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Structure and luminescence characteristics of quartz from pegmatites

JENS GÖTZE,[1,*] MICHAEL PLÖTZE,[2] AND TORALF TRAUTMANN[3]

[1]TU Bergakademie Freiberg, Institute of Mineralogy, Brennhausgasse 14, D-09596 Freiberg, Germany
[2]ETH Zürich, Division for Geotechnical Engineering, ClayLab, CH-8093 Zürich. Switzerland
[3]Endress & Hauser Conducta GmbH, Dieselstrasse 24, D-70839 Gerlingen, Germany

ABSTRACT

Samples of pegmatite quartz from several localities in Norway and Namibia were investigated by cathodoluminescence (CL) microscopy and spectroscopy, electron paramagnetic resonance (EPR) measurements, and trace-element analysis (ICP-MS) to obtain information about their structure and luminescence characteristics.

The defect structure and trace-element composition of the pegmatite quartz samples that were studied differ from those of quartz of other origin (hydrothermal, igneous and metamorphic quartz). EPR measurements reveal an almost complete lack of intrinsic lattice defects associated with O or Si vacancies (e.g., E' center, O_2^{3-} center), whereas some trace elements (Al, Ti, Ge, Li) are apparently enriched and form paramagnetic centers. The results indicate that there possibly is a redistribution of alkali ions during electron irradiation. The diamagnetic $[AlO_4/M^+]^0$ center transforms into the paramagnetic $[AlO_4]^0$ center, while the compensating ions diffuse away and may be captured by the diamagnetic precursor centers of $[GeO_4]^0$ and $[TiO_4]^0$ to form paramagnetic centers ($[TiO_4/Li^+]^0$, $[GeO_4/Li^+]^0$).

These defects result in a specific luminescence behavior, which is very similar for all samples. In general, quartz from pegmatites shows homogeneous CL without growth zoning or internal structures suggesting constant physicochemical conditions during crystal growth. The CL emission is dominated by a transient bluish-green CL, which disappears after 60–100 s of electron irradiation. The two main emission bands centered at 505 nm (2.45 eV) and 390 nm (3.18 eV) are probably related to alkali-compensated, trace-element centers in the quartz structure. Other CL emission bands, which are characteristic features of igneous, metamorphic, or hydrothermal quartz (e.g., at 450 nm = 2.75 eV, 580 nm = 2.14 eV, 650 nm = 1.91 eV) are almost completely lacking. This fact indicates that the defects responsible for these CL emissions are absent in pegmatite quartz.