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BOOK OF ABSTRACTS

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Multi-Wavelengths Fluorescence and Raman Spectroscopic Study of The SiV Center Containing Diamond Nanostructures

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Optically active point defects or so called “color centers” in diamond nanostructures are very promising nano-objects and they are attracted the interest of many researchers and companies in the last decades. Some diamond color centers, like nitrogen-vacancy (NV) or silicon-vacancy (SiV) have unique physical and optical properties like intensive, stable and narrow emission band, single photon emission and optically addressable and readable spin state at room temperature. The mentioned properties in combination with the unique nature of diamond nanostructures can significantly contribute to the development of such nowadays intensively studied fields like quantum information processing, nanophotonics, nanobiology and nanomedicine [1].

In high quality diamond crystals - due to the strong covalent bond between the carbon atoms and the well-packed nature of the diamond lattice - the impurity related optically active defect centers behave as individual molecule and the luminescence spectrum of a color center consists of a narrow zero phonon line (ZPL - which is the pure electronic transition of the defect) and a broad phonon sideband (PSB - which is the phonon assisted replica of the pure transition). But the diamond lattice of nanostructures – more interesting for novel applications – can be partially destroyed or may contain non-diamond fragments, which can affect the spectral characteristics and the emitted light intensity of the color centers embedded in this structures [2].

In this paper we report about the experimentally studied effect of different diamond nanostructures on the emission intensity and spectral parameters (peak position and full with at half maximum) of the embedded SiV centers, being one of the most intensively studied impurity related optically active defect in diamond.

SiV centers were created in isolated diamond nanocrystals, nanodiamond films and diamond nanopillars by using the hot filament chemical vapor deposition (HFCVD), the microwave enhanced chemical vapor deposition (MWCVD) and the combination of HFCVD and electron beam lithography techniques, respectively.

Photoluminescence (PL) spectroscopy was used to detect the created SiV centers within the nanostructures and to determine their spectral parameters, while the bonding structure in surrounding of the centers was investigated by Raman spectroscopy. All measurements were performed on a Renishaw micro-Raman spectrometer attached to a Leica microscope and using 325, 488, 532, 635 nm laser lines for excitation.

The results of our experiments show that the created diamond nanostructures with different amount of non-diamond content in form of amorphous and graphitic carbon have significant effect on the emission intensity and on the spectral characteristics of the SiV centers, but the shape and size of the nanostructures are also important. Most tentatively, for the SiV center containing nanodiamond films and nanopillars the grain boundary related internal stress, while for the individual nanocrystals the graphitic carbon shell is the main source of the differences observed in the SiV PL parameters.

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[2] L. Himics et al. Optical and Quantum Electronics, 48(2016), 394.