Cathodoluminescent characterization of radiation-damage halos in quartz after He^+ ion implantation

H. NISHIDO[1] T. OKUMURA[1] K. KOMURO[2] S. TOYODA[3] AND K. NINAGAWA[3]

[1] Research Institute of Natural Sciences, Okayama University of Science; nishido@rins.ous.ac.jp
[2] Institute of Geoscience, University of Tsukuba
[3] Department of Applied Physics, Okayama University of Sciences

Cathodoluminescence (CL) microscopy and spectroscopy were conducted on natural low-quartz samples after He^+ ion implantation in order to quantitatively evaluate the relationship between dose and CL halo development.

He^+ implantation experiments were performed with a 3M-tandem ion accelerator at 4 MeV with a dose density over 1.77×10^{-5} Ccm^{-2}. The homogeneous He^+ ion beam was irradiated perpendicularly on the polished surface of the quartz chips, which were prepared from quartz monocrystal from Minas Geras, Brazil. CL imaging and spectral measurements were carried out using scanning electron microscope combined with a grating monochromator (SEM-CL).

CL images of quartz after He^+ implantation show bright halos of about 14 μm in width from the implantation surface. CL emission is enhanced with an increase of dose density, but the width of CL halo is unchanged. The width is consistent with the value obtained using CCD camera method with a cold-cathode Luminoscope [1] and the prediction by the theoretical calculation [2]. The increase in CL intensity with increasing dose density is also confirmed in CL line analysis on the section of the samples. The shape of this profile is comparable with the Bragg's curve, characteristic of the electronic energy losses.

CL spectra with two peaks around at 400 nm (blue region) and 650 nm (red region) were obtained from the halo area at room temperature. These emissions might be assigned to [AlO_4/M^+] center and nonbridging oxygen hole center (NBOHC), respectively. Further addition of He^+ ion irradiation results in an increase in CL intensity of blue spectral peak whereas the intensity in red region is unchanged.

The relationship between dose density and CL intensity was obtained from the integrated intensity of the CL line profile after subtraction of the intensity of host matrix. The CL intensity increases with an increase in dose density, where the gradient gradually decreases. The CL halos are expected to be used for the dosimetry, and could be applied to the dating using radiation-damage in quartz.

References

[1] Komuro K., Horikawa Y. and Toyoda S. (2002) *Min. Petrol.* **76**, 261-266.
[2] Owen M.R. (1988) *Geology* **16**, 529-532.