microscopy showed that the dried products prepared by both acid and base catalysis consist of aggregates of fibers ~200 μm long and 150–600 nm in diameter. Similar fiber aggregates were observed for the assemblies produced by the organogelator alone, proving its role as the template. The fibers produced by acid-catalyzed polymerization were smooth, while those produced by base-catalyzed polymerization had rough surfaces. This difference was ascribed to the production of TiO_2 particles during base-catalyzed polymerization.

Unlike the dried product, the calcined samples exhibited fiber structures only when the polymerization was base-catalyzed. This result is consistent with the presence of anionic propagation species during base-catalyzed sol-gel polymerization. These negatively charged intermediates adsorb onto the positively charged organogelator template, and the polymerization proceeds along the template. Transmission electron micrographs of the calcined base-catalyzed product show that the nanofibers are hollow and have internal diameters of 50–150 nm. X-ray diffraction studies of the calcined nanofibers show that they have the desired anatase structure.

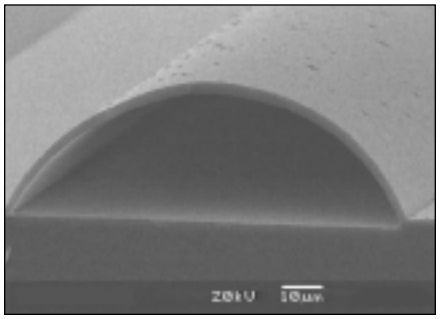
GREGORY KHITROV

Low-Temperature Process Produces Microcanals for Microfluidic Chips

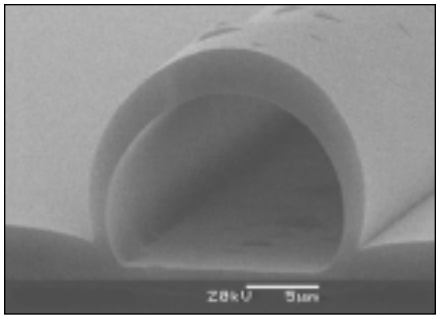
Researchers at Sandia National Laboratories have developed a microchip processing technique that creates raised microscopic canals on chips, through which liquids or gases can flow from one chip feature to another. The raised hemispherical canals, 8–100 μm in diameter, have been created on silicon, glass, and quartz surfaces. Some of the canals have been made with curvatures with radii as small as 8 μm. These canals can be small enough and curvy enough that some liquids or gases pass easily through them and others pass more slowly. This ability to distinguish among fluidic materials is useful for chemical-separation applications, the most common use of microfluidic devices.

To make the canals, the researchers pattern a thin layer of photoresist on the wafer's surface using a conventional photo mask and light, then develop away areas of photoresist exposed to the light, leaving a network of photoresist ridges on the wafer's surface that eventually becomes the canals' interiors.

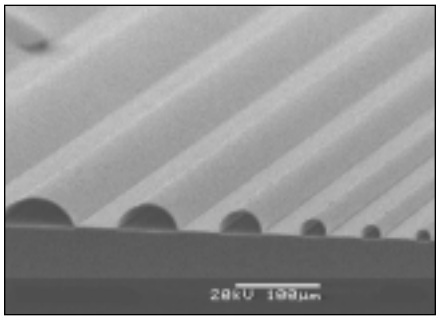
Next, they heat the wafer to a relatively low temperature of 100°C for about 20 s, which causes the square-edged ridges to slump into a hemispherical shape. A 2-μm-thick film of silicon oxynitride is deposited over the rounded photoresist, and the entire wafer is soaked in an acetone bath until the remaining photoresist is dissolved, leaving hollow tunnels on the wafer's surface.



Radius of curvature: 52 μm



Radius of curvature: 8 μm



Microscopic views of raised hemispherical canals 8–100 μm in diameter.

The traditional trench-and-seal method involves the joining of two pre-trenched wafers. But the intense heat required for bonding—up to 1000°C—can damage other chip features, and the care required to remove contaminant particles from the two halves increases the difficulty and cost of manufacturing.

The newly developed and patented technique is 10 to 100 times faster than the trench-and-seal method, said co-developer Carol Ashby. She said that the resulting tunnels are virtually indestructible.

Co-developer Carolyn Matzke of Sandia's Compound Semiconductor Research Laboratory said that the technique's compatibility with standard semiconductor batch-processing tools should allow future microfluidic devices to be made quickly and cheaply in a microchip factory.

Calculations Indicate that 2D Photonic Crystals Based upon Archimedean-Like Tilings Have Nearly Isotropic Properties

Two-dimensional (2D) artificial crystals with photonic-band structures can be used for applications such as microwave or millimeterwave filters for rf photonics or for suppression of spontaneous emission in microcavity resonators. However, 2D photonic crystals based upon real 2D crystals belong to one of the five 2D Bravais lattices. These crystals possess few symmetry elements and are too few to achieve ideal optical isotropy. In calculations performed by S. David, A. Chelnokov, and J.-M. Lourtioz of the Institut d'Electronique Fondamentale at the Université Paris-Sud, three Archimedean-like 2D tiling configurations were considered. Each of these configurations displayed 12-fold symmetry, making the resulting 2D crystal nearly photoisotropic, as they reported in the July 15 issue of *Optics Letters.*

Complete tiling of a plane with a single type of regular polygon can only occur for squares, triangles, and hexagons. However, combinations of squares, triangles, and hexagons can be used to completely tile a plane. The researchers described the Archimedean tilings as "regular convex polygons that are not necessarily identical, but are identically arranged around each vertex." The five 2D Bravais lattices are a subcategory of Archimedean tilings. Three tilings used in this experiment are composed of squares and equilateral triangles. Atoms are then assigned to either square or triangular Bravais lattices, thus allowing definition of Wigner cells. This enabled the team to investigate these theoretical entities with numerical methods, generating information on their band structure and gaps as a function of lattice direction.

Theoretical diffraction patterns of these systems are generated with Fourier transform calculations. The result is a set of points that outlines the vertices of a dodecagon, implying 12-fold symmetry. The plane-wave method was used to construct band diagrams for these crystals. Calculations were performed on main crystallographic directions for both transverse electric (TE) and transverse magnetic (TM) polarizations. These results were

https://doi.org/10.1557/mrs2000.134 Published online by Cambridge University Press