Shrinking sensors to the nanoscale introduces novel selectivity mechanisms and enables the ultimate sensitivity limit, single-molecule detection. Single-walled carbon nanotubes, with a bright fluorescence signal and no photobleaching, are a platform for implantable near-IR sensors capable of selectively detecting a range of small-molecules including the radical signaling molecule nitric oxide, the hormone estradiol, and sugars such as glucose. Selectivity is achieved by engineering an adsorbed phase of polymers, DNA, or surfactants at the nanotube/solution interface. Understanding these sensors requires a range of modeling and simulation tools and presents a unique opportunity to learn how these phases interact with small molecules. I will discuss methods and limits to integrating data from many noisy stochastic sensors, show how we can use these sensors to monitor nitric oxide inside cells with unprecedented spatiotemporal resolution, and describe what is needed to engineer a selective adsorbed phase.