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FROM OPAQUE HEAVY METAL OXIDES TO TRANSPARENT GLASSY WAVEGUIDES USING PULSED LASER DEPOSITION

J. Gonzalo, O. Sanz, A. Perea, J.M. Fernández Navarro, C.N. Afonso, J. García López*

Instituto de Optica, CSIC, Serrano 121, 28006 Madrid, Spain.

*Centro Nacional de Aceleradores, P. Tecnológico "Cartuja 93", 41092 Sevilla, Spain

The development of high capacity communication networks has generated a large research effort to find new materials that can be used as base media for either passive or active photonic devices. Heavy metal oxide (HMO) glasses, characterized by high Bi or Pb contents, present several physical properties that make them very attractive for applications such as gain or nonlinear optical devices and optical waveguides in the near-mid IR. In particular, they have high linear and nonlinear refractive index, broad transparence range and low phonon energy when compared to other oxide glasses, this last property being essential to achieve long lifetimes and good quantum efficiencies in the case of rare earth doping. Among HMO glasses, lead-germanate based glasses combine the above mentioned properties with good mechanical thermal and chemical properties. Nevertheless, the optical response strongly depends on the heavy metal oxide content and unfortunately, the compositional range in which transparent bulk or fiber glasses can be obtained is very narrow. The production of these materials in thin film configuration is still a challenge.

In this work, transparent lead-germanate based planar waveguides with a heavy metal oxide content well outside the bulk glass formation region have been produced by pulsed laser deposition (PLD). Experimental results show that a fine tuning of the the oxygen pressure and the laser energy density is required in order to obtain transparent materials with low propagation losses. The refractive index (n) was found to increase linearly as the heavy metal oxide content was increased and values as high as 2.35 have been achieved in transparent glass waveguides. Optimum waveguides with minimum propagation losses were obtained for an oxygen pressure close to 5×10^{-2} mbar, although they were slightly oxygen defficient. The dependence of the refractive index on the deposition parameters is discussed in terms of densification processes and surface roughness, wehereas the achieved extended glass forming region is discussed in terms of the high cooling rates achieved in the PLD process.

Contact author & presenting author:

NAME:	Gonzalo
First Name:	José
Affiliation:	Instituto de Optica, C.S.I.C. Serrano 121. 28006 Madrid. Spain
Phone:	34 – 915616800
Fax:	34 – 915645557
e-mail:	j.gonzalo@io.cfmac.csic.es