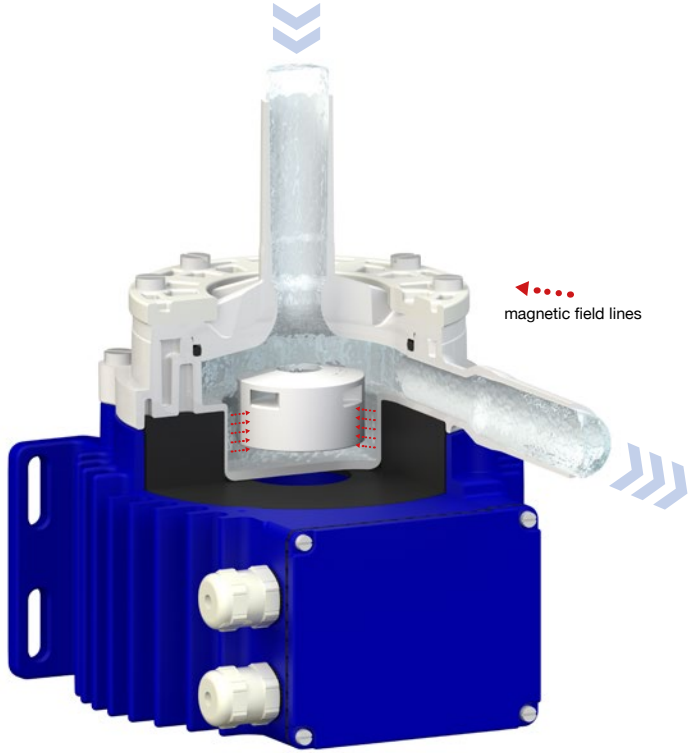
LEVITRONIX® PUMP SYSTEMS FOR SEMICONDUCTOR MANUFACTURING

LEVITRONIX®



THE PUREST PUMP SYSTEM IN SEMICONDUCTOR MANUFACTURING

The Levitronix® pump system is a revolutionary pump that has no bearings that wear out or seals that break. Based on the principle of magnetic levitation, the pump's impeller is suspended, contact-free, inside a sealed casing and is driven by the magnetic field of the motor. The impeller and pump head casing are both fabricated from chemical-resistant, high purity fluorocarbon resins which together comprise the pump head. A continuous flow rate and pressure are precisely controlled by electronically regulating the impeller speed, which eliminates any pulsation. Thanks to the absence of a mechanical bearing and the self-contained pump head design, the risk of contamination is drastically reduced. The absence of narrow gaps between the impeller and pump head casing plus the low-shear pump design allow for gentle and smooth pumping of sensitive liquids.

Technical Benefits
of the Levitronix® Pump System

The purest pump
Proven by industry Experience - The purest pump within semiconductor manufacturing (and beyond)! Since there is no mechanical coupling between the impeller and the pump head casing, there is no wear and therefore virtually no particle generation.

Pulsation Free Flow
Accurate, stable and reliable flow and pressure for your process. The open pump head design, high flow resolution, centrifugal pump principle and the absence of valves lead to a completely pulsation-free flow.

Low Shear Design
Ideal for Slurry and delicate plating liquids. The smooth wetted plastic surfaces and the absence of a mechanical bearing, narrow gaps, fissures and dead-zones allow for gentle processing of sensitive liquids.

High Controllability and wide flow range
No more flow throttling – highly accurate flow and pressure. Due to its variable speed and high resolution, the Levitronix pump allows precise control of flow or pressure over a wide operating range.

Highest MTBF (>100 years)
Extremely high reliability. There are no bearings to wear out or seals to break down, therefore equipment uptime increases massively, which extends the life of the process equipment and reduces maintenance costs.

Highest Turndown Ratio
Widest flow range – From ultra low flow to maximum flow. The high speed and resolution of a Levitronix pump allows to control and maintain the flow from a few ml/min up to the maximum flow rate.

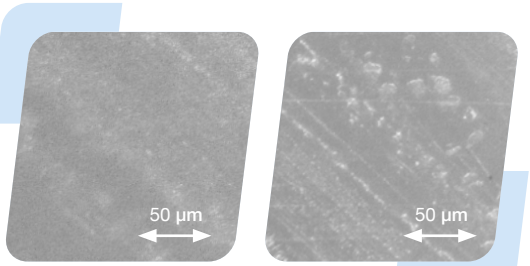
Small Footprint
Substantially smaller than air operated pumps. The highly integrated design of the pump and motor combined with the absence of a mechanical bearing results in a system that greatly reduces the space requirements and allows for installation in confined spaces.

Long history proven technology
More than 25 years experience. Levitronix pumps are firmly established in highly demanding industries beyond semiconductor manufacturing such as biopharmaceutical production.

Constant delivery of equipment data
Smart Pumps for Smart Manufacturing. Levitronix® pumps allow high-performance data acquisition, ideal for predictive maintenance and for factory wide system integration.

Low noise and low vibration
Substantially less noise than with pneumatic pumps. Since there is no mechanical coupling of the impeller and the pump casing, the pump produces virtually no vibrations resulting in a very quiet operating pump system.

LEVITRONIX IN COMPARISON TO OTHER PUMP SYSTEMS



new *2 months*

Close up view of check valve: After two months of operation, distinctive wear is observed, wich explains particle contamination in diaphragm and bellows pumps.

Particle Generation //
comparison to bellows and diaphragm pumps

Facts

Friction due to mechanical contact of moving parts such as check valves, bellows or diaphragms leads to wear. Wear can result in particle shedding, which causes wafer defectivity.

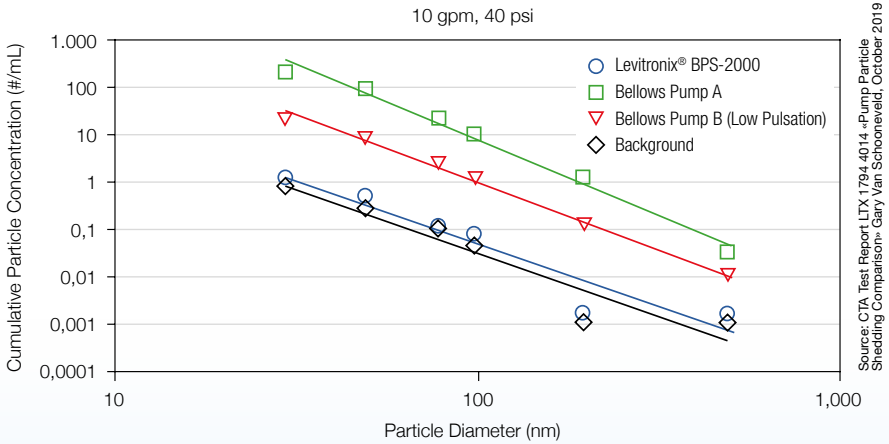
Test Conditions

Pumps from different manufacturers were evaluated for particle shedding in ultra pure water during operation at multiple test conditions. The test conditions were chosen such that all pumps in the group could be compared under typical operating conditions.

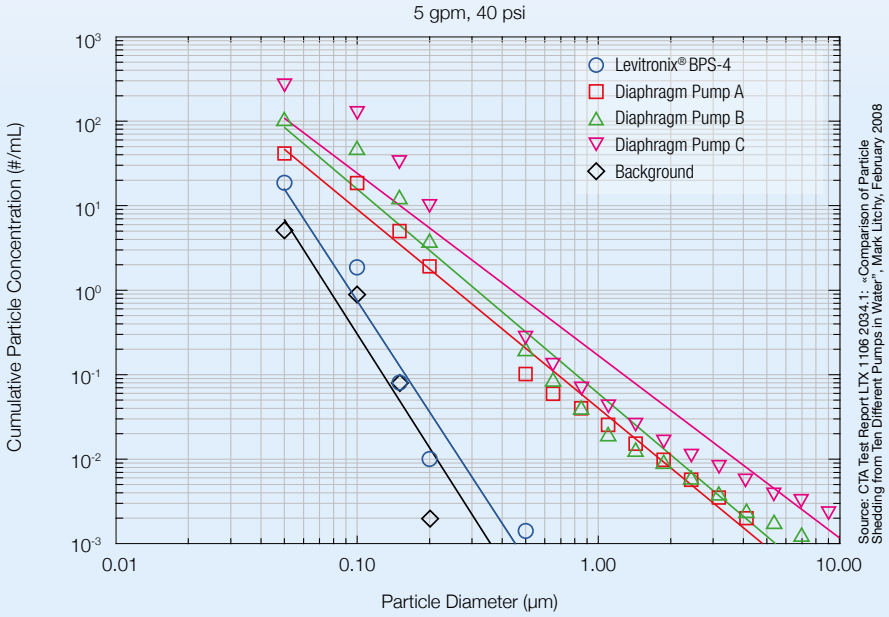
Results

The Levitronix® pumps consistently shed the fewest particles of all the pumps evaluated, regardless of pump operating conditions. In all tests, the particle concentrations measured downstream of the Levitronix® pumps were very close to the concentrations measured without a test pump in the system.

PARTICLE SHEDDING OF A LEVITRONIX® PUMP COMPARED TO TWO BELLOWS PUMPS

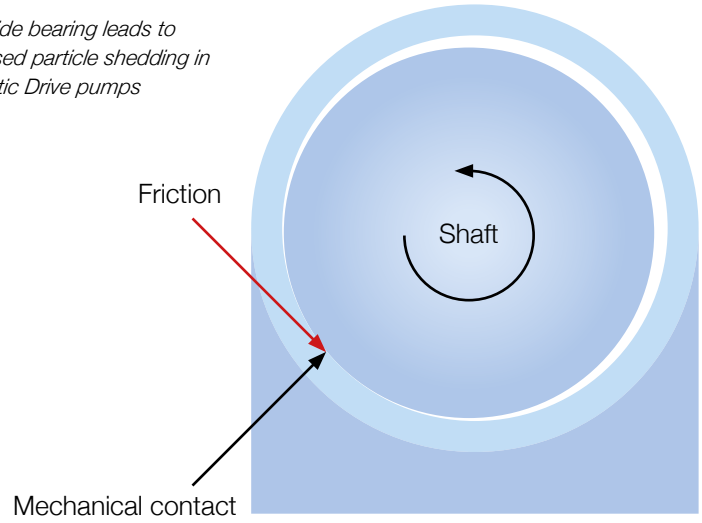


PARTICLE SHEDDING OF A LEVITRONIX® PUMP COMPARED TO THREE DIAPHRAGM PUMPS



Particle Generation //
comparison to magnetic drive pumps

The slide bearing leads to increased particle shedding in Magnetic Drive pumps



Facts

Friction due to mechanical contact of moving parts such as slide bearings leads to wear. Wear can result in particle shedding, which causes wafer defectivity.

Test conditions

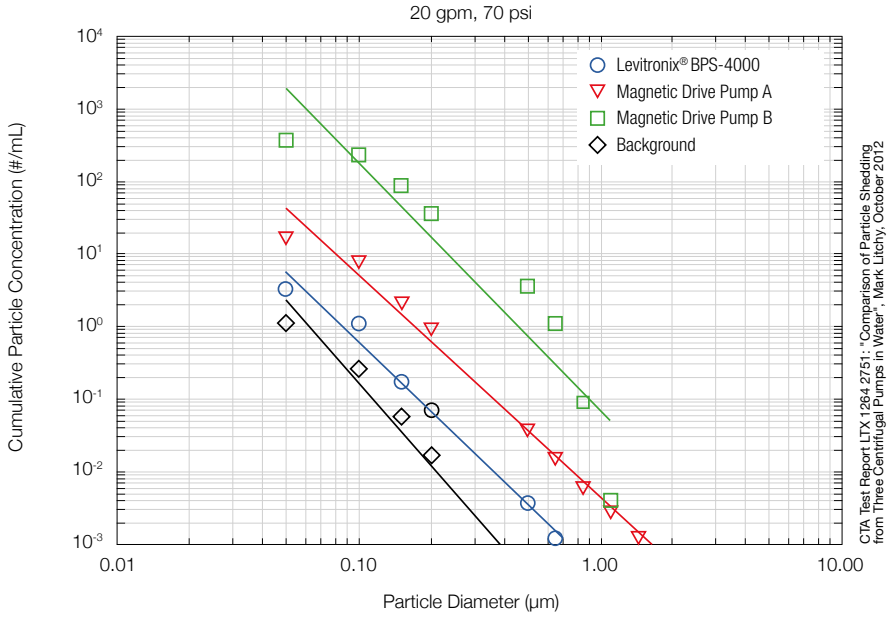
Three high capacity centrifugal pumps from different manufacturers were evaluated for particle shedding in ultrapure water during operation at multiple test conditions. The flow rates varied from 11 – 190 lpm, while pump outlet pressure varied from 3.5 to 6.2 bar.

Results

The Levitronix® pump consistently shed the fewest particles of the pumps evaluated in this study, regardless of operating conditions. In all tests, the particle concentrations measured downstream of the Levitronix® pumps were very close to the concentrations measured without a test pump in the system.

Competing pump systems shed up to 400 times as many particles as the Levitronix pump.

PARTICLE SHEDDING OF A LEVITRONIX® PUMP COMPARED TO TWO MAGNETIC DRIVE PUMPS



Pressure Pulsation and Filter Retention //

comparison to bellows and diaphragm pumps

Facts

Pump induced pressure and flow pulsations generate hydraulic shocks due to discontinuous discharge of liquid. Hydraulic shocks through microporous membrane filters increase particle release from the filters, which leads to wafer defectivity.

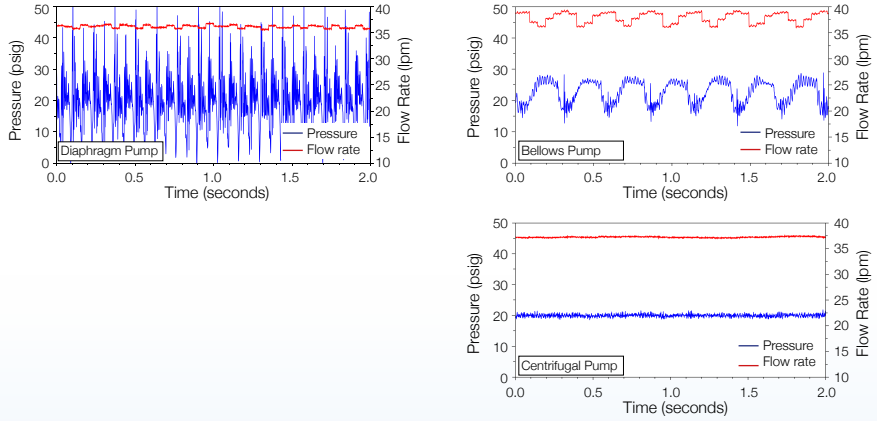
Test conditions

Pump induced flow pulsations of a diaphragm, a bellows and a Levitronix® pump were compared for the effect on filter retention efficiency and particle hold up. Three different membrane filters were used. The retention efficiency is presented as the Log Reduction Value (LRV) at a particle size of 125 nm for each filter.

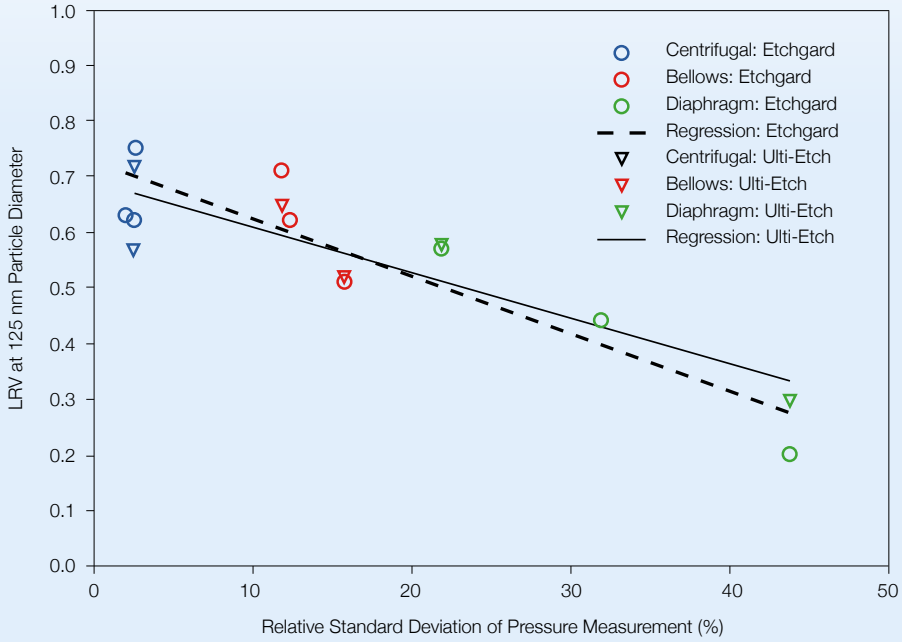
Results

Pressure pulsations have a negative effect on filter retention regardless of the filter used. The Levitronix® pump, which provides the most stable flow, exhibited the highest retention values at each flow rate tested.

BELLOWS AND DIAPHRAGM PUMPS GENERATE FLOW PULSATIONS WHEREAS LEVITRONIX® PUMPS ARE PULSATION FREE



FILTER RETENTION EFFICIENY VS. PRESSURE PULSATION



Source: CTA Test LTX 848 1222: "Effect of Pressure and Flow Pulsations on Filter Retention", Mark Litchy, May 2005

Metal Contamination //

comparison to diaphragm and magnetic drive pumps

Facts

Exposure of the pump's wet surface to acid chemicals leads to leach out of trace metals. Trace metal contamination can cause alteration of electrical properties in semiconductor devices.

The wet surface area of a Levitronix pump is several times smaller than in comparison to pneumatic pumps of comparable hydraulic power.

Magnetic drive pumps are produced by centrifugal casting, which can lead higher contamination of trace metal in the wet area.

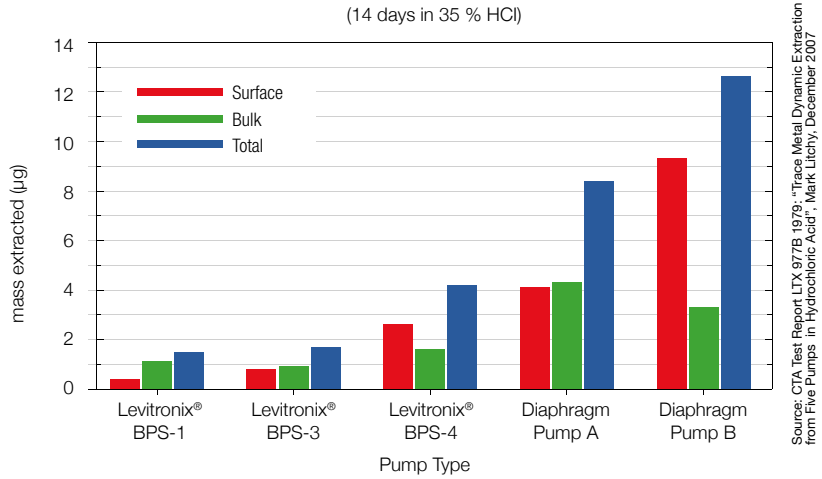
Test conditions

35% HCl was used as extractant. Continuous flow of the chemical was maintained through the pumps during each test. A background sample was taken prior to each test and sample were taken at approximately even spaced time intervals on a logarithmic scale from a sample port. The results of the analyses were converted to cumulative mass extracted.

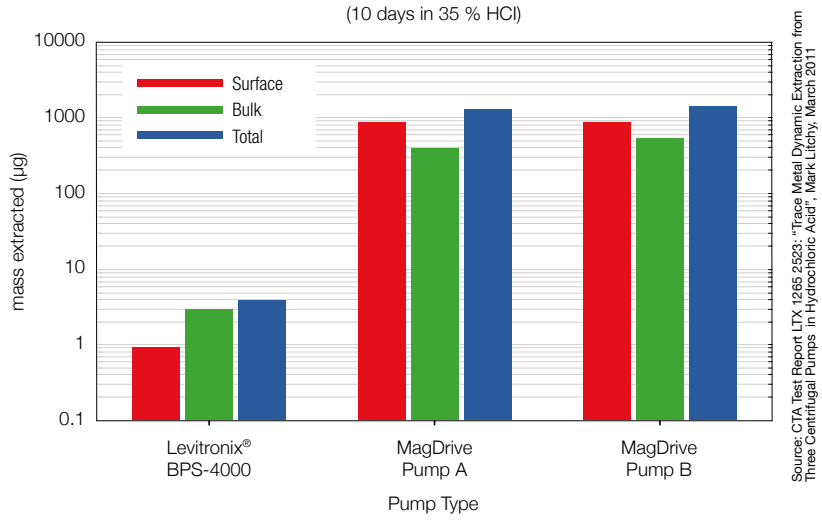
Results

The surface contamination from the diaphragm and magnetic drive pumps compared to Levitronix® was up to 3 times and up to 1,000 times, respectively, higher.

TRACE METAL EXTRACTION OF THREE LEVITRONIX® PUMPS COMPARED TO TWO DIAPHRAGM PUMPS



TRACE METAL EXTRACTION OF A LEVITRONIX® PUMP COMPARED TO TWO MAGNETIC DRIVE PUMPS



Slurry Agglomeration //
comparison to bellows and diaphragm pumps

Facts
Shear stress in pumps causes slurry agglomeration. Agglomerated slurry particles lead to micro scratches, which can cause wafer defectivity in CMP.

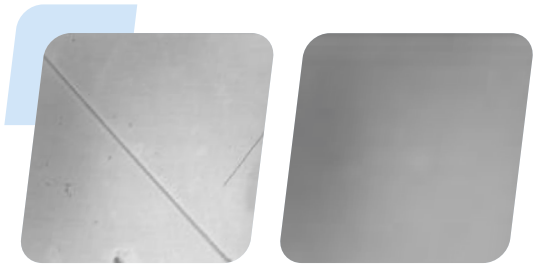
Test conditions
12 liters of slurry[1] were recirculated at a flow of 30 lpm and 2.1 bar. Samples were drawn from the system at selected times for analysis. The particle size distribution of each sample was measured and the increase in particle concentration relative to the initial concentration was compared.

Results
Little change in the particle size distribution was observed with Levitronix® pumps, regardless of particle size. With bellows and diaphragm pumps, significant increases particularly in the large particle concentrations were observed. The results remained identical at different flows and pressures as well as for different slurries.

Remarks
The same pump systems were tested to determine how their use affected the lifetime of CMP filters. The tests were continued until the ΔP across the filter increased by at least 10 psig or more than 10,000 turnovers in the system were achieved.

The filter lifetime with Levitronix® was 30 days compared to 2 and 5 days with a bellows and diaphragm pump, respectively.

1 Tested slurries: Cabot EP-C6618, Cabot iCue 600Y75, Cabot Semi-Sperse 12, Cabot SiLECT 6000, Cabot WIN W7300-A18, Hitachy HS-T805-1S

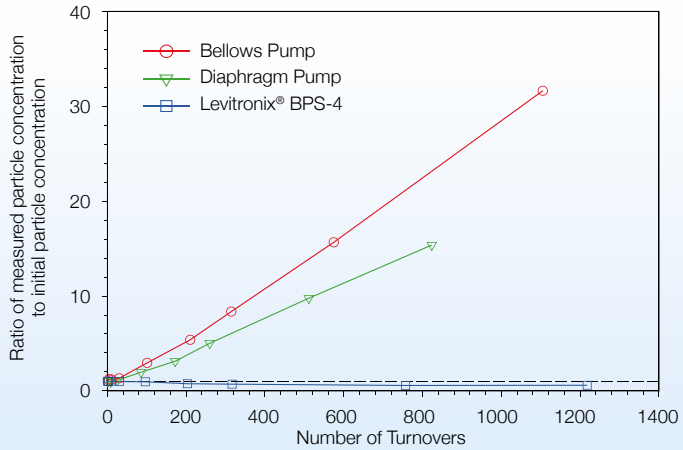


*Typical microscratches on polished wafer surfaces with **diaphragm pump***

*Smooth wafer surface with **Levitronix®***

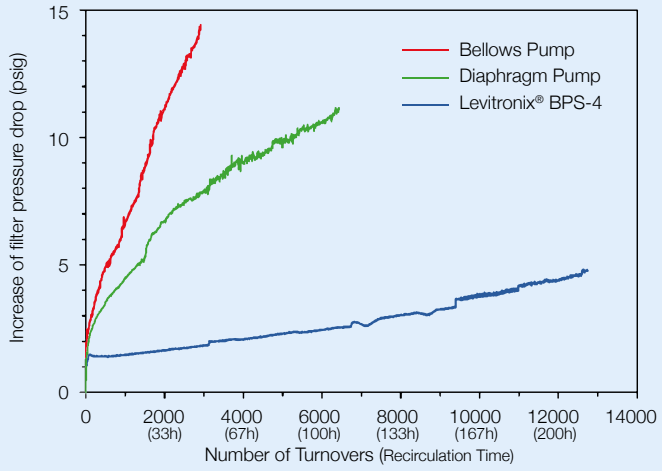
Source: St. Lawrence Nanotech

PARTICLE > 0.56 MM generated by different pumps



Source: CTA Test Report LTX979 1589: »Comparison of Four Pump Systems on the Particle Size Distribution of Slurry Cabot iCue 600Y75 Slurry«, Mark Litchy, November 2006

INCREASE IN DIFFERENTIAL PRESSURE across filter over time for three different pumps



Source: CTA Test Report LTX 775 1020: » Phase II: Comparison of Filter Lifetime during Circulation of Cabot Semi-Sperse® 12 Slurry with 3 Types of Pumps«, Mark Litchy, September 2004

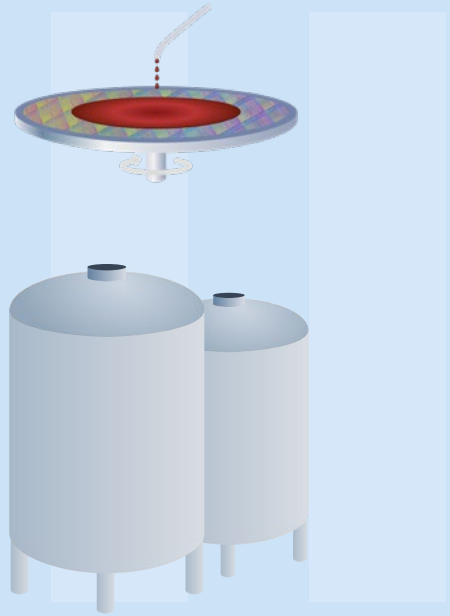
HOW DO LEVITRONIX PUMPS BENEFIT YOUR PROCESS

Photo Chemical Handling

A uniform photo resist thickness without any contamination is of great concern to the lithography process. Levitronix® pumps convey photo resist, developer and cleaner in the most accurate, reliable and purest way possible.

Bulk Chemical Delivery

Managing process integrity starts with the chemicals that come into direct contact with the wafer. In comparison to pumps, pressurized vessels can cause water hammer that leads to particle release and safety concerns. Furthermore, pressurized vessels bear the risk of microbubbles at the point-of-use. Levitronix® is the purest pump throughout and therefore the ideal choice in delivery of bulk chemicals.

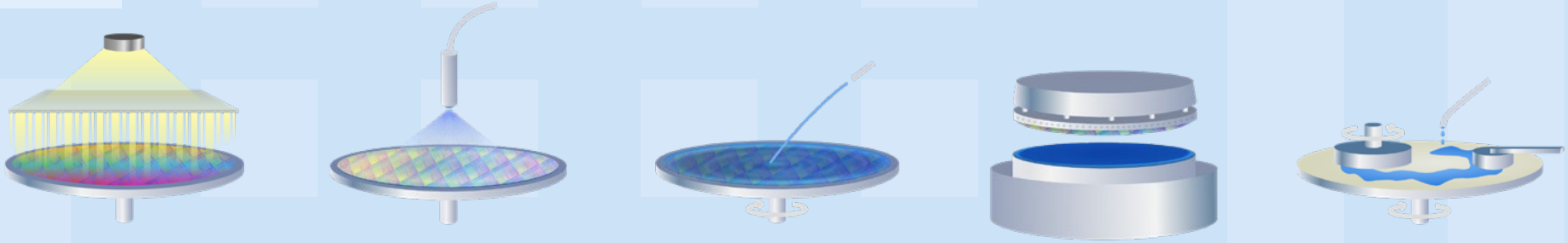


Wet Etching

Selectivity and anisotropy are of great concern to the etching process. Due to the high controllability and pulsation-free flow, Levitronix® pumps convey etchants in the most accurate, reliable and purest way possible.

Metal Plating

Levitronix® pump systems provide a very consistent electrolyte flow which is one of the key drivers for the plating uniformity. In Levitronix® pumps, there are no bearing surfaces where metal can plate out and stop the pump.



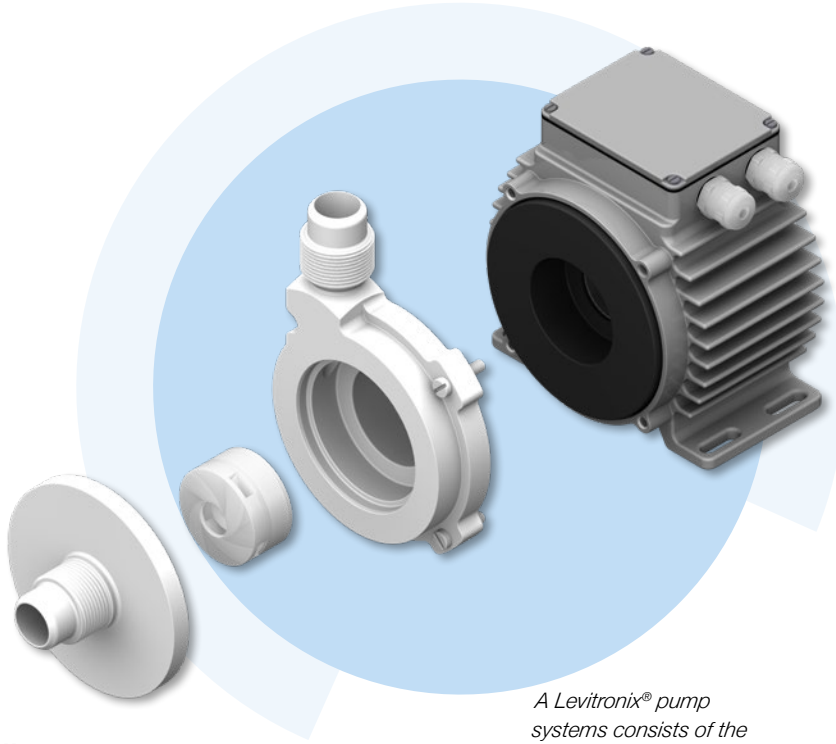
Cleaning

Highest purity is the major goal in batch- and single wafer cleaning. Levitronix® is the purest pump system throughout and therefore industry standard in ultrapure cleaning applications.

CMP Slurry Delivery

When conveying slurries, high shear forces caused by Diaphragm or Bellows pumps result in particle agglomerations. Micro-scratches originated by these oversized particles or particle agglomerations lead to wafer defectivity. Due to their low shear force design Levitronix® pumps can reduce micro-scratches in CMP applications by up to 80%.

PRODUCT OVERVIEW



A Levitronix® pump systems consists of the motor and pump head

Simple Pump Head Design

A Levitronix® pump head consists of the magnetically levitated impeller, a bottom casing and a top casing. All wet materials meet the highest industry requirements and are fabricated of either chemical resistant high-purity fluoropolymers, stainless steel or other high-performance plastic resins. The pump head can be configured with tube end or common semiconductor fittings such as Flaretek or Pillar.

Bearingless Pump Motor

The Levitronix® pump is comprised of a single motor/bearing unit that provides both drive and magnetic bearing functions simultaneously. Selected motors are ATEX/IECEx or Hazardous Location NRTL certified and can be operated in explosive environments.

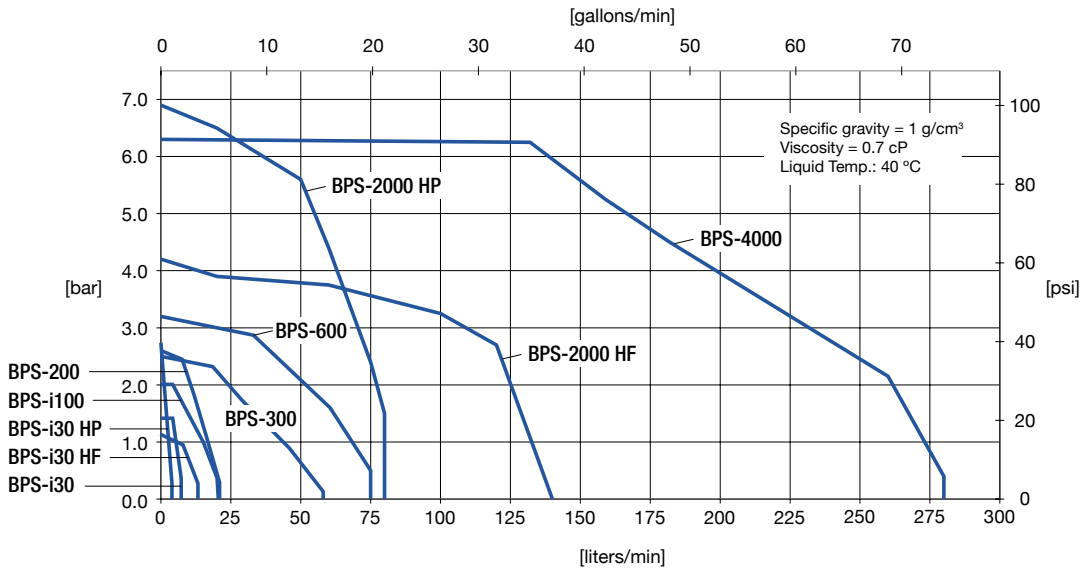
Standalone and Extended Controller

Two basic systems are available. The standalone configuration includes an integrated user panel to set the speed manually. The extended version includes a PLC interface, which allows to set a process set point with automatic closed loop speed regulation via an external control signal such as a flow or pressure sensor.

iF Series

Selected pump systems are available with integrated flow sensor electronics. This allows for a direct connection of a Levitronix® flow sensors to the pump, which rduces the footprint and simplifies installation.

Selected pumps are available with integrated flow sensor electronics such as the BPS-iF30



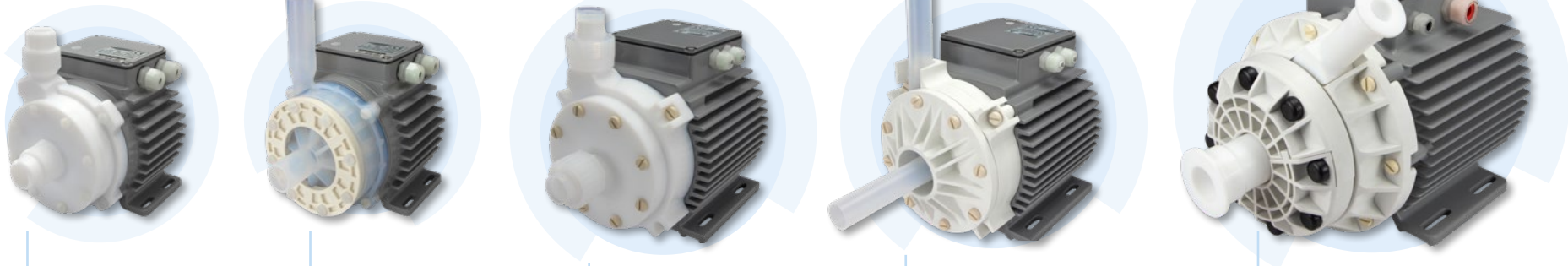
BPS-i30 Standard
1.5 bar (22 psi)
7.4 l/min (2 gpm)

BPS-i30 High Pressure
2.8 bar (40 psi)
3.8 l/min (1 gpm)

BPS-i30 High Flow
1.1 bar (16 psi)
14.7 l/min (3.9 gpm)

BPS-i100
2 bar (29 psi)
20 l/min (5.3 gpm)

BPS-200
2.6 bar (37.7 psi)
21 l/min (5.5 gpm)



BPS-300
2.5 bar (36.2 psi)
58 l/min (15.3 gpm)

BPS-600
3.2 bar (46 psi)
75 l/min (20 gpm)

BPS-2000 High Pressure
6.9 bar (100 psi)
80 l/min (21 gpm)

BPS-2000 High Flow
4.2 bar (61 psi)
140 l/min (37 gpm)

BPS-4000
6.3 bar (91 psi)
280 l/min (74 gpm)

Flow Sensors

LFS Series Sensor

LEVIFLOW® LFS-008
LEVIFLOW® LFS-04
LEVIFLOW® LFS-08
LEVIFLOW® LFS-20
LEVIFLOW® LFS-50
LEVIFLOW® LFS-80

The LEVIFLOW® inline and clamp-on flowmeters are designed for non-invasive flow measurements of high purity fluids.

Two piezoelectric transducers, mounted in the sensor housing, generate and receive an ultrasonic wave. The wave going in direction of the flow is accelerated and the wave going against the flow direction is slowed down. The difference between the transit time of both waves is proportional to the velocity and therefore the flow of the fluid.

Facts

- Ultrasonic transit time measurement
- High precision flow measurement (inline sensor accuracy 1%, clamp-on sensor accuracy 1%-3%)
- Wide flow range
- Highly dynamic flow control with Levitronix® MagLev pumps
- No contamination due to non-invasive flow measurement
- No moving parts -> no particle generation
- All wet materials are fabricated from PFA

Clamp-on Sensor

LEVIFLOW® LFSC-06D.1
LEVIFLOW® LFSC-09D.1
LEVIFLOW® LFSC-11D.1
LEVIFLOW® LFSC-17D.1
LEVIFLOW® LFSC-23D.1
LEVIFLOW® LFSC-30D.1
LEVIFLOW® LFSC-35D.1

Converter

LEVIFLOW® LFC-1C
LEVIFLOW® LFC-6CIO

Customer Success with Levitronix®

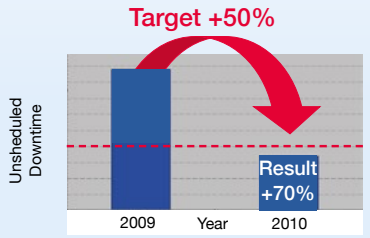
Infineon

Project Scope //
Improvements of wet chemical etch equipment to support Infineon Zero Defect Strategy

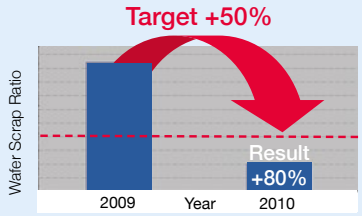
Key Drivers //
Process Stability, Equipment Stability and Wafer Scrap

Results //

Equipment Performance
before and after tool modifications



Wafer Scrap
before and after tool modifications



Source: INFINEON Austria AG

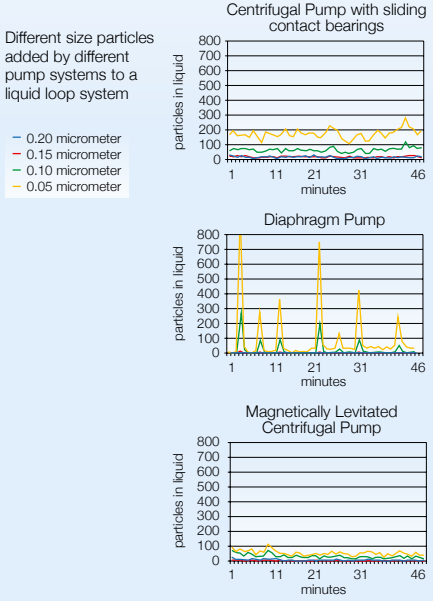
Freiberger

Project Scope //
Influence of different pumping technologies on the particle emission during wet processing of GaAs wafer

Key Drivers //
Decreasing the number of particles on wafer surface by reducing particles in critical process steps of wet cleaning

Results //

Different size particles added by different pump systems to a liquid loop system



Source: Freiberger Compounds Materials GmbH

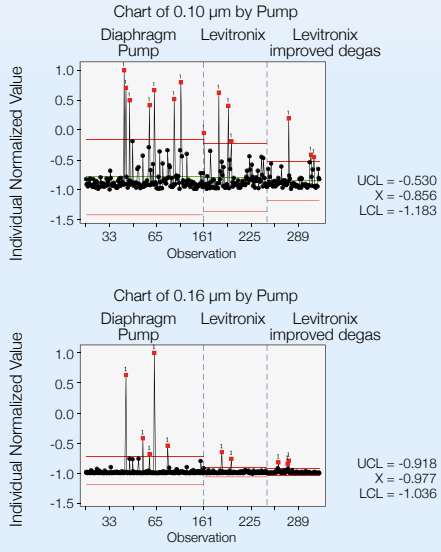
OKMETIC

Project Scope //
Retrofit of the SC1 Module with Levitronix® Pump in Final Clean Wetbench. Pump comparison: Bellows pump vs. Levitronix®

Key Drivers //
Constant flow, increased flow rate, low particle concentration

Results //

Particle concentration comparison Bellows Pump vs. Levitronix® BPS-600



Source: OKMETIC

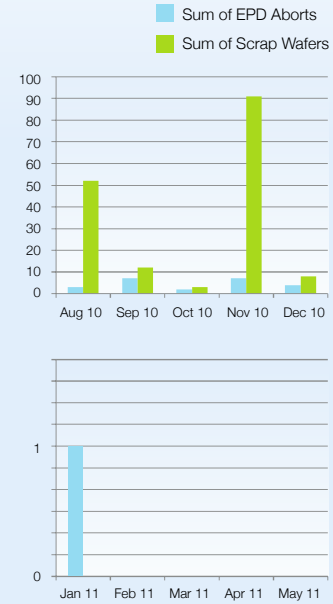
NXP

Project Scope //
Retrofit of SAT Tools to reduce wafer scraps and EPD aborts

Key Drivers //
Stable flow and reduced maintenance costs

Results //

Wafer scrap and EPD aborts with Pneumatic Pumps vs. Levitronix® BPS-4



Source: NXP

Swiss Quality since 2001

With more than 100,000 pumps sold, Levitronix® is the worldwide leader in magnetically levitated bearingless pump technology, specialized in supplying fluid handling devices for life sciences, microelectronics and industrial applications.

The patented technology allows the motor and magnetic bearing to be combined into a single unit with products that achieve maximum reliability, long life, and the ability to convey fluids in the harshest of environments.

LEVITRONIX®

Headquarter and European Contact

Levitronix GmbH
Technoparkstr. 1
CH-8005 Zurich
Switzerland

Phone +41 44 974 4000
E-Mail salesEurope@levitronix.com

US Contact

Levitronix Technologies LLC
10 Speen Street, Suite 102
Framingham, Massachusetts 01701
USA

Phone +1 508 861 3800
E-Mail salesUS@levitronix.com

Japan Contact

Levitronix Japan K.K.
Wing Eight 5floor, 4-16-4
Asakusabashi, Taito-ku
Tokyo, 111-0053 Japan

Phone +81 3 5823 4193
E-Mail salesJapan@levitronix.com

Taiwan Contact

Levitronix Taiwan
5F, No. 251, Dong Sec. 1,
Guangming 6th Rd., Chu Pei City,
Hsin-Chu 302, Taiwan, R.O.C.

Phone +886 3 657 6209
E-Mail salesAsia@levitronix.com