How to clean/etch items with geometries

16th April 2018 **Source:** JST Manufacturing Inc

Posted By : Lanna Cooper

Cleaning, an integral part of many manufacturing and maintenance processes, is often critical to the performance of a broad range of technologies in the semiconductor, defence, MEMS, photonics and biotech industries. 'Cleaning', in this case, refers to the use of agents such as solvents, acids or bases to remove unwanted particulates and other contaminates from products ranging from optics to semiconductor and electronic devices.

It also refers to the etching process utilised in semiconductor fabrication, where the 'cleaning' is the precision removal of thin layers of material.

Today, many of these processes are relatively standardised. Semiconductor wafers, for example, are produced in several sizes and processed the same way, no matter the type.

However, for products with non-standard geometries, shapes, sizes and even weight, cleaning takes on a new dimension: figuring out how to optimally get each item in and out of the equipment at each stage of processing.

Within this category are a potpourri of items such as optical lenses for the world's largest telescopes and high energy lasers, the crystals used in nuclear sensors or guidance systems,glass substrates, MEMs devices, probe sensors, medical implants, chemically machined subcomponents, etc.

With these types of items, creative solutions must be employed to load items in and out of what is typically a multi-stage process. This can include utilising automated gantry robots, machined fixtures and loading carts.

Careful consideration must also be given to the orientation and, potentially, the rotation of the item after it enters the process baths.

"We are not just concerned with the cleaning equipment, but also how to get the products in and out of that tool," said Louise Bertagnolli, President of JST Manufacturing (Boise, ID), a specialist in wet processing and precision cleaning equipment.

"The handling of non-standard items of various geometries, sizes and weights is a factor that most customers don't think about," added Bertagnolli. "Instead, they focus almost solely on the cleaning process - the temperatures and chemical concentrations. Yet, how product handling can impact the amount of chemicals required, processing time and even quality of cleaning."

Lifting, transporting with gantry robots

Companies that choose to automate a cleaning process usually do so to ensure the repeatability of cleaning results. This means precisely controlling the measurement and dispensing of the cleaning agents and rinsing solutions. It also means providing the systems and tools necessary to transport the items from one bath to another.

For this, robots are often used to lift and transport items to multiple stations or modules.

At companies like JST, this necessitates working closely with automation partners such as Bosch Rexroth (Charlotte, NC) to develop cleaning stations using linear motion and electric drive and control technology.

In a recent project the two firms worked together to create an automated system for cleaning silicon chunks to the extreme purity of 11N to meet requirements for the manufacture of semiconductor chips. The project entailed building a cleaning line 138ft. in length and incorporating multiple gantry robots.

The throughput volume requirement for the chunks was four tons for every 22-hour shift. To accomplish this, JST had to develop a basket system to transport the material throughout the process.

To provide for such a long cleaning system, JST engineered and built it in two units. In the 24-ft-long unit, baskets of chunks are manually loaded through an auto-door. Then two-axis robots cycle the baskets through five acid etch baths and two rinse baths arranged in a single row down the length of the second unit.

In some cases, gantry robots are the only solution, particularly for heavy items that may be too much for workers to handle safely. Bertagnolli has seen products that must be lifted that exceed 50, even 100lbs.

In a project for Lawrence Livermore National Laboratories' National Ignition Facility (NIF), JST was charged with figuring out a solution for handling thousands of heavy optical lenses.

NIF operates one of the world's highest energy laser systems, which consists of 192 laser beams that can focus nearly two million joules of energy. Each of the 192 beams is supported by up to 50 lenses.

"If these lenses were not as clean as possible then we would start to degrade the performance of our laser," explained Patrick Williams, NIF Optics Maintenance Manager.

"The optics are heavy and rather large, so we don't want to handle them a lot," added Williams. "JST suggested that there might be an easier and more cost effective way to transport, clean and inspect the optics. They came back with an original

design, and then we tweaked it into a system that has worked for over 16 years."

One of the innovations in the NIF cleaning tool, which was a tank-like configuration, was to eliminate the need to move the optics to different locations to perform the washing, rinsing and drying functions. In lieu of moving the optics, all cleaning, rinsing and drying is done in one tank. The chemistries move, not the product.

Machined fixtures
Bertagnolli said another important element to consider is the fixturing - the devices that hold or position the products being processed.

Single or multiple item fixtures are typically designed and machined to fit the specific application. Because precision cleaning equipment is largely a task involving metal fabrication and machining, suppliers like JST can also provide custom designed fixtures.

Well-designed fixtures can even accommodate quick-change inserts that allow it to be re-used for other parts.

Orienting the part
Attention should also be given to optimising the orientation of the part if it has blind holes or other geometric features facing up that can hold chemistry when lifted out. The same holes, if horizontal, can create unwanted bubbles or air pockets.

For these reasons, it might be necessary to design a solution that orients the part in certain direction and then rotates it later in the process.

Even if no blind holes are involved, etching the entire surface of a part may require rotating the part while minimises contact with the surface.

Such was the case in a project JST was involved in that involved the cleaning of silicon 'seed rods' that grow the polysilicon ingots from which the chucks are made.

The seed rod cleaning equipment utilised a gantry robot to move the ingot-carrying cylindrical carriages through a sequence of etch baths. JST designed a custom fixture that rotates the rods to ensure they etch evenly.

"The rotational fixture enables the rods to be cleaned to a very high purity," Bertagnolli noted. "We incorporate rotational fixtures quite often for cleaning."

Attention early in design phase
According to Bertagnolli, sufficient consideration of these factors must be given early in the design phase. Racks and fixtures need to be designed to safely handle parts and the fixtures themselves must be designed to withstand the chemicals involved.

"With a full engineering staff and 3D modeling, JST can complete a structural analysis and look at the deflection and really have a good idea before anything is ever built," said Bertagnolli.

In some cases, her company is called in to consult on handling solutions for other provider's equipment or when manual loading/unloading proves problematic.

"There are a lot of different ways to handle the issue," said Bertagnolli. "It just takes some engineering, manufacturing capability and experience in the industry. Given that so much is invested in the cleaning process tool, it makes sense to ensure repeatability with an appropriate product handling system."

Write a comment

No comments

Similar articles

- Optimizing benchtop cleaning
- Gold coating could control luminescence of nanowires
- Sourcing the right subassembly maker provides key be...

- Designing lab equipment with research flexibility in...
- Photonics 4.0 brings new dimensions to industrial pr...
- Gallium could work as a reversible adhesive

- Low viscosity epoxy resists aggressive chemicals
- Coating improves from power plants to ketchup bottle...
- How to deal with contaminant residues on PCBs

- Zestron plans to clean up at SMT Hybrid Packaging
- Accessing the latest wet processing equipment
- Automating cleaning processes for quality & volu...

More from JST Manufacturing Inc

- How to clean/etch items with geometries 16th April 2018