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Comprehensive advances in gas sensing: Mechanisms, material innovations, and applications in environmental and health monitoring

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ABSTRACT

A novel strategy is required to address global concerns such as indoor air quality (IAQ) monitoring, outdoor pollution, battery monitoring, medical diagnosis, and industrial safety. Metal oxide semiconductor-based gas sensors are evolving by overcoming the associated challenges such as high operating temperature, poor selectivity, poor temporal, and chemical stability with the synergistic effect of Metal Organic Frameworks (MOFs). MOFs are ultra-high porous materials with appropriate morphology that help to improve the cross-sensitivity of the target analyte by tailoring the pore size and their ultra-high surface area. Noble metals with their catalytic effect create additional active sites by creating more oxygen vacancies on the surface. In this review, authors introduce novel high-performance gas sensor design and elaborate all possible sensing mechanisms for various structures including different factor dependence such as receptor factor, transducer factor, and utility factor. The effect of gas deployment methodology and preconcentrator choice on gas sensing measurement are demonstrated. The nature of signal processing and interfacing in smart sensor electronics is elucidated, highlighting their roles in analog-to-digital conversion, noise reduction, data transmission, and system integration for enhanced sensing accuracy and functionality. Ultrafast ultraviolet (UV) sensors and their sensing mechanisms are thoroughly elaborated, emphasizing their rapid response and high sensitivity. In nutshell, authors give a detailed insight to the gas sensing mechanism, technological development, and attempt to find an answer for the existing problems in the field of gas sensing by exploiting some new aiding tools.

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