Synthesis of Mg^{2+}, Cr^{4+}:YAG Optical Ceramics for Passive Q-switch Lasers

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The general trend of modern microelectronics to decrease the size of electronic and optoelectronic devices is now imposing strict requirements on solid-state lasers. At the same time demands on the laser beam quality also increase. Progress in fabrication of compact solid-state lasers implies the development of new type of highly-doped active media containing high concentration of functional ions [1].

$Y_3Al_5O_{12}$ (YAG) optical ceramics is a promising material for obtaining of laser materials with high doping concentration of active ions. Ceramics synthesis occurs in accordance with the corresponding equilibrium phase diagrams of binary or ternary systems, whereas non-stationary processes on the crystallization front play significant role during single crystals growth. Nowadays there are a lot of reports on the synthesis of high-quality Nd^{3+}:YAG ceramics [2], but fabrication peculiarities of Cr^{4+}:YAG optical ceramics are insufficiently covered [3]. The aim of this work is to establish fabrication pathway of Mg^{2+},Cr^{4+}:YAG optical ceramics as a model system prospective for passive Q-switches.

Mg^{2+},Cr^{4+}:YAG optical ceramics were synthesized by solid-state reaction sintering in vacuum. The effect of magnesium and chromium ions concentration on the structural-phase state and optical properties of Mg^{2+},Cr^{4+}:YAG ceramics was studied. The concentration of magnesium ions was optimized resulting in Mg^{2+},Cr^{4+}:YAG ceramics with optical transmission of 80% at λ=1064 nm. Mg^{2+} ions incorporated into YAG matrix create oxygen vacancies, which increase the effective diffusion coefficient of constituent ions and accelerate pore removal from the ceramic volume. It was shown that for highly chromium doped ceramic samples, an enhancement of the concentration of Cr^{4+} ions in the samples occurs, due to the increased probability of forming [$Mg^{2+}Cr^{4+}$] pairs.

The possibility of using Mg^{2+},Cr^{4+}:YAG optical ceramic as passive Q-switch was tested. Quasi-continuous wave diode pumping of 0.3 at.% Nd^{3+}:YVO_4 single crystal that was passively Q-switched with Mg^{2+},Cr^{4+}:YAG saturable absorber ceramic results in the generation of laser pulses with 3.1 μJ pulse energy and 45 ns pulse width.

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[2] I. O. Vorona et al., *Quantum Electronics* **45**(9) (2015) 819.
[3] Z. Tianyuan et al., *Journal of the American Ceramic Society* **98**(8) (2015) 2459.