 (2) |
| C1 | 0.084 (5) | 0.037 (3) | 0.056 (3) | 0.008 (3) | −0.028 (3) | −0.004 (3) |
| C16 | 0.048 (3) | 0.052 (4) | 0.076 (4) | 0.004 (3) | 0.003 (3) | 0.000 (3) |
| C14 | 0.083 (5) | 0.066 (5) | 0.047 (3) | −0.015 (4) | 0.011 (3) | −0.001 (3) |
| C19 | 0.090 (6) | 0.052 (4) | 0.066 (4) | −0.001 (4) | 0.037 (4) | −0.005 (3) |
| C11 | 0.063 (4) | 0.064 (4) | 0.059 (3) | −0.001 (3) | −0.004 (3) | 0.007 (3) |
| C18 | 0.066 (5) | 0.060 (5) | 0.103 (6) | 0.007 (4) | 0.044 (4) | −0.003 (4) |
| C17 | 0.058 (4) | 0.054 (4) | 0.104 (6) | 0.007 (3) | 0.022 (4) | −0.003 (4) |
| C12 | 0.068 (4) | 0.086 (6) | 0.060 (4) | −0.029 (4) | −0.004 (3) | 0.015 (4) |
| C5 | 0.084 (5) | 0.071 (5) | 0.082 (5) | −0.020 (4) | 0.017 (4) | 0.003 (4) |
| C13 | 0.098 (6) | 0.077 (5) | 0.043 (3) | −0.036 (5) | 0.002 (4) | −0.002 (3) |
| C10 | 0.060 (4) | 0.094 (7) | 0.089 (5) | 0.014 (4) | 0.019 (4) | −0.018 (5) |
| C7 | 0.106 (7) | 0.079 (6) | 0.093 (6) | 0.053 (6) | −0.027 (6) | −0.036 (5) |
| C2 | 0.104 (7) | 0.039 (4) | 0.107 (6) | 0.011 (4) | −0.051 (6) | 0.003 (4) |
| C9 | 0.054 (5) | 0.160 (12) | 0.107 (7) | 0.014 (6) | 0.018 (5) | −0.053 (8) |
| C8 | 0.114 (9) | 0.102 (9) | 0.106 (7) | 0.049 (7) | 0.007 (6) | −0.035 (6) |

| | | | | | | |
|---|---|---|---|---|---|---|
| C3 | 0.129 (9) | 0.072 (7) | 0.124 (8) | −0.042 (7) | −0.056 (7) | 0.032 (6) |
| C4 | 0.125 (9) | 0.081 (7) | 0.086 (6) | −0.036 (6) | −0.011 (6) | 0.027 (5) |

*Geometric parameters (Å, °)*

| | | | |
|---|---|---|---|
| Cd1—N1 | 2.407 (6) | C11—C12 | 1.391 (10) |
| Cd1—N2 | 2.331 (5) | C18—C17 | 1.344 (12) |
| Cd1—N3 | 2.339 (4) | C12—C13 | 1.359 (12) |
| Cd1—N4 | 2.399 (5) | C5—C4 | 1.381 (12) |
| Cd1—I2 | 2.8352 (6) | C10—C9 | 1.397 (12) |
| Cd1—I1 | 2.9368 (6) | C7—C8 | 1.362 (16) |
| I2—Ag1 | 2.9058 (8) | C2—C3 | 1.325 (15) |
| I3—Ag1 | 2.8036 (7) | C9—C8 | 1.358 (17) |
| I3—Ag1$^{i}$ | 2.8155 (7) | C3—C4 | 1.353 (17) |
| I1—Ag1 | 2.8784 (7) | C1—H1A | 0.930 |
| Ag1—I3$^{i}$ | 2.8155 (7) | C2—H2A | 0.930 |
| Ag1—Ag1$^{i}$ | 3.2260 (11) | C3—H3A | 0.930 |
| N3—C20 | 1.332 (7) | C4—H4A | 0.930 |
| N3—C16 | 1.341 (8) | C5—H5A | 0.930 |
| N4—C11 | 1.317 (8) | C6—H6A | 0.930 |
| N4—C15 | 1.337 (8) | C7—H7A | 0.930 |
| N2—C10 | 1.328 (9) | C8—H8A | 0.930 |
| N2—C6 | 1.341 (9) | C9—H9A | 0.930 |
| N1—C1 | 1.316 (9) | C10—H10A | 0.930 |
| N1—C5 | 1.332 (9) | C11—H11A | 0.930 |
| C15—C14 | 1.376 (9) | C12—H12A | 0.930 |
| C15—C20 | 1.489 (9) | C13—H13A | 0.930 |
| C6—C7 | 1.365 (10) | C14—H14A | 0.930 |
| C6—C1 | 1.503 (11) | C15—H15A | 0.930 |
| C20—C19 | 1.412 (9) | C16—H16A | 0.930 |
| C1—C2 | 1.400 (11) | C17—H17A | 0.930 |
| C16—C17 | 1.369 (10) | C18—H18A | 0.930 |
| C14—C13 | 1.374 (11) | C19—H19A | 0.930 |
| C19—C18 | 1.364 (12) | C20—H20A | 0.930 |
| N2—Cd1—N3 | 155.03 (18) | N1—C1—C6 | 116.4 (6) |
| N2—Cd1—N4 | 90.75 (18) | C2—C1—C6 | 123.2 (7) |
| N3—Cd1—N4 | 69.61 (17) | N3—C16—C17 | 121.4 (7) |
| N2—Cd1—N1 | 69.7 (2) | C13—C14—C15 | 119.3 (7) |
| N3—Cd1—N1 | 92.37 (19) | C18—C19—C20 | 118.0 (7) |
| N4—Cd1—N1 | 84.32 (17) | N4—C11—C12 | 123.3 (8) |
| N2—Cd1—I2 | 96.99 (13) | C17—C18—C19 | 120.4 (7) |
| N3—Cd1—I2 | 101.70 (12) | C18—C17—C16 | 119.8 (8) |
| N4—Cd1—I2 | 171.04 (13) | C13—C12—C11 | 117.7 (8) |
| N1—Cd1—I2 | 94.10 (13) | N1—C5—C4 | 123.2 (10) |
| N2—Cd1—I1 | 99.88 (16) | C12—C13—C14 | 119.6 (6) |
| N3—Cd1—I1 | 94.44 (12) | N2—C10—C9 | 120.7 (10) |
| N4—Cd1—I1 | 86.86 (12) | C8—C7—C6 | 117.7 (11) |
| N1—Cd1—I1 | 166.23 (14) | C3—C2—C1 | 120.5 (9) |

| | | | |
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| I2—Cd1—I1 | 96.217 (17) | C8—C9—C10 | 117.8 (10) |
| Cd1—I2—Ag1 | 81.934 (18) | C9—C8—C7 | 121.8 (10) |
| Ag1—I3—Ag1$^{i}$ | 70.08 (2) | C2—C3—C4 | 119.9 (9) |
| Ag1—I1—Cd1 | 80.672 (18) | C3—C4—C5 | 117.6 (11) |
| I3—Ag1—I3$^{i}$ | 109.92 (2) | H2A—C2—C1 | 118.70 |
| I3—Ag1—I1 | 109.69 (2) | H2A—C2—C3 | 120.25 |
| I3$^{i}$—Ag1—I1 | 116.74 (2) | H3A—C3—C2 | 118.67 |
| I3—Ag1—I2 | 118.40 (2) | H3A—C3—C4 | 118.70 |
| I3$^{i}$—Ag1—I2 | 105.86 (2) | H4A—C4—C3 | 120.25 |
| I1—Ag1—I2 | 95.96 (2) | H4A—C4—C5 | 120.22 |
| I3—Ag1—Ag1$^{i}$ | 55.135 (19) | H5A—C5—C4 | 120.69 |
| I3$^{i}$—Ag1—Ag1$^{i}$ | 54.790 (19) | H5A—C5—N1 | 120.71 |
| I1—Ag1—Ag1$^{i}$ | 133.27 (3) | H7A—C7—C6 | 118.22 |
| I2—Ag1—Ag1$^{i}$ | 130.68 (3) | H7A—C7—C8 | 118.28 |
| C20—N3—C16 | 119.5 (5) | H8A—C8—C7 | 118.38 |
| C20—N3—Cd1 | 118.8 (4) | H8A—C8—C9 | 118.39 |
| C16—N3—Cd1 | 121.8 (4) | H9A—C9—C8 | 120.51 |
| C11—N4—C15 | 118.6 (6) | H9A—C9—C10 | 120.52 |
| C11—N4—Cd1 | 124.2 (4) | H10A—C10—C9 | 120.59 |
| C15—N4—Cd1 | 115.9 (4) | H10A—C10—N2 | 120.64 |
| C10—N2—C6 | 120.0 (7) | H11A—C11—N4 | 120.53 |
| C10—N2—Cd1 | 121.3 (6) | H11A—C11—C12 | 120.57 |
| C6—N2—Cd1 | 118.7 (5) | H12A—C12—C11 | 118.34 |
| C1—N1—C5 | 118.3 (7) | H12A—C12—C13 | 118.41 |
| C1—N1—Cd1 | 117.6 (5) | H13A—C13—C12 | 118.67 |
| C5—N1—Cd1 | 124.1 (5) | H13A—C13—C14 | 118.70 |
| N4—C15—C14 | 121.4 (6) | H14A—C14—C13 | 120.25 |
| N4—C15—C20 | 116.5 (5) | H14A—C14—C15 | 120.22 |
| C14—C15—C20 | 122.1 (6) | H16A—C16—N3 | 120.69 |
| N2—C6—C7 | 121.9 (9) | H16A—C16—C17 | 120.71 |
| N2—C6—C1 | 117.5 (5) | H17A—C17—C16 | 118.22 |
| C7—C6—C1 | 120.5 (9) | H17A—C17—C18 | 118.28 |
| N3—C20—C19 | 120.9 (6) | H18A—C18—C17 | 118.38 |
| N3—C20—C15 | 117.0 (5) | H18A—C18—C19 | 118.39 |
| C19—C20—C15 | 122.1 (6) | H19A—C19—C18 | 120.51 |
| N1—C1—C2 | 120.3 (8) | H19A—C19—C20 | 120.52 |

Symmetry codes: (i) −*x*+2, −*y*, −*z*+1.

**Fig. 1**