Low-temperature photoluminescence properties of diamond optical centers in diamond (program Kvantové technologie)

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Abstract:

Diamond optical centers are defects of diamond lattice that can emit single photons. Recently, optical centers based on group IV elements emerged as potential candidates for quantum applications or sensing.[1] One of the already well-explored group IV color center is a silicon vacancy (SiV) center which possesses zero-phonon-line emission centered at around 738 nm.[2] SiV centers can be relatively easily fabricated in diamond using the chemical vapor deposition technique yielding centers with almost life-time limited optical emission and high Debye-Waller factor. However, one of the main drawbacks of the SiV centers is intrinsically low quantum efficiency and sub-microsecond spin coherence time even at cryogenic temperatures.[3] Therefore, other defects based on group IV elements are being investigated with a goal to find a center with better performance than the SiV center.

The goal of the thesis is to use CVD growth to fabricate group IV defects in diamond and to investigate optical properties of the prepared samples. Namely, the optical centers will be prepared in polycrystalline diamond grown on SiO2 substrate and in monocrystalline diamond on commercially available diamond substrates. Both single centers and ensembles will be fabricated with the aim to prepare (i) indistinguishable source of single photons and (ii) ensembles with low inhomogeneous broadening of their photoluminescence (PL). The samples will be characterized by a set of techniques in order to provide feedback for the fabrication process. Namely, the applicant will evaluate the external quantum yield, cw excited PL spectra, Raman spectra, time and temperature resolved PL properties. Moreover, SEM and AFM analysis will be realized in order to complete the basic picture of the samples. Antibunching and coherence time will be evaluated for single emitters and possibly an optical gain will be measured in the best-performing ensembles. The main goal of the work is to understand physics underlying photoluminescence properties of the centers and to optimize their optical properties for their utilization in quantum photonics.

References:

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