Sub-diffraction resolution imaging of local light-matter interaction

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Light-matter interaction at nanoscale has been widely studied in the researches of nanophotonics and nanoelectronics. Various metallic and semiconductor nanostructures have been designed to modify the local electromagnetic field, and subsequently control the local light-matter interaction. Detecting the local electromagnetic field with high resolution and high fidelity is then necessary for the theoretical and experimental researches [1]. The near field scanning probe microscopy has been used for the electromagnetic field detection. However, the moving of probe usually perturbs the local electromagnetic field.

In this work, we demonstrated a noninvasive sub-diffraction electromagnetic field imaging by combining an optical far-field super-resolution microscopy with near-field electromagnetic field detection. Arrays of high density nitrogen vacancy (NV) centers in diamond were used as probes to detect the local electromagnetic field. A low power charge state depletion (CSD) super-resolution microscopy was used to collect the fluorescence signal of NV center. In the experiments, silver nanowires with diameter of 120 nm were deposited on the diamond plate. The electromagnetic field around silver nanowires was detected with spatial resolution of 50 nm. Subsequently, the optical and electrical properties, such as the local density of optical states and electrical conduction, of silver nanowires were obtained. Due to the improving of spatial resolution, our results showed that the fidelity of sensing was also improved. Using a diamond plate as the cover glass, we expect a quantum microscope can be developed for multifunctional sensing with sub-diffraction resolution.

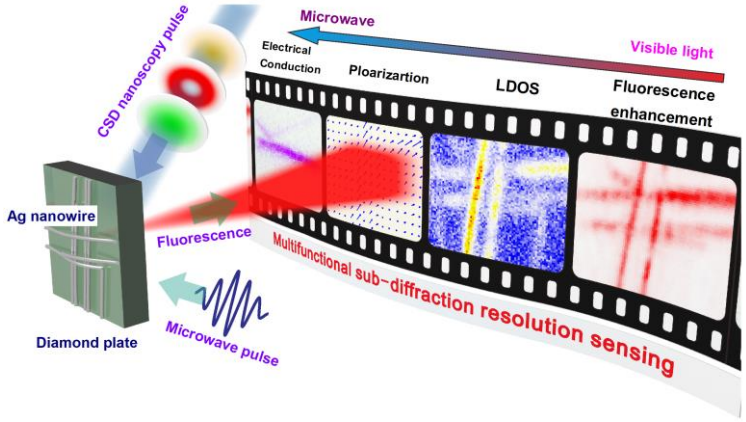

Figure 1, Schematic of the experiments. Nano-structures were deposited on a diamond plate that was embedded with near-surface NV center arrays. CSD microscopy laser pulses were applied for NV center super-resolution initialization and detection. Microwave pulses were applied for NV center spin manipulation.

Reference:

[1] N. Rotenberg and L. Kuipers, Nature Photon. 8, 919-926 (2014);