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Potentiality of Pr³⁺- and Pr³⁺ + Ce³⁺-doped crystals for tunable UV upconversion lasers

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Abstract

Gain experiments based on the interconfigurational 4f5d to 4f² 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, ¹I₆ intermediate levels of the 4f² 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 Pr³⁺ ion photoionisation and color center formation, were too high to observe any amplification. However, these losses were found definitely weaker in fluoride crystals (Pr:LiLuF₄, Pr:LiLuF₄) than in oxides (Pr:YAlO₃) and, probing the 5d → 4f emission of Ce³⁺ under two-step excitation pumping of the Pr³⁺ 4f5d states in co-doped Pr,Ce:LiLuF₄ crystals, no losses were detected at all.

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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 4fⁿ⁻¹5d → 4fⁿ interconfigurational transitions. These 4fⁿ⁻¹5d → 4fⁿ 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 Ce³⁺ and Nd³⁺ (see [1–3] for a review) but never with Pr³⁺-doped

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