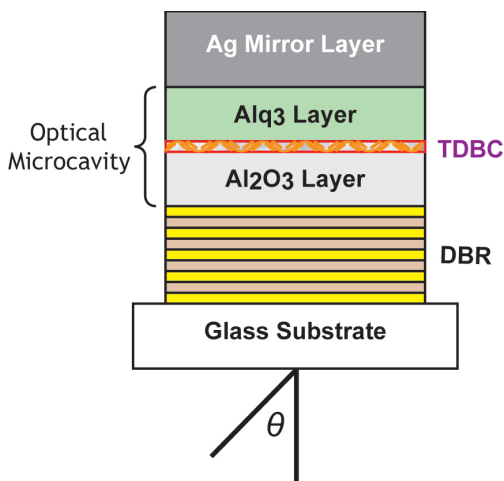


Exciton-polaritons at Room Temperature in Metal-dielectric Microcavities

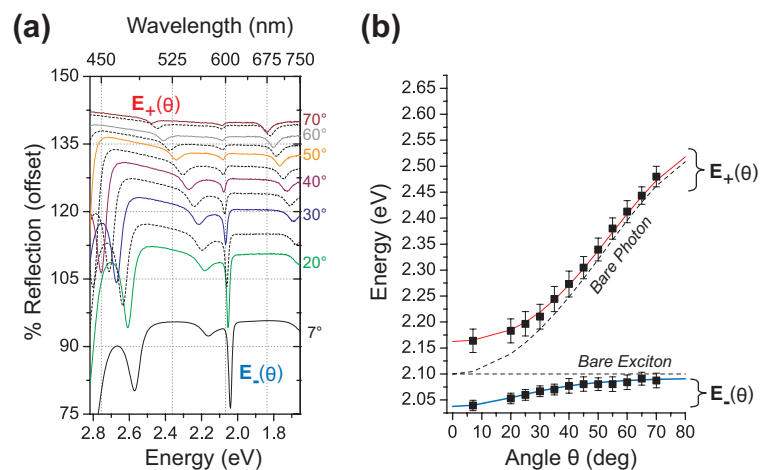
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Sponsorship: DARPA, NDSEG, MIT NSF MRSEC

Exciton-polariton-based photonic devices are a novel platform for realizing low-threshold lasing [1] and optical switching [2] in a scalable integrated architecture. Use of organic materials such as the excitonic component facilitates room-temperature operation of such devices [3]. Here we report room-temperature exciton-polariton devices consisting of layer-by-layer (LBL) assembled thin films of polyelectrolyte and the J-aggregates of the cyanine dye TDBC inserted in a resonantly-tuned planar $\lambda/2n$ optical microcavity with metal mirror and dielectric Bragg reflector (DBR). The device exhibits Rabi-splitting of $\Omega_R = 125 \pm 7$ meV with a polyelectrolyte/J-aggregate layer that is only 5.1 ± 0.5 nm thick [4]. Furthermore, the linewidth of the lower energy polariton state, measured on resonance, is $\Gamma = 12.1$ meV. The ratio $\Omega_R/2\Gamma = 5.1$ indicates that the device operates in a limit where the light-matter coupling (Ω_R) significantly exceeds competing dephasing processes (Γ). These figures of merit are achieved by virtue of the nanostructured film's large absorption

coefficient of $\alpha \sim 1.0 \times 10^6$ cm⁻¹ and by location of the 5.1 ± 0.5 -nm-thick layer at the microcavity anti-node. Rabi-splitting and polaritonic dispersion are observed in the reflectance, transmittance, and photoluminescence measurements of the device. Because strong coupling is achieved with such thin films, the majority of the microcavity modal volume is available for integrating a variety of optically active materials, such as colloidal quantum dots and fluorescent polymers, into devices that could leverage the coherent properties of the strongly coupled states. Moreover, the LBL process provides nanometer-scale thickness control of ~ 1.7 nm per polymer/dye bilayer, suggesting that this device can be used to investigate fundamental physical phenomena such as non-radiative energy transfer and laser action in the strong coupling limit.



▲ Figure 1: Device design of polaritonic structure. Microcavity consists of a DBR and a silver mirror layer. On top of the J-aggregate layer, a film of small molecule Alq3 is thermally evaporated.



▲ Figure 2: (a) Angularly resolved reflectance measurements and (b) dispersion relation for resonantly tuned polaritonic structure. The microcavity is resonantly tuned at normal (at $\theta = 0^\circ$) to the exciton resonance of 2.10 eV. The $E_-(\theta)$ denotes the lower energy polariton states; $E_+(\theta)$, the higher energy polariton states. Reflectance is measured with TE polarized incident light. Measurements from $\theta = 20^\circ$ to 70° are relative values. Data at $\theta = 7^\circ$ is absolute reflectance.

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