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Modifiable spin-coated hydrogel platform for the delineation of analyte interactions on individual single-walled carbon nanotubes

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Single-walled carbon nanotubes (SWCNTs) have been used in a variety of sensing and imaging applications recently due to their unique optical properties. In the solution-phase, SWCNTs are employed as near-infrared (NIR) fluorescence-based sensors of target analytes via modulations in emission intensity and/or wavelength. In an effort to lower the limit of detection, research has been conducted into isolating SWCNTs adhered to surfaces for potential single molecule analyte detection. However, it is known that SWCNT fluorescence is adversely affected by the inherently rough surfaces that are conventionally used for their observation, such as glass coverslips. Here, using a spin coating method with thin films of hydrogel and SWCNTs, we demonstrate that a novel hydrogel platform can be created to investigate immobilized individual SWCNTs without significantly perturbing their optical properties as compared to solution-phase values. In contrast to the glass coverslip, which red-shifted DNA-functionalized (6,5)-SWCNTs by an average of 3.4 nm, the hydrogel platform reported emission wavelengths that statistically matched the solution-phase values. We also show by adding a common surfactant, sodium dodecyl sulfate (SDC) to our platform, diffusion can be controlled to observe fluorescence modulations on individual SWCNTs over time. As the surfactant replaces the DNA on the SWCNT surface, the DNA binding stability can be determined, revealing critical information for the fabrication of stable and biocompatible DNA-SWCNT biosensors. Finally, we show that upon the addition of a model analyte (calcium chloride), the optical response can be spatially resolved along the length of a single SWCNT, enabling localized analyte detection on the surface of a single nanoscale sensor. Thus, this platform can be modified to sensitively detect a wide range of biologically relevant analytes.