Acta Crystallographica Section E
Structure Reports Online
ISSN 1600-5368

Poly[(2,2′-bipyridyl)-μ_3-cyanido-di-μ_2-cyanido-dicopper(I,II)]

Yu-lan Rui[a,b]* and Mai-xi Lu[a]

[a]School of Chemical and Environmental Engineering, China University of Mining and Technology (Beijing), Beijing 100083, People's Republic of China, and [b]College of Chemical Engineering and Biotechnology, Hebei Polytechnic University, Tangshan 063009, People's Republic of China
Correspondence e-mail: tsrylan@126.com

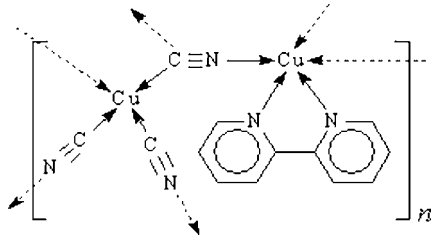
Received 7 November 2007; accepted 19 November 2007

Key indicators: single-crystal X-ray study; T = 293 K; mean σ(C–C) = 0.005 Å; R factor = 0.031; wR factor = 0.081; data-to-parameter ratio = 15.9.

The title compound, $[Cu_2(CN)_3(C_{10}H_8N_2)]_n$, crystallizes as a cyanido-bridged three-dimensional polymeric structure, where there coexist Cu^I and Cu^{II} ions along with μ_3- and μ_2-bridging cyanide groups. Each Cu^I ion is coordinated by four C atoms [Cu—C = 1.956 (3)–2.147 (3) Å] from two μ_3- and two μ_2-cyanide groups in a tetrahedral environment. The Cu^{II} ion is coordinated by two N atoms from the 2,2′-bipyridyl ligand and three N atoms from one μ_3- and two μ_2-cyanide groups in a square-pyramidal geometry [Cu—N = 1.967 (3)–2.183 (3) Å]. The Cu^I ions are paired by two C atoms from two cyanide groups into a dinuclear unit with a short $Cu^I\cdots Cu^I$ distance of 2.5398 (8) Å. Each dinuclear unit links six Cu^{II} ions by four μ_2- and two μ_3-cyanide groups to form a 4,6-connected framework, with $Cu^I\cdots Cu^{II}$ separations ranging from 4.864 (4) to 5.252 (4) Å.

Related literature

For related crystal structures, see: Chesnut & Zubieta (1998); He *et al.* (2005); Mao *et al.* (2005); Yan *et al.* (2006).



Experimental

Crystal data

$[Cu_2(CN)_3(C_{10}H_8N_2)]$
M_r = 361.32
Monoclinic, $P2_1/n$
a = 8.3009 (17) Å
b = 13.972 (3) Å
c = 10.814 (2) Å
β = 90.27 (3)°
V = 1254.2 (4) Å^3
Z = 4
Mo $K\alpha$ radiation
μ = 3.39 mm^{-1}
T = 293 (2) K
0.10 × 0.08 × 0.08 mm

Data collection

Bruker SMART CCD area-detector diffractometer
Absorption correction: multi-scan (*SADABS*; Bruker, 1998)
T_{min} = 0.948, T_{max} = 1.000
(expected range = 0.723–0.763)
12108 measured reflections
2869 independent reflections
2458 reflections with $I > 2\sigma(I)$
R_{int} = 0.044

Refinement

$R[F^2 > 2\sigma(F^2)]$ = 0.031
$wR(F^2)$ = 0.081
S = 1.09
2869 reflections
181 parameters
H-atom parameters constrained
$\Delta\rho_{max}$ = 0.50 e Å^{-3}
$\Delta\rho_{min}$ = −0.60 e Å^{-3}

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

The authors thank China University of Mining and Technology (Beijing) and Hebei Polytechnic University for supporting this work.

Supplementary data and figures for this paper are available from the IUCr electronic archives (Reference: CV2355).

References

Bruker (1998). *SMART* (Version 5.051), *SAINT* (Version 5.01), *SADABS* (Version 2.03) and *SHELXTL* (Version 6.1). Bruker AXS Inc., Madison, Wisconsin, USA.
Chesnut, D. J. & Zubieta, J. (1998). *Chem. Commun.* pp. 1707–1708.
He, X., Lu, C.-Z., Yuan, D.-Q., Chen, S.-M. & Chen, J.-T. (2005). *Eur. J. Inorg. Chem.* pp. 2181–2188.
Mao, H., Zhang, C., Xu, C., Zhang, H., Shen, X., Wu, B., Zhu, Y., Wu, Q. & Wang, H. (2005). *Inorg. Chim. Acta*, **358**, 1934–1942.
Sheldrick, G. M. (1997). *SHELXL97* and *SHELXS97*. University of Göttingen, Germany.
Yan, B., Golub, V. O. & Lachgar, A. (2006). *Inorg. Chim. Acta*, **359**, 118–126.

  doi:10.1107/S1600536807060771

supplementary materials

Acta Cryst. (2007). E**63**, m3134 [**doi:10.1107/S1600536807060771**]

Poly[(2,2'-bipyridyl)-μ_3-cyanido-di-μ_2-cyanido-dicopper(I,II)]

Y. Rui and M. Lu

Comment

The crystal structures of some cyano-bridged Cu^I or Cu^{II} complexes with 2,2'-bipyridyl as co-ligand have been reported, such as catena-[(μ_2-cyano)-bis(2,2'-bipyridyl)-copper(I)] hexakis[(μ_2-cyano)-penta-copper(I)] (Chesnut & Zubieta, 1998); catena-[(μ_2-cyano)-(2,2'-bipyridyl)-copper(I)] (He et al., 2005, Mao et al., 2005) and catena-[(μ_2-cyano)-bis(2,2'-bipyridyl)-cyano-copper(II)] (Yan et al., 2006). In such complexes, one type of Cu ion either Cu^I or Cu^{II} appeared, and the cyano groups adopted only μ_2 bridging mode. Herein, we report a new three-dimensional polymeric Cu complex, $C_{13}H_8Cu_2N_5$ (I), in which there exist both Cu^I and Cu^{II} ions, and μ_3– and μ_2– coordination cyano groups.

As shown in Fig. 1, the Cu^I ion [Cu1] is coordinated to four C atoms from two μ_3– and two μ_2-cyano groups, respectively, in a tetrahedral environment. The Cu^{II} ion [Cu2] coordinates with two N atoms of one 2,2'-bipyridyl ligand, one μ_3– and two μ_2-cyano N atoms in a square-pyramidal geometry. In the structure, each two Cu^I atoms [Cu1 and Cu1A] are bridged by two μ_2-C atoms of μ_3– cyano groups to form a dinuclear unit with a Cu—Cu distance of 2.5398 (8) Å. Each such dinuclear unit is further linked to six Cu^{II} ions by four μ_2– and two μ_3-cyano groups, to give a 4,6-connected framework, with the Cu^I—Cu^{II} separations of 4.864 (4) Å for Cu1—Cu2, 4.963 (4) Å for Cu1B—Cu2, 5.010 (4) Å for Cu1C—Cu2 and 5.252 (4) Å for Cu1A—Cu2, corresponding to Fig. 1.

Experimental

$CuCl_2{\cdot}2H_2O$ (34 mg, 0.2 mmol), 2,2'-bipyridine (31 mg, 0.2 mmol) and cyanoacetic acid (51 mg, 0.6 mmol) were dissolved in ammonium hydroxide (20%, 10 ml). The solution was filtered and the filtrate was allowed to stand for about 30 days. Black crystals of (I) were isolated in about 20% yield with respect to Cu. The cyano groups and Cu^I ions in the product come from the in situ decomposition of cyanoacetic acid and the reduction of Cu^{II} ions, respectively.

Refinement

H atoms were included in calculated positions and treated in the subsequent refinement as riding atoms, with C—H = 0.93 Å and U_{iso}(H) = 1.2 U_{eq}(C).

Figures

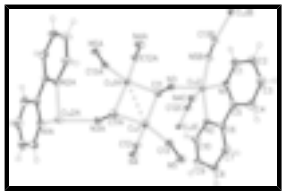


Fig. 1. A portion of the polymeric network in (I), showing the atomic numbering and 30% probability displacement ellipsoids [symmetry codes: (A) −*x*, 1 − *y*, 1 − *z*; (B) 1/2 − *x*, 1/2 + *y*, 3/2 − *z*; (C) 1 − *x*, 1 − *y*, 1 − *z*].

Poly[(2,2'-bipyridyl)-μ$_3$-cyano-di-μ$_2$-cyano-dicopper(I,II)]

Crystal data

$[Cu_2(CN)_3(C_{10}H_8N_2)]$	F_{000} = 716
M_r = 361.32	D_x = 1.914 Mg m^{-3}
Monoclinic, $P2_1/n$	Mo $K\alpha$ radiation λ = 0.71073 Å
Hall symbol: -P 2yn	Cell parameters from 10053 reflections
a = 8.3009 (17) Å	θ = 3.1–27.5º
b = 13.972 (3) Å	μ = 3.39 mm^{-1}
c = 10.814 (2) Å	*T* = 293 (2) K
β = 90.27 (3)º	Block, black
V = 1254.2 (4) Å^3	0.10 × 0.08 × 0.08 mm
Z = 4	

Data collection

Bruker SMART CCD area-detector diffractometer	2869 independent reflections
Radiation source: fine-focus sealed tube	2458 reflections with $I > 2\sigma(I)$
Monochromator: graphite	R_{int} = 0.044
T = 293(2) K	θ_{max} = 27.5º
φ and ω scan	θ_{min} = 3.1º
Absorption correction: multi-scan (SADABS; Bruker, 1998)	*h* = −10→10
T_{min} = 0.948, T_{max} = 1.000	*k* = −17→18
12108 measured reflections	*l* = −13→14

Refinement

Refinement on F^2	Secondary atom site location: difference Fourier map
Least-squares matrix: full	Hydrogen site location: inferred from neighbouring sites
$R[F^2 > 2\sigma(F^2)]$ = 0.031	H-atom parameters constrained
$wR(F^2)$ = 0.081	$w = 1/[\sigma^2(F_o^2) + (0.0283P)^2 + 1.8789P]$ where $P = (F_o^2 + 2F_c^2)/3$
S = 1.09	$(\Delta/\sigma)_{max}$ = 0.001

2869 reflections	$\Delta\rho_{max} = 0.50$ e Å^{-3}
181 parameters	$\Delta\rho_{min} = -0.60$ e Å^{-3}
Primary atom site location: structure-invariant direct methods	Extinction correction: none

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}
Cu1	0.07091 (5)	0.42052 (3)	0.51708 (3)	0.02646 (11)
Cu2	0.44880 (5)	0.61074 (3)	0.75886 (3)	0.02377 (11)
N1	0.3200 (3)	0.57131 (19)	0.9116 (2)	0.0273 (6)
N2	0.4729 (3)	0.46640 (18)	0.7511 (2)	0.0272 (6)
N3	0.2456 (4)	0.59756 (19)	0.6310 (3)	0.0322 (6)
C12	0.2496 (4)	0.3838 (2)	0.4065 (3)	0.0282 (7)
C13	0.0437 (4)	0.3177 (2)	0.6380 (3)	0.0293 (7)
C1	0.2443 (4)	0.6312 (3)	0.9891 (3)	0.0356 (8)
H1A	0.2484	0.6967	0.9738	0.043*
C2	0.1606 (4)	0.5987 (3)	1.0907 (3)	0.0402 (9)
H2A	0.1075	0.6415	1.1423	0.048*
C3	0.1570 (5)	0.5032 (3)	1.1144 (3)	0.0431 (9)
H3A	0.1024	0.4801	1.1830	0.052*
C4	0.2352 (5)	0.4403 (3)	1.0356 (3)	0.0401 (8)
H4A	0.2345	0.3749	1.0511	0.048*
C5	0.3145 (4)	0.4766 (2)	0.9334 (3)	0.0282 (7)
C6	0.3988 (4)	0.4166 (2)	0.8423 (3)	0.0269 (6)
C7	0.4030 (5)	0.3175 (2)	0.8446 (3)	0.0374 (8)
H7A	0.3535	0.2841	0.9083	0.045*
C8	0.4813 (5)	0.2692 (2)	0.7519 (4)	0.0428 (9)
H8A	0.4853	0.2027	0.7525	0.051*
C9	0.5534 (5)	0.3196 (3)	0.6583 (4)	0.0422 (9)
H9A	0.6056	0.2880	0.5944	0.051*
C10	0.5469 (5)	0.4182 (2)	0.6612 (3)	0.0382 (8)
H10A	0.5960	0.4525	0.5980	0.046*
C11	0.1443 (4)	0.5593 (2)	0.5813 (3)	0.0313 (7)
N4	0.3625 (4)	0.37243 (19)	0.3484 (3)	0.0338 (6)
N5	0.0438 (4)	0.2456 (2)	0.6877 (3)	0.0350 (7)

Atomic displacement parameters (Å^2)

	U^{11}	U^{22}	U^{33}	U^{12}	U^{13}	U^{23}
Cu1	0.0284 (2)	0.0192 (2)	0.0318 (2)	0.00216 (15)	0.00388 (15)	0.00332 (14)
Cu2	0.0269 (2)	0.01838 (19)	0.02610 (19)	−0.00175 (14)	0.00628 (14)	−0.00388 (13)
N1	0.0273 (14)	0.0282 (14)	0.0262 (13)	−0.0015 (11)	0.0030 (10)	−0.0018 (10)
N2	0.0318 (15)	0.0206 (13)	0.0292 (13)	−0.0009 (11)	0.0045 (11)	−0.0020 (10)
N3	0.0315 (15)	0.0267 (14)	0.0383 (15)	0.0014 (12)	−0.0078 (12)	−0.0078 (11)
C12	0.0302 (17)	0.0217 (15)	0.0329 (16)	−0.0012 (13)	0.0062 (13)	−0.0025 (12)
C13	0.0328 (18)	0.0245 (16)	0.0308 (16)	0.0033 (13)	0.0085 (13)	0.0019 (13)
C1	0.0350 (19)	0.0338 (19)	0.0380 (18)	0.0014 (15)	0.0076 (14)	−0.0052 (14)
C2	0.0316 (19)	0.058 (2)	0.0308 (17)	0.0021 (17)	0.0095 (14)	−0.0071 (16)
C3	0.037 (2)	0.062 (3)	0.0303 (18)	−0.0030 (18)	0.0115 (15)	0.0063 (16)
C4	0.041 (2)	0.042 (2)	0.0374 (19)	−0.0071 (16)	0.0013 (15)	0.0112 (15)
C5	0.0250 (16)	0.0316 (17)	0.0281 (16)	−0.0021 (13)	−0.0007 (12)	−0.0004 (12)
C6	0.0262 (16)	0.0259 (16)	0.0286 (15)	−0.0036 (12)	−0.0019 (12)	0.0006 (12)
C7	0.045 (2)	0.0251 (18)	0.0423 (19)	−0.0033 (15)	0.0011 (16)	0.0067 (14)
C8	0.055 (2)	0.0163 (16)	0.057 (2)	0.0014 (15)	−0.0017 (18)	−0.0020 (15)
C9	0.051 (2)	0.0264 (18)	0.049 (2)	0.0051 (16)	0.0104 (17)	−0.0089 (15)
C10	0.048 (2)	0.0252 (17)	0.0418 (19)	−0.0012 (15)	0.0150 (16)	−0.0041 (14)
C11	0.0291 (17)	0.0346 (18)	0.0302 (16)	−0.0008 (14)	0.0058 (13)	−0.0047 (13)
N4	0.0359 (16)	0.0244 (14)	0.0411 (16)	−0.0030 (12)	0.0109 (13)	−0.0021 (11)
N5	0.0423 (17)	0.0266 (15)	0.0361 (15)	0.0041 (12)	0.0131 (12)	0.0059 (11)

Geometric parameters (Å, °)

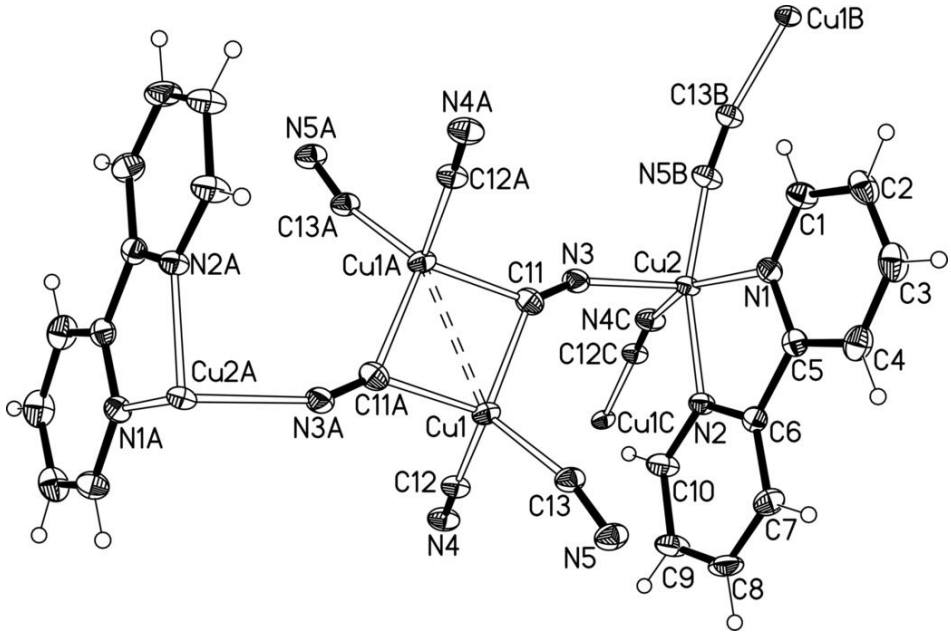
Cu1—C11^{i}	2.094 (4)	C2—C3	1.359 (6)
Cu1—C11	2.147 (3)	C2—H2A	0.9300
Cu1—C12	1.977 (3)	C3—C4	1.387 (5)
Cu1—C13	1.956 (3)	C3—H3A	0.9300
Cu1—Cu1^{i}	2.5398 (8)	C4—C5	1.385 (5)
Cu2—N1	2.047 (3)	C4—H4A	0.9300
Cu2—N2	2.028 (3)	C5—C6	1.473 (4)
Cu2—N3	2.183 (3)	C6—C7	1.385 (5)
Cu2—N4^{ii}	1.967 (3)	C7—C8	1.375 (5)
Cu2—N5^{iii}	1.972 (3)	C7—H7A	0.9300
N1—C1	1.343 (4)	C8—C9	1.373 (5)
N1—C5	1.344 (4)	C8—H8A	0.9300
N2—C10	1.335 (4)	C9—C10	1.379 (5)
N2—C6	1.357 (4)	C9—H9A	0.9300
N3—C11	1.131 (4)	C10—H10A	0.9300
C12—N4	1.143 (4)	C11—Cu1^{i}	2.094 (4)
C13—N5	1.142 (4)	N4—Cu2^{ii}	1.967 (3)
C1—C2	1.380 (5)	N5—Cu2^{iv}	1.972 (3)
C1—H1A	0.9300		
C13—Cu1—C12	107.62 (13)	C2—C1—H1A	119.0

C13—Cu1—C11^{i}	109.73 (14)	C3—C2—C1	119.0 (3)
C12—Cu1—C11^{i}	111.61 (13)	C3—C2—H2A	120.5
C13—Cu1—C11	118.70 (13)	C1—C2—H2A	120.5
C12—Cu1—C11	102.58 (13)	C2—C3—C4	119.7 (3)
C11^{i}—Cu1—C11	106.44 (11)	C2—C3—H3A	120.2
C13—Cu1—Cu1^{i}	133.18 (10)	C4—C3—H3A	120.2
C12—Cu1—Cu1^{i}	119.19 (9)	C5—C4—C3	118.9 (3)
C11^{i}—Cu1—Cu1^{i}	54.18 (9)	C5—C4—H4A	120.5
C11—Cu1—Cu1^{i}	52.25 (10)	C3—C4—H4A	120.5
N4^{ii}—Cu2—N5^{iii}	92.00 (11)	N1—C5—C4	121.1 (3)
N4^{ii}—Cu2—N2	90.89 (11)	N1—C5—C6	115.2 (3)
N5^{iii}—Cu2—N2	163.61 (12)	C4—C5—C6	123.6 (3)
N4^{ii}—Cu2—N1	158.12 (12)	N2—C6—C7	121.0 (3)
N5^{iii}—Cu2—N1	92.08 (11)	N2—C6—C5	114.4 (3)
N2—Cu2—N1	79.50 (10)	C7—C6—C5	124.7 (3)
N4^{ii}—Cu2—N3	104.58 (12)	C8—C7—C6	119.3 (3)
N5^{iii}—Cu2—N3	106.79 (12)	C8—C7—H7A	120.3
N2—Cu2—N3	88.05 (11)	C6—C7—H7A	120.3
N1—Cu2—N3	94.78 (11)	C9—C8—C7	119.6 (3)
Cu1^{i}—C11—Cu1	73.56 (11)	C9—C8—H8A	120.2
C1—N1—C5	119.2 (3)	C7—C8—H8A	120.2
C1—N1—Cu2	125.7 (2)	C8—C9—C10	118.6 (3)
C5—N1—Cu2	115.1 (2)	C8—C9—H9A	120.7
C10—N2—C6	118.9 (3)	C10—C9—H9A	120.7
C10—N2—Cu2	125.3 (2)	N2—C10—C9	122.6 (3)
C6—N2—Cu2	115.8 (2)	N2—C10—H10A	118.7
C11—N3—Cu2	155.8 (3)	C9—C10—H10A	118.7
N4—C12—Cu1	171.4 (3)	N3—C11—Cu1^{i}	144.0 (3)
N5—C13—Cu1	164.3 (3)	N3—C11—Cu1	142.2 (3)
N1—C1—C2	122.0 (3)	C12—N4—Cu2^{ii}	164.9 (3)
N1—C1—H1A	119.0	C13—N5—Cu2^{iv}	168.8 (3)
N4^{ii}—Cu2—N1—C1	115.0 (4)	Cu2—N1—C5—C4	178.2 (3)
N5^{iii}—Cu2—N1—C1	14.4 (3)	C1—N1—C5—C6	179.1 (3)
N2—Cu2—N1—C1	−179.7 (3)	Cu2—N1—C5—C6	−1.4 (4)
N3—Cu2—N1—C1	−92.6 (3)	C3—C4—C5—N1	1.7 (5)
N4^{ii}—Cu2—N1—C5	−64.5 (4)	C3—C4—C5—C6	−178.8 (3)
N5^{iii}—Cu2—N1—C5	−165.1 (2)	C10—N2—C6—C7	1.7 (5)
N2—Cu2—N1—C5	0.7 (2)	Cu2—N2—C6—C7	178.2 (3)
N3—Cu2—N1—C5	87.8 (2)	C10—N2—C6—C5	−177.3 (3)
N4^{ii}—Cu2—N2—C10	−23.5 (3)	Cu2—N2—C6—C5	−0.8 (3)
N5^{iii}—Cu2—N2—C10	−123.7 (4)	N1—C5—C6—N2	1.4 (4)
N1—Cu2—N2—C10	176.3 (3)	C4—C5—C6—N2	−178.1 (3)
N3—Cu2—N2—C10	81.0 (3)	N1—C5—C6—C7	−177.5 (3)
N4^{ii}—Cu2—N2—C6	160.3 (2)	C4—C5—C6—C7	3.0 (5)

N5^{iii}—Cu2—N2—C6	60.2 (5)	N2—C6—C7—C8	−1.1 (5)
N1—Cu2—N2—C6	0.1 (2)	C5—C6—C7—C8	177.8 (3)
N3—Cu2—N2—C6	−95.1 (2)	C6—C7—C8—C9	−0.2 (6)
N4^{ii}—Cu2—N3—C11	110.5 (7)	C7—C8—C9—C10	0.8 (6)
N5^{iii}—Cu2—N3—C11	−152.8 (7)	C6—N2—C10—C9	−1.1 (6)
N2—Cu2—N3—C11	20.1 (7)	Cu2—N2—C10—C9	−177.1 (3)
N1—Cu2—N3—C11	−59.2 (7)	C8—C9—C10—N2	−0.2 (6)
C12—Cu1—C13—N5	−24.5 (12)	Cu2—N3—C11—Cu1^{i}	160.3 (4)
C11^{i}—Cu1—C13—N5	97.1 (12)	Cu2—N3—C11—Cu1	−28.0 (10)
C11—Cu1—C13—N5	−140.2 (12)	C13—Cu1—C11—N3	60.8 (5)
Cu1^{i}—Cu1—C13—N5	156.1 (11)	C12—Cu1—C11—N3	−57.6 (5)
C5—N1—C1—C2	−0.1 (5)	C11^{i}—Cu1—C11—N3	−175.0 (5)
Cu2—N1—C1—C2	−179.6 (3)	Cu1^{i}—Cu1—C11—N3	−175.0 (5)
N1—C1—C2—C3	1.2 (6)	C13—Cu1—C11—Cu1^{i}	−124.25 (13)
C1—C2—C3—C4	−0.8 (6)	C12—Cu1—C11—Cu1^{i}	117.34 (12)
C2—C3—C4—C5	−0.6 (6)	C11^{i}—Cu1—C11—Cu1^{i}	0.0
C1—N1—C5—C4	−1.4 (5)	Cu1—C13—N5—Cu2^{iv}	−16 (3)

Symmetry codes: (i) −*x*, −*y*+1, −*z*+1; (ii) −*x*+1, −*y*+1, −*z*+1; (iii) −*x*+1/2, *y*+1/2, −*z*+3/2; (iv) −*x*+1/2, *y*−1/2, −*z*+3/2.

Fig. 1


Cu1B
C13B
N4A
N5A
C12A
N5B
C2
C13A
C1
N2A
Cu1A
C11
N3
Cu2
N1
C3
N4C
C12C
C5
C4
Cu2A
C11A
Cu1C
N1A
N3A
Cu1
N2
C6
C12
C13
C10
C7
N4
N5
C9
C8