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Effects of Birefringence on the Electromagnetic Guidance of Structures Produced by Femtosecond Laser

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***Abstract*— Analysis of the state of polarization of light guided by structures recorded in lithium niobate and lithium fluoride crystals indicates that the recording method is determinant in the formation of birefringent structures. Each structure was written with a single and continuous translation of the crystal transversally to the laser beam. Birefringence was observed in the structures recorded in both crystals, despite the lack of intrinsic birefringence in lithium fluoride. The recorded structures are anisotropic showing regions with different birefringence. The structure generated with femtosecond laser is directly linked to the recording method and the crystalline lattice. This characteristic can be advantageous for application in photonic devices.**

***Index Terms*—** Lithium Fluoride, Lithium Niobate, State of Polarization, Waveguide Femtosecond Writing.

I. INTRODUCTION

The inscription of structures in dielectric materials by exposure to ultrafast laser pulses was described in 1996 [1]. An advantage of this method is the modification of the refractive index only in the region of the material exposed to the focused energy of the laser, making possible the creation of three-dimensional structures [2]. Different types of dielectrics, such as glasses, crystals or polymers, can be used to manufacture photonic devices as it is a nonchemical method [3]-[4]. However, the bulk material must have adequate characteristics for the intended applications, such as broad band range of transparency or high electro-optic coefficients [5]. Tightly focused femtosecond laser pulses can cause multiphoton and electron impact ionization into the material. These two processes are the main ones responsible by the material breakdown and consequent formation of a microplasma. According to ref [6], two types of damage were produced in LiNbO3 by the incidence of fs laser. Under low laser fluences, localized defects created in the crystalline lattice cause an increase in the extraordinary refractive index and can be annealed at moderate temperatures. On the other hand, high laser fluences focused in the crystal produce localized lattice distortions leading to a volume increase and a refractive index decrease. The material surrounding region is affected by the structural modification and is subjected to a stress-induced birefringence. In this scenario, beam defocusing by the microplasma competes with the self-focusing leading to laser pulses filamentation. In this sense, the

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