Cathodoluminescence Microscopy and Spectroscopy of a Plagioclase Particle from Asteroid Itokawa: Results of a Preliminary Investigation.

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Introduction:

Cathodoluminescence (CL) is the emission of photons in the visible range from a material stimulated by an incident electron beam, being applicable for high-spatial resolution (~1 μm) spectroscopy. CL studies for minerals, especially feldspar, have been conducted in the planetary sciences to characterize shock metamorphic effects, to identify high-pressure minerals and shock-induced microdeformations such as planar deformation features (PDFs), to observe their distribution in meteorites and impactites, and to clarify the degree of the irradiation damage. An Itokawa sample was used to demonstrate the further capabilities to use of ScanningElectron Microscope-Cathodoluminescence (SEM-CL) methods in studies of the fine-grained astromaterials.

Sample and Experimental Procedure:

A plagioclase-dominated particle containing a relatively high albitic content was allocated by JAXA (RB-QD04-0022, length: 25 μm, width: 13 μm), which was obtained by the Hayabusa sample return mission in 2010. CL spectral data were recorded by a photon counting method using a photomultiplier tube (Hamamatsu: R2228) and converted to digital data. Corrected CL spectra in energy units were deconvoluted into the Gaussian components corresponding to each emission center. A peak-fitting software (Peak Analyzer) in OriginPro 8J SR2 was used for the correction and deconvolution of each emission center. Further details of the CL equipment and analytical procedure can be found in Kayama et al. [1] and references therein.

Results and Discussion:

The result shows that two components in blue region were assigned to defect center related to Al-O--Al/Ti centered at 2.83 eV (maxima at 438 nm) and impurity center of Ti at 3.06 eV with maxima at 405 nm (Fig. 1). However, any emissions of Fe^{3+} and Mn^{2+} usually found in terrestrial plagioclase could not be detected in this particle. Its CL image exhibits bright emissions in blue region with relatively homogeneous intensity. It implies that the plagioclase formed from nonferrous silicate melt at slightly higher temperature and after that has not been affected by thermal or hydrothermal alteration, which easily eliminates defect centers [1].

Conclusions:

This preliminary CL study of an Itokawa particle shows that the SEM-CL technique as a multiple technological approach is applied to investigate tiny samples as a powerful method, and could provide the first evidence of impact related micro-deformation on such a small body. However, further studies must be performed to understand how the irradiation could change the spectral properties of the sample, for instance.

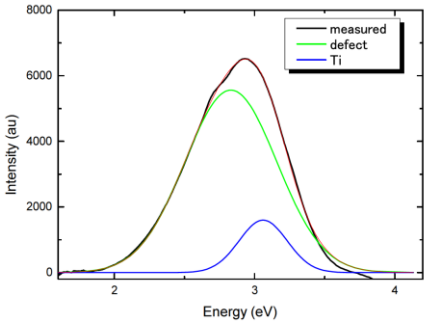

Figure 1. *Energy vs Intensity plot of the Hayabusa plagioclase particle showing the defect and Ti-related peaks.*

References:

[1] Kayama et al. (2012) *JGR: Planets*, *117*, E09007.