**Preparation of cobalt-based metal oxides and their gas-sensing performance**

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Both triethylamine (TEA) and hydrogen sulfide (H2S) can irritate the skin and mucous membranes, as well as the central nervous system, and even cause death. Even if the concentration of gas is low, long-term exposure can do harm to the body[1 – 3]. Therefore, it is of great significance to explore a sensor with low cost, small volume, fast response and low detection limit, which can monitor the above two gas in real time. At present, p-type semiconductor metal oxides have some shortcoming, such as high working temperature, poor stability and high detection limit, which limit their practical application [4]. In order to solve these problems, p-type semiconductor materials such as Co3O4 and ZnCo2O4 were synthesized by in-situ growth method, and TEA and H2S were detected respectively.

Co3O4 materals were directly in-situ grown on the ceramic tubes by hydrothermal method and characterized by XRD (Fig. 1, a). The Co3O4-0.10 sensor made of three materials showed good sensitivity to TEA gas. The response of 100 ppm TEA gas was 31,27 at the optimal operating temperature of 160 ℃ for Co3O4-0.10 sensor (Fig. 1, b).

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*Fig. 1.* (a) XRD pattern; (b) Responses toward 100 ppm of TEA at different temperatures of Co3O4 sensors.

ZnCo2O4 materals also were directly in-situ grown on the ceramic tubes by hydrothermal method and characterized by XRD (Fig. 2, a). The ZCO-600 sensor based on ZnCo2O4 materials demonstrated excellent sensitivity towards H2S gas. Notably, the optimal operating temperature for the ZCO-600 sensor was 90 °C. The response of 100 ppm H2S gas was 38,38 at the optimal operating temperature of 90 ℃ (Fig. 2, b).

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*Fig. 2.* (a) XRD pattern; (b) Responses toward 100 ppm of H2S at different temperatures of ZnCo2O4 sensors.

Both materials exhibit reduced operating temperatures compared to conventional metal oxide sensors due to their enhanced catalytic activity and improved oxygen adsorption capabilities. The precisely controlled crystalline structures, confirmed by XRD analysis, contribute to better charge carrier mobility and stability. Additionally, the carefully optimized stoichiometry in both materials maximizes surface redox reactions - with Co₃O₄ facilitating TEA oxidation through cobalt ion transitions, while ZnCo₂O₄ promotes H₂S dissociation through formation of cobalt-sulfur bonds. These material innovations address the traditional limitations of p-type semiconductors by combining high sensitivity, lower operating temperatures, and improved stability in a cost-effective sensor design suitable for real-time gas monitoring applications. The superior performance demonstrates how tailored material engineering can overcome the challenges of high working temperatures and poor stability that have previously limited practical applications of metal oxide gas sensors.

**R E F Е R E N C E**

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