CATHODOLUMINESCENCE CHARACTERIZATION OF HIGH-PRESSURE SILICA AND FELDSPAR MINERALS.

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Introduction: High-pressure minerals in various meteorites have been investigated in planetary sciences for a clarification of shock metamorphic processes. Although recent studies apply cathodoluminescence (CL) of stishovite and high-pressure glass to identify such high-pressure silica minerals, CL mechanisms of high-pressure silica minerals have not been clarified in detail. Furthermore, high-pressure feldspar minerals such as $KAlSi_3O_8$-hollandite and maskelynite have not been studied from the perspective of CL spectroscopy. In this study, natural and synthetic high-pressure silica and feldspar minerals have been characterized by CL spectroscopy to clarify their emission mechanisms.

Samples and Methods: Synthesized stishovite, coesite, $KAlSi_3O_8$-hollandite, and experimentally shock-induced sanidine and quartz at pressure of 40 GPa by a propellant gun were selected for CL measurements. A scanning electron microscopy-cathodoluminescence (SEM-CL) was used to obtain CL spectra of these samples.

Results and Discussion: CL spectrum of synthetic stishovite has a pronounced emission band at ~390 nm. CL intensity of the blue emission decreases with an increase in electron irradiation time. Similar blue emission was observed in CL spectra of silica minerals in Martian meteorites of NWA 2975 and Shergotty. On the other hand, synthetic coesite exhibits dull UV emission peaked below 300 nm and blue emission at ~380 nm. CL spectrum of experimentally shocked quartz at 40 GPa shows blue emissions at 460 nm, which have not been recognized in CL of natural quartz up to now. CL spectral patterns and features of these high-pressure silica minerals are quite different from other silica minerals such as quartz, tridymite and cristobalite.

CL spectrum of $KAlSi_3O_8$-hollandite consists of emission bands at 330 and 380 nm in UV-blue region. Similar UV-blue emission bands were detected in experimentally shocked sanidine at 40 GPa. Alkali feldspar glasses in NWA 2975 and Shergotty also exhibit UV-blue emissions at 330 and 380 nm , which might be assigned to defect centers in Al and Si octahedra produced under high pressure process. $KAlSi_3O_8$-hollandite has higher emission intensities than shocked samples at 40 GPa and the glasses in shergottite. It might be responsible for completely octahedral coordination of Si and Al in $KAlSi_3O_8$-hollandite and partially one in diaplectic glass. CL spectrum of $KAlSi_3O_8$-hollandite also shows emissions at 550, 580, 660, 710 and 730 nm, which were undetectable in shocked sanidine at 40 GPa and the glasses in shergottite. These emission bands are characteristics of CL signals derived from $KAlSi_3O_8$-hollandite.

These results indicate that CL signals can be applicable to identify high-pressure silica and feldspar minerals and to observe their distributions in meteorites with high spatial resolution (~1 μm). CL and infrared-CL (from 800 to 1800 nm) spectroscopy at room and liquid nitrogen temperature for these synthetic and experimentally shocked samples will be discussed here for further clarification of their CL mechanism.