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Editorial

Emerging Chemical Sensing Technologies: Recent Advances and Future Trends

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Contemporary chemical sensing research is rapidly growing, leading to the development of new technologies for applications in almost all areas, including environmental monitoring, disease diagnostics and food quality control, among others [1–3]. These relevant scientific and technological developments are intrinsically related to the emergence of new materials, synthesis methods, device manufacturing processes, and advanced characterization techniques for different chemical sensors [4–6].

The constant search for greener, more reliable, and cheaper syntheses methods has led to the progress on the development of smart materials for chemical sensors [7,8]. Thus, enhanced electrical, electromagnetic, electrochemical, optical or bio-activity properties have been discovered in nanostructured semiconductor metal oxides, polymers, carbon, biological materials, 2D nanomaterials, which, consequently, have enabled improving the sensing performance [9–12]. For instance, the development of hybrid organic and/or inorganic nanostructures has emerged as an effective and promising approach for the development of a new generation of biosensing devices [13,14]. Moreover, manufacturing processes, such as nanolithography or nanomanufacturing, have provided efficient tools for the development of nano-active sensing layers and, consequently, to the miniaturization of such devices [15–17]. Thus, the development of research furthering understanding of the relationship between optimized synthesis conditions and the enhanced properties of the material combined with new manufacturing processes are necessary and highly recommended for the development of a new generation of high-performance chemical sensors.

In addition, the emerging of in situ and/or operando characterization techniques, which contribute to monitoring of the interaction and the transduction mechanisms under real-time operating conditions, have allowed deeper insights into the chemical sensing phenomenology, contributing to more exact descriptions and understanding of the sensing mechanisms [18,19]. For instance, the use of analytical techniques, such as Raman spectroscopy, DRIFT spectroscopy, ultraviolet–visible (UV–Vis) absorption spectroscopy, X-ray absorption near-edge structure (XANES), among others, concomitantly with electrical measurements, has been used to investigate the adsorption/desorption surface kinetics on gas sensing applications [20]. This kind of approach in chemical sensing studies is very important and required because it leads to real-time monitoring of the sensing activity, providing deeper information on the dynamic sensing processes. In addition, theoretical and computational simulations have gaining great importance in sensing applications because they can help to predict material's capability to exhibit an enhanced sensing behavior, rationalizing time and costs on the development of new sensor devices, as well as to support innovative experimental sensing studies [21,22].

As a future trend, sensors are expected to be the top five most in-demand components as the world is entering in an age of devices exchanging information on the internet, the Internet of Things (IoT), which will enable the collection of sensing data and act to propose solutions in most human life situations. [23,24]. In addition, the sensor networks generate a huge amount of data; therefore, the uses of Big Data and machine learning in the chemical sensing field are strongly increasing, aiming to predict diseases and achieve real-time environmental monitoring, food quality control, etc. [1,25–27]. Moreover, Big Data and machine learning technologies have been used in the development of new chemical-sensing-related technologies, which includes the synthesis prediction of new organic and inorganic materials, compound identification, the modeling of biosensing activity, manufacturing, etc. [28–30]. Thus, the combination of different chemical sensors with Big Data and machine learning tools will have an enormous impact on human life and the economy in the coming decades.

We hope that this Editorial and the published manuscripts in this Special Issue will stimulate the interest of readers towards the recent advances and future trends and perspectives of such a strategical and interdisciplinary field.

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