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Selective Detection of Natural Gas Odorants Using Microfluidic Gas Sensors with Embedded Micro- and Nanofeatures

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Extended Abstract

Natural gas (NG) composition can change based on location and time [1]; however, it mostly consists of methane, ethane, propane, carbon dioxide, and small amounts of hydrogen sulphide [2, 3]. Because of this composition, NG is colourless, and odourless which makes it undetectable in the case of leakage [4]. These properties of NG have caused a few disasters such as the explosion of the New London school in Texas, US [4,5]. After this catastrophe, the odorization of NG became mandatory in Canada [6]. An appropriate NG odorization system requires a continuous monitoring system in addition to the proper injection setup to satisfy the odorization regulations while preventing over odorization. As other sulphur-based odorants such as hydrogen sulphide can also co-exist in the NG, selectivity is one of the main challenges for monitoring NG odorants. Microfluidic gas sensors are compact, fast, low-cost, and easy operated devices that offer selective and sensitive detection capabilities and have been recently applied for the detection of sulphur-based compounds [8,9]. These sensors generally consist of a gas detector and a microchannel [10]. In this study, we achieved improved selectivity for detection of NG odorants (mixture of tert-butyl mercaptan and methyl ethyl sulphide) by introducing micro-and nanofeatures to the microchannel of microfluidic gas sensors. In the first step, microfeatures are added into the microchannel and their dimensions and locations are optimized using the Taguchi method. In the next step, the microchannel and microfeatures are coated with graphene oxide, to introduce nanofeatures and increase the surface to volume ratio. The modified microchannel is characterized by SEM, XPS, and water contact angle measurement. The responses of the modified sensor are recorded and compared to a plain microfluidic gas sensor. The modified sensor shows a selectivity value of 28.59, indicating a 32.54% improvement in the selectivity of the modified sensor towards NG odorants. These results show that the developed microfluidic gas sensor has a promising application for selective monitoring of the NG odorant in the ambient.

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