Unravelling the ozone sensing mechanism of all-inorganic metal halide perovskites

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Gas sensors play an important role in many aspects of our lives due to their ability to detect a wide range of air pollutants, toxic and combustible gases. Therefore, there is an increasing demand for the development of novel materials that would provide new opportunities in terms of sensitivity, selectivity and stability. Furthermore, the fundamental understanding of the underlying sensing mechanism that involves the interaction between the target gasses and the sensing element needs further exploration.
Recently, metal halide perovskite crystals with the chemical formula ABX_3, where A and B are two cations with very different sizes and X is a halogen anion, have appeared in gas sensing research since they can reversibly transduce any environmental stimuli into optical or electrical signal. According to the aforementioned, the aim of this research is the fabrication of sensitive perovskite-based sensing elements that would be able to detect ultra-low concentrations of the target gases. [1,2] Herein, we present the sensing performance of ligand-free all-inorganic $CsPbX_3$ (where X= Cl, Br or their mixtures) microcrystals to detect ultra-low concentrations of ozone. In comparison, doped systems with manganese have been fabricated with similar morphology in order to reduce the lead content and provide a more environmentally friendly sensing material. Both materials were grown by a cost-effective solution-based process under ambient conditions. Their sensing capability was evaluated by electrical measurements carried out under different gas concentrations, at room temperature operating conditions (Fig. 1a for the $CsPbBr_3$ sensing element). Remarkably, each sensor displayed enhanced sensing behavior upon time, providing information of the underlying sensing process. Additionally, the high performance of the μCs as O_3 sensing elements in terms of sensitivity and stability, compared to the state-of-the-art semiconducting materials along with the fully elucidation of the sensing mechanism opens up new possibilities for environmental-friendly gas sensing materials.

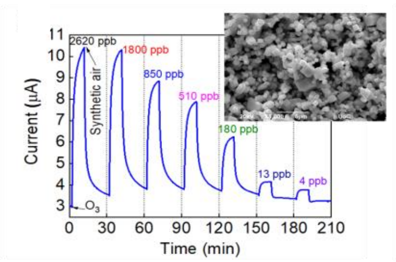

Figure 1. Electrical response of $CsPbBr_3$ sensing elements upon different O_3 concentrations ranging from 2620 ppb to 4 ppb. Inset: SEM image of $CsPbBr_3$ microcubes.

References

[1] Brintakis et al., Nanoscale Adv. **7**, 2699 (2019).
[2] Argyrou et al., J. Mater. **8**, 446 (2022).

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