

H.-T. Xia,\* Y.-F. Liu and S.-A. Li

Department of Chemical Engineering, Huaihai  
Institute of Technology, Lianyungang Jiangsu  
222005, People's Republic of China

Correspondence e-mail: xht161006@sohu.com

**Tetrakis( $\mu$ -naphthalene-1-acetato- $\kappa^2$ O:O')-  
bis[ $(N,N$ -dimethylformamide- $\kappa$ O)copper(II)]  
 $N,N$ -dimethylformamide disolvate**

The centrosymmetric title compound,  $[\text{Cu}_2(\text{C}_{12}\text{H}_9\text{O}_2)_4(\text{C}_3\text{H}_7\text{NO})_2] \cdot 2\text{C}_3\text{H}_7\text{NO}$ , consists of a dinuclear copper paddle-wheel cage structure bridged by four bidentate naphthaleneacetate carboxylate groups. The  $N,N$ -dimethylformamide molecules at the axial positions complete the octahedral coordination.

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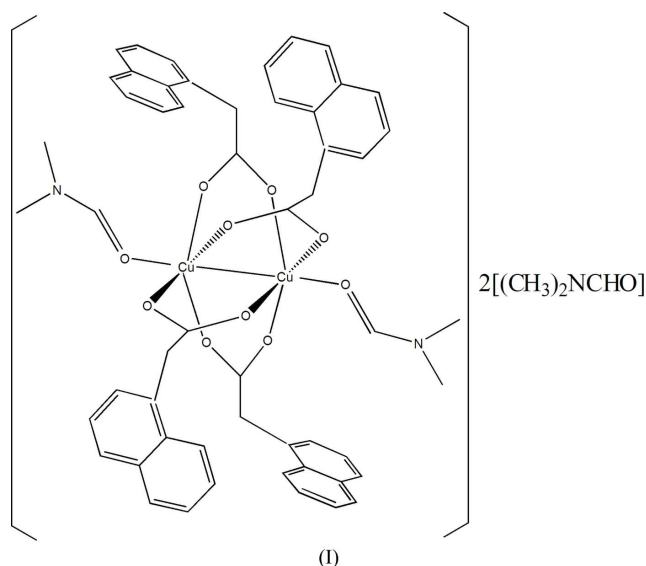
**Key indicators**

Single-crystal X-ray study  
 $T = 298 \text{ K}$   
Mean  $\sigma(\text{C}-\text{C}) = 0.006 \text{ \AA}$   
Disorder in solvent or counterion  
 $R$  factor = 0.037  
 $wR$  factor = 0.095  
Data-to-parameter ratio = 12.5

For details of how these key indicators were automatically derived from the article, see <http://journals.iucr.org/e>.

**Comment**

Naphthalene-1-acetic acid is a plant-growth regulator and our attention is focused on its coordination with the  $\text{Cu}^{\text{II}}$  ion. A green crystal of the cupric naphthalene-1-acetate salt, (I), was obtained from an  $N,N$ -dimethylformamide (DMF) solution. The crystal structure of (I) consists of a centrosymmetric dinuclear cage unit, in which each  $\text{Cu}^{\text{II}}$  atom is coordinated by four O atoms [ $\text{O}1^i$ ,  $\text{O}2$ ,  $\text{O}3^i$  and  $\text{O}4$ ; symmetry code: (i)  $1 - x$ ,  $1 - y$ ,  $1 - z$ ] from four different carboxylate groups in equatorial positions and atom  $\text{O}5$  from DMF at the axial position (Fig. 1). The dihedral angles of the naphthyl ring planes formed by atoms  $\text{C}3-\text{C}12$  and atoms  $\text{C}15-\text{C}24$  with the equatorial plane formed by the four O atoms ( $\text{O}1^i$ ,  $\text{O}2$ ,  $\text{O}3^i$  and  $\text{O}4$ ) are  $63.43(6)$  and  $60.39(6)^\circ$ , respectively. Selected bond parameters are listed in Table 1.



A dimethyl sulfoxide (DMSO) analogue of (I), viz. (II), has been reported previously (Chen *et al.*, 2004). The coordination environment of the  $\text{Cu}^{\text{II}}$  atoms in (II) is similar to that in (I), except that the axial O atoms are from the coordinated DMSO.

Experimental

A mixture of naphthalene-1-acetic acid (2 mmol) and CuCO<sub>3</sub> (1 mmol) was stirred in water (20 ml); the colour of the resulting precipitate changed from blue to green after about 30 min. The precipitate was washed with water and then dissolved in DMF. Green blocks of (I) suitable for X-ray analysis were obtained by evaporation of this DMF solution at ambient temperature for two months.

Crystal data

[Cu<sub>2</sub>(C<sub>12</sub>H<sub>9</sub>O<sub>2</sub>)<sub>4</sub>(C<sub>3</sub>H<sub>7</sub>NO)<sub>2</sub>]  
 ·2C<sub>3</sub>H<sub>7</sub>NO  
*M<sub>r</sub>* = 1160.23  
 Triclinic, P $\bar{1}$   
*a* = 10.056 (2) Å  
*b* = 11.936 (2) Å  
*c* = 13.636 (2) Å  
 $\alpha$  = 73.506 (2)°  
 $\beta$  = 84.991 (2)°  
 $\gamma$  = 65.205 (2)°  
*V* = 1423.7 (4) Å<sup>3</sup>  
*Z* = 1  
*D<sub>x</sub>* = 1.353 Mg m<sup>-3</sup>  
 Mo *K*α radiation  
 $\mu$  = 0.81 mm<sup>-1</sup>  
*T* = 298 (2) K  
 Block, green  
 0.46 × 0.33 × 0.21 mm

Data collection

Bruker SMART CCD area-detector diffractometer  
 $\varphi$  and  $\omega$  scans  
 Absorption correction: multi-scan (SADABS; Sheldrick, 1996)  
*T<sub>min</sub>* = 0.707, *T<sub>max</sub>* = 0.848  
 7495 measured reflections  
 4948 independent reflections  
 3999 reflections with *I* > 2σ(*I*)  
*R<sub>int</sub>* = 0.016  
 $\theta_{max}$  = 25.0°

Refinement

Refinement on *F*<sup>2</sup>  
*R*[*F*<sup>2</sup> > 2σ(*F*<sup>2</sup>)] = 0.037  
*wR*(*F*<sup>2</sup>) = 0.095  
*S* = 1.04  
 4948 reflections  
 395 parameters  
 H-atom parameters constrained  
 $w = 1/[\sigma^2(F_o^2) + (0.0403P)^2 + 0.6167P]$   
 where  $P = (F_o^2 + 2F_c^2)/3$   
 $(\Delta/\sigma)_{max} = 0.001$   
 $\Delta\rho_{max} = 0.35 \text{ e } \text{Å}^{-3}$   
 $\Delta\rho_{min} = -0.27 \text{ e } \text{Å}^{-3}$

Table 1 Selected geometric parameters (Å, °).

Cu1—O3	1.964 (2)	Cu1—O5	2.1493 (18)
Cu1—O4 <sup>i</sup>	1.965 (2)	Cu1—Cu1 <sup>i</sup>	2.6273 (7)
Cu1—O2 <sup>i</sup>	1.9664 (18)	O2—Cu1 <sup>i</sup>	1.9664 (18)
Cu1—O1	1.9673 (18)	O4—Cu1 <sup>i</sup>	1.966 (2)
O3—Cu1—O4 <sup>i</sup>	168.46 (8)	O3—Cu1—Cu1 <sup>i</sup>	84.86 (6)
O3—Cu1—O2 <sup>i</sup>	89.95 (9)	O4 <sup>i</sup> —Cu1—Cu1 <sup>i</sup>	83.62 (6)
O4 <sup>i</sup> —Cu1—O2 <sup>i</sup>	89.09 (9)	O2 <sup>i</sup> —Cu1—Cu1 <sup>i</sup>	81.65 (6)
O3—Cu1—O1	89.61 (9)	O1—Cu1—Cu1 <sup>i</sup>	86.69 (5)
O4 <sup>i</sup> —Cu1—O1	89.02 (8)	O5—Cu1—Cu1 <sup>i</sup>	172.80 (6)
O2 <sup>i</sup> —Cu1—O1	168.33 (7)	C1—O1—Cu1	119.84 (17)
O3—Cu1—O5	94.69 (8)	C1—O2—Cu1 <sup>i</sup>	126.02 (17)
O4 <sup>i</sup> —Cu1—O5	96.83 (8)	C13—O3—Cu1	122.01 (19)
O2 <sup>i</sup> —Cu1—O5	91.17 (8)	C13—O4—Cu1 <sup>i</sup>	123.40 (19)
O1—Cu1—O5	100.49 (7)	C25—O5—Cu1	120.90 (18)

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

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

<i>D</i> —H... <i>A</i>	<i>D</i> —H	H... <i>A</i>	<i>D</i> ... <i>A</i>	<i>D</i> —H... <i>A</i>
C26—H26 <i>B</i> ...O1 <sup>ii</sup>	0.96	2.49	3.430 (4)	165

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

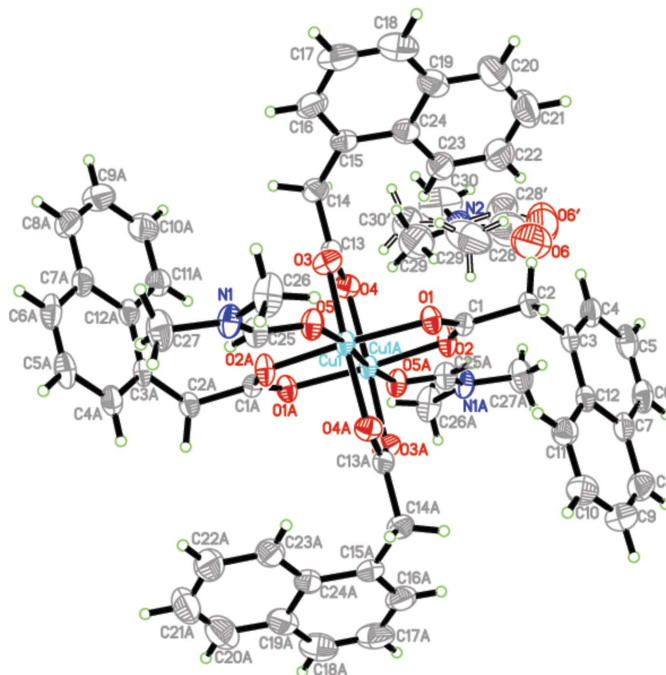


Figure 1 The molecular structure of (I), showing the atom-labelling scheme. Displacement ellipsoids are drawn at the 30% probability level. Both disordered DMF components are shown. [Symmetry code: (A)  $1 - x, 1 - y, 1 - z$ ].

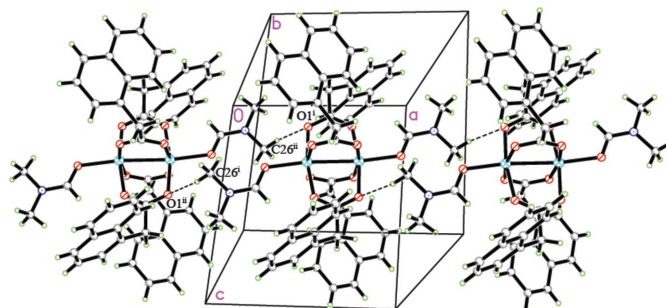


Figure 2 A packing diagram of the title compound, showing the weak intermolecular C—H...O interactions as dashed lines. The DMF solvent molecules have been omitted for clarity. [Symmetry codes: (i)  $x, y, z$ ; (ii)  $2 - x, 1 - y, 1 - z$ ].

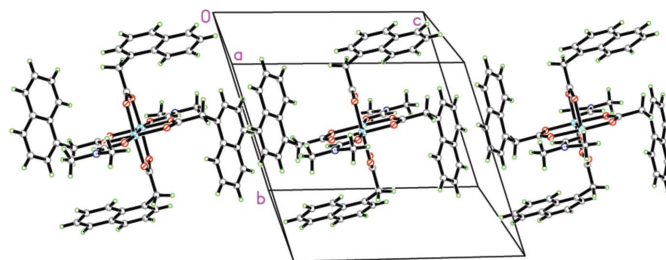


Figure 3 A packing diagram of (I). The DMF solvent molecules have been omitted for clarity.

All H atoms were located in difference Fourier maps. H atoms bonded to C atoms were treated as riding atoms, with C–H = 0.93 (aromatic, formyl), 0.97 (methylene) and 0.96 Å (methyl), and with  $U_{\text{iso}}(\text{H}) = 1.2U_{\text{eq}}(\text{C})$  (aromatic, formyl, methylene) or  $1.5U_{\text{eq}}(\text{C})$  (methyl). The methyl groups bonded to N of the solvent DMF were found to be disordered over two sites. The coordinates of these two sites were refined with the occupancies tied to sum to unity. The site occupancies for C28–C30 with attached H atoms and C28'–C30' with attached H atoms refined to 0.554 (7) and 0.446 (7), respectively.

Data collection: *SMART* (Siemens, 1996); cell refinement: *SAINTE* (Siemens, 1996); data reduction: *SAINTE*; program(s) used to solve structure: *SHELXS97* (Sheldrick, 1997a); program(s) used to refine structure: *SHELXL97* (Sheldrick, 1997a); molecular graphics: *SHELXTL* (Sheldrick, 1997b); software used to prepare material for publication: *SHELXTL* and *MERCURY* (Macrae *et al.*, 2006).

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