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Advances in Laser Applications and Condensed Matter Physics: Collected Contributions

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Contents

A method of developing intensity modulated light signal using two modulating signals simultaneously by a $LiNbO_3$ crystal.

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Abstract

$LiNbO_3$ is a very well established electro-optic crystal which can generate intensity modulated signal for optical communication. Several optical methods are already proposed for using $LiNbO_3$ as optical switch for communication and data processing. Here in this paper we propose a new method of generating an intensity modulated signal using two different electro-optic crystals each biased by a different electronic signal in parallel on a single light wave. This technique ultimately generates a joint modulation scheme on a single wave for communication of two signals in parallel.

Introduction

Lithium niobate is an important electro-optic material used in various optical applications. Due to its important physical properties, it is very much suitable for communication and data processing (1-5).It is a negative uniaxial crystal with electro-optic pockels effect, which is several times larger compared to KDP or ADP. With the application of an external electric field E_z along the optic axis (chosen as the z-axis) of a $LiNbO_3$ crystal, the refractive indices for a light beam polarized along the x, y and z-directions are given by

$$n_x = n_0 - \frac{1}{2} n_0^3 r_{13} E_z$$
$$n_y = n_0 - \frac{1}{2} n_0^3 r_{13} E_z$$

$n_z = n_e - \frac{1}{2} n_e^3 r_{33} E_z$ respectively(1) . Here r_{13} and r_{33} are the electro-optic coefficients of the material. We consider the transverse mode of operation of $LiNbO_3$ crystal where a linearly polarized light beam is propagating along the y-direction that is perpendicular to the external electric field axis (z). If the incident light is polarized at 45° to the z-direction in the x-z plane, then the retardation after traversing a distance l of the crystal from the input surface will be $\Delta\varphi = \frac{2\pi}{\lambda_0}(n_e - n_0)\, l - \frac{\pi}{\lambda_0}(n_e^3 r_{33} - n_0^3 r_{13}) E_z\, l$.

The zero voltage phase shift $\frac{2\pi}{\lambda_0}(n_e - n_0)$ gives the intrinsic birefringence of the material and the V_π voltage is given by $V_\pi = \frac{\lambda_0}{(n_e^3 r_{33} - n_e^3 r_{13})} \frac{d}{l}$, where d is the thickness of the crystal and $E_z = \frac{V}{d}$. In our proposed scheme we consider two $LiNbO_3$ crystals of lengths l_1 and l_2 and thickness d_1 and d_2 respectively. The incident light is polarized along 45° to the z axis and propagating along y-direction. Fig.1 shows the proposed scheme. The two components of the incident light beam along x and z-directions after traversing a length l_1 of the first $LiNbO_3$ crystal are passed through the second $LiNbO_3$ crystal of length l_2.

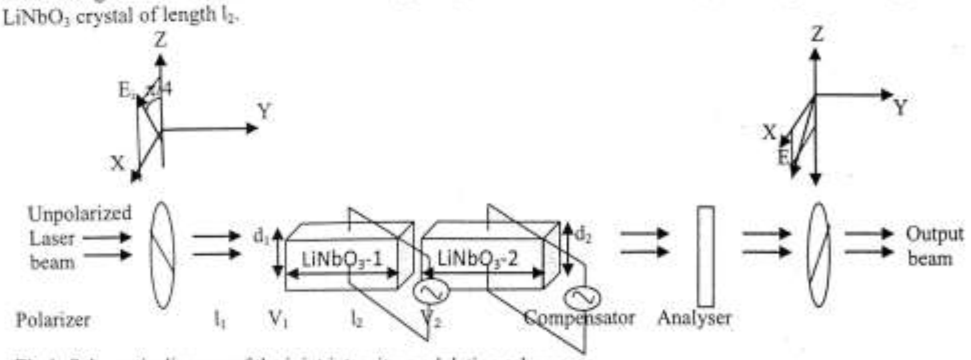

Fig.1: Schematic diagram of the joint intensity modulation scheme.

After that the output is sent through an analyser, whose pass axis is perpendicular to the incident polarizer's pass axis. We will give now the analytical study on the effect of the biasing signals of the two crystals on the optical radiation simultaneously.