pores (as much as 7×10^{10} cm^{-2}), and lengths of pores (up to about 100 nm) can be tailored by selection of fabrication conditions.

In a given case, the catalytic metal, catalytic metal alloy, or catalytic-metal/polytetrafluoroethylene composite is electrodeposited in the pores of the alumina nanotemplate. The dimensions of the pores, together with the electrodeposition conditions, determine the sizes and surface areas of the catalytic particles. Hence, the small features and large surface areas of the porosity translate to the desired small particle size and large surface area of the catalyst (see figure).

When polytetrafluoroethylene is included, it is for the purpose of imparting hydrophobicity in order to prevent water from impeding the desired diffusion of gases through the catalyst layer. To incorporate polytetrafluoroethylene into a catalytic-metal/polytetrafluoroethylene nanocomposite, one suspends polytetrafluoroethylene nanoparticles in the electrodeposition solution. The polytetrafluoroethylene content can be varied to obtain the desired degree of hydrophobicity and permeability by gas.

This work was done by Nosang Myung, Sekharipuram Narayanan, and Dean Wiberg of Caltech for NASA's Jet Propulsion Laboratory. 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:

Innovative Technology Assets Management
JPL
Mail Stop 202-233
4800 Oak Grove Drive
Pasadena, CA 91109-8099
(818) 354-2240
E-mail: iaoffice@jpl.nasa.gov

Refer to NPO-30840, volume and number of this NASA Tech Briefs *issue, and the page number.*

Capillography of Mats of Nanofibers

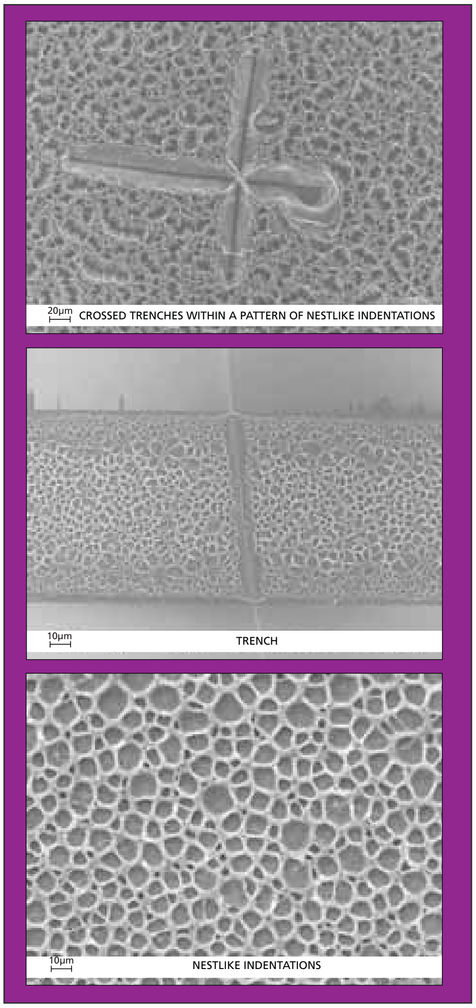
These mats can be the basis of small devices and instruments.

NASA's Jet Propulsion Laboratory, Pasadena, California

Capillography (from the Latin capillus, "hair", and the Greek graphein, "to write") is a recently conceived technique for forming mats of nanofibers into useful patterns. The concept was inspired by experiments on carpetlike mats of multiwalled carbon nanotubes. Capillography may have the potential to be a less-expensive, less-time-consuming alternative to electron-beam lithography as a means of nanoscale patterning for the fabrication of small devices and instruments.

In capillography, one exploits the lateral capillary forces exerted on small objects that pierce the surface of a liquid. If the small objects are identical, then the forces are always attractive. Two examples of the effects of such forces are the agglomeration of small particles floating on the surface of a pond and the drawing together of hairs of a wet paintbrush upon removal of the brush from water. Because nanoscale objects brought into contact remain stuck together indefinitely due to Van der Waals forces, patterns formed by capillography remain even upon removal of the liquid.

For the experiments on the mats of carbon nanotubes, a surfactant solution capable of wetting carbon nanotubes (which are ultra-hydrophobic) was prepared. The mats were wetted with the solution, then dried. Once the mats were dry, it was found that the nanotubes had become ordered into various patterns, including nestlike indentations, trenches, and various combinations thereof (see figure).



These **Scanning Electron Micrographs** show representative patterns formed in mats of multiwalled carbon nanotubes that were wetted with a surfactant solution and then dried.

It may be possible to exploit such ordering effects through controlled wetting and drying of designated portions of mats of carbon nanotubes (and, perhaps, mats of nanofibers of other materials) to obtain patterns similar to those heretofore formed by use of electron-beam lithography. For making patterns that include nestlike indentations, it has been conjectured that it could be possible to control the nesting processes by use of electrostatic fields. Further research is needed to understand the physics of the patterning processes in order to develop capabilities to control patterns formed in capillography.

This work was done by Flavio Noca, Elijah Sansom, Jijie Zhou, and Mory Gharib of Caltech for NASA's Jet Propulsion Laboratory. For 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:

Innovative Technology Assets Management
JPL
Mail Stop 202-233
4800 Oak Grove Drive
Pasadena, CA 91109-8099
(818) 354-2240
E-mail: iaoffice@jpl.nasa.gov

Refer to NPO-40980, volume and number of this NASA Tech Briefs *issue, and the page number.*