SHOCK-INDUCED EFFECT ON CHATHODO-LUMINESENCE OF EXPERIMENTALLY SHOCKED QUARTZ.

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Introduction: Shock metamorphism due to impact cratering on Earth, especially shock pressure recorded on shock-induced minerals, provides valuable information on the cratering mechanism [1]. Quartz, one of the most abundant and widely distributed rock-forming minerals on Earth, has been conventionally used to evaluate shock pressure [2]. However, the previous pressure estimations using planar deformation features (PDFs) obverved in shocked quartz, are applied as a rather qualitative method [e.g., 3]. Therefore, a new advanced method for a quantitative evaluation of shock pressure should be required to clarify the process during impact cratering.

Cathodoluminescence (CL) is an emission of photon in ultraviolet to infrared wavelength regions when electrons are irradiated on the materilas. Quartz indicates a change of its CL in response to shock-metamorphic effects [4]. However, a systematic study focused on pressure dependence of CL has not been reported so far. Here, we show the results of the variation of CL spectral features with an increasing in shock pressure obtained from a series of systematic shock recovery experiments on quartz.

Methods: The shock-recovery experiments were systematically performed on single crystals of natural (Minas Gerais, Brazil) and synthetic quartz in the National Institute for Material Science (NIMS) using a propellant gun. The flyer plate was accelated from 0.5 to 1.8 km/s, which produces a peak-shock pressure from 5 to 40 GPa. Recovered samples were preperared for polished thin sections using 1 μm diamond paste, which were observed under an optical microscope. Their CL spectra were measured by a scanning electron microscopy combined with a grating monochromator (SEM-CL) instrument at Okayama University of Science.

Results & Discussions: Under optical observation, quartz grains show frequently multiple sets of PDFs in both natural and synthetic samples which experienced shock pressure at around 20 GPa. At higher pressures, most of the grains have isotropic extinction, suggesting the transition to amorphous glass.

CL of both quartz samples show drastic changes in spectral pattern with an increase in shock pressure. Both starting materials have only one weak broad emission peak at around 630 nm. Above 20 GPa, a broad peak appears at 450-460 nm in a blue region with CL intensity ~10 times higher than that of the starting material. At higher pressures, the CL intensity of a blue emission increases drastically ~100 times higher compared with that of the starting material. On the other hand, a CL emission intensity at around 630 nm changes less than 3 times with an increasing pressure.

CL spectra of quartz with a β-form (e.g., quartz from Goroku, Japan) show an extremely intense blue emission similar to the luminescence of the present shock-experimental samples, suggesting an enhancement of the blue CL with the defects probably associated with Daufiné twins resulted from an α-β transition. Also, quartz from terrestrial impact craters as well as experimentally recovered samples contains Daufiné twins [5,6]. On the other hand, a continuous increase in CL intensity of blue emission at higher presures for both quatz and glass indicates a spectral change related to the extent of amorphization.

Realtionship between CL properties and shock metamorphic features such as amorphization and Dauphiné twin density will be clarified using raman spectroscopy and EBSD results.

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