TCAD in Selete

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1. Change of competition field

The equipment for the fabrication of semiconductor devices has become sophisticated and thus, the field of competition of the technologies considered up to now has changed. The author analyzes the causes of the changes in the competition fields and a solution is proposed from the view point of the TCAD technology. The purpose and activity of TCAD in Selete is also described.   Selete is a stock company established by the LSI manufacturers(*).

Until now, the technological competition in the LSI development has been in the following areas,

(1) circuit technology,

(2) device technology,

(3) process integration technology,

(4) process technology,

(5) equipment technology.

In these areas, it was considered that the major technical issue was process technologies because they were very unstable.   Then, an enormous know-how was accumulated in order to overcome this instability, and it allowed LSI manufacturers to become competitive. However, these technologies and know-how have gradually been transferred to equipment manufacturers and have been incorporated into equipment. A considerable part of the many development processes will finish with the introduction of the latest equipment and the process conditions will be optimized by many experiments. By this time, it will be considered that process technology is not the best card for LSI manufacturers to be holding, if they wish to be competitive.

Thus, under these conditions TCAD has become very important in strengthening the competitive ability of LSI manufacturers in the areas of circuit, device, and proc-

ess-integration technologies.

2. Meaning of TCAD technology

It has recognized that TCAD is a technology that can be used for the efficient development of LSIs.

There are two modes for improving the productivity of R&D by using TCAD technology. The first is a substitution of trial fabrication, which reduces the number of expensive trial fabrications. In trial fabrications of high-performance LSI, turn around time (TAT) is lengthened due to the increase in the number of process steps and time. In addition, since the latest facility is expensive, the cost of LSI development has become high. These are very negative factors in competition. To maintain competitive ability, it is necessary to reduce their influence by using TCAD.

The second is the development of TCAD, because this will be quite effective in providing a real understanding of semiconductor processes and devices. R&D engineers needed to be able to understand the physics of semiconductors because the technology level which is required for the recent LSI developments has become complex and precise in its theory. So the development of TCAD will bring real technological strength to LSI·manufacturers in the long term. In other words genuine technology will be established by a proper understanding of semiconductors which will be obtained through developing precise physical models applying to TCAD. But these effects will appear gradually. By this reasoning it is clear that cultivating the technological ability needed to develop or make TCAD is very important for the LSI manufacturers. TCAD is a strategic technology.

The activity of TCAD development in Selete is described in the following sections.

3. Development of a TCAD system

Since the theory of TCAD technology has become complex, the ability to develop TCAD has also been relatively reduced because presently companies can not recruit enough researchers who have the talent needed for developing advanced models. To improve this situation, the foundation of an organization that will collaborate on TCAD development is desired. Selete aims to meet this requirement. The researchers who have joined from the participating companies collaborate through the form of a virtual laboratory.

A decision was made to develop an environment by which the researchers knowl-

edge can be easily integrated and needless duplicate development can be avoided. The environment which is mentioned here is the group of programs that function as a base for the research of TCAD.

The establishment of this environment allows the following epochal effects.

(1) an identical common base for evaluation,

(2) research and development focused on the most potential area,

(3) easy utilization of the research of universities.

4.The Selete's TCAD system

The TCAD system of Selete consists of a framework, process/device simulators, and a measured database (Fig. 1). The users of this system execute simulators through the framework which has a role of supervisor. The framework and simulators are designed to handle three dimensional structures.

As Selete's TCAD system was designed as an environment for TCAD technology, widely accepted models were incorporated into the design. For the process simulator, a point defect model [1], a visco-elastic oxidation model [2], and a plus one (implantation) model [3] were adopted. The DD model [4], heat flow model [5], and local/nonlocal impact ionization model [6,7] were used for the device simulator. For these simulators the tetrahedral mesh was adopted.

The Selete's TCAD system also includes a platform with a common file format for Plug & Play. The essential features required for a platform are as follows:
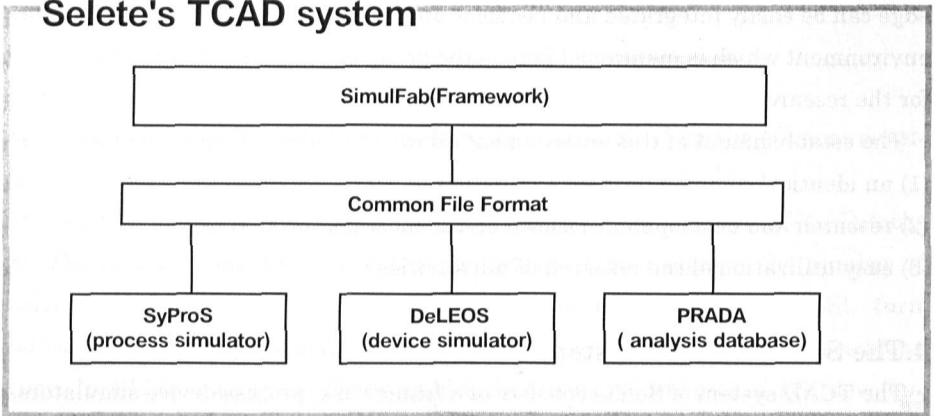
(1) data exchange between existing programs,

(2) a program structure which allows the easy addition and modification of programs without influencing other parts of the program

The function called Plug & Play consists of two elements which are the object oriented (OO) approach using C++ and a file format and its interpreter. The modifications and addition of new program routines are easily done by using the OO approach. The routine treatment of complicated three dimensional data is safely handled by class methods which have been designed for many types of data.

The data exchange between other external programs is ensured by the common file format and its interpreter which supports the reading and writing of many kinds of data format. Therefore, Selete's TCAD system can be easily improved and linked to existing programs, so that it will well act as an environment for TCAD technology.

The concept of the program structure is illustrated for the process simulator in

Selete's TCAD system

| SimulFab(Framework) |
| Common File Format |

| SyProS
(process simulator) | DeLEOS
(device simulator) | PRADA
(analysis database) |

SimulFab :Simulation Based Fabricator
DeLEOS   :Device－level Electrical Operation Simulator
PRADA   :Process Analysis DataBase

Figure 1.   Selete's TCAD system.
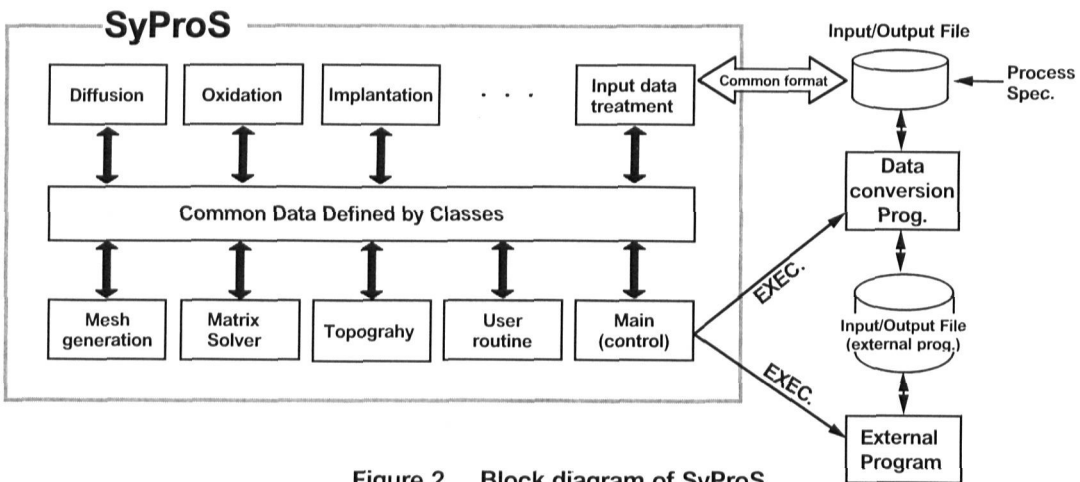
SyProS

Figure 2.   Block diagram of SyProS.

Fig.2.

To promote the improvement of TCAD technology, Selete will make available, as much as possible, the Selete's TCAD system to all who have an interest in TCAD.

5. Conclusion

This activity started in December 1996. The first release of Selete's TCAD system to the client companies is planned for March 1999.

It is a great pleasure that due to the participation of many researchers an environment for the integration of intelligence has been established.

* Fujitsu Limited, Hitachi, Ltd., Matsushita Electric Industrial Co., Ltd., Mitsubishi Electric Corporation, NEC Corporation, Oki Electric Industry Co., Ltd., Sanyo Electric Co., Ltd., Sharp Corporation, Sony Corporation, and Toshiba Corporation.

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