Magnetic Condensation of Rare Earth Ions

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Magnetic separation is a technique to separate mixed substances using a magnetic force. In the early magnetic separation, the target of magnetic separation was limited to ferromagnetic materials with large particle size. However, paramagnetic ions have become the target of magnetic separation due to the recent improvement in magnet performance. [1] The magnetic force F for an ion with magnetic susceptibility κ_{ion} under the influence of magnetic flux density B is expressed by Eq. (1).

$$F = \kappa_{ion} B \left(\frac{dB}{dz}\right), \quad (1)$$

The targets of magnetic separation in this study are paramagnetic rare earth ions. Currently, rare earth metals are used for various purposes such as high-tech products, and its demand is expected to increase hereafter. However, it is difficult to supply them in Japan and relies on imports. Therefore, the goal of this study is to establish a rare earth reuse technology.

The experimental system was constructed to obtain concentration changes from light interference fringes with a Mach-Zehnder interferometer as shown in Fig. 1. An aqueous solution of $DyNO_3 \cdot 6H_2O$ (99.5%, FUJIFILM Wako Pure Chemical Corporation) was sealed in an optical cell, and a magnetic field was applied by a Nd permanent magnet. The frequency component was obtained by performing continuous wavelet transform and analyzing the interference fringes using MAMTLAB. Fig. 2 (a) shows the interference fringes 600 s after the magnetic field is applied, and Fig. 2 (b) illustrates the concentration analyzed.

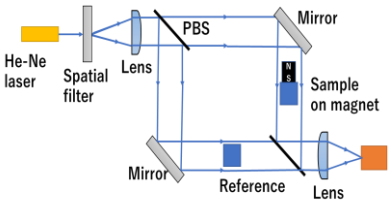
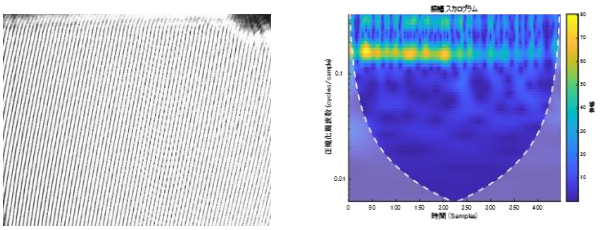


Fig. 1. The optical detection system for magnetic condensation. PBS denotes polarizing beam splitter.



(a) (b)

Fig. 2. (a) The image of the interference fringes 600 s after the start of magnetic field application and (b) the analyzed image.

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Reference : [1] Agnieszka Franczak *et al.*, Phys. Chem. Chem. Phys. 18 (2016) 27342.