The Highest Standards of Technical Cleanliness

The assemblies and components used in the production of semiconductors must be almost entirely free of contamination in the form of films or particles. In other words, all the stages and all the processes must comply with the highest standards of technical cleanliness. A current project demonstrates how this can be achieved.

Gerhard Koblenzer

The increasing levels of networking, miniaturisation and automation in the digital world are placing growing demands on the performance of computers. For this reason, more and more transistors have to be fitted into the same small space. As a result, semiconductor structures are gradually taking on the dimensions of atoms. This has an impact on the industry that manufactures them.

CO_2 laser systems for the chip industry

Trumpf is a company based in Ditzingen in Germany that has been manufacturing CO_2 laser systems for the semiconductor industry since 2014. These systems play a key role in the production of chips. They are used to generate a luminous plasma that exposes wafers to extreme ultraviolet radiation (EUV). This allows structures to be created on microchips using a special illumination process which are less than ten nanometres in size, in other words, smaller than the flu virus. According to the company: "In future it will be possible to fit more than ten billion transistors on a single microchip, which will significantly improve the performance of smartphones and other devices."

When producing laser systems for use in the chip industry, important cleanliness considerations include the removal of films of organic contamination and organic and inorganic particle residues. The company's existing ultrasonic multi-bath system was no longer able to handle the batch sizes, the higher standards of cleanliness required or the tasks that it would be expected to perform in future.

Because LPW has already been producing cleaning systems for suppliers of semiconductor manufacturers for several years and has special procedures, processes and machine concepts in its portfolio, it was included in the selection process. Trumpf required a new system consisting of a preliminary and interim cleaning machine and a separate final cleaning machine before the cleanroom assembly phase for the extended production of pulsed CO_2 laser systems for the chip industry.

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The new machine has been successfully in use since February 2019. From left to right: Kamil Nowak, machine manager, Renato Reye Righi, machine operator, Marielle Bonenberger, production engineer, Dr Frank Wirth, head of the production department, and Sebastian Pöschl, group manager.

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The huge size of the machine meant that it had to be delivered to Ditzingen in the form of five abnormal loads.

Cyclic nucleation combined with ultrasound

The preliminary tests of different kinds of cleaning systems from the selected machine manufacturers were carried out under conditions similar to real-life production. They showed that a vacuum-based CNp (cyclic nucleation) machine combined with ultrasound produced the best results by far within the specified limits, particularly with regard to organic residues. Subsequently, LPW designed a multi-chamber cleaning system for Trumpf from its PowerJet CNp range with three modules for preliminary, interim and final cleaning:

Module 1:

- Three vacuum chambers each with a volume of around 1500 litres
- An upstream automated feed system with laminar flow units and a connection to the cleanroom
- A CNp system for all the cleaning and rinsing processes in all the chambers
- Vacuum-resistant multi-frequency ultrasound systems
- The option of retrofitting ultrasound systems to the rinsing chambers
- Set of vacuum pumps for CNp processes and drying
- Waste air system with vapour condenser

Module 2:

Media supply module that provides the cleaning and rinsing media, including the accompanying filter systems, which is located in the basement underneath the first module.

Module 3:

Ultra-pure water (UPW) system that supplies fresh water and recycles the water from the final rinsing processes with an inlet temperature of 65°C.

Strong, homogeneous sound field

One of the challenges presented by this project was to use air cushions to damp the vibrations of the first module in order to prevent them from being transmitted to the sensitive measuring equipment in the building. In addition, a special vacuum- and CNp-resistant multi-frequency ultrasound system had to be integrated into the machine.
Weber Ultrasonics, LPW's partner on the project, supplied the new generators (the multi-frequency variant of the SonoPower 3S, 4th generation). These can be individually adjusted to the cleaning solution. The SonoBoost-Sweep and SonoPower-Modulation functions produce a particularly strong and homogeneous sound field. The generators have interfaces to all the common field bus systems, such as Profinet and Ethercat, which means that they can easily be integrated into the control systems of the production line.
The new system has been in use by Trumpf since February 2019. It currently cleans 15 to 20 baskets of components per week and this number is growing. As Sebastian Pöschl, group manager at Trumpf explains: "In the start-up phase, we were able to meet the requirements for contaminant films using only the CNp process. We have not made full use of the range of cleaning processes available and we expect to achieve even better cleaning results in future." //

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