

**UNIVERSITI TEKNOLOGI MARA**

**SYNTHESIS, CHARACTERIZATION AND  
CONDUCTIVITY STUDIES OF CONJUGATED  
CYCLIC SCHIFF BASE COMPOUNDS DERIVED  
FROM SUBSTITUTED SALICYLALDEHYDE AND  
PHENYLENEDIAMINE DERIVATIVES**

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## ABSTRACT

Organic semiconductors have considerable important over the past decades because of its easy preparation. Schiff base ligand is one example of organic semiconductor. Six conjugated Schiff base ligands were synthesized by condensation of phenylenediamine derivatives and substituted salicylaldehyde namely L1, L2, L3, L4, L5 and L6. Metal complexes of L1 and L2 were prepared using cobalt(II) acetate tetrahydrate, copper(II) acetate monohydrate, nickel(II) acetate tetrahydrate and zinc(II) acetate dihydrate by *in-situ* method. All compounds were characterized by elemental analysis, NMR spectroscopy, infrared spectroscopy, UV-Visible spectroscopy and magnetic susceptibility measurements. Conductivity measurements were done using EIS method. The C=N peaks appeared in the range of 1607 – 1622  $\text{cm}^{-1}$  for all Schiff base ligands indicates the formation of Schiff base ligand. The C=N band is shifted to lower frequency after complexation with metal ions. Complexation occurs by coordination of nitrogen to the metal ion. This was proven by the presence of M-N peak at 500 – 543  $\text{cm}^{-1}$ . All metal complexes were suggested to exhibit tetrahedral or square planar geometries based on magnetic susceptibility measurements. Co(II) metal complexes having magnetic moments 3.67 and 3.60 BM for L1Co and L2Co respectively. The magnetic moments of Cu(II) complexes lie in the range 1.83 – 1.87 BM. Conductivity studies and the optical band gap of these compounds were investigated to determine their conductivity values and band gap energy. The conductivity value of synthesized compounds were obtained in the range of  $10^{-8}$  –  $10^{-5} \text{ Scm}^{-1}$  which include in organic semiconductor range between  $10^{-9}$  and  $10^3 \text{ Scm}^{-1}$ . Both ligands L1 and L2 show higher conductivity value compared to all their metal complexes. Conductivity value of L1 is  $1.37 \times 10^{-7}$  while its metal complexes L1Co, L1Ni, L1Cu and L1Zn are  $9.31 \times 10^{-8}$ ,  $8.97 \times 10^{-8}$ ,  $7.55 \times 10^{-8}$  and  $1.63 \times 10^{-8} \text{ Scm}^{-1}$  respectively. The band gap energy for L1 is 1.56 eV while its metal complexes L1Co, L1Ni, L1Cu and L1Zn are 2.69, 3.17, 2.76 and 2.53 eV respectively. Generally, the optical band gap energy supports the conductivity value as the lower band gap energy indicates higher conductivity value. This study presents a beneficial basis to further apply in electronic industrial application especially in semiconductor.

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# CHAPTER ONE

## INTRODUCTION

### 1.1 BACKGROUND OF STUDIES

#### 1.1.1 Coordination Chemistry

The coordination chemistry history begins when Tassaert discovered  $\text{Co}(\text{NH}_3)_6\text{Cl}_3$  in 1798. But then Werner systematized the theory in 1893. Sir R.S. Nyholm acknowledged that major developments in inorganic chemistry had been in the field of coordination chemistry (Banerjea, 1993). Coordination chemistry is the study of compounds formed between metal ions and other neutral or negatively charged molecules (Cartere, 2008). Coordination chemistry is one of the most significant research areas in inorganic chemistry and plays a very major role in our lives. The study of them has contributed to the highest degree of understanding the chemical bond in inorganic chemistry. One definition of a metal complex or coordination compound is a compound formed from a Lewis acid and a Brønsted base; a Lewis acid being an electron pair acceptor and a Brønsted base a proton acceptor. Metal ions and organic ligands are the two significant components for preparing the coordination compounds (Sarkar et al. 2008). According to the modern concept, even the organometallic compounds belong to the general class of coordination compounds and a host of such compounds of a large majority of metals have been synthesized with a wide variety of organic substrate (Banerjea, 1993).

A survey of the literature shows that coordination chemistry covers diverse fields such as dyes, colour photography, mineral extraction, nuclear fuels, toxicology, bioinorganic chemistry, inorganic solid state chemistry, organometallic chemistry, analytical chemistry, medicine, catalysis, material science, ceramics, microelectronics, photonics, as well as semiconductors (Cartere, 2008). Not all coordination compounds were prepared in the laboratories. Some of them naturally occurred such as in the human and plants living systems. The living system is partially supported by coordination compounds such as hemoglobin, myoglobin, chlorophyll and cytochromes. Figure 1.1 shows the structure of chlorophyll *a*, a specific form of chlorophyll used in oxygenic