Role of Er doping on isoamyl alcohol sensing performance of $LaFeO_3$ microspheres and its prospects in wheat mildew detection†

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Abstract

It is essential for food safety to recognize isoamyl alcohol, one of the biomarkers of wheat mildew. However, there has been limited research on isoamyl alcohol gas sensors with superior sensing performance. Herein, highly sensitive Er-doped $LaFeO_3$-based sensors were fabricated using simple hydrothermal combined with dip-coating, and 5 at% Er@$LaFeO_3$ exhibited extraordinary response (219.1 @ 25 ppm), outstanding selectivity, repeatability (435.7 ± 5.0 @ 50 ppm), and long-term stability (432.0 ± 8.2 @ 15 days). The superior isoamyl alcohol sensing performance could be ascribed to several factors, including the smaller particle size (3.02 μm), higher concentration of oxygen vacancies (21.3%) and chemisorbed oxygen (36.2%), larger specific surface area (54.102 $m^2 g^{-1}$), and narrower band gap (1.86 eV). DFT calculations elucidated the sensitization mechanism of Er doped $LaFeO_3$: the reduction in adsorption energy and the enhancement of interaction forces between gas molecules and the sensing coating. Furthermore, the practical application of 5 at% Er@$LaFeO_3$ to volatile gases generated from stored wheat confirmed the potential of fabricated Er-doped $LaFeO_3$ microsphere-based sensors in the analysis of wheat mildew. This work may serve as a guide for the selection of sensing materials to detect biomarkers emitted throughout the wheat mildew process, which may contribute to developing non-destructive and rapid detection technology to minimize losses during wheat storage.