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Modeling of Co_2 Gas Detector Using Comsol Multiphysics

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ABSTRACT

In these papers we have simulatedcarbon dioxide sensor using COMSOL Multiphysics (MEMS module). These sensors are cheap, highly sensitive and selective. We got the results of CO_2 detector electric potential variation at 300C temperatures with high dependability using less power.

KEYWORDS: COMSOL Multiphysics, CO_2 gas detector.

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INTRODUCTION

The CO_2 gas in the atmosphere is one of the main reason for global warming, consequently monitoring CO_2 gas in the atmosphere is essential for good atmospheric conditions. To detect atmospheric carbon dioxide (CO_2), the CO_2 sensor is required. Currently, in present world there are many CO_2 sensors are available, usually, they are fabricated by using the infrared sensing devices (IRD), but the magnitude of these sensors are relatively large and they required a very high power and temperature for the operation[1].

In this paper, we suggested a designed CO_2 sensor in micrometer size (110 µm), which is designed by using a MEMS module of COMSOL Multiphysics software. The different type of CO_2 sensors presently used is Mixed Oxide Sensors [2], NASICON-based sensors [3], CNT sensors [4], Gas Chromatographs and Spectroscopic Sensors (Non-Dispersive Infrared-NIRD). Similarly, in [4], the aspect on wireless, passive Carbon Gas Sensor is given.

This type of detector has the disadvantage like high power consumption, would like high operational temperature, not easy for mobility circuits and sophisticated procedure. NIRD sensors needed additional power input in the order of mill watts and may price between fifty to five hundred USD. Potentiometric mixed chemical compound detectors and NASICON based sensor are quite tough to induce stabilized activity [5], this variety of sensors measure to rely on concentration of gas and operational temperature ought to be quite 350 C. The greenhouse gas detector is often wont to calibrate warmth performance of the sensor; numerous sensors forever have thermal inertia and finite heat electrical phenomenon, which alter the waveform of the Temperature versus Time [6]. At present, it is essential to provide high-quality CO_2 gas sensors for many fields like food industries, agriculture industries, air-conditioning, and atmospheric monitoring due to the massive rise of CO_2 levels in the atmospheric because of greenhouse effects [7]. Solid state potentiometric CO_2 sensors are precisely favorable to detect low levels of CO_2 concentrations; also they provide the firm reaction, ease, and long term stability. The sensor's electromotive force (emf) displays a linear relationship with the logarithm of CO2 concentration based on solid electrolyte for an air quality control system [8]. In Electric noses for observing environmental pollution and building relapse model arranged the detail case study about the present system for examining the use of different sensors grid system concerning urban air fumes monitoring for carbon monoxide, carbon dioxide (CO, CO_2) gases for three different regions in Alexandria- Egypt and 2 different traffic roads [9]. In solid-state potentiometric CO_2 sensor in dense film technology for breath examination described with the detail observing of the CO_2 gas, the concentration which is valuable in numerous applications, for example, to define the air quality, to monitor food quality or for breath analysis. In it is projected a low-power-consumption CO_2 gas sensor using ionic liquids for green energy management. They study of the impedance of the iconic liquid material havinglow concentration of the CO_2gas which increases in the air. In this paper, we suggested a sensor which protects the Gold electric terminals of the sensor by dropping the foam drop over the sensor electrodes, which reduce the atmospheric oxygen effect on the sensor performance. In this sensor model, [10] we examine the electric potential variation with respect to the arc length plotted on the top surface gold electrodes of the CO_2 sensor. The sensor resides of an interdigitated transducer (IDT) etched onto a piezoelectric SiO_2 substrate and enclosed with the foam material. The mass of the foam material increases as it increases the absorption of CO_2 from the air. The bottom layer of copper material is exertion as a heater for CO2 sensor[11].

MODEL DEFINITION

The Geometry of the CO_2 Detector

Fig. 1 shows a cross-sectional view of the CO_2 gas detector in the COMSOL Multiphysics simulation software. The gold electrodes are fixed on both cross surfaces of SiO_2 and Si-surface film. The higher exterior is painted by a BF4 foam material to guard the electro-active portion of the device[12], the globule then covers the whole surface of the sensor. BF_4 is the best.

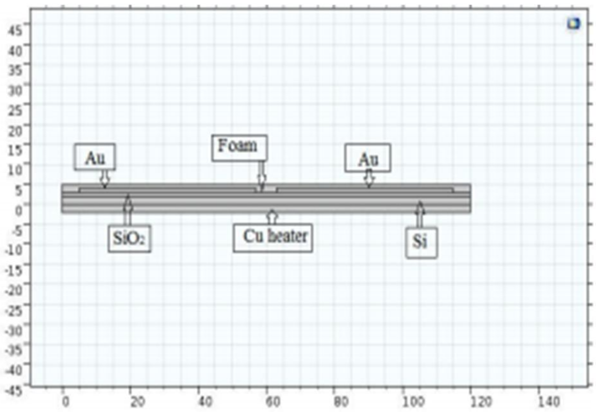

Figure I: Geometry and Dimensions of the CO_2 detector

Fig.1. also, demonstrations the dimensional view of the detector, the height of the sensor is 7µm and the length of the sensor is 120µm. The gap between the two electrodes is 10µm and from both the border side it is 5 µm distances maintained.

Boundary Conditions

The model is simulated underneath with flexible material over the piezoelectric material and the foam is at the higher layer of the model[13]. Foam is used to captivate the CO_2 gas. The model has an intervallic boundary condition at the vertical edge and simulated for Eigen frequency as a solver[14]. Solid mechanics, electric current, electrostatics, and heat transfer physics are sequentially solved in the geometrical conduction.

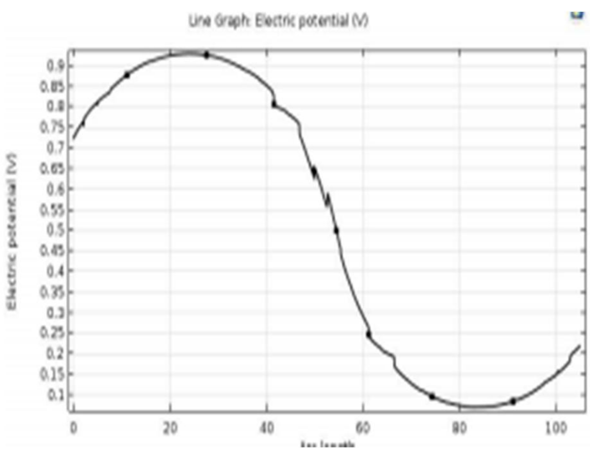

Figure II: Electric Potential VS Field

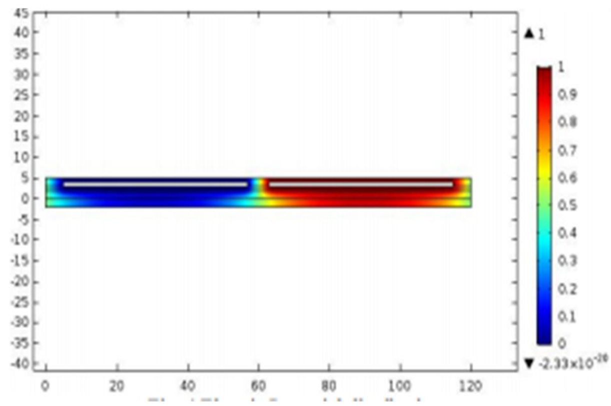

Figure III: Thermal image

RESULT AND DISCUSSION

The irreversible reaction of SiO_2 and CO_2 is given in (4). Where, produced CO_2 is negatively charged. When CO_2 get adsorb on SiO2 layer electrons are transferred from SiO_2 to CO_2 i.e. CO_2 extract electrons from SiO_2. As electrons are transferred from SiO_2, the potential of SiO2 is increases (*). Potential distribution in SiO2 is increases with increase in concentration of CO_2. The basic cause of impedance varies with CO_2 concentration is shown by following graph decreases the overall cost of the sensor. The optimum design is simulated and its deformation effect.

CONCLUSION

Nowadays, considerable amount of work is being carried out in order to develop sensors that are more cost efficient, simple to use, sensitive and selective. Research efforts have developed gas sensors for inflammable and toxic gases. Sensors are all around us and their prevalence is growing rapidly. Sensors play a very important role in the modern society with all the modern technology around us. Co_2 sensor is cheap and can be easily fabricated.

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