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Photosensitive lead germanate glass waveguides grown by Pulsed Laser Deposition.

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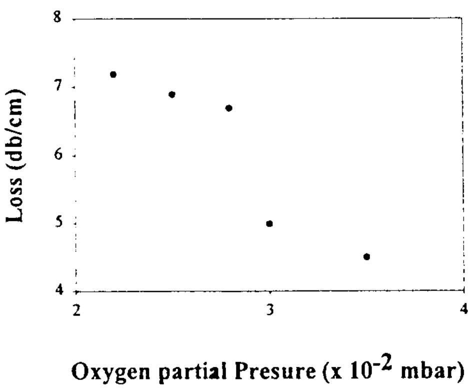
Photosensitivity in (predominantly) germanium doped fibres and planar waveguide structures is the subject of intense current interest. Permanent refractive index gratings, written using UV light from either pulsed or c.w. laser sources, can be produced by interferometric exposure, yielding Δn values ranging from10^{-5} to 10^{-3}. Additional techniques such as hydrogen loading, or flame brushing, can further increase this value to $\sim 10^{-2}$. In this paper, we report our studies of planar waveguides of lead germanate glass, grown by Pulsed Laser Deposition. The films are grown under various partial pressures of oxygen, and show distinct and systematic differences in colour, waveguide loss and photosensitivity. We interpret our results in the context of induced oxygen vacancies produced during the growth.

Excimer lasers operating at 248 nm and 193 nm were used to grow the films. For both cases, there is a strong correlation between oxygen partial pressure during growth, and the resultant material properties. At low pressures (below 10^{-2} mbar), the films are very opaque, and losses are high. At higher pressures above 5×10^{-2} mbar, the films appear diffuse, and do not adhere well to the substrates. Between these two pressure regions, films are produced with colours varying between clear and pale yellow. Losses for films grown at pressures of $3\text{-}4\times10^{-2}$ mbar are at the ~4 dB per cm. If these are subsequently annealed, the losses reduce to ~2 dB per cm.

Films have also been exposed to illumination at 244nm through a phase mask. The diffraction efficiencies recorded indicate that photoinduced index changes of order 1-5x 10^{-4} can be achieved: the largest value is obtained with films grown at the high end of the pressure range investigated. We will report on these results, and also on index changes produced by exposure to pulsed excimer laser light at a wavelength of 193 nm. Annealing studies of these glasses reveal that while losses can be reduced, the photosensitivity is also reduced, and an optimum parameter range exists therefore for useful film growth.

Films grown with ArF (193 nm) Excimer Laser



Induced Δn versus Oxygen partial pressure