Solid-State Sintering and Luminescent Properties of Yb^{3+}, Er^{3+}:YAG Transparent Ceramics

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Er^{3+} and Yb^{3+} co-doped hosts have been proposed for obtaining up-conversion and down-conversion luminescence by energy transfer between Yb^{3+} and Er^{3+} ions [1, 2], as well as for active media of diode-pumped solid-state lasers operated at 1.6 µm wavelength [3]. Polycrystalline Yb^{3+}, Er^{3+}:YAG is a promising material for laser and photonics applications due to excellent solubility of dopants into garnet matrix, high optical and structural quality, which are beneficial properties for obtaining of efficient laser devices. Nowadays there is an increasing interest in obtaining of YAG-based materials via advanced ceramic technology.

Yb^{3+}, Er^{3+}:YAG transparent ceramics contained 5 at.% of Yb^{3+} ions and 0.5 to 1.5 at.% of Er^{3+} ions were produced by the solid-state reactive sintering method [4]. Influence of Yb, Er doping on shrinkage and the microstructure of reactive-sintered ceramics was investigated. Temperature conditions that are responsible for effective densification and inhibition of grain coarsening were optimized. Structural, optical and luminescence properties of ceramics, obtained under optimized condition were studied. In accordance to XRD analysis and SEM observations, the obtained ceramics have single phase garnet structure and no secondary segregated phases were observed. They have near-theoretical density (residual porosity not excess 10 ppm) and high transparency. Luminescent properties of obtained ceramics were measured under Xe-lamp and 975 nm diode excitation corresponding to up- and down-conversion modes.

The results could be used for optimization of eye-safe compact ceramic diode-pumped solid-state lasers, for range-finders, optical and communication devices, or for light convertors of semiconductor detectors and solar cells.

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[1] J. De Wild, J.K. Rath, A. Meijerink, W. Van Sark, R.E.I. Schropp, Enhanced nearinfrared response of a-Si:H solar cells with b-$NaYF_4$:Yb^{3+} (18%), Er^{3+} (2%) up-conversion phosphors, *Sol. Energy Mater. Sol. Cells* **94** (2010) 2395–2398.

[2] V.D. Rodriquez, V.K. Tikhomirov, J. Mendez-Ramos, A.C. Yanes, V.V. Moshchalkov, Towards broad range and highly efficient down-conversion of solar spectrum by Er^{3+}-Yb^{3+} co-doped nano-scale glass-ceramics, *Sol. Energy Mater. Sol. Cells* **94** (2010) 1612–1617.

[3] E. Georgiou, F. Kiriakidi, O. Musset, J.-P. Boquillon, 80mJ/1.64µm pulsed Er:Yb:YAG diode-pumped laser, *Proceedings of SPIE* **5460** (2004) 272-283.

[4] R.P. Yavetskiy, D.Yu. Kosyanov, A.G. Doroshenko, S.V. Parkhomenko, P.V. Mateychenko, I.O. Vorona, A.V. Tolmachev, A.V. Lopin, V.N. Baumer, V.L. Voznyy, Microstructure evolution of SiO_2, ZrO_2- doped $Y_3Al_5O_{12}$:Nd^{3+} ceramics obtained by reactive sintering, *Ceram. Int.* **41** (2015) 11966–11974.