NANO-MASTER, Inc. SWC and LSC Technologies for Mask, Wafer, and Display Panel Cleaning

Damage-Free Megasonic and Chemical Cleaning:

The latest developments in Megasonic and Chemical Cleaning Technology have opened up new horizons to achieve the cleanest wafers and masks used in the MEMS and Semiconductor Industry.

NANO-MASTER offers Megasonic Single Wafer & Mask Cleaning (SWC) Systems and Large Substrate Cleaning (LSC) Systems for state of the art, damage-free megasonic cleaning of delicate patterned or unpatterned substrates including Pelliclized Masks. To achieve maximum cleaning optimization without substrate damage, the megasonic energy density must be kept slightly below the damage threshold at any point on the sample. NANO-MASTER's patented technology assures uniform distribution of the acoustic energy across the entire surface of the substrate, therefore allowing ideal cleaning by maximizing the distributed energy while staying below the sample's damage threshold.

The SWC and LSC provide controlled chemical dispensing capabilities. With this ability, particle release from the surface is enhanced. The SWC and LSC utilize a Point-of-Use Chemical Dispense System designed for minimal use of chemistries. The dispense system allows for programmable chemical mixing abilities supplying a controlled chemical distribution over the full area of the substrate.

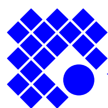
Utilizing the chemical dispense in conjunction with NANO-MASTER's megasonic cleaning technology the tool's capability to remove particles is optimized. Particle release from the surface is enhanced with the tool's chemical dispense. Afterwards, the released particles are removed from the substrate surface with the least number of reattachments by sweeping off the particles with the radial flow of the DI water. Without the advantage of radial flowing DI water, state-of-the-art stationary recirculating megasonic-cleaning tanks allow a greater number of reattachments and therefore requiring additional time to remove these particles by simple random walk.

In addition, both NANO-MASTER cleaners offer an array of options. A PVA brush system provides a mechanical means of removing stains and resist residues on unpatterned substrates. The DI water ozonation option allows removal of organics without the use of aggressive chemicals. Our hydrogenated DI water system in conjunction with Megasonic energy makes removal of particles in the nano scale possible. Depending on the application, certain options will further enhance the tool's ability to remove unwanted particles and residues.

Both SWC and LSC tools are capable to do in-situ spin drying with heated N2 or IPA. Therefore, "Dry-In-Dry-Out" one step processing is possible with the lowest capital investment and Cost of Ownership. The process time for NANO-MASTER's cleaners can vary between 1-3 minutes per substrate depending on the substrate's size and the additional cleaning options used.

NANO-MASTER's technology is also applicable to cleaning backside or alignment marks on the front side of Pelliclized Masks, reducing the need for unnecessary removal and re-pellicilization of these masks. Also, it can be used for removal of the pellicle frame-mounting adhesive and can prepare the surface for re-pelliclization. In addition, megasonic cleaning and spin drying of the full front surface of the pelliclized mask without damage and seepage condensation is being further studied.

The SWC is the ideal tool with a small footprint and can be easily installed in any clean room where space is limited. The LSC's architecture is developed to deliver the most advanced capabilities for current and next generation wafer and substrate sizes. Both deliver superior cleaning ability for a variety of substrates.



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LSC 4000 Chamber

LSC 4000 System

LSC Applications

- Patterned or Un-patterned Mask or Wafer Cleaning
- Diced Chips on Wafer Frame
- Cleaning of the ITO coated Display
- Cleaning of Mask Blanks
- Cleaning Contact Masks

LSC Features

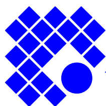
- Up to 21" circular, 15"x15" square substrates
- Large Environmental chamber with up to three arms for:
    - Megasonic
    - Brush
    - Hot DI , high pressure DI or Piranha
- PC Control with Lab View Software
- Touch Screen User Interface
- Compatible with Robotic load unload

Options

- Mask (M) or Wafer
- Brush Cleaning
- Ozonated DI Water (20 ppm)
- Hot DI
- High Pressure DI
- Hydrogenated DI
- Piranha
- Auto load un load
- HEPA Filtered mini environment

Optional Stand Alone Modules

- Chemical Delivery Module
- Ozone Generator
- Hydrogenated DI water generator
- High Pressure DI module
- Sulphuric Acid Hydrogen Peroxide Mixing Module
- Robotic load unload module



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SWC 4000 Stand-alone Unit

SWC System Applications

- Patterned or Un-patterned Wafer and Mask Cleaning
- Ge, GaAs and InP Wafer Cleaning
- Post CMP Wafer Cleaning
- Cleaning of the Diced Chips on Wafer Frame
- Cleaning after Plasma Etch or Photoresist Stripping
- Cleaning after Lapping and prior to Bonding
- Cleaning of X-ray Masks, EUV Masks
- Pelliclized Reticle Cleaning
- Cleaning of Mask Blanks
- Cleaning Contact Masks
- Cleaning of the ITO coated Display Panels
- Cleaning of Ceramic Substrates w/ laser drilled holes
- Optical Lens Cleaning
- Megasonic assisted Lift-off Process

SWC 4000 Features

- Stand alone unit
- Damage free Megasonic, chemical, brush clean and spin dry
- 12" circular, 9" square substrates
- Micro processor controlled
- Chemical Dispense Unit
- Separate Solvent and Acid drains
- Heated N2

SWC 4000 Options

- Mask (M) or wafer
- Ozone Clean
- Brush Clean
- High Pressure DI Clean
- N2 ionizer

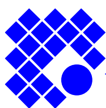
SWC 3000 Table Top Unit

SWC 3000 Features

- Table top unit
- Damage free Megasonic Mask or wafer clean and spin dry
- 12" circular, 9" square substrates
- Micro processor controlled
- IR Lamp

SWC 3000 Options

- Mask (M), or Wafer
- Brush Cleaning
- Chemical Cleaning (CDU)
- Nitrogen Ionizer



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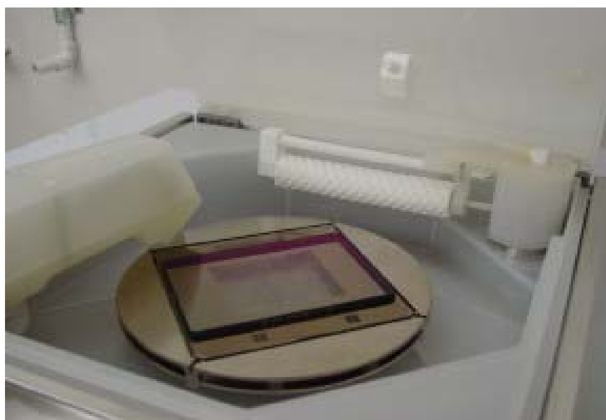
Nano-Master's Response to Challenges in Cleaning

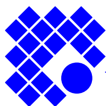
Cleaning Issues	Solutions
Damage	Patented Uniform Megasonic Energy Deposition
Delicate Substrates	Megasonic Cleaning, Vacuum Chuck
Particle Size	Megasonic Frequency
Particle Reattachment	Spin Processing
Organic Contaminants	Ozonated DI water, Piranha Clean
Inorganic Contaminants	Chemical dispense, pH Control
Metal Contamination	SC1, SC2 Cleans
Back Surface Defectivity	Back Surface Clean with 1 mm Edge Contact
Re-Contamination	Single Step Process: Dry In Dry Out
Passivation	In-situ

Brush Cleaning

Diced Chips on the Wafer Frame


Pelliclized Mask Front Side Cleaning

Pelliclized Mask Back Side Cleaning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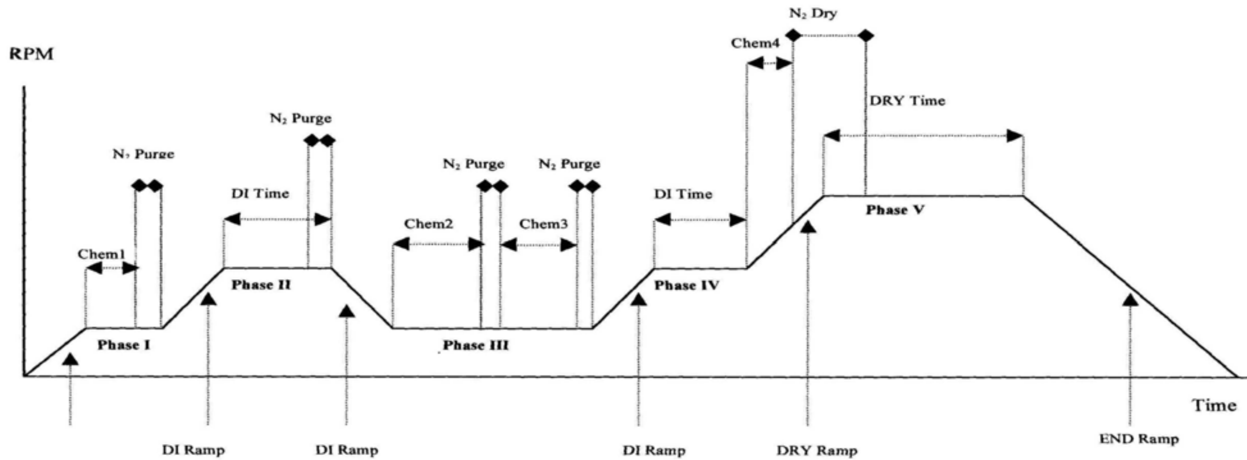
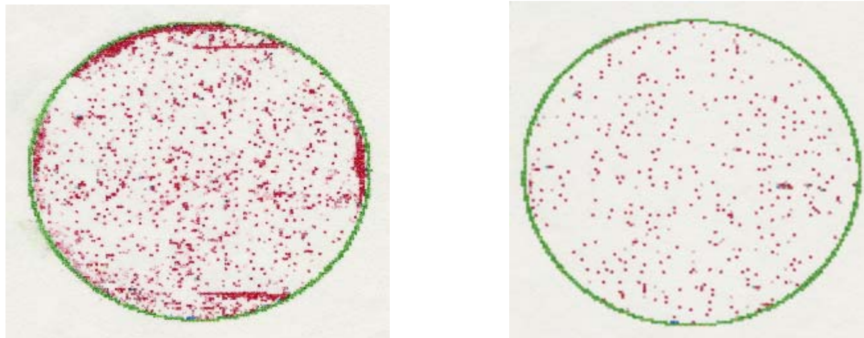
The following graph shows a typical SWC process:



PHASE I = Chem1+N2 Purge
PHASE II = DI Time
PHASE III = Chem2+N2 Purge+Chem3+N2 Purge
PHASE IV = DI Time
PHASE V = Dry Time

SWC GERMANIUM WAFER CLEANING



The pictures above were taken from the surface of two Germanium wafers, which were polished, and cleaned in parallel to compare the standard tank wafer cleaning (left) with Nano-Master SWC megasonic cleaning with DI water (right). The standard cleaning produced non uniform cleaning and the caused damage from spin drying (the cassette stress marks are evident). In other applications such as for ceramic substrates, AlTiC wafers, and ITO cleaning customer expectations were exceeded and yield improvements were experienced.

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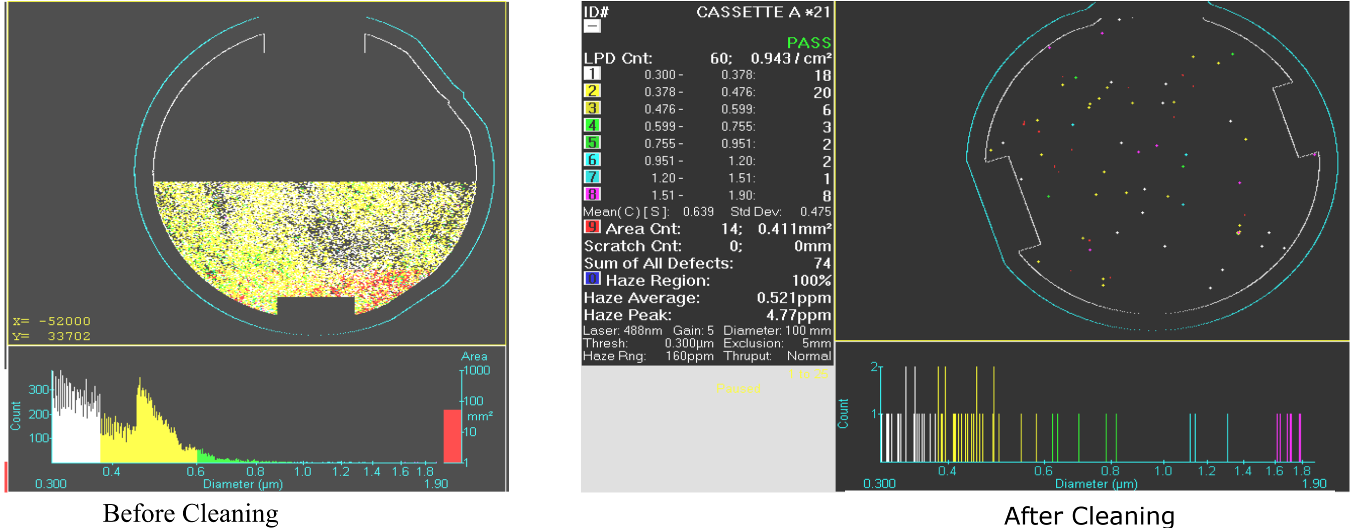
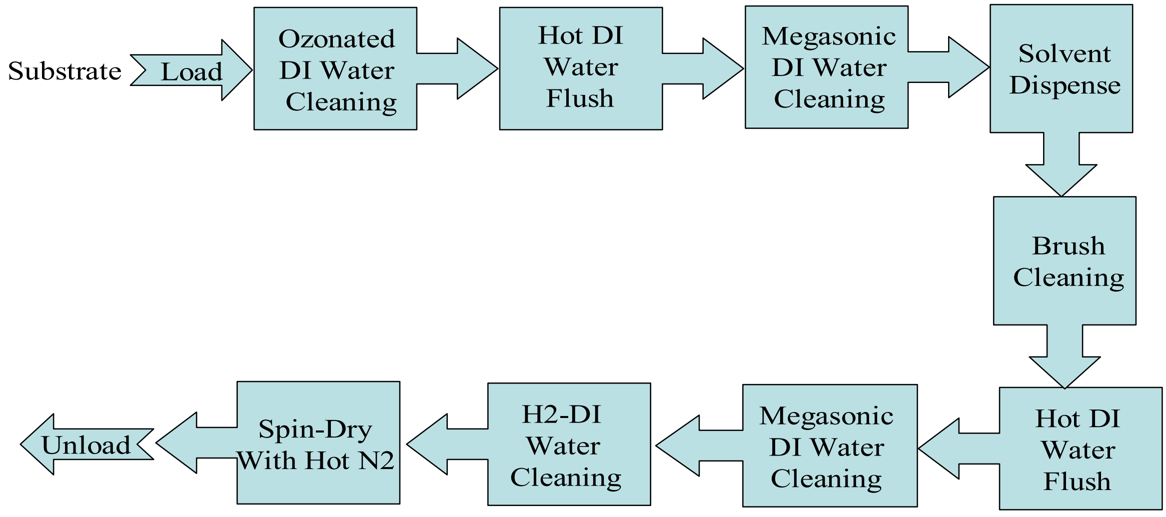
SWC CMP CLEANING PERFORMANCE



Before Cleaning After Cleaning

The first picture above was taken from the surface of a silicon wafer after the polisher. Half of the wafer was scanned because the surface scanner stops after the maximum total particle count was reached. The second picture is after cleaning with SWC system, 4 passes with the megasonic arm, total process time including drying is 1 minute and 30 seconds. No chemicals were used.

AN EXAMPLE OF LSC 4000 CLEANING PROCESS:



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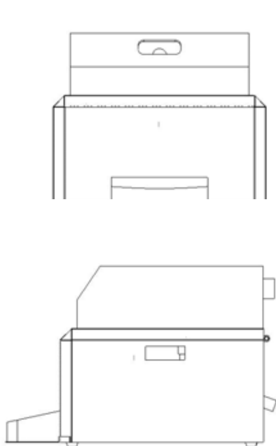
SWC GENERAL SPECIFICATIONS

Maximum Wafer Size:	12”
Maximum Mask Size:	6”x6”
Typical Clean Time:	1 minute
Standard Megasonic Frequency:	1 MHz
RF Power supply Maximum Output:	60 Watt
Minimum DI Water Flow:	1.5 liter/minute
Maximum Spinner Speed:	4000 RPM
System Control	Microprocessor controlled with PLC programming
Loading and Unloading	Manual
N2 Heater (as option)	Max 200 °C

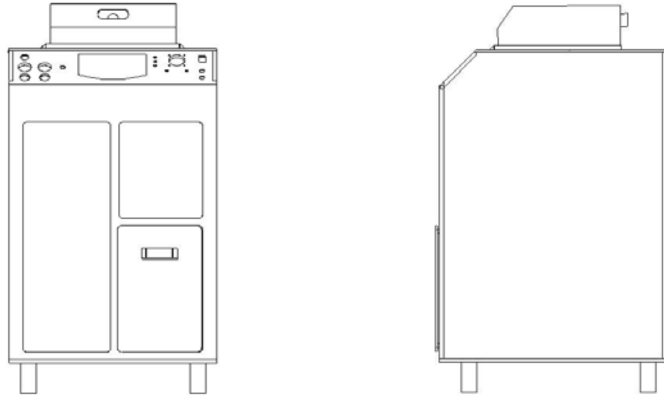
FACILITY REQUIREMENTS

Power Input	110VAC, 15 A
CDA Input	2.2 cfm @ 70 - 80 psi for internal vacuum pump
Chemical Dispense rate	@15PSI of N2, 83ccm @20PSI of N2, 133 ccm
Drain	2 x 1.0” MNPT outlet for solvent and acid drains
Nitrogen	<20PSI
Exhaust (System)	1-2 cfm, 1” FNPT
Exhaust (Chamber)	>1-2 cfm 3/8” Tube
Oxygen for Ozonated DI Water option	9-12 PSI

DIMENSIONS

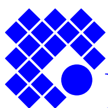


SWC 3000 Front and Side View



SWC 4000 Front and Side View

	Width	Depth	Height
SWC 3000	18-3/4” (476 mm)	22-1/2” (572 mm)	16-1/4” (413 mm)
SWC 4000	26” (660 mm)	30” (762 mm)	52” (1321 mm)
LSC 4000	26” (660 mm)	30” (762 mm)	65” (1651 mm)
RF Power Supply (SWC 3000)	11-1/8 (283 mm)	14-7/8 (378 mm)	5-1/4 (133 mm)
N_2/IPA Supply Box (Standard SWC 3000)	8-1/4 (210 mm)	10-1/4 (210 mm)	13 (330 mm)
Chemical Box (Option for SWC 3000)	8-1/4 (210 mm)	13 (330 mm)	22-1/4 (565 mm)



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