Hybrid Photonic Nano-Structures For Lasing And Switching Applications

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Combining organic films with highly optimized photonic nanostructures could lead to new optic elements. In one case organic lasers are improved by incorporating a photonic crystal that consists of a thin layer of Ti02. The Ti02 increases the index contrast and the confinement in the waveguide. Thus the mode coupling is increased which results in larger feedback given to the lasing modes. The larger feedback leads to smaller devices as the interaction length is decreased to achieve the lasing threshold. To employ a photonic crystal consisting of a high-index material in this way gives rise to new design criteria. These criteria are investigated and employed to design an optimum organic photonic crystal laser. Devices have been fabricated according to optimum parameters and characterized. The measured spectral features of the laser agree very well with the predictions of the simulations.

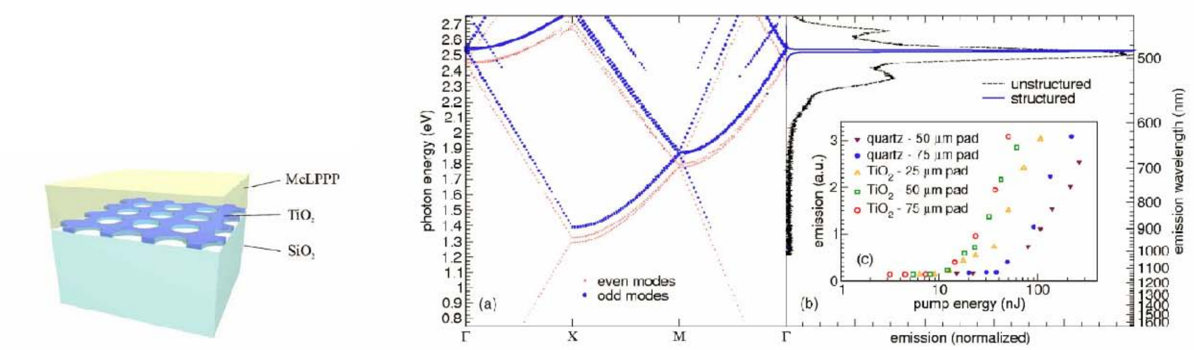

Figure 1: (a) Scheme of the basic structure of the investigated device. The photonic crystal structure is transferred into the thin TiO2 layer. (b) On the left the band structure calculations for the basic structure (a) are shown. On the right the experimental spectra of the neat material in comparison with the structure are shown. The inset displays the laser thresholds.

In the other case Fabry-Perot cavities are fabricated by incorporating an organic non-linear Kerr material between two dielectric mirrors. Using femto-second pump and probe measurements we characterize these hybrid 1-D photonic band gap structures for various organic materials. Promising organic materials are C60 and MEH-PPV. By varying the pump beam wavelength across the cavity resonance we are able to delineate between the various underlying nonlinear processes. It turns out that in the spectral region between 780 nm to 880 nm the nonlinear absorption dominates the signal. However, for larger wavelengths of around 1300 nm to 1500 nm refractive nonlinear effects dominate the signal. Comparing these measurements with computations we are able to quantify both the refractive and absorptive nonlinear coefficients of various organic materials.

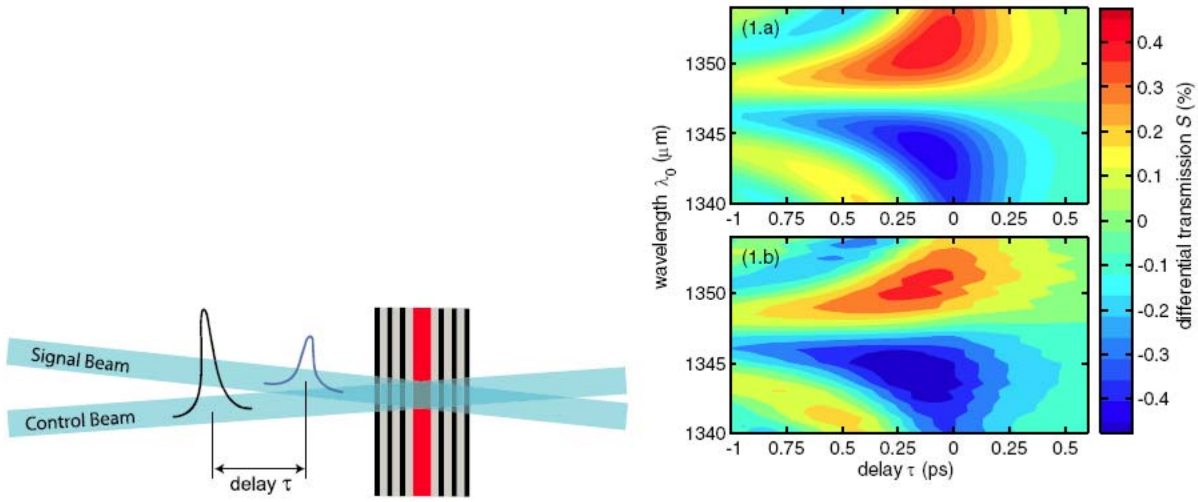

Figure 2: (a) Two light beams (control and signal) are coupled in an optical resonator in a way that the maximum intensity is within the nonlinear optical material (red). (b) Differential transmission of a C60-filled cavity as a function of wavelength and pump-probe delay. Here, the refractive part of the nonlinearity is dominant. The graph in the lower row shows a fit of the simulated data to the experiment (upper row).