228b Electrochemically Functionalized Single-Walled Carbon Nanotubes Based Gas Sensors

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Semiconducting single-walled carbon nanotube (SWNT) and conducting polymers nanowires are promising 1-D nanomaterials for chemical and biological sensor applications. With its unique electrical, thermal and mechanic properties, SWNT has shown promise for superior sensitivity compared to conventional bulk sensing materials in a transistor configuration for detection of NH_3 and NO_2. Conducting polymers such as polyaniline and polypyrrole, with their tunable electoral properties, high surface area and unique redox properties, have also made themselves very attractive in various sensing devices. Limitations, however, prevent both from replacing conventional sensors in practical applications: the presence of metallic and semiconducting SWNT mixture display less than ideal sensitivity due to the insensitivity of metallic SWNT to analytes, while conducting polymers suffer from low mechanical strength and thermal instability. Combining the two by functionalizing SWNT with appropriate conducting polymers creates a synergistic combination with improved mechanical stability, efficient electrical conduction and large surface/interface area for better sensitivity and broader selectivity.

In this study, we demonstrate a facile electrochemical method to functionalize SWNT with polyaniline (SWNT-PANI). This simple and efficient fabrication method enables targeted functionalization to allow for creation of high-density individually addressable nanosensor arrays. Nanosensors made by SWNT-PANI networked across interdigitated electrodes were tested for on-line monitoring of ammonia gas. The SWNT-PANI sensors exhibited improved sensitivity, detection limit, recovery time, and reproducibility over intrinsic SWNT sensors. SWNT-PANI based sensor displayed a relative electrical resistance change $\Delta R/R$ of 2.24% per ppm_v NH_3, a detection limit as low as 50 ppb_v, and excellent reproducibility when repeatedly exposed to 10ppm_v NH_3. Response time was on the order of minutes and recovery time from less than 1 hour to around 4 hours corresponding to various NH_3 concentrations. Compared to purified SWNT based sensor, the SWNT-PANI sensor exhibited several to tens times higher sensitivity upon exposure to NH_3. Recent results including sensor arrays as well as sensing of other gaseous compounds will be presented and discussed at the conference.