iron-dominated core, explains Heckel. "So one wants to know that the Earth and moon don't fall at different rates due to composition differences, and by an amount which could cancel a gravitational self-energy effect," adds Nordtvedt. Such a cancellation is "quite unlikely," but the Seattle group has sought to resolve this potential ambiguity.

The Seattle experiment, reported in this week's *Physical Review Letters*, consists of a torsion balance: a fine wire supporting a tray that can rotate by twisting the wire. On the tray are four weights, alternating toy Earths and moons, all weighing exactly 10 grams. The two Earth-like weights are made of steel to simulate Earth's core material, while the two moon-like weights are made of quartz and magnesium-based materials that simulate both the Earth's and the moon's mantle material. The whole experiment is rotated so that the "planets" turn past the sun in 40-minute-long "days." Any gravitational preference of the sun for the toy moon or toy Earth should yield a twist in the torsion balance. "It's a very clever idea, making these little models for the planets," says Clifford Will at Washington University, St. Louis. The experimenters have produced "extraordinarily precise measurements."

The team found no twist. Their results, combined with the laser ranging, show that "gravitational binding energy falls at the same rate as all other forms of mass-energy to better than a part per thousand," says Heckel. Heckel declares himself unsurprised at the result, and Einstein's theory triumphs yet again.

Yet there's some comfort for the string theorists too, says Will, because differences in the rates of fall of different bodies could lie beyond the sensitivity of current experiments. "We really think there's a chance of finding a violation at some level," Will says. So the dating game continues, but gravity remains as aloof and celibate as ever.

–ANDREW WATSON

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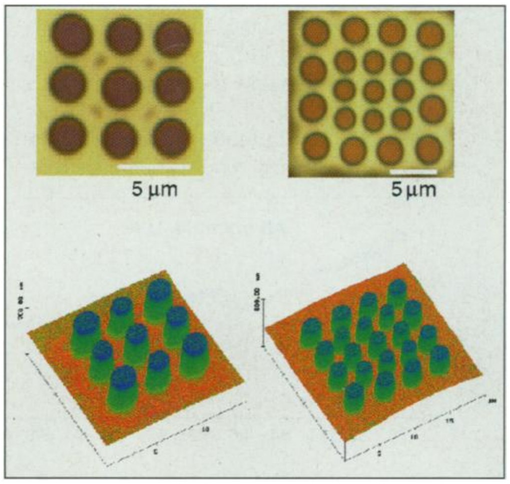
NANOTECHNOLOGY

Patterning Plastic With Plentiful Pillars

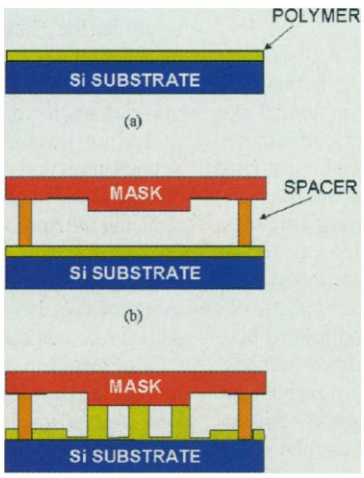
RICHMOND, VIRGINIA—Rome wasn't built in a day, but a nanosized version of it may be in the near future. At the International Symposium on Cluster and Nanostructure Interfaces here last week, Stephen Chou, an electrical engineer from Princeton University in New Jersey, described a new microscopic patterning technique capable of creating arrays of plastic pillars, each less than a thousandth of a millimeter across, that resemble nothing so much as tiny versions of the great columns of Rome's coliseum. Cheap, fast, and versatile, the patterning scheme could help create novel plastic displays and electronic devices. The pillars themselves could not only be used as wires in plastic electronics, but could also direct the growth of other materials, such as metals and semiconductors, into regular patterns.

"It's very beautiful work," says Peru Jena, a physicist at the Virginia Commonwealth University in Richmond. It's the beauty of simplicity, says Jena, because the technique requires nothing more than putting a mask above a heated thin polymer film and waiting a few minutes while the pillars assemble themselves. Chou says that, at around 500 nanometers in diameter, the pillars are now more than twice as large as the finest features that photolithography—the workhorse patterning technology of the chip industry—can lay down on silicon. Nevertheless, K. V. Rao, a physicist at the Royal Institute of Technology in Stockholm, Sweden, points out that photolithography has been refined over decades. As for the new technique, "this is just the beginning," he says.



All rise. Polymer pillars rise from a flat molten polymer layer toward an adjacent mask.

It was an unexpected beginning, Chou says. He and his students were working on a related patterning technique in which they imprint a pattern of nano-sized ridges and grooves on a soft polymer with a tiny embossing stamp. In one experiment, however, tiny dust grains, each about 0.5 micrometers high, strayed onto the polymer before the stamp was applied. Like tiny boulders, the dust grains prevented the stamp from pushing into the polymer and making an impression. Yet when the Princeton researchers removed the stamp and looked at the surface of the film, they still saw a pattern of dots that matched features on the stamp. The stamp had somehow elicited a pattern without ever touching the surface.



Self-made. Electrical attractions caused pillars to take shape.

Surprised, they repeated the experiment to see if they could find out what had happened. They created another set of masks, this time incorporating tiny posts that held them about half a micrometer above the polymer surface, and again they saw the array of dots. Those dots turned out to be tiny polymer pillars that had grown up from the surface of the plastic layer to the mask.

"We still can't be sure" what causes the pillars to form, Chou says. He and his colleagues have determined that a polymer film produces pillars only when it is heated enough to melt and the masking material above is electrically conductive, which leads Chou to speculate that the interplay of electrical charges in the mask and the polymer film creates the pillars. Localized concentrations of charge in the mask likely induce an opposite charge in the nearby film, he says, generating electrostatic forces that pull the pliable polymer upward.

If correct, says Chou, this explanation suggests that the pillars should form first at the corners of the mask, since charges preferentially bunch there. And when the Princeton team set up a video camera to watch their pillars grow, they found that pillars formed first at the corners and edges of the film below the mask and slowly worked their way in toward the center.

So far, Chou and his colleagues have made most of their pillars in a polymer called polymethylmethacrylate, more commonly known as plexiglass. But the technique also works with conducting polymers, which could serve as the basis of futuristic flat panel displays and disposable electronics. To test whether their pillars could make conductive wires for such devices, Chou and his colleagues laid down a film of conducting polymer on a metal strip and then grew pillars upward to touch another metal strip passing over the first at right angles. The group hasn't tested the electrical behavior of the pillars, but Chou says he fully expects that they will provide conductive pathways between the metal conductors. If so, plastic pillars may be in for a rising future.

–ROBERT F. SERVICE

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