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Coherent Optical Sources using Micromolecular Ordered Structures

UNIVERSITY OF CAMBRIDGE

Band-edge liquid crystal lasers

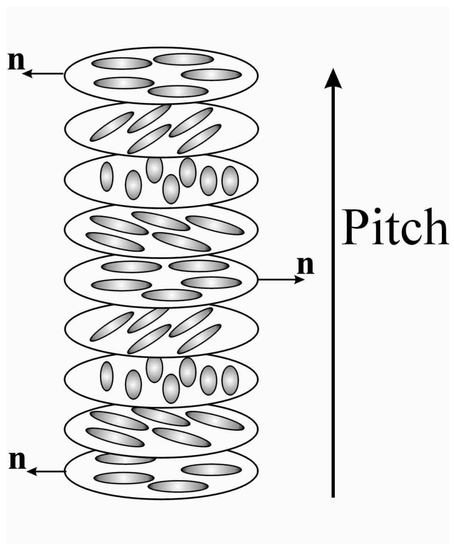
S.M. Morris, P.J.W. Hands, T.D. Wilkinson, H.J. Coles

Centre of Molecular Materials for Photonics and Electronics (CMMPE)
Department of Engineering, University of Cambridge

Ingredients for a band-edge liquid crystal laser

Distributed Feedback Structure

Chiral nematic liquid crystal



• Chiral nematic liquid crystals spontaneously self-organize to form periodic dielectric structure – creates photonic band gap (PBG). Macroscopic structure is helical.

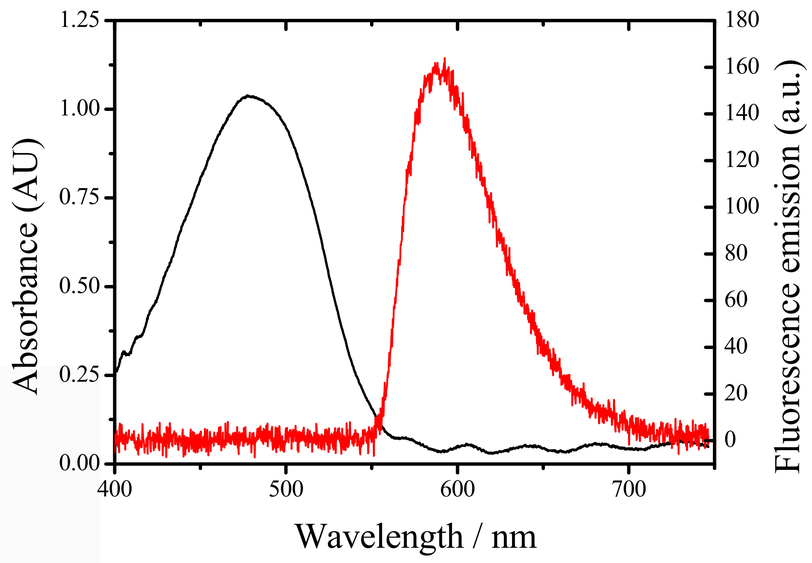
• Enhanced density of photon states at band-edge of the PBG.

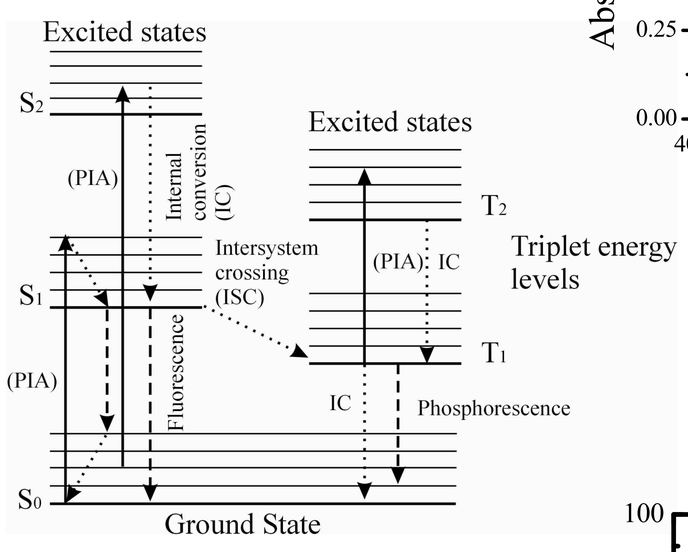
• Lasing threshold reduced at band-edge due to increased gain.

Gain medium

Four-level laser dye or light emitter

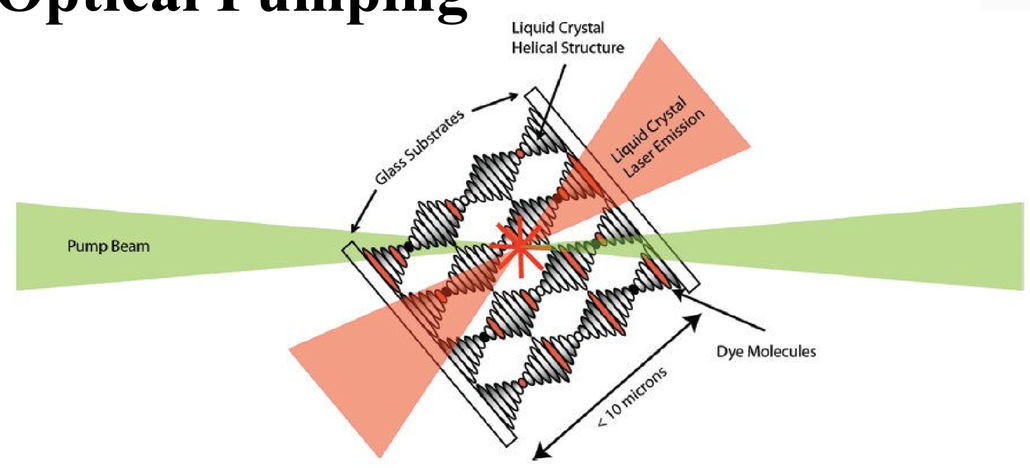
(Right) **Absorbance** (black) and **fluorescence** emission (red) spectra for a dye-doped liquid crystal (DCM in E49*). Pumping wavelength chosen to match absorbance peak. Chiral dopant concentration chosen so band-edge matches with fluorescence peak.



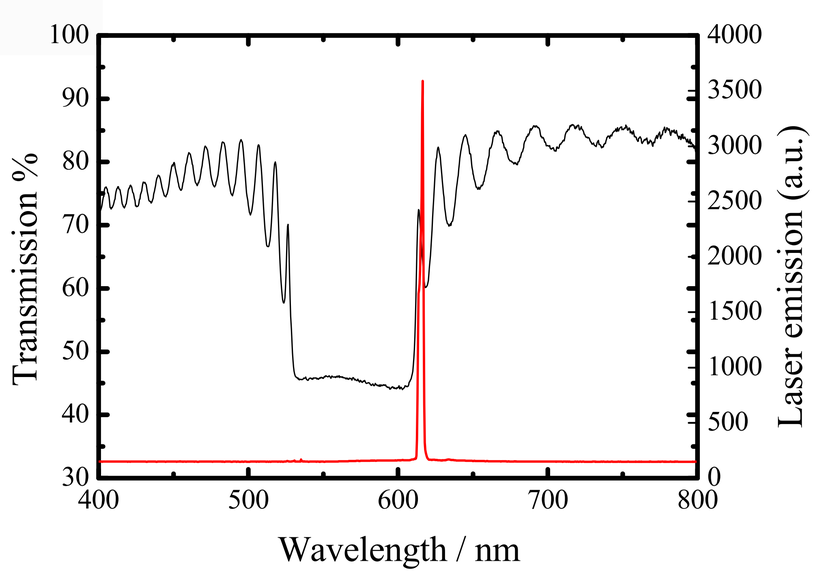


(Left) Energy level diagram showing the four-level lasing process in a dye. Cross-over to triplet states and/or excitation to 2nd excited singlet states lead to degradation of performance.

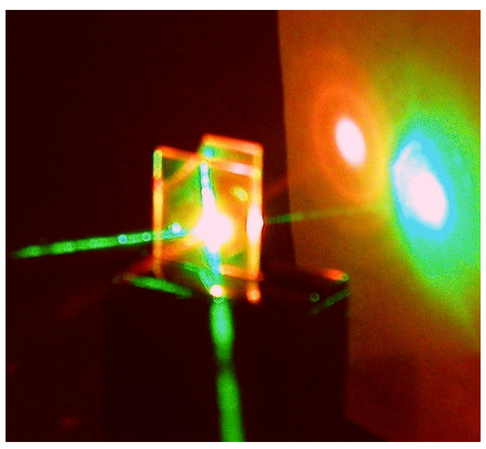
Optical Pumping

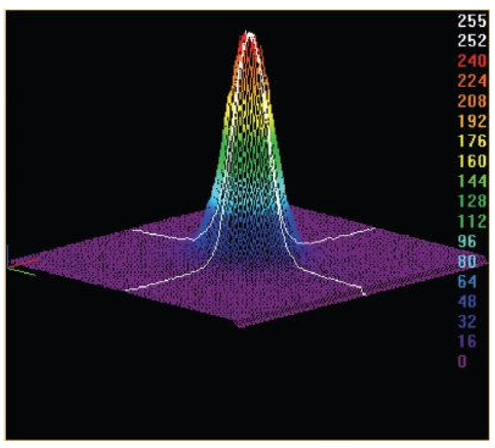


(Right) The **photonic band gap** in a chiral nematic liquid crystal (E49*) (black line), and associated **lasing** at the long band-edge in a dye-doped chiral nematic cell (DCM in E49*) (red line).



(Above & below) Nd:YAG pump focussed into an LC laser cell, generating red laser emission.





Further reading: *A.D. Ford, S.M. Morris, H.J. Coles*, Materials Today, **9** (7-8), pp.36-42, (2006).
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