16A1/2002S2003

Combinatorial XAFS imaging of CO_2 absorbent lithium ferrites

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Introduction

2D imaging of fluorescence X-ray absorption fine structure (XAFS) is a feasible application of a projection-type X-ray fluorescence (XRF) microscope [1,2]. It is possible to obtain XAFS spectra simultaneously and rapidly for many specimens prepared in the same single substrate [3]. This report describes its performance in the evaluation of CO_2 absorbent, lithium ferrites.

Experimental

Lithium ferrites were individually synthesized by solid-state reaction of hydroxides under 4 different sets of conditions. Less than 1mg of each of these products was then arranged in four separate columns on a quartz glass substrate measuring 12 mm × 10 mm × 1 mm^t. Each column was then exposed to CO_2 under different conditions. Instrumental details of the projection-type XRF microscope and the procedure for XAFS imaging can be found elsewhere [2].

Results and Discussion

Figure 1 shows an approximately 8 mm × 8 mm part of the XRF image observed when the primary X-ray energy is 7.13 keV (just above the Fe K edge). In the image, the XRF intensity of each product was obtained by integrating the X-ray intensities in the pixels corresponding to each product. The intensity for 3 images was added together and the XAFS spectrum for each product was obtained by plotting the intensities as a function of the incident X-ray energy.

Figure 2 shows the XAFS spectra near the Fe-K edge of the 2^{nd} product from the top, as an example. Because the absorption edge shifts toward the higher energy side through exposure to CO_2, it was confirmed that CO_2 was chemically absorbed by the product. It was found that the shift is large even in a short exposure time at low temperature, indicating a high capacity and rate to absorb CO_2.

Through the present XAFS observation, not only structural information was obtained, but also the performance of a functional material could be evaluated in the way of so-called combinatorial scheme. Therefore, the technique seems very promising for the development of combinatorial materials. Further studies are now under way. The authors gratefully acknowledge the kind assistance of Drs. H. Sawa, Y.Wakabayashi, and Y.Uchida during the experiments. This research was partially supported by SHISEIDO Grants for Scientific Research.

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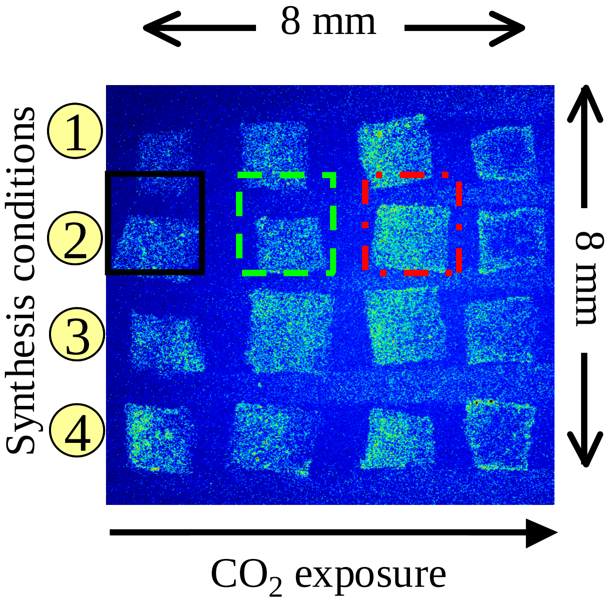

Figure 1 XRF image from the combinatorial sample of Li-Fe double oxide at an incident energy of 7.13 keV and by 3 sec exposure. For each product (1 ~ 4), exposure to CO_2 was carried out under a variety of conditions.

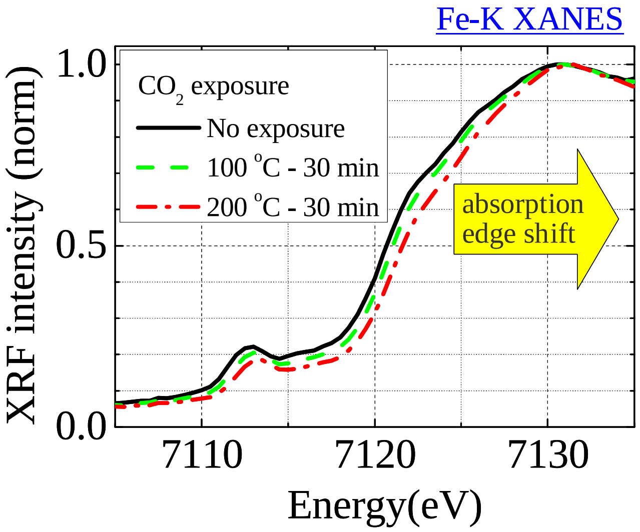

Figure 2 Fluorescence XAFS (Fe K absorption edge) of products in squares in Fig. 1. CO_2 absorption was confirmed by the shift in the absorption edge to the high energy side.