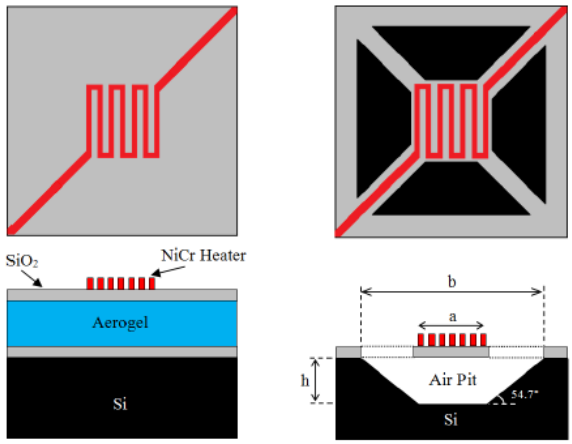
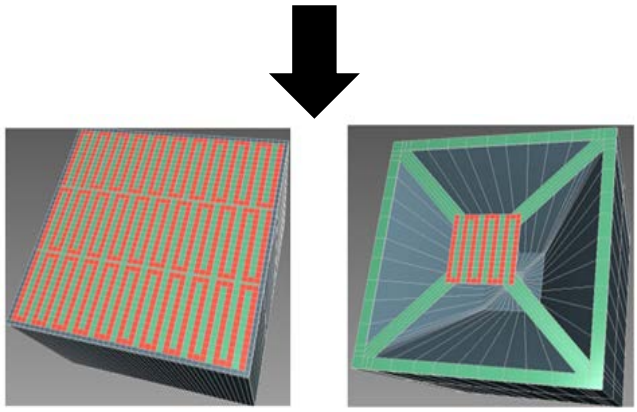
Low Power, Ultra Dense MOX Gas Sensors & Methods for Making the Same

Metal Oxide (MOX) gas sensors are a specific type of air pitted gaseous sensors with diverse applications in many areas, such as the detection of flammable or hazardous gases, and the aging of food stored in warehouses or refrigerators. Using material such as tin oxide, zinc oxide, titanium oxide and others, an array of several MOX materials can detect the presence of almost any gaseous substance. In the operation of MOX sensors, and other air pitted gaseous sensors, the microhotplate (μHP) must maintain elevated temperatures (300-500°C) to permit maximum sensitivity to MOX gases. In this way, the μHP consumes nearly all of the power used by the MOX sensor. Fortunately, researchers at the Univ. of Louisiana at Lafayette (UL Lafayette) have recently invented methods of incorporating silica aerogel into the MOX sensor design that permits a significant reduction in power consumption, a dramatic increase in sensor density and precludes the need of a recessed airpit in the MOX sensor design. Further, the developed CMOS compatible Aerogel technology has applications in 3D ICs for heat management, and low capacitance material for very fast ICs.

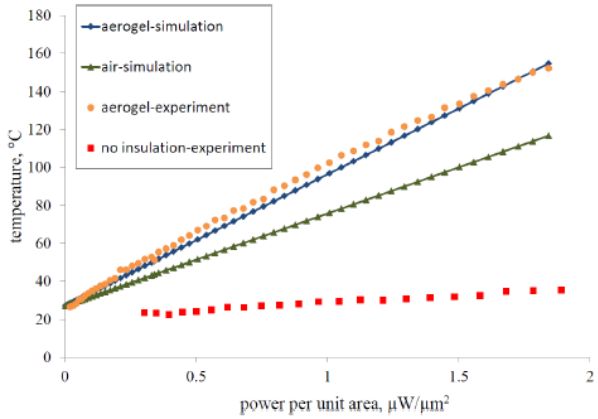


(a) heater built on aerogel (b) heater built on air pit

Schematic structure of heaters in MOX sensor design with aerogel or airpit as insulation.



Absence of airpit and superior insulation performance of aerogel permit dramatic increase in heater / sensor density.



Temperature versus power per unit area for 0.8 μm thick aerogel insulation, 0.8 μm deep air insulation, and no insulation.

KEY ASPECTS OF THE TECHNOLOGY

- Precludes air pit micromachining and related shortcoming and limitations;
- Superior insulation performance of aerogel permits dramatic reduction in power usage and a significant increase in sensor density;
- Superior methodology for good quality thin film of silica aerogel;
- Material of choice for 3D ICs heat management;
- Low capacitance material for fast IC's interlayer;
- Ideal material for waveguide for integrated optics and electronic/optical ICs ;
- Ultra sensitivity gas sensors with high surface area composite aerogel;
- Design & Method based on University-owned patent pending technologies.

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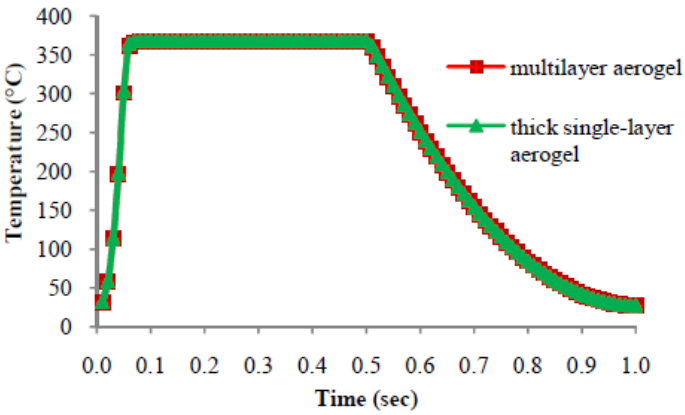
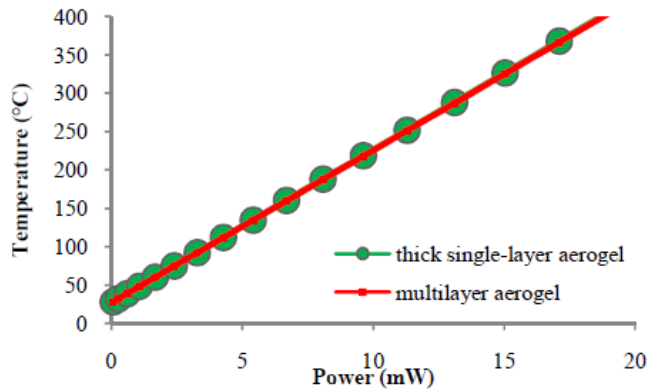
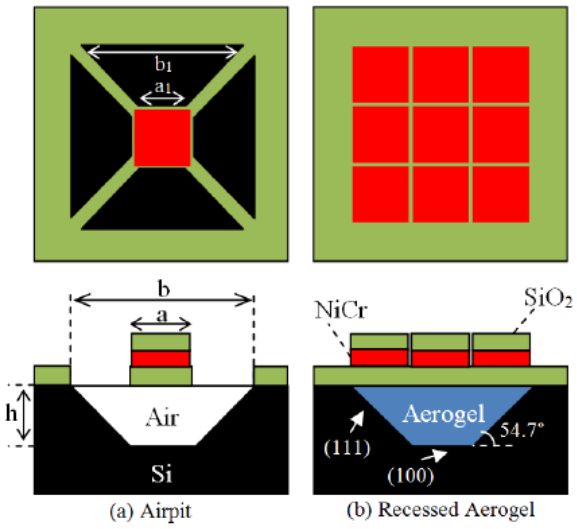
A sufficiently thick layer of aerogel is required for insulation performance. This can be achieved by depositing of a single sufficiently thick aerogel layer or multilayer processing of aerogel with multiple spin coating separated by thin SiO_2 wafers. Both methods yield similar performance metrics with the multiple coating methodology exhibiting superior manufacturing robustness.





Alternatively, a micromachined recessed pit can be filled with succulent aerogel for insulation. This permits accommodation of various heater/sensor designs where a thin-film aerogel masking could be used to provide heat insulation only in areas needed, not over the entire substrate, and compatible with CMOS processing. The results of this research show performance similar to non-recessed, layered aerogel and are in press for publication.



Design schematic of (a) a single µHP on recessed airpit and (b) array of µHP on recessed airpit filled with aerogel

UL Lafayette understands the value of this research and technology to various industries. Moreover, we recognize that for successful commercial implementation, significant industry acumen will be needed. Accordingly, UL Lafayette aims to establish industry-academic partnerships at this early stage of R&D to focus and guide the development of this technology to specifically meet the needs of our industry partner(s). To learn more about this research and/or partnership opportunities please contact UL Lafayette's Office Of Innovation Management via the information provided below.

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