



EVOH Barrier Film

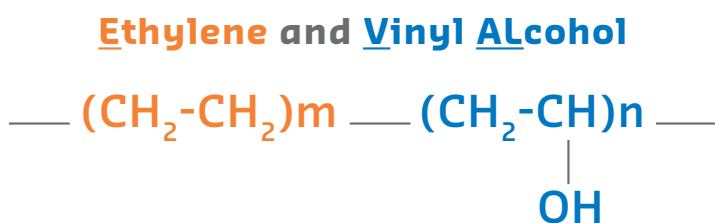
 **EVAL**



kuraray

Unique technology from Kuraray

Kuraray Co., Ltd. is the world leader in the production and development of EVOH (ethylene vinyl alcohol copolymer) resins under the trade name EVAL™. EVAL™ EVOH is available either as a resin in pellet form, or as film for lamination. Combining the excellent gas barrier properties and resistance to organic solvents of polyvinyl-alcohol with the thermoforming and water resistance properties of polyethylene, EVAL™ is a crystalline polymer with the following molecular structure:



General properties

Superior gas barrier properties

EVAL™ films have outstanding gas barrier properties. Without a gas barrier, oxygen may penetrate packaging and spoil the contents. EVAL™ keeps oxygen out and safeguards quality, making it especially suitable for food, medical, pharmaceutical, cosmetics, agricultural and industrial packaging applications.

Flavour and aroma barrier

While preventing oxygen and undesirable odours from sneaking into the package, the barrier properties

of EVAL™ effectively maintain fragrances and lock the aromas in.

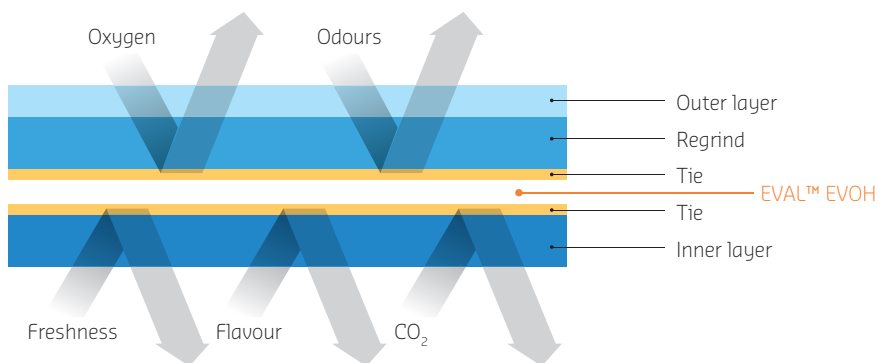
This guarantees an extended shelf life for food and cosmetic products.

Excellent flex-crack resistance

High-barrier structures containing an EVAL™ layer have an excellent flex-crack resistance. An EVAL™ layer makes sure that the integrity of the barrier remains unharmed during transport, handling and storage or even when the package is folded.

Resistance to oil and organic solvents

An EVAL™ layer offers very high resistance to hydrocarbons, oils and organic solvents. When EVAL™ is used in a multilayer structure, it prevents the evaporation of chemical substances. This property makes EVAL™ films very suitable for use in applications involving chemicals, such as fuel tanks, chemical packaging and protective clothing.



Food safety

Food regulation compliance status of EVAL™ films

EVAL™ films are in compliance with the EC Directive for food packaging and its transposition in the national regulations of the member states. EVAL™ films have also been approved for use in direct food contact, indirect or multilayer food contact and for retort applications as outlined under the Food and Drug Administration regulations in the USA.

EVAL™ has passed the specification/standard test of Official Notice No.20 (1982) from Japan's Ministry of Health and Welfare.

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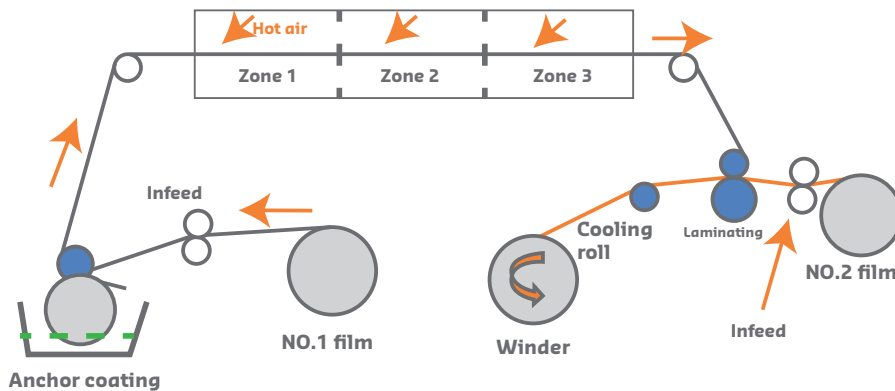
EVAL™ film types

Typical applications

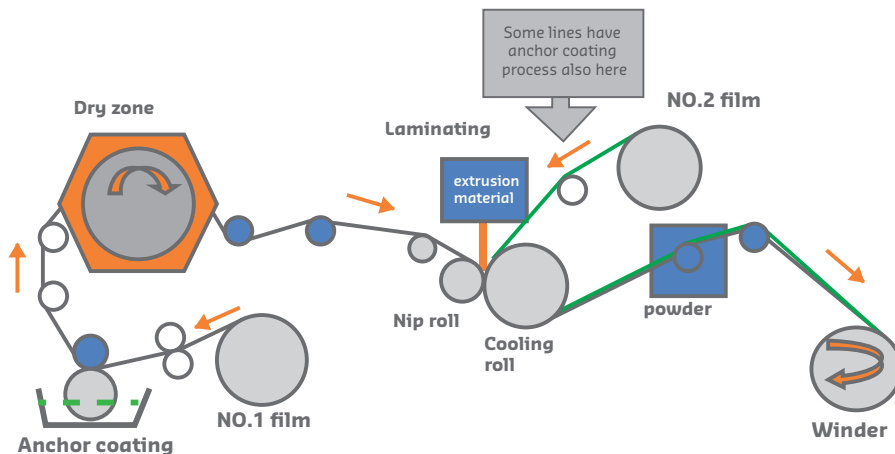
Film types	Film grades	Processing	Applications
Casted grade	EF-F	Casted, Deep-draw molding	Foods
	EF-E	Casted, Deep-draw molding, Sealable	Foods, Pharmaceuticals, Industrials
Oriented grade	EF-XL	Biaxially oriented	Foods, Pharmaceuticals, Industrials
Metalized grade	VM-XL	Biaxially oriented, Aluminium-metalized	Foods, Pharmaceuticals, Industrials
Pre-coated grade/wallpaper application	HF-ME	Casted, Matted, Pre-coat adhesive for PVC (substrate of wallpaper)	Wallpaper

Processing of EVAL™ film

Typical dry lamination line



Typical extrusion lamination line



EVAL™ film grades and typical characteristic values

EVAL™ films have the advantage of excellent gas barrier properties, aroma preservation, oil resistance, resistance to organic solvents, gloss and transparency as well as being thermoformable, in addition to food packaging, they are employed in a wide range of applications, including packaging for chemicals and cosmetics, wallpaper and industrial uses such as for construction materials.

Characteristic values of EVAL™ films according to grade

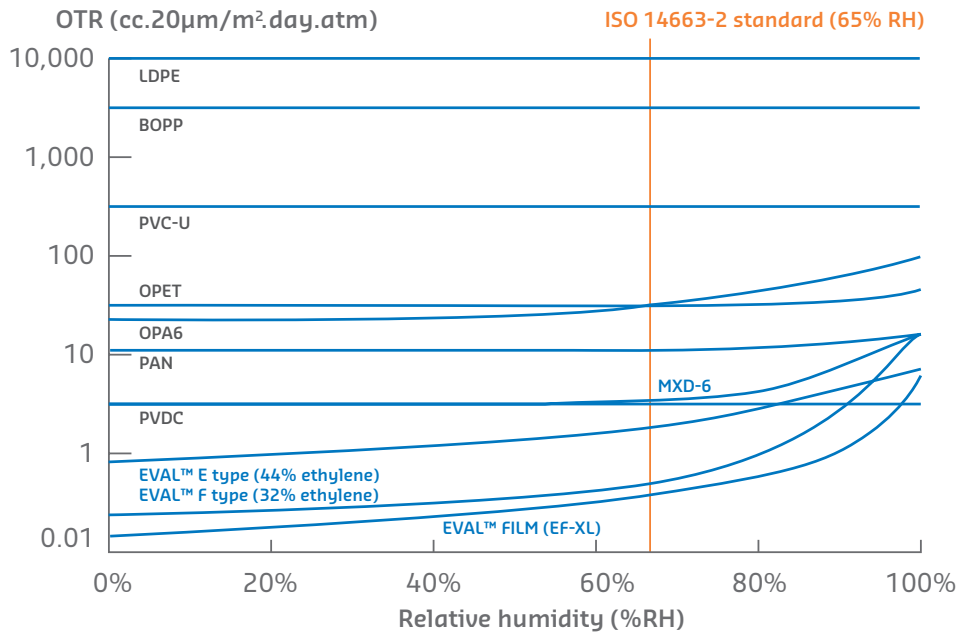
Grade	EF-XL	EF-F	EF-E	VM-XL	HF-M
Type	Biaxially oriented High-barrier	Non-oriented High-barrier	Non-oriented Deep-draw molding	Biaxially oriented Aluminium-metallized Ultra-high barrier	Non-oriented Matted Wallpaper use
Thickness (µm)	12-15	12-15-20	15-20-25	15	12
Width (cm) *cut to even number	50-120	50-120	50-120	custom made	96
Roll length (m)	4,000	2,000 - 4,000	2,000	4,000	4,000

Item	Unit	Method of measurement	Conditions	EVAL™ films					Other films				
				EF-XL	EF-F	EF-E	VM-XL	HF-M	CPP	LDPE	OPP	OPA	PET
Thickness (µm)	µm			15	15	20	15	12	50	50	20	15	12
Tensile strength at break	MD	MPa	ISO1184 23°C 50%RH	210	110	80	210	40	50	20	130	200	160
	TD			200	40	40	200	20	40	20	250	220	190
Tensile elongation at break	MD	%	ISO1184 23°C 50%RH	100	300	330	100	150	730	340	140	90	140
	TD			110	100	140	110	20	730	600	50	90	60
Young's modulus	MD	GPa	ISO1184 23°C 50%RH	4.0	3.0	2.0	4.0	1.2	0.7	0.1	1.9	1.7	3.4
	TD			3.7	2.8	2.0	3.7	1.1	0.7	0.2	3.4	1.5	3.9
Elmendorf tearing strength	MD	N/mm	ISO6383-2 23°C 50%RH	4.7	2.3	2.6	4.7	1.3	6.9	137.3	2.0	4.9	2.0
	TD			4.3	3.7	3.5	4.3	4.4	4.9	58.8	1.0	5.9	2.0
Impact strength	J	Kuraray method	23°C 50%RH	0.8	0.2	0.5	0.8	0.0	0.6	0.4	0.9	1.0	0.4
Puncture strength	N	JAS	23°C 50%RH	8.1	4.6	2.9	8.1	0.9	2.3	1.5	6.8	9.5	4.1
Moisture permeability	g/m ² .day	JISZ0208	40°C 90%RH	29.0	69.0	27.0	0.5* ²	56.0	7.0	9.0	7.0	260.0	55.0
Water absorption rate	%	Kuraray method	30°C 24 hr	8.2	10.9	8.3	8.5	7.2	0.3	0.3	0.3	8.0	0.3
Moisture absorption rate	%	Kuraray method	23°C 50%RH	2.4	3.0	2.4	2.4	1.9	0.2	0.2	0.2	4.0	0.2
Dimensional change on heating	MD	%	Kuraray method 140°C 1 hr	-4.0	-2.7	-0.8	-4.2	1.0	-	-	-13.0	-1.5	-1.6
	TD			-2.2	-1.8	-0.8	-2.2	-2.2	-	-	-15.0	-0.9	0.3
Oxygen Transmission Rate	cm ³ /m ² .day. atm	ISO14663-2	20°C 0%RH	0.2	0.2	0.8	<0.05	-	1,300	2,700	2,100	40	85
			20°C 65%RH	0.3	0.5	1.5	<0.05	-	1,300	2,700	2,100	50	85
			20°C 85%RH	1.0	2.0	3.3	<0.05	-	1,300	2,700	2,100	90	85
Surface electrical resistance	Ω	Kuraray method	23°C 50%RH	2x10 ¹⁵	2x10 ¹⁵	2x10 ¹⁵	-	-	3x10 ¹⁵	3x10 ¹⁵	3x10 ¹⁵	5x10 ¹⁴	>10 ¹⁶
Transparency (haze)	%	JISZ7105	23°C 50%RH	0.6	1.5	1.5	-	73.0	5.0	6.0	2.2	3.0	2.5
Slip	°C	Kuraray method	23°C 50%RH	44	27	27	40	30	10	30	31	44	30

*² This value was determined by eliminating from the measured value obtained from laminated products using PET or polyolefin film the influence of the moisture permeability of the PET or polyolefin film.

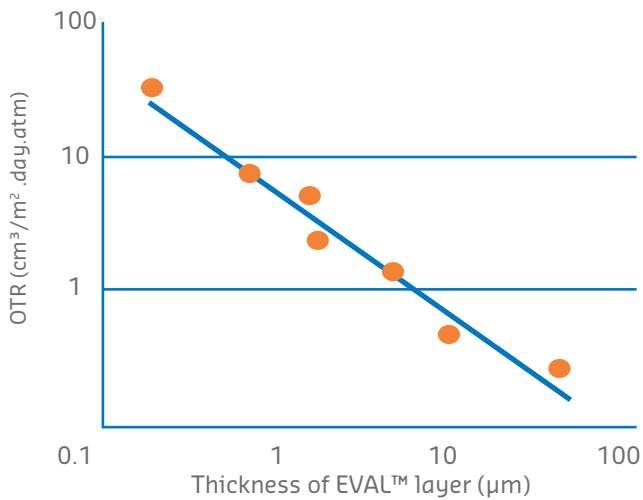
Gas barrier properties of EVAL™ film

Relative humidity and oxygen transmission rate of various materials

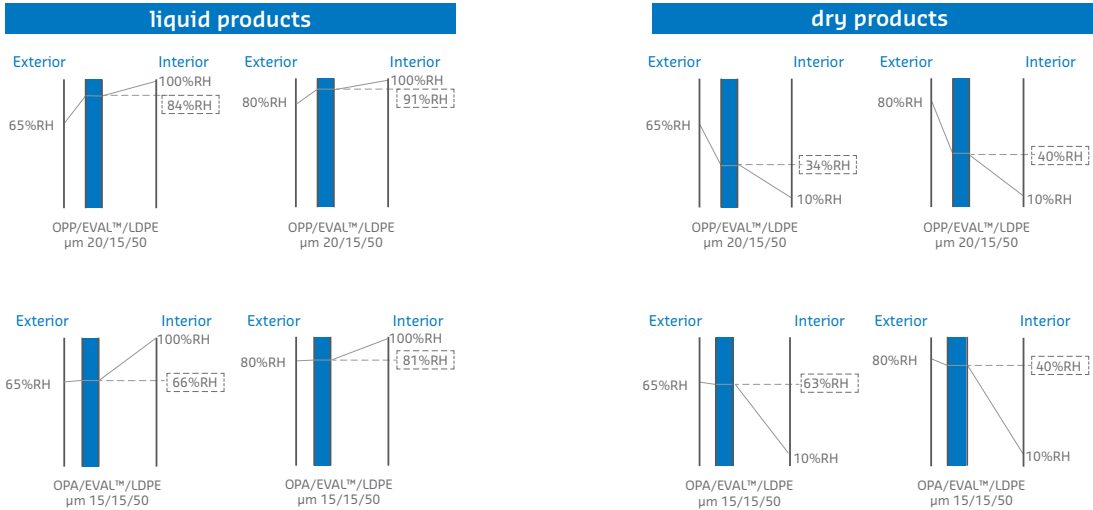


EVAL™ layer thickness and OTR

Conditions: EVAL™ EF-F multilayer film 35°C, 0% RH



Relative humidity of EVAL™ layer in laminated structures

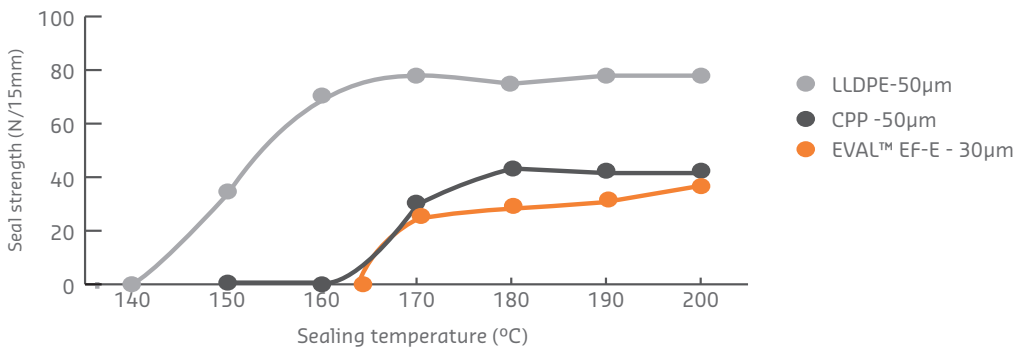


Heat seal properties

a. Flavour absorption of EVAL™ film

Item	Unit	Measurement	Flavours	Material		
				EF-E	LDPE	CPP
Flavour absorption (liquid)	ppm	Kuraray method	d-Limonene	280	1,480	2,040
			n-Butyl acetate	80	420	610
			Ethyl acetate	<50	<50	<50
Flavour absorption (gas)	mg/g	Kuraray method	1-Menthol	0,2	9,6	21
			Salicylic acid methyl	1.7	26.0	35

b. Heat seal curve of EVAL™ film



Examples of use and structure of EVAL™ film

Typical applications

- Dried Bonito flakes
- Miso paste and bouillon
- Soup
- Rice cakes
- Fruit jelly (lid material)
- Cooked rice (lid material)
- Sweet bean jelly

Typical structure (out/in)

- OPP/EVAL™ film/PE
- OPP/EVAL™ film/PE
- OPA/EVAL™ film/PE
- EVAL™ film/PE
- OPA/EVAL™ film/PE
- OPA/EVAL™ film/PE
- OPA/EVAL™ film/PP
- OPA/EVAL™ film/PE
- OPA/EVAL™ film/PE



Typical applications

- Bean sprouts
- Drip coffee packs
- Ketchup for restaurant use
- Long-lasting balloons
- Wallpaper
- Vacuum insulation panels

Typical structure (out/in)

- CPA/**EVAL™ film**/CPP
- PET/**EVAL™** (VM-XL)/LLDPE
- OPA/**EVAL™ film**/PE
- PET/**EVAL™** (VM-XL)/PE
- **EVAL™**/PVC/Paper
- OPA/VM-PET/**EVAL™** (VM-XL)/PE



Environmental benefits of EVAL™ resins and film

As the impact we create on our environment becomes an ever greater concern, the world continues to look for solutions that are truly sustainable. EVAL™ EVOH resins and films can help, providing valuable function while conserving resources, improving efficiency and avoiding waste, often throughout the entire life cycle of the product.

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A one millimetre thickness of EVAL™ EVOH has about the same gas barrier properties as ten metres of LDPE. With such high performance, EVAL™ layers of only a few microns can add real function to multilayer structures. Barrier performance previously only available from metal or glass can thus be added to lightweight structures based on other recyclable and energy recoverable plastics, or renewable resources like PLA and paperboard.

Protecting quality and value

Although product development tends to focus specifically on EVAL™'s functional barrier properties, EVAL™ helps conserve resources and avoid waste throughout a product's life cycle. Reducing waste, and thus avoiding the loss of all resources invested in the production and distribution of fresh food, is the best way to reduce environmental impact.

When used in laminated structures for food packaging, EVAL™ film layers of just 15-25 microns providing valuable

barrier function, usually allowing a decrease in the total amount of packaging materials used. Optimized portion size, lightweight and extended freshness help improve the efficiency of storage, transport and display, saving costs and preserving resources.

Reduced emissions

When used in barrier structures for construction, agricultural and automotive fuel system applications, EVAL™ helps create lightweight structures that help protect the environment from gas, fuel or chemical emissions.

Recyclable and recoverable

EVAL™ EVOH is recyclable as post-consumer plastic waste, and will not disrupt polyolefin or PET recycling streams.

EVAL™ has excellent and safe energy recovery properties, often reducing the amount of extra fuel necessary for energy generation from the thermal disposal of sorted waste. Under perfect combustion, the few microns of EVAL™ in the package emit only small amounts of CO₂ and water vapour.



Introducing Kuraray and EVAL™

Kuraray Co., Ltd. was established in 1926 in Kurashiki, Japan, for the industrial manufacture of chemical fibres. As the world's largest producer of vinyl acetate monomer (VAM) derivatives, Kuraray has long been a leader in high gas barrier technology and development. Today the Kuraray Group consists of about 70 companies, employing around 7,000 people worldwide.

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EVAL

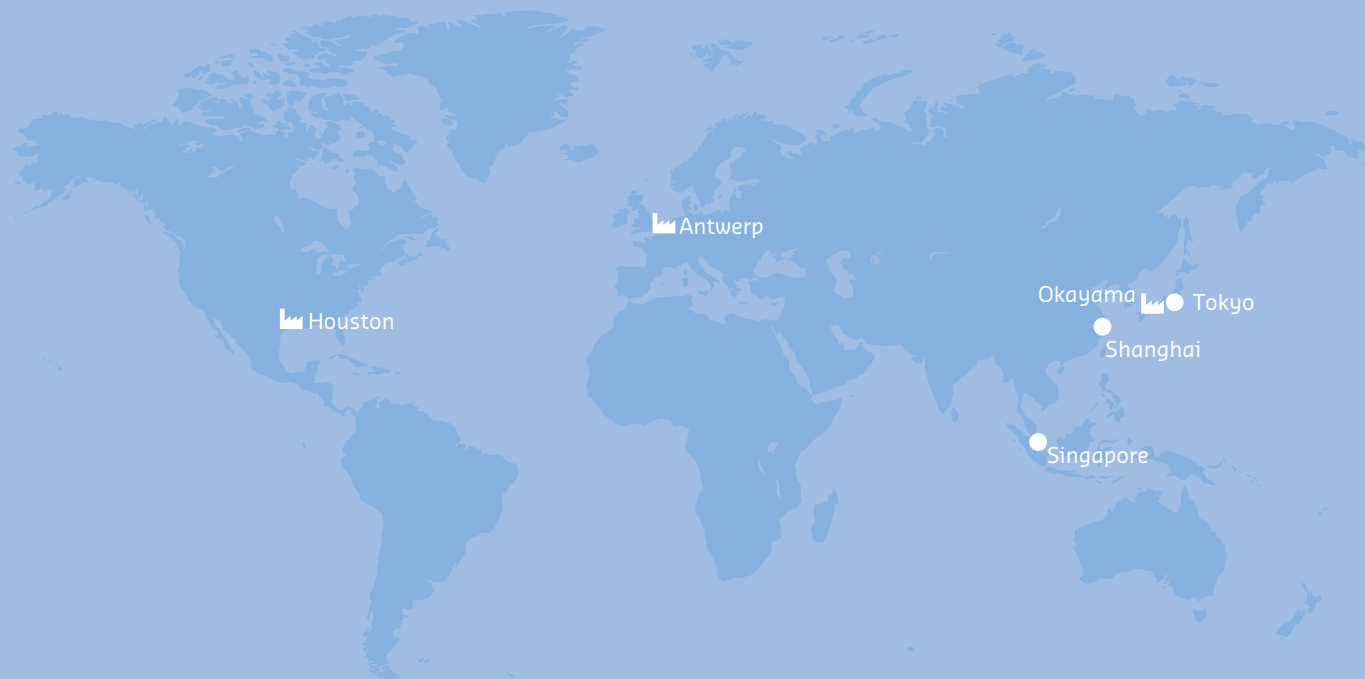
Kuraray has been manufacturing and marketing ethylene vinyl-alcohol copolymers (EVOH) under the name EVAL™ since 1972, and remains the world leader in EVOH production and market development.

EVAL™ is one of Kuraray's core businesses. EVAL™ resins are produced in Japan, the USA and Europe. EVAL™ films are produced in Japan. The sales and technical development of EVAL™ resins and films is supported by specialised local teams in each region.

Building better barriers

EVAL™ adds superior barrier functionality to multilayer plastic structures. Even very thin EVAL™ layers provide excellent results. EVAL™ is widely used as a functional gas and flavour/aroma barrier in food, medical, pharmaceutical and cosmetic packaging, and as a gas and solvent barrier in industrial, construction, agricultural and automotive fuel system applications.





EVAL™ the world's leading EVOH

Europe

EVAL Europe nv (Antwerp, Belgium)
Capacity: 24,000 tons/year
Europe's first and largest EVOH production facility

Americas

EVAL Company of America (Pasadena, Texas, USA)
Capacity: 35,000 tons/year
The world's largest EVOH production facility

Asia-Pacific

Kuraray Co. Ltd. (Okayama, Japan)
Capacity: 10,000 tons/year
The world's first EVOH production facility

NOTICE

The information, specifications, procedures, methods and recommendations herein are presented in good faith, are believed to be accurate and reliable, but may well be incomplete and/or not applicable to all conditions or situations that may exist or occur. No representation, guarantee or warranty is made as to the completeness of said information, specifications, procedures, methods and recommendations or that the application or use of any of the same will avoid hazards, accidents, losses, damages or injury of any kind to persons or property or that the same will not infringe patents of others or give desired results. Readers are cautioned to satisfy themselves as to the suitability of said information, specifications, procedures, methods and recommendations for the purpose intended prior to use.



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EVAL™ resins are produced worldwide under unified Kuraray product and quality specifications.

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