

Patience, know-how and integrated concepts

A successful system concept in the high-purity segment calls for close cooperation between the manufacturer and user, a comprehensive testing phase, and support with integration. The **SEMICONDUCTOR** industry is driving development.

Figure 1. Complex assemblies with high-purity requirements for subsequent cleanroom assembly require coherent overall concepts



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Whether mini or XXXL, whether a single unit or split over multiple floors of a building – system concepts in the high-purity segment are becoming increasingly complex in terms of architecture, the inner workings of the process engineering and when it comes to infrastructure. The major drivers in the sector include the big players in high-vacuum technology for semiconductor production, who are producing increasingly complex components with constantly stricter purity requirements. As a consequence, machining suppliers are being faced with new challenges. Complex geometries and high production precision, combined with significantly more stringent cleanliness requirements, require high purity environments, a perfectly coordinated process chain and appropriate cleaning

technology. Cleaning system suppliers have to act as partners, show patience and a sound level of know-how, and offer integrated concepts.

Components for lithography systems in the semiconductor industry are pushing the high-purity market forwards (**Figure 1**). A huge range of materials and geometries, from structural components to valve assemblies, mirrors and lenses through to sensors and cooling tubes made of stainless steel, aluminium

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Figure 2. Tightly packed components in an assembly or combination of multiple components in a batch places very high demands on machines and processes

copper, ceramic or various plastics, all require modified manufacturing processes that take into account the required levels of purity of both the product and the process (**Figure 2**). But that's not all. Customers now expect intensive co-engineering in designing solutions, trial and testing facilities under cleanroom conditions with experienced personnel (**Figure 3**), the option of qualified contract cleaning during the transition and support with integration into the process chain. Furthermore, integration of cleaning systems into the company's specific infrastructure is an important issue. For high purity, it almost always means linking to a cleanroom and to suitable media supply systems. Application engineering has also become an important topic.

For some years, supply chains have been confronted with cleanliness requirements from their customers. For components with simpler geometry, such as mirrors and glass, existing ultrasonic multi-bath systems can of course be used. But cleaning processes for more complex components (for example with vias and undercuts, gaiters, pipes, hoses or tightly packed batches) require special planning and implementation. As a result, the system manufacturer firstly needs to know about the customer's requirements and processes, and to have an in-depth understanding of the various appropriate cleaning, rinsing and drying processes themselves, the required media processing circuits and, above all, the issue of avoiding recontamination and cross-contamination at every step.

Cleaning concept for manufacturers in Netherlands

Over the past 15 years, LPW Reinigungssysteme GmbH from Riederich in Swabia, Germany, has acquired a huge amount of expertise, especially in the field of high-vacuum technology. A number of

special systems have been developed for key customers in the industry, generally with a direct connection to a cleanroom, in Europe, Asia and North America.

Regular customers also include companies in the Netherlands – an important high-tech location in Europe, particularly for the semiconductor industry, which is where the ASML Group produces EUV lithography systems. Two suppliers from this sector approached LPW as they had to upgrade their production from Grade 4 (comparable with conventional particulate cleanroom tasks) to Grade 2 – with an option of moving up to Grade 1. This means that the focus is on filmic and ultra-fine particulate conditions for high-purity and ultra-high-purity cleaning, with strict requirements for the purity of the environmental parameters.

First of all, LouwersHanique from Hapert in the Netherlands came to the Riederich firm with their high-quality glass and metal components. This was followed by an enquiry from AAE from Helmond in the Netherlands, which produces a wide range of high-quality machinable structural components (mainly aluminium) for its customers, with a large variety of parts and huge complexity. In this project, the focus was on challenging geometric shapes, through and blind vias with diameters from 2 to 6mm (threaded or not) and sensitive surfaces in terms of possible mechanical damage. The first series of tests at LPW was carried out using specially produced test components. Components made of copper, aluminium, titanium, PEEK and stainless steel were consciously selected to simulate the broadest possible range of materials. Analyses performed included UV-A black light inspection. The components were then subjected to a bake out process.

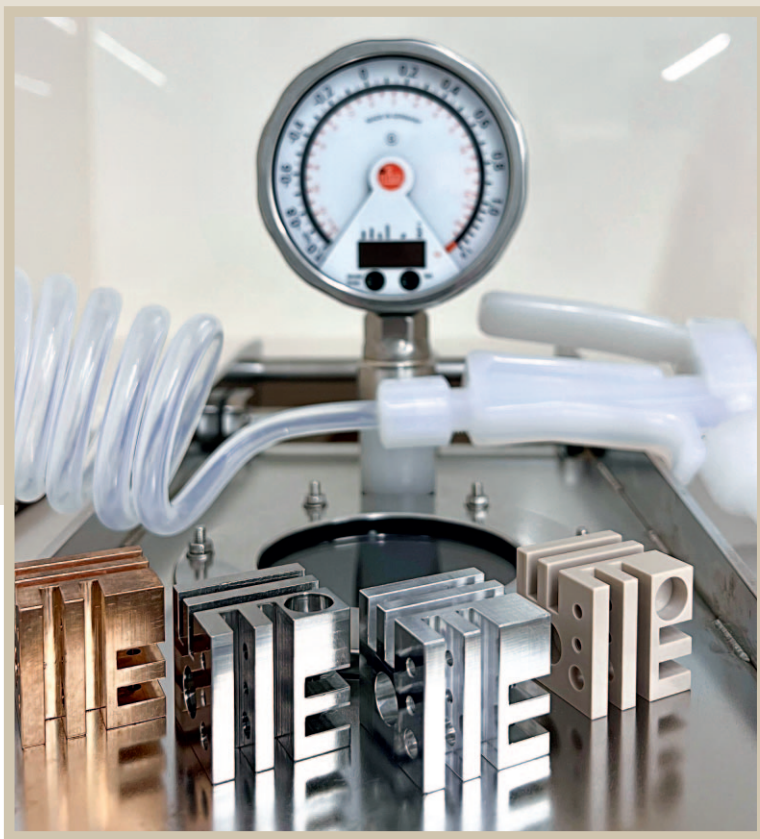


Figure 3. Before the design of a suitable cleaning system, the viability of current and where possible future tasks are tested in preliminary trials, in this case with components

Intensive co-engineering

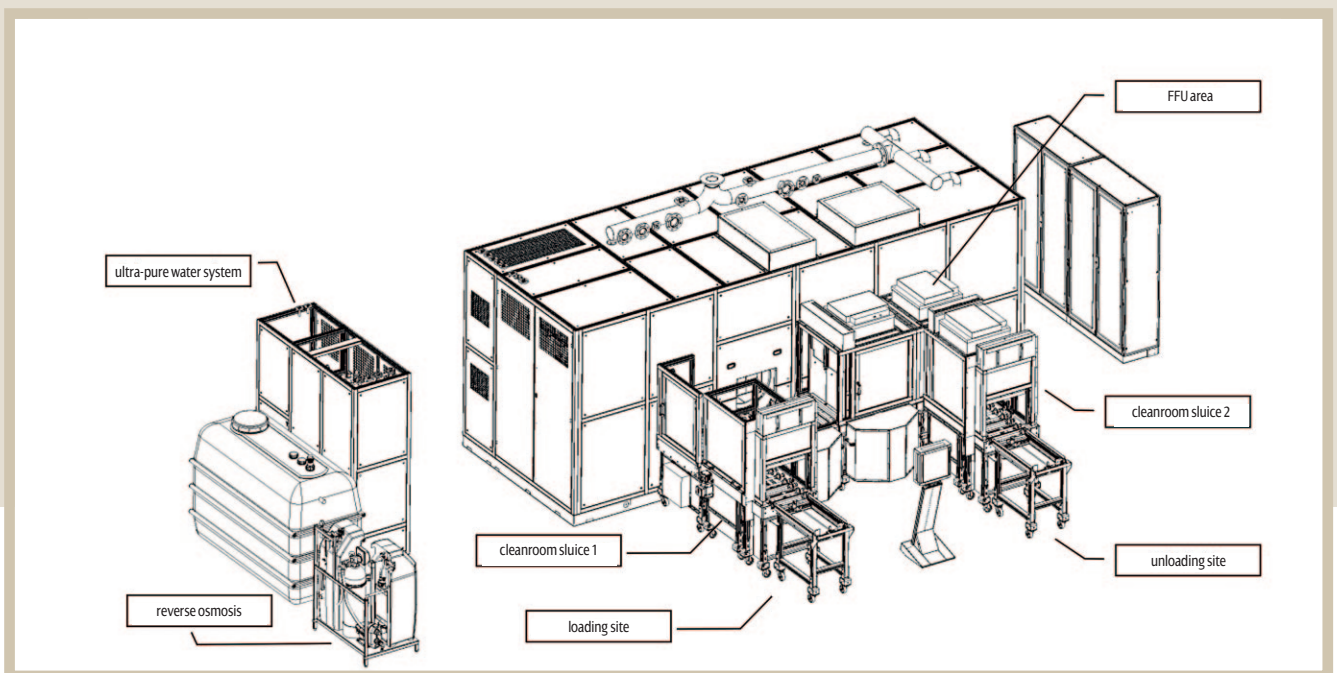
Both customers have reservations about using a pure ultrasonic system, in terms of cleaning quality and possible damage. In addition, preliminary trials with other system manufacturers involving complex components had delivered unsatisfactory results. The question was how to move forward? The requirement was for intensive co-engineering from day one – projects of this nature must be steered by both sides and require in-depth discussion about issues such as processes, materials and their properties, handling and evaluation of the quality. Each individual cleaning operation, i.e. mechanical washing, rinsing and also drying, has to be tested and evaluated in terms of its positive and negative influence on the required result. And this is long before an actual purchase decision is made. Openness is essential, as is trust in the people you are dealing with and their environment. In essence, although a new cleaning system is being developed, the aim is actually to implement a higher quality level in production. So it's not enough to produce a quotation, carry out a test and then negotiate the contract. The first testing day highlights all the areas that need to achieve a result acceptable to both parties in subsequent testing. At this stage, customers often want the pilot series to be covered by contract cleaning. This is another place where we see that cleaning alone is not an option. Transparent and traceable batch or component specific documentation and verification of each individual cleaning and handling operation must be guaranteed, alongside the contract cleaning itself.

Modular system concept

After intensive testing at the LPW's in-house cleanroom testing and service centre, including contract cleaning and the design of an appropriate overall process, LouwersHanique and AAE finally placed their orders. Customised solutions were implemented for both companies, based on the modular ›PowerJet Ultra‹ high-purity system concept (**Figure 4**). This system features special treatment chambers, optimised to meet the strictest requirements in terms of recontamination and cross-contamination during the fluid and drying processes. Further details of the systems for the ASML suppliers are as follows:

- Two distinct treatment chambers to separate the cleaning and rinsing processes
- Three or five storage tanks (pre-cleaned / not pre-cleaned components)
- Multi-frequency ultrasound, at least in chamber 1
- CNp (short and long cycles) in all chambers
- Integrated TOC, conductivity and particle measurement
- Laminar flow protected supply and discharge automation with cleanroom link
- High-quality stainless steel (min. 1.4571) and plastic design of systems in contact with media
- Integrated de-ionised circuit systems
- Low particle / supply air-free dryers (IR vacuum)
- Soft filling and emptying
- Connection to on-site or LPW ultra-pure water system as additional final circuit and follow-up media supply

The systems were delivered to the Eindhoven region in the spring of this year (**Figure 5**). But the cooperation between the project partners did not come to an end after delivery and installation. As well as the normal service tasks such as maintenance, repairs and spare parts supply through the LPW application engineering business unit, the customers still have access to the cleaning specialists in Riederich on issues of process chain optimisation, process simulation and validation support.



These are precisely the capabilities that have seen LPW establish itself as a partner in the worldwide high-purity segment in recent years, delivering high-quality alternatives to conventional multi-bath ultrasonic systems. This specialist segment now accounts for over 60 percent of turnover. The LPW cleanroom test centre is not only continuously carrying out tests with clients, it is also engaged in constant research to further refine and develop the technologies and processes. The result is customised complete solutions for large suppliers, tailored and integrated into new and existing processes. From small but powerful and through to XXXL with cleaning chambers with capacities of several thousand litres. Final cleaning systems with direct ISO-5 cleanroom connection have been a regular part of

the product family since 2008. There are also highly flexible automation solutions developed in-house for requirements relating to or adapted for cleanrooms, the corresponding media treatment (such as ultra-pure water circuits/UPW) and suitable monitoring systems for integration into validated overall processes. In addition to the Ultra system concept described, with its ›PowerJet compact CNp‹ series, the company can now offer high-purity standard systems with a minimal footprint that grow with the level of business, specially designed for SME suppliers in the new business segments. ■

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Figure 4. The basic concept of the ›PowerJet Ultra‹ is always similar, but is adapted to specific requirements in collaboration with the user



Figure 5. The standard ›PowerJet Ultra‹ series can be installed and integrated on site without significant assembly work after the installation and testing phase