Development and deterministic nanofabrication of single quantum dot devices for applications in photonic quantum technologies

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Photonic quantum devices are key building blocks for the implementation of quantum networks and for the realization of photonic quantum processors. Moreover, they allow one to explore exciting physics in the quantum regime of single emitters and single photons. Of particular interest are devices generating, routing, processing and detecting single photons which act as information carriers in the field of photonic quantum technologies. In this talk I present recent progress in the development and deterministic fabrication of high-performance single-photon sources (SPSs) and on-chip quantum circuits based on semiconductor quantum dots (QDs and quantum dot molecules (QDMs). Here, QDs act as close-to-ideal photon emitters with high quantum efficiency and excellent quantum nature in terms of single-photon purity and photon indistinguishability. Using an advanced nanoprocessing technology platform, namely in-situ electron beam lithography, we pre-select suitable QDs and integrate them with nm accuracy into photonic nanostructures such as circular Bragg gratings to enhance the brightness of the sources [1, 2], to develop fiber-coupled stand-alone single-photon sources [3, 4, 5], and to enable the development of highly functional integrated quantum circuits [6, 7]. The talk gives an insight into the physics of such devices and discusses technological challenges, current limitations as well as perspectives of semiconductor QD based quantum devices.

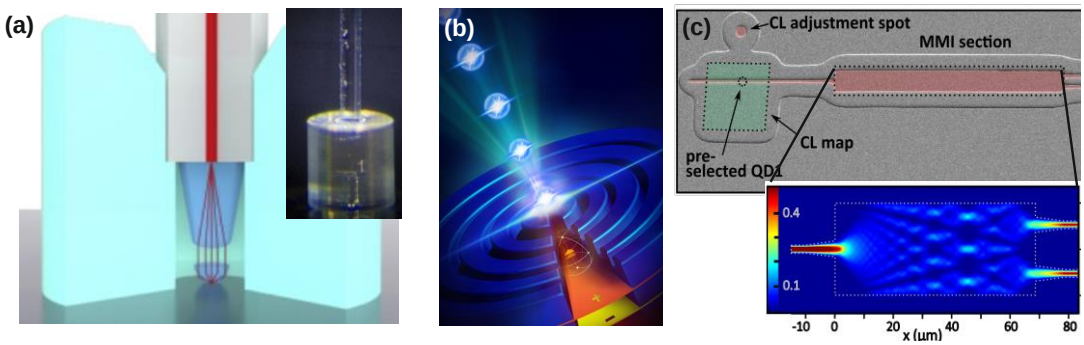

Figure 1: (a) Fiber-coupled QD SPS. (b) Schematic of an electrically controlled QDM device. (c) Integrated quantum circuit realized by in-situ electron beam lithography.

References

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