'Dialing-in' wet processing parameters for compound semiconductor manufacturing

Companies engaged in compound semiconductor wafer processing experience benefits from using wet processing equipment designed to handle a variety of application parameters.

With the growing range of microelectronic devices that utilize compound semiconductors, increased attention is being paid to the design and selection of the wet processing equipment used for etching, photoresist wet stripping, photolithography, metal lift-off, and related polymer removal processes.

By doing so, compound semiconductor manufacturers of LED chips, non-silicon-based photovoltaics, power electronics, optoelectronics, sensors and other micro- and nano-technologies can increase product quality and throughput, while reducing downtime and chemical costs and disposal.

Although there are similarities in the wet processing techniques used to create a broad variety of compound semiconductors, each process might not be identical in concentration, time, temperature and chemical used in wafer processing.

As a result, there is a wide variety of equipment designs available that include process modules for solvents, acid, bases, deionized water rinse and drying. Mechanical, ultrasonic or megasonic agitation as well as high-pressure spraying and other processes may also be incorporated, if needed.

Another consideration is safety, and there are many mandated requirements for items such as ventilation, fire suppression, chemical handling and explosion prevention.

Dialing-in equipment design

Although manual wet benches are available, with the growth of the compound semiconductor market many manufacturers are turning to automated equipment to increase throughput and ensure process repeatability.

Fully automated process equipment 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 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 Inc of Boise, ID, USA 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 those provided by JST Manufacturing, end-users can 'dial-in' and optimize their processes, and can minimize 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.

"Even though a manufacturer arrives with a good idea how they want to handle the wet processing, we are often able to recommend modifications after we have a chance to review the project," says JST's president Louise Bertagnolli, adding that a majority of JST Manufacturing's customers are in the compound semiconductor market. "Sometimes design variations will perform the cleaning or etching work in the manner required, but will also save money, reduce the floor space requirement, simplify maintenance or provide other benefits," she adds.

Dialing-in parameters

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

For example, JST utilizes standard products and standard methodologies to design and manufacture equipment. Using SOLIDWORKS 3D modeling software, the company can make minor changes and customizations 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.

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"We like to give customers added flexibility by programming their equipment to do everything that the equipment is capable of doing," explains Bertagnolli. "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," she adds. "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."

Optimizing manual applications

According to Dennis M. Schweiger, senior director of Infrastructure at the University of Michigan's Lurie Nanofabrication Facility (LNF), soliciting the opinion of equipment manufacturers regarding equipment design can be highly beneficial.

The LNF is a world-class facility in all areas of semiconductor device and circuit fabrication, integrated microsystems 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.

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

The original equipment design for the new lab area's 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," adds Schweiger.

In addition, some of the new equipment had its decks reconfigured once the tools were installed. Several of the earlier wet 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 or 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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