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Cyclic Voltammetric and Polarographic Study of Conducting Properties of Poly Methyl Aniline (PMA) and its Complex with Zn

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Abstract— The development of the field of conducting polymers has continued to accelerate at an unexpectedly rapid rate. in this development there have been contributions from a wide spectrum of scientists such as chemists ,physicists, polymer materials scientists ,spectroscopists, electronic and electrical engineers ,thereby making this field as one of the most interdisciplinary fields of science today . by now these polymers are showing commercial promise in such areas as power equipment , light weight and rechargeable batteries ,micro machines, adhesives and many more applications have been proposed using these exciting systems. In this paper Cyclic Voltammetric parameters and Polarographic parameters for PMA i.e. Poly Methyl Aniline and its Complex formation with Zn have been presented. To find out the number of electrons involved in the electrode process cyclic voltammetric studies have been performed. Sets of solutions containing varying concentration of each of the polymers in 0.1 M potassium chloride (overall concentration) were prepared and the pH was adjusted to 8.0 ± 1 and scan rate was 40 mVs-1 ,similar sets of poly methyl aniline –Zn complex of Various concentration were prepared Cyclic voltammograms of these sets were recorded on the Pulse polarograph CL90 . Fig- 2.2and 2.7 show the cyclic voltammogramms of PMA, Zn –PMA complexes respectively. The cyclic voltammetric data for these species have been tabulated in tables.

Keywords— Cyclic voltammetry, PMA, half wave potential, diffusion current dropping mercury electrode

I. INTRODUCTION

Focusing attention on such an emerging field and taking stock of the progress made in this field, would give further fillip to research in this field. Polymer is a generic name given to a vast number of materials which exist in countless forms and numbers of materials which exist in countless forms and numbers. Because of a very large number and types of atoms present in their molecules, polymers can have different chemical structures, physical properties, mechanical behavior, thermal ways etc.[1] All the Chemicals used were of anala R/BDH grade. 0.01 M metal (Zn++) solutions were prepared by dissolving the requisite quantity of their soluble salts in double distilled water 0.1 M Poly Methyl Aniline solutions were prepared in small amount of hydrochloric acid diluted to required volume with distilled water 1. Experimental sets of solutions containing overall concentration of supporting electrolyte (KCl) and Metal ion fixed at 0.1 M and 1.0 mM respectively.[2] Whereas in other sets in addition to the above supporting electrolyte and metal ion concentration of each polymer (legend) was varied.Polarograms were recorded on an ELICO (Hyderabad) pulse polarograph Model CL-90 having a dropping mercury electrode (DME) a saturated calomel electrode (SCE) a working electrode as a working electrode reference electrode respectively.[3]

II. MATERIALS AND METHODS

Poly Methyl Aniline sulphate was prepared by chemical method applying oxidant (Potassium dichromate) the polymerization of 0.4 moles of methyl aniline in 1lit. of 1M sulphuric acid was affected using 1g equivalent of the potassium dichromate a precipitate was separated, washed, dried and weighed as poly Methyl Aniline sulphate Poly Methyl Aniline Chloride was prepared by equilibrating the Poly Methyl Aniline sulphate with1M HCl for about 10 hrs. The mass so obtained was separated, washed and dried and weighed as Poly Methyl Aniline Chloride. Preparation of Poly Methyl Aniline complex –An adequate quantity of the Poly Methyl Aniline host and the inorganic salts of Zn were separately dissolved in suitable solvent (e.g. acetonitrile).[4] The two solutions were then mixed and after stirring the solvent evaporated slowly to finally obtain powder form of Poly Methyl Aniline - Zn complexes.

Table: 1 : Some Cyclic Voltammetric and Polar graphic parameters observed for Poly Methyl Aniline (PMA)

Concentration mM	Id (µA)	$E_{1/2}$ V vs SCE	E_{pa} (V)	E_{pc} (V)	$E_{pc} - E_{pa}$ (V)	Ipa (µA)	Ipc (µA)	No. of electrons involved
0.1	0.96	-1.08	-1.06	-1.10	-0.04	0.20	0.26	2
0.2	1.06	-1.1	-1.05	-1.08	-0.3	0.20	0.24	2
0.3	0.9	-1.08	-1.05	-1.08	-0.3	0.20	0.28	2

Table.2: Some Cyclic Voltammetric and polarographic parameters observed for Zn (II)- Poly Methyl Aniline (Zn-PMA) complex

Concentration mM	Id (µA)	E1/2 V vs. SCE	Epa (V)	Epc (V)	Epc - Epa (V)	Ipa (µA)	Ipc (µA)	No.of electrons involved
0.1	1.1	-0.66	0.62	-0.64	-0.02	0.24	0.30	3
0.2	1.0	-0.64	0.62	-0.64	-0.02	0.22	0.24	3
0.3	0.84	-0.65	0.62	-0.64	-0.02	0.20	0.20	3

III. RESULT AND DISCUSSION

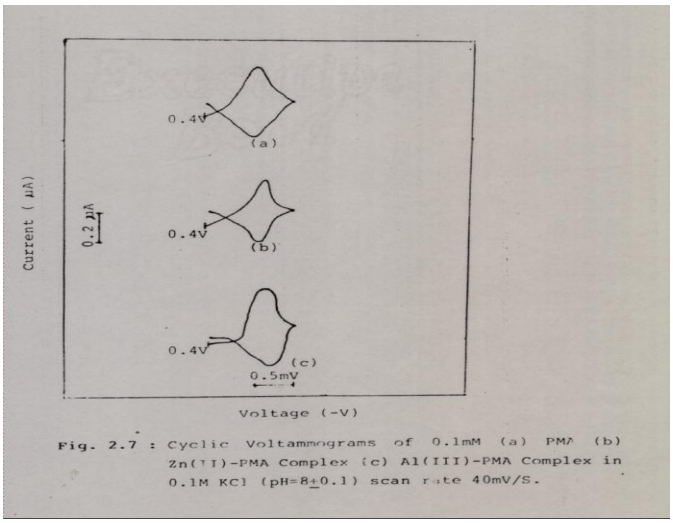

Fig. 2.7 : Cyclic Voltammograms of 0.1mM (a) PMA (b) Zn(II)-PMA Complex (c) Al(III)-PMA Complex in 0.1M KCl (pH=8±0.1) scan rate 40mV/S.

Fig.1. Pictures of Original Graphs recorded using pulse polarograph CL-90.

From tables and graphs it can be conclude that in case of Poly Ethyl Aniline - Zn complexes (Zn–PEA),the Epc-Epa i.e.cathodic and anodic peak potential values, indicating the involvement of 3, 2 and 3 electrons in the reversible electrode reduction process of the said species respectively[5].the Ipc and Ipa values are also tabulated in tables-1.1and table 1.2 which also supports this argument. Characteristic nature of $E_{1/2}$ of metal is changed when it forms a complex with some legend. It has been observed by Lingan[1] that $E_{1/2}$ of the metal ion is shifted to more electronegative value on complex formation and its diffusion current is shortened. On gradual increase of the polymer concentration the half wave potential of the metal ion shifted to more negative value in each case and the diffusion current also decreased which revealed complex formation of the Zn metal ion with Poly Ethyl Aniline.[5] To determine the composition and stability constants of binary complex plots of $\Delta E_{1/2}$ (shift in half wave potential ,$E_{1/2} = (E_{1/2})_c - (E_{1/2})$**s** against log C_x (logarithm of the complaxation of the legend)were drawn. The plots were linear showing the formation of single complex species in solution .Lingane treatment of the observed polarographic data revealed 1: 2 Zn : PMA complex formation in each case with formation constant log B=13.146 for Zn (II) PANI.

Polarographic parameters of Zn- Poly Ethyl Aniline complex formation is confirmed by its shortened diffusion current. Lingane has given a method for the study of dissociation /formation constant of the complex using polarographic method.[6]

Q In selt[4] observed that the temperature dependence of the Poly Ethyl Aniline film voltammetric response in aqueous and non aqueous, only a very slight shift into the direction of more negative potentials (Ca-10 mV) and a small increase in the temperature is increased by 30^0C

IV. SURVEY OF LITERATURE

W.John Albery[3], et.al have used electrode such as Poly Ethyl Aniline, poly pyrrol. Poly Ethyl Aniline and poly thiophene. They showed that the behavior of the different polymers is similar and may be explained by a chemical model involving localized redox species with two possible conformations of the polymer.

The temperature dependence of the Poly Ethyl Aniline film voltammetric response in aqueous and non aqueous media has been investigated by G.Inzelt[2] .He observed that only a very slight shift into the direction of more negative potentials in the peak potentials (Ca -10mv) and a small increase in the peak current as the temperature is increased by 30^0C.

Youn Chaol on Park Yong Woo studied behavior Poly Ethyl Aniline and found that the electrons are moving in and out changing the Poly Ethyl Aniline structure from one form to the another form

C. Herold 12 Yazmi, DBillaud attempted study of sodium doped poly paraphenylene film, John Alberry, et.al.

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