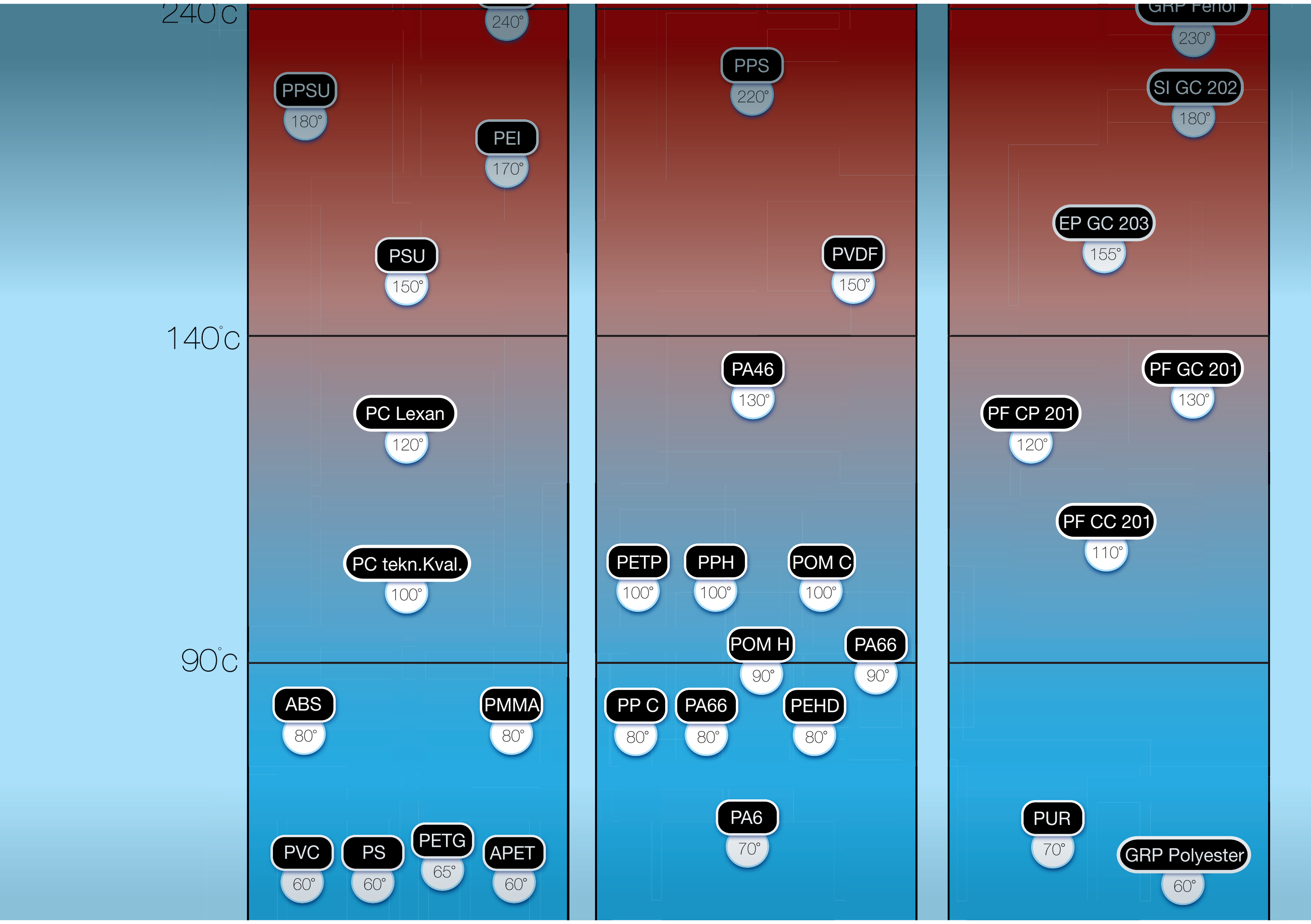
Comparing plastic materials

A technical guide



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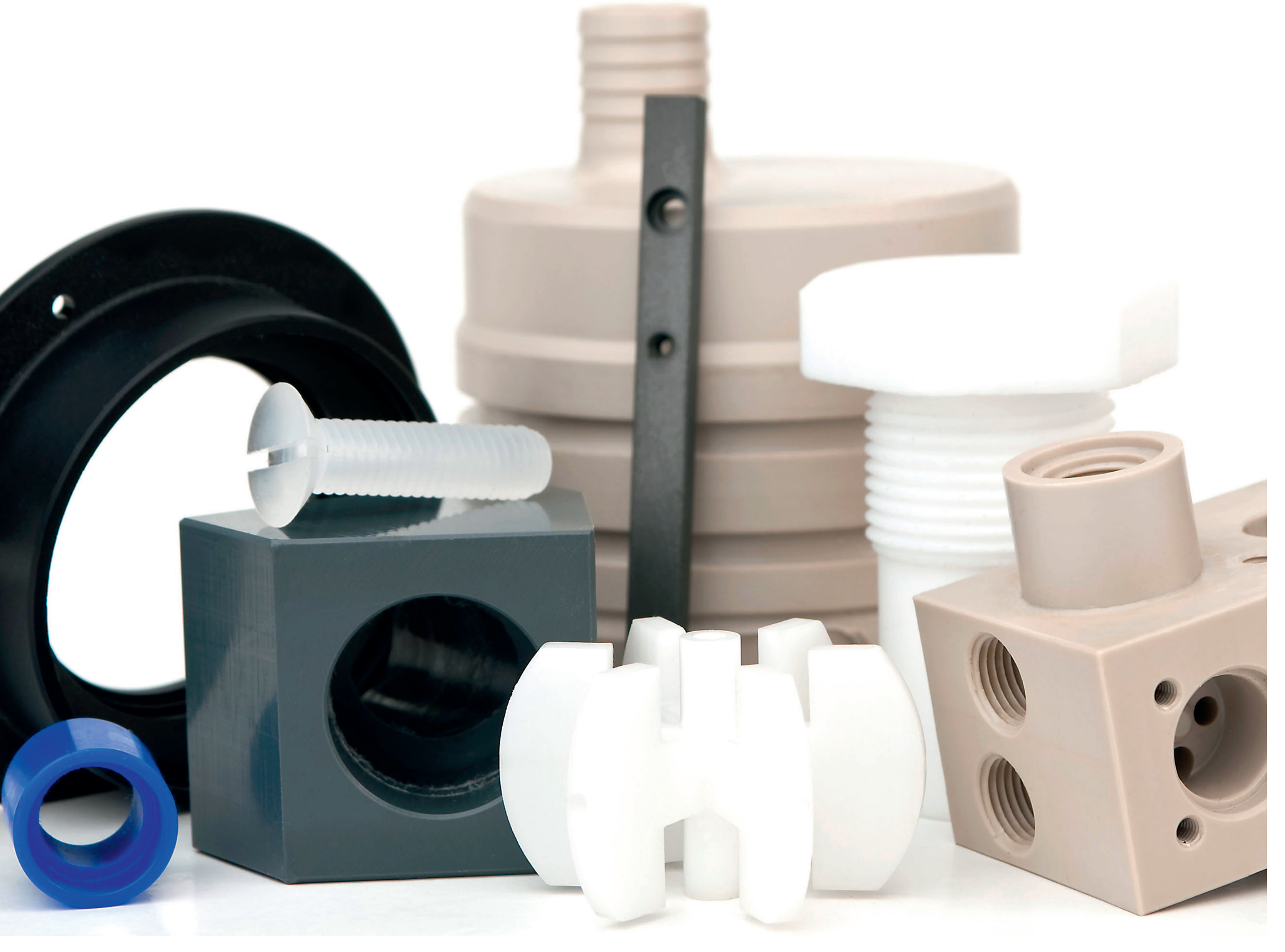
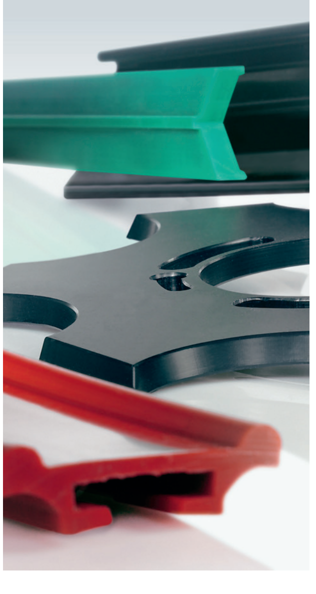
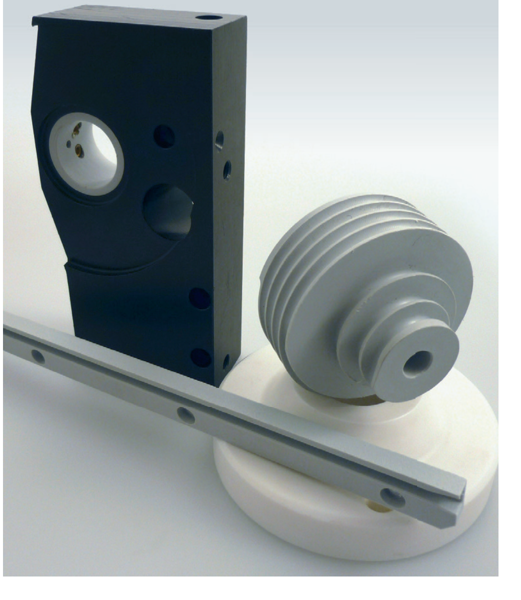






Content

An introduction

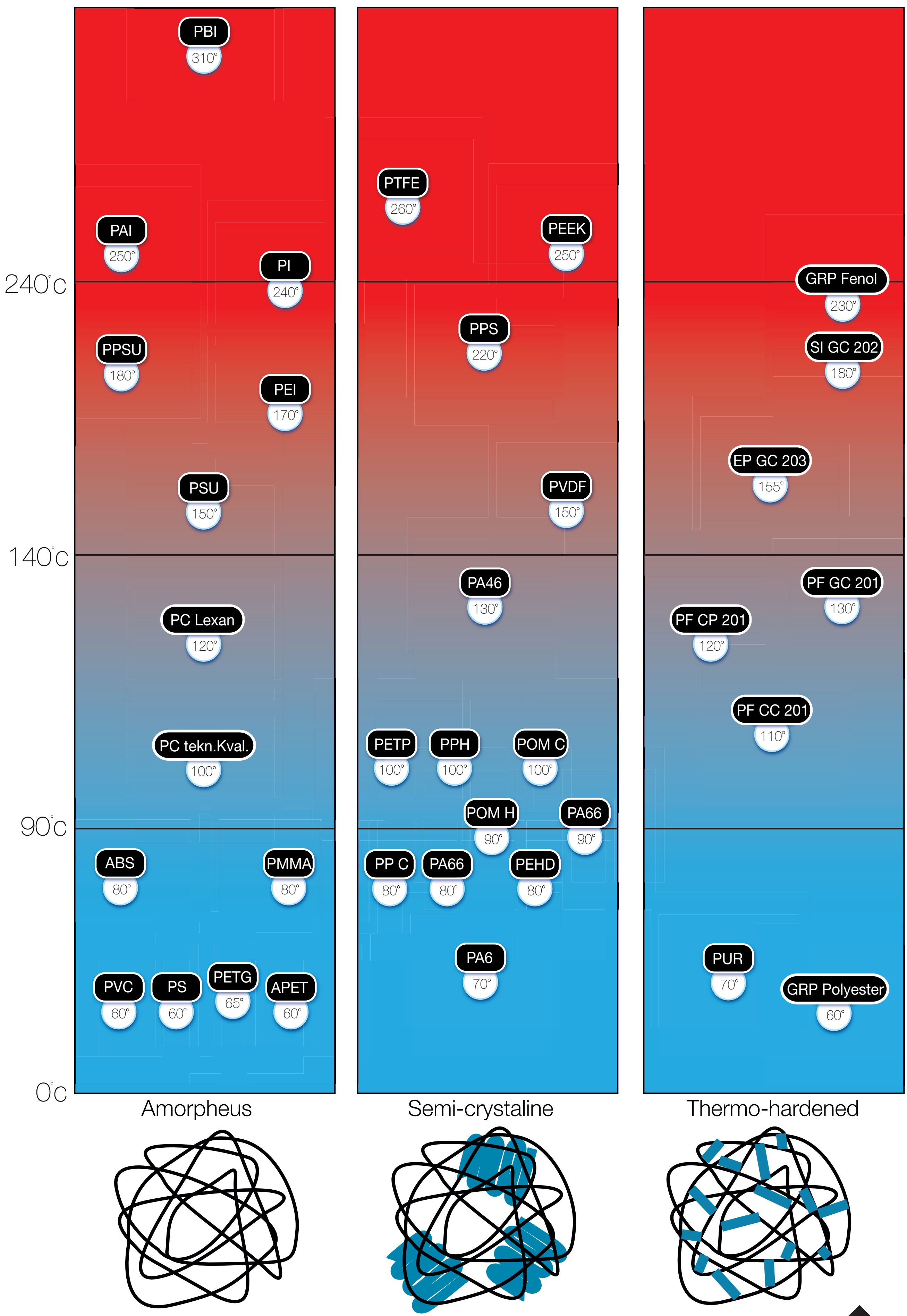
Since being founded in 1968, Vink Denmark has worked under a philosophy of ”Supplying plastics in applications where they add value”. It’s a philosophy, that has been upheld throughout the years and we continously aim to fulfill its promise through constant education of our staff and a vast supply of documentation. The end goal is, always to be able to supply our customers with the support and help, which ensures that our plastics are always used the optimal way. This process of adding value, maintains a high level of quality in industrial machinery and equipment produced in Denmark, keeping international competetiveness and quality at a premium.

This guide is a part of a series: „Plastguiden®“. The guide is a tool for engineers and constructional employees. With comparisons of numerous plastic products, it has proven itself as a popular tool within the industry segment. The materials selected are therefore the most commonly used ones, that fulfill the requirements regularly needed.

In the guide we only work with plastics and how to destinguish them apart. The graphics presented and data defined can only be viewed as a general indicator for the material itself. The result should in other words only be taken as comparative guideline. If a more thorough data on the individual product and its specifications is required, we refer to our technical catalogues contained in the ”Plastguiden®” or the assistance from one of our technical engineers.

We hope that this guide find a use within the business area amongst engineers and trainees alike. At the same time, we encourage you to consider Vink as a partner, because we believe that only together, we can expand the correct use of plastics within the industry.

Max. service temperatures in air with little- or no load



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Min. /Max. service temperatures in air

When using plastics, you should always take into account the limitations both at high- and low temperatures

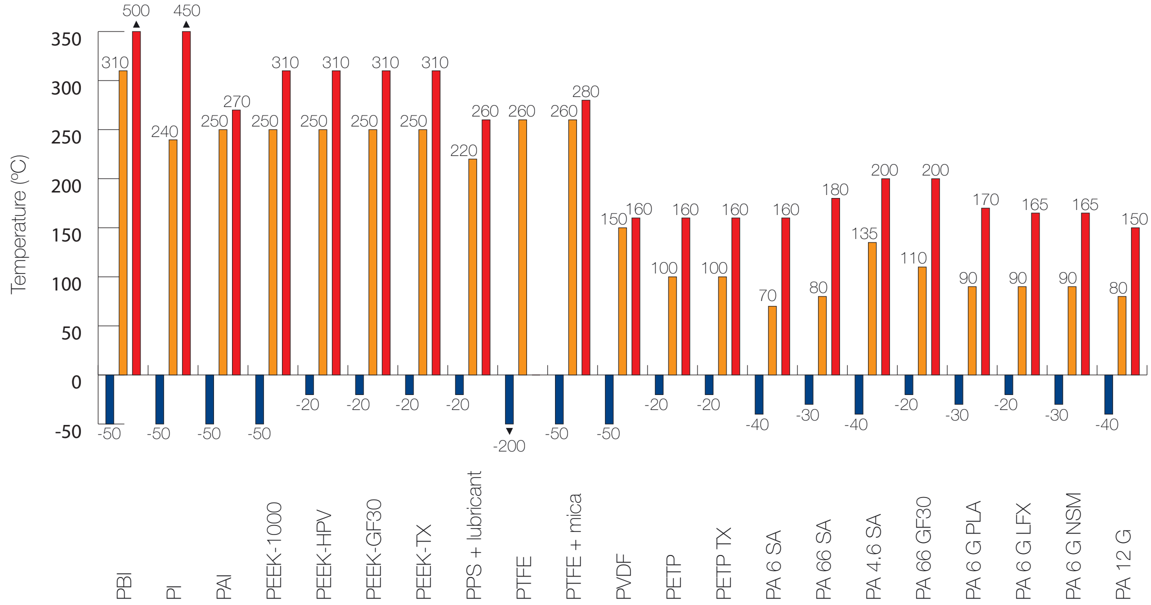
In general:
- at high temperatures, that plastic will start to degrade thus damaging its mechanical properties
- at low temperatures, it becomes "crisp" and fragile when notched/impacted

Max. service temperature over a period of a min. 20.000 hours. After this period of time, the loss af strength accours (measured at 23° C) at approx. 50% when compared to the original value.

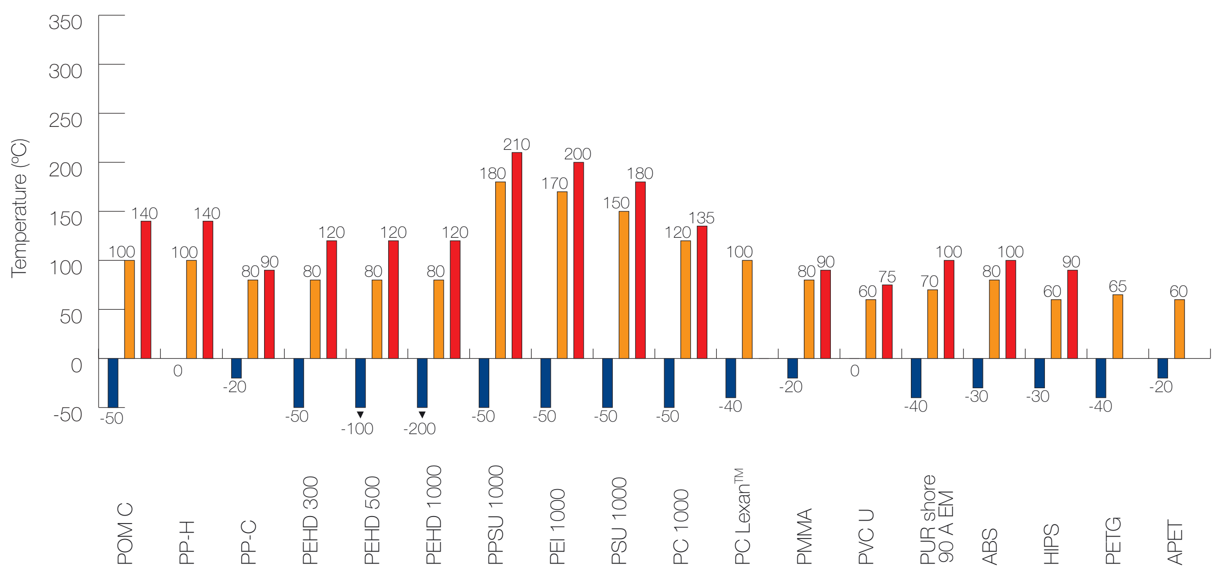
Max. service temperature short time
Heat influence (a few hours), in which the material shows little loss of strenght when tested with minor mechanical wear.

Min. service temperatures
The lowest service temperature area is largely determined by whether or not the material is exposed to sudden impacts. The value is given based on optimal terms and as such cannot be viewed as the absolute, in practical use .

Min./Max. service temperatures in air



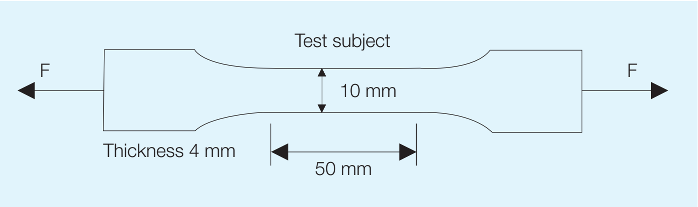
Min./Max. service temperatures in air



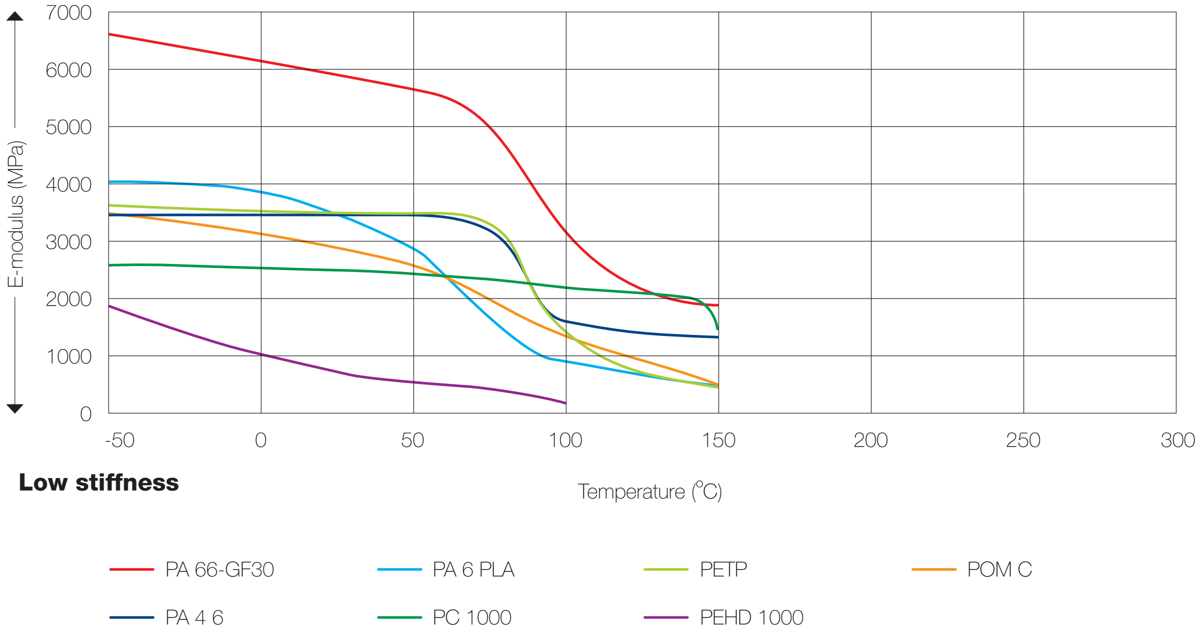
Modulus of elasticity (E-modulus)

Tensile tests (elongation test results) are used when producing isochron curves for dimensional specification in products. Using isochron curves allows you to pin-point the materials E-modulus, which is an definition on the stiffness of the material.

Please note, that the material E-modulus further deteriorates over longer spans of time, which the shown curves below does not take into account.



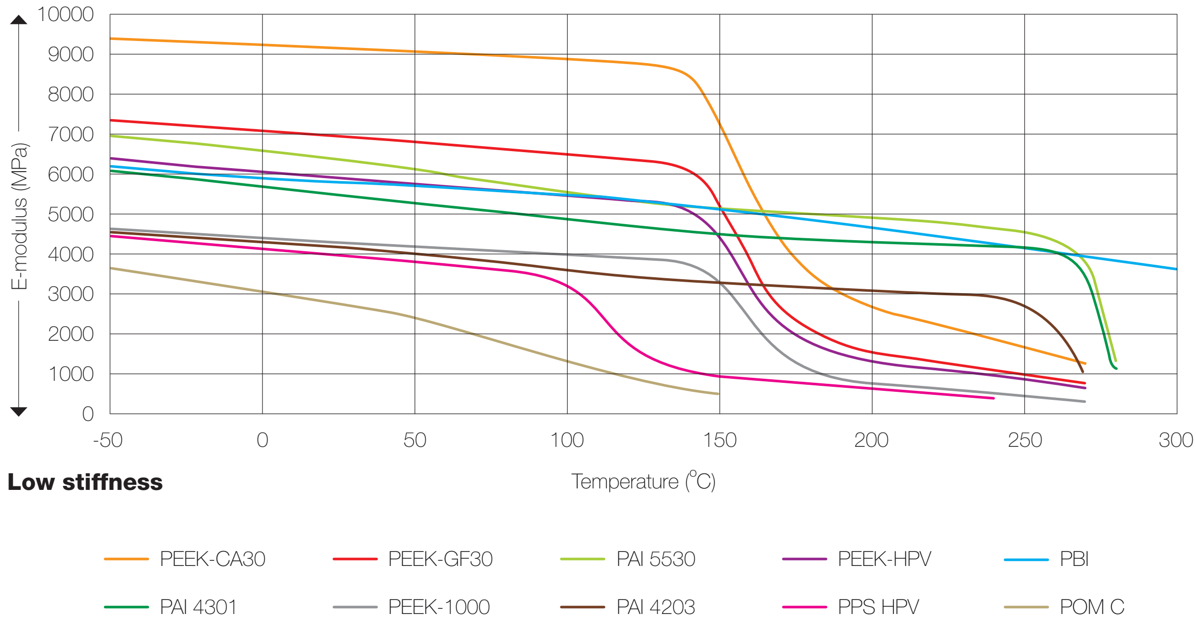
High stiffness **Stiffness depending on temperature**



Low stiffness

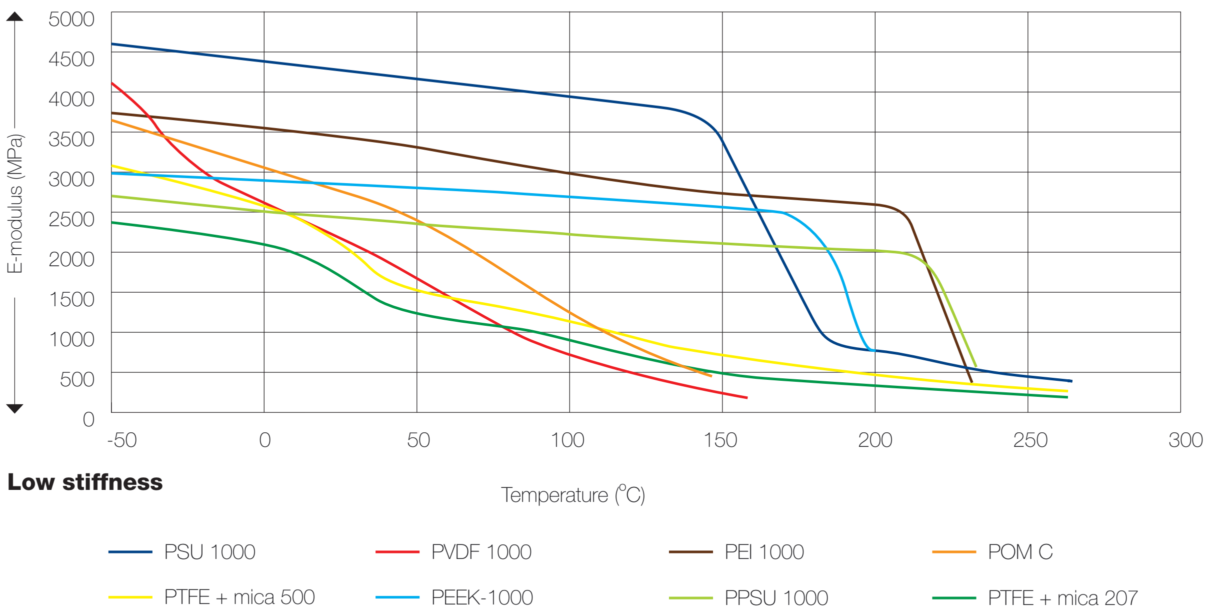
Modulus of elasticity (E-modulus)

High stiffness **Stiffness depending on temperature**



Low stiffness

High stiffness **Stiffness depending on temperature**

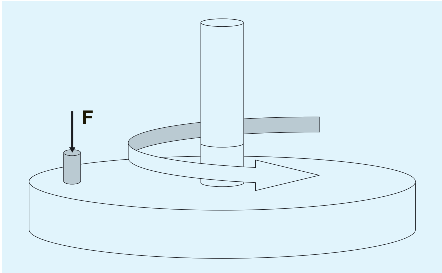


Low stiffness

Dynamic coefficient of friction is measured using a plastic pin that is pressed down against a rotating steel disc.

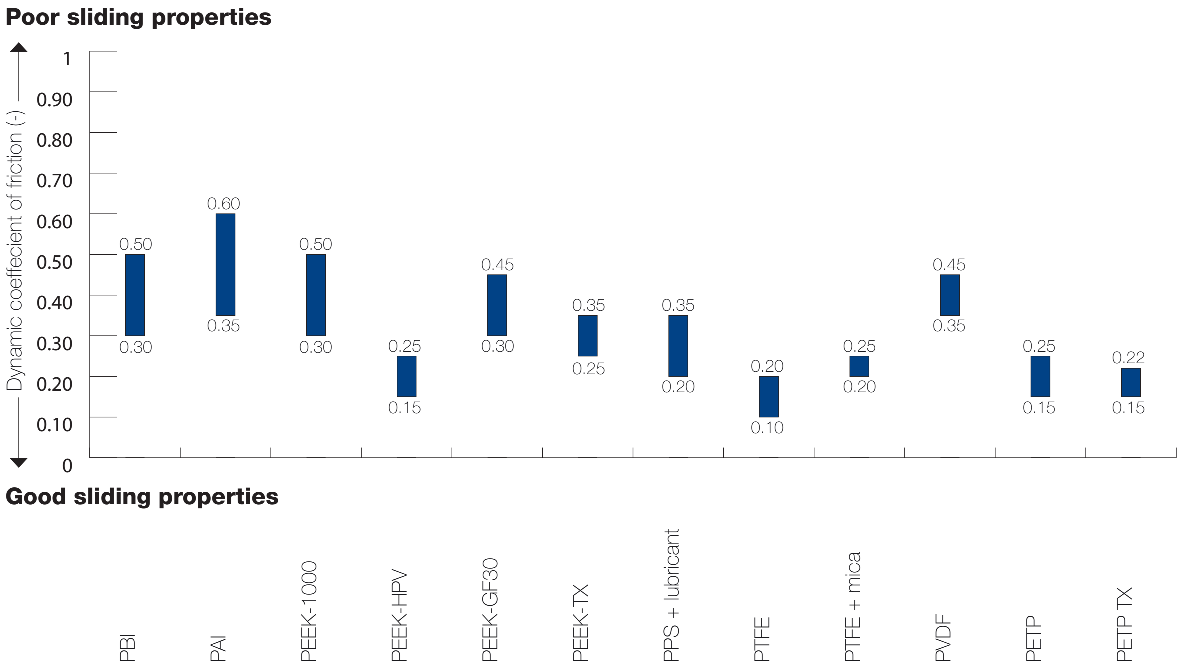
■ Steel disc at 23°C

■ Steel disc heated to 150°C

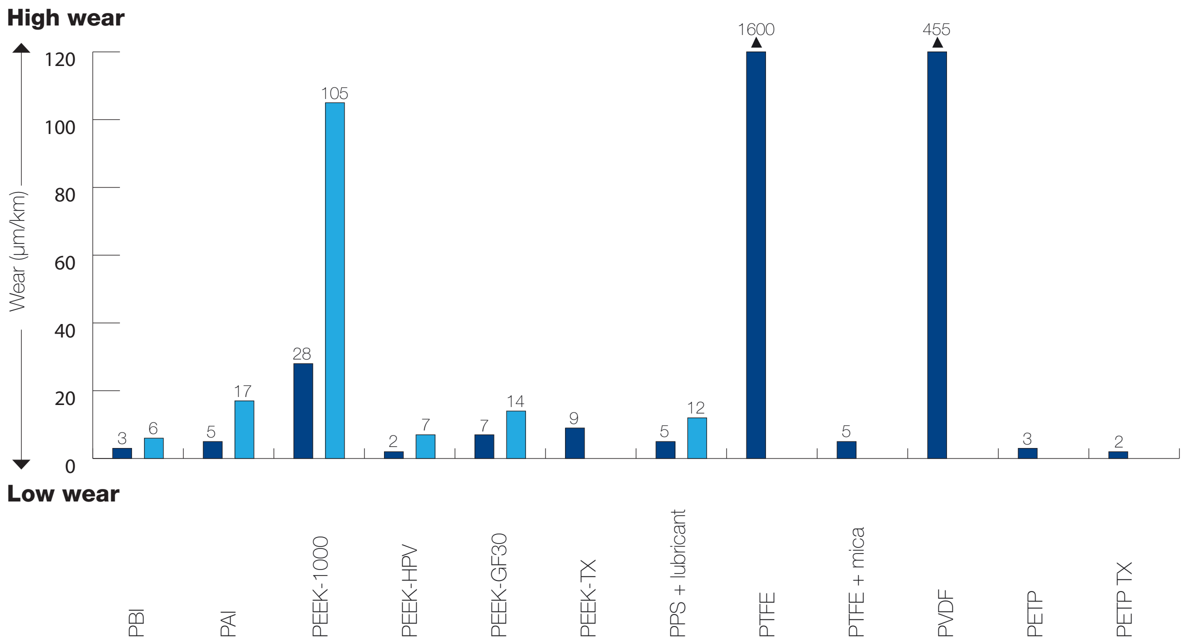


Test conditions:
- Preassure: 3 Mpa
- Sliding velocity: 0,33 m/s
- Surface roughness of steel disc: Ra=0,70-0,90 µm
- Total distance run: 28 km
- Normal environment: 23°C/50%RH
- Unlubricated operation

Dynamic coefficient of friction

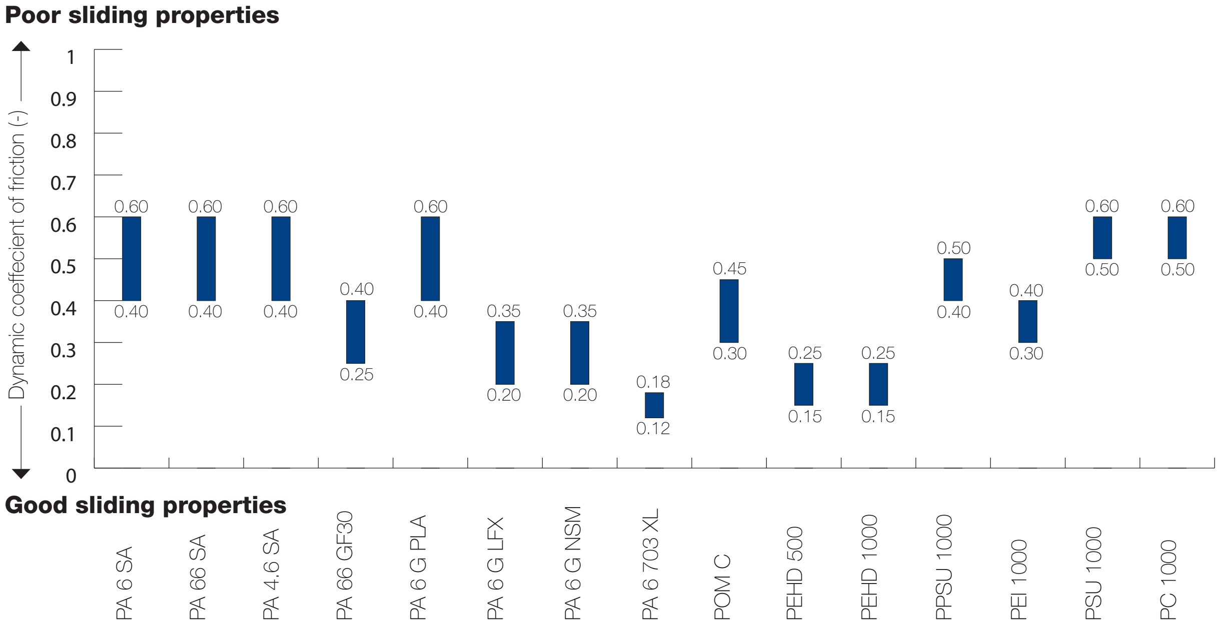


Wear resistance

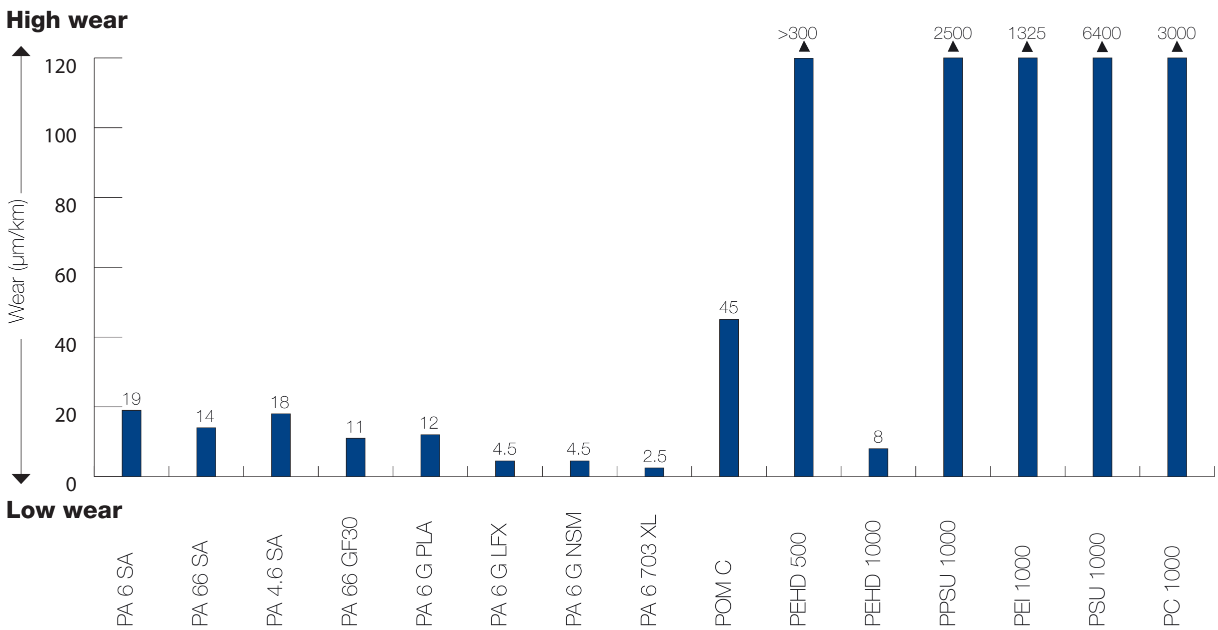


Dynamic coefficient of friction/wear resistance

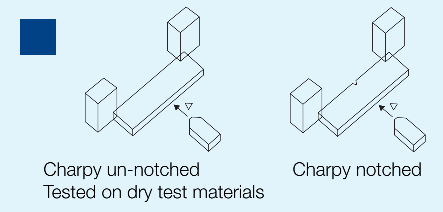
Dynamic coefficient of friction



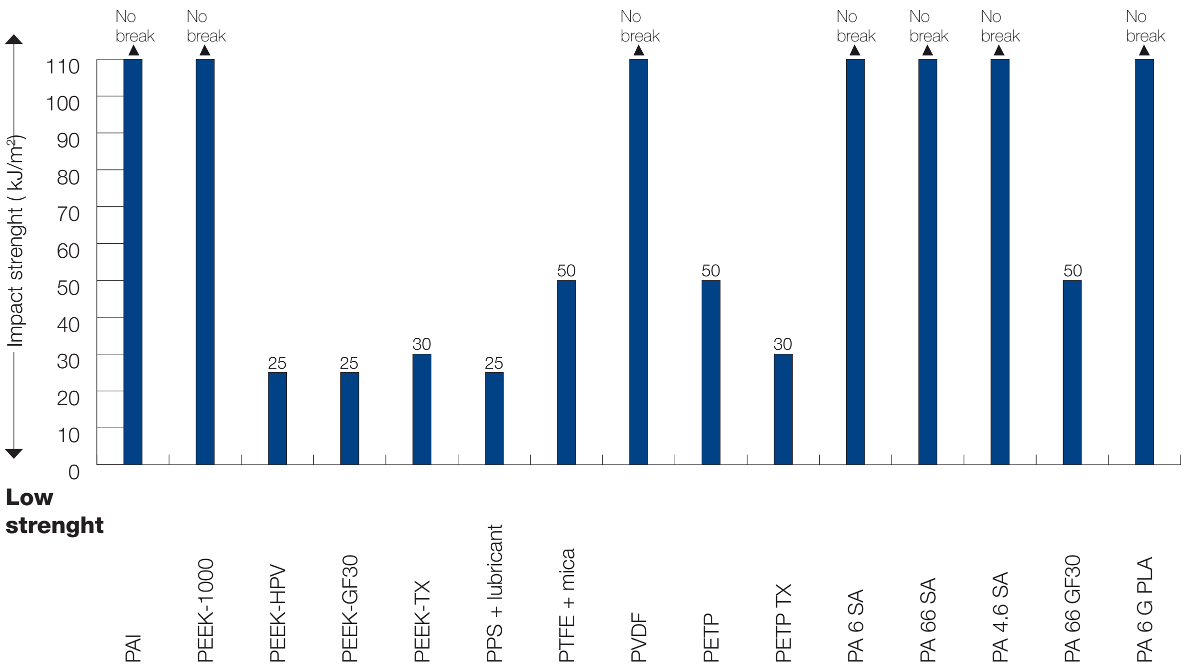
Wear resistance



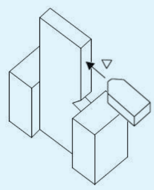
The impact strenght of a material designates the materials ability to withstand controlled impacts. The impact is based on the Charpy-model, in which impacts are based on notched and un-notched test material.

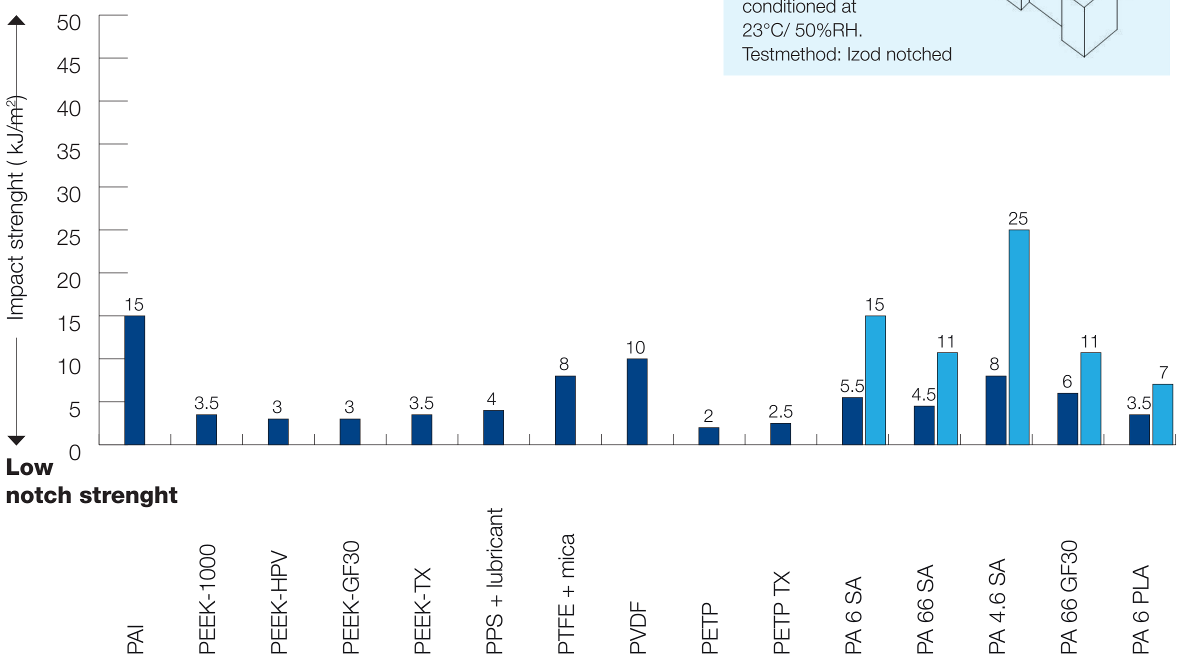


Charpy impact strenght – un-notched (ISO 179-1/1eA)



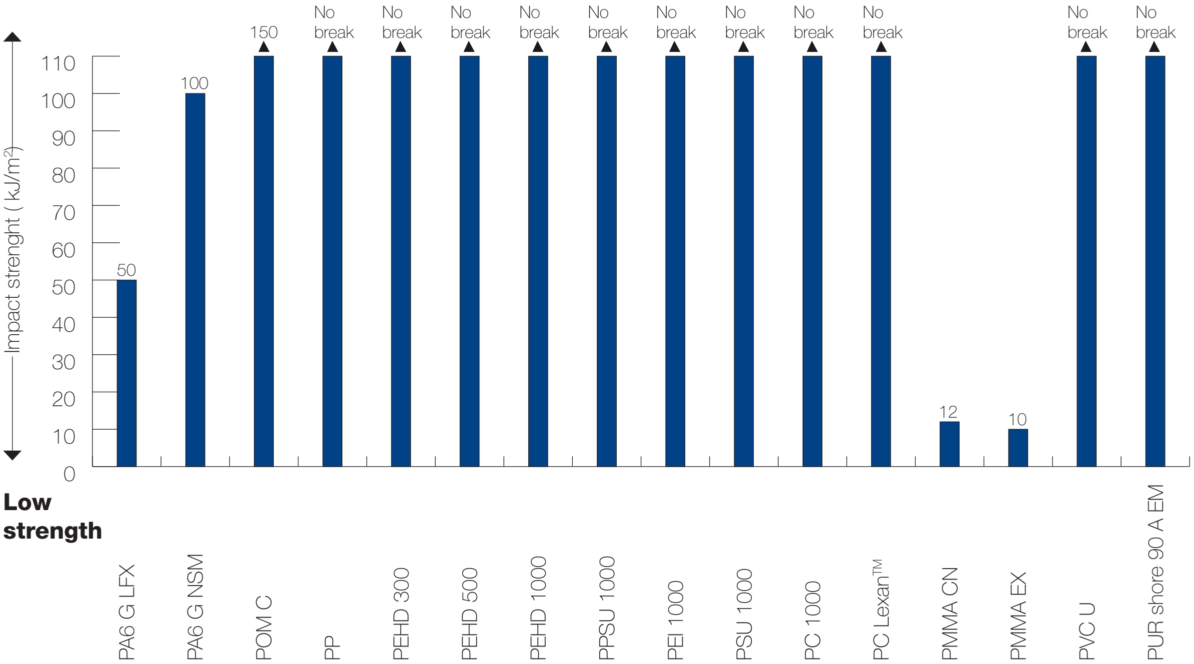
Charpy impact strenght – notched (ISO 179-1/1eA)



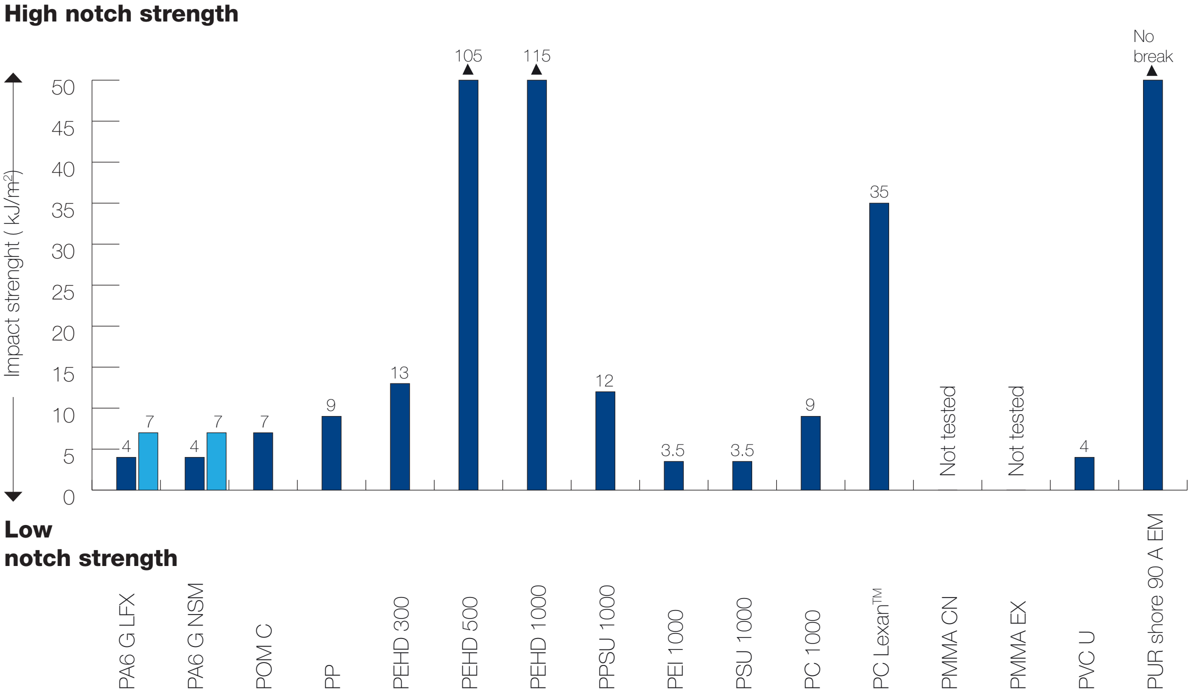


Impact strenght – Charpy

Charpy impact strenght – un-notched (ISO 179-1/1eA)



Charpy impact strenght – notched (ISO 179-1/1eA)



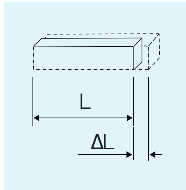
Water absorption & thermal expansion

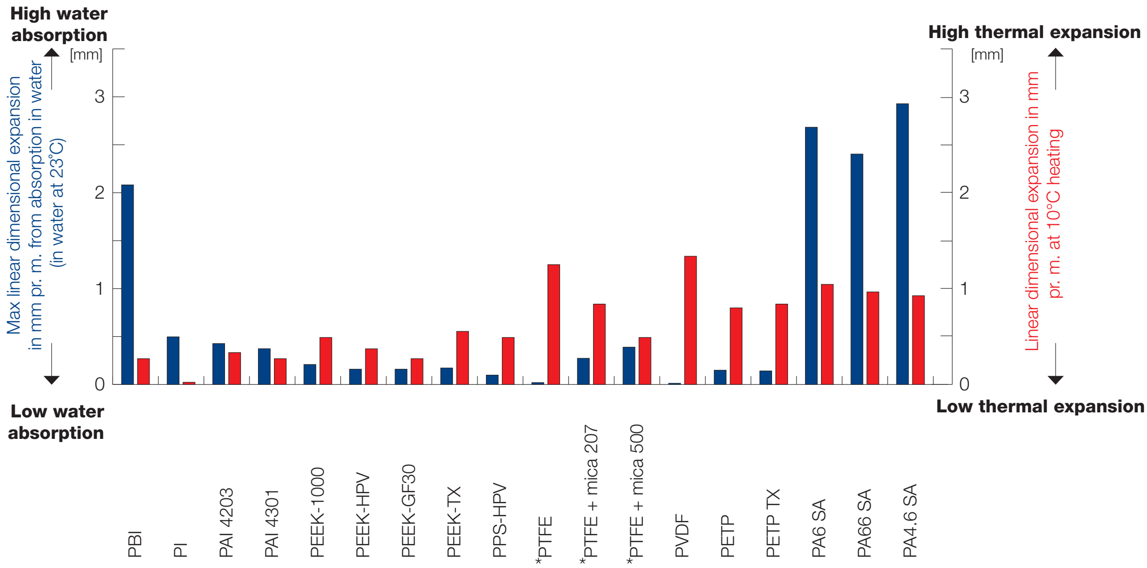
Water absorption and thermal expansion influence the dimensional stability of plastic materials.

The graphs below show water absorption/expansion in saturation with water at 23°C and thermal expansion of the material at a 10°C heating in temperatures between 23° and 100°C.

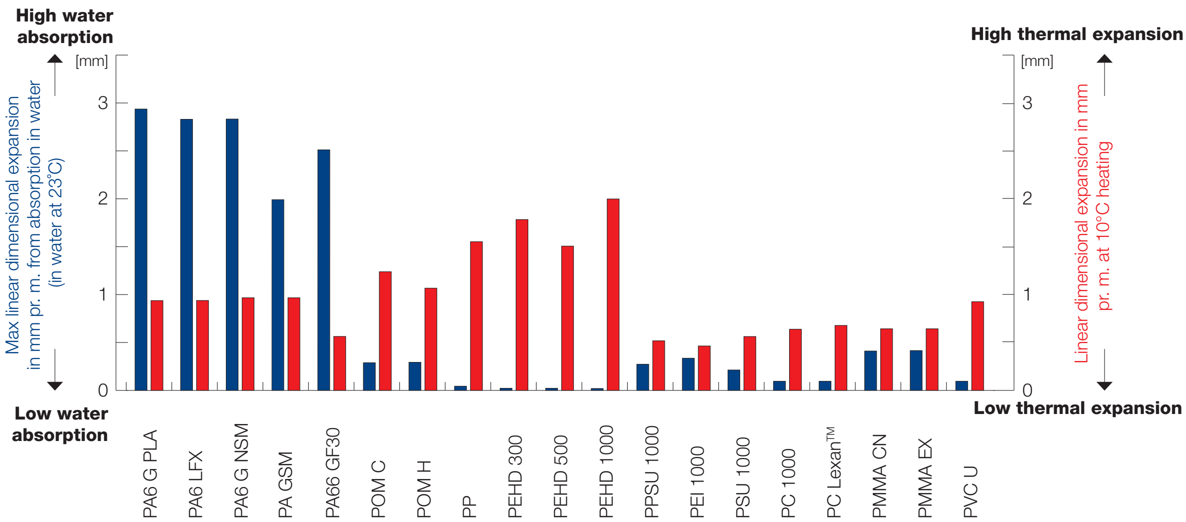
The largest water absortion is typical for the PA materials.

The largest expansions in various temperature increases are seen with PEHD-, PP-, PUR- and fluor plastic materials (PTFE and PVDF).

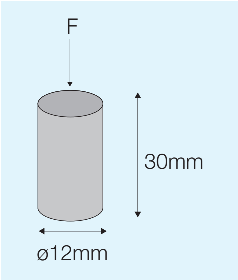




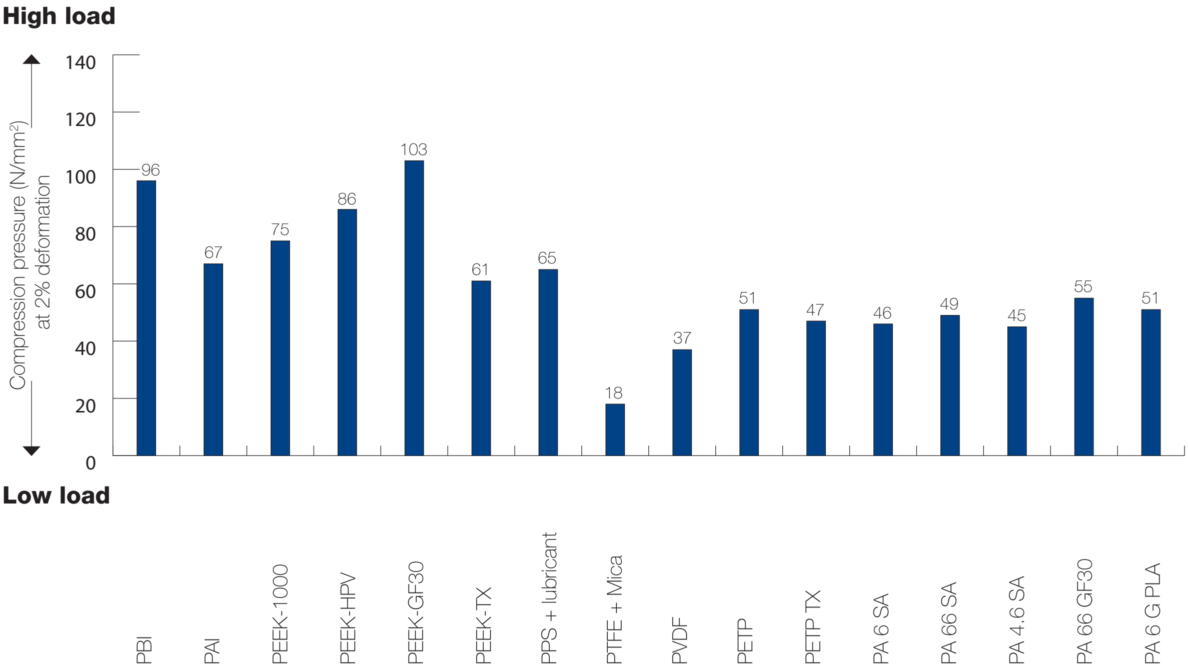
*Please note, that the temperature expansion for PTFE "jumps" at 19°



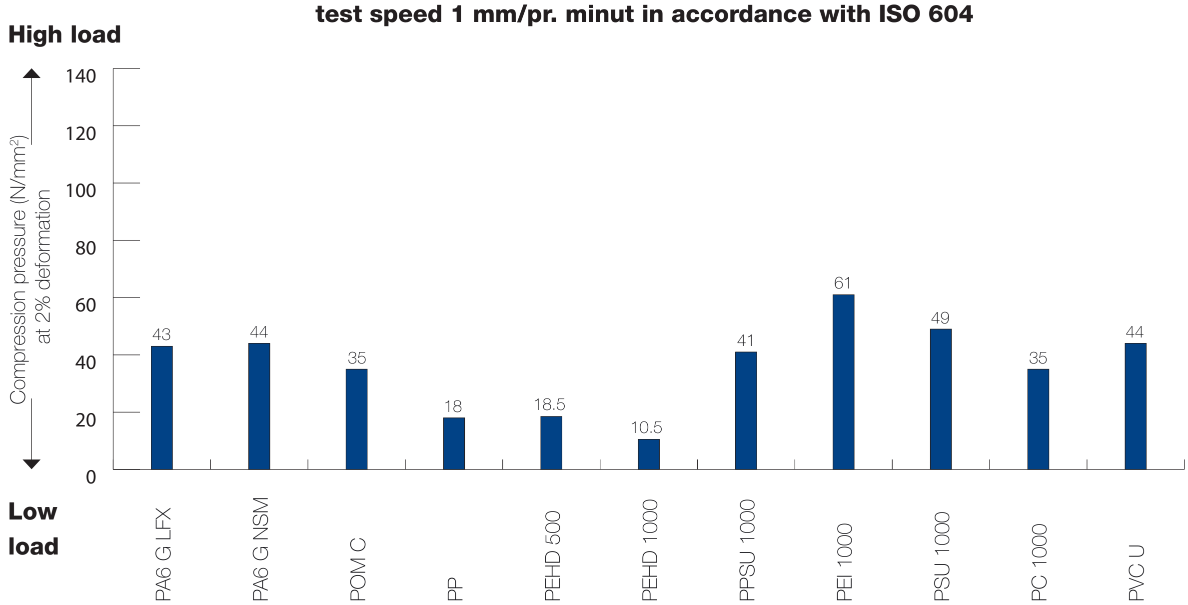
Deformation under load



The deformation test is performed at 23° C, 2% deformation/compression, test speed 1 mm/pr. minut in accordance with ISO 604

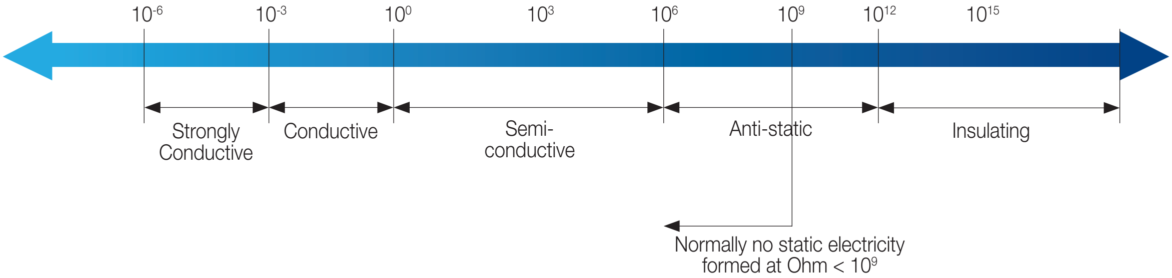


The deformation test is performed at 23° C, 2% deformation/compression, test speed 1 mm/pr. minut in accordance with ISO 604



Surface resistance/static electricity

Most plastics are electrically insulating, which is why static electricity can occour. A material with a surface resistance of less then 10^9 Ohm will under normal circumstances not form static electricity.
There are however special materials amongst e.g. PE, PP, PVDF and PEI that are anti-static or semi conductive.



Properties	Test-method ISO/(IEC)	Unit	PBI	PAI	PEEK 1000	PEEK GF30	PEEK TX	PPS + lubricant
Surface resistance	(60093)	Ω	> 10^{14}	> 10^{14}	> 10^{14}	> 10^{13}	> 10^{13}	> 10^{13}

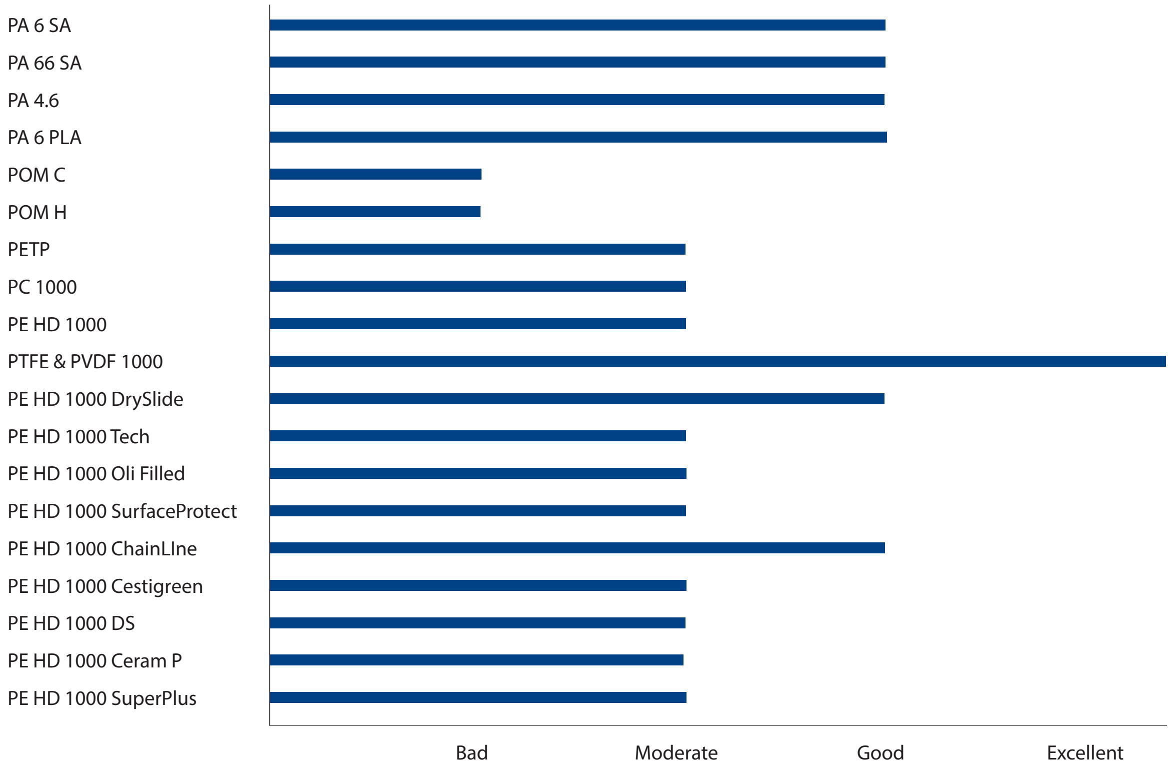
PTFE + Mica	PVDF	PETP	PETP TX	PA 6 SA	PA 66 SA	PA 4.6 SA	PA 66 GF30	PA 6 G PLA	PA 6 G LFX	PA 6 G NSM	PA 12G
> 10^{13}	> 10^{13}	> 10^{13}	> 10^{13}	> 10^{13}	> 10^{13}	> 10^{13}	> 10^{13}	> 10^{13}	> 10^{13}	> 10^{13}	10^{13}

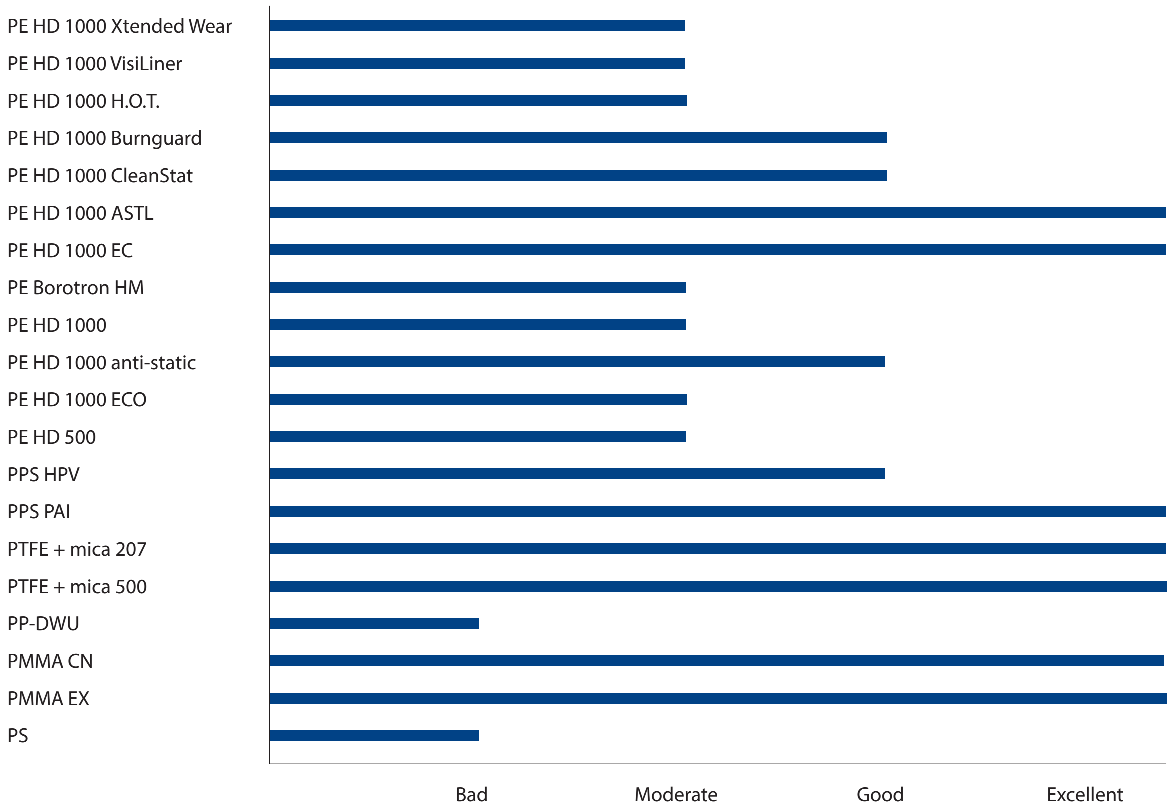
POM C	PP	PEHD 300	PEHD 500	PEHD 1000	PPSU 1000	PEI 1000	PSU 1000	PC 1000	PVC U
> 10^{13}	10^{14}	10^{14}	> 10^{12}	> 10^{12}	> 10^{13}	> 10^{13}	> 10^{13}	> 10^{13}	10^{13}

UV-Resistance

With outdoor use of plastics, it is of highest importance to check how the materials react to sunlight - i.e. whether or not the material is UV-resistant. The material selected can either be UV resistant in itself or an additive - e.g. carbonblack - can be added for protection. UV rays can - if unprotected - damage the material surface, discolour it and/or weaken its mechanical properties.

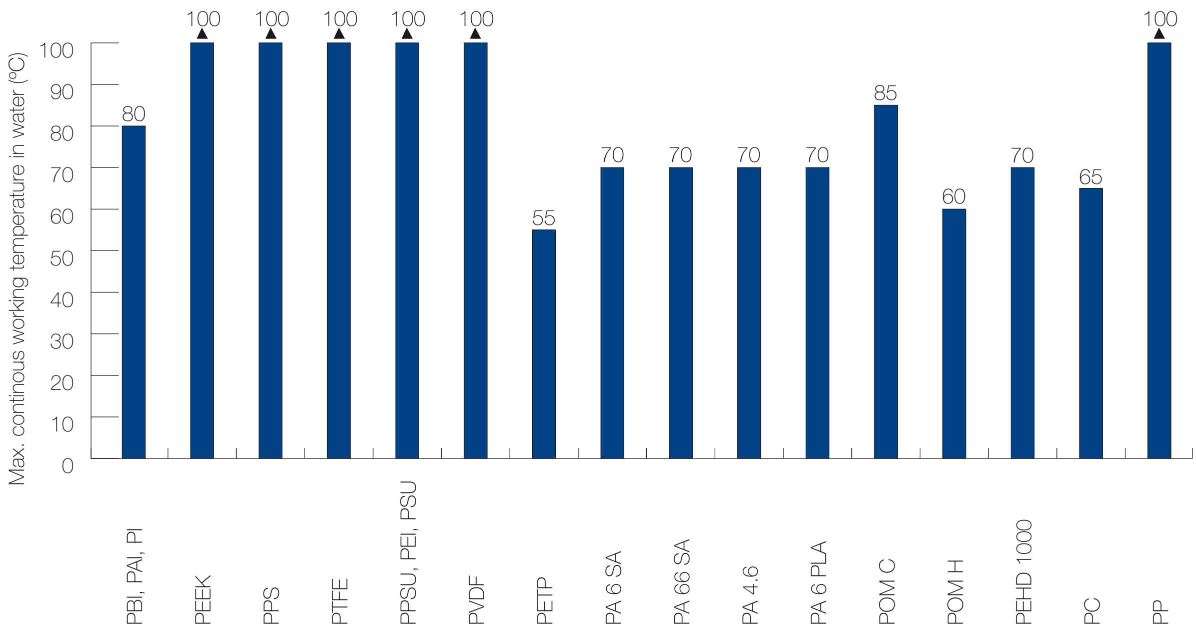
UV-Resistance (Sunlight)





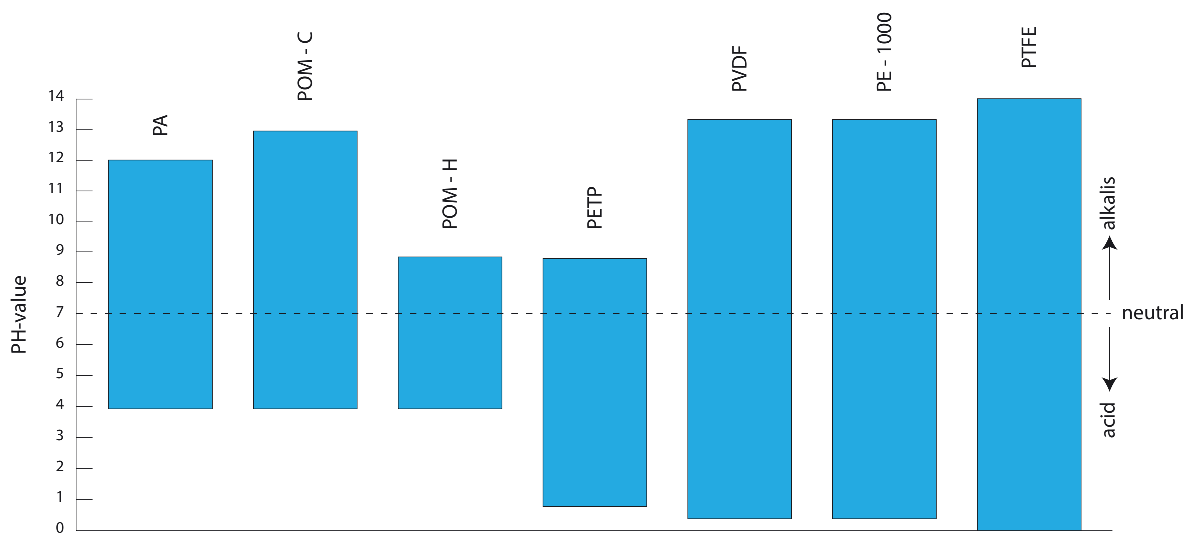
Hydrolysis is a chemical reaction or process in which a molecyle reacts with water and splits into smaller molecyles. Some plastics are not hydrolysis resistant, which means that they break down in hot water. In these cases the water acts as a chemical that attacks the plastic material. In the table below, we have listed the temperature limit for the water, in which each plastic material can be continually used, before it starts to break down.

Hydrolysis resistance



The diagram below illustrates each plastic materials chemical resistance at temperatures of 23 °C. It is however important to point out, that when selecting a material, it has to be examined which chemicals are used, and at what temperatures the material is used in. If several chemicals are being used together, the chemical mix has to be evaluated as well. It is NOT enough to ensure, that the material is resistant to each chemical individually.

Chemical resistance at 23°C



Plastics and food

Plastics are frequently used in industrial applications where the material is in direct contact with foods. This table shows which plastic types are approved to such use according to the following regulations:

EU: Complies with (EC) no. 1935/2004 and 2023/2006/EC and GMP: Good Manufacturing Practice and relevant demands in directive EC10/2011 and changes/amendments in up untill EC 1183/2012

FDA: Complies with USA Food and Drug Administration and (21CFR)

FCM = Food Contact Material). All materials supplied from Vink Plast with the FCM logo are compliant and are supplied with a declaration to such compliance. For information on which material is better suited for your applications, as well as examples of such documentations, please contact Vink.

Material	Quality/colour	EC 1935/2004	FDA
PE-LD	Vink PE-W nature	-	+
PE HD	Vink PE-HD nature FCM	+	+
	Vink PE HD black FCM	+	-
	Vink PE 100 FCM nature	+	-
	Vink PE 100 FCM black	+	-
PE HD 500	PE 500 FCM nature - sheets	+	+
	PE 500 FCM blue 7020 - sheets	+	+
	PE 500 FCM red brown - sheets	+	-
PE HD 1000	TIVAR 1000 FCM nature - sheets and rods	+	+
	TIVAR 1000 blue FCM 7020 - sheets	+	+
	TIVAR 1000 FCM green 3010 - rods	+	-
	TIVAR 1000 antistatic FCM black - sheets	+	-
	TIVAR 1000 EC FCM black - sheets	+	+
	TIVAR 1000 ASTL FCM black -sheets	+	-
	TIVAR ChainLine black	-	+
	TIVAR CleanStat FCM black - sheets	+	+
	TIVAR DS yellow and grey - sheets	-	+
	TIVAR DS FCM yellow - sheets	+	+
	TIVAR H.O.T. FCM white - sheets and rods	+	+

Material	Quality/colour	EC 1935/2004	FDA
	TIVAR Oil Filled grey	-	+
	TIVAR SurfaceProtect nature	-	+
	TIVAR TECH FCM grey black - sheets	+	-
	TIVAR MD FCM blue - sheets and rods	+	+
	TIVAR HPV FCM blue - sheets and rods	+	+
	Dehoplast 1000 FCM nature	+	+
	Vink PE 1000 FKM nature - sheets and rods	+	+
PA	ERTALON 6 SA FCM nature - sheets and rods	+	+
	ERTALON 66 SA FCM nature - sheets, rods and tubes	+	+
	ERTALON 6 PLA FCM natuer & blue - sheets and rods	+	+
	NYLATRON LFG nature & blue	-	+
	NYLATRON MD FCM dark blue - sheets and rods	+	+
POM	ERTACETAL C FCM nature - sheets and rods	+	+
	ERTACETAL C FCM blue - sheets and rods	+	-
	ERTACETAL C FCM black - rods	+	+
	ERTACETAL C FCM black 90 - sheets	+	+

Plastics & foods

Material	Quality/colour	EC 1935/2004	FDA
	Ertacetal C LG FCM nature	+	+
	Acetron MD FKM blue - sheets and rods	+	+
	Vink POM-C FCM nature	+	+
	Vink POM-C FCM black	+	+
PETP	ERTALYTE FCM nature - sheets and rods	+	+
	ERTALYTE TX FCM light grey - sheets, rods and tubes	+	+
	ERTALYTE FCM black - sheets and rods	+	+
PC 1000	PC 1000 nature	-	+
PC	LEXAN 9030 FA clear	-	+
PC	LEXAN 9030 FA XR clear	-	+
PEEK	KETRON PEEK-1000 FCM nature - sheets, rods and tubes	+	+
	KETRON PEEK-1000 SP nature - sheets, rods and tubes	-	+
	KETRON PEEK-1000 FCM black - sheets, rods and tubes	+	+
	KETRON PEEK-TX FCM blue - sheets and rods	+	+
PPS	Ketron PEEK FCM MD blue	+	+
	TECHTRON HPV PPS FCM blue - sheets, rods and tubes	+	+
PPSU	Techtron PPS nature	-	+
	Vink PPSU FCM black	+	+
	Vink PPSU FCM black - sheets and rods	+	+
PEI	Duratron PEI nature	-	+
PSU	Vink PSU nature yellow translucent	-	+
PVDF	Vink PVDF nature FCM	+	+
PTFE	FLUOROSINT 207 white	-	+

Material	Quality/colour	EC 1935/2004	FDA
	FLUOROSINT MPV	-	+
	Vink PTFE G400 FCM	+	+
PP	Vink PP-DWU AlphaPlus FCM grey	+	+
	Vink PP-DWST FCM nature	+	+
	Vink PP-DWV nature	-	+
PVC	Vink PVC-U FCM grey	+	+
	Vink PVC Flex FCM - softened sheets	+	+
E-CTFE	Vink E-CTFE nature	-	+
APET	Axpet clear	-	+
PETG	Vivak FCM clear and bronze	+	+
PMMA	Altuglas CN FCM 156.10000	+	-
	Perspex FCM, cast clear	+	+
	Perspex FCM extruded, transparent, coloured and impact resistant	+	-
	Perspex FCM, coloured	+	-
	PMMA clear, rods and tubes	-	+
Alu/ PMMA	Kerrock all colours	+	-

The used symbols mean the following:

+ According to the directive

- Does not comply with- or information is insufficient, to directive

Plastics and fire

The below listed materials are an overview of our plastic materials and their capabilities in relation to fire.

Some of the materials can in certain cases also be supplied with fire retardent additives giving them a better rating.

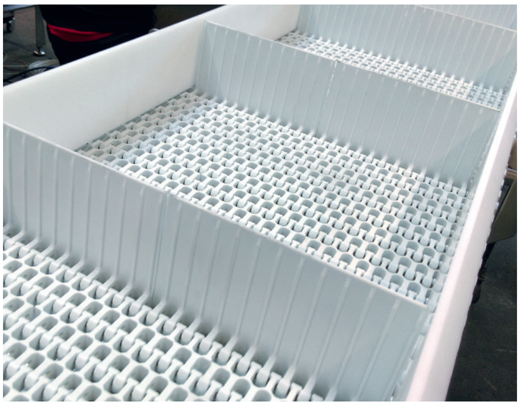
Material	Brand name	Colour	UL 94	DIN 4102	EN13501-1
PE HD 500	Quadrant PE 500	all	HB* from 3mm		
PE HD 1000	Tivar® 1000	all	HB* from 3mm		
PE HD 1000 fire retardent	Tivar® Burnguard	black	V-O* from 6mm		
PA 6 SA, extruded	Ertalon® 6 SA	nature (white) / black	HB* from 3mm		
PA 66 SA, extruded	Ertalon® 66 SA	nature (creme) / black	HB* from 3mm V-2* from 6mm		
PA 66 SA-C, extruded	Ertalon® 66 SA-C	nature (white)	HB* from 3mm		
PA 66 + 30% glass, extruded	Ertalon® 66-GF30	black	HB* from 3mm		
PA 66 + M0S2, extruded	Nylatron® GS	grey black	HB* from 3mm		
PA 4.6, extruded	Ertalon® 4.6	red brown	HB* from 3mm		
PA 6 G cast	Ertalon® 6 PLA	nature (ivory) / black	HB* from 3mm		
PA 6 G heat stabilized, cast	Ertalon® 6 XAU+	black	HB* from 3mm		
PA 6 + oil filled, cast	Ertalon® 6 LFX	green	HB* from 3mm		
PA 6 G modified, cast	Nylatron® MC 901	blue	HB* from 3mm		
PA 6 + M0S2, cast	Nylatron® GSM	grey black	HB* from 3mm		
PA 6 + lubricant, cast	Nylatron® NSM	grey	HB* from 3mm		
PA 6 + oil, cast	Nylatron® LFG	nature (ivory) / blue	HB* from 3mm		
PA 6 + modified, cast	Nylatron® 703 XL	violet	HB* from 3mm		
POM-C	Ertacetal® C	nature (white) / black	HB* from 3mm		
POM-H	Ertacetal® H	nature (white) / black	HB* from 3mm		
POM-H + PTFE	Ertacetal® H-TF	dark brown	HB* from 3mm		
PETP	Ertalyte®	nature (white) / black	HB* from 3mm		
PETP TX + lubricant	Ertalyte® TX	light grey	HB* from 3mm		
PVDF	Symalit® PVDF 1000	nature (white)	V-0* from 3mm		
PPS BG	Techtron® HPV PPS	dark blue	V-0* from 1,5mm		
PTFE reinforced w. mica	Fluorosint® 207	white	V-0* from1,5mm		
PTFE reinforced w. mica	Fluorosint® 500	ivory	V-0* from1,5mm		
PTFE + mica, electric discharging	Semitron® ESd 500HR	white	V-0* from1,5mm		
PEEK	Ketron® PEEK-1000	nature (grey brown) / black	V-0* from 1,5mm		
PEEK + CF + PTFE + graphite	Ketron® PEEK-HPV	black	V-0* from 1,5mm		
PEEK + 30% glass	Ketron® PEEK-GF30	nature (brown grey)	V-0* from 1,5mm		
PEEK + 30% carbon	Ketron® PEEK-CA30	black	V-0* from 1,5mm		
PEEK + lubricant, food contact approved	Ketron® PEEK-TX	blue	V-0* from 1,5mm		
PC (technical quality)	PC 1000	nature (translucent)	HB* from 3mm		
PSU	PSU 1000	nature (yellow translucent)	HB* from 1,5mm		
PEI	Ultem® PEI	nature (amber translucent)	V-0* from 1,5mm		
PPSU 1000	Radel® PPS 1000	black	V-0* from 1,5mm		
PAI	Torlon® 4203 PAI	ocher yellow	V-0* from 1,5mm		

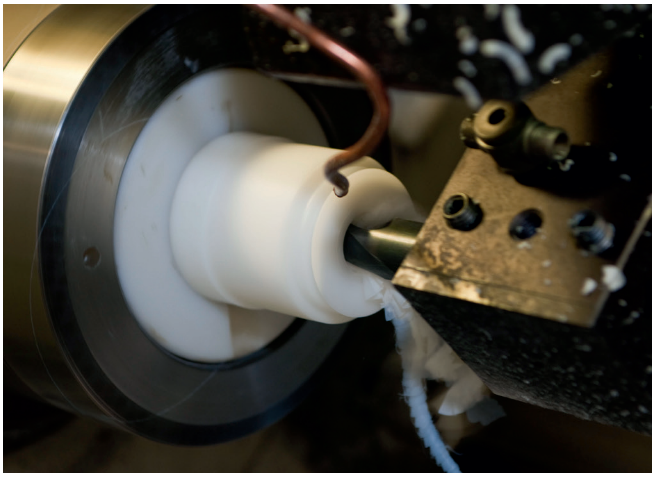
* The specified fire classifications are derived from data supplied by raw material suppliers. There is not “UL file Number” also known as a Yellow card on the material.

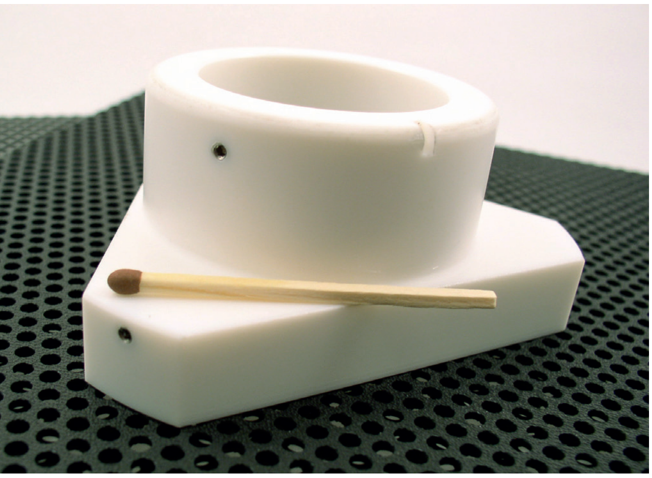
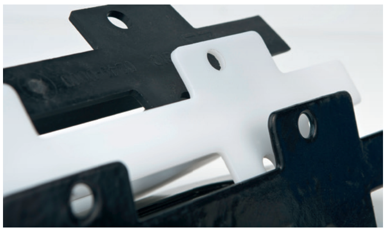
Plastics and fire

Material	Brand name	Colour	UL 94	DIN 4102	EN13501-1
PAI + graphite + teflon	Torlon® 4301 PAI	black	V-0* from 1,5mm		
PAI - GF30	Torlon® 5530 PAI	black	V-0* from 1,5mm		
PAI electric discharging	Semitron® ESd 520HR	grey	V-0* from 1,5mm		
PBI	Celazole® PBI	black	V-0* from 1,5mm		
POM electric discharging	Semitron® ESd 225	beige	HB* from 1,5mm		
PEI electric discharging	Semitron® ESd 410C	black	V-0* from 1,5mm		
PVC-CAW	Simona PVC-CAW	all	V-0 from 1mm	B1 up to 4mm	
PVC-Glass	Simona PVC-Glas	transparent	V-0 from 1mm	B1 up to 4mm	
PVC-TF Extra impact res., UV-stabilized	Simona PVC-TF	all	V-0 from 1mm		
PP-DWU	Simona - Alpha Plus	grå		B2	
PP-EL	Simona	black		B2	
PP-ELs	Simona	black	V-O from 4mm		
PPs	Simona	grey & white		B1 (2-20mm)	
PP foamed	Simona	grey		B2	
PPs, fire resistant	Simona PPs	grey		B1 in 2-20mm	
PETG	Vivak®	transparent 099	V-2* from 3mm	BI (indoor) 0,5-12mm	B-s1, d0 in 2-8mm
	Vivak®	all	V-2* from 3mm	BI (indoor) 0,5-12mm	B-s2, d0 in 2-6mm
PETG UV stabilized	Vivak® UV	transparent 2099	V-0*	B1 in 2-12mm	B-s1, d0 in 2-8mm
PETG UV stabilized	Vivak® UV	all			B-s2-d0 (2-6mm)
	Vivak® UV	grey and bronze		B1 i 5 and 6mm	
PETG	Vivak® design	transparent 099		B1 in 2-5mm	B-s1, d0
A-PET	Axpet® 099	transparent 099	V-2* from 3mm	B1 (indoor) 0,8-6mm	
	Axpet® white 130	white		B1 (indoor)(1-4mm)	
	Axpet® NR clear 099	anti-reflex		B1 (indoor) (0,8-2mm)	
PVC WA 112	KOEMADUR® WA	white and grey	V-O from 1mm	B1 in 1-3 mm	
PVC ES 669 ex. impact resistant	KOEMADUR® ES 699	white	V-O from 0,97mm	B1 in 1-2 mm	
PVC softened sheet	PVC FLEX	all		B2	
PVC softened strips	PVC FLEX NK-C	all		B2	
Foamed PVC extruded	Vikupor® sheet	white		B1 up to 5mm	
Foamed PVC extruded	Vikupor® light	white		B1 in 3-19mm	
PUR Shore EM5 90 A	Puralis	all	V-0	B2 in 12mm	
PVC-U	Gehr PVC-U		V-0*		
ABS	Polythex® ABS	all	HB* from 1,6mm		
	Polythex® ABS brandh.	all	V-0* from 1,5mm		
PMMA cast	Altuglas® CN	transparent	HB from 1,5mm	B2 in 3,4mm	E in 3mm
PMMA extruded	Altuglas® EX	transparent	HB from 1,5mm	B2 in 3mm	E in 3mm
PC 9030	Lexan™ 9030	all	HB from 0,75mm V-0 from 10mm		B-s1, d0 in 2-6mm
PC Margard MR5E scratch resistant	Lexan™ Margard™ MR5E	transparent	HB from 3mm V-0 from 9,5mm	B2	
PC Exell® D and D-ST	Lexan™ Exell™ D og D-ST	transparent			B-s1, d0 in 2-6mm
PC F2000	Lexan™ F2000	transparent and white	V2 from 2mm V0 from 3mm		
		bronze	V0 from 6mm		
		transparent, bronze and grey	5VA from 6mm		
PC F2500	Lexan™ F2500	transparent	V0 from 2mm		
		grey	V0 from 2mm V0,5VB from 5mm		
PC SG 305	Lexan™ SG 305	transparent			B-s1, d0 i 2-6mm
PC film high optical quality and flame retardent	Lexan™ 8010 V	all	VTM-2 0,076-0,381mm / V-2 from 0,381mm		

* The specified fire classifications are derived from data supplied by raw material suppliers.
There is not “UL file Number” also known as a Yellow card on the material.



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