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Poly[(μ_3 -quinoline-6-carboxylato- κ^3 N:O:O')silver(I)]Chun-Wei Yeh,^a Ay Jong,^b Chi-Hui Tsou,^c Fu-Chang Huang^d and Maw-Cherng Suen^{e*}^aDepartment of Chemistry, Chung-Yuan Christian University, Jhongli 32023, Taiwan,^bDepartment of Applied Cosmetology, Taoyuan Innovation Institute of Technology, Jhongli 32091, Taiwan, ^cDepartment of Materials Science and Engineering, National Taiwan University of Science and Technology, Taipei 10607, Taiwan, ^dDepartment of Civil and Environmental Engineering, Department of Materials Science and Engineering, Taoyuan Innovation Institute of Technology, Jhongli 32091, Taiwan, and ^eDepartment of Materials and Fibers, Taoyuan Innovation Institute of Technology, Jhongli 32091, Taiwan

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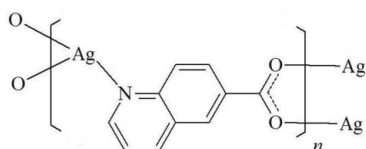
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Key indicators: single-crystal X-ray study; $T = 294$ K; mean $\sigma(\text{C}-\text{C}) = 0.004$ Å; R factor = 0.027; wR factor = 0.075; data-to-parameter ratio = 13.2.

In the title coordination polymer, $[\text{Ag}(\text{C}_{10}\text{H}_6\text{NO}_2)]_n$, the Ag^+ cation is coordinated by two O atoms and one N atom from three 6-quinolinecarboxylate anions in a distorted T-shaped AgNO_2 geometry, in which the O—Ag—O angle is 160.44 (9)°. The 6-quinolinecarboxylate anion bridges three Ag^+ cations, forming a nearly planar polymeric sheet parallel to (101). The distance between Ag^+ cations bridged by the carboxyl group is 2.9200 (5) Å. In the crystal, π - π stacking is observed between parallel quinoline ring systems, the centroid-centroid distance being 3.7735 (16) Å.

Related literature

For background to coordination polymers with organic ligands, see: Kitagawa *et al.* (2004); Chiang *et al.* (2008); Yeh *et al.* (2008, 2009); Hsu *et al.* (2009). For related pyridine-carboxylate structures, see: Yeh *et al.* (2004); Ockwig *et al.* (2005); Chen *et al.* (2008); Hirano *et al.* (2002) and for related 6-quinolinecarboxylate structures, see: Lin & Maggard (2007); Du *et al.* (2008a,b); Hu *et al.* (2008); Xu *et al.* (2009).



Experimental

Crystal data

 $[\text{Ag}(\text{C}_{10}\text{H}_6\text{NO}_2)]$
 $M_r = 280.03$

 Monoclinic, $C2/c$
 $a = 13.0008$ (10) Å

 $b = 14.3900$ (11) Å
 $c = 9.3431$ (7) Å
 $\beta = 103.446$ (1)°
 $V = 1700.0$ (2) Å³
 $Z = 8$

 Mo $K\alpha$ radiation
 $\mu = 2.34$ mm⁻¹
 $T = 294$ K
 $0.39 \times 0.28 \times 0.25$ mm

Data collection

 Bruker APEXII CCD diffractometer
 Absorption correction: multi-scan (SADABS; Bruker, 2000)
 $T_{\min} = 0.471$, $T_{\max} = 1.000$

 4717 measured reflections
 1674 independent reflections
 1543 reflections with $I > 2\sigma(I)$
 $R_{\text{int}} = 0.021$

Refinement

 $R[F^2 > 2\sigma(F^2)] = 0.027$
 $wR(F^2) = 0.075$
 $S = 1.08$
 1674 reflections

 127 parameters
 H-atom parameters constrained
 $\Delta\rho_{\text{max}} = 0.37$ e Å⁻³
 $\Delta\rho_{\text{min}} = -0.94$ e Å⁻³

Table 1

Selected bond lengths (Å).

Ag—O ⁱ	2.2067 (19)	Ag—N	2.397 (2)
Ag—O ⁱⁱ	2.252 (2)		

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

Data collection: APEX2 (Bruker, 2010); cell refinement: SAINT (Bruker, 2010); data reduction: SAINT; program(s) used to solve structure: SHELXS97 (Sheldrick, 2008); program(s) used to refine structure: SHELXL97 (Sheldrick, 2008); molecular graphics: DIAMOND (Brandenburg, 2010); software used to prepare material for publication: SHELXL97.

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Supplementary data and figures for this paper are available from the IUCr electronic archives (Reference: XU5546).

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Yeh, C.-W., Chen, J.-D. & Wang, J.-C. (2008). *Polyhedron*, **27**, 3611–3618.

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supporting information

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Poly[(μ_3 -quinoline-6-carboxylato- κ^3 N:O:O')silver(I)]

Chun-Wei Yeh, Ay Jong, Chi-Hui Tsou, Fu-Chang Huang and Maw-Cherng Suen

S1. Comment

The synthesis of metal coordination polymers has been a subject of intense research due to their interesting structural chemistry and potential applications in gas storage, separation, catalysis, magnetism, luminescence, and drug delivery (Kitagawa *et al.*, 2004). Roles of anion, solvent and ligand conformations in self-assembly of coordination complexes containing polydentate nitrogen ligands are very interesting (Chiang *et al.*, 2008; Yeh *et al.*, 2008; Hsu *et al.*, 2009; Yeh *et al.*, 2009). In the past, the pyridinecarboxylate ligands have been subjected to many studies of its coordination ability to metal centers (Yeh *et al.*, 2004; Ockwig *et al.*, 2005; Chen *et al.*, 2008; Hirano *et al.*, 2002). The various metal complexes containing 6-quinolinecarboxylate (*L*-) ligands have been reported, which show various multi-dimensional frameworks (Lin & Maggard, 2007; Du *et al.*, 2008*a,b*; Hu *et al.*, 2008; Xu *et al.*, 2009). The Ag⁺ cations are coordinated with two N atoms from two 1,2-bis(4,4-dimethyl-4,5-dihydrooxazol-2-yl)ethane (*L*) ligands (Fig. 1). The Ag...Ag distances separated by the bridging *L*- anions are 2.9200 (5), 9.974 (1) and 10.469 (1) Å, while the unit of dinuclear Ag⁺ are forming (4,4) polymeric nets (Fig. 2). The two-dimensional polymeric nets are interlinking through Ag...O interactions [2.954 (2) Å] and pi—pi stacking interactions in the crystal structure (Fig. 3).

S2. Experimental

An aqueous solution (5.0 ml) of AgNO₃ (1.0 mmol) was layered carefully over a methanolic solution (5.0 ml) of 6-quinolinecarboxylic acid (1.0 mmol) in a tube and kept it in the dark. Colourless crystals were obtained after several weeks.

S3. Refinement

All the H atoms were constrained to ideal geometries, with C—H = 0.93 Å (aromatic) and $U_{\text{iso}}(\text{H}) = 1.2U_{\text{eq}}(\text{C})$.

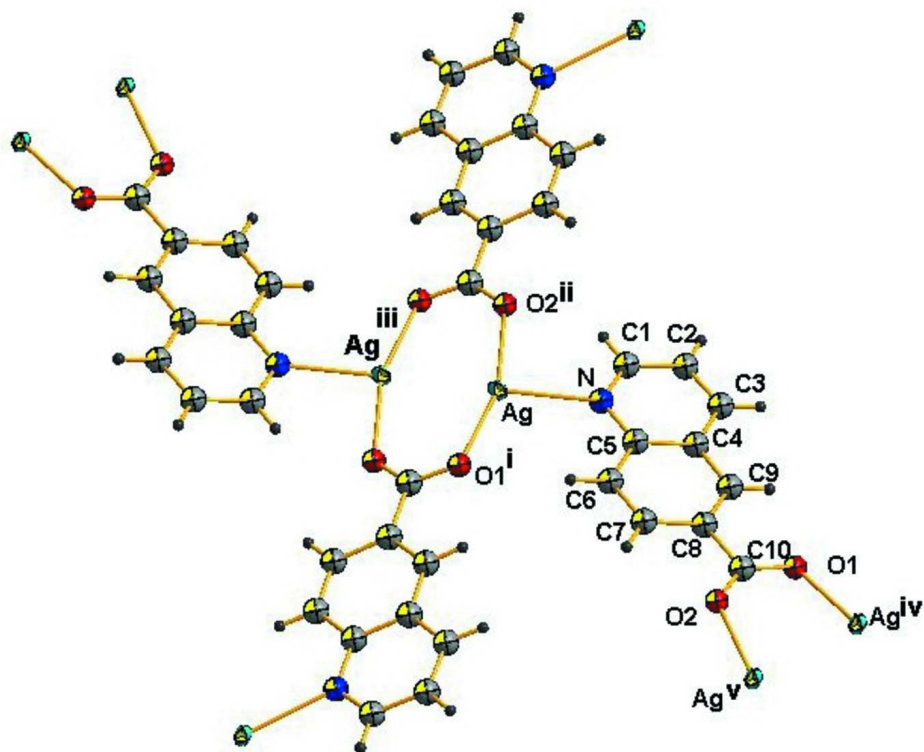


Figure 1

A portion of the two-dimensional grid. Ellipsoids are drawn at 30% probability level. Symmetry codes: (i) $-x + 1/2, y + 1/2, -z + 1/2$; (ii) $x + 1/2, -y + 1/2, z - 1/2$; (iii) $-x + 1, -y + 1, -z$; (iv) $-x + 1/2, y - 1/2, -z + 1/2$; (v) $x - 1/2, -y + 1/2, z + 1/2$.

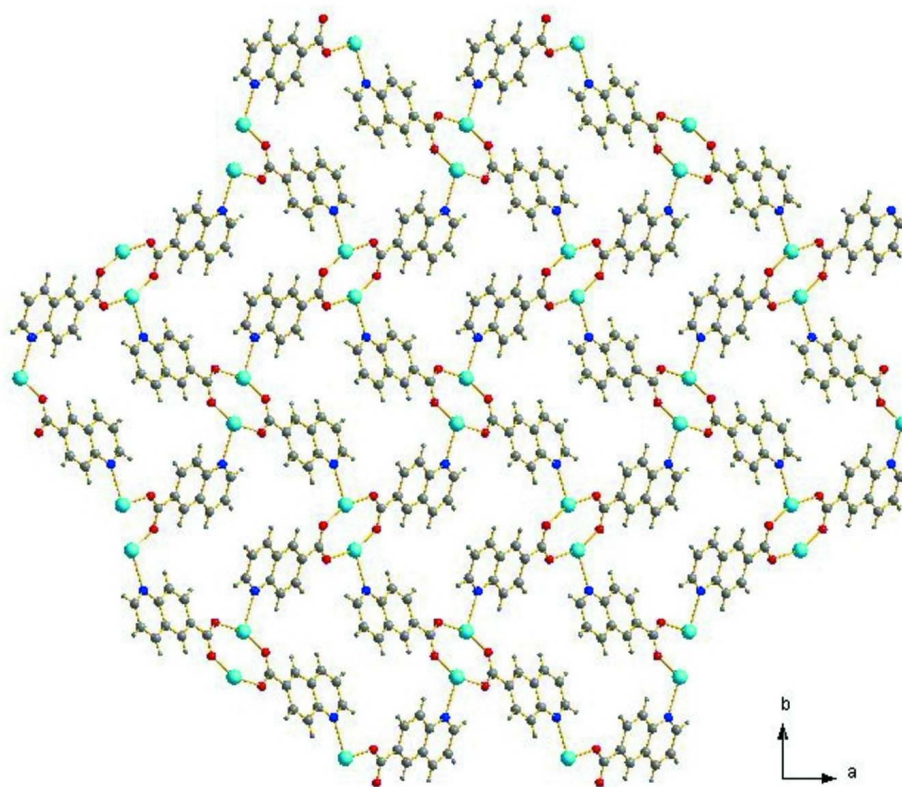


Figure 2

The view shows the pleated (4,4) net along (001) direction.

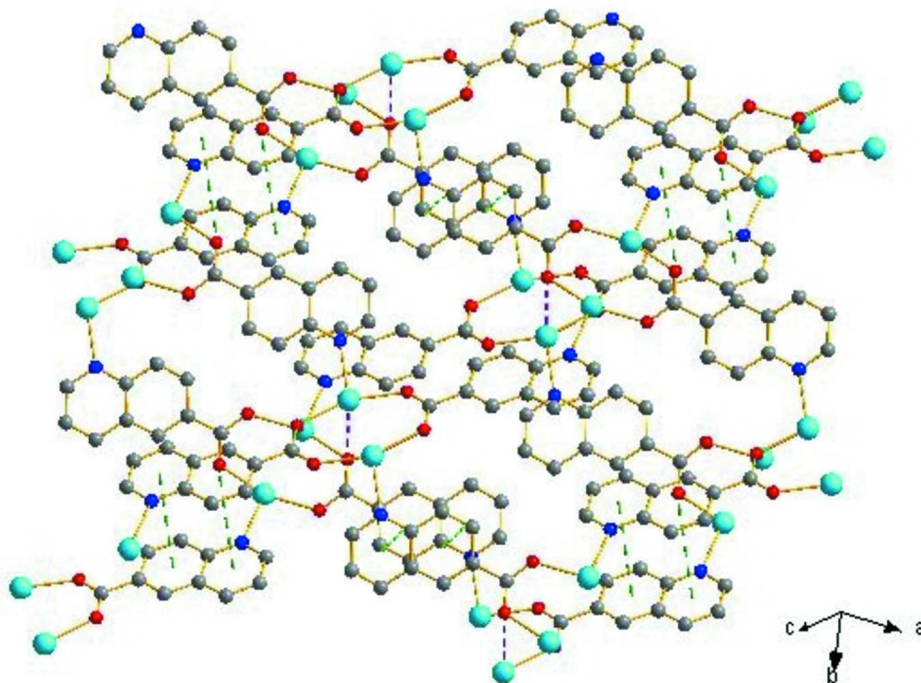


Figure 3

The packing diagram shows the Ag \cdots O interactions and π - π stacking interactions between the two-dimensional networks.

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Crystal data

[Ag(C₁₀H₆NO₂)]

$M_r = 280.03$

Monoclinic, *C2/c*

Hall symbol: -C 2yc

$a = 13.0008$ (10) Å

$b = 14.3900$ (11) Å

$c = 9.3431$ (7) Å

$\beta = 103.446$ (1)°

$V = 1700.0$ (2) Å³

$Z = 8$

$F(000) = 1088$

$D_x = 2.188$ Mg m⁻³

Mo $K\alpha$ radiation, $\lambda = 0.71073$ Å

Cell parameters from 3671 reflections

$\theta = 2.2$ – 26.0 °

$\mu = 2.34$ mm⁻¹

$T = 294$ K

Block, colourless

$0.39 \times 0.28 \times 0.25$ mm

Data collection

Bruker APEXII CCD
diffractometer

Radiation source: fine-focus sealed tube

Graphite monochromator

φ and ω scans

Absorption correction: multi-scan
(*SADABS*; Bruker, 2000)

$T_{\min} = 0.471$, $T_{\max} = 1.000$

4717 measured reflections

1674 independent reflections

1543 reflections with $I > 2\sigma(I)$

$R_{\text{int}} = 0.021$

$\theta_{\max} = 26.0$ °, $\theta_{\min} = 2.1$ °

$h = -16 \rightarrow 7$

$k = -17 \rightarrow 17$

$l = -11 \rightarrow 11$

Refinement

Refinement on F^2
 Least-squares matrix: full
 $R[F^2 > 2\sigma(F^2)] = 0.027$
 $wR(F^2) = 0.075$
 $S = 1.08$
 1674 reflections
 127 parameters
 0 restraints
 Primary atom site location: structure-invariant
 direct methods

Secondary atom site location: difference Fourier
 map
 Hydrogen site location: inferred from
 neighbouring sites
 H-atom parameters constrained
 $w = 1/[\sigma^2(F_o^2) + (0.0444P)^2 + 2.6516P]$
 where $P = (F_o^2 + 2F_c^2)/3$
 $(\Delta/\sigma)_{\max} = 0.001$
 $\Delta\rho_{\max} = 0.37 \text{ e } \text{\AA}^{-3}$
 $\Delta\rho_{\min} = -0.94 \text{ e } \text{\AA}^{-3}$

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 (\AA^2)

	x	y	z	$U_{\text{iso}}^*/U_{\text{eq}}$
Ag	0.47914 (2)	0.410289 (16)	0.06057 (3)	0.04647 (13)
O1	0.12021 (17)	-0.00759 (14)	0.3242 (2)	0.0426 (5)
O2	0.1053 (2)	0.12550 (16)	0.4404 (3)	0.0530 (6)
N	0.42688 (18)	0.25041 (16)	0.0564 (2)	0.0345 (5)
C1	0.4658 (2)	0.2003 (2)	-0.0380 (3)	0.0422 (7)
H1A	0.5138	0.2286	-0.0840	0.051*
C2	0.4390 (3)	0.1078 (2)	-0.0724 (4)	0.0460 (7)
H2A	0.4675	0.0765	-0.1412	0.055*
C3	0.3706 (2)	0.0635 (2)	-0.0040 (3)	0.0398 (6)
H3A	0.3529	0.0015	-0.0243	0.048*
C4	0.3274 (2)	0.11373 (19)	0.0982 (3)	0.0303 (5)
C5	0.3568 (2)	0.20801 (18)	0.1252 (3)	0.0298 (5)
C6	0.3125 (2)	0.25912 (18)	0.2252 (3)	0.0328 (5)
H6A	0.3305	0.3213	0.2434	0.039*
C7	0.2435 (2)	0.21763 (19)	0.2955 (3)	0.0326 (5)
H7A	0.2150	0.2522	0.3610	0.039*
C8	0.2145 (2)	0.12338 (19)	0.2705 (3)	0.0297 (5)
C9	0.2555 (2)	0.07253 (19)	0.1723 (3)	0.0320 (5)
H9A	0.2360	0.0107	0.1544	0.038*
C10	0.1398 (2)	0.07663 (19)	0.3510 (3)	0.0324 (6)

Atomic displacement parameters (\AA^2)

	U^{11}	U^{22}	U^{33}	U^{12}	U^{13}	U^{23}
Ag	0.0560 (2)	0.03486 (17)	0.0611 (2)	0.00687 (9)	0.03898 (14)	-0.00040 (9)

O1	0.0516 (12)	0.0344 (11)	0.0518 (11)	-0.0060 (9)	0.0324 (10)	-0.0010 (9)
O2	0.0695 (15)	0.0394 (12)	0.0698 (15)	-0.0088 (11)	0.0563 (13)	-0.0094 (11)
N	0.0351 (12)	0.0319 (12)	0.0425 (12)	-0.0010 (9)	0.0209 (10)	0.0046 (9)
C1	0.0440 (16)	0.0419 (16)	0.0501 (15)	-0.0009 (13)	0.0304 (13)	0.0016 (13)
C2	0.0533 (19)	0.0432 (16)	0.0529 (18)	0.0022 (14)	0.0354 (15)	-0.0056 (13)
C3	0.0457 (16)	0.0351 (14)	0.0453 (15)	-0.0009 (13)	0.0246 (13)	-0.0048 (12)
C4	0.0313 (13)	0.0293 (12)	0.0342 (13)	0.0022 (10)	0.0159 (10)	0.0024 (10)
C5	0.0293 (12)	0.0313 (13)	0.0319 (12)	0.0013 (10)	0.0135 (10)	0.0040 (10)
C6	0.0377 (14)	0.0260 (12)	0.0380 (13)	-0.0021 (10)	0.0158 (11)	-0.0021 (10)
C7	0.0359 (13)	0.0328 (14)	0.0334 (12)	0.0022 (11)	0.0168 (10)	-0.0018 (10)
C8	0.0306 (12)	0.0300 (13)	0.0327 (12)	0.0021 (11)	0.0158 (10)	0.0041 (10)
C9	0.0364 (14)	0.0270 (12)	0.0377 (13)	-0.0004 (10)	0.0193 (11)	0.0009 (10)
C10	0.0323 (13)	0.0349 (14)	0.0358 (13)	0.0022 (11)	0.0196 (11)	0.0046 (10)

Geometric parameters (Å, °)

Ag—O1 ⁱ	2.2067 (19)	C2—H2A	0.9300
Ag—O2 ⁱⁱ	2.252 (2)	C3—C4	1.414 (4)
Ag—N	2.397 (2)	C3—H3A	0.9300
Ag—Ag ⁱⁱⁱ	2.9200 (5)	C4—C5	1.416 (4)
O1—C10	1.252 (3)	C4—C9	1.415 (4)
O1—Ag ^{iv}	2.2067 (19)	C5—C6	1.413 (4)
O2—C10	1.252 (4)	C6—C7	1.366 (4)
O2—Ag ^v	2.252 (2)	C6—H6A	0.9300
N—C1	1.327 (4)	C7—C8	1.412 (4)
N—C5	1.374 (3)	C7—H7A	0.9300
C1—C2	1.395 (5)	C8—C9	1.375 (4)
C1—H1A	0.9300	C8—C10	1.517 (4)
C2—C3	1.367 (5)	C9—H9A	0.9300
O1 ⁱ —Ag—O2 ⁱⁱ	160.44 (9)	C5—C4—C9	119.7 (2)
O1 ⁱ —Ag—N	109.04 (8)	C3—C4—C9	121.8 (3)
O2 ⁱⁱ —Ag—N	90.51 (8)	N—C5—C4	121.6 (2)
O1 ⁱ —Ag—Ag ⁱⁱⁱ	84.15 (5)	N—C5—C6	119.7 (2)
O2 ⁱⁱ —Ag—Ag ⁱⁱⁱ	77.68 (6)	C4—C5—C6	118.8 (2)
N—Ag—Ag ⁱⁱⁱ	156.92 (6)	C7—C6—C5	120.3 (2)
C10—O1—Ag ^{iv}	122.44 (18)	C7—C6—H6A	119.8
C10—O2—Ag ^v	128.3 (2)	C5—C6—H6A	119.8
C1—N—C5	117.8 (2)	C6—C7—C8	121.3 (2)
C1—N—Ag	112.45 (18)	C6—C7—H7A	119.3
C5—N—Ag	129.42 (18)	C8—C7—H7A	119.3
N—C1—C2	123.9 (3)	C9—C8—C7	119.4 (2)
N—C1—H1A	118.0	C9—C8—C10	119.2 (2)
C2—C1—H1A	118.0	C7—C8—C10	121.4 (2)
C3—C2—C1	119.5 (3)	C8—C9—C4	120.4 (3)
C3—C2—H2A	120.3	C8—C9—H9A	119.8
C1—C2—H2A	120.3	C4—C9—H9A	119.8
C2—C3—C4	118.8 (3)	O1—C10—O2	126.1 (3)

C2—C3—H3A	120.6	O1—C10—C8	117.1 (2)
C4—C3—H3A	120.6	O2—C10—C8	116.9 (2)
C5—C4—C3	118.4 (2)		

Symmetry codes: (i) $-x+1/2, y+1/2, -z+1/2$; (ii) $x+1/2, -y+1/2, z-1/2$; (iii) $-x+1, -y+1, -z$; (iv) $-x+1/2, y-1/2, -z+1/2$; (v) $x-1/2, -y+1/2, z+1/2$.