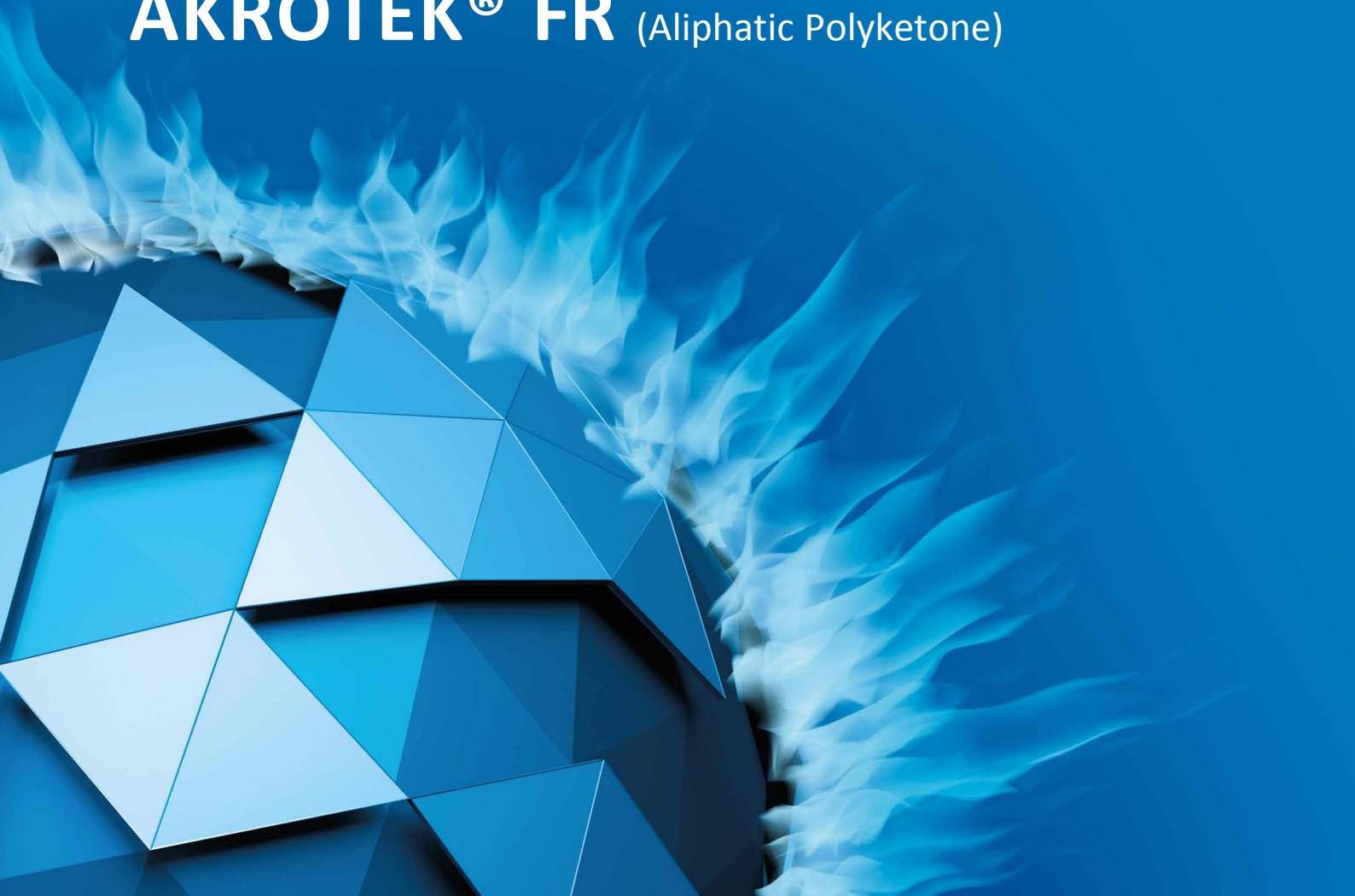


HALOGEN-FREE FLAME-RETARDANT COMPOUNDS

AKROMID® FR (PA 6.6, PA 6, PA 6.6/PA 6, PPA)

AKROLOY® FR (PA Blend)

AKROTEK® FR (Aliphatic Polyketone)



AKRO-PLASTIC 
Think Polyamide

AKRO-PLASTIC GmbH
Member of the Feddersen Group

Flame-retardant products – increasingly important for extended areas of application

Requirements for low flammability performance or self-extinguishing performance of engineering plastics are increasing. AKRO-PLASTIC meets these with a family of flame-retardant compounds.

The ICX[®] Technology (innovative compounding and extrusion technology), jointly developed with the mechanical engineering and sister company FEDDEM GmbH & Co. KG, contributes to ensuring a consistently high as well as location-independent quality. This includes an identical machine and peripheral technology as well as uniform processes at all production sites.

Special attention is paid to AKRO-PLASTIC's processing equipment, such as the absence of corrosion-promoting ingredients. Therefore, the use of iodine and bromine is completely avoided in products that are named FR-EN. However, the flame retardant agents being used can still act as donors of ions, which can still create some corrosion. This is the difference to our general EN grades (electrically neutral grades), in which we can confirm in the factory test certificate the content of iodine or bromine less than 1 ppm and thus the electrical neutrality.

Compounds FR

Typical values for material at 23 °C				A3 1 FR		A3 K1 FR		A3 GF 30 FR-EN		B3 1 FR		B3 K8 9 FR		B3 K1 FR		B3 K6 FR		C3 1 FR													
Test specification	Test method	Unit		PA 6.6 FR (30+72)		PA 6.6 GF 25 FR (30+40)		PA 6.6 GF 30 FR (30+40)		PA 6 FR (30+72)		PA 6 GF 20 FR (30)		PA 6 GF 25 FR (30+40)		B3 GF 30 FR (30+40)		PA 6.6/6 FR (30)													
ISO designation according to EN ISO 1043-4:1999				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	MPa	3,500	1,500	9,200	6,500	10,500	5,500	3,500	1,300	6,000	3,000	10,000	5,500	10,500	6,500	3,500	1,300												
Yield Stress*/Tensile stress at break	5 mm/min	ISO 527	MPa	80/	50/	/140	/100	/150	/78	75/	40/	/95	/57	/130	/90	/130	/90	80/	45/												
Elongation at break	5 mm/min	ISO 527	%	>5	>100	3	4	3	5	10	>100	4.5	15	3	6.5	2.5	6	>15	>100												
Flexural modulus	2 mm/min	ISO 178	MPa	3,300	1,560	8,960	6,700			3,540	1,300	5,000	3,200	8,820	5,600	10,300	7,000	3,000	1,300												
Flexural strength	2 mm/min	ISO 178	MPa	125	55	220	170			112	45	145	90	212	145	225	160	110	45												
Charpy impact strength	23°C	ISO 179/1eU	kJ/m²	85	n.b.	65	70	67	70	80	n.b.	65	85	70	70	60	72	100	n.b.												
Charpy impact strength	-30°C	ISO 179/1eU	kJ/m²	80		10						50						90													
Charpy notched impact strength	23°C	ISO 179/1eA	kJ/m²	5	9	11	13	10	13	4	11	4	9	11	16	11	15	5	11												
Charpy notched impact strength	-30°C	ISO 179/1eA	kJ/m²	4								3							4												
Electrical properties																															
Dielectric strength	3 mm	IEC 60243	kV/mm	19		28		30 (d = 1 mm)																							
Comparative tracking index (CTI)	Test solution A	IEC 60122		>600		>600		600				550		600				>600													
Thermal properties																															
Melting point	DSC, 10 K/min	ISO 11357-1	°C	262		262		262		225		225		225		225		262													
Heat distortion temperature, HDT/A	1.82 MPa	ISO 75-1/2	°C	80		246				65		210						70													
Heat distortion temperature, HDT/B	0.45 MPa	ISO 75-1/2	°C	220		261				180		220		220				210													
Flammability																															
Specimen thickness			mm	0.4	0.8	1.6	3.2	0.4	0.8	1.6	3.2	0.4	0.8	1.6	3.2	0.4	0.8	1.6	3.2	0.4	0.8	1.6	3.2	0.4	0.8	1.6	3.2	0.4	0.8	1.6	3.2
Flammability acc.UL 94		UL 94	Class	V-2	V-0	V-0	V-0	V-0	V-0	V-0	V-0	V-0	V-0	V-0	V-0	V-0	V-0	V-0	V-0	V-2	V-2	V-2	V-2	V-1	V-0	V-0	V-0	V-0	V-0	V-0	V-0
High amperage arc ignition (HAI)		UL 746 A	Class		0																							0	0	0	0
Hot wire ignition (HWI)		UL 746 A	PLC		4																							4	4	0	0
Glow wire flammability index (GWFI)		IEC 60695-2-12	°C	960	960	960	960	960	960	960	960	960	960	960	960	960	960	960	960	n.a.	n.a.	960	960	960	960	960	960	960	960	960	960
Glow wire ignition temperature (GWIT)		IEC 60695-2-13	°C	775	775	775	775	775	750	775	775	775	775	775	775	775	775	775	775	775	750	750	750	775	750	775	775	775	775	775	775
Relat. thermal index (RTI), electrical		UL 746 B	°C		65				65	65	65																	65	65		65
Relat. thermal index (RTI), mech. strength		UL 746 B	°C		65				65	65	65																	65	65		65
Relat. thermal index (RTI), mech. impact		UL 746 B	°C		65				65	65	65																	65	65		65
Limiting oxygen index (LOI)		ISO 4589-1/2	%	32		34				34		>27						34													
General properties																															
Density	23 °C	ISO 1183	g/cm³	1.18		1.34		1.39		1.19		1.3		1.37		1.39		1.17													
Content minerals/reinforcement		ISO 1172	%	-		25		30		-		20		25		30		-													
Moisture absorption	70 °C/62 % r.h.	ISO 1110	%															2.3													
Processing																															
Processing shrinkage, flow		ISO 294-4	%	1.06		0.3		0.7		1.44		0.6						1.1													
Processing shrinkage, transverse		ISO 294-4	%	1.13		1.3		0.8		1.49		0.8						1.1													

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

n.b. = not broken
 n.a. = not applicable
 = UL Yellow Card

Compounds FR

Typical values for material at 23 °C		Test specification	Test method	Unit	C3 GF 25 1 FR				T1 K9 FR				PA K17 FR				PK-VM GF 20 FR			
ISO designation according to EN ISO 1043-4:1999					PA 6.6 GF 25 FR (30+40)				PPA-I GF 40 FR (40)				PA 6.6 + X GF 35 FR (30+40)				PK GF 20 FR (30+40)			
Mechanical properties					d.a.m.		cond.		d.a.m.		cond.		d.a.m.		cond.		d.a.m.		cond.	
Tensile modulus	1 mm/min	ISO 527	MPa	9,200	5,600	15,500	15,000	11,200	9,000	5,500										
Yield Stress/Tensile stress at break	5 mm/min	ISO 527	MPa	/143	/90	/215	/176	/135	/100	/90										
Elongation at break	5 mm/min	ISO 527	%	3	6	2.5	2	2	3	4										
Flexural modulus	2 mm/min	ISO 178	MPa	8,800	5,700	14,500	15,500			5,800										
Flexural strength	2 mm/min	ISO 178	MPa	222	160	295	285			160										
Charpy impact strength	23°C	ISO 179/1eU	kJ/m ²	73	72	75	65	60		60										
Charpy impact strength	-30°C	ISO 179/1eU	kJ/m ²																	
Charpy notched impact strength	23°C	ISO 179/1eA	kJ/m ²	11	15	9	9			13										
Charpy notched impact strength	-30°C	ISO 179/1eA	kJ/m ²																	
Electrical properties																				
Dielectric strength	3 mm	IEC 60243	kV/mm																	
Comparative tracking index (CTI)	Test solution A	IEC 60122				600		600												
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	°C	262		310		262		220										
Heat distortion temperature, HDT/A	1.82 MPa	ISO 75-1/2	°C	222		285														
Heat distortion temperature, HDT/B	0.45 MPa	ISO 75-1/2	°C	250																
Flammability																				
Specimen thickness			mm	0.4	0.8	1.6	3.2	0.4	0.8	1.6	3.2	0.4	0.8	1.6	3.2	0.4	0.8	1.6	3.2	
Flammability acc.UL 94		UL 94	Class	V-0	V-0	V-0	V-0	V-0	V-0	V-0	V-0	V-0	V-0	V-0	V-0	V-0	V-0	V-0	V-0	
High amperage arc ignition (HAI)		UL 746 A	Class																	
Hot wire ignition (HWI)		UL 746 A	PLC																	
Glow wire flammability index (GWFI)		IEC 60695-2-12	°C	960	960	960	960	960	960	960	960	960	960	960	960	960	960	960	960	
Glow wire ignition temperature (GWIT)		IEC 60695-2-13	°C	775	775	775	775	775	775	775	775	775	775	775	775	775	775	775	775	
Relat. thermal index (RTI), electrical		UL 746 B	°C																	
Relat. thermal index (RTI), mech. strength		UL 746 B	°C																	
Relat. thermal index (RTI), mech. impact		UL 746 B	°C																	
Limiting oxygen index (LOI)		ISO 4589-1/2	%																	
General properties																				
Density	23 °C	ISO 1183	g/cm ³			1.54		1.5		1.39										
Content minerals/reinforcement		ISO 1172	%	25		40		35		20										
Moisture absorption	70 °C/62 % r.h.	ISO 1110	%			1.1		1.4												
Processing																				
Processing shrinkage, flow		ISO 294-4	%			0.2		0.4		0.8										
Processing shrinkage, transverse		ISO 294-4	%			0.8		0.9		1										

* = yield stress and elongation at break: test speed 10 mm/min for non-reinforced compounds
 "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 %

Product Characterisation

AKRO-PLASTIC offers to developers and producers of electrical and electronic components a wide range of thermoplastic insulation materials. Flame-retardant and with low corrosion, suitable for bright colors and non-hazardous in processing.

All products in the FR portfolio contain flame-retardant agents that are free of red phosphorous, bromine and iodine. In special cases the classification as FR-EN can be guaranteed. In these cases the materials do not contain any iodide or bromide, a corresponding test can be accurately measured to 1 ppm in the in-

house laboratory of AKRO-PLASTIC and confirmed in the factory test certificate. The use of metal stearates is also excluded. Corrosive processes can thus be reduced to a minimum.

Our portfolio includes unreinforced PA 6.6 and PA 6 as well as blends of PA 6.6/6 with flame-retardants, that pass testing according to UL 94 with the result of V-0. The unreinforced AKROMID® C3 1 FR shows a good combination of flowability, strength and elongation at break. Looking at the stress-strain curves, one can see the suitability of this material for ap-

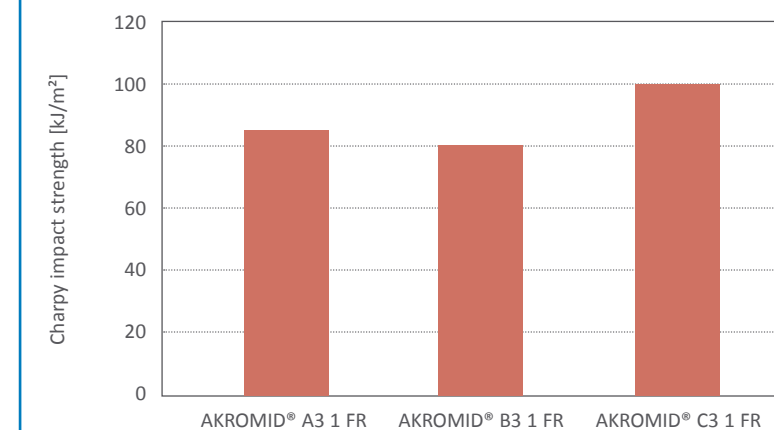
plications that need high flexibility, such as film hinges (fig. 2). The temperature index according IEC 218 shows, that the AKROMID® C3 1 FR is suitable for continuous operating temperatures of 110 °C.

Furthermore we offer reinforced materials with 25 % and 30 % glass fibres, which also qualify as V-0 according to UL 94. In addition, AKROMID® B 3 K8 9 FR is a product which complies with UL 94 V-2. With 20 % glass fibres and a good glow-wire-flammability-index (GWFI), it is therefore suitable for applications in low-voltage technology. Our AKRO-LOY® PA K17 FR, extends the performance scale upwards. The blend of PA 6.6 with a higher melting point phase and 35 % glass fibres is suitable for applications that need to withstand short term a temperature of 265 °C. A low smoke density and low smoke toxicity recommend the use of this material in aircraft, railway and busses.

Even higher temperature resistance and creep resistance are achieved with AKROMID® T1 K9 FR. The PPA with 40 % glass fibres and a melting temperature of 310 °C absorbs only little water in humid climates and changes its strength and stiffness very little with moisture absorption.

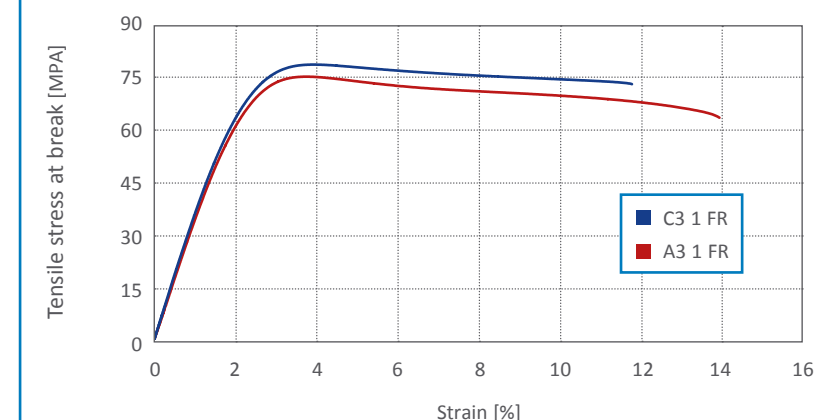
Charpy Impact Strength at 23 °C, d.a.m.

(Fig. 1)



Stress-strain Curves at 23 °C, d.a.m.

(Fig. 2)

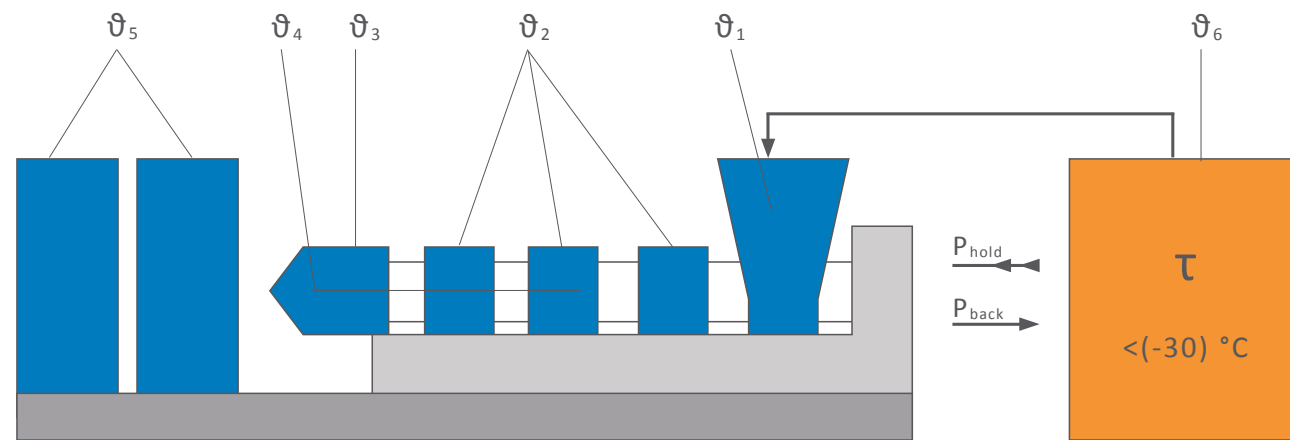


Processing Recommendations

Our flame-retardant products can be processed on commercially available injection moulding machines

with standard screws according to the recommendations of the machine manufacturer. Please refer to

the tables below for our recommended machine, mould and dryer settings (see sketch):



Flame-retardant products		AKROMID® A non-reinforced	AKROMID® B non-reinforced	AKROMID® C non-reinforced	AKROLOY® PA reinforced
Flange	ϑ ₅	60 – 80 °C	60 – 80 °C	60 – 80 °C	60 – 80 °C
Sector 1 – sector 4	ϑ ₂	260 – 290 °C	220 – 260 °C	250 – 280 °C	280 – 300 °C
Nozzle	ϑ ₃	260 – 300 °C	230 – 270 °C	260 – 280 °C	280 – 310 °C
Meld temperature	ϑ ₄	270 – 290 °C	240 – 270 °C	260 – 280 °C	280 – 310 °C
Mould temperature	ϑ ₅	60 – 80 °C	60 – 80 °C	60 – 80 °C	80 – 130 °C
Drying	ϑ ₆	80 °C, 2 – 4 h	80 °C, 2 – 4 h	80 °C, 2 – 4 h	80 °C, 2 – 4 h
Holding pressure, spec.	P _{hold}	300 – 800 bar	300 – 800 bar	300 – 800 bar	300 – 800 bar
Back pressure, spec.	P _{back}	30 – 100 bar	30 – 100 bar	30 – 100 bar	30 – 100 bar

Flame-retardant products		AKROMID® A reinforced	AKROMID® B reinforced	AKROMID® C reinforced	AKROMID® T reinforced
Flange	ϑ ₁	60 – 80 °C	60 – 80 °C	60 – 80 °C	60 – 90 °C
Sector 1 – sector 4	ϑ ₂	260 – 290 °C	220 – 280 °C	260 – 290 °C	310 – 340 °C
Nozzle	ϑ ₃	270 – 300 °C	240 – 280 °C	260 – 300 °C	320 – 340 °C
Meld temperature	ϑ ₄	270 – 290 °C	240 – 280 °C	260 – 300 °C	320 – 340 °C
Mould temperature	ϑ ₅	60 – 100 °C	60 – 100 °C	60 – 100 °C	100 – 160 °C
Drying	ϑ ₆	80 °C, 2 – 4 h	80 °C, 2 – 4 h	80 °C, 2 – 4 h	80 °C, 2 – 4 h
Holding pressure, spec.	P _{hold}	300 – 800 bar	300 – 800 bar	300 – 800 bar	300 – 800 bar
Back pressure, spec.	P _{back}	30 – 100 bar	30 – 100 bar	30 – 100 bar	30 – 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 0.02 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.

Applications

AKROMID® B3 K8 9 FR is a material for low-voltage applications. In this area, the most important property is the GWFI. Cable glands and cable ties can be made from materials that are UL 94 V-2. For this, AKROMID® A3 HU, B3 HU and C3 HU are the materials of choice. In addition, it is also possible to use products with UL 94 V-0 specification, such as AKROMID® A3 1 FR, B3 1 FR, C3 1 FR.

Terminal blocks and cable identification tags can be made of products

with V-0 or with V-2 specification, such as AKROMID® C3 1 FR or AKROMID® C3 GF25 1 FR. Components in the automation and safety-technology need high GWFI values, light colors and good mechanical properties.

In electric motors, very small wall thicknesses, good flowability, V-0 and the best GWIT values (glow wire ignition temperature) are required. Here, AKROMID® C3 GF 25 1 FR is the ideal material.

Special components in the low-voltage switchgear industry require a high creep resistance and good stiffness. AKROMID® T1 K9 FR is particularly suitable.

AKROLOY® PA K17 FR is a product that meets highest requirements of smoke density and smoke toxicity. It is used in aircraft and railways for this reason.



Figure 3: Power connection



Figure 4: Circuit breaker

Applications

Electric/Electronic

- Plug connectors
- Switches
- Control housing
- Circuit breakers
- Terminal blocks

Automotive

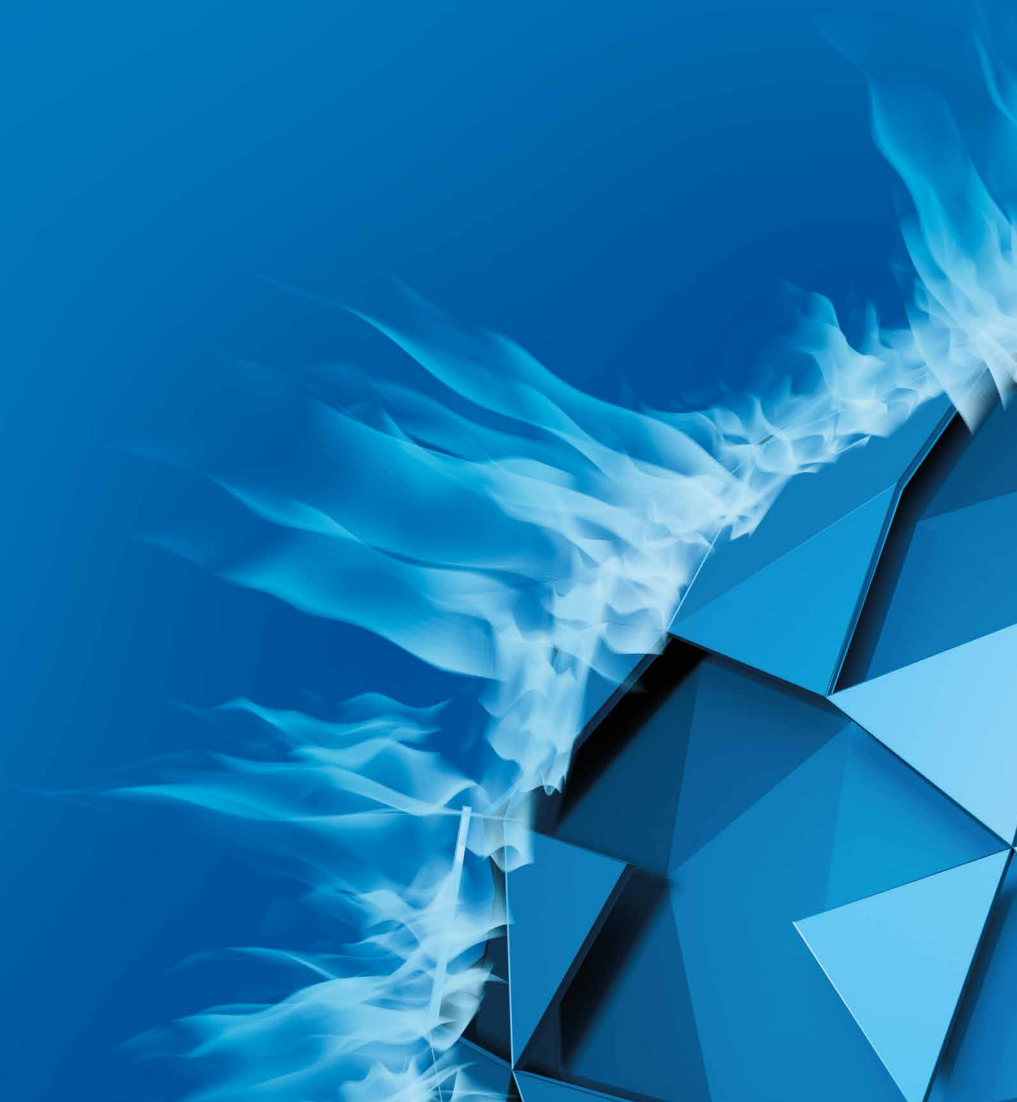
- Covers
- Control housing
- Plug connectors
- Sensors
- Battery periphery

Others

- Seats and components in rail and air traffic
- Cable ducts
- Cable mounting
- Rollers for elevator cabins

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. AKRO®, AKROMID®, AKROLEN®, AKROLOY®, AKROTEK® and ICX® are registered trademarks of the Feddersen Group.

We Will Be Pleased to Meet You!



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