

# Public Transportation – Materials for a Moving Market



**AKRO-PLASTIC**   
Think Polyamide

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

## **Weight-Reduced Products – Gaining Importance for Applications in the Transportation Sector**

EU guidelines on the reduction of CO<sub>2</sub> emissions have also created demand for weight-reducing materials in the transportation sector. Plastics can substitute metals in components and thus contribute to the reduction of the CO<sub>2</sub> output. Plastics also allow for greater design freedom and therefore more comfort for passengers. The transportation sector comprises the fields of application in rail vehicles, buses and aircraft.

AKRO-PLASTIC GmbH is meeting the increasing requirements for materials in the transportation sector and developed tailored compound solutions, of which the technical data and details on standards as well as possible applications are summarised in this brochure. You will find technical data on the products, details concerning current standards and application examples.

# Compounds

Typical values for color material at 23 °C	Test specification	Test method	Unit	B3 1 FR black (5983)				B28 GF 15 natural (6940)				B3 GF 25 FRT natural (6910)				B28 GF 25 natural (6430)				B28 GF 30 natural (6941)				B3 GF 30 FR black (6665)				A3 K1 FR natural (2312)				A3 GF 25 FRT natural (6705)				PA GF 25 FRT natural (6701)				PA K17 FR black (5762)			
ISO designation according to EN ISO 1043-4:1999				PA6-FR (30+72)				PA6-GF15				PA6-GF25 (30+40)				PA6-GF25				PA6-GF30				PA6-GF25 (30+40)				PA66-GF25FR (30+40)				PA66-GF25FR (30+40)				PA66+X-GF25FR (30+40)				PA66+X-GF35FR (30+40)			
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.	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	1,300	5,300		9,500	5,800	8,000		10,200		10,000	6,900	9,200	6,500	9,500	6,200	10,000	6,900	12,500	9,200																				
Stress at yield/Tensile stress at break	5 mm/min	ISO 527	MPa	75/	40/	/120		/130	/83	/170		/170		/150	/99	/140	/100	/135	/86	/130	/91	/160	/115																				
Strain at break <sup>1</sup>	5 mm/min	ISO 527	%	10	>100	3		3	4.4	3.4		3		3	5	3	4	3	5.4	2.5	3.6	2.5	3																				
Flexural modulus	2 mm/min	ISO 178	MPa	3,540	1,300	4,450		9,000				8,400		10,440		8,960	6,700	9,800		9,900																							
Flexural strength	2 mm/min	ISO 178	MPa	112	45	166		200				235		237		220	170	218		215																							
Charpy impact strength	23 °C	ISO 179/1eU	kJ/m <sup>2</sup>	80	n.b.	39		58	60			74		75	77	65	70					60	60																				
Charpy notched impact strength	23 °C	ISO 179/1eA	kJ/m <sup>2</sup>	4	11			11	15					12	17	11	13					12	12																				
Thermal properties				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	220				220				262				220				220				262				262				260											
Temp. of deflection under load HDT/A	1.82 MPa	ISO 75-1/2	°C	65				205				208				208				210				210				246				250											
Temp. of deflection under load HDT/B	0.45 MPa	ISO 75-1/2	°C	180				220				220				220				220				261				261				261											
Flammability				d.a.m.				d.a.m.				d.a.m.				d.a.m.				d.a.m.				d.a.m.				d.a.m.															
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	0.4	0.8	1.6	3.2								
Flammability acc. UL 94		UL 94	Class		V-0	V-0	V-0	HB	HB	HB	HB	V-0	V-0	V-0	V-0	HB	HB	HB	HB	HB	HB	HB	V-2	V-2	V-2	V-2	V-0	V-0	V-0	V-0	V-0	V-0	V-0	V-0									
Limiting oxygen index (LOI)		ISO 4589-1/2	%	>32				>32				>32				>32				>32				>32				>32															
Fire protection on railway vehicles		EN 45545-2		R22/23/24/26 HL3				R19/21/23/24/26 HL3 R22 HL2				R24 HL3				R24/26 HL 3				R19/21/23/24/26 HL3 R22 HL2				R19/21/23/24/26 HL3 R22 HL2				R26 HL3															
Fire protection on buses		ECE R 118		Annex 6 and 8				Annex 6 and 8				Annex 6 and 8				Annex 6 and 8																											
Fire protection on aircraft		ABD0031																						AITM 2.0002 A, AITM 2.0002 B, AITM 2.0007 A, AITM 3.0005																			
General properties				d.a.m.				d.a.m.				d.a.m.				d.a.m.				d.a.m.				d.a.m.																			
Density	23 °C	ISO 1183	g/cm <sup>3</sup>	1.19				1.23				1.37				1.31				1.35				1.39				1.34				1.40				1.42				1.50			
Content minerals/reinforcement		ISO 1172	%	-				15				25				25				30				30				25				25				35							
Moisture absorption	70 °C/62 % r.h.	ISO 1110	%	2.1–2.3				1.6–1.8				1.7–1.9				1.7–1.9				1.7–1.9				1.7–1.9				1.7–1.9				1.4											
Processing				d.a.m.				d.a.m.				d.a.m.				d.a.m.				d.a.m.				d.a.m.																			
Flowability	Flowspiral <sup>2</sup>	AKRO	mm	520																460																							
Processing shrinkage, flow		ISO 294-4	%	0.9–1				0.2–0.3				0.1–0.2				0.1–0.2				0.1–0.2				0.1–0.2				0.1–0.2				0.4											
Processing shrinkage, transverse		ISO 294-4	%	1.0–1				0.7–0.8				0.5–0.6				0.6–0.7				0.5–0.6				0.6–0.7				0.6–0.7				0.9											

<sup>1</sup> = stress at yield and strain at break: test speed 50 mm/min for non-reinforced compounds  
<sup>2</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 %

n.b. = not broken

<sup>2</sup> = AKROMID® A: mould temperature: 100 °C, melt temperature: 310 °C, injection pressure: 600–750 bar, cross section of flow spiral: 7 mm x 2 mm  
 AKROMID® B: mould temperature: 100 °C, melt temperature: 300 °C, injection pressure: 550–650 bar, cross section of flow spiral: 7 mm x 2 mm  
 AKROMID® C: mould temperature: 100 °C, melt temperature: 310 °C, injection pressure: 700–750 bar, cross section of flow spiral: 7 mm x 2 mm

# Product Characterisation

## UN/ECE R 118 Annex 6 and 8:

### Test to Determine the Vertical Burning Rate of Materials in Vehicles of Categories M<sub>3</sub>, II and III

Regulation No. 118 of the United Nations Economic Commission for Europe (UNECE) concerns the burning behaviour and/or properties of the materials used in the construction of busses and city busses. Tests

apply to the ignitability, burning rate and melting behaviour. Annex 6 of the Regulation defines the horizontal burning rate of materials. All components built in a position deviating from the horizontal by more

than 15 ° must be tested in accordance with annex 8. The materials manufactured by AKRO-PLASTIC GmbH were tested in accordance with Annex 8 and as such also meet the requirements of annex 6.

## DIN EN 45545-2:

### European Railway Standard

The European Railway Standard DIN EN 45545-2 defines the requirements in terms of the fire behaviour of materials and components for railway vehicles. The purpose of this standard is to allow the evacuation and rescue of passengers in the event of a fire. This means that the

probability of fire must be minimised, the spread of fire must be prevented and the effects of a fire on humans must be minimised.

In the standard, a differentiation is made according to operating and construction categories in order to

determine the hazard levels (HL) (Table 1). The higher the hazard level, the stricter the requirements for the fire behaviour of the materials and components.

Operating Category (Properties of the infrastructure)		Construction Category (Construction design of the vehicle)			
		N Standard	A Automatic	D Double-decker	S Sleeping car
1	Surface vehicle	HL1	HL1	HL1	HL2
2	Tunnel max. 5 km	HL2	HL2	HL2	HL2
3	Tunnel >5 km	HL2	HL2	HL2	HL3
4	No side evacuation possible	HL3	HL3	HL3	HL3

Table 1: Allocation of hazard levels (HL)

C No.*	Name
IN	Interior
EX	Exterior
F	Furniture
E	Electrical equipment
M	Mechanical equipment

Table 2: Sub-groups of listed components

\* = component number

Once the hazard level of the materials and components has been defined, it is determined whether it is a listed or a non-listed component. Listed components are initially categorised in sub-groups according to their installation point and their function (Table 2).

Within this sub-group, the requirements set for each of the listed components is laid down (R1–R26). Table 3 lists an extract from the requirements for listed components.

All components which are not listed in Table 2 according to DIN EN 45545-2 are considered as non-listed components. In the requirements, a differentiation is made according to the exposed surface and the installation point (Table 4). If applicable, group rules must also be considered in the assessment.

C No.*	Name	Description	Requirement
EL6A	Supply inlet system and high components – interior	Insulators, electricity and voltage transformers, Main switches, contactors	R22
EL6B	Supply inlet system and high components – exterior	Insulators, electricity and voltage transformers, Main switches, contactors	R23
EL7A	Chokers and coils – interior	Choke coils to filter the supply line, windings for air-cooled transformers, including spacers and air baffles	R22
EL7B	Chokers and coils – exterior	Choke coils to filter the supply line, windings for air-cooled transformers, including spacers and air baffles and insulation of travel motor winding	R23
EL10	No electrical components	Examples include low power circuit breakers, overpower relays, contactors, contact relays, switches, control or signal switches, terminals, fuses	R26

Table 3: Extract from the requirements for listed components

Surface	Installation Point	Requirements Set
>0.20 m <sup>2</sup>	interior	R1
>0.20 m <sup>2</sup>	exterior	R7
≤0.20 m <sup>2</sup>	interior	R22
≤0.20 m <sup>2</sup>	exterior	R23

Table 4: Requirements for non-listed components, by exposed surface and installation point in the vehicle

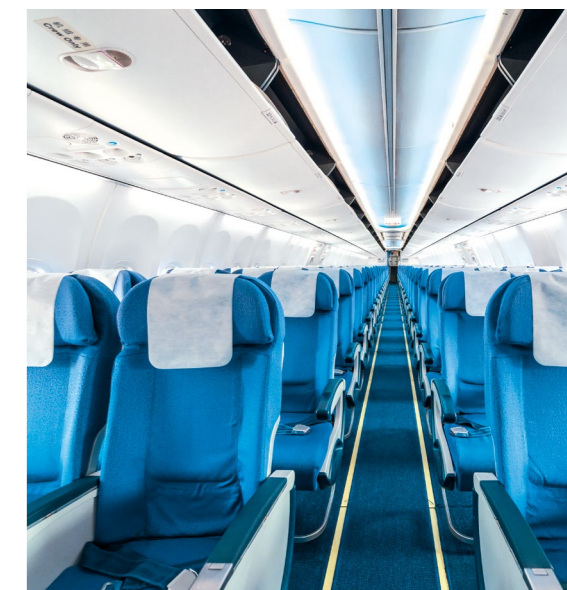
## FAR 25.853:

### International Aviation

In order to ensure certain standards in terms of fire safety in commercial aircraft, the Federal Aviation Administration (FAA) requires that a range of fire tests be carried out. In the event of contact with heat or a flame, this must reflect the performance of the material with regard to fire occurrence. The requirements of the test are specified in Federal Aviation Regulation (FAR) 25.853.

AKROLOY® PA K17 FR black (5762) is a 35 % glass fibre reinforced PA 6.6

blend with a high-melting component which passes the tests according to Airbus test standard AITM 2.0002 A, AITM 2.0002 B, AITM 2.0007 A and AITM 3.0005. As such, the material meets the requirements for flammability, smoke density and toxicity of fire gases in the interior.

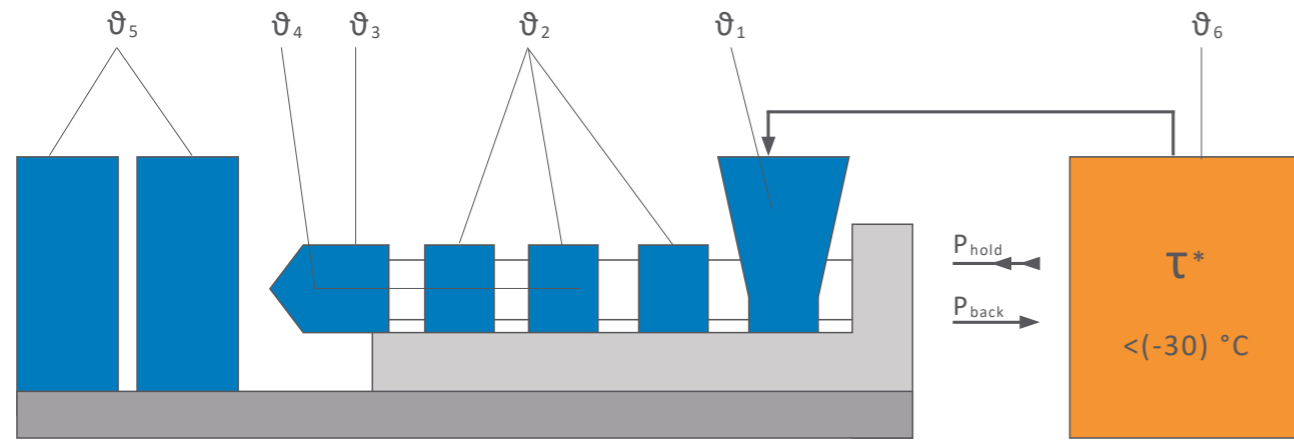


# Processing Recommendations

Our 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):



		AKROMID® A FR reinforced	AKROMID® B FR reinforced	AKROMID® B FR non-reinforced
Flange	ϑ <sub>1</sub>	60–80 °C	60–80 °C	60–80 °C
Sector 1 – sector 4	ϑ <sub>2</sub>	260–290 °C	220–280 °C	220–260 °C
Nozzle	ϑ <sub>3</sub>	270–300 °C	240–280 °C	230–270 °C
Meld temperature	ϑ <sub>4</sub>	270–290 °C	240–280 °C	240–270 °C
Mould temperature	ϑ <sub>5</sub>	60–100 °C	60–100 °C	60–80 °C
Drying	ϑ <sub>6</sub>	80 °C, 2–4 h	80 °C, 2–4 h	80 °C, 2–4 h
Holding pressure, spec.	P <sub>hold</sub>	300–800 bar	300–800 bar	300–800 bar
Back pressure, spec.	P <sub>back</sub>	30–100 bar	30–100 bar	30–100 bar

		AKROLOY® PA FR reinforced	AKROMID® B reinforced
Flange	ϑ <sub>1</sub>	60–80 °C	60–80 °C
Sector 1 – sector 4	ϑ <sub>2</sub>	280–300 °C	220–300 °C
Nozzle	ϑ <sub>3</sub>	280–310 °C	230–300 °C
Meld temperature	ϑ <sub>4</sub>	280–310 °C	240–300 °C
Mould temperature	ϑ <sub>5</sub>	80–130 °C	80–100 °C
Drying	ϑ <sub>6</sub>	80 °C, 2–4 h	0–4 h
Holding pressure, spec.	P <sub>hold</sub>	300–800 bar	300–800 bar
Back pressure, spec.	P <sub>back</sub>	30–100 bar	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. 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

For the back pan of seats for city buses, materials with a very good surface in long flow paths and thin wall thicknesses are required. AKROMID® B28 GF 25 has very high fluidity, stiffness and is excellent for coloring in all colors.

AKROMID® B3 1 FR black (5983) meets the requirements pursuant to R22, R23, R24 and R26 HL3 and can therefore be used for electrical insulation materials (EIM) and for cable ties. The materials can also be very

easily processed and has a very good surface.

Applications for AKROLOY® PA K17 FR black (5762) are components such as brackets or connection elements in aviation, since the material is specified for interior use in accordance with Federal Aviation Regulation (FAR) 25.853. The material absorbs little humidity, whereby the good mechanical properties are also maintained when conditioned.



"Citos" seating system manufactured by Franz-Kiel GmbH in Nördlingen

## Application Areas

### Bus

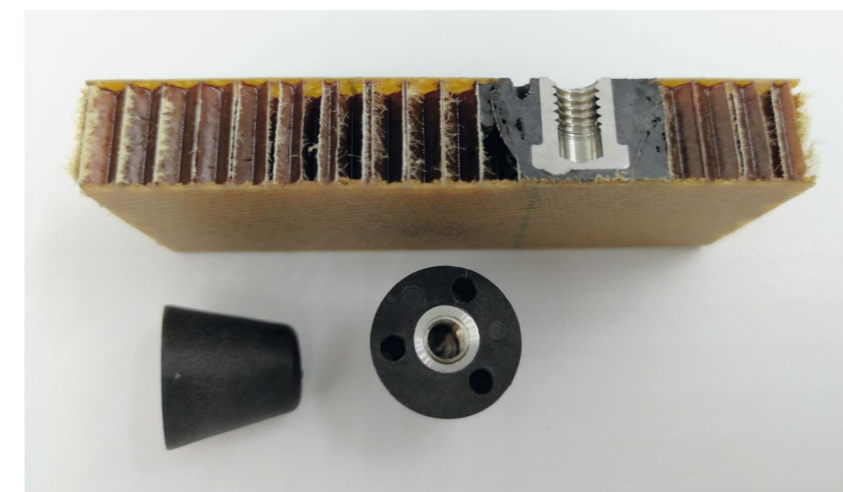
- Seats and seat components
- Ash trays
- Luggage storage
- Barrels

### Rail

- Screw fittings
- Cable ties
- Switches
- Insulators
- Seats
- Armrests
- Tables
- Luggage storage

### Aviation

- Cable ducts
- Fasteners
- Structural components
- Bracket contours



Thermal adhesive bonding boss (TSSD®) manufactured by Ejot Holding GmbH & Co. KG: Connection element for lightweight construction

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

# We Will Be Pleased to Meet You!

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**Indústria e Comércio de Polímeros**  
**de Desempenho Ltda.**

Member of the Feddersen Group

Rua Ramon Reina Bonilha, 280  
13295-000 Itupeva – SP

Brasil

Telefone: +55 11 4230-1990

info.br@akro-plastic.com

www.akro-plastic.com

**For more locations, visit [www.akro-plastic.com](http://www.akro-plastic.com)**