



## Experimental Modeling of Sterilization Effects for Atmospheric Entry Heating on Microorganisms

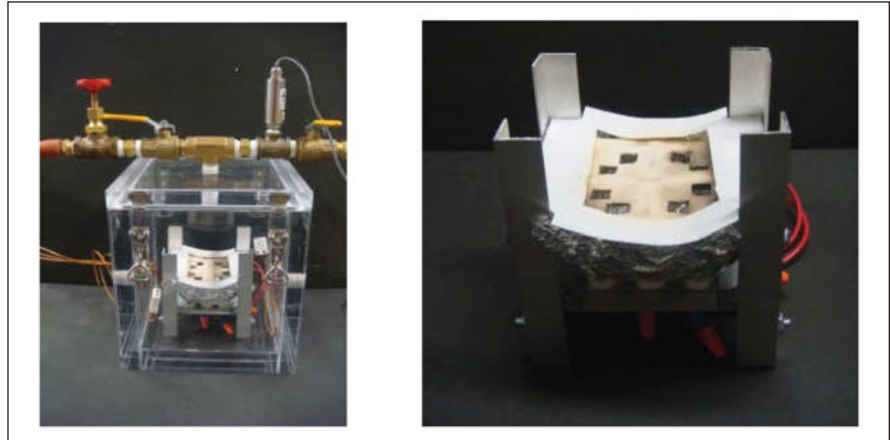
**Silicon was chosen for sample coupons.**

*NASA's Jet Propulsion Laboratory, Pasadena, California*

The objective of this research was to design, build, and test an experimental apparatus for studying the parameters of atmospheric entry heating, and the inactivation of temperature-resistant bacterial spores. The apparatus is capable of controlled, rapid heating of sample coupons to temperatures of 200 to 350 °C and above. The vacuum chamber permits operation under vacuum or special atmospheric gas mixtures.

A radiant heating system using tungsten-halogen lamps was chosen to heat the spores to the desired temperatures. This method of heating was preferred because there was no physical contact between the heater and the sample coupons, the radiant heat can be controlled more precisely than heating methods by conduction and convection, and halogen light bulbs are readily available. The design allowed for the bulbs to radiantly heat the backside of the sample coupons, avoiding possible sterilization of the spores by a method other than just heating, such as ultraviolet radiation.

The material chosen for the sample coupons was silicon, due to its favorable properties for this application. Silicon is chemically and biologically inert, and has very high thermal conductivity. Fur-



The **Experimental Apparatus** consists of a vacuum chamber (left) and the stand for the silicon chips (right).

thermore, silicon has high emissivity in the visible and near-infrared portion of the electromagnetic spectrum, and has a lower emissivity in the mid-infrared range. This means that the silicon coupons are able to absorb a significant portion of the radiation output by the halogen light bulbs, but not re-radiate much mid-infrared radiation at the sample temperatures. This unique property of silicon allows for the sample coupons to be heated very quickly and accurately using the radiant heat from the halogen

light bulbs. Furthermore, due to the widespread use of silicon in the microelectronics industry, silicon was available in very thin wafers. The low thermal mass of the thin wafers helped them heat up very quickly.

*This work was done by Wayne W. Schubert and James A. Spry of Caltech; Paul D. Ronney and Nathan R. Pandian of the University of Southern California; and Eric Welder of Stanford University for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). NPO-48091*

## Saliva Preservative for Diagnostic Purposes

**This preservative can be used in remote areas without refrigeration for at least two months.**

*Lyndon B. Johnson Space Center, Houston, Texas*

Saliva is an important body fluid for diagnostic purposes. Glycoproteins, glucose, steroids, DNA, and other molecules of diagnostic value are found in saliva. It is easier to collect as compared to blood or urine. Unfortunately, saliva also contains large numbers of bacteria that can release enzymes, which can degrade proteins and nucleic acids. These degradative enzymes destroy or

reduce saliva's diagnostic value. This innovation describes the formulation of a chemical preservative that prevents microbial growth and inactivates the degradative enzymes. This extends the time that saliva can be stored or transported without losing its diagnostic value. Multiple samples of saliva can be collected if needed without causing discomfort to the subject and it does not

require any special facilities to handle after it is collected.

The preservative contains sodium dodecyl sulfate (SDS), ethylenediaminetetraacetic acid (EDTA), and Tris buffer. This preservative was developed to preserve saliva from astronauts during spaceflight without refrigeration to determine if virus DNA was present. Saliva with added preservative can be

stored at room temperature for up to 60 days without any measurable degradation. Viral DNA is routinely measured from saliva stored in this manner without refrigeration. Thus, this preservative can be used to preserve critical macromolecules (nucleic acids and proteins) without consuming power resources. This preservative has been used on flight experiments aboard both the Space Shuttle and the International Space Station.

Saliva contains hormones such as cortisol and DHEA, cytokines (immune markers), DNA and RNA viruses, antibodies, and many other substances of diagnostic value. Saliva also contains

many bacteria that produce proteases that destroy proteins, nucleases that destroy DNA and RNA, and other degradative enzymes. Typically, saliva and other body fluids are refrigerated (or frozen) to prevent or slow the degradation process. Refrigeration and freezers are extremely limited resources in spacecraft, undeveloped countries, and during activities away from electricity. Although not tested, the preservative is expected to be effective for other body fluids such as urine and blood. In addition, the toxicity of the preservative is very low.

The preservative consists of 0.5% sodium dodecylsulfate (a detergent),

1.0 mM EDTA (a metal chelator), and 1.0 mM Tris (a buffer to maintain correct pH). The preservative is stable at room temperature for at least six months. A small volume of the liquid preservative is added to saliva (or other body fluids), the mixture is mixed by inversion, and then is left undisturbed at room temperature until the analysis is conducted. No other preservative has been identified that stabilizes saliva and other body fluids at room temperature for subsequent analyses.

*This work was done by Duane L. Pierson of Johnson Space Center and Satish K. Mehta of EASI. Further information is contained in a TSP (see page 1). MSC-25144-1*

## Hands-Free Transcranial Color Doppler Probe

**These probes enable full use of TCD technology for neurological diagnostics.**

*Lyndon B. Johnson Space Center, Houston, TX*

Current transcranial color Doppler (TCD) transducer probes are bulky and difficult to move in tiny increments to search and optimize TCD signals. This invention provides miniature motions of a TCD transducer probe to optimize TCD signals.

The mechanical probe uses spherical bearing in guiding and locating the tilting crystal face. The lateral motion of the crystal face as it tilts across the full range of motion was achieved by minimizing the distance between the pivot location and the crystal face. The smallest commonly available metal spherical bearing was used with an outer diameter of 12 mm, a 3-mm tall retaining ring, and 5-mm overall height. Small geared motors were used that would provide sufficient power in a very compact package. After confirming the validity of the basic positioning concept, optimization design loops were completed to yield the final design.

A parallel motor configuration was used to minimize the amount of space wasted inside the probe case while minimizing the overall case dimensions. The distance from the front edge of the crys-

tal to the edge of the case was also minimized to allow positioning of the probe very close to the ear on the temporal lobe. The mechanical probe is able to achieve a  $\pm 20^\circ$  tip and tilt with smooth repeatable action in a very compact package. The enclosed probe is about 7 cm long, 4 cm wide, and 1.8 cm tall.

The device is compact, hands-free, and can be adjusted via an innovative touchscreen. Positioning of the probe to the head is performed via conventional transducer gels and pillows. This device is amendable to having advanced software, which could intelligently focus and optimize the TCD signal.

The first effort will be development of monitoring systems for space use and field deployment. The need for long-lived, inexpensive clinical diagnostic instruments for military applications is substantial. Potential future uses of this system by NASA and other commercial end-users include monitoring cerebral blood flow of ambulatory patients, prognostic of potential for embolic stroke, ultrasonic blood clot treatment, monitoring open-heart and carotid endarterectomy surgery, and resolution of the

controversy regarding transient ischemic attacks and emboli's role. Monitoring applications include those for embolism formation during diving ascents, changes in CBFV (cerebral blood flow velocity) in relation to cognitive function as associated with sick building syndrome or exposure to environmental and workplace toxins, changes of CBFV for testing and evaluating Gulf War Syndrome, and patients or subjects while moving or performing tasks.

*This work was done by Robert Chin of Gen-eXpress Informatics, and Srihdar Madala and Graham Sattler of Indus Instruments for Johnson Space Center. Further information is contained in a TSP (see page 1).*

*In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:*

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*Refer to MSC-24702-1, volume and number of this NASA Tech Briefs issue, and the page number.*