

# Would you like to have more information?

---

## Please do not hesitate to contact us!

Please do not hesitate to contact us for advice on the selection, design and colour of your plastic products. A personal consultant ensures that you receive competent advice from the first meeting to the delivery of the product.

Our contact information:

Tel: +49 (0) 6026 977 99-0

Fax: +49 (0) 6026 977 99 -30

E-mail: [info@vitlab.com](mailto:info@vitlab.com)

[www.vitlab-promotional.com](http://www.vitlab-promotional.com)

# Technical information

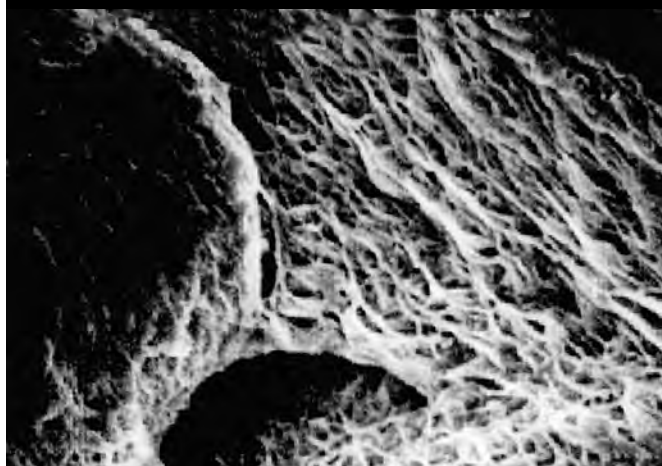
---

	Page
• Fluoroplastic PFA	130
• VITLAB® UV-protect	132
• Plastics and their properties	133
• Classification and type description of plastics	133
• Chemical stability of plastics	137
• Physical properties of plastics	146
• Cleaning and maintenance of plastics	147
• Sterilisation of laboratory equipment made of plastics	148
• Disposal and recycling	150
• Suitability for foodstuffs	150
• Accuracy of volumetric instruments	151

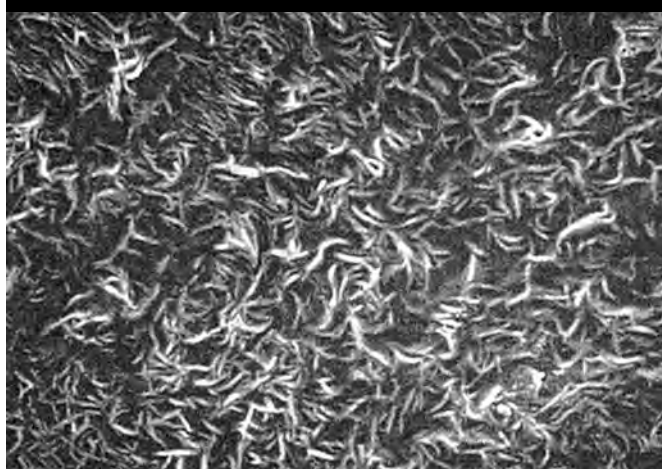
PFA evaporating dish



PTFE beaker



PE-HD bottle



## Fluoroplastic PFA

Today, trace analysis operates with concentrations in the range of ng/g (ppb) and pg/g (ppt). Thus, all modern processes require a corresponding trace analytical laboratory hygiene. However, the analytical accuracy of the measurement depends not only on the accuracy of the analytical instrument, but also directly on the judicious selection of container materials and the preparation of the samples themselves. Under these conditions, the fluoroplastic PFA truly shows its worth.

Labware made from polyolefins, such as polypropylene (PP) or polyethylene (PE), has found broad application in modern laboratories. Since catalysts (e.g., Ziegler-Natta or Philipps) are used during the manufacturing process, the constituent elements (frequently Al, Cr, Mg, Si, Ti or Zn) can still be detected in the ultra-trace range, and thus might affect the analysis results. In direct comparison to these manufacturing processes, PFA is especially suitable for trace element analysis because it is manufactured without the use of additives, and therefore cannot become contaminated by the additive components.

In addition to this advantage, PFA has other remarkable properties. PFA can be used for a broad range of applications by virtue of its resistance to almost all organic and inorganic compounds. PFA is one of the most resistant materials after platinum, and is practically chemically inert. Moreover, PFA stands apart with extraordinarily high thermal stability, making it possible to operate in the temperature range of -200 to +260 °C.

For all PFA products, VITLAB uses only high-purity PFA, which is particularly well-suited for trace analysis. For less critical uses, e.g. if the main requirement is a high chemical resistance, VITLAB offers bottles of "economy grade" PFA, which are partly made of recycled PFA. These are favourably priced and also environmentally friendly.

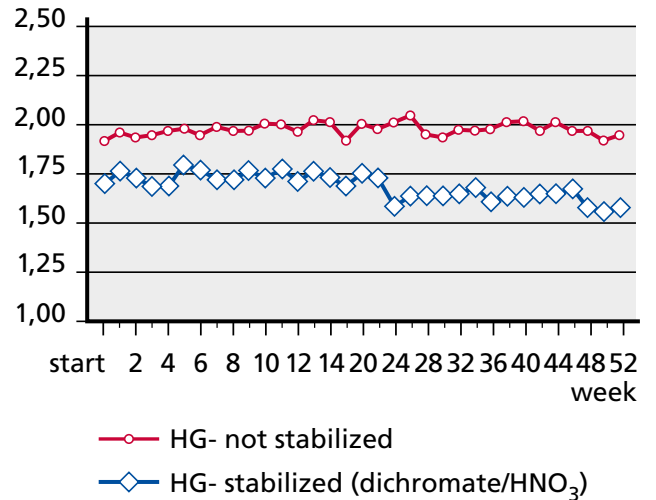
Pictures of the surface structure of PTFE, PFA, and PE-HD with a scanning electron microscope (8000 times magnification).

# Technical information

VITLAB's PFA vessels have unique, extremely smooth, liquid-repellent surfaces that are made possible through modern manufacturing processes and acknowledged expertise (see pictures on "Surface Structure"). This is especially significant in the illustrative comparison. The pictures taken in a scanning electron microscope show uneven and irregular surfaces for PE-HD and PTFE, and deep pores and concavities can be identified in the PTFE surface. In contrast to the uneven surfaces, PFA evaporating dishes had to be marked (X) and exhibit a completely smooth, even and uniform surface structure.

Due to this characteristic, all PFA labware is particularly easy to clean and presents hardly any interactions with samples as compared to conventional container materials. With these advantages combined with the minimal water absorption by PFA (< 0.03%), even samples at very low concentration can be stored for long periods of time in PFA containers without changes in their concentration (see the application example on Mercury Standards).

Concentration 2 ppb (ng/g) each

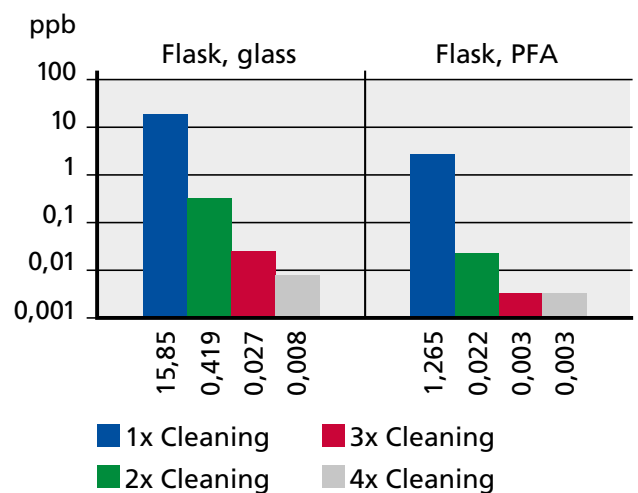


Application Example - Mercury Standards: Storage of an Hg standard in high-purity PFA containers (concentration 2 ppb (ng/g) each). Source: GIT Laboratory Trade Magazine 1/95

## Cleaning after contamination

The valuable properties of PFA, primarily the near absence of memory effects, ensure the reliability of trace analytical results. In comparison with a commercially available glass flask, the simple cleaning after contamination with lead (Pb) solution at a concentration of 1000 ppb (ng/g) is a telling example (see the section on Cleaning of Volumetric Flasks). The cleaning of the glass and PFA volumetric flasks was conducted by shaking with 65% HNO<sub>3</sub> \*Suprapur® (Pb < 0.005 ppm) at room temperature. With PFA volumetric flasks, the minimum concentration of 0.003 ppb is reached after three rinses, while substantially higher lead concentrations can be measured in glass flasks even after four rinses. The experiment also shows that PFA labware does not require the usual time-consuming boiling.

Mean of 4 Graduated Flask 500 ml each



Cleaning of glass and PFA volumetric flasks after contamination. Source: Kali-Forschungsinstitut, K. Mangold

\*Suprapur® is a trademark of Merck KGaA.

# Volumetric flasks VITLAB® UV-protect



## VITLAB® UV-protect volumetric flasks, PMP, Class A

UV-absorbent to protect light-sensitive substances. The tolerances correspond to Class A according to DIN EN ISO 1042. With printed lot number and batch certificate. Thermal stress up to 121 °C (autoclaving) does not permanently exceed the tolerance limit. Available with a screw cap (PP) or an NS stopper (PP) in 7 different sizes from 10 to 1,000 ml.

## Greater protection for light-sensitive substances

Light shielding is an important factor for numerous laboratory applications (see Fields of Application). Accordingly, volumetric flasks made of amber glass are part of the basic equipment of a laboratory. Alternatively, coloured plastic products are used. Both solutions have disadvantages in practice: The glass flasks are fragile and most plastic products are completely opaque so that the filling level can not be read.

The UV-protect volumetric flasks are very close to the shade of amber glass, they are transparent and provide comparable protection for sensitive substances in the visible light spectrum (750 – 400 nm). In the UV range (380 – 200 nm), they shield even better.

For the user, this means easier sample preparation through improved readability of the volume mark combined with higher UV absorption to protect the sample contents. Added to this are the higher break resistance and the very good chemical resistance of polymethylpentene. As PMP also has high temperature stability, the volumetric flasks are also ideal for use in biological laboratories, where products are autoclaved regularly at 121° C before use.

This makes VITLAB® UV-protect the ideal alternative to conventional amber glass and conventional coloured plastic containers for most applications.

## Fields of Application

In many fields of application, light-sensitive substances are used –, i.e. those which change or decompose through light. These include, for example, silver salts (silver chloride, silver nitrate), iodine solutions and pharmaceutical active ingredients. In laboratories, there are various sources of light (daylight, fluorescent tubes, UV lamps), from which these media must be effectively protected.

The fields of Life Sciences and Microbiology, for example, deal with living organisms that are sensitive to light, such as light-sensitive microorganisms or cell cultures. These can come from an environment in which there is little to no light –, for example, from the deep sea or the soil. In environmental analysis, sampling under light protection is also often very important –, for example, in water samples. The sample is taken on site, sealed, transported to the laboratory and analysed at a later time. In the chemical-analytical field, custom-made standard solutions should last as long as possible in order to be able to carry out exact comparative analyses. Light irradiation can change the composition of a sample and lead to incorrect results.

## Classification and type description of plastics

In general, plastics can be divided into the three groups. The abbreviations of the described plastics used are those according to DIN 7728.

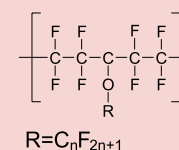
### Thermoplastics

Plastics with a linear molecular structure, with or without side chains, can be reversibly moulded through heat treatment without changing their thermoplastic properties. Thermoplastics are frequently used in the production of plastic labware. Hence we provide here a brief description of some of the more important plastics, and explain their molecular structure, as well as their mechanical, chemical and physical properties. The most frequently used thermoplastics are polyolefins, such as polyethylene and polypropylene.

#### PFA (perfluoroalkoxy copolymer)

121°C

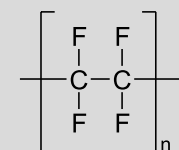
- Highly transparent, elastic thermoplastic with high-molecular, semi-crystalline structure
- Very good temperature stability
- Broad range of application, from -200 °C to +260 °C
- Virtually chemically inert, excellent chemical stability against practically all chemicals
- Very low water absorption (< 0.03%)
- Ultra-smooth, anti-adhesive surface with unique surface structure
- Typical products are, for example: Class A volumetric flasks, bottles, sample containers
  - ➔ Especially suitable for use in trace analysis, and for the storage of low-concentration solutions



#### PTFE Polytetrafluoroethylene

121°C

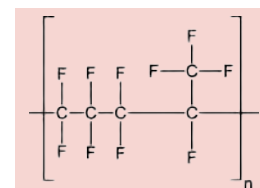
- Non-transparent, white, elastic thermoplastic with high-molecular, semi-crystalline structure
- Very good temperature stability
- Broad range of application, from -200 °C to +260 °C
- Virtually chemically inert, excellent chemical stability against practically all chemicals
- Anti-adhesive surface
- Very good sliding properties and electrical insulating capability (very low friction coefficient)
- Typical products are, for example: Bottles, beakers, sheathing for magnetic stir bars



#### FEP Tetrafluoroethylene-perfluoropropylene copolymer

121°C

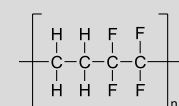
- Translucent, white, thermoplastic copolymer with high-molecular, semi-crystalline structure
- Anti-adhesive surface
- Very good temperature stability
- Broad range of application, from -100 °C to +205 °C
- Excellent chemical stability



#### ETFE Ethylene-tetrafluoroethylene copolymer

121°C

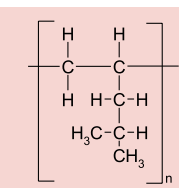
- Translucent, white copolymer from ethylene and tetrafluoroethylene
- Very good temperature stability
- Broad range of application, from -100 °C to +150 °C
- Very good chemical stability
- Typical products are, for example: Thread adapters, Griffin beakers, threaded connectors



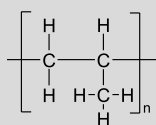
#### PMP Polymethylpentene

121°C

- Highly transparent, stiff thermoplastic
- Similar structure to PP, with the methyl group replaced by an isobutyl group
- Good thermal stability
- Range of application from 0 to +150 °C
- Good tensile strength and dimensional stability
- Good chemical stability
- Typical products are, for example: Class A volumetric flasks, Class A measuring cylinders
  - ➔ For the storage of light-sensitive substances, also available in highly transparent, UV-absorbing VITLAB® opaque



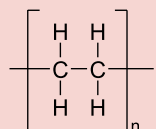
## Classification and type description of plastics



### PP Polypropylene

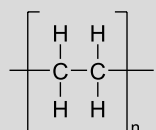
121°C

- Highly transparent, elastic thermoplastic
- Similar structure to PE, with a methyl group attached to alternate carbon atoms in an isotactic arrangement
- Good thermal stability
- Range of application from 0 °C to +125 °C
- Good tensile strength and dimensional stability
- Good chemical stability, comparable to PE
- Typical products are, for example: Class B volumetric flasks, Class B measuring cylinders, measuring pitchers, sample containers, funnels
  - ➔ For the storage of light-sensitive substances, also available in highly transparent, UV-absorbing VITLAB® opaque



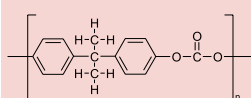
### PE-HD High-density polyethylene

- Transparent, elastic thermoplastic
- Good thermal stability
- Range of application from -50 °C to +105 °C
- Compact, with increased tensile strength due to less cross-linking compared with PE-LD
- Good chemical stability
- Better chemical stability to organic solvents compared to PE-LD
- Typical products are, for example: Bottles, buckets, scoops
  - ➔ For the storage of light-sensitive materials, also available in brown-dyed version



### PE-LD Low-density polyethylene

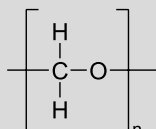
- Highly transparent, elastic thermoplastic
- Moderate thermal stability
- Range of application from -50 °C to +80 °C
- Very good flexibility
- Good chemical stability
- Typical products are, for example: Wash bottles, dropping pipettes



### PC Polycarbonate

121°C

- Transparent, stiff thermoplastic
- Linear polymer of carbon dioxide
- Very good temperature stability
- Broad range of application, from -130 °C to +125 °C
- Good tensile strength and impact resistance
- Moderate chemical stability
- Typical products are, for example: Desiccators
- Note: Polycarbonates can lose their tensile strength through autoclaving or exposure to alkaline detergents



### POM Polyoxymethylene

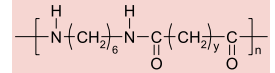
121°C

- Non-transparent, white, stiff, and high-molecular thermoplastic
- Good thermal stability
- Broad range of application, from -40 °C to +130 °C
- High hardness and dimensional stability
- Good sliding properties and abrasion resistance
- Good chemical resistance to aliphatic, aromatic, and halogenated hydrocarbons, and alkalis. Unstable to acids and esters
- Typical products are, for example: Slide boxes, staining jars
  - ➔ Especially good chemical stability to organic solvents
  - ➔ POM can replace metal in many applications

## Classification and type description of plastics

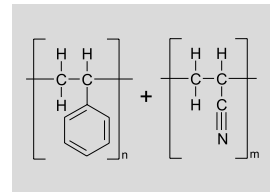
### PA Polyamide

- Linear polymers with regularly repeating amide bonds along the main chain
- Good thermal stability
- Range of application from -40 °C to +100 °C
- Outstanding durability and tensile strength, often used as construction material and for metal coatings
- Good chemical resistance to organic solvents
- Readily attacked by acids and oxidising agents
- Typical products are, for example: Spatula



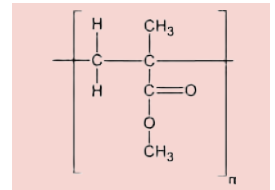
### SAN Styrene-acrylonitrile copolymer

- Crystal clear, stiff thermoplastic copolymer
- Moderate thermal stability
- Range of application from -40 °C to +70 °C
- Brittle and dimensionally stable
- Low tendency to form stress cracks
- Moderate chemical stability, SAN is slightly more chemically stable than PS
- Typical products are, for example: Graduated beakers, Class B graduated cylinders



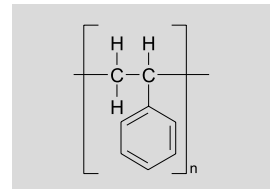
### PMMA Poly(methyl methacrylate)

- Crystal clear ("organic glass"), dimensionally stable thermoplastic
- Moderate thermal stability
- Range of application from -50 °C to +65 °C
- Very good UV radiation stability
- Poor chemical stability
- Typical products are, for example: Cuvettes



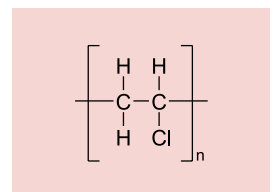
### PS Polystyrene

- Crystal clear, stiff, amorphous or semi-crystalline thermoplastic
- Moderate thermal stability
- Range of application from -20 °C to +70 °C
- Hard, brittle, and dimensionally stable
- Tendency to form stress cracks
- Moderate chemical stability
- Typical products are, for example: Containers, cuvettes



### PVC Poly(vinyl chloride)

- Amorphous thermoplastic, transparent with a slight blue tint
- Moderate thermal stability
- Range of application from -20 °C to +80 °C
- Good chemical stability, especially resistant to oils
- The addition of plasticisers opens up many useful applications, ranging from artificial leather to injection moulding components
- Typical products are, for example: Drawer organisers, dishes, trays

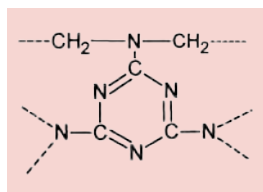




## Classification and type description of plastics

### Thermosets

Plastics with densely cross-linked molecules, which are very hard and brittle at normal temperatures. Heating causes irreversible hardening. These plastics are rarely used for plastic labware. The best known thermosets are the melamine resins. Melamine resin is produced by polycondensation of melamine with formaldehyde.

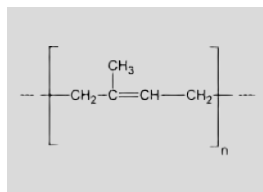


#### MF Melamine-formaldehyde resin

- Colourless thermoset, also belongs to the aminoplast group
- Good thermal stability
- Broad range of application, from -80 °C to +120 °C
- High surface hardness, abrasion resistance, and fire resistance
- Good electrical insulator, high creep resistance
- Good chemical stability
- Typical products are, for example: Trays, plates, mixing bowls
- Caution necessary when used in a microwave oven: Heating can release amounts of melamine and formaldehyde that can be harmful to health!

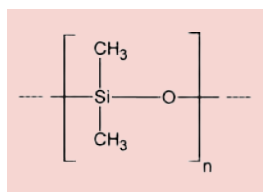
### Elastomers

Plastics with loosely cross-linked molecules that exhibit rubber-like elasticity at room temperature. Heating causes irreversible integration (vulcanisation). The best known elastomers are natural rubber and silicone rubber.



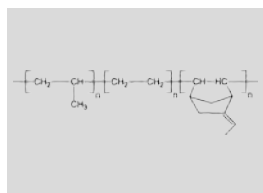
#### NR Natural rubber

- Elastomer obtained from latex (milk-like sap from rubber tree bark) and vulcanised with sulphur to improve the elasticity
- Composed of polymerised isoprene, with an extremely uniform structure
- Moderate thermal stability, not stable to UV
- Range of application from -40 °C to +80°C
- High tensile strength and elongation at rupture
- Poor chemical stability
- Typical products are, for example: pipette filler bulbs



#### SI Silicone rubber

- Synthetic elastomer in which silicon atoms are linked together by oxygen atoms
- Includes polyorganosilanes that have groups such as hydrogen atoms, hydroxyl groups or vinyl groups for cross-linking reactions
- Very good thermal stability, and resistance to UV, ozone, and weather
- Broad range of application, from -60 °C to +180 °C
- High dimensional stability, even at high temperatures
- Very good durability, even at low temperatures
- Poor chemical stability



#### EPDM Ethylene-propylene-diene rubber

- Synthetic terpolymeric elastomer
- Manufactured with metallocene or Ziegler-Natta catalysts that utilise vanadium compounds and aluminium alkyl chlorides
- Good thermal stability
- Range of application from -40 °C to +130 °C
- High elasticity, even at low temperatures
- Stable to UV and ozone, and weather-resistant
- Very good chemical stability

# Technical information

## Chemical resistance of plastics

With regard to chemical stability, plastics are classified as follows:

**+**

Very good chemical resistance

Within 30 days, continuous exposure to media causes no damage to the plastic. The plastic may remain resistant for years.

**0**

Good to limited chemical resistance

Within 7-30 days, continuous exposure to media causes minor damage (e.g. swelling, softening, loss of mechanical strength, discolouration), some of which is reversible.

**-**

Poor chemical resistance

Not suitable for continuous exposure to media. Immediate damage may occur (e.g. loss of mechanical strength, deformation, discolouration, cracking, liquification).

## Chemical resistance of plastics to various substance classes

Classes of substances at 20 °C	PFA	PTFE	FEP	ETFE	PMP	PP	PE-HD	PE-LD	PC	POM	PA	SAN	PMMA	PS	PVC	MF	NR	SI	EPDM	FKM
Alcohols, aliphatics	+	+	+	+	+	+	+	+	+	+	0	+	-	+	+	+	+	+	+	-
Ethers	+	+	+	+	-	0	0	0	-	+	+	-	-	-	-	-	-	-	-	-
Aldehydes	+	+	+	+	0	+	+	0	0	0	0	-	0	-	-	+	0	0	+	+
Esters	+	+	+	+	0	0	0	0	-	-	+	-	0	-	-	+	0	0	0	-
Hydrocarbons, aliphatic	+	+	+	+	0	+	+	0	0	+	0	-	+	-	+	+	-	-	-	0
Hydrocarbons, aromatic	+	+	+	+	-	0	+	0	-	+	0	-	-	-	-	+	-	-	-	0
Hydrocarbons, halogenated	+	+	+	+	-	0	0	0	-	+	0	-	-	-	-	+	-	-	-	0
Ketones	+	+	+	0	0	0	0	0	-	+	+	-	-	-	-	+	-	-	0	-
Alkalis	+	+	+	+	+	+	+	+	-	+	+	+	+	+	+	-	+	0	+	0
Acids, strong or concentrated	+	+	+	+	+	+	+	+	-	-	-	-	-	0	+	-	-	-	+	0
Acids, weak or diluted	+	+	+	+	+	+	+	+	0	-	-	0	-	0	+	0	0	0	+	+
Oxidising acids, oxidising agents	+	+	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0	0

The carefully prepared recommendations listed here are based on technical literature and made available by the manufacturers of raw materials, to provide information and advice. However, nothing can replace suitability tests conducted by the end user under the actual conditions of use.

## Chemical stability of plastics

Medium	PFA/FEP		PTFE		ETFE		PMP		PP		HDPE		LDPE	
	20 °C	50 °C	20 °C	50 °C	20 °C	50 °C	20 °C	50 °C	20 °C	50 °C	20 °C	50 °C	20 °C	50 °C
Acetaldehyde	+	+	+	+	+	0	0	-	+	-	+	0	+	-
Acetic acid (glacial acetic acid), 100%	+	+	+	+	+	+	+	0	+	0	+	+	+	0
Acetic acid, 50%	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Acetic anhydride	+	+	+	+	+	+	+	0	0	0	0	0	-	-
Acetone	+	+	+	+	+	0	+	+	+	+	+	+	+	0
Acetonitrile	+	+	+	+	+	+	0	-	+	0	+	0	+	0
Acetophenone	+	+	+	+	+	+	0	-	0	0	0	0	-	-
Acetyl chloride(acetic acid chloride)	+	+	+	+	+	+			+		+		+	
Acetylacetone	+	+	+	+	+	+	+		+		+		+	
Acrylic acid (2-propenic acid)	+	+	+	+	+	+	+		+		+		+	
Acrylonitrile	+	+	+	+	+	+	-	-	0	-	+	+	+	+
Adipic acid	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Allyl alcohol (2-propan-1-ol)	+	+	+	+	+	+	+	0	+	+	+	+	+	+
Aluminium chloride	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Aluminium hydroxide	+	+	+	+	+	+	+	0	+	+	+	+	+	+
Amino acids	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Ammonium chloride	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Ammonium fluoride	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Ammonium hydroxide, 30% (ammonia)	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Ammonium sulphate			+	+			+	+	+	+	+	+	+	+
n-Amyl acetate (pentyl acetate)	+	+	+	+	+	+	+	0	0	-	+	0	0	-
Amyl alcohol (pentanol)	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Amyl chloride (chloropentane)	+	+	+	+	+	+	-	-	-	-	-	-	-	-
Aniline	+	+	+	+	+	0	+	0	+	+	+	+	+	0
Aqua regia	+	+	+	+	+	+	-	-	-	-	-	-	-	-
Barium chloride	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Benzaldehyde	+	0	+	+	+	0	+	+	+	+	+	+	+	+
Benzene	+	+	+	+	+	+	0	0	+	0	+	+	0	-
Benzoyl chloride			+	+	+	+	0	0	+	0	+	+	0	-
Benzyl alcohol	+	+	+	+	+	+	0	-	0	-	0	-	0	-
Benzyl chloride			+	+	+	+								
Benzylamine	+	+	+	+	+	+	0		0		0		0	-
Boric acid, 10%	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Bromine	+	+	+	+	+	+	-	-	-	-	-	-	-	-
Bromobenzene	+	+	+	+	0	-	-	-	-	-	-	-	-	-
Bromoform	+	+	+	+	+	+	-	-	-	-	-	-	-	-
Bromonaphthalene	+	+	+	+	+	+								
Butanediol	+	+	+	+	+	+	+	+	+	+	+	+	+	+
1-Butanol (butyl alcohol)	+	+	+	+	+	+	+	0	+	+	+	+	+	+
n-Butyl acetate (acetic acid n-butyl ester)	+	+	+	+	+	+	+	0	0	0	+	+	0	0
Butyl methyl ether	+	+	+	+	+	0	+	-	+	0	0	-	0	-
Butylamine			+	+	+	+								
Butyric acid (butanoic acid)	+	+	+	+	+	+			-	-	0	-	-	-
Calcium carbonate	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Calcium chloride	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Calcium hydroxide	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Calcium hypochlorite	+	+	+	+	+	+	+	0	+	+	+	+	+	+

# Technical information

PC		POM		PA		SAN		PMMA		PS		PVC		MF	NR	SI	EPDM	FKM
20 °C	50 °C	20 °C	50 °C	20 °C	50 °C	20 °C	50 °C	20 °C	50 °C	20 °C	50 °C	20 °C	50 °C	20 °C	20 °C	20 °C	20 °C	20 °C
0	-	+	+	0		-	-	-	-	-	-	-	-		-	-	0	-
-	-	-	-	-	-					-	-			0	0	0	0	-
+	0	0	-	-	-	+	0	-	-	0	0	+	0	+	-	-	-	-
-	-	-	-	0	0					-	-	-	-		0	0	0	-
-	-	+	+	+		-	-	-	-	-	-	-	-	+	0	-	+	-
-	-	+		+		-	-	-	-	-	-	-	-		-	-	-	-
-	-	+		+		-	-	-	-	-	-	-	-	+	-	-	+	-
-	-			-	-	-	-	-	-	-	-	-	-		-	-	-	+
-	-	+				-	-	-	-	-	-	-	-		-	-	+	-
-	-	-	-			-	-	-	-	-	-	-	-		-	-	-	-
-	-	-	-	+		-	-	-	-	-	-	-	-		-	-	-	-
+	+	+	+	+		+	+	+	+	+	+	+	0		+	+	+	+
0	0	+	+	0		0	-	-	-	0	0	0	-		0	-	+	+
-	-	+	0	0	-	+	+	+	+	+	+	+	0	+	0	0	+	+
0	-	+	+	+	+	0	0	0	0	0	0	+	+		+	+	+	+
+	+	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+	+
0	0	+	+	+		+	+	0	0	+	+	+	0		+	+	+	+
0	0	+	+	+		+	+	0	0	+	+	+	0		-	+	+	0
-	-	0	0	0		+	0	+	+	0	-	+	0	+	+	0	+	-
+	+	+	+	+		+	+	+	+	+	+	+	+		0	0	+	-
-	-	+	+	0		-	-	+	+	-	-	-	-		0	-	0	-
+	+	+	+	+		+	+			0	0	0	0		0	-	0	0
-	-	+	+	+		-	-	-	-	-	-	-	-		-	-	-	+
0	-	0	0	0	-	-	-	-	-	-	-	-	-		-	-	-	-
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
+	+	+	+	+		+	+	+	+	+	+	+	+		+	+	+	+
0	-	+	+	0		-	-	-	-	-	-	-	-		-	-	0	-
-	-	+	0	+		-	-	-	-	-	-	-	-	+	-	-	-	0
-	-	+	0	-	-	-	-	-	-	-	-	-	-		-	-	-	+
0	0	+	+	-	-	-	-	-	-	-	-	0	0		-	0	0	+
		+		+		-	-	-	-	-	-				-	-	-	+
-	-	+				-	-	-	-	-	-	-	-		-	0	0	+
+	+	+	+	+		+	+	+	+	+	+	+	+		+	+	+	+
-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	0
-	-			+		-	-	-	-	-	-	-	-		-	-	-	+
-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-		
		+	+	+		-	-	-	-	-	-				0	-	+	-
0	0	+	+	+	0	+	0	0	-	0	-	0	0		+	0	0	+
-	-	+	0	+		-	-	-	-	-	-	-	-		-	-	0	-
-	-	+	+			-	-	-	-	-	-	-	-		-	-	-	-
		+	+			-	-			-	-				-	0	-	-
0	-			0	0	-	-			-	-				-	-	-	0
+	+	+	+	+	+	+	+	+	+	+	+	+	+		+	+	+	+
+	+	+	+	-	-	+	+	+	+	+	+	0	-		+	+	+	+
-	-	+	+	+		+	0	+	+	+	0	+	+		+	0	+	+
0	-	+	+	+	-	+	+	0	0	+	+	0	-		-	0	+	+

## Chemical stability of plastics

Medium	PFA/FEP		PTFE		ETFE		PMP		PP		HDPE		LDPE	
	20 °C	50 °C	20 °C	50 °C	20 °C	50 °C	20 °C	50 °C	20 °C	50 °C	20 °C	50 °C	20 °C	50 °C
Carbon disulphide	+	+	+	+	+	0	-	-	-	-	-	-	-	-
Carbon tetrachloride	+	+	+	+	+	+	-	-	-	-	0	-	0	-
Chloroacetaldehyde, 45%			+	+	+	+								
Chloroacetic acid (monochloroacetic acid)	+	+	+	+	+	+	+	0	+	0	+	+	+	+
Chloroacetone			+	+	+	+								
Chlorobenzene	+	+	+	+	+	0	-	-	-	-	-	-	-	-
Chlorobutane	+	+	+	+	+	+	0	-	0	-	0	-	0	-
Chloroform	+	0	+	+	+	0	0	-	-	-	0	-	0	-
Chloronaphthalene			+	+	+	+								
Chlorosulphonic acid	+	+	+	+	0	-								
Chromic acid, 10%	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Chromic acid, 50%	+	+	+	+	+	+	0	0	0	0	+	0	+	0
Chromic-sulphuric acid	+	+	+	+	+	+	0	-	-	-	-	-	-	-
Copper sulphate	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Cresol	+	+	+	+	+	0	-	-	0	0	0	-	-	-
Cumene (isopropylbenzene)	+	+	+	+	+	+	-	-	0	-	+	0	0	-
Cyclohexane	+	+	+	+	+	0	-	-	0	-	0	-	0	-
Cyclohexanone	+	+	+	+	+	+	0	0	0	-	0	-	-	-
Cyclopentane	+	+	+	+	+	+	0	-	0	-	0	-	-	-
Decane	+	+	+	+	+	+	0		0		0	-		
1-Decanol	+	+	+	+	+	+	+		+		+			
Di(ethylene glycol)	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Dibenzyl ether	+	+	+	+	+	+	0		+		+			
Dibromoethane	+		+	+	0									
Dibutyl phthalate	+	+	+	+	+	+	+	0	+	0	0	-	0	-
Dichloroacetic acid	+	+	+	+	+	0	+	+	0	-	0	0	0	-
Dichlorobenzene	+	+	+	+	+	0	-	-	0	-	0	-	0	-
Dichloroethane	+	+	+	+	+	+	0	-	0	-	0	-	0	-
Dichloromethane (methylene chloride)	+	+	+	+	0	0	0	-	0	-	0	-	0	-
Diesel oil (heating oil)	+	+	+	+	+	+	0	-	+	0	+	0	0	-
Diethanolamine			+	+					0		0			
Diethyl ether	+	+	+	+	+	+	-	-	0	-	0	-	-	-
Diethylamine	+	+	+	+	+	0	0	0	0	-	0	-	-	-
1,2 Diethylbenzene	+	+	+	+	+	0	-	-	-	-	0	-	-	-
Dimethyl sulphoxide (DMSO)	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Dimethylaniline	+	+	+	+	+	+								
Dimethylformamide (DMF)	+	+	+	+	+	+	+	+	+	+	+	+	+	+
1,4-Dioxane	+	+	+	+	+	0	0	0	+	0	+	+	+	0
Diphenyl ether			+	+										
1,2 Ethanediol (ethylene glycol, glycol)	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Ethanol (ethyl alcohol)	+	+	+	+	+	+	+	0	+	+	+	+	+	+
Ethanolamine	+	+	+	+	+	+			+					
Ethyl acetate (acetic acid ethyl ester)	+	+	+	+	+	+	0	-	+	0	+	+	+	+
Ethyl methyl ketone (MEK)	+	+	+	+	0	0	-	-	+	0	0	-	0	-
Ethylbenzene	+	+	+	+	0	0	-	-	-	-	-	-	-	-
Ethylene oxide	+	+	+	+	+	+	0	-	0	-	0	0	0	0
Fluoroacetic acid			+											

# Technical information

PC		POM		PA		SAN		PMMA		PS		PVC		MF	NR	SI	EPDM	FKM
20 °C	50 °C	20 °C	50 °C	20 °C	50 °C	20 °C	50 °C	20 °C	50 °C	20 °C	50 °C	20 °C	50 °C	20 °C	20 °C	20 °C	20 °C	20 °C
-	-	+	+	0		-	-	-	-	-	-	-	-		-	-	-	+
-	-	0	0	-	-	-	-	0	-	-	-	-	-	+	-	-	-	+
0	-	-	-	-	-	-	-	0	-	0	-	+	0		-	-	0	0
															0	-	+	-
-	-			-	-	-	-	-	-	-	-	-	-		-	-	-	0
		-	-															0
-	-	-	-	0	-	-	-	-	-	-	-	-	-	+	-	-	-	0
		-	-												-	-	-	+
		-	-	-	-										-	-	-	-
+	0	0	0	-	-	-	-	0	-	-	-	+	0		-	0	-	+
0	-	-	-	-	-	0	0	-	-	-	-	+	-		-	-	-	+
-	-	-	-	-	-	0	0	-	-	0	0	+	0		-	-	-	+
+	+	+	+	+		+	0	+	+	+	+	+	0		0	+	+	+
-	-			-	-					-	-	-	-		-	-	-	+
-	-	+	-			-	-	-	-	-	-	-	-		-	-	-	+
-	-	+	+	+						-	-	-	-	+	-	-	-	+
-	-			+						-	-	-	-		-	-	-	-
-	-									-	-	-	-		-	-	-	+
0		+				0				0		+			0	0	-	+
0		+				0				0		+			0	0	+	+
0	0	+	0	0		+	+	-	-	0	-	-	-		+	0	+	+
		+				-	-	-	-	-	-				-	-	0	-
-	-	+	+			-	-	-	-	-	-	-	-		-	0	0	0
0	-			-	-					0	-	0	-		-	-	-	-
-	-	-	-	+		-	-	-	-	-	-	-	-		-	-	-	+
		-	-	0											-	-	-	0
-	-			0	-					-	-	-	-		-	-	-	0
-	-	+	+	+	+	-	-	0	-	-	-	0	-		-	-	-	+
-	-					-	-	-	-	-	-						0	
-	-	+	+	+	+	-	-	-	-	-	-	-	-		0	0	0	-
0	0	0	0	+		-	-	-	-	-	-	-	-		-	-	0	-
		0		0		-	-	-	-	-	-				-	-	-	0
+	+	+	+	0	0	+	+	+	+	+	+	+	+	+	-	+	+	0
+	0	+	+	+		0	-	-	-	0	-	+	0	+	0	0	+	0
															-	-	+	
-	-			+		-	-	-	-	-	-	-	-	+	-	-	0	-
-	-	-	-	+		-	-	-	-	-	-	-	-		-	-	-	-
-	-					-	-	-	-	-	-	-	-		-	-	-	0
0	-	+	+	0		-	-	-	-	-	-	0	-		-	-	-	-
-	-	-	-			-	-	-	-	-	-	-	-		-	-	-	-

## Chemical stability of plastics

Medium	PFA/FEP		PTFE		ETFE		PMP		PP		HDPE		LDPE	
	20 °C	50 °C	20 °C	50 °C	20 °C	50 °C	20 °C	50 °C	20 °C	50 °C	20 °C	50 °C	20 °C	50 °C
Formaldehyde, 40%	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Formamide	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Formic acid, 98-100%	+	+	+	+	+	+	+	0	+	+	+	+	+	+
Gasoline (petroleum spirits)	+	+	+	+	+	+	0	0	0	0	+	+	0	-
Glycerine	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Glycolic acid, 70%	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Heating oil (Diesel oil)	+	+	+	+	+	+	0	-	+	0	+	0	0	-
Heptane	+	+	+	+	+	+	0	0	0	0	0	0	0	-
Hexane	+	+	+	+	+	+	0	-	+	0	+	0	0	-
Hexanoic acid			+	+										
Hexanol	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Hydrochloric acid, 10%	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Hydrochloric acid, 20%	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Hydrochloric acid, 37%	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Hydrofluoric acid, 40%	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Hydrofluoric acid, 70%	+	+	+	0	+	+	+	0	+	0	+	0	+	-
Hydrogen bromide	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Hydrogen peroxide, 35%	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Hydroiodic acid	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Isoamyl alcohol (3-methyl-1-butanol)	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Isobutanol (isobutyl alcohol)	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Isooctane	+	+	+	+	+	+								
Isopropanol (2-propanol)	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Isopropyl ether	+	+	+	+	+	0	-	-	-	-	-	-	-	-
Lactic acid (2-hydroxypropionic acid)	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Lugol's solution (iodine/potassium iodide solution)	+	+	+	+	+	+	+	0	+	+	-	-	-	-
Mercury	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Mercury chloride	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Methanol	+	+	+	+	+	+	+	+	+	+	+	+	+	0
Methoxybenzene	+	+	+	+	+	+								
Methyl butyl ether	+	+	+	+	+	0	+	0	+	+	0	-	-	-
Methyl ethyl ketone (MEK)	+	+	+	+	0	0	-	-	+	0	0	-	0	-
Methyl formate (formic acid methyl ester)	+	+	+	+	+	+								
Methyl propyl ketone	+	+	+	+	+	+	0	0	+	0	+	+	+	0
Methylene chloride (dichloromethane)	+	+	+	+	+	+	-	-	0	-	0	-	0	-
Mineral oil (motor oil)	+	+	+	+	+	+	+	+	+	+	+	+	+	0
Monochloroacetic acid	+	+	+	+	+	+	+	0	+	0	+	+	+	+
Nitric acid, 10%	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Nitric acid, 30%	+	+	+	+	+	+	0	-	0	-	0	-	0	0
Nitric acid, 70%	+	+	+	+	+	+	-	-	-	-	-	-	-	-
Nitrobenzene	+	+	+	+	+	+	-	-	-	-	0	-	-	-
Oleic acid	+	+	+	+	+	+								
Oxalic acid	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Ozone	+	+	+	+	+	+	+	+	0	-	0	-	0	-
n-Pentane	+	+	+	+	+	+								
Peracetic acid	+	+	+	+	+	+								
Perchloric acid	+	0	+	+	+	+	0	-	+	-	+	-	+	-
Perchloroethylene	+	+	+	+	+	+	-	-	-	-	-	-	-	-

# Technical information

PC		POM		PA		SAN		PMMA		PS		PVC		MF	NR	SI	EPDM	FKM
20 °C	50 °C	20 °C	50 °C	20 °C	50 °C	20 °C	50 °C	20 °C	50 °C	20 °C	50 °C	20 °C	50 °C	20 °C	20 °C	20 °C	20 °C	20 °C
+	0	+	+	+	0	+	+	-	-	-	-	0	-		0	0	+	0
		-	-	+											+		0	0
+	0	-	-	-	-	0	0	-	-	+	0	-	-	+	0	-	0	-
0	-	+	+	+		-	-	+		-	-	0	-	+	-	-	-	+
+	+	0	0	+	+	+	+	+	+	+	+	+	+	+	0	+	+	0
				-	-										+	+	+	0
-	-	+	+	+		-	-	0	-	-	-	0	-		-	-	-	+
+	0			+				0	-	-	-	-	-		-	-	-	+
-	-	+	+	+		+	+	0	0	-	-	0	-		-	-	-	+
								+										
								+							0	0	-	+
-	-	-	-	-	-	0	-	0	-	+	+	+		-	0	0	+	+
0	0	-	-	-	-	0	-	0	-	+	+	0		-	0	-	+	+
-	-	-	-	-	-	0	-	0	-	0	0	0	-	-	0	-	+	0
-	-	-	-	-	-	+	0	-	-	+	+	0	-	-	-	-	0	0
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
+	+	-	-	-	-					0	-				0	-	0	+
+	+	+	-	-	-	+	+	-	-	+	+	+	0	0	-	0	0	
		+	+														+	+
+	+	+	+			0	-	0	-	0	0	+	0		+	+	+	+
0				+		0	-			0	-				-	-	-	+
+	+	+	+	+		+	-	0	-	0	0	+	0		+	0	+	+
-	-			-	-					-	-	-	-		-	-	-	-
+	+	+	-	0	-	+	+	0	-	+	+	0	0		0	0	0	+
0	-	0	0			0	-	-	-	0	-	-	-		+	-	+	+
+	+	+	+	+		+	+	+	+	+	+	+	+		+	+	+	+
+	+	0	0	-	-	+	+	+	+	+	0	-	-		+	+	+	+
+	0	+	+	0		0	-	-	-	0	-	+	0		0	+	+	-
-	-	0				-	-	-	-	-	-				-	-	-	-
-	-	0				-	-	-	-	-	-	-	-		-	-	-	-
-	-	-	-			-	-	-	-	-	-	-	-		-	-	0	-
-	-	+				-	-	-	-	-	-				-	0	0	
-	-	+	+			-	-	-	-	-	-	-	-		-	-	0	-
-	-	-	-	0	-	-	-	-	-	-	-	-	-		-	-	-	0
+		+	+			+		+	+	+		+	+		-	0	-	+
0	-	-	-	-	-	-	-	0	-	0	-	+	0		-	-		0
+	0	-	-	-	-	+	0	+	0	-	-	+	0	-	-	-	0	0
+	0	-	-	-	-	0	-	0	0	-	-	0	-	-	-	-	-	0
-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
-	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
				+		-	-	-	-	-	-				-	-	-	0
+	+	+	+	-	-	+	+	+	+	+	+	+	+		0	0	+	+
-	-	-	-	-	-	0	0	+	0	0	0	+	0		-	+	+	+
				+											-	-	-	+
-	-	-	-			-	-	-	-	-	-	0	-		-	-	0	+
-	-	+	0	-	-	0	0	0	-	-	-	-	-		-	-	-	0



## Chemical stability of plastics

Medium	PFA/FEP		PTFE		ETFE		PMP		PP		HDPE		LDPE	
	20 °C	50 °C	20 °C	50 °C	20 °C	50 °C	20 °C	50 °C	20 °C	50 °C	20 °C	50 °C	20 °C	50 °C
Petroleum	+	+	+	+	+	+	0	0	0	-	0	-	0	-
Petroleum ether	+	+	+	+	+	+							0	
Phenol	+	+	+	+	+	+	0	0	+	+	+	+	+	0
Phenylethanol	+	+	+	+	+	+			0		0			
Phenylhydrazine	+	+	+	+	+	+			0		0			
Phosphoric acid, 85%	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Piperidine	+	+	+	+	+	+			+		+			
Potassium chloride	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Potassium dichromate			+	+										
Potassium hydroxide	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Potassium permanganate	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Propanol	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Propionic acid	+	+	+	+	+	0	+	0	+	0	+	0	0	-
Propylene glycol (propanediol)	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Pyridine	+	+	+	+	-	-	+	0	0	0	+	0	+	0
Salicylaldehyde	+	+	+	+	+	-	+	+	+	+	+	+	+	+
Salicylic acid	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Silver acetate	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Silver nitrate	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Sodium acetate	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Sodium chloride	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Sodium dichromate	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Sodium fluoride	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Sodium hydroxide	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Sulphuric acid, 60%	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Sulphuric acid, 98%	+	+	+	+	+	+	+	+	-	-	0	-	0	-
Tartaric acid	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Tetrachloroethylene	+		+	+	0									
Tetrahydrofuran (THF)	0	0	+	+	+	0	0	-	-	-	0	-	0	-
Tetramethylammonium hydroxide	+	+	+	+	+	+								
Toluene	+	+	+	+	+	+	0	-	0	-	0	0	0	-
Tri(ethylene glycol)	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Tri(propylene glycol)	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Trichloroacetic acid	+	+	+	+	+	0	+	+	0	-	0	0	0	-
Trichlorobenzene	+	+	+	+	+	0	0	0	-	-	-	-	-	-
Trichloroethane	+	+	+	+	+	+	-	-	-	-	0	-	-	-
Trichloroethylene	+	+	+	+	+	+	-	-	-	-	0	-	-	-
Trichlorotrifluoroethane	+	+	+	+	0	-								
Triethanolamine	+	+	+	+										
Trifluoroacetic acid (TFA)	+	-	+	0										
Trifluoroethane	+	0	+	+										
Turpentine	+	+	+	+	+	+	0	0	-	-	0	-	0	-
Urea	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Xylene	+	+	+	+	+	+	0	-	-	-	0	-	0	-
Zinc chloride, 10%	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Zinc sulphate, 10%	+	+	+	+	+	+	+	+	+	+	+	+	+	+

# Technical information

PC		POM		PA		SAN		PMMA		PS		PVC		MF	NR	SI	EPDM	FKM
20 °C	50 °C	20 °C	50 °C	20 °C	50 °C	20 °C	50 °C	20 °C	50 °C	20 °C	50 °C	20 °C	50 °C	20 °C	20 °C	20 °C	20 °C	20 °C
0	0	+	+	+				+		-	-	+	-		-	0	-	+
		+	+	+				+		-	-	0	-		-	-	-	+
-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	0
				0											0	-	-	0
+	+	+	-	-	-	+	+	-	-	+	0	+	0	-	-	-	0	+
															-	-	-	-
+	+	+	+	+		0	0	+	+	0	0	+	0		+	+	+	+
				-	-										0	0	+	0
-	-	+	+	+		0	0	+	+	0	0	0	0	-	0	-	+	-
+	+	0	0	-	-	+	0	+	+	+	+	+	+		-	-	+	+
0		+	+	+	+	+	+	0		0		+	+		+	0	+	+
-	-	-	-	0	0					0	-	0	-		-	-	0	+
+	0	+	+	-	-	-	-	0	0	+	+	0	-		+	+	+	+
-	-	+	0	+		-	-	-	-	-	-	0	-		-	-	-	-
0	0					-	-			-	-	-	-					
		-	-	+		+	+			+	+	0	-		+	+	+	+
+	+	0	0			0	0	0	0	0	0	0	0		+	+	+	+
+	+	0	0	+		+	+	+	+	0	0	0	0		+	+	+	+
+	+	+	0	+		+	+	-	-	+	+	0	0		+	0	+	-
+	+	+	+	+		+	+	+	+	+	+	+	+		+	+	+	+
+	-	+	+	+		+	0	+	0	+	0	+	+		+	0	+	+
+	+	+	+	+		+	+	+	+	+	+	+	+		0	0	+	+
-	-	+	+	+	0	+	+			+	+	+	+	-	0	0	+	0
0	0	-	-	-	-	+	0	-	-	-	-	0	-		-	-	-	+
-	-	-	-	-	-	-	-	-	-	-	-	-	-		-	-	-	+
+	+	+	+	0	0	+	+	0	0	+	+	+	+	-	+	+	0	+
				-	-										-	-	-	0
-	-	0	0	+		-	-	-	-	-	-	-	-	+	-	-	-	-
-	-	-	-														+	-
-	-	+	+	+		-	-	-	-	-	-	-	-		-	-	-	0
+	0	+	0			+	+	0	0	+	+	0	-		0	+	+	+
+	0	+	0			+	+	0	0	+	+	0	-		+	+		
0	-			-	-					0	-	0	-		0		0	-
-	-									-	-	-	-					
-	-	0	-	0		-	-	-	-	-	-	-	-		-	-	-	+
-	-	-	-	0		-	-	-	-	-	-	-	-		-	-	-	0
				0		-	-			-	-						0	
						-	-			-	-				0	-	0	-
		-	-			-	-			-	-							-
						-	-			-	-				-	-	-	+
-	-	+	+	+		0	0	+	+	-	-	+	+		-	-	-	+
-	-	+	+	+		+	+	+	+	+	+	0	-	+	+	+	+	+
-	-	+	+	+		-	-	-	-	-	-	-	-		-	-	-	0
+	+	+	0	-	-	+	+	-	-	+	+	+	0		+	+	+	+
+	+	0	-	-	-	+	+	0	0	+	+	+	0		0	+	+	+

## Physical properties of plastics

Plastics	Max. temperature for use °C	Brittleness temperature °C	Microwaveability*	Density g/cm <sup>3</sup>
PFA	260	-200	yes	2,17
PTFE	260	-200	yes	2,17
FEP	205	-100	yes	2,15
ETFE	150	-100	yes	1,70
PMP	150	0	yes	0,83
PP	125	0	yes	0,90
PE-HD	105	-50	yes	0,95
PE-LD	80	-50	yes	0,92
PC	125	-130	yes	1,20
POM	130	-40	no	1,42
PA	90	0	-	1,13
SAN	70	-40	no	1,03
PMMA	65 - 95	-50	no	1,18
PS	70	-20	no	1,05
PVC	80	-20	no	1,35
MF	120	-80	yes**	1,50
NR	80	-40	no	1,20
SI	180	-60	no	1,10
EPDM	130	-40	-	-
FKM	220	-30	-	-

\* Mind the chemical and temperature suitability!

\*\* Caution necessary when used in a microwave oven: Heating can release amounts of melamine and formaldehyde that can be harmful to health!

## Cleaning and maintenance of plastics

---

All polyolefins, such as PE-LD, PE-HD, PP and PMP, as well as the fluoroplastics PTFE, PFA, FEP and ETFE have water-repellent surfaces that are very durable and easy to clean. For cleaning, depending on the level of contamination, commercially available neutral or alkaline detergents can be used. Polycarbonate (PC) labware should not be cleaned with alkaline cleaning agents (> pH 7). Please note that no scrubbing agents or scouring pads should be used for labware made from plastics.

### **Cleaning with dishwashers**

Labware made from the above-named plastics (except for PE-LD, due to the temperature limit) can be cleaned and dried in a laboratory dishwasher together with other apparatus. Machine cleaning with laboratory dishwashers is gentler to labware than cleaning in an immersion bath. The labware is exposed to the cleaning solution for relatively short rinsing periods when sprayed by the jet or injector nozzles. Due to their light weight, we recommend securing the apparatus to be washed with washing nets to prevent them from tumbling in the water jet. Labware is better protected against scratching when the wire baskets in the washing machine are plastic coated.

### **Cleaning in an ultrasonic bath**

Plastic labware may be cleaned in an ultrasonic bath. However, direct contact with the acoustic membrane should be avoided.

### **Cleaning in trace analysis**

To avoid contamination with cations and anions in trace analysis, plastic labware should be allowed to stand with a 1N HCl or HNO<sub>3</sub> solution for a maximum of 6 hours at room temperature, and be rinsed afterwards with purified distilled water. For trace analysis conducted in the concentration range of ng/g (ppb) or pg/g (ppt), containers made of the fluoroplastic PFA are particularly suitable, because they have a smooth surface, are easy to clean without carry-over (memory effects) and interaction with the container material.

## Sterilisation of laboratory equipment made of plastics

### Autoclaving

#### Recommended autoclaving protocol

20 minutes at 121 °C (2 bar),  
according to DIN EN 285

Autoclaving (steam sterilisation) is defined as the destruction or irreversible inactivation of all reproducible microorganisms under exposure to "saturated steam at a minimum of 120 °C." (DIN 58946-1, 1987). DIN EN 285 specifies a minimum exposure time ( $t_g$ ) of 20 minutes (killing time and safety margin) at a sterilisation temperature of 121 °C. For the correct sterilisation procedure, including biological safety (DIN EN 285), please contact your hygiene specialist.

Prior to autoclaving plastic labware, ensure that no soiling or residual contamination remains on the equipment. Otherwise, the residual contamination will bake on solidly during the autoclaving process. Even substances that have no effect on the plastic at room temperature can still lead to destruction of the plastic during the autoclaving process. Additionally, microorganisms might not be killed effectively if they are protected by the residual contamination.

### Notes on autoclaving



- Containers with screw tops or stoppers must be **open** during autoclaving to allow for pressure equalisation
  - ➔ Autoclaving of a closed container will lead to the deformation or destruction of the container
- Plastic labware should be **stood upright on a level surface** during autoclaving to avoid shape deformation.
  - ➔ Plastic labware should not be laid on its side during autoclaving
- **No mechanical stresses** should be present during autoclaving
  - ➔ For example, do not stack items
- Do not autoclave any container that contains residual contamination or even rinsing agent
- Not all plastics are resistant to steam sterilisation! For example, polycarbonate loses its tensile strength
  - ➔ Mind the temperature limits for the plastics
  - ➔ Autoclavable products are identified with a "121 °C" symbol in this catalogue

The surfaces of some plastics can be attacked by chemicals present during autoclaving, which can cause persistent clouding. Some transparent plastics can absorb minute quantities of steam, which can lead to reversible clouding. This clouding disappears upon drying, which can be accelerated through the use of a drying oven.

### Note!

For gas sterilisation, dry heat, and prior to heating in a microwave oven, all closures and stoppers must be removed as well.

### Heating plastics in microwave ovens

Many plastics are suitable for use in microwave ovens. More accurate information can be obtained from the Table "Physical Properties of Plastics" on page 146. In this connection, it is important to be mindful of the chemical and temperature stability of the various plastics, and to ascertain whether the particular article and its contents are compatible with the given temperature. When aggressive acids, alkalis, or solvents are to be heated, the use of fluoroplastics is recommended. It is very important to provide for adequate ventilation (e.g., fume hoods).

Prior to the use of plastic labware in a microwave oven, the closures and stoppers must be removed from the apparatus.

## Sterilisation\* of plastics

Plastics	Autoclave 121 °C, t <sub>e</sub> 20 min according to DIN	Heated air 160 °C (dry)	Gas (Ethylene oxide)	Chemical (Formalin, ethanol)	β-/γ-radiation 25 kGy
PFA	yes	yes	yes	yes	no
PTFE	yes	yes	yes	yes	no
FEP	yes	yes	yes	yes	no
ETFE	yes	no	yes	yes	no
PMP	yes	no	yes	yes	yes
PP	yes	no	yes	yes	yes (limited)
PE-HD	no	no	yes	yes	yes
PE-LD	no	no	yes	yes	yes
PC	yes <sup>1)</sup>	no	yes	yes	yes
POM	yes <sup>1)</sup>	no	yes	yes	yes (limited)
PA	no	no	yes	yes	yes
SAN	no	no	yes	yes	no
PMMA	no	no	no	yes	yes
PS	no	no	no	yes	yes
PVC	no	no	yes	yes	no
MF	no	no	yes	no	no
NR	no	no	yes	yes	no
SI	yes	-	yes	yes	no
EPDM	yes	-	yes	yes	-
FKM	yes	-	yes	yes	-

\* Before sterilisation, labware must be carefully cleaned and rinsed with distilled water. Always remove covers from containers!

<sup>1)</sup> Frequent autoclaving may reduce mechanical stability!

## Suitability of plastics for foodstuffs



The marked products comply with the lawful regulations of the German Consumer Goods Ordinance and/or Directives (EC) No. 1935/2004, (EC) No. 975/2009 and (EU) No. 10/2011 as amended.

In the testing for compliance with the threshold values for the global migration (or respectively, the specific migration threshold values), no determinations exceeded the allowed values. In addition, sensory testing found no olfactory and flavour-related impairments. The testing was implemented according to the 82/711/EEC and 85/572/EEC Guidelines by an independent, accredited institute.

All source materials used in the manufacturing of the products are listed in the German Consumer Goods Ordinance as at 20.12.2006, or respectively, Directive (EU) 10/2011, in accordance with the present attestation. Therefore, they represent permissible source materials in accordance with food law and may be used in the production of food commodities in accordance with the specified restrictions concerning migration threshold values and permissible residual content in the end product.

Marked PP products are suitable for contact with all foodstuff categories providing that a contact period of 24 hours and a contact temperature of 40 °C are not exceeded. Marked SAN products are suitable for contact with all aqueous, alcoholic and fatty foods, providing that a contact period of 24 hours and a contact temperature of 40 °C are not exceeded.

## Disposal and Recycling of Plastics

If the disposal of a piece of plastic labware is unavoidable, regional laws and regulations must be observed. Recycling centres can be found in many cities, which are designed for the disposal of recyclable materials. To simplify the task of sorting in these recycling centres, the majority of labware from VITLAB can be easily identified and presorted by using the engraved or imprinted recycling code. Prior to disposal, plastic labware must be cleaned, and sterilised if necessary, according to the currently valid regulations.

To simplify the separation of plastics for recycling, so that these can later be reused as raw material for manufacture, plastic identification labels (number 01-07) have been introduced. This identification scheme was published in 1988 under the title "SPI resin identification coding system" by the Society of the Plastics Industry (SPI). For coding, the commonly used shorthand for plastics according to the DIN 7728 is also used.



SPI number 07 stands for "other". This is used to indicate other plastics such as PMP, PFA, PTFE etc. VITLAB doesn't use the "0"; rather, it identifies the specific raw material with the abbreviation according to DIN 7728 to simplify identification of the plastic for the end user.

## Accuracy

### What do “tolerance, accuracy, coefficient of variation, and precision” mean in volumetric measurements?

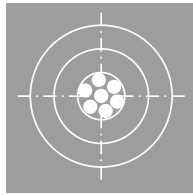
#### Graphic illustration of precision and accuracy

The dart board simulates the volume range around the centred nominal value, the white dots simulate the different measured values of a specified volume.

**Good accuracy:** All hits are near the centre, i.e., the nominal value.

**Good precision:** All hits are close together.

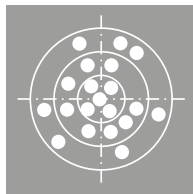
**Result:** The manufacturing process is well controlled by an accompanying quality assurance program. Minimal systematic deviations and a narrow variance in products. The permissible limits are not exceeded. There are no rejects.



**Good accuracy:** On average, the hits are evenly distributed around the centre.

**Poor precision:** No substantial errors, but hits widely scattered.

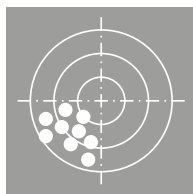
**Result:** All deviations are “equally probable”. Instruments exceeding the permissible tolerance should be rejected.



**Poor accuracy:** Although all hits are close together, the centre (nominal value) is still missed.

**Good precision:** All hits are close together.

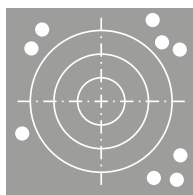
**Result:** Improperly controlled production, with systematic deviation. Instruments exceeding the permissible tolerance should be rejected.



**Poor accuracy:** The hits are far removed from the centre.

**Poor precision:** The hits are widely scattered.

**Result:** These volumetric instruments are of inferior quality.



#### Calculation formulae

The accuracy of glass volumetric instruments is commonly defined by “Tolerance Limits”, whereas for liquid handling instruments the statistical terms “Accuracy [%]” and “Coefficient of Variation [%]” have been established.

#### Tolerance

The term “tolerance” (tol.) in the corresponding standards defines the maximum permissible deviation from the nominal value.

$$\text{Tol.} \geq |V_{\text{meas.}} - V_{\text{nom.}}|$$

#### Accuracy

Accuracy (A) indicates the closeness of measured mean volume to the nominal value, i.e., systematic measurement deviation. Accuracy is defined as the difference between the measured mean volume ( $\bar{V}$ ) and the nominal value ( $V_{\text{nom.}}$ ), related to the nominal value in percent.

$$A[\%] = \frac{\bar{V} - V_{\text{nom.}}}{V_{\text{nom.}}} \cdot 100$$

#### Coefficient of Variation

The coefficient of variation (CV) indicates the closeness of values from repeated measurements, i.e., random measurement deviation. The coefficient of variation is defined as standard deviation in percent, related to the mean volume.

$$CV[\%] = \frac{s \cdot 100}{\bar{V}}$$

#### Partial volumes

(analogous to  $CV_{\text{part.}}[\%]$ )

Generally, A and CV are based on

the nominal volume ( $V_{\text{nom.}}$ ). These data in percent must be converted to partial volumes ( $V_{\text{part.}}$ ). By contrast, there is no conversion for partial volumes if A and CV are stated in volume units (e.g. ml).

$$A_{\text{part.}}[\%] = \frac{V_{\text{nom.}}}{V_{\text{part.}}} \cdot A_{\text{nom.}}[\%]$$

#### Tolerance from A and CV

To a good approximation, the tolerance, e.g. for the nominal volume ( $V_{\text{nom.}}$ ), can be calculated from the accuracy and coefficient of variation.

$$\text{Tol.} \geq \frac{|A\%| + 2CV\%}{100\%} \cdot V_{\text{nom.}}$$

#### Precision

If the variance in the individual measurement results about the mean volume  $\bar{V}$  is given in units of volume, this relates to precision.