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Determination of the thermal coefficient of the optical path length change in the PLZT ceramic by optical interferometric method

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Abstract – In this work the optical interferometric method, was applied to determine the temperature coefficient of the optical path length change and the thermal coefficient of the refractive index of the transparent ferroelectric ceramic $(Pb,La)(Zr,Ti)O_3$, as a function of lanthanum concentration. The results showed that the thermo-optical properties were significantly modified with the lanthanum concentration. This information is important for the use of the PLZT ceramic as host of active ions for laser generation. In addition, the optical interferometric method is a powerful tool to determine the temperature coefficient of the optical path length change in transparent ferroelectric ceramics.

In the last years the transparent ferroelectric ceramic (TFC) has received great attention, due to their attractive properties and considerable improvements in their optical properties. Recent studies showed the potentiality of the transparent PLZT as host of rare-earth (RE) for the construction of diode-pumped laser, that permits applications in optical communications, medicine and dentistry [1]. But, when this material materials are used as optical devices, the thermal processes related to the nonradiative conversion of the absorbed energy, affect the beam quality inducing a distortion in the propagation of laser beam. In this way the temperature coefficient of the optical path length change (ds/dT) are among the most important characteristics of the optical materials, because describes the distortion of the laser beam induced by a temperature change in the medium. In this sense, the optical interferometric (OI) method allows to obtain in a direct way the ds/dT parameter and estimated the thermal coefficient of the refractive index (dn/dt). Therefore, considering the potential of application of the PLZT ceramic as optical components, the fact that their thermo-optical properties is not completely available in the literature and the ability of the OI to determine the ds/dT parameter, the aim of this work is to apply optical interferometric method to determine the ds/dT of PLZT ceramic as a function of lanthanum concentration. The optical interferometric measurements were performed as described in a previous work [2]. The samples used in this work were $((Pb_{1-x}La_x)(Zr_{0.65}Ti_{0.35})_{1-x/4}O_3)$ or lead lanthanum modified titanate zirconate (PLZT), with x = 0.09, 0.10 and 0.11, obtained by a conventional mixed oxides technique and hot uniaxial pressing as densification method. Details of the ceramic processing were reported in a literature [1]. The samples were polished to act as a Fabry-Perot interferometer. The variation of the (ds/dT) parameter obtained in this work, it was of ~15% with the increase of the lanthanum concentration. The results obtained for the dn/dT parameter showed a variation of ~28% with the increase of the lanthanum content. The thermo-optical properties showed a significant variation, caused by the increase of the lanthanum content. These results are very important to the application of these ceramics in the photonic area, especially for their use as active media for the construction of diode-pumped laser. Finally, these results suggest that the optical interferometric method is a powerful tool to determine the temperature coefficient of the optical path length change in transparent ferroelectric ceramics.

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