The 4TH International Conference on the Physics of Optical Materials and Devices

BOOK OF ABSTRACTS

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Published and printed by: Institut za nuklearne nauke “Vinča” Beograd

Print run: 300

ISBN: 978-86-7306-134-4

August 2015, Budva, Montenegro

CIP - Каталогизација у публикацији - Народна библиотека Србије, Београд

538.9(048)(0.034.2)

INTERNATIONAL Conference on Physics of Optical Materials and Devices (4 ; 2015 ; Budva)
Book of Abstracts [Elektronski izvor] / The 4th International Conference on the Physics of Optical Materials and Devices - ICOM 2015, Budva, Montenegro, August 31st - September 4th, 2015 ; [editors Miroslav Dramićanin, Bruno Viana, Rachid Mahiou]. - Beograd : Institut za nuklearne nauke "Vinča", 2015 (Beograd : Institut za nuklearne nauke "Vinča"). - 1 USB fleš memorija ; 1 x 3 x 6 cm

Sistemski zahtevi: Nisu navedeni. - Nasl. sa naslovne strane dokumenta. - Tiraž 300. - Bibliografija uz većinu apstrakata.

ISBN 978-86-7306-134-4

а) Физика кондензоване материје - Апстракти b) Физика чврстог стања - Апстракти
COBISS.SR-ID 216811788

ICOM 2015

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Budva, Montenegro

August 31st – September 4th, 2015

P1-15-305

CATHODOLUMINESCENCE STUDY OF LuAG:CeGdGa SINGLE CRYSTALLINE FILMS

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Cerium activated single crystals of lutetium aluminum garnet (LuAG:Ce) are prospective scintillation materials for detection of X-rays, gamma rays or high energy particles [1]. However, the LuAG:Ce single crystals usually contain various unwanted structural defects (mainly antisite defects) which can result in nonradiative recombination and in delayed luminescence decay (afterglow). It was shown previously [2] that the concentration of these defects decreases with the decreasing temperature of the crystal growth. Therefore, single crystalline epitaxial films have attracted a lot of attention recently because the growth temperature of LuAG:Ce films is about a half (1000 °C) of the bulk ones (2000 °C). Although some new defects can be created due to strain in the film, the concentration of the antisite defects is highly reduced, as shown in this work. Moreover, the influence of Gd and Ga substitution on the cathodoluminescence (CL) properties was studied.

Specimens of the LuAG:CeGdGa multicomponent epitaxial films with different concentration of Ce, Gd and Ga were grown from lead-free BaO-B_2O_3-BaF_2 flux. The films were excited by an electron beam with energy of 10 keV using a specialized CL apparatus [3]. CL spectra, CL intensity decays and thermoluminescence glows in the temperature range between 100 and 500 K were obtained.

It was shown, that a balanced Gd and Ga admixture into the LuAG:Ce film provided an excellent scintillator where the effect of unwanted structural defects was suppressed, the spectrally corrected CL light yield value exceeded 150 % of the commercially available bulk LuAG:Ce single crystal, and CL decay was dominated by a component with 50-80 ns decay time which is close to that of Ce^{3+} (5d-4f) photoluminescence decay. Moreover, a weak fast decay component with 11 ns decay time was observed. Since now, comparable component has been published only in one work related to similar structures [4]. The origin of this component could be in the strain in the film due to different lattice parameter of the film and the layer. Measured CL decays of approximately homoepitaxial film and of a bulk LuAG:Ce affirm this theory because the 11 ns fast component wasn't observed here.

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