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Investigations on template $CrO_4^{2-}/Cr_2O_7^{2-}$ influence in forming series of silver-chalcogenide clusters

Yan-Ling Li,[a] Qing-Qing Xu,[a] Si Li,[a] Ren-Wu Huang,[a] Xiao-Fei Liu,[a] Yong-Li Wei*[a] and Shuang-Quan Zang *[a]

[a] *College of Chemistry and Molecular Engineering, Zhengzhou University, Zhengzhou.*

450001, China.

*E-mail: zangsqzg@zzu.edu.cn

weiyongli@ zzu.edu.cn

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Preparation of ligand 2-(methylthio)naphthalene ($HSCH_2C_{10}H_7$)

A mixture of 2-methylnaphthalene (2.84 g, 0.0200 mol), N-Bromosuccinimide (NBS) (3.92 g, 0.0220 mol) and tetrachloromethane (100.0 mL) in a 250-ml three-necked, round-bottom flask was heated to 80 ^oC under stirring. Then 0.125 g (0.000761 mol) of azodiisobutyronitrile (AIBN) was added as initiator. The reaction mixture was refluxed for 12 h, afterwards the resultant solution was filtered and extracted by deionized water, and dried over anhydrous magnesium sulfate. The product 2-bromomethyl-naphthalene was got by rotationally evaporation. ^{1}HNMR ($CDCl_3$):δ4.70 (s, 2H), 7.50–7.57 (m, 3H), 7.82–7.93 (m, 4H). IR data (KBr, cm^{-1}): 3060 w, 897 w, 823 s, 752 s.

20.0 mL of acetone solution containing 2-bromomethyl-naphthalene (0.77 g, 0.0035 mol) and thiourea (0.40 g, 0.0051 mol) was stirring for 2 h when refluxing. The mother solution was cooled to room temperature, and the precipitates were collected by filtration and dried overnight in vacuum. The precipitates were dissolved in aqueous NaOH solution (2 mol/L). The aqueous solution was refluxed for 2 h, and then cooled to room temperature and adjusted to pH≈2.0 using hydrochloric acid (2 mol/L). The solution was extracted by dichloromethane and dried over anhydrous magnesium sulfate. The product of 2-(methylthio)naphthalene was got by successively suction filtrating and rotationally evaporating, and dried in vacuum. ^{1}HNMR ($CDCl_3$): δ 1.84 (t, 1H), 3.94 (d, 2H), 7.46–7.52 (m, 3H), 7.76–7.85 (m, 4H). Anal. Calcd for $C_{11}H_{10}S$: C 75.82, H 5.78, S 18.40 %. Found: C 75.44, H 6.08, S 18.48 %. IR data (KBr, cm^{-1}): 3050 w, 866 m, 823 m, 742 s.

X-Ray Crystallography

Single-crystal X-ray diffraction measurement of complexes **1** - **3** were performed on a Rigaku XtaLAB Pro diffractometer. Data collection and reduction were performed using the program CrysAlisPro.[S1] Data collection and reduction were performed using the program SADABS.[S2] All the structures were solved with direct methods (*SHELXS*)[S3] and refined by full-matrix least squares on F^2 using *OLEX2*,[S4] which utilizes the *SHELXL*-2015 module.[S5] All the atoms were refined anisotropically. Hydrogen atoms were placed in calculated positions refined using idealized geometries and assigned fixed isotropic displacement parameters. Structure refinement was handled with different strategies according to the electron density distribution and the complexity of the disorder.

The detailed information of the crystal data, data collection and refinement results for all compounds are summarized in Table S1.

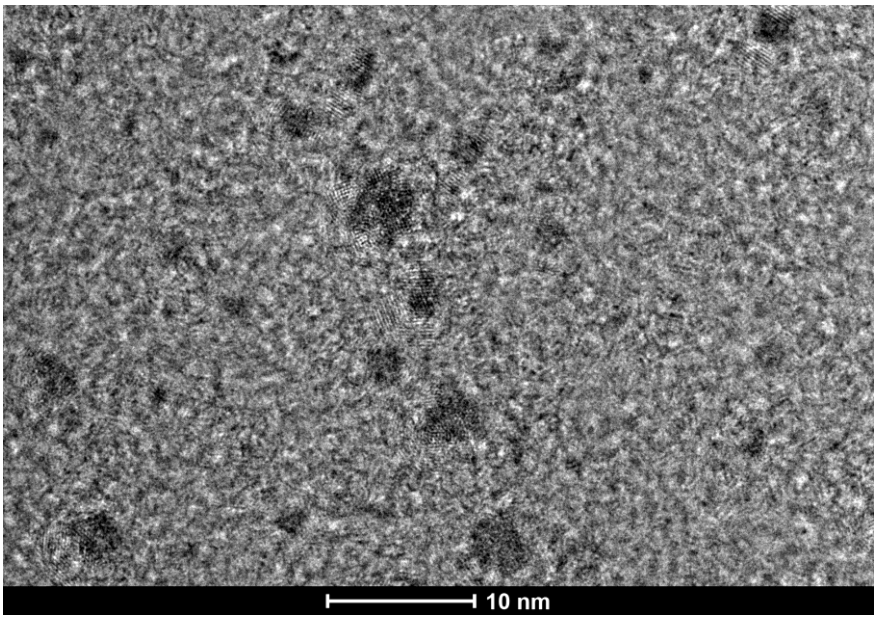

Figure S1. Representative TEM image of cluster $[Ag_{14}(SCH_2C_{10}H_7)_6(CF_3CO_2)_8(DMAc)_6]$ (**1**) in ethonal.

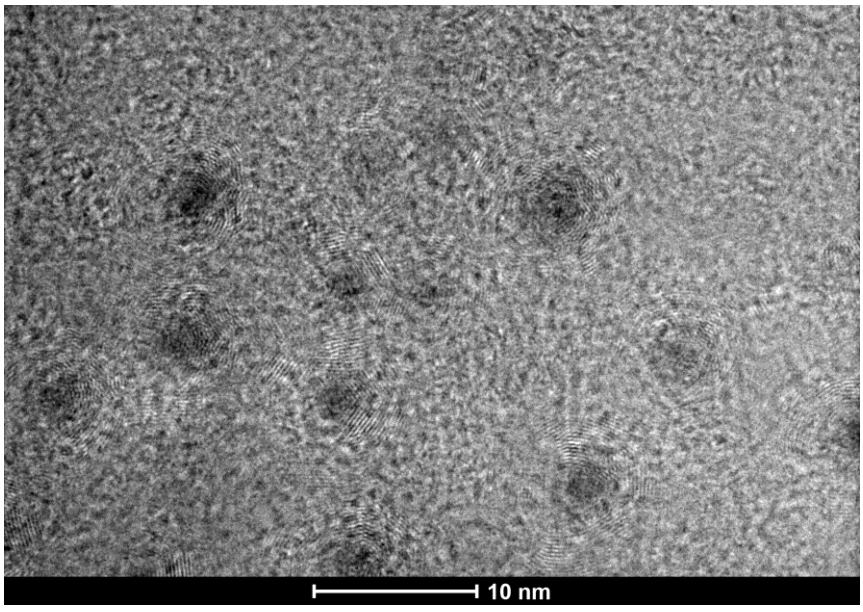

Figure S2. Representative TEM image of cluster $[Ag_{30}(SCH_2C_{10}H_7)_{18}(CrO_4)_2(DMAc)_2(CF_3CO_2)_8]$ (**2**) in ethonal.

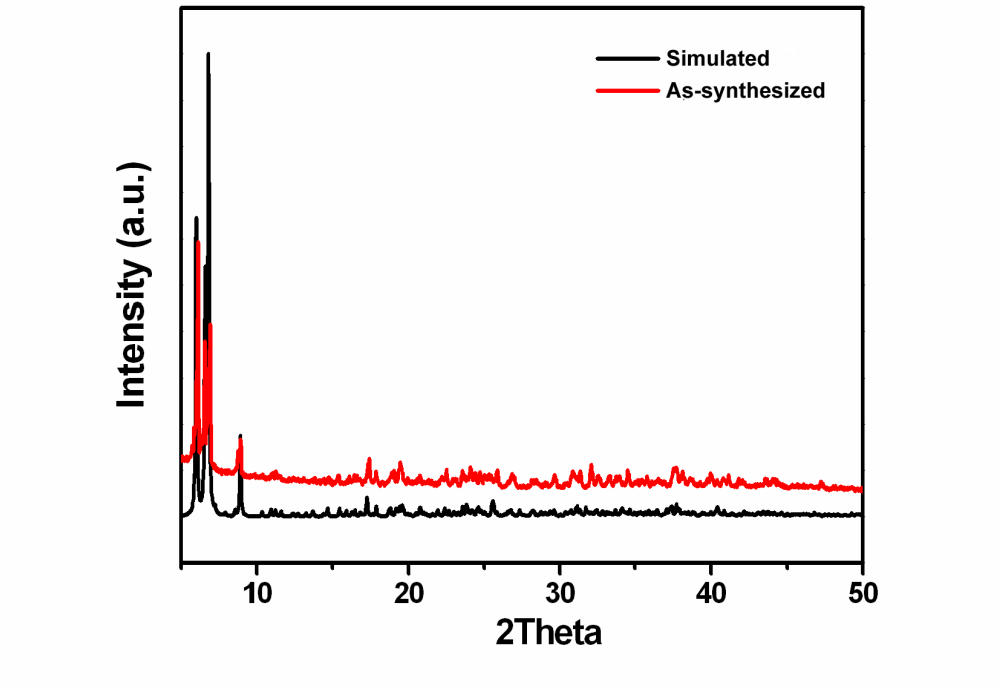

Figure S3. The PXRD pattern of compound **1** at room temperature.

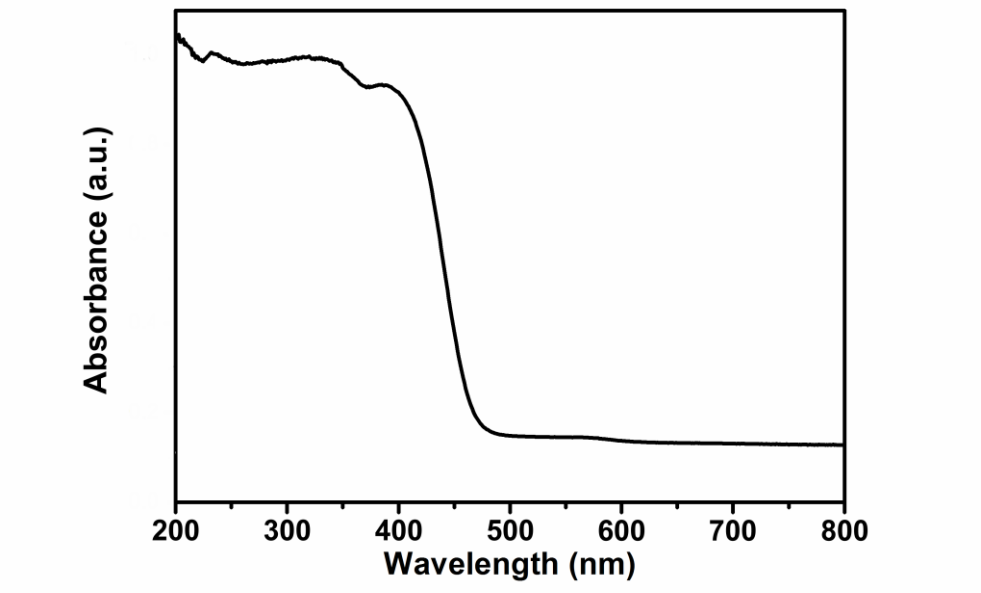

Figure S4. UV-vis spectrum for **1** in solid state.

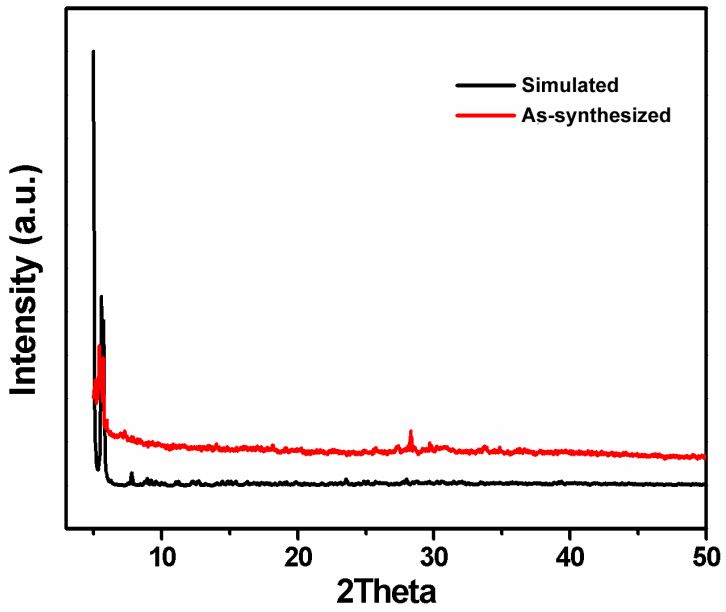

Figure S5. The PXRD pattern of compound **2** at room temperature.

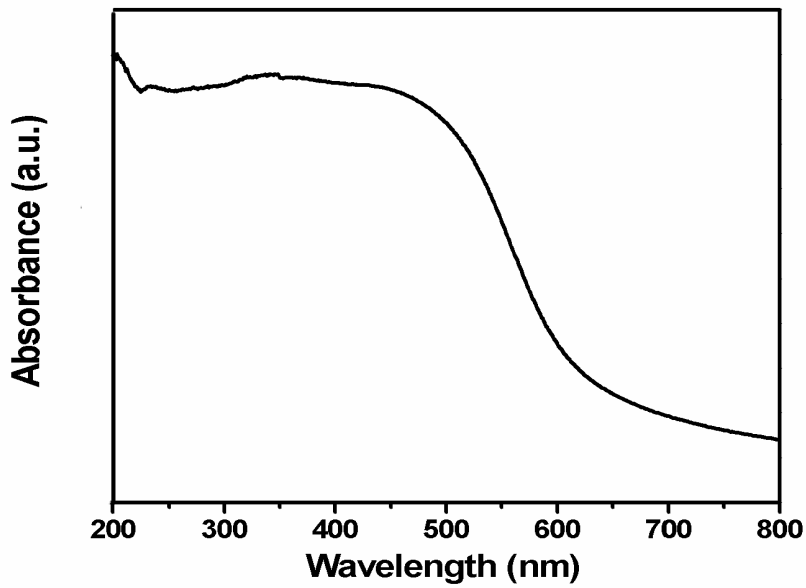

Figure S6. UV-vis spectrum for **2** in solid state.

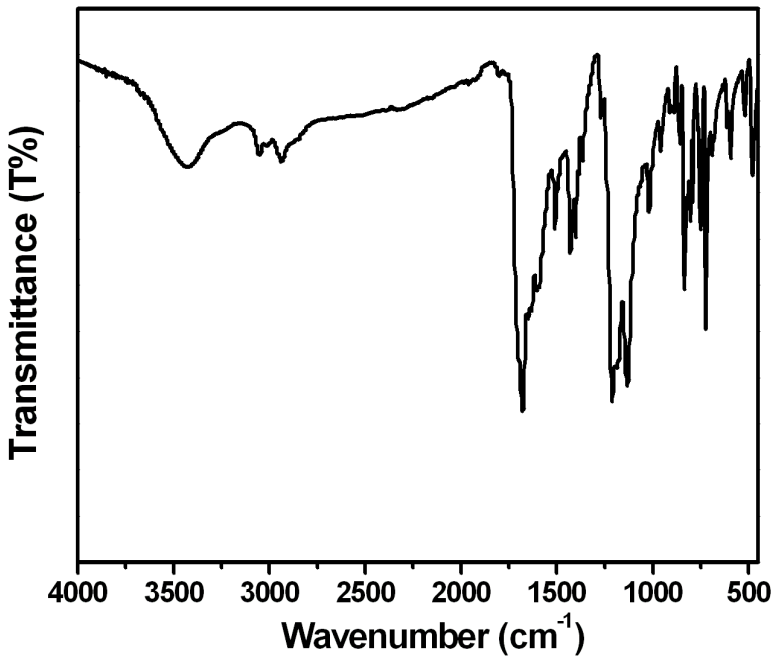

Figure S7. IR absorption spectrum for **1.**

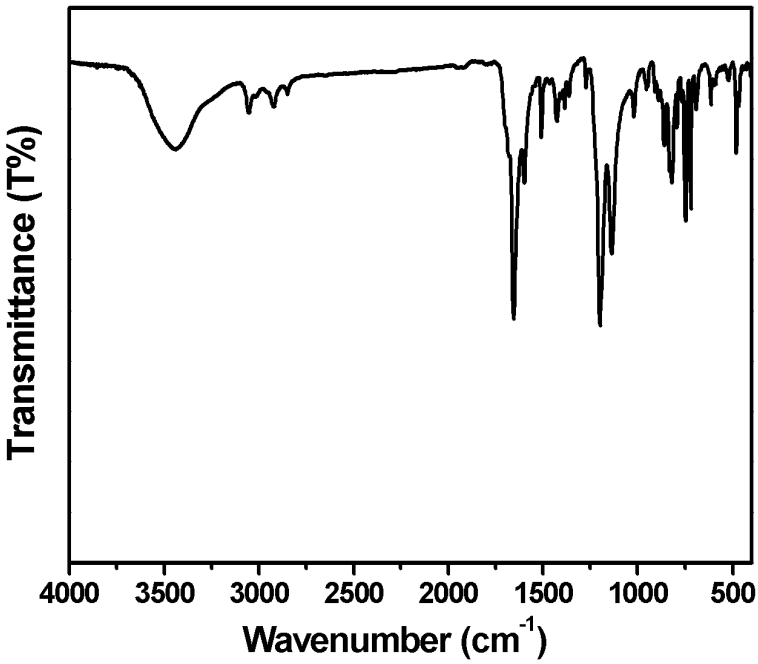

Figure S8. IR absorption spectrum for **2**

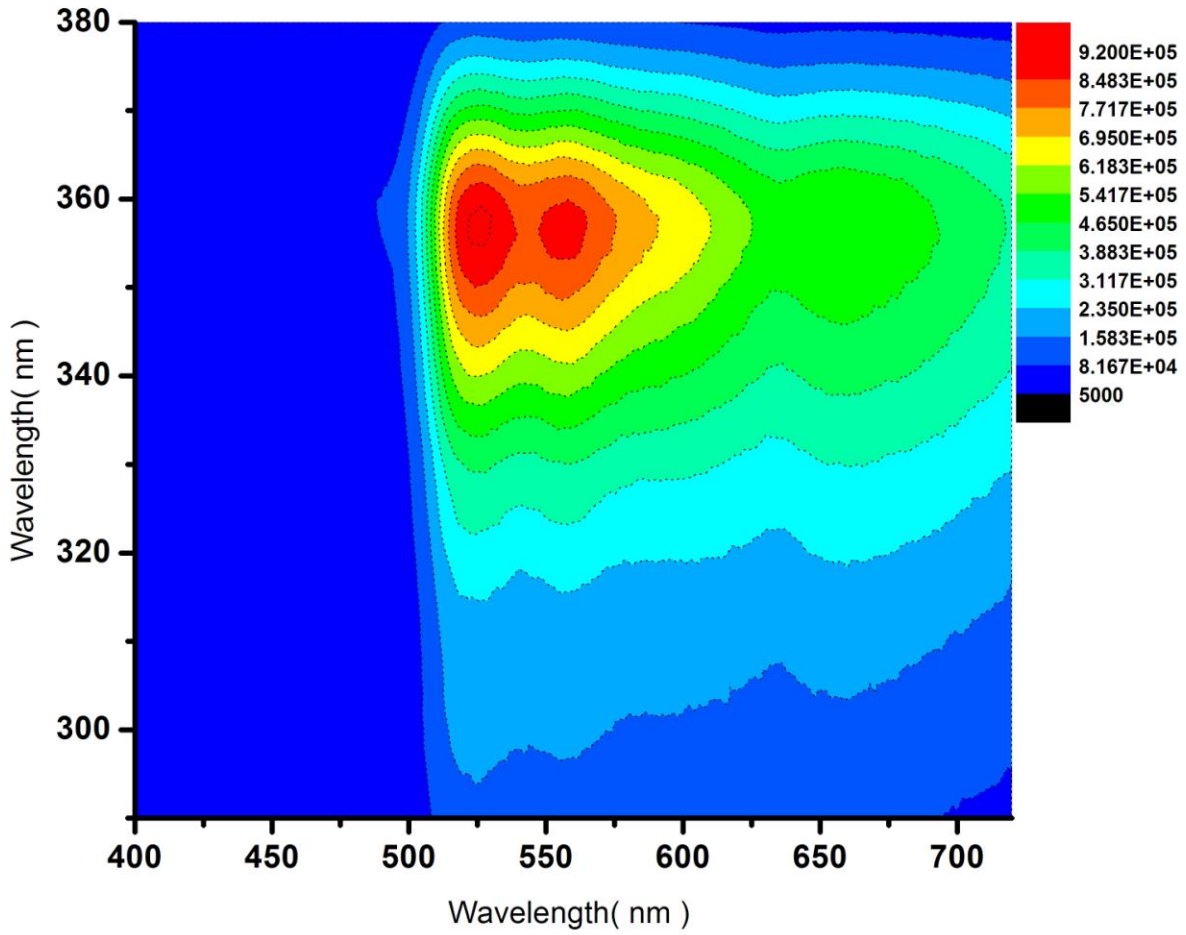

Figure S9. The temperature-dependent luminescence spectra of cluster **1** excited at 360 nm in the solid state

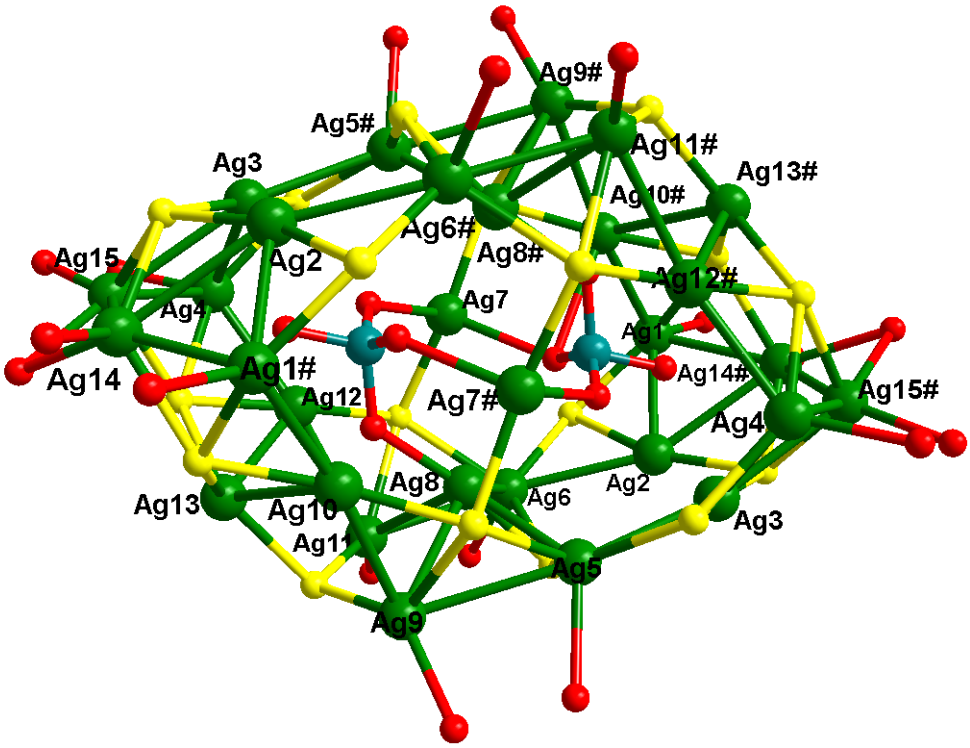

Figure S10. Coordination environments of Ag atoms of cluster **2.**

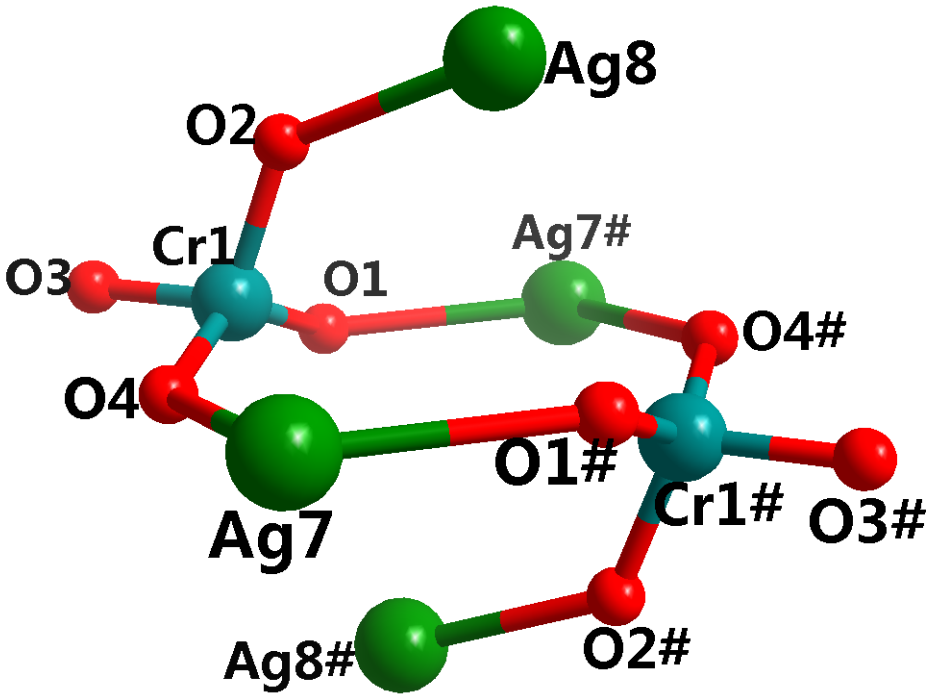

Figure S11. The lingkage mode of CrO_4^{2-} anions of cluster **2.**

Table S1 Crystal data and structure refinement for **1**—**3**.

Cluster	**1**	**2**	**3**
CCDC number	1869847	1869848	1869846
Empirical formula	$C_{106}H_{108}N_6O_{22}S_6F_{24}Ag_{14}$	$C_{230}H_{198}N_4O_{28}S_{18}F_{24}Cr_2Ag_{30}$	$C_{86}H_{68}Ag_{12}Cr_2F_{12}N_6O_{15}S_6$
Formula weight	3976.52	7839.09	3244.26
Crystal size, mm^3	0.20 × 0.18 × 0.16	0.20 × 0.21 × 0.25	0.18 × 0.18 × 0.16
Crystal system	Orthorhombic	Triclinic	triclinic
Space group	*P*bca	$P\bar{1}$	$P\bar{1}$
a, Å	17.109(13)	17.8479(4)	10.5753(3)
b, Å	26.729(9)	21.0072(4)	16.3742(8)
c, Å	29.365(13)	21.9628(4)	17.2297(9)
α, deg	90	62.618(2)	66.079(5)
β, deg	90	83.842(2)	72.957(4)
γ, deg	90	65.100(2)	82.717(3)
Volume, $Å^3$	13429(12)	6594.1(3)	2607.4(2)
Z	4	1	1
Temperature, K	293(2)	102	293(2)
Density (calcd.), g cm^{-3}	1.967	1.974	2.066
Absorption coeff., mm^{-1}	2.180	2.465	2.597
F(000), e	7728	3792	1562
Theta range for data	3.02 to 25.00°	3.426 to 26.00°	2.89 to 25.00

collection			
Index ranges	–10≤h≤20, –29≤k≤31, –34≤l≤22	-22≤h≤20, -20≤k≤25, -24≤l≤27	-12 ≤h≤12, -19≤k≤19, -20≤l≤18
Completeness to theta = 25.00°	99.8%	99.7%	99.7%
Absorption correction	Semi–empirical from equivalents	Semi-empirical from equivalents	Semi-empirical from equivalents
Max. and min. transmission	0.7218 and 0.6696	1.000 and 0.899	0.660 and 0.633
Refinement method	Full–matrix least–squares on F^2	Full-matrix least-squares on F^2	Full-matrix least-squares on F^2
Data/restraints/parameters	11813/262/808	25823/57/1519	9178 /1420 /689
Wavelength	0.71073 Å	0.71073 Å	0.71073 Å
Reflections collected/independent/R_{int}	32173[R(int) = 0.0421]	61028[R(int) = 0.0459]	17036 [R(int)=0.0477]
Final $R1/wR2[I \geq 2\sigma(I)]$	0.0688 / 0.2005	0.0432 / 0.0913	0.0630/0.1096
Final $R1/wR2$ (all data)	0.1083 / 0.2278	0.0657 / 0.1032	0.1442/0.1313
Goodness of fit (GOF)	1.056	1.014	0.991
Final diff. peaks(max/min), e Å^{-3}	1.979/–0.780	1.743/–2.461	1.452/-0.883

$R_1 = \sum||F_o|-|F_c||/\sum|F_o|$. $wR_2 = [\sum w(F_o^2 - F_c^2)^2/\sum w(F_o^2)^2]^{1/2}$

Table S2 Selected bond lengths [Å] and angles [°] for **1** - **3**.

1			
Bond lengths (Å)			
Ag1–O1	2.249(9)	Ag6–O5	397(11)
Ag1–O9	2.436(9)	Ag6–S2	2.474(3)
Ag1–Ag2	2.948(2)	Ag6–Ag7	3.138(2)
Ag1–Ag7#1	3.0957(17)	Ag7–O6	2.262(11)
Ag2–O3	2.340(9)	Ag7–O8#1	2.385(11)
Ag2–O2	2.414(8)	Ag7–S1#1	2.554(3)
Ag2–Ag3	3.0084(15)	Ag7–Ag1#1	3.0957(17)
Ag2–Ag6	3.103(2)	Ag4–S1	2.888(3)
Ag3–O4	2.421(8)	Ag4–Ag7#1	2.9539(16)
Ag3–Ag6	2.9152(17)	Ag5–S3	2.636(3)
Ag3–Ag4	3.077(2)	Ag4–S2#1	2.496(3)
Ag3–Ag5	3.3057(18)	Ag4–O10	2.544(8)
S2–Ag5#1	2.510(3)	O9–Ag7#1	2.581(9)
S3–Ag1#1	2.535(3)		
Bond Angles (°)			
O1–Ag1–O9	104.6(4)	O9–Ag1–S3#1	113.5(2)
O1–Ag1–S3#1	125.2(3)	O1–Ag1–S1	125.3(2)
S1–Ag1–Ag2	54.13(6)	S1–Ag1–Ag7#1	51.36(6)
O1–Ag1–Ag7#1	153.7(3)	Ag2–Ag1–Ag7#1	104.52(5)
O9–Ag1–Ag7#1	54.1(2)	O2–Ag2–S1	118.7(3)
O3–Ag2–Ag3	85.5(3)	S1–Ag2–Ag1	59.16(7)
O2–Ag2–Ag3	162.2(3)	O2–Ag2–Ag6	136.0(3)
S2–Ag2–Ag3	104.83(7)	S2–Ag2–Ag6	50.67(7)
O4–Ag3–S3	92.1(3)	O4–Ag3–S1	104.1(3)
S3–Ag3–O10	98.7(2)	O10–Ag3–Ag6	151.4(2)
S3–Ag3–Ag2	116.60(7)	S1–Ag3–Ag4	61.22(7)
O10–Ag3–Ag2	142.99(19)	S3–Ag3–Ag4	115.46(8)
S2#1–Ag4–Ag6#1	52.69(6)	O10–Ag4–Ag3	53.25(18)

O10–Ag4–Ag6#1	125.43(19)	S1–Ag4–Ag3	49.74(6)
S1–Ag4–Ag6#1	72.28(5)	Ag7#1–Ag4–Ag3	98.78(5)
Ag7#1–Ag4–Ag6#1	63.74(4)	Ag6#1–Ag4–Ag3	76.24(3)
O7–Ag4–Ag3	125.2(4)	O11–Ag5–S2#1	133.7(3)
S2#1–Ag5–S3	99.44(9)	O11–Ag5–S3	126.6(3)
O11–Ag5–Ag3	128.7(3)	O5–Ag6–S2	94.3(3)
S2#1–Ag5–Ag3	76.94(6)	O5–Ag6–S3	104.9(3)
S3–Ag5–Ag3	48.80(7)	S2–Ag6–S3	160.36(10)
S2–Ag6–Ag4#1	53.38(7)	O5–Ag6–Ag3	123.8(3)
S3–Ag6–Ag4#1	128.03(7)	S2–Ag6–Ag3	110.13(8)
Ag3–Ag6–Ag2	59.89(4)	Ag3–S1–Ag7#1	129.21(11)
Ag4#1–Ag6–Ag7	57.59(3)	Ag1–S1–Ag4	128.47(9)
Ag2–Ag6–Ag7	162.07(4)	Ag2–S1–Ag1	66.71(7)
O6–Ag7–O8#1	90.5(5)	Ag3–S1–Ag4	69.04(7)
O6–Ag7–S1#1	154.8(3)	Ag7#1–S1–Ag4	65.42(7)
O8#1–Ag7–S1#1	108.5(4)	S1#1–Ag7–O9#1	95.3(2)
O6–Ag7–O9#1	97.2(4)	O6–Ag7–Ag4#1	105.1(4)
O8#1–Ag7–O9#1	101.0(4)	S1#1–Ag7–Ag4#1	62.74(7)
O8#1–Ag7–Ag4#1	82.6(3)	Ag6–S2–Ag4#1	73.94(9)

2

Bond lengths (Å)			
Ag1-Ag3	2.8754(6)	Ag1-Ag4	2.9396(6)
Ag1-Ag5	2.9577(7)	Ag1-Ag7	3.1215(7)
Ag1-S4	2.4355(16)	Ag1-O1	2.193(4)
Ag1-O2#1	2.555(5)	Ag2-Ag7	2.9821(7)
Ag2-Ag9	3.1999(6)	Ag2-Ag14	2.8706(7)
Ag2-S1	2.4304(16)	Ag2-S2	2.4132(15)
Ag3-Ag7	3.2067(7)	Ag3-Ag13	2.9747(7)
Ag3-S2	2.6511(17)	Ag3-S4	2.5333(16)
Ag3-S7	2.5577(14)	Ag3-O11	2.413(4)
Ag4-Ag5	2.9843(7)	Ag4-Ag12	2.9391(7)
Ag4-S3	2.4267(17)	Ag4-S5	2.5595(15)

Ag4-O12	2.281(4)	Ag5-Ag15	3.0237(7)
Ag5-S4	2.5363(15)	Ag5-S5	2.6355(16)
Ag5-S9	2.5515(16)	Ag5-O10	2.392(4)
Ag6-Ag10	3.0019(7)	Ag6-Ag14	2.9295(6)
Ag6-Ag15 #1	3.2283(7)	Ag6-S1	2.5861(15)
Ag6-S8	2.5472(16)	Ag6-O6	2.496(4)
Ag6-O9	2.364(5)	Ag7-S2	2.6254(15)
Ag7-S3	2.4313(15)	Ag7-O4	2.277(4)
Ag8-Ag10	3.0187(7)	Ag8-Ag12	2.8686(7)
Ag8-Ag13#1	2.9282(6)	Ag8-S6	2.6254(16)
Ag8-S7#1	2.4454(15)	Ag8-O5	2.301(4)
Ag9-Ag12	3.3434(7)	Ag9-S1	2.6008(16)
Ag9-S3	2.5324(16)	Ag9-S6	2.6457(16)
Ag9-O13	2.517(5)	Ag10-Ag13#1	3.0321(7)
Ag10-S6	2.5600(16)	Ag10-S8	2.5348(15)
Ag10-O6	2.556(5)	Ag10-O8	2.324(4)
Ag11-S2	2.4388(15)	Ag11-S5#1	2.4611(15)
Ag11-O2	2.424(5)	Ag11-O14#1	2.462(6)
Ag12-S5	2.4199(17)	Ag12-S6	2.4146(17)
Ag13-S7	2.4431(17)	Ag13-S8#1	2.4398(17)
Ag14-Ag15#1	2.9342(7)	Ag14-S1	2.5472(15)
Ag14-S9#1	2.4415(15)	Ag14-O7	2.346(5)
Ag15-S8#1	2.4577(15)	Ag15-S9	2.4534(15)
Cr1-O1	1.578(4)	Cr1-O2	1.528(5)
Cr1-O3	1.537(5)	Cr1-O14	1.542(5)

Bond Angles (°)

O1-Ag1-Ag7	82.63(11)	O1-Ag1-S4	174.24(12)
O1-Ag1-O2#1	97.41(17)	O2#1-Ag1-Ag3	99.60(10)
Ag14-Ag2-Ag7	169.92(2)	Ag14-Ag2-Ag9	104.972(19)
S1-Ag2-Ag7	127.65(4)	S1-Ag2-Ag9	52.90(4)
S2-Ag2-S1	171.67(6)	Ag1-Ag3- Ag7	61.472(15)
Ag1-Ag3-Ag13	108.98(2)	Ag13-Ag3-Ag7	164.73(2)

S2-Ag3-Ag1	77.36(3)	S2-Ag3-Ag7	52.21(3)
S2-Ag3-Ag13	140.52(4)	S4-Ag3-Ag1	53.07(4)
O11-Ag3-S4	99.85(13)	O11-Ag3-S7	98.84(12)
Ag1-Ag4-Ag5	59.899(16)	Ag12-Ag4-Ag1	87.001(17)
O12-Ag4-Ag12	121.28(12)	O12-Ag4-S3	123.80(13)
O12-Ag4-S5	97.46(13)	Ag1-Ag5-Ag4	59.301(16)
Ag1-Ag5-Ag15	100.602(18)	Ag4-Ag5-Ag15	158.67(2)
S4-Ag5-Ag1	51.94(4)	S4-Ag5-Ag4	91.24(4)
O10-Ag5-Ag15	116.45(11)	O10-Ag5-S4	106.14(12)
O10-Ag5-S5	100.43(11)	O10-Ag5-S9	104.30(13)
Ag10-Ag6-Ag15#1	94.235(18)	Ag14-Ag6-Ag10	133.20(2)
Ag14-Ag6-Ag15#1	56.663(15)	S1-Ag6-Ag10	102.94(4)
S1-Ag6-Ag14	54.58(3)	S1-Ag6-Ag15#1	98.55(4)
O9-Ag6-S1	100.23(11)	O9-Ag6-S8	121.29(11)
O9-Ag6-O6	103.98(15)	Ag1-Ag7-Ag3	54.029(14)
Ag2-Ag7-Ag1	80.199(17)	Ag2-Ag7-Ag3	97.965(18)
S2-Ag7-Ag1	73.42(4)	S2-Ag7-Ag2	50.49(3)
S2-Ag7-Ag3	52.94(4)	S3-Ag7-Ag1	71.97(4)
O4-Ag7-S2	92.57(11)	O4-Ag7-S3	139.29(11)
Ag12-Ag8-Ag10	97.57(2)	Ag12-Ag8-Ag13#1	99.742(19)
Ag13#1-Ag8-Ag10	61.287(16)	S6-Ag8-Ag10	53.40(4)
S6-Ag8-Ag12	51.91(4)	S6-Ag8-Ag13#1	97.37(4)
S1-Ag9-Ag2	48.19(3)	S1-Ag9-Ag12	123.88(4)
S1-Ag9-S6	104.67(5)	S3-Ag9-Ag2	78.91(4)
Ag6-Ag10-Ag8	139.27(2)	Ag6-Ag10-Ag13#1	96.656(18)
Ag8-Ag10-Ag13#1	57.886(15)	S6-Ag10-Ag6	102.91(4)
O8-Ag10-O6	97.78(15)	S2-Ag11-S5#1	156.27(5)
S2-Ag11-O14#1	105.95(13)	S5#1-Ag11-O14#1	87.41(13)
O2-Ag11-S2	108.50(12)	O2-Ag11-S5	90.85(12)
O2-Ag11-O14#1	89.23(19)	Ag4-Ag12-Ag9	77.023(17)
Ag8-Ag12-Ag4	166.67(2)	Ag8-Ag12-Ag9	108.27(2)
S5-Ag12-Ag4	56.05(4)	S5-Ag12-Ag8	121.81(4)

S6-Ag12-S5	173.46(5)	Ag3-Ag13-Ag10#1	159.14(2)
Ag8#1-Ag13-Ag3	104.09(2)	Ag8#1-Ag13-Ag10#1	60.828(16)
S7-Ag13-Ag3	55.29(4)	S7-Ag13-Ag8#1	53.24(4)
S7-Ag13-Ag10	113.69(4)	S8#1-Ag13-Ag3	137.37(4)
S8#1-Ag13-Ag8#1	114.65(4)	S8#1-Ag13-Ag10#1	53.88(4)
S1-Ag14-Ag15#1	107.50(4)	S9#1-Ag14-Ag2	109.50(4)
S9-Ag14-Ag6	118.70(4)	S9#1-Ag14-Ag15#1	53.36(4)
Ag14-Ag15-Ag6	56.526(15)	S8#1-Ag15-Ag5	146.11(4)
S8#1-Ag15-Ag6#1	51.06(4)	S8#1-Ag15-Ag14#1	107.16(4)
S9-Ag15-Ag5	54.33(4)	S9-Ag15-Ag6#1	108.29(4)
S9-Ag15-Ag14#1	52.98(4)	S9-Ag15-S8#1	159.14(6)
O2-Cr1-O1	109.9(2)	O2-Cr1-O3	110.9(3)
O2-Cr1-O14	110.7(3)	O3-Cr1-O1	109.1(3)
O3-Cr1-O14	108.2(3)	O14-Cr1-O1	108.0(3)

3

Bond lengths (Å)

Ag1-O4	2.325(8)	Ag2-O6	2.371(7)
Ag1-S8	2.486(2)	Ag2-S10	2.479(3)
Ag2-Ag6#1	3.1568(12)	Ag4-N1	2.304(10)
Ag3-N3	2.255(11)	Ag4-O5	2.370(7)
Ag5-Ag6	2.9876(11)	Ag5-S9	2.421(2)
Ag6-N2	2.229(9)	Ag5-S8	2.426(2)
Ag6-S10#1	2.435(2)	Cr1-O1	1.589(6)
Ag6-S8	2.590(3)	Cr1-O3	1.599(7)
Cr1-O2	1.575(6)	Cr1-O8#1	1.789(14)
Cr1-O8	1.783(14)		

Bond Angles (°)

O4-Ag1-S8	127.3(2)	O4-Ag1-O3	82.4(3)
S8-Ag1-O3	93.89(10)	O4-Ag1-S10	97.1(2)

S8-Ag1-S10	133.07(8)	O3-Ag1-S10	107.73(17)
O4-Ag1-Ag4	82.8(2)	S8-Ag1-Ag4	111.46(5)
O3-Ag1-Ag4	154.63(16)	S10-Ag1-Ag4	54.02(6)
O4-Ag1-Ag5	162.7(2)	S8-Ag1-Ag5	49.98(6)
O3-Ag1-Ag5	80.85(16)	S10-Ag1-Ag5	92.17(7)
Ag4-Ag1-Ag5	114.35(3)	O6-Ag2-S10	106.7(2)
O6-Ag2-S9	111.4(2)	S10-Ag2-S9	138.60(8)
O6-Ag2-O1	80.3(3)	S10-Ag2-O1	106.0(2)
S9-Ag2-O1	95.8(2)	O6-Ag2-Ag5	152.9(2)
S10-Ag2-Ag5	97.08(6)	S9-Ag2-Ag5	51.72(6)
O1-Ag2-Ag5	80.83(18)	O6-Ag2-Ag3#1	77.79(19)
S10-Ag2-Ag3#1	118.76(6)	S9-Ag2-Ag3#1	56.99(5)
O1-Ag2-Ag3#1	134.1(2)	Ag5-Ag2-Ag3#1	102.16(3)
O6-Ag2-Ag6#1	92.6 (2)	S10-Ag2-Ag61	49.41(5)
S9-Ag2-Ag6#1	112.40(5)	O1-Ag2-Ag6#1	151.4(2)
Ag5-Ag2-Ag6#1	112.96(3)	Ag3#1-Ag2-Ag6#1	69.59(3)
N3-Ag3-O7#1	110.8(4)	N3-Ag3-S8	110.2 (2)
O7#1-Ag3-S8	122.1(2)	N3-Ag3-S9#1	99.1(3)
O7#1-Ag3 -S9#1	117.45(18)	S8-Ag3-S9#1	94.11(7)
N3-Ag3 -Ag2#1	147.9(2)	O7#1-Ag3-Ag2#1	79.77(19)
S8-Ag3-Ag2#1	86.44(5)	S9#1-Ag3-Ag2#1	51.13(5)
N1-Ag4-O5	93.3(3)	N1-Ag4-S9#1	107.3(2)
O5-Ag4-S9#1	122.6(2)	N1-Ag4-S10	119.0(3)
O5-Ag4-S10	98.3 (2)	S9#1-Ag4-S10	115.17(8)
N1-Ag4-Ag1	164.7 (2)	O5-Ag4-Ag1	76.3(2)
S9#1-Ag4-Ag1	87.85(5)	S10-Ag4-Ag1	53.20(5)
N1-Ag4-Ag5#1	100.4(3)	O5-Ag4-Ag5#1	165.2(2)
S9#1-Ag4-Ag5#1	47.69(5)	S10-Ag4-Ag5#1	79.99(6)
Ag1-Ag4-Ag5#1	91.31(3)	S9-Ag5-S8	166.70(7)
S9-Ag5-Ag2	54.58(6)	S8-Ag5-Ag6	56.00(6)
S8-Ag5-Ag2	122.36(6)	Ag2-Ag5-Ag6	154.70(3)
S9-Ag5-Ag6	120.15(6)	S9-Ag5-Ag1	125.37(6)

S8-Ag5-Ag1	51.70(6)	S8-Ag5-Ag4#1	124.92(6)
Ag2-Ag5-Ag1	71.25(3)	Ag2-Ag5-Ag4#1	102.10(3)
Ag6-Ag5-Ag1	105.26(4)	Ag6-Ag5-Ag4#1	69.77 (3)
S9-Ag5-Ag4#1	50.61(6)	Ag1-Ag5-Ag4#1	154.22(3)
N2-Ag6-S10#1	136.4(3)	S10#1-Ag6-Ag5	87.51(6)
N2-Ag6-S8	103.3(3)	S8-Ag6-Ag5	50.97(5)
S10#1-Ag6-S8	119.32(8)	N2-Ag6-Ag2#1	151.0(3)
N2-Ag6-Ag5	115.1(3)	S10#1-Ag6-Ag2#1	50.64(6)
Ag5-Ag6-Ag2#1	91.60(3)	S8-Ag6-Ag2#1	84.26(5)
O2-Cr1-O1	108.7(4)	O1-Cr1-O8#2	121.7(6)
O2-Cr1-O3	110.8(4)	O3-Cr1-O8#2	110.1(6)
O1-Cr1-O3	112.3(4)	O8-Cr1-O8#2	35.5(6)
O2-Cr1-O8	124.6(5)	Ag5-S8-Ag1	78.32(7)
O1-Cr1-O8	96.0(5)	Ag5-S8-Ag3	136.31(8)
O3-Cr1-O8	103.6(6)	Ag1-S8-Ag3	100.49(9)
O2-Cr1-O8#2	91.1(5)	Ag2-S9-Ag4#1	146.13(10)
Ag5-S8-Ag6	73.03(7)	Ag5-S9-Ag3#1	132.26(10)
Ag1-S8-Ag6	144.95(9)	Ag2-S9-Ag3#1	71.88(6)
Ag3-S8-Ag6	87.02(7)	Ag4#1-S9-Ag3#1	111.19(7)
Ag5-S9-Ag2	73.70(7)	Ag6#1-S10-Ag2	79.95(8)
Ag5-S9-Ag4#1	81.70(7)	Ag6#1-S10-Ag1	139.41(6)
Ag2-S10-Ag1	89.32(8)	Cr1-O1-Ag2	129.9(4)
Ag6#1-S10-Ag4	90.77(4)	Cr1-O3-Ag1	126.2(3)
Ag2-S10-Ag4	140.05(10)	O8#2-O8-Cr1	72.5(14)
Ag1-S10-Ag4	72.78(7)	O8#2-O8-Cr1#2	71.9(14)
Cr1-O8-Cr1#2	144.5(6)		

Symmetry transformations used to generate equivalent atoms: #1 –x+1,–y+1,–z for **1**; #1 1-x,2-y,-z for **2;** #1 1-x,1-y,-z; #2 -x,1-y,-z for **3**.

References

[1] CrysAlis^{Pro} Version 1.171.36.31. (**2012**). Agilent Technologies Inc. Santa Clara, CA, USA.

[2] L. Krause, R. Herbst-Irmer, G. M. Sheldrick, D. Stalke, *J. Appl. Cryst.* **2015**, *48*, 3.

[3] G. M. Sheldrick, *Acta Cryst. A* **2008**, *64*, 112.

[4] O. V. Dolomanov, L. J. Bourhis, R. J. Gildea, J. A.-K. Howard, H. Puschmann, *J. Appl. Cryst.* **2009**, *42*, 339.

[5] G. M. Sheldrick, *Acta Cryst. C* **2015**, *71*, 3.