Advances in High-Sensitivity Electro-Optic Sensors

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In a previous paper (EUROEM 2006) we reviewed the promise of electro-optic (EO) sensors as an alternative to conventional heterodyne detection of electromagnetic radiation. EO response data on $LiNbO_3$ and $Sr_{0.75}Ba_{0.25}Nb_2O_6$ (SBN:75), configured as laser-beam polarization-rotation detectors, were presented and discussed. From these early studies we concluded that, in order to exploit the properties of high Pockels-coefficient materials, we would have to control or suppress their photorefractive behavior. Photorefraction introduces incoherence into the polarization state of the laser beam, as it travels through the crystal, and reduces the normal EO response of the sensor material. In the case of SBN:75, the reduction can be as much as a factor of 100; in SBN:61 it is even greater. By contrast, in $LiNbO_3$ it is relatively small. Local spatial variations in the EO response also occur, depending on where the laser beam passes through the crystal, and temporal drift in the EO signal is also observed. We have now successfully modeled the EO response of photorefractive crystals by analytically separating the signal produced by the applied electromagnetic field from the signal produced by intrinsic (or natural) fluctuations in the index of refraction. Both spatial and temporal variations of the EO signal are included in this model. The model allows us to determine an effective V_π (the voltage required for a phase rotation of 180°) for a photorefractive material, to suppress the temporal instabilities in the EO output signal, and to measure the level of incoherence introduced by photorefraction. Data on both the tungsten bronzes and lithium niobate will be presented. In addition, we will describe the enhanced detection (up to a factor of 350) of repetitively pulsed microwave beams, using piezoelectric lithium niobate, and the configuration and packaging of an EO sensor for use in the field. *

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