Researchers realize nanoscale electrometry based on magnetic-field-resistant spin sensors

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A team led by Prof. Du Jiangfeng, Prof. Shi Fazhan, and Prof. Wang Ya from University of Science and Technology of China, of the Chinese Academy of Sciences, proposed a robust electrometric method utilizing a continuous dynamic decoupling technique, where the continuous driving fields provide a magnetic-field-resistant dressed frame. The study was published in *Physical Review Letters* on June 19.

Characterization of electrical properties and comprehension of the dynamics in nanoscale become significant in the development of modern electronic devices, such as semi-conductor transistors and quantum chips, especially when the feature size has shrunk to several nanometers.

The nitrogen-vacancy (NV) center in diamond—an atomic-scale spin sensor—has shown to be an attractive electrometer. Electrometry using the NV center would improve various sensing and imaging applications. However, its natural susceptibility to the magnetic field hinders effective detection of the electric field.

The NV center is a defect in diamond, which consists of a substitutional nitrogen and an adjacent vacancy. The NV center benefits from such properties as its convenient state polarization and long coherence time due to the spin-purity environment.

In this study, the researchers used a Ramsey-like sequence to measure the electric field. Also, they measured the dephasing of the near-surface NV centers (8 nm deep from the diamond surface) to evaluate the surface electric noise.

They demonstrated a robust method for nanoscale electrometry based on spin sensors in diamond. Comparing to the electrometry by applying a nonaxial magnet field, their method has the same susceptibility to the electric field, and more robust to the magnetic noise. Therefore, a higher electric-field sensitivity is achievable.

Their electrometry is more applicable in the presence of strong magnetic field inhomogeneity or fluctuation, which is favorable for practical applications using near-surface NV centers—for example: the characterization of multiferroic materials.

They also use this method to study the noise environment of near-surface NV centers. By excluding the magnetic noise, they observed a quantitative relation between the dephasing rate of NV centers and the relative dielectric permittivity of surface covered liquids.

This study helps further understanding of the noise environment of near-surface NV centers, which is essential for a wide range of sensing applications and offers interesting avenues for nanoscale dielectric sensing.

More information: Rui Li et al, Nanoscale Electrometry Based on a Magnetic-Field-Resistant Spin Sensor, *Physical Review Letters* (2020). DOI: 10.1103/PhysRevLett.124.247701

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