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Optics of photonic liquid crystals at frequencies of localized modes

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Recently great attention was paid to the localized optical modes in photonic crystals, in particular, in photonic liquid crystals due to their efficient application in the linear and nonlinear optics. Here a brief survey of the publications and original theoretical results on the localized optical modes in photonic liquid crystals in connection with explanation of the corresponding experimental observations are presented. Theoretical studies were performed for the certainty, as the example of chiral liquid crystals (CLCs). The chosen model (absence of dielectric interfaces in the studied structures) allows one to get rid off the polarization by mixing at the surface of the CLC layer and the defect structure (DMS) to reduce the corresponding equations to equations for the light of diffraction in the CLC polarization, to obtain an analytic description of localized edge (EM) and defect (DM) modes. The dispersion equations determining connection of the EM and DM frequencies with the CLC layer parameters and other parameters of the DMS are obtained. Analytic expressions for the transmission and reflection coefficients of the DMS are presented and analyzed. Specific cases were considered, as DMS with an active (i.e. transforming the light intensity or polarization) defect layer, CLC layer of local anisotropic absorption and conic-helical director structures. It is shown that the active layer (excluding an amplifying one) reduces the DM life-time (and increase the lasing threshold) in comparison with the case of DM at an isotropic defect layer. The case of CLC layers with an anisotropic local absorption is also analyzed and, in particular, shown that due to the Borrmann effect the EM life-times for the EM frequncies at the opposite stop-bands edges may be signifinately different and so in the experiment optimization of it should be taken into account. The experimentally observed enhancement of some optical effects in photonic liquid crystals at the EM and DM frequencies (lowering of the lasing threshold, abnormally strong absorption, etc.) are in good agreement with the presented theory. Options of experimental observations of the new theoretically revealed phenomena are discussed. It is emphasized that the presented localized modes in CLC results are of a general nature and are qualitatively applicable for the localized modes in other structures.

Biography

V A Belyakov graduated from Moscow Engineering Institute in 1961 and was a Postgraduate student of I V Kurchatov Atomic Energy Institute during 1961–64. He received Doctor of Science degree in 1974. He was the Head of Laboratory in All-Union Physics-Technical and Radio–Technical Institute from 1964 to 1982 and Surface and Vacuum Research Centre, Moscow during 1982–1995. Since 1995, he is a Senior Researcher in L D Landau Institute for Theoretical Physics. Since 1982, he is a Part-time Professor in Moscow Institute for Physics and Technology; and short term Visiting Professor of some universities: Leuven (Belgium), Tokyo (Japan), Paris Sud (France), Glasgow Thrathclyde (Scotland), etc. He is the Author of the following monographs: Optics of Cholesteric Liquid Crystals, 1982, Optics of Chiral Liquid Crystals, 1989; Diffraction Optics of Complex Structured Periodic Media , 1988, 1992; Optics of Photonic Crystals, Publishing House of Moscow Institute of Physics and Technology, 2013 (Textbook, in Russian). He is honored with the Grants of Russian Foundation for Basic Research (RFBR), Soros Grants, and INTAS Grants. He is a Member of Russian Academy of Natural Sciences, Member of Russian Academy of Metrology, Member of International Liquid Crystal Society and Liquid Crystal Society of CIS (member Governing body 1982).

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