



## Isolation of the *Paenibacillus phoenicis*, a Spore-Forming Bacterium

NASA's Jet Propulsion Laboratory, Pasadena, California

A microorganism was isolated from the surfaces of the cleanroom facility in which the Phoenix lander was assembled. The isolated bacterial strain was subjected to a comprehensive polyphasic analysis to characterize its taxonomic position. Both phenotypic and phylogenetic analyses clearly indicate that this isolate belongs to the genus *Paenibacillus* and represents a novel species.

*Bacillus* spores have been utilized to assess the degree and level of microbiological contamination on spacecraft and

their associated spacecraft assembly facilities. Spores of *Bacillus* species are of particular concern to planetary protection due to the extreme resistance of some members of the genus to space environmental conditions such as UV and gamma radiation, vacuum, oxidation, and temperature fluctuation. These resistive spore phenotypes have enhanced potential for transfer, and subsequent proliferation, of terrestrial microbes on another solar body. Due to decreased nutrient conditions within spacecraft as-

sembly facility clean rooms, the vegetative cells of *Bacillus* species and other spore-forming *Paenibacillus* species are induced to sporulate, thereby enhancing their survivability of bioreduction

*This work was done by James N. Benardini, Parag A. Vaishampayan, and Kasthuri J. Venkateswaran of Caltech; Shariff Osman of Lawrence Livermore National Laboratory; and Masataka Satomi of the Japanese National Research Institute for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov. NPO-47232*

## Monolithically Integrated, Mechanically Resilient Carbon-Based Probes for Scanning Probe Microscopy

These probes can be used in medical applications for bacteria or protein imaging.

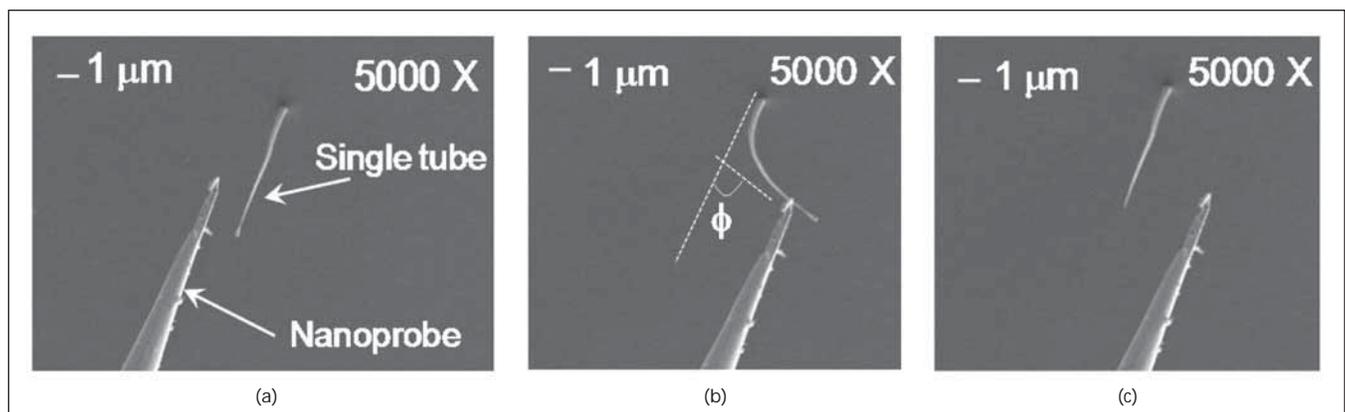
NASA's Jet Propulsion Laboratory, Pasadena, California

Scanning probe microscopy (SPM) is an important tool for performing measurements at the nanoscale in imaging bacteria or proteins in biology, as well as in the electronics industry. An essential element of SPM is a sharp, stable tip that possesses a small radius of curvature to enhance spatial resolution. Existing techniques for forming such tips are not ideal. High-aspect-ratio, monolithically integrated, as-grown carbon

nanofibers (CNFs) have been formed that show promise for SPM applications by overcoming the limitations present in wet chemical and separate substrate etching processes.

The CNFs of this innovation have been synthesized in a load-lock-based DC PECVD (plasma-enhanced chemical vapor deposition) growth chamber, where the CNF growth was done on Si substrate with high-purity acetylene

( $C_2H_2$ ) and ammonia ( $NH_3$ ) at 700 °C. The ratio of  $C_2H_2:NH_3 = [1:4]$ , which has been determined to minimize the amount of amorphous carbon on the substrate during growth. When the desired growth pressure was attained (3–15 Torr), a DC glow discharge was ignited, and growth was continued for a fixed duration. The PECVD growth parameters, such as growth pressure, catalyst thickness, and plasma power, were var-



The CNFs Are Mechanically Resilient and should enable enhanced cycling longevity for NEMS applications: (a) A nanoprobe was in close proximity to a single CNF. (b) The probe was mechanically manipulated so that it deflected the CNF to the right. The CNF accommodated large bending angle without fracture or delamination, with  $\phi \approx 70^\circ$  over tens of cycles. (c) The CNF returned elastically to its initial position after the probe was removed.