5th JSAP Achievement Awards (research achievements)

Recipient List

Title: Pioneering research in silicon MOS devices and contributions to the development of LSI technologies
Award recipient: Takuo Sugano

Takuo Sugano has been conducting research in Si-MOSFET, which is at the core of current LSI technologies, since shortly after the birth of MOSFET technologies in the early 1960s. Dr. Sugano undertook pioneering research related to interface irregularities and structural analysis of silicon oxide film on silicon, and clarified the mechanisms that formed the basis for an effective means of resolving the major problem of instability in the characteristics of MOS elements by adding phosphorous atoms. He also conducted research in evaluation methods for accurately measuring the interface trap level that exists on the interface between the silicon and the silicon oxide film, thus making significant contributions to the theoretical study of interface trap levels, the clarification of their origins, and the reduction of these trap levels. He investigated the structure of deterioration in the characteristics of ultra-short channels and demonstrated the effectiveness of SOI structures, establishing a basic understanding of device designs in the field of MOS-LSI, where miniaturization continues to evolve. With regard to the physics of electron conduction in Si-MOSFETs, he conducted pioneering research that included the first clarification of the importance of the quantum size effect in FET channels at room temperature. This research created an extremely significant "academic ripple effect" as the foundations for the quantum effect in 2-D systems, and contributed to forming the groundwork for the development of heterostructure elements using 2-D systems. Silicon MOS-FET technologies include a variety of different elements, including process technologies and structural evaluations, physics of interface defects, and low-dimension electronic conduction, and Dr. Sugano has demonstrated pioneering achievements in all these areas. It is worthy of note that in addition to the research results outlined above, he has played a leading role in manpower training and making improvements to broad academic foundations that support the development of the LSI industry in Japan, and as such has made a dramatic contribution to the growth of the Japanese LSI industry. For many years, he has significantly contributed to the development of the semiconductor industry in Japan and throughout the world, and he has made major contributions to the prosperity of today's semiconductor field and LSIs in particular. These achievements are truly worthy of the JSAP Achievement Awards (research achievements).

Title: Pioneering research in the application of beam technologies in semiconductor engineering
Award recipient: Susumu Namba

Susumu Namba had been conducting pioneering research in electron, ion and photon beam technology since the late 1950s, but one of his most important achievements is the introduction of the ion implantation technology into semiconductor devices. Around 1965, the thermal diffusion process was used to introduce impurities into semiconductors, which limited the further miniaturization of transistors. At that time, Dr. Namba promoted the use of the ion implantation technique to overcome the limitation. He demonstrated that the impurity distribution and concentration could be controlled by the ion energy and the ion dose, and were in good agreement with the theory. In this way, he established the scientific foundations of the ion implantation technique for the impurity doping. In 1968, he built the first ion implantation equipment in Japan based on the scientific basis he established, which had been carried out as a project supported by the Research Development Corporation in Japan. The importance of his achievement is obvious if one realizes that the ion implantation has now being used as a standard technique in the present semiconductor industry.

Another important achievement was the use of the ion beam for etching in a submicron scale. One of the biggest problems in conventional wet etching technique was a limitation in the pattern formation accuracy that resulted from the isotropic nature of the wet etching. Dr. Namba introduced ion beam technique into the etching process to overcome the problem, and succeeded in drastically improving the etching pattern with the anisotropic nature. This had made it possible to fabricate devices with a submicron scale, which led the semiconductor device process from micron to submicron era. He used the technique to fabricate the echellet diffraction grating, for the first time, with outstanding resolution and extremely small stray light, even enabling the industrial application.

In addition to the above achievements, he had made pioneering work on the focused ion beam technology, the application of synchrotron radiation for the submicron lithography, and the excimer laser lithography, as well as the development of nanometer-scale electron beam lithography system. His research achievements related to various microfabrication technologies with electron, ion and photon beams have laid the foundations for today's nano-processing technologies, which still maintains the importance and originality even now. These achievements are truly worthy of the JSAP Achievement Awards (research achievements).