Abstract

Yury Kuzminykh, *Crystalline, Rare-Earth-doped Sesquioxide and YAG PLD-Films*

This thesis presents the results of fabrication as well as structural and spectroscopic characterization of pulsed-laser-deposited oxide films. The fabricated films are activated by rare-earth ions and proven to be crystalline. Such films are promising for the fabrication of integrated optical devices or compact light sources. The application as active medium for thin disk lasers is considered as well.

The films produced include scandia (Sc_2O_3), yttria (Y_2O_3), lutetia (Lu_2O_3), ytterbia (Yb_2O_3) and yttrium-aluminum garnet ($Y_3Al_5O_{12}$) films with thicknesses in the range from 500 nm to 10 µm. Their structural properties have been investigated by means of X-ray diffraction. The influence of the deposition parameters on the characteristics of the scandia films has been investigated in more detail and the optimal deposition parameters have been determined.

The scandia films are highly textured along the <111>-direction and the crystallite dimensions reach several hundreds of nanometers. The lutetia films deposited under the same conditions demonstrate substantially smaller crystallites (<50 nm), which are mostly <111>-oriented. However, other orientations are also present in the diffraction patterns of the lutetia films.

The YAG films deposited at 700°C have been proven to be amorphous. After annealing at 1200°C the XRD analysis revealed a polycrystalline behavior of the Yb:YAG films and their spectroscopic properties resembled those of the bulk.

Waveguiding has been demonstrated in a 1.2 µm thick Eu:Y_2O_3 film as well as in 3 µm and 10 µm thick Nd:Sc_2O_3 films. The light propagation losses have been estimated to be 19.5 dB·cm^{-1} and 12 dB·cm^{-1}, respectively, for the 3 µm and 10 µm Nd:Sc_2O_3 films. The excitation and emission spectra for the Nd:Sc_2O_3 films are close to those of the bulk material. The lifetime of the $^4F_{3/2}(Nd^{3+})$ multiplet in the scandia PLD-film is somewhat reduced compared to that in the bulk material.

Spectroscopic investigations of ytterbia as well as Yb-doped scandia, lutetia, and YAG films have been performed. For the ytterbia films the emission has only been detected at temperatures below 20 K. The spectra of the Yb:Sc_2O_3 and Yb:Lu_2O_3 films are bulk-like and vary slightly depending on the used substrate and the post annealing treatment (at 900°C). The luminescence quantum efficiency was up to 66% or up to 78%, respectively for the Yb-doped lutetia and scandia films.