CATHODOLUMINESCENCE PROPERTIES OF THE FORSTERITE FORMED UNDER SUPER COOLING: AN IMPLICATION FOR METEORITICS

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Purpose: In this study, cathodoluminescence (CL) microscopy and spectroscopy of the experimentally-grown forsterite spherule has been characterized to understand more about the mechanism of the crystal growth under the rapid cooling conditions, which may be applied to the study of the meteoritic forsterite.

Samples and Experimental Procedure: Forsterite crystals with 1 mm in diameter were grown as a chondrule analogue by the aero-acoustic levitation u floating method [1,2] and gas jet levitation methods [3]. Since levitated melt crystallizes under very high super cooling due to homogeneous nucleation, the growth rate of crystallization is quite larger compared with that near equilibrium temperature. The lab-chondrule is well reproduced the texture of natural chondrule. CL spectroscopy was made by a SEM-CL system at Okayama University of Science (Okayama, Japan).

Results and Discussion: In previous CL studies of the meteoritic forsterite samples in Allende and Murchison, a significant blue center (between 400-500 nm) was observed [4-6]. However, these authors were not able to identify the defect-related centers of the CL emission between 400-500 nm in the synthetic and meteoritic forsterite samples. In our samples, the red CL color and its heterogeneous distribution were observed in , which show two broad emission bands at around 630 nm in red region and over 720 nm in red–IR region. The former band can be assigned to impurity center of divalent Mn ion as an activator [4-6]. The latter one shows a magnificent red emission in a wide range of wavelength responsible for trivalent Cr ions [4], which possess two components of Cr activator and structural defect caused by interstitial Cr ions. The color CL image of experimentally-grown forsterite exhibits significant blue luminescence in the main branches of the interior structure of lab-chondrule, which reflects an order of crystallization. CL spectra from the blue luminescent area give a characteristic broad band emission at around 450 nm, which is associated with a relatively small concentration of Al, Ca, Ti refractory elements [4]. A new CL band centered at 480 nm (blue/green CL color) might be assigned to a microdefect-related center, which was formed due to the rapid growth from super cooled melt of forsterite.

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