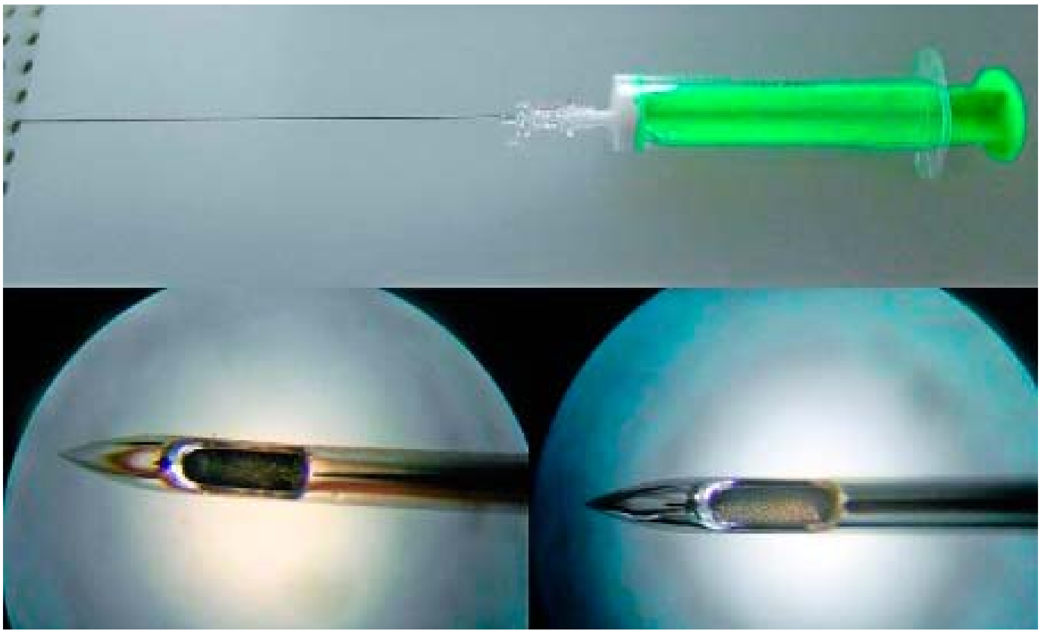
Cleaning Components Like in the Semiconductor Industry

Ultrafine cleaning procedure | Before sterilisation, the final product must be free of all residue from industrial manufacturing and toxic substances. A new patent-pending cleaning procedure from the semiconductor industry offers more options and could also be of interest for medical technology.



Even fine structures, like the epidural needle shown here, can be cleaned with CNP.

Photo: LPW Reinigungssysteme

When you think about cleaning medical devices, their reprocessing quickly comes to mind. Medical devices with all of their recesses and cavities are cleaned before they are even used for the first time: immediately after the manufacturing process and before sterilisation.

Any procedure used in this context has to meet two requirements. It must first dislodge all forms of "contamination" from the component and secondly also carry them away from porous surfaces or capillary structures. The standard procedure used today is heat; sometimes appropriate chemicals or ultrasonic treatment are used—or a combination of all three.

"It is difficult to detect whether the components are truly clean after such treatment—sometimes only destructive testing will determine that," says Gerhard Koblenzer, Managing Director at LPW Reinigungssysteme GmbH from Riederich in Baden-Württemberg. He proposes a new cleaning process for such applications. The new process is already being used reliably in the semiconductor industry and the patent is pending: It is called the cyclic nucleation process, or CNP for short.

This process is based on getting material to flow in even the smallest cavities. "The entire system is initially put under vacuum," explains Koblenzer. At negative pressure, the air is replaced with the cleaning or rinsing agent. Under the vapour pressure, water starts to bubble and small bubbles of water vapour form. "We work directly on the surface of the component. The next goal is to get the media to flow on the entire surface of the component being cleaned," says the Managing Director. This is achieved by re-increasing the pressure in the system, which causes the imploding bubbles to create cavitation and flow everywhere. This not only dislodges contamination but also carries it away from the surface—even in inaccessible angles of the component.

YOUR KEYWORDS

- New patent-pending process for cleaning components
- Suitable for medical devices
- Success depends on the right parameters

Changes in pressure keep process working

The process is called a cyclic process because the process steps have to be repeated multiple times in short intervals with changes in pressure. LPW employees have already gained a lot of experience with this process. "We have primarily used it in industrial component cleaning so far," continues Koblenzer, "but we have also completed the first tests in cleaning medical devices—with very promising results.” For example, it was used to clean epidural needles after manufacturing, and tubes and medical instruments after use.

LPW specialists say that this cleaning process is still not very well known, despite its positive results. For tasks that cannot be solved using water-based cleaning technology and in which even solvent-based techniques have problems getting the job done, this is an alternative.

This procedure not only applies to the areas of fine and ultra-fine cleaning known from the electronics/semiconductor industry, medical technology, and the optical industry. The classic examples from this field are fine drill holes in fuel injection technology or concealed and complex internal geometries like those found in cooling elements. Capillary conditions occur in other circumstances as well: for example, with densely packed goods or tightly arranged bulk material. “CNP can offer solutions anywhere where ‘normal’ particulate and film-like deposits need to be eliminated,” explains Koblenzer. CNP could also be used in combination with other processes, such as the well-established ultrasonic cleaning procedure. “When ultrasonic cleaning has dislodged the contamination, in the next step CNP can generate the media flow that is needed to carry away the dislodged particles.” (op) ■

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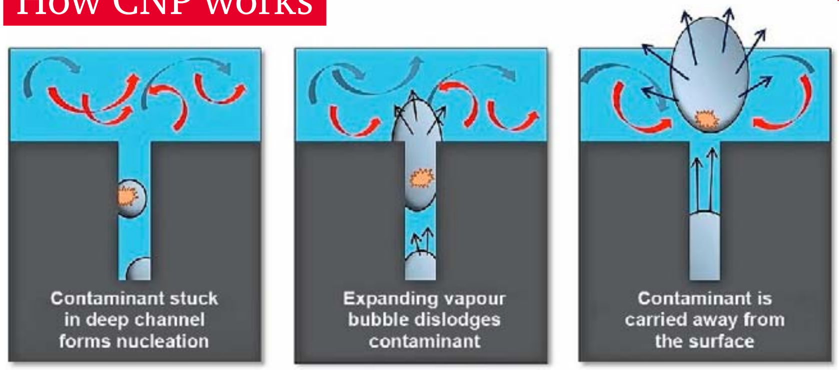
How CNP works



The asymmetrical volume flow creates a pump effect. When the bubbles burst, there is an exchange of media in the capillaries and drill holes which helps remove contaminants.

The CNP effect can be created using common basic principles. Negative pressure is created in a closed chamber filled with medium. The gas bubbles (created by the boiling medium) form on all reactive surfaces, including surfaces in complex structures like capillaries and drill holes. When the negative pressure is suddenly removed, the bubbles collapse (they implode) and create a shock wave, also known as the cavitation effect. This phenomenon has a noticeable mechanical effect on the entire surface of the component. The isostatic properties of liquids cause the changes in pressure to propagate all the way into the last angle of complex internal geometries, even in the capillary structures that have an unfavourable cross-section/length ratio. This process can actively clean tubes or capillary drill holes that have an inner diameter of 1 mm or less at a length of 1,000 mm and more.

The gas bubbles created by the negative pressure grow and shrink as the pressure changes which is continuously occurring in the cyclic process. The flow of media this generates is also called “asymmetrical volume flow.”

In addition to the negative-pressure process, variants have also been developed that work with pressure changing from negative to positive pressure. These fluctuations increase the mechanical washing effects. How effective the process depends, amongst others things, on the material properties and structure and on the temperature of the substrate in relation to the temperature of the media.

All metals are suitable due to their surface structure and ability to record temperature. Whether cyclic nucleation can be used with isolators, such as plastics, depends on the properties of the isolators. Plastics that contain carbon, for example, are well suited.