Light-Matter Strong Coupling in Liquid Fabry-Perot Nanocavities

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Interactions between light and matter can be profoundly altered by the presence of an optical cavity. For the resonance case, rapid energy exchange between the cavity photonic mode and a transition dipole of the material brings the system into the strong coupling regime generating two new light-matter hybrid states [1].

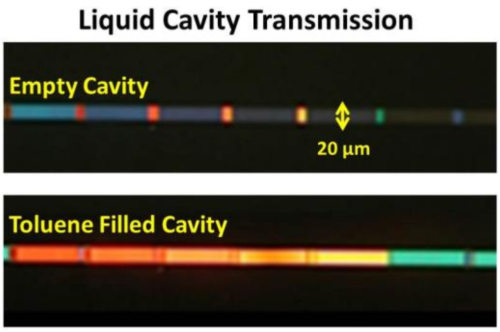

Figure 1: Optical micrographs showing white light transmission through our nanofluidic FP cavities before and after filling them with toluene. The colored rectangles represent FP cavities of varying thicknesses, with the corresponding dispersion of the confined light mode.

Many studies have shown that these hybrid states (polaritons) have modified properties compared to their original constituents. For instance, it was shown that the polaritons emission is dispersive and the quantum yield of polaritons is dominated by non-radiative emission [2]. In the visible spectral range, strong coupling of light with nanomaterials can be achieved using Fabry-Perot (FP) cavities with nanoscale dimensions. While all-solid nanoscale FP cavities are relatively simple to fabricate, liquid phase FP nano-cavities are far more challenging. Herein, we report a facile method we developed for the fabrication of metallic nano-fluidic FP cavities tunable over a wide range of wavelengths in the visible spectrum (Fig. 1).

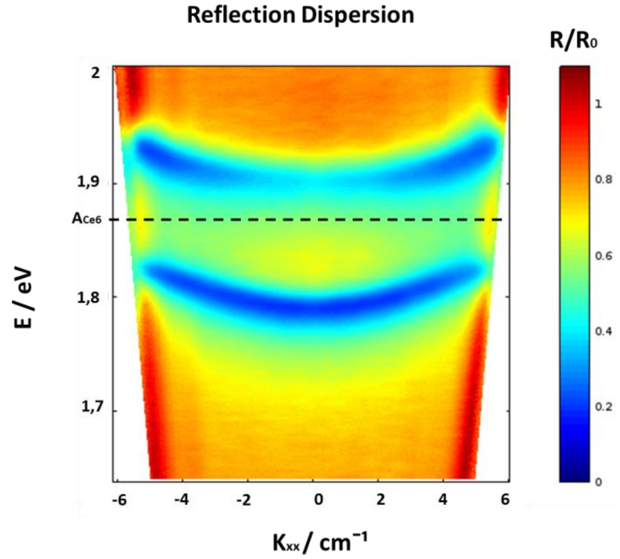

Figure 2: Dispersion showing reflection from a resonant FP liquid cavity filled with chlorin e6 solution. The dashed line represents the transition energy of Ce6.

Our nano-fluidic cavities have been fully characterized and put to use to achieve the strong coupling of various dyes in solution phases. Particularly we show modifications to the photo-physical properties of a dissolved dye, chlorin e6 upon its strong coupling to the optical modes of our cavities. In Fig. 2 we can see the reflection dispersion relation in k space for chlorin e6 placed in a resonant liquid FP nano-cavity.

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References:

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[2] Shaojun Wang, Thibault Chervy, Jino George, James A. Hutchison, Cyriaque Genet, and Thomas W. Ebbesen, *J. Phys. Chem. Lett.* **2014**,5,1433-1439