

The best material for original Eppendorf Tubes[®] and Plates: Properties and chemical resistance of polypropylene

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Abstract

Consumables in the laboratory should be made from a material which is able to withstand strong mechanical and thermal stress, while at the same time possessing high chemical resistance. This Technical Report provides information about general properties and advantages of polypropylene, the material which is used for the

manufacturing of the Eppendorf Tubes[®] and Plates. Important quality criteria of Eppendorf products regarding raw material and production will be described. In addition, a comprehensive overview of chemical resistance of polypropylene is available.

Quality criteria for reaction tubes

Reaction tubes, in single tube format as well as in plate format, are used in the laboratory for the preparation, transport and storage of solutions, as well as reaction vessels. They are frequently opened, closed, shaken, centrifuged, heated, cooled, and filled with different solvents. For all these reasons, reaction containers need to be made of a material which is able to withstand all these different challenges.

All Eppendorf Tubes and Eppendorf Plates are manufactured from pure polypropylene (PP). Low wettability, high stability and mechanical strength across a broad temperature range are the hallmarks of this plastic. Furthermore, PP is resistant to most organic and inorganic acids, bases and organic solvents used in the laboratory, and it is widely biologically inert.



Fig. 1: Eppendorf Tubes, Deepwell Plates (right) and Polypropylene Microplates (right)

In comparison with other plastics, PP has clear advantages. It is more stable and transparent than polyethylene (PE), it features better chemical resistance and lower binding of biological molecules than polystyrene (PS) and polycarbonate (PC), and it may be used across a broader temperature range than polystyrene (Table 1). These properties make PP the ideal material for a wide spectrum of applications. Comparatively low binding of biological molecules such as nucleic acids and proteins is of special importance for molecular applications.

Eppendorf consumables are made exclusively from high quality, ultra pure PP, which complies with FDA guidelines 21 CFR § 177.1520 »Olefin Polymers«, and 21 CFR § 178.2010 »Antioxidants and Stabilizers for Polymers«. Additives such as plasticizers, slip agents and biocides are present neither in the raw material for Eppendorf Tubes and Plates, nor are they used during the manufacturing process. Furthermore, the dyes used do not contain organic substances or heavy metals.

In order to guarantee premium product quality without additives or other substances, high quality injection tools are required. The very smooth surface of the tubes and plates is achieved through careful optimization of the manufacturing process. The surfaces thus show very good flow performance and low wettability, which is beneficial during sample recovery. The entire production takes place under clean room conditions, and the process, from injection to packaging, is automated. Since manual interventions are virtually unnecessary, contaminations are prevented. The lot number printed on the packaging of every product provides additional security, as each product may be traced back.

Extensive quality checks are in place prior to and during production. An initial quality control of the resin is performed, faulty material is removed, and the production tools are maintained on a regular basis. Furthermore, the final product is examined for functionality and purity. The functionality tests for tubes include lid closure security in a boiling water bath, centrifugation stability and vapor tightness. These quality controls and tests ensure the sustained high product quality across the entire production phase.

Table 1: Comparison of properties of the materials PP and PS

	PP	PS	Relevant areas of application
Transparency	Medium	High	Transmission measurements
Temperature stability	ca. 120 °C	up to ca. 60 °C	Incubation, storage, autoclaving
Resistance to organic solvents	High	Low	Nucleic acid purification, protein analytic, compounds, assays
Mechanical strength	High	Low	Centrifugation, automation
Binding of biomolecules	Low	Low to high depending on the type	Applications using nucleic acids and proteins

Chemical resistance properties of polypropylene

Resistance of PP to numerous chemicals is listed below. For each substance, the resistance at three different temperatures (+20 °C, +40 °C, +60 °C) is described. The data are recommendations for colorless PP and were derived from the literature [1]. These details also apply to the colored Eppendorf reaction tubes, the black and white

Microplates, as well as the OptiTrack® matrix of the Eppendorf Plates, which consist of a colored rim with alphanumeric labeling. If in doubt, we recommend that you test the chemical in question on the consumable article prior to the actual work step.

Chemical substance	Mass fraction (%)	PP		
		+ 20 °C	+ 40 °C	+ 60 °C
A				
Acetaldehyde (ethanal), aqueous	40	1	1	1
Acetic acid, aqueous	25–60	1	1	1
Acetic acid (pure)	100	1	1	2
Acetic anhydride	100	1	0	2
Acetone (dimethyl ketone)	100	1	1	2
Acrylonitrile		1	0	0
Adipic acid (hexanedioic acid), aqueous	saturated	1	1	1
Allyl alcohol (2-propene-1-ol)	96	1	1	1
Aluminum chloride, aqueous	saturated	1	1	1
Ammonia, aqueous	30	1	1	1
Ammonium chloride, aqueous	saturated	1	1	1
Ammonium hydroxide, aqueous	30	0	0	2
Amyl acetate (acetic acid amyl ester)	100	2	0	3
Amyl alcohol (1-pentanol)	100	1	1	1
Amyl chloride (1-chloropentane)	100	3	0	0
Aniline	100	1	1	1
Aniline, aqueous	saturated	2	2	2
Aqua regia (HNO ₃ , concentrated HCl)		2	0	3
B				
Benzaldehyde, aqueous	saturated	1	0	0
Benzene	100	2	0	3
Benzine	100	2	0	3
Benzoyl chloride		2	0	0
Benzyl alcohol	100	1	0	2
Boric acid, aqueous	saturated	1	1	1
Bromic acid		1	0	0
Bromine, liquid	100	3	3	3
Bromo benzene		3	3	3
1,3-Butadiene	100	2	0	3
Butanol (butyl alcohol)	100	1	1	2
Butyl acetate (acetic acid butyl ester)	100	2	0	3
Butyric acid	100	1	0	0
Butyric acid, aqueous	20	1	0	0

0 = not tested 1 = resistant; several months lifetime 2 = conditionally resistant; a few weeks lifetime 3 = non-resistant; a few hours lifetime or rapid destruction

All values are recommendations without guarantee.

Chemical substance	Mass fraction (%)	PP		
		+ 20 °C	+ 40 °C	+ 60 °C
C				
Calcium chloride, aqueous	saturated	1	1	1
Calcium hydroxide, aqueous	all	1	1	1
Calcium hypochloride, 12.5 % effective chlorine		1	1	1
Carbon disulfide	100	1	0	3
Carbon tetrachloride (tetrachloromethane)	100	3	3	3
Chloroacetic acid (mono), aqueous	85	1	1	1
Chloroacetic acid (mono)	100	1	1	1
Chlorobenzene	100	1	0	0
Chloroform (trichloromethane)	100	2	0	3
Chromic acid, aqueous	50	2	2	2
Chromic-sulfuric acid mixture		3	3	3
Citric acid	all	1	1	1
Copper sulfate, aqueous	saturated	1	1	1
Cresol, aqueous	up to 90	1	0	0
Crude oil		2	0	0
Cyclohexane	100	1	1	1
Cyclohexanol	100	1	0	2
Cyclohexanone	100	1	0	2
D				
Decahydro naphthalene	100	2	2	2
Dibutyl ether		2	0	3
Dibutyl phthalate	100	1	0	2
Dichlorobenzene		2	0	0
Diesel fuel		1	0	2
Diethylene glycol		1	1	1
Diethyl ether		2	0	0
Diisopropyl ether	100	2	0	3
Dimethyl ether		2	0	0
Dimethyl formamide	100	1	1	1
Dimethyl sulfate	100	2	0	0
Dioxane	100	2	2	2
E				
Ethanol, aqueous	all	1	1	1
Ethanol	100	1	1	1
Ethyl acetate (acetic acid ethyl ester)	100	1	2	2
Ethyl benzene	100	2	0	0
Ethylene chloride (1,2-dichloroethane)	100	2	0	3
Ethylene oxide (1,2-epoxyethane)	100	1-2	0	0

0 = not tested 1 = resistant; several months lifetime 2 = conditionally resistant; a few weeks lifetime 3 = non-resistant; a few hours lifetime or rapid destruction
 All values are recommendations without guarantee.

Chemical substance	Mass fraction (%)	PP		
		+ 20 °C	+ 40 °C	+ 60 °C
F				
Formaldehyde (methanal), aqueous	40	1	1	1
Formic acid (methanoic acid)	100	1	1	2
G				
Glycerol	100	1	1	1
Glycol	100	1	1	1
Glycol, aqueous	all	1	1	1
H				
Heating oil	100	1	0	2
Heptane	100	2	2	2
Hexane	100	1	0	2
Hydrochloric acid, aqueous	greater than 30	1	1	1
Hydrofluoric acid, aqueous	up to 40	1	1	1
Hydrogen peroxide, aqueous	up to 30	1	0	2
Hydrogen peroxide, aqueous	90	1	0	0
Hydroquinone (1,4-dihydroxybenzene)	all	1	1	1
I				
Iodine-potassium iodide solution	50	1	1	1
Isopropanol, aqueous	all	1	1	1
Isopropanol	100	1	1	1
K				
Kerosene	100	2	2	2
L				
Lactic acid (2-hydroxypropanoic acid), aqueous	up to 90	1	1	1
Linseed oil	100	1	1	1
M				
Mercury	100	1	1	1
Methanol	100	1	1	1
Methyl acetate (acetic acid methyl ester)	100	1	1	1
Methyl chloride (chloromethane)	100	2	0	3
Methylene chloride (dichloromethane)	100	2	3	3
Mineral oil	100	1	0	2
N				
Nitric acid, aqueous	up to 30	1	1	2
Nitric acid, aqueous	65	3	3	3
Nitrobenzene	100	1	1	1
Nitrous acid	up to 50	2	0	0
O				
Oleic acid (9-octadecenoic acid)	100	1	0	2
Oxalic acid (ethanedioic acid), aqueous	all	1	0	2

0 = not tested 1 = resistant; several months lifetime 2 = conditionally resistant; a few weeks lifetime 3 = non-resistant; a few hours lifetime or rapid destruction

All values are recommendations without guarantee.

Chemical substance	Mass fraction (%)	PP		
		+ 20 °C	+ 40 °C	+ 60 °C
P				
Paraffin oil	100	1	0	2
Perchloric acid, aqueous	20	1	1	1
Petroleum	100	1	0	2
Petroleum ether	100	1	0	2
Phosphoric acid, aqueous	80	1	1	1
Phosphoric acid, aqueous	95	1	0	2
Potassium chloride, aqueous	saturated	1	1	1
Potassium permanganate, aqueous	saturated	1	1	1
Pyridine	100	2	2	2
S				
Silicone oil	100	1	1	1
Silver nitrate, aqueous	all	1	1	1
Sodium acetate, aqueous		1	1	1
Sodium hydroxide	50	1	1	1
Sodium hypochloride, aqueous	diluted	1	1	1-2
Sulfuric acid, aqueous	50	1	1	1
Sulfuric acid, aqueous	96	2	0	3
T				
Tartaric acid (2,3-dihydroxybutanedioic acid), aqueous	saturated	1	1	1
1,1,2,2-tetrachloroethane	100	2	0	3
Tetrahydrofuran	100	2	0	3
1,2,3,4-tetrahydronaphthalene (tetralin)	100	3	3	3
Thionyl chloride	100	3	3	3
Toluene	100	2	0	3
Trichloroacetic acid	100	1	1	1
Turpentine	100	3	3	3
U				
Urea, aqueous	saturated	1	1	1
V				
Vaseline		1	0	1-2
X/Z				
Xylene	100	3	3	3
Zinc chloride, aqueous	diluted	1	1	1
Zinc chloride, aqueous	saturated	1	1	1
Zinc sulfate, aqueous	diluted	1	1	1
Zinc sulfate, aqueous	saturated	1	1	1

0 = not tested 1 = resistant; several months lifetime 2 = conditionally resistant; a few weeks lifetime 3 = non-resistant; a few hours lifetime or rapid destruction

All values are recommendations without guarantee.

Literature

[1] Carlowitz, B.: Kunststofftabellen. 4. Aufl. München: Hanser, 1995. ISBN 3-446-17603-9.

Ordering Information

Description	Order no. international			Order no. North America		
	0.5 mL	1.5 mL	2.0 mL	0.5 mL	1.5 mL	2.0 mL
Safe-Lock Tubes , Eppendorf Quality Colorless*	per 500 pcs. 0030 121.023	per 1000 pcs. 0030 120.086	per 1000 pcs. 0030 120.094	per 500 pcs. 022363611	per 500 pcs. 022363204	per 500 pcs. 022363352
Safe-Lock Tubes , PCR clean Colorless	per 500 pcs. 0030 121.301	per 1000 pcs. 0030 123.328	per 1000 pcs. 0030 123.344	per 500 pcs. 022363719	per 500 pcs. 022363212	per 500 pcs. 022363344
Protein LoBind Colorless	per 100 pcs. 0030 108.094	per 100 pcs. 0030 108.116	per 100 pcs. 0030 108.132	per 100 pcs. 022431064	per 100 pcs. 022431081	per 100 pcs. 022431102
DNA LoBind Colorless	per 250 pcs. 0030 108.035	per 250 pcs. 0030 108.051	per 250 pcs. 0030 108.078	per 250 pcs. 022431005	per 250 pcs. 022431021	per 250 pcs. 022431048
Safe-Lock Tubes , Eppendorf Biopur® Individually wrapped	per 50 pcs. 0030 121.570	per 100 pcs. 0030 121.589	per 100 pcs. 0030 121.597	per 50 pcs. 022600001	per 100 pcs. 022600028	per 100 pcs. 022600044
Eppendorf Tubes® 3810X (Flex-Tube®) Colorless**		per 1000 pcs. 0030 125.150			per 500 pcs. 022364111	
Eppendorf Tubes® 3810X , PCR clean Colorless		per 1000 pcs. 0030 125.215			per 500 pcs. 022364120	

* Also available in the colors yellow, red, green, blue, as well as in a light protective variant (amber).

** Also available in the colors yellow, red, green, blue.

Ordering Information

Description	Order no. international	Order no. North America
Eppendorf Tubes® 5.0 mL , Eppendorf Quality, 200 tubes	0030 119.401	0030119401
Eppendorf Tubes® 5.0 mL , PCR clean, 200 tubes	0030 119.460	0030119460
Eppendorf Tubes® 5.0 mL , Sterile, 200 tubes	0030 119.487	0030119487
Eppendorf Tubes® 5.0 mL , Eppendorf Biopur®, 50 tubes (individually wrapped)	0030 119.479	0030119479
Eppendorf Protein LoBind Tubes 5.0 mL , PCR clean, 100 tubes	0030 108.302	0030108302
Eppendorf DNA LoBind Tubes 5.0 mL , PCR clean, 200 tubes	0030 108.310	0030108310
Starter Pack Eppendorf Tubes® 5.0 mL , PCR clean, 400 tubes, 2 racks (16 spaces), white, 8 universal adapters for rotors with bore for 15 mL conical tubes	0030 119.380	0030119380
Tube Clip 5.0 mL , 10 pcs., secures lid for boiling	0030 119.509	0030119509

Ordering Information Eppendorf Microplates*, 80 plates (5 bags of 16)

Description	Quality	Well color	Border color	Order no. international	Order no. North America
Microplate 96/F-PP	PCR clean	clear	white	0030 601.106	951040005
	Sterile			0030 602.102	951040021
Microplate 96/U-PP	PCR clean	clear	white	0030 601.203	951040048
	Sterile			0030 602.200	951040081
Microplate 96/U-PP	PCR clean	black	white	0030 601.807	951040102
Microplate 96/U-PP	PCR clean	white	gray	0030 601.572	951040145
Microplate 96/V-PP	PCR clean	clear	white	0030 601.300	951040188
	Sterile			0030 602.307	951040227
Microplate 96/V-PP	PCR clean	black	white	0030 601.904	951040260
Microplate 96/V-PP	PCR clean	white	gray	0030 601.670	951040308
Microplate 384/F-PP	PCR clean	clear	white	0030 621.107	951040341
	Sterile			0030 622.103	951040383
Microplate 384/V-PP	PCR clean	clear	white	0030 621.301	951040421
	Sterile			0030 622.308	951040464
	DNA LoBind, PCR clean			0030 623.304	951040546
	Protein LoBind, PCR clean			0030 624.300	951040589
Microplate 384/V-PP	PCR clean	black	white	0030 621.905	951040481
Microplate 384/V-PP	PCR clean	white	gray	0030 621.670	951040503

*Upon request, all Microplates are available with barcode

Ordering Information Eppendorf Deepwell Plates*, 20 plates (5 bags of 4)

Description	Quality	Border color**	Order no. international	Order no. North America
Deepwell Plate 96/2000 µL	Standard	white	0030 501.306	951033405
	Sterile		0030 502.302	951033502
	Protein LoBind		0030 504.305	0030504305
Deepwell Plate 96/1000 µL	Standard	white	0030 501.209	951032603
	Sterile		0030 502.205	951032701
	DNA LoBind		0030 503.201	951032808
	Protein LoBind		0030 504.208	951032905

Ordering Information Eppendorf Deepwell Plates*, 40 plates (5 bags of 8)

Description	Quality	Border color**	Order no. international	Order no. North America
Deepwell Plate 96/500 µL	Standard	white	0030 501.101	951031801
	Sterile		0030 502.108	951031909
	DNA LoBind		0030 503.104	951032000
	Protein LoBind		0030 504.100	951032107
Deepwell Plate 384/200 µL	Standard	white	0030 521.102	951031003
	Sterile		0030 522.109	951031101
	DNA LoBind		0030 523.105	951031208
	Protein LoBind		0030 524.101	951031305

*Upon request, all Deepwell Plates are available with barcode

**Available in five color codes (white, yellow, red, green, blue).

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