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D-INV1. Nano-Sensors: Fabrication, Characterization, and Modelling

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ABSTRACT

In this paper the fabrication of nanosensors and nanosensor arrays is presented. The sensors are formed of polymers of both single elements and compounds. The fabrication process is followed by characterization and modeling to facilitate the design process of signal conditioning circuits. Different fabrication techniques are used, namely, sol gel and temperature controlled reaction techniques. The sensor or sensor array characterization is carried out using X-ray diffraction and/or scanning electron microscopy. The purity and intensity of the nano produced nano elements (dots, rods, or sheets), play an important role in the sensor fabrication and the resulting sensor characteristic. The sensor characteristic is manifested in the responsivity, noise equivalent power, and detectivity. Results show good dynamic range, better noise performance, and size reduction. The family of sensors referred to as nanosensors include nanowires, nanofibers, nanobelts, nanograins, nanotubes, nanoprobes and quantum dots.

The nanowire is a wire of metal, the diameter of which is less than 100 nm. Nano fiber is a submicron-sized fiber whose diameter is in the range from 50 to500 nm. Nanotubes are hollow cylinders few nanometers wide, made of one element such as carbon. Nanobelts are nanostructures in the form of belts. Nanoprobes are optical devices for viewing extremely small objects. Quantum dots are nanosized fluorescent semiconductor crystals. In this paper three main types of nanosensors are fabricated and characterized. These are the pyroelectric infrared detectors and the polypyrrole coated copper nanosensors. The pyroelectric infrared detector measured characteristic shows a suitable range of frequency extended from 0.01 Hz to 1000Hz using chopper circuit, a responsivity of about 157V/W, a specific detectivity of 1.82x106 cm/ Hz1/2/W and a noise equivalent power of 2.35x10-7 W/Hz1/2 and 2.67 W/Hz1/2 at 5% and 10%weights of added polyaniline respectively.

The second family of the fabricated and characterized sensors is the polypyrrole coated copper nanowire gas sensors. The dynamic range of temperature over which adequate values of sensitivity to carbon dioxide and hydrogen extends from 20 to 200oC. This range is suitable for most of the applications. Arrays of gas sensors of similar elements and hybrid elements are also introduced. For the arrays of similar elements, the results show an enhancement in sensitivity, while those of hybrid elements show a good response to both carbon dioxide and hydrogen. So the single sensor can be used for sensing the existence of two gases. The third family of gas sensors is based on zinc oxide and aluminium doped zinc oxide nanopowder. Investigations including different shapes of the nanoelements such as rods and dots are also introduced arrays of these elements are also characterized. The number of elements in the array and the type of element as well as the percentage of the doped aluminium all play important role in the sensitivity of the sensor and the array.