Magnetic Condensation of Rare Earth Ion

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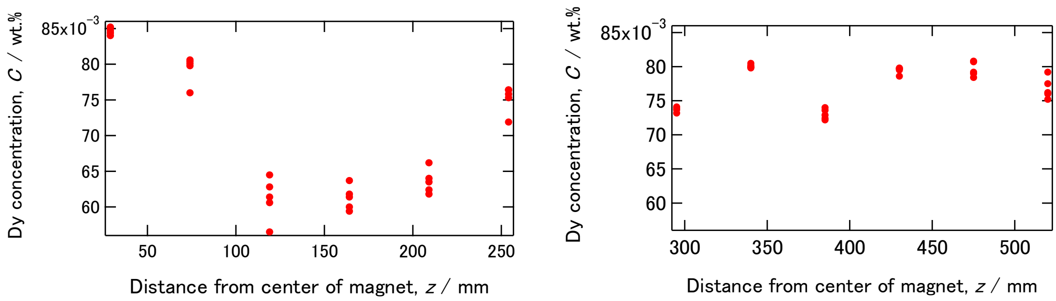
Rare earth elements are valuable as functional materials such as electronic materials and magnetic materials, but they are limited so must be recycled. New methods to condense the target element from the rare earth solution is required. Magnetic separation is used widely for large solid, so similar effect to small particles can be expected because Faraday force explained by Eq. (1) works with the same mechanism regardless of the size of the object depended on magnetic susceptibility and magnetic force field.

$$F = \kappa_{ion} B \frac{dB}{dZ}, \qquad (1).$$

However, there are few reports of magnetic condensation of atomic size magnetic ions [1, 2], and the details of the magnetic field effect are not clarify. In this study, magnetic condensation of paramagnetic rare earth ions was migrated and evaluated by plasma emission spectrometry.

An aqueous solution of $Dy(NO_3)_3 \cdot 6H_2O$ (Wako, 99.5 %) was prepared as a sample solution. In order to suppress the diffusion 1.0 wt.% of agar (Zunsei, first grade) was added, and a gelled sample was sealed in a pyrex made reactor with ID 7 mm and a length of 300 mm. Several reactors were set under the high and low horizonal gradient magnetic fields for 30 h. The sample gel was separated after migration and diluted 100 times with hot water. The dependence of Dy^{3+} concentration on sample position was investigated by a plasma spectrometry. As shown in Fig. 1 (a), Dy^{3+} was condensed towards the center of the magnet bore which was left hand side in Fig. (a), under the high gradient magnetic field. The difference between the maximum and the minimum was 2.5 ± 0.5 ppm. Because the concentration change under the low gradient magnetic field was 1 ppm, the magnetic concentration of the Dy ion was recognized.



(a) Under high gradient magnetic field (b) Under low gradient magnetic field

Fig. 1 Position dependences of Dy ion concentration

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References: [1] Agnieszka Franczak *et al*. Phys. Chem. Chem. Phys. 18 (2016) 27342. [2] M. Yamaguchi, T. Takeda, T. Kogawa, and I. Yamamoto, Procs.2nd Int. Workshop on Materials Analysis and Processing in Magnetic Fields (2006) pp. 54-59.