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catena-Poly[[[(triphenylphosphane)copper(I)]-di-μ-iodido-[(triphenylphosphane)copper(I)]-μ-[3,6-bis(4-pyridyl)-1,2,4,5-tetrazine]] acetonitrile disolvate]

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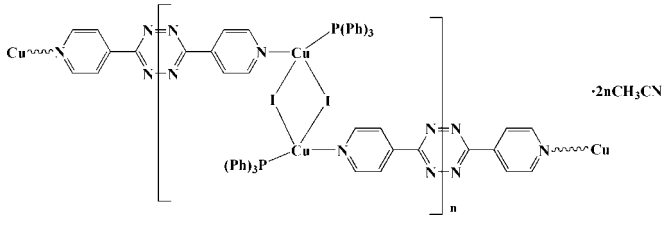
Key indicators: single-crystal X-ray study; T = 293 K; mean σ(C–C) = 0.007 Å; R factor = 0.040; wR factor = 0.079; data-to-parameter ratio = 16.9.

The title compound, $\{[Cu_2I_2(C_{12}H_8N_6)(C_{18}H_{15}P)_2]\cdot 2CH_3CN\}_n$, contains centrosymmetric dinuclear $Cu_2I_2(PPh_3)_2$ units bridged by 3,6-bis(4-pyridyl)-1,2,4,5-tetrazine ligands lying also across crystallographic inversion centers, giving a chain structure in the *ab* plane. The distorted tetrahedral Cu^I atoms in the dinuclear unit are coordinated by two bridging iodide anions, one pyridine N atom from the substituted tetrazine ligand and one terminal triphenylphosphine P-atom donor. The Cu···Cu distance is 2.8293 (12) Å, implying a weak Cu···Cu interaction.

Related literature

For examples of metal-organic compounds with intriguing architectures and topologies, see: Eddaoudi *et al.* (2001). For potential applications of these compounds, see: Banerjee *et al.* (2008); Zhang *et al.* (2007). For examples of metal-organic frameworks constructed using long bridging ligands, see: Withersby *et al.* (2000).



Experimental

Crystal data

$[Cu_2I_2(C_{12}H_8N_6)(C_{18}H_{15}P)_2]\cdot 2C_2H_3N$
M_r = 1223.80
Monoclinic, $P2_1/c$
a = 12.344 (3) Å
b = 11.675 (2) Å
c = 18.521 (4) Å
β = 101.41 (3)°
V = 2616.4 (10) Å^3
Z = 2
Mo $K\alpha$ radiation
μ = 2.10 mm^{-1}
T = 293 K
0.25 × 0.20 × 0.15 mm

Data collection

Rigaku Saturn724 diffractometer
Absorption correction: multi-scan (*CrystalClear*; Rigaku, 2007)
T_{min} = 0.779, T_{max} = 1.000
12271 measured reflections
5042 independent reflections
4233 reflections with $I > 2s(I)$
R_{int} = 0.030

Refinement

$R[F^2 > 2\sigma(F^2)]$ = 0.040
$wR(F^2)$ = 0.079
S = 1.09
5042 reflections
299 parameters
H-atom parameters constrained
$\Delta\rho_{max}$ = 0.49 e Å^{-3}
$\Delta\rho_{min}$ = −0.47 e Å^{-3}

Data collection: *CrystalClear* (Rigaku, 2007); cell refinement: *CrystalClear*; data reduction: *CrystalClear* ; program(s) used to solve structure: *SHELXS97* (Sheldrick, 2008); program(s) used to refine structure: *SHELXL97* (Sheldrick, 2008); molecular graphics: *SHELXTL* (Sheldrick, 2008); 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: ZS2071).

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supplementary materials

Acta Cryst. (2010). E**66**, m1480 [**doi:10.1107/S1600536810042807**]

catena-Poly[[[(triphenylphosphane)copper(I)]-di-μ-iodido-[(triphenylphosphane)copper(I)]-μ-[3,6-bis(4-pyridyl)-1,2,4,5-tetrazine]] acetonitrile disolvate]

J. Zhang

Comment

Metal-organic frameworks have attracted great attention in recent years not only because of their intriguing structures (Eddaoudi *et al.*, 2001) but also their potential applications (Banerjee *et al.*, 2008; Zhang *et al.*, 2007). Long bridging ligands can be employed for the construction of interesting metal-organic frameworks (Withersby *et al.*, 2000). The extended bridging ligand 2,6-bis(4-pyridyl)-1,2,4,5-tetrazine was used to synthesize the title compound $\{[Cu_2I_2(C_{12}H_8N_6)((C_6H_5)_3P)_2 .2(CH_3CN)\}_n$ (3,6-di$_2$(PPh$_3$)$_2$ (I) by using a diffusion reaction and the crystal structure is presented here.

The centrosymmetric dinuclear $Cu_2I_2(PPh_3)_2$ complex units in (I) are linked by the extended 3,6-di-4-pyridyl-1,2,4,5-tetrazine ligands, also lying across crystallographic inversion centers, giving a one-dimensional chain structure (Fig. 1). Each tetrahedral Cu^I centre in the dinuclear unit is coordinated by two bridging I anions [Cu—I, 2.6412 (9), 2.6603 (9) Å], one pyridine-N from the bridging substituted tetrazine ligand [Cu—N, 2.066 (3)Å] and one terminal triphenylphosphine P-donor [Cu—P, 2.2388 (11) Å]. The Cu···Cu^i distance is 2.8293 (12) Å, implying a weak Cu···Cu interaction [symmetry code: (i) -*x*, -*y*, -*z*].

Experimental

CuI (0.1 mmol) and triphenylphosphine (0.2 mmol) were added to a mixture of 3 ml of dimethylformamide and 2 ml of H_3CN with thorough stirring for 2 minutes. After filtering, the filtrate was carefully layered with a solution of 0.1 mmol 3,6-bis(4-pyridyl)-1,2,4,5-tetrazine in 3 ml of CH_2Cl_2. Blue block crystals were obtained after two weeks.

Refinement

H atoms were positioned geometrically with C—H(phenyl, pyridyl) = 0.93 Å or 0.96 Å (methyl) and refined using a riding model, with U_{iso}(H) = 1.2U_{eq}(C)$_{phenyl,\ pyridyl}$ or 1.5U_{eq}(C)$_{methyl}$.

Figures

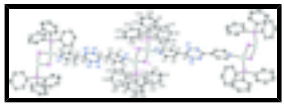


Fig. 1. The molecular structure of a portion of the title compound, with atom labels and 30% probability displacement ellipsoids. All H atoms have been omitted. Symmetry codes: (i) -*x*, -*y*, -*z*; (ii) -*x* + 1, -*y* - 1, -*z*.

catena-Poly[[[(triphenylphosphane)copper(I)]-di-μ-iodido- [(triphenylphosphane)copper(I)]-μ-[3,6-bis(4-pyridyl)-1,2,4,5-tetrazine]] acetonitrile disolvate]

Crystal data

$[Cu_2I_2(C_{12}H_8N_6)(C_{18}H_{15}P)_2]\cdot 2C_2H_3N$	$F(000) = 1212$
$M_r = 1223.80$	$D_x = 1.553$ Mg m^{-3}
Monoclinic, $P2_1/c$	Mo $K\alpha$ radiation, $\lambda = 0.71073$ Å
Hall symbol: -P 2ybc	Cell parameters from 10225 reflections
$a = 12.344$ (3) Å	$\theta = 2.8$–$29.1°$
$b = 11.675$ (2) Å	$\mu = 2.10$ mm^{-1}
$c = 18.521$ (4) Å	$T = 293$ K
$\beta = 101.41$ (3)°	Block, blue
$V = 2616.4$ (10) Å^3	0.25 × 0.20 × 0.15 mm
$Z = 2$	

Data collection

Rigaku Saturn724 diffractometer	5042 independent reflections
Radiation source: fine-focus sealed tube	4233 reflections with $I > 2s\tilde{}I$)
graphite	$R_{int} = 0.030$
ω scans	$\theta_{max} = 26.0°$, $\theta_{min} = 2.8°$
Absorption correction: multi-scan (*CrystalClear*; Rigaku, 2007)	$h = -15\rightarrow 11$
$T_{min} = 0.779$, $T_{max} = 1.000$	$k = -14\rightarrow 14$
12271 measured reflections	$l = -18\rightarrow 22$

Refinement

Refinement on F^2	Primary atom site location: structure-invariant direct methods
Least-squares matrix: full	Secondary atom site location: difference Fourier map
$R[F^2 > 2\sigma(F^2)] = 0.040$	Hydrogen site location: inferred from neighbouring sites
$wR(F^2) = 0.079$	H-atom parameters constrained
$S = 1.09$	$w = 1/[\sigma^2(F_o^2) + (0.0303P)^2 + 0.5456P]$ where $P = (F_o^2 + 2F_c^2)/3$
5042 reflections	$(\Delta/\sigma)_{max} = 0.001$
299 parameters	$\Delta\rho_{max} = 0.49$ e Å^{-3}
0 restraints	$\Delta\rho_{min} = -0.47$ e Å^{-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}
I1	−0.01591 (2)	−0.05190 (2)	0.113971 (13)	0.04604 (10)
Cu1	0.11635 (4)	0.00036 (4)	0.02284 (2)	0.04082 (13)
P1	0.23134 (8)	0.14551 (8)	0.06241 (5)	0.0398 (2)
N1	0.1998 (2)	−0.1497 (2)	0.01109 (16)	0.0407 (7)
N2	0.4794 (3)	−0.4221 (3)	−0.05567 (17)	0.0466 (8)
N3	0.4453 (3)	−0.4974 (3)	0.05724 (16)	0.0468 (8)
N4	0.1913 (5)	0.7319 (6)	0.2563 (3)	0.121 (2)
C6	0.4276 (3)	−0.4218 (3)	0.0010 (2)	0.0393 (9)
C13	0.3435 (3)	0.1093 (3)	0.13879 (19)	0.0433 (9)
C2	0.3008 (3)	−0.3135 (3)	0.0653 (2)	0.0518 (10)
H2	0.3187	−0.3623	0.1055	0.062*
C23	0.0102 (5)	0.3983 (5)	0.0741 (4)	0.101 (2)
H23	−0.0614	0.4153	0.0498	0.121*
C22	0.0648 (6)	0.4706 (5)	0.1276 (4)	0.106 (2)
H22	0.0300	0.5367	0.1394	0.128*
C21	0.1706 (5)	0.4459 (4)	0.1637 (4)	0.0941 (19)
H21	0.2070	0.4945	0.2004	0.113*
C3	0.3460 (3)	−0.3303 (3)	0.00372 (19)	0.0383 (8)
C1	0.2290 (3)	−0.2235 (3)	0.0664 (2)	0.0517 (10)
H1	0.1990	−0.2137	0.1083	0.062*
C8	0.3772 (4)	0.1219 (4)	−0.0334 (2)	0.0648 (12)
H8	0.3975	0.0542	−0.0078	0.078*
C7	0.3016 (3)	0.1947 (3)	−0.01016 (19)	0.0463 (9)
C4	0.3140 (3)	−0.2564 (3)	−0.0553 (2)	0.0483 (10)
H4	0.3409	−0.2660	−0.0984	0.058*
C19	0.1689 (3)	0.2757 (3)	0.0911 (2)	0.0481 (10)
C16	0.5102 (4)	0.0355 (4)	0.2532 (2)	0.0654 (13)
H16	0.5662	0.0099	0.2910	0.079*
C5	0.2420 (3)	−0.1687 (3)	−0.0490 (2)	0.0472 (10)
H5	0.2214	−0.1197	−0.0890	0.057*
C17	0.5309 (4)	0.1236 (4)	0.2086 (2)	0.0631 (12)
H17	0.5998	0.1587	0.2166	0.076*
C18	0.4468 (3)	0.1597 (4)	0.1513 (2)	0.0554 (11)
H18	0.4606	0.2190	0.1208	0.066*
C14	0.3247 (4)	0.0209 (3)	0.1853 (2)	0.0522 (10)
H14	0.2557	−0.0141	0.1779	0.063*
C24	0.0620 (4)	0.2999 (4)	0.0565 (3)	0.0708 (13)
H24	0.0245	0.2500	0.0210	0.085*

C11	0.3177 (5)	0.3187 (5)	−0.1108 (3)	0.0841 (16)
H11	0.2973	0.3857	−0.1371	0.101*
C15	0.4076 (4)	−0.0155 (4)	0.2426 (2)	0.0646 (13)
H15	0.3940	−0.0740	0.2737	0.078*
C10	0.3914 (5)	0.2462 (6)	−0.1326 (3)	0.0908 (19)
H10	0.4206	0.2632	−0.1740	0.109*
C12	0.2727 (4)	0.2936 (4)	−0.0497 (2)	0.0648 (12)
H12	0.2226	0.3440	−0.0353	0.078*
C20	0.2222 (4)	0.3491 (4)	0.1454 (3)	0.0706 (13)
H20	0.2939	0.3326	0.1697	0.085*
C9	0.4224 (4)	0.1483 (5)	−0.0934 (3)	0.0834 (16)
H9	0.4741	0.0994	−0.1075	0.100*
C26	−0.0159 (6)	0.7161 (6)	0.2552 (3)	0.125 (3)
H26A	−0.0565	0.7385	0.2076	0.187*
H26B	−0.0362	0.7646	0.2922	0.187*
H26C	−0.0329	0.6380	0.2647	0.187*
C25	0.1023 (7)	0.7271 (6)	0.2569 (3)	0.0907 (19)

Atomic displacement parameters (Å^2)

	U^{11}	U^{22}	U^{33}	U^{12}	U^{13}	U^{23}
I1	0.04230 (17)	0.05492 (18)	0.04190 (15)	0.00885 (12)	0.01074 (11)	0.00954 (12)
Cu1	0.0381 (3)	0.0371 (3)	0.0471 (3)	0.0054 (2)	0.0081 (2)	0.0014 (2)
P1	0.0371 (5)	0.0416 (5)	0.0413 (5)	−0.0004 (4)	0.0089 (4)	0.0018 (4)
N1	0.0381 (18)	0.0412 (17)	0.0443 (17)	0.0114 (14)	0.0116 (14)	0.0046 (15)
N2	0.048 (2)	0.0468 (18)	0.0485 (18)	0.0197 (16)	0.0180 (15)	0.0066 (15)
N3	0.050 (2)	0.0467 (18)	0.0454 (18)	0.0190 (16)	0.0146 (15)	0.0055 (16)
N4	0.108 (5)	0.154 (5)	0.095 (4)	0.031 (5)	0.005 (4)	0.022 (3)
C6	0.037 (2)	0.0367 (19)	0.044 (2)	0.0082 (16)	0.0076 (17)	0.0012 (17)
C13	0.037 (2)	0.052 (2)	0.0395 (19)	0.0020 (18)	0.0045 (17)	−0.0006 (18)
C2	0.062 (3)	0.049 (2)	0.049 (2)	0.027 (2)	0.019 (2)	0.0137 (19)
C23	0.076 (4)	0.080 (4)	0.138 (5)	0.033 (3)	−0.001 (4)	−0.028 (4)
C22	0.103 (5)	0.062 (3)	0.158 (6)	0.020 (3)	0.033 (5)	−0.038 (4)
C21	0.082 (4)	0.072 (4)	0.129 (5)	−0.004 (3)	0.023 (4)	−0.046 (3)
C3	0.033 (2)	0.037 (2)	0.045 (2)	0.0086 (16)	0.0087 (16)	−0.0022 (17)
C1	0.056 (3)	0.056 (2)	0.049 (2)	0.025 (2)	0.0236 (19)	0.012 (2)
C8	0.066 (3)	0.070 (3)	0.062 (3)	−0.005 (3)	0.022 (2)	−0.003 (2)
C7	0.045 (2)	0.053 (2)	0.041 (2)	−0.0093 (19)	0.0079 (18)	0.0023 (19)
C4	0.051 (2)	0.053 (2)	0.044 (2)	0.019 (2)	0.0167 (18)	0.0094 (19)
C19	0.047 (2)	0.044 (2)	0.055 (2)	−0.0004 (19)	0.0153 (19)	−0.002 (2)
C16	0.060 (3)	0.085 (3)	0.046 (2)	0.014 (3)	−0.004 (2)	−0.010 (2)
C5	0.046 (2)	0.052 (2)	0.045 (2)	0.0205 (19)	0.0113 (18)	0.0115 (19)
C17	0.044 (3)	0.082 (3)	0.060 (3)	−0.006 (2)	0.002 (2)	−0.006 (3)
C18	0.046 (3)	0.068 (3)	0.052 (2)	−0.002 (2)	0.008 (2)	0.002 (2)
C14	0.052 (3)	0.060 (3)	0.045 (2)	−0.001 (2)	0.009 (2)	0.002 (2)
C24	0.060 (3)	0.063 (3)	0.084 (3)	0.012 (2)	0.002 (3)	−0.014 (3)
C11	0.095 (4)	0.095 (4)	0.062 (3)	−0.029 (3)	0.014 (3)	0.023 (3)
C15	0.078 (4)	0.066 (3)	0.046 (2)	0.009 (3)	0.003 (2)	0.009 (2)

C10	0.102 (5)	0.129 (5)	0.048 (3)	−0.047 (4)	0.032 (3)	−0.002 (3)
C12	0.068 (3)	0.066 (3)	0.061 (3)	−0.011 (2)	0.011 (2)	0.014 (2)
C20	0.055 (3)	0.063 (3)	0.094 (3)	−0.007 (2)	0.015 (3)	−0.028 (3)
C9	0.086 (4)	0.102 (4)	0.074 (3)	−0.020 (3)	0.044 (3)	−0.021 (3)
C26	0.147 (7)	0.118 (5)	0.129 (6)	0.040 (5)	0.076 (5)	0.056 (4)
C25	0.118 (6)	0.096 (4)	0.060 (3)	0.033 (5)	0.022 (4)	0.022 (3)

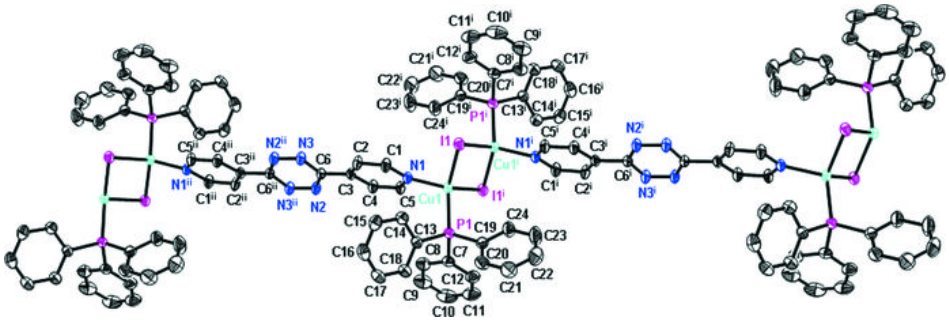
Geometric parameters (Å, °)

Cu1—N1	2.066 (3)	C8—C7	1.392 (6)
Cu1—P1	2.2388 (11)	C8—H8	0.9300
Cu1—I1^{i}	2.6603 (9)	C7—C12	1.376 (6)
Cu1—Cu1^{i}	2.8293 (12)	C4—C5	1.376 (5)
P1—C13	1.823 (4)	C4—H4	0.9300
P1—C19	1.830 (4)	C19—C24	1.378 (5)
P1—C7	1.831 (4)	C19—C20	1.384 (6)
N1—C1	1.333 (4)	C16—C17	1.374 (6)
N1—C5	1.338 (4)	C16—C15	1.378 (6)
N2—N3^{ii}	1.327 (4)	C16—H16	0.9300
N2—C6	1.333 (5)	C5—H5	0.9300
N3—N2^{ii}	1.327 (4)	C17—C18	1.395 (5)
N3—C6	1.349 (4)	C17—H17	0.9300
N4—C25	1.102 (8)	C18—H18	0.9300
C6—C3	1.476 (5)	C14—C15	1.386 (6)
C13—C18	1.382 (5)	C14—H14	0.9300
C13—C14	1.393 (5)	C24—H24	0.9300
C2—C1	1.378 (5)	C11—C10	1.361 (8)
C2—C3	1.378 (5)	C11—C12	1.387 (6)
C2—H2	0.9300	C11—H11	0.9300
C23—C22	1.372 (8)	C15—H15	0.9300
C23—C24	1.385 (6)	C10—C9	1.368 (7)
C23—H23	0.9300	C10—H10	0.9300
C22—C21	1.376 (8)	C12—H12	0.9300
C22—H22	0.9300	C20—H20	0.9300
C21—C20	1.373 (6)	C9—H9	0.9300
C21—H21	0.9300	C26—C25	1.460 (9)
C3—C4	1.387 (5)	C26—H26A	0.9600
C1—H1	0.9300	C26—H26B	0.9600
C8—C9	1.374 (6)	C26—H26C	0.9600
Cu1—I1—Cu1^{i}	64.51 (3)	C8—C7—P1	118.6 (3)
N1—Cu1—P1	112.29 (9)	C5—C4—C3	119.0 (4)
N1—Cu1—I1	104.81 (9)	C5—C4—H4	120.5
P1—Cu1—I1	113.43 (3)	C3—C4—H4	120.5
N1—Cu1—I1^{i}	103.87 (8)	C24—C19—C20	119.0 (4)
P1—Cu1—I1^{i}	106.64 (4)	C24—C19—P1	117.0 (3)
I1—Cu1—I1^{i}	115.49 (3)	C20—C19—P1	123.9 (3)
N1—Cu1—Cu1^{i}	117.65 (9)	C17—C16—C15	120.8 (4)

P1—Cu1—Cu1^{i}	129.83 (4)	C17—C16—H16	119.6
I1—Cu1—Cu1^{i}	58.07 (3)	C15—C16—H16	119.6
I1^{i}—Cu1—Cu1^{i}	57.42 (3)	N1—C5—C4	123.9 (3)
C13—P1—C19	105.43 (17)	N1—C5—H5	118.1
C13—P1—C7	104.18 (18)	C4—C5—H5	118.1
C19—P1—C7	103.94 (19)	C16—C17—C18	119.0 (4)
C13—P1—Cu1	114.42 (13)	C16—C17—H17	120.5
C19—P1—Cu1	116.59 (13)	C18—C17—H17	120.5
C7—P1—Cu1	111.05 (12)	C13—C18—C17	121.4 (4)
C1—N1—C5	116.3 (3)	C13—C18—H18	119.3
C1—N1—Cu1	122.1 (2)	C17—C18—H18	119.3
C5—N1—Cu1	120.8 (2)	C15—C14—C13	120.8 (4)
N3^{ii}—N2—C6	117.8 (3)	C15—C14—H14	119.6
N2^{ii}—N3—C6	117.0 (3)	C13—C14—H14	119.6
N2—C6—N3	125.2 (3)	C19—C24—C23	120.3 (5)
N2—C6—C3	117.7 (3)	C19—C24—H24	119.8
N3—C6—C3	117.0 (3)	C23—C24—H24	119.8
C18—C13—C14	118.3 (3)	C10—C11—C12	120.7 (5)
C18—C13—P1	124.4 (3)	C10—C11—H11	119.7
C14—C13—P1	117.3 (3)	C12—C11—H11	119.7
C1—C2—C3	119.3 (3)	C16—C15—C14	119.7 (4)
C1—C2—H2	120.4	C16—C15—H15	120.1
C3—C2—H2	120.4	C14—C15—H15	120.1
C22—C23—C24	119.8 (5)	C11—C10—C9	119.7 (5)
C22—C23—H23	120.1	C11—C10—H10	120.1
C24—C23—H23	120.1	C9—C10—H10	120.1
C23—C22—C21	120.4 (5)	C7—C12—C11	120.5 (5)
C23—C22—H22	119.8	C7—C12—H12	119.7
C21—C22—H22	119.8	C11—C12—H12	119.7
C20—C21—C22	119.7 (5)	C21—C20—C19	120.8 (5)
C20—C21—H21	120.2	C21—C20—H20	119.6
C22—C21—H21	120.2	C19—C20—H20	119.6
C2—C3—C4	117.6 (3)	C10—C9—C8	120.1 (5)
C2—C3—C6	121.5 (3)	C10—C9—H9	120.0
C4—C3—C6	120.9 (3)	C8—C9—H9	120.0
N1—C1—C2	123.9 (4)	C25—C26—H26A	109.5
N1—C1—H1	118.1	C25—C26—H26B	109.5
C2—C1—H1	118.1	H26A—C26—H26B	109.5
C9—C8—C7	121.1 (5)	C25—C26—H26C	109.5
C9—C8—H8	119.4	H26A—C26—H26C	109.5
C7—C8—H8	119.4	H26B—C26—H26C	109.5
C12—C7—C8	117.9 (4)	N4—C25—C26	177.2 (8)
C12—C7—P1	122.9 (3)		

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

Fig. 1


C11i
C10i
C9i
C12i
C21i
C8i
C17i
C22i
C20i
C7i
C18i
C16i
C23i
C19i
P1i
C13i
C14i
C15i
C24i
C5i
C4i
N2i
I1
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C3i
Cu1i
C1i
C2i
C6i
N3i
N2ii
N3
C6
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C15
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P1
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C8
C7
C20
C22
C17
C9
C12
C21
C10
C11