Short Communication

Waly Diallo*, Libasse Diop, Laurent Plasseraud* and Hélène Cattey [*n*-Bu₂NH₂]₃[SnPh₃(SeO₄)₂]: the first triorganotin(IV) complex with terminally coordinated selenato ligands

Abstract: The reaction of SeO₄H₂ and SnPh₃OH in the presence of *n*-Bu₂NH led to the formation of $[(n-Bu_2NH_2)]_3$ $[SnPh_2(SeO_4)_2]$ (1), which crystallizes in the orthorhombic space group $P2_12_12_1$ with Z=4, a=16.2509(7) Å, *b*=17.2412(8) Å, *c*=17.6881(5) Å, and *V*=4955.9(3) Å³. The structure of the novel trianion of 1 consists of a SnPh, moiety trans-coordinated by two monodentate selenato ligands involving a trigonal bipyramid geometry around the Sn(IV) atom. The charges of $[SnPh_2(SeO_4)_2]^{3-}$ are compensated by three [*n*-Bu₂NH₂]⁺ cations. From a supramolecular point of view, the three uncoordinated oxygen atoms of each selenato ligand are involved in hydrogen bonding interactions with the surrounding di-n-butylammonium cations through N-H---O contacts, leading to a three-dimensional network. The structural characterization of salt 1 was completed by infrared and NMR spectroscopy and elemental analysis, which confirm the X-ray elucidation.

Keywords: hydrogen bonding; selenate; triphenyltin; X-ray crystallography; 3D supramolecular network.

DOI 10.1515/mgmc-2014-0011 Received May 16, 2014; accepted June 23, 2014; previously published online July 16, 2014 Numerous molecules belonging to organotin(IV) and halotin(IV) classes are known for their applications in many various fields (Evans and Karpel, 1985; Davies et al., 2008) that still arouse a strong worldwide interest for fundamental and applied studies. For many years, our group has been involved in the study of the reactivity of organotin(IV) derivatives with oxyanions (Diallo et al., 2009; Qamar-Kane and Diop, 2010; Gueye et al., 2011; Sarr et al., 2013; Sow et al., 2013). In the course of our ongoing studies on the structural elucidation of new selenato and selenito adducts of tin(IV) (Diassé-Sarr et al., 1997; Diop et al., 2001, 2007; Diallo et al., 2007), we report herein the result of the reaction involving *n*-Bu₂NH, SeO₄H₂, and SnPh₂OH and leading to the crystallization of the new organotin salt, [n-Bu₂NH₂]₃[SnPh₃ $(SeO_{1})_{1}$ (1), in which both selenato ligands are terminally coordinated.

Compound 1 was obtained in two steps (Scheme 1). Aqueous solutions of selenic acid (H₂SeO₄) and di-n-butylamine (*n*-Bu₂NH) were first mixed together leading to the in situ formation of [n-Bu₂NH₂][HSeO₄]·nH₂O (for examples of structurally isolated ammonium hydrogen selenates, see Baran et al., 1997; Zakharov et al., 2001). An equimolar molar of SnPh₂OH in ethanolic solution was then added. After 2 h stirring, a white precipitate formed, which could be assigned to (Ph₂Sn)₂O, according to the ¹¹⁹Sn{¹H} NMR spectrum (CDCl₃, 298 K, δ =-84 ppm, J(¹¹⁹Sn-O-¹¹⁹Sn)=408 Hz) (Blunden and Hill, 1987; Fresno et al., 2006). In addition, colorless single crystals were isolated from slow evaporation of the supernatant solution. The preliminary infrared in attenuated total reflectance (ATR) mode analysis of crystals revealed in particular the presence of strong absorption bands at 856, 838, and 798 cm⁻¹ matching with stretching vibrations of SeO, groups. Less intense absorptions are also observed at 2708, 2475, and 1740 cm⁻¹ indicating the presence of N-H--O bonds. Indeed, this series of three bands can be explained by the resulting Fermi resonances between vNH and the overtones 2δ NH and 2yNH (Sarr and Diop, 1987). The ¹¹⁹Sn{¹H} NMR spectrum

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Scheme 1 Reagents and conditions: (i) H₂O, room temperature (r. t.); (ii) Ph₂SnOH, ethanol, r.t.

of **1** in CD₃OD exhibits only one resonance of low intensity, at δ =-232 ppm. This value of chemical shift, in the range of -200 ppm to -260 ppm, suggests a five-coordinated tin(IV) center in a *trans* trigonal bipyramidal geometry environment (Holecek et al., 1983).

An X-ray crystallographic analysis on suitable crystals solved unambiguously the structure of **1** which consists of a $[\text{SnPh}_3(\text{SeO}_4)_2]^3$ trianion surrounded by three noncoordinating $[n-\text{Bu}_2\text{NH}_2]^+$ cations. Crystallographic data and refinement details are summarized in Table 1. An ORTEP view, together with selected bonds lengths and angles, is shown in Figure 1. The stannate(IV) anion of **1** corresponds to a SnPh₃ moiety *trans*-coordinated by two oxygen atoms of two SeO₄² ligands. Corroborating the

Table 1	Crystal	data	and	structure	refinement	of	compound	1
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Formula	C ₁₈ H ₁₅ O ₈ Se ₂ Sn·3C ₈ H ₂₀ N			
Formula weight (g/mol)	1026.66			
Temperature	115(2) K			
Crystal system	Orthorhombic			
Space group	P2,2,2			
Unit cell dimensions	<i>a</i> =16.2509(7) Å α=90°			
	$b=$ 17.2412(8) Å $eta=$ 90 $^{\circ}$			
	<i>c</i> =17.6881(5) Å γ=90°			
Volume	4955.9(3) ų			
Ζ	4			
Density (calculated)	1.376 Mg/m ³			
Absorption coefficient	2.032 mm ⁻¹			
F(000)	2120			
Crystal size (mm)	0.19×0.07×0.06			
heta range for data collection	3.30 to 27.48°			
Index ranges	-21≤h≤18, -22≤k≤20, -21≤l≤22			
Reflections collected	26,966			
Independent reflections	10,449 [<i>R</i> (int)=0.0548]			
Completeness to θ_{max}	98.4%			
Refinement method	Full-matrix least-squares on <i>F</i> ²			
Data/restraints/parameters	10,449/236/480			
Goodness-of-fit on F ²	1.248			
Final <i>R</i> indices $[I > 2\sigma(I)]$	$R_1 = 0.0909, wR_2 = 0.1406$			
R indices (all data)	$R_1 = 0.1513, wR_2 = 0.1636$			
Absolute structure	0.45(3)			
parameter				
Largest difference peak/	0.56/-0.44			
hole (e/ų)				
CCDC number	933,485			





Hydrogen atoms are omitted for clarity. Selected bond lengths and angles [Å, °]: 01-Sn1 2.155(12), 05-Sn1 2.181(11), C1-Sn1 2.134(9), Sn1-C13 2.101(13), Sn1-C7 2.113(9), 01-Se1 1.595(12), 02-Se1 1.626(11), 03-Se1 1.598(11), 04-Se1 1.600(13); Se1-01-Sn1 170.6(12), Se2-05-Sn1 170.8(8), C2-C1-C6 120.0, C2-C1-Sn1 119.1(7), C6-C1-Sn1 120.9(7), C13-Sn1-C7 117.4(5), C13-Sn1-C1 124.0(5), C7-Sn1-C1 118.4(5), C13-Sn1-01 92.7(8), C7-Sn1-01 89.5(6), C1-Sn1-01 91.0(6), C13-Sn1-05 90.0(6), C7-Sn1-05 89.7(5), C1-Sn1-05 87.0(5), 01-Sn1-05 177.2(7), C8-C7-Sn1 121.5(8), C12-C7-Sn1 118.5(8).

¹¹⁹Sn^{{1}H} NMR data, the environment around the tin(IV) atom can be viewed as trigonal bipyramidal. The equatorial plane is occupied by the three phenyl groups [C1-Sn1 2.134(9), Sn1-C13 2.101(13), and Sn1-C7 2.113(9) Å]. The Sn-C distances are in the typical range of Sn-C bonds reported earlier for related compounds (Allen et al., 1983). The sum of the angles at tin [C13-Sn1-C7 117.4(5), C13-Sn1-C1 124.0(5), and C7-Sn1-C1 118.4(5)°] is equal to 359.8°. The apical positions are occupied by two oxygen atoms of two monodentate SeO², terminally coordinated [O1-Sn1 2.155(12) and O5-Sn1 2.181(11) Å]. The Sn-O distances are slightly shorter than those already reported for didentate or tridentate selenato adducts of tin(IV) (Diop et al., 2001, 2007). A comparison of the Sn-O(Se) and Se-O(Sn) bond lengths (Å) and the Sn-O-Se angles (deg) with related compound is given in Table 2. The O-Sn-O angle [O1-Sn1-O5 177.2(7)°] indicates a slight deviation from linearity. Further information can be obtained by estimating the structural index

Compounds	Sn-O(Se) (Å)	Se-O(Sn) (Å)	Sn-O-Se (deg)	CSD Identifier	References
{Ph ₄ P[(SeO ₄)(SnPh ₃)(SnPh ₃ Cl)]} _n	2.276 (7)	1.658 (7)	149.7 (4)	QENRUV	Diop et al. (2001)
	2.314 (5)	1.611 (7)	141.1 (4)		
		1.648 (7)			
{Ph ₄ P[(SeO ₄)(SnPh ₃)(SnPh ₃ Br)]} _n	2.276 (3)	1.641 (3)	149.7 (2)	QENQUV	Diop et al. (2001)
	2.284 (3)	1.630 (3)	142.2 (2)		
		1.644 (3)			
(SnMe ₃) ₂ SeO ₄ ·2H ₂ O	2.253 (2)	1.643 (6)	129.2 (2)	QOTCOS	Diop et al. (2007)
		1.631 (6)			
(SnPh ₃) ₂ SeO ₄ ·1.5H ₂ O	2.217 (2)	1.639 (2)	146.9 (1)	QOTCIM	Diop et al. (2007)
	2.250 (2)	1.644 (2)	140.2 (1)		
	2.309 (2)	1.660 (2)	143.7 (1)		
	2.203 (2)	1.649 (2)	141.2 (1)		
	2.279 (2)	1.639 (2)			
[(<i>n</i> -Bu ₂ NH ₂)] ₃ [SnPh ₃ (SeO ₄) ₂]	2.152 (9)	1.599 (9)	170.7 (9)	UDOMOR	This work
	2.182 (8)	1.632 (8)	170.8 (6)		

Table 2 Comparison of Sn-O(Se), Se-O(Sn) bond lengths (Å), and Sn-O-Se angles (deg) in selenato tin(IV) complexes.

 τ , which represents the relative amount of trigonality [for a square pyramid, τ =0; for a trigonal pyramid, τ =1, with τ =(β - α)/60°) and where α and β are the two largest angles] . For **1**, 01-Sn1-O5 [177.2(7)°] is assigned to β and C13-Sn1-C1 [124.0(5)°] to α . The calculated value of τ is found to be 0.887(14)°, which expresses a distorted character for the trigonal bipyramidal geometry, which is consistent with earlier reports (Parvez et al., 2000).

In the crystal lattice, the three noncoordinating oxygen atoms of both SeO² linked to Sn(IV) are involved in hydrogen bonding interactions with six distinct surrounding *n*-Bu₂NH₂⁺ cations [N1H····O3=2.781(18) Å, N1H····O6ⁱ=2.757 (17) Å, N2H····O4ⁱⁱ=2.70(2) Å, N2H····O8ⁱⁱⁱ=2.761(18) Å, N3H…O2=2.749(17) Å, and N3H…O7ⁱⁱⁱ=2.733(18) Å, the symmetry codes being (i) x-1/2, -y+3/2, -z; (ii) x+1/2, -y+3/2, -z+1; and (iii) -x+1, y-1/2, -z+1/2]. From a supramolecular point of view, the simplest organization can be viewed as a trinuclear macrocyclic ring based on intermolecular contacts between three stannate(IV) anions and three dibutylammonium cations and involving two noncoordinating oxygen atoms of each $[SnPh_2(SeO_4)_2]^{3-}$ (Figure 2A). The interconnection between these supramolecular rings through additional NH···O hydrogen bonds (implicating the remaining four noncoordinating oxygen atoms of each $[SnPh_{2}(SeO_{4})_{2}]^{3}$ leads to a three-dimensional supramolecular architecture which can be compared to a porous framework (Figure 2B).

Solid-state structures of selenato adducts of tin(IV) are relatively uncommon. To this date, only 13 crystallographic reports have been registered in the Cambridge Structural Database (CSD). To the best of our knowledge, no tin(IV) complexes containing selenite or selenate oxyanion in monodentate coordination mode has yet been reported in the literature. Up to now, only related organotin derivatives or complexes in which selenite and selenate are didentate or tridentate oxyanions such as (SnPh₃)₂SeO₃ (Diallo et al., 2007), (SnMe₃)₂SeO₃.H₂O (Diassé-Sarr et al., 1997), Ph, PSeO, SnPh, SnPh, Br (Diop et al., 2001), (SnMe₃)₂SeO₄.2H₂O (Diop et al., 2007), [Me₃ $Sn(O_2SeC_2H_2Cl)$, (Ma et al., 2011), and [{2,6-(Me_2NCH_2)_2}] C₆H₃}(Ph)SnSeO₃], (Mairychová et al., 2013) are known. The enlargement of the CSD search to all chalcogens (E) showed that X-ray structures of discrete triorganotin(IV) complexes presenting a trans EO-Sn-OE skeleton are also unusual. To our knowledge, no examples of tellurium and polonium derivatives are known and only two sulfur-based examples have been previously described with methanesulfonato and trifluoromethanesulfonato ligands, respectively: {[Et₂NMe][Ph₂Sn(OSO₂Me)₂]} (Shankar et al., 2012) and [(allyl-PNP)Mn(CO)₂][Bu₂Sn(OSO₂CF₂)₂] (Radosevich et al., 2009). In either case, as for 1, the tin atom adopts a trigonal bypyramidal geometry and both oxyanions are trans-coordinated. Regarding the sulfato analogue of 1, SO, units bound to Sn exhibit bidentate and tridentate coordination modes leading to the dimeric tetra-tin nuclear structure [(Ph₂Sn)₂SO₄]₂ (Zhang et al., 2008).

In conclusion, the solid-state structure of $[n-Bu_2 NH_2]_3[SnPh_3(SeO_4)_2]$ (1) can be considered as unprecedented, highlighting a new coordination mode of SeO_4^{-2} to a triorganotin(IV) moiety. Further work is currently underway to isolate new examples of this type of compound.

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Figure 2 Crystal packing of 1 through intermolecular NH···O hydrogen bonds.

(A) Representation of the trinuclear macrocyclic ring [Hydrogen atoms were omitted for clarity. Hydrogen bonding interactions are shown by dashed lines: N1H…O3=2.781(18) Å, N1H…O6=2.757(17) Å, N2H…O4=2.70(2) Å, N2H…O8=2.761(18) Å, N3H…O2=2.749(17) Å, N3H…O7=2.733(18). MERCURY view]. (B) Space-fill representation of the resulting three-dimensional supramolecular porous framework. Hydrogen and carbon atoms were omitted for clarity (MERCURY view).

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Experimental

General

H₂SeO₄ was purchased from Merck Chemicals (Hohenbrunn, Germany), while *n*-Bu₂NH and SnPh₃OH were acquired from Sigma-Aldrich (Steinheim am Albuch, Germany) and used without any further purification. Infrared spectra were recorded on a Bruker Vector 22 spectrometer (Wissembourg, France) equipped with a Specac Golden Gate[™] ATR device. The NMR spectra were recorded on a Bruker Avance 400 MHz spectrometer with a wide band sensor broad band fluorine observation (BBFO). ¹H chemical shifts (δ , ppm) were determined from the residual solvent signal (CH₃OH δ =3.31). ¹¹⁹Sn¹H} chemical shifts (δ , ppm) were reported downfield from (CH₃)₄Sn used as external standard. Elemental analyses were performed at the Institut de Chimie Moléculaire, Université de Bourgogne, Dijon-France.

Isolation of $[n-Bu_2NH_2]_3[SnPh_3(SeO_4)_2]$ (1)

When 0.3 g (2.05 mmol) of selenic acid (H_2SeO_4 , 96%) dissolved in 10 mL of water reacts with 0.531 g (4.10 mmol) of di-*n*-butylamine (*n*-Bu₂NH) dissolved in 10 mL of water, a clear solution of [*n*-Bu₂NH₂] [HSeO₄]·nH₂O is obtained. To this solution, 1.509 g (4.10 mmol) of triphenyltin hydroxyl, SnPh₃OH, dissolved in 15 mL of ethanol are added dropwise. After 2 h stirring, a white precipitate of (Ph₃Sn)₂O is obtained and filtered, while the clear filtrate was submitted to a slow solvent evaporation at room temperature. One week later, colorless X-ray-suitable crystals were obtained (1.604 g, 38%) and characterized as **1**.

¹H-NMR (CD₃OD): δ =0.96 (m, 18H, CH₃, *n*-Bu), 1.26 (s, 6H, NH₂, *n*-Bu), 1.38 (m, 12H, CH₂, *n*-Bu), 1.62 (m, 12H, CH₂, *n*-Bu), 2.94 (m, 12H, CH₂, *n*-Bu), 7.42 (m, 9H, CH, Ph), 7.88 (m, 6H, CH, Ph). ¹¹⁹Sn{¹H} NMR (CD₃OD): δ =-232. IR (ATR, cm⁻¹): 2962 (w), 2872 (w), 2708 (br, w), 2475 (w), 1740 (br, w), 1465 (m), 1430 (m), 1077 (m), 856 (vs), 838 (vs), 798 (s), 730 (s), 695 (s). Anal. Calcd. for C₄₂H₇₅N₃O₈SnSe₂ (1026).69): C 49.13, H **7**.36, N 4.09; Found: C 50.84; H 7.07; N 4.31.

X-ray crystallography

Diffraction data were collected from suitable crystals on a Bruker Nonius ApexII CCD (Mo-K α radiation, λ =0.71073 Å). The structures were solved using Charge Flipping Algorithm Methods (SUPERFLIP) (Palatinus and Chapuis, 2007) and refined with full-matrix leastsquares methods based on F^2 (SHELX-97) (Sheldrick, 1998) with the aid of the WINGX program (Farrugia, 2012). All nonhydrogen atoms were anisotropically refined. Hydrogen were included in their calculated positions and refined with a riding model. The three *n*-Bu₂NH₂⁺ cations were refined with a set of restraints applied to the distances as well as to the thermal parameters. One cation was found disordered over two positions with occupancy factors 0.68:0.32. The three phenyl groups were constrained to regular hexagons. Furthermore, the crystal displays an inversion twinning with a population of 0.55/0.45.

Programs used for the representation of the molecular and crystal structures were the following: ORTEP (Farrugia, 1997) and MERCURY (Macrae et al., 2008). Crystallographic data for the structure reported in this paper have been deposited at the Cambridge

Crystallographic Data Centre (CCDC). Copies of the data may be obtained free of charge from the Director, CCDC, 12 Union Road, Cambridge CB2 1EZ, UK (fax: +44 1223 336 033; e-mail: deposit@ccdc.cam. ac.uk or www: http://www.ccdc.cam.ac.uk).

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References

- Allen, F. H.; Kennard, O.; Taylor, R. Systematic analysis of structural data as a research technique in organic chemistry. Acc. Chem. Res. **1983**, *16*, 146–153.
- Baran, J.; Barnes, A. J.; Marchewka, M. K.; Pietraszko, A.; Ratajczak, H. Structure and vibrational spectra of the bis(betaine)-selenic acid molecular crystal. J. Mol. Struct. 1997, 416, 33–42.
- Blunden, S. J.; Hill, R. Mixed triorganotin compounds, R₃Sn-X-SnR'₃: ¹¹⁹Sn NMR evidence for their formation in solution. *J. Organomet. Chem.* **1987**, *333*, 317–321.
- Davies, A. G.; Gielen, M.; Pannell, K. H.; Tiekink, E. R. T. Tin Chemistry, Fundamentals, Frontiers, and Applications; John Wiley & Sons, Ltd, Chichester, UK, 2008.
- Diallo, W.; Diassé-Sarr, A.; Diop, L.; Mahieu, B.; Biesemans, M.; Willem, R.; Kociok-Köhn, G.; Molloy, K. C. X-ray structure of tetrabutylammonium chlorotrimethyltin hydrogenosulfate: the first cyclic dimer hydrogenosulfato hydrogen bonded adduct. *St. Cerc. St. CICBIA* **2009**, *10*, 207–212.
- Diallo, W.; Diop, C. A. K.; Diop, L.; Mahon, M. F.; Molloy, K. C.; Russo, U.; Biesemans, M.; Willem, R. Molecular structures of [(Ph₃Sn)₂O₃Se] and [(Ph₃Sn)₂O₄Cr](CH₃OH). J. Organomet. Chem. 2007, 692, 2187–2192.
- Diassé-Sarr, A.; Diop, L.; Mahon, M. F.; Molloy, K. C. X-ray structure of (SnMe₃)SeO₃[SnMe₃(H₂O)]. *Main Group Met. Chem.* **1997**, *20*, 223–229.
- Diop, C. A.; Diop, L.; Russo, U.; Sanchez-Diaz, A.; Castineiras, A. Synthesis, spectroscopic characterization and crystal and molecular structures of {Ph₄P[(SeO₄)(SnPh₃)(SnPh₃X)]}_n (X=Cl, Br). *Z. Naturforsch., B: Chem. Sci.* 2001, *56*, 233–238.
- Diop, C. A. K.; Toure, A.; Diop, A.; Bassene, S.; Sidibe, M.; Diop, L.; Mahon, M. F.; Molloy, K. C.; Russo, U. Synthesis, infrared, Moessbauer, NMR spectroscopic characterization and X-ray structure of [(Ph₃Sn)₂O₄Se]·1.5H₂O, [(Me₃Sn)₂O₄Se](OH₂)₂ and [Me₃Sn O,AsMe₃]·0.5H₃O. *J. Soc. Ouest-Afr. Chim.* **2007**, *12*, 49–59.
- Evans, C. J.; Karpel, S. (1985). Organotin Compounds in Modern Technology. In J. Organomet. Chem. Library; Ed. Elsevier Science Ltd: Amsterdam, 1985; Vol. 16, pp. 1–279.
- Farrugia, L. J. ORTEP-3 for windows a version of ORTEP-III with a graphical user interface (GUI). J. Appl. Crystallogr. **1997**, *30*, 565.
- Farrugia, L. J. WinGX and ORTEP-3 for Windows. J. Appl. Crystallogr. 2012, 45, 849–854.

- Fresno, F.; Tudela, D.; Maira, A. J.; Rivera, F.; Coronado, J. M.; Soria, J. Triphenyltin hydroxide as a precursor for the synthesis of nanosized tin-doped TiO₂ photocatalysts. *Appl. Organomet. Chem.* **2006**, *20*, 220–225.
- Gueye, N.; Diop, L.; Molloy, K. C.; Kociok-Köhn, G. Crystal structure of C₂O₄(SnPh₃.dimethylformamide)₂. *Main Group Met. Chem*. **2011**, *34*, 3–5.
- Holecek, K.; Nadvornik, M.; Handlir, K.; Lycka, A. Carbon-13 and tin-119 NMR study of some four- and five-coordinate triphenyltin(IV) compounds. J. Organomet. Chem. **1983**, *241*, 177–184.
- Ma, C.; Guo, M.; Ru, J.; Zhang, R.; Wang, Q. Synthesis, characterizations, and crystal structures of triorganotin(IV) derivatives with areneseleninic acids. *Inorg. Chim. Acta* 2011, 378, 213–217.
- Macrae, C. F.; Bruno, I. J.; Chisholm, J. A.; Edgington, P. R.; McCabe,
 P.; Pidcock, E.; Rodriguez-Monge, L.; Taylor, R.; van de Streek,
 J.; Wood, P. A. Mercury CSD 2.0-new features for the visualization and investigation of crystal structures, *J. Appl. Crystallogr.*2008, 41, 466.
- Mairychová, B.; Svoboda, T.; Erben, M.; Růžička, A.; Dostál, L.; Jambor, R. Intramolecularly coordinated group 14 and 15 chalcogenites. *Organometallics* **2013**, *32*, 157–163.

Palatinus, L.; G. Chapuis. Superflip. J. Appl. Cryst. 2007, 40, 786.

Parvez, M.; Bhatti, M. H.; Ali, S.; Mazhar, M.; Qureshi, S. I. (N-Maleoylglycinato)trimethyltin(IV). Acta. Crystallogr. 2000, C56, 327–328.

Qamar-Kane, H.; Diop, L. Interactions between $(Me_4N)_2(C_2O_4)_2SnPh_2 H_2O$ and $SnCl_2 H_2O$: $(Me_4N)_2(C_2O_4)_2SnPh_2 SnCl_4$ or $(Me_4N)_2(C_2O_4)_2SnCl_2 SnPhCl_3$? The Mossbauer effect solution. *St. Cerc. St. CICBIA* **2010**, *11*, 389–392.

- Radosevich, A. T.; Melnick, J. G.; Stoian, S. A.; Bacciu, D.; Chen, C.-H.; Foxman, B. M.; Ozerov, O. V.; Nocera, D. G. Ligand reactivity in diarylamido/bis(phosphine) PNP complexes of Mn(CO)₃ and Re(CO)₄. *Inorg. Chem.* **2009**, *48*, 9214–9221.
- Sarr, O.; Diop L. Infrared and Raman spectra of alkali metal phosphate hydrates (M₃HP₂O₇·nH₂O) (M=Na, Cs; n=0, 1, 9). Correlation between the phosphorus-oxygen-phosphorus bridge vibrational frequencies and the phosphorus-oxygen-phosphorus angle value. *Spectrochim. Acta* **1987**, *43A*, 999–1005.
- Sarr, M.; Diasse-Sarr, A.; Diallo, W.; Plasseraud, L.; Cattey, H. Bis(cyclohexylammonium) tetrachlorido(oxalato)stannate(IV). *Acta Crystallogr.* **2013**, *E69*, m473–m474.
- Shankar, R.; Singh, A. P.; Jain, A.; Kociok-Köhn, G.; Molloy, K. C. Synthesis and characterization of di-/triorgano stannates bearing tin-sulfonate bonds. *Inorg. Chim. Acta* 2012, *387*, 420–425.
- Sheldrick, G.M. Shelx-97 (Includes Shelxs-97 and Shelxl-97), Release 97-2, Programs for the Refinement of Crystal Structures, University of Göttingen, Göttingen (Germany) 1998.
- Sow, Y.; Diop, L.; Molloy, K. C.; Kociok-Kohn, G. Tetramethylammonium aquatrichloridooxalatostannate(IV) monohydrate. Acta Crystallogr. 2013, E69, m106–m107.
- Zakharov, M. A.; Troyanov, S. I.; Rybakov, V. B.; Aslanov, L. A.; Kemnitz, E. Structures of the crystal modifications of [N(CH₃)₄] (HSeO₄) at 298, 363, and 380 K. *Kristallografiya* **2001**, *46*, 1057–1062.
- Zhang, J.; Ma, C.; Zhang, R. Crystal and supramolecular structure of a novel organotin sulphate: {[(Ph₃Sn)₂SO₄]₂ (H₂O)₃} 2EtOH. *J. Inorg. Organomet. Polym.* **2008**, *18*, 296–299.