574b Understanding the Dynamics of Signal Transduction for Adsorption of Gases and Vapors on Carbon Nanotube Sensors

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Adsorption dynamics and their influence on signal transduction for carbon nanotube- based chemical sensors are explored using continuum site balance equations and a mass action model. These sensors are shown to possess both reversible and irreversible binding sites that can be modeled independently. For the case of irreversible adsorption, it is shown that the characteristic response time scales inversely with analyte concentration. It is inappropriate to report a detection limit for this type of sensor, since any non-zero analyte concentration can be detected in theory, but at a cost of increasing transduction time with decreasing concentration. The response curve should examine the initial rate of signal change as a function of analyte concentration. Conversely, a reversible sensor has a predefined detection limit, independent of the detector geometry with a characteristic time scaling that becomes constant in the zero analyte concentration limit. A simple analytical test is presented to distinguish between these two mechanisms from the transient response of a nanotube sensor array. Two systems appearing in the literature are shown to have an irreversible component, and regressed surface rate constants for this component are similar across different sensor geometries and analytes.