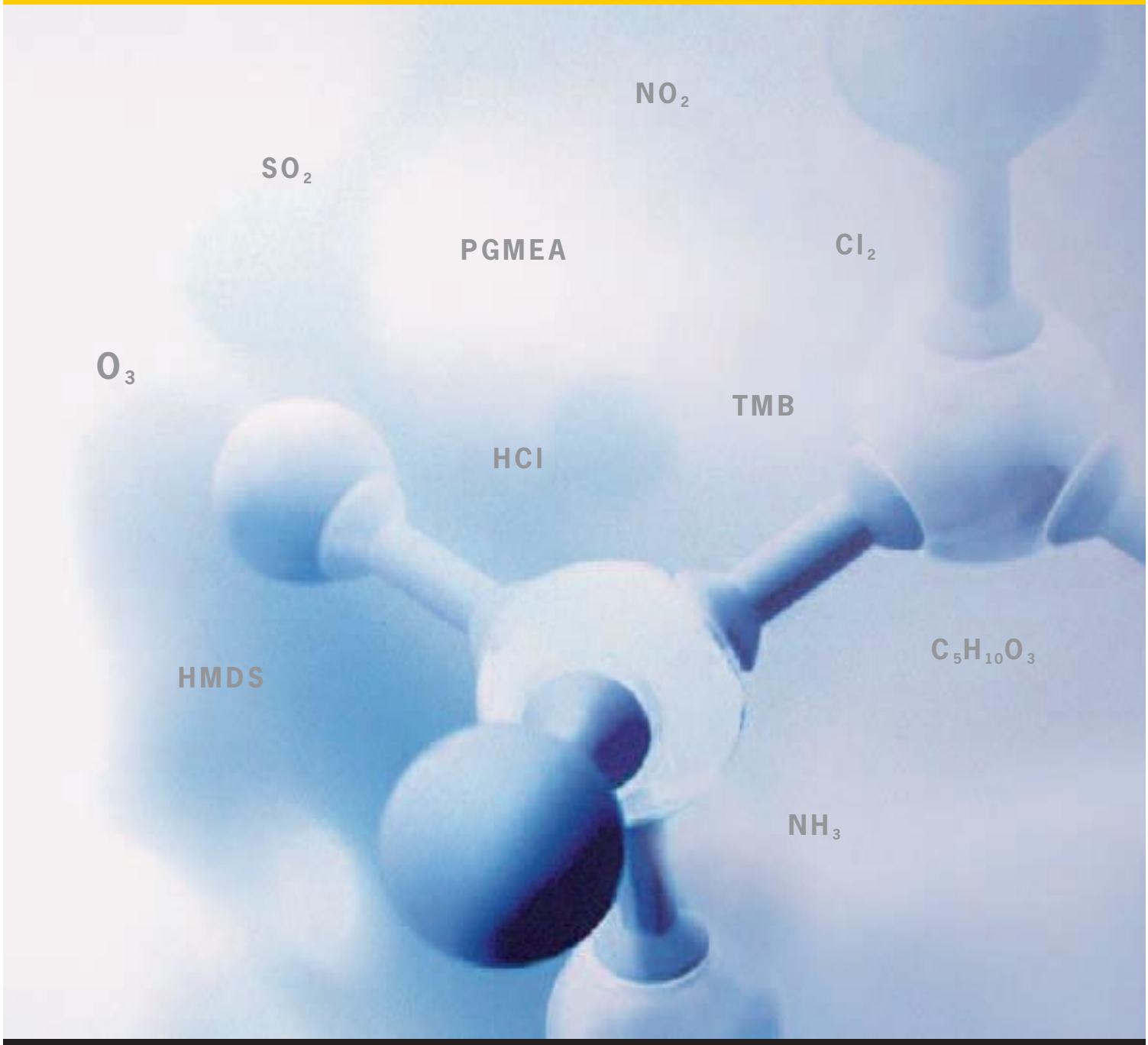
camfil FARR



gigapleat

Camfil Farr	Microelectronics
High performance molecular filter solutions	
Camfil Farr – clean air solutions	

information roadmap

Camfil Farr corporate philosophy

Camfil Farr is a world leader in clean air technology and air filter production. Our organisation specialises in the field of air filtration solutions. We are focused on research and development, state-of-the-art manufacturing, and marketing of air filtration products and services on a global basis.

The Camfil Farr group of companies is the world's largest designer and manufacturer of air filters with 22 manufacturing facilities around the globe.

Camfil Farr takes great pride in the fact that our products are of the highest quality, offering our customers air filters with the longest life, and lowest operating and maintenance costs.

Camfil Farr started to manufacture combined gas and particle filters for the nuclear industry in the early sixties. In recent years, Camfil Farr has continued to increase its effort in the field of molecular filtration. Acquisition of other companies has brought extensive experience in specialised areas such as gas filtration for pulp and paper and chemical plants. Large investments have been made in R&D and uniquely, we have built our own full-scale test-rig for chemical filtration.

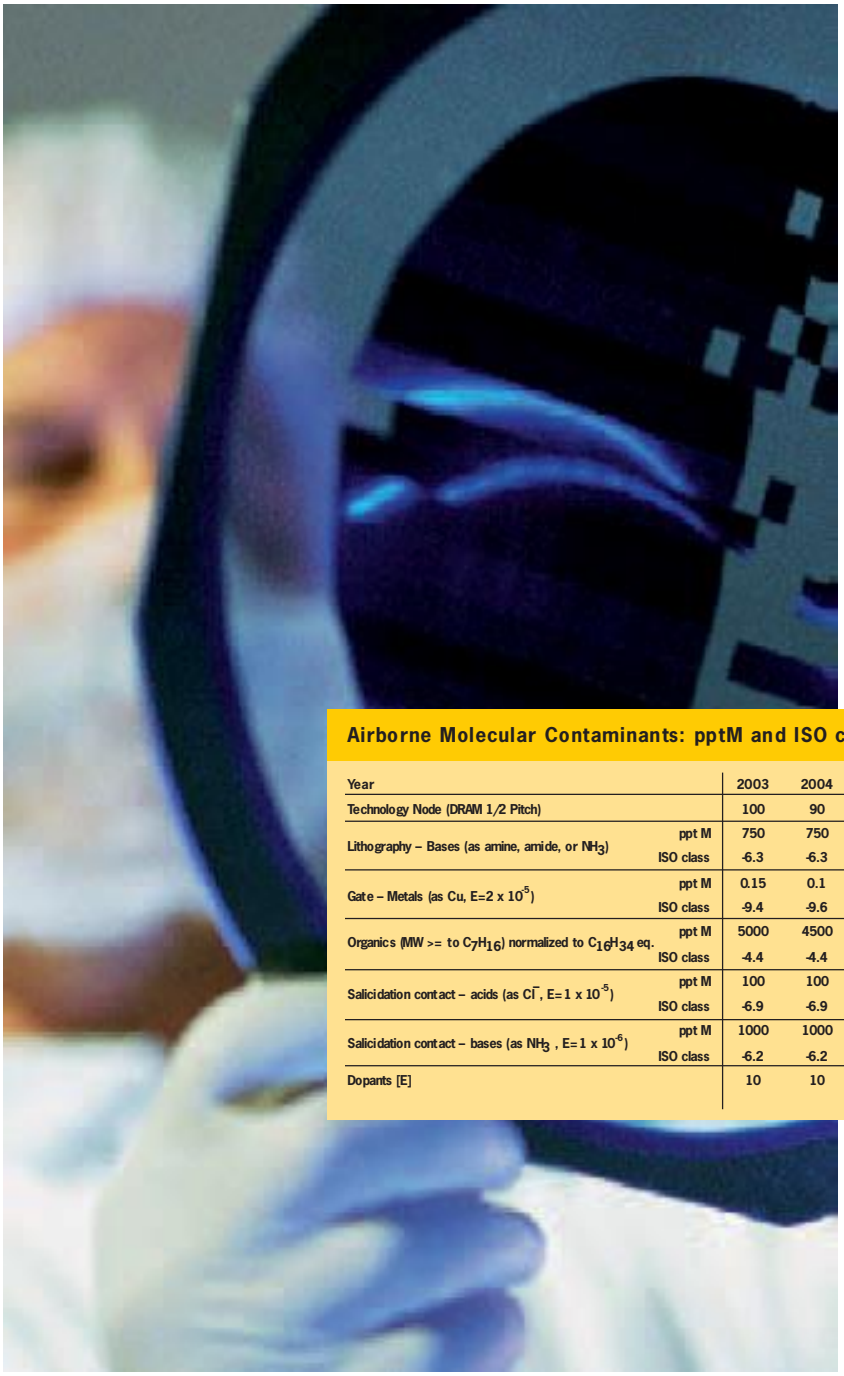
Our efforts are driven by the need to offer our clients an extensive range of products and services, catering to many diverse requirements, whether based on technical or commercial criteria.

Strength factors

As the global leader in air filtration, Camfil Farr offer our customers the security of a long-term partnership, backed by a documented capability to analyse needs and supply total air filtration solutions.

Our product range can meet your every need – from standard ventilation filters to highly specialised filters for applications that are extremely sensitive to air pollution. We provide the best possible clean air solutions, customised and optimised for price and performance. We are a driver and standard setter in the filter industry's major trade groups and organisations.

Molecular filtration will counteract yield losses resulting from airborne molecular contamination (AMC)



Today it is well known that airborne molecular contamination (AMC) can be seriously detrimental to the yield rate of some steps in microelectronics manufacturing processes. Molecular dimensions are orders of magnitude smaller than the finest particulate materials. AMC is not therefore removed by even the highest grades of HEPA or ULPA filters.

If otherwise untreated, cleanrooms with high recirculation rates may be more polluted by AMCs than other spaces!

According to the International Technology Roadmap for Semiconductors (ITRS 2004) "The percentage of process steps affected by non-particulate or molecular contamination is expected to increase".

The unavoidable conclusion is that acceptable AMC limits will be much lower in the future as product geometry becomes smaller.

Airborne Molecular Contaminants: pptM and ISO class according to ISO / DIS 14644 – 8

Year		2003	2004	2005	2006	2007	2008	2009	2010	2016
Technology Node (DRAM 1/2 Pitch)		100	90	80	70	65	57	50	45	22
Lithography – Bases (as amine, amide, or NH_3)	ppt M	750	750	750	500	500	500	500	250	250
	ISO class	-6.3	-6.3	-6.3	-6.5	-6.5	-6.5	-6.5	-6.8	-6.8
Gate – Metals (as Cu, E=2 x 10^{-5})	ppt M	0.15	0.1	0.1	0.07	0.07	0.07	0.07	0.07	0.07
	ISO class	-9.4	-9.6	-9.6	-9.8	-9.8	-9.8	-9.8	-9.8	-9.8
Organics (MW >= to C_7H_{16}) normalized to $C_{16}H_{34}$ eq.	ppt M	5000	4500	4000	3500	3000	3000	2500	2500	2500
	ISO class	-4.4	-4.4	-4.5	-4.5	-4.6	-4.6	-4.7	-4.7	-4.7
Salicidation contact – acids (as Cl^-, E=1 x 10^{-5})	ppt M	100	100	100	10	10	10	10	10	10
	ISO class	-6.9	-6.9	-6.9	-7.9	-7.9	-7.9	-7.9	-7.9	-7.9
Salicidation contact – bases (as NH_3 , E=1 x 10^{-6})	ppt M	1000	1000	1000	100	100	100	100	100	100
	ISO class	-6.2	-6.2	-6.2	-7.2	-7.2	-7.2	-7.2	-7.2	-7.2
Dopants [E]		10	10	10	10	10	10	10	10	10

Table 1. A comparison of the limits for the 100 mm process and the forecast of ITRS -04[1].

[1] Semiconductor Industry Association. International Technology Roadmap for Semiconductors: 2004 edition.

gigapleat

a range of molecular filter solutions
using pleated media loaded with adsorbents
in a range of framing options

To suit all locations in the cleanroom ventilation system, Gigapleat filters are available in four patterns:

Cell type – NXPC
Panel type – NXPP
Header Frame type – NXPH
Gigalam

Gigapleat is complemented by the established Camfil Farr carbon filter products Camcarb which is recommended for use in fresh air make-up units, where high efficiency must be achieved on a one-pass basis against comparatively high inlet concentrations.

Gigapleat, NXPP

Gigapleat, NXPC

Gigapleat NXPH

Camcarb

Gigalam

Molecular filter solutions are available for virtually all installation designs and applications.

Applications/Models	Gigapleat NXPC	Gigapleat NXPP (cell)	Gigapleat NXPH (panel)	Gigalam (header)	Camcarb 2600/3500 (cylinder)
Make-up air	Yes		Yes		Yes
Recirculation units	Yes		Yes		
Ceilings		Yes			
Tools/mini-environments	Yes	Yes		Yes	

Table 2. Application guide for different patterns of molecular filters.

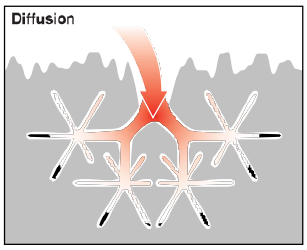
Features/ Models	Gigapleat NXPC (cell)	Gigapleat NXPP (panel)	Gigapleat NXPH (header)	Gigalam	Camcarb 2600/3500 (cylinder)
Initial efficiency	Typically >95%	Typically >95%	Typically >95%	Typically >95%	Typically >95%
Rated face velocity	2.0 m/s (610x610)	<0.6 m/s (depends on layer configuration)	2.0 m/s	<0.6 m/s (depends on layer configuration)	e.g. 2 m/s (depends on configuration)
Pressure drop	50 Pa	(depends on layer configuration)	depends on media	(depends on layer configuration)	100 Pa (3500)
Activated carbon media	Yes	Yes	Yes	Yes	Yes pellets/granular
Ion exchange media	Yes	Yes	Yes	Yes	No
Frame material	ABS or Galv. S	Aluminium	PS	Aluminium	ABS+HDPE, SS or Galv. S
Particle filtration	No	No	F7 option	HEPA, ULPA	No
Available sizes [mm]	610x610x292 594x594x292 (half size versions)	Flexible	592x592x292 592x490x292 592x287x292	Flexible	610x610x525 (2600) 305x610x525 (2600) 610x610x675 (3500) 305x610x675 (3500)

Table 3. Features of different patterns of molecular filters.

Gas control mechanisms

Several distinct processes are involved in the overall removal mechanism of gases or vapours from air. It is important to understand the extent to which these different processes are involved in each application and how they may be positively or adversely influenced by other factors. In all applications, a material with a high internal surface area, a suitable pore structure and appropriate surface chemistry is essential for an effective solution.

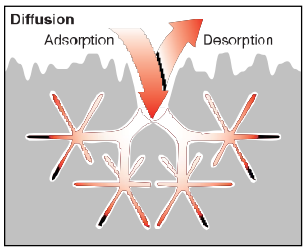
Diffusion



Gas molecules must enter and travel through the pore structure of the media and reach the internal surface. This process is called diffusion. Diffusion occurs because the gas laws require that molecules will move away from an environment of high concentration towards an area of lower concentration. In some applications, particularly those involving low concentrations of contaminants (typified by microelectronics applications), the diffusion process can be the critical rate-determining step and be the major influence on overall performance.

The diffusion process is completed most rapidly in small particles because the molecules have less distance to travel. Once the contaminant gas molecules are inside the pore structure they continue to exhibit random (Brownian) motion. The rate of diffusion increases with temperature.

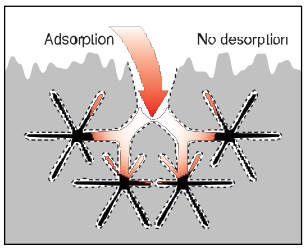
Physical adsorption



Molecules inevitably collide with the internal surface of the media. If the chemical and physical nature of the surface is favourable, then an interaction will be formed and the molecule will be held on the internal media surface. This process is called Physical Adsorption or Physisorption. The locations where adsorption takes place are called active sites. The interactions may be weak and therefore reversible.

The adsorbed molecule may be removed by increasing temperature or displaced by a more favourable (heavier and less volatile) molecule. Carbons that act by Physical Adsorption are referred to as base or standard carbons. Base carbons usually exhibit "Broad Spectrum" behaviour, i.e. they have an affinity, albeit variable, towards a very wide range of vapours and gases.

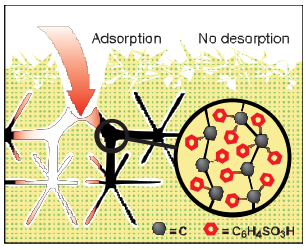
Chemical adsorption



Some molecules are too light or too volatile to be retained on the internal surface by physical adsorption, except at the most energetic sites. For these gases the surface of the media can be chemically treated during manufacture to effectively increase the number of active sites. The chemical sites react with the pollutant molecules and a very strong interaction is formed.

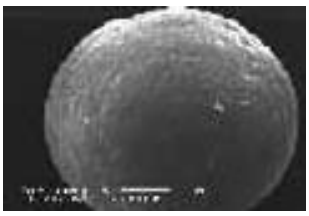
Chemically adsorbed molecules are not usually removed from the treated media except in extreme conditions. Chemically treated medias are usually manufactured to target a specific gas or group of chemicals. Examples of chemisorption media include: impregnated carbons, ion exchange medias, impregnated aluminas and impregnated zeolites.

Ion exchange material



Ion exchange materials are porous polymer structures often made from cross-linked styrene divinylbenzene. Different chemical reactions are employed to place functional groups on the polymer. The functional groups will work in the same manner as the impregnants used on an activated carbon and act by a chemisorption mechanism.

Ion exchange medias are selective in their action (like impregnated carbons) and different materials are employed to specifically target acids and bases. Unlike impregnated activated carbon, ion exchange medias have low capacity for physical adsorption.



airborne molecular contamination (AMC)

SEMI and SEMATECH

Since 1995, SEMI and SEMATECH have been investigating the effects of AMC on production yields in microelectronics manufacturing processes. According to the SEMI F21-95 standard, AMC are classified into Acids (A), Bases (B), Condensables (C) and Dopants (D).

This standard established a basis for assessing AMC problems using the four "chemical" classes MA, MB, MC and MD. Maximum permissible levels are defined by a numerical system of 1, 10, 100 etc. in units of pptM (parts per trillion Molar).

SEMATECH has identified the process steps that are the most sensitive to AMC related yield loss (SEMATECH Technology Transfer 95052812A-TR),

These are:

- **pre-gate oxidation**
- **salicidation**
- **contact formation**
- **DUV photolithography**

Pre-gate oxidation is extremely sensitive to dopants.

Salicidation and contact formation are most sensitive to acids.

DUV photolithography is extremely sensitive to bases.

These processes are also sensitive to condensables.

As an essential step to providing an effective solution, AMC sources need to be identified, concentrations measured and distribution patterns evaluated.

From this information, acceptable steady state concentration levels can be determined. Filtration products and systems can then be selected to satisfy critical performance parameters.

Sources of AMC

In order to prevent yield losses, AMC sources must first be identified.

Examples of known sources are:

- Aggressive chemicals used in microelectronics manufacture.
- Out-gassing from construction materials used in cleanrooms and production tools.
- Make up air (MUA) contaminated by urban pollutants.

Issues to address:

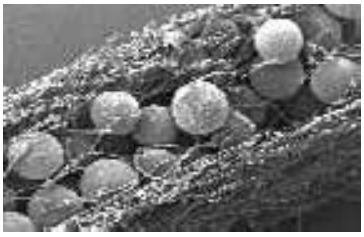
- Minimise contamination from chemicals used in production.
- Construct cleanrooms and tools from low out-gassing materials.
- Develop reliable methodology to assess problems and verify solutions.

The adverse effects of AMC can be controlled by Chemical Filtration, which is suitable for:

- Diffusive leaks
- Out-gassing
- Operator related spills
- Pollution from external sources (MAU applications)

The conclusion is that acceptable AMC limits will be much lower in the future!

The Gigapleat advantage



Gigapleat filter

The Camfil Farr Gigapleat filters are a range of unique products based on the use of adsorbents that are incorporated in a non-woven fibre web.

The adsorbents are arranged in a thin close packed layer and a special bonding process stabilises them within the web, without the requirement for adhesives or binders. This method ensures that there is no detriment to the adsorptive efficiency or capacity of the adsorbents and as a consequence, the highest levels of performance are achieved.

Media

The media is pleated into flat panels and the panels are mounted in a holding frame (cell, panel or header type).

Camfil Farr expertise in pleating concepts and technologies ensures that the optimum combination of C^3E^2 factors is obtained. In particular high efficiency and capacity values are achieved at low pressure loss.

Material selections and processing conditions have been made to ensure the highest levels of product cleanliness and the lowest levels of chemical out-gassing.

Very high quality carbon

The adsorbents may be made from a very high quality carbon or ion-exchange resin. Variants are available for the removal of acids, bases and condensables.

Dopants with acidic, basic or organic properties are also removed. For instance the distribution of boron within a cleanroom is believed to involve BF_3 which chemically is a weak acid and therefore adsorbed as an acid. Ozone can also be effectively removed.

Activated Carbon versus Ion Exchange Resin Media

There are four principal differences in the characteristics of carbon and ion exchange resin capacity, by-reaction sensitivity, selectivity and oxidation sensitivity. These differences may be exploited to enhance product performance for specific applications.

AMC vs Media Type	L	B	A	C
Acids				YES
Bases		YES	YES	
Condensables (B.Pt > 150 deg. C)	YES		Yes	Yes
Dopants (Organophosphates)	YES		Yes	Yes
Dopants (BF3)				YES
Organics (B.Pt < 150 deg. C)	YES			
Ozone	YES		Yes	Yes

The primary and secondary applications for different chemical filter media types are shown in the adjacent table. Other molecular filter media types are also available for specific contaminants.

An example is the control of AMC bases: Resin (B) has much better capacity for ammonia and has a much lower potential for generating by-reactions. However resin (B) is more selective than carbon (A) and will not remove anything besides bases. It may also be sensitive to high concentrations of oxidising species e.g. ozone and chlorine gas. As a consequence of being based on activated carbon, adsorbents (acids or bases) will have some capacity for VOC even when it is impregnated. In the case of very large molecular size amines it can be speculated that carbon will have a higher capacity than resin. Gigapleat A and Gigapleat B will therefore be complementing products.

Optimise product selection according to performance requirements

The relative importance of the various technical parameters will be different for each molecular filter installation. A convenient method to evaluate and optimise a molecular filter is to use the C^3E^2 factors: Compatibility, Efficiency, Capacity, Energy Loss and Cleanliness.

C^3E^2

Compatibility

It is essential to determine what type(s) of AMC are present and which are to be controlled. According to SEMI F21-95, these can be characterised as acids, bases, condensables and dopants. Different adsorption materials and techniques are used to remove different types of AMC. Gigapleat and Camcarb are available with different media grades to target acids, bases and condensables. Dopants with the characteristic of an acid or condensable will also be removed. Oxidising compounds such as ozone are also removed.

Efficiency

Removal efficiency is defined as the percentage of the challenge AMC concentration removed by the molecular filter. Efficiency is principally controlled by two factors, mass transfer and contact time. Extremely low steady state concentrations can be achieved in a cleanroom with optimised molecular filtration solutions. Efficiency is a particularly important consideration in a "once-through" installation like make up air (MAU). In situations with high recirculation rates, the effect of high efficiency is rather more marginal and low steady state concentrations can still be achieved when the filter efficiency has been reduced from its initial value. This behaviour can be demonstrated using the Camfil Farr simulation software.

Capacity

This corresponds to the maximum amount of AMC that the filter can remove and therefore the life time of the filter. This theoretical endpoint is only reached when the efficiency has fallen to 0%. In reality, the practical service life will be determined by the limiting target concentration for the cleanroom rather than the theoretical maximum capacity of the filter. The Camfil Farr simulation software package can be used to estimate service life based on the highest acceptable concentration of an AMC that the process can tolerate.

Energy loss

The energy cost to compensate for the pressure drop over the molecular filter is very important in high flow installations like a cleanroom. Camfil Farr have used their proven expertise in pleating technology and filter frame design to optimise the Gigapleat series of products for low pressure drop and minimal energy costs.

Cleanliness

A molecular filter should not release detrimental amounts of particles or chemical out-gassing. This can be controlled by using special qualities of adsorption media and construction materials selected for their low out-gassing characteristics.

Chemquest

To assist the selection of the optimum C^3E^2 factors, Camfil Farr have engineered a suite of tools to support the customer.

The first tool is the CHEMQUEST questionnaire. A completed questionnaire will allow the Camfil Farr technical and customer support departments to evaluate the application and propose the best possible chemical filtration solution. One of the most important points is to determine the steady state target concentration in the cleanroom, e.g. ammonia levels must not exceed 1 ppb.

The target concentration can be based on customer knowledge or on forecasted data like the ITRS table shown on page 4. Your local Camfil Farr representative will provide you with a copy of CHEMQUEST and provide the necessary assistance for its completion.

How to choose your product?

In this illustration the suggested installation locations of Gigapleat (Cell type, Panel type, Header type), Gigalam (mini-environment) and Camcarb are given. Molecular filters may have "Broad Spectrum" or "Specific Functionality" against different chemical types of AMC. By using a combination of filters, an installation will have the ability to adsorb different types of AMCs. The different product tables on page 5 indicate the range of available options. More detailed data can be found by following the Information Roadmap on page 2.

Gigacheck is introduced on this page. Gigacheck is an economic and convenient method of measuring AMC concentrations in different locations within the cleanroom and air system to evaluate the need for molecular filtration.

2

Filter type:

Gigapleat (NXPP) Panel type

Gigapleat panel filters are fitted on top of HEPA / ULPA filters or Fan Filter Units (FFUs) in cleanroom ceilings. This arrangement enables the removal of AMCs directly before the air enters the cleanroom. A single NXPP filter can be fitted with up to 4 layers of the Gigapleat media. This allows the filter to adsorb multiple AMC types or provide a higher capacity for a limited number of AMC types. A ceiling installation may also be fitted with different media types in different areas to suit variations in process sensitivity.

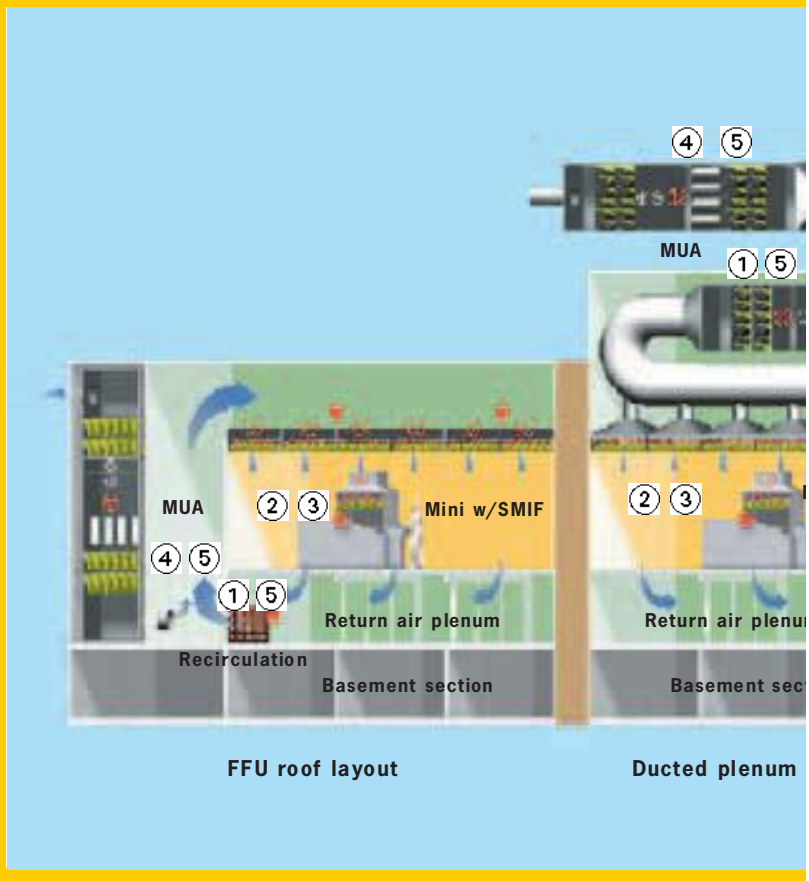
3

Filter type:

Gigalam

Gigalam panel filters are combination products specially developed for mini-environment and process tool applications. An ULPA filter using standard glass media, low boron media or PTFE is combined with single or multiple layers of Gigapleat media. Sizes are custom made to suit specific pieces of process equipment. The compact form of Camfil Farr Gigalam filters means that often, they may be installed in the same space as the original particle filter.

installation example fo



5

Filter type:

Gigapleat (NXPH) Header Frame Type

Gigapleat NXPH filters are fitted in make up air applications or air recycling units. The filter uses a plastic frame to mount a single media layer.

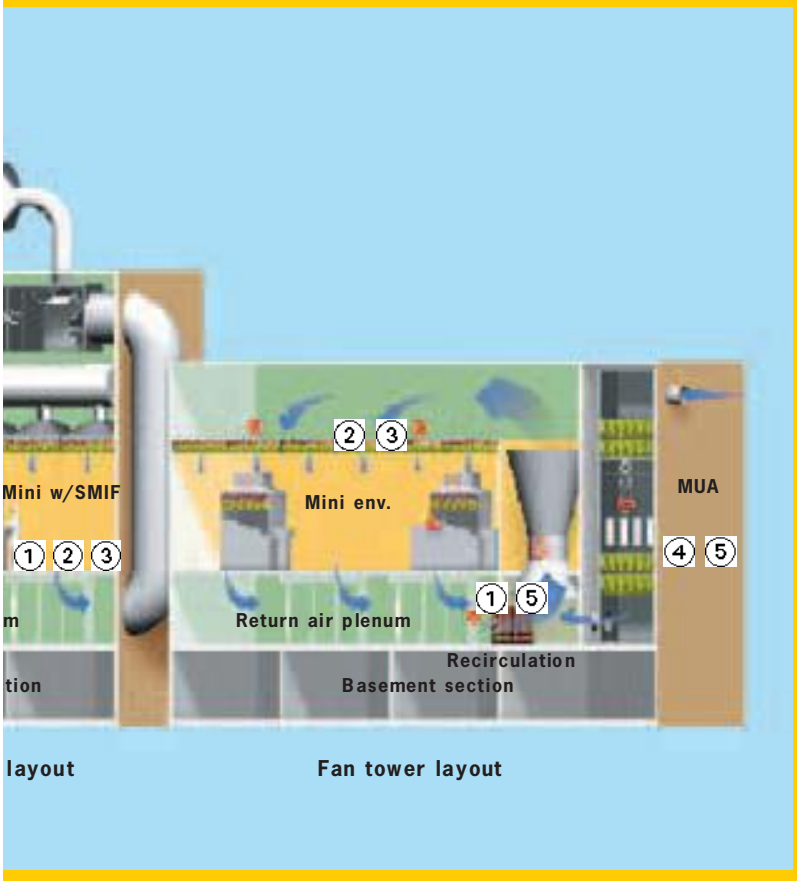
Gigacheck KIT and DUO holder together with a table showing the gases that can be measured together with detection limits in ppb(v) for one month sampling.

sulfur dioxide, SO_2	0.08
nitrogen dioxide, NO_2	0.05
chlorine, Cl_2	1.02
nitric acid,HNO_3	0.04
hydrochloric acid,HCl	0.33
ammonia, NH_3	0.43
ozone, O_3	0.2

Gigacheck KIT and DUO

Gigacheck selectively measures gaseous airborne molecular contamination (AMC) in clean rooms and accompanying air handling systems. This passive sampling method is an excellent choice to perform average measurements on a weekly or monthly basis and for screening of many locations within the cleanroom and supporting areas. The strength of Gigacheck is to evaluate average levels over extended time periods with a minimum of training, installations and cost. It is not intended for detecting fast variations or instantaneous values. For these types of measurements contact Camfil Farr for support.

r 3 cleanroom designs



layout

Fan tower layout

4

Filter type:

Camcarb 2600/3500

Camcarb chemical filters are a modular system of cylindrical cartridges filled with pelletized activated carbon or other adsorbents. The cylinders are mounted onto a rigid base-plate which can be installed in the Make-Up Air (MAU) unit. The high carbon content makes Camcarb the ideal solution for handling the concentrations of AMC that may be present in outdoor air, particularly in industrial areas.

1

Filter type:

Gigapleat (NXPC) Cell type

Gigapleat cell filters are usually fitted in air-recycling units but can also be used for Make-Up Air applications.

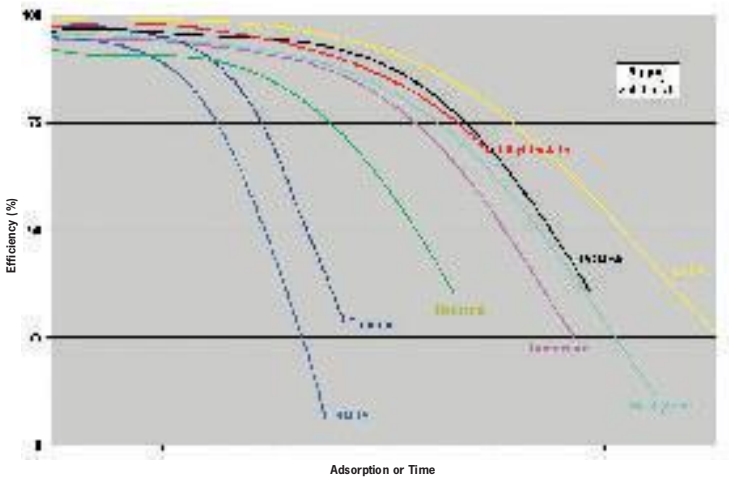
gigapleat efficiency

The Gigapleat ranges of filters delivers high removal efficiency values against their target AMCs. Typical efficiency / capacity curves are shown for Condensables, Bases and Acids in the adjacent Figures. It is necessary to combine and optimise a number of factors to ensure high efficiency values are achieved. These include; adsorbent characteristics, even distribution in the web, pleat configuration and the elimination of internal leaks. All of these parameters have been addressed by the Camfil Farr development technicians.

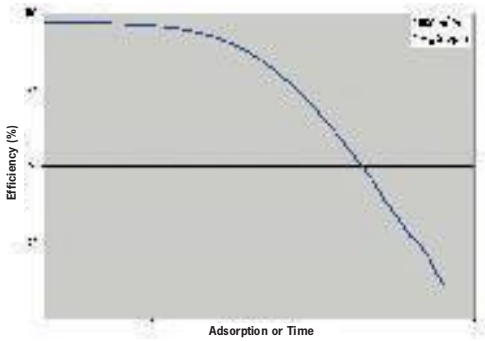
High performance and rapid adsorption dynamics (RAD)

Another critical factor applicable to microelectronic cleanroom applications is the relatively low challenge concentrations, which may only be in the low parts per billion (ppb) range. Diffusion processes or mass transport, an essential pre-cursor for adsorption may be slow under such conditions. Mass transport involves all the steps necessary for the AMC molecule to move from the carrier air stream, through laminar layers close to the adsorbents, diffusion through the pore network of the adsorbents and finally adsorption at the internal surface. Mass transport adsorbents is maximized by close packing of the adsorbents in the support web. Mass transport within the adsorbents is enhanced by the selective use of small diameters as this allows Rapid Adsorption Dynamics (RAD).

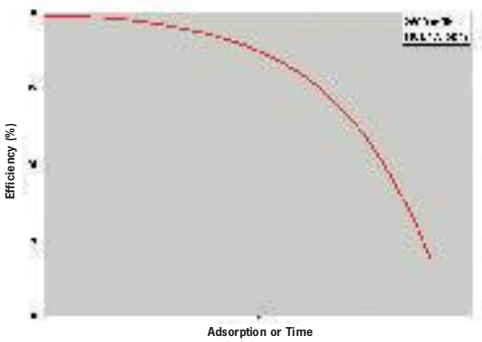
Gigapleat filter with L grade media



Gigapleat filter with B grade media



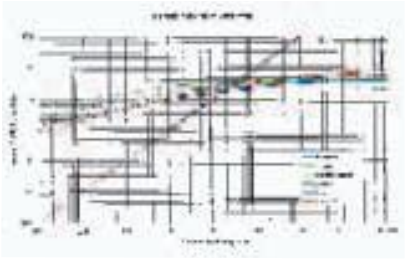
Gigapleat filter with C grade media



Theoretical, practical and simulated capacity

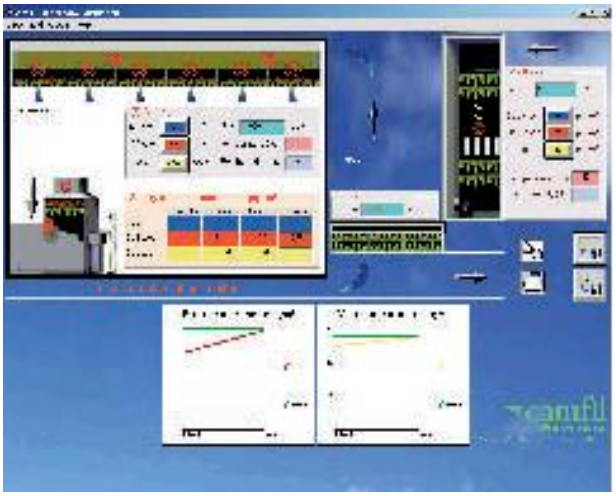
For a media that relies upon a physical adsorption mechanism, the capacity of the media and therefore service life is governed by the challenge concentration of the AMC and the molecular and physical characteristics of the AMC molecule. A curve showing the relationship between the amount adsorbed and inlet concentration is termed an adsorption isotherm, typical examples for organic AMCs are shown below. The principal molecular factors that enhance capacity at a given concentration are high molecular weight, high boiling point, low vapour pressure and complex functionality in the structure.

For a chemisorbent media, the amount of impregnant is normally 2-15 % (wt/wt) of the dry media. From the media weight, percentage of impregnant and molar relationship (impregnant versus the AMC compound in question) the theoretical adsorption capacity can be calculated. This value corresponds to the maximum amount of AMC that the filter can remove and therefore also to the lifetime of the filter.



When this endpoint is reached the efficiency will be 0%, clearly this condition is not acceptable. It is for this reason that the practical life of a molecular filter is actually determined by a final efficiency value that remains adequate to maintain the required certain steady state concentration in the clean room.

For all medias, capacity will also be affected by other factors including the presence of competing species, temperature, relative humidity and filter engineering.



Camfil Farr has developed sophisticated simulation software.

Steady state calculations for entire cleanroom system

The principal concern for the customer is to secure production and yield. According to present knowledge this requires that concentrations of those AMCs which are detrimental to the process must be maintained below certain threshold values. The forecasted limit data from ITRS is an attempt to arrive at such safe levels.

Cleanroom steady state concentrations are affected by many factors including: airflow pattern, sources and generation rates of AMC inside and outside of the cleanroom and the positive impact of molecular filters which may be located in different positions within the air distribution system. The efficiency / time relationship for individual filter types is also a critical issue.

To solve the complex calculations and to allow rapid evaluation and comparison of different molecular filter solutions, Camfil Farr has developed sophisticated simulation software.

This package is pre-loaded with performance data for various Gigapleat molecular filter solutions, obtained from a combination of real use experience and from the Camfil Farr Molecular Filter test rigs (see page 17).

Entering the physical data concerning the cleanroom and measured cleanroom AMC concentrations allows generation rates and steady state concentrations to be calculated (without molecular filtration). Selecting filter types, number and location together with various final efficiency values will produce reduced steady state concentrations and projected service life values for the molecular filters.

Energy cost calculation

The semiconductor industry is becoming increasingly competitive. In the battle to control costs, manufacturers are demanding that their plants are as energy efficient as possible.

Figures published in the U.S.A. by the Environmental Protection Agency (EPA), highlight potential savings that could be made by the selection of the correct filters in the HVAC system. The average semiconductor plant can use upwards of a 100 million kWh per year. EPA research shows that the energy to run the HVAC systems that supply the clean room accounted for an average of 46% of the plant's overall energy use.

Gigapleat pressure drop data

The energy demand of the fan is directly related to the pressure drop across the chemical filter. The relationship between energy requirement and pressure loss for any filter is given below, it can be readily seen that lower pressure loss values require less energy.

The equation also takes account of system flow rate and the necessity to provide low pressure loss values becomes even more critical in clean room applications where the flows can be extremely high.

Through the use of enhanced media production and pleating techniques, the Gigapleat series of molecular filters is optimized for minimum pressure drop characteristics. Unlike particle filtration, adsorption processes are not accompanied by an increase in pressure loss. The low initial pressure loss values for Gigapleat filters will be maintained throughout life.

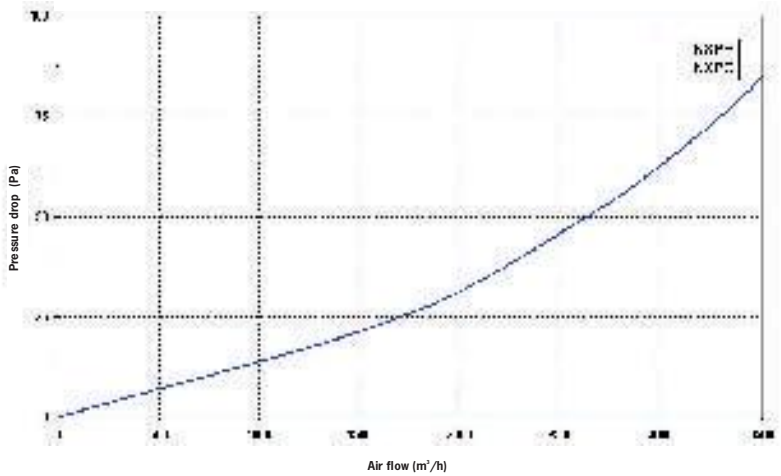
Filter economy

The energy consumption is easily calculated with the formula stated below:

$$E = \frac{q \times \Delta p \times h}{\eta \times 1000}$$

E = energy output/year
q = airflow m^3/s
h = operating time hours/year
(year round operation 8760 h)
η = fan efficiency

Pressure drop Gigapleat NXPC, NXPH



Product cleanliness

Material selection and processing methods assure the highest possible levels of cleanliness

Cleanliness

Cleanliness is a desirable characteristic of any filter. In the case of a product for cleanroom applications, cleanliness is of paramount importance. The Gigapleat range of products has been verified to have absolutely minimum levels of particle emissions and chemical out-gassing during all normal handling and operational conditions.

The non-adsorbent components of Gigapleat filters were selected only after evaluations to ensure minimal chemical out-gassing. Material specific processing conditions ensure that the characteristics of the adsorbent are transferred to the finished product.

Particle shedding

Particle shedding was tested at two face velocities 0.5 and 1.0 m/s. At each velocity, 10 measurements of 1 dm^3 were made. The results show that at nominal air velocity (0.5 m/s) measured values are in the range of the detection limit of the particle counter and therefore no particle release was detected.

Out-gassing

The polyurethane adhesive was tested for out-gassing using thermal desorption at 50 °C and 100 °C over 30 minute periods, followed by GC-MS. The tests were made in a specialist independent laboratory in the USA.

The total out-gassing was found to be very low compared to standard PU. The only compounds detected were high volatility substituted propanols.

Particle count – (particles per litre at 0.5 m/s

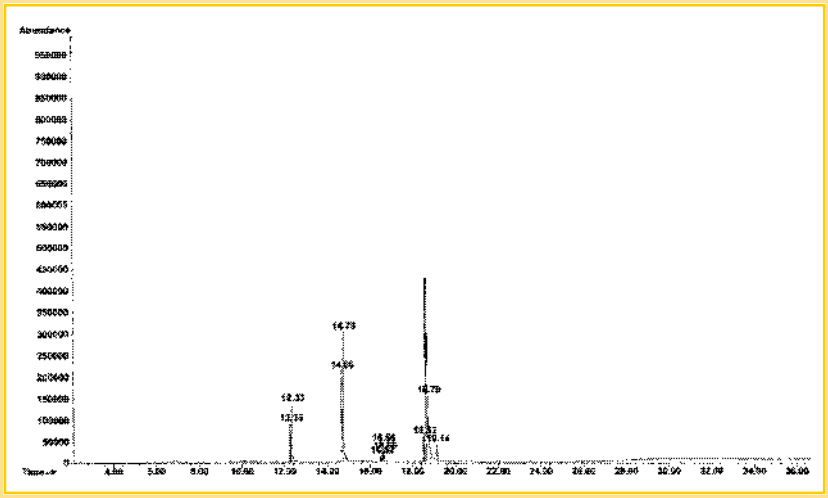
Size range (micron)		1	2	3	4	5	6	7	8	9	10	Av.
0.1	0.12	5	3	4	0	1	2	3	3	2	1	2.4
0.12	0.15	0	0	0	0	0	0	0	0	0	0	0
0.15	0.20	0	0	0	0	0	0	0	0	0	0	0
0.20	0.25	0	0	0	0	0	0	0	0	0	1	0.1
0.25	0.35	0	0	0	0	0	0	0	0	0	0	0
0.35	0.45	0	0	0	0	0	0	0	0	0	0	0
0.45	0.60	0	0	0	0	0	0	0	0	0	0	0
0.60	0.75	0	0	0	0	0	0	0	0	0	0	0
0.75	1.0	0	0	0	0	0	0	0	0	0	0	0
1.0	1.5	0	0	0	0	0	0	0	0	0	0	0

Particle count – (particles per litre at 1.0 m/s

Size range (micron)		1	2	3	4	5	6	7	8	9	10	Av.
0.1	0.12	4	3	2	5	3	7	4	5	4	0	3.7
0.12	0.15	1	0	1	0	0	0	2	1	1	0	0.6
0.15	0.20	0	1	0	0	0	2	2	1	0	0	0.6
0.20	0.25	0	0	0	0	0	0	0	0	0	1	0.1
0.25	0.35	0	0	0	0	0	0	1	0	0	0	0.1
0.35	0.45	0	0	0	0	0	0	0	0	0	0	0
0.45	0.60	0	0	0	0	0	0	0	0	0	0	0
0.60	0.75	0	0	0	1	0	0	0	0	0	0	0.1
0.75	1.0	0	0	0	0	0	0	0	0	0	0	0
1.0	1.5	0	0	0	0	0	0	0	0	0	0	0

Results of outgassing of polyurethane adhesive (50°C for 30 min)

Sample ID	R.T. (min)[1]	Concentration ppmw (ug/g)[2]
	12.27	0.18
	12.33	0.35
Special	14.66	0.54
grade	14.73	0.83
	18.52	0.12
	18.59	0.96
	18.65	1.2
	18.70	0.68
	Total outgassing[3]	5.1



[1] R.T. = retention time, +/- 0.2 mins

[2] Based on the response factor of external standard n-decane, the detection limit. estimated to be 0.1 ug/g

[3] Includesall the peaks integrated in the chromatogram

Production/quality/installation

Production

Gigapleat filters are produced on dedicated lines designed and constructed by Camfil Farr's own manufacturing engineers. Manufacturing takes place in controlled environment areas where the use of chemicals is strictly managed. Only low out-gassing adhesives that are compliant with Camfil Farr specifications are used in the assembly processes. Where there is a requirement for cleaning agents, these are either water based or use only very high volatility alcohols. All Gigapleat panels are packed in air-tight polyethylene or aluminium foil bags prior to shipping.

All line operatives and area supervisors are fully trained in the appropriate quality assurance procedures and are responsible for their own work and the output of the entire cell.

Quality

All Gigapleat filters are manufactured under procedures that are compliant with ISO9001 (1994) in facilities that are compliant with the requirements of the environmental standard EN14001.

Handling and Installation

Handling, Storage and Packing of Gigapleat filters.

The following guidelines should be followed to ensure that all Gigapleat/ Camcarb filters provide the very best levels of performance.

General	• Only handle Gigapleat filters by its frame, using 2 hands. NEVER touch the pleated filter media. • Do NOT drop, throw or bump any filter. Do not walk on a filter or a boxed filter.
Pre-use Storage	• Only store Gigapleat/Camcarb filters in their designated location(s). This will be a segregated, clean and dry area fitted with appropriate racking or shelves. The area must as far as possible be free from airborne chemical contamination. Gigapleat filters are packed in a special aluminium-laminated foil to avoid contaminations before installation. • Only store Gigapleat/Camcarb filters in their "as-delivered" packaging. • Never place anything else on top of Gigapleat/Camcarb filters. • Observe all orientation arrows on packing showing storage method.
Installation	• Installation technicians must observe all of the above. • Do not remove Gigapleat/Camcarb filters from their factory packing until immediately before installation. • Follow all specific instructions for specific frame designs. • Avoid use of all cleaning agents or sealants.

Filter test rigs

Full-scale filter test rig at Camfil Farr's head-quarters in Trosa, Sweden.

Scanning Electron Microscope (SEM) at Camfil Farr.

Media test rig at Camfil Farr's head-quarters in Trosa, Sweden.

Camfil Farr maintain a strong commitment to quality control and R&D. We have rigorous in-house and field trial procedures to ensure all products are compliant with specification.

The molecular media test rig and the unique full-scale chemical filter test rig at our corporate headquarters in Trosa, Sweden are examples of the significant investment made in the field of molecular filtration.

Media test rig

The Media test rig allows raw chemical medias to be evaluated under a wide range of conditions and challenged with a wide variety of gases and vapours. Multiple parallel test lines allow simultaneous evaluation of medias for development and quality assurance purposes.

Molecular Filter test rig

In this unique facility, full size gas filters can be operated in the rig under a wide range of temperature and humidity conditions and challenged with different gases. The efficiency and life are determined using an array of sophisticated gas detection equipment.

SEM

The scanning electron microscope with EDAX facility, located at Trosa is essential for looking at the structure of adsorbent medias and impregnant contents.

Strategy

We continually seek to develop existing materials and identify new medias. We maintain strategic relationships with key suppliers to ensure we secure premium materials tailored to our specific requirements.

gigacheck/gigamonitor/air analysis

Simulation software:

The simulation software package is pre-loaded with performance data for the various molecular filter solutions, obtained from a combination of real use experience and from the Camfil Farr Molecular Filter test rigs (CFTR). Entering the physical data for the cleanroom and measured cleanroom AMC concentrations allows generation rates and steady state concentrations to be calculated (without molecular filtration). Selecting filter types, number and location together with specific final efficiency values will produce reduced steady state concentrations and projected service life values for the chemical filters.

The Gigapleat range of molecular filters is enhanced by a comprehensive range of support services to assist in product selection and performance monitoring.

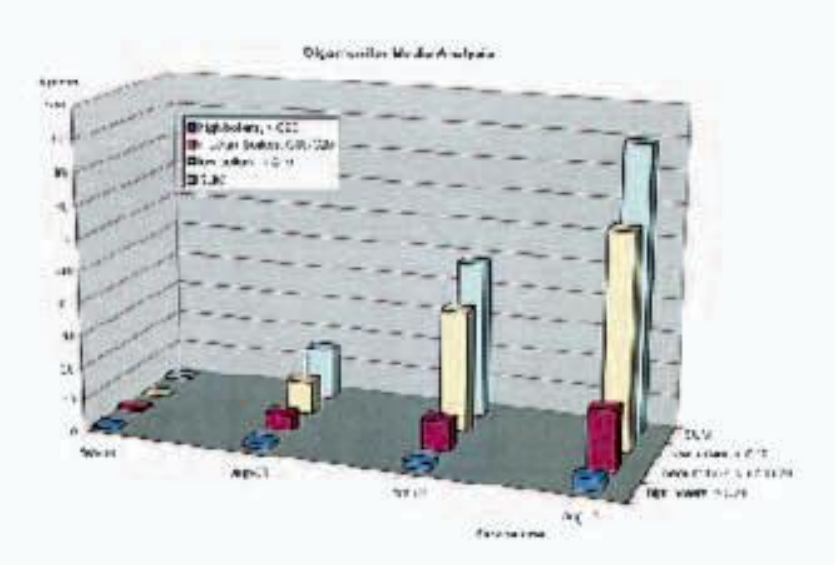
Gigacheck

Gigacheck is a passive diffusion method to selectively measure gaseous airborne molecular contamination (AMC) in cleanrooms and accompanying air handling systems.

The product has been developed to be deployed directly by the customer without the need for specialist technicians, tools or other equipment.

Gigamonitor

Gigamonitor is a technique to evaluate the condition or residual life of a molecular filter based on analysis of the adsorbent media. In the case of a filter used to control condensables (L), a representative media sample will be analysed to determine the content of organic molecules in different C-atom ranges.



For acids (C) and base (A, B) the analysis is to determine the residual molecular adsorption capacity. It is strongly recommended that a series of Gigamonitor measurements are made over time to provide a predictive trend for the end of the life of the filter.

Air analysis

AMC originating outside the fab and entering via the fresh air make up may be of unknown and variable composition. To be sure that the optimum Gigapleat product selection is made, it is necessary to identify the nature of the external AMCs.

Camfil Farr offers a service to make comprehensive analyses of the external air. Analyses should be made over an extended period to ensure typical variations in AMC levels are identified.

Product evaluation

Camfil Farr can re-validate their own product or make comparative measurements on equipment from other manufacturers using the Molecular Filter Test Rig (CFTR).

Please contact your local customer support office for data sheets and more detailed information concerning these support services.

Gigapleat NXPP (panel)

A panel filter – Ideal solution for cleanroom plenum, FFU or mini-environment applications.

Description

- Extremely low pressure drop
- High media cleanliness
- Aluminium frame
- Extremely small form factor
- Low weight
- Multiple media types can be combined into the same filter (same or different types)

Gigapleat NXPC (cell)

A four V-cell type chemical filter – Ideal solution for cleanroom recirculation and MUA applications for AMC removal.

Description

- Low pressure drop
- High media cleanliness
- Galvanised steel construction with negligible outgassing
- Plastic frame with high chemical resistance and low out-gassing
- Sizes: 610x610x292, 594x594x292 mm, 1/2 sizes

Gigapleat NXPH (header frame)

A four V-cell type molecular filter with a header frame – Solution for cleanroom recirculation.

Description

- Low pressure drop
- High media cleanliness
- Plastic frame with high chemical resistance and low out-gassing
- Size: 592x592x292, 592x490x292 and 592x287x292 mm

Gigalam

A combination filter – Ideal solution for Mini-environment and tool. Combination of HEPA / ULPA particle filtration and AMC molecular filtration.

Description

- Extremely small form factor – often the same as for particle filtration only
- Choice of standard, low boron or PTFE particle media
- Choice of different Gigapleat media
- Low pressure drop
- High media cleanliness

Camcarb 2600/3500

Camcarb cylinders are the high performance robust solution to molecular pollution in make-up applications. The cylinders can be filled with different grades of activated carbon and Camcarb is therefore a highly flexible molecular filtration system. Camcarb metal cylinders are easily refillable and so maintenance costs are minimal.

Description

- Different framing options for 305x610 and 610x610 mm and two different cylinder lengths (450mm and 600 mm)
- Many activated carbon options to suit different needs
- appr. 69 litre for a 610x610x525 -2600 unit
  appr. 91 litre for a 610x610x675 -3500 unit
- SS, GS or plastic cylinders

camfil FARR

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FOR FURTHER INFORMATION PLEASE CONTACT YOUR NEAREST CAMFIL FARR OFFICE.
YOU WILL FIND THEM ON OUR WEB.

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