NASA TECH BRIEF

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Quartz Crystal Microbalance Used in Biological Studies

Quartz crystals have been used as sensitive microbalances to detect changes in mass of the order of 10^{-11} g. For this purpose, the crystals are used as oscillators; the fundamental frequency of a crystal is changed when a mass of material is deposited on its surfaces. The change in frequency that is observed with similar crystals (same cut, etc.) for equal mass increments is nearly the same, but since the sensitivity to mass changes as a function of temperature and is somewhat variable from crystal to crystal, a calibration factor must be established under controlled environmental conditions for each crystal.

Two-crystal microbalances have been used in studies of the relationship between spore survival and mass change when spores are exposed to various conditions of temperature, humidity, and vacuum. Four two-crystal systems are used in conjunction with identical monitoring systems and a vacuum chamber which includes nine resistance-heaters and four temperature sensors. The chamber can be brought to a temperature of 125°C in about two minutes, and it has been designed to minimize the mass and volume to be heated. Its size is such that it can be inserted into an available constant-humidity cabinet.

The crystals may be used individually, in a variety of combinations, or in pairs with one crystal as a reference and the other as a sensor for changes of mass. Two types of crystals have been used, one being stable at 25°C and the other at 125°C. Each crystal is connected by a triaxial cable to its associated oscillator circuitry; the inner shield is fed with voltage in phase with the "hot" lead from a low-impedance source in the oscillating circuit and the outer shield is the crystal voltage return. This arrangement minimizes capacitance effects between the crystal and the oscillator input; more importantly, however, it is possible to separate the crystal from the oscillator circuit by distances up to twelve feet at a frequency of five megahertz.

Studies of the effect of vacuum on a mass of bacterial spores were performed with the quartz crystal microbalance. A quartz crystal was seeded with 10 microliters of an aqueous suspension of *B. subtilis* var. *niger* (10^9 viable spores per ml); the other was operated as the control. The inoculated crystal was allowed to dry at 24°C and a relative humidity of 46 percent. Application of a vacuum produced a mass loss of 6.8 micrograms; upon release of the vacuum, the regained mass over a period of 8 minutes corresponded to 0.5 microgram, but the total mass gain rapidly became 6 micrograms after an additional equilibration period of 4 minutes.

In another series of tests, 5.3×10^7 bacterial spores were brought to a temperature of 125°C. Typically, 30-minute heating periods caused losses of 1.2 to 3.6 micrograms; from 11 to 14 percent of the spores survived. On the other hand, for 60-minute periods of exposure at 125°C, only 1.4 to 1.5 percent of the spores survived; weight losses ranged from 4.2 to 8.1 micrograms.

(continued overleaf)

Note:

Requests for further information may be directed to:

Technology Utilization Officer
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4800 Oak Grove Drive
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Reference: TSP 72-10243

Patent status:

No patent action is contemplated by NASA.

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(NPO-11346)