Kolloquium

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Organic-semiconductor devices: from optical strong-coupled microcavities to commercialisation of technology

physikalisches

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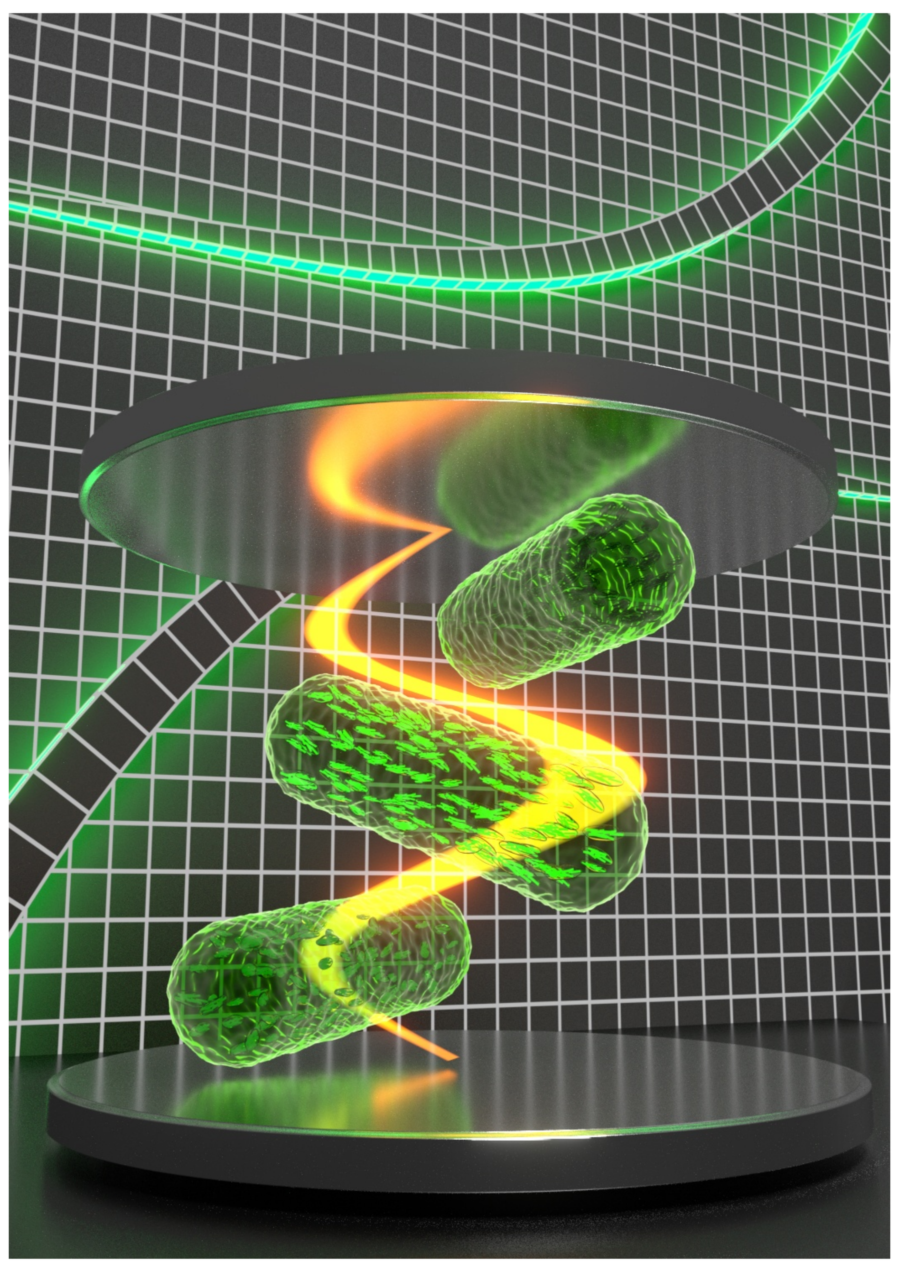
A semiconductor-microcavity is an optical structure composed of two mirrors separated by a layer of semiconducting material. If the energy of the confined photon and excitonic transition are degenerate, interactions can occur in the strong-coupling regime, with the eigenstates of the system now being cavity polaritons. Such bosonic polaritons are delocalised throughout the cavity and can be formally thought as being composed of a coherent superposition between light and matter. As a result of their bosonic nature, cavity polaritons are also able to undergo 'condensation' when created at high density, forming a macroscopically occupied coherent state. Light emission from such states is coherent and monochromatic, but different from regular lasing as it no longer requires the creation of a population inversion.

In this talk, I introduce our recent experiments on strongly coupled organic and hybrid-semiconductor microcavities and discuss polariton condensation in organic semiconductor microcavities containing boron-dipyrromethene family molecular dyes. Here, I show that it is possible to create polaritonic lasers that emit light across the yellow and green part of the visible spectrum.



To explore the possibility of the electrical generation of organic-semiconductor polariton-lasing, I then discuss the fabrication of coupled microcavity structures in which mixing of optical states occurs between strong and weak-coupled cavities that contain organic and inorganic semiconductors. I show in proof of principle experiments that energy transfer can occur between two 'coupled' cavities, with electrical injection of the inorganic semiconductor creating organic-exciton polariton states (albeit at a threshold way below that required for condensation).

I then show that strong-coupling is not limited to synthetic semiconductors, but that the intense absorption transition of the chlorosomes within a living green-sulphur bacteria can also undergo strong-coupling. This creates states that we term 'living polaritons' (see figure).

Finally, in an abrupt change of direction, I will talk about setting up the company Ossila Ltd. Ossila was founded to serve the organic electronics community with materials and substrates, but now has a mission to serve the whole materials science community. I discuss how we develop and sell our products, and hope to convince you that entrepreneurship can sit comfortably alongside basic science research.

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