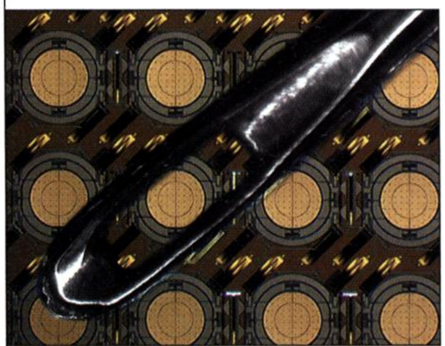
Taking the Initiative

It has been almost a decade since *Science* devoted a special issue to nanotechnology, and even the title of that issue ("Engineering a Small World," 29 November 1991) reflected the scarcity of actual working nanotechnology at the time. Like others, we pointed to Richard Feynman's 1959 lecture "There's Plenty of Room at the Bottom" to provide some justification for why nanotechnology would emerge as a discipline from early efforts in atomic imaging and nanofabrication. The present special issue can reflect only some of the current trends in this rapidly expanding area.

In the News section (p. 1524), writer Robert Service surveys nanotechnology's near-term prospects: the role of funding infusions, such as the U.S. National Nanotechnology Initiative and its European and Japanese counterparts, and the real promise of new materials and devices. He also takes a jaundiced view of some of the prophecies of boom and doom made by the field's boosters and critics. Meanwhile, amid the nanohype, researchers are forging ahead on several exciting fronts. Short profiles of five research groups aim to give some sense of the range of work now under way throughout the world, without pretending to be exemplary or comprehensive.

Three Reviews focus mainly on nanomechanics, which builds on (or perhaps below) the advances that have been witnessed in microelectromechanical systems (MEMS). Some of the MEMS advances are stunning enough in themselves. For example, micromirror arrays developed at Lucent can be tilted to steer light beams from one channel to another for routing fiber-optic signals. Craighead (p. 1532) discusses how even smaller nanoelectromechanical systems (NEMS) will have higher resonant frequencies and lower masses that will facilitate several new applications. Complex freestanding structures can now be fabricated and used, for example, to sense adsorbed mass, or as radiofrequency devices in the 1- to 10-megahertz range. These structures can be set in motion with applied electrical fields or with piezoelectric driving of supports. Sacrificial fabrication can also be used to create channel structures of varying complexity for fluidic systems and molecular separations.

Although many nanomechanical systems have been fabricated in hard, inorganic materials, polymeric materials are now being exploited for micromechanics and nanofabrication. Quake and Scherer (p. 1536) point out that soft polymeric systems have some natural advantages in fluidics, in that the pumps and valves used in "labs on chips" normally need soft seals and seats to work seamlessly. Soft materials can be molded and assembled in layers to leave complex fluidic networks or to create diffractive optical elements.



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Producing complex movements in devices is still a challenge, especially for potential applications in biological systems. Jager *et al.* (p. 1540) review how conducting polymers could solve some problems. Bimorph actuators produce movement through the differential expansion of a layer of one material pressed against a dissimilar material. In polypyrrole-gold bimorphs, an applied electrical field creates a volume change in the polymer that produces motion (and can even peel a newly fabricated device from its supports). These actuators could find use as cell manipulators or as microrobots, all within a cellular milieu.

Nanotechnologists are now creating devices the performance of which will be tested and improved by new experiments and by more accurate theoretical treatments. Although there is still plenty of "room at the bottom," researchers have done much more than stake out claim sites: They are digging in.

—ROBERT COONTZ AND PHIL SZUROMI

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