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Sistema de caracterización eléctrica

An electrical characterization system design

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Abstract:

In this work, the design, of an electrical characterization system is presented to obtain the surface resistivity (ranging from 1Ω to 1 GΩ) or conductivity of different thin films, thick films and pellets in a very precise manner. The surface resistivity changes are measured at different temperatures ranging from room temperature to 300 0C, which allows to test for all organic and inorganic materials. Gas sensitivity (change in surface resistance with respect to gas) of SnO2 pellets are measured; higher sensitivities (~ 25) with faster sensing response (~45 s) for a very low gas concentrations (~ 2 ppm to 2000 ppm) are easily achieved in a cost-effective way by enjoining a basic flow meter with reduced sensing chamber volume (500 mL). The GPIB interface made the data acquisition of the samples for very small-time intervals (~ 50 ms), which resulted in obtaining both static and dynamic sensor characteristic plots. The assembled system in this work is a portable, cost effective and miniaturized instrument which can be utilized for obtaining gas sensing properties as well as the I-V hysteresis curves for testing various samples as memristors.

Keywords:

Gas sensing, memristors, conductivity, resistivity, thin films, pellets

Resumen:

En este trabajo, se presenta el diseño de un sistema de caracterización eléctrica para obtener la resistividad superficial (que varía de 1Ω a 1 GΩ) o la conductividad de diferentes películas delgadas, películas gruesas y pastillas de una manera muy precisa. Los cambios de resistividad de la superficie se miden a diferentes temperaturas que van desde la temperatura ambiente hasta 300oC, lo que permite probar todos los materiales orgánicos e inorgánicos. Se mide la sensibilidad del gas (cambio en la resistencia de la superficie con respecto al gas) de los gránulos de SnO2; sensibilidades más altas (~ 25) con respuesta de detección más rápida (~ 45 s) para concentraciones de gas muy bajas (~ 2 ppm a 2000 ppm) se logran fácilmente de una manera rentable al ordenar un medidor de flujo básico con volumen de cámara de detección reducido (500 ml). La interface GPIB realizó la adquisición de datos de las muestras para intervalos de tiempos muy pequeños (~ 50 ms), lo que dio como resultado de la obtención de diagramas característicos tanto del sensor estático como dinámico. El sistema ensamblado en este trabajo es un instrumento portátil, rentable y miniaturizado que puede utilizarse para obtener propiedades de detección de gas, así como las curvas de histéresis I-V para probar diversas muestras como memristores..

Palabras Clave:

Detección de gas, memristores, conductividad, resistividad, películas delgadas, patillas

Introduction

The excessive accumulation of greenhouse gases (NO, NO2, CO2, O3) in the atmosphere 1, emission of hydrocarbons (CH4, C3H8) 2, toxic gas (CO, SO2, H2S) leakages from industries has impacted adversely on environmental and health part in worldwide, which provokes the detection of gases very prominent. Many gases mentioned above are corrosive, colourless, odourless and highly toxic to human health 3, the toxicity levels with corresponding sources of emission of different gases are tabulated in Table.1. A simple, precise and cost-effective way for detecting the gases is by utilizing a chemical sensor with Metal Oxide Semiconductors (MOS) as sensing materials 4: a sample MOS surface which undergoes a reversible chemical reaction with different

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gas molecules, at different temperatures (30-300 0C) and gives an electrical signal (change in the surface electrical resistance). This signal is later transmitted via transducing circuit and utilized as an input signal for various applications such as alarms, GSM modules, air quality measurement, etc.., 5.

GAS	Source	Toxicity Level	Reference	Gas emission sources	
CO	V, I, T, F, VL	Very high	5	V- Vehicles	A - Agricultural sector (manure)
CO_2	I, B, F, C, VL	Very high	6	I - Industrial activity	S - Stoves
NO	Af, F, A, N	High	7	T - Tobacco smoke	G - Gas stove
NO_2	V, A, S, G, E, N	High	8	B - Burning of forest	E - Electrics plants
SO_2	F, VL	Moderate	9	L - Landfills	N - Nitrogen oxides
CH_4	L, F, A	Moderate	10	Af - Artificial fertilizers	C - Cement industry
O_3	F, N	Low	11	F - Fossil fuels (petroleum, carbon, Natural Gas)	VL- Volcano

Table. 1: Toxicity level and their corresponding sources of emissions of different gases.

Measuring the gas sensitivity by obtaining the slope of the resistance calibration curve with an electrical characterization system Main advantages of very short response time (<15s.), very good repeatability, very good reproducibility, low cost, easy to calibrate and service, can be replaced easily, small, long life (usually 2-4 years), versatile in a wide range of gases.

Adsorption of the sample gas on the oxide surface followed by a catalytic oxidation 12, ends in a change in the electrical resistance of oxidized material, which can be related to the gas concentration, the chemical reaction that occurs when the gas contacts causing the sensor electrical resistance in the sensor decreases.

The resistance change is visualized by a Keithley 2002 multimeter connected to a computer via interphase GPIB to graph the data and get better results 13. These data are used in various applications such as laboratory analysis, academy purposes or to prevent the health of the inhabitants. Sensitive to different gases changes with temperature, the filament is heated by an electric current. Figure 1 below shows the proposed design of the electrical characterization system for gas sensing.

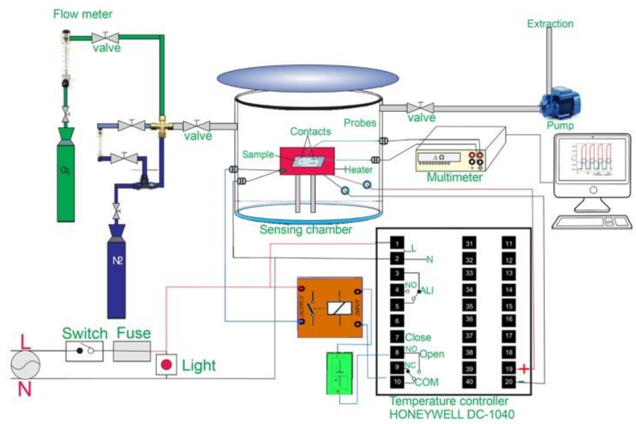

Figure 1: Gas sensing system design”

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