Evaluation of radiation damage effect on feldspar using cathodoluminescence method

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CL halo in quartz caused by alpha-radiation has shown the correlation between CL intensity of the halo and the dose density, suggesting its application as a geodosimeter, although the halo in feldspar minerals, most common mineral in the Earth's crust, has not been studied from the point of CL characterization. Radiation-damaged halo in feldspar minerals has been investigated mainly with a SEM-CL microscopy, which enables to collect CL spectra from micro meter area and visualize high-resoluted CL imaging. A single crystal of alkali feldspar, sanidine ($Or_{90}Ab_{10}$), was employed for CL measurements. He^{+} ion implantation (dose density: 0.0001231 and 0.0007388 C/cm^2) in the sample was performed on a 3M-tandem ion accelerator, where the accelerator energy was set at 4 MeV corresponding to the energy of alpha particles emitted from the decay of ^{238}U. CL imaging and spectral analysis were carried out on a SEM-CL system comprised of a SEM (JEOL 5410LV) with a grating-type monochromator (Oxford Instruments MonoCL2) in wavelength range of 300-800 nm at 15 kV acceleration voltage and a beam current of 1.0 nA.

CL halo was observed in the surface of He^{+} ion implanted samples. Approximately 15 micron meter width of CL halo might be consistent with theoretical range of alpha-particles from disintegration of ^{238}U in feldspar. In the section of halo area, CL intensities of both samples gradually decrease from the implantation surface to the inside up to approximately 15 micron meters, over which it jumps up to bulk emission level. CL line analyses with panchromatic mode of both samples show that the distribution patterns of CL intensity in halo are reciprocally related to the Bragg's curve, which indicates energy loss process of specific ionization along the track of a changed particle. CL spectra of sanidine have blue and red spectral peak at 400 and 700 nm, respectively. The former could be assigned to Al-O^{-}-Al defect center and the later to Fe^{3+} impurity center. Raman spectra compose of peaks at around 480, 520, 780 and 1130 cm^{-1}, suggesting Si-O or Al-O atomic vibration. Their intensity decrease from the implantation surface to the inside up to approximately 15 micron meters. These facts imply He^{+} implantation appears to cause structural destruction, especially breakage of framework configuration in lattice. It might reduce emission centers such as Al-O^{-}-Al defect center in halo.