

PLASTIC ADDITIVES  
**BLOWING AGENTS**





The unique advantage:

## Expertise of a strong partner

With decades of experience and customers spread across the globe, LANXESS is already one of the world's major chemical manufacturers. LANXESS was formed in 2004 through the carve-out of major portions of the chemical activities of the Bayer Group and parts of its polymer operations, which means it has many years of experience to look back on, with roots going all the way back to the founding of Bayer in 1863. This is the basis on which LANXESS now develops, produces and markets a portfolio consisting of basic and fine chemicals, color pigments plastics, fibers, special-purpose rubbers, rubber chemicals, material protection and water treatment products and chemicals for the production of leather, textiles and paper. In so doing, LANXESS provides reliable solutions worldwide for a wide range of different applications.

LANXESS has the experience and sound market knowledge of an established global player, combined with the commitment of a new, young enterprise. This is a combination that makes LANXESS strong and active. We are ready to break new ground, when and wherever our customers ask us to go.

You want the very best – so do we. Together we can build on this common ground, because LANXESS offers you the best conditions for a continued and successful partnership. Our claim is to provide our partners with all-important stimulus through innovative concepts and a customer-focused and solution-oriented approach that allows you to develop unique products.

In the area of plastic additives this involves, above all, a consistent strategy to meet the market's commercial, technical and chemical demands, alongside a wide range of products. LANXESS taps extensive expertise and application-related experience for the development of modifiers, plasticizers, bonding agents and blowing agents, and as a customer you benefit from this. From the development of formulations and individual customization to meet specific product require-

ments through to process optimization, knowledge from each individual area of application is used consistently to enable optimization in all related areas. In addition, LANXESS has a network of research and testing departments that ensures worldwide proximity to customers and an ability to respond quickly.

And last but not least, in all our activities, we focus on one thing, namely maintaining the ecological equilibrium by taking special safety measures and remaining aware of our responsibilities in the future. After all, LANXESS's solutions involve much more than just supplying raw materials. They are always the end product of well thought out, forward-looking development, adapted to meet your requirements.

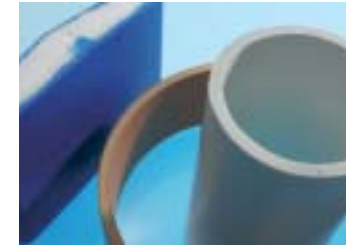
Chemical blowing agents are organic and inorganic compounds capable of producing foam structures in polymers. They decompose at elevated temperatures and in doing so have one significant feature: at least one of the decomposition products is a gas.

There are numerous advantages in producing and using foamed products. Blowing agents give products new and optimized properties, e.g.:

- improved temperature and sound insulation
- light weight properties supporting energy efficiency in cars or during transport
- ease of handling
- production of complicated, thick-walled injection molded parts without sink marks.

Ecological considerations play a key role too. That's because chemical blowing agents enable savings in terms of raw materials and therefore contribute to a responsible use of natural resources. **Azodicarbonamide** (Porofor® ADC) from LANXESS is the most comprehensive and effective chemical blowing agent. Porofor® ADC is used universally in plastic and rubber applications. It decomposes when heated and then produces large quantities (220 ml/g) of gas. This gas predominantly consists of nitrogen and carbon monoxide. Solid decomposition residues are also formed which have the advantage of being both white and odorless. As an exothermic chemical blowing agent, azodicarbonamide produces energy during decomposition and therefore supports complete decomposition.

The decomposition temperature of pure Porofor® ADC is approximately 215 °C. This extremely high value may be reduced by the addition of activators to approximately 150 °C and so adapted to each individual area of application. The most effective activators include metallic compounds and amines/amides. Premodified grades for specialty applications can be found in the Genitron®/Ficel® range.



PE rotomolding and PVC pipe



Diver's wet suit

An overview:

# Chemical blowing agents



Chemical blowing agents:

# Highly specialized products for optimum results

**Sulfonylhydrazides** are a second group of chemical blowing agents that are exothermic. The best known grade of the sulfonyl hydrazides is 4,4'-oxybis (benzenesulfonylhydrazide) [Genitron® OB]. This is used in rubber and the injection molding and extrusion of thermoplastics. Thermal decomposition releases nitrogen as a gas; at standard processing temperatures the additional water vapor produced contributes to the formation of foam. The solid decomposition residues are both white and odorless and, in the case of Genitron® OB, which is an oligomeric decomposition product of a divalent compound, also display low volatility. This group also includes the use of p-toluene sulfonylhydrazide [Porofor® TSH]. With its low decomposition temperature this product is suitable for use in the rubber sector.

In addition to exothermic agents, endothermic blowing agents are also used for the foaming of thermoplastics. Their main feature is that they require energy for decomposition. Inorganic endothermic blowing agents include **hydrogen carbonates** and **carbonates**. Hydrogen carbonates release carbon dioxide and water which, at standard processing temperatures, may be used as additional foaming material. Hydrogen carbonates can be used at comparatively low processing temperatures. Carbonates require more energy than hydrogen carbonates for the decomposition reaction and are suitable for high-temperature applications. Carbonates split off carbon dioxide as a blowing agent.

In order to optimize the blowing agent properties, mixtures have been developed using various grades. The result can be seen clearly: high gas yield at low temperatures, light, fine-cell foams, good processability and improved expansion control. These preblended grades can be found in the Genitron®/Ficel® range.

### The product range

Pure blowing agents	<ul style="list-style-type: none"> <li>For the plastics and rubber industry (azodicarbonamide and sulfonyl hydrazides)</li> </ul>
Speciality blowing agents	<ul style="list-style-type: none"> <li>For PVC pastes</li> <li>For injection molding and extrusion of thermoplastic foams</li> <li>For rubber applications</li> <li>For crosslinked polyolefin foams (azodicarbonamide/sulfonyl hydrazide preparations, endothermic blowing agents)</li> </ul>
Blowing agent masterbatches	<ul style="list-style-type: none"> <li>For injection molding and extrusion of thermoplastic foams</li> <li>For expanded rubber articles</li> </ul>

Foamed products are widely used in domestic and industrial applications. Indeed, they are integral to our daily lives. Foamed products range from seals, sealing profiles and thermal insulation products used in buildings and automobiles to rigid sheets and profiles for the construction industry.

LANXESS's chemical blowing agents may be used universally to produce the whole range of chemically foamed products.

They are equally suitable for a great variety of polymers such as

- flexible and rigid PVC
- the polyolefins polypropylene (PP), high and low density polyethylene (HDPE, LDPE)
- polystyrene and copolymers such as styrene acrylonitriles (SAN, ABS)
- engineering thermoplastics such as polyphenyloxide (PPO), polyamide (PA), polybutylene and polyethylene terephthalate (PBT, PET) and
- natural and the following grades of synthetic rubber: styrene-butadiene copolymers (SBR), polyisoprene (IR), acrylonitrile-butadiene copolymers (NBR, Perbunan® NT), blends of NBR and PVC (NBR/PVC, Perbunan® NT/VC), polychloroprene (CR, Baypren®), ethylene-vinylacetate copolymers (EVA, Levapren®) and ethylene-propylene terpolymers (EPDM, Buna® EP)



Baby carriage tires

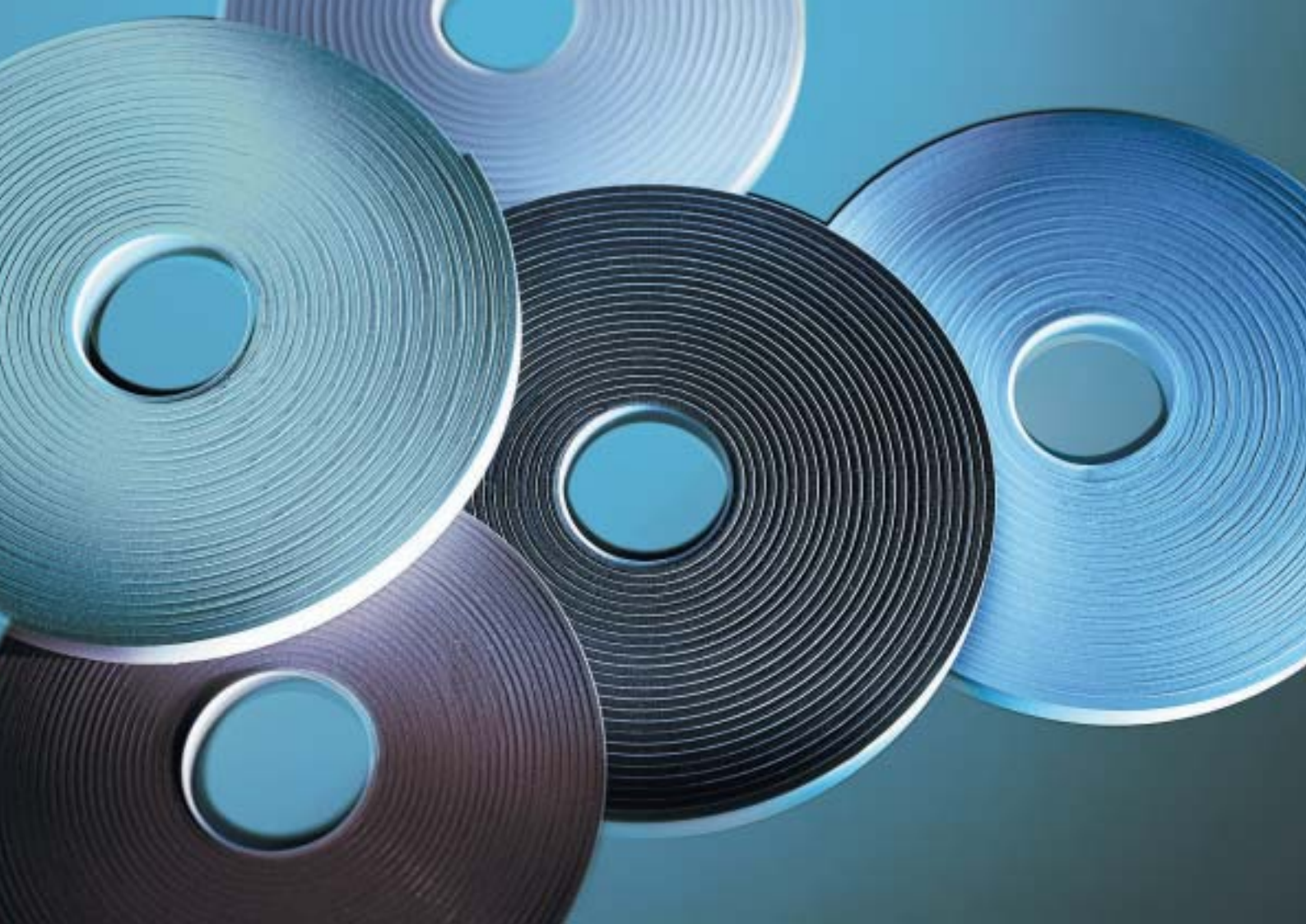
#### Typical applications:

- chemically embossed PVC floor and wall coverings
- spread coated PVC structural foamed wallpapers
- crosslinked polyethylene foam sheets for the leisure, automotive and construction industries
- lightweight rigid PVC extruded sheets, profiles and foamed core pipes for the construction industry
- injection molded electronic cabinets and housings
- divers' wet suits made from CR
- PVC/NBR thermal insulation foams and foamed pipeline sheets
- crosslinked injection molded components such as EVA tires and rubber footwear soles
- injection molded or extruded imitation wood for furniture or picture frames made from PS or wood flour filled thermoplastics
- rotational molded PE drums, storage tanks

Using chemical blowing agents:

# Applications for foam





The right combination for all your needs:

# The Porofor<sup>®</sup> ADC range of products

The pure Porofor<sup>®</sup> ADC standard blowing agents differ primarily in median particle size. Because azodicarbonamide (ADC) is insoluble in polymers and plasticizers, decomposition activation and therefore adaptation to the processing conditions can only take place via the blowing agent surface. The decomposition rate is influenced by the quantity and type of activator, the specific surface area and the particle size.

Increasing the specific surface area and thus reducing the average particle size of the ADC intensifies the effect of the activator. Fine particle types are therefore used if a high degree of activation is required - for applications with comparatively low processing temperatures such as PVC pastes or rubbers for example. To reduce dust pollution, these products are supplied in a low-dust form.



PVC structural foamed wallpaper

### Specific properties of azodicarbonamide

Properties	Typical values	Measurement
Color/Appearance	yellow / crystalline powder	
Molecular mass	116.08	g/mole
ADC content	approx. 99	%
Specific gravity	approx. 1.65	g/cm <sup>3</sup>
Bulk density*	300-600	g/l
Average particle size*	3.0-15.0	µm
Spec. product surface area*	3.2-0.8	m <sup>2</sup> /cm <sup>3</sup>
Decomposition temperature	approx. 215	°C
Gas quantity	approx. 220	ml/g

\*depending on the grade

The coarser grades are used in applications with high processing temperatures. In this process it is much more the freeflowing nature of these products that is the decisive factor rather than a high suitability for activation.

In its pure form, ADC is a yellow, crystalline powder with a decomposition temperature of approx. 215 °C.

Approximately 220 ml gas/g blowing agent is released during thermal decomposition while the median particle size of commercially available grades ranges from approx. 3.0 to 15 µm. This leads to a specific surface area of approx. 3.2 to 0.8 m<sup>2</sup>/cm<sup>3</sup> and a bulk density of 300 to 600 g/l.

**The Porofor® ADC range of products**

Trade name	Average particle size [µm]	Gas yield [approx. ml/g]	Description
Porofor® ADC/L-C2	3.0 ± 0.4	220	Easily dispersible, low-dust standard ADC with very small median particle size, highly suitable for activation
Porofor® ADC/M-C1	3.9 ± 0.6	220	Easily dispersible, low-dust standard ADC, highly suitable for activation
Porofor® ADC/S-C2	6.7 ± 1.0	220	Easily dispersible, low-dust standard ADC, suitable for activation
Porofor® ADC/F-C2	14.9 ± 1.5	220	Coarse standard ADC, for crosslinked polyolefin foams, low dust formation

Porofor® ADC/F-C2

Porofor® ADC:

**All sizes to suit your needs**





Lighter foams, improved effectiveness:

# Crosslinked polyolefins

Crosslinked polyethylene foams are used in the automotive, sports, leisure and packaging industries. They are produced continuously according to either the Furukawa process (or similar processes such as the Hitachi process) or the Sekisui process. The Furukawa and Sekisui processes differ in the type of crosslinking system used. In the case of the Furukawa process the polyethylene is crosslinked by means of a chemical reaction with peroxides, whilst in the Sekisui process the polyolefin is radiation-crosslinked. A suitable material for crosslinked polyolefin foam is Porofo<sup>®</sup> ADC/F-C2.

The main problems in the continuous production of chemically crosslinked polyethylene foams are the yellow appearance of the surface due to atmospheric oxidation of the polymers and the fact that the gas released is not totally used up for foaming.

Genitron<sup>®</sup> VPSP 51014 was developed to combat these limitations. In the manufacture of chemically crosslinked polyethylene foams, products with light colored surfaces and low density are obtained using Genitron<sup>®</sup> VPSP 51014 without the disadvantage of premature collapse of the foam.

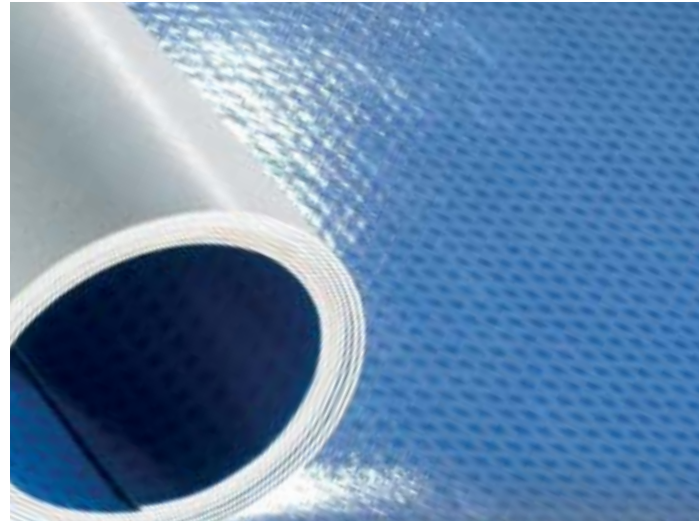
## Blowing agents for the production of polyolefins

Trade name	Average particle size [µm]	Gas yield [approx. ml/g]	Description
Porofo <sup>®</sup> ADC/F-C2	14.9 ± 1.5	220	ADC for chemically crosslinked polyolefin foams
Genitron <sup>®</sup> VPSP 51014	masterbatch	90	40 % ADC preparation in LDPE for chemically crosslinked PE foam



Foam mats

The decomposition temperature of azodicarbonamide (ADC) can be reduced effectively by adding special activators to the finer grades of ADC using a specific production process. This leads to improved contact between the blowing agent and the activator which simplifies processing considerably. The result: effective decomposition and lighter foam when compared to pastes with standard ADC plus externally added activators. Thanks to the rapid decomposition, the processing temperatures and oven residence times can be reduced as required.



PVC floor covering

#### Blowing agents for the foaming of PVC plastisols

Trade name	Gas yield [approx. ml/g]	Description
Genitron® SCE	155	Activated blowing agent preparation with good dispersibility, specially developed for chemically embossed PVC foams, typical processing temperature is 175 - 205 °C
Genitron® DL	150	Activated blowing agent preparation with good dispersibility for foaming at low temperatures or short oven residence times, typical processing temperature is 165 - 205 °C
Genitron® LE	150	Blowing agent preparation displaying excellent activity for foaming at low temperatures or short oven residence times, typical processing temperature is 160 - 205 °C
Genitron® TP BCH 51028	150	Blowing agent preparation displaying excellent activity for foaming at low temperatures or short oven residence times, typical processing temperature is 155 - 205 °C

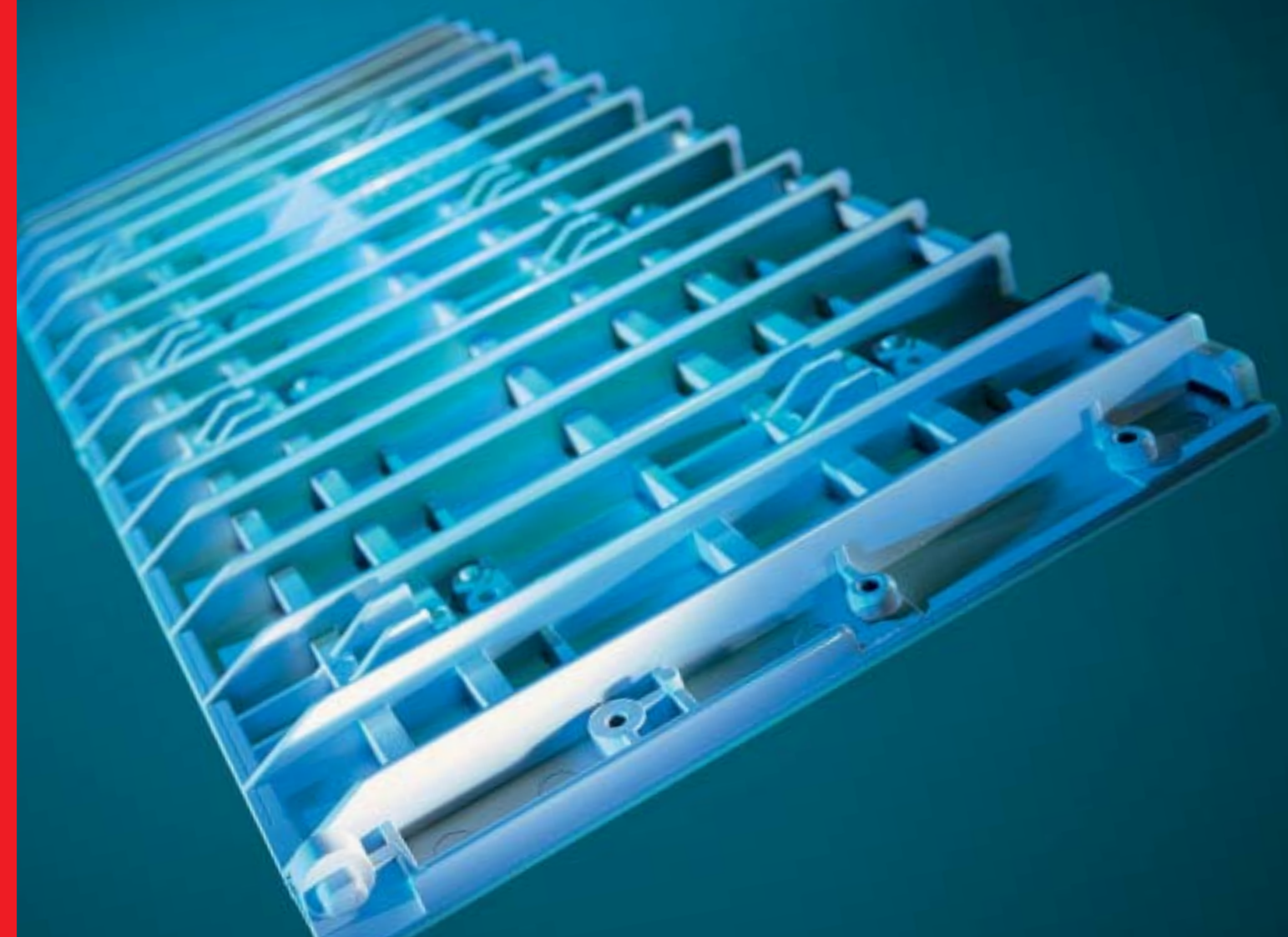
Saving time and energy:

## Specialties for PVC plastisols



Effective protection against plate-out:

# The Genitron® EP product range



Injection molded photocopier component

The residues resulting from the decomposition of standard ADCs are sometimes incompatible with polymers. They form solid deposits („plate-out“) on molds, screws, nozzles and other metal parts. This leads to serious problems such as reduced machine operating times and an increase in the cleaning required.

The Genitron® EP product range was developed to avoid this problem. These high-quality preparations meet the high demands of injection molding and extrusion. A comprehensive range of products has been developed to meet the demands

of a wide range of applicational areas which can be used in the typical processing temperature range of 150 °C to 230 °C. This degree of flexibility in processing temperature also makes these grades highly suitable for other process methods including rotational molding, vacuum forming and blow molding.

These special preparations from the Genitron® EP product range are also available as granulated masterbatches for improved ease of handling and to fulfil additional requirements.

## The Genitron® EP product range

Trade name	Gas yield [approx. ml/g]	Description
Genitron® EPA	200	ADC preparation for minimizing plate-out during processing, typical processing temperature is 200 - 230 °C <sup>1</sup>
Genitron® EPB	220	Activated ADC preparation for minimizing plate-out, typical processing temperature is 170 - 225 °C <sup>2</sup>
Genitron® EPC	190	Highly activated ADC preparation, typical processing temperature is 160 - 190 °C <sup>3</sup>
Genitron® EPE	150	Highly activated ADC/OBSH preparation for minimizing plate-out, typical processing temperature is 150 - 190 °C <sup>4</sup>

<sup>1</sup> mainly used in PP, HDPE, PS and engineering thermoplastics such as PA, PBT, PET, PPO

<sup>2</sup> mainly used in PVC, LDPE, PS

<sup>3</sup> mainly used in PVC, EVA, LDPE

<sup>4</sup> mainly used in PVC, thermoplastic rubbers, LDPE

Genitron® thermoplastic masterbatches are high-grade polymer bound blowing agent preparations for the injection molding and extrusion of thermoplastics. They are based on tried and tested Genitron® preparations. The effectiveness and quality of Porofo® and Genitron® powders are combined with the beneficial and efficient handling of polymer-bound masterbatches, enabling dust-free handling without expensive additional dust protection.



Storage box



PVC pipes

Because of the low percentage of blowing agents Genitron® thermoplastic masterbatches make the metering, incorporation and dispersion of small amounts of blowing agents easier such as they are used to avoid sink marks. Furthermore, the free-flowing masterbatches facilitate the use of a feed hopper where otherwise blowing agent in powder form can cause problems due to bridge-forming or agglomeration.

If the blowing agent is mixed with polymer granules into a processable compound, then the use of Genitron® thermoplastic masterbatches in granule form minimizes the risk of separation.

LANXESS offers several exothermic and endothermic blowing agents in its product range for various uses in all types of thermoplastic applications at typical processing temperatures of 150 to 280 °C.

#### Genitron® thermoplastic masterbatches

Trade name	Gas yield [approx. ml/g]	Description
Genitron® UA-25	50	Dust-free granules for minimizing plate-out, mainly used in engineering plastics and polyolefins, 25% Genitron® EPA in EVA
Genitron® PB-20	44	Dust-free granules for minimizing plate-out, mainly used in polyolefins, 20% Genitron® EPB in LDPE, activated
Genitron® UB-25	55	Dust-free granules for minimizing plate-out, mainly used in polyvinyl chloride and styrenics, 25% Genitron® EPB in EVA
Genitron® UN-30	28	Dust-free EVA granules, mainly used in polyolefins, ABS, PS, endo/exothermic, high temperature application
Genitron® DP 50/33	44	Dust-free granules for minimizing plate-out, mainly used in polyolefins, 40% Genitron® DP 35/22 in LDPE
Genitron® VPKA 9174	90	Dust-free pellets, endothermic; mainly used in polyolefins, PVC; 60% Genitron® VPKA 9175 in EVA
Genitron® VPSP 51011	135	Dust-free granules, good dispersion, mainly used in foamed rigid vinyl, foamed core pipes; 60% blowing agent preparation in EVA
Genitron® VPSP 51014	90	Dust free granules; chemically crosslinked polyethylene foams, low density, bright surface; 40% blowing agent preparation in LDPE
Genitron® VPSP 51016	80	Dust-free granules; highly activated; mainly used in rigid PVC, sheets and profiles; 50% exothermic preparation
Genitron® VPSP 51019	95	Dust-free granules; activated; mainly used in rigid PVC, foamed core pipes; 50% exothermic preparation

Injection molded TV casing



Dust-free handling:

# Genitron® thermoplastic masterbatches

Something different:

# Endothermic preparations



Carbonates are inorganic endothermic chemical blowing agents which release carbon dioxide upon decomposition. Tried and tested products are sodium bicarbonate-based preparations for applications from 160 °C to 230 °C.

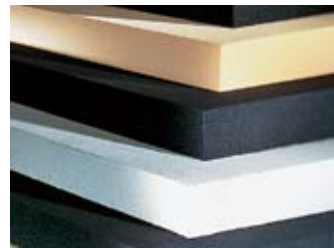
## Endothermic preparations

Trade name	Gas yield [approx. ml/g]	Description
Genitron® VP KA 9175	165	Sodium bicarbonate preparation, standard product with a high gas yield, mainly used polyolefins, polystyrenes, PVC
Genitron® DP 35/22	110	Sodium bicarbonate preparation, specialty for controlled, uniform foaming with broad processing window
Genitron® TP BCH 51051	165	Sodium bicarbonate preparation; specialty for the foaming of PVC plastisols and injection molding and extrusion of thermoplastics
Genitron® DP 11/28	90	Endo/exothermic preparation for high temperature applications

For applications involving rubber we recommend our standard ADC grades with small median particle sizes such as Porofo<sup>®</sup> ADC/L-C2, Porofo<sup>®</sup> ADC/M-C1 and Porofo<sup>®</sup> ADC/S-C2. Due to the high specific surface area of the particles, the decomposition temperature can be easily reduced using activators and therefore adapted to the processing conditions in the rubber industry. Particular processes require additional blowing agent specialties in powder form. Sulfonyl hydrazides are used widely in the foaming of rubber due to the low decomposition of their pure, unmodified form. Preparations of ADC and sulfonyl hydrazide combine the advantages of both product groups such as high gas yield and start of decomposition at low temperatures. Both standard blowing agents and specialties in polymer-bound, dust-free form are available to fulfil customers' additive requirements.



Rubber masterbatch



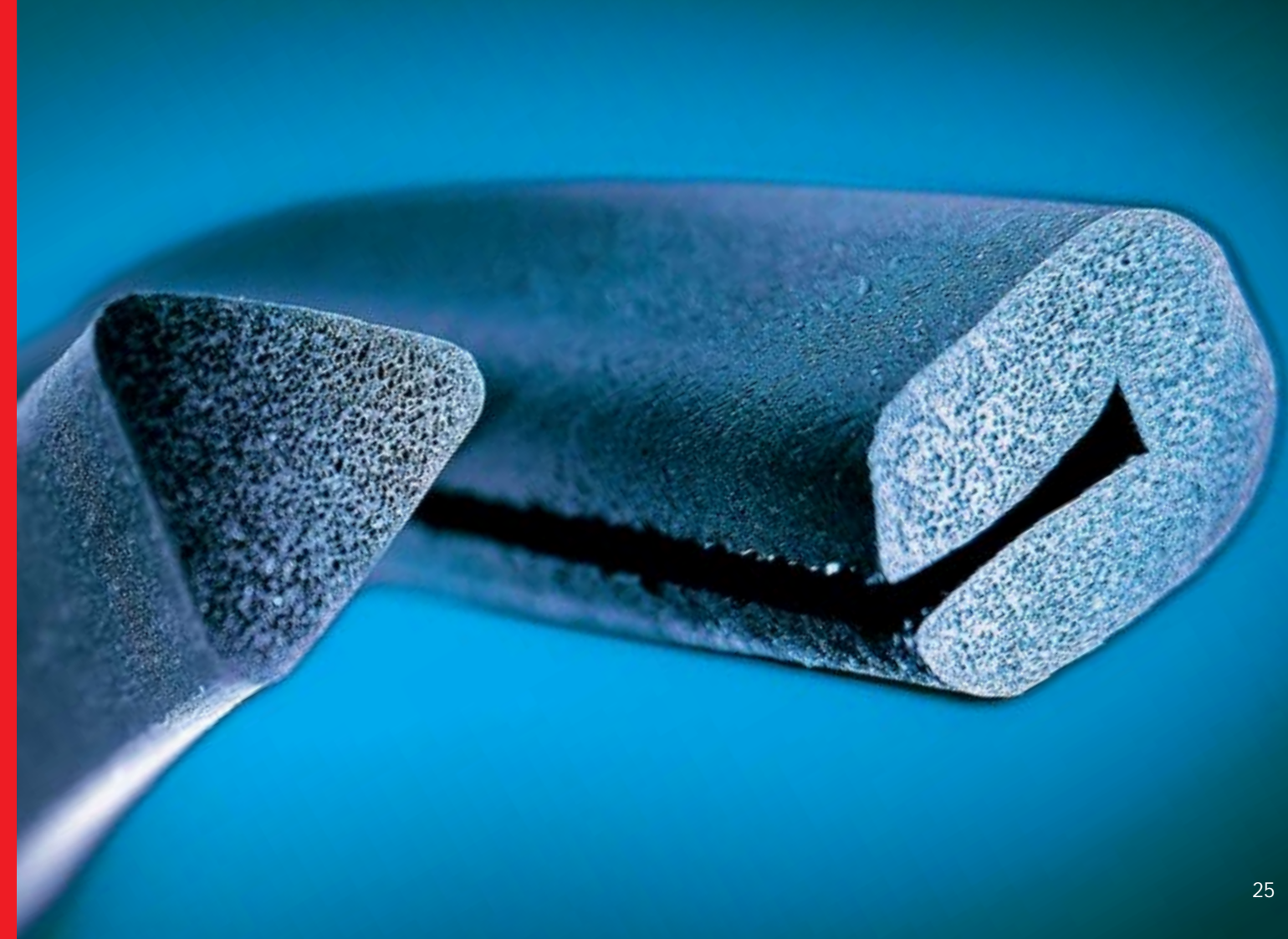
Foamed rubber sheets

#### Blowing agents for the foaming of rubber

Trade name	Gas yield [approx. ml/g]	Description
Genitron <sup>®</sup> AC2M	220	Oil-extended ADC formulation, low-dust, good dispersing, improved blending on a roll mill
Porofo <sup>®</sup> TSH	120	Toluene sulfonyl hydrazide powder (TSH) for foaming of rubber at low temperature
Porofo <sup>®</sup> TSH-75	84	Low dust 75% toluene sulfonyl hydrazide preparation (TSH) for foaming of rubber
Genitron <sup>®</sup> OB	125	Colorless OBSH powder with low decomposition temperature for light foams
Genitron <sup>®</sup> ACR	175	ADC/TSH preparation for rubber applications with high gas yield at low temperatures
Genitron <sup>®</sup> E4-75	165	Dust-free 75% masterbatch of Porofo <sup>®</sup> ADC/L-C2 in an EPM carrier, highly suitable for activation
Genitron <sup>®</sup> ER-75	130	Dust-free 75% masterbatch of Genitron <sup>®</sup> ACR (ADC/TSH preparation) in an EPM carrier

Flexible processing:

# Specialties for the foaming of rubber



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#### **Forward-looking statements**

This brochure contains forward-looking statements based on current assumptions and forecasts made by LANXESS Deutschland GmbH management. Various known and unknown risks, uncertainties and other factors could lead to material differences between the actual future consolidated

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