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Effects of Mg and Fe contents in impact glass analogs on Raman spectra: Evaluation for the Mars Moons eXploration (MMX) mission

SHOKO IMAMURA[1,2], YASUHITO SEKINE[1], YOSHIO KONO[3], YUICHIRO CHO[4], KAZUKI KOMATSU[2], TOMOYO MORITA[5], YOSHIO TAKAHASHI[6], HARUHISA TABATA[2], SHOKI MORI[2], TOMOKI NAKAMURA[5] AND HIROYUKI KAGI[2]

[1]Tokyo Institute of Technology
[2]The University of Tokyo
[3]Ehime University
[4]Uni Tokyo
[5]Tohoku University
[6]Department of Earth and Planetary Science, The University of Tokyo

Presenting Author: shoko@elsi.jp

The Martian moons Phobos and Deimos would contain ultramafic quenched glass if they were formed by a giant impact [1]. A series of our studies aim to provide laboratory dataset that will be used to interpret the Raman spectra of surface materials obtained by the Raman spectrometer for MMX (RAX) in the Mars Moons eXplorer (MMX) mission. Raman spectroscopy can identify crystalline minerals (such as olivine) on Phobos if exist; however, laboratory data are very limited for ultramafic quenched glasses. In our previous study [2], we synthesized quenched glasses with different Fe/Si ratios simulating different types of the impactor for the moon forming impact on early Mars. Our results showed that the Raman spectra for ultramafic quenched glasses are characterized by broad bimodal peaks. The intensity ratio of these broad peaks shows a positive correlation with the Fe/Si molar ratio of the quenched glass. However, the features of Raman spectra could be also affected by the abundances of other major elements and the redox state of Fe.

In the present study, we investigate the effects of the abundance of other major elements and the redox state of Fe on the Raman spectra of ultramafic quenched glass. We synthesized quenched glasses with different Mg/Si and Mg/Fe ratios using aerodynamic levitation and a CO_2 laser. Our results show that broad bimodal peaks appear at Mg/Si < ~0.67 similar to our previous study [2]; however, there was no clear correlation between Mg/Si ratio and the intensity ratio of the broad peaks unlike our previous results for the Fe/Si ratio. At Mg/Si ~1.8, the sharp peaks of olivine appear in the Raman spectra overlapped with the broad bimodal peaks. When glasses contain no Mg, the Raman spectra become a unimodal peak without the broad peak in the high wavenumber band. These characteristic features of the Raman spectra would allow us to distinguish different types of impact glasses, such as Mg-rich type, Fe-rich type, and Si-rich type, possibly existing on Phobos in the MMX mission.

[1] R. Hyodo et al. (2017). *The Astrophysical Journal,* 845.2, 125. [2] Imamura et al. (2022). *JpGU Meeting 2022*.