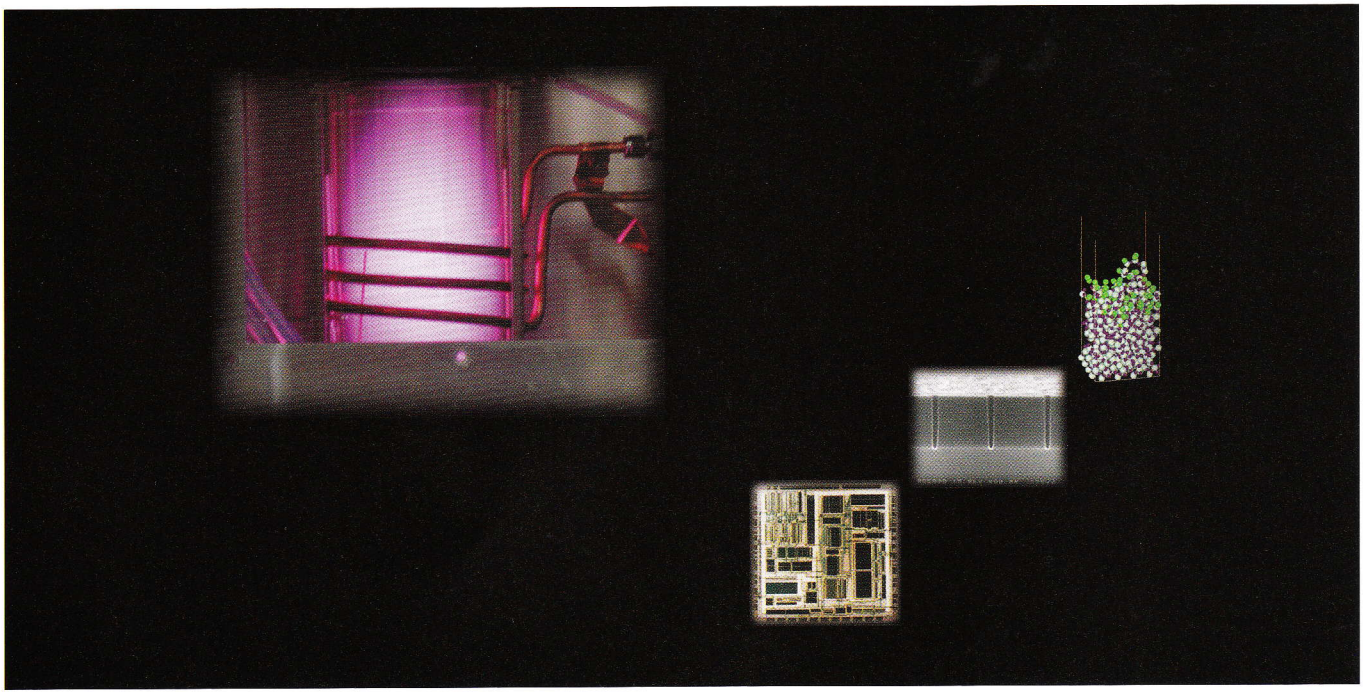
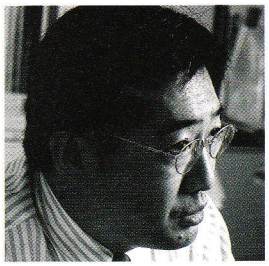


SEMICONDUCTOR-ORIENTED NATION



NEXT ▶ Nano-Micro Cluster

This cluster shall contribute to the clarification of the nanothermal fluid phenomenon and its application for the technological development of innovative nano-micro devices and systems.

"Restoration of Japan as a Semiconductor-Oriented Nation"

Professor Seiji Samukawa, Head of the Nano-Micro Cluster

Becoming a "semiconductor-oriented nation" again

Japan's semiconductor industry, which once achieved supremacy in the world, is now rapidly losing power.

This is because they ceased to develop semiconductor manufacturing technology within companies and released their technology to the manufacturers of semiconductor devices. Japan's manufactures that have become mere manufacturing plants have lost their technological advantage. We strongly wish to contribute to reversing this inferior situation of Japan's semiconductor industry and the restoration of "Japan as a semiconductor-oriented nation."

While we are developing a variety of technology, what is developed as microfabrication technology is bio-nanofabrication technology, which is the result of an integration of nanotechnology and biotechnology. It is ultrafine microfabrication technology of 10nm or less which has not been realized with the existing technology.

There is a protein called "ferritin" in the living body. The outer diameter of ferritin is approximately 13nm, and its inner cavity of approximately 7nm in diameter can accommodate iron. Since ferritin is a biological protein, the mass production of ferritin of the same structure and size by utilizing DNA is possible. When such mass-produced ferritin is arranged to a silicon substrate surface, self-assembly unique to protein occurs, and the proteins align at regular distances. If the proteins are removed by a treatment such as heat treatment, 7nm-diameter iron microparticles remain on the substrate surface in a reticular pattern. If a neutral particle beam is applied to it, iron microparticles will serve as an etching mask, which enables 7nm ultrafine microfabrication.

Moreover, the use of a quantum effect will enable the control of single electron with a small power supply, and the micro-miniaturization of arithmetic elements and memory devices. It may become possible to achieve the computing speed of a supercomputer with the size of a current cell phone and control complicated autonomous robots with a single chip.

Improvements in processing accuracy as quantitative change lead to a quantum effect element as qualitative change, which may possibly cause a revolution in the field of semiconductor devices.

In addition, on-wafer monitoring technology is currently focused on as well. In this technology, 4 types of sensors are placed on a wafer, the etching progress is checked in real time, and the manufacturing process is controlled with the information obtained from the sensors. This on-wafer monitoring is technology aiming at the intelligent control of semiconductor manufacturing devices. These monitoring sensors monitor in real time the following 4 factors; the energy speed closely related to the processing accuracy and process yield of semiconductors, the accumulated quantity of electric charge, the amount of ultraviolet light corresponding to defect production amount, and the sidewall conductive property which indicates the condition of the surface reaction.

Even though etching is a fundamental technology for semiconductor manufacturing, its manufacturing was actually empirical. How to increase process yield was judged by experience. This monitoring system aims at 100% process yield by the introduction of science in the field of semiconductor manufacturing.