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Cathodoluminescence microscopy and spectroscopy of synthetic ruby crystals grown by the optical floating zone technique

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Abstract

Synthetic rubies were grown by the optical floating zone method and characterized by cathodoluminescence (CL) microscopy and spectroscopy in combination with microprobe analysis. The measured intensity of the Cr^{3+}-induced CL of corundum is influenced by different parameters such as the sample thickness and orientation, the intensity of the beam current, and the quality of the sample surface. Furthermore, the spectral distribution of the CL emission changes with different concentrations of Cr in the corundum structure. Due to these effects, it is usually not possible to estimate the Cr content directly by using the measured CL intensity. However, we have developed an indirect method that is not significantly affected by these parameters. By using intensity ratios instead of measured intensities, a level of quantification of Cr in natural and synthetic corundum is now possible. Our study shows that the intensity ratio between the N-line at 701.6 nm and the sideband maximum at 713.2 nm displays a nearly linear dependence on the Cr concentration from ca. 100–300 ppm up to ca. 1.1 mol% Cr_2O_3. These results give a possible approach to develop an optical-microscope-based CL spectroscopy for quantitative measurements of Cr in natural rubies and synthetic α-Al_2O_3 materials.

Keywords: Quantitative cathodoluminescence, α-Al_2O_3, CL, rubies, crystal growth, floating zone technique