DOI 10.5162/EUROSENSORSXXXVI/PT5.68

Fe-doped SnO_2 based gas sensor produced by SILAR for acetone gas sensing

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Summary:
The findings suggest that Fe-doped SnO_2 sensors, synthesized through the SILAR method, exhibit promising capabilities for detecting acetone efficiently, offering an effective solution for developing high-performance gas sensors with specific selectivity to acetone vapor.

Keywords: acetone gas sensors, MOS, SILAR, nanoparticles

Volatile organic compound (VOC) vapors hold considerable importance due to their substantial presence among indoor environmental pollutants, posing a detrimental impact on human health. It has been confirmed a strong correlation between the emission of VOCs and the incidence of certain types of cancers [1]. The VOCs as acetone, which is also referred to as propanone, dimethyl ketone, 2-propanone, propan-2-one, and β-ketopropane, finds widespread usage in both laboratory and industrial settings [2]. The acetone is detectable in the breath of individuals with diabetes, serving as a potential biomarker for diagnosing the condition [3]. Research findings suggest that employing a non-invasive, painless, rapid, and cost-effective method for diagnosing diabetes, which involves measuring the concentration of acetone in breath, could serve as a viable alternative to traditional blood analysis techniques [4]. Hence, there is considerable interest in efficiently detecting acetone levels.

Metal-oxide-semiconductors (MOSs) as a class of chemoresistive sensors have attracted great attention in environmental monitoring due to their sensitivity to various gases and VOCs. Their ability to detect changes in electrical resistance in response to interactions with target molecules makes them valuable for applications such as air quality monitoring, industrial safety, and medical diagnostics [5–7].

In recent times, significant endeavors have been directed towards the creation of gas sensors utilizing a range of oxide semiconductors such as SnO_2, WO_3, In_2O_3, ZnO, NiO, MnO_2, and V_2O_5. Among the oxide semiconductors, SnO_2, characterized as an n-type semiconductor with a wide band gap of 3.6 eV, has garnered significant attention owing to its superior performance and remarkable chemical stability. Certainly, doping is indeed a promising strategy for enhancing the gas sensitivity and selectivity of oxide semiconductor gas sensors. Doping involves introducing specific impurities or foreign elements into the semiconductor material to alter its electrical and chemical properties. The desired sensors can be obtained by successive ionic layer adsorption and reaction (SILAR) method. The TiO_2/CuO heterostructure gas sensors were synthesized by SILAR method using $SnCl_2$ as source of Sn and $FeCl_2$ as source of Fe. Doping has the capacity to modify the grain size, crystal structure, oxygen distribution, and carrier concentration of gas sensing materials, thereby amplifying the sensing properties of SnO_2 sensor. The uniform conditions 100 ppm gases and 175°C were employed for every gas selectivity assessment, showcasing the viability of employing Fe-doped SnO_2 as sensor for detecting volatile organic compound especially acetone. 0.5 mol.% Fe-doped SnO_2 showed high response and high selectivity to acetone among we used gases and fast recovery time approximately 20 sec. Thus, the research findings indicate that the Fe-doped SnO_2 sensors synthesized by SILAR method showed high selectivity to acetone vapour in air atmosphere and fast recovery time. Therefore, doping Fe ions into SnO_2 promise as an effective approach for developing and producing high-performance gas sensors selective to acetone.

Acknowledgements

This research has been funded by the Science Committee of the Ministry of Education and Science of the Republic of Kazakhstan (Grant No. AP14872138, Innovative strategy to recognize the diabetic state of people: metal oxide nanorods as ultrasensitive exhaled gas sensor).

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