Electro-optically controlled TIR switching in domain-engineered $LiNbO_3$

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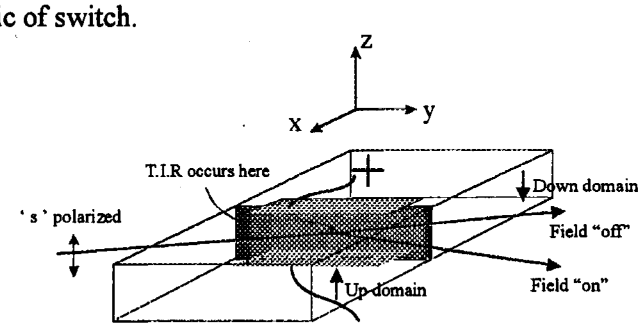
We have developed a novel electro-optically addressable total internal reflection (TIR) switch in a sample of $LiNbO_3$ that has been engineered to have a sharp boundary between two anti-parallel domain regions [1]. Such a switch can provide numerous advantages including ease of fabrication, the possibility of high contrast ratios (TIR is a 100% efficient process), relatively low drive voltages, and a wavelength dependence that is superior to other electro-optic devices such as Pockels cells.

The $LiNbO_3$ sample is z-cut, and has been patterned and electric-field poled to produce equal areas of oppositely oriented domain regions. The boundary region should ideally be very smooth, and free from residual poling-induced strain. In our case we observe a static index difference at the boundary, this affects the choice of angle for the grazing incidence beam and hence the contrast achievable experimentally. When an external electric field is applied to this boundary, equal magnitude refractive index changes of opposite sign will occur between the adjacent domain regions. If the value of index change is sufficiently large TIR can occur for the incident beam, thereby leading to switching of beam direction at the boundary from transmission to reflection. A schematic for the switch can be seen below in figure 1.

Figure 1. Schematic of switch.



Light incident on the boundary at an angle that is less than the angle for TIR will be transmitted through it. If however the light is incident on the boundary at angles greater than the TIR angle then it will be reflected with a theoretical efficiency of 100%. As the device consists of anti-parallel regions within a single electro-optic composite crystal the incident beam will only see a change in refractive index when a suitable field is applied.

We will discuss results achieved for electro-optically modified reflectivity versus applied electric field, for light of *s* and *p* polarisations, and wavelengths in the visible and the near I.R. Initial results have already shown a contrast ratio of greater than 20dB which we expect to be improved with the optimization of annealing, manufacturing and design parameters

To conclude, we have constructed a domain engineered electro-optic total internal reflection switch in a sample of $LiNbO_3$. This novel switching approach can be further improved and optimized, but already shows a good switching contrast ratio and the possibility for practical device implementation.

[1] A.J. Boyland, G.W. Ross, S.Mailis, P.G.R. Smith, R.W. Eason 'Electro-optically addressable total internal reflection switch in domain-engineered $LiNbO_3$' Sub. Elec. Lett. (2000).