

抗菌药物柳氮磺胺镉配聚物的合成和晶体结构

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Synthesis and Crystal Structure of a Novel Cd(II) Coordination Polymer with Antibacterial Drug Sulfasalazine

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Abstract: A novel coordination polymer, $[\text{Cd}(\text{py})(\text{SSZ})_2]_n$, was synthesized under hydrothermal conditions and characterized by elemental analysis, IR spectra and X-ray single crystal diffraction. CCDC: 295625.

Key words: sulfasalazine; coordination polymer; crystal structure

0 Introduction

Crystal engineering of pharmaceutical solids represents a fertile and emerging research field^[1]. The impetus for discovery of diverse crystal forms of drugs stems from the critical need to balance stability, bioavailability and other performance characteristics as well as provides valuable intellectual property protection. Sulfasalazine (synonyms salazopyridine and salazosulfapyridine, abbreviated as H-SSZ) is a conjugate of 5-aminosalicylic acid and sulfapyridine possessing antimicrobial properties, which is used as drug for treating inflammatory bowel disorders^[2] and rheumatoid arthritis^[3]. It is also a known inhibitor of alpha,

mu and pi class GSTs with concentrations of 28 μM or less required to inhibit 50% of enzymatic activity^[4]. We are investigating the interaction between above mentioned drug and metal ions with a view to obtain complexes with useful medicinal properties. Recently, Chen et al., reported the first crystal structure of Sr(II) ionic compound with sulfasalazine^[5], to the best of our knowledge, no any other complex has been reported so far, probably due to the difficulty in obtaining suitable crystals. To our surprise, the hydrothermal treatment of $\text{Cd}(\text{ClO}_4)_2 \cdot 6\text{H}_2\text{O}$ and sulfasalazine affords a one-dimensional coordination polymer $\text{C}_{41}\text{H}_{31}\text{CdN}_9\text{O}_{10}\text{S}_2$ (**1**). Herein, we would like to report the synthesis and crystal structure of the compound.

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1 Experimental

1.1 Materials and methods

All of the chemicals were purchased from Aldrich and used without further purification. The IR spectra were recorded from KBr pellets on a Nicolet Avatar 360 FTIR spectrometer. Elemental analysis for C, H, and N were performed on a Perkin-Elmer 240C analyzer.

1.2 Synthesis of $[\text{Cd}(\text{py})(\text{SSZ})_2]_n$ (**1**)

H-SSZ (0.08 g, 0.2 mmol) and $\text{Cd}(\text{ClO}_4)_2 \cdot 6\text{H}_2\text{O}$ (0.08 g, 0.2 mmol) were thoroughly mixed in ethanol (7 mL), water (8 mL) and pyridine (0.05 mL), then the mixture was transferred into a autoclave Teflon-lined stainless vessel (23 mL). The vessel was sealed and heated to 120 °C for 5 days, then cooled to room temperature, tablet orange crystals were obtained. Yield: 60% based on H-SSZ (Calc. (%) C, 49.88; H, 3.14; N, 1.28; Found(%): C, 50.03; H, 3.24; N, 1.40). IR (KBr, cm^{-1}): 3 448(s), 1 631(s), 1 459(s), 1 393(m), 1 310(m), 1 137(m), 1 082(m), 953(m), 845(m), 777(ms), 679(ms),

616(s), 581(ms).

1.3 X-ray crystallography

X-ray single crystal diffraction data collection for the compound was carried out on a Bruker SMART APEX area detector diffractometer with a cryostat, using graphite-monochromated $\text{Mo } K\alpha$ radiation ($\lambda = 0.071\,073\text{ nm}$). The unique reflections of 4 512 were measured, of which 3 980 with $I > 2\sigma(I)$ was used in structure solution and refinements. Semi-empirical absorption correction based on equivalent reflections was applied. The structure was solved by direct methods^[6]. All the non-hydrogen atoms of the framework structure were refined by full-matrix least squares using anisotropic displacement parameters. All the hydrogen atoms were placed in calculated positions and refined using a riding model^[7]. Final refinement gave $R_1 = 0.037\,3$, $wR_2 = 0.102\,4$, the goodness-of-fit = 1.087. Crystal data, data collection and refinement parameters are given in Table 1, while selected bond distances and angles are listed in Table 2.

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Table 1 Crystallographic data for the compound **1**

Empirical formula	$\text{C}_{41}\text{H}_{31}\text{CdN}_9\text{O}_{10}\text{S}_2$	Z	4
Formula weight	986.27	T / K	150(2)
Crystal system	Monoclinic	λ	0.710 73
Space group	$C2/c$	$\rho_{\text{calc}} / (\text{g} \cdot \text{cm}^{-3})$	1.675
a / nm	4.453 1(2)	μ / cm^{-1}	7.4
b / nm	1.100 92(6)	R_1	0.037 3
c / nm	0.800 52(4)	wR_2	0.102 4
$\beta / (^\circ)$	94.849 0(10)	GOF	1.087
V / nm^3	3.910 5(3)	Min. and max. residual densities / ($\text{e} \cdot \text{nm}^{-3}$)	−694, 793

Table 2 Selected bond distances (nm) and angles ($^\circ$) for the compound **1**

Cd(1)-N(5)	0.222 7(3)	Cd(1)-O(1)A	0.225 9(2)	Cd(1)-O(3)	0.252 6(2)
Cd(1)-O(1)	0.225 9(2)	Cd(1)-O(3)B	0.247 4(2)		
N(5)-Cd(1)-O(1)	137.30(6)	O(1)A-Cd(1)-O(3)B	109.93(7)	O(3)B-Cd(1)-O(3)C	169.43(9)
O(1)-Cd(1)-O(1)A	85.39(12)	N(5)-Cd(1)-O(3)C	84.71(4)	N(5)-Cd(1)-O(3)A	95.67(4)
N(5)-Cd(1)-O(3)B	84.71(4)	O(1)-Cd(1)-O(3)C	109.92(7)	O(1)-Cd(1)-O(3)A	115.93(7)
O(1)-Cd(1)-O(3)B	78.15(8)	O(1)A-Cd(1)-O(3)C	78.15(8)	O(1)A-Cd(1)-O(3)A	54.37(7)

Symmetry transformations: A=− x , y , − $z+1/2$; B= x , − $y+1$, $z+1/2$; C=− x , − $y+1$, z .

2 Results and discussion

Single crystal structure analysis of compound **1** revealed a 1D chain structure. Compound **1** crystal-

lizes in monoclinic, space group $C2/c$. All atoms lie on general positions. Each cadmium centre in **1** is surround by six oxygen atoms from carboxylate group of four different SSZ ligands and one pyridyl nitrogen

atom to result in the formation of capped octahedron (Fig.1). The O3-C9-O1 carboxylate coordinates in a chelating fashion with a Cd1-O3 distance of 0.252 6(2) nm and Cd1-O1 distance of 0.225 9(2) nm, O3 also coordinates to a second Cd forming a bridge between adjacent Cd centres, and thus the SSZ adopts an exo-tridentate bridging mode. The exo-tridentate SSZ ligands serve to link adjacent dimetal units to form 1D chain structure. The 1D chain formed by the Cd centers and the exo-tridentate SSZ ligands are cross-linked by several hydrogen-bonding (N2-H2B... N1D,

$D \cdots A = 0.289\ 2(3)$ nm) interaction and other weak electrostatic forces ($O4 \cdots H3A$, $0.242\ 0(5)$ nm; $H13A \cdots H3A$, $0.231\ 3(5)$ nm), resulting 2D wave-like layer structure as shown in Fig.2. The distance of Cd-N ($0.222\ 7$ nm) is shorter than those found in diiodo-bis(methyl-2-pyridinecarboxylato-N,O)-cadmium (II)^[8] methanol solvent ($0.236\ 0$ and $0.235\ 8$ nm) and catena (μ_4 -tetraphthalato-pyridine-cadmium(II)^[9] ($0.228\ 1$ nm). While the bond lengths of Cd-O ($0.225\ 9 \sim 0.252\ 6$ nm) are comparable to those of above mentioned two compounds ($0.230\ 7 \sim 0.256\ 5$ nm).

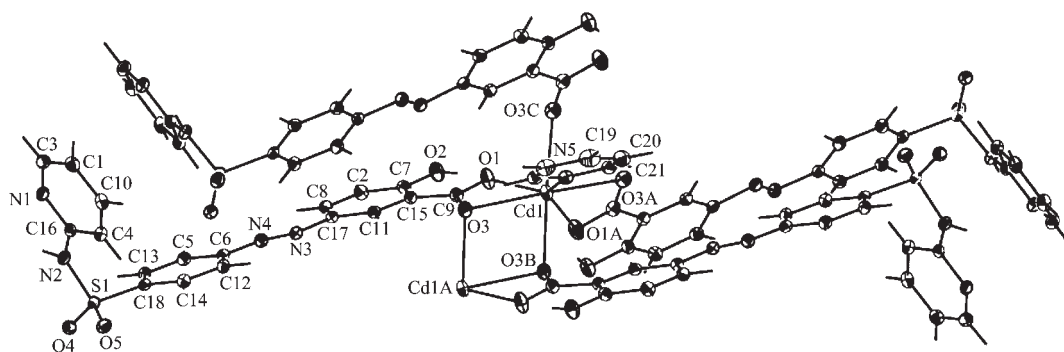


Fig.1 Cadmium coordination environment in **1**

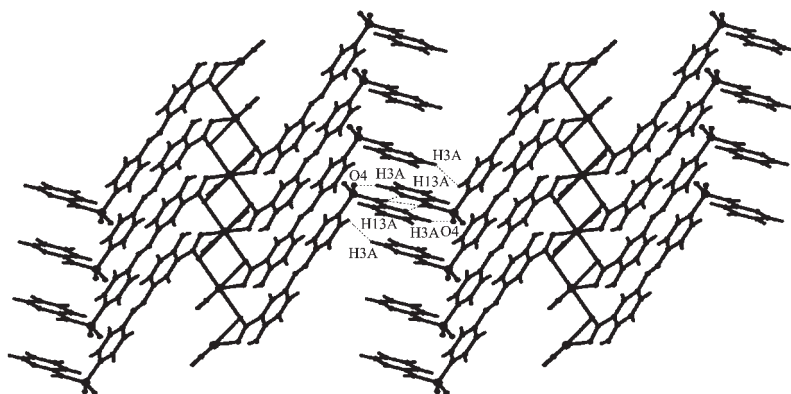


Fig.2 Wave-like polymer of **1** viewing along the *b*-axis

In conclusion, we have demonstrated that H-SSZ can coordinate to metal ions as a poly-dentate chelating agent. Apart from providing a new insight into the reaction of H-SSZ with metal ions, the work has also demonstrated the potential for the use of low symmetry ligands in the generation of coordination polymer. We will investigate the bacteriostatic activity of this compound, and compare the results with the pure medicine ligand sulfasalazine.

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