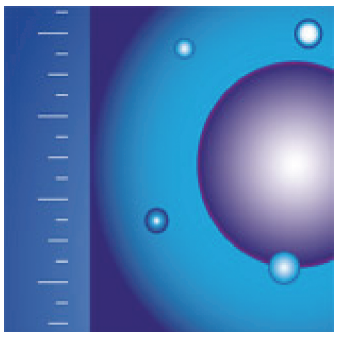
Ultrapure Water



General Filter Requirements

Achieving and maintaining ultrapure water (UPW) is extremely important in light of its widespread presence throughout the manufacture of semiconductor integrated circuits. The technology of the industry has advanced so rapidly over the past few years that it has redefined cleanliness requirements, specifically with regard to the need for quantitatively removing colloidal silica, particles, total organic carbon (TOC), bacteria, pyrogens (bacterial fragments) and metal ions.

A well-designed UPW system with strategically placed filters, will ensure achievement of this goal, since the type of filter selected in each of the key areas will make a measurable difference in ultimate quality.

To meet the demands of a high-purity deionized (DI) water system, filters must:

- Not contribute organic, particulate or metal ion contamination to the effluent stream
- Not unload trapped contaminants or shed filter material
- Be integrity testable to verify removal ratings
- Perform identically from lot to lot
- Have a low-pressure drop for long life and maximum economy.

DI Water Filter

A well-maintained UPW system will have a number of carefully selected filters and purifiers placed in strategic positions.

A schematic of a DI water system is depicted below. The locations of the filters are representative of those found in a typical water system.

Reverse Osmosis (RO) Pretreatment

Microza* UNA System

Pretreatment is required to operate RO units effectively and economically. The pretreatment will vary depending on the source of the incoming feed water. With surface water as the feed, conventional pretreatment may include such unit operations as coagulation, flocculation, settling, granular media filtration, and cartridge filtration. Even municipal feeds may have elevated SDI levels due to the presence of fine colloids and bacteria. These colloids may be too fine to be effectively removed by typical multimedia filters, leading to rapid blockage of cartridge filters and/or premature RO membrane fouling.

An alternate to conventional pretreatment for RO units is a microfiltration (MF) system with Pall's Microza UNA modules. The Microza MF system provides a consistent, high-quality effluent not generally achievable by conventional processes, regardless of incoming feed water quality. This may permit RO units to be operated at lower pressures for longer periods because of reduced membrane fouling, thus decreasing electrical power costs. The frequency of chemical cleanings may also be significantly decreased, saving on labor and chemical costs and extending RO membrane life.

* Microza is a trademark of Asahi Kasei Corporation.

Cartridge Filtration

For conventional pretreatment systems, Pall recommends the absolute rated Ultipleat High Flow Profile filter with a 99.98% removal at 4.5 µm. Finer ratings are also available.

Resin Trap Filters

As their name implies, the purpose of resin trap filters is to retain resin beads or fines that are occasionally released from ion exchange beds. Placing a filter immediately after a resin bed or polishing bottle should be considered as an insurance policy against a potentially catastrophic, downstream contamination.

Ultrafiltration Pre-Filter

Installing a fine filter between the polishing bottles and the ultrafiltration modules can serve two purposes; 1) as a resin trap and 2) to maintain particle inlet specifications to the OLT modules.

Central/Loop Ultrafiltration (UF) Modules

Most UPW systems have UF modules installed as the main filter in their DI water loop. Microza OLT modules, with their 6,000 daltons molecular cut-off rating, reliably remove colloidal contaminants such as silica, bacterial breakdown products and dissolved organic molecules larger than their removal rating.

Pall Microza UF modules with their unique, uniform double-skinned, hollow fiber membrane feature:

- High mechanical strength for long term reliability
- Stable long-term flux
- Uniform smooth outer membrane surfaces minimize fouling by contaminants
- Double filtration ensures high removal efficiency.

Hollow fiber ultrafiltration medium shown at 300X magnification.

Central/Loop Cartridge Filters

Membrane filters rated at 0.2 µm, 0.1 µm, 0.04 µm or 0.02 µm are the most frequently selected filters. The following criteria will assist in the selection of the appropriate filter.

Rating

What data are available to substantiate the claimed efficacy? Bacteria, particle or latex bead challenge tests are helpful in characterizing the performance of a filter cartridge.

Membrane Zeta Potential
Most materials when immersed in water exhibit a zeta potential. The majority of DI water contaminants, including most colloids, particles, bacteria, and pyrogens (bacterial fragments), are negatively charged. Filter media can be chemically modified to give them a positive zeta potential.

Positive and negative zeta potential filters are given the same pore size, i.e., micron ratings. Positive zeta potential filters thus provide removal by interception equal to that of negative zeta potential filters.

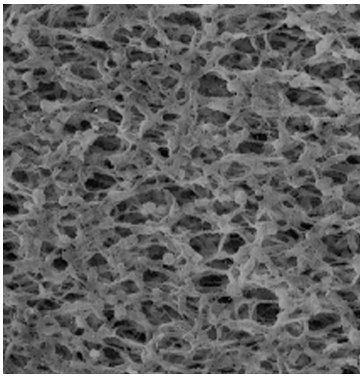
However, Pall positive zeta potential elements provide an important advantage: they additionally remove very fine negatively charged organisms and particles, well below their micron rating. The removal mechanism is electrostatic attraction, and is effective in water over the typical DI water pH range (pH 5-8).

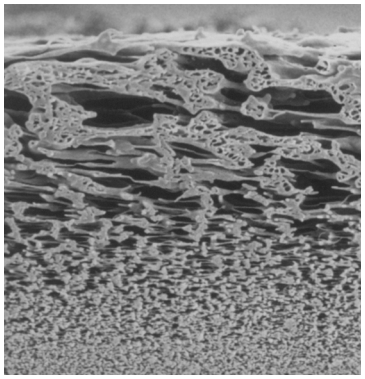
As the active sites become occupied by the collected particles, the removal efficiency by electrostatic attraction decreases. However, actual efficiency will not drop below the removal rating of the filter. Because of the highly porous nature of the membrane, actual total membrane area containing positive zeta potential sites is several orders of magnitude greater than the effective filtration area. Thus, the capacity for electrostatic adsorption of fine particles is very large.

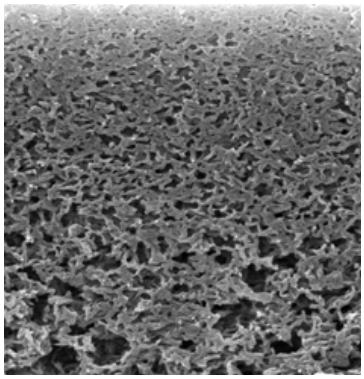
Asymmetric Membranes
To meet the need for particle removal ratings down to 20 nm while maintaining relatively low differential pressures, Pall has developed asymmetric membranes. These membranes have a tapered pore geometry with an open upstream section and a fine downstream structure.

Integrity Testable
All central and final filters intended for use in a UPW system should be integrity tested by the manufacturer prior to shipment, and should be easily integrity testable by the end user. Such a test will verify that the filter cartridges have not been damaged and have been properly installed in their housings.

Traceability
Filters should be serialized by the manufacturer for lot control and traceability of components.


PVDF Membrane shown at 3000X magnification.


Highly Asymetric Polysulfone Membrane at 400X magnification.


Asymmetric nylon membrane at 5000x magnification

Point-of-Use (POU) Filters and Purifiers

POU filters are used at or within tools to eliminate trace contaminants (particulate, metallic or bacterial) from entering the tool as well as from traveling back from the tool and into the DI water loop.

IonKleen™ Purifiers are targeted for final rinse water to remove trace metallic contaminants that may deposit onto wafers. Their high capacity for and rapid removal of metallic ions allows for economical installations that are typically changed out once a year in UPW systems.

Hot DI Water Filters

Pall Corporation offers both UF and MF solutions. The Microza OLT modules, discussed above, can operate continuously in 80°C water. The Varafine T filters with their highly asymmetric, polysulfone membranes and polysulfone/ECTFE hardware can readily tolerate hot (95°C) water service.

Tank Vent Filters

To prevent ingression of particles and bacteria into DI water storage tanks, the Emflon, hydrophobic membrane, filter is highly recommended. For sizing, please contact Pall Microelectronics.

Process Cooling Water

Pall's High Flow Ultipleat filters provide the most economical solution to filtering cooling water in order to prevent occlusion and fouling of heat exchanger tubes.

Sanitization

The minimization of bacteria growth in semiconductor DI water loops is typically achieved via periodic shock or continuous sanitization with hydrogen peroxide, ozone, or hot H2O. The compatibility of the filter materials of construction will depend on the particular sanitization technique employed (see compatibility guide page below for details).

Membrane Types

Nylon, PVDF, polysulfone microfiltration and hollow fiber microfiltration/ultrafiltration media are recommended for use in DI water applications. Photomicrographs of these media are shown above.

Construction Techniques

Pall electronic grade (E Grade) DI water filters are manufactured in a controlled, clean environment with strict quality controls of all incoming materials. Their pleated filter construction provides for high void volumes, resulting in low pressure drops, high flow rates and long service life. Pall "E" Grade DI water filters are subjected to a post-manufacturing high velocity water flush to ensure that the filters meet the stringent cleanliness requirements of the semiconductor industry.

Sanitization Recommendations

The information presented in the table below is for general guidance only. It is not to be considered for long term or continuous exposure to the listed chemicals. Because so many factors can affect the chemical resistance of a given product, it should be tested under the same conditions that it will see in service. All applicable safety practices should be observed, such as those provided in the Material Safety Data Sheet for each chemical. Please contact Pall Microelectronics for specific recommendations or to ask any questions.

Sanitation Guide

R Recommended
NR Not Recommended

	Filter Cartridges							Modules	Housings				O-Rings				
	Ultipleat® High Flow	Profile® II	Ultipleat® Depth	Posidyne® / Asymmetric P-Nylon	Varafine™	Varafine™ T	Fluorodyne®	OLT Series	316L SS Electropolished	Polypropylene	PFA	PVDF	Viton[2] A	FEP / Viton	Silicone	EPDM	Kalrez[2]
Hot DI Water (< 90°C)	NR	NR	NR	NR	NR	R	NR	R	R	NR	R	R	NR	R	R	NR	R
DI Water (< 3% H_2O_2) ambient	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
DI Water (20-30 ppb ozone) ambient	NR	NR	NR	NR	NR	NR	R*	NR	R	NR	R	R	NR	R	NR	NR	R

[1] Limited exposure only.

[2] Viton and Kalrez are registered trademarks of E. I. du Pont de Nemours and Company.

Summary

Pall offers a variety of products for all types of water:

- Depth filters
- Membranes with positive zeta potential
- Asymmetric and isometric membranes
- Hollow fiber membranes for ultrafiltration and microfiltration
- Reactive membranes (purifiers)

To optimize your system, please contact Pall Microelectronics.

DI Water Flow Schematic
General DI Water Recommendations

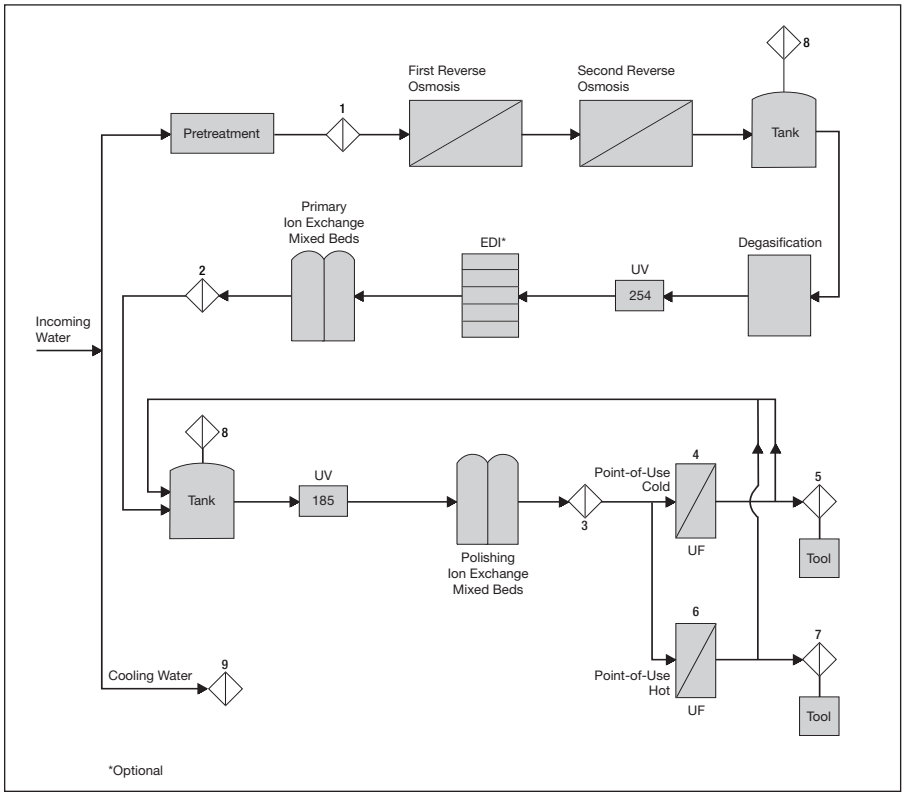


Diagram Number	Application	Filter Type	Removal Ratings
1	*Pre-RO*	Microza[1] Modules: UNA System	0.1 µm
		Ultipleat® High Flow Depth	4.5 µm
2	*Resin Trap*	Fluorodyne®	0.2 µm
		Varafine™	0.45 µm
		Ultipleat Depth	3 µm
3	*UF Prefilter*	Posidyne®	0.1 µm
		Varafine™	0.1 µm
4	*Central UF*	Microza UF Modules: OLT Series	6,000 daltons
5	*POU (Cold DI)*	IonKleen™ AQ Series	Trace metal ions >98%
		Asymmetric P-Nylon	20 nm
		Posidyne	40 nm
		Varafine	20 nm
		Fluorodyne	40 nm
		Microza UF Modules: OLT Series	6,000 daltons
6	*Hot DI Water*	Microza UF Modules: OLT Series	6,000 daltons
7	*POU (Hot DI)*	Varafine T	20 nm
		Fluorodyne	40 nm
8	*Tank Vent*	Emflon®[2]	3 nm (in gas)
9	*Cooling Water*	Ultipleat High Flow Depth	20 µm; 40 µm

[1] Microza is a trademark of Asahi Kasei Corporation

[2] Data sheet available under Gas Filtration Section

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