

## **Grivory GV**

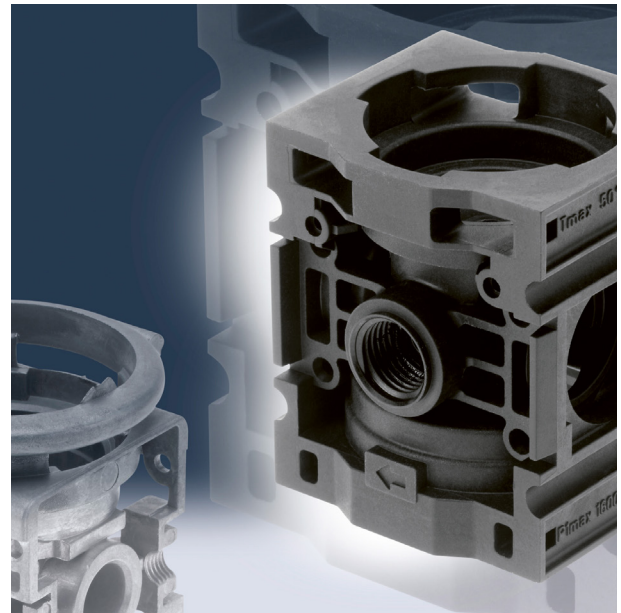
**The Proven Material  
for Metal Replacement**

**GRIVORY®**  
**EMS**



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## Introduction

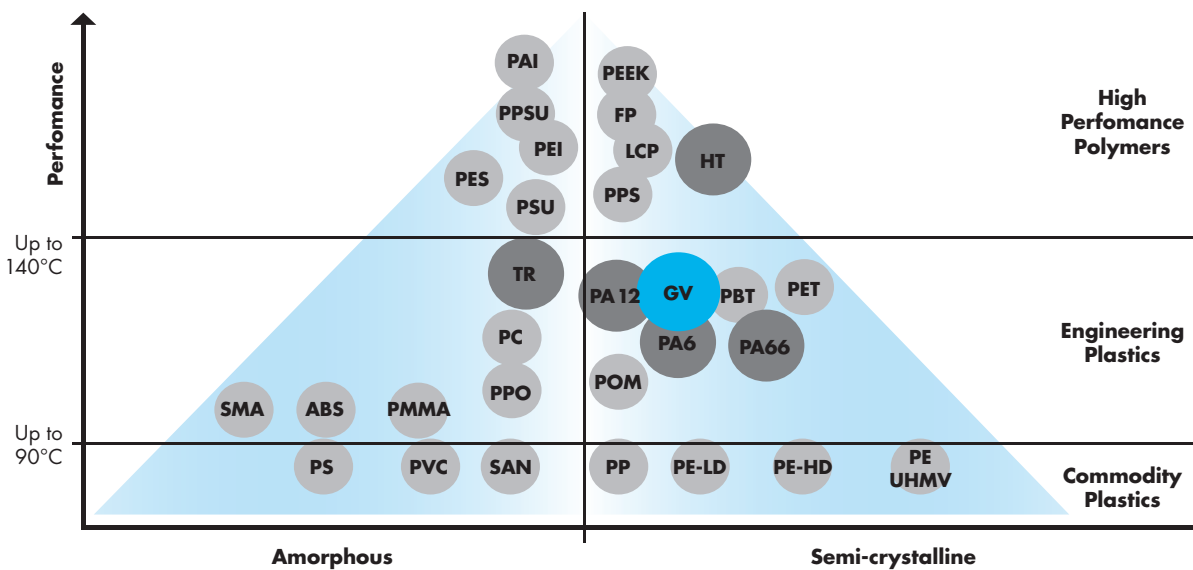
Grivory is the trade name for EMS-GRIVORY's family of semi-crystalline, partially aromatic polyamides for metal replacement. Grivory GV encompasses alloys of partially aromatic and aliphatic polyamides with the following basic properties:

- High stiffness and strength
- Excellent creep resistance
- Minimal influence of moisture on strength and stiffness
- High dimensional stability
- Good chemical resistance
- Very high surface quality

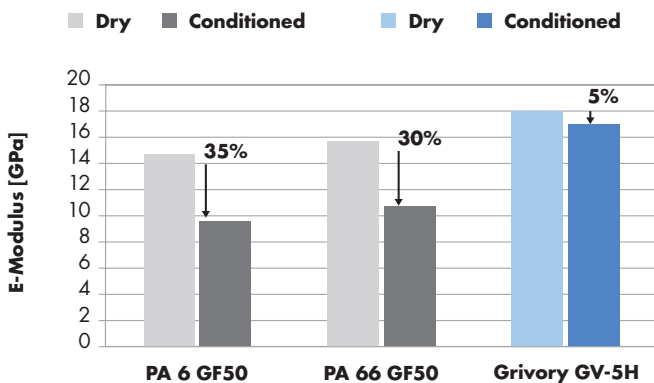
Grivory brings enhanced properties with each generation:

- G – PA 66 + PA6I/X – Original  
The standard for metal replacement
- G5 – PA66 + X  
Creep resistant at high temperatures
- G6 – PA612 + PA 6I/X  
Low moisture absorption
- G7 – PA 66/X  
High gloss, UV-stable

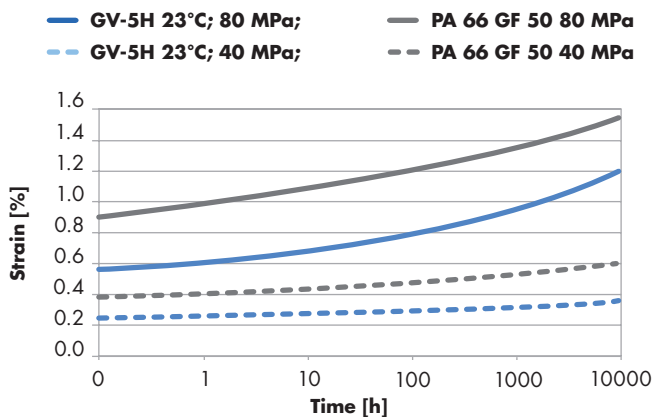
The Grivory G product portfolio is a powerhouse of reinforcement and modification combinations. The rugged properties of Grivory G complements metal replacement applications across all markets.



### Grivory GV maintains high stiffness and strength even after moisture absorption



### Grivory GV: Low Creep Grivory GV-5H vs. PA 66 GF50 (50% r.h.)





## ■ Grivory GV Highlights

Grivory G5V, G6V, and G7V are the newest members of the Grivory family. The following table rates their

features in relation to each other as well as to the standard grades.

Grivory	GV	GV EF	GVS	GVX	G5V	G6V(X)	G7V
Flowability	○	+	++	+	○	○	++
Strength	+	+	○	+	+	○	○
Creep resistance	○	○	○	+	++	○	○
Surface quality	○	○	+	++	○	+	+++
Warpage	○	○	○	+++	○	++	+
UV resistance	○	○	○	○	○	+	++
Moisture abs.	○	○	○	○	+	++	○
Max. operating temperature [°C]	80	80	80	70	100	80	70

+++ Best ++ Very Good + Better ○ Good

## ■ Grivory GV Product Assortment

The following table lists the reinforcements and modifications available (main products).

Grade	Reinforcement	Characteristic
GV	20%, 40%, 50%, 60% glass fiber	The Standard for Metal Replacement
GV EF	50%, 60% glass fiber	Easy flow, Good Surface Quality
GVS	50%, 60% glass fiber	High Flow, Very Good Surface Quality
GVX	50%, 60%, 65%, 70% glass fiber	High Transversal Strength and Stiffness, Low Warpage
GV FWA	20%, 40%, 50%, 60% glass fiber	Food and Drinking Water Contact
GV V0	30%, 40%, 50% glass fiber	UL94 V0, some Products with UL 94 5VA
GVN	35%, 50% glass fiber	Impact Modified Grivory GV
GC	40% carbon fiber	Extreme Stiffness and Strength, Electrically Conductive
GM	40% mineral	Mineral Filled, Low Warpage
G4V	50% glass fiber	High Flow, Slow Crystallisation, Good Surface Quality
G5V	35%, 50% glass fiber	Creep Resistant, Constant Properties up to 80 °C
G6V	55%, 60%, 70% glass fiber	Low Moisture Absorption, Improved Dimensional Stability
G7V	35%, 50% glass fiber	Maximum Surface Quality and Flow Properties, UV stable

# Grivory GV

## ■ Grivory GV V0

Grivory GV V0 is also suitable for metal replacement, where flame protection is necessary.

There are UL94 5VA-Materials additionally offering VL94 5VA for critical applications.

Products	Description
GV XE 3950 GV GF 30 V0	VO >0.35mm ALL, GWIT 775°C (2mm), RTI EL 140°C (0.75mm)
GV XE 3951 GV GF 40 V0	VO >0.45mm ALL, GWIT 775°C (1mm), RTI EL 140°C (1mm)
GV XE 11119 GVX GF50 V0	VO >0.75mm ALL, UL 94 5VA >0.75mm, GWIT 800°C (1mm)
GV XE 5106 GVL LGF40 V0	VO >1.6mm, UL 94 5VA >1.6mm (bk) GWIT 800°C (1.6mm)
GV XE 5107 GVL LGF50 V0	VO >1.6mm, UL 94 5VA >1.6mm (bk) GWIT 800°C (1.6mm)

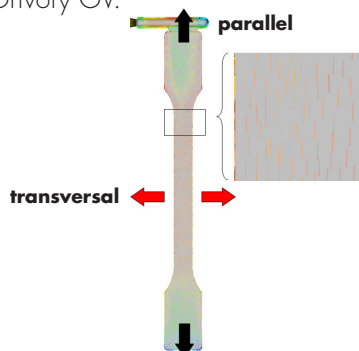
## ■ Grivory GV V0 properties

Conditioned	XE 3950 GF 30	XE 3951 GF40	XE 11119 XGF50	XE 5106 LGF 40	XE 5107 LGF 50
E-Modulus [GPa]	9.5	12	16.5	13	16.5
Strength [MPa]	110	120	130	175	205
Elongation at break [%]	2	2	1.5	2.1	2.4
Impact Charpy [kJ/m <sup>2</sup> ]	45	40	30	65	80
Notched Impact Charpy [kJ/m <sup>2</sup> ]	9	8	8	25	30
Density [g/cm <sup>3</sup> ]	1.4	1.53	1.65	1.54	1.59
UL 94 VO [mm]**	0.4 – 3.2	0.4 – 3.2	0.8 – 3.0	1.6 – 3.0*	1.6 – 3.0*
UL 94 5VA [mm]**	–	–	0.8 – 3.0	1.6 – 3.0*	1.6 – 3.0*
GWIT 1mm [°C]**	750	775	800	800	800

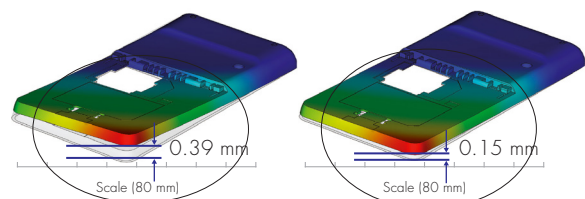
\* Black only. \*\* Acc. to UL Yellow Cards

## ■ Grivory GVX – Low warpage

Grivory GVX shows higher transversal stiffness than Grivory GV.



Grivory GVX shows lower warpage than Grivory GV.





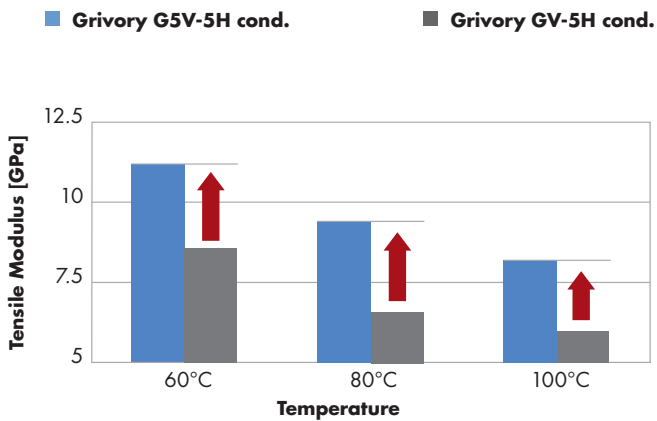
## ■ Grivory G5V Creep Resistance

Grivory G5V is a line of products with improved temperature and creep performance. It bridges the gap between Grivory GV and the PPA-product line Grivory HT.

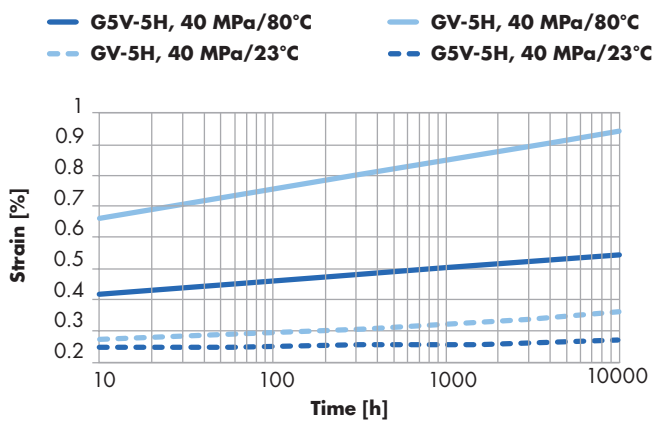
- Higher stiffness than standard GV at temperatures between 80°C and 100°C.

- Higher creep modulus than standard GV after 10,000 hours under constant load of 40 MPa at 23°C.
- Stable processing at 300°C to 320°C with water heated tool temperatures of 110°C to 130°C.

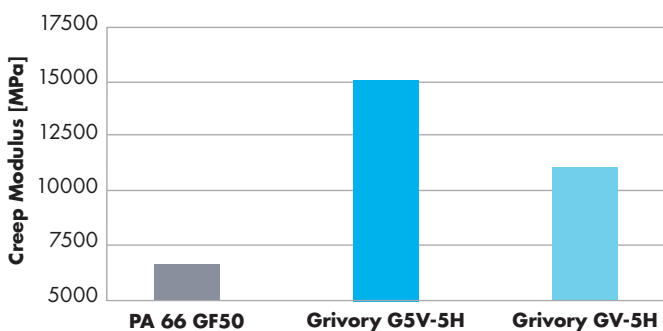
### Grivory G5V Higher stiffness at high temperatures



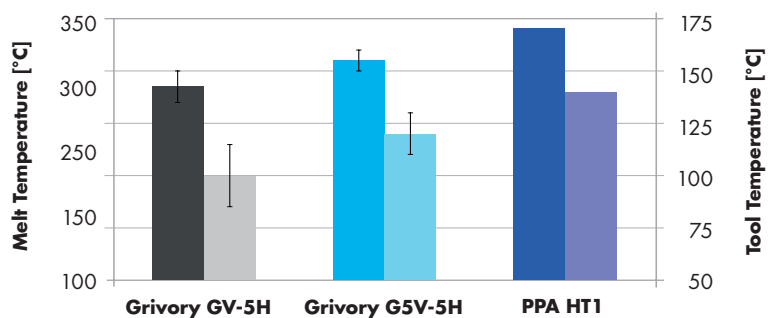
### Creep: G5V-5H vs. GV-5H



### Grivory G5V High Creep Modulus



### Grivory G5V Processing Conditions



## ■ Grivory G5V Product Assortment

Property	Standard	Unit	G5VN-35H <sup>A</sup> Dry/Cond.	G5VN-5H <sup>A</sup> Dry/Cond.	G5V-5H Dry/Cond.	G5VX-5H <sup>B</sup> Dry/Cond.
Degree of Reinforcement	ISO 3451	%	35% GF	50% GF	50% GF	50% GF
E-Modulus	ISO 527	MPa	10500/8500	15000/13500	17500/15500	17500 /17000
Strength	ISO 527	%	170/115	200/155	250/200	255/220
Charpy Impact 23°C	ISO 179	kJ/m <sup>2</sup>	80/80	100/90	90/90	80/80
Charpy Notched Impact 23°C	ISO 179	kJ/m <sup>2</sup>	13/16	16/17	15/15	15/14
Melt Point	ISO 2039-1	°C	255/-	255/-	260/-	280/-
HDT 1.80 MPa	ISO 75	°C	240/-	240/-	250/-	250/-
Density	ISO 1183	kg/m <sup>3</sup>	1.42/-	1.56/-	1.59/-	1.59/ -
Water Absorption, 23°C	ISO 1183	%	4.0	3.4	3.5	3.5
Moisture Absorption, 23°C/50%	ISO 62	%	1.5	1.2	1.3	1.3
Shrinkage (Longitudinal)	ISO 294	%	0.15/-	-	0.15/-	-
Shrinkage (Transverse)	ISO 294	%	0.45/-	-	0.55/-	-
Melt Tempera- tures	-	°C	300 to 320	310 to 315	330 to 340	290 to 310
Mold Tool Temperature	-	°C	110 to 130	110 to 130	110 to 130	110 to 130

<sup>A</sup> Impact modified | <sup>B</sup> Specialty glass fiber

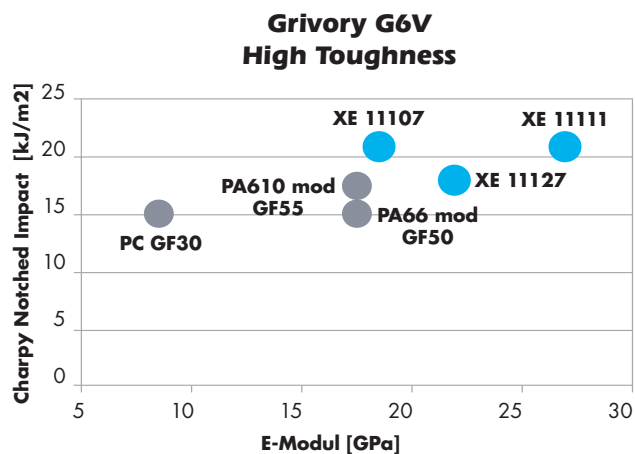
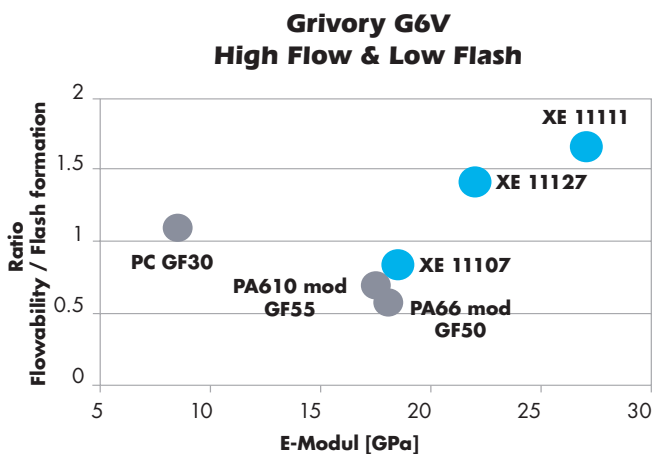


## ■ Grivory G6V Advanced Performance

Grivory G6V is the choice for precision components in computers, smartphones, tablets, and wearable devices such as watches, fitness monitors, and virtual reality headsets. Extraordinary stiffness and impact strength with simultaneous high dimensional stability are the vital properties of Grivory G6V which supports progressive technology development.

Further properties:

- High flow with low flash
- Low warpage
- Excellent surface quality
- Easy processability
- Low moisture absorption





## ■ Grivory G6V Product Assortment

Property	Standard	Unit	XE 11107 Dry/Cond.	XE 11127 Dry/Cond.	XE 11111 Dry/Cond.
Degree of Reinforcement	ISO 3451	%	55	60	70
E-Modulus	ISO 527	MPa	18500/17500	22000/21000	27000/26000
Strength	ISO 527	%	245/215	250/220	265/225
Charpy Impact 23°C	ISO 179	kJ/m <sup>2</sup>	105/100	100/90	85/70
Charpy Notched Impact 23°C	ISO 179	kJ/m <sup>2</sup>	21/20	17/17	21/22
Melt Point	ISO 2039-1	°C	215/-	213/-	220/-
HDT 1.80 MPa	ISO 75	°C	200/-	200/-	–
Density	ISO 1183	kg/m <sup>3</sup>	1.60/-	1.67/-	1.87/-
Water Absorption, 23°C	ISO 1183	%	2.5	1.6	1.1
Moisture Absorption, 23°C/50%	ISO 62	%	1.0	0.7	0.6
Shrinkage (Longitudinal)	ISO 294	%	0.10/-	0.10/-	0.10/-
Mold Shrinkage (Transverse)	ISO 294	%	0.40/-	0.30/-	0.30/-
Melt Temperatures	–	°C	260 to 300	260 to 300	260 to 300
Tool Temperature	–	°C	60 to 100	60 to 100	60 to 100



## ■ Grivory G7V Brilliant Surface Quality

Grivory G7V exhibits high gloss surface, exceptional weathering resistance, and easy processing. Grivory G7VX 50% glass fiber content demonstrates highly reflective surface in train image (right), which is uncommon in highly reinforced products. Grivory G7V makes for an extended metal replacement option eliminating coating or painting. Mechanical properties and chemical resistance are similar to standard Grivory GV.

- High gloss surfaces close to «piano black»
- UV-Stable
- No deflashing (different than PARA/PA MXD6)
- Low warpage
- High flow at low temperatures

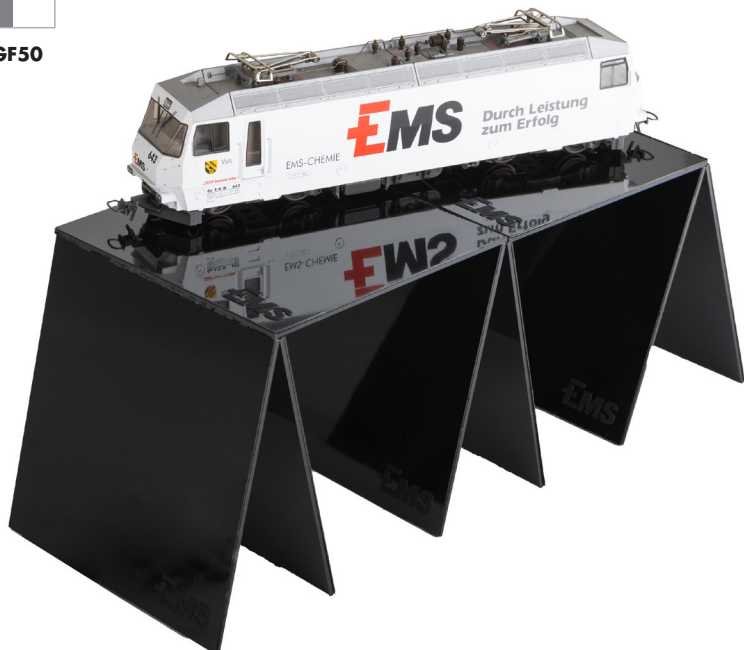
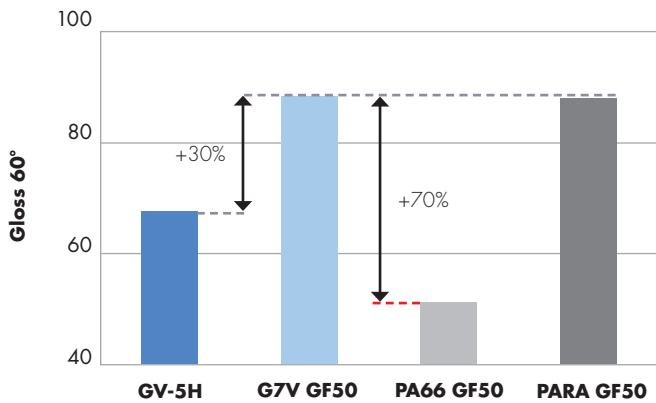
Material	Warpage	Weldline	Tool Temp.	Flash[a.u.]*
G7V GF50 (FE 10765)	+	+	100 °C	6
G7V GF50 X (FE 10766)	++	+	100 °C	11
GV-5H	-	○	100 °C	5
PA MXD6 GF50	+	+	130 °C	12

Easy processing of Grivory G7V

\* a.u. = arbitrary units

■ inferior, ○ neutral, +, ++ better

### Gloss 60°



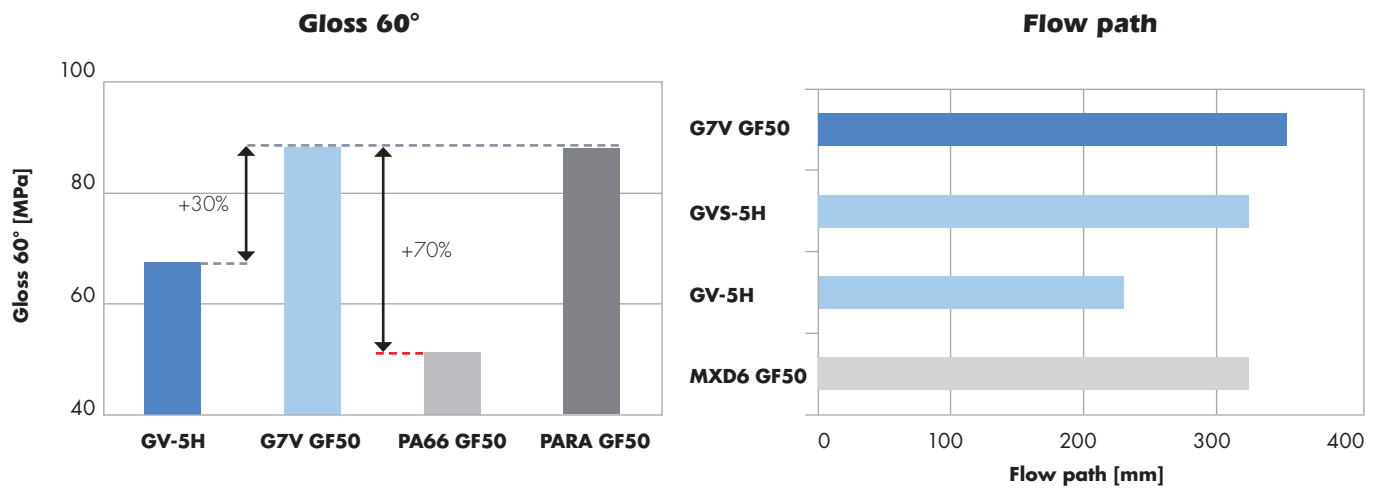
## ■ Grivory G7V High Gloss

Grivory G7V surfaces lack the haziness and blurriness expected from standard reinforced grades. Reflective-

ness remains clear in color as displayed by Grivory G7VX 50% in the train image (below).

Product	Gloss	DOI	Haze
G7VX 35% GF	93.0	78.8	2.3
G7VX 50% GF	89.8	43.9	9.9
G7V 50% GF	86.4	33.4	16.4
GV-5H	53.6	4.5	24.4

Gloss 60°, ISO 2813: Reflection  
 Distinctness of Image (DOI), ASTM E430: Clarity, >50 is reflective  
 Haze, ASTM E430: Milky Appearance

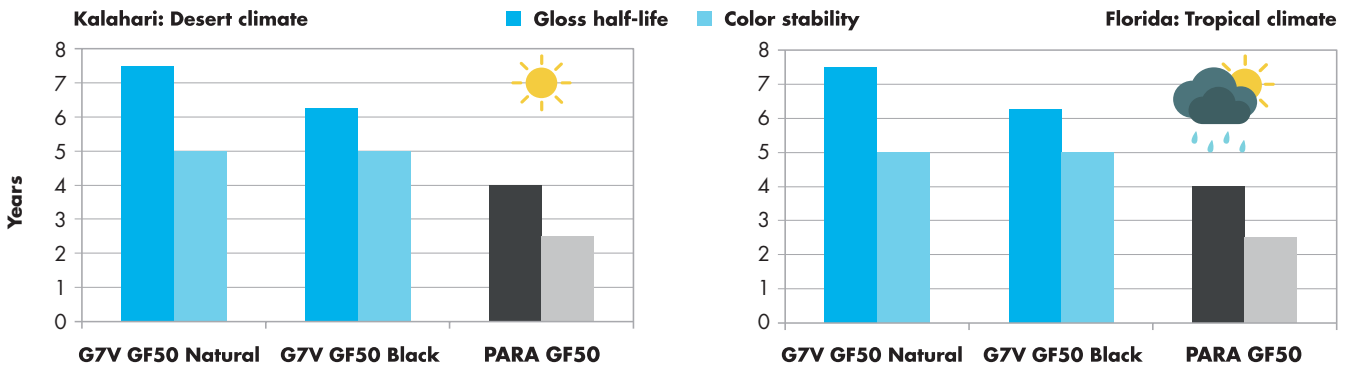




## ■ Grivory G7V UV-Stability

Different than other partially aromatic polyamides (e.g. MXD6-based polyamides or Grivory GV standard grades), Grivory G7V is inherently stable to UV-light.

This leads to low discoloration and a strongly improved gloss half life time with UV-exposure.



## ■ Grivory G7V Product Assortment

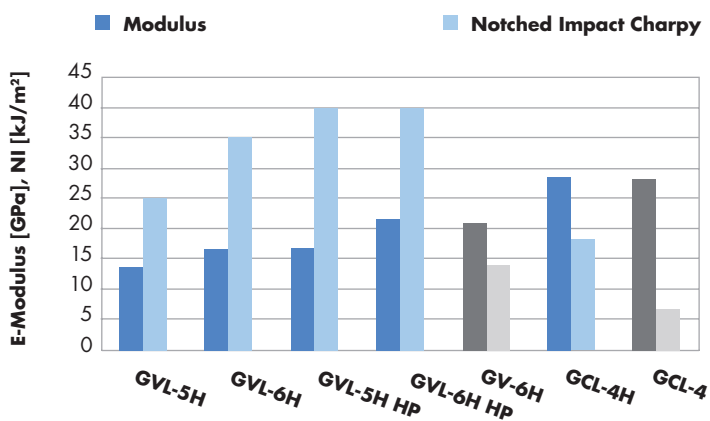
Property	Standard	Unit	FE 10767 Dry/Cond.	FE 10765 Dry/Cond.	FE 10766 Dry/Cond.
Degree of Reinforcement	ISO 3451	%	35% GF	50% GF	50% X-GF
E-Modulus	ISO 527	MPa	11500/10500	17000/15500	17000/15500
Strength	ISO 527	%	190/155	230/180	230/190
Charpy Impact 23°C	ISO 179	kJ/m <sup>2</sup>	45/45	70/70	70/70
Charpy Notched Impact 23°C	ISO 179	kJ/m <sup>2</sup>	10/10	10/10	12/12
Melt Point	ISO 2039-1	°C	215/-	215/-	215/-
HDT 1.80 MPa	ISO 75	°C	190/-	195/-	200/-
Density	ISO 1183	kg/m <sup>3</sup>	1400/-	1560/-	1560/-
Water Absorption, 23°C	ISO 62	%	-	-/4.5	-/4.5
Moisture Absorption, 23°C/50%	ISO 62	%	-	-/1.6	-/1.6
Shrinkage (Longitudinal)	ISO 294	%	-/0.10	-/0.10	-/0.05
Mold Shrinkage (Transverse)	ISO 294	%	-/0.35	-/0.70	-/0.35
Melt Temperatures	-	°C	250 to 280	260 to 280	260 to 280
Tool Temperature	-	°C	100 to 120	≥ 100	≥ 100

## ■ Grivory Long Fiber Reinforcement – stiff and tough

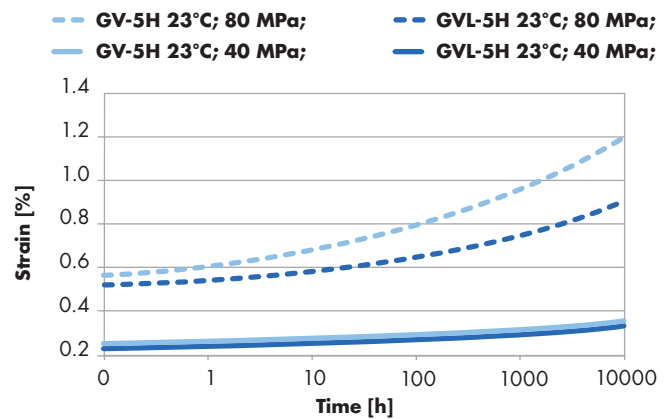
Grivory long fiber reinforced (LFT) polyamides are an excellent fit in challenging, highly technical metal-replacement applications. LFT products show enhanced properties at the same temperature and a wider application temperature range than short glass fiber reinforced grades. The LFT-properties lead to higher crash resistance. Grivory LFT products demonstrate the following properties:

- Superior strength and stiffness
- Very low creep under constant loads and stable fatigue behavior
- Crash Resistance: Excellent energy absorption through improved notched impact strength and high strength under rapid deformation speeds
- Low warpage
- High temperature resistance
- Chemical resistance as known from short fiber reinforced compounds.

### Grivory GVL, GVL HP und GCL – stiff and tough Stiffness and Notched Impact, LFT vs. short fiber compounds



### GRIVORY GVL – Low Creep Grivory GVL-5H vs. Grivory GV-5H (50% r.h.)





## ■ Grivory Long Glass Fibers vs Standard Glass Fibers

Property	Standard	Unit	GV-6H Dry	GVX-6H <sup>A</sup> Dry	GVL-6H Dry	GVL-6H HP <sup>A</sup> Dry	FE 16157 <sup>AB</sup> G5VL-6H HP Dry
Degree of Reinforcement	ISO 3451	%	60% GF	60% GF	60% LFT	60% LFT	60% LFT
E-Modulus	ISO 527	MPa	22000	22500	23000	23500	22500
Strength	ISO 527	%	260	290	290	310	300
Charpy Impact 23°C	ISO 179	kJ/m <sup>2</sup>	80	75	105	125	100
Charpy Notched Impact 23°C	ISO 179	kJ/m <sup>2</sup>	14	15	35	40	35
Melt Point	ISO 2039-1	°C	260	260	260	260	260
HDT 1.80 MPa	ISO 75	°C	235	250	255	255	260
Density	ISO 1183	kg/m <sup>3</sup>	1.69	1.69	1.69	1.69	1.69
Water Absorption, 23°C	ISO 62	%	3.5	3.5	3.5	3.5	3.0
Moisture Absorption, 23°C/50%	ISO 62	%	1.2	1.2	1.2	1.2	0.8
Shrinkage (Longitudinal)	ISO 294	%	0.05	0.05	0.1	0.15	–
Shrinkage (Transverse)	ISO 294	%	0.30	0.25	0.2	0.25	–
Melt Temperatures	–	°C	270 to 300	270 to 300	290 to 310	290 to 310	300 to 315
Tool Temperature	–	°C	80 to 120	80 to 120	80 to 120	80 to 120	100 to 140

<sup>A</sup> Specialty glass fiber | <sup>B</sup> Provisional values

## ■ Grivory LFT Product Assortment

Several options of LFT grades are available. The following table lists grade, reinforcement content, and key attributes. Grivory G5VL is a new LFT option for the crash resistance grade. Grivory G5VL demonstrates

higher stiffness and strength at 80°C to 100°C; improved creep resistance at 23°C, and similar processing behavior in comparison to standard Grivory GVL.

Grade	Reinforcement	Characteristic
GVL	30%, 40%, 50%, 60% glass	Base grade, balanced profile
GVL HP	50%, 60% glass	Crash resistant, constant properties up to 80 °C
GVL HP FC	60% glass (FE 16147)	Easy flow
GVL VO	40%, 50%, 60% glass	Flame retardant grades
GCL	30%, 40% carbon	Extreme stiffness, low density
G5VL	40% glass (FE 16168)	Crash resistant up to 100°C
G5VL HP	40% glass (FE 16169) 50% glass (FE 16185) 60% glass (XE 16157)	Crash resistant up to 100°C

## ■ EMS-GRIVORY Service and Support

EMS-GRIVORY is a specialist in polyamide synthesis and the processing of polyamide materials. Our services focus on the success of customer applications with our specialty products and range from manufacturing and material supply to full technical support.

### Quality System Certification

IATF 16949:2016  
All manufacturing sites

### Laboratory Accreditation

ISO/IEC 17025:2017  
Sumter South Carolina Site

### Design Concept

Design Proposals (Variants)  
Part Cost Calculations

### Material Selection

Comparative evaluation  
Design Evaluation

Design recommendations  
Moldflow and FEA

### Prototypes

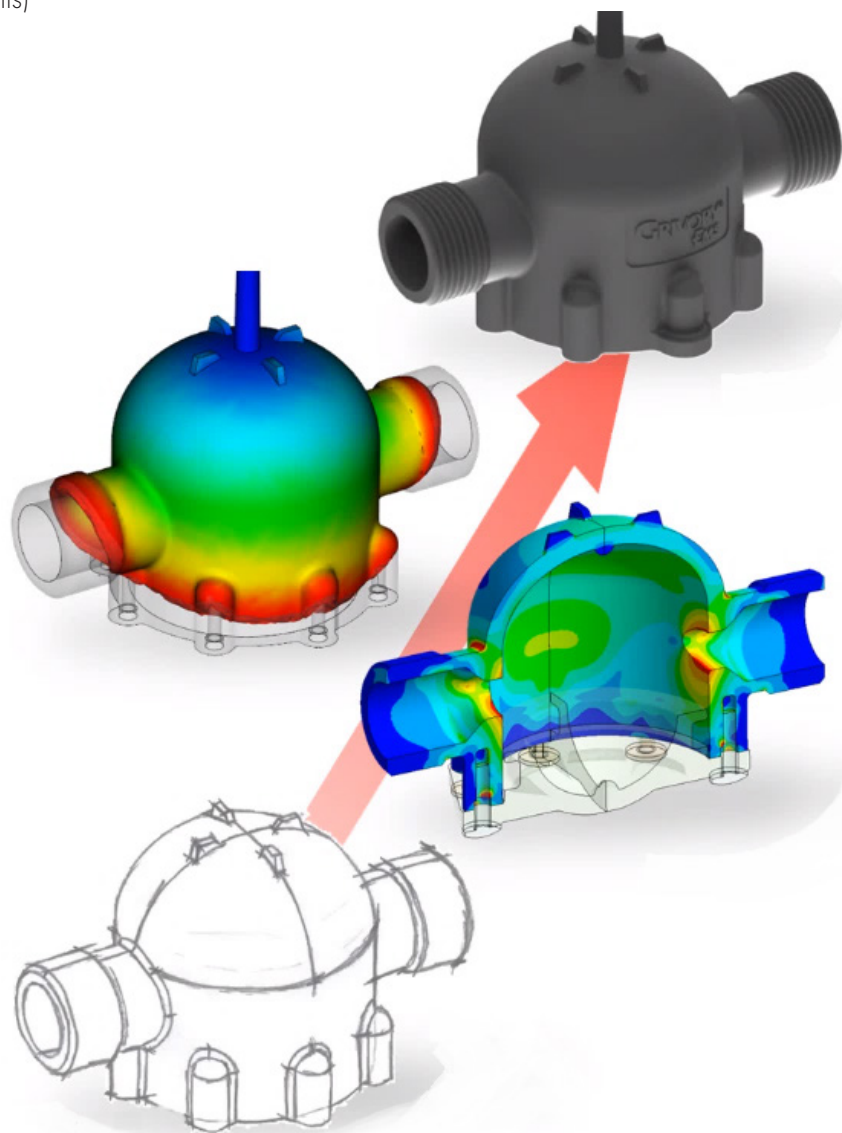
Prototype production  
Die cast tool modification

### Application Related Tests

Test method development  
Characterization and Analysis

### Sampling and start of production

Processing and tool optimization





## EMS-GRIVORY worldwide

[www.emsgrivory.com](http://www.emsgrivory.com)

### EMS-GRIVORY – The leading manufacturer of high-performance polyamides

EMS-GRIVORY is the leading manufacturer of high-performance polyamides and the supplier with the widest range of polyamide materials. Our products are well-known throughout the world under the trademarks Grilamid, Grivory and Grilon.

We offer our customers a comprehensive package of high-capacity and high-quality products along with segment-specific advisory competence in distribution and application development. We maintain our market leadership through continual product and application development in all segments.

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