

## Designing Microfabrication *Lab Equipment for Today and Tomorrow*

*Optimizing today's R&D labs can require vendor collaboration and planning to provide required future versatility.*

by Del Williams, Technical Writer

As research has become more complex, sophisticated cleanrooms have become a virtual necessity for a wide range of cutting-edge physical science, material science and biomedical disciplines.

Due to the financial investment required for such facilities, both university and private R&D laboratories are designed and built to accommodate the needs of a wide range of researchers. This presents a challenge: few administrators have the experience to select and set up lab equipment with the versatility required to serve such a diverse group of users over decades of continually changing research.

Now, a growing number of lab administrators are optimizing their microfabrication equipment, both for current and future needs, by involving their vendors early in the process. This enables expert planning as well as the selection of standard equipment options that can improve safety, usability and efficiency while cutting cost.

"Often university lab administrators have never built their own cleanroom before, so they hire an architectural firm to do the design, but are still a little lost on how to lay out the equipment for all the different potential uses," said Louise Bertagnolli, president of JST Manufacturing. "Because universities are always pushing the boundaries of research, the equipment has to be very flexible so it can be used in ways not even conceived of yet."

Whether for compound semiconductor, nanotechnology, microelectromechanical systems (MEMS), biophotonics, biomedical electronics, or creating solar power alternatives to traditional silicon wafer construc-



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tion, much of the advanced research done in labs today requires microfabrication operations. This typically includes wet processing equipment for metal lift-off, stripping, etching, plating/coating, cleaning and de-bonding.

Dennis Schweiger, Senior Director of Infrastructure at the University of Michigan's Lurie Nanofabrication Facility (LNF), said he believes 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 microsystems and MEMS technologies, nanotechnology, nanoelectronics, nanophotonics and nanobio-technology. 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 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," said Schweiger.

According to Bertagnolli, who has guided numerous R&D lab administrators through the equipment design and selection process, the main concern is about setting up the cleanroom and procedures to serve the needs of users, but the process is not always well defined and there are many unknowns.

"When designing and laying out cleanroom equipment, it is important to talk with a vendor or consultant with the experience to help you achieve your evolving research goals," says Bertagnolli. "It is also essential that they help ensure it is correctly set up, that the proper safety, operation and maintenance procedures are in place, and that lab managers are properly trained to carry these out."

Maintaining safety and flexible function for wet processing equipment often requires selecting the most appropriate options from a number of technologies. This may involve various chemistries, temperature controls, chemical baths/dips and ergonomic designs, as well as cleaning, filtration, ventilation, safety and disposal technologies.

### **Designing modular and custom 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.

In this case, the solution is equipment that is modular by design, allowing for easy changing and reconfiguration should process or product requirements change.

Another powerful feature: each unit should be 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.

The flexibility enables users to dial in applications, such as chemical concentrations, but also turn various features off, depending on process requirements. Even though a user may not need some of the features today, that doesn't mean those same features won't be in demand in a few years' time.

Specifying the design parameters for 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.

"Certain processes like etchings and

cleanings lab managers will want to be flexible enough to accommodate a wide range of users and projects," says Bertagnolli.

"We are often asked for tank construction materials that can withstand a number of concentrated acids, so part of design flexibility is ensuring you use the most compatible materials for the most acids. Another aspect to consider is properly separating, neutralizing and disposing of all the chemistries involved after use, whether in drains or tanks for treatment or pick up."

Having the vendor visit the user's facility can contribute to equipment design versatility that can accommodate changes in lab use over the long term.

"An eye toward optimizing working space, operating cost or maintenance can go a long way toward creating a cleanroom that will serve the user community well now and in the future," says Bertagnolli.

### **Optimizing LNF's lab**

LNF's Schweiger recalls that the original equipment design for the new lab area's wet

processing benches was very specific, and determined by 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 says.

Schweiger adds that 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 or flexible enough, [so] we worked to implement modifications so that the bench decks were simpler, and could provide more working space," Schweiger concluded. 📍