Developing Fluorescent Nanodiamonds for Quantum Photonics

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We report on the development of new approaches to the controlled formation of fluorescent centers in nanodiamonds synthesized from hydrocarbons at high pressure and high temperature (HPHT). The conditions of HPHT synthesis have been determined, allowing for the highly efficient production of scalable single-photon emitters based on single silicon-vacancy (SiV) centers in individual diamond nanoparticles of about 200 nm in size. The recorded rate of their emission reaches 1 million photons per second. The fundamental possibility of obtaining diamond crystallites containing single NV and SiV centers emitting photons at two different wavelengths, 638 and 738 nm, respectively, has been demonstrated. Such two-color single-photon sources (SPSs) possess a multimodality (the ability to use the unique spin properties of NV centers in combination with the luminescent properties of SiV centers) and increased selectivity. It was found that hydrogen-terminated HPHT nanodiamonds contain a new type of single photon sources emitting in a wide spectral range (500-800 nm) at room temperature [1]. The recorded rate of their emission reaches 10 million photons per second. A connection was established between these SPSs and nitrogen impurities in the diamond volume and hydrogen on its surface. The developed SPS are proposed to be used in quantum communication and computing technologies.

In recent years, we are actively developing an all-optical method for measuring ultra-local temperature fields based on temperature-dependent spectral properties of fluorescent SiV centers in nanodiamonds [2]. It was established that the temperature sensitivity of nanodiamond sensors depends on the technique of diamond synthesis. HPHT diamond nanoparticles were found to demonstrate greater temperature sensitivity than CVD nanodiamonds, which is explained by the higher structural quality of the former.

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References

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