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Laser devices formed from two dimensional photonic crystals (PC), based upon both inorganic and organic materials, have been fabricated demonstrating a range of remarkable emission properties [1 - 3]. Control of the laser emission characteristics, which is an important requirement for practical purposes, can be provided at the fabrication stage by pre-selecting the periodicity and the geometrical arrangement of the lattice. However, many potential applications of PC lasers would benefit from in-situ control of the emission properties. Obtaining some degree of tuneability can be achieved by infiltrating liquid crystals (LCs) into PCs so as to vary the spectral position of the photonic band gap through a range of external stimuli. However, it is often difficult to align the LC uniformly in the zero-field state resulting in limited tuning capabilities and functionality of the laser because of the small change in the LC refractive index [4, 5].

In this presentation it is shown that by covering a nano-patterned titanium dioxide photonic crystal within a well-oriented film of dye-doped LC, a distributed feedback laser with 3D emission can be constructed whereby the emission characteristics can be manipulated in-situ using an electric field. This hybrid organic-inorganic structure permits simultaneous selectivity of both beam pattern and laser wavelength by electrical addressing of the LC director [6]. We present experimental results on the laser emission characteristics of the hybrid structure in terms of the excitation threshold, sensitivity to input polarization, emission wavelength and laser beam profile. Comparison with a conventional 1D chiral nematic liquid crystal laser shows that for this hybrid device the excitation threshold is reduced by a factor of three. Along with experimental data, a theoretical model is presented that is based upon an approximate calculation of the band structure of this birefringent tuneable laser device.

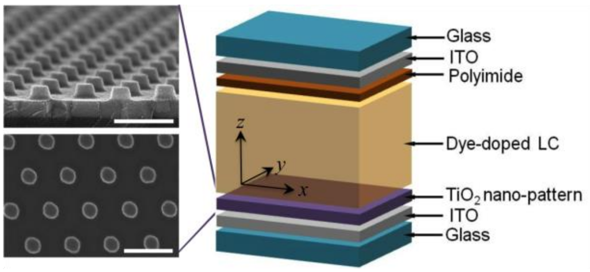

Figure 1: Schematic of the laser device with scanning electron microscope images of the nano-patterned layer.

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