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Concentration effects of Er^{3+} ion in YAG:Er laser crystals

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Abstract

Laser crystals of $(Y_{1-x}Er_x)_3Al_5O_{12}$ (YAG:Er) have been grown by the Czochralski method and the spectral properties have been studied for different Er^{3+} concentrations. The effects of various Er^{3+} concentrations on the structural distortions, luminescence quenching of $^4F_{9/2}$, $^2H_{11/2}$, $^4S_{3/2}$ and red shift in laser wavelength have been discussed for the YAG:Er laser crystals. By using absorption spectra and Judd-Ofelt theory the experimental oscillator strengths, Ω_λ parameters and the excited state integrated absorption cross sections of Er^{3+} ion are reported and some variation regularities of these parameters have been observed.

Introduction

Erbium yttrium aluminum garnet $(Y_{1-x}Er_x)_3Al_5O_{12}$(YAG:Er) lasers at wavelengths near 1.6 μm and 2.9 μm are of interest [1], [2], [3], [4], because nowadays infrared lasers enjoy wide usage in laser chemistry, nonlinear laser spectroscopy and other applications, such as coherent laser radar, laser measurement distance and laser medicine. Up to now there are a lot of reports on the crystal growth, spectroscopy and sensitization between Er^{3+} and other ions, such as Ce^{3+} [3], Tm^{3+}, Yb^{3+} and Ho^{3+}, for YAG:Er laser crystals, but little is known about the effects of Er^{3+} concentrations on the unit cell dimensions, spectral properties and laser wavelength.

The purpose of this paper is to study the concentration effects of Er^{3+} ion in various Er^{3+} doped YAG single crystals in the near UV, visible and infrared regions and some spectral parameters. Such knowledge is necessary to understand for an efficient laser action in Er^{3+} doped YAG.

Section snippets

Experimental details

YAG:Er laser crystals containing different Er^{3+} ion concentrations have been grown by the Czochralski technique. The crystal structures are measured by Four-Circular Diffractometer. The data have been collected and analyzed by computer. At room temperature the absorption spectra were recorded with a Japan UV-365 Spectrophotometer and the emission spectra by a U-100 lm double grating monochromator, which was made by ourselves, in the regions of near UV, visible and infrared (200 nm–3000 nm).

Structure

The compositions of YAG:Er crystals are made of three oxides (Y_2O_3, Er_2O_3 and Al_2O_3). In the YAG:Er structure the Er^{3+} ion is in the place of the Y^{3+} site in a dodecahedron. From the results of the crystal structure analysis the cell parameters are given in Table 1. It shows that the structures of various Er^{3+} doped YAG crystals are similar to that of pure YAG and have a cubic symmetry with space group O_h^{12}–*Ia3d*. Fig. 1 shows the Er^{3+} concentration dependence of unit volumes. It can be seen

Conclusion

This work set out to get a better knowledge about the slight structural distortion of YAG:Er crystals that occurs with increasing Er^{3+} concentrations. The absorption cross sections, oscillator strengths and intensity parameters were determined, and the spontaneous radiative transition rate A and the branching ratio β were calculated for the YAG:Er laser crystals. The fluorescent intensities of $^2H_{11/2}$, $^4F_{9/2}$ and $^4S_{3/2}$ states are quenched by increasing Er^{3+} concentrations. The self-saturation

References (5)

- Y.Q Yu *et al.*
  J. Alloys and Comp.
  (1995)
- A.A Kaminskii

There are more references available in the full text version of this article.