Current Status of the Division of Silicon Technology, and Outlook for the Future

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The Silicon Technology Division was established as a Professional Group in 1998, and was promoted to the status of Division 1999. It is currently comprised of more than 600 members, and is extremely active in a variety of fields. Silicon Technologies encompass a very broad range of technical fields. In fact, the areas within the Division itself are so diverse that a committee system has been established to allow greater focus on areas ranging from materials to process and devices. The Division is currently comprised of eight Committees: Lithography, ULSI devices, Surfaces / Interfaces / Silicon Materials, Multilayer Wiring Systems, Modeling, Junction Technologies, Silicon Nano-technologies, and Nano / Micro-fabrication. One of the most unique characteristics of this Division is the lively meetings hosted by the each Committee, which enables horizontal and vertical connections among a diverse range of technical fields. These meetings were held about once each month. Each meeting has an average of about 50 participants, and each year nearly 800 pages of materials are prepared in Japanese in relation to the meeting proceedings. Sometimes the meetings include discussions on new technologies based on materials gathered by researchers in related fields, while other meetings provide overviews of research presented at notable international conferences, such as IEDM and the VLSI Symposium. The various committees plan and propose these meetings to respond to the needs of Division members. Workshops and international conferences that transcend the boundaries of Committees and even Divisions are also held independently and jointly with other organizations, with a focus on specified themes. Some of the more well-established events include the International Workshop of Junction Technology (IWJT), the Advanced Metallization Conference (ADMETA), and the International Workshop on Dielectric Thin Films for Future ULSI Devices (IWDTF). The Gate Stack Technology Workshop, a domestic conference, is also held every year. Recently, given the unique characteristics of this field, an increasing number of conferences have been held jointly with the Silicon Device and Materials (SDM) Committee in the Institute of Electronics Information and Communication Engineers (IEICE).

It goes without saying that silicon technologies are closely tied in with the silicon LSI industry. Although the development of ULSI technologies is often said to have reached a limit, it seems that these limits have always been overcome through further technological developments. This does not necessarily mean, however, that the same will continue to happen in the future. We are already approaching atom-level sizes in the context of miniaturization. At the laboratory level, research is being conducted on transistors with gate lengths of less than 10nm, and on the application level, there are requirements for silicon dioxide gate insulator film with a thickness of less than 1nm. In order to overcome these limits, studies are ongoing not only regarding miniaturization, but regarding the introduction and development of new material technologies. Research and development has been conducted targeting silicon dioxide gate insulator film with high dielectric constants, it is now possible to intentionally add strain to the silicon substrates to increase mobility. These new technologies are increasing the scope of applied physics and promoting further development of material technologies and manufacturing technologies, and have become a central theme of silicon-related technologies at JSAP as well. There are people who will say off-handedly that “Silicon is finished,” but in fact, we have just reached a point where silicon researchers are being tested, and where the technologies are starting to get really interesting. In the past, most research in silicon technologies was conducted by corporations, and it was often difficult for university research to see its day in the sun; at least not directly. As a result, it was fairly rare for university research in new fields related to silicon to receive national level support, and researchers were relatively few in number. What is truly needed now, however, is new research in materials, processes, devices, and circuits — research that is firmly rooted in the fundamentals. It stands to reason that this research will form the core of the new information technologies of the future. It can be hard to categorize the quality of research, but there is little doubt if universities do not invest energy into research in these fields, the future of these technologies will be put into question.

The unique characteristic of this field is that it incorporates all levels, from pure fundamental research to commercial products, and this characteristic has promoted a broader scope and greater dynamism among researchers. Products that use ULSI technologies obviously use silicon technologies, but they use other technologies as well; recently, an extremely close connection has developed between silicon technologies and biotechnologies. In that sense, a unique feature of this field is that rather than focusing on whether the research is basic or complex, if something is related to silicon technologies, then a strong relationship is developed, and research is conducted using any means available, as long as those means prove to be useful. Individual technologies must naturally demonstrate depth, but trying to confine silicon technologies to a limited field induces a kind of siege mentality. Before we know it, silicon substrates could form the base for installations of compound semiconductor transistors, lasers, or bio/organic devices. Of course, plasma is used in production, as is ultra-thin film technologies. Even as we focus on establishing firm foundations for next-generation silicon ULSI technologies, we must incorporate effective technologies regardless of the field, and demonstrate the functions of silicon as a “priming agent” for the creation of cross-cutting technologies that bind other technologies together. We must create new frontier fields in applied physics, develop new industrial technologies, and conduct research while promoting exchanges with many interdisciplinary fields. Achieving these goals will act as the driving force behind silicon technologies in the 21st century.

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