Cathodoluminescence of ultrahigh-temperature metamorphosed zircon and its application to geochronology

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Zircon in UHT (up to approximately 1000 ^{o}C) metamorphic rocks from Alps, Italy, Kodaikanal, India and Kandy, Sri Lanka were selected for CL measurements. Metamorphic ages dated from these zircon by the U-Pb method were 35, 500 and 550 Ma for Italy, India and Sri Lanka, respectively. SEM-CL (JEOL: JSM-5410), SEM (JEOL: JSM-5410) combined with a grating monochromator (OXFORD: Mono CL2), was used to measure CL spectra in the range from 300 to 800 nm, where the operation condition is at 15 kV and 1.0-2.0 nA. CL image was obtained by using a MiniCL, equipped with SEM-CL.

Panchromatic CL image of each sample shows bright emission in the rim and dull in the interior. It corresponds to zonal structure in zircon observed under petrographic microscope. CL spectra of the rim have three broad peaks: (1) UV CL peak at around 300 nm, which can be assigned to structural defects in the host lattice as intrinsic center, (2) blue CL peak at around 390 nm, resulted from lattice defects, and (3) yellow peak at around 580 nm, which is related to [SiO_4] groups (e.g. oxygen vacancies) or activation by Yb^{2+} generated by radiation.

Three samples show different intensity in the emission region of UV, blue and yellow, which are affected by the radiation from radioactive U/Th and annealing caused by UHT metamorphism. The structural regeneration of metamict zircon starts at 800 ^{o}C (Nasdala et al., 2002). The zircon annealed up to 1000 ^{o}C exhibits intense UV, weak blue and yellow emission by comparing with untreated sample. This fact implies that radiation damage in zircon reduces UV emission and enhances blue and yellow ones. Therefore, structural regeneration during UHT metamorphism eliminates radiation damage in zircon structure and the zircon should have a record of a net accumulation of radiation damage since it was cooled at 800 ^{o}C during retrograde UHT metamorphism.