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Photorefractive Damage Removal in $LiNbO_3$ Channel Waveguides

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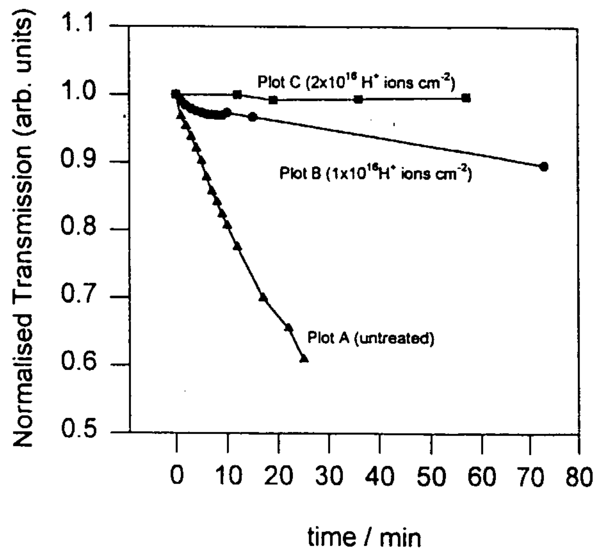
Proton exchange (PE) is a well established process used to fabricate waveguides in materials such as $LiNbO_3$ and $LiTaO_3$. The unwelcome photorefractive properties inherent to these materials however, seriously limit the usefulness of these guides, particularly for visible wavelength operation where the high intensities within the guides cause catastrophic damage. We report here a novel approach whereby ion-beam implantation (IBI) is used as a post-processing technique which dramatically reduces the photorefractive effect in previously fabricated annealed proton exchanged (APE) channel waveguides in $LiNbO_3$.

IBI has previously been shown to have a considerable impact on the photorefractive properties of other electro-optic crystalline materials such as $BaTiO_3$ and SBN [1], indicating that it is a powerful tool for efficient manipulation of these properties. The non-processed APE guides, fabricated by the HOYA Corporation, were evaluated by time dependent transmission decay measurements and were clearly photorefractive (Fig 1, plot A). Samples cut from the same wafer were subsequently implanted with 1.0MeV H^+ ions (protons) with doses ranging from 2×10^{15} ions cm^{-2} to 4×10^{16} ions cm^{-2}. Figure 1, plots B and C, show similar results for the treated waveguides. Here it can be observed how the implantation has dramatically decreased the time dependent transmission losses implying that photorefractivity has been greatly reduced. *Note that for plot C, all deleterious effects appear to have been eradicated completely.* This result is of great significance as it provides a simple method of producing non-photorefractive $LiNbO_3$ guided-wave devices which have previously been susceptible to photorefractive damage.

We will present these new results and discuss explanations of the effect in the context of IBI induced conductivity and the impurity ion oxidation state ratio.

Fig. 1 Transmission through APE channel waveguides Plot A is untreated waveguide, Plots B and C have had implants of 1×10^{16} and 2×10^{16} ions cm^{-2} respectively.



[1] Elaine E. Robertson *et al*, Optics letters, **21** (9), pp641-643, 1996