# UHeater on a Buckled Cantilever Plate for Gas Sensor Applications

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## Abstract

Introduction: In semiconductor gas sensors, the base of the gas detection is the interaction of the gaseous species at the surface of the semiconducting sensitive material. As a consequence of this surface interaction, charge transfer takes place between the absorbed species and the sensitive material. The change of the concentration of the free charge carriers is translated into a change of the overall resistance of the sensing layer. Table 1 shows a list of some materials used as sensitive layers for gas sensors. The most widely used material for this purpose is SnO2. But, a single metal-oxide material can sense many gases, implying that selectivity is a major concern. Selectivity can be improved by varying the operating temperature of the sensor. Since the chemical reactions at the surface of the sensor material are functions of temperature, sensitivity strongly depends on the sensor's operating temperature. This is why a heat generator transducer or micro hotplate is so important for this application. A typical micro-hotplate based sensor structure is shown in Figure 1 [1]. We called this feature a micro-heater (uHeater). The uHeater is suspended to provide thermal insulation on a Buckled Cantilever Plate (Figure 2) [9]. Also, the low mass of the suspended structure gives low thermal time constants. A temperature sensor (polysilicon resistance or metal plate with calibrated temperature coefficient of resistance) is often placed above the heater, separated by an insulating layer. The electrodes are directly in contact with the sensing film while being isolated from the temperature sensor. Use of COMSOL Multiphysics: As part of our work we have used COMSOL 4.2a to simulate our uHeater design embedded on a Buckled Cantilever Plate (BCP). Such structure allows the sensor to be suspended for thermal insulation, once the BCP is its assembled position (Figure 3). We have integrated both the Structural Mechanical interface and the Joule Heating interface. The assembled position is using the Structural Mechanics Module for the simulation, while the Joule Heating interface simulates the corresponding heat generated by the input voltage applied to the system. The metals used for the uHeater are Gold for the connection lines and Tungsten for the heating spiral feature. The metal layers with a thickness of 0.4 um are deposited on polyimide with a thickness of 5um as the structural layer. Results & Conclusions: The main objective of our work is to calculate the appropriate parameters needed to generate 350 °C on the plate surface, which is the working temperature aimed for our gas sensor. The simulation suggest that the working voltage for the uHeater should be around 0.2 V. More work is being done to calculate the power consumption with the simulation results. The simulation will allow us verify the efficiency of the current designs and if needed we can proceed with modifications. Devices have been fabricated and current work is on its testing. Figure 4 shows an assembly of a fabricated device.

## Reference

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## Figures used in the abstract

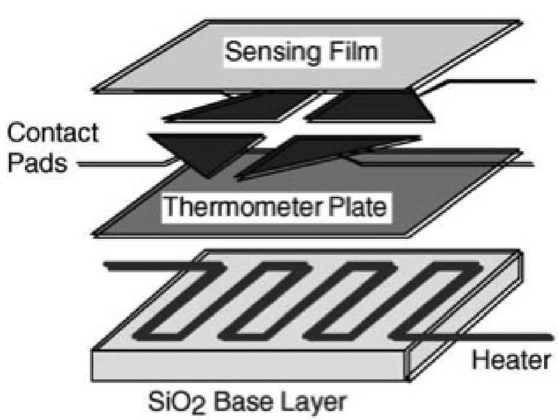


**Figure 1**: Typical micro-hotplate based sensor structure [Semancik et al., 2001].

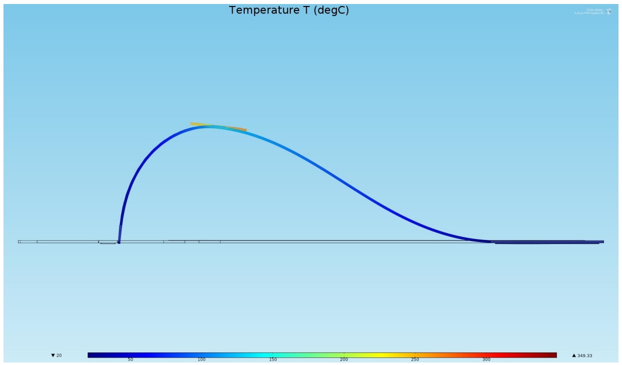


**Figure 2**: Lateral view of uHeater on BCP.

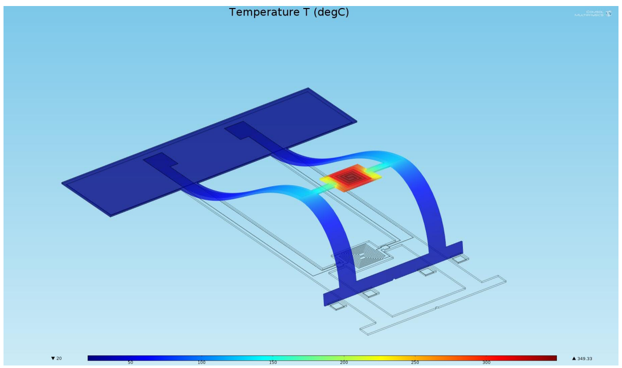


**Figure 3**: Simulation of the uHeater on BCP. Highest temperature=349.33 °C.

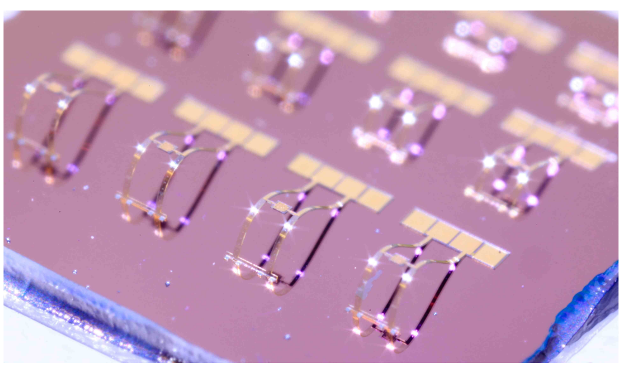

**Figure 4**: Fabricated BCP gas sensor.