LOCALIZED OPTICAL MODES IN PHOTONIC LIQUID CRYSTALS: OPTIONS FOR DFB LASING ENHANCEMENT AND MORE

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A brief survey of the recent experimental and theoretical results on the low threshold distributed feedback (DFB) lasing in chiral liquid crystals (CLC) as well as new original theoretical results in the field are presented. The main attention is paid to the analytic approach in the theory of the DFB lasing in CLC based on the exact solutions of the boundary problems for light propagating along the helical axis in CLC layers [1]. Properties of the eigen edge (EM) and defect (DM) modes are investigated. The dispersion equations for EM and DM are found and the expressions determining the decay rate for these modes are presented. Lasing thresholds at frequencies corresponding to the spatially localized “stop band edge lasing modes” and “defect modes” in CLC are studied and it is shown that EM and DM present options for a further reduction of the lasimg thresholds. It is demonstrated that the analytic approach reproduces all features of the DFB lasing in CLC obtained by the traditional numerical approach [2] and, more over, allows to reveal some qualitative effects escaped from the researchers employing the numerical methods and to predict new options for a low threshold lasing. Namely, the effect of anomalously strong absorption at the DM frequency, a direct analogue of the corresponding effect at the EM frequency [3], is predicted [4]. Analytic expressions for the transmission and reflection coefficients of the defect mode structure (CLC-layer-CLC) are obtained and the dispersion equation determining connection of the defect mode frequency and the lasing threshold gain with the isotropic layer thickness and the other CLC parameters is analysed. It is shown also that the localized “stop band edge modes” and “defect modes” reveal themselves in an enhancement of some inelastic and nonlinear optical processes in photonic LCs. As examples the corresponding experimentally observed effects for the enhancement of nonlinear optical second harmonic generation [5] and lowering of the lasing threshold [6] in photonic LCs are briefly discussed. The work is supported by the RFBR grant 09-02-00448.

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