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Electrochemical Kinetics Study of Ga(III) with Amino Acids at different temperature on dropping mercury electrode (d.m.e)

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ABSTRACT

Polarographic behaviour of Ga(III) has been investigated in the presence of amino acids at d.m.e and the reduction of Ga(III) has been found to be irreversible in the presence of supporting electrolyte with or without complexing agent. The complexes of Ga(III) with serine amino acid have been investigated and their kinetics parameters have been evaluated. Transfer coefficient (α) and formal rate constant (K°_{fh}) have been determined in aqueous medium at 308K and 318K by applying Koutecky's method.

Keywords: Ga(III), Serine, d.m.e., Kinetics parameter, Koutecky's method

I. INTRODUCTION

Amino acids play an important role in our body, which improves the growth and maintenance the cells of our body. Serine amino acid has a important role in metabolism that it is participates in the biosynthesis of purine and pyrimidines. D-serine synthesized by serine racemase. L-serine serves as a neuronal signal by activating NMDA receptors in the brain[1].

The equation for the polarographic current potential curve corresponding to a totally irreversible process who rate governed by a single electron transfer step has been obtained by several authors[2-3]. An extensive work has been carried out on the electrochemical behaviour of amino acids and their complex with several metal ions by many workers[4]. Vinita Sharma carried out the electrode kinetics study of Ga(III) DL-alanine N-glycyl-glycine and pyridine in a aqueous and non aqueous media.The kinetics of alanine at a d.m.e. was studied in solutions with the Pd(II) by V.N spiridonov et al[5]. The electrode kinetics of anticancer drug zileutron was investigated by DCP and DPP using d.m.e. by N.Y sreedhar et al[6].Farid Khan and Rakhi Agarwal[7] study the kinetics parameter and stability constant of Mn complexs with many drugs such as doxycyline, chlorotetracyline, oxytetracyline, tetracycline, monocyline, amoxicilline, by polarographically.

The kinetics study of Ga(III) complex with hippuric acid at different temperatures was done through polarographic technique[8]. The binary and ternary Pd(II) complex of the N-sulfonyl derivative[9] of aspargine and glutamate were studied by Polarography technique. Polarographic studies of histidine with some p-block elements like Ga(III), In(III), Tl(I) have been carried out separately at constant ionic strength (μ=1.0) using KCl at 298K and 308 K temperature[10]. The electrode kinetics study of Ga(III) complexes with citrulline and tyrosine at different temperature has been carried out by polarographic[11-12] method. The literature search reveals that plarographic study of Ga(III) complex with serine has not been attempted so far. This fact inspired us to investigat polarographic behaviour of Ga(III) in presence of amino acids.

II. METHODS AND MATERIAL

A CL-362 polarographic analyser was used to record polarograms using saturated calomel electrode as the reference electrode and d.m.e. used as microelectrode. All chemicals were used in analytical grade and serine was used as a complexing agent. All solution were prepared in double distilled water. 1M KNO_3 was used as a supporting electrolyte to maintain constant ionic strength. The test solution contains 0.1mM of Ga(III) ,Triton X-100 was used in the final solution to suppress the maxima observed. The d.m.e had following

characteristics, m=4.62,mg/s, t=2 sec and height of the mercury column $h_{eff=}$ 43mμ, purified N_2 was used for deaeration.

III. RESULTS AND DISCUSSION

The current voltage curve was obtained. Ga(III) and its complex gave well defined three electron irreversible reduction wave and process is diffusion controlled. The value of half- wave potential ($E^r_{½}$) exhibits cathodic shift and diffusion current shows descending behaviour with the increase in the concentration of serine, this indicates complexation between Ga(III) and serine.By knowing the value of 'n', the diffusion coefficient ($D^{1/2}$) of the depolarizer was calculated by using IIkovic equation at different concentration of the ligand . The effect of increasing concentration of serine on polarographic characteristics'and kinetics parameter are recorded in table 1 and table 2 at 308K and 318K.

The decrease in the value of 'α' with increase in concentration of the ligand, show that the transfer of electrons is getting increasingly difficult and the reduction of Ga(III) can also be noticed from the decreasing trends of K°_{fh}.

The effect of temperature on different parameters can also measured. The result show that $E^r_{½}$ values shift to less negative values as the temperature increased which indicates the easier reduction of Ga(III)-serine system at d.m.e. .The increase of values of α and K°_{fh} with the temperature shows that the electrode reduction of Ga(III) serine system tends to become less irreversible as the temperature is increased . The result show, that there is a regularly variation in the standard rate constant K°_{fh}. As the concentration of the ligand increases, the value of formal rate constant decreases on increasing the temperature. The reason of decreases of formal rate constant at higher temperature may be due to the breaking of chelating rings. At higher temperature the ring may be broken down of the complex. At higher temperature the bidentate chelate ligand may become more energetic to colloid which might be causing faster reaction.

Table 1. Kinetic parameters of Ga(III) in various concentration of serine at 308 K in aqueous medium [Ga(III) = 0.1mM, ionic strength (μ) =1.0 (KNO_3)]

Cx (Serine Concentration in Mole/litre)	İd μA	$D^{1/2}$ Cm^2 sec^{-1}	Slope	α	$E^r_{1/2}$ -V vs S.C.E	$logK^\circ_{fh}$ cm sec^{-1}	$logK^\circ_{fh}$ x10^{-17}
0	8.2	-	0.1902	0.2840	1.2284	-1.2366	7.7587
0.001	8.1	1.4433	0.1911	0.2836	1.2998	-1.25066	6.4662
0.002	8.0	0.7127	0.1918	0.2825	1.2309	-1.25068	6.30019
0.003	7.9	0.4692	0.1929	0.2809	1.2320	-1.2592	1.4574
0.004	7.8	0.3474	0.1932	0.2798	1.2334	-1.26498	0.2554
0.005	7.5	0.2672	0.1549	0.2780	1.2348	-1.2765	0.848045
0.006	7.4	0.2157	0.1961	0.2763	1.2366	-1.28945	0.02985
0.007	7.3	0.1858	0.1973	0.2747	1.2375	-1.30226	0.00141

Table 2. kinetic parameters of Ga(III) in various concentration of serine at 318 K in aqueous medium [Ga(III) = 0.1mM, ionic strength (μ) =1.0 (KNO_3)]

Cx (Serine Concentration in Mole/litre)	İd μA	$D^{1/2}$ Cm^2 sec^{-1}	Slope	α	$E^r_{1/2}$ -V vs S.C.E	$logK^\circ_{fh}$ cm sec^{-1}	$logK^\circ_{fh}$ x10^{-17}
0	8.5	-	0.3093	0.3093	1.2060	1.3883	3.4990
0.001	8.3	1.4789	0.3070	0.3070	1.2074	1.3897	3.4080
0.002	8.2	0.7305	0.3043	0.3043	1.2086	1.41961	1.9023
0.003	8.0	0.4751	0.3019	0.3019	1.2094	1.4170	0.13352
0.004	7.9	0.3519	0.2932	0.2992	1.2112	1.4286	0.12844
0.005	7.6	0.2744	0.2962	0.2969	1.2125	1.4484	0.12117
0.006	7.4	0.2257	0.2947	0.2947	1.2137	1.4585	0.00055
0.007	7.4	0.1883	0.2932	0.2932	1.2157	1.4690	0.00002821

IV. CONCLUSION

We conclude that the value of diffusion coefficient $D^{1/2}$ and transfer coefficient (α) are higher at 318K than 308K. The value of formal rate constant K°_{fh} are lower at higher temperature.

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