quency range from 300 to 600 GHz (see figure). The part of the microfluidic channel lying in the waveguide would constitute an interaction volume. The dimensions of the interaction volume would be chosen in accordance with the anticipated amount of solid sample material needed to ensure extraction of sufficient amount of target molecules for detection and analysis. By means that were not specified at the time of reporting the information for this article, the solid sample material would be placed in the interaction volume. Then the electromagnetic field would be imposed within the waveguide and water would be pumped through the interaction volume to effect the extraction.

This work was done by Xenia Amashukeli, Harish Manohara, Goutam Chattopadhyay, and Imran Mehdi of Caltech for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov. NPO-46150

Microwell Arrays for Studying Many Individual Cells

Lyndon B. Johnson Space Center, Houston, Texas

"Laboratory-on-a-chip" devices that enable the simultaneous culturing and interrogation of many individual living cells have been invented. Each such device includes a silicon nitride-coated silicon chip containing an array of micromachined wells sized so that each well can contain one cell in contact or proximity with a patch clamp or other suitable single-cell-interrogating device. At the bottom of each well is a hole, typically ≈ 0.5 μm wide, that connects the well with one of many channels in a microfluidic network formed in a layer of poly(dimethylsiloxane) on the underside of the chip. The microfluidic network makes it possible to address wells (and, thus, cells) individually to supply them with selected biochemicals. The microfluidic channels also provide electrical contact to the bottoms of the wells.

This work was done by Albert Folch and Turgut Fettah Kosar of the University of Washington for Johnson Space Center. For further information, contact the JSC Innovation Partnerships Office at (281) 483-3809.

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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Office of Technology Licensing
University of Washington
1107 NE 45th Street, Suite 200
Seattle, WA 98105

Refer to MSC-24046-1, volume and number of this NASA Tech Briefs *issue, and the page number.*

Droplet-Based Production of Liposomes

Lyndon B. Johnson Space Center, Houston, Texas

A process for making monodisperse liposomes having lipid bilayer membranes involves fewer, simpler process steps than do related prior methods. First, a microfluidic, cross-junction droplet generator is used to produce vesicles comprising aqueous-solution droplets contained in single-layer lipid membranes. The vesicles are collected in a lipid-solvent mix that is at most partially soluble in water and is less dense than is water. A layer of water is dispensed on top of the solvent. By virtue of the difference in densities, the water sinks to the bottom and the solvent floats to the top. The vesicles, which have almost the same density as that of water, become exchanged into the water instead of floating to the top. As there are excess lipids in the solvent solution, in order for the vesicles to remain in the water, the addition of a second lipid layer to each vesicle is energetically favored.

The resulting lipid bilayers present the hydrophilic ends of the lipid molecules to both the inner and outer membrane surfaces. If lipids of a second kind are dissolved in the solvent in sufficient excess before use, then asymmetric liposomes may be formed.

This work was done by Donald E. Ackley and Anita Forster of Nanotrope, Inc. for Johnson Space Center. For further information, contact the JSC Innovation Partnerships Office at (281) 483-3809.

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-24302-1, volume and number of this NASA Tech Briefs *issue, and the page number.*

Identifying and Inactivating Bacterial Spores

NASA's Jet Propulsion Laboratory, Pasadena, California

Problems associated with, and new strategies for, inactivating resistant organisms like *Bacillus canaveralius* (found at Kennedy Space Center during a survey of three NASA cleanrooms) have been defined. Identifying the particular component of the spore that allows its heightened resistance can guide the development of sterilization procedures that are targeted to the specific molecules responsible for resistance, while avoiding using unduly harsh methods that jeopardize equipment.

The key element of spore resistance is a multilayered protein shell that encases the spore called the spore coat. The coat of the best-studied spore-forming mi-

crobe, *B. subtilis*, consists of at least 45 proteins, most of which are poorly characterized. Several protective roles for the coat are well characterized including resistance to desiccation, large toxic molecules, ortho-phthalaldehyde, and ultraviolet (UV) radiation.

One important long-term specific goal is an improved sterilization procedure that will enable NASA to meet planetary protection requirements without a terminal heat sterilization step. This would support the implementation of planetary protection policies for life-detection missions. Typically, hospitals and government agencies use biological indicators to ensure the quality control of sterilization processes. The spores of *B. canaveralius* that are more resistant to osmotic stress would serve as a better biological indicator for potential survival than those in use currently.

This work was done by David Newcombe, Anne Dekas, and Kasthuri Venkateswaran of Caltech for NASA's Jet Propulsion Laboratory.

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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