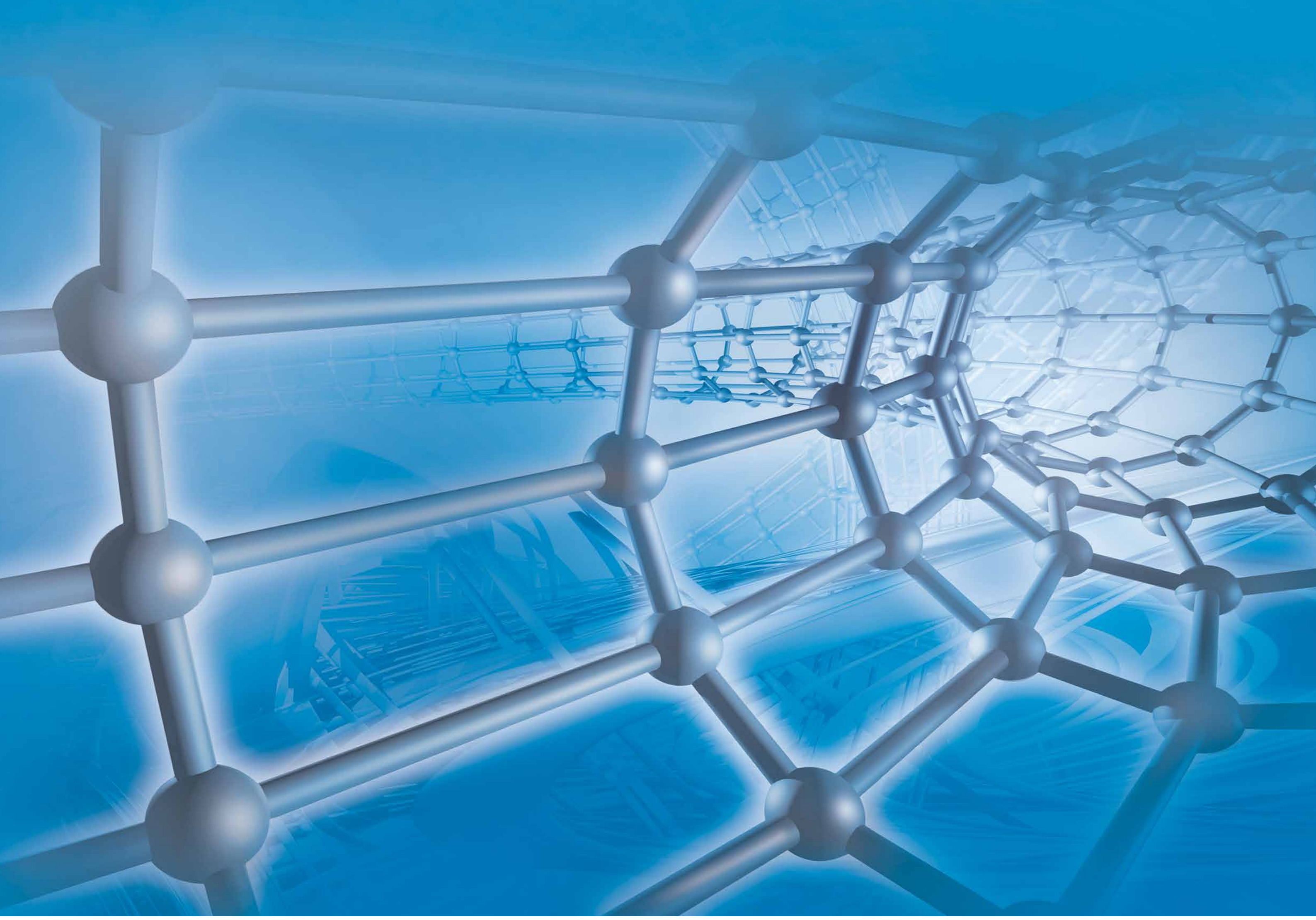
LGF reinforced compounds – Safe under extreme loads



AKRO-PLASTIC
Think Polyamide

AKRO-PLASTIC GmbH
Member of the Feddersen Group

LGF reinforced compounds

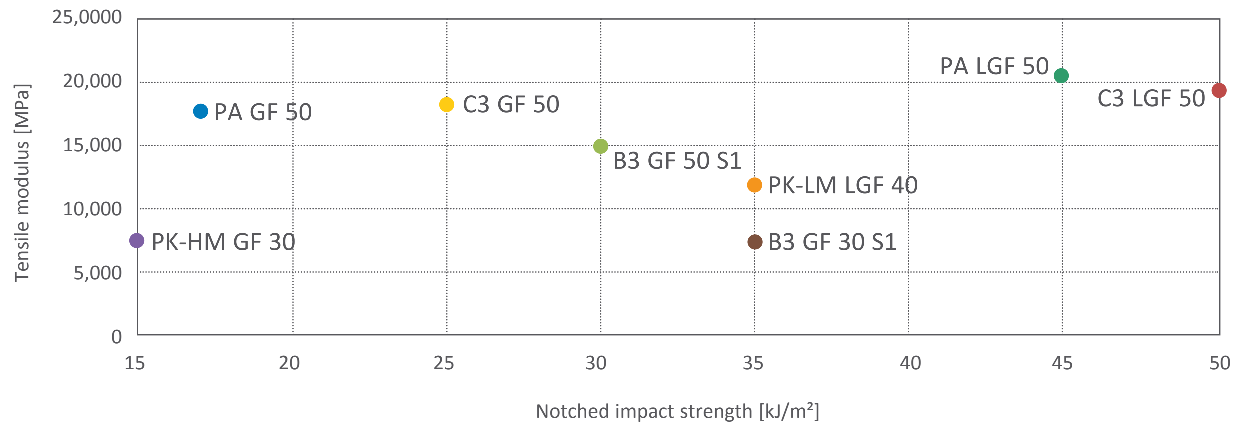
Typical values for naturalal color material 23 °C	Test specification	Test method	Unit	B28 LGF 40 1 L black (6155)		B3 GF 40 1 L black (4683)		PA LGF 50 natural (5504)		PA GF 50 natural (2916)		C3 LGF 50 5 XTC natural (5574)		C3 GF 50 5 XTC natural (4946)		PK-LM LGF 40 9 natural (5713)		PK-VM GF 40 natural (5855)	
Mechanical properties				d.a.m.	cond.	d.a.m.	cond.	d.a.m.	cond.	d.a.m.	cond.	d.a.m.	cond.	d.a.m.	cond.	d.a.m.	cond.	d.a.m.	cond.
Tensile modulus	1 mm/min	ISO 527-1/2	MPa	12,000	9,500	12,000	9,000	20,500	20,000	17,500	16,500	20,000	12,000	17,500	10,500	12,000	12,000	11,500	10,500
Tensile stress at break	5 mm/min	ISO 527-1/2	MPa	200	150	160	110	290	265	250	220	300	190	260	160	180	180	135	130
Elongation at break	5 mm/min	ISO 527-1/2	%	2.5	2.5	3	3.6	2.3	2.3	3	3	2.4	2.8	3	5	2	2.1	1.8	1.8
Flexural modulus	2 mm/min	ISO 178	MPa	8,000				18,500		16,400		19,000		17,000		11,000		11,000	
Flexural stress	2 mm/min	ISO 178	MPa	220				445		380		450		420		250		210	
Charpy impact strength	23 °C	ISO 179-1/1eU	kJ/m²	100	80	70	68	115	110	105	100	120	130	130	140	90	50	45	35
Charpy impact strength	-30 °C	ISO 179-1/1eU	kJ/m²	80		57	55	90		95		80		130		75		45	
Charpy notched impact strength	23 °C	ISO 179-1/1eA	kJ/m²	35	35	17	19	45	45	17	17	50	55	25	30	35	28	12	12
Charpy notched impact strength	-30 °C	ISO 179-1/1eA	kJ/m²	35		16	17	45		15		55		25		32		12	
Thermal properties				d.a.m.		d.a.m.		d.a.m.		d.a.m.		d.a.m.		d.a.m.		d.a.m.		d.a.m.	
Melting point	DSC, 10 K/min	ISO 11357-1/3	°C	220		220		255		255		245		245		220		220	
Heat distortion temperature, HDT/A	1.8 MPa	ISO 75-2	°C	200		200		230		230		230		230		215		215	
Heat distortion temperature, HDT/C	8 MPa	ISO 75-2	°C	190		135		200		135		200		195		210		195	
General properties																			
Density	23 °C	ISO 1183	g/cm³	1.36		1.36		1.59		1.59		1.58		1.58		1.54		1.54	
Content reinforcement		ISO 1172	%	40		40		50		50		50		50		40		40	
Moisture absorption	70 °C/62 % r.h.	ISO 1110	%	1.2		1.3		1.3		1.3		1.7		1.7		0.6		0.6	

"d.a.m." = dry as moulded test values = residual moisture content <0.1 %

Test values "cond." = conditioned have been measured on test specimens stored according to DIN EN ISO 1110.

Product characterisation

Mechanical properties
(Fig. 1)



As design materials, plastics are now well-established in many areas of our lives. To improve strength, thermoplastics are typically reinforced with glass or carbon fibres. Particularly at higher loads such as impact stress or in applications at higher or lower temperatures, the fibre length in short glass fibre reinforced compounds is insufficient, as the polymer matrix begins to soften or become more brittle in such cases. Special compounds reinforced with long glass fibres were developed for this reason (see Fig. 1).

To further extend their suitability for high-temperature applications, AKRO-PLASTIC developed long glass fibre compounds with XTC stabilisation. This shielding technology extensively protects the polymer matrix against oxidative degradation at temperatures between approximately 170 °C and 230 °C. This was previously reserved for far more expensive thermoplastics such as PPA or PPS and metals.

Improved impregnation
At higher temperatures, the polymer begins to soften. For this reason, much longer fibres are needed to transfer the forces to fibre reinforcement. Even after processing, compounds reinforced with long glass fibres still have significantly greater fibre lengths than short glass fibre reinforced compounds. This means that as temperatures rise, more fibre length is available. As a result, creep is also significantly less pronounced in long glass fibre reinforced compounds under load and/or at higher temperatures than in comparable short glass fibre reinforced compounds. This is again due to the critical fibre length.

In addition to fibre length, good fibre wetting with polymer matrix is critical. This is the only way to improve the strength of as many embedded fibres as possible. Our long glass fibre reinforced compounds also demonstrate significantly increased energy absorption. The notched impact strength values for long glass fibre reinforced compounds are twice those of short glass fibre reinforced compounds (see Fig. 7). This itself is based on the fact that a particular fibre length is required to transfer forces or energy from the polymer matrix to the fibre reinforcement. Although at room temperature, the residual fibre length of short glass fibre reinforced compounds resulting after injection moulding is generally adequate, this is not always the case at higher temperatures.

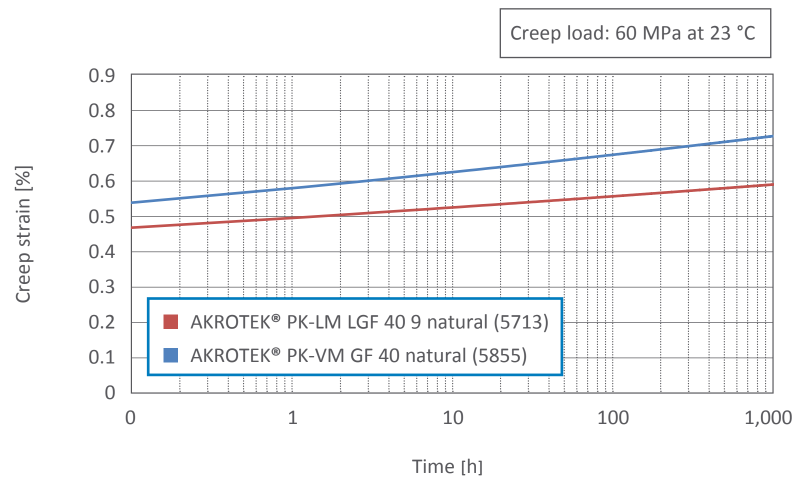
Possibilities of use for AKROMID®, AKROTEK® and AKROLOY® LGF compounds
Long glass fibre compounds have been successfully used in various segments of the industry for several decades. The new product lines AKROMID®, AKROTEK® and AKROLOY® LGF compounds now offer solutions that extend to other segments thanks to the use of base polymers.

Overview of the advantages of long glass fibre reinforced compounds:

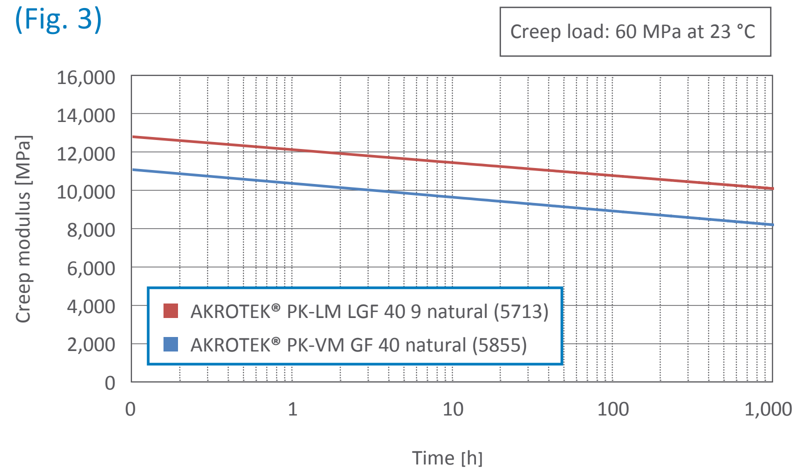
- Better mechanics at increased temperatures
- Less creep
- Higher working absorption during impact stress

AKROTEK® PK

Creep strain (Fig. 2)



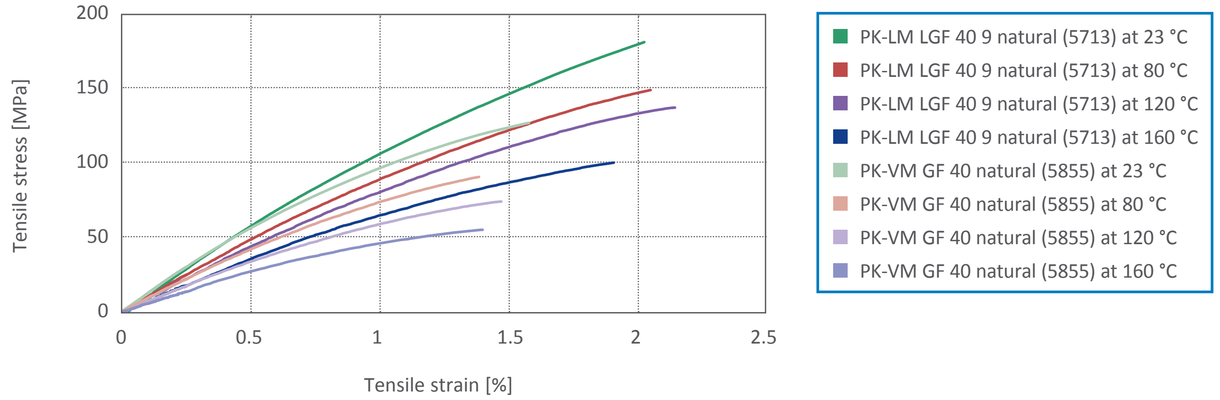
Creep modulus
(Fig. 3)



In addition to short glass fibre reinforced aliphatic polyketone, AKRO-PLASTIC GmbH now offers polyketone-based long glass fibre reinforced compounds. Advantages of these compounds compared with short glass fibre reinforced products include higher strengths, particularly at high temperatures, and higher notched impact strengths at 23 °C and -30 °C. Excellent chemical resistance and high dimensional stability (low moisture absorption) are further characteristic properties of these products.

In long glass fibre reinforced PK compounds (see Fig. 2) a low creep tendency can be observed. A well-developed fibre network is responsible for this property. At 23 °C/60 MPa, the PK-LM LGF 40 9 natural (5713) exhibits a less pronounced creep behaviour than a PK-VM GF 40 natur (5855) at these parameters (see Fig. 3).

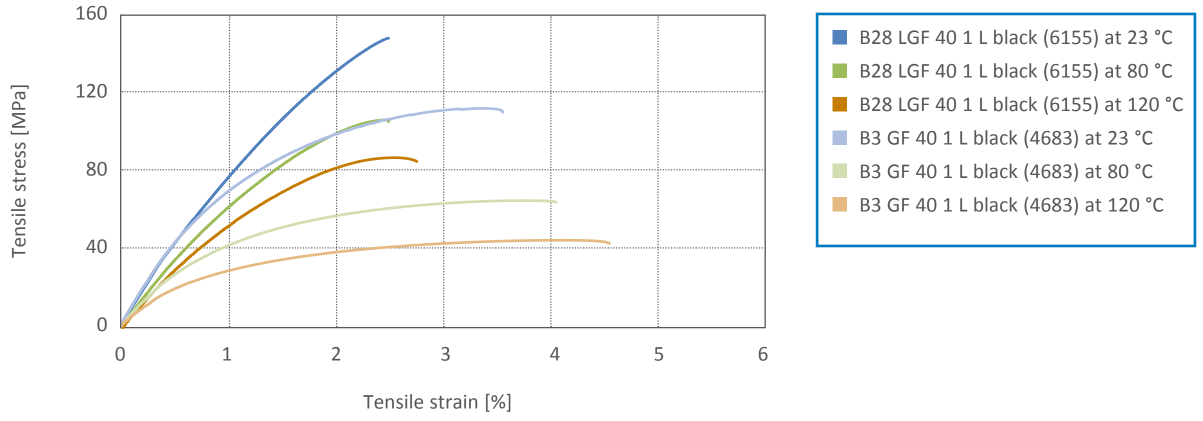
Stress strain diagram for different temperatures, d.a.m.
(Fig. 4)



AKROMID® Lite

Stress strain diagram for different temperatures, conditioned

(Fig. 5)



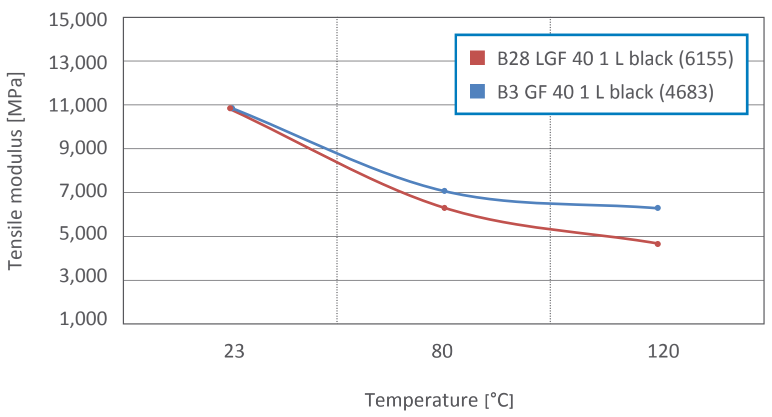
AKROMID® Lite closes this gap between polyamide and polypropylene. Compared to polypropylene, **AKROMID® Lite** exhibits a better surface quality, improved mechanical properties and higher heat distortion temperature.

The mechanical properties in particular can be improved even further by using long glass fibre compounds. This applies at normal as well as at higher temperatures (see Fig. 5 + 6).

Our long glass fibre reinforced **Lite** compounds also demonstrate significantly increased energy absorption. The Charpy notched impact strength values for long glass fibre reinforced compounds are twice those of short glass fibre reinforced compounds (see Fig. 7). This itself is based on the fact that a particular fibre length is required to transfer forces or energy from the polymer matrix to the fibre reinforcement. At room temperature, the residual fibre length of short glass fibre reinforced compounds resulting after injection moulding is generally adequate.

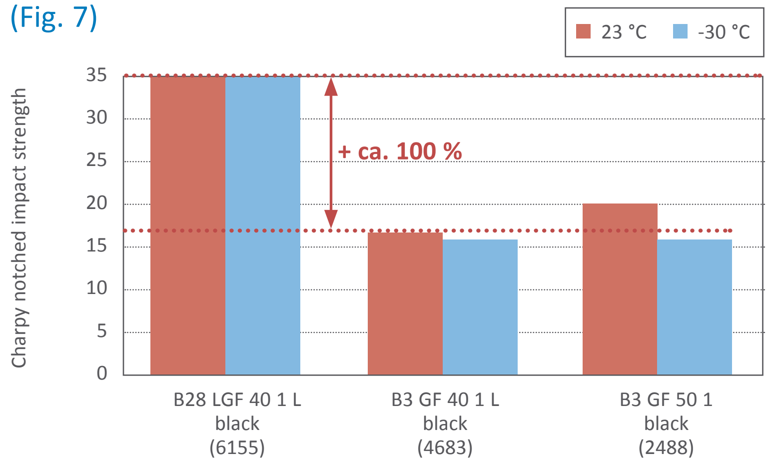
Tensile modulus vs. temperature, d.a.m.

(Fig. 6)



Charpy notched impact strength, d.a.m.

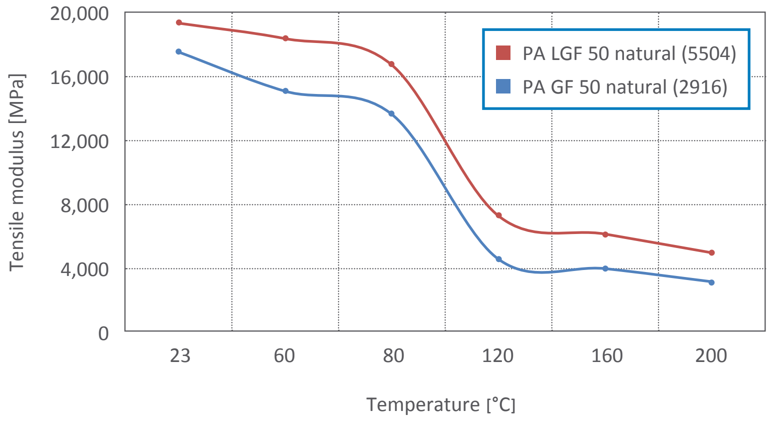
(Fig. 7)



AKROLOY® PA

Tensile modulus vs. temperature, d.a.m.

(Fig. 8)



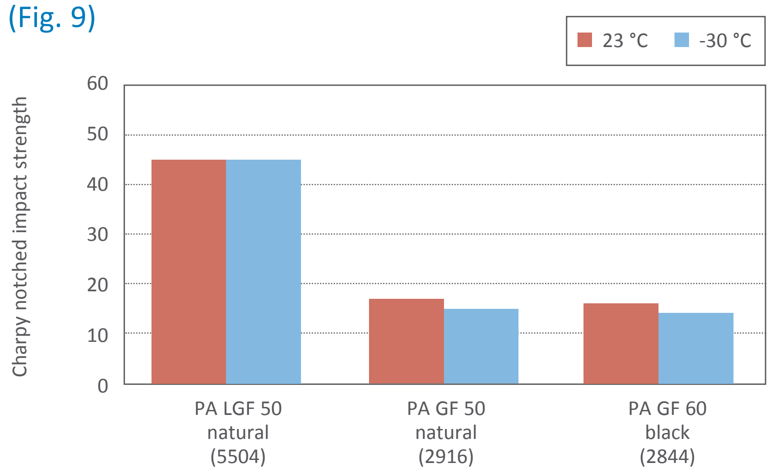
Over the last 10 years, die-cast and stamped bent parts have been substituted with engineering plastics especially in the automotive sector as well as in sanitary installations and general mechanical engineering where they have become the most feasible solution.

By blending PA 6.6 with a partially aromatic CoPA (PA 6I/6T), it has been possible to significantly reduce the effect of moisture on the product properties. Whereas a PA 6.6 GF 50 exhibits approx. 25 % drop in rigidity and strength in ambient conditions, a partially aromatic blend exhibits a decline of less than 10 %.

This is particularly evident in stress/strain curves (see Fig. 10) at increased temperatures and measurements of the Charpy notched impact strength (see Fig. 9). Thus AKROLOY® PA LGF 50 natural (5504) can absorb the same load compared with short glass fibre PA GF 50 natural (2916) at temperatures approx. 40 °C higher. At the same temperature, it is able to withstand significantly higher loads.

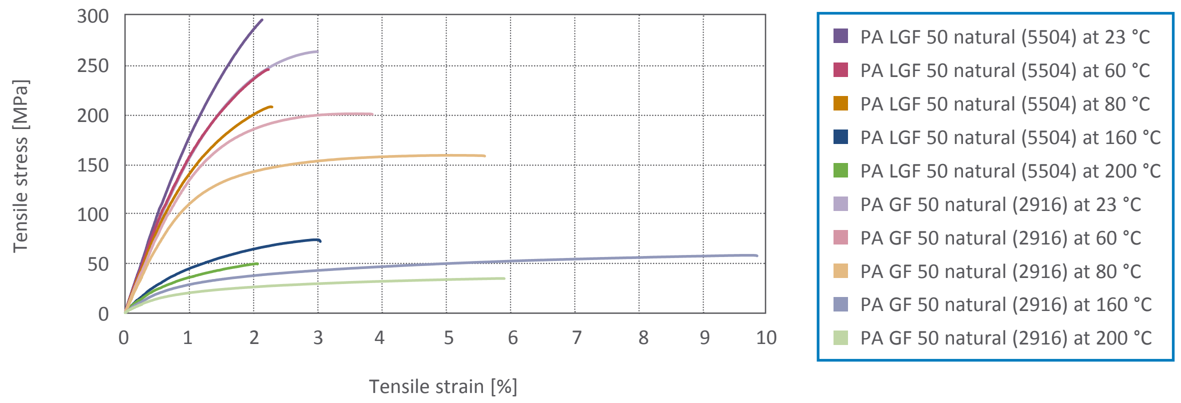
Charpy notched impact strength, d.a.m.

(Fig. 9)



Stress strain diagram for different temperatures, d.a.m.

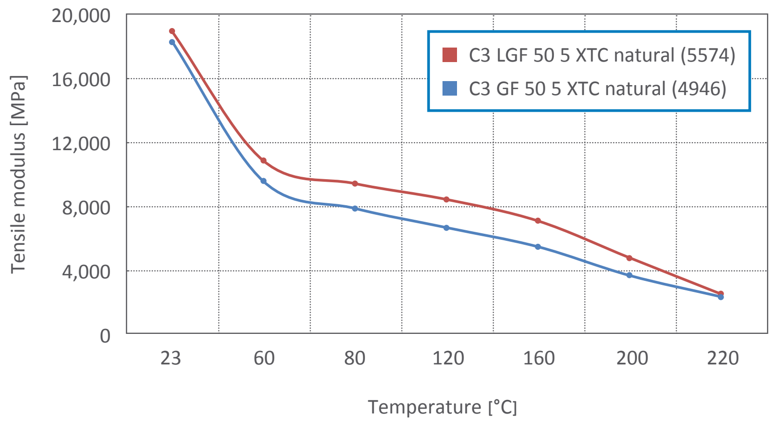
(Fig. 10)



AKROMID® C3 XTC

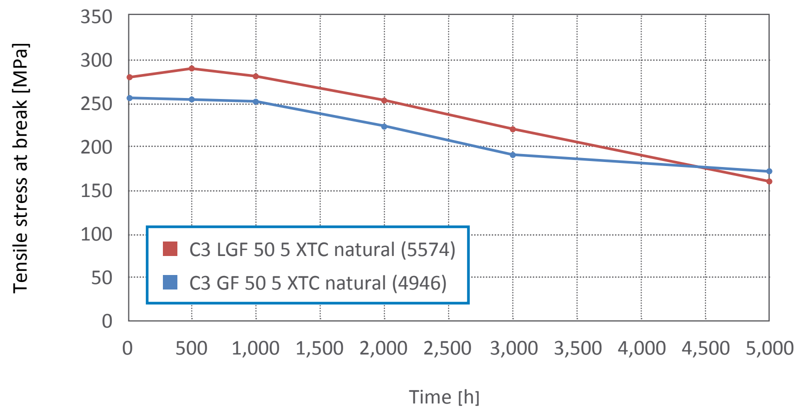
Tensile modulus vs. temperature, d.a.m.

(Fig. 11)



Tensile stress at break after heat aging at 210 °C

(Fig. 12)

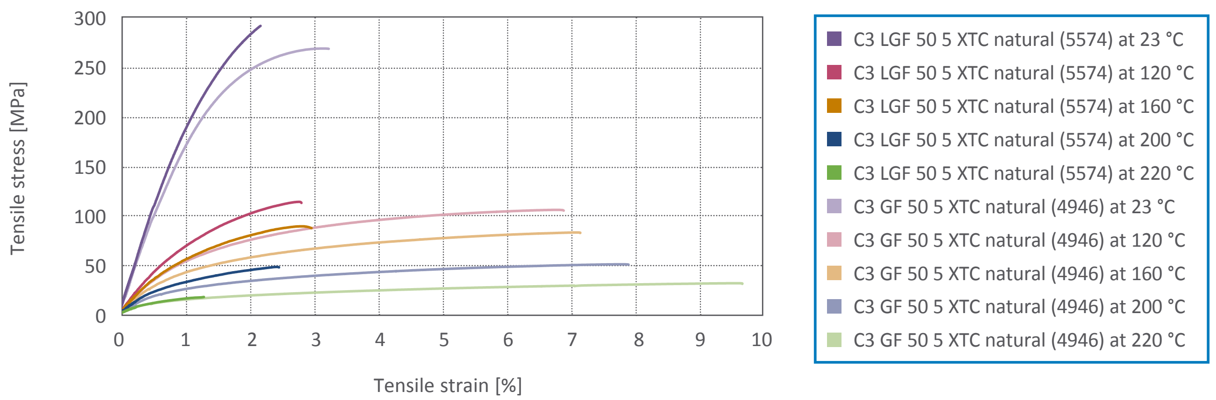


In AKROMID® C3 LGF 50 5 XTC natural (5574), the product development team at AKRO-PLASTIC GmbH has developed an innovative compound. Its mechanical properties meet the highest standards, even after storage at temperatures up to 210 °C. After 3,000 h at 210 °C, for example, 80 % of the initial tensile strength is retained (see Fig. 12). A further advantage of this stabilisation is the compound is free from halogen-based additives. It is therefore highly recommended for use in electrical applications.

As described above, long glass fibre reinforcement provides substantially improved mechanics and long-term properties compared with short glass fibre reinforced compounds – particularly at increased temperatures. Only the special XTC stabilisation makes it possible to take full advantage of long glass fibre technology even at high temperatures, supplanting other high-temperature compounds such as PPA or PPS.

Stress strain diagram for different temperatures, d.a.m.

(Fig. 13)



Processing recommendations

To fully leverage the technical benefits of long fibre compounds, it is recommended to consider the following proposals: Low intrusion processing parameters are essential and the aim is low-shear production wherever possible. This ensures that the required function and performance can be achieved.

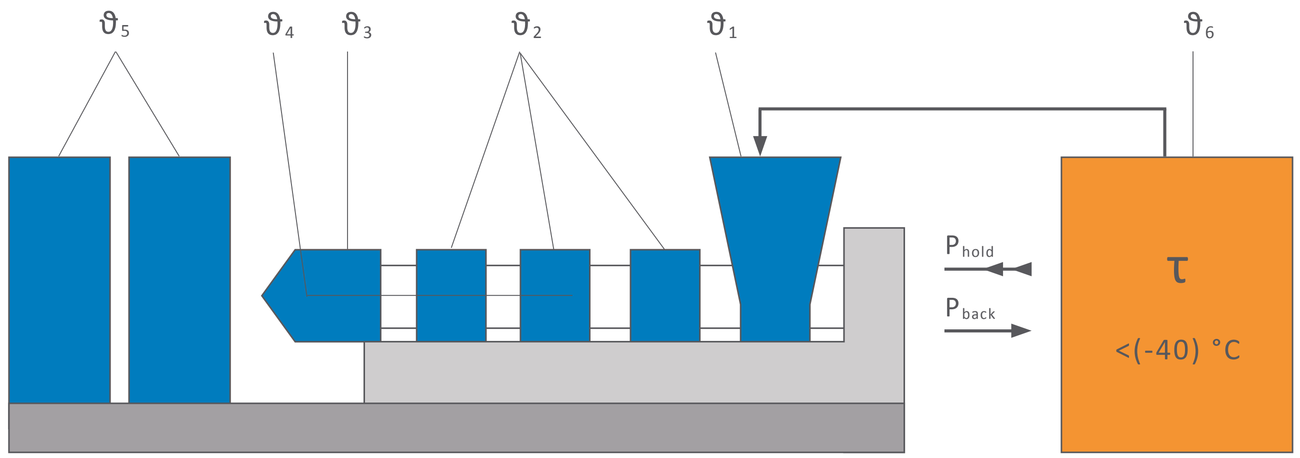
Machinery equipment:
Long fibre compounds can basically be processed on all common injection moulding machines. The same standard screws and cylinders as used for highly reinforced short fibre compounds can also be used for long fibre compounds. Only additional mixed/shearing elements should be avoided. Long fibre compounds can be processed effortlessly with a screw diameter of 35 mm and over.

Temperature control:
In contrast to short fibre reinforced compounds, it is recommended to process long fibre compounds with a reverse temperature profile. This ensures less shearing of the long glass fibres when dosing to achieve optimum fibre lengths in the finished part.

Dosing and dynamic pressure:
One of the most serious sources of risk is if the screw rotational speed is set too high when dosing the long fibre compounds. A maximum dosage speed of 0.1 m/sec is recommended. Fibre shortening can also be caused by the dynamic pressure set too high – sometimes less is definitely more.

Injection speed:
Care also has to be taken in this respect. A too high injection speed can also cause the repeated breakage of long fibres. By redirecting the melt flow which can be the result of some extremely complex part geometries, this can cause additional shearing in the long fibre compound in combination with a high injection speed. The optimum range is between 10 – 25 mm/s.

To summarise, we would like to point out that the aforementioned processing information should be regarded as recommendations only. It could be necessary to adjust the specific part accordingly. We are pleased to provide on-site assistance to achieve the best results.



Injection moulding		AKROLOY® PA LGF	AKROMID® B LGF Lite
Flange	ϑ_1	60 – 80 °C	60 – 80 °C
Sector 1 – sector 4	ϑ_2	300 – 270 °C	290 – 240 °C
Nozzle	ϑ_3	280 – 300 °C	240 – 290 °C
Meld temperature	ϑ_4	290 – 310 °C	250 – 290 °C
Mould temperature	ϑ_5	90 – 130 °C	80 – 100 °C
Drying	ϑ_6	80 °C, 0 – 4 h	80 °C, 0 – 4 h
Holding pressure, spec.	P_{hold}	300 – 800 bar	300 – 800 bar

The specified values are for reference values. For increasing filling contents the higher values should be used. For drying, we recommend using only dry air or a vacuum dryer. Processing moisture levels between 0.02 and 0.1 % are recommended. No pre-drying of bagged products is required if the bags have not been opened and the bags stored correctly. We recommend completely processing containers. Granulates from opened containers and silo-stored products could have absorbed humidity depending on the storage conditions and require a longer drying time.

We will be pleased to meet you!

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