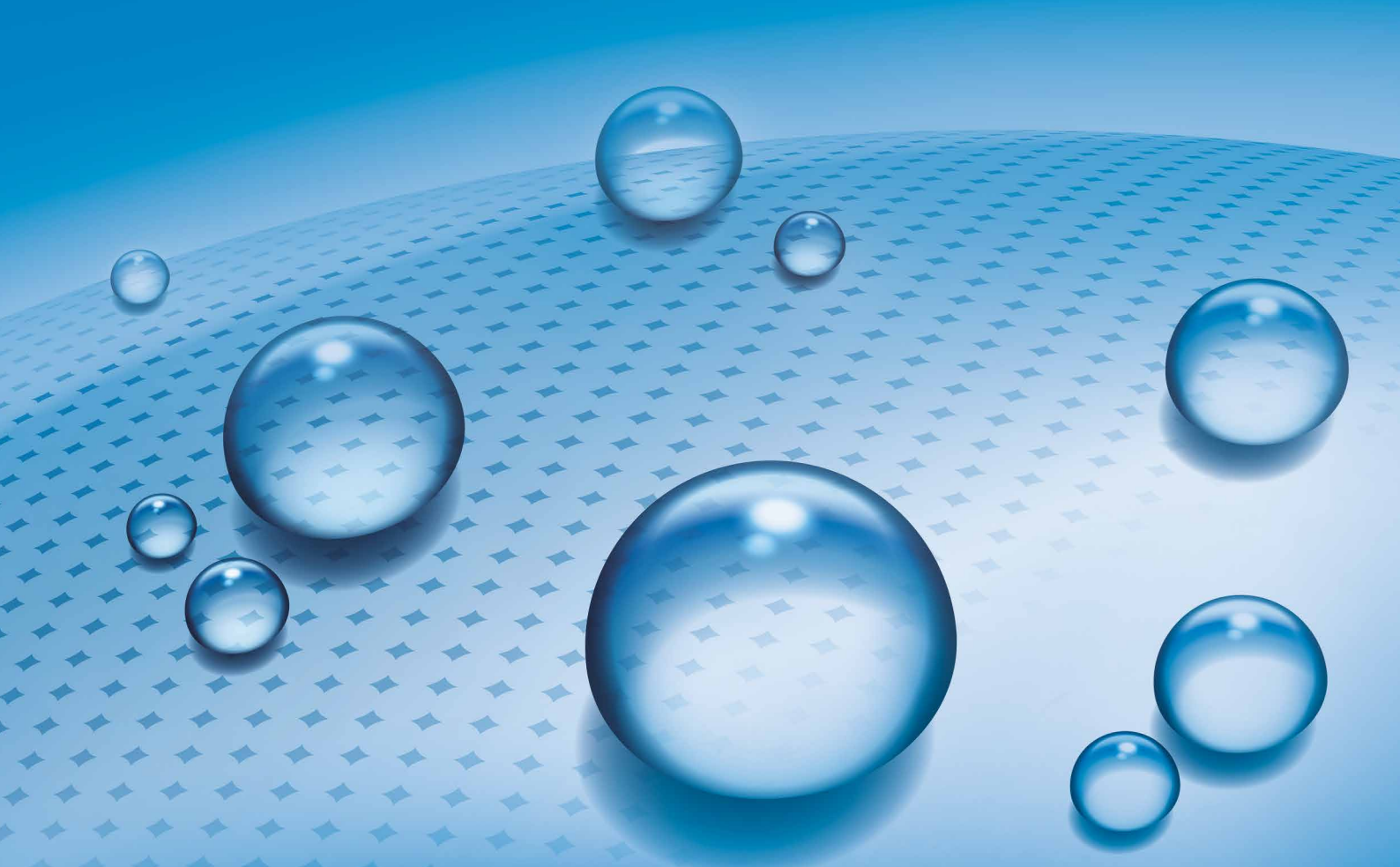


AKROMID[®] RM – The Polyamide with Reduced Moisture Absorption



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 color material at 23 °C				B3 GF 15 RM-M (3696)		B3 GF 30 RM-M (3016)		B3 GF 50 RM-M (3146)		B3 GF 30 9 RM-M (30 99)		B3 GF 50 9 RM-M (31 47)		B3 GF 15 4 RM-M (3440)		B3 GF 30 4 RM-M (3476)		B3 GF 50 4 RM-M (3221)		B3 GF 60 4 RM-M (5238)	
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	10,500	7,500	17,800	13,000	6,300	4,300	10,500	7,500	16,500	13,000	22,500	17,000
Yield stress ² /Tensile stress at break	5 mm/min	ISO 527-1/2	MPa	125	85	165	110	210	135	170	115	215	145	130	87	170	115	210	160	225	175
Elongation at break	5 mm/min	ISO 527-1/2	%	3	4.5	2.6	4.5	2.2	3	2.6	4.2	2.4	3	3	4.5	2.8	4.2	2	2.7	2	2.7
Flexural modulus	2 mm/min	ISO 178	MPa	4,800		9,600		17,500		9,600		17,200		4,800		9,500		16,800			
Flexural stress ³	2 mm/min	ISO 178	MPa	190		250		320		250		330		190		250		320			
Charpy impact strength	23 °C	ISO 179-1/1eU	kJ/m ²	45	50	70	70	70	70	70	70	70	70	42	50	75	70	75	75	60	65
Charpy impact strength	-30 °C	ISO 179-1/1eU	kJ/m ²	40	40	65	60	60	60	65	60	60	60	40	40	65	60	60	60	55	
Charpy notched impact strength	23 °C	ISO 179-1/1eA	kJ/m ²	7	8	12	15	20	20	12	13	20	20	7	8	12	13	20	20	22	
Charpy notched impact strength	-30 °C	ISO 179-1/1eA	kJ/m ²	7	7	10	10	15	20	10	10	16	20	7	7	10	10	16	20	18	
Ball indentation hardness	HB 961/30	ISO 2039-1	MPa	180		230		280		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		205		210		210		195		200		205	
Heat distortion temperature, HDT/C	8 MPa	ISO 75-1/2	°C			160		165		160		165		165		160		165		165	
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		1.41		1.61		1.61		1.28		1.41		1,6	
Content reinforcement		ISO 1172	%	15		30		50		30		50		50		15		30		50	
Moisture absorption	70 °C/62 % r.h.	ISO 1110	%	2.2		1.65		1.2		1.6		1.2		1.2		2.1		1.6		1,2	
Processing																					
Flowability	Flowspiral ¹	AKRO	mm	880		700		500		700		500		500		820		670		500	
Processing shrinkage, flow		ISO 294-4	%	0.5		0.3		0.4		0.4		0.4		0.4		0.4		0.25		0.3	
Processing shrinkage, transverse		ISO 294-4	%	0.9		0.8		0.7		1.0		0.7		0.7		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

³ = unreinforced compounds at flexural strain of 3.5 %
+ = passed

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

AKROMID® RM-D *Design Series (PA 6)*

Typical values for black color material at 23 °C	Test specification	Test method	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.
Mechanical properties													
Tensile modulus	1 mm/min	ISO 527-1/2	MPa	2,500	1,500	2,300	1,300	2,000	1,100	6,800	5,000	9,300	7,000
Yield stress ² /Tensile stress at break	5 mm/min	ISO 527-1/2	MPa	60	45	50	35	47	30	120	85	145	110
Elongation at break	5 mm/min	ISO 527-1/2	%	>30	>100	>40	>100	>50	>100	2.7	3.5	2.3	3
Flexural modulus	2 mm/min	ISO 178		2,300		2,200		2,100		6,300		9,200	
Flexural stress ³	2 mm/min	ISO 178		70		70		70		175		210	
Charpy impact strength	23 °C	ISO 179-1/1eU	kJ/m ²	n.b.	n.b.	n.b.	n.b.	n.b.	n.b.	55	50	55	50
Charpy impact strength	-30 °C	ISO 179-1/1eU	kJ/m ²	n.b.	n.b.	n.b.	n.b.	n.b.	n.b.	50	50	50	45
Charpy notched impact strength	23 °C	ISO 179-1/1eA	kJ/m ²	15	17	20	65	60	85	12	12	13	11
Charpy notched impact strength	-30 °C	ISO 179-1/1eA	kJ/m ²	10	11	15	16	15	17	10	10	11	9
Ball indentation hardness	HB 961/30	ISO 2039-1	MPa							175		195	
Electrical properties													
Comparative tracking index, CTI	Test solution A	IEC 60112		d.a.m.		d.a.m.		d.a.m.		d.a.m.		d.a.m.	
Thermal properties													
Melting point	DSC, 10 K/min	ISO 11357-1	°C	225		225		225		220		220	
Heat distortion temperature, HDT/A	1.8 MPa	ISO 75-1/2	°C	80		75		67		170		175	
Heat distortion temperature, HDT/C	8 MPa	ISO 75-1/2	°C										
Flammability													
Flammability acc. UL 94	0.8 mm	UL 94	Class	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	1.10		1.08		1.07		1.24		1.33	
Content reinforcement		ISO 1172	%	-		-		-		20		30	
Moisture absorption	70 °C/62 % r.h.	ISO 1110	%	1.65		1.63		1.6		1.4		1.4	
Processing													
Flowability	Flowspiral ¹	AKRO	mm	650		620		550		550		500	
Processing shrinkage, flow		ISO 294-4	%	0.8		0.8		0.9		0.3		0.3	
Processing shrinkage, transverse		ISO 294-4	%	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 DIN EN ISO 1110
"d.a.m." = dry as moulded test values = residual moisture content <0.10 %

Resistance to Media

The information regarding chemical resistance are subjective ratings based on resistance experiments

according to standards DIN EN ISO 175, DIN EN ISO 11403-3, DIN EN ISO 22088.

The information is intended for an initial assessment only.

AKROMID® RM-M

Medium	Temp. (°C)	Conc. (%)	pass	fail
Acetone	23	100	•	
Benzine	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 EN 590)	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	•	
Diesel (EN 590)	90	100	•	
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.

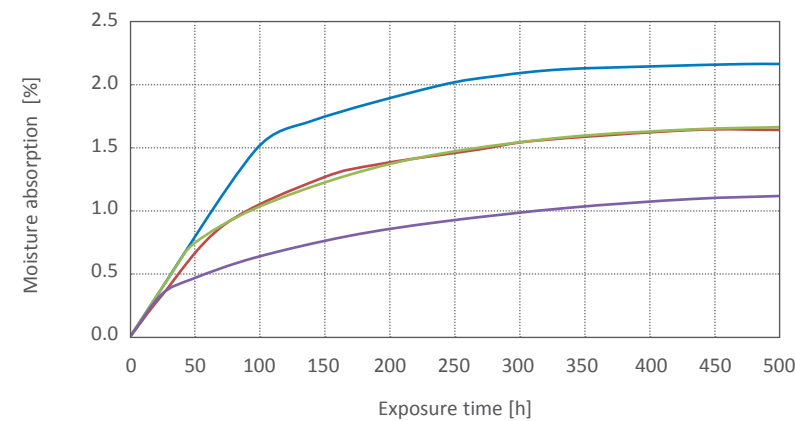
(4) applies to AKROMID® RM-M with surface treatment 4 (chemical-stabilised)

Product Characterisation AKROMID® RM-M *Mechanical*

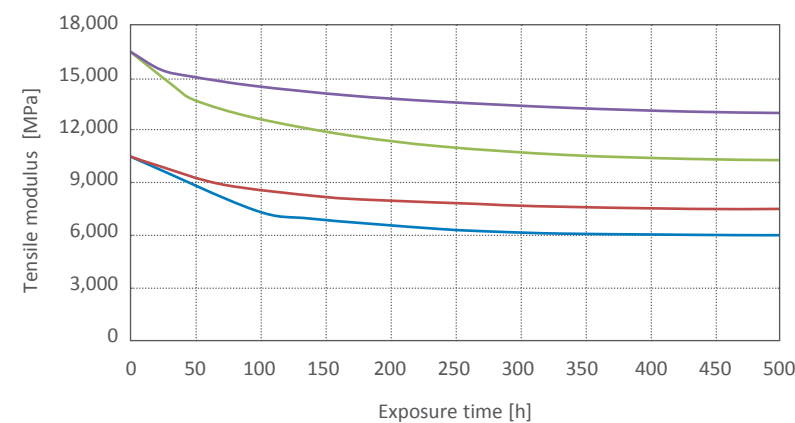
- B3 GF 30 black
- B3 GF 30 9 RM-M black (3099)
- B3 GF 50 black
- B3 GF 50 9 RM-M black (3147)

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

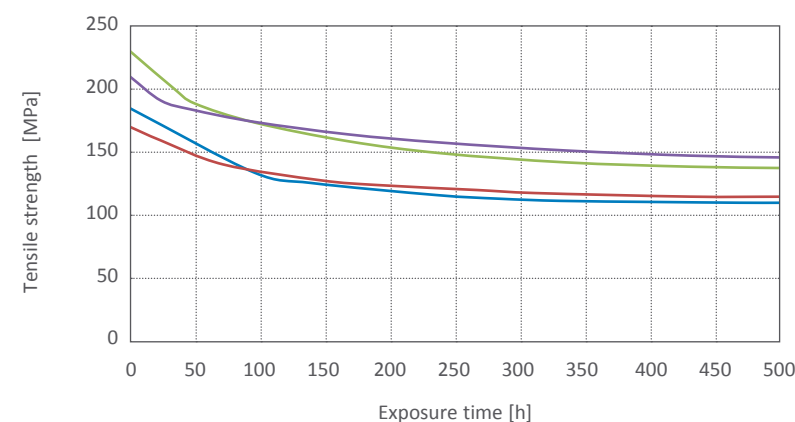
Moisture Absorption as a Function of Exposure Time (Fig. 1)



Tensile Modulus as a Function of Exposure Time (Fig. 2)



Tensile Strength as a Function of Exposure Time (Fig. 3)

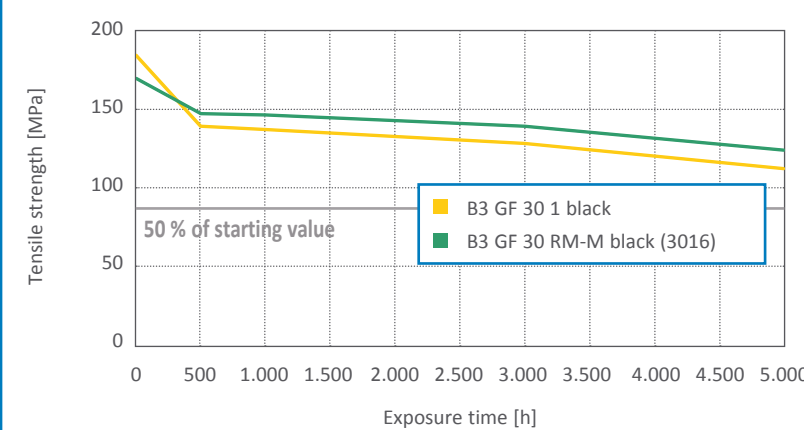


The new **AKROMID® RM** comes in two product lines: **AKROMID® RM-M** (mechanical grades) is suitable as a construction material for components subjected to high mechanical loads. This product line is offered exclusively in reinforced compounds with differing glass-fibre contents in three versions: standard,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

Heat Ageing – Tensile Strength vs. Exposure Time @ 150 °C (Fig. 4)



CaCl₂ Resistance in Comparison (Fig. 5)



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 ageing 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 significantly 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 (state: 2002).

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.

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)

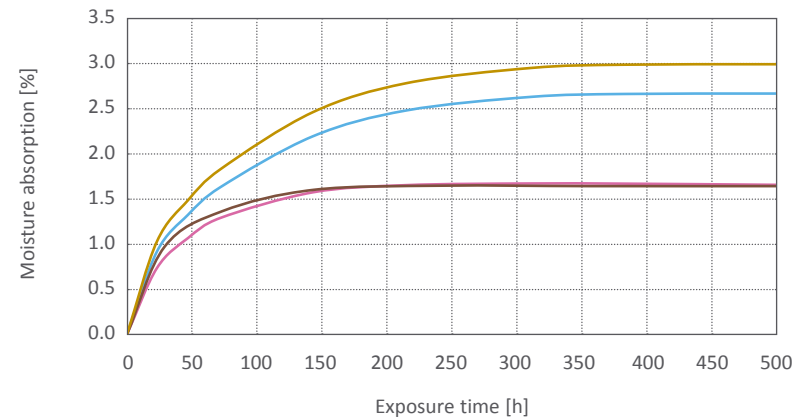
Ageing conditions:
 Temperature: 70 °C
 Rel. humidity: 62 %
 Ageing period: 500 h

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.

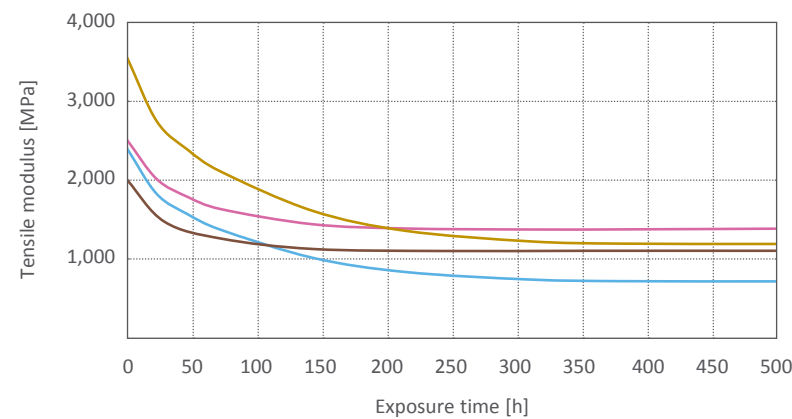
Available with UV-stabilised, impact-resistant or high-impact surface treatments, the non-reinforced grades excel due to their excellent surface quality. The reinforced grades are also characterised by good surface quality and optimised processing behaviour.

The AKROMID® RM-D series exhibits an improvement of 50 % in moisture uptake compared to standard PA6 – see fig. 7. This leads to significantly improved dimensional stability compared with standard PA6. The characteristic good processing behaviour of PA6 is comparable.

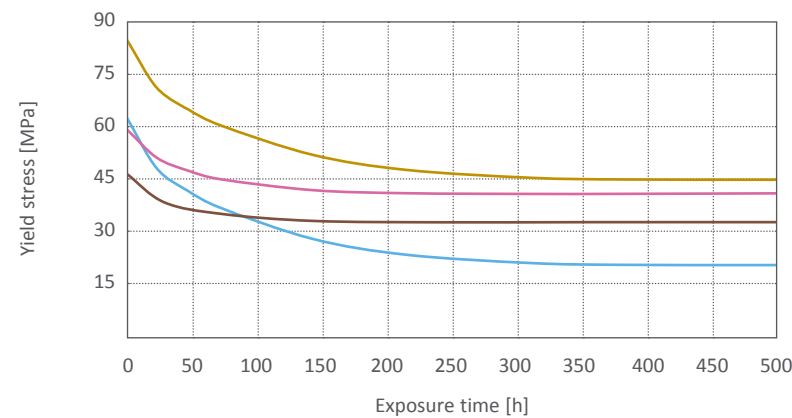
Moisture Absorption as a Function of Exposure Time (Fig. 7)



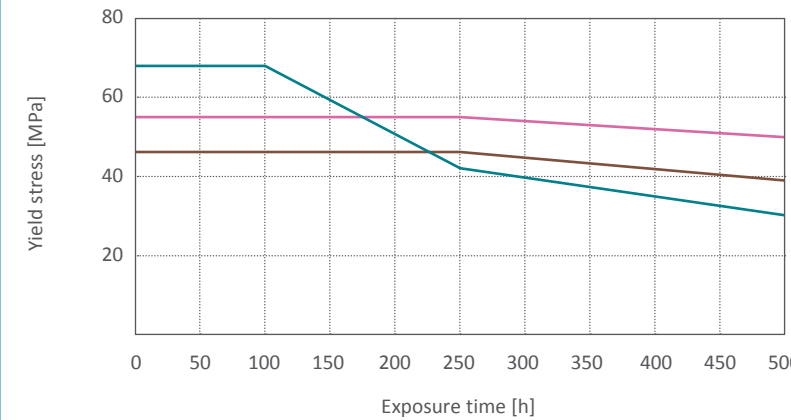
Tensile Modulus as a Function of Exposure Time (Fig. 8)



Yield Stress as a Function of Exposure Time (Fig. 9)



Heat Ageing – Yield Stress vs. Exposure Time @ 125 °C (Fig. 10)



- 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® RM-D 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. 8.

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. 9.

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.10.

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.

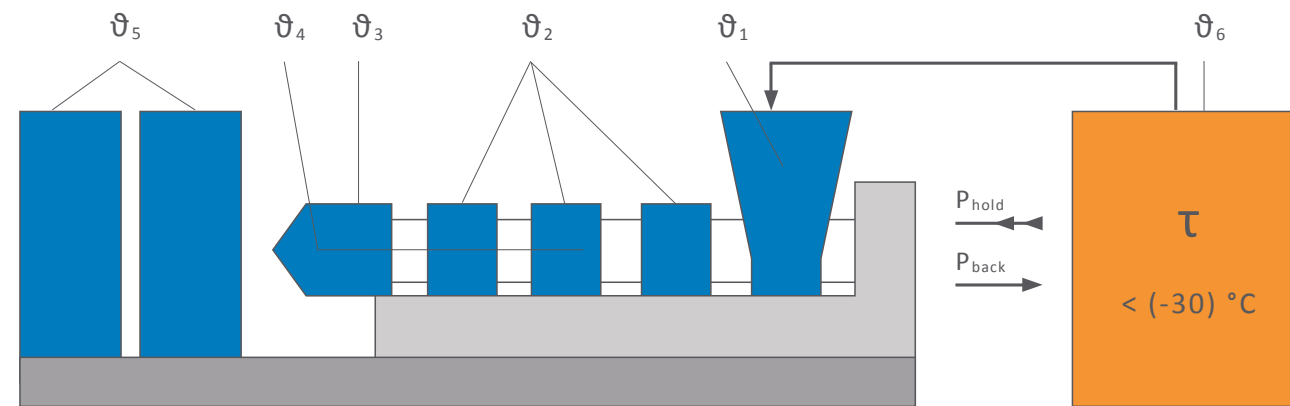
AKROMID® RM-D also has better acoustic behaviour and superior damping properties compared with materials such as ABS, PC + ABS, etc. However, the achievable surface finish is dull compared to that of ABS.

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		
Flange	ϑ_1	60–80 °C
Sector 1 – sector 4	ϑ_2	220–300 °C
Nozzle	ϑ_3	240–290 °C
Melt temperature	ϑ_4	260–290 °C
Mould temperature	ϑ_5	80–100 °C
Drying	ϑ_6	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 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

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



Air discharge installation VW Touran: AKROMID® B3 GF 60 4 RM-M (5238)



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



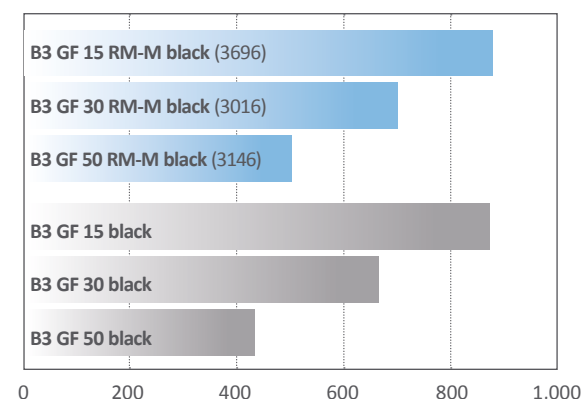
Trim panel for automotive interior: AKROMID® B3 GF 30 RM-D black (3424)



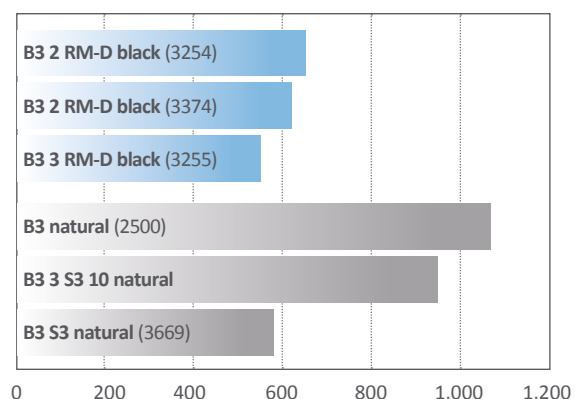
Carrier for airbag module: AKROMID® B3 GF 40 RM-M black (3534)

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Flow length AKROMID® RM-M

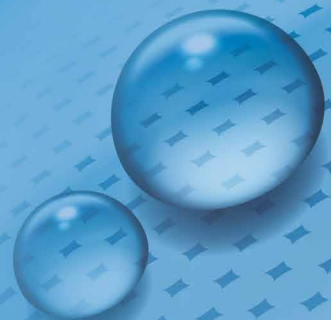


Flow length AKROMID® RM-D



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)

We Will Be Pleased to Meet You!



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