Preparation of Er:YbAG waveguides

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Synthetic garnets are very popular materials in optical and optoelectronic applications such as lasers and scintillators. Garnet structure is a suitable matrix for doping with optically active elements and it can therefore be used for the preparation of active optical planar waveguides. Depending on the application, dopants can be the cations of transition metals (for example Cr, Co, Mn) or rare earth metals. Erbium ion is nowadays one of the most often used activators. Garnets doped with trivalent erbium (Er^{3+}) can emit luminescence in visible and infrared light depending on the excitation energy. The problem of Er^{3+} is in a small effective cross-section. To solve this problem, Er^{3+} is co-doped with another cation, most often Yb^{3+}. The energy levels of Er^{3+} and Yb^{3+} are close enough for an efficient energy transfer.

The goal of this work was to prepare thin films of $(Yb_{1-x}Er_x)_3Al_5O_{12}$, (x = 0.005; 0.02; 0.1) where ytterbium is a part of the matrix and is therefore in close vicinity to every Er^{3+} ion. Fused silica and monocrystalline $SiO_2(0001)$ were used as substrates. Solutions for deposition of thin films were prepared from erbium acetate and ytterbium acetate together with aluminium chloride. As chelating agents, acetic acid and polyvinylpyrrolidone were used. Thin films were deposited by spin-coating and thermally decomposed and crystallized under two different atmosphere pressures. The phase composition of prepared samples was studied by XRD. The microstructure of the films was analysed by AFM and SEM methods. Optical properties were measured by m-line and photoluminescence spectroscopy.

All prepared films were single phase and their thickness was sufficient to guide an optical signal at 1552 nm. Crystallite size of the layers was around 100 nm and their surface roughness was in the order of units of nanometres. All prepared layers show photoluminescence of the Er^{3+} ions in the near infrared region ($^4I_{11/2} \rightarrow {}^4I_{15/2}$).