The Nitrogen-Vacancy Centers In Nanodiamonds: Super-Resolution Imaging And Quantum Sensing

Yan-Kai Tzeng; Pei-Chang Tsai; Hsiang Hsu; Ming-Shien Chang*; Huan-Cheng Chang*

Institute of Atomic and Molecular Sciences, Academia Sinica, Taipei 106, Taiwan

msc@gate.sinica.edu.tw ; hchang@gate.sinica.edu.tw

The negatively charged nitrogen-vacancy (NV^-) defect center in diamond is one of the most widely studied defects in the solid state. The center is a point defect with several unique photophysical properties, including being magneto-optical, exceptionally photostable (without either photobleaching or blinking), and relatively simple in electronic structure. Much of the studies in the past have been focused on their quantum information and computation applications at room temperature. Our group, on the other hand, has been interested in the characterization and use of these color centers in nanoscale diamonds (NDs) for super-resolution bioimaging and quantum sensing. Starting with bombarding type-Ib ND powders with 40-keV He^+ ions, followed by thermal annealing and air oxidation at high temperatures, we have been able to produce routinely fluorescent NDs (FNDs) containing a high-density ensemble (up to 10 ppm) of NV^- centers in our laboratories. FNDs with sizes between 20 nm and 100 nm have been fabricated. They are useful as photostable contrast agents for super-resolution imaging by stimulated emission depletion (STED) microscopy and quantum sensors for nanoscale thermometry with optically detected magnetic resonance (ODMR) at the single particle level. We present in this talk our recent efforts in producing brighter and smaller FNDs using nitrogen-rich type Ib diamond powders as well as the development and application of these advanced technologies.