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The Study of Semiconducting Behaviour of Some Metal-Ligand Complexes

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Abstract: ***Metal-ligand complexes of Cr(III), Mn(III), Fe(III), Ti(III), Co(III), Ni(III), and Cu(III) and with 3-(2-hydroxyl-3-Bromo-4-methyl phenyl)-5-phenyl isoxazoline [HBMPPI]. Generally these metal-ligand complexes are insoluble in water. The electrical conductivity of the metal-ligand complexes has been measured in wide range of temperature (315-493 K). At room temperature electrical conductivity (σ) values of the metal-ligand complexes lies in the range of (2.10 x 10^{-9} to 2.60 x 10^{-11} Ω^{-1} m^{-1}) typical of semiconductors. After the observation plot graph of log σ vs 1/T were showed to be linear, also indicating the semiconducting nature of the metal-ligand complexes in the studied range of temperature. The general behavior of electrical conductivity (σ) obeys the relation $\sigma = \sigma_0 \exp(-Ea/KT)$, where σ_0 is a constant, Ea, the activation energy of conduction process, T the absolute temperature and K the Boltzman constant. The energy of activation (Ea) of metal-ligand complexes is obtained from the slopes of plots which is in the 1.070 - 0.440 eV range and decreases in the order Ti > Cu > Cr > Fe > Co > HBMPPI > Mn > Ni.***

Keywords: ***Electrical conductivity, semi conductivity, metal-ligand chelates***

I. INTRODUCTION

The novel isoxazoline derivative is a main focus of medicinal chemist, due to their good pharmacological activity. Isoxazoline derivatives have been reported as antifungal antibacterial, anticonvulsant, anti-inflammatory, antiviral and analgesic activity. In addition, isoxazoline derivatives have played a crucial role as intermediates in the organic synthesis of number of heterocyclic pharmacological active compounds [1-6]. Some metal-ligand ions complexes have especial characteristics of semiconducting and catalytic properties [7]. Literature survey reveals that the most of the work has been done on the bivalent transition metal complexes of Schiff bases and some workers determined the semiconductivity of metal-ligand chelates [8-9]. Hence in a present investigations we have reviewed that the semiconductivity of 3-(2-hydroxyl-3-Bromo-4-methyl phenyl)-5-phenyl isoxazoline [HBMPPI] and its chelates with Cr(III), Mn(III), Fe(III), Ti(III), Co(III), Ni(III), and Cu (III).

II. EXPERIMENTAL

The electrical conductivity was measured by using (d.c) micro volt meter. The well powdered compounds were placed in a steel die .A thin aluminium foil was used for good electrical contact and the pellet was placed between two spring-loaded brass electrodes of a specially designed sample holder. For electrical conductivity measurement at different temperatures, a suitable electric furnace was used and the sample holder was kept in the centre of the furnace.

III. RESULTS AND DISCUSSION

The ligand 3-(2-hydroxyl-3-Bromo-4-methyl phenyl)-5-phenyl isoxazoline [HBMPPI] acts as a bidentate molecule having phenolic oxygen atoms. The electrical conductivity was studied from temperature 315 K to 493 K, as shown in Table 1.

Compound	Electrical Conductivity (σ)		Activation Energy (E_a)
	At 315 K	At 493 K	
[HBMPPI]	9.08×10^{-11}	2.77×10^{-7}	0.824
$[Cr.HBMPPI.Cl(H_2O)]_n$	2.94×10^{-9}	4.59×10^{-8}	0.957
$[Mn.\ HBMPPI.\ (OA_C)]_n$	3.51×10^{-11}	3.74×10^{-8}	0.713
$[Fe.HBMPPI.Cl(H_2O)]_n$	4.59×10^{-10}	5.89×10^{-8}	0.941
$[Co.\ HBMPPI]_n$	7.02×10^{-10}	2.81×10^{-8}	0.911
$[Ni\ HBMPPI.DMF]_n$	3.09×10^{-9}	3.21×10^{-7}	0.596
$[Ti.\ HBMPPI.Cl(H_2O)]_n$	2.46×10^{-10}	2.19×10^{-8}	1.059
$[Cu.\ HBMPPI]_n$	5.16×10^{-10}	5.89×10^{-8}	0.997

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At room temperature the electrical conductivity (σ) of the ligand and their metal ions (chelates) was found to be between 3.09 x 10^{-9} and 3.51 x 10^{-11} Ω^{-1} m^{-1} indicating their semiconducting nature [10]. The electrical conductivity decreases in the order Ni > Cr > Co > Cu > Fe > Ti > [HBMPPI] >Mn.

The electrical conductivity (σ) obeys the relation (1).

$$\sigma = \sigma_0 \exp(-Ea/KT) \quad \ldots\ldots\ldots\ldots (1)$$

Where- σ_0 is a constant

Ea - activation energy of conduction process

T -absolute temperature and

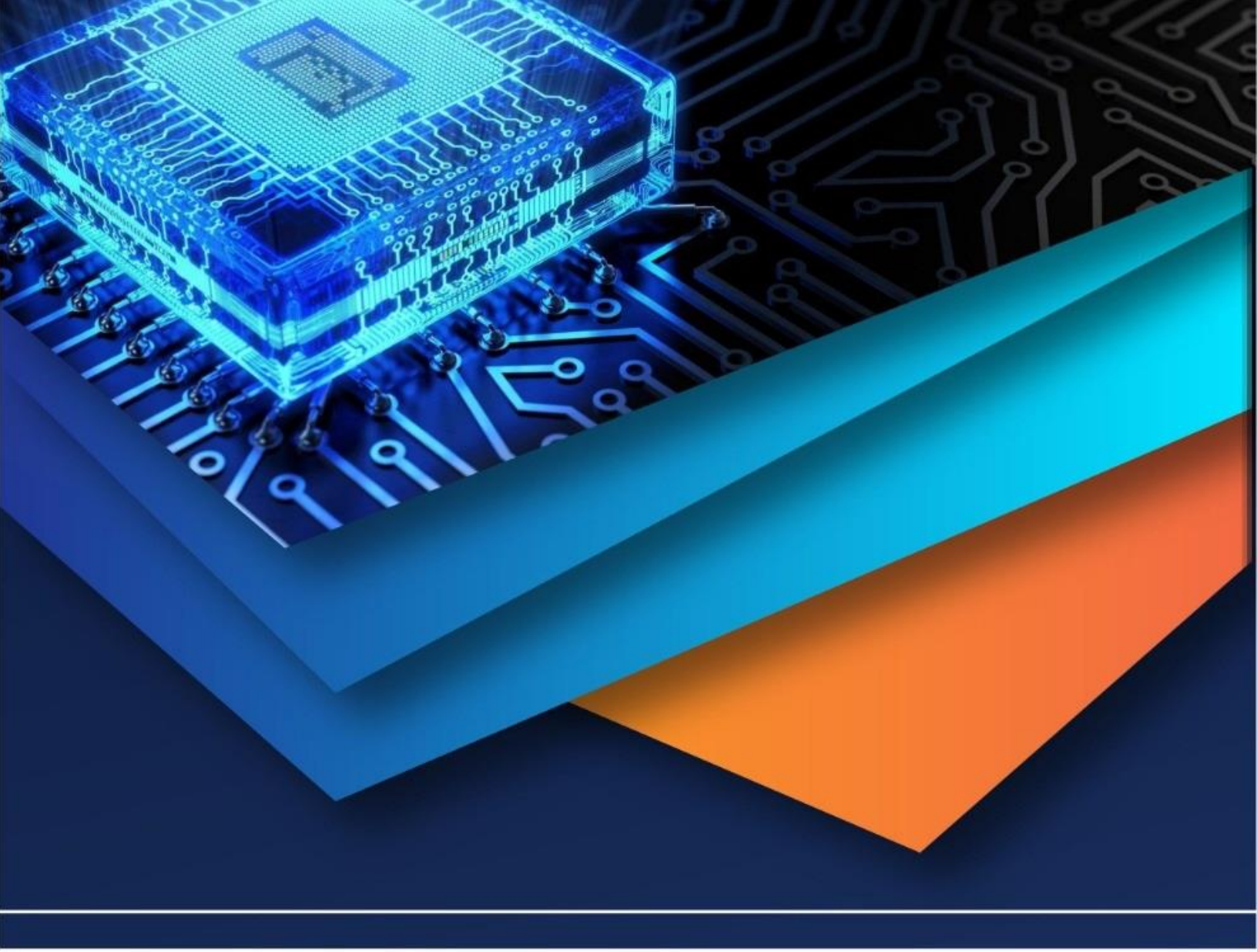
K -Boltzman constant

The temperature depends on the electrical conductivity of the ligand and chelates. By observing graph between log σ vs 1/T were found to be linear indicating their semiconducting nature at different temperature. The conductivity increase with increase in temperature this showing semiconducting behavior [11].The activation energy (electrical conduction) of [HBMPPI] and their chelates was obtained in the higher temperature region, which lies in the range 1.059 - 0.997 eV, and decreases in the order Ti > Cu > Cr > Fe > Co > HBMPPI > Mn > Ni. The results indicate that the electrical conductivity and activation energy of chelates was varying with the metal ion, which may be due to the formation of different metal ions in chelates.

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