

Selectivity Acetone Detection by Spinel Mn_xO_y Sensor

Reinaldo dos Santos Theodoro^{1,2}, Tiago Elías Abi-Ramia Silva², Matteo D'Andria², Diogo Paschoalini Volanti¹, Andreas T. Güntner²

¹ São Paulo State University (UNESP), Rua Cristóvão Colombo 2265, 15054-000 São José do Rio Preto, Brazil,

² ETH Zurich, CH-8092 Zurich, Switzerland
andreas.guentner@hsl.ethz.ch

Summary:

The accurate detection of volatile organic compounds such as acetone has drawn great attention. We present manganese oxide films fabricated via flame spray pyrolysis as acetone sensor with humidity enhanced sensitivity.

Keywords: Chemoresistor, Nanotechnology, Gas sensors, Breath Analysis

Background

In recent years, the precise detection of Volatile Organic Compounds (VOCs) has attracted the attention of the scientific community, mainly because these VOCs can be used to evaluate indoor air quality, as well as for health monitoring [1].

Therefore, developing sensor materials capable of selectively detecting acetone at ppb-level in high relative humidity is essential for practical applications. This work presents a chemoresistor acetone sensor based on semiconductor metal oxide nanoparticles, specifically manganese oxide. Sensor films composed of the Mn_xO_y were fabricated using flame spray pyrolysis (FSP) [2] with varying thicknesses.

Experimental

Mn_xO_y -based sensing films were prepared using flame spray pyrolysis (FSP) [3]. A precursor solution based on Mn (II) 2-ethylhexanoate in xylene was atomized, and combusted. Nanoparticles were collected on a filter positioned above the flame. The Mn_xO_y nanoparticles were directly deposited onto Al_2O_3 substrates with interdigitated Pt electrodes and a resistance temperature detector (RTD). The thickness of the film was adjusted according to the deposition time. Finally, the Mn_xO_y films were annealed at 500 °C for 5 h. Fig. 1 illustrates the fabrication of sensor films. The sensors were mounted on specific holders and connected to a gas mixing system for analysis, using hydrocarbon-free synthetic air and calibrated mass flow controllers to create the desired gas mixture composition [4]. The sensor response (S) was determined as:

$$S = \frac{R_a}{R_g} - 1$$

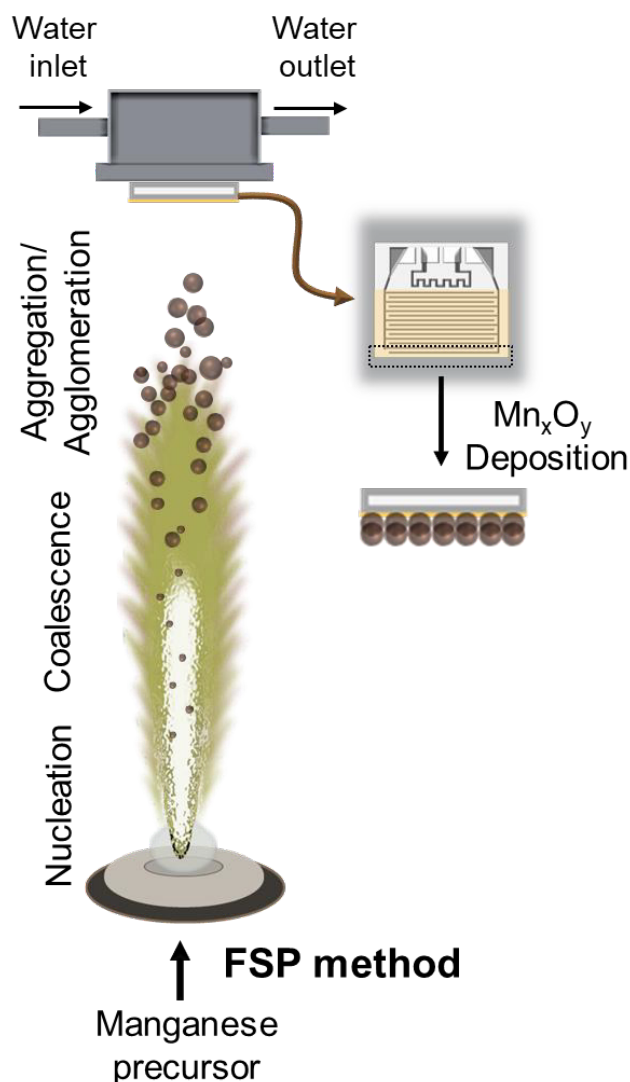


Fig. 1. Schematic illustration of sensor films fabrication.

Results

Sensor was tested for acetone detection. The initial results showed that Mn_xO_y -based sensors exhibited significant sensing performance for acetone, with good selectivity against major interfering gases, as shown in Fig. 2.

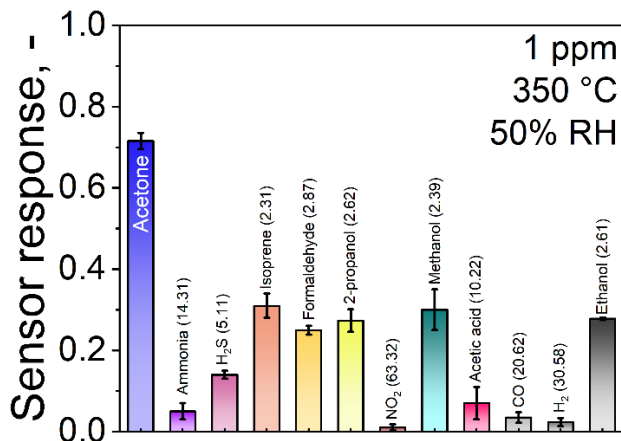


Fig. 2. Selectivity graphs for acetone detection against interfering gas at 350 °C and 50% RH.

The Mn_xO_y sensor was tested under different relative humidity (RH) conditions and various acetone concentrations (in ppm) to evaluate its humidity robustness, as shown in Fig. 3. As can be seen, the sensor demonstrates enhanced sensitivity under different RH conditions. These findings suggest that the sensor can be used in various application fields, such as breath analysis, where acetone is a marker of fat metabolism during dieting [5] and exercising [6].

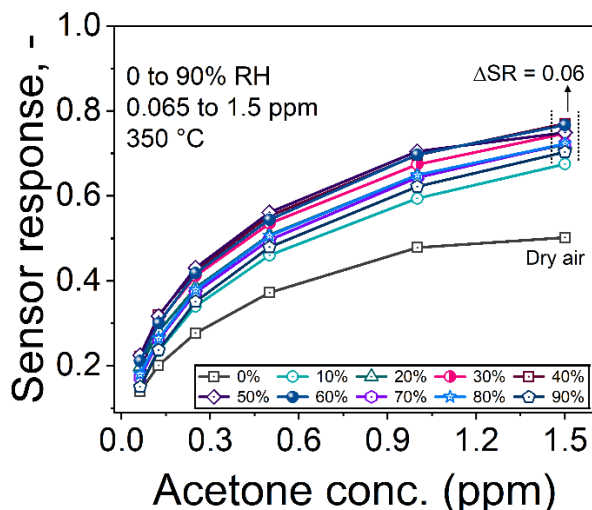


Fig. 3. Sensing performance under different RH (0 – 90%) in different acetone configurations at 350 °C.

Our analysis will be complemented by crystallographic analysis by X-ray diffraction, surface area measurement by N_2 adsorption as well as electron microscopic characterization.

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