Journal of Luminescence 222 (2020) 117172

Contents lists available at ScienceDirect

Journal of Luminescence

journal homepage: http://www.elsevier.com/locate/jlumin

Spatial anomalies in spectral-kinetic properties of Pr^{3+} - Doped $LiY_{1-x}Lu_xF_4$ mixed crystals☆

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ARTICLE INFO

Keywords:
Rare earth doped materials
Solid state lasers
Visible lasers
Spectroscopy
Excited-state absorption
Fluoride crystals

ABSTRACT

We present the spectral-kinetic including excited state absorption spatial-dependent features of Pr^{3+} - doped $LiY_{1-x}Lu_xF_4$ mixed crystals grown by Bridgeman technique.

1. Introduction

The praseodymium doped dielectric crystals and glasses are very attractive for design of visible lasers based on 4f-4f transitions of praseodymium ions and for UV lasing performed by subsequent conversion to the second harmonic. The visible laser action was realized in several crystal hosts and glasses doped with Pr^{3+} ions: $LiYF_4$, $LiLuF_4$, $LiY_{0.3}Lu_{0.7}F_4$ $LiGdF_4$, KYF_4, KY_3F_{10}, LaF_3, BaY_2F_8, $YAlO_3$, $SrAl_{12}O_{19}$, ZBLAN and ZBLA [1–5]; the UV and near-UV lasing was demonstrated by the visible laser operation intracavity frequency doubling at 261 [6], 302 [7], 303 [8], 320 [2,9–11], 349 [12] and 360 nm [13] in Pr:$LiYF_4$, 303.5 nm in Pr:BaY_2F_8 [14], 305 nm in Pr:KY_3F_{10} [15], 284 nm using both Pr:YLF and Nd: YVO_4 [16], 373.5 nm in Pr:$YAlO_3$ [17,18], 320 nm in Pr:$LiLuF_4$ [10], 320 nm in Pr:BaY_2F_8 [11]. The most of the publications are devoted to $LiYF_4$ and $LiLuF_4$ hosts providing the best and the variable laser properties.

The prospect of visible and UV lasers development is obvious because they can be used in the several regions of human needs. Only applications in such important areas as medicine and biology are impressive: in ophthalmology for treatment of vascular diseases and retina; in dermatology for treatment of allergic dermatitis, psoriasis, pyoderma, vasculitis, scleroderma, viral dermatitis, vitiligo, angiokeratomas, telangiectasia, poikiloderma of Civatte etc.; in cosmetology for hair and tattoo removal, not ablative resurfacing, removal of benign pigmented lesions, etc.; for intravenous laser blood irradiation (ILBI); in stomatology for caries detection; in surgery; in cardiology for atherosclerotic plaques removal; in biology for matrix-assisted laser desorption ionization–time of flight mass spectrometry, thermal sensing of a single eukaryotic cell internalized with nanoparticles, antimicrobial photodynamic therapy, bacterial identification and many others [19–23].

It is well known that the key parameters determining the opportunity of effective laser action and the intracavity second harmonic generation are: the cross-sections of absorption spectra from the ground and excited states (GSA and ESA, correspondently) and stimulated emission, fluorescence kinetics and quantum yield properties, distribution coefficient of the dopant, the optical quality of the crystal etc. In practice, the essential role of the choice of the crystal matrix is the cost of the host chemical compounds and the technological expenses for the unit of crystalline active element. To reach a balance between distribution coefficient of light rare earth elements that higher for $LiYF_4$ host, cost of chemical components that lower for $LiYF_4$ host, technological advantages and optical quality that higher for $LiLuF_4$ and associated with the congruent melting character of the one [24–27], the solid solution of $LiY_{1-x}Lu_xF_4$ with the variable parameter « x » can be used. These mixtures were also studied as perspective UV laser materials [28].

In the present search we studied the series of the crystals Pr^{3+}:$LiY_{1-x}Lu_xF_4$ with the varied x-parameter form 0 to 1. Moreover the spectral-kinetic features of the samples were studied along the crystal boules. It

☆ Declarations of interest: none.

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https://doi.org/10.1016/j.jlumin.2020.117172
Received 20 August 2019; Received in revised form 26 February 2020; Accepted 27 February 2020
Available online 29 February 2020