



# Rebuilding the Properties of Recycled Polyolefins



Bridging the gap between virgin  
and recycled PP and PE

**Nouryon**

# Nouryon Creates Everyday Essentials

Nouryon is your partner in essential solutions for a sustainable future.

We are a global, specialty chemicals leader. Markets and consumers worldwide rely on our essential solutions to manufacture everyday products, such as personal care, cleaning goods, paints and coatings, agriculture and food, pharmaceuticals, and building products. Furthermore, the dedication of approximately 8,200 employees with a shared commitment to our customers, business growth, safety, sustainability and innovation has resulted in a consistently strong financial performance. We operate in over 80 countries around the world with a portfolio of industry-leading brands.

Within our Polymer Specialties business, we produce everyday essentials for the global polymer, recycling and polymer processing industries. We are among the world's leading producers of organic peroxides, metal alkyls and organometallic specialties, which are essential ingredients for the thermo-plastic, composite and rubber industries. We are widely known for our world-class products, including Butanox®, Trigonox®, Perkadox® and Ketjenblack® brands.

As a company of innovation, we have recently introduced new initiators, which have an improved performance in selectivity and HSE profile, including Trigonox® 421 and Trigonox® 301 products for example.

## A global partner

Our manufacturing sites and distribution centers are found all around the globe. Our global distribution network allows us to deliver our products to you anywhere in the world. That's how we ensure security of supply and easy access to quality products wherever you are.

All our sites are ISO 9001 and ISO 14001 certified to ensure the highest product quality and strict compliance with environmental regulations. We continually invest in manufacturing techniques, high quality standards, safety, innovation, active technical support and a reliable supply chain.



# Advanced Mechanical Recycling of Polyolefins

We are the global leader in the production of organic peroxides for the polymer, rubber and resin industry. Markets worldwide rely on our essential chemistry, our global production footprint and safety expertise to enable the polymer life cycle.

The combination of:

- Our strong commitment to sustainability
- Our long history in serving the polymer industry
- Our unique reactive chemistry

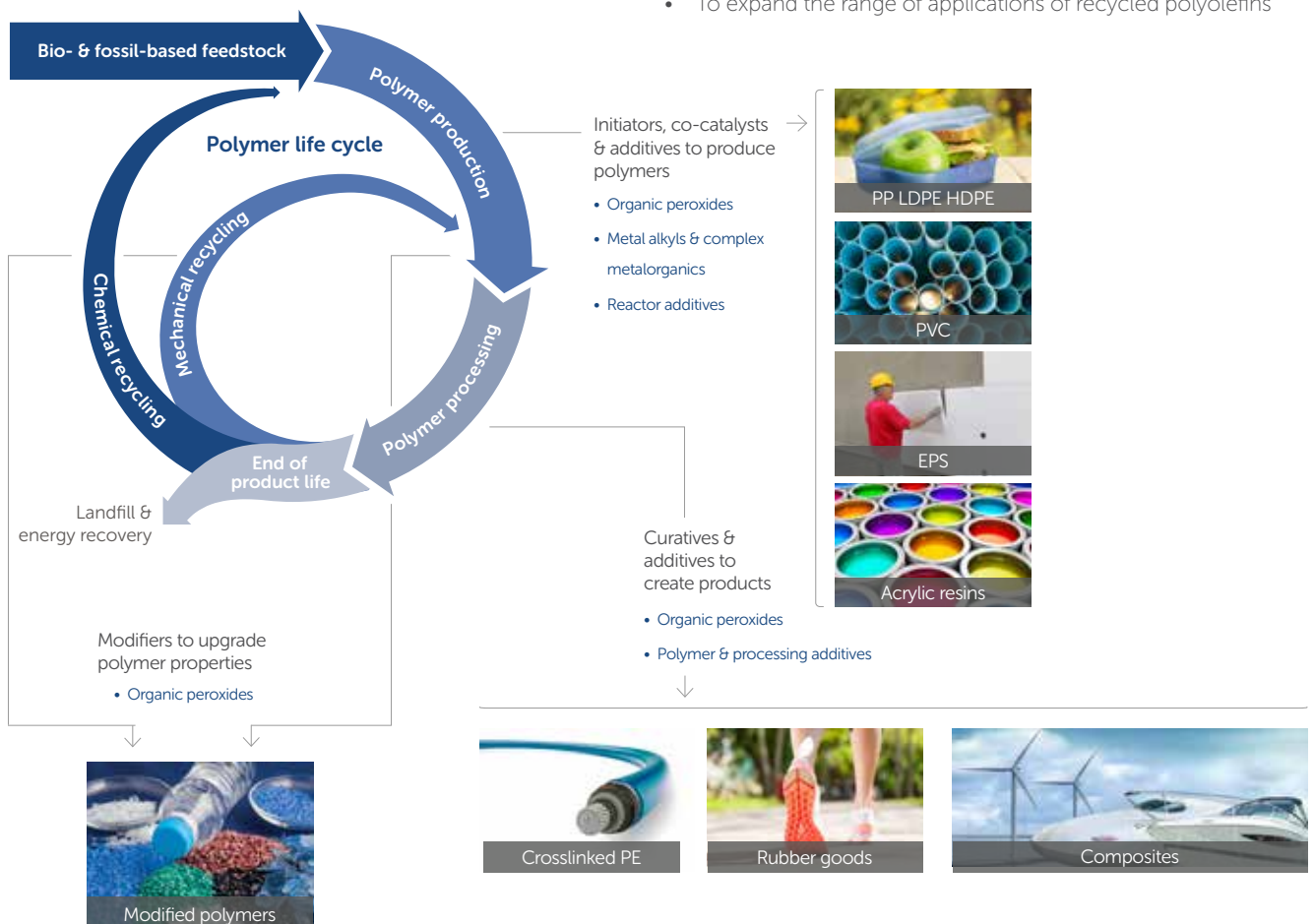
is what drives Nouryon to develop essential ingredients for the polyolefins recycling industry.

Our products for modification of recycled polyolefins:

- Improve the properties and the performance of recyclate by modifying the polymer molecular structure
- Allow 100% recycled content claims
- Enable re-recyclability

Our Trigonox® and Perkadox® products enable the recycling industry:

- To meet increasingly demanding market needs in terms of quality and recycled content
- To produce more recycled polyolefin grades from available waste streams
- To expand the range of applications of recycled polyolefins

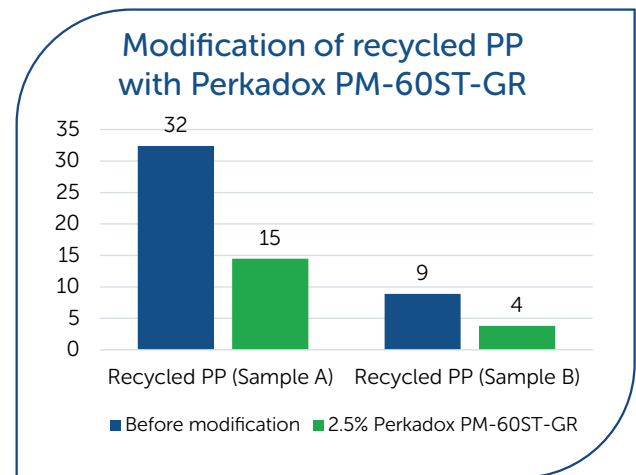
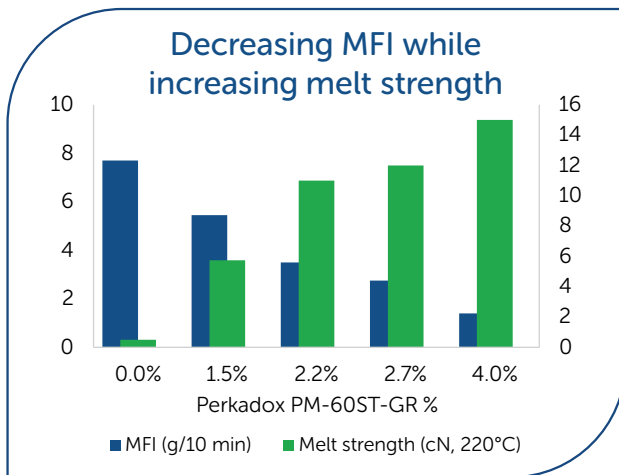


# Our Latest Innovation to Repair Degraded Recycled PP

We can rebuild the molecular weight of degraded recycled PP (polypropylene) so that higher recycled content can be used in final products.

Most of the properties of recycled plastics are inferior to those of virgin resin. Exposure to UV and sunlight during the articles' lifetime lead to degradation of the polymer chains lowering their molecular weight. In addition, recycled feedstocks with low MFI are scarce and expensive.

Perkadox® PM-60ST-GR has shown extremely good performance on recycled polypropylene (rPP) feedstocks of different type: post-consumer/post-industrial rPP with different starting MFI and different contamination levels (0 - 20% of other polymers, mainly HDPE).



Nouryon has patented a new technology in which Perkadox® PM-60ST-GR is used in the extrusion step of mechanical recycling to rebuild its molecular weight by adding long chain branches.

Perkadox® 24L is used for decreasing the MFI of virgin PP. Its use in the recycling industry is difficult due to its relatively low decomposition temperature.

With the use of Perkadox® PM-60ST-GR the MFI of recycled PP decreases. At the same time, the melt strength and melt elasticity of the modified recycled PP increases significantly, enabling new processing opportunities and applications like foaming, blow molding and even thermoforming.



# Boost the Mechanical Properties of your Recycled PP

Our innovative mechanical properties booster can lead to improved properties of recycled polypropylene: higher impact resistance, and greater tensile and flexural strength. As a result, this recycled PP can be used in higher end applications.

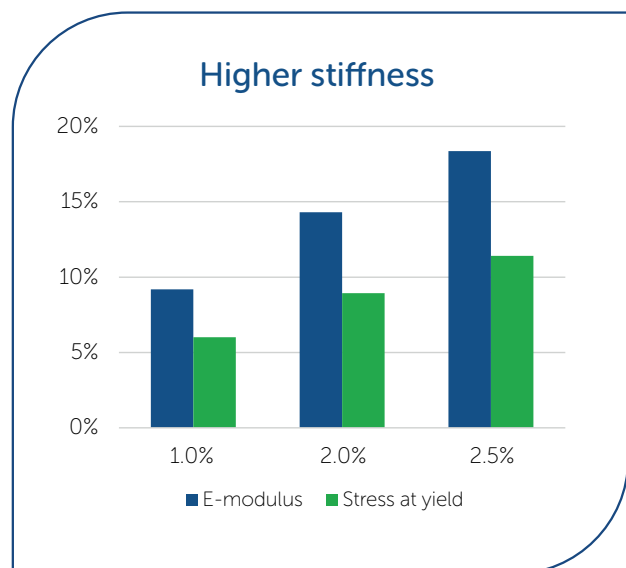
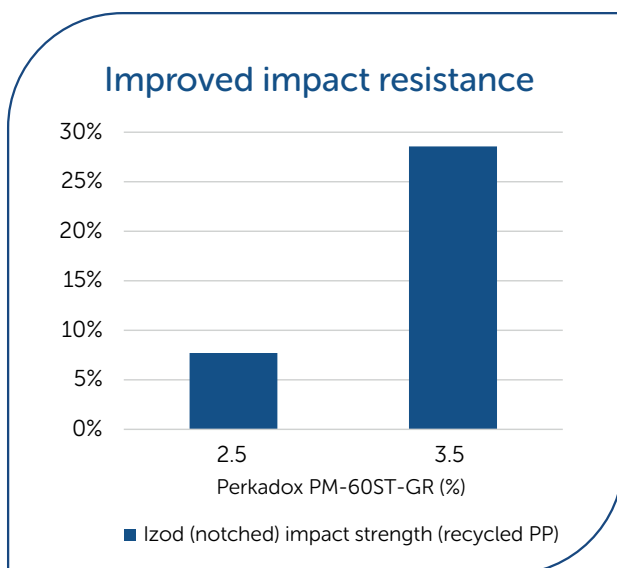
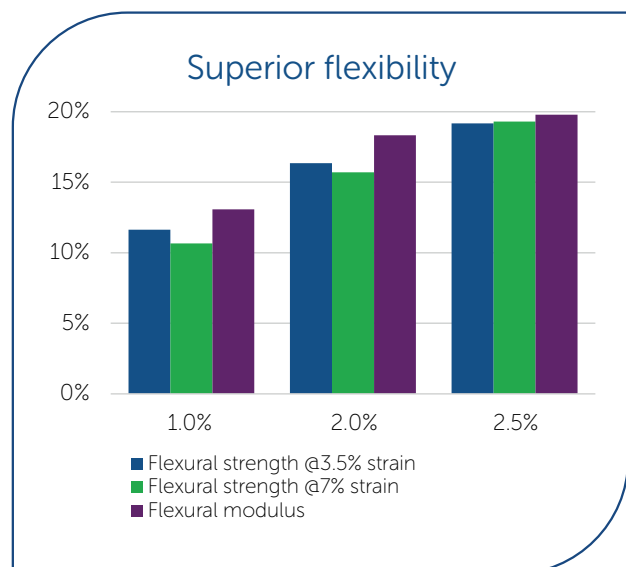
Perkadox® PM-60ST-GR generates long chain branches on recycled polypropylene. The increased molecular weight of the modified recycled PP has a strong impact on the performance of the polymer in terms of mechanical properties.

With 1-3% of Perkadox® PM-60ST-GR we measured:

- Up to 30% improvement in impact resistance
- Up to 20% improvement in flexibility
- Up to 20% improvement in stiffness (E-modulus)

The graphs show improvement in mechanical properties compared to the blank - polypropylene extruded without using Perkadox® PM-60ST-GR.

Impact resistance usually increases when using Perkadox® PM-60ST-GR; in some cases impact resistance after modification is equal to the starting, virgin feedstock.



Contact us for testing the effect of Perkadox® PM-60ST-GR on your recycled polypropylene!

# A Wide Choice of Peroxides to Increase the MFI of Recycled PP

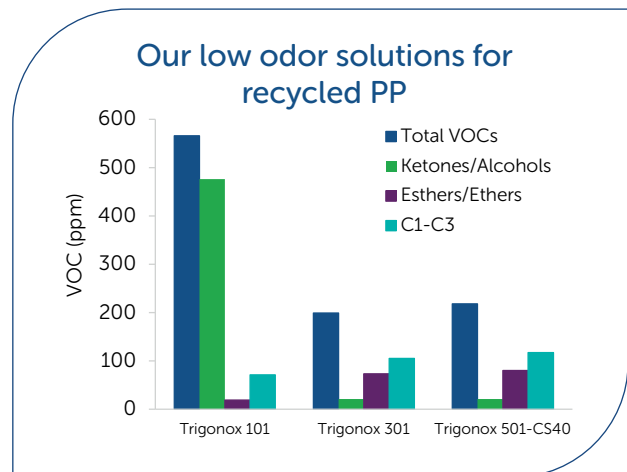
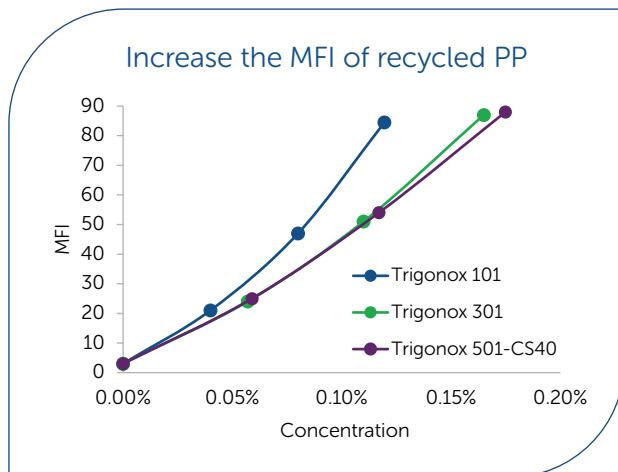
Our proprietary products are a low odor solution to increase the MFI of recycled polypropylene, obtaining a more homogeneous product quality for better processing at converters.

Recycled Polypropylene (PP) is produced from feedstocks with different Melt Flow Indexes (MFI) resulting in varying quality, causing instability during processing at converters. In addition, recycled feedstocks are available in a restricted MFI range, usually 10-20 gr/10 min, or 10-30.

Several peroxides such as Perkadox® 14, Trigonox® 101 and Trigonox® 501-CS40 are already used in the mechanical recycling of polypropylene to achieve a higher MFI, enabling the use of recycled content in applications requiring different properties than the available feedstocks.

Organic peroxides are also used to narrow the wide molecular weight distribution typical of recycled PP, resulting in a constant and reproducible recycled PP quality. This helps avoiding undesirable fluctuations in further processing steps.

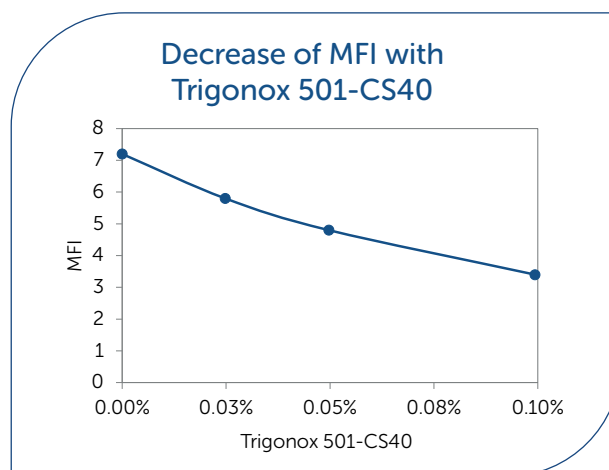
Our latest generation peroxides for controlled-rheology, Trigonox® 301 and Trigonox® 501-CS40, generate lower VOC levels compared to traditional peroxides (i.e. Trigonox® 101, Perkadox® 14). TBA and acetone as well as aromatics are in fact absent when using Trigonox® 301 and Trigonox® 501-CS40. In addition, Trigonox® 301 and Trigonox® 501-CS40 have FDA and BfR food contact approvals. These peroxides have been widely adapted in the virgin PP industry, and their low-odor characteristic is making them the preferred choice in high end applications.



# Improving the Properties of Recycled Polyethylene

Our proprietary products can rebuild the molecular weight of polyethylene, improving its mechanical properties.

Trigonox® 301 and Trigonox® 501-CS40 have been proven very successful in generating long chain branching of recycled polyethylene. Other organic peroxides such as Perkadox® 14 or Trigonox® 101 can also be used for the same purpose, but due to their lower decomposition temperature they tend to generate more gels than when using Trigonox® 301 and Trigonox® 501-CS40.



## Our Products

PRODUCT NAME Chemical name [CAS no.]	GENERAL DATA			Physical form	STORAGE DATA		KINETIC DATA*		
	Mol. weight	Assay (%)	Main carrier / solvent		Ts max. (°C)	Ts min. (°C)	0.1 h	1.0 h	10 h
1,2,4,5,7,8-Hexoxonane, 3,6,9-trimethyl-3,6,9-tris (Et and Pr) [1613243-54-1]							170	146	125
Trigonox 501-CS40		40	iso-paraffins	liquid	40	-25			
3,6,9-Triethyl-3,6,9-trimethyl-1,4,7-triperoxonane [24748-23-0]	264.3						170	146	125
Trigonox 301		41	iso-paraffins	liquid	40	10			
Trigonox 301-20PP		8	on polypropylene	beads	40				
2,5-Dimethyl-2,5-di(tert-butylperoxy)hexane [78-63-7]	290.4						156	134	115
Trigonox 101		>92	-	liquid	40	10			
Trigonox 101-20PP		20	on polypropylene	beads	30				
Trigonox 101-7.5PP-BD		7.5	on polypropylene	beads	30				
Trigonox 101-45B-GR		45	calcium carbonate	granules	30				
Trigonox 101-45B-PD		45	silica	powder	30				
Trigonox 101-E70		70	mineral oil	liquid	40	5			
Di(tert-butylperoxyisopropyl)benzene [25155-25-3; 2212-81-9]	338.5						156	134	114
Perkadox 14S		96	-	solid	30				
Perkadox 14S-FL		96	-	flakes	20				
Perkadox 14-40B-PD		40	calcium carbonate	powder	30				
Perkadox 14-40B-GR-S		40	calcium carbonate	granules	30				
Perkadox 14-EP40		40	POE, calcium carbonate	granules	30				
Di(4-methylbenzoyl) peroxide [895-85-2]	270.3								
Perkadox PM-60ST-GR		60	stabilization package	granules	30				
Dicetyl peroxydicarbonate [26322-14-5]	570.9						84	65	48
Perkadox 24L		91	-	powder	20				

# Contact Us

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For product inquiry and ordering information, please contact your Nouryon account manager or send us an email.

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## Additional information

Product Data Sheets (PDS) and Safety Data Sheets (SDS) are available at [nouryon.com](https://www.nouryon.com)

All information concerning this product and/or suggestions for handling and use contained herein are offered in good faith and are believed to be reliable. Nouryon, however, makes no warranty as to accuracy and/or sufficiency of such information and/or suggestions, as to the product's merchantability or fitness for any particular purpose, or that any suggested use will not infringe any patent. Nouryon does not accept any liability whatsoever arising out of the use of or reliance on this information, or out of the use or the performance of the product. Nothing contained herein shall be construed as granting or extending any license under any patent. Customer must determine for himself, by preliminary tests or otherwise, the suitability of this product for his purposes. The information contained herein supersedes all previously issued information on the subject matter covered. The customer may forward, distribute, and/or photocopy this document only if unaltered and complete, including all of its headers and footers, and should refrain from any unauthorized use. Don't copy this document to a website.

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