# Syntheses and Characterization of Organotin(IV) Complexes Derived from 2-Mercapto-1,3,4-thiadiazole

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**ABSTRACT:** Four complexes organotin the  $[(Ph_3Sn)(C_2HN_2S_2)]$ of types (1). $[(CH_3)_3Sn(C_2HN_2S_2)]_n$  (2),  $[(Bu_2Sn)(C_2HN_2S_2)_2]$ (3), and  $[(Me_2Sn)_4(C_2HN_2S_2)_2(\mu_3-O)_2(C_2H_5O)_2]$  (4) have been obtained by 2-mercapto-1,3,4-thiadiazole and triorganotin chloride or diorganotin dichloride. All the complexes were characterized by elemental analysis, IR and NMR spectroscopy, and X-ray diffraction analyses, which revealed that complexes 1 and 3 are mononuclear structures, complex 1 can further form a one-dimensional (1D) helical chain, and complex 3 can further form a 22-membered macrocycle through the intermolecular  $C-H \cdots N$ hydrogen bond; complex 2 is a 1D infinite chain linked by intermolecular  $N \rightarrow Sn$  and  $S \rightarrow Sn$  bonding interactions; complex **4** is a typical ladder structure. © 2012 Wiley Periodicals, Inc. Heteroatom Chem 00:1-8, 2012; View this article online at wilevonlinelibrary.com. DOI 10.1002/hc.21046

## INTRODUCTION

Organotin complexes have attracted more and more attention in recent years, owing to their determinate or potential pharmaceutical value, which have been reported several times before [1–8], as well as the versatile molecular structure and supramolecular architecture exhibited by these complexes [9– 11]. Among them, an organotin heterocyclic thiol complex is a interesting field because of their biological activity as well as their variable molecular structures [12–15]. As an extension of this research program, we selected 2-mercapto-1,3,4-thiadiazole as a heterocyclic thiol ligand and obtained four organotin heterocyclic thiol complexes by using this ligand with organotin chloride. In this paper, we report the synthesis and characterization of these organotin complexes.

## EXPERIMENTAL

## Materials and Measurements

All reagents were commercially available, and they were used without further purification. The melting points were obtained with X-4 digital micromelting point apparatus and were uncorrected. Infrared spectra were recorded on a Nicolet-5700 spectrophotometer (Thermo Nicolet Corporation, Madison, WI) using KBr disks and sodium chloride optics. <sup>1</sup>H and <sup>119</sup>Sn NMR spectra were recorded on a Varian Mercury Plus 400 spectrometer (Varian Medical Systems, Palo Alto, CA) operating at 400 and 149.2 MHz, respectively. The spectra were acquired at 298 K. The chemical shifts were reported in ppm with respect to the references and were stated relative to external tetramethylsilane for <sup>1</sup>H NMR and neat

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tetramethyltin for <sup>119</sup>Sn NMR. Elemental analyses (C, H, N) were performed with a PE-2400II apparatus (Perkin Elmer, Waltham, MA).

[(*Ph*<sub>3</sub>*Sn*)(*C*<sub>2</sub>*HN*<sub>2</sub>*S*<sub>2</sub>)] (1). The reaction was carried out under nitrogen atmosphere. 2-Mercapto-1,3,4-thiadiazole (0.118 g, 1 mmol), sodium ethoxide (0.068 g, 1 mmol), and Ph<sub>3</sub>SnCl (0.385 g, 1 mmol) were added to the solution of benzene (20 mL), continuing the reaction for 12 h at 40°C. The solid was recrystallized from ether, and colorless crystals were formed. Yield: 75%. mp 147–149°C. Anal. Found: C 51.67, H 3.59, N 5.73. Calcd for C<sub>20</sub>H<sub>16</sub>N<sub>2</sub>S<sub>2</sub>Sn: C 51.42, H 3.45, N 6.05. IR (KBr, cm<sup>-1</sup>): ν(S–C=N), 1551; ν(C–S), 977; ν(Sn–S), 335. <sup>1</sup>H NMR (CDCl<sub>3</sub>, ppm): δ 8.35 (s, 1H, CH=N), 7.28–7.61 (m, 15H, Ph-H). <sup>13</sup>C NMR (CDCl<sub>3</sub>. ppm): 168.3 (C–S–Sn), 150.5 (CH=N), 137.6 (<sup>1</sup>*J*<sub>119<sub>Sn</sub>1<sub>3c</sub> = 538 Hz), 134.9 (<sup>2</sup>*J*<sub>119<sub>Sn</sub>1<sub>3c</sub> = 34 Hz), 130.7, 129.4 (Ar–C); <sup>119</sup>Sn NMR (CDCl<sub>3</sub>, ppm): 78.4.</sub></sub>

[(*CH*<sub>3</sub>)<sub>3</sub>*Sn*(*C*<sub>2</sub>*HN*<sub>2</sub>*S*<sub>2</sub>)]<sub>*n*</sub> (**2**). The procedure is similar to that of complex **1**. 2-Mercapto-1,3,4thiadiazole (0.118 g, 1 mmol), sodium ethoxide (0.068 g, 1 mmol), and Me<sub>3</sub>SnCl (0.199 g, 1 mmol) were added to the solution of benzene (20 mL), continuing the reaction for 12 h at 40°C. The solid was recrystallized from ether, and colorless crystals were formed. Yield: 73%. mp 155–157°C. Anal. Found: C 21.08, H 3.75, N 9.71. Calcd for C<sub>5</sub>H<sub>10</sub>N<sub>2</sub>S<sub>2</sub>Sn: C 21.37, H 3.59, N 9.97. IR (KBr, cm<sup>-1</sup>):  $\nu$ (S–C=N) 1549,  $\nu$ (C–S) 953,  $\nu$ (Sn–S) 344,  $\nu$ (Sn–N) 447. <sup>1</sup>H NMR (CDCl<sub>3</sub>, ppm): δ 8.40 (s, 1H, CH=N), 0.92 (s, 9H, CH<sub>3</sub>, <sup>2</sup>*J*<sub>119</sup><sub>Sn<sup>1</sup>H</sub> = 81.6 Hz). <sup>13</sup>C NMR (CDCl<sub>3</sub>. ppm): 167.8 (C–S–Sn), 153.7 (CH=N), 13.8 (CH<sub>3</sub>, <sup>1</sup>*J*<sub>119</sup><sub>Sn<sup>1</sup>C</sub> = 504 Hz). <sup>119</sup>Sn NMR (CDCl<sub>3</sub>, ppm): 27.5.</sub></sub>

 $[(Bu_2Sn)(C_2HN_2S_2)_2]$ (**3**). The procedure is similar to that of complex 1. 2-Mercapto-1,3,4thiadiazole (0.236 g, 2 mmol), sodium ethoxide (0.136 g, 2 mmol), and Bu<sub>2</sub>SnCl<sub>2</sub> (0.325 g, 1 mmol) were added to the solution of benzene (20 mL), continuing the reaction for 12 h at 40°C. The solid was recrystallized from ether, and colorless crystals were formed. Yield: 71%. mp 132–134°C. Anal. Found: C 30.69, H 4.55, N 12.21. Calcd for C<sub>12</sub>H<sub>20</sub>N<sub>4</sub>S<sub>4</sub>Sn : C 30.84, H 4.31, N 11.99. IR (KBr, cm<sup>-1</sup>): v(S–C=N) 1552, v(C-S) 958, v(Sn-S) 342. <sup>1</sup>H NMR (CDCl<sub>3</sub>, ppm): δ 8.46 (s, 2H, CH=N), 0.89 (s, 6H, CH<sub>3</sub>), 1.26-1.54 (m, 12H, Sn-CH<sub>2</sub>-CH<sub>2</sub>-CH<sub>2</sub>,  ${}^{2}J_{119}_{Sn^{1}H} = 73$  Hz). <sup>13</sup>C NMR (CDCl<sub>3</sub>, ppm): 166.4 (C-S-Sn), 151.8 (CH=N), 29.1 ( ${}^{2}J_{119}_{s_{n}^{13}c}$  = 46 Hz), 26.8 ( ${}^{3}J_{119}_{s_{n}^{13}c}$  = 108 Hz), 25.3 ( ${}^{1}J_{119_{sn}{}^{13}C} = 498$  Hz), 13.8 (Sn-C-C-C). <sup>119</sup>Sn NMR (CDCl<sub>3</sub>, ppm): 43.2.  $[(Me_2Sn)_4(C_2HN_2S_2)_2(\mu_3 - O)_2(C_2H_5O)_2](\mathbf{4}).$ 

The procedure is similar to that of complex **1**. 2-Mercapto-1,3,4-thiadiazole (0.118 g, 1 mmol), sodium ethoxide (0.068 g, 1 mmol), and Me<sub>2</sub>SnCl<sub>2</sub> (0.438 g, 2 mmol) were added to the solution of benzene (20 mL), continuing the reaction for 12 h at 40°C. The solid was recrystallized from ether, and colorless crystals were formed. Yield: 68%. mp 171–173°C. Anal. Found: C 20.37, H 3.95, N 5.58. Calcd for C<sub>16</sub>H<sub>36</sub>N<sub>4</sub>O<sub>4</sub>S<sub>4</sub>Sn<sub>4</sub>: C 20.19, H 3.81, N 5.89. IR (KBr, cm<sup>-1</sup>):  $\nu$ (S–C=N) 1553,  $\nu$ (C–S) 966,  $\nu$ (O–Sn–O) 652,  $\nu$ (Sn–N) 439. <sup>1</sup>H NMR (CDCl<sub>3</sub>, ppm):  $\delta$  8.36 (s, 2H, CH=N), 0.95 (s, 24H, Sn–CH<sub>3</sub>, <sup>2</sup>J<sub>119<sub>Sn</sub>1</sup><sub>H</sub> = 84.2 Hz); <sup>13</sup>C NMR (CDCl<sub>3</sub>. ppm): 165.1 (C–S–Sn), 152.4 (CH=N), 14.2 (Sn–CH<sub>3</sub>, <sup>1</sup>J<sub>119<sub>Sn</sub>1</sup><sub>C</sub> = 615 Hz). <sup>119</sup>Sn NMR (CDCl<sub>3</sub>, ppm): –121.7, –157.4.</sub></sub>

## X-Ray Crystallography

Data were collected at 298 K on a Bruker SMART CCD 1000 diffractometer fitted with Mo K $\alpha$  radiation. The structures were solved by direct methods and refined by a full-matrix least squares procedure based on *F*2 using the SHELXL-97 program system. All non-hydrogen atoms were included in the model at their calculated positions. The positions of hydrogen atoms were calculated, and their contributions to structural factor calculations were included. Crystal data and experimental details of the structure determinations are presented in Table 1.

## RESULTS AND DISCUSSION Synthesis of Complexes 1–4

The synthetic procedure is shown in Scheme 1.

## IR Spectroscopic Studies of Complexes 1-4

The stretching frequencies of interest are those associated with the Sn–S and Sn–N groups. The explicit features in the infrared spectra of complexes **1–3** are strong absorption appearing in the range of 335–344 cm<sup>-1</sup> in respective complexes, which are absent in the free ligand and could be assigned to the Sn–S stretching mode [16]. While for complexes **2** and **4**, new bands at 447 and 439 cm<sup>-1</sup> in respective spectra are assigned to  $\nu$ (Sn–N), indicating the nitrogen atom from the ligand moiety coordinates to the central tin atom [17]; moreover, the strong peak at 652 cm<sup>-1</sup> in complex **4** is assigned to  $\nu$  (O–Sn–O), indicating the O–Sn–O bridging structure in complex **4** [18].

 TABLE 1
 Crystal Data and Refinement Details for Complexes 1, 2, 3 and 4

		Com	plex	
Complexes	1	2	3	4
Empirical formula Formula weicht	C <sub>20</sub> H <sub>16</sub> N <sub>2</sub> S <sub>2</sub> Sn 467 16	C <sub>5</sub> H <sub>10</sub> N <sub>2</sub> S <sub>2</sub> Sn 280.96	C <sub>12</sub> H <sub>20</sub> N <sub>4</sub> S <sub>4</sub> Sn 467 25	C <sub>16</sub> H <sub>36</sub> N <sub>4</sub> O <sub>4</sub> S <sub>4</sub> Sn <sub>4</sub> 951 49
Crystal system	Tetragonal	Monoclinic	Monoclinic	Monoclinic
Space group	p43	p21/n	p21/n	p21/c
		Unit cell dimensions		
a (Å)	12.3322(11)	8.6200(11)	13.653(2)	8.3171(8)
b (Å)	12.3322(11)	11.0504(12)	10.3739(18)	16.8700(14)
c (Å)	13.0605(15)	10.5916(14)	13.653(2)	12.1678(11)
( <sub>0</sub> ) x	06	06	06	06
8 (o)	06	93.5320(10)	92.83	107.5680(10)
( <sub>0</sub> ) <i>A</i>	06	06	06	06
V (Å <sup>3</sup> )	1986.3(3)	1007.0(2)	1931.5(6)	1627.6(3)
	4	4	4	5
Dc (mg m <sup>−3</sup> )	1.562	1.853	1.607	1.941
Absorption coefficient (mm <sup>-1</sup> )	1.501	2.891	1.753	3.316
F(0 0 0)	928	544	936	912
Crystal size (mm)	$0.39 \times 0.36 \times 0.25$	0.40  imes 0.24  imes 0.13	$0.56 \times 0.42 \times 0.35$	0.20 imes 0.14 imes 0.09
∂ range (°)	1.65–25.01	2.67–25.02	2.06–28.34	2.13–25.01
Reflections collected	8257	4663	23818	8426
Independent reflections	3448	1746	4551	2866
Data/restraints/parameters	3448 / 1 / 227	1746 / 0 / 94	4551 / 0 / 182	6773 / 2 / 829
Goodness-of-fit on F2	1.211	0.979	1.133	1.044
Final <i>R</i> indices [/> 2ơ(/)] <i>R</i> indices (all data)	R1 = 0.0277, $wR2 = 0.0609R1 = 0.0371$ , $wR2 = 0.0670$	R1 = 0.0631, wR2 = 0.1451 R1 = 0.0957, wR2 = 0.1802	R1 = 0.0513, wR2 = 0.1456 R1 = 0.0587, wR2 = 0.1583	R1 = 0.0303, $wR2 = 0.0755R1 = 0.0403$ , $wR2 = 0.0825$



#### SCHEME 1

### NMR Data of Complexes 1-4

The <sup>1</sup>H NMR data show that the signal of the –SH proton in the spectrum of the free ligand is absent in complexes 1-3, indicating the removal of the -SH proton and the formation of Sn-S bond. The structural changes occurring in the ligand upon deprotonation and coordination to the tin atom could be reflected by the changes in the <sup>13</sup>C NMR spectra of complexes. The <sup>13</sup>C NMR spectra of all complexes 1-4 show a downfield shift of all carbon resonances compared with the free ligand, which indicates the formation of the tin complexes [19,20]. Furthermore, in solution the C-Sn-C angles estimated by  ${}^{1}J_{119}{}_{sn^{13}c}$  coupling constants as reported in the literature are 119° for complex **2** and 130° for complex 4 [21], which are basically consistent with the C-Sn-C angles in solid state. The <sup>119</sup>Sn NMR spectra of complexes **1–4** show resonances between 27.5 and -157.4 ppm. As reported in the literature [22], values of  $\delta$  (<sup>119</sup>Sn) in the ranges -210 to -400, -90 to -190, and 200 to -60 ppm have been associated with six-, five-, and four-coordinated tin centers, respectively. On this basis, we can conclude that complexes 1 and 3 are typical of four coordinated

and complex **4** is five coordinated. These data are confirmed by the X-ray crystal structures of complexes **1,3**, and **4**; whereas complex **2** has the signals in 27.5 ppm, thus indicating four-coordinated environment around the tin atoms for complex **2**; which is not accordant with the structure in solid state. It can reasonably be assumed that the Sn–N dative bond of complex **2** is probably broken in the solution.

## Crystal Structure of Complexes 1 and 2

The molecular structure or repeating unit of complexes **1** and **2** are illustrated in Figs. 1–3 and 4 along with 5, respectively; selected bond lengths and bond angles are given in Tables 2 and 3, respectively. Complex **1** has the common structural property with a monomeric coordination structure. The tin atom is four-coordinated tetrahedron geometry. The Sn–S bond length in complex **1** is 2.4677(14) Å, which approaches the range reported for triphenyltin heteroarenethiolates (2.405–2.481 Å) and the sum of the covalent radii of tin and sulfur (2.42 Å) [23], showing the sulfur atom coordinates to the tin atom

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FIGURE 1 Molecular structure of complex 1.



FIGURE 2 1D helical chain of complex 1, propagation via intermolecular  $C-H\cdots N$  hydrogen bond interactions.



FIGURE 3 View of the 1D helical chain of complex 1 from c axis, propagation via intermolecular C—H $^{...}N$  hydrogen bond interactions.



FIGURE 4 Repeating unit of complex 2.

by a covalent bond. Furthermore, the C–H···N hydrogen bond is found in complex **1**, which connects the adjacent molecules to give rise to a onedimensional (1D) helical chain, the N(2)···H(11) and C(11)-H(11) distances are 2.554 and 0.931 Å, respectively, and the C–H···N angle is 166.43°. These data are similar to other triorganotin complexes that have been reported [24].

Complex **2** exhibit a infinite 1D polymeric chain structure via the tin and nitrogen atoms from the ligand coordinating to the tin atom. All the tin atoms are five-coordinated geometry with slight distortion from an ideal trigonal bipyramidal. The distortion lies at the angle of N(1)-Sn(1)-S(1)#1 is 174.3(2)°,



FIGURE 5 1D infinite chain of complex 2.

which is slightly deviated from the normal angle of  $180^{\circ}$ . Three methyl groups defined at the equatorial plane, and the axial positions are occupied by the sulfur and nitrogen atoms. The bond length of Sn(1)–S(2) is 2.591(3) Å, which is longer than the sum of the covalent radii of tin and sulfur (2.42 Å), but much shorter than the sum of the van der Waals radii of tin and sulfur (4.0 Å) [23]. The Sn(1)–N(2)#1 bond length (2.541(10) Å) is longer than the covalent radii of tin and nitrogen (2.15 Å) [25], but shorter than those found in other similar triorganotin complexes [26,27].

## Crystal Structure of Complexes 3 and 4

The molecular structure of complexes **3** and **4** are illustrated in Figs. 6 along with 7 and 8, respec-

tively; selected bond lengths and bond angles are given in Tables 4 and 5, respectively. In complex 3, two carbon atoms and two sulfur atoms are covalently linked to the tin atom, so the tin atom is four-coordinated tetrahedron geometry, The Sn-C distances [from 2.130(5) to 2.135(4) Å] are close to those found in  $(n-Bu)_2Sn(SC_5H_5N_2)_2$  [28]. The Sn–S distances [2.5506(11) Å and 2.5545(13) Å] are little longer than those found in complex **1** and little shorter than those found in complex 2. Similar to complex 1, the C–H $\cdots$ N hydrogen bond is found in complex **3**, which connects the adjacent molecules to give rise to a 22-membered macrocycle structure, the width of the macrocycle is 9.307 Å  $\times$  3.982 Å [transannular N(2) $\cdots$ N(2a) and N(3) $\cdots$ N(4)], which is similar to those found in other complex [29].

Complex **4** is a typical ladder structure. It consists of  $Sn_4O_4$  ladders with one nitrogen atom from

Bor	ad lengths	
2.128(5) 2.128(4)	Sn(1)-C(9) Sn(1)-S(2)	2.146(4) 2.4677(14)
Boi	nd angles	- ( )
119.01(17)	C(15)–Sn(1)–C(9)	107.50(17)
112.31(17)	C(15)-Sn(1)-S(2)	111.36(14)
108.79(11)	C(9)-Sn(1)-S(2)	95.33(12)
	Bor 2.128(5) 2.128(4) Bor 119.01(17) 112.31(17) 108.79(11)	Bond lengths           2.128(5)         Sn(1)-C(9)           2.128(4)         Sn(1)-S(2)           Bond angles         Bond angles           119.01(17)         C(15)-Sn(1)-C(9)           112.31(17)         C(15)-Sn(1)-S(2)           108.79(11)         C(9)-Sn(1)-S(2)

TABLE 2 Selected Bond Lengths (Å) and Bond Angles (°) for Complex 1

TABLE 3 Selected Bond Lengths (Å) and Bond Angles (°) for Complex 2

	Bond lengths		
Sn(1)-C(5) Sn(1)-C(3) Sn(1)-S(2)	2.074(12) 2.162(12) 2.591(3)	Sn(1)–C(4 Sn(1)–N(2)#1	2.109(11) 2.541(10)
	Bond angles		
C(5)-Sn(1)-C(4) 1	17.8(5)	C(5)–Sn(1)–C(3)	121.2(6)
C(4)-Sn(1)-C(3) 1	18.0(6)	C(5)–Sn(1)–N(2)#1	83.0(5)
C(4)-Sn(1)-N(2)#1	85.5(4)	C(3)–Sn(1)–N(2)#1	84.4(5)
C(5)-Sn(1)-S(2)	96.4(4)	C(4)–Sn(1)–S(2)	99.8(3)
C(3) - Sn(1) - S(2)	91.1(4)	N(2)#1-Sn(1)-S(2)	174.3(2)



FIGURE 6 Molecular structure of complex 3.



FIGURE 7 Macrocycle structure of complex 3, propagation via intermolecular C $-H\cdots$ N hydrogen bond interactions (three carbon atoms of the Sn-butyl group were omitted for clarity).

the ligand coordinating to the tin atom. This situation is similar to previously reported double Ocapped organo-oxotin cluster [30]. The four tin atoms and four oxygen atoms are basically coplanar. Each of the ladders consists of four tin centers held together by two  $\mu_3$ -oxygen atoms. According to their different coordinative environments, the four tin atoms can be divided into two types: Two tin atoms Sn2 and Sn2A are each bonded to two  $\mu_3$ oxygen atoms and one nitrogen atom derived from the ligand; other two tin atoms Sn1 and Sn1A are bonded to two  $\mu_3$ -oxygen atoms. All of the tin atoms are five-coordinated distorted trigonal bipyramidal geometry. The bond lengthenlargethispage-12pt of Sn(2)–N(1) is 2.290(4) Å, approaching the sum of the



FIGURE 8 Molecular structure of complex 4.

covalent of radii of tin and nitrogen (2.15 Å<sup>o</sup>) [25], concerning the distance of Sn(1)–N(2) [2.852(5) Å], is midway between the sum of the van der Waals and covalent radii of tin and nitrogen (3.75–2.15 Å) [25], and it can be regarded as a weak coordinative bond. Thus, the environment of Sn1 increases to sixcoordinated distorted octahedral geometry.

## **CONCLUSIONS**

Four organotin heterocyclic thiol complexes derived from 2-mercapto-1,3,4-thiadiazole have been synthesized and characterized. In our work, various structures are found, including the mononuclear structure, 1D zigzag infinite chain structure, ladder structure, and 22-membered macrocycle structure propagation via the intermolecular  $C-H\cdots N$  hydrogen. These organotin structures reported in this paper further enrich the organotin heterocyclic thiol chemistry in the structural field.

## SUPPLEMENTARY DATA

Atomic coordinates, thermal parameters, and bond lengths and angles for complexes **1**, **2**, **3** and **4** have been deposited in the Cambridge Crystallographic Data Center, CCDC nos. CCDC 857747, 857748, 857749 and 857750. Copies of this information may be obtained free of charge from the Director, CCDC, 2 Union Road, Cambridge CB2 1EZ, UK on request (fax: +44-1223-336-033; E-mail: deposit@ccdc.cam.ac.uk or URL:http:// www.ccdc.cam.ac.uk).

Sn(1)–C(3) Sn(1)–S(3)	Bond le 2.130(5) 2.5506(11)	engths Sn(1)–C(9) Sn(1)–S(2)	2.135(4) 2.5545(13)
	Bond a	nales	
C(3)-Sn(1)-C(9)	141.18(18)	C(3)–Sn(1)–S(3)	102.79(13)
C(9)–Sn(1)–S(3)	104.02(14)	C(3)–Sn(1)–S(2)	106.15(14)
C(9) - Sn(1) - S(2)	103.62(15)	S(3)-Sn(1)-S(2)	85.18(4)

TABLE 4 Selected Bond Lengths (Å) and Bond Angles (°) for Complex 3

TABLE 5 Selected Bond Lengths (Å) and Bond Angles (°) for Complex 4

		Bond lengths	
Sn(1)–O(1)#1	2.064(3)	Sn(1)–C(3)	2.107(5)
Sn(1) - C(4)	2.111(5)	Sn(1)–O(1)	2.122(3)
Sn(1)–O(2)	2.219(4)	Sn(2)–N(1)	2.290(4)
Sn(2)–O(1)	2.015(3)	Sn(2)–C(5)	2.109(6)
Sn(2)–C(6)	2.112(5)	Sn(2)–O(2)#1	2.157(4)
Sn(1)–N(2)	2.852(5)		
		Bond angles	
O(1)#1–Sn(1)–C(3)	106.1(2)	C(3)–Sn(1)–C(4)	145.0(3)
O(1)#1-Sn(1)-O(1)	75.21(14)	C(3) - Sn(1) - O(1)	99.03(19)
O(1)#1–Sn(1)–O(2)	72.56(13)	O(1)–Sn(1)–O(2)	147.69(13)
O(1)#1–Sn(1)–N(2)	147.80(13)	O(1)-Sn(1)-N(2)	72.62(12)
O(2)-Sn(1)-N(2)	139.64(13)	O(1)–Sn(2)–O(2)#1	74.82(13)
O(1)-Sn(2)-N(1)	84.82(14)	C(5)–Sn(2)–C(6)	133.7(3)

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