

## Molecular Complexes of Some Tetravalent Tin Compounds

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**Summary:** Reactions of the following tin(IV) salts: dimethyltin dichloride, diphenyltin dichloride and tin tetrachloride with a variety of nitrogen and oxygen donating ligands were studied. Besides the physical properties the partial ir-spectral features, the thermal and electrolytic behaviour of the formed complexes are reported. An attempt was made to compare between the complexes of the three considered salts.

### Introduction

It is reported that all the four tetrahalide of tin,  $\text{SnX}_4$ , form complexes with certain electron donors, L, such as amines, cyanides, ethers, sulphides, ketones, phosphines, etc. [1-6]. The most usual stoichiometry of these compounds is  $\text{SnX}_4 \cdot 2\text{L}$ , but the presence of 1:1 adducts has been demonstrated in solution [7].

In recent years considerable progress has been made in the applications of organotin compounds in various branches of technology [8] as well as Mossbauer spectroscopy [9]. A useful feature of tin-Mossbauer spectra is obvious in the field of mineralogical analysis of tin-containing samples [10]. The whole field of organotin chemistry is based upon the use of the organotin halides as precursors [11]. The organotin halides are chemically very reactive and behave as Lewis acids, similar to the tin (IV) halides. The Lewis acidity of such compounds increases considerably with higher halogen content [12]. Thus, for the tetraorganic tin there is little evidence of Lewis acid behaviour [13]. There are some scattered reports on

the coordination chemistry of organotin compounds [14-17], but no systematic study of these derivatives has been made. The halides  $\text{R}_2\text{SnCl}_2$  react with many bases to form different types of coordination complexes [18-20]. Several reports on the reactions of diphenyltin dichloride,  $\text{Ph}_2\text{SnCl}_2$ , with a variety of Lewis bases are found in the literature [21-23]. The main aim of this work is to study similar reactions with dimethyltin dichloride,  $\text{Me}_2\text{SnCl}_2$ , and some more reactions with the other two salts: diphenyltin dichloride and tin tetrachloride,  $\text{SnCl}_4$ .

### Experimental

#### *Materials*

All the chemicals were of analytical grade and used as received except some ligands containing phosphorous, which were prepared following literature methods. These ligands are: triphenylphosphine oxide,  $\text{Ph}_3\text{PO}$  [24,25], and 1,2-bis(diphenyl phosphine) ethane oxide, diphos-ethane oxide [26].

Solvents were dried by conventional methods [27].

*Procedure:*

The general method used for the preparation of the complexes involved the addition of an ethyl acetate solution of the ligand to the tin(IV) salt in the same solvent, applying different mole ratios. The newly formed compound was filtered, washed and crystallised from the proper solvent.

Elemental analysis, ir spectra, thermogravimetric analysis and conductivity measurements were carried out for the prepared complexes.

*Analysis and Techniques:*

Microanalyses of C, H and N were carried out in the Microanalytical laboratory of El Nasr Company, Cairo, Egypt. Tin was determined as stannic oxide using Gilman method [28]. Ir spectra were recorded on Perkin-Elmer 398 ir spectrophotometer in the range 4000-400  $\text{cm}^{-1}$  using KBr discs. TGA were carried out using a thermobalance A.D.A.M.E.L., type Th 59, fitted with a linear temperature programme. Conductivities were calculated using Backman electronic switchgear bridge model RA-2A with balance indicator.

Table-1: Analytical Results

a)  $\text{Me}_2\text{SnCl}_2$ -complexes.

Compound*	Yield (%)	m.p. (°C)		C	H	N (%)	Sn	Formula
1. $\text{Me}_2\text{SnCl}_2 \cdot \text{Ph}_3\text{PO}$	99.0	120	Found	48.93	5.61		23.81	$\text{C}_{20}\text{H}_{21}\text{Cl}_2\text{OP}_2\text{Sn}$
			Required	48.33	4.55		23.59	
2. $\text{Me}_2\text{SnCl}_2 \cdot \text{Diphos methane dioxide}^{**}$	87.6	210	Found	51.60	4.90		18.80	$\text{C}_{27}\text{H}_{28}\text{Cl}_2\text{O}_2\text{P}_2\text{Sn}$
			Required	50.98	4.44		18.64	
3. $\text{Me}_2\text{SnCl}_2 \cdot \text{Diphos ethane dioxide}^{**}$	99.5	247	Found	52.05	6.67		18.72	$\text{C}_{28}\text{H}_{30}\text{Cl}_2\text{O}_2\text{P}_2\text{Sn}$
			Required	51.74	4.65		18.24	
4. $\text{Me}_2\text{SnCl}_2 \cdot \text{bis(py-N-oxide)}$	97.0	140	Found	35.98	4.39	6.22	28.72	$\text{C}_{12}\text{H}_{16}\text{Cl}_2\text{N}_2\text{O}_2\text{Sn}$
			Required	35.18	3.94	6.84	29.01	
5. $\text{Me}_2\text{SnCl}_2 \cdot \text{bis(2-Me-py-N-oxide), MeCN}$	90.5	130	Found	39.97	5.40	8.39	24.85	$\text{C}_{16}\text{H}_{23}\text{Cl}_2\text{N}_3\text{O}_2\text{Sn}$
			Required	40.10	4.84	8.76	24.75	
6. $\text{Me}_2\text{SnCl}_2 \cdot \text{bis(picolinic acid), MeCN}$	85.0	215	Found	38.30	4.53	7.80	24.10	$\text{C}_{16}\text{H}_{19}\text{Cl}_2\text{N}_3\text{O}_4\text{Sn}$
			Required	37.90	3.70	8.20	23.40	
7. $\text{Me}_2\text{SnCl}_2 \cdot \text{bis(3-picoline)}$	95.0	145	Found	41.77	5.33	7.42	29.40	$\text{C}_{14}\text{H}_{20}\text{Cl}_2\text{N}_2\text{Sn}$
			Required	41.40	5.00	6.90	29.23	
8. $\text{Me}_2\text{SnCl}_2 \cdot \text{bis(piperidine).H}_2\text{O}$	98.0	> 250	Found	35.09	7.90		29.20	$\text{C}_{12}\text{H}_{30}\text{Cl}_2\text{N}_2\text{OSn}$
			Required	35.30	7.40		29.10	

Table-1 (Contd.)

Compound*	Yield (%)	m.p. (°C)		C	H	N (%)	Sn	Formula
9. $2\text{Me}_2\text{SnCl}_2$ .pyrazine	86.8	liq.	Found	18.54	3.06	4.96	45.60	
			Required	18.48	3.10	5.38	45.62	$\text{C}_8\text{H}_{16}\text{Cl}_4\text{N}_2\text{Sn}_2$
10. $\text{Me}_2\text{SnCl}_2$ ,DM-bipy	99.8	265	Found	42.50	4.51	5.72	29.21	
			Required	41.63	4.49	6.93	29.30	$\text{C}_{14}\text{H}_{18}\text{Cl}_2\text{N}_2\text{Sn}$
11. $\text{Me}_2\text{SnCl}_2$ ,tripy, $3\text{H}_2\text{O}$	87.3	198	Found	40.31	4.37	7.39	23.22	
			Required	40.28	4.57	8.20	23.30	$\text{C}_{17}\text{H}_{23}\text{Cl}_2\text{N}_3\text{O}_3\text{Sn}$
12. $\text{Me}_2\text{SnCl}_2$ ,bis(benzo-thiazole)	96.0	90	Found	40.04	3.73		24.10	
			Required	39.20	3.29		24.20	$\text{C}_{16}\text{H}_{16}\text{Cl}_2\text{N}_2\text{S}_2\text{Sn}$
13. $\text{Me}_2\text{SnCl}_2$ ,N,N-DM-hydrazine	88.0	> 250	Found	17.65	5.50	10.46	42.52	
			Required	17.17	5.04	10.01	42.40	$\text{C}_4\text{H}_{14}\text{Cl}_2\text{N}_2\text{Sn}$

\*The abbreviations: py-N-oxide, DM-bipy and tripy stand for pyridine-N-oxide, dimethyl bipyridyl and tripyridyl respectively.

\*\* In these two cases the ligands: Diphos methane and Diphos ethane were used but we obtained Diphos methane dioxide- and Diphos ethane dioxide-dimethyltin (IV) dichloride complexes respectively.

## Results and Discussion

### Elemental analysis:

From the microanalytical results obtained in the present work (Table 1) and previous ones reported from this lab for  $\text{Ph}_2\text{SnCl}_2$  and  $\text{SnCl}_4$  [23], it could be concluded that the three Sn(IV) salts, having enough Lewis acidity, form stable complexes with most of the studied ligands.  $\text{Me}_2\text{SnCl}_2$  can be considered, with nearly equal probability, as a mono- as well as a di-functional acceptor. The number of the 1:1 complexes formed between  $\text{Ph}_2\text{SnCl}_2$  and the organic ligands slightly exceeds those having the mole

ratio 1:2. The most usual stoichiometry of  $\text{SnCl}_4$ -complexes is 1:2. This behaviour may be explained on the basis of increasing Lewis acidity from  $\text{Ph}_2\text{SnCl}_2$  to  $\text{Me}_2\text{SnCl}_2$  to  $\text{SnCl}_4$ . The stronger Lewis bases (L) such as pyridine oxides, picolinic acid, picolines and benzothiazoles form 2L-Sn (IV) complexes with the three considered salts and they are usually insoluble in common organic solvents. The other interesting exception is the 4:1 complex formed between  $\text{Ph}_2\text{SnCl}_2$  and thymolphthalien. This latter complex is formed due to the presence of the four possible coordination sites in the ligand molecule: CO, two OH groups and one oxygen atom. The bulky

Table-1 Analytical Results  
b)  $\text{Ph}_2\text{SnCl}_2$ -complexes

Compound	Yield (%)	m.p. (°C)		C H N Sn				Formula
				(%)				
1. $\text{Ph}_2\text{SnCl}_2$ ,bis(2-M-py-N-oxide)	90	172	Found	51.80	5.30	3.90	21.1	$\text{C}_{24}\text{H}_{24}\text{Cl}_2\text{N}_2\text{O}_2\text{Sn}$
			Required	51.29	4.30	4.90	20.9	
2. $\text{Ph}_2\text{SnCl}_2$ ,tris(picolinic acid)	82	223	Found	51.56	3.96		17.1	$\text{C}_{30}\text{H}_{25}\text{Cl}_2\text{N}_3\text{O}_6\text{Sn}$
			Required	50.51	3.53		16.6	
3. $4\text{Ph}_2\text{SnCl}_2$ ,thymolphthalien	69	150	Found	50.42	4.14		27.3	$\text{C}_{76}\text{H}_{70}\text{Cl}_8\text{O}_4\text{Sn}_4$
			Required	50.55	3.90		26.3	
4. $\text{Ph}_2\text{SnCl}_2$ .bis(benzamide)	88	110	Found	53.15	4.06		20.3	$\text{C}_{26}\text{H}_{24}\text{Cl}_2\text{N}_2\text{O}_2\text{Sn}$
			Required	53.28	4.12		20.2	
5. $\text{Ph}_2\text{SnCl}_2$ ,alizarin red-S	72	> 250	Found	44.72	3.11		16.1	$\text{C}_{26}\text{H}_{19}\text{Cl}_2\text{O}_8\text{NaSn}$
			Required	44.36	2.72		16.9	
6. $\text{Ph}_2\text{SnCl}_2$ .(2-picoline)	86	100	Found	48.94	3.97	3.26	27.2	$\text{C}_{18}\text{H}_{17}\text{Cl}_2\text{NSn}$
			Required	49.40	3.92	3.20	27.2	
7. $\text{Ph}_2\text{SnCl}_2$ ,bis(pyrazine), $4\text{H}_2\text{O}$	92	181	Found	48.48	3.48	12.17	23.3	$\text{C}_{20}\text{H}_{26}\text{Cl}_2\text{N}_4\text{O}_4\text{Sn}$
			Required	48.45	5.28	11.29	23.9	
8. $\text{Ph}_2\text{SnCl}_2$ ,bis(phenylhydrazine), $\text{H}_2\text{O}$	70	> 250	Found	49.40	5.01		21.1	$\text{C}_{24}\text{H}_{28}\text{Cl}_2\text{N}_4\text{OSn}$
			Required	49.81	4.88		20.8	
9. $\text{Ph}_2\text{SnCl}_2$ ,tris(o-anisidine)	75	116	Found	55.73	6.19		16.9	$\text{C}_{33}\text{H}_{37}\text{Cl}_2\text{N}_3\text{O}_3\text{Sn}$
			Required	55.56	5.23		16.6	

volume of such a molecule may help and increase the ability of these sites for coordination. This can also be seen clearly from the ir spectra of the ligand and the complex.

### Infrared Spectra

Comparison of the spectra of the formed complexes with those of the

free ligands used were undertaken to assess the extent of any structural changes as a result of co-ordination.

Generally, the absorption bands at  $450\text{--}530\text{ cm}^{-1}$ , which are typical of the Sn-C bond [29,30] in the free salts, appeared at higher frequencies on complexation. This may be ascribed to increased electron density on this bond.

Table-1: Analytical Results  
c) SnCl<sub>4</sub>-complexes

Compound	Yield (%)	m.p. (°C)		C H N Sn				Formula
				(%)	(%)	(%)	(%)	
1. SnCl <sub>4</sub> ,bis (2-Me-py-N-oxide)	98.0	220	Found	29.07	3.41	4.25	24.50	C <sub>12</sub> H <sub>14</sub> Cl <sub>4</sub> N <sub>2</sub> O <sub>2</sub> Sn
			Required	30.09	2.95	5.80	24.70	
2. SnCl <sub>4</sub> ,bis(picolinic acid)	74.5	228	Found	28.87	2.80	4.70	23.80	C <sub>12</sub> H <sub>10</sub> Cl <sub>4</sub> N <sub>2</sub> O <sub>4</sub> Sn
			Required	28.44	2.00	5.50	23.40	
3. SnCl <sub>4</sub> ,bis(N,N-DM-acetamide)	98.8	150	Found	22.18	4.54	5.94	26.90	C <sub>8</sub> H <sub>18</sub> Cl <sub>4</sub> N <sub>2</sub> O <sub>2</sub> Sn
			Required	22.10	4.17	6.44	27.29	
4. SnCl <sub>4</sub> ,bis(3-picoline), 2H <sub>2</sub> O	97.0	> 250	Found	30.40	3.84	5.26	24.30	C <sub>12</sub> H <sub>18</sub> Cl <sub>4</sub> N <sub>2</sub> O <sub>2</sub> Sn
			Required	29.89	3.76	5.80	24.58	
5. SnCl <sub>4</sub> ,bis(benzothiazole)	98.0	> 250	Found	31.63	2.31		21.80	C <sub>14</sub> H <sub>10</sub> Cl <sub>4</sub> N <sub>2</sub> S <sub>2</sub> Sn
			Required	31.71	1.90		22.36	
6. SnCl <sub>4</sub> ,bis(benzotriazole)	97.0	> 250	Found	29.70	2.76	16.01	23.10	C <sub>12</sub> H <sub>10</sub> Cl <sub>4</sub> N <sub>6</sub> Sn
			Required	28.89	2.02	16.84	23.38	
7. SnCl <sub>4</sub> ,1.5 (N,N-DM-hydrazine.MeCN	86.0	120	Found	14.70	5.04	15.56	30.28	C <sub>5</sub> H <sub>15</sub> Cl <sub>4</sub> N <sub>4</sub> Sn
			Required	15.33	3.86	14.32	30.41	
8. SnCl <sub>4</sub> ,bis (N,N-DM-aniline.2H <sub>2</sub> O	83.0	250	Found	35.05	4.95			C <sub>16</sub> H <sub>26</sub> Cl <sub>4</sub> N <sub>2</sub> O <sub>2</sub> Sn
			Required	35.66	4.86			

With oxygen donors, the most important absorption bands to be followed are those due to any oxygen-attaching groups, e.g. C-O, C=O, N-O or P-O. Either shifts to lower frequencies or complete disappearance of such bands are observed in the ir spectra of the formed complexes. These shifts indicate localization of the electron density on these functional groups toward the stannyl group. Some examples are reported in Table 2a.

Reaction with nitrogen donating bases is considered in Table 2b for any change in the frequencies of either N-H, N=N, C=C or C-N absorption groups (depending on the ligand used).

These evident changes in the ir spectra of the obtained compounds in both cases suggest the formation of coordination bonds between tin atoms

## Ir-spectra of Some Ligands and Their Complexes with Sn(IV) Salts.

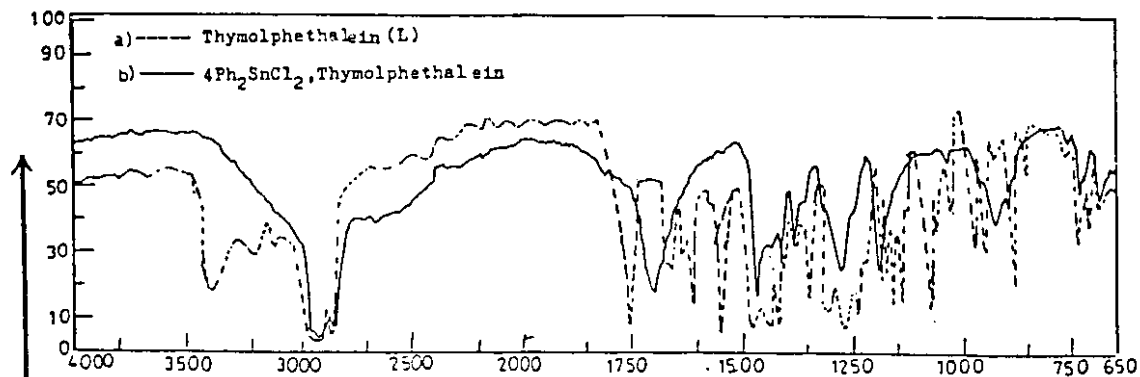


Fig. (1)

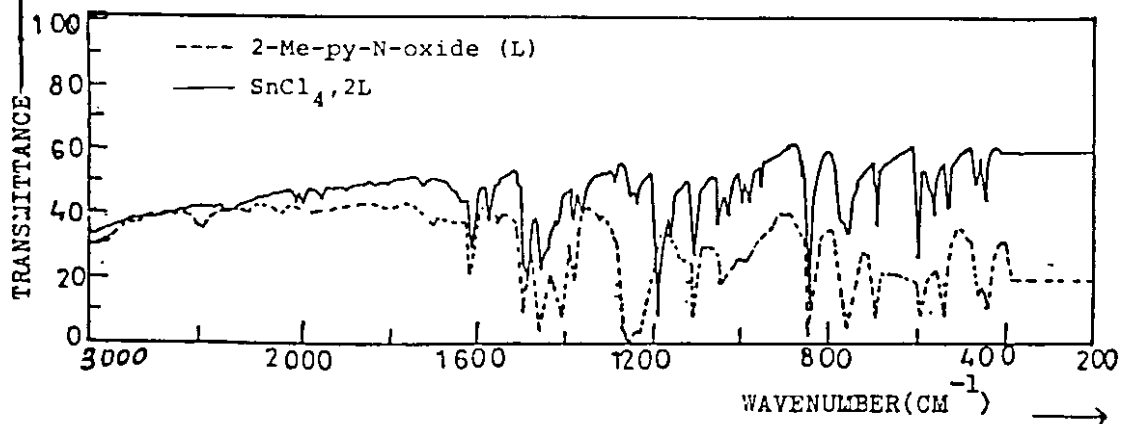


Fig. (2)

and the oxygen or the nitrogen atoms of the respective ligands (Figs. 1 & 2).

### *Thermogravimetric analyses*

Thermal decomposition of the complexes was studied in the temperature range 20-800°C to investigate their thermal stability. Table 3 represents the stage-wise thermal analysis of the complexes as obtained from the respective thermograms. The third column in the table represents the formulas of the complexes and those of the

assumed intermediate compounds, based on the coincidence between the observed and calculated molecular weights of these compounds. It could be observed that nearly all the Sn(IV) complexes investigated exhibit thermal stability up to 75-80°C. However, Me<sub>2</sub>SnCl<sub>2</sub> complexes can be considered generally as the most stable ones compared with those of Ph<sub>2</sub>SnCl<sub>2</sub> and SnCl<sub>4</sub>. It was also found that either SnO<sub>2</sub> or Sn metal are usually formed as the final products. In some other

Table-2: Some Partial IR-Spectral Features of Some Ligands and Their Complexes with the Tin(IV) Salts

## a- Oxygen donating ligands

Compound	$\nu$ P=O	$\nu$ N-O ( $\text{cm}^{-1}$ )	$\nu$ C=O	$\nu$ O-H
- $\text{Ph}_3\text{PO}$ (L)	1190			
$\text{Me}_2\text{SnCl}_2 \cdot \text{L}$	1140			
-Diphos methane (L)	1190			
$\text{Me}_2\text{SnCl}_2 \cdot \text{L}$	1160			
- Diphos ethane (L)	1190			
$\text{Me}_2\text{SnCl}_2 \cdot \text{L}$	1140			
- 2-Me-py-N-oxide (L)		1250		
$\text{Me}_2\text{SnCl}_2 \cdot 2\text{L} \cdot \text{MeCN}$		1200		
$\text{Ph}_2\text{SnCl}_2 \cdot 2\text{L} \cdot \text{SnCl}_4 \cdot 2\text{L}$		1190		
- Picolinic acid (L)			1660	
$\text{Me}_2\text{SnCl}_2 \cdot 2\text{L}$			1680	
$\text{Ph}_2\text{SnCl}_2 \cdot 3\text{L}$			1720	
$\text{SnCl}_4 \cdot 2\text{L}$			1670	
- Thymolphthalien (L)			1750	3400-3100
$4\text{Ph}_2\text{SnCl}_2 \cdot \text{L}^*$			1700	absent
- Alizarine red-S (L)			1655	
$\text{Ph}_2\text{SnCl}_2 \cdot \text{L}$			1630	

\* Also the band at  $1350 \text{ cm}^{-1}$  and those lying in the region  $1150-1050 \text{ cm}^{-1}$ , which may be assigned to either OH deformation or C-O stretching absorption, are nearly absent in the ir spectrum of the complex.

Table-2:

b-Nitrogen donating ligands

Compound	$\nu_{C=N}$	$\nu_{N-H}$	$\nu_{NH_2}$ ( $cm^{-1}$ )	ring vibration
- Piperidine (L)	1325			
Me <sub>2</sub> SnCl <sub>2</sub> .2L	1200 & 1180 (splitting)			
- Pyrazine (L)	1300-1060			1490-1385
2Me <sub>2</sub> SnCl <sub>2</sub> .L	1145-1030			1410-1350
Ph <sub>2</sub> SnCl <sub>2</sub> .2L.4H <sub>2</sub> O	1170-1025			1455-1370
- Benzothiazole (L)	1610			
Me <sub>2</sub> SnCl <sub>2</sub> .2L	1590			
SnCl <sub>4</sub> .2L	1670 & 1620 (splitting)			
-N, N-DM-hydrazine (L)		1590	3400	
Me <sub>2</sub> SnCl <sub>2</sub> .L		1640	3450	
SnCl <sub>4</sub> .1.5L.MeCN		1630	3300	

cases no residue was obtained due to the decomposition and volatilization of the compounds up to 800°C.

#### Conductivity studies

Some of the obtained Sn(IV) complexes are soluble in organic solvents, such as acetonitrile. Molar conductivities of millimolar solutions of these complexes have been measured at 25.0±0.1°C. All results indicate that conductances of these solutions are too low as compared with the literature value of 1:1 electrolytes in acetonitrile:

150 Ohm<sup>-1</sup> cm<sup>-2</sup> [31]. This could also be predicted from the shape of the curves plotted between the conductance and the concentration for some complexes (Fig. 3-6).

It should be noted that attempted reactions of the three Sn(IV) salts with 5-sulphosalicylic acid, 2-hydroxy acetophenone, 4-methoxy acetophenone, 2,4-dinitrophenyl hydrazine, xanthene and xanthone gave either the starting materials unchanged or gave oily products that cannot be identified.



Conductivity Measurements For Some Sn(IV)-  
Complexes in Acetonitrile at  $25.0^{\circ}\text{C} \pm 0.1$

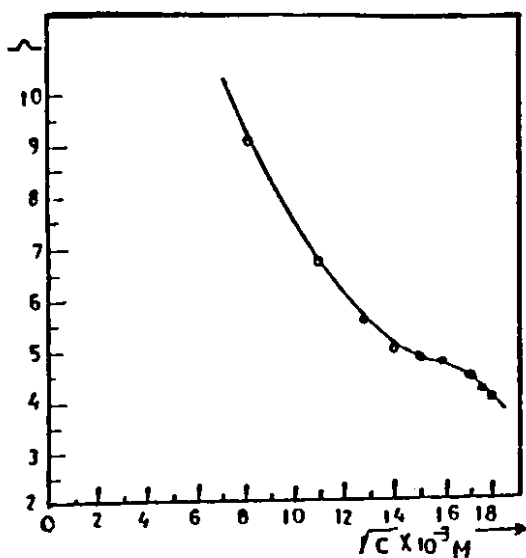


Fig. (3):  $\text{Me}_2\text{SnCl}_2$ .Diphos-methane dioxide.

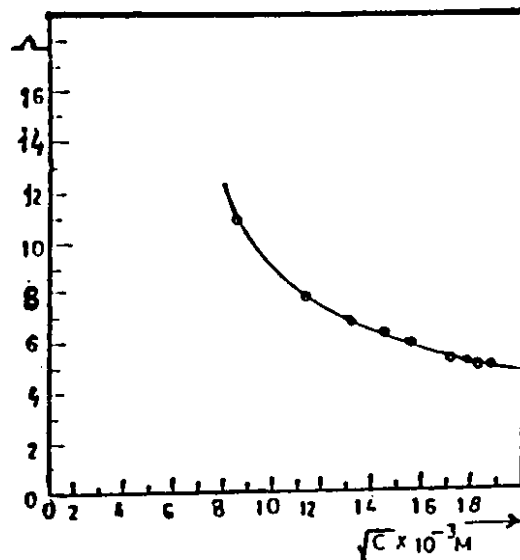


Fig. (4):  $\text{Me}_2\text{SnCl}_2$ .Diphos-ethane dioxide.

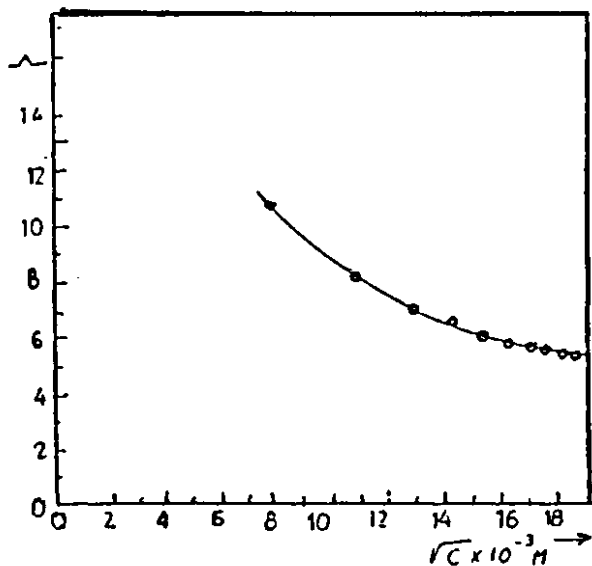


Fig. (5):  $\text{Ph}_2\text{SnCl}_2$ .2(Benzamide).

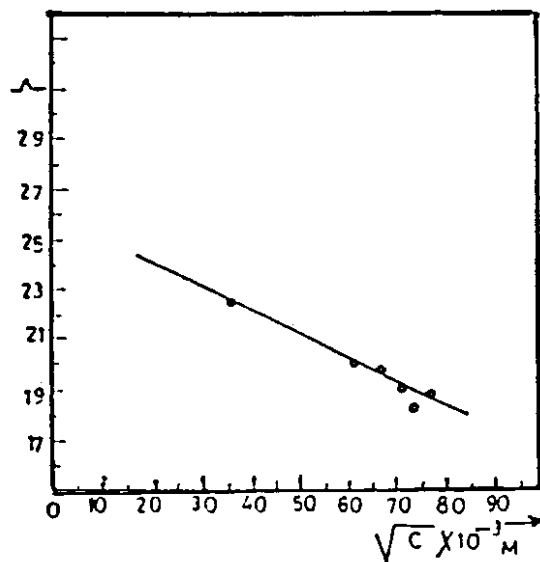


Fig. (6):  $\text{SnCl}_4$ .2(Benzothiazole).

Table-3: Thermal Decomposition of Some Tin(IV) Complexes

Temp. (°C)	M <sub>obs.</sub>	Formula	M <sub>Cal.</sub>
1. Me <sub>2</sub> SnCl <sub>2</sub> .Diphos-ethane dioxide			
20-150		Me <sub>2</sub> SnCl <sub>2</sub> .Diphos-ethane dioxide	650
310-350	465	Me <sub>2</sub> SnCl <sub>2</sub> .Ph <sub>3</sub> P	482
575-850	125	Sn	119
2. Me <sub>2</sub> SnCl <sub>2</sub> .Py-N-oxide			
20-100		Me <sub>2</sub> SnCl <sub>2</sub> .Py-N-oxide	409
400-850	10	Sn	119
3. Me <sub>2</sub> SnCl <sub>2</sub> .bis(3-Picoline)			
25-100		Me <sub>2</sub> SnCl <sub>2</sub> .bis(3-Picoline)	409
200-850	-	Volatile	-
4. Me <sub>2</sub> SnCl <sub>2</sub> .tripyridyl.3H <sub>2</sub> O			
20-100		Me <sub>2</sub> SnCl <sub>2</sub> .tripy.3H <sub>2</sub> O	507
at 190	472	Me <sub>2</sub> SnCl <sub>2</sub> .tripy.2H <sub>2</sub> O	471
400-490	300	Me <sub>2</sub> SnCl <sub>2</sub> .Py.	299
650-850	155	SnO <sub>2</sub>	151
5. Ph <sub>2</sub> SnCl <sub>2</sub> .tris(picolinic acid)			
20-60		Ph <sub>2</sub> SnCl <sub>2</sub> .3 picolinic acid	713
275-350	470	Ph <sub>2</sub> SnCl <sub>2</sub> .picolinic acid	467
450-525	205	SnOCl <sub>2</sub>	206
700-850	152	SnO <sub>2</sub>	151
6. Ph <sub>2</sub> SnCl <sub>2</sub> .(2-picoline)			
20-75		Ph <sub>2</sub> SnCl <sub>2</sub> .(2-picoline)	437
80-130	425	Ph <sub>2</sub> SnCl <sub>2</sub> .pyridine	422
Up to 850	-	Volatilization	-

Table-3: (Condt.)

Temp. (°C)	M <sub>obs.</sub>	Formula	M <sub>Cal.</sub>
7. Ph <sub>2</sub> SnCl <sub>2</sub> .2 phenylhydrazine.H <sub>2</sub> O			
20-100		Ph <sub>2</sub> SnCl <sub>2</sub> .2 phenylhydrazine.H <sub>2</sub> O	578
100-115	557	Ph <sub>2</sub> SnCl <sub>2</sub> .2 phenylhydrazine	560
At 160	350	Ph <sub>2</sub> SnCl <sub>2</sub>	344
430-850	116	Sn	119
8. SnCl <sub>4</sub> .bis(2Me-Py-N-oxide)			
20-60		SnCl <sub>4</sub> .bis(2Me-Py-N-oxide)	478
80-175	445	SnCl <sub>4</sub> .2Py-N-oxide	448
250-850	150	SnO <sub>2</sub>	151
9. SnCl <sub>4</sub> .2 DM-acetamide			
20-190		SnCl <sub>4</sub> .2DM-acetamide	435
at 300	-	Volatile	-

M<sub>obs.</sub> is the observed molecular weight in the thermograms.

M<sub>cal.</sub> is the calculated molecular weight for the expected intermediate compounds.

## References

1. W.R. McGregor, B.E. Bridgland, *J. Inorg. nucl. Chem.* **31**, 3325 (1969).
2. C.J. Wilkins, H.M. Haendler, *J. Chem. Soc. Lond.*, 3174 (1965).
3. Y. Kawasaki, M. Hori, K. Uenaka, *Bull. Chem. Soc. (Japan)*, 2463 (1967).
4. C.E. Michelson, D.S. Dyer, R.O. Ragsdale, *J. Inorg. nucl. Chem.*, **32**, 833 (1970).
5. P.A. Yeats, J.R. Sams, F. Aubke, *Inorg. Chem.* **9**(4), 740 (1970).
6. T.N. Srivastava, P.C. Srivastava, Neelu Bhakru, *J. Indian Chem. Soc.* **55**(5), 434 (1978).
7. D.P.N. Satchell, J.L. Wardell, *Proc. Chem. Soc.*, 405 (1964).
8. C.J. Evans, S. Karpel, *Organotin Compounds in Modern Technology*, Elsevier Science Publishers, Amsterdam, (1985).
9. B.W. Fitzsimmons, N.J. Seeley, A.W. Smith,

10. G.K. Wertheim,  
*J. Chem. Soc. A(1)*, 143 (1969).  
The Mossbauer Effect: Principles and Applications, Academic Press, New York and London, (1964).
11. J.J. Myher, K.E. Russell,  
*Canad. J. Chem.*, 42, 1555 (1964).
12. I.P. Goldstein, E.N. Guryanova, E.D. Delinskaya, K.A. Koche-shkov,  
*Doklady Akad. Nauk S.S.S.R.*, 136, 1079 (1961).
13. I.R. Beattie, G.P. McQuillan,  
*J. Chem. Soc.*, 1519 (1963).
14. G. Matsubayashi, T. Tanaka, R. Okawara,  
*J. Inorg. nucl. Chem.* 30, 1831 (1968).  
G. Matsubayashi, N. Nishh, T. Tanaka,  
*Bull. Chem. Soc. (Japan)* 42, 2369 (1969).
15. T. Tanaka, T. Kamitani,  
*Inorg. Chem. Acta*, 2(2), 175 (1968)
16. Z.M. Rzaev, S.G. Mamedova, F. B. Rustamov,  
Third Intern. Conf. Organometallic and Coordination Chem. of Germanium, Tin and Lead, Abstr., p. 13, Dortmund, (1980).
17. W. Kitching, C.J. Moore, D. Doddrell,  
*Aust. J. Chem.*, 22(6), 1149 (1969).
18. R.C. Poller,  
*J. Organometal. Chem.*, 3(4), 321 (1965).
19. M. Gielen, N. Sprecher,  
*Organometal. Chem. Rev.*, 1(4), 455 (1966).
20. O.A. Reutov, O.A. Ptytzina, M. D. Patrina,  
*Zhur. Obshe. Khim.*, 28, 588 (1958)
21. F.P. Mullis,  
*Canad. J. Chem.*, 49, 2719 (1971).
22. J.E. Fergusson, W.R. Roper, C. J. Wilkins,  
*J. Chem. Soc.*, 3716 (1965).
23. M.A. Wassef, S. Hessin,  
*Commun. Fac. Sc. Univers. Ankra*, 27(12), 141 (1981).  
M.A. Wassef, S. Hessin,  
*Egypt. J. Chem.*, 24, 87 (1981).
24. R.C. Weast, S.M. Selby,  
Handbook of Chemistry and Physics Chemical Rubber, 27th ed, pp. 765 (1966).
25. J.D. Roberts, M.C. Cassio,  
Basic Principles of Organic Chemistry Benjamin, New York, pp. 11980 (1964).
26. P. Gans, B.C. Smith,  
*J. Chem. Soc.*, 4172 (1964).
27. A.W. Weissberger, E.S. Proskauer,  
Organic Solvents, Physical Properties and Methods of Purification, Interscience, New York, 2nd ed. (1965).
28. H. Gilman, S.D. Rosenberg,  
*J. Amer. Chem. Soc.*, 75, 3592 (1953).
29. W.P. Neumann,  
The Organic Chemistry of Tin, Ferdinand Enke Verlag, Stuttgart, (1967).
30. N.A. Chumayevski,  
Oscillation Spectra of Hetero-organic Compounds with IVB and VB Elements, Nauka Publishers, Moscow, (1971).
31. W.M. Carmichael, A.D. Edwards, R.A. Walton,  
*J. Chem. Soc.* 97, (1966).