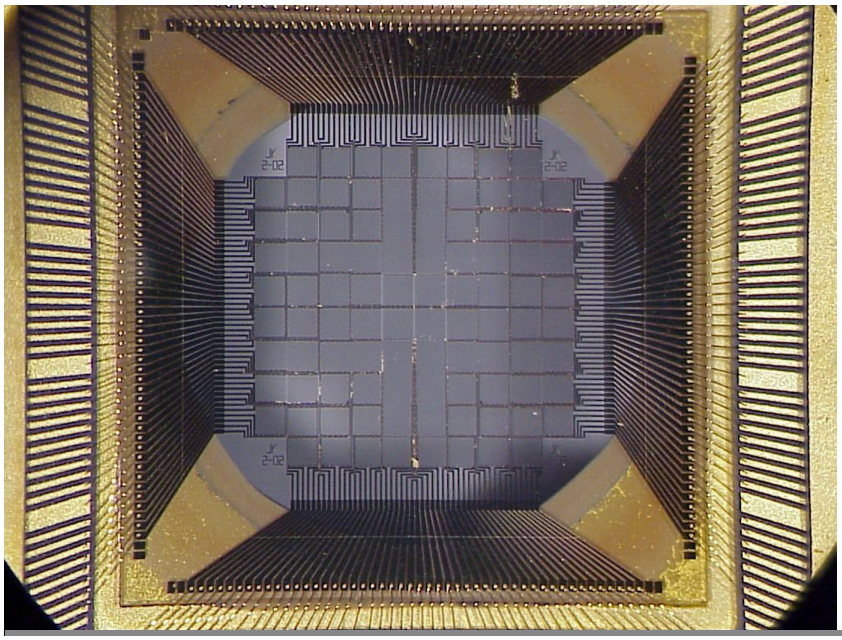

National Aeronautics and Space Administration

TECHNOLOGY SOLUTION

Electrical and Electronics

Built-in temperature sensing method in a microheater

A cost effective temperature sensing method harnessing an inherent mechanism

NASA Ames Research Center has developed an innovative built-in temperature sensing method for microheaters. The temperature sensing of chip-based microheaters, is conventionally done with the aid of a separate sensor, which typically adds to the production cost and can cause inaccuracy. These have been widely used in many applications including gas sensors, flow meters, polymerese chain reaction chambers and the hot-stage in transmission electron microscopes, where accurate monitoring of temperature is critical. NASA has developed a novel resistor-based microheater which relies on a Joule heating mechanism. The resistance is dependent on the body temperature which means that the microheater has an inherent sensing mechanism and eliminates the need for embedded sensors.

BENEFITS

- Accurate monitoring of temperature
- Accelerated response and recovery times for temperature sampling
- Enhanced sensitivity and temperature dependent specificity and selectivity
- Enables own body temperature sensing at low cost with negligible self-heating and interruption of cooling effects
- Inherent mechanism that avoids the need for an embedded sensor

THE TECHNOLOGY

This technology is a cost effective temperature sensing method that harnesses an inherent mechanism to eliminate the need for embedded sensors. The physical structures of both the Joule heater and the thermistor are equivalent in principle, i.e., a resistor, which implies that the resistor pattern can offer dual functions of heating and temperature sensing simultaneously. However, two assumptions need to be confirmed in order to assure the dual functions. First, the parasitic power during the temperature sensing operation should not heat up or cool down the system. Second, the interrupt period for the temperature sampling should be sufficiently short so as to avoid temperature perturbations. It is found that an intermittent temperature sampling in the middle of the heating cycle does not disturb the body temperature if the temperature sampling voltage and pulse width are sufficiently low and short, respectively. The built-in temperature sensing is attributed to the electrical time constant being few orders of magnitude smaller than the thermal time constant. The temperature estimation results using the built-in method show excellent agreement with the benchmark measurements from an infrared pyrometer. Intermittent interruption for the temperature sampling is found to be allowable during the heating period as long as the sampling is made at very low voltages lasting short duration. The electrical time constant of the order of tens of picoseconds is nine orders of magnitude smaller than the thermal time constant in the order of tens of milliseconds. In addition, a clock frequency of 10 megahertz that is easily affordable since low cost electronics can sample pulses of 100 nanoseconds. This results in temperature sampling within six orders magnitude faster than the time required to drop 1degree Celsius. Therefore, this method enables own body temperature sensing at low cost with negligible self-heating and interruption of cooling effects.

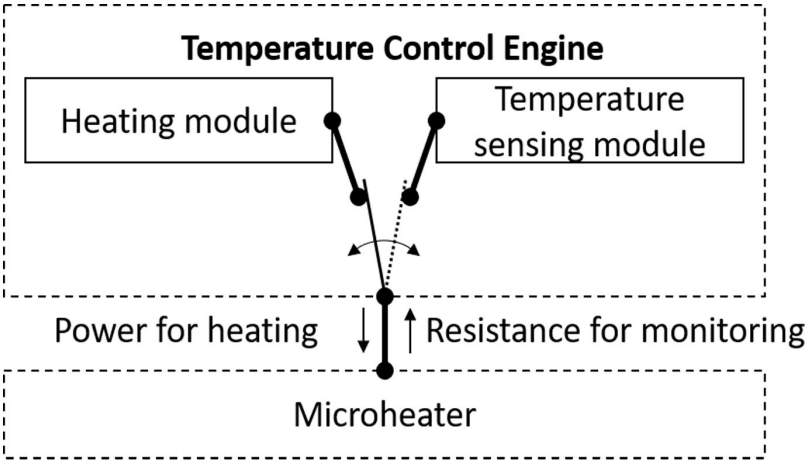

Diagram showing the operation scheme of the technology

APPLICATIONS

The technology has several potential applications:

- Electronic devices
- Microhotplate based devices
- Microelectromechanical systems
- Chip based polymerese chain reactions
- Thermosensitive resonator
- Space industry

PUBLICATIONS

Patent No: 10,816,411

http://ieeexplore.ieee.org/document/7480357/

technology.nasa.gov

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More Information

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