

Abstract

Deoxyribonucleic acid (DNA) functionalized carbon nanotube (DFC), with its fascinating chemical properties have emerged as an exciting platform for sensing technology. The nucleobases of the DNA are non-covalently immobilized on the nanotube surface by van der Waals force driven π - π stacking interactions. In this work, we determine the orientations of various coexisting nucleobases on nanotube surface, based on the enhanced and suppressed hypochromism of the respective dipole moments of the nucleobases. Fabrication of devices with solution processed DFC is realized using micro-cantilever based drop dispensing technique which possesses precise position and drop diameter control. This technique is most suitable for the development of solution processed bio-functionalized CNT based sensors as it does not require drying of the sensing material after drop casting.

The thesis establishes DFC network as a promising chemical sensing platform which works on the principle of variation in conductance of the network when exposed to a chemical analyte. Firstly, we develop DFC based humidity sensor having fast response and recovery times with insignificant baseline shift. The threshold voltage shift in the transfer characteristics plot is attributed to the charge transfer mechanism between the electron rich phosphate backbone of the ssDNA and water molecules. The work further utilizes DFC resistive network as a sensing platform to probe non-covalent bi-molecular interactions between L-Histidine (L-His) and the nucleobases. Interaction of L-His with nucleobases through non-covalent π - π stacking interactions change the electrostatic landscape of the DFC network, leading to distortions in the e-cloud of both nucleobases and the L-His molecules which causes e-scattering at the adsorbed sites, decreasing the conductance of the DFC network. Finally, a selective Hg (II) ion sensor is also developed using the chelation chemistry between the nucleobases and the Hg (II) ions. The nucleobases serve as natural multi-site ligands that possess strong affinities for Hg(II) ions producing more stable chelate complex with nucleobases than that with Cd(II) and Pb(II) ions and thus is utilized in the selective detection of Hg(II) ions by DFC resistive network.