Strong light–matter interactions for facilitated light emission

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Our aim is to explore a novel concept on the extraction of light from the electronically excited molecular states. In organic light emitting diodes (OLEDs), an electron and a hole are recombined to form an excited state of either singlet (25%) or triplet (75%) character, from which a photon is emitted. However, triplet states emit light much slower and inefficiently than the singlet states, which limits the achievable efficiency of the system. Molecular system that could channel excitation energy through a singlet pathway no matter whether the molecule is excited to a singlet or triplet state would thus directly contribute to the development of more stable and efficient organic light emitting devices.

One possible way for tuning the energy levels of the molecule is the coupling of the molecule to the zero point fluctuations of the electromagnetic field (vacuum field).[1,2] This so called strong coupling occurs inside an optical cavity, when exchange of energy between a cavity mode and a molecular state is larger than any dissipation process, leading to the creation of hybrid light–matter states (Fig. 1). The formed hybrid states (polaritons) can be viewed as a linear combination of light (vacuum field) and matter (molecules), thus enabling the creation of molecular systems with unique features.

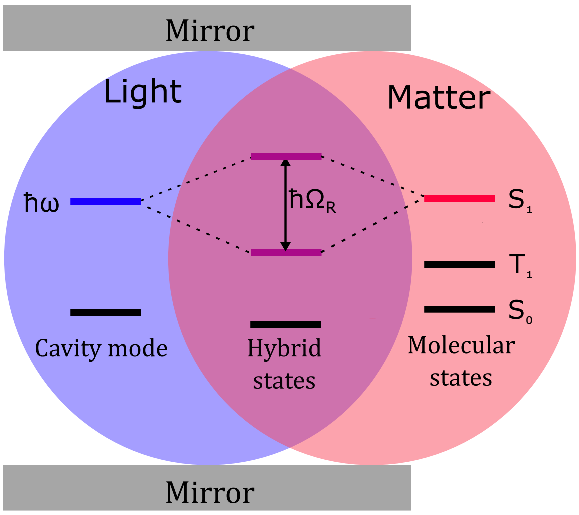

Figure 1: Schematic diagram of a cavity formed by two mirrors that is in resonance with the absorption of molecule that hybridizes with the cavity, splitting the state into two hybrid states.

The basic theory of strong light-matter coupling suggests the possibility of modifying the energy levels of singlet states, without significantly perturbing the energy levels of triplet states even if at resonance. Here, we demonstrate on the possibility to selectively tune excited state processes by modifying the energy landscape of the molecule by placing it inside a Fabry-Pérot cavity. The changes in emission properties of the molecule inside the cavity are detected by using the steady state and time resolved optical spectroscopy techniques.

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