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Flokal® wet-etch & clean

Issue 15-September 2003

Flokal® wet-etch & clean.

- ✓ Wet-etching processing overview.
- ✓ Etching equipment.

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ABOUT US

FLOKAL® - the ultimate resource for:

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We are ISO 9001: 2000 certified

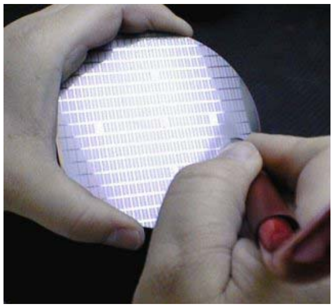
Wet-etching processing overview

Research and manufacturing related to silicon devices, circuits, and systems often relies on the wet-chemical etching of silicon wafers. The dissolution of silicon using liquid solutions is needed for deep etching and micromachining, shaping, and cleaning. Also, wet-chemistries are often used for defect delineation in single crystal silicon materials.

Cleaning

A sequence of chemistries is typically used to clean silicon wafers. This sequence was first developed at the RCA laboratories, and is therefore often referred to as the RCA process. This chemical sequence does not attack the silicon material, but selectively removes the organic and inorganic contamination that resides on the wafer surface. The following is a typical RCA process; many variations to the ordering of the sequence and chemical ratios are used throughout the industry.

- General Clean: A general cleaning is accomplished by using a mixture of Sulfuric Acid and Hydrogen Peroxide.



Mixing these chemicals is dangerous and generates extreme heat. This industry standard clean removes organic and inorganic contamination from the wafer. 2-10 minute clean is recommended. Strong rinse in DI water is required after this cleaning step.

- Particle Removal: A Megasonic clean (at about 70 C) in a 5:1:1 ratio mixture of DI water: Ammonium Hydroxide : Hydrogen Peroxide will remove silica and silicon particles from the wafer, as well as remove certain organic and metal surface contamination. 2-10 minute clean is recommended. Strong rinse in DI water is required after this cleaning step.
- Oxide Removal: A 15-60 second dip in 1:20 HF:DI water will remove the native oxide layer and any contamination in the oxide from the wafer surface. HF is extremely dangerous and must be handled with great care. Strong rinse in DI water is required after this cleaning step.
- Metal Contamination Removal: A Megasonic clean (at about 70 C) in a 6:1:1 ratio mixture of DI water: HCL : Hydrogen Peroxide will remove certain ionic and metal surface contamination. 2-10 minute clean is

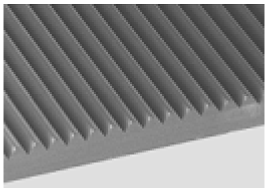
recommended. Strong rinse in DI water is required after this cleaning step.

- Spin Rinse Dry: Wafers should be rinsed and dried in a standard spin-rinse dryer.

Megasonic agitation is commonly used with the chemical bath and most commonly with the particle removal step. Also, heavy DI rinse steps are used between each chemical treatment. DI rinsing may use dump-baths, over-flow baths, and spray-dump baths, as well as combinations. Proper removal of all cleaning chemistry with 18MegaOhm DI water is critical and needed after each chemical bath. Any text book on the topic of semiconductor or silicon processing is an excellent resource for further information regarding the RCA cleaning process.

There are commercially available premixed cleaning solutions that can be used directly to clean wafers and serve the same purpose of the RCA cleaning process. These chemicals typically achieve the function of several cleaning steps with one solution.

Anisotropic KOH Etching



KOH is one the most commonly used silicon etch chemistry for micromachining silicon wafers.

1. Anisotropic KOH Etching Rates vs. Orientation
The KOH etch rate is strongly effected by the crystallographic orientation of the silicon (anisotropic).

2. KOH Etching Rates vs. Composition and Temperature
As with all wet-chemical etching solutions, the dissolution rate is a strong function of temperature. Significantly faster etch rates at higher temperatures are typical, but less ideal etch behavior is also common with more aggressive etch rates. Also, heavy boron doping can significantly harden the silicon and sharply reduce the etch rate.

Anisotropic TMAH (tetramethylammonium hydroxide) Etching

Similar to KOH etching, TMAH is commonly used for fast removal and silicon micromachining.

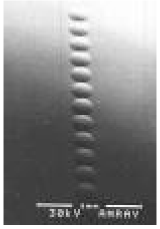
1. TMAH Etching Rates vs. Orientation
The orientation dependence of the TMAH etch rate is similar to KOH and varies similarly in accordance to the atomic organization of the crystallographic plane.

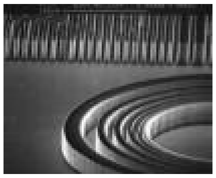
2. TMAH Etching Rates vs. Composition and Temperature
Similar to KOH, the TMAH etch rate varies exponentially with temperature.

EDP

Similar to KOH, EDP is often used for fast removal and silicon micromachining.

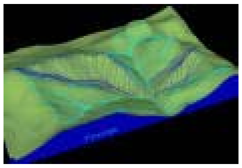
Isotropic Silicon Etches





Often, isotropic etchants having dissolution rates independant of orientation are needed. These chemical mixtures tend to uniformly remove material, and are limited by the mass transport of chemical species to the crystal surface. The actual surface reaction rates are so great that variations to atomic structure do not alter the reaction speed relative to chemical transport.

Silicon Defect Delineation Etches



Certain chemical etchants are strongly dependent on defects, and defect structures in the single crystal silicon. These etchants are commonly used to high-light or delineate defects in the material.

There are many wet-chemical etch recipes known for etching silicon. These processes are used for a variety of applications including micromachining, cleaning, and defect delineation. The detailed behaviour and rate of the etchant will vary between laboratory enviroments and exact processes. However, the data and phenomena recorded above have been reported by many researchers and manufactures.

Flokal offers variety of units for wet etching. Amongst them:

Thermogard™ NE Filters.

Thermogard NE disposable and cartridge filters provide increased structural stability for high temperature and high-viscosity conditions while using the same proprietary non-wetting and prewet PTFE membrane technology as QuickChange® filters. This technology offers quick startup, optimum filtration efficiency and flow, and simple and fast installation, resulting in a low total cost of ownership.

QuickChange® AT and ATX Cartridge Filters

QuickChange AT and ATX Cartridge filters, designed for use in any aqueous-based chemical are shipped water-wet, and require no IPA prewetting procedures. Without an IPA prewetting requirement, QuickChange AT and ATX filters prevent alcohol/chemical interaction, avoid potential sources of contamination, and eliminate the cost and inconvenience of hazardous waste disposal. QuickChange AT and ATX filters reduce filter changeout time, minimize system downtime, and lower cost-of-ownership.

QuickChange® PF-40 and PF-80 Cartridge and Disposable Filters

QuickChange PF Cartridge and Disposable filters, designed for use in any aqueous-based chemical are shipped water-wet, and require no IPA prewetting procedures. Without an IPA prewetting requirement, QuickChange PF filters prevent alcohol/chemical interaction, avoid potential sources of contamination, and eliminate the cost and inconvenience of hazardous waste disposal. QuickChange PF filters reduce filter change-out time, minimize system downtime, and lower cost-ofownership.

QuickChange® 1000, 1500, 3000 Disposable Filters

QuickChange Disposable filters, designed for use in any aqueous-based chemical, are shipped water-wet and require no IPA prewetting procedures. Without an IPA prewetting requirement, QuickChange Disposable filters prevent alcohol/chemical interaction, avoid potential sources of contamination, and eliminate the cost and inconvenience of hazardous waste disposal.

QuickChange® ATX Disposable Filters

QuickChange ATX Disposable filters, designed for use in any aqueous-based chemical, are shipped water-wet and require no IPA prewetting procedures. Without an IPA prewetting requirement, QuickChange Disposable filters prevent alcohol/chemical interaction, avoid potential sources of contamination, and eliminate the cost and inconvenience of hazardous waste disposal. QuickChange Disposable filters reduce filter changeout time, minimize system downtime, and lower cost-of-ownership.

Pumpgard II Filters

Pumpgard II filters protect chemical pumps and final filters against damage from broken silicon wafer pieces. Pumpgard II filters have a 60 µm retention rating, which is ideal to capture larger wafer pieces before they reach the pump and/or final filter. Within the normal operation of a wet bench, process wafers can break and release wafer shards into the process bath. These shards can cause damage to the bellows (made of Teflon® fluoropolymer resin) or to diaphragms within the pump. Pumpgard II filters, installed on the upstream side of the recirculation pump, can remove shards from process chemical baths before damage to expensive chemical pumps occurs.

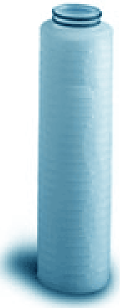
pHasor® II Membrane Contactor

PFA hollow fiber technology delivers a high concentration of bubble-free dissolved gas in high purity chemicals or water. The pHasor II Membrane Contactor uses a unique gas permeable membrane with very high water intrusion pressure, which permits gas to rapidly dissolve into a liquid stream, while preventing liquid water from permeating across the membrane.

Chem-Line™ II PF-40 and PF-80 Filter with Flaretek® Fittings

Chem-Line II PF-40 and PF-80 filters are designed for the most demanding point-of-use filtration of process chemicals. Chem-Line filters are recommended for use with most acids, bases, and non-flammable solvents at both ambient or elevated temperatures. Their O-ringless design prevents bypass and eliminates compatibility issues often associated with O-ring materials. Chem-Line II PF filters have been engineered for safe and convenient in-line installation to minimize the risks associated with the handling of corrosive chemicals. Incorporating the Wafergard® unique stacked-disc technology, filter elements do not flex or shed particles. The entire filter is constructed of Teflon® PTFE and PFA 440HP and provides superior downstream cleanliness with broad chemical compatibility.

Microgard PI Cartridge Filters



Microgard PI filters use a patented ultra-high molecular weight polyethylene (UPE) membrane, which has the highest retention efficiency of any membrane: > 99.999% of the rated pore size. This revolutionary membrane has excellent retention capabilities to meet the increasing demands of today.s leading edge technology. Microgard PI filters offer low surfactant binding, excellent wettability and superior downstream cleanliness.

Panelgard™ PDP Cartridge Filters

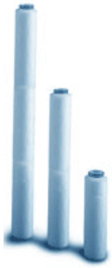
The Panelgard PDP Cartridge Filter is a final point-of-use surface type cartridge filter using unwoven polypropylene material. With high retention efficiency, high flow rate, and long product life, it contributes to better cost performance.

Wafergard PF Cartridge Filters

Description: Fully constructed of Teflon; Stacked-disc design provides maximum retention and downstream cleanliness.

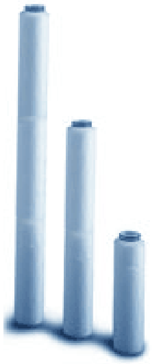
Applications: Designed for the most demanding and critical point-of-use chemical filtration at ambient and high temperatures.

Microgard UPE & UPX Cartridge Filters



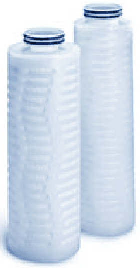
Microgard UPE/UPX filters use a patented ultra-high molecular weight polyethylene (UPE) membrane, which has the highest retention efficiency of any membrane: > 99.999% of the rated pore size. This revolutionary membrane has excellent retention capabilities to meet the increasing demands of today.s leading edge technology. Microgard UPE/UPX filters offer low surfactant binding, excellent wettability and superior downstream cleanliness.

Microgard™ Plus Cartridge Filters



Microgard Plus filters use a patented ultra-high molecular weight polyethylene (UPE) membrane, which has the highest retention efficiency of any membrane: up to 99.999% at retention rating particle size. This revolutionary membrane has excellent retention capabilities to meet the increasing demands of today’s leading edge technology. Microgard Plus filters offer low surfactant binding, excellent wettability and superior downstream cleanliness.

Intercept® HP & HPX Cartridge Filters

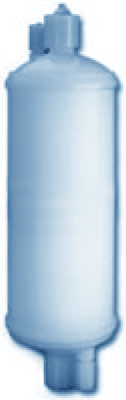


Intercept filters utilize a patented hydrophilic membrane which activates multiple particle capturing mechanisms. The Intercept membrane minimizes the electrostatic repulsion between the membrane surface and particles allowing for retention of particles smaller than the pore size of the filter.

Guardian™ ATX Disposable Filters

The combination of a high-efficiency PTFE membrane and a large filtration-area device allows Guardian ATX disposable filters to deliver low particle counts without compromising flow rates, even with high-viscosity fluids such as sulfuric and phosphoric acids. Recommended applications for Guardian ATX disposable filters include filtration of sulfuric acid, nitric acid, acetic acid, phosphoric acid, hydrochloric acid, hydrogen peroxide, organic strippers, and various nonflammable solvents. The Guardian ATX disposable filter is ideal for single pass and spray tool filtration applications and bulk chemical delivery.

Guardian™ DEV Disposable Filters

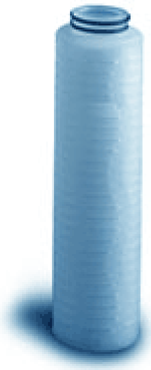


Guardian DEV Disposable filters provide cost-effective performance for KOH and TMAH based developer solutions and other high pH chemical filtration applications. The Guardian DEV arrive read-to-use for maximum system up-time. The patented hydrophilic membrane (UPE) requires no prewetting and no flushing for operation in aqueous solutions. The membrane does not dewet in aqueous solutions. The cartridges deliver quick flush up time and excellent flow/retention characteristics.

Guardian™ AT and ATX Cartridge Filters

Constructed with a high-quality, high-retention PTFE membrane, Guardian AT and ATX filters provide the best retention efficiency and the lowest particle counts in chemical delivery systems. Guardian AT and ATX filters are ideal for single pass and spray tool filtration applications and bulk chemical delivery.

Guardian™ DEV Cartridge Filters



Guardian DEV filters provide cost-effective performance for KOH and TMAH based developer solutions and other high pH chemical filtration applications. The Guardian DEV arrive read-to-use for maximum system up-time. The patented hydrophilic membrane (UPE) requires no prewetting and no flushing for operation in aqueous solutions. The membrane does not dewet in aqueous solutions. The cartridges deliver quick flush up time and excellent flow/retention characteristics.

Guardian™ HP and HPX Cartridge Filters

Guardian HP and HPX cartridge filters provide the best retention efficiency and the lowest particle counts in chemical delivery systems that provide fluids critical to semiconductor cleaning and wet etching, including HF, BOE, NH4F, Copper Plating Solution, and Super-Q etch. The Guardian HP and HPX cartridges arrive read-to-use for maximum system up-time. The patented hydrophilic membrane (UPE) requires no prewetting for operation in aqueous solutions, no flushing, and does not dewet in aqueous solutions. The cartridges deliver quick flush up time and excellent flow/retention characteristics.

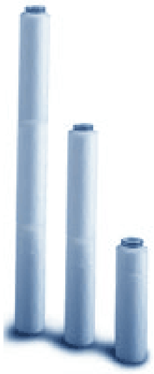
Guardian™ HPX Disposable Filters

Guardian HPX disposable filters provide the best retention efficiency and the lowest particle counts in chemical delivery systems that provide fluids critical to semiconductor cleaning and wet etching. Guardian HPX disposable filters are recommended for use in HF, BOE, NH4F, and Super-Q etch chemical delivery systems. The Guardian HPX disposable's large surface area provides high particle retention without sacrificing flow.

Fluorogard® AT and ATX Cartridge Filters

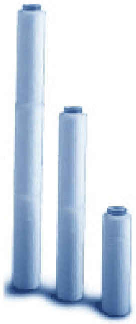
Fluorogard AT and ATX cartridge filters are fully constructed of fluoropolymer materials and are designed to efficiently remove particles from a broad range of acids, bases, solvents and other microelectronic process chemicals. These cartridges are recommended for medium to high flow applications. ATX cartridges are also ideal for high viscosity filtration applications.

Fluorogard® Plus Cartridge Filters



Fluorogard Plus filters, manufactured with hydrophobic Teflon® fluoropolymer PTFE pleated membranes with polypropylene supports, provide unmatched durability and cleanliness for filtration of process fluids used in the semiconductor industry. The filters are desiged to withstand 100 psi differential pressure at 25° C in the forward direction and 75 psi differential pressure at 25° C in the reverse direction.

Fluorogard® FP and FP-HP Cartridge Filters



Fluorogard FP and FP-HP filters, manufactured with Teflon® fluoropolymer PTFE pleated membranes with polypropylene supports, provide unmatched durability and cleanliness for filtration of process fluids used in the semiconductor industry.

Fluorogard® AT and ATX Disposable Filters

Fluorogard AT and ATX disposable filters use PTFE and PFA materials with excellent chemical compatibility and thermal stress resistance. Fluorogard AT and ATX disposable filters eliminate handling of the filter element and decrease the possibility of contamination, making these filters ideal for critical applications that require highest purity liquids. Fluorogard AT and ATX disposable filters feature a compact and easy-to-handle housing shell, which reduces potential exposure to hazardous chemicals during installation and disposal.

Fluorogard® RS Cartridge and Disposable Filters

Fluorogard RS filters and pre-filters deliver ultimate protection from films, gels, and hard particle contamination by providing high capacity removal of contaminants from photoresist stripping and residue removal chemistries. Specifically designed for long-life filtration of photoresist stripping chemistries at elevated temperatures.

Fluorogard® TPX and TPX-HP Cartridge Filters

As film display glass substrates get increasingly larger, filtration efficiency is critical to ensure that high quality chemical reach point-of-use without compromising production time. Fluorogard TPX and TPX-HP filters are designed for high flow filtration applications. The PTFE membrane provides strong chemical resistance. The unique hydrophilic membrane has been through a surface modification to eliminate the need for alcohol wetting thereby reducing organic extractables.

Etchgard™ HP and HPX Cartridge Filters

Etchgard HP and HPX Cartridge Filters achieve the highest rates of quality and efficiency, improving Overall Equipment Efficiency (OEE) rates.Bath particle counts directly impact the device particle counts. In a recirculation bath, a high turnover rate ensures rapid particle removal. Mykrolis manufactures Etchgard HP and HPX Cartridge Filters with a patented high-efficiency, high-flow membrane that delivers improved bath quality. The large filtration area and high flow rates result in more passes through the filter and optimal bath turnover.

Etchgard™ HPX Disposable Filters

Filter installation, start-up and flushing times are markedly decreased when using the Etchgard HPX disposable filter. The patented hydrophilic UPE membrane eliminates the need for prewetting and the large filtration area of the HPX disposable filter enhances membrane retention and flow. Low differential pressure delivers high flow rates and decreases microbubble generation. High membrane surface area also means longer time between filter change-outs, greatly increasing system up-time.

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- ✓ Accredited calibrations (flow, temperature, pressure, level)
- ✓ Process Analytical solutions
- ✓ Automation and Software
- ✓ Flow meters

For the pharmaceutical industry

- ✓ Cryotechnology
- ✓ Gas / liquid flow measurement & display
- ✓ Temperature measurement & display
- ✓ Pressure measurement & display
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- ✓ In-line particle analyzers
- ✓ Fluid dispensers & metering pumps
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- ✓ Process Analytical solutions
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