HIGH PERFORMANCE POLYMERS

Bio from renewable sources

BIONSIDE™

naturally radilon

RADICI GROUP

Bionside™ is bio inside.

The natural extension of our Radilon® line of products.

At RadiciGroup, innovation starts from the very building blocks of chemistry. **Bionside™ is our collection of bio-based polyamides** of the Radilon family, developed through years of expertise in material science and an unwavering commitment to sustainability. This collection is the result of extensive research into bio-sourced solutions, with each polymer carefully designed and produced within RadiciGroup's advanced facilities.

Our Research & Development team is continuously pushing the boundaries, exploring new ways **to create innovative and eco-friendly materials**. Bionside™ is just the beginning of our journey towards a more sustainable future, offering **high-performance solutions with a reduced environmental impact.**

Why choose Bionside™

To improve environmental performance

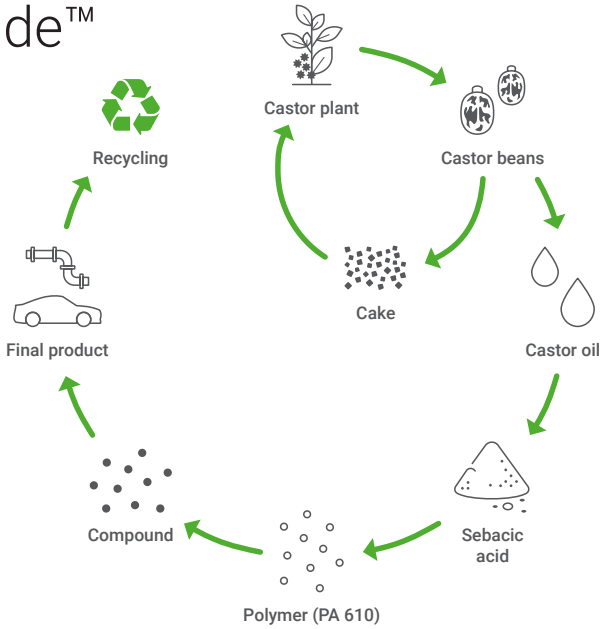
Choosing bio-sourcing represents an important commitment to the environment and to reducing dependency on fossil fuels. Bio-based renewable polymers are a viable alternative to fossil-based polymers due to their lower environmental impact, including CO_2 emissions.

To achieve specific technical performance

Thanks to their chemical conformation, bio-based polyamides can offer particularly high levels of performance, making them the most suitable material for specific applications.

The renewable source of Bionside™

Bionside™ is crafted using **renewable raw materials**, primarily derived from the oil extracted from castor beans. The castor plant is cultivated in semi-arid regions, requiring minimal water to thrive. This approach not only reduces water consumption but also supports sustainable agricultural practices, **making Bionside™ an eco-friendly choice** for industries seeking to lower their environmental impact without compromising on quality and performance.



Sustainable facts about the castor plant.

- It is cultivated **without competition to the human or animal food chain**.
- It **doesn't cause deforestation**.
- It can **be grown in poor soil**.
- It is **naturally drought resistant**.
- It is a **secure income** source for farmers.

Market drivers and key opportunities using bio-polyamides.

Driver	Requirements	Preferred Bio Solution
Metal replacement.	Grades with high properties (mechanical & others).	Radilon D (PA610), Radilon PX (PA510), Radilon P (PA56), other.
Metal replacement in water management.	Grades with excellent mechanical properties including creep, hydrolysis resistance, suitable for potable water contact.	Radilon D (PA610), Radilon PX (PA510).
E-mobility specialties (battery enclosure, power electronics).	Grades with good electrical properties. FR properties may be requested in many cases.	Radilon D (PA610), Radilon P (PA56).
Thermal management components for EV.	Excellent road salt resistance, long term hydrolysis resistance.	Radilon D (PA610), Radilon TT (PA1012).
Special grades for various industries.	Transparency (air pipes, sport soles), low extractable (in tank fuel lines), high flexibility without plasticizer.	Radilon TT (PA1012).

Applications

Bionside™ is the ideal solution for all those sectors where sustainability and high performance are required.
It has countless applications in:


Automotive


Water management


Electrical/ Electronic


Power tools


Furniture


Sports accessories

Radilon® D PA610

An available option to reduce environmental impact.

What is it?

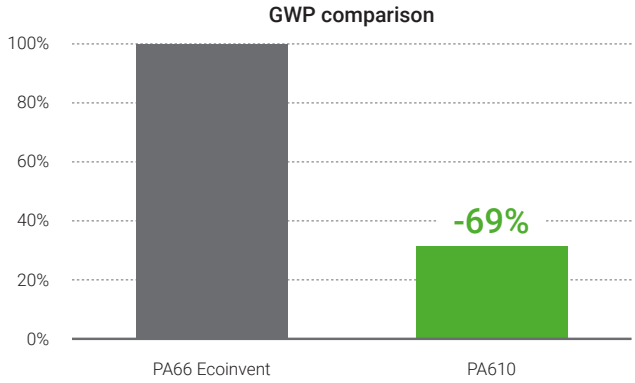
Polyamide 610 with **64% bio-based content**.

How is it made?

The **bio-based portion is derived from castor oil**, from which sebacic acid is obtained and then combined with hexamethylenediamine during polymerization.

What are the performance benefits?

With equal or improved technical performance, we have measured **a reduction in GWP (Global Warming Potential) of nearly 70%** compared to a standard PA66.

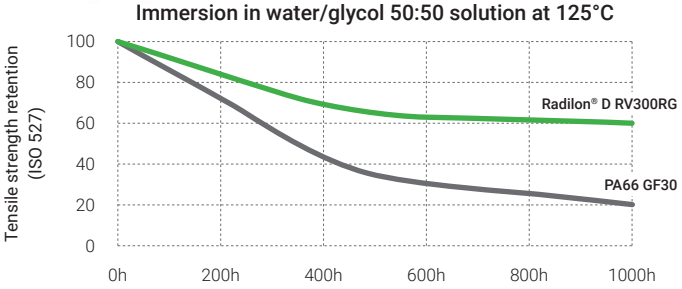


The calculation is carried out through SimaPro v. 9.3.0.3, the database Ecoinvent 3.5 and the assessment method IPCC 2021 (incl. CO_2 uptake). It is a cradle-to-gate study critically reviewed by Certiquality in 2022. Data refer to 2019 production data, kindly provided by Radici InNova.

Radilon® D PA610 applications

Cooling line connectors

Material: Radilon® D RV300RG (PA610-GF30, hydrolysis resistant)



Main requirements

- Resistance to cooling liquid
- Resistance to road salts solutions contact
- Dimensional stability

Results

- +42% retention with Radilon® D polymer
- 60% retention with Radilon® D RV300RG
- 22% retention with standard PA66-GF30

Vacuum brake booster hose

Material: Radilon® D 40EP25ZW (PA610, flexible)

Main requirements

- Stress cracking resistance
- UV resistance
- In compliace with:
  ISO 7628, DIN 74324, SAE J844, FMVSS106
- Excellent processability by extrusion

In tank fuel lines

Materials: Radilon® D 40P50K (PA610, flexible) and Radilon® D 40EP50XK1C 333 BK
(conductive and flexible PA610 for internal layer)

Main requirements

- Resistance to different fuels (diesel & gasoline)
- Conductivity retention after prolonged fuel immersion for two layers solution
- Excellent processability

High gloss trims

Material: Radilon® D HSUK 3010 BK
(PA610, UV stabilized, high gloss black colour)

Main requirements

- High gloss
- Excellent surface appearance
- Excellent UV resistance (SAE J 2412)
- Low moisture sensitivity
- Abrasion and scratch resistance

Monofilaments

Material: Radilon® D 24D 1000 NT 3010 BK
(PA610, low viscosity)

Main requirements

- Excellent chemical resistance
- Easy processing
- Low moisture sensitivity
- Bend recovery

What's next?

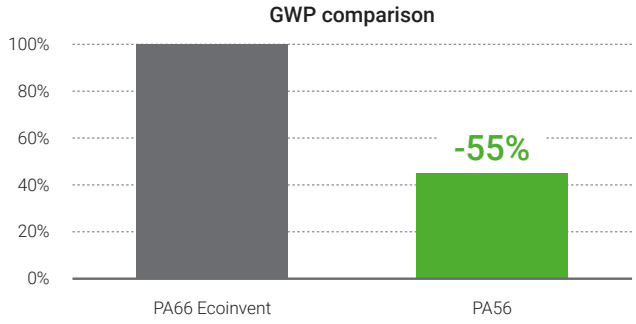
New possibilities for bio-based polyamides.

To expand its sustainable product range and improve technical performance, **RadiciGroup is testing new materials**.

In developing new solutions, RadiciGroup has also **explored renewable materials with the aim of achieving 100% bio-based content** and testing sources other than castor oil. Initial tests show that these materials exhibit **unique technical properties**.

Radilon® P PA56

With a **41% bio-based** content, it's a valid alternative to fossil based solutions, including flame retardant formulations.



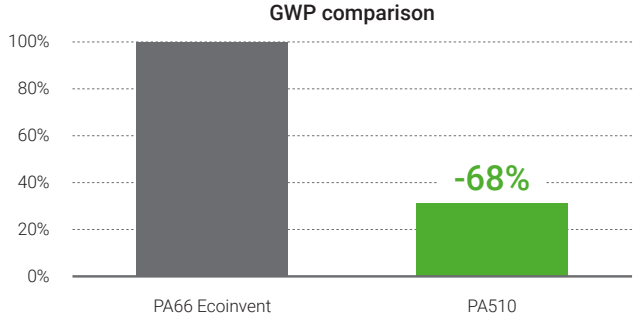
The calculation is carried out through SimaPro v. 9.3.0.3, the database Ecoinvent 3.5 and the assessment method IPCC 2021 (incl. CO_2 uptake). It is a cradle-to-gate study critically reviewed by Certiquality in 2022. Data refer to 2019 production data, kindly provided by Radici InNova.

Key features

- **Easy Flow**
- **Melting point close to PA66**
- **High moisture absorption**
- **High LOI**
- **High crystallinity**

Radilon® PX PA510

A **100% bio-based** polyamide solution that is a valid alternative for metal replacement.



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Key features

- **Easy Flow**
- **Excellent surface appearance**
- **Lower moisture absorption**
- **Improved dimensional stability**
- **Lower density**

Radilon® TT PA1012

With a **43% bio-based content**, it offers transparency and hydrolysis resistance properties.

Key features

- **Transparency**
- **High flexibility**
- **Excellent chemical resistance**
- **Very low moisture absorption**
- **Low extractable**
- **Excellent stress cracking resistance**

A possible application of **Radilon® TT PA1012**

Sport shoe insoles and other consumer goods

Material: Radilon TT P25 100 NT (PA1012, experimental grade)

Main requirements

- Flexural fatigue resistance in a cold environment
- Hydrolysis resistance
- Excellent flexibility at different temperatures
- Colour stability
- High bend resistance
- Good bonding to TPU and synthetic shoe material

RadiciGroup.
Inside your world.

RadiciGroup is one of the world's leading producers of a wide range of chemical intermediates, polyamide polymers, high performance engineering polymers and advanced textile solutions, including nylon yarn, polyester yarn, yarn made from recovered and bio-source materials, nonwovens and personal protective equipment for the industrial and healthcare fields. These products are the result of the Group's outstanding chemical expertise and vertically integrated polyamide production chain and have been developed for use in a variety of industrial sectors, such as: automotive, electrical and electronics, household appliances, consumer and industrial goods, apparel, furnishing, construction, sports. The basis of the Group's strategy is a strong focus on innovation, quality, customer satisfaction and social and environmental sustainability.

Sustainability

Every day at RadiciGroup, we work to make circularity our business model. We optimize the use of materials while fine-tuning our processes, eliminating waste and promoting recyclability from the earliest product design phases. We are always looking for low-impact solutions in terms of natural resources and energy. We rely on certified management systems for Quality, Health and Safety, Environment and Energy to keep our companies in line with the highest sustainability standards.

1st Sustainability Report in 2004

GRI, third-party certified **Sustainability Report** covering all RadiciGroup companies worldwide.

>70% Emission reduction

Since 2011, in RadiciGroup plants.

Water reused up to 60 times

Water reused in RadiciGroup production plants.

Data Source: RadiciGroup Sustainability Reports

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