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Time-Resolved Luminescence Nanothermometry with Nitrogen-Vacancy Centers in Nanodiamonds PEI-CHANG TSAI, OLIVER Y. CHEN, YAN-KAI TZENG, HSIOU-YUAN LIU, HSIANG HSU, SHAIO-CHIH HUANG, JESON CHEN, Academia Sinica, Institue of Atomic and Molecular Science, FU-GHOUL YEE, Department of Physics, National Taiwan University, Taipei 106, Taiwan, HUAN-CHENG CHANG, MING-SHIEN CHANG, Academia Sinica, Institue of Atomic and Molecular Science — Measuring thermal properties with nanoscale spatial resolution either at or far from equilibrium is gaining importance in many scientific and engineering applications. Although negatively charged nitrogen-vacancy (NV^-) centers in diamond have recently emerged as promising nanometric temperature sensors, most previous measurements were performed under steady state conditions. Here we employ a three-point sampling method which not only enables real-time detection of temperature changes over 100 K with a sensitivity of 2 K/$(Hz)^{1/2}$, but also allows the study of nanometer scale heat transfer with a temporal resolution of better than 1 μs with the use of a pump-probe-type experiment. In addition to temperature sensing, we further show that nanodiamonds conjugated with gold nanorods, as optically-activated dual-functional nanoheaters and nanothermometers, are useful for highly localized hyperthermia treatment. We experimentally demonstrated time-resolved fluorescence nanothermometry, and the validity of the measurements was verified with finite-element numerical simulations. The approaches provided here will be useful for probing dynamical thermal properties on nanodevices in operation.

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