3.10 Electro-optical Waveguide Modulator on $KNbO_3$

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Waveguide modulators are advantageous compared to bulk crystal devices due to the lower driving voltage. The successful formation of waveguides in $KNbO_3$ allows us to exploit the high electro-optic coefficients of this material for guided-wave optical devices. We have constructed an electro-optic modulator based on an ion-implanted $KNbO_3$ planar waveguide with two 100µm wide gold electrodes deposited on the top surface separated by 100µm. In a Mach-Zehnder interferometer configuration a modulation depth of 20dB and a half-wave voltage of 18V at a wavelength of 515nm was measured. Modulation was demonstrated up to several megahertz and was then limited by the electronic equipment.

The planar waveguide was also used for phase-matched second harmonic generation of blue light at 435nm. Applying an electric field along the polar c-axis induces a change of the refractive index of the second harmonic wave. As a result, the phase-matching condition for efficient frequency doubling can be switched on and off, and hence, the second harmonic blue output is modulated. We have demonstrated such a directly modulated frequency doubler in a planar $KNbO_3$ waveguide. Such a blue laser could find application for optical memories where fast modulation of the read-out beam is required. Based on these results we envisage further improvement of the waveguide modulators on $KNbO_3$ by optimising the design of the electrodes and the waveguide implantation parameters.