Spectroscopic properties of Cr^{3+}:YGG ceramics

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Cr-doped materials find an application as NIR LEDs, solid state lasers, luminescent thermometry, etc.. However, the presence of parasitic processes, such as energy transfer, can reduce the performance of such devices. One such process is the energy-transfer "chain" phenomenon, in which the absorbed energy by one ion is transferred among the multiple Cr^{3+} ions before being emitted or transferred to a luminescence quenching center. This phenomenon can also induce changes in the emission spectra.

It was shown earlier that an increase in Cr^{3+} concentration led to a redshift of the emission of Cr^{3+}:YGG nanocrystals, while the crystal field strength remains nearly unchanged [1]. These changes were observed at low temperatures, whereas at room temperature the emission spectra remain similar. This behavior has been attributed to the energy-transfer "chain" phenomena. The presence of Cr^{3+} ions in a weak crystal field among interacting ions promotes emission from these sites, resulting in a redshifted emission.

The proposed energy transfer chain phenomenon was used to explain changes in Cr^{3+} emission in nanopowders [1] and nanoceramics [2]. However, the observed patterns could be attributed to the inhomogeneous microstructure of the investigated nanomaterials. Therefore, it remains unclear whether similar behavior occurs in bulk materials. If the proposed hypothesis is valid, a similar pattern should be observed in bulk materials with the same compositions [1].

In this work, we present a detailed study of the spectroscopic properties of Cr^{3+}:YGG ceramics doped with 0-5 at.% of Cr^{3+}. It was shown that increasing the Cr^{3+} concentration results in a redshift of the emission spectra, consistent with earlier results for the nanopowders of the same compositions [1]. These spectral changes are interpreted in terms of energy transfer between Cr^{3+} ions occupying octahedral sites with different local crystal-field strengths. The results support the existence of multiple inequivalent Cr^{3+} centers in the YGG ceramic and indicate that excitation energy migration between them plays an important role in shaping the overall luminescence spectra.

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