D40 An Array of ZnO and SnO_2 Heterojunction Semiconducting Metal Oxide Gas Sensors Used as a Tool for Explosive Detection

Lauren Horsfall, MRes, UCL, 35 Tavistock Square, London, UNITED KINGDOM; Christopher S. Blackman, PhD, UCL, Chemistry Department, 20 Gordon Street, London WC1H 0AJ, UNITED KINGDOM; and Ivan P. Parkin, PhD, UCL, 20 Gordon Street, London WC1H 0AJ, UNITED KINGDOM*

After attending this presentation, attendees will recognize the current technological difficulties involved regarding explosives detection, the importance of explosive gas sensing for threat detection, and the new possible technologies for sensing explosive gases.

This presentation will impact the forensic science community by demonstrating the threat to national and global security posed by terrorists' use of explosives and the efforts to develop new methods of disaster prevention through the detection of explosive gases.

Terrorists frequently use explosives and represent an imminent threat to national and global security. Recent events highlight the necessity of explosive detection, demonstrating the need for developing and applying new sensors for explosive gas detection. Currently sniffer dogs provide the highest sensitivity when detecting explosives; however, the costs associated with the training, together with the limited information produced from the sniffer dog, establishes the need to improve current technology within explosive detection. Semiconducting metal oxide gas sensors can be incorporated into electronic noses, which provide a cheap, portable, and highly sensitive device, therefore making them a reliable method when detecting explosives.

Using unmodified, admixed, and 2-layered sensors consisting of ZnO and SnO_2, an array of seven heterojunction semiconducting metal oxide sensors was produced. A heterojunction is the combination of two dissimilar metal oxides with differing band gaps. Creating a heterojunction with metal oxides ZnO and SnO_2 with wide band gaps of 3.4 and 3.6, respectively, has improved sensing properties. Therefore, having already yielded some promising results, ZnO and SnO_2 are a good heterojunction to be tested against the range of explosive-associated gases.

The sensors were produced by screen printing the metal oxide inks onto 3mm by 3mm alumina substrates with gold interdigitated patterned electrodes on the top and integrated platinum resistance heater tracks underneath. All seven sensors were tested against gases associated with explosive materials at 300^{o}C, 400^{o}C, and 500^{o}C. Characterization techniques were performed in order to establish if any structural changes occurred to the array due to the exposure of the gases or temperatures. All sensors produced underwent X-Ray Diffraction (XRD), Scanning Electron Microscopy (SEM), Energy-Dispersive X-ray Spectroscopy (EDX), and Raman spectroscopy, both before and after being exposed to the test gases. No changes to the structure of the metal oxides were detected.

Both the admixtures and the 2-layered semiconducting metal oxide gas sensors have been shown to enhance sensor response when detecting explosive associated gases. The admixed semiconducting metal oxide gas sensors have increased responses to NO_2, 2-ethylhexanol, nitromethane and ammonia when compared to the unmodified metal oxides; whereas, the produced 2-layered sensors, proved highly successful when detecting 2,3-dimethyl-2,3-dinitrobutane (DMNB). The data collected was processed against a support vector machine in order to comprehend the sensors application into an electronic nose. The technique produced a high data classification when classifying the gases used within the study. Therefore, the array produced has successfully discriminated the test gases from one another; consequently, showing the potential use of the array implemented into an electronic nose for the use of explosive detection to be an effective method.

Gas Sensing, Explosives, Heterojunctions