# Optical Properties of GGG Epitaxial Films Grown from $PbO\text{-}B_2O_3\text{-}V_2O_5$ Flux

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Garnet crystals are known to be used as materials for solid-state lasers and garnets doped with transition metals for passive Q-switching in range 1…1,6 μm. Single crystalline films grown by liquid phase epitaxy (LPE) have some advantages in comparison with bulk crystals such as homogeneity, structural perfection, optical transparency, etc.

The present work is devoted to growth of the high-quality gadolinium gallium garnet $Gd_3Ga_5O_{12}$ (GGG) homoepitaxial films and investigation of the influence of technology parameters on their optical properties.

Single crystalline films of GGG were grown on (111)-oriented pure GGG substrate by LPE method from fluxes based on $PbO\text{-}B_2O_3$ and $PbO\text{-}B_2O_3\text{-}V_2O_5$. The growth temperature was in the range of 880…1010 °C. The films with thickness of 4…60 μm were grown at growth rate changing from 0.1 to 1.0 μm/min.

Optical absorption spectra of grown films were measured in the range of 200…1500 nm. The absorption band at 280 nm which correspond to electron transition ($6s^2$) $^1S_0 \rightarrow {}^3P_1$ of $Pb^{2+}$ ions [1] were observed in all films grown from both fluxes. Besides the wide absorption band with maximum around 345 nm is observed in films grown from $PbO\text{-}B_2O_3$ (Fig. 1*a*). This absorption can be connected with the hole $O^-$ centers which localized near $Gd^{3+}$ in octahedral position [2]. The additional absorption bands were observed (Fig. 1*b*) in films grown from $PbO\text{-}B_2O_3\text{-}V_2O_5$ flux. The first one with maximum at 322 nm corresponds to charge transfer from the oxygen to $Pb^{4+}$ ($O^{2-}+Pb^{4+}+h\nu \rightarrow Pb^{3+}+O^-$) and the second one with maximum at 550 nm is due to intervalence pair-wise transitions in $Pb^{2+}$ and $Pb^{4+}$ ions ($Pb^{2+}+Pb^{4+}+h\nu \rightarrow Pb^{3+}+Pb^{3+}$) [1]. Moreover, any absorption peaks which correspond to ions $V^{3+}$ or $V^{4+}$ ions were not detected.

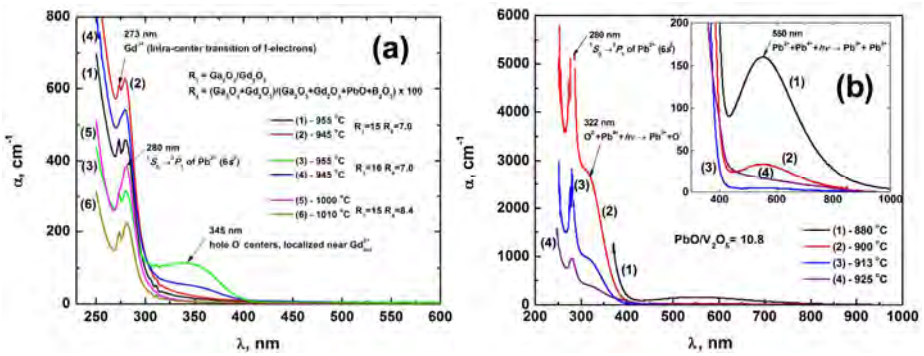


**Fig. 1.** Optical absorption spectra of the homoepitaxial GGG films grown from $PbO\text{-}B_2O_3$ (*a*) and $PbO\text{-}B_2O_3\text{-}V_2O_5$ (*b*) fluxes at different temperatures.

Influence of flux composition contained $V_2O_5$ on optical properties of GGG epitaxial films are discussed.

[1] G. B. Scott and J. L. Page, Pb valence in iron garnets, *Journal of Applied Physics* **48** (1977) 1342-1349.
[2] A. Matkovskii, P. Potera, D. Sugak, L. Grigorjeva, D. Millers, V. Pankratov, and A. Suchocki, Stable and transient color centers in $Gd_3Ga_5O_{12}$ crystals, *Crys. Res. Technol.* **39**(9) (2004) 788-795.