

# Humidity Enhance the Isopropyl Alcohol Detection by Co-Mn Oxide

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## Summary:

Humidity is considered a major challenge in gas sensing applications. In this context, manganese-based sensing materials have attracted increasing interest due to their tolerance to humid environments. Here, we report a cobalt-manganese mixed oxide capable of detecting isopropyl alcohol at ppb levels under high humidity conditions. Remarkably, humidity enhances the sensing performance, resulting in a boost in sensitivity.

**Keywords:** Metal oxides, manganese-based oxides, gas sensing, humidity-enhanced sensing, isopropyl alcohol

## Background

Isopropyl alcohol (IPA) is a volatile organic compound (VOC) that, together with acetone, can serve as a potential biomarker in diabetic breath analysis and lipid metabolism studies [1]. In addition, IPA can be used as a marker of air quality in controlled environments, such as cleanrooms in pharmaceutical and device manufacturing [2]. In this context, IPA emerges as an alternative marker for various field applications. However, a major limitation is the influence of humidity, which often compromises the sensing performance of many metal oxide (MO<sub>x</sub>) sensors [3]. Here, we describe a p-type cobalt-manganese oxide capable of detecting IPA under high humidity conditions, where the sensing material exhibits enhanced sensitivity toward IPA.

## Experimental

Cobalt-manganese oxide-based sensors and nanoparticles were fabricated by flame spray pyrolysis (FSP) [4]. The precursor solution consisted of Co(II) 2-ethylhexanoate and Mn(II) 2-ethylhexanoate dissolved in xylene, which were atomized and combusted in a flame with a precursor/dispersion (P/D) ratio of 5/5. The resulting nanoparticles were directly deposited onto Al<sub>2</sub>O<sub>3</sub> substrates with interdigitated Pt electrodes and an integrated resistance temperature detector. In parallel, nanoparticles were collected on a filter positioned above the flame. Both samples were subsequently annealed at 500 °C for 5 h.

The sensor was mounted on dedicated holders and connected to a gas mixing system using hydrocarbon-free synthetic air and calibrated mass flow controllers to achieve the desired gas composition [5]. The sensitivity (S) was defined as follows:

$$S = R_g/R_a - 1 \quad (1)$$

## Results

Co-Mn oxide synthesized by the FSP was characterized by X-ray diffraction (XRD, Fig 1), scanning electron microscopy (SEM), and energy-dispersive X-ray spectroscopy (EDX).

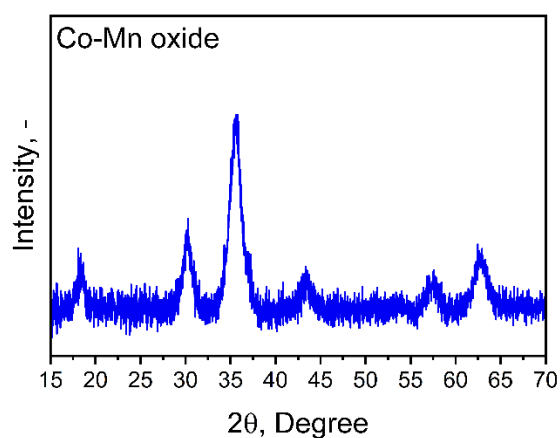


Fig. 1. XRD data of Co-Mn oxide.

Fig. 2 shows sensor response of the Co-Mn oxide sensor when exposed to IPA (1000 ppb) at 310 °C under different relative humidity levels (0

– 90% RH). Under humid conditions, the Co-Mn oxide sensor exhibits greater conductivity modulation than in dry air, suggesting a boosting effect of surface-adsorbed hydroxyl groups during interaction with IPA. This enhanced conductivity modulation reflects higher sensitivity under humid conditions.

These findings highlight the remarkable ability of manganese oxides to withstand humidity effects. Moreover, water vapor does not act as an interfering factor; instead, it plays a critical role in enhancing the sensing performance for the detection of gases and VOCs. Therefore, Mn oxide-based sensing materials present strong potential to overcome a common challenge in gas sensing and enable improved performance in real-world applications.

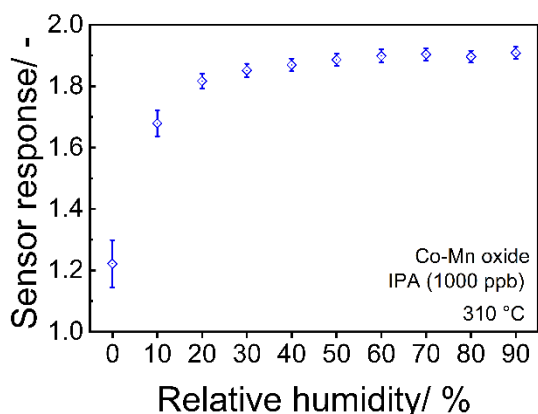


Fig. 2. Sensor response of Co-Mn oxide sensor to 1000 ppb of IPA under different relative humidity (RH) conditions.

The combination of cobalt and manganese oxides for IPA detection under humid conditions highlights the intrinsic ability of manganese-based materials to overcome humidity-related limitations. This finding opens new avenues for the rational design of advanced sensing materials, where the incorporation of manganese with transition metals, rare earths, or noble metals can further enhance sensitivity, selectivity, and long-term stability. Notably, humidity robustness – typically a major challenge in gas sensing – is inherently addressed by manganese oxides, positioning them as key materials for next-generation sensors in real-world applications.

## References

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## Acknowledgements

This work was sponsored by São Paulo Research Foundation (FAPESP); Process numbers: 2020/06421-1, 2022/05381-1, and 2024/12700-1.