Integrated optical microdisk-waveguide systems with II/VI semiconductor quantum wells

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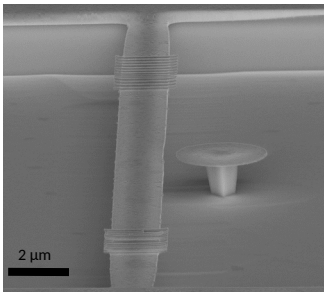

In the last decade the emerging explorative research on solid-state quantum light sources has become a focus of study in different semiconductor materials, each with their own material specific strengths and weaknesses. Hereby typical devices are single-photon sources and optically controllable spin qubits. A major requirement of robust coupling between stationary spin qubits points to the interconnection and control of many disconnected qubits through optical interfaces, which are flexibly accessible by standard lab-sized optical components. The latter demands sophisticated designs to combine single-photon sources, microcavities, waveguides, beam-splitter and even detectors unified in suitable all-on-one-chip systems, which form integrated-optical building blocks on the nanoscale.

Here I report on a novel design of waveguides and microdisks fabricated from ZnSe/(Zn,Mg)Se and ZnCdSe/(Zn,Mg)Se quantum wells (QWs). The QW heterostructures were grown by molecular beam epitaxy on GaAs substrates and provide suitable components for integrated-optical devices in the blue/green spectrum. Additionally, doping of the QWs with fluorine allows the realization of modern devices such as low-threshold lasers [1] and single photon sources [2,3] and their all-on-one-chip integration.

The analysis of spatial-resolved µ-photoluminescence measurements along the waveguide demonstrates photon transfer between microdisk and waveguide. Moreover, lasing is observed at specific whispering gallery modes of the microdisks, which denote efficient photon guiding along the waveguide. In addition, higher fluorine concentrations in the QW results in a higher β-factor and a lower laser threshold. Finally, I demonstrate functional operation of microdisk-waveguide couplers based on ZnSe/(Zn,Mg)Se QW structures which open-up substantial potential for larger scale integrated-optical systems tailored for the blue/green spectral range.

[1] A. Pawlis et al., Phys. Rev. B 77 (2008) 153304
[2] K. Sanaka et al., Phys. Rev. Lett. 103 (2009) 053601
[3] K. Sanaka et al., Nano Letters 12 (9) (2012) 4611