ADVERTISEMENT FEATURE

FOCAL POINT ON NANOTECHNOLOGY IN JAPAN

BIG AMBITIONS FOR HARNESSING THE TINY

Building on its traditional strengths in material science and manufacturing, Japan has much to contribute to THE NANOTECHNOLOGY REVOLUTION.

Considering Japan's strength in the field, it seems appropriate that the first person to coin the term 'nanotechnology' is generally recognized as a Japanese researcher — Norio Taniguchi of Tokyo Science University. In a visionary paper published in 1974, he stated: "nano-technology mainly consists of the processing of separation, consolidation and deformation of materials by one atom or one molecule."

At the time, the technology to realize such minuscule manipulations must have seemed a very long way off, but today we're surrounded by the benefits of nanotechnology — sunscreens contain nanoparticles, smartphones use nanoscale processors and memory components, and ubiquitous lithium-ion batteries have electrodes coated with nanoparticles. And we're only beginning to scratch the surface of unleashing the full potential of nanotechnology.

Having worked in the field for three decades, Tomoji Kawai, a professor at Osaka University in Japan, has witnessed its transformation. "When I first started working in nanotechnology, the technology itself was a challenge: how to fabricate a very narrow line or observe single molecules," he recalls. "But now we've mastered the technology, making it possible to realize ever more sophisticated devices through integration."

NANOTECHNOLOGY'S APPEAL

The allure of nanotechnology lies not just in its ability to shrink components — far more powerful is how it can totally transform the properties of materials. "A gram of aluminium in bulk scale and a gram of aluminium in nanoscale are two completely different entities," says Shigekazu Hayashi, director general of the Materials Technology and Nanotechnology Department at the New Energy and Industrial Technology Development Organization (NEDO). "This is a very attractive aspect of nanotechnology."

This transformative nature of the nanoscale provides engineers with previously unimagined control and functionality. "By gaining the ability to control structure at the nano-level, we will be able to design semiconductor devices with the performance we really want," says Hayashi.

Kawai, who is also a fellow of NEDO's Technology Strategy Center, sees nanotechnology as indispensable for producing better components and devices: "Nanotechnology can enhance the value of products, giving companies a competitive edge."

To illustrate this, he cites multilayer ceramic capacitors. First developed in Japan, they are now used worldwide in smartphones, laptops and electric vehicles. Thanks in part to nanoparticles, they pack many capacitive layers into a small space, making them ideal for storing charge in small devices.

POOLING RESOURCES

A key national initiative by the Japanese government to pool nanotechnology resources is the Advanced Research Infrastructure for Materials Nanotechnology Japan (ARIM Japan). Consisting of six hub and 19 spoke organizations, it provides access to state-of-the-art equipment and expertise.

"Automated and high-throughput advanced facilities will be introduced to continue the shared use of facilities," says Hayashi. "And the material data generated through the shared use will be collected, accumulated, and stored in a form that is easy to use."

ARIM Japan will also benefit the commercialization of nanotechnology. "Even if a small company has an idea, they can use this platform to make and test prototype devices," says Kawai.

STRENGTHS AND WEAKNESSES

For Japan, nanotechnology is a natural progression of its long history of material-science research and strong manufacturing base. "Japan has been developing various material technologies for a long time," says Hayashi. "One of the country's strengths lies in its material design and manufacturing technologies."

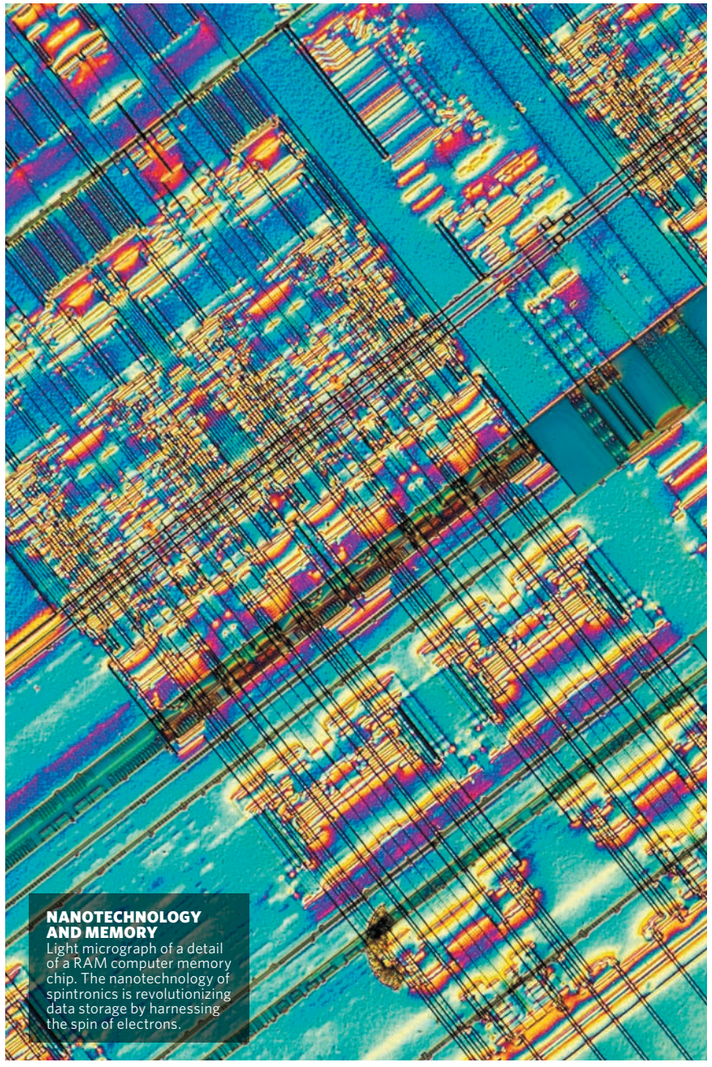
Kawai traces Japan's interest in nanotechnology back to its *monozukuri* culture of making things. "Traditionally, Japanese people like to make very small things; it's a national trait," he says. "So nanotechnology appeals to Japanese scientists and engineers."

But Japan faces stiff competition globally, notes Olga Bubnova, a senior editor of *Nature Nanotechnology*. "Material science is strong in Japan, but South Korea and China tend to be more active in commercial applications of nanotechnology," she says. Specific areas that need addressing are a poor gender balance and obstacles faced by foreign scientists. Hayashi sees data processing as another area in which Japan could improve.

FUTURE OUTLOOK

Nanotechnology holds much promise for the future. As individual technologies improve, so do engineers' ability to develop better devices. One example is the ability to image light atoms. "Recently, we've succeeded in imaging light atoms such as lithium and hydrogen," says Kawai. "We can now directly image how these light atoms move in catalysts and batteries, which is a very exciting prospect."

If the past is anything to go by, Japan is sure to play a key role in future developments. Taniguchi did more than envision the future of nanotechnology, he helped create it. "My personal heroes are Taniguchi and [Kenji] Watanabe," says Bubnova. "You'll see them cited if you look at any 2D materials paper, just because they produce the best hexagonal boron nitride in the world, and that alone has enabled so many discoveries in the field. I think this is a very Japanese example of mastering one thing to perfection." ■

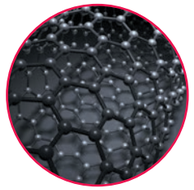


NANOTECHNOLOGY AND MEMORY
Light micrograph of a detail of a RAM computer memory chip. The nanotechnology of spintronics is revolutionizing data storage by harnessing the spin of electrons.

Alfred pasieka/Science photo library/Getty

1

Japanese researcher Sumio Iijima's 1991 paper on carbon nanotubes has been cited **MORE THAN 35,000 TIMES** and was the 36th most cited paper of all time in 2014.



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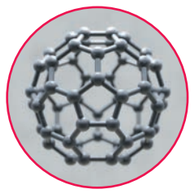
Fullerene, a novel form of carbon, was theoretically predicted by **JAPANESE RESEARCHER EIJI OSAWA** in 1970, 15 years before it was produced in the lab.



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3

Three Japanese researchers, Isamu Akasaki, Hiroshi Amano and Shuji Nakamura, shared **THE 2014 NOBEL PRIZE IN PHYSICS** for the development of blue LEDs.

Shigekazu Hayashi
A DIRECTOR GENERAL AT NEDO

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