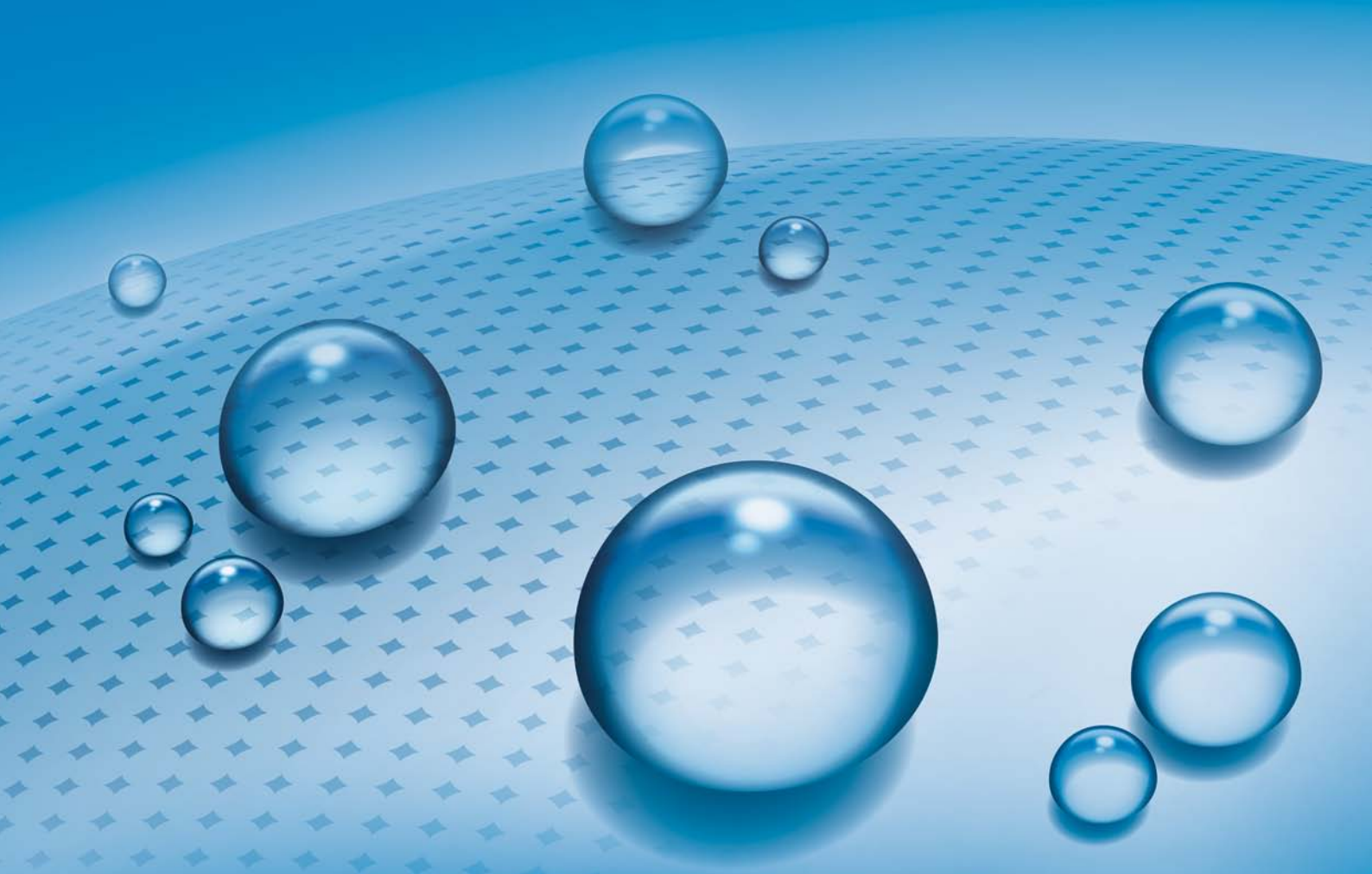


AKROMID® RM – the polyamide with reduced moisture absorption



AKRO-PLASTIC 
Think Polyamide

AKRO-PLASTIC GmbH
Member of the Feddersen Group

Polyamides are materials which have an extremely balanced profile of properties and can therefore be used in many industries to produce a wide range of components.

However, polyamides absorb water (e.g. humidity). This absorption results in increased flexibility and toughness and reduced stiffness, strength and hardness. Resultant changes in volume (swelling) can lead to warpage of the component. With **AKROMID® RM** (Reduced Moisture), AKRO-PLASTIC GmbH has successfully met the challenge of developing a polyamide which exhibits the typical, positive properties of PA6 yet has lower water/moisture absorption rates. AKROMID® RM is available in two product lines: **AKROMID® RM-M (mechanical grades)** and **AKROMID® RM-D (design grades)**.

With a reduction in water absorption of up to 50 % compared with standard PA6, the residual stiffness and strength of the components after conditioning is greater than with standard PA6. Weight-saving is therefore possible.

In the overview (right) and on the following pages, the technical data and possibilities are displayed for a whole variety of technically innovative applications with greater dimensional stability.

AKROMID® RM-M *mechanical series (PA 6)*

Typical values for black colour material at 23 °C				B3 GF 15 RM-M (3696)		B3 GF 30 RM-M (3016)		B3 GF 50 RM-M (3146)		B3 GF 15 9 RM-M (3512)		B3 GF 30 9 RM-M (30 99)		B3 GF 50 9 RM-M (3147)		B3 GF 15 4 RM-M (3440)		B3 GF 30 4 RM-M (3476)		B3 GF 50 4 RM-M (3221)	
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.
Mechanical Properties																					
Tensile modulus	1 mm/min	ISO 527-1/2	MPa	6,200	4,200	11,000	7,100	17,000	12,000	6,200	4,200	10,500	7,500	16,000	13,000	6,300	4,300	9,500	7,500	16,500	13,000
Yield stress ² /Tensile stress at break	5 mm/min	ISO 527-1/2	MPa	125	85	165	110	210	135	125	85	170	115	210	145	130	87	170	115	210	160
Elongation at break	5 mm/min	ISO 527-1/2	%	3	4.5	2.6	4.5	2.2	3	3	4.5	2.6	4.2	2.2	3	3	4.5	2.8	4.2	2	2.7
Flexural modulus	2 mm/min	ISO 178	MPa	4,800		9,600		17,500		4,800		9,600		17,200		4,800		9,500		16,800	
Flexural stress ³	2 mm/min	ISO 178	MPa	190		250		320		190		250		330		190		250		320	
Charpy impact strength	23 °C	ISO 179-1/1eU	kJ/m ²	45	50	70	70	70	70	45	50	70	70	70	70	42	50	75	70	75	75
Charpy impact strength	-30 °C	ISO 179-1/1eU	kJ/m ²	40	40	65	60	60	60	40	40	65	60	60	60	40	40	65	60	60	60
Charpy notched impact strength	23 °C	ISO 179-1/1eA	kJ/m ²	7	8	12	15	20	20	7	8	12	13	20	20	7	8	12	13	20	20
Charpy notched impact strength	-30 °C	ISO 179-1/1eA	kJ/m ²	7	7	10	10	15	20	7	7	10	10	16	20	7	7	10	10	16	20
Ball indentation hardness	HB 961/30	ISO 2039-1	MPa	180		230		280		180		230		280		180		230		280	
Electrical 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.		d.a.m.	
Comparative tracking index, CTI	Test solution A	IEC 60112		600		600		600		600		600		600		600		600		600	
Thermal Properties																					
Melting point	DSC, 10 K/min	ISO 11357-1	°C	225		225		225		225		225		225		225		225		225	
Heat distortion temperature, HDT/A	1.8 MPa	ISO 75-1/2	°C	200		210		215		195		205		205		210		195		200	
Heat distortion temperature, HDT/C	8 MPa	ISO 75-1/2	°C			160		165				160		160		165				160	
Flammability																					
Flammability acc.UL 94	0.8 mm	UL 94	Class	HB		HB		HB		HB		HB		HB		HB		HB		HB	
Rate acc. FMVSS 302 (< 100 mm/min)	> 1 mm thickness	FMVSS 302	mm/min	+		+		+		+		+		+		+		+		+	
General Properties																					
Density	23 °C	ISO 1183	g/cm ³	1.28		1.41		1.62		1.28		1.41		1.41		1.61		1.28		1.41	
Content reinforcement		ISO 1172	%	15		30		50		15		30		30		50		15		30	
Moisture absorption	70 °C/62 % r.h.	ISO 1110	%	2.2		1.65		1.2		2.1		1.6		1.6		1.2		2.1		1.6	
Processing																					
Flowability	Flowspiral ¹	AKRO	mm	880		700		500		830		700		700		500		820		670	
Processing shrinkage, flow		ISO 294-4	%	0.5		0.3		0.4		0.5		0.4		0.4		0.4		0.4		0.25	
Processing shrinkage, transverse		ISO 294-4	%	0.9		0.8		0.7		0.8		1.0		1.0		0.7		0.7		0.7	

¹ = mould temperature: 80 °C, melt temperature: 270 °C
injection pressure: 750 bar, cross section of flow spiral: 7 mm x 3,5 mm
² = yield stress and elongation at break: test speed 50 mm/min

* = unreinforced compounds at flexural strain of 3.5 %
+ = passed

"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 %

AKROMID® RM-D *design series (PA 6)*

Unit	B3 2 RM-D (3254)		B3 2 RM-D (3374)		B3 2 RM-D (3255)		B3 GF 20 2 RM-D (3375)		B3 GF 30 2 RM-D (3424)	
	d.a.m.	cond.	d.a.m.	cond.	d.a.m.	cond.	d.a.m.	cond.	d.a.m.	cond.
MPa	2,500	1,500	2,300	1,300	2,000	1,100	6,800	5,000	9,300	7,000
MPa	60	45	50	35	47	30	120	85	145	110
%	> 30	> 100	> 40	> 100	> 50	> 100	2.7	3.5	2.3	3
	2,300		2,200		2,100		6,300			
	70		70		70		175			
kJ/m ²	n.b.	n.b.	n.b.	n.b.	n.b.	n.b.	55	50	55	50
kJ/m ²	n.b.	n.b.	n.b.	n.b.	n.b.	n.b.	50	50	50	45
kJ/m ²	15	17	20	65	70	85	12	12	13	11
kJ/m ²	10	11	15	16	15	17	10	10	11	9
MPa							175		195	
	d.a.m.		d.a.m.		d.a.m.		d.a.m.		d.a.m.	
°C	225		225		225		220		220	
°C	80		75		67		170		175	
°C										
Class	HB		HB		HB		HB		HB	
mm/min	+		+		+		+		+	
g/cm ³	1.10		1.08		1.07		1.24		1.33	
%	-		-		-		20		30	
%	1.65		1.63		1.6		1.4		1.4	
mm	650		620		550		550		500	
%	0.8		0.8		0.9		0.3		0.3	
%	1.0		1.0		1.1		0.55		0.55	

³ = unreinforced compounds at flexural strain of 3.5 %
+ = passed
n.b. = not broken

"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 %

Resistance to media

The specifications for chemical resistance are subjective classifications based on resistance analyses as per the standards ISO 175, ISO 11403-3, ISO 4599, ISO 4600, ISO 6252, etc. These specifications should only be used as a basis for an initial evaluation. Use of the plastic when subjected to stress from the specified media is dependent upon prior completion of practical experiments.

AKROMID® RM-M

Medium	Temp. (°C)	Conc. (%)	pass	fail
Acetone	23	100	•	
Benzene	23	100	•	
Benzol	23	100	•	
Brake fluid (DOT4)	130	100		•
Brake fluid (DOT4)	23	100	•	
Biodiesel	50	100	•	
Calcium chloride, aqueous	23	10	• (4)	•
Calcium chloride, alcoholic	23	10	• (4)	•
Diesel fuel (DIN 51601)	23	100	•	
Sulphuric acid	23	96		•
Toluene	23	100	•	
Water	up to 50	100	•	
Zinc chloride, aqueous	23	50		•
Citric acid	23	10	•	

AKROMID® RM-D

Medium	Temp. (°C)	Conc. (%)	pass	fail
Acetone	23	100		•
Calcium chloride, aqueous	23	10	•	
Calcium chloride, alcoholic	23	10	•	
Acetic acid	23	20	•	
Ethanol	23	96	•	
Fruit juices	50	100	•	
Isopropanol	23	100	•	
Methanol	23	100	•	
Sodium hydroxide solution, aqueous	23	1	•	
Sulphuric acid	23	96		•
Spirits	23	100	•	
Toluene	23	100		•
Water	up to 50	100	•	
Hydrogen peroxide	23			•
Zinc chloride, aqueous	23	50	•	
Citric acid	23	10	•	

Resistant means:
Complete resistance under specified conditions.

Non-resistant means:
Even after short-term contact, the material may exhibit some damage, in case of prolonged contact there will quickly be visible signs of chemical degradation.

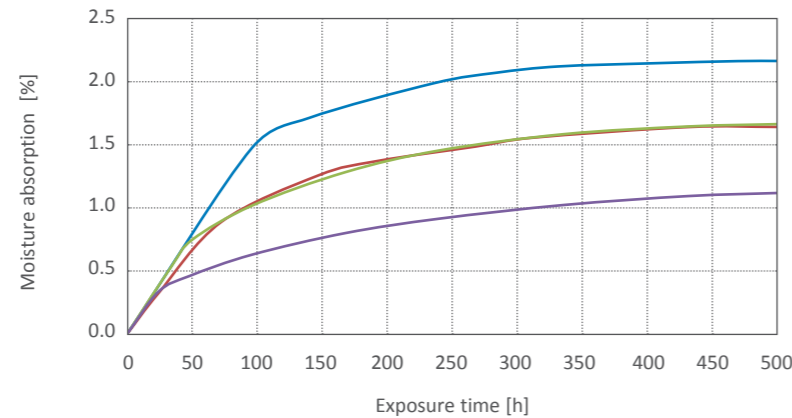
(4) applies to AKROMID® RM-M with surface treatment 4 (chemical-stabilised)

Product characterisation AKROMID® RM-M Mechanical

- B3 GF 30 black
- B3 GF 30 9 RM-M black (3099)
- B3 GF 50 black
- B3 GF 50 9 RM-M black (3147)

Ageing conditions:
 Temperature: 70 °C
 Rel. humidity: 62 %
 Ageing period: 500 h

Moisture absorption as a function of exposure time (Fig. 1)

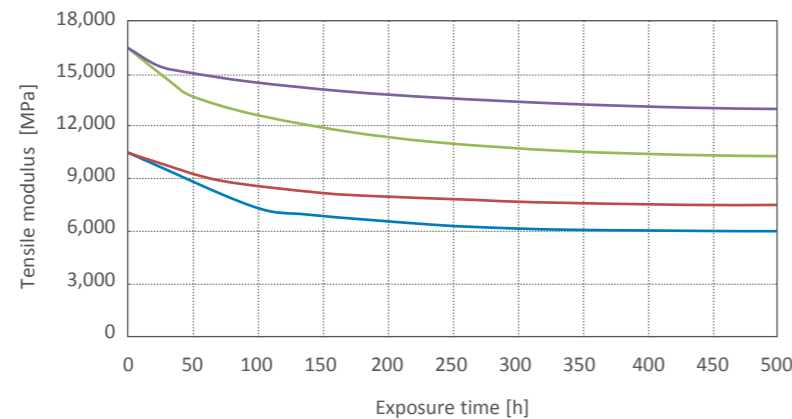


The new AKROMID® RM comes in two product lines: AKROMID® RM-M (mechanical grades) is suitable as a construction material for components subjected to high mechanical loads. This product line is offered exclusively in reinforced compounds with differing glass-fibre contents in three versions: standard, surface-modified ("9") and with increased chemical resistance ("4").

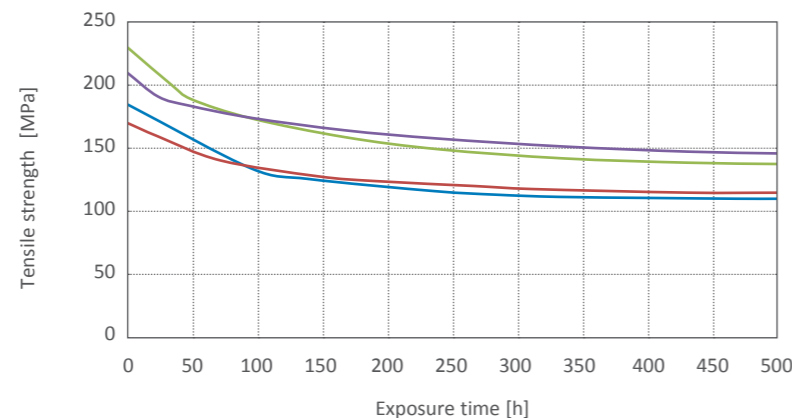
The AKROMID® RM-M series has significantly lower moisture absorbing compared to standard PA6. Grades with 30 % glass-fibre content absorb just as much water as a standard grade with 50 % glass-fibre content – see Fig. 1. As a result, the tensile modulus of AKROMID® RM-M decreases significantly less over the conditioning period than that of standard PA6 – see Fig. 2.

Although the tensile strength of dry as moulded AKROMID® RM-M is lower than in standard PA6, the strength of the two products is equivalent after conditioning – see Fig. 3.

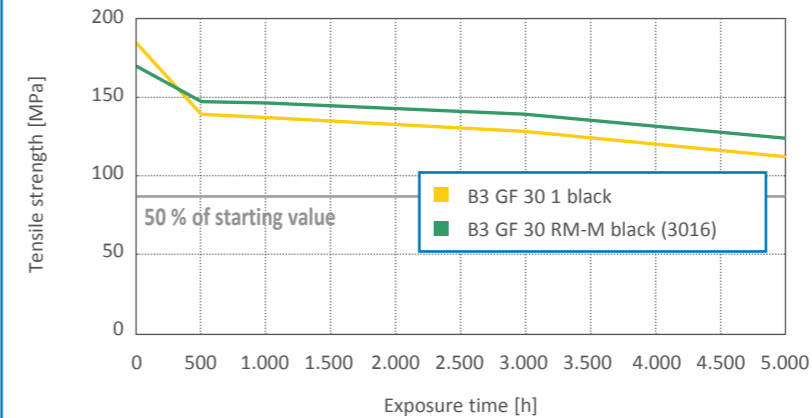
Tensile modulus as a function of exposure time (Fig. 2)



Tensile strength as a function of exposure time (Fig. 3)



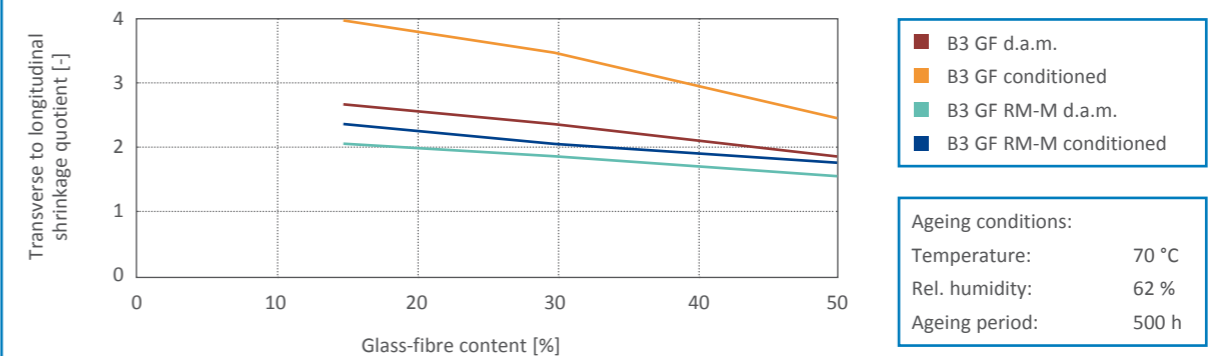
Heat ageing – tensile strength vs. exposure time @ 150 °C (Fig. 4)



CaCl₂ resistance in comparison (Fig. 5)



Ratio of transverse shrinkage to longitudinal shrinkage as a function of glass-fibre content (Fig. 6)



Mechanical Properties	B3 GF 30 RM-M		B3 GF 30	
	d.a.m.	conditioned	d.a.m.	conditioned
Tensile modulus	11,000	7,100	10,500	6,200
Shrinkage coefficient	1.9	2.1	2.4	3.5

Even the heat aging resistance of the AKROMID® RM-M tends to be better than standard PA6 – see Fig. 4.

In comparison with AKROMID® B3 GF 50 1 black and AKROMID® standard grade B3 GF 50 RM-M black (3146), AKROMID® B3 GF 50 9 RM-M black (3147) demonstrates a signifi-

cantly improved resistance to CaCl₂. AKROMID® B3 GF 50 4 RM-M black (3221) demonstrates the highest resistance (Fig. 5). These ageing conditions correspond to those described in Daimler Benz test specification DBL 5416.

The transverse to longitudinal shrinkage ratio (shrinkage coefficient) is significantly more favourable with AKROMID® RM-M series compared to the AKROMID® standard series. This ensures less warpage and a higher geometric stability of the component. These advantages are particularly prominent after conditioning – see Fig. 6.

Product characterisation AKROMID® RM-D *Design*

- B3 S3 natural (3438)
- B3 2 RM-D black (3254)
- B3 2 RM-D black (3255)
- B3 1 black (2501)

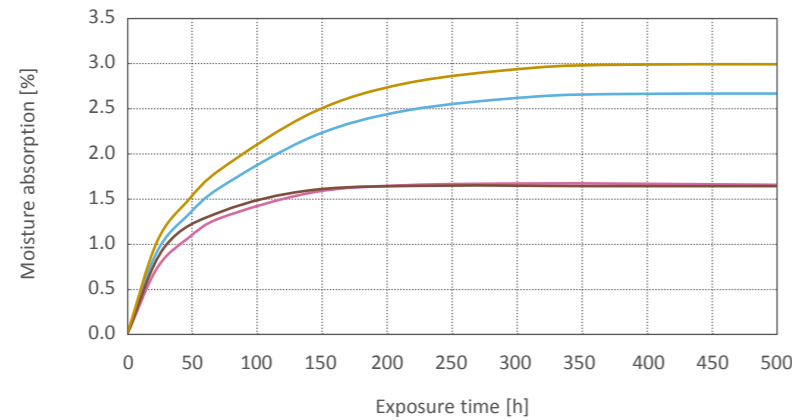
Ageing conditions:
 Temperature: 70 °C
 Rel. humidity: 62 %
 Ageing period: 500 h

AKROMID® RM-D (design grades) is particularly well-suited for visible parts or insert-moulded trim elements, such as interior parts in the automotive sector where low warpage and small clearances after **moisture absorption** are required. Also, sanitary applications are suitable, where minimal loss of stiffness and high strength at extremely high moisture contents is required. This product line provides an impressive property profile and is available in non-reinforced compounds as well as reinforced compounds with extremely high notched impact strength and low warpage tendency.

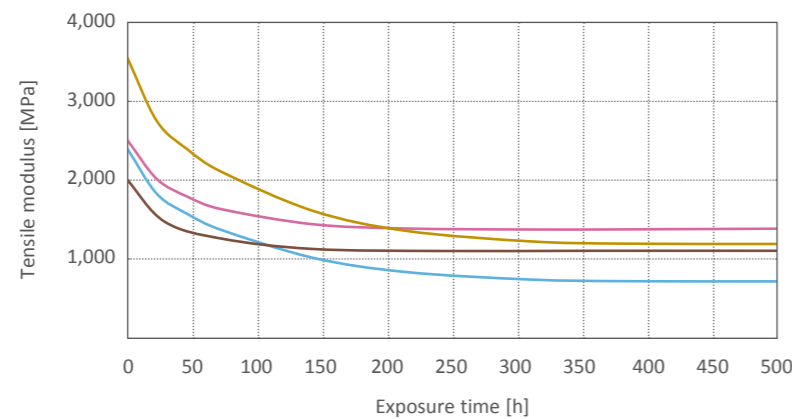
Available with UV-stabilised, impact-resistant or high-impact surface treatments, the non-reinforced grades excel due to their excellent surface quality. The reinforced grades are also characterised by good surface quality and optimised processing behaviour.

The AKROMID® RM-D series exhibits an improvement of 50 % in moisture uptake compared to standard PA6 – see Fig. 1. This leads to significantly improved dimensional stability compared with standard PA6. The characteristic good processing behaviour of PA6 is comparable.

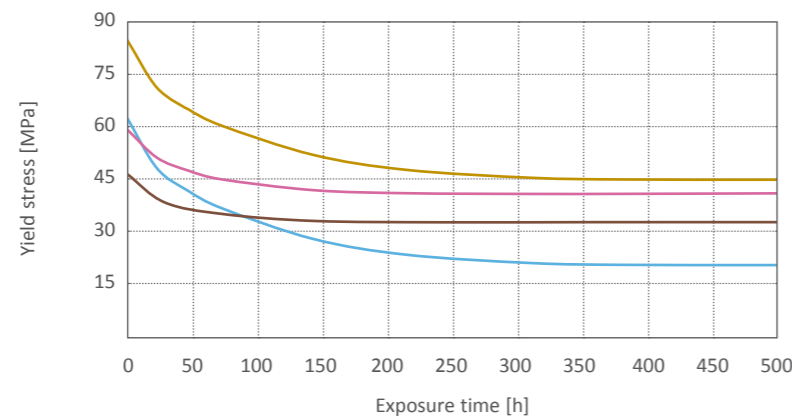
Moisture absorption as a function of exposure time (Fig. 1)



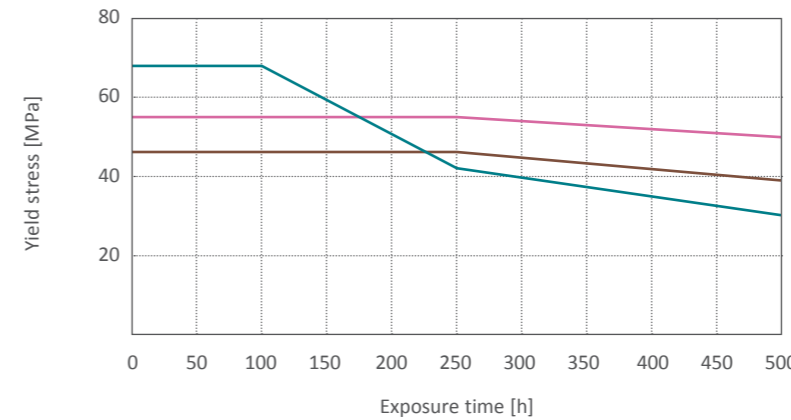
Tensile modulus as a function of exposure time (Fig. 2)



Yield stress as a function of exposure time (Fig. 3)



Heat ageing – yield stress vs. exposure time @ 125 °C (Fig. 4)



- B3 3 S3 10 black
- B3 2 RM-D black (3254)
- B3 2 RM-D black (3255)

Typical values for black colored products at 23 °C	B3 2 RM-D (3254)		B3 (2500)		B3 3 S3 10	
Mechanical Properties	d.a.m.	conditioned	d.a.m.	conditioned	d.a.m.	conditioned
Density	1,1		1,13		1,1	
Charpy notched impact strength RT	15	17	3	12	10	28
Tensile modulus	2.500	1.500	3.600	1.200	2.700	955

The **tensile modulus** of the AKROMID® series decreases less than standard PA types. AKROMID® B3 2 RM-D Black (3255) has a lower stiffness compared to standard PA6 dry as moulded, but after conditioning the stiffness is at the same level as AKROMID® B3 1 black (2501) and considerably higher than the impact modified version AKROMID® B3 S3 (3438) – see Fig. 2.

The **yield stress** shows a similar behaviour, decreasing far less with AKROMID® RM-D grades compared to standard PA6 at elevated exposure time. Therefore, the stiffness of AKROMID® B3 S3 natural (3438) after conditioning, is significantly lower when considering a higher value in the dry as moulded condition. This very consistent behaviour is an essential added value for application design – see Fig. 3.

The AKROMID® RM-D grades are characterised by **excellent heat ageing resistance**. The tensile strength shows only slight variation over 500 hours at 125 °C – higher than that of the standard product after ageing. The standard grade demonstrates greater strength when dry as moulded – see Fig. 4.

Of particular importance is the approximate 5 % **lower density** of AKROMID® RM-D compared with conventional PA6, which can be used to achieve a weight advantage for the component – see table.

AKROMID® RM-D also has better acoustic behaviour and superior damping properties compared with materials such as ABS, PC + ABS, etc. However, the achievable surface finish is dull compared to that of ABS.

We will be pleased to meet you!



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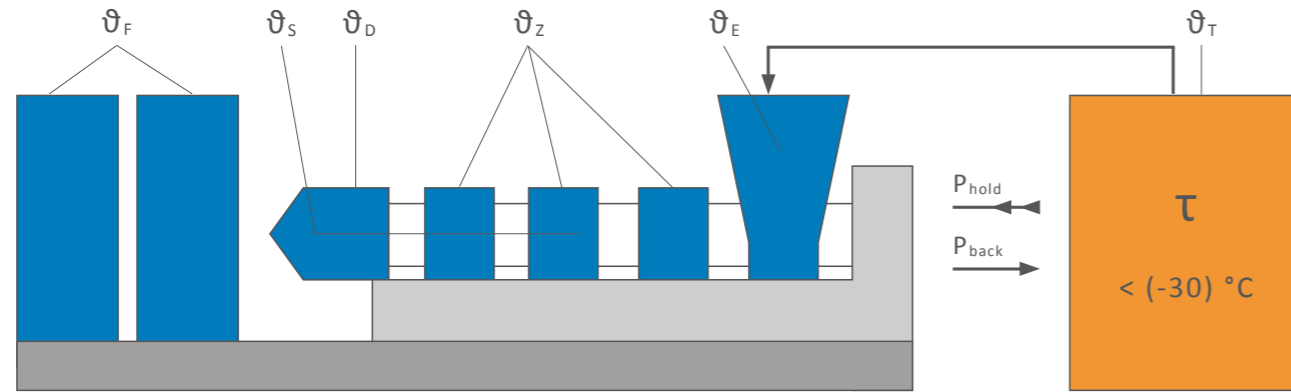
For more locations, visit www.kdfeddersen.com

Processing recommendations

AKROMID® RM can be processed on commercially available injection moulding machines with standard

screws according to the recommendations of the machine manufacturer. Please refer to the table below

for our recommended machine, mould and dryer settings (see diagram):



AKROMID® RM		
Feed section	ϑ_E	60 – 80 °C
Sector 1 – Sector 4	ϑ_Z	225 – 290 °C
Nozzle	ϑ_D	240 – 285 °C
Melt temperature	ϑ_S	260 – 290 °C
Mould surface	ϑ_F	80 – 100 °C
Drying	ϑ_τ	80 °C, up to 4 h
Holding pressure, spec.	P_{hold}	300 – 800 bar
Back pressure, spec.	P_{back}	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. The drying time of freshly-opened bags is up to 4h. It is recommended to use opened bags completely. Material processed from silo or boxes requires a minimum drying time of 4h.

Applications

AKROMID® RM-M

Electric/Electronic

- Sensor housings
- Coil formers (o. UL)
- Connectors
- Edge connectors

Automotive

- Sensor housings
- Electr. drives
- Windscreen wiper arms
- Door handles
- Steering-column switches
- Mirror components
- Sunroof frames
- Airbag module

Industry

- Functional parts in printers
- Copy machines
- Valve housings
- Pumps

AKROMID® RM-D

Automotive

- Trim panels in inside fittings for climate-control actuating elements
- Roof consoles
- Sunroof frames
- Instrument panels
- Brackets for decorative elements
- Elements in the vehicle exterior area such as commercial vehicle trim panels
- Motorbike trim panels
- Side walls
- Trim grilles
- Air vent slats

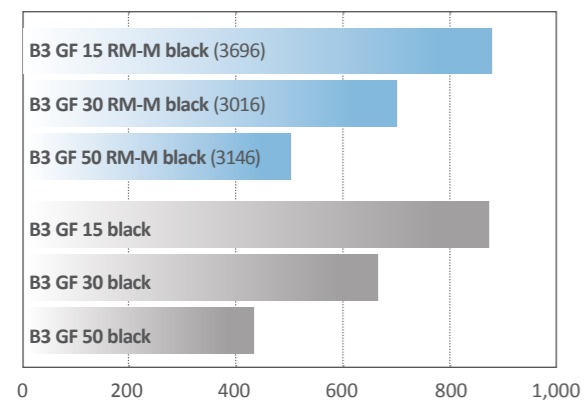
Industry

- Housings and visible parts of printers, copy machines, cash register systems, card-reader devices, etc.
- Sanitary applications
- Furniture applications

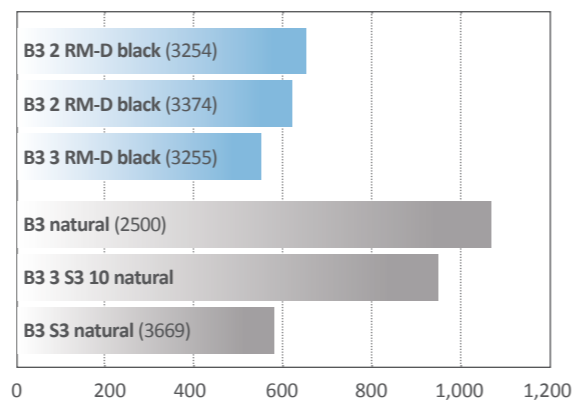


Trim panel for automotive interior: AKROMID® B3 GF 30 RM-D black (3424)

Flow length AKROMID® RM-M



Flow length AKROMID® RM-D



Length of melt-flow spiral in mm (mould temperature: 80 °C, melt temperature: 270 °C, injection pressure 750 bar, cross section of melt-flow spiral: 7 mm x 3.5 mm)



Carrier for airbag module: AKROMID® B3 GF 40 RM-M black (3534)



Cross support for office chair: AKROMID® B3 GF 30 2 RM-M black (4154)



Head with built-in hinge for shower: AKROMID® B3 2 RM-D white (3478)

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