DERIVATION OF THE CELL PARAMETERS OF METEORITIC OLIVINE IN A THIN SECTION BY ENERGY-SCANNING X-RAY DIFFRACTION WITH SYNCHROTRON RADIATION

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Introduction: There have been several X-ray diffraction (XRD) studies on minerals in a thin section performed by the Laue method combined with micro-beam obtained from polychromatic synchrotron radiation (SR). However, their cell parameters cannot be directly obtained by this method. The stationary sample method with polychromatic X-ray is advantageous, because the irradiated area of the sample is always same and fixed, meaning that all diffraction spots occur from the same area of the sample. In order to obtain the cell parameters even in the case of the sample stationary method, we applied energy scanning of micro-beam of monochromatic SR, which necessarily requires more intense X-ray source. Application of this energy scanning method to Si powder sample gave the exact same cell parameter of 5.4311(10) Å compared with the value of 5.4311 written in the documentation of the sample.

Experimental: Diffraction spot can be measured on the two-dimensional detector with certain energy by this method. The cell parameters are derived and refined from the set of diffraction spots with (x,y) positions on the detector, indices and energies. We employed the intense X-ray source of SPring-8. In the beam line 37XU the undulater is installed, and Kirkpatrick and Baez mirror is equipped at upstream of the sample giving the beam size of 0.7(V) x 2(H) μm^2 on the sample position in the thin section. The thin section from a CM chondrite clast in the Jodzie howardite [e.g., 1] was attached on the sample holder, and the target olivine in the thin section was adjusted on the micro-beam position under an optical microscope. We applied energies from 20 to 30 KeV (λ=0.6199-0.4133 Å) with the increment of 20 eV step with each exposure time being 0.5 seconds.

Analysis and Result: The total number of diffraction spots obtained was 27. In spite of shorter exposure time, almost all diffraction spots were saturated because of the high X-ray intensity at Spring-8. Therefore, the profile fitting with the asymmetric Gaussian function to the unsaturated feet of diffraction spot was carried out in order to estimate the whole diffraction profile. Then, the position of the diffraction spot was obtained as those of the top of the diffraction profile after fitting. Among 27 diffraction spots, only 10 spots have saturated intensities level with more than one fourth of those of the top of the profile. The obtained cell parameters (Å) are a=4.7634, b=10.2112, and c=5.9871 with $\sigma(a)$=0.0031, $\sigma(b)$=0.0014, and $\sigma(c)$=0.0021, respectively.

Discussion and Conclusion: The obtained cell parameters suggest that the olivine crystal analyzed is close to the end-member forsterite composition whose Fo composition is higher than Fo_{95} [e.g., 2]. This is consistent with the microprobe analysis of the present olivine crystal (Fo_{99}). Therefore, this study demonstrates that the stationary sample method with energy scanning of micro-beam of monochromatic SR is a powerful tool for the XRD analysis of minerals in a thin section.

References: [1] Bunch T. E. et al. 1979. *Geochimica et Cosmochica Acta* 43:1727–1742. [2] Akimoto S. and Fujisawa H. 1968. *Journal of Geophysical Research* 73:1467–1479.