Yarns from Bio-based Polymers

Sustainable options for technical textiles

Yarns from Bio-based Polymers: Sustainable options for technical textiles

The need to reduce CO_2 emissions and to become independent of fossil-based fiber products motivated PHP Fibers to search for bio-based alternatives.

Our investigations revealed two potential candidates, both of which are thermoplastic polymers suitable for fiber spinning.

Diolen® 150BT – bio-based and bio-degradable high-tenacity polyester yarn

Diolen® 150BT yarn

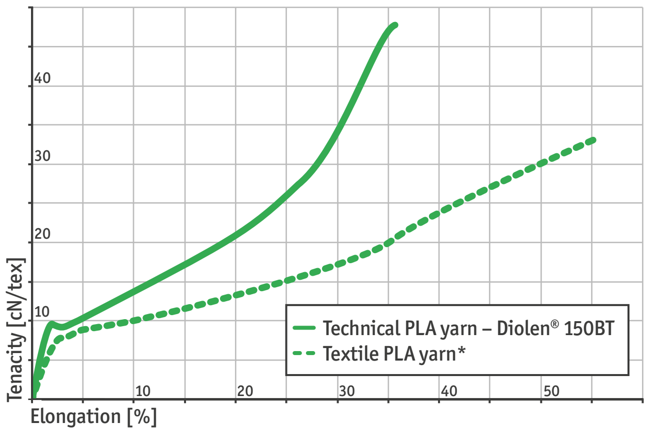
- Based on polylactic acid polymer (PLA)
- 100% bio-based
- Biodegrades under industrial composting conditions
- Shows low moisture absorption
- Provides good UV stability
- Low flammability

Biodegradation after storage under composting conditions in accordance to EN 14046:2003; Source: ITV Denkendorf

start 5 weeks 8 weeks

Diolen® 150BT – technical high-tenacity yarn

- Diolen® 150BT demonstrates superior tensile performance over textile yarns
- Diolen® 150BT is an option for a variety of sustainable applications, e.g.:
  - Substitution for non-biodegradable fixtures in agricultural and horticultural environments
  - Sustainable packaging reinforcement for paper-based adhesive tapes



**) Source "Polylactic acid fibers", D W FARRINGTON et al., NatureWorks LLC*

Polymer	Melting Temperature, Tm °C	Glass Transition Temperature, Tg °C	Density g/cm³	Moisture Uptake at 50 % RH* %	Tensile Modulus dry* MPa	Tensile Modulus conditioned 50 % RH* MPa	Bio-base %	CO_2 Emission* kg CO_2 eq / kg polymer
PLA	160 – 180	55 – 60	1.24	0.2	2900 – 3000	n.a.	100	0.6
PET	250 – 260	70	1.38	0.4	2800 – 3100	n.a.	0	3.4

Polymer properties of bio-based PLA polymer vs. fossil-based PET polymer

**) Sources: Mary Ann Liebert, Inc. Vol.6, no.4, August 2010, Industrial Biotechnology, Natureworks*

Enka® Nylon BIO – bio-based high-tenacity polyamide yarn

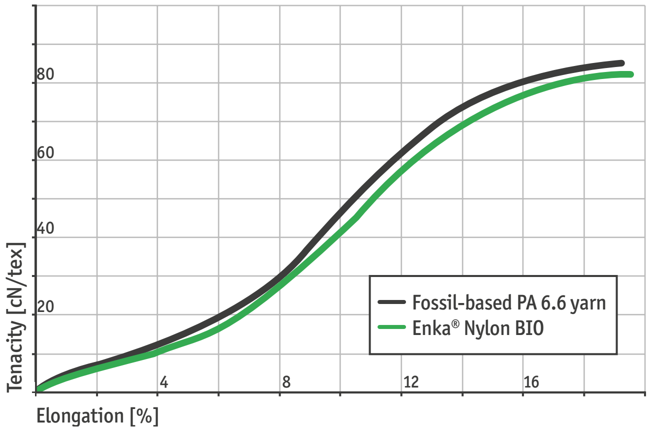
For existing technical fiber applications it would be particularly advantageous if yarns manufactured from bio-based polymers could be considered as so-called ”drop in“ alternatives for current fossil-based products. In this case, similar processing conditions could be used without the need to make significant adaptions. In comparison to fossil-based PA 6.6 polymer, the bio-based PA 4.10 polymer was judged to provide a very good match:

- Melting temperature and glass transition temperature are at the level of PA 6.6
- Lower density than PA 6.6
- Picks up less moisture
- Provides 40 % higher tensile modulus under humid storage conditions
- 70 % bio-based
- CO_2 emission balance is almost zero

Technical bio-based PA 4.10 yarn VS. Technical fossil-based PA 6.6 yarn

Spinning evaluations carried out on an industrial scale proved that the bio-based PA 4.10 polymer can be converted into technical multifilament yarn:

- Tensile characteristics are largely comparable to those of fossil-based PA 6.6 technical yarns
- At low elongations, the modulus of bio-based PA 4.10 yarn is certainly at the level of PA 6.6
- Elongation at break is higher
- Breaking force is slightly lower
- In Mechanical Rubber Goods application PA 4.10 yarns/ cords provide good adhesion to rubber and fatigue resistance at the level of reference PA 6.6



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Bio PA 4.10	250	70	1.09	1.9	3100	1750	70	0
PA 6.6	255	74	1.14	2.7	3250	1250	0	6.4

Polymer properties of bio-based PA 4.10 vs. fossil-based PA 6.6,
**) Sources: DSM primary data for PA 4.10 (EcoPaXX), Plastics Europe eco-profiles for PA 6.6*

Contact:
Andreas Flachenecker
Technical Marketing and Development Manager

PHP Fibers GmbH

Kasinostraße 19 – 21
42103 Wuppertal
Germany
T +49 202 32-2672
M +49 173 72 88 041
F +49 202 32-2377

andreas.flachenecker@php-fibers.com
www.php-fibers.com