Introduction of LUMIPLAS

Light diffusion materials

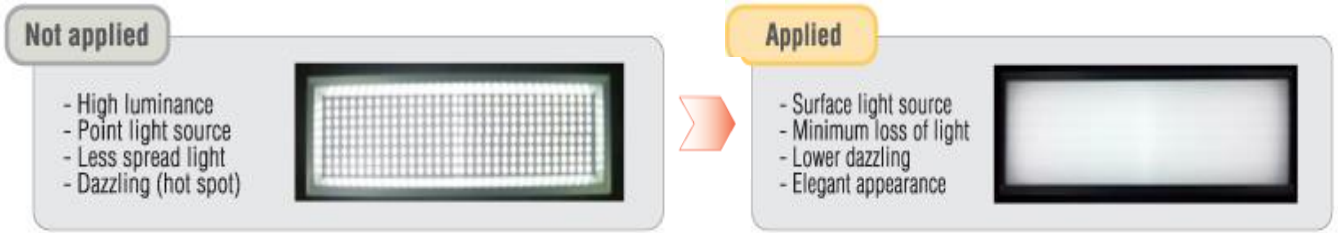
Dec. 2018

LG Chem

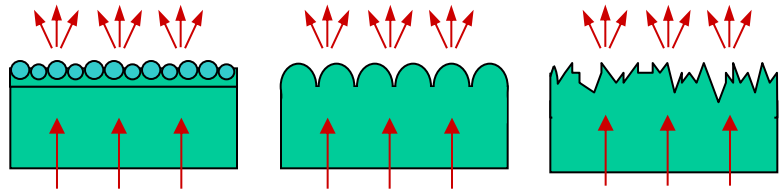
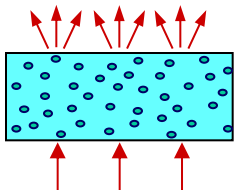
Introduction

What`s light diffusion material?

- Material with the ability to efficiently diffuse the light from the backside light source
  - ➢ Uniform brightness
  - ➢ Anti-glare
  - ➢ Aesthetic appearance

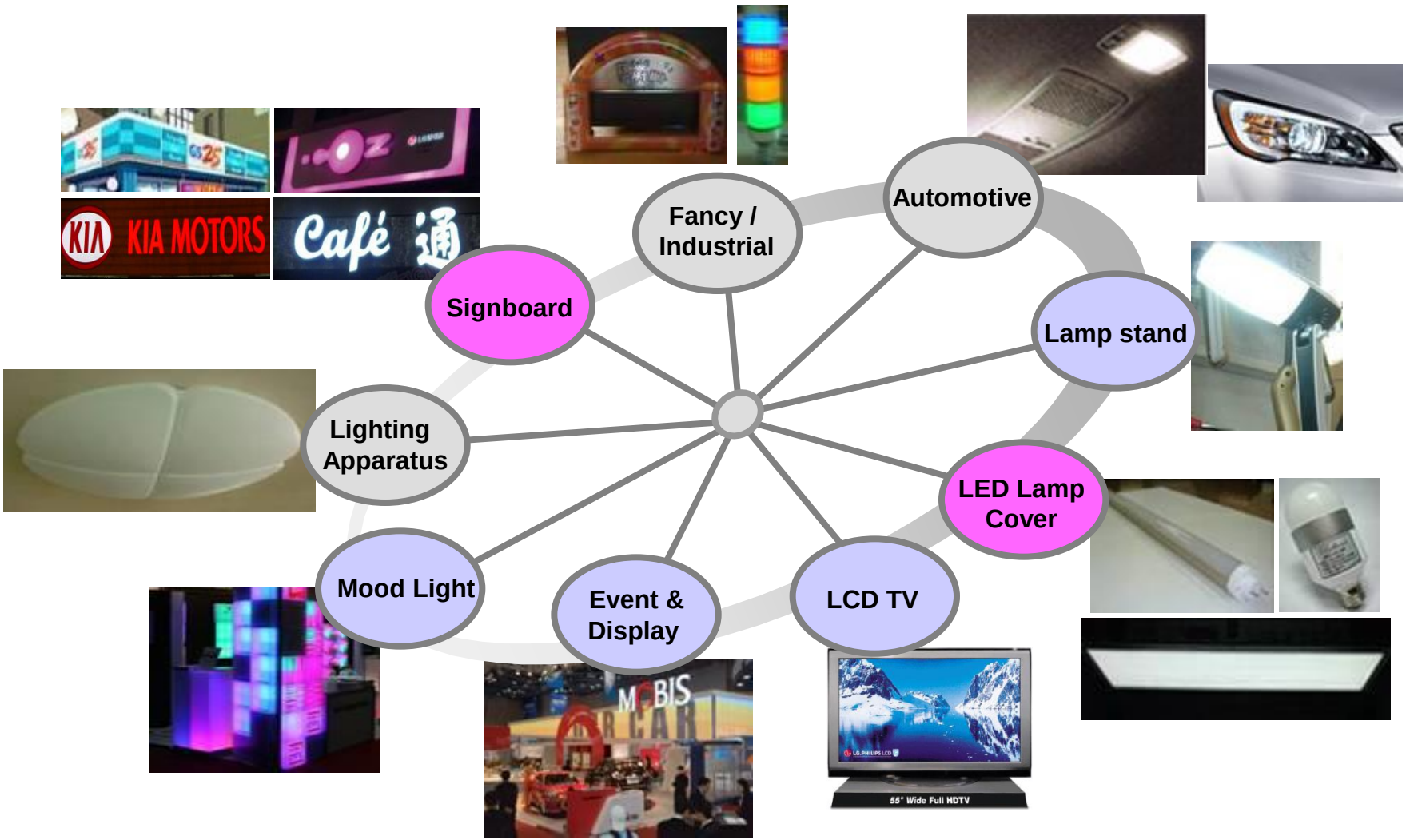


Method for providing light diffusion function

	Method of light diffution	Remarks
Surface molding	 Surface coating embossing corrosion	• High transmittance • Limited light diffusivity • Sensitive to surface scratches
Material	 Transparent resin + Light diffuser	• Adjustable light diffusibility [High transmittance ↔ High diffusion] • Easy processing

Applications of light diffusion materials

- The needs of light diffusion material is increasing with the growth of LED industry



The need of light diffusion material

Characteristics of LED light

- LED will replace conventional lamp due to lots of its benefits

Environment	Energy saving Eco-friendly
Technology	Energy efficiency Long lifetime Various color Design flexibility

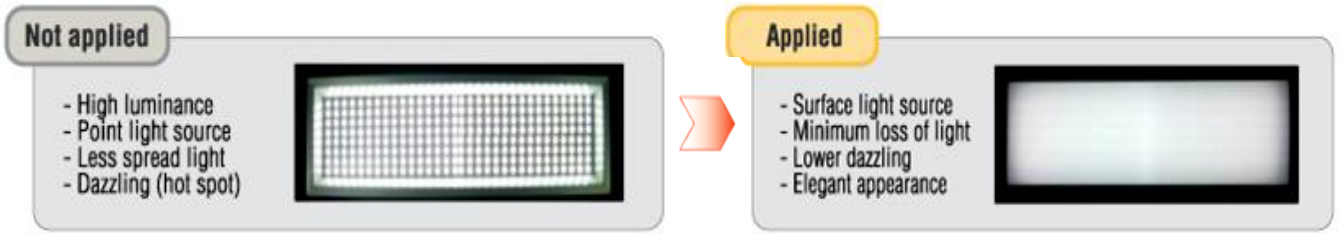
Efficiency (lm/W)	Incand.(20)/Fluor.(80)/ LED(100)
Eco-friendly	Mercury-free
Lifetime (hr)	Incand.(1,000)/Fluor.(10,000) LED(80,000)
Various color	LED: All color available Incand./Fluro : very limited
Design flex.	Curved surface & Slim lighting device *(Small size of light source)*

➢ Strong light from small size of light source ➔ Light diffusion cover is required

Introduction of light diffusion material

Function of light diffusion material

- Even Brightness
- Lower dazzling (prevent eye damage)
- Elegant appearance



The required properties of light diffusion material

Optical Properties

- Transmittance (efficiency)
- Diffusion ability (hiding LED hot spot)
- Color

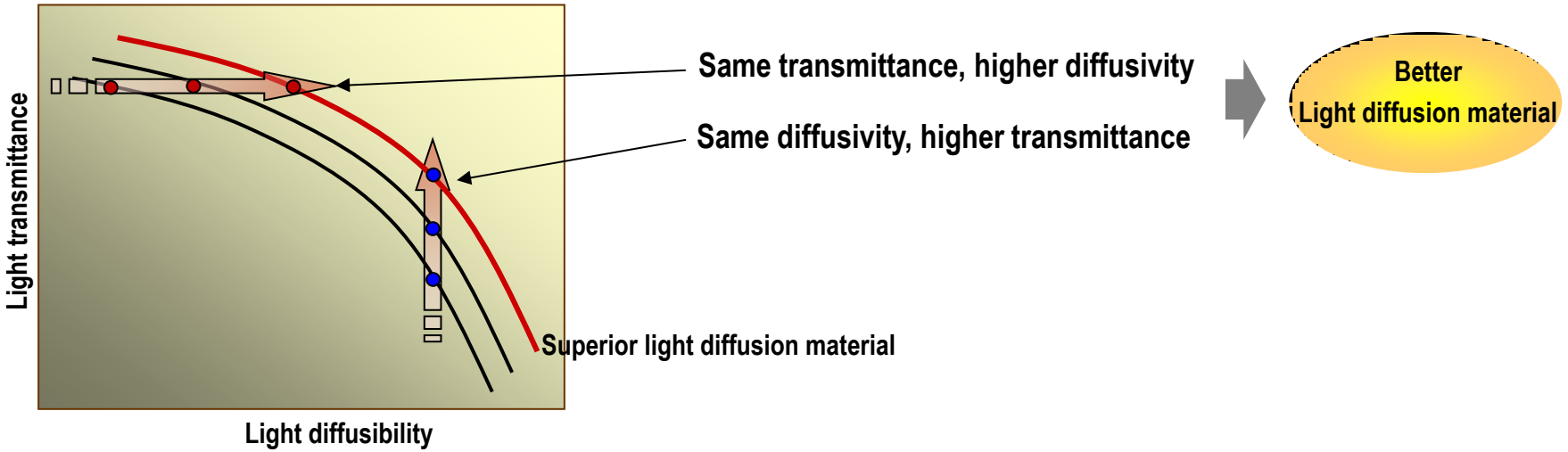
Other Properties

- Flame retardancy
- Weatherability
- Durability (high temp, high humidity,...)
- Physical properties (impact, ...)

...

Optical property of Light diffution materials (Light transmittance vs. light diffusibility)

- Transmissivity and diffusion performance are in conflict
- Possible to cause difference in optical characteristics due to additional characteristics (flame retardancy, ..)



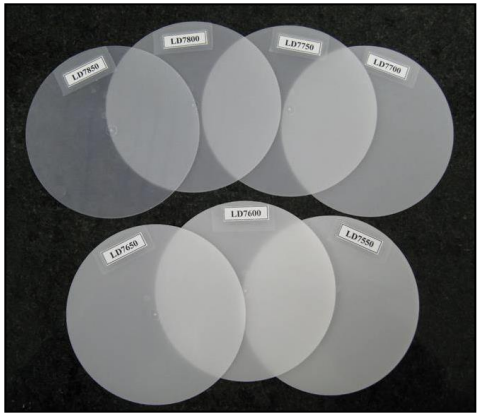
➔ Comparison of light diffusing materials : Need to review both transmittance and diffusivity

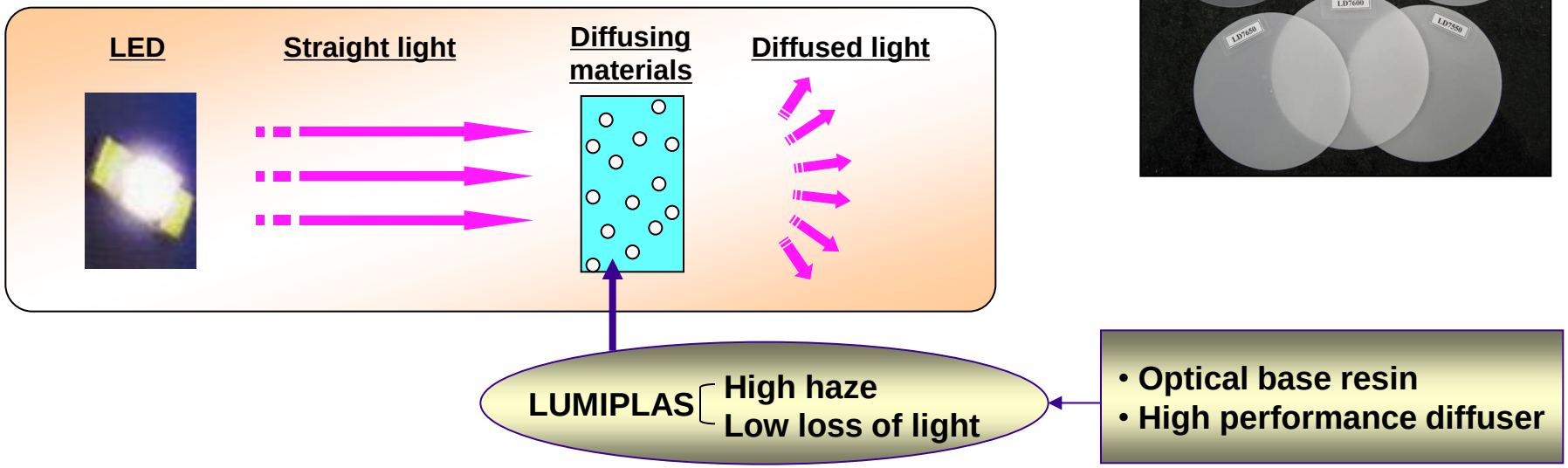
Introduction of LUMIPLAS

LUMIPLAS

- Light diffusion material of LG Chem for LED lighting and signboard

- LUMIPLAS has excellent Optical properties
  - Optimized optical properties [Transmittance and Diffusion of light]
  - Various kinds of optical grades

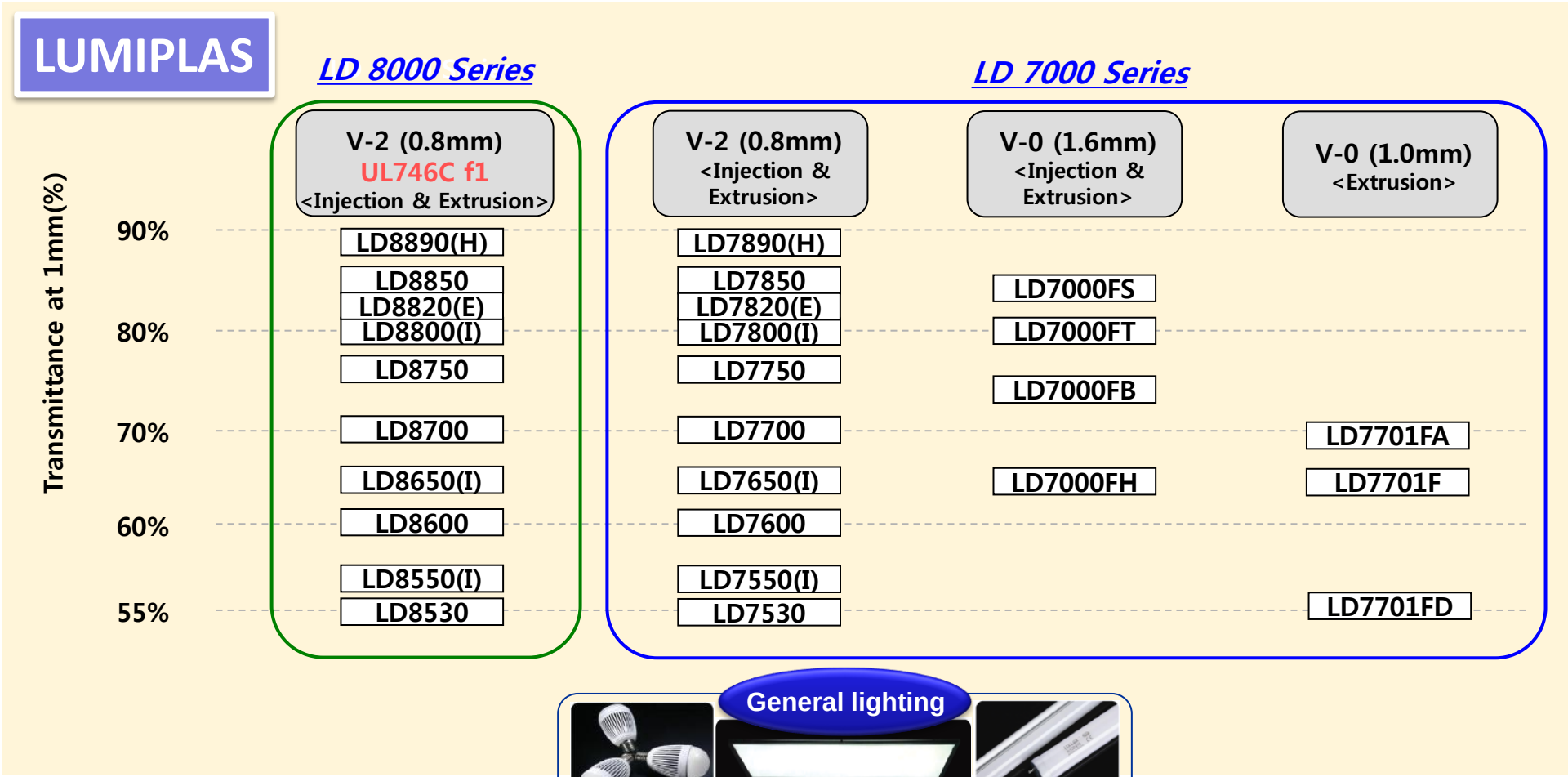




Introduction of LUMIPLAS

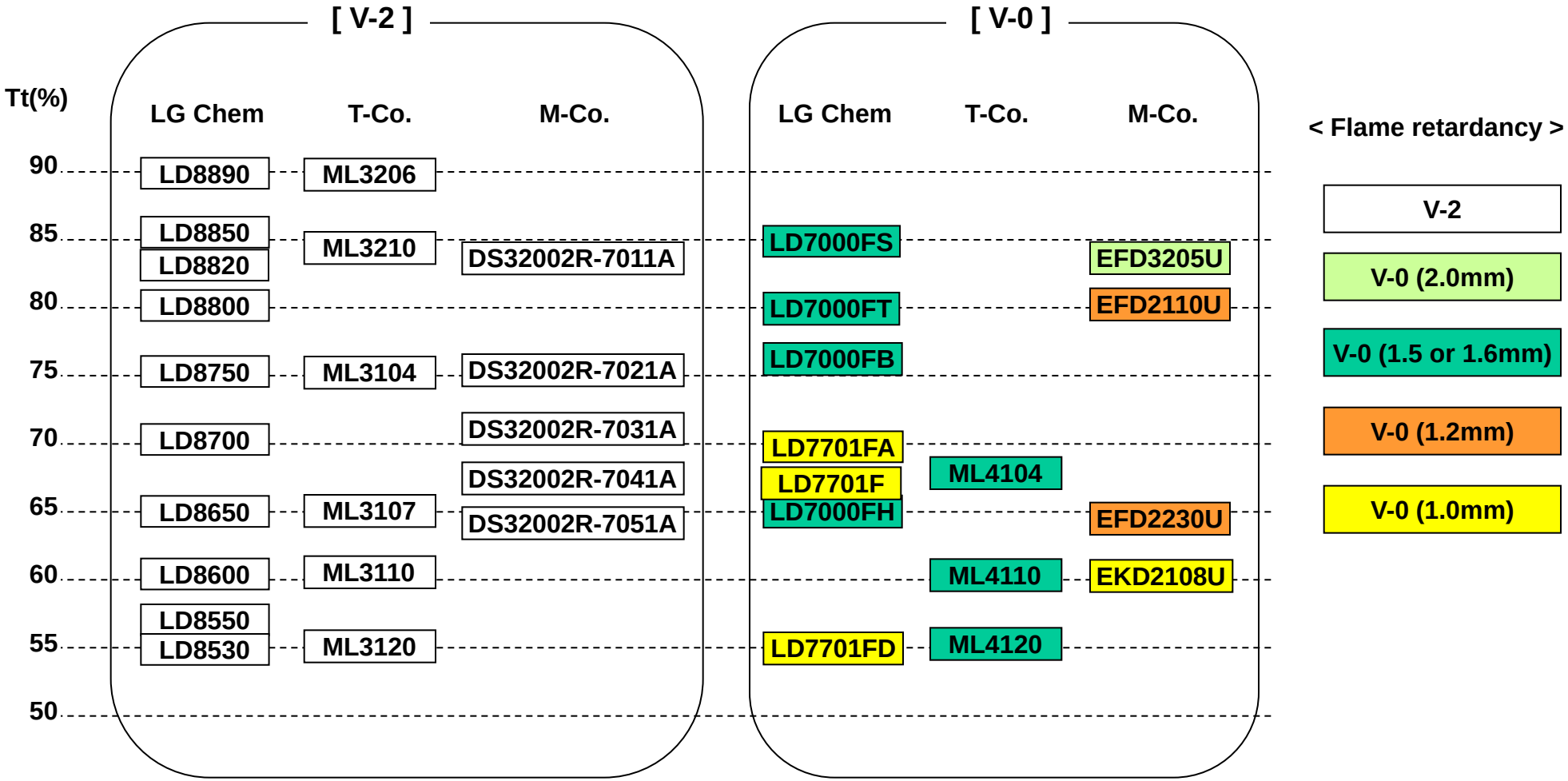
Products of LUMIPLAS

- LD7000 series (PC based) : **Excellent optical, thermal and impact properties (Flame Retardancy)**
- LD8000 series (PC based) : **Excellent optical, thermal and impact properties (Weatherability), RTI 120℃ , UL 746C F1**



Comparison of light diffusion materials

- Comparison of PC based light diffusion materials of several company



Optical properties of PC based LUMIPLAS

Transmittance (Tt), Haze , Half angle (HA)

- Tt & Haze : measured by Hazemeter
- HA : measured by Goniophotometer

※ Test methods: See attached file

Group	General grade	UV resistant grade	Optical properties (1 mm thickness)			Flammability
			Tt (%)	Haze (%)	HA	UL
PC base	LD7890H	LD8890H-W1017J	89	68.3	1.5	V-2 (0.8mm)
	LD7890	LD8890-W1017J	89	94.5	12.7	
	LD7850	LD8850-W1017J	87	95.5	10.1	
	LD7820(E)	LD8820-W1516J	82	97.0	15.3	
	LD7800(I)	LD8800-W1020J	80	98.5	20.4	
	LD7750	LD8750-W1020J	75	99.2	26.6	
	LD7700	LD8700-W1052J	70	99.4	33.6	
	LD7650(I)	LD8650-W1052J	65	99.5	45.9	
	LD7600	LD8600-W1052J	60	99.7	54.3	
	LD7550(I)	LD8550-W1181J	58	99.8	57.9	
	LD7530	LD8530-W1181J	54	99.5	60.1	
	-	LD7000FS-WxxxxJ	85	72.6	7.1	V-0 (1.6mm)
	-	LD7000FT-W1284J	80	94.4	11.0	
	-	LD7000FB-W1020J	75	96.9	11.5	
	-	LD7000FH-W1020J	65	99.4	37.8	
	-	LD7701FA-W1020J	68	99.3	30.8	V-0 (1.0mm)
	-	LD7701F-W1020J	64	99.4	35.3	
	-	LD7701FD-WxxxxJ	56	99.6	58.5	

*) Typical values are only for material selection guide. Values given should not be interpreted as specification and not be used for part or tool design.,

Optical properties of PC based LUMIPLAS

Transmittance (Tt), Haze , Half angle (HA)

- Tt & Haze : measured by Hazemeter
- HA : measured by Goniophotometer

※ Test methods: See attached file

Group	General grade	UV resistant grade	Optical properties (2 mm thickness)			Flammability
			Tt (%)	Haze (%)	HA	UL
PC base	LD7890H	LD7890H-W1017J	89	97.4	6.0	V-2 (0.8mm)
	LD7890	LD7890-W1017J	85	98.2	21.6	
	LD7850	LD7850-W1017J	77	99.0	27.7	
	LD7800	LD7800-W1020J	62	99.5	41.0	
	LD7750	LD7750-W1020J	56	99.6	48.6	
	LD7700	LD7700-W1052J	53	99.5	52.9	
	LD7650	LD7650-W1052J	51	99.6	59.0	
	LD7600	LD7600-W1052J	49	99.8	61.4	
	LD7550	LD7550-W1019J	47	99.8	62.1	
	-	LD7000FB-W1020J	57	99.1	36.4	V-0 (1.6mm)

*)본 수치는 grade 선정의 참고를 위한 실험치로서 환경에 따라 다른 결과를 나타낼 수 있으며, 보증치가 아님

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Optical properties of PC based LUMIPLAS

Transmittance (Tt), Haze , Half angle (HA)

- Tt & Haze : measured by Hazemeter
- HA : measured by Goniophotometer

※ Test methods: See attached file

Group	General grade	UV resistant grade	Optical properties (3 mm thickness)			Flammability
			Tt (%)	Haze (%)	HA	UL
PC base	LD7890	LD7890-W1017J	78	99.0	26.5	V-2 (0.8mm)
	LD7850	LD7850-W1017J	63	99.4	46.4	
	LD7700	LD7700-W1052J	45	99.6	58.4	
	LD7600	LD7600-W1052J	41	99.8	63.6	

*)본 수치는 grade 선정의 참고를 위한 실험치로서 환경에 따라 다른 결과를 나타낼 수 있으며, 보증치가 아님

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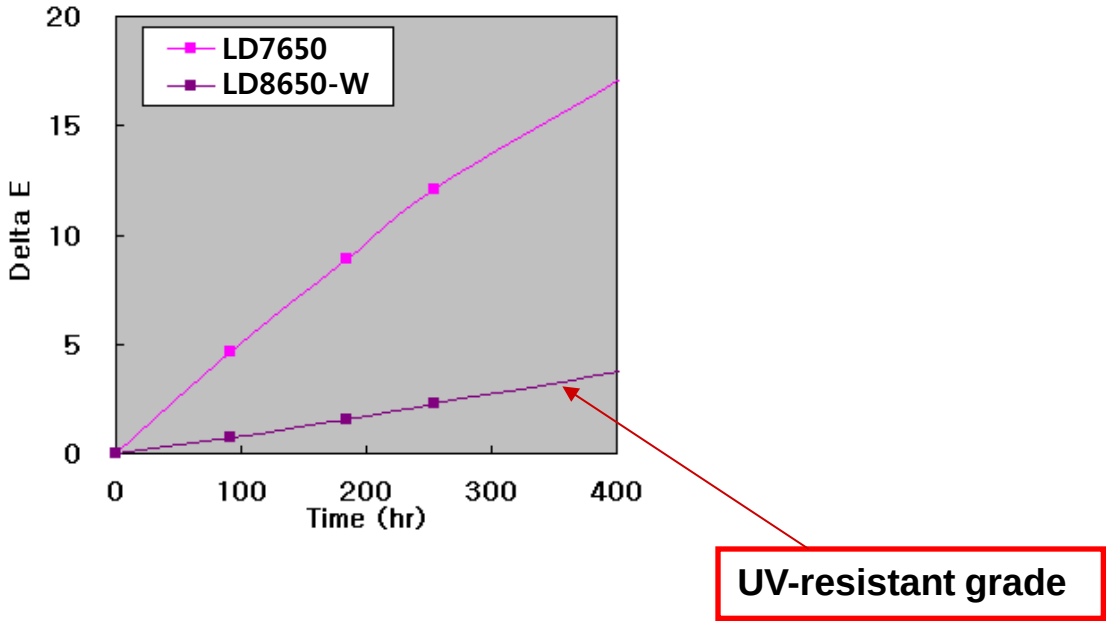
Weather resistant properties

※ QUV-test

- Test method : QUV (UVA, 0.77 W/m^2 at 340nm, 60°C)
- Samples: 1mm thickness specimens



	Grade	ΔE
		400h
General grade	LD7650	17.8
UV-resistant grade	LD8650-W1052J	3.77

*) Typical values are only for material selection guide. Values given should not be interpreted as specification and not be used for part or tool design.,

Certification

UL

LUMIPLAS LD7(xx)0(#)

Polycarbonate (PC), "LUMIPLAS", furnished as pellets

Color	Min Thk (mm)	Flame Class	HWI	HAI	RTI Elec	RTI Imp	RTI Str
ALL	0.8	V-2	-	-	80	80	80
	1.6-1.7	V-2	-	-	80	80	80

Comparative Tracking Index (CTI): -
Dimensional Stability (%): -
High-Voltage Arc Tracking Rate (HVTR): -
High Volt, Low Current Arc Resis (D495): -
Dielectric Strength (kV/mm): -
Volume Resistivity (10^x ohm-cm) : -

(#) - May be followed by optional suffix letter from A-Z incl., except F, and except Grades AF302G, HT700B, XR401B, LI912A, AF303G, AF303S, XR404T, XR407D, XR407E, HF380X.

(xx) - Indicates a two digit number 50-90 incl. denoting the light transmittance.

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: 2010-01-05
Last Revised: 2011-05-24
Underwriters Laboratories Inc®

Component - Plastics E67171

LG CHEMICAL LTD
20 YOIDO-DONG, YONGDUNGPO-GU, SEOUL 150-721 KR

LUMIPLAS LD7701F(#)

Polycarbonate (PC), "LUMIPLAS", furnished as pellets

Color	Min Thk (mm)	Flame Class	HWI	HAI	RTI Elec	RTI Imp	RTI Str
ALL	1.0	V-0	1	0	80	80	80
	3.0	V-0	1	0	80	80	80

Comparative Tracking Index (CTI): 3
Dimensional Stability (%): 0.068
High-Voltage Arc Tracking Rate (HVTR): -
High Volt, Low Current Arc Resis (D495): -
Dielectric Strength (kV/mm): -
Volume Resistivity (10^x ohm-cm) : -

(#) - May be followed by optional suffix letter from A-Z incl., except F, and except Grades AF302G, HT700B, XR401B, LI912A, AF303G, AF303S, XR404T, XR407D, XR407E, HF380X.

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Report Date: 2011-05-12
Last Revised: 2011-05-31
Underwriters Laboratories Inc®

Component - Plastics [guide info] E67171

LG CHEM LTD
20 YOIDO-DONG, YONGDUNGPO-GU, SEOUL 150-721 KR

LUMIPLAS LD8(xx)0(#) (f1)

Polycarbonate (PC), "LUMIPLAS", furnished as pellets

Color	Min Thk (mm)	Flame Class	HWI	HAI	RTI Elec	RTI Imp	RTI Str
ALL	0.5	V-2	-	-	80	80	80
	1.6	V-2	2	0	120	105	120
	2.5	V-2	2	0	120	105	120
	3.0	V-2	2	0	120	105	120

Comparative Tracking Index (CTI): 3
Inclined Plane Tracking (IPT): -
Dielectric Strength (kV/mm): 12
Volume Resistivity (10^x ohm-cm): 15
High-Voltage Arc Tracking Rate (HVTR): 2
High Volt, Low Current Arc Resis (D495): 5
Dimensional Stability (%): 0

(#) - May be followed by optional suffix letter from A-Z incl., except F, and except Grades HT700B, XR401B, LI912A, AF303G, AF303S, XR404T, XR407D, XR407E, HF380X.
(f1) - Suitable for outdoor use with respect to exposure to Ultraviolet Light, Water Exposure and Immersion in accordance with UL 746C.
(xx) - Indicates a two digit number 50-90 incl. denoting the light transmittance.
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: 2001-11-29
Last Revised: 2015-03-24
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RoHS

LG Chem Research Park
104-1, Moonji-dong, Yuseong-gu, Deajeon, 305-380, Korea
Tel: 042 866 2401, Fax: 042 861 2057

Test Report

2009. 08. 31

Result(s) :
Sample ID N
Sample Des

Heavy Metal

Test Item
Pb
Cd
Cr
Hg

* Cr content

Flame Retard

Test Item
Monobromobiphe
Dibromobiphenyl
Tribromobiphenyl
Tetrabromobiphe
Pentabromobiphe
Hexabromobiphe
Heptabromobiphe
Octabromobiphe
Nonabromobiphe
Decabromobiphe
Monobromodiphe
Dibromodiphenyl
Tribromodiphenyl
Tetrabromodiphe
Pentabromodiphe
Hexabromodiphe
Heptabromodiphe
Octabromodiphe
Nonabromodiphe
Decabromodiphe

* ND : Not D
* MDL : Met

LG Chem Research Park
104-1, Moonji-dong, Yuseong-gu, Deajeon, 305-380, Korea
Tel: 042 866 2401, Fax: 042 861 2057

Test Report

2009. 08. 31

Result(s) :
Sample ID No. : R09-06213 (4)
Sample Description : LUMIPLAS LD7700-All colors

Heavy Metals Unit : mg/kg

Test Items	Results	MDL	Test Method
Pb	ND	5	ICP/OES, IEC 62321 Ed. 1.0 : 2008 / EPA 3052:1996
Cd	ND	2	
Cr	ND	2	
Hg	ND	1	Direct Mercury Analyzer, EPA 7473:2007

* Cr content includes entire Cr species including Cr^{6+}

Flame Retardants-PBBs/PBDEs Unit : mg/kg

Test Items	Results	MDL	Test Method
Monobromobiphenyl	ND	5	GC/MS, IEC 62321 Ed. 1.0 : 2008 / EPA 8270C: 1996
Dibromobiphenyl	ND	5	
Tribromobiphenyl	ND	5	
Tetrabromobiphenyl	ND	5	
Pentabromobiphenyl	ND	5	
Hexabromobiphenyl	ND	5	
Heptabromobiphenyl	ND	5	
Octabromobiphenyl	ND	5	
Nonabromobiphenyl	ND	5	
Decabromobiphenyl	ND	5	
Monobromodiphenyl ether	ND	5	
Dibromodiphenyl ether	ND	5	
Tribromodiphenyl ether	ND	5	
Tetrabromodiphenyl ether	ND	5	
Pentabromodiphenyl ether	ND	5	
Hexabromodiphenyl ether	ND	5	
Heptabromodiphenyl ether	ND	5	
Octabromodiphenyl ether	ND	5	
Nonabromodiphenyl ether	ND	5	
Decabromodiphenyl ether	ND	5	

* ND : Not Detected
* MDL : Method Detection Limit

-End of Report-

Thank You!

[Appendix] Physical properties

Typical properties of LUMIPLAS

Property	Test Method	Unit	LD7700	LD7000FB	LD7701F
Mechanical properties					
Tensile strength	ASTM D638	Kg/cm^2	630	630	630
Tensile elongation		Kg/cm^2	150	150	150
Flexural strength	ASTM D790	Kg/cm^2	950	950	950
Flexural modulus		Kg/cm^2	23,000	23,000	23,000
Impact strength (notched Izod)	ASTM D256	Kg·cm/cm	80	80	80
Thermal properties					
Heat distortion temperature - 18.6kg/㎠	ASTM D648	°C	130	125	125
Melt Flow Rate - 300℃/1.2kg	ASTM D1238	g / 10 min	11	5	5
Flammability	UL94		V-2 (0.8mm)	V-0 (1.6mm)	V-0 (1.0mm)

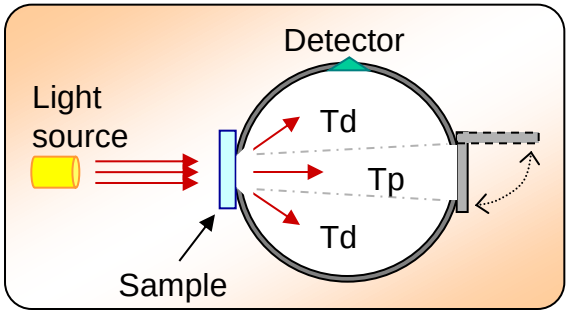
*) Typical values are only for material selection guide. Values given should not be interpreted as specification and not be used for part or tool design.,

[Appendix] Test methods for optical properties

Test methods

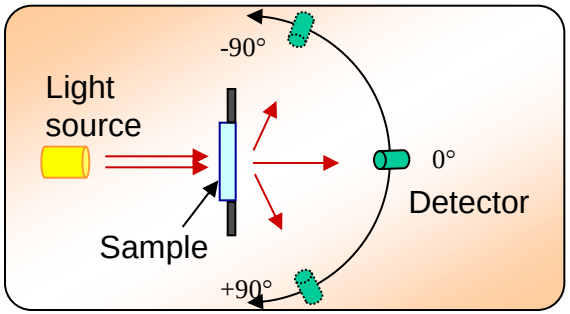
- **Total transmittance (Tt) : Total amount of transmitted light**
- **Haze , Diffusion Factor (DF) and Half Angle (HA) : different kinds of methods for indicating the light diffusing ability**

< Hazemeter >

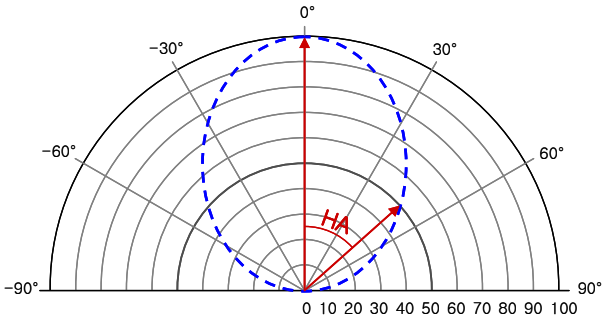


- **Tt** (Total transmittance) = Td + Tp (JIS 7361)
- **Haze** = Td / Tt

< Goniophotometer >



- **HA**: angle at which half amount of light flux is measured



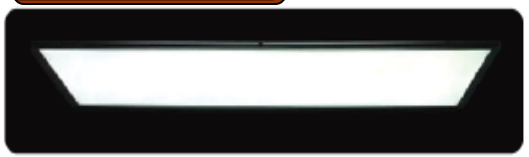
[Appendix] Tips for selecting suitable grade

- **Optical materials should be selected by considering the structure of application product**

Bulb type

Characteristics	• High transmittance and low haze ∵ long distance between lamp and cover
Recommended	• LD8800, LD8850, LD8890

Flat panel type



Characteristics	• Medium transmittance and medium haze ∵ long distance between lamp and cover - long distance between lamp and lamp
Recommended	• LD8650, LD8700, LD8750

Tube type

Characteristics	• Low transmittance and High haze ∵ short distance between lamp and cover
Recommended	• LD8600, LD8650, LD8700

※ The suitable grade may differ from above examples due to the structure of final product.