The CUNY Center for Advanced Technology In Photonics Applications (CUNY CAT)
Designated by NYSTAR, the New York State Foundation for Science, Technology and Innovation

Band-Edge Lasing in Cholesteric Liquid Crystals

There is growing interest in the possibility of observing suppressed spontaneous emission and low-threshold lasing in 3D photonic crystals. We have demonstrated that spontaneous and stimulated emission, as well as the absorption coefficient, are inhibited within the stop band and enhanced at the band edge of a 1D, self-organized structure - a dye-doped cholesteric liquid crystal (CLC) film. Figure 1 illustrates the molecular ordering for CLC periodic helical structure with pitch P ($=\lambda_c/n$) that can be either right or left-handed. For sufficiently thick films, the reflectance of normally incident, circularly polarized light, with the same sign of rotation as the CLC structure, is nearly 100% within a broad band centered at a wavelength in the medium equal to the pitch of the structure.

This results in low-threshold, high-efficiency, diffraction-limited lasing at the edge of the CLC stop band as shown in Figure 2. The ratio of right to left circularly polarized spontaneous emission agrees well with the calculated density of photon states. This indicates that the exceptional properties predicted for 3-D photonic band gap materials are observed to dramatically alter the linear and nonlinear optical properties of 1-D periodic structures.

The distinction between the laser emission frequency, which occurs at the band edge, and the frequencies of peak reflection and of spontaneous emission in this system allows for flexibility in the design of mirrorless microlasers. The dependence of the lasing frequency upon the position of the edge of the reflection gap suggests that the frequency of the laser can be readily modulated by an applied electric, magnetic or optical field, and by temperature or pressure changes that modulate the CLC pitch. The compact nature of these structures and the ease with which they can be fabricated suggest that they may be useful for producing integrated lasers and photonic devices.

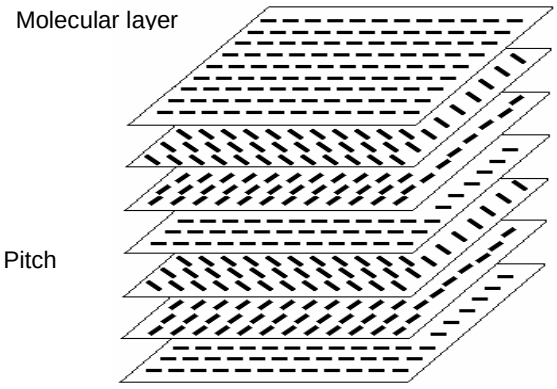

Fig. 1. Molecular ordering of a right-handed planar-textured CLC film.

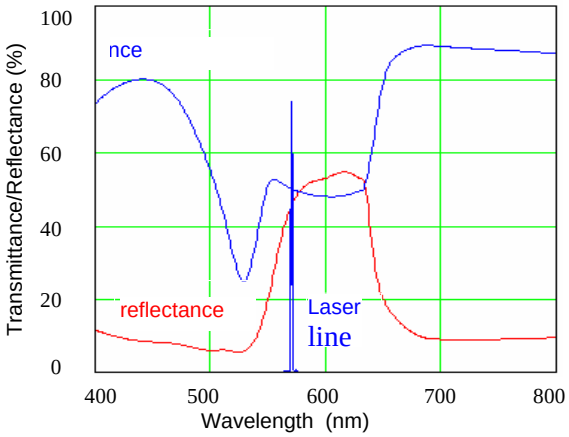

Fig. 2. Transmittance and reflectance spectra for unpolarized light of dye-doped CLC with superimposed laser emission.

This technology opportunity sheet describes continuing efforts in this area. Several patents may have been issued or are pending and which may be available for licensing.

For Details, contact Alan Doctor; email: alan.doctor@qc.cuny.edu; Phone: 718-997-4279 Fax: 718-997-4278
Queens College • Razran 314 • 65-30 Kissena Boulevard • Flushing, NY 11367 www.cunyphotonics.com