

FLAME-RETARDANT COMPOUNDS

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

**AKROLOY® FR** (PA Blend)



**AKRO-PLASTIC**   
Think Polyamide

**AKRO-PLASTIC do Brasil**  
**Indústria e Comércio de Polímeros**  
**de Desempenho Ltda.**  
Member of the Feddersen Group

## **Flame-retardant Products – Increasingly Important for Extended Areas of Application**

Requirements for reduced flame spread or self-extinguishing performance of engineering plastics are gaining more importance. 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 quality. This quality is the same in all global plant locations. 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, and to the absence of corrosion-promoting ingredients. 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. Ions can still create some corrosion. This is the difference to our general EN grades (electrically neutral grades), which are free of all ions. For them we can confirm in the certificate of accomplishment, that the content of iodine or bromine is less than 1 ppm.

# 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													
ISO designation according to EN ISO 1043-4:1999				PA 6.6 FR (30)		PA 6.6 GF 25 FR (30+40)		PA 6.6 GF 30 FR (30+40)		PA 6 FR (30)		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)													
Mechanical properties				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.												
Tensile modulus	1 mm/min	ISO 527	MPa	3,500	1,500	9,200	6,500	10,500	7,600	3,500	1,300	6,000	3,000	10,000	5,500	10,500	6,500	3,500	1,300												
Stress at yield/Tensile stress at break	5 mm/min	ISO 527	MPa	80/	50/	/140	/100	/150	/107	75/	40/	/95	/55	/130	/90	/130	/90	80/	45/												
Strain at break	5 mm/min	ISO 527	%	>5	>100	3	4	2.7	3.9	10	>100	4.5	15	3	7	2.5	6	>15	>100												
Flexural modulus	2 mm/min	ISO 178	MPa	3,300	1,500	9,000	7,000	11,500		3,550	1,300	5,000	3,200	8,800	6,000	10,500	7,000	3,000	1,300												
Flexural strength	2 mm/min	ISO 178	MPa	125	55	220	170	230		115	45	145	90	215	145	225	155	110	45												
Charpy impact strength	23°C	ISO 179/1eU	kJ/m <sup>2</sup>	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/m <sup>2</sup>	80		10		61				50						90													
Charpy notched impact strength	23°C	ISO 179/1eA	kJ/m <sup>2</sup>	5	8	11	13	10	13	4	11	4	9	11	16	11	15	5	11												
Charpy notched impact strength	-30°C	ISO 179/1eA	kJ/m <sup>2</sup>	4				9				3							4												
<b>Electrical properties</b>																															
Dielectric strength	3 mm	IEC 60243	kV/mm	19		28																									
Comparative tracking index (CTI)	Test solution A	IEC 60122	V/PCL	>600/0		>600/0		>600/0		>600/0		550/1		>600/0		>600/0		>600/0													
<b>Thermal properties</b>				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		262		262		225		222		225		225		260													
Temp. of deflection under load HDT/A	1.82 MPa	ISO 75-1/2	°C	80		246		246		65		210				210		70													
Temp. of deflection under load HDT/B	0.45 MPa	ISO 75-1/2	°C	220		261		261		180		220		220		220		210													
<b>Flammability</b>																															
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	V2	V0	V0	V0	V0	V0	V0	V0	V0	V0	V0	V0	V2	V2	V2	V2	V1	V0	V0	V0	V0	V0	V0	V0	V0	V0	V0	V0
High amperage arc ignition (HAI)		UL 746 A	PCL		0																										
Hot wire ignition (HWI)		UL 746 A	PLC		4																										
Glow wire flammability index (GWFI)		IEC 60695-2-12	°C	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	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	775	775	775	775	775	775	775	775	775	775	
Relat. thermal index (RTI), electrical		UL 746 B	°C		65				65					65	65	65	65											65	65	65	65
Relat. thermal index (RTI), mech. strength		UL 746 B	°C		65				65					65	65	65	65											65	65	65	65
Relat. thermal index (RTI), mech. impact		UL 746 B	°C		65				65					65	65	65	65											65	65	65	65
Limiting oxygen index (LOI)		ISO 4589-1/2	%	32		34				34		>27								34											
<b>General properties</b>																															
Density	23 °C	ISO 1183	g/cm <sup>3</sup>	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		-													
<b>Processing</b>																															
Processing shrinkage, flow		ISO 294-4	%	1.1		0,3		0.6-0.7		0.9-1.1		0.6		0.1-0.2		0.4		1.2													
Processing shrinkage, transverse		ISO 294-4	%	1.1		1.3		0.7-0.8		1.0-1.1		0.8		0.5-0.6		0.8		1.4													

\* = stress at yield and strain at break: test speed 50 mm/min for non-reinforced compounds  
 "cond." test values = conditioned 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 GF 40 FR			
<b>ISO designation according to EN ISO 1043-4:1999</b>				PA 6.6 GF 25 FR (30+40)				PPA-I GF 40 FR (40)			
<b>Mechanical properties</b>				d.a.m.		cond.		d.a.m.		cond.	
Tensile modulus	1 mm/min	ISO 527	MPa	9,500		5,700		16,800		15,100	
Stress at yield <sup>1</sup> /Tensile stress at break	5 mm/min	ISO 527	MPa	/145		/90		/230		/205	
Strain at break	5 mm/min	ISO 527	%	3		6		2.5		2.3	
Flexural modulus	2 mm/min	ISO 178	MPa	8,800		6,000		16,500			
Flexural strength	2 mm/min	ISO 178	MPa	225		160		260			
Charpy impact strength	23°C	ISO 179/1eU	kJ/m <sup>2</sup>	75		75		92		83	
Charpy impact strength	-30°C	ISO 179/1eU	kJ/m <sup>2</sup>								
Charpy notched impact strength	23°C	ISO 179/1eA	kJ/m <sup>2</sup>	11		15		13			
Charpy notched impact strength	-30°C	ISO 179/1eA	kJ/m <sup>2</sup>								
<b>Electrical properties</b>											
Dielectric strength	3 mm	IEC 60243	kV/mm								
Comparative tracking index (CTI)	Test solution A	IEC 60122	V/PCL							>600/0	
<b>Thermal properties</b>						d.a.m.				d.a.m.	
Melting point	DSC, 10 K/min	ISO 11357-1	°C	260				310			
Temp. of deflection under load HDT/A	1.82 MPa	ISO 75-1/2	°C	222				276			
Temp. of deflection under load HDT/B	0.45 MPa	ISO 75-1/2	°C	250							
<b>Flammability</b>											
Specimen thickness			mm	0.4	0.8	1.6	3.2	0.4	0.8	1.6	3.2
Flammability acc. UL 94		UL 94	Class	V0		V0		V0		V0	
High amperage arc ignition (HAI)		UL 746 A	PCL								
Hot wire ignition (HWI)		UL 746 A	PLC								
Glow wire flammability index (GWFI)		IEC 60695-2-12	°C	960		960		960		960	
Glow wire ignition temperature (GWIT)		IEC 60695-2-13	°C	775		775		775		900	
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	%								
<b>General properties</b>											
Density	23 °C	ISO 1183	g/cm <sup>3</sup>	1.34				1.5			
Content minerals/reinforcement		ISO 1172	%	25				40			
<b>Processing</b>											
Processing shrinkage, flow		ISO 294-4	%	0.1–0.2				0.1–0.2			
Processing shrinkage, transverse		ISO 294-4	%	0.6–0.7				0.4–0.5			

<sup>1</sup> = stress at yield and strain at break: test speed 50 mm/min for non-reinforced compounds  
 "cond." test values = conditioned 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. Test results can confirm the absence of bromine and iodine within limits

of 1ppm. Certificates of accomplishment are available lot by lot. The use of metal stearates is also excluded. Corrosive processes can thus be reduced to a minimum.

The 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 V0. 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 applications that need high flexibility,

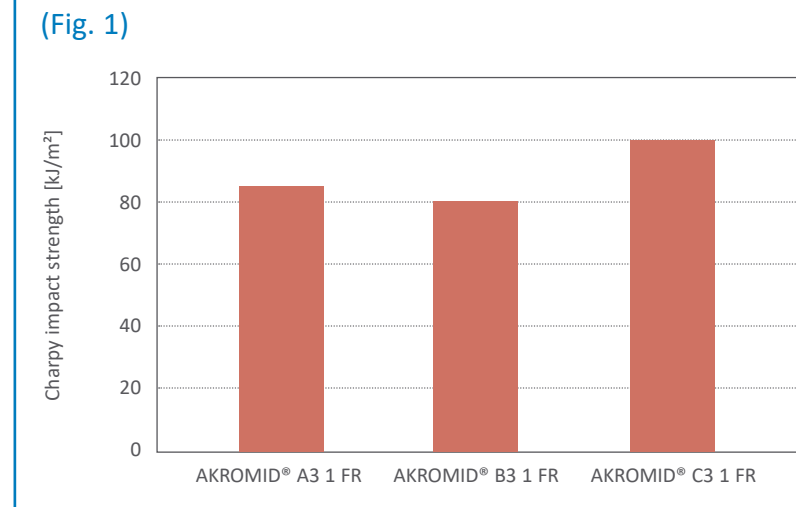
such as film hinges (fig. 2). The temperature index according IEC 218 shows, that the AKROMID® C3 1 FR is suitable for continuous operating temperatures of 110 °C.

Furthermore we offer reinforced materials with 25 % and 30 % glass fibres, which are also qualified as V0 according to UL 94. In addition, AKROMID® B 3 K8 9 FR is a product which complies with UL 94 V2. With 20 % glass fibres and a good glow-wire-flammability-index (GWFI), it is suitable for applications in low-voltage. Our AKROLOY® PA K17 FR extends the performance scale. The blend of PA 6.6 contains a higher melting point phase and 35 % glass fibres. It 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.

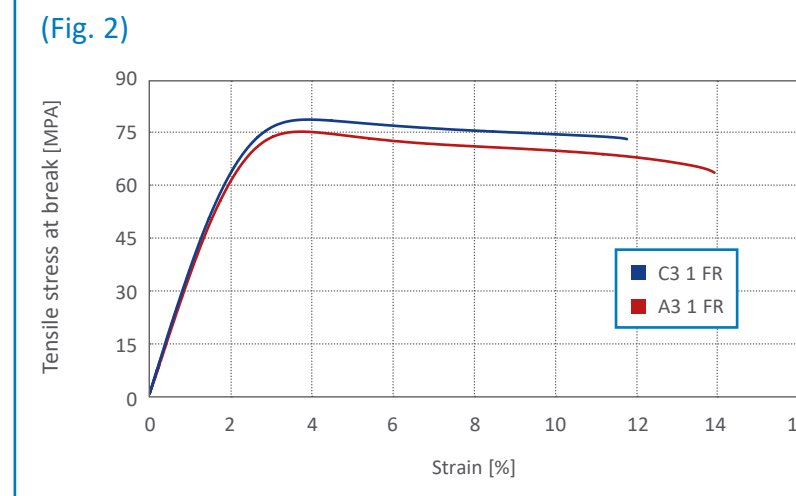
Even higher temperature resistance and creep resistance are achieved with AKROMID® T1 GF 40 FR. The PPA with 40 % glass fibres and a melting temperature of 310 °C absorbs only little water in humid climates and changes its strength and stiffness very little with moisture absorption.

PA K17 FR			
PA 6.6 + X GF 35 FR (30+40)			
d.a.m.		cond.	
12,500		9,200	
/160		/115	
2.5		3	
60		60	
12		12	
>600/0			
d.a.m.			
260		250	
960		960	
800		800	
1.5		35	
0.3		0.7	

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



Stress-strain Curves at 23 °C, d.a.m.

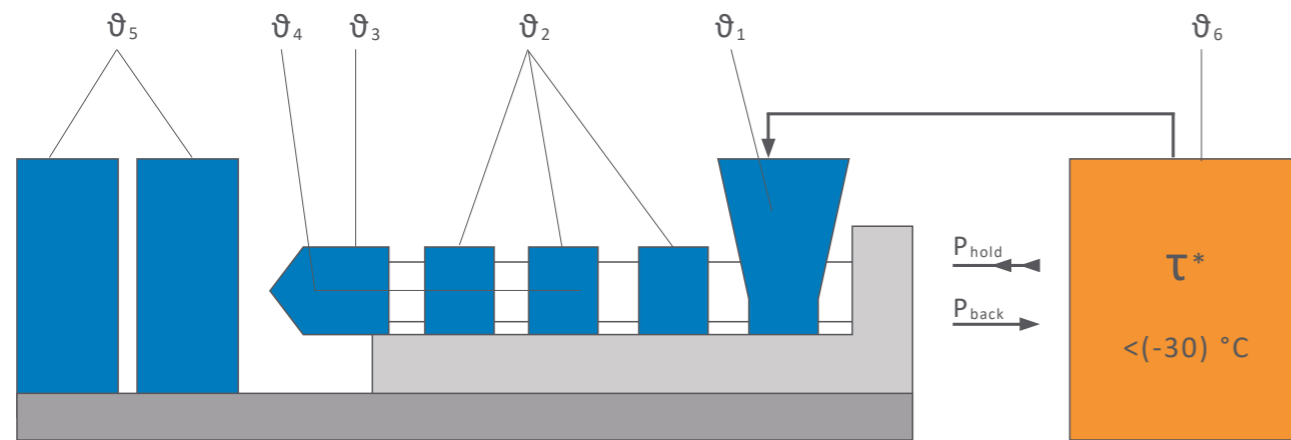


# Processing Recommendations

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	$\varnothing_1$	60–80 °C	60–80 °C	60–80 °C	60–80 °C
Sector 1 – sector 4	$\varnothing_2$	260–290 °C	220–260 °C	250–280 °C	280–300 °C
Nozzle	$\varnothing_3$	260–300 °C	230–270 °C	260–280 °C	280–310 °C
Meld temperature	$\varnothing_4$	270–290 °C	240–270 °C	260–280 °C	280–310 °C
Mould temperature	$\varnothing_5$	60–80 °C	60–80 °C	60–80 °C	80–130 °C
Drying	$\varnothing_6$	80 °C, 2–4 h	80 °C, 2–4 h	80 °C, 2–4 h	80 °C, 2–4 h
Holding pressure, spec.	$P_{\text{hold}}$	300–800 bar	300–800 bar	300–800 bar	300–800 bar
Back pressure, spec.	$P_{\text{back}}$	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	$\varnothing_1$	60–80 °C	60–80 °C	60–80 °C	60–90 °C
Sector 1 – sector 4	$\varnothing_2$	260–290 °C	220–280 °C	260–290 °C	310–340 °C
Nozzle	$\varnothing_3$	270–300 °C	240–280 °C	260–300 °C	320–340 °C
Meld temperature	$\varnothing_4$	270–290 °C	240–280 °C	260–300 °C	320–340 °C
Mould temperature	$\varnothing_5$	60–100 °C	60–100 °C	60–100 °C	100–160 °C
Drying	$\varnothing_6$	80 °C, 2–4 h	80 °C, 2–4 h	80 °C, 2–4 h	80 °C, 2–4 h
Holding pressure, spec.	$P_{\text{hold}}$	300–800 bar	300–800 bar	300–800 bar	300–800 bar
Back pressure, spec.	$P_{\text{back}}$	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. \*dew point (measure for "dryness" of air)

# Applications

AKROMID® B3 K8 9 FR is a material for low-voltage applications. In this application area, the most important property is the GWFI. Cable glands and cable ties can be made from materials that are UL 94 V2. AKROMID® A3 HU, B3 HU and C3 HU are the materials of choice for this. In addition, it is possible to use products with UL 94 V0 specification, such as AKROMID® A3 1 FR, B3 1 FR, C3 1 FR.

Terminal blocks and cable identification tags can be made of prod-

ucts with V0 or with V2 specification, such as AKROMID® C3 1 FR or AKROMID® C3 GF 25 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, V0 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 GF 40 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

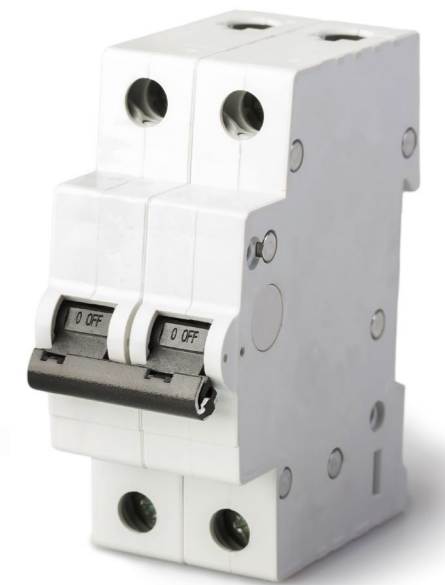


Figure 4: Circuit breaker

## Applications

### Electric/Electronic

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

### Automotive

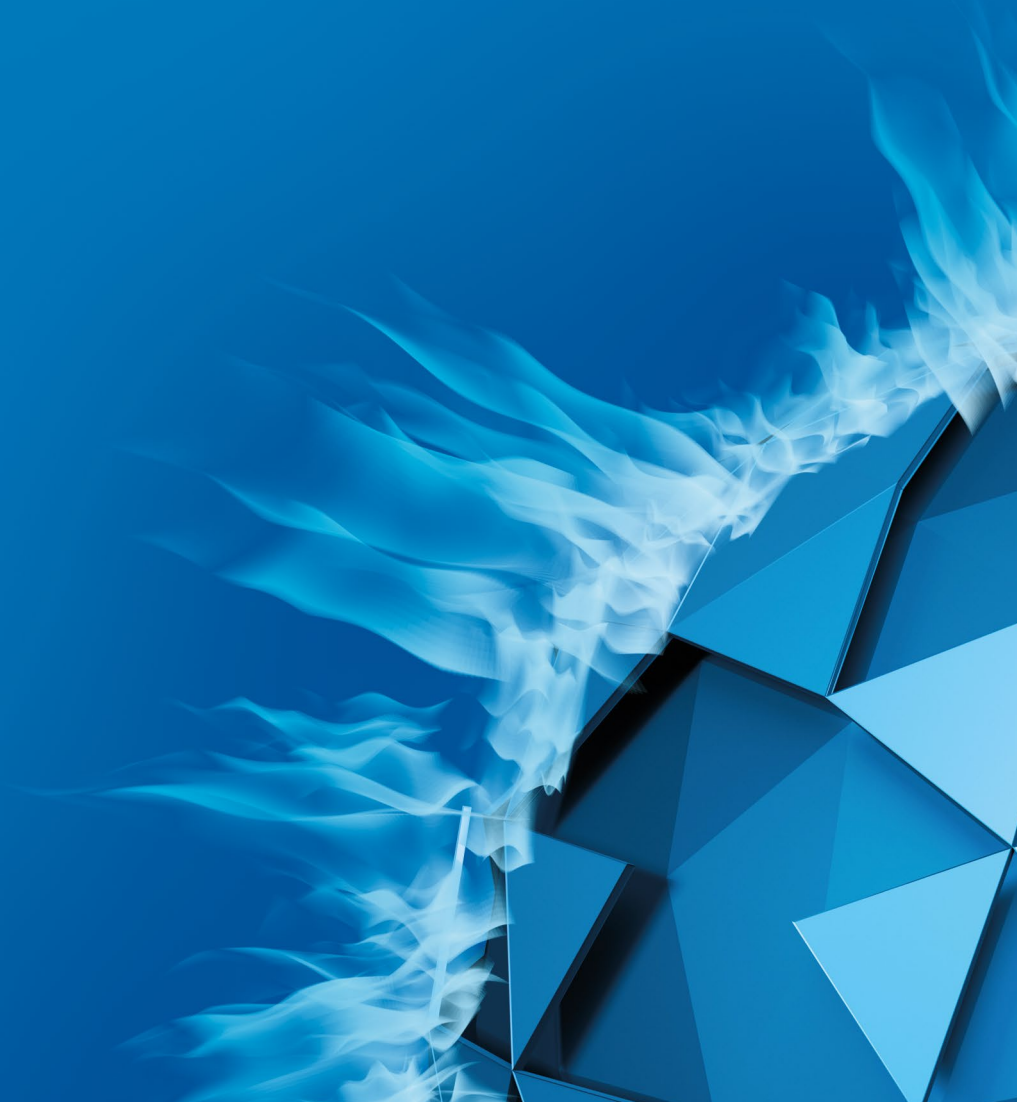
- Covers
- Control housing
- Plug connectors
- Sensors
- Battery periphery

### 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. AKROMID®, AKROLEN®, AKROLOY®, AKROTEK®, PRECITE®, AF-Carbon®, AF-Color®, AF-Complex®, AF-Clean®, ICX®, BIO-FED®, M-VERA® and AF-Eco® and are registered or applied trademarks of the Feddersen Group.

# We Will Be Pleased to Meet You!



**AKRO-PLASTIC do Brasil**  
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