The effect of particulate density on performance of waveguide lasers grown by Pulsed Laser Deposition

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Abstract: We have successfully grown buried and uncapped waveguiding layers of Nd:Gadolinium Gallium garnet on YAG by pulsed laser deposition for purposes of studying the effects of particulates on waveguiding and lasing performance.
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Pulsed Laser deposition (PLD) has always been a potentially attractive method of fabricating waveguides due to low running and capital costs. The ability to quickly and easily grow stoichiometric, epitaxial films of a large variety of laser media makes it an almost ideal fabrication process. PLD has been avoided as a preferred method, however, due to the large number of particulates generated on the waveguides during growth. There has been no direct correlation however, between the number of particulates seen on the films and the losses generated. In this paper we report on the comparison between losses observed in a waveguide and particulate density. We shall also report the performance of a buried waveguide structure, in which the effects of particulates should prove less important. Using similar to conditions to those reported earlier, [1] we have grown films of epitaxial <100> Nd:GGG on a <100> YAG substrate. The XRD data shown in fig.1 confirms the crystallinity of the films.

![X-ray diffraction data for Nd:GGG films.](image)

Fig.1. shows X-ray diffraction data for the Nd:GGG films. The YAG (100) line is weak due to the thickness of the sample. No other peaks are observed.

The films are approximately 4μm thick. We have used a piezo-electric gas valve to modify the particulate density in the film during growth as described elsewhere[2]. Fig.2 shows the surface of two films grown with and without the gas-jet interaction with the plasma plume. Fig.2a shows normal particulate density when the film is grown with no gas-jet interaction with the plume Fig.2b shows a factor of five decrease when the gas jet is directed into the plume.
We will report the losses associated with these films and corresponding lasing thresholds and slope efficiencies for these waveguide lasers. As well as reducing particulate density we have grown a buried waveguide where the effect of the particulates is reduced. The fabrication of such devices is simple as it only involves a change of target during growth of the film. We have grown a further layer of YAG on top of the Nd:GGG layer. The losses and lasing threshold will be reported on, and conclusions drawn concerning whether there is need for particulate reduction in such a device.
