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Editorial

Chemical Sensors for Volatile Organic Compound Detection

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The detection of volatile organic compounds (VOCs) is in high demand in various fields, such as environmental pollution monitoring, early disease screening, and food freshness assessment [1–3]. A variety of methods, including spectroscopic analysis [4], mass spectrometry [5], chromatographic analysis [6], electrochemical gas sensors [7], infrared gas sensors [8,9], and semiconductor gas sensors [10–12], have been extensively used for VOC detection. This is especially the case for semiconductor sensors thanks to their high sensitivity, fast response time, and cost-effectiveness [13–15].

Under the unremitting efforts of researchers, the research of semiconductor gas sensors has made a major breakthrough. There have been advanced research results with high sensitivity [16–19], a low minimum detection limit [20–23], room temperature sensing [24–27], and other advanced properties. Li et al. prepared s-Nb_2O_5 @ SnO_2 composite, and its response to 500 ppb acetone at 250 °C was 37 [28]. Xiao et al. prepared TiO_2 NCs-implanted $LaFeO_3$ nanomaterials, and its response to 100 ppm formaldehyde was 221.8 [29]. Hu et al. prepared Au-functionalized MoO3 nanoribbons, which realized the detection of formaldehyde at room temperature [30]. Compared with toluene, ethanol, methanol, and acetone, the sensitivity to formaldehyde is one to two orders of magnitude higher. Li et al. realized the identification of VOC gas at room temperature by using an ultraviolet light regulation method [31].

However, there are still problems to be solved from the perspective of large-scale commercial applications. Firstly, the low temperature response speed of the sensor needs to be improved. Sensors can detect the target gas at room temperature, thus reducing the explosion risk and power consumption. However, their response to the target gas is relatively slow, and the response curve cannot completely recover to the response baseline or is slow after the response. Secondly, the selectivity of semiconductor sensors has not been fundamentally improved. The sensitivity difference between target gas and non-target gas is increased by adjusting the material structure. Thirdly, the practical application ability of the sensor needs further verification. Most research papers only focus on the laboratory stage, and the related gas sensing performance research needs to be carried out with the help of high-purity air and high-precision instruments.

In view of the above difficulties, this Special Issue presents a comprehensive and detailed exploration of the latest achievements in VOC detection based on chemical sensors. Modifying sensitive materials is a practical approach to enhance the gas-sensing performance of semiconductor metal oxide sensors. Li et al. synthesized nickel-doped ZnO-sensitive materials with core–shell structures, doped at ratios of 0.5%, 1%, and 2%, which achieved the rapid detection of toluene [32]. Based on a doping ratio of 1%, the sensors exhibited a response of up to 210 for 100 ppm toluene, with a detection limit as low as 0.5 ppm. Research indicates a significant enhancement in sensor performance through the combined action of a narrower bandgap, higher specific surface area, and ion catalysis. San et al. designed a series of three-dimensional rGO-functionalized flower-shaped In_2O_3 structures, enabling the low-temperature and rapid detection of acetone. The working temperature of 150 °C and a fast response time of 3 s can be attributed to the introduction of an appropriate amount of graphene [33]. Scholars have tried to achieve breakthroughs in detection methods, data analysis, and sensor system design, aiming to further enhance the capability of detecting VOCs in real-world application scenarios. In terms of detection methods, Wang et al. synthesized Pt/$Ti_3C_2T_x$-CNT and employed cataluminescence technology to achieve the non-invasive and rapid detection of the lung cancer biomarker toluene at lower operating temperatures [34]. Regarding the construction of physical systems, Shen et al. developed a wireless luminescent sensor system with excellent luminescent characteristics, featuring high visible light intensity and a high signal-to-noise ratio [35]. Zhang et al. completed a comprehensive review of the detection of triethylamine using chemical sensors [36]. This paper commences with the fundamental characteristics of sensors and typical sensing mechanisms, providing a comprehensive summary of the latest advancements in enhancing the sensing performance of triethylamine sensors from various perspectives. It serves as a detailed entry point for readers interested in exploring VOC detection.

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