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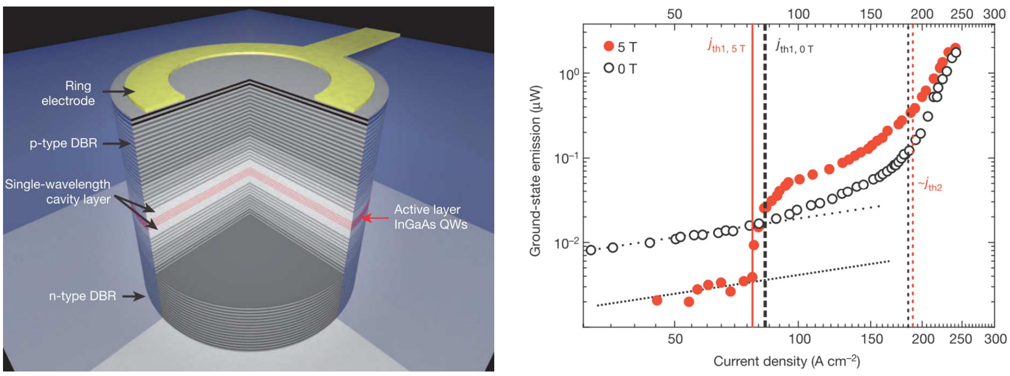
School of Physics and Astronomy
Quantum Physics and Quantum Engineering Group

PhD thesis

Electrically driven polariton devices

Exciton-polaritons are mixed bosonic quasiparticles that form when excitons and photons strongly interact inducing a steady energy exchange between both types of particles. Polaritons are usually created in semiconductor microcavities providing quantum confined excitons in active quantum well layers and photonic confinement by sandwiching those active layers between top and bottom Bragg mirrors. In contrast to conventional semiconductor lasers that rely on the stimulated emission of photons, polariton lasers undergo stimulated scattering promising ultra-low threshold generation of coherent light by the macroscopic occupation of the bosonic polariton ground state. This process does not require population inversion as it is the basic requirement for the operation of a conventional laser. The evidence for room-temperature polariton condensation in optically pumped polariton microcavities [1] besides the recent first demonstration of an electrically driven polariton laser [2] establish the young scientific branch of 'polaritonics' as a serious option besides 'photonics'.



Left: Scheme of an electrically pumped polariton laser with gold ring electrodes, *p*-doped top and *n*-doped bottom Bragg mirrors and active InGaAs QW layers. Right: Current density vs ground state emission with (red dots) and without (black circles) applied magnetic field [2].

This project aims at pushing electrically driven polariton light emitting devices to their maximum performance. This includes the unambiguous evidence for electrically induced polariton condensation without applying an external magnetic field as well as reducing the condensation threshold and figures of merit for condensation. The latter requires an improvement of both the current injection and polariton stability by optimization of the microcavity geometry and morphology.

[1] S Christopoulos *et al*, Phys Rev Lett **98**, 126405 (2007)
[2] C Schneider *et al*, Nature **497**, 348 (2013)

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