Institut Matériaux Microélectronique Nanosciences de Provence

Low power multi-sensors for selective gas detection

Virginie Martini, Khalifa Aguir, Bruno Lawson and Marc Bendahan
Aix-Marseille University, Université de Toulon, CNRS, IM2NP, Marseille, France
Contact : virginie.martini@im2np.fr

Context : MOX gas sensors for industrial market
Objectives : small size, heater integration with low power consumption for portable systems, adapted to selective detection, multisensors and selectivity of MOX sensors
=> Development of integrated multi-sensors with a novel design

Requirements

structure on one plan - several detection areas - few electrical contacts - high temperature homogeneity - low power to 573 K heating

Multi-sensors design characteristics

two parallel platinum tracks to divide the consumption per 4 versus single track
20 µm width and 100 nm thickness – resistance of 100 ohm - 3 measurement electrode pairs

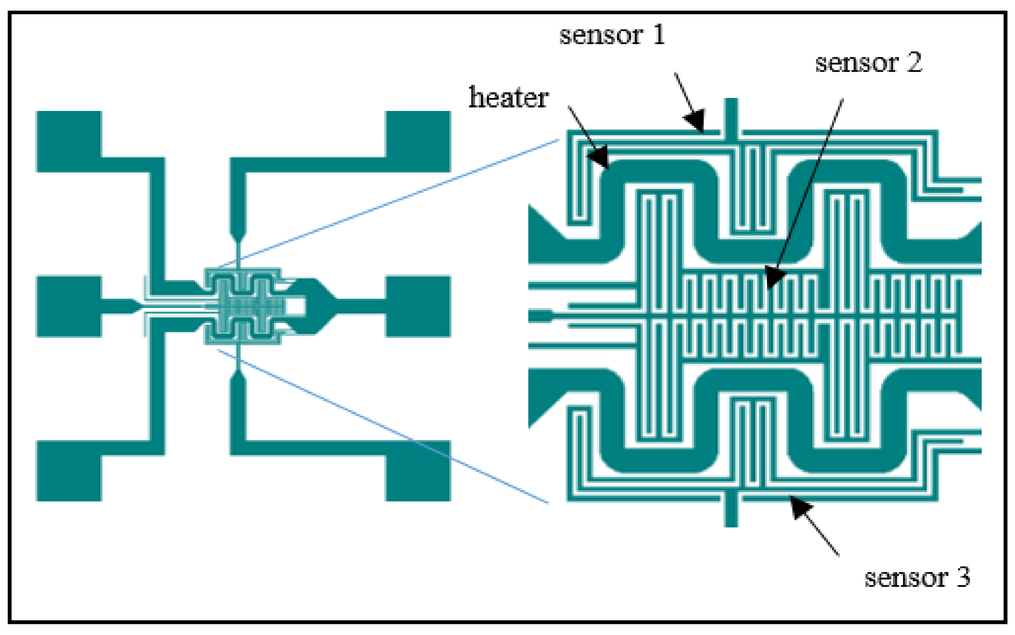
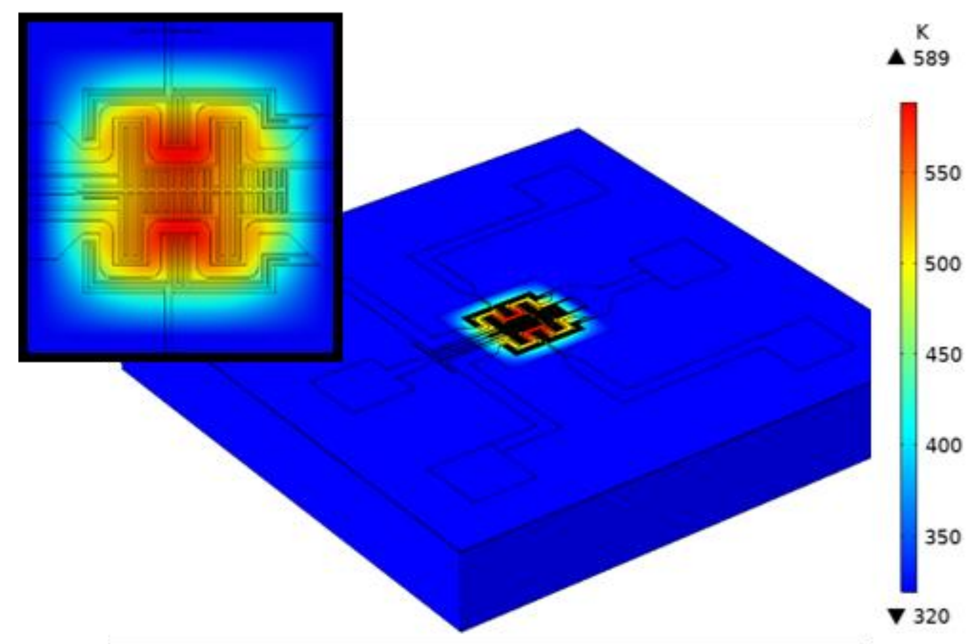


Figure 1 : Gas multi-sensors design.



Heater behaviour study

Model using Comsol Multiphysics software
Simulations of power consumption and heat transfer on the device
Multi-sensor on insulating membrane of Si_3N_4/SiO_2 on the top of Si substrate
Study of membrane thickness influence between 2 µm and 6 µm
Heating electrical voltage tested : 0,4 V to 1,4 V

Figure 2 : Heat repartition on the multi-sensor device with a membrane thickness of 2 µm and a heater biasing of 1.2 V.

Simulation results

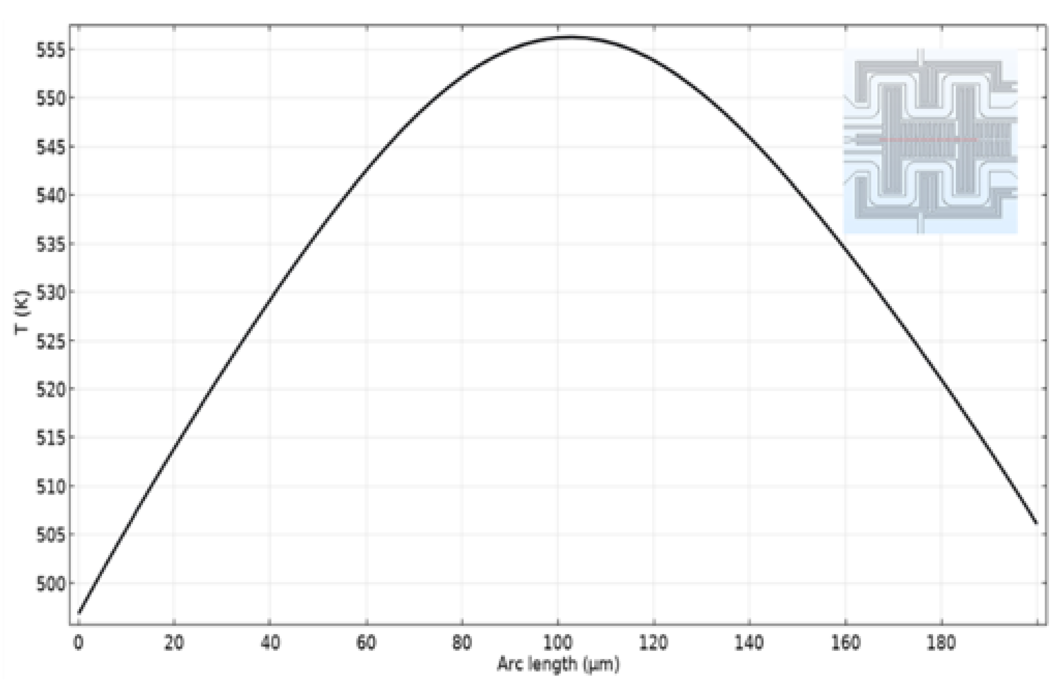


Figure 3 :Heat repartition plotted on the surface of the central sensor along the red axis.

The temperature repartition is good but can be improved by design modification in external parts to limit heat losses

Membrane thickness strongly influences the heating efficiency. The smallest thickness is more adapted for a low power consumption

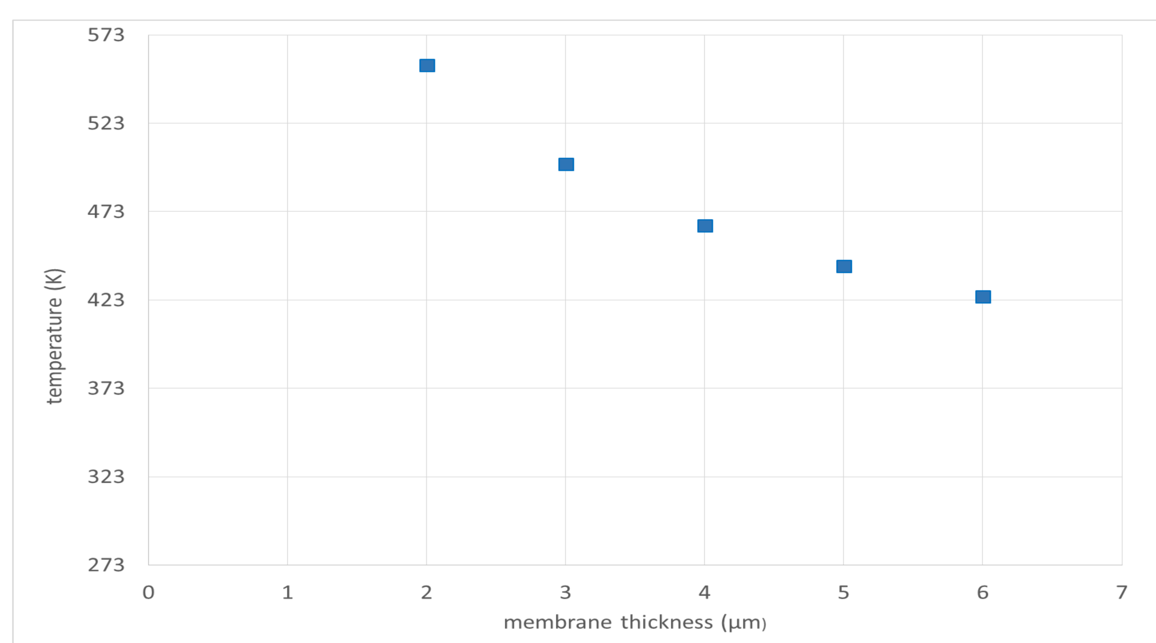


Figure 4 :Maximal temperature simulated on the heater versus membrane thickness of the device.

Realization and gas detection

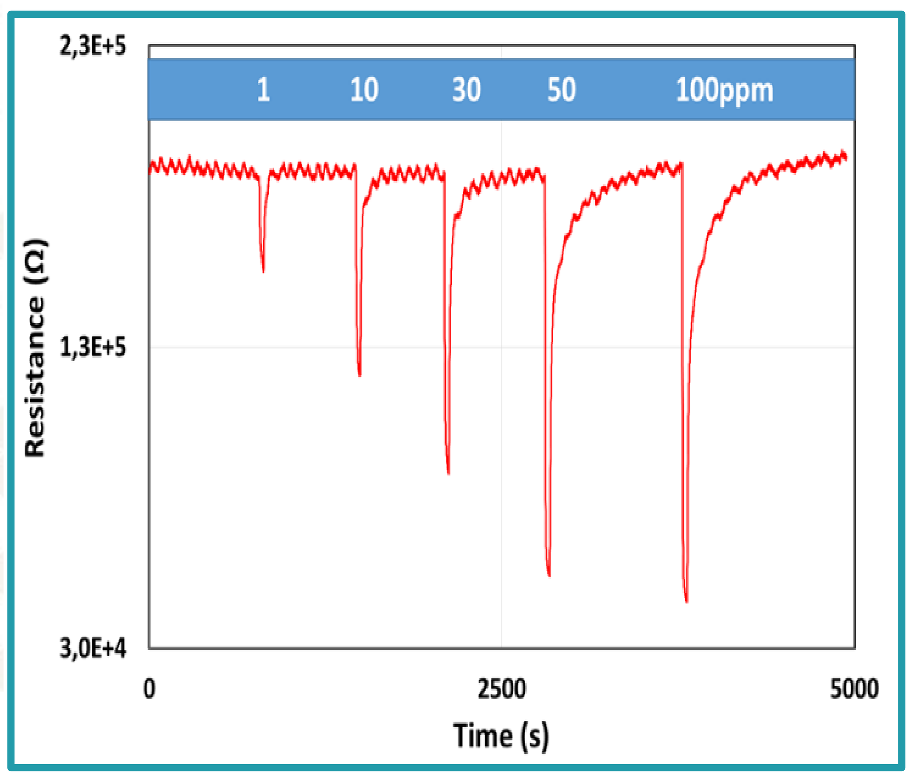


Figure 5 :Ethanol detection by central sensor at 533K and 50% RH.

Platinum thin films were deposited by RF magnetron sputtering and lift-off process, with a very thin layer of titanium. Deep Reactive Ion Etching was used to release the membrane. Finally, the SnO_2 sensitive layers were deposited by reactive RF magnetron sputtering and annealed under ambient air at 773K during 1h30.

Gas detection performance studied under ethanol between 1 ppm and 100 ppm in dry and wet air. The gas response at 50% RH is from 1.4 to 9.2. Good sensitivity and stability in wet air.

The results of figure 5 illustrate the different three sensor responses under ethanol in dry and wet air. These responses will be analyzed to achieve selectivity .

In the future works we want to use all sensors of the device to create a database in order to work out a selective device.