LETTER FROM JAPAN

Near-Term Nanotech

Japan's strategy: enhance conventional devices

In January 2000, President Bill Clinton announced the creation of a National Nanotechnology Initiative. "Just imagine," he said, "shrinking all the information at the Library of Congress into a device the size of a sugar cube." Clinton intended the initiative—whose funding the Bush administration has continually increased, requesting $982 million for fiscal 2005—to stimulate scientific progress and economic growth in the United States.

But the biggest beneficiary instead may be Japan.

To be sure, nanotechnology had long been a Japanese research interest. Sumio Iijima at NEC discovered the carbon nanotube—a molecule of extraordinary electrical properties and strength—in 1991. But Clinton's speech, according to Yoshio Bando of the National Institute for Materials Science in Tsukuba, jolted both the Japanese government and its research establishment "into realizing how important this field will be." A year after Clinton's speech, Japan began a nano initiative of its own—one that today shows every sign of taking off commercially far sooner than its progenitor in the U.S.

Whereas U.S. efforts emphasize fundamental research on breakthroughs like molecular computing, the Japanese efforts are more rooted in nearer-term technologies. In essence, the two main Japanese scientific funders—MEXT (Ministry of Education, Culture, Sports, Science, and Technology) and METI (Ministry of Economy, Trade, and Industry)—are focusing on using nanotech to enhance materials in conventional devices.

Some companies have proven eager to adopt nanotech: Nissan's X-Trail sport-utility vehicle has nanotube-reinforced bumpers, for example. Much more technically innovative is NEC's fuel-cell-powered laptop, to appear later this year. With clusters of carbon nanohorns—a variant nanotube with a horn-shaped configuration that was also discovered by Iijima—as electrodes, the fuel cells use methanol to make electricity and last as much as 10 times longer than conventional laptop batteries of the same size. NEC plans to introduce a model with a 40-hour life between methanol fill-ups next year. Similar laptops are expected from Toshiba and Hitachi, which announced in March that it had developed a fuel-cell personal digital assistant with an estimated life of five hours.

According to Louis Ross, managing director of the Global Emerging Technology Institute, Japan's concentration on existing consumer products lets it take advantage of its long tradition of excellence in materials development. In typical Japanese fashion, Ross says, companies, academic researchers, and government officials spent months hammering out the approach that they believed would best leverage Japanese expertise into commercial success. "Which means that everyone is starting off pointing in the same direction," he says. "Doing things this way is slower, but once the Japanese get going, they are very tough to beat."

Japan's nano-research budget, some $800 million in 2003, is now second only to that of the United States. According to a December survey by Nihon Keizai Shimbun, the Japanese equivalent of Dow Jones, about one out of every three large Japanese industrial firms is working on nanotechnology R&D or planning to do so in the near future. And many of them are creating products that will go directly into the hands of consumers and businesses.

Ultrathin flat-panel displays, featherweight protective clothing, supertough automobile and airplane coatings—all are in progress in Japan. Some of the most exciting applications involve nanoglass, centerpiece of the government-industry collaboration called the Nanotechnology Glass Project. Researchers led by Hirao Kazuyuki of Kyoto University, for example, can precisely control the glass coating on DVDs, so the laser beam that plays them should be able to focus more precisely; DVDs could then be packed with more information, vastly increasing their storage capacity.

NEC used carbon nanohorns (inset) in fuel cell electrodes to provide longer life to a laptop powered by a methanol cartridge.

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Others are working on punching three-dimensional tracks in glass to steer beams of light. Such waveguides will act like circuit pathways in tomorrow's optical computers. According to Koji Fujita, a Kyoto nanoglass researcher, these new materials "are close to being produced" on an industrial scale. That would bring us a step nearer to fitting the contents of the Library of Congress on a device the size of a sugar cube—though they may well be preceded by the contents of the National Diet Library in Tokyo, the Japanese equivalent. **Charles Mann**