

Micro-Raman characterization of cation disordering in ringwoodite

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Introduction: Ringwoodite is a high-pressure polymorph of olivine occasionally found from shocked L-type meteorites. In such a case of NWA 5011, the phase transformation is often uncomplete in shock melt veins. A short-period pulse of shock pressure makes an insufficient phase transformation of olivine due to not enough time for the complete cation ordering, suggesting new or metastable phases frequently with structural defects. Previously we found out a new Raman spectral peak at 880 cm⁻¹ in NWA 5011 ringwoodite [1], which was also observed in the Taiban chondrite [2]. In this study we have characterized this spectral data to clarify the cation ordering in NWA 5011 ringwoodite.

Result and Discussion: Ringwoodite aggregates with ~150 μm size were selected for micro-Raman measurements. All spectra were collected using a Thermo DXR Micro-Raman microscope under same conditions with the laser at 532 nm during 600 sec on a 1 μm spot. The measured area (Fig. 1) in the same ringwoodite aggregate shows the domain-like texture with colorless and blue in OM-image. In this area we have collected three spectra from the colorless areas, and three ones from the blue-colored areas. From the colorless areas, the spectral peaks were detected at 712, 798, 845, and 918 cm⁻¹. The peaks at 712 and 918 cm⁻¹ are probably assigned to wadsleyite, but the others at 798 and 845 cm⁻¹ belong to ringwoodite. From the blue-colored areas, the peaks at 798 and 880 cm⁻¹ were observed. The chemical investigation reveals neither difference in chemical composition, nor chemical heterogeneity between them. The most characteristic difference is the intensities of the spectral peaks collected from the different-colored areas. Fig. 2 shows the spectra normalized by referring the intensities of colorless and blue-colored areas. It indicates a characteristic peak at 880 cm⁻¹ in the spectrum from the blue-colored areas, which has not been assigned to any olivine-related structures. The appearance of 880 cm⁻¹ peak may be explained by the reason of partial occupancy in tetrahedral sites of ringwoodite with Fe²⁺ (or oxidized to Fe³⁺) as an acceptable theory, however which conflicts with the absence of 845 cm⁻¹ peak as the main characteristics of SiO₄ antisymmetric stretching vibration in ringwoodite and the very weak one at 798 cm⁻¹ peak. This uncertainty could be dissolve if, the structure is beginning to ordering into inverse spinel, and at the moment stage is represent a disordered unrelaxed ringwoodite structure. This possibility should be investigated in details. The spectrum of blue-colored area implies the presence of inverse spinel structure

in it, or the presence of an intermediate phase may be a possibility at extreme conditions [3]. We assume that the observed 880 cm⁻¹ peak in the Raman spectrum from the blue-colored areas can show the degree of the cation disordering in ringwoodite, resulting in the various cooling history even within the same aggregate.

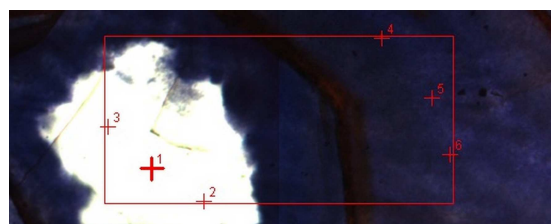


Fig. 1. Six measured points (signed by red cross) in the selected ringwoodite aggregates from NWA 5011 meteorite. The numbers of 1, 2 and 3 correspond to colorless areas, and the numbers of 4, 5 and 6 to blue-colored areas. The width of picture is 150 μm. OM-image.

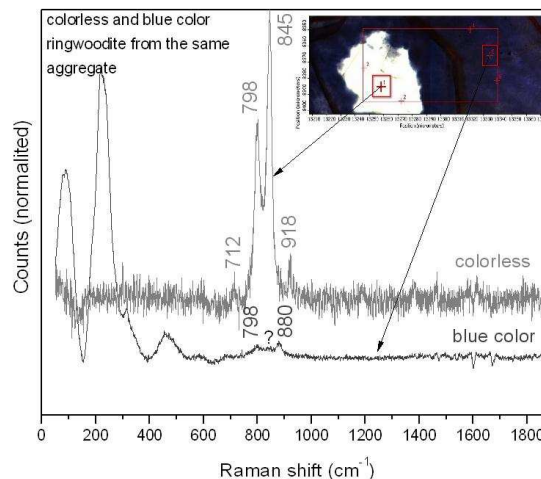


Fig. 2. Raman spectra normalized by referring the intensities of colorless and blue-colored areas.

References:

- [1] Nagy Sz. et al., (2010) LPSC 41, Abs#1228. [2] Acosta T. E. et al., (2012) LPSC 43, Abs# 2725. [3] Kiefer B. et al., (1999) *Am. Min.*, 84, 288-293.