Cr^{3+} behavior at the content < 100 > 0 ppmw within α-Al_2O_3: case study of Ilmen blue sapphires by RS PL and LA-ICP-MS mappings

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The luminescence features of α-Al_2O_3:Cr^{3+} (a mineral corundum) have been studied since the time of first ruby solid-state lasers development. In the α-Al_2O_3:Cr^{3+} spectra induced by the Raman laser-emission (RS PL) at the Cr content > 100 - 300 ppmw, when the N-lines (~701 and ~705 nm) appear, their intensities ratio toward those of sidebands of Cr^{3+} (~710 and 714 nm) was applied for Cr^{3+} quantitative calculations in the corundum lattice [1], [3]. Meanwhile the use of R-lines intensities (~692 and 694 nm) for this estimation was eliminated due to their quenching in the presence of Fe.

In Ilmen sapphires, Cr^{3+} RS PL maps of R-line peak area demonstrated oscillatory behaviour with at least 2 well-defined zones. Laser ablation - inductively coupled plasma - mass spectrometry (LA-ICP-MS) element mapping of Fe, V and Ga showed the minor degree of element heterogeneity within the α-Al_2O_3; Cr chemical map was found to be consistent with the oscillatory zonation of Cr^{3+} RS PL map in R-line peak area.

Thus, undertaken research showed: 1) Cr^{3+} RS PL mapping of R-line peak area may be used for estimation of Cr^{3+} content <100ppmw in α-Al_2O_3; 2. The source of Cr in Ilmen sapphires may not be linked to the marine sediments since no evidence of correlation observed among Cr, Fe, V, and Ga on LA-ICP-MS maps.

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