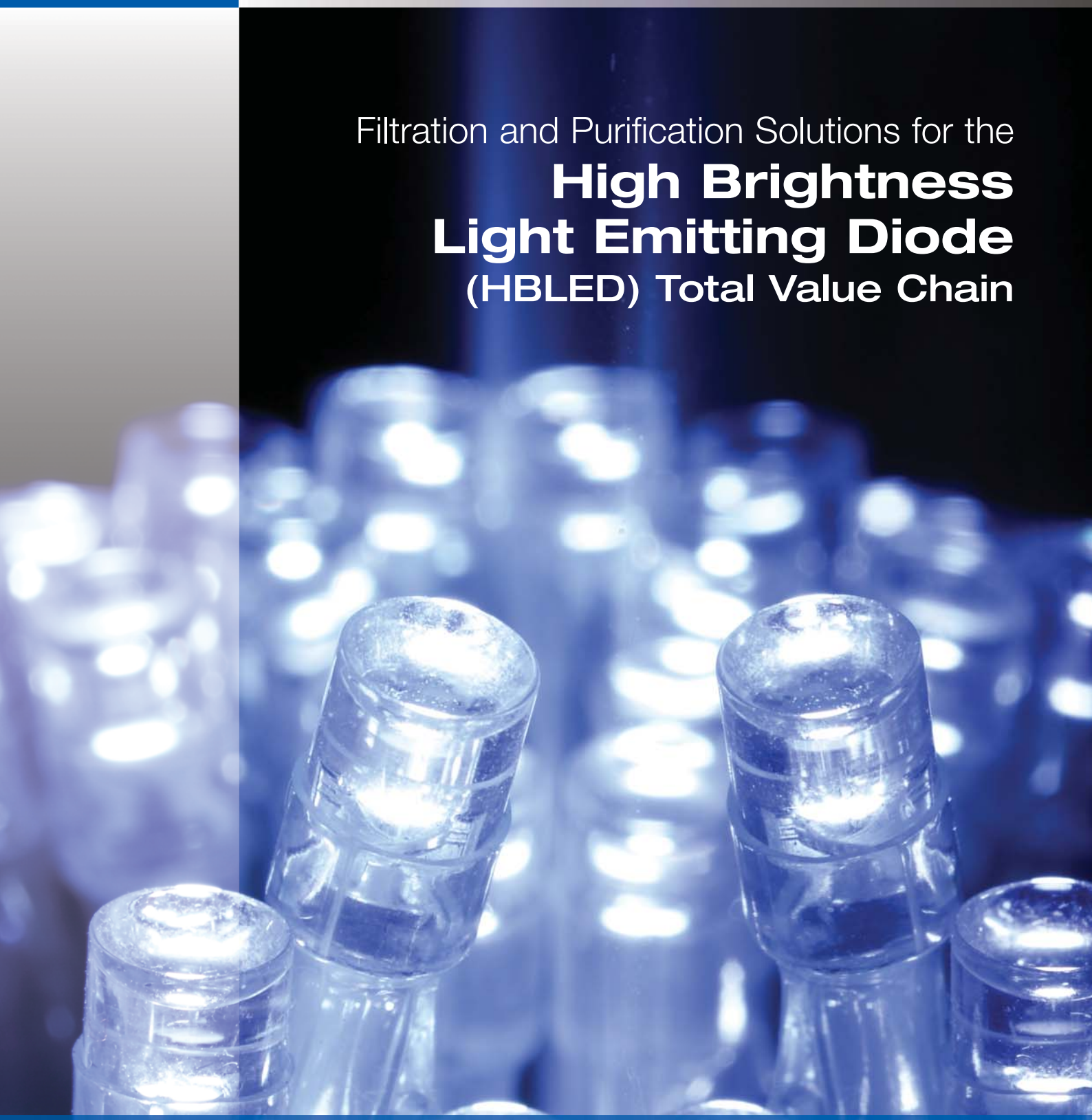
Pall Corporation

Filtration and Purification Solutions for the

High Brightness Light Emitting Diode (HBLED) Total Value Chain



*Filtration. Separation. Solution.*SM

MEHBLEDEN

Introduction

Company Profile

Pall Corporation is the global leader in the rapidly growing field of filtration, separation and purification. Pall is organized into two businesses: Life Sciences and Industrial. These businesses provide leading-edge products to meet the demanding needs of customers in biotechnology, pharmaceutical, transfusion medicine, energy, electronics, municipal and industrial water purification, aerospace, transportation and broad industrial markets. Pall's total revenues are around $2.5 billion with over 10,000 employees.

The company headquarters is in Port Washington, New York with extensive operations and local companies throughout the world. As consumers we rarely stop to consider how the products we use are made. Whether they are computers or solar panels, a favorite beer or wine, tap water, medicine, electricity, gasoline, or the paint on our cars, we simply expect high quality, reliability and reasonable prices. For the most part, we get them. Pall's highly sophisticated technologies are among the reasons why. These technologies are invisible to consumers, but essential to industry.

Our customers have a common enemy: contamination. It can destroy products, shut down plants, hinder compliance with regulations and slow innovation. We help them to:

- Optimize process efficiency
- Ensure product purity
- Meet stringent regulations
- Remove barriers to innovation
- Develop integrated solutions
- Enable new processes and products

Pall Microelectronics

Pall Microelectronics is the global leader in filtration, separations and purification technologies for the microelectronics industry. It supports the Compound Semiconductor (e.g. HBLED), solar cell, semiconductor, data storage, fiber optic, advance display, ink jet, and materials markets with a comprehensive suite of contamination control solutions for chemical, gas, water, chemical mechanical polishing (CMP) and photolithography processes. Integrated circuits, which control almost every device and machine in routine use today, simply would not exist without sophisticated purification technologies.

Our strategic diversification into the macro electronics side of the market is enabling us to capitalize on demand for computer gaming consoles, solid state lighting, MP3 players, flat panel displays, multimedia cell phones and ink jet printers and cartridges.

Pall's experience in these markets and applications positions us to be a valued partner in the HBLED industry.

"Over recent years, Pall technologies have contributed to the rapid growth in the manufacturing of HBLEDs"

Pall Total Filter Value Chain for HBLEDs

"Pall filtration devices in the process stream maximize productivity and profitability while minimizing problems."

Filtration for Process Efficiency

A manufacturing process consists of many steps, each fraught with potentially costly problems. For example, a dirty fluid stream can decrease productivity and lead to high rejection rates.

Pall filters are designed to be deployed in strategic locations in the process stream in order to maximize productivity and profitability. For example, a filter can protect a critical orifice (i.e. a cleaning nozzle) so that the openings do not become clogged and cause downtime. If the fluid in question is re-circulating, bath or fluid lifetime can be maximized by placing a filter in the line. Removing haze or dust are other reasons for using filtration. This is exemplified by the increase in tool up-times that can be achieved with proper filtration to protect vacuum pumps.

Finally, since gases are fluids, the removal of aerosols or mists can be achieved with high efficiency filter elements known as coalescers. Vapors can be removed with activated carbon filters and molecular contamination can be removed by purification technology. Cleaner gases lead to reduced defects within thin film layers.

Pall's Total Filter Value Chain for HBLEDs

Pall has designed specific filtration technologies for almost all process steps from crystalline ingot growth, shaping and wafering to thin film processing and back end packaging. Pall also addresses waste treatment for slicing slurry, water/silicon reclamation in pre-shaping operations and puller exhaust gas dust abatement.

There are many steps in thin film processing. Pall provides filtration, purification and separation solutions for substrate cleaning, chemical bath deposition, thin film deposition and reclaim applications.

The following pages show these diverse products. Pall, through Total Fluid Management℠ (TFM), filters literally all process fluids. Ask us about our solutions for ultrapure water, process cooling water, bulk gases and bulk chemical filtration.

Substrate Processing

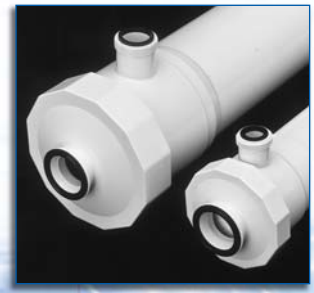
Blending Al_2O_3 Slurry	Crystal Growing	Sawing	Grinding and Lapping	CMP	Cleaning
Pall Filters	Pall Filters and Purifiers	Pall System	Pall Filters. Pall water and waste treatment and recovery systems	Pall Filters. Pall water and waste treatment and recovery systems	Pall Filters

Device Processing

Backside Processing

Epitaxial Growing (MOCVD)	Photolithography	Developing	Etching (Dry & Wet)	Stripping & Cleaning	Backside Grinding	Dicing
Pall Filters and Purifiers	Pall Filters	Pall Filters	Pall Filters	Pall Filters	Pall Filters. Pall water and waste treatment and recovery systems	Pall Filters. Pall water and waste treatment and recovery systems

UltiKleen™ filter cartridges for chemical filtration



Microza* modules for ultrapure water filtration

PhotoKleen™ EZD assemblies for photoresist filtration

Gaskleen® purifiers for gas purification

Filters and Purifiers for Process Consistency

"Pall offers purification and filtration products that deliver the highest purity gases required by HBLED Manufacturers"

Gas Applications

Czochralski Pullers

AresKleen™ INP medium purifies the argon used as a blanket within CZ Puller tools.

- Crystalline defects are minimized during alumina ingot growing
- Additional remelting steps are reduced or eliminated

Bulk and Distributon Equipment

LED fabrication plants utilize bulk gas facilities supplying the plant with various high volume process gases. High Flow Emflon® filter elements and housings and High Flow gas purification skids are ideally suited to cost effective filtration and purification of bulk high purity gases.

Within the fabrication facility bulk gases pass through gas distribution systems including valves, flow control devices and various monitoring equipment. Our Gaskleen, Ultramet-L® and Gasket-Sert™ filters provide distribution and point of use particulate filtration.

MOCVD

The active layers in an LED device are fabricated using Metal-organic chemical vapour depostion (MOCVD). The purity of gas entering the reaction chamber is critical to LED device performance. Pall products such as the Gaskleen V filter assembly and Gaskleen purifier assemblies provide gases at the required purity.

The exhaust gas from MOCVD equipment contains particulate which must be prevented from entering the atmosphere. Pall polymeric HDC® II filters provide low cost, high efficiency exhaust gas particulate removal. For higher temperature applications Pall metal media filter elements provide the ideal solution.

Gas Filtration and Purification Solutions

Ultramet-L and Gasket-Sert metal filter products

Developed for applications that are particularly sensitive to pressure drop and have limited space.

- All-stainless steel construction
- Available in 3 nm and 0.4 µm removal ratings
- 1/4" or 1/2" gasket seal fittings

Gaskleen purifier assemblies

Gaskleen purifiers remove molecular contaminants from process gases used in the production of HBLEDs.

- Purifiable gases include nitrogen, argon, hydrogen and ammonia
- Moisture, oxygen and carbon dioxide are removed to < 1 ppb
- Flow rates up to 1000 slpm
- All purifier assemblies contain integral particle filtration

High Flow Emflon filter cartridges

Designed for bulk gas applications in HBLED, PV and semi-conductor industries where flow rates exceed 2000 Nm³/hr

- Flow rate up to 6500 Nm³/hr through a single element
- 3 nm removal rating
- 100 % integrity tested
- Housings available in a wide variety of connection sizes, types, surface finishes and code requirements

Gaskleen V filter assemblies

Designed to provide high-purity gas filtration for the semiconductor and display markets:

- Fluoropolymer cartridge in a stainless steel housing, O-ringless design
- > 3 nm particle removal
- Gasket seal and compression fittings
- Broad compatibility with process gases

ChamberKleen™ gas diffusers

ChamberKleen gas diffusers are designed for vent applications on load lock interfaces and other vacuum chamber applications

- Reduces turbulent flow during venting of vacuum process chambers
- Optimizes gas flow
- > 3 nm removal rating
- Stainless steel filter medium, diffuser and hardware
- Fluorocarbon O-ring

HDC II filter cartridges

An all-polypropylene membrane filter designed specifically for high dirt holding capacity

- All-polypropylene construction
- Available in ratings from 0.6 µm up to 70 µm
- Low clean differential pressure
- Tapered pore medium giving high dirt holding capacity

Ultramet-L filter assemblies for high purity gas lines

Gaskleen purifiers for Cz pullers and MOCVD feed gas

ChamberKleen diffusers for vacuum chamber protection

High Flow Emflon housings for bulk gas filtration

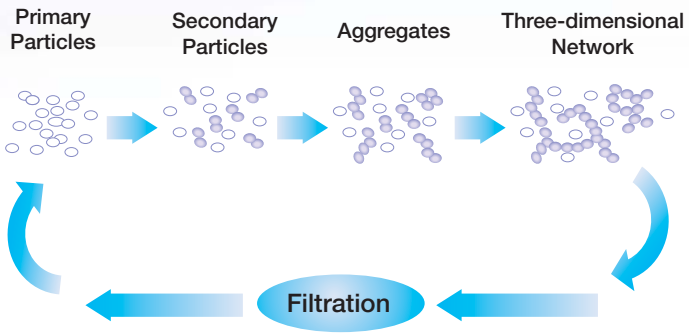
HDC II filter cartridges for MOCVD exhaust gas filtration

Filters for Process Consistency

CMP Process in HBLED Manufacture

The efficiency of HBLEDs is related to the uniformity of the GaN layer. Surface roughness, thickness tolerance and warpage of the sapphire substrate all affect the uniformity of the substrate and hence the GaN layer. For sapphire substrates a surface roughness of < 0.1 nm is required, achieved using a CMP process.

Colloidal silica slurry forms aggregates which can cause scratch defects. Filtration of the polishing slurry removes aggregates and allows scratch-free polishing however it is not an easy task. Surface clogging and removal of native slurry particles are typical process issues associated with slurry filtration, however Profile® II filters offer an optimized solution for improved manufacturing yield.



CMP Slurry Filtration Solutions

Profile II filter cartridges and capsules

Profile II filters effectively remove agglomerated particles and gels from CMP slurry. Filtration provides consistency in the CMP process leading to reduced defects and reduced polishing time.

- Depth filter with high dirt capacity giving long service life
- 99.98 % removal of particles at the given rating
- Graded pore structure for built-in pre-filtration
- Media, core, cage and end caps are polypropylene
- Removal rating grades from 0.2 µm to 40 µm

DFA capsule filters

The DFA capsule filter is a compact assembly designed for small volume batch processing.

- Low hold up volume
- Vent at highest point, drain at lowest point
- Manufactured in a clean room environment
- Available with a range of filter media types and removal ratings

Photoresist Filtration in the Photolithography Patterning Process

The quality of the photolithography process is critical to the efficiency of HBLEDs. Native photoresist contains gels and insoluble components which have a detrimental effect on the precision patterning required for HBLED manufacture. Filtration of the resist removes contamination and provides consistent quality patterning types, surface finishes and code requirements

PhotoKleen EZD series assemblies

PhotoKleen EZD Series assemblies are easy to change, robust filter capsules designed specifically for photoresist filtration. The assemblies are available in two sizes depending on flow rate / volume and liquid viscosity requirements.

- Low hold-up volume
- Manufactured in a clean room environment
- Top in/top out flow direction
- Quick filter disconnect
- Minimized dead space
- Various filter media types available including nylon, polyethylene and PTFE
- Core, cage and end caps are made from high density polyethylene


Profile II filter cartridges for CMP slurry filtration


DFA capsules for CMP slurry filtration


PhotoKleen EZD assemblies for developer filtration


PhotoKleen EZD-2 / EZD-3 assemblies for photoresist filtration

Filters for Process Consistency

Process Chemical Filtration Solutions

As the size of substrate wafers used for HBLED manufacture increases so too does the volume of liquid chemical used in the cleaning and wet stripping processes. The filters used in these re-circulating chemical baths must provide high purity, high efficiency filtration and long service life is reducing the cost of the manufacturing process.

UltiKleen™ series cartridge filters

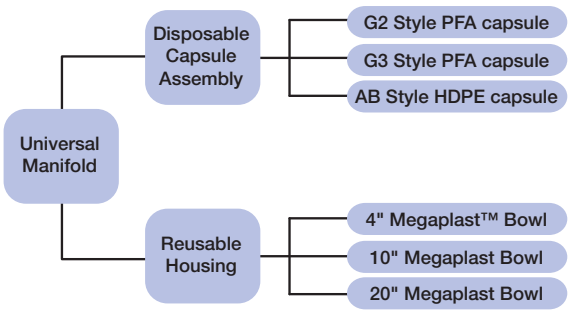
- All-fluoropolymer construction
- Excellent compatibility and low extractables
- High flow rates
- Available in a range of removal ratings down to 20 nm

FlexBowl™ Filter Housing Systems

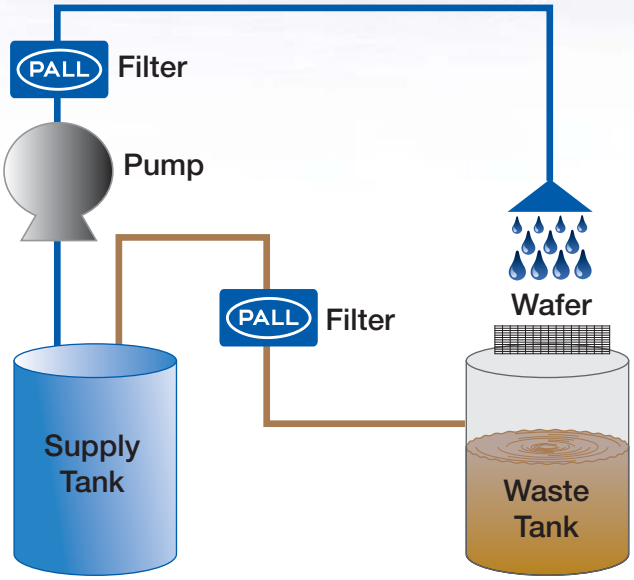
A highly flexible modular filtration solution with minimal tool space required for filter change-out. Options include:

- High purity reusable PFA housing or
- High purity PFA disposable capsule
- Low cost HDPE disposable capsule

The FlexBowl Filter Pressure Vessel System



The universal manifold can accept either a housing or capsule



Chemical liquid recirculation line

UltiKleen KC Assemblies

The UltiKleen KC assembly is a completely disposable all-fluoropolymer filter assembly

- All-fluoropolymer construction
- No O-rings
- Excellent compatibility
- High temperature and pressure capability

UltiKleen filter cartridges for high purity chemical filtration

FlexBowl filter housing assemblies for high purity chemical filtration

UltiKleen KC filter assemblies for high purity chemical filtration

Recover Your Waste

Process Water Reclamation and Substrate Reclamation

Shaping of substrate ingots prior to wafering comprises several cutting and grinding operations. Similar operations are applied later in the LED process chain as well, among them CMP and backgrinding of processed wafers. All these operations have one feature in common: large quantities of water must be used to cool tools and substrate surfaces, to act as a lubricant and to remove the resultant solid fines.

The spent process water leaves the tools highly contaminated by substrate particles and in some cases, depending on the substrate, contaminated by dissolved matter too. Pall Corporation provides a new generation of fully automated separation systems for the reclamation of water and substrate sludge from the spent grinding/sawing water.

The systems enable LED wafer manufacturers to:

- Re-use up to 95 % of spent process water as high quality water
- Reduce wastewater discharge volumes
- Improve sawing/grinding performance by controlling process water specifications
- Reduce machine fouling and uncontrolled sedimentation in pipes, tanks and sinks
- Collect de-watered substrate debris having very little chemical contamination, as feedstock for re-use or controlled landfill.

The heart of such a reclaim system is a membrane filtration unit, optionally combined with physico-chemical treatment and de-watering of the concentrated substrate particles.

Typically 90 to 95 % of the contaminated process water is perfectly clarified and ready for re-use. The remaining concentrate may be discharged, mixed with other wastewater streams, or subjected to some additional treatment to meet discharge regulations. Other options are available on request.

Pall has numerous systems, treating 2 to 33 m^3/hr wastewater containing semiconductor substrates, operating successfully throughout the world.

Crystal Growing

Protection of Vacuum Pumps with Pall PV Blowback Filtration Units

The exhaust gas out of Czochralski pullers used for monocrystalline ingot growing contains dust particles that form by condensation above the alumina melt. This dust needs to be filtered to protect people, environment and the vacuum pumps. Pall has long term experience in this application. Pall PSS® stainless steel filter elements and housings in combination with our blowback technology are the best long-term proven solution in the market.

Traditional Filter Technology

- HDC II polymeric filters proven low cost, long service life
- Metal mesh filters for high temperature applications

PSS Filter Media with Blowback Technology

- Pall has the best available, proven long-term solution on the market
- The filter housing does not need to be opened for dust removal
- Cleaning is quick and easy after each cycle using the blowback technology
- Extremely robust PSS filter media, resistant to high temperatures
- These filtration units are available semi-or fully automated
- Blowback units have been in service for several years without a filter change-out
- Cost of Ownership (CoO) model shows return on investment (RoI) in one to two years
- No leakage, long pump life, low CoO are all hallmarks of the Pall blowback units

HDC II filter cartridges for vacuum pump protection

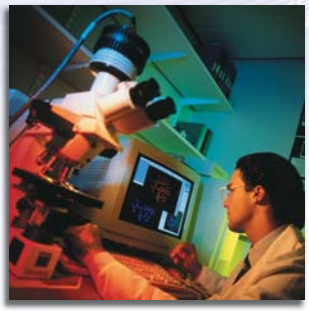
PSS filter elements with blowback technology for regenerable vacuum pump protection

Scientific and Laboratory Services (SLS)

Your Partner in Innovation

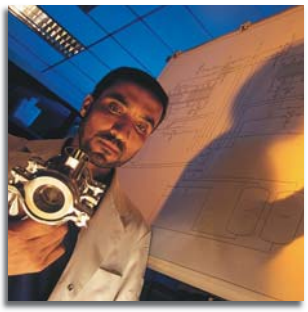
Across virtually every industry, Pall's scientific laboratory services teams are exploring ways to improve performance and productivity...

Pall SLS scientists and engineers provide our customers with the most advance technology in filtration, operating and purification and in identifying and controlling microbial particulate, and chemical contamination. To accomplish this, SLS works closely with our customers' scientific and engineering staffs. Frequently this involves on-site testing as well as extensive work in SLS laboratories. In the Industrial market, SLS supports such diverse applications as advanced electronics technology, chemical, polymer, and petroleum processing, municipal and waste water process, food and beverage production, industrial hydraulic and lubrication systems, and fluid systems in aircraft and marine, land and space vehicles.



...and pioneer solutions based on a thorough understanding of customer processes and the applications in their markets.

The SLS team endeavors to develop a close relationship with every Pall customer. With first-hand knowledge of the customer's total processes, they anticipate where problems might occur and make appropriate recommendations to avoid them. Following policies and procedures that create the highest levels of confidentiality, they solve complex problems, evaluate new products in the early stages of development and investigate break-through applications. Whether pushing the envelope to develop cutting-edge solutions or assisting with routine, day-to-day operations, Pall customers can count on SLS for a pro-active response that is fast, effective and efficient.



ENABLING A GREENER FUTURE℠

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