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Crystal growth, EPR and site-selective laser spectroscopy of Gd^{3+} -activated $LiCaAlF_6$ single crystals

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Abstract

Ce^{3+} -activated $LiCaAlF_6$ (LiCAF) and $LiSrAlF_6$ (LiSAF) single crystals are the most prospective active media for directly pumped UV solid-state tunable lasers. Due to the heterovalent activation nature of these crystals, crystal spectroscopic properties as well as their laser efficiency strongly depend on the actual crystal growth conditions. In order to establish the growth-related peculiarities of activator center formation in LiCAF, concerted crystal growth, EPR and site-selective laser spectroscopic studies were performed. For EPR and optical spectroscopic studies, the Gd^{3+} -“probe” activation of LiCAF crystal was used here instead of much harder to interpret Ce^{3+} activation. The obtained results indicate that up to three types of structurally distinct Gd^{3+} centers are formed in the LiCAF crystals with their relative concentrations changing depending on the crystal growth conditions. The results are being applied for growing Ce^{3+} -activated LiCAF crystals with the desired luminescence and laser performance. © 2001 Elsevier Science B.V. All rights reserved.

Keywords: Rare-earth ions; Laser materials; Ultraviolet tunable lasers

1. Introduction

The $LiCaAlF_6$ (LiCAF) and $LiSrAlF_6$ (LiSAF) single crystals activated by Ce^{3+} ions are the most prospective active media for directly pumped UV solid-state tunable lasers based on interconfigurational $5d4f^{n-1} \leftrightarrow 4f^n$ transitions of rare-earth ions [1–3]. Although due to the heterovalent activation nature of these crystals by the Ce^{3+} ion, crystal spectroscopic properties, their laser efficiency and tunability immensely depend on the actual crystal

growth conditions [4]. In-depth investigation of multi-site Ce^{3+} activation nature in these crystals would lead to improving laser materials and, thus, advanced tunable UV laser performance.

In order to establish all growth-related peculiarities of spectroscopically distinct activator center formation in LiCAF and properly interpret each optical center model, concerted crystal growth, EPR and site-selective laser spectroscopic studies were performed in this work. For EPR/optical spectroscopic studies aimed at revealing the structure of doping centers and interpreting the observed multi-site optical spectral features, the Gd^{3+} “probe” activation of LiCAF single crystals was used in lieu of a much more complex

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