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Potentiality of Pr^{3+}- and $Pr^{3+} + Ce^{3+}$-doped crystals for tunable UV upconversion lasers

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Abstract

Gain experiments based on the interconfigurational 4f5d to $4f^2$ optical transitions in praseodymium-doped fluoride crystals were achieved. The measurements were performed under upconversion pumping of the 4f5d excited configuration via the ^3P_J, $^1I_6$ intermediate levels of the $4f^2$ configuration, using a pump-probe set-up with three synchronized Q-switched nanosecond pulsed lasers. In spite of this two-step excitation, optical losses, due excited state absorption (4f5d → conduction band transition) leading to Pr^{3+} ion photoionisation and color center formation, were too high to observe any amplification. However, these losses were found definitely weaker in fluoride crystals ($Pr:LiYF_4$, $Pr:LiLuF_4$) than in oxides ($Pr:YAlO_3$) and, probing the 5d → 4f emission of Ce^{3+} under two-step excitation pumping of the Pr^{3+} 4f5d states in co-doped $Pr,Ce:LiLuF_4$ crystals, no losses were detected at all.

1. Introduction

An attractive solution for obtaining tunable UV or VUV laser sources that are efficient, compact and of reasonable cost, is to take advantage of the trivalent rare earth $4f^{n-1}5d \rightarrow 4f^n$ interconfigurational transitions. These $4f^{n-1}5d \rightarrow 4f^n$ emissions are intense (allowed electric dipolar transitions) and spectrally broad due to the strong coupling between the 5d electron of the active ion and its crystalline environment. Solid state lasers of this type were demonstrated with Ce^{3+} and Nd^{3+} (see [1–3] for a review) but never with Pr^{3+}-doped

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