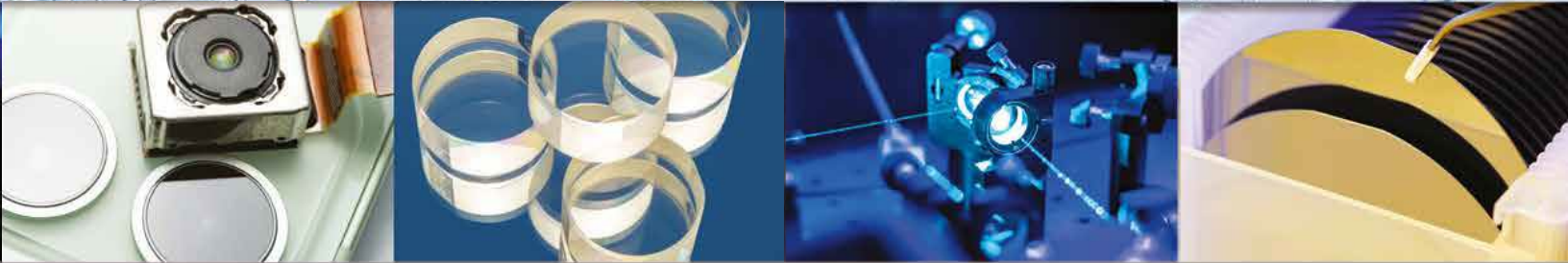




## ULTRASONIC CLEANING PROCESSES IN PRECISION OPTICS

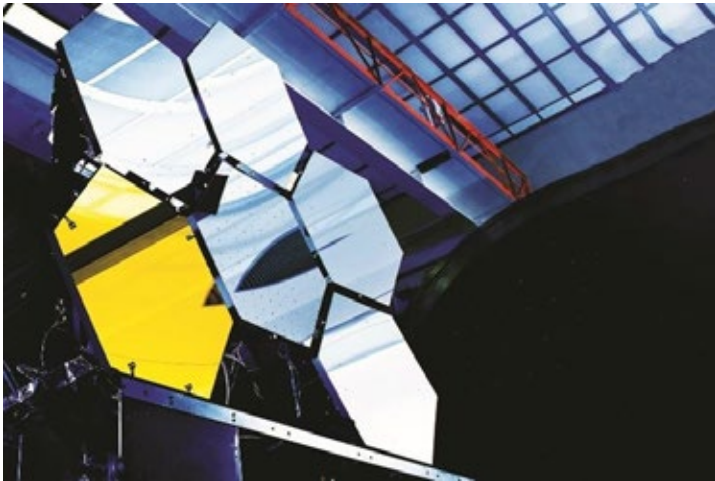


ECOLOGICAL CLEANING SOLUTIONS

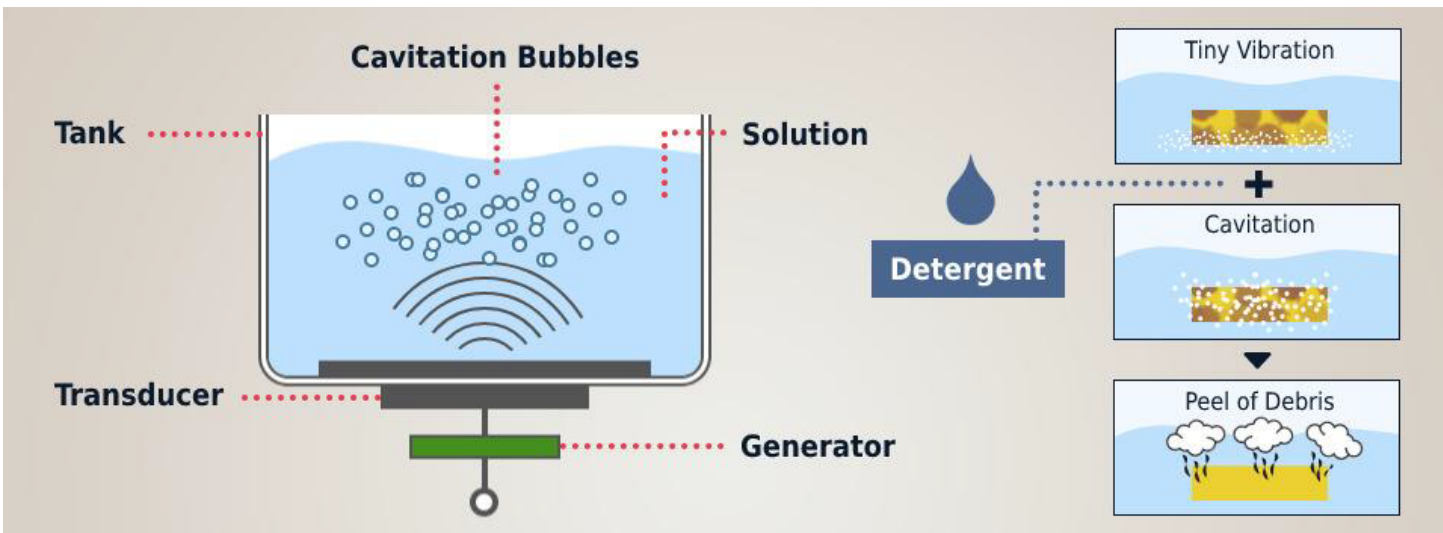
 SWISS QUALITY

# Introduction

Precision optics play a pivotal role in various industries, including aerospace, medical devices, telecommunications, and scientific research. The quality and performance of optical components are directly linked to their cleanliness and integrity. Ultrasonic cleaning processes have emerged as a highly effective method for maintaining the pristine condition of precision optics. This article briefly explores ultrasonic cleaning in the realm of precision optics.



Ultrasonic cleaning is based on the principle of high-frequency sound waves, typically above the range of human hearing, to generate cavitation bubbles in a liquid medium. These bubbles form and collapse rapidly, producing a microscopic scrubbing action that dislodge contaminants from the surfaces of optical components without causing damage to the delicate. The process is highly efficient, reaching intricate geometries and tight spaces that are challenging for traditional cleaning methods such as hand wiping with a cloth.



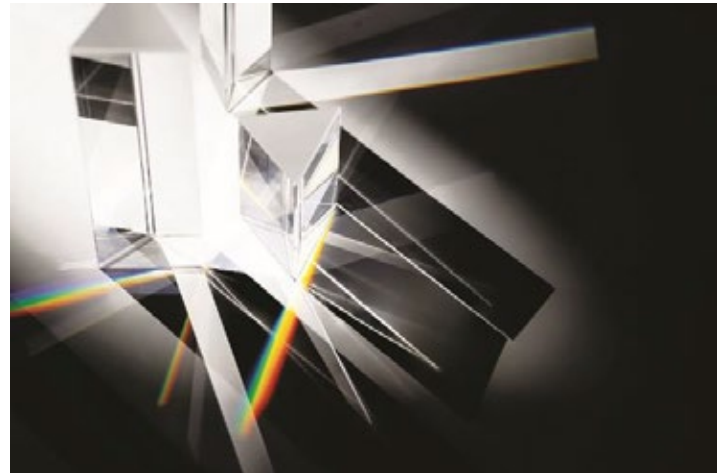
# Applications of Ultrasonic Cleaning in Precision Optics

**Lens Cleaning:** Ultrasonic cleaning is highly effective in removing fingerprints, oils, polishing compounds, and other contaminants from the surfaces of lenses. In applications such as cameras, microscopes, and telescopes, maintaining optical clarity is paramount for achieving accurate and reliable results.

**Prism and Mirror Cleaning:** Precision optics often involve prisms and mirrors, crucial components in various optical instruments. Ultrasonic cleaning ensures the removal of dust particles and coatings that may accumulate on these surfaces, preserving the reflective and refractive properties.

**Fiber Optic Components:** Fiber optic systems are integral in modern communication networks. Cleaning fiber optic connectors and other components is essential for ensuring optimal signal transmission. Ultrasonic cleaning is particularly effective in removing microscopic contaminants that can degrade signal quality.

**Medical Optics:** Precision optics are extensively used in medical devices, including endoscopes and surgical instruments. Ultrasonic cleaning provides a reliable method for washing and maintaining the cleanliness of these optical components, reducing the risk of quality control issues.



## Important Parameters in Ultrasonic Cleaning:

**Chemistry:** The detergent solution used in ultrasonic cleaning plays a crucial role in breaking down and removing contaminants from surfaces. At the right concentration, it enhances the cleaning effectiveness by reducing surface tension, promoting cavitation, and facilitating the removal of oils, greases, and other substances. The detergent selected should be compatible with the materials needed to be cleaned to prevent damage or degradation. Not all acidic or alkaline detergents may be suitable for certain optical components. There are also contaminant-specific detergents that could help remove the

unwanted pollution better than a general detergent. The detergent can also help prevent recontamination as they can often be tailored to leave a hydrophilic or hydrophobic surface depending on the requirements. As environmental consciousness grows, selecting environmentally friendly detergents becomes increasingly important. Many companies are switching from solvent-based to aqueous-based detergents that may contain less harmful compounds. Opting for eco-friendly detergents aligns with sustainable practices and regulatory requirements.

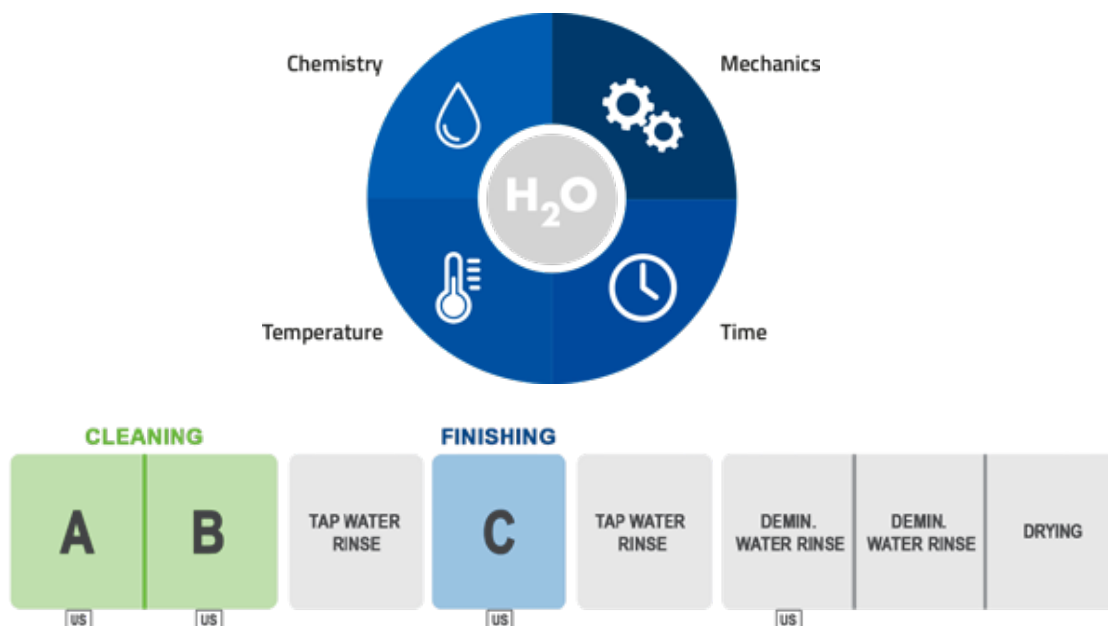


**Mechanical Action:** The frequency of ultrasonic waves is a critical parameter in precision optics cleaning. Lower frequencies, around 20-40 kHz, are suitable for heavy-duty cleaning tasks, while higher frequencies, between 40-200 kHz, are favored for delicate optics to minimize the risk of damage. The industry standard in most cleaning tanks is approximately 40 kHz, this is typically adequate for general optical components, but a higher frequency may be required for more sensitive objects. Additionally, the power density of the ultrasonic waves can be adjusted to accommodate different levels of contamination. Components of the ultrasonic tank, such as the transducers, should be regularly checked to ensure that they are properly functioning.

**Temperature:** The temperature significantly influences the efficiency of ultrasonic cleaning. Elevated temperatures enhance the activity of the cleaning solution and promote faster chemical reactions, improving the overall cleaning process. The temperature should be selected based on the cleaning requirements and the materials being processed. Some materials may be sensitive to high temperatures, so it's important to strike a balance between enhanced cleaning and material safety.

**Time:** The duration of the ultrasonic cleaning process is critical for achieving the desired cleanliness. It takes time for cavitation bubbles to form and collapse, effectively dislodging contaminants. The cleaning time needs to be optimized to avoid unnecessary exposure of items to the cleaning process. Longer cleaning times may be necessary for heavily soiled items, but excessive exposure could potentially damage delicate materials. It's essential to determine the appropriate cleaning time based on the specific cleaning requirements.

**Water Quality:** The quality of the water used in ultrasonic cleaning can impact the overall effectiveness of the process. The choice of water depends on the contaminants being targeted and the desired level of cleanliness. The minerals in tap water can help remove any remaining detergent on the surface, making it a good first rinse after a detergent bath. However, the impurities in tap water may contribute to residue or unwanted reactions in the final rinses. This is where the use of high-quality water in final rinsing processes ensures a better surface finish. Adequately monitored deionized or reverse osmosis water is often preferred for final rinsing to minimize the presence of impurities.



## Conclusion

Ultrasonic cleaning processes have become indispensable in the maintenance of precision optics, ensuring the longevity and optimal performance of optical components across various industries. The principles of ultrasonic cleaning and its wide-ranging applications highlight its versatility and efficiency. However, the correct selection of detergent is paramount to unlocking the full potential of ultrasonic cleaning, emphasizing the importance of a tailored approach based on the nature of contaminants and the materials involved. Careful considerations and control of specific parameters are essential to balance effectiveness with the safety and integrity of the items being cleaned.

### When reviewing your ultrasonic process, ask yourself the following questions:

Is this the correct chemical to remove this pollution from my material?

Is the ultrasonic frequency satisfactory?

Is the temperature of the cleaning / rinse steps too high? Too low?

Is the time in each cleaning / rinse step enough?

Is the quality of water adequate?

As technology advances and the demand for precision optics continues to grow, ultrasonic cleaning remains a cornerstone in achieving and maintaining the highest standards of optical cleanliness.



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