Guest editorial

This Special Issue is devoted to gas sensing. Gas sensors play a vital role in a multitude of industries where they prevent fires and explosions, protect humans from toxic compounds, monitor and control all manner of industrial processes and protect the atmospheric environment. A global research effort seeks to develop new and innovative gas sensors. Of over 30 papers submitted for consideration in this Special Issue, 11 have been selected to provide a technologically varied insight into this matter. They include both reviews and original research. The first paper aims to show how a number of new and emerging applications are driving innovations in gas sensor technology.

Since the discovery of carbon nanotubes (CNTs) in 1991, these and other nanomaterials have attracted huge interest from the gas sensing community and are the topic of five papers which illustrate the many different ways in which they can be used. The first provides a review of some of the more important classes of gas sensors based on CNTs that have been developed since 2003, and the second shows how these materials can be used as an adsorbent to concentrate trace environmental samples by a factor of 15 in a miniaturised, MEMS-based gas chromatograph. In the third paper, the authors report a sensitive nitrogen dioxide sensor based on the two-dimensional material graphene and show how the recovery time can be greatly improved through the use of optical illumination and heating, thus greatly enhancing its potential utility. The use of low-cost nanoparticulate metal-oxide sensors to detect ethylene, a gas associated with fruit ripening, is described in the fourth paper, and in the fifth the authors report the development of an array of polypyrrole/metal oxide-based nanocomposite fibre sensors and show how this can be used to analyse a range of volatile organic compounds (VOCs) associated with foods. This is an example of an electronic nose (EN) and an intriguing review paper by one of the pioneers of EN technology provides details of how hybrid bioelectronic systems incorporating biological odour recognition elements from the olfactory pathways of vertebrates and insects are being used to construct "bionic noses".

Optical techniques play a major role in gas detection practices, and two papers in this issue describe innovative optical gas sensor developments. In one, it is shown that the use of wavelength modulation spectroscopy applied to the light emitted by a diode laser can be used to detect accurately the concentration of water vapour at differing pressures. This is particularly important in the context of preventing corrosion in electrical power equipment. In the second paper, the authors describe an innovative hydrogen sensor based on optical fibres and a membrane of a palladium/silver alloy on a glass substrate. Hydrogen is a difficult gas to detect selectively at low concentrations, and measurement of its concentration will become increasingly important with the growing use of fuel cells.

It is very gratifying to publish two papers which address real-world problems by combining existing types of sensors with innovative engineering design. Both are also based on optical sensing techniques and have the potential to save lives. In the first, a multi-channel sampling system is described which can detect methane leakage from underground gas pipelines using an NDIR sensor. This is an absolutely critical function, as gas explosions have led to several hundred fatalities in recent years. In the second paper, the authors describe a lightweight instrument package which was deployed on a small UAV and tethered balloons to analyse and study the vertical structure of aerosol (particulate) pollution using a laser technique, while making simultaneous measurements of temperature, relative humidity and atmospheric pressure. Air pollution is believed to cause over one million excess fatalities per year in China, and understanding the structure and formation of particulate pollution will ultimately help to alleviate this problem.

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