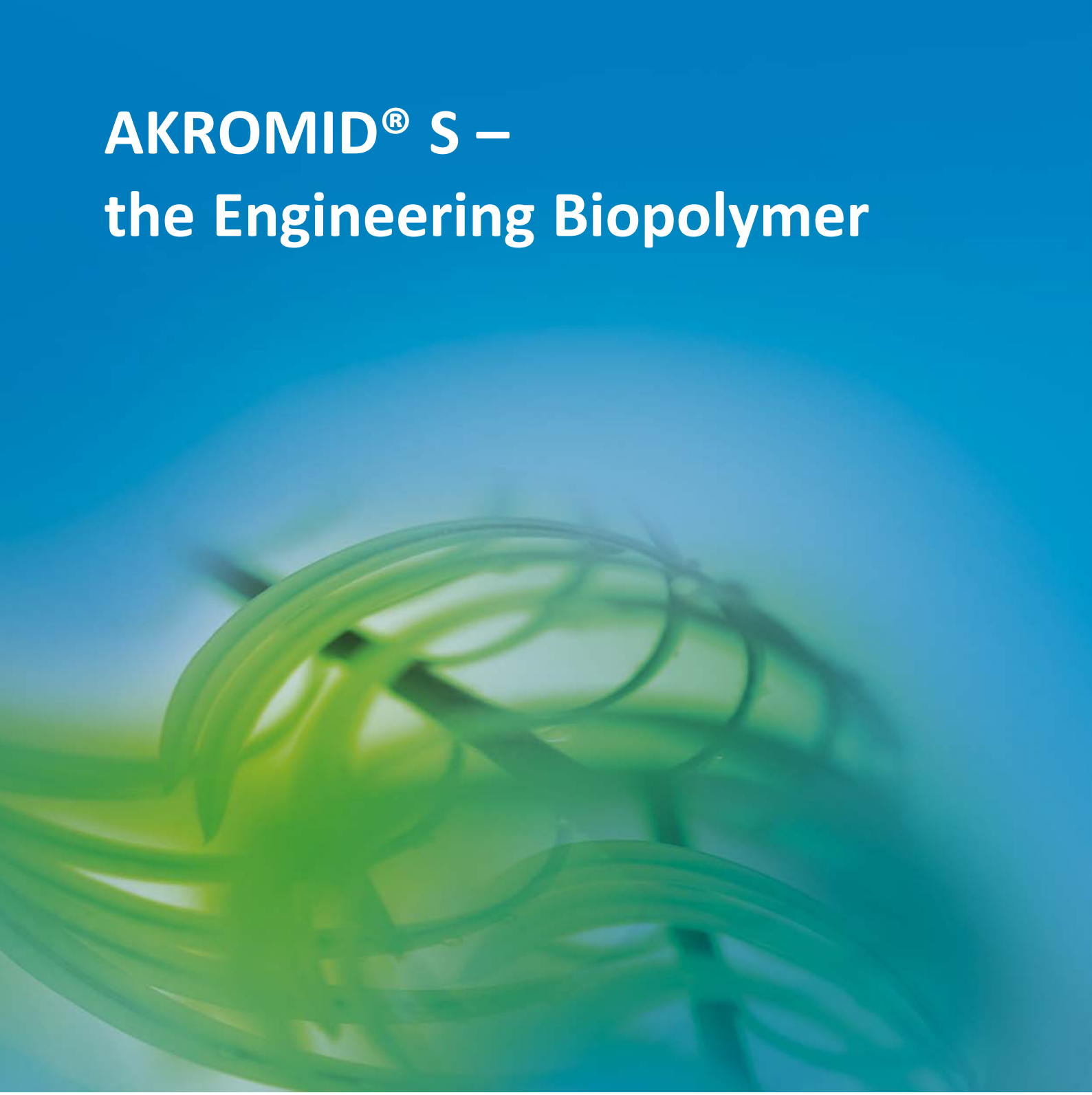
# AKROMID® S – the Engineering Biopolymer



AKRO-PLASTIC
Think Polyamide

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

# AKROMID® S series (Polyamid 6.10)

Although sebacic acid-based polyamides were developed and commercialised as early as the 1950s, they remained niche products on the market, due to the promotion of large-scale industrial standard products. In recent years, however, the plastics processing industry has seen a steadily growing interest in materials based on renewable resources. AKRO-PLASTIC GmbH is fully committed to meeting the demands generated by this interest. Focusing on the development of polyamide specialities, we have therefore developed a renewable resource-based polyamide 6.10 which has ushered in a veritable renaissance of this material.

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

| Typical values for natural colour material at 23° C | Test Specification | Test Method | Unit | S3 1 (3484) | | S3 GF 15 1 (3223) | | S3 GF 23 1 (2917) | | S3 GF 30 1 (3222) | | S3 GF 30 4 (3552) | | S3 GF 50 1 (3533) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **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. |
| Tensile modulus | 1 mm/min | ISO 527-1/2 | MPa | 2,400 | 1,200 | 5,000 | 3,500 | 7,000 | 5,000 | 9,000 | 6,200 | 8,600 | 6,200 | 14,500 | 11,000 |
| Yield stress[2]/Tensile stress at break | 5 mm/min | ISO 527-1/2 | MPa | 70[2] | 50[2] | 110 | 75 | 140 | 100 | 160 | 110 | 155 | 110 | 200 | 150 |
| Elongation at break | 5 mm/min | ISO 527-1/2 | % | > 50[2] | > 50[2] | 5.5 | 15 | 4.5 | 10 | 4.5 | 7.5 | 5.5 | 6.5 | 3.5 | 4.5 |
| Flexural modulus | 2 mm/min | ISO 178 | MPa | 1.900 | | | | 6,500 | | 7,700 | | 7,700 | | 13,800 | |
| Flexural strength | 2 mm/min | ISO 178 | MPa | 100 | | | | 210 | | 230 | | 230 | | 310 | |
| Charpy impact strength | 23 °C | ISO 179-1/1eU | kJ/m² | o.B. | o.B. | 75 | 80 | 90 | 85 | 100 | 100 | 110 | 90 | 100 | 100 |
| Charpy impact strength | -30 °C | ISO 179-1/1eU | kJ/m² | o.B. | | 60 | | 90 | | 100 | | 110 | | 105 | |
| Charpy notched impact strength | 23 °C | ISO 179-1/1eA | kJ/m² | 4 | 12 | 5 | | 15 | | 17 | | 16 | | 20 | |
| Charpy notched impact strength | -30 °C | ISO 179-1/1eA | kJ/m² | 4 | | 5 | | 10 | | 12 | | 12 | | 16 | |
| Ball indentation hardness | *HB 961/30 | ISO 2039-1 | MPa | 125* | | | | 180 | | 195 | | 195 | | 230 | |
| **Electrical Properties** | | | | 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 | | | | | | | | | | | |
| **Thermal Properties** | | | | | | | | | | | | | | | |
| Melting point | DSC, 10 K/min | ISO 11357-1 | °C | 220 | | 220 | | 220 | | 220 | | 220 | | 220 | |
| Heat distortion temperature, HDT/A | 1.8 MPa | ISO 75-1/2 | °C | 55 | | 190 | | 200 | | 205 | | 200 | | 205 | |
| Heat distortion temperature, HDT/B | 0.45 MPa | ISO 75-1/2 | °C | 150 | | 220 | | | | | | | | | |
| Heat distortion temperature, HDT/C | 8 MPa | ISO 75-1/2 | °C | | | 75 | | 115 | | 145 | | 140 | | 170 | |
| **Flammability** | | | | | | | | | | | | | | | |
| Flammability acc. to UL 94 | 0.8 mm | UL 94 | Class | HB | | HB | | HB | | HB | | HB | | HB | |
| Burning rate acc. to FMVSS 302 (< 100 mm/min) | > 1 mm thickness | FMVSS 302 | mm/min | + | | + | | + | | + | | + | | + | |
| **General Properties** | | | | | | | | | | | | | | | |
| Density | 23 °C | ISO 1183 | g/cm³ | 1.08 | | 1.18 | | 1.25 | | 1.31 | | 1.31 | | 1.51 | |
| Reinforcement content | | ISO 1172 | % | | | 15 | | 23 | | 30 | | 30 | | 50 | |
| Moisture absorption | 70 °C/62 % r.F. | ISO 1110 | % | 1.7 | | 1.5 | | 1.3 | | 1.2 | | 1.2 | | 0.9 | |
| **Processing** | | | | | | | | | | | | | | | |
| Flowability | Flowspiral[1] | AKRO | mm | 700 | | 450 | | 450 | | 400 | | 400 | | 350 | |
| Processing shrinkage, flow | | ISO 294-4 | % | 1.6 | | 0.6 | | 0.4 | | 0.3 | | | | 0.3 | |
| Processing shrinkage, transverse | | ISO 294-4 | % | 1.8 | | 1.1 | | 0.9 | | 0.9 | | | | 1.0 | |

[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:
testing speed 50 mm/min

n.b. = not broken

+ = passed

“cond.” test values = conditioned, measured on test specimens stored according to ISO 1110

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

*Test condition unreinforced = HB 358/30

# Product characterisation

A characteristic property of AKROMID® S (PA 6.10) is that it has a renewable-resource content of up to 70 % and therefore fulfils the current definition of a bioplastic[1]. The plant-based raw material used is sebacic acid, synthesized from castor oil which is obtained from the seeds of Ricinus communis, the castor oil plant.

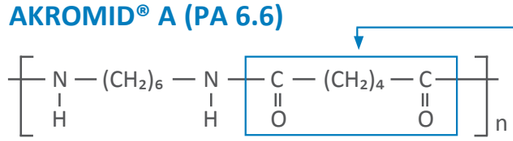
From a technical standpoint, AKROMID® S closes the gap between PA6/PA6.6 and PA12. It is characterized by significantly lower moisture absorption compared to PA6 and PA6.6. At 23 °C and 50 % relative humidity, typical values for these product types are 3 % and 2.8 %, respectively. With a value of approximately 1.4 %, PA 6.10 absorbs just half as much moisture and can therefore be used as an engineering material in applications requiring a high dimensional accuracy. Moreover, it exhibits excellent cold impact resistance. Other outstanding characteristics include very good chemical resistance due to the structure of the polymer and high hydrolysis resistance, although it can be processed like all common polyamides.

The materials from the PA 6.10 product family are further characterized by exceptional dimensional stability, good surface quality, good surface quality, abrasion resistance, wear behaviour, and an improved carbon footprint. This is due to the fact that the plant-based raw materials have already removed $CO_2$ from the environment during their growth phase.

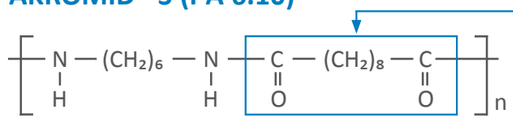
The product portfolio currently comprises one non reinforced variant and several reinforced variants with a glass-fibre content ranging from 15 % to 50 %.

[1] = definition of Bioplastics according to Prof. Dr. Ing. H.-J. Endres, FH Hannover

## AKROMID® A (PA 6.6)



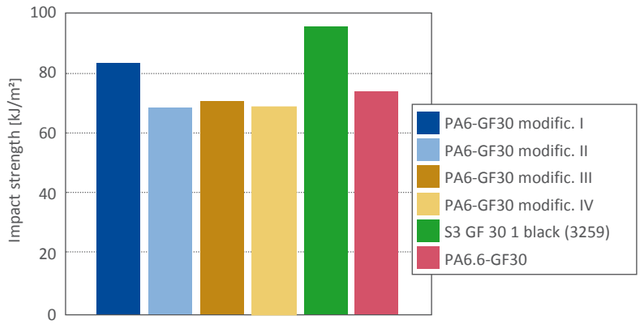

## AKROMID® S (PA 6.10)




## AKROMID® S3 GF 30 1


AKROMID® S3 GF 30 1 following ageing in $ZnCl_2$ solution under flexural load

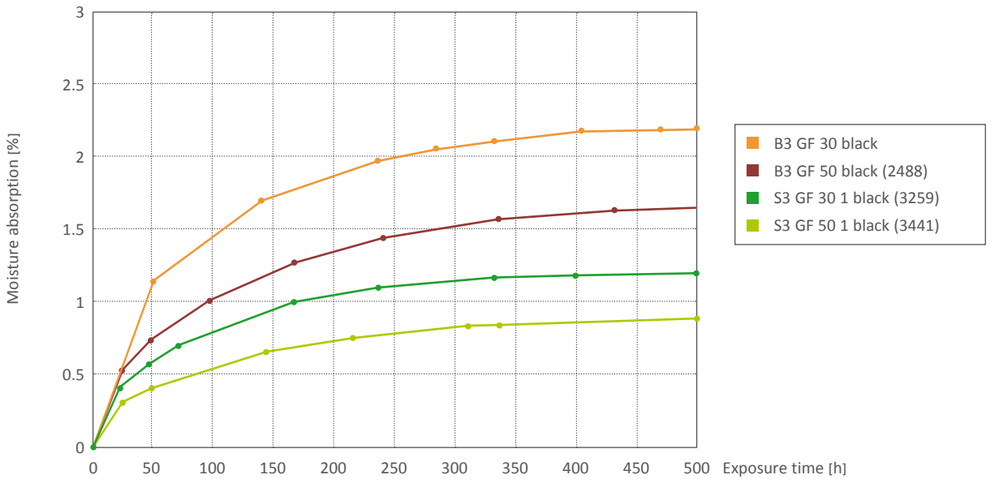
## Impact strength after 200 hours in $ZnCl_2$ solution




AKROMID® S3 GF 30 1 exhibits significantly better impact strength compared to PA6/PA6.6-GF30

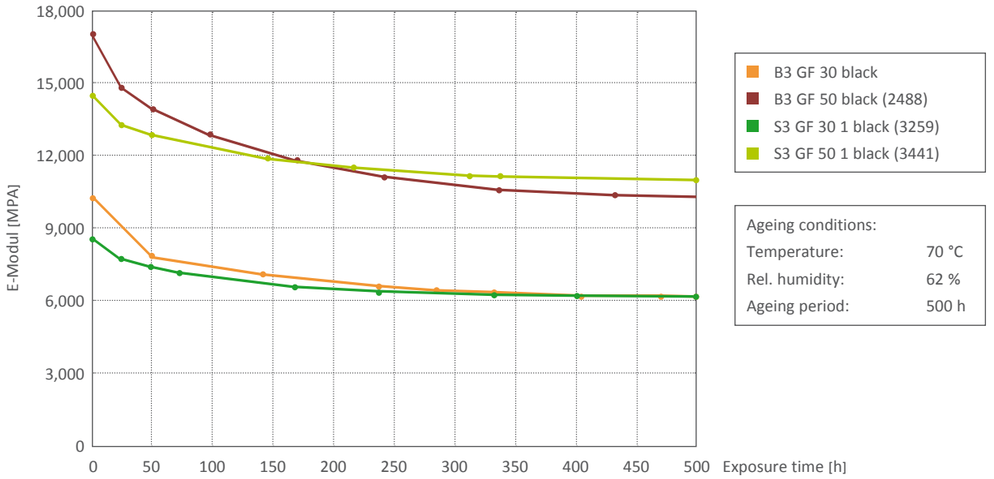
A comparison of technical properties shows the outstanding differences between AKROMID® S and comparable PA 6 compounds:

## Moisture absorption vs. exposure time – 500 h at 70 °C and 62 % rel. humidity




AKROMID® S absorbs approx. 50 % less moisture than a PA 6 GF 30 or PA 6 GF 50

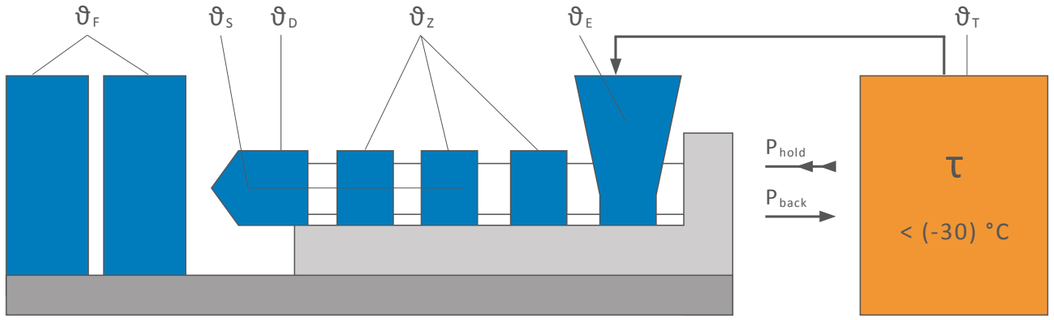
## Young's modulus as a function of exposure time




Following moisture absorption, Young's modulus in AKROMID® S decreases significantly less than in PA 6 GF 30 or PA 6 GF 50

# Processing recommendations

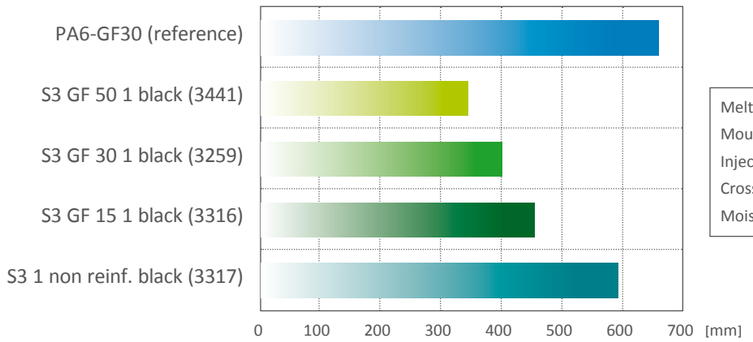
AKROMID® S can be processed on commercially available injection moulding machines with standard screws according to the recommendations of the machine manufacturer. Please refer to the table below for our recommended machine, mould and dryer settings (see diagram):




| | | AKROMID® S3 |
|---|---|---|
| Feed section | $\vartheta_E$ | 60 – 80 °C |
| Sector 1 – Sector 4 | $\vartheta_Z$ | 220 – 300 °C |
| Nozzle | $\vartheta_D$ | 240 – 295 °C |
| Melt temperature | $\vartheta_S$ | 260 – 310 °C |
| Mould surface | $\vartheta_F$ | 70 – 100 °C |
| Drying | $\vartheta_T$ | 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 4h. It is recommended to use opened bags completely.
Material processed from silo or boxes requires a minimum drying time of 4h.

## Flow length




Melt temperature: 270 °C
Mould temperature: 80 °C
Injection pressure: 750 bar
Cross section: 7*3.5 [mm²]
Moisture content: 0.06 – 0.07 %



# Applications

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

**Automotive sector**
- Connectors and housings
- Non-return valves
- Power steering-fluid reservoirs
- Corrugated tubing and fluid pipes

**Machine construction and tool-building**
- Gears
- Door handles and fittings
- Office equipment, housings, functional parts, amongst others
- Connectors and plugs
- Power tools


**Sports and leisure**
- Components in high-end garden tools
- Bicycle accessories
- Sail-boat accessories
- Winter sports accessories

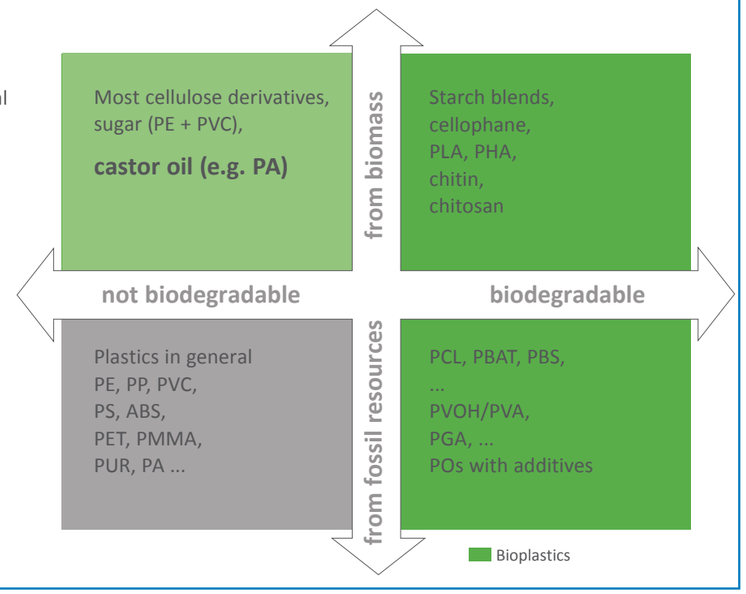
AKROMID® S is a bioplastic according to today's standards. Unlike certain materials used in the packaging industry, however, the material is not biodegradable.
The distinguishing feature of AKROMID® S is its reduced ecological footprint: The use of harmful $CO_2$ per tonne of polyamide produced from renewable resources is significantly lower compared to one tonne produced from fossil-based resources, without affecting the product's performance characteristics.

## Definition

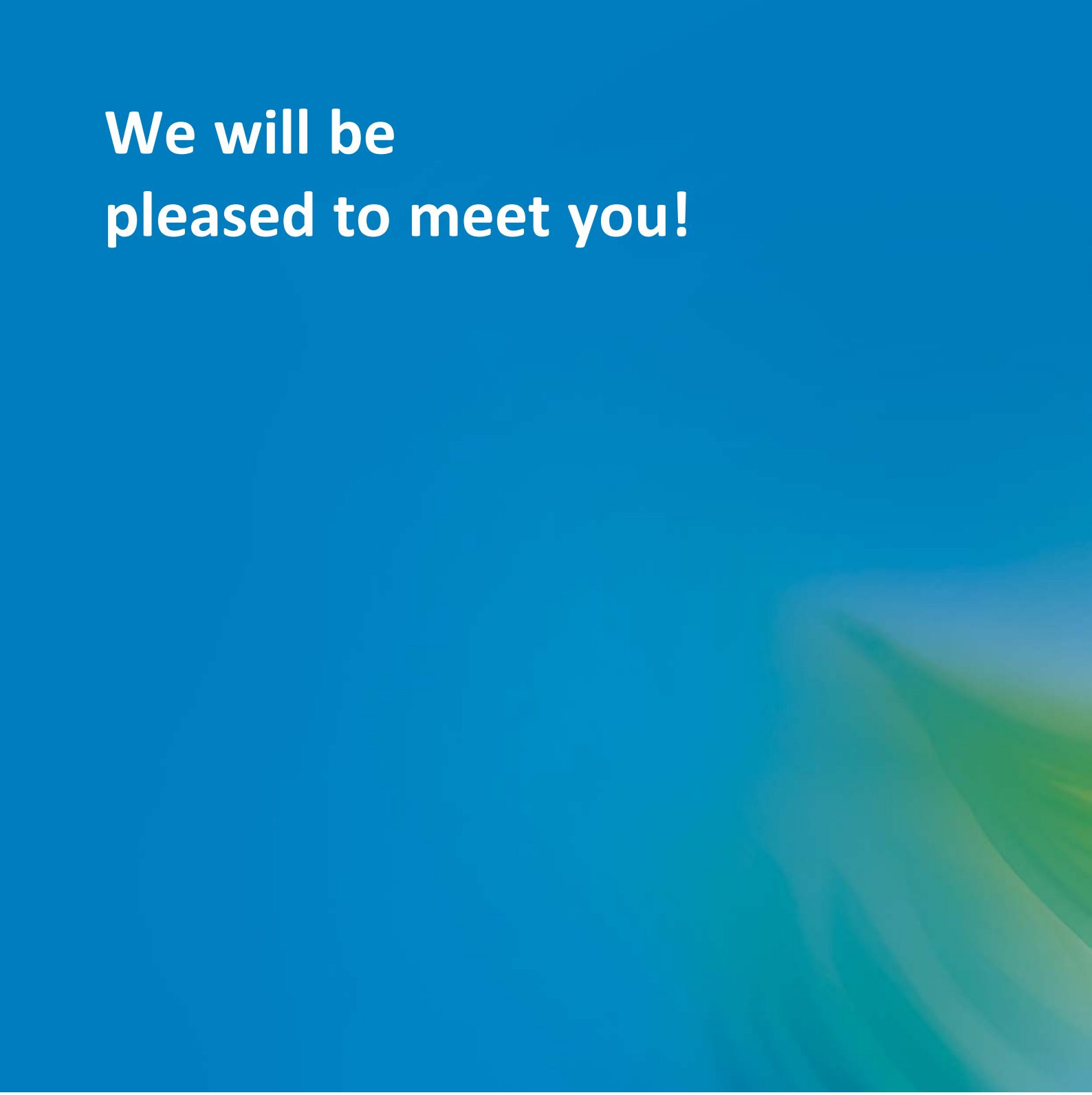
**Biopolymers**
- part of the European Commission's Lead Market Initiatives (sufficient industrial base + non-food product)

Definition of Bioplastics according to Prof. Dr. Ing. H.-J. Endres, FH Hannover

**AKROMID® S**
- has a biogenic content of up to 70 %



# We will be pleased to meet you!



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

Industriegebiet Brohltal Ost
Im Stiefelfeld 1
56651 Niederzissen
Germany
Phone: +49(0)2636-9742-0
Fax: +49(0)2636-9742-31
info@akro-plastic.com
www.akro-plastic.com

**For more locations, visit www.kdfeddersen.com**

09/2013