High Efficiency Polarizing Beamsplitter- 10% Improvement

OPT-APP-1003, Rev A

Abstract

The Moxtek® wire grid polarizer technology offers a reliable, highly durable solution to high quality LCoS display technology with a perfect polarization match to the LC imager. Recent improvements in the polarizing beam splitter (PBS) technology enable a 10% improvement in efficiency.

Introduction

This technical brief compares imaging needs and how Moxtek is improving its products. It explains how competing technologies in LCoS projectors compare in terms of brightness, performance, durability and reliability.

PBS Efficiency

Efficiency (Tp*Rs) for a polarizing beamsplitter is a measure of how perfectly a polarizer converts randomly polarized light into (reflected) s and (transmitted) p polarized light. If all of the light is converted, then the beamsplitter would be 100% efficient. In reality, some of the light is absorbed, some 's' is transmitted and some 'p' is reflected, reducing the efficiency.

The Moxtek standard PBS is typically 81% efficient at 550 nm wavelength. Recently, with improved manufacturing techniques and new wire grid technology, this efficiency has been dramatically improved.

Figure 1 shows the improvement in efficiency for the Moxtek High Efficiency PBS (HEPBS) versus standard PBS. This represents a 10% improvement.

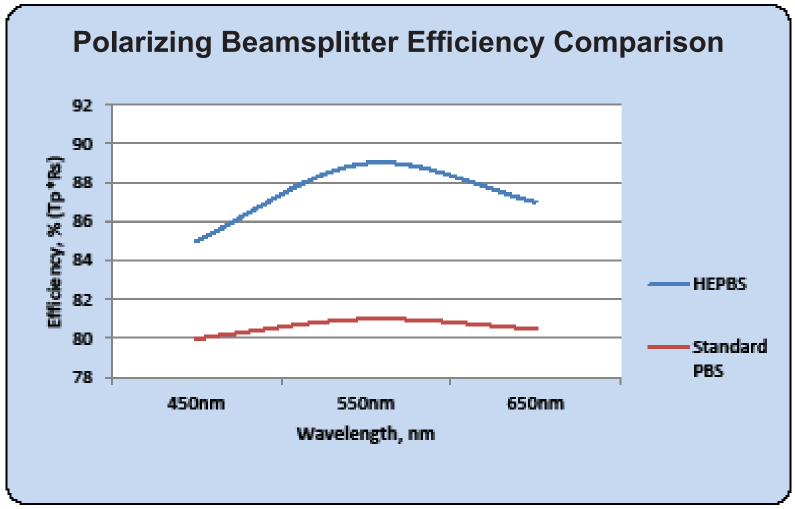

Figure 1 Beamsplitter Efficiency Comparison (Typical)

Comparison of Other Technologies

Table 1. "Comparison of Technologies", shows a comparison of wire grid polarizer, stretched polymer absorbing films (dichroic polarizers), and Brewster's angle polarizers (MacNeille cubes).

Flatter response of ProFlux polarizer across both wavelength and angle creates a more uniform picture from the projector. The wide acceptance angle allows for small f/# optical designs while maintaining color and contrast uniformity. Figure 2 shows an angular map comparison of the Proflux Beam Splitter and the MacNielle Cube.

Element	ProFlux Wire Grid	Dichroic Polarizer	MacNeille Polarizer
Polarizing Mechanism	Polarizer using a nano-structured thin film	Resonant absorption in thick stretched film	Reflects s-polarization and transmits p-polarization
Significance	A perfect polarization match to the LC imager, even skew rays can align to the LC. PBS: f/1.5 and below. PPL: f/1.0 and below.	Thick polarizing film results in beam depolarization	Polarization irection depends on incoming ray: skew rays are not aligned to LC
Contrast	Excellent brightness, contrast, and on-screen uniformity	Reduced contrast and uniformity	Reduced contrast and uniformity
Durability	Made from all inorganic materials for high durability	Polymer film degrades over time and in high flux conditions	Requires polymer waveplate for correct polarization

Table 1 Comparison of Technologies

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Figure 2 shows the center of the circle is a 45º angle of incidence on the plate. The radius of the circle is 33º, representing behavior over an f/0.9 cone. The ProFlux beam splitter shows no TIR cutoff, and may be used at a much smaller f/# than the MacNielle PBS, retaining high contrast.

Figure 3, "AOI Comparison for Proflux Wire Grid and Dichroic Polarizers", shows how the flat response of ProFlux for rotation in both axes is an indication of its superior performance with skew ray polarization. Dichroic sheet depolarization reduces the ability to maintain high polarization contrast in optical systems.

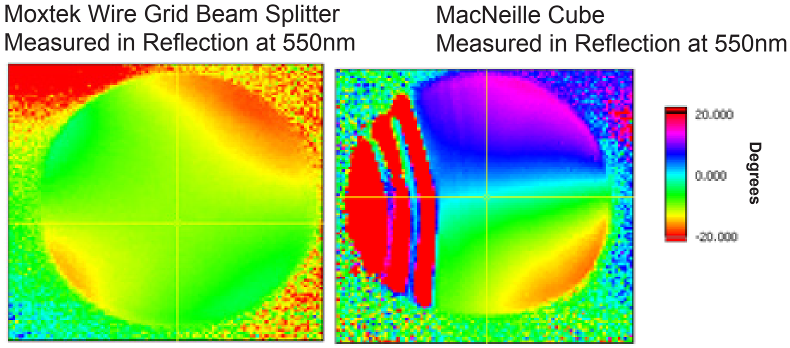

Figure 2 Angular Map Comparison

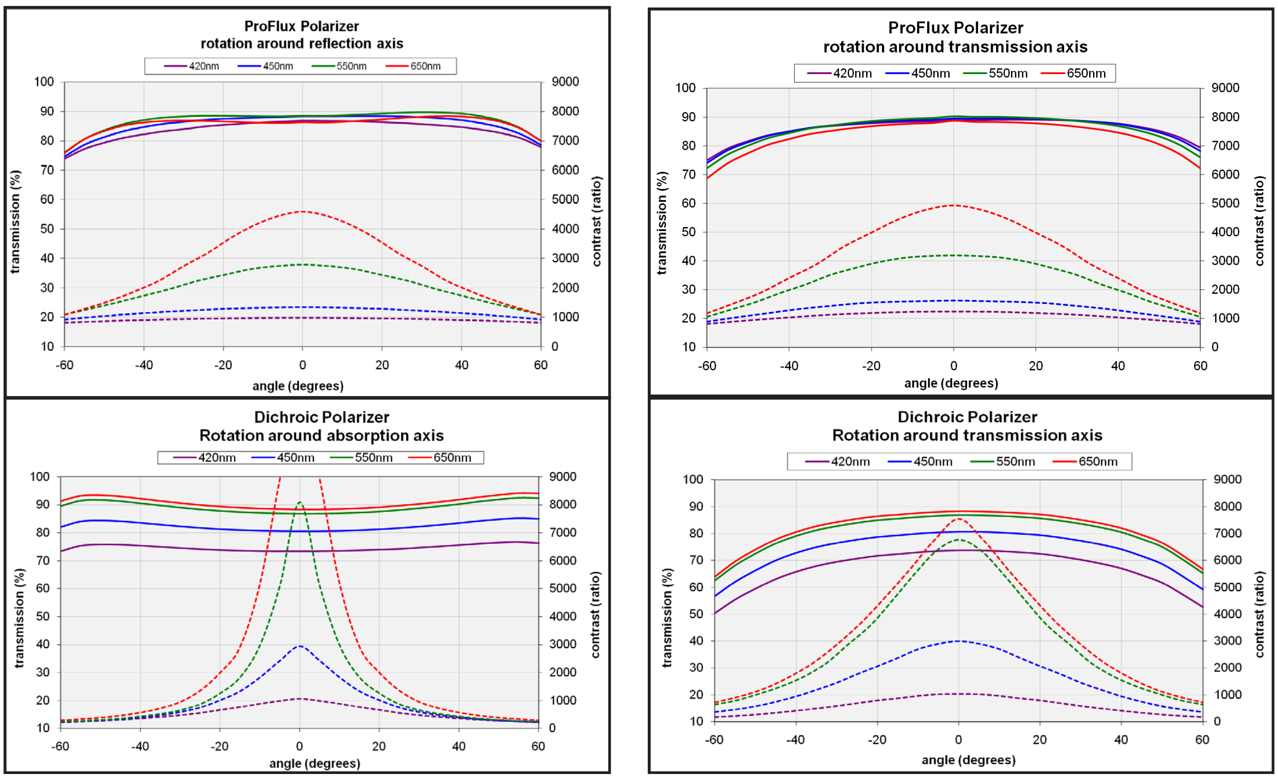

Figure 3 AOI Comparison for ProFlux Wire Grid and Dichroic Polarizers

Conclusion

An important advantage of the ProFlux PBS over a MacNeille cube is the direction of polarization. A cube polarizes in a direction defined by the orientation of the incoming ray, that is, by the plane of incidence. Because the plane of incidence changes as the skew ray direction changes, uniform polarization over a large cone is impossible for a standalone cube PBS.

ProFlux PBS, on the other hand, polarizes relative to the direction of the wire grid structure. Rays along the principal axis, as well as skew rays, are all polarized in the same direction. This has been called a Cartesian polarizer and is a critical quality for good PBS polarization. Using ProFlux PBS polarizers creates improved full screen performance by providing uniform polarization brightness and contrast across the entire angular aperture at the PBS. The ProFlux PBS is now available as HEPBS, providing a 10% improvement in efficiency.

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