FERROELECTRIC LIQUID CRYSTAL MATERIALS RESEARCH CENTER

RESEARCH REVIEW

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Liquid Crystal Optical Phased Arrays

Abstract: Over the past several years there has been a significant amount of work performed to advance liquid crystal optical phased array (LCOPA) technology to a level of maturity sufficient for it to enable completely non-mechanical optical beam steering systems. This talk will present an overview of LCOPA technology, an assessment of the current state of the art, and a look at the technical challenges that remain. Besides this high-level overview of the technology, the talk will also present a detailed examination at some of the phenomena in these devices that currently limit performance. The basic operation of LCOPAs is quite simple to describe: An array of electrodes is used to reorient the molecules in a thin liquid crystal layer resulting in a spatially varying index of refraction profile. If the voltages on the electrodes are chosen so that the index of refraction profile across the device aperture is that of a blazed phase grating then the device will redirect the incoming light into the first diffraction order of the phase grating. In general, these devices can be thought as electrically programmable phase holograms. In reality, the opto-electronic behavior of these devices is much more complicated. LCOPA devices are more properly described as three-dimensional, spatially varying, inhomogeneous, anisotropic birefringent layers with a complex relationship between the local optical properties and the voltages on the addressing electrodes. The details of LCOPA operation lead to a host of non-ideal effects that can have very significant effects on LCOPA performance and lead to non-intuitive device behavior. Experimental data and numerical models will be used to illustrate how the details of device operation can have large effects on steering efficiency and the polarization properties of the steered light. Besides issues related to the details of device behavior, many materials science, manufacturing, and systems engineering issues also remain. The talk will conclude with a discussion of these issues and how they affect optical power handling, switching speed, and the integration of LCOPA technology into complete, wide angle beam steering concepts. In particular, the results of recent experiments evaluating both the peak and average power handling capabilities of LCOPA devices and components will be presented.

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Duane Physics, 11th Floor Commons Room

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