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COMMERCIAL MICRO MANUFACTURING

in this issue

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10
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Height = 2mm

‘Dialing-In’

WET PROCESSING PARAMETERS

Companies using micro fabrication can gain important benefits by using wet processing equipment designed to handle a variety of application parameters

<< Figure 1: Increased attention is being paid to the design and selection of processing equipment that can make a significant difference in product quality and throughput. >>

Now that a burgeoning range of microelectronic devices have adopted the micro fabrication techniques of semiconductors, increased attention is being paid to the design and selection of processing equipment that can make a significant difference in product quality and throughput.

Those potential gains exist for the profuse array of applications that require micro fabrication processes, including in the MEMS, biotech, photovoltaic, LED panel, sensor and other micro and nano-technology industries.

The products from all of these sectors are dependent on silicon as well as compound semiconductor materials that undergo a variety of processes requiring specialised equipment, accessories and software. The performance of that equipment and software (e.g., precision, throughput, flexibility) can be significantly improved through various types of optimisation.

Such is the case with the wet processing equipment used to etch silicon and other semiconductor materials used in micro fabrication. A wide variety of equipment designs is available (both manual and automated) to accommodate the many different wet process requirements, which may vary in materials, throughput, size of products being processed and type of chemicals.

Essentially, manual processing equipment consists mainly of benches that are used for low-throughput applications in laboratories and production facilities that have low volume requirement.

Conversely, automated equipment is typically used for high-throughput, high-volume cleanroom applications, and is normally found within mass production micro fabrication environments. Usually having far greater complexities in terms of tooling and also utilising software, the automated wet processing equipment offers the highest potential benefits from some type of optimisation.

Dialing-in equipment design

Fully automated process equipment for high-speed production often includes multiple stations or modules as well as robotics, sophisticated control, data logging and monitoring systems. Since the design of many wet processing systems is proprietary,

specifications are protected by the equipment manufacturer and user alike. Therefore, considering all of the possible design variables, it may be advisable for users in the market for an automated wet processing system to visit an equipment manufacturer with design capabilities and an application laboratory.

One of the prominent designers and builders of wet processing equipment, JST Manufacturing (Boise ID), has an on-site applications laboratory where end users can develop their process with various chemistries and do tests on real equipment ranging from immersion and spray tools to dryers. The laboratory includes sophisticated metrology equipment including a scanning electron microscope and a Tencor particle counter.

By visiting applications labs such as JST's, end users can "dial-in" on the optimisation of their processes, and can minimise the amount of chemicals required and/or determine the tool features they need for their applications. This can save the customer money by eliminating features they do not need.

Typical examples of automated systems include process modules for solvents, acid, bases, deionised water rinse and drying. Mechanical, Ultrasonic or Megasonic agitation and other processes may also be incorporated, if desired. Another consideration is safety and there are many mandated requirements for items such as ventilation, fire suppression, chemical handling and explosion prevention.

Application-wise, systems designs may vary widely. In operation, there is quite a difference in the etching of silicone rods and the crystals used in nuclear sensors. One of the major differences may be the chemistry involved, its concentration and temperature. Chemical compatibility with the materials of construction are a must. Most solvents require stainless steel tanks and in other cases plastic tanks and baths may suffice.

Dialing-in parameters

To facilitate the economical design and building of a wet processing equipment solution, many users insist on a standardized approach with customisable features that will best handle their applications parameters.

For example, JST utilises standard products and standard methodologies to design and manufacture equipment. Using SOLIDWORKS 3D-modelling software, the company can make minor changes and customisations to meet the needs of each application. Also, the equipment is modular by design, allowing for easy changing and reconfiguration should process or product requirements change.

Another powerful feature: each unit is designed with software that is capable of performing all tool functions, including those that are not required. With this, end users can create their own process, or recipes, with all sub-routines at their disposal.

"We like to give customers added flexibility by programming their equipment to do everything that the equipment is capable of doing," explained Louise Bertagnolli, JST president. "This enables them to dial in applications, such as chemical concentrations. They can also turn various features on or off, depending on your process requirements. Even though they may not need some of the features today, they may want to turn them on in the future, which can be both economical and powerful."

Optimising manual applications

Specifying the design parameters for many manual benches may not be as involved as those of automated systems. However, soliciting the opinion of equipment manufacturers regarding equipment design may be highly beneficial.

"Sometimes we will visit a user's facility and help define the production parameters and specifications of their manual wet processing equipment," said Louise Bertagnolli. "Even though they had a good idea how they wanted to handle the wet processing end of it, after we had a chance to review the project, we recommended that they consider doing it in a somewhat modified manner. Sometimes we'll suggest a design variation that will perform the cleaning or etching work in the manner required, but will also save money or reduce the floor space requirement, or simplify maintenance, or provide other benefits."

Dennis M. Schweiger, Senior Director of Infrastructure at the University of Michigan's Lurie Nanofabrication Facility (LNF), feels that the right combination of user requirements and assistance from the equipment fabricator can make a significant difference in the design, layout, and operation of a wet processing station.

The LNF is a world-class facility in all areas of semiconductor device and circuit fabrication, integrated micro systems and MEMS technologies, nanotechnology, nanoelectronics, nanophotonics and nanobiotechnology. The LNF is an open use facility with hundreds of users from various UM departments, as well as many other universities and businesses.

Schweiger stated: "Since we essentially rent lab space and equipment to our diverse users, it is important that we provide them with benches that suit their purposes well, from those who are processing wafers to those who may be doing very advanced research or testing on non-wafer components."

<< Figure 2: JST Mfg has an on-site applications laboratory where end users can develop their process with various chemistries and do tests on real equipment ranging from immersion and spray tools to dryers. >>

Schweiger explained that the original equipment design for the new lab areas wet processing benches was very specific, and determined by the LNF staff.

"We had looked at it in terms of process flow, from start to finish, not really taking into account the variety, and variation, of process samples that our user community might be working with, how we'd accommodate non-standard sample sizes, or what the impact might be in total cost of ownership with respect to chemical usage," he said.

Schweiger adds that the some of the new benches had their decks reconfigured once the tools were installed. Several of the earlier benches, some of which were purchased over 20 years ago, were also modified to allow for more flexibility in meeting the process needs of the user community.

"In retrospect, our initial plan for the deck space, and processing capability of the benches, wasn't adaptable/flexible enough, and we worked with JST to implement modifications so that the bench decks were simpler, and could provide more working space," Schweiger concluded.

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