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23000 sq. ft. Facility, 1000 sq. ft. Clean Room

- Automating America and the World
- Engineering Wet Processing Equipment for the Semiconductor Industries future and beyond
- Standard Products
- Megasonic Units
- Custom Designed Products
- Spin Process System
- CNC Routing Capabilities
- Neutralization Systems
- Sub Contract Manufacture
- Field Service
- Repairs to existing equipment



# MEGASONIC CLEANING SYSTEMS

# Megasonic Background

- Megasonics have become an important and widely accepted cleaning method for contamination-sensitive products.
- Most manufacturers in the integrated circuit, hard drive, raw silicon, mask, flat panel display, and other industries affected by contamination have turned to megasonic cleaning to help meet stringent cleanliness requirements.
- Megasonic cleaning uses the piezoelectric effect to enable removal of sub-micron particles from substrates.



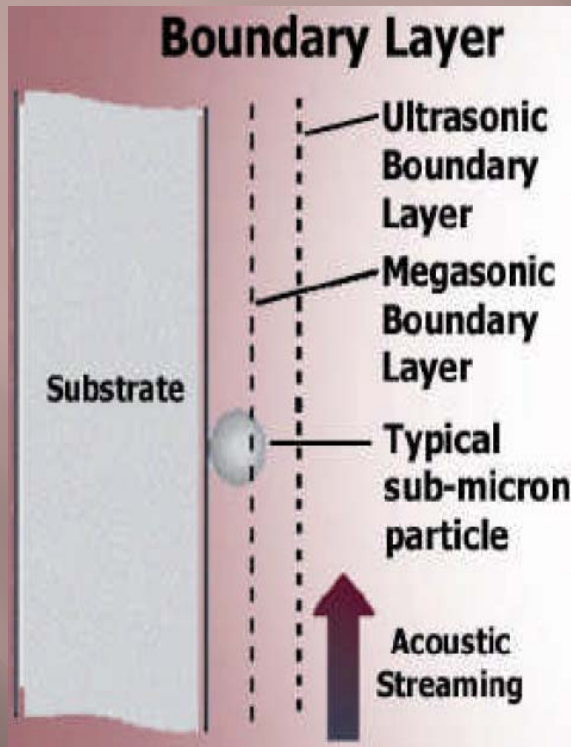
# Megasonic Background

Cleaning is accomplished by several mechanisms;

- Acoustic Streaming
- Microstreaming
- Microcavitation
- Chemistry
- Acceleration Forces
- Standing Waves
- Radiation Pressure Force
- Resonance Cleaning

**Note: Some are more important than others**

# Megasonic Background

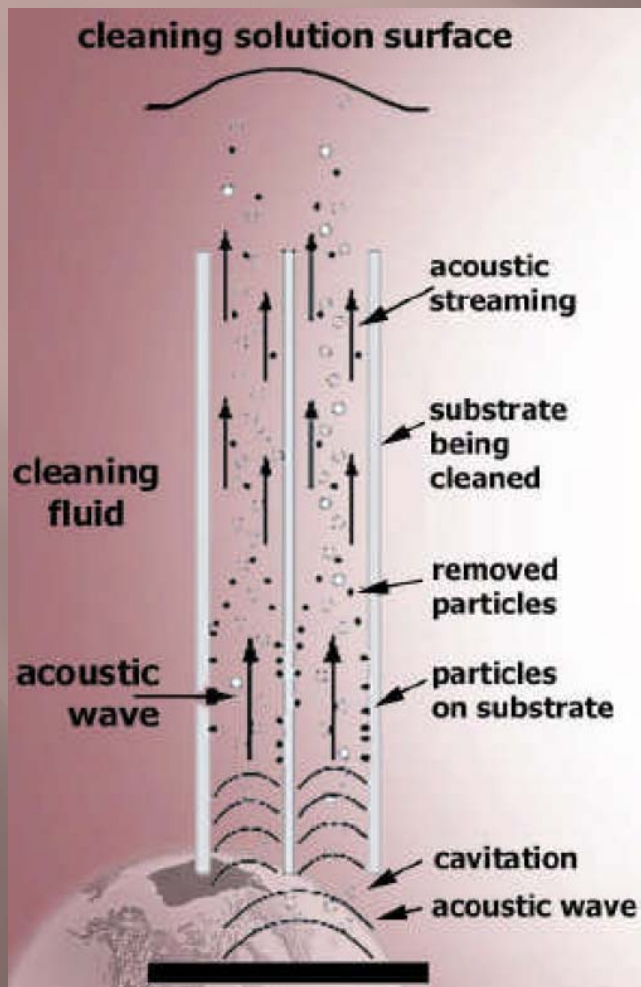


## Benefits of reducing the Boundary Layer

- Increased removal of sub  $0.5\mu$  particles  
Increased particle removal overall
- Increased transport of removed particles through increased acoustic streaming
- Higher chemistry refresh rate at the substrate surface resulting in faster cleaning
- Increased chemical access to small surface features for enhanced etch or strip applications
- More uniform oxide growth in SC1

**Note: This Boundary Reducing Effect is especially important in removing small particles and accessing small surface features.**

# Megasonic Background



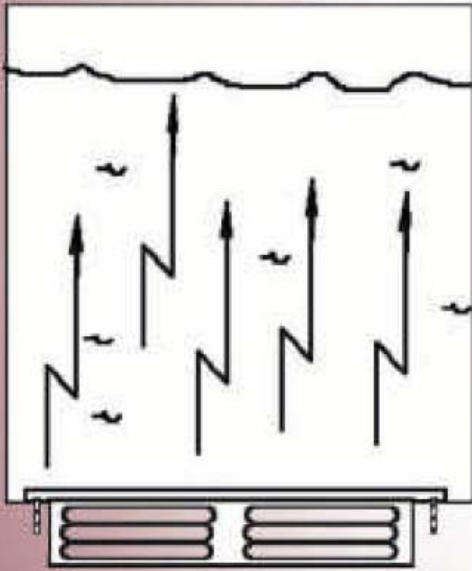
- Five key variables when using megasonics:
  - Chemical concentration
  - Temperature
  - Exposure time
  - Megasonic power
  - Flow dynamics
- Typical exposure times
  - 5 to 15 minutes for batch processing
  - ½ to 2 minutes for single wafer

# Megasonic Background

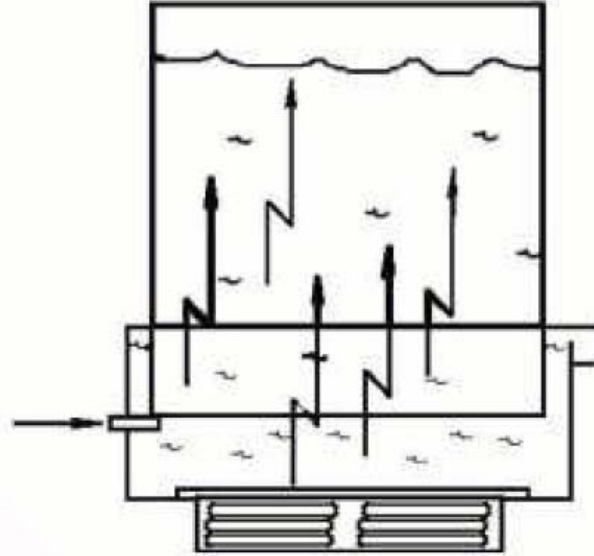
- ▣ CHEMISTRY - ZETA POTENTIAL
- ▣ A measure of the repulsive force between a particle and a substrate
  - Both positive
  - Both negative
  - One positive, one negative
- ▣ Chemistry (pH) and surfactants can change the surface charge of a material. Different materials may react differently as pH is changed



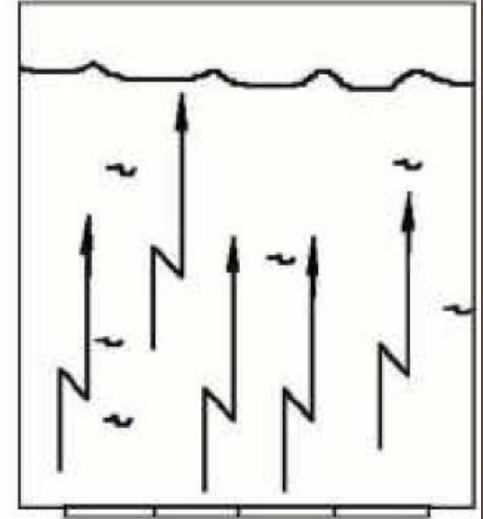
# Megasonic Power Coupling



Direct



Indirect

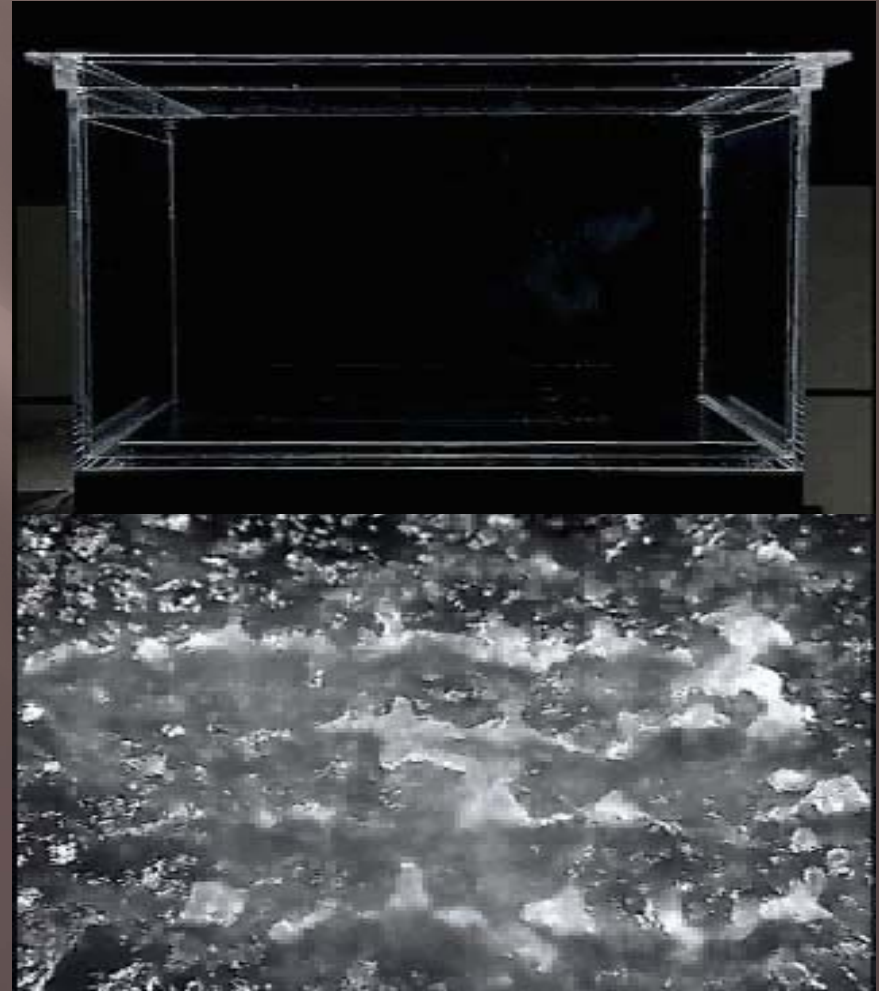


Bonded



# Modutek Corporation Kaijo Transducers

- ▣ High Frequency 2 MHz,  
950 kHz,
- ▣ Better Efficiency
- ▣ All Transducers fire  
simultaneously,  
therefore covering a  
larger area.
- ▣ Sub-micron Cleaning  
0.20 $\mu$ m



# Megasonic Theory

- Reduces thickness of the hydrodynamic boundary layer near wafer surface
- Micro-cavitation and micro-streaming dislodge particles from the surface
- Acceleration force scrubs off particles
- Acoustic Streaming carries off dislodged particles and prevents reattachment

# Megasonic Testing

## Constants:

- Silicon Nitride Contamination
- 300mm Bare (non-patterned) Silicon Wafers
- 52 wafers - 1/2 pitch
- 4 Quick Dump Rinses
- Surface Tension Gradient Dry
- Sensor Scan @0.12-0.20 $\mu$  & 0.21-0.40 $\mu$

## Variables:

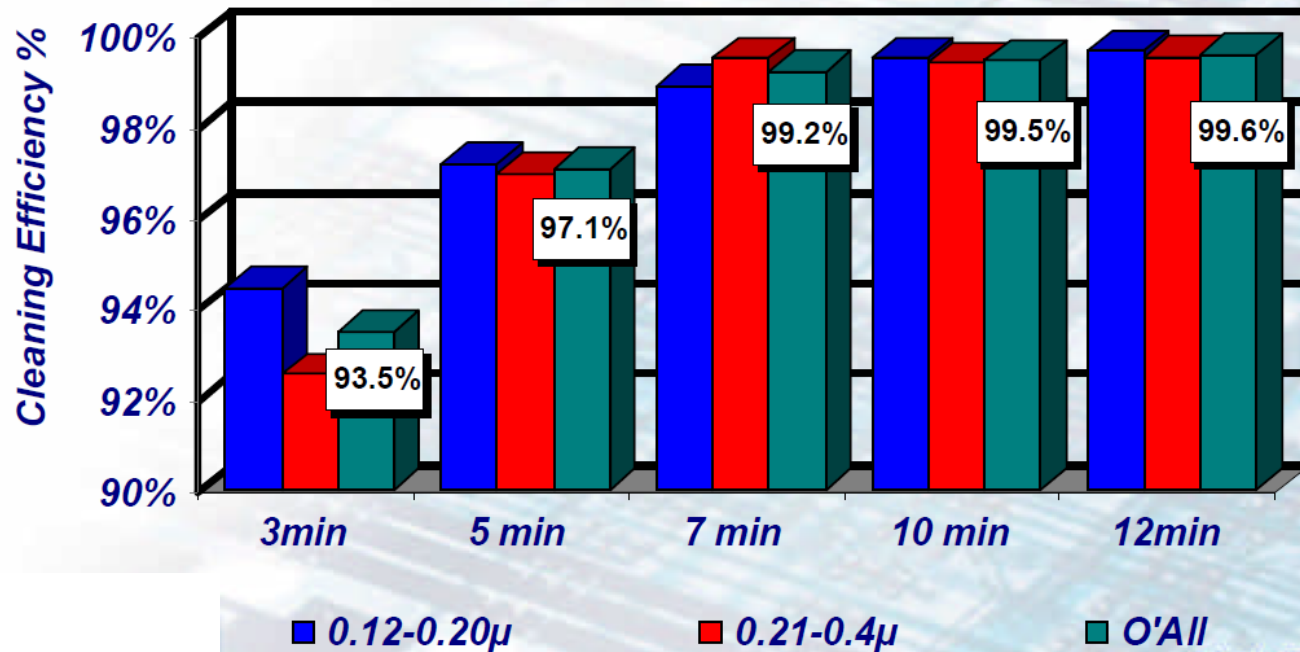
- Continuous power
- Process times – 3, 5, 7, 10 & 12 minutes
- 35°C & 45°C– dilute SC1 – 50:2:1

# Megasonic Results

## Cleaning Efficiency on 300mm Wafers

$\frac{1}{2}$  pitch / with Dilute SC-1 (50:2:1)

3,5,7,10 & 12 minutes / 2.76cm<sup>2</sup> / 35°C / 4 QDR / STG Dry



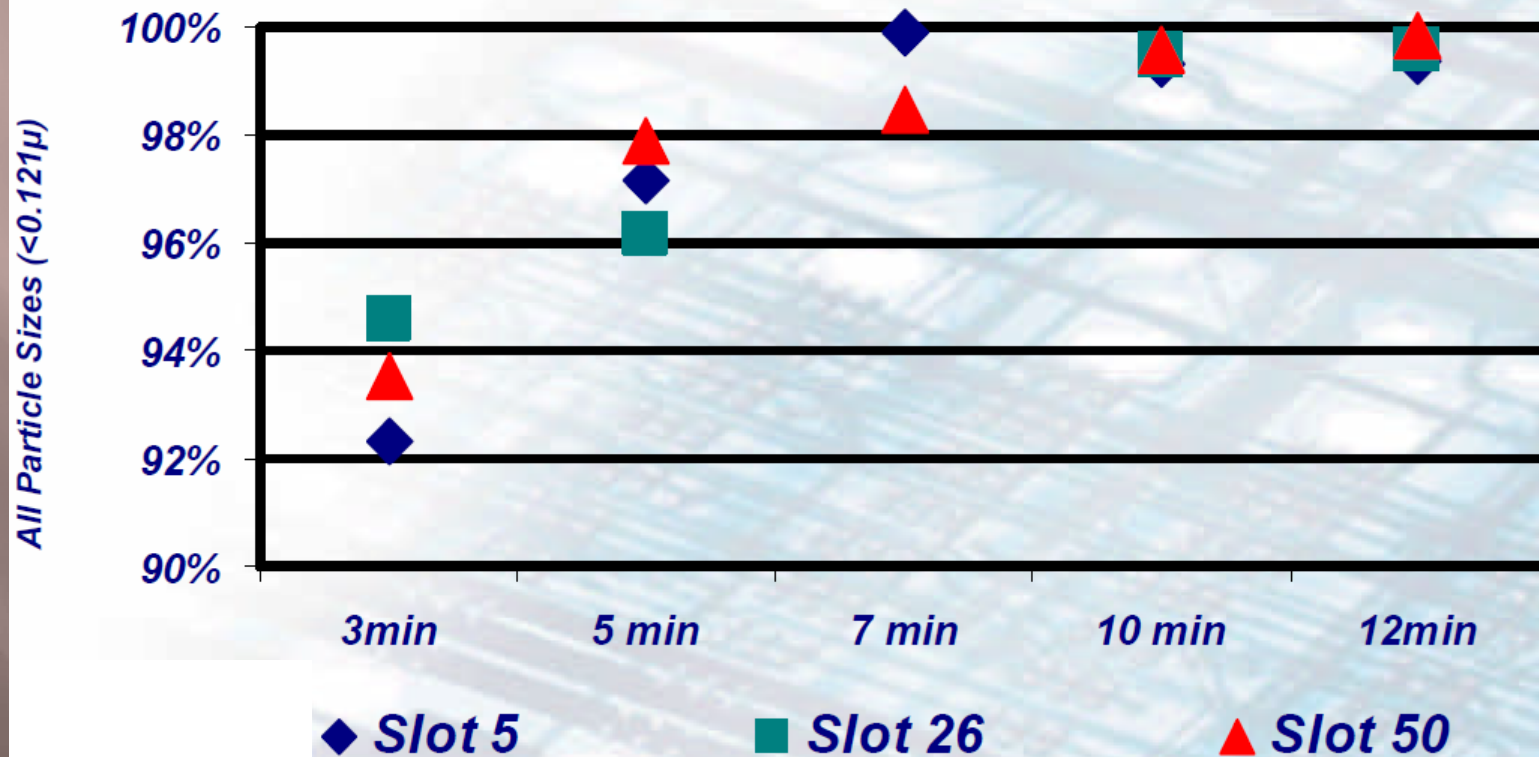


# Megasonic Results

## Cleaning Efficiency Across the Cassette

Dilute SC-1 (50:2:1) / 300mm Wafers /  $\frac{1}{2}$  pitch

3,5,7,10 & 12 minutes /  $2.76\text{cm}^2$  /  $35^\circ\text{C}$  / 4 QDR / STG Dry



# Test Conclusions

- Cleaning Efficiencies of  $\geq 97\%$  at  $0.12\mu$  were achieved in all testing with cleaning times  $\geq 5$  minutes
- No appreciable improvement in cleaning  $\geq 7$  minutes
- Even with  $35^{\circ}\text{C}$  and shorter than industry standard times, cleaning efficiencies of  $\geq 99\%$  can be achieved (*spec*  $> 97\%$  @  $0.12\mu$ )

# Test Conclusions

- Cleans 300mm wafers with
  - Higher efficiency
  - In shorter times
  - Lower temperatures
  - Lower chemical concentrations
- Highest power is not always the answer
- Bounce Technology works
- In-Direct systems perform well with short times
- Reduces cleaning times with increased efficiency

# Megasonic Cleaning System

- Applications: pre-diffusion, pre-EPI, monitor wafer clean, post laser scribe clean, side-wall polymer removal
- Cleaning efficiency: >97% @ .12 um
- Wafers: 150/200/300mm, Single, Dual, 52 wafer
- Substrates: Flat Panel Displays, Photo Mask, Rigid Disks, Optics and other

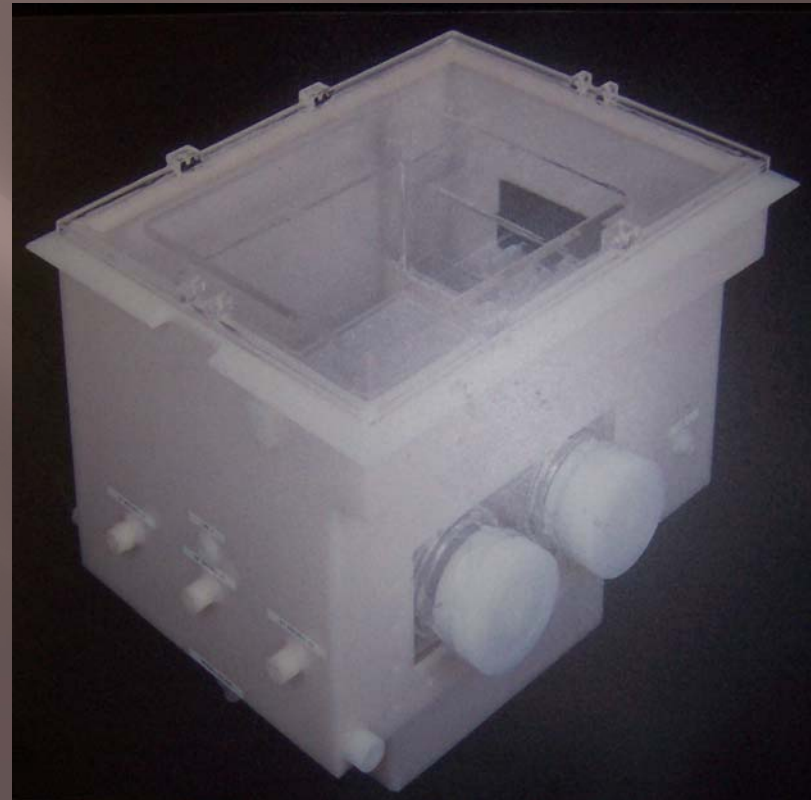


# Halar Megasonic



# Quartz / PVDF Quick Dump Rinser

- ▣ All Quartz Dump Rinser
- ▣ PVDF Housing Material
- ▣ Dual High Flow Dump Valves
- ▣ Indirect Megasonic Plate 950 kHz, 2mHz
- ▣ Direct Megasonic Plate 950 kHz , 2 mHz



# Quartz Megasonic

- ▣ Quartz with circulation
- ▣ Indirect design
- ▣ Uniform up flow
- ▣ Designed for high temp
- ▣ Easy installation
- ▣ All Teflon or quartz flow path

