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SYNTHESIS AND CHARACTERISATION OF SOME Pb(II) MACROCYCLIC COMPLEXES

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ABSTRACT

One hundred twenty complexes of Pb(II) of the type [Pb_{1-3}^{1-10} X_2] (where X= Cl or Br or NO_3 or CH_3COO and L_{1-3}^{1-10} = macrocyclic ligands derived from the condensation of trimesic acid or þthathalic acid or squaric acid with different aliphatic diamines in 2:2 molar ratio) have been synthesized and characterized by elemental analysis, molar conductivity, Infrared and XPS i.e. X-ray photoelectron spectra data. An octahedral geometry was also established for them.

Keywords: Lead (II) Complexes, Macrocyclic Schiff Base Ligands, XPS.
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INTRODUCTION

The macrocyclic, macroacyclic, compartmental macrocyclic ligands and their transition metal and lanthanides complexes are an interesting area among inorganic and bioinorganic chemists due to their utilization in coordination and bioinorganic chemistry.[1-20] During last few decades many macrocyclic ligands such as porphyrins[21], crown ethers[22], N_4S_2 donor macrocyclic[23,24-32], polyazamacrocyclic[22,33-37], saturated and unsaturated polyamines[38-43] have been reported[38-43], Many macrocyclic metal complexes have been used as metal ion separation[44-46], as anticancerous[47], as antifungal[48], as coordinating agent[49-50], as therapeutic and radiotherapeutic agents[51-52], as catalyst[53-56], as pharmacological agent[57-59], In photosynthesis and dioxygen transport[60-61], as photosensitizer[62-63], as antitumour[64], as environmental importance[65], as potential medical applications[66-77], as in labeling monoclonal antibodies with radioactive models[68-70], as modeling the active sites of metalloenzymes[71], as highly stable complexes with transition metals and lanthanides in MRI contrasting agents[69], as radio-pharmaceuticals[69], as luminescent probes[69], in sensor technology[69], as protein binding[69], as molecular recognition of DNA, RNA and related biomolecules with aza-macrocyclic ligands[69], in sodium and potassium ion transport[69], as catalyst in carbonylation, hydrogenation; hydroformylation and epoxidation reaction[72-73] and providing supramolecular chemistry by various metal complexes with macrocyclic ligands. Recently few reviews have also been published on macrocyclic ligands, their metal complexes, and applications.[74-79] Lead toxicity is known from ancient times and many studies have explored the mechanisms and symptoms of this toxicity. The literature survey revealed that antioxidants can play an extremely important role in abating some toxic effects of lead. Few antioxidants appear to have a potential for chelating lead and removing it from the blood stream[80]. Lead has unique properties like softness, ductility low melting point, high malleability, and resistance to corrosion and is used in different industries like automobiles, paints, plastics, ceramics, etc. The main reason for its prolonged persistence in the environment is its non-biodegradable nature. The design of drugs to counteract the effects of lead poisoning needs to establish the perfect ligands of lead and its stereochemistry. In recent years many reports relating coordination chemistry of lead (II) with chelating ligands[81], lariat ethers[82-83], cryptands[84], and macrocycles[85-86] have been published. The relationship between structure and stability of lead (II) complexes with macrocyclic ligands is correlated. Organolead compounds are useful as fungicidal as well as bactericidal activities[87-88], allergies, asthma, and influenza[89], as algicides, herbicides, and also as anticancerous agents.[90-92]

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$[Pb(Mac_2)Z_2]$ (where Z= Cl or NO_3 or CH_3COO) containing 14-18 membered rings macrocyclic ligands have synthesized by the template condensation reactions of malonic acid and succinic acid with 1,2 aminoethane and 1,3- diamino propane in methanol and characterized by elemental analysis, molar conductivity, IR, and ^{1}HNMR, spectral studies[93]. $[Pb(L^{1-5}) S_2P(OR)_2]$ (where L= macrocyclic ligands L^1 or L^2 or L^3 or L^4or L^5 and R=CH_3 or C_3H_7 have been synthesized and characterized.[94] $[Pb(L)(ClO_4)_2]$ complexes where L=a new macrocyclic ligand 1, 1^1-bis -(bis-(6,6^1 - oxymethylenyl -2- 2^1 –bipyridine) has been synthesized and characterized.[95] Lead (ll) complexes with macrocyclic receptors derived from 4,13-diaza - 18 -crown -6 have been synthesized.[96] Salih et al[97] have synthesized Pb(ll) complexes with Schiff base macrocyclic ligands. Pb(ll) complexes by template reaction of 1,2- bis (2-formyl phenyl) ethane have been synthesized and characterized and their structure was posed on the basis of elemental analysis, molar conductivity, IR, and ^{1}H NMR.[102] By template reaction of 1,4-bis (3-amino-propoxy) butane with $Pb(NO_3)_2$ and 1,3-bis (2- formyl phenyl) propane or 1,4-bis (2formylphenyl) butane, eight new macrocyclic complexes were synthesized and their structure was proposed on basis of physicochemical techniques.[98] Salih *et al*[99] have synthesized various Pb(II) complexes with a new macrocyclic Schiff base derived from 2,6-diaminopyridine and 1,7- bis (2-fomylphenyl) -1,4,7-trioxaheptane.[100] Hassan Keypour *et al*.[101] have synthesized and characterized some new Pb (II) complexes with pentaaza macrocyclic ligand containing a piperazine moiety. Bahram Ghanbari *et al*[102] have synthesized and characterized various Pb (II) complexes with naphthodiaza crown macrocyclic ligands. Bis (benzyl) ethylenediamine react with $PbCl_2$ or $Pb(OAc)_2$ and primary diamine i.e. 1,2-diaminoethane or 1,3- diminopropane in a 1:1:1 Molar ratio in methanol to give $[Pb(L)X_2]$ complexes (where L= macrocyclic ligand and X= Cl or OAc).[103]

In this present research paper, we will synthesize $[PbX_2.L]$ complexes (where X= Cl or Br or NO_3 and L= macrocyclic Schiff base ligands i.e. L^1 = derived from trimesic acid and different diamines; L^2 = derived from phthalic acid and different diamines and L^3 =derived from squaric acid and different diamines) and characterized by different physicochemical techniques.

EXPERIMENTAL

The chemicals trimestic acid (BDH);phthalic acid (BDH); squaric acid (BDH); $PbCl_2$ (Aldrich); $PbBr_2$(BDH);$Pb(NO_3)_2$(BDH);$Pb(CH_3COO)_2$(BDH);$NH_2CH_2CH_2CH_2NH_2$(LOBA);$NH_2CH_2CH(CH_3)CH_2NH_2$(BDH); $NH_2CH_2NH(CH_2)_2NH_2$(BDH); $NH_2CH_2C(CH_3)_2CH_2NH_2$(BDH); $NH_2(CH_2)_6NH_2$(LOBA); $NH_2(CH_2)_7NH_2$(BDH);$NH_2(CH_2)_8NH_2$(BDH);$NH_2(CH_2)_9NH_2$(BDH);$NH_2(CH_2)_{10}NH_2$(BDH);$NH_2(CH_2)_{12}$(BDH) and methanol (BDH) were used after purification and dried as given in literature.[104-105] Solvents were distilled from appropriate drying agents immediately prior to use. Melting points were determined by using digital melting point apparatus and were uncorrected. Molar conductivity was recorded on a PW9526 Digital Conductivity meter. IR spectra were recorded on a Shimudzu-170-IR spectrophotometer using CsI as pallets in the range 4000-200cm^{-1}. X-ray photoelectron spectra were recorded on VG Scientific ESCA-II Spectrometer using Alk$_\alpha$ as an X-ray source.

Preparation of $[PbLX_2]$ Complexes

In terephthalic acid or squaric acid or trimestic acid (2mmol) in 50ml dry methanol added different aliphatic diamines (2mmol) i.e. $NH_2CH_2CH_2CH_2NH_2$ or $NH_2CH_2CH(CH_3)CH_2$ NH_2 or $NH_2CH_2NH(CH_2)$ NH_2; NH_2CH_2C $(CH_3)_2$ CH_2NH_2 or NH_2 $(CH_2)_6$ NH_2 or $NH_2(CH_2)_7NH_2$ or $NH_2(CH_2)_8$ NH_2 or $NH_2(CH_2)_9NH_2$ or $NH_2(CH_2)_{10}NH_2$ or $NH_2(CH_2)_{12}$ NH_2 and refluxed for 4hrs and then put PbX_2(where X=Cl or Br or NO_3 or CH_3COO) (1mmol) and refluxed again for 3hrs. The resulting precipitate was filtered- and recrystallized into benzene: pet-ether (9:1) and air-dried (Figs.-1, 2, and 3).

RESULTS AND DISCUSSION

All these prepared complexes [Pb L_{1-3}^{1-10} X_2] (where X= Cl or Br or NO_3 or CH_3COO and L_{1-3}^{1-10} = macrocyclic ligands i.e. L_1^1 or L_1^2 or L_1^3 or L_1^4 or L_1^5 or L_1^6 or L_1^7 or L_1^8 or L_1^9 or L_1^{10} or L_2^1 or L_2^2 or L_2^3 or L_2^4 or L_2^5 or L_2^6 or L_2^7 or L_2^8 or L_2^9 or L_2^{10} or L_3^1 or L_3^2 or L_3^3 or L_3^4 or L_3^5 or L_3^6 or L_3^7 or L_3^8 or L_3^9 or L_3^{10}) are white solid. The elemental analysis for C, H, N, and X = Cl or Br were observed within ±0.5%. The molar conductance of all these complexes [Pb L_{1-3}^{1-10} X_2] was found below 20-30 ohm^{-1}cm^{2}mol^{-1}` in DMF solution at room temperature showing that all these complexes are non-electrolyte.[106]

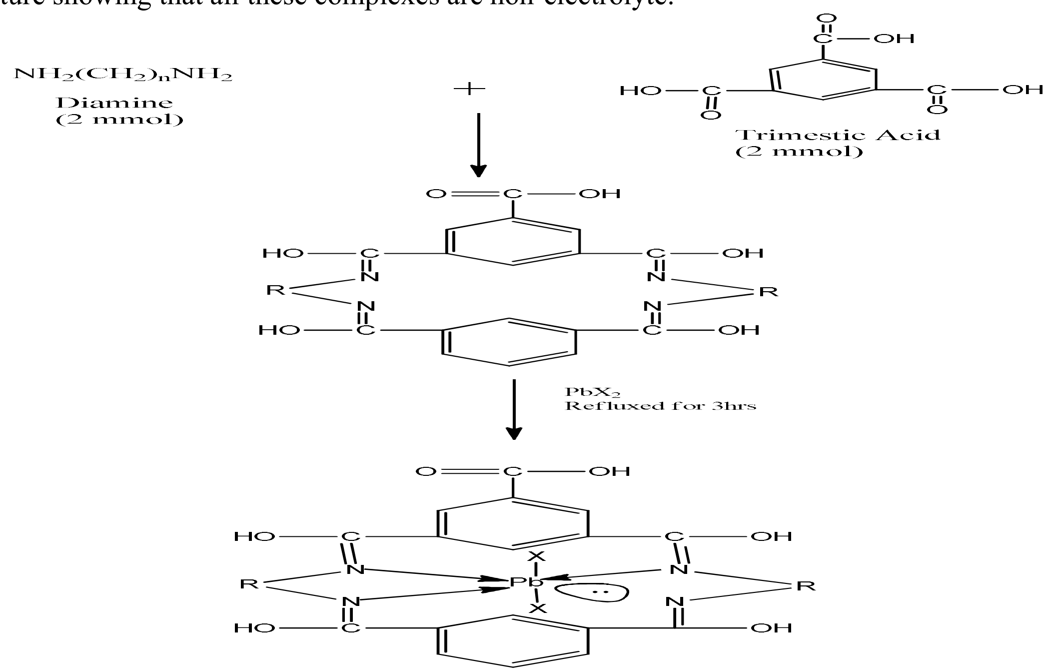

Fig.-1: Preparation of [PbX_2. L_1^{1-10}] Complexes Where X =Cl or Br or NO_3 or CH_3COO and L_1^1 =R = -$CH_2CH_2CH_2$- ; L_1^2 = R= -$CH_2CH(CH_3)CH_2$- ; L_1^3 = R = -$CH_2NH(CH_2)_2$- ; L_1^4 = R = -$CH_2C(CH_3)_2CH_2$- ; L_1^5 = R = -$(CH_2)_6$- ; L_1^6 =R= -$(CH_2)_7$- ; L_1^7 = R = -$(CH_2)_8$- ; L_1^8 = R = -$(CH_2)_9$- L_1^9 = R = -$(CH_2)_{10}$ - ; L_1^{10} = R = -$(CH_2)_{12}$-

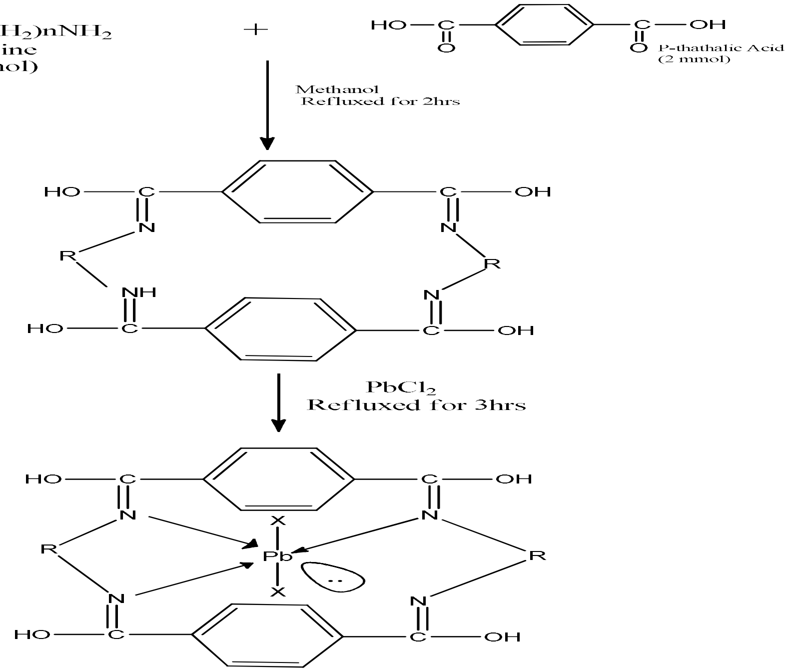

Fig.-2: Preparation of [PbX_2. L_2^{1-10}] Complexes Where X=Cl or Br or NO_3 or CH_3COO and L_2^1 = R = -$CH_2CH_2CH_2$ -; L_2^2 = -CH_2CH $(CH_3)CH_2$- ; L_2^3 = $CH_2NH(CH_2)_2$- ; L_2^4 = R = -$CH_2C(CH_3)_2CH_2$- ; L_2^5 = R = -$(CH_2)_6$- ; L_2^6 = R = -$(CH_2)_7$- ; L_2^7 = R = -$(CH_2)_8$ - ; L_2^8 = R = -$(CH_2)_9$- ; L_2^9 = R = -$(CH_2)_{10}$- and L_2^{10} = R = -$(CH_2)_{12}$-

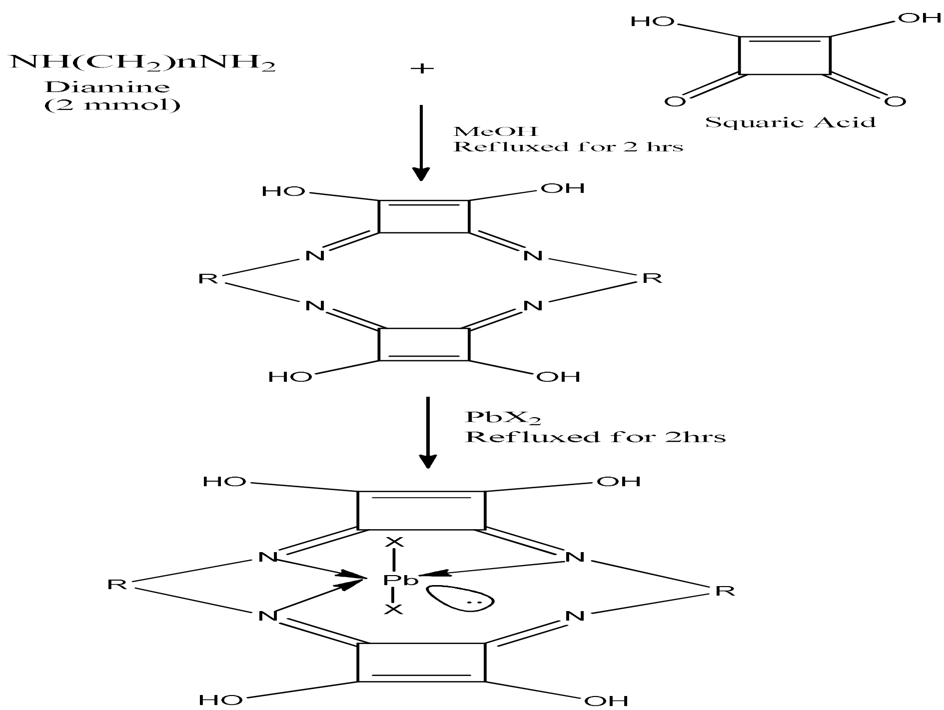

Fig.-3: Preparation of [PbX_2. L_3^{1-10}] Complexes Where X= Cl or Br or NO_3 CH_3COO and L_3^1 = R = $-CH_2CH_2CH_2-$; L_3^2 = $-CH_2CH(CH_3)CH_2-$; L_3^3 = R = $-CH_2NH(CH_2)_2-$; L_3^4 = R = $-CH_2C(CH_3)_2CH_2-$; L_3^5 = R = $-(CH_2)_6-$; L_3^6 = R = $-(CH_2)_7$; L_3^7 = R = $-(CH_2)_8-$; L_3^8 = R = $-(CH_2)_9-$; L_3^9 = R = $-(CH_2)_{10}-$ and L_3^{10} = R = $-(CH_2)_{12}-$

The presence of sharp bands observed in the range of 485-496 cm^{-1} confirms the formation of ϑ_{Pb-Cl}.[107-110] The presence of a band in the far -IR region at 430 - 475 cm^{-1} is due to the ϑ_{Pb-N} vibration that supports the coordination of the imine nitrogen to the lead metal ion[111]. The IR spectra for ϑ_{sym} (OCO) appear at 1370cm^{-1} and ϑ_{asym} (OCO) together with the imine $\vartheta_{C=N}$ as an intense broad absorption band in the region 1605-1626 cm^{-1}F, suggesting monodentate coordination in the metal complexes [Pb L_{1-3}^{1-10}(OAC)$_2$].[107] The binding energies (eV) of PbX_2 (where X- Cl or Br or NO_3 or CH3COO); L_{1-3}^{1-10} i.e. macrocyclic ligands and [Pb L_{1-3}^{1-10} X_2] complexes for Pb3$d_{3/2,5/2}$ and N1s photoelectron peaks are listed in Table-1 and Figs.- 4 and 5.

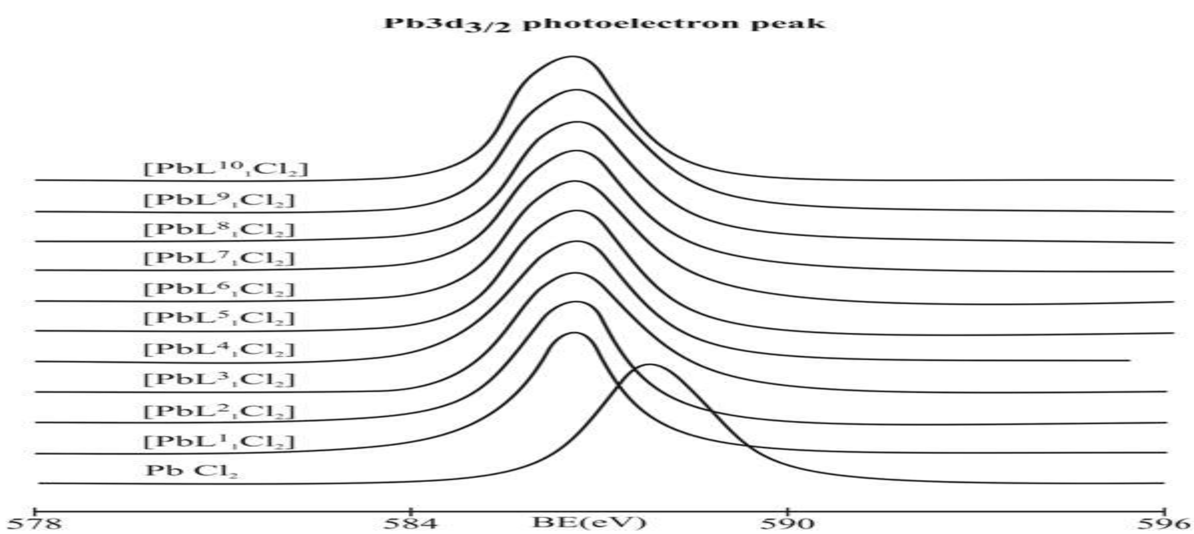

Fig.-4: Pb3$d_{3/2}$ Binding Energy (eV) in [$PbL_1^{1-10}Cl_2$] Complexes

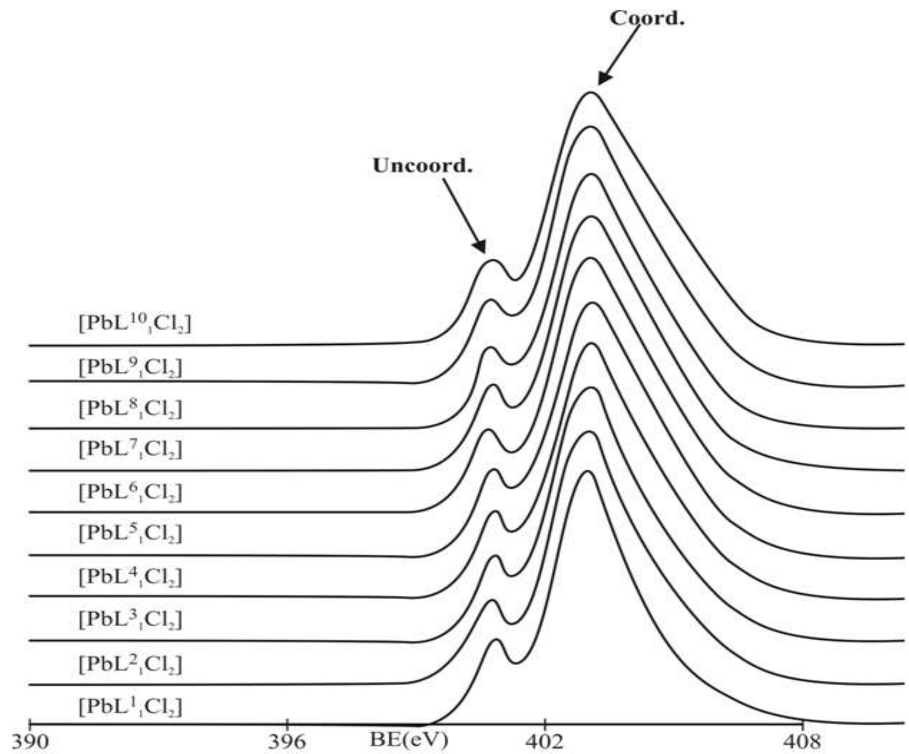

Fig.-5: N1s Binding Energy (eV) in [$PbL_1^{1-10}Cl_2$] Complexes

It was observed that binding energies (eV) of Pb $3d_{3/2,\,5/2}$ in starting material $PbCl_2$ or $PbBr_2$ or $Pb(NO_3)_2$ or $Pb(OAc)_2$ were $Pb3d_{3/2}$ = ~ 587.8 eV - 587.2eV and $Pb3d_{5/2}$ ~485.8 - 485.2 eV, higher than in [Pb L_{1-3}^{1-10} X_2] complexes $Pb3d_{3/2}$ = ~586.6 – 586.0 eV and $Pb3d_{5/2}$ = ~484.6 - 484.0 eV. One can conclude from these XPS data that electron density in lead metal is more in molecular complexes [Pb L_{1-3}^{1-10} X_2] than in PbX_2 due to coordination (Fig.-4) (Table-1).[112] The N1s photoelectron spectra of all these [Pb L_{1-3}^{1-10} X_2] have shown two photoelectron peaks in a 1:3 intensity ratio; one weak intensity photoelectron peak in the same position as in ligand and another higher intensity photoelectron peak towards a higher binding energy side than ligand N1s photoelectron peak suggested one nitrogen atom is uncoordinated, while rest three nitrogen atoms macrocyclic ligand is coordinated to lead metal ion.[112-113] But, in the Case of [Pb L_{1-3}^{1-10} $(NO_3)_2$], three N1s photoelectron peaks in intensity ratio 1:3:2 were observed due to one nitrogen atom uncoordinated, three nitrogen atoms coordinated from the macrocyclic ligand, and two coordinated nitrogen atoms from two NO_3 group(Table-1).[112-113]

Table-1: Pb 3 Table-1: Pb $3d_{3/2}$, Pb $3d_{5/2}$ and N 1s Binding Energies (eV) in Ligands, PbX_2 and [Pb L_{1-3}^{1-10} X_2] Complexes Where X = [Cl or Br or NO_3 or CH_3COO]$d_{3/2}$, Pb $3d_{5/2}$ and N 1s Binding Energies (eV) in Ligands, PbX_2 and [Pb L_{1-3}^{1-10} X_2] Complexes Where X = [Cl or Br or NO_3 or CH_3COO]

S. No.	Ligand & Complex	Pb $3d_{3/2,5/2}$		N 1s	
		$Pb_{3/2}$	$Pb_{5/2}$	Uncoordinated	Coordinated
1	$L^1{}_1$	-	-	400.8	-
2	$L^2{}_1$	-	-	400.8	-
3	$L^3{}_1$	-	-	400.8	-
4	$L^4{}_1$	-	-	400.8	-
5	$L^5{}_1$	-	-	400.8	-
6	$L^6{}_1$	-	-	400.8	-

Vol. 15 | No. 2 |1390-1402| April - June | 2022

7	$L^7{}_1$	-	-	400.8	-
8	$L^8{}_1$	-	-	400.8	-
9	$L^9{}_1$	-	-	400.8	-
10	$L^{10}{}_1$	-	-	400.8	-
11	$L^1{}_2$	-	-	400.8	-
12	$L^2{}_2$	-	-	400.8	-
13	$L^3{}_2$	-	-	400.8	-
14	$L^4{}_2$	-	-	400.8	-
15	$L^5{}_2$	-	-	400.8	-
16	$L^6{}_2$	-	-	400.8	-
17	$L^7{}_2$	-	-	400.8	-
18	$L^8{}_2$	-	-	400.8	-
19	$L^9{}_2$	-	-	400.8	-
20	$L^{10}{}_2$	-	-	400.8	-
21	$L^1{}_3$	-	-	400.8	-
22	$L^2{}_3$	-	-	400.8	-
23	$L^3{}_3$	-	-	400.8	-
24	$L^4{}_3$	-	-	400.8	-
25	$L^5{}_3$	-	-	400.8	-
26	$L^6{}_3$	-	-	400.8	-
27	$L^7{}_3$	-	-	400.8	-
28	$L^8{}_3$	-	-	400.8	-
29	$L^9{}_3$	-	-	400.8	-
30	$L^{10}{}_3$	-	-	400.8	-
31	$PbCl_2$	587.8	485.8	-	-
32	$PbL^1{}_1Cl_2$	586.6	484.6	400.8	402.8
33	$PbL^2{}_1Cl_2$	586.6	484.6	400.8	402.8
34	$PbL^3{}_1Cl_2$	586.6	484.6	400.8	402.8
35	$PbL^4{}_1Cl_2$	586.6	484.6	400.8	402.8
36	$PbL^5{}_1Cl_2$	586.6	484.6	400.8	402.8
37	$PbL^6{}_1Cl_2$	586.6	484.6	400.8	402.8
38	$PbL^7{}_1Cl_2$	586.6	484.6	400.8	402.8
39	$PbL^8{}_1Cl_2$	586.6	484.6	400.8	402.8
40	$PbL^9{}_1Cl_2$	586.6	484.6	400.8	402.8
41	$PbL^{10}{}_1Cl_2$	586.6	484.6	400.8	402.8
42	$PbL^1{}_2Cl_2$	586.6	484.6	400.8	402.8
43	$PbL^2{}_2Cl_2$	586.6	484.6	400.8	402.8
44	$PbL^3{}_2Cl_2$	586.6	484.6	400.8	402.8
45	$PbL^4{}_2Cl_2$	586.6	484.6	400.8	402.8
46	$PbL^5{}_2Cl_2$	586.6	484.6	400.8	402.8
47	$PbL^6{}_2Cl_2$	586.6	484.6	400.8	402.8
48	$PbL^7{}_2Cl_2$	586.6	484.6	400.8	402.8
49	$PbL^8{}_2Cl_2$	586.6	484.6	400.8	402.8
50	$PbL^9{}_2Cl_2$	586.6	484.6	400.8	402.8
51	$PbL^{10}{}_2Cl_2$	586.6	484.6	400.8	402.8
52	$PbL^1{}_3Cl_2$	586.6	484.6	400.8	402.8
53	$PbL^2{}_3Cl_2$	586.6	484.6	400.8	402.8
54	$PbL^3{}_3Cl_2$	586.6	484.6	400.8	402.8
55	$PbL^4{}_3Cl_2$	586.6	484.6	400.8	402.8
56	$PbL^5{}_3Cl_2$	586.6	484.6	400.8	402.8
57	$PbL^6{}_3Cl_2$	586.6	484.6	400.8	402.8
58	$PbL^7{}_3Cl_2$	586.6	484.6	400.8	402.8
59	$PbL^8{}_3Cl_2$	586.6	484.6	400.8	402.8
60	$PbL^9{}_3Cl_2$	586.6	484.6	400.8	402.8

61	$PbL^{10}{}_3Cl_2$	586.6	484.6	400.8	402.8
62	$PbBr_2$	587.6	485.6	-	-
63	$PbL^1{}_1Br_2$	586.6	484.6	400.8	402.8
64	$PbL^2{}_1Br_2$	586.6	484.6	400.8	402.8
65	$PbL^3{}_1Br_2$	586.6	484.6	400.8	402.8
66	$PbL^4{}_1Br_2$	586.6	484.6	400.8	402.8
67	$PbL^5{}_1Br_2$	586.6	484.6	400.8	402.8
68	$PbL^6{}_1Br_2$	586.6	484.6	400.8	402.8
69	$PbL^7{}_1Br_2$	586.6	484.6	400.8	402.8
70	$PbL^8{}_1Br_2$	586.6	484.6	400.8	402.8
71	$PbL^9{}_1Br_2$	586.6	484.6	400.8	402.8
72	$PbL^{10}{}_1Br_2$	586.6	484.6	400.8	402.8
73	$PbL^1{}_2Br_2$	586.6	484.6	400.8	402.8
74	$PbL^2{}_2Br_2$	586.6	484.6	400.8	402.8
75	$PbL^3{}_2Br_2$	586.6	484.6	400.8	402.8
76	$PbL^4{}_2Br_2$	586.6	484.6	400.8	402.8
77	$PbL^5{}_2Br_2$	586.6	484.6	400.8	402.8
78	$PbL^6{}_2Br_2$	586.6	484.6	400.8	402.8
79	$PbL^7{}_2Br_2$	586.6	484.6	400.8	402.8
80	$PbL^8{}_2Br_2$	586.6	484.6	400.8	402.8
81	$PbL^9{}_2Br_2$	586.6	484.6	400.8	402.8
82	$PbL^{10}{}_2Br_2$	586.6	484.6	400.8	402.8
83	$PbL^1{}_3Br_2$	586.6	484.6	400.8	402.8
84	$PbL^2{}_3Br_2$	586.6	484.6	400.8	402.8
84	$PbL^3{}_3Br_2$	586.6	484.6	400.8	402.8
86	$PbL^4{}_3Br_2$	586.6	484.6	400.8	402.8
87	$PbL^5{}_3Br_2$	586.6	484.6	400.8	402.8
88	$PbL^6{}_3Br_2$	586.6	484.6	400.8	402.8
89	$PbL^7{}_3Br_2$	586.6	484.6	400.8	402.8
90	$PbL^8{}_3Br_2$	586.6	484.6	400.8	402.8
91	$PbL^9{}_3Br_2$	586.6	484.6	400.8	402.8
92	$PbL^{10}{}_3Br_2$	586.6	484.6	400.8	402.8
93	$Pb(NO_3)_2$	587.4	485.6	-	-
94	$PbL^1{}_1(NO_3)_2$	586.6	484.6	400.8	402.8
95	$PbL^2{}_1(NO_3)_2$	586.6	484.6	400.8	402.8
96	$PbL^3{}_1(NO_3)_2$	586.6	484.6	400.8	402.8
97	$PbL^4{}_1(NO_3)_2$	586.6	484.6	400.8	402.8
98	$PbL^5{}_1(NO_3)_2$	586.6	484.6	400.8	402.8
99	$PbL^6{}_1(NO_3)_2$	586.6	484.6	400.8	402.8
100	$PbL^7{}_1(NO_3)_2$	586.6	484.6	400.8	402.8
101	$PbL^8{}_1(NO_3)_2$	586.6	484.6	400.8	402.8
102	$PbL^9{}_1(NO_3)_2$	586.6	484.6	400.8	402.8
103	$PbL^{10}{}_1(NO_3)_2$	586.6	484.6	400.8	402.8
104	$PbL^1{}_2(NO_3)_2$	586.6	484.6	400.8	402.8
105	$PbL^2{}_2(NO_3)_2$	586.6	484.6	400.8	402.8
106	$PbL^3{}_2(NO_3)_2$	586.6	484.6	400.8	402.8
107	$PbL^4{}_2(NO_3)_2$	586.6	484.6	400.8	402.8
108	$PbL^5{}_2(NO_3)_2$	586.6	484.6	400.8	402.8
109	$PbL^6{}_2(NO_3)_2$	586.6	484.6	400.8	402.8
110	$PbL^7{}_2(NO_3)_2$	586.6	484.6	400.8	402.8
111	$PbL^8{}_2(NO_3)_2$	586.6	484.6	400.8	402.8
112	$PbL^9{}_2(NO_3)_2$	586.6	484.6	400.8	402.8
113	$PbL^{10}{}_2(NO_3)_2$	586.6	484.6	400.8	402.8
114	$PbL^1{}_3(NO_3)_2$	586.6	484.6	400.8	402.8

115	$PbL^2{}_3(NO_3)_2$	586.6	484.6	400.8	402.8
116	$PbL^3{}_3(NO_3)_2$	586.6	484.6	400.8	402.8
117	$PbL^4{}_3(NO_3)_2$	586.6	484.6	400.8	402.8
118	$PbL^5{}_3(NO_3)_2$	586.6	484.6	400.8	402.8
119	$PbL^6{}_3(NO_3)_2$	586.6	484.6	400.8	402.8
120	$PbL^7{}_3(NO_3)_2$	586.6	484.6	400.8	402.8
121	$PbL^8{}_3(NO_3)_2$	586.6	484.6	400.8	402.8
122	$PbL^9{}_3(NO_3)_2$	586.6	484.6	400.8	402.8
123	$PbL^{10}{}_3(NO_3)_2$	586.6	484.6	400.8	402.8
124	$Pb(CH_3COO)_2$	587.2	485.2	-	-
125	$PbL^1{}_1(OAc)_2$	586.0	484.2	400.8	402.8
126	$PbL^2{}_1(OAc)_2$	586.0	484.2	400.8	402.8
127	$PbL^3{}_1(OAc)_2$	586.0	484.2	400.8	402.8
128	$PbL^4{}_1(OAc)_2$	586.0	484.2	400.8	402.8
129	$PbL^5{}_1(OAc)_2$	586.0	484.2	400.8	402.8
130	$PbL^6{}_1(OAc)_2$	586.0	484.2	400.8	402.8
131	$PbL^7{}_1(OAc)_2$	586.0	484.2	400.8	402.8
132	$PbL^8{}_1(OAc)_2$	586.0	484.2	400.8	402.8
133	$PbL^9{}_1(OAc)_2$	586.0	484.2	400.8	402.8
134	$PbL^{10}{}_1(OAc)_2$	586.0	484.2	400.8	402.8
135	$PbL^1{}_2(OAc)_2$	586.0	484.2	400.8	402.8
135	$PbL^2{}_2(OAc)_2$	586.0	484.2	400.8	402.8
137	$PbL^3{}_2(OAc)_2$	586.0	484.2	400.8	402.8
138	$PbL^4{}_2(OAc)_2$	586.0	484.2	400.8	402.8
139	$PbL^5{}_2(OAc)_2$	586.0	484.2	400.8	402.8
140	$PbL^6{}_2(OAc)_2$	586.0	484.2	400.8	402.8
141	$PbL^7{}_2(OAc)_2$	586.0	484.2	400.8	402.8
142	$PbL^8{}_2(OAc)_2$	586.0	484.2	400.8	402.8
143	$PbL^9{}_2(OAc)_2$	586.0	484.2	400.8	402.8
144	$PbL^{10}{}_2(OAc)_2$	586.0	484.2	400.8	402.8
145	$PbL^1{}_3(OAc)_2$	586.0	484.2	400.8	402.8
146	$PbL^2{}_3(OAc)_2$	586.0	484.2	400.8	402.8
147	$PbL^3{}_3(OAc)_2$	586.0	484.2	400.8	402.8
148	$PbL^4{}_3(OAc)_2$	586.0	484.2	400.8	402.8
149	$PbL^5{}_3(OAc)_2$	586.0	484.2	400.8	402.8
150	$PbL^6{}_3(OAc)_2$	586.0	484.2	400.8	402.8
151	$PbL^7{}_3(OAc)_2$	586.0	484.2	400.8	402.8
152	$PbL^8{}_3(OAc)_2$	586.0	484.2	400.8	402.8
153	$PbL^9{}_3(OAc)_2$	586.0	484.2	400.8	402.8
154	$PbL^{10}{}_3(OAc)_2$	586.0	484.2	400.8	402.8

The Pb $3s_{1/2}$ photoelectron peak in all these [Pb L_{1-3}^{1-10} X_2] complexes have shown a symmetrical peak i.e., have not shown a multiple splitting effect, suggesting all these complexes are diamagnetic.[112-113]

CONCLUSION

Based on physicochemical data of all these [Pb L_{1-3}^{1-10} X_2] complexes i.e., elemental analysis, molar conductivity, IR, and XPS data may be proposed the structure of these as shown in Fig.-1, 2, & 3 and an octahedral geometry may be established.

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