Cleanliness in Submicrometer and Atomic Percent Range

Particulate and filmic component cleanliness must be achieved reliably and efficiently in series production, especially when manufacturing, joining and coating technologies change. In parallel, requirements are growing due to ever stricter regulatory specifications. In addition to cleaning and drying processes designed to meet specific requirements and suitable technology, the software and the cleaning environment must also be adapted accordingly.

Whether production equipment for the semi-inductor industry, biotechnology, laser and sensor technology, devices for measuring and analysis technology, components for accumulators and fuel cells, optical systems or metal cutting tools, the requirements for performance and reliability are extremely high. This not only leads to high demands in terms of production precision of the parts, but also their cleanliness. For medical technology products such as implants, instruments, cannulae and endoscopes, particulate and film-type contamination from manufacturing processes is an essential criterion due to regulatory specifications. Moreover, there is a trend for miniaturisation and functional integration with ever smaller and more complex components. These developments entail that particulate cleanliness specifications in the mi-

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Figure 1 > The various treatment stations of this individually designed ultrasonic ultrafine cleaning system can be flexibly accessed.

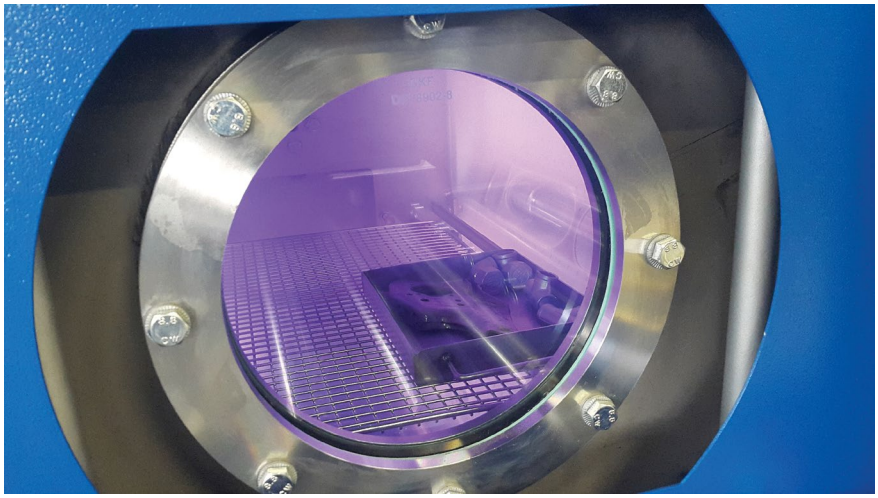

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Figure 2 > By combining wet chemical and low-pressure plasma cleaning methods for ultrafine degreasing in a single machine, the surface characteristics required for downstream coating or bonding are efficiently achieved.

crometer and even nanometer ranges as well as very stringent requirements regarding residual film-like contaminations must be met by more and more industry sectors. Depending on components and/or applications, outgassing rates for organic substances and residual moisture may also have to be met. The same applies in the area of of surface analyses for residues of prohibited substances, whose limit values are partly in the atomic percent range. atomic percent range when it comes to surface analyses for residues of prohibited substances. For the production of these miniaturized components there is also an evolution towards ever larger integrated manufacturing modules. This also creates new challenges for the cleaning processes and the machine systems required to implement them.

Plant concepts for cleaning

For component cleaning, this results in very demanding tasks, which cover the entire production chain. chain. As a full-range supplier, the companies of the SBS Ecoclean Group cover the entire spectrum of precision and ultra-fine cleaning (*Figure 1*). This enables them to adapt cleaning processes, their control software as well as the machinery and ambient conditions to the requirements and applications on hand.

For selection of the suitable cleaning system for a specific task, the first thing looked at is whether the system is to be used for pre-cleaning, intermediate cleaning or final cleaning. Depending on the use and cleanliness specifications to be achieved, the solution may be chamber or multi-tank immersion machine, a flexible ultrasonic multitank machine based on standardized modules, or a customized ultrasonics-based ultrafine cleaning system. The cleaning chemicals as well as the optimal process technologies are also specifically chosen for the application and the contaminants to be eliminated. Process technologies that may be considered include, for example, spraying, high-pressure, immersion, ultrasonic or megasonic and plasma cleaning (*Figure 2*), injection flood washing, Pulsated Pressure Cleaning (PPC) and passivation/preservation, if required.

Cleaning processes and systems for ultra-high cleanliness

The design of customized ultrasonic multi-chamber systems and processes for ultrafine cleaning applications are the core competence of the Switzerland-based com-

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Figure 3 > For integration into clean rooms the ultrasonic ultrafine cleaning systems are fitted out in compliance with the applicable clean room class.

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Figure 4 > In the immersion/spray rinse tanks specifically developed for ultrafine cleaning processes, the parts are sprayed off as they exit the bath which enhances the rinsing result.

pany UCM. Key factors to be considered are the material and geometry of the parts to be cleaned, the type and quantity of contaminants, the particulate or film-type cleanliness specifications and, where applicable, permitted outgassing rates and maximum acceptable residues of prohibited substances in the atomic percentage rate. In addition, attention is paid to the selection of suitable cleaning chemicals and media supply, for example the use of the use of osmosis or demineralized water. The materials and manufacturing methods used to build the cleaning system and automatic transport system are also selected with the prevention of dirt build-up, recontamination and cross-contamination already in mind. Outfitting with clean room-grade components and interfacing with clean rooms are also possible (*Figure 3*).

Requirements for the process development

Standard equipment installed in precision and ultrafine cleaning systems are multifrequency ultrasonic systems that offer flexible adjustment of ultrasonic frequency and intensity to the requirements of different parts to be cleaned. With parts that present complex geometries, capillary structures or porous surfaces, such as for example sintered metal components or additive manufactured components, the PPC method comes into play. Features such as multi-side overflow in all wash and rinse tanks as well as the immersion/spray rinse technology specially developed for ultrafine cleaning systems contribute to the reliable meeting of very severe cleanliness specifications (*Figure 4*).

The decision which parts are taken to which wash and rinse tanks as well the part-specific process parameters such as temperatures, ultrasonic output and frequency, intensity of PPC, dwell time in the various wash and rinse tanks, are defined during the process development phase. Depending on the complexity and heat absorption capacity of the parts, drying is mostly done using infrared or vacuum technology. The resulting part-specific cleaning programs are stored in the machine controller. The software-controlled implementation of the cleaning sequence plays a decisive role in this context. It ensures among other things that the specified dwell times in wash and rinse tanks are precisely observed, and that prioritized sequences – e.g. for very fragile parts – can be programmed.

The optimal system and process solution from a cleanliness and economic efficiency point of view can be determined through cleaning trials with original parts in Ecoclean's and UCM's precision cleaning technology centres. //

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