Determination of formation constant of Er (III) systems with different N, S & O donor ligands

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Abstract

Formation Constant of Erbium (III) Systems with different N, S & O donor ligands have been measured with the help of Spectrophotometric method. Result indicates that solution of these complexes in solid state is difficult.

Keywords: Lanthanide (III), Complexes, Formation constant.

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Introduction

The term stability cannot be generalized for complexes, since a complex may be quite stable to one reagent and may decompose readily in presence of another reagent. [1-2]

The complexes of d-block transition metals and alkaline earth metals with various ligands have been studied extensively [3-16], where as in case of F-block lanthanide metal complexes, a limited study has so far been carried out, because of their poor tendency to form complexes. [17-19]

Formation constant K shows the stability, although lanthanide complexes [20-24] are thermodynamically and kinetically less stable as compared to transition metal complexes and actinide complexes.

EXPERIMENTAL

Jobs method is a variation of spectrophotometric method [25-27] which is based on the fact that most of the complexes absorb light differently than the metal ions from which they are formed. The relationship between the absorbance or optical density at particular wavelength and concentration is expressed by Beer's law. [28-29]

In this method, standard grade chemicals which were used in the present study were of AR grade. $ErCl_3.6H_2O$ (M.W - 273.61) was procured from Across India Ltd, USA and ligands with 99% purity were procured from HIMEDIA, India Ltd. The three N, S, and O donor ligands have been used for preparation of system with Er (III) and the solution spectra of these system have been recorded by using a standard spectrophotometer.

Three representative ligands (L_1, L_3, L_4) have been used for this study.

Table 1. Observed values of absorbance at various concentrations of Er (III) with ligands containing N, S& O donor ligands

Metal ion concentration (in %) with ligands	Values of absorbance in mixed solutions with ligands		
	With L_1	With L_3	With L_4
10	0.0085	0.0089	0.0097
20	0.0090	0.0096	0.0104
30	0.0105	0.0112	0.0119
40	0.0120	0.0128	0.0133
50	0.0155	0.0169	0.0183
60	0.0127	0.0141	0.0153
70	0.0101	0.0123	0.0122
80	0.0091	0.0098	0.0111
90	0.0082	0.0088	0.0096

Table 2 Values of absorbance in different mixed solutions

Concentration of Er (III)	Concentration of ligands	Absorbance in mixed solutions of Er (III) with ligands		
		L_1	L_3	L_4
M/40	M/40	0.021	0.020	0.024
M/50	M/40	0.017	0.018	0.022
M/60	M/40	0.016	0.017	0.019
M/70	M/40	0.015	0.016	0.011
M/80	M/40	0.012	0.010	0.010

Table 3 Computed values of formation constant from observed data

Liganad No	Initial conc. of Er (III) in mole/lit A	Initial conc. of ligand in mole/lit A	Equilibrium conc. of complex in moles/lit x	Equilibrium conc. of Er (III) in moles/lit a-x	Equilibrium conc. of ligand in moles/lit a-x	$K = \frac{x}{\ldots\ldots (a-x)(a-x)}$	log K
L_1	M/50	M/50	M/65	M/50 - M/65	M/50 - M/65	692.6	2.8400
L_3	M/50	M/50	M/70	M/50 - M/70	M/50 - M/70	422.11	2.6254
L_4	M/50	M/50	M/62	M/50 - M/62	M/50 - M/62	1058.514	3.0240

Results and discussion

Order of formation constant (k)

The computed values of the formation constants from the spectroscopic data have been tabulated in tables 3.

the following order-

Er (III) - L_4 > Er (III) - L_1 > Er (III) - L_3

Comparative values of stability constants for various complexes have been shown in table-3

The formation constant data show that the stability of lanthanide complexes is similar to following type of complexes, which have been reported by earlier workers [27] at room temperature.

$[Ag(NH_3)_2]$ + type of complex (logK =3.24 -3.81)

1:1 Pr (III)-Oxy diacetic acid (logK=2.53)

1:1 Nd (III)-Oxy diacetic acid (logK=2.67)

1:1 Pr (III)-Sulphonanilide ligand (logK=2.9118-3.3551)

Low stability constant makes the isolation of these complexes in solid state difficult, so doped model technique has been taken as system in the electronic-spectral study.

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