

COMPOUNDS FOR METAL REPLACEMENT

AKROMID® T (PPA)

AKROLOY® PA (PA Blend) + **PARA**



AKRO-PLASTIC GmbH
Member of the Feddersen Group

Meeting Your Requirements

For decades, polyamides have formed the leading group of engineering plastics for a wide range of applications i.e. in the automotive, mechanical, E/E or construction industry as well as for sport and leisure. Overall the robust mechanical performance, chemical resistance and easy processing as well as an optimal price-performance ratio are key factors for this success.

Increasing requirements such as higher processing temperatures, a more consistent performance for conditioned polyamides or the need for better surface finish, have pushed the limits and require for new products.

This is where compounds based on polyphthalamide, blends of PA 6.6 with PA6-I/6-T or polyarylamid, enter the scene. These new products typically aim for metal replacement applications at different temperature ranges. The choice of those materials depends on the requirements, because all of them offer a unique package of advantages.

AKROLOY® PA (PA 6.6 + PA 6I/6T Reinforced) + PARA Series

Typical values for products at 23 °C				PA GF 30 (6415)		PA GF 40 (6416)		PA GF 50 (6507)		PA GF 60 (6418)		PA ICF 30 (5269)		PA ICF 40 (5270)		PA GF 50* (6546)		PARA GF 50 1 (5750)		PARA GF 60 1 (6165)		PARA ICF 40 (6128)	
Test specification	Test method	Unit		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.	d.a.m.	cond.	d.a.m.	cond.
Mechanical properties																							
Tensile modulus	1 mm/min	ISO 527-1/2	MPa	9,800	9,000	13,000	12,500	17,000	15,500	20,000	21,000	25,000	23,000	35,000	32,000	17,000	15,500	19,000	19,000	24,000	24,000	39,000	39,000
Tensile stress at break	5 mm/min	ISO 527-1/2	MPa	200	135	235	160	265	190	275	225	220	200	250	230	265	190	310	280	320	290	270	260
Elongation at break	5 mm/min	ISO 527-1/2	%	2.8	2.8	2.8	2.8	2.7	2.7	2.4	2.4	1.5	1.6	1.5	1.5	2.5	2.5	2.3	2.3	2	2	1	1
Flexural modulus	2 mm/min	ISO 178	MPa	9,500	9,500	12,500	12,500	16,500	15,000	21,000	21,000	21,000	21,000	35,000		17,500	16,000	20,000	20,000			37,000	36,000
Flexural strength	2 mm/min	ISO 178	MPa	280	230	330	245	385	285	410	360	320	300	400		400	390	445	410			410	360
Flexural strain at break	2 mm/min	ISO 178	%	3.4	3.5	3.1	3	2.8	2.8	2.5	2.6	2	2	1.5		2.8	2.8	2.5	2.5			1.2	1.2
Charpy impact strength	23 °C	ISO 179-1/1eU	kJ/m ²	65	65	95	95	105	105	100	100	50	50	50	50	100		100	100	80	85	35	
Charpy impact strength	-30 °C	ISO 179-1/1eU	kJ/m ²	60	60	75	75	95	95	95	95	40	40	50									
Charpy notched impact strength	23 °C	ISO 179-1/1eA	kJ/m ²	11	11	15	15	17	17	19	19	7	7	8		20		19	18			6	
Charpy notched impact strength	-30 °C	ISO 179-1/1eA	kJ/m ²	10	10	13	13	17	17	18	18	6	6	7									
Electrical properties																							
Surface resistivity		IEC 60093	Ohm									1.0E+4	1.0E+4	1.0E+4	1.0E+4							1.0E+4	1.0E+4
Thermal properties																							
Melting point	DSC, 10 K/min	ISO 11357-1	°C	255		255		255		255		255		255		255		238		238		238	
Temp. of deflection under load, HDT/A	1.8 MPa	ISO 75-1/2	°C	235		237		245		245		230		235		245		230					
Temp. of deflection under load, HDT/B	0.45 MPa	ISO 75-1/2	°C																				
Temp. of deflection under load, HDT/C	8 MPa	ISO 75-1/2	°C	120		173		185		193								200		205			
Coefficient of linear thermal expansion (CLTE), flow	20 °C–80 °C	ISO 11359-1/2	10E-4/K																				
Coefficient of linear thermal expansion (CLTE), transverse	20 °C–80 °C	ISO 11359-1/2	10E-4/K																				
Temperature index for 50 % loss of tensile strength	5,000 h	IEC 60216	°C	150		150		150		150						150							
Temperature index for 50 % loss of tensile strength	20,000 h	IEC 60216	°C	115		115		115		115						115							
Flammability																							
Flammability acc. UL 94	1.6 mm	UL 94	Class	HB		HB		HB		HB		HB		HB		HB		HB		HB		HB	
Burning rate acc. FMVSS 302 (<100 mm/min)	>1 mm thickness	FMVSS 302		+		+		+		+		+		+		+		+		+		+	
General properties																							
Density	23 °C	ISO 1183	g/cm ³	1.36		1.47		1.56		1.69		1.29		1.35		1.57		1.65		1.76		1.4	
Content reinforcement		ISO 1172	%	30		40		50		60		30		40		50		50		60		40	
Moisture absorption	70 °C/62 % r.h.	ISO 1110	%	1.9		1.6		1.4		1.1		1.6		1.3		1.4		0.8		0.7		1.02	
Verarbeitung																							
Flowability	Flowspiral ¹	AKRO	mm	160		140		100		60													
Flowability	Flowspiral ²	AKRO	mm	500		400		260		200				360									
Processing shrinkage, flow		ISO 294-4	%	0.3		0.3		0.4		0.5		0.2		0.3				0.1		0.1–0.2		0.25–0.3	
Processing shrinkage, transverse		ISO 294-4	%	0.8		0.8		0.7		0.7		0.5		0.4				0.3		0.2–0.4		0.3–0.35	

"d.a.m." = dry as moulded test values = residual moisture content <0.10 %.
 "cond." test values = conditioned, measured on test specimens stored according to DIN EN ISO 1110.
 + = passed

¹ = AKROLOY® PA: mould temperature: 100 °C, melt temperature: 320 °C, injection pressure: 750 bar, cross section of flow spiral: 7 mm x 1 mm
² = AKROLOY® PA: mould temperature: 100 °C, melt temperature: 320 °C, injection pressure: 750 bar, cross section of flow spiral: 7 mm x 2 mm
 *provides extraordinary increased mechanical properties in crossflow direction

AKROMID® T Series (Polyphthalamide)

Typical values for products at 23 °C			Test specification	Test method	Unit	T1 GF 40 (3464)	T1 GF 40 9 (3499)	T1 GF 50 (3101)	T1 GF 50 9 (3257)	T5 GF 40 (6486)	T5 GF 50 (6247)	T5 GF 60 (6748)	T1 ICF 20 (5147)	T1 CGM 15/10 S1 (6431)	T1 GF 15 S1 (4625)								
						d.a.m.	cond.	d.a.m.	cond.	d.a.m.	cond.	d.a.m.	cond.	d.a.m.	cond.								
Mechanical properties																							
Tensile modulus	1 mm/min	ISO 527-1/2	MPa	15,500	15,500	15,000	14,000	20,000	20,000	19,500	18,500	16,000	16,000	20,000	20,000	21,000	21,000	18,000	17,500	15,000		6,200	
Tensile stress at break	5 mm/min	ISO 527-1/2	MPa	240	220	240	220	270	255	275	250	245	230	280	260	280	260	200	190	180		142	
Elongation at break	5 mm/min	ISO 527-1/2	%	2.4	2.4	2.4	2.6	2	2	2	2.1	2.4	2.4	2.1	2.1	2	2	1.5	1.5	2		4	
Flexural modulus	2 mm/min	ISO 178	MPa	14,500		14,500		18,000		17,000		15,600	15,000	19,000	19,000	22,000	22,000	17,000	16,200				
Flexural strength	2 mm/min	ISO 178	MPa	345		360		380		390		380	350	440	380	435	410	300	290				
Flexural strain at break	2 mm/min	ISO 178	%	2.7		3		2		2.6		2.8	2.8	2.6	2.6	2.4	2.4	2	2				
Charpy impact strength	23 °C	ISO 179-1/1eU	kJ/m ²	75		70		90	85	90		80	80	90	90	70	70	35	30	50		90	
Charpy impact strength	-30 °C	ISO 179-1/1eU	kJ/m ²	60		55		70		80		73	73	75	75	65	65			8		12	
Charpy notched impact strength	23 °C	ISO 179-1/1eA	kJ/m ²	11		11		14		14		11	11	13	13			4	4				
Charpy notched impact strength	-30 °C	ISO 179-1/1eA	kJ/m ²	11		11		14		14		10	10	12	11								
Electrical properties																							
Surface resistivity		IEC 60093	Ohm															1.0E+5	1.0E+5	1.0E+5			
Thermal properties																							
Melting point	DSC, 10 K/min	ISO 11357-1	°C	313		308		313		308		325		325		325		313		308		308	
Temp. of deflection under load, HDT/A	1.8 MPa	ISO 75-1/2	°C	285		275		285		275		280		280								200	
Temp. of deflection under load, HDT/B	0.45 MPa	ISO 75-1/2	°C	310				310															
Temp. of deflection under load, HDT/C	8 MPa	ISO 75-1/2	°C	205		195		230		205		220		235		240							
Coefficient of linear thermal expansion (CLTE), flow	20 °C–80 °C	ISO 11359-1/2	10E-4/K			0.17				0.15													
Coefficient of linear thermal expansion (CLTE), transverse	20 °C–80 °C	ISO 11359-1/2	10E-4/K			0.59				0.53													
Temperature index for 50 % loss of tensile strength	5,000 h	IEC 60216	°C	165		155		165		155													
Temperature index for 50 % loss of tensile strength	20,000 h	IEC 60216	°C	140		130		140		130													
Flammability																							
Flammability acc. UL 94	1.6 mm	UL 94	Class	HB		HB		HB		HB		HB		HB		HB		HB		HB		HB	
Burning rate acc. FMVSS 302 (<100 mm/min)	>1 mm thickness	FMVSS 302		+		+		+		+		+		+		+							
General properties																							
Density	23 °C	ISO 1183	g/cm ³	1.5		1.52		1.62		1.62		1.5		1.65		1.74		1.25		1.29		1.28	
Content reinforcement		ISO 1172	%	40		40		50		50		40		50		60		20		25		15	
Moisture absorption	70 °C/62 % r.h.	ISO 1110	%	1.1		1.2		0.9		0.95				0.8		0.6		1.45					
Verarbeitung																							
Flowability	Flowspiral ¹	AKRO	mm	300		670		530				120		100		100		400					
Flowability	Flowspiral ²	AKRO	mm									300		280		260							
Processing shrinkage, flow		ISO 294-4	%	0.2		0.3		0.3		0.2		0.2		0.2		0.2		0.22				0.7	
Processing shrinkage, transverse		ISO 294-4	%	0.8		0.8		0.7		0.7		0.6		0.5		0.4		0.64				0.81	

"d.a.m." = dry as moulded test values = residual moisture content <0.10 %.
"cond." test values = conditioned, measured on test specimens stored according to DIN EN ISO 1110.
+ = passed

¹ = AKROMID® T: mould temperature: 130 °C, melt temperature: 340 °C, injection pressure: 750 bar, cross section of flow spiral: 7 mm x 1 mm
² = AKROMID® T: mould temperature: 130 °C, melt temperature: 340 °C, injection pressure: 750 bar, cross section of flow spiral: 7 mm x 2 mm

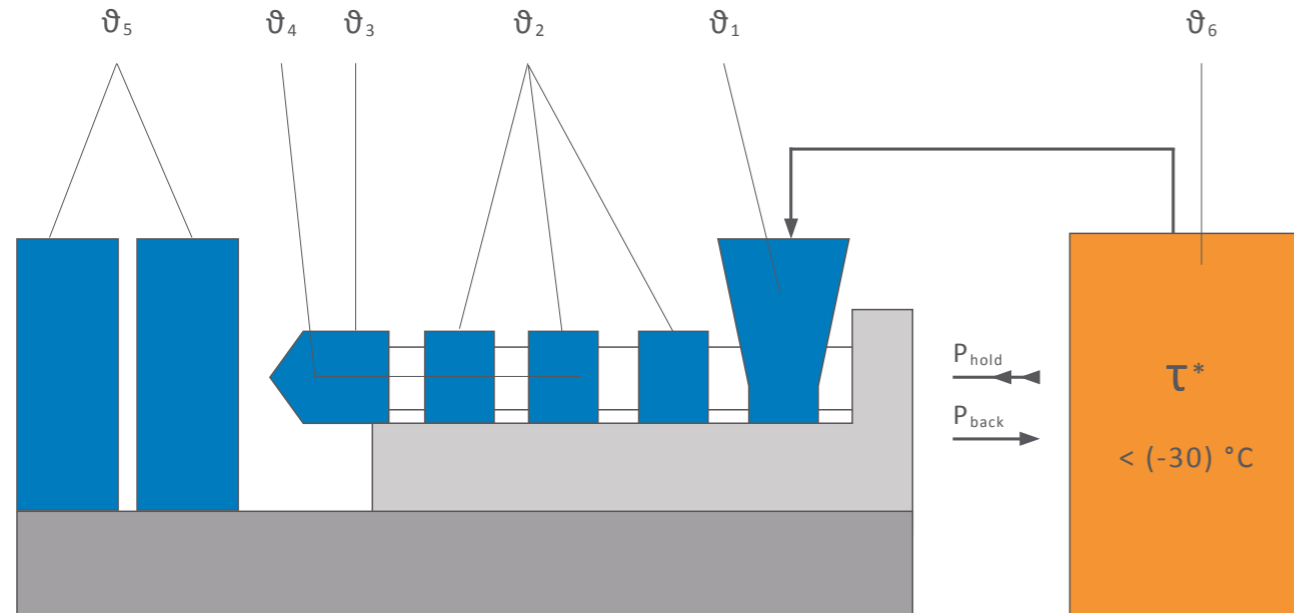
Processing Recommendations

AKROMID® T1, T1 9, T5 and AKROLOY® PA, PARA can be processed on commercially available injection moulding machines with standard screws according to the recommendations of the machine manufacturer.

Please refer to the diagram below for our recommended machine, mould and dryer settings.

Bagged-product processing: Undamaged bags with the original seals

intact can generally be processed without pre-drying. Excessive drying can result in filling and surface problems; processing below a residual moisture content of 0.02 % is therefore not recommended.



		AKROLOY® PA	AKROLOY® PARA	AKROMID® T1	AKROMID® T1 9	AKROMID® T5
Flange	Θ ₁	60–80 °C	60–80 °C	60–90 °C	60–90 °C	60–90 °C
Sector 1 – sector 4	Θ ₂	260–310 °C	250–300 °C	310–340 °C	310–335 °C	320–350 °C
Nozzle	Θ ₃	270–300 °C	270–300 °C	320–340 °C	320–330 °C	330–350 °C
Meld temperature	Θ ₄	280–300 °C	270–300 °C	320–340 °C	320–340 °C	330–350 °C
Mould temperature	Θ ₅	90–130 °C	120–160 °C	120–160 °C	100–130 °C	120–160 °C
Drying	Θ ₆	80 °C, 0–4 h	80–90 °C, 4–12 h	120 °C, 0–4 h	120 °C, 0–4 h	120 °C, 0–4 h
Holding pressure, spec.	P _{hold}	300–800 bar	300–1,500 bar	300–800 bar	300–800 bar	300–800 bar
Back pressure, spec.	P _{back}	50–150 bar	50–150 bar	50–150 bar	50–150 bar	50–150 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. For AKROMID® delivered in bags, no predrying is required when properly stored. It is recommended to use opened bags completely. Material processed from silo or open boxes may have absorbed moisture and require a longer drying time. *dew point (measure for “dryness” of air)

Product Characterisation

For applications made of thermoplastic compounds higher temperatures can become critical. Semi crystalline thermoplastics consist of crystalline and amorphous contents. The amorphous phase starts to soften at the glass transition temperature (T_g). This results in a reduction of strength and stiffness in line with an increase of creep. The tool temperature during moulding should be above the T_g . Otherwise internal stresses are frozen and will be released once the part temperature reaches T_g , resulting in recrystallisation, additional shrinkage and possibly warpage.

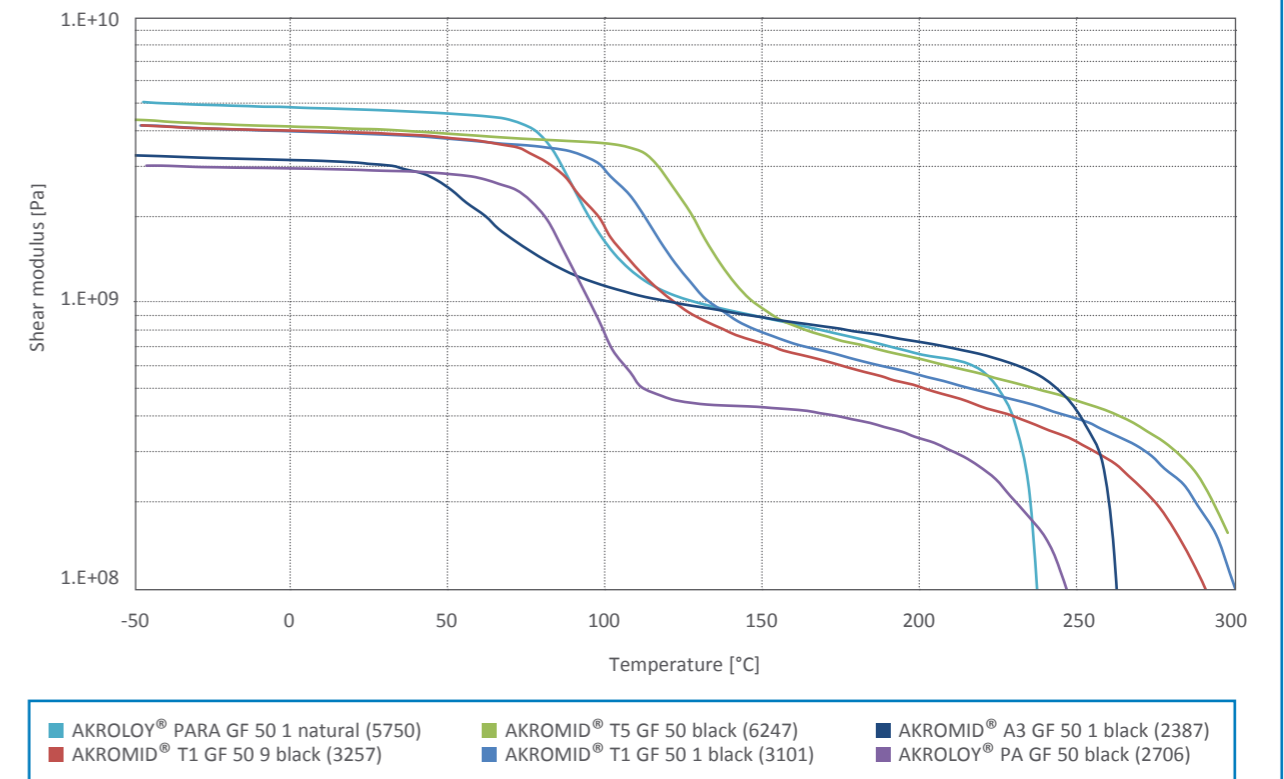
Polyphthalamides (PPA) show a relatively high T_g , which qualifies these products for demanding applications in the automotive industry which are exposed to higher temperatures like for instance the cooling pump housing. Depending on the specific kind of PPA, the T_g can vary. AKROMID® T5 shows a T_g of around 130 °C, around 15 °C higher than AKROMID® T1 and even 80 °C higher than PA 6.6.

The shear modulus over temperature illustrates the effect of the T_g very well. Up to T_g the modulus and thus the mechanical performance is

stable. Then, when the amorphous phase starts to soften above T_g , the modulus and mechanical performance drops (Fig. 1).

Another advantage of the aromatic PPA compounds is a reduced impact of moisture on the mechanical properties. Usual PA 6.6 compounds loose reversibly about 30 % of their stiffness and strength when taking up moisture, but PPA compounds keep their performance independently from moisture content.

Shear modulus – d.a.m.
(Fig. 2)

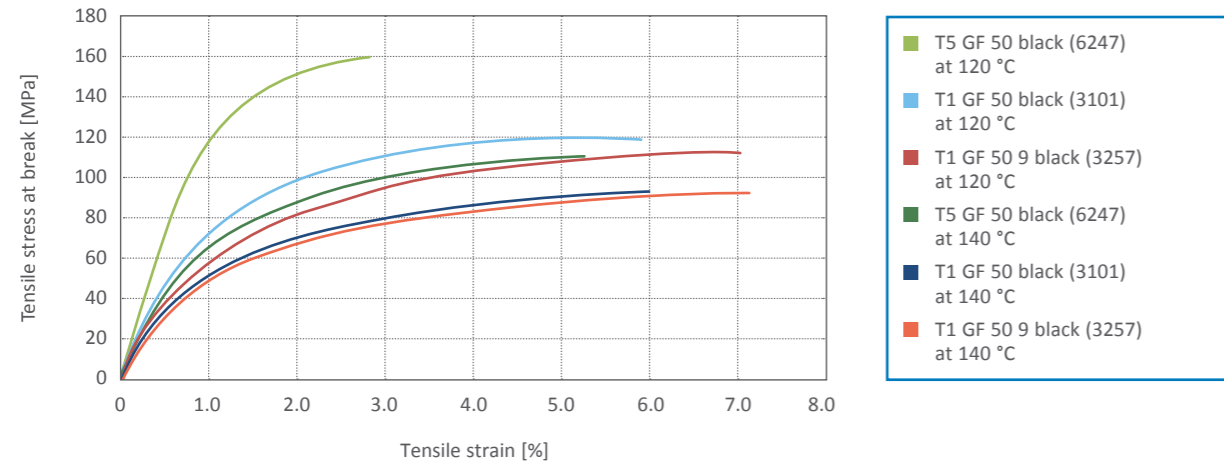


For detailed technical information on the products and newest data, please visit our website at:

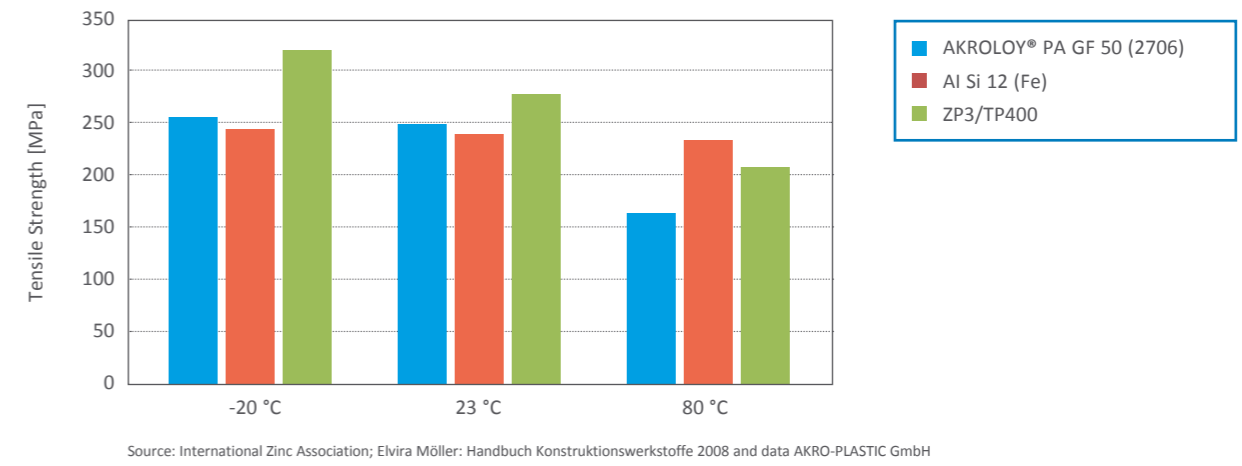
akro-plastic.com/metal-replacement

Product Characterisation

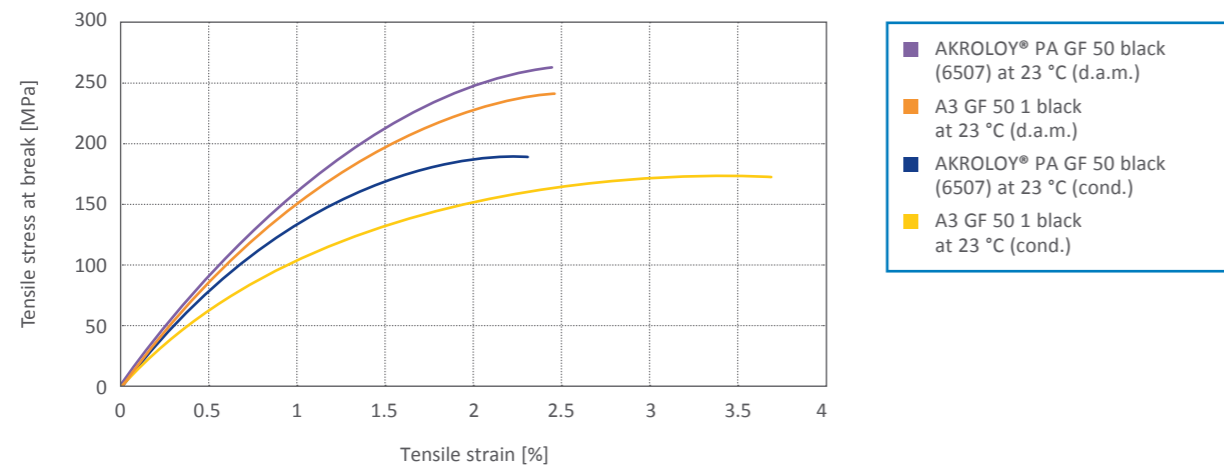
Stress Strain Diagram for Different Temperatures AKROMID® T (Fig. 2)



Tensile Strength AKROLOY® PA GF 50 vs. Metalle (Fig. 5)

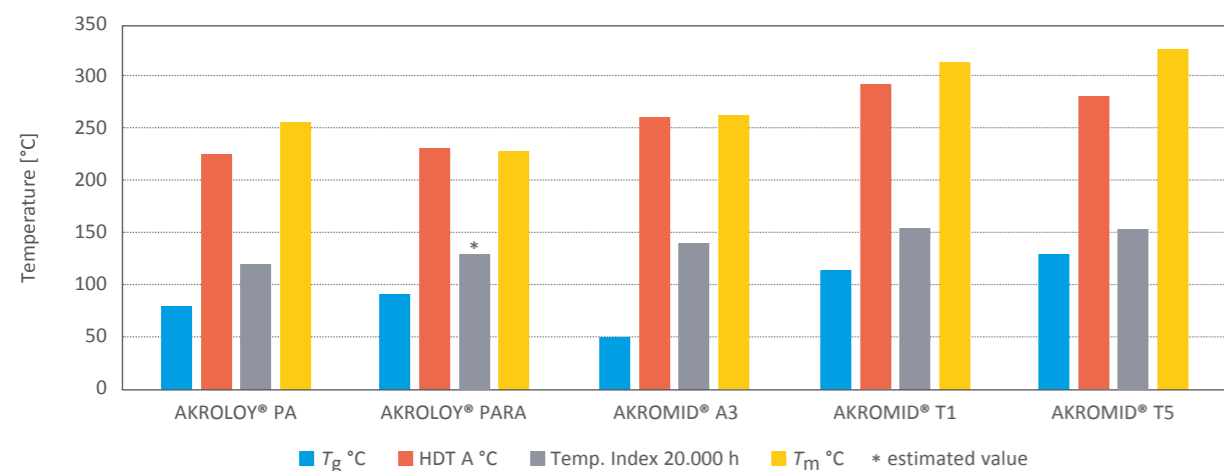


Stress Strain Diagram for Different Temperatures AKROLOY® (Fig. 3)



Material	Standard			
	EU10/2011	FDA	KTW up to 85 °C	W270
T5 8 black (6454) + natural (6459)	X	X	X	X
T5 GF 10 8 black (6455) + natural (6460)	X	X	X	X
T5 GF 20 8 black (6456) + natural (6461)	X	X	X	X
T5 GF 30 8 black (6457) + natural (6462)	X	X	X	X
T5 GF 40 8 black (6458) + natural (6463)	X	X	X	X
T5 GF 50 8 black (6205) + natural (6464)	X	X	X	X

Key Temperatures for Compounds with 50 % GF (Fig. 4)



Material	Standard	
	EU10/2011	FDA
PA GF 30 8 black (6730) + natural (6727)	X	X
PA GF 40 8 black (6731) + natural (6728)	X	X
PA GF 50 8 black (6732) + natural (6606)	X	X
PA GF 60 8 black (6733) + natural (6729)	X	X

Disclaimer: All specifications and information given in this brochure are based on our current knowledge and experience. A legally binding promise of certain characteristics or suitability for a concrete individual case cannot be derived from this information. The information supplied here is not intended to release processors and users from the responsibility of carrying out their own tests and inspections in each concrete individual case. AKROMID®, AKROLEN®, AKROLOY®, AKROTEK®, PRECITE®, AF-Carbon®, AF-Color®, AF-Complex®, AF-Clean®, ICX®, BIO-FED®, M-VERA® and AF-Eco are registered or applied trademarks of the Feddersen Group.

We Will Be Pleased to Meet You!

AKRO-PLASTIC GmbH

Member of the Feddersen Group

Industriegebiet Brohltal Ost

Im Stiefelfeld 1

56651 Niederzissen

Germany

Phone: +49(0)2636-9742-0

Fax: +49(0)2636-9742-31

info@akro-plastic.com

www.akro-plastic.com

For more locations, visit www.akro-plastic.com