3.8 High Gain Two-beam Coupling in Fe:$KNbO_3$ Planar Waveguides

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Photorefractive (PR) single domain crystals are widely investigated for all-optical signal processing, optical phase-conjugation and two-wave mixing (TWM). Iron-doped $KNbO_3$ is very interesting due to its large electro-optic coefficients and its high PR gain. Although many applications may be envisaged, one drawback has been the relatively slow response time at moderate incident optical power. The PR response time can be considerably decreased by confining the beams within a waveguide.

We have fabricated waveguides in iron-doped $KNbO_3$ by He^+ and H^+ implantation. We measured exponential gains as high as 40 cm^{-1} at 514.5 nm and 7.5 cm^{-1} at 830 nm and response times of <1 ms at a power level of only 1 mW in two-beam coupling experiments. The direction of the energy transfer is such that the majority charge carriers in the waveguide are electrons and not holes as in the bulk crystal. These results indicate that ion implantation not only creates a waveguiding thin layer by a modification of the refractive index, but also alters the PR properties of Fe:$KNbO_3$ from p-type to n-type and increases the trap density. These two effects lead to higher gain and faster response times than in the bulk crystal, thus providing a promising potential of ion-implanted Fe-doped $KNbO_3$ waveguides for applications, such as self-pumped and incoherent phase-conjugation.