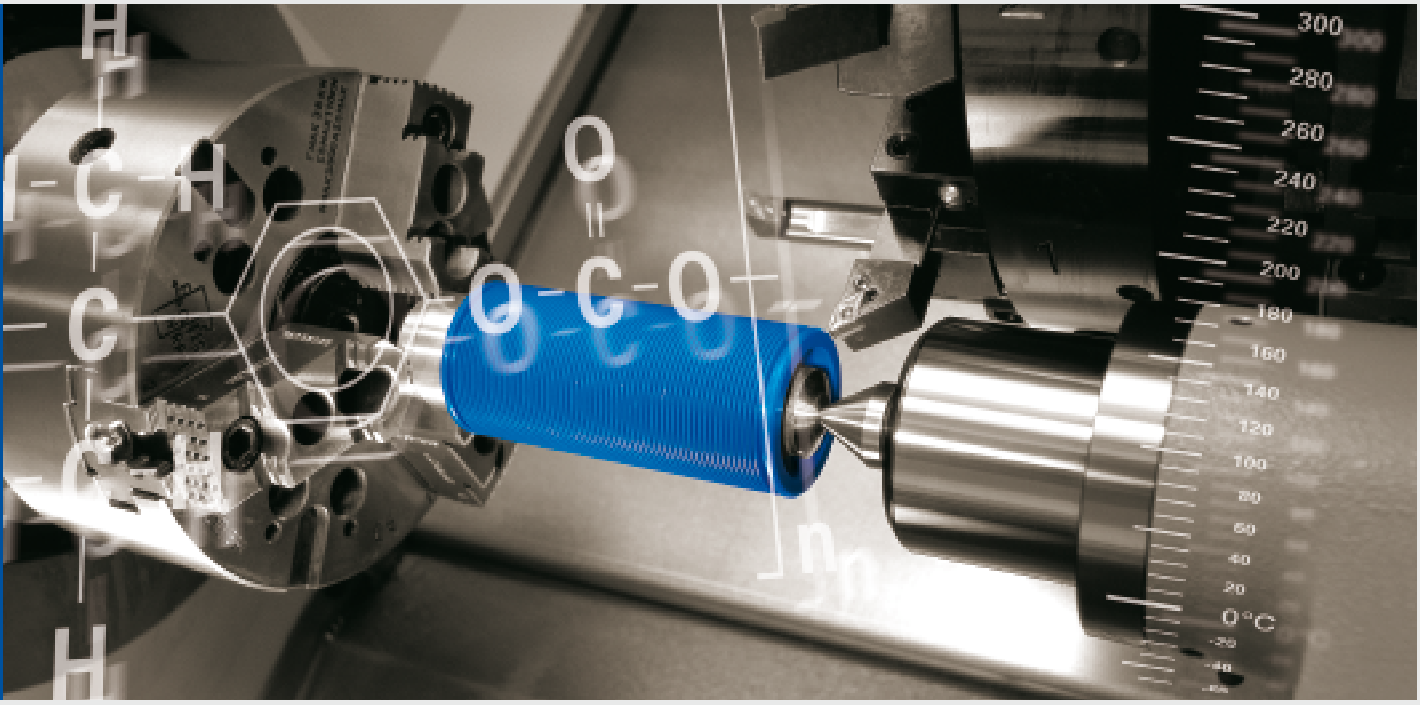
ENSINGER essentials.
Technical know-how for plastic applications.



ENSINGER

ASK. THINK. SUCCEED.

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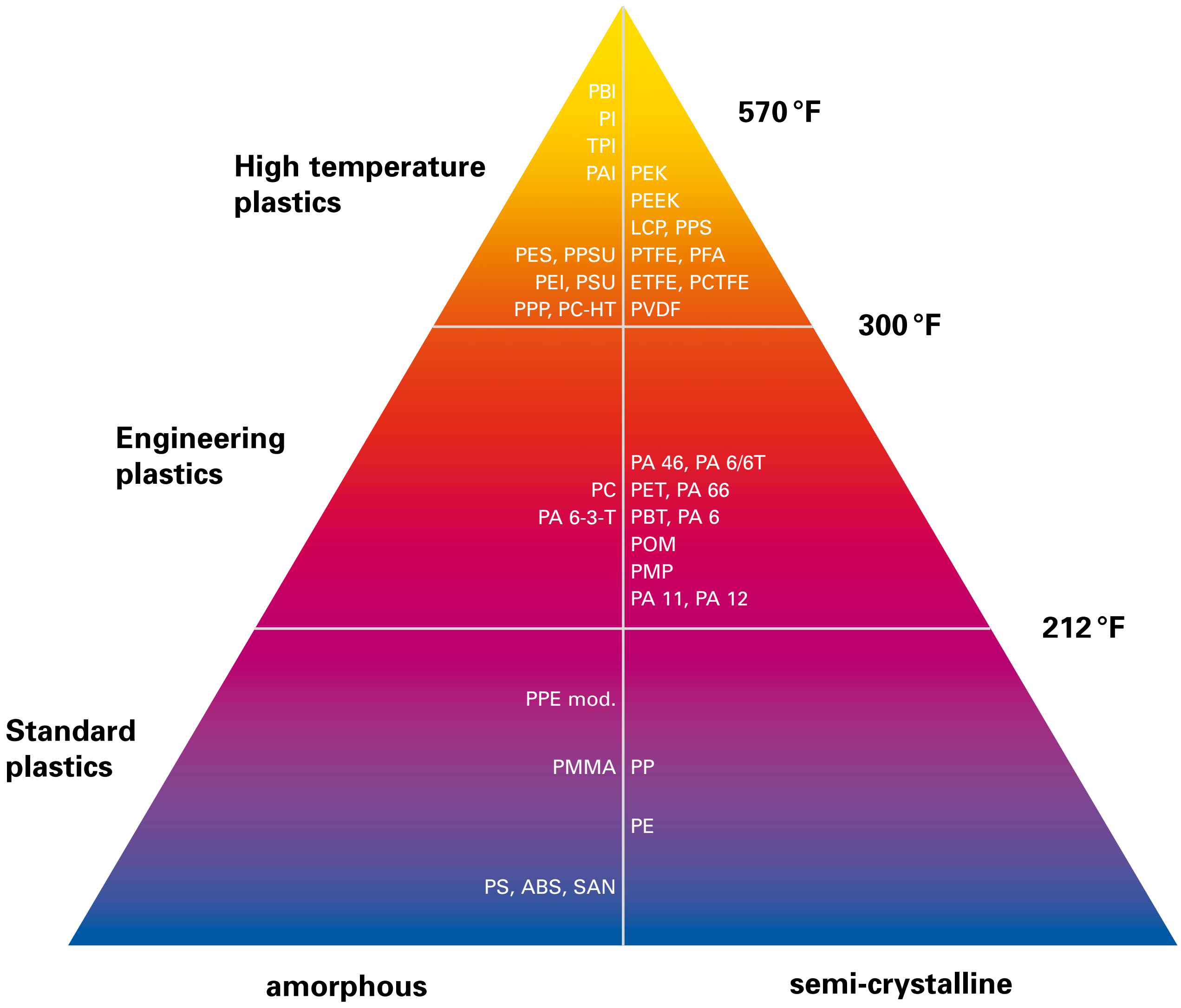
Classification of Plastics



Thermoplastic polymers can be divided into amorphous and semi-crystalline on the basis of their structure.

Polymers with an amorphous structure are normally transparent and tend to be sensitive to stress cracking. They are suitable for making precision parts due to their high dimensional stability.

Semi-crystalline plastics are opaque, mostly tough and show good or very good chemical resistance.

Plastics can also be differentiated according to their temperature resistance:

High-temperature plastics have long term service temperatures of above 300 °F and have a high level of thermo-mechanical properties.

Plastics suitable for the highest application temperatures (PI, PBI, PTFE) cannot be processed using melting processes. Production of parts is carried out by sintering.

Engineering plastics can be used permanently at temperatures between 212 °F and 300 °F. They exhibit good mechanical properties and good chemical resistance.

Standard plastics can be used permanently at temperatures below 212 °F.

The above pyramid of plastic materials shows a detailed overview of thermoplastic polymers on the basis of these criteria.

High Temperature Plastics

I SINTIMID (PI)
Depending upon the type, provide high strength with a low level of creep and good wear-resistance up to 570 °F in continuous use. Dimensional stability, electrical insulation, high purity, low outgassing. Suitable for thermally and mechanically stressed engineering elements and components. Inherently flame resistant.

I TECATOR (PAI)
Very good physical stability low level of creep, high chemical resistance. Good wear resistance, low thermal expansion coefficient inherently flame resistant.

I TECAPEEK HT (PEK)
Increased level of properties compared to TECAPEEK. Very good abrasion characteristics. Suitable for high load sliding applications. Very good chemical resistance. Inherently flame resistant.

I TECAPEEK (PEEK)
Balanced profile of properties; low level of creep, high modulus of elasticity. Excellent tribological properties, especially abrasion resistance. Very good resistance to different media, FDA conformity and physiologically harmless. Very good chemical resistance. Inherently flame resistant.

I TECATRON (PPS)
Chemical resistance; low level of creep, high dimensional stability due to low moisture absorption, high modulus of elasticity, inherently flame resistant.

I TECASON E (PES)
Inherently flame resistant, good electrical and dielectric properties and thus well suited for use as electrical insulators.
FDA compliant.

I TECASON P MT (Radel® R PPSU)
Good impact strength, chemical resistance and resistance to hydrolysis. Inherently flame resistant.
FDA compliant.

I TECASON S (PSU)
High strength, rigidity and hardness. Low moisture uptake and very good dimensional stability.
Inherently flame resistant.
FDA compliant.

I TECAPEI (Ultem® PEI)
Very good mechanical and electrical properties. Inherently flame resistant. FDA compliant.

I TECAFLON PTFE (PTFE)
Highest chemical resistance, permanent service temperature of 500 °F. Exceptional sliding characteristics as well as excellent electrical properties. Inherently flame resistant. FDA compliant.

I TECAFLON ETFE (E/TFE)
Good kinetic friction properties, very good chemical resistance and very good mechanical properties.
Inherently flame resistant.
FDA compliant.

I TECAFLON PVDF (PVDF)
Very good chemical resistance, good electrical and thermal properties. Can be processed as a thermoplastic and physiologically harmless. Inherently flame resistant.

Engineering Plastics

- **TECAMID 12 (PA 12)**
Very high durability, good chemical resistance, lowest water uptake of all polyamides. FDA compliant.

- **TECAMID 46 (PA 46)**
Good thermal insulation. Very well suited for sliding and wearing parts which are exposed to raised temperatures. High durability.

- **TECAMID 66 (PA 66)**
Good rigidity, hardness, wear-resistance and dimensional stability, good kinetic friction characteristics, types complying to FDA available. FDA compliant. For parts which are exposed to higher mechanical and heat loads.

- **TECAMID 6 (PA 6)**
Semi-crystalline thermoplastic with good damping capacity, good impact strength and high degree of toughness even at low temperatures, good wear-resistance, especially against rough frictional surfaces.

- **TECAST Vekton 6 (PA 6 G)**
Polyamide casting material with similar properties to TECAMID 6. Production of parts with large volumes and large wall thickness possible.

- **TECAST Vekton 12 (PA 12 G)**
Polyamide casting material with similar properties to TECAMID 12, production of parts with large volumes and large wall thickness possible.

- **TECARIM (PA 6 G)**
Very tough polyamide 6 block co-polymer. Very good strength and toughness to be used advantageously in the low temperature range. Excellent resistance to impact and abrasion, chemical resistance. Application specific adjustability of the material properties.

- **TECANAT (PC)**
Amorphous, transparent material with excellent impact strength, permanent service temperature 250 °F, good mechanical strength, low level of creep and very good dimensional stability.
FDA compliant.

- **TECADUR PET (PET)**
Good wear properties in moist or dry surroundings, high dimensional stability due to low thermal expansion, low moisture uptake, good dielectric properties, good chemical resistance. FDA compliant.

- **Hydex 4101 (PBT)**
High strength and durability with good sliding wear characteristics. Good dimensional stability due to low moisture absorption. FDA compliant. A lubricated version, Hydex 4101L is also available and is FDA compliant as well.

- **TECAFORM AH (POM-C)**
Semi-crystalline POM-copolymer with good physical properties. Low moisture uptake, good fatigue strength and rigidity, very simple machine processing, good shape stability, parts with narrow tolerances. Good sliding characteristics. FDA compliant.

- **TECAFORM AD (Delrin®)**
Slightly higher mechanical values in comparison to TECAFORM AH, very good resilience and high surface hardness, excellent wear and friction properties.

- **TECAFINE (PE, PP)**
High chemical resistance, high degree of durability and elongation at break, low tendency to stress corrosion cracking, very low water uptake, good sliding characteristics and low abrasion.

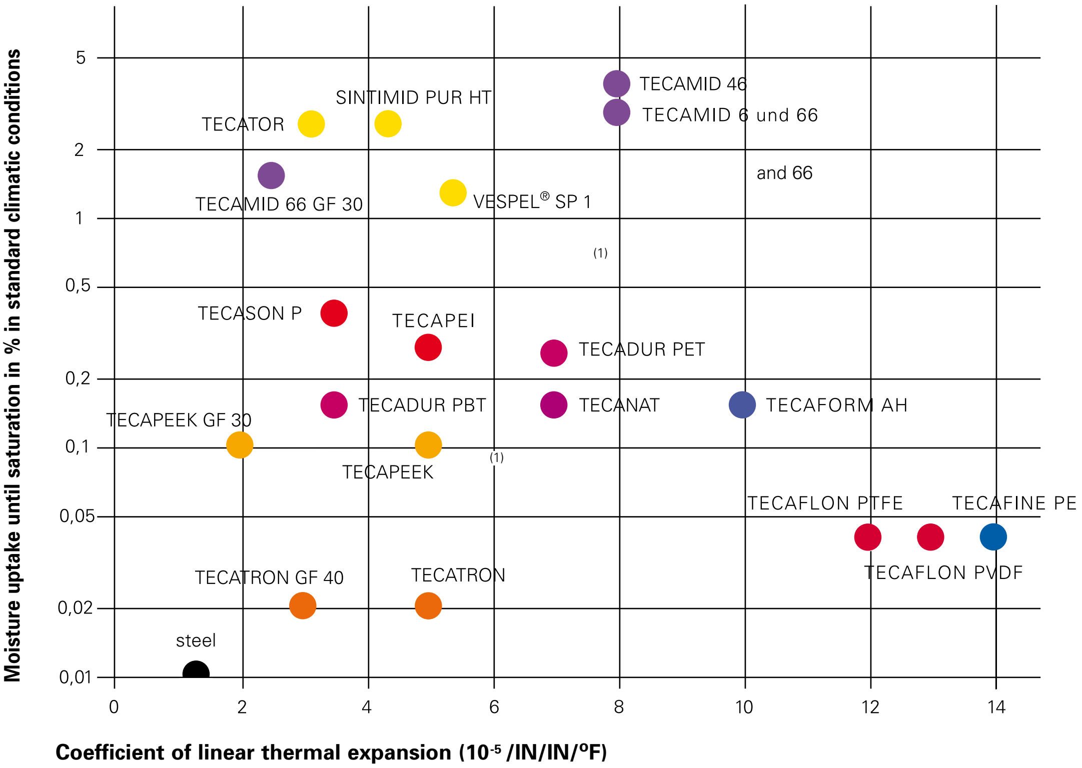
- **TECAPRO MT (PP)**
Low stress, dimensionally stable polypropylene homopolymer for medical applications.

- **TECARAN ABS (ABS)**
Very good electrical insulation, low water absorption, good damping capacity, can be bonded, high toughness and rigidity. Resistant to diluted acids and cleaning agents.

- **TECANYL (PPE)**
Very good electrical insulation, good welding and bonding characteristics, good strength, high toughness, resistant to hot water.

- **TECAFINE PE (PE)**
Very good electrical insulation, very low moisture absorption, good kinetic friction characteristics, good impact strength at low temperatures, good welding characteristics, resistant to various acids and cleaning agents, low density.

Water Absorption



Polyamides show increased water absorption in comparison to other engineering plastics. This leads to dimensional changes to finished parts, to a reduction of the strength factors and also changes the electrical insulating characteristics absorption.

Modification Options

The profile of plastic properties can be modified to the required application by the specific use of fillers.

Reinforcing fiber

Glass fiber are used mainly to increase the mechanical strength, particularly tensile strength. Other values, such as compression strength and temperature-dependent dimensional stability, are also improved.

Carbon fiber may be used as an alternative to glass fibre to increase mechanical strength. Due to the lower density, higher strength values can be achieved using the same proportion by weight. Furthermore, carbon fibers improve the sliding and wear characteristics.

Color

The incorporation of pigments and colorants into technical plastics allows individually customized color standards to be produced (e.g. according to RAL, Pantone, etc.), although the choice of pigments with high-temperature plastics is limited.

Light stabilization

Weathering or continual exposure to high temperatures can lead to discoloration or affect the mechanical properties of many plastics. The addition of UV or thermal stabilizers helps prevent such effects.

Friction and wear-reducing fillers

Graphite is pure carbon, which in a finely ground state exhibits high lubricating properties. By incorporating it uniformly into a polymer, the coefficient of friction can be lowered.

PTFE is a high temperature fluorinated polymer. Typical of this material is its remarkable non-sticking properties. Under pressure the particles from PTFE filled plastics develop a fine, sliding polymer film on the opposite material surface.

Molybdenum disulphide is used primarily as a nucleating agent and forms a uniform fine crystalline structure even when small amounts are added, with increased abrasion resistance and reduced friction.

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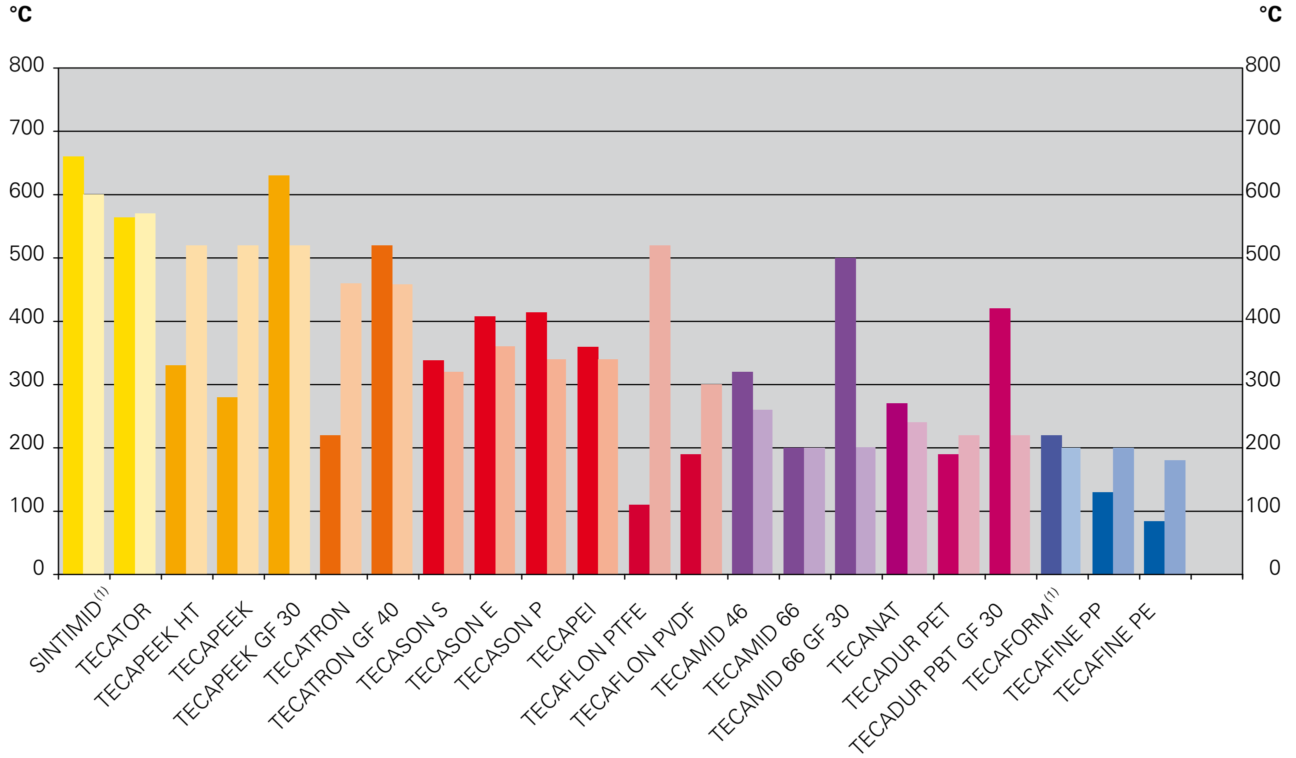
(1) Sales in Germany and Great Britain

Thermal Resistance



Left column: Heat deflection temperature according to the HDT-A procedure
Right column: long term service temperature

The thermal resistance of a plastic is characterised mainly by the heat deflection temperature and the long term service temperature.

The heat deflection temperature (HDT) is described as the temperature under which an extreme fibre elongation of 0.2 % is achieved under a specific bending stress. With the frequently used HDT-A procedure the bending stress used is 264 psi.

The heat deflection temperature provides an indication of the maximum temperature in use for mechanically loaded components.

The long term service temperature represents the temperature above which material decomposition takes place due to thermal stress. It should be noted that the mechanical properties at this temperature differ considerably from those at room temperature.

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Characteristic Mechanical Values

Mechanical characteristics in tensile testing

Tensile testing according to ASTM D 638 serves to assess the characteristics of plastics in short-term, single-axle stressing.

Important factors for the choice of a plastic apart from the characteristics under stress and elongation are also the temperature and the time the load is applied.

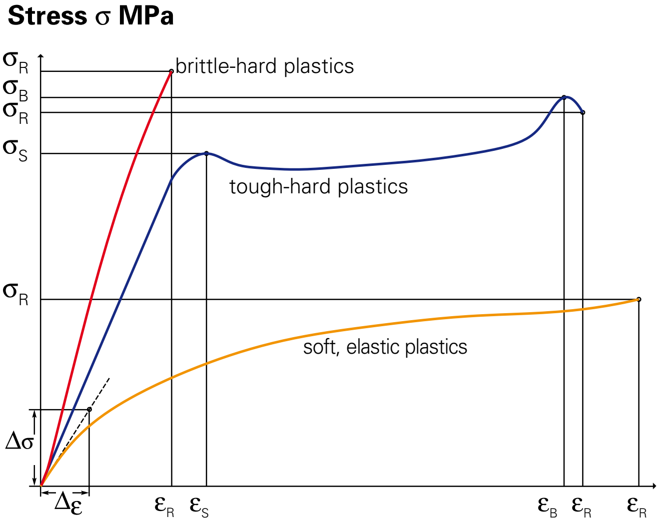
- **Tensile stress σ**
  σ is the tensile force in relation to the smallest measured initial cross-section of the test specimen at every arbitrary point during the experiment.

- **Tensile strength σ_B**
  σ_B is the tensile stress at maximum force.

- **Tensile strength at break σ_R**
  is the tensile stress at the moment of break.

- **Tensile strength at yield σ_S**
  is the tensile stress at which the slope of the curve describing the change of force versus length (see graph) equals zero for the first time.

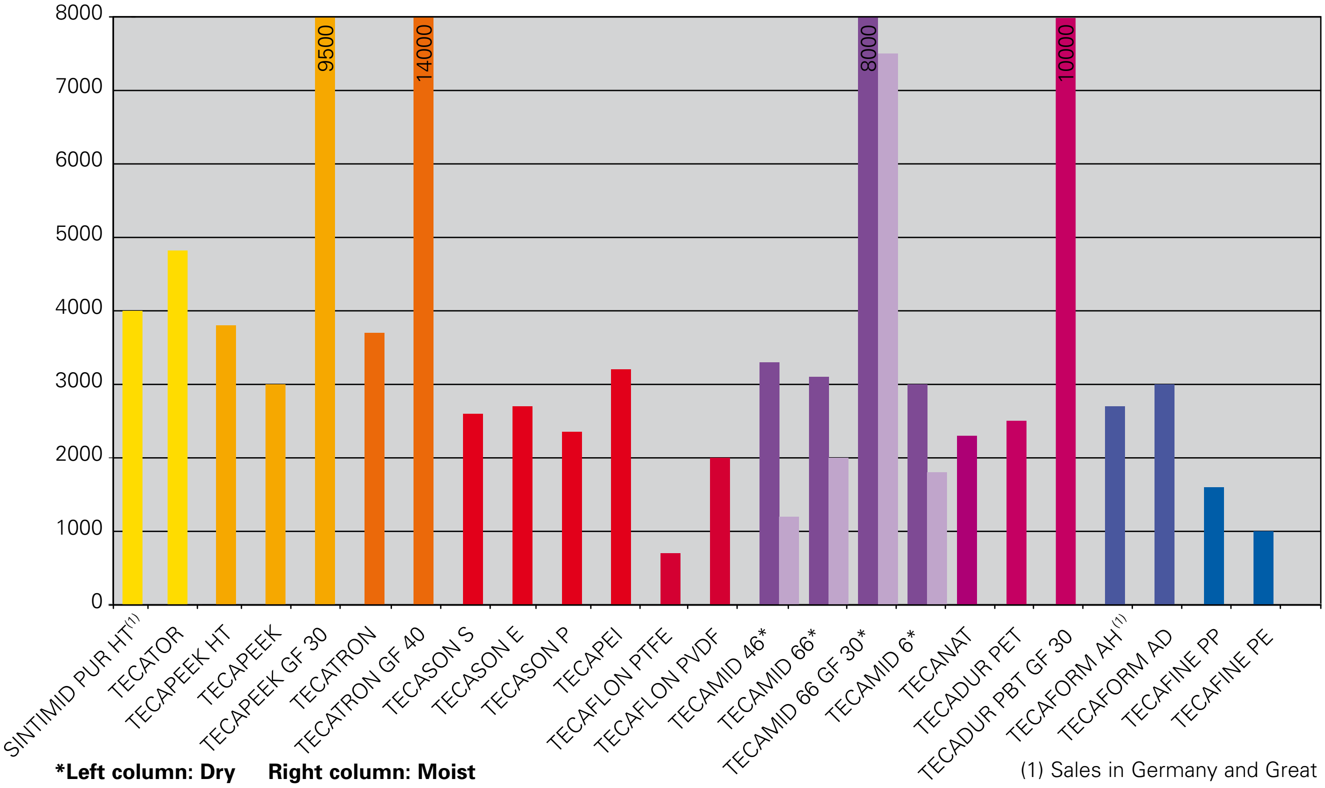
- **Elongation ε**
  Is the change in length ΔL in relation to the original length L_0 of the specimen at every arbitrary point during the experiment. The elongation at maximum force is described as ε_B, the elongation at break by ε_R, the yield stress with ε_S.



σ_B	maximum stress	ε_B	elongation at maximum stress
σ_R	tensile strength at break	ε_R	elongation at break
σ_S	tensile strength at yield	ε_S	elongation at yield

- **Modulus of elasticity E**
  A linear relationship can only be observed in the lower range of the stress-elongation diagram for plastics. In this range Hooke's law applies, which says that the quotient of the stress and strain (modulus of elasticity) is constant.
  $E = \sigma/\varepsilon$ in MPa.

Comparison of E-modulus of different plastics (room temperature) in MPa



***Left column: Dry**   **Right column: Moist**

(1) Sales in Germany and Great Britain

Sliding and Abrasive Characteristics

Plastics have proven to be useful in various applications as sliding materials. Particularly advantageous are their dry running properties, low noise and maintenance characteristics, chemical resistance and electrical insulation.

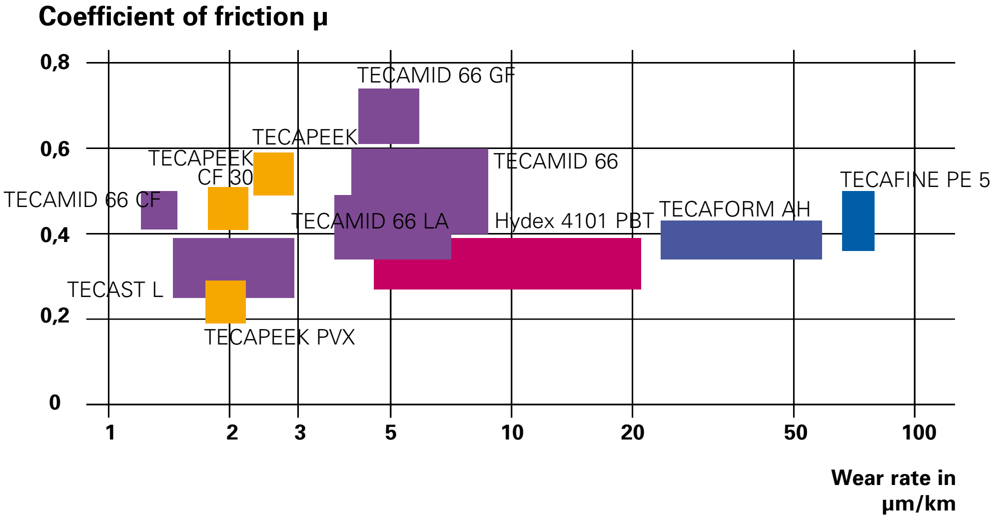
The sliding and abrasive behaviour is in this respect not a material property, but is determined specifically by the tribological system with various parameters such as material combination, surface roughness, lubricant, load, temperature, etc.

The inherently good sliding properties of plastics can also be modified to specific requirements by the use of additives (see section "Modification Options", page 6).

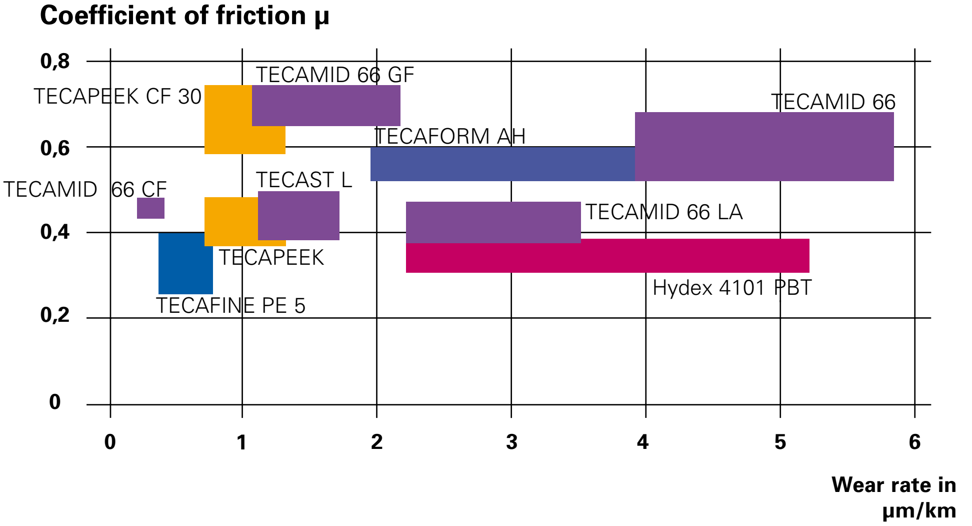
Additives such as glass fibre, glass beads or mineral fillers normally act abrasively on the sliding parts.

Cast polyamides are frequently used for slide bearing applications, which is why a large number of dynamic friction-optimized materials are also available.

If bearings also have to work at high temperatures, high speeds or strong contact pressures, high temperature plastics are used. In the following diagrams, the tribological properties of various materials used for sliding bearings with different degrees of surface roughness are compared.



Conditions:
Load: 145 psi,
Speed: 3.3 ft/sec.,
against steel with **R_z = 98 µin**



Conditions:
Load: 145 psi,
Speed: 3.3 ft/sec.,
against steel with **R_z = 7 µin**

Flame Protection Classification

High standards are set for flame protection in various plastic applications.

The classification of materials is generally made according to the "UL Standard 94" of the Underwriters' Laboratories.

The classification into different fire classes is achieved using two test set-ups:

Horizontal flame experiment according to UL 94 HB

Material which is classified according to UL 94 HB may not exceed a maximum combustion rate of 76.2 mm/min at a wall thickness of less than 3.05 mm and with horizontal clamping. At a wall thickness of 3.05 – 12.7 mm this value should not exceed maximum 38.1 mm/min.

Materials classified in this way are easily flammable and therefore hardly meet the requirements of other flammability tests.

Vertical flame experiment according to UL 94

In this experiment a flame is held for ten seconds against the vertically clamped test specimen and then removed. The time taken for the last flame to extinguish itself is measured, and this experiment is repeated ten times. Apart from the combustion time, the classification also takes into consideration whether burning droplets are formed. The various criteria are listed in the following table.

Classification according to UL 94

	Classification according to UL 94		
	V-0	V-1	V-2
Burning time after each flaming	≤10 s	≤30 s	≤30 s
Burning time after 10 repetitions	≤50 s	≤250 s	≤250 s
Formation of burning droplets	no	no	yes

Oxygen index according to ASTM D 2863

The oxygen index of a material is defined as the minimum concentration of oxygen, expressed in vol.-% of an oxygen/nitrogen mixture, which maintains combustion of a defined material sample.

Material	DIN Description	Fire class acc. to UL 94	Oxygen index according to ASTM D 2863
SINTIMID	**PI**	V-0 (3,2 mm)	44
TECATOR	**PAI**	V-0 (3,2 mm)	
TECAPEEK HT	**PEK**	V-0 (1,6 mm)	40
TECAPEEK	**PEEK**	V-0 (1,45 mm)	35
TECAFLON PTFE	**PTFE**	V-0 (3,2 mm)	95
TECATRON	**PPS**	V-0 (3,2 mm)	
TECATRON GF 40	**PPS**	V-0 (0,4 mm)	
TECASON E	**PES**	V-0 (1,6 mm)	39
TECASON P	**PPSU**	V-0 (0,8 mm)	
TECASON S	**PSU**	V-0 (4,5 mm)	32
TECAFLON PVDF	**PVDF**	V-0 (0,8 mm)	43
TECANAT	**PC**	HB (3,2 mm)	
TECANAT GF 20	**PC**	HB (3,2 mm)	
TECADUR PET	**PET**	HB (3,2 mm)	
TECALUBE	**PA 6 G**	V-2	

Radiation Resistance of Plastics

Plastics can come into contact with different types of radiation, depending upon the area of application, which affect the structure of the material.

The spectrum of electromagnetic radiation ranges from radio frequencies, with long wave-lengths, to normal daylight with short wave-length UV radiation to very short wave-length X-rays and gamma radiation. The shorter the wave-length of the radiation the more easily it can damage the plastic.

An important characteristic value in connection with electromagnetic radiation is the dielectric loss-factor, which describes the amount of energy absorbed by the plastic.

Plastics with high dielectric loss-factors strongly heat up in an alternating electrical field and are therefore not suitable as high frequency and micro-wave insulating materials.

Ultraviolet radiation

UV-radiation from sunlight is particularly effective in unprotected open-air applications.

Plastics which are inherently resistant are to be found in the group of fluorinated polymers, e.g. unsurpassed are PTFE and PVDF. Without respective protective measures, various plastics begin to yellow and become brittle depending upon the level of irradiation.

UV protection is achieved using additives (UV stabilizers) or protective surface coatings (paints, metallization). The addition of carbon black is cost-effective, frequently used and is a very effective method.

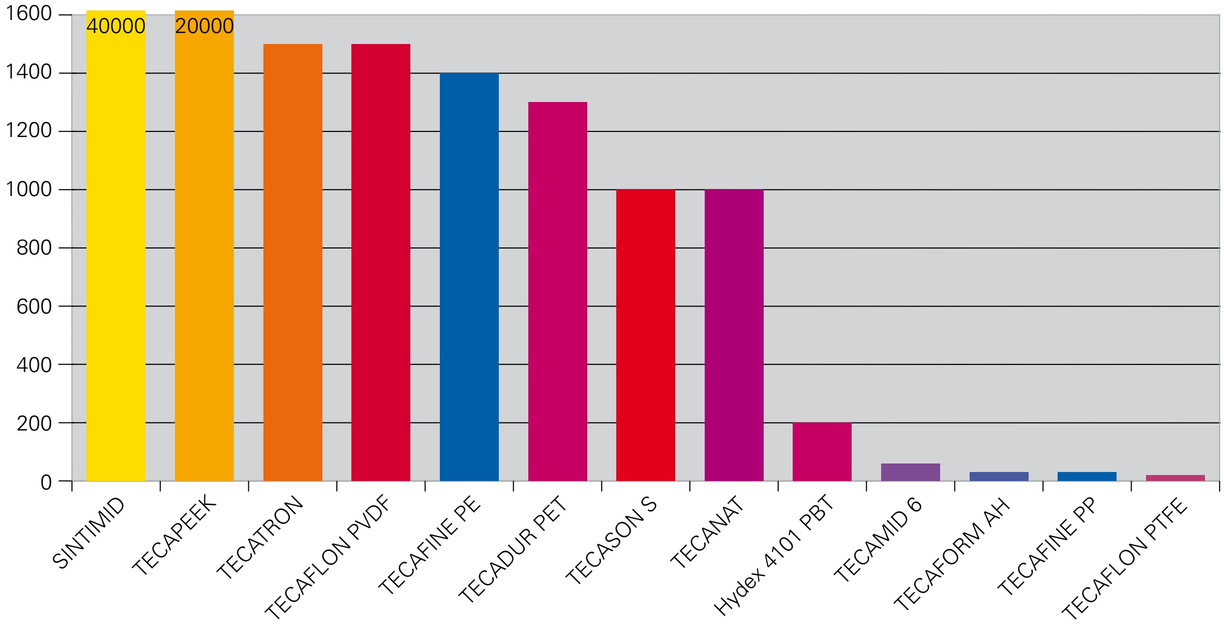
Gamma radiation resistance

Gamma and X-ray radiation are frequently to be found in medical diagnostics, radiation therapy, in the sterilisation of disposable articles and also in the testing of materials and in test instrumentation.

The high energy radiation often leads in these applications to a decrease in the expansion characteristics and the development of brittleness. The overall service life is dependent upon the total amount of radiation absorbed.

PEEK HT, PEEK, PI and the amorphous sulphur-containing polymers, for example, been proved to have very good resistance towards gamma radiation and X-rays. On the other hand, PTFE and POM are very sensitive and therefore are practically unsuitable for this purpose.

Radiation dose in mega rads (mrads) which reduces elongation by less than 25 %.



Applications in Electrical Engineering

It is often required of plastics used in electrical engineering applications that they discharge or conduct static electricity.

This is achieved by the specific addition of electrically active substances, such as special conducting carbon blacks, carbon fibre, conducting micro-fibres with nanostructures or inherently conducting substances.

Conducting carbon blacks are used only for applications outside of clean-room production, where the actual semi-conductor structures are closed and sealed.

Carbon fibres, nanotubes and inherently conducting substances are more abrasion-resistant and tend to lead to considerably less contamination.

The electrical parameters can thus be kept within better definable limits.

A material with a surface resistance of 10^6 ohm to 10^{12} ohm is considered to discharge static electricity. If the surface resistance is smaller than 10^6 ohm, then the material is said to be electrically conducting.

Material	DIN Description	Volume resistivity in ohm • cm	Surface resistivity in ohm
SINTIMID PAI ESD	**PAI**	10^9 - 10^{11}	10^9 - 10^{11}
Hydel PEI-7	**PEI**	10^6 - 10^8	10^8 - 10^{10}
Hydel PC-7	**PC**	10^7 - 10^9	10^8 - 10^{10}
TECAFORM AH SD	**POM-C**	10^9 - 10^{11}	10^9 - 10^{11}
TECAPEEK ELS nano	**PEEK**	10^2 - 10^4	10^1 - 10^3
TECAPEEK CF 30	**PEEK**	10^5 - 10^7	10^5 - 10^7
TECAFLON PTFE C25	**PTFE**	10^2 - 10^4	10^2 - 10^4
TECAFLON PVDF AS	**PVDF**	10^2 - 10^4	10^2 - 10^4
TECAFLON PVDF CF 8	**PVDF**	10^3 - 10^5	10^5 - 10^7
TECAMID 66 CF 20	**PA 66**	10^2 - 10^4	10^2 - 10^4
TECAFORM AH ELS	**POM-C**	10^2 - 10^4	10^2 - 10^4
TECAFINE PP ELS	**PP**	10^3 - 10^5	10^3 - 10^5

🟦 Antistatic

⬜ Electrically conducting

Applications in Food Processing and Medical Technology

Special requirements are necessary in the areas of foodstuffs and medical technology with regard to physiological suitability and resistance.

FDA conformity

The American Food and Drug Administration (FDA) checks the suitability of materials with regard to their contact with foodstuffs. Raw materials, additives and properties of plastics are specified by the FDA in the "Code of Federal Regulations" CFR 21. Materials which fulfill the respective requirements are considered to conform to FDA.

Biocompatibility

The biocompatibility describes the compatibility of a material to the tissue or the physiological system of the patient. The assessment is performed using various tests according to USP (U.S. Pharmacopoeia) Class VI or according to ISO 10993.

Resistance to different sterilisation procedures and chemicals: multiple-use equipment in medical technology has to have good resistance towards preparatory procedures such as sterilisation and disinfection. These requirements are best met with high-performance plastics.

Material	DIN Description	FDA conformity*	Biocompatibility*	Sterilization	
				Steam 278 °F	Gamma radiation
TECAPEEK MT	PEEK	x	x	+	+
TECAPEEK CF 30 MT	PEEK CF 30		x	+	+
TECAFLON PTFE	PTFE	x		+	-
TECATRON MT	PPS		x	+	+
TECASON E	PES	x		o	+
TECAPEI MT	PEI	x	x	+	+
TECAPEI (Ultem® 1000)	PEI	x	x	+	+
TECASON P	PPSU	x	x	+	+
TECASON S	PSU	x	x	o	+
TECAFLON PVDF	PVDF	x		+	+
TECANAT	PC	x		-	+
TECAMID 66	PA 66	x		-	o
TECADUR PET	PET	x		-	+
TECANYL MT TECAFORM AH MT	PPE POM-C	x	x	⊕	+
TECAFORM AH MT	POM-C	x		o	-
TECAFINE PMP TECAFINE PP	PMP PP	x		-	+
TECAPRO MT	PP	x	x	+	+
TECAFINE PE	PE	x		-	+
TECAPRO MT	PP	x	x	o	-
TECAFINE PE	PE	x		-	+

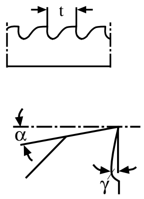
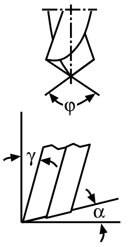
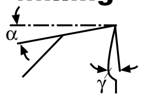
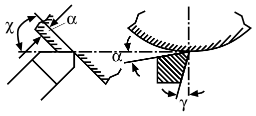
- x Material corresponds to FDA conformity and biocompatibility
- \+ Resistant
- o Limited resistance
- \- Not resistant

* FDA conformity and biocompatibility applies to natural materials. Pigments used are checked for their suitability according to FDA regulations.

Biocompatibility is not a material specification and necessitates prior testing, if necessary special production.

Processing of Plastics

Machining guidelines

		TECAMID/TECARIM TECAST	TECAFINE PE, PP, PMP	TECAFORM AH, AD	TECADUR PET, PBT TECAPET	TECANAT	TECANYL	TECAMID TR	TECARAN ABS	TECAFLON ETFE, PVDF, PTFE	TECASON S, P, E	TECAPEI	TECATRON	TECAPEEK	SINTIMID, PI	SINTIMID, TECATOR PAI	Reinforced/filled ENSINGER materials*
Sawing  α Clearance angle (°) γ Rake angle (°) V Cutting speed ft/min t Pitch in	α	20 - 30	20 - 30	20 - 30	15 - 30	15 - 30	15 - 30	15 - 30	15 - 30	20 - 30	15 - 30	15 - 30	15 - 30	15 - 30	5 - 10	5 - 10	15 - 30
	γ	2 - 5	2 - 5	0 - 5	5 - 8	5 - 8	5 - 8	5 - 8	0 - 5	5 - 8	0 - 4	0 - 4	0 - 5	0 - 5	0 - 3	0 - 3	10 - 15
	V	1640	1640	1640 - 2600	980	980	980	980	980	980	1640	1640	1640 - 2600	1640 - 2600	2600 - 2950	2600 - 2950	650 - 980
	t	0.118 - 0.315	0.118 - 0.315	0.078 - 0.197	0.118 - 0.315	0.118 - 0.315	0.118 - 0.315	0.118 - 0.315	0.078 - 0.315	0.078 - 0.197	0.078 - 0.197	0.078 - 0.197	0.118 - 0.197	0.118 - 0.197	0.118 - 0.50	0.118 - 0.50	0.118 - 0.197
Drilling  α Clearance angle (°) γ Rake angle (°) φ Point angle (°) V Cutting speed ft/min S Feed in/rev The twist angle β of the drill bit should be approx. 12° to 16°	α	5 - 15	5 - 15	5 - 10	5 - 10	8 - 10	8 - 10	8 - 10	8 - 12	10 - 16	3 - 10	3 - 10	5 - 10	5 - 10	5 - 10	5 - 10	6
	γ	10 - 20	10 - 20	15 - 30	10 - 20	10 - 20	10 - 20	10 - 20	10 - 30	5 - 20	10 - 20	10 - 20	10 - 30	10 - 30	5 - 10	5 - 10	5 - 10
	φ	90	90	90	90	90	90	90	90	130	90	90	90	90	120	120	120
	V	165 - 490	165 - 490	165 - 650	165 - 320	165 - 320	165 - 320	165 - 320	165 - 650	790 - 650	65 - 260	65 - 260	160 - 650	160 - 650	260 - 320	260 - 320	260 - 320
	S	0.004 - 0.012	0.004 - 0.012	0.004 - 0.012	0.008 - 0.012	0.008 - 0.012	0.008 - 0.012	0.008 - 0.012	0.008 - 0.012	0.004 - 0.012	0.004 - 0.012	0.004 - 0.012	0.004 - 0.012	0.004 - 0.012	0.008 - 0.004	0.008 - 0.004	0.004 - 0.012
Milling  α Clearance angle (°) γ Rake angle (°) χ Side angle (°) V Cutting speed ft/min The feed can be up to 0.02 in/tooth	α	10 - 20	10 - 20	5 - 15	5 - 15	10 - 20	10 - 20	10 - 20	5 - 10	5 - 15	2 - 10	2 - 10	5 - 15	5 - 15	2 - 5	2 - 5	15 - 30
	γ	5 - 15	5 - 15	5 - 15	5 - 15	5 - 15	5 - 15	5 - 15	0 - 10	5 - 15	1 - 5	1 - 5	6 - 10	6 - 10	0 - 5	0 - 5	6 - 10
	V	920 - 1640	920 - 1640	920 - 1640	980	980	980	980	980 - 1640	920 - 1640	920 - 1640	920 - 1640	920 - 1640	920 - 1640	300 - 330	300 - 330	260 - 330
Turning  α Clearance angle (°) γ Rake angle (°) χ Side angle (°) V Cutting speed ft/min S Feed in/rev The nose radius r must be at least 0.021 in	α	6 - 10	6 - 10	6 - 8	5 - 10	5 - 10	5 - 10	5 - 10	5 - 15	10	6	6	6 - 8	6 - 8	2 - 5	2 - 5	6 - 8
	γ	0 - 5	0 - 5	0 - 5	0 - 5	6 - 8	6 - 8	6 - 8	25 - 30	5 - 8	0	0	0 - 5	0 - 5	0 - 5	0 - 5	2 - 8
	χ	45 - 60	45 - 60	45 - 60	45 - 60	45 - 60	45 - 60	45 - 60	15	10	45 - 60	45 - 60	45 - 60	45 - 60	7 - 10	7 - 10	45 - 60
	V	920 - 1640	920 - 1640	980 - 1660	980 - 1330	980	980	980	650 - 1640	490 - 1640	1140 - 1300	1140 - 1300	920 - 1640	920 - 1640	320 - 390	320 - 390	490 - 650
	S	0.004 - 0.020	0.004 - 0.020	0.004 - 0.015	0.008 - 0.015	0.004 - 0.020	0.004 - 0.020	0.004 - 0.020	0.008 - 0.020	0.004 - 0.012	0.004 - 0.012	0.004 - 0.012	0.004 - 0.020	0.004 - 0.020	0.002 - 0.003	0.002 - 0.003	0.004 - 0.020

* Reinforcing agents/fillers: Glass fibres, glass beads, carbon fibres, graphite, mica, talcum, etc.

Special measures

Heat before sawing:

from 2.25 in diameter	TECAPEEK GF/PVX, TECATRON
from 3.25 in diameter	TECAMID 66 GF, TECADUR PET/PBT
from 4.00 in diameter	TECAMID 6 GF, 66, 66 MH

Heat before drilling in the centre:

from 2.25 in diameter	TECAPEEK GF/PVX, TECATRON GF/PVX
from 3.25 in diameter	TECAMID 66 MH, 66 GF, TECADUR PET/PBT
from 4.00 in diameter	TECAMID 6 GF, 66, TECAM 6 Mo, TECANYL GF

🟥 Preheat material to 120 °C

🟦 Caution when using coolants: susceptible to stress cracking

⬜ Use carbide-tipped tools

General information*

Non-reinforced thermoplastic polymers can be machined using high speed tools. For reinforced materials, carbide-tipped tools are necessary.

In all cases, only correctly sharpened tools should be used.

Due to the poor thermal conductivity of plastics, good heat flow must be ensured. The best form of cooling is heat dissipation via the chips.

Dimensional stability

Dimensionally accurate parts presuppose the use of stress relieved semi-finished products. Heat from machining will otherwise unavoidably result in the release of machining stresses and distortion of the part. If large material volumes are to be machined, intermediate tempering may be necessary after rough machining to relieve the resulting thermal stresses. Specific temperatures and times to be used according to material can be obtained from us upon request.

Materials with high moisture absorption (e.g. polyamides) may have to be conditioned before processing.

Plastics require higher production tolerances than metals. Furthermore, the very much higher thermal expansion needs to be taken into consideration.

Machining methods

1. Turning

Guide values for tool geometry are given in the table. For surfaces with particularly high quality requirements, the cutting edge must be designed as a broad smoothing tool as shown in Figure 1.

For cutting off, the lathe tool should be ground as shown in Figure 4 to prevent the formation of burrs.

For thin-walled and particularly flexible workpieces, on the other hand, it is better to work with tools that are ground to a knife-like cutting geometry (Figures 2 and 3).

2. Milling

For plane surfaces, end-milling is more economical than peripheral milling. For circumferential and profile milling the tools should not have more than two cutting edges so that vibrations caused by the cutters can be kept low and the gaps between the chips is sufficiently large.

Optimum cutting performance and surface finish are obtained with single-cutter tools.

3. Drilling

Twist drills can generally be used; these should have an angle of twist of 12° to 16° and very smooth spiral grooves for good removal of cuttings.
Larger diameters should be pre-drilled or should be produced using hollow drills or by cutting out. Particular attention should be paid to using properly sharpened drills when drilling into solid material, as otherwise the resulting compression stresses can increase to the extent that the material splits.

Reinforced plastics have higher residual processing stresses and a lower impact resistance than non-reinforced plastics and are therefore particularly susceptible to cracking. Where possible, they should be heated to around 250 °F before drilling (heating time approx. 1 hour per 0,50" cross-section). This method is also recommended for polyamide 66 and polyester.

4. Sawing

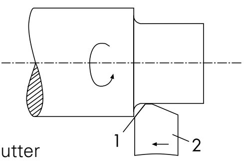
Unnecessary heat generation caused by friction must be avoided, as generally thick-walled parts are cut with relatively thin tools during sawing. Well-sharpened and strongly offset saw blades are therefore recommended.

5. Thread cutting

Threads are best cut using thread chasers; burring can be avoided by using twin-toothed chasers.

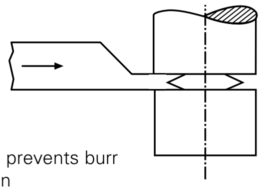
Die cutters are not recommended as re-cutting can be expected during removal of the cutter.

A machining allowance (dependent on material and diameter; guide value: 0.004 Inch) must frequently be taken into account when using tap drills.



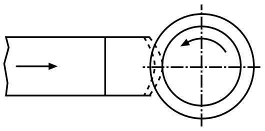
1 Secondary cutter
2 Lathe tool

Figure 1



Grinding prevents burr formation

Figure 4



Cutting off flexible plastics

Figure 2

Stress produced with a blunt drill

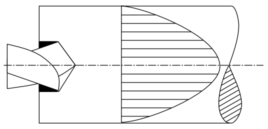
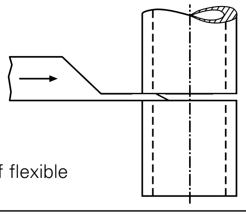


Figure 5



Parting off flexible plastics

Figure 3

Stress produced with a sharp drill

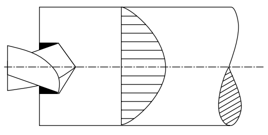


Figure 6

6. Safety precautions

Failure to observe the machining guidelines can result in localized overheating which can lead to material degradation. Decomposition products which may be released, e.g. from PTFE fillers, should be removed using extraction facilities. In this respect, tobacco products should be kept out of the production area due to the risk of poisoning.

*Our application engineering advice, provided both written and orally, is intended to help you in your work. It must be regarded as a recommendation without obligation, also with respect to possible third-party property rights. We can assume no liability for any possible damage which arises during processing.

Annealing specifications

When processing plastic semi-finished goods using machining processes it is recommended under certain circumstances, an annealing process is carried out after rough machining, in order to achieve the best dimensional stability and resistance.

Annealing is a temperature treatment, which serves the following purposes:

- Increase the crystallinity to improve the strength and chemical resistance.
- Reduces inner tension, which can arise by extrusion or machining.
- Increases the dimensional stability over a broad range of temperatures.

The parameters given in the following annealing specification are approximate values and apply up to a wall thickness of 2″. For larger wall thicknesses please contact our technical marketing department.

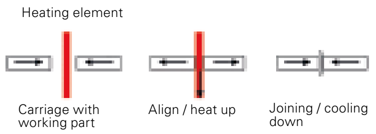
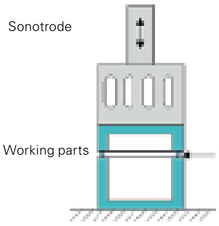
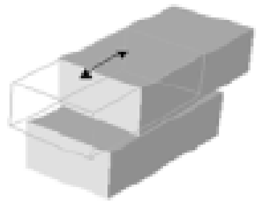
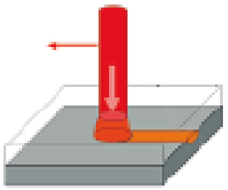
Material	DIN-Description	Heating-up phase	Maintaining phase **	Cooling down phase
SINTIMID	**PI**	2 h to 320 °F 6 h to 530 °F	2 h at 320 F 10 h at 530 F	50 F/h to 100 °F
TECAPEEK	**PEEK**	3 h to 250 °F 4 h to a 430 °F	1,5 h 0.5″ wall thickness	50 F/h to 100 °F
TECATRON	**PPS**	3 h to 250 °F 4 h to 430 °F	1,5 h 0.5″ wall thickness	50 F/h to 100 °F
TECASON E	**PES**	3 h to 212 °F 4 h to 392 °F	1 h 0.5″ wall thickness	50 F/h to 100 °F
TECASON P	**PPSU**	3 h to 212 °F 4 h to 392 °F	1 h 0.5″ wall thickness	50 F/h to 100 °F
TECASON S	**PSU**	3 h to 212 °F 3 h to 330 °F	1 h 0.5″ wall thickness	50 F/h to 100 °F
TECAPEI (Ultem®)	**PEI**	3 h to 212 °F 4 h to 392 °F	1 h 0.5″ wall thickness	50 F/h to 100 °F
TECAFLON PVDF	**PVDF**	3 h to 190 °F 3 h to 300 °F	1 h 0.5″ wall thickness	50 F/h to 100 °F
TECANAT	**PC**	3 h to 175 °F 3 h to 266 °F	1 h 0.5″ wall thickness	50 F/h to 100 °F
TECADUR PET	**PET**	3 h to 212 °F 4 h to 350 °F	1 h 0.5″ wall thickness	50 F/h to 100 °F
Hydex 4101 PBT	**PBT**	3 h to 212 °F 4 h to 350 °F	1 h 0.5″ wall thickness	50 F/h to 100 °F
TECAMID 6	**PA 6**	3 h to 190 °F 3 h to 320 °F	1 h 0.5″ wall thickness	50 F/h to 100 °F
TECAMID 66	**PA 66**	3 h to 212 °F 4 h to 350 °F	1 h 0.5″ wall thickness	50 F/h to 100 °F
TECAFORM AH	**POM-C**	3 h to 190 F 3 h to 300 °F	1 h 0.5″ wall thickness	50 F/h to 100 °F
TECAFORM AD	**POM-H**	3 h to 190 °F 3 h to 320 °F	1 h 0.5″ wall thickness	50 F/h to 100 °F

** at maximum temperature, unless otherwise specified.

Welding

A common technique used to join plastics is welding and heat-sealing. Depending upon the process used, certain design guidelines have to be observed during the construction phase. With high temperature plastics it should be remembered that quite high amounts of energy are required for plastification of the material.

The following table shows different welding processes in comparison.

Process	**Heating element and hot gas welding**	**High-frequency welding**	**Vibrational/frictional welding**	**Laser welding**
				
Principle	The parts to be joined are heated up using a heating element or with hot gas; join together applying pressure	A zone to be joined is heating up (with special geometry) by ultra-sound vibrations	The parts to be joined are heated up using vibration or friction; joined together applying pressure	The parts to be joined are heated up using a laser beam
Weld-time	20 to 40 s	0.1 to 2 s	0.2 to 10 s	
Advantage	High strength, cost-effective	Shortest cycle times, easy to automate	Suitable for larger parts, oxidation-sensitive plastics can be welded	High strength, almost any weld geometry possible, high precision

Adhesion

In order to connect plastics there are

- solvent adhesives
- hot-melt adhesives
- epoxy, polyurethane, rubber and cyanoacrylate based adhesive cements

When bonding plastics, tensional peaks should be avoided and a pressure or shear load should preferably be applied to the adhesive bond joint.

Flexural, peeling or plain tensile stresses should be avoided.

In order to improve strength, pre-treatment of the plastic surfaces is recommended to increase the surface activity.

For this purpose the following methods are useful:

- cleaning and de-greasing the material surfaces
- mechanical surface enlargement by sanding or sand-blasting
- physical activation of the surface by flame, plasma or corona treatment
- chemical etching in order to form a defined boundary layer

In general, pre-trials are required for the adhesion of plastics which should be carried out as close to the situation in practice as possible. Furthermore, it is recommended contact is made with experienced adhesive manufacturers.

The following manufacturers provide adhesives for engineering and high-performance plastics:

3M Adhesives
3M Center Bild, 220-8E-05
St. Paul MN 55144-1000
Telephone: 800-362-3550
www.3m.com/adhesives

Henkel Loctite Corp.
1001 Trout Brook Crossing
Rocky Hill, CT 06067
Telephone: 800-562-8483
www.loctite.com

ITW Devcon
30 Endicott Street
Danvers, MA 01923
Telephone: 800-733-8266
www.devcon.de

Material	**DIN Description**	**Solvent adhesive**	**Adhesive cement on the basis of**			
			Epoxy resins	**Polyurethane**	**Rubber**	**Cyanoacrylate**
SINTIMID	**PI**		x	x	x	x
TECAPEEK	**PEEK**		x	x	x	x
TECATRON	**PPS**		x	x	x	x
TECASON E	**PES**		x	x		
TECASON P	**PPSU**	x	x	x		
TECASON S	**PSU**	x	x	x		
TECAFLON PVDF	**PVDF**	x	x	x	x	x
TECANAT	**PC**	x	x	x		
TECADUR PET	**PET**		x	x	x	x
Hydex 4101 PBT	**PBT**		x	x	x	x
TECAMID 6	**PA 6**	x				
TECAMID 66	**PA 66**	x	x	x	x	x
TECAFORM AH	**POM-C**	x				
TECAFORM AD	**POM-H**	x				
TECAFINE PP	**PP**		x	x	x	
TECAFINE PE	**PE**		x	x	x	

x = suitable adhesives available

Available Dimensions for Semi-Finished Goods

Our materials can be produced in the following dimensions. The current availability of certain dimensions should be clarified as required.

Material	DIN specification	Rods*	Plates**
SINTIMID	**PI**	$^{3}/_{16}$“ - 4 $^{3}/_{4}$“ / 5“ - >5“	24“ x 48“ / 48“ x 120“
TECAPEEK HT	**PEK**	$^{3}/_{16}$“ - 4 $^{3}/_{4}$“ / 5“ - >5“	24“ x 48“ / 48“ x 120“
TECAPEEK	**PEEK**	$^{3}/_{16}$“ - 4 $^{3}/_{4}$“ / 5“ - >5“	24“ x 48“ / 48“ x 120“
TECAPEEK GF 30	**PEEK**	$^{3}/_{16}$“ - 4 $^{3}/_{4}$“ / 5“ - >5“	24“ x 48“ / 48“ x 120“
TECAPEEK PVX	**PEEK**	$^{3}/_{16}$“ - 4 $^{3}/_{4}$“ / 5“ - >5“	24“ x 48“ / 48“ x 120“
TECAFLON PTFE	**PTFE**	$^{3}/_{16}$“ - 4 $^{3}/_{4}$“ / 5“ - >5“	24“ x 48“ / 48“ x 120“
TECATRON	**PPS**	$^{3}/_{16}$“ - 4 $^{3}/_{4}$“ / 5“ - >5“	24“ x 48“ / 48“ x 120“
TECATRON GF 40	**PPS**	$^{3}/_{16}$“ - 4 $^{3}/_{4}$“ / 5“ - >5“	24“ x 48“ / 48“ x 120“
TECATRON PVX	**PPS**	$^{3}/_{16}$“ - 4 $^{3}/_{4}$“ / 5“ - >5“	24“ x 48“ / 48“ x 120“
TECASON E	**PES**	$^{3}/_{16}$“ - 4 $^{3}/_{4}$“ / 5“ - >5“	24“ x 48“ / 48“ x 120“
TECASON P	**PPSU**	$^{3}/_{16}$“ - 4 $^{3}/_{4}$“ / 5“ - >5“	24“ x 48“ / 48“ x 120“
TECASON S	**PSU**	$^{3}/_{16}$“ - 4 $^{3}/_{4}$“ / 5“ - >5“	24“ x 48“ / 48“ x 120“
TECAFLON PVDF	**PVDF**	$^{3}/_{16}$“ - 4 $^{3}/_{4}$“ / 5“ - >5“	24“ x 48“ / 48“ x 120“
TECANAT	**PC**	$^{3}/_{16}$“ - 4 $^{3}/_{4}$“ / 5“ - >5“	24“ x 48“ / 48“ x 120“
TECANAT GF 20	**PC**	$^{3}/_{16}$“ - 4 $^{3}/_{4}$“ / 5“ - >5“	24“ x 48“ / 48“ x 120“
TECADUR PET	**PET**	$^{3}/_{16}$“ - 4 $^{3}/_{4}$“ / 5“ - >5“	24“ x 48“ / 48“ x 120“
Hydex 4101 PBT	**PBT**	$^{3}/_{16}$“ - 4 $^{3}/_{4}$“ / 5“ - >5“	24“ x 48“ / 48“ x 120“
TECAST	**PA 6 G**	$^{3}/_{16}$“ - 4 $^{3}/_{4}$“ / 5“ - >5“	24“ x 48“ / 48“ x 120“
TECARIM	**PA 6 G**	$^{3}/_{16}$“ - 4 $^{3}/_{4}$“ / 5“ - >5“	24“ x 48“ / 48“ x 120“
TECAMID 6	**PA 6**	$^{3}/_{16}$“ - 4 $^{3}/_{4}$“ / 5“ - >5“	24“ x 48“ / 48“ x 120“
TECAMID 66	**PA 66**	$^{3}/_{16}$“ - 4 $^{3}/_{4}$“ / 5“ - >5“	24“ x 48“ / 48“ x 120“
TECAMID 66 GF 30	**PA 66**	$^{3}/_{16}$“ - 4 $^{3}/_{4}$“ / 5“ - >5“	24“ x 48“ / 48“ x 120“
TECAFORM AH	**POM-C**	$^{3}/_{16}$“ - 4 $^{3}/_{4}$“ / 5“ - >5“	24“ x 48“ / 48“ x 120“
TECAFORM AD	**POM-H**	$^{3}/_{16}$“ - 4 $^{3}/_{4}$“ / 5“ - >5“	24“ x 48“ / 48“ x 120“

Exclusion of liability

This information is only to assist and advise you on current technical knowledge and is given without obligation or liability. All trade and patent rights should be observed. All rights reserved. Data obtained from injection molded samples.

Note to the material standard values on pages 20 to 25

The information corresponds with current knowledge, and indicates our products and possible applications. We cannot give you a legally binding guarantee of the physical properties or the suitability for a specific application. Existing commercial patents are to be taken into account. A definite quality guarantee is given in our general conditions of sale.
Tests are carried out in a standard atmosphere of 23 °C 50 RH according to DIN 50 014.
We reserve the right to make technical alterations.

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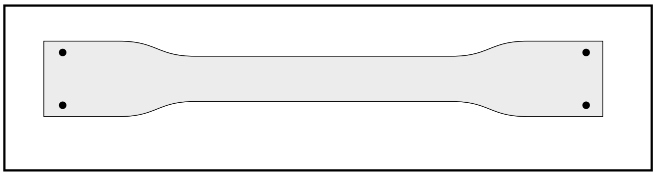
Vespel® is not sold by ENSINGER USA.



These values represents the average of a number of individual measurements. Unless otherwise stated the test results apply to injection molded samples.

Remark: For polyamides the values strongly depend on the humidity contents.
* humid, after storage in standard atmosphere 23 °C 50 RH (DIN 50 014) until saturation.
** For materials where also in black is detailed under "additives and/or color" the electrical values do not apply to the black type.
Additionally, the black variants are resistant to weathering.

n. b.= not broken
\+ = Resistant
(+) = Limited resistance
– = Not resistant
(depending on concentration, time and temperature)

ENSINGER High temperature plastics.
Material standard values.

Mechanical properties

Trade name	Description	Additives and/or colour	Long Term Service Temp °F	Density (ASTM D 792, DIN EN ISO 1183) ρ	Tensile strength at yield (ASTM D 638, DIN EN ISO 527) σ_S psi	Tensile strength at break (ASTM D 638, DIN EN ISO 527, ASTM D 1708 (a)) σ_R psi	Elongation at break (ASTM D 638, DIN EN ISO 527, ASTM D 1708 (a)) ε_R %	Modulus of elasticity (ASTM D 638, DIN EN ISO 527) E_Z ksi	Flexural Modulus (ASTM D 790, DIN EN ISO 178) E_B ksi	Rockwell Hardness (ASTM D 790) H_K	Notched Izod Impact (ASTM D 790) a_n ft-lb/in	Creep rupture strength after 1000 h $\sigma_{B/1000}$ psi	Time Limit for 1% elongation after 1000 h $\sigma_{1/1000}$ psi	Dynamic COF (ASTM D 37 02) μ	Wear (ASTM D 37 02) V	Trade name
SINTIMID PUR HT	PI	black	572	1,35		16820	9	580	580	M120	0.6		1740			**SINTIMID PUR HT**
SINTIMID 15 G	PI CS 15 TF10	15% graphite, black	572	1,42		14000	2,8	580	580	M115	0.4					**SINTIMID 15 G**
SINTIMID 30 P	PI TF 30	30% PTFE	500	1,51		11800	4,1									**SINTIMID 30 P**
SINTIMID 40 G	PI CS 40	40% graphite, black	572	1,57		9400	2,2	580	580	M111	0.3					**SINTIMID 40 G**
SINTIMID PVX	PI CS 15 TF 10	15% graphite, 10% PTFE, black	572	1,48		11100	2,9									**SINTIMID PVX**
TECATOR 5013	PAI	yellow-brown	500	1,42	27840	23780	15	710	725							**TECATOR 5013**
TECATOR 5031 PVX	PAI CS 12 TF 3	graphite, PTFE, black	500	1,46		19000	10		870	M109	2.0					**TECATOR 5031 PVX**
TECATOR CF 30	PAI CF 30	carbon fiber PTFE, black	500	1,61			6	3232	2686							**TECATOR CF 30**
TECATOR GF 30	PAI GF 30	30% glass fiber	500	1,58		17000	2		821	M116	0.7					**TECATOR GF 30**
TECAPEEK HT	PEK	black	500	1,32	15900		20	551	594							**TECAPEEK HT**
TECAPEEK CLASSIX™	PEEK	white opaque gray	500	1,38	13775		>25		609							**TECAPEEK CLASSIX™**
TECAPEEK	PEEK	natural, also black(1) grey	500	1,30	13700		25	435	594	M99 R126	1.6			0.25	200	**TECAPEEK**
TECAPEEK GF 30	PEEK GF 30	30% glass fibre	500	1,51		26100	2,5	1377	1450	M103		5220				**TECAPEEK GF 30**
TECAPEEK CF 30	PEEK CF 30	30% carbon fibre, black	500	1,40		31000	1,5	1718	2900						170	**TECAPEEK CF 30**
TECAPEEK CF 30 MT	PEEK CF 30	30% carbon fibre, black	500	1,4		23200	3	2102			1.6					**TECAPEEK CF 30 MT**
TECAPEEK PVX	PEEK CF CS TF	10% carbon fibre, graphite, PTFE, black	500	1,48		18800	1,5	1377	1174					0,20	150	**TECAPEEK PVX**
TECAPEEK MT	PEEK	coloured, also in black (1)	500	1,30	13700			435	594	M99				0,25	200	**TECAPEEK MT**
TECAPEEK ELS nano	PEEK	CNT, black	500	1,3		14500	15	594			0.9					**TECAPEEK ELS nano**
TECAPEEK CMF	PEEK	white, ceramic	500	1,6		12470		652	652		0.9					**TECAPEEK CMF**
TECAPEEK TF 10	PEEK TF 10	PTFE, natural	500	1,35	11600		15	435								**TECAPEEK TF 10**
TECATRON	PPS	natural	446	1,35	10800	12500	4	536	522	M93	0,5			0.24	540	**TECATRON**
TECATRON MT black	PPS	black	446	1,35	10800		4	536	522							**TECATRON MT black**
TECATRON GF 40	PPS GF 40	40% glass fibre, natural	446	1,64		26825	1,9	2030	1885							**TECATRON GF 40**
TECATRON PVX	PPS CF CS TF	10% carbon fibre, graphite, PTFE, black	446	1,47		16600	1,5	1450								**TECATRON PVX**
TECATRON LAM VF	PPS LAM	natural, glas fiber		1,35	13050		8	275								**TECATRON LAM VF**
TECATRON GF 15 VF	PPS GF 15	15% glass fibre, black		1,44		17400	2	1116	1087							**TECATRON GF 15 VF**
TECATRON GF 30 VF	PPS GF 30	30% glass fibre, black		1,58		23200	2	1595	1508							**TECATRON GF 30 VF**
TECATRON GF 40 VF	PPS GF 40	40% glass fibre, black		1,65		26825	1,9	2030	2030							**TECATRON GF 40 VF**
TECASON S	PSU	translucent	320	1,24	11600		> 50	377	390	R120 M69	1.3	6090	3190	0.37	1500	**TECASON S**
TECASON S GF 30	PSU GF 30	30% glass fibre	320	1,49		18000	1,8	1435					2900			**TECASON S GF 30**
TECASON E	PES	translucent	365	1,37	1300		6.5	391								**TECASON E**
TECASON E GF 30	PES GF 30	30% glass fibre	356	1,60		20300	2	1479								**TECASON E GF 30**
TECASON P MT	PPSU	coloured, Radel® R 5500 opaque	360	1,29	10100		60	340		R123	13					**TECASON P MT**
TECASON P MT XRO	PPSU	coloured, radio-opaque	338	1,3	10150		> 50	290	304	122,5 (r)						**TECASON P MT XRO**
TECASON P MT VF	PPSU	coloured, black (1)	338	1,29	10100		> 50	340	377	R123	13					**TECASON P MT VF**
TECAPEI 1000 (ULTEM)	PEI	(Ultem®) translucent	338	1,27	15225		> 50	464	478	M109	1.			0.17	4000	**TECAPEI 1000 (ULTEM)**
TECAPEI 1000 colored	PEI	(Ultem®) colors	338	1,27	15225			464	478					0.17	4000	**TECAPEI 1000 colored**
TECAPEI 2300 (ULTEM)	PEI GF 30	(Ultem®) 30% glass fibre	338	1,51		23900	2	1377	1305					0.24	130	**TECAPEI 2300 (ULTEM)**
HYDEL PEI-7 (ULTEM)	PEI	(Ultem®) carbon nanotube	340	1,27	9400		4	400	400		1,4					**HYDEL PEI-7 (ULTEM)**

	Thermal properties								Electrical properties(1)						Miscellaneous data					
	Melting point (ASTM D 2133) *Vicat Softening Point	Glass transition temperature (DIN 53 765)	Heat Deflection 264 psi (ASTM D 648, ISO-R 75, A)	Heat Deflection 66 psi (ASTM D 648, ISO-R 75, B)	Max Service short term	Thermal conductivity (ASTM C 177)	Specific heat	Coefficient of linear thermal expansion (ASTM D 696)	Dielectric constant (10^6 Hz, ASTM D 150, DIN 53 483, IE-250)	Dielectric loss factor (10^6 Hz, ASTM D 150, DIN 53 483, IE-250)	Specific volume resistance (ASTM D 257, EC 93, DIN IEC 60093)	Surface resistance (ASTM D 257, EC 93, DIN IEC 60093)	Dielectric strength (ASTM D 149, DIN EN 60093)	Resistance to tracking (DIN EN 60112, VDE 0303 part 1)	Moisture absorption to equilibrium 23 °C/50% rel. humidity (DIN EN ISO 62)	Water absorption at saturation (DIN EN ISO 62)	Resistance to hot water washing soda	Flammability acc. to UL-Standard 94	Resistance to weathering(5)	
Trade name	T_m °F	T_g °F	HDT/A °F	HDT/B °F	°F	λ BTU-in/hr-ft² °F	c BTU/lb · °F	α x 10^5 in/in/°F	ε_r –	tan δ –	ρ_D Ω·cm	R_O Ω/SQ	E_d v/mil	grade	$W(H_2O)$ %	W_S %	–	–	–	Trade name
SINTIMID PUR HT		680-707	694		662	1.53	0.25	2.44	3,1	0,003	10^{17}	10^{16}	304		2,6	3,6	(+)	V0	(+)	**SINTIMID PUR HT**
SINTIMID 15 G		626	572		662	3.68	0.27	2.1				10^7			2,3		(+)	V0	+	**SINTIMID 15 G**
SINTIMID 30 P		626			662			2.8			10^{17}	10^{16}								**SINTIMID 30 P**
SINTIMID 40 G		626			662			1.7										V0	+	**SINTIMID 40 G**
SINTIMID PVX		626	626		662			2.8							2,3				+	**SINTIMID PVX**
TECATOR 5013		545	532		518	1.80		1.7	3,9	0,031	> 10^{18}	> 10^{18}			2,5	4,5	+	V0	-	**TECATOR 5013**
TECATOR 5031 PVX			534						3.8	0.012	8 x 10^{13}	8 x 10^{13}			1.9	3.5	-		-	**TECATOR 5031 PVX**
TECATOR CF 30		545	539		518	3.68		0.5	4,2	0,05	2 x 10^{17}	10^{18}	34		2,5	3,5		V0		**TECATOR CF 30**
TECATOR GF 30			194					2.1	3.8	0.006			450				+	V0	-	**TECATOR GF 30**
TECAPEEK HT	705	314	329					3.2	3,3	0,0035	10^{16}							V0	-	**TECAPEEK HT**
TECAPEEK CLASSIX™	649	649	289																	**TECAPEEK CLASSIX™**
TECAPEEK	649	289	284	360	570	1.73	0.08	2.8	3,2-3,3	0,001-0,004	10^{16}	10^{15}	480		0,1	0,5	+	V0	-	**TECAPEEK**
TECAPEEK GF 30	649	289	599		570	2.98		1.1		0,004	10^{15}	10^{15}	609		0,1	0,1	+	V0	-	**TECAPEEK GF 30**
TECAPEEK CF 30	649	289	599		570	6.38		0.8			10^5-10^7(2)	10^5-10^7(2)			0,1	0,1	+	V0	+	**TECAPEEK CF 30**
TECAPEEK CF 30 MT	649	289	599		570	6.38		0.8							0,1	0,1	+	V0	+	**TECAPEEK CF 30 MT**
TECAPEEK PVX	649	289	530		570	1.66		1.2			3x10^5	5x10^6			0,1	0,1	+	V0	+	**TECAPEEK PVX**
TECAPEEK MT	649	289	284	360	570	1,73	0,08	2,8	3,2-3,3	0,001-0,004	10^{16}	10^{15}	480		0,1	0,5	+	V0	-	**TECAPEEK MT**
TECAPEEK ELS nano	649	289		360	570	1,73	0,08	2,8	3,2-3,3		10^2-10^4	10^1-10^3			0,1	0,5	+	V0	-	**TECAPEEK ELS nano**
TECAPEEK CMF	649	289	426	500	570	2,98	0,249	2,4	4,1	< 0,0050	>10^{14}	>10^{14}	386		0,0002			V0		**TECAPEEK CMF**
TECAPEEK TF 10	572	289			570			2,8							0,1	0,1	+	V0	-	**TECAPEEK TF 10**
TECATRON	536	194	230	400	500	2.08		2,8			10^{13}	10^{15}	450		0,01		+	V0	-	**TECATRON**
TECATRON MT black	536	194	230		500	2,08		2,8			10^{13}	10^{15}			0,01		+	V0	+	**TECATRON MT black**
TECATRON GF 40	536	194	500		500	1.73	0.28	2.2	4	0,004	10^{13}	10^{15}	304	KC 175	0,02	1	+	V0	-	**TECATRON GF 40**
TECATRON PVX	536	194			500			3.0			4x10^5	1x10^6			0,02		+	V0	+	**TECATRON PVX**
TECATRON LAM VF	536	188	230		500	1.73		2.8			10^{13}	10^{15}			0,01			V0		**TECATRON LAM VF**
TECATRON GF 15 VF	536	194	428									10^{15}			0,02			V0		**TECATRON GF 15 VF**
TECATRON GF 30 VF	536	194	491								10^{15}	10^{15}			0,02			V0		**TECATRON GF 30 VF**
TECATRON GF 40 VF	280	90	260		260	0,25		ca. 3			10^{13}	10^{15}	304	KC 175	0,02	1		V0		**TECATRON GF 40 VF**
TECASON S		356	336	359	356	1.73	0.24	1.2	3,1	0,005	10^{16}	10^{14}	42	KA 1 KB 175	0,2	0,8	+	V0	-	**TECASON S**
TECASON S GF 30		370	361	366	356			3.0	3,7	0,006	10^{16}	10^{14}			0,1	0,5	+	V0	-	**TECASON S GF 30**
TECASON E		437	399	417	428	1.25	0.27	1.2	3,5	0,005	10^{16}	10^{14}	406		0,7	2,1	+	V0	-	**TECASON E**
TECASON E GF 30		437	413	420	428			3.1	4	0,004	10^{16}	10^{14}	380	KB 200 KC 175	0,5	1,5	+	V0		**TECASON E GF 30**
TECASON P MT	424*		420	428	360		0.27	1.7	3,45		10^{15}	10^{13}	360		0,37	1,1	+	V0	+	**TECASON P MT**
TECASON P MT XRO		428	405	417	374			3.1	3,45				381		1,1		+	V0		**TECASON P MT XRO**
TECASON P MT VF	424*		420	428	360		0.27	1.7	3,45		10^{15}	10^{13}	360		0,37	1,1	+	V0	+	**TECASON P VF**
TECAPEI 1000 (ULTEM)		422	356	392	392	1.53		1.1	3,15	0,001	10^{15}	10^{15}			0,7	1,25	+	V0	-	**TECAPEI 1000 (ULTEM)**
TECAPEI 1000 colored		422	356	392	392	1.53		1.1	3,15	0,001	10^{15}	10^{15}			0,7	1,25	+	V0	-	**TECAPEI 1000 colored**
TECAPEI 2300 (ULTEM)		422	410	420	392	1.60		2.9	3.7	0.007	10^{15}	10^{15}	770		0.5	0.9	+	V0	-	**TECAPEI 2300 (ULTEM)**
HYDEL PEI-7 (ULTEM)	426*		390					2.9				10^6-10^9			0.25		+	V0	-	**HYDEL PEI-7 (ULTEM)**

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Mechanical properties

Trade name	Description	Additives and/or colour	Long Term Service Temp °F	Density (ASTM D 792, DIN EN ISO 1183) ρ	Tensile strength at yield (ASTM D 638, DIN EN ISO 527) σ_S psi	Tensile strength at break (ASTM D 638, DIN EN ISO 527, ASTM D 1708 (a)) σ_R psi	Elongation at break (ASTM D 638, DIN EN ISO 527, ASTM D 1708 (a)) ε_R %	Modulus of elasticity (ASTM D 638, DIN EN ISO 527) E_Z ksi	Flexural Modulus (ASTM D 790, DIN EN ISO 178) E_B ksi	Rockwell Hardness (ASTM D 790) H_K	Notched Izod Impact (ASTM D 790) a_n ft-lb/in	Creep rupture strength after 1000 h $\sigma_{B/1000}$ psi	Time Limit for 1% elongation after 1000 h $\sigma_{1/1000}$ psi	Dynamic COF (ASTM D 37 02) μ	Wear (ASTM D 37 02) V	Trade name
TECAFLON PVDF	PVDF		300	1,77	7250		> 30	290	290	R100	3.0	4930	435	0.24	1000	**TECAFLON PVDF**
TECAFLON PVDF AS	PVDF	conductive carbon, black(1)	300	1,83	7975	6235	25	609	652							**TECAFLON PVDF AS**
TECAMID 46	PA 46		266	1,18	14500/ 9425*		40/ 280*	478/ 174*								**TECAMID 46**
TECAMID 46 GF 30	PA 46 GF 30	30% glass fibre	285	1,41		30450/ 17400*	4/8*	1450/ 652*								**TECAMID 46 GF 30**
HYDLAR	PA 66	aramid fiber	230	1.19	17300		4	802	664	M80/ R121	1.2			0.32	19	**HYDLAR**
TECAMID 66 SF 20	PA 66 SF 20	20% aramid fibre, black	230	1,20		14500/ 12300	3/7.5	507								**TECAMID 66 SF 20**
TECAMID 66 ST 801	PA 66	impact modified	185	1,08	7200		60		245	R112	17			0.28	200	**TECAMID 66 ST 801**
TECAMID 66	PA 66		212	1,14	11600/ 8700		40/ 150*	449/ 290	410	R121 M80	1.2	7975	1160	0.28	200	**TECAMID 66**
TECAMID 66 HI	PA 66	heat stabilisator, brown	212	1,14	11600/ 8700		50/ 150*	391/ 232*		170/ 100*	n. b. (c)		870	0.28	200	**TECAMID 66 HI**
TECAMID 66 GF 30	PA 66 GF 30	30% glass fibre, black	240	1,35		23000/ 20300	3/5*	1160/ 1087	1200	M101	2.1		5800	0,31	75	**TECAMID 66 GF 30**
TECAMID 66 CF 20	PA 66 CF 20	20% carbon fibre, black	230	1,23		27500/ 21750	2,5/6*	1885/ 1450						0,2	40	**TECAMID 66 CF 20**
TECAMID SF 20	PA 66 SF 20	20% aramid fibre, black	230	1,20		14500/ 12300	3/7.5	507								**TECAMID SF 20**
TECAMID 66 LA	PA 66	lubricated	230	1,11	8700/ 7250*		10/40*	290/ 232*								**TECAMID 66 LA**
TECAMID 66 MH	PA 66	MoS_2, black(1)	200	1,14	10875		> 25	362					435	0,3	160	**TECAMID 66 MH**
TECAST T Vekton 6PA	PA 6 G		200	1.15	10000		25	350	350	R115	0.06			0.26	200	**TECAST T Vekton 6PA**
TECAST L Vekton 6PAL	PA 6 G	oil lubricated	200	1.14	8800		25	350	325	R100	1.2					**TECAST L Vekton PAL**
TECAST Vekton 6PALM	PA 6 G	MoS_2/si oil	200		8500		40		400	R110	1.7			0.16	61	**TECAST Vekton 6PALM**
TECAST Vekton 6PALM/PAG	PA 6 G	MoS_2/graphite	200	1.16	11000		20	350	350	R115	0.6					**TECAST Vekton 6PALM/PAG**
TECAST ST Vekton 6PB	PA 6 G			1.14	9300- 10600			310- 425		R110- R115	0.8- 1.0					**TECAST ST Vekton 6PB**
TECAST HI Vekton 6XAU	PA 6 G		260	1.15	11000		20	350		R115	0.7					**TECAST HI Vekton 6XAU**
TECAST Vekton HPV	PA 6 G	proprietary lube	200		7300		50		400	R106	1.5			0.14	49	**TECAST Vekton 6HPV**
TECARIM 1500	PA 6 G	15% elastomere natural	200	1,12	7800/ 6380		90/ 320*	304/ 130								**TECARIM 1500**
TECARIM 4000	PA 6 G	40% elastomere natural	200	1,13	3770/ 3200		420	652/ 333								**TECARIM 4000**
TECAMID 6 VF GF 12	PA 6 GF	natural, glass fiber	250	1,20	15225	15225	5	783	609							**TECAMID 6 VF GF 12**
TECAMID 6/12	PA6/12	low moisture nylon	185	1.06	8000		20	300	275	R114	0.9				190	**TECAMID 6/12**
TECAMID 6/6T	PA6/6T		250	1.16	11600/ 8700		11/20	464						0.31	200	**TECAMID 6/6T**
TECAMID TR	PA 6-3-T	transparent	212	1,12	1300		> 50	406				7250	1740			**TECAMID TR**
TECAMID 12	PA 12	natural, opaque	212	1,02	5800		240	174				3335	507			**TECAMID 12**
TECAMID 12 GF 30	PA 12 GF 30	30% glass fibre	212	1,24		15225	6	855					4060			**TECAMID 12 GF 30**
TECAMID 11	PA 11		176	1,04	5800		230/ 280*	145				3335	507			**TECAMID 11**
TECAMID 11 GF 30	PA 11 GF 30	30% glass fibre	176	1,26		13775	6/4*	725	464				4060			**TECAMID 11 GF 30**

	Thermal properties								Electrical properties[1]						Miscellaneous data					
	Melting point (ASTM D 2133) *Vicat Softening Point	Glass transition temperature (DIN 53 765)	Heat Deflection 264 psi (ASTM D 648, ISO-R 75, A)	Heat Deflection 66 psi (ASTM D 648, ISO-R 75, B)	Max Service short term	Thermal conductivity (ASTM C 177)	Specific heat	Coefficient of linear thermal expansion (ASTM D 696)	Dielectric constant (10^6 Hz, ASTM D 150, DIN 53 483, IE-250)	Dielectric loss factor (10^6 Hz, ASTM D 150, DIN 53 483, IE-250)	Specific volume resistance (ASTM D 257, EC 93, DIN IEC 60093)	Surface resistance (ASTM D 257, EC 93, DIN IEC 60093)	Dielectric strength (ASTM D 149, DIN EN 60093)	Resistance to tracking (DIN EN 60112, VDE 0303 part 1)	Moisture absorption to equilibrium 23 °C/50% rel. humidity (DIN EN ISO 62)	Water absorption at saturation (DIN EN ISO 62)	Resistance to hot water washing soda	Flammability acc. to UL-Standard 94	Resistance to weathering[5]	
Trade name	T_m °F	T_g °F	HDT/A °F	HDT/B °F	°F	λ BTU-in/hr-ft² °F	c BTU/lb · °F	α x 10^5 in/in/°F	ε_r –	tan δ –	ρ_D Ω·cm	R_O Ω/SQ	E_d v/mil	grade	W(H_2O) %	W_S %	–	–	–	**Trade name**
TECAFLON PVDF	341	-25		284	302	0.76		7.2	8	0,06	10^{14}	10^{13}		KA 1	<0,05	<0,05	+	V0	+	**TECAFLON PVDF**
TECAFLON PVDF AS	341	-22			356			0.7	2.5		10^2-10^4	10^2-10^4			0,07		+	V0	+	**TECAFLON PVDF AS**
TECAMID 46	563	167	320		428	2.03	2.,03	4.4	4.1	0,21 0,35	10^{15}	10^{16}		KC >425	3,7	14	(+)	V2	-	**TECAMID 46**
TECAMID 46 GF 30	563	167			392	2.29	2.29	1.1		0,013	10^{14}	10^{16}			2,6	10	(+)	HB	-	**TECAMID 46 GF 30**
HYDLAR	491		194	455	350		0.4	3.5	4.0	0.01	10^{15}		350		1.2	8.5	-		-	**HYDLAR**
TECAMID 66 SF 20	500	161/41	431	482	248			2.2			10^{15}	10^{13}			2.2	6-7	(+)	HB	+	**TECAMID 66 SF 20**
TECAMID 66 ST 801	492		295	392				6.5				10^{15}			1.2	6.7	-	HB	-	**TECAMID 66 ST 801**
TECAMID 66	500	161/41	212	392	356	1.60	1.60	4.4	3.6-5	0,026-0,200	10^{12}	10^{10}	350	CTI 600	2,8	8,5	(+)	HB	-	**TECAMID 66**
TECAMID 66 HI	500	161/41	212	392	338	1.60	1.60	4.4	3.2-5	0,025-0.200	10^{12}	10^{10}	350	KB>600 KC>600	2,8	8,5	(+)	HB	-	**TECAMID 66 HI**
TECAMID 66 GF 30	500	161/41	482	482	338	1.87	1.87	1.7			8x$10^{13(2)}$	6x$10^{13(2)}$	530		1,5	5,5	(+)	HB	+	**TECAMID 66 GF 30**
TECAMID 66 CF 20	500	161/41	473	482	338	2.98	2.98	3.0			10^2-10^4	10^2-10^4			2,2	6,5	(+)	HB	+	**TECAMID 66 CF 20**
TECAMID SF20	500	161/41	431	482	248			2.2			10^{15}	10^{13}			2.2	6-7	(+)	HB	+	**TECAMID SF20**
TECAMID 66 LA	500	161/41	185	365	338	1.60	1.60	8.3	3,3	0,015	6x10^{13}	10^{14}		CT >600	2,5	7,5	(+)	HB	-	**TECAMID 66 LA**
TECAMID 66 MH	500	161/41	221	482	311	1.60	1.60	6.7			7x10^{13}	5x10^{13}	350		2,6	7	(+)	HB	+	**TECAMID 66 MH**
TECAST T Vekton 6PA	431		200	370	300	1.67	0.4	4	3.7				500		1.2		-	HB	-	**TECAST T Vekton 6PA**
TECAST L Vekton 6PAL	434														0.95		-	HB	-	**TECAST L Vekton PAL**
TECAST Vekton 6PALM	435																			**TECAST Vekton 6PALM**
TECAST Vekton 6PALM/PAG	433		200	370	300			4	3.7				500		1.2		-	HB	-	**TECAST Vekton 6PALM/PAG**
TECAST ST Vekton 6PB	430														1.2		-	HB	-	**TECAST ST Vekton 6PB**
TECAST HI Vekton 6XAU	432		200	370	300			4	3.7				500		1.2		-	HB	-	**TECAST HI Vekton 6XAU**
TECAST Vekton HPV	436																			**TECAST Vekton 6HPV**
TECARIM 1500	417							4.4	4,2	0,1	5x10^9	4x10^8		500	2,5		(+)	HB		**TECARIM 1500**
TECARIM 4000	417				320			4.4	4,8	0,1	2x10^9	2x10^8		600	1,6		(+)	HB		**TECARIM 4000**
TECAMID 6 VF GF 12	220		75	190	160	0,23	1,7	8	3,7-7	0,031-0,300	10^{13}	10^{12}		CTI 600	3	9,5	(+)	HB		**TECAMID 6 VF GF 12**
TECAMID 6/12	422		194			1.53	0.45	5	4	0.02		10^{15}			0.25	3	-	HB	-	**TECAMID 6/12**
TECAMID 6/6T	563	221	230		356	1.60	1.60	3.9	4.3-4.5	0,03-0,04	10^{13}	10^{13}		KC 600	1.8	6.5-7.5	(+)	V2	+	**TECAMID 6/6T**
TECAMID TR		302	266	284	248	1.60	0.34	2.8	3-4	0,02-0,03	10^{15}	10^{15}		KC>600	3	5,6-6,4	(+)	HB	-	**TECAMID TR**
TECAMID 12	347	113	122	284	302	1.60	0.50	5.5	3,1-3,6	0,03-0,04	10^{14}	10^{14}		KA 38 CTI 600	0,7	1,6	+	HB	-	**TECAMID 12**
TECAMID 12 GF 30	347	113	248	329	302	1.60	0.41	5	4	< 0,04	10^{13}	10^{14}		KB 400 CTI 600	0,4	1	(+)	HB	-	**TECAMID 12 GF 30**
TECAMID 11	361	109	55	150	150	0,23	2,1	2.8	3,2-3,6	0,03-0,08	10^{13}-2x10^{15}	10^{14}		KC 600	0,9	1,9	+	V2	-	**TECAMID 11**
TECAMID 11 GF 30	361	109	131	302	302	0,23		5			10^{14}	> 10^{14}		KB 600 KC 600	0,45	1,3	(+)	HB	-	**TECAMID 11 GF 30**

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Mechanical properties

				Density (ASTM D 792, DIN EN ISO 1183)	Tensile strength at yield (ASTM D 638, DIN EN ISO 527)	Tensile strength at break (ASTM D 638, DIN EN ISO 527, ASTM D 1708 (a))	Elongation at break (ASTM D 638, DIN EN ISO 527, ASTM D 1708 (a))	Modulus of elasticity (ASTM D 638, DIN EN ISO 527)	Flexural Modulus (ASTM D 790, DIN EN ISO 178)	Rockwell Hardness (ASTM D 790)	Notched Izod Impact (ASTM D 790)	Creep rupture strength after 1000 h	Time Limit for 1% elongation after 1000 h	Dynamic COF (ASTM D 37 02)	Wear (ASTM D 37 02)	
Trade name	**Description**	**Additives and/or colour**	**Long Term Service Temp °F**	ρ	σ_S psi	σ_R psi	ε_R %	E_Z ksi	E_B ksi	H_K	a_n ft-lb/in	$\sigma_{B/1000}$ psi	$\sigma_{1/1000}$ psi	μ	V	**Trade name**
TECANAT HT	PC-HT	transparent	284	1,15	9425		7	333	319							**TECANAT HT**
TECANAT	PC	transparent	248	1,20	8700		50	333		R118/ M70	17	6960	2610	0,38	2500	**TECANAT**
TECANAT GF 20	PC	20% glass fibre	266	1,35	16000		5	860	798		2.06			0,22	120	**TECANAT GF 20**
HYDEL PC-7	PC	carbon nanotube	260	1,20	9000		8	333	340		1,2					**HYDEL PC-7**
HYDEL PCP	PC	carbon powder	260	1,27	9500		5				1,5					**HYDEL PCP**
TECADUR PET	PET	opaque, also in black (1)	230	1,37	11600			406		R117	0.7	5220	1885	0,25	210	**TECADUR PET**
TECAPET	PET	natural, also in black (1)	230	1,37	12760		4	464000			no break	5220	1885	0,25	210	**TECAPET**
TECAPET TF	PET	solid lubricant, grey	230	1,44	12760		4	464000			no break					**TECAPET TF**
HYDEX 4101 PBT	PBT	opaque	230	1.31	7975			362		M72		5220	1740	0.25	210	**HYDEX 4101 PBT**
HYDEX 4101 L	PBT	proprietory lubricant	221	1.36	7200		40	380	390		0.7			0.11	38	**HYDEX 4101 L**
TECAFORM AH	POM-C	opaque, also in black (1)	212	1,41	9425		30	391		M75		5800	1885	0,21	65	**TECAFORM AH**
TECAFORM AH GF 25	POM-C GF 25	25% glass fibre	212	1,58		18850	3	1305								**TECAFORM AH GF 25**
TECAFORM AH LA	POM-C	solid lubricant, blue	212	1,35	6525			232	304							**TECAFORM AH LA**
TECAFORM AH ELS	POM-C	conductive carbon, black	212	1,45	7250		15	290		M97						**TECAFORM AH ELS**
TECAFORM AH SD	POM-C	beige	212	1,33	6525		> 25	203	210	R110						**TECAFORM AH SD**
TECAFORM AH MT col.	POM-C	colored, medicine grade	212	1.41	7975		30	304				5800	1885	0.21	65	**TECAFORM AH MT col.**
TECAFORM AD 150	POM-H	Delrin® 150 opaque	212	1.42			25		380	R120/ M94	2.3	5800	1885	0.20	55	**TECAFORM AD 150**
TECAFORM AD 511P	POM-H	Delrin® 511P opaque	212	1.42	10400		33	490	480		1.4					**TECAFORM AD 511P**
TECAFORM AD AF	POM-H	Delrin® AF PTFE lube	212	1.54			10		349					0.16	20	**TECAFORM AD AF**
TECAFORM AD GF 20	POM-H GF 20	Delrin® 570 20% glass fibre	212	1,56		7975	10	870		R118/ M90	0.8		4060			**TECAFORM AD GF 20**
TECAFORM AD CL 500	POM-H	Delrin® CL500 chemical lubricant	212	1.42	10145	2900		400	730	R118/ M90				0.12	35	**TECAFORM AD CL 500**
TECAFORM AD HPV 13	POM	PTFE lubricant	185	1.54	6800		10	340	350	R118	0.7			0.12	20	**TECAFORM AD HPV 13**
TECAPRO MT	PP	heat stabilisator, also in black(1)	100	0,92	5000		30		270	100 (r)	1					**TECAPRO MT**
TECAFINE PP	PP	also in black(1) and grey	212	0,91	4350			232		R90	0.9	3190	580			**TECAFINE PP**
TECAFINE PP ELS	PP	conductive carbon, black	212	0,98		3625	4	188								**TECAFINE PP ELS**
TECAFINE PP GF 30	PP GF 30	30% glass fibre	212	1,14		12325	3	797								**TECAFINE PP GF 30**
TECAFINE PE	PE-HD	also in black(1)	194	0,96	3625			145	145-203			1812	580			**TECAFINE PE**
HYDEX 202	RTPU	opaque	200	1,20	10000		40	260	320	R123	10			0.52	337	**HYDEX 202**
HYDEX 301	RTPU	transparent/ translucent	275	1,20	10000		140	310	340	R123	2.4					**HYDEX 301**
HYTREL 5556	TPU	opaque	122	1,78	1000		560		30		NB			0.59	100	**HYTREL 5556**
TECACRYL	PMMA	transparent	212	1.18	8700		3-8	435								**TECACRYL**
TECARAN	ABS	natural/black(1)	170	1.06	7250			348	340	R105	7.5	4060	2465	0.35	3500	**TECARAN**
TECANYL	PPO	Noryl®, also in black(1) and grey	185	1,06	7975			333	370	R119	3.5		3045	0.39	3000	**TECANYL**
TECANYL MT	PPO	colored	185	1,08	9800	7977	16,3	471	368		2.6 (ai)					**TECANYL MT**
TECANYL GF 30	PPO GF 30	Noryl® GFN3 30% glass fiber	185	1,29		15225	2	1160	1130	R108	2.2		6815		230	**TECANYL GF 30**

	Thermal properties								Electrical properties(1)						Miscellaneous data					
	Melting point (ASTM D 2133) *Vicat Softening Point	Glass transition temperature (DIN 53 765)	Heat Deflection 264 psi (ASTM D 648, ISO-R 75, A)	Heat Deflection 66 psi (ASTM D 648, ISO-R 75, B)	Max Service short term	Thermal conductivity (ASTM C 177)	Specific heat	Coefficient of linear thermal expansion (ASTM D 696)	Dielectric constant (10^6 Hz, ASTM D 150, DIN 53 483, IE-250)	Dielectric loss factor (10^6 Hz, ASTM D 150, DIN 53 483, IE-250)	Specific volume resistance (ASTM D 257, EC 93, DIN IEC 60093)	Surface resistance (ASTM D 257, EC 93, DIN IEC 60093)	Dielectric strength (ASTM D 149, DIN EN 60093)	Resistance to tracking (DIN EN 60112, VDE 0303 part 1)	Moisture absorption to equilibrium 23 °C/50% rel. humidity (DIN EN ISO 62)	Water absorption at saturation (DIN EN ISO 62)	Resistance to hot water washing soda	Flammability acc. to UL-Standard 94	Resistance to weathering(5)	
Trade name	T_m °F	T_g °F	HDT/A °F	HDT/B °F	°F	λ BTU-in/hr-ft² °F	c BTU/ lb · °F	α x 10^5 in/in/°F	ε_r –	tan δ –	ρ_D Ω·cm	R_O Ω/SQ	E_d v/mil	grade	$W(H_2O)$ %	W_S %	–	–	–	**Trade name**
TECANAT HT		109	321-386	343	383			3.9	2,9	0,01	> 10^{16}	10^{15}	380	CTI 600	0,2			HB	-	**TECANAT HT**
TECANAT		356	275	284	284	1.32	0.29	3.9	3	0,006	10^{13}	10^{15}	380	KA 1	0,15	0,36	-	HB	-	**TECANAT**
TECANAT GF 20	329*		244	298	275	1.32	0.30	1.5	3.17	0.0009		10^{17}	490				-	HB	-	**TECANAT GF 20**
HYDEL PC-7	329*		280					3.7			10^7-10^{10}	10^7-10^{10}			0.15	0.15	-	V2	-	**HYDEL PC-7**
HYDEL PCP	329*											10^7-10^{12}			0.18	0.18	-	V2	-	**HYDEL PCP**
TECADUR PET	491	68	203	338	338	1.66	0.26	3.9	3,2	0,0021	10^{13}	10^{15}	400	KC 350	0,25	0,5	-	HB	-	**TECADUR PET**
TECAPET	491	158	203	338	338	1.7	0.26	3.9	3,2	0,0021	10^{13}	10^{15}	400	KC 350	0,25	0,5		HB		**TECAPET**
TECAPET TF	491	158	203	338	338	1.7	0.26	3.9	3,2	0,0021	10^{13}	10^{15}	400	KC 350	0,25	0,5		HB		**TECAPET TF**
HYDEX 4101 PBT	437	158	176	329	338	1.46	0.29	4.4	3	0.012	>10^{13}	>10^{15}	400	KB 425 KC>600	0.25	0.4	-	HB	-	**HYDEX 4101 PBT**
HYDEX 4101 L	428		195		250			6.5			10^{15}				0.07		-		+	**HYDEX 4101 L**
TECAFORM AH	329	140	230	320	284		0.36	5.5	3,5	0,003	10^{14}	10^{14}	500	KA 3c	<0,3	0,5	(+)	HB	-	**TECAFORM AH**
TECAFORM AH GF 25	329	-76			284	2.15		1.7	4,8	0,005	10^{14}	10^{12}			0,15					**TECAFORM AH GF 25**
TECAFORM AH LA	329	-76	190		284		0.36	8.9	3,8	0,007	7x 10^{13}(2)	9x10^{13}	500	CTI 600	0,2	0,8	(+)	HB	-	**TECAFORM AH LA**
TECAFORM AH ELS	329	-76	192		284			6.1			10^2-10^4	10^2-10^4			<0,3	0,5	(+)	HB	+	**TECAFORM AH ELS**
TECAFORM AH SD	329	-76	190		284	2.08		6,7			10^9-10^{11}	10^9-10^{11}			0,25	0,8	(+)	HB	-	**TECAFORM AH SD**
TECAFORM AH MT col.	329	-76	230	320	284	2.15	0.36	5.5	3.5	0,003	10^{14}	10^{14}	500	KA 3c	< 0,3	0,5	(+)	HB	-	**TECAFORM AH MT col.**
TECAFORM AD 150	329	-76	190		284	2.08		6.7			10^9 - 10^{11}	10^9 - 10^{11}			0.25	0.8	(+)	HB	-	**TECAFORM AD 150**
TECAFORM AD 511P	347	-76	237	336	302			5.5	3.7	0.005	10^{14}	10^{14}	460		0.25		(+)	HB	-	**TECAFORM AD 511P**
TECAFORM AD AF	347	-76	244	334	302			4.4	3.1	0,009	>10^{15}	> 10^{15}	400		0,18	0,72	-	HB	-	**TECAFORM AD AF**
TECAFORM AD GF 20	347	-76	316	345	302			3.3	3.9	0.005	> 10^{15}	> 10^{15}	490		0.1	1	-	HB	-	**TECAFORM AD GF 20**
TECAFORM AD CL 500	347	-76			302	2.57	0.35	5.5	3.5	0.006	10^{15}	10^{15}	400		0.24	1	-	HB	-	**TECAFORM AD CL 500**
TECAFORM AD HPV 13	347		120	334	300			5.1							0.22		-	HB	-	**TECAFORM AD HPV 13**
TECAPRO MT	325			230	250						10^{15}		>40		>0.05	0.1	-	HB	-	**TECAPRO MT**
TECAFINE PP	329	-1	149	221	266	1.53	0.41	9.4	2.25	0.0002	>10^{14}	> 10^{13}		KA 3c C>600	<0.1	<0.1	+	HB	-	**TECAFINE PP**
TECAFINE PP ELS	329	-1	149	311	248	1.53		5.0			<10^3	>10^3			<0.1	<0.1	(+)	HB	-	**TECAFINE PP ELS**
TECAFINE PP GF 30	165	-18	120	155	140	0.27	1.47	6	2.64		>10^{14}	>10^{13}		KA3c KB>600 KC>600	<0.1	<0.1	+	HB	-	**TECAFINE PP GF 30**
TECAFINE PE	266	-139	107	212	194	2.43-2.98	0.32	7.2-8.3	2.4	0.0002	>10^{15}	> 10^{13}	>50	KA 3c	<0.05	0.05	+	HB	-	**TECAFINE PE**
HYDEX 202	292*			289	280		0.26	3.7	2.6	0,025		10^{16}	570		0.15	1.4	-	HB	+	**HYDEX 202**
HYDEX 301	228*		261	219	200		0.26	3.4	3.5	0.025		10^{16}	635		0.14	1.4	-	HB	+	**HYDEX 301**
HYTREL 5556			190	214	185			6.5	4.4	0.08		10^{10}	410		0.3		-	HB	-	**HYTREL 5556**
TECACRYL		221	140	204-226	212	1.32		3.9	3.4	0.004	10^{15}			KB >600 KC >600	1	2	-	HB	-	**TECACRYL**
TECARAN		239	180	280	212	118		4.4-6.1	3.3	0,015	10^{15}	10^{13}	450	KA 3b	0,4	0,7	-	HB	-	**TECARAN**
TECANYL		302	266	289	230	1.53		3.9	2,6	0,001	10^{13}	10^{15}	500	KA 1	0,1	0,2	+	HB	-	**TECANYL**
TECANYL MT	168		296		110			4.8							0,06	0,23				**TECANYL MT**
TECANYL GF 30		302	225		230			1.7	3,1	0,0021	10^{15}	10^{15}	530	KB 250	0,05	0,18	(+)	HB	-	**TECANYL GF 30**

Chemical Resistance

Important criteria for testing chemical resistance are temperature, the concentration of the agents, the residence time as well as the mechanical load.

The resistance against various chemicals is listed in the following table. These details correspond to the present state of our knowledge and are meant to provide information about our products and their applications. They do not mean that the chemical resistance of products or their suitability for a particular purpose is guaranteed in a legally binding way. Any existing commercial proprietary rights are to be taken into account. We guarantee perfect quality within the scope of our general terms and conditions.

For specific applications it is recommended to establish suitability first. Standard testing is performed in normal climatic conditions 23/50 according to DIN 50 014.

	SINTIMID (PI)	TECAPEEK HT (PEK)	TECAPEEK (PEEK)	TECAPEI (PEI)	TECATRON (PPS)	TECASON E (PES)	TECASON P (PPSU)	TECASON S (PSU)	TECAFLON PTFE (PTFE)	TECAFLON ETFE (E/TFE)	TECAFLON PVDF (PVDF)	TECAFLON PCTFE (PCTFE)	TECAMID 6 (PA 6)	TECAMID 46, 66 (PA 46, 66)	TECAMID 11, 12 (PA 11, 12)	TECAST/TECARIM (PA 6 G)	TECANAT (PC)	TECAFINE PMP (PMP)	TECADUR PET PBT TECAPET (PET, PBT)	TECAFORM AH (POM-C)	TECAFORM AD (POM-H)	TECAFINE PP (PP)	TECAFINE PE (PE)	TECARAN ABS (ABS)	TECANYL (PPE)
Acetamide 50%									+	+	+		+	+	+						+			+	
Acetone	+	+	+		+	-	-	-	+	+	(+)	+	(+)	(+)	(+)	(+)	-	(+)	-	+	+	+	(+)	-	-
Formic acid, aqueous solution 10%	+	+	+	-	+	+			+	+	+	+	-	-	-	-	+	+	+	+	-	+	+	+	+
Ammonia solution 10%	-	+	+	-	+	(+)		(+)	+	+	+	+	+	+	+	+	-	+	+	+	(+)	+	+	+	+
Anone						-			+	+	(+)		+	+	+		-				+	+	(+)		
Benzine	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+	-		+	+	+	(+)	(+)	(+)	-
Benzene	+				(+)	+	(+)	-	+	+	+	+	+	+	+		-	-	(+)	+	+	(+)	(+)	-	-
Bitumen	+								+				(+)	(+)	(+)		-			+	+	(+)	(+)		
Boric acid, aqueous solution 10%		+	+			+			+		+		+	+	+	+	+			-	+	+	+	+	
Butyl acetate	+				+	(+)	+	(+)	+	+	+		+	+	+		-	-	+	+	+	(+)	(+)	-	
Calcium chloride, solution 10%	+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	+	+	+	+	(+)	+	+	+	
Chlorbenzene	+			+	(+)	-			+			+	+	+	+		-	-	-	+	+	+	-	-	
Chloroform	+				(+)	-		-	+	+	+	(+)	-	(+)	-		-	-	-	-	-	(+)	-	-	-
Clophene A60, 50%									+				+	+	+				+	+	(+)		+		
Cyclohexane	+				+	+	+	+	+		+	+	+	+	+	+	-			+	+	+	+	+	+
Cyclohexanone	+				+	-			+	+	(+)		+	+	+		(+)	(+)		+	+	+	+	-	+
Decalin	+								+	+			+	+	+	+	(+)	(+)		+	+	+	+	-	+
Diesel oil	+			+	+	+		+	+		+		+	+	+	+	(+)	(+)	+	+	+	(+)	+	+	+
Dimethyl formamide	(+)				+	-			+	+		+	+	+	(+)	+	-	+		+	-	+	+	-	
Diocthyl phthalate					(+)	+		+	+				+	+	+		(+)	+		+	+	+	+		+
Dioxane	+			+	+	(+)			+		+		+	+	+		-		(+)	(+)	+	+	(+)		(+)
Acetic acid, concentrated	(+)		-		+	+		+	+	(+)			-	-	-	-	-	(+)	-	(+)	-	+	+	-	+
Acetic acid, aqueous solution 10%	+		+	+	+	+	+	+	+		+		-	-	(+)	-	+	+	(+)	+	(+)	+	+	+	+
Acetic acid, aqueous solution 5%	+		+		+	+	+	+	+		+		+	+	(+)	+	+	+	+	+	(+)	+	+	+	+
Etanolo 96%	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	(+)	+	+	+	+	+	+	+	+
Etilacetato	+			+		-		-	+	+	+		+	+	+	+	-	(+)	(+)	(+)	+	+	+		+
Etiletere	+					+	+	+	+	+	+		+	+	+	+	-		+	+	+	+	+		
Cloruro di etilene	+			+					+	+			+	+	(+)	+	-		-	-	-	+	(+)	-	
Hydrofluoric acid, 40%								(+)	+	+		+	-	-	-		(+)		-	-	-	+	+	(+)	+
Formaldehyde, aqueous solution 30%		+	+	+	+	+	+		+		+	(+)	+	+	(+)	+		+		+	-	+	+	+	+
Formamide									+				+	+	(+)						(+)		(+)		
Freon, Frigen, liquid	+	-	-		+	+		+	+	+			+	+	+	+	-		+		+	-	(+)	(+)	+
Fruit juices	+			+					+				+	+	+	+	-	+	+	+		+	+	+	+
Glykol	+	+	+		+	+		+	+	+	+	+	+	+	+		+	+	+	+	+	+	+	+	+
Glysantin, aqueous solution 40%	+	+	+		+	+		+	+	+	+		+	+	+		+		+	+	+	+	+		+
Glycerine	+			+		+		+	+		+		+	+	+	+	(+)		+	+	+	+	+	+	+
Urea, aqueous solution	+					+			+				+	+	+		+			+	+	+	+	+	+
Heating oil	+				+	+			+		+		+	+	+	+	(+)		+	+	+	(+)	+	+	+
Heptane, Hexane	+	+	+	+	+	+		+	+			+	+	+	+	+	+	-	+	+	+	+	-	+	+
Iso-octane	+			+		+	+	+	+				+	+	+						+	+	+	+	+
Isopropanol	+				+	+	+	(+)	+		+	+	+	+	(+)		(+)	+	+	+	+	+	+	(+)	+
Iodine solution, alcohol solution	+								+				-	-	-		(+)	+			(+)	+	+	(+)	+
Potassium lye, aqueous 50% [1]	-	+	+		+	+			+		-	+	+	+	+		-	+	-	+	-	+	+	+	+
Potassium lye, aqueous 10%	(+)				+	+			+	+	(+)	+	+	+	+	+	-	+	-	+	-	+	+	+	+
Potassium dichromate, aqueous solution 10%	-								+		+		+	+	(+)		+	+	+	+	(+)	+	+	+	+
Potassium permaganate, aqueous solution 1%	+	+	+	+	+				+		+		-	-	-	-	+	+	+	+	(+)	+	+	(+)	+
Cupric sulphate 10%	+	+	+		+	+			+		+	+	+	+	+		+			+	-	+	+	+	+

	SINTIMID (PI)	TECAPEEK HT (PEK)	TECAPEEK (PEEK)	TECAPEI (PEI)	TECATRON (PPS)	TECASON E (PES)	TECASON P (PPSU)	TECASON S (PSU)	TECAFLON PTFE (PTFE)	TECAFLON ETFE (E/TFE)	TECAFLON PVDF (PVDF)	TECAFLON PCTFE (PCTFE)	TECAMID 6 (PA 6)	TECAMID 46, 66 (PA 46, 66)	TECAMID 11, 12 (PA 11, 12)	TECARIM/TECARIM (PA 6 G)	TECANAT (PC)	TECAFINE PMP (PMP)	TECADUR PET, PBT TECAPET (PET, PBT)	TECAFORM AH (POM-C)	TECAFORM AD (POM-H)	TECAFINE PP (PP)	TECAFINE PE (PE)	TECARAN ABS (ABS)	TECANYL (PPE)
Linseed oil	+				+	+			+		+		+	+	+	+	+	+	+	+	+	+	+	+	+
Methanol	+				+	+	(+)	+	+		+	+	+	+	(+)	+	-	+	+	+	+	+	+	(+)	+
Methyl ethyl ketone	+	+	+	+	+	-	(+)	-	+	+	(+)	(+)	+	+	+	+	-	(+)	+	(+)	+	+	+	-	-
Methylene chloride	+				(+)	-	-	-	+	+	+	(+)	(+)	(+)	-		-	+	-	(+)	(+)	-	(+)	-	
Milk	+					+			+		+		+	+	+	+	+	+		+	+	+	+	+	+
Lactic acid, aqueous solution 90%	+			+	+	(+)			+		+		-	-	(+)		+			+	-	+	+	-	-
Lactic acid, aqueous solution 10%	+	+	+	+	+	+			+		+		+	+	+		+			+	(+)	+	+	+	+
Sodium bisulphite, aqueous solution 10%	+	+	+	+	+				+		+	+	+	+	+		+	+	+	-	-	+	+	+	
Sodium carbonate, aqueous solution 10%	(+)	+	+	+	+				+		+		+	+	+	+	+	+	+	+	(+)	+	+	+	+
Sodium chloride, aqueous solution 10%	+	+	+	+	+	+	+	+	+		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Sodium nitrate, aqueous solution 10%	+				+				+		+		+	+	+	+		+	+	+	+	+	+	+	
Sodium thiosulphate 10%	+				+				+		+		+	+	+				+	+	+	+	+	+	
Soda lye, aqueous 50%	-	+	+	-	+	+			+	+	+	+	+	+	+		-	+	-	+	-	+	+	+	+
Soda lye, aqueous 5%	(+)				+	+		+	+	+	+	+	+	+	+	+	-	+		+	-	+	+		+
Nitrobenzene	+				(+)	-			+			+	(+)	(+)	(+)		-	+		(+)	(+)	+	+	-	
Oxalic acid, aqueous solution 10%	+	+	+			+		+	+		+	+	(+)	(+)	+		+	+		-	(+)	+	+	+	+
Ozone	(+)								+		+	+	-	-	-		-			-	-		(+)		
Paraffin oil	+			+		+			+		+	+	+	+	+	+	+		+	+	+	+	+	+	+
Perchlorethylene	+				(+)	-		-	+		+		(+)	(+)	-		(+)		(+)	+	+	-	-	(+)	
Petroleum	+				+				+		+		+	+	+	+	-		+	+	+	+	+	(+)	+
Phenol, aqueous solution	+				(+)				+		+	+	-	-	-		-	+	-	-	-	+	+	(+)	
Phosphoric acid, concentrated	(+)	+	+		+			+	+	+	+	+	-	-	-	-			+			+	+	+	
Phosphoric acid, aqueous solution 10%	(+)	+	+	+	+				+			+	-	-	-	-	+	+		(+)	-			+	+
Propanol	+								+		+		+	+	-	+	+		+	+	+	+	+	+	+
Pyridine	-			-	(+)	-			+	+	+	+	+	+			-	(+)		+	(+)	(+)	(+)	-	
Pyridine 3 solution, aqueous solution									+				+	+	+		-			+	-				
Salicylc acid	+								+		+	+	+	+	+						(+)			+	
Nitric acid, aqueous solution 2%	+	+	+	-	+	+	+	+	+	+	+	+	-	-	-	-	-	+	+	-	-	+	+	+	-
Hydrochloric acid, aqueous solution 36%	-	+	+	+	(+)	+		(+)		+	+	+	-	-	-	-	+	+	-	-	-	+	+	+	+
Hydrochloric acid, aqueous solution 2%	+	+	+		(+)	+	+	+	+	+	+	+	-	-	(+)		+	+	+	-	-	+	+	+	+
Sulphur dioxide	+					(+)			+	+	+		+	+	+		-		+	+	+	+	(+)	-	
Sulphuric acid, concentrated 98%	-	-	-			-		-	+	+	(+)	+	-	-	-	-	-	+	-	-	-	+	(+)	-	-
Sulphuric acid, aqueous solution 2%	+	+	+	+	+	+	+	+	+	+	+	+	-	-	-		+	+	-	+	-	+	+	+	+
Hydrogen sulphide, saturated		+	+			+			+			+	+	+	(+)		+				-	+	+	-	+
Soap solution, aqueous solution	(+)					+		+	+				+	+	+	+	+	+	+	+	+	+	+		+
Silicone oils	+					+			+		+		+	+	+	+	+	+	+	+	+	+	+	+	+
Soda solution, aqueous solution 10%	(+)								+		+	+	+	+	+		+		+		+	+	+	+	
Edible fats, Edible oils	+			+	+	+			+		+		+	+	+	+	+				+	+	+		+
Styrene	+								+				+	+	+		-				+	(+)	(+)		-
Tar	+			+		+			+				(+)	(+)	(+)						+	+			
Carbon tetrachloride	+					+		(+)	+	+	+		+	+	-	+	-		+	+	(+)	-	-	-	-
Tetrahydrofurane	+			+	+	-			+	+	+	+	+	+	+		-	-	-	(+)	-	(+)	(+)	-	
Tetralin	+								+				+	+	+		-		+	+	+		(+)	-	
Ink	+								+		+		+	+	+	+	+		+			+	+	+	
Toluene	+	+	+	+	(+)	-	(+)	-	+	+	+	(+)	+	+	+	+	-	-	(+)	+	+	+	(+)	-	
Transformer oil	+				+	+	+	+	+		+		+	+	+	+		(+)	+	+	+	(+)	+		+
Triethanolamine	-				(+)				+			+	+	+	+		-			+	-	+	+	+	
Trichlorethylene	+	+	+		(+)	-		-	+		+	-	(+)	(+)	(+)		-	-	-	-	-	(+)	-	-	-
Trilon B, aqueous solution 10%	+								+				+	+	+										
Vaseline	+			+		+			+		+		+	+	+	+	+	+	+	+	+	+	(+)	+	
Wax, molten	+	+	+	+		+			+	+	+		+	+	+	+	+		+	+	+	(+)	(+)		+
Water, cold	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Water, warm	-	+	+	-	+		(+)	(+)	+	+	+		(+)	(+)	(+)	(+)	(+)	+	-	(+)	-	+	+	+	+
Hydrogen peroxide, aqueous solution 30%	-	(+)	(+)		(+)	+		(+)	+	+	+	+	-	-	-	-	+		+	-	-	+	+		+
Hydrogen peroxide, aqueous solution 0,5%	+				+	+		+	+	+	+	+	-	-	-	-	+		+	+	(+)	+	+	+	+
Wine, Brandy	+					+			+		+		+	+	+	+	+	+		+	+	+	+	+	+
Tartaric acid	+	+	+			+			+		+		+	+	+		+			(+)	(+)	+	+	+	+
Xylene	+	+	+		+	(+)	+	-	+		+	(+)	+	+	(+)		-	-	(+)	+	+	-	-	-	-
Zink chloride, aqueous solution 10%	+	+	+		+	+	+		+	+	+	+	(+)	(+)	(+)		+			+	-	+	+	+	+
Citric acid, aqueous solution 10%	+	+	+			+	+	+	+		+		(+)	(+)	(+)	+	+	+	+	(+)	-	+	+	+	+

+ = Resistant (+) = Limited resistance - = Not resistant (also dependent on concentration, time and temperature)

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