FET gas sensor with carbon nanotube film channel and MOS gate

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Carbon nanotubes (CNTs) are considered to be ideal channel materials for building high-performance field effect transistor (FET) and integrated circuits, due to the high mobility, few intrinsic defects, and excellent electrical and thermal stability [1]. Our group has reported that a sensor based on floating gate FET with CNTs network films as channel, which shows a high sensitivity to H_2, and the lower limit (LOD) could be as low as ppb level [2]. In the present work, the sensitization of floating gates was achieved by nanosized MOS materials to enhance the gas-sensing characteristics, and the selective response of MOS was significantly modulated with the help of the back-gate voltage. A conventional micromanufacturing process is adopted to prepare gas-sensitive floating gate with typical MOS materials, such as WO_3, SnO_2, ZnO, and CuO. FET gas sensors were constructed with network CNTs films as channel. It was found that the sensors have a high sensitivity, and the preparation of floating gate with different MOS films can be realized for the detection of different gases. In addition, the selective responses could be effectively alterled by the back gate in addition with operation temperature modulation. Based on the photolithography process, MOS floating gate films can be prepared by mental evaporation, sputtering, screen-printing, and microdroplet. A batch fabrication of sensor device in wafer-level (4-inch) was achieved and the consistency of sensors devices were significantly improved. This study gives full play to the unique advantages of CNTs and FET devices, and provides a new platform for further promoting the application of MOS materials in gas sensors and enriching the study of sensitive response mechanism.

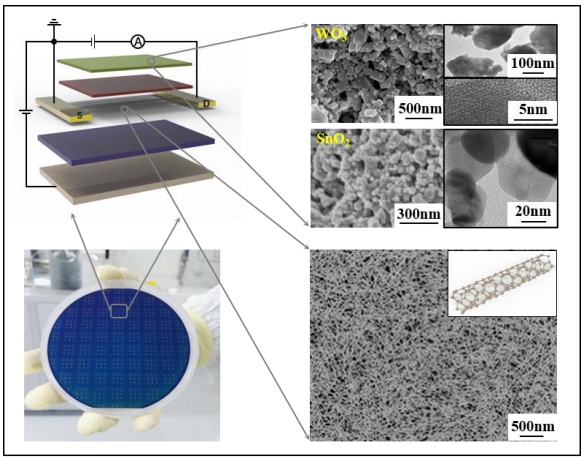

Fig. 1. Schematic drawing of sensor structure and sensor read-out of FET gas sensor with CNTs channel and MOS floating gate.

[1] L.M. Peng, Z.Y. Zhang, S. Wang, Mater. Today 17, 433−442 (2014)
[2] M.M. Xiao, S.B. Liang, J. Han, D.L. Zhong, J.X. Liu, Z.Y. Zhang, L.M. Peng, ACS Sens. 3, 749−756 (2018)