

AKROMID® HI – The polyamide with high impact resistance



AKRO-PLASTIC 
Think Polyamide

AKRO-PLASTIC GmbH
Member of the Feddersen Group

High-performance materials – impact-modified AKROMID® compounds

Polyamides are the largest product group of engineering plastics. They are typically used in engineering parts in the form of compounds. Alongside non-reinforced compounds, filled or reinforced compounds are used primarily to increase stiffness and strength.

It is known that the mechanical properties of thermoplastics are significantly influenced by environmental conditions. In addition to temperature, this includes water absorption and humidity, since components made from conditioned polyamides exhibit different strengths than freshly moulded parts. Thermoplastics are modified appropriately to perform under a wide range of ambient conditions.

AKRO-PLASTIC GmbH have developed a product range of impact-modified compounds for this purpose. These are suited specifically for applications which are exposed to harsh conditions. There are two types of **modified compounds: cold-impact-resistant (S1) and dry-impact-resistant (S3) compounds**. Non-reinforced and reinforced compounds with differing glass-fibre content are available.

Typical values for black colored products at 23 °C	Test Specification	Test Method
Mechanical properties		
Tensile modulus	1 mm/min	ISO 527-1/2
Yield stress ¹ /Tensile stress at break	5 mm/min	ISO 527-1/2
Elongation at break	5 mm/min	ISO 527-1/2
Charpy impact strength	23 °C	ISO 179-1/1eU
Charpy impact strength	-30 °C	ISO 179-1/1eU
Charpy notched impact strength	23 °C	ISO 179-1/1eA
Charpy-notched impact strength	-30 °C	ISO 179-1/1eA
Thermal properties		
Melting point	DSC, 10 K/min	ISO 11357-1
Heat distortion temperature, HDT/A	1.8 MPa	ISO 75-1/2
Flammability		
Flammability acc. UL 94	1.6 mm	UL 94
Rate acc. FMVSS 302 (<100 mm/min)	> 1 mm thickness	FMVSS 302
General Properties		
Density	23 °C	ISO 1183
Moisture absorption	70 °C/62 % r.h.	ISO 1110
Processing		
Flowability	Flow spiral ²	AKRO
Processing shrinkage, flow		ISO 294-4
Processing shrinkage, transverse		ISO 294-4

Despite identical nomenclature the AKROMID® materials produced by AKRO in China are identified by differential batch numbering.



AKROMID® HI (PA 6.6)

Unit	A3 1 (2417)		A3 S1 (1071)		A3 S1 (4567)		A3 S1 (1114)	
	d.a.m.	cond.	d.a.m.	cond.	d.a.m.	cond.	d.a.m.	cond.
MPa	3,200	1,100	2,000	900	2,000	900	3,000	2,000
MPa	85	50	50	40	50	40	77	56
%	>20	>20	>50	>100	>50	>100	> 20	> 50
kJ/m ²	o.B.	o.B.	o.B.	o.B.	o.B.	o.B.	o.B.	o.B.
kJ/m ²	o.B.		o.B.	o.B.	o.B.	o.B.	o.B.	o.B.
kJ/m ²	5	13	>80	>100	90		8	
kJ/m ²	2		35	35	20		7	
	d.a.m.		d.a.m.		d.a.m.		d.a.m.	
°C	262		262		262		262	
°C	75		60				70	
Class	V2		HB		HB		HB	
mm/min	+		+		+		+	
g/cm ³	1.14		1.07				1.12	
%	2.9 – 3.1		2.0				2.3	
mm	1,040		770					
%	1.9		1.4				1.4	
%	2.3		1.4				2.1	

"cond." test values = conditioned, measured on test specimens stored according to ISO 1110

"d.a.m." = dry as moulded test values = residual moisture content < 0.10 %

n.b. = not broken + = passed



A3 GF 30 S1 (1365)		A3 GM 20/10 S1 (2006)		A3 1 S3 (1139)		A3 5 S3 15 (1434)	
d.a.m.	cond.	d.a.m.	cond.	d.a.m.	cond.	d.a.m.	cond.
9,600	8,000	6,900	4,800	2,700	1,300	2,500	1,220
180	120	130	92	63	45	65	45
5	6	3.5	6	>35	>100	30	>100
105	110	77	77	o.B.	o.B.	o.B.	o.B.
85	100	76		o.B.	o.B.	o.B.	o.B.
17	20	15	16	15	25	15	25
12	12	8		10	13	15	
d.a.m.		d.a.m.		d.a.m.		d.a.m.	
262		262		262		262	
255		245		70			
HB		HB		HB		HB	
+		+		+		+	
1.34		1.31		1.10		1.11	
1.7				2.1		1.9	
690				800		800	
0.3		0.5		2.1			
1.2		1.3		2.2			

¹ = yield stress and elongation at break: test speed 50 mm/min for non-reinforced compounds

² = AKROMID® A – mould temperature: 100 °C, melt temperature: 320 °C, injection pressure: 750 bar, cross section of flow spiral: 7 mm x 3.5 mm

Typical values for black colored products at 23 °C	Test Specification	Test Method
Mechanical properties		
Tensile modulus	1 mm/min	ISO 527-1/2
Yield stress ¹ /Tensile stress at break	5 mm/min	ISO 527-1/2
Elongation at break	5 mm/min	ISO 527-1/2
Charpy impact strength	23 °C	ISO 179-1/1eU
Charpy impact strength	-30 °C	ISO 179-1/1eU
Charpy notched impact strength	23 °C	ISO 179-1/1eA
Charpy-notched impact strength	-30 °C	ISO 179-1/1eA
Thermal properties		
Melting point	DSC, 10 K/min	ISO 11357-1
Heat distortion temperature, HDT/A	1.8 MPa	ISO 75-1/2
Flammability		
Flammability acc.UL 94	1.6 mm	UL 94
Rate acc. FMVSS 302 (<100 mm/min)	> 1 mm thickness	FMVSS 302
General Properties		
Density	23 °C	ISO 1183
Moisture absorption	70 °C/62 % r.h.	ISO 1110
Processing		
Flowability	Flow spiral ²	AKRO
Processing shrinkage, flow		ISO 294-4
Processing shrinkage, transverse		ISO 294-4



AKROMID® HI (PA 6)

Unit	B3 1 (2501)		B3 S1 (3726)		B4 S1 (1327)		B3 GF 15 S1 (1270)	
	d.a.m.	cond.	d.a.m.	cond.	d.a.m.	cond.	d.a.m.	cond.
MPa	3,600	1,200	2,000	550	2,300	550	5,800	3,000
MPa	85	45	50	45	60	55	115	70
%	20	>50	>50	>100	50	>100	3,5	10
kJ/m ²	n.b.	n.b.	n.b.	n.b.	n.b.	n.b.	70	95
kJ/m ²	n.b.		n.b.	n.b.	n.b.	n.b.	50	45
kJ/m ²	5	12	45	110	30		6	15
kJ/m ²	2		55	40			5	5
	d.a.m.		d.a.m.		d.a.m.		d.a.m.	
°C	220		222		220		222	
°C	60		48		55		200	
Class	V2		HB		HB		HB	
mm/min	+		+		+		+	
g/cm ³	1.13		1.07		1.1		1.22	
%	2.6 – 3.4		2.3				2.3	
mm	1,070		600					
%	1.1		1.5					
%	1.0		1.9					

"cond." test values = conditioned, measured on test specimens stored according to ISO 1110

"d.a.m." = dry as moulded test values = residual moisture content < 0.10 %

n.b. = not broken + = passed



B3 GF 15 S1 (3228)		B3 GF 30 S1 (1281)		B3 GF 30 S1 (2091)		B3 GF 50 S1 (2000)	
d.a.m.	cond.	d.a.m.	cond.	d.a.m.	cond.	d.a.m.	cond.
6,000	3,100	8,800	5,500	7,500	4,200	15,000	7,800
120	75	150	90	125	70	190	120
4	10	3,5	6	6	13	5	8
70	95	85	100	110	135	>100	>110
50	45			>100	>100	>100	
4	14	15	20	35	45	25	40
6	5	10		25	22	20	
d.a.m.		d.a.m.		d.a.m.		d.a.m.	
222		222		222		222	
200		190		200		210	
HB		HB		HB		HB	
+		+		+		+	
1.22		1.35		1.28		1.54	
2.3				1.4		1.3	
730				530			
0.6		0.4		0.4		0.5	
0.9		0.9		0.9		0.9	

¹ = yield stress and elongation at break: test speed 50 mm/min for non-reinforced compounds

² = AKROMID® B – mould temperature: 80 °C, melt temperature: 270 °C, injection pressure: 750 bar, cross section of flow spiral: 7 mm x 3.5 mm

Typical values for black colored products at 23 °C	Test Specification	Test Method
Mechanical properties		
Tensile modulus	1 mm/min	ISO 527-1/2
Yield stress ¹ /Tensile stress at break	5 mm/min	ISO 527-1/2
Elongation at break	5 mm/min	ISO 527-1/2
Charpy impact strength	23 °C	ISO 179-1/1eU
Charpy impact strength	-30 °C	ISO 179-1/1eU
Charpy notched impact strength	23 °C	ISO 179-1/1eA
Charpy-notched impact strength	-30 °C	ISO 179-1/1eA
Thermal properties		
Melting point	DSC, 10 K/min	ISO 11357-1
Heat distortion temperature, HDT/A	1.8 MPa	ISO 75-1/2
Flammability		
Flammability acc.UL 94	1.6 mm	UL 94
Rate acc. FMVSS 302 (<100 mm/min)	> 1 mm thickness	FMVSS 302
General Properties		
Density	23 °C	ISO 1183
Moisture absorption	70 °C/62 % r.h.	ISO 1110
Processing		
Flowability	Flow spiral ²	AKRO
Processing shrinkage, flow		ISO 294-4
Processing shrinkage, transverse		ISO 294-4



AKROMID® HI (PA 6) + (PA 6.6/6 Blend)

Unit	B3 1 (2501)		B3 S3 (3671)		B3 3 S3 10		B3 GF 15 S3 (2345)	
	d.a.m.	cond.	d.a.m.	cond.	d.a.m.	cond.	d.a.m.	cond.
MPa	3,600	1,200	2,000	650	2,700	955	5,800	3,000
MPa	85/	45/	50/	30/	70/	40/	/120	/75
%	20	>50	>40	>100	>45	>100	4	10
kJ/m ²	n.b.	n.b.	n.b.	n.b.	n.b.	n.b.	75	100
kJ/m ²	n.b.		n.b.	n.b.	n.b.	n.b.		
kJ/m ²	5	12	>60	>100	10	28	12	
kJ/m ²	2		15	20	8	10		
	d.a.m.		d.a.m.		d.a.m.		d.a.m.	
°C	220		222		222		222	
°C	60		50		60		200	
Class	V2		HB		HB		HB	
mm/min	+		+		+		+	
g/cm ³	1.13		1.05		1.10		1.21	
%	2.6 – 3.4		2.1		2.6			
mm	1,070		580		850			
%	1.1		1.2		1.3			
%	1.0		1.8		1.7			

"cond." test values = conditioned, measured on test specimens stored according to ISO 1110

"d.a.m." = dry as moulded test values = residual moisture content < 0.10 %

n.b. = not broken + = passed



B3 GF 30 S3 (3954)		C3 1 (4546)		C3 1 S3 (4294)		C3 1 S3 (4297)	
d.a.m.	cond.	d.a.m.	cond.	d.a.m.	cond.	d.a.m.	cond.
9,000	5,500	3,100	1,100	2,500	1,100	2,500	1,100
/155	/110	80/	45/	65/	45/	65/	45/
5	10	5	> 50	30	> 100	25	> 100
>100	>100	n.b.	n.b.	n.b.	n.b.	n.b.	n.b.
>100	>100			n.b.		n.b.	
25	50	3	13	10	30	7	20
15	15			6		6	
d.a.m.		d.a.m.		d.a.m.		d.a.m.	
222		260		260		260	
						60	
HB		V2		HB		HB	
+		+		+		+	
1.33		1.14				1.12	
1.4		2.6		2.6		2.6	
520		1,600		1,200		1,200	
0.3		1.2		1.4		1.4	
0.8		1.9		2.1		2.2	

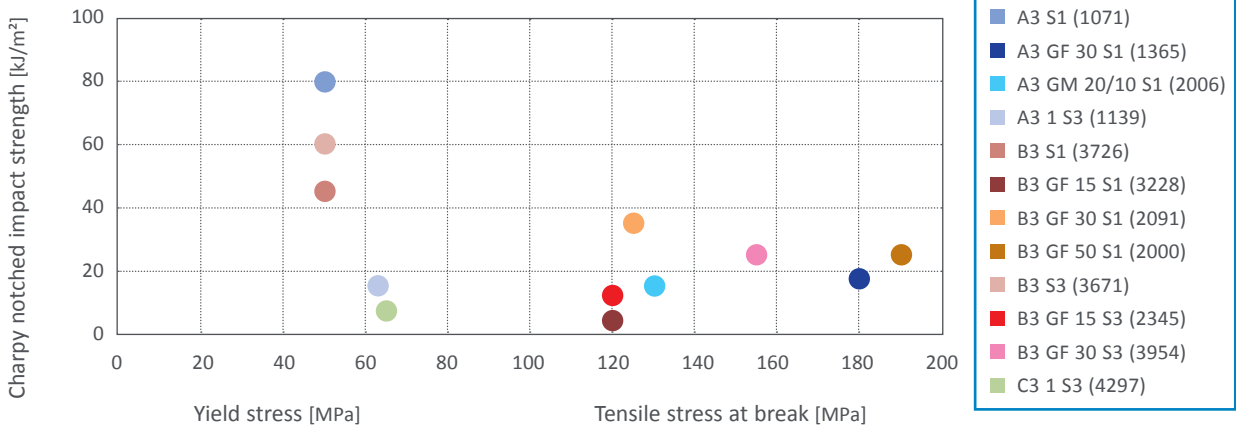
¹ = yield stress and elongation at break: test speed 50 mm/min for non-reinforced compounds

² = AKROMID® B – mould temperature: 80 °C, melt temperature: 270 °C, injection pressure: 750 bar, cross section of flow spiral: 7 mm x 3.5 mm
AKROMID® C – mould temperature: 90 °C, melt temperature: 300 °C, injection pressure: 750 bar, cross section of flow spiral: 7 mm x 3.5 mm

Product characterisation

Notched impact strength through yield stress/tensile stress at break

(Fig. 1)

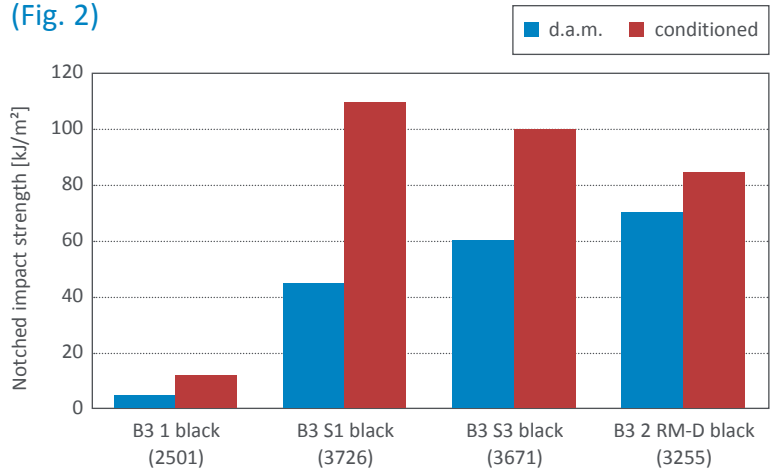


The requirements of the material to be used depend on the type of component. The optimal combination of strength and toughness can be formulated based on the composition of impact-modified compounds. Non-reinforced impact-modified compounds can exhibit extremely high impact strengths (see Fig. 1). By contrast, the glass-fibre grades in this product family are designed to provide a good balance of properties at significantly higher strengths.

As to be expected, impact strength increases at room temperature for all polyamide compounds in this overview as a result of conditioning. Dry impact resistant AKROMID® grades were developed for use in dry climates or as a way to avoid post conditioning steps. Thus in many cases, parts with snap-on connections can be clipped in immediately following injection moulding, which can accelerate the production process. AKROMID® B3 2 RM-D black (3255) – a special PA-ABS blend with good dry-impact properties – is an interesting alternative to conventional impact-modified compounds.

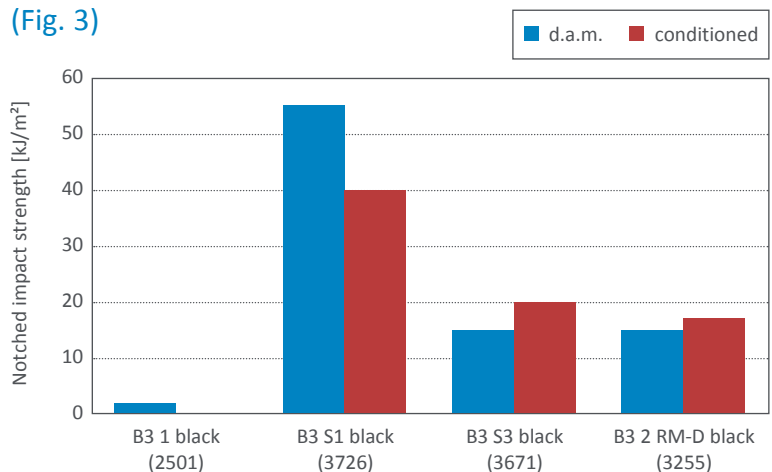
Notched impact strength at 23 °C

(Fig. 2)



Notched impact strength at -30 °C

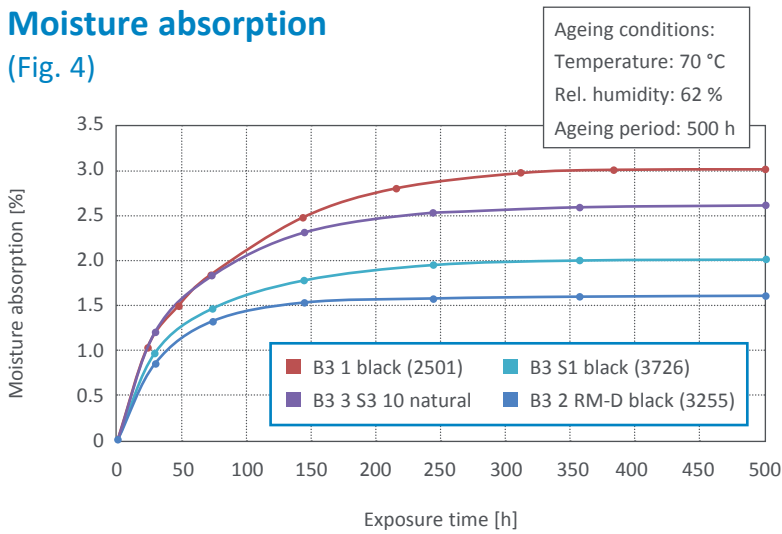
(Fig. 3)





Moisture absorption

(Fig. 4)



The effect of conditioning is the lowest with the RM (reduced moisture) formulation (see AKROMID® RM brochure). A standard PA 6 B3 1 black (2501) was used as the reference product (see Fig. 2).

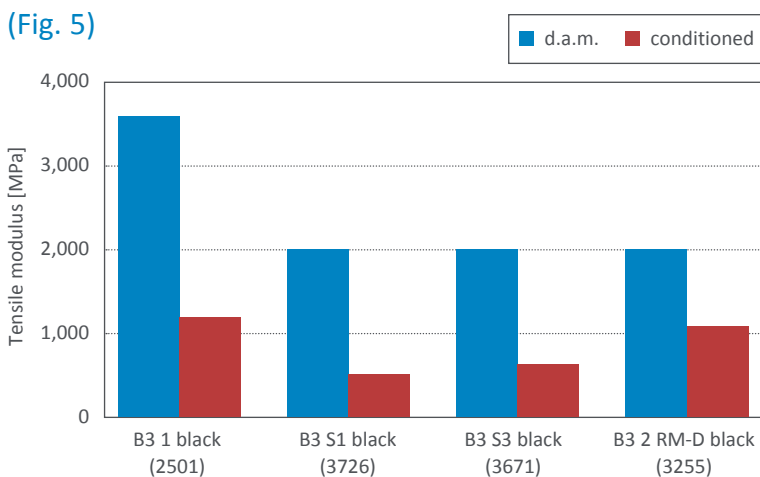
The impact strength diminished in the conditioned material at -30 °C, however. This was likely due to a complex interaction between the impact-strength modifier and the polymer matrix (see Fig. 3).

It is in the nature of polyamides to absorb moisture. Conditioning changes not only toughness, but also strength. The greater the moisture absorption, the more dramatic it is. The impact-strength modifiers themselves absorb very little moisture, which is why moisture absorption and thus the effect of strength due to conditioning are lower in these compounds than in unmodified compounds (see Fig. 4).

One of the advantages of AKROMID® B3 1 black (2501) is its greater stiffness when freshly moulded. With a reduction of the tensile modulus by more than 2 GPa, however, moisture absorption has a significantly greater effect than is the case in impact-modified compounds. This must be taken into account when designing parts (see Fig. 5).

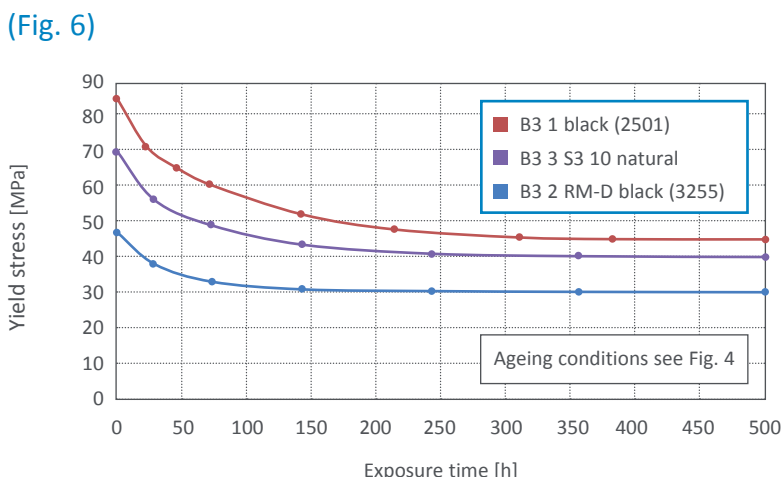
Tensile modulus

(Fig. 5)



Yield stress as a function of exposure time

(Fig. 6)



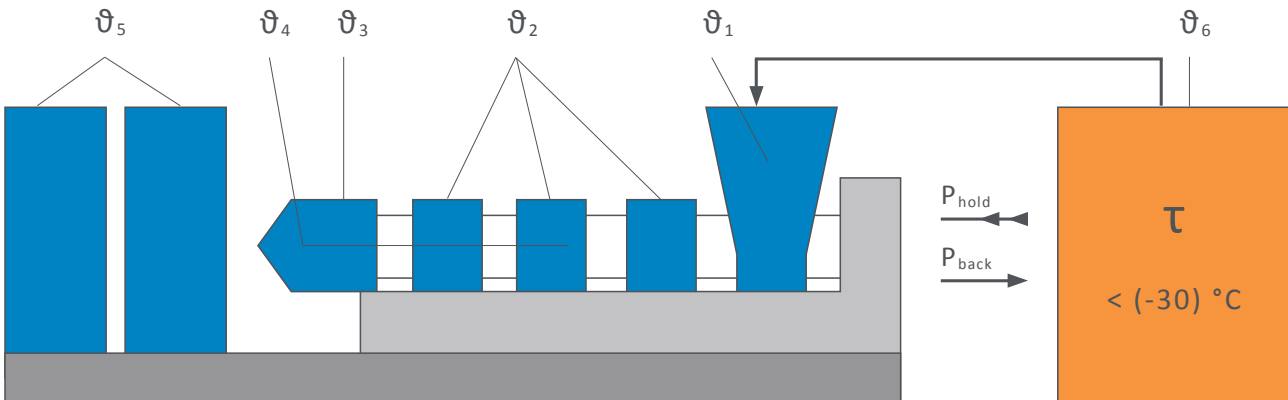
As can clearly be seen, the yield stress of AKROMID® B3 1 and AKROMID® B3 3 S3 10 colourless is approximately the same when conditioned (see Fig. 6).

Processing recommendations

In terms of processing, it must be noted that impact-modified compounds have a higher viscosity than standard polyamides. These diffe-

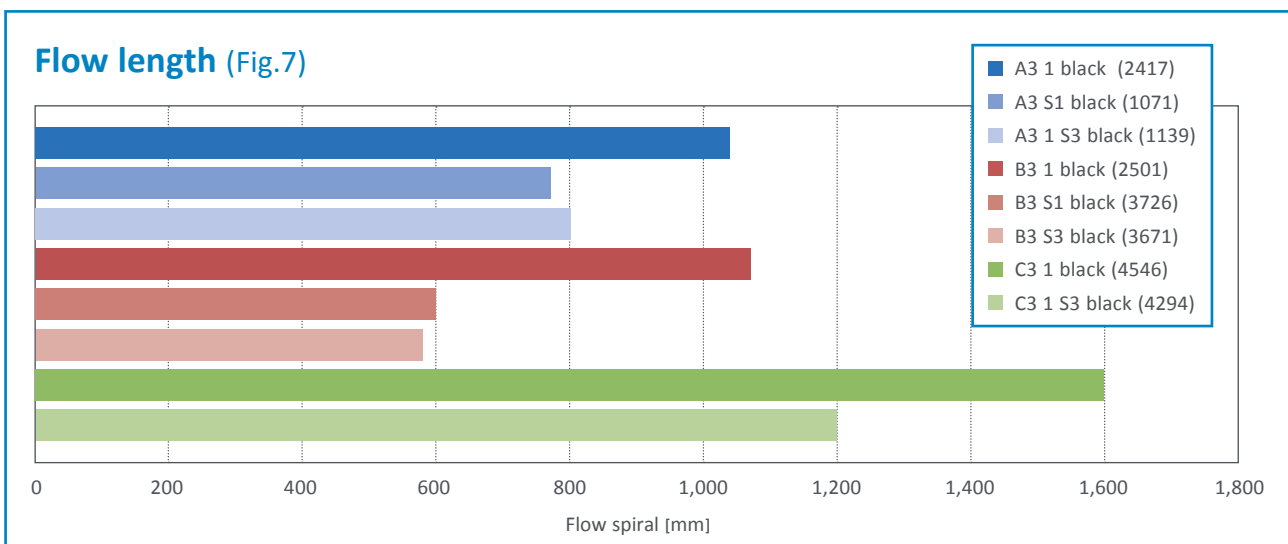
rent flow characteristics can be clearly evident in certain cases, as demonstrated by AKROMID® B3 S1 black (3726) and AKROMID® B3 S3

black (3671) (see Fig. 7). It is generally possible, however, to formulate special compounds with favourable flow characteristics.



		AKROMID® A	AKROMID® B	AKROMID® C
Flange	ϑ_1	60 – 80 °C	60 – 80 °C	60 – 80 °C
Sector 1 – Sector 4	ϑ_2	260 – 300 °C	225 – 300 °C	225 – 300 °C
Nozzle	ϑ_3	280 – 295 °C	240 – 280 °C	280 – 295 °C
Melt temperature	ϑ_4	280 – 310 °C	260 – 300 °C	280 – 310 °C
Mould temperaturee	ϑ_5	80 – 100 °C	80 – 100 °C	80 – 100 °C
Drying	ϑ_6	80 °C, 2 h	80 °C, 2 h	80 °C, 2 h
Holding pressure, spec.	P_{hold}	300 – 800 bar	300 – 800 bar	300 – 800 bar
Back pressure, spec.	P_{back}	50 – 100 bar	50 – 100 bar	50 – 100 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 0.05 and 0.1 % are recommended. The drying time of freshly-opened bags is up to 4 h. It is recommended to use opened bags completely. Material processed from silo or boxes requires a minimum drying time of 4 h.





Applications

Impact-modified AKROMID® compounds are used in all industrial sectors.

Components for sports and leisure activities are frequently confronted with high forces or even impact loads. An interesting example is an ice skate from T-Blade, for which an impact-resistant AKROMID® was used to make the blade holder. The blade itself can be replaced with a new one as soon as it is worn out. The material meets the high standards of the component even at the low temperatures at work here.

Highly reinforced compounds are typically used as metal substitutes. Glazpart Ltd. (UK) have replaced a steel design with an intelligently developed plastic part made of a high-impact-modified AKROMID® compound which is used to protect a gas canister valve. It has passed all tests in the -40 °C to +65 °C range required for gas canisters with a gross weight of 100 kg.

In the motorcar industry, typical applications include window frame trim, cable ducts, fasteners and housings which may be subjected to impact loads. In these cases, dry-impact-resistant compounds are frequently used to bypass the conditioning step during assembly. Because polyamides are significantly more brittle at low temperatures than at room temperature, cold-impact-modified compounds are used when the requirements call for this.



Valve guard for gas canisters, Glazpart Ltd. (UK): AKROMID® A3 S1 grey (4377)

The examples shown here are just a few of the possible applications. We will be happy to discuss further specific applications personally with you.

Ice skate blade holder, T-Blade: AKROMID® B3 GF 30 S1 black (2091)



Application areas

Automotive industry

- Airbag clips
- Airbag housings
- Aerial housings
- Fastening clips
- Seat add-on parts
- Belt guides/holders
- Cable ducts
- Fan blades

Electric/Electronic

- CEE plugs
- Electrical plugs
- Housing parts
- Cable ties

Industry

- Dowels
- Cable ties
- Chain drives
- Valve guard for gas canisters
- Furniture fittings
- Tool parts
- Pump housings

Sports

- Ice skate blade holders
- Ski binding parts
- Parts for inline skates

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We will be pleased to meet you!

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