Double Electron–Electron Resonance for C-Centers in Diamond: Optimization, Coherent Control and Concentration Measurements

A V Akimov[1]

[1] *Quantum simulators and Integrated Photonics group, Russian Quantum Center, Bolshoy boulevard, 30/1, Innovation Center Skolkovo, 121205, Moscow, Russia. Contact Phone: +79163473597*
Contact Email: aa@rqc.ru

NV-centers in diamond recommend themselves as good sensors of environmental fields as well as detectors of diamond impurities. The sensitivity of a sensor depends on coherence properties of NV centers, their concentration and so on. Thus, optimization of sensitivity of a sensor is hard experimental task. Both wat of sensor operation and diamond plates use for sensing are subject of such an optimization. In the latter case a lot of attention lately were dedicated to post grown procedures of diamond.

One of the key factors affecting sensitivity of NV center-based sensors are C-centers, often also called p_1-centers. These centers are on one side source of electrons for NV centers on another one of the main sources of decoherence. The relative concentration of C-centers and NV center more specifically negatively charged NV centers is often the focus of diamond plates optimization. The C-center themselves may be detected using in-diamond NV center magnetometer via so called double electron-electron resonance, thus providing insight into local distribution of impurities.

The double electron-electron resonance can also be used to measure the C-center concentration. Here, we measured the concentration of C-centers in several diamond plates and compared results with often used infrared spectroscopy method. We also investigated an influence of the free precession time of the NV-center on the observed contrast of double electron-electron resonance spectrum. The dependence of the resonance amplitudes and widths on the concentration of C-centers as well as the length of the combined C-center driving and NV-center π-pulse is discussed. The optimal contrast-free precession time was determined for each C-center concentration, showing a strong correlation with both the concentration of C-centers and the NV-center T_2 time.

Besides, series of experiments on optimization of NV-centers to C-centers concentration ratio, or yield of NV centers, in electron beam irradiation post processing with consequent annealing was performed along with study of associated coherence properties change. The optimization was performed for cases of medium and high concentration of nitrogen in a diamond, for which optimal procedures were established. As high as 37(4) percent conversion efficiency of C-centers into negatively charged NV centers was demonstrated.