# Light Splash

## Transparent pipes shape microstructures

**A little high-tech plumbing and colored** water may change how engineers make miniaturized fluid-carrying structures.

A team at the University of Washington in Seattle has added a new twist to the light-blocking patterns, or photomasks, used like stencils in microchip manufacturing. They've invented photomasks containing tiny, transparent pipes into which the engineers have injected dyes that dim the ultraviolet (UV) radiation passing through. Where less UV light penetrates the photomask, there's less breakdown of the photosensitive coatings, called photoresists, that cover chips during processing. The coating left behind forms a structure of varying heights that can serve as a mold.

With their additional control over UV exposure, the researchers have patterned polymeric materials with microscopic ramps, stairs, and other complex shapes. Such graded 3-D polymer structures may go into microfluidic devices—networks of microscopic pipes, pumps, and valves that can function, for instance, as teeny chemistry labs (*SN: 9/28/02, p. 198*).

Bioengineer Albert Folch says that these new masks, which are themselves microfluidic devices, could be used to create improved miniature fluid networks. Such devices would have channels of various depths and find uses including medical diagnostics, testing drugs in cells, and sensing biological agents.

Folch, Chihchen Chen, and Danny Hirdes describe their microfabrication method in the Feb. 18 *Proceedings of the National Academy of Sciences*.

Tiny 3-D structures are tough to construct with conventional photomasks, which generally yield flat components, notes Folch. Typical masks are made of metal patterns deposited on glass and have no internal plumbing. They project only all-or-nothing light patterns onto a photoresist, resulting in microstructures of uniform height. To make variable-height structures, engineers now use multiple exposures of multiple stencils, all of which must be in perfect register.

To develop an alternative approach, Folch and his colleagues laid down ridges of photoresist on a silicon wafer. They coated these ridges with the transparent polymer polydimethylsiloxane and permitted the material to cure. Then they peeled the polymer skin, now laced with channels, from the silicon to use as their adjustable photomask.

To then make molds for microfluidic devices with channels of varying depths, the team filled the new mask's channels with dye solutions of differing concentrations. Under intense light, the mask rendered ridges of photoresist in various heights on other wafers.

Engineers can quickly change the dye configuration in such a mask to make a different device, points out David Beebe of the University of Wisconsin–Madison. By adding this new technique to a growing toolkit, "we could now make almost any microscale structure as fast as you can [design] the mask on the computer," he says. —P. WEISS