Breath-level detection of H_2S in humid air by selective carbon-nanotube sensor arrays

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The potential of exhaled breath analysis as a cost-effective and non-invasive approach for the precise identification of diseases has been intensively studied in the past years [1]. However, addressing the selective detection of specific molecules in highly complex media like human breath remains a great challenge. To tackle this problem, emerging gas sensing technologies are taking advantage of the special properties of nanostructured materials as a promising alternative to reach the selectivity and sensitivity needed for such application [2,3].

In this context, we present the selective detection of low parts per billion (ppb) concentrations of H_2S gas in humid air and at room temperature by a multichannel chemiresistive gas sensing platform based on semiconducting single-walled carbon nanotubes (sc-SWCNTs) functionalized with gold nanoparticles (AuNP). The multichannel device, consisting of 64 individual sensors (Figure 1a), was fabricated using standard UV-lithography and metal deposition techniques, and the sc-SWCNTs were deposited by a controlled dielectrophoretic process. The sensing area was then functionalized with gold nanoparticles by potentiostatic electrodeposition achieving an optimal average particle diameter of 60 nm and separation distances of around 100 nm along single tube agglomerations (Figure 1b). AuNP-functionalized sensors showed an increased sensitivity to all tested concentrations compared to non-functionalized tubes of 0.122 %/ppb and a calculated limit of detection (LOD) of 3 ppb (Figure 1c). Moreover, the sensors demonstrated low cross-sensitivity to relevant breath concentrations of NH_3 and NO, and higher sensitivity compared to commercial electrochemical-based gas sensors (AlphaSense, UK). These results suggest the potential application of our sensing platform in the field of exhaled breath analysis.

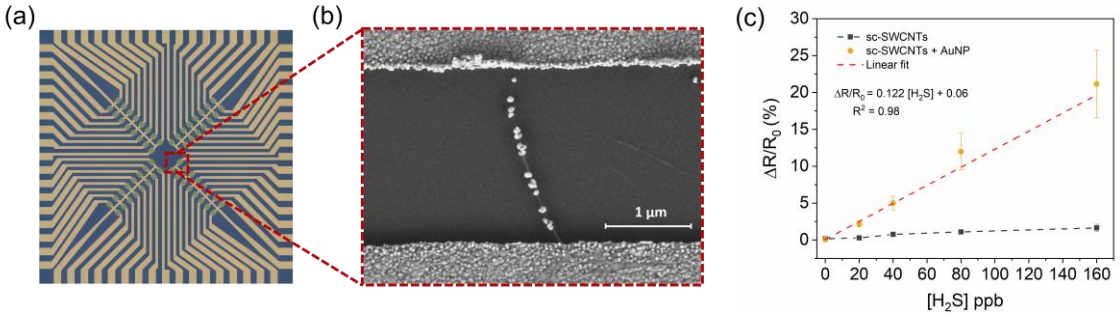

Figure 1. Multichannel gas sensing platform and exposure experiments to H_2S gas. (a) Optical image of the multichannel device comprising 64 individual sensors. (b) Scanning electron micrography of AuNP-functionalized sc-SWCNT. (c) Sensing response ($\Delta R/R_0$) of AuNP-functionalized and non-functionalized sensors to low ppb concentrations of H_2S.

References

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