



pro-K Fluoropolymergroup

Technical Brochure 06:
*Tolerances for the machining of
PTFE-parts*

Preamble

The fully fluorinated polymer PTFE is the most widely used fluoropolymer and based on its unique properties is established as an indispensable construction material in modern industries.

The main extraordinary properties of PTFE are resistance to most chemicals, a broad service temperature range, the excellent electrical properties, resistance to embrittlement, ageing resistance and very high purity.

This technical brochure provides information about the tolerances for the machining of PTFE parts, 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). It replaces the information sheet from 2014 with a few changes.

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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 PTFE-turned parts

1.1 Area of application

Chapter 1 deals with the maintainable tolerances that can be achieved with chipping of a length $5 \sqrt{d}$, maximum 50 mm machined length („d“ = outer diameter to be machined). The measurement is done at a normal climate¹. The samples have to be in a thermal equilibrium.

1.2 Selection of tolerances

The following table is consistent with the geometric product specification (GPS) ISO tolerance system for lengths part 1. Basics for tolerances, deviances and fits (ISO/DIS 286-1:2007); German Version EN ISO 286-1:2007

Following tolerances apply (in μm):

Up to 50 mm: for the wall thickness	IT 10
for the diameter	IT 11
above 50 to 180 mm:	
for the wall thickness	IT 11
for the diameter	IT 12
above 180 to 500 mm:	
for the wall thickness	IT 12
for the diameter	IT 12

¹ According to DIN EN ISO 291 there are different normal climates. First normal climate 23/50 (for non tropic countries) and the normal climate 27/65 (for tropic countries). For both climates there are two classes 1 and 2. Class 1 requires a temperature tolerance of $\pm 1^\circ\text{C}$ and a moisture tolerance of $\pm 5\%$. Class 2 requires a temperature tolerance of $\pm 2^\circ\text{C}$ and a moisture tolerance of $\pm 10\%$.

Table 1: Basis for tolerances, deviations and fits (ISO/DIS 286-1:2007)

Nominal- measure- ment range mm	Radial wall thickness							Diameter						
	8	9	10	11	12	13	14	8	9	10	11	12	13	14
from 1 to 3	1 4	25	40	60	100	140	250	14	25	40	60	100	140	250
from 3 To 6	1 8	30	48	75	120	180	300	18	30	48	75	120	180	300
From 6 To 10	2 2	36	58	90	150	220	360	22	36	58	90	150	220	360
From 10 To 18	2 7	43	70	110	180	270	430	27	43	70	110	180	270	430
From 18 To 30	3 3	52	84	130	210	330	520	33	52	84	130	210	330	520
From 30 To 50	3 9	62	100	160	250	390	620	39	62	100	160	250	390	620
From 50 To 80	4 6	74	120	190	300	460	740	46	74	120	190	300	460	740
From 80 To 200	5 4	87	140	220	350	540	870	54	87	140	220	350	540	870
From 200 To 800	6 3	100	160	250	400	630	1000	63	100	160	250	400	630	1000
From 800 To 5000	7 2	115	185	290	460	720	1150	72	115	185	290	460	720	1150
From 5000 To 15000	8 1	130	210	320	520	810	1300	81	130	210	320	520	810	1300
From 15000 To 40000	8 9	140	230	360	570	890	1400	89	140	230	360	570	890	1400
From 40000 To 50000	9 7	155	250	400	630	970	1550	97	155	250	400	630	970	1550

1.3 Admissable deviations for length

According to ISO 2768 (Page 1), Table 1: upper and lower limit for length, exactness grade „fine“

Table 2: Upper and lower limits for length measurement, accuracy “fine”, according to ISO 2768 (sheet 1)

Exactness	Measurement range (mm)		
	0,5 to 6	above 6 to 30	above 30 to 120
Fine	$\pm 0,05$	$\pm 0,1$	$\pm 0,15$

The measurements are performed at normal climate 23/50 according to DIN 50014.

In case it is necessary for the correct operation to have a lower tolerance, which would require higher efforts, a product related commitment has to be agreed on between the customer and the PTFE-supplier.

Chipless formed turned parts require bigger tolerances than machined ones. They have to be agreed on between customer and PTFE supplier.

2 PTFE-milled parts

2.1 Area of application

Chapter 2 deals with the tolerances that can be achieved with normal production efforts. The peculiar behaviour of the face machining of PTFE often requires higher tolerances for complicated shaped parts or forms.

2.2 Selection of tolerances

The table of tolerances is consistent with the ISO tolerance (IT) according to ISO 286-1. It contains a limitation of the fineness with respect to the basic tolerances of the IT chapters 13, 14 and 15.

Table 3: ISO Tolerance Series (IT) according to ISO 286-1

Machining dimension mm	IT										
	8	9	10	11	12	13	14	15	16	17	18
From 1 To 3	14	25	40	60	100	140	250	400	600	---	---
Above 3 To 6	18	30	48	75	120	180	300	480	750	---	---
Above 6 To 10	22	36	58	90	150	220	360	580	900	1500	---
Above 10 To 18	27	43	70	110	180	270	430	700	1100	1800	2700
Above 18 To 30	33	52	84	130	210	330	520	840	1300	2100	3300
Above 30 To 50	39	62	100	160	250	390	620	1000	1600	2500	3900
Above 50 To 80	46	74	120	190	300	460	740	1200	1900	3000	4600
Above 80 To 120	54	87	140	220	350	540	870	1400	2200	3500	5400
Above 120 To 180	63	100	160	250	400	630	1000	1600	2500	4000	6300
Above 180 To 250	72	115	185	290	460	720	1150	1850	2900	4600	7200
Above 250 To 315	81	130	210	320	520	810	1300	2100	3200	5200	8100
Above 315 To 400	89	140	230	360	570	890	1400	2300	3600	5700	8900
Above 400 To 500	97	155	250	400	630	970	1550	2500	4000	6300	9700

In case it is necessary for the correct operation to have a lower tolerance, which would require higher efforts, a product related commitment has to be agreed on between the customer and the PTFE-supplier.

3 PTFE-blanked parts

3.1 Area of application

The specified tolerances are valid for one side of the blanked part, the opposite side may differ by the conical shape of the cut face. For this reason the reference dimension for the tolerance is for the inside dimension the smallest size and for the outside dimension is the biggest size.

3.2 Selection of tolerances for the diameter and other dimensions (except thickness)

For blanked parts, that have been machined with precision tools (combination die, knife cut) the basic tolerances of the IT row 15 according to EN ISO 286-1: 2007 apply.

The values of tolerance are valid up to a thickness of max. 3 mm.

3.3 Admissible deviations for the thickness

Up to a nominal thickness of 2 mm: $\pm 10\%$;

For a thickness above 2mm the defined tolerances for thickness of PTFE plates described in pro-K guidelines apply.

4 Admissible deviations for dimensions without defined tolerance of faced or rotation symmetric PTFE-parts

4.1 Diameter and length

According to ISO 2768 General tolerances: Length and angles, shape and position, not for new constructions, edition 4. 1991 (page 1) Table 1 upper and lower limits for lengths, exactness grade medium and coarse, identical to ISO 2768-1 general tolerances.

Table 4: Upper and Lower Limits for Length Dimensions

Exactness grade	Limit dimensions in mm for the nominal measurement range						
	0,5 to 3	Above 3 to 6	Above 6 to 30	Above 30 to 120	Above 120 to 400	Above 400 to 1000	Above 1000 to 2000
medium	$\pm 0,1$	$\pm 0,1$	$\pm 0,2$	$\pm 0,3$	0,5	0,8	1,2
coarse	$\pm 0,2$	$\pm 0,3$	$\pm 0,5$	$\pm 0,8$	$\pm 1,2$	$\pm 2,0$	± 3

For the nominal measurement range of 0,5 to 120 mm the exactness grade medium applies. For measurement ranges above 120 -2000 mm as well as for complicated (thin walled) parts the exactness grade coarse has to be applied, provided there is no specific agreement in place.

4.2 Radius of curvature and cant (heel)

According to ISO 2768 (Page 1), Table 2, upper and lower limit for radius of curvature and heel height the exactness grade fine/medium –identical with DIN ISO 2768-1 general tolerances applies.

Table 5: Upper and lower limits for radius of roundness and bevel heights

Exactness grade	Limit dimension in mm for the nominal measurement range				
	0,5 to 3	Above 3 to 6	Above 6 to 30	Above 30 to 120	Above 120 to 315
Fine/medium	± 0,2	± 0,5	± 1,0	± 2,0	± 4,0

4.3 Angular dimension

According to ISO 2768 (Page 1), Table 3: Exactness grade „fine/medium“

Table 6: Exactness grade

Exactness grade	Limit of angular dimensions for the nominal measurement range of the short arm in mm		
	to 10	above 10 to 50	above 50 to 120
	Grad	Grad	Grad
Fine medium	± 1°	± 30"	± 20"

4.4 Deviations in shape

PTFE hollow articles - especially those with thin walls - are difficult to measure with respect to deviations in shape. The following tolerances are valid only for massive shaped pieces or hollow articles with a diameter/thickness ratio < 5. These parts may utilize the tolerances of the particular nominal dimension given in table 4.1 to 4.3

5 Surface quality

5.1 Test method

DIN EB USI 3274 Geometric product specifications (GPS) – surface quality: Code procedure – Nominal properties of code tools (ISO 3274:1996); German Edition EN ISO 3274:1998.

It is recommended to use the reference area code system with a code radius of 0,005 mm.
Because of the softness of PTFE a very low measuring force of (0,7 mN) should be applied.

5.2 Requirements

The guidance levels for the acceptable roughness of face machined surfaces are as follows:

PTFE-grade	Roughness R_z
Virginal	< 16 μm
Filled* ²	< 25 μm

Please ensure the necessary test length.

The surface quality can be improved by increased manufacturing effort.

6 Measuring equipment and test method for the surface measurement

It is recommended to use a spring loaded scanning system. The probe type is carried out as a cone with a rounded peak. The curve radius should amount maximum 5 μm . Especially when testing filled PTFE products a diamond needle is recommended.

² Is affected by the character and amount of filler as well as its particle size, fibre length e.g glass fibre typical values $L_{50} = 60 \mu\text{m}$, maximum fibre length about 150 μm .

The following companies contributed to this brochure:



