In this study, we examine the behavior of the transmission coefficient and the Density of Photon States (DOS) in liquid crystal dye-doped films in the presence of loss mechanisms and gain. We find a good agreement with experimentally determined lasing thresholds and extend our analysis to traditional DFB structures as well as to transmission characteristics of oblique and defect modes in these resonators. Absorption and gain are introduced through the addition of a small imaginary part in the dielectric constant parallel and perpendicular to the molecular director, for which we can also take into account frequency dispersion. Hence, we assume that $\varepsilon_\parallel = \varepsilon_\parallel + i\gamma_\parallel$ and $\varepsilon_\perp = \varepsilon_\perp + i\gamma_\perp$. Our treatment builds upon the analysis of Schmidtke et al.[1] and de Vries [2] for a lossless system, according to which the transmission coefficient and the DOS in a chiral nematic liquid crystal cell for the $j^{th}$ normal mode are given by the expressions

$$ T_j = (1 + r_j)(1 - r_j) \frac{\exp(ik_jNp)}{1 - r_j^2\exp(2ik_jNp)} = X_j + iY_j, \quad \rho_j = \frac{1}{Np} \frac{X_j dY_j - Y_j dX_j}{X_j^2 + Y_j^2}, \quad j = 1, 2, $$

respectively, where $p$ is the pitch of the helical structure, $N$ is the number of pitches contained in the cell, $k_j$ is the ‘effective wavenumber’ and $r_j$ is the reflection coefficient for the corresponding electric eigenfield. We observe that for a sufficiently high value of losses and in the absence of dichroism, there is a reversal of the dominant edge mode [Fig. 1(a),(b)], and consequently in the threshold gain. In the presence of gain [Fig. 1(c)], the DOS diverges virtually to infinity when the lasing threshold condition is met. This means that the characteristic time required for the establishment of the steady state in the generation of almost monochromatic light attains also very large values [3]. From Figures 1(d),(e), we can ascertain that the profile of the maximum DOS exhibits a roll-over for a decreased sample thickness with increasing anisotropy, which is also verified experimentally.


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