Harsh environment MEMS

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Goals and Potential Impact if Successful

Operation of MEMS sensors and actuators in harsh environments (temp. up to 650 C, corrosive gas or fluid environments (e.g. hydraulics fluids, exhaust gas, etc.); temperature and flow control of micro hotplate and microfluidic systems operating in harsh env.

-Micro hotplates for gas analysis systems

-Micro dispenser/inkjet printhead technology (e.g. direct solder printing as replacement for screen printing)

-Lab-on-a-chip / DNA analysis systems

-High temperature pressure/force sensors

Materials (3C-SiC, GaN, SOI, metallisation systems) and appropriate system design (e.g. wafer/chip level packaging) for harsh environment MEMS

Improve understanding of material characteristics in harsh env. and modeling of convection and other flow effects on a micro scale to work towards improved simulation tools and better control loop

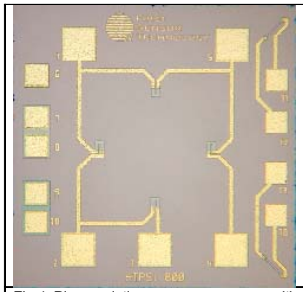

Fig.1 Piezoresistive pressure sensor with RIE etched 3-C SiC piezoresitors on SOI substrate [4].

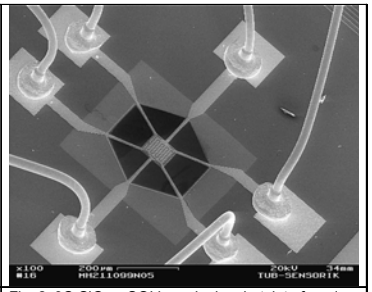

Fig. 2: 3C-SiC on SOI based micro hotplate for micro gas sensor applications (max. 650 °C/ 1000 °C) [5].

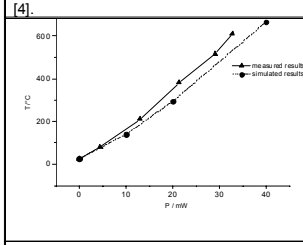

Fig. 4: Heater temperature as function of heater power for SiC-based heater with 10 µm bridge width

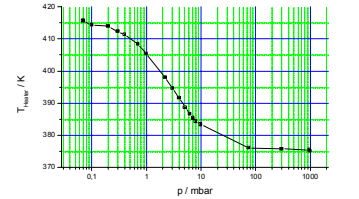

Fig. 4: Heater temperature as function of ambient pressure (8mW power consumption)

Approach and/or Accomplishments

Modeling/control:

-studies (analytical and numerical modeling and characterization) on thermal loss effects and convection behavior of micro hotplates

-improved accuracy of numerical models leading to better device predictability and device control

Materials/Fabrication technology

- Study and understand material characteristics changes upon exposure to harsh environments (temperature, corrosive gas atmospheres)
- Improve long term stability and operation temperature range of chemical and physical devices by use of new Materials (SiC, HfB_2, SOI, metal oxides)

Bottlenecks and Open Research Questions

-Reliable modeling and analysis tools (simulation software) is to a large extend unavailable, almost every "task" has to be solved individually using self written software

-Limited understanding of underlying physical/chemical effects leading to uncertainty in model building, particularly when looking at microfluidics / convection effects/surface effects, but also covering understanding of material properties in harsh environments

-Communication between technology/device researchers and application researchers as well as between adjacent fields needs to be improved: we don't make proper use of a cross sectional technology: MEMS