How to Select a Syringe Filter and How to Use it?

Knowledge of Syringe Filter Membrane, Pore Size, Diameter, and Usage Guide

In this article:

As a Syringe Filters Manufacturer

A wide selection of membrane materials, diameters, and both sterile and non-sterile types are available, these syringe filters offer outstanding microfiltration for applications in HPLC, water treatment, environmental, biotechnology, beverages, food, pharmaceuticals, and other fields related.

What is a syringe filter?

A syringe filter (sometimes called a **wheel filter** for its wheel-like shape) is a single-use membrane based filter cartridge, to be attached with a syringe to remove impurities in liquid solutions. This pre-filtration step is vital in preventing damage to instruments (e.g. liquid chromatography, ICP, etc.).

Disposable syringe filters are widely used in labs for quick and efficient filtering, material purification or even sterilization for solutions <250mL, to avoid setting ups of Buchner filters or similar.

It is essential that the right selection of syringe filters is chosen to ensure reliable testing results and best purifying performance. **Membrane diameters, materials, pore size,** and **housing** all affect the right choice. Here we'll walk through the important factors to help you make the right choice compatible.

How to Select a Right Syringe Filter?

Syringe Filter Quick Selection Guide

1. Determine whether your application requires pre-filtration.		
2. Choose a suitable membrane type		
Characteristics of Solution		
Aqueous	**Non-Polar**	**Protein**
Nylon	Nylon	PVDF
MCE	PTFE	PES

	PVDF	
3. Choose Suitable Syringe Filter Diameter.		
Volume of Samples		
<10ml	<100ml	<250ml
13mm	25mm	33mm

4. Choose the suitable pore size.	
Micron Size of Column	
>3um	<3um
0.45um	0.22um

There are several **factors** to consider when choosing a syringe filter. Some of the key figures are:

1. Determine whether your application requires pre-filtration

2. How to select the right membrane syringe filter?

The following chart will help you quickly choose the proper filter membrane type.

Features of Your Applictaions:	**Compatible Filter Membrane Type:**
Hydrophilic Syringe Filter	PES, Nylon, MCE, Hydrophilic PTFE or PVDF
Hydrophobic Syringe Filter	PTFE, Hydrophobic PVDF
Compatible with aqueous samples only	CA, Nylon, or PES
Compatible with organic and aqueous samples	Hydrophilic PTFE, Nylon, or Hydrophilic PVDF
Compatible with gaseous samples	MCE, or PTFE
Can handle high temperature liquids <100 ℃	PES, MCE, or PTFE
Low protein binding	MCE, PES, , Hydrophilic PVDF or Hydrophilic PTFE
Nonspecific binding	Nylon or PVDF
Excellent flow rates	MCE, Nylon, PES, PTFE, or PVDF
High throughput loading	Nylon, or PTFE
Autoclave by 125℃for 15 minutes	Nylon, MCE, PES, PTFE or PVDF

3. What's the syringe filter diameter to be chosen? 13mm or 25mm?

All filter inlets are female Luer-Lock compatible, have inert polypropylene housings and come in three diameters. The diameter is determined by the volume to be filtered.

13 mm Syringe Filters

- For sample volumes <10 mL range;
- Ideal choice for most applications;
- Holdup (dead) volume is <15 ul.
- Female inlet luer lock
- Maximum operation pressure <15 bar
- Bubble point: Hydrophilic 2-3 bar; Hydrophobic 1-1.2 bar

25 mm Syringe Filters

- For sample volumes <100 mL range;
- Holdup (dead) volume is <125 ul.
- Female inlet luer lock
- Maximum operation pressure <10 bar
- Bubble point: Hydrophilic 2-3 bar; Hydrophobic 1-1.2 bar

33 mm filters

- For sample volumes <250 mL range;
- Holdup (dead) volume is <180 ul.
- Female inlet luer lock
- 33mm filters are ideal for high throughput labs

4. Which Pore Sizes to Select? 0.22um or 0.45um?

The most commonly used syringe filter pore sizes are 0.2/0.22 um and 0.45 um syringe filters, for research and medical applications.

1. The pore size to be used is usually determined by the particle size to be eliminated. For example, for the purpose of filtering out particulate >0.2 microns in diameter, then choose a syringe filter with a 0.2 micron pore size.

2. Another way to determine the micron size of columns, 0.45 um for >3 um, and 0.22 um for <3um.
3. 0.45 um membranes are typically used for general filtration and particle removal while 0.2/0.22um membranes, or sterilizing-grade membranes, are most commonly used for solution sterilization (bacteria removal).

5. Sterile or Non-Sterile?

As we use syringe filters to eliminate unwanted particles from a solution, we can either choose sterile or non-sterile (much cheaper option), depending on the processing applications:

- If a sterilized solution needed, sterile syringe filters come individually wrapped to ensure optimal performance without contamination.
- If your solution is going to be filtered through a sterilization process, then a non-sterile syringe filter should meet your requirements.

The main options of syringe filters are below:

PTFE Hydrophobic Syringe Filters 0.22 or 0.45um

Hydrophobic PTFE (Polytetrafluoroethylene) syringe filters are suitable for gaseous and organic solutions, with excellent performance for high corrosive samples. It is possible for an extended sampling range using hydrophobic PTFE filters for wider chemical resistance to aggressive substances and outstanding temperature stability. A PTFE syringe filter is an ideal choice for filtering and de-gassing chromatography solvents.

With proper pre-wetting (commonly used alcohol), aqueous samples are also compatible. When using air-vents, these syringe filters are capable of stopping moisture from passing through. Workable pH range: 1-14.

- Organic solvents with **strong chemical** causticity filtration
- Strong **acid solvents** filtration, with an excellent flow rate
- **Alkali** solvents filtration
- Compatible with **gaseous** samples
- Can handle **high-temperature** liquids

PTFE Hydrophilic Syringe Filters 0.22 or 0.45um

Resisting nearly all corrosive chemicals makes PTFE syringe filters an ideal choice. However, natural hydrophobic PTFE has it's disadvantages not letting aqueous solutions passing through while many of these chemicals are diluted with water. The solution comes to be hydrophilic PTFE syringe filter from AirekaCells.

Hydrophilic PTFE syringe filters offer a choice for **aqueous samples** that are diluted with harsh chemicals. These filters can handle **high-temperature liquids**, excellent flow rates, low protein binding, and are compatible with most bases, acids and organic solvents.

- Inorganic solvent with strong chemical causticity filtration
- Mixed solvent filtration in HPLC(Acetonitrile/Water)
- Alkali solutions filtration
- Compatible with organic and gaseous samples
- Low protein binding

Chemicals Compatible with PTFE Syringe Filters

Acids	Methanol, 98%	Pyridine
Acetic, Glacial	n-Propanol	Acetonitrile
Acetic 25%	Propylene Glycol	**Halogenated Hydrocarbons**
Hydrochloric Concentrated	**Esters**	Methylene Chloride
Hydrochloric 25%	Ethyl Acetate/ Methyl Acetate	Chloroform
Sulfuric Concentrated	Amyl Propyl/ Butyle Acetate	Trichloroethylene
Sulfuric 25%	Propyl Acetate	Monochlorobenzene Freon
Nitric Concentrated	Propylene Glycol Acetate	Carbon Tetrachloride
Nitric 25%	2-Ethoxyethyl Acetate	**Hydrocarbons**
Phosphoric 25%	Methyl Cellosolve Acetate	Hexane Xylene
Formic 25%	Benzyl Benzoate	Toulene Benzene
Trichloroacetic 10%	Isopropyl Myristate	Kerosene Gasoline
Bases	Tricresyl Phosphate	Tetralin Decalin
Ammonium Hydroxide 25%	**Organic Oxides**	**Ketones**
Sodium Hydroxide 3 Normal	Ethyl Ether	Acetone

Alcohols	Dioxane/ Tetrahydrofuran	Cyclohexanone
Amyl Alcohol (Butanol)	Triethanolamine	Methyl Ethyl Ketone
Benzyl Alcohol	Dimethyl sulfoxide (DMSO)	Icepropylacetone
Butyl Alcohol	Isopropyl Ether	Methyl Isobutyl Ketone
Ethanol 70%	**Amines and Amides**	**Miscellaneous**
Ethanol 98%	Dimethyl Formamide	Phenol Aqueous 10%
Ethylene Glycol	Diethylacetamide	Formaldehyde Aqueous 30%
Glycerine (Glycerol)	Triethanolamine	Hydrogen Peroxide 30%
Isopropanol	Aniline	Silicone Oil & Mineral Oil

PVDF Hydrophilic Syringe Filters 0.22um or 0.45um

Hydrophilic PVDF (Polyvinylidene Fluoride) is an optimal choice for protein-based samples with high non-specific binding, HPLC (High Performance Liquid Chromatography) and UHPLC (Ultra HPLC).

Our PVDF filters are high defined pore structure, low nonspecific binding, compatible with organic and aqueous solvents. Please note that Hydrophilic PVDF syringe filters are not compatible with majority of strong acids and caustic solutions, such as dimethyl sulfoxide, dimethylformamide (DMF), acetone, ketones, esters, and ethers.

- Compatible with organic and aqueous samples
- Compatible with gaseous samples
- Low protein binding
- Nonspecific binding
- Excellent flow rates
- Well-defined pore structure
- High-temperature filtration

Chemicals Compatible with PVDF Syringe Filters

Acids	Ethanol, 98%	**Halogenated Hydrocarbons**
Acetic, Glacial	Ethylene Glycol	Methylene Chloride
Acetic, 25%	Glycerine (Glycerol)	Chloroform
Hydro-chloric, Concentrated	Isopropanol	Trichloroethylene
Hydro-chloric, 25%	Methanol, 98%	Mono-chloro-benzene, Freon
Sulfuric, 25%	n-Propanol	Carbon Tetra-chloride

Nitric, Concentrated	Propylene Glycol	**Hydro-carbons**
Nitric, 25%	**Esters**	Hexane, Xylene
Bases	Ethyl Acetate/ Methyl Acetate	Toulene, Benzene
Sodium Hydroxide, 3 Normal	**Organic Oxides**	Kerosene, Gasoline
Alcohols	Ethyl Ether	Tetralin, Decalin
Amyl Alcohol (Butanol)	Isopropyl Ether	**Ketones**
Benzyl Alcohol	**Amines and Amides**	**Miscellaneous**
Butyl Alcohol	Aceto-nitrile	Formaldehyde Aqueous, 30%
Ethanol, 70%		Silicone Oil & Mineral Oil

Nylon Syringe Filters >> 0.22um-0.45um

Nylon syringe filer is naturally hydrophilic. For most aqueous and organic slovens in the lab, the Nylon syringe filters are compatible. Excellent flow rate and high throughput loading and affordable cost make nylon syringe filters a common choice for semiconductor industrial applications.

This type of nylon filter is not optimal for protein samples with high non-specific binding. Nylon can be sterilized by autoclaving at 120°C, gamma radiation, or ethylene oxide. Please check the compatible chemicals below in the chart.

- Compatible with aqueous samples only
- Nonspecific binding
- Excellent flow rates
- High throughput loading
- Electric semiconductor industrial water filtration
- Chemicals filtration
- Beverage filtration

Chemicals Compatible with Nylon Syringe Filters

Acids	Ethyl Acetate/Methyl Acetate	Trichloroethylene
Acetic, 25%	Amyl Propyl/Butyle Acetate	Monochlorobenzene, Freon
Bases	Propyl Acetate	Carbon Tetrachloride
Ammonium Hydroxide, 25%	Benzyl Benzoate	**Hydrocarbons**
Sodium Hydroxide, 3 Normal	Isopropyl Myristate	Hexane, Xylene
Alcohols	**Organic Oxides**	Toulene, Benzene
Amyl Alcohol (Butanol)	Ethyl Ether	Kerosene, Gasoline

Benzyl Alcohol	Dioxane/Tetrahydrofuran	**Ketones**
Butyl Alcohol	Triethanolamine	Acetone
Ethanol, 98%	Dimethylsulfoxide (DMSO)	Cyclohexanone
Ethylene Glycol	**Amines and Amides**	Methyl Ethyl Ketone
Glycerine (Glycerol)	Diethylacetamide	Icepropylacetone
Isopropanol	Triethanolamine	**Miscellaneous**
Methanol, 98%	Pyridine	Formaldehyde Aqueous, 30%
n-Propanol	Acetonitrile	Hydrogen Peroxide, 30%
Propylene Glycol	**Halogenated Hydrocarbons**	
Esters	Chloroform	

MCE Syringe Filters

MCE (Mixed Cellulose Esters) Syringe Filter is very low protein binding which makes it ideal for aqueous based samples. MCE is an outstanding choice for maximum protein recovery. Lab studies show that MCE bind even less protein than PVDF or PES syringe filters.

MCE syringe filters also have excellent flow rates but with limited organic solvent or benzyl alcohol resistance. Workable pH range ~4-8.

- Filtration of tissue culture media and sensitive biological samples
- Gas particulate and bacteria filtration
- Oil particulate and bacteria filtration
- Alcohol particulate and bacteria filtration
- Other solvent particulate and bacteria filtration

Chemicals Compatible with MCE Syringe Filters

Acids	Methanol, 98%	Trichloroethylene
Phosphoric, 25%	n-Propanol	Monochlorobenzene, Freon
Trichloroacetic, 10%	**Esters**	**Hydrocarbons**
Bases	Benzyl Benzoate	Hexane, Xylene
Ammonium Hydroxide, 25%	Isopropyl Myristate	Toulene, Benzene
Alcohols	Tricresyl Phosphate	Kerosene, Gasoline
Amyl Alcohol (Butanol)	**Organic Oxides**	Tetralin, Decalin
Butyl Alcohol	Ethyl Ether	**Ketones**

Ethanol, 70%	Triethanolamine	Icepropylacetone
Ethanol, 98%	Isopropyl Ether	**Miscellaneous**
Ethylene Glycol	**Amines and Amides**	Formaldehyde Aqueous, 30%
Glycerine (Glycerol)	Triethanolamine	Hydrogen Peroxide, 30%
Isopropanol	**Halogenated Hydrocarbons**	Silicone Oil & Mineral Oil

PES Syringe Filters

PES (Polyethersulfone) syringe filter is natural hydrophilic which makes is an ideal choice (highly recommended) for aqueous solutions and alcohols. It’s not necessary to treat the filter membrane surface with wetting agents.

With PES syringe filter membrane mechanically strong character, it can handle high-temperature liquids, with great flow rate (better than PTFE), and low protein binding. With these features, PES syringe filters offer superior performance for use with biological samples and media culture. Workable pH range ~3-14.

- Compatible with organic and aqueous samples
- Mechanically strong for high flow rate
- Low protein binding
- Tissue culture media filtration
- High-temperature filtration
- Sterile filtering protein solution
- Tissue culture additive filtration

Check PES Syringe Filter Chemical Compatibility Chart Below.

Chemicals Compatible with PES Syringe Filters

Acids	Amyl Alcohol (Butanol)	**Organic Oxides**
Acetic, Glacial	Butyl Alcohol	Ethyl Ether
Acetic, 25%	Ethanol, 70%	Isopropyl Ether
Hydrochloric, Concentrated	Ethanol, 98%	**Amines and Amides**
Hydrochloric, 25%	Ethylene Glycol	**Halogenated Hydrocarbons**
Sulfuric, 25%	Glycerine (Glycerol)	**Hydrocarbons**
Nitric, 25%	Isopropanol	**Ketones**
Bases	Methanol, 98%	**Miscellaneous**
Ammonium Hydroxide, 25%	n-Propanol	Formaldehyde Aqueous, 30%
Sodium Hydroxide, 3 Normal	Propylene Glycol	Silicone Oil & Mineral Oil

Alcohols	Esters	

How to Use a Syringe Filter? Instructions

As syringe filters are very commonly used in the lab, sometimes improper use of these filters might cause unnecessary trouble, such as sample leakage, filter breakage, or filter falling off the syringe. This instruction aims to provide a step by step guides for researchers new to syringe filter.

Step 1: Open Syringe

- Open the syringe package and remove the syringe needle. A syringe with a **luer-lock** tip is recommended. Syringe Volume depends on the samples to be filtered.

Step 2: Attach a syringe filter to the Syringe

- Open the syringe filter package so that you can later pick the filter up easily, especially for individually packed sterile syringe filters.

a. For sample volume < 10 mL

1. Draw a small amount of air (about 1 mL) into the syringe before loading the sample solution. The air is used to purge the filter to minimize hold up volume.
2. Attach the filter securely to the syringe using a clockwise motion.

Note: Please use caution when using small volume syringes as they can generate high pressure.

b. For sample volume≥ 10 mL

1. Remove the plunger from the syringe.
2. Attach the filter securely to the syringe using a twisting motion.
3. Pour the sample solution from the unpreserved fill bottle into the top of the syringe leaving space for the plunger.
4. Reinsert the plunger.

Note: The individually packed sterile syringe filter can be held in the original package to minimize contamination while attaching the syringe.

Step 3: Secure the Syringe Filter

- Secure the syringe filter using a clockwise motion with luer-lock syringe. **DO NOT overtighten**.

Step 4: Filter the Solution

- Hold the assembled syringe and filter it upright. Filter the solution into the receiving bottle by slowly pressing down the syringe plunger to push the sample through the filter.

Note: Avoid pressing excessively as this could cause the filter housing to burst.

Step 5: Filter more Samples

1. If more solutions need to be filtered, detach the syringe filter from the syringe tip.
2. Reattach the syringe filter with a clockwise motion.
3. Pour the sample solution from the top of the syringe leaving space for the plunger.
4. Reinsert the plunger and continue filtering.

Note: If the backpressure increases significantly, change the filter as it may have been clogged.

Step 6: Discard the Filter

- Detach and discard the used syringe filter.

Typical Particle Sizes

Typical Particle Sizes	
Gelatinous Precipitates	**μm**
Metal hydroxides	25–40
Precipitated silica	25–40
Crystalline Precipitates	
Ammonium phosphomolybdate	20
Calcium oxatate	15
Lead sulphate	10
Barium sulphate (hot ppt.)	8
Barium sulphate (cold ppt.)	3
Blood Cells	
Platelets	2–3
Erythrocytes (average)	7.0
Polymorphs	8–12
Small lymphocytes	7–10
Large lymphocytes	12–15
Monocytes	16–22
Bacteria*	
Cocci	0.5
Bacilli	1.0 x (1.0–1.0)
Serratia marcescens	0.5 x (0.5–1.0)

Pneumococcus	1.0
Bacillius tuberculosis	0.3 x (2.5–3.5)
Amoeba	12-30
E.coli	0.5 x (1.0–3.0)
Smallest bacteria	0.22
Other Microorganisms, etc.	
Yeast cells	2.0–8.0
Tobacco smoke	0.5
Colloids	0.06–0.30
Rye grass pollen	34
Ragweed pollen	20
Puffball spores	3.3

How to select correct autosampler Vial and Cap

A guide to autosampler vials concerning about materials, sizes, types and compatibility

Some Suggestions about Autosampler Vials and Closures

In this article, we aim to discuss the following topics:

- What if I select the incorrect autosampler vials?
- Potential Risks by Using Incorrect Vial/Cap/Septum.
- What are the autosampler vial components?

Introduction:

What if I select the incorrect autosampler vials?

The choice of autosampler vials may seem much less important compared to the significance chromatography instruments many laboratories use. However, the wrong choices of HPLC or GC vials, caps, septas and inserts might well lead to lower experiment productivity and reproducibility or even mechanical damage to the autosampler.

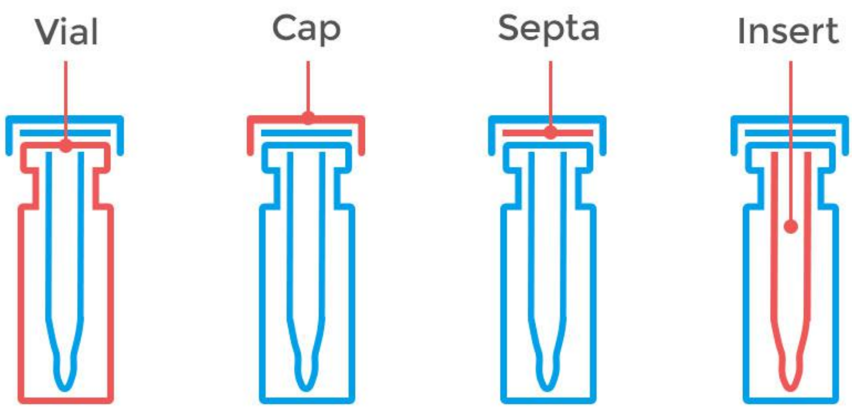
Potential Risks by Using Incorrect Vial/Cap/Septum:

- Loss of samples due to evaporation
- Extra peaks due to solvent↔septum interaction
- Mechanical damage to autosampler
- Sample degradation
- Irreproducible injection volumes

To avoid these risks we need to understand each chromatography vial component in-depth and how to avoid mistakes that might waste your precious samples.

What are the autosampler vial components?

HPLC / GC autosampler vials, caps, septas, and inserts working as a whole to prevent sample degradation and loss of samples caused by evaporation. Below is an image illustration of each vial components:



We'll discuss factors that will effect the components below.

Part 1 >> Autosampler Vials

What to Consider When Choosing an Autosampler Vial?

Several factors need to be considered when choosing laboratory glass vials- autosampler compatibility, sample volume, sample compatibility, neck design, vial glass material and especially exposure to heat or freezing temperatures.

►Note: The factors to consider when choosing autosampler vials:

- Contain the sample without allowing it to **absorb** into the vial
- Reduce the **extractable** from the vial and septa
- Prevent **leaching** of materials from the vial

1. Autosampler Vial Compatibility

Not all autosamplers are similar using the same vial specifications. Some is using robotic arms to pick up a sample vial; some use tray rotation, while for others, moving the injection needle to the respective vial coordinates. The design of correct autosampler vials may vary.

A large percentage of autosamplers are equipped with trays that use 12x32mm 2mL vial but there are instruments, i.e. the Waters Wisp, require a 15x45mm 4mL vial. Check your autosampler operating manual and manufacturer or refer to our autosampler compatibility chart with brand and instrument list to determine the autosampler vial specifications required.

2. Chromatography Sample Volume

The sample amount for chromatography analysis determines the vial volume. For a small limited amount of sample available, **vial inserts** that are compatible with regular 2ml sampler vials are an decent choice.

►Which vial is best for my sample size?

There are several factors to consider, including analysis type, analytical platform, and sample availability. Use the diagram below as a starting point for choosing the size you need based on your sample volume.

<2mL	2mL	>2mL	
Inserts (150 µl - 300 uL)	Glass HPLC vials (2 mL)	4 mL vials	40 mL vials
Polypropylene vials (250 uL)	Glass GC vials (2 mL)	6 mL vials	60 mL vials
Vials with integrated inserts (250 µl to 300 uL)	Polypropylene vials (2 mL)	Headspace vials (10 mL to 20 mL)	Storage vials (4 mL to 40 mL)

Note: Most 12x32 mm autosampler vials hold between 1.5mL to 2mL of solutions. The sizes for 12x32mm vials outer dimensions are standard between manufacturers but the length of the neck and screw thread of the 9mm (N9) vial may vary, because 9mm short thread is not industry standardized.

3. Chromatography Sample Compatibility

The sample solvent compatibility should be considered when choosing vials and septas. For example, amber glass vials are mostly used for **light-sensitive** samples while plastic polypropylene vials are used for solutions that are **sensitive to glass**. **Volatile** samples require closures that reduce the risk of analyte loss due to evaporation.

4. Crimp Vial vs. Snap Vial vs. Screw Cap Vial, How to Choose?

Vials are available in three closure types; crimp, snap and screw cap. The closures have advantages and disadvantages.

Crimp Vials squeeze the septum between the rim of the glass vial and the crimped aluminum cap. This forms an excellent seal preventing evaporation. The septum stays seated during piercing by the autosampler needle. The crimp cap vial requires crimping tools to carry out the sealing process. For low volume settings, manual crimper tools are the choice. For high volume settings, automated crimpers are available.

Snap Cap Vials are an extension of the crimp cap system of sealing. A plastic cap is stretched over the rim of the vial to form a seal by squeezing the septum between the glass and the stretched plastic cap. Plastic has memory and wants to return to the original dimension. This tension in the cap to return to original size is the force forming the seal between glass, cap and septum. The advantage of a plastic snap cap is **no tools** are required to assemble. The snap-top cap is a compromise sealing system.

- If the fit of the cap is very tight, they are hard to apply and may be subject to **cracking**.
- If the fit is too loose, the seal is not very good, and the septa may be subject to **dislodging**.

Screw Cap Vials are **universal**. Screwing the cap applies a mechanical force that squeezes the septum between the glass rim and the cap. Screw caps form an **excellent seal** and mechanically hold the septum in place during piercing. **No tools** are required for assembly.

Note on cap tightening: This is the mechanism that forms the seal and holds the septum in place during needle insertion. There is no need to over-tighten the cap, this can compromise the seal and lead to dislodging. The septum begins to cup or indent when you begin to over tighten.

Quick Comparison of Different Autosampler Vial Designs

Cap Design	Strength Design	Remark
Crimp Vials	Excellent Seal	Requires Tools
Snap Cap Vials	Moderate Seal	No Tools, Some Cap Cracking
Screw Cap Vials	Excellent Seal	Universal, Most Commonly Used

Some more tips:

Based on our years of chromatography vial experience, **crimp-cap vials** are most situations best for **GC and GC/MS** analysis, while **screw-cap vials** are better choice used for most of **HPLC and LC MS** applications. However, your personal preference and specific chromatography experiment requirements are also important factors to consider.

Snap Cap is fast to seal but sealing strength is not as good as crimp and screw vials. However, even both types of crimp and screw vials have a good seal, crimp vials provide an additional guarantee of sealing for **food**, **forensics**, and other applications for which you want to avoid **sample tampering**. A crimping sealing is also recommended for the storage of **volatile** compounds.

Types of Glass Materials

Different glass bottle materials are available in the market for autosampler vials, the important factors to consider is linear coeffcient of expansion and USP types.

What is Linear Coefficient of Expansion and USP Types?

Linear Coefficient of Expansion refers to the fractional change in the length of glass per degree of change in temperature, in short, the ability of the glass to tolerate rapid thermal changes. The lower the coefficient of expansion the better the glass can handle temperature change without fracturing. Classifications for laboratory glass based on its resistance to attack from water were established by the United States Pharmacopoeia, USP.

Glass Vials Classfications:

Pharmaceutical glass container materials can be classified as **USP Type I, II, III or NP**.

►Type I

Borosilicate glass represents the **least reactive** glass. Type I glass has the **least pH shift**, **lowest leaching** characteristics, linear coefficient of expansion 33 or 51, 33 for clear autosampler vials and 51 for amber vials.

USP Type I, 33 Borosilicate Glass is the most inert and chemically resistant glass widely used in laboratories especially for chromatography applications. Type I glass is composed primarily of silicone and oxygen, with trace amounts of boron and sodium. It has the **lowest leaching** characteristics and a linear coefficient of expansion of 33.

USP Type I, 51 Borosilicate Glass which is composed of silicone and oxygen, trace amounts of boron, sodium and other element is more alkaline than Class A glass but still adequate for laboratory use. All amber borosilicate glass is made of Class B unless otherwise specified and has an expansion coefficient of 51.

►Chemical Composition of Type I Glasses

Chemical Composition (main components in approx. wt %)

	SiO2	B2O3	Al2O3	TiO2	Fe2O3	Na2O	K2O	BaO	CaO
Amber 51-expansion	69	10	6	3	1	6	2	2	0.5
Clear 33-expansion	80	11	7	–	–	7	2	<0.1	0.5

Free Ion Content

Ions	Na	K	Ca	Mg	Al	Fe	Ba	Zn	Mn	Si
Clear(33)	0.3-0.5	ND	ND	ND	ND	ND	ND	ND	ND	ND
Amber(51)	0.4-1.4	0.02	0.1	ND	0.5	ND	0.2	ND	ND	5

ND = non detectable results in µg/mL

►Type II, III and NP

Type II glass is de-alkalized **soda-lime** glass with higher levels of sodium hydroxide and calcium oxide. **Type III** is **soda-lime** glass - cannot be autoclaved. **Type NP** is a general-purpose **soda-lime** glass used where chemical durability and heat shock are not factors. Coefficient of Expansion = 92.

USP Types II, III and NP glass are manufactured from **soda-lime** which has **less chemical resistance** than **borosilicate** Type I glass vials.

►Special Glasses

Silanized or deactivated glass vials are borosilicate glass bottles that have undergone further deactivation by treating the surface of the glass with an organosilane. The surface becomes more hydrophobic and inert making the vial suitable for use with pH sensitive compounds, trace analyses and applications requiring long term sample storage.

Plastic Polypropylene Vials

For some applications glass vials are not suitable due to their composition and their chemical properties. Amongst these are heavy metal analysis, water and protein analysis, atomic absorption, capillary electrophoresis (CE) and ion chromatography (IC). For all these cases high purity polypropylene vials with 0.3 mL, 0.7 mL and 1.5 ml in transparent and amber are available.

All ALWSCI glass autosampler vials are made from USP Type I Glass. Glasses in the USP Type I classification are borosilicate glass with **superior chemical resistance**. This class of glass represents the least reactive glass containers available. Typically, this glass can be used for most applications, including packaging for parenteral and non-parenteral products. Type I glass may be used to package acidic, neutral and alkaline products. Type I glass can be subject to chemical attack under certain conditions, so container selection must be made carefully for very low and very high pH applications.

Part 2 >> Autosampler Vial Inserts

Limited volume inserts are an economical solution when there is a limited amount of sample and injection is done using an autosampler. Most autosamplers have a set depth that the injection needle can go into the vial without bottoming out. Inserts increase the sample depth within the vial even if there is a very minute volume of sample available.

What to consider when selecting the HPLC / GC vial insert?

1. Insert Shape and Point Style

The style of HPLC / GC vial insert chosen is dependent on the amount of sample available and the residual volume after sampling.

Conical glass inserts have a tapered bottom with pulled tips and are available with or without plastics polypropylene springs. The spring acts as a shock absorber during needle penetration and raises the insert above the bottom of the vial, allowing greater sample recovery.

Flat bottom glass inserts have the largest capacity and are the most economical inserts. These inserts are cylindrical in shape with a flat bottom

2. Solvent Compatibility

Type I borosilicate glass inserts are most commonly used for trace analysis in chromatography.

Polypropylene inserts are less expensive than glass and are suitable for applications involving pH sensitive samples.

3. Dimensions of the Autosampler Vial

Choosing the incorrect size of the autosampler vial insert can result in poor reproducibility between sample injections, damage to the autosampler needle and an inadequate seal between the septum and the vial.

The dimensions listed for insert size in the article refer to the outside diameter and length. Inserts with an outside diameter of 5mm are used with vials with standard mouth openings and the 6mm are used with wide mouth vials. The length of the insert should be flush with the neck of the vial to prevent the insert from causing the septum to bulge.

Part 3 >> Chromatography Caps and Septas (Closures)

Chromatography vial closures also referred to as seals, are the combination of a cap and septa. To ensure reliable analyses, it is therefore important that all closures are inert and uncontaminated as well as the vial itself.

1. Types of Autosampler Vial Closures

HPLC / GC Vials are available in three closure types; crimp, snap and screw cap. The closures have advantages and disadvantages.

Crimp Caps squeeze the septum between the rim of the glass vial and the crimped aluminum cap. This forms an excellent seal preventing evaporation. The crimp cap vial requires crimping tools to carry out the sealing process.

Snap Caps are an extension of the crimp cap system of sealing. A plastic cap is stretched over the rim of the vial to form a seal by squeezing the septum between the glass and the stretched plastic cap. The advantage of a plastic snap cap is no tools are required to assemble. Snap caps are a compromise sealing system.

- If the fit of the cap is very tight, they are hard to apply and may be subject to cracking.
- If the fit is too loose, the seal is not very good, and the septa may be subject to dislodging.

Screw Cap Vials are universal. Screwing the cap applies a mechanical force that squeezes the septum between the glass rim and the cap. Screw caps form an excellent seal and mechanically hold the septum in place during piercing. No tools are required for assembly.

Note on cap tightening: This is the mechanism that forms the seal and holds the septum in place during needle insertion. There is no need to over tighten the cap, this can compromise the seal and lead to dislodging. The septum begins to cup or indent when you begin to over tighten.

Quick Comparison of Different Autosampler Vial Designs

Cap Design	Strength Design	Remark
Crimp Vials	Excellent Seal	Requires Tools
Snap Cap Vials	Moderate Seal	No Tools, Some Cap Cracking
Screw Cap Vials	Excellent Seal	Universal, Most Commonly Used

2. Austosampler Vial Septas (Septums)

What to consider when selecting chromatography vial septa?

Septa compatibility or chemical resistance with the sample and solvent is the main consideration when choosing vial septa. Any interaction can lead to sample degradation or the appearance of ghost peaks in the testing results.

PTFE is the most inert but its poor resealability making it unsuitable for multiple injections or storage. For layered septa such as PTFE/silicone the chemical resistance of the septa is that of PTFE until the septum is punctured. Once punctured, the silicone layer is exposed and able to react with sample/solvent so the chemical resistance of silicone should be considered when using these septa.

Note: The thicker the facings on the seal the better the resealability but it compromises the ability of the autosampler needle to pierce the septum.

Septa Material	Advantages	Chemical Resistance	Applications	Max Temp
PTFE	Economical	Excellent	For single injection only	550°C
PTFE/silicone	Excellent resealing capabilities	Excellent until punctured Not suitable for chlorosilanes	Multiple injections than moderate resistance	200°C
Pre-slit PTFE/silicone	Reduces coring Prevents vacuum from inside the vial	Excellent until punctured than moderate resistance	Multiple injections	200°C
PTFE/silicone/ PTFE	Resistant to coring Autoclavable	Excellent	Above average resealing Multiple injections or applications with long periods between	200°C

			injections	

Compatibility of septa and sample

Make sure the septa you choose are chemically compatible with your sample and solvent. Chemical compatibility can vary, based on factors such as solvent concentration, molecular weight, and temperature.

►Septa Chemical Compatibility

	PTFE	PTFE /Silicone	PTFE /Silicone/ PTFE*
Acetonitrile	C	C	C
Hydrocarbons (hexane, heptane, methane)	C		C
Methanol	C	C	C
Benzene	C		C
THF	C		C
Toluene	C		C
DMF	C	C	C
DMSO	C	C	C
Ether	C	C	C
Chlorinated Solvents (methylene chloride)	C		C
Alcohols (ethanol)	C	C	C
Acetic Acid	C	C	C
Acetone	C	C	C
Phenol	C	C	C
Cyclohexane	C		C

*PTFE/silicone/ PTFE has the same chemical compatibility of PTFE only until punctured.
“C” indicates that the septa from this category are compatible with the solvent in most configurations.

Pre-slit or Not, Which One to Choose?

Chromatography septas can be pre-slit or not and must be considered by evaluating a few factors. A pre-slit septum is an ideal choice in applications requiring 20% or more of the sample injection each time from the vial so that suction is avoided.

The slit allows ambient gas to equalize the gas in the vial so that a vacuum is not created in the vial from the tight seal around the needle. If coring or clogging from a narrow needle or needle deflection from highly durable septa material is a concern, then choosing a pre-slit septum is a better choice.

The non-pre-slit septas help to reduce carryover from vial to vial because the resealing characteristics of the septum act as a squeegee to wipe solution from the outside of the needle. Typically, a non-slit septum exhibits resealing capabilities for a limited number of needle punctures but for long-term storage in the vial, using a new non-punctured septum is best practice.

Storage Considerations for Silicone/PTFE:

Silicone rubber can readily absorb chemicals from the environment. Care needs to be taken in storing caps prior to use.

►Recommendations include:

- Don't store the septa in locations where chemicals vapor is present for prolonged periods.
- Do not write in the sealed bag with a marker. Solvent vapors will penetrate the bag and be absorbed in the silicone rubber.
- Close a partially consumed bad limiting exposure for prolonged periods.

Part 4 Conclusions:

Some Recommendations about Closure Selection in HPLC / GC

The choice of the best closure depends on certain features of the instrument (needle type / design, transportation mechanism of the autosampler, etc.) as well as on the requirements of the application (temperature, the sensitivity of the analysis, single/multiple injections, etc.) and thus is more complicated and more individual than the selection of the correct vial type.

►Basically the following recommendations can be made:

- Due to the relatively thick and blunt HPLC needles, **only** Silicone / PTFE closures, either with or without slit, should be used in combination with them.

- Screw thread closures **N9 (9mm)** 2ml vials and closures are **universally suitable** on most autosamplers, **convenient** in handling and available in a broad selection of different cap colors and septum materials. They fulfill all requirements with regard to **tightness** and **analytical purity** for GC as well as for HPLC. Due to the relatively thin septa penetration is safe and easy.

- Crimp closures **N11** are also universally suitable with regard to autosampler compatibility, however, they are **not as safe and convenient** in their closing technique as the screw closures N 9 (9mm) 2ml vials and closures.

- Snap ring closures **N11** should only be used in HPLC, as the punctual compacting pressure of the septum against the vial rim by the four pins in the cap does not achieve the same level of tightness as the evenly applied pressure through a screw thread or by crimping.

- For **sensitive analyses** only high purity Silicone / PTFE closures can be used; if additionally there is a need for minimal coring during penetration, a PTFE / Silicone / PTFE septum (sandwich septum) is recommendable.

- **Cap colors** may be used for marking (sample marking / lab marking / shift marking). However, please consider that some autosamplers work with photocells which may not be able to recognize **transparent** caps.

- For sample storage closed top screw closures (without center hole) should be used. Generally, these also need an elastomeric liner for sealing vials with liquid samples tightly.

- Due to their artificially reduced cap height screw caps **N9 don't have a standardized thread** design. Therefore, it is recommendable only to use vials and closures from one source of supply, in order to ensure a harmonious and tight matching of both components.

- Replacement septa are partially available, however, in case of manual assembly you have the risk of **contamination** with skin fat / sweat and of a possible wrong side orientation. Therefore we highly recommend only to use ready assembled closures, where the liner perfectly matches the cap and has been automatically inserted under strict hygienic conditions.

Part 5 Autosampler Vial Instrument Compatibility

This table indicates the categories of vials that are compatible with various models of autosamplers. Certain autosamplers require the purchase of optional vial trays and, in few cases, programming upgrades to use all of the vials listed.

Brand	**Model**	11mm Crimp **And** Snap (N11)	8-425 Screw (N8)	9mm Screw (N9)	**10-425 Screw (N10)**	13-425 Screw	**Head-space**
Agilent	1050, 1090	C		C			
	1100/1200	C		C			
	7673A/7683A	C		C			
	7693A	C	C	C		C	
	5880/5890	C		C			
	6850 (27 Pos. Tray)	C		C			
	6850 (22 Pos. Tray)					C	
	6890	C		C			
	CTC HTS+HTC PAL+CTC GC PAL	C		C			
	CTC Combi PAL						H
Beckman	501, 502/502e, 507/507e	C	C	C	C		
	Marathon, Promis	C	C	C			
	Triathlon,Standard Tray	C	C	C			C
CTC	A200S	C	C	C	C		
	A200 LC	C	C	C	C		C
	HS 500						C
CTC (LEAP)	LC PAL (216 Pos.)	C	C	C	C		C
	HTX PAL, HTC PAL, HTS PAL (54/98 Pos. Tray)	C	C	C	C		C
	HTX PAL, HTC PAL, HTS PAL (32 Pos. Tray), Combi PAL (32 Pos. Tray),						H
	GC PAL (32 Pos. Tray), Combi PAL SPME Mode (32 Pos. Tray)						H

	Combi PAL (98 Pos. Tray), GC PAL (98 Pos. Tray)	C		C			
	Combi PAL SPME Mode (98 Pos. Tray)	C		C			
	UltiMate Analytical, cylindrical, WPS-3000 SL, 120 Pos. Rack (2ml)	C	C	C	C		C
Gerstel	MPS	C	C	C		C	H
Gilson	201/202, 221/222, 231/401/232/402, Aspec, Aspec Xli, Aspec XL4		C	C			
	221XL/222XL, 223, 231XL/232XL/233XL						
	235/235P/SP 235/SP 235P		C	C			
HTA	HT200H						C
	HT250D, HT280T, HT300L	C	C	C	C		C
	HT300A, HT310A, HT3000A, HT3100A, HT3200A	C	C	C	C		
PerkinElmer	AS2000/AS2000B	C			C		
	AS-300, AS8300, Autosystem	C					
	LC 600, 60 vial tray	C			C		
Shimadzu	SIL-20A (Prominence) 105 vial tray/SIL-20AC (Prominence) 70 vial tray	C	C	C	C		
	SIL-20A/Sil-20AC (Prominence) 50 vial tray,					C	
	LC2010C + LC2010A 100 Pos. Tray					C	
	LC2010C + LC2010A 350 Pos. Tray						
	LC2010C + LC2010A 140 Pos. Tray	C	C	C	C		
	HSS-2B						C
	SIL-20AXR/SIL-20ACXR (Prominence) 175 (1-mL vials),	C	C	C		C	
	70 (1.5-mL vials), 50 (4-mL vials)	C	C	C		C	
	SIL-30AC(Nexera) 175 (1-mL vials), 105 (1.5-mL vials),	C	C	C		C	
	50 (4-mL vials)	C	C	C		C	
Thermo Scientific	AS1000 (TRACE GC), AS200, AS2000 90 vial tray (TRACE GC)	C	C	C			
	AS300	C	C	C			
	AI3000 (II)/AS3000 (II) AS3500	C		C			C

	(TRACE GC + FOCUS GC)						
	A200LC, AS 100	C	C	C			
	HS250, HS500, HS800, HS 850, HS2000						H
	TriPlus (=GC PAL) (AS+ Duo)	C	C	C			H
	TriPlus HS, TriPlus SPME						H
	Surveyor (Surveyor Plus)	C	C	C			C
	Accela High Speed LC Autosampler (200 Pos.)	C	C	C			
	Accela Open Autosampler (342 Pos)	C	C	C			
	TriPlus RSH	C	C	C			C
	TriPlus 300						C
VWR(Merck) / Hitachi	L2200 (LaChrom Elite)/L2200-U (LaChrom Ultra) (200 Pos. Tray),	C	C	C			
	L7200 (LaChrom) (80 Pos. Tray)/L7250(LaChrom) (Pos. Tray)	C	C	C			
	655-A40 (108 Pos. Tray), L-9100, AS 2000 (50 Pos. Tray),	C	C	C			
	AS 4000 (150 Pos. Tray)	C	C	C			
	5210 (Chromaster) 195 Pos (1mL), 120 Pos 1.5mL (Standard),	C	C	C		C	
	72 Pos. (4mL), 2 x MTP (96,384)	C	C	C		C	
	AS 6000	C	C	C			
Waters	Acquity Sample Organizer	C		C			
	Acquity/CapLC/Waters/Nano Acquity	C		C			
	Alliance HTS						
	Model 2767	C	C				
	Model 2707	C	C				
	Model 2777	C	C				
	ACQUITY™ UPLC Systems			C		C	
	Wisp 48 position					C	
	Wisp 96 position, 717, 96 Position Carousel						
	717, 48 Position Carousel					C	
	Alliance, Alliance HT Syst.	C		C	C		
	Alliance GPC 2000					C	
	Alliance 2790/2795, Alliance 2690/2695	C		C	C		

"C" indicates that the vials from this category are compatible with the autosampler in most configurations.

"H" indicates that a magnetic seal is required for use with the autosampler.