Care and Safe Handling of Laboratory Glassware

CORNING

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GLASS: THE INVISIBLE MATERIAL

From the 16th century to today, chemical researchers have used glass containers for a very basic reason: the glass container is transparent, almost invisible and so its contents and reactions within it are clearly visible. But because chemists must heat, cool and mix chemical substances, ordinary glass is not adequate for laboratory work. A chemistry laboratory requires special heat and chemically resistant glass.

Glass has also played a critical role in the life sciences starting with the lenses that made the first microscopes possible in the 17th century. Soon glass Petri dishes and other vessels were being used to study and grow living organism *in vitro* – literally "in glass." But ordinary glasses often leach toxic substances that can be harmful to growing cells, so cell biologists require glasses with low levels of extractables.

For 90 years, Corning has developed special glasses for use in both chemical and life science laboratories. PYREX®, PYREXPLUS®, VYCOR®, and Corning® glassware are the result: products designed to meet researchers' specifications and expectations.

PYREX glassware is made from Type 1, Class A low expansion borosilicate glass that is ideal for most laboratory applications. The glass composition gives PYREX products special properties:

- Except for bottles, jars or other items with heavy walls, PYREX glassware can be heated directly on hot plates or above Bunsen burners with low risk of thermal breakage because its thermal expansion is very low.
- PYREX glassware resists chemical attack. It reacts only with hydrofluoric or phosphoric acid or a strong, hot alkali. *Caution*: glass will be chemically attacked by hydrofluoric acid, phosphoric acid, and strong hot alkalis. It should never be used to contain or process these materials.
- PYREX glassware has very low extractables and is ideal for storing culture media and other life science applications.
- PYREX glassware is designed for maximum mechanical strength.
- PYREX glassware comes in a wide variety of laboratory shapes, sizes and degrees of accuracy — a design to meet every experimental need.

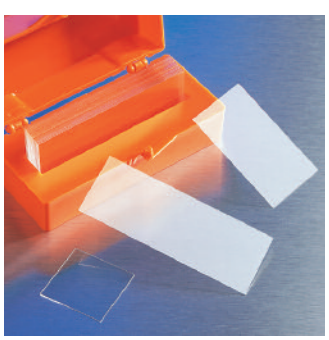
While we feel PYREX laboratory glassware is the best all-purpose glassware for most laboratory applications, you may require the advantages of other special glasses for certain scientific applications:

- PYREXPLUS glassware is PYREX laboratory glassware with tough transparent plastic vinyl coating to reduce scratching and help contain spills should the glass vessel break.
- VYCOR glassware is 96% silica glass. It out-performs PYREX glassware in terms of very high service temperatures, and thermal shock resistance.
- PYREX Low Actinic glassware is PYREX glass that has had a light filtering red stain fused to it so it will protect ultraviolet-sensitive materials.
- PYREX VISTA™ glassware is an economical option for the customer who is willing to forgo the premium benefits of PYREX products. Manufactured to Corning/PYREX standards and price competitive with comparable products, PYREX VISTA glassware offers a full range of products from beakers to pipets and is easily recognized by its blue graduations and novel marking spot.
- Corning Disposable glassware offers the convenience of high quality disposable culture tubes and microscope slides, coverslips and sterile pipets, eliminating the need for cleaning. Disposal is easier and safer with disposable glassware

In selecting your glassware, study the various types available from Corning. See if one particular design or glass appears to fit your specific requirements. While the glass composition is important, you should also be concerned with the shape which ideally fits your needs – something Corning has spent years researching. Emphasis on small details has made Corning glassware the most widely accepted in the world.

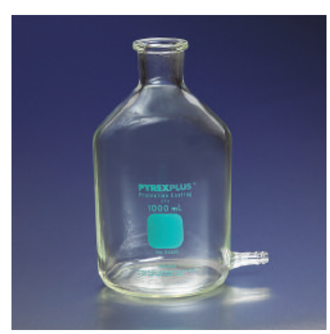
The following pages contain information on the technical properties of various glasses, suggestions on the proper use and care of this glassware, and a glossary of glass terminology.

PYREX VISTA glassware offers a full range of economical products from beakers to pipets and is easily recognized by its blue graduations and novel marking spot.



Corning Disposable Glass Coverslips offer ultra-flat glass in several thicknesses to give optimal viewing with high-powered microscope objectives.

When it comes to use at very high temperatures, VYCOR® glassware outperforms all other glass formulations.



PYREXPLUS® glassware has a tough plastic coating on the outside and PYREX glass on the inside for increased safety and reduced breakage.

GLASS TECHNICAL DATA

Corning® products are made from different glass compositions which are sold under a variety of brand names. The following information summarizes some of the properties of these glasses.

PYREX® Glassware

Most PYREX glassware is made from Code No. 7740 PYREX borosilicate glass, the most widely known of Corning's family of low expansion Type 1, Class A borosilicate glasses (ASTM E438 *Standard Specification for Glasses in Laboratory Apparatus*). It comes closest to being the ideal glass for most laboratory applications. It will withstand nearly all temperatures used in normal laboratory use. It is highly resistant to chemical attack. Its low coefficient of expansion allows it to be manufactured with relatively heavy walls giving it mechanical strength, while retaining reasonable heat resistance. It is the best glass available for laboratory use (Tables 1, 3 and 4).

Table 1. Chemical Composition of PYREX Code 7740 Glass

Composition	Approximate Percent
SiO_2	80.6
B_2O_3	13.0
Na_2O	4.0
Al_2O_3	2.3
Miscellaneous Traces	0.1

PYREXPLUS® Glassware

This extra durable glassware is made from Code No. 7740 PYREX borosilicate glassware which has been coated with a tough, transparent plastic vinyl. The coating, which is applied to the outside of the vessel, helps prevent exterior surface abrasion. It also helps minimize the loss of contents and helps contain glass fragments if the glass vessel is broken.

PYREX Low Actinic Glassware

This glassware is generally made from Code No. 7740 glass with a red stain fired into the exterior surface. PYREX Low Actinic glassware was originally developed for work in the vitamin field, but it has found other uses in applications with chemicals sensitive to light in the 200 to 500 nanometer range.

VYCOR® Glassware

This glassware is made from Code No. 7913 glass and has several exceptional properties. Since it is 96% silica, it is similar to fused quartz in its thermal properties. It may be used at much higher temperatures than Code No. 7740 borosilicate glass and will withstand considerably more thermal shock. Being of a very simple composition, only five elements, it is used for very critical analytical work.

Table 2. Chemical Composition of VYCOR Code 7913 Glass

Composition	Approximate Percent
SiO_2	96.4
B_2O_3	3.0
Al_2O_3	0.5
Miscellaneous Traces	0.1

Thermal Properties

Table 3 compares the thermal properties of Code Nos. 7740 and 7913 glasses. The strain point represents the extreme upper limit of serviceability for annealed glass. Except for Code No. 7913 glass, the practical maximum service temperature will always be below this point.

Table 3. Relative Thermal Properties

	PYREX No. 7740 Glass	VYCOR No. 7913 Glass
Coefficient of Expansion 0-300°C	32.5×10^{-7} cm/cm/°C	7.5×10^{-7} cm/cm/°C
Annealing Point	560°C	1020°C
Strain Point	510°C	890°C
Softening Point	821°C	1530°C

As a general rule, the coefficient of expansion indicates the thermal shock resistance of the glass. The lower the expansion, the greater is the resistance of the glass to sudden temperature changes.

The annealing point is the temperature, at the upper end of the annealing range, at which the internal stress is reduced to a commercially acceptable value over a period of time. In an annealing operation, the glass is slowly cooled from above the annealing point to somewhat below the strain point.

The softening point is the temperature at which a small diameter fiber of the glass will elongate under its own weight.

Chemical Durability

The resistance to attack of different glasses by various chemicals may vary depending to a great extent upon temperature and pH values. The best way to determine which glass is most satisfactory is by simultaneous testing. Table 4 gives some representative figures for the glasses.

Table 4. Relative Chemical Durability*

	5% NaOH	5% HCl
PYREX Glass No. 7740	5.0	0.005
VYCOR Glass No. 7913	4.0	0.020

*Weight Loss mg/cm^2 (a) in 24 hours at 95°C. (Milligrams of glass removed per cm^2 surface area exposed to reagent.)

The coating on PYREXPLUS glassware is designed to resist leakage resulting from a brief chemical exposure that might occur if the vessel is broken. Prolonged and/or repeated chemical exposure of the coating to aldehydes, ketones, chlorinated solvents and concentrated acids should be avoided.

SUGGESTIONS FOR SAFE USE OF PYREX® GLASSWARE

PYREX glassware has proven itself to be tough and reliable during over 90 years of demanding use in the laboratory environment. The PYREX name is associated with high quality, corrosion and thermally resistant laboratory glassware throughout the world.

Corning® products are designed and produced with safety in mind, but it's very important to remember that most glassware products are designed for specific applications. Be sure you have the right piece of glassware for the use you have in mind. Using laboratory glassware for applications other than those it was designed for can be dangerous.

Lab safety is one of the most critical concerns of any lab. To help improve lab safety, Corning has compiled these common sense suggestions concerning the safe use of glass and plastic labware.

Safely Using Chemicals

When working with volatile materials, remember that heat causes expansion, and confinement of expansion results in explosion. Remember also that danger exists even though external heat is not applied.

Do not mix sulfuric acid with water inside a cylinder. The heat from the reaction can break the base of the vessel because of the thickness of the base and the seal.

Perchloric acid is especially dangerous because it explodes on contact with organic materials. Do not use perchloric acid around wooden benches or tables. Keep perchloric acid bottles on glass or ceramic trays having enough volume to hold all the acid in case the bottle breaks. Always wear protective clothing when working with perchloric acid.

Glass will be chemically attacked by hydrofluoric acid, hot phosphoric acid and strong hot alkalis, so it should never be used to contain or to process these materials.

Always flush the outside of acid bottles with water before opening. Do not put the stopper on the counter top where someone else may come in contact with acid residue.

Mercury is highly toxic. Special care is needed when dealing with mercury. Even a small amount of mercury in the bottom of a drawer can poison the room atmosphere. Mercury toxicity is cumulative, and the element's ability to amalgamate with a number of metals is well known. After an accident involving mercury, the area should be cleaned carefully until there are no globules remaining. Check with your local safety office for assistance. All mercury containers should be well labeled and kept tightly closed.

DO NOT taste chemicals for identification. Smell chemicals only when necessary and only by wafting a small amount of vapor toward the nose.

Never fill a receptacle with material other than that specified by the label. Label all containers before filling. Dispose of the contents of unlabeled containers properly. All bottles and containers holding chemicals shall be accurately and clearly labeled. Whenever possible, hazards and necessary precautions shall also be included on the label.

For over 90 years PYREX glass has provided researchers with high quality, corrosion and thermally resistant laboratory glassware.

Always work in a well-ventilated area. When working with chlorine, hydrogen sulfide, carbon monoxide, hydrogen cyanide and other very toxic substances, always use a protective mask or perform these experiments under a fume hood in a well-ventilated area. Cryogenic liquids should be stored and handled in well-ventilated areas to prevent excessive buildup of gas concentration. These should never be used in closed environmental chambers.

Safely Handling Glassware

Handle glassware carefully. Hold beakers, bottles and flasks by the sides and bottoms rather than by the tops. The rims of beakers or necks of bottles and flasks may break if used as lifting points. Be especially careful with multiple neck flasks.

Never drink from a beaker. A standard beaker or other laboratory vessel used specifically for drinking is a personal health hazard in the laboratory. Use disposable or recyclable cups. Never drink from any standard laboratory product to avoid any possibility of personal injury or health hazard.

Avoid over tightening clamps. To avoid breakage while clamping glassware, use coated clamps to prevent glass-to-metal contact, and do not use excessive force to tighten clamps. Neck clamps should not be used as sole support for vessels larger than 500 mL.

Heating and Cooling

Always watch evaporation work closely. A vessel, heated after evaporation has already occurred, may crack.

Do not put hot glassware on cold or wet surfaces, or cold glassware on hot surfaces. It may break with the temperature change. Although PYREX® and VYCOR® products can take extreme temperatures, always use caution.

Do not heat glassware that is etched, cracked, chipped, nicked, or scratched. It is more prone to break.

Glassware with thick walls, such as bottles and jars, should not be heated over a direct flame or comparable heat source. We suggest the use of our 16790 VYCOR immersion heater.

Do not heat glassware directly on electrical heating elements. Excessive stress will be induced in the glass, and this can result in breakage.

Do not look down into any vessel being heated. A reaction might cause the contents to be ejected.

Be sure to check laboratory or product instruction manuals when working with heat sources.

Cool all glassware slowly to prevent breakage, unless you are using VYCOR glassware which can go from high heat to ice water with no damage.

Use extra care when removing glassware, especially bottles, from ultra-low temperature freezers (-70º to -150ºC) to prevent thermal shock and cracking. For best results immediately rinse the entire bottle under cold running water until thawing begins. Never place bottles directly from the freezer into warm water baths.

Bunsen Burners

Adjust Bunsen burners to get a large soft flame. It will heat slowly but also more uniformly. Uniform heating is a critical factor for some chemical reactions.

Adjust the ring stand or clamp holding the glassware so that the flame touches the glass below the liquid level. Heating above the liquid level does nothing to promote even heating of the solution and could cause thermal shock and breakage of the vessel. A ceramic-centered wire gauze in the ring will diffuse the burner flame to provide more even heat.

Rotate test tubes to avoid overheating one particular area. Uniform heating may be critical to your experiment.

Heat all liquids slowly. Fast heating may cause bumping, which in turn may cause the solution to splatter.

Hot Plates

There are several types of hot plates. Some are heated electrically, some are water-heated. They may have a ceramic or metal top. You should consult your hot plate product manual before using a hot plate for the first time.

On hot plates the entire top surface heats and then remains warm for some time after you have turned the hot plate off. Be careful with any hot plate that has recently been used.

When using electrically heated hot plates be sure to check the wiring and the connector plug for wear. If signs of wear appear, have the plug and/or wire replaced immediately. Do not use the hot plate until it is repaired. A frayed wire or damaged plug can cause a severe electrical shock.

Corning offers digital hot plates that can also stir and control the temperature of the solution stirring in the vessel.

Always use a hot plate larger than the bottom of the vessel being heated.

Corning® Digital Hot Plates have a PYROCERAM® top made of a glass-ceramic material that resists chemical attack, is easy to clean, and provides even heat. The top of the hot plate overhangs the body to keep solutions from spilling into the body of the unit. It also turns a pale yellow when heated above 400°F.

Corning PYROCERAM hot plates should not be used to heat metal vessels.

They are not explosion proof and should not be used to heat or stir volatile or flammable materials. Do not use them in the vicinity of volatile or flammable materials.

Thick walled glassware, such as jars, bottles, cylinders and filter flasks, should never be heated on hot plates.

Autoclaving

Autoclaves are widely used to sterilize instruments, glassware and plasticware, solutions and media as well as to decontaminate biological wastes. Because of the physical hazards (e.g. heat, steam and pressure) associated with autoclaves, extra care must be taken to ensure their safe use. Each autoclave has unique characteristics and operating requirements. Review and understand the owner's manual before using any autoclave for the first time and as needed thereafter. Also follow all of your institution's safety regulations for autoclaving.

Corning recommends the following safety practices when autoclaving laboratory glassware:

- Never autoclave items containing corrosives (e.g. acids, bases, and phenol), solvents or volatiles (e.g. ethanol, methanol, chloroform) or radioactive materials.
- Use only borosilicate glassware, such as PYREX glass, which can better withstand the stresses of autoclave temperatures and pressures.
- Load the autoclave properly as per the manufacturer's recommendations.
- Individual glassware pieces should be placed within a heat resistant plastic or metal tray on a shelf or rack and never placed directly on the autoclave bottom or floor.
- Check any plastic caps, tubing or other items to ensure they can be safely autoclaved with the glassware.
- Add 1/4 to 1/2 inch of water to the tray so the glassware will heat more evenly.

- Fill glassware only half full with liquids to be sterilized. Take into account the volume of liquid to be autoclaved. A 2L flask containing 1L of liquid takes much longer to sterilize than four 500 mL flasks each containing 250 mL of liquid.
- Do a test run when autoclaving larger volumes of liquid to make sure the liquid has reached 121ºC. Suspend an autoclave thermometer (with a thin wire) in the middle of the liquid filled container to record the highest temperature reached. Then check its reading after the autoclave run is finished, if the temperature is too low then the run time will need to be increased or the volume will need to be reduced.
- Large heavy glassware, such as 3L or larger spinner flasks and 5L or larger bottles and carboys, should have a small amount of distilled water placed inside them to help generate steam when they are being sterilized empty in an autoclave.
- To prevent bottles from shattering during pressurization, the caps of containers with liquids must be fully loosened before loading. Always use the slow exhaust or liquid cool cycle after autoclaving liquids to prevent liquid boil over which can result in loss of contents.
- Never autoclave a sealed container of liquids as this may result in an explosion of super-heated liquid during the cycle or when the container is opened.
- Wear heat-resistant gloves when opening the autoclave door after a cycle. At a minimum, when removing items from an autoclave, a rubber apron, rubber sleeve protectors and heat-resistant gloves should be worn.
- Wait 5 minutes before removing dry glassware from the autoclave, and wait 10 to 20 minutes for glassware containing liquids. The larger the volume of liquid the longer you should wait. Liquids removed too soon may boil and overflow the vessel, burning the operator.
- DO NOT tighten caps on vessels immediately after autoclaving as the vacuum resulting from the cooling of the steam in the vessel will stress the glass and possibly cause the bottles to break. This is especially important on larger vessels.
- To avoid thermal shock do not place hot, liquid filled bottles onto cold, wet or metal surfaces. It is safer to let bottles containing hot liquids cool before moving them.

Mixing and Stirring

Use a rubber policeman on glass or metal stirring rods, or use Teflon® rods to prevent scratching the inside of a vessel.

Do not mix sulfuric acid with water inside a cylinder. The heat from the reaction can break the base of the vessel.

Be careful using large stir bars to mix solutions at high speed inside thin wall glass vessels such as volumetric flasks. If the stir bar decouples while stirring it can shatter the vessel.

Using Stopcocks

Glass stopcocks on burets and separatory funnels should be lubricated frequently to prevent sticking. If one does stick, a stopcock plug remover, available from laboratory supply houses, should be used to remove it.

Two types of lubricant are commonly used on standard taper joints:

(a) Hydrocarbon stopcock grease is the most widely used. It can be easily removed by most laboratory solvents, including acetone.

(b) Because hydrocarbon grease is so easily removable, silicone stopcock grease is often preferred for higher temperature or high vacuum applications. It can be removed readily using chlorinated solvents.

Corning offers three types of stopcocks:

PYREX® All Glass Stopcocks

General purpose PYREX glass stopcocks with $ symbol are manufactured with 1:10 tapers and finishes as specified in ASTM E-675. They feature interchangeable solid glass plugs. They can function safely at vacuums down to 10^{-4} torr (mm of mercury) with minimal leakage.

PYREX all-glass stopcocks should be lubricated to prevent sticking.

Rotaflo® in-line stopcock can be used at vacuums down to 10^{-8} torr and require no lubrication.

PYREX Glass Bodied Stopcocks with Teflon Plugs

These general purpose stopcocks are marked with the $ symbol and manufactured with 1:5 tapers and finishes, as specified by ASTM. Because no lubricant is needed, they are ideal for applications where grease contamination is a factor.

Rotaflo Stopcocks

Rotaflo high performance stopcocks can be used under varying conditions ranging from general purpose to high vacuum applications. These stopcocks are ideal for applications where contamination is a factor; they do not require grease, only PTFE and borosilicate glass come in contact with liquids or gases. The Rotaflo stopcock is designed to function safely at vacuums down to 10^{-8} torr (mm of mercury) with minimal leakage. They can be used at temperatures ranging from -20°C to 200°C and autoclaved at 20 psi and 126°C.

Joining and Separating Ground Joints and Stopcocks

When glassware with stopcocks, ground joints or glass or polymer stoppers are not in use for an extended period of time, it is best to take them apart to prevent sticking. Remove the grease from the joints. Teflon stoppers and stopcocks should be loosened slightly. For easy storage and reuse, put a strip of thin paper between ground joint surfaces.

If a ground joint sticks, the following procedure will generally free it. Immerse the joint in a glass container of freshly poured carbonated liquid (soda). You will be able to see the liquid penetrate between the ground surfaces. When the surfaces are wet (allow 5 to 10 minutes submersion) remove the joint and rinse with tap water. Wipe away excess water. Then gently warm the wall of the outer joint by rotating it for 15 to 20 seconds over a low Bunsen burner flame. (Be sure that 50% of the inner surface is wet before inserting the joint in the flame.) Remove from the flame and, taking care to protect your hands and fingers, gently twist the two members apart. If they do not come apart, repeat the procedure. Never use force separating joints by this method.

Do not store alkaline solutions in glass stoppered bottles and flasks; they may stick.

We recommend applying a light coat of stopcock or other grease completely around the upper part of the joint. Use only a small amount and avoid greasing that part of the joint which contacts the inner part of the apparatus.

Three types of lubricant are commonly used on standard taper joints:

(a) Hydrocarbon grease is the most widely used. It can be easily removed by most laboratory solvents, including acetone.

(b) Because hydrocarbon grease is so easily removable, silicone grease is often preferred for higher temperature or high vacuum applications. It can be removed readily with chlorinated solvents.

(c) For long-term reflux or extraction reactions, a water-soluble, organic-insoluble grease, such as glycerin, is suitable. Water will wash off glycerin.

Using Rubber Stoppers

Always try to use rubber stoppers that fit approximately halfway into the vessel opening being sealed (Table 5).

Wet both tubing and stopper with glycerin or water when trying to insert glass tubing into a rubber stopper or flexible plastic tubing. *Caution*: ALWAYS protect hands with a towel or leather gloves when cutting or inserting glass tubing. Hold elbows close to the body to limit movement when handling tubing. Always pull rather than push on the glass tubing when possible.

Fire polish rough ends of glass tubing before inserting into flexible tubing or through a stopper. If it becomes impossible to remove a thermometer from a rubber stopper, it is best to cut away the stopper rather than to risk breaking the thermometer.

Vacuum Applications

All glass containers used in vacuum work or which are under vacuum must be securely and adequately taped or shielded to restrain flying glass in the event of an implosion or other accident. Always wear safety glasses, goggles, or a face shield.

Never use glassware that is etched, cracked, chipped, nicked, or scratched. It is more prone to break, especially under vacuum applications or if heated. Never use glass containers for vacuum applications that have been repaired.

Do not use round PYREX® glass screw cap storage bottles larger than 2L with bottle top vacuum filters or for any other vacuum applications. Never use square glass or plastic storage bottles of any size with bottle top vacuum filters or for any other vacuum applications. Never use any bottle under positive pressure.

Never use an Erlenmeyer flask under vacuum as a filtering flask. Filtering flasks are manufactured with extra thick walls to withstand vacuum applications. Corning recommends using PYREXPLUS® coated filtering flasks for an extra margin of safety.

Not all PYREX desiccators are designed for vacuum applications. Vacuum rated desiccators are only rated to one atmosphere of vacuum. Never heat a vacuum desiccator. Never carry or move a desiccator while it is under vacuum.

Because of variations in conditions, Corning cannot guarantee any glassware against breakage under vacuum or pressure. Adequate precautions should be taken to protect personnel doing such work.

Table 5. Selecting Rubber Stoppers *(All measurements are in mm)*

Stopper Size (U.S.)	Diameter		Length	Fits openings with	
	Top	Bottom		O. D.	I. D.
000	12.7	8.2	21	10 to 12	8.2 to 10
00	15	10	25	12 to 15	10 to 13
0	17	13	25	16 to 18	13 to 15
1	19	14	25	19 to 20	15 to 17
2	20	16	25	20 to 21	16 to 18.5
3	24	18	25	22 to 24	18 to 21
4	26	20	25	25 to 26	20 to 23
5	27	23	25	27 to 28	23 to 25
5½	28	24	25	28 to 29	25 to 26
6	32	26	25	29 to 30	26 to 27
6½	34	27	25	30 to 34	27 to 31.5
7	37	30	25	35 to 38	30 to 34
8	41	33	25	38 to 41	33 to 37
9	45	37	25	41 to 45	37 to 41
10	50	42	25	45 to 50	42 to 46
10½	53	45	25	48 to 51	45 to 47
11	56	48	25	52 to 56	48 to 51.5
11½	63	50	25	57 to 61	51 to 56
12	64	54	25	62 to 64	54 to 59
13	68	58	25	64 to 68	58 to 63
14	90	75	39	80 to 90	75 to 85
15	103	83	39	92 to 100	83 to 95

SUGGESTIONS FOR SAFE USE OF PYREXPLUS GLASSWARE

PYREXPLUS glassware is coated with a tough, transparent plastic vinyl. The coating, which is applied to the outside of the vessel, helps prevent exterior surface abrasion. It also helps minimize the loss of contents and helps contain glass fragments if the glass vessel is broken.

Your attention to a few details regarding the use and care of this product will maximize product life and will provide you with a safer laboratory vessel.

PYREXPLUS separatory funnels have a protective PVC coating for better gripping and to reduce spills.

- Do not place PYREXPLUS® glassware over direct heat or open flame.
- Do not expose to dry heat above 110°C (230°F).
- Do not autoclave above 121°C (250°F).
- Do not continuously expose PYREXPLUS glassware to temperatures above 80°C.
- Do not refrigerate below -20°C (-4°F).
- Do not remove the protective coating. Do not use a vessel on which the coating is hardened, darkened or otherwise damaged.
- Do not use PYREXPLUS glassware to store hazardous chemicals below room temperature.
- Do not allow prolonged or repeated exposure of the coating to strong acids or solvents.
- Do not use a vessel once the glass is broken. Immediately transfer the contents of a broken vessel to an approved container and properly dispose of the broken vessel.
- Do not incinerate broken or discarded vessels. Place in proper disposal containers.

Proper care and handling of PYREXPLUS glassware or any labware will greatly increase its life and increase the safety of your workplace. The following suggestions will help you get the most from your PYREXPLUS glassware.

Exposure to Heat

PYREXPLUS glassware is designed to withstand the temperatures associated with steam sterilization. However, it should not be placed over direct heat or an open flame. Prolonged exposure to dry heat above 80°C may also cause the coating to become brittle and thereby reduce the useful life of the vessel. A brown appearance or hardening of the tough coating is a sign that the coating has become brittle and should be discarded.

The upper temperature limit for PYREXPLUS glassware is 110°C (230°F). PYREXPLUS glassware should not be exposed to elevated temperature in a vacuum greater than 5 inches (127 mm) mercury.

Exposure to Cold

PYREXPLUS glassware should not be exposed to temperature below -20°C (-4°F). Extremely low temperatures may result in the coating becoming cracked. Exposure to temperatures below room temperature (23°C or 73°F) can temporarily reduce the ability of the coating to contain its contents if the vessel is broken.

Exposure to Chemicals

The coating of PYREXPLUS glassware is designed to resist leakage resulting from a brief chemical exposure that might occur if the vessel is broken. Prolonged and/or repeated chemical exposure of the coating to aldehydes, ketones, chlorinated solvents and concentrated acids should be avoided.

Exposure to Ultraviolet

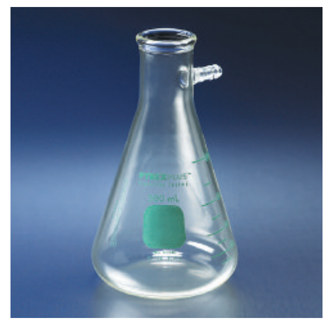
Prolonged and/or repeated exposure of the PYREXPLUS glassware coating to direct sunlight or ultraviolet sources (such as sterilization lamps) is not recommended.

Exposure to Microwave

PYREXPLUS glassware is completely microwave safe. However, as with any microwave vessel, be sure there is a load (water or other microwave absorbing material) in the microwave oven. Also, be sure all caps and closures are loosened.

Exposure to Vacuum

PYREXPLUS containers have demonstrated the ability to contain glass fragments upon implosion at room temperature. Only the 250 mL to 2L screw cap round storage bottles and the filter flasks are recommended for use under vacuum applications. In keeping with safe laboratory practice, always use a safety shield around vessels under negative pressure.



PYREXPLUS coated heavy wall filter flasks are ideal for vacuum aspiration.

Autoclaving

PYREXPLUS glassware can be successfully sterilized repeatedly (Table 6) using liquid or dry cycle sterilization which involves no vacuum or low vacuum (less than 5 inches mercury).

Table 6. Recommended Cycles for PYREXPLUS Glassware in Automated Autoclaves

	Autoclave Type	
Autoclave Cycle	Gravity	Prevacuum
Liquid	Yes	Yes
Dry	Yes	No
Prevac	-	No

Caution: Always autoclave vessels with loose caps or closures.

Sterilization time should not exceed 15 minutes at 121°C (250°F). Drying time should not exceed 15 minutes at 110°C (230°F). The actual cavity temperature of the autoclave should be checked to be sure the autoclave temperature does not exceed the recommended sterilization and drying temperature. Vessels should not be allowed to touch each other during autoclaving.

It is better to use a slow cool cycle for venting rather than fast venting to reduce the chance that air pockets will form between the glass and the coating.

Should the coating appear clouded due to dissolved moisture, simply let dry overnight at room temperature or briefly heat to 110°C (230°F).

Labeling and Marking

Use water-based markers for temporary marking or labeling of the PYREXPLUS® glassware coating. Solvent-based markers, dyes and stains cannot be removed from the coating.

Note: A slight "plastic" odor may be detected when handling PYREXPLUS glassware. This is due to additives in the plastic coating which are responsible for its superior performance. The odor is normal and will not affect the inertness of the inside borosilicate glass surface.

SUGGESTIONS FOR SAFE USE OF FRITTED GLASSWARE

Corning's line of fritted PYREX® glassware encompasses numerous applications including vacuum filters, thimbles for Soxhlet solvent extraction, and Gooch crucibles and Buchner funnels for collecting precipitates. Fritted gas washing bottles are used to saturate a liquid with a specific gas but can also be used to saturate the CO_2 gas mixtures with water to better maintain high humidity levels in cell culture incubators

Gas washing bottles with fritted discs are a very effective way to humidify carbon dioxide-air mixtures for maintaining high humidity in gassed cell culture incubators.

Selecting Fritted Glassware

There are five different porosities of PYREX fritted glassware so that precipitates varying in size can be filtered at maximum speed with no sacrifice of retention. Porosity is controlled in manufacture and discs are individually tested and graded into these classifications. The extra coarse and coarse porosities are held toward the maximum pore diameter as listed. The medium and fine are held toward the minimum pore diameter as listed (Table 7). The porosity for the pore diameter of the filter is determined in the same manner as specified in ASTM E-128, *Maximum Pore Diameter and Permeability of Rigid Porous Filters for Laboratory Use*. Also, where the size of the piece permits, it is marked with the ASTM designation followed by the pore range as shown in the column Nominal Maximum Pore Size.

The "whiteness" of various fritted products may vary slightly from piece to piece due to minor color variations in the batch mix. This color variation does not affect product filtration performance nor is it frit contamination.

Proper Care of Fritted Glassware

Cleaning

A new fritted filter should be washed by suction with hot hydrochloric acid and then rinsed with water before it is used. This treatment will remove loose particles of foreign matter such as dust. It is advisable to clean all PYREX fritted filters as soon as possible after use. This will prolong their life.

Many precipitates can be removed from the filter surface simply by rinsing from the reverse side with water under pressure not exceeding 15 lb/sq. in. Drawing water through the filter from the reverse side with a vacuum pump is also effective. Some precipitates tend to clog the pores of a fritted filter and may require special cleaning solutions (Table 8).

Table 8. Recommended Cleaning Solutions for PYREX Fritted Glassware

Material	Cleaning Solution
Fatty materials	Carbon tetrachloride
Organic matter	Hot concentrated cleaning solution, or hot concentrated sulfuric acid plus a few drops of sodium or potassium nitrite.
Albumen	Hot ammonia or hot hydrochloric acid
Glucose	Hot mixed acid; H_2SO_4 + HNO_3)
Copper or Iron Oxides	Hot hydrochloric acid plus potassium chlorate
Mercury Residue	Hot nitric acid
Silver Chloride	Ammonia or sodium hyposulfite
Viscose	5-10% NaOH, followed by cleaning solution
Aluminous and Siliceous Residues	2% hydrofluoric acid followed by concentrated sulfuric acid; rinse immediately with distilled water followed by a few mL of acetone. Repeat rinsing until all traces of acid are removed.

Table 7. Fritted Glassware Porosities

Porosity	Catalog Abbreviation	Nominal Maximum Pore Size (µm)	Principal Uses
Extra Coarse	EC	170 - 220	Filtration of very coarse materials. Gas dispersion, gas washing, extractor beds, support of other filter materials
Coarse	C	40 - 60	Filtration of coarse materials. Gas dispersion, gas washing, gas absorption. Mercury filtration. Extraction apparatus.
Medium	M	10 -15	Filtration of crystalline precipitates. Extraction apparatus. Removal of "floaters" from distilled water.
Fine	F	4 - 5.5	Filtration of fine precipitates. Mercury valve. Extraction apparatus.
Ultra-Fine	UF	0.9 -1.4	Filtration of Bacteria. (Not recommended for sterile filtering.)

Operating Pressures

Fritted glassware is designed primarily for vacuum filtration or for gas flow at relatively low pressures. If used for pressure work, the MAXIMUM differential on the disc should not exceed 15 pounds per square inch. Care should be taken when preparing sample solutions to avoid trapping air. If dissolved air is present, the flow rate may be reduced by up to 50%.

Thermal Limitations

The resistance to thermal shock of fritted glassware is less than that of solid PYREX® glassware. Therefore, fritted glassware should not be subjected to excessive temperature changes or to direct flame. Dry fritted crucibles at room temperature may be placed into a drying oven operating at 150°C. Fritted glassware may be safely heated in a furnace to 500°C without ill effect, provided that the cycle of heating and cooling is gradual.

Corning® 5646 series VERIFIED volumetric flasks are guaranteed to meet Class A volumetric tolerances on every single flask.

Each flask is labeled with "VERIFIED" and a lot number. With this information you can access a Certificate of Analysis with lot specific data regarding both measurements and methods.

SUGGESTIONS FOR SAFE USE OF VOLUMETRIC GLASSWARE

The accuracy of volumetric glassware depends on the precision used in calibrating it, using the correct type of product, handling the glassware properly and ensuring the glassware is clean.

Calibration of volumetric glassware is usually done at 20°C, and the glassware should be used at approximately this temperature. Refrigerated liquids should be allowed to come to room temperature before measuring them.

Never apply heat directly to empty glassware used for volumetric measurements. Such glassware should be dried at temperatures of no more than 80°C to 90°C.

Be careful using large stir bars to mix solutions at high speed inside thin wall volumetric flasks. If the stir bar decouples while stirring it can shatter the vessel.

Types of Volumetric Glassware

- **Serialized/Certified flasks** are calibrated to Class A specifications. Each flask is individually serialized and furnished with a Certificate of Identification and Capacity, traceable to NIST standards, guaranteeing its calibration.
- **VERIFIED** Class A flasks are manufactured using a process that validates the measurement of each individual flask's capacity per ASTM E-542 during production, guaranteeing conformance to Class A specifications called out in ASTM E-288. Each flask is labeled with "VERIFIED" and has a lot number enabling you to access a Certificate of Analysis with lot specific data regarding both measurements and methods.
- **Class A flasks** are manufactured to tolerances established by ASTM E-694 for volumetric ware, ASTM E-542 for calibration of volumetric ware and ASTM E-288 for volumetric flasks. Utilizes the same tolerances as Certified and Verified flasks, but are not individually certified or verified. Lot specific certificates of compliance are available but contain no lot specific data.
- **Class B flasks** are generally calibrated to twice the tolerance of Class A flasks.
- **Other Types:** There are also some specifications for other calibrate glassware, set by various Federal Bureaus or professional societies. Tolerances for these and references to the specification are found in Corning's laboratory catalog under individual product descriptions.

Calibrated Glassware Markings

Lines on graduated ware may be acid etched, wheel engraved, abrasive blasted, enameled, or permanently stained into the glass. Etched or engraves lines are usually colored by fired-in enamels. The width of the lines should not exceed 0.4 mm for subdivided ware or 0.6 mm for single line ware.

In addition to the lines, volumetric glassware should be marked with its capacity, the temperature at which it should be used and whether the piece was calibrated TC, "to contain," or TD, "to deliver" the stated volume. TC means that the ware is calibrated so that the mark indicates the volume held in the container. TD means the mark indicates the amount of air-free distilled water at 20°C that is delivered when it is poured out.

Numbers indicating volume at certain lines are placed immediately above the line. Major calibrations on burets, pipets, and cylinders nearly encircle the body; intermediate lines go two-thirds around and minor lines at least half way. Volumetric flask markings must cover at least 90% of the neck circumference.

Reading Volumetric Glassware

ASTM E 542 details the method of reading the meniscus as follows: For all apparatus calibrated by this procedure, the reading or setting is made on the lowest point of the meniscus. In order that the lowest point may be observed, it is necessary to place a shade of some dark material immediately below the meniscus, which renders the profile of the meniscus dark and clearly visible against a light background. A convenient device for this purpose is a collar-shaped section of thick black rubber tubing, cut open at one side and of such size as to clasp the tube firmly. Alternatively, black paper may be used.

Corning's laboratory products are calibrated in accordance with clause 7.3.2.1 of ASTM E 542 which states: "The position of the lowest point of the meniscus with reference to the graduation line is horizontally tangent to the plane of the upper edge of the graduation line. The position of the meniscus is obtained by having the eye in the same plane of the upper edge of the graduation line."

SUGGESTIONS FOR CLEANING AND STORING GLASSWARE

Clean glassware is critical for both chemical and biological applications, although the criteria for cleanliness may be different.

Good laboratory technique demands clean glassware, because the most carefully executed piece of work may give an erroneous result if dirty glassware is used. In all instances, glassware must be physically clean; it must be chemically clean; and in many cases, it must be sterile. All glassware must be absolutely grease-free. The safest criterion of cleanliness is uniform wetting of the surface by distilled water. This is especially important in glassware used for measuring the volume of liquids. Grease and other contaminating materials will prevent the glass from becoming uniformly wetted. This in turn will alter the volume of residue adhering to the walls of the glass container and thus affect the volume of liquid measured or delivered. Furthermore, in pipets and burets, the meniscus will be distorted and the correct adjustments cannot be made. The presence of small amounts of impurities may also alter the meniscus.

Safety Considerations

Eye protection and heavy duty slip-resistant and chemically resistant gloves should be used when washing glassware. Depending on the detergents and cleaning solutions being used an apron and fume hood may also be required. Always check with your Safety Office before using caustic washing solutions.

Cleaning PYREX® Glassware

Wash glassware as quickly as possible after use. The longer it is left unwashed the harder it will be to clean. If a thorough cleaning is not possible immediately, disassemble the glassware and put it to soak in water. This is especially important for ground glass stopcocks and stoppers. If glassware is not cleaned immediately, it may become impossible to remove the residue. Do not overload sinks, dishwashers, or soaking bins. Rubber sink and counter mats can help reduce the chance of breakage and resultant injury.

Most new glassware is slightly alkaline in reaction. For precision chemical tests, new glassware should be soaked several hours in acid water (a 1% solution of hydrochloric or nitric acid) before washing.

Glassware Cleaners

When washing glassware, soap, detergent, or cleaning powder (with or without an abrasive) may be used. Cleaners for glassware include Alconox®, Liquinox®, Lux®, Tide® and Fab®. The water should be hot. For glassware that is exceptionally dirty, a cleaning powder with a very mild abrasive action, such as BonAmi®, will give more satisfactory results. The abrasive should not scratch the glass.

During the washing, all parts of the glassware should be thoroughly scrubbed with a brush. This means that a full set of brushes should be available: brushes to fit large and small test tubes, burets, funnels, graduates and various sizes of flasks and bottles. Brushes with wooden or plastic handles are recommended as they will not scratch or abrade the glass surface. Motor driven revolving brushes are valuable when a large number of tubes or bottles are processed. Do not use cleaning brushes that are so worn that the brush spine hits the glass. Serious scratches may result. Scratched glass is more prone to break during experiments. Any mark in the uniform surface of glassware is a potential breaking point, especially when the piece is heated or used in vacuum applications. Do not allow acid to come into contact with a piece of glassware before the detergent (or soap) is thoroughly removed. If this happens, a film of grease may be formed.

Other Cleaning Methods

Caution! The following methods can cause serious damage to the eyes, mucus membranes, skin and lungs and should only be undertaken by people trained in their proper use and fully equipped with heavy duty slip resistant and chemically resistant gloves, eye protection, lab coat, apron and, when appropriate, a fume hood.

If glassware becomes unduly clouded or dirty or contains coagulated organic matter, it must be cleansed with more aggressive and potentially dangerous cleaning solutions often using concentrated acids or bases. Special types of precipitates may require removal with nitric acid, aqua regia or fuming sulfuric acid. These are very corrosive substances and should be used only when required. Chromic acid, commercially available as Chromerge®, dissolved in concentrated sulfuring acid is also a very powerful cleaner. However, the use of Chromerge or other chromate-based cleaning solutions is not recommended in many research laboratories because the chromium ions are highly toxic to the environment and pose a severe waste disposal problem, even in small quantities. In addition, the chromium present in Chromerge is considered to be a potent human carcinogen. A safer alternative is the use of NoChromix, containing hydrogen peroxide, which is also made up in sulfuric acid. While still very caustic, it does not contain any toxic chromium. Please follow the manufacturer's direction for use of this product.

When NoChromix solution is used the glassware may be rinsed with the cleaning solution or it may be filled with it and allowed to stand. The length of time it is allowed to stand depends on the amount of contamination on the glassware. Relatively clean glassware may require only a few minutes of exposure; if debris is present, such as blood clots, it may be necessary to let the glassware stand all night. Due to the intense corrosive action of the NoChromix solution, it is good practice to place the stock bottle, as well as the glassware being treated, in flat glass pans or pans made from plastic polymer determined to be compatible with the concentration of NoChromix you are using. Extra care must be taken to be sure all caustic cleaning solutions are disposed of properly.

Removing Grease

Grease is best removed by boiling in a weak solution of sodium carbonate. Acetone or any other fat solvent may be used. Strong alkalis should not be used. Silicone grease is most easily removed by soaking the stopcock plug or barrel for 2 hours in warm decahydronaphthalene. Grease can also be removed from ground joints by wiping with a paper towel soaked in acetone or other appropriate solvent. Use a fume hood to minimize exposure to the fumes.

Drain and rinse degreased glassware with acetone or use fuming sulfuric acid for 30 minutes. Be sure to rinse off all of the cleaning agents.

Rinsing

It is imperative that all soap, detergents and other cleaning fluids be removed from glassware before use. This is especially important with the detergents, slight traces of which will interfere with serologic and cell culture applications.

After cleaning, rinse the glassware with running tap water. When test tubes, graduates, flasks and similar containers are rinsed with tap water, allow the water to run into and over them for a short time, then partly fill each piece with water, thoroughly shake and empty at least six times. Pipets and burets are best rinsed by attaching a piece of rubber tubing to the faucet and then attaching the delivery end of the pipets or burets to a hose, allowing the water to run through them. If the tap water is very hard, it is best to run it through a deionizer or reverse osmosis system before using.

Next rinse the glassware in a large bath of high purity or distilled water. Then do a final individual rinse of each item with high purity water. To conserve water, use a five gallon bottle as a reservoir. Store it on a shelf near your clean-up area.

Cleaning Pipets

Place pipets, tips down, in a cylinder or tall jar of water immediately after use. Do not drop them into the jar, since this may break or chip the tips and render the pipets useless for accurate measurements. A pad of cotton or glass wool at the bottom of the jar will help to prevent breaking of the tips. Be certain that the water level is high enough to immerse the greater portion or all of each pipet. At a convenient time, the pipets may then be drained and placed in a cylinder or jar of dissolved detergent or, if exceptionally dirty, in a jar of chromic acid cleaning solution. After soaking for several hours, or overnight, drain the pipets and run tap water over and through them until all traces of dirt are removed. Soak the pipets in distilled water for at least 1 hour. Remove from the distilled water, rinse, dry the outside with a cloth, shake the water out and dry.

In laboratories where a large number of pipets are used daily, it is convenient to use an automatic pipet washer. Some of these, made of metal, are quite elaborate and can be connected directly by permanent fixtures to the hot and cold water supplies. Others, such as those made with polyethylene, are less elaborate and can be attached to the water supplies by a rubber hose. Polyethylene baskets and jars may be used for soaking and rinsing pipets in chromic acid cleaning solution. Electrically heated metallic pipet driers are also available.

After drying, place chemical pipets in a dust-free drawer. Wrap serologic and bacteriologic pipets in paper or place in pipet cans and sterilize in the dry air sterilizer at 180°C for 2 hours. Pipets used for transferring infectious material should have a plug of cotton placed in the top end of the pipet before sterilizing. This plug of cotton will prevent the material being measured from being drawn accidentally into the pipetting device. Corning also offers a full line of sterile, ready to use disposable glass and plastic pipets to eliminate the need for cleaning and sterilizing.

Cleaning Burets

Remove the stopcock or rubber tip and wash the buret with detergent and water. Rinse with tap water until all the dirt is removed. Then rinse with distilled water and dry.

Wash the stopcock or rubber tip separately. Before a glass stopcock is placed in the buret, lubricate the joint with stopcock lubricant. Use only a small amount of lubricant.

Burets should always be covered when not in use.

Cleaning Fritted Ware

A new fritted filter should be washed by suction with hot hydrochloric acid and then rinsed with water before it is used. This treatment will remove loose particles of foreign matter such as dust. It is advisable to clean all PYREX® fritted filters as soon as possible after use. This will prolong their life.

Many precipitates can be removed from the filter surface simply by rinsing from the reverse side with water under pressure not exceeding 15 lb/sq. in. Drawing water through the filter from the reverse side with a vacuum pump is also effective. Some precipitates tend to clog the pores of a fritted filter and may require special cleaning solutions (Table 9).

Table 9. Recommended Cleaning Solutions for PYREX® Fritted Glassware

Material	Cleaning Solution
Fatty materials	Carbon tetrachloride
Organic matter	Hot concentrated cleaning solution, or hot concentrated sulfuric acid plus a few drops of sodium or potassium nitrite.
Albumen	Hot ammonia or hot hydrochloric acid.
Glucose	Hot mixed acid; H_2SO_4 + HNO_3).
Copper, or Oxides	Hot hydrochloric acid plus potassium Iron chlorate.
Mercury Residue	Hot nitric acid.
Silver Chloride	Ammonia or sodium hyposulfite.
Viscose	5-10% NaOH, followed by cleaning solution.
Aluminous and Siliceous Residues	2% hydrofluoric acid followed by concentrated sulfuric acid; rinse immediately with distilled water followed by a few milliliters of acetone. Repeat rinsing until all traces of acid are removed.

Slides and Cover Glass

It is especially important that microscope slides and cover glass used for the preparation of blood films or bacteriologic smears be perfectly clean and free from scratches. Slides should be washed, placed in glacial acetic acid for 10 minutes, rinsed with distilled water and wiped dry with clean paper towels or cloth.

Before use, wash with alcohol and wipe dry. Or the slides, after acid treatment and rinsing, may be placed in a wide jar and covered with alcohol.

As needed, remove from the jar and wipe dry.

Cleaning PYREXPLUS® Glassware

Any non-abrasive glassware detergent may be used for hand or automatic dishwasher cleaning. If using a dishwasher or glassware dryer, care should be taken to be sure the drying temperature does not exceed 110°C (230°F). Exposure to dry heat should be minimized.

Heavy duty PYREXPLUS storage bottles have a protective PVC coating for extra security and can be autoclaved at 121°C.

Avoid brushes and cleaning pads which could abrade the glass or damage the coating. If using a chromic acid cleaning solution minimize contact of the solution with the coating.

Autoclaving

PYREXPLUS glassware can be successfully sterilized repeatedly (Table 10) using liquid or dry cycle sterilization which involves no vacuum or low vacuum (less than 5 inches mercury).

Table 10. Recommended Cycles for PYREXPLUS Glassware in Automated Autoclaves

	Autoclave Type	
Autoclave Cycle	**Gravity**	**Prevacuum**
Liquid	Yes	Yes
Dry	Yes	No
Prevac	-	No

Caution: Always autoclave vessels with loose caps or closures.

Sterilization time should not exceed 15 minutes at 121°C (250°F). Drying time should not exceed 15 minutes at 110°C (230°F). The actual cavity temperature of the autoclave should be checked to be sure the autoclave temperature does not exceed the recommended sterilization and drying temperature. Vessels should not be allowed to touch each other during autoclaving.

It is better to use a slow cool cycle for venting rather than fast venting to reduce the chance that air pockets will form between the glass and the coating.

Should the coating appear clouded due to dissolved moisture, simply let dry overnight at room temperature or briefly heat to 110°C (230°F).

Cleaning Cell Culture Glassware

Corning offers a full selection of both reusable and disposable PYREX glass and plastic storage bottles designed to meet the stringent requirements of cell culture.

Cell culture glassware should first be soaked, then washed and repeatedly rinsed with both tap water and high-quality water, i.e., purified by distillation, deionization or reverse osmosis. Special attention should be given to the source of water used during the washing process. Copper tubing is frequently a source of toxic metallic ions in cell culture systems. To eliminate this problem, appropriate plastic or stainless steel tubing can be substituted. Another source of toxic metallic ions may be the hot water heating system used in glassware washing. A separate glass lined hot water system, located in proximity to the glass washing area, may eliminate this.

A source of toxic heavy metal ions often overlooked are media storage bottles that have been previously used to hold staining solutions for electron microscopy that contain osmium tetrachloride, uranyl acetate or lead nitrate. These metal ions can bind tightly to the glass and may not be released during cleaning unless concentrated acid cleaners are used. When media are then stored in the bottles the metal ions will slowly release from the glass surface back into the medium resulting in cell toxicity. Disposable bottles are recommended for storing these solutions.

Usually only borosilicate (such as PYREX®) glassware is recycled. Soft soda lime or flint glasses should be used once and then discarded; repeated use of soft glass may cause leaching of toxic materials into solutions or cultures. It is essential that glassware be thoroughly cleaned and rinsed. Some cleaning agents, such as 7X®, have been specifically developed for washing cell culture glassware and are designed to leave no toxic detergent residues after rinsing. If a central glass washing service cannot provide the attention necessary to process cell culture grade glassware, then glassware must be washed within individual laboratories. The use of disposable plasticware can eliminate or greatly reduce this problem.

Blood Cell Count Diluting Pipets

After use, rinse thoroughly with cool tap water, distilled water, alcohol or acetone, and then either.

Dry by suction. (Do not blow into the pipets as this will cause moisture to condense on the inside of the pipet).

To remove particles of coagulated blood or dirt, a cleaning solution should be used. One type of solution will suffice in one case, whereas a stronger solution may be required in another. It is best to fill the pipet with the cleaning solution and allow it to stand overnight. Sodium hypochlorite (laundry bleach) or a detergent may be used. Hydrogen peroxide is also useful. In difficult cases, use concentrated nitric acid. Some particles may require loosening with a horse hair or piece of fine wire. Take care not to scratch the inside of the pipet.

Culture Tubes

Culture tubes which have been used previously must be sterilized before cleaning. The best general method for sterilization cultures is by autoclaving for 30 minutes at 121°C (15 lb. pressure). Media which solidify on cooling should be poured out while the tubes are hot. After the tubes are emptied, brush with detergent and water, rinse thoroughly with tap water, rinse with distilled water, place in a basket and dry.

If tubes are to be filled with a medium which is sterilized by autoclaving, do not plug until the medium is added. Both medium and tubes are thus sterilized with one autoclaving.

If the tubes are to be filled with a sterile medium, plug and sterilize the tubes in the autoclave or dry air sterilizer before adding the medium. Corning also offers a variety of disposable glass and plastic culture tubes to eliminate the need for cleaning.

Rinsing, Drying and Storing Glassware

When rinsing or washing pipets, cylinders or burets be careful not to let tips hit the sink or the water tap. Most breakage occurs in this way. Dry test tubes, culture tubes, flasks and other glassware by hanging them on wooden pegs or placing them in baskets with their mouths downward and allowing them to air dry. Alternatively, place them in baskets and dry in an oven. The temperature for drying should not exceed 140°C. Never apply heat directly to empty glassware used for volumetric measurements. Such glassware should be dried at temperatures of no more than 80°C to 90°C. Before placing glassware in a basket, cover the bottom of the basket with a clean folded towel or clean piece of cloth. This prevents the mouths of the tubes from becoming dirty.

Dry burets, pipets and cylinders by standing them on a folded towel. Protect clean glassware from dust. This is done best by plugging with cotton, corking, taping a heavy piece of paper over the mouth or placing the glassware in a dust-free cabinet.

When storing, place pieces in racks designed especially for them. Be sure pieces do not touch each other, to avoid inadvertent mechanical damage. Do not store glassware close to the front edge of shelves.

Do not store alkaline liquids in volumetric flasks or burets. Stoppers or stopcocks may stick.

GLASS TERMINOLOGY

Anneal: To prevent or remove objectionable stresses in glassware by controlled cooling.

Binder (Fibrous Glass): Substances employed to bond or hold the fibers together.

Blister: An imperfection a relatively large bubble or gaseous inclusion.

Check: An imperfection; a surface crack in a glass article.

Chill Mark: A wrinkled surface condition on glassware, resulting from uneven contact in the mold prior to forming.

Chip: An imperfection due to breakage of a small fragment from an otherwise regular surface.

Cord: An unattenuated glassy inclusion, possessing optical and other properties differing from those of the surrounding glass.

Cullet: Waste or broken glass, usually suitable as an addition to raw batch.

Devitrification: Crystallization in glass.

Dice: The more or less cubical fracture of tempered glass.

Fiber: An individual filament made by attenuating molten glass. A continuous filament is a glass fiber of great or indefinite length. A staple fiber is a glass fiber of relatively short length (generally less than 44 cm).

Fusion: Joining by heating.

Glass Ceramic: A material melted and formed as a glass, then converted largely to a crystalline form by processes of controlled devitrification.

I.D.: Inside diameter.

Lampworking: Forming glass articles from tubing and rod by heating in a gas flame.

Lap: (1) An imperfection; a fold in the surface of a glass article caused by incorrect flow during forming. (2) A process used for mating ground surfaces.

Liquidus Temperature: The maximum temperature at which equilibrium exists between the molten glass and its primary crystalline phase.

Mat (Fibrous Glass): A layer of intertwined fibers bonded with some resinous material or other adhesive.

O.D.: Outside diameter.

Out-of-Round: Asymmetry in round glass articles.

Sealing: Joining by heating.

Seed: An extremely small gaseous inclusion in glass.

Softening Point: The temperature at which a uniform fiber, 0.5 to 1.0 mm in diameter and 22.9 cm in length, elongates under its own weight at a rate of 1 mm per minute when the upper 10 cm of its length is heated in a prescribed furnace at the rate of approximately 5°C per minutes. For a glass of density near 2.5, this temperature corresponds to viscosity of $10^{7.6}$ poises.

Standard Taper:

- ST is the symbol used to designate interchangeable glass joints, stoppers, and stopcocks complying with the requirements of ASTM E 676, and requirements of ATSM E 675. All mating parts are finished to a 1:10 taper.
- SJ is the designation for spherical (semi-ball) joints complying with ASTM E 677. The complete designation of a spherical joint also consists of a two-part number of 12/2, with 12 being the approximate diameter in millimeters of the ball and 2 the bore in millimeters of the ball and the socket.

- ₸ is the designation for tapered stopcocks using a fluorocarbon plug complying with ASTM E 911. All mating parts are finished to a 1:5 taper.

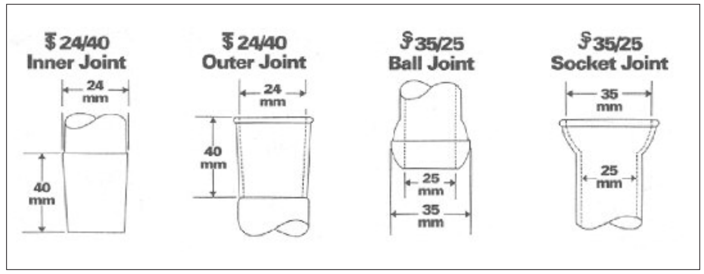
The size of a particular piece appears after the appropriate symbol. Due primarily to the greater variety equipped with fittings, a number of different types of identifications are used, as follows:

- **Joints:** a two part number, ₸24/40, with 24 being the approximate diameter in millimeters at the large end of the taper and 40 the axial length of taper, also in millimeters.
- **Stopcocks:** a single number, ₸2, with 2 being the approximate diameter in millimeters of the hole or holes through the plug. For the fluorocarbon plug, a single number is used, as with stopcocks. Thus, a ₸2 means a stopcock with a hole of approximately 2 mm in the plug.
- **Bottles:** a single number, ₸19, with 19 being the approximate diameter in millimeters of the opening at top of neck.
- **Flasks:** (other than most boiling flasks) a single number 19, with 19 again being the approximate diameter in millimeters at top of neck.

For dimensional details of the various stoppers, see the individual listing in the Corning catalog.

Stone: An imperfection; crystalline contaminations in glass.

Stria: A cord of low intensity generally of interest only in optical glass.



Tempered Glass: Glass that has been rapidly cooled under rigorous control from near the softening point to increase its mechanical and thermal strength.

Thermal Endurance: The relative ability of glassware to withstand thermal shock.

Weathering: Attack of a glass surface by atmospheric elements.

Working Range: The range of surface temperature in which glass is formed into ware in a specific process. The "upper end" refers to the temperature at which the glass is ready for working (generally corresponding to a viscosity of 10^3 to 10^4 poises), while the "lower end" refers to the temperature at which it is sufficiently viscous to hold its formed shape (generally corresponding to a viscosity greater than 10^6 poises). For comparative purposes, when no specific process is considered, the working rage of glass is assumed to correspond to a viscosity range from 10^4 to $10^{7.6}$ poises.

For additional product, technical, or distributor information, please visit **www.corning.com/lifesciences** or call 800.492.1110. Customers outside the United States, please call +1.978.442.2200 or contact your local Corning sales office listed below.

CORNING

Corning Incorporated
Life Sciences
Tower 2, 4th Floor
900 Chelmsford St.
Lowell, MA 01851
t 800.492.1110
t 978.442.2200
f 978.442.2476
www.corning.com/lifesciences

Worldwide Support Offices

ASIA/PACIFIC

Australia
t 61 2-9416-0492
f 61 2-9416-0493

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f 886 2-2716-0339

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f 0800 101 2427

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f 0800 279 1117

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t 31 (0) 20 659 60 51
f 31 (0) 20 659 76 73

LATIN AMERICA

Brasil
t (55-11) 3089-7419
f (55-11) 3167-0700

Mexico
t (52-81) 8158-8400
f (52-81) 8313-8589

Corning Incorporated, One Riverfront Plaza, Corning, NY 14831-0001