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GROWTH OF LASER HOST THIN-FILM OPTICAL WAVEGUIDES BY PULSED LASER DEPOSITION.

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Optical waveguides of laser gain media are highly desirable because the high intensity-length product and good pump-signal mode overlap, which can be achieved in the waveguide geometry, leads to a reduced threshold pump power as compared to bulk lasers. Pulsed laser deposition (PLD) has emerged as a viable means of depositing epitaxial thin films of the correct composition. We report here the deposition of GGG and YGG thin films on YAG substrates and the deposition of sapphire on sapphire substrates.

GGG and YGG films were deposited by ablating a crystal target of GGG and YGG respectively using a KrF excimer laser, operating at a wavelength of 248nm, with an incident laser fluence of $\approx$ 5J/cm^2. A YAG substrate was positioned 2.5cm away from the target and heated on its front surface with a 10W CO_2 laser beam to a maximum temperature of 750°C.

X-ray diffraction (XRD) was used to analyse the crystalline quality of the films. At a substrate temperature of 750°C and 650°C, the GGG and YGG films respectively had grown exclusively in the highly-oriented (444) plane parallel to the (444) YAG surface. The stoichiometry of the GGG thin films was investigated using Rutherford backscattering spectroscopy. The best fit to the experimental data was modelled by assuming a 1620nm-thick film with a composition of $Gd_3Ga_{4.5}O_{11}$ (cf $Gd_3Ga_5O_{12}$ for bulk crystal) implying a slight gallium deficiency during deposition. Furthermore, we assumed a 180nm-thick layer between the film and substrate where a linear interdiffusion has occurred due to the high substrate temperatures. The refractive index of the GGG film was measured using a dark-mode prism coupling technique. This had a value of 1.972 at 633nm which has a close agreement with the bulk crystal (n_{GGG}=1.965).

In parallel with this work has been the investigation of sapphire films with the potential application as a Ti:sapphire waveguide laser. The growth, by PLD, of layers formed from targets of pure alumina ceramics onto single-crystal sapphire substrates will be reported. X-ray texture camera analysis and XRD studies indicate that the films do consist of α-alumina (i.e. sapphire).

Results showing the in-situ doping of the thin films with rare earth ions, (Nd for the GGG and YGG films and Ti for the sapphire) will also be reported.