Gas-sensitive *p*-type nanomaterials for air quality (AQ) monitoring

The two main contributors to the decline in outdoor air quality in South Africa are identified as the combustion of low-grade coal for the generation of electricity and the increase in private transportation. Most of South Africa's electricity is generated by coal-power plants, located in the Gauteng and Mpumalanga provinces. According to reports released by the Department of Environmental Affair (DEA) in 2013 and 2016, the air quality around the power plants exceeds the National ambient air quality standards. In 2018, the country was reported to have one of the world's largest NO_2 air pollution hotspots.

Semiconducting metal oxide (SMOx) gas sensors are used to detect and monitor different gaseous environments, which have resulted in emerging applications including medical breath analyses, food quality, environmental pollution and air quality (AQ) monitoring. SMOx nanomaterial sensors enable low-cost, compact and user-friendly portable gas analysers.[1,2] The performance of SMOx gas sensors can be enhanced by tuning the morphology of the nanostructure, doping with additives to electronically and chemically sensitise the oxide semiconductor.[3–5] Introducing additives (like Pt and Au) is a common way to improve the sensitivity, selectivity and the effect of humidity of SMOx sensors.[6,7] The interest in *p*-type SMOx, particularly Co_2O_3 and CuO, is driven by their capability to detect gases at low temperatures (typically below 150 °C) with reasonable sensitivity and low response/recovery times. The capability to measure at low temperatures, for instance at 150 °C instead of 300 °C, would significantly decrease the sensor power consumption (i.e. the use of batteries is possible) for numerous applications.[2,8–10]

The aim of the project is to study the low temperature sensing behaviour of different pristine *p*-type SMOX, like CuO, Co_2O_3 and doped nanomaterials for NO_2, CH_4 and CO detection. During this study, several parameters, including morphology and average particle size, the dopant type and loading amount as well as the film thickness of the sensitive layer, will be closely optimized and controlled to reduce the operating temperature and cross-sensitivity to gases other than the target gas.[11] The selectivity toward other gaseous analytes and cross-sensitivity to humidity of these sensors will be tested and quantified.

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