Lasing in Metal-Organic Microcavities

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Organic microcavities offer fascinating prospects for studying the interactions of light and matter and various coherence phenomena. Such observations are made possible by the large oscillator strengths and exciton binding energies provided by organic semiconductors. For electrically driven devices, highly conductive electrodes have to be integrated. For this purpose metallic electrodes are under study, but the large absorption properties of metals are generally to prevent optical coherence.

In this talk, we will focus on the impact of metallic structures implemented into organic microcavities. Optimizing the structural design and introducing a higher order confinement are beneficial to maintain optical coherence at low thresholds.

At first, a homogeneous silver layer of 40nm thickness is implemented into a high quality organic microcavity, where an active half-wavelength layer of the organic host:guest system Alq3:DCM (2 wt.%) is embedded between two dielectric mirrors (DBRs). By exciting this structure non-resonantly the transition from a single photonic cavity mode to two coupled Tamm states is observed [1]. Optimizing the design reduces the overall optical losses and increases the Q factor to 650 allowing for the observation of coherent emission from cavity photons and Tamm plasmons at room temperature [2].

A lateral confinement of the optical modes can be introduced by generating an optical gain grating or by structuring the metal layer by means of photo-lithography. The optical approach enables a dynamic manipulation of the optical mode and its far field emission pattern according to the spatial gain distribution. Structuring the metal layer into periodically placed stripes leads to the observation of surface plasmon polaritons and Bloch-like photonic bands. Above the lasing threshold, macroscopic coherence is observed occurring on different Bloch states localized either at the center or at the edges of the resulting Brillouin zone [3].

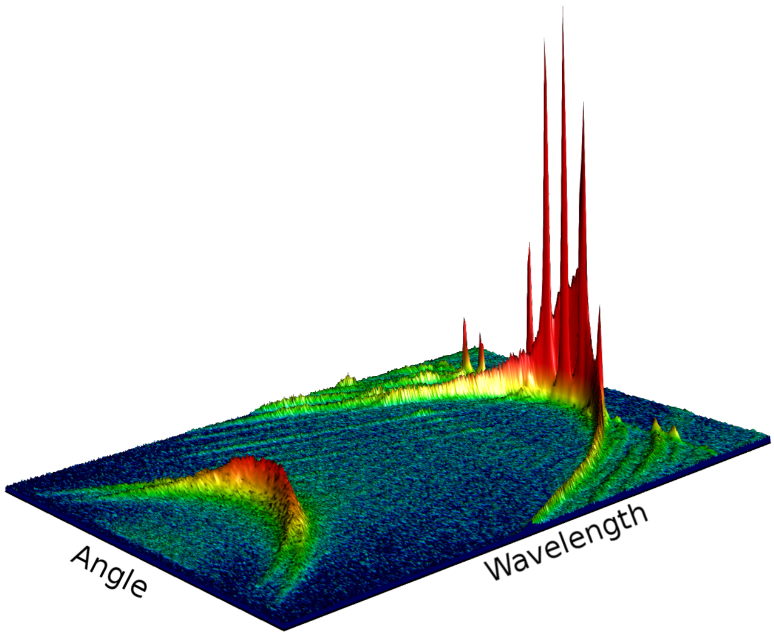

Figure 1: Dispersion of an organic microcavity laser with implemented metal grating which may act as electrode for contacting the active area. An in-phase-locked coherent mode spreads over macroscopic distances resulting in a 2π-state (red peaks). Quasi-linear branches inside the parabolic intensity ridge (green lines) reveal an efficient coupling to surface plasmons polaritons [3].

References

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