Title:	Exploring Exciton-Polariton Formation in an Organic Single Crystal Semiconductor Microcavity
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Keywords:	optical cavity Hopfield coefficients etraphenyltetracene
Issue Date:	May-2024
Publisher:	IISER Mohali
Abstract:	This thesis investigates the formation of mixed polaritonic states in rubrene single crys- tals, leveraging their inherent optical anisotropy. The optical properties of rubrene crystals were extensively studied, revealing significant variations in absorption and photolumines- cence responses depending on the polarization axes. For example, the vibronic spectra show an intense (1, 0) transition when excited with polarization parallel to the c-axis. To further explore the interaction between rubrene crystals and confined cavity modes, an open cavity setup was developed on a Si − SiO 2 substrate, enabling effective confinement of elec- tromagnetic waves within the cavity and facilitating their coupling with molecular excitons. Experimental investigations conducted with polarization along various crystal axes demon- strated the formation of polaritonic states when coupled to highly dissipative cavity modes. The interaction between multiple higher-order cavity modes and various vibronic transi- tions of rubrene led to the emergence of mixed polaritonic states, evidenced by clear split- ting in the reflection spectra. Additionally, the reflection spectra revealed the multi-mode coupling of rubrene single crystals. Further, we tracked their dispersion using back-focal imaging techniques. Clear dispersive behavior was also observed in the photoluminescence of the coupled system, further confirming the formation of mixed polaritonic states. TMM simulation supports the experimental observations. Photoluminescence emission originat- ing from the lower polaritonic state clearly indicates the formation of the polaritonic ladder and the on-set of strong coupling in the crystal lattice. Further improvement is required to get a thin single crystal to study the single cavity-exciton coupling experiments. Along with the optical signature, we also tapped the electrical response of a rubrene single crystal and observed a typical p-type organic semiconductor behavior. The optical studies, along with the conductivity studies in rubrene, are promising for investigating the effects of light- matter strong coupling in quantum transportation and sensing.
Description:	Under Embargo Period
URI:	http://hdl.handle.net/123456789/5699
Appears in Collections:	MS-19