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Nitrogen-vacancy centers in nanodiamonds as temperature sensors and immunoassay reporters

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Abstract

The negatively charged nitrogen-vacancy (NV−) center in fluorescent nanodiamonds (FNDs) is a point defect with unique magneto-optical properties. It has found wide applications in frontier areas of science and many new innovations are emerging. Here, we present two new applications of this quantum sensor: (1) FNDs embedded in polymer films as temperature sensing devices and (2) FNDs conjugated with antibodies as immunodiagnostic reagents. In the first task, we closely examined the temperature dependence of the peak positions and heights of the zero phonon line of NV− centers in poly(2-hydroxyethyl methacrylate) films from 35 to 120 °C. A measurement sensitivity of better than 0.5 K Hz−1/2 was achieved over this temperature range. In the second task, we magnetically modulated the fluorescence intensities of NV− centers in FNDs. We achieved selective detection of 100 nm FNDs on a highly fluorescent nitrocellulose membrane at a particle density of 0.04 ng/mm2 (or ~2 × 104 particles/mm2). The utility and versatility of these techniques were demonstrated with a study for the energy transfer kinetics of a resistively heated gold microwire embedded in the films as well as an application to background-free detection of FNDs as reporters for lateral flow immunoassays.