Enhancing Spatial Sensitivity of Multiple NV Centers in Diamonds Using Rabi Oscillation

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Abstract (Century Gothic 11)
The Nitrogen-Vacancy (NV) center in diamonds holds great promise for quantum sensing applications. Accurately pinpointing the NV center's location within the diamond lattice is crucial for successful sensing. Traditionally, researchers usually scan and determine the location of a single NV center by measuring Photoluminescence(PL) intensity and fitting the map with a gaussian function.
In this work, we present a method for enhancing spatial sensitivity on multiple NV centers by using electron spin resonance (ESR). We measure the optically detected magnetic resonance(ODMR) at the maximal PL intensity spot of the multiple single centers to determine the resonance frequencies of the single NV centers in four orientations. Then, we scan the multiple NV centers spatially and measure Rabi oscillation with different resonance frequencies as carrier frequencies in three-dimensional space. After fitting Rabi curves with the cosine function, we get Rabi amplitudes. We build up a 3D map as the amplitude function of the space. Finally, we demonstrate the effectiveness of our method by comparing the amplitude map and the PL map.
Our results show a clear improvement in locating NV centers in different orientations, allowing us to accurately enhance the spatial resolution of the NV center in multiple NV centers. This work represents an important step towards the development of NV center-based quantum sensors with improved precision and sensitivity. By accurately determining the location of the NV center in each orientation, we can optimize NV center performance for a wide range of sensing applications.

References

[1] J. R. Maze, et al, Nature 455.7213 (2008): 644-647
[2] P. Maletinsky, et al, Nature Nanotechnology 7.5 (2012): 320-324

Figures

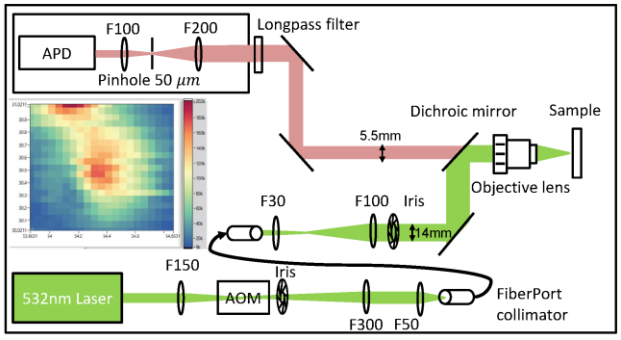

Figure 1: Schematic of the confocal microscope for initializing and detecting single NV centers. The inset shows an image of the single NV center we used in the experiment.

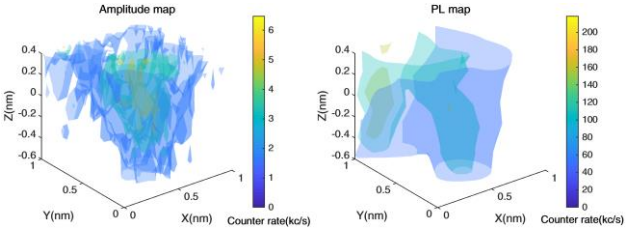

Figure 2: The amplitude and PL map with the 2792.4 MHz carrier frequency. The spatial range along x, y, and z axis are 1 mm. The increments along x, y, and z axis are 0.05, 0.05, 0.2mm.