AR-NW10A, BL-9C/2012G526

EXAFS and XANES study on the zirconium local structures in tektites and natural glasses.

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1 Introduction

In nature, several kinds of glasses are formed by various geological activities. Tektites and impact glasses are produced by meteorite impact event. Upon a devastating impact of a giant meteoroid on the Earth, particles of the Earth's surface were melted and catapulted into outer space, where they finally solidified and fell back to the Earth. Tektites should be formed by this series of processes. Impact glasses are not fly out to space. They are genetically equivalent to coherent impact melt rocks present in craters developed in crystalline targets. It was known that tektite has characteristic XANES spectra and distinguishable from other natural glasses [1]. Zirconium should be useful probe for obtaining information on the local structures of glasses, physical conditions and formation process of tektites and impact-related glasses. XANES and EXAFS studies of the local structure around Zr in tektite from six strewn fields and impact-related glasses will provide more comprehensive data on the impact event[2].

2 Experiment

The specimens of tektites are from different strewn fields: hainanite, indochinite, philippinite, australite from the australian strewn field; bediasite from the North American strewn field; and moldavite from the European strewn field. Köfelsite, suevite, darwin glass and libyan desert glass are impact-related glasses. Pitch stone and obsidian are volcanic glasses. These samples Zr content are 50-300ppm. Zr K-edge XAFS measurements were performed at beam line BL-NW10A, equipped with Si (311) double-crystal monochromator. Zr K-edge spectra were recorded in the fluorescence mode by the Lytle type detector from 17.97 KeV to 18.05 KeV with steps from 0.723 to 14.466 eV and 2 to 15 s counting time. The EXAFS function, $\chi(k)$, was extracted from each measured spectrum using the standard procedure. In quantitative analyses we carried out a Fourier-filtering technique and a non-linear least- squares fitting method. Because the third- and fourth-order terms in the cumulant expansion were negligible, the final refinement was performed as the harmonic model by the structural parameters R_{AB}, σ_2, η and ΔE_0 values. The reliability of fit parameters were less than 0.0127.

3 Results and Discussion

The Zirconium XANES spectra in tektites and natural glasses are shown in Fig. 1. These spectra divided into five types of pattern according to the pre-edge and main absorption edge: type I köfelsite and suevite; typeII fulgurite; type III darwin glass and libyan desert glass; type IV, australite, indochinite, hainanite, moldavite-green, moldavite-brownish and philippinite; type V pitch stone and obsidian; type V fulgurite. Type III has a clear pre-edge peak and the pre-edge peak height at 17.987 keV for darwin glass and libyan desert glass are 27.8% and 26.9% respectively. The main absorption edge (peak A) is located at 18.002 keV for type I and II. The main absorption edges (peak B) are located at 18.014 keV for Type III, IV and V. The heights of peak B increase in the order from III to V. Tektite and impact-related glasses have unique XANES spectra and distinguishable from volcanic glasses [2]. Glass structure is affected by the pressure and temperature conditions during the glass formation and annealing process. Different formation process of natural glasses gives different local structure of zirconium ions. The average coordination number of Zr^{4+} in darwin glass, LDG, volcanic glass and tektite are between 6 and 7. The eight-coordinated Zr^{4+} shows different XAFS pattern in fulgurite, suevite and köfelsite.

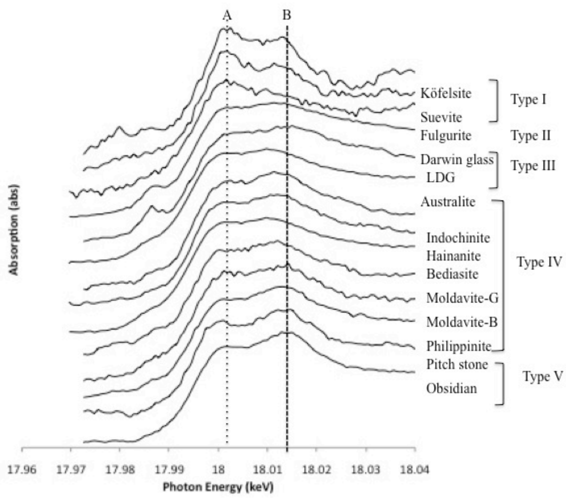

Fig. 1: Experimental Zr K-edge XANES spectra of tektites and natural glasses.

References

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