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Design and optimization of high-performance H_2 sensors for leak detection in production, storage and utilization environments

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Hydrogen (H_2) is a promising clean fuel, but its flammability in the 4–75% range necessitates rapid leak detection. Chemiresistive gas sensors offer an efficient solution due to their low cost, small size, and tunable properties. This study focuses on optimizing functional materials for H_2 sensing. (Ti,Sn)O_2 solid solutions were chosen for their superior sensing performance over pure oxides, and Pd was added to enhance catalytic activity and mitigate humidity effects. SnO_2, TiO_2, and (Ti,Sn)O_2 with a Ti:Sn ratio of 25:75 (TS25) were synthesized using standard procedures, with Pd-loaded samples (TSP) prepared by adding 1.5 at% Pd. FE-SEM and XRD analyses revealed nanoparticle morphologies (˜10 nm) and single-phase structures: cassiterite SnO_2, anatase TiO_2, and rutile solid solutions. Screen-printed sensing layers were fired at 600 ℃ and electrically tested, confirming n-type behavior. At their optimal temperatures, the response to 100 ppm H_2 followed this order: TSP (400 ℃), TS25 (450 ℃), SnO_2 (450 ℃), and TiO_2 (550 ℃). Both TSP and TS25 detected H_2 from 0–1000 ppm, even at 60% humidity. Selectivity tests revealed CO as the main interferent, though H_2 still induced the strongest response.
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