OPTIMA™ CMP

Filter Cartridges on Target for CMP Particle Classification

CUNO®
Cuno Incorporated

Applications

- **Semiconductor** – Oxide/Low-k Dielectrics, Shallow Trench Isolation (STI), Interlevel Dielectric (ILD), Polysilicon, Tungsten, and Copper
- **Data Storage** – Magnetic Heads, Nickel and Glass Substrates
- **Data Transmission** – Optical Fiber
- **Compound Semiconductor** - Light Emitting Diodes (LED)

Superior reduction of large particle counts for improved yields

OPTIMA™ CMP filter cartridges are high capacity depth filters optimized for oxide and metal slurries used in chemical mechanical planarization (CMP) applications. OPTIMA CMP filters are composed of all-polypropylene components and features a multi-zone "graded-porosity" design for the optimum level of particle classification. This novel construction provides enhanced flow characteristics, including low pressure drop, to minimize shearing of the slurry while providing superior service life.

The objective of a slurry filter is for the majority of particles to pass through it unchanged, while only removing the undesired or “oversized” particles. The oversized particle population is commonly referred to as large particle counts (LPC) and they typically form over time when the suspended particles in the slurry settle forming aggregates, agglomerates, and gels. Large particles can also be the result of adverse shipping conditions, shearing, slurry drying, and interaction with other distribution loop components such as fittings, tanks, piping, valves, and pumps. These large particles can scratch metal and interlevel dielectrics potentially causing wafer defects.

CUNO’s OPTIMA CMP filter reduces large particle counts that can potentially reduce yields while maintaining the polishing characteristics of the slurry.

Feature	Benefit
Graded Porosity Design	Superior removal of hard and soft gel contaminants, for reduced defectivity and improved yields High contaminant holding capacity reduces downtime and increases overall equipment effectiveness The filters are "matched" to the slurry providing the optimum level of performance needed to dramatically reduce defect causing particles Provides a low pressure drop reducing the potential for fluid shear of the slurry
100% Polypropylene Construction	Low cartridge extractables, free of adhesives, binders, and surfactants Excellent chemical compatibility with low and high pH slurries
Quality Manufacturing	ISO certified quality management system Non-contact welding reduces a potential source for contamination Manufactured and double-bagged in a clean environment to provide superior downstream cleanliness out of the package
Built to Exacting Specifications	Provides a consistent quality of slurry enabling repeatability of the planarization process

Particle Size Distribution

The filtration of CMP slurries is a unique and challenging process as compared to the filtration of high purity chemicals used in electronics manufacturing. High purity chemical filtration is typically performed using 0.2 micron or tighter membrane filters that have a sharp particle removal cut-off at the rated pore size. The majority of CMP slurries contain a desired mean particle size that ranges from 0.03 - 0.2 microns. Consequently, the filter that was specifically designed for particle clarification of high purity chemicals would strip out the desired particles and adversely affect the polishing characteristics of the CMP slurry. Oversized particles in the slurry typically greater than 0.5 micron are undesired and represent the “tail” (Figure 1) of the particle size distribution (PSD). OPTIMA CMP filters remove the PSD tail while allowing the majority of desired or “target” size particles to pass through it unchanged.

Particle Removal Efficiency is the Best Measure of Filter Performance

Figure 1 compares the PSD of colloidal-silica slurry and a laboratory test dust which is typically used by filter suppliers to establish depth filter ratings. The data shows that test dust has a broader PSD above 0.5 micron proving that it is not a true representation of the types of particles in CMP slurry. A wide variation in performance also exists from one filter supplier to the next because there is no industry accepted standard for rating retention of depth filters. Furthermore, Absolute and Nominal filter ratings are both used to specify particle removal efficiency which only serves to confuse the situation while not providing the application specific information needed. In Figure 2, particle removal efficiency is compared for the same grade of CMP filters from CUNO. The filters were challenged using both a laboratory test dust and colloidal silica slurry. There is a significant difference in particle removal efficiency, which is a direct result of the contaminant PSD distribution. The broad PSD of the test dust yields significantly higher particle removal efficiency than achieved when tested with slurry. Therefore, test dust is not representative of slurry and ratings based on test dust will likely be overstated and meaningless for CMP slurry applications. In Figure 3, particle removal efficiency is compared for equivalent rated CMP filters from CUNO, Competitor P, and Competitor M in colloidal silica slurry. The data clearly shows that equivalent rated filters from different manufacturers does not deliver equivalent performance and reinforces the fact that the “rating” generated in a lab using test dust is not meaningful in predicting actual performance. Based on this information particle removal efficiency generated in slurry is the best measure of filter performance. Other important factors in selecting the appropriate slurry filter include particle classification, pressure drop, and filter lifetime.

Figure 1. - Particle Size Distribution > 0.5 micron - Colloidal Silica Slurry & ISO Test Dust

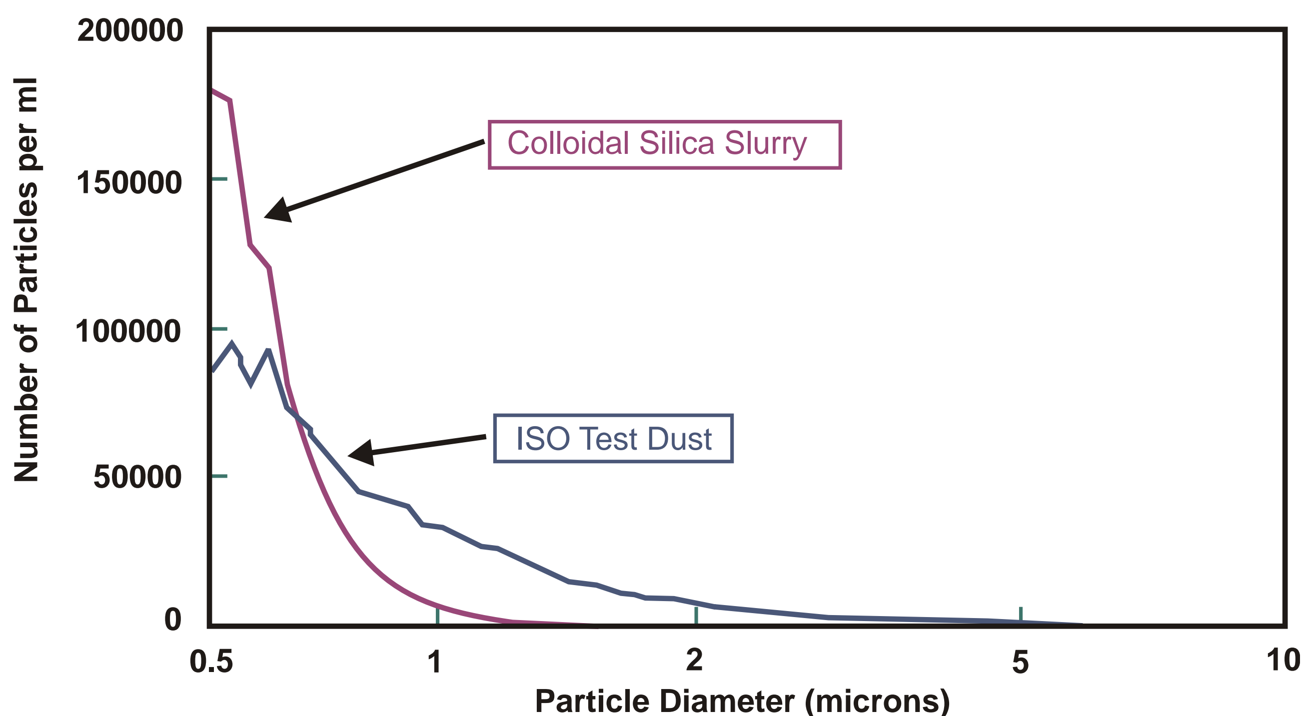


Figure 2. - Particle Removal Efficiency

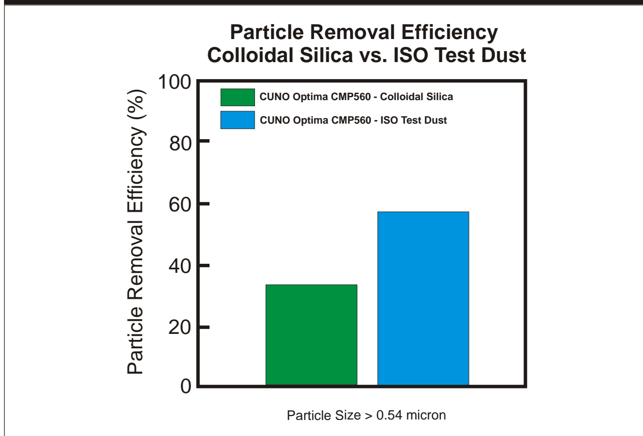
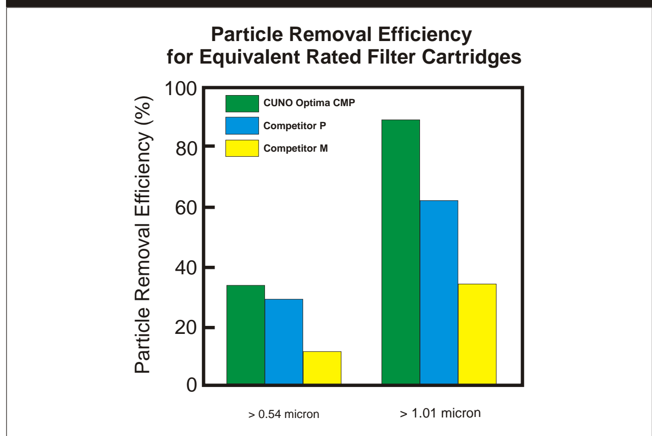


Figure 3. - Comparative Particle Removal Efficiency in Colloidal Silica



Superior Particle Retention through Graded Porosity Design

OPTIMA CMP filter media was specifically engineered to provide a low porosity, downstream section with a sharp retention cut-off that closely aligns to the size distribution of undesired particles to be removed. This sharp removal cut-off will not alter percent solids (Figure 4) or remove desired or "target" size particles thus preserving the polishing characteristics of the slurry. In contrast, competitive point-of-use filters (Figure 4) that have a broad removal range can in fact retain particles smaller than the PSD. Removing these "target" size particles can alter the percent solids of the slurry which in turn reduces filter lifetime because more particles are being removed than required in the application. The multiple higher porosity layers on the upstream section (Figure 5) provide effective pre-filtration of oversized particles resulting in higher contaminant removal capacity and increased filter lifetime. This novel graded porosity (Figure 5) design also provides a tortuous downstream path and low pressure drop which is ideal for gel capture and reduced shear effect on the slurry.

Proper Filtration Provides for Reduced Defectivity

Large particles, greater than 0.5 micron, can scratch metal and interlevel dielectrics potentially causing wafer defects. Variations in particle size distribution and particle counts in the slurry can affect repeatability of the planarization process. In both cases, major reductions in large particle counts can be associated to proper filtration, resulting in reduced defectivity (Figure 6) and an increase to yields. Proper filtration also provides a consistent quality of slurry which enables repeatability of the planarization process. The ideal slurry filter will have a retention curve that closely aligns to the PSD of "undesired" particles to be removed. By matching that characteristic, OPTIMA

Figure 4. - Percent Solids Comparison

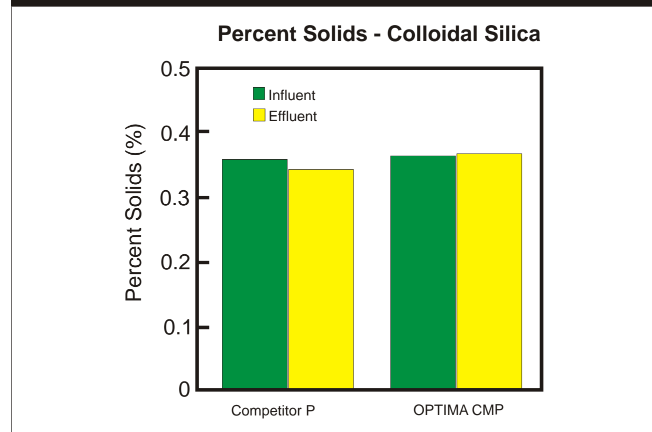
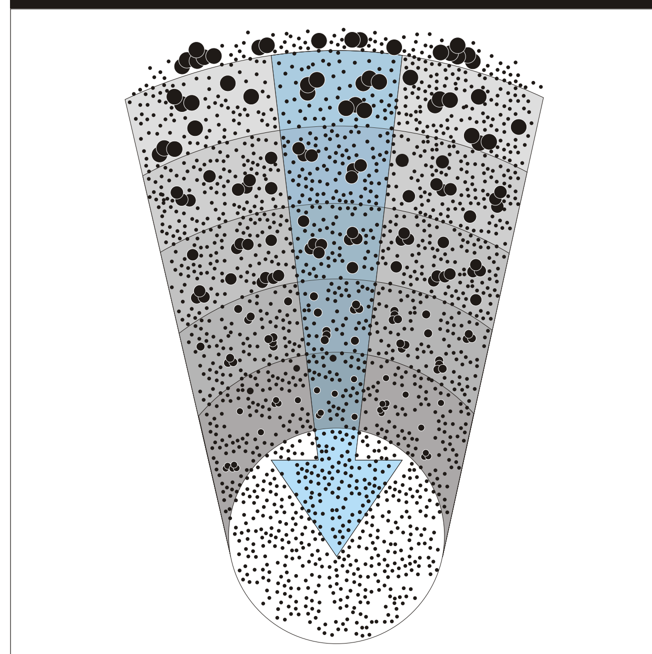


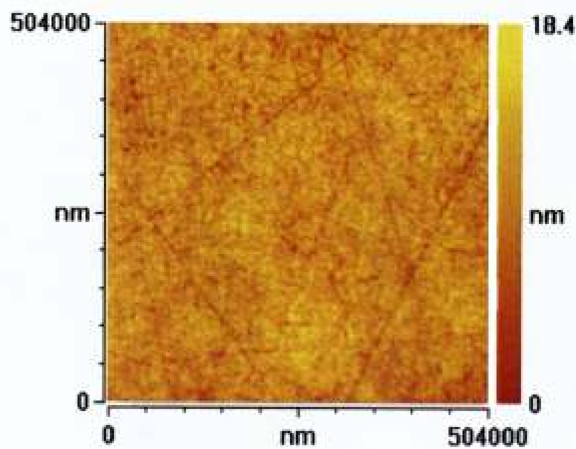
Figure 5. - Graded Porosity Design



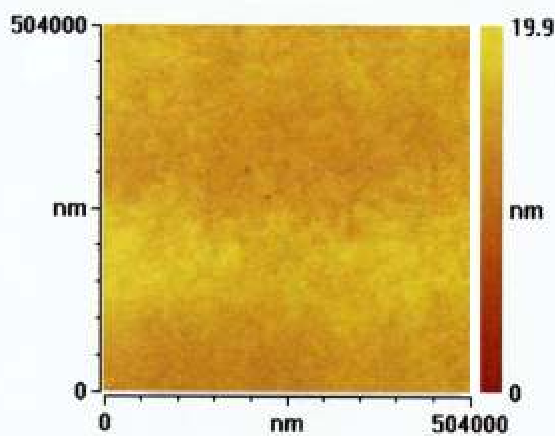
CMP filters are able to maintain the polishing characteristics of the slurry, maximize contaminant holding capacity, and increase filter lifetime.

Figure 6. - Benefits of Proper Filtration - Horizon Capture of Copper Wafer Surface

No Filtration - High Level of Defectivity



With Filtration - Relatively Defect Free



Cartridge Removal Efficiencies

Depending on the location in the slurry distribution system a filter with a sharp particle removal cut-off and a filter with a broad particle removal cut-off will be needed to reduce defectivity and increase yields. For example, in single pass applications at point-of-use the filter should have a sharp cut-off which is slightly larger than the desired PSD. Figure 7 shows that OPTIMA CMP510, CMP520, CMP530, and CMP540 contain that sharp cut-off making it ideal for particle classification at point-of-use. However, in the distribution loop, the filter should have a broad removal range that closely aligns to the undesired PSD tail to be removed like that exhibited by OPTIMA CMP550, CMP560, CMP570, CMP580 and CMP590. OPTIMA CMP filters for distribution loop applications contain a higher porosity media as compared to OPTIMA CMP filters at point-of-use. The higher porosity media increases flow while reducing pressure drop and fluid shear on the slurry. Increasing flow while maintaining particle removal efficiency results in particle specifications being achieved in less time. Figure 8, shows the particle removal efficiency of an OPTIMA CMP560 filter in re-circulation mode over specific time intervals.

"Matching" the slurry to the proper OPTIMA CMP filter provides the peak level of performance needed to dramatically reduce defect causing large particle counts.

Figure 7. - OPTIMA CMP Particle Removal Efficiency

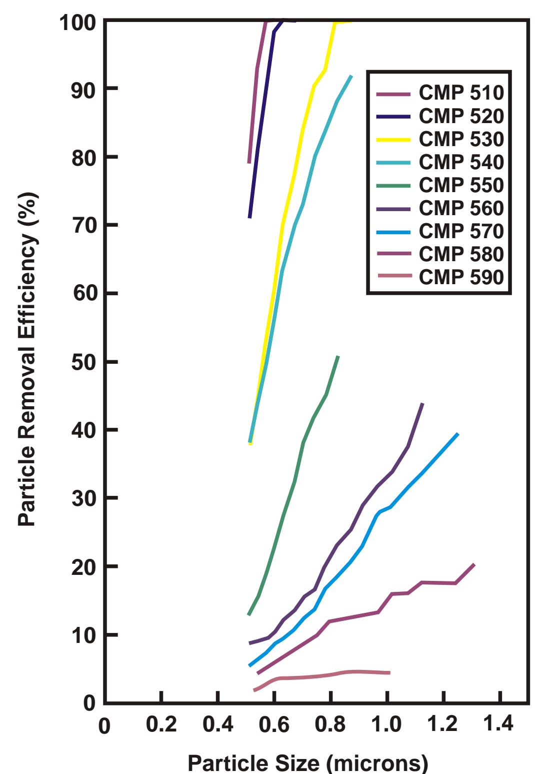
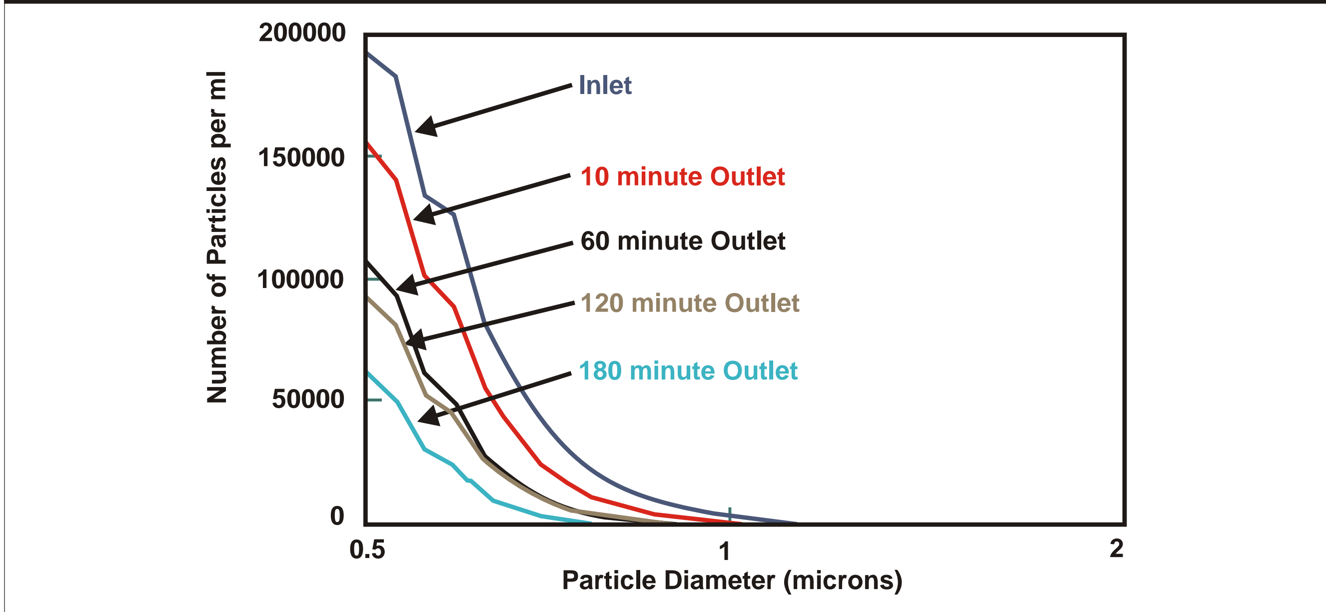


Figure 8. - Particle Removal Efficiency Over Time



The porosity of the media layers can also be customized to meet the specific requirements of CMP slurry manufacturers.

OPTIMA CMP Cartridge Construction

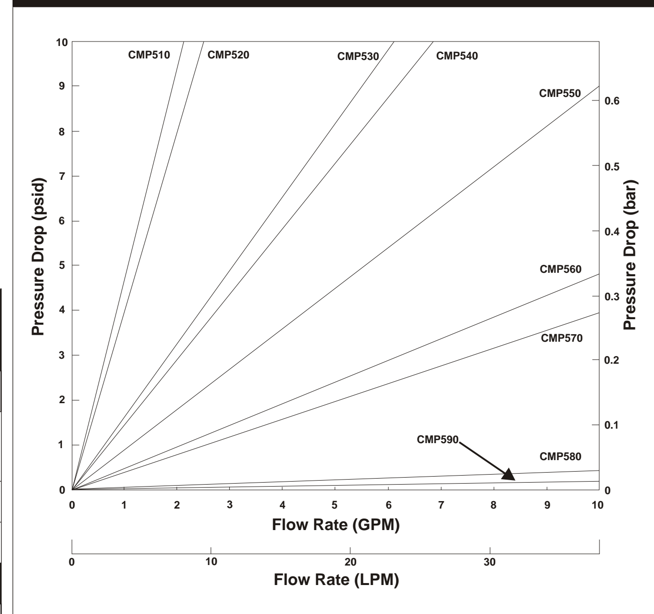
OPTIMA CMP filter cartridges are constructed using all polypropylene components (see Table 1). Cartridges are manufactured using the most advanced non-contact thermoplastic welding techniques - no adhesives, binders, or surfactants are used in the process - and are double-bagged in a clean environment to ensure superior cleanliness out of the package. The OPTIMA CMP filter manufacturing site operates within an ISO certified quality management system.

Table 1. - Product Specifications	
Materials of Construction	
Media	Polypropylene
Media Support Layer	Polypropylene
Core and End Caps	Polypropylene
“O” Rings/Gaskets	See ordering guide
Dimensions	
Length	See "Cartridge Configurations"
Outside Diameter	2.6” (6.6 cm)
Operating Conditions	
Maximum Forward Differential Pressure	60 psid @ 86°F (4.1 bar @30°C) 30 psid @ 140°F (2.0 bar @ 60°C)
Maximum Operating Temperature	140°F (60°C)

OPTIMA CMP Cartridge Flow Rates

Figure 9 depicts typical 10" cartridge flow rates for 1 cp fluids at 20°C.

Figure 9. - 10" Cartridge Flow Rate vs. Pressure Drop for 1cp Fluids @ 20°C



SASS

CUNO Electronics performs in-house and on-site filtration studies worldwide through its Scientific Applications Support Services (SASS) group using the most advanced particle counting technologies (PSS-780A) to optimize the CMP process at the customer facility. In addition, CUNO Electronics works closely with the slurry manufacturers to characterize and customize filtration solutions that meet current and future requirements.

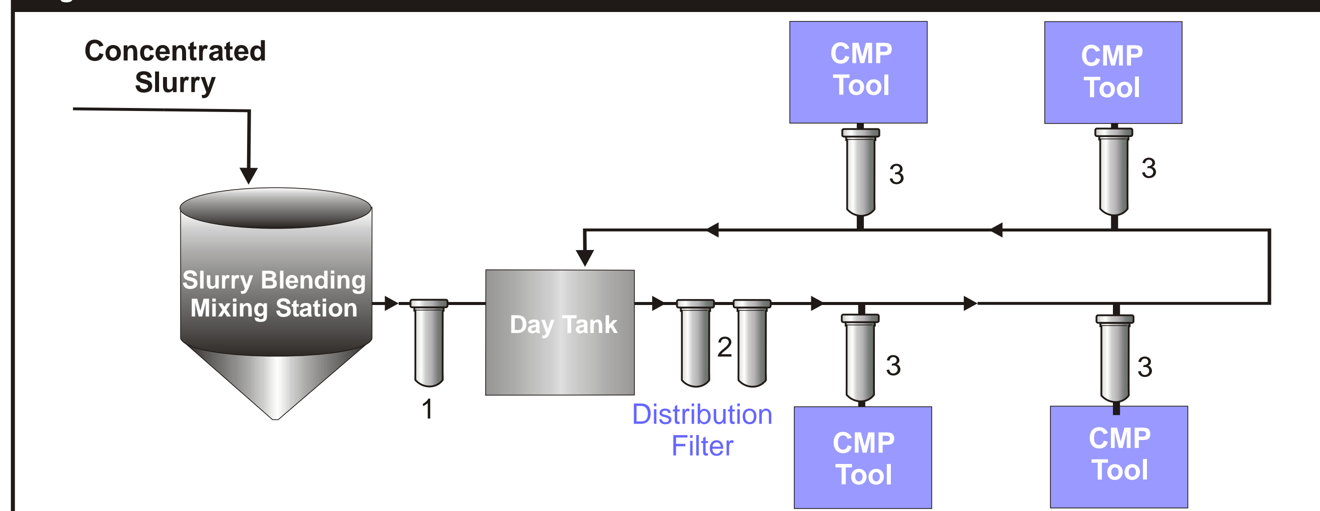
Particle Sizing Instrumentation

OPTIMA CMP Filter Recommendation Guide

Slurry Type	Filtration Location (see Figure 10)		
	Post Blending (1)	Distribution Loop(2)	POU Dispense(3)
Fumed Silica Oxide*	CMP560	CMP560, CMP570, or CMP580	CMP540, CMP550, or CMP560
Colloidal Silica Oxide	CMP560	CMP550, CMP560, or CMP570	CMP520, CMP530, or CMP540
Silica Based Metal	CMP560	CMP560 or CMP570	CMP520, CMP530, or CMP540
Non - Silica Based Metal < 2% Solids	CMP540 or CMP550	CMP540 or CMP550	CMP510 or CMP520
Non – Silica Based Metal > 2% Solids	CMP560	CMP560 or CMP570	CMP530 or CMP540

* Shear sensitive

Figure 10. - CMP Filtration Locations



OPTIMA CMP Filter to Pore Size Cross-Reference

Optima CMP Filter Grade	Typical Pore Size (Micron)
510	0.3
520	0.5
530	0.8
540	1
550	3
560	5
570	10
580	25
590	50

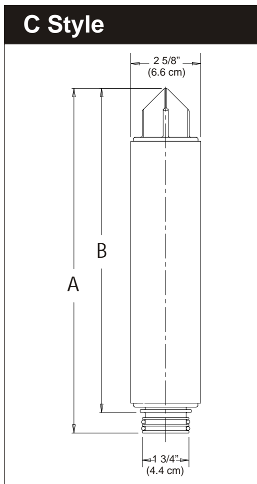
Optima™ CMP Filter Cartridge Ordering Guide

Cartridge	Filter Grade	Media	Length (Inches)	End Modification	Gasket/O-ring Material
CMP	**510**	**P** -Polypropylene	**04** - 4*	**C** - 222 O-ring & Spear	**C** - EPR
	520		**10** - 10	**F** - 222 O-ring & Flat Cap	
	530		**20** - 20	**U** - 222 O-ring & Flat Cap**	
	540		**30** - 30		
	550				
	560		**09** - 9	**N** - Double Open End	**G** - Polyethylene
	570		**19** - 19		
	580		**29** - 29		
	590				

* F only; ** Replaces Mykrolis Code 0, 10" length only (see U Style below).

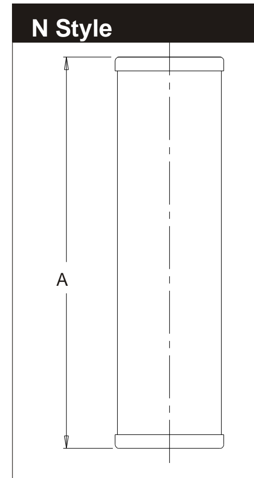
Optima CMP Cartridge Configurations

C Style



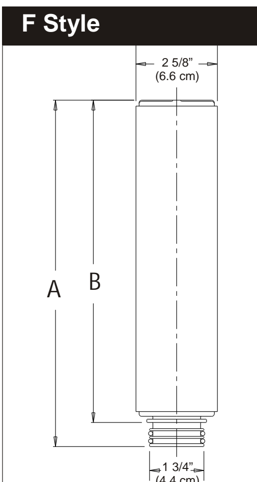
C Style				
	Inches		Centimeters	
	A	B	A	B
1 High	12.8	12.0	32.5	30.5
2 High	22.5	21.8	57.2	55.4
3 High	32.4	31.7	82.3	80.5

N Style



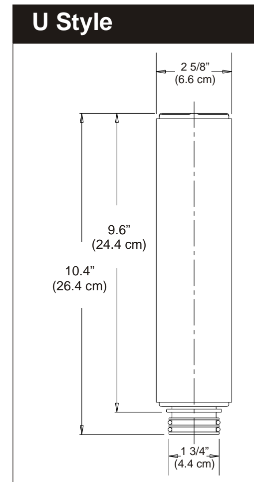
N Style		
	Inches	Centimeters
	A	A
1 High	9.8	24.9
2 High	19.6	49.8
3 High	29.4	74.7

F Style



F Style				
	Inches		Centimeters	
	A	B	A	B
1/2 High	5.2	4.4	13.2	11.2
1 High	11.0	10.2	27.9	25.9
2 High	20.7	20.0	52.6	50.8
3 High	30.6	29.8	77.7	75.7

U Style



CUNO … A World Leader in Fluid Purification

CUNO's manufacturing sites operate under ISO 9001 registered quality systems. Global manufacturing together with trained stocking distributors and state-of-the-art laboratory support bring quality solutions to existing and challenging filtration applications.

WARRANTY

Seller warrants its equipment against defects in workmanship and material for a period of 12 months from date of shipment from the factory under normal use and service and otherwise when such equipment is used in accordance with instructions furnished by Seller and for purposes disclosed in writing at the time of purchase, if any. Any unauthorized alteration or modification of the equipment by Buyer will void this warranty. Seller's liability under this warranty shall be limited to the replacement or repair, F.O.B. point of manufacture, of any defective equipment or part which, having been returned to the factory, transportation charges prepaid, has been inspected and determined by the Seller to be defective. THIS WARRANTY IS IN LIEU OF ANY OTHER WARRANTY, EITHER EXPRESSED OR IMPLIED, AS TO DESCRIPTION, QUALITY, MERCHANTABILITY, FITNESS FOR ANY PARTICULAR PURPOSE OR USE, OR ANY OTHER MATTER. Under no circumstances shall Seller be liable to Buyer or any third party for any loss of profits or other direct or indirect costs, expenses, losses or consequential damages arising out of or as a result of any defects in or failure of its products or any part or parts thereof or arising out of or as a result of parts or components incorporated in Seller's equipment but not supplied by the Seller.

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Fluid Purification

CUNO Filtration Asia Pte Ltd
18 Tuas Link 1 (3rd Floor)
Singapore 638599

Cuno Filtration Shanghai Co, Ltd
No. 2 Xin Miao San Rd,
Xin Miao Town,
Song Jiang District,
Shanghai. China. 201612

CUNO Pacific Pty Ltd
140 Sunnyholt Road
Blacktown, NSW 2148
Australia

CUNO K.K.
Hodogaya Station
Building 6F
1-7 Iwai-cho, Hodogaya-ku
Yokohama 240 Japan

CUNO Latina Ltda
Rua Amf Do Brasil 251
18120 Mairinque-Sp
Brazil

CUNO Ltd
21 Woking Business Park
Albert Drive
Woking, Surrey GU215JY
United Kingdom

Cuno Incorporated
400 Research Parkway
Meriden, CT 06450, U.S.A.
Tele: (800) 243-6894
(203) 237-5541
Fax: (203) 238-8977

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