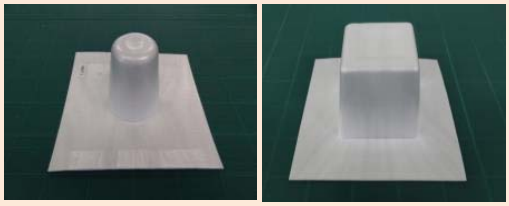
Next Stage of Polystyrene

TOYO STYRENE Co.,Ltd.

<Lineup of Toyo Styrene's High Functional Polystyrene>



Example of Deep Drawing

Light Guide Plate

Lid for Hot Drink Cup

Good Appearance PS
Light Guide Plate
LED Lighting

HMT-PS
(High Melt Tension PS)
Various Food Packages
Foamed Deep Drawing

ESCR-HIPS
(Environmental Stress Cracking Resistance)
Lids for Hot Drink Cup
Food Packages for Oily Food
Improvement of Strength

Excellent Transparency

Good Moldability for Foamed PS

Oil Resistance

Conventional GPPS／HIPS

Heat Resistance

Minimize Residual Monomer/Oligomer

Flame Retardant

TF-polymer/TFP
Microwavable Food Packages

High Purity GP/HI
Reduction of Gas evolution at Molding or Eluted Materials from Packages

Lunch Boxes

Flame Retardant PS
Halogenated/Halogen-free
Flame Retardant Compound PS

Packages of Low Volatile Monomer

Package for

Toner Container

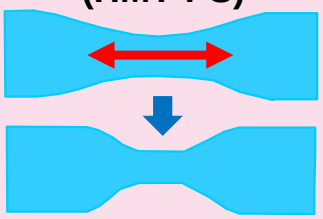
Distribution Board

Packages of Low Oligomer

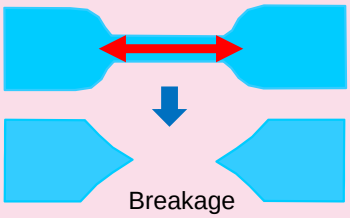
High Melt Tension Polystyrene (HMT-PS)

HMT-PS has very high Melt Tension by our own polymerization technology.
Good material for SHEET/FILM productoin.
Forming productions of HMT-PS have good FORMABILITY, THICKNESS UNIFORMITY.

High strain-Hardening (HMT-PS)

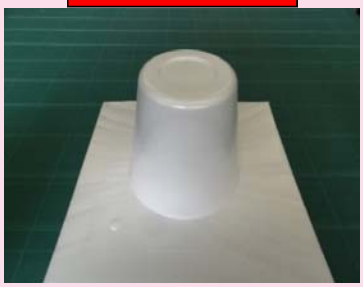


Low strain-Hardening (Conventional PS)



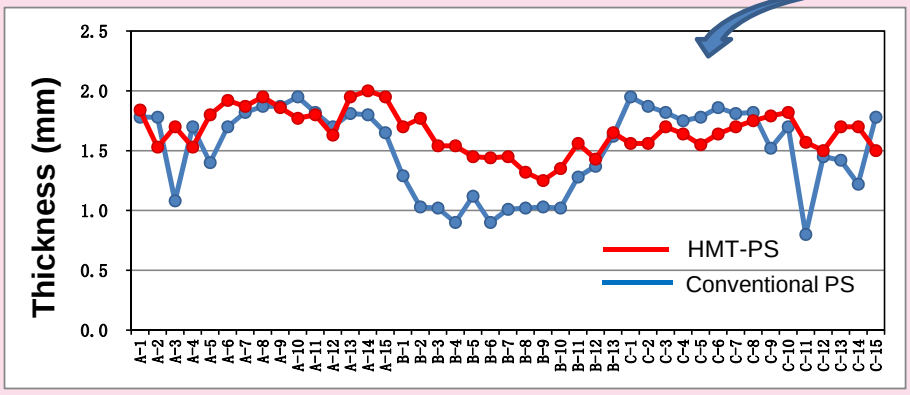
[Forming test]

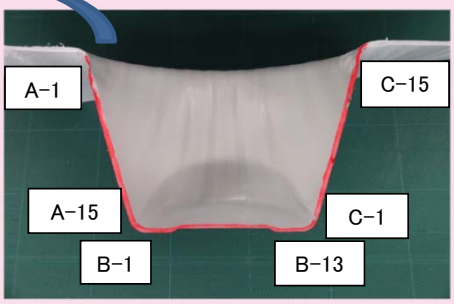
HMT-PS



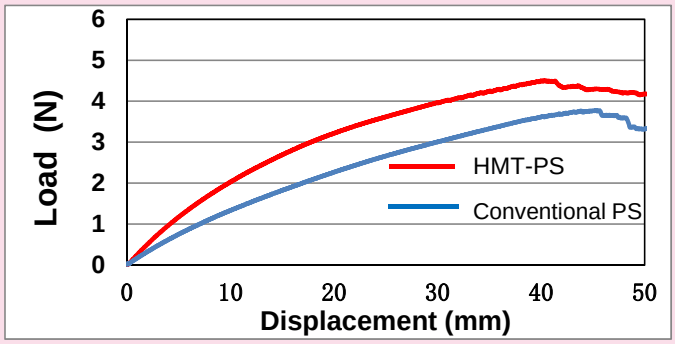
Conventional PS

[Food container thickenss uniformity]

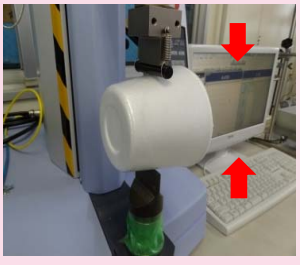




[Compression strength of food container]



Measuring method



HIPS sheet formed package

[Application]

- Polystyrene Paper (PSP, Foamed expansion sheet for food container)
- Expanded Polystyrene board (XPS, Foamed heat insulation material)
- Biaxial Oriented Polystyrene(BOPS)
- Injection blow formed productions
- Inflation films
- HIPS sheet formed package

Oil Resistance HI Polystyrene EX7

EX7 shows optimum performance as a material for vacuum forming Coffee cup lids

Japan's coffee cup lid market
Share:approximately 80%

by Toyo Styrene estimate

Good point of EX7	Merit for Coffe cup lids.
Good oil resistance	Preventinon cracking deu to milk fat
Highly rigid	Fitting compatibilty & No leakage coffee tilting the cup
Maintaining demensional stability	
Good tear strength	No break easily even if downguaging lids thickness
Good folding endurance	

Coffee Cup lid

Performance comparison for coffee cup lid

Item	EX7	HI-PS+SBR	PP
Resistance to milk	Excellent	Fair	Excellent
Moldability	Good	Good	Poor
Dimensional stability at the molding	Good	Good or Fair	Poor
Stiffness	Good	Good or Fair	Poor
Thickness	Thin	Thick	Thick
Weight	Light	Heavy	Heavy
Cost	Good	Fair	Fair

（Toyo Styrene research）

Sheet properties

Item	unit	Conventional HI-PS	EX7
Folding endurance MD	times	180	＞5000
Folding endurance TD	times	117	＞5000
Tearing strength MD	N/mm	3.7	5.7

EX7 prevents cracking.

(Appications)

- Hot coffee cup lid
- Food packaging that is possiblity of oil adheres.

High Performance ESCR-HIPS for Refrigerator liners

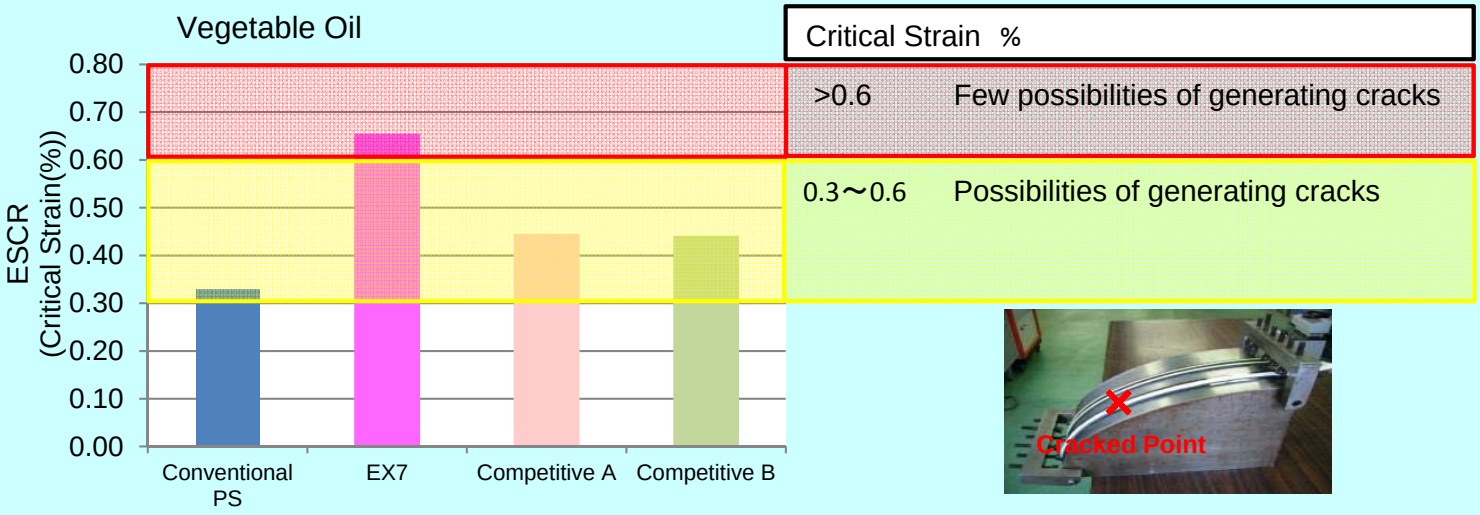
- Superior Strength
- Stand up to foods and foaming agents
- Potential to downgauge of liner thickness

Physical Properties

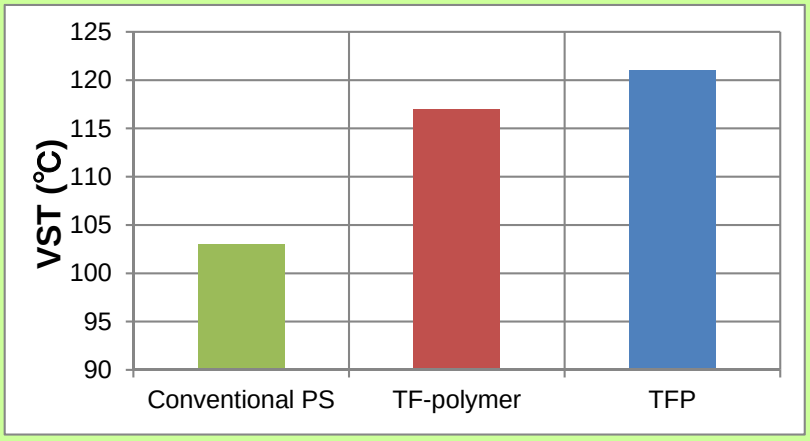
	Unit	EX7	Competitive A Other Company	Competitive B Other Company
Melt Mass Flow Rate(MFR)	g/10min	3.2	2.3	3.7
Vicat Softening Temperature(VST)	℃	88	93	88
Charpy Impact Strength	kJ/m^2	17	10	11
Flexural Modulus	MPa	1770	1750	1680

Measured by Toyo Styrene

Chemical resistance performance



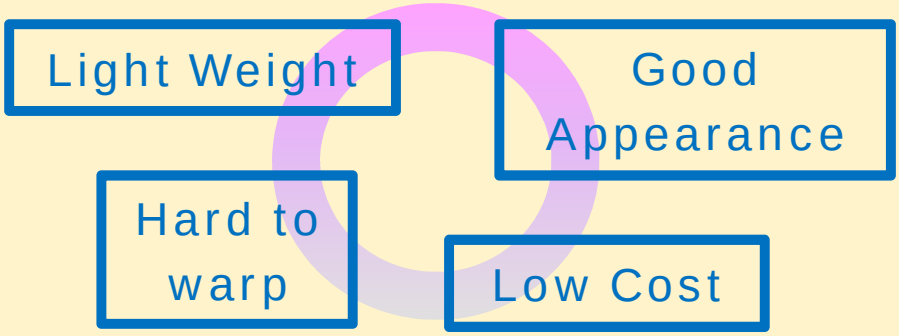
Heat Resistance Polystyrene(TF & TFP)



Application: Microwavable Food Package, etc.

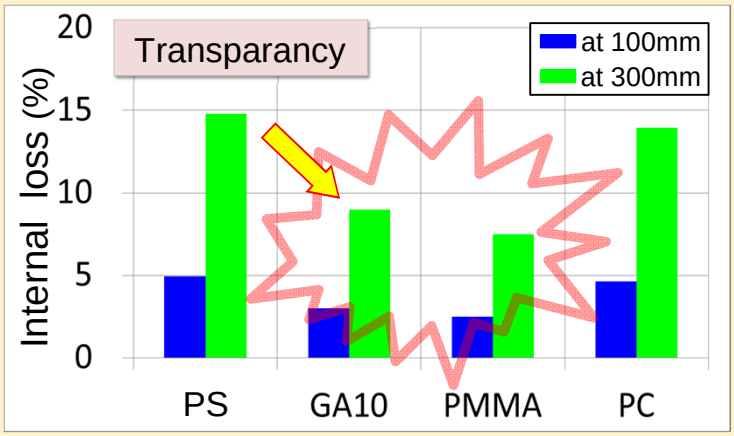
Good Appearance Polystyrene : GA

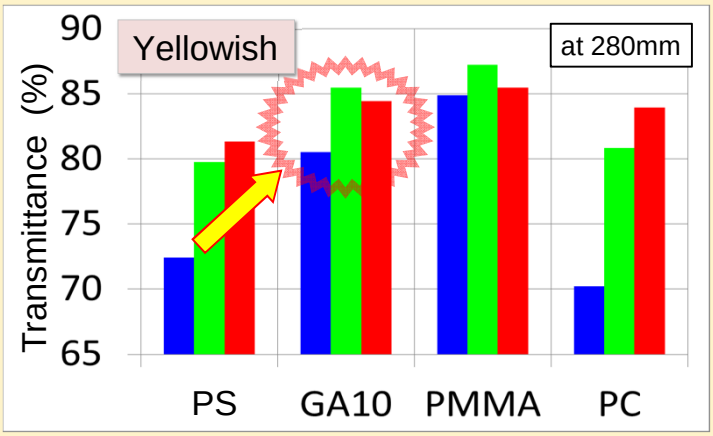
Combines Good appearance close to PMMA and benefits of PS

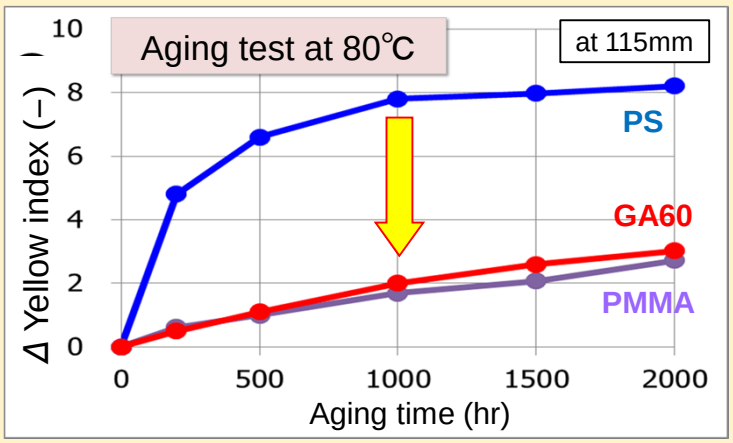


◆ Property Comparison

	PS	GA	PMMA	PC
Specific gravity	Excellent	**Excellent**	**Fair**	**Fair**
Moisture absorption	Excellent	**Excellent**	**Poor**	Good
Price per volume	Excellent	**Excellent**	**Fair**	**Fair**
Formability & Workability	Excellent	**Excellent**	Good	**Fair**
Transparency	Good	**Excellent**	Excellent	Good
Yellowish	**Fair**	**Excellent**	Excellent	**Fair**
Aging Yellowing	Good	**Excellent**	Excellent	Good
Strength	Good	**Good**	Good	Excellent







< Applications >

- Light guide plates
- Lightings
- Optical Components etc.

TOYO STYRENE Flame Retardant PS Resin Genealogy

Toyo Styrene Flame Retardant PS is a polystyrene resin with a certain flame-retardant.
By the flame-retardant class, we have not only V-2/V-0 series but also 5VA that is usually difficult in PS systems.
It has been adopted in response to needs such as consumer electronics, OA equipments and housing equipments.

◆ Representative grade

LCD TV-B/C

Heat Stability and Super Light Resistance

Halogen type ：LH30 (V-2)
：ES150 (5VA)

Copying Machine

High Flow and Good Light Resistance

Halogen type ：J2 (V-2)

High Flow and Good Heat Resistance

Halogen type ：FS100S (V-0)

Flame-Retardant Compound Resin
・Halogen type
・Non-Halogen type

Distribution Board

High Strength and Heat Stability

Non-Halogen ：NR5 (5VB)

LCD Monitor Housing-B/C

High Cycle Molding and
High Heat Creep Endurance

Halogen type ：LH30 (V-2)
Non-Halogen ：LX20 (V-2)

Toner Container

◆ FR-PS Masterbatch

Name	Direction
Flame-retardant MB (V-0) ：Halogen type	Good control for combination ratio between MB & Resin: Enable customer to design FR-HIPS which is suitable for anticipated Flame Retardance by mixed with optional resins. (compatibility is needed)
Flame-retardant MB (V-2) ：Halogen type	

FR-MB
(Bromine contents : x%)

※ Color : All color and Black color

＋

－Options by Customers－

Thinner Base Resin (PS) → Plasticization (Extrusion、Processing)

Ratio between MB & Resin mast be controled.

→ **Finished FR-HIPS V-0 or V-2**

◆ Corresponding to the EPEAT (the United States)

For electronics-related customers, we have developed a product that can correspond to the EPEAT *1 registration. **It is a V-2（registration in preparation）compatible products using post-consumer recycled materials and non-halogenated flame retardants.**

*1："Electronic Products Environmental Assessment Tool"

It is a system to evaluated according to certain criteria whether the product has been designed and manufactured taking into account the environmental impact.The materials for the products are required to be some of the matters such as the use of post-consumer recycled materials, the content less than halogen-based retardant content standards, compliance with the RoHS Directive, etc.
It is one of a procurement requirement for electronic products by federal govermment institutions in the U.S.

Flame Retardant PS (5VA)

The world's-first performance[1)]

1) except for SPS（syndiotactic polystyrene）

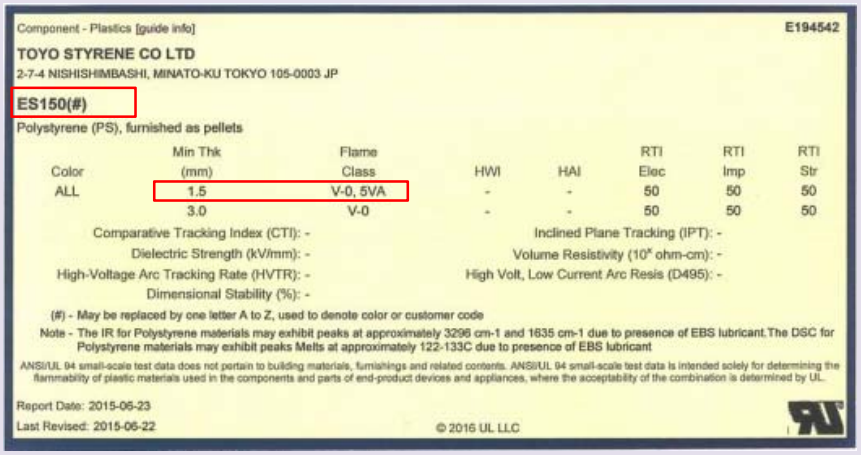
「ES150」 UL standard“1.5㎜／5VA”

FRPS of the TOYO STYRENE confidence having highest flame retardant performance and superior lightfastness.

【Physical properties】

Property	unit	ES150
Melt mass flow rate (MFR)	g/10min	7
Vicat softening temperature (VST)	℃	88
Heat deflection temperature	℃	70
Charpy impact strength	kJ/m^2	10
Tensile elongation at break	%	50
Flexural strength	MPa	45
Flexural modulus	MPa	2250
Density	Kg/m^3	1185
Burning behaviour(UL94)	-	1.5mm/5VA 1.5~3.0mm/V-0

【UL Certification】



Component - Plastics [guide info] E194542

TOYO STYRENE CO LTD

2-7-4 NISHISHIMBASHI, MINATO-KU TOKYO 105-0003 JP

ES150(#)

Polystyrene (PS), furnished as pellets

Color	Min Thk (mm)	Flame Class	HWI	HAI	RTI Elec	RTI Imp	RTI Str
ALL	1.5	V-0, 5VA	-	-	50	50	50
	3.0	V-0	-	-	50	50	50

Comparative Tracking Index (CTI): -

Dielectric Strength (kV/mm): -

High-Voltage Arc Tracking Rate (HVTR): -

Dimensional Stability (%): -

Inclined Plane Tracking (IPT): -

Volume Resistivity (10^x ohm-cm): -

High Volt, Low Current Arc Resis (D495): -

(#) - May be replaced by one letter A to Z, used to denote color or customer code

Note - The IR for Polystyrene materials may exhibit peaks at approximately 3296 cm-1 and 1635 cm-1 due to presence of EBS lubricant.The DSC for Polystyrene materials may exhibit peaks Melts at approximately 122-133C due to presence of EBS lubricant

ANSI/UL 94 small-scale test data does not pertain to building materials, furnishings and related contents. ANSI/UL 94 small-scale test data is intended solely for determining the flammability of plastic materials used in the components and parts of end-product devices and appliances, where the acceptability of the combination is determined by UL.

Report Date: 2015-06-23

Last Revised: 2015-06-22

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【example:1】Electrical box for air conditioner

【example:2】Wattmeter box

【other examples】

・Electrical box（Refrigerator・Laundry machine・Air cleaner）

・OA equipment exterior

Toyo Styrene suggests solution to the problems of waste

Ways of Plastic Recycle (In General)

Type (Called In Japan)	Method of Recycling		ISO 15270
Material Recycle	Reuse	by Materialization by Productization	Mechanical Recycle
Chemical Recycle	Raw Materialization/ Monomerization		Feedstock Recycle
	Blast Furnace Deoxidation		
	Chemical Raw Materialization by Coke Oven		
	Gasification/Oiled	Chemical Materialization	
		Conversion to fuel	
Thermal Recycle	Raw Fuel for Cement Production		Energy Recovery
	Waste Power Generation		
	RPF, RDF		

RPF: Refuse Paper and Plastic Fuel
RDF: Refuse Drived Fuel

Plastic Recycle by Coke Oven Chemical Materialization Method

Consumer

Containers, Package Plastic Products

Classified Discharge

Container / Package

Container/Package Converter

Manufacturing of Container & Package

Toyo Styrene

Production of Polystyrene

Pellets of Resin

Municipalities

Collect/Sort/Compaction/Strage

Collected Plastics

Nippon Steel & Sumikin Chemical

Styrene Monomer

Benzene
Toluene
Xylene etc.

Carbon Black
Pitch Coke
Naphtalene etc.

Styrene Plant

Light Oil

Tar

Utilize for Chemical Raw Materials

Nippon Steel & Sumitomo Metal

210,000t/y(2014)
Processed 1/3 of Collection by Japanese Municipalities

Thermal Decomposition at Coke Ovens
(Plastics are heated by the heating chamber to about 1200˚C in the absense of oxygen)

Coke Ovens

Coke (20%)

Blast Furnace

Steel Products

Coke Oven Gas (40%)

Power Plant

Electricity

Hydrocarbon Oil (40%)

※The contents and numbers of Thermal Decomposition are based on the information at Website of Nippon Steel & Sumitomo Metal.

POLYSTYRENE IS A SAFE FOOD PACKAGING MATERIAL

Polystyrene is made from styrene, listing as " possibly cause cancer to human".
Is polystyrene food packaging safe ?

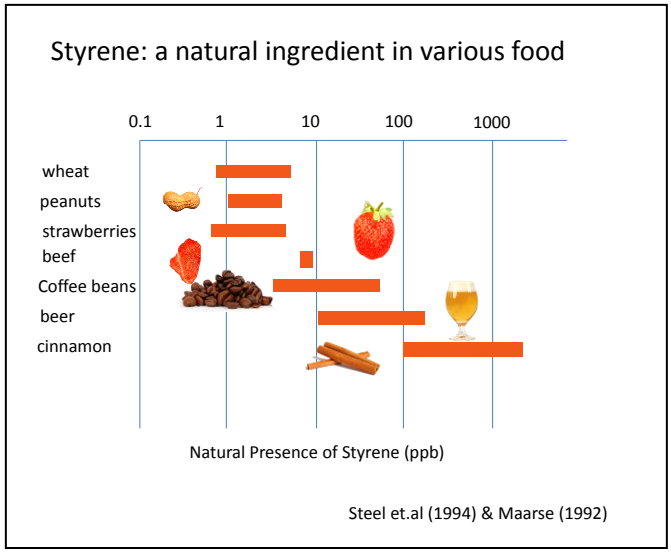
Yes. PS is safe.

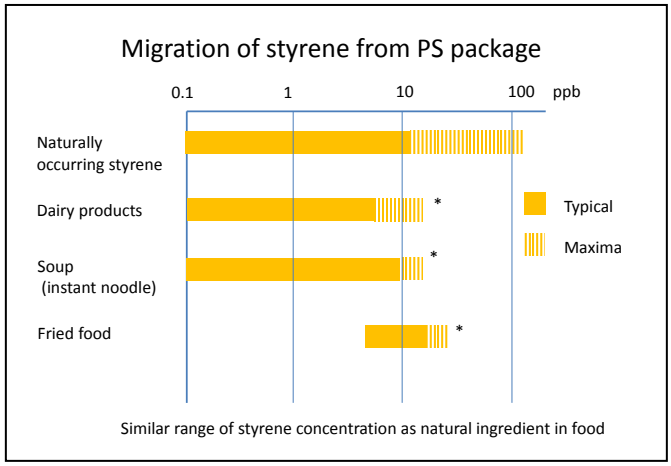
・Minor residual revel of styrene is remain in polystyrene and may migrate to food. But there is no data suggesting that the level of styrene migrating to food cause any harmful effect to animals and humans. The listing as carcinogen for styrene is based on studies of workers and animals exposed by inhalation to very high levels of styrene .

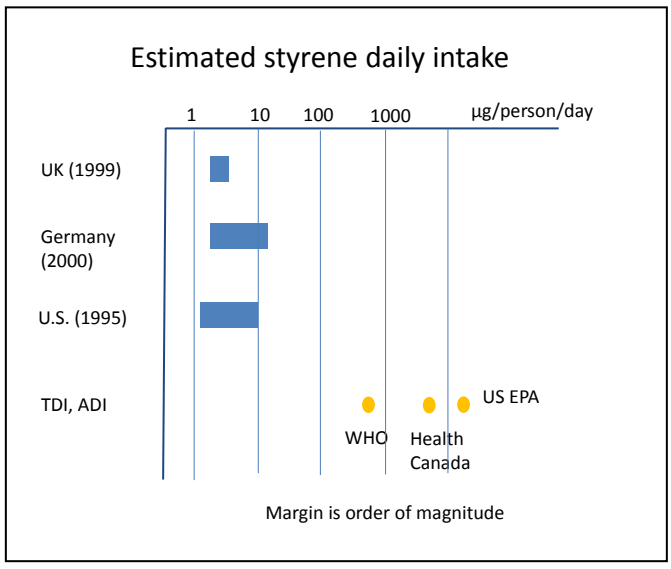
・Styrene occurs naturally in some foods (e.g., strawberries, peanuts, beef, beer, coffee and spices). Styrene concentration of these natural diet and migration from PS food packaging into food are similar range.

・ Acceptable Daily Intake (ADI) and Tolerable Daily Intake (TDI) for styrene based on animal studies ,0.46 ～ 12.0 mg/person/day, are published by several authorities. Estimated styrene daily intake in EU and U.S. are in the range of 1 ～10 μ g/person/day. Styrene intake is 40～ 1000 times below safe intake level.

・Polystyrene is authorized for food contact materials in U.S.A, EU , Japan and China etc.







Styrene(SM): Is there any concern about cancer risk to human ?

No. There is not. Styrene is not a human carcinogen.

・The results of extensive health studies of workers in styrene-related industries and a two-year styrene inhalation study in rats exposed to high concentrations of styrene show that exposure to styrene does not increase the risk of developing cancer.

・The International Agency for Research on Cancer (IARC) has classified for styrene as a "possible" human carcinogen. Many scientists have disputed this action because it was not based on new studies. Competent authorities of EU decided not to classify styrene for carcinogenicity taking into account all available scientific information in 2007.

Styrene dimers and trimmers (SDT) :

What are SDT ?

・ Residual amount (～ 1 %)of SDT present in polystyrene resin as reaction byproducts and degradation products. Very low migration (less than 50 ppb) of SDT from PS food container into food were reported.

・SDT was suspected of having estrogenic activity in the Wingspread Declaration [Our Stolen Futures, 1996] despite the lack of scientific analysis.

Are there any risk for human health ?

No. There is no risk.

・ Endocrine disruption activity:

Competent authorities in Japan concluded no specific actions are judged to be necessary for the time being, since no evidence indicating the endocrine disrupting activity of SDT has been found from the test results on purely synthesized SDT and extracts from polystyrene, then Japanese EPA deleted SDT from suspected materials list (2000).

・Other health effects_

a) General toxicity

A mixture of styrene dimers and trimers extracted from polystyrene was orally administered to pregnant rats at up to 1 mg/kg/day. There were no test compound-related clinical signs or effects in dams and offspring. The highest dosage of 1.0 mg/kg・bw/day is 1000 times of the maximum estimated daily intake of SDT assuming that a man of 60 kg takes 1 liter of instant noodle and soup a day (Nagao,2000) .

b) Genotoxicity

A mixture of SDT extracted from polystyrene was examined conformed to the FDA test guide line for food contact materials. Point mutation using bacteria (Ames test) and Chromosomal aberration using mammalian cell were negative (unpublished, 2013).

Ethylbenzene (EB):

Can EB migrate into food from PS packaging ? If so, are the migration of EB of concern to consumers?

No. it is of no concern.

It is unlikely to cause any health risks to humans due to EB migrated from PS packaging.

・In the production of PS, they primarily use EB as a solvent . Small amount of EB may remain in PS as a residual volatile substance.

・The migration concentration level of EB into foods are extremely low. Migration level of EB is similar as of styrene monomer.

・Estimated maximum daily intake for EB migrated from PS packaging is 6 μ g/person.

This value is about 2 order lower than the TDI established by WHO (580 μ g/person).

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