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Picosecond spectroscopy of transition-metal-ion-doped solid state laser materials

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The development of tunable solid state lasers requires a detailed and quantitative understanding of relaxation processes in excited states of impurity ions in crystals.

Recently, the kinetics of nonradiative transitions from the excited states to metastable storage level was investigated in ruby, alexandrite, emerald and Ti-sapphire [1,2]. An upper limit of 7 ps was obtained for the 4T_2 state nonradiative lifetime of Cr^{3+} in ruby. In alexandrite and emerald the nonradiative relaxation time of 17 ps and 23 ps for intra 4T_2 vibrational transitions and 27 ps and 20 ps for the $^4T_2 \rightarrow ^2E$ electronic transition were measured. An upper limit of 3.5 ps for the intra 2E_g state vibrational relaxation time in Ti-sapphire was estimated.

The obtaining of laser action on chromium-doped forsterite and YAG in the near infrared excites great interest to Cr^{4+} and other tetrahedrally coordinated ions in crystalline hosts. In this paper saturation of absorption and relaxation processes in excited states of the tetrahedrally coordinated Cr^{4+} in garnets and forsterite, V^{3+} in YAG and Co^{2+} in GSGG are investigated. Absorption cross section of the $^3A_2 \rightarrow ^3T_2$ transition was measured to be $5 \times 10^{-18} \text{ cm}^2$ and $2.3 \times 10^{-18} \text{ cm}^2$ for the Cr^{4+} in garnets and forsterite, respectively, and $8 \times 10^{-18} \text{ cm}^2$ for the V^{3+} in YAG. An upper limit for the intra 3T_2 state vibrational relaxation time was estimated to be 8 ps for the Cr^{4+} in garnets and 15 ps for the Cr^{4+} in forsterite and V^{3+} in YAG. Nonradiative lifetime of the $^4T_1(^4P)$ and $^4T_1(^4F)$ excited states of the Co^{2+} GSGG was estimated to be approximately 35 and 20 ps.

Q-switched and mode-locked laser pulses have been obtained for a number of solid state lasers in the near infrared (747 nm - 1.34 μm) using chromium-doped crystals and V:YAG as the saturable absorbers.

References

1. S.K. Gayen, W.B. Wang, V. Petricevic et al, Appl. Phys. Lett. **47** (1985) 455, **49** (1986) 437, **50** (1987) 1484.
2. S.K. Gayen, W.B. Wang, V. Petricevic, S.G. Demos, and R.R. Alfano, J. Lumin. **47** (1991)