Environmental electrometry with luminescent carbon nanotubes

Jonathan C. Noé[1], Manuel Nutz[1], Jonathan Reschauer[1], Nicolas Morell[2], Ioannis Tsioutsios[2], Antoine Reserbat-Plantey[2], Kenji Watanabe[3], Takashi Taniguchi[3], Adrian Bachtold[2], and Alexander Högele[1]

[1] *Fakultät für Physik, Munich Quantum Center, and Center for NanoScience (CeNS), Ludwig-Maximilians-Universität, Geschwister-Scholl-Platz 1, 80539 München, Germany*
[2]*ICFO-Institute de Ciencies Fotoniques, The Barcelona Institute of Science and Technology, 08860 Castelldefels Barcelona, Spain*
[3]*National Institute for Materials Science, Tsukuba, Ibaraki 305-0044, Japan*

We demonstrate that localized excitons in luminescent carbon nanotubes can be utilized to study electrostatic fluctuations in the nanotube environment with sensitivity down to the elementary charge. By monitoring the temporal evolution of the cryogenic photoluminescence from individual carbon nanotubes grown on silicon oxide and hexagonal boron nitride we characterize the dynamics of charge trap defects for both dielectric supports. We find a one order of magnitude reduction in the photoluminescence spectral wandering for nanotubes on extended atomically flat terraces of hexagonal boron nitride. For nanotubes on hexagonal boron nitride with pronounced spectral fluctuations our analysis suggest proximity to terrace ridges where charge fluctuators agglomerate to exhibit spatial densities exceeding those of silicon oxide. Our results establish carbon nanotubes as sensitive probes of environmental charge fluctuations and highlight their potential for applications in electrometric nanodevices with all-optical readout.