3D-IMAGING OF ORIENTATIONAL STRUCTURES IN LIQUID CRYSTALS USING FLUORESCENCE CONFOCAL POLARIZING MICROSCOPY

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The director fields that specify average molecular orientation in liquid crystals (LCs) often form complex 3D patterns and are widely used in many optical applications. We demonstrate how to image the 3D director fields using approach which we call the fluorescence confocal polarizing microscopy (FCPM). We employ the property of liquid crystals to orient fluorescent dye molecules, dissolved in small quantities in the liquid crystal 'host'. When the observation is performed in polarized light, the measured fluorescence signal is determined by the orientation of the molecules [1,2]. We use twisted nematic cells to control the polarization state of the probing light. The analysis of FCPM textures for different polarization states of excitation/fluorescence light reveals the orientation of molecules in the studied sample. We show that by using special dyes and probing light with well-controlled polarization state, the confocal microscopy can give an access not only to the 3D spatial positional patterns and concentrational distributions, but also to the 3D pattern of molecular orientation. We present the patterns of orientational order associated with static and dynamic processes, such as climb and glide of dislocations in cholesterics, field-induced transitions in nematics, formation of ordered structures in emulsions and suspensions, etc. Computer-simulated and experimental FCPM textures of these patterns closely match each other.

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