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Conductometric NO_2 gas sensor based on nanolayered amorphous tellurium for room temperature operation

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Highlights

- Simultaneous involvement of contact and surface phenomena reduces the reaction time at gas sensing of Te films.
- Design details: a-Te of nanometric thickness; work function difference of contacting materials exceeds the Te forbidden gap.
- At contacts Pt/a-Te can arise a degenerate region (metallic) of p-type Te.
- Adsorption of NO_2 molecules into contact gaps modulate portions of semiconducting a-Te turned into metallic one.

Abstract

A fast operating NO_2 sensor based on amorphous Te layer of a nanometric thickness, enclosed between Pt electrodes has been developed and investigated. The gas sensor operates at room temperature and by sensitivity ~ 60% / ppm it exhibits a response time around 5 s. The long – term stability of the sensor tested by operating it 12 weeks showed no appreciable changes in the characteristics. To elucidate the mechanism of so fast gas detection, the sensor structure and active material have been investigated by scanning electron microscopy (SEM), X-ray diffraction (XRD) analysis, energy-dispersive X-ray spectroscopy (EDX) and atomic force microscopy (AFM), being followed with its characterization via studying the current - voltage characteristics, dynamic response, long – term stability, effects of temperature, humidity and other gases. It is shown that combination of used materials as well as the developed sensor design allow the simultaneous involvement of contact, and surface phenomena in sensor mechanism of operation, making possible the gas induced modulation of charge carriers simultaneously on Te film surface, accumulation regions at contacts, which include the portions of the degenerate (metallic) p-Te, as well as in contact gaps (transition regions), originated from microscopically roughness, formed since during electrode deposition. The last referred process leads to increasing the portion of the semiconducting Te nanolayer turned into metal of p-type Te, which at closed – circuit conditions results in a sharp increasing of the current flow through the device. Such explanation of obtained results reflects the fundamentals of metal – semiconductor junctions, the properties of used materials and meets the modern models proposed for interpretation of adsorption processes in similar devices.

Previous Next

Keywords

Gas sensors; Nanolayers; Amorphous Te; NO_2

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Dumitru Tsiulyanu received his Ph.D. degree in Physics of semiconductors and dielectrics from Academy of Sciences of Moldova in 1975. From 1979 until 1989 he worked at the Institute of Applied Physics ASM, occupying leading research positions. In 1988 he received his degree of Doctor of Sciences and in 1989 became a Professor in Physics and Head of Department at Technical University of Moldova (TUM). Since 2020, he holds the position of the Principal scientific researcher and Head of the research center of amorphous and nanostructured materials of the Department of Physics TUM. His scientific interests include investigation of basic physical properties of chalcogenide semiconductors and their application in electronics, including gas sensors.

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