RARE-EARTH DOPED GLASS WAVEGUIDES PREPARED BY PULSED LASER DEPOSITION

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ABSTRACT:

Glasses have been widely used as laser hosts and several rare-earth ions in a wide range of glass compositions have been investigated. In particular, doping with Er is attracting lot of attention because of its optical transition at 1.54 μm, that is a wavelength of high interest in optical communications. In order to fully integrate both passive devices and active devices such as optical amplifiers and lasers, thin film planar waveguides of these glasses are required.

Pulsed laser deposition is a very suitable technique to produce complex oxide films and optically dense films. It has been mostly applied to produce crystalline films by epitaxy onto suitable heated substrates, like high temperature superconducting or ferroelectric films. Although the growth of composite glass films is much simpler since they do not require high substrate temperatures or match to a particular substrate, their production by laser ablation has been very limited. To our knowledge, this is the first report on rare-earth doped glass films prepared by pulsed laser deposition.

Films are grown at room temperature onto glass, quartz and Si substrates. The target is a phosphate glass doped with Er_2O_3 and Yb_2O_3. An ArF laser beam (12 ns, 193 nm) is focused onto the target at 45. The background pressure of the system is $2x10^{-5}$ mbar and the films are grown in an oxygen pressure. A He-Ne laser beam (632.8 nm) is used to record in real time the evolution of the reflectivity and transmission of the substrate as the film grows, thus allowing us to control the film growth and thickness in addition to determine the film refractive index. The surface quality of the films is studied by means of stylus profilometer.

The results show that planar waveguides were successfully grown by pulsed laser deposition. The films thicker than 1 μm and grown on quartz were found to support three waveguide modes as expected from predictions. The refractive index of the films calculated from the real time reflectivity curves is in close agreement with that calculated from the dark modes (1.562 $\pm$ 0.003). Some degree of scattering, probably related to the presence of particulates and/or clusters is observed while the surface topography of the films depends on the substrate used and the film thickness. The quality of the planar waveguides will be discussed as a function of the nature of the substrate, the film thickness and the oxygen pressure applied during deposition.