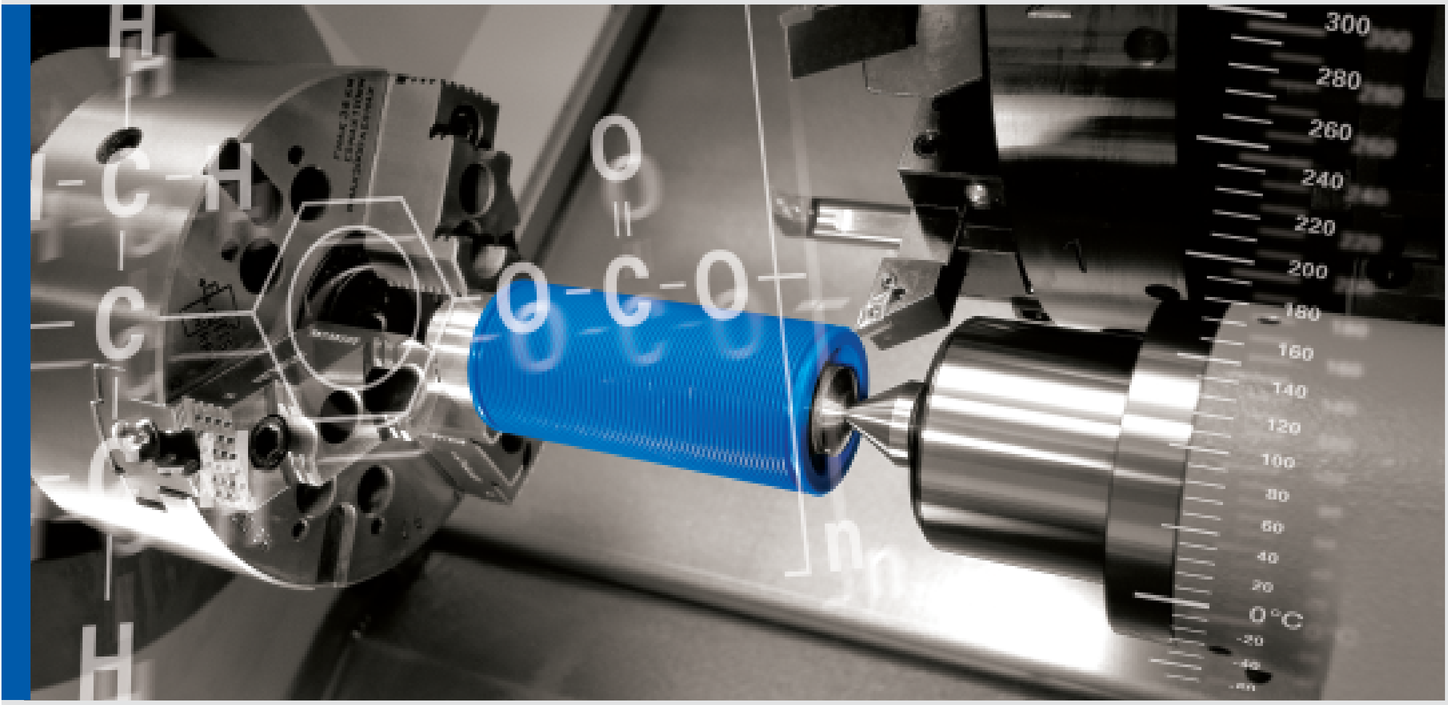
ENSINGER essentials.
Technical know-how for plastic applications.



ENSINGER
ASK. THINK. SUCCEED.

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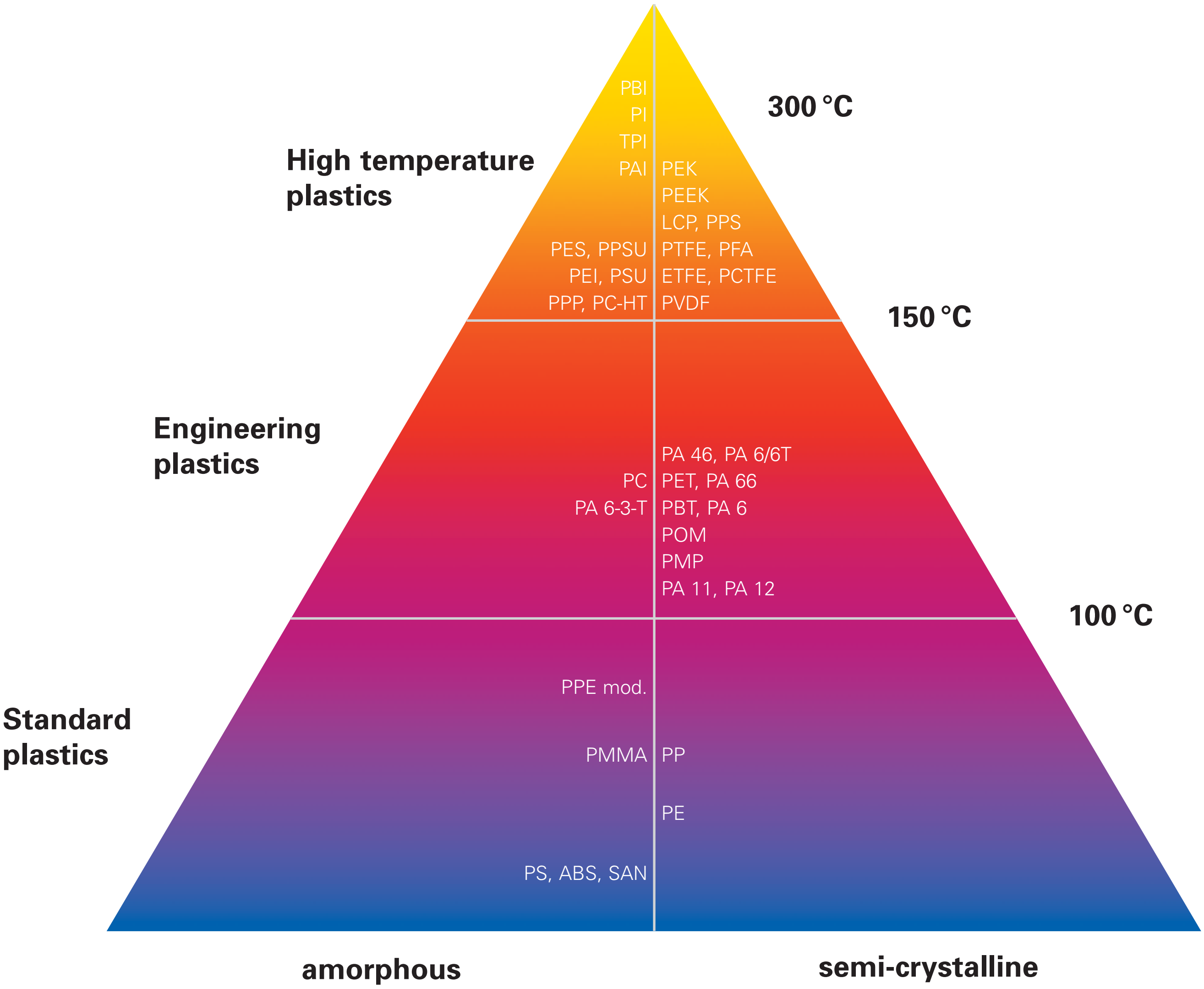
Classification of Plastics



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 150 °C 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 100 °C and 150 °C. They exhibit good mechanical properties and good chemical resistance.

Standard plastics can be used permanently at temperatures below 100 °C.

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

High Temperature Plastics

I VESPEL® and SINTIMID (PI)
Depending upon the type, provide high strength with a low level of creep and good wear-resistance up to 300 °C 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. Fulfils the foodstuffs requirements.

I TECASON P (PPSU)
Good impact strength, chemical resistance and resistance to hydrolysis. Inherently flame resistant. Fulfils the foodstuffs requirements.

I TECASON S (PSU)
High strength, rigidity and hardness. Low moisture uptake and very good dimensional stability. Inherently flame resistant. Fulfils the foodstuffs requirements.

I TECAPEI (PEI)
Very good mechanical and electrical properties. Inherently flame resistant. Fulfils the foodstuffs requirements.

I TECAMAX SRP (PPP)
Stiffer and harder than other non-reinforced thermoplasts. High scratch and abrasion resistance. Good resistance against hot steam and chemicals. Outstanding mechanical properties. Low density.

I TECAFLON PTFE (PTFE)
Highest chemical resistance, permanent service temperature of 260 °C. Exceptional sliding characteristics as well as excellent electrical properties. Inherently flame resistant. Fulfils the foodstuffs requirements.

I TECAFLON ETFE (E/TFE)
Good kinetic friction properties, very good chemical resistance and very good mechanical properties. Inherently flame resistant. Fulfils the foodstuffs requirements.

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

TECAMID 12 (PA 12)
Very high durability, good chemical resistance, lowest water uptake of all polyamides. Fulfils the foodstuffs requirements.

TECAMID 46 (PA 46)
Heat-stabilized, 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. Fulfils the foodstuffs requirements. 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 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 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 coplymer. Very good strength and toughness to be used advantageously in the low temperature range. Excellent resistance to impact and abrasion, chemical resistance. Appliction specific adjustability of the material properties.

TECANAT (PC)
Amorphous, transparent material with excellent impact strength, permanent service temperature 120 °C, good mechanical strength, low level of creep and very good dimensional stability. Fulfils the foodstuffs requirements.

TECAPET/ 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. Fulfils the foodstuffs requirements.

TECADUR PBT (PBT)
High strength and durability with good dimensional stability, good sliding and wear characteristics, high precision thanks to low water uptake, very high rigidity as well as a low thermal expansion coefficient due to glass-fibre reinforcement.

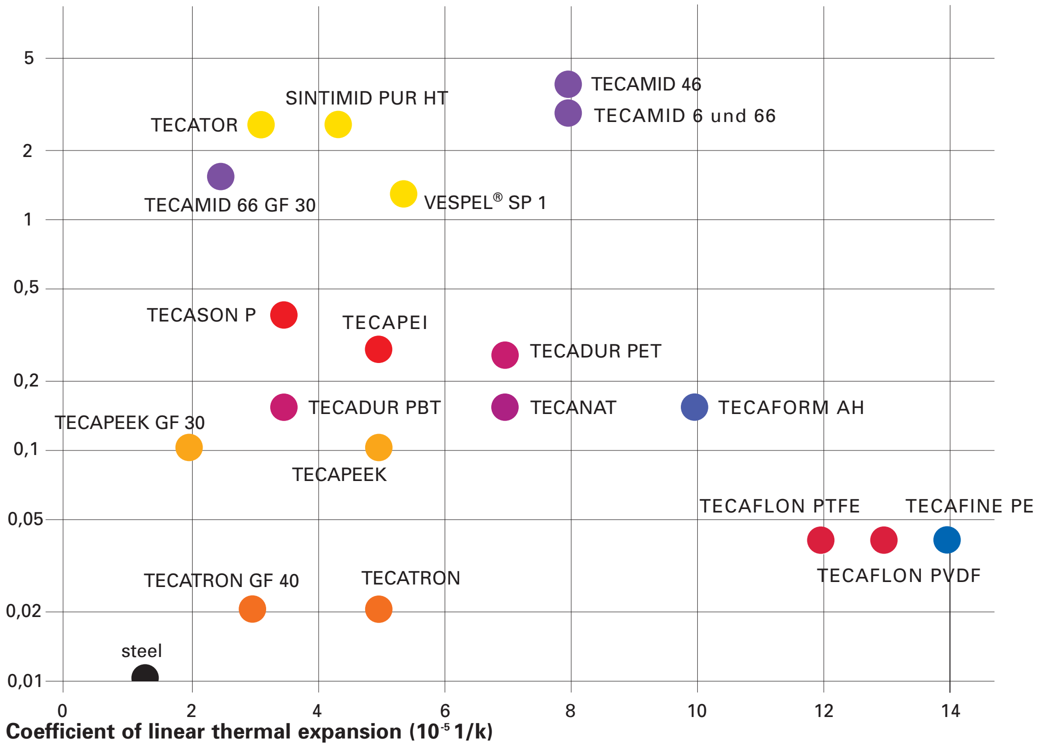
TECAFORM AH (POM-C)
Semi-crystalline POM-copolymer with good physical properties. Low moisture uptake, good fatigue strength and rigidity, very simple machine processing, good shape stability, parts with narrow tolerances. Good sliding characteristics. Fulfils the foodstuffs requirements.

TECAFORM AD (POM-H)
Slightly higher mechanical values in comparison to TECAFORM AH, very good resilience and high surface hardness, very good kinetic 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.

Water Absorption

Moisture uptake until saturation in % in standard climatic conditions



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 fibres**

  Glass fibres 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 fibres 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 fibres improve the sliding and wear characteristics.

- **Colour**

  The incorporation of pigments and colorants into technical plastics allows individually customized colour 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 discolouration or affect the mechanical properties of many plastics. The addition of **UV** or **thermal stabilizers** helps prevent such effects.

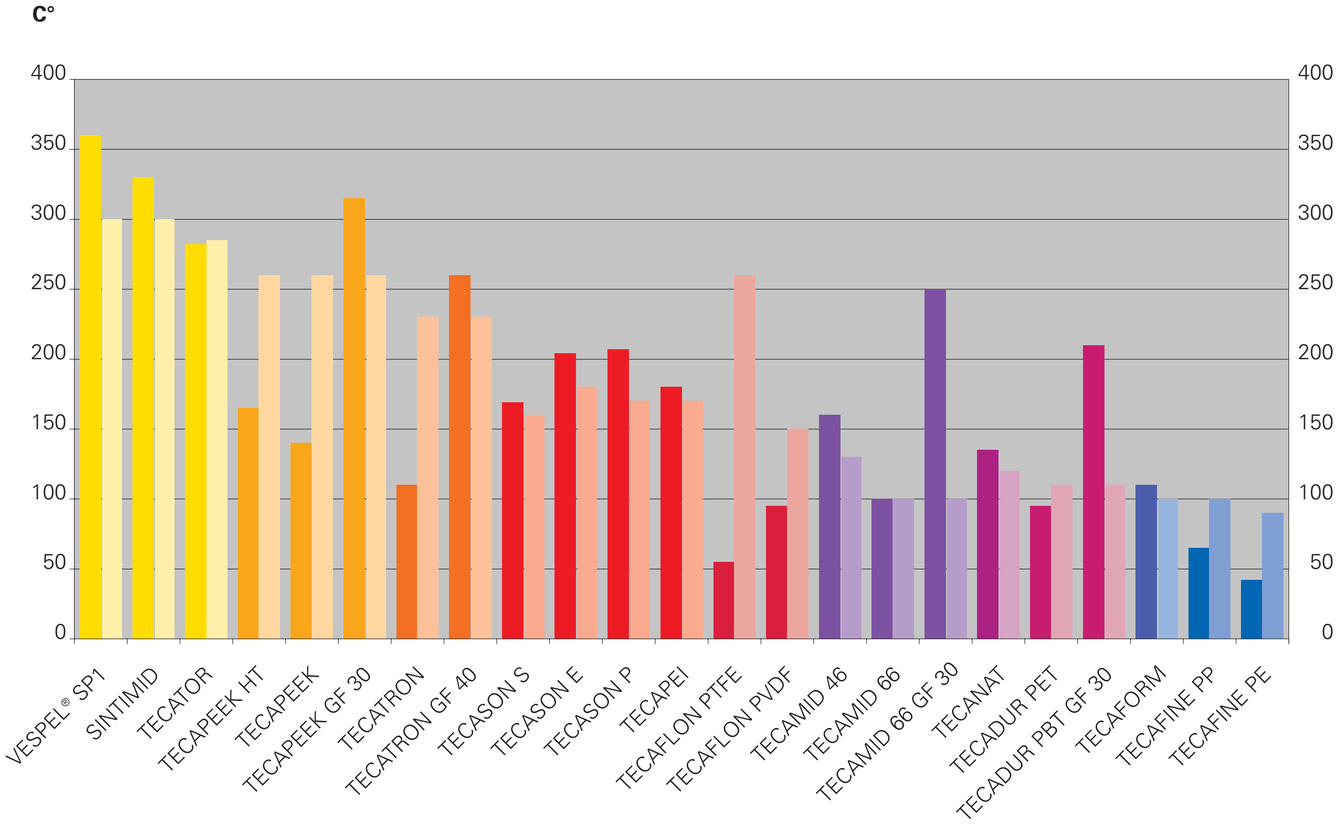
- **Friction and wear-reducing fillers**

  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.

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 1.8 MPa.

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.

Characteristic Mechanical Values

Mechanical characteristics in tensile testing

Tensile testing according to DIN EN ISO 527 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.

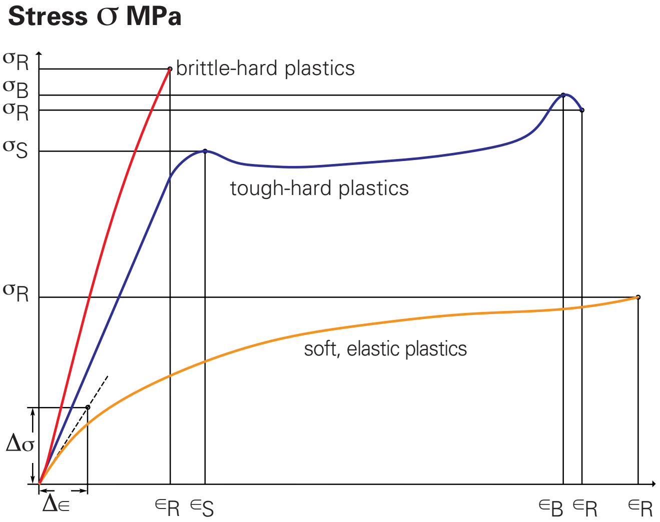
- **Tensile stress** σ
  σ is the tensile force in relation to the smallest measured initial cross-section of the test specimen at every arbitrary point during the experiment.

- **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.

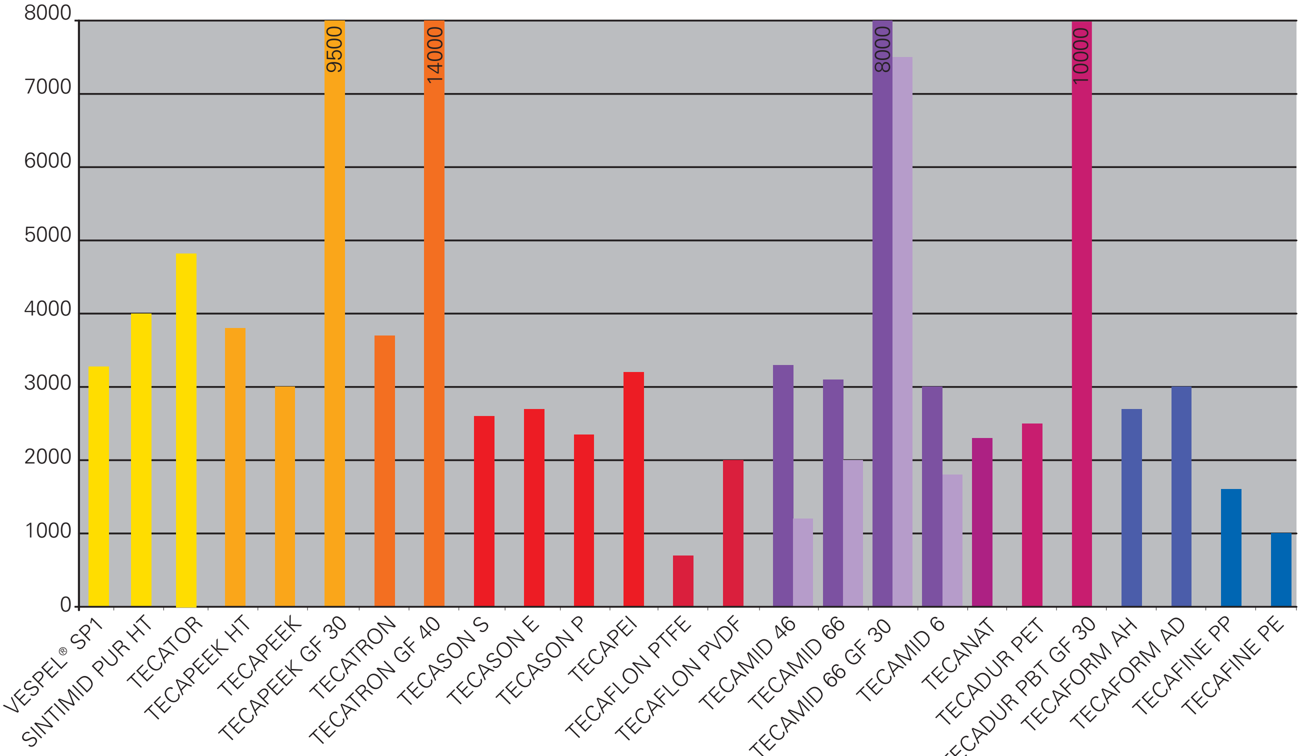
- **Elongation** ϵ
  Is the change in length ΔL in relation to the original length L_0 of the specimen at every arbitrary point during the experiment. The elongation at maximum force is described as ϵ_B, the elongation at break by ϵ_R, the yield stress with ϵ_S.



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.
  $E = \sigma / \epsilon$ in MPa.

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



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

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.

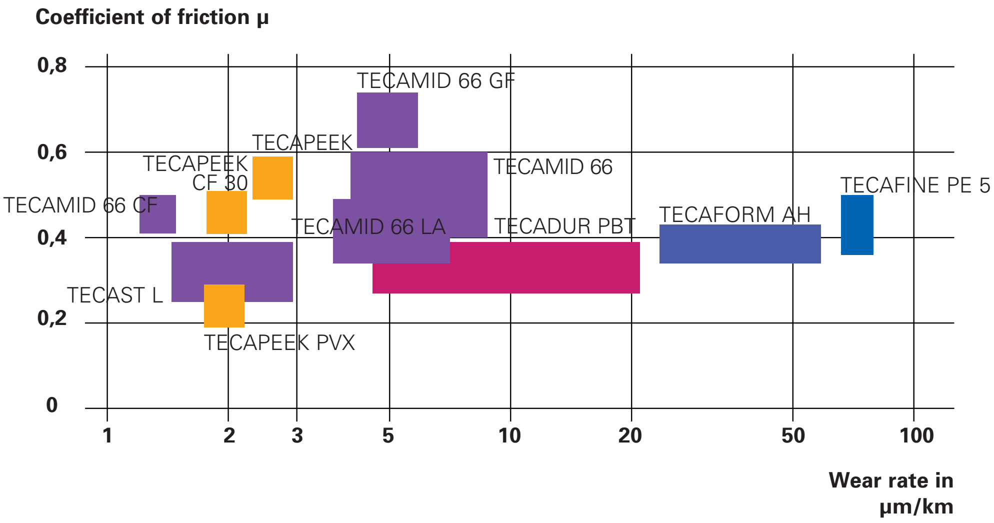
The sliding and abrasive behaviour is in this respect not a material property, but is determined specifically by the tribological system with various parameters such as material combination, surface roughness, lubricant, load, temperature, etc.

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).

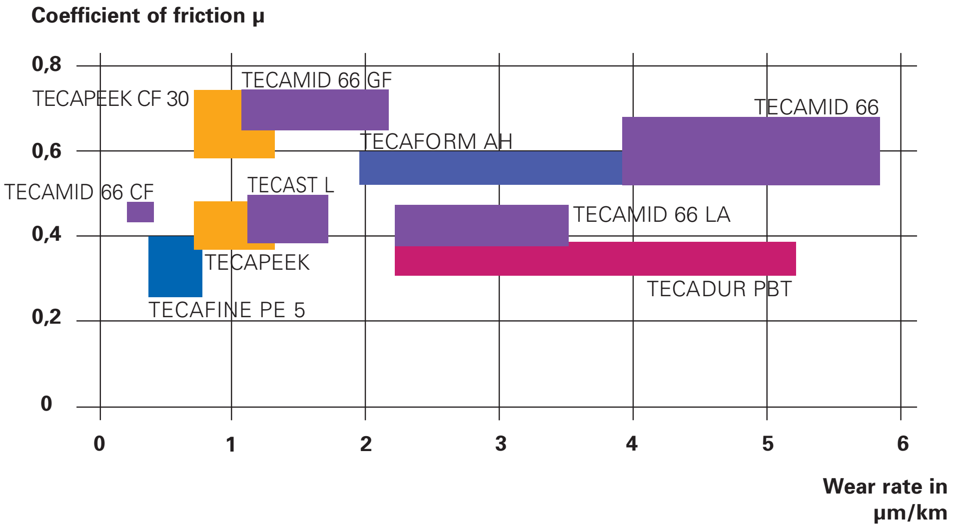
Additives such as glass fibre, glass beads or mineral fillers normally act abrasively on the sliding parts.

Cast polyamides are frequently used for slide bearing applications, which is why a large number of dynamic friction-optimised 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: 1 MPa,
Speed: 0,5 m/s,
against steel with **R_z = 2,5 μm**



Conditions:
Load: 1 MPa,
Speed: 0,5 m/s,
against steel with **R_z = 0,2 μm**

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
VESPEL®	**PI**	V-0 (3,2 mm)	49
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**	V-2 (3,2 mm)	
TECANAT GF 30	**PC**	V-1 (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.

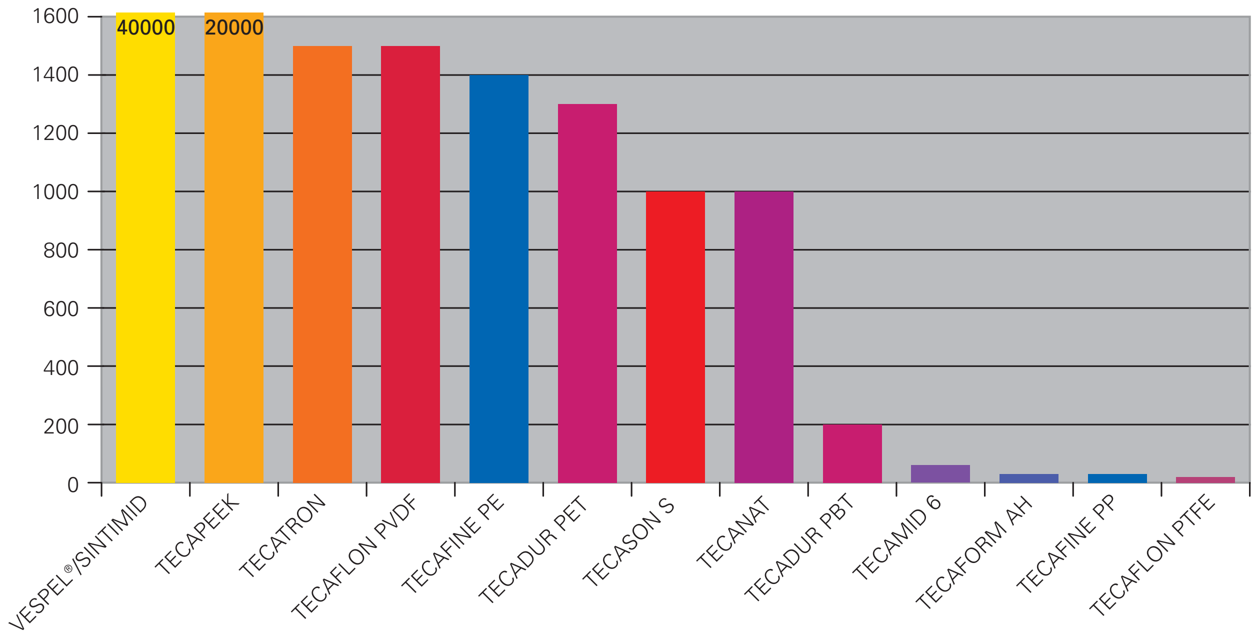
Gamma radiation resistance

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 kilograys (kGy) 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 $10^6\,\Omega$ to $10^{12}\,\Omega$ is considered to discharge static electricity. If the surface resistance is smaller than $10^6\,\Omega$, then the material is said to be electrically conducting.

Material	DIN Description	Specific volume resistance in $\Omega \cdot \text{cm}$	Surface resistance in Ω
SINTIMID PAI ESD	**PI**	10^9 - 10^{11}	10^9 - 10^{11}
TECAPEI ESD 7	**PEI**	10^6 - 10^8	10^8 - 10^{10}
TECANAT ESD 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	**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 Foodstuffs 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 fulfil 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	
				Hot steam 137 °C	Gamma radiation
TECAPEEK MT	PEEK	x	x	+	+
TECAFLON PTFE	PTFE	x		+	-
TECATRON MT	PPS		x	+	+
TECASON E	PES	x		o	+
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		-	+
TECAFORM AH MT	POM-C	x		o	-
TECAFINE PMP	PMP	x		-	+
TECAFINE PP	PP	x		-	+
TECAFINE PE	PE	x		-	+

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

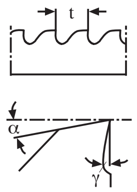
* FDA conformity and biocompatibility applies to natural materials. Pigments used are checked for their suitability according to FDA regulations.

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

Processing of Plastics

Machining guidelines

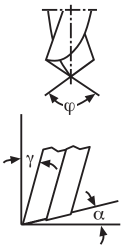
Sawing



α Clearance angle (°)
γ Rake angle (°)
V Cutting speed m/min
t Pitch mm

	TECAMID TECAST	TECAFINE PE, PP, PMP	TECAFORM AH, AD	TECADUR PET, PBT	TECANAT	TECANYL	TECAMID TR	TECARAN ABS	TECAFLON ETFE, PVDF, PTFE	TECASON S, P, E	TECAPEI	TECATRON	TECAPEEK	SINTIMID, PI	SINTIMID, TECATOR PAI	VESPEL®	Reinforced/filled ENSINGER materials*
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	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	0 - 3	10 - 15
V	500	500	500 - 800	300	300	300	300	300	300	500	500	500 - 800	500 - 800	800 - 900	800 - 900	800 - 900	200 - 300
t	3 - 8	3 - 8	2 - 5	3 - 8	3 - 8	3 - 8	3 - 8	2 - 8	2 - 5	2 - 5	2 - 5	3 - 5	3 - 5	10 - 14	10 - 14	10 - 14	3 - 5

Drilling

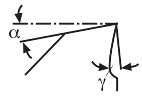


α Clearance angle (°)
γ Rake angle (°)
φ Point angle (°)
V Cutting speed m/min
S Feed mm/rev

The twist angle β of the drill bit should be approx. 12° to 16°

	TECAMID TECAST	TECAFINE PE, PP, PMP	TECAFORM AH, AD	TECADUR PET, PBT	TECANAT	TECANYL	TECAMID TR	TECARAN ABS	TECAFLON ETFE, PVDF, PTFE	TECASON S, P, E	TECAPEI	TECATRON	TECAPEEK	SINTIMID, PI	SINTIMID, TECATOR PAI	VESPEL®	Reinforced/filled ENSINGER materials*
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	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	5 - 10
φ	90	90	90	90	90	90	90	90	130	90	90	90	90	120	120	90 - 120	120
V	50 - 150	50 - 150	50 - 200	50 - 100	50 - 100	50 - 100	50 - 100	50 - 200	150 - 200	20 - 80	20 - 80	50 - 200	50 - 200	80 - 100	80 - 100	80 - 100	80 - 100
S	0,1 - 0,3	0,1 - 0,3	0,1 - 0,3	0,2 - 0,3	0,2 - 0,3	0,2 - 0,3	0,2 - 0,3	0,2 - 0,3	0,1 - 0,3	0,1 - 0,3	0,1 - 0,3	0,1 - 0,3	0,1 - 0,3	0,02 - 0,1	0,02 - 0,1	0,05 - 0,15	0,1 - 0,3

Milling

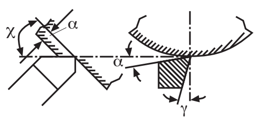


α Clearance angle (°)
γ Rake angle (°)
χ Side angle (°)
V Cutting speed m/min

The feed can be up to 0.5 mm / tooth

	TECAMID TECAST	TECAFINE PE, PP, PMP	TECAFORM AH, AD	TECADUR PET, PBT	TECANAT	TECANYL	TECAMID TR	TECARAN ABS	TECAFLON ETFE, PVDF, PTFE	TECASON S, P, E	TECAPEI	TECATRON	TECAPEEK	SINTIMID, PI	SINTIMID, TECATOR PAI	VESPEL®	Reinforced/filled ENSINGER materials*
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	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	0 - 5	6 - 10
V	250 - 500	250 - 500	250 - 500	300	300	300	300	300 - 500	250 - 500	250 - 500	250 - 500	250 - 500	250 - 500	90 - 100	90 - 100	90 - 100	80 - 100

Turning



α Clearance angle (°)
γ Rake angle (°)
χ Side angle (°)
V Cutting speed m/min
S Feed mm/rev

The nose radius r must be at least 0.5 mm

	TECAMID TECAST	TECAFINE PE, PP, PMP	TECAFORM AH, AD	TECADUR PET, PBT	TECANAT	TECANYL	TECAMID TR	TECARAN ABS	TECAFLON ETFE, PVDF, PTFE	TECASON S, P, E	TECAPEI	TECATRON	TECAPEEK	SINTIMID, PI	SINTIMID, TECATOR PAI	VESPEL®	Reinforced/filled ENSINGER materials*
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	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	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	7 - 10	45 - 60
V	250 - 500	250 - 500	300 - 600	300 - 400	300	300	300	200 - 500	150 - 500	350 - 400	350 - 400	250 - 500	250 - 500	100 - 120	100 - 120	100 - 120	150 - 200
S	0,1 - 05	0,1 - 05	0,1 - 0,4	0,2 - 0,4	0,1 - 0,5	0,1 - 0,5	0,1 - 0,5	0,2 - 0,5	0,1 - 0,3	0,1 - 0,3	0,1 - 0,3	0,1 - 0,5	0,1 - 0,5	0,05 - 0,08	0,05 - 0,08	0,05 - 0,25	0,1 - 0,5

Special measures

Heat before sawing:

from 60 mm diameter	TECAPEEK GF/PVX, TECATRON
from 80 mm diameter	TECAMID 66 GF, TECADUR PET/PBT
from 100 mm diameter	TECAMID 6 GF, 66, 66 MH

Heat before drilling in the centre:

from 60 mm diameter	TECAPEEK GF/PVX, TECATRON GF/PVX
from 80 mm diameter	TECAMID 66 MH, 66 GF, TECADUR PET/PBT
from 100 mm 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

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* Reinforcing materials/fillers: glass fibre, glass beads, carbon fibres, graphite, mica, talcum. etc.

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 120 °C before drilling (heating time approx. 1 hour per 10 mm cross-section). This method is also recommended for polyamide 66 and polyester.

4. Sawing

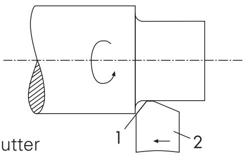
Unnecessary heat generation caused by friction must be avoided, as generally thick-walled parts are cut with relatively thin tools during sawing. Well-sharpened and strongly offset saw blades are therefore recommended.

5. Thread cutting

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

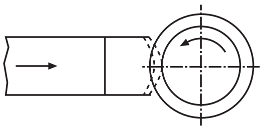
Die cutters are not recommended as re-cutting can be expected during removal of the cutter.

A machining allowance (dependent on material and diameter; guide value: 0.1 mm) must frequently be taken into account when using tap drills.



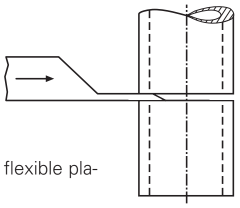
1 Secondary cutter
2 Lathe tool

Figure 1



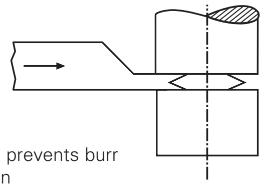
Cutting off flexible plastics

Figure 2



Parting off flexible plastics

Figure 3



Grinding prevents burr formation

Figure 4

Stress produced with a blunt drill

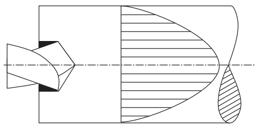


Figure 5

Stress produced with a sharp drill

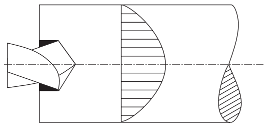


Figure 6

6. Safety precautions

Failure to observe the machining guidelines can result in localised 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 50 mm. For larger wall thicknesses please contact our technical marketing department.

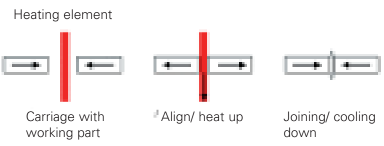
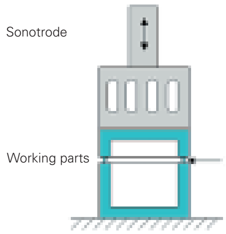
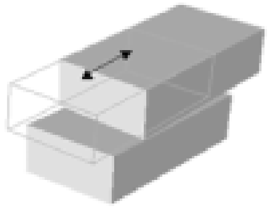
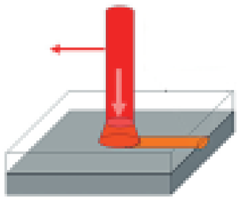
Material	DIN specification	Heating-up phase	Maintaining phase **	Cooling down phase
VESPEL®	**PI**	2 h to 160 °C 2 h to 300 °C	1 h per cm wall thickness	at 20 °C/h to 40 °C
SINTIMID	**PI**	2 h to 160 °C 6 h to 280 °C	2 h at 160 °C 10 h at 280 °C	at 20 °C/h to 40 °C
TECAPEEK	**PEEK**	3 h to 120 °C 4 h to 220 °C	1,5 h per cm wall thickness	at 20 °C/h to 40 °C
TECATRON	**PPS**	3 h to 120 °C 4 h to 220 °C	1,5 h per cm wall thickness	at 20 °C/h to 40 °C
TECASON E	**PES**	3 h to 100 °C 4 h to 200 °C	1 h per cm wall thickness	at 20 °C/h to 40 °C
TECASON P	**PPSU**	3 h to 100 °C 4 h to 200 °C	1 h per cm wall thickness	at 20 °C/h to 40 °C
TECASON S	**PSU**	3 h to 100 °C 3 h to 165 °C	1 h per cm wall thickness	at 20 °C/h to 40 °C
TECAFLON PVDF	**PVDF**	3 h to 90 °C 3 h to 150 °C	1 h per cm wall thickness	at 20 °C/h to 40 °C
TECANAT	**PC**	3 h to 80 °C 3 h to 130 °C	1 h per cm wall thickness	at 20 °C/h to 40 °C
TECADUR PET	**PET**	3 h to 100 °C 4 h to 180 °C	1 h per cm wall thickness	at 20 °C/h to 40 °C
TECADUR PBT GF 30	**PBT**	3 h to 100 °C 4 h to 180 °C	1 h per cm wall thickness	at 20 °C/h to 40 °C
TECAMID 6	**PA 6**	3 h to 90 °C 3 h to 160 °C	1 h per cm wall thickness	at 20 °C/h to 40 °C
TECAMID 66	**PA 66**	3 h to 100 °C 4 h to 180 °C	1 h per cm wall thickness	at 20 °C/h to 40 °C
TECAFORM AH	**POM-C**	3 h to 90 °C 3 h to 155 °C	1 h per cm wall thickness	at 20 °C/h to 40 °C
TECAFORM AD	**POM-H**	3 h to 90 °C 3 h to 160 °C	1 h per cm wall thickness	at 20 °C/h to 40 °C

** 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	
Advantages	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:

Panacol-Elosol GmbH
Obere Zeil 6-8
61440 Oberursel
Telephone: 06171/6202-0, Fax: 06171/6202-90
www.panacol.de

Henkel Loctite Deutschland GmbH
Arabellastrasse 17
81925 München
Telephone: 089/9268-0, Fax: 089/9101978
www.loctite.com

Dymax Europe GmbH
Trakehner Strasse 3
60487 Frankfurt
Telephone: 069/7165-3568, Fax: 069/7165-3830
www.dymax.de

DELO Industrieklebstoffe GmbH & Co. KG
Ohmstrasse 3
86899 Landsberg
Telephone: 08191/3204-0, Fax: 08191/3204-44
www.delo.de

Material	DIN Description	Solvent adhesive	Adhesive cement on the basis of			
			Epoxy resins	Polyurethane	Rubber	Cyanoacrylate
VESPEL®	**PI**		x	x	x	x
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
TECADUR 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	Tubes
VESPEL®	**PI**	6,3 mm - 82,5 mm	1,6 mm - 50,8 mm	40,6/27,9 mm - 180/142 mm
SINTIMID	**PI**	5 mm - 100 mm	5 mm - 100 mm	55/30 mm - 125/95 mm
TECAPEEK HT	**PEK**	5 mm - 150 mm	5 mm - 70 mm	
TECAPEEK	**PEEK**	5 mm - 200 mm	5 mm - 100 mm	40/25 mm - 300/200 mm
TECAPEEK GF 30	**PEEK**	5 mm - 100 mm	6 mm - 80 mm	
TECAPEEK PVX	**PEEK**	5 mm - 100 mm	5 mm - 60 mm	40/25 mm - 250/200 mm
TECAFLON PTFE	**PTFE**	4 mm - 300 mm	1 mm - 150 mm	
TECATRON	**PPS**	4 mm - 60 mm	8 mm - 50 mm	
TECATRON GF 40	**PPS**	4 mm - 60 mm	8 mm - 70 mm	
TECATRON PVX	**PPS**	4 mm - 60 mm	8 mm - 50 mm	
TECASON E	**PES**	4 mm - 150 mm	5 mm - 80 mm	
TECASON P	**PPSU**	4 mm - 150 mm	5 mm - 80 mm	
TECASON S	**PSU**	4 mm - 200 mm	5 mm - 80 mm	
TECAFLON PVDF	**PVDF**	4 mm - 300 mm	5 mm - 100 mm	
TECANAT	**PC**	4 mm - 250 mm	1 mm - 100 mm	
TECANAT GF 30	**PC**	4 mm - 180 mm	5 mm - 100 mm	
TECADUR PET	**PET**	4 mm - 200 mm	1 mm - 100 mm	25/18 mm - 300/200 mm
TECADUR PBT GF 30	**PBT**	4 mm - 150 mm	5 mm - 100 mm	
TECAST	**PA 6 G**	20 mm - 1000 mm	8 mm - 200 mm	60/30 mm - 710/500 mm
TECAST 12	**PA 12 G**	15 mm - 150 mm	8 mm - 60 mm	
TECARIM	**PA 6 G**	30 mm - 150 mm	30 mm - 100 mm	
TECAMID 6	**PA 6**	4 mm - 300 mm	1 mm - 100 mm	25/18 mm - 300/200 mm
TECAMID 66	**PA 66**	4 mm - 200 mm	5 mm - 100 mm	
TECAMID 66 GF 30	**PA 66**	4 mm - 150 mm	5 mm - 100 mm	
TECAFORM AH	**POM-C**	3 mm - 250 mm	1 mm - 100 mm	25/18 mm - 505/390 mm
TECAFORM AD	**POM-H**	3 mm - 200 mm	5 mm - 100 mm	

More materials and sizes on request.

Exclusion of liability

Our information and statements do not constitute a promise or guarantee whether these are express or inferred. They are in accordance with the present state of our knowledge and are intended to provide information about our products and the possibilities for their use. Any Information supplied is therefore not intended as a legally binding assurance or guarantee of the chemical resistance, the nature of the products or the marketable nature of the goods.

The suitability for the end use of the products are influenced by various factors such as choice of materials, additions to the material, design of shaped parts and tools, and processing or environmental conditions. Unless otherwise indicated, the measured values are guideline values which are based on laboratory tests under standardized conditions. The information provided does not, alone, form any sufficient basis for component or tool design. The decision as to the suitability of a particular material or procedure or a particular component and tool design for a specific purpose is left exclusively to the customer in question. Suitability for a specific purpose or a particular use is not assured or guaranteed on a legally binding basis, unless we have been informed in writing about the specific purpose and conditions of use and we have confirmed in writing that our product is suitable for this purpose within the conditions notified.

The nature of our products conform to statutory provisions valid in Germany at the time of the transfer of risk, in so far as these statutory provisions contain regulations regarding the nature of these products specifically. The customer must expressly point out in writing that he intends to export our products – after processing or installation if applicable – only then will we confirm the suitability for export expressly in writing. We also ensure compliance with the export regulations of the European Union, its member states, the other states who are signatory to the agreement on the European Economic Area (Norway, Iceland, Liechtenstein) and Switzerland and the USA. We are not obliged to take any steps to comply with the statutory regulations of other states.

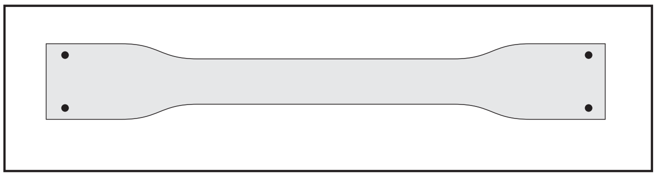
We are responsible for ensuring that our products are free from any rights or claims by third parties based on commercial or other intellectual property (patents, patented designs, registered designs, authors' rights and other rights). This obligation applies for Germany; it also applies for the other member states of the European Union and the other states who are signatory to the agreement on the European Economic Area and Switzerland and the USA. Only if the customer expressly points out to us in writing that he intends to export our products – after processing or installation if applicable - and we expressly confirm in writing that the products can be exported will we accept any liability for states other than those listed.

We reserve the right to make changes to the design or form, deviations in colour and changes to the scope of delivery or service in so far as the changes or deviations are reasonable for the customer whilst taking our interests into account.

Our products are not destined for use in medical and dental implants.

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.



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

Vespel® is registered trademark of E.J. du Pont de Nemours and Company.

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.

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

(1) When plastics are listed under „additives and colour“ as available „also in black“, the electrical properties are not valid for the black variant.
(2) Testing on semi-finished products.
(3) Expected values.
(4) Impact resistance is measured with different methods.
The values in the following tables are marked with the following letters:
(c) Charpy: DIN EN ISO 179: a_n kJ/m^2
(ai) Izod: ASTM D 256: a_n J/m
(di) Izod: DIN EN ISO 180, a_n kJ/m^2
(k) Notch impact strength: DIN EN ISO 179: a_n kJ/m^2

ENSINGER High-temperature plastics. Material standard values.

Mechanical properties

Trade name	DIN-abbreviation	Additives and/or colour	Service temperature °C long term	Density (ASTM D 792, DIN EN ISO 1183) ρ g/cm^3	Tensile strength at yield (ASTM D 638, DIN EN ISO 527) σ_S MPa	Tensile strength at break (ASTM D 638, DIN EN ISO 527, ASTM D 1708 (a)) σ_R MPa	Elongation at break (ASTM D 638, DIN EN ISO 527, ASTM D 1708 (a)) ε_R %	Modulus of elasticity after tensile test (ASTM D 638, DIN EN ISO 527) E_Z MPa	Modulus of elasticity after flexural test (ASTM D 790, DIN EN ISO 178) E_B MPa	Hardness (ball indentation: ISO 2039/1, Shore D: ASTM D 2240, DIN 53 505 (d), Rockwell: ASTM D 785, ISO 2039/2 (r), others: ASTM D 785 (a), DIN 43 456 (s)) H_K MPa	Impact resistance see footnote 4) on page 19	Creep rupture strength after 1000 h with static load $\sigma_{B/1000}$ MPa	Time yield limit for 1% elongation after 1000 h $\sigma_{1/1000}$ MPa	Coefficient of friction p = 0,05N/mm² v = 0,6 m/s on steel, hardened and ground μ –	Wear (conditions as previous) V μ/km	Trade name
VESPEL® SP1	PI	brown	300	1,43		86 (a)	7,5 (a)	3275	3100					0,35		**VESPEL® SP1**
VESPEL® SP21	PI CS 15	black	300	1,51		66 (a)	4,5 (a)		3790					0,30		**VESPEL® SP21**
VESPEL® SP3	PI	molybdenum disulphide anthracite,	300	1,6		59 (a)	4 (a)		3280							**VESPEL® SP3**
SINTIMID PUR HT	PI	black	300	1,35		116	9	4000	4000		75(c)		12	0,8		**SINTIMID PUR HT**
SINTIMID 15 G	PI CS 15	15% graphite, black	300	1,42		97	2,8	4000	4000	88(d)	26(ai)			0,27		**SINTIMID 15 G**
SINTIMID 30 P	PI TF 30	30% PTFE	260	1,51		82	4,1			84(d)	23(ai)			0,45		**SINTIMID 30 P**
SINTIMID 8000	PTFE + PI	Polyimid P84, brown	250	1,85		15	200			65(d)	o. Br.(c)			0,15-0,2		**SINTIMID 8000**
SINTIMID PAI ESD	PAI	black	300	1,54	85		4	4500		93(d)	21(ai)					**SINTIMID PAI ESD**
SINTIMID PAI PUR	PAI	brown	300	1,38	110		5,5	4500	4240	91(d)	23(ai)					**SINTIMID PAI PUR**
TECATOR	PAI	yellow/brown	260	1,42	192		15	4900	5000	E 86						**TECATOR**
TECATOR PVX 1	PAI CS 12 TF 3	PTFE, graphite, black	260	1,46		164	7	6600	6900	E 72						**TECATOR PVX 1**
TECAPEEK HT	PEK		260	1,32	110		20	3800	4100	108(r)	52 (ai)					**TECAPEEK HT**
TECAPEEK CLASSIX(TM)	PEEK	white	260	1,38	95		>25		4200		7,6 (d)					**TECAPEEK CLASSIX(TM)**
TECAPEEK	PEEK	also black(1)	260	1,30	95		25	3000	4100	M99	o. Br.(c)			0,30-0,38		**TECAPEEK**
TECAPEEK GF 30	PEEK GF 30	30% glass fibre	260	1,51		180	2,5	9500	10000	M103	60(c)	36		0,38-0,46		**TECAPEEK GF 30**
TECAPEEK CF 30	PEEK CF 30	30% carbon fibre, black	260	1,40		215	1,5	18500	20000	255(2)	35(c)					**TECAPEEK CF 30**
TECAPEEK PVX	PEEK	10% carbon fibre, graphite, PTFE, black	260	1,48		130	1,5	9500	8100	208(2)	30(c)			0,11		**TECAPEET PVX**
TECAPEEK MT	PEEK	coloured also black(1)	260	1,30	95		20	3000	4100	M99(r)	o. Br.(c)			0,30-0,38		**TECAPEEK MT**
TECAPEEK ELS	PEEK CF	carbon fibre, black	260	1,44		175	1	15500		M105	30(c)					**TECAPEEK ELS**
TECAPEEK TF 10	PEEK TF 10	PTFE	260	1,35	80		15	3000			o. Br.(c)					**TECAPEEK TF 10**
TECATRON	PPS		230	1,35	75		4	3700	3600	190	50(c)					**TECATRON**
TECATRON MT sw	PPS	black	230	1,35	75		4	3700	3600	190	50(c)					**TECATRON MT sw**
TECATRON GF 40	PPS GF 40	40% glass fibre	230	1,64		185	1,9	14000	13000	320	45(c)					**TECATRON GF 40**
TECATRON PVX	PPS	10% carbon fibre, graphite, PTFE, black	230	1,47		115	1,5	10000		203(2)	20(c)			0,21	0,69	**TECATRON PVX**
TECATRON LAM VF	PPS		230	1,35	90		8	1900								**TECATRON LAM VF**
TECATRON GF 15 VF	PPS	15% glass fibre	230	1,44		120	2	7700	7500		32(c)					**TECATRON GF 15 VF**
TECATRON GF 30 VF	PPS	30% glass fibre	230	1,58		160	2	11000								**TECATRON GF 30 VF**
TECATRON GF 40 VF	PPS	40% glass fibre	230	1,65		185	1,9	14000	14000	320	45(c)					**TECATRON GF 40 VF**
TECASON S	PSU	translucent	160	1,24	80	6	> 50	2600		147	o. Br.(c)	42	22	0,4		**TECASON S**
TECASON S GF 30	PSU GF 30	30% glass fibre	160	1,49		125	1,8	9900		202	20 (di)					**TECASON S GF 30**
TECASON E	PES	translucent	180	1,37	90	6	6,5	2700		148	o. Br.(c)		20			**TECASON E**
TECASON E GF 30	PES		180	1,60		140	2,0	10200		221	35(c)					**TECASON E GF 30**
TECASON P, P MT	PPSU	coloured	170	1,29	70		> 50	2350	2600							**TECASON P, P MT**
TECASON P VF	PPSU		170	1,29	70		> 50	2350	2600							**TECASON P VF**
TECAPEI TECAPEI MT	PEI	translucent, coloured	170	1,27	105		> 50	3200	3300	140	4(c)					**TECAPEI TECAPEI MT**
TECAPEI GF 30	PEI GF 30	30% glass fibre	170	1,51		165	2	9500	9000	165	40(c)					**TECAPEI GF 30**
TECAPEI ESD 7	PEI ESD 7	black	170	1,26		65	4	2760	2920	123 (r)	7,5 (ai)					**TECAPEI ESD 7**

	Thermal properties								Electrical properties**						Miscellaneous data					
	Melting point (DIN 53 736)	Glass transition temperature (DIN 53 736)	Heat distortion temperature (ISO-R 75, method A (DIN 53 461))	Heat distortion temperature (ISO-R 75, method B (DIN 53 461))	Maximum service temperature short term	Thermal conductivity (23°C)	Specific heat (23°C)	Coefficient of linear thermal expansion (23°C, ASTM D 696, DIN 53 752, ASTM E 831)	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)	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, IEC-243, VDE 0303 part 2)	Resistance to tracking (DIN 53 480, VDE 0303 part 1)	Moisture absorption to equilibrium 23 °C/50% relative 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**	
Trade name	T_m °C	T_g °C	HDT/A °C	HDT/B °C	°C	λ W/(K·m)	c J/(g·K)	α 10^{-5} 1/K	ε_r –	tan δ –	ρ_D Ω · cm	R_O Ω	E_d kV/mm	Grade	$W(H_2O)$ %	W_S %	–	–	–	**Trade name**
VESPEL® SP1			360	360	360	0,35	1,13	5,4	3,55	0,0034	10^{14} - 10^{15}	10^{15} - 10^{16}	22		1,3			V0		**VESPEL® SP1**
VESPEL® SP21			360	360	360	0,87		4,9	13,4	0,01	10^{12} - 10^{13}		9,84		1,1			V0		**VESPEL® SP21**
VESPEL® SP3																				**VESPEL® SP3**
SINTIMID PUR HT		360-375	368		350	0,22	1,04	4,4	3,1	0,003	10^{17}	10^{16}	20		2,6	3,6	(+)	V0	(+)	**SINTIMID PUR HT**
SINTIMID 15 G		330	300		350	0,53	1,13	3,8				10^{7}			2,3		(+)	V0	+	**SINTIMID 15 G**
SINTIMID 30 P		330			350			5			10^{17}	10^{16}								**SINTIMID 30P**
SINTIMID 8000	327	-20			260	0,25	1	6	2,3		10^{18}				0,5	0,7	(+)	V0	+	**SINTIMID 8000**
SINTIMID PAI ESD		340			320			3,3			10^{9}-10^{11}	10^{9}-10^{11}				2,1	(+)	V0	(+)	**SINTIMID PAI ESD**
SINTIMID PAI PUR		340			300			4,8								3		V0		**SINTIMID PAI PUR**
TECATOR		285	278		270	0,26		3,1	3,9	0,031	> 10^{15}	> 10^{18}	23,6		2,5	4,5	+	V0	-	**TECATOR**
TECATOR PVX 1		285	279		270	0,54		2,5							1,9	3,5	+	V0	+	**TECATOR PVX 1**
TECAPEEK HT	374	157	165					5,7	3,3	0,0035	10^{16}							V0	-	**TECAPEEK HT**
TECAPEEK CLASSIX(TM)		143			300															**TECAPEEK CLASSIX(TM)**
TECAPEEK	343	143	140	182	300	0,25	0,32	5,0	3,2-3,3	0,001-0,004	10^{16}	10^{15}	20		0,1	0,5	+	V0	-	**TECAPEEK**
TECAPEEK GF 30	343	143	315		300	0,43		2,0		0,004	10^{15}	10^{15}	24,5		0,1	0,1	+	V0	-	**TECAPEEK GF 30**
TECAPEEK CF 30	343	143	315		300	0,92		1,5(2)			10^{5}-10^{7}(2)	10^{5}-10^{7}(2)			0,1	0,1	+	V0	+	**TECAPEEK CF 30**
TECAPEEK PVX	343	143	277		300	0,24		2,2			$3x10^{6}$	$5x10^{6}$			0,1	0,1	+	V0	+	**TECAPEEK PVX**
TECAPEEK MT	343	143	140	182	300	0,25	0,32	5,0	3,2-3,3	0,001-0,004	10^{16}	10^{15}	20		0,1	0,5	+	V0	-	**TECAPEEK MT**
TECAPEEK ELS	343	143			300	0,9		1,5			10^{2}-10^{4}	10^{1}-10^{3}			0,1	0,2	+	V0	+	**TECAPEEK ELS**
TECAPEEK TF 10	300	143			300										0,1		+	V0	-	**TECAPEEK TF 10**
TECATRON	280	90	110		260	0,25		5			10^{13}	10^{15}			0,01		+	V0	-	**TECATRON**
TECATRON MT sw	280	90	110		260	0,25		5			10^{13}	10^{15}			0,01		+	V0	+	**TECATRON MT sw**
TECATRON GF 40	280	90	260		260	0,25	1,18	ca. 3	4	0,004	10^{13}	10^{15}	20	KC 175	0,02	1	+	V0	-	**TECATRON GF 40**
TECATRON PVX	280	90			260			3-4(2)			$4x10^{5}$(2)	$1x10^{6}$(2)			0,02		+	V0	+	**TECATRON PVX**
TECATRON LAM VF	280	87	110		260	0,25		5			10^{13}	10^{15}			0,01			V0		**TECATRON LAM VF**
TECATRON GF 15 VF	280	90	220	115								10^{15}			0,02			V0		**TECATRON GF 15 VF**
TECATRON GF 30 VF	280	90	255								10^{15}	10^{15}			0,02			V0		**TECATRON GF 30 VF**
TECATRON GF 40 VF	280	90	260		260	0,25	1,18	ca. 3	4	0,004	10^{13}	10^{15}	20	KC 175	0,02			V0		**TECATRON GF 40 VF**
TECASON S		180	169	181	180	0,25	1	5,5	3,1	0,005	10^{16}	10^{14}	42	KA 1 KB 175	0,2	0,8	+	V0	-	**TECASON S**
TECASON S GF 30		188	183	186	180			2,1	3,7	0,006	10^{16}	10^{14}	>60		0,1	0,5	+	V0	-	**TECASON S GF 30**
TECASON E		225	204	214	220	0,18	1,12	5,5	3,5	0,005	10^{16}	10^{14}	40		0,7	2,1	+	V0	-	**TECASON E**
TECASON E GF 30		225	212	215	220			2,1	4	0,004	10^{16}	10^{14}	20	KB 200 KC 175	0,5	1,5	+	V0		**TECASON E GF 30**
TECASON P, P MT		220	207	214	190	0,35		5,6	3,45		10^{15}	10^{13}	15		0,37	1,1	+	V0	+	**TECASON P, P MT**
TECASON P VF		220	207	214	190	0,35		5,6	3,45		10^{15}	10^{13}	15		0,37			V0		**TECASON P VF**
TECAPEI TECAPEI MT		217	180	200	200	0,22		5	3,15	0,001	10^{15}	10^{15}	33		0,7	1,25	+	V0	-	**TECAPEI TECAPEI MT**
TECAPEI GF 30		217	210	215	200	0,23		2	3,7	0,007	10^{15}	10^{15}	30		0,5	0,9	+	V0	-	**TECAPEI GF 30**
TECAPEI ESD 7		215	190		200	0,25		5,2			10^{6}- 10^{8}	10^{8}- 10^{10}				0,25		V0	+	**TECAPEI ESD 7**

ENSINGER High-temperature plastics. Material standard values.

Mechanical properties

Trade name	DIN-abbreviation	Additives and/or colour	Service temperature °C long term	Density (ASTM D 792, DIN EN ISO 1183) ρ g/cm³	Tensile strength at yield (ASTM D 638, DIN EN ISO 527) σ_S MPa	Tensile strength at break (ASTM D 638, DIN EN ISO 527, ASTM D 1708 (a)) σ_R MPa	Elongation at break (ASTM D 638, DIN EN ISO 527, ASTM D 1708 (a)) ε_R %	Modulus of elasticity after tensile test (ASTM D 638, DIN EN ISO 527) E_Z MPa	Modulus of elasticity after flexural test (ASTM D 790, DIN EN ISO 178) E_B MPa	Hardness (ball indentation: ISO 2039/1, Shore D: ASTM D 2240, DIN 53 505 (d), Rockwell: ASTM D 785, ISO 2039/2 (r), others: ASTM D 785 (a), DIN 43 456 (s)) H_K MPa	Impact resistance see footnote 4) on page 19	Creep rupture strength after 1000 h with static load $\sigma_{B/1000}$ MPa	Time yield limit for 1% elongation after 1000 h $\sigma_{1/1000}$ MPa	Coefficient of friction p = 0,05N/mm² v = 0,6 m/s on steel, hardened and ground μ –	Wear (conditions as previous) V μ/km	Trade name
TECAMAX SRP	PPP		140(3)	1,21	207			8300	8300	80B (r)	41,9(ai)					**TECAMAX SRP**
TECAFLON PTFE	PTFE	natural	260	2,18	25		> 50	700		30	o. Br.(c)	5	1,58	0,08-0,10	21	**TECAFLON PTFE**
TECAFLON PTFE TFM	PTFE		260	2,18	25		> 50		700	30	o. Br.(c)	5	1,58	0,08-0,10	21	**TECAFLON PTFE TFM**
TECAFLON PFA	PFA		260	2,18	20		300		600	28	o. Br.(c)			0,20-0,30		**TECAFLON PFA**
TECAFLON ETFE	E/TFE		150	1,73	45		40	800		60(d)	o. Br.(c)			0,4		**TECAFLON ETFE**
TECAFLON ETFE GF 25	E/TFE GF 25	25% glass fibre	150	1,86		82	8	8250								**TECAFLON ETFE GF 25**
TECAFLON PVDF	PVDF		150	1,78	50		> 30	2000	2000	80	o. Br.(c)	34	3	0,3		**TECAFLON PVDF**
TECAFLON PVDF CF 8	PVDF CF 8	8% carbon fibre, black	150	1,78		93	1	6000	6000					0,23		**TECAFLON PVDF CF 8**
TECAFLON PVDF AS	PVDF	conductive carbon black, black	150	1,83	55	43	25	4200	4500	82 (d)	60 (ai)			0,23		**TECAFLON PVDF AS**
TECAFLON ECTFE	E/CTFE		150	1,68	15	32	200	1700	1700	50						**TECAFLON ECTFE**
TECAFLON PCTFE	PCTFE	natural	150	2,09		35	> 50	1400		70	o. Br.(c)			0,35		**TECAFLON PCTFE**
TECAMID PPA GF 33	PPA GF 33	33% glass fibre	160	1,43		193*	2,5		11400*		41*(c)					**TECAMID PPA GF 33**
TECAMID 46	PA 46		130	1,18	100/ 65*		40/280*	3300/ 1200*		90 (d)	o. Br.(c)			0,20-0,45		**TECAMID 46**
TECAMID 46 GF 30	PA 46 GF 30	30% glass fibre	140	1,41		210/ 120*	4/8*	10000/ 4500*		90 (d)	80(c)					**TECAMID 46 GF 30**
TECAMID 66/X GF 50 sw	PA 66 + PA 63/ 6T	50% glass fibre, partly aromatic,black	130	1,56		210	3	17000			85(c)					**TECAMID 66/X GF 50 sw**
TECAMID 66	PA 66		100	1,14	80/60*		40/150*	3100/ 2000*	2830	170/ 100*	o. Br.(c)	55	8	0,35-0,42	0,9	**TECAMID 66**
TECAMID 66 HI	PA 66	heat stabilizer, brown	115	1,14	80/60*		50/150*	2700/ 1600*		170/ 100*	o. Br.(c)		6			**TECAMID 66 HI**
TECAMID 66 GF 30	PA 66 GF 30	30% glass fibre, black	110	1,35		160/ 140*	3/5*	8000/ 7500*		175(2)	70(c)		40	0,45-0,5		**TECAMID 66 GF 30**
TECAMID 66 CF 20	PA 66 CF 20	20% carbon fibre, black	110	1,23		190/ 150*	2,5/6*	13000/ 10000*		187/ 200*(2)	45(c)			0,16-0,2	0,7	**TECAMID 66 CF 20**
TECAMID SF 20	PA 66 SF 20	20% aramid, black	110	1,2		100/83*	3/7,5*	3500	4800/ 3100*		50 / 70*(c)			0,39		**TECAMID SF 20**
TECAMID 66 LA	PA 66	with lubricant	90	1,11	60/50*		10/40*	2000/ 1600*		117/ 100(2)	50(c)		3	0,18-0,20	0,08	**TECAMID 66 LA**
TECAMID 66 MH	PA 66	black, molybdenum disulphide	100	1,14	75		> 25	2500		107(2)	o. Br.(c)		8,5	0,20-0,25	0,08	**TECAMID 66 MH**
TECAST 12	PA 12 G		110	1,03	54	40	> 100	1800			o. Br.(c)					**TECAST 12**
TECAST HI	PA 6 G	heat stabilizer, brown	115	1,15	80/60*		5/50*	4000/ 3300*		170						**TECAST HI**
TECAST ST	PA 6 G	Toughness modifier	100	1,15	50		50/70*	2000		95						**TECAST ST**
TECAST R	PA 6 G		100	1,15	85/60*		5/50*	4000/ 3300*		170						**TECAST R**
TECAST T	PA 6 G		100	1,15	85/60*		3/50*	3300/ 1700*		90/ 160	o. Br.(c)	50	5	0,4		**TECAST T**
TECAST M	PA 6 G	MoS_2, anthracite	100	1,15	90		5/30*	3500		175						**TECAST M**
TECAST TM	PA 6 G	MoS_2, anthracite	100	1,15	75		40/60*	2800		145						**TECAST TM**
TECAST L	PA 6 G	natural	100	1,15	70		20/40*	2500		125						**TECAST L**
TECARIM 1500	PA 6 G	15% elastomer, natural	95	1,12	54/44*		90/320*	2100/ 900*	2280/ 1100*	77/ 73* (d)	20/42* (k)					**TECARIM 1500**
TECARIM 4000	PA 6 G	40% elastomer, natural	95	1,13	26/22*		420/ 420*	450/ 230*	500/ 240*	59/52* (d)						**TECARIM 4000**
TECAM 6 MO	PA 6	MoS_2, black	100	1,14	75		> 25	2700		107/ 85*(2)	o. Br.(c)		5	0,32-0,37	0,16	**TECAM 6 MO**
TECAMID 6	PA 6		100	1,13	85/60*		70/ 200*	3000/ 1800*		160/ 70*	o. Br.(c)	45	4,5	0,38-0,45	0,23	**TECAMID 6**
TECAMID 6 GF 30	PA 6 GF 30	30% glass fibre, black	100	1,35		140/ 110*	2,5/5*	8500/ 6000*		147(2)	55(c)		21-35	0,46-0,52		**TECAMID 6 GF 30**
TECAMID 6 VF	PA 6		140	1,20	105/60*	105/ 55*	5/19*	5400*/ 2500	4200*/ 210	140	70/ 105*(c)					**TECAMID 6 VF**

	Thermal properties								Electrical properties**						Miscellaneous data					
Trade name	Melting point (DIN 53 736) T_m °C	Glass transition temperature (DIN 53 736) T_g °C	Heat distortion temperature (ISO-R 75, method A (DIN 53 461)) HDT/A °C	Heat distortion temperature (ISO-R 75, method B (DIN 53 461)) HDT/B °C	Maximum service temperature short term °C	Thermal conductivity (23°C) λ W/(K·m)	Specific heat (23°C) c J/(g·K)	Coefficient of linear thermal expansion (23°C, ASTM D 696, DIN 53 752, ASTM E 831) α 10^{-5} 1/K	Dielectric constant (10^6 Hz, ASTM D 150, DIN 53 483, IE-250) ε_r –	Dielectric loss factor (10^6 Hz, ASTM D 150, DIN 53 483, IE-250) tan δ –	Volume resistance (ASTM D 257, EC 93, DIN IEC 60093) ρ_D Ω · cm	Surface resistance (ASTM D 257, EC 93, DIN IEC 60093) R_O Ω	Dielectric strength (ASTM D 149, IEC-243, VDE 0303 part 2) E_d kV/mm	Resistance to tracking (DIN 53 480, VDE 0303 part 1) Grade	Moisture absorption to equilibrium 23 °C/50% relative humidity (DIN EN ISO 62) W(H_2O) %	Water absorption at saturation (DIN EN ISO 62) W_S %	Resistance to hot water, washing soda –	Flammability acc. to UL standard 94 –	Resistance to weathering** –	Trade name
TECAMAX SRP		155	152		150			3-4		3,1	6x10^{15}	2x10^{16}	6,44	CTI 150	0,5	0,5		V0		**TECAMAX SRP**
TECAFLON PTFE	327	-20	55	121	260	0,25	1	12	2,1	0,0002	10^{16}	10^{16}	48	KA 3c KB>600	< 0,05		+	V0	+	**TECAFLON PTFE**
TECAFLON PTFE TFM	327	-20	55	121	260	0,25		12	2,1	0,0002	10^{18}		48				+	V0	+	**TECAFLON PTFE TFM**
TECAFLON PFA	305		48	74	260	0,25	1,12	13	2,04	0,0002	10^{18}		55	KA 3c KB>600	0,03		+	V0	+	**TECAFLON PFA**
TECAFLON ETFE	267	-100	71	105	150	0,24	0,9	13	2,6	0,001	>10^{16}	> 10^{16}	40		<0,05	0,03	+	V0	+	**TECAFLON ETFE**
TECAFLON ETFE GF 25	270	-100			200	0,21	1,7	3,4		0,005	10^{16}	10^{15}				0,02	+	V0	+	**TECAFLON ETFE GF 25**
TECAFLON PVDF	172	-18	95	140	150	0,11	1,2	13	8	0,06	10^{14}	10^{13}	40	KA 1	<0,05	<0,05	+	V0	+	**TECAFLON PVDF**
TECAFLON PVDF CF 8	172	-18			150			3,6			10^{3}-10^{5}	10^{5}-10^{7}			0,04		+	V0	+	**TECAFLON PVDF CF 8**
TECAFLON PVDF AS	174	-30			150			1,2-1,4			10^{2}-10^{4}	10^{2}-10^{4}			0,07		+	V0	+	**TECAFLON PVDF AS**
TECAFLON ECTFE	240				180	0,13		5	2,5	0,009	10^{15}	10^{15}	40			0,1	+	V0	+	**TECAFLON ECTFE**
TECAFLON PCTFE	216	52		126	180	0,24	0,9	6,5	2,5	0,02	10^{16}	10^{16}	55-81	KA 3c KB>600	< 0,05		+	VO	+	**TECAFLON PCTFE**
TECAMID PPA GF 33	312	126	285	297	180			2,4-6	4,2	0,017	10^{16}		21,6				(+)	HB	-	**TECAMID PPA GF 33**
TECAMID 46	295	75	160		220	0,3	2,1	8	9,4 -1,1	0,21 0,35	10^{15}	10^{16}	> 20	KC>425	3,7	14	(+)	V2	-	**TECAMID 46**
TECAMID 46 GF 30	295	75			220	0,33	1,7	2	4,1	0,013	10^{14}	10^{16}	20		2,6	10	(+)	HB	-	**TECAMID 46 GF 30**
TECAMID 66/X GF 50 sw	260				200			1,5			10^{12}	10^{13}			1,3		(+)		+	**TECAMID 66/X GF 50 sw**
TECAMID 66	260	72/5*	100	>200	170	0,23	1,7	8	3,6-5	0 026- 0,200	10^{12}	10^{10}	28*/ 30	CTI 600	2,8	8,5	(+)	HB	-	**TECAMID 66**
TECAMID 66 HI	260	72/5*	100	200	180	0,23	1,7	8	3,2-5	0,025- 0,2	10^{12}	10^{10}	80*/100	KB>600 KC>600	2,8	8,5	(+)	HB	-	**TECAMID 66 HI**
TECAMID 66 GF 30	260	72/5*	250	250	170	0,27	1,5	2-3(2)			8x10^{13}(2)	6x10^{13}(2)			1,5	5,5	(+)	HB	+	**TECAMID 66 GF 30**
TECAMID 66 CF 20	260	72/5*	245	250	170	0,43	1,8	5,5(2)			10^{2}-10^{4}(2)	10^{2}-10^{4}(2)			2,2	6,5	(+)	HB	+	**TECAMID 66 CF 20**
TECAMID SF 20	260	72/5*	222	250	170			4			10^{15}	10^{13}			2,2	6-7	(+)	HB	+	**TECAMID SF 20**
TECAMID 66 LA	260	72/5*	85	185	120	0,23	1,7	15(2)	3,3	0,015	6x10^{13}(2)	10^{14}(2)	80*/120	CT>600	2,5	7,5	(+)	HB	-	**TECAMID 66 LA**
TECAMID 66 MH	260	72/5*	105	>200	170	0,23	1,8	12(2)			7*10^{13}(2)	5*10^{13}(2)			2,6	7	(+)	HB	+	**TECAMID 66 MH**
TECAST 12	175			122	155												(+)	HB	-	**TECAST 12**
TECAST HI	220	40/5*			180			8	3,7	0,03		5x10^{12}	50		2,5	7	(+)	HB	-	**TECAST HI**
TECAST ST	220	40/5*			150	0,24		10								5,0-6	(+)	HB	-	**TECAST ST**
TECAST R	220	40/5*			180	0,24		8							2,5	6,0-7	(+)	HB	-	**TECAST R**
TECAST T	220	40/5*	95	195	180	0,24	1,7	6	3,7	0,03- 0,30	10^{12} - 5x10^{14}	5x10^{12}	50	KA 3c KA 3b	2,5	6,0-7	(+)	HB	-	**TECAST T**
TECAST M	220	40/5*			180			8,5								6-7	(+)	HB	+	**TECAST M**
TECAST TM	210	40/5*			170			9,5							2,5	6	(+)	HB	+	**TECAST TM**
TECAST L	220	40/5*			180			9								6	(+)	HB	-	**TECAST L**
TECARIM 1500	214				160			ca. 7-8	4,2	0,1	5*10^{9}	4*10^{8}		500	2,5		(+)	HB		**TECARIM 1500**
TECARIM 4000	214							ca. 7-8	4,8	0,1	2*10^{9}	2*10^{8}		600	1,6		(+)	HB		**TECARIM 4000**
TECAM 6 MO	220	40	100	195	160	0,23	1,7	18(2)			6x10^{13}(2)	3x10^{13}(2)			3	8-9	(+)	HB	+	**TECAM 6 MO**
TECAMID 6	220	60/5*	75	190	160	0,23	1,7	8	3,7-7	0,031- 0,3	10^{13}	10^{12}	20*/50	CTI 600	3	9,5	(+)	HB		**TECAMID 6**
TECAMID 6 GF 30	220	60/5*	210	220	180	0,28	1,5	2-3(2)			9x10^{13}(2)	5x10^{13}(2)			2,1	6,6	(+)	HB	+	**TECAMID 6 GF 30**
TECAMID 6 VF	222		170	205				4										HB		**TECAMID 6 VF**

ENSINGER Engineering plastics. Material standard values.

Mechanical properties

Trade name	DIN-abbreviation	Additives and/or colour	Service temperature °C long term	Density (ASTM D 792, DIN EN ISO 1183) ρ g/cm³	Tensile strength at yield (ASTM D 638, DIN EN ISO 527) σ_S MPa	Tensile strength at break (ASTM D 638, DIN EN ISO 527, ASTM D 1708 (a)) σ_R MPa	Elongation at break (ASTM D 638, DIN EN ISO 527, ASTM D 1708 (a)) ε_R %	Modulus of elasticity after tensile test (ASTM D 638, DIN EN ISO 527) E_Z MPa	Modulus of elasticity after flexural test (ASTM D 790, DIN EN ISO 178) E_B MPa	Hardness (ball indentation: ISO 2039/1, Shore D: ASTM D 2240, DIN 53 505 (d), Rockwell: ASTM D 785, ISO 2039/2 (r), others: ASTM D 785 (a), DIN 43 456 (si)) H_K MPa	Impact resistance see footnote 4) on page 19	Creep rupture strength after 1000 h with static load $\sigma_{B/1000}$ MPa	Time yield limit for 1% elongation after 1000 h $\sigma_{1/1000}$ MPa	Coefficient of friction p = 0,05N/mm² v = 0,6 m/s on steel, hardened and ground μ –	Wear (conditions as previous) V μ/km	Trade name
TECAMID TR	PA 6-3-T	transparent	100	1,12	90		> 50	2800		100	o. Br.(c)	50	12			**TECAMID TR**
TECAMID 12	PA 12	natural	100	1,02	40		240	1200		72 (d)	o. Br.(c)	23	3,5	0,32-0,38	0,8	**TECAMID 12**
TECAMID 12 GF 30	PA 12 GF 30	30% glass fibre	100	1,24		105	6	5900		113R (r)	70(c)		28			**TECAMID 12 GF 30**
TECAMID 11	PA 11		80	1,04	40/42*		230/ 280*	1000		90	o. Br.(c)	23	3,5	0,32-0,38	0,8	**TECAMID 11**
TECAMID 11 GF 30	PA 11 GF 30	30% glass fibre	80	1,26		100/95*	6/4*	5000	3200	115 R (r)	70(c)		28			**TECAMID 11 GF 30**
TECANAT HT	PC-HT	transparent	140	1,15	65		7	2300	2200	115	o. Br.(c)					**TECANAT HT**
TECANAT	PC	transparent	120	1,20	60			2300		100	o. Br.(c)	48	18	0,52-0,58	22	**TECANAT**
TECANAT GF 30	PC GF 30	30% glass fibre	120	1,42		130	2,5	7500		148(2)	55(c)	>50				**TECANAT GF 30**
TECANAT ESD 7	PC		120	1,22		62	8	2290	2340		6,4 (ai)					**TECANAT ESD 7**
TECAFINE PMP	PMP	transparent	120	0,83		15			1500		o. Br.(c)	85				**TECAFINE PMP**
TECADUR PET	PET	natural, also black(1)	110	1,37	80			2800		95	o. Br.(c)	36	13	0,25	0,35	**TECADUR PET**
TECAPET	PET	natural, also black(1)	110	1,37	88			3200		95	40(c)		13	0,25	0,35	**TECAPET**
TECAPET TF	PET		110	1,44	73			2900			40(c)			0,1		**TECAPET TF**
TECADUR PBT	PBT	natural	110	1,31	55			2500		125	o. Br.(c)	36	12	0,24	0,2	**TECADUR PBT**
TECADUR PBT GF 30	PBT GF 30	30% glass fibre light grey	110	1,53		135	2,5	10000		190	60(c)		57	0,24		**TECADUR PBT GF 30**
TECAFORM AH	POM-C	natural	100	1,41	62		30	2700		145	o. Br.(c)	40	13	0,32	8,9	**TECAFORM AH**
TECAFORM AH GF 25	POM-C GF 25	25% glass fibre	100	1,58		130	3	9000		195	40(c)					**TECAFORM AH GF 25**
TECAFORM AH LA	POM-C	solid lubricant	100	1,35	45	25		1600	2100	90(2)	> 40(c)			~0,2		**TECAFORM AH LA**
TECAFORM AH ELS	POM-C	conductive carbon black, black	100	1,45	50		15	2000		M97(r)	>1000(di)					**TECAFORM AH ELS**
TECAFORM AH SD	POM-C	beige	100	1,33	45		> 25	1400	1450		100 (ai)			0,18		**TECAFORM AH SD**
TECAFORM AH TF 10	POM-C	natural	100	1,44	50		12	2300		81(d)	o.Br.(c)					**TECAFORM AH TF 10**
TECAFORM AH MT farbig	POM-C	also black**	100	1,41	55		30	2100		145	o. Br.(c)	40	13	0,32	8,9	**TECAFORM AH MT farbig**
TECAFORM AD	POM-H	natural	110	1,42	70		25	3000	2620	170	o. Br.(c)	40	13	0,34	4,6	**TECAFORM AD**
TECAFORM AD AF	POM-H	PTFE, brown	110	1,54	50		10	2900	2410		40(c)			0,14		**TECAFORM AD AF**
TECAFORM AD GF 20	POM-H GF 20	20% glass fibre	110	1,56	5	5	10	6000			40(c)		28	0,35		**TECAFORM AD GF 20**
TECAFORM AD CL	POM-H	lubricant	100	1,42	70	20	3100	2760		M92(r)	o. Br.(c)			0,1		**TECAFORM AD CL**
TECAPRO MT			100	0,92	35				1470	100(r)	0,69(ai)					**TECAPRO MT**
TECAFINE PP	PP	also black** and grey	100	0,91	30		> 50	1600		80	o. Br.(c)	22	4	0,3	11	**TECAFINE PP**
TECAFINE PP ELS	PP	conductive carbon, black	100	0,95		25	4	1300		75	30(c)					**TECAFINE PP ELS**
TECAFINE PP GF 30	PP GF30	30% glass fibre	100	1,14		85	3	5500		110	40(c)			0,5	8,4	**TECAFINE PP GF 30**
TECAFINE PE 10	PE-UHMW	natural	90	0,93	17	40	> 50	650	800	35	o. Br.(c)			0,29		**TECAFINE PE 10**
TECAFINE PE 5	PE-HMW	natural	90	0,95	25	40	> 50	1100	900	52	o. Br.(c)			0,29		**TECAFINE PE 5**
TECAFINE PE	PE-HD	also black**	90	0,96	25			1000	1000	50	o. Br.(c)	12,5	3	0,29		**TECAFINE PE**
TECACRYL	PMMA	transparent	100	1,18	60		3-8	3000		180	18(c)					**TECACRYL**
TECARAN ABS	ABS	grey	75	1,06	50			2400		85	o. Br.(c)	28	17	0,5	8,4	**TECARAN ABS**
TECANYL	PPE	grey	85	1,06	55			2300		125	o. Br.(c)		21	0,4	90	**TECANYL**
TECANYL GF 30	PPE GF 30	30% glass fibre, beige	85	1,29		105	2	8000			30(c)		47			**TECANYL GF 30**

	Thermal properties								Electrical properties**						Miscellaneous data					
Trade name	Melting point (DIN 53 736) T_m °C	Glass transition temperature (DIN 53 736) T_g °C	Heat distortion temperature (ISO-R 75, method A (DIN 53 461)) HDT/A °C	Heat distortion temperature (ISO-R 75, method B (DIN 53 461)) HDT/B °C	Maximum service temperature short term °C	Thermal conductivity (23°C) λ W/(K·m)	Specific heat (23°C) c J/(g·K)	Coefficient of linear thermal expansion (23°C, ASTM D 696, DIN 53 752, ASTM E 831) α 10^{-5} 1/K	Dielectric constant (10^6 Hz, ASTM D 150, DIN 53 483, IE-250) ε_r –	Dielectric loss factor (10^6 Hz, ASTM D 150, DIN 53 483, IE-250) tan δ –	Volume resistance (ASTM D 257, EC 93, DIN IEC 60093) ρ_D Ω · cm	Surface resistance (ASTM D 257, EC 93, DIN IEC 60093) R_O Ω	Dielectric strength (ASTM D 149, IEC-243, VDE 0303 part 2) E_d kV/mm	Resistance to tracking (DIN 53 480, VDE 0303 part 1) Grade	Moisture absorption to equilibrium 23 °C/50% relative humidity (DIN EN ISO 62) $W(H_2O)$ %	Water absorption at saturation (DIN EN ISO 62) W_S %	Resistance to hot water, washing soda –	Flammability acc. to UL standard 94 –	Resistance to weathering** –	Trade name
TECAMID TR		150	130	140	120	0,23	1,45	5	3-4	0,02-0,03	10^{15}	10^{15}	25	KC>600	3	5,6-6,4	(+)	HB	-	**TECAMID TR**
TECAMID 12	175	45	50	140	150	0,23	2,1	10	3,1-3,6	0,03-0,04	10^{14}	10^{14}	24-30	KA 38 CTI 600	0,7	1,6	+	HB	-	**TECAMID 12**
TECAMID 12 GF 30	175	45	120	165	150	0,23	1,7	5	4	< 0,04	10^{13}	10^{14}	>45	KB 400 CTI 600	0,4	1	(+)	HB	-	**TECAMID 12 GF 30**
TECAMID 11	183	43	55	150	150	0,23	2,1	10	3,2-3,6	0,03-0,08	10^{13}-$2x10^{15}$	10^{14}	40	KC 600	0,9	1,9	+	HB	-	**TECAMID 11**
TECAMID 11 GF 30	185	43	120	165	150	0,23		5			10^{14}	> 10^{14}	45	KB 600 KC 600	0,45	1,3	(+)	HB	-	**TECAMID 11 GF 30**
TECANAT HT		180	161-197	173-195	170			7	2,9	0,01	> 10^{16}	10^{15}	35	CTI 600	0,2		<60°C	HB	-	**TECANAT HT**
TECANAT		148	135	140	140	0,19	1,2	7	3	0,006	10^{13}	10^{15}	27	KA 1	0,15	0,36	-	HB	-	**TECANAT**
TECANAT GF 30		148	142		140	0,26		$3^{(2)}$	3,3	0,009	$10^{16(2)}$	$10^{14(2)}$	30	KB 160	0,1	0,28	-	HB	-	**TECANAT GF 30**
TECANAT ESD 7								6,7			10^7-10^9	10^8-10^{10}			0,1	0,3	-	V2	+	**TECANAT ESD 7**
TECAFINE PMP	245	20	51	85		0,17	2,18	12	2,12		10^{14}	10^{13}	65	KA 3c KB>600	<0,05	0,01	+	HB	-	**TECAFINE PMP**
TECADUR PET	255	70	95	170	170	0,24	1,1	7	3,2	0,0021	10^{13}	10^{15}	60	KC 350	0,25	0,5	-	HB	-	**TECADUR PET**
TECAPET	255	70	95	170	170	0,24	1,1	7	3,2	0,0021	10^{13}	10^{15}	60	KC 350	0,25	0,5		HB		**TECAPET**
TECAPET TF	255														0,25	0,5				**TECAPET TF**
TECADUR PBT	225	60	80	165	170	0,21	1,21	8	3	0,012	>10^{13}	> 10^{15}	>45	KB 425 KC>600	0,25	0,4	-	HB	-	**TECADUR PBT**
TECADUR PBT GF 30	225	60	210	225	200		1,5	3,5	3,8	0,009	10^{13}	10^{15}	50	KB 225 KC 550	0,15	0,35	-	HB	-	**TECADUR PBT GF 30**
TECAFORM AH	165	-60	110	160	140	0,31	1,5	10	3,5	0,003	10^{14}	10^{14}	>50	KA 3c	<0,3	0,5	(+)	HB	-	**TECAFORM AH**
TECAFORM AH GF 25	165	-60			140			3	4,8	0,005	10^{14}	10^{12}	>50		0,15					**TECAFORM AH GF 25**
TECAFORM AH LA	165	-60	88		140		1,5	$16^{(2)}$	3,8	0,007	$7*10^{13(2)}$	$9*10^{13(2)}$	35	CTI 600	0,2	0,8	(+)	HB	-	**TECAFORM AH LA**
TECAFORM AH ELS	165	-60	89		140			11			10^2-10^4	10^2-10^4			<0,3	0,5	(+)	HB	+	**TECAFORM AH ELS**
TECAFORM AH SD	165	-60	88		140	0,3		12			10^9-10^{11}	10^9-10^{11}			0,25	~0,8	(+)	HB	-	**TECAFORM AH SD**
TECAFORM AH TF 10	165	-60	98		140												(+)	HB	-	**TECAFORM AH TF 10**
TECAFORM AH MT farbig	165	-60	110	160	140	0,31	1,5	10	3,5	0,003	10^{14}	10^{14}	> 50	KA 3c	< 0,3	0,5	(+)	HB	-	**TECAFORM AH MT farbig**
TECAFORM AD	175	-60	124	170	150	0,31	1,5	10	3,7	0,005	>10^{14}	> 10^{14}	>50	KA 3c	<0,3	0,5	-	HB	-	**TECAFORM AD**
TECAFORM AD AF	175	-60	118	168	150			8	3,1	0,009	>10^{15}	> 10^{15}	15		0,18	0,72	-	HB	-	**TECAFORM AD AF**
TECAFORM AD GF 20	175	-60	158	174	150			6	3,9	0,005	> 10^{15}	> 10^{15}	19		0,1	1	-	HB	-	**TECAFORM AD GF 20**
TECAFORM AD CL	175	-60			150	0,37	1,47	10	3,5	0,006	10^{15}	10^{15}	15		0,24	1	-	HB	-	**TECAFORM AD CL**
TECAPRO MT	163	86			140						>10^{15}		>40		>0,05	0,1	-	HB	-	**TECAPRO MT**
TECAFINE PP	165	-18	65	105	130	0,22	1,7	17	2,25	0,0002	>10^{14}	> 10^{13}	>40	KA 3c	<0,1	0,03	+	HB	-	**TECAFINE PP**
TECAFINE PP ELS	165	-18	65	105	120	0,22		9			10^3-10^5	10^3-10^5				0,03	(+)	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	<0,1	0,17	+	HB	-	**TECAFINE PP GF 30**
TECAFINE PE 10	135		42	~70	120	0,41	1,84	20	3		10^{14}	10^{12}	45	KA3c KB>600	0,01	0,02	+	HB	-	**TECAFINE PE 10**
TECAFINE PE 5	136		44	~70	120	0,41	1,84	20	2,9	0,0004	10^{15}	10^{13}	>150	KC>600	0,01		+	HB		**TECAFINE PE 5**
TECAFINE PE	130	-95	42-49	70-85	90	0,35-0,43	1,7-2	13-15	2,4	0,0002	>10^{15}	> 10^{13}	>50	KA 3c	<0,05	0,02	+	HB	-	**TECAFINE PE**
TECACRYL		105	60	100	100	0,19	1,47	7	3,4	0,004	10^{15}		> 45	KB>600 KC>600	1	2	-	HB	-	**TECACRYL**
TECARAN ABS		115	82-104	96-108	100	0,17	1,2	8-11	3,3	0,015	10^{15}	10^{13}	>22	KA 3b	0,4	0,7	-	HB	-	**TECARAN ABS**
TECANYL		150	130	138	110	0,22	1,2	7	2,6	0,001	10^{13}	10^{15}	50	KA 1	0,1	0,2	+	HB	-	**TECANYL**
TECANYL GF 30		150	135	143	110		1,34	3	3,1	0,0021	10^{15}	10^{15}	50	KB 250	0,05	0,18	(+)	HB	-	**TECANYL GF 30**

Chemical Resistance

Factors like temperature, concentration of the driving forces, duration and mechanical load are important criterions for the examination of chemical resistance.

In the following table, you can see the materials resistance to different chemicals.

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.

	VESPEL® SP1 (PI)	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 (PA 6 G)	TECANAT (PC)	TECAFINE PMP (PMP)	TECADUR PET, PBT (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%		+		+		+	+	+	+	+		+		+	+	(+)	+	+	+	+	+	(+)	+	+	+	+
Ethanol 96%		+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	(+)	+	+	+	+	+	+	+	+
Ethyl acetate	+	+			+		-		-	+	+	+		+	+	+	+	-	(+)	(+)	(+)	+	+	+		+
Ethyl ether		+					+	+	+	+	+	+		+	+	+	+	-		+	+	+	+	+		
Ethylene chloride	(+)	+			+					+	+			+	+	(+)	+	-		-	-	-	+	(+)	-	
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%		+	+	+		+	+			+		+	+	+	+	+		+			+	-	+	+	+	+

	VESPEL® SP1 (PI)	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 (PA 6 G)	TECANAT (PC)	TECAFINE PMP (PMP)	TECADUR PET, PBT (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 2)		(+)								+		+	+	-	-	-		-			-	-		(+)		
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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