Nanobioptics: Engineering Optical Biosensors Based on Single-walled Carbon Nanotube (SWCNT) Fluorescence

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The last decade has realized an onset of novel optical, SWCNT-based sensors that have been crucial in shaping a distinct generation of unconventional analytical tools. These optical nanosensors exploit the advantageous fluorescence properties of semiconducting SWCNTs, which benefit from stable and sensitive near-infrared emissions capable of deep-tissue sensing and imaging applications. SWCNTs are non-covalently wrapped in a variety of chemical moeities, including DNA, polymers, and proteins, that impart the SWCNT with selectivity towards specific analytes of interest. Recent research endeavors have largely focused on designing wrappings that control the sensor's selectivity by modulating the surface coverage of the nanotube in the presence of an analyte. In addition to selectivity, these wrappings also modulate fluorescence properties such as emission intensity; properties that play an integral role in determining the sensitivity limits of these sensors. We have developed a model that explores the perturbations of SWCNT fluorescence emissions in the presence of a wrapping. By de-coupling the structural and chemical contributions of the polymer wrapping and challenging underlying assumptions of uni-dimensional contributions, this model enables a comparative approach towards achieving design rules for the rational engineering of sensor wrappings.