EFFECT OF OXIDATION ANNEALING AT DIFFERENT TEMPERATURES ON CATHODOLUMINESCENCE PROPERTIES OF YAG:Ce SINGLE CRYSTALS

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Highlights

The cathodoluminescence properties of YAG:Ce single crystals annealed in oxidation atmosphere at different temperatures

Abstract

The cerium-activated yttrium aluminium garnet (YAG:Ce, chemical formula $Y_{3-x}Ce_xAl_5O_{12}$) is frequently used as a yellow-green emitting scintillator for high-energy particle detectors, or as a phosphor for white-light emitting LED sources [1]. The popularity of this material consists in its relatively fast decay, high light yield, good mechanical properties and low production costs. However, the YAG:Ce single crystals usually contain various unwanted structural defects which can result in non-radiative recombination and in delayed luminescence decay (afterglow). Thus, an effort is put into decreasing the concentration of material defects, which could bring desired increase of the light yield and reduction of the afterglow.

It was shown previously [2] that one type of the material defects in YAG:Ce single crystals consists of oxygen vacancies (V_O); however their role on the luminescence properties is still disputable [3]. Such defects can be eliminated by material annealing in oxidation atmosphere. In order to study the influence of V_O concentration decrease, the YAG:Ce single crystals were annealed in the air at different temperatures. The annealed and unannealed specimens were excited by an electron beam with the energy of 10 keV using a specialized cathodoluminescence (CL) apparatus [4]. CL spectra (Fig. 1), CL intensity decays (Fig. 1, inset) and thermoluminescence glows in the temperature range between 100 and 500 K were obtained.

The results show difference in CL properties of the annealed and unannealed specimens. The role of the V_O on the CL light yield and CL decay is discussed and energy levels in the bang gap are ascribed to the V_O. The results proved that higher temperatures of annealing decrease the concentration of the V_O more efficiently than lower temperatures; however a low concentration still remains in the interaction volume of the 10 keV e-beam after the annealing for 12 hours.

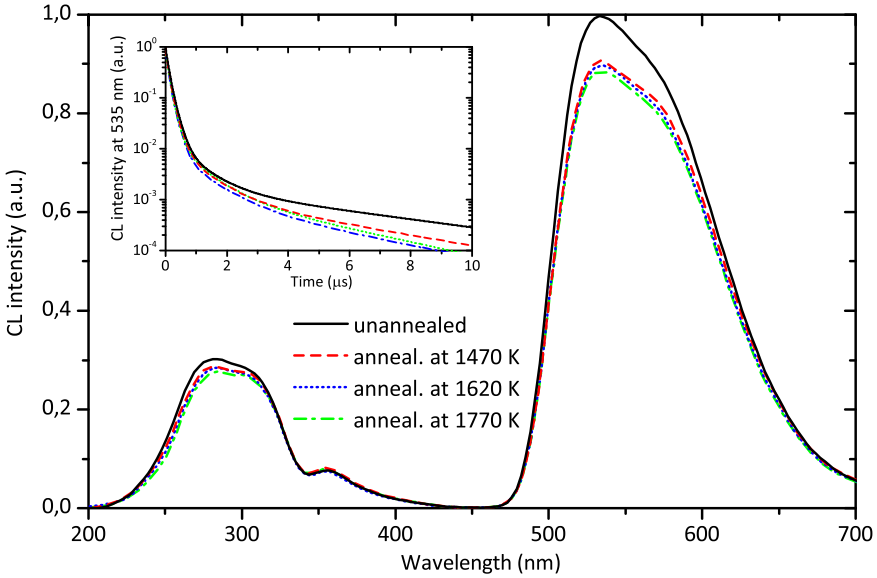

Figure 1. Cathodoluminescence (CL) spectra of the YAG:Ce crystals annealed in the air at different temp. for 12 hours. Their CL intensity decays after excitation by the 100 ns electron beam pulse are shown in the inset graph. Both experiments were carried out at room temp.

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