Preface

Ferroelectric lithium niobate (LiNbO$_3$) is one of the most widely used materials for optical communication networks and integrated photonic device applications. But till date all of the properties of the crystal are not well explored and hence requires lot of research. In this work some critical parameters of the crystal, such as its electro-optic parameters, coercive field, internal field, etc. and their dependency on the domain stability are examined. Subsequent investigations of those parameters are made possible by using room temperature electric field poling which, in the present work, is slightly modified from the conventionally used methods. Domain inversion of the crystal is verified by chemical etching of the poled sample followed by identification of poled regions under an optical microscope. When light wave is allowed to pass along the optic axis of a z-cut lithium niobate crystal under an applied electric field, due to electro-optic effect of the crystal there will be a net phase change of the output wave, which is measureable by an interferometer. Using a Mach-Zehnder interferometer experimentally obtained halfwave voltage, required for $180^\circ$ phase change, is compared with the theoretically estimated one. A good agreement has validated the experimental procedure. The same interferometer when used for poled LiNbO$_3$, has exhibited much lower halfwave voltage and indicates an enhancement of the corresponding electro-optic parameter, $r_{13}$. Again internal field of the crystal is examined for various domain configuration of the crystal by monitoring the measured halfwave voltages for different types of crystal samples. Time and temperature evolution of internal field for domain inverted LiNbO$_3$ is also performed. It is reported that the strengths of internal field for as-bought LiNbO$_3$ and annealed domain inverted LiNbO$_3$ crystal are same with a visible change of direction of the crystallographic $z$ axis of the crystal. But for frustrated domain inverted crystal the strength of internal field is reported to be a function of time elapsed after the domain inversion process. Appropriate crystallographic defect model is employed to explain those observed phenomena. Again components causing internal field of the crystal are explored and their quantitative strengths are reported. Finally a theoretical model to achieve tunable differential polarization phase modulation using specially shaped bulk LiNbO$_3$ crystal is discussed.