



Metal Alkyls



Our products and capabilities

Nouryon

Nouryon Creates Everyday Essentials

Nouryon is your partner in essential solutions for a sustainable future

We are a global, specialty chemicals leader. 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 thermoplastic, composite and rubber industries. We are widely known for our world-class products, including Butanox®, Trigonox® and Perkadox® brands.

We have a long history in metal alkyls, starting with large-scale production of aluminum alkyls in 1959, using technology licensed by Nobel laureate Karl Ziegler. Since then we have added many new metal alkyls to our product

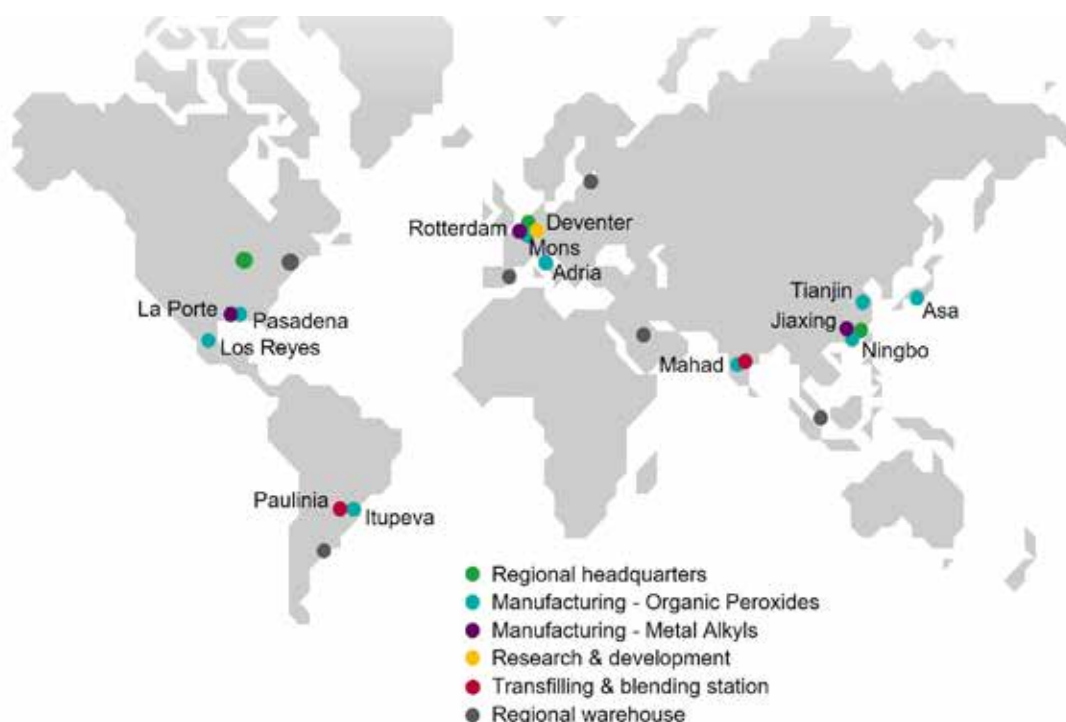
portfolio, with the growth of plastics in everyday life. Today, we are the global number one producer offering a broad range of metal alkyls, including aluminum, magnesium, boron and zinc alkyls. Each year, millions of tons of polypropylene, polyethylene, and several types of synthetic rubber are manufactured with our products. These polymers find their way into a wide variety of consumer products such as plastic packaging, toys and automotive parts.

Our products are also used in chemical synthesis of medicines and fine chemicals. In fact, some of the world's best selling active pharmaceutical ingredients are synthesized using our organometallic specialties.

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.



Enabling the Polymer Cycle

Building on a sustainability driven strategy. We provide essential ingredients to enable the polymer cycle.



Contributing to a Sustainable Future

We partner with our customers, suppliers and employees to deliver innovative solutions, drive progress and create a safe and sustainable today and tomorrow for everyone.

Our 'Commitment to a Sustainable Future,' is based on three pillars:

		
<p>IMPROVE</p>	<p>GROW</p>	<p>ENGAGE</p>
<p>Improve our safety and environmental performance</p>	<p>Innovate to create Sustainable Solutions, enabling customers to be more sustainable</p>	<p>Engage with customers, suppliers, employees, and society to drive progress</p>
<p>Key sustainable development goals:</p> 	<p>Key sustainable development goals:</p> 	<p>Key sustainable development goals:</p> 
		

Our effort to **IMPROVE** our environmental performance includes ambitious targets:

<p>Safety ambition: zero injuries, waste, and harm</p>	
<p>2025</p>	
<p>25% carbon emission reduction ⁶</p>	<p>70% low carbon energy ⁷</p>
<p>2030</p>	
<p>Carbon Neutral</p>	<p>10% reduction of water usage and waste generation ⁸</p>
<p>2050</p>	
<p>Net Zero carbon emissions</p>	

⁶ Including carbon emissions from our operations (scope 1) and purchased energy use (scope 2)

⁷ Based on the portion from low carbon sources (biomass, renewable, and nuclear) compared with fossil-based sources as reported by our global manufacturing sites

⁸ Intensity measured on a per tons product basis

⁹ Reflects the percentage of innovation that is focused on sustainability

Your Safety Our Priority



Nouryon is recognized as a global leader in metal alkyl safety. Our proven success in safe handling of metal alkyls and other (metal-)organic specialties is due to our long-term commitment to safety. Safety is always our top priority.

Sharing our experience in safety is one of the most important resources we offer. Through our safety programs we provide expert advice on the handling of these materials including:

- classroom training of safety and handling of metal alkyls
- consultation on metal alkyl facility design
- demonstrations on the safe use, handling and control of metal alkyls
- on-site assistance and advice regarding procedures

Our Safety Research Laboratory in Deventer, the Netherlands, is heavily involved in R&D, ensuring the development of safe products and processes. Studies are carried out, in order to ensure a high level of safety in manufacturing, handling and transport of dangerous substances. Please contact us if you are interested in such

services.

Safety and technical support is offered globally to our customers. We have a team of regional Technical Development Managers, who are the liaison between the market and R&D. They understand your future needs and are committed to the success of our customers.



A Broad Range of Organometallics

Organometallics are used in a wide range of applications. The main area of application of metal alkyls is the polymerization of olefins and dienes by Ziegler-Natta catalyst systems. Metal alkyls and aluminoxanes are also used as (co)catalyst in a variety of related technologies that are extensions of Ziegler chemistry. These include oligomerization of ethylene, dimerization and cyclodimerization of olefins and dienes, and ring opening polymerization.

In pharmaceutical and fine chemical synthesis, our products are especially useful in reduction, addition, alkylation and deprotonation, where they facilitate various asymmetric steps. Some of our products are presently used in the production of some of the world's leading blockbuster drugs. Our products can be provided as neat metal alkyls, as blends in solvents, or custom mixtures of metal alkyls.

We bring you solutions. Whatever your particular requirements, we can develop the product to match. This product guide provides an overview of our main commercially available metal alkyls and aluminoxanes.

For detailed properties of metal alkyls, please refer to our Product Data Sheets which are available at nouryon.com

Aluminum alkyls

CHEMICAL NAME	ACRONYM	MOLECULAR FORMULA	CAS NO.	EINECS/ELINCS NO.
Trimethylaluminum	TMAL	$(\text{CH}_3)_3\text{Al}$	75-24-1	200-853-0
Triethylaluminum	TEAL	$(\text{C}_2\text{H}_5)_3\text{Al}$	97-93-8	202-619-3
Triisobutylaluminum	TIBAL	$(i\text{-C}_4\text{H}_9)_3\text{Al}$	100-99-2	202-906-3
Tri-n-hexylaluminum	TNHAL	$(n\text{-C}_6\text{H}_{13})_3\text{Al}$	1116-73-0	214-241-6
Tri-n-octylaluminum	TNOAL	$(n\text{-C}_8\text{H}_{17})_3\text{Al}$	1070-00-4	213-964-4
Diethylaluminum ethoxide	DEAL-E	$(\text{C}_2\text{H}_5)_2\text{AlOC}_2\text{H}_5$	1586-92-1	216-447-1
Diisobutylaluminum hydride	DIBAL-H	$(i\text{-C}_4\text{H}_9)_2\text{AlH}$	1191-15-7	214-729-9
Isoprenylaluminum	ISOPRENYL	$(i\text{-C}_4\text{H}_9)_m\text{Al}(\text{C}_5\text{H}_9)_n$	70024-64-5	274-261-6
Diethylaluminum chloride	DEAC	$(\text{C}_2\text{H}_5)_2\text{AlCl}$	96-10-6	202-477-2
Ethylaluminum sesquichloride	EASC	$(\text{C}_2\text{H}_5)_3\text{Al}_2\text{Cl}_3$	12075-68-2	235-137-7
Ethylaluminum dichloride	EADC	$\text{C}_2\text{H}_5\text{AlCl}_2$	563-43-9	209-248-6
Diisobutylaluminum chloride	DIBAC	$(i\text{-C}_4\text{H}_9)_2\text{AlCl}$	1779-25-5	217-216-8
Isobutylaluminum dichloride	MONIBAC ^{a)}	$i\text{-C}_4\text{H}_9\text{AlCl}_2$	1888-87-5	217-563-5

^{a)} From monoisobutylaluminum dichloride



Aluminoxanes

CHEMICAL NAME	ACRONYM	STANDARD SOLVENT	CAS NO.	EINECS/ELINCS NO.
Polymethylaluminumoxane	PMAO	Toluene	120144-90-3	a)
Modified methylaluminumoxane, Type 3A	MMAO-3A	Heptane	146905-79-5	a)
Modified methylaluminumoxane, Type 7	MMAO-7	Isopar® E	206451-54-9	a)
Modified methylaluminumoxane, Type 12	MMAO-12	Toluene	206451-54-9	a)
Isobutylaluminumoxane, Type 65	IBAO-65	Hexane	220326-29-4	a)
Bis(diisobutylaluminum) oxide	DIBAL-O	Hexane	998-00-5	213-646-5

a) Regarded as polymeric substance which does not require EINECS/ELINCS notification

Magnesium alkyls

CHEMICAL NAME	ACRONYM	MOLECULAR FORMULA	CAS NO.	EINECS/ELINCS NO.
n-Butylethylmagnesium ^{a)}	MAGALA® BEM	$n-C_4H_9MgC_2H_5$	62202-86-2	263-454-0
Di-n-butylmagnesium	MAGALA® DNBM	$(n-C_4H_9)_2Mg$	1191-47-5	214-736-7

a) Also available in formulations containing approx. 0.5% and approx. 1.0% (molar) of butylated hydroxytoluene. This formulation is called MAGALA® BEM-2436. Note: All Magnesium alkyls are in heptane, but can in principle be supplied in select other solvents.

Boron alkyls

CHEMICAL NAME	ACRONYM	MOLECULAR FORMULA	CAS NO.	EINECS/ELINCS NO.
Triethylborane	TEB	$(C_2H_5)_3B$	97-94-9	202-620-9

Zinc alkyls

CHEMICAL NAME	ACRONYM	MOLECULAR FORMULA	CAS NO.	EINECS/ELINCS NO.
Dimethylzinc	DMZ	$(CH_3)_2Zn$	544-97-8	208-884-1
Diethylzinc	DEZ	$(C_2H_5)_2Zn$	557-20-0	209-161-3

With respect to REACH we can state the following: We have filed all of the appropriate registrations with the European Chemicals Agency (ECHA). If applicable, exposure scenarios are provided as part of an extended Safety Data Sheet (eSDS). If available/applicable, the REACH registration number of this product and/or the REACH registration numbers of the individual ingredients of this product can be found on Section 3 of the applicable European Safety Data Sheet (SDS).



Shipping Containers

We maintain a fleet of cylinders, portable tanks, ISO containers, tank trailers and rail cars designed for the shipment of metal alkyls and organometallic specialties. Our shipping containers are designed and constructed to meet all national and international transport regulations and are tested periodically, in accordance with the appropriate regulations.

CYLINDER	VOLUME (90% FULL)	DIMENSIONS	
		Diameter	Height
Pyrosafe	0.85 l (0.225 gal)	9.0 cm (3.562 in)	26.7 cm (10.5 in)
B-2	9.8 l (2.59 gal)	23.2 cm (9.125 in)	46.4 cm (18.25 in)
B-5	19.6 l (5.18 gal)	30.8 cm (12.125 in)	53.3 cm (21 in)
B-28	98.4 l (26.0 gal)	37.1 cm (14.625 in)	129.5 cm (51 in)
B-118	405 l (107 gal)	76.2 cm (30.0 in)	145.7 cm (57.4 in)





PORTABLE TANK	VOLUME (90% FULL)	DIMENSIONS		
		Length	Diameter	Height
C-250	829 l (219 gal)	208 cm (82 in)	81 cm (32 in)	96.5 cm (38 in)
C-430 dome type	1,465 l (387 gal)	208 cm (82 in)	107 cm (42 in)	122 cm (48 in)
C-430 saddle type	1,465 l (387 gal)	208 cm (82 in)	107 cm (42 in)	128 cm (50.5 in)
C-480 saddle type	1,692 l (447 gal)	219.6 cm (86.4 in)	110 cm (43.3 in)	130.5 cm (51.4 in)
C-1980	6,745 l (1,782 gal)	305 cm (120 in)	190 cm (74.8 in)	224 cm (88.2 in)
ISO ^a	19,200-21,150 l (5,068-5,584 gal)	606 cm (239 in)	244 cm (96 in)	259 cm (102 in)

^a Exact volume of an ISO tank container depends on the model

Rail car (34,070 l (9,000 gal) (90% full)) and tank trailer (22,100 l (5,838 gal)) containers are available in North America only.

Our continuous investment in shipping containers and our global distribution network are demonstrations of our commitment to security of supply.





Custom Synthesis

We offer custom-manufactured complex organics, such as ligands, metallocenes, single site catalysts and other specialty chemicals. We provide proprietary technology, scale-up expertise and commercial scale production.

We have developed significant capabilities in this field, using synergies with Nouryon's organic synthesis strengths.

Our expertise and facilities find growing use in the synthesis of (single site) catalysts and specialty chemicals, that are used in polyolefin, elastomer, pharmaceutical, and fine chemical industries.

Our core competencies are in complex and hazardous chemistries, and the handling of highly reactive chemicals (incl. metal alkyls, titanium tetrachloride, Grignard reagents).

We have the expertise to work in an oxygen and water free environment. We strive for the highest product purity and consistency.

We have broad experience in developing and optimizing process routes, and recycling process streams, thereby reducing or eliminating waste in manufacturing.

Our custom-manufactured organometallic specialities are shipped to customers throughout the world.



We want to be your preferred supplier, producing custom specific products through arrangements protected by confidentiality agreements. From gram-scale to multiple-metric-ton level, we're happy to meet with you and discuss your target molecule.

Moreover, we manufacture non-proprietary metallocenes like bis(cyclopentadienyl) titanium dichloride (TDC, CAS No. 1271-19-8).

Contact Us

For product inquiry and ordering information, please contact your Nouryon account manager or regional Nouryon sales office.

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Additional information

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

On request we also provide specific publications on subjects such as applications of metal alkyls, analytical technique, safe use and storage of metal alkyls, facilities design and maintenance, and unloading procedures.

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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Nouryon

Nouryon is 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 more than 8,300 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.

[nouryon.com](https://www.nouryon.com)