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Gan Nanowire-Based Sensor Array for the Detection of Cross-Sensitive Gases Using Principal Component Analysis

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Abstract : Though the efforts had been made, the problem of cross-sensitivity for a single metal oxide-based sensor can't be fully eliminated. In this work, a sensor array has been designed and fabricated comprising of platinum (Pt), copper (Cu), and silver (Ag) decorated TiO2 and ZnO functionalized GaN nanowires using industry-standard top-down fabrication approach. The metal/metal-oxide combinations within the array have been determined from prior molecular simulation study using first principle calculations based on density functional theory (DFT). The gas responses were obtained for both single and mixture of NO2, SO2, ethanol, and H2 in the presence of H2O and O2 gases under UV light at room temperature. Each gas leaves a unique response footprint across the array sensors by which precise discrimination of cross-sensitive gases has been achieved. An unsupervised principal component analysis (PCA) technique has been implemented on the array response. Results indicate that each gas forms a distinct cluster in the score plot for all the target gases and their mixtures, indicating a clear separation among them. In addition, the developed array device consumes very low power because of ultra-violet (UV) assisted sensing as compared to commercially available metal-oxide sensors. The nanowire sensor array, in combination with PCA, is a potential approach for precise real-time gas monitoring applications.

Keywords : cross-sensitivity, gas sensor, principle component analysis (PCA), sensor array
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