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Conductometric NO2 gas sensor based on nanolayered amorphous tellurium for room temperature operation

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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.

Keywords: sensors, tellurium layers