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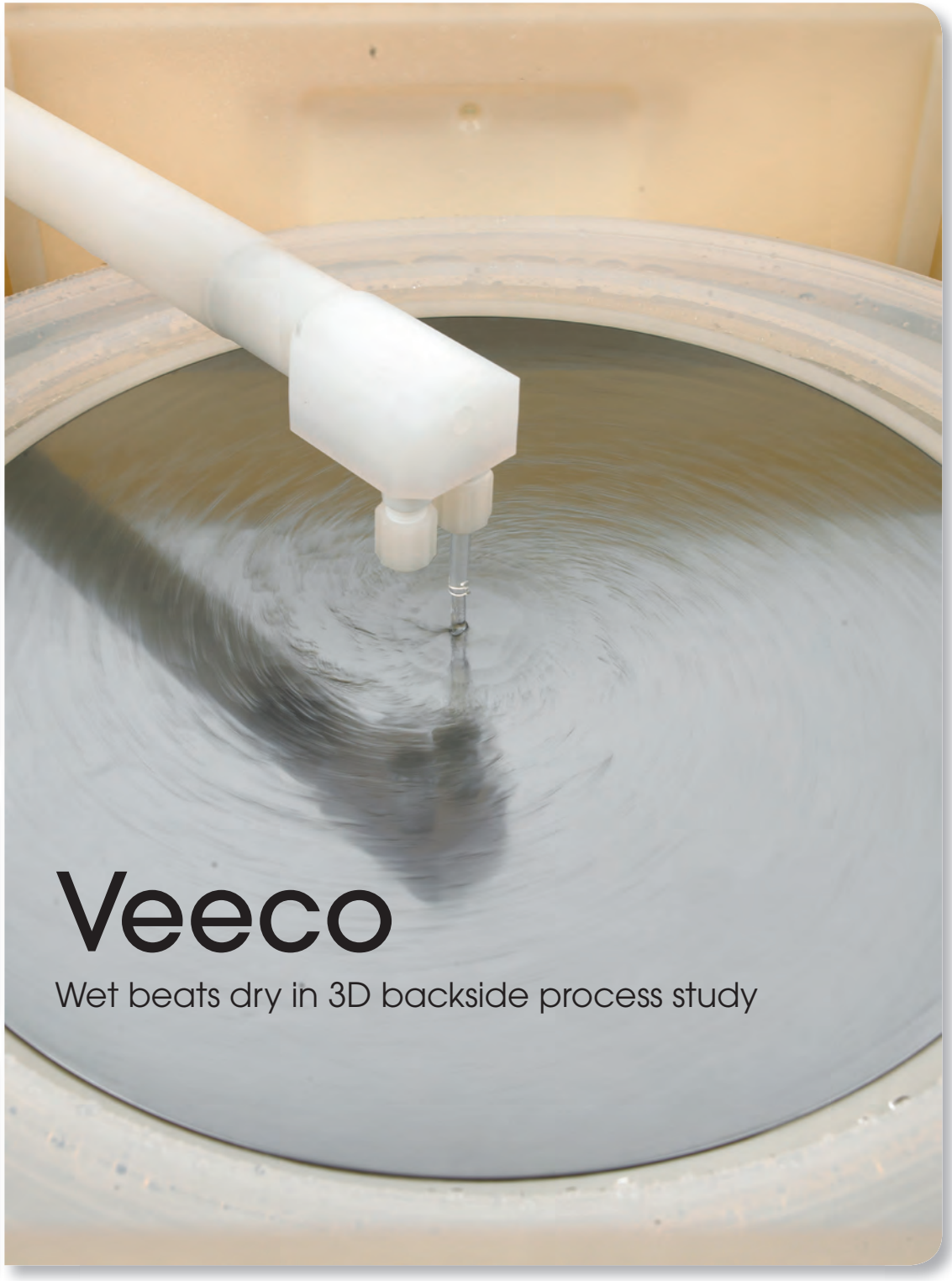

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JST Mfg has an on-site applications laboratory where end users can develop their process with various chemistres and do tests on real equipment ranging from immersion and spray tools to dryers

# Dialing-In' wet processing parameters for MEMS, nano manufacturing and R&D

Technology companies experience benefits from using wet processing equipment designed to handle a variety of application parameters. JST Manufacturing explains.

AS THE MARKET for nanotechnology (nano) and MEMS (Micro-Electro-Mechanical Systems) solutions continues to ramp up, the rate of organizations seeking to get involved with this sector is also burgeoning. Yet there are still significant challenges that are, in many cases, posing difficulties in entering this market.

For example, many developers who would like to enter the MEMS or nano field lack the resources, including development time and equipment, to do so. Also, specialized packaging in these areas, which requires simultaneous contact with its own environment while being isolated from other environments, is often expensive and difficult to achieve.

"MEMS research and manufacturing organizations are meeting those challenges in unique ways," says Louise Bertagnolli, president of JST Manufacturing (Boise ID), a specialist in wet processing equipment for the MEMS, nano, photovoltaic, wafer and related industries. "An increasing number of universities and institutions offer the facilities, including equipment and instrumentation, to conduct MEMS and nano research and even produce prototypes and modest production runs."

Wet processing systems, one of the areas that organizations focus their attention on, are used for such procedures as etching, photoresist wet stripping, photolithography, metal lift-off, and related polymer removal processes.

Those processes aid researchers and manufacturers in improving product quality and throughput in a wide range of MEMS and nano applications such as microsensor- and microactuator-based devices. Some of these capabilities are used in contemporary applications such as the screen rotation of today's cell phone displays and the optical switches and mirrors to redirect or modulate light beams. Future applications will provide complete "system-on-a-chip" capabilities.


A wide variety of equipment designs is available to accomodate the many different wet process requirements

## Making research more available

Although the cost of MEMS and nano application development can be very expensive, some institutions are installing facilities and making them available to both educational and commercial researchers. The University of Michigan's Lurie Nanofabrication Facility (LNF) is one example.

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. According to Dennis M. Schweiger, Senior Director of Infrastructure, soliciting the opinion of equipment manufacturers regarding equipment design for such facilities can be highly beneficial.

"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," 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 Manufacturing to implement modifications so that the bench decks were simpler, and could provide more working space," Schweiger concluded.

"Although there are similarities in the wet processing techniques used to create a broad variety of MEMS and nano devices, each process might not be identical in concentration, time, temperature and chemicals used," JST's Bertagnolli explains. As a result, there are 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 MEMS and nano markets 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, 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, 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 Bertagnolli. "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.

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## 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 modifications to meet the needs of each application. Also, the equipment is modular by design, allowing for easy changing and reconfiguration should the 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," explains 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 their 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."