

PMMA Materials for Automotive Application

CRYSTALUX®



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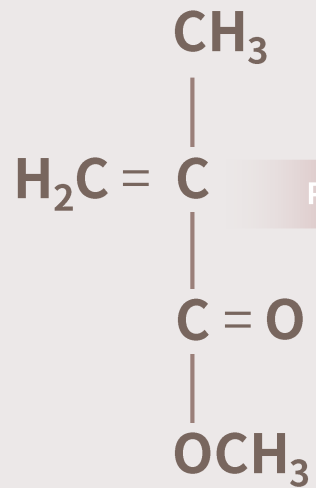
PMMA Materials for Automotive Application

- Introduction to PMMA
- Application
- Grade Line-up
- Lamp Application
- Exterior Application
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Introduction to PMMA

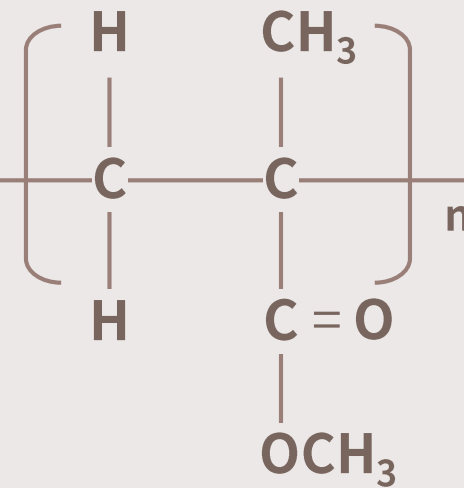
PMMA (Polymethyl methacrylate)

MMA



PMMA

Polymerization



Transparent, Liquid phase,
100.01 g/mol

Transparent, Solid phase

Characteristics of PMMA



High Transparency

More than 92% Transmittance
The most excellent transparency among plastics



Excellent Weatherability

The most excellent weatherability
among plastics



High Scratch Resistance

Excellent scratch resistance &
High surface hardness

Application

CRYSTALUX®

Lamps



Rear Lamp Lens

- IH830C
- IH830CA / IH830SR

Turn Signal Indicator

- IH830C

Aspherical Lens / Light Guide

- IH830L
- IH830XT

Pillars / Spoiler



1K Molding

- HI542-S9678

2K Molding

- IH830-9678
- IH830C-9678

Spoiler Garnish

- HI835MS-9678
- HI781-S9678 (PMMA/ASA)

Mirrors



1K Molding

- HI753-S9678
- HI781-S9678

2K Molding

- IH830-9678
- IH830C-9678

Base Plate

- HI835MS-9678

Grilles



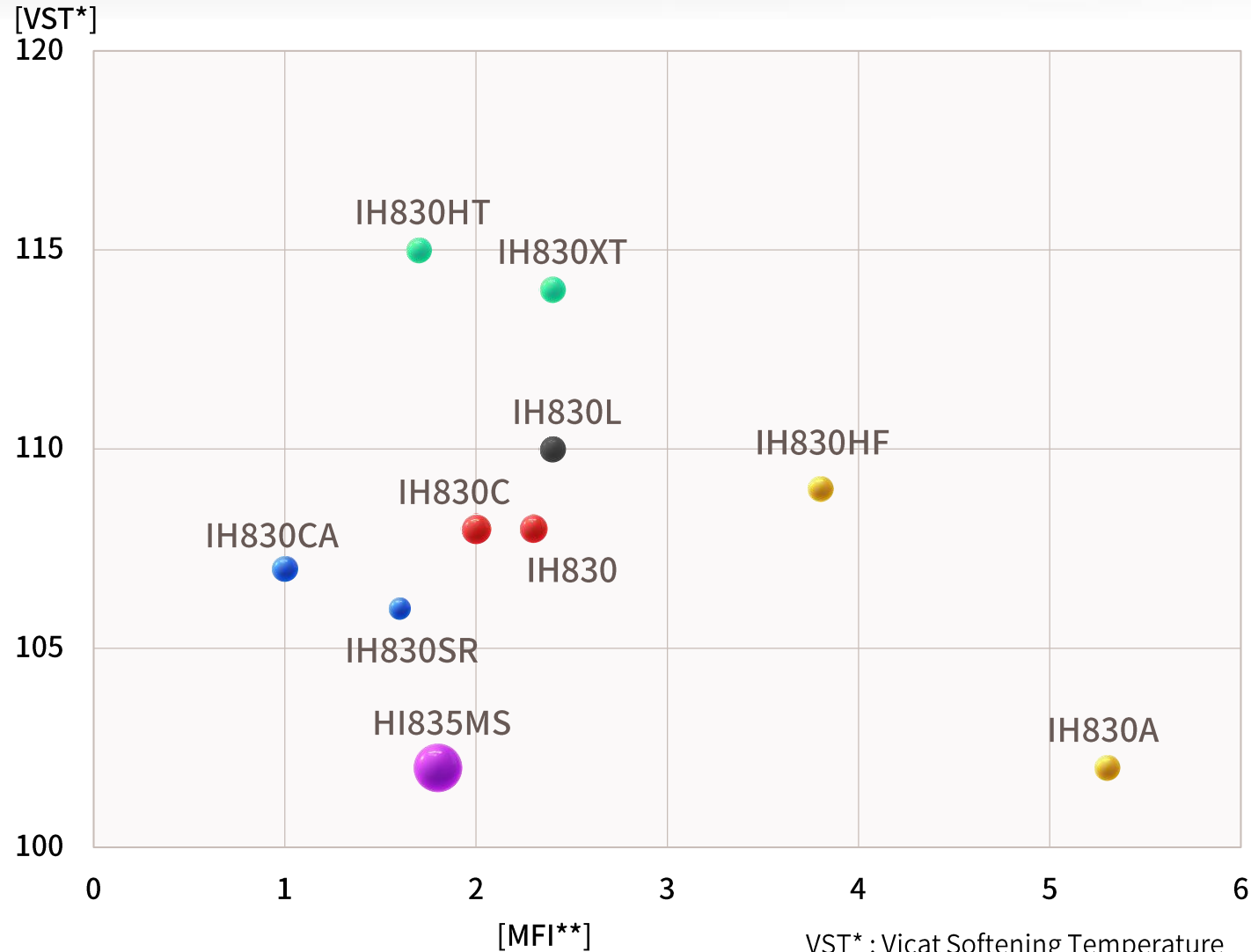
PMMA/ASA

- HI753-S9678
- HI781-S9678

Grade Line-up

		 Classification	 Grade	 Global Application
	Optical (Transparent)	General	IH830, IH830C	Lighting (AMECA Certified)
		High Flow	IH830A, IH830HF	
		Impact Strength	HI835MS	
		LED Aspherical Lens	IH830L	
		Heat Resistance	IH830XT, IH830HT	
		Chemical Resistance	IH830CA, IH830SR	
	High Gloss (Opaque) PMMA	General	IH830-9678 IH830HF-9678	Pillar Spoiler Garnish
		High Impact	HI835MS-9678 HI542-S9678	
	High Gloss (Opaque) PMMA/ASA	High Impact Strength	HI753-S9678	Radiator Grille Pillar Spoiler Garnish
			HI781-S9678	

Grade line-up Lamp



VST* : Vicat Softening Temperature
MFI** : Melt Flow Index
Note : Circle size indicates the level of Impact

Classification	Grade	MFI (g/10min)	VST (°C)	Charpy (kJ/m²)
General	IH830	2.3	109	1.5
	IH830C	2	108	1.5
High Flow	IH830HF	3.8	109	1.5
	IH830A	5.3	102	1.5
Impact Resistant	HI835MS	1.8	102	2.6
Optical	IH830L	2.4	110	1.5
Heat Resistant	IH830XT	2.4	114	1.5
	IH830HT	1.7	115	1.5
Chemical Resistant	IH830CA	1	107	1.5
	IH830SR	1.6	106	1.2

General PMMA IH830 / IH830C

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Main Characteristics

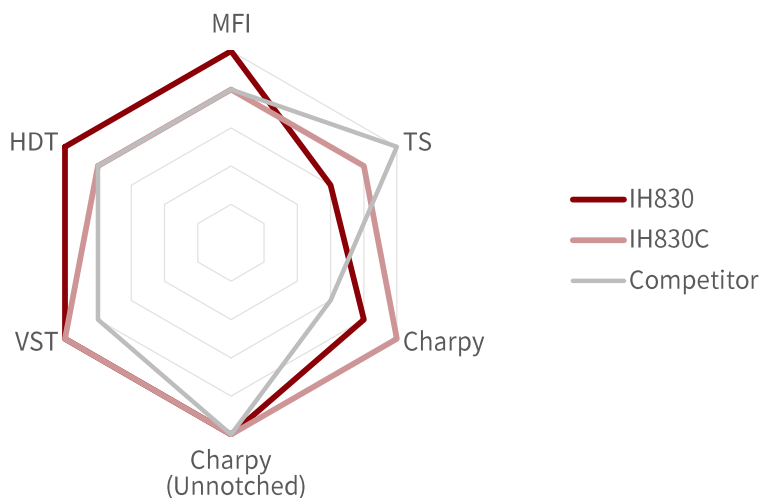
- Well Balanced Mechanical Property
- AMECA Certified

Application



- Rear Combination Lamp
- High Mount Stop Lamp

Property



OEM Homologation List

	SPEC No.	LX MMA Grade
GM	GMW 16635P-T2	IH830C
Ford	WSS-M4D776-B3	IH830C
	WSS-M4D776-B5	IH830C-S9678
Stellantis	MS-DB-75 GPN4232	IH830, IH830C
Daimler	DBL 5416-Type 90	IH830-9678
Renault	EP 10-1b	IH830, IH830C IH830C-40060
	EP 15	IH830-9678
	DP02b	IH830-9678
VW	TL 591	IH830, IH830C
	TL 526 71-Type B	IH830C-9678
HKMC	MS235-01-TA	IH830, IH830C
CHERY	Q/SQR S1-68-2013-A1	IH830, IH830C
	Q/SQR S1-68-2013-A2	IH830C
SAIC	SMTC 5310 022	IH830C
SAIC MAXUS	CVTC 52142-T2	IH830C
DF Peugeot-Citroen	FTM 60 0007	IH830C

High Flow PMMA IH830HF / IH830A

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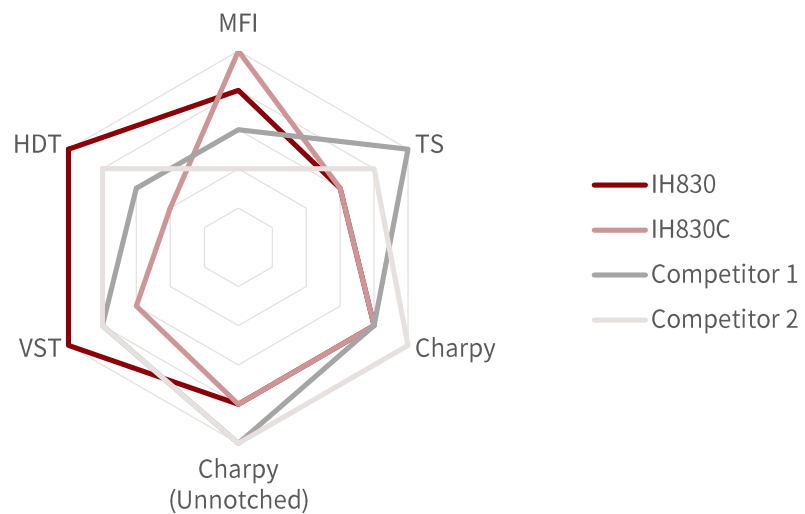
Main Characteristics

- High Flow with Heat Resistance
- AMECA Certified

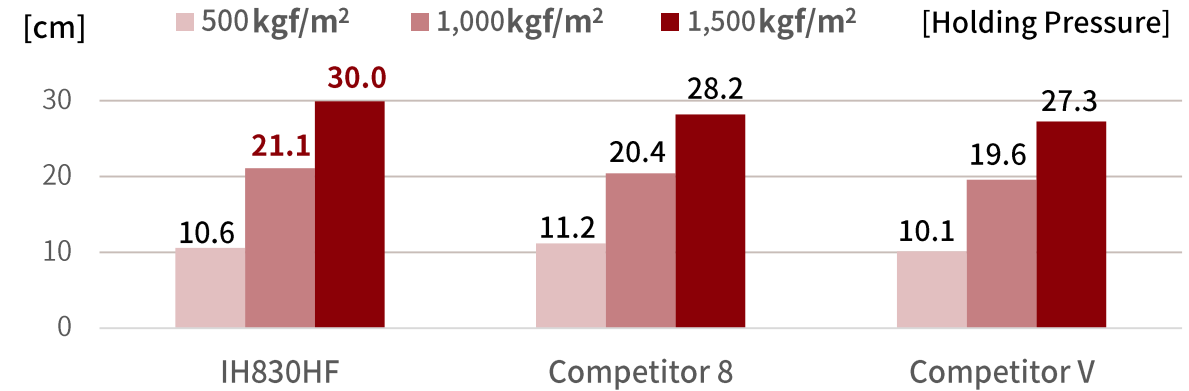
Application

- Interior, I/P Windows
- Cluster Cover

Property



Spiral Flow Test



Injection Condition

- Nozzle / Mold Temp. : 240 / 60°C
- Injection Machine : Fanuc 110Ton

OEM Homologation List

	SPEC No.	LX MMA Grade
GM	GMW16635P-T2HF	IH830HF
	GMW16635P-T3	IH830A
HKMC	MS235-01-TA	IH830HF

Optical PMMA IH830L / IH830XT

Main Characteristics

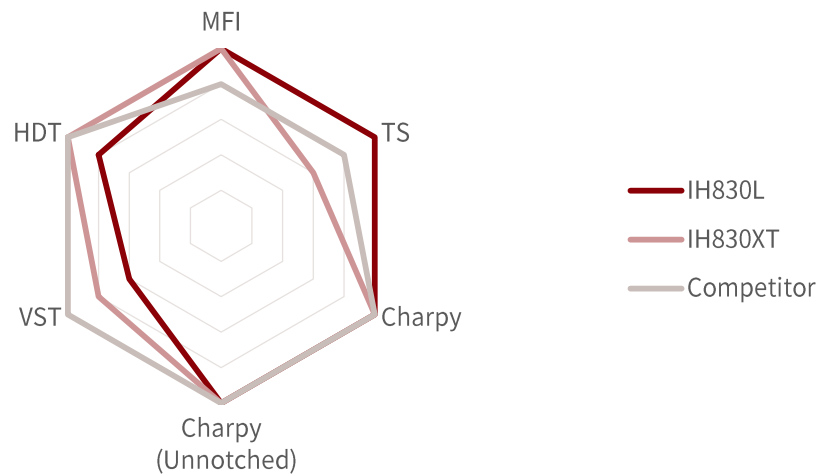
- Well Balanced Mechanical Property
- AMECA Certified

Application



- LED Aspherical Lens
- Daytime Running Light (DRL) Light Guide

Property



PMMA Aspherical Lens

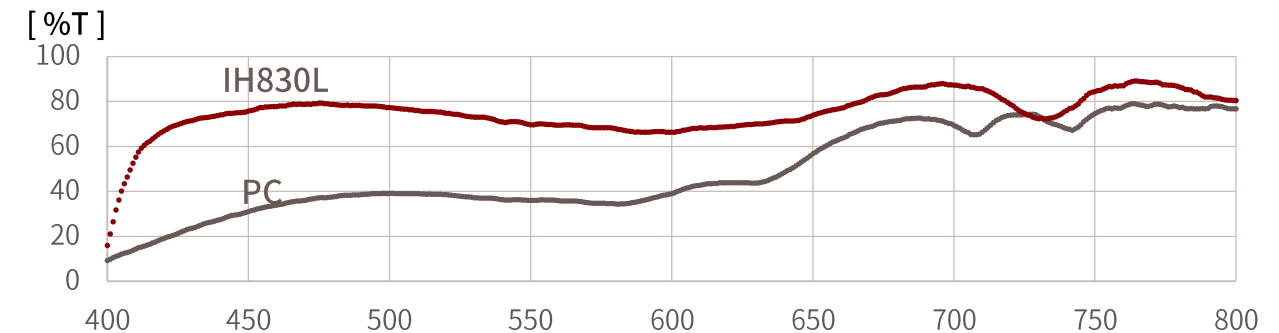


- Light Weight & Flexible Design

Long-path (300mm) Transmittance

Wavelength (nm)	800	700	600	500	400
IH830L (%T)	80.4	87.3	66.4	77.3	16.0
PC (%T)	76.8	69.4	39.1	39.2	9.2

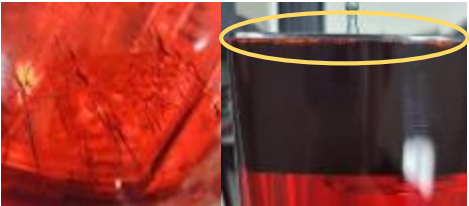
- Better transmittance than PC



Tested by Hitachi UH4150 Spectrophotometer

Chemical Resistance PMMA IH830CA / IH830SR

Main Characteristics

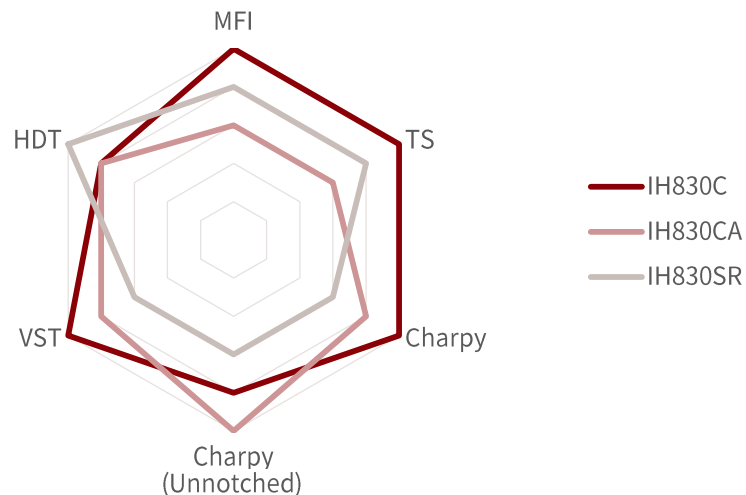


- Excellent Chemical Resistance
- Unnecessary UV-hard Coating
- AMECA Certified

Application

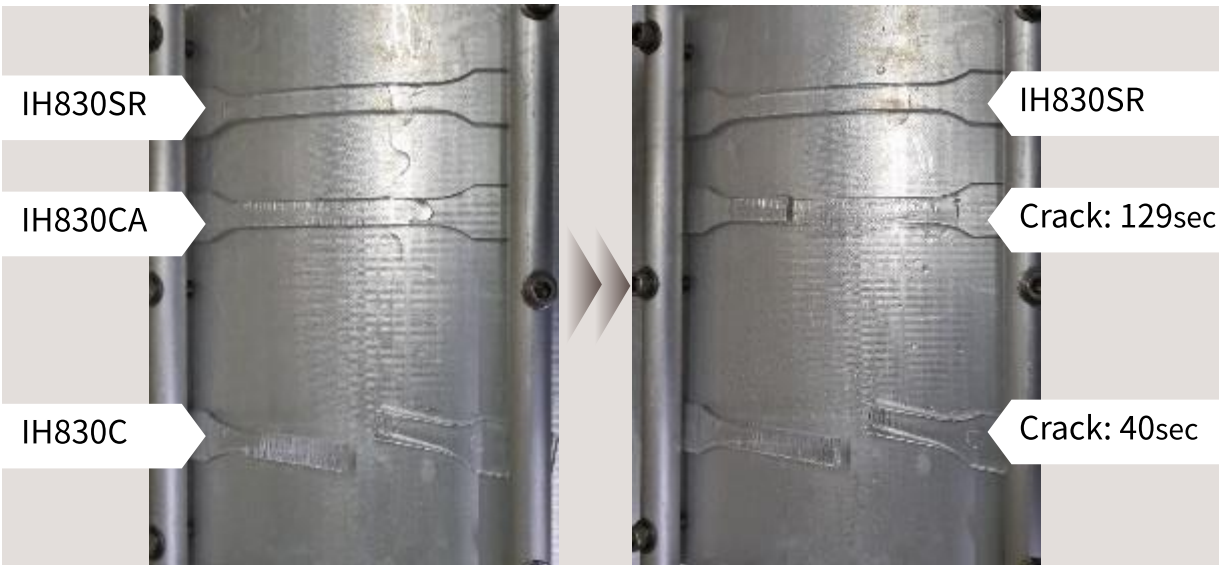
- Rear Combination Lamp (RCL)
- Center High Mount Stop Lamp (CHMSL), Trunk Garnish Lamp

Property



ESCR* Test Result

- 70% Ethanol, 0.9% Strain



OEM Homologation List

	SPEC No.	LX MMA Grade
GM	GMW16635P-T2	IH830CA
HKMC	MS235-01-TC	IH830CA

ESCR* : Environmental Stress Crack Resistance

Opaque Black Color(83447) Transmitting NIR Ray

Laser Transmission Welding (vs. Conventional Welding)

- High Precision, No Flash, No residue, Minimum Thermal Stress
- Fast Welding Speed, High Weld Strength

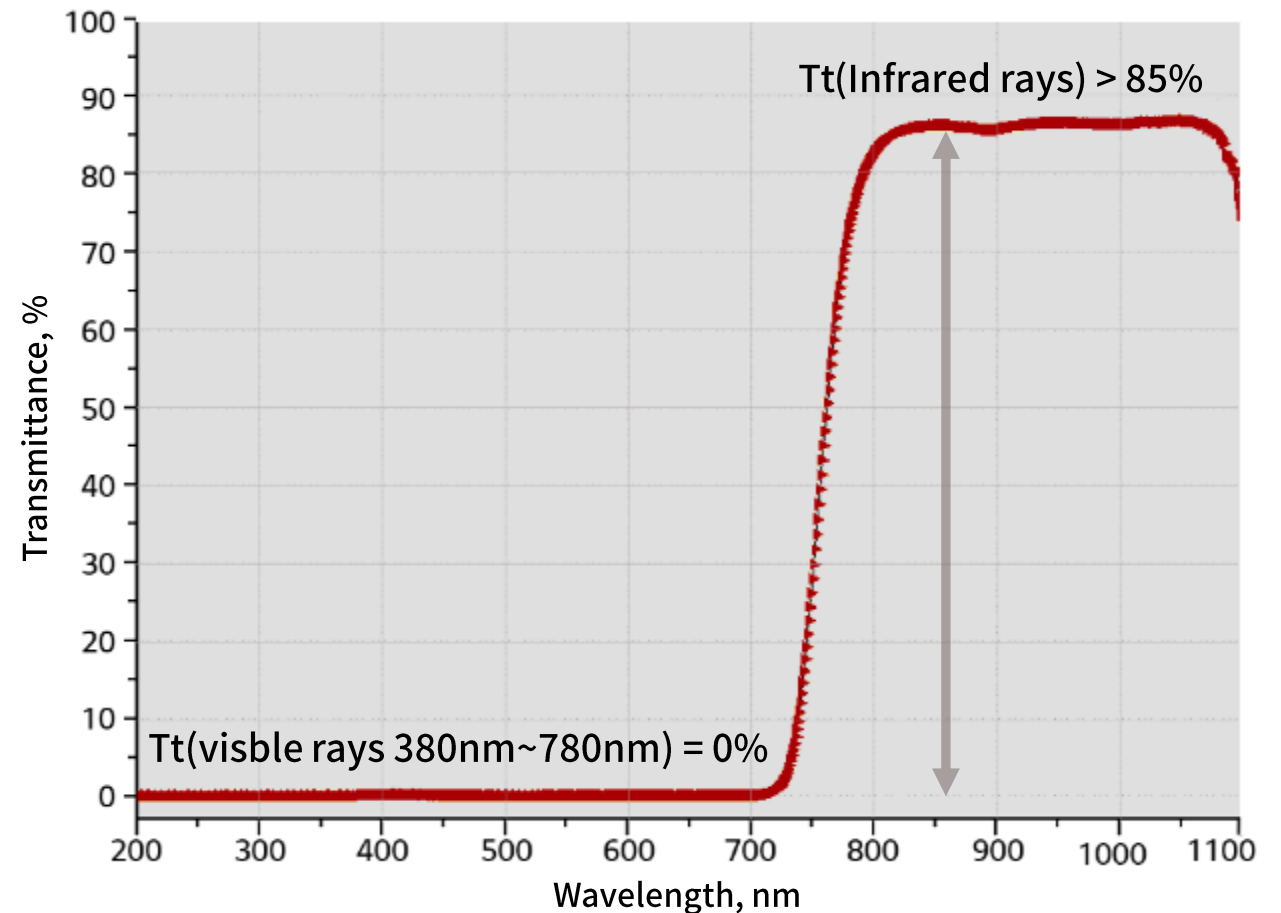
Black Bezel with Double Layer Injection Molding

- In general, Black does not allow visible & NIR Ray through

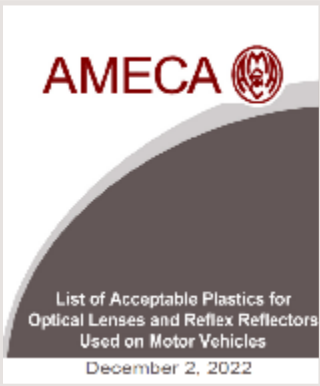


Light Transmittance Curve

- High Transmittance at 800~1,000nm

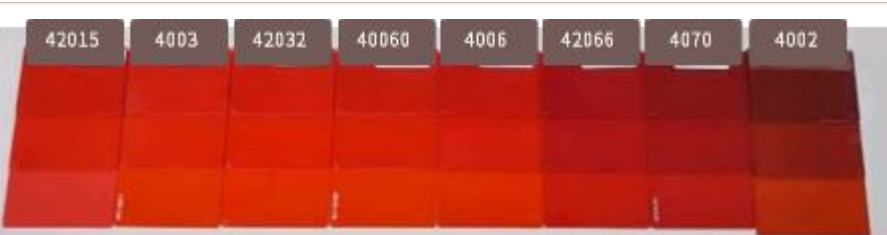


Plastics for Optical Lens & Reflex Reflectors



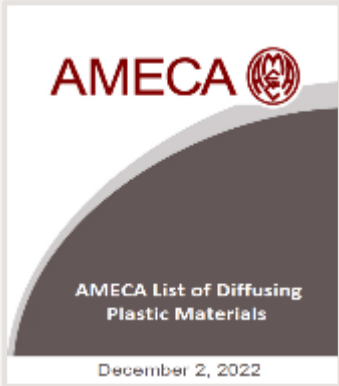
PLASTIC TYPE	PLASTIC NAME	PLASTIC NUMBER
Acrylic	Acrylic	42015
Acrylic	Acrylic	4003
Acrylic	Acrylic	42032
Acrylic	Acrylic	40060
Acrylic	Acrylic	4006
Acrylic	Acrylic	42066
Acrylic	Acrylic	4070
Acrylic	Acrylic	4002

AMECA Listed Red Color For Rear Combi. Lamp Application

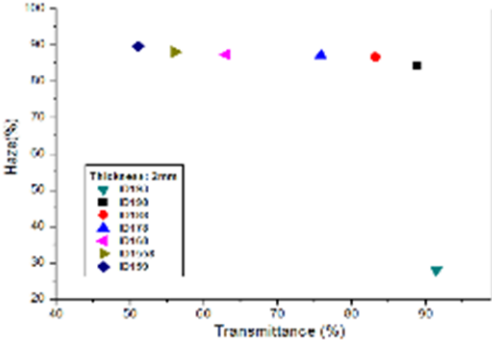
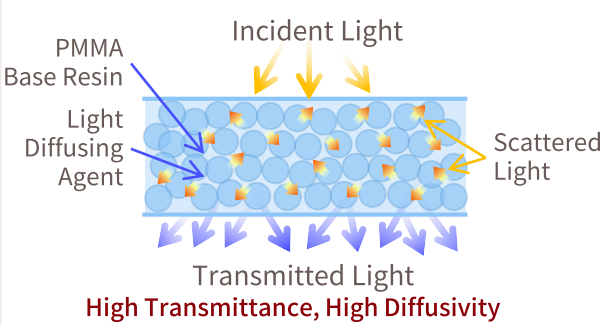


Transmittance (%)	Thickness	42015	4003	42032	40060	4006	42066	4070	4002
	2mm	32	30	27	28	27	19	18	20
	3mm	27	27	24	24	23	17	15	14

Diffusing Plastic Materials



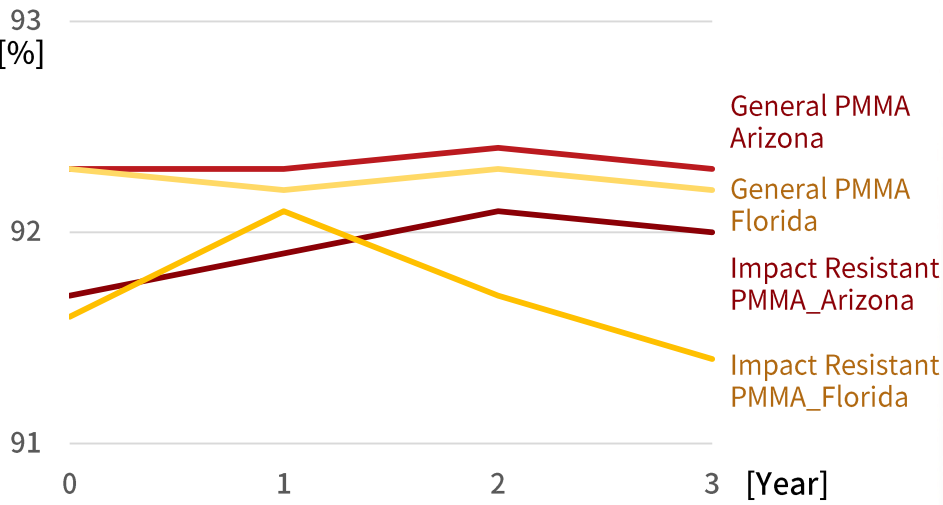
MFR.	TRADE NAME AND FLOW FORMULATION	TYPE OF RESIN	NUMBER	COLOR
LXMMMA CORP.	IH530MS	Polymethyl Methacrylate	ID38	Diffusion
	IH530C		ID58	Diffusion
	IH530HR		ID78	Diffusion
Formerly LXMMMA Corporation			ID158	Diffusion
			ID168	Diffusion
			ID198	Diffusion
			ID193	Diffusion
			ID1540	Diffusion
			ID1559	Diffusion



AMECA Weatherability Test

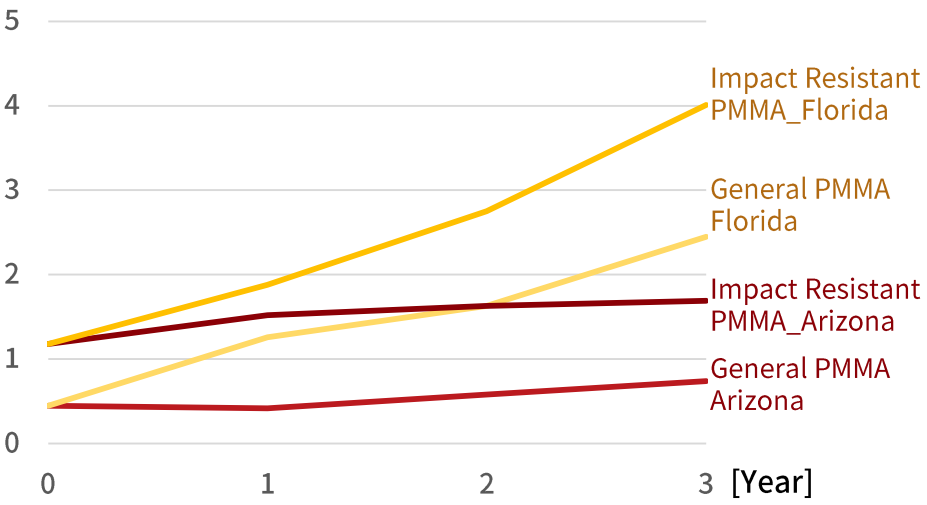
Arizona & Florida 3 Years Test Result

Transmittance



		STD	1 Year	2 Year	3 Year	Retention after 3 Years
General PMMA	Arizona	92.3	92.3	92.4	92.3	100 %
	Florida	92.3	92.2	92.3	92.2	99.9 %
Impact Resistant PMMA	Arizona	91.7	91.9	92.1	92.0	100 %
	Florida	91.6	92.1	91.7	91.4	99.8 %

Haze



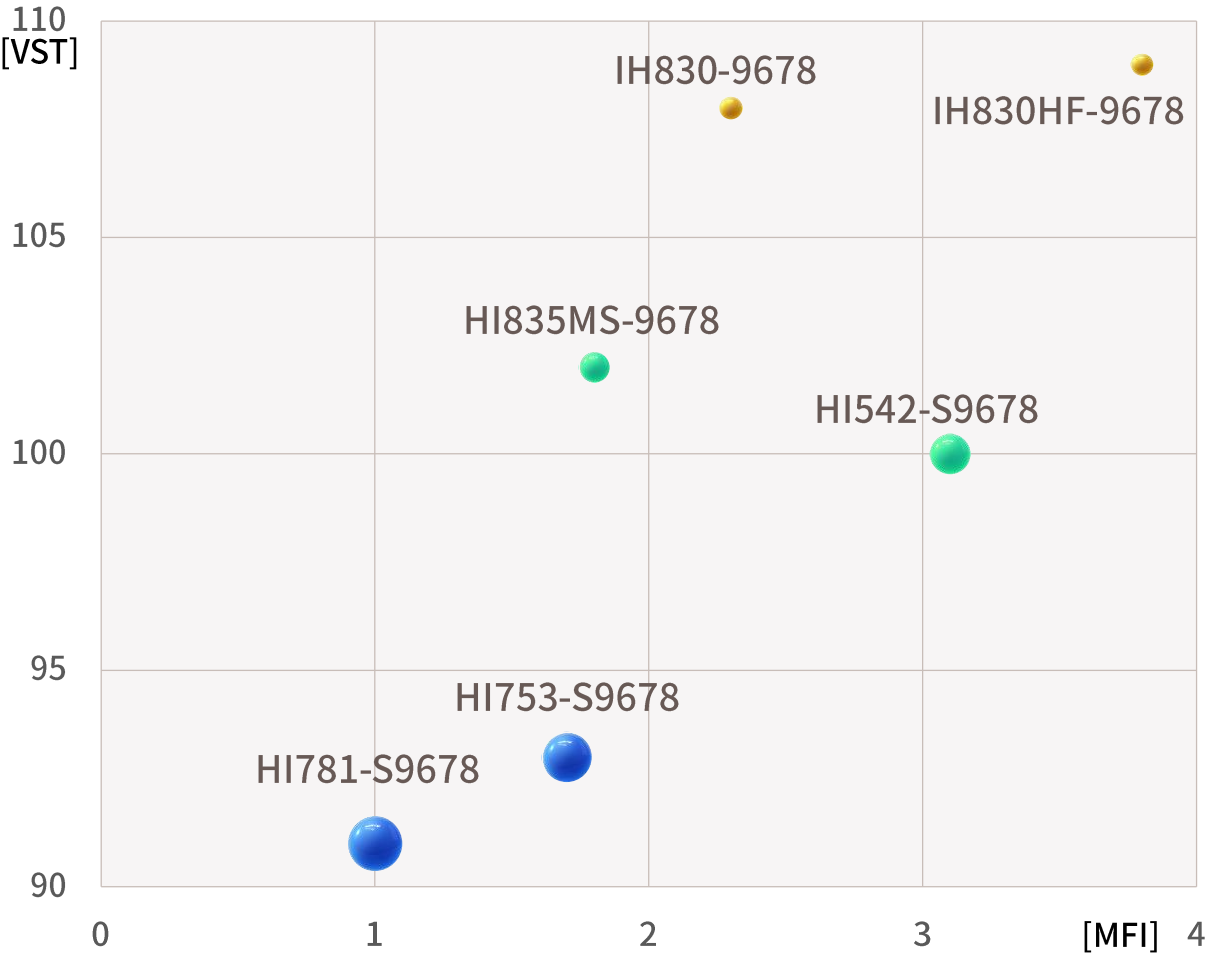
		STD	1 Year	2 Year	3 Year	△ Haze
General PMMA	Arizona	0.45	0.42	0.58	0.74	0.29
	Florida	0.45	1.26	1.63	2.45	2.00
Impact Resistant PMMA	Arizona	1.18	1.52	1.63	1.69	0.51
	Florida	1.18	1.88	2.75	4.01	2.83



After Weatherability Test
: No Objectionable defects
(Test Method : PV3929, 3000hr)

Grade line-up Exterior

Deep Black Color for Non-Paining Application



VST* : Vicat Softening Temperature
MFI** : Melt Flow Index

Note : Circle size indicates the level of Impact

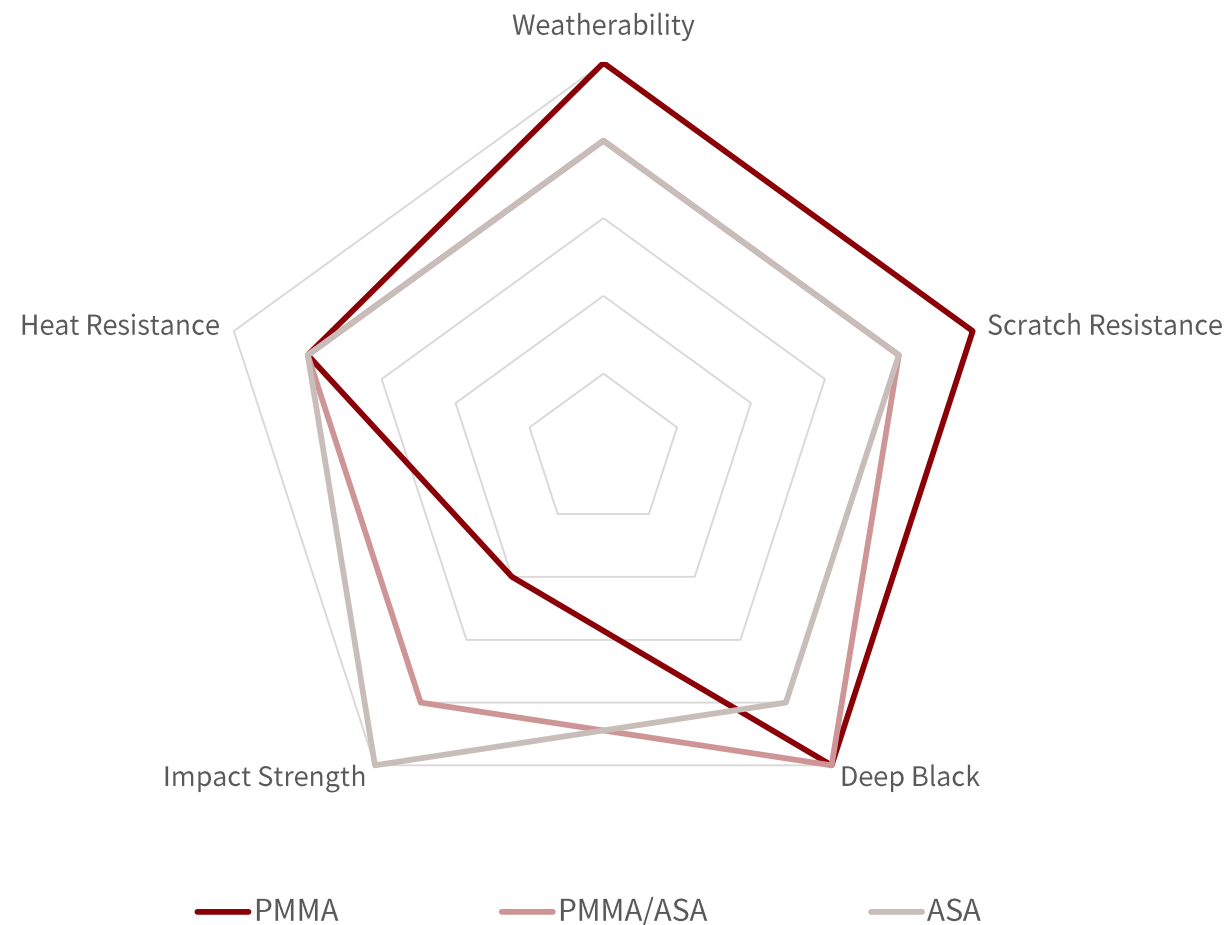
	Grade	MFI (g/10min)	VST (°C)	Charpy (kJ/m²)
PMMA for Exterior	IH830-9678*	2.3	109	1.5
	IH830HF-9678	3.8	109	1.4
	HI835MS-9678	1.8	102	2.6
	HI542-S9678	3.1	100	4.5
PMMA/ASA for Exterior	HI753-S9678	3.3	99	5
	HI781-S9678	2	96	8.7

Scratch↑

Charpy Imp.↑

9678* : LX MMA representative black color No.

Comparison with Other Resin



	PMMA	PMMA/ASA	ASA
Weatherability	◎	○	○
Scratch Resistance	◎	○	○
Deep Black	◎	◎	○
Impact Strength	△	○	◎
Heat Resistance	○	○	○

◎ : Excellent, ○ : Good, △ : Moderate

PMMA Piano Black IH830-9678 / IH830HF-9678

CRYSTALUX®

Main Characteristics

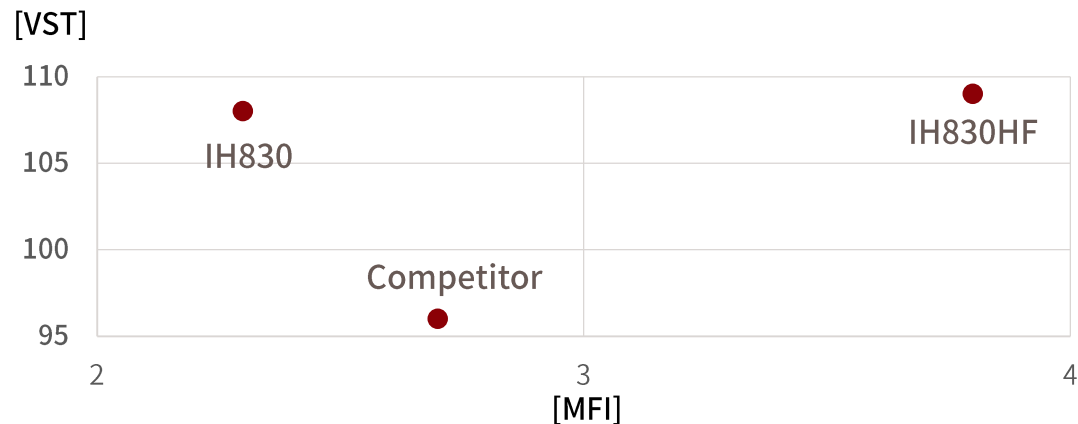
- Excellent Weatherability
- High Glossy without painting (Eco-friendly)

Application

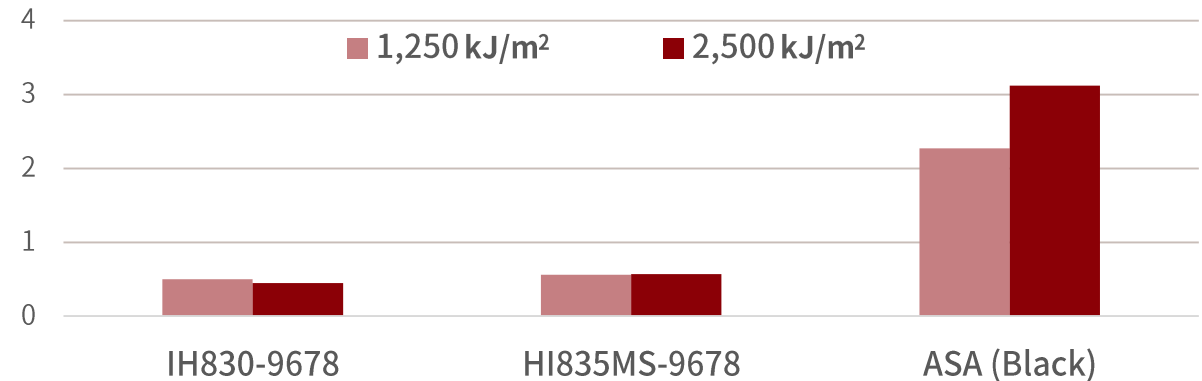


- Pillar, Lamp Bezel
- Decorations : Covers, Panels etc.

Property



Weatherability



*Test Method : SAE J2527

OEM Homologation List

	SPEC No.	LX MMA Grade
Ford	WSS-M4D776-B5	IH830C-9678
Renault	EP15, DP02b	IH830-9678
VW	TL 526 71 – Type B	IH830C-9678 IH830HF-9678
HKMC	MS235-01 Type A	IH830, IH830HF

High Impact Piano Black HI835MS-9678 / HI542-S9678

Main Characteristics

- Excellent Scratch Resistance & Surface Hardness
- Recyclable (Eco-friendly)

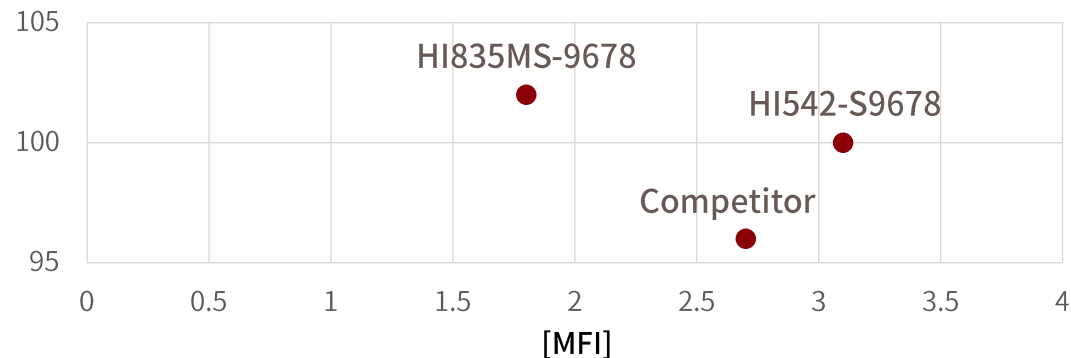
Application



- Pillar
- Spoiler

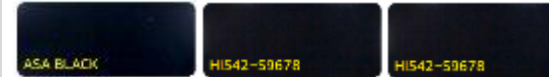
Property

[VST]

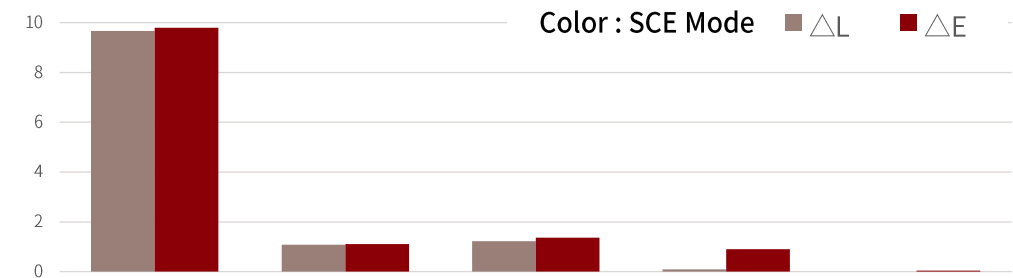


Ericshen Scratch Test

Before Test



After Test



	ASA (Black)	ASA (Black_2)	HI835MS-9678	HI835MS-S9678	HI542-S9678
Gloss retention (%)	69	98	98	100	99.8

OEM Homologation List

	SPEC No.	LX MMA Grade
Renault	EP15	HI835MS-9678
HKMC	MS 235-01 Type E	HI835MS-9678
	MS 235-01 Type F	HI542-S9678

High Impact Piano Black HI753-S9678 / HI781-S9678

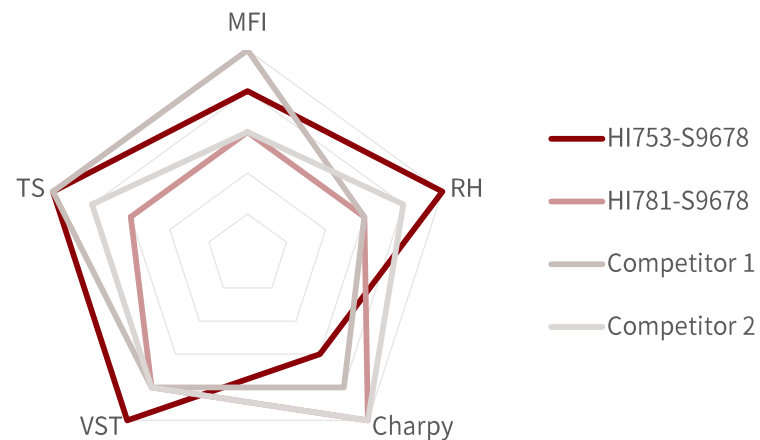
Main Characteristics

- High Impact Strength & Scratch Resistance
- Scratch Resistance with Non Painting

Application

- Side Mirror Housing
- HI753-S9678 : 1K Molding Pillar, Side/Rear Spoiler
- HI781H-9678 : Radiator Grille, Front/ Rear Bumper Trim

Property



Ericshen Scratch Test



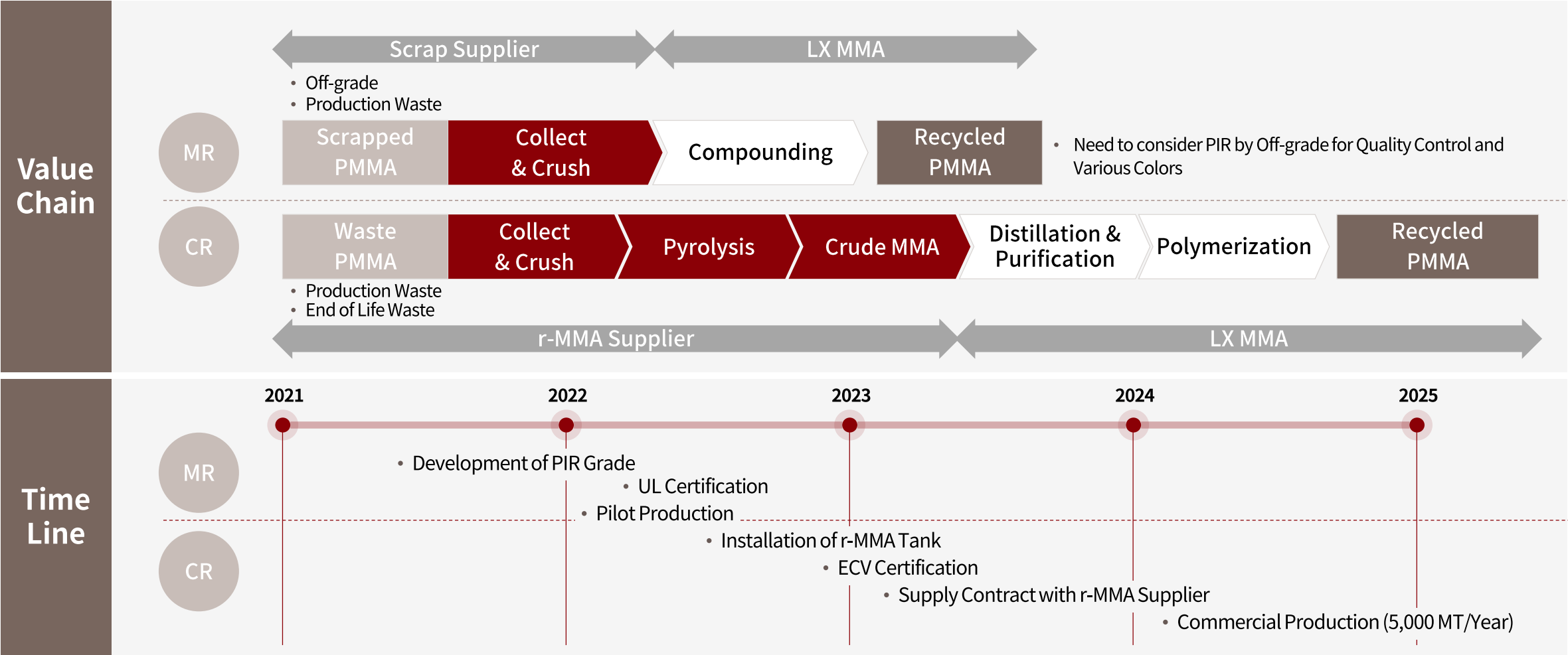
	HI781-S9678	ASA	Competitor M
ΔL	1.93	0.59	11.93
Gloss retention (%)	76	79	73

Wing Mirror Parts



	Base Plate Covers	Puddle Lamp Covers	Mirror Housing Covers	Mirror Scalp
HI753-S9678	○	○	○	
HI781-S9678		○		○

Stable supply of r-MMA is under study and LX MMA plans to produce by 2023.



Mechanical Property Lamp

Property		Condition	Unit	General		High Flow		Impact Resistant	Aspherical Lens	Heat Resistant		Chemical Resistant	
				IH830	IH830C	IH830HF	IH830A	HI835MS	IH830L	IH830XT	IH830HT	IH830CA	IH830SR
Thermal	MFI	230°C, 3.8kg	g/10min	2.3	2.0	3.8	5.3	1.8	2.4	2.4	1.7	1.0	1.6
	VST	B/50	°C	109	108	109	102	102	110	114	115	107	106
	HDT	1.8MPa, Annealed	°C	101	100	102	95	98	102	104	104	100	102
Mechanical	Density	-	g/cm ³	1.19	1.19	1.19	1.19	1.18	1.19	1.19	1.19	1.19	1.16
	Charpy Imp.	Notched	kJ/m ²	1.5	1.5	1.5	1.5	2.6	1.5	1.5	1.5	1.5	1.2
	RH	M Scale	-	95	97	96	95	78	95	99	99	96	92
	TS	5mm/min	Mpa	71	74	65	65	67	72	68	70	70	73
	TE	5mm/min	%	5.0	6.5	4.5	5.0	30	5.0	4.0	4.5	8.1	25
	TM	1mm/min	Mpa	3,300	3,400	2,800	2,900	2,500	3,100	3,100	3,200	3,200	2,900
	FM	2mm/min	Mpa	3,000	3,000	2,800	2,900	2,400	3,100	3,200	3,100	3,000	3,100
	FS	2mm/min	Mpa	111	113	100	103	85	113	115	118	115	116
Optical	Tt	3mm	%	92	92	92	92	91	92	92	92	92	90
	Haze	3mm	%	<0.5	<0.5	<0.5	<0.5	<1.5	<0.5	<0.5	<0.5	<0.5	<0.5

REMARKS : The listed values should be used for reference purpose only.

Processing Guide Lamp

Classification		General		Optical	High Flow		Impact Resistant	Heat Resistant		Chemical Resistant	
Grade		IH830	IH830C	IH830L	IH830HF	IH830A	HI835MS	IH830XT	IH830HT	IH830CA	IH830SR
Drying Temp.		90 – 95			90 – 95		80 – 85	90 - 95			
Drying Time		3 – 4			3 – 4		3 – 4	3 – 4			
Barrel Temp.	Hopper	200 – 210			200 – 210		200 – 220	200 - 220			
	Center	215 – 225			210 – 220		215 - 235	220 - 240			
	Nozzle	230 – 240			220 – 230		235 – 255	250 - 260			
Hot-runner Temp.		240 – 255			240 - 255		240 – 255	250 – 265			
Melt Temp.		230 – 240			220 – 230		235 - 255	250 - 260			
Mold Temp.		50 – 70			50 – 70		50 – 70	50 - 70			
Injection Pressure (kg/cm ²)	Filling	700 – 1200			700 – 1200		700 – 1200	700 – 1200			
	Holding	700 - 900			700 – 900		700 – 900	700 - 900			
	Back pressure	15 – 30			15 – 30		20 – 40	15 – 30			
Screw RPM		60 – 100			60 – 100		60 – 100	60 – 100			

Mechanical Property & Processing Guide High Gloss/Exterior

		Condition	Unit	PMMA				PMMA/ASA	
				IH830-9678	IH830HF-9678	HI835MS-9678	HI542-S9678	HI753-S9678	HI781-S9678
Property	Density	-	g/cm ³	1.19	1.19	1.18	1.17	1.15	1.14
	MFI	230°C, 3.8kg	g/10min	2.3	3.8	1.8	3.1	3.3	2.0
	RH	M Scale	-	95	96	78	70	R (114)	R (107)
	Charpy Imp.	Notched	kJ/m ²	1.5	1.5	2.6	4.5	5.6	8.7
	VST	B/50	°C	108	109	102	100	99	96
Drying Temp.				80 - 85		75 - 80		75 - 80	
Drying Time				3 - 5		3 - 5		3 - 5	
Barrel Temp.		Hopper		200 - 210		200 - 210		200 - 210	
		Center		215 - 235		225 - 245		230 - 250	
		Nozzle		225 - 245		235 - 255		245 - 265	
Mold Temp.				Min. 65		Min. 65		Min. 65	
Injection Pressure (kg/cm ²)		Filling		700 - 1100		700 - 1,100		700 - 1,100	
		Holding		500 - 900		500 - 900		500 - 900	
		Back pressure		5 - 10		10 - 15		15 - 20	

Global OEM Homologation

America

	SPEC No.	Description	LX MMA Grade
GM (GMW16635P)	T1	High Heat Resistance	IH830HR, IH830HT
	T2	General Purpose	IH830C, IH830L, IH830CA
	T2HF	Heat Flow	IH830HF
	T3	High Flow	IH830A
	T4	Impact Resistance	HI835MS
Ford (WSS-M4D776)	B3	Exterior High Heat	IH830C
	B5	Exterior Trim	IH830C-9678
Stellantis (MS-DB-75CPN4232)	General Purpose	General Purpose	IH830, IH830C
	General Purpose	General Purpose	IH830

Europe

	SPEC No.	Description	LX MMA Grade
Daimler	DBL 5416	Type 90 PMMA	IH830-9678
Renault	EP 10-1b	Rear Light	IH830, IH830C, IH830C-40060
	EP 15	Trim	IH830-9678, HI835MS-9678
	DP02b	High Gloss Trims	IH830-9678
PSA	FTM 60 0007		IH830C
VW	TL 591	Glass, Reflector, Exterior Lighting, Lighting	IH830, IH830C
	TL 526 71-Type A	1K Molding	HI781-S9678
	TL 526 71-Type B	2K Molding	IH830C-9678, IH830HF-9678

Asia

	SPEC No.	Description	LX MMA Grade
HKMC (MS 235-01)	Type A	General Purpose	IH830, IH830C, IH830HF
	Type B	High Heat Resistance	IH830HR
	Type C	Chemical Resistance	IH830CA
	Type E	Exterior. High Glossy Black (Impact Resistance)	HI835MS-9678
	Type F	Exterior. High Glossy Black (Impact Resistance/ Scratch Resistance)	HI542-S9678
CHERY (Q/SQR S1-68-2013 CMP.PMMA)	A1	Grille, Trim	IH830, IH830C
	A2	Lens	IH830C
SAIC	SMTC 5310 022	General Purpose	IH830C
SAIC MAXUS	CVTC 52142-T2	General Purpose	IH830C
DF Peugeot-Citroen	FTM 60 0007	General Purpose	IH830C

CRYSTALUX®

Thank you

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www.lxmma.com

January 2023

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