Conjugation of TEM-EDX and optical spectroscopy tools for the localization of Yb^{3+}, Er^{3+} and Co^{2+} dopants in laser glass ceramics composed of $MgAl_2O_4$ spinel nano-crystals embedded in SiO_2 glass.

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Streszczenie

The main goal of this work is to conjugate two independent techniques of TEM-EDX and optical spectroscopy, which is rare, for the localization of Yb^{3+} and Er^{3+} rare earth ions and Co^{2+} transition metal ions as dopants in a compact self-Q-switched microchip laser glass ceramic composed of $MgAl_2O_4$ spinel nano-crystals of 10–20 nm size embedded in SiO_2 glass. The use of the TEM-EDX technique associated with both the elemental mapping of each dopant and the direct visualization of the heavier rare earth ions has led to the result that Er^{3+} and Yb^{3+} rare earth ions are preferentially located in the spinel nano-crystals. Regarding the low Co^{2+} concentration this technique was not accurate enough for characterization and finally we have used absorption spectroscopy to probe the main presence of Co^{2+} ions in the spinel nano-crystals. The use of Yb^{3+} ions as structural probes allows the identification of the 0-phonon broad line at 977 nm as both that of the disordered glass and that of the spinel inverted phases. A new Yb^{3+} radiationless center has been pointed out by the presence of a strong absorption line at 970 nm which has been assigned to the strongly perturbed area of the spinel nano-crystallite surface. This dopant characterization is worthwhile to be shown as a special case where characterization of rare earth and transition metal ions needs the use of both TEM and spectroscopic techniques.