



ANNOUNCEMENT - TALK

Title: Nanothermometry at the molecular level in nanoprinted crystals

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Abstract

Understanding heat propagation at the nanoscale is crucial for developing better thermalization techniques for modern nano-electronic and low-dimensional devices. The ultimate system would be the combination of a point-like thermometer with a well-defined point-like heat source. Realizing such a platform, however, is challenging because of the low heating power of a nanoscale point-like source. As a result, the associated temperature changes are weak and highly localized, requiring a sensor with both high temperature sensitivity and high spatial resolution. In this talk, I present a novel all-optical temperature sensor based on an atomic-scale defect, often termed as a two-level system (TLS), that is capable of resolving sub-millikelvin temperature changes with ~ 10 nm spatial resolution at cryogenic temperatures of about 2K.

The thermometer resides in a printed micron-sized molecular crystal, that is doped with 100's of dye molecules, which are individually optically addressed and precisely localized [1,2]. Dispersive coupling between a TLS and a nearby dye molecule imprints the TLS state into intensity of the molecule's fluorescence. This readout allows us to characterize the rate of TLS fluctuations, from which we extract its temperature. We then use other fluorescent molecules located 100–800 nm from the TLS as picowatt-scale point heat sources. The distance dependence of heating efficiency reveals a phonon transport regime that lies between the limits expected for purely diffusive and ballistic transport [3]. Finally, I discuss an alternative single-molecule-based thermal sensing scheme that provides access to transient thermal dynamics with a temporal resolution reaching nanoseconds [4].

[1] C. Toninelli, *et al. Nat. Mater.* **20**, 1615 (2021)

[3] M. Musavinezhad, *et al. In prep*

[2] M. Musavinezhad, *et al. ACS Nano* **18**, 21886 (2024) [4] M. Musavinezhad, *et al. In prep*

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Location: **MPSD 900.EG.136**
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