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Electrical Conductivity and Antimicrobial Screening of Transition Metal Complexes of Tetradentate Unsymmetrical Ligand

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Abstract: The electrical conductivity of the solid Ni(II), Co(II), Mn(II), Cu(II), Fe(III) and Cr(III) complexes of unsymmetrical tetradentate Schiff base ligand derived from salicyladehyde, *o*-hydroxy acetophenone and ethylene diamine were measured and the activation energy of complexes were also calculated from Arrehenius plots. Ligand and its complexes were tested against various microorganisms and all of them found to be active against the organisms.

Key words: Unsymmetrical · Tetradentate · Electrical conductivity · Antimicrobial activity

INTRODUCTION

From more than last one decade, there has been a dramatic growth of interest in inorganic complexes based materials that exhibit unusual properties [1]. Schiff bases derived from an amine and aldehyde/ketones are an important class of ligands that coordinate to metal ion via azomethine nitrogen and have been studied extensively [2]. Schiff base complexes have been found to be important precursor for semi conducting materials [3, 4]. Various studies have shown that Schiff base derived from salicyladehyde and its derivative containing nitrogen, sulphur and/or oxygen as ligand atoms are of interest as simple structural models of more complicated biological systems [5, 6] and their metal complexes shown wide spectrum of application such as biochemical, analytical, industrial and antimicrobial agents [7, 8]. In our previous publication [10], we have reported the synthesis and characterization of Ni(II), Co(II), Mn(II), Cu(II), Fe(III) and Cr(III) complexes of Schiff base ligand *N*-(salicylidene)- *N'*-(*o*-hydroxyacetophenone)-ethylenediamine (H_2L) (Fig.1). In the present paper, we report the electrical conductivity and antimicrobial screening of these complexes.

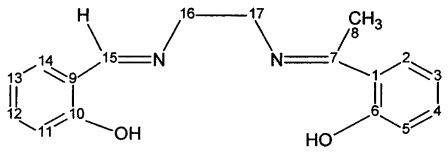

Fig. 1: N-(salicylidene)-N'-(*o*-hydroxyacetophenone)-ethylenediamine (H_2L)

Experimental: The solid state electrical conductivity of complexes was measured in their compressed pellet form by the two-probe method using Zentech resistivity meter in the temperature range 313 K≤T≤403 K. The antibacterial activities of the ligand and the complexes have been carried out against the bacteria *Staphalococcus aureus*, *Bacillus Subtilis*, *Salmonella typhimurium* and *Escherichia coli* using nutrient agar medium by the disc diffusion method. Solutions of 100, 200 and 300 ppm of the compounds in DMSO were used for the studies. These discs were placed on the already seeded plates and incubated at 35°C for 24h. The diameter (mm) of the inhibition zone around each disc was measured after 24h. The antifungal activity was evaluated by the same disc diffusion method using potato dextrose agar medium containing starch 20g. Dextrose 20g and agar-agar powder 15g dissolved in 1000ml distilled water. Same concentrations of compounds were used. The organisms used were *Aspergillus oryzae* and *Fusarium species.* The fungicidal activity of the compounds was recorded after 7 days.

RESULTS AND DISCUSSION

Electrical Conductivity: The DC electrical conductivity of Ni(II), Co(II), Mn(II), Cu(II), Fe(III) and Cr(III) complexes have been studied in the temperature range 313 K≤T≤403 K using the two probe technique Table 1. The values of the solid state electrical conductivity of the complexes were found in the range of 10^{-10} to 10^{-6} $\Omega^{-1}cm^{-1}$ and their conductivity increases with increase in temperature and

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Table 1: Electrical conductivity and activation energy of complexes

Compound	σ_($\Omega^{-1}cm^{-1}$)	Ea (eV)
[NiL]	1.82 x 10^{-8}	0.779
[$CoL(H_2O)_2$]	5.65 x 10^{-10}	0.638
[$MnL(H_2O)_2$]	6.96 x 10^{-7}	0.598
[$CuL(H_2O)_2$]	2.47 x 10^{-9}	0.530
[FeLCl (H_2O)]	7.90 x 10^{-6}	0.503
[$CrLCl(H_2O)$]	3.53 x 10^{-6}	0.515

Table 2: Antimicrobial activities of ligand and its complexes

	Diameter of inhibition zone (mm) (Concentration in ppm)																	
	Antibacterial Screening Data												Antifungal Screening Data					
	Staphalococcus aureus			*Bacillus Subtilis*			*Salmonella typhimurium*			*Escherichia coli*			*Aspergillus oryzae*			*Fusarium species*		
Compound	100	200	300	100	200	300	100	200	300	100	200	300	100	200	300	100	200	300
LH_2	9	17	6	6	8	9	7	7	9	8	12	17	-	-	-	6	-	8
[NiL]	9	8	8	6	6	7	6	7	9	10	6	6	-	10	-	-	-	-
[$CoL(H_2O)_2$]	-	25	13	-	8	-	7	6	-	7	11	11	-	-	6	9	6	-
[$MnL(H_2O)_2$]	6	9	7	6	6	8	6	7	8	7	12	10	-	8	6	-	-	-
[$CuL(H_2O)_2$]	7	-	-	-	6	6	6	-	7	-	6	7	6	-	7	-	-	-
[$FeLCl(H_2O)$]	16	11	9	6	6	7	10	8	8	6	11	11	-	-	-	7	8	9
[$CrLCl(H_2O)$]	6	6	7	6	8	9	7	6	6	6	8	9	-	-	-	7	6	-

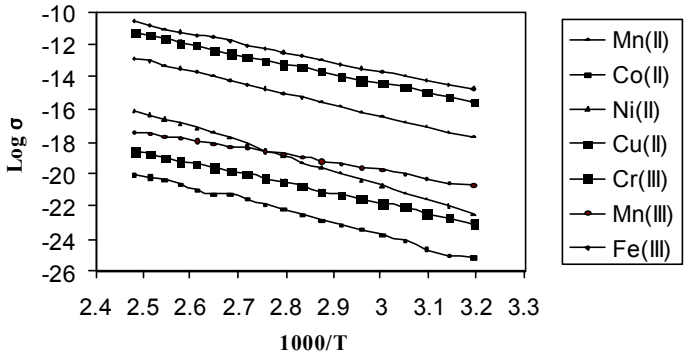

Fig. 2: DC electrical conductivity *vs.* 1000/*T*.

decreases upon cooling over the studied temperature range indicating their semi conducting behavior [10]. The activation energy-temperature dependence follows the Arrehenius relation.

$$\sigma = \sigma_0 \exp(-Ea/kT),$$

where σ_0, Ea and k are conductivity constants, the activation energy and the Boltzman constant, respectively. The plots of log σ vs. 1000/*T* (Fig. 2) for all the compounds are found to be linear over the entire temperature range. The activation energy of the compounds lies in the range 0.503-0.779.

Antimicrobial Screening: The Schiff base and its metal complexes were evaluated for antimicrobial activity against two strain Gram +ve bacteria (*Staphalococcus aureus*, *Bacillus subtilis*), Gram-ve bacteria (*Salmonella typhimurium*, *Escherichia coli*) and fungus (*Aspergillus oryzae*, *Fusarium species*). The antimicrobial screening results are given in Table 2. These observations show that the majority of the compounds are more active than their respective Schiff bases. In some cases, Schiff bases and their complexes have similar activity against bacteria and fungi [11]. Chelation may enhance or suppress the biochemical potential of bioactive organic species. The antibacterial screening shows that compounds

$[CoL(H_2O)_2]$ and $[FeLCl(H_2O)]$ exhibit the most activity [12]. The fungicidal screening shows that compounds $[CoL(H_2O)_2]$, $[FeLCl(H_2O)]$ and $[CrLCl(H_2O)]$ are most effective against *Fusarium species*.

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