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Gas Sensors Based on Semiconducting Metal Oxides: Fundamentals and Applications

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Abstract

Chemoresistive gas sensors based on semiconducting metal oxides (SMOX) are cost-efficient, small-sized and easy to integrate devices, which enable the detection and, sometimes, the quantification of the concentration of various reducing or oxidizing gases and vapors present in the ambient atmosphere. Because of their advantages they are in the focus of fundamental and applied research since almost 70 years with SnO_2, WO_3, In_2O_3 and ZnO being the most widely studied and used in science and industry. Their applications are ranging from safety in households and industrial process control over in-cabin air quality to medical ones. Their fabrication technology evolved from individual devices built as ceramic pellets, which needed approx. 5W to reach their operation temperature, to the current state of the art miniaturized four-sensors-array with integrated driving and evaluation electronics, whose power consumption is only 20 mW and can be integrated even in mobile phones. The understanding of their sensing mechanism was initially based on ex-situ and surface science methods, thus leaving large gaps between investigation and application conditions and materials and, as a consequence, produced little useful information for the developers, who relied mostly on empirical optimization of their devices. With increasing availability of in-situ and operando investigation methods it became possible to bring fundamental understanding and sensor development together. Some examples of significant advances with practical applications in the improvement of gas sensor performances are: the understanding of the water vapor interference in gas sensing; the elucidation of the impact of conduction mechanism on the performance of *n* and p-type SMOX; the understanding of the chemical and electronic impact of noble metal additives on gas sensing performance. The talk will review the evolution of gas sensor technology and understanding of sensing with SMOX materials and will also present some of the most important current applications and most promising future ones.

Semiconducting Metal Oxides; Gas sensors; Sensing Mechanism; Operando Investigations.