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Abstract: Planar optical systems are well suited for various applications, such as optical interconnects and security devices. We demonstrate dynamic or adaptive functionality of such microoptical systems through the integration of modal liquid-crystal-devices.

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Planar integrated free space optics [1] combines the advantages of free space optics and the precise alignment possibilities of planar fabrication technology. Due to their robust setup these systems well suited e.g. for optical interconnects, relay systems and security applications [2,3]. Difffractive optical elements provide the necessary degrees of freedom for optimized optical performance along the folded optical axis. Refractive optical elements integrated into these systems provide a higher efficiency compared to purely diffractive systems [4].

A variety of planar systems have been demonstrated so far which almost exclusively show static optical functionality. Conceptualiy it is possible to use hybrid integration technologies to combine planar optics with active devices such as micromechanical (micromirrors) or optoelectronic devices. We demonstrate an planar optical 4f-setup integrated with a modal liquid crystal lens [5] for image plane tuning. Modal lenses are liquid crystal devices that generate variable phase profiles. Depending on the shape of the electrodes these elements can either generate a spherical or a linear phase profile. Each profile can be varied continuously by the amplitude and frequency of the driving voltage. Thus it is possible to change e.g. the focus of the system (see fig. 1) and/or to tip-tilt the system's channels for switching or scanning. In comparison, devices such as spatial light modulators (SLM) just allow stepwise shifts of the focus due to their pixelated structure.

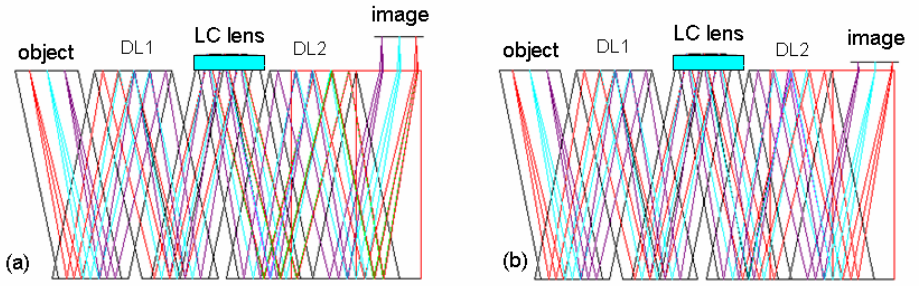

Figure 1: PIFSO with LC lens (a) LC lens switched off and (b) LC lens switched on to maximal phase depth shifting the focus for 1.5mm downwards to the substrate surface.

Optimized ray-tracing designs with ZEMAX have been performed such that very good imaging quality is achieved for image planes shifted in the range from 0.5 mm to 2 mm above the substrate surface by simply tuning the modal lens element.

Summary

Planar optical systems are well suited for various applications, such as optical interconnects and security devices. We demonstrate dynamic or adaptive functionality of such microoptical systems through the integration of modal liquid-crystal-devices.

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