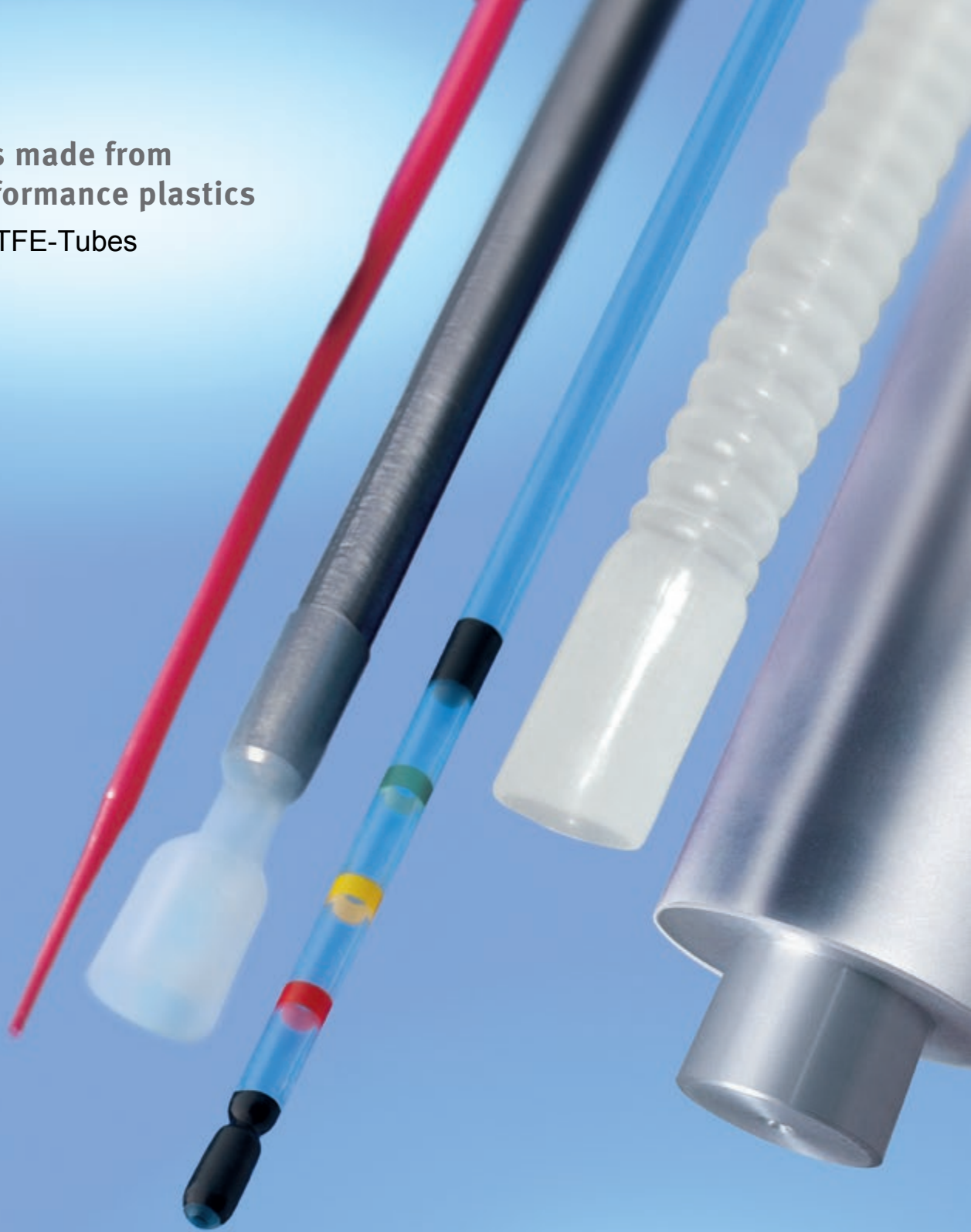


Tubes made from
high-performance plastics
Excerpt: PTFE-Tubes



elringklinger
Engineered Plastics



POLYTETRAFLON™-PTFE tubes for your applications



Broad spectrum of applications for PTFE tubes

PTFE is a highly popular fluoropolymer because of its exceptional chemical, thermal, and dielectric properties. Its almost universal chemical resistance and large working temperature range of -200°C to $+260^{\circ}\text{C}$ for continuous operation make it suitable for a broad spectrum of applications. Thanks to these properties, POLYTETRAFLON™-PTFE tubes are increasingly used in the chemical, electrical, and mechanical industries, as well as in medical technology.

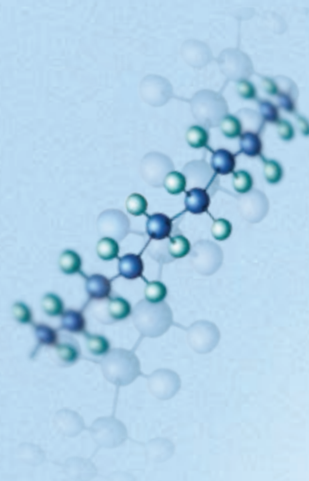
Paste-extruded tubes in a large number of variants

In paste extrusion, paste-like PTFE is mixed with a lubricant in a cartridge, preformed, and then pressed through a nozzle. It then undergoes an external sintering process, which takes place over a relatively long distance. During this process, 100% of the lubricant evaporates. Various PTFE pastes with different properties are currently on the market.

ElringKlinger Kunststofftechnik therefore offers high standard qualities as well as application specific properties that can be tailored to customer requirements. In the standard qualities, different raw materials can be used.

Customized properties with PTFE compounds

The use of modified PTFE types and PTFE compounds allows the typical properties of virgin PTFE to be precisely tailored to specific requirements. Typical fillers include glass, graphite, bronze, or color pigments (black, orange, red, etc.). Tubes made from PTFE compounds with varying filler contents are available on request.



Need more information?

Give us a call:

Bietigheim-Bissingen plant

Telephone +49 7142 583-0

or e-mail:

sales.ekt@elringklinger.com

Application examples: POLYTETRAFLON™-PTFE tubes

Chemical industry

- For analysis or measuring devices in chromatography and laboratory technology as well as for sheathing for measurement sensors in chemical plant engineering
- For transport of food products, oils, resins, and paints
- For transport of aggressive media such as acids, bases, gases, and solvents

Plant design, e.g., paint shops

In paint spray shops where pressure-tested tubes are used because of the specific operating conditions.

Electrical engineering

- Insulation of high-voltage cables
- Cladding of electrical heating elements, as a protective layer in electro-plating and microelectronics

Mechanical applications

The low friction coefficient of PTFE allows cladding of Bowden cables, for example. Applications in the automotive industry are gaining in importance because of the high ambient temperature, e.g., in the manufacture of wire harnesses and in emissions reduction.

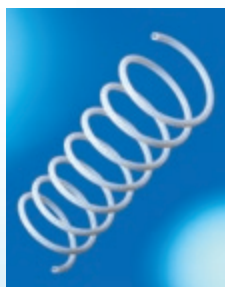
Liquid chromatography

Ultrapure POLYTETRAFLON™-PTFE tubes without aromatic compounds that interfere with analysis.

Medical and laboratory technology

Because it is physiologically harmless, PTFE can be used in the medical sector (see also pages 4–9).

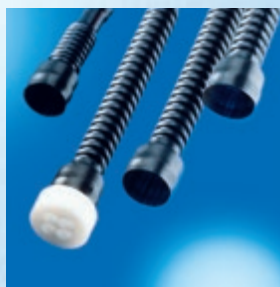
Examples of special solutions



Helical tubes made from POLYTETRAFLON™-PTFE, Moldflon™-PFA and -PVDF



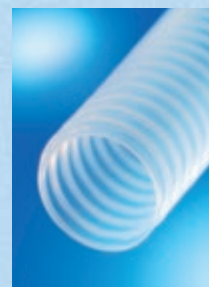
Profiles with different geometries and dimensions



Blow-molded tubes—cable protection for lambda sensors



Curved tubes, e.g., for transmissions



Corrugated tubes made from Moldflon™-PTFE, -PFA, -FEP, or MFA



POLYTETRAFLON™-PTFE tubes in standard dimensions

Internal Ø in mm	Wall thickness	Part no.	Internal Ø in mm	Wall thickness	Part no.
0.50	0.75	062.782	2.70	0.4	066.125
0.60	0.25	062.804	3.00	0.45	064.106
0.70	0.65	062.898	3.00	1	064.203
0.90	0.3	062.936	4.00	0.5	064.262
1.00	0.25	062.979	4.00	1	064.270
1.00	0.3	063.002	4.50	0.75	216.801
1.00	0.4	063.010	5.00	0.5	064.327
1.00	0.5	063.096	5.00	1	064.335
1.00	1	063.177	6.00	0.5	064.378
1.15	0.3	063.231	6.00	1	064.386
1.40	0.4	063.320	7.00	0.5	064.424
1.50	0.5	063.452	8.00	0.5	386.073
1.50	0.75	063.460	8.00	1	064.467
2.00	0.5	063.525	9.00	1	064.483
2.00	1	063.541	9.00	1.5	224.480
2.50	0.75	063.835	10.00	1	064.491
2.50	1	063.843	14.00	1	064.556
2.70	0.25	063.878			

Standard dimensions also available in our online shop: www.ek-kt.de/shop

Technical details

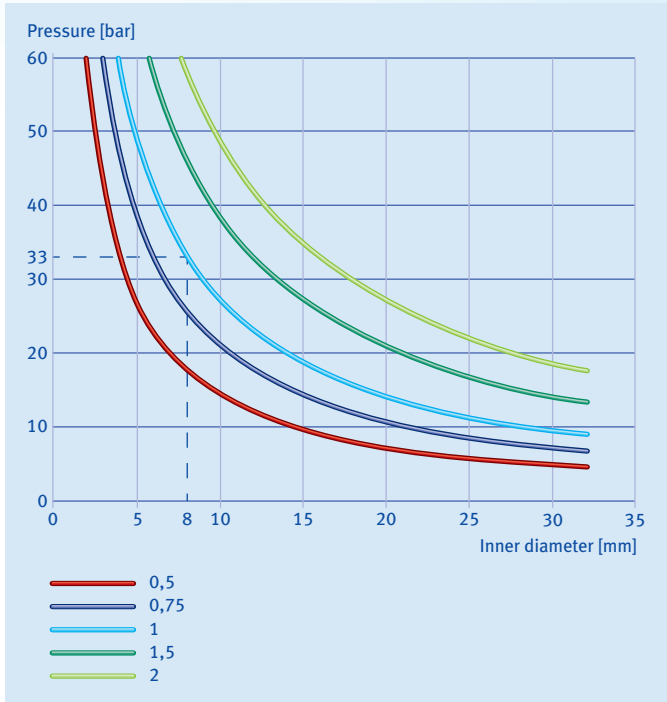
Tolerances for paste-extruded virginal PTFE tubes, in accordance with the pro-K guidelines.

Internal Ø in mm	Tolerance in mm	Wall thickness in mm	Tolerance
3– 5	±0.20	0.10–0.30	±0.05
> 5– 7	±0.25	> 0.30–0.60	±0.10
> 7–10	±0.30	> 0.60–1.00	±0.15
> 10–15	±0.35	> 1.00–2.00	±0.20
> 15–20	±0.40	> 2.00–4.00	±0.40
> 20–30	±0.50	> 4.00–6.00	±0.50
> 30–40	±0.60		
> 40		on request	

Narrowing of tolerances for functional reasons is possible, subject to consultation.

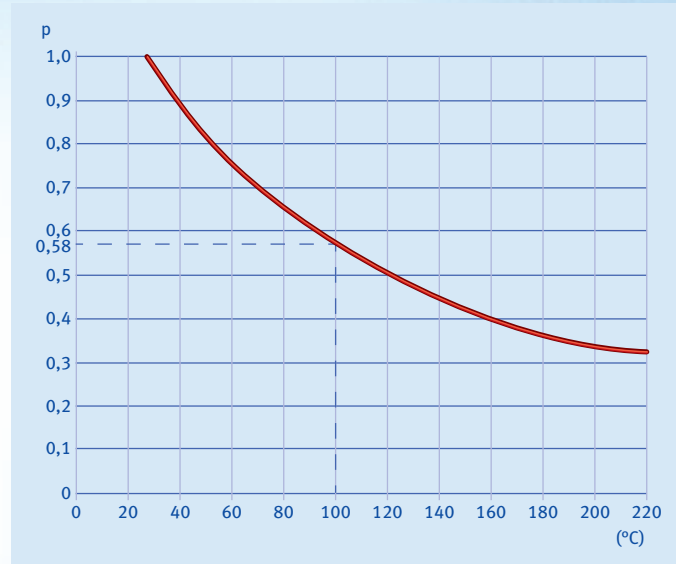
Technical details

Burst pressure at room temperature (depending on wall thickness [mm])



Calculating the operating pressure at room temperature
 Example: Internal Ø 8 mm, wall 1 mm
 Value on burst pressure curve = 33 bar
 Safety factor = 3 = divide by 3 = 33:3 = 11 bar operating pressure RT

Temperature correction curve Burst pressure



Example:
 Internal Ø 8 mm, wall 1 mm at 100°C
 Operating pressure at RT = 11 bar
 Value on temperature curve = 0.58
 Calculation: 11 bar x 0.58 = 6.4 bar max. operating pressure at 100°C

These calculated values are used as guide values and do not take into account any other contributing factors such as ambient pressure or temperature. The burst pressure may be further increased by means of special process control and materials. Contact us for more information.



POLYTETRAFLON™-PTFE tubes in AWG (American Wire Gauge) sizes

AWG no.	Internal Ø in mm			Wall thickness in mm tolerance		
	Nominal Ø	min. Ø	max. Ø	thick-walled	thin-walled	standard-walled
30	0.3	0.25	0.38	0.23 ± 0.05	0.15 ± 0.05	0.23 ± 0.05
28	0.4	0.33	0.48	0.23 ± 0.05	0.15 ± 0.05	0.23 ± 0.05
26	0.5	0.41	0.56	0.23 ± 0.05	0.15 ± 0.05	0.23 ± 0.05
24	0.6	0.51	0.69	0.30 ± 0.075	0.15 ± 0.05	0.25 ± 0.075
23	0.65	0.58	0.76	0.30 ± 0.075	0.15 ± 0.05	0.25 ± 0.075
22	0.7	0.65	0.81	0.30 ± 0.075	0.15 ± 0.05	0.25 ± 0.075
20	0.9	0.81	1.02	0.40 ± 0.075	0.15 ± 0.05	0.30 ± 0.075
19	1.0	0.91	1.12	0.40 ± 0.075	0.15 ± 0.05	0.30 ± 0.075
18	1.1	1.01	1.24	0.40 ± 0.075	0.15 ± 0.05	0.30 ± 0.075
17	1.2	1.14	1.37	0.40 ± 0.075	0.15 ± 0.05	0.30 ± 0.075
16	1.4	1.29	1.55	0.40 ± 0.075	0.15 ± 0.05	0.30 ± 0.075
15	1.5	1.45	1.70	0.40 ± 0.075	0.15 ± 0.05	0.30 ± 0.075
14	1.7	1.63	1.88	0.40 ± 0.075	0.20 ± 0.05	0.30 ± 0.075
13	1.9	1.83	2.08	0.40 ± 0.075	0.20 ± 0.05	0.30 ± 0.075
12	2.2	2.06	2.31	0.40 ± 0.075	0.20 ± 0.05	0.38 ± 0.075
11	2.4	2.31	2.57	0.40 ± 0.075	0.20 ± 0.05	0.38 ± 0.075
10	2.7	2.59	2.84	0.40 ± 0.075	0.20 ± 0.075	0.30 ± 0.075
9	3.0	2.89	3.15	0.51 ± 0.100	0.20 ± 0.05	0.38 ± 0.075
8	3.4	3.28	3.58	0.51 ± 0.100	0.20 ± 0.05	0.38 ± 0.075
7	3.8	3.66	4.01	0.51 ± 0.100	0.20 ± 0.05	0.38 ± 0.075
6	4.2	4.11	4.52	0.51 ± 0.100	0.25 ± 0.075	0.38 ± 0.075
5	4.7	4.62	5.03	0.51 ± 0.100	0.25 ± 0.075	0.38 ± 0.075
4	5.3	5.18	5.69	0.51 ± 0.100	0.25 ± 0.075	0.38 ± 0.075
3	6.0	5.82	6.32	0.51 ± 0.100	0.25 ± 0.075	0.38 ± 0.075
2	6.7	6.55	7.06	0.51 ± 0.100	0.25 ± 0.075	0.38 ± 0.075
1	7.5	7.34	7.90	0.51 ± 0.100	0.25 ± 0.075	0.38 ± 0.075
0	8.4	8.26	8.81	0.51 ± 0.100	0.25 ± 0.075	0.38 ± 0.075

- All tubes are available in production lengths on spools or cut into tube sections.
- Our standard dimensions are generally available from stock.
- POLYTETRAFLON™ tubes are manufactured in metric and imperial dimensions.
- Customer-specific dimensions and packaging variants are available on request.

Pigmentation is available in the following colors:

- Black
- Green
- Brown
- Blue
- Red
- Orange

Advantages of different tube materials

POLYTETRAFLON™-PTFE

- Lowest friction coefficient of any polymer
- Very good sliding characteristics—self-lubricating effect
- No water absorption, water repellent
- Anti-adhesive
- Exceptionally large operating temperature range: –200°C to +260°C
- Almost universal chemical resistance
- Good electrical and dielectric properties
- Resistant to superheated steam
- Light, weather and radiation resistant
- Self extinguishing in acc. with UL 94 V-0
- Physiologically harmless
- Suitable for contact with foodstuffs and medical applications
- UV resistant
- Sterilizable with ethylene oxide and autoclave

POLYTETRAFLON™-modified PTFE (mod. PTFE)

- Comparable properties to PTFE with additional advantages
- Lower permeation and denser, less porous polymer structure
- Reduced pore formation when stretched (stretch void index)
- Higher elongation at break
- Significantly decreased deformation under load
- Smoother surface structure
- Improved weldability
- Higher transparency than standard PTFE

Moldflon™-PTFE

- In contrast to conventional PTFE, can be processed thermoplastically by means of injection molding and extrusion (particularly attractive for large-scale production)
- Continuous operating temperature of up to 260°C
- Significantly better wear behavior than PTFE and mod. PTFE, particularly as an unfilled material
- Optimal sliding and frictional behavior in dynamic applications
- Suitable for contact with foodstuffs

- Biocompatible in accordance with USP Class VI and in terms of cytotoxicity
- Excellent chemical resistance
- Resistant to weather and ageing
- Self extinguishing in acc. with UL 94 V-0

Moldflon™-PFA

- Outstanding purity properties
- Good stress cracking resistance
- Good weldability
- Outstanding thermal resilience
- Very high chemical resistance
- High electrical resistance
- Very high oxygen index
- Self extinguishing in acc. with UL 94 V-0
- Physiologically harmless
- Combines the attributes of PTFE and FEP
- Low gas permeability
- Smoother surface structure than FEP and PTFE
- Can be sterilized with gamma radiation, ethylene oxide, e-beam radiation, and autoclave

Moldflon™-FEP

- Lower gas and vapor permeability than most plastics
- Good stress cracking resistance
- Good weldability
- High purity
- Outstanding thermal resilience
- Very high chemical resistance
- High electrical resistance
- Very high oxygen index
- Self extinguishing in acc. with UL 94 V-0
- Physiologically harmless
- Greater flexibility than PTFE
- Better optical clarity than PTFE
- Better sliding characteristics than PFA
- Excellent UV transmission rates
- Outstanding dielectric strength

Moldflon™-ETFE

- Continuous operating temperature of up to 150°C
- Improved mechanical strength and stiffness
- High chemical resistance to acids/bases and organic solvents
- Resistant to ageing and weather
- Self extinguishing in acc. with UL 94 V-0
- Suitable for contact with foodstuffs
- Can be joined by electron beam welding

Moldflon™ PCTFE

- Continuous operating temperature of up to 160°C
- Outstanding mechanical properties and good machinability
- Suitable for cryogenic applications with temperatures as low as -250°C
- High chemical resistance
- Self extinguishing in acc. with UL 94 V-0
- Physiologically harmless

Moldflon™-PVDF

- Has the best mechanical properties of any unfilled fluoropolymer
- Very good machinability
- Good weldability
- Fulfills the highest purity standards
- Highly resistant to chemicals
- Very good electrical insulation properties
- Resistant to hot water
- Self extinguishing in acc. with UL 94 V-0
- Very high radiation resistance

- Approved in accordance with FM 4910
- Physiologically harmless

Moldflon™-ECTFE

- Continuous operating temperature of up to 150°C
- Optimal permeation resistance
- High chemical resistance
- Outstanding surface quality
- High wear resistance
- Self extinguishing in acc. with UL 94 V-0
- High resistance to UV and gamma radiation
- Good weldability
- Physiologically harmless

Moldflon™-PEEK

- Continuous operating temperature of up to 260°C
- Outstanding mechanical strength and viscosity
- Very good dimensional stability
- High wear resistance and good frictional properties
- Excellent chemical resistance
- Self extinguishing in acc. with UL 94 V-0
- Suitable for contact with foodstuffs and drinking water

Moldflon™-PEI

- Continuous operating temperature of up to 170°C
- High mechanical strength and stiffness
- Creep resistance and dimensional stability over a large temperature range
- Excellent electrical insulator
- Resistant to high energy radiation
- High hydrolysis resistance
- Self extinguishing in acc. with UL 94 V-0
- Low smoke emission in the event of a fire

Overview of technical characteristics of different tube materials

			POLYTETRAFLON™		Moldflon™
General property	Standard	Unit	PTFE	mod. PTFE	PTFE
Density	ISO 1183	g/cm ³	2.14–2.19	2.14–2.19	2.13–2.18
Upper operating temperature, no load		°C	250–260	250–260	250–260
Flammability	UL94	–	V-0	V-0	V-0
Water absorption at 23°C saturation		%	< 0.05	< 0.05	< 0.05
Thermal					
Thermal	Standard	Unit	PTFE	mod. PTFE	PTFE
Melting temperature	ISO 11357	°C	327	327	310–320
Coefficient of linear thermal expansion	DIN 52612	10 ⁻⁵ *K ⁻¹	10–16	10–16	10–16
Thermal conductivity at 23°C	ISO	W/(m*K)	0.23	0.23	0.22
Specific heat at 23°C		kJ/(kg*K)	1.01	1.01	1.09
Oxygen index		%	> 95	> 95	> 95
Mechanical					
Mechanical	Standard	Unit	PTFE	mod. PTFE	PTFE
Tensile strength at 23°C	ISO 527	MPa	29–39	30–42	20–25
Tensile strength at 150°C			14–20	15–24	
Yield stress at 23°C	ISO 527	MPa	10	12	
Tensile strength at 23°C	ISO 527	%	200–500	400–600	330–380
Young's modulus at 23°C	ISO 527	MPa	400–800	500–900	650
Limiting bending stress at 23°C	ISO 178	MPa	18–20	19–22	
Flexural modulus of elasticity	ISO 527	MPa	600–800	650–900	
Ball indentation hardness 23°C	ISO 2039		25–30	26–31	25–30
Rockwell hardness R	ISO 2039		20–30	22–32	25–35
Shore hardness D	ISO 868		55–72	56–75	60–65
Friction coefficient			0.05–0.2	0.05–0.2	0.15–0.25
Electrical					
Electrical	Standard	Unit	PTFE	mod. PTFE	PTFE
Dielectric constant at 100 Hz	IEC 60250		< 2.1	< 2.1	< 2.1
Dielectric constant at 10 ⁶ Hz			< 2.1	< 2.1	< 2.1
Dielectric loss factor at 100 Hz		*10 ⁻⁴	0.5–0.7	0.5–0.7	0.5–0.7
Specific contact resistance	IEC 60093	Ω*cm	> 10 ¹⁸	> 10 ¹⁸	> 10 ¹⁸
Surface resistance	DIN 53482	Ω	> 10 ¹⁶	> 10 ¹⁶	> 10 ¹⁶
Tracking resistance	IEC 60112	CTI	600	600	600
Dielectric strength	IEC 60243-2	kV/mm	> 40	> 40	> 50

PFA	FEP	ETFE	PCTFE	PVDF	ECTFE	PEEK	PEI
2.12–2.17	2.12–2.17	1.71–1.78	2.10–2.16	1.75–1.78	1.67–1.70	1.3	1.27
250–260	200–205	150–180	150–180	150–170	150–180	260	170
V-0	V-0	V-0	V-0	V-0	V-0	V-0	V-0
< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	0.45	1.25

PFA	FEP	ETFE	PCTFE	PVDF	ECTFE	PEEK	PEI
300–310	253–282	265–275	185–210	165–178	240–247	340–350	217
10–16	10–14	8–12	4–8	8–18	4–8	4.7	5
0.22	0.20	0.23	0.19	0.17	0.15	0.29	0.24
1.09	1.17	1.95	0.92	1.38		1.4	2.0
> 95	> 95	30	> 95	43	60	24	47

PFA	FEP	ETFE	PCTFE	PVDF	ECTFE	PEEK	PEI
27–32	19–25	36–48	31–42	38–50	41–54	98	129
15–21	4–6	8–12	1–2	7.5–10.5	3.5–4.5		
14	12	24	40	46	34	98	130
300	250–350	200–500	80–250	20–250	200–300	34	60
650	350–700	500–1,200	1,000–1,200	1,800–1,800	1,200–1,800	3,500	3,200
15		25–30	52–63	55	50	130	140
650–700	660–680	1,000–1,500	1,200–1,500	1,200–1,400	1,700	3,800	3,400
25–30	23–29	34–40	55–70	62–68	55–65	220	165
25–35	20–30	45–55	103–118	100–115	85–95		M 115
60–65	55–60	63–75	70–90	73–85	70–80	85	
0.2–0.3	0.3–0.35	0.3–0.5	0.3–0.4	0.2–0.4	0.65	N/A	0.3–0.4

PFA	FEP	ETFE	PCTFE	PVDF	ECTFE	PEEK	PEI
< 2.1	< 2.1	2.6	2.3–2.8		2.3–2.6	3.2	3
< 2.1	< 2.1	2.6	2.3–2.4			3.1	3
0.5–0.7	0.5–0.7	0.5–0.6				30	0.002
> 10 ¹⁸	> 10 ¹⁸	> 10 ¹⁶	> 10 ¹⁸	> 10 ¹⁵	> 10 ¹⁵	> 10 ¹⁴	
> 10 ¹⁶	> 10 ¹⁶	> 10 ¹⁴	> 10 ¹⁶	> 10 ¹³	> 10 ¹²	> 10 ¹⁶	> 10 ¹³
600	600	600	600	600	600	150	175
> 50	> 50	> 40	> 40	> 40	> 40	19	> 20

This table, intended for guidance only, shows typical values obtained with standard samples. The material properties expressly do not constitute any legal basis for specification or design purposes and may deviate substantially depending on the material, components, and processing and operating conditions.

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