other wild type spore formers, have nevertheless been shown to survive up to six years under interstellar space conditions. Previously undescribed spore-forming species, such as *Rummelibacillus stabekisii*, may exhibit even greater resilience. It is in the best interests of NASA to thoroughly understand the physiological capabilities of each and every novel micro-organism isolated from these spacecraft-associated cleanrooms.

This work was done by Kasthuri Venkateswaran, Myron T. La Duc, and Parag A. Vaishampayan of Caltech for NASA's Jet Propulsion Laboratory. For more information, contact iaoffice@jpl.nasa.gov. NPO-46221.

Further Development of Scaffolds for Regeneration of Nerves

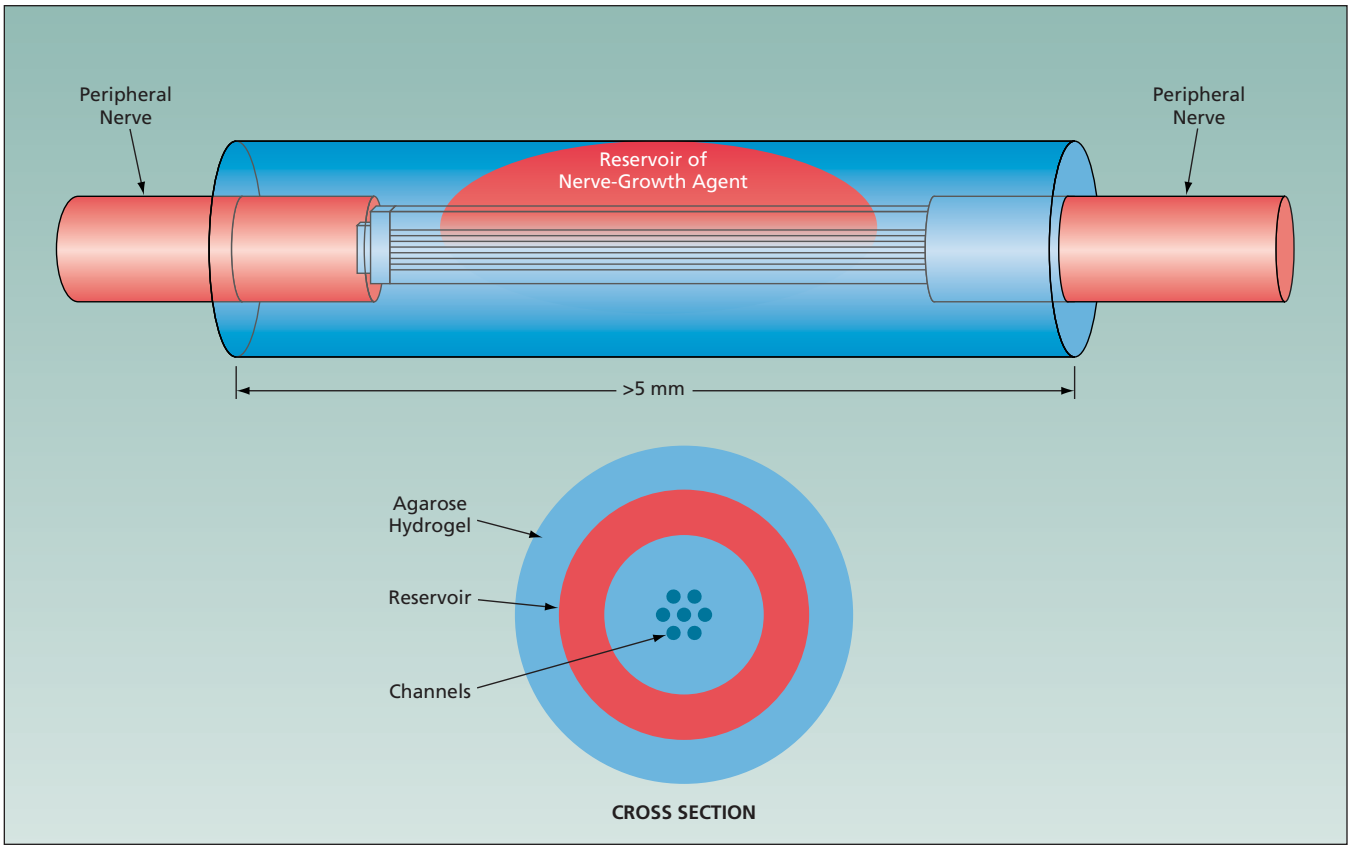
Scale-up toward clinically significant dimensions has been partially completed.

NASA's Jet Propulsion Laboratory, Pasadena, California

Progress has been made in continuing research on scaffolds for the guided growth of nerves to replace damaged ones. The scaffolds contain pores that are approximately cylindrical and parallel, with nearly uniform widths ranging from tens to hundreds of microns. At the earlier stage of development, experimental scaffolds had been made from agarose hydrogel. Such a scaffold was made in a multistep process in which poly(methyl methacrylate) [PMMA] fibers were used as templates for the pores. The process included placement of a bundle of the PMMA fibers in a tube, filling the interstices in the tube with a hot agarose solution, cooling to turn the solution into a gel, and then immersion in acetone to dissolve the PMMA fibers. The scaffolds were typically limited to about 25 pores per scaffold, square cross sections of no more than about 1.5 by 1.5 mm, and lengths of no more than about 2 mm.

To be clinically relevant, the scaffolds must be scaled up: They are required to have typical cross-sectional dimensions of the order of 1 cm and to have lengths in the approximate range of 2 to 2.5 cm. For repairs of the central nervous system, there is an additional requirement that each scaffold contain between about 100 and about 1,000 pores; for repairs of peripheral nerves, there is a requirement for sustained or timed release of brain-derived neurotrophic factor (BDNF) or another suitable nerve-growth agent to enable growth to continue to the required lengths.

The work performed since the earlier stage has been oriented toward satisfying these and other requirements. The work has included development of a more-complex version of the prior multistep process that has made it possible to partly satisfy the scaling-up requirements in that scaffolds having cross sections exceeding 1 cm^2 in area and lengths up to 1 cm have been fabricated. One notable feature of the present version of the process is a multistep subprocess in which a template of polystyrene (PS) fibers is made from a composite of polystyrene fibers surrounded by a continuous PMMA matrix. Another notable fea-



A **Nerve-Growth Scaffold** containing a reservoir of a nerve-growth agent would be attached to severed ends of a peripheral nerve.

ture of the present version of the process is the use of centrifugation to ensure complete permeation of the template by the hot agarose solution.

To satisfy the requirement for sustained or timed release of nerve-growth agents, it has been proposed to incorporate, into scaffolds, reservoirs containing such agents. In cases in which the agent is BDNF, the proposal encompasses an alternative approach in which the reservoirs would be filled with genetically engineered cells that secrete BDNF. The figure illustrates the proposal as it might be implemented in a scaffold that would be attached to the severed ends of a peripheral nerve. Attached to the scaffold would be open-ended sleeves that would enable attachment to the severed nerve ends. The pores in the scaffold would serve as channels to guide the growth of the nerve ends toward each other. The reservoir containing the nerve-growth agent would be integrated into the outer wall of the scaffold. The nerve-growth agent would be delivered from the reservoir to the channels by diffusion through the agarose hydrogel matrix.

This work was done by Jeffrey Sakamoto of Caltech and Mark Tuszynski of UC San Diego 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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Refer to NPO-45303, volume and number of this NASA Tech Briefs *issue, and the page number.*

Chemically Assisted Photocatalytic Oxidation System

Lyndon B. Johnson Space Center, Houston, Texas

The chemically assisted photocatalytic oxidation system (CAPOS) has been proposed for destroying microorganisms and organic chemicals that may be suspended in the air or present on surfaces of an air-handling system that ventilates an indoor environment. The CAPOS would comprise an upstream and a downstream stage that would implement a tandem combination of two partly redundant treatments. In the upstream stage, the air stream and, optionally, surfaces of the air-handling system would be treated with ozone, which would be generated from oxygen in the air by means of an electrical discharge or ultraviolet light. In the second stage, the air laden with ozone and oxidation products from the first stage would be made to flow in contact with a silica-titania photocatalyst exposed to ultraviolet light in the presence of water vapor. Hydroxyl radicals generated by the photocatalytic action would react with both carbon-containing chemicals and microorganisms to eventually produce water and carbon dioxide, and ozone from the first stage would be photocatalytically degraded to O_2. The net products of the two-stage treatment would be H_2O, CO_2, and O_2.

This work was done by Jean Andino, Chang-Yu Wu, David Mazyck, and Arthur A. Teixeira of the University of Florida 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-23828-1, volume and number of this NASA Tech Briefs *issue, and the page number.*

Use of Atomic Oxygen for Increased Water Contact Angles of Various Polymers for Biomedical Applications

Improved polymer hydrophilicity is beneficial for cell culturing and implant growth.

John H. Glenn Research Center, Cleveland, Ohio

The purpose of this study was to determine the effect of atomic oxygen (AO) exposure on the hydrophilicity of nine different polymers for biomedical applications. Atomic oxygen treatment can alter the chemistry and morphology of polymer surfaces, which may increase the adhesion and spreading of cells on Petri dishes and enhance implant growth. Therefore, nine different polymers were exposed to atomic oxygen and water-contact angle, or hydrophilicity, was measured after exposure. To determine whether hydrophilicity remains static after initial atomic oxygen exposure, or changes with higher fluence exposures, the contact angles between the polymer and water droplet placed on the polymer's surface were measured versus AO fluence. The polymers were exposed to atomic oxygen in a 100-W, 13.56-MHz radio frequency (RF) plasma asher, and the treatment was found to significantly alter the hydrophilicity of non-fluorinated polymers.

Pristine samples were compared with samples that had been exposed to AO at various fluence levels. Minimum and maximum fluences for the ashing trials were set based on the effective AO erosion of a Kapton witness coupon in the asher. The time intervals for ashing were determined by finding the logarithmic values of the minimum and maximum fluences. The difference of these two values was divided by the desired number of intervals (ideally 10). The initial desired fluence was then multiplied by this result (2.37), as was each subsequent desired fluence. The flux in the asher was determined to be approximately 3.0×10^{15} atoms/cm^2 sec, and each polymer was exposed to a maximum fluence of 5.16×10^{20} atoms/cm^2.

It was determined that after the shortest atomic oxygen exposure (fluence of 2.07×10^{18} atoms/cm^2), non-