OPTICAL ABSORPTION AND LUMINESCENCE OF CHROMIUM DOPED $Gd_3Ga_5O_{12}$ EPITAXIAL FILMS

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As an alternative to bulk crystals the Cr-doped yttrium-aluminium garnet (YAG) epitaxial films are used as a passive Q-switching medium for Nd-activated lasers [1]. From other hand the Cr-doped gadolinium-gallium garnet (GGG) films have some advantages in comparison with YAG films. The main is that saturation of phototropic centers absorption take place at high level power emission.

Single crystalline films of GGG:Cr were grown up on [111]-oriented pure GGG substrate by standard isothermal liquid-phase epitaxy (LPE) method from supercooled solution of garnet-forming components dissolved in flux solvent based on Bi_2O_3-B_2O_3. The growth temperature was in the range of 1000…1040^{o}C. The MgO was introduced into the melt to obtain quadrivalent state for the chromium ions. The films with thickness of 14…100 μm were grown at growth rate changed from 0.5 to 1.4 μm/min.

The absorption and excitation spectra, emission spectra under photo- and X-ray excitation, as well as the time resolved spectra and decay kinetics were investigated.

Optical absorption spectra of the Cr-doped GGG films were computed from transmission spectra measured by spectrophotometer Shimadzu UV-3600 at room temperature. For all films were observed two characteristic Y-and U- absorption bands of the Cr^{3+} ions in octahedral sites at wavelengths of 460 nm ($^4A_2 \rightarrow {}^4T_1$) and 630 nm ($^4A_2 \rightarrow {}^4T_2$) respectively. Moreover, broad absorption band with the maximum at 860 nm also was observed for the films co-doped with chromium and magnesium impurities.

Besides the characteristic excitation bands in the visible spectral region the UV excitation band that may be attributed to charge transfer is observed. The luminescence spectra of Cr^{3+} ions with maximum near 730 nm at X-ray excitation correlate with photoluminescence spectra. The influence of annealing in vacuum and air on optical and luminescent properties of epitaxial films was investigated.

The decay kinetics of chromium ions luminescence with variation of impurities concentration (Cr, Mg) and technological features of the epitaxial films growth has been analyzed. It shows non-single exponential behavior and demonstrates that emitting ions occupy different sites in a crystalline lattice.

Possible mechanisms of activator ions luminescence excitation and the nature of absorption band in IR spectral region are discussed.

Reference

[1] A.O. Matkovsky, Materials of Quantum Electronics (Liga-Press, Lviv, 2000, Ukraine), pp. 274 – 280.