The Solubility and Anion Exchange Behavior of Heavy Lanthanide Elements in a Potassium Carbonate Solution

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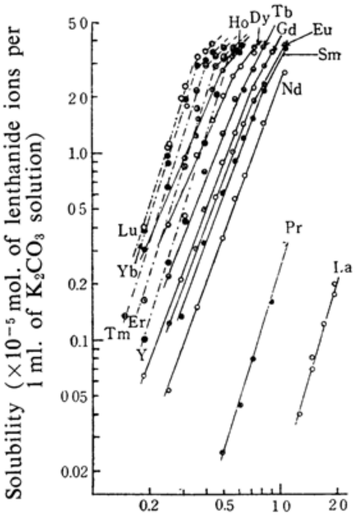
(Received March 13, 1964)

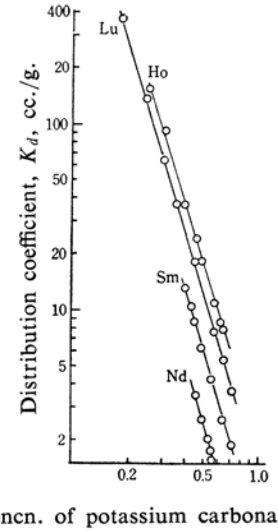
In a previous paper,[1] the present author reported that several lanthanide elements dissolved in a potassium carbonate solution were adsorbed on an anion exchange resin and that both the amount dissolved and that adsorbed increase with the increase in atomic number. However, it was impossible to distinctly detect the order of these amounts dissolved and adsorbed, as well as the position of yttrium among those of lanthanide elements, because of the lack of data for heavy lanthanide elements.

This study treats the behavior of tripositive lanthanide elements other than cerium and promethium. Since the solubilities of lanthanum and praseodymium are small and since the convenient concentration for an anion exchange measurement can not be obtained, both these elements are eliminated from the measurement. From the results obtained, it was observed that there was a distinct difference between the heavy lanthanide elements (Er, Tm, Yb, Lu and Y) and the other light elements. The standard solutions were prepared by dissolving the pure oxides (purity more than 99.8～99.9%) in dilute hydrochloric acid. The quantities of these lanthanide elements and the volumes of the potassium carbonate solutions used in this experiment were identical, i. e., ca. 2×10^{-4} mol. and 5 ml. for the measurement of the solubility (S), and ca. 2×10^{-5} mol. and 20 ml. for that of the distribution coefficient (K_d, cc./g.) respectively. The anion exchange resin used was 1 g. of Dowex 1, X-8, in the carbonate form, of the size of 50～100 mesh.



Concn. of potassium carbonate, M

Fig. 1. Relation between the solubility of lanthanide elements and the concentration of potassium carbonate at 20°C.



Concn. of potassium carbonate, M

Fig. 2. Distribution coefficient of lanthanide ions between Dowex 1 and potassium carbonate solution at about 20°C.

Figure 1 shows that, when the amount dissolved is more than about 3×10^{-5} mol./ml., the solubility increases with the increase in atomic number, and that, on the other hand, when the amount is less than that, the slope of the curve $\log S$ vs. $\log CO_3^{2-}$ in the heavy lanthanide elements obviously differs from that in other light elements. It may be thought that the order of the solubility varies with the concentration of potassium carbonate. Figure 2 shows the logarithmic plot of the K_d values of four representative lanthanide elements against various concentrations of potassium carbonate. All the curves of $\log K_d$ vs. $\log CO_3^{2-}$ obtained in this experiment give a linearity,

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[1] T. Taketatsu, This Bulletin, 35, 1573 (1962).

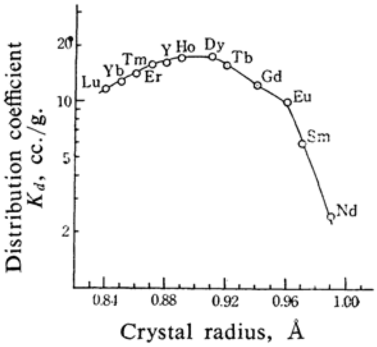

Fig. 3. Relation between the K_d value in a 0.5 M potassium carbonate solution and the crystal radius of tripostive lanthanide ions at about 20°C.

and the lines are parallel to one another, with a negative slope. The relation between the K_d values in a 0.5 M potassium carbonate solution and the crystal radii of tripositive lanthanide ions given by Zachariasen[2] is shown in Fig. 3. These K_d values increase with the increase in atomic number from neodymium to dysprosium or holmium; on the other hand, the values decrease with the increase from erbium to lutetium. The position of yttrium is found to be between erbium and holmium. It is interesting to consider that the maximum K_d value corresponds with the maximum magnetic susceptibility of the lanthanide element.

The details of the experimental procedure will be presented and the findings discussed elsewhere.

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2) W. H. Zachariasen, *Phys. Rev.*, 73, 1104 (1948).