Optoelectronic devices in bulk and thin-film electro-optic crystals.

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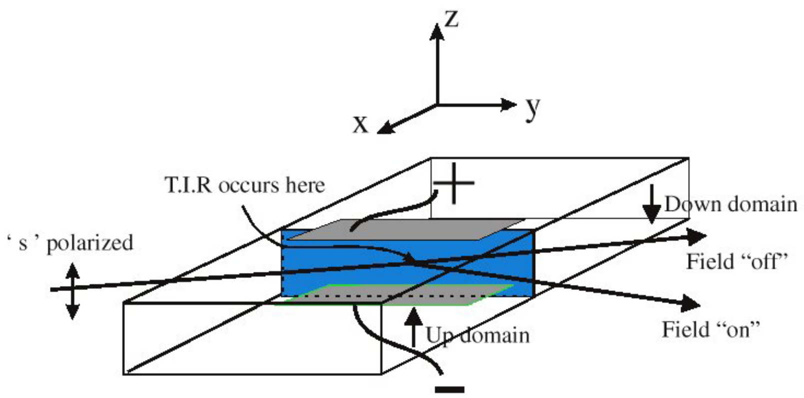
The electro-optic (e-o) effect in crystalline materials such as $LiNbO_3$ or $LiTaO_3$ has been extensively exploited for devices such as Mach-Zehnder modulators, which combine optical waveguide technology with e-o modulation to generate modulation speeds of up to 40GHz, as used in current optical communications switches. However, in addition to such phase modulation applications, it is also possible to utilise these small refractive index changes ($\Delta n \sim 10^{-4} – 10^{-3}$) induced via the e-o effect in applications such as beam-steering, deflection and switching, utilising an engineered interface geometry between two anti-parallel domain regions.

Using this approach, several groups have demonstrated beam deflectors that utilise cascaded prism-based geometries [Gahagan et al. Appl.Opt., **38**, 1186, (1999)], or total internal reflection (TIR) switching, under grazing incidence [Eason et al. Opt. Commun., **197,** 201, (2001)], as shown below. The talk will briefly outline the TIR approach, and will discuss how deflection can be extended to both 2-D and also RGB colour scanning. To date, using a single 1-D scanner, a deflection range of ~20^o has been demonstrated using this monolithic domain-engineered approach. Additional work involving e-o control of Fresnel zone plates will briefly be mentioned [Cudney et al. Opt.Express., **12**, 5783, (2004)], and a brief conclusion presented on how to best utilise such small Δn changes for macroscopically large final effects.



In addition to domain-engineered device concepts, the second part of the talk will address our recent work in direct-write techniques using scanned UV laser sources, to induce both permanent optical waveguides in $LiNbO_3$, and to achieve spatially selective domain inversion through light-assisted poling, direct optical poling, or latent light-assisted poling. This topic area is extensive, and over the past few years we have used c.w., ns, and fs pulsed lasers, with wavelengths from 244nm into the near I.R region to demonstrate a range of sophisticated domain-engineering, at scales down to 100nm. For such directly-written guides, UV lasers (244nm to 305nm) operating in the c.w. regime are particularly effective, and we have explored the large parameter space afforded via such a scanned writing regime. I shall present our most recent work on UV writing of these waveguides [Ganguly et al., JLT in press (2009)] and illustrate the versatility of this approach via subsequent e-o modulation observed in both the cut-off and mode properties of such optical waveguides.

I shall conclude with a brief discussion of our future intentions and directions in combining direct-writing of waveguides with light-assisted poling and subsequent domain-sensitive chemical etching for applications that would encompass periodically poled waveguides, piezo-electric applications, opto-fluidics and surface acoustic wave interactions, to create a lab-on-a-chip platform using $LiNbO_3$ as the host material instead of the more common, but far less functional, alternatives, such as silicon, glass or polymer.