DEVELOPMENT OF A STABLE ELECTRO-OPTICAL MODULATOR

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The activity of the sun can be studied through the measurement of its magnetic field. The measurement of the polarization state of the sunlight in a narrow spectral bandwidth can be related to the magnetic fields strengths and directions over the active sunspots. Measuring the polarization state can be done using the vector magnetograph. The essential component of the vector magnetograph is the polarization modulators. Electro-optical modulators are used as a dynamic retarders. KD^*P (potassium dideuterium phosphate) crystals provide variable retardation which can be controlled by the applied voltage. KD^*P's have a high contrast ratio but suffer some problems; they require a high voltage and have a limited modulation lifetime.

The KD^*P modulator forms the heart of the polarimeter assembly which is used for carrying out accurate measurements of linear polarization of the sun. It is therefore important to study the optical and electrical behavior of the KD^*P crystals so that the ultimate goal of making stable electro-optical modulators in the laboratory is achieved.

Over the period of this contract a number of activities were performed in coating and testing the KD^*P crystals. A summary of these activities are as follows:

1. The KD^*P crystals were coated with SiO_2 (as an insulator) of thickness approximately 1400 A. To ensure that the deposition of the film was accurate and repeatable, the process was carried out on glass substrates 30x30x4 mm using the ion beam sputtering unit.

2.The deposition was carried out on seven different samples and the thickness of the deposited film was measured to check for any differences. It was found that the thickness of the deposited films were inconsistent, even though all the parameters were kept the same during the different runs. It was later attributed to the leakage in the system, because the pressure inside the chamber would not go below 10.6 Torr. The leak was detected in the O-ring gasket in the door of the chamber.

3. The polishing of the of the already coated KD^*P crystals was then undertaken using ethylene glycol as a vehicle and alumina grit (7 mm). The polished surface appeared to be alright, but there appeared a milky/cloudy formation inside the crystal. The crystal attracted moisture regardless of the effort to prevent that. Two samples were polished but the same problem arise. After studying the problem it was decided to use the diamond turning machine at the UAH's Center for Applied Optics to do the polishing.

4. Computer simulation subroutines for extending the field of view of the KD^*P electro-optic modulators (Introduced by Ed. West) were written to study the biaxial behavior of the KD^*P and also to see if there was any effect of temperature changes on the field of view of the KD^*P.

5. Experimental data was obtained to show that the lens in the system was behaving a retarder, i.e. the lens actually modulating the intensity of the laser source which affects the overall performance of the system.

6. The nonsymmetry in the KD^*P modulation characteristics were investigated. It was found the nonlinearity in the response of the photomultiplier was the problem and it was corrected and accounted for.

7. Various experiments were performed using different optical elements to determine the angle of NBFA and Pockels fast axis.