Comparative Growth Study of Garnet Crystal Films Fabricated by Pulsed Laser Deposition

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We report here a comparative film growth study of several different garnet crystal compositions intended for optical waveguide applications. Films of Nd,Cr:$Gd_3Sc_2Ga_3O_{12}$, Cr:$Gd_3Sc_2Al_3O_{12}$, Nd,Cr:$Y_3Sc_2Al_3O_{12}$, Nd:$Gd_3Ga_5O_{12}$, $Y_3Ga_5O_{12}$, $Y_3Al_5O_{12}$ (YAG) and $Yb_3Al_5O_{12}$ (YbAG) have all been grown by the technique of pulsed laser deposition (PLD). X-ray diffraction results from the films are in line with the occurrence of single crystal epitaxial growth on the YAG (100) oriented substrates and reveal that they have well ordered crystal structures, some being of a quality approaching that of the substrates. Energy dispersive X-ray analysis shows that the film compositions can be slightly deficient compared to the targets and a relative 'deposition volatility' of different elements can be assigned which follows a trend related to elemental boiling points, suggesting that the compositional deficiencies may occur as a result of rejection from the growing film. Spectroscopic measurements of a YbAG film show that the strength of absorption for different Yb^{3+} transitions is not the same as for bulk crystal, indicating the possibility for tuning the absorption properties of films to a desired pump wavelength. This growth study has shown that several different garnet crystals can be grown under the same deposition conditions and indicates the potential of PLD to be used as a fabrication technique for advanced multilayer planar waveguide laser structures.

Keywords: pulsed laser deposition, garnet crystal, optical, waveguide and film.

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