X-RAY DIFFRACTIONS OF STONY METEORITES USING THE GANDOLFI ATTACHMENT.

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Introduction: The X-ray diffraction (XRD) techniques have been applied to various extraterrestrial materials from macroscopic [e.g., 1-3] to microscopic [e.g., 4-6] approaches. Macro XRD has been developed mainly in laboratories [1-3]. While micro XRD has been developed normally in synchrotron radiation facilities [4, 5] but recently also in laboratories [e.g., 6]. We applied the apparatus (SmartLab, RIGAKU) at NIPR, which have been used mainly for macro XRD, to micro XRD, combining with the polycapillary unit and the Gandolfi attachment in the present study. We show that the technique in air is convenient for the rapid characterization of tiny stony meteorites.

Experiments: Cu Kα X-ray from sealed X-ray tube was generated on the condition of 40 kV and 30 mA for glass tube and 40 kV and 40 mA for ceramic tube. Goniometer radius was 30 cm. Only the strip detector was scanned mainly on the range of 2θ = 28-50º (5-33º only for the Jbilet Winselwan CM2 chondrite), where θ is Bragg angle, while the incident X-ray position was not scanned but fixed. Sample diameter was in the range of 0.2-0.8 mm. Fragment or powder sample was used. The sample was adhered normally on the tip of the glass fiber of 13 μm in diameter and 1 cm in length using cyanobond. Various samples of the San Carlos olivines and NWA 4719 L6 chondrites were measured and used for the calibration focused on the olivine 130 index. The measured samples were ordinary chondrites (OCs) of 14 H, 8 L, and 5 LL, five various carbonaceous chondrites (CCs), and four others.

Results: *Characteristics of the Ol 130 position.* The 2θ positions of the San Carlos olivine and NWA 4719 for powder aggregates are consistent with expected positions by [7], respectively. However, those of grains for both are commonly slightly (< 0.1º) higher than the expected values by [7], and the intensities of the NWA 4719 L6 chondrite grain are heterogeneous among each grains depending on the modal abundance of olivine.

OCs. The 2θ positions (2θ = ~32º) of Ol 130 for grains show the slightly positive correlation with the grain diameter but not for powders. The Oen 511 peak (2θ = ~31.5º) is the useful indicator to distinguish the unequilibrated ordinary chondrites (UOCs) and equilibrated ordinary chondrites (EOCs) [1,2]. Oen 511 peak usually appears for EOCs, but are not clear for some EOCs, which is due to the low intensity of the peak and possibly low abundance of Oen.

CCs. The powders were only measured. The Ol 130 peak is common, and the peak positions for three (A-882094 CO3.5, Y-86751 CV3, and Allende CV3) are smaller than the others. That for Jbilet Winselwan is higher than EOCs and that for Y-86720 CY2 is within the range of EOCs. Oen is commonly lacking, but Cen occurs except Y-86720.

The other stony meteorites. Their diffraction patterns are different from ordinary and carbonaceous chondrites: Oen is dominant for the NWA 7401 EL6 chondrite and the Bilanga diogenite, Cen is dominant for the Pena Blanca Spring aubrite, and the pigeonite (ferroan) and anorthite is mixed for the Cachari eucrite.

Discussion: Powder sample may nearly represent mean bulk compositions, since olivine and pyroxenes commonly coexist for chondrites. However, it may be suggested that grains are heterogeneous for the stony meteorites since the relative peak intensities of the phases are highly changeable. The least square fitting for the peak position of Ol 130 of grains of EOCs was carried out against grain diameter, D (mm). Then the dependence of Δ2θ against D is given by D (mm) = 11.28 × Δ2θ (º) with one σ of 0.055º. When the 2θ is corrected from the equation, the chemical group of H, L, and LL for EOCs may be distinguished. The matrices of the Jbilet Winselwan CM2 chondrite are altered, since the serpentine 001 peak is detected at 2θ = ~12º, and only forsteritic olivines in chondrules is detected. The olivines with the intermediate compositions (which is consistent position of Ol 130 with EOCs) for Y-86720 may be originated from the dehydration from the precursor phyllosilicates, since they are commonly fine-grained [8,9]. The lower peak positions of the other three CCs correspond to the ferroan olivine in matrices.

Summary: We successfully explored the convenient technique for characterizing the tiny extraterrestrial materials.

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