Abstract #2795, 224th ECS Meeting, © 2013 The Electrochemical Society

Transient Thermal Response of MicroTCD for Identification of Gases

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Abstract

A Microbridge Thermal Conductivity Gas Sensor was developed and tested for detection of gas composition (Fig 1). Heat is generated in a polysilicon microbridge through Joule heating and dissipated to the surrounding materials mostly via conduction. To get a better understanding of the phenomena and optimize the sensor design, a model of the microbridge and surroundings was simulated in COMSOL Multiphysics (Fig 2). The model was prepared with minimal simplifications; it includes the Joule heating in doped polysilicon with temperature dependent resistance, considers temperature dependent properties for the surrounding gas, and radiation heat transfer. Simulation results reveal the temperature distribution in the microbridge and calculate the electrical resistance of the sensor. Transient response of the sensor was obtained for the sensor under different gases using this model. (Fig 3).

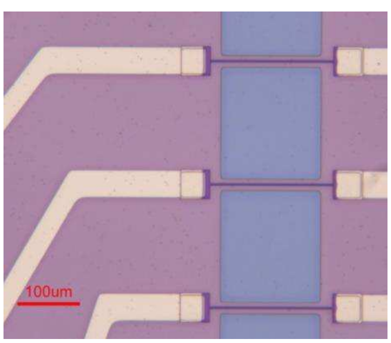

Figure 1. Optical image of fabricated microbridges

Table 1 summarizes time constant of the transient response as well as changes in resistance and other specifications of the sensor under different gases obtained from simulation. These results can predict optimal operating condition that yields to the best sensitivity and least power consumption; these data are experimentally investigated on the fabricated sensors.

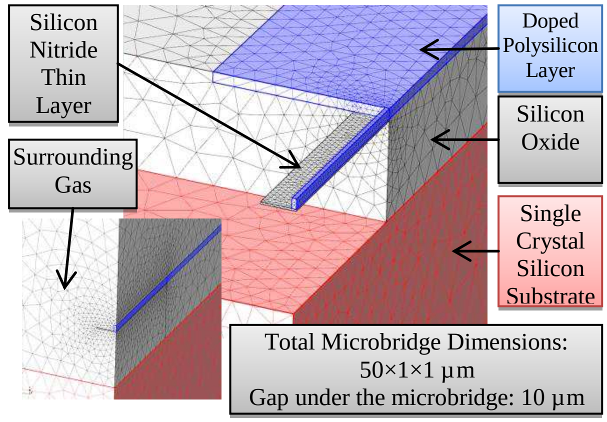

Figure 2 Model setup in COMSOL (Due to the dual plane symmetry of the problem only 1/4 of the bridge is modeled)

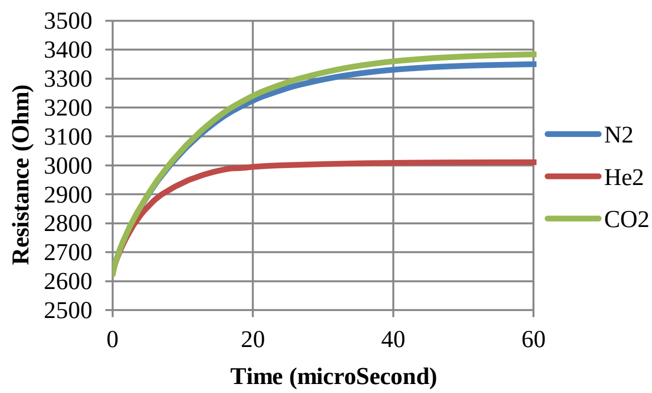

Figure 3 Transient response of microTCD to different gases, for a constant 5 V potential along the microbridge

Table 1 Summary of simulation results for three different gases

	Steady State Power (mW)	Time Constant (us)	Change in Resistivity (Ohm)	Maximum Local Temperature (K)
CO_2	7.4	11.9	761	825
N_2	7.5	11.4	726	800
He	9.5	5.5	387	548