Mechanical Simulator and Process Analysis Tools

Mizuho Information & Research Institute, Inc. Micro-Electro-Mechanical Systems, Science and Technology
Yasuroh Iriye, Associate General Manager;
Atsushi Sato, Senior Consultant; and
Takuya Iwasaki, Ph.D., Chief Consultant

In the previous issue of the MICROMACHINE magazine (May 2005 issue), Hiroyuki Fujita, the project leader of MemsONE, summarized the entire MemsONE project. In this issue, we will introduce the mechanical simulator and process analysis tools led by the Mizuho Information & Research Institute.

As shown in Fig. 1, the mechanical simulator and process analysis tools are provided in the MemsONE system as basic analytical functions that can be used through a software framework in the form of a GUI and can be linked with the material and process database, for example. The software framework for the MemsONE system comes with CAD and visualization functions so that coherent mechanical analysis and process analysis can be performed through this system alone.

The mechanical simulator is a set of programs for studying and evaluating the mechanical properties of MEMS devices and can be used in specification studies during the initial design stage. The simulator may also be used for final performance evaluations once the shape of the device has been determined. The mechanical simulator includes the following functions.

- **Stress-strain analysis**
  Can predict structural behavior, such as vibrations, deformation, and stress characteristics
- **Electromagnetic field analysis**
  Can evaluate Lorentz force and distributions of electric potential, electric current, and magnetic fields in devices employing electromagnetic drive systems
- **Piezoelectric analysis**
  Can predict structural behavior in devices having piezoelectric material
- **Thermal analysis**
  Can analyze changes in the temperature distribution in structures over time and thermal deformation in such changes
- **Effect analysis of ambient gases**
  Can find the damping rate of a MEMS structures that oscillates rapidly in gases
- **Coupling analysis**
  Can perform coupled analysis of the aforementioned functions in the mechanical simulator and can comprehensively verify and evaluate structural stress-strain, electrostatic fields, magnetic fields, piezoelectric and other drive mechanisms, and moving mechanisms in such MEMS as electromagnetic actuators, electrostatic actuators, and thermal actuators

The process analysis tools are used to create device structures, as well as to study mask layout and process flow design. Three-dimensional device structures developed with this tool can be imported into the mechanical simulator described above. The process analysis tools include the following functions.

- **Anisotropic wet etching**
  Provides a simulator to analyze anisotropic wet etching processes in order to predict transient changes in the 3D etching profile
- **Dry etching**
  Can confirm the etching shape produced through a dry etching process
- **Thin film deposition**
  Creates a 3D structure by emulating a physical or chemical vapor process according to a geometric method
- **Multiprocessing**
  Provides a function for creating 3D structures according to an emulator using a geometric method, and enables the thermal history and other data described in the 3D structural data and the process recipe to be used in the mechanical simulator

It is our hope that many people engaged in the design and development of MEMS devices will make use of these tools, and that the tools will contribute to the development of MEMS industry in Japan.

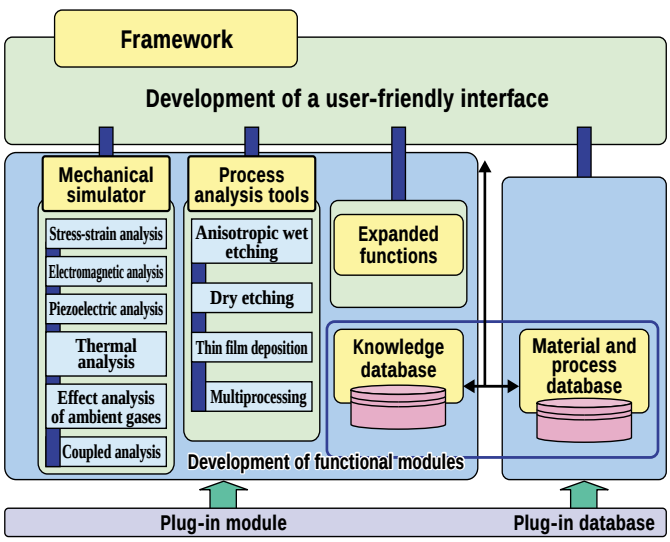

Fig. 1 Configuration of the MemsONE system