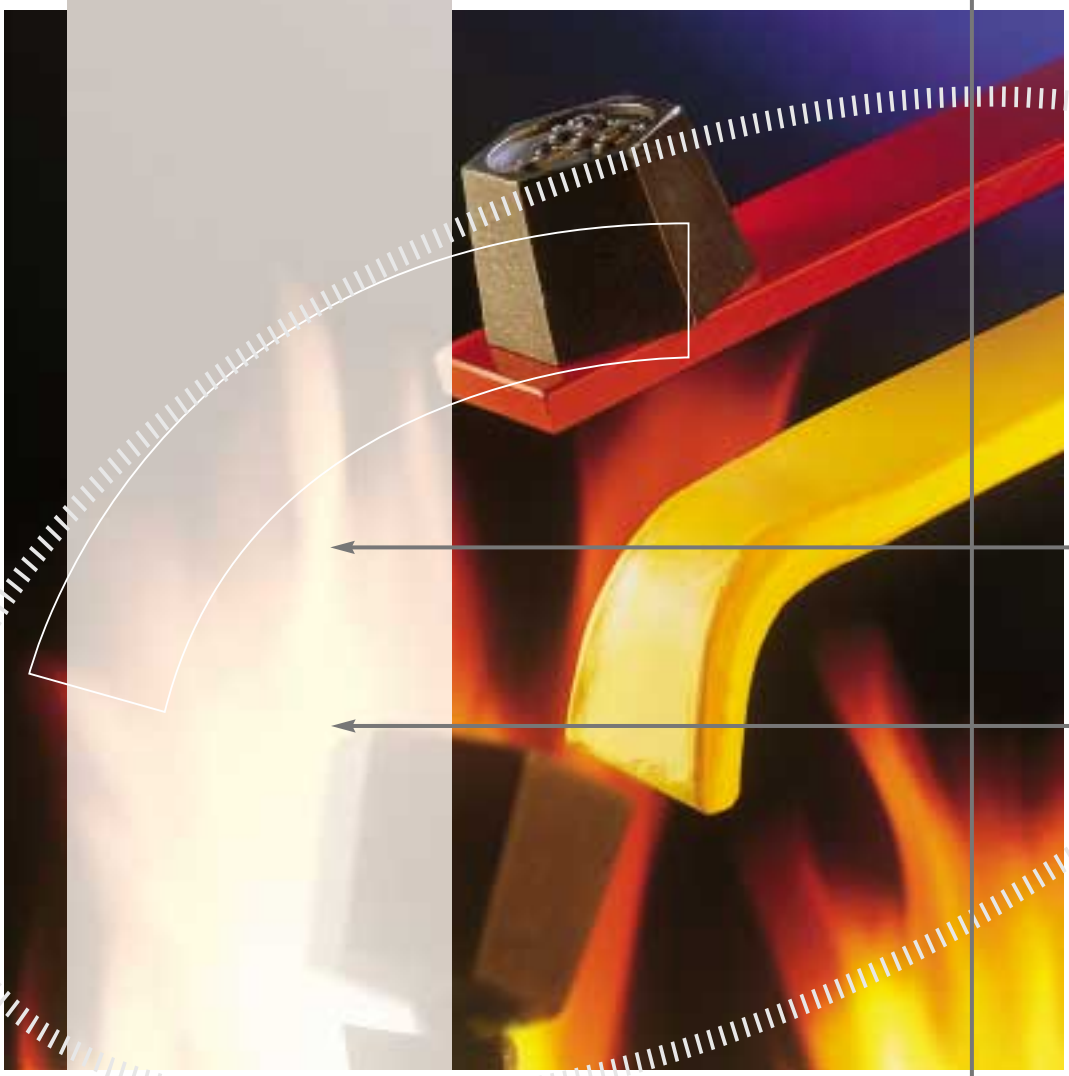

Grivory HT

Enhanced Performance at High Temperatures

GRIVORY®
EMS

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GRIVORY®
EMS

Introduction

Grivory® is the trade name of a group of engineering plastics manufactured and marketed by EMS-GRIVORY.

Grivory HT is a semi-crystalline thermoplastic construction material based on polypthalamide (copolyamides PA 6T/6I and PA 6T/66).

EMS-GRIVORY has developed a completely new and specific process for the polymerisation and compounding of Grivory HT in Domat/Ems (Switzerland).
With the new manufacturing plant, which can be described as the most up-to-date in the world, EMS-GRIVORY is the first and currently only European plastics manufacturer able to produce the new material polyphthalamide using readily available raw materials.

Grivory HT is characterised by a high performance property profile. Technical injection moulded parts made of this material have impressive dimensional stability, even at high temperatures. The property profile of Grivory HT overlaps the performance range of high-performance plastics. The values of Grivory HT for properties such as stiffness and strength at application temperatures up to 120°C - important for the replacement of metals - surpass those of materials such as PPS or PEEK.

Grivory HT is available as granules for processing by injection-moulding methods using conventionally available machines and moulds. The different grades of material within the range result from the type and composition of the basic polymers and their modification with reinforcing materials (glass fibre, minerals), stabilisers and processing aids.

Grivory HT is used for the manufacture of technical components which are characterised by:

- stiffness and strength at high application temperatures
- property values which are influenced very little by water uptake
- good dimensional stability and a low tendency to warp
- good resistance to chemicals
- good surface quality
- efficient and cost-effective manufacture

Grivory HT versions:

- PPA basic polymer: PA6T/6I (Grivory HT1)
- PPA basic polymer: PA6T/66 (Grivory HT2)
- reinforced with glass fibres
- reinforced with mineral
- fire retardant, reinforced with glass fibres (UL-94 V0)
- heat stabilised
  : for maximum long-term working temperatures, e.g. Grivory HTV-5H1
  : for direct contact with foodstuffs or drinking water, e.g. Grivory HTV-5X1

Grivory Nomenclature Example

Grivory H T V - 5 H 1 black 9205

- black 9205 → colour
- 1 → PA 6T/6I
- H → heat stabilised
- 5 → 50%
- V → glass fibres
- T → polyphthalamide

Grivory H T 2 V - 3 H natural

- natural → inherent colour
- H → heat stabilised
- 3 → 30%
- V → glass fibres
- 2 → PA 6T/66
- T → Polyphthalamide
- H → Polyphthalamide

Characteristics of Grivory HT grades

Grivory grade	Characteristcs and properties	Application segment
HTV-3H1 **HTV-4H1** **HTV-45H1** **HTV-5H1** **HTV-6H1**	Injection-moulding grades with 30 - 60 wgt.% glass-fibre reinforcement based on copolyamide (polyphthalamide) PA 6T/6I. Stiff and strong at high application temperatures. Heat stabilised, dimensionally stable, low water uptake, good resistance to chemicals, good resistance to automotive media (fuel, oils, brake fluid) even at high temperatures. UL listed.	Stiff, dimensionally accurate technical parts in mechanical engineering, automotive and electro applications. Functional parts in contact with chemicals and requiring good performance values at high application temperatures.
HTV-4X1 **HTV-5X1** **HTV-6X1**	Injection-moulding grades with 40 - 60 wgt.% glass reinforcement, based on copolyamide (polyphthalamide) PA 6T/6I. Heat stabilised for direct contact with foodstuffs. Stiff and strong even at high application temperatures, good resistance to chemicals. Approved for use in direct contact with hot drinking water according to KTW, WRAS, NSF. Conforms to EU regulations for use in direct contact with foodstuffs. UL listed.	Stiff, dimensionally accurate technical parts in mechanical engineering, automotive and electro applications. Functional parts in direct contact with drinking water at high working temperatures in domestic appliances. All kinds of fittings and seals for warm and cold water.

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Characteristics of Grivory HT grades

Grivory grade	Characteristics and properties	Application segment
HTM-4H1	Injection-moulding grade with 40 wgt.% mineral reinforcement, based on copolyamide (polyphthalamide PA 6T/6I. Stiff and strong, even at high application temperatures. Heat stabilised. Isotropic properties, low warpage, dimensionally stable, low thermal expansion, UL listed.	Stiff, dimensionally accurate technical parts with good dimensional stability and low thermal expansion. Functional and visible parts with electro-chemical surface coating.
HT2V-3H HT2V-45H HT2V-5H	Injection-moulding grades with 30 - 50 wgt.% glass fibre reinforcement, based on copolyamide (polyphthalamide) PA 6T/66 Easy processing, stiff and strong at high application temperatures. Heat stabilised, dimensionally stable, good resistance to chemicals. UL listed.	Stiff, dimensionally accurate technical parts in mechanical engineering, automotive and electro applications. Functional parts in contact with chemicals and requiring good performance values at high application temperatures.
Grivory XE 3818	Injection-moulding grade with 30 wgt.% glass-fibre reinforcement, based on copolyamide (polyphthalamide) PA 6T/66. Self-extinguishing (UL-94 V0 at 0.8 mm). Good flow properties. Stiff and strong at high application temperatures. UL listed.	Stiff, dimensionally accurate technical parts in electro applications. Suitable for SMT soldering processes.
Grivory XE 3819	Injection-moulding grade with 40 wgt.% glass-fibre reinforcement, based on copolyamide (polyphthalamide) PA 6T/66. Self-extinguishing (UL-94 V0 at 0.8 mm). Good flow properties. Stiff and strong at high application temperatures. UL listed.	Stiff, dimensionally accurate techncial parts in electro applications. Suitable for SMT soldering processes.

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Application examples

Electro/Electronic

Examples	Suitable grades
Adjusting screw, metrical hexagonal	Grivory XE 3818
Brush holder	Grivory XE 3818
Card holder	Grivory HTV-6H1
Card reading device housing	Grivory HTV-5H1
Coil former, magnetic valves	Grivory HT2V-5H
Functional parts, laser printable	Grivory HTV-4H1 sw 9219 lw
Functional components	Grivory HTV-4H1
Fuse switch housing	Grivory HTV-5H1
Gear lever	Grivory HTV-4H1
Manufacturing aid, integrated control circuit	Grivory HTV-3H1
Miniature plug, mobile phone	Grivory XE 3819
Motor systems, brush holders	Grivory HTV-6H1
Radar plug	Grivory XE 3818
Switch housings	Grivory HT2V-3H
Table lamps, switches and adjustment mechanism	Grivory HTV-4H1
Transformer housing	Grivory XE 3819

Automotive, under-bonnet

Adjusting flange for inlet manifold	Grivory HTV-5H1
Adjusting screw for alternator	Grivory HTV-5H1
Brush holder plate, assisted steering pump	Grivory HTV-5H1
Brush holder, exhaust gas recirculation valve	Grivory HTV-5H1
Butterfly valve	Grivory HTV-5H1
Butterfly valve	Grivory HTV-6H1
Dome/cooling bath	Grivory HTV-5H1
Exhaust gas recirculation valve housing	Grivory HTV-5H1
Holder for alternator cooling system	Grivory HT2V-45H
Lid motor end plate	Grivory HTV-5H1
Shaft for inlet manifold	Grivory HTV-6H1
Housing, diesel injection pump	Grivory HTV-4H1
Throttle body housing	Grivory HTV-6H1

Chassis, brakes, clutch

ABS sensor support	Grivory HTV-45 H1
Bobbin for ABS/TSC/ESP	Grivory HT2V-3H
Clutch central slave cylinder	Grivory HTV-5H1
Functional parts for power steering	Grivory HTV-4H1
Pedal support	Grivory HTV-5H1
Stabiliser bearing	Grivory HTV-6H1
Valve for hydropneumatic suspension	Grivory HTV-4H1
Venting screw clutch slave cylinder	Grivory HT2V-5H

Automotive construction, interior, exterior, lighting

Bumper adjustment wedge	Grivory HTV-6H1
Cover for middle arm rest	Grivory HTV-5H1
Cover for middle console	Grivory HTV-5H1
Rotation lock for glove compartment	Grivory HTV-5H1

Automotive construction, interior, exterior, lighting

Examples	Suitable grades
Bearing, centre console cover	Grivory HTV-6H1
Fog lamp housing	Grivory HTV-3H1
Functional support, centre console	Grivory HTV-6H1
Guide for steering column adjusting lever	Grivory HT2V-5H
Hatchback lock component	Grivory HTV-5H1
Headlight adjusting screw	Grivory HTV-5H1
Housing for door mechanism	Grivory HTV-3H1
Lamp socket	Grivory HT2V-3H
Lever windshield	Grivory HTV-5H1
MID plate seat adjustment	Grivory HT2V-3H
Spring housing	Grivory HTV-5H1
Support framework headlights	Grivory HTV-5H1
Supporting ring, pneumatic spring	Grivory HTV-4X1
Telephone coves, middle arm rest	Grivory HTV-6H1
Window crank cog segment	Grivory HTV-6H1

Automotive construction cooling systems and air-conditioning

Auxiliary water pump housing	Grivory HTV-3H1
Connector for water collector	Grivory HTV-3H1
Cooling air inlet	Grivory HTV-6H1
Heat exchanger end caps	Grivory HTV-3H1
Insulation, auxiliary heater	Grivory HTV-6H1

Household, foodstuff industry

Clamp valve drive	Grivory HTV-5H1
Hot water feed system for coffee machines	Grivory HTV-4X1
Kitchen slice	Grivory HTV-4X1
Lid of kitchen mixer	Grivory HTV-4X1
Milking machine components	Grivory HTV-4X1
Steam nozzle, Espresso coffee machine	Grivory HTV-4X1
Thermostat coffee machine	Grivory HTV-5X1

Construction, plumbing

Guide sockets	Grivory HTV-6H1
Functional elements, water treatment unit	Grivory HTV-5X1
Housing of kitchen tap	Grivory HTV-4X1
Thermostat control valve housing	Grivory HTV-4X1
Water supply mixer tap lever	Grivory HTV-4X1
Water meter housing support ring	Grivory HTV-6H1

Tools and equipment

Handle, cap, MIG welding unit	GriveryHTV-3H1
Plaster saw tool fastening	Grivory HTV-4H1
Trigger for dispenser of 2-component moulding compound	Grivory HTV-6H1

Properties

Mechanical properties				
Tensile E-modulus	1 mm/min	ISO 527	MPa	dry cond.
Tensile stress at break	5 mm/min	ISO 527	MPa	dry cond.
Elongation at break	5 mm/min	ISO 527	%	dry cond.
Impact strength	Charpy, 23°C	ISO 179/2-1eU	kJ/m^2	dry cond.
Impact strength	Charpy, -30°C	ISO 179/2-1eU	kJ/m^2	dry cond.
Notched impact strength	Charpy, 23°C	ISO 179/2-1eA	kJ/m^2	dry cond.
Notched impact strength	Charpy, -30°C	ISO 179/2-1eA	kJ/m^2	dry cond.
Shore D hardness		ISO 868	-	dry cond.
Ball indentation hardness		ISO 2039-1	MPa	dry cond.
Thermal properties				
Melt temperature	DSC	ISO 11357	°C	dry
Heat deflection temperature HDT/A	1.8 MPa	ISO 75	°C	dry
Heat deflection temperature HDT/C	8.0 MPa	ISO 75	°C	dry
Thermal expansion longitudinal	23 - 55°C	ISO 11359	10^{-4}/K	dry
Thermal expansion transverse	23 - 55°C	ISO 11359	10^{-4}/K	dry
Maximum working temperature	long-term	ISO 2578	°C	dry
Maximum working temperature	short-term	ISO 2578	°C	dry
Electrical properties				
Dielectric strength		IEC 60243-1	kV/mm	dry cond.
Comparative tracking index	CTI	IEC 60112	-	cond.
Specific volume resistance		IEC 60093	Ω m	dry cond.
Specific surface resistance		IEC 60093	Ω	cond.
General properties				
Density		ISO 1183	g/cm^3	dry
Flammability (UL94)	0.8 mm	ISO 1210	Rating	-
Water absorption	23°C/saturated	ISO 62	%	-
Moisture absorption	23°C/50% r.h.	ISO 62	%	-
Linear mould shrinkage	longitudinal	ISO 294	%	dry
Linear mould shrinkage	transverse	ISO 294	%	dry
Product designation as per ISO 1874				PA6T/6I,

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	HTV-3H1 black 9205	HTV-4H1 black 9205	HTV-45H1 black 9205	HTV-5H1 black 9205	HTV-6H1 black 9205	HTM-4H1	HTV-4X1 black 9205	HTV-5X1 black 9205	HTV-6X1 black 9205
	11 000 11 000	14 500 14 000	16 500 16 000	18 000 17 500	23 000 22 500	7 500 7 500	14 500 14 000	18 000 17 500	23 000 22 500
	190 170	220 210	235 230	250 240	260 250	105 105	220 210	250 240	260 250
	2 2	2 2	2 2	2 2	1.5 1.5	1.5 1.5	2 2	2 2	1.5 1.5
	50 50	70 70	75 75	80 80	75 75	50 50	70 70	80 80	75 75
	50 50	70 70	75 75	80 80	75 75	20 25	70 70	80 80	75 75
	7 7	8 8	12 12	11 11	11 11	5 5	8 8	11 11	11 11
	7 7	8 8	12 12	10 10	10 10	3 4	8 8	10 10	10 10
	91 90	92 91	92 91	93 92	93 92	90 89	92 91	93 92	93 92
	280 270	310 300	325 320	340 340	360 360	260 260	310 300	340 340	360 360
	325	325	325	325	325	325	325	325	325
	280	280	285	285	290	145	280	285	290
	155	200	205	210	215	115	200	210	215
	0.20	0.15	0.15	0.15	0.15	0.5	0.15	0.15	0.15
	0.50	0.50	0.45	0.40	0.40	0.5	0.50	0.40	0.40
	150	150	150	150	150	140	140	140	140
	250	250	250	250	250	250	250	250	250
	35 35	35 35	35 35	35 35	35 35	32 32	35 35	35 35	35 35
	575	600	600	600	600	575	600	600	600
	10^{11} 10^{11}	10^{11} 10^{11}	10^{11} 10^{11}	10^{11} 10^{11}	10^{11} 10^{11}	10^{11} 10^{11}	10^{11} 10^{11}	10^{11} 10^{11}	10^{11} 10^{11}
	10^{12}	10^{12}	10^{12}	10^{12}	10^{12}	10^{12}	10^{12}	10^{12}	10^{12}
	1.44	1.53	1.59	1.65	1.78	1.55	1.53	1.65	1.78
	HB	HB	HB	HB	HB	HB	HB	HB	HB
	3.5	3.5	3.3	3.0	3.0	3.5	3.5	3.0	3.0
	1.8	1.5	1.4	1.3	1.2	1.5	1.5	1.3	1.2
	0.20	0.10	0.05	0.05	0.05	0.70	0.10	0.05	0.05
	0.70	0.55	0.50	0.45	0.25	0.85	0.55	0.45	0.25
	MH, 12-110, GF30	MH, 12-140, GF40	MH, 12-160, GF45	MH, 12-190, GF50	MH, 12-220, GF60	MH, 12-070, GM40	MH, 12-140, GF40	MH, 12-190, GF50	MH, 12-220, GF60

Properties				
Mechanical properties				
Tensile E-modulus	1 mm/min	ISO 527	MPa	dry cond.
Tensile stress at break	5 mm/min	ISO 527	MPa	dry cond.
Elongation at break	5 mm/min	ISO 527	%	dry cond.
Impact strength	Charpy, 23°C	ISO 179/2-1eU	kJ/m^2	dry cond.
Impact strength	Charpy, -30°C	ISO 179/2-1eU	kJ/m^2	dry cond.
Notched impact strength	Charpy, 23°C	ISO 179/2-1eA	kJ/m^2	dry cond.
Notched impact strength	Charpy, -30°C	ISO 179/2-1eA	kJ/m^2	dry cond.
Shore D hardness		ISO 868	-	dry cond.
Ball indentation hardness		ISO 2039-1	MPa	dry cond.
Thermal properties				
Melt temperature	DSC	ISO 11357	°C	dry
Heat deflection temperature HDT/A	1.8 MPa	ISO 75	°C	dry
Heat deflection temperature HDT/C	8.0 MPa	ISO 75	°C	dry
Thermal expansion longitudinal	23 - 55°C	ISO 11359	10^{-4}/K	dry
Thermal expansion transverse	23 - 55°C	ISO 11359	10^{-4}/K	dry
Maximum working temperature	long-term	ISO 2578	°C	dry
Maximum working temperature	short-term	ISO 2578	°C	dry
Electrical properties				
Dielectric strength		IEC 60243-1	kV/mm	dry cond.
Comparative tracking index	CTI	IEC 60112	-	cond.
Specific volume resistance		IEC 60093	Ω m	dry cond.
Specific surface resistance		IEC 60093	Ω	cond.
General properties				
Density		ISO 1183	g/cm^3	dry
Flammability (UL94)	0.8 mm	ISO 1210	Rating	-
Water absorption	23°C/saturated	ISO 62	%	-
Moisture absorption	23°C/50% r.h.	ISO 62	%	-
Linear mould shrinkage	longitudinal	ISO 294	%	dry
Linear mould shrinkage	transverse	ISO 294	%	dry
Product designation as per ISO 1874				PA6T/66

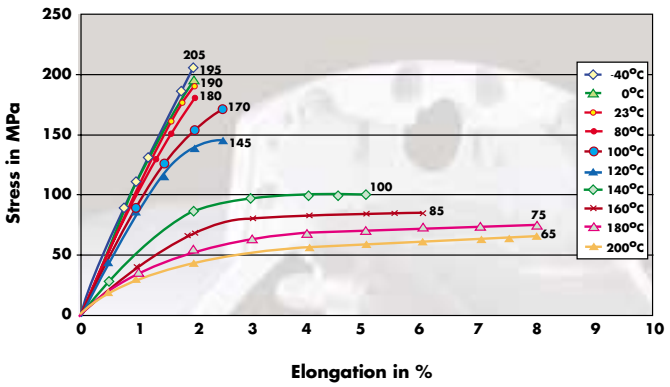
Exit

	HT2V-3H	HT2V-45H	HT2V-5H	XE 3818	XE 3819
	11 000 11 000	16 000 15 500	17 500 17 000	12 500 12 500	16 000 16 000
	200 175	240 215	250 225	150 145	185 180
	2.5 2.5	2.0 2.0	2.0 2.0	1.5 1.5	1.5 1.5
	50 50	75 75	85 85	40 35	35 35
	45 45	65 65	70 70	40 35	35 35
	9 9	13 13	13 13	13 13	12 12
	9 9	12 12	13 13	13 13	12 12
	89 88	90 90	91 91	90 89	91 90
	275 265	315 310	325 325	275 260	320 305
	310	310	310	310	310
	280	285	285	285	290
	200	235	240	215	235
	0.20	0.15	0.15	0.10	0.1
	0.70	0.60	0.55	0.65	0.5
	140	140	140	120 - 140	120 - 140
	240	240	240	240	240
	38 37	38 37	38 37	31 31	31 31
	600	600	600	400	400
	10^{10} 10^{10}	10^{10} 10^{10}	10^{10} 10^{10}	10^{11} 10^{11}	10^{11} 10^{11}
	10^{12}	10^{12}	10^{12}	10^{13}	10^{13}
	1.42	1.56	1.62	1.67	1.76
	HB	HB	HB	V0	V0
	5.0	4.0	3.5	3.5	3.0
	1.8	1.4	1.2	1.3	1.0
	0.15	0.10	0.10	0.10	0.10
	0.80	0.75	0.70	0.65	0.55
	MH, 12-110, GF30	MH, 12-160, GF45	MH, 12-190, GF50	MHF, 11-120, GF30	MHF, 11-160, GF40

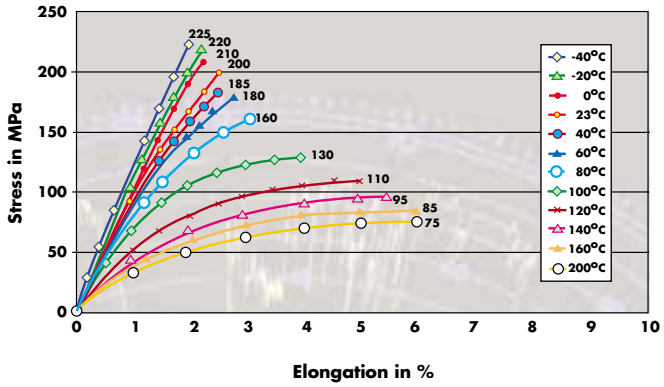
Design data - short-term behaviour

Mechanical properties as a function of temperature

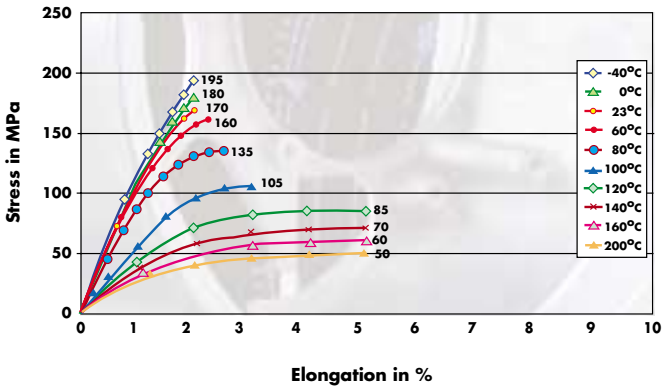
Tensile test Grivory HTV-3H1 - dry



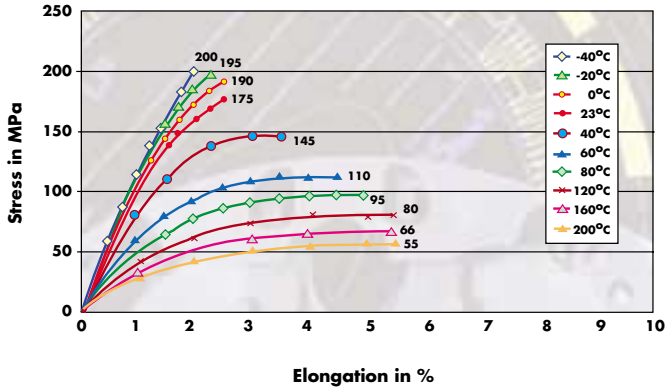
Tensile test Grivory HT2V-3H - dry



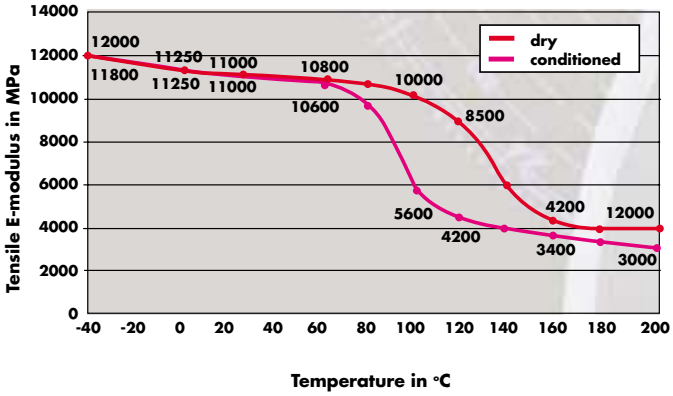
Tensile test Grivory HTV-3H1 - conditioned



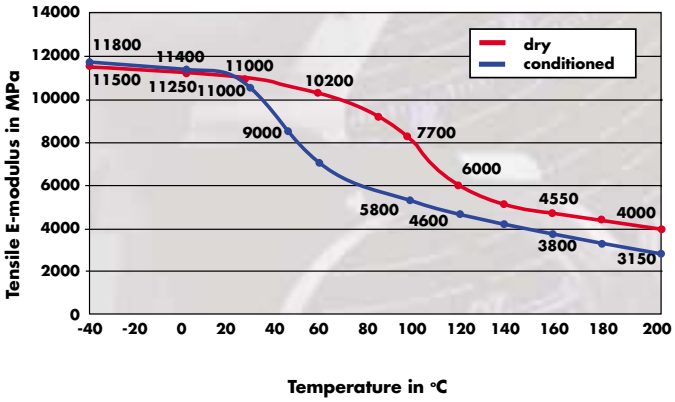
Tensile test Grivory HT2V-3H - conditioned



Tensile E-modulus Grivory HTV-3H1



Tensile E-modulus Grivory HT2V-3H

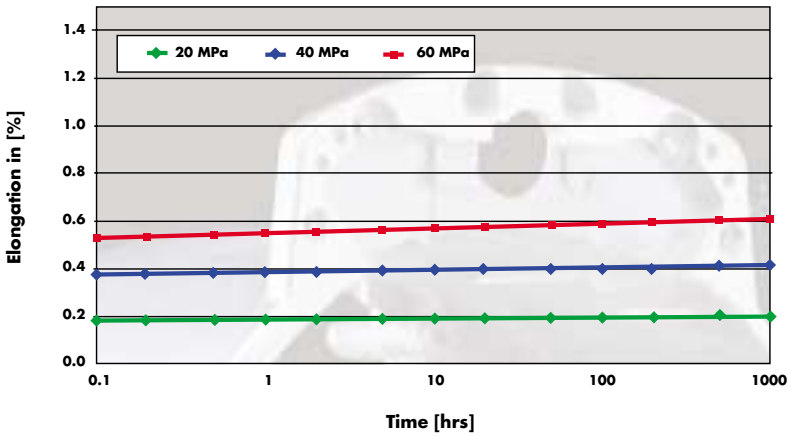


Exit

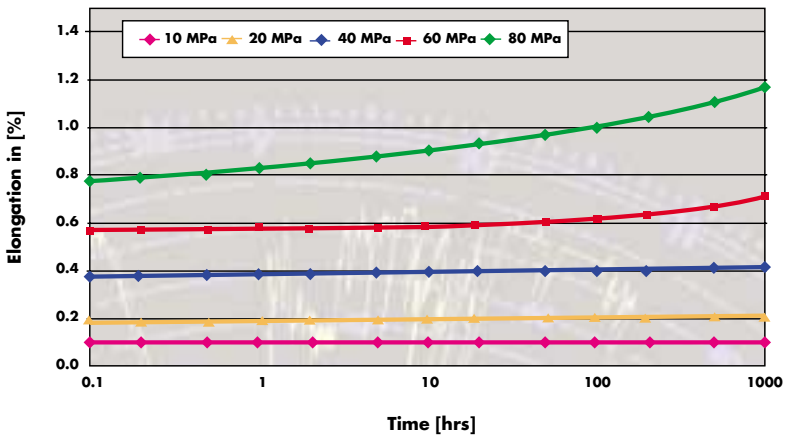
Design data - long-term behaviour

With static, long-term stressing of a material under different mechanical loads, characteristic creep curves can be obtained for plastics. These materials creep as a result of the effects of stress and temperature.

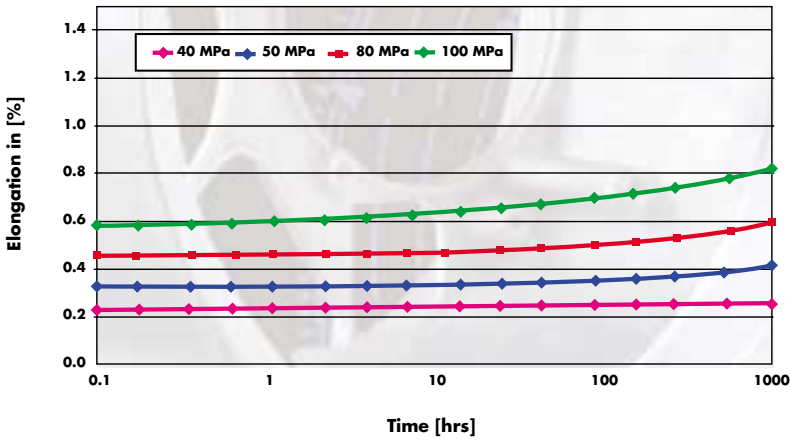
Creep curves for Grivory HTV-3H1
at 23°C / 50 % rel. humidity



Creep curves for Grivory HT2V-3H
at 23°C / 50 % rel. humidity

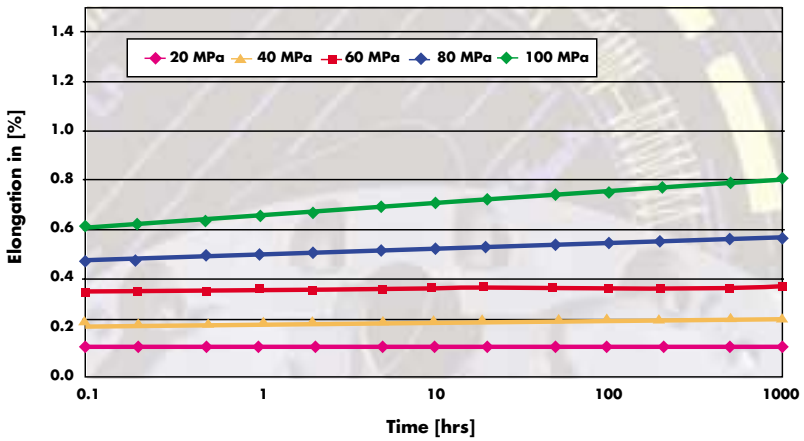


Creep curves for Grivory HTV-5H1
at 23°C / 50 % rel. humidity

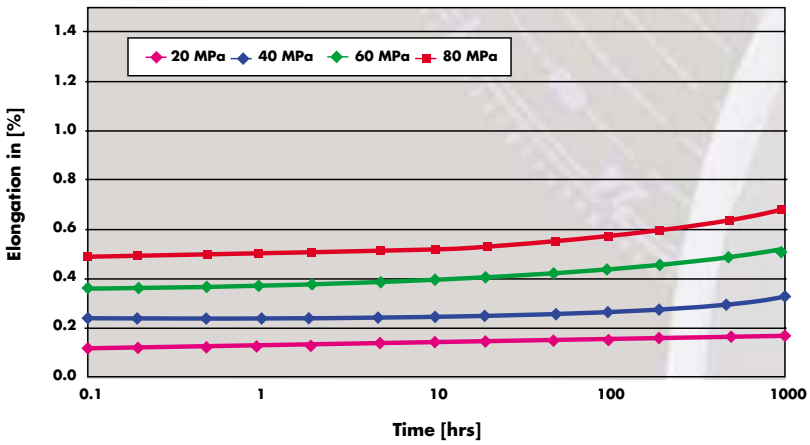


Design data - long-term behaviour

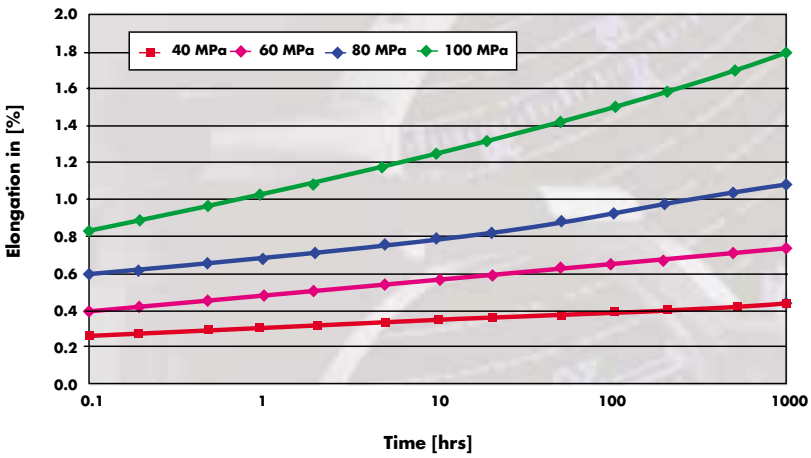
Creep curves for Grivory HT2V-5H at 23°C / 50 % rel. humidity



Creep curves for Grivory HTV-5H1 at 80°C



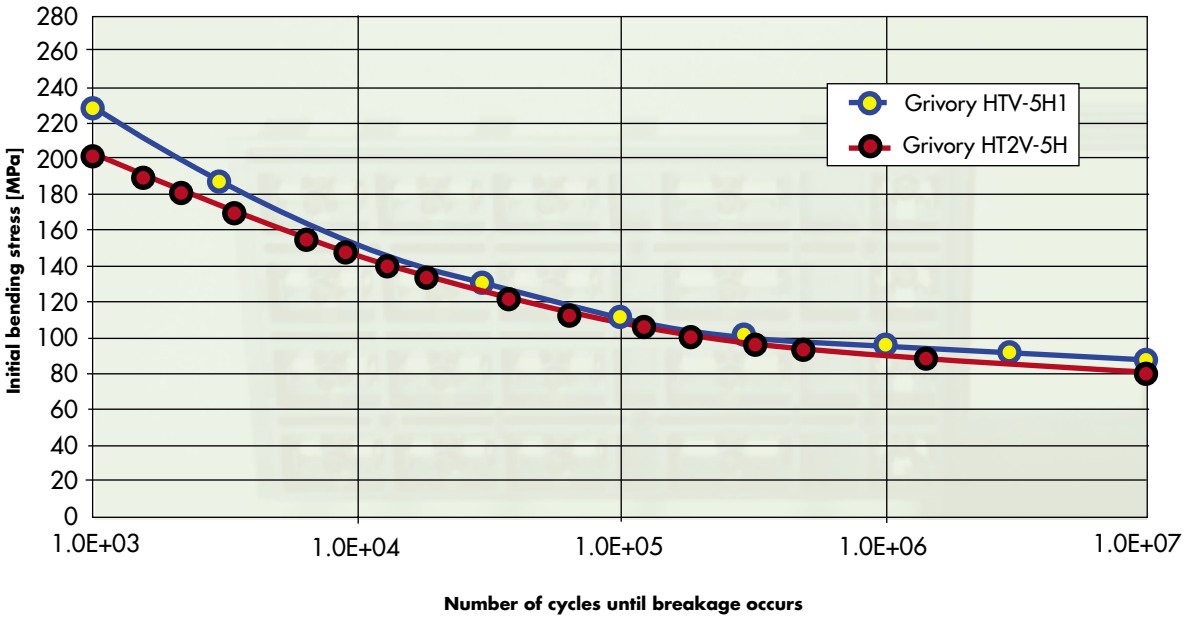
Creep curves for Grivory HT2V-5H at 80°C



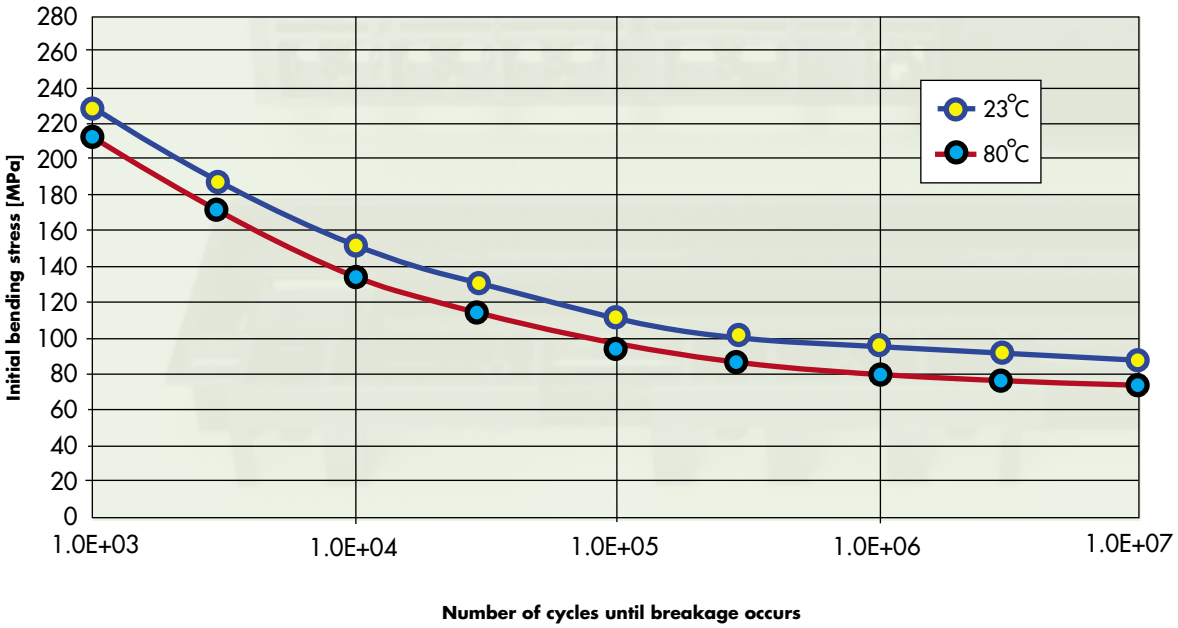
Flexural fatigue strength - Wöhler curves

Dynamic long-term stressing may lead to failure of a construction material. Breakage occurs after a certain number of stress cycles depending on the intensity of the mechanical flexural stress.

Comparison Grivory HTV-5H1 - Grivory HT2V-5H
Flexural fatigue strength



Comparison Grivory HTV-5H1 at 23°C and 80°C
Flexural fatigue strength



Resistance to weathering

The influence of UV radiation causes a change in the physical and chemical properties of all plastics - and therefore, also of polyamides. In particular, the combination of radiation, oxygen, moisture and temperature may lead to a reduction in the working life of construction materials due to chain scission, cross-linking and other oxidative processes.

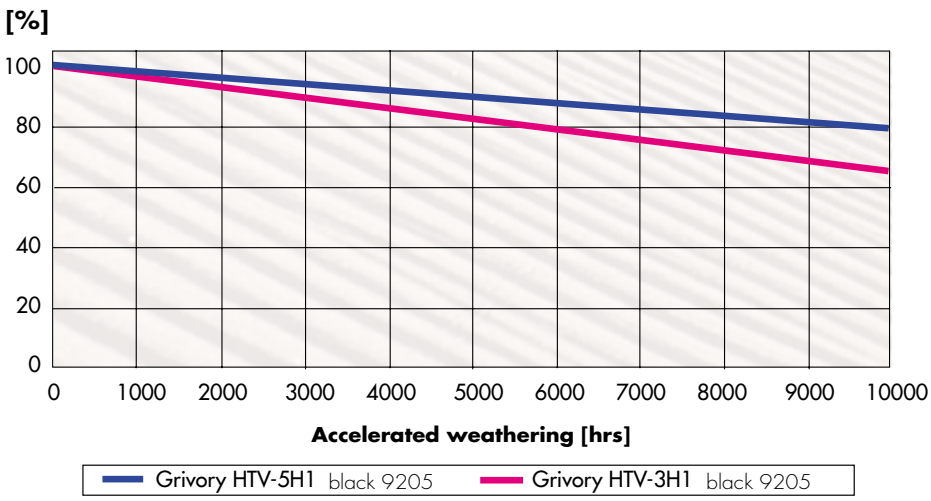
Resistance to weathering is dependent on the structure of the polymers and the kind of reinforcement used (glass, mineral, carbon black etc.). As the plastic usually suffers mainly from weathering of the surface area, the service life of a component is largely dependent on its wall thickness.

The working life of polyamide parts is determined both in accelerated weathering apparatus (filtered Xenon rays according to ISO 4892-2) and in open-air weathering tests (alpine climate at EMS).

In order to test weathering stability, 1-mm-thick test bars are exposed to weathering and their tensile impact strength tested at set intervals.

Grivory HT exhibits very good resistance to weathering and is suitable for long-term exterior applications even under extreme climatic conditions. After 10,000 hours of accelerated weathering the tensile impact strength values for Grivory HTV-3H1 black 9205 are more than 60% and for Grivory HTV-5H1 black 80% of the original figures. Thick-walled parts will have a much longer working life in practical use.

Tensile impact strength of Grivory HTV after weathering



Test method: ISO 4892-2
Test piece: tensile impact bar 1mm
Criterion: tensile impact strength in % of the original value

Exit

Resistance to heat ageing

At raised temperatures, evidence of ageing becomes apparent for all plastic materials including polyamides. Over time, this ageing may have a negative effect on the properties of the material.

The processes involved are of a chemical nature, e.g. oxidation reactions, but may also be caused by physical phenomena such as post-crystallistion or changes in morphology.

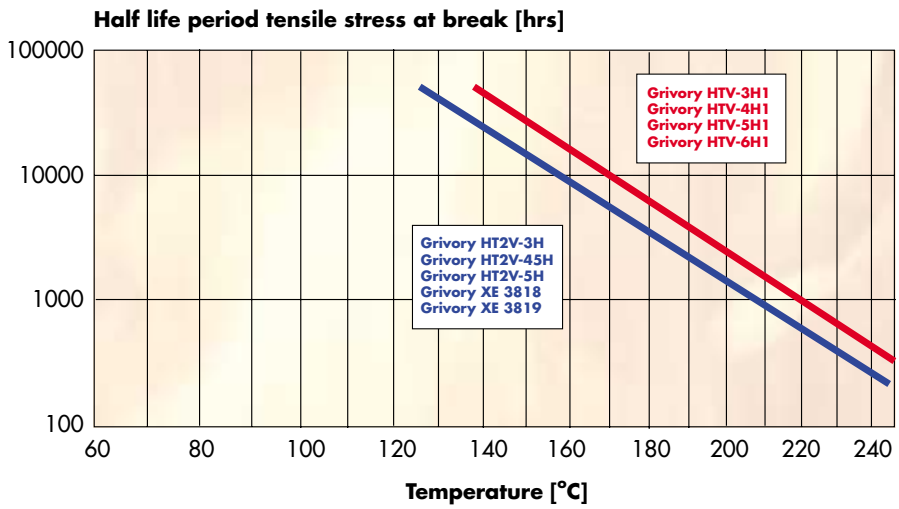
In practice, specification of a temperature-time limit within which the properties of the thermally stressed plastic material must remain at an acceptable level, is of great importance.

In order to determine these temperature-time limits, extensive testing has been carried out. This allows that Grivory HT to be used successfully, even at high temperatures, through the correct choice of product and grade.

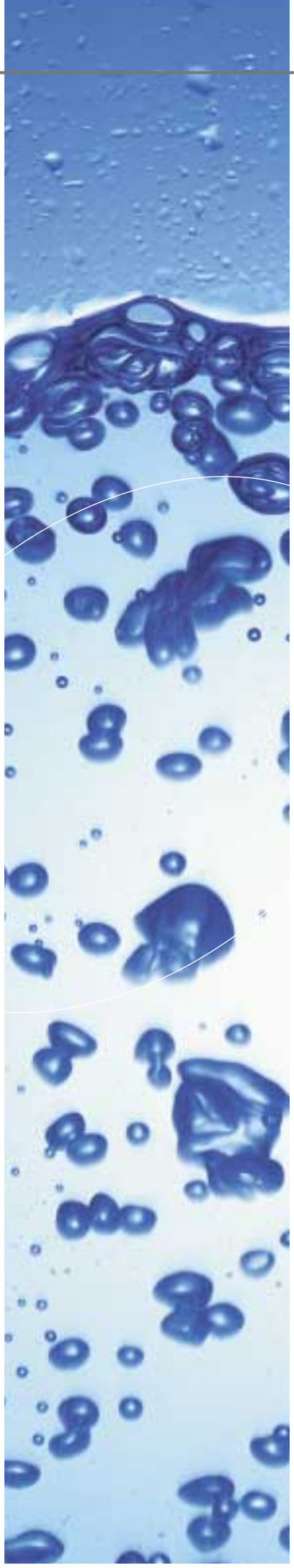
The maximum time or temperature at which a material retains 50% of ultimate tensile strength, compared to the original value, can be read from the data presented in an Arrhenius curve.

Grivory HTV-4H1 has a relative temperature index (RTI) as listed by UL (Underwriter's Laboratories Inc.) of 140°C for impact strength and 150° for tensile strength.

Heat ageing resistance
Arrhenius curve of Grivory HT



Test method: ISO 2578
Test piece: ISO 3167 type A, tensile bar 4mm
Criterion: 50 % reduction in tensile stress at break



Resistance to chemicals

Grivory HT exhibits very good resistance to a variety of organic solvents, fuel, oils, fats and alkalis.
Strong acids such as sulphuric acid, nitric acid or formic acid cause relatively rapid hydrolytic degradation of all polyamides; Grivory HT, however, has good resistance to dilute acids.

Some aggressive chemicals such as cresol, hexafluorisopropanol, methanolic calcium chloride solution or trifluoroacetic acid can cause polyamides to dissolve completely. Glycols and other alcohols, however, only attack these materials aggressively at high temperatures.

•	Acetic acid, conc.
•••	Acetone
•••	Ammonia
•••	Amyl acetate
••	Aniline
••	Antifreeze
•••	Benzene
•	Benzyl alcohol
•	Bromine
•••	Butane
•••	Butanol
•••	Carbon tetrachloride
o	Chlorine
•••	Chlorobenzene
•	Chloroform
••	Citric acid, conc.
•••	Copper sulphate, satt.
o	Cresol
•••	Crude oil
•••	Diesel fuel
•••	Diethyl ether
•••	Engine oil
•••	Ethanol
•••	Ethylene oxide
•••	Fats
o	Fluorine
•	Formaldehyde
••	Formic acid 10% aqueous
o	Formic acid, conc.
•••	Freon liquid F12
•	Freon liquid F22
•••	Glycerine
•••	Heptane
•••	Hydraulic oil
••	Hydrochloric acid 1%
•	Hydrochloric acid 10%
••	Hydrogen peroxide 2%
•	Hydrogen peroxide 10% aq.soln.
o	Hydrogen peroxide 30% aq.soln.
•••	Hydrogen sulphide
o	Iodine tincture, alcholic
•••	Isooctane
•••	Isopropanol
•••	Kerosene
••	Lactic acid conc.
•••	Magnesium chloride 50%
•••	Methane
•••	Methanol
•••	Methyl ethyl ketone
••	Methylene chloride
•••	Mineral oil
o	Nitric acid, conc.
••	Nitrobenzene
o	Oleum
••	Oxalic acid 10% aqueous
•	Ozone
•••	Perchlorethylene
•••	Petrol
•••	Petroleum ether
•	Phenol
•	Phosphoric acid 50% aqueous
•••	Potash (potassium carbonate,
o	Potassium permanganate 5%
•••	Propane
•••	Pyridine
o	Resorcinol
•••	Salicylic acid, saturated
•••	Sea water
•••	Silicone oil
•••	Soap solution
•••	Soda lye 50%
•••	Soda solution 50%
•••	Sodium carbonate 50%
•••	Sodium chloride, satt.
•	Sodium hypochlorite 5% aqueous
•••	Styrene
•••	Sulphur
••	Sulphur dioxide <5%
•	Sulphuric acid 10%
o	Sulphuric acid, conc.
••	Tartaric acid, conc.
•••	Terpentine
•••	Tetralin
•••	Toluol
•••	Transformer oil
••	Trichlorethane
••	Trichlorethylene
•••	Urea 20%, aqueous
••	Uric acid, conc.
••	Vinegar
•••	Water
•••	Wine
•••	Xylol
•••	Zinc chloride, 50% aqueous

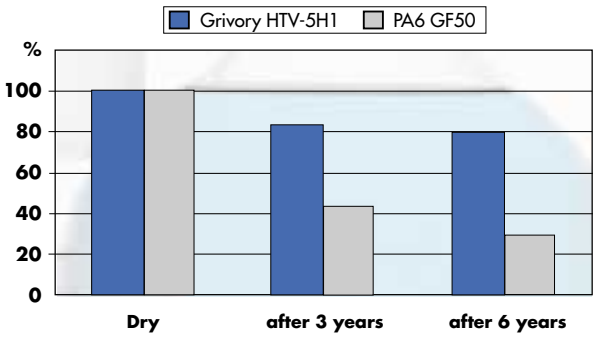
•••	resistant; no or only slight, reversible changes in weight and dimension
••	limited resistance; appreciable changes in dimension and possible irreversible changes in property values occur after longer periods of exposure. Consultation advisable before use.
•	not resistant; may be used in some conditions short-term exposure).
o	soluble or already strongly attacked after only a short time

Exit

Resistance to cold water

Parts made of Grivory HTV absorb water only slowly and in small quantities. Even after many years in contact with water, stiffness values of shaped articles remain practically unchanged. Strength values for parts made of Grivory HTV-5H1 were measured at 200 MPa after 6 years storage in water. This is substantially higher than for comparable parts made of glass-fibre polyamide 6.

The following graph shows measured values of tensile test pieces made of Grivory HTV-5H1 and PA6 GF50 after several years storage in cold water at 23°C.

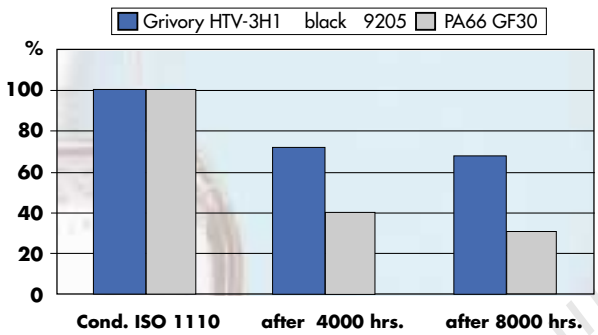


The relative initial values (100%) refer to the tensile strength of freshly moulded, dry parts.

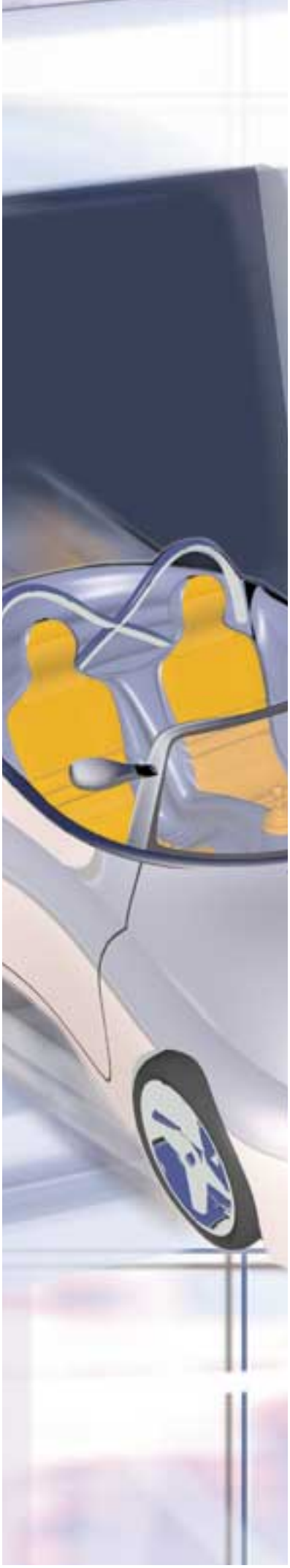
Resistance to hot water and hydrolysis

Parts made of Grivory HTV absorb less water and significantly more slowly than parts made of polyamide 6 (PA6GF) or polyamide 66 (PA66GF). Compared to these materials, Grivory HTV also exhibits markedly better resistance to hydrolysis.

The following graph shows the results of storage of Grivory HTV-3H1 black 9205 and PA66 GF30 black in hot water at 110°C. The specimens used were ISO tensile bars 60 x 10 x 3 mm.



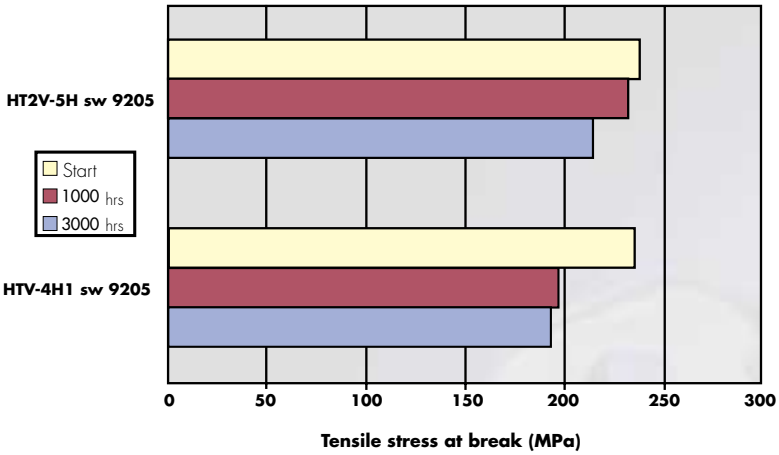
The relative initial values (100%) refer to the tensile strength after conditioning according to ISO 1110.



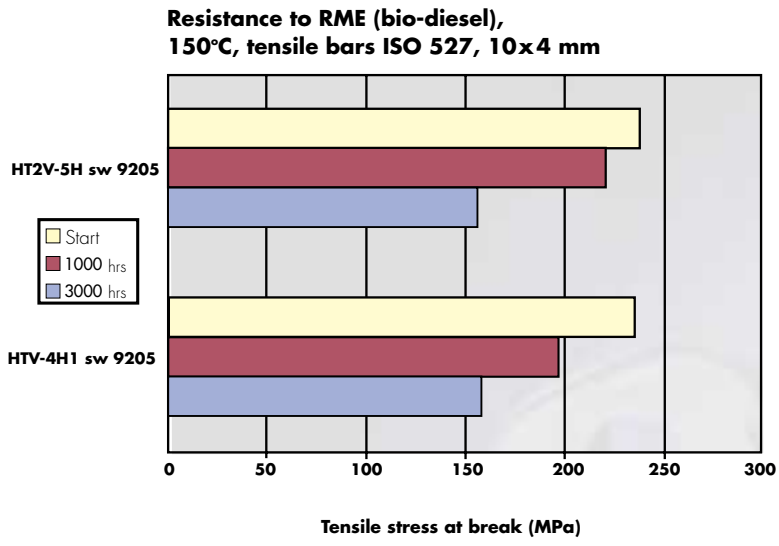
Resistance to automotive media

Grivory HT1 and HT2 exhibit excellent resistance to all common automotive media such as fuels, oils and lubricants.
Both PPA grades are characterised by their resistance to non-polar mineral oil products and synthetic oils at high temperatures.

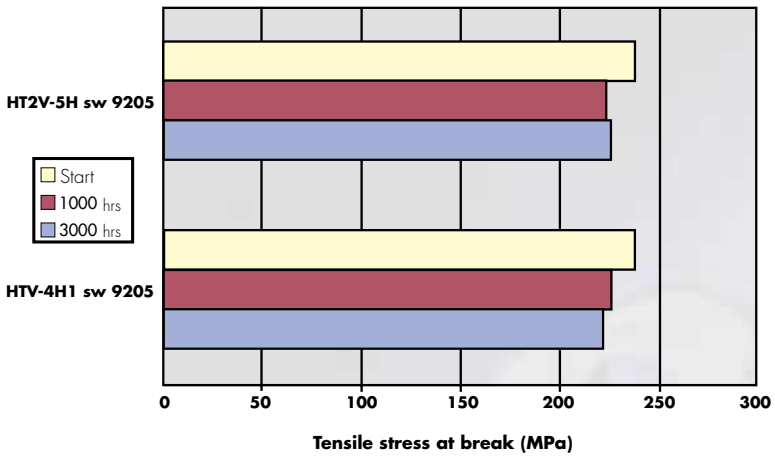
Resistance to diesel fuel,
150°C, tensile bars ISO 527, 10x4 mm



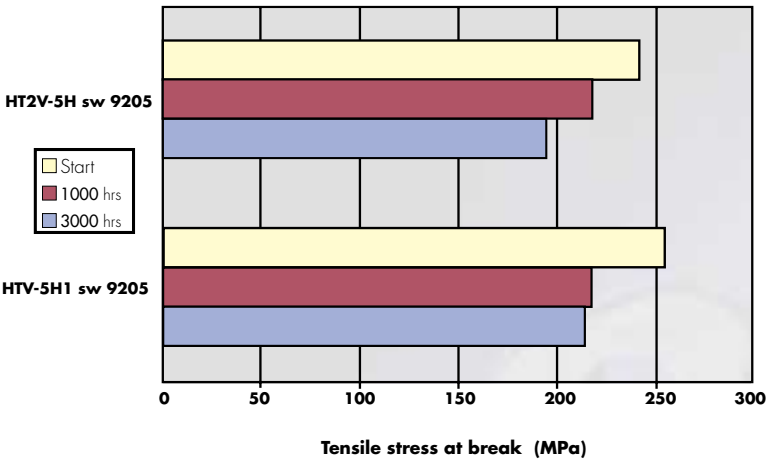
Resistance to RME (bio-diesel),
150°C, tensile bars ISO 527, 10x4 mm



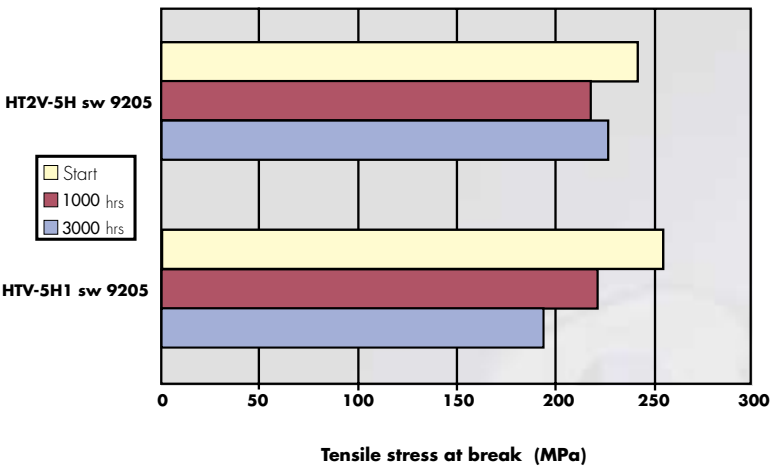
Resistance to Super lead-free petrol,
60°C, tensile bars ISO 527, 10x4 mm



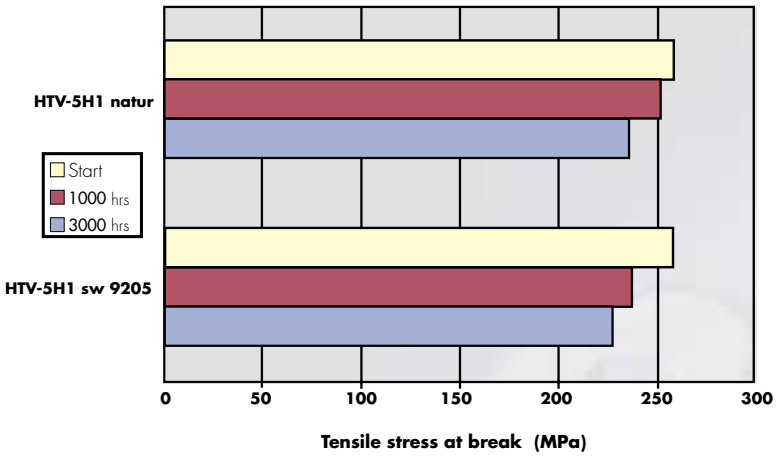
Resistance to brake fluid (DOT 4), 135°C, tensile bars ISO 527, 10x4 mm



Resistance to engine oil SAE 10W 40 (Shell Helix Plus), 135°C, tensile bars ISO 527, 10x4 mm



Resistance to battery acid (H_2SO_4 36 %), 23°C, tensile bars ISO 527, 10x4 mm



Exit

Comparison to other construction materials

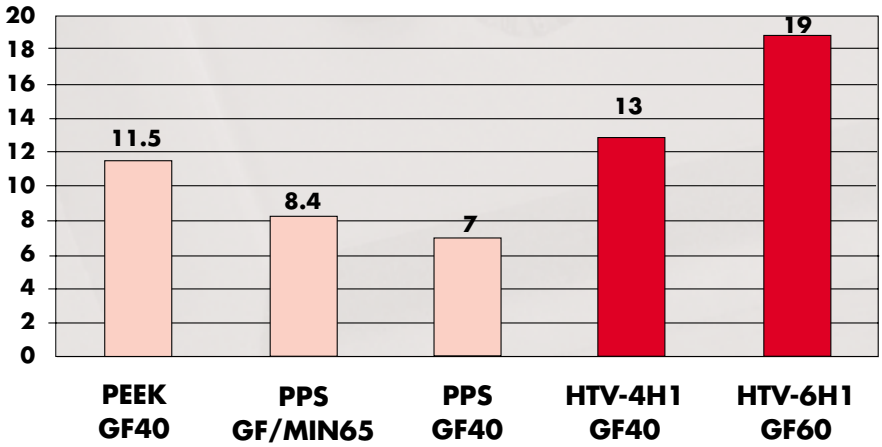
- Thermoplastics

Among thermoplastic materials Grivory HT is positioned in the transition area between high-quality engineering plastics and high-performance plastics.

Fundamentally, the polyphthalamide Grivory HT has the property charactistics of polyamide. Compared to traditional materials based on polyamide 6 (PA6) or polyamide 66 (PA66), Grivory HT is characterised by the fact that its mechanical property values are very little influenced by the take-up of water which is typical of all polyamides. Stiffness, strength and heat deflection temperature values remain at a very high level.

- High-performance thermoplastics

At high application temperatures Grivory HT meets or exceeds the performance of PPS or PEEK with regard to hardness, strength and stiffness. At high temperatures Grivory HT also offers good resistance to a wide range of chemicals, dimensional stability and high strength values even after long-term use. The long-term service temperature for parts made of Grivory HT lies between 140°C and 150°C. Such parts made of Grivory HT1 can also resist short-term thermal impulses of up to 300°C.



- Thermosets

Even though the processing technologies (thermoset/thermoplastic) are different, quality of the finished products with regard to mechanical and thermal properties are comparable.

Material	Breaking strength (MPa)	Tensile E-modulus (MPa)	Heat deflection temperature HDT/A (°C)
Grivory HTV-3H1 (GF30)	170	11000	280
Grivory HTV-6H1 (GF60)	250	21000	290
Melamine formaldehyde	50 – 90	7000 – 9000	155 – 215
Melamine phenol	55 – 85	7000 – 16000	155 – 200
Phenolic resin	35 – 70	8000 – 12000	110 – 250

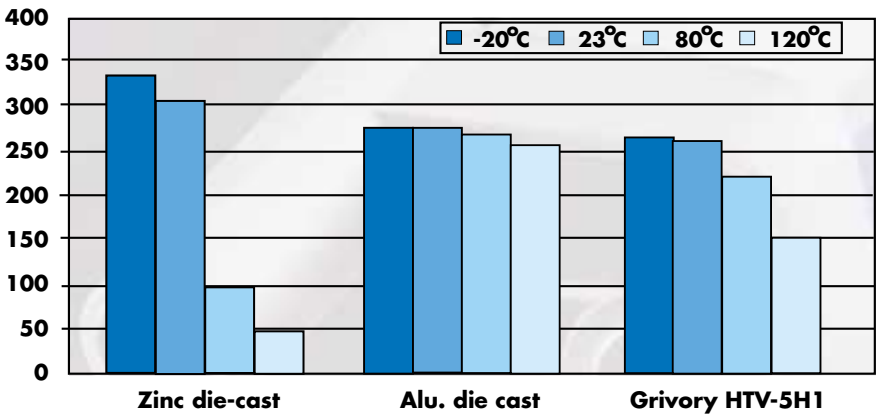
The thermoplastic Grivory HT has better values for key properties, such as stiffness, strength and heat deflection temperature, than most thermoset injection-moulding compounds. The advantage of less costly raw materials is more than offset by the outlay for post-treatment (deflashing). Another point in favour of themoplastic Grivory HT is the fact that it can readily be used as regranulate or recycled.

- Die-cast alloys

Grivory HT is ideatly suited for the substitution of metal, particularly in parts previously made of die-cast alloys.

In such cases the mechanical-thermal properties of Grivory HT are usually sufficient to ensure reliable working of the part.
Parts made of Grivory HT offer significant weight advantages and are resistant to corrosion without surface post-treatment.

Grivory HT, tensile strength (MPa), compared to die-cast alloys



By the use of Grivory HT in place of metals, manufacturing costs can be reduced by 30 – 50 %. Post-treatment processes typical for die-cast alloys - deflashing, coating (colouring) or subsequent cutting of threads - are no longer necessary.

These advantages may already become apparent simply through changes in manufacturing technology due to the use of a different material. A further, in some cases substantial, decrease in costs can be achieved through design integration. Composite (metal/plastic) parts can be made of one material using Grivory HT, several components of an assembly can be combined, metal inserts (e.g. thread bushing) can sometimes be eliminated.

Exit

Approvals

Grivory HT in contact with foodstuffs

EU

In the directive 90/128/EEC and its supplements, the European Union stipulates all conditions which polymers must fulfil if they are to come into direct contact with foodstuffs. According to these guidelines, the polymer matrix of Grivory HT grades fulfils all requirements for contact with foodstuffs. This EU directive has been accepted by the EU countries and Switzerland and has been incorporated into national legislation.

The end products must satisfy the following regulations:
Global migration limit: 60 mg/kg foodstuff

Specific migration value of the monomers:
Hexamethylene diamine: 2.4 mg/kg foodstuff
Isophthalic acid: 5.0 mg/kg foodstuff
Terephthalic acid: 7.5 mg/kg foodstuff

Materials may only be used in contact with foodstuffs if their various additives (flow agents, etc.) have also been approved. The following Grivory HT grades satisfy the EU guidelines (including Synoptic Document No. 7, SCF-L 0-4) for repeated contact with foodstuffs.

Grivory HTV-4X1 natural and black 9205,
Grivory HTV-5X1 natural and black 9205,
Grivory HTV-6X1 natural and black 9205.

Grivory HT in contact with drinking water

If fittings are used for applications where they come into contact with drinking water the fittings themselves and, according to national regulations in some countries the material of which they are made, must be approved.

Germany (KTW):
The following products have been tested according to KTW recommendations of the German Federal Health Authority and are approved for applications where they are in contact with hot drinking water (90°C):

Grivory HTV-4X1 natural and black 9205,
Grivory HTV-5X1 natural and black 9205,
Grivory HTV-6X1 natural and black 9205.

UK (WRAS):
The following materials have been tested and are considered approved products (or WRc) according to the Water Regulations Advisory Scheme (WRAS). They are approved for applications where they are in contact with hot drinking water (85°C):

Grivory HTV-4X1 natural and black 9205,
Grivory HTV-5X1 natural and black 9205,
Grivory HTV-6X1 natural and black 9205.

USA (NSF):

The NSF (National Sanitation Foundation) carries out tests to determine whether or not materials are suitable for drinking water applications.
The following Grivory HT grades are certified for hot-water applications (82°C) according to NSF, Standard 61, "Health Effects":

Grivory HTV-4X1 natural and black 9205,
Grivory HTV-5X1 natural and black 9205,
Grivory HTV-6X1 natural and black 9205.

Fire behaviour

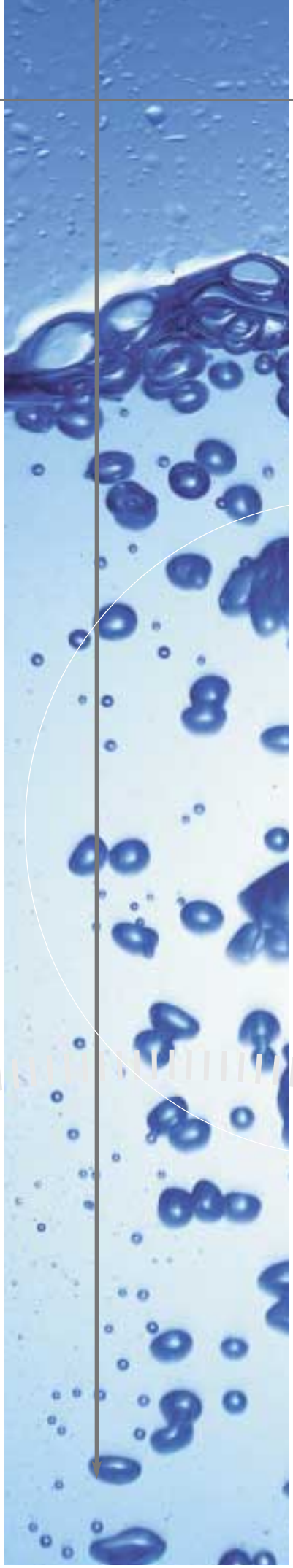
Requirements placed on plastic materials with regard to their fire behaviour are varied and follow the national regulations of each country and legislation governing the field of application. For electronics use, an approval from the Underwriters Laboratories (UL approval) for both the plastic material and finished parts is required in the USA and in European countries. In the annually issued, so-called yellow book, the "Recognized Component Directory", types of plastic material as well as construction components are registered and classified. The "Yellow Cards" of the products are also available via the internet at: http://data.ul.com/iqlink/.

The following Grivory HT products are listed under the reference number of EMS-CHEMIE E 53898 in the flammability class UL94-HB:

Grivory HTV-3H1	Grivory HTV-4X1	Grivory HT2V-3H
Grivory HTV-4H1	Grivory HTV-5X1	Grivory HT2V-45H
Grivory HTV-5H1	Grivory HTV-6X1	Grivory HT2V-5H
Grivory HTM-4H1		

Grivory XE 3818 and Grivory XE 3819 are fire retardant products (UL94-V0) with respectively 30 and 40% glass-fibre reinforcement. The "Yellow Cards" show the properties listed by UL.

All Grivory HT products satisfy the requirements of FMVSS 302 (ISO 3795, DIN 75200). Their burning rates, measured in plate flaming tests, give values which are less than 100 mm/min for wall thicknesses of 1mm and above.



Drying and storage

Grivory HT is delivered dried and ready for use in air-tight bags. Pre-drying is not necessary if it is handled and stored correctly.

Sealed, undamaged bags can be stored for years if sheltered from the weather. A dry room where bags are protected from damage is recommended as storage space. Bags which do become damaged should be immediately re-sealed, or the material placed in an air-tight metal container. It is important that material to be used is stored for some days at processing temperature so that condensation does not form on the surface of the granules when the bags are opened.
The packaging should be opened shortly before processing begins. Material which is in contact with the air for any length of time may reach a critical water content of more than 0.1% in the top layer of granules. During long dwell times with granules in the hopper, a hopper heating system or hopper dryer should be used.

Following manufacture, Grivory HT is dryed to a water content of less than 0.1 % and packed in air-tight bags. If the packaging is damaged or the material stored in contact with the air for too long, the granules will need to be dried again. A too high water content may become apparent through bubbles or foam in an air shot or silvery streaking on the surface of the moulded parts.

Drying can be carried out using the following methods:

Dessicant dryer

Temperature:	max. 80°C
Time:	4 - 12 hours
Dew point of the dry air:	-40°C

Vacuum oven

Temperature:	max. 100°C
Time:	4 - 12 hours

Circulating air ovens are NOT recommended as they tend to cause moistening of the granules due to a high ambient temperature and high air humidity.

The drying time is dependent to a great degree on the moisture content. In case of doubt, drying should be carried out for about 12 hours. Drying temperatures above 80°C in a dessicant dryer can lead to yellowing of the granules. A higher temperature can be used (100°C) in a vacuum oven with lower partial oxygen pressure.

Processing using injection-moulding methods

The processing latitude for Grivory HT1 grades lies between 330° and 350°C; for Grivory HT2 grades between 310°C und 340°C. The recommended processing temperature for each Grivory HT grade is given in the respective data sheet.

Screw

Grivory HT can be processed efficiently using a single-flighted universal three-zone screw with non-return valve. The effective screw length should be between 18 D and 22 D.
Use of a wear-resistant screw is recommended for the processing of Grivory HT grades with high glass-fibre reinforcement levels.

Heating

At least three separately regulated heating zones should be available, capable of achieving barrel temperatures up to 350°C. A separate nozzle heating system is also necessary. The temperature of the barrel flange must also be be adjustable.

Nozzle

An open nozzle may be used when processing Grivory, as this allows free flowing of the material and is very long-lasting due to its simple structure. Needle valve nozzles have proved useful if the melt tends to drool.

Mould design

Design rules typical for thermoplastic materials are valid for mould design and all kinds of sprue system can be used for processing Grivory HT. Conventional wear-resistant tool steel, hardened to approx. 56 - 65 HRC, is sufficient for the shaping surfaces of the mould. Additional abrasion protection is recommended for areas with a higher flow speed.
The mould cavity must have extensive venting. Additional machined ejectors and venting slits (0.02 mm) must be provided at the mould parting line.
As these materials set over a relatively narrow range of temperatures, the sprue must be large enough to compensate for volume reduction during cooling in the holding pressure phase.

Mould temperature

A good heating system combined with a correct and uniform mould temperature is a prerequisite for the manufacture of high-quality injection-moulded articles. The mould temperature influences the setting behaviour and the degree of crystallinity of the article and the surface quality, shrinkage behaviour, warpage, mass tolerance and level of internal stressing linked with this.

Grivory HT1 grades are processed with mould temperatures between 140°C and 160°C, Grivory HT2 grades with mould temperatures between 100°C and 140°C. In order to achieve good surface quality, higher mould temperatures should be used. Pipes and connectors used for heating of the mould must be suitable for use at these temperatures.

Post treatment

Bonding

Grivory HT is one of those construction materials which are more difficult to bond due to their excellent resistance to chemicals. However, technical bonds can be created with a careful choice of adhesive and the correct process technology.

The most common reaction adhesives:

Single-component systems:

• Cyano acrylate or methacrylate adhesives are well suited for bonding Grivory HT to metal. Due to their very short setting times, these single-component adhesives are particularly advantageous for bonding of shaped parts with a small surface area.

Two-component systems:

• Epoxy resin adhesives with a long pot life (curing time) are suitable for use on large bonding areas and can be used to fill gaps.

A significant improvement in bond quality can be achieved by pre-treatment.

Kinds of pre-treatment:

- Degreasing: use of organic solvents such as acetone, for example.
- Mechanical removal: brushing, grinding, sand blasting
- Electro-chemical: Corona discharge, low-pressure plasma
- Thermal: flaming
- Chemical: treatment with caustic substances or primers. Suitable systems are available from adhesive manufacturers.

The choice of suitable adhesive must be made separately for every application as apart from the material to be bonded, the joint geometry, the bonding gap and the surface quality all have a large influence on the resulting bond. Our customer advice department will be happy to supply you with further information regarding choice of adhesive and suppliers.

Welding

Good welding results can be achieved for all highly reinforced Grivory HT grades using friction welding methods such as ultra-sonic and vibration welding. During design work the maximum possible size of joint area should be planned for parts to be welded. During welding the contact pressure must be selected and adjusted according to the type of material and the geometry of the parts being welded. This pressure may lie between 4 MPa and 7 MPa. Only limited welding is possible with Grivory HT using infra-red and hot-plate methods. Due to the large degree of reinforcement and rapid cooling times, an increase in temperature to only slightly above the melting point of 310 - 325°C is not sufficient to achieve a good weld using infra-red or hot-plate welding methods. Welding at temperatures above 360°C is not possible due to the risk of degradation of the material.

Screw fastening

Parts made of Grivory HT can be fastened well with self-tapping screws. Metric threads can be integrated directly into components.

Painting

Due to its excellent resistance to most solvents, Grivory HT can be painted with one or several coats of different kinds of paint to achieve a good cover without impairing the mechanical properties. Single and two-component paints with their solvent content adjusted to suit the material to be painted, are most suitable.

Pre-treatment:

Improved paint adhesion to shaped parts made of Grivory HT can be achieved using the pre-treatment methods given above under "Bonding".

Laser printing

Grivory HT grades can be made suitable for inscribing with laser-printing by the addition of special pigments (e.g. black 9219 LW) or masterbatches.

Machining

It should be borne in mind that, for economical reasons, the design of a component should make machining unnecessary. If machining is used to make prototypes, it should be remembered that the properties are not necessarily identical to those of an injection-moulded component. The following guidelines have proved helpful:

		Method			
	Unit	Turning	Milling	Sawing	Drilling
Clearance angle	degrees	5-10	3-15	15-30	5-10
Rake angle	degrees	2-10	5-15	3-6	6-15
Cutting speed	m/min	200-400	300-800	200-500	50-120
Rate of feed	mm/U	0.1-0.5	0.1-0.5	-	0.1-0.5
Tip	degrees	-	-	-	90-120
Circular pitch	mm	-	2-8	-	-

Use of carbide-tipped tools is recommended due to the large amount of reinforcing material in Grivory HT grades.

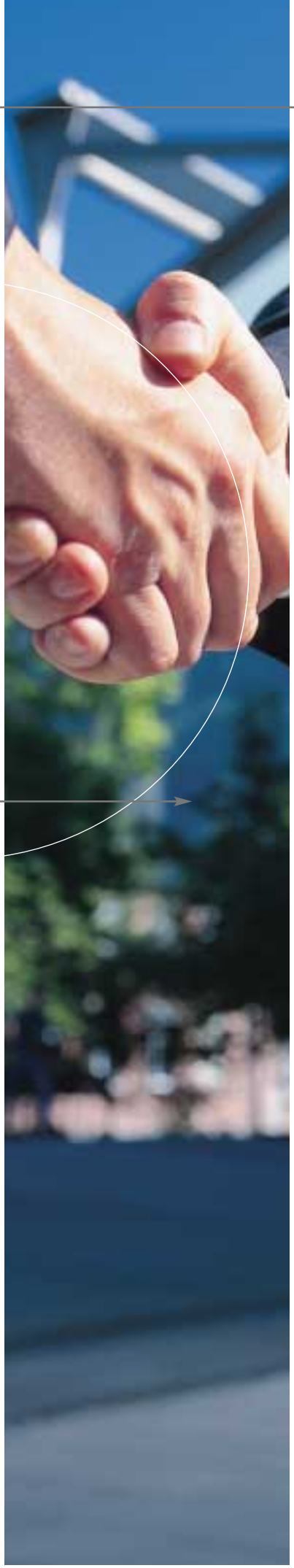
Use of reclaimed material

As the material is thermoplastic, it is possible to reprocess faulty parts made of Grivory HT and carry out recycling of a certain amount of reclaimed material in the injection-moulding process. The following points should, however, be taken into consideration:

- Water already absorbed
- Milling: dust content and grain size distribution
- Pollution from other polymers, dust, oil etc.
- Quantity ratio, percentage added to original material
- Possible changes in colour
- Changes of the mechanical properties

Particular care must be taken by the operator during addition of the reclaimed material.

GRIVORY® EMS



Customer services and technical support

We advise and support our customers with know-how, starting from development right through to serial production of a part. We also offer quality, reliability and technical support as part of our customer services.

- We create an optimal material recommendation for your application.
- Our customer service centre is equipped with modern injection-moulding machinery and extruders to find solutions to problems which may arise.
- The high quality of our materials is constantly subjected to tests and quality assurance in order to provide you with high-performance products.
- Our up-to-date testing laboratories are at your disposal for testing of mechanical, thermal, electical and chemical properties.

CAE

Using computer-aided calculation systems, the customer services of EMS-GRIVORY are capable of offering well-founded design support in this sector. The CAE systems used are simulation of injection-moulding processes with the Moldflow programme modules MF/Flow, MF/Cool, MF/Fiber and MF/Warp on the one hand and part design using the Finite Element (FE) programmes I-DEAS und ANSYS on the other. Rheological simulation allows determination of the optimum gate position(s) for a mould even before work on its construction has begun. These programmes can also help when changes to existing moulds become necessary, by indicating the most focussed way of arriving at a solution. The scope of calculations covers simple filling simulation with the possibility of taking the influence of the cooling system into account, right through to qualitative statements about shrinkage and warpage of shaped parts. Part design using FE methods provides information about the most greatly stressed areas. This can indicate possible weak points and allows suitable modifications to be carried out. Use of the two 3D-CAD systems I-DEAS and CATIA in combination with the VDA, IGES and STEP interfaces, allows EMS-GRIVORY to use the customer's own 3D-CAD data as a basis for the simulation calculations.

Prototype moulds

Quick realisation and rapid implementation of a good new idea is the key to success. With construction of prototype moulds, EMS-GRIVORY helps minimise the risk, save valuable time and reduce costs. As with manufacturing moulds, MOLDFLOW and FEM simulations can be carried out for mould design. Using prototype moulds, a small series of moulded parts can be manufactured at minimum expense, thus allowing practical tests to be carried out before starting serial production. This preparation work reduces outlay and helps avoid expensive modifications to a manufacturing mould before the start of serial production.

Testing

The Business Unit EMS-GRIVORY has state of the art equipped laboratories at its disposal in our material testing and quality control departments.

Our equipment infrastructure not only allows us to determine conventional mechanical, thermal and electrical properties of our construction materials for data sheets and homologisation, but also to carry out research and development work and to support application development work with practical tests.

- The rheology laboratory is capable of providing key material data necessary for the simulation of injection-moulding processes.

- Tests to determine the resistance to chemicals, heat and weathering provide us with indications of application possibilities for our materials under exteme conditions.

- Chemical and mechanical property tests allow us to check the quality of our products and to ensure consistency of quality levels.

We can also help customers with specific questions. In order to help reduce hydrocarbon emissions from vehicles we have developed a method for determining the permeability of plastic materials to circulating fuel. The EMS P-Tester (P as in permeation) is now available to the automotive industry for measurement of the permeation behaviour of fuel system components under practical conditions.

In addition, our material testing department uses a wide variety of special equipment. Among these testing systems are a fuel circulation plant to test the working life of plastic fuel lines under extreme conditions and a hot-air swelling test apparatus for testing extrusion blow-moulded parts.

With these services we offer our customers active support in the choice of material and material development as well as with design and testing.

CAMPUS

EMS-GRIVORY has worked actively on the formation of the CAMPUS data bank since 1989. At the moment, our test laboratories have characterised around 150 construction materials according to the CAMPUS profile with regard to physical and mechanical properties. These are available both in table form (primary properties) and in graph form (functions). Material descriptions, typical applications and processing notes supplement the product profile.

CAMPUS stands for Computer Aided Material Preselection by Uniform Standards.

The data bank contains a chosen selection of meaningful test results which accurately describe the property profile of the material. Test bars on which the test data is obtained, are manufactured according to standardised injection conditions. Determination of the characteristic figures is also carried out according to uniform ISO standards.

The particular advantage of this data bank is that customers can make a direct comparison of the properties of construction materials from more than 40 manufacturers. Following distribution of CAMPUS, it has been possible to avoid uneconomical duplication of specifications and measuring methods. At the same time, possibilities for rationalisation and automation of the testing of moulding compounds have become apparent.

We will be pleased to provide you with a CAMPUS disk or CD on request. The CAMPUS data, together with the data bank programme, can be downloaded from our homepage - www.emsgrivory.com - at any time and at no cost.

Quality standards

Our quality management system is based on the standards ISO 9001 and QS-9000. It is certified by the "Schweizerischen Vereinigung für Qualitäts- und Management-Systeme" (SQS). The new regulation QS-9000 was created by the American automotive industry. In contrast to ISO 9001, valid throughout the world, QS-9000 contains more far-reaching and stricter regulations.

Our management system is process-oriented. Customer satisfaction is our highest priority. Our efforts are concentrated on conformity with quality requirements and appropriate use of resources.

The quality planning cycle begins with market research and ends with customer service. In the intermediate development phase, research and manufacturing are both involved in-depth.
Development projects are handled by interdepartmental teams. These teams work on the principle of "Simultaneous Engineering": The team members do not think and act solely within the confines of their respective department, but all work towards a mutual goal. Modern technology (such as statistical test planning) and preventive methods (such as failure mode and effect analyses) play a central role. The guiding principle of project management is "Prevention before Correction".

Following the wishes of our automotive customers we use the product release process (PPAP) according to Daimler-Chrysler, GM and Ford for new or adapted products.

Statistical process control is used for monitoring and improving our manufacturing processes. The accuracy of our testing and measuring equipment is determined in control tests.

Continual improvement of products, services and productivity is the subject of official improvement programmes to which all employees are committed.

In the first place, our quality management system serves our customers, which is why we always focus on their actual requirements and not on bureaucratic methods.

Grivory-Link

Further information can be found on our homepage:

www.emsgrivory.com

or from the following brochures which can be ordered directly from our public relations department quoting the corresponding code number:

Product data:

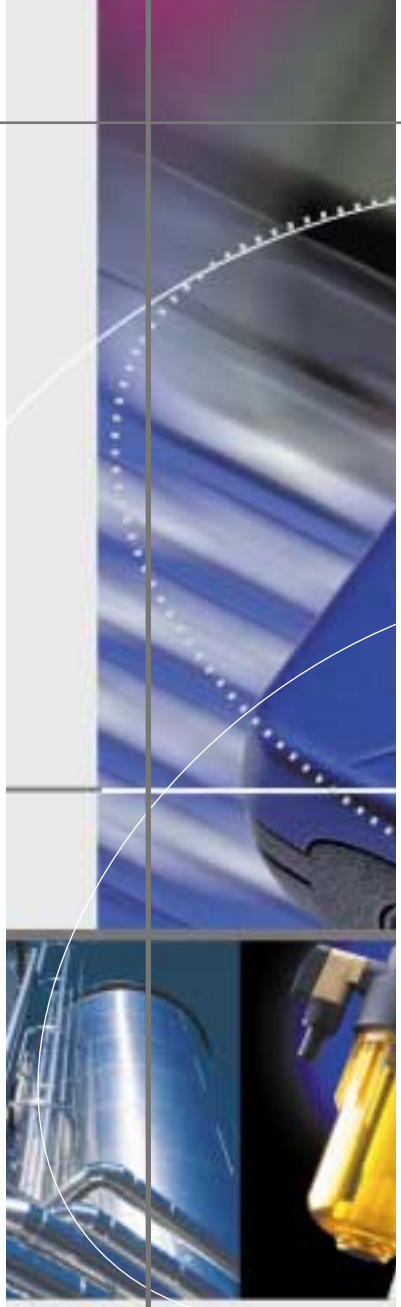
- Comparison table Grilamid, Grivory, Grilon: Comparison of mechanical, electrical, thermal and general properties
  Code: 2.002
- Product review engineering plastics
  Code: 2.001
- Grivory GV - The economical material alternative to die-cast alloys
  Code: 5.009
- Grivory GV – Piece-costs halved - Strong polyamide replaces metal
- Code: 5.003
- Grivory GV – Helps cool calculators save costs
  Code: 5.005

Technical data

- Notes concerning injection moulding of Grilamid, Grivory and Grilon
  Code: 7.001
- Injection moulding equipment
  Code: 7.005
- Resistance to chemicals
  Code: 2.006
- UL and CSA registration in the USA and Canada for Grilamid, Grivory and Grilon
  Code: 2.007
- Tube extrusion
  Code: 7.002
- Designations of EMS-GRIVORY thermoplastic materials according to ISO and DIN
  Code: 2.003
- Campus CD-Rom
  Code: 11.002

Market segments

Automotive
- Innovative system solutions for automotive construction
  Code: 10.001



Delivery form

Grivory is delivered as dry, cylindrical granules packed in moisture-tight bags.

Pre-drying is not necessary if the bags remain unopened and undamaged. A wide variety of Grivory grades are available from stock in both natural and black.

Special colours or bulk deliveries are available on request. Our sales engineers will be happy to advise you further.

Recycling of packaging material

The disposal markings on our packaging materials are a criterion for sorting and ensure segregated disposal.

In some European countries EMS-GRIVORY pays a disposal charge e.g. with RIGK for the return of empty containers free of charge. Please refer to the brochure "Standard packaging" for details.

The data and recommendations given here correspond to our current knowledge. Liability with regard to application and processing cannot be accepted.
Note: EMS-GRIVORY cannot assess possible future health risks which may result from direct contact of its products with blood or tissue. For this reason, EMS-GRIVORY cannot promote medical applications involving direct contact of plastic with blood or tissue.

Domat/Ems, February 2003

GRIVORY® EMS

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