Ultrasensitive toxic gas detector

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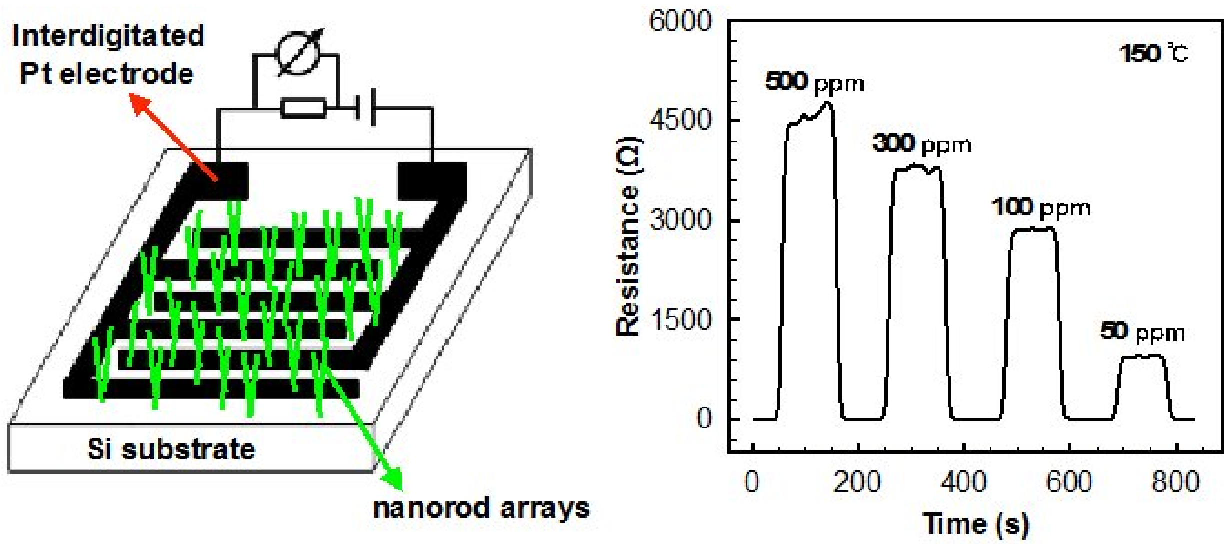

A schematic illustration of the gas sensor device based on the hybrid nanorod arrays. The real time resistance versus time of the vertically aligned WO_3-CuO core-shell nanorod arrays-based gas sensor to varied concentrations of NH_3 decreasing from 500 ppm to 50 ppm at 150 ?. The resistance of the WO_3-CuO hybrid increases upon exposure to NH_3, consistent with p-type semiconductor behavior. The response of the hybrid sample increasing with increasing NH_3 concentration at 150. The response and recovery times range from 10 to 15 s for all NH_3 concentrations. Credit: *Nano* (2018). DOI: 10.1142/S1793292018501229

In a paper published in *Nano*, researchers from the School of Microelectronics in Tianjin University have discovered a two-step sputtering and subsequent annealing treatment method to prepare vertically aligned WO_3-CuO core-shell nanorod arrays which can detect toxic NH_3 gas.

Over the years, WO_3 has received considerable attention among the numerous transition metal oxides as a wide band-gap n-type semiconductor in various gas detection, such as NO_x, H_2S, H_2, and NH_3. CuO has the unique property of being intrinsically p-type. In the last decade, p-n heterojunction sensors composed of an n-type metal oxide and CuO were reported to have a good sensitivity to reducing gases owing to the interface between n-metal oxide and CuO. Much effort has been focused on the WO_3-based nanocomposites, since the synergetic enhancement and heterojunction effects attributes to the enhanced gas sensing properties. However, gas sensors based on 1D WO_3-CuO composite structures are limited. Additionally, the template or catalyst was usually necessary to synthesize WO_3-based nanorod arrays, including using chemical vapor deposition, electrochemical anodization and hydrothermal approaches.

Among toxic gases causing adverse impact on living organisms, NH_3 is one of the most hazardous substances. It is necessary to build up ultrasensitive NH_3 gas sensors with short response and recovery time. Metal oxides have been widely used in gas sensor applications. In order to obtain great sensing performances of metal oxide sensors, 1D metal oxide nanostructures and 1D heterojunction composite nanostructures have been investigated due to their large surface area, size-dependent properties, and the nano-heterojunction effects. Vertically aligned ordered 1D arrays effectively avoid the dense stacking of rod monomers, especially, resulting in novel physicochemical characteristics, such as higher gas response and shorter gas recovery.

Here, vertically aligned WO_3-CuO core-shell nanorod arrays are synthesized using a non-catalytic two-step annealing process of sputtered metal film on silicon wafer. The growth mechanism of the vertically aligned nanorod arrays are discussed. The NH_3 sensing behaviors of the WO_3-CuO core-shell arrays at different temperatures are reported. A possible NH_3 sensing mechanism for the hybrid is proposed.

More information: Wenjun Yan et al, Vertically Aligned WO_3–CuO Core–Shell Nanorod Arrays for Ultrasensitive NH_3 Detection, *Nano* (2018). DOI: 10.1142/S1793292018501229

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