# Fizikiniai procesai kvantinėje duobėje

# Insights into nitrogen doped diamond micro-nano dot

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Single nitrogen defects created on diamond surface due to their unique size-dependent optical properties, have been as a good candidate as bio-electrodes or for molecular imaging of the cancered cells [1,2,3]. In this report, single nitrogen defects by low energy and by high energy proton irradiation were created, after theoretical and experimental study of this implanted surface was performed. By irradiation process one carbon atom is removed from diamond lattice and nitrogen atom is replaced in this position. Structural and morphological studies by AFM and HRTEM reveal non-heterogeneity of the destroyed diamond surface. During bombardment process to the (001) diamond surface size-dependent dots from different proton energy power were observed.

For nitrogen ions implanted into diamond with low energies few nanometers size dots were registered by HRTEM. As the ion energy increases to the MeV range or until 10 MeV micro-nano dots recorded as result broadening of the ion-implanted volume (see Fig. 1.).

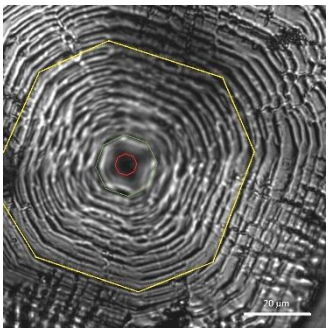


Fig. 1. Image of nitrogen doped diamond surface.

This occurs due to the multiple collisions of the moving protons with the carbon atoms perpendicular to the (001) diamond plane and quantitatively is defined as the square root of the variance of the ion distribution. Response of the *I-V* electrical signal insight dot and close to the dot differs. The voltage drops mainly across the less-conducting barrier. Registered the current changes in the *I-V* characteristics appear as pronounced steps, the so-called Coulomb staircase [2] what demonstrate quantum nature of the dot. The current steps $\Delta I$ occur at voltage intervals $\Delta V \approx e/C$. This agree with measured capacity $C$ results.

The strong red florescence spectra in the dot center were detected when fluorescence images were acquired on confocal laser scanning microscope. Irradiated damaged surface consisting from nanodiamonds with specific nitrogen replacement in lattice was simulated theoretically. Low-energy irradiation could be used with spatial accuracy in the nanometer range for nanoscale ion implantation. In this case, however small amount of nitrogen ions was implanted and ions come to rest in close proximity to the surface, at a depth of a few nanometers. High-energy proton irradiation till 10 MeV implants more nitrogen ions but with damaged diamond surface.

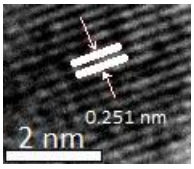


Fig. 2. High resolution TEM image of nitrogen doped diamond dot center.

*Key words: nitrogen defect, diamond, quantum dot, Coulomb blockade.*

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