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Poly[bis[diaqua(isonicotinato-κ^2O,O')dysprosium(III)][bis(isonicotinato-κO)copper(II)]tetra-(μ_3-isonicotinato-$\kappa^3O:O':N$)]

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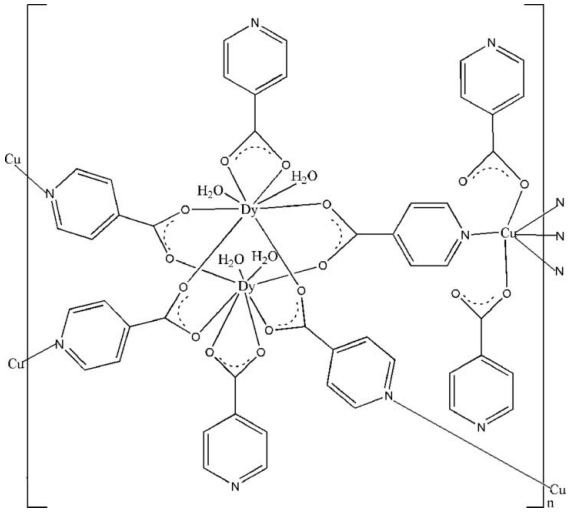
Key indicators: single-crystal X-ray study; T = 294 K; mean σ(C–C) = 0.006 Å; R factor = 0.025; wR factor = 0.058; data-to-parameter ratio = 12.4.

The title compound, $\{[Dy(C_6H_4NO_2)(H_2O)_2]_2[Cu(C_6H_4NO_2)_2](C_6H_4NO_2)_4\}_n$, is a three-dimensional coordination polymer. The six-coordinate Cu^{II} atom, lying on an inversion center, is bonded to two O atoms from two monodentate isonicotinate ligands and four N atoms from four bridging isonicotinate ligands. Two Dy^{III} atoms form a centrosymmetric dinuclear unit and each Dy^{III} atom is eight-coordinated by six O atoms from five different isonicotinate ligands and two O atoms from two water molecules. These metal coordination units are connected by the bridging isonicotinate ligands, generating a three-dimensional network. The crystal structure is further stabilized by hydrogen bonds.

Related literature

For related literature, see: Costs *et al.* (1998); Kahn *et al.* (1999); Sanz *et al.* (1996).



Experimental

Crystal data

$[Dy_2Cu(C_6H_4NO_2)_8(H_2O)_4]$
M_r = 1437.43
Monoclinic, $P2_1/n$
a = 9.456 (1) Å
b = 14.966 (3) Å
c = 18.166 (4) Å
β = 93.74 (1)°
V = 2565.4 (8) Å^3
Z = 2
Mo $K\alpha$ radiation
μ = 3.38 mm^{-1}
T = 294 (2) K
0.54 × 0.42 × 0.28 mm

Data collection

Bruker SMART 1000 CCD area-detector diffractometer
Absorption correction: multi-scan (*SADABS*; Sheldrick, 1996)
T_{min} = 0.199, T_{max} = 0.391
5313 measured reflections
4638 independent reflections
3853 reflections with $I > 2\sigma(I)$
R_{int} = 0.018

Refinement

$R[F^2 > 2\sigma(F^2)]$ = 0.026
$wR(F^2)$ = 0.058
S = 1.03
4638 reflections
375 parameters
4 restraints
H atoms treated by a mixture of independent and constrained refinement
$\Delta\rho_{max}$ = 0.61 e Å^{-3}
$\Delta\rho_{min}$ = −0.89 e Å^{-3}

Table 1
Selected bond lengths (Å).

Dy—O7	2.298 (3)	Dy—O6	2.433 (3)
Dy—O2^{i}	2.300 (3)	Dy—O5	2.513 (3)
Dy—O8^{i}	2.313 (3)	Cu—O3	1.976 (3)
Dy—O1	2.324 (3)	Cu—N1	2.004 (3)
Dy—O10	2.366 (3)	Cu—N4^{ii}	2.639 (4)
Dy—O9	2.409 (3)		

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

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

D—H···A	D—H	H···A	D···A	D—H···A
O9—H9A···O4^{iii}	0.81 (3)	1.98 (3)	2.778 (4)	169 (5)
O9—H9B···N3^{iv}	0.82 (3)	2.07 (3)	2.883 (5)	176 (5)
O10—H10A···O5^{v}	0.82 (3)	1.98 (2)	2.784 (4)	166 (5)
O10—H10B···N2^{vi}	0.81 (4)	1.99 (2)	2.796 (5)	169 (6)

Symmetry codes: (iii) $x, y+1, z$; (iv) $x-\frac{1}{2}, -y+\frac{3}{2}, z+\frac{1}{2}$; (v) $-x+1, -y+1, -z+1$; (vi) $x+\frac{1}{2}, -y+\frac{1}{2}, z+\frac{1}{2}$.

Data collection: *SMART* (Bruker, 2001); cell refinement: *SAINT* (Bruker, 2001); 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, 2001); 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: HY2080).

  doi:10.1107/S1600536807043899

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supplementary materials

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Poly[bis[diaqua(isonicotinato-κ^2O,O')dysprosium(III)][bis(isonicotinato-κO)copper(II)]tetra(μ_3-isonicotinato-$\kappa^3O:O':N$)]

D.-Z. Kuang, Y.-L. Feng, Y.-L. Peng and Y.-F. Deng

Comment

In the past few years, more extensive attention had been paid to the research on the chemistry of heterometallic complexes containing simultaneously lanthanide and transition metal ions (Costs *et al.*, 1998; Kahn *et al.*, 1999; Sanz *et al.*, 1996). As an extension of this research, we report here the structure of the title compound, a new heterometallic coordination polymer,

In the title compound (Fig. 1), the Cu^{II} atom lies on an inversion center and is six-coordinated by two O atoms from two monodentate isonicotinate ligands and four N atoms from the other four isonicotinate ligands. Thus the Cu^{II} atom has a slight distorted octahedral coordination geometry. The Dy^{III} atom is eight-coordinated by six O atoms from five different isonicotinate ligands and two O atoms from two water molecules in a square antiprism geometry (Table 1). The adjacent Cu and Dy coordination units are bridged by the tridentate isonicotinate ligands, forming a three-dimensional network structure (Fig. 2).

Experimental

A mixture of CuO (0.082 g, 1.0 mmol), Dy_2O_3 (0.181 g, 0.5 mmol), isonicotinic acid (0.248 g, 2.0 mmol), H_2O (10 ml, 0.55 mmol) and two drops of acetic acid, with a pH value about 2.0, was sealed in a 25 ml Teflon-lined reaction vessel at 443 K for 5 d. The reaction mixture was cooled to room temperature over a period of 48 h. The product was collected by filtration, washed with water and air-dried. Blue block crystals suitable for X-ray analysis were obtained. Analysis, calculated for $C_{48}H_{40}CuDy_2N_8O_{20}$: C 40.11, H 2.80, N 7.80%; found: C 40.05; H 2.59, N 7.97%.

Refinement

H atoms bonded to C atoms were positioned geometrically and refined as riding, with C—H = 0.93Å and U_{iso}(H) = 1.2U_{eq}(C). H atoms of water molecules were found from difference Fourier maps and refined isotropically with a restraint of O—H = 0.82 (1) Å.

Figures

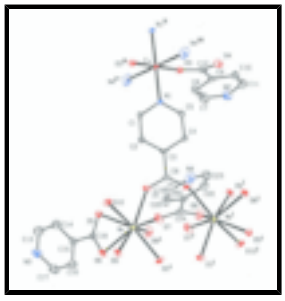

Fig. 1. The asymmetric unit of the title compound, together with symmetry-related atoms to complete the coordination units. Displacement ellipsoids are drawn at the 50% probability level. H atoms have been omitted for clarity. [Symmetry codes: (i) −*x*, −*y* + 1, −*z* + 1; (ii) −*x* + 1, −*y*, −*z* + 1; (iii) −*x* + 1/2, *y* − 1/2, −*z* + 3/2; (iv) 1/2 + *x*, 1/2 − *y*, −1/2 + *z*.]

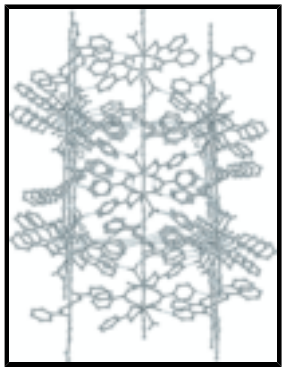

Fig. 2. A view of the three-dimensional structure of the title compound. Dotted lines denote hydrogen bonds.

Poly[bis[diaqua(isonicotinato-κ2*O*,*O*')dysprosium(III)] [bis(isonicotinato-κ*O*)copper(II)]tetra(μ3-isonicotinato-κ3*O*:*O*':*N*)]

Crystal data

$[Dy_2Cu(C_6H_4NO_2)_8(H_2O)_4]$	F_{000} = 1410
M_r = 1437.43	D_x = 1.861 Mg m^{-3}
Monoclinic, $P2_1/n$	Mo $K\alpha$ radiation λ = 0.71073 Å
Hall symbol: -P 2yn	Cell parameters from 4174 reflections
a = 9.456 (1) Å	θ = 2.6–14.6º
b = 14.966 (3) Å	μ = 3.38 mm^{-1}
c = 18.166 (4) Å	*T* = 294 (2) K
β = 93.74 (1)º	Block, blue
V = 2565.4 (8) Å^3	0.54 × 0.42 × 0.28 mm
Z = 2	

Data collection

Bruker SMART 1000 CCD area-detector diffractometer	4638 independent reflections
Radiation source: normal-focus sealed tube	3853 reflections with $I > 2\sigma(I)$
Monochromator: graphite	R_{int} = 0.018
T = 294(2) K	θ_{max} = 25.3º
φ and ω scans	θ_{min} = 1.8º

Absorption correction: multi-scan (SADABS; Sheldrick, 1996)

T_{min} = 0.199, T_{max} = 0.391

5313 measured reflections

h = 0→11

k = 0→17

l = −21→21

Refinement

Refinement on F^2

Least-squares matrix: full

$R[F^2 > 2\sigma(F^2)]$ = 0.026

$wR(F^2)$ = 0.058

S = 1.03

4638 reflections

375 parameters

4 restraints

Primary atom site location: structure-invariant direct methods

Secondary atom site location: difference Fourier map

Hydrogen site location: inferred from neighbouring sites

H atoms treated by a mixture of independent and constrained refinement

$w = 1/[\sigma^2(F_o^2) + (0.0289P)^2]$ where $P = (F_o^2 + 2F_c^2)/3$

$(\Delta/\sigma)_{max}$ = 0.002

$\Delta\rho_{max}$ = 0.61 e Å^{-3}

$\Delta\rho_{min}$ = −0.89 e Å^{-3}

Extinction correction: SHELXL97

Extinction coefficient: 0.00120 (9)

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

	x	*y*	*z*	U_{iso}*/U_{eq}
Dy	0.195701 (18)	0.583911 (12)	0.500576 (9)	0.01381 (7)
Cu	0.5000	0.0000	0.5000	0.01940 (16)
O1	0.2280 (3)	0.43001 (18)	0.50421 (17)	0.0337 (8)
O2	0.0274 (3)	0.3543 (2)	0.50973 (19)	0.0402 (8)
O3	0.3581 (3)	−0.05366 (19)	0.42852 (15)	0.0255 (7)
O4	0.1845 (3)	−0.1225 (2)	0.48600 (15)	0.0345 (8)
O5	0.3964 (3)	0.56810 (18)	0.41742 (14)	0.0243 (6)
O6	0.2726 (3)	0.69240 (19)	0.41176 (15)	0.0298 (7)
O7	0.1052 (4)	0.5477 (2)	0.61110 (16)	0.0390 (8)
O8	−0.0907 (3)	0.4660 (2)	0.61044 (16)	0.0398 (8)
O9	0.2216 (3)	0.7219 (2)	0.56835 (17)	0.0281 (7)
O10	0.4068 (3)	0.5705 (2)	0.57715 (16)	0.0272 (7)
N1	0.3863 (3)	0.1131 (2)	0.49738 (16)	0.0168 (7)
N2	0.0145 (4)	−0.1238 (3)	0.2173 (2)	0.0425 (11)
N3	0.5756 (5)	0.7292 (3)	0.1969 (2)	0.0467 (11)
N4	0.0917 (4)	0.4501 (4)	0.8722 (2)	0.0475 (12)
C1	0.4533 (4)	0.1926 (3)	0.4982 (2)	0.0230 (9)
H1	0.5517	0.1933	0.4988	0.028*
C2	0.3828 (4)	0.2722 (3)	0.4983 (2)	0.0215 (9)
H2	0.4329	0.3257	0.4987	0.026*
C3	0.2366 (4)	0.2729 (3)	0.4979 (2)	0.0194 (9)
C4	0.1649 (4)	0.1919 (3)	0.4943 (2)	0.0221 (9)
H4	0.0664	0.1900	0.4919	0.027*
C5	0.2442 (4)	0.1140 (3)	0.4944 (2)	0.0220 (9)

H5	0.1964	0.0597	0.4924	0.026*
C6	0.1574 (4)	0.3599 (3)	0.5038 (2)	0.0220 (9)
C7	0.1288 (6)	−0.0714 (4)	0.2280 (3)	0.0491 (15)
H7	0.1616	−0.0417	0.1875	0.059*
C8	0.2008 (5)	−0.0592 (3)	0.2961 (2)	0.0385 (12)
H8	0.2775	−0.0202	0.3008	0.046*
C9	0.1591 (4)	−0.1045 (3)	0.3564 (2)	0.0227 (9)
C10	0.0435 (4)	−0.1607 (3)	0.3463 (2)	0.0300 (10)
H10	0.0117	−0.1931	0.3857	0.036*
C11	−0.0242 (5)	−0.1681 (3)	0.2768 (3)	0.0374 (12)
H11	−0.1016	−0.2064	0.2709	0.045*
C12	0.2395 (4)	−0.0932 (3)	0.4307 (2)	0.0230 (9)
C13	0.6322 (6)	0.6681 (4)	0.2435 (3)	0.0545 (16)
H13	0.7200	0.6444	0.2337	0.065*
C14	0.5697 (5)	0.6376 (4)	0.3052 (3)	0.0424 (13)
H14	0.6148	0.5950	0.3357	0.051*
C15	0.4397 (4)	0.6712 (3)	0.3210 (2)	0.0255 (9)
C16	0.3780 (5)	0.7340 (3)	0.2730 (2)	0.0397 (12)
H16	0.2901	0.7584	0.2814	0.048*
C17	0.4488 (6)	0.7599 (4)	0.2122 (3)	0.0497 (14)
H17	0.4051	0.8014	0.1801	0.060*
C18	0.3660 (4)	0.6428 (3)	0.3878 (2)	0.0192 (9)
C19	0.1568 (5)	0.5134 (4)	0.8384 (3)	0.0528 (16)
H19	0.2187	0.5495	0.8671	0.063*
C20	0.1418 (5)	0.5311 (4)	0.7644 (2)	0.0373 (12)
H20	0.1930	0.5767	0.7438	0.045*
C21	0.0486 (4)	0.4793 (3)	0.7215 (2)	0.0214 (9)
C22	−0.0190 (4)	0.4097 (3)	0.7547 (2)	0.0292 (10)
H22	−0.0812	0.3723	0.7275	0.035*
C23	0.0088 (5)	0.3974 (4)	0.8296 (3)	0.0418 (13)
H23	−0.0334	0.3490	0.8516	0.050*
C24	0.0185 (4)	0.4987 (3)	0.6407 (2)	0.0210 (9)
H9A	0.223 (5)	0.7683 (18)	0.545 (2)	0.043 (16)*
H9B	0.178 (4)	0.734 (3)	0.6043 (15)	0.033 (13)*
H10A	0.468 (4)	0.533 (2)	0.572 (3)	0.043 (16)*
H10B	0.433 (6)	0.592 (4)	0.6169 (17)	0.08 (2)*

Atomic displacement parameters (Å^2)

	U^{11}	U^{22}	U^{33}	U^{12}	U^{13}	U^{23}
Dy	0.01477 (10)	0.01319 (10)	0.01358 (10)	0.00195 (9)	0.00165 (6)	0.00091 (8)
Cu	0.0195 (3)	0.0130 (3)	0.0247 (4)	0.0058 (3)	−0.0065 (3)	−0.0050 (3)
O1	0.0367 (19)	0.0121 (16)	0.052 (2)	0.0043 (14)	0.0036 (15)	0.0001 (14)
O2	0.0233 (17)	0.0296 (19)	0.068 (2)	0.0145 (15)	0.0071 (16)	0.0005 (17)
O3	0.0259 (16)	0.0243 (16)	0.0250 (15)	0.0031 (13)	−0.0088 (12)	−0.0052 (12)
O4	0.045 (2)	0.0325 (18)	0.0256 (17)	0.0004 (16)	0.0011 (15)	0.0013 (14)
O5	0.0253 (15)	0.0255 (17)	0.0229 (14)	0.0021 (13)	0.0075 (12)	0.0046 (12)
O6	0.0399 (18)	0.0192 (16)	0.0324 (16)	0.0038 (14)	0.0184 (14)	0.0026 (13)

O7	0.054 (2)	0.042 (2)	0.0232 (16)	−0.0082 (18)	0.0164 (15)	0.0048 (15)
O8	0.0355 (18)	0.060 (2)	0.0224 (16)	−0.0039 (18)	−0.0074 (14)	−0.0027 (16)
O9	0.0396 (18)	0.0194 (17)	0.0267 (17)	−0.0007 (15)	0.0140 (14)	−0.0017 (14)
O10	0.0242 (16)	0.0313 (19)	0.0248 (16)	0.0093 (15)	−0.0086 (13)	−0.0053 (14)
N1	0.0174 (16)	0.0169 (17)	0.0158 (15)	0.0039 (14)	−0.0022 (13)	−0.0021 (13)
N2	0.048 (3)	0.041 (2)	0.035 (2)	−0.007 (2)	−0.0195 (19)	0.005 (2)
N3	0.063 (3)	0.040 (3)	0.041 (2)	0.004 (2)	0.029 (2)	0.011 (2)
N4	0.041 (2)	0.082 (4)	0.019 (2)	0.003 (3)	−0.0027 (18)	0.009 (2)
C1	0.016 (2)	0.022 (2)	0.031 (2)	−0.0044 (18)	0.0064 (17)	−0.0001 (18)
C2	0.016 (2)	0.018 (2)	0.030 (2)	−0.0011 (17)	−0.0006 (16)	−0.0022 (18)
C3	0.023 (2)	0.014 (2)	0.022 (2)	0.0114 (17)	0.0023 (17)	0.0010 (16)
C4	0.015 (2)	0.021 (2)	0.030 (2)	0.0027 (17)	0.0022 (17)	−0.0006 (18)
C5	0.028 (2)	0.014 (2)	0.024 (2)	−0.0027 (18)	0.0012 (17)	−0.0031 (16)
C6	0.024 (2)	0.021 (2)	0.021 (2)	0.0081 (18)	−0.0023 (17)	−0.0011 (17)
C7	0.060 (3)	0.052 (4)	0.033 (3)	−0.018 (3)	−0.016 (2)	0.017 (3)
C8	0.042 (3)	0.036 (3)	0.036 (3)	−0.016 (2)	−0.015 (2)	0.013 (2)
C9	0.023 (2)	0.019 (2)	0.025 (2)	0.0030 (18)	−0.0035 (17)	−0.0009 (17)
C10	0.027 (2)	0.030 (3)	0.032 (2)	−0.004 (2)	0.0017 (19)	−0.002 (2)
C11	0.032 (3)	0.036 (3)	0.042 (3)	−0.008 (2)	−0.011 (2)	−0.004 (2)
C12	0.029 (2)	0.014 (2)	0.025 (2)	0.0058 (19)	−0.0040 (17)	−0.0054 (18)
C13	0.051 (3)	0.055 (4)	0.063 (4)	0.017 (3)	0.039 (3)	0.019 (3)
C14	0.036 (3)	0.047 (3)	0.046 (3)	0.011 (2)	0.017 (2)	0.018 (2)
C15	0.027 (2)	0.027 (2)	0.023 (2)	−0.001 (2)	0.0096 (18)	−0.0005 (18)
C16	0.045 (3)	0.038 (3)	0.039 (3)	0.012 (2)	0.018 (2)	0.012 (2)
C17	0.063 (4)	0.044 (3)	0.044 (3)	0.010 (3)	0.020 (3)	0.019 (3)
C18	0.0154 (19)	0.023 (2)	0.019 (2)	−0.0054 (18)	−0.0009 (16)	0.0014 (17)
C19	0.043 (3)	0.093 (5)	0.023 (3)	−0.017 (3)	−0.001 (2)	−0.017 (3)
C20	0.036 (3)	0.053 (3)	0.023 (2)	−0.014 (2)	0.0017 (19)	−0.004 (2)
C21	0.021 (2)	0.029 (2)	0.0154 (19)	0.0051 (19)	0.0068 (16)	−0.0001 (17)
C22	0.030 (2)	0.033 (3)	0.024 (2)	−0.002 (2)	0.0009 (18)	0.000 (2)
C23	0.052 (3)	0.043 (3)	0.031 (3)	0.005 (3)	0.014 (2)	0.014 (2)
C24	0.024 (2)	0.025 (2)	0.0138 (19)	0.0036 (19)	−0.0014 (17)	−0.0001 (17)

Geometric parameters (Å, °)

Dy—O7	2.298 (3)	C1—C2	1.365 (5)
Dy—O2^{i}	2.300 (3)	C1—H1	0.9300
Dy—O8^{i}	2.313 (3)	C2—C3	1.382 (5)
Dy—O1	2.324 (3)	C2—H2	0.9300
Dy—O10	2.366 (3)	C3—C4	1.388 (6)
Dy—O9	2.409 (3)	C3—C6	1.510 (5)
Dy—O6	2.433 (3)	C4—C5	1.386 (6)
Dy—O5	2.513 (3)	C4—H4	0.9300
Dy—C18	2.828 (4)	C5—H5	0.9300
Cu—O3	1.976 (3)	C7—C8	1.385 (6)
Cu—O3^{ii}	1.976 (3)	C7—H7	0.9300
Cu—N1	2.004 (3)	C8—C9	1.369 (6)
Cu—N1^{ii}	2.004 (3)	C8—H8	0.9300

Cu—N4^{iii}	2.639 (4)	C9—C10	1.382 (6)
O1—C6	1.243 (5)	C9—C12	1.515 (5)
O2—C6	1.244 (5)	C10—C11	1.384 (6)
O2—Dy^{i}	2.300 (3)	C10—H10	0.9300
O3—C12	1.271 (5)	C11—H11	0.9300
O4—C12	1.240 (5)	C13—C14	1.378 (6)
O5—C18	1.266 (5)	C13—H13	0.9300
O6—C18	1.253 (5)	C14—C15	1.376 (6)
O7—C24	1.248 (5)	C14—H14	0.9300
O8—C24	1.239 (5)	C15—C16	1.385 (6)
O8—Dy^{i}	2.313 (3)	C15—C18	1.499 (5)
O9—H9A	0.81 (3)	C16—C17	1.384 (6)
O9—H9B	0.82 (3)	C16—H16	0.9300
O10—H10A	0.82 (3)	C17—H17	0.9300
O10—H10B	0.81 (4)	C19—C20	1.368 (6)
N1—C5	1.341 (5)	C19—H19	0.9300
N1—C1	1.348 (5)	C20—C21	1.377 (6)
N2—C11	1.339 (6)	C20—H20	0.9300
N2—C7	1.340 (6)	C21—C22	1.382 (6)
N3—C17	1.331 (6)	C21—C24	1.504 (5)
N3—C13	1.334 (6)	C22—C23	1.381 (6)
N4—C19	1.304 (7)	C22—H22	0.9300
N4—C23	1.325 (7)	C23—H23	0.9300
O7—Dy—O2^{i}	76.94 (12)	C3—C2—H2	120.2
O7—Dy—O8^{i}	121.52 (12)	C2—C3—C4	118.6 (4)
O2^{i}—Dy—O8^{i}	73.71 (12)	C2—C3—C6	120.4 (4)
O7—Dy—O1	78.31 (12)	C4—C3—C6	120.9 (3)
O2^{i}—Dy—O1	121.25 (11)	C5—C4—C3	118.1 (3)
O8^{i}—Dy—O1	75.69 (12)	C5—C4—H4	120.9
O7—Dy—O10	79.29 (11)	C3—C4—H4	120.9
O2^{i}—Dy—O10	144.72 (12)	N1—C5—C4	123.3 (4)
O8^{i}—Dy—O10	141.53 (11)	N1—C5—H5	118.3
O1—Dy—O10	78.16 (11)	C4—C5—H5	118.3
O7—Dy—O9	77.68 (11)	O1—C6—O2	126.1 (4)
O2^{i}—Dy—O9	76.06 (11)	O1—C6—C3	117.4 (4)
O8^{i}—Dy—O9	138.25 (12)	O2—C6—C3	116.4 (4)
O1—Dy—O9	145.75 (11)	N2—C7—C8	123.5 (5)
O10—Dy—O9	73.66 (11)	N2—C7—H7	118.3
O7—Dy—O6	151.75 (11)	C8—C7—H7	118.3
O2^{i}—Dy—O6	89.43 (11)	C9—C8—C7	120.0 (4)
O8^{i}—Dy—O6	76.52 (11)	C9—C8—H8	120.0
O1—Dy—O6	129.48 (10)	C7—C8—H8	120.0
O10—Dy—O6	99.76 (11)	C8—C9—C10	117.5 (4)
O9—Dy—O6	75.05 (10)	C8—C9—C12	120.3 (4)
O7—Dy—O5	147.35 (11)	C10—C9—C12	122.2 (4)
O2^{i}—Dy—O5	135.54 (10)	C9—C10—C11	119.0 (4)

O8^{i}—Dy—O5	75.13 (10)	C9—C10—H10	120.5
O1—Dy—O5	79.68 (10)	C11—C10—H10	120.5
O10—Dy—O5	72.79 (10)	N2—C11—C10	124.2 (4)
O9—Dy—O5	109.42 (10)	N2—C11—H11	117.9
O6—Dy—O5	52.71 (9)	C10—C11—H11	117.9
O7—Dy—C18	165.56 (11)	O4—C12—O3	127.4 (4)
O2^{i}—Dy—C18	112.24 (11)	O4—C12—C9	118.0 (4)
O8^{i}—Dy—C18	72.62 (11)	O3—C12—C9	114.6 (4)
O1—Dy—C18	104.46 (11)	N3—C13—C14	124.5 (5)
O10—Dy—C18	87.36 (11)	N3—C13—H13	117.7
O9—Dy—C18	93.40 (11)	C14—C13—H13	117.7
O6—Dy—C18	26.21 (10)	C15—C14—C13	119.1 (5)
O5—Dy—C18	26.58 (10)	C15—C14—H14	120.4
O3—Cu—O3^{ii}	180.000 (1)	C13—C14—H14	120.4
O3—Cu—N1	89.27 (12)	C14—C15—C16	117.4 (4)
O3^{ii}—Cu—N1	90.73 (12)	C14—C15—C18	122.3 (4)
O3—Cu—N1^{ii}	90.73 (12)	C16—C15—C18	120.2 (4)
O3^{ii}—Cu—N1^{ii}	89.27 (12)	C17—C16—C15	119.2 (4)
N1—Cu—N1^{ii}	180.00 (17)	C17—C16—H16	120.4
O3—Cu—N4^{iii}	102.43 (12)	C15—C16—H16	120.4
O3^{ii}—Cu—N4^{iii}	77.57 (12)	N3—C17—C16	124.0 (5)
N1—Cu—N4^{iii}	93.04 (14)	N3—C17—H17	118.0
N1^{ii}—Cu—N4^{iii}	86.96 (14)	C16—C17—H17	118.0
C6—O1—Dy	140.1 (3)	O6—C18—O5	121.4 (3)
C6—O2—Dy^{i}	150.7 (3)	O6—C18—C15	119.2 (4)
C12—O3—Cu	137.0 (3)	O5—C18—C15	119.3 (4)
C18—O5—Dy	90.7 (2)	O6—C18—Dy	59.05 (19)
C18—O6—Dy	94.7 (2)	O5—C18—Dy	62.69 (19)
C24—O7—Dy	143.9 (3)	C15—C18—Dy	172.3 (3)
C24—O8—Dy^{i}	144.4 (3)	N4—C19—C20	125.5 (5)
Dy—O9—H9A	118 (3)	N4—C19—H19	117.3
Dy—O9—H9B	124 (3)	C20—C19—H19	117.3
H9A—O9—H9B	105 (5)	C19—C20—C21	118.0 (5)
Dy—O10—H10A	125 (3)	C19—C20—H20	121.0
Dy—O10—H10B	133 (4)	C21—C20—H20	121.0
H10A—O10—H10B	102 (5)	C20—C21—C22	118.3 (4)
C5—N1—C1	117.4 (3)	C20—C21—C24	121.2 (4)
C5—N1—Cu	123.0 (3)	C22—C21—C24	120.5 (4)
C1—N1—Cu	119.6 (3)	C23—C22—C21	117.8 (4)
C11—N2—C7	115.7 (4)	C23—C22—H22	121.1
C17—N3—C13	115.7 (4)	C21—C22—H22	121.1
C19—N4—C23	115.9 (4)	N4—C23—C22	124.3 (5)
N1—C1—C2	122.8 (3)	N4—C23—H23	117.8
N1—C1—H1	118.6	C22—C23—H23	117.8
C2—C1—H1	118.6	O8—C24—O7	126.3 (4)
C1—C2—C3	119.7 (4)	O8—C24—C21	117.1 (4)

C1—C2—H2	120.2	O7—C24—C21	116.5 (4)

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

Hydrogen-bond geometry (Å, °)

D—H···*A*	*D*—H	H···*A*	*D*···*A*	*D*—H···*A*
O9—H9A···O4^{iv}	0.81 (3)	1.98 (3)	2.778 (4)	169 (5)
O9—H9B···N3^{v}	0.82 (3)	2.07 (3)	2.883 (5)	176 (5)
O10—H10A···O5^{vi}	0.82 (3)	1.98 (2)	2.784 (4)	166 (5)
O10—H10B···N2^{vii}	0.81 (4)	1.99 (2)	2.796 (5)	169 (6)

Symmetry codes: (iv) *x*, *y*+1, *z*; (v) *x*−1/2, −*y*+3/2, *z*+1/2; (vi) −*x*+1, −*y*+1, −*z*+1; (vii) *x*+1/2, −*y*+1/2, *z*+1/2.

Fig. 1

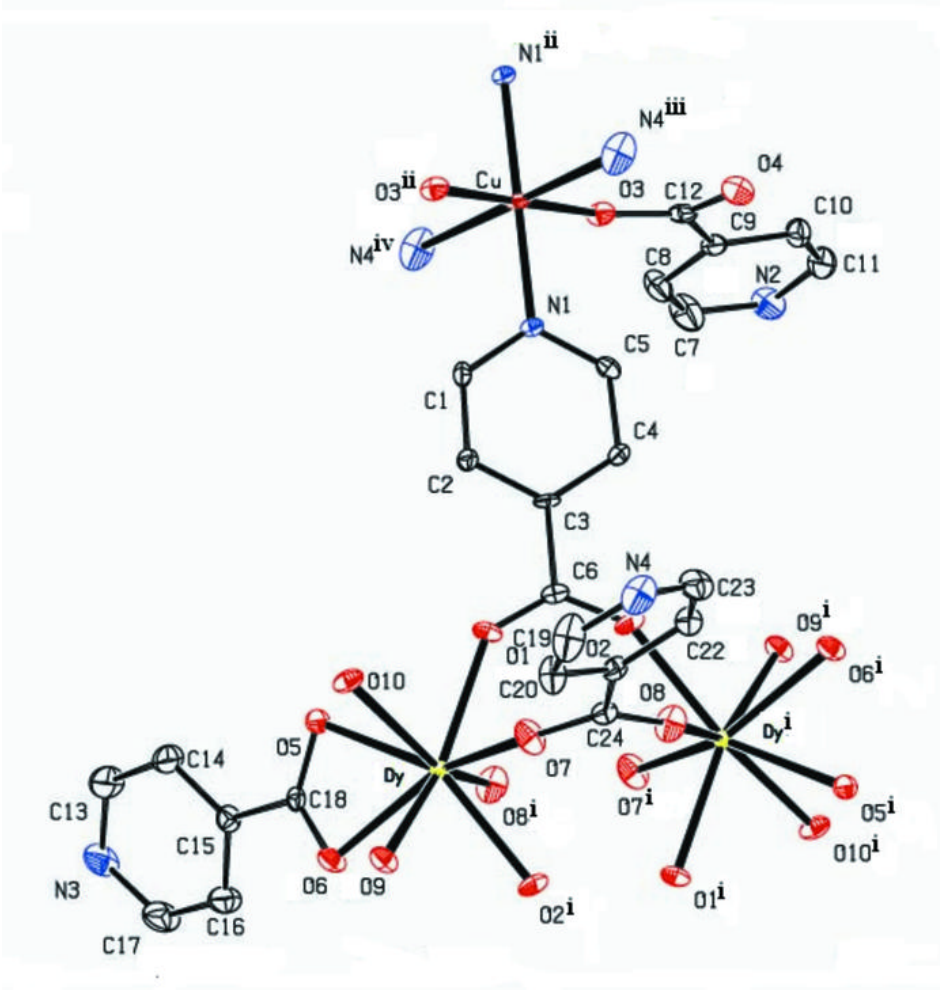
N1ii
N4iii
O4
O3ii
Cu
O3
C12
C10
C9
N4iv
C8
C11
N2
N1
C5
C7
C1
C4
C2
C3
C6
N4
C23
O9i
C19
O1
O2
C22
O6i
O10
C20
O8
C24
Dyi
O5
C14
O7
Dy
O7i
C13
C18
O8i
O5i
C15
O10i
N3
O6
O9
O2i
O1i
C16
C17

Fig. 2