



# TMAI Solar



Trimethyl aluminum for solar cells

**Nouryon**

# Welcome to Nouryon

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We are a global specialty chemicals leader. Industries worldwide rely on our essential chemistry in the manufacture of everyday products such as paper, plastics, building materials, food, pharmaceuticals, and personal care items. Building on our nearly 400-year history, the dedication of our 10,000 employees, and our shared commitment to business growth, strong financial performance, safety, sustainability, and innovation, we have established a world-class business and built strong partnerships with our customers.

We operate in over 80 countries around the world and we supply customers around the world with ingredients for the manufacture of life's essentials. Specialty chemicals are used in, among others, paints, detergents, foods, plastics, cosmetics, construction, pulp and paper, pharmaceuticals, electronics, agriculture and for plastics.

Our products can be used in a variety of ways. For example, as basic building blocks of manufactured products, in the processing of raw materials, as intermediates used to produce finished goods, or they may be used to enhance the functionality and durability of manufactured products.

You'll find us in the food you eat, the buildings you live and work in, the vehicles and roads you use to move around, as well as everyday items such as paper products and your children's toys.

We produce everyday essentials for the global polymer and electronic industries. Our product portfolio includes organic peroxides, metal alkyls, organometallic specialties and polymer additives, which are essential ingredients for the thermoplastic, composite and rubber industries.

We have a long history in metal alkyls, starting with large-scale production of aluminum alkyls in 1959. Today, we're one of the world's top producers with a broad range of metal alkyls, including aluminum, magnesium, boron and zinc alkyls. Our ultra-high purity semiconductor-grade product range includes gallium-, indium-, aluminum-, zinc- and magnesium-based MO-sources.

We are the only fully integrated high purity metalorganics supplier serving the semiconductor industry, producing our own trimethyl aluminum, a key raw material for these products.

Nouryon also plays a role in the fast-growing solar cell market. We have developed new technology for the production of high purity trimethyl aluminum (TMAI), which is used by solar cell manufacturers to create an aluminum oxide passivation layer to increase efficiency of solar cells.

## Proven performance, cost-effective

TMAI Solar has proven performance in ALD and PECVD processes used in the solar industry. It offers a cost-effective alternative to the ultra-pure trimethyl aluminum used in the semiconductor industry. Not to forget its superior performance over industrial grade TMAI used in the plastics industry. Our advanced purification technology guarantees consistent, high quality solar trimethyl aluminum.

In addition we supply high purity diethyl zinc (DEZn) for thin film solar cells. It is our contribution to solar energy, for the benefit of our planet.



# A secure partner

Nouryon pioneered the large-scale production of diethyl zinc (DEZn) and has been producing commercial quantities in La Porte (Tx - USA) since the 1960s. Main applications are as ZnO precursor for the TCO layer in thin film solar cells and in pharmaceutical synthesis. Our product grade specifically aimed to serve the needs of the solar cell industry is called DEZn TCO.

We supply a broad range of metal alkyls from our La Porte (Tx - USA) and Rotterdam (the Netherlands) sites, as well as from smaller facilities in China, India and Brazil. Our global distribution network allows us to deliver products to you anywhere in the world.

Nouryon has acquired Zhejiang Friend Chemical Co. (Friend), the largest Chinese producer of triethyl aluminum (TEAL) – a metal alkyl used in the production of high-volume polymers, such as polypropylene and polyethylene.

The acquisition will substantially raise our organization's global TEAL production and strengthen our position as a leading global producer of TEAL. The deal also makes us the only truly global producer of metal alkyls.

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. Additionally, La Porte is an OSHA VPP Star site and both Rotterdam and Paulinia have achieved OHSAS 18001 certification. Our sites in the Americas have achieved RC 14001 certification as well.



- Headquarters
- Manufacturing
- Manufacturing - Metal Alkyls/HPMO
- Research, Development & Innovation
- Transfilling & blending stations
- Warehouses

# TMAI Solar product data



Nouryon uses leading edge processes, purification and transfilling techniques that ensure the repeatable and consistent delivery of our TMAI Solar in each cylinder that we supply. We apply state of the art techniques such as ICP-OES for trace metal analysis to meet customer's demands. Product specifications are provided on our Product Data Sheet (PDS), which is available on [hpmo.nouryon.com](http://hpmo.nouryon.com)

## PRODUCT DESCRIPTION

Molecular formula	(CH <sub>3</sub> ) <sub>3</sub> Al
Molecular weight	72.1
CAS No.	75-24-1
EINECS/ELINCS No.	200-853-0
TSCA status	listed on inventory
UN No.	3394

## CHARACTERISTICS

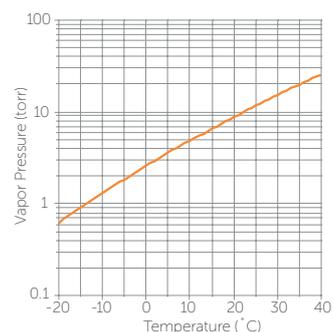
Appearance	clear, colorless liquid
Density, 30°C	0.743 g/ml
Melting point	15°C
Viscosity, 30°C	0.9 mPa.s
Boiling point, 760 torr	127°C
Stability to air	ignites upon exposure
Stability to water	reacts violently
Solubility	soluble in aromatic and saturated aliphatic and cycloaliphatic hydrocarbons

## THERMOCHEMICAL PROPERTIES

Specific heat, 57°C	2.213 J/g.°C (0.529 cal/g.°C)
Heat of vaporization $\Delta H_v$ , at 127°C	247 J/g (59 cal/g)
Heat of formation $\Delta H_f^\circ$ , 25°C, 1 bar	-151 kJ/mole (-36 kcal/mole)
Heat of combustion $\Delta H_c^\circ$ , 25°C	-3180 kJ/mole (-760 kcal/mole)

## VAPOR PRESSURE

at 10°C (283.15 K)	4.87 torr
at 20°C (293.15 K)	8.80 torr
Gas constants	$\log P(\text{torr})=B-A/T(K)$
A	2134
B	8.224



# Shipping containers

We maintain a fleet of cylinders and portable tanks designed for the shipment of TMAI Solar. Shipping containers are designed and constructed to meet all national and international transport regulations and are tested periodically, in accordance with the appropriate regulations. Our standard containers are fabricated from carbon steel and are equipped with dip tubes for top discharge. Valves are equipped with standard VCR connections. Other containers are available on request.

CYLINDER	MAX. FILLING WEIGHT (90%)	DIMENSIONS	
		Diameter	Height
B-2	7.2 kg (15.9 lb)	23.2 cm (9.125 in)	46.4 cm (18.25 in)
B-5	14.2 kg (31.3 lb)	30.8 cm (12.125 in)	53.3 cm (21 in)
B-28	72 kg (159 lb)	37.1 cm (14.625 in)	129.5 cm (51 in)
B-118	300 kg (661 lb)	76.2 cm (30 in)	145.7 cm (57.375 in)

PORTABLE TANK	MAX. FILLING WEIGHT (90%)	DIMENSIONS		
		length	diameter	height
C430 saddle type	1088 kg (2399 lb)	208 cm (82 in)	107 cm (42 in)	128 cm (50.5 in)
C1980	5013 kg (11052 lb)	305 cm (120 in)	190 cm (74.8 in)	224 cm (88.2 in)





# Safety: Our top priority

Nouryon's success in safely handling TMAI is due to our long-term commitment to safety. Knowledge of proper handling techniques, carefully designed facilities and thorough training of personnel can overcome the hazards. Personnel who understand and pay proper attention will be able to handle metal alkyls confidently and safely.

## Safety and handling

TMAI ignites upon exposure to air and reacts violently with water. TMAI must be handled under a dry, inert atmosphere, e.g. nitrogen or argon. TMAI may undergo exothermic decomposition with evolution of flammable gas if heated above 120°C (248°F). The decomposition may become self-accelerating and UNCONTROLLABLE and may result in an explosion. Water must be scrupulously removed from process equipment prior to putting it into metal alkyls service. Failure to do so may result in an explosion. Products of complete combustion of TMAI are aluminum oxide, carbon dioxide and water. TMAI causes severe burns to the skin and eyes. It is imperative that proper personal protective equipment be worn when handling TMAI.

## Storage

TMAI is stable when stored under a dry, inert atmosphere and away from heat. TMAI may undergo violent exothermic decomposition with flammable gas evolution if stored at temperatures above 120°C (248°F). Metal alkyls should, in general, be kept 6-12°C above their melting point. In case of solidified TMAI (melting point 15°C) place the container for at least 16 hours in a temperature controlled room at 25-35°C until the product is completely liquified.

## Safety services

Nouryon is recognized as a global leader in metal alkyl safety. We always place safety as our top priority. Sharing our experience in safety is one of the most important resources we offer. Through our safety programs we can provide expert advice on the handling of these materials including:

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

As such, we routinely advise our customers on the development of systems which deliver TMAI from our bulk containers to their production tools and the safety procedures that should be employed in these production processes. Please contact us if you are interested in such services.





# Contact us

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Your global Nouryon HPMO team is here to serve you. For more information, please contact your sales manager or regional Nouryon sales office.

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## Additional information

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