



EVOH barrier resins and monolayer film



[www.evalevoh.com](http://www.evalevoh.com)

***kuraray***



# More function, less waste

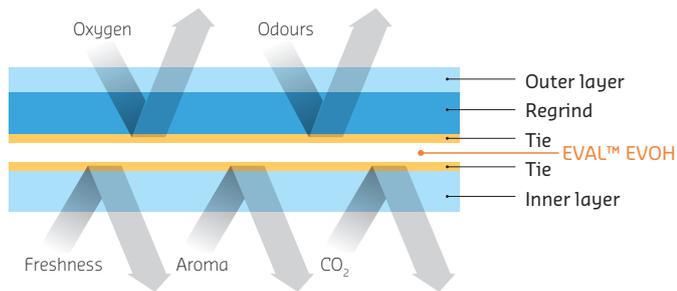
Kuraray Co., Ltd. is the world leader in the production and development of EVOH (ethylene vinyl alcohol copolymer) barrier plastic raw materials. It is available worldwide under the name EVAL™, either in pellet form for coextrusion and coinjection, or as monolayer film for lamination.



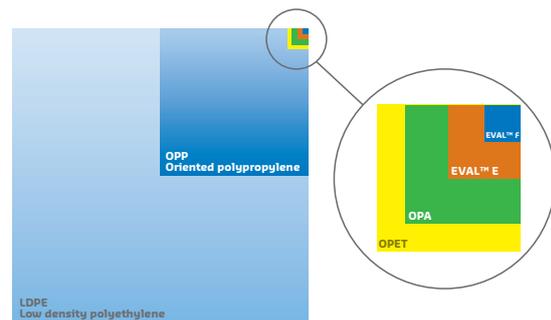
1mm of EVAL™ has the same gas barrier as a 10 meter thick wall of LDPE. With such performance, very thin layers of EVAL™ add valuable barrier function to efficient multilayer structures. This barrier function works in both directions, keeping harmful oxygen and contamination away from sensitive products, while locking aroma and value inside.

Multilayer structures provide functional protection with a minimum amount of material. Polyolefins provide cost-effective structure and humidity barrier. PA can provide toughness and assist forming. Tie layers provide structural integrity. EVAL™ provides the necessary gas and migration barrier function to the entire structure.

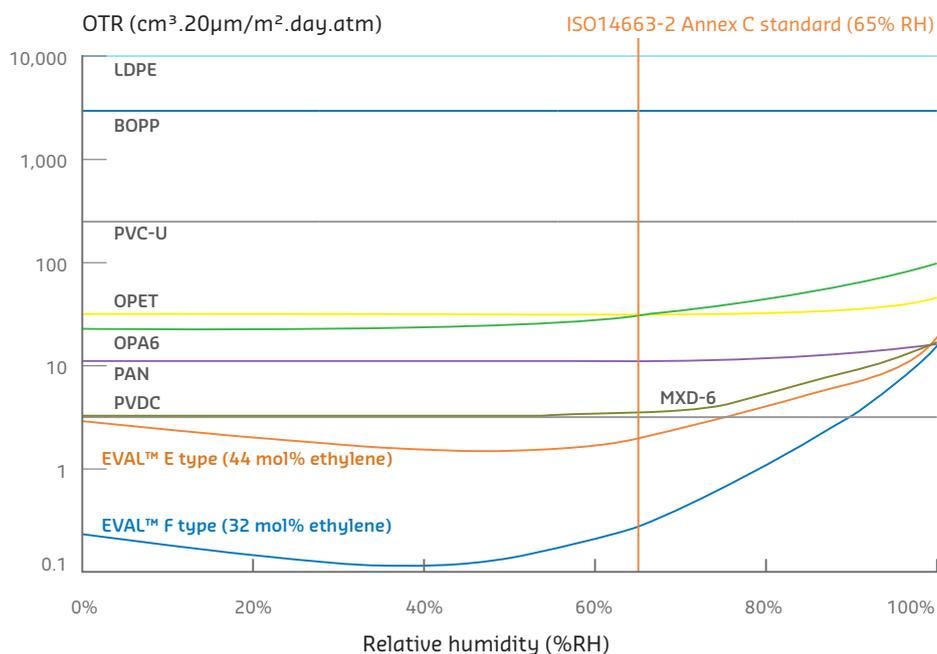
## TYPICAL MULTILAYER STRUCTURE WITH EVAL™



## AMOUNT OF OXYGEN PERMEATION THROUGH EQUAL THICKNESS OF DIFFERENT PLASTICS



## OXYGEN TRANSMISSION RATE OF VARIOUS POLYMERS VERSUS RELATIVE HUMIDITY AT 20°C



# Making structures more efficient, attractive and safe

*The key is to let each component of the structure do what it does best, in an appropriate layer thickness. Different materials combined effectively may actually decrease the total amount of packaging materials required.*

EVAL™ provides the functional gas, aroma and grease barrier in food, medical, pharmaceutical and cosmetic packaging, and as a gas and solvent barrier in industrial, construction, agricultural and automotive fuel system applications.

All-plastic structures with EVAL™ offer a safe, lightweight, transparent and unbreakable alternative to glass and metal. Thin layers

of EVAL™ add reliable barrier to renewable materials like paper-board and PLA. At end of life, structures containing EVAL™ can be recycled, or provide safe energy recovery without toxic emissions or metal residue.

METAL CAN



PLASTIC CUP/LID



**LIGHTWEIGHT  
TRANSPARENT  
MICROWAVEABLE**

GLASS BOTTLE



EFFICIENT BAG-IN-BOX



**UNBREAKABLE  
TRANSPORT MORE GOODS  
LESS PACKAGING**

GLASS JAR



ALL-PLASTIC BARRIER BOTTLE



**LIGHTWEIGHT  
SQUEEZABLE  
USE WITH METAL DETECTORS**

STEEL FUEL TANK



PLASTIC FUEL SYSTEM



**LIGHTWEIGHT  
FREEDOM OF DESIGN  
SAFETY IN USE**

# Reliable and safe protective function in packaging

## High gas barrier properties

### Extended freshness, less waste

Without an effective gas barrier, oxygen may penetrate packaging and spoil the contents. EVAL™ keeps oxygen out and safeguards quality, extending shelf life and avoiding waste. This cost-saving function is commonly added to food, medical, pharmaceutical, cosmetic, agricultural and industrial packaging applications.



## Migration barrier

### Improving food safety

EVAL™ provides excellent functional barrier against organic solvents, protecting food against the migration of contamination like MOSH/MOAH mineral oils that can compromise food safety. EVAL™ also resists permeation of hydrocarbons and grease, maintaining packaging appearance. In addition to protecting food, this property also protects the environment, locking chemical substances inside safe and convenient plastic packaging.



## Aroma barrier, no flavour scalping

### Assuring quality in new forms of distribution

While keeping oxygen and other gases out, EVAL™ also effectively blocks odours, protecting product integrity. EVAL™ locks volatile fragrance and ingredients inside packaging without absorbing them, and preserves aroma until it can be enjoyed by the consumer.



## Transparency

### A clear and reliable alternative to aluminium foil

All-plastic EVAL™ barrier layers have excellent flex crack and pinhole resistance, even when flexed, folded and shaken during processing and distribution. EVAL™ offers a reliable barrier alternative to Al foil, with the addition of excellent transparency and safe and low-impact energy recovery at end of life.



## Process efficiency

### Reduce costs and waste in production and distribution

Plastic barrier structures with EVAL™ can be designed for aseptic filling, reducing energy use during processing. Lightweight structures with EVAL™ allow transporting more goods instead of unnecessarily heavy packaging. Inexpensive but functional packaging design helps bring quality products to new markets.



## Food contact compliance

EVAL™ has passed the specification/standard test of Official Notice No.370 (1959) from Japan's Ministry of Health and Welfare. EVAL™ is in compliance with the EC Directive on plastic materials intended to come into contact with food. EVAL™ has 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.

# Properties that create value for industry

## Hydrophilic, anti-static and glossy appearance

### More than just a gas barrier layer

EVAL™ is a hydrophilic polar material with anti-static properties and a glossy appearance when used as an outside layer. In addition to packaging, its unusual mix of properties leads to use as a technical plastic for industrial, electronic and medical components.

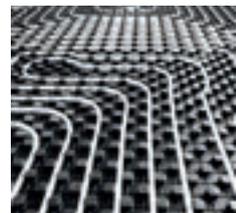


# Avoiding energy waste and reducing emissions

## Extended service life

### Special pipe grades maintain cost-saving performance for decades

EVAL™ adds barrier function to structures that were previously not possible with plastics. Barrier plastic pipes for under-floor heating are easy to install and help avoid corrosion, extending service life.



## Energy efficiency

### Extending the performance of insulation

EVAL™ can replace Al foil in vacuum insulation panels, maintaining the vacuum and efficiency and generating savings. A thin layer of EVAL™ can maintain the insulation properties of Polyurethane foam, used in preinsulated heating and cooling pipes.



## Fuel vapour barrier

### Safety and environmental protection

Lightweight barrier plastic tanks and lines improve the performance and safety of automotive fuel systems. EVOH is the only conventional plastic that meets strict international emission standards.



## Solvent resistance

### Safe protection against permeation of solvents and agricultural chemicals

EVAL™ shows excellent physical resistance to solvents, and barrier against their permeation into the environment. Because of its resistance to absorption and swelling, EVAL™ is typically used as the inner contact layer in UN-approved chemical bottles. A safe way to transport chemical concentrates.



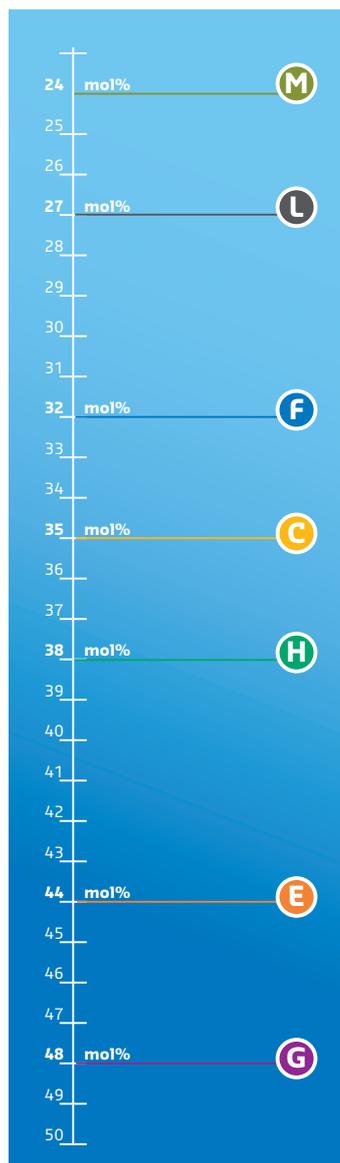
## Less waste, improved safety for Agriculture

EVAL™ provides the barrier function in TIF™ (Totally Impermeable Film) mulch films. Agricultural chemicals stay where they are needed, reducing emissions and improving safety for workers and nearby residents. Barrier silage films, land silos and hermetic storage bags protect feed and produce until they can be used or shipped to market. UN regulation compliant plastic chemical bottles block emissions from chemical concentrates.

# About EVAL™, a Kuraray technology

The EVAL™ copolymer combines the humidity resistance and easy processing of ethylene with the exceptional gas barrier and resistance to organic solvents of polyvinyl-alcohol. By adjusting the balance of the copolymer, Kuraray has created the world's widest range of EVOH grades. Our global development teams help determine the grade best suited for an application's required converting and secondary processing.

## Ethylene and Vinyl Alcohol



## Types of EVAL™

### EVAL™ M type

has the lowest ethylene content available, and provides the highest barrier for automotive and flexible applications.

### EVAL™ L type

has a very low ethylene content and is suitable as an ultra-high barrier in flexible, bottle and sheet applications.

### EVAL™ F type

offers superior barrier performance with long-term process stability, and is widely used as the standard grade for flexible, automotive, bottle and tube applications. Specific versions exist for coating and pipe applications.

### EVAL™ C type

can be used for high-speed coextrusion coating and cast flexible applications.

### EVAL™ H type

combines high-barrier properties and long-term run stability and thermoformability. The higher ethylene content allows easier processing and longer running times on older coextrusion equipment, especially for blown flexible structures.

### EVAL™ E type

has a higher ethylene content that allows for greater flexibility and even easier processing.

### EVAL™ G type

has the highest ethylene content, making it the best candidate among standard EVAL™ types for stretch and shrink film applications.

# EVAL™ resin grades

## 1. Standard grades

Grade	Et.Cont. (mol%)	Density* <sup>1</sup> (g/cm <sup>3</sup> )	MFR* <sup>2</sup> (g/10min)	Tm (°C)	Tg* <sup>3</sup> (°C)	OTR* <sup>4</sup> (cm <sup>3</sup> .20µm/m <sup>2</sup> .day.atm)	Application
L171B	27	1.21	4.0* <sup>5</sup>	190	63	0.1	ultra high-barrier
F101B	32	1.19	1.6	183	60	0.3	fuel tank, bottle
F171B	32	1.19	1.6	183	60	0.3	bottle, sheet, film, tube
H171B	38	1.17	1.7	172	56	0.7	bottle, sheet, film, tube
E105B	44	1.14	5.5	165	53	1.9	sheet, film, tube
G156B	48	1.12	6.4	157	50	3.7	oriented shrink film

\*<sup>1</sup> 20°C \*<sup>2</sup> 190°C, 2,160g \*<sup>3</sup> Dry \*<sup>4</sup> 20°Cx65%RH, ISO 14663-2 annex C \*<sup>5</sup> 210°C, 2,160g

## 2. Grades for specific processing conditions

Grade	Et.Cont. (mol%)	Density* <sup>1</sup> (g/cm <sup>3</sup> )	MFR* <sup>2</sup> (g/10min)	Tm (°C)	Tg* <sup>3</sup> (°C)	OTR* <sup>4</sup> (cm <sup>3</sup> .20µm/m <sup>2</sup> .day.atm)	Application
F101A	32	1.19	1.6	183	60	0.3	F101 without external lubricant
F104B	32	1.19	4.4	183	60	0.3	high MFR F-type
FP101B	32	1.19	1.6	183	60	0.3	extended pipe service life
FP104B	32	1.18	4.4	183	60	0.3	extended pipe service life
T101B	32	1.19	2.0	183	55	0.4	thermoformed film, sheet
J102B	32	1.17	2.0	183	54	0.6	deep thermoforming, sheet
C109B	35	1.18	8.5	177	53	0.5	extrusion coating
E171B	44	1.14	1.7	165	53	1.9	low MFR E-type

\*<sup>1</sup> 20°C \*<sup>2</sup> 190°C, 2,160g \*<sup>3</sup> Dry \*<sup>4</sup> 20°Cx65%RH, ISO 14663-2 annex C

## 3. Special grades

Characteristics	Comparison to standard grades	Grade
Thermoforming grade	Improved EVAL™ layer distribution during deep thermoforming	SP series, LT series, J171B
Soft grade	Improved flex-crack resistance with similar barrier	FS201B
High impact strength grade	Improved impact strength	LA170B
Fuel tank grade	Ultra high barrier properties for automotive	M100B
Pipe grade	Provides extended service life at high temperature	FP101B, EP105B
Retort grade	Retort flexible grade. Improved retort performance for thin transparent structures.	FR101B, LR171B

Please contact us for more information concerning Special grades.

## 4. SP Grades. Improved orientation and layer distribution during secondary processing.

Grade	Et.Cont. (mol%)	Density* <sup>1</sup> (g/cm <sup>3</sup> )	MFR* <sup>2</sup> (g/10min)	Tm (°C)	Tg* <sup>3</sup> (°C)	OTR* <sup>4</sup> (cm <sup>3</sup> .20µm/m <sup>2</sup> .day.atm)	Application
SP521B	27	1.19	4.1* <sup>5</sup>	190	63	0.2	improved layer distribution in forming
SP482B	32	1.16	2.0	183	60	0.6	improved film orientation
SP292B	44	1.13	1.9	165	48	3.0	improved film orientation

\*<sup>1</sup> 20°C \*<sup>2</sup> 190°C, 2,160g \*<sup>3</sup> Dry \*<sup>4</sup> 20°Cx65%RH, ISO 14663-2 annex C \*<sup>5</sup> 210°C, 2,160g

## 5. Processing agents for EVAL™ resin

We also offer the following processing agents, useful for specific EVAL™ resin applications and processing methods

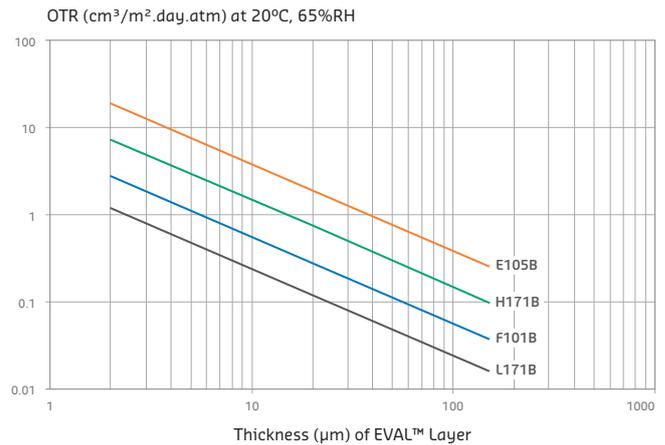
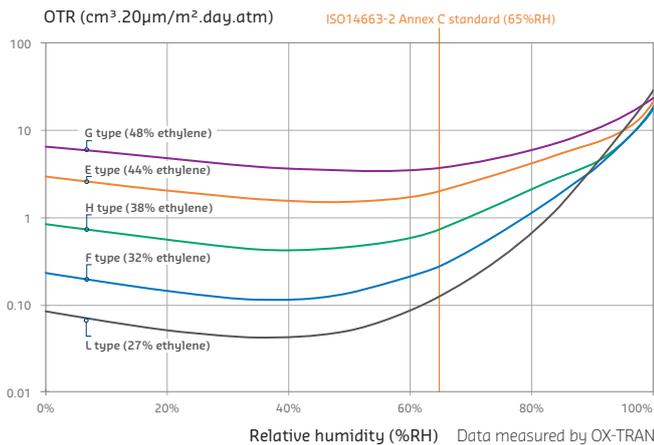
- Recycling agent
  - Purging agent
- Please contact us for more information.

# EVAL™ monolayer film grades

Grade	Type	Thickness (µm)	Ethylene Content (mol%)	Density (g/cm³)	OTR*1 (cm³/m².day.atm) 20°C 65% RH ISO 14663-2	Applications
EF-XL	Biaxially oriented	12	32	1.20	0.4	high barrier
EF-F	Non-oriented	12	32	1.20	0.6	high barrier, deep draw
EF-E	Non-oriented	30	44	1.14	1.0	sealable, deep draw
VM-XL	Biaxially oriented, Aluminium metalized.	15	32	1.20	<0.05	ultra-high barrier
HF-M	Non-oriented	12	-	1.10	-	matt for wallpaper use

## Gas barrier properties of EVAL™

### EVAL™ LAYER THICKNESS AND OXYGEN TRANSMISSION RATE



EVAL™ gas barrier performance is affected by humidity and temperature, but even in extreme conditions it offers exceptional barrier properties.

What is important is the equilibrium relative humidity of the EVAL™ layer itself. EVOH is a hydrophilic polymer. But as an EVAL™ layer loses any humidity it may have absorbed, the barrier performance improves.

EVAL™ gas barrier is higher than that of any conventional polymer. Barrier performance is directly related to layer thickness.

Compared to other plastics, EVAL™ can usually offer higher barrier performance even while reducing the amount of material used.

### TRANSMISSION RATES OF OTHER GASES AT 0% RH

Film type	H <sub>2</sub> (20°C)	N <sub>2</sub> (25°C)	CO <sub>2</sub> (25°C)	He (25°C)	Ar (35°C)	Ar (50°C)	Kr (35°C)	Kr (50°C)
F101B	30*	0.017	0.81	160	-	0.5	-	0.4
E105B	200	0.13	7.1	410	1.6	7.0	-	1.8
OPA	-	12	205	2,000	-	-	-	-
CPA	-	-	-	-	60	150	23	68
OPET	-	8	110	3,100	-	-	-	-
OPP	10,000	730	9,100	-	8,100	28,000	6,900	23,000
LDPE	-	3,100	42,000	28,000	19,000	46,000	25,000	74,000

Measuring conditions: 0%RH cm³.20µm/m².day.atm \*F171B

# Resistance and barrier against solvents and other chemicals

## RESISTANCE OF EVAL™ TO VARIOUS ORGANIC SOLVENTS

Solvent	SP value ( $\sqrt{\text{cal}/\text{m}^3}$ )	Weight increase (wt%)					
		20°C, 1 month		20°C, 6 months		20°C, 1 year	
		SP = Solubility parameter	F101B	PA6	F101B	PA6	F101B
Xylene	8.8	0	0	0	0.8	0	0.7
Ethylacetate	9.1	0	0	0	0.2	0	0.3
Benzene	9.2	0	0	0	0.8	0.04	1.0
Acetone	9.9	0	0	0	0.6	0	1.2
Pyridine	10.7	0.5	0	0.3	1.2	0.5	1.2
Ethanol	12.7	1.5	5.2	2.0	12.0	2.3	11.4
Salad oil	-	0	0.04	-	-	0.1	0.2

Measurement conditions: swelling method. SP value of EVAL™ F = 19.0; the SP value of PA6 = 12.7. For best results, the difference between the material and solvent SP values should be as large as possible.

## EVAL™ barrier against solvent permeation

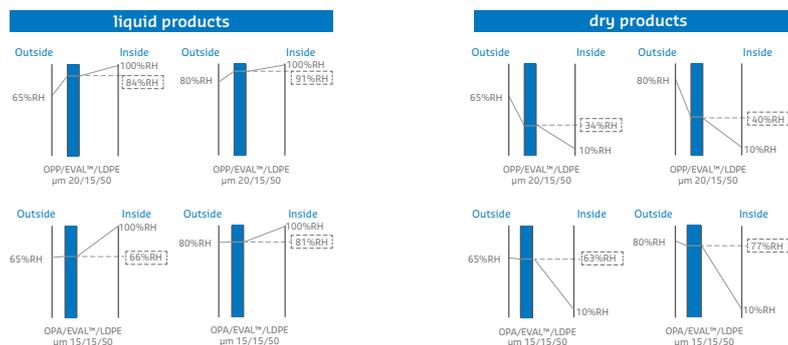
Film type	Chloroform	Xylene	Methyl ethyl ketone	Kerosene
EVAL F	0.20	<0.04	0.09	<0.04
EVAL E	0.21	<0.06	0.13	<0.06
OPA	16.9	1.19	3.38	0.48
OPP	3740	350	12	53
LDPE	6900	813	185	190

Unit:  $\text{g} \cdot 20\mu\text{m}/\text{m}^2 \cdot \text{day} \cdot \text{atm}$

## EVAL™ resists flavour absorption

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

## Adjusting structure design for optimal performance



Based on the application and typical conditions of use, it is possible to optimise barrier performance. The equilibrium relative humidity of the EVAL™ layer can be lowered by shifting its location or by carefully choosing the other materials in the structure.

# Applications in Food Packaging

Flexible (blown, cast, lamination)

Extended freshness and protected value



Fresh meat shrink wrap  
PA/EVAL™/PA/tie/PE  
outside inside



Sliced ham  
PET/tie/EVAL™/PA/tie/EVA  
outside inside



MAP with long-lasting gas mix  
PET//PE/tie/EVAL™/tie/EVA  
outside inside

Al foil-free for safety and reduced environmental impact



Ultra efficient bag-in-box liner  
PE/tie/EVAL™/tie/EVA  
outside inside



Al foil-free aroma barrier  
PET//PE/tie/EVAL™/tie/PE  
outside inside



Transparent barrier lid film  
PA//EVAL™ film//PP  
outside inside



Affordable UHT milk pouch  
PE/tie/EVAL™/tie/PE  
outside inside



Affordable soup powder sachet  
Paper//PE/tie/EVAL™/tie/PE  
outside inside



Transparent packs for sensitive foods  
OPP//EVAL™ film/PE  
outside inside

## Rigid (tray, cup, bottle, tube)

### Thermoforming to replace metal cans and trays



Baby food  
PP/tie/EVAL™/tie/PP  
outside inside



Pet food tray  
PP/tie/EVAL™/tie/PP  
outside inside



Deep draw beverage "can"  
PS/tie/EVAL™/tie/PS  
outside inside

### Improving safety, shelf life without conservatives



Metal replacement, no sharp edges  
PE/tie/EVAL™/tie/regrind/PE  
outside inside



Shelf-stable dairy  
PE/tie/EVAL™/tie/PE  
outside inside



Freshness without conservatives  
PE or PP/tie/EVAL™/tie/PE or PP  
outside inside

### High quality packaging, protecting valuable ingredients



Seamless coextruded tube  
PE/tie/EVAL™/tie/PE  
outside inside



Glossy, printable exterior layer  
EVAL™/tie/PP  
outside inside



Barrier guaranteed vitamin content  
PE/tie/EVAL™/tie/PE  
outside inside

## Coating (paperboard, paper)

### Adding barrier function to renewable materials



Aroma barrier paper sachet  
Paper//PE/tie/EVAL™/tie/PE  
outside inside



Migration barrier paper liner  
Paper/PE/tie/EVAL™/tie/PE  
outside inside



Al-free carton for liquids  
PE/paper/PE/tie/EVAL™/tie/PE  
outside inside

### New technologies that boost packaging shelf appeal



Coinjected barrier can  
PP/EVAL™/PP/EVAL™/PP  
outside inside



Barrier in-mould label cup  
PE/tie/EVAL™/tie/PE/PE  
outside inside



Ultralight tomato sauce pouch  
PET//PE/tie/EVAL™/tie/PE  
outside inside

# Applications in Medical and Pharmaceutical

### Ensuring product integrity and protection from contamination



Sealable medicine sachet  
PET//AL//EVAL™ film  
outside inside



Nutrition provided intact  
PE/tie/EVAL™/tie/PE  
outside inside



Visibility and protection  
PET//PE/tie/EVAL™/tie/PE  
outside inside

# Applications in Building and Construction and Fuel containment

Extended energy efficiency and service life



Underfloor heating pipe  
EVAL™/tie/PEX  
outside inside



VOC barrier construction membranes  
PE/PE/tie/EVAL™/tie/PE/PE  
outside inside



Preinsulated pipe  
PE/tie/EVAL™/PUR foam/EVAL™/tie/PEX  
outside inside



Vacuum insulation panels  
Film/Film/EVAL™ film/sealant  
outside inside



Durable and stain-resistant wallpaper  
EVAL™ film/PVC/paper  
outside inside



Fuel tanks, lines and filler pipes  
PE/tie/EVAL™/tie/PE  
outside inside

# Applications in Agriculture

Fewer chemical emissions, less waste of farm produce



TIF much films  
PE/PE/tie/EVAL™/tie/PE/PE  
outside inside



Chemical and solvent resistant bottles  
PE/tie/EVAL™  
outside inside



Barrier IBC  
PE/tie/EVAL™/tie/PE  
outside inside

# Open innovation

## Application development with the world's barrier experts

*Kuraray is a world leader in specialty chemicals and functional materials. We are committed to developing products that ensure quality and value while helping our business partners differentiate themselves from their competition.*

Kuraray Co. Ltd. was the first company in the world to produce and commercialise EVOH, starting in Okayama, Japan in 1972. Today Kuraray is the world's largest producer of Vinyl Acetate Monomer derivatives, and is still the leader in EVOH technology, production, structure analysis and technical development.

EVAL™ production began in Houston, USA in 1986, and in Antwerp, Belgium in 1999.

Technical centres were established in Kurashiki, Japan, at the Houston and Antwerp production sites, and in Singapore. At each site we work together with converters and end users, bringing our expertise in barrier technology and structure optimisation.

To learn more about our open innovation development, visit our global website

**[www.evalevoh.com](http://www.evalevoh.com)**



HOUSTON, USA



ANTWERP, BELGIUM



-  EVAL™ production site
-  EVAL™ Technical Centre
-  EVAL™ Kuraray sales office

\*Increase from 47,000T/year in mid-2018



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The Kuraray logo features the word 'kuraray' in a lowercase, blue, sans-serif font, with a stylized blue 'K' symbol to its left.  
**kuraray**