



pro-K Fluoropolymergroup

Technical brochure 05
*Tolerances for
sintered PTFE-products*

Preamble

Polytetrafluorethylene (PTFE) is a high performance polymer. Due to its unique properties PTFE has become an indispensable material in modern industrial society.

Among the outstanding properties of PTFE, the high chemical resistance, the broad service range, the excellent dielectric properties, the ageing *resistance*, the resistance to embrittlement and high purity have to be mentioned.

Due to their outstanding properties PTFE, modified PTFE and PTFE compounds are preferred materials in system engineering where complex regulations require high compatibility i.e. compliance with regulations for the contact with oxygen, food or potable water.

Apart from the selection of the appropriate and suitable materials, system and regulatory requirements in high-grade application have to be taken into account and to be considered when starting a new project. For this reason, the complex sets of rules are increasingly the focus of high-quality system engineering applications.

This technical brochure provides information on the tolerances for sintered products made from PTFE, which are essential for high quality PTFE products.

This brochure replaces and in parts respectively augments the brochure "quality requirements, test guidelines and tolerances" for PTFE products edited in 1993 by the Gesamtverband Kunststoffverarbeitende Industrie e. V (GKV).

This technical brochure is edited by the pro-K Fluoropolymergroup and presents the state of knowledge as of February 2022.

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Important note:

This brochure is provided for information only. The information given herein has been prepared according to our best knowledge at this time. The author and pro-K do not provide any warranty for its correctness and completeness. Each reader has to make sure that the information is suitable and appropriate for his purpose.

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Fluoropolymergroup

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1 Field of application

The tolerances listed in this technical brochure are valid for filled and unfilled PTFE products as well as for reprocessed PTFE.

2 General

The tests described below shall be carried out in an air-conditioned test room. The specifications as described in DIN EN ISO 20568-2 (Plastics - Fluoropolymer dispersions and moulding and extrusion materials) apply.

The measurement shall be performed at a laboratory temperature of $23^{\circ}\text{C} \pm 2^{\circ}\text{C}$.

Since fluoropolymers do not absorb moisture, it is not necessary to maintain a constant humidity during testing. A humidity monitoring of the test room is not obligatory. For tests on preconditioned samples in powder or pellet form, however, it must be ensured that no condensation of air humidity occurs on the surface of the powder or pellet particles.

2.1 Skived films and sheets

Table 1: Thickness and tolerances

Thickness	Tolerance
< 0,1 mm	+0,01 mm/ -0 mm
≥ 0,1 mm	+10 % / -0 %

The standard tolerance for width is +3 %/ -0 %, maximum 30 mm.

The standard tolerance for length is +2 %/ -0 %.

For surface roughness the tolerance is $\leq 0,8 \mu\text{m}$

Depending on the intended application, separate agreements between supplier and customer may be made for the following criteria. The following four minimum requirements are recommended as guidance:

Edge waviness

A PTFE-skived film of the length L and the width B is placed on a support plate. A parallel flat plate is placed over the highest point of the sheet. For practical purposes this can also be done by spanning of two cords. The determination of the maximal tolerated waviness of the edge is performed according to the test method described in DIN ISO 1101.

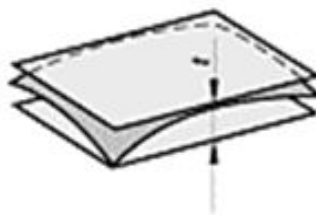


Figure 1 Edge waviness (from DIN ISO 1101 (University Essen / Duisburg, ipe))

Flatness tolerance

The film must lie between two parallel planes with a separation "t." The following maximum values of t are allowed:

Table 2: Flatness tolerance

	Thickness of film (mm)	width (mm)	t (mm) normal film
Standard PTFE	$\leq 2,5$	600	30
		1000	50
		1200	60
		1500	80
	$\leq 5,0$	600	40
		1000	60
		1200	70
		1500	90
Modified PTFE	$\leq 2,5$	600	30
		1000	60
		1200	70
		1500	90
	$\leq 5,0$	600	55
		1000	70
		1200	85
		1500	110

Straightness of edge

The PTFE-skived film of length L is placed without strain on a plane support. The starting point and end point of the film are connected by a straight line. Parallel to this line a second parallel line is drawn at a distance of C . The bent edge of the film must always be between the two lines.

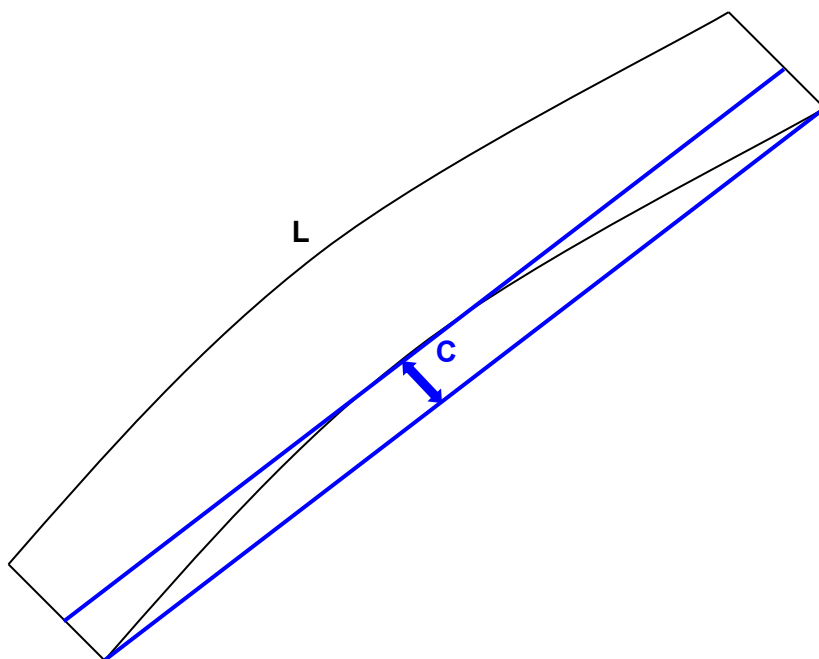


Figure 2: Straightness of edge

The straightness of edge is usually not part of general quality specifications. For films of the thickness ≤ 5 mm the following guideline may be applied:

Table 3: Guidance values for straightening behaviour

	C in % of L
Standard PTFE	3
Modified PTFE	5

Contamination

The determination of the contamination is done by a visual inspection of the surface. Contaminations adhering to the surface caused by the machining are not taken into account.

The following criteria may be regarded as a recommendation for the assessment.

Moulded sheets and thick films

The quality of semi-finished goods is defined by the following table:

Table 4: Permissible error frequency depending on the formats

Sheet/film dimensions	Description
600 x 600 mm	2 inclusions per side With a maximum diameter of 1 mm
1000 x 1000 mm	3 inclusions per side With a maximum diameter of 2 mm
1200 x 1200 mm 1220 x 1220 mm	4 inclusions per side With a maximum diameter of 2 mm
1500 x 1500 mm	5 inclusions per side With a maximum diameter of 2 mm

Thin skived films

For this kind of films higher requirements apply. These have to be agreed on between the customer and the supplier.

Moulded parts

The quality of semi-finished products is defined in the following table:

The number of contaminants applies to mouldings up to a diameter of 400 mm and to a length of 300 mm or mouldings above Ø 400 mm and a length of 100 mm.

Table 5: Permissible error rate as a function of Ø

Dimensions	Description
up to Ø 100 mm. (Ø D);	2 inclusions With a maximum diameter of 1 mm
above Ø 100 to 300 mm (Ø D)	3 inclusions With a maximum diameter of 1 mm
above Ø 300 mm (Ø D)	3 inclusions With a maximum diameter of 1 mm

Extruded parts

The quality of semi-finished products is defined in the following table: (Length 1000 mm)

Table 6: Permissible error rate as a function of Ø

Dimensions	Description
from Ø 4 to Ø 40 mm (Ø OD)	2 inclusions With a maximum diameter of 1 mm per rod / pipe
above Ø 40 to Ø 80 mm (Ø OD)	3 inclusions With a maximum diameter of 1 mm per rod / pipe
above Ø 80 mm (Ø OD)	4 inclusions With a maximum diameter of 1 mm per rod / pipe

Quality control via determination of the mechanical properties

Information about the mechanical properties is provided in the technical brochure 4 „Quality requirements and test guidelines for PTFE products“, edited in February 2020 by pro K.

2.2 Moulded sheets

Table 7: Tolerances for pressed plates

Thickness	Tolerance
< 5 mm	+0,75 / -0 mm
≥ 5 mm	+15 / -0 %

The tolerance with regard to length and width is +3 / -0 %, maximum 35 mm. The surface roughness shall be ≤ 16 µm.

Requirements regarding the **planeness** of moulded sheets are not defined. If necessary these parameters have to be agreed on between the customer and the supplier.

2.3 Extruded and moulded rods, extruded tubes (Ram-Extrusion)

For this process only a plus-tolerance is defined. The standard tolerance for extruded and moulded rods as well as for extruded tubes (Ram-Extrusion) with respect to length is:

Table 8: Tolerances for extruded and pressed pipes in relation to length

Length	Tolerance
< 500 mm	+10 / -0 mm
≥ 500 mm	+2 / -0 %

Diameter tolerance (inside and outside) for extruded rods

Table 9: Diameter tolerances for rods in relation to the outer diameter

Rods with Outside- Ø	Tolerance - Ø
< 10 mm	+0,6 / -0 mm
≥ 10 mm	+6 / -0 %

The tolerance for diameter for ground rods requires a separate agreement.

Diameter tolerance (inside and outside) for extruded tubes

Table 10: Diameter tolerances (inside and outside) for extruded pipes

Outside- Ø	Tolerance	
	Inside- Ø	Outside- Ø
< 10 mm	+0 / -0,6 mm	+0,6 / -0 mm
≥ 10 mm	+0 / -6 %	+6 / -0 %

2.4 Diameter - and wall thickness-tolerances for moulded, free sintered tubes

The tolerances for the diameter and wall thickness depend essentially on the length and thickness of the moulded product. The plus tolerance for the outside diameter and the minus tolerance for the inside diameter are higher than in extruded tubes. Only limited lengths can be moulded due to the process and the properties of the resin used. The conditions for processing agreed on between the customer and the supplier have to be met for the complete length of the pipe.

2.5 Paste extruded parts, hoses and pipes

The standard tolerance for the inside- Ø and the wall thickness is:

Table 11: The standard tolerance on the inside Ø and the wall thickness is:

Dimension	Tolerance
Inside- Ø < 5 mm	± 0,25 mm
Inside- Ø ≥ 5 mm	± 5 %
Wall thickness < 1,0 mm	± 0,1 mm
Wall thickness ≥ 1,0 mm	± 10 %

The standard tolerance for the length is +2 / -0 %.

Table 12: Concentration deviations

Deviation from the center	
Thickness (mm)	Tolerance (mm)
Up to 5	0,3
above 5 to 20	0,5
above 20 to 40	1,0
above 40	Depending on agreement

Paste extruded tubes

Table 13: Tolerances for paste extruded pipes

Outside diameter (mm)	Tolerance (mm)
Up to 50	$\pm 2,0$
above 50 to 80	$\pm 2,5$
above 80 to 125	$\pm 3,0$
above 125 to 150	$\pm 3,5$
above 150 to 200	$\pm 4,0$
above 200 to 250	$\pm 5,0$
above 250 to 350	$\pm 5,5$
above 350 to 300	$\pm 6,0$
above 400	Depending on agreement

Tolerances for the wall thickness

Table 14: Tolerances for wall thickness

Thickness (mm)	Tolerance (mm)
Up to 3,0	$\pm 0,3$
above 3,0 to 4,0	$\pm 0,40$
above 4,0 to 5,0	$\pm 0,50$
above 5,0 to 7,5	$\pm 0,6$
above 7,5	Depending on agreement

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