Chapter one

Introduction:

Development in inorganic and organometalic chemistry has result in a significantly increased understanding of the bonding, structure and reactivity of coordination compounds

These developments have been applied fruitfully to design of model system that shed light on the behavior of metal ions in biological processes and ultimately to look more closely in those processes themselves(1).

On the other side a large number of metal containing therapeutical agents and other biologically active complexes have been prepared and proven to be of great effectiveness in this respect (2).

1.1-Bioinorganic chemistry:

The boundaries of inorganic chemistry extend from physical and organic chemistry to the boundaries of theoretical physics, this statement still valid even if we add boundaries of biological science, therefore, inorganic chemistry can be considered as growing organism with respect to the increasing flow of data.

It is known that coordination chemistry refer to that part of inorganic chemistry which deals with studying the properties of both the central metal and the group of ligands surrounding it, in the first days of chemistry the coordination compounds were considered as a great chaleng for the inorganic chemist, now a days it forms a big part of the recent research in inorganic chemistry and about 70% of the issues publishes in inorganic chemistry are of coordination compounds.

However, even the classical coordination theories were extended and modified to include these complexes, it still suffering from series problems which are waiting to be resolved. Inorganic biochemistry is the most growing filed which is based on the role of coordination compounds in the living system(3). The importance of metal ions in the living system diver the interest of a large number of researchers in pure inorganic chemistry toward the field of bioinorganic chemistry. Bioinorganic chemistry is a rapidly developing filed and there is enormous potential for application in medicine. Medicinal inorganic chemistry offers real possibities to pharmaceutical industries, which have traditionally been dominated by organic chemistry alone, for the discovery of truly novel drugs with new mechanism of action (4).

1.2- Interaction of the ligand with metal ion:

The tendency of metal ion to form stable complex with ligands depend on many rules such as the hard and soft acid base (HSAB) rule of pearson(5) which simply state that metal ion tend to coordinate with certain donor atoms of the ligand to form stable complex. Hardness and softness refer to special stability of hard–hard and soft–soft interaction and should be carefully distinguished from inherent acid or base. The Lrving Williams series of stability for a given ligand is a good criterion for the stability of complex with dipositive metal ions which follows the order:

$\mathbf{Ba^{+2} < Sr^{+2} < Ca^{+2} < Mg^{+2} < Mn^{+2} < Fe^{+2} < Co^{+2} < Ni^{+2} < Cu^{+2} > Zn^{+2}}$

This order arises in part from decrease in size across the series and part from ligand field effects. The tendency of transition metal ions for special oxidation state is affected by coordinating to certain ligands, this phenomena is called (symboiosis) (7).

The increase of the positive charge on the central transition metal ion strengthens the metal-ligand bands. The metal ion prefers to bind with atoms of high electron density such as N^{-3}, O^{-2}, P^{-3}, S^{-2}, C^{-4} (8).

The ligand should have certain characteristic properties to make it convenient to form stable complex with transition metal ion. The size, geometrical shape, number and geometrical arrangement of ligand and donor atoms play the important role in the stability of the resultant complex.

Metal centers, positively charged, are favored to bind to negatively charged biomolecules, the constituents of proteins and nucleic acid offer excellent ligands for binding to metal ions(9)

For example, phosphine (R_3P) and thioethers (R_2S) have much greater tendency to coordination with Hg,Pd, and ammonia, amines (R_3N) prefer Be, Ti and Co .Such a classification has proved very useful in accounting (10,11) for and predicting the stability of coordination compounds

A thorough discussion of the factors operating in hard and soft interaction will be post bond temporarily but may be noted now that the hard species, both acid and base, tend to be small, slightly polarized species and soft acid and base tend to be large and more polarized. Hard acid prefer to bind to hard bases and soft acids prefer to bind to soft bases. It should be noted that this statement is not explanation or a theory but a simple rule of thump that enable the user to predict qualitatively the relative stability of acid – base adducts.

1.3- Tran's effect:

Molecules or ions having the same chemical composition but different structures are called isomers. In metal complexes, the ligands may occupy different types of positions around the central atom. Since the ligands are usually either next to one another (cis) or opposite to each other (trans) , this type of isomerism is often also refered to as cis-trans isomerism cis-trans isomerism is very common for square planar and octahedral complexes(12)

The Trans effect may be defined as the labilization of ligands trans to other, trans-directing ligands. By comparison of a large number of reactions it is possible to set up a trans-directing series:

$CN^- \sim CO \sim NO \sim H^- > CH3 \sim SC(NH_2) \sim SR_2 \sim PR_3 > SO_3H^- > NO_2 \sim I^- \sim SCN^- > Br^- > Cl^- >$
$py > RNH_2 \sim NH_3 > OH^- > H_2O$

The Trans effect must be kinetically controlled since the thermodynamically most stable isomer is not always produced depending on the reaction sequence(14).

The Trans effect illustrates the importance of studying the mechanism of complex substitution reaction.

The distinction between the thermodynamic terms stable and unstable and the kinetic terms labile and inert should be clarified some complexes are extremely stable from a thermodynamic point of view, yet kinetically they are quite different (15).

The Trans effect may be utilized to provide the desired isomer in an otherwise complicated system (13).

1.4. Chemistry of Copper (II):

The copper (II) state (d^9) is the most important one for copper. Most Cu (I) compounds are fairly readily oxidized to Cu (II) compounds, but further oxidation to Cu (III) is more difficult. There is a well – defined aqueous chemistry of Cu^{+2} and a large number of salts of various anions, many of which are water soluble, exist in addition to a wealth of complexes (11).

The d^9 configuration makes Cu^{II} subject to Jahn-Teller distortion if placed in an environment of cubic (regular octahedrad or tetrahedral) symmetry, and this has a profound effect on all its stereochemistry. When six–coordinated the □□(octahedral) is severely distorted(11-16).

The most common coordination numbers of copper (II) are 4, 5and 6, but regular geometries are rare and the distinction between square-planar and tetragonally distorted octahedral coordination is generally not easily made (17).

Copper (II) also forms stable complexes with O-donor ligands, also mixed O,N- donor ligands such as Schiff bases(18) are of interest in that they provide examples not only of square-planar coordination but also in the solid state , example of square-pyramidal coordination by dimerization, it was found that the magnetic moment of dimeric copper (II) is lower than the spin-only value (1.73 BM at room temperature).Clearly the single unpaired electrons on the copper atoms interact or “couple” antiferromgnetically (19) as the temperature reduce the population of the diamagnetism is eventually approached.

1.5- Palladium (II) Complexes:

Palladium is one of the (4d) transition elements and has the outer electronic configuration ($4d^{8}$) shell which is quite easy to break. The most characteristic feature in its chemistry is its similarity with platinum, its (5d) congener.

Palladium has a well – established chemistry in the (O, I, II) and (IV) oxidation states. Palladium (IV) complexes are less stable then the corresponding palladium compounds and are readily reduced to palladium(II); palladium(II) is the dominate oxidation state and usually the compound are diamagnetic with low spin (d^{8}),It is generally regarded as (soft) metal and this is reflected in the rich chemistry with sulfur and phosphorus donor ligand, however, palladium (II) will also complex with hard ligands such as oxygen and nitrogen(20). But generally, it forms stronger complexes with sulfur donors than with oxygen donor ligand.

Another contribution to the strength of the palladium (II) sulphur made be by (π) back – donation of electron density from the metal atom. The empty, relatively low energy (d) orbital on sulphur, Ligands such as sulphite ions, thiosulphate ions that bind to palladium (II) through a sulphur atom generally exhibit a high trans effect as deduced from preparative studies (21).

However, the trans influence of these ligands is negligible; thus has been deduced; for example, from (IR) stretching frequencies of Pd –Cl bond. Palladium (II), as a soft metal ion, does not form strong bond with oxygen donors and therefore complexes with unidentate ligands readily undergo substitution reaction the chelate effect leads to a great number of stable complexes for bidentate ligands, oxygen donor can also be stabilized by incorporation in a bidentate ligand with other more strongly binding atoms such as nitrogen or sulphur (22).

A wide variety of organic compounds contain nitrogen atoms have been prepared; the strength of the palladium-nitrogen bond had led to a large number of stable compounds being prepared. Complexes of the majority of simple amines have been prepared including recently those of hydroxyl amine (23) ; aziridine (24) and the trimethyl amine(25).Normally the trans isomer (or mixture of isomers) is isolated though by control of additions, the pure cis isomer may be obtained.

1.6- Cationic Complexes of Pd (II) and Pt (II):

Dimethylsulphoxide complexes of Pd (II) and Pt (II). The catonic complexes $[Pd(DMSO)_4]X_2$ ($X^-=BF_4^-$, ClO_4^-) is now known to contain both S- and O- bonded DMSO in a cis configuration in the solid state.

The IR spectrum for $[Pt(DMSO)_4]$ $(ClO4)_2$ is very similar to that of the palladium complexes with two strong bands in both S- bonded (1155,1143 cm^{-1}) and O-bonded(897,879 cm^{-1}) υSO region (The far-IR spectrum contain bands at 517 and 438 cm^{-1} which are assigned to Pt-ligand stretching frequencies(26).

We turn now to the second general class of complexes those in which the sulphoxide is coordinating through the sulphur atom. The compounds $PdCl_2$.2DMSO and $PtCl_2$.2DMSO appear to be of this type their spectra are similar to spectra of O-bonded compounds in the C-H stretching and deformation region. i.e. down to the ~1300 cm^{-1}(27). However, for $PdCl_2$.2DMSO and $PtCl_2$.2DMSO, the SO stretching frequency is higher (1116 cm^{-1}) in the complex than in the free ligand. In the platinum compound, there are strong bands at 1157 and 1134 cm^{-1}, one or both of which must be assigned to S-O stretching. In both the platinum and palladium complexes, the four strong to medium intensity band found between ~1025 and ~920 cm^{-1}. May be assigned to CH_3 rocking modes. The bands at 730 and 683 cm^{-1}.In the palladium compound may presumably be assigned to C-S stretching frequencies. The behavior of these bands in these S-bonded compounds is in a marked contrast to their behavior in the O-bonded compounds In the latter the C-S stretching bands are generally much weaker(often the symmetric stretches not observed) (28).

The infra-red spectra of dimethylsulphoxide, dimethylsulphoxide d^6, numerous complexes of DMSO- d^6 with metal salts are reported and discussed. Assignments are proposed for the bands observed in the region 650-4000 cm^{-1} The effect of complex formation and sulphoxonium ion formation by dimethylsulphoxide upon its S-O stretching frequency are given a particular attention and it is shown that observed shifts may be correlated with occurrence of S- or O- bonding in the adducts by considering the electronic nature of the S-O linkage (29). The infrared spectra (4000-270) cm^{-1} was recorded and assignments for the main absorption bands were used to determine the ligand donor sites and to comment on the relative acceptor ability of palladium (II). The complex $Pd(DMSO)_4^{+2}$ has the novel feature of containing both sulfur and oxygen bonded dimethylsulphoxide. The IR spectra are most consistent with two sulfur and two oxygen coordination sites in a cis configuration the solid sulfur-bonded complexes trans $Pd(DMSO)_2CI_2$ is found to convert to the cis complex in acetonitrile solution(30). Further evidence for the presence of mixed sulfur and oxygen coordination sites is supplied by the presence of more IR bands than would be expected for four equivalent DMSO ligand .In particular, the spectral regions for δs(CSO)and δa(CSO) each contain two more bands .In the far-ir there are at least three bands (493,437,420) cm^{-1} that can be associated with Pd – ligand stretching frequencies(31) .

The splitting of υSO in both the sulfur-bonded and oxygen-bonded regions along with at least three ir active Pd ligand stretching is most consistent with a cis arrangement of S-and O-bonded DMSO ligands.

In order to examine for the possible presence of oxygen bonded DMSO, The deuterated complex Pd $[DMSO\text{-}d6]_4^{+2}$ was prepared and tests IR spectrum was recorded. The methyl rocking bands shift~20 cm in the deuterated complex thus cleaning the υSO (oxygen bonded) region for inspection. The strong band at 920 and 905 cm^{-1} in the deuterated complex are thus assigned to υSO oxygen-bonded DMSO.

In sulfur bonded bis-DMSO complexes, the DMSO ligands are commonly found in the cis configuration (32,33), the Pd-S bond distance in the cis nitrate complex are significantly shorter than those in the trans-chloride complex, which is considered to be the result of more favorable dπ-dπ Pd-S bonding in the cis configuration. Assuming that the observed cis structures are the thermodynamically most stable form and do not simply result from kinetic stability, then the presence of the trans structure for Pd $(DMSO)_2CL_2$ is surprising. The trans-configuration of $Pd(DMSO)_2CL_2$ may not be the most stable molecular form but is obtained in the solid state because it leads to more stable crystal form .A study of Pd $(DMSO)_2CL_2$ in solution was undertaken to aid in understanding this problem .Their spectrum for solid trans-Pd $(DMSO)_2CL_2$ has a single S-O at 1118 cm^{-1} and single Pd-Cl and Pd-S stretches at 415 and 353cm^{-1} , respectively(34) .A single S-O stretching frequency at 1125 cm^{-1} in DMSO solution indicates retention the trans-structure in DMSO solvent(35)

For example cis-blocked, square planar palladium (II) and platinum (II) complexes with bidentate or tridentate pyridine-based ligands have been used to prepare molecular boxes and cages that are soluble in either water or organic solvents .Although there has been much interest in the metal molecular triangle, as the simplest such polygon, there are still relatively few examples and fewer studies of the binding properties of these compound (36).

1.7. Metal complexes, chemistry of polydentate ligands:

Large molecules, which contain a number of donating atoms, have the ability to bind to the metal ion through more than one atom. Polydentate ligands. especially those which have equivalent atoms, with respect to their coordination ability show different behavior with respect to the number of binding sites with the central metal,eg (ethylene-diamine tetraacetate may have coordination number between 2and 6).The P_H of the reaction mixture has also a large effect on the binding properties of the polydentate ligand.In addition to that the type of solvent and the metal concentration of the ligand and other factors which may effect the mechanism of ligand exchange, have also important role in this respect(37) .

1.8- Metal complexes for the poly dentate ligand which contain sulphur atom:

The chelating compound containing two sulphur atoms. The sulphur atom, as ligand, can be divided into two types.

I- The covalently bonded sulphur which is derived from an ion like the mercaptide or the oxanthate.

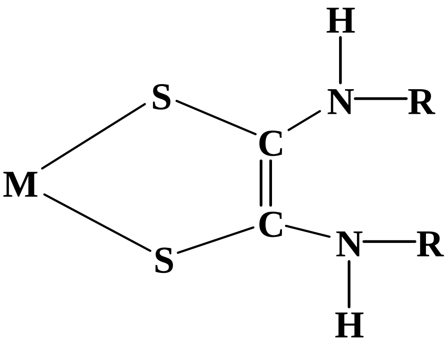
II- the coordination bonded sulphur which is derived from the thio ether.

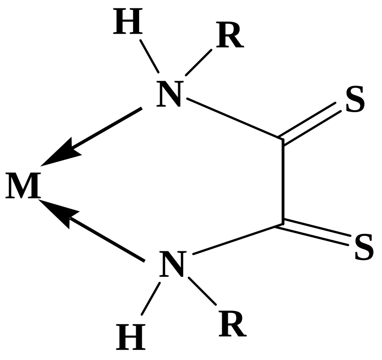
The sulphur atom of the first type is bivalent, therefore it has V shape while the second type is trivalent and it has pyramidal shape.

The thioether cannot coordinate strongly with the metal except Pd, Pt and Hg but the ability for the coordination increase when it forms chelating ring, on the other side the mercaptans (thiols) coordinate more strongly when they lose a proton, especially in the case of Pd (II), Pt (II) and Hg (38). Williams suggest a reason for the main differences between thiols and thioethers as ligands that thiol are largely polarized but they are found inactive because they are active as π-acidic electronic as in thioether (39).

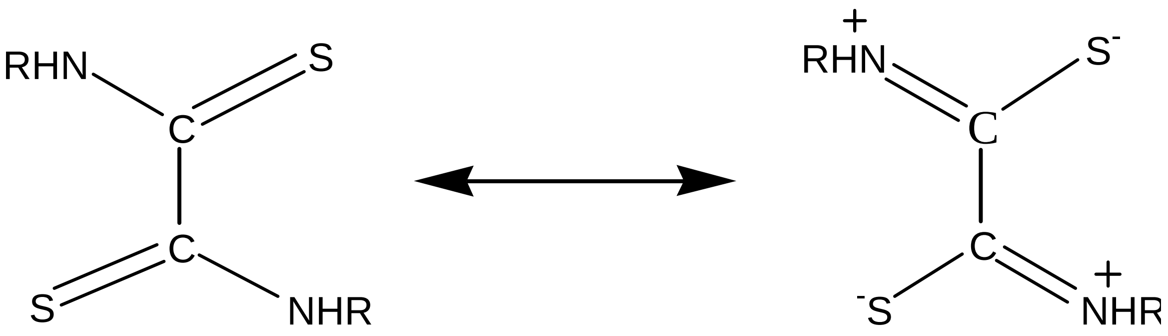
1.9- Dithiooxamide and its metal complexes:

Dithiooxamide from a class of compounds, which contain the thiamine groups, and contain tow soft sulfur atoms beside tow hard nitrogen atoms in one molecule (40). Dithiooxamide, and its derivatives were received more attention during the last decade the interaction of these ligands with some transition metal ions especially Pd(II), Pt(II) gave a great interest for versatility from the point of structure In 1:1 complexes of N,N$^-$ mono substituted dithiooxamide concluded from infrareds spectra that metal such as Ni (II) and Cu(II) are primarily bonded to the N, where as metal such as Hg (II), Pd(II), Pt (II) are bonded to the S atom..





The presence of the “soft” sulfur atoms beside the “hard” nitrogen atom in this thioamide moiety (keeping aside the effects of remainder of the molecules containing it) render these molecules to be potent ligands with a wide diversity and biological importance besides other applications. The studies of infrared spectra has shown that in N, N- mono substituted dithiooxamide the following canonical forms can be considered (41).



The hydrogen of the thiamine group is removed on complex formation and metal can form bonds through both sulfur and nitrogen, both these possibilities will be reflected in the spectra of complexes. Bonding through sulfur will decrease the bond order of the carbon sulfur band toward the value for a single bond; approaches the value for double bond if on the contrary nitrogen – metal bond is found; just the opposite effect is to be expected

Although investigation of series of analogues of mono substituted thio-amides seemed to be necessary to resolve doubtful assignments of the (NHCS) group frequencies. It has to be noted that if the band is attributed to a specific motion of some group of atoms, this should be understand to imply only a major contribution from that motion(42).

In a previous work (in our laboratory) , Al-Qaissy(43) have prepared a number Pd(II),Pt(II),and Cu(II) complexes with Dithiooxamide and it's derivatives.

This include first Dithiooxamide itself which gave octahedral stracture with Pd(IV), Pt(II)and Cu(II) with 1:2 M:L ratio in each case. The second member , which was the benzaldehyde Schiff base of dithiooxamide, gave square planar complexes with Pd(II), and Au(II), and octahedral with Cu(II) and Pt(IV) ions in which M:L ratio was also 1:2. The third member of this class was the *o*- nitro benzaldehyde Schiff base of dithiooxamide this gave octahedral complexes with Pt(IV) and Cu(II) in 1:2 M:L ratio . The last derivative was the cyclic 3,4-dimine-1,4-dithiarine which form square-planar complexes with Pt(II) and Pd(II) of 1:1 M:L ratio. The prepared complexes were studied using infrared and ultra-visible. Spectroscopy, metal and elemental (C. H. N) analyses, the metal to ligand ratio was studied following molar ratio and conductimetric titration methods.

The biological activity studies of the prepared compounds showed that the cyclic derivative have a greater antibacterial but lower antifungal activity compound to the Schiff base derivative, while the two complexes of the former derivative with Pd (II) and Pt (II) showed a higher antibacterial and antifungal activity compound to the ligand itself.

Also in our laboratory, Al-Samraiy, Jassim and Muhyedeen(44) , prepared 5,5-di (n-propyl) dithiooxamide and the Ni(II), Cu(II) and Pd(II) complexes of dithiooxamide and it's n-propyl derivative.

Ab-initio methods have been used to calculate the relative energies, infrared and ultraviolet spectra of all the prepared compounds (the two ligands and their metal complexes), in addition to semi-impirical PM3 method was used for IR calculation and ΔH_f^o. The calculated electrostatic potential and HOMO-LOMO of the reactant molecules were employed to characterize the reactive sites. Experimental IR and UV-Vis spectra, metal analysis, thermal study and magnetic measurements were carried out to characterize the prepared copper compounds. The *ab-initio* calculations indicate the tautomeric structure of dithiooxamide, and helped to predict the trans isomer to be the most stable one among the four probable structures of amide and imide form of dithiooxamide.

Aim of the present work:

The aim of this work is to prepare a series of mixed ligand complexes of Pd (II) and Cu (II) based on the cyclic dithiarine derivatives using different nitrogen , phosphorous and arsine containing ligands, and to study structure and bonding aspects of these new different complexes , using the suitable techniques. The chosen metal ions and the ligands are both scientific and pharmaceutical importance.

The work is to be accomplished through the following steps:

1. Preparation of dithiarine ligand starting from dithiooxamide.
2. Preparation of $Pd(DMSO)_2Cl_2$ as astarting material.
3. Preparation of dithiarine complex of Pd(II) by reaction with $Pd(DMSO)_2Cl_2$.
4. Reaction of dithiarine complex of Pd(II) with the following ligands, NPh_3 , PPh_3, $AsPh_3$, $2,2^{/}$-dipyridyl and dithiooxamide.
5. Preparation of analoguses complexes of Cu(II) as described above starting with copper chloride.
6. Characteriztion of all the prepared compounds using infrared, ultra violet-visible Spectroscopy, magnetic susceptibility and conductivity measurements and metal analysis.
7. Test the biological activity of all compound aginst two bacteria ***Staphylococcus aureus*** and ***Pseudomonas mallei***

3.5-Electronic spectra, magnetic properties and conductivity measurements:-

Electronic absorption spectra of transition metal complexes are usually attributed to the partially filled d- orbitals of the metal. The energy required for such transition is that the near U.V and visible region. Charge transfer spectra are due to transition between metal and ligand. Study of electronic spectra of complexes help in the determination of structure of the complexes through the electronic interaction of the metal d-orbital and ligand orbitals. In our work, the spectra were recorded in the range (200-1100) nm using Dimethyl Sulphoxide (DMSO) as solvent.

Measurement of magnetic susceptibility contributes to the determination of structure of the complexes. In addition these measurements provide information about the type of bonding and strength of ligand field of complexes by giving information. About the number of the unpaired electrons.

The effective magnetic spin of the complexes was calculated using spin-only magnetic moment according to the following equation $^{(61)}$:

$$\mu_{S.O} = 2\sqrt{S(S+1)} \quad \text{B.M.}$$

Where S= n/2 (n=number of unpaired electrons).

The results obtained from this equation were compared with the actual values obtained through magnetic measurement. These values were corrected for diamagnetic effects using the following relationships:

$$\mu_{eff} = 2.828\sqrt{X_A.T}$$

$$X_A = X_M - D$$

$$X_M = X_g \times \text{M.wt}$$

Where:

T= Absolute temperature (298°K).

D = Correction factor.

X_A = Atomic susceptibility.

X_g = Gram susceptibility.

X_M = Molar susceptibility.

The experimental values of magnetic moment are usually greater than calculated values of magnetic moment.

Conductivity measurements of the prepared complexes in the appropriate solvent are used to decide whether a complex is electrolyte or neutral (62,63).

The UV-Vis spectra of the transion metal with partially filled d-orbital are generally characterized by charge – transfer (C.T) bands which involve an electron transfer from M to L during optical excitation by which the oxidation number of central ion is changed by on, while the ligand field bands correspond to the same oxidation number in the excited and the ground state(64).These redox process bands are strong and their wave numbers decreases (or wavelength increases), the more oxidizing the central ion and the more reducing the ligand

The Pd (II) ion is considered to be weaker as oxidizing as and more stable than their tetravalent states. The transition metal ions have been arranged according to the shifting toward higher wavelength of the first strong band of their halide complexes (C.T.bands), and increasing in “oxidizing power” in the same direction, briefly as:

Ir(III)> Pt(IV)> Rh(III)> Pt(II)> Pd(IV)> Pd(II)> Fe(III)> Cu(II).

This is undoubtedly determined by the oxidizing character of the central ion.

The first strong band in the spectra of the Pd (II) complexes is assigned as (L→ MC.T.) band. The spectra of these complexes show some weak ligand-field bands, but their interpretation is not certain, this is a general feature of the spectra of spin- paired complexes in that the amount of information which can be obtained from them is a good deal less than that available from spin free complexes(65).

3.5.1-Magnetic properties, condectivity measurement and electronic spectra of Pd (II) complexes.

The majority of Pd (II) complexes have square planer geometry(66.67)and a little is known which have octahedral geometry(10,17).

The value of μ_{eff} that was measured at room temperature for all palladium complexes were around 0.60B.M,this value show that all the complexes are diamagnetic and is in the rang of square planar geometry. The analysis of the U.V-Vis spectra of the prepared Pd (II) complexes, Fig's (3-16to3-21)show the existence of a band in the rang (24,390-26,525)cm^{-1} which might be assigned to the transition $^1A_1g\rightarrow{}^1B_1g$ this came in accordance with the published data for square Pd (II) complexes(68,69). according to these data and those obtain from infra- red spectra and conductivity measurements, table(3-5), a square planner geometry around Palladium can be suggested for all the prepared complexes as shown in fig.(3-15).

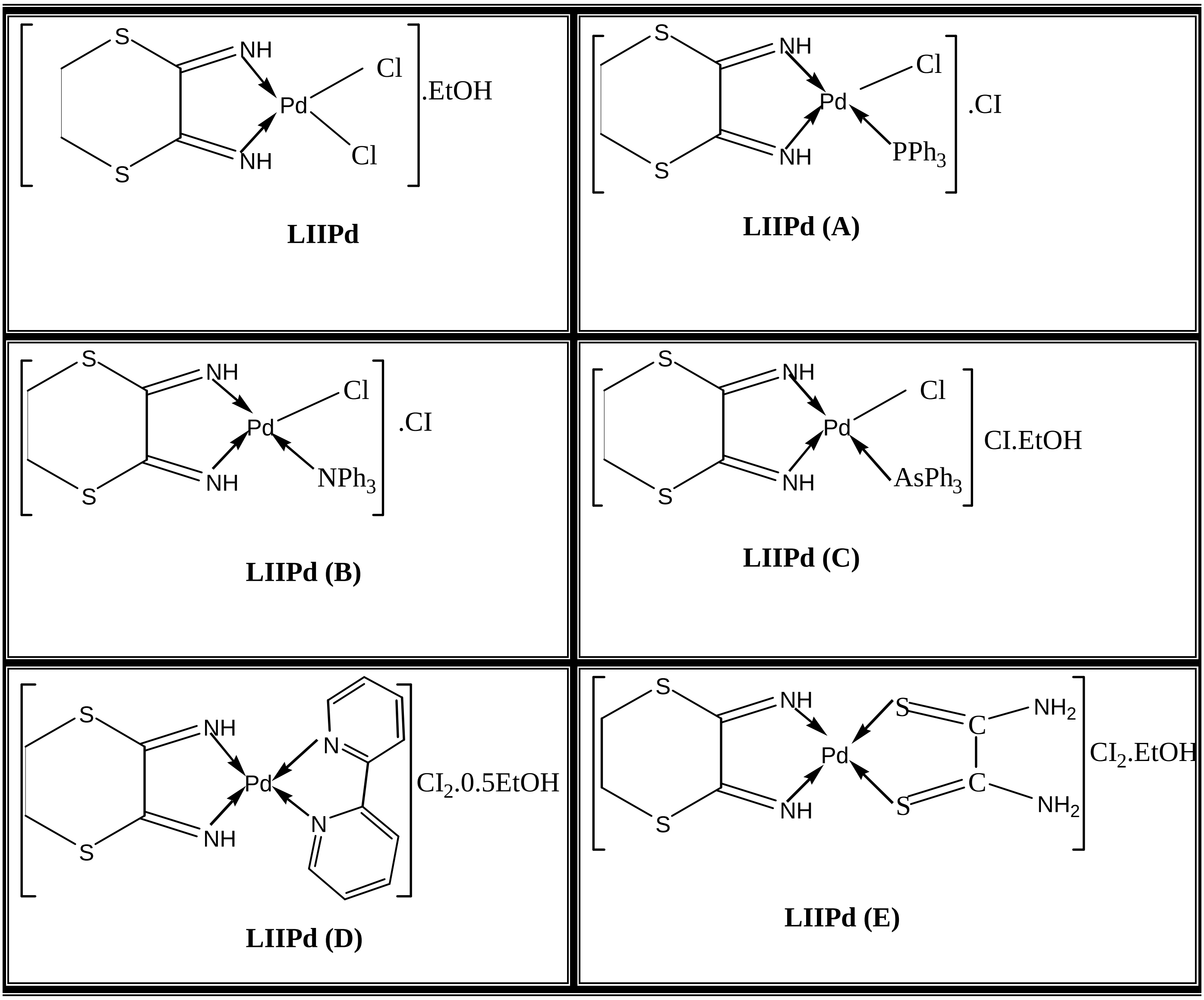
Table (3-5): Electric spectra, magnetic properties, conductivity and suggested structures for Pd (II) complexes.

Symbol	Absorption cm^{-1}	Magnetic properties	Conductivity In DMSO,µscm^{-1}	Suggested Structure
LII Pd	25,125(398)	Diamagnetic	15	Square-planar
LII Pd A	24,875(402)	Diamagnetic	70	Square-planar
LII Pd B	24,390(410)	Diamagnetic	74	Square-planar
LII Pd C	24,630(406)	Diamagnetic	72	Square-planar
LII Pd D	26,109(383)	Diamagnetic	80	Square-planar
LII Pd E	26,525(377)	Diamagnetic	78	Square-planar

Which show the complex LIIPd to be non-ionic, while the complexes LIIPdA,LIIPdB and LIIPdC have 1:1ionic structure, the LIIPdD andLIIPdE were both have1:2ionic structure(66,67).

Table is showed the conductivity bounders of DMSO solvent.

DMSO M:L	NON	1:1	1:2	1:3	1:4
Bounder conductivity	0-20	30-40	70-80	-	-



LIIPd

LIIPd (A)

LIIPd (B)

LIIPd (C)

LIIPd (D)

LIIPd (E)

Fig(3-15):The suggested structures of LIIPd, LIIPdA ,LIIPdB, LIIPdC,LIIPdD and LIIPdE complexes

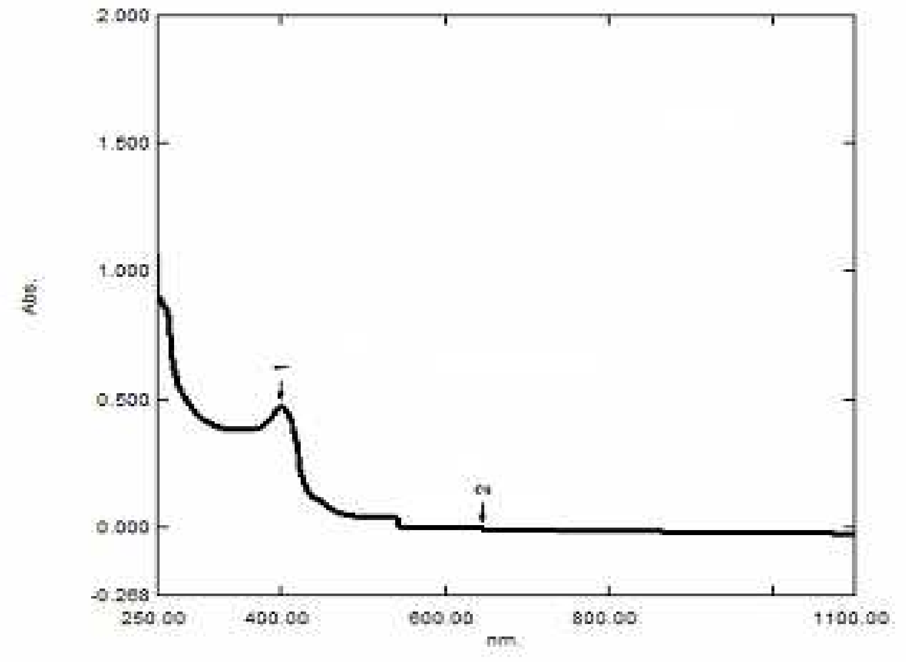


Figure (3-16): Electronic Spectrum of LIIPd

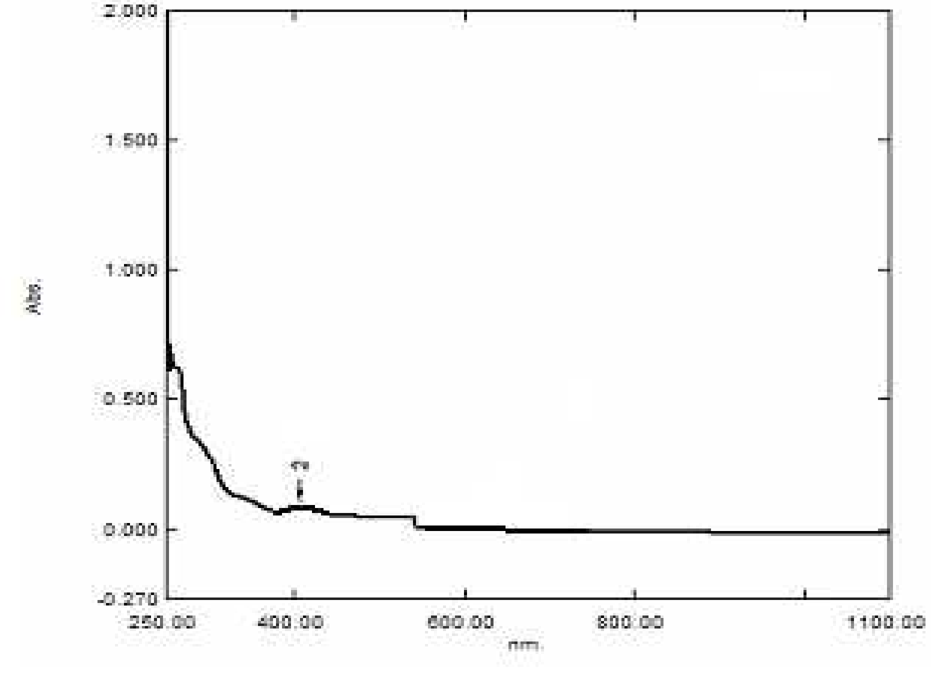


Figure (3-17): Electronic Spectrum of LIIPdA

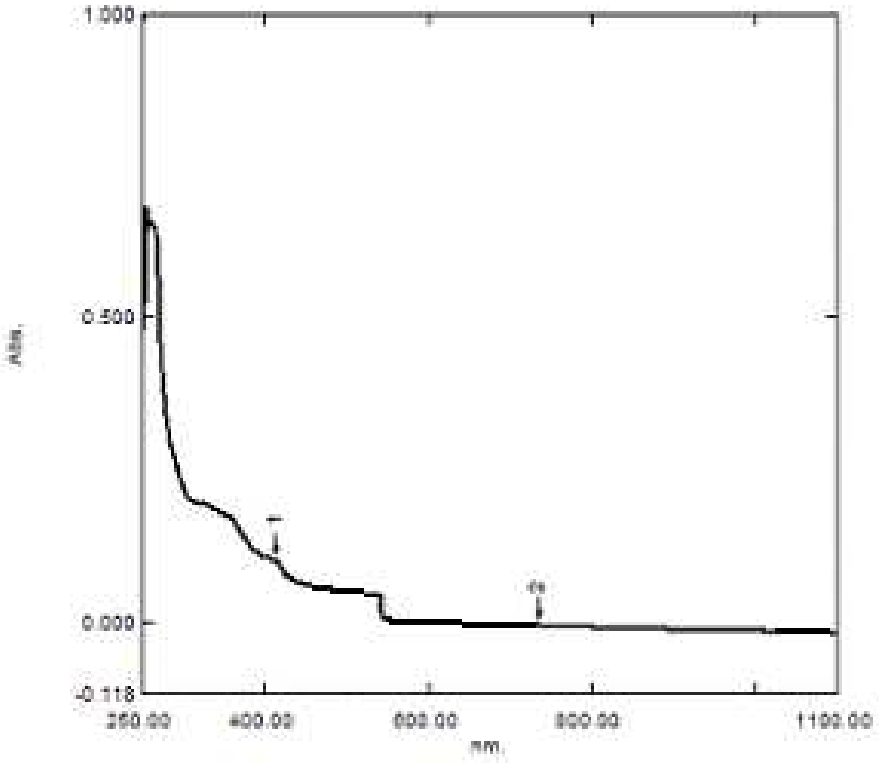


Figure (3-18): Electronic Spectrum of LIIPdB

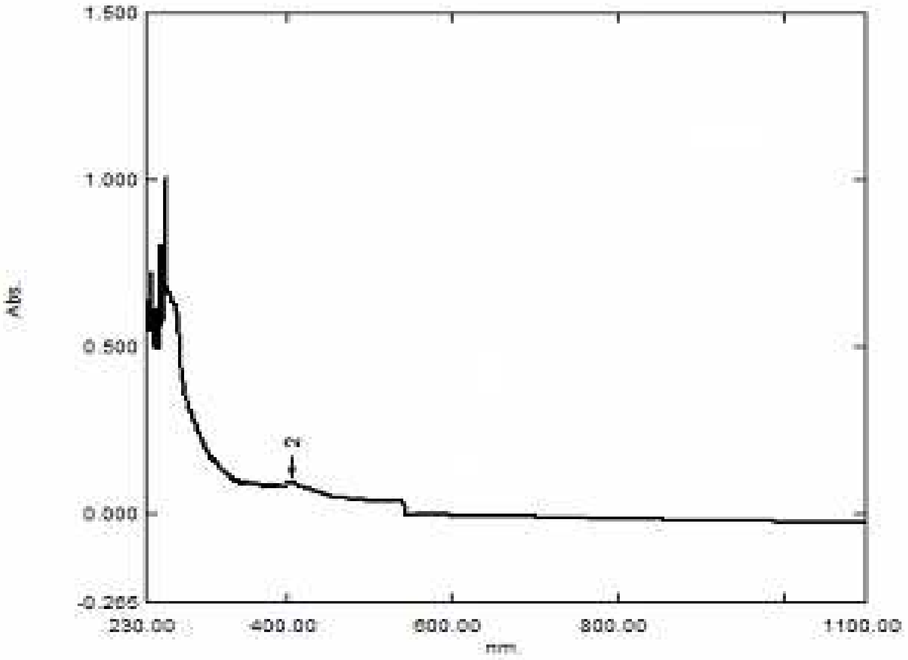


Figure (3-19): Electronic Spectrum of LIIPdC

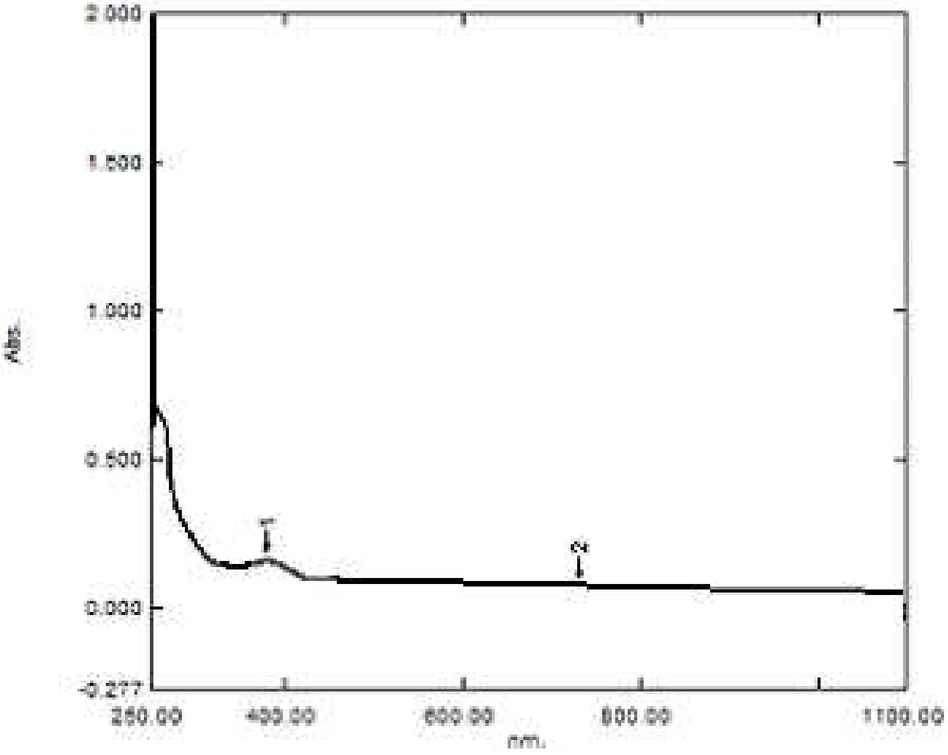


Figure (3-20): Electronic Spectrum of LIIPdD

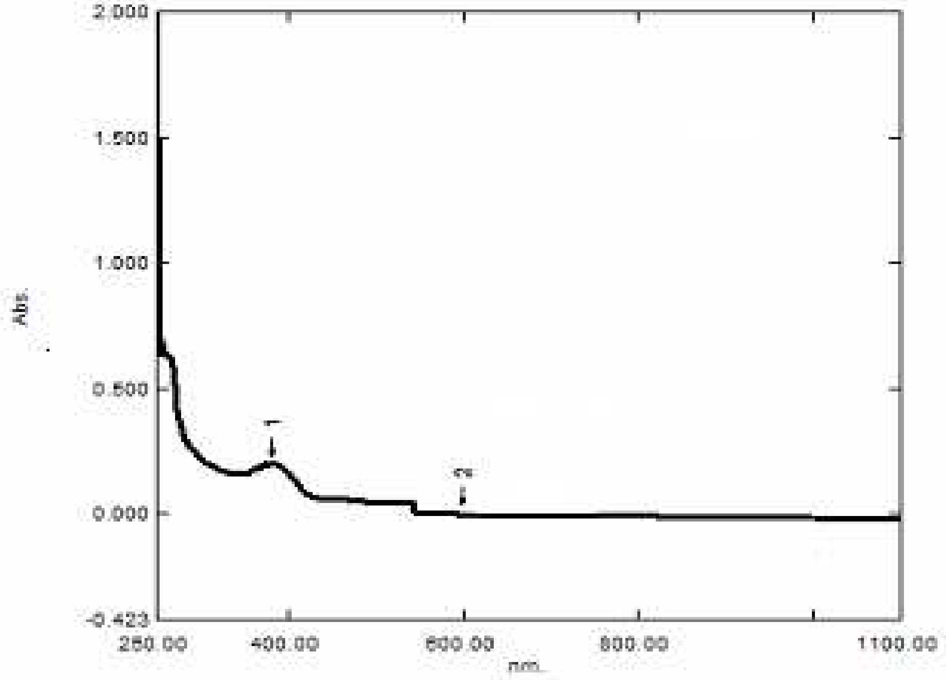


Figure (3-21): Electronic Spectrum of LIIPdE

3.5.2- Magnetic properties, conductivity measurement and electronic spectra of Cu (II) complexes.

Cu (II) compounds are blue or green because of single broad a absorption band in the region (11,000-16,000) cm^{-1} (69) The d^9 ion is characterized by large distortion from octahedral symmetry and the band is unsymmetrical, being the result of a number of transition, which are by no means easy to assign unambiguously. The free ion ground ^2D term is expected to split in a crystal field in the same way as the ^5D term of the d^4 ion and a similar interpretation of the spectrum is like wise expected and according to the following diagram (11,69) .

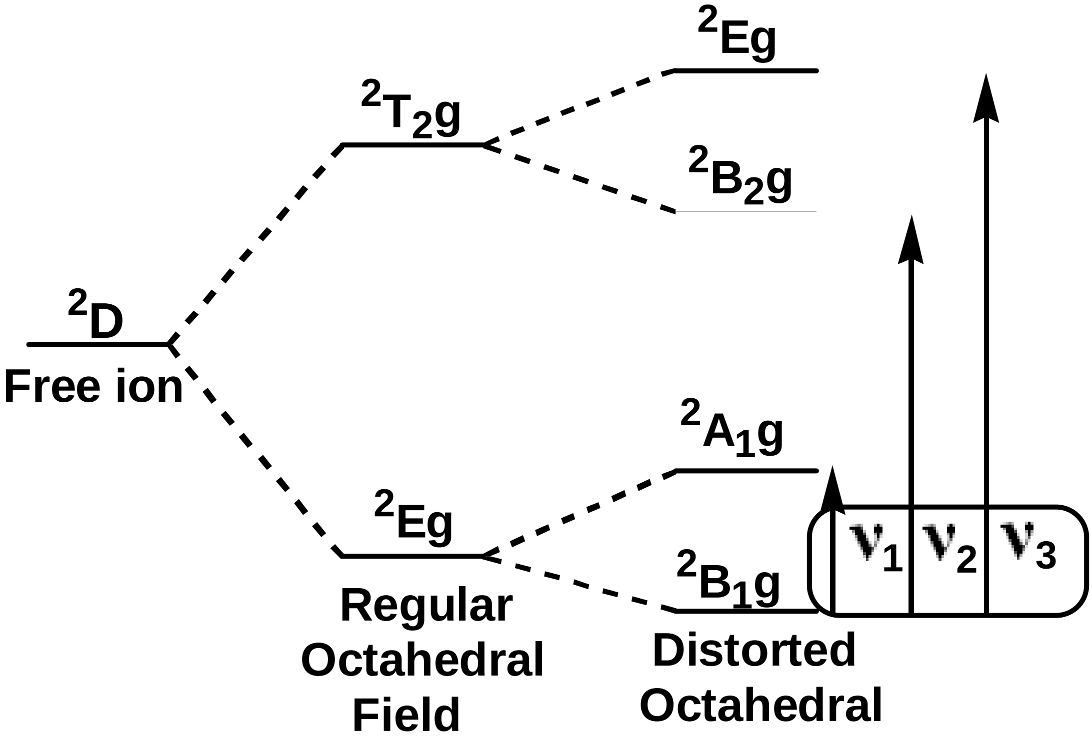


Fig. (3-22): Crystal field splitting of the ^2D term of a d^9 ion.

Unfortunately, this is more difficult because of the greater over lapping of bands, which occurs in the case of Cu (II).

In the present work, the spectra of all the prepared Cu(II) complexes fig(3-24to3-29) show abroad band at about 16,000cm^{-1} ,table(3-6),this band can be assigned to the transition υ_1,$\upsilon_2$and$\upsilon_3$fig(3-27).

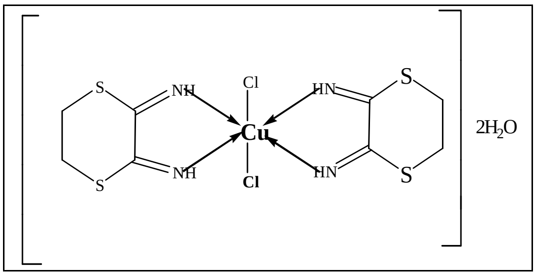
The values of effective magnetic moments of the new complexes (LIIICu, LIIICuA, LIIICuB, LIIICuC, LIIICuD, LIIICuE) are show in table (3-6).these values are in the rang of octahedral geometry(70,71). .

Conductivity measurement, table (3-6) show that the LIIICu complex to be non-ionic, while the other complexes to have 1:2 ionic structures.

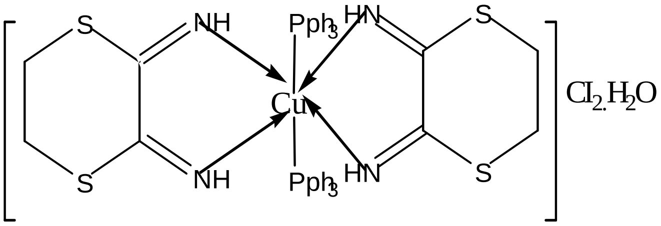
According to the above data and discussion the following geometrical structures can be suggested for the new Cu (II) complexes:

Table (3-6):- Electronic spectral, magnetic moment, conductivity and suggest structure for Cu (II) complexes.

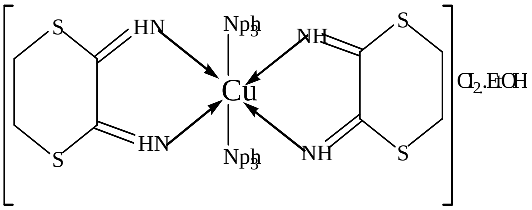
Symbol	Absorption cm^{-1} (nm)	Magnetic moment(B.M)	Conductivity InDMSO,μs.cm^{-}	Suggested Structure
LIIICu	15,432(648)	1.89	10	Octahedral
LIIICuA	15,576(642)	1.92	45	Octahedral
LIIICuB	15,873(630)	1.80	49	Octahedral
LIIICuC	15,267(655)	1.99	45	Octahedral
LIIICuD	16,129(620)	2.01	44	Octahedral
LIIICuE	15,974(626)	2.12	50	Octahedral



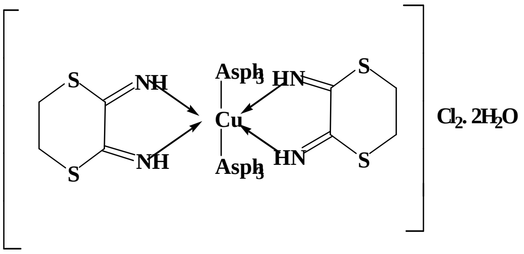
LIIICu



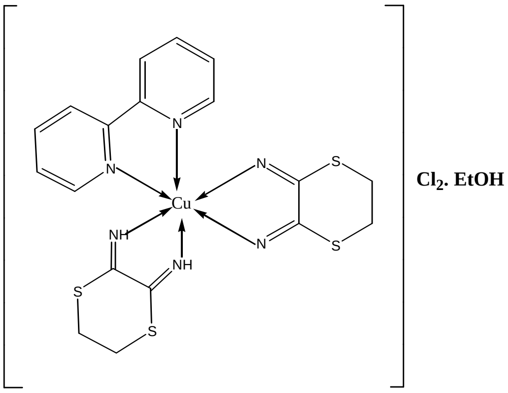
LIIICu (A)



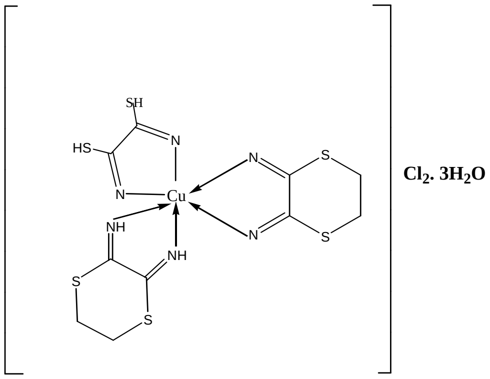
LIIICu (B)



LIIICu (C)



LIIICu (D)



LIIICu (E)

Fig(3-23):The suggested structures of LIIICu, LIIICuA, LIIICuB,LIIICuC, LIIICuD and LIIICuE.

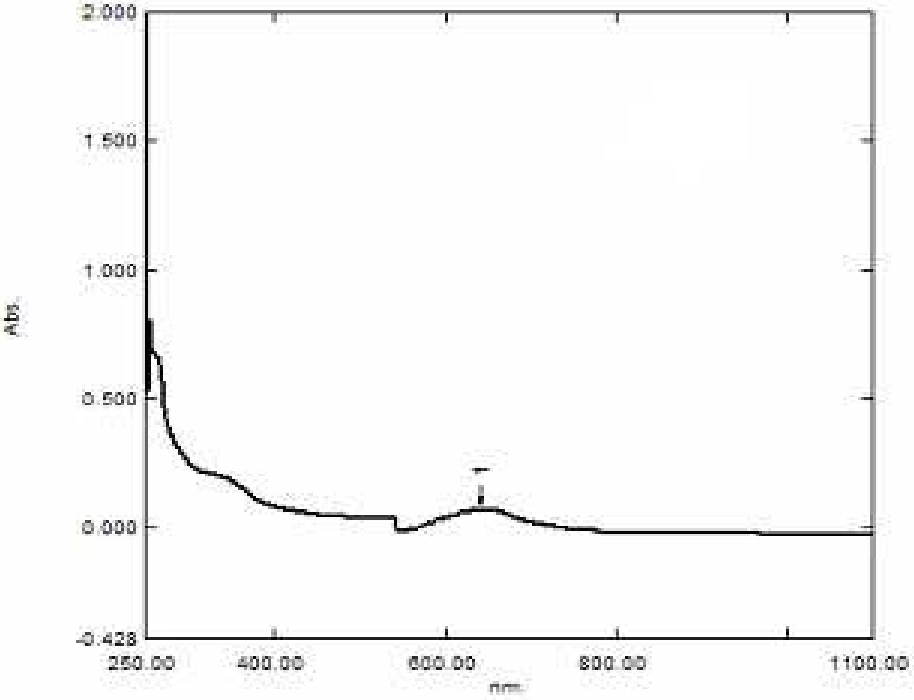


Figure (3-24): Electronic Spectrum of LIIICu

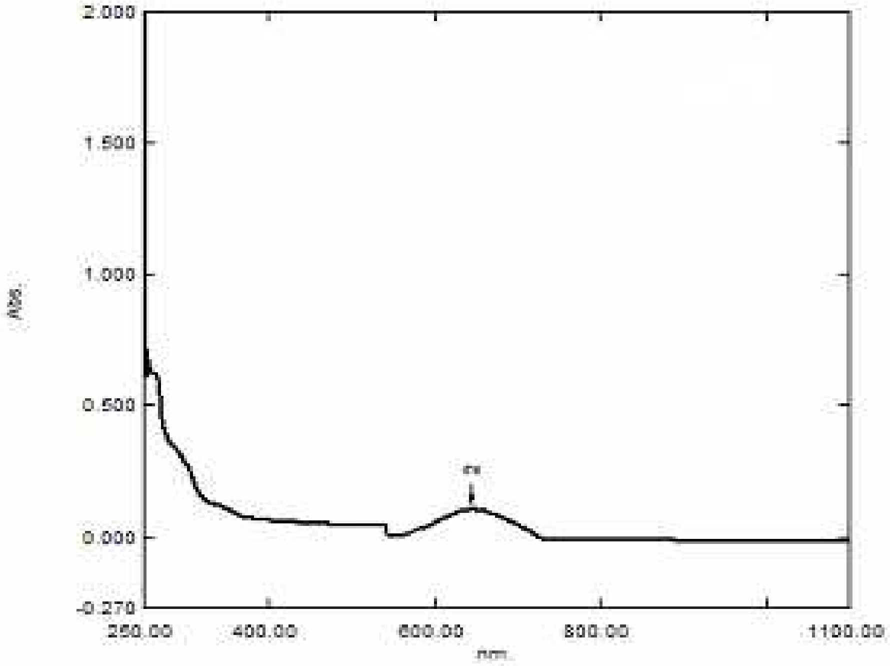


Figure (3-25): Electronic Spectrum of LIIICuA

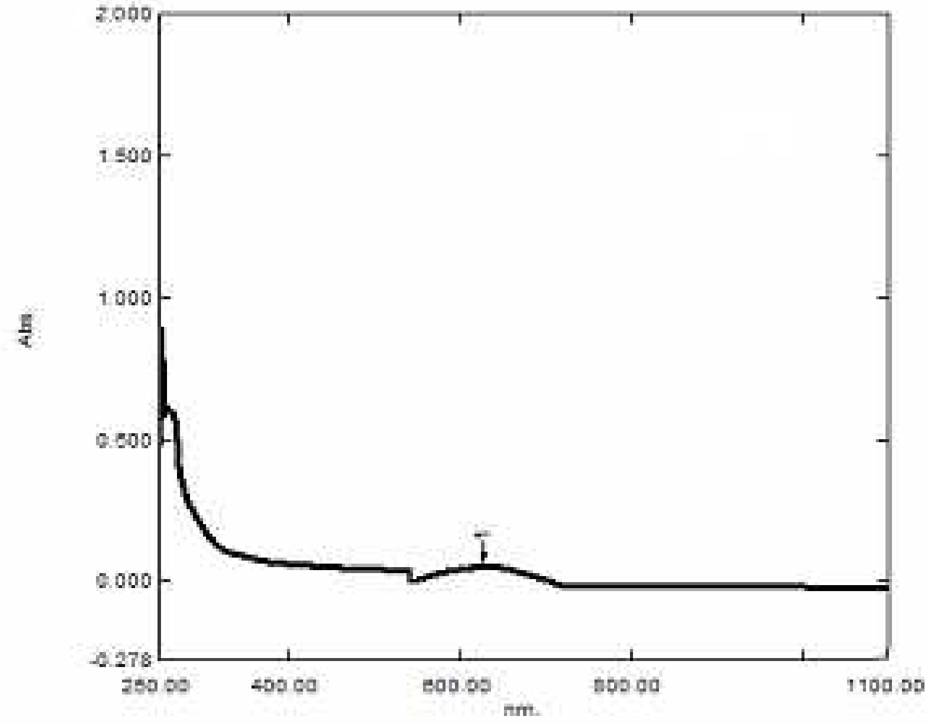


Figure (3-26): Electronic Spectrum of LIIICuB

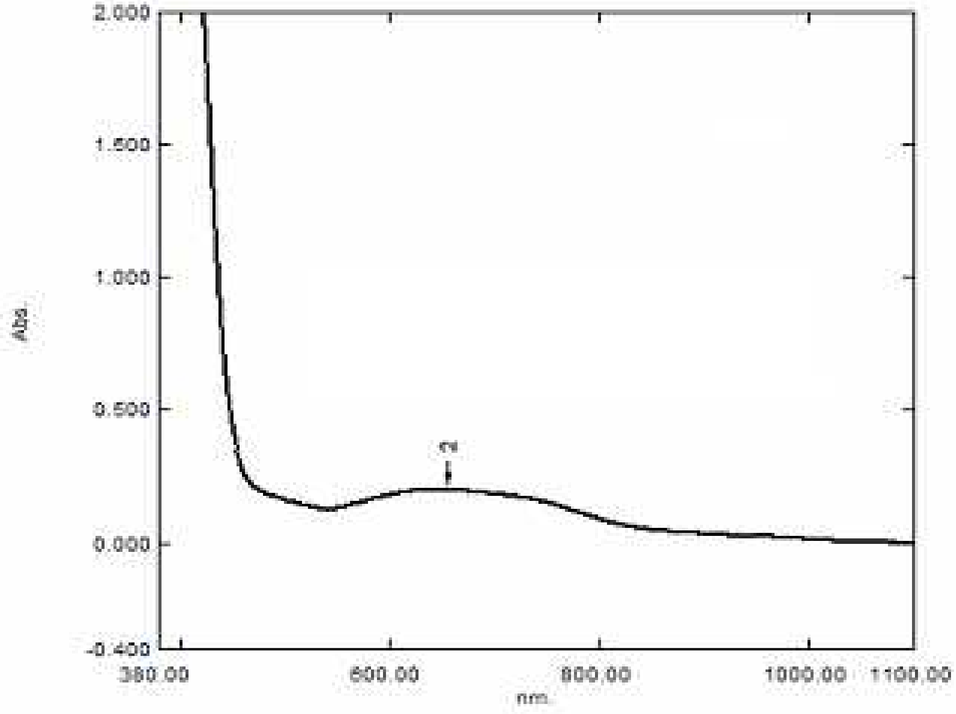


Figure (3-27): Electronic Spectrum of LIIICuC

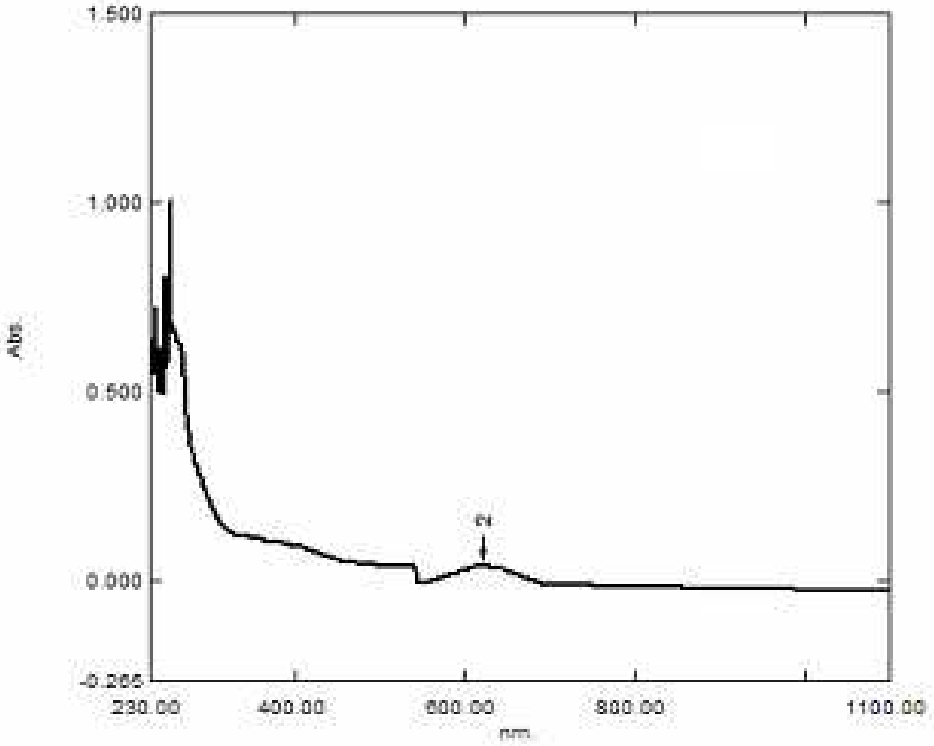


Figure (3-28): Electronic Spectrum of LIIICuD

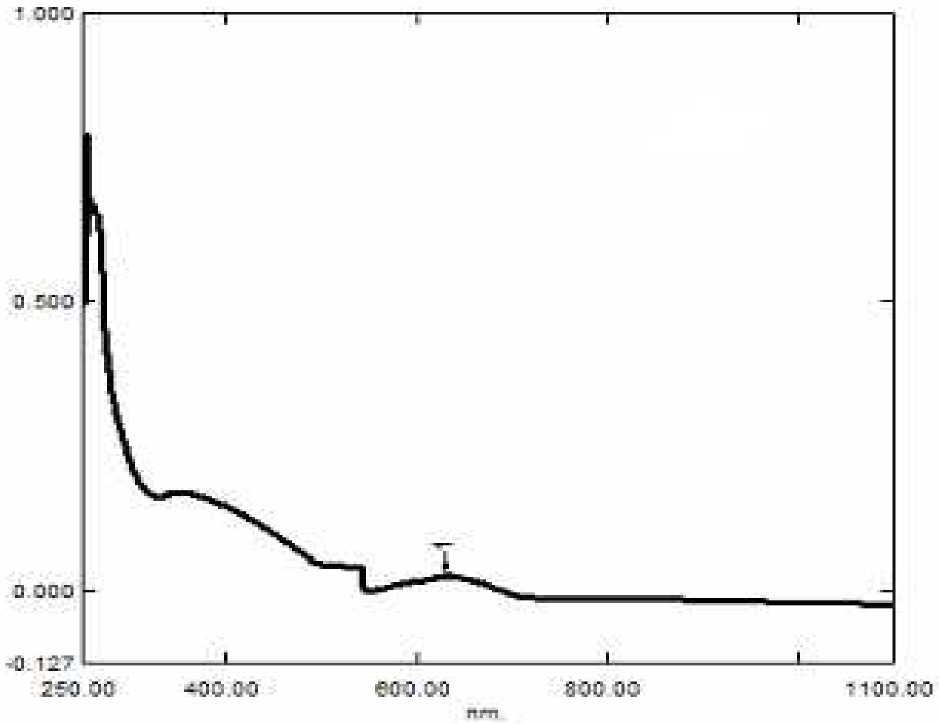


Figure (3-29): Electronic Spectrum of LIIICuE

4.1- Biological activity.

Microorganismcauses different kinds of diseases to humans and animals. Discovery of chemotherapeutic agents played a very important role in controlling and preventing such diseases.

The roles of the inorganic species in medicines are promise for the logical design of inorganic therapeutic agents that are relatively innocuous to the host, while being toxic to unwanted types of cell components.

Chemotherapeutic agents isolated either from living organism are known as antibiotic like penicillin and tetracycline etc. or they are chemical compounds prepared by chemists such as sulfa drugs.

Certain metal complexes are active at low concentrations against arrange of bacteria, fungi and viruses.

Issues of concern regarding gram-negative bacteria and gram-positive bacteria include the extended drug resistance spectrum of ***pseudomonas mallei and staphlococeus aureus*** are becoming common causes of infection in the acute and long term care unites in hospitals. The emergence of these resistance bacteria has created. A major concern and an urgent need to synthesize agents of structural classes which resembles the known chemotherapeutic agents.

It is clear that the metal cheats can act in a number of ways. thus they may inactivate the virus by occupying sites on it is surface which would normally be utilized in the initiation of the infection of the host cell. the first step in the infection would be the adsorption reaction involving electrostatic interactions.

Alternatively, the complex cations may penetrate the cell wall and prevent virus reproduction.

The most essential feature of good chemotherapeutic agent is that, it must show a high degree of selective toxicity towards a microorganism, so that, it can be given in sufficient doses to inhibit or kill the microorganism through tout the boodt without harming the body cell.

Complexes are considered an important class of compounds having a wide spectrum of biological activity$^{(72)}$..

4.2-Chemicals.

1-Dimethylsulphoxide(DMSO).

2-Nutrient agar medium from maknus lab.

3-Autoclave from Hiraymama company.

4.3-Types of bacteria.

1-***Staphylococcus aureus (gram positive).***

2-***Pseudomonas mallei (gram negative).***

4.4-Method

Preparation of nutrient agar were added to 1L of distilled in conical flask was stirred with heating until it completely dissolved .the flask was stoppered by cotton and the medium was sterilized by placing it an autoclave for 20min at 121°C under pressure of 15 bound /inch. After that the medium was cooled to (45-55°C) and placed in petridish about (15-20ml)for each one, and was left to cool and solidified. Therefore the medium was ready for bacteria growth. The studied bacteria were placed on the nutrient agar surface using the loop and by streaking processor$^{(73)}$. After that the disc saturated with the tested compound solution was placed in the dishes which were then incubated for 24hour, at37°C.

4.5-Result and discussion.

In this research the antibacterial study of all the prepared Pd(II) and Cu(II)complexes were studied, the result are shown in table(4-1).

Bacteria which are studied are gram negative ***Pseudomonas mallei*** and gram positive ***Staphylococcus Aureus***. Prepared agar and petridishes were sterilized by autoclaving for 15 min at 121°C. The agar plates were surface inoculated microorganisms. In the solidified medium suitably spaced apart holes were made a ll6mm in diameter(72,73). The holes were filled with 0.1ml of DMSO solvent),DMSO was used as a solvent. These plates were incubated at 37°C for 24 hr for bacteria(74). The inhibition zones caused by the various compounds were examined. The result of the preliminary screening teats are listed in table(4-1).

Table (4-1): Antibacterial activities of the synthesized complexes.

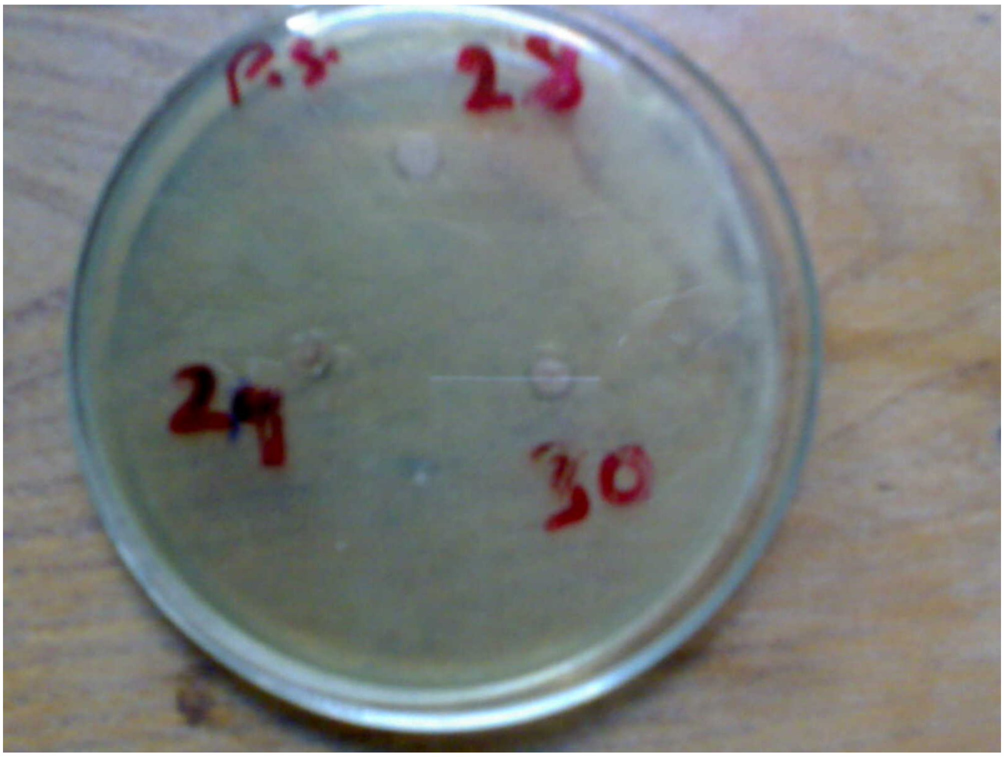
Compound	*Staphylococcus Areus*	*Pseudomonasmallei*
LIIPdA	-	-
LIIPdB	-	-
LIIPdC	-	-
LIIPdD (11)	+	-
LIIPdE	-	-
LIIICuA(25)	+	-
LIIICuB	-	-
LIIICuC(26)	+	-
LIIICuD	-	-
LIIICuE(29)	-	+

Note:

- =No inhibition =inactive.

+= (5-10) mm=slightly active.

From the obtained data, it is found clearly that compounds LIIPdD, LIIICuA and LIIICuC have highest activity against ***Staphylococcus Aureus*** than the odd activity of LIIICuE complexes against pseudomonas mallei may be attributed to the presence of free terminal Sand N atoms in the structure of this complex, which have the ability to penetrate the cell wall (75).



Fig(4-1):Effect of LIIICuE(29),LIIPdE(30)andLIIICuD(28) on *Pseudomonas maleic*.

Fig(4-2):Effect of LIIPdB(21) andLIIPdA(25) on *Staphylococcus aureus*.

Fig(4-3):Effect of LIIPd(A)(2),LIIPd(C)(3)and LIIPd(D)(11) on *Staphylococcus aureus.*

Fig(4-4):Effect of LIIICu(C) (26)and LIIICu(B)(27) on *Staphylococcus aureus.*

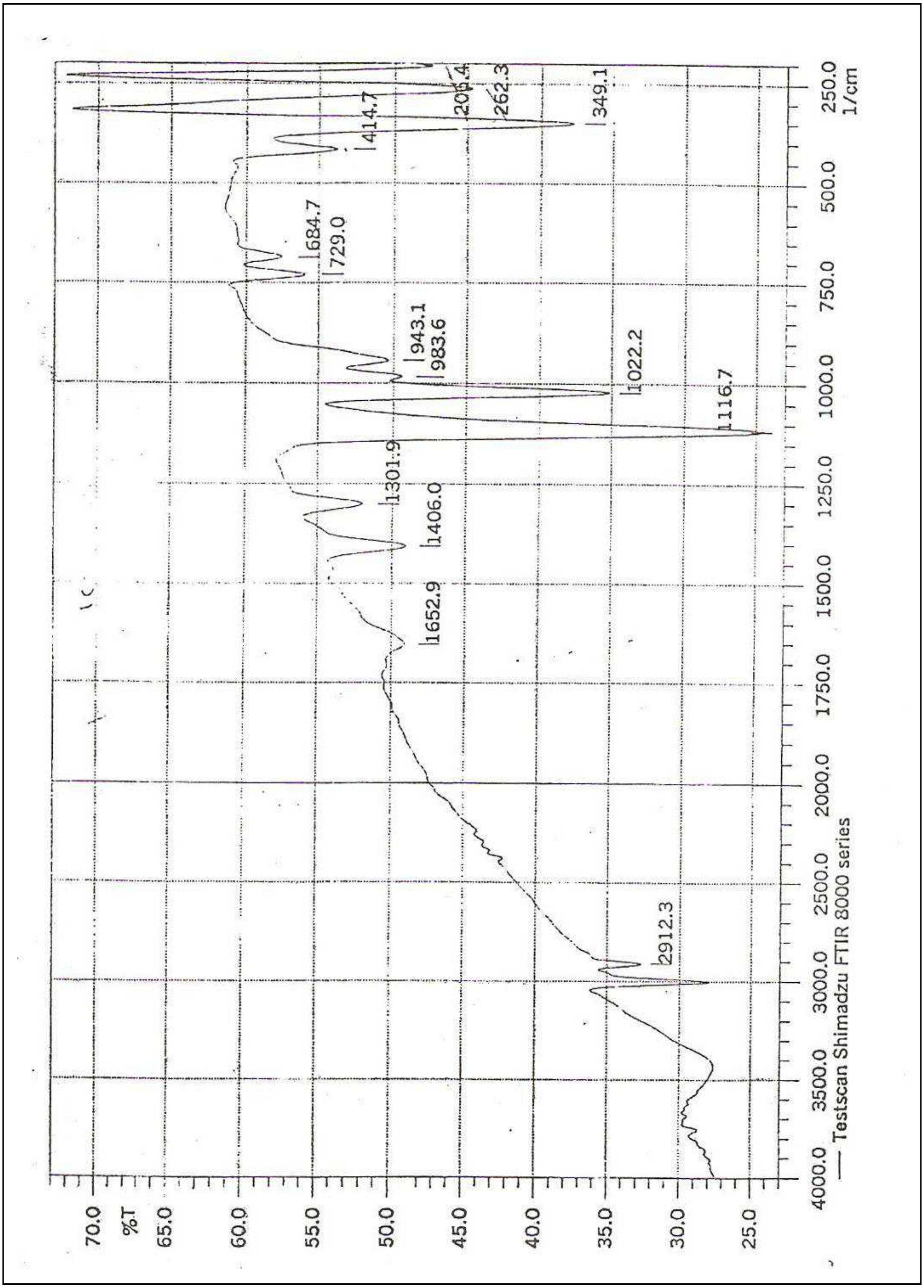


Fig (3-1): FTIR Spectrum of Trans-PdCl2(DMSO)2

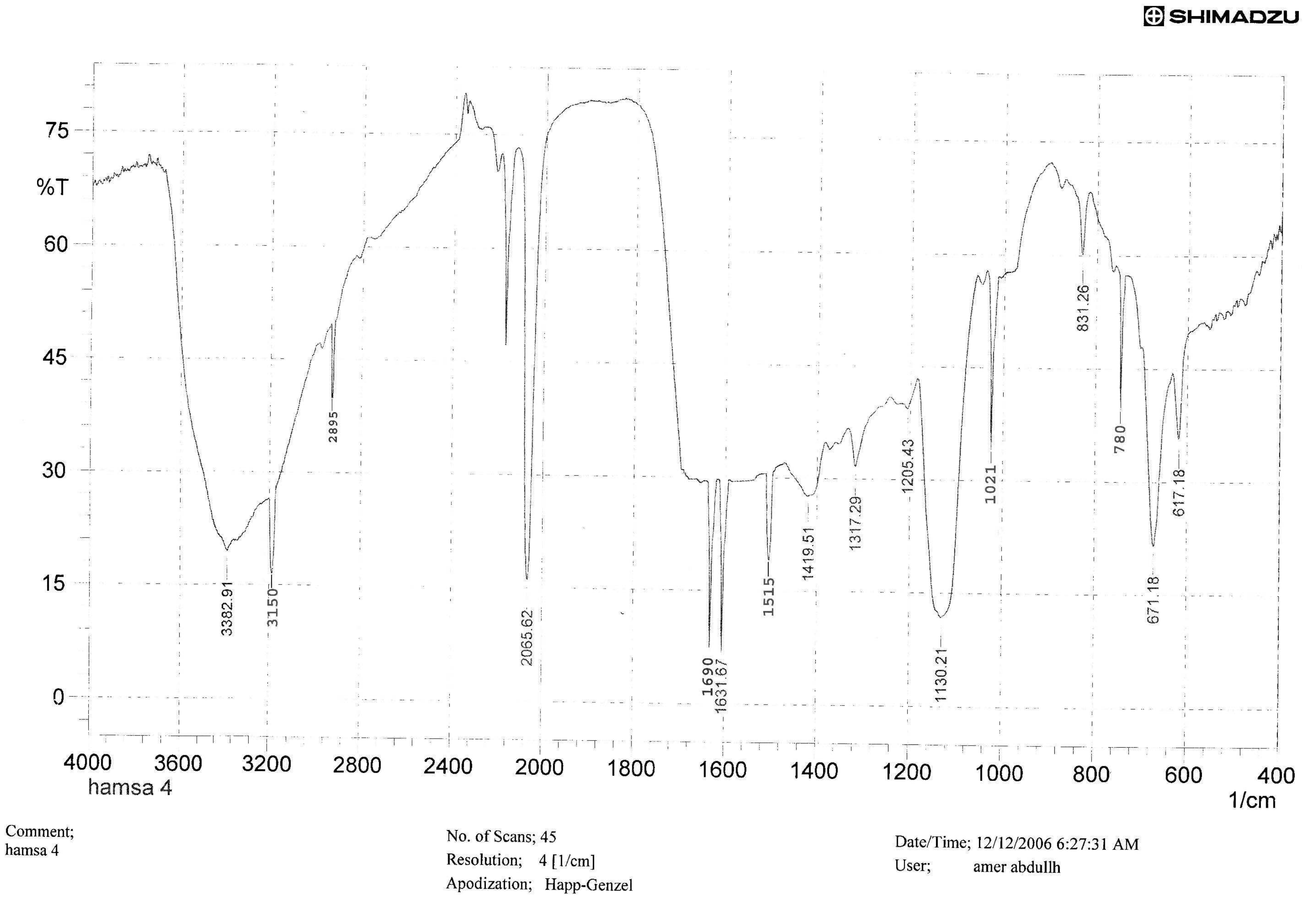


Fig (3-2): FTIR Spectrum of LI

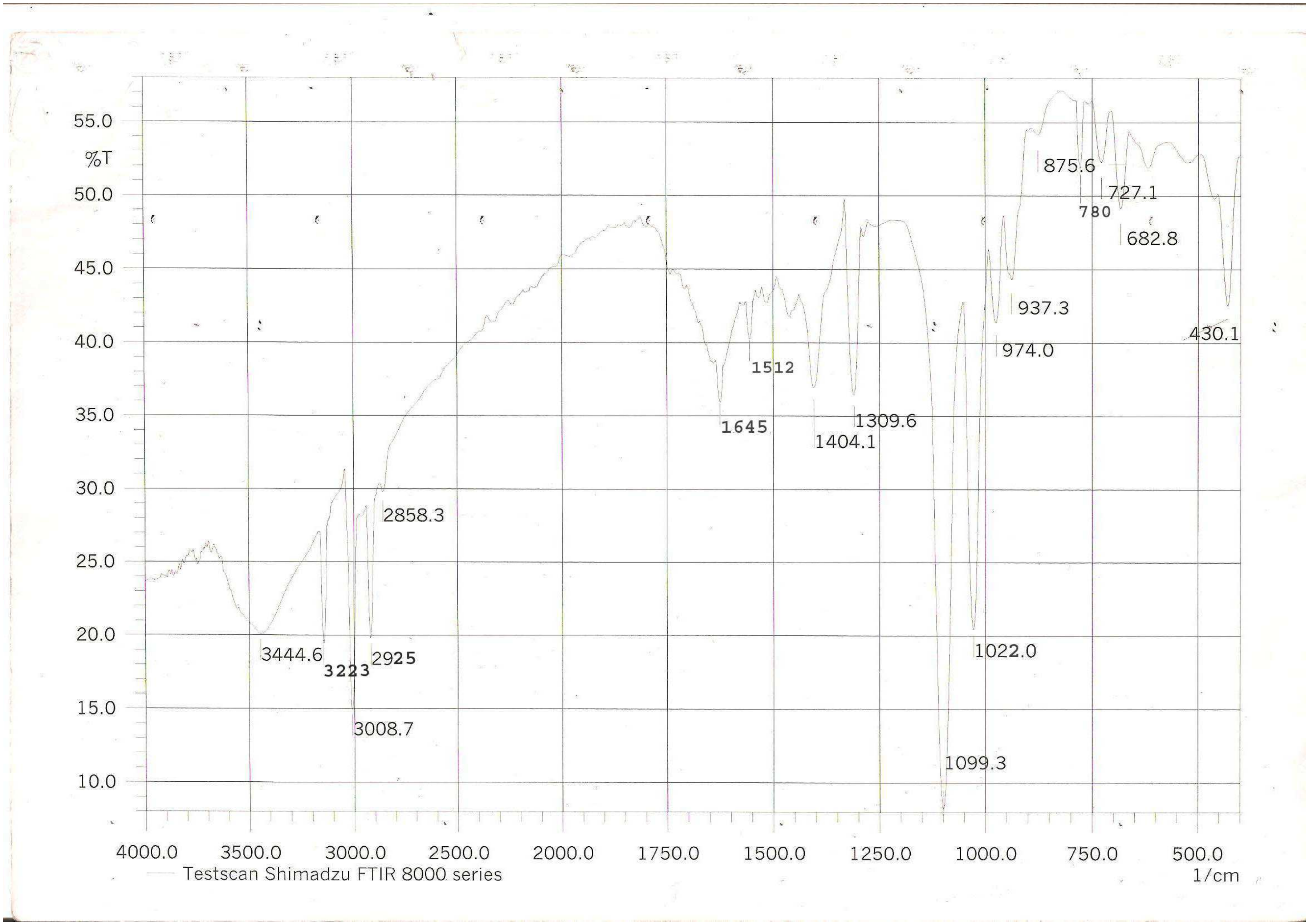


Fig (3-3): FTIR Spectrum of LIIPd

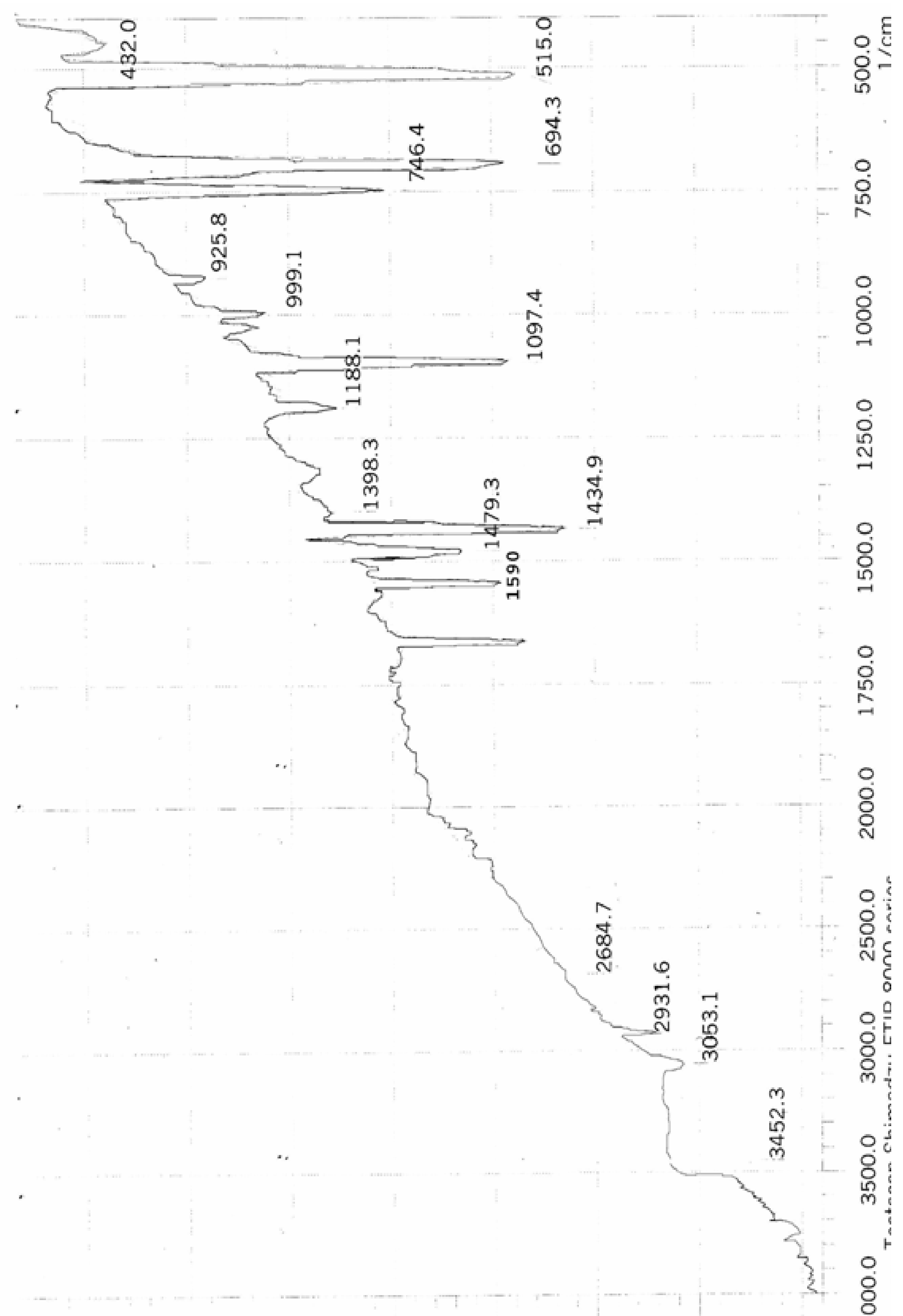


Fig (3-4): FTIR Spectrum of LIIPdA

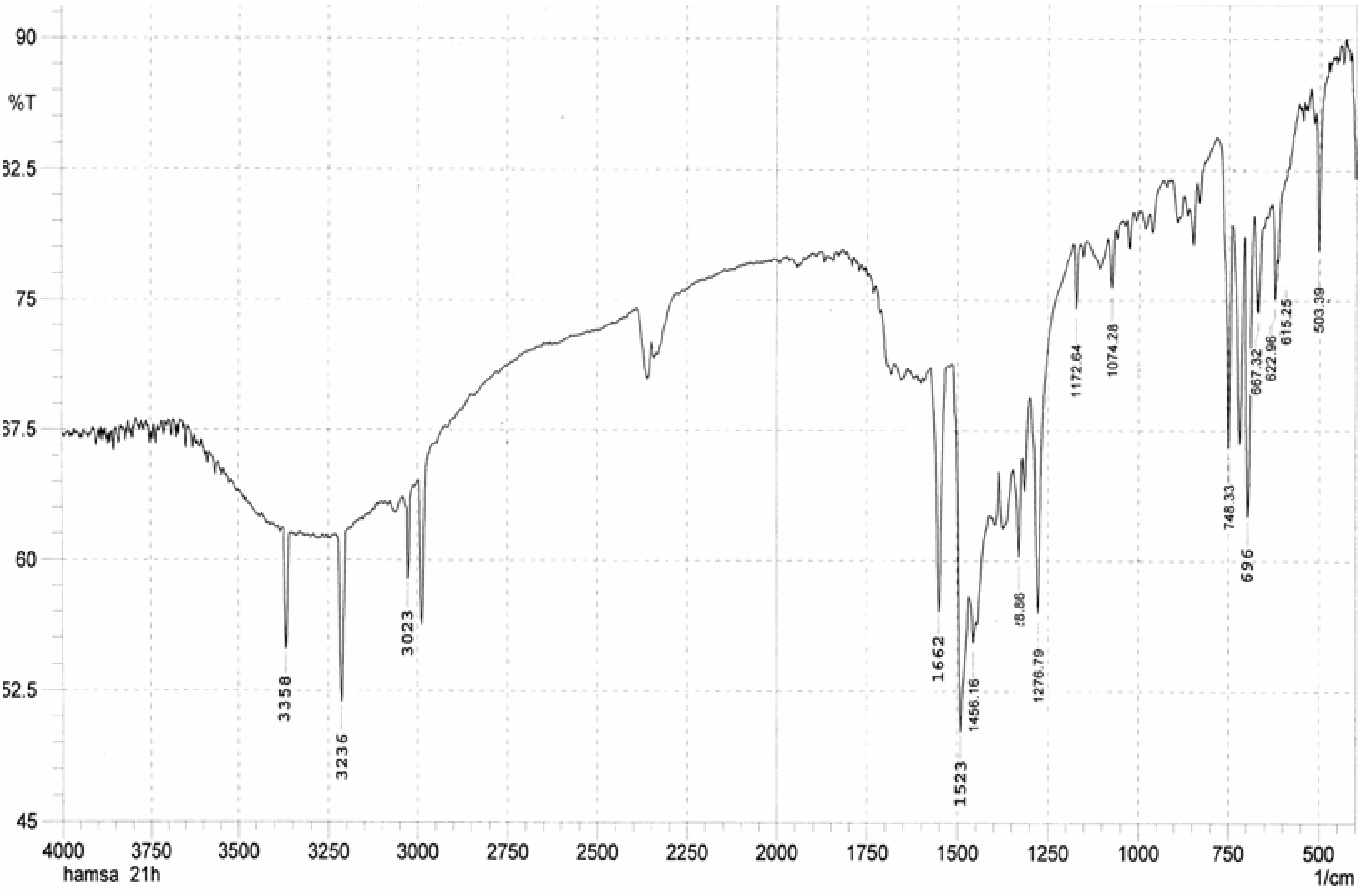


Fig (3-5): FTIR Spectrum of LIIPdB

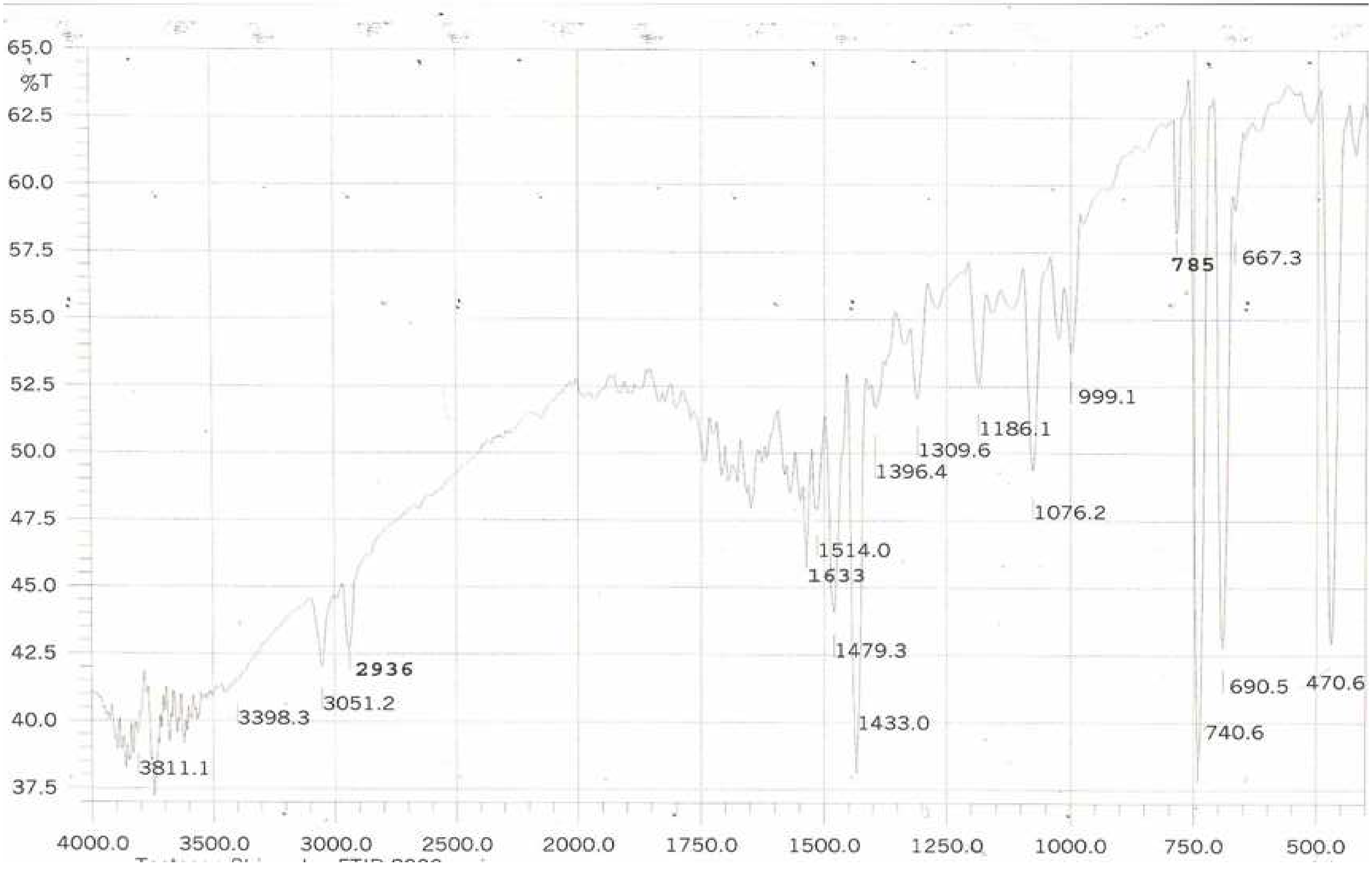


Fig (3-6): FTIR Spectrum of LIIPdC

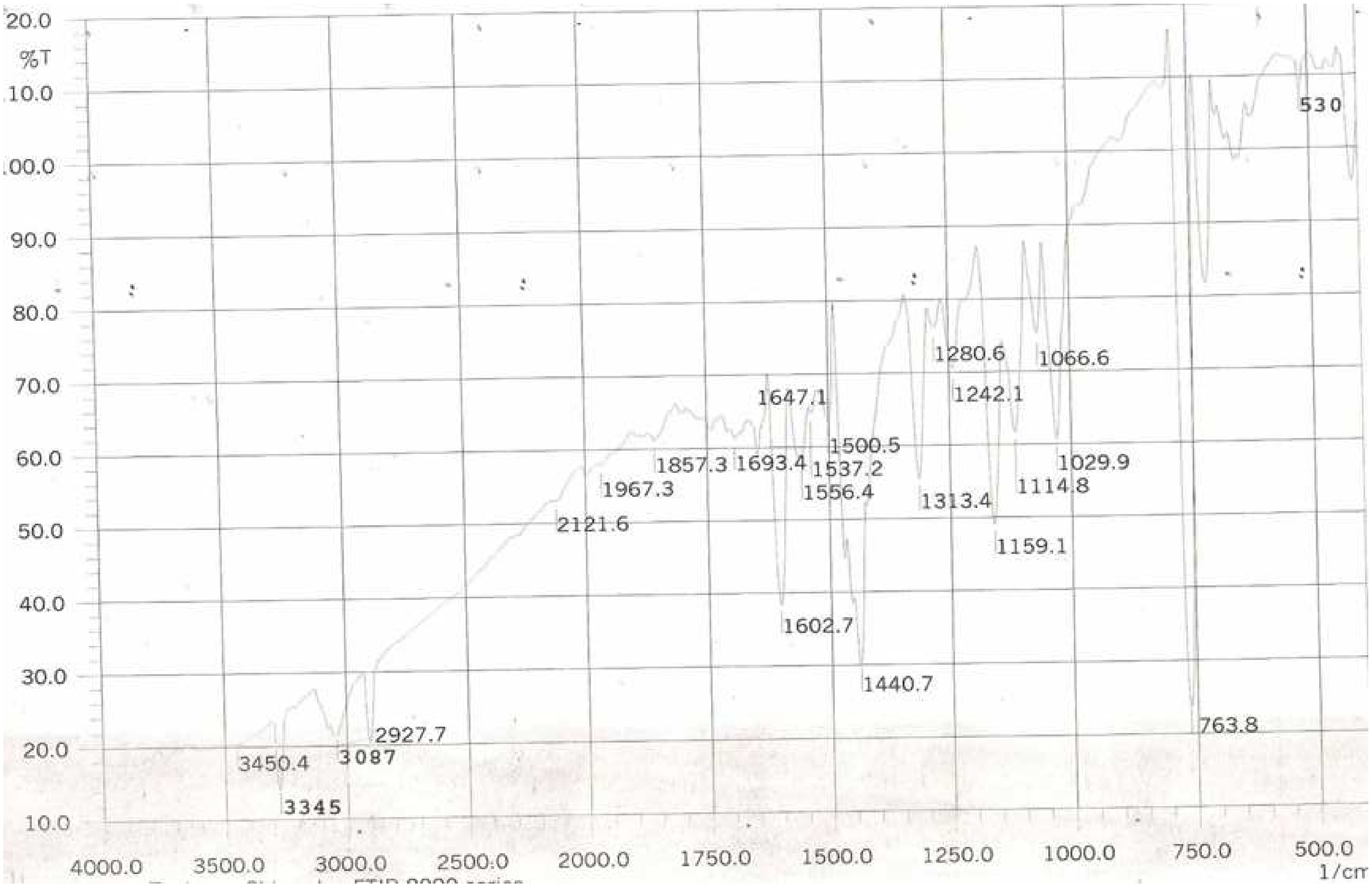


Fig (3-7): FTIR Spectrum of LIIPdD

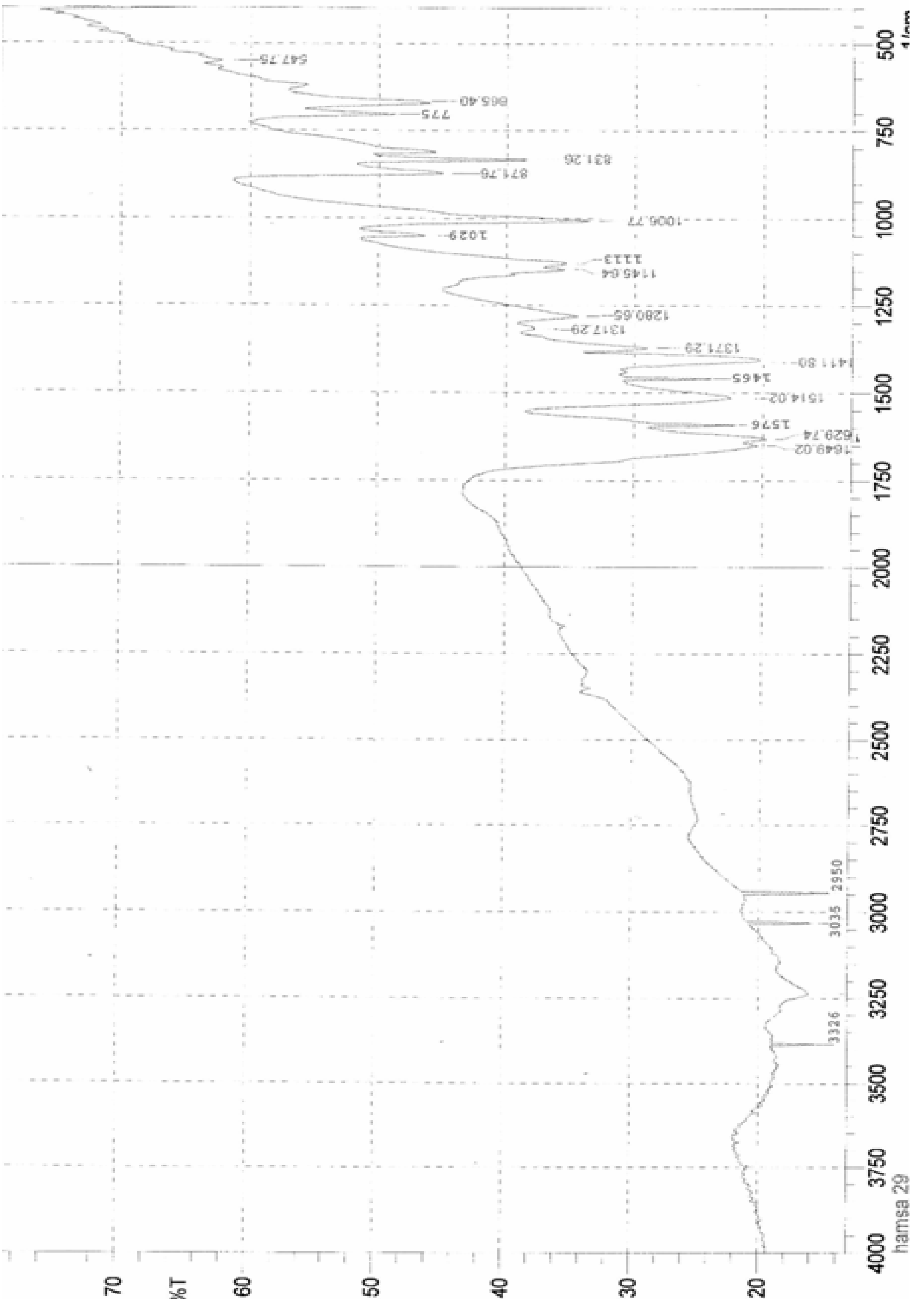


Fig (3-8): FTIR Spectrum of LIIPdE

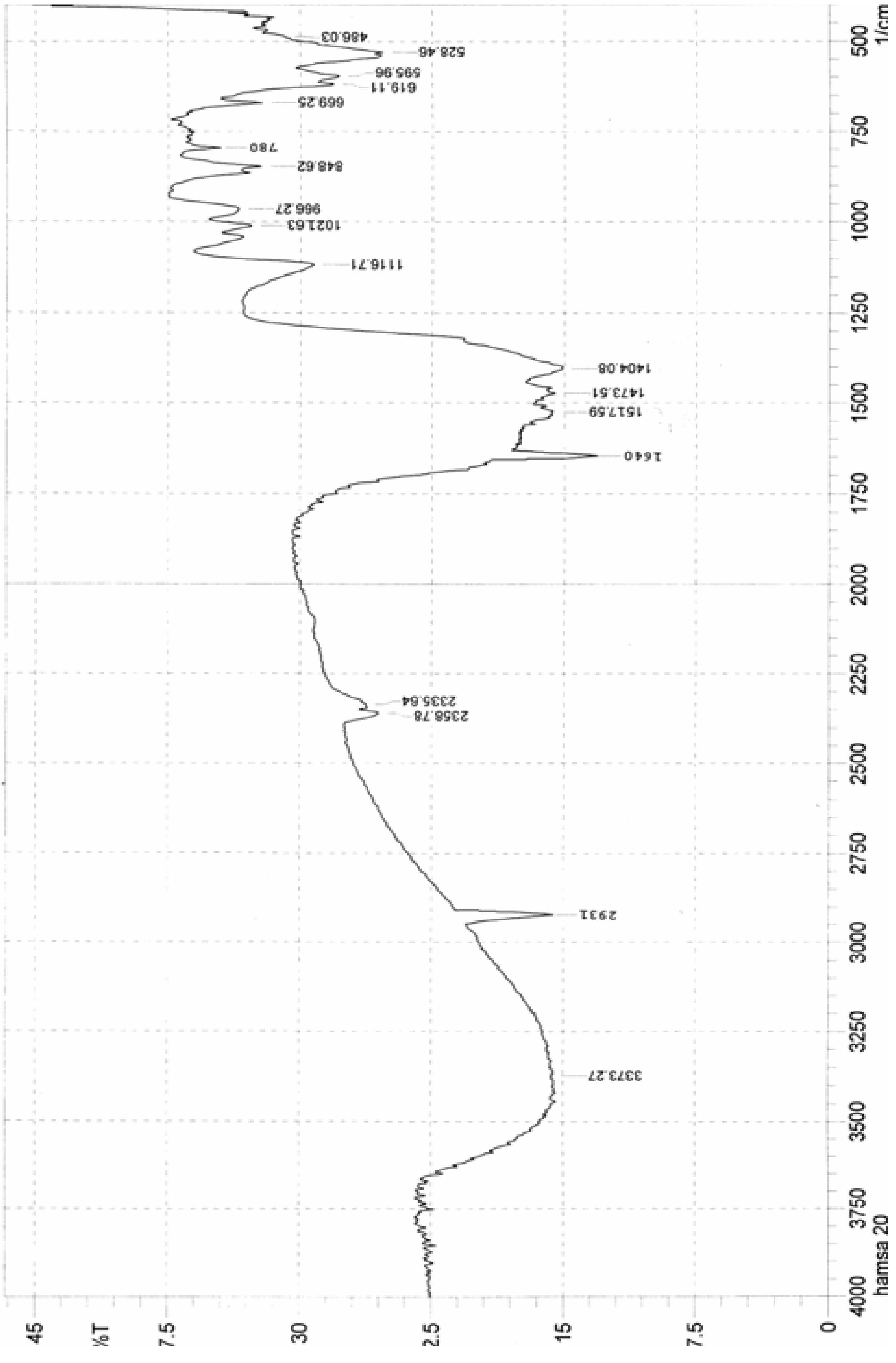


Fig (3-9): FTIR Spectrum of LIIICu

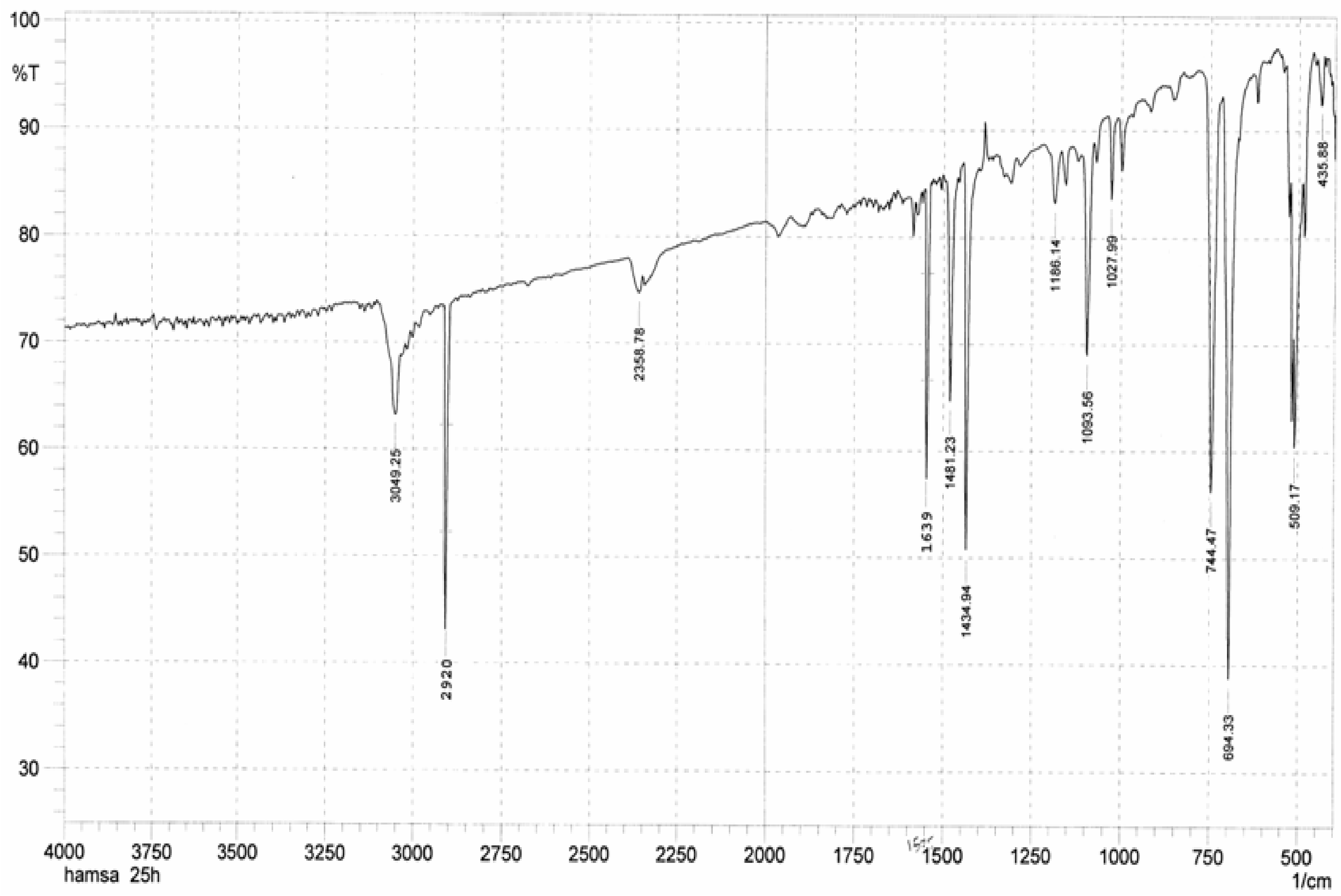


Fig (3-10): FTIR Spectrum of LIIICuA

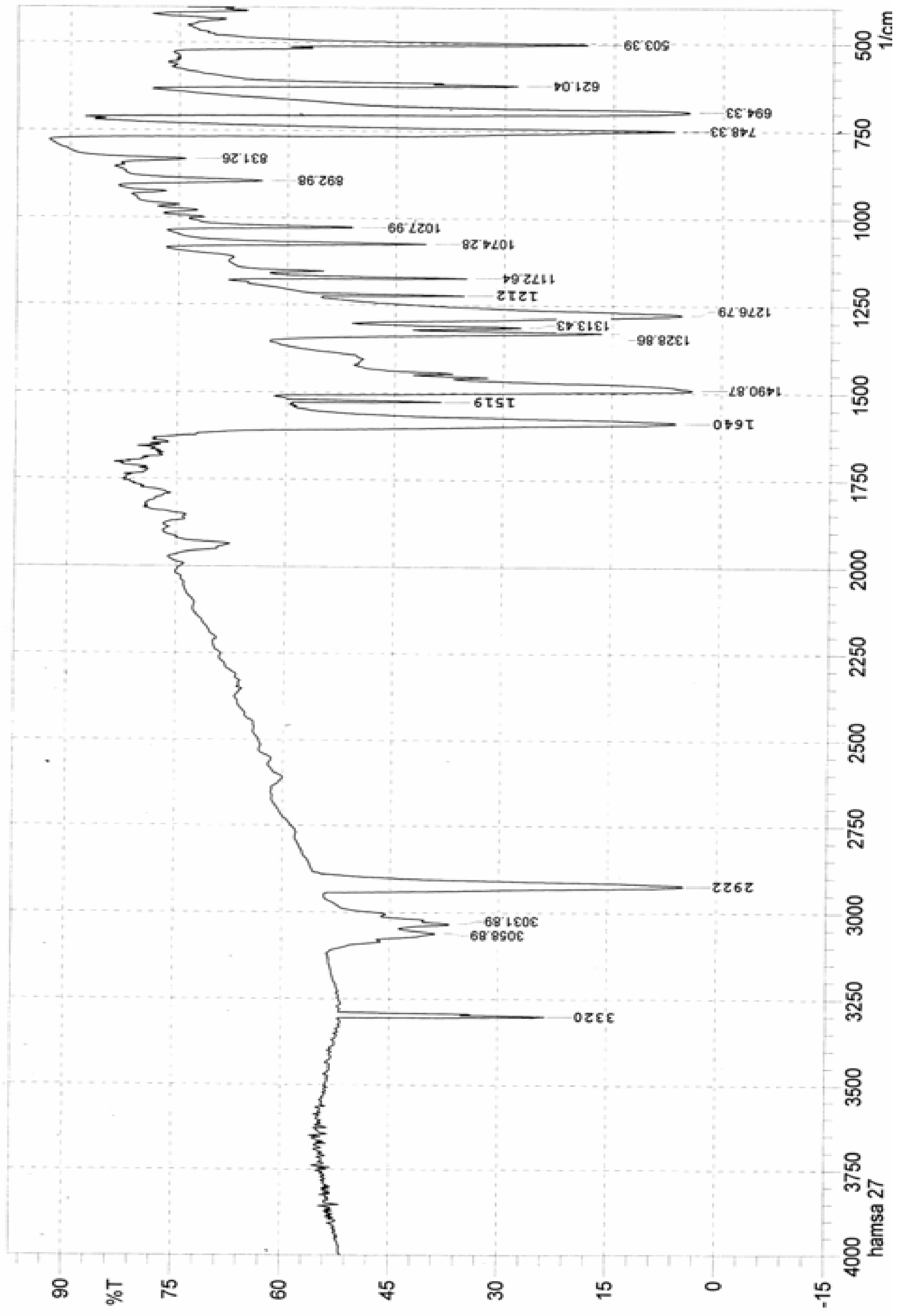


Fig (3-11): FTIR Spectrum of LIIICuB

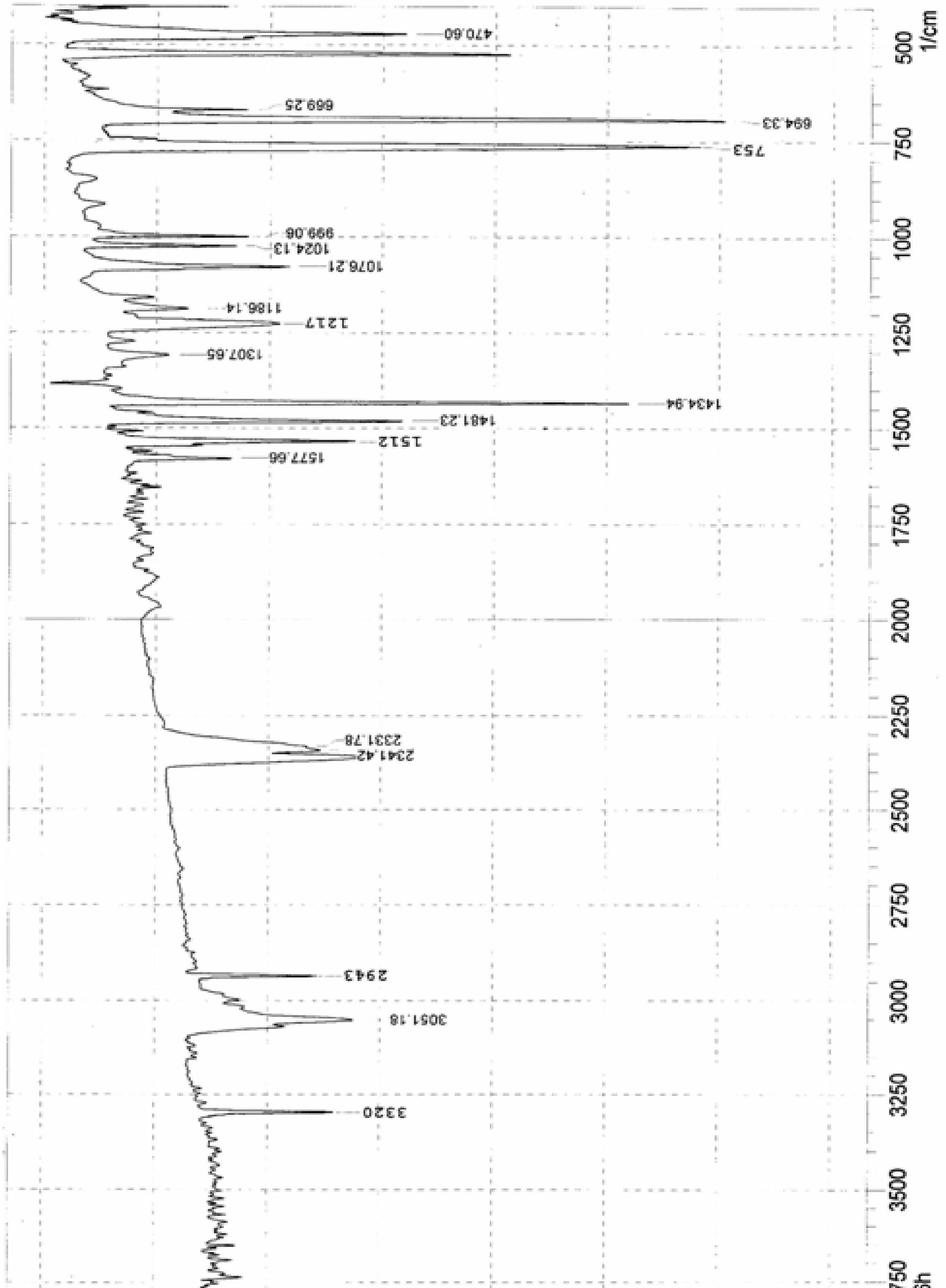


Fig (3-12): FTIR Spectrum of LIIICuC

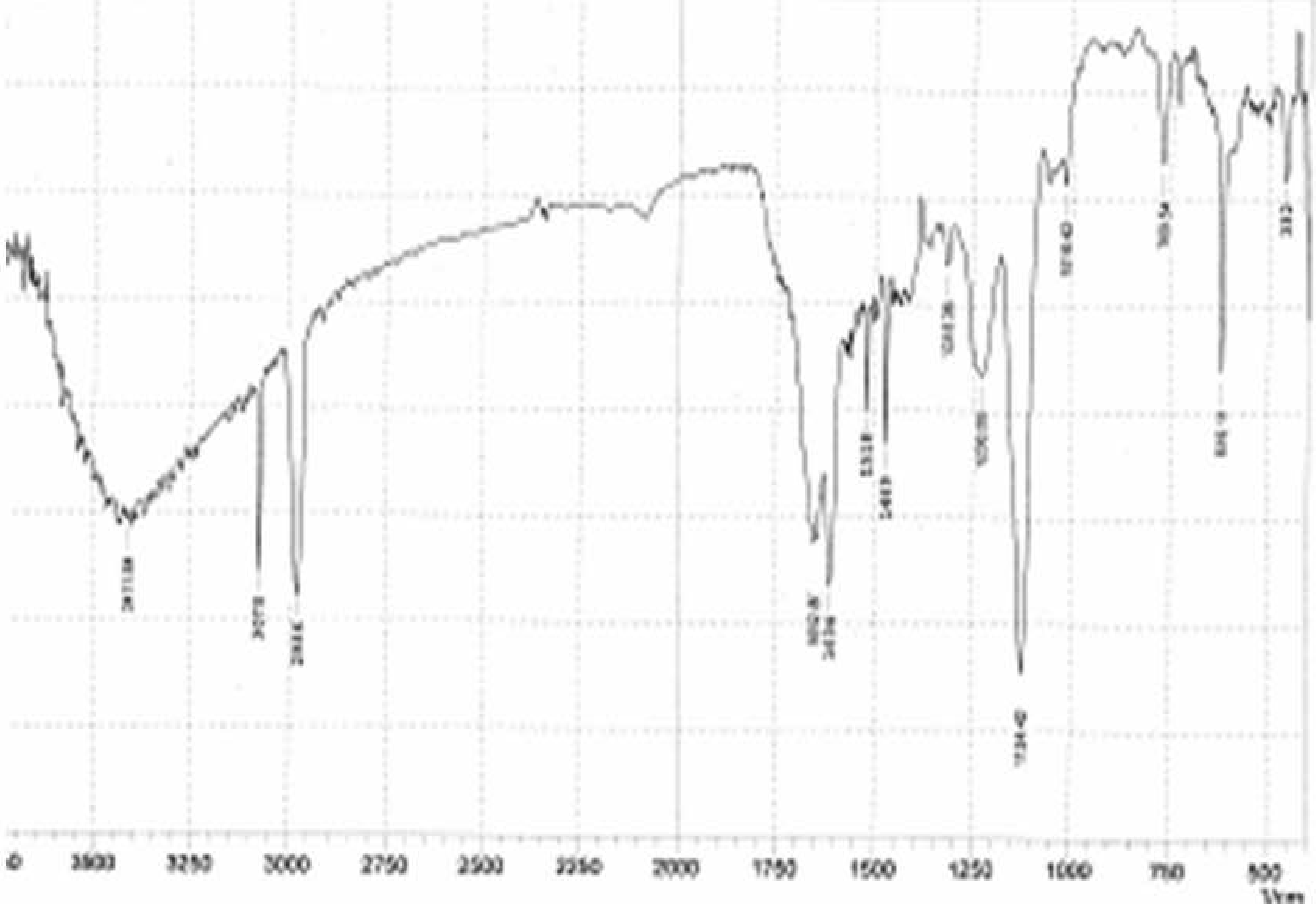


Fig (3-13): FTIR Spectrum of LIIICuD

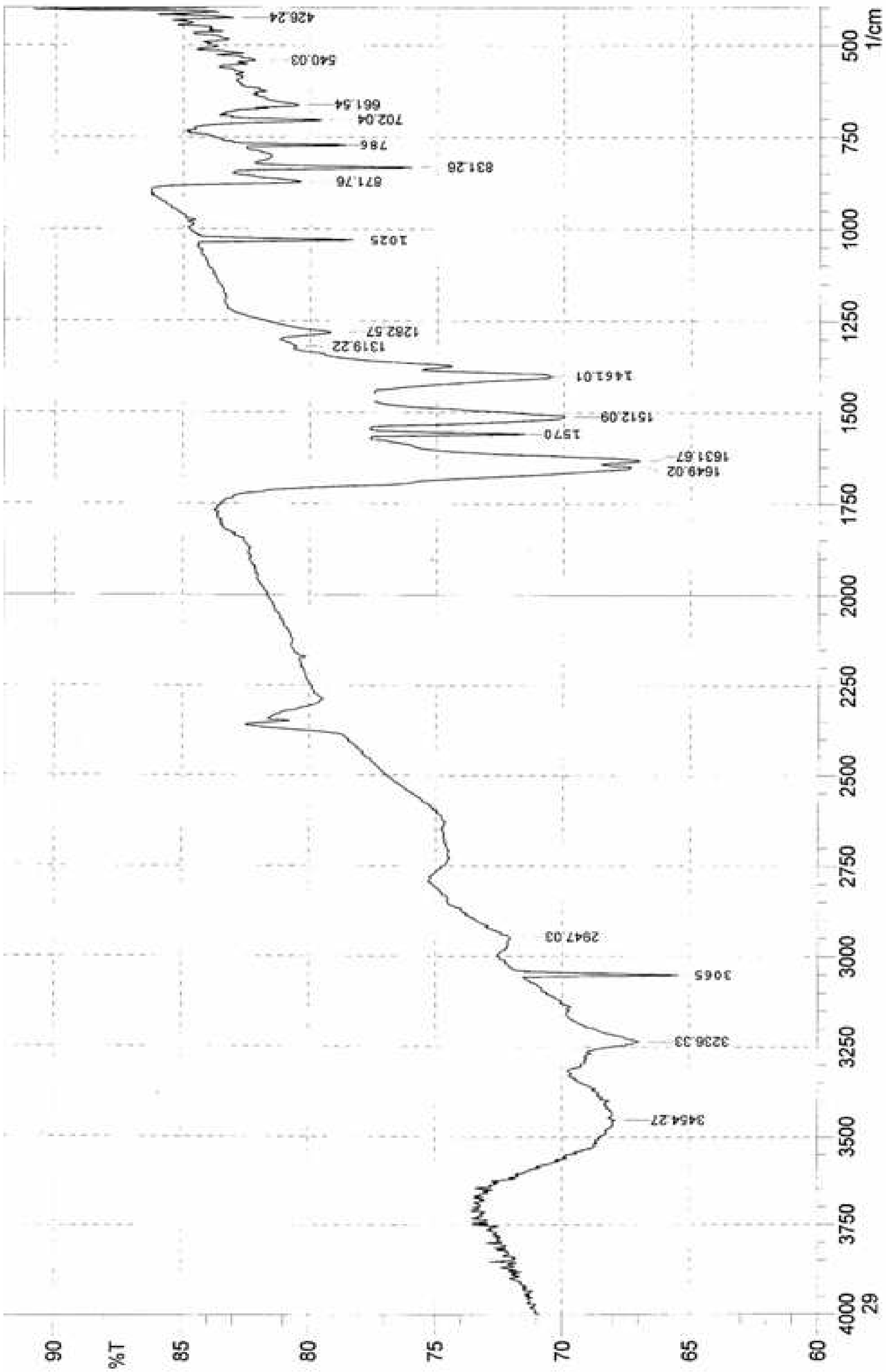


Fig (3-14): FTIR Spectrum of LIIICuE

Chapter two

(Experimental part)

2.1-Chemicals and Instrument:

Chemicals:

All the chemical used in this work were of highest purity available and supplied without further purification. The following table (2-1) shows the reagents and the companies which supply them.

Table (2.1): Chemicals, purity and their manufacturers.

Compounds	Purity %	Company
Absolute Ethanol	99.99	BDH
Dithiooxamide	99	BDH
1,2 Dibromo ethane	99	BDH
Dimethyl sulphoxide	98	BDH
Diethyl ether	95	BDH
Triphenyl amine	98	BDH
Triphenyl arsine	98	BDH
Triphenyl phosphine	98	BDH
Potassium hydroxide	85	BDH
Copper chloride	99	Fluka
Palladium(II) chloride	99	BDH

2- Instrumentals:

A) Infrared absorption spectra:

The infrared spectra of the prepared compound were recoded using FT-IR (8300) Fourier Transform Infrared spectrophotometer of SHIMADZU Company as potassium bromide (KBr) discs in wave number range of (4000-400) cm^{-1}.spectral range.

B) Electronic absorption spectra:

The electronic spectra of the complexes were obtained using SHIMADZU UV-Vis 160A Ultra –Violet spectrophotometer .at room temperature using quartz cell of 1.0 cm length and using ethanol or DMSO as solvent, in the range of wavelength (200-1100)nm.

C) Magnetic susceptibility measurements:

The magnetic susceptibility values for the prepared complexes were obtained at room temperature using (Magnetic susceptibility balance); of Johnson Mattey Catalytic System Division, England.

D) Metal analysis:

The metal content of the prepared complexes was measured using atomic absorption technique by PERKIN – ELMER – 5000 atomic absorption spectrophotometer.

E) Conductivity measurements:

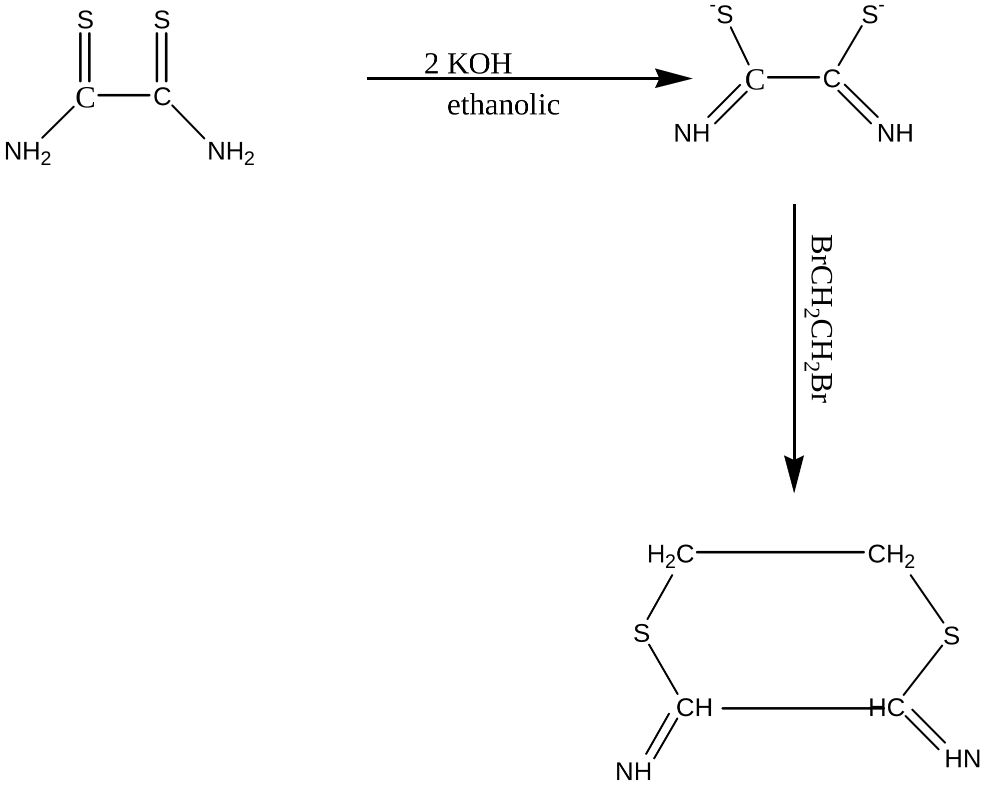
The molar conductivity measurements were obtained using Corning conductivity 220 apparatus.

F) Melting point:

Gallenkamp M.F.B 600-01 of melting point apparatus was used to measure the melting points of all the prepared compounds.

2.2.1-Procedures of the stepwise syntheses:

The stepwise synthesis of 2,3- dimine -1, 4-dithiarine was preformed as follows starting from dithiooxamide.



Scheme (2-1) : Synthesis of 2,3- dimine – 1,4- dithiarine (LI)

2.2.1- Synthesis of 2,3 – dimine-1,4 – dithiarine (LI) :

A 0.92 g (0.02 mole) of KOH was added to ethanolic solution of dithiooxamide 1.202 g (0.01mole) under heating for 5 min until all diothiooxamide was reacted. A 1 ml (0.01 mole) of 1,2- dibromoethane was then added and the mixture was refluxed for 25 min until a golden brown precipitate was formed which was turned to a slight yellow precipitate. The precipitate was finally recristillized using ethanol then dried under vacuum.

2.2.2- Preparation of trans–dichlorobis (dimethylsulphoxide palladium (II) (LII).

The neutral palladium sulphoxide complex was prepared by dissolving 0.25 g (0.762mmole) of palladium(II) chloride in 5ml of dimethylsulphoxide (DMSO) at 50°C, the DMSO complex was precipitated upon addition of anhydrous diethylether with stirring. The complex was dried in vacuum for 5 hours (44,45).

2.2.3- Preparation trans-dichloro(2,3 -dimine-1,4-dithiarine palladium(II)) (LIIPd).

Dichloro (2,3–dimine–1,4–dithiarine)palladium(II) was prepared the addition of a solution of 0.037 g (0.145mmole) of (LII) dissolved in 6 ml of hot ethanol to the resulting yellow solution 0.0214 g (0.145mmole) of (LI).The mixture was refluxed for 2 hours and cooled. The resulting deep-brown precipitate was filtered and washed with diethyl ether several times and dried under vacuum.

2.3-Preparation of Pd(II) complexes:

2.3.1- Chloro(2,3-dimine–1,4-dithiarine)(triphenylphosphine) palladium(II) LIIPd(A).

This complex was prepared by dissolving 0.1g (0.312mmol)of (LIIPd) in warm ethanol which was then added to 0.0818 g (0.312mmole) of (Ph_3P) dissolved in absolute ethanol, the mixture was refluxed with stirring for 1 hour and then filtered yielding brown precipitate which was washed with diethyl ether and dried in vacuum for 3 hours

2.3.2- Chloro(2,3-dimine–1,4-dithiarine)(triphenyl amine) palladium(II) LIIPd(B).

This complex was prepared by dissolving 0.l g(0.312m mole)of (LIIPd) in warm ethanol which was then added to 0.0763 g(0.312m mole) of (ph_3N) dissolved in absolute ethanol the mixture was refluxed with stirring for 1 hour and then filtered yielding deep-brown precipitate, which was washed with diethyl ether and dried in vacuum for 3 hours.

2.3.3- Chloro(2,3-dimine–1,4-dithiarine)(triphenyl arsine) Palladium (II) LIIPd(C).

. This complex was prepared by dissolving 0.l g (0.312mmole)of(LIIPd) in warm ethanol which was then added to 0.095g(0.312m mole) of (Ph_3As) dissolved in absolute ethanol the mixture was refluxed with stirring for 1 hour and then filtered yielding brownish precipitate, which was washed with diethyl ether and dried in vacuum for 3 hours.

2.3.4- (2,3-dimine–1,4-dithiarine)(2,2$^{/}$-dipyridyl) palladium(II) LIIPd (D).

This complex was prepared by dissolved 0.1 g(0.312mmole)of (LIIpd) in warm ethanol which was then added to0.0486g (0.312mmole of 2,2$^{\backslash}$□ - dipyridyl dissolved in ethanol . the mixture was refluxed with stirring for 1 hour yielding bright – yellow precipitate which was filtered and washed with diethylether and dried in vacuum for 3 hours.

2.3.5-(2,3-dimine–1,4-dithiarine)(dithiooxamide)palladium (II) LIIPd (E).

This complex was prepared by dissolving0.1 g (0.312mmole) of (LIIPd) an warm ethanol which was then added to 0.0374g (0.312mmole) of dithiooxamide dissolved in warm ethanol the mixture was refluxed for 1 hour yielding brown precipitate which was filtered and washed with diethyl ether and dried in vacuum for 3 hours

2.4- Cu (II) complexes.

2.4.1- Chloro(2,3-dimine–1,4-dithiarine copper (II) (LIII).

This complex was prepared by dissolving 0.296 g(2 mmole) of (LI) in warm ethanol which was then added to 0.171 g (1 mmole) of Cu $Cl_{2.}$ $2H_2O$ dissolving in ethanol the mixture was refluxed with stirring yielding greenish-blue color precipitate which was filtered and washed with diethyl ether and dried in vacuum for 3 hours.

2.4.2- Chloro (2,3–dimine-1,4 dithiarine)(triphenylphosphine) Copper (II) LIIICu(A).

This complex was prepared by dissolving0.463 g(1 mmole) of (LIII) in warm ethanol which was then added to 0.523 g(2 mmole)of (Ph_3P) dissolving in ethanol the mixture was refluxes with stirring yielding light gray precipitate which was filtered and washed with diethyl ether and dried in vacuum for 3 hours.

2.4.3- Chloro (2,3–dimine-1,4-dithiarine)(triphenylamine) Copper (II) LIIICuC (B).

This complex was prepared by dissolving0.463 g (1 mmole) of (LIII) in warm ethanol which was then added to 0.49 g(2 mmole)of (Ph_3N) dissolving in ethanol the mixture was refluxes with stirring yielding (deep-brown) precipitate which was filtered and washed with diethyl ether and dried in vacuum for 3 hours.

2.4.4- Chloro (2,3-dimine –1,4- dithiarine)(triphenyl arsine) Copper (II) LIIICu(C).

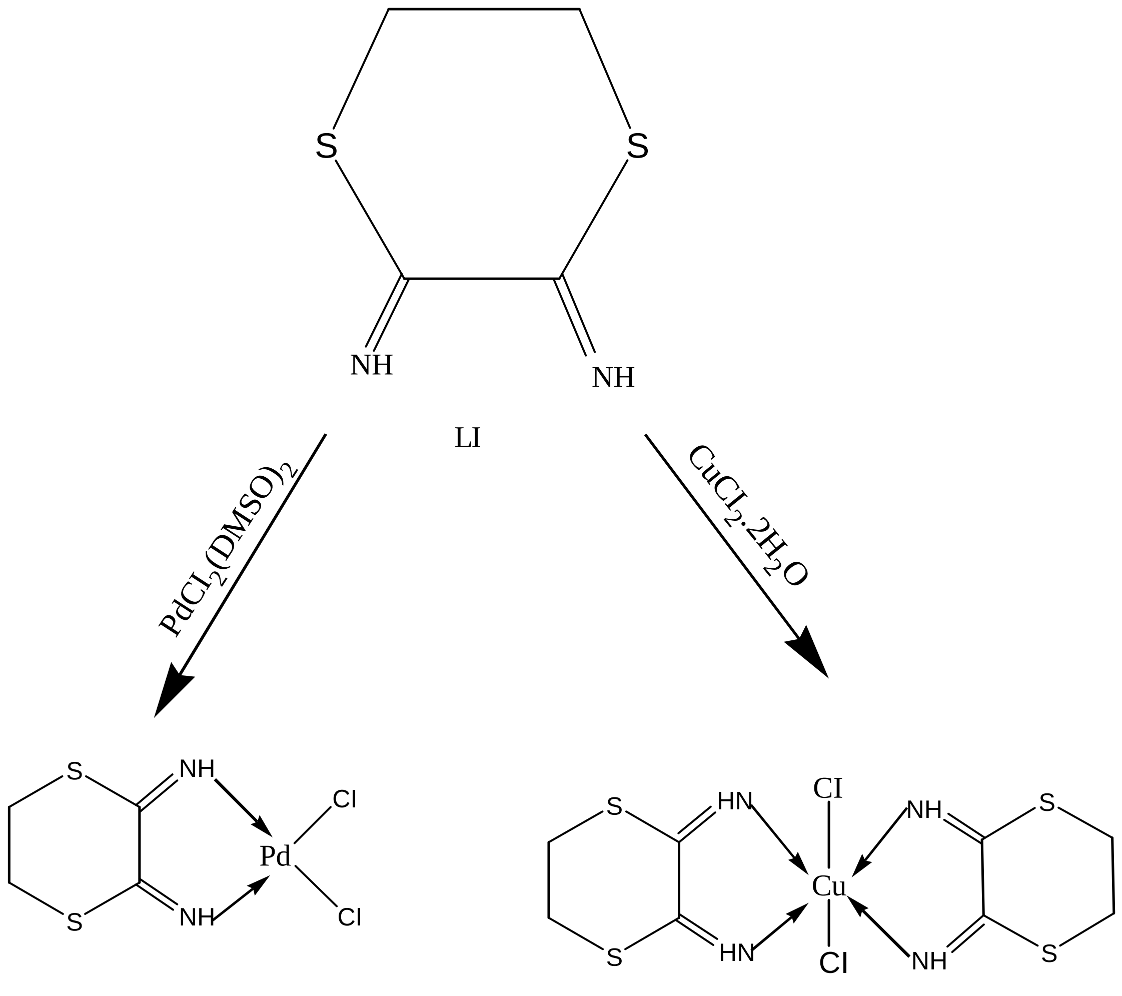
This complex was prepared by dissolving 0.463 g(1 mmole)of(LIII) in warm ethanol which was then added to0.611 g (2 mmole) of (ph_3As) dissolved in ethanol the mixture was refluxed with stirring yielding (dark-green) precipitate which was filtered and washed with diethyl ether and dried under vacuum for 3 hours.

2.4.5- (2,3- dimine-1,4- dithiarine)(2,2$^{/}$-Dipyridyl) copper (II) LIIICu(D).

This complex was prepared by dissolving 0.463 g (1 mmole) of (LIII) in warm ethanol which was then added to0.156 g(1 mmole) of 2,2^{-} dipyridyl dissolving in ethanol the mixture was refluxed with stirrin yielding beep- green precipitate which was filtered and washed with diethyl ether and dried under vacuum for 3 hours.

2.4.6- (2,3- dimine – 1,4 dithiarine)(diothiooxamide) copper(II) LIIICu(E).

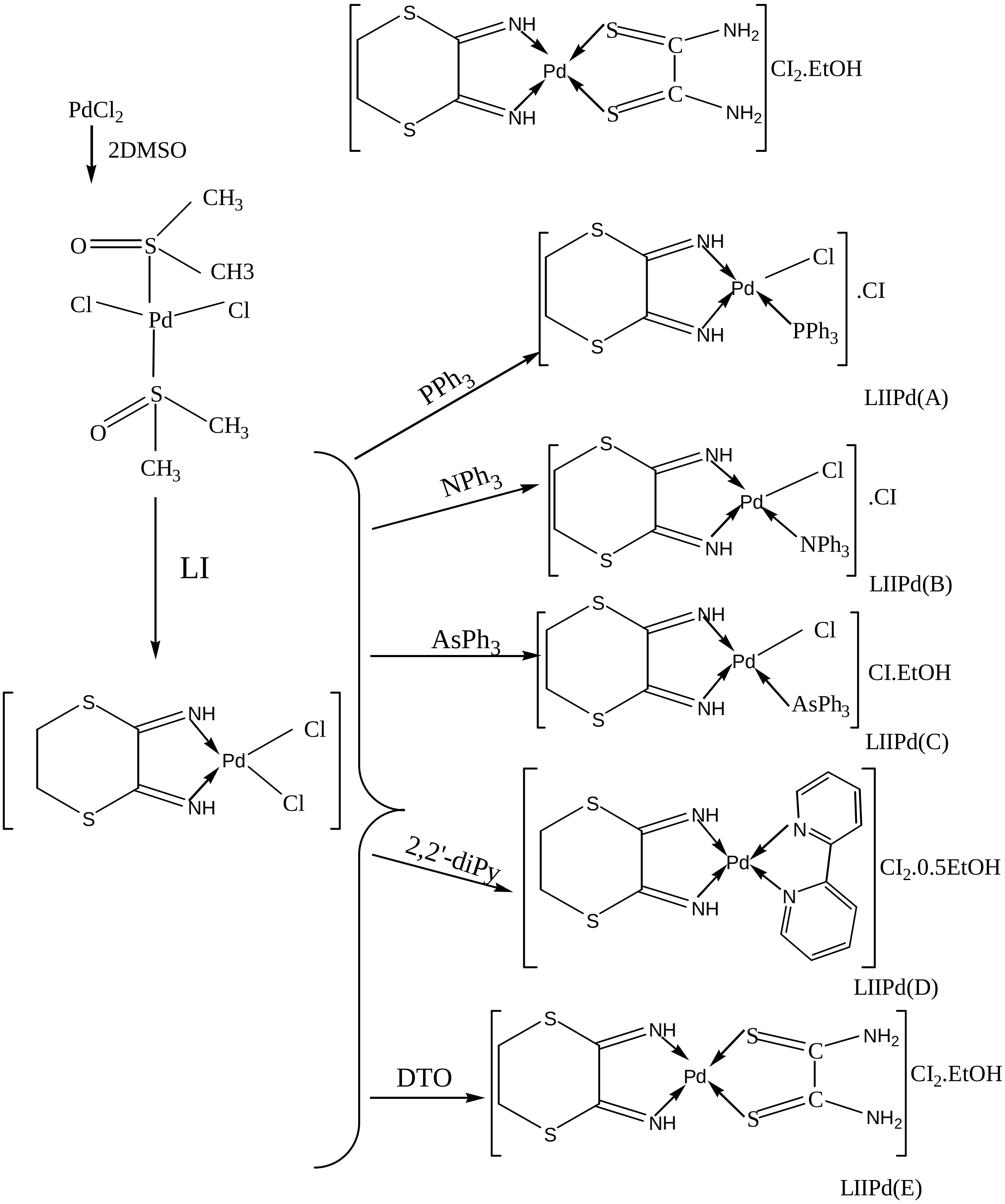
This complex was prepared by dissolving 0.463 g (1 mmole)of (LIII) in warm ethanol which was then added to0.120 g(1 mmole)of DTO dissolving in ethanol the mixture was refluxed with stirring yielding olive-green precipitate which was filtered and washed with diethyl ether and dried in vacuum for 3 hours.



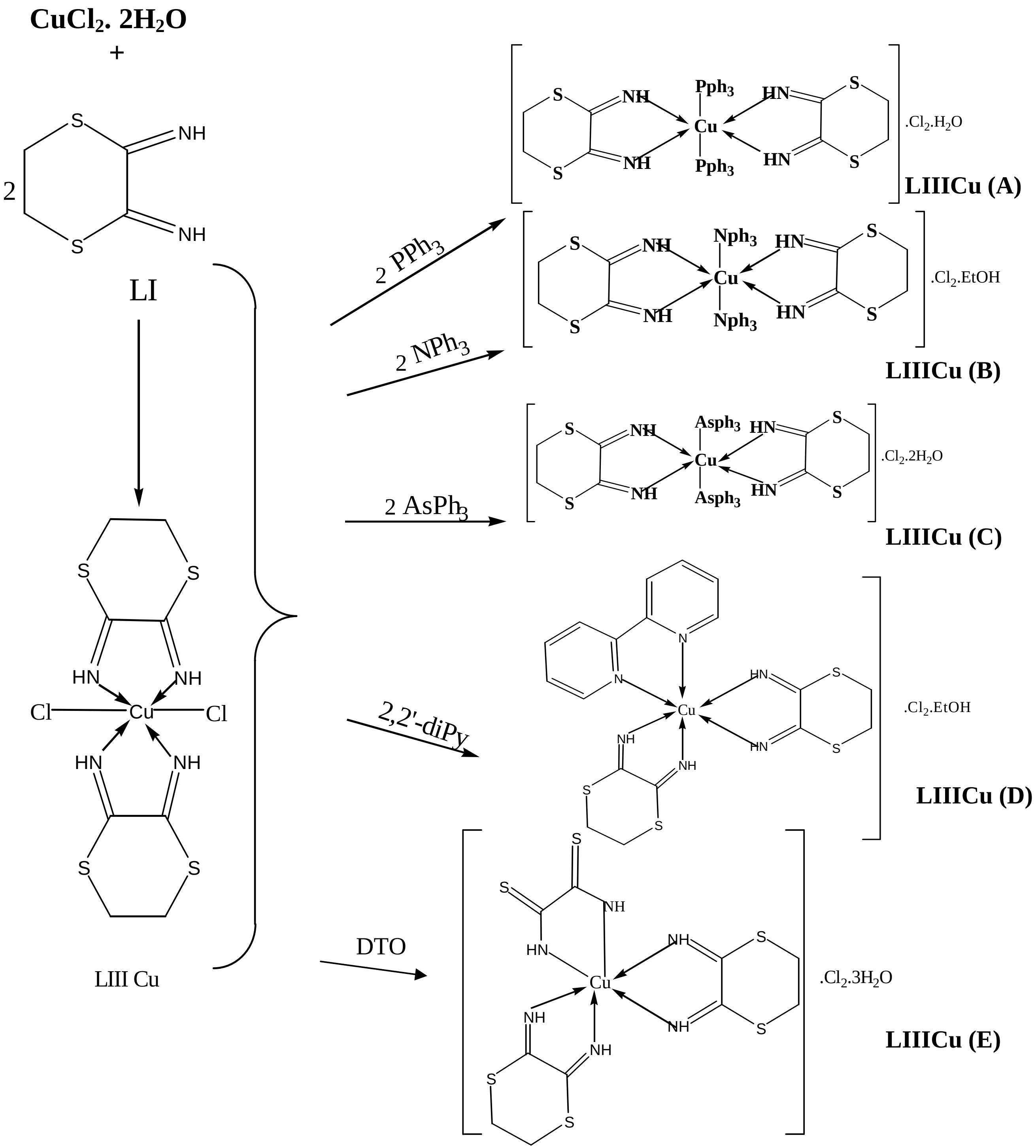
LIIPd

LIIICu

Scheme (2-2) Preparation trans-dichloro (2,3-diamine-1,4-dithiarine Palladium (II) (LIIPd) and dichloro (2,3-diamino-1,4-dithiarine copper (II) (LIIICu)



Scheme (2-3) :- Preparation of Palladium complexes



Scheme (2-4):- Preparation of Copper complexes

Results and Discussion

3.1-Physical properties of the prepared complexes:

Tables (3-1) and (3-2) show the physical data for the prepared complexes. The new complexes show different melting points, some of them were higher than the parent ligand; others were of lower melting points. The colors of the complexes were useful in structure determination. All the prepared compounds were stable towards air, moisture and light.

All reactions were carried out under heating conditions and absolute ethanol was used as solvent in all reactions.

Identification and study of these complexes were carried out by metal analysis {the results are shown in table (3-1) and (3-2)}, infrared, ultra – visible spectrophotometer, magnetic susceptibility and electronic conductivity measurements. According to these measurements, the chemical formulas of the prepared complexes have been suggested as given in table (3-5) and (3-6).

Table (3-1): Physical properties, yield%, and metal content for Palladium complexes.

Symbol	Color	M.P (°C)	Yield (%)	Metal content (%)	
				Calc	found
LI	Golden brown	198	89	-	-
LII Pd	Deep- Brown	275	71	29.6	29.02
LII Pd (A)	Brown	260	66	18.16	19.11
LII Pd (B)	Deep- brown	178	75	18.70	17.9
LII Pd (C)	Brownish	Dec 270	70	16.08	16.12
LII Pd (D)	Bright-yellow	Dec 300	65	20.6	21.2
LII Pd (E)	Brown	Dec 287	82	22.3	22.9

Table (3-2): Physical properties, yield, and metal content for copper complexes

Symbol	Color	M.P. (°C)	Yield (%)	Metal content (%)	
				calc	Found
LI	Golden brown	198	89	-	-
LIII Cu	Greenish blue	125	79	13.8	12.8
LIII Cu (A)	Light green	165	60	6.7	7.0
LIII Cu (B)	Green	124	80	6.7	6.9
LIII Cu (C)	Dark green	169	60	5.9	5.6
LIII Cu (D)	Deep green	248	70	10.7	11.2
LIII Cu (E)	Olive green	225	75	10.04	9.6

3.2-Preparation and identification of 2,3-dimine 1, 4- dithiarine (LII) and its metal complexes .

It was aimed to place the two sulfur atoms in cyclic structure in order to limit the coordination possibility of the sulfur atoms in the same time converting the amino groups to the imine group free to coordinate with the metal.

2,3- dimine- 1,4- dithiarine (LI) was prepared from DTO using dibromoethane in basic medium. Two complexes of these cyclic compounds were prepared by reaction with (Pd) and (Cu) ions. The ligand (LI) and its metal complexes were identified using FT–IR U.V – Visible spectroscopy, magnetic susceptibility, metal analysis and electric conductivity measurements.

3.3-Preparations of the metal complexes.

The reaction of hot DMSO with palladium chloride (II), gave yellow needle- like crystals, stable toward air and moisture. The expected geometry of the resulting complex is trans–square planar $[PdCl_2 (DMSO)_2]$ (47,48).

When $[PdCl_2 (DMSO)_2]$ was reacted with 2,3-diamino-1,4-dithiarine in ethanol under reflux condition, it gave a brown fine powder with good air and moisture stability in which the two labile DMSO molecules were substituted by one chelating (LI) molecule giving two exchangeable chloro atoms. This fact was utilized to prepare five different complexes using phosphine, nitrogen and arsine donor neutral ligands, i.e. triphenyl phosphine, triphenylamine, triphenyl arsine,2, 2$^{/}$-dipyridyl and dithiooxamide.

For preparing a mixed ligand complexes of palladium a direct method was followed, in which 2,2$^{/}$-dibyridyl complex. [Pd (dipy) (LII)]CI_2 was prepared by reaction of equimolar quantities of [$PdCl_2$LII] and bibyridyl in hot ethanol giving bright yellow crystalline powder. DTO was reacted with LII (Pd) in hot ethanol a brown crystalline powder was obtained, both complexes were stable toward air and moisture.

The result of reacting equimolar quantities of LIIPd with Ph_3P, Ph_3N or Ph_3As in ethanol at room temperature was the precipitation of brown, deep brown and brownish fine crystals respectively, which were stable toward air and moisture.

The reaction of (LI) with cupperic chloride dihydrate in hot absolute ethanol gave greenish blue fine crystalline powder, which was also stable toward air and moisture. Different new mixed ligand complexes derived from the resulting complex were prepared by using phosphorous, nitrogen, and arsine donor neutral ligands i.e., triphenyl phosphine, triphenyl amine, triphenyl arsine, 2, 2$^{/-}$ dibyridyl and dithiooxamide.

3, 4-Infra-Red Spectral study:

The IR spectra were taken for the prepared complexes and compared with those of their respective ligands. The measurements were carried out for each compound in solid state as KBr disc in the range of (4000-400) cm^{-1}.

3.4.1–Dimethyl Sulphoxide complex:

Infrared spectra of DMSO complexes have proven to be useful in distinguishing between coordination through the oxygen or sulfur donor site. Previous structure determination studies of trans $PdCl_2(DMSO)_2$ have demonstrated that DMSO coordinate through S-atoms(49).

The trans configuration of $PdCl_2$ (DMSO) $_2$ may not be the most stable molecular form but is obtained in the solid state because it leads to amore stable crystal form (50,51).

The FT.IR spectrum of our starting complex $PdCl_2$ $(DMSO)_2$, Fig (3-1) and Table (3-3), showed a sharp strong single S=O stretching band at 1116 cm^{-1} and a well defined band for Pd-S stretching at 414 cm^{-1} (52,53).

The bands appeared at 2912 cm^{-1} and 1406 cm^{-1} may be attributed to CH_3 vibration stretching. These i.r. spectral data in accordance with the expected trans- S-bonded DMSO.

Table (3-3) The FT.IR spectral bands of Pd(II) complex with DMSO.

Sample	υ S=o	υ CH_3	δCH_3	υ M-S
DMSO	**1050**	**2998** **2971**	**1414**	**-**
Trans-$PdCl_2(DMSO)_2$	**1116**	**2912**	**1406**	**414**

This was expected following the solid-state studies of several workers (54, 55).

3.4.2- 2,3-dimino-1, 4–dithiarine(LI) and its metal complexes.

The thiamine bands of (LI) have been fully discussed previously . Where the four bands have been assigned as follows, band (I) is due to υ(C=N) (major) +δ(N-H) (major), band (II) is due to υ(C=N) and υ(C=S), band (III) and (IV) are due to υ(N-C-S) and υ(C-S) frequencies respectively(56, 57).

Table (3-4) gives the diagnostic frequencies of the LI and it metal complexes(58). In this ligand, the most characteristic band is the aliphatic υ(C-

H) band at 2859cm^{-1}, fig (3-2), beside the four-thioamide bands. Pd (II) and Cu (II) complexes of (LI) showed a similar spectral changes and as follows; band (I) which appeared as a doublet at 1690 cm^{-1} and 1631cm^{-1}, shows itself as a single band at a lower frequency [1645cm^{-1} for Pd(II) complex and (1640) cm^{-1} for Cu complex] upon the complexation with the two ions. Band (II) also shifted to lower frequency upon the complexation appearing at 1512 cm^{-1} for Pd (II) but cupper complex shifted to higher frequency at 1517 cm^{-1}, indicating the coordination of these ions through the nitrogen atom of this ligand, another indication for the coordination through only nitrogen atom (and not from the sulfur atom) is that band (III) and (IV) so not change. In the spectra of the two complexes, υM-N band were found at 682cm^{-1} and 528cm^{-1} for Pd (II), Fig (3-3), and Cu (II) complexes ,fig(3-9).respectively,

Table (3-4):Showed the FTIR spectred bands of Pd (II) Cu (II) complexes with LI.

Table (3-4): The FT-IR spectral bands of Pd (II) and Cu (II) complexes with (LI).

Compound	υ C=H Aliphatic	Thioamide Band(I)	Thioamide Band(II)	Thioamide Band(III)	Thioamide Band(IV)	M-N
LI	**2895**	**1690** **1631**	**1515**	**1021**	**780**	**-**
LIIPd	**2925**	**1645**	**1512**	**1022**	**780**	**482**
LIIICu	**2931**	**1640**	**1517**	**1021**	**781**	**528**

3.4.3- Triphenyl phosphine, triphenyl amine and triphenyl arsine complexes of LIIPd and LIIICu complexes.

As the neutral P-donating (Ph_3P), N-donating (Ph_3N) and As-donating (Ph_3As) ligands react with LIIPd in 1:1 mole ratio and with LIIICu in 1:2mole ratio, only one of chloride is substituted. In the case of palladium complex LIIPd the spectrum of (LIIPd A) complex with Ph_3P, Fig (3-4) show a set of new well –characterized bands, where two sharp and strong bands appeared at 746 and 694 cm^{-1} due to mono substituted phenyl groups. The band characteristic of υΦ-P appeared at 1434 cm^{-1} .which is about 63 cm^{-1} lower than that for the free Ph_3P(58,59).

The spectrum of LIIPd with Ph_3N(LIIPd B), Fig (3-5) show the substituted pattern of phenyl groups at 748 and 696 cm^{-1} as sharp bands. The υΦ-N appeared at 1280cm^{-1}, which is about 20 cm^{-1} lower than that for the free Ph_3N(58,59).

The spectrum of LIIPd C with Ph_3As, Fig (3-6) show the substituted pattern of phenyl group at (740) and (690) cm^{-1} as sharp bands. The υΦ-As appeared at (1433) cm^{-1}, which is about (43) cm^{-1} lower than that for the free ph_3As(58,59).

Inspection of the spectra of LIIICuA, LIIICuB and LIIIICuC complexes with ph_3P, ph_3N, ph_3As, figs. (3-10),(3-11) and(3-12), show nearly identical changes which took place as that noticed and discussed in the case of LIIPdA, LIIPdB and LIIPdC complexes.

3.4.4- Dipyridyl (dipy) complexes:

The complex LIIPdD showed a spectrum seen in Fig (3-7), which contain the characteristic bands of dibyridyl at 1602 and 1440 cm^{-1} (due to υ C=N & υ

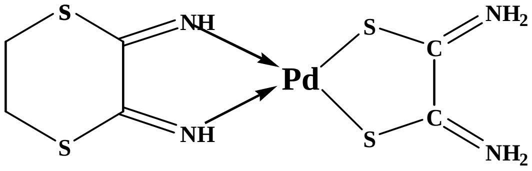
C=C of the ring) and 3087 cm^{-1} due to υ C-H. .This indicates the coordination of 2,2$^{/}$-dibyridyl with Pd atom.

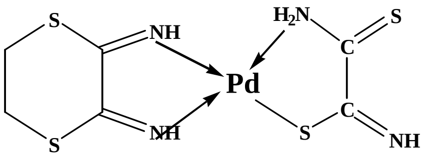
The complex LIIICuD showed a spectrum seen in Fig (3-13), which contain the characteristic band of dibyridyl at (1604) and (1469) cm^{-1} (due to υ C=N & υ C=C of the ring) and (3070) cm^{-1} due to υ C-H$^{(60)}$.This indicates the coordination of dibyridyl with Cu.

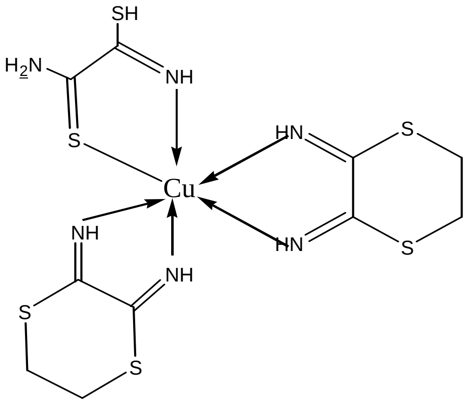
3.4.5- Dithiooxamide (DTO) complexes:

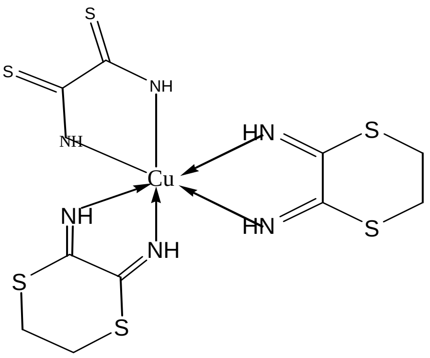
The complexes LIIPdE, fig (3-8), show the characteristic bands of DTO {(I) at (1576), II at (1465), III at (1030) and IV at (773) cm^{-1}} .This indicates the coordination of DTO with LIIPd.

For the complex LIIICuE, fig (3-14), the characteristic DTO bands appeared at { I (1570), II (1461), III (1025) and IV at (786) cm^{-1}}, this indicates the coordination of DTO with LIIICu. There are three possibilities for the coordination of DTO with Pd or Cu atoms, giving three linkage isomers, which can be illustrated as follows;

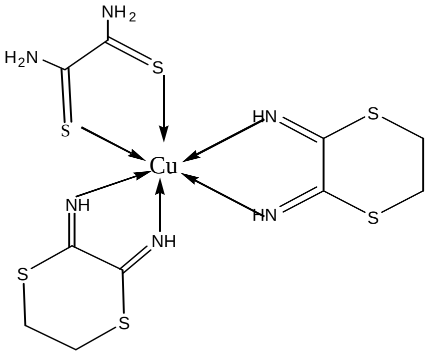


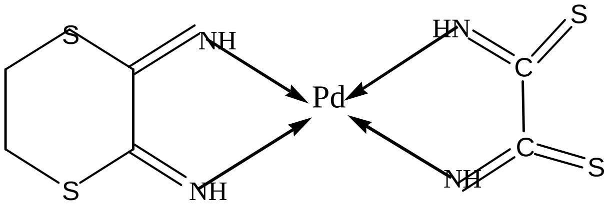






Since the spectra of both complexes showed the bands of υC=S at 1025 and 1030 cm^{-1} for Cu and Pd respectively, the first and second isomers are more probable.





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Republic of Iraq
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and Scientific Research
Al-Nahrain University
College of Science
Department of Chemistry

SYNTHESIS AND STUDY OF MIXED LIGAND COMLEXES OF PALLADIUM (II) AND COPPER (II)

A Thesis

Submitted to the College of Science Al-Nahrain University in partial fulfillment of the requirements for the Degree of Master of Science in Chemistry

By
Hamsa Thamer AL-Rafaqany
(B.Sc. 2004)

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جمهورية العراق
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جامعة النهرين
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Supervisor certification

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In view of the available recommendation, I forward this thesis for debate by the Examining Committee.

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بسم الله الرحمن الرحيم

و انزل الله عليك الكتاب و الحكمة و علمك

مالم تكن تعلم وكان فضل الله عليك عظيما

صدق الله العلي العظيم

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Symbols and Abbreviations

FTIR	**Fourier transform infrared**
UV-Vis	**UItraviolet-Visible**
DMSO	**Dimethyl Sulphoxide**
EtOH	**Ethanol**
DTO	**Dithiooxamide**
Bipy	**2,2-Bipyridyl**
Nm	**Nanometer**
M,P	**Melting Point**
υ	**Stretching**
λ	**Wave length**
σ	**Bending**
Pph_3	**Triphenyl phosphine**

Abstract

The chemistry of Palladuim and Copper is briefly reviewed, with emphasis on their +2 oxidation state, unique properties and structures of their complexes, beside the basic aspects of bonding, structure and geometrical aspected of metal complexation.

The structure and bonding chemistry relevant to the use of dithiooxamide in metal complex synthysis is discussed and related to the questions posed in this work.

The preparation of 1:1 for Palladuim (II) and 1:2 for Copper (II) to dithiarine complexes is described , as well as the preparation of mixed ligand complexes by further reaction with NPh_3 , PPh_3, $AsPh_3$, 2,2$^{/}$-dipyridyl and dithiooxamide. The use of FTIR, UV-Vis spectroscopy, magnetic susceptibility and conductivity measurements and metal analysis for the prepared complexes are described and their structure implications are discussed and compared with results from other studies.

The Pd (II) complexes are sequar planar geometry, but Cu (II) complexes show to have octahedral geometry.

الخلاصة

تم من خلال هذه الرسالة استعراض موجز لكيمياء البلاديوم و النحاس ،مع التاكيد على حالة الاكسدة(٢+)لكل منهما ، كذلك الخواص الفريدة و الصيغ التركيبية لهما ، ذلك الى جانب استعراض اسس و صيغ النواحي التاصرية والتركيب و الاشكال الفراغية عند تكوين المعقدات.

تم مناقشة الكيمياء التركيبية و التاصرية المتعلقة باستخدام(Dithiooxamide) كاليكاند في تحضير المعقدات الفلزية و علاقة ذلك بالمشاكل و الاسئلة التي تتولد من العمل الحالي .

جرى و صف طرق تحضير معقد البلاديوم الثنائي مع (dithiarine) بنسبة١:١ (فلز:ليكاند) ولمعقد النحاس الثنائي مع (dithiarine) بنسبة ٢:١ (فلز:ليكاند) اضافة لوصف طرق تحضير معقداتهما المحتوية على مزيج من ليكندين بمفاعلة المعقدات و الناتجة مع اليكندات الهجينة dithiooxamide, $2,2^{/}$-dipyridyl, $AsPh_3$, PPh_3 , NPh_3.

تم الوصف باستخدام طرق تحليل الاشعة تحت الحمراء و الاشعة فوق البنفسجية – المرئية الطيفية و قياسات الحساسية المغناطيسية و التوصيلية الكهربائية و تحليل الفلز (باستخدام تقنية الامتصاص الذري) لتشخيص المعقدات المحضرة و تم مناقشة التركيب على اساسها و المقارنة مع نتائج الدراسات الاخرى ظهر ان معقدات البلاديوم الثنائي ذات شكل مربع مستوي بينما كانت معقدات النحاس الثنائي ذات شكل ثماني السطوح المشوه.

الاهداء

الى من توج أسمي باسمه الى الذي افنى عمره ووهب لي عطفه وبره وشد من أزري في السعي لمطلب العلم.....

روح والدي الطاهرة

قدوتي ومصدر فخري

الى التي لم تبخل علي بسنين عمرها وجادت لي حتى بروحها........
الى من سقتني الحنان وكان لي حضنها بر الامان.......
الى من اضاءت لي الدرب والتي تأنس روحي بقربها ويستنير دربي بدعائها وتغفو أحزاني بأبتسامة عينها......

أمي حنان الدنيا كلها

ورمز التضحية

الى ملامح طفولتنا وعنوان شبابنا...
الى من طال بهم شوط الانتظار الى روافد الوفاء...
الى من أشد بهم أزري...
الى من حبهم يجري في عروقي .....

سندي وعزي

أخوتي أحمد وحيدر

الى رفاق الدرب الطويل .....

اصدقائي الاوفياء

الى كل من احبني وأراد مودتي.....
أهدي ثمرة هذا الجهد المتواضع..... همسة

بسم الله الرحمن الرحيم

(الذين أذا أصابتهم مصيبة قالوا أنا لله و أنا أليه راجعون)

صدق الله العظيم

يا أستاذي ....

أي يوم كان يومك، هو الخلود والمجد أبيت الأ أن تكون في مصافي السعداء بعد أن كنت في مصافي العلماء، وخط أسمك في ديوان الشهداء عانقت الشهادة وسلكت سبيل المجد.

أخبرني أي أخلاص هذا الذي فيك، وأي صدق هذا الذي بين جنبيك حتى حباك ربك بمثل هذه الخاتمة السعيدة والغاية البعيدة.......

أبي، أيها الراحل الى عالم الخلود، تعجز كلماتي وعباراتي في حقك فماذا أقول في رثائك عجبي لهذا العالم الذي أخذك منا بسرعة البرق فما زلنا بحاجه إليك. إلى كلماتك يا مربينا وأستاذنا ....

ما زلنا بحاجه إليك في هذا العالم الغريب الذي لم يعد للحب والأمل والخير. لم يعد لعيون الطيبين والمسامحين مثلك .....

أبي اغتالوك وما اغتالوا الأ البدن فالذكر باق والنهج باق والدرب منير وقرابينه كثير جمت عن الإحصاء عدد كنت واحدا منها.......

وهل مات من أحيا علما ؟.........

موتك هز الشرفاء وأنتزع الدمع واحرق قلوبا حرى لم تنم عين ولم يهدأ جفن....

دمك الطاهر ينير لنا الدرب وصوتك باق فينا لم تلوثه يد ملطخه بالدماء نثرت جسدك بل هو رمز للتضحية والعلم والنصر...

References

1- M.N. Hughes, "***Inorganic Chemistry of Biological Processes*** ", 2nd Ed., John Wiley and Son, (1988).

2- A.H. Jassim, ***Ph.D. Thesis***, AL-Nahrain University, Iraq.(1993).

3- C.X. Xhang and S.J. Lippard, "***Current Opinion in Chemical Biology",*** 7***,*** 481, (2003).

4- G.E. Davidson " ***Group theory for Chemist*** "1th. Ed, London, (1991).

5- A) J.E. Brady and G.E. Humiston "***General Chemistry, Principle and Structure*** "4th Ed. John Wily and son Inc., (1986).

B) C.E.Housecroft and A.Q.Sharpe"***Inorganic Chemistry***", 3rd Ed. Prentice Hall, (2008).

6- R.G. Pearson, ***J.Chem. Edu***., 45(10), 581- 643, (1968).

7- H.A.O. Hill, J.M.Patt,and J.P. Williams, Chem. Brit,5**,** 156,(1969).

8- R.G. Pearson,***J.Am***. Soc., 85,3533, (1963).

9- C.x. Zhang and S.J. Lippard," ***Current Opinion inChemical Biology",*** 7,481-489, (2003).

10- J.E. Huheey, "***Inorganic Chemistry***",3rd Ed., Harper and Row, (1980).

11- F.A. Cotton and G. Wilkinson, "***Advanced Inorganic Chemistr***", 4th Ed., John Wilkey and Sons, Chichester, Toronto, Signapore, (1980).

12- F. Basolo and R.G. Johnson "***Coordination Chemistry***" California,(1962).

13- J.E. Huheey, " ***Inorganic Chemistry***, ***Principles of Structure and Reactivity***", Harper and Row., NewYork, P.424-425, (1972).

14- F.Basolo.R.G.Pearson***,*** ***Prog. Inorg. Chem***.,4,381-453,(1962) 15- J.E.Huheey,E.A.Keiter and R.L.Keiter"***Inorganic Chemistry***",4th Ed., Harper Collins College Publishers,(1993).

16- J. Gazo, et al.," ***Coord. Chem. Rev***.,18, 253.,(1976) .

17- N.N Green Wood and A..Earnshow,"***Chemical of Element***", Pergamon Press,P.1382, (1984**).**

18- H.S. Maslen and T.N. Waters,"***The conformation of Schiff-base complexes of copper (II): A stereo-electronic view".*** Coord. Chem. Revs. 17,137, (1975).

19- J.Catterick and P.Thornton**.*,"Structures and physical properties of polynuclear Cu(II) Carboxylates complexes*"** Inorg. Chem. Radiochem.20, 291-362(1977).

20-K.G. Pearson and Songested ,J.Am. Chem. Soc.89**,** 1827,(1967).

21- M.Misono , J.Inorg. Nucl. Chem ,29**,** 2685, (1967).

22- C.K. Jorgensen, Inorg. Chem**,** 3**,**1201,(1984).

23- P,M. Maitlis, P. Espinet and M.J.H. Russell, "***Coprehensive Organometallic Chemistry"*** 2ed Ed., Pergamon, Oxfored, (1982).

24- F.R. Hartley," ***The Chemistry of Platinum and Palladium***" 3th Ed., London, (1973).

25- J.V. Quagliano and L.Schubert, Chem. Rev**.,** 50**,** 201, (1952).

26- F.A. Cottan and R. Francis, J. Amer, Chem. Soc., 82**,**2986, (1960).

27- F. A. Cottan and R. D. Barnes ,J. Chem. Soc**.,** 2199, (1960)

28- J.L. Burmeister and F. Basolo, Inorg Chem**.** 3**,**1587, (1964).

29- K.F. Purcell and R.S. Dragon , J.Am. Chem., Soc., **88,**914, (1996).

30- D.A. Ltangs, C.R. Hare and R.G. Little, ***Chem. Commun***,21, 1080,(1967).

31- M.Mcpartlin and R. Mason, Chem. Commun**.,** 23**,**545, (1967).

32- R. A. Walton and G. B. F. G. Johnson, ***Spectro Chem***. ***Acta***, 22**,**1853, (1966).

33- P. Espinet, K. Solatic, and J.P.H. Charmant; ***Chem. Commun.***, 915, (2000).

34- R.D. Schnebeck and E. Freisinger ***Chem. Commun.*** 675,(1999).

35- J.R. Hall; S.J.Loebj and G.K. Shimizu,Chem., Int. Ed., 37**,** 121, (1988).

36- Z.Qin and S. Jenning Chem. Commune**.,** 354 , (2002).

37- F. Basolo and R.G. Pearson "***Mechanism of Inorganic Reaction*** ". P. 12. (1964).

38- C.K. Jorgenson, J. Inorg. Nucl. Chem., 24**,**157-158, (1962).

39- E.GonickW.C. Fernelius and B.E. Douglas, J. Am. Chem. Soc., 76,4671, (1954).

40- F.A. Cotton and R. Francis, J.Amer, Chem. Soc., 82**,**2986,(1960).

41- B.B. Way Land and R.F. Schramm, Chem. Commun., 1465,(1968).

42- B.B. Way Land and R.F. Schramm, Inorg. Chem. 8**,**971,(1960).

43- M.H. AL-Qaissy***, Ph.D.Thesis***, AL-Nahrain University, Iraq, (2001).

44- F.M.I.AL-Samraiy,A.H.Jassim and B.R.J.Muhydlecn,Eur Journal of SciRes., 19(1**),**38-57,(2007).

45- M. Fujita, O. Sasak, T. Mitsuhash, J. Xazaki, K. Xamaguchi and K. Ogara, Chem . Commun.,11535,(1996).

46- J.Hprice A.N.Williamson R.fschramamm and B.B.Wayland Inorg. Chem 116,(1972).

47- K.M Berlin.Struct Bond,68,89,(1987).

48-T.Liny,Z.H.Jiag,L.Mas, J.Bail,D.Z.Liao,S.P.Yan and G.L.Wang,***Trans.Met.Chem***.,19**,**332,(1994).

49- K. Nakamoto, J. Fusite, and H. Murata, J. Am. Soc., 80. 4817, (1988).

50- A.R. Brause, F. Kaplan, and M.Orchin, J.Am. Chem. Soc.,89, 2661, (1967).

51- W. M.farlane, J.Am.Chem.Soc., A, 1922,(1967).

52- K.Nakamoto "***Infrared Spectra of Inorganic and Coordination Compoundds"*** ,4th Ed. Wiley,. NewYork, (1986).

53- B.Start, W.George and P.Mcintyre,"***Modern Infrared Spectrocopy"*** John Wiely and Sons, New York, (1996).

54- J. Chatt, L.A. Duncanson and L.M. Venanzi, J. Chem. Soc., 4456, (1962).

55-I. Suzki, Bull. Chem. Soc., 35, 1286, (1962).

56- J.S.Stewart,J.Chem.Phys.26,248,(1957).

57- K.A.Jensen and P.H.Neilsen,Acta.Chem.20,597**,(**1966).

58- R.M. Silverstein, G.C. Bassler and T.G. Morrill "***Spectrometric Identification of Organic Chemistry "***John Wiely and Son.,(1981).

59-A.J.Baker and T.Cairns,"***Spectroscopic technigues in organic chemistry".***Published by Heydenic and sonlimited,(1966).

60-D.A. Brown, W.K. Glass and M.A.Burke, Spectrochemical. Acta, 32A, 37-43,(1967).

61- Nicholis "***Complexes and first. Row Transition Element***". Translated by Dr.w.l. Azeez, pp.141, (1984**).**

62- C. Preti, G.D.Tosi and Verani .J.Inorg. Chem., 6, 3725, (1974).

63- S.F.Akatti***, Coord. Compound***, London,P.1968, (1975).

64- Nada. A., ***M. Sc. Thesis***, AL-Nahrian University, (2000).

65- A.Hetzheim and K.Mockel,"***Advanced in Heterocyclic Chemistry",***Academic press,Inc.,New york.P.188-224,(1966).

66- T.N.Hazarika and T.Baro,Trans.Met.Chem**.,7,**210,(1988).

67-R.Vaddle,S.S.Jagannathatha,S.Somuandl.Transe.Met.Chem.,9**,**103 (1984).

68- A.B.P.Lever."***Inorganic Electronic Spectroscopy***" Elsevier publishing Conpamg,London,New york,(1968).

69- J. E. Huheey ***''Inorganic Chemistry, Principles of structure and Reactivity"***, Cd. Horpar and Row. , New york, p.422-425,(1988).

70-E.W.Anisceugh,A.M.Bodie,W.A.Denny,G.J.Finaly and J.D.Ranford,J. *Inorg.Biochem*.,77,125-133,(1998).

71 E.W.Anisceugh,A.M.Bodie,W.A.Denny,G.J.Finaly and J.D.Ranford,J. *Inorg-Biochem*,70,175-185(1998).

72-E.O.Lima,E.F.Queroz and V.C.Filho,Bio.Soc.Chil.,44.210(1999).

73-- Harrigan,W.F.andMcCacer,M.E.Laboraty"*Methods in food and Dairy Microbiology*".Academic press Inc.London.p.451,(1976).

74- M.U.Rahman,and S.Gul.Biotechnol. 1(1):55-60, (2002).

75- E.H.EI-Tmany,E.M.Salem,R.N.Matwaily and A.H.Soghier, Egypt.J. Chem.,40(5),339,(1997).