PO Elastomers, Innovative Solution for Plastics

LUCENE™

Jan. 20rd. 2014

LG Chem

Contents

- Introduction to POE
- Applications of POE

  - Automotives
  - Footwear foam
  - Film packaging
  - Others

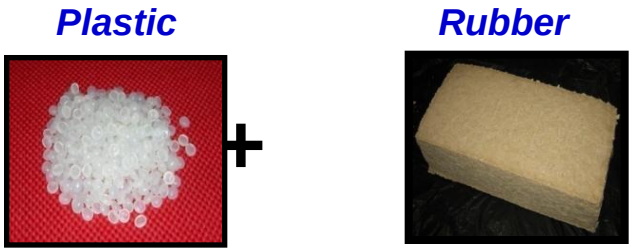
POE, As a Thermoplastic Elastomer

- **Polyolefin Elastomers(POEs) are elastic polymers modified from ethylene and α-olefins.**

Elastomer

◆Elastomer is a polymer with elastic property of returning itself to an initial form or style after deformation.

◆Elastomers
Natural Rubber, Synthetic Rubbers
SBCs, TPUs, TPOs

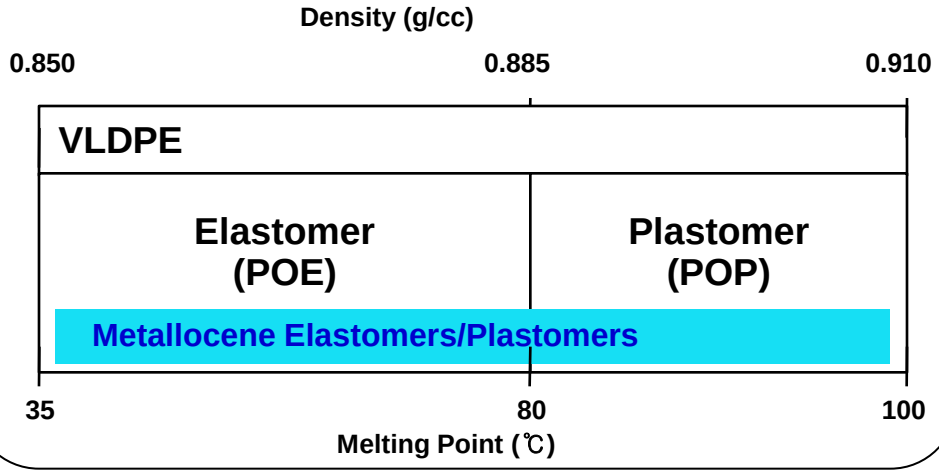


POE

◆Copolymers of either ethylene-butene or ethylene-octene.

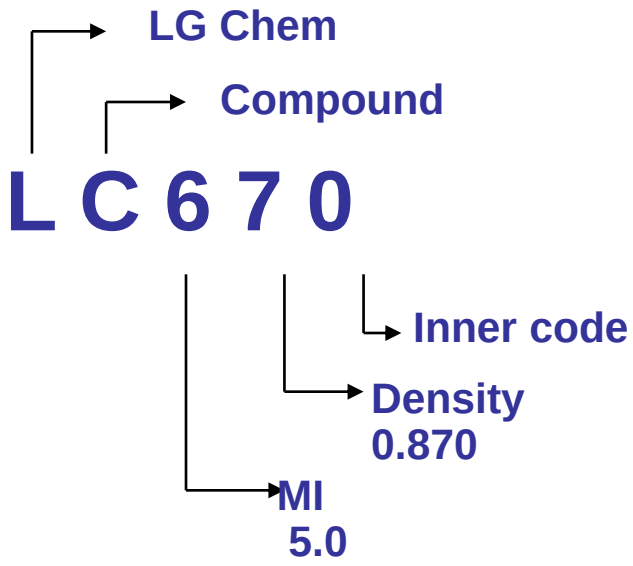
◆Copolymers with high content of α-olefin comonomer exhibit elastic behavior.

◆POE & POP are indicated as a whole as POE.



Nomenclature of LG POE Grade

Grade Name : LC670



.1st Character : LG Chem

.2nd Character : Application

C : Compound , T : T-Die coating & Lamination,

F : Film

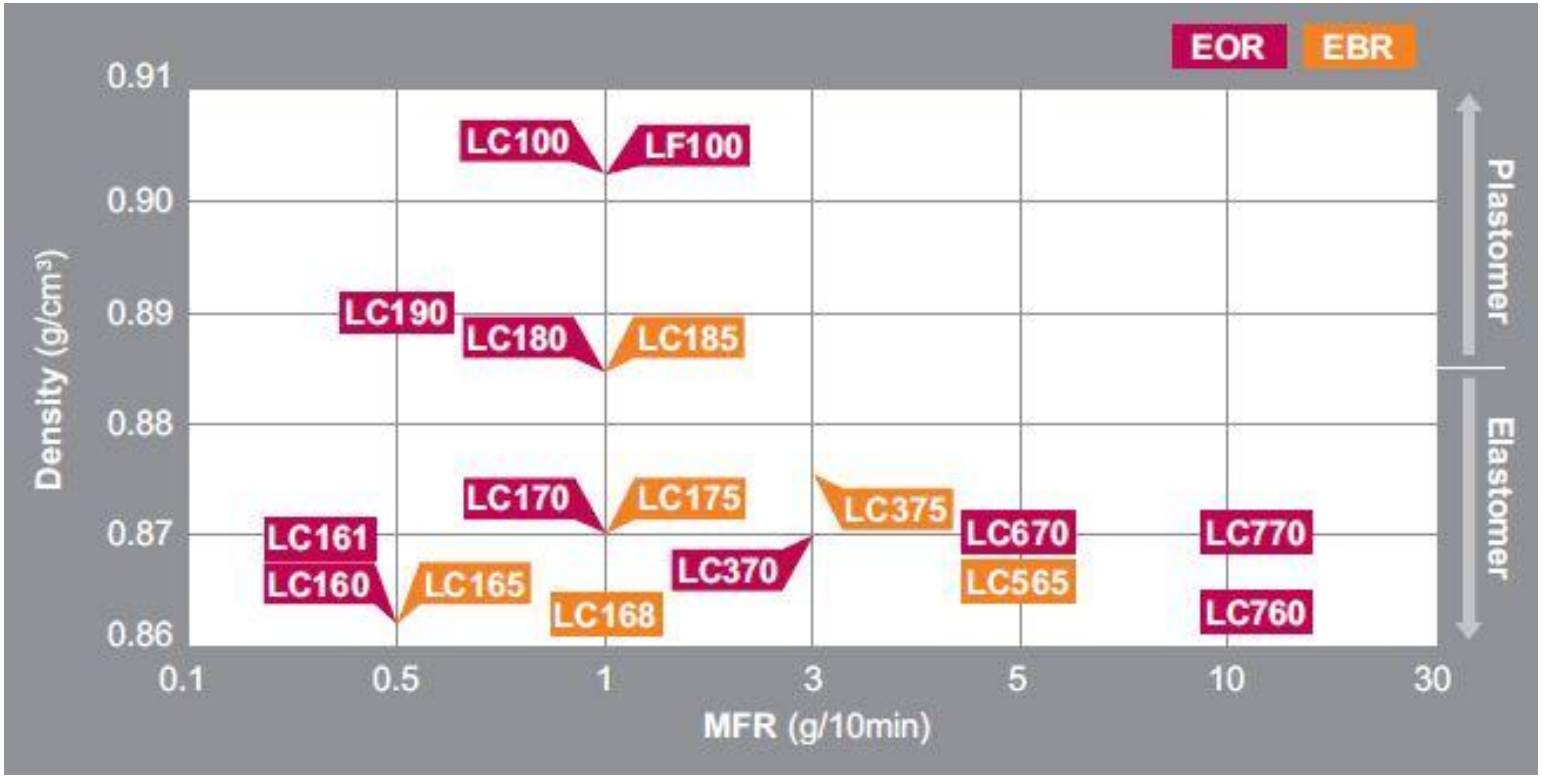
.3rd Figure : Melt Index

.4th Figure : Density

.5th Figure : Inner Code(Additives, Comonomers etc.)

LG POE(LUCENE™) Types & Grades

- **LG Chem's POE*(LUCENE™) is an elastic polymer modified from ethylene and α-olefins(1-Octene, 1-Butene).**



- **Advantages of EOR***
  - Excellent mechanical strength
  - Balance between toughness & stiffness
  - Outstanding curing for foaming

- **Advantages of EBR***
  - Lower crystallinity
  - Good impact strength at low temp.
  - Better cost effectiveness (vs. EPDM, EVA, EOR etc.)

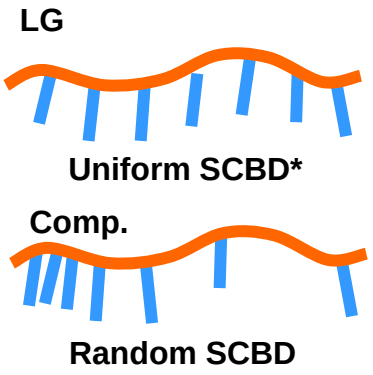
* EOR : Ethylene-1-Octene Copolymer, EBR : Ethylene-1-Butene Copolymer

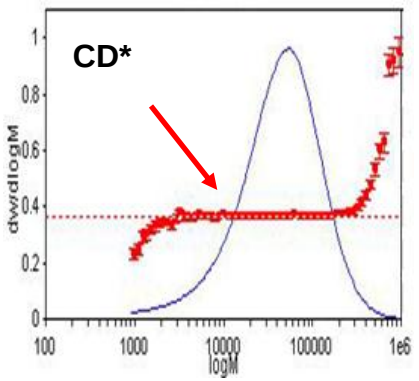
POE, A New Elastomer from LG Chem

- **LG Chem's POE(LUCENE™) was produced by LG Chem's own metallocene catalyst in solution process since 2008.**

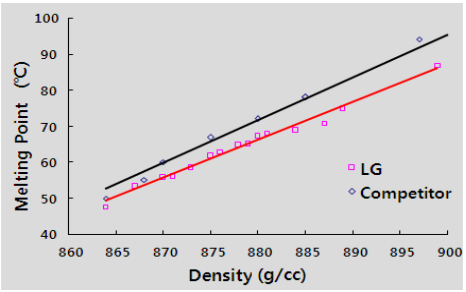
Unique Catalyst System

- **Uniform co-monomer distribution**





- **Lower melting temperature at same density**



Property Enhancement

- **Differentiated impact & elastic properties**
- **Lower heat sealing temp.**
- **Advantages**
  - **Optimal property & economy (vs. EPDM)**
  - **Better mechanical property & thermal stability (vs. EVA)**

*** SCBD : Short Chain Branch Distribution, CD : Comonomer Distribution**

LUCENE™ EOR_ Base Resin Properties

Item	Properties	MI	Density	Melting Temp.	Mooney Viscosity ML1+4@121℃	Tensile Strength at Break	Elongation at Break	Flexural Modulus 1% Secant	Hardness	Tear Strength	Glass Transition Temp.
	Test Method (ASTM)	D1238	D1505	LG	D1646	D638(	D638	D790	D2240	D624	LG
	Unit / Grade	g/10min	g/㎤	℃	MU	Mpa	%	Mpa	Shore A	kN/m	℃
EOR	LC160	0.5	0.863	46	36	6.1	>900	10	57	33	-56
	LC161	0.5	0.868	54	35	9.4	>900	13	67	54	-53
	LC760	13	0.863	41	4	1.3	>800	8	48	26	-55
	LC170	1.1	0.870	58	23	9.5	>900	14	71	40	-53
	LC370	3.0	0.870	57	13	8.0	>900	14	70	39	-55
	LC670	5.0	0.870	58	9	5.5	>900	13	70	38	-55
	LC770	15	0.870	58	3	3.2	>800	13	65	29	-55
	LC180	1.2	0.885	73	20	28	>800	30	86	58	-45
	LC190	0.5	0.890	80	30	36	>800	41	87	78	-38
	LC100	1.2	0.903	96	23	38	660	83	91	87	-31
	LL600	6.5	0.901	90	7	21	>900	53	90	85	-38
	LL700	10	0.901	90	5	18.5	>900	47	90	83	-38

LUCENE™ EBR_ Base Resin Properties

Item	Properties	MI	Density	Melting Temp.	Mooney Viscosity ML1+4@121℃	Tensile Strength at Break	Elongation at Break	Flexural Modulus 1% Secant	Hardness	Tear Strength	Glass Transition Temp.
	Test Method (ASTM)	D1238	D1505	LG	D1646	D638(	D638	D790	D2240	D624	LG
	Grade \ Unit	g/10min	g/㎤	℃	MU	Mpa	%	Mpa	Shore A	kN/m	℃
EBR	LC165	0.5	0.862	30	32	2.2	>800	9	43	17	-58
	LC168	1.2	0.862	32	20	1.8	>800	8	46	17	-57
	LC565	5.0	0.865	36	8	1.8	550	8	54	20	-54
	LC175	1.1	0.870	42	18	4.4	>900	12	63	34	-51
	LC375	3.0	0.875	56	12	6.3	>800	13	70	32	-50
	LC185	1.2	0.885	69	19	14.2	>800	23	85	59	-39

Applications of POE

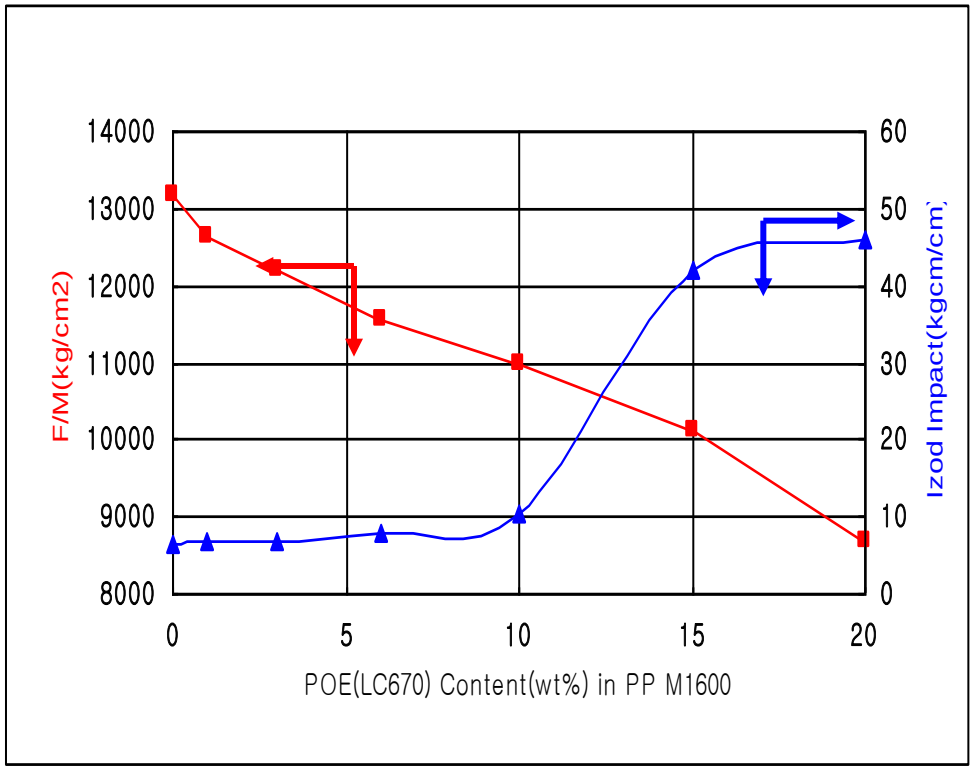
Applications – Automotives

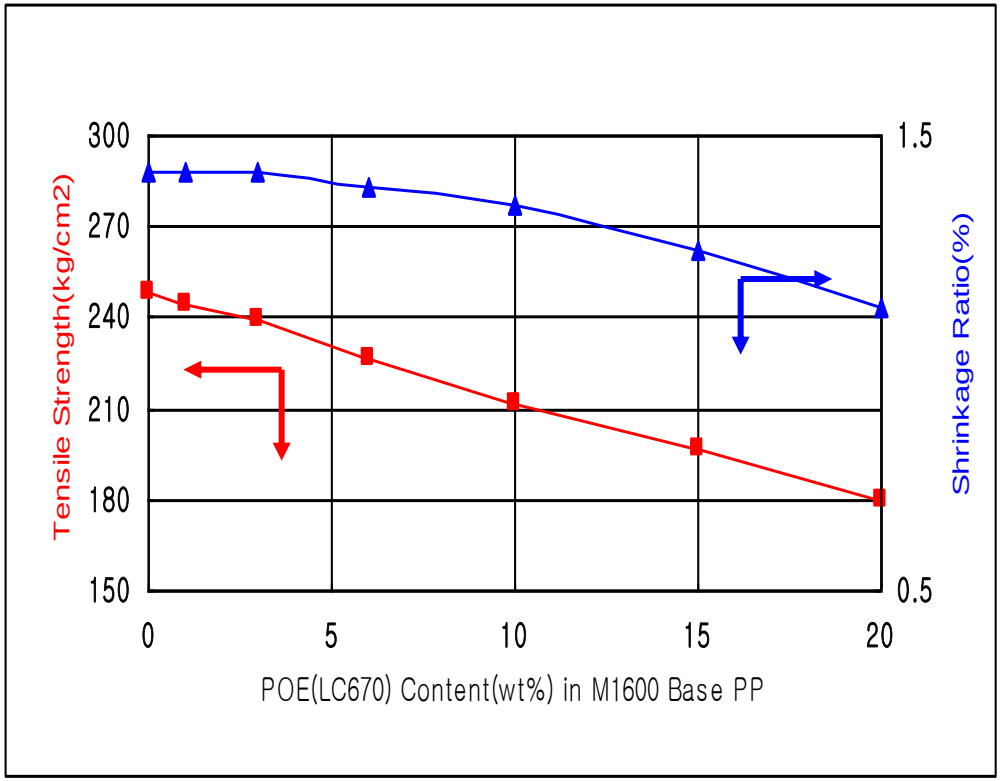
Typical formulation of automotives

Part \ Material		PP	POE	Talc
Exterior	Bumper Fascia	65~75	15~20	10~15
	Side seal molding	62~73	17~23	10~15
Interior	Door trim	75~85	5~10	10~15
	Instrument panel	60~70	20~25	10~15

PP Compound with POE addition

- **As increase of POE content in PP compound**
  - **Increased Izod impact strength**
  - **Decreased Flexural modulus, Tensile strength and Shrinkage**





Applications - Automotives

LC670, LC170, LC160, LC760, LC565, LC168, LC165

- Based on EOR or EBR/PP blends
- Good impact strength at low-temperature
- Easier processing

➢ **LG POEs have similar performance compared to competitor's**

Comparison of properties

• PP/POE(wt%) : 80/20

Properties		Unit	LC670 (EOR)	Competitor (EOR)	LC760 (EOR)	Competitor (EOR)
Melt Index		g/10min	17	18	18	19
Density		g/cc	0.996	0.996	172	182
Tensile Strength at yield		kgf/㎠	201	204	12,529	12,747
Flexural Modulus	6.4T	kgf/㎠	13,000	13,200	6.2	6.0
Izod Impact	23℃	kgfcm/cm	53.7	51.5	52.6	49.6
	-30℃	kgfcm/cm	4.7	4.6(-30℃)	5.2	5.2

* LC670/Company D : MI 5, Den. 0.870, LC565 : MI 5, Den. 0.865, Company M : MI 3.6, Den. 0.862

LG POE(LUCENE™) EOR & EBR Comparison

- EOR LC670 : Tensile, Flexural strenght, Impact strength at room temp. ↑
- EBR LC565 : Impact strength at low temp. ↑, Shrinkage ↓

PP Compound properties 1)

Properties \ Grade			#1 LC670	#2 LC565
Compound MI		g/10min	22.9	22.1
Tensile strength		kg/㎠	172	165
Flexural strength		kg/㎠	233	224
Flecural Modulus		kg/㎠	9,940	9,750
Impaact (Izod)	23 ℃	kg-m/m	56.2	52.8
	-10 ℃	kg-m/m	13.3	14.4
	-30 ℃	kg-m/m	6.9	7.8
Shrinkage		1/1000	7.7	7.3
Heat distortion temp.		℃	108	111

1) PP(MI 40 g/10min) /POE/ Talc = 70/20/10 %

PP compound properties

PP Compund properties with POE and Talc.

Properties / Item	Impact Strength	Flexural Modulus	Heat Distorsion Temp.	Gloss	Shrinkage	Injection Molding Flow
Low Density of POE -Low Tg -Low Crystallinity	▲▲	▼	▼	▼	▼	-
Lower MI of POE -High Mw	▲	-	-	▼	-	▼
Narrow MWD	△	-	-	△	▽	▽
Increasing POE contents	▲▲	▼	▼	▼	▼	▽
Increasing Talc contents	▼	▲	▲▲	▼	▼▼	-

▲▲: much higher ▲:higher △: slightly higher
▼▼: much lower ▼:lower ▽: slightly lower

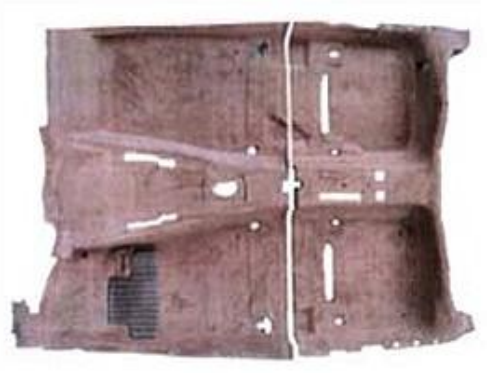
Automotive NVH

An Acoustical Barrier/Absorber used in multiple applications for noise reduction.

- **LC670, LC370, LC170, LC565**
  - **Based on POE / EVA and Inorganic filler blends**
  - **Better filler loading, light weight, easy processing**
- **NVH : Noise, Vibration, Harshness**
  - **Sources of NVH**

    Engine, driveline, tire contact on the road, brake, and wind
- **Heavy layer**
  - **A heavy mass sheet of polymers, which has viscoelastic properties that make it an excellent solution for acoustic attenuation of airborne and impact noise.**
  - **POE is used as a binding agent with fillers and softening agent.**
- **Floor carpet back coating**

*** Floor insulation, front/rear**



*** Carpet with insulation**

Footwear foam application

LG POE(LUCENE™) Applications

- **POE is mainly used as a key property enhancer in the fields of footwear foam applications.**

		EOR					EBR			
Properties \ Grade		LC170	LC370	LC670	LC180	LC100	LC168	LC565	LC175	LC185
Melt Index	g/10min	1.1	3.0	5.0	1.2	1.2	1.2	5.0	1.1	1.2
Density	g/cc	0.870	0.870	0.870	0.885	0.903	0.862	0.865	0.870	0.885
Applications	Automotive	O	O	O			O	O	O	
	Footwear	O	O	O	O	O		O	O	O
	Film, Coating			O	O	O				O
	Wire & Cable				O	O			O	O
	MAH-grafting	O	O	O			O	O	O	
Counter Grade		8100	8452	8200	8003	8480	7467 DF610	7447 DF640	DF710	DF810

Application - Footwear

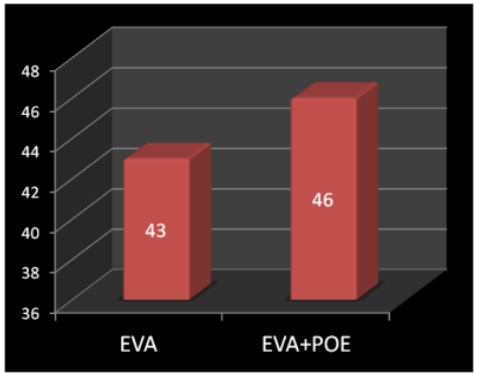
EVA modification

- Based on EOR or EBR/EVA blends
- Light weight and resilience(elasticity)
- Higher tear strength

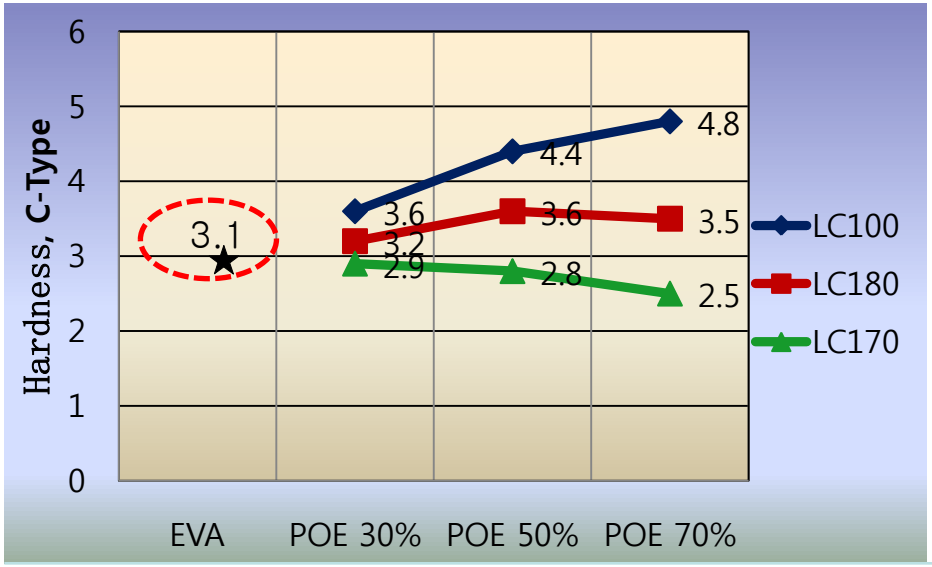
Footwear part - Midsole

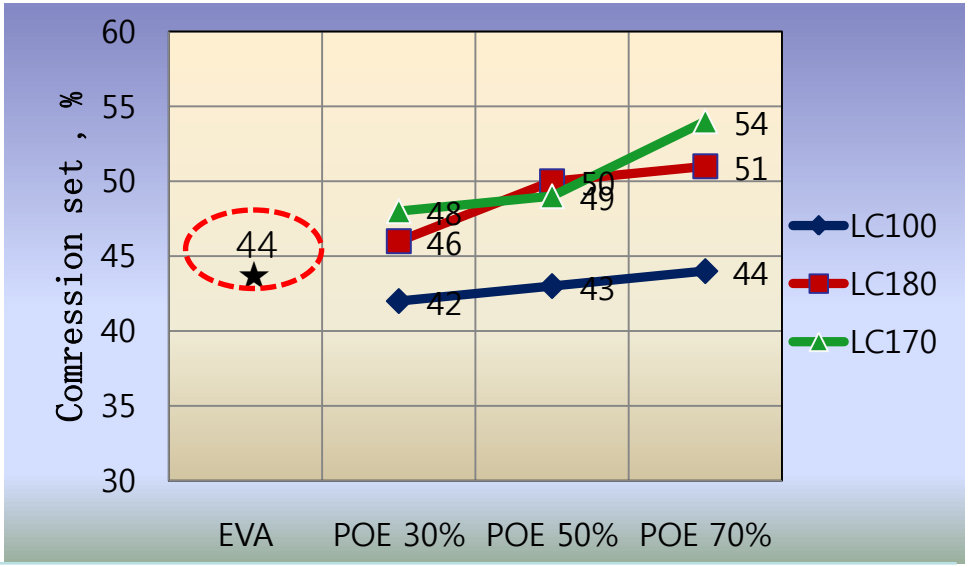
- Fuctions
  - . Cushioning, Shock absorptiion

Rebound resilience(%)



◆ Properties





EVA1316: VA18% LC100: MI 1.2, Den 0.903 LC180 : MI 1.2, Den 0.885 LC170 : MI 1.2, Den 0.870

* Foaming 160%, Curing agent(DCP) /Blowing agent(ADCA) /ZnO / Stearic acid / TiO2 (phr) = 0.8/3.2/3/1/4

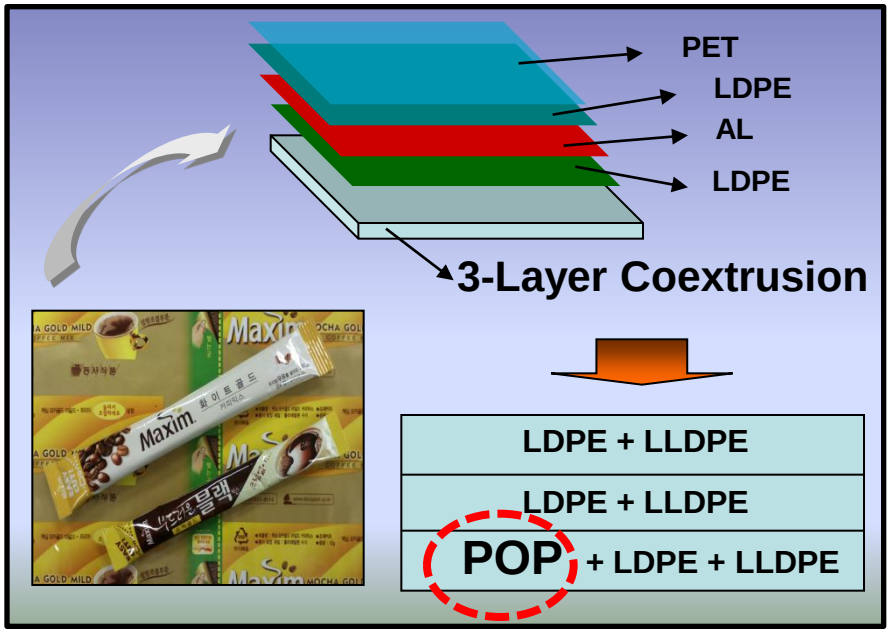
Film packaging application

LF100 Mechanical Property

LF100

- Based on EOR/LLDPE blends
- Excellent low-temperature sealing
- Hot tack strength

➢ **Lamination layer of multi-layer film**



Comparison of properties

Properties		Unit	LG LF100	Competitor
Tear Strength at Break	MD	kgf/㎠	300	300
	TD	kgf/㎠	316	303
Elongation	MD	%	580	580
	TD	%	630	630
Dart Impact Strength(Method A, 380mm)		g	455	448

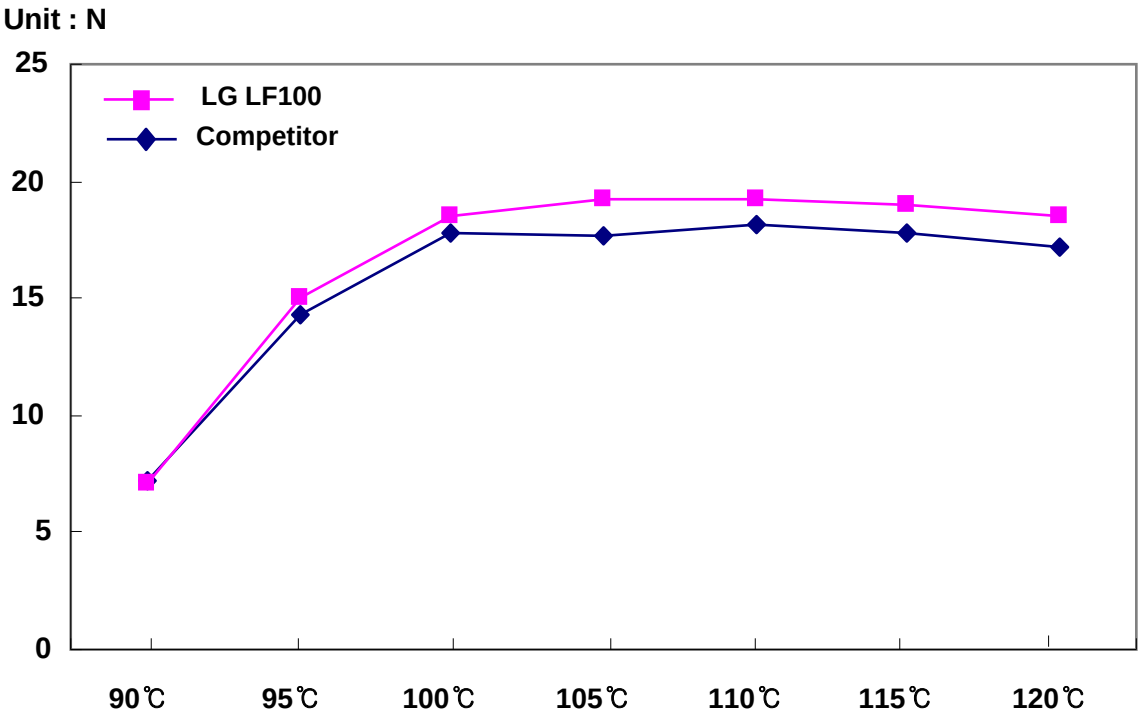
• Film thickness : 80 ㎛

• 3 layers film : POP/LD+LLD/LD+LLD = 1/1/1

* LF100 : MI 1.2, Density 0.903, Company D : MI 1.0, Density 0.902 (with A/B, Slip agent)

Sealing Property of LF100 – Heat Sealing

- **LF100 shows outstanding heat sealing strength than competitor's.**



-Film: Multilayer(3layer) Film
PET/LDPE/ AL /Sealant Laminated Film
Thickness 80㎛
- Test: Dwell 1.0sec, Delay 30sec, Pressure 0.1MPa

LL700 - Mechanical Properties

- **LL700**
  - **- Based on EOR**
  - **- Excellent low-sealing temperature**
  - **- Hot tack strength**

➢**Coating layer between the substrate**
➢**Sealant layer of multi-layer cast film**

- **Comparison of properties**

Properties	Unit	LL700	Competitor
Tensile strength at break	kgf/㎠	188	159
Elongation	%	930	950
Tear strength	kgf/㎝	95	87
Hardness	Shore A	78.0	78.0

*** LL700 : MI 10.0, Density 0.901**
Measured on a standard compression molded specimens.

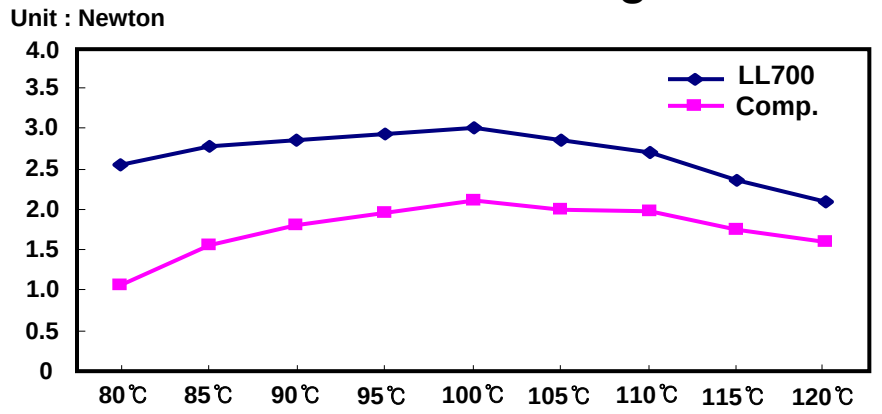
LL700 – Film properties

LL700 shows outstanding film properties.

Item		Unit	LL700	Comp.
Tensile Strength	MD	kgf/㎠	266	243
	TD	kgf/㎠	257	237
Elongation	MD	%	670	660
	TD	%	800	800
Tear Strength	MD	kgf/㎝	97	90
	TD	kgf/㎝	93	84
HAZE		%	6.5	7.1

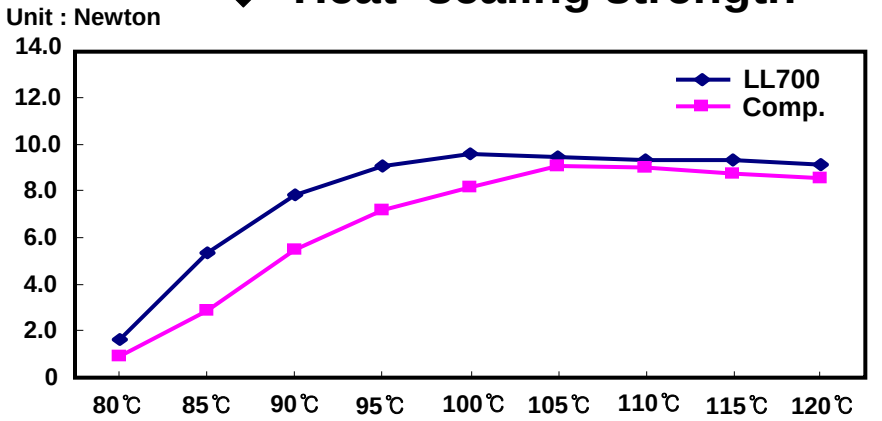
- Mono Layer Film
  POP (LL700 or competitor) / LDPE = 70% / 30%,
  Thickness: 55㎛

◆ Hot-tack strength



-Test 조건 :
Sealing time: 0.5 sec, Cooling time : 0.1 sec, Pressure: 0.275 MPa

◆ Heat- sealing strength



-Test Condition:
Sealing time: 1.0sec, Cooling time: 30 sec, Pressure: 0.1MPa

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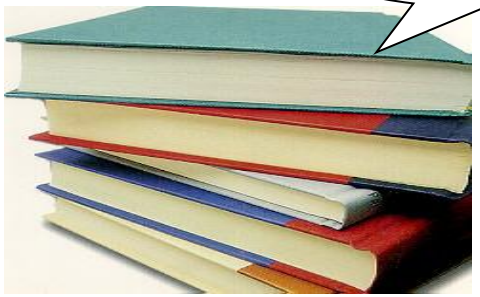
Other applications of POE & POP

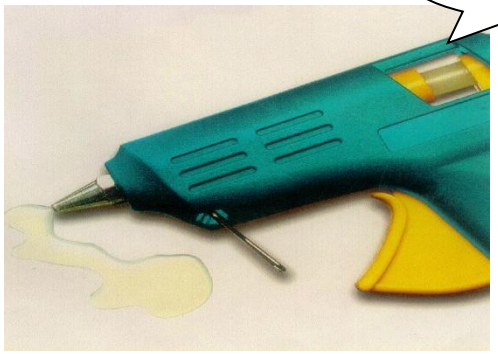
Applications – HMA

- **Hot Melt Adhesive Applications (LC670 MI 5.0)**
  - **- Odor free and improved thermal stability compared to EVA HMA**
  - **- High melt flow resins are mainy used: MI 150, 400 ~1,000**

Packaging sealing



Book Binding



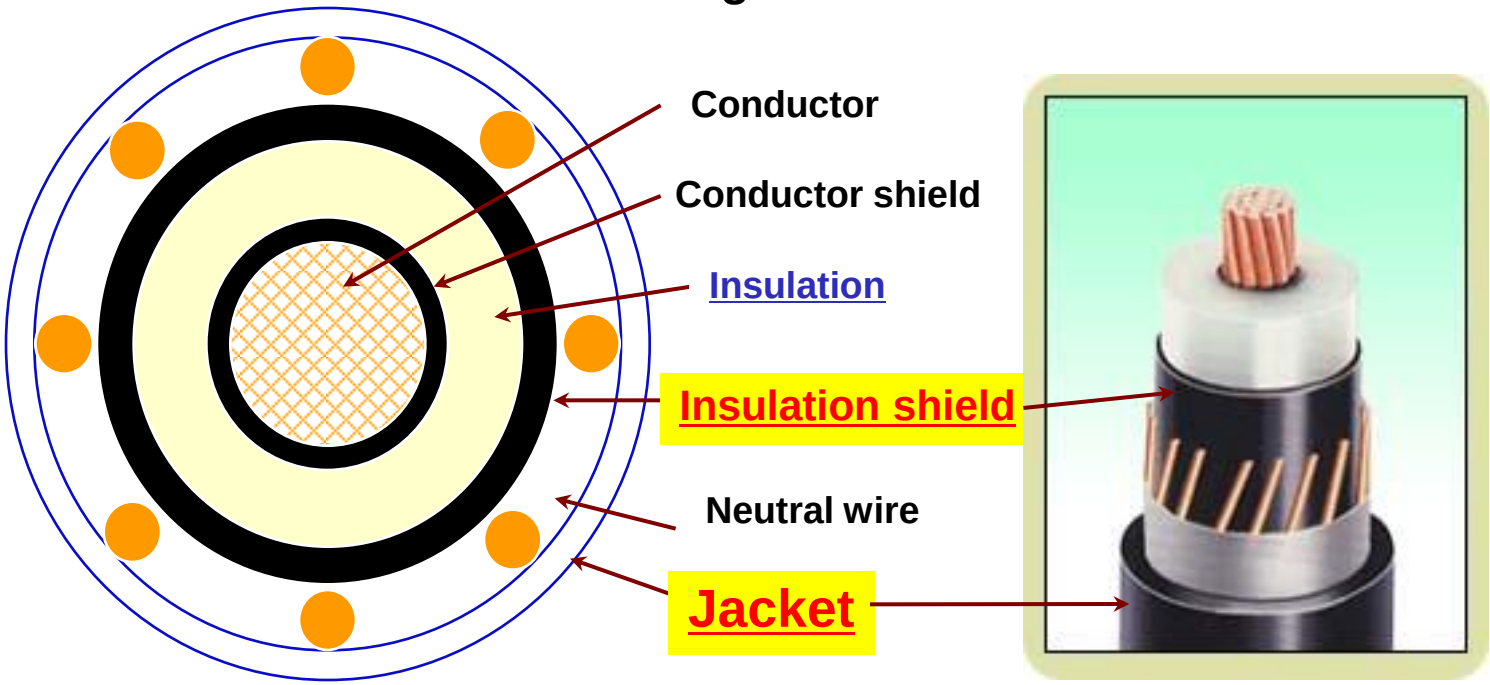
Gun stick

Wood furniture

Road Marking

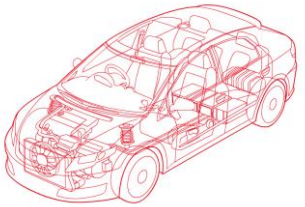
Application – W & C

- **Offshore & Shipboard Cable**
  - HV&LV Power cable, Instrumentation & communication cable
  - Halogen-free thermoplastic compound(SHF1): IEC 60092-359
- **LC170, LC180, LC185**
  - Light weight, High filler loading, Easy processing, High e-resistivity
  - Based on POE/EVA/LLDPE and Inorganic filler blends



Applications – Others

- **Toughening of engineering thermoplastics**
  - **MAH-grafted-POE as the compatilbilizer in the nylon compound**
  - **Increasing impact strength**



- ➢ **Industrial / Sports & Leisure materials**

- **Plastic modification**
  - **Based on EOR or EBR/PE or PP Blend**
  - **Increasing impact strength of PE & PP**
  - **Improving softness**

- ➢ **Bottle, binder, tube, W&C, fan heater housing, etc**

Packaging & Loading

Packaging in 25kg PP Woven Bag

Palletized		Loose Bag
20ft	40ft	20ft
13MT	22MT	16MT
		

Summary

- LG Chem has developed a unique metallocene catalyst and solution process technology for polyolefin elastomers & plastomers.
- LG Chem has commercialized Ethylene-octene copolymers and Ethylene-butene copolymers that can be successfully used in various applications such as automotive, footwear, wire & cable, sheet and film packaging, etc.
- LG Lucene™ EOR and EBR products can provide a better performance and cost effectiveness.
- LG Chem wishes to be market leader in metallocene based POE & POP with complete portfolio of products.

Thank you !!!

▸ ***Our Web site :***

http://www.chemwide.com