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Comparative studies of Conducting Behavior of Various Polymers

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Abstract

Present paper is to study the conductivity of various polymeric materials specially,
Polyaniline and its complexes and plyethyl aniline with its metal complexes and poly methyl aniline and its complex materials. With the help of polarographic curves and cyclovoltammograms obtained using pulse polarograph, this paper is prepared and result so obtained is discussed hereby. On gradual increase of the Polyaniline concentration the half wave potential of the metal ion like Zn (II)or Al(III) shifted to more negative value in each case and the diffusion current also decreased ,thereby indicating complex formation of the metal ions with Polyaniline is an important conducting polymer because of its good environmental stability. Its conductivity on complexation is arousing considerable commercial interests. Unlike other conducting polymers Polyaniline (PANI) has a unique feature as a conductor in acidic and insulator in the basic medium. Lingane Treatment of the observed polarographic data showed 1:1 metal: Polymer complex formation in each case with formation constants for Zn(II)-Polymer equal to log B=0.2787and log B=4.50,respectively. To find out the number of electrons involved in the electrode process cyclic voltammetric studies have been performed. Various sets of solutions containing varying concentrations of each of the polymers in 0.1 M potassium chloride(over all concentration) were prepared and the pH was adjusted to 8.0±0.1and scan rate was 40mVs-1, similar sets were prepared. Containing varying concentration of the polymer complexes under study. Cyclic voltammograms of these sets were recorded on pulse polarograph CL-90. PolyEthylAniline complexes generally have a multiple nature, consisting of salt rich crystalline phase and amorphous phase with dissolved salts.

Introduction

To assure high conductivity to the electrolyte. polyaniline complexes generally have a multiple nature ,consisting of salt rich crystalline phase and amorphous phase with dissolved salts .Therefore one of the most important characteristic of polyaniline electrolyte is that their conductivity is a property of the amorphous elastomeric phase.
Therefore one of the most important characteristic of PolyEthylAniline electrolyte is that their conductivity is a property of the amorphous elastomeric phase. PolyEthylAniline may be converted into electro active materials using various doping methods. The chemical and electrochemically induced doping process greatly modifies the electrolytes are generally complexes between metal salts and polyaniline containing solvating etheroatoms. Since, the ionic mobility in these complexes may be interpreted on the basis of hopping mechanism between coordinating sites[2,4] local structural relaxations and segmental motions of the polyaniline chains essential conducting properties of the PolyEthylAniline.
Ion conducting polymers were first studied by write and coworkers but their potentials as practical electrolyte materials in electrochemical devices were recognized by armend and coworkers .These materials are generally complexes between metal salts and high molecular weight polymers containing solvating etheroatoms.The most common examples are complexes formed by Zn(II) and Al(III) complexes with PolyEthylAniline.

Experimental

PolyMethylAniline 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 polyMethyAaniline sulphate
PolyMethylAniline Chloride was prepared by equilibrating the PolyMethylAniline sulphate with1M HCl for about 10 hrs. The mass so obtained was separated, washed and dried and weighed as PolyMethylAniline Chloride.
An adequate quantity of the PolyMethylAniline host and the inorganic salts of Zn were separately dissolved in suitable solvent (e.g. acetonitrile). The two solutions were then mixed and after stirring the solvent evaporated slowly to finally obtain powder form of PolyMethylAniline - Zn complexes.

Study of PolyMethylAniline -Zn complexes.

-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 PolyMethylAniline solutions were prepared in small amount of hydrochloric acid diluted to required volume with distilled water.

Experimental sets of solutions containing overall concentration of supporting electrolyte (KCl) and Metal ion fixed at 0.1 M and 1.0 mM respectively. 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. The DME had a characteristics of m=2.33 mgs^{-1} t=3.03at 40cm effective height of mercury column, $m2^{/3}$ $t^{1/6}$=2.13$mg^{2/3\ s-1/2}$

Some polarographic parameters observed for Polyaniline (PANI)

Concentration mM	*Id μ*	*$E_{1/2}$ V vs SCE*	*E_{pa} v*	*E_{pc} v*	***E_{pc} - E_{pa} v***
0.1	1.26	-0.56	0.56	-0.60	-0.04
0.2	1.18	-0.56	0.56	-0.60	-0.04
0.3	1.16	-0.56	0.56	-0.60	-0.04

Some polarographic parameters observed for Zn (II)-Polyaniline (Zn-PANI) complex

Concentration mM	*Id μ*	*$E_{1/2}$ V vs SCE*	*E_{pa} v*	*E_{pc} v*	***E_{pc} - E_{pa} v***
0.1	1.1	-1.10	1.08	-1.12	-0.04
0.2	1.0	-1.10	1.08	-1.12	-0.04
0.3	0.9	1.10	1.08	1.12	0.04

Some Cyclic Voltammetric and Polar graphic parameters observed for PolyMetylAniline (PMA) Table-1.1

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	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

Some Cyclic Voltammetric and polarographic parameters observed for Zn (II)-PolyMethylAniline (Zn-PMA) complex

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

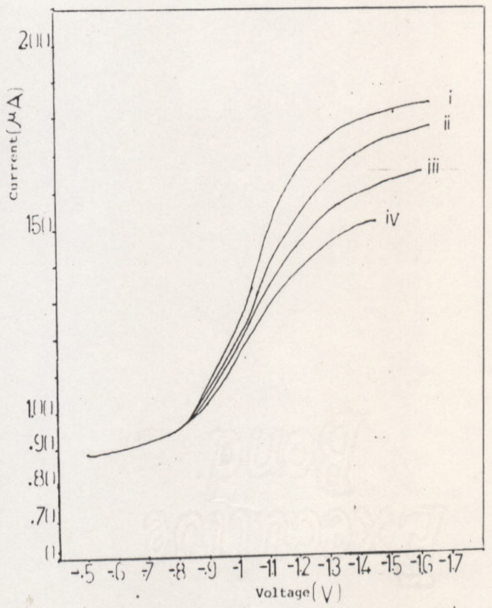

Fig. 2.2(a) : DC Polarogram of Zn(II)-Polymethylaniline in 0.1M KCl (pH=8±1) (i) 0.1mM PMA (ii) 0.2mM PMA (iii) 0.3mM PMA (iv) 0.4mM PMA.

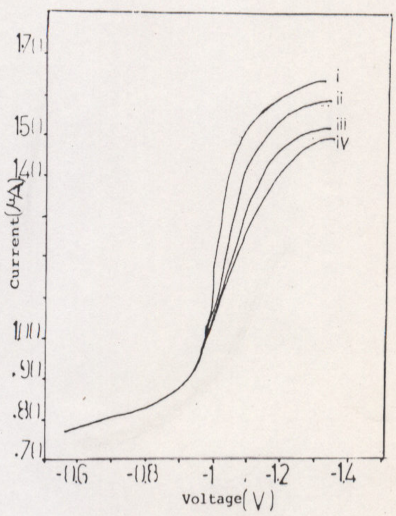

Fig. 2.1(a) : DC Polarogram of Zn(II)-Polyaniline in 0.1M KCl (pH=8±1) (i) 0.1mM PANI (ii) 0.2mM PANI (iii) 0.3mM PANI (iv) 0.4mM PANI.

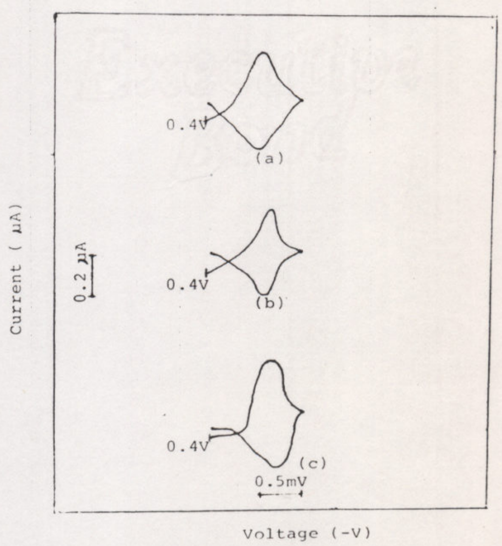

Fig. 2.7 : Cyclic Voltammograms of 0.1mM (a) PMA (b) Zn(II)-PMA Complex (c) Al(III)-PMA Complex in 0.1M KCl (pH=8±0.1) scan rate 40mV/S.

Survey of literature

W.John Albery[3], et.al have used electrode
such as polyaniline, polypyrol and polythiophene. 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 polyaniline 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^{0}C.

Youn Chaol on Park Yong Woo studied behaviour Polyaniline and found that the electrons are moving in and out changing the polyaniline structure from one form to the another form

C. Herold 12 Yazmi, D.Billaud attempted study of sodium doped polyparaphenylene film,

John Alberry, et.al

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