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Phase generation in white light with a 6-Pi Liquid Crystal on Silicon (LCoS) device

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Abstract content
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Phase modulators based on liquid crystal are currently applied in many fields. The development of Liquid Crystal on Silicon (LCoS) technology has notably improved the performance of these devices. Analyzing vision with Adaptive Optics is one of the new applications taking advantage from these gadgets. In Vision Analysis procedures, subjects undergo visual testing through modified aberration patterns, controlled and manipulated by the operator. Some of the typical drawbacks of liquid crystals, such as slow response or diffraction losses, have been significantly reduced in LCoS devices but they are still present to some extent and can be relevant, especially when large aberrations are involved. This is typically the case for the eye, even in normal subjects, when low order terms are included. Therefore, there is a continued interest to produce enhanced devices. In this context, we present results for a new LCoS device capable for 6Pi modulation (Holoeye Photonics AG, Germany), comparing performance to that of a regular 2Pi LCoS. An experimental setup was built incorporating the two modulators, so that simultaneous operation and comparison could be performed, a Hartmann-Shack wavefront sensor and a camera for experimental point spread function (PSF) recording. Measurements were taken using a laser source and a tuned spectrum provided by a thermal source coupled to a liquid crystal tunable filter. The 6Pi modulator showed slightly slower temporal response than the standard 2Pi device, but still in the useful range for visual applications. Comparison between monochromatic PSFs showed similar fidelity for both devices, but diffraction effects were less marked in the 6Pi device. Wavefront measurements for different wavelengths showed less than 10% variation across the visible spectrum for the 2Pi modulator and less than 7% for the 6Pi device. In either case, this means a small chromatic degradation, especially when compared to the eye's natural chromatic aberration. In conclusion, the new 6Pi device has the potential for reducing the diffraction ghost produced by phase wrapping, in addition presenting lower chromatic dispersion than the 2Pi device. These features are particularly interesting for Vision Analysis applications, where subjects perform visual testing, typically in white light, through modified phase masks generated by an LCoS spatial light modulator.

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