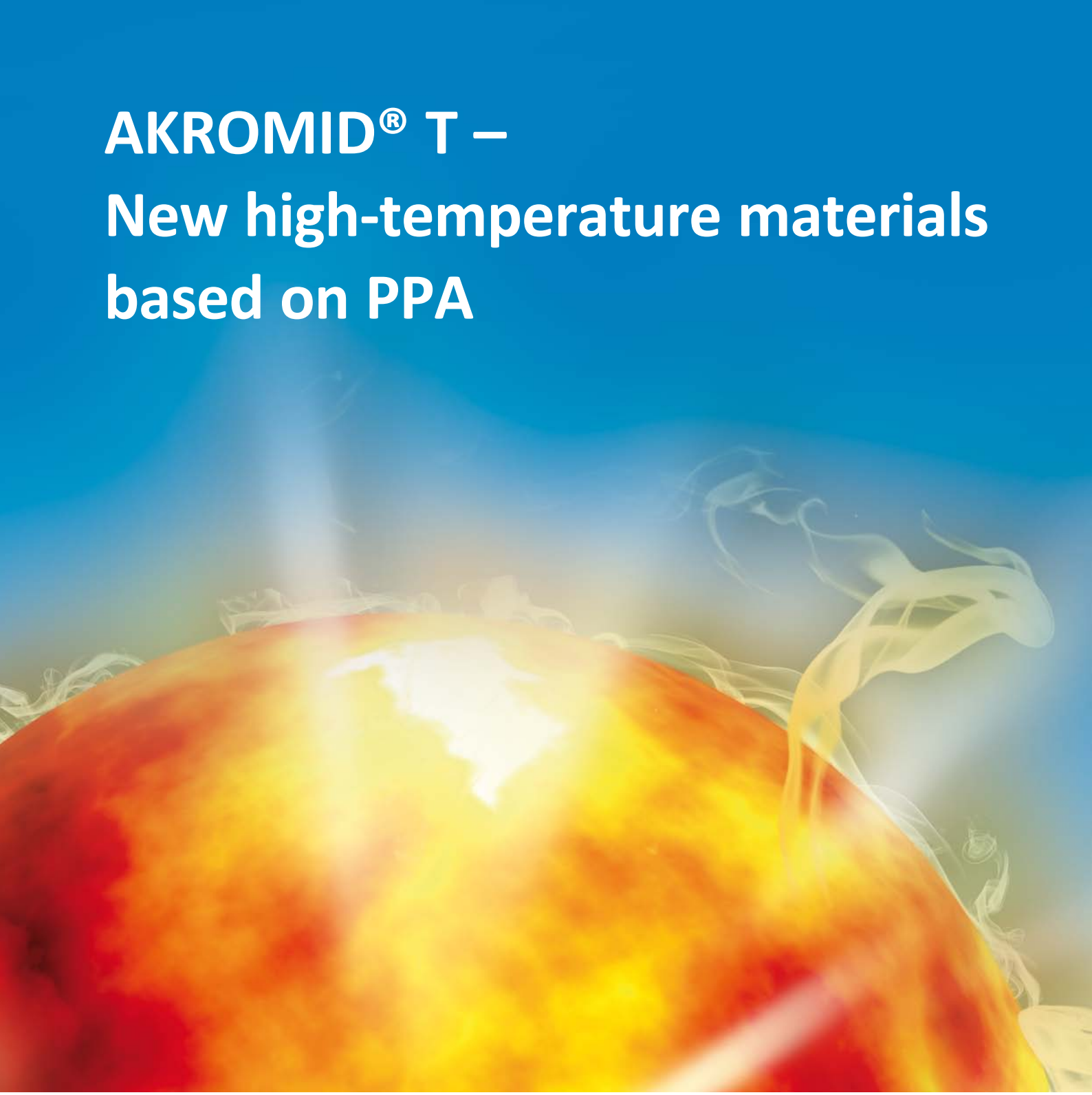
# AKROMID® T – New high-temperature materials based on PPA



AKRO-PLASTIC
Think Polyamide

**AKRO-PLASTIC GmbH**
Member of the Feddersen Group

Ever higher demands for cost and weight reductions have made metal substitution a much-discussed topic for years in many industries. In the automotive industry, it has already become standard practice to substitute engineering plastics for die casting; now, in sanitary installations and general mechanical engineering, this has begun to emerge as a feasible solution as well. The key benefit: the moulded part is formed in only one step and immediately undergoes further processing, resulting in significantly lower production costs per component.

At AKRO-PLASTIC GmbH, we are fully committed to keeping pace with these increasing requirements. That is why we have developed AKROMID® T, a new high temperature-resistant, polyphthalamide (PPA)-based material used specifically in applications where metal was traditionally used. From the very outset, one of our primary objectives was to modify polyamides for higher performance.

In the overview at right and on the following pages, you will find technical data and possibilities for a whole host of technically innovative applications.

| Typical values for black colored products at 23 °C | Test Specification | Test Method |
|---|---|---|
| **Mechanical Properties** | | |
| Tensile modulus | 1 mm/min | ISO 527-1/2 |
| Tensile stress at break | 5 mm/min | ISO 527-1/2 |
| Elongation at break | 5 mm/min | ISO 527-1/2 |
| Flexural modulus | 2 mm/min | ISO 178 |
| Flexural strength | 2 mm/min | ISO 178 |
| Flexural strain at break | 2 mm/min | ISO 178 |
| Charpy impact strength | 23 °C | ISO 179/1eU |
| Charpy impact strength | -30 °C | ISO 179/1eU |
| Ball indentation hardness | HB 961/30 | ISO 2039-1 |
| **Electrical Properties** | | |
| Comparative Tracking Index, CTI | Test solution A | IEC 60112 |
| **Thermal Properties** | | |
| Melting point | DSC, 10 K/min | ISO 11357-1 |
| Heat distortion temp., HDT/A | 1.8 MPa | ISO 75-1/2 |
| Heat distortion temp., HDT/B | 0.45 MPa | ISO 75-1/2 |
| Heat distortion temp., HDT/C | 8 MPa | ISO 75-1/2 |
| Temp. index for 50 % loss of tensile strength | 5,000 h | IEC 216 |
| Temp. index for 50 % loss of tensile strength | 20,000 h | IEC 216 |
| **Flammability** | | |
| Flammability acc. to UL 94 | 0.8 mm | UL 94 |
| Burning rate acc. to (< 100 mm/min) | > 1 mm thickness | FMVSS 302 |
| **General Properties** | | |
| Density | 23 °C | ISO 1183 |
| Reinforcement content | | ISO 1172 |
| Moisture absorption | 70 °C/62 % r.h. | ISO 1110 |
| **Processing** | | |
| Processing shrinkage, flow | | ISO 294-4 |
| Processing shrinkage, transverse | | ISO 294-4 |

# AKROMID® T Series (Polyphthalamide)

| Unit | T1 GF 30 (3466) | | T1 GF 40 (3464) | | T1 GF 50 (3101) | | T1 GF 30 9 (3498) | | T1 GF 40 |
|---|---|---|---|---|---|---|---|---|---|
| | d.a.m. | cond. | d.a.m. | cond. | d.a.m. | cond. | d.a.m. | cond. | d.a.m. |
| MPa | 12,500 | 12,000 | 15,500 | 15,500 | 20,000 | 20,000 | 12,000 | 12,000 | 15,000 |
| MPa | 215 | 200 | 260 | 230 | 270 | 255 | 210 | 190 | 250 |
| % | 2.2 | 2.2 | 2.4 | 2.1 | 2 | 2 | 2.4 | 2.3 | 2.4 |
| MPa | 11,000 | | 14,500 | | 18,000 | | 11,000 | | 14,500 |
| MPa | 300 | | 345 | | 380 | | 300 | | 360 |
| % | 3 | | 2.7 | | 2.4 | | 3 | | 2.9 |
| kJ/m² | 60 | | 75 | | 90 | 85 | 50 | | 70 |
| kJ/m² | 45 | | 60 | | 70 | | 45 | | 55 |
| MPa | 290 | | 330 | | 360 | | 270 | | 310 |
| | d.a.m. | | d.a.m. | | d.a.m. | | d.a.m. | | d.a.m. |
| | 600 | | 600 | | 600 | | 600 | | 600 |
| | | | | | | | | | |
| °C | 313 | | 313 | | 313 | | 308 | | 308 |
| °C | 285 | | 285 | | 285 | | 275 | | 275 |
| °C | 310 | | 310 | | 310 | | | | |
| °C | 165 | | 205 | | 230 | | 165 | | 195 |
| °C | 170 - 180 | | 170 - 180 | | 170 - 180 | | 150 - 160 | | 150 - 160 |
| °C | 150 - 160 | | 150 - 160 | | 150 - 160 | | 130 - 140 | | 130 - 140 |
| | | | | | | | | | |
| Classification | HB | | HB | | HB | | HB | | HB |
| mm/min | + | | + | | + | | + | | + |
| | | | | | | | | | |
| g/cm³ | 1.40 | | 1.50 | | 1.62 | | 1.42 | | 1.52 |
| % | 30 | | 40 | | 50 | | 30 | | 40 |
| % | 1.25 | | 1.10 | | 0.85 | | 1.30 | | 1.10 |
| | | | | | | | | | |
| % | 0.4 | | 0.2 | | 0.3 | | | | 0.3 |
| % | 0.9 | | 0.8 | | 0.7 | | | | 0.8 |

+ = passed "cond." test values = conditioned, measured on test specimens stored according to ISO 1110

| 9 (3499) | T1 GF 50 9 (3257) | | T6 GF 30 (3501) | | T6 GF 40 (3500) | | T6 GF 50 (3106) | |
|---|---|---|---|---|---|---|---|---|
| cond. | d.a.m. | cond. | d.a.m. | cond. | d.a.m. | cond. | d.a.m. | cond. |
| 15,000 | 19,500 | 18,500 | 11,000 | 10,500 | 13,000 | 13,000 | 17,000 | 17,000 |
| 220 | 290 | 250 | 200 | 180 | 240 | 205 | 270 | 230 |
| 2.1 | 2.1 | 2.1 | 2.2 | 2.5 | 2.5 | 2.4 | 2.5 | 2.2 |
| | 17,000 | | 10,500 | | | | 17,000 | |
| | 390 | | 285 | | | | 390 | |
| | 2.6 | | 3.0 | | | | 2.7 | |
| | 90 | | 50 | | 70 | | 85 | |
| | 80 | | 45 | | 60 | | 75 | |
| | 340 | | | | | | | |
| d.a.m. | d.a.m. | | d.a.m. | | d.a.m. | | d.a.m. | |
| 600 | 600 | | 600 | | 600 | | 600 | |
| | | | | | | | | |
| 308 | 308 | | 304 | | 304 | | 304 | |
| 275 | 275 | | 290 | | 290 | | 290 | |
| | | | | | | | | |
| 195 | 205 | | 225 | | 240 | | 250 | |
| 150 - 160 | 150 - 160 | | 150 - 160 | | 150 - 160 | | 150 - 160 | |
| 130 - 140 | 130 - 140 | | 130 - 140 | | 130 - 140 | | 130 - 140 | |
| | | | | | | | | |
| HB | HB | | HB | | HB | | HB | |
| + | + | | + | | + | | + | |
| | | | | | | | | |
| 1.52 | 1.62 | | 1.50 | | 1.51 | | 1.65 | |
| 40 | 50 | | 30 | | 40 | | 50 | |
| 1.10 | 0.95 | | 1.35 | | 1.15 | | 0.95 | |
| | | | | | | | | |
| 0.3 | 0.2 | | | | | | 0.3 | |
| 0.8 | 0.7 | | | | | | 0.7 | |

"d.a.m." = dry as moulded test values = residual moisture content < 0.10 %

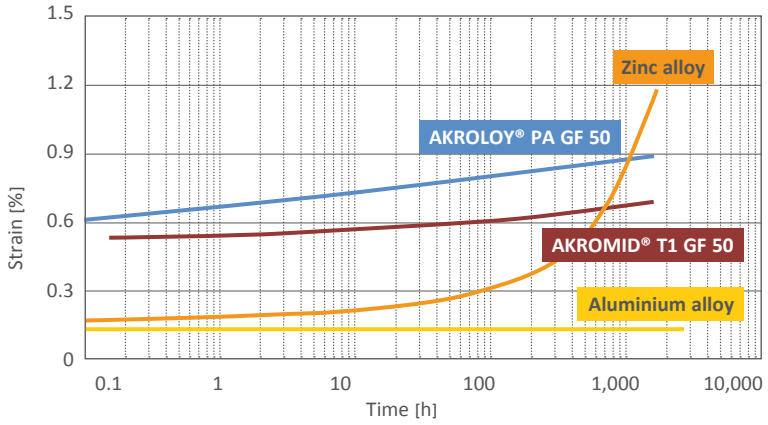
# Product Characterisation

The new AKROMID® T is characterised primarily by high heat resistance and the lowest moisture absorption of the three PA grades (PA 6, PA 6.6, PPA). This makes it particularly well-suited in the automotive sector for high-temperature applications in the engine compartment and in machine building for components subjected to high mechanical loads. It easily maintains its high initial stability even at temperatures of up to 140 °C and also exhibits minimal creep, which is further enhanced by extremely low moisture absorption.
(Fig. 1, Fig. 2)

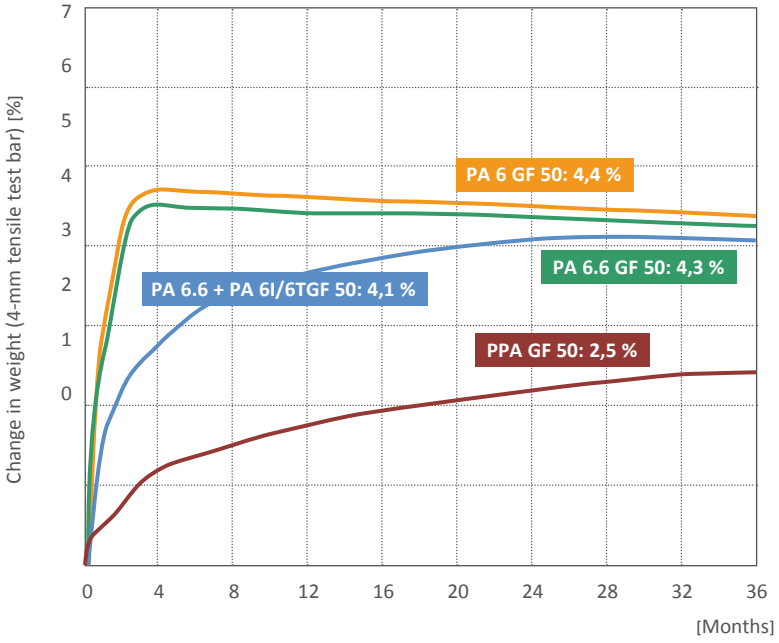
With AKROMID® T, AKRO-PLASTIC has developed a product line of different PPA compounds (polyphthalamides) to meet a wide range of technical requirements, including easy processability. PPA means that a partially aromatic polyamide block such as a PA 6T is found in the polymer chain. The chemical structure is based on a reaction between aliphatic diamines, e.g. hexamethylenediamine, usually with aromatic dicarboxylic acids such as terephthalic or isophthalic acid, but also aliphatic dicarboxylic acids such as adipic acid.
(Fig. 3)

## Creep behaviour (Fig. 1)

100 MPa @ 23 °C

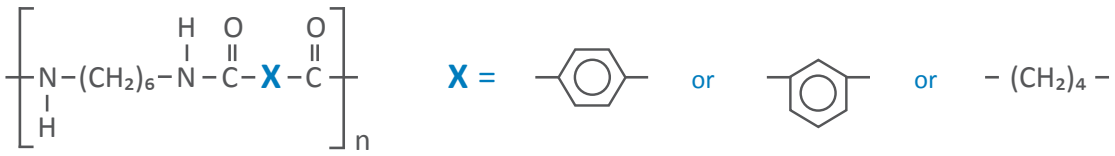



## Cold-water storage (Fig. 2)




After storage in water for 3 years at 23 °C, parts made of PPA (AKROMID® T) exhibit the lowest water absorption by comparison

## AKROMID® T – Chemical structure (Fig. 3)



**AKROMID® T1:**
Maximum stiffness and high heat resistance,

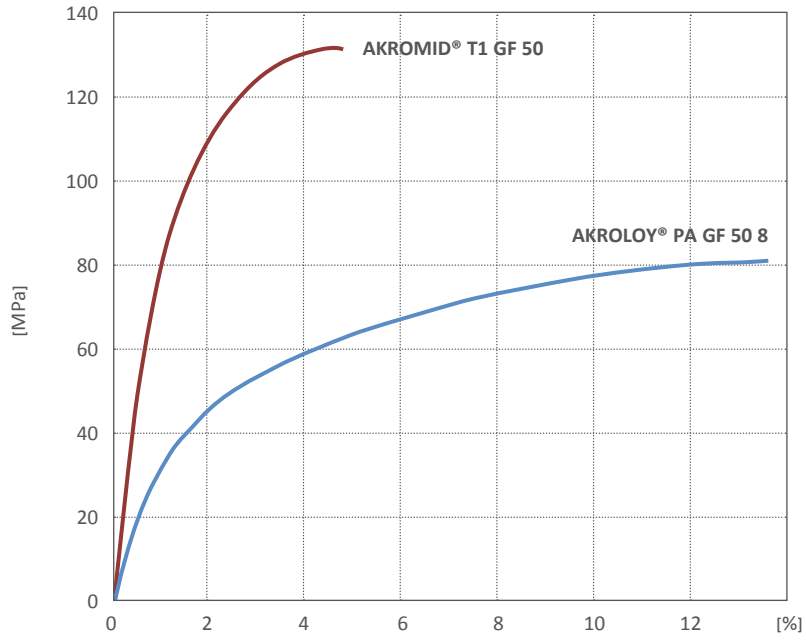
Tg = 130°C

**AKROMID® T6:**
Maximum heat distortion temperature with easy processability, lowest creep behaviour at 150 °C,
Tg = 95°C

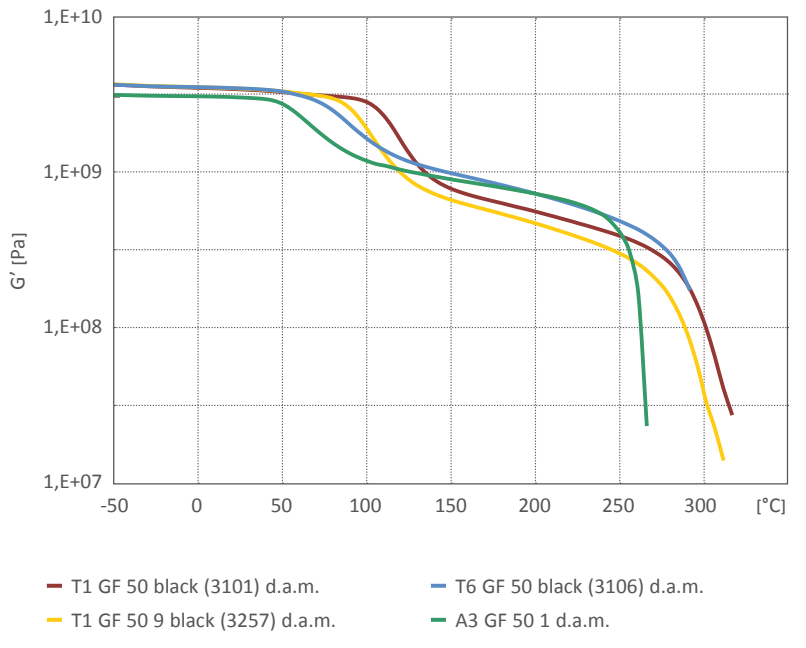
**AKROMID® T1 “9”:**
Process-optimized PPA compounds,

Tg = 100 °C

## Stress-strain curves at 120 °C (Fig. 4)




## Shear modulus characteristics (Fig. 5)




The partially aromatic component ensures increased heat and chemical resistance in particular, as well as reduced moisture absorption. (Fig. 2, Fig. 4)

The material can be combined with other PPA and PA blocks to produce a range of technical properties, resulting in differences in the glass transition Tg and shear modulus (Fig. 5).

Under specific ambient conditions (short-term stress), AKROMID® T6 in particular can also be used in applications above 150°C, as is evident from the shear modulus (Fig. 5).

Modification of the base grades has also made the material suitable for applications requiring a high-quality surface finish.

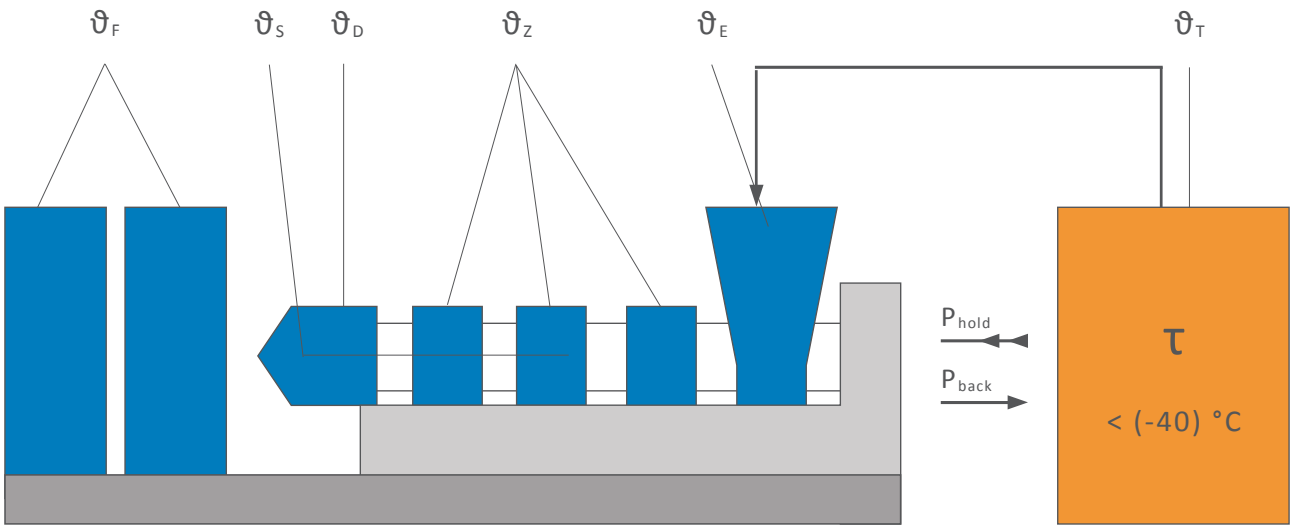
A further key advantage over PA 6 or PA 6.6 is demonstrated in the significantly improved chemical and hydrolytic resistance. In combination with the aforementioned mechanical properties, the material becomes an ideal solution for difficult applications in industrial pumps and fluid filters. Its low water absorption over extended periods is yet another advantage in this regard (Fig. 2).

# Processing Recommendations

AKROMID® T1, T1 “9” and T6 can be processed on commercially available injection moulding machines with standard screws according to the recommendations of the machine manufacturer. Please refer to the diagram below for our recommended machine, mould and dryer settings:

Bagged-product processing: Undamaged bags with the original seals intact can generally be processed without pre-drying.

Excessive drying can result in filling and surface problems; processing below a residual moisture content of 0.02 % is therefore not recommended.

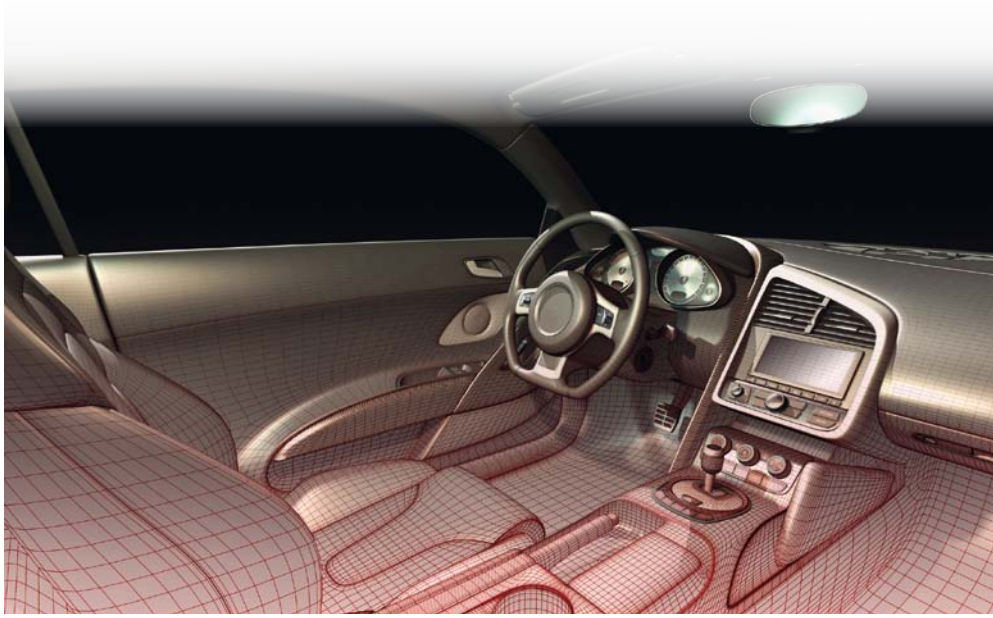



| | | AKROMID® T1 | AKROMID® T6 | AKROMID® T1 “9” |
|---|---|---|---|---|
| Feed section | $\vartheta_E$ | 80 – 95 °C | 80 – 95 °C | 80 – 95 °C |
| Sector 1 | $\vartheta_Z$ | 315 – 325 °C | 310 – 320 °C | 310 – 320 °C |
| Sector 2 | $\vartheta_Z$ | 320 – 330 °C | 315 – 325 °C | 315 – 325 °C |
| Sector 3 /4 | $\vartheta_Z$ | 325 – 340 °C | 320 – 335 °C | 320 – 335 °C |
| Nozzle | $\vartheta_D$ | 325 – 335 °C | 320 – 330 °C | 320 – 330 °C |
| Melt temperature | $\vartheta_S$ | 330 – 340 °C | 325 – 340 °C | 325 – 340 °C |
| Mould surface | $\vartheta_F$ | 135 – 160 °C | 95 – 140 °C | 100 – 130 °C |
| Drying, temperature | $\vartheta_\tau$ | 90 °C | 90 °C | 90 °C |
| Drying, time | $\vartheta_\tau$ | 2 – 16 h | 2 – 16 h | 2 – 16 h |
| Drying, moisture | $\vartheta_\tau$ | < 0.1 % | < 0,1 % | < 0,1 % |
| Holding pressure, spec. | $P_{hold}$ | 300 – 800 bar | 300 – 800 bar | 300 – 800 bar |
| Back pressure, hydr. | $P_{back}$ | 2.0 – 6,5 bar | 2.0 – 6.5 bar | 2.0 – 6.5 bar |

The specified values are reference values. For increasing filling contents the higher values should be used.
For drying, we recommend using only drying air or a vacuum dryer.

# Applications

Based on the characteristic features and technical properties shown, the following applications are possible:



**Automotive sector**

- Cooling system (thermostat housing, connectors, etc.)
- Parts in the oil circuit (tensioner bases, etc.)
- Parts in the brake system (valve bodies, etc.)
- Clutch components (central clutch release bearing, etc.)
- Air ducting parts (side pieces for charge-air coolers, control shafts, etc.)
- Parts subjected to high loads in the interior (centre armrest, etc.)

# Resistance to Media

The information on chemical resistance are subjective ratings based on resistance experiments according to standards ISO 175, ISO 11403-3, ISO 4599, ISO 4600, ISO 6252 etc. The information is intended for an initial assessment only.

**Resistant means:**
Unrestricted resistance under the specified conditions.

**Not resistant means:**
In spite of short-term resistance the material may be damaged, in case of prolonged contact there will be quickly visible chemical degradation.

In any case, AKROMID® intended for use with one of the listed media may only be used after practical testing.

| Medium | Temp. (°C) | Conc. (%) |
|---|---|---|
| Acetone | 23 | 100 |
| Formic acid | 23 | 100 |
| Petrol | 23 | 100 |
| Diesel fuel (DIN 51601) | 23 | 100 |
| Acetic acid | 23 | 100 |
| Ethylene glycol/water | 120 | 50 |
| Ethanol | 23 | 96 |
| Urea, aqueous | 23 | 20 |
| Hydraulic oil | 23 | 100 |
| Isopropanol | 23 | 100 |
| Kerosene | 23 | 100 |
| Cresol | 23 | 100 |
| Methanol | 23 | 100 |
| Engine oil | 23 | 100 |
| Phenol | 23 | 100 |
| Sulphuric acid | 23 | 96 |
| Silicone oil | 23 | |
| Toluene | 23 | 100 |
| Water | 23 | 100 |
| Xylene | 23 | 100 |
| Zinc chloride, aqueous | 23 | 50 |

**Electrical engineering**

- Mobile telephone parts (chip carrier, etc.)
- Coil formers
- Motor parts (brush holders, etc.)
- Plugs and connectors
- Bulb and LED sockets

**Industry and household**

- Heating systems (fan housings, etc.)
- Components for coffee machines (grades compliant with KTW – German recommendation for polymers in drinking-water systems)

- Water meters and water filters (KTW-compliant, hot water)
- Pump systems (misc. functional parts)

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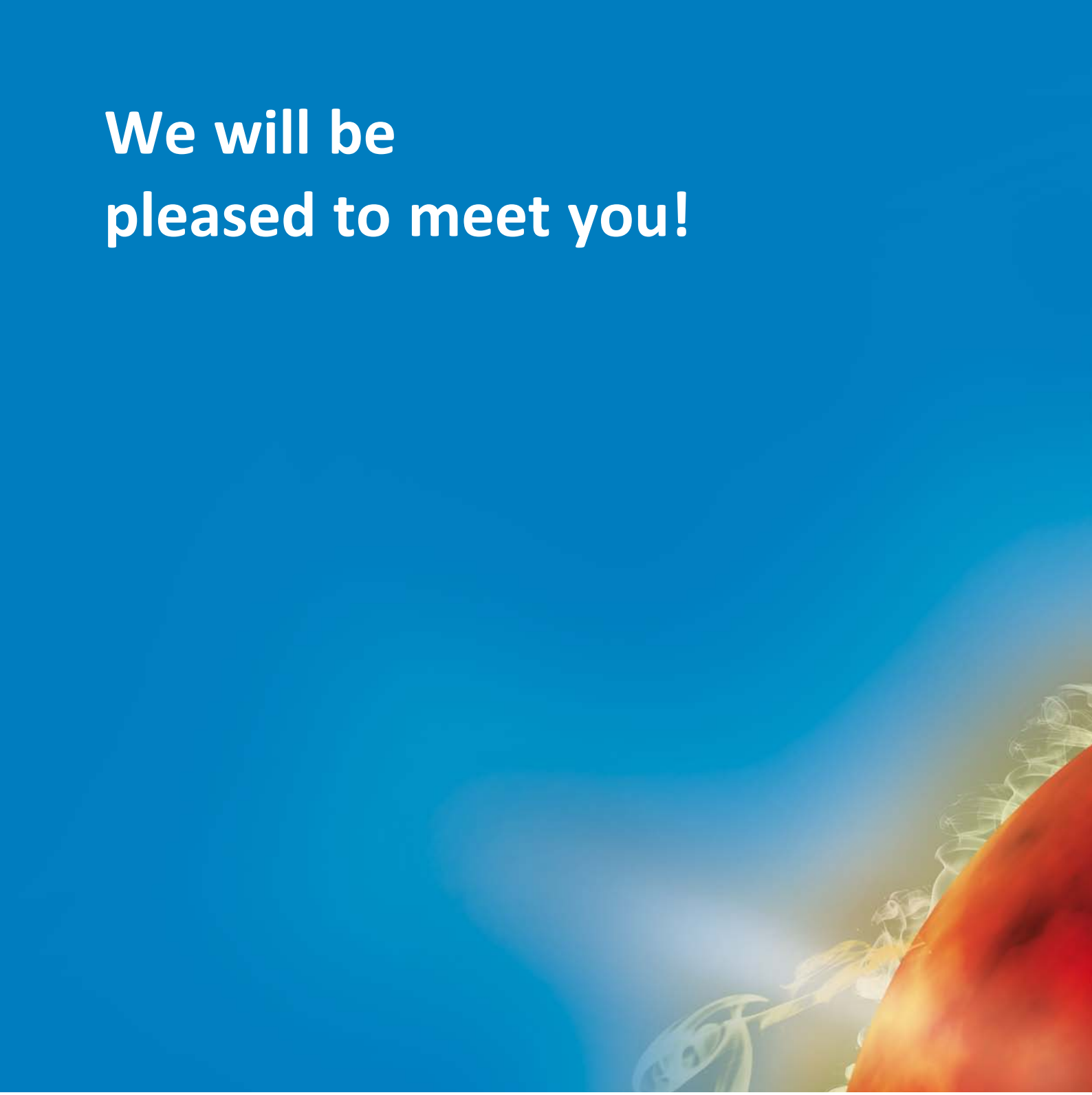
# Summary:

| T1 | |
|---|---|
| Chemical resistance | +++ |
| Creep behaviour at 80 °C | +++ |
| Creep behaviour at 120 °C | +++ |
| Creep behaviour at 150 °C | + |
| Water absorption rate | +++ |
| Stiffness and strength, conditioned | +++ |
| Stiffness and strength at 80 °C | +++ |
| Stiffness and strength at 120 °C | +++ |
| Stiffness and strength at 150 °C | + to ++ |
| Heat ageing behaviour | +++ |
| Surface quality | + to ++ |
| Processing behaviour | + |
| Impact strength/toughness | + to ++ |
| **T6** | |
| Chemical resistance | ++ |
| Creep behaviour at 80 °C | ++ |
| Creep behaviour at 120 °C | ++ |
| Creep behaviour at 150 °C | +++ |
| Water absorption rate | ++ to +++ |
| Stiffness and strength, conditioned | +++ |
| Stiffness and strength at 80 °C | ++ |
| Stiffness and strength at 120 °C | ++ |
| Stiffness and strength at 150 °C | +++ |
| Heat ageing behaviour | +++ |
| Surface quality | + |
| Processing behaviour | + to ++ |
| Impact strength/toughness | + to ++ |
| **T1 “9”** | |
| Chemical resistance | ++ |
| Creep behaviour at 80 °C | ++ to +++ |
| Creep behaviour at 120 °C | + |
| Creep behaviour at 150 °C | + |
| Water absorption rate | ++ to +++ |
| Stiffness and strength, conditioned | ++ to +++ |
| Stiffness and strength at 80 °C | ++ to +++ |
| Stiffness and strength at 120 °C | + |
| Stiffness and strength at 150 °C | + |
| Heat ageing behaviour | ++ |
| Surface quality | ++ |
| Processing behaviour | ++ |
| Impact strength/toughness | + to ++ |

# We will be pleased to meet you!



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