

**Structure-function correlation of mononuclear nonheme copper(II)  
compounds based on ligand topology and phenoxazinone synthase activity**

Sarvesh S. Harmalkar, Vishnu R. Chari, Rohan K. Kunkalekar Sunder N. Dhuri\*

*School of Chemical Sciences, Goa University, Taleigao Plateau, Goa, India*

*\*corresponding author: [sndhuri@unigoa.ac.in](mailto:sndhuri@unigoa.ac.in)*

## Synthesis and characterization of BQPN

**BQPN-H<sub>2</sub>** was prepared by modification of a reported procedure [1]. To a stirred THF solution (40 mL) of **BQPN-H<sub>2</sub>** (3.8 g, 10.86 mmol), 21.0 mL of aqueous formaldehyde (37%) (6.48 g, 217 mmol) was added. The solution slowly turned dark red after ~5min. To this red mixture, the sodium cyanoborohydride (1.38 g, 22.0 mmol) was added slowly till a yellow colour solution was obtained. The solution was stirred for ~24 h and THF was removed which afforded yellow crude powder. This crude product on recrystallization in hot ethanol resulted in a crystalline solid. Yield = 3.0 g. Anal. Calc. for C<sub>23</sub>H<sub>24</sub>N<sub>4</sub> **BQPN** (MW = 356.46 g mol<sup>-1</sup>): C, 77.50; H 6.79; N 15.72; Found: C, 78.35; H, 6.92; N, 15.06. Selected IR bands (KBr, cm<sup>-1</sup>): 1562  $\nu$ (C-N); 3134–2746  $\nu$ (CH).

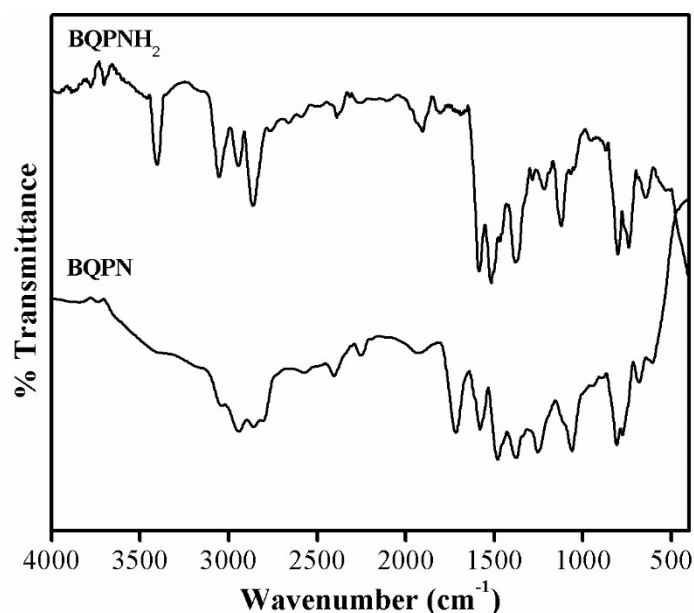


Fig. S1 – Comparative IR spectra's of BQPNH<sub>2</sub> and BQPN.

## Synthesis of Cu(II) complex [Cu<sup>II</sup>(BQEN)(CH<sub>3</sub>CN)](ClO<sub>4</sub>)<sub>2</sub> (**1**)

CHCl<sub>3</sub> solution of BQEN (0.43 g / 1.26mmol) was added dropwise to the acetonitrile solution of Cu(ClO<sub>4</sub>)<sub>2</sub>·6H<sub>2</sub>O (0.462 g / 1.26 mmol) resulting in an blue solution. The solution was left for stirring for 12 h and then filtered. Diethyl ether solution was added slowly to yield blue coloured compound. Yield = 0.7g. Crystals suitable for single crystal XRD were grown by slow diffusion of diethyl ether in acetonitrile solution. Anal. Calcd. for C<sub>24</sub>H<sub>25</sub>N<sub>5</sub>Cl<sub>2</sub>O<sub>8</sub>Cu **1** (MW = 645.93 g mol<sup>-1</sup>): C, 44.63; H, 3.90; N, 10.84%. Found: C, 44.90; H, 3.65; N, 10.59%.

IR data (KBr,  $\text{cm}^{-1}$ ): 3184–2777  $\nu(\text{CH})$ , 1091, 623  $\nu(\text{ClO}_4^{-1})$ . UV–Vis.  $\lambda_{\text{max}}(\text{nm})$  ( $\epsilon$ , in  $\text{L mol}^{-1} \text{cm}^{-1}$ ) in  $\text{CH}_3\text{CN}$ : 201 (319597), 230 (233240), 301 (60290), 612 (624).

Synthesis of Cu(II) complex  $[\text{Cu}^{\text{II}}(\text{BQPN})(\text{CH}_3\text{CN})](\text{ClO}_4)_2$  (**2**)

$\text{CHCl}_3$  solution of BQPN (0.45 g / 1.26mmol) was added dropwise to the acetonitrile solution of  $\text{Cu}(\text{ClO}_4)_2 \cdot 6\text{H}_2\text{O}$  (0.462 g / 1.26 mmol) resulting in an blue solution. The solution was left for stirring for 12 h and then filtered. Diethyl ether solution was added slowly to yield blue coloured compound. Yield = 0.8g. Crystals suitable for single crystal XRD were grown by slow diffusion of diethyl ether in acetonitrile solution. Anal. Calcd. for  $\text{C}_{25}\text{H}_{27}\text{N}_5\text{Cl}_2\text{O}_8\text{Cu}$  **2** (MW = 659.96  $\text{g mol}^{-1}$ ): C, 45.50; H, 4.12; N, 10.61%. Found: C, 45.48; H, 4.28; N, 10.54%. IR data (KBr,  $\text{cm}^{-1}$ ): 3199–2706  $\nu(\text{CH})$ , 1089, 628  $\nu(\text{ClO}_4^{-1})$ . UV–Vis.  $\lambda_{\text{max}}(\text{nm})$  ( $\epsilon$ , in  $\text{L mol}^{-1} \text{cm}^{-1}$ ) in  $\text{CH}_3\text{CN}$ : 203 (298203), 227 (182402), 302 (46819), 495 (610).

### Phenoxazinone synthase activity

The catalytic oxidation of  $\text{H}_2\text{AP}$  was studied by addition of  $1 \times 10^{-5}$  M solution of Cu(II) complex with 100 equiv. of 2-aminophenol ( $\text{H}_2\text{AP}$ ,  $1 \times 10^{-3}\text{M}$ ) in MeOH under aerobic conditions at room temperature. The catalysed conversion of  $\text{H}_2\text{AP}$  to 2-aminophenoxazine-3-one (2-APX) was monitored at a wavelength of 434 nm (time scan) [2-8] in MeOH. The oxidized product was extracted as 2-aminophenoxazinone species through column chromatography. Neutral alumina was used as a solid support in column and benzene-ethyl acetate solvent mixture was employed as an eluent mixture in the chromatographic separation. The purity of oxidative dimerization product of  $\text{H}_2\text{AP}$  was examined by  $^1\text{H}$  NMR spectral analysis as well as to identify the final product.  $^1\text{H}$  NMR data for 2-amino-3H-phenoxazine-3-one (APX), ( $\text{CDCl}_3$ , 400 MHz,)  $\delta\text{H}$ : 7.61 (m, 1H), 7.44 (m, 3H), 6.47 (s, 1H), 6.35 (s, 1H), 6.24 (s, 1H).

### References

1. J. England, G. J. P. Britovsek, N. Rabadia, A. J. P. White, *Inorg. Chem.* 2007, **46**, 3752.
2. P. K. Mudi, N. Bandopadhyay, M. Joshi, M. Shit, S. Paul, A.R. Choudhury, B. Biswas, *Inorg. Chim. Acta.*, 2020, **505**, 119468.
3. N. C. Jana, M. Patra, P. Brand~ao, A. Panja, *Inorg. Chim. Acta.*, 2019, **490**, 163.
4. S. S. Massoud, T. Junk, F.A. Mautner, *RSC Adv.*, 2015, **5**, 87139.
5. K. Ghosh, M.G.B. Drew, S. Chattopadhyay, *Inorg. Chim. Acta.*, 2018, **482**, 23.
6. S. Thakur, S. Banerjee, S. Das, S. Chattopadhyay, *New J. Chem.*, 2019, **43**, 18747.

7. (a) S. Pal, B. Chowdhury, M. Patra, M. Maji, B. Biswas, *Spectrochim. Acta Part A: Mol. Biomol. Spectros.*, 2015, **144**, 148; (b) A. De, D. Dey, H.R. Yadav, M. Maji, V. Rane, R.M. kadam, A.R. Choudhury, B. Biswas, *J. Chem. Sci.*, 2016, **128**, 1775.
8. C. K. Pal, S. Mahato, H.R. Yadav, A.R. Choudhury, B. Biswas, *Polyhedron*, 2019, **174**, 114156.

Table S1. Selected bond lengths, angles and Hydrogen bonding Parameters for **1**.

Bond lengths [Å]					
Cu(1)-N(1)	2.004(2)	1.997	Cu(1)-N(2)	2.275(3)	2.236
Cu(1)-N(3)	2.126(2)	2.239	Cu(1)-N(4)	1.973(2)	1.997
Co(1)-N(5)	2.036(3)	2.078			
Bond angles [°]					
N(1)-Cu(1)-N(2)	80.30(10)	81.41	N(1)-Cu(1)-N(3)	94.62(9)	96.64
N(1)-Cu(1)-N(4)	177.15(10)	177.29	N(1)-Cu(1)-N(5)	89.11(11)	91.41
N(2)-Cu(1)-N(3)	83.27(9)	84.56	N(2)-Cu(1)-N(4)	101.32(10)	96.53
N(2)-Cu(1)-N(5)	101.70(12)	138.10	N(3)-Cu(1)-N(4)	83.28(10)	81.37
N(3)-Cu(1)-N(5)	174.25(11)	137.33	N(4)-Cu(1)-N(5)	92.84(11)	91.30

Table S2 – Hydrogen bonding Parameters (Å, °) for **1**.

Compound <b>1</b>				
D-H...A	D-H/Å	H...A/Å	D...A/Å	D-H...A/°
C1-H1... O3	0.930	2.336	3.050	133.33
C13-H13B... O1	0.960	2.652	3.509	149.01
C13-H13B... O3	0.960	2.621	3.174	116.96
C21-H21... N5	0.930	2.495	3.032	116.93
C10-H10B... O1 <sup>i</sup>	0.960	2.452	3.308	148.40
C24-H24A... O2 <sup>i</sup>	0.960	2.650	3.266	122.28
C15-H15... O7 <sup>ii</sup>	0.930	2.488	3.416	175.98
C24-H24C... O2 <sup>iii</sup>	0.960	2.632	3.238	121.49

<sup>i</sup> = [x+1, y, z], <sup>ii</sup> = [-x+1, -y+1, -z], <sup>iii</sup> = [-x, -y+1, -z+1]

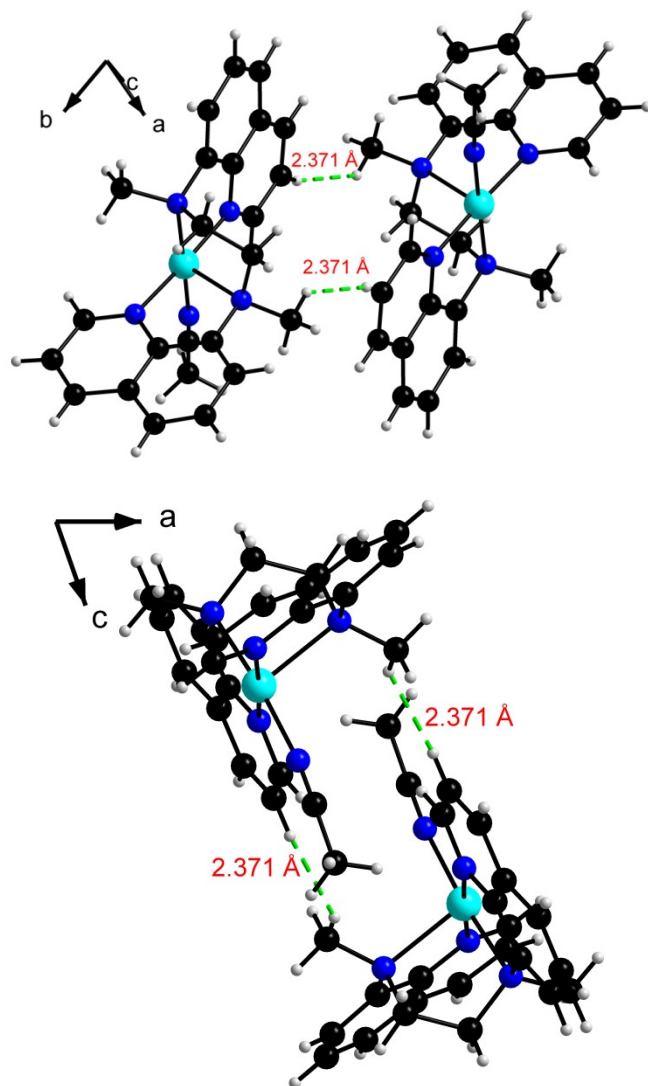
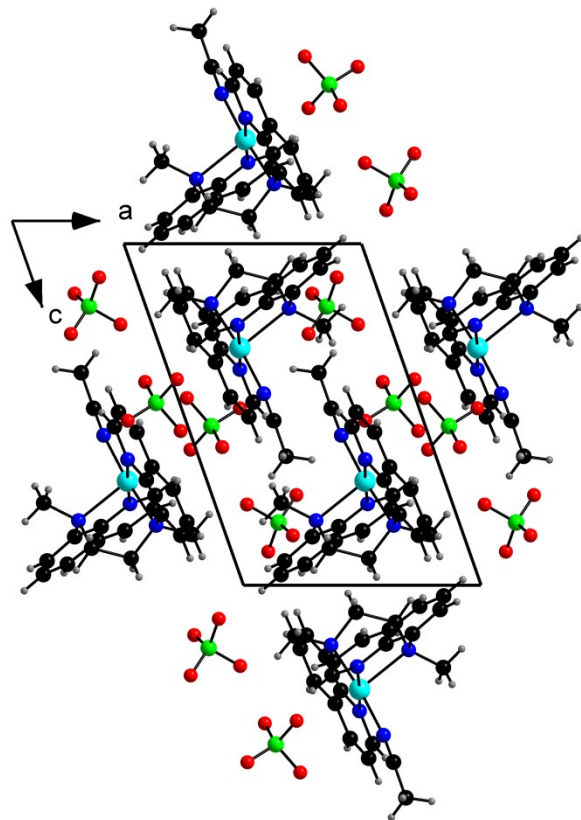
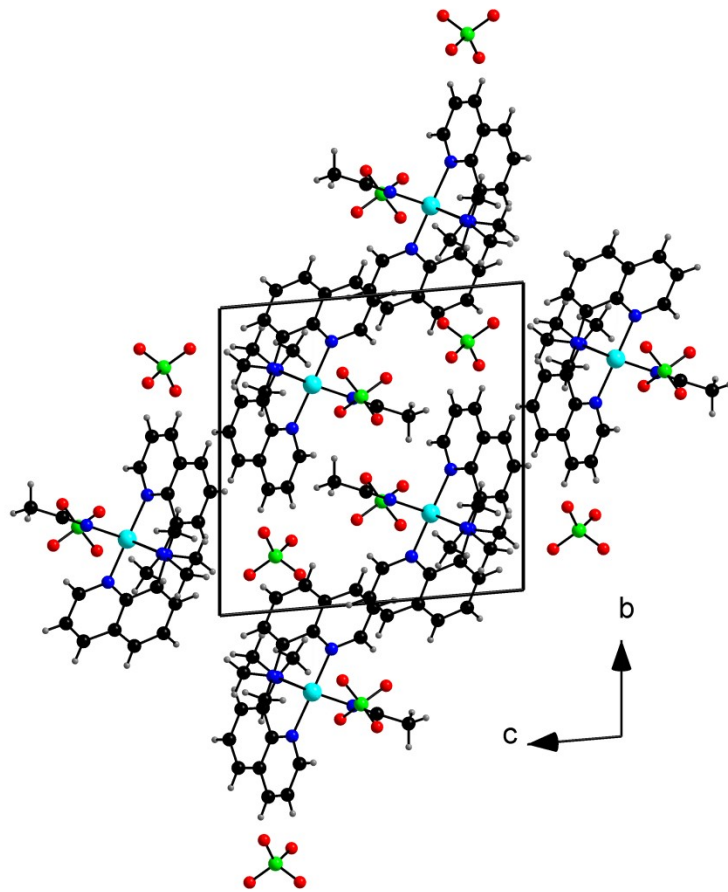


Fig. S2 – C-H...H-C interactions in **1**.



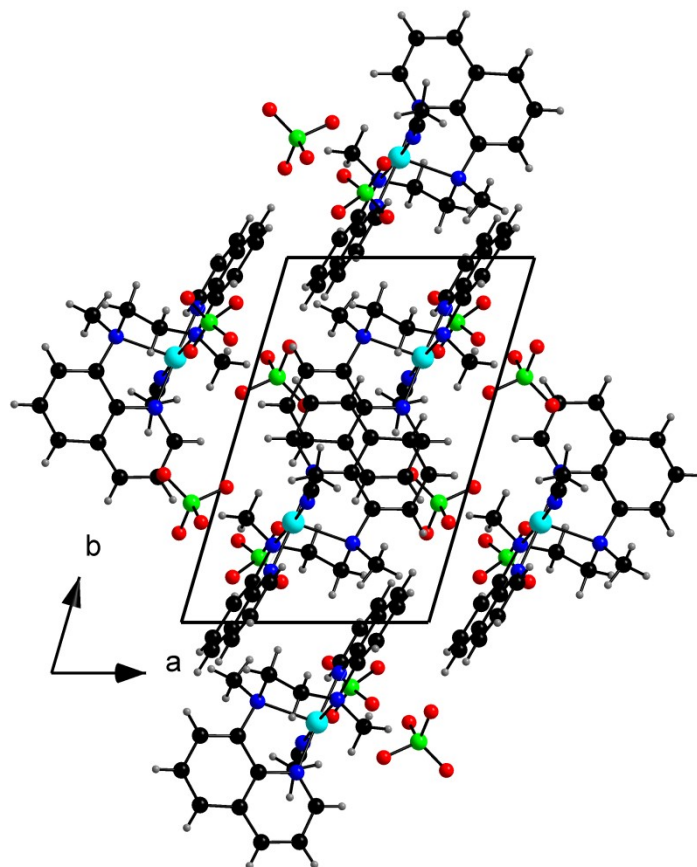


Fig. S3 – Packing diagram in **1** along crystallographic *a*, *b* and *c* axis.

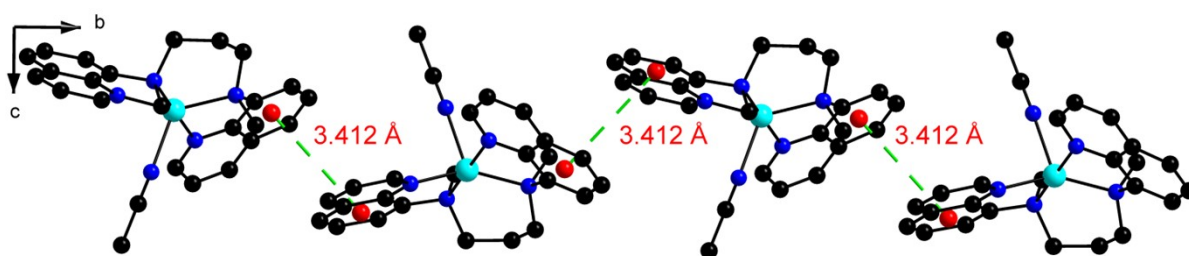
Table S3. Selected bond lengths] and angles [°] for **2**.

Bond lengths [Å]					
Cu(1)-N(1)	1.994(3)	2.012	Cu(1)-N(2)	2.096(2)	2.173
Cu(1)-N(3)	2.053(3)	2.067	Cu(1)-N(4)	2.024(2)	2.109
Co(1)-N(5)	2.283(3)	2.274			
Bond angles [°]					
N(1)-Cu(1)-N(2)	81.99(11)	81.67	N(1)-Cu(1)-N(3)	176.81(11)	177.85
N(1)-Cu(1)-N(4)	98.90(11)	97.00	N(1)-Cu(1)-N(5)	87.25(11)	89.03
N(2)-Cu(1)-N(3)	96.16(11)	97.84	N(2)-Cu(1)-N(4)	149.07(10)	139.74
N(2)-Cu(1)-N(5)	118.72(11)	112.89	N(3)-Cu(1)-N(4)	84.03(11)	82.01
N(3)-Cu(1)-N(5)	91.39(11)	93.08	N(4)-Cu(1)-N(5)	92.16(11)	107.31

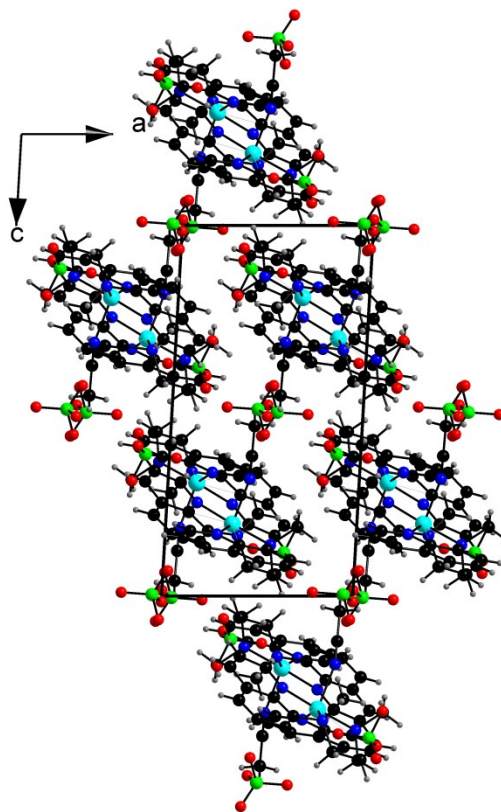
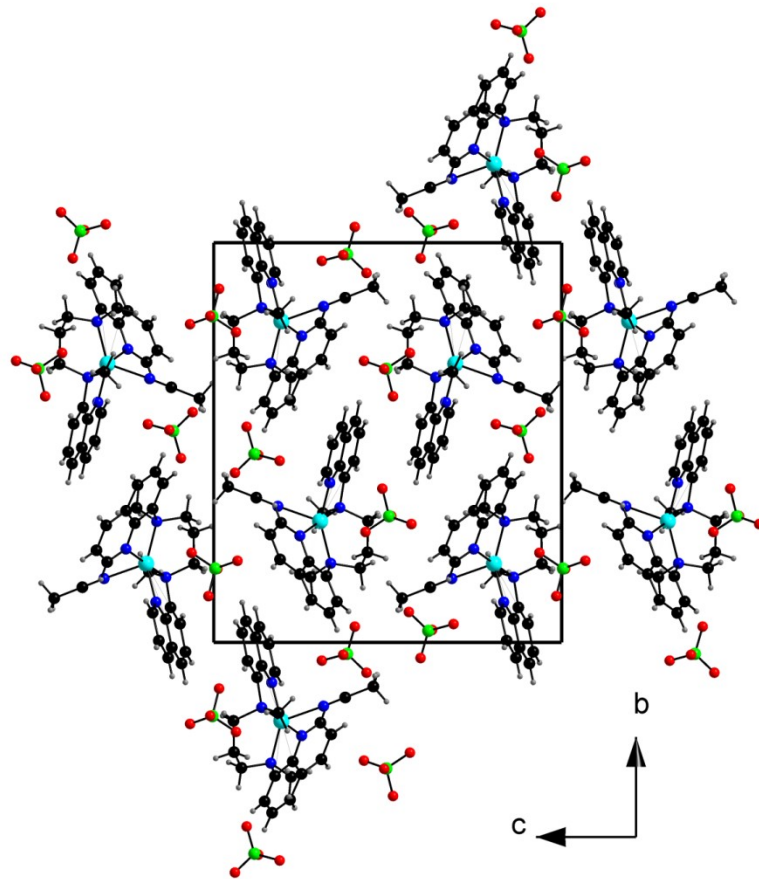
**Table S4**– Hydrogen bonding Parameters (Å, °) for **2**.

Compound <b>2</b>				
D-H···A	D-H/Å	H···A/Å	D···A/Å	D-H···A/°
C13-H13B··· O6	0.970	2.469	3.379	155.97
C1-H1··· O2 <sup>i</sup>	0.930	2.588	3.441	152.78
C11-H11B··· O4 <sup>ii</sup>	0.970	2.633	3.446	141.59
C14-H14B··· O7 <sup>ii</sup>	0.960	2.551	3.457	157.41
C16-H16··· O8 <sup>ii</sup>	0.930	2.541	3.427	159.34
C14-H14A··· O1 <sup>iii</sup>	0.960	2.531	3.446	159.24
C25-H25C··· O3 <sup>iii</sup>	0.960	2.647	3.429	138.96
C25-H25B··· O4 <sup>iv</sup>	0.960	2.599	3.455	148.56

$i = [-x+1/2, y-1/2, -z+1/2]$ ,  $ii = [x+1, y, z]$ ,  $iii = [-x+3/2, y-1/2, -z+1/2]$ ,  $iv = [x+1/2, -y+3/2, z-1/2]$

Fig. S4 –  $\pi\cdots\pi$  interactions in **2**.





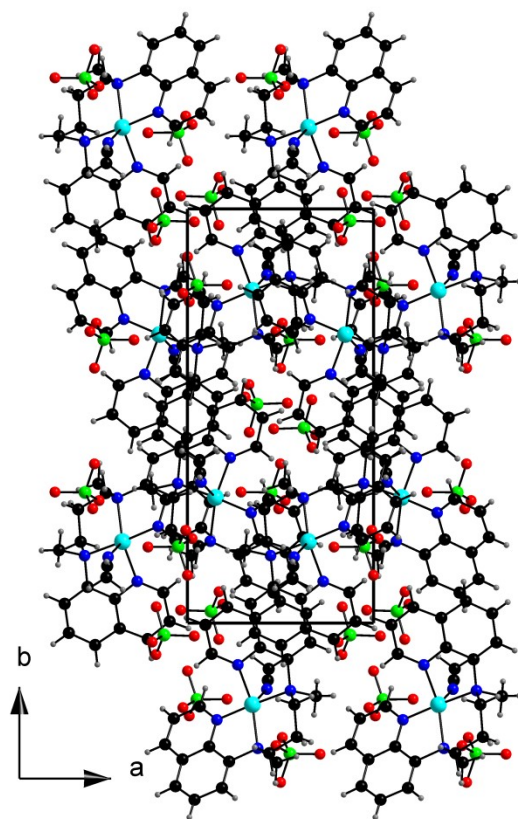


Fig. S5 – Packing diagram in **2** along crystallographic *a*, *b* and *c* axis.

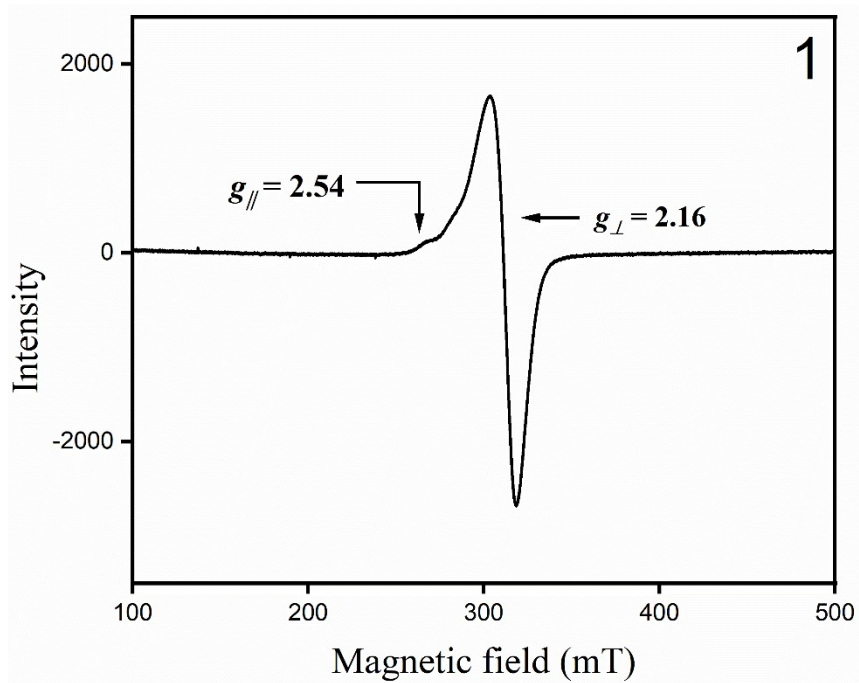


Fig. S6 – X-band EPR spectra of **1** recorded at 77 K in  $\text{CH}_3\text{CN}$ .

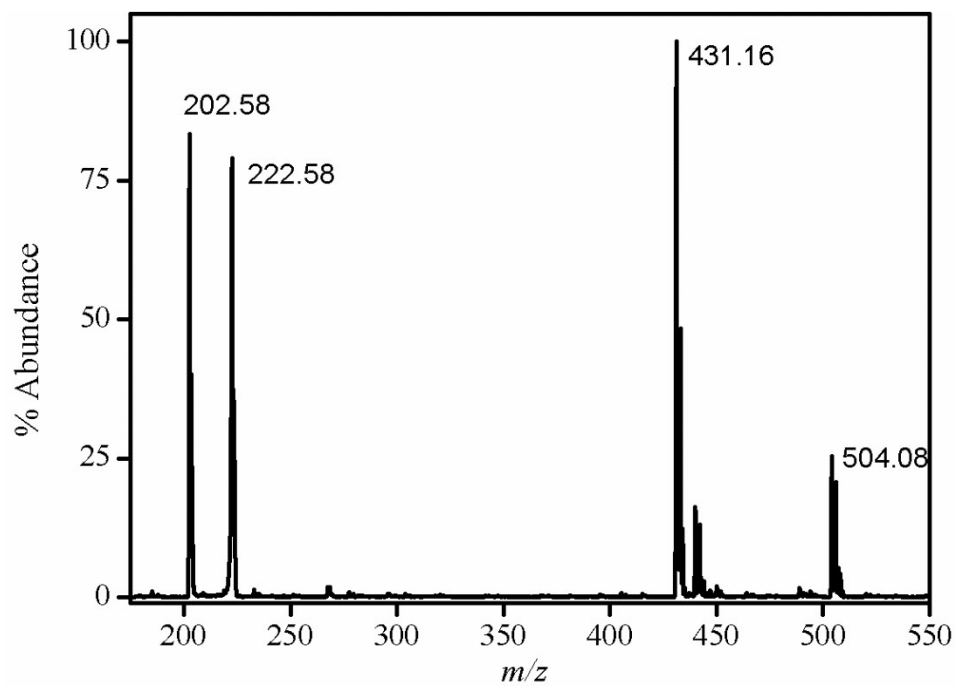


Fig. S7 – ESI-MS spectra of **1**.

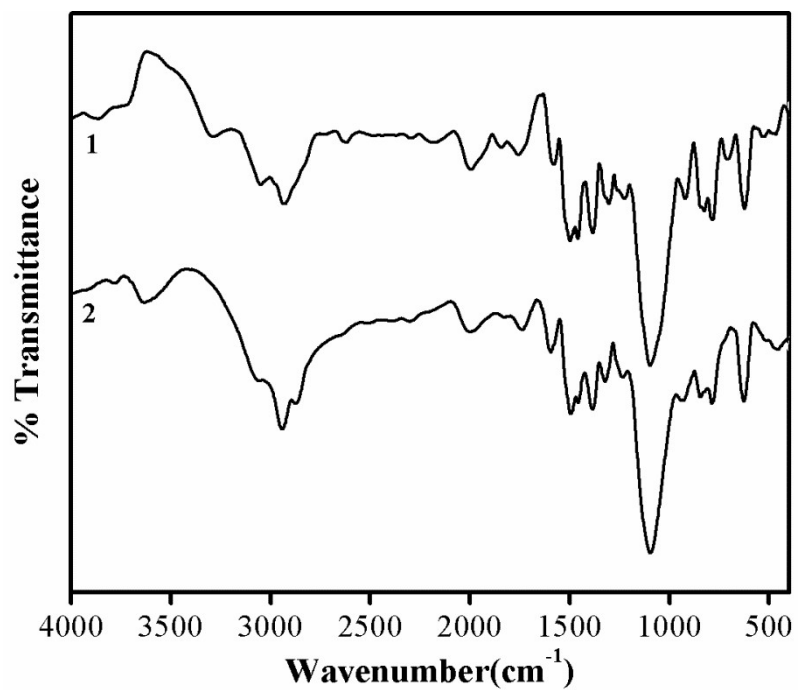


Fig. S8 – Comparative IR spectra's of **1** and **2**.

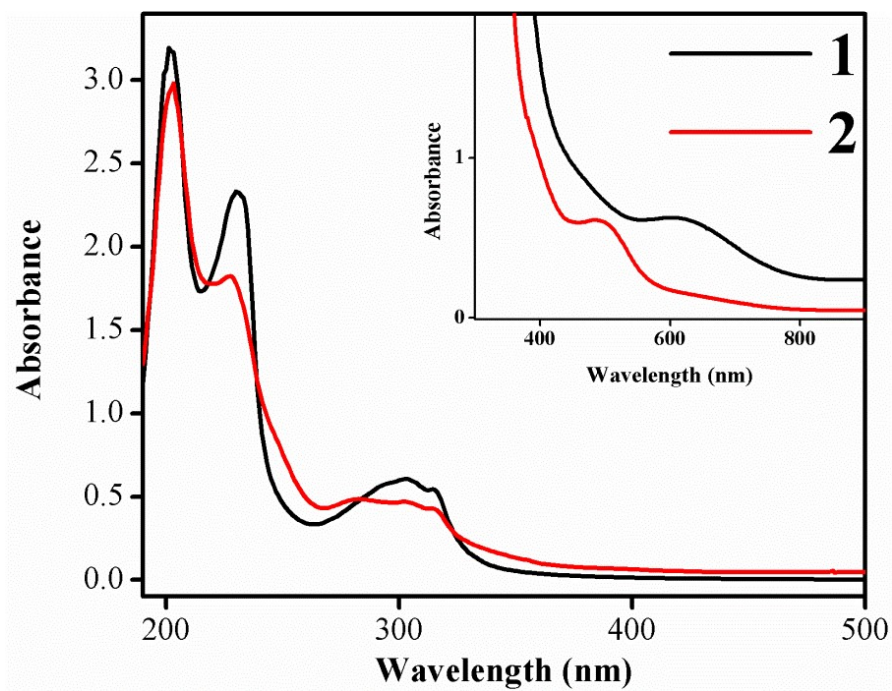


Fig. S9 – Comparative UV-visible spectrum of **1** and **2**.

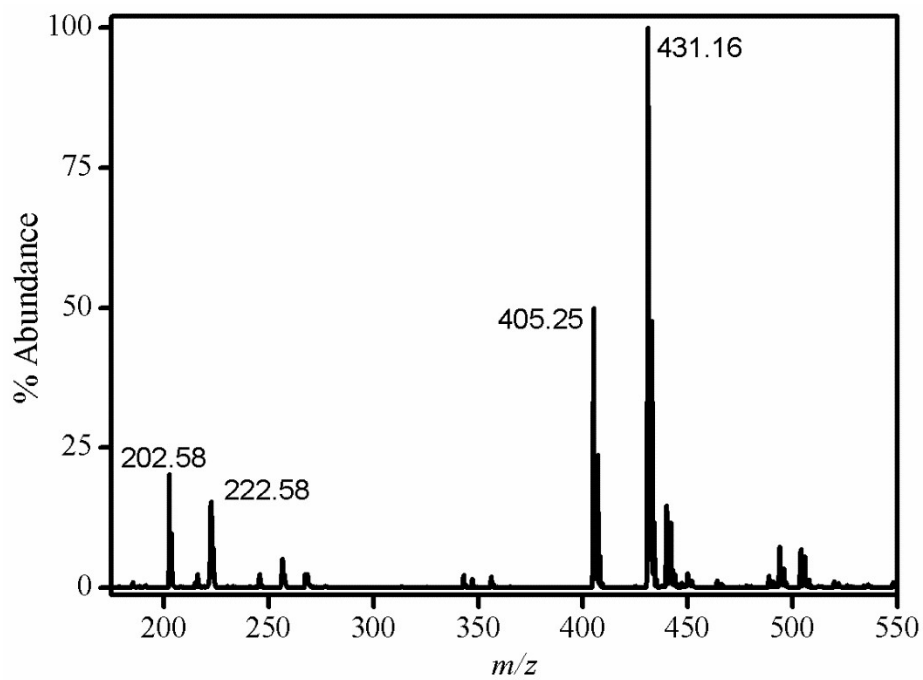


Fig. S10. ESI-MS spectra of **1** with 5 eq. H<sub>2</sub>AP

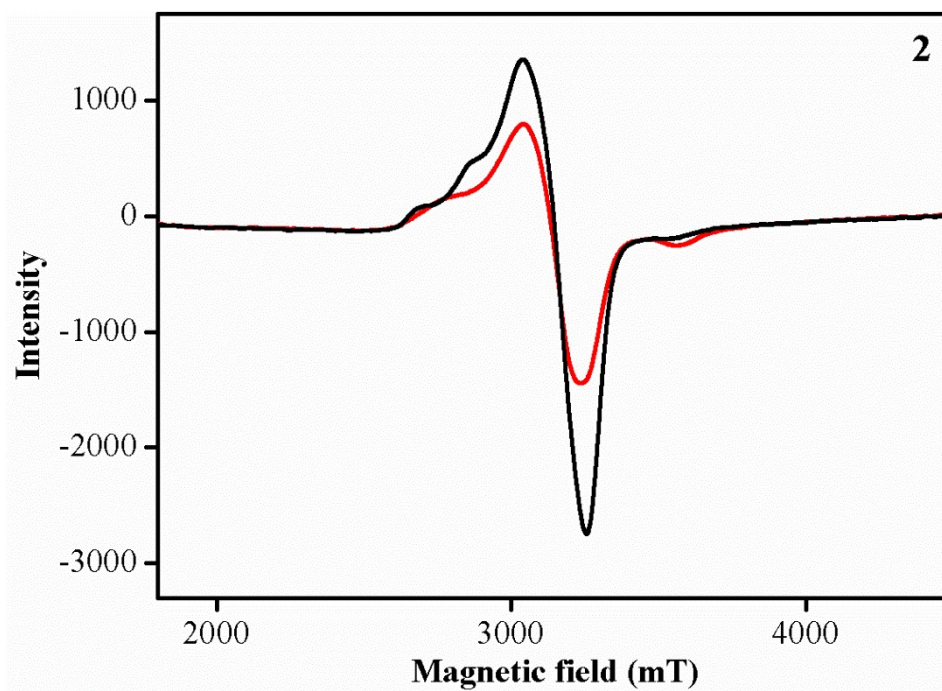


Fig. 9. X-band EPR spectra of **2** with 5 eq. H<sub>2</sub>AP recorded at 77 K CH<sub>3</sub>CN.

## checkCIF/PLATON report

Structure factors have been supplied for datablock(s) shelx

THIS REPORT IS FOR GUIDANCE ONLY. IF USED AS PART OF A REVIEW PROCEDURE FOR PUBLICATION, IT SHOULD NOT REPLACE THE EXPERTISE OF AN EXPERIENCED CRYSTALLOGRAPHIC REFEREE.

No syntax errors found.      CIF dictionary      Interpreting this report

### Datablock: shelx

---

Bond precision:    C-C = 0.0056 A                      Wavelength=0.71073

Cell:                a=8.8978(2)                b=12.9429(3)                c=13.0536(3)  
                      alpha=89.505(1)            beta=71.260(1)             gamma=74.536(1)

Temperature:    296 K

	Calculated	Reported
Volume	1367.17(6)	1367.17(6)
Space group	P -1	P -1
Hall group	-P 1	-P 1
Moiety formula	C24 H25 Cl Cu N5 O4, Cl O4 ?	
Sum formula	C24 H25 Cl2 Cu N5 O8	C24 H25 Cl2 Cu N5 O8
Mr	645.94	645.94
Dx, g cm-3	1.569	1.569
Z	2	2
Mu (mm-1)	1.051	1.051
F000	662.0	662.0
F000'	663.50	
h,k,lmax	11,17,17	11,17,17
Nref	6788	6769
Tmin,Tmax	0.675,0.802	0.676,0.746
Tmin'	0.617	

Correction method= # Reported T Limits: Tmin=0.676 Tmax=0.746  
AbsCorr = MULTI-SCAN

Data completeness= 0.997                      Theta(max)= 28.282

R(reflections)= 0.0517( 5497)                wR2(reflections)= 0.1617( 6769)

S = 1.035                                      Npar= 364

---

The following ALERTS were generated. Each ALERT has the format  
**test-name\_ALERT\_alert-type\_alert-level.**  
Click on the hyperlinks for more details of the test.

---

● **Alert level C**

PLAT241_ALERT_2_C	High	'MainMol' Ueq as Compared to Neighbors of	03	Check
PLAT242_ALERT_2_C	Low	'MainMol' Ueq as Compared to Neighbors of	C23	Check
PLAT260_ALERT_2_C	Large Average Ueq of Residue Including	C12	0.169	Check
PLAT910_ALERT_3_C	Missing # of FCF Reflection(s) Below Theta(Min) .		6	Note

---

● **Alert level G**

PLAT154_ALERT_1_G	The s.u.'s on the Cell Angles are Equal ..(Note)		0.001	Degree
PLAT232_ALERT_2_G	Hirshfeld Test Diff (M-X) Cu1 --O3 .		25.0	s.u.
PLAT242_ALERT_2_G	Low 'MainMol' Ueq as Compared to Neighbors of		C11	Check
PLAT244_ALERT_4_G	Low 'Solvent' Ueq as Compared to Neighbors of		C12	Check
PLAT432_ALERT_2_G	Short Inter X...Y Contact O2 ..C23		3.00	Ang.
		-x,1-y,1-z =	2_566	Check
PLAT793_ALERT_4_G	Model has Chirality at N2 (Centro SPGR)		S	Verify
PLAT793_ALERT_4_G	Model has Chirality at N3 (Centro SPGR)		S	Verify
PLAT794_ALERT_5_G	Tentative Bond Valency for Cu1 (II) .		2.21	Info
PLAT883_ALERT_1_G	No Info/Value for _atom_sites_solution_primary .		Please	Do !
PLAT912_ALERT_4_G	Missing # of FCF Reflections Above STh/L= 0.600		12	Note
PLAT941_ALERT_3_G	Average HKL Measurement Multiplicity .....		4.8	Low
PLAT978_ALERT_2_G	Number C-C Bonds with Positive Residual Density.		3	Info

---

0 **ALERT level A** = Most likely a serious problem - resolve or explain  
0 **ALERT level B** = A potentially serious problem, consider carefully  
4 **ALERT level C** = Check. Ensure it is not caused by an omission or oversight  
12 **ALERT level G** = General information/check it is not something unexpected

2 ALERT type 1 CIF construction/syntax error, inconsistent or missing data  
7 ALERT type 2 Indicator that the structure model may be wrong or deficient  
2 ALERT type 3 Indicator that the structure quality may be low  
4 ALERT type 4 Improvement, methodology, query or suggestion  
1 ALERT type 5 Informative message, check

---

It is advisable to attempt to resolve as many as possible of the alerts in all categories. Often the minor alerts point to easily fixed oversights, errors and omissions in your CIF or refinement strategy, so attention to these fine details can be worthwhile. In order to resolve some of the more serious problems it may be necessary to carry out additional measurements or structure refinements. However, the purpose of your study may justify the reported deviations and the more serious of these should normally be commented upon in the discussion or experimental section of a paper or in the "special\_details" fields of the CIF. checkCIF was carefully designed to identify outliers and unusual parameters, but every test has its limitations and alerts that are not important in a particular case may appear. Conversely, the absence of alerts does not guarantee there are no aspects of the results needing attention. It is up to the individual to critically assess their own results and, if necessary, seek expert advice.

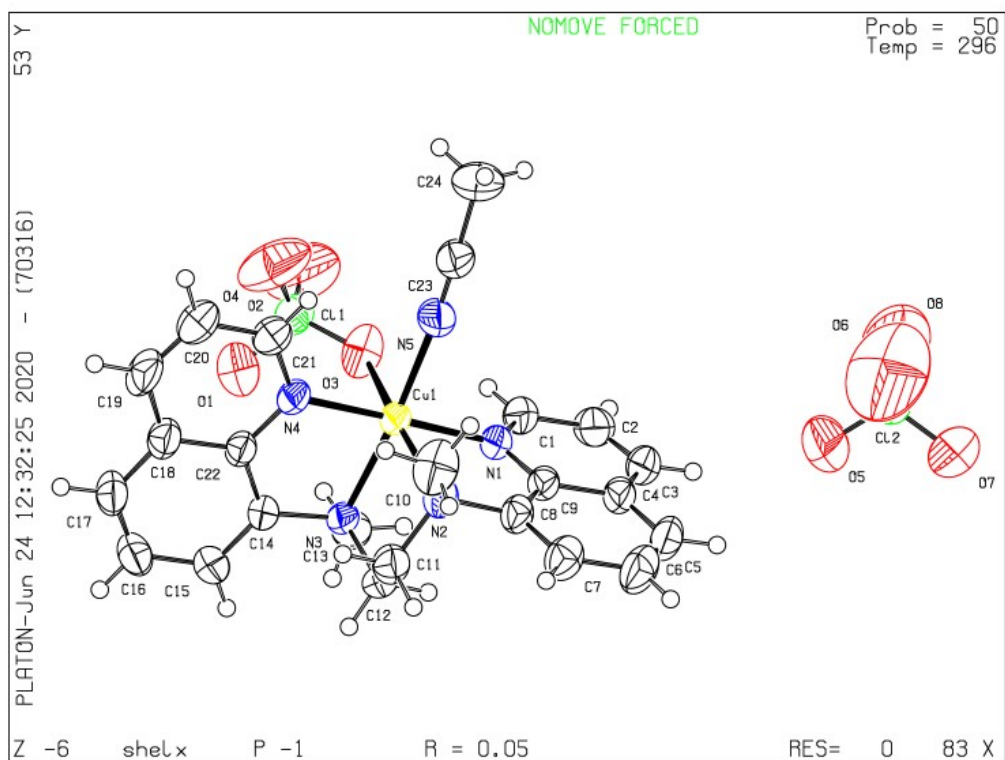
#### **Publication of your CIF in IUCr journals**

A basic structural check has been run on your CIF. These basic checks will be run on all CIFs submitted for publication in IUCr journals (*Acta Crystallographica*, *Journal of Applied Crystallography*, *Journal of Synchrotron Radiation*); however, if you intend to submit to *Acta Crystallographica Section C* or *E* or *IUCrData*, you should make sure that full publication checks are run on the final version of your CIF prior to submission.

#### **Publication of your CIF in other journals**

Please refer to the *Notes for Authors* of the relevant journal for any special instructions relating to CIF submission.





## checkCIF/PLATON report

Structure factors have been supplied for datablock(s) shelx

THIS REPORT IS FOR GUIDANCE ONLY. IF USED AS PART OF A REVIEW PROCEDURE FOR PUBLICATION, IT SHOULD NOT REPLACE THE EXPERTISE OF AN EXPERIENCED CRYSTALLOGRAPHIC REFEREE.

No syntax errors found.      CIF dictionary      Interpreting this report

### Datablock: shelx

---

Bond precision:    C-C = 0.0056 A                      Wavelength=0.71073

Cell:                      a=8.6168(3)              b=19.1651(7)              c=16.7109(7)  
                                    alpha=90              beta=93.221(1)              gamma=90

Temperature:              296 K

	Calculated	Reported
Volume	2755.31(18)	2755.31(18)
Space group	P 21/n	P 21/n
Hall group	-P 2yn	-P 2yn
Moiety formula	C25 H27 Cu N5, 2(Cl O4)	?
Sum formula	C25 H27 Cl2 Cu N5 O8	C25 H27 Cl2 Cu N5 O8
Mr	659.97	659.97
Dx, g cm-3	1.591	1.591
Z	4	4
Mu (mm-1)	1.045	1.045
F000	1356.0	1356.0
F000'	1359.01	
h,k,lmax	10,23,20	10,23,20
Nref	5630	5615
Tmin,Tmax	0.668,0.891	0.666,0.745
Tmin'	0.557	

Correction method= # Reported T Limits: Tmin=0.666 Tmax=0.745  
AbsCorr = MULTI-SCAN

Data completeness= 0.997                      Theta(max)= 26.387

R(reflections)= 0.0469( 4498)              wR2(reflections)= 0.1450( 5615)

S = 1.057                                      Npar= 373

---

The following ALERTS were generated. Each ALERT has the format  
**test-name\_ALERT\_alert-type\_alert-level.**  
Click on the hyperlinks for more details of the test.

---

● **Alert level C**

PLAT242_ALERT_2_C	Low	'MainMol' Ueq as Compared to Neighbors of		C24	Check
PLAT260_ALERT_2_C	Large Average Ueq of Residue Including		C11	0.142	Check
PLAT260_ALERT_2_C	Large Average Ueq of Residue Including		C13	0.142	Check
PLAT480_ALERT_4_C	Long H...A H-Bond Reported H11B	..04	.	2.63	Ang.
PLAT480_ALERT_4_C	Long H...A H-Bond Reported H25B	..04	.	2.65	Ang.
PLAT911_ALERT_3_C	Missing FCF Refl Between Thmin & STh/L=	0.600		4	Report
PLAT976_ALERT_2_C	Check Calcd Resid. Dens.	0.94A	From O6	-0.44	eA-3
PLAT976_ALERT_2_C	Check Calcd Resid. Dens.	0.85A	From O2	-0.40	eA-3

---

● **Alert level G**

PLAT244_ALERT_4_G	Low	'Solvent' Ueq as Compared to Neighbors of		C11	Check
PLAT244_ALERT_4_G	Low	'Solvent' Ueq as Compared to Neighbors of		C13	Check
PLAT793_ALERT_4_G	Model has Chirality at N2	(Centro SPGR)		R	Verify
PLAT793_ALERT_4_G	Model has Chirality at N3	(Centro SPGR)		S	Verify
PLAT794_ALERT_5_G	Tentative Bond Valency for Cu1	(II)	.	2.07	Info
PLAT883_ALERT_1_G	No Info/Value for _atom_sites_solution_primary				Please Do !
PLAT910_ALERT_3_G	Missing # of FCF Reflection(s) Below Theta(Min).			4	Note
PLAT912_ALERT_4_G	Missing # of FCF Reflections Above STh/L=	0.600		9	Note
PLAT913_ALERT_3_G	Missing # of Very Strong Reflections in FCF ...			3	Note
PLAT978_ALERT_2_G	Number C-C Bonds with Positive Residual Density.			3	Info

---

- 0 **ALERT level A** = Most likely a serious problem - resolve or explain  
0 **ALERT level B** = A potentially serious problem, consider carefully  
8 **ALERT level C** = Check. Ensure it is not caused by an omission or oversight  
10 **ALERT level G** = General information/check it is not something unexpected

- 1 ALERT type 1 CIF construction/syntax error, inconsistent or missing data  
6 ALERT type 2 Indicator that the structure model may be wrong or deficient  
3 ALERT type 3 Indicator that the structure quality may be low  
7 ALERT type 4 Improvement, methodology, query or suggestion  
1 ALERT type 5 Informative message, check
- 
-

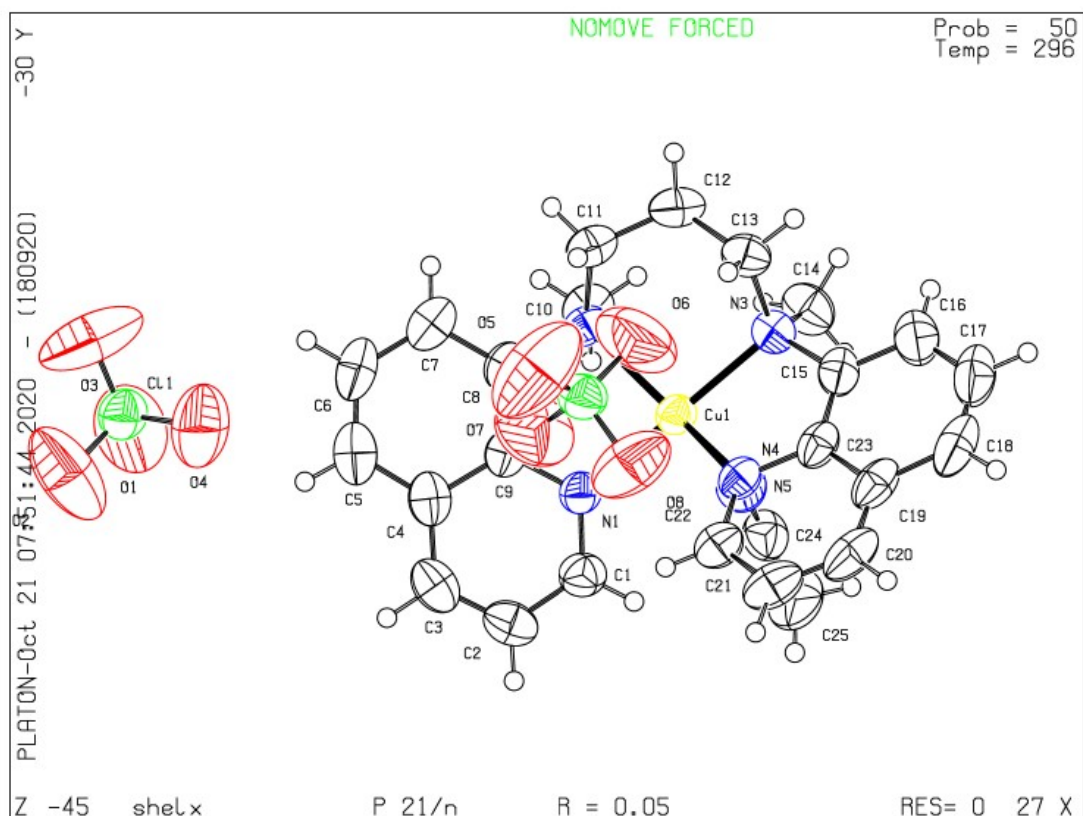
It is advisable to attempt to resolve as many as possible of the alerts in all categories. Often the minor alerts point to easily fixed oversights, errors and omissions in your CIF or refinement strategy, so attention to these fine details can be worthwhile. In order to resolve some of the more serious problems it may be necessary to carry out additional measurements or structure refinements. However, the purpose of your study may justify the reported deviations and the more serious of these should normally be commented upon in the discussion or experimental section of a paper or in the "special\_details" fields of the CIF. checkCIF was carefully designed to identify outliers and unusual parameters, but every test has its limitations and alerts that are not important in a particular case may appear. Conversely, the absence of alerts does not guarantee there are no aspects of the results needing attention. It is up to the individual to critically assess their own results and, if necessary, seek expert advice.

#### **Publication of your CIF in IUCr journals**

A basic structural check has been run on your CIF. These basic checks will be run on all CIFs submitted for publication in IUCr journals (*Acta Crystallographica*, *Journal of Applied Crystallography*, *Journal of Synchrotron Radiation*); however, if you intend to submit to *Acta Crystallographica Section C* or *E* or *IUCrData*, you should make sure that full publication checks are run on the final version of your CIF prior to submission.

#### **Publication of your CIF in other journals**

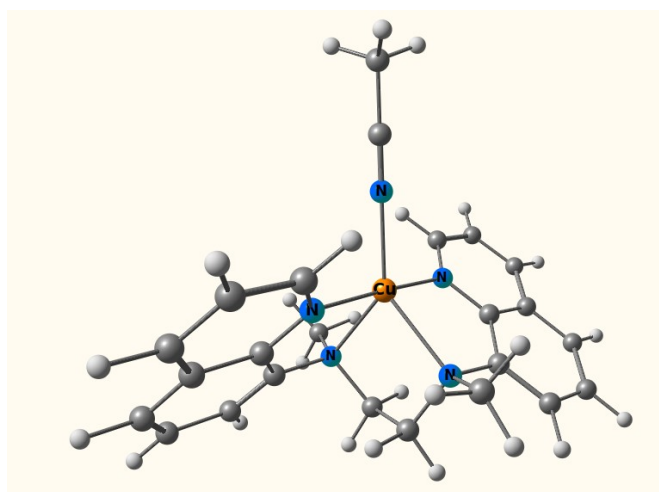
Please refer to the *Notes for Authors* of the relevant journal for any special instructions relating to CIF submission.



Cartesian coordinates and total energies for the geometry optimizations.

1.  $[\text{Cu}(\text{BQEN})(\text{CH}_3\text{CN})]^{2+}$  (**1**) zero point corrected energy=-2842.906094 a.u.

Cu	0.00000	0.00000	0.00000
N	0.32259	1.95803	0.22699
C	-0.63369	2.86842	0.39436
H	-1.65761	2.50945	0.36577
N	2.22852	0.00000	-0.21204
C	-0.36267	4.23256	0.60723
N	0.00000	0.00000	-2.23633
C	0.95112	4.65021	0.66186



H	1.19386	5.69455	0.83583
C	1.99882	3.71124	0.48929
N	-0.26048	-1.95745	-0.29828
C	3.37300	4.06484	0.53487
H	3.64689	5.09944	0.71655
C	4.34108	3.10263	0.35054
H	5.39189	3.36949	0.38687
C	3.97877	1.75594	0.10586
H	4.76676	1.02508	-0.04579
C	2.65188	1.37182	0.05819
C	1.64012	2.34616	0.25869
C	2.92028	-0.98202	0.66772
H	2.46950	-1.96551	0.52564
H	2.80515	-0.67711	1.70926
H	3.98882	-1.05884	0.43755
C	2.41430	-0.35806	-1.65345
H	2.29511	-1.44153	-1.73889
H	3.43306	-0.11580	-1.98032
C	1.41681	0.35946	-2.55912
H	1.51232	1.44291	-2.44801
H	1.64448	0.11803	-3.60469
C	-0.94292	0.98118	-2.84082
H	-1.96836	0.67569	-2.62596

H -0.81647 1.05702 -3.92657  
H -0.75872 1.96509 -2.40662  
C -0.30851 -1.37192 -2.63298  
C -0.47886 -1.75590 -3.94978  
H -0.40042 -1.02518 -4.74852  
C -0.75663 -3.10251 -4.28768  
C -0.85123 -4.06452 -3.30653  
H -1.05816 -5.09902 -3.56232  
C -0.67840 -3.71089 -1.94252  
C -0.75366 -4.64955 -0.88308  
H -0.95028 -5.69380 -1.10830  
C -0.57685 -4.23164 0.41980  
H -0.62431 -4.92613 1.25079  
C -0.33859 -2.86763 0.66953  
H -0.21432 -2.50846 1.68616  
C -0.41476 -2.34596 -1.60699  
N -1.38781 0.00103 1.54695  
H -1.18555 4.92733 0.73100  
H -0.89011 -3.36946 -5.33059  
C -2.16201 0.00605 2.40784  
C -3.13643 0.01275 3.48941  
H -3.09353 0.96732 4.02226  
H -2.91691 -0.79743 4.19131

H -4.14227 -0.12868 3.08247

2. [Cu(BQPN)(CH<sub>3</sub>CN)]<sup>2+</sup> (**2**) zero point corrected energy=-2882.187576 a.u.

Cu 0.00000 0.00000 0.00000

C -2.78468 0.91511 0.63135

H -2.28211 1.65455 1.24711

N -2.01177 0.01351 0.03422

C -4.18471 0.93734 0.47902

H -4.76570 1.69412 0.99393

N -0.34252 -1.97284 -0.84523

N 0.25472 1.95706 -0.61489

C -3.99226 -0.98668 -0.97865

C -4.78311 0.00299 -0.34219

H -5.85781 0.01119 -0.49977

N 2.10591 0.00000 -0.11349

C -4.52329 -1.99399 -1.82646

H -5.58975 -2.01023 -2.02839

N 0.00000 0.00000 2.27362

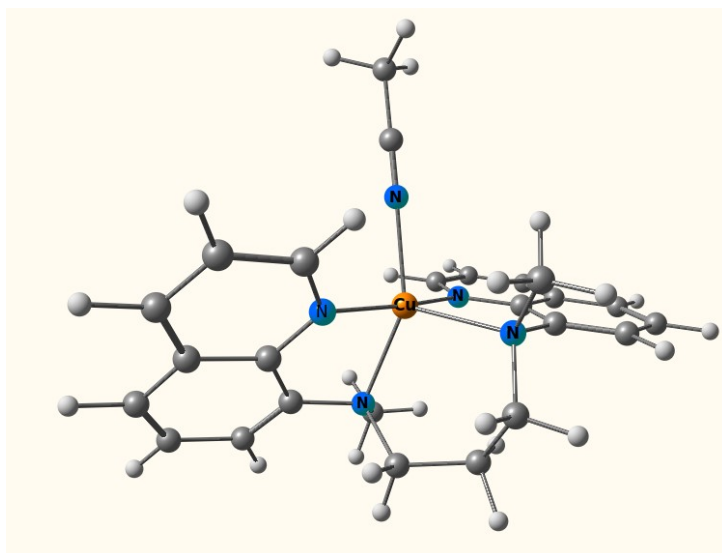
C -3.68843 -2.94065 -2.37774

H -4.09016 -3.71178 -3.02635

C -2.30172 -2.94324 -2.08515

H -1.68900 -3.73548 -2.50161

C -1.74935 -1.97203 -1.27287





C -2.58535 -0.96406 -0.73348  
C -0.18183 -3.03886 0.19564  
H -0.86811 -2.84189 1.01987  
H 0.83777 -3.04518 0.57783  
H -0.40410 -4.02462 -0.22751  
C 0.57149 -2.20887 -2.01249  
H 0.24929 -1.53263 -2.81016  
H 0.43144 -3.23431 -2.37474  
C 2.05930 -2.00512 -1.72671  
H 2.41650 -2.68673 -0.94893  
H 2.58542 -2.31766 -2.63641  
C 2.50419 -0.56861 -1.45802  
H 3.59722 -0.51204 -1.52705  
H 2.09661 0.10197 -2.22050  
C 2.74588 -0.76788 0.99603  
H 2.63755 -0.21016 1.92382  
H 3.80773 -0.93933 0.79298  
H 2.26043 -1.73441 1.11120  
C 2.52406 1.41034 -0.08841  
C 3.82239 1.81231 0.15674  
H 4.59052 1.09084 0.41251  
C 4.18588 3.17835 0.06035  
H 5.21182 3.46521 0.26493

C	3.26131	4.12726	-0.31568
H	3.54677	5.16968	-0.41712
C	1.91965	3.74656	-0.58110
C	0.91643	4.65508	-1.00402
H	1.16631	5.70341	-1.13945
C	-0.36011	4.19632	-1.25148
H	-1.14403	4.86006	-1.59814
C	-0.65232	2.83580	-1.03047
H	-1.65655	2.46125	-1.19526
C	1.54607	2.37708	-0.42902
C	-0.10864	0.01833	3.42787
C	-0.24038	0.04017	4.87937
H	-1.24501	-0.28246	5.16784
H	-0.06872	1.05377	5.25334