

## Bio-nano processing technology - Enhancing intelligent device development

Professor Seiji Samukawa says, "I want Japan to come back as the world's leading semiconductor manufacturer".

Currently, semiconductor devices are manufactured by plasma processing, with a maximum accuracy of 22 nanometers (nm). In order to make exceed the current limit, Professor Samukawa and his research group have developed ultra-high precise etching technology.

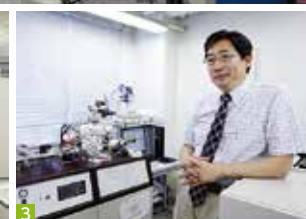
"With conventional plasma etching, material damage occurs due to electrical charges and ultraviolet rays. As an ultra-low damage process free from these factors, a new etching process using a "neutral beam" was developed. In this process, a neutral beam which maintains almost 100% kinetic energy can be produced as plasma passes through an aperture.

"We have further expanded this idea, and are developing a processing technology with accuracies of better than 10nm, by fusing neutral beam technology and biotechnology."

A mask, or a mold is necessary in top-down processing. However, in conventional lithography technology, developing a microscopic mask smaller than 22nm is not possible. To overcome this, the idea to utilize Ferritin, a protein containing iron particles in its core, was conceived. Ferritin can construct uniform structures to a measurement error of only 0.1nm. The iron particles, which remain after removing the protein shells, could be formed into lines at equal intervals. A micro-mask was developed using this alignment. Using neutral beam etching for this mask pattern, precisely-aligned quantum dots on a silicon substrate can now be created.

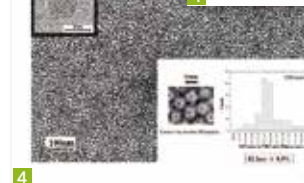
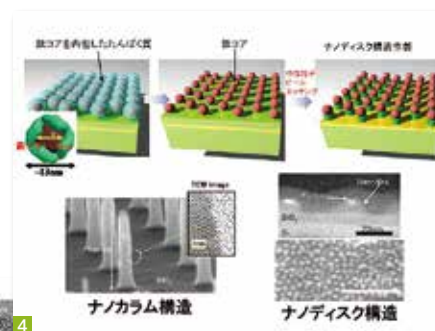
"A next-generation solar battery with energy conversion efficiency greater than 45% can be developed using this silicon as material. Since precise quantum dots can be created, power generation efficiency will be remarkably increased."

Establishment of an epoch-making processing technology has paved the way for further developments in the creation of solar batteries with high efficiency, laser devices, organic semiconductor devices, etc.

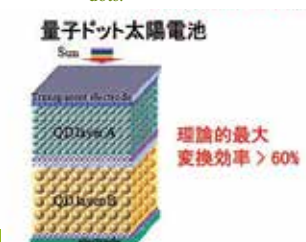


[Photo 1] Research on device-manufacturing using more precise plasma etching technology is now underway in the clean room. [Photo 2] Development of a generator for a highly efficient, low energy neutral beam which uses minus ions is now underway. [Photo 3] "I want Japan to come back as the world's leading semiconductor manufacturer." Professor Seiji Samukawa says.

[Photo 4] Research to create ultra-minute structures using bio-nano processing technology.



[Photo 5] The realization of a highly efficient solar battery is possible by using precisely-aligned quantum dots.



Intelligent Nano-Process Laboratory Targeted Research Division,  
Transdisciplinary Fluid Integration Research Center, Institute of Fluid Science  
Professor **Seiji Samukawa**

Born in Ishikawa Prefecture in 1959. He finished his doctoral course at the Faculty of Science and Technology, Keio University, specializing in Nano-Process Engineering. Dr. Samukawa has worked as a Chief Researcher at the Microelectronics Research Laboratory, NEC Corporation, and has served in his current post since 2000.  
<http://www.ifs.tohoku.ac.jp/samukawa/index.htm>

## Seeking business innovations which connect to regional resources with an entrepreneurial spirit

99% of all industrial and business entities in Japan are said to be small and medium-sized businesses. So how can innovation occur in such companies?

Professor Michi Fukushima says, "Through our studies, we have seen cases of innovation which are concentrated in specific areas."

Take, for example, Austin, Texas. Prior to the mid 1980s, it was a sleepy town without any significant industries. However, since the arrival of George Kozmetsky, a key figure who focused on various resources found in the region, the town was dramatically transformed into a high-tech mecca only in 20 years. This transformation could be achieved by Kozmetsky's vision, "Austin should be a large center of technology."

Even in areas without abundant resources, regional innovation is still possible. Professor Fukushima presents following five points:

1) Entrepreneurs, 2) connection within the region, 3) not having a fixed view of resources, 4) diversity, and 5) a device to maximize potential.

From this standpoint, how does the situation in the Tohoku region look now?

"After the earthquake, people have become mobile, and more young people are returning to the stricken areas, creating a mixture of people who would like to do something about the area, and those ones who have found new business possibilities. I have great expectations for these regions."

At the Regional Innovation Research Center where Professor Fukushima belongs to, various studies and research activities are carried out for local enterprises through two simultaneous approaches, the Local Industries Recovery Project and the Human Resources Development Project, with the goal of revitalizing local industries. For example, large-scale business surveys have been conducted, and attention has been focused on promising activities such as renewable energy, etc.

"The whole world is watching the Tohoku region. We have a chance to bring about big changes in the social order. No, we MUST change it."



Business Administration Course, Regional Enterprises,  
Graduate School of Economics and Management

Professor **Michi Fukushima**

Born in Shizuoka Prefecture in 1969. She graduated from the faculty of Economics, Tohoku University, with a master's and doctoral course of the Graduate School of Commerce and Management, Hitotsubashi University, specializing in Business Administration. Professor Fukushima has worked as visiting scholar at the University of Texas at Austin, IC<sup>2</sup> Research Institute & Red McCombs School of Business, and has been in her current position since 2012.  
<http://www.econ.tohoku.ac.jp/~michi/newpage7.html>



[Photo 1] A symposium hosted by the Local Industry Recovery Project. Proposals for the recovery of local industries from the Great East Japan Earthquake were discussed. [Photo 2] A policy workshop for business recovery. Through active discussions at the workshop, innovative ideas are created. [Photo 3] Although still underway, coastal regions hit by the earthquake and tsunami are being revitalized, thanks to the mobility of people and the entrepreneurial spirit of young ones moving into the region.



[Photo 4] Professor Fukushima, in her book "University Venture Companies and Cluster Strategies", discusses whether the Austin model can be repeated in Japan.



[Photo 5] "Regional Innovation I - The Challenge from Tohoku" (jointly edited by the Tohoku Regional Advancement Center) introduces quiet innovations by undiscovered entrepreneurs in the Tohoku region, their efforts, and keys to success in making such innovations.

