Optically Addressed Liquid Crystal Spatial Phase Modulator

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Liquid crystal materials are attractive for optical devices because of their high optical birefringence $\Delta n = n_e - n_o$. Electrically addressed liquid crystal spatial light modulators (EA LC SLM) are widely used in modern optics [1]. Pixelated structure of these modulators limits optical resolution because of diffraction of coherent beam on pixels [2]. Optically addressed liquid crystal spatial light modulators (OA LC SLM) were proposed in order to overcome these disadvantages [3]. Local reorientation of molecules in the modulator, i.e. local changes of effective refractive index $n_{eff}(x,y)$ are induced by modulated light intensity I(x,y). Wavefront of light beam passing through such modified LC layer experiences phase modulation $\varphi(x,y)$ according to the intensity I(x,y). Phase shift $\delta\varphi(x,y)$ under influence of addressing light can be calculated using formula:

$$\delta\varphi(x, y) = \frac{1}{L}\int_0^L \frac{2\pi\delta n_e(I(x, y), z)}{\lambda} dz,$$

where L - thickness of liquid crystal layer, λ - wavelength of the incoming light beam, $\delta n(z, I(x,y))$ - light induced I(x,y) refractive index local change: $\delta n(z) = n(z, I(x,y) \neq 0) - n(z, I'(x,y) = 0)$. OA SLM can be used as a phase plate or spatial phase filter in which phase shift is a function of an externally applied voltage and an intensity of addressing light.

In this work we present the preliminary results of phase shift obtained in optically addressed liquid crystal panels observed in Mach-Zehnder interferometer. Experiments were performed in the panels filled with smectic and nematic liquid crystals. Optical addressing was realised by laser beam with wavelength λ=514,5 nm (Ar+ laser). Reading beam was supplied from He-Ne laser (632.8 nm). Operation voltage for studied panels was 4-20V. The general results achieved for panels: total phase shift under influence of addressing light: 2 - 6 π, sensitivity to the addressing light (~$\mu W/cm^2$ per 2π phase change), speed of response to the light (20 ms-30s), recovery time (0.5-120 s).

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