Enhanced ppt-Level NO_2 Detection Using Hierarchical C-MoS_2 Nanobranches

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A continuous increase in atmospheric emissions of industrial hazardous gases highlights the critical importance of monitoring toxic gases such as NO_2 to safeguard public health. Furthermore, as the contamination problem caused by fine residual gases has been raised at semiconductor manufacturing sites, the demand for the development of ppt-level gas sensors has increased. This study explores novel approaches to enhance NO_2 sensing capabilities utilizing hierarchical C-MoS_2 nanobranches incorporating carbon for augmented reactivity. Using the metal-organic chemical vapor deposition (MOCVD), we synthesized large-scale, uniformly distributed C-MoS_2 nanobranches rich in adsorption edge sites. Through controlled carbon impurity incorporation during synthesis, we engineered a hierarchical structure conducive to heightened gas interaction. Our gas sensors, based on these tailored nanobranches, demonstrated exceptional sensitivity, detecting NO_2 concentrations as low as 5 ppb with a response factor of 1.67 (R_0/R_{gas}) at room temperature. Notably, the calculated limit of detection for NO_2 reached an impressive ~1.58 ppt, showcasing the remarkable performance of our sensor platform. This research not only advances the frontier of material engineering but also heralds a new era of ultra-sensitive NO_2 detection vital for environmental and industrial monitoring.

Figures

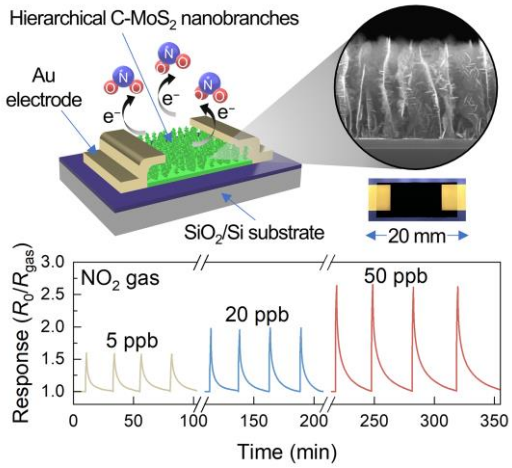

Figure 1: Schematic of C-MoS_2 nanobranches gas sensor and response curves of the gas sensor for NO_2 concentration of 5–50 ppb.

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