SONOSYS®

Mastering
nanoClean together

»Mastering nanoClean together
with high frequency ultrasonic cleaning systems«

SONOSYS®

Mastering nanoClean together

Member of

IVAM.

SILICON SAXONY® THE HIGH-TECH NETWORK

microTEC Südwest

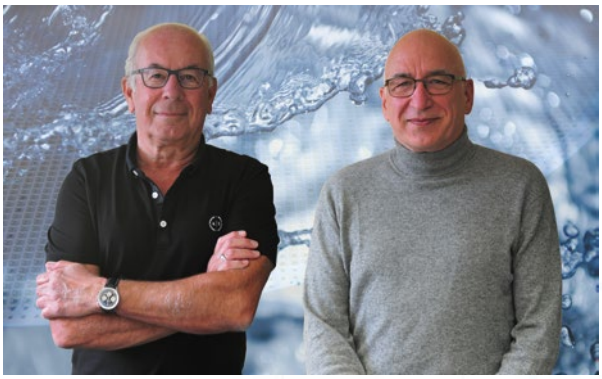
The story behind SONOSYS®

How it all begun
The company was founded in 1995 by Joachim Straka and Johann Brunner. The idea was to offer high frequency ultrasonic cleaning to the semiconductor and research industry. With a background in ultrasonic products and solutions both founders identified the raising demand at that time with no solution available from any German or European vendor in this space. By own research and development as well as collaboration with research institutes like the Karlsruhe Institute of Technology (KIT), first systems were shipped already in the year of foundation and shortly after that also internationally.

25+ years of experience
Nowadays, with 25+ years of experience in the field of megasonic cleaning, **SONOSYS®** is considered as one of the major players in this field. Numerous tool-maker and end customer in different market segments trust in the high frequency ultrasonic cleaning method that is available today in various product models for single and batch substrate cleaning. The markets served are still and predominantly in the semiconductor industry with wafer and photomask cleaning, as well as MEMS and other micro- and nano-structures. On top of that, adjacent applications with high demand in clean surfaces are served, such as the optical industry, automotive varnishing and even different fields like the food industry. The rich experience in this field allows **SONOSYS** to provide excellent counselling when it comes to your cleaning task.

What's to come
Even though proven and reliable technology for the cleaning tasks is available with the existing product portfolio, innovation and development at **SONOSYS** never stops. Whether we look at improving cleaning results at always smaller node sizes or reduce the potential pattern damage with the smallest structures – there is ongoing new challenges coming up in the semiconductor industry. As a result, we will see a number of new innovations to be released in the coming months and years, such as our fully digital generator series; or nozzle systems with frequencies up to 9MHz; and in a triple nozzle configuration just to name a few.

We are looking to address your cleaning application together, according to our guiding motto:
"Mastering nanoClean together"



Founders: Joachim Straka and Johann Brunner

Performance optimization, hand-in-hand

It is not accidental that we are the first European company in the global market to provide ultrasonic cleaning systems in the frequency range from 400 kHz to 9 MHz . After all, **SONOSYS®** is a company with more than 25 years of experience and know-how in the development, production and sales of innovative technologies. Special competencies and synergies result from the close cooperation between our own research and development department and world-renowned institutes and facilities like the Fraunhofer Gesellschaft, the IMEC in Belgium, the Ferdinand Alexander Universität (FAU), the Karlsruhe Institute of Technology (KIT - IMT) and CSIRO Australia. This is a decisive contributory factor to our solutions in the area of ultrasonic systems being not just state-of-the-art, but also forward-looking.

Fraunhofer Gesellschaft

Imec Leuven, Belgien

Friedrich-Alexander Universität Erlangen-Nürnberg

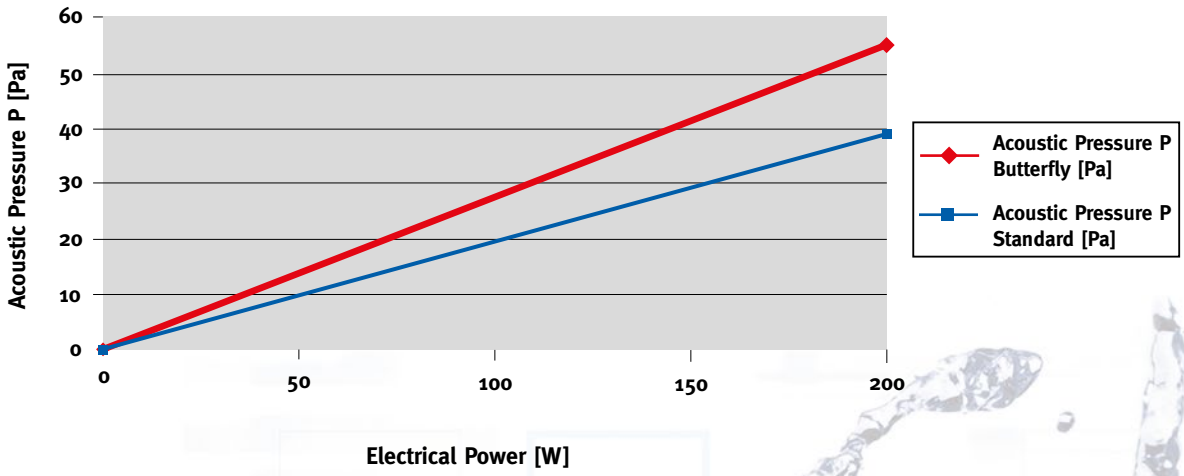
Karlsruhe Institute of Technology

»Inside Sonosys« means: up to 30% more efficiency with patented transducers

All over the world, **SONOSYS®** stands for unique and future-secured solutions. This particularly holds true for our Megasonic systems in the frequency range of 1 MHz.

The extremely uniform energy transmission ensures a so far unachieved cleaning performance, while at the same time providing the best protection to the micro- and structures. Unique in the world: our transducer systems, with patented piezo-ceramics, achieve a 40% higher sound pressure or an up to 30% higher efficiency.

Acoustic pressure „standard“ piezo ceramic versus „Butterfly“ technology



Ex-factory efficiency
Greatest possible flexibility, shorter process times, high performance. These are the important requirements that customers expect us to fulfill. It is precisely in this area that we offer efficient systems from a single source. Thus, in the development of the **SONOSYS®** Megasonic systems, our focus is not only on the maximum possible compactness of the generators or the total system. The unique modular design of our solutions is also a distinct advantage. **SONOSYS®** Megasonic Systems are designed to be compact, modular, and efficient by their very nature.

Almost anything is possible

In the development of our Megasonic systems, we attach a great deal of importance on a dialog with you. Because you know exactly which results you expect. And we know exactly what is technically feasible. Your benefits: from **SONOSYS®**, you will get state-of-the-art system solutions that are developed customized according to your ideas, requirements, and particular area of use, if our standard system do not fit. Other services for increasing your efficiency: information management, know-how workshops as well as new business consultancy.

Integration with SONOSYS® - is just so simple

Simple operation, highly compact form factor and low installation cost and efforts guarantee a smooth integration of our systems into your equipment and processes.

Modular, nearly maintenance-free and service-friendly

The high reliability and durability, along with easy maintenance is the result of the modular concept of our Megasonic systems. All components are nearly maintenance-free. We can supply any electronics module at short notice and these modules can be replaced instantly.

How Megasonic cleaning works

The ultrasonic/megasonic generator transforms the mains voltage of 50/60 Hz to a frequency corresponding to the operative frequency of the transducer.
Piezoelectric transducers bonded on a plate outside of a tank produce high frequency sound waves that propagate through a liquid. Each point along the wave oscillates between a maximum and minimum pressure. When the pressure minimum is below the vapor pressure of the liquid, bubbles are formed in the liquid. When the pressure increases to maximum pressure, the bubbles implode, sending out an intense shockwave of energy as the fluid rushes in to fill the void left by the collapsed bubble (this effect is referred to as “cavitation”). Subsequently the energy is referred to as cavitation energy and is well-suited for removing particles or contaminants from a substrate.

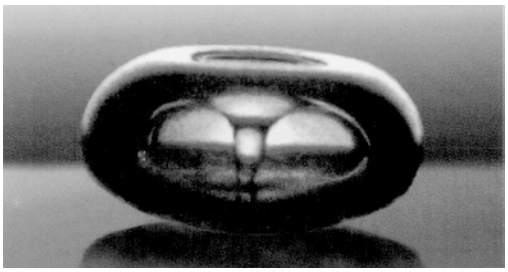
Megasonics compared to ultrasonics
Different factors can affect the intensity of the cavitation energy in an ultrasonic / megasonic process, such as the surface tension of the liquid or the distance of the substrate from the transducer.

Megasonic	**Ultrasonic**
400 kHz - 9 MHz	25 kHz - 250 kHz
Little or no damage	Possible damage

The most critical factor is the frequency of the sonic waves.
In a typical Ultrasonic cleaning process, the transducer works with a frequency between 25 kHz and 100 kHz.

This lower frequency creates bigger bubbles up to diameters of 150 µm and creating higher cavitation energy when they collapse. Megasonic processes utilize frequencies from 400 kHz up to 9 MHz. These higher frequencies create smaller bubbles and when they collapse, produce a proportionally smaller amount of cavitation energy.

The high cavitation energy produced in Ultrasonic cleaning can damage sensitive structures of substrates. The gentler cleaning energy produced by Megasonic waves is able to remove particles down to some few tenths of nm without damaging sensitive devices.

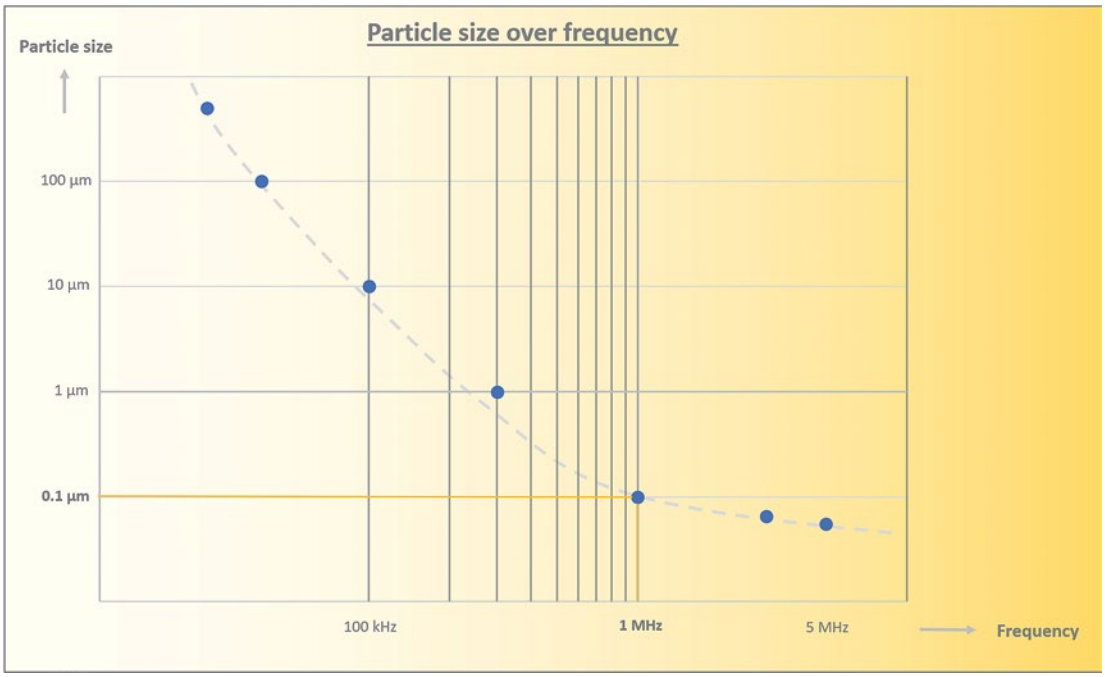


Multiple enlarged cavitation bubble at a frequency of **25 kHz** during the implosion

Reference: L.A. Crum, Applied Physics Laboratory, University of Washington

We preserve your nano- and microstructures

With traditional ultrasonics (20kHz to 100kHz) particles in the 10+ µm range can be removed. For smaller particles, i.e. below 10µm or even down to the nanometer range, higher frequencies become necessary (Megasonic at Sonosys ranges from 400 kHz up to 9 MHz).
With the higher frequency the cavitation energy becomes significantly lower as well – which allows for reduced to non-damage of smallest and fragile structures.



Let's find the right solution for you!

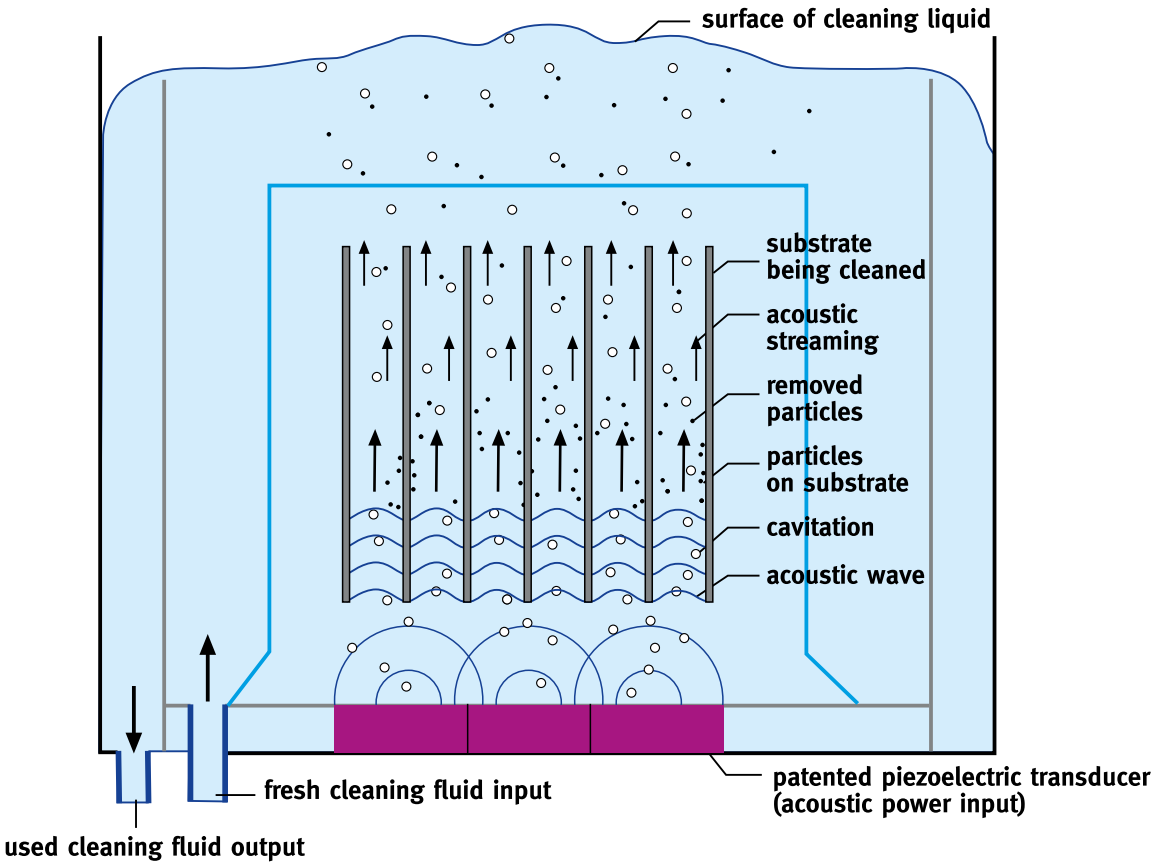
To find the right solution for your application a good starting point is to let us know:

- Substrate size
- Single or batch processing, number of substrates in carrier
- Substrate material
- Chemicals used, if any
- Maximum medium temperature
- Tank size & material
- Application

An online request form can be found at: https://www.sonosys.de/en/request.html

Nanoclean · particle free · SONOSYS®

During processing, the transducer generates high frequency (400 kHz - 2 MHz) sonic waves with controlled cavitation and micro streaming, which is transmitted to the surface of substrates in a liquid medium. Both, chemical and Megasonic action are utilised to break down the attraction forces holding the particle to the surface.

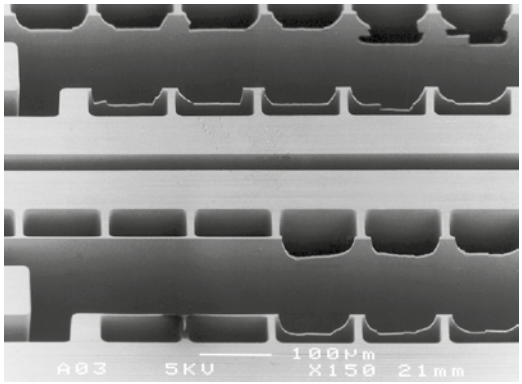


Megasonic Cleaning Mechanism

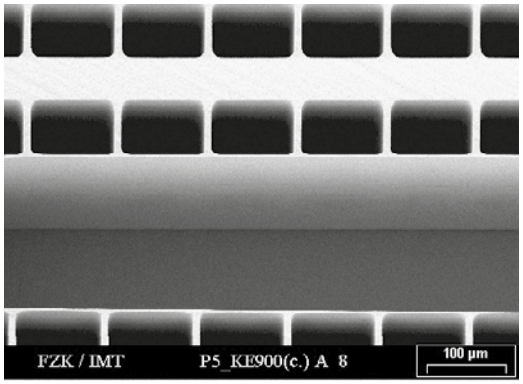
Convincing comparison

Comparison of the ultrasonic frequency of 40 kHz and 1 MHz during the developing process within the LIGA-Technique

An important advantage of the application of Megasonic is the smooth cleaning of extremely fragile microstructures. The figure on the left shows that the microstructure has been destroyed by the high cavitation energy at the ultrasonic frequency of **40 kHz.** The destroyed ridges have a thickness of approx. 4 µm. At an ultrasonic frequency of **1 MHz,** the microstructure remains undamaged (fig. on right).



Destroyed fragile microstructure approx. 200 µm high, developed at a frequency of **40 kHz**.



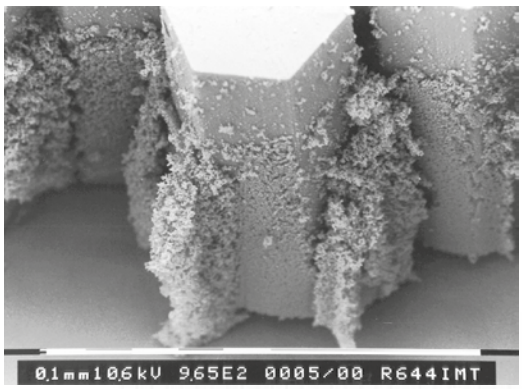
Undamaged fragile microstructure 400 µm high, developed at a frequency of **1 MHz.**

Decrease the development time by a factor of 7 with SONOSYS®

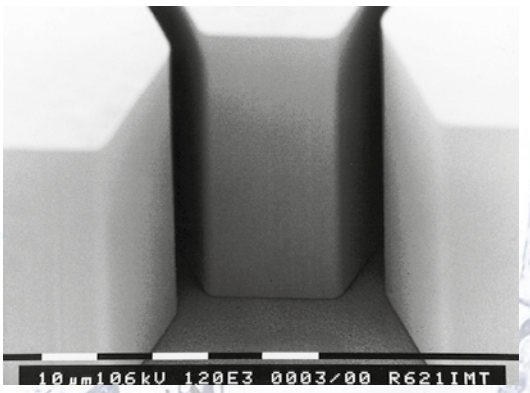
Process support for the development of microstructures with high aspect ratios

The residue-free development of dense and deep structures is of particular importance when it comes to producing microstructures via X-ray lithography.

During the development process of microstructures **(e.g. LIGA technology)** with high aspect ratio, the particles are completely flushed out due to the created microstream, and the development time is reduced by a **factor of 7.** For fragile structures, the depth of the structures can be increased by a **factor of 2.**



Microstructure developed **without** Megasonic support



Microstructure developed **with** Megasonic support

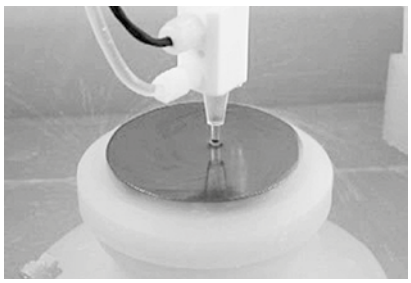
Concentrated Cleaning -
Contactless with Megasonic Single / Dual Nozzle

Particle removal of semiconductor wafers:

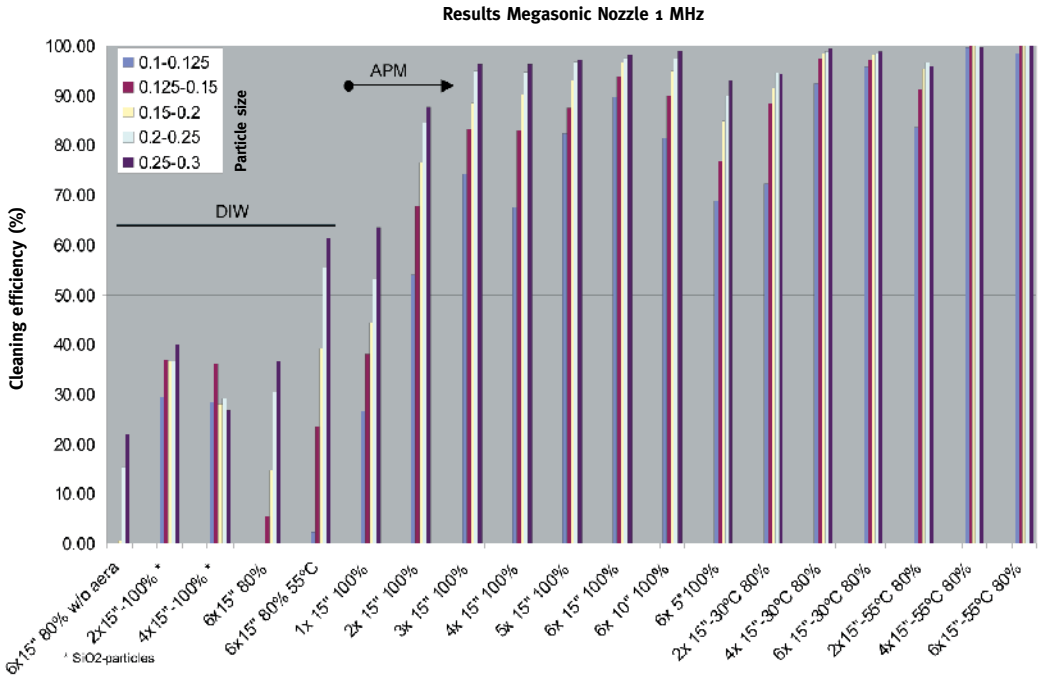
Experiments carried out at the Research Center for Microelectronics IMEC (Leuven / Belgium) with SONOSYS® 1MHz Nozzle system on experimental spinning tool with Rotagoni® drying technique

Test condition for all 200 mm wafers:

- 1MHz Nozzle at 80% and 100% output power
- Medium flow = 1.0 l/min.
- Distance Nozzle opening to wafer surface 22 mm
- Cleaning sweep 15 sec. above the wafer
- Si_3N_4-, SiO_2 - Contamination (~12000 particles) very uniform for all wafer
- Media: DIW (DI-water) or APM (SC_1) 1:2:50 (NH_4OH:H_2O_2:H_2O)
- Temperature of media RT, 30°C and ~55°C.



Experimental set-up



The results show that particles of the size from 0.3 µm to 0.1 µm can be removed with DI-water at room temperature to 40% and at 55°C to more than 60%.
Using APM (SC1) at 55°C with 4 cleaning sweeps (within 1 minute) at 80% Megasonic output power of the nozzle, 100% of the particles are removed.

9 reasons to use Megasonic

For better cleaning results without damage
Today there is a number of challenges when it comes to the cleaning of micro- and nano-structures. Key focus is the removal of smallest particle residues from wafer or photomask surfaces to increase the yield (=good wafers out of total production). Thereby, the cleaning must be effective, but smooth, to not damage the fine structures.

On top of these technical challenges there are the concerns about product and supplier reliability, which is key to this highly automated processing industries. A reliable and flexible partner is therefore mandatory.

Against the background of the above mentioned, which benefits can the SONOSYS® solutions provide? - Have a look at the following listing for our main benefits:

- Avoid damage → *Solution:* Using high frequencies
  Benefit: No damage, increased yield, saving costs
- Removal of small(est) particles → *Solution:* Go up in frequency, optimal process parameters. ***Benefit:*** Effective cleaning, PER of ≥98% @ ≤ 1µm, higher yield
- Little space/constraints → *Solution:* Custom-specific adaptions, modular system
  Benefit: Get it work at even low space availability
- Standard solution does not fit → Solution: Custom-specific adaptions, tailored custom solution. ***Benefit:*** Gives the solution the customer needs
- Inhomogeneous sound field & cleaning results → *Solution:* Long evolution history of homogeneous sound field development. QC by own cavity-sensor.
  Benefit: Uniform cleaning results, reliable quality control
- Lack of know-how in Megasonics → *Solution:* 25+ years' experience, knowledge of relevant applications & markets. ***Benefit:*** Expert counseling, avoiding expensive mistakes, access to extensive partner network, proven technology.
- Harsh environment conditions → *Solution:* Indirect Megasonic system, different coatings for transducer. ***Benefit:*** Industry level reliability, withstands harsh environments, low metal contamination.
- (Low) product reliability/lifespan → *Solution:* High quality & robust design, maintenance-free products. ***Benefit:*** Less/no downtime, less/no recurring costs.
- Finding a reliable supplier → *Solution:* Highly flexible organization, ISO 9001-certified, stable management, proven technology. ***Benefit:*** Long-lasting partnerships, reliable solutions, less/no downtime, good product availability

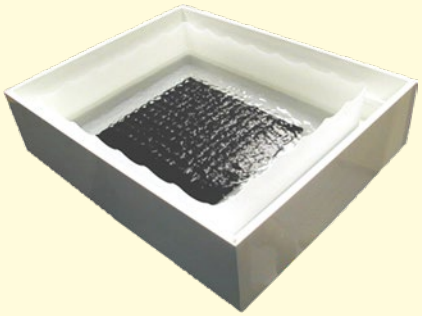
SONOSYS® Megasonic product offering

Megasonic transducer plates

The transducer plates can have customized dimensions and active sound field areas or standard systems can be used. The latter uses wafer cleaning standard sizes of 4", 6", 8" and 12". Further features of the transducer plates are:

- Frequency from 400kHz up to 2MHz
- Stainless steel (VA) or PFA/PVDF coated versions
- Welded or screwed into the tank
- Optional: N2 flooding/cooling
- With customized adaptions to fit application

Typical applications: Bath cleaning, batch processing, lift off



Tanks

Stainless steel or plastic material tanks are typically used. The customer usually provides the tank for integration; sourcing via SONOSYS® with one of our partners is possible as well.

Megasonic generators

Compact design and modular power set up are the main characteristics of the SONOSYS® generator series. Built in a 19" rack version they consume little space and are easy to integrate. In steps of 500W modules with the larger generators can be built up to 84TE, which corresponds to 2'000W in one housing. If more than 2'000W is needed, several generators are used. For the nozzle systems, the SlimLine generators provide 35W per module and 70W per generator, they come in a slim 28TE width housing.

Megsonic submersible transducer

Completely encapsulated transducers made of stainless steel or plastic (PVDF/PFA) to be positioned at the bottom or at the side wall of an existing tank. Besides the standard systems for 4", 6" and 8" substrates, custom-specific solutions of ubmersible transducers are available. This very flexible configuration allows cost-effective upgrading of process tanks with a Megasonic system. The available frequencies are 400kHz, 600kHz, 1MHz and 2MHz.

Typical applications: Bath cleaning, tank upgrade solutions

Megasonic nozzles

Contactless single substrate cleaning with Megasonic nozzles with either single-, dual- or triple channels and any combination of frequencies between 600kHz and up to 9MHz. The transducer in the Megasonic nozzle generates a Megasonic wave, which is transmitted via a flowing liquid (the medium, e.g. DI-water) to the surface of the substrate. The energy is concentrated on a small point of 4mm. Usually the nozzle is mounted on a movable arm over a rotating substrate for best results. Our customers like this system because of its simplicity to apply and yet get highest cleaning results with low or none damage to the pattern. Especially the latter is a key factor in the always smaller node sizes and output power – which is configurable with SONOSYS® systems – is adapted to the needs of the particular application.

Typical applications: Single wafer and photomask cleaning, lift-off

SONOSYS® Megasonic product offering

Face to face (FTF) transducer
Hermetically encapsulated transducer made of PFA, to be mounted above the rotating substrate. The Megasonic energy is transmitted homogeneously with a uniform power distribution via an active piezo transducer surface of e.g. 150 x 25mm, 100 x 25mm or 150 x 10mm to the substrate. The FTF transducer is an alternative to the nozzles and primarily used in single substrate cleaning applications. There is two frequencies available for the FTF, 400kHz or 1MHz.
Typical applications: Single wafer cleaning, conveyer band

Megasonic atomizer
The atomizer generators a very fine fog which remains in air due to its small diameter size of approx. 3µm (=aerosol). This ultra-fine mist is used when smallest droplets are required, such as in solar cells doping application.
The atomizer head swims in the liquid to be atomized and produces the fog vertical up and can then be diverted by a reflector plate or air duct. Further the atomizer can be cascaded and multiple heads operated out of one large generator.
Typical applications: Doping at solar cells or flat panel displays

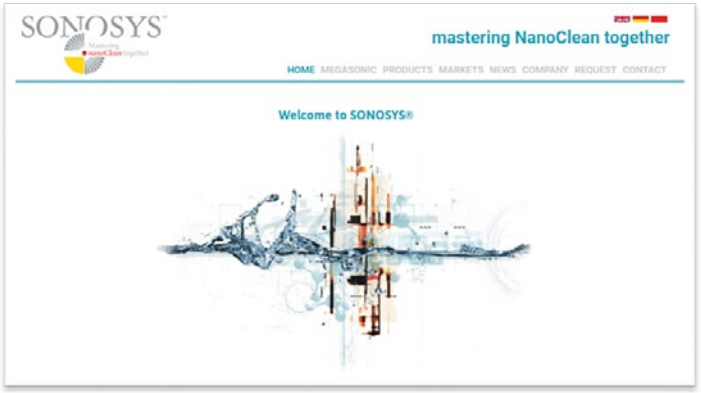
Nebulizer
Our nebulizers can produce small droplets in the range between 20 and 40µm, depending on the model. The fine mist of droplets allows the production of a fine film to moisten surfaces, to produce a coat of varnish or simply regulate humidity in air. The US1 to US20 series allows for flows ranging from approx. 1l/h to 20l/h and are excited by ultrasound between 45 and 100kHz. There various options available like with or without carrier gas, spray angle and form factors.
Typical applications: Humidification, coating, desinfection

Cavitation sensor
To measure cavitation in the active sound field of a transducer or a nozzle jet stream is key to determine the Megasonic performance. By means of measuring the acoustic noise with a Quartz glass rod, the number of cavitation events can be estimated. There is a cavitation sensor for batch and single wafer processing.

Demo & test systems for rent
There is nothing better than trying out yourself when it comes to the practical part of looking at Megasonics. For this purpose, SONOSYS® offers a range of test systems for renting and trying out before purchase. This way you make sure, the results are what you expect and can raise questions before a possible buy. We further cooperate with partners in the space, that allow for example single nozzle testing in a professional wet bench environment using our nozzle systems. Last but not least SONOSYS® has a demo system that can illustrate single- and dual nozzle operation as well as the 3MHz atomizer in one compact table-top housing. This demo can be seen on trade shows or on request.

How to get in touch

Visit us at www.sonosys.de

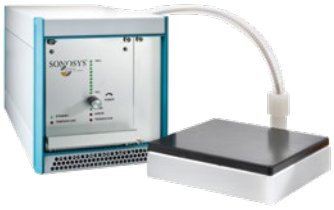


and reach out to us at: info@sonosys.de

SONOSYS® products

Further information

Request your demo system online



https://www.sonosys.de/en/life-is-life.html

Further resources: Articles, Blogs, Videos

Youtube® Video series

IVAM Innovation Blog:
"Megasonic cleaning – the new ultrasonic cleaning?"

LinkedIn Blog:
"9 reasons to use a SONOSYS® Megasonic System"

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- Single or batch processing, number of substrates in carrier
- Substrate material
- Chemicals used, if any
- Maximum medium temperature
- Tank size & material
- Application

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SONOSYS® Ultraschallsysteme GmbH

Daimlerstraße 6 · 75305 Neuenbürg / Germany
Phone +49(0)7082 / 79184-0
Fax +49(0)7082 / 79184-99
info@sonosys.de
www.sonosys.de