CVD synthesis of diamond needles with controlled charge state of NV centers

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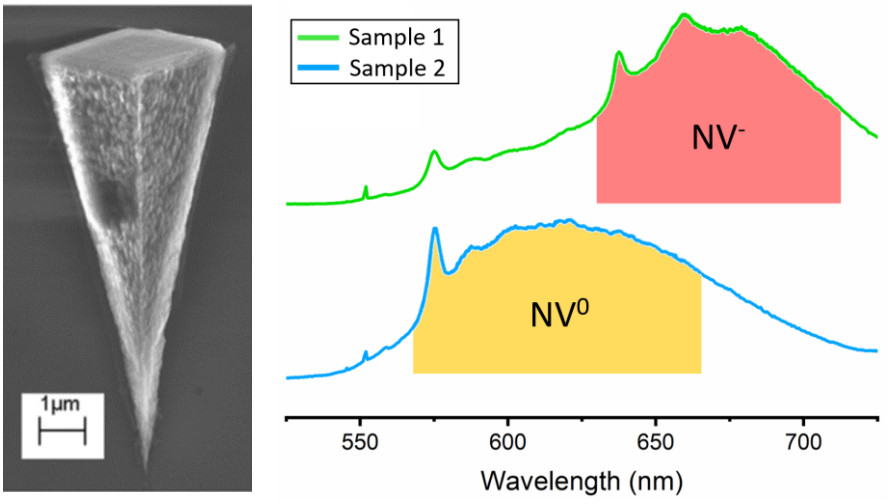
Manipulations with the objects of few nanometers size and characterization of their properties are required during variety of modern research performed in Physics, Chemistry, Biology and even Medicine. Decreasing size of the analysed objects significantly complicates investigations and requires development of particular research approaches and devices. Nanoscale quantum-optical sensors are promising for such small objects analysis. The nitrogen-vacancy (NV) centers in diamond are of great interest for the quantum-optical sensing. It is because of combination of unique properties of diamond itself (biocompatibility, high thermal conductivity, record hardness) and quantum features of NV centers [1]. The NV centers in diamond were demonstrated as high-sensitive nano-thermometer [2], sensors of magnetic and electric fields [3], mechanical stress sensor [4]. To provide nanoscale spatial resolution diamond probes with NV centers their size should be in nanometer scale at least in two dimensions. Moreover, robust methodology for manipulation and assembling of the diamond crystallites are required for production of the nanoscale sensors. Single crystal diamond needle (SCDN) demonstrates one of the most promising shape for nanoscale quantum sensors (see Figure 1a) [5]. Formation of NV centers in SCDN and their optical properties were previously demonstrated in works [6–9].

Here we present the recent research results aimed at controlling of the luminescent charge states of NV centers (Figure 1b) in SCDNs by adjusting parameters of chemical vapor deposition (CVD) process.



(a) (b)

Fig. 1. Electron image of individual SCDN (a) and photoluminescence spectra of two samples obtained at different parameters of CVD process (b). Main spectral areas of NV^0 and NV^- centers luminescence highlighted by yellow and red colors respectively.

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