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Beneficial effect of Lu^{3+} and Yb^{3+} ions in UV laser materials

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Abstract

Several Lu^{3+}- and Y^{3+}-based oxide and fluoride single crystals with isomorphic structures and doped with Ce^{3+} (or Pr^{3+}) or codoped with Yb^{3+} ions have been grown and studied to show the beneficial effects of the Lu^{3+} and Yb^{3+} ions on their broad-band UV luminescence properties. Time-resolved color center absorption measurements clearly show the reduction of the usually observed UV laser pump-induced optical losses and thus confirm the previous gain and laser results obtained in these materials. Some preliminary interpretations of the involved mechanisms are advanced.

1. Introduction

Most of the Ce^{3+} or Pr^{3+} doped materials known for their broad-band 5d–4f UV emissions and which have been investigated in the past for their potentials as tunable solid-state laser media suffer from photochromic (solarization) effects, when they are pumped in the near UV spectral domain, which usually limit their laser performance or even hinder any laser action [1,2]. However, several recent works involving materials with Lu^{3+} instead of Y^{3+} or codoped with Yb^{3+} ions showed reduced solarization effects and improved laser performance [3–7].

The present paper thus gives the state of the art in this field of research and some preliminary interpretations of the beneficial effects of these Lu^{3+} and Yb^{3+} ions. Crystal characteristics are gathered in Section 2. Transient absorption measurement conditions are described in Section 3. Section 4 gives a comparison of the results obtained in the Lu^{3+}- and Y^{3+}-based materials. Finally, Section 5 presents the results obtained in Ce^{3+} doped crystals codoped with Yb^{3+} ions.

2. Crystal growth and sample characteristics

In order to verify the beneficial effect of Lu^{3+}, two families of single crystals—namely $LiY(Lu)F_4$ and $Y(Lu)PO_4$—were synthesised. These materials were selected for their perfect isomorphisms and because they have already demonstrated interesting and encouraging properties for a laser emission

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