TECHNICAL NOTE

SUMITOMO CHEMICAL

Ultra-High Heat Resistant Engineering Plastics

SUMIKASUPER™ LCP

Liquid Crystal Polymer

Liquid
Crystal
Polymer

Version 04 / Nov. 2023

SUMITOMO CHEMICAL Co., Ltd.   Advanced Polymers Division

Proper Use of SUMIKASUPER LCP

The information contained in this document has been prepared based on materials, information and data currently available and is subject to revision based on new findings.

1. Handling

The following is a list of key points that must be observed when handling SUMIKASUPER LCP. Before handling SUMIKASUPER LCP, please be sure to read the Safety Data Sheet (SDS), which has been prepared separately. Please note that it is the responsibility of the user to investigate the safety of any additives used in conjunction with SUMIKASUPER LCP.

(1) Safety and Health

Ensure to avoid contact with the eyes and skin, as well as the inhalation of gases that are generated when drying and melting SUMIKASUPER LCP. In addition, be careful not to directly touch the resin while it is still hot. Local ventilation equipment must be installed and proper protective gear (such as protective goggles and protective gloves) must be worn while drying or melting this product.

(2) Flammability

SUMIKASUPER LCP is a flame-resistant material (classified as UL94 V-0). However, it should be handled and stored in places well away from heat and ignition sources. If the material catches fire, toxic gases may be released. Use water, foam, or fine chemical extinguishers to extinguish any flames.

(3) Disposal

SUMIKASUPER LCP may be disposed by burial or incineration. Burial of the material should be conducted by certified industrial waste processors or by the local municipal authorities in accordance with the Waste Management and Public Cleansing Act. Incineration should be conducted using a furnace which complies with the laws and regulations of the Air Pollution Control Act. Toxic gases may be released when this product is incinerated.

(4) Storage

Store SUMIKASUPER LCP at room temperature away from direct sunlight, water, and humidity.

2. Applicable standards

SUMIKASUPER LCP comes in a variety of grades which comply with standards specified by Underwriters Laboratories Inc., such as. UL94 and UL746, and by the Electrical Appliances and Materials Safety Act, such as. ball pressure temperature. Refer to this booklet or contact Sumitomo Chemical for further details. Contact Sumitomo Chemical for information regarding the use of this material in other special applications.

3. Security Trade Control

The products of SUMIKASUPER LCP are not on the control list of the Export Trade Control Order of Japan. However, row 16 (catch-all control) in Appended Table 1 of the same Order does apply.

4. Other

All data in this document is for reference only and is not intended as guarantees on product performance.
Be aware of intellectual property rights when using this product.

SUMIKASUPER LCP Technical Notes Index

1. Features and Grade Lineup of SUMIKASUPER LCP

1-1 Features

Introduction

SUMIKASUPER LCP is a thermotropic liquid crystalline polyester that possesses the highest heat resistance among all engineering plastics. Its basic chemical composition is shown in the diagram below. Thermotropic liquid crystalline polyester is one of the most common types of liquid crystalline polyester (LCP).

Figure 1-1-1 Skin Core Structure and Photograph of SUMIKASUPER LCP

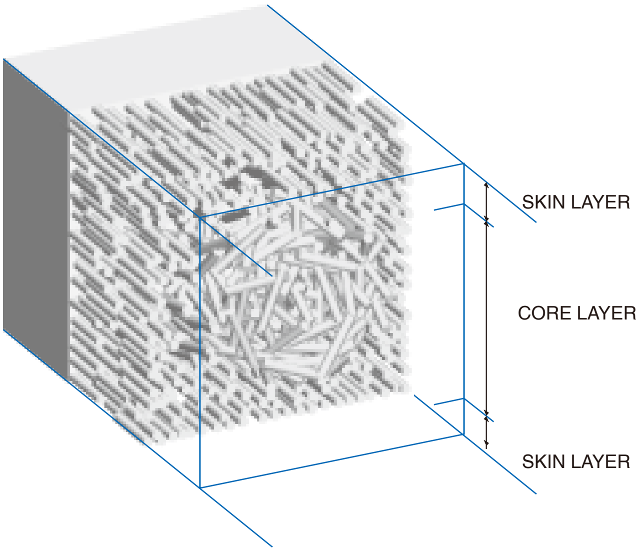
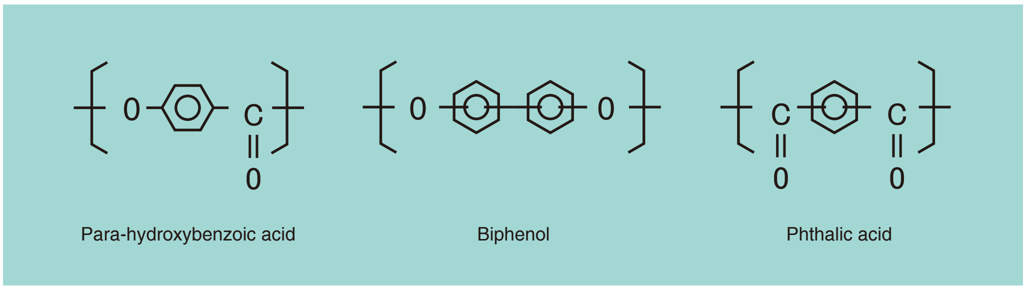


Figure 1-1-2 Representative Chemical Structures of SUMIKASUPER LCP



As indicated by their name, one property of liquid crystalline polyester is that they become liquid crystalline state when they enter a molten state. This special phenomenon, unique to liquid crystalline polyester, can be observed under a polarizing microscope: as the temperature of a polymer increases and it begins to melt, its light transmittance also increases significantly.

Figure 1-1-3 Device for Observing the Melting of Liquid Crystal

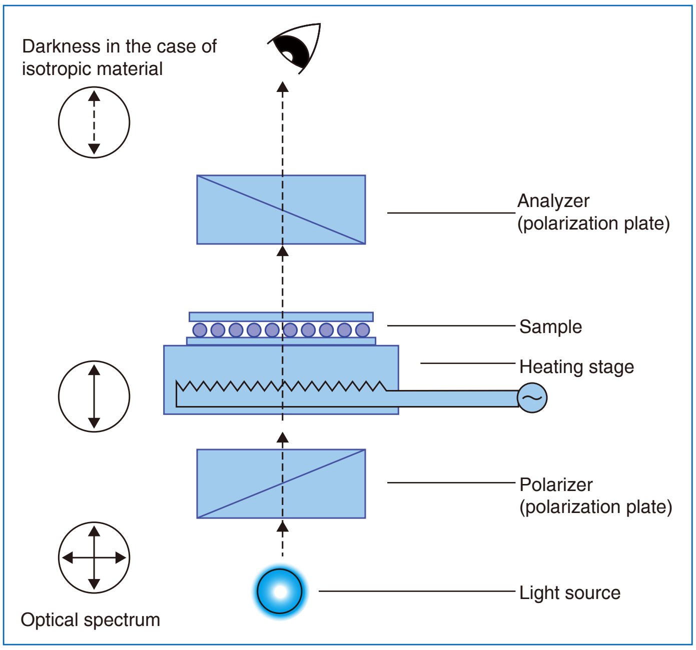


Figure 1-1-4 Transmission of Light through Polarizer (Observation by Polarizing Microscope)

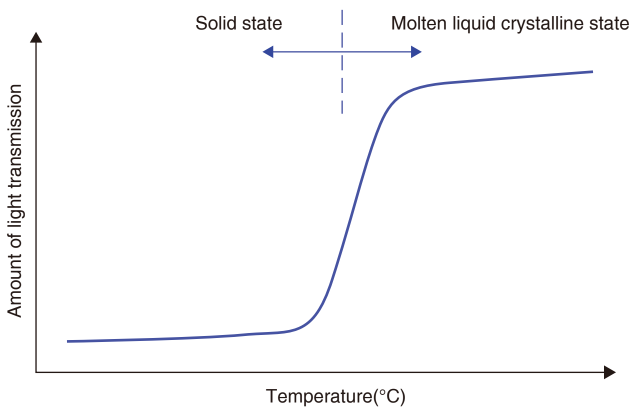
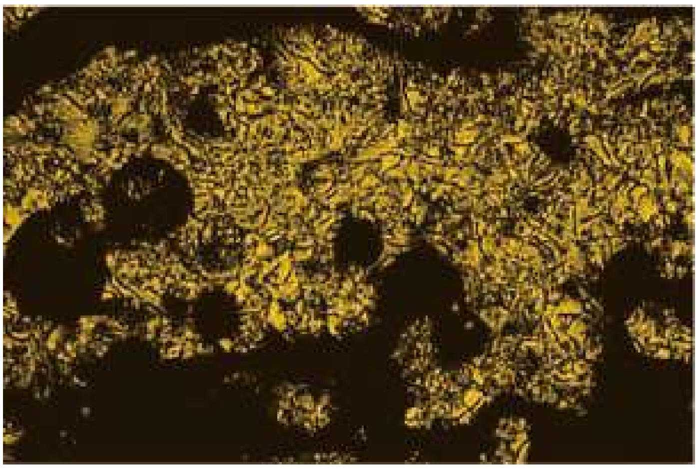
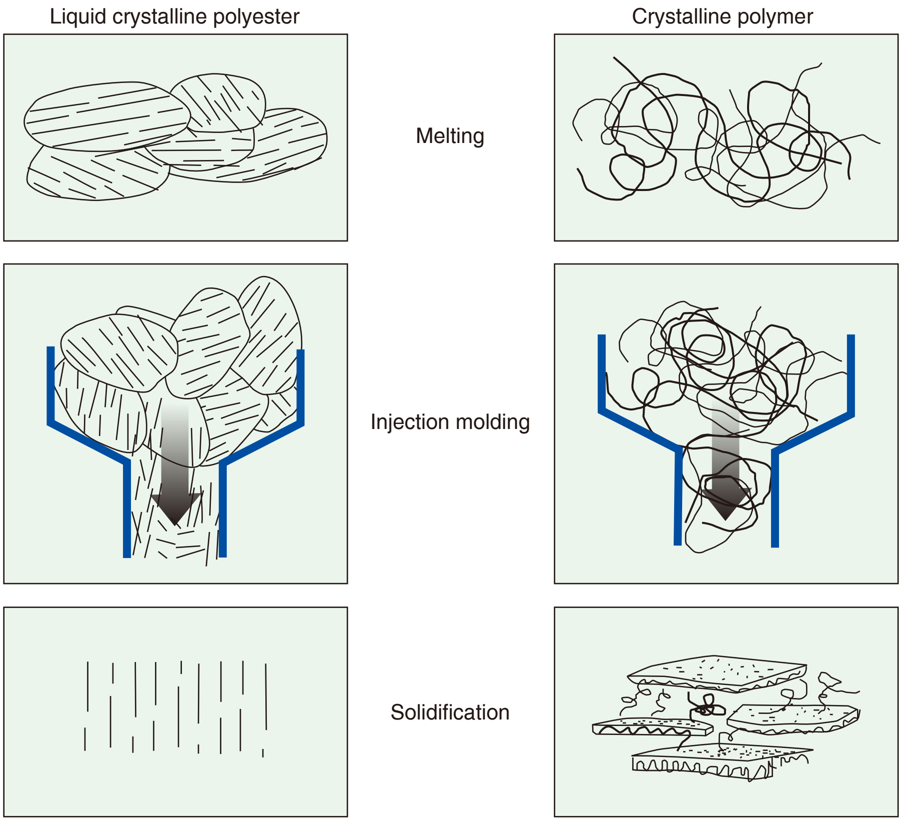


Figure 1-1-5 Polarization Microscopic Photograph of SUMIKASUPER LCP



With SUMIKASUPER LCP, the liquid crystalline state (crystalline state) is indicated for the liquid crystallization temperature or higher. Liquid crystal molecules become oriented via injection molding, and it shows characteristics such as high strength, high the elastic modulus, high flow characteristics, and a low coefficient of linear thermal expansion.

Figure 1-1-6 Structure of SUMIKASUPER LCP



Properties and Characteristics of LCP

As SUMIKASUPER LCP is a wholly aromatic liquid crystalline polyester, it possesses both properties based on liquid crystalline properties and properties based on wholly aromatic properties.

Table 1-1-1 Characteristics Based on Wholly Aromatic Liquid crystalline polyester

Properties Based on Liquid Crystalline Nature -> Effect of Molecular Orientation		Characteristics Based on Wholly Aromatic Properties
Advantages	Disadvantages	
■High strength, High rigidity ■Low viscosity, High flowability ■Low shrinkage, Low linear expansion coefficient (flow direction) ■Rapid solidification, Low flash property ■Low mold temperature	■Anisotropy (strength, shrinkage) ■Low weld strength	■High heat resistance (high DTUL, high heat aging resistance) ■Solder heat resistance ■Flammability ■Low water absorbency ■Chemical resistance

1-2 Grade Lineup

Grade Lineup and Grade Features

SUMIKASUPER LCP including the E5000, E4000, E6000, E6000HF, SZ, SV, and SR series, making it one of the best lineups in the industry. The following table shows its characteristics and correlation between SUMIKASUPER LCP representative grades. Many grades in addition to the ones listed are also available, which may be most suitable for your applications, so please contact us.

Table 1-2-1 Grade Lineup and Features of SUMIKASUPER LCP 1

series	Typical Grade	Filler content (%)	Filler	Features	DTUL (°C)*1	Standard molding temperature (°C)
E5000 series	E5006L	30	Glass fiber	Ultra-high heat resistance/High strength/ Low coefficient of linear thermal expansion	355	400
	E5008	40	Glass fiber	Ultra-high heat resistance/ Low coefficient of linear thermal expansion	335	
	E5008L	40	Glass fiber	Ultra-high heat resistance/Low shrinkage	339	
	E52008	40	Glass fiber	Ultra-high heat resistance/Good flowability	336	
	E5204L	20	Glass fiber/Inorganic	Ultra-high heat resistance/ Low thermal conductivity/ Low relative permittivity	351	
E4000 series	E4006L	30	Glass fiber	High heat resistance/Low shrinkage	324	380
	E4008	40	Glass fiber	High heat resistance/High strength	326	
	E4009	45	Glass fiber	High heat resistance/High strength	326	
	E4205R	25	Glass fiber/Inorganic	High heat resistance/ Low thermal conductivity/ Low relative permittivity	305	
E6000 series	E6006	30	Glass fiber	High strength/Good flowability/ High mold release ability	280	360
	E6006L	30	Glass fiber	High strength/Low shrinkage/ High mold release ability	284	
	E6007AS	35	Glass fiber/Inorganic	Antistatic	274	
	E6008	40	Glass fiber	High strength/High flowability	279	
	E6008 KE	40	Glass fiber	High strength/High flowability	276	
	E6205L	25	Glass fiber/Inorganic	Low thermal conductivity/ Low relative permittivity	258	
	E6807T	35	Inorganic	High surface smoothness	262	
	E6809U	45	Glass fiber/Inorganic	Low warpage/High heat resistance/ Good flowability	270	
	E6809T	45	Inorganic	High surface smoothness	262	

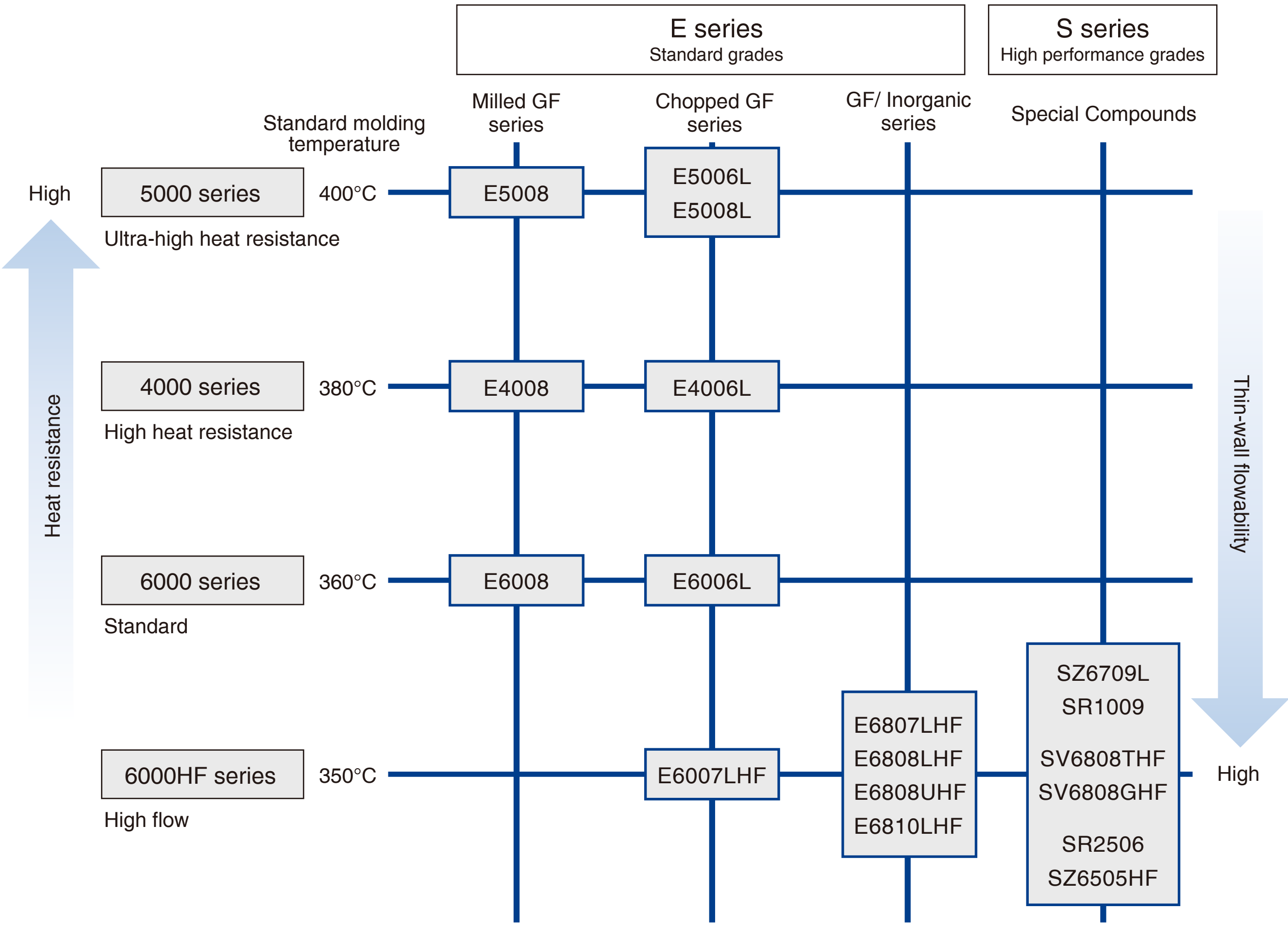
(*1) Measured at ASTM D648 1.82 MPa
Some of the above grades are custom manufactured products.

Table 1-2-2 Grade Lineup and Features of SUMIKASUPER LCP 2

series	Typical Grade	Filler content (%)	Filler	Features	DTUL (°C)*1	Standard molding temperature (°C)
E6000HF series	E6007LHF	35	Glass fiber	Low warpage/High strength	269	350
	E6007LHF-MR	35	Glass fiber	Low warpage/High strength/ High mold release ability	269	
	E6807LHF	35	Glass fiber/Inorganic	Low warpage/High strength	269	
	E6808LHF	40	Glass fiber/Inorganic	Low warpage/High strength	274	
	E6808GHF	40	Glass fiber/Inorganic	Low warpage/High flowability/High strength	268	
	E6808UHF	40	Glass fiber/Inorganic	Low warpage/High flowability	240	
	E6810LHF	50	Glass fiber/Inorganic	Low warpage/Low shrinkage/ Low anisotropy	266	
	E6810KHF	50	Glass fiber/Inorganic	Low warpage/Low shrinkage/ Low anisotropy	265	
SV6000 series	SV6808THF	40	Glass fiber/Inorganic	Ultra-low warpage/High flowability	270	
	SV6808GHF	40	Glass fiber/Inorganic	Low warpage/High flowability/High strength	255	
	SV6808L	40	Glass fiber/Inorganic	Low warpage/High heat resistance/ High strength	293	360
SR1000 series	SR1009	45	Glass fiber	Ultra-high strength/Good flowability	277	
	SR1009L	45	Glass fiber	Ultra-high strength/High hardness	286	
	SR1205L	25	Glass fiber/Inorganic	Low relative permittivity/ Low dielectric dissipation factor	252	
SR2000 series	SR2506	30	Glass fiber/Inorganic	Low warpage/Thin-wall ultra-high flowability	239	350
	SR2507	35	Inorganic	Ultra-low warpage/ Thin-wall ultra-high flowability	240	
SZ series	SZ6505HF	25	Inorganic	Low warpage/Super high flowability	244	
	SZ6506HF	30	Inorganic	Low warpage/Super high flowability	245	
	SZ4506	30	Inorganic	Low warpage/High heat resistance/ High surface smoothness	296	380
	SZ6709L	45	Glass fiber/Inorganic	High whiteness	275	350

(*1) Measured at ASTM D648 1.82 MPa
Some of the above grades are custom manufactured products.

Figure 1-2-1 Features of Typical Grades of SUMIKASUPER LCP



For more information, please contact us.

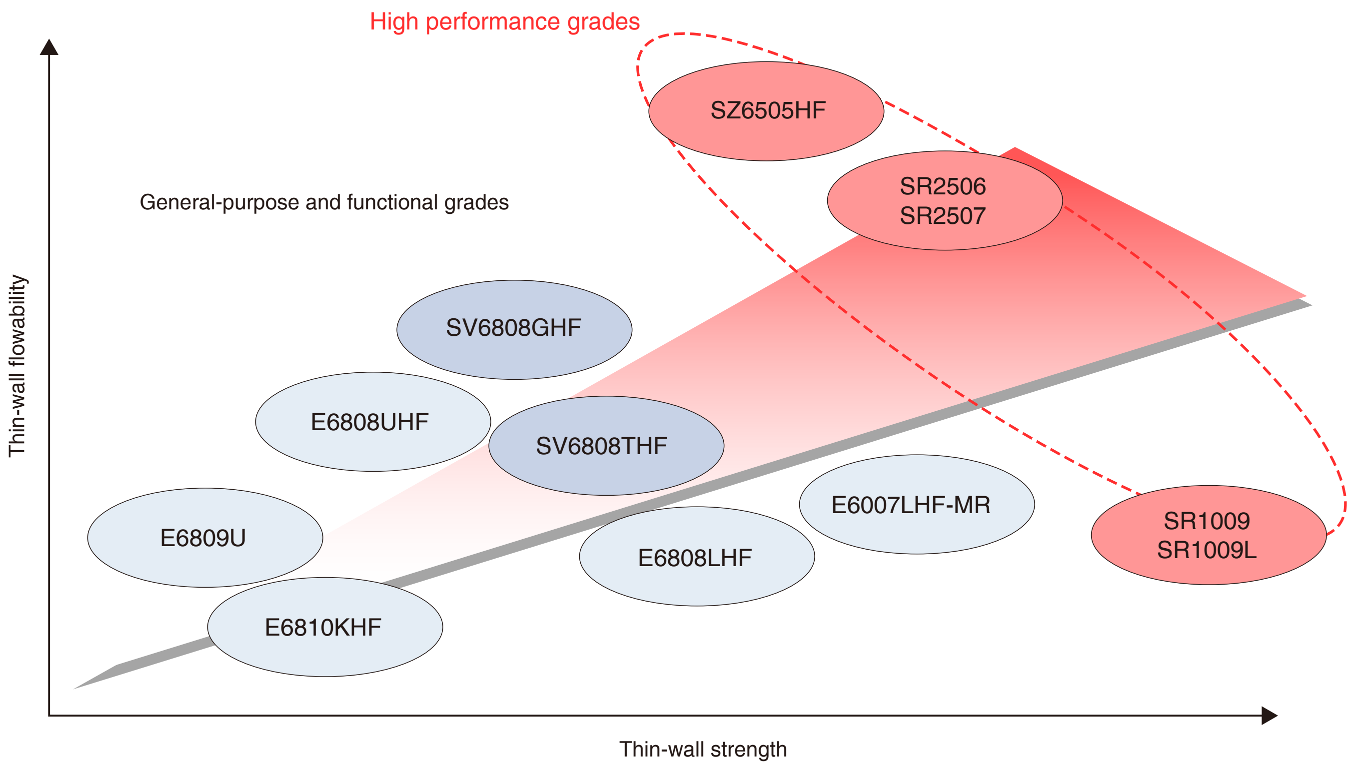
High Flow and Low Warpage Grade of SUMIKASUPER LCP

Surface mounting technology (SMT) where electronic components are mounted on boards at high temperatures of 250 to 270°C has become common in recent years. Therefore, LCP is widely used for SMT-compatible connectors due to its excellent heat resistance, dimensional stability, and precision molding. In addition to having heat resistance compatible with SMT, the grade of SUMIKASUPER LCP that is compatible with SMT has excellent thin-wall flowability and thin-wall strength even at wall thicknesses of 0.2mm or less. The following table shows the positioning of thin-wall flowability and thin-wall strength with SUMIKASUPER LCP high flow and low warpage grades. When selecting a grade, refer to Table 1-2-3, Figure 1-2-2, and the SUMIKASUPER LCP selection guides in Chapter 6 Applications of LCP, or contact us directly.

Table 1-2-3 Typical Grades and Features of SUMIKASUPER LCP

Filler	Features		E series	E/SV series	SZ/SR series
			Standard	General-purpose and functionality	High performance
Glass fiber	Standard		E6007LHF	E6007LHF-MR	SR1009 SR1009L
Glass fiber / inorganic or inorganic alone	Low warpage	Standard	E6807LHF E6808LHF	SV6808THF	SZ6505HF
		High flow	E6808UHF E6808GHF	SV6808GHF	SR2506
		Low anisotropy	E6810KHF	E6809U	SR2507

Figure 1-2-2 Positioning of Typical Grades of SUMIKASUPER LCP



Grade Notation Method

As shown in the table below, SUMIKASUPER LCP grades use a notation method that makes it easy to quickly recognize the composition. However, there are some exceptions to this notation such as with ultra-high toughness grades and high flowability grades.

Table 1-2-4 Grade Notation for SUMIKASUPER LCP

Naming Conventions for SUMIKASUPER Grades			
Position	Characteristics	Example	Meaning
First and second letters	Types of functionalities of resins	E SR SV SZ	Standard grades High performance resin grades Functional standard grades Functional grades
First digit	Base polymer types	5000 4000 6000 6000HF 1000 2000	5000 series base polymers 4000 series base polymers 6000 series base polymers 6000HF series base polymers 1000 series base polymers 2000 series base polymers
Second digit	Types of filler	0 2 5 7 8	Glass fiber Inorganic filler A, or glass fiber / inorganic filler A Inorganic filler B, or glass fiber / inorganic filler B Inorganic filler C, or glass fiber / inorganic filler C Inorganic filler D, or glass fiber / inorganic filler D
Third and fourth numbers	Total amount of filler	05 06 07 08 09 10	25% 30% 35% 40% 45% 50%
Next character(s)	Grade Features	None L G,U,T,K	Short glass fiber filled or unfilled Long glass fiber filled Glass fiber / inorganic filler ratio change
Space			
Next character	Functionalization or color codes	MR AS None B GR CY Z	Addition of mold releasing properties Addition of antistatic properties Natural Black Gray Blue Company control symbol

2. Table of Physical Properties

General Physical Properties of SUMIKASUPER LCP

The following table shows the typical physical property data for each grade of SUMIKASUPER LCP. All data is for reference only and is not intended as guarantees on product performance.

Table 2-1 General Physical Properties of SUMIKASUPER E5000 and E4000 series

				E5000 series					E4000 series			
General Physical Properties		Test method	Unit	E5006L	E5008	E5008L	E52008	E5204L	E4006L	E4008	E4009	E4205R
Color				Natural/ Black	Natural/ Black	Natural/ Black	Natural/ Black	Black	Natural/ Black	Natural/ Black	Natural	Natural/ Black
Filler				Glass fiber	Glass fiber	Glass fiber	Glass fiber	Glass fiber/ inorganic	Glass fiber	Glass fiber	Glass fiber	Glass fiber/ inorganic
Filler contents			wt%	30	40	40	40	20	30	40	45	25
Physical properties												
Density		ISO 1183	g/cm^3	1.60	1.69	1.69	1.69	1.21	1.60	1.70	1.76	1.18
Specific gravity		ASTM D792	-	1.60	1.69	1.69	1.69	1.21	1.60	1.70	1.76	1.18
Water absorption rate	23°C, Underwater 24hr	ISO 62	%	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Mold shrinkage	MD	Internal*1	%	0.02	0.06	0.05	0.08	0.57	0.11	0.10	0.11	0.66
	TD		%	0.86	1.25	0.81	1.23	1.70	0.78	1.32	1.22	1.67
Mechanical properties												
Tensile strength		ISO 527-1,2	MPa	116	101	108	97	67	115	103	-	58
		ASTM D638	MPa	151	111	123	112	89	182	150	152	82
Tensile elongation		ISO 527-1,2	%	1.6	2.5	0.9	2.4	1.9	2.3	3.1	-	2.3
		ASTM D638	%	4.5	4.8	3.7	5.8	5.5	5.6	5.0	5.4	5.0
Tensile modulus		ISO 527-1,2	MPa	16,600	11,900	17,000	-	7,000	13,700	11,900	-	6,300
Flexural strength		ISO 178	MPa	179	144	168	117	97	196	153	-	90
		ASTM D790	MPa	152	127	127	124	93	155	139	145	85
Flexural modulus		ISO 178	MPa	15,800	13,300	17,000	11,600	7,600	14,900	12,900	-	6,000
		ASTM D790	MPa	14,200	12,200	13,400	12,000	7,000	11,900	12,300	13,300	5,600
Charpy impact strength	Unnotched	ISO 179/1eU	kJ/m^2	39	54	36	27	28	47	54	-	31
Izod impact strength	Unnotched	ISO 180/1U	kJ/m^2	25	40	24	23	17	32	43	-	20
		ASTM D256	J/m	382	441	324	401	343	461	520	374	-
Rockwell hardness	R scale	ASTM D785	-	99	102	100	-	103	104	106	-	-
Thermal properties												
Deflection temperature under load	1.80MPa	ISO 75	°C	330	330	326	312	313	328	304	-	279
	1.82MPa	ASTM D648	°C	355	335	339	336	351	324	326	326	305
Coefficient of linear thermal expansion	MD (50 - 150°C)	ISO11359-1,2	$10^{-5}/K$	1.7	0.1	0.2	-	1.3	0.2	1.4	1.5	-
	TD (50 - 150°C)		$10^{-5}/K$	7.3	6.4	6.0	-	7.3	8.1	6.2	6.3	-
Electrical properties												
Relative permittivity	1MHz	IEC 60250	-	3.7	4.2	4.2	-	3.1	3.7	3.9	-	2.9
	1GHz		-	3.4	3.7	3.7	-	3.0	-	3.7	-	2.8
Dielectric dissipation factor	1MHz	IEC 60250	-	0.022	0.031	0.031	-	0.018	0.035	0.034	-	0.013
	1GHz		-	0.005	0.005	0.005	-	0.006	-	0.006	-	0.004
Electric strength		IEC 60243-1	kV/mm	-	> 40	37	-	-	43	43	-	-
Volume resistivity		IEC 60093	Ωm	$>10^{13}$	$>10^{13}$	$>10^{13}$	$>10^{13}$	$>10^{13}$	$>10^{13}$	$>10^{13}$	$>10^{13}$	$>10^{13}$
Arc resistance		ASTM D495	sec	-	128	128	-	-	130	130	-	-
Tracking resistance		IEC 60112	V	-	175	185	-	-	185	175	-	-
Flammability												
Flame retardant rank		IEC 60695-11-10	class	V-0	V-0	V-0	V-0	V-0	V-0	V-0	V-0	V-0
UL Yellow Card File No.		-	-	E249884	E249884	E249884	E249884	E249884	E249884	E249884	E249884	E249884

*1 Mold shrinkage is measured on a 64mm x 64mm x 3mm flat test piece.

Table 2-2 General Physical Property of SUMIKASUPER E6000 series

General Physical Properties		Test method	Unit	E6000 series								
				E6006	E6006L	E6007AS	E6008 KE	E6008	E6205L	E6807T	E6809U	E6809T
Color				Black	Natural/ Black	Black	Natural/ Black	Natural/ Black	Natural/ Black	Natural/ Black	Natural/ Black	Black
Filler				Glass fiber	Glass fiber	Glass fiber/ inorganic	Glass fiber	Glass fiber	Glass fiber/ inorganic	Inorganic	Glass fiber/ inorganic	Inorganic
Filler contents			wt%	30	30	35	40	40	25	35	45	45
Physical properties												
Density		ISO 1183	g/cm^3	1.62	1.61	1.63	1.70	1.70	1.20	1.67	1.78	1.85
Specific gravity		ASTM D792	-	1.62	1.61	1.63	1.70	1.70	1.20	1.67	1.78	1.85
Water absorption rate	23°C, Underwater 24hr	ISO 62	%	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Mold shrinkage	MD	Internal*1	%	0.21	0.19	0.31	0.16	0.18	0.68	0.31	0.30	0.20
	TD		%	1.21	0.74	1.08	1.53	1.16	1.38	1.01	0.80	0.61
Mechanical properties												
Tensile strength		ISO 527-1,2	MPa	142	115	97	100	105	57	87	92	-
		ASTM D638	MPa	166	164	121	146	147	74	106	90	94
Tensile elongation		ISO 527-1,2	%	4.1	1.5	2.1	2.0	2.0	2.9	6.0	2.9	-
		ASTM D638	%	7.1	5.0	6.8	5.1	5.2	5.7	9.8	5.0	5.7
Tensile modulus		ISO 527-1,2	MPa	-	11,500	-	12,800	11,800	4,800	6,500	-	-
Flexural strength		ISO 178	MPa	145	184	131	138	155	89	106	-	-
		ASTM D790	MPa	127	153	126	139	143	88	97	105	107
Flexural modulus		ISO 178	MPa	10,600	13,300	10,200	12,200	13,100	5,100	7,600	-	-
		ASTM D790	MPa	9,800	11,300	9,800	11,200	12,300	5,300	7,300	9,500	9,600
Charpy impact strength	Unnotched	ISO 179/1eU	kJ/m^2	53	44	29	-	43	22	55	36	-
Izod impact strength	Unnotched	ISO 180/1U	kJ/m^2	43	32	21	36	32	18	48	32	-
		ASTM D256	J/m	490	363	343	537	412	280	515	350	410
Rockwell hardness	R scale	ASTM D785	-	-	113	-	-	109	108	103	-	-
Thermal properties												
Deflection temperature under load	1.80MPa	ISO 75	°C	262	288	260	256	275	236	240	253	-
	1.82MPa	ASTM D648	°C	280	284	274	276	279	258	262	270	262
Coefficient of linear thermal expansion	MD (50 - 150°C)	ISO11359-1,2	10^{-5}/K	-	2.0	-	0.3	1.3	-	-	1.0	-
	TD (50 - 150°C)		10^{-5}/K	-	8.9	-	7.2	5.6	-	-	6.0	-
Electrical properties												
Relative permittivity	1MHz	IEC 60250	-	-	3.7	-	-	3.9	3.0	-	-	-
	1GHz		-	-	3.5	-	-	3.8	2.9	3.4	-	-
Dielectric dissipation factor	1MHz	IEC 60250	-	-	0.034	-	-	0.032	0.024	-	-	-
	1GHz		-	-	0.005	-	-	0.005	0.005	0.005	-	-
Electric strength		IEC 60243-1	kV/mm	-	48	-	36	45	-	50	-	-
Volume resistivity		IEC 60093	Ωm	$>10^{13}$	$>10^{13}$	10^{4}-10^{11}	$>10^{13}$	$>10^{13}$	$>10^{13}$	$>10^{13}$	$>10^{13}$	$>10^{13}$
Arc resistance		ASTM D495	sec	-	130	-	-	130	-	133	-	-
Tracking resistance		IEC 60112	V	-	175	-	-	175	-	175	-	-
Flammability												
Flame retardant rank		IEC 60695-11-10	class	V-0	V-0	V-0	V-0	V-0	V-0	V-0	V-0	V-0
UL Yellow Card File No.		-	-	E249884	E249884	E249884	E249884	E249884	E249884	E249884	E249884	E249884

*1 Mold shrinkage is measured on a 64mm x 64mm x 3mm flat test piece.

Table 2-3 General Physical Properties of SUMIKASUPER E6000HF and SV series

			E6000HF series							SV series		
General Physical Properties	Test method	Unit	E6007LHF	E6807LHF	E6808GHF	E6808LHF	E6808UHF	E6810LHF	E6810KHF	SV6808THF	SV6808GHF	SV6808L
Color			Natural/ Black	Natural/ Black	Natural/ Black	Natural/ Black	Natural/ Black	Natural/ Black	Natural/ Black	Natural/ Black	Natural/ Black	Natural/ Black
Filler			Glass fiber	Glass fiber/ inorganic	Glass fiber/ inorganic	Glass fiber/ inorganic	Glass fiber/ inorganic	Glass fiber/ inorganic	Glass fiber/ inorganic	Glass fiber/ inorganic	Glass fiber/ inorganic	Glass fiber/ inorganic
Filler contents		wt%	35	35	40	40	40	50	50	40	40	40
Physical properties												
Density	ISO 1183	g/cm³	1.65	1.67	1.70	1.71	1.72	1.82	1.82	1.72	1.71	1.70
Specific gravity	ASTM D792	-	1.65	1.67	1.70	1.71	1.72	1.82	1.82	1.72	1.71	1.70
Water absorption rate 23°C, Underwater 24hr	ISO 62	%	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Mold shrinkage MD	Internal*1	%	0.20	0.20	0.14	0.23	0.22	0.13	0.39	0.25	0.26	0.20
Mold shrinkage TD	Internal*1	%	0.60	0.73	1.11	0.63	1.02	0.38	0.61	0.56	0.86	0.50
Mechanical properties												
Tensile strength	ISO 527-1,2	MPa	120	112	118	110	78	95	102	102	97	113
Tensile strength	ASTM D638	MPa	157	135	122	127	100	105	105	110	107	145
Tensile elongation	ISO 527-1,2	%	1.3	1.4	1.7	1.2	2.8	1.1	1.3	1.9	2.9	2.3
Tensile elongation	ASTM D638	%	5.1	5.3	5.4	4.5	5.0	4.0	3.7	5.5	6.2	3.3
Tensile modulus	ISO 527-1,2	MPa	12,500	11,700	11,700	12,600	7,400	12,100	11,500	10,400	10,700	10,500
Flexural strength	ISO 178	MPa	194	178	171	176	110	150	154	153	131	189
Flexural strength	ASTM D790	MPa	158	145	147	146	120	133	130	137	127	150
Flexural modulus	ISO 178	MPa	14,600	12,700	12,400	13,800	8,900	13,700	13,400	10,400	10,100	14,600
Flexural modulus	ASTM D790	MPa	11,800	12,100	12,300	11,800	9,400	12,600	12,100	9,000	10,500	11,500
Charpy impact strength Unnotched	ISO 179/1eU	kJ/m²	33	35	43	34	45	25	22	42	36	36
Izod impact strength Unnotched	ISO 180/1U	kJ/m²	24	25	40	22	32	16	21	35	28	-
Izod impact strength Unnotched	ASTM D256	J/m	251	335	448	302	350	200	190	404	401	250
Rockwell hardness R scale	ASTM D785	-	110	106	109	110	100	102	105	103	105	105
Thermal properties												
Deflection temperature under load 1.80MPa	ISO 75	°C	277	276	261	279	228	273	267	262	244	294
Deflection temperature under load 1.82MPa	ASTM D648	°C	269	269	268	274	240	266	265	270	255	293
Coefficient of linear thermal expansion MD (50 - 150°C)	ISO11359-1,2	10^{-5}/K	0.2	1.0	0.7	0.4	1.0	0.5	0.9	0.6	1.3	1.0
Coefficient of linear thermal expansion TD (50 - 150°C)	ISO11359-1,2	10^{-5}/K	8.5	6.3	7.6	8.1	6.2	8.0	7.1	5.2	6.8	9.0
Electrical properties												
Relative permittivity 1MHz	IEC 60250	-	3.8	3.8	4.0	3.8	3.8	4.1	-	3.8	3.8	-
Relative permittivity 1GHz	IEC 60250	-	3.8	3.5	3.6	3.6	3.5	3.8	-	3.5	3.5	-
Dielectric dissipation factor 1MHz	IEC 60250	-	0.026	0.030	0.033	0.038	0.033	0.020	-	0.012	0.029	-
Dielectric dissipation factor 1GHz	IEC 60250	-	0.005	0.004	0.004	0.004	0.004	0.004	-	0.004	0.004	-
Electric strength	IEC 60243-1	kV/mm	51	48	36	49	41	47	47	53	41	-
Volume resistivity	IEC 60093	Ωm	$>10^{13}$	$>10^{13}$	$>10^{13}$	$>10^{13}$	$>10^{13}$	$>10^{13}$	$>10^{13}$	$>10^{13}$	$>10^{13}$	$>10^{13}$
Arc resistance	ASTM D495	sec	111	133	125	130	155	171	181	180	132	-
Tracking resistance	IEC 60112	V	175	175	190	150	200	200	200	175	175	-
Flammability												
Flame retardant rank	IEC 60695-11-10	class	V-0	V-0	V-0	V-0	V-0	V-0	V-0	V-0	V-0	V-0
UL Yellow Card File No.	-	-	E249884	E249884	E249884	E249884	E249884	E249884	E249884	E249884	E249884	E249884

*1 Mold shrinkage is measured on a 64mm x 64mm x 3mm flat test piece.

Table 2-4 General Physical Properties of SUMIKASUPER SR1000, SR2000 and SZ series

				SR1000 series			SR2000 series		SZ series			
General Physical Properties		Test method	Unit	SR1009	SR1009L	SR1205L	SR2506	SR2507	SZ4506	SZ6505HF	SZ6506HF	SZ6709L
Color				Natural/ Black	Natural/ Black	Natural/ Black	Natural/ Black	Natural/ Black	Natural/ Black	Natural/ Black	Natural/ Black	Natural
Filler				Glass fiber	Glass fiber	Glass fiber/ inorganic	Glass fiber/ inorganic	Inorganic	Inorganic	Inorganic	Inorganic	Glass fiber/ inorganic
Filler contents			wt%	45	45	25	30	35	30	25	30	45
Physical properties												
Density		ISO 1183	g/cm^3	1.74	1.76	1.15	1.62	1.68	1.63	1.58	1.63	1.89
Specific gravity		ASTM D792	-	1.74	1.76	1.15	1.62	1.68	1.63	1.58	1.63	1.89
Water absorption rate	23°C, Underwater 24hr	ISO 62	%	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Mold shrinkage	MD	Internal*1	%	0.30	0.10	0.48	0.21	0.30	0.21	0.22	0.22	0.17
	TD		%	0.70	0.45	0.86	0.51	0.50	0.55	0.60	0.47	0.80
Mechanical properties												
Tensile strength		ISO 527-1,2	MPa	118	142	80	124	115	119	118	116	111
		ASTM D638	MPa	146	179	100	133	128	143	130	127	115
Tensile elongation		ISO 527-1,2	%	2.8	1.2	3.6	2.3	2.3	2.1	1.9	1.9	1.5
		ASTM D638	%	4.5	3.5	6.2	7.0	3.8	3.7	7.0	6.1	5.0
Tensile modulus		ISO 527-1,2	MPa	11,600	15,800	3,600	12,900	12,800	-	9,900	10,800	-
Flexural strength		ISO 178	MPa	210	270	125	165	160	148	151	151	155
		ASTM D790	MPa	174	191	115	147	150	132	140	140	140
Flexural modulus		ISO 178	MPa	14,300	16,600	5,700	12,800	13,800	12,900	11,600	11,600	7,300
		ASTM D790	MPa	12,600	13,100	5,300	11,700	12,800	10,000	11,200	11,900	11,000
Charpy impact strength	Unnotched	ISO 179/1eU	kJ/m^2	21	-	14	48	40	49	92	-	33
Izod impact strength	Unnotched	ISO 180/1U	kJ/m^2	17	17	10	40	40	43	69	54	-
		ASTM D256	J/m	151	121	120	352	252	509	430	360	310
Rockwell hardness	R scale	ASTM D785	-	118	116	120	112	103	101	100	101	107
Thermal properties												
Deflection temperature under load	1.80MPa	ISO 75	°C	267	285	234	231	230	283	235	238	275
	1.82MPa	ASTM D648	°C	277	286	252	239	240	296	244	245	275
Coefficient of linear thermal expansion	MD (50 - 150°C)	ISO11359-1,2	$10^{-5}/K$	0.2	0.2	1.1	0.7	0.5	0.1	1.1	1.0	0.9
	TD (50 - 150°C)		$10^{-5}/K$	7.1	7.1	5.6	5.2	2.7	5.9	7.6	6.6	8.1
Electrical properties												
Relative permittivity	1MHz	IEC 60250	-	4.0	4.2	2.8	3.6	3.7	3.7	3.8	3.5	5.6
	1GHz		-	4.0	3.9	2.8	3.5	3.5	-	3.4	3.5	5.0
Dielectric dissipation factor	1MHz	IEC 60250	-	0.008	0.009	0.007	0.029	0.029	0.031	0.023	0.011	0.011
	1GHz		-	0.003	0.003	0.002	0.004	0.005	-	0.004	0.005	0.004
Electric strength		IEC 60243-1	kV/mm	27	29	27	53	-	53	50	50	-
Volume resistivity		IEC 60093	Ωm	$>10^{13}$	$>10^{13}$	$>10^{13}$	$>10^{13}$	$>10^{13}$	$>10^{13}$	$>10^{13}$	$>10^{13}$	$>10^{13}$
Arc resistance		ASTM D495	sec	-	121	-	125	-	-	125	125	-
Tracking resistance		IEC 60112	V	-	125	-	150	-	-	200	175	-
Flammability												
Flame retardant rank		IEC 60695-11-10	class	V-0	V-0	V-0	V-0	V-0	V-0	V-0	V-0	V-0
UL Yellow Card File No.		-	-	E249884	E249884	E249884	E249884	E249884	E249884	E249884	E249884	E249884

*1 Mold shrinkage is measured on a 64mm x 64mm x 3mm flat test piece.

3. Physical Properties

3-1 Heat Resistance

Deflection temperature under load

The approximate deflection temperature under load (DTUL) for each grade of SUMIKASUPER LCP is as follows.
The deflection temperature under load can be used as a general indicator for short-term heat resistance. Keep in mind that the results are from tests performed at different measured stresses (0.45MPa and 1.82MPa).

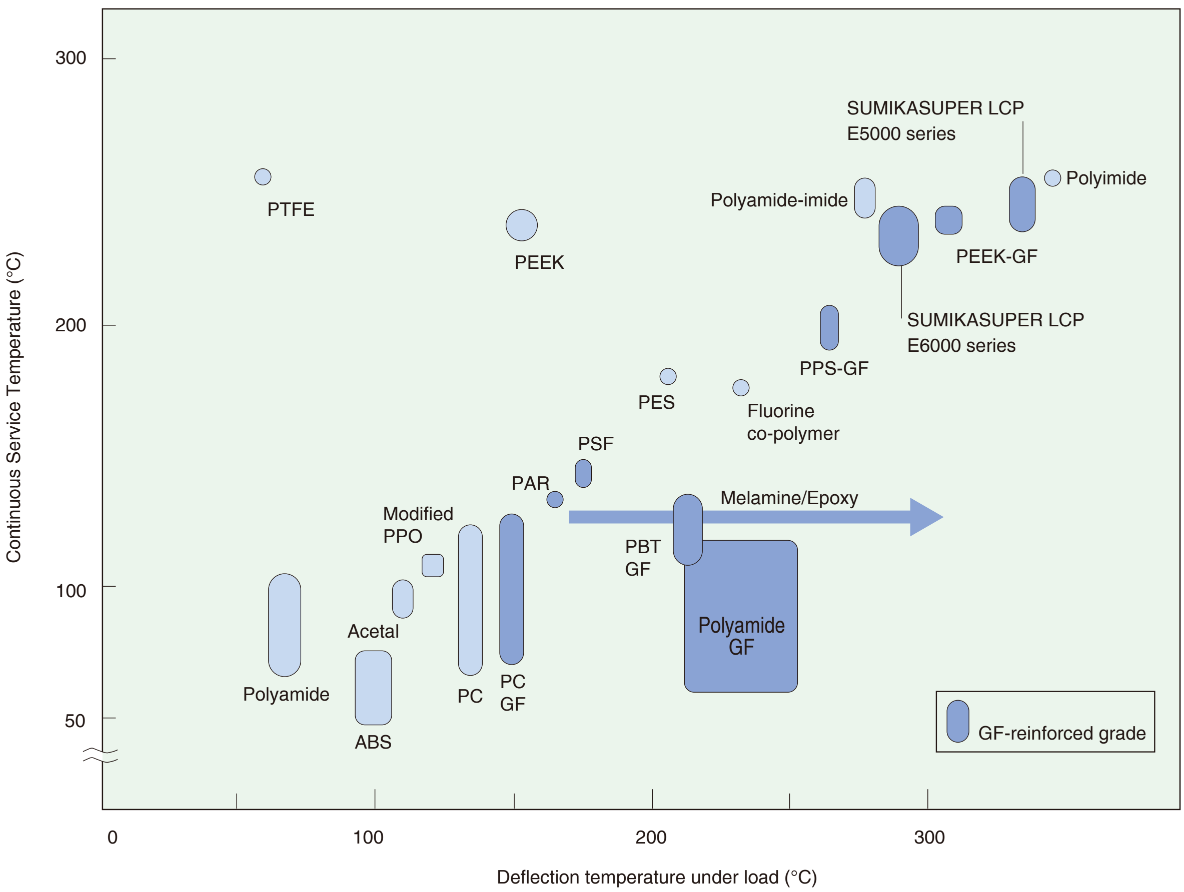
Table 3-1-1 DTUL of SUMIKASUPER LCP

Under Load	0.45MPa	1.82MPa
E5000 series	350-390°C	330-360°C
E4000 series	330-340°C	300-320°C
E6000 series SV6000 series SR1000 series	300-320°C	270-290°C
E6000HF series SV6000HF series	280-320°C	250-280°C
SZ6000HF series SR2000 series	270-300°C	240-270°C

Continuous Service Temperature and DTUL

SUMIKASUPER LCP has an excellent balance between the continuous service temperature and DTUL.

Figure 3-1-1 Continuous Service Temperature and DTUL (1.82MPa)



Thermal Decomposition Temperature

The results from TGA (Thermogravimetric Analysis) indicate that the temperature of thermal decomposition in nitrogen is quite high, being approximately 450°C, and the decrease in mass at a temperature of 500°C is extremely small (only 1%). Therefore, SUMIKASUPER LCP can be seen to exhibit high thermal stability.

Figure 3-1-2 TGA Curves of SUMIKASUPER LCP and Other Engineering Plastics

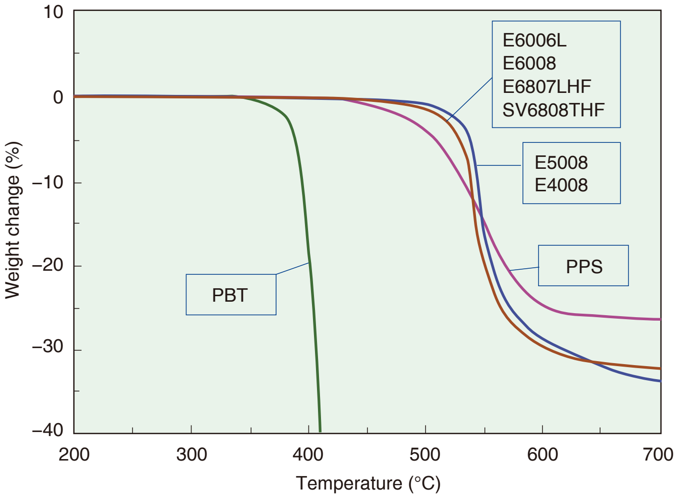


Table 3-1-2 Thermal Decomposition Temperature

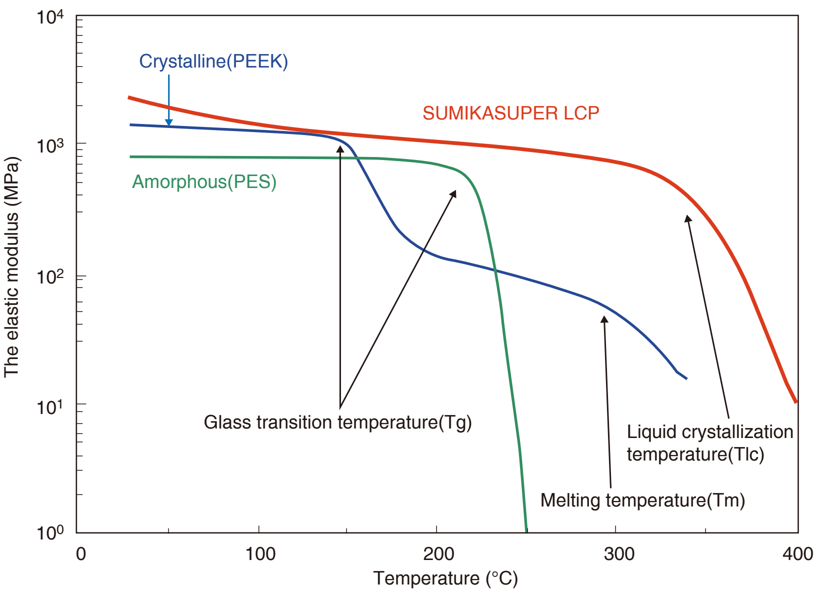
Resin components	Decomposition temperature(°C)	
	1% weight loss temperature	Main decomposition temperature
E5008 E5008L	520	559
E4008	520	555
E6008 E6006L	500	550
E6007LHF E6807LHF SV6808THF SZ6505HF	500	550
PBT-GF30	370	421
PPS-GF40	460	556

Measuring equipment:TG50 model by Shimadzu
Temperature ramp rate:10°C/min
Atmosphere:Under nitrogen

Dynamic viscoelasticity (DMA)

The following data show the temperature dependence of dynamic viscoelasticity for the elastic modulus for comparing SUMIKASUPER LCP, crystalline polymers (PEEK), and amorphous polymers (PES). For PEEK, there is a significant decrease in the elastic modulus at 140°C, while LCP maintains high mechanical properties even at 200°C and above without showing glass transition behavior. Thermal analysis using a differential scanning calorimeter (DSC) also indicates no thermal transition (Tg) that is seen with conventional crystalline and amorphous polymers. There is also no clear melting point observed with SUMIKASUPER LCP. SUMIKASUPER LCP appears to melt at the liquid crystallization temperature (Tlc). This indicates that the tool temperature can be set widely up to the molding temperature.

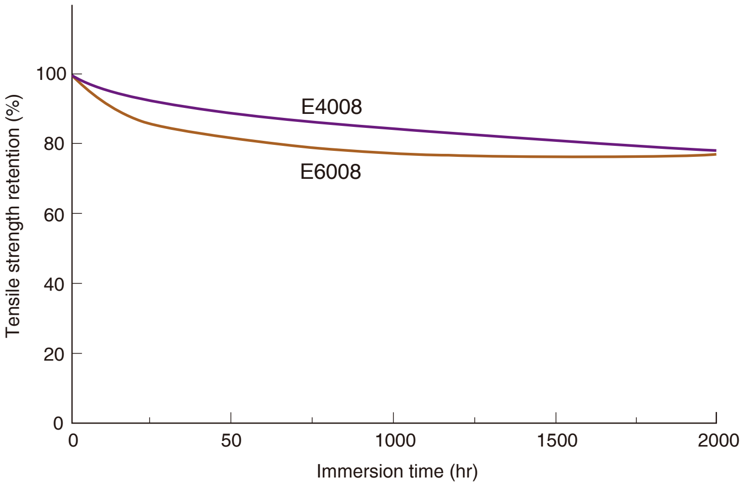
Figure 3-1-3 Dynamic viscoelastic curve Curve of SUMIKASUPER LCP



Hot Water Resistance

It maintains practical strength even after immersion for 2,000 hours in water at 80°C. It cannot be used in water vapor of 120°C or higher since susceptibility to hydrolysis increases and strength is greatly reduced.

Figure 3-1-4 Hot Water Resistance of SUMIKASUPER LCP (80°C)



Soldering Heat Resistance

SUMIKASUPER LCP possesses the highest soldering heat resistance among all heat-resistant engineering plastics.

Table 3-1-3 Soldering Heat Resistance of SUMIKASUPER LCP

	Resin components	Solder bath temperature (°C)															
		220		240		260		280		300		320		340		360	
SUMIKASUPER LCP	E5000 series	>60														5	
	E4000 series	>60													10		
	E6000 series	>60									10						
	E6000HF series	>60								10							
	SV6000HF series	>60								10							
	SZ/SR series	>60								10							
PEEK	GF30%	>60											10	3			
PPS	GF40%	>60					5	3									
	High filler content	>60					10	1									

Sample size : JIS K7113 No. 1(1/2) dumbbell x 1.2mm
Solder : H60A (60% tin, 40% lead)

*The values within the above table represent the limit, in seconds (">60" means the product will not deform, even when dipped in a solder bath for 60 seconds). Blistering may occur, even in temperatures less than the above deformation temperatures, depending on the molding condition.

Long-Term Heat Resistance

SUMIKASUPER LCP has excellent long-term heat resistance. The following data show the relative temperature index (RTI) for SUMIKASUPER LCP. The RTI indicates the temperature at which the impact strength (Imp) and tensile strength (Str) of the electrical properties (Elec) and mechanical properties (Mech) become half their initial values after the material is aged 100,000 hours. Generally, deterioration is faster for thin test pieces, so RTI evaluation for UL is performed according to the thickness of the test piece.

Table 3-1-4 Relative Temperature Index of SUMIKASUPER LCP (UL 746B)

Grade	Thickness (mm)	RTI		
		Elec	Imp	Str
E5008	0.75	240	200	220
	1.5	240	220	240
	3.0	240	220	240
E5008L	0.75	240	200	220
	1.5	240	220	240
	3.0	240	220	240
E4008	0.15	220	200	220
	0.30	240	200	240
	0.75	240	220	240
	1.5	240	220	240
	3.0	240	220	240
E6008	0.15	220	200	220
	0.27	240	200	240
	0.54	240	220	240
	0.75	240	220	240
	1.5	240	220	240
	3.0	240	220	240
E6007LHF-MR	0.50	220	210	210
	0.75	220	210	210
	1.5	220	220	220
	3.0	220	220	220

Arrhenius Plot

The temperature range where the resin can be used for a long time is limited by the thermal stability of the resin. According to the UL -compliant RTI evaluation, the aging test continues until the observable target property value becomes half the initial value. Perform aging tests at several different temperatures and create an Arrhenius plot based on that data. An Arrhenius plot is a graph created by plotting the heat aging time (also called half-life) required for the property value to reach half the initial value against the reciprocal of the aging temperature (K).

Figure 3-1-5 Temperature Dependence of Tensile Strength Half-life of SUMIKASUPER E5008

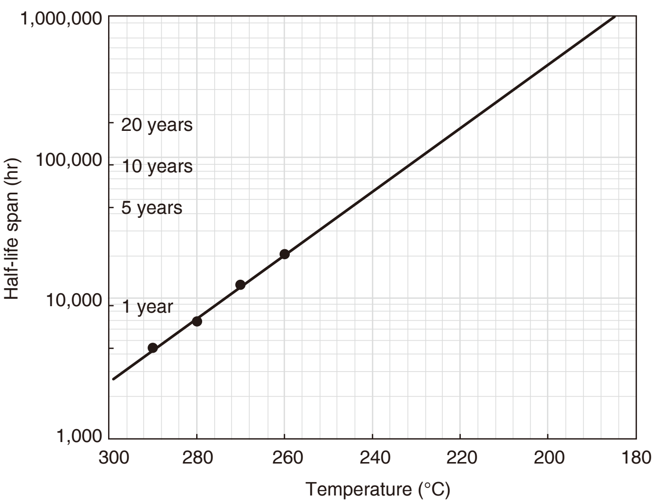
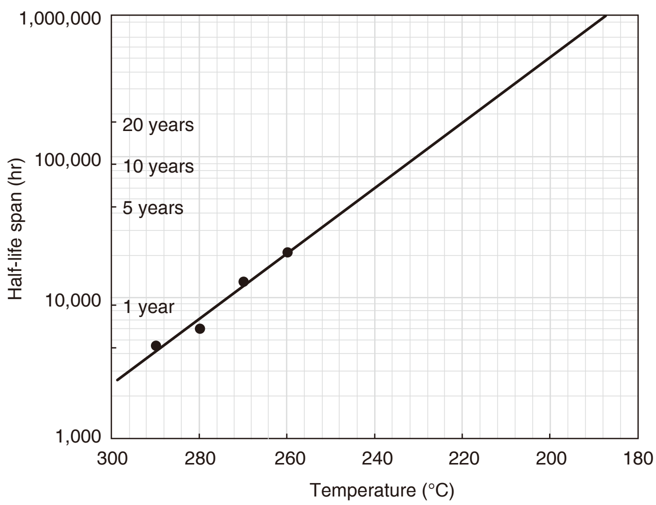


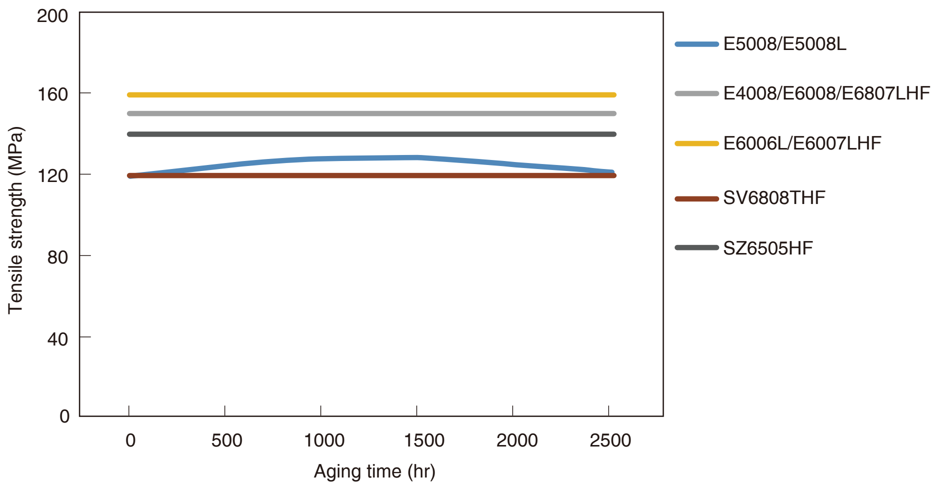
Figure 3-1-6 Temperature Dependence of Tensile Strength Half-life of SUMIKASUPER E6008



Heat aging resistance (260°C in air)

The following figure shows the strength retention performance of SUMIKASUPER LCP in air at 260°C. There is almost no loss of tensile strength, even in air at 260°C.

Figure 3-1-7 Resistance to after heat aging (260°C in air)



3-2 Mechanical Properties

Tensile strength

The stress-strain curve (hereinafter referred to as S-S curve) from the tension test for SUMIKASUPER LCP is shown. Stress and strain are proportional until the stress reaches a certain level. When designing plastic strength, it is important to remember that there are portions where the stress and strain are not proportional.
Figures 3-2-2 and 3-2-3 show the temperature dependence of the tensile strength for E6008 and E5008. The tension properties change according to the environmental temperature, but SUMIKASUPER LCP maintains high tensile strength over a wide temperature range.

Figure 3-2-1 S-S Curve of SUMIKASUPER LCP

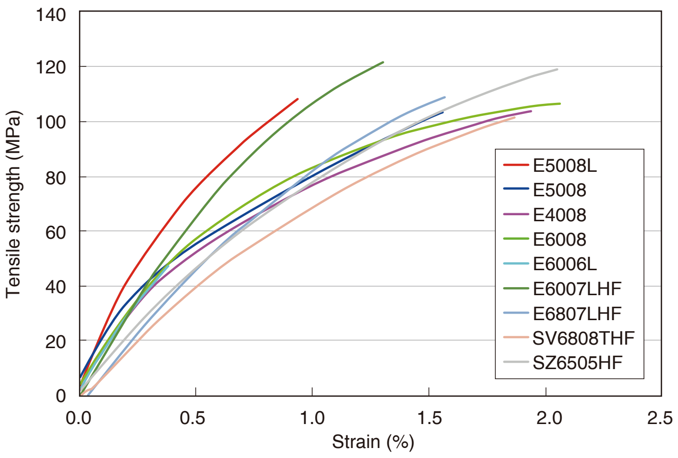


Figure 3-2-2 Temperature Dependence of Tensile Strength of E6008

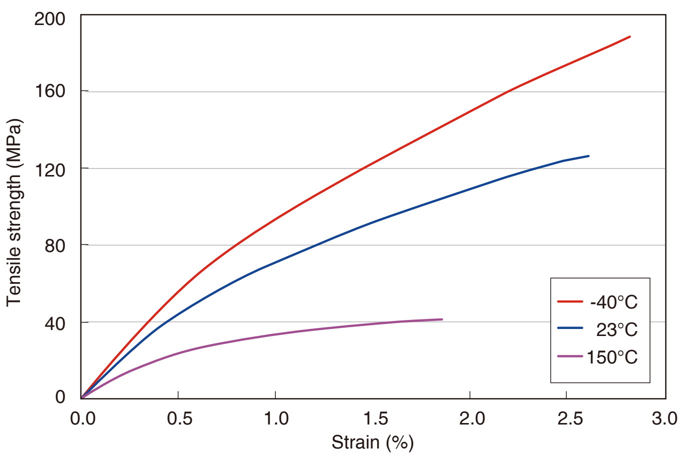
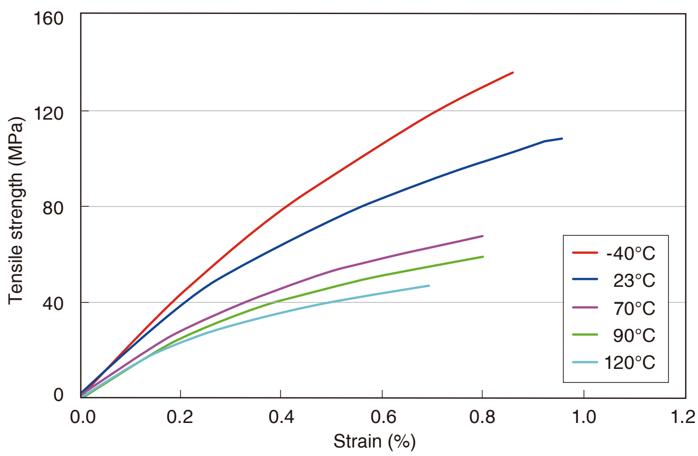


Figure 3-2-3 Temperature Dependence of Tensile Strength of E5008



Thickness Dependence of Moldings

The molecules of SUMIKASUPER LCP are easily oriented due to shearing forces at the time of melting. The thinner the walls of moldings, the greater the percentage of the skin layer. This skin layer has a very uniform molecular orientation, therefore providing greater relative strength per area of cross section. Table 3-2-1 shows the tensile properties of SUMIKASUPER LCP in thin walls. Figure 3-2-4 and Table 3-2-2 show the thickness dependence of tensile strength and flexural strength.

Table 3-2-1 Thin-wall Tensile Strength of SUMIKASUPER LCP

Item	Thickness (mm)	E5008L	E5008	E4008	E6008	E6006L	E6007LHF	E6807LHF	SV6808THF	SZ6505HF
Tensile strength (MPa)	0.5	151	161	178	199	215	153	144	130	140
	0.8	151	139	171	184	194	141	139	123	137
	1.2	135	119	158	164	172	141	127	116	144
	1.6	132	113	131	149	160	144	126	114	144
Tensile elongation (%)	0.5	2.4	2.9	3.0	3.0	2.4	2.7	2.8	2.1	4.8
	0.8	2.7	3.1	3.7	3.5	2.8	3.6	4.1	2.8	5.7
	1.2	2.8	3.3	4.1	4.0	3.4	3.8	4.1	3.3	6.2
	1.6	3.1	3.5	4.5	4.2	3.7	4.2	4.3	3.6	6.8
Tensile modulus (GPa)	0.5	18.6	17.6	19.5	18.6	21.7	17.7	16.9	15.8	14.9
	0.8	16.1	15.4	17.1	16.5	15.8	15.2	14.8	12.0	13.2
	1.2	14.1	12.4	13.4	12.4	12.2	11.9	11.1	10.5	11.8
	1.6	11.6	11.0	10.8	11.0	9.8	11.0	10.0	9.5	10.6
Molding temperature (°C)		400		380	350					

Figure 3-2-4 Thickness Dependence of Tensile Strength of SUMIKASUPER LCP

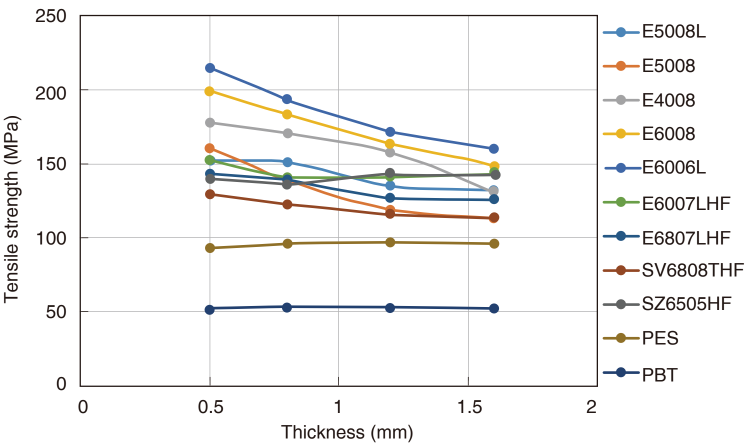


Figure 3-2-5 Skin/Core Diagram

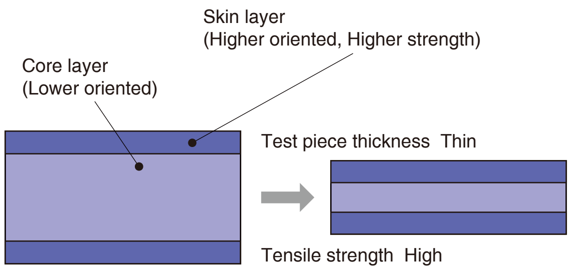


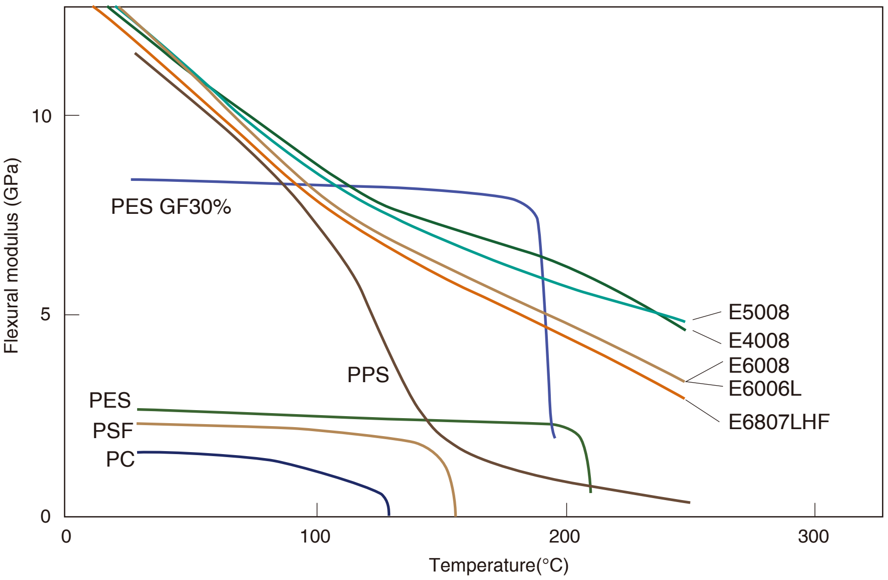
Table 3-2-2 Thickness Dependence of Flexural Strength of SUMIKASUPER LCP

Item	Thickness (mm)	E6007LHF	E6807LHF	E6808LHF	E6808UHF	E6808GHF	E6810KHF	SV6808THF	SZ6505HF	SZ6506HF
Flexural strength (MPa)	0.5	234	198	220	131	184	174	160	155	153
	0.8	234	202	216	126	177	174	163	155	155
	1.2	224	198	201	121	168	165	160	157	162
	1.6	217	188	194	124	170	159	157	169	173
Flexural modulus (GPa)	0.5	25.4	20.5	24.8	16.5	20.3	21.5	12.9	18.4	19.2
	0.8	21.0	16.6	18.7	12.6	16.7	17.7	11.3	15.7	16.0
	1.2	17.6	14.4	15.4	9.6	13.1	14.2	10.4	12.6	13.7
	1.6	14.8	11.7	12.9	8.7	11.7	12.4	8.9	12.0	13.2

Temperature Dependence of Flexural Modulus

The elastic modulus of liquid crystalline polyester, such as SUMIKASUPER LCP, does not dramatically decrease at the glass transition temperature like crystalline and amorphous polymers. Rather, it tends to decrease gradually as the temperature increases. Each series has a practical flexural modulus even at 250°C, so it ranks high among heat-resistant engineering plastics. In addition, when thermal treatment is applied to a product after molding, the skin structure becomes harder and the elastic modulus tends to improve. There is a similar tendency as the elastic modulus with strength, thermal deformation temperature, and creep properties.

Figure 3-2-6 Temperature Dependence of Flexural Modulus of SUMIKASUPER LCP



Anisotropy of physical properties

The anisotropic properties of SUMIKASUPER LCP are shown in the table below. It is apparent that the values for the flow direction (MD) differ greatly from the values perpendicular to the flow direction (TD). Please ensure that the gates are positioned properly when designing molds used in the injection molding process.

Table 3-2-3 Anisotropy of Physical Properties of SUMIKASUPER LCP

Item	Unit	Measurement direction	E5008L	E5008	E4008	E6008	E6006L	E6007LHF
Mold shrinkage	%	MD	0.05	0.06	0.10	0.18	0.19	0.20
	%	TD	0.81	1.25	1.32	1.16	0.74	0.60
Flexural strength	MPa	MD	137	130	138	136	156	158
	MPa	TD	58	56	57	61	92	95
Flexural modulus	GPa	MD	13.4	12.6	12.7	12.2	11.4	14.0
	GPa	TD	3.7	3.3	3.0	4.4	4.7	5.1

Mold shrinkage test piece : 64 x 64 x 3mm (1mm film gate)
Flexural property test piece : 13w x 3t x 64Lmm
Distance between fulcrums : 40mm
Injection molding machine : Nissei Plastic Industry PS40E5ASE

Weld strength

Generally, since LCP has a high solidification rate with high anisotropy, it tends to have low weld strength. Since the mechanical properties of the weld tend to lose strength due to poor adhesion, sufficient consideration needs to be given when designing products and manufacturing molds.
This shows the weld flexural strength of SUMIKASUPER LCP. Two types of welds are evaluated: weld 1 where the LCP resin converges at the opening and begins to flow again, and weld 2 at the flow end where the LCP resin converges at the opening and stops flowing.

Figure 3-2-7 Weld Flexural Strength of SUMIKASUPER LCP (3mm thickness)

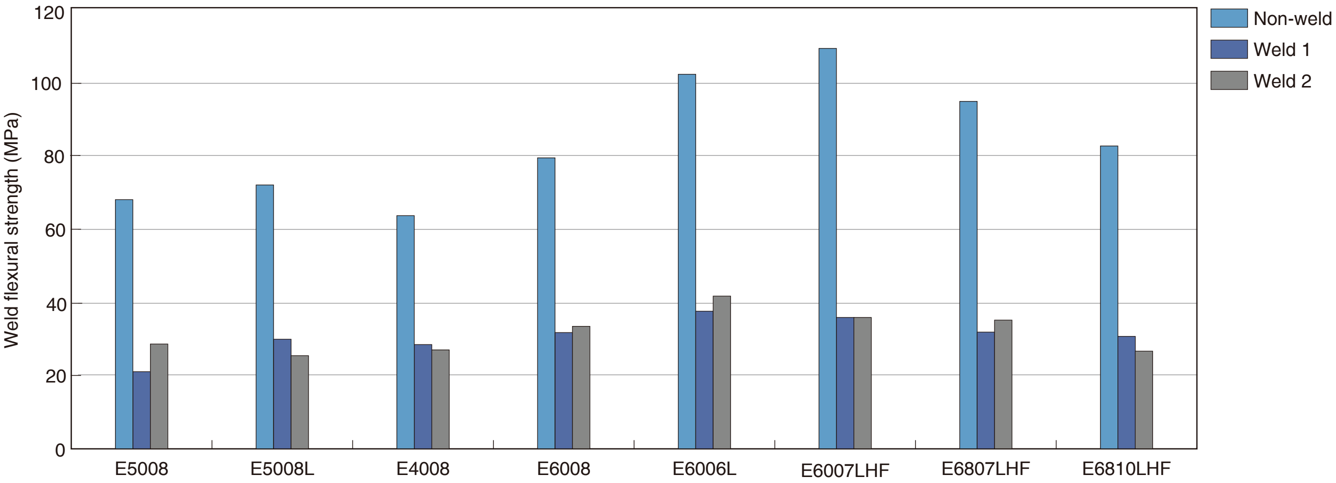


Figure 3-2-8 Test Pieces for Weld Evaluation of SUMIKASUPER LCP

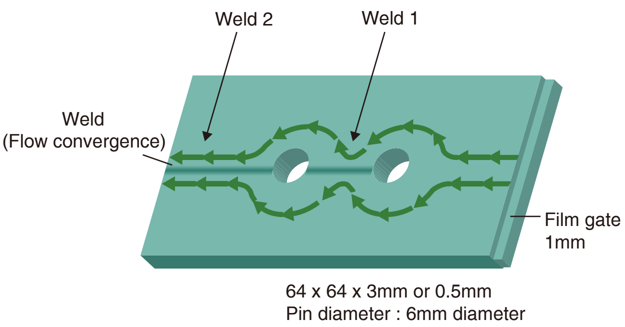
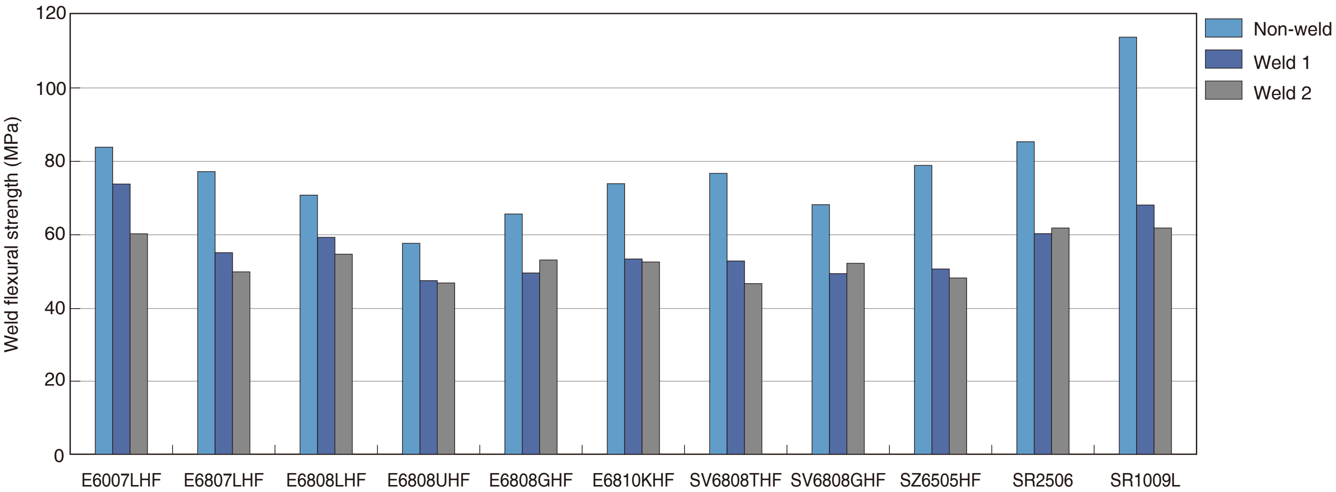


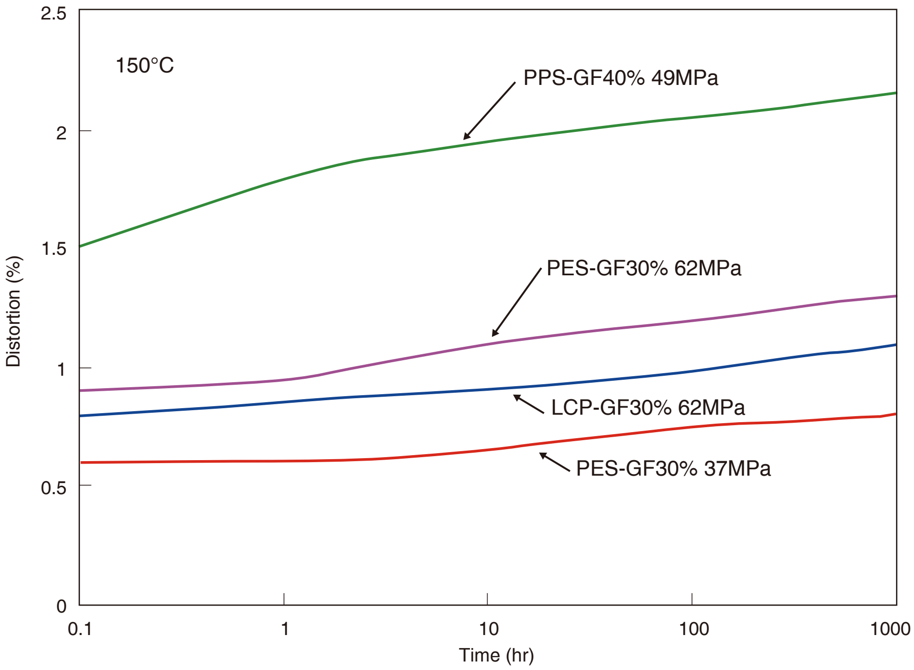
Figure 3-2-9 Weld flexural Strength of SUMIKASUPER LCP (0.5mm thickness)



Creep properties

When calculating the strength of practical parts, it is necessary to consider changes to the dimensions and strength of the moldings under use conditions based on the creep properties and property changes caused by temperature. Figure 3-2-10 shows the flexural creep properties at 150°C for E6006L, which is a glass fiber reinforced grade. SUMIKASUPER LCP demonstrates excellent creep properties compared to crystalline PPS (40% glass fiber reinforced grade) and SUMIKAEXCEL PES (30% glass fiber reinforced grade).

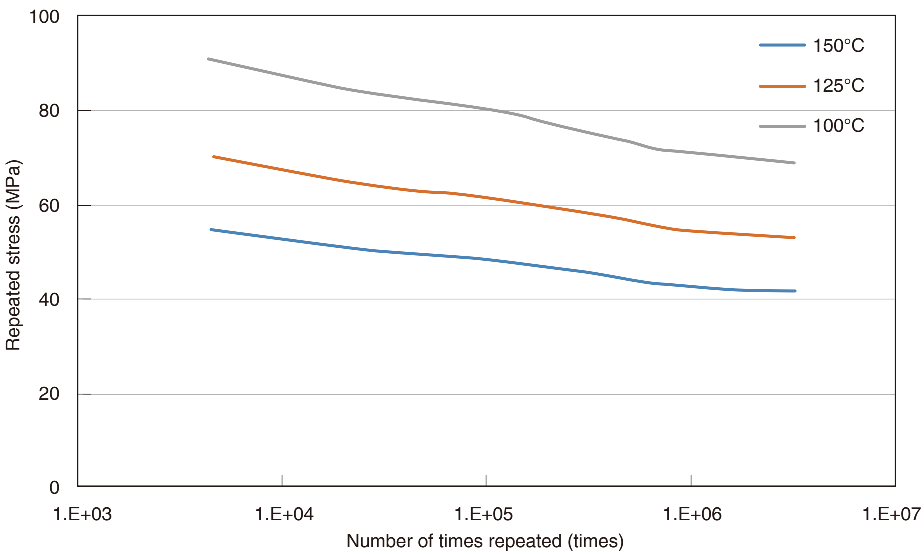
Figure 3-2-10 Creep Properties of SUMIKASUPER LCP



Fatigue Properties

Materials under loads that fluctuate over a long period of time experience fatigue fractures. The stress-life curve from a tensile fatigue test for SUMIKASUPER LCP E6006L is shown.

Figure 3-2-11 Fatigue Properties of SUMIKASUPER LCP



3-3 Dimensional Stabilities

Mold shrinkage

With SUMIKASUPER LCP, there is a great difference in mold shrinkage between the flow direction (MD) and the direction perpendicular to the flow direction (TD), and anisotropy is large. When considering the dimensions of the mold, set the adjustable mold shrinkage rate to a value between the MD and TD values.
It is recommended that small, thin-walled products in particular be designed with a shrinkage rate of 0% in the MD direction.

Table 3-3-1 Anisotropy of Physical Properties of SUMIKASUPER LCP

Item	Unit	Measurement direction	E5008L	E5008	E4008	E6008	E6006L	E6007LHF	SV6808THF	SZ6505HF
Mold shrinkage	%	MD	0.05	0.06	0.10	0.18	0.19	0.20	0.25	0.22
	%	TD	0.81	1.25	1.32	1.16	0.74	0.60	0.56	0.60
Flexural strength	MPa	MD	137	130	138	136	156	158	120	145
	MPa	TD	58	56	57	61	92	95	50	77
Flexural modulus	GPa	MD	13.4	12.6	12.7	12.2	11.4	12.0	10.0	12.0
	GPa	TD	3.7	3.3	3.0	4.4	4.7	3.5	3.0	6.0

Mold shrinkage test piece : 64 x 64 x 3mm (1mm film gate)
Bending property test piece : 13w x 3t x 64Lmm
Distance between fulcrums : 40mm
Injection molding machine : Nissei Plastic Industry PS40E5ASE

Figure 3-3-1 Mold Shrinkage of E6008

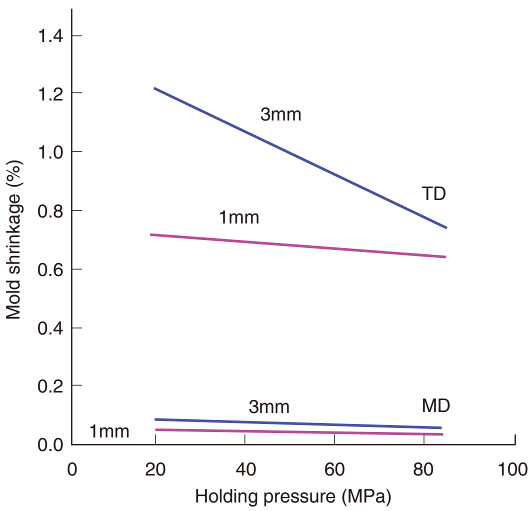
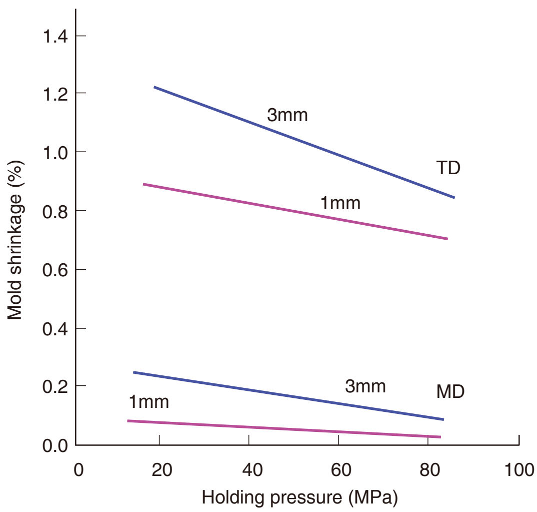


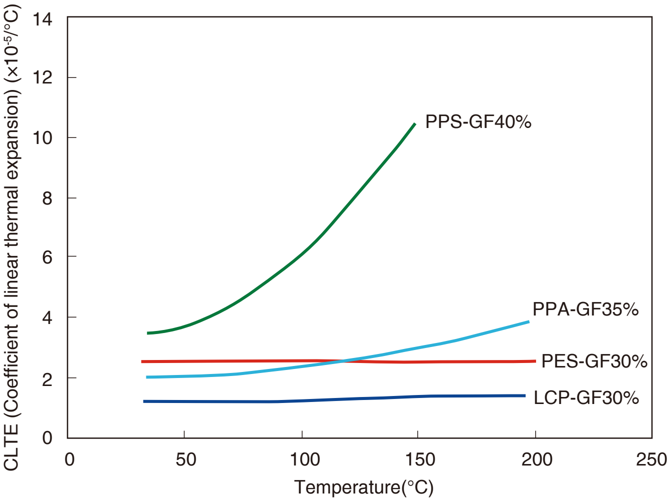
Figure 3-3-2 Mold Shrinkage of E5008



CLTE (Coefficient of linear thermal expansion) of SUMIKASUPER LCP

One excellent feature of SUMIKASUPER LCP is that its CLTE is extremely low. Its CLTE has linearity with almost no change even when the temperature changes, and the CLTE in the MD direction is the same level as that of metal, which is very low. However, similar to other properties, with LCP, anisotropy exists in the thermal expansion coefficient, and the CLTE in the TD direction becomes large.

Figure 3-3-3 Comparison of the CLTE of SUMIKASUPER LCP with That of Other Resins



CLTE (Coefficient of linear thermal expansion)

The CLTE (Coefficient of linear thermal expansion) is the displacement amount caused by thermal expansion per 1°C of the molding. Generally, the coefficient of linear thermal expansion indicates the average linear expansion coefficient within a certain temperature range. The CLTE of SUMIKASUPER LCP differs greatly between the MD and TD according to the filler type, filler amount, and the flow orientation (anisotropy). In this measurement, the difference between MD and TD is clear because the CLTE of the test piece that was machined from the center of the dumbbell test piece, which tends to have relatively large anisotropy.

Table 3-3-2 Coefficient of Linear Thermal Expansion of SUMIKASUPER LCP

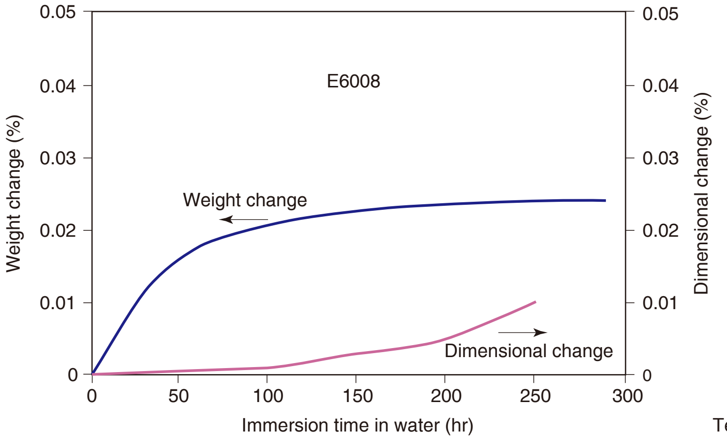
Unit : 10^{-5}/°C

Series	Grade	CLTE	
		MD	TD
E5000 series	E5006L	1.7	7.3
	E5008	0.1	6.4
	E5008L	0.2	6.0
	E5204L	1.3	7.3
E4000 series	E4006L	0.2	8.1
	E4008	1.4	6.2
	E4009	1.5	6.3
E6000 series	E6006L	2.0	8.9
	E6008 KE	0.3	7.2
	E6008	1.3	5.6
	E6809U	1.0	6.0
E6000HF series	E6007LHF	0.2	8.5
	E6007LHF-MR	0.2	8.5
	E6807LHF	1.0	6.3
	E6808GHF	0.7	7.6
	E6808LHF	0.4	8.1
	E6808UHF	1.0	6.2
	E6810LHF	0.5	8.0
	E6810KHF	0.9	7.1
SV series	SV6808THF	0.6	5.2
	SV6808GHF	1.3	6.8
	SV6808L	1.0	9.0
SR1000 series	SR1009	0.2	7.1
	SR1009L	0.2	7.1
	SR1205L	1.1	5.6
SR2000 series	SR2506	0.7	5.2
	SR2507	0.5	2.7
SZ series	SZ4506	0.1	5.9
	SZ6505HF	1.1	7.6
	SZ6506HF	1.0	6.6
	SZ6709L	0.9	8.1

Water Absorption Properties of SUMIKASUPER

SUMIKASUPER LCP shows very low water absorption of only 0.02%. As well, even if left in water over extended periods of time, almost no changes in weight or dimensions will be observed.

Figure 3-3-4 Change in Weight and Dimensions of SUMIKASUPER E6008

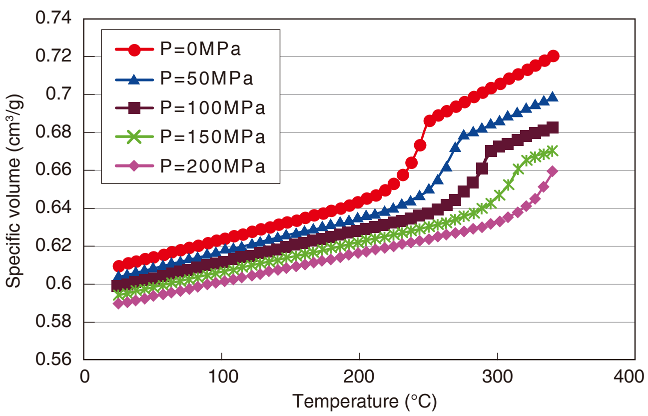


Test piece : 64 x 64 x 3mm

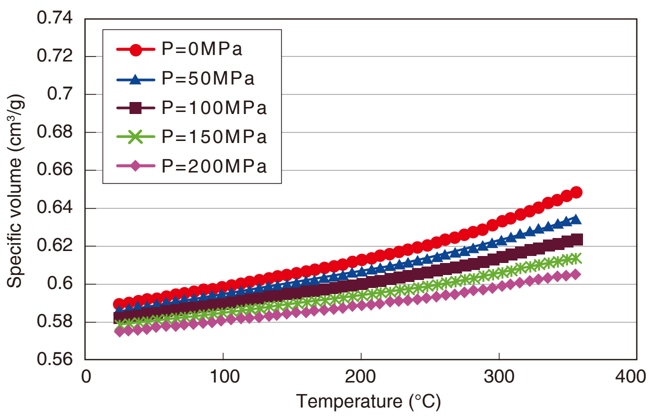
PVT Characteristics

The specific volume of thermoplastic resin, including SUMIKASUPER, changes according to the pressure regardless of whether it is in a solid or molten state. The compressibility of this resin is expressed as the relationship among Pressure, Specific Volume, and Temperature (PVT characteristics). The volume of crystalline resins such as PPS changes greatly at the melting point (crystallization), but since LCP appears to melt at the liquid crystallization temperature, there is little change in volume due to solidification. There is also little change in volume due to pressure. Therefore, it has excellent dimensional stability.

Figure 3-3-5 Comparison of PVT Characteristics between PPS-GF40% and SUMIKASUPER E6808LHF



PPS-GF40%



SUMIKASUPER E6808LHF

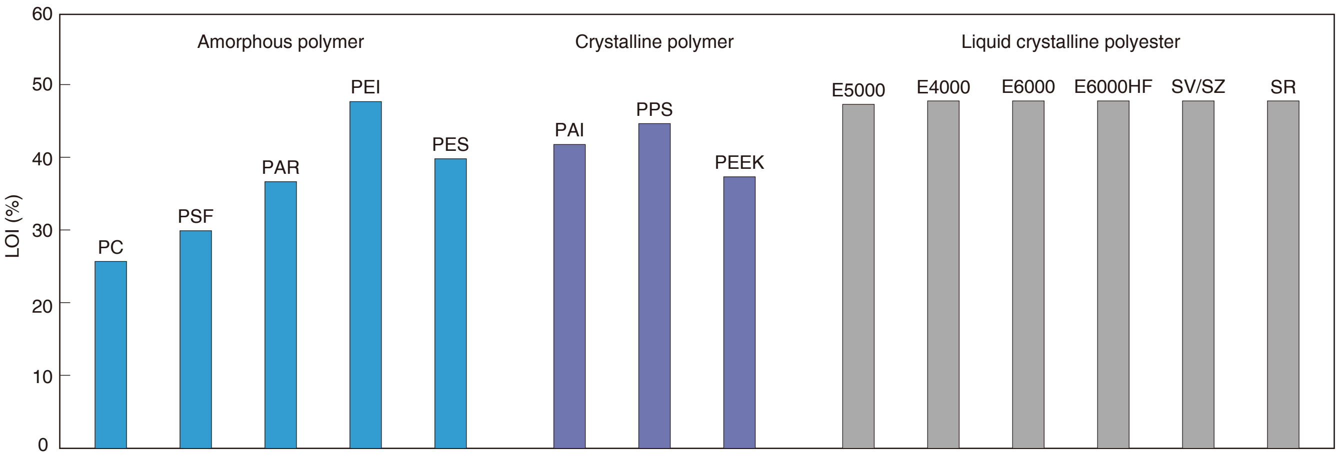
3-4 Flammability

SUMIKASUPER LCP has excellent flammability despite not containing flame retardants. The main out-gasses during combustion are carbon dioxide and water.

limiting Oxygen Index

The Limiting Oxygen Index (LOI) of SUMIKASUPER LCP is high, at the highest level among engineering plastics.

Figure 3-4-1 Comparison of the Limiting Oxygen Index of Engineering Plastics and SUMIKASUPER LCP



UL Standard

The UL 94 flammability standard, established by Underwriters Laboratories Inc. is a system for classifying plastic materials based on their flammability resistance. The UL file number for SUMIKASUPER LCP is registered as E249884. Please refer to the UL file for details.

Table 3-4-1 UL Registration Status of SUMIKASUPER LCP

Grade	Thickness (mm)	Flame Class	HWI	HAI	CTI	RTI		
						Elec	Imp	Str
E5008	0.75	V-0	3	4	3	240	200	220
	1.5	V-0	1	4	3	240	220	240
	3.0	V-0	0	4	3	240	220	240
E5008L	0.75	V-0	3	4	4	240	200	220
	1.5	V-0	1	4	4	240	220	240
	3.0	V-0	0	4	4	240	220	240
E4008	0.15	V-0	4	-	3	220	200	220
	0.30	V-0	3	0	3	240	200	240
	0.75	V-0	3	0	3	240	220	240
	1.5	V-0	2	0	3	240	220	240
	3.0	V-0	1	0	3	240	220	240
E6008	0.15	V-0	4	3	3	220	200	220
	0.27	V-0	4	0	3	240	200	240
	0.54	V-0	4	0	3	240	220	240
	0.75	V-0	4	0	3	240	220	240
	1.5	V-0	2	0	3	240	220	240
	3.0	V-0	1	0	3	240	220	240
E6007LHF-MR	0.50	V-0	4	1	3	220	210	210
	0.75	V-0	4	1	3	220	210	210
	1.5	V-0	4	1	3	220	220	220
	3.0	V-0	0	0	3	220	220	220

Flame Class : Flammability
Relative Thermal Index(RTI) : Temperature index
Hot Wire Ignition(HWI) : Hot wire ignition resistance
High Ampere Arc Resistance(HAI) : High current arc ignition resistance
Comparative Tracking Index(CTI) : Comparative tracking index
PLC : HWI, HAI and CTI are indicated by a grade of Performance Level Categories (PLC).

3-5 Chemical Stabilities

Chemical Resistance

The chemical resistance data for SUMIKASUPER LCP is shown in the table below. SUMIKASUPER LCP possesses outstanding chemical resistance and will not expand or deteriorate when exposed to oils, even at high temperatures. However, the evaluation of effects should be conducted on actual moldings prior to usage.

Table 3-5-1 Chemical Resistance of SUMIKASUPER LCP

Chemical name	Condition		SUMIKASUPER LCP Evaluation
	Temperature(°C)	Time	
20% Hydrochloric acid	50	30 days	G
20% Sulfuric acid	50	30 days	G
40% Nitric acid	50	30 days	G
Glacial acetic acid	50	30 days	G
10% Sodium hydroxide	50	30 days	P
10% Ammonia water	50	30 days	P
Acetone	Reflux	100hr	G
Methyl ethyl ketone	Reflux	100hr	G
Trichloroethane	Reflux	100hr	G
Methylene chloride	Reflux	100hr	G
Toluene	Reflux	100hr	G
Methanol	Reflux	100hr	G
Ethanol	Reflux	100hr	G
Ethyl acetate	Reflux	100hr	G
Dimethylformamide	Reflux	100hr	P
Gasoline	Room temperature	30 days	G
Engine oil	120	2000hr	G
Gear oil	120	2000hr	G

Evaluation G = Good : Reduction of tensile strength 5% or less, Change of weight 2% or less
P = Poor : Not usable

Gases Generated from Moldings

The amount of gas generated when SUMIKASUPER LCP is heated in moldings is extremely low.

Figure 3-5-1 Analysis Method for Gas Components Generated from Moldings

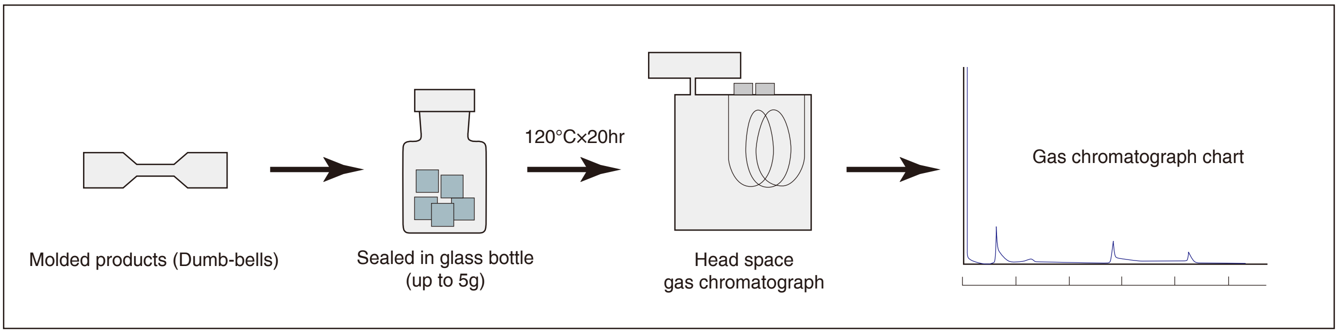
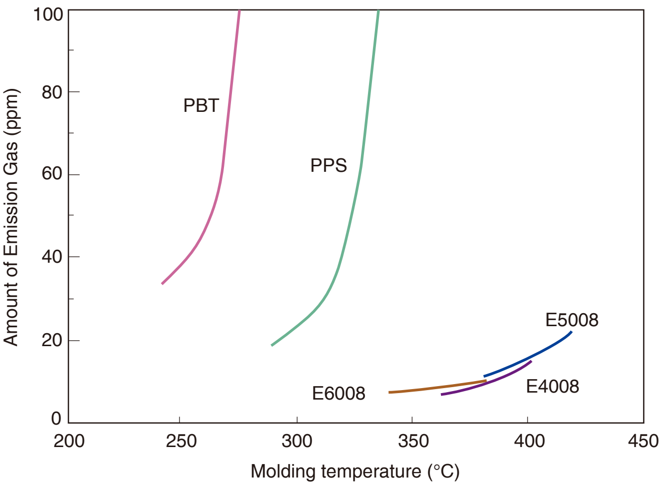


Figure 3-5-2 Amount of Gas Generated from SUMIKASUPER LCP



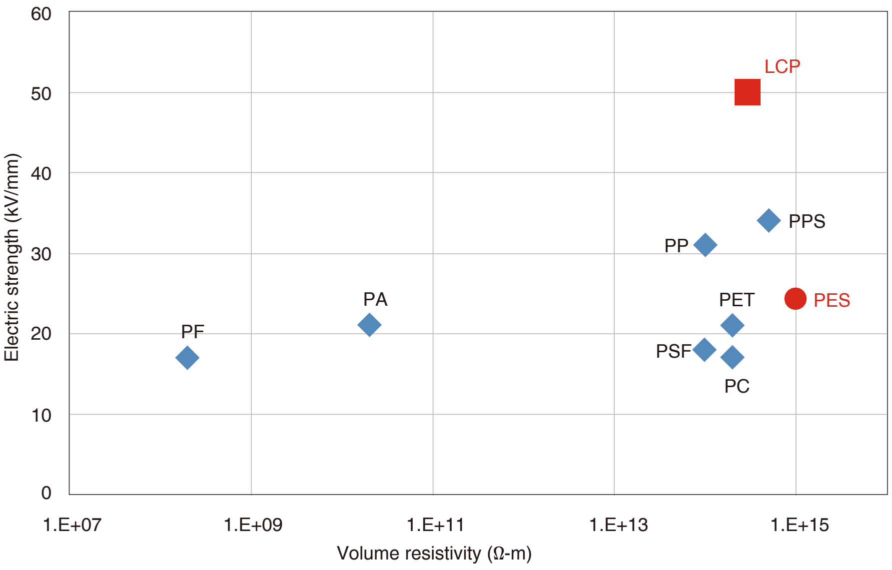
Analyzer : Headspace gas chromatograph
Sample pre-treatment conditions : 120°C, 20hr heating

3-6 Electrical Properties

Volume Resistivity

The volume resistivity of a material is defined as the electrical resistance indicated by the unit cube of the material, which indicates the current flowing through the material when a voltage of DC 500V is applied to the material for one minute. The higher the electrical insulation, the higher the volume resistivity. SUMIKASUPER LCP has high insulation due to the strong orientation of the skin layer.

Figure 3-6-1 Volume Resistivity and Electric Strength of SUMIKASUPER LCP



Insulation Characteristics

The electric strength is an index for indicating how high a voltage a material can withstand without causing dielectric breakdown. Test results are reported in kV/mm, and the dielectric strength is affected by the thickness and temperature of the test piece. The electric strength of SUMIKASUPER LCP increases as the thickness decreases, similar to the tensile strength. In addition, the electric strength remains high when heated, so it has excellent insulation characteristics.

Figure 3-6-2 Thickness Dependence of Electric strength of SUMIKASUPER LCP

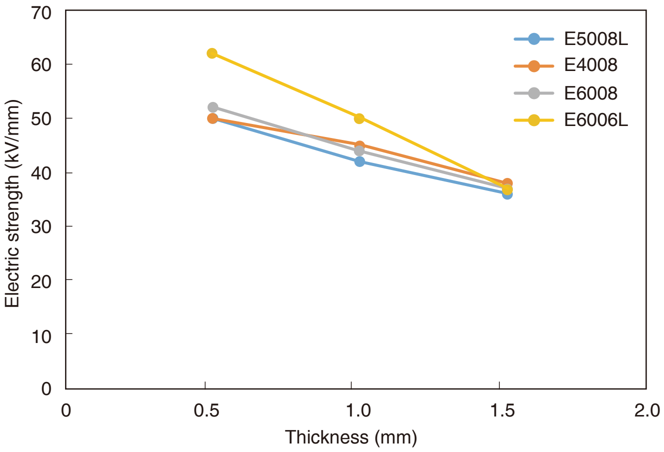
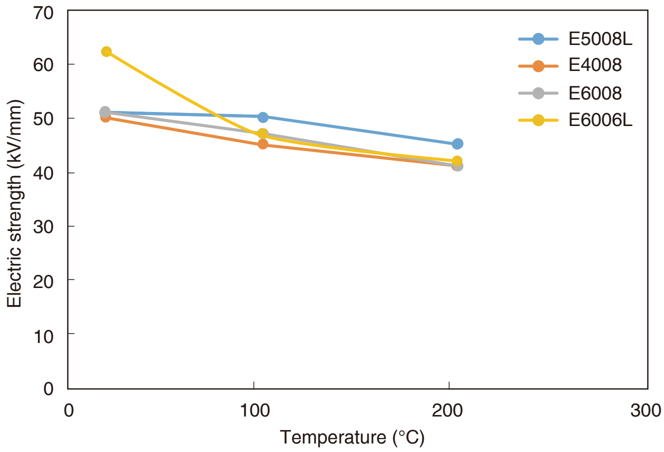


Figure 3-6-3 Temperature Dependence of Electric strength of SUMIKASUPER LCP



Dielectric properties

SUMIKASUPER LCP possess low, stable values for the dependence of dielectric constant and dielectric dissipation factor on temperature and frequency.The dielectric dissipation factor of LCP is especially low in the gigahertz range.

Figure 3-6-4 Temperature Dependence of Relative permittivity

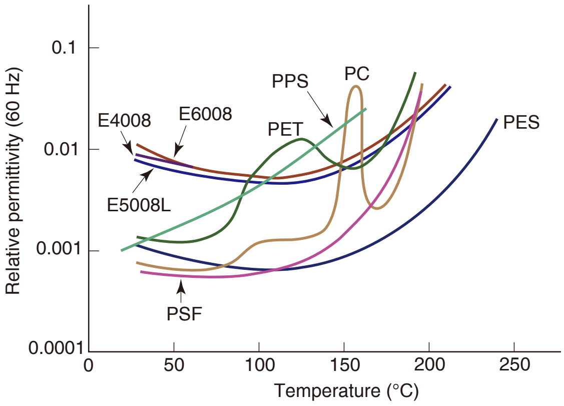


Figure 3-6-5 Frequency Dependence of Dielectric Dissipation Factor

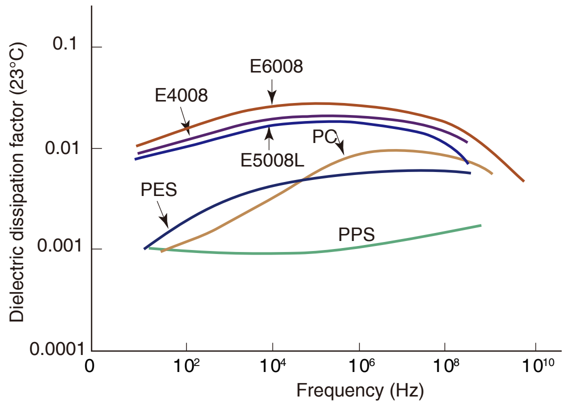


Table 3-6-1 Electrical Properties of SUMIKASUPER LCP

Test item		Test method	E5008L	E5008	E5204L B	E4008	E4205R	E6008	E6006L	E6007LHF	E6807LHF	SR1009
Relative permittivity	1kHz	IEC 60250	4.7	4.7	-	4.5	-	4.4	4.3	-	4.3	-
	1MHz		4.2	4.2	3.1	3.9	2.9	3.9	3.7	3.8	3.8	4.0
	1GHz		3.7	3.7	3.0	3.7	2.8	3.8	3.7	3.8	3.5	4.0
	10GHz	IEC 62810	3.8	3.7	3.0	3.6	2.9	3.7	3.5	3.6	-	4.0
Dielectric dissipation factor	1kHz	IEC 60250	0.013	0.015	-	0.018	-	0.022	0.023	-	0.020	-
	1MHz		0.031	0.031	0.018	0.034	0.013	0.032	0.034	0.026	0.030	0.008
	1GHz		0.005	0.005	0.006	0.005	0.004	0.005	0.005	0.005	0.004	0.003
	10GHz	IEC 62810	0.005	0.005	0.012	0.006	0.005	0.006	0.005	0.005	-	0.005

Table 3-6-2 Electrical Properties of SUMIKASUPER LCP

Test item		Test method	E6205L	SR1205L	E6808LHF	E6808UHF	SV6808THF	SV6808GHF	SR2506	SR2507	SZ6505HF	SZ6506HF
Relative permittivity	1kHz	IEC 60250	-	-	-	-	-	-	-	-	-	-
	1MHz		3.0	2.8	3.8	3.8	3.8	3.8	3.6	3.7	3.8	3.5
	1GHz		2.9	2.8	3.6	3.5	3.5	3.5	3.5	3.5	3.4	3.5
	10GHz	IEC 62810	2.8	2.7	3.7	3.6	3.7	3.7	3.6	3.7	3.5	3.6
Dielectric dissipation factor	1kHz	IEC 60250	-	-	-	-	-	-	-	-	-	-
	1MHz		0.024	0.007	0.038	0.033	0.012	0.029	0.029	0.029	0.023	0.011
	1GHz		0.005	0.002	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.005
	10GHz	IEC 62810	0.005	0.003	0.005	0.004	0.004	0.005	0.003	0.003	0.004	0.003

3-7 Other Properties

Vibration Damping Properties

Since SUMIKASUPER LCP has high rigidity and high vibration damping, it has excellent vibration damping compared to other resins. The relationship between the loss factor and the flexural modulus is shown in Figure 3-7-1, which indicates a high loss factor while maintaining a high the elastic modulus.

Figure 3-7-1 Relationship between Loss Factor and Flexural

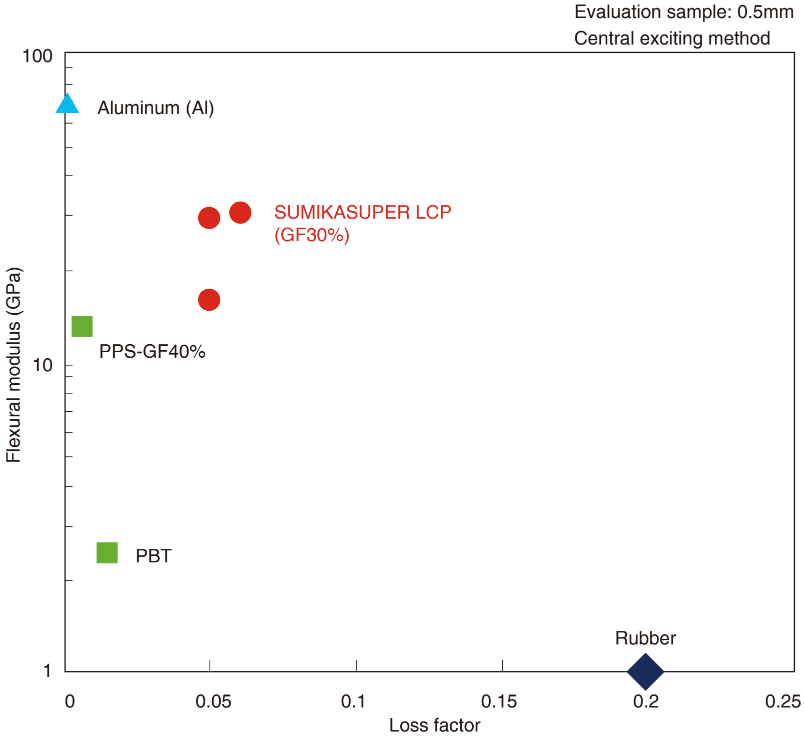


Figure 3-7-2 Comparison of Vibration Damping between LCP and PPS

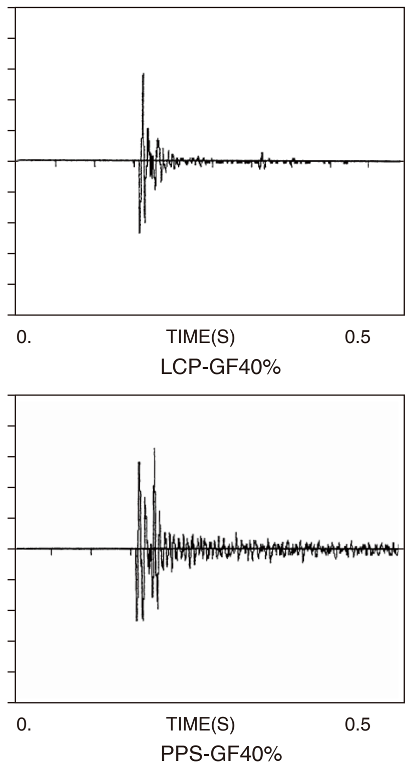


Figure 3-7-3 Resonance Properties of SUMIKASUPER LCP

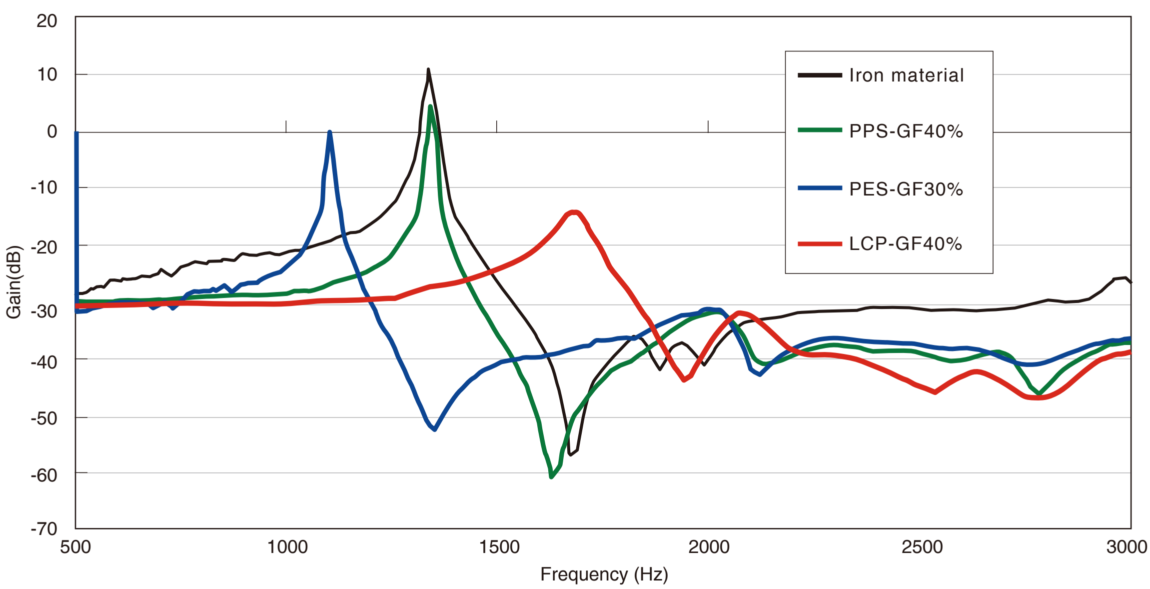


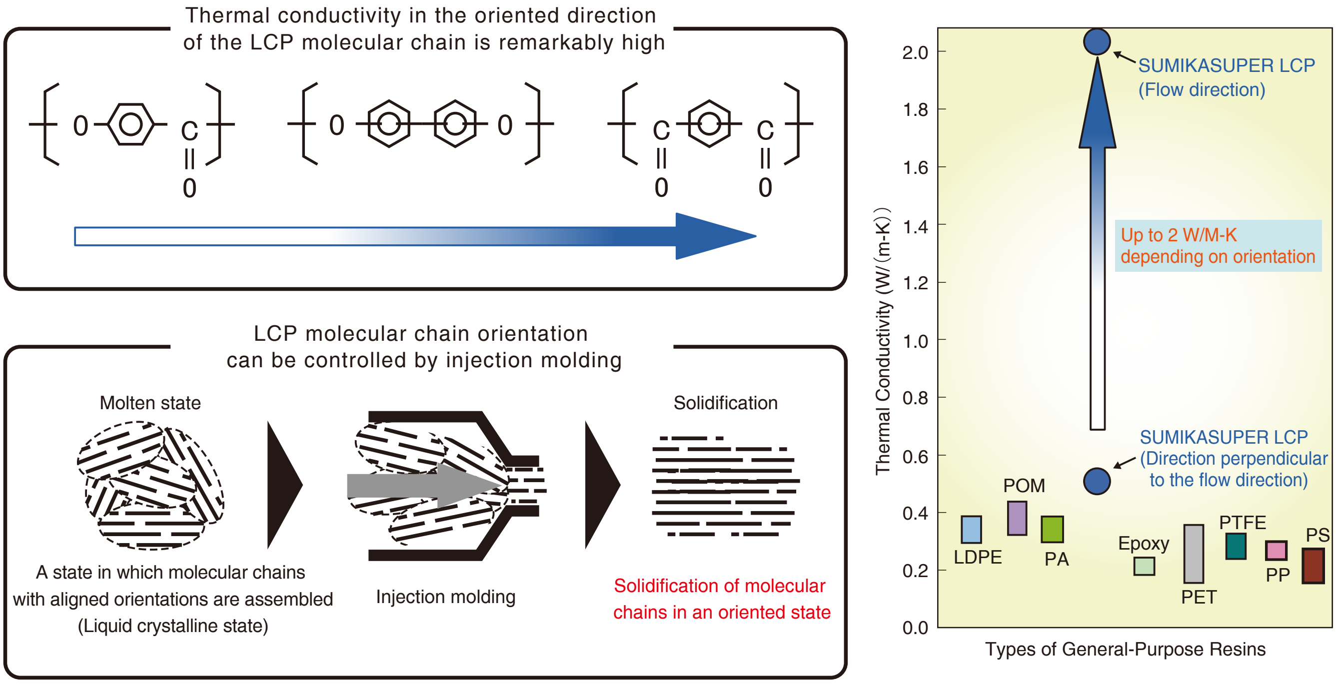
Table 3-7-1 Comparison between SUMIKASUPER LCP and Other Resins

	Resonance frequency (Hz)	Loss factor
LCP-GF40%	1,680	0.0491
PES-GF30%	1,100	0.0092
PPS-GF40%	1,340	0.0093
Iron material	1,340	0.0095

Thermal Conductivity

The thermal conductivity of SUMIKASUPER LCP changes according to the orientation of the resin, and high thermal conductivity is seen in the flow direction. Also, since the thermal conductivity of fillers such as glass fiber is higher compared to that of LCP resin, the thermal conductivity differs according to the type and content of the filler.

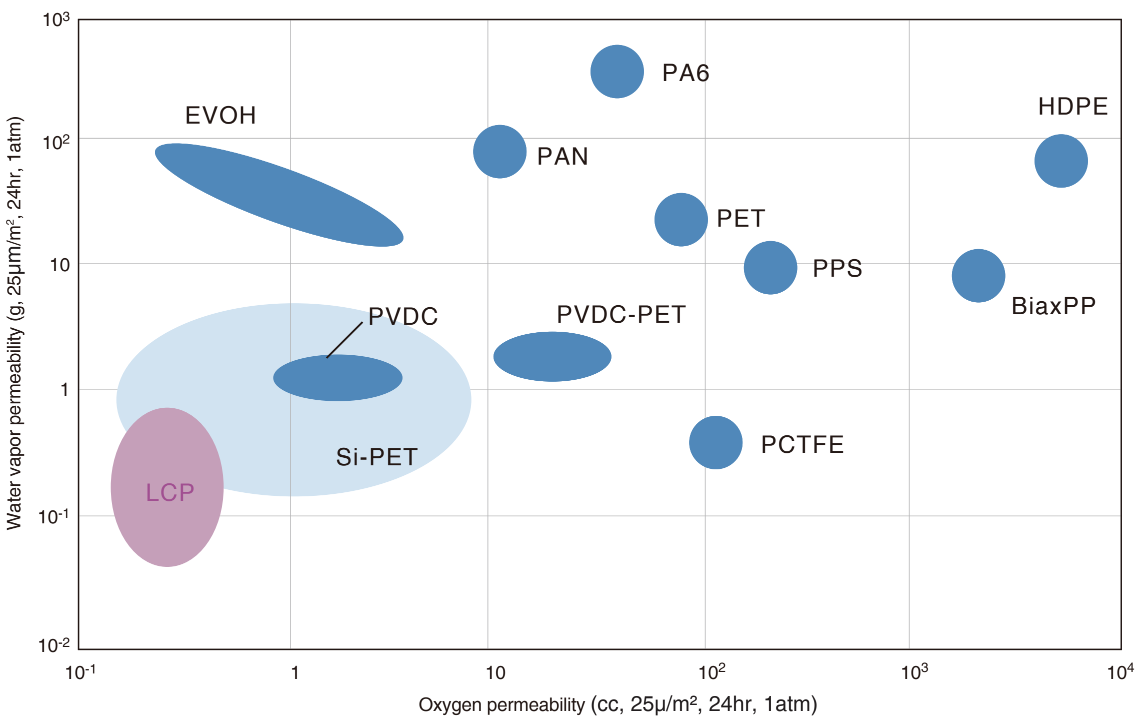
Figure 3-7-4 Thermal Conductivity of SUMIKASUPER LCP



Gas Barrier Properties

Gas barrier properties are the amount of gas that permeates 1 m² in 24 hours and is referred to as the permeability rate. The slower the permeability rate, the smaller the permeation amount and the better the barrier properties. Since gas barrier properties are inversely proportional to the thickness of the test piece, the thickness in the figure below is set to a specific value of 25μm (cc, 25μ/m², 24hr, 1atm). SUMIKASUPER LCP has a low permeability rate for both water vapor permeability and oxygen permeability, and has excellent gas barrier properties.

Figure 3-7-5 Gas Barrier Properties of SUMIKASUPER LCP



CAE Analysis

CAE (Computer-Aided Engineering) analysis can be used to evaluate (simulate) product design issues using a computer. The table below shows some of the technical data required for CAE. The following data was measured for CAE analysis. Please contact us to obtain the technical data required for CAE analysis.

Table 3-7-2 CAE Characteristics of SUMIKASUPER LCP 1

	Test method	Unit	E5204L	E5006L	E4008	E6006L	E6008	E6807T	E6007LHF	E6808LHF	E6810LHF
Specific heat	ASTM E1269	J/(kg·K)	1,067	1,068	812	839	812	1,012	967	1,009	974
Thermal conductivity	ISO 22007-2	W/(m·K)	0.37	0.44	0.51	0.50	0.51	0.64	0.43	0.43	0.70
Melt density	PVT method	g/cm³	1.10	1.35	1.54	1.42	1.54	1.52	1.50	1.53	1.65
Solid density	PVT method	g/cm³	1.23	1.58	1.70	1.59	1.70	1.68	1.68	1.73	1.84
Young's modulus(MD)	ASTM D638	MPa	8,000	-	13,000	14,000	13,000	8,700	14,000	11,000	9,900
Young's modulus(TD)	ASTM D638	MPa	3,000	-	3,600	3,800	3,600	3,900	5,100	4,800	5,600
Poisson's ratio(MD)	ASTM D638	-	0.43	-	0.46	0.48	0.46	0.25	0.39	0.34	0.28
Poisson's ratio(TD)	ASTM D638	-	0.86	-	0.88	0.87	0.88	0.82	0.72	0.71	0.73

Table 3-7-3 CAE Characteristics of SUMIKASUPER LCP 2

	Test method	Unit	E6808UHF	SV6808THF	SV6808GHF	SZ6505HF	SZ6506HF	SR2506	SR2507	SR1009L	SR1205L
Specific heat	ASTM E1269	J/(kg·K)	1,203	920	890	1,121	1,110	1,042	979	897	856
Thermal conductivity	ISO 22007-2	W/(m·K)	0.33	0.56	0.66	0.48	0.47	0.48	0.55	0.29	0.38
Melt density	PVT method	g/cm³	1.54	1.57	1.53	1.42	1.44	1.46	1.54	1.60	1.06
Solid density	PVT method	g/cm³	1.73	1.73	1.69	1.58	1.63	1.64	1.69	1.75	1.16
Young's modulus(MD)	ASTM D638	MPa	8,000	8,000	10,000	11,200	11,000	12,000	13,000	14,000	7,600
Young's modulus(TD)	ASTM D638	MPa	4,100	4,600	4,800	5,900	6,300	6,000	8,100	5,800	4,200
Poisson's ratio(MD)	ASTM D638	-	0.25	0.28	0.32	0.25	0.12	0.23	0.21	0.43	0.40
Poisson's ratio(TD)	ASTM D638	-	0.80	0.74	0.91	0.80	0.80	0.74	0.94	0.64	0.53

4. Injection Molding

4-1 Molding Conditions

The following shows typical molding conditions such as recommended molding conditions and condition ranges for SUMIKASUPER LCP. Resin temperature control is very important for SUMIKASUPER LCP. If there is a difference between the set temperature for the cylinder and the actual resin temperature, it is necessary to control it using the actual resin temperature.

Table 4-1-1 Standard Molding Conditions for SUMIKASUPER E5000, E4000, and E6000 series

		E5000 series		E4000 series		E6000 series	
		Recommended	Range	Recommended	Range	Recommended	Range
Drying temperature (°C)		130	120-140	130	120-140	130	120-140
Drying time (hr)		5	4-24	5	4-24	5	4-24
Cylinder temperature (°C)	Rear	340	330-360	320	310-340	300	280-320
	Center	380	370-390	360	350-370	330	320-340
	Front	400	390-410	380	370-390	360	340-370
	Nozzle	400	390-410	380	370-390	360	340-370
Suitable resin temperature (°C)		400	390-410	380	370-390	360	340-370
Tool (Mold) temperature (°C)		70-90	60-160	70-90	60-160	70-90	60-160
Injection pressure (MPa)		120-160	80-160	120-160	80-160	120-160	80-160
Holding pressure (MPa)		40-60	10-80	40-60	10-80	40-60	10-80
Holding time (sec)		0.2-0.5	0.2-1	0.2-0.5	0.2-1	0.2-0.5	0.2-1
Back pressure (MPa)		0.5-1	0.5-5	0.5-1	0.5-5	0.5-1	0.5-5
Injection speed (mm/sec)		50-200	50-400	50-200	50-400	50-200	50-400
Screw rotation (rpm)		50-250	50-350	50-250	50-350	50-250	50-350
Sack back (mm)		1-2	0-2	1-2	0-2	1-2	0-2

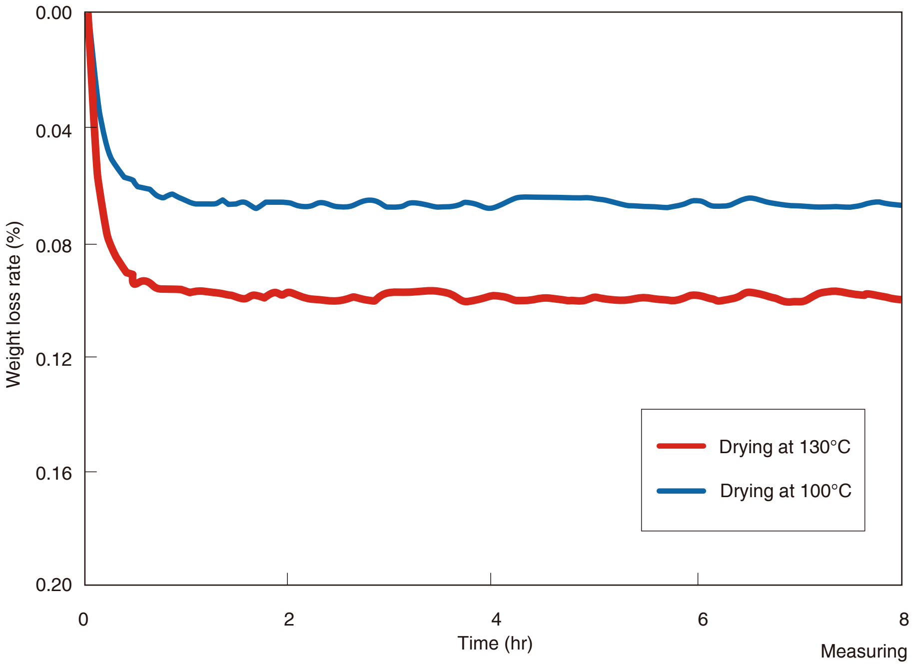
Table 4-1-2 Standard Molding Conditions for SUMIKASUPER SV6000, SR1000, E6000HF, SV6000HF, SZ6000HF, and SR2000 series

		SV6000, SR1000 series		E6000HF, SV6000HF series		SZ6000HF, SR2000 series	
		Recommended	Range	Recommended	Range	Recommended	Range
Drying temperature (°C)		130	120-140	130	120-140	130	120-140
Drying time (hr)		5	4-24	5	4-24	5	4-24
Cylinder temperature (°C)	Rear	300	280-320	300	280-320	300	280-320
	Center	330	320-340	330	320-340	330	320-340
	Front	360	340-370	350	340-370	350	330-370
	Nozzle	360	340-370	350	340-360	350	330-360
Suitable resin temperature (°C)		360	340-370	350	330-360	350	330-360
Tool (Mold) temperature (°C)		70-90	60-160	70-90	60-160	70-90	60-160
Injection pressure (MPa)		80-160	80-180	80-160	80-180	80-160	80-180
Holding pressure (MPa)		10-40	10-80	10-40	10-80	10-40	10-80
Holding time (sec)		0.2-0.5	0.2-1	0.2-0.5	0.2-1	0.2-0.5	0.2-1
Back pressure (MPa)		0.5-1	0.5-5	0.5-1	0.5-5	0.5-1	0.5-5
Injection speed (mm/sec)		50-200	50-500	50-200	50-500	50-200	50-500
Screw rotation (rpm)		50-250	50-350	50-250	50-350	50-250	50-350
Sack back (mm)		1-2	0-2	1-2	0-2	1-2	0-2

Pre-drying

SUMIKASUPER LCP has a very low water absorption rate of 0.02%, so it does not require a long drying time. However, it is recommended to dry it to 0.01% to obtain the best physical properties for molding. It is recommended to dry it using a hopper dryer between 4 to 24 hours at around 130°C. Use a dehumidification dryer or hopper dryer to prevent moisture absorption in the hopper during molding. If the drying temperature is too high, the resin may deteriorate, so make sure that the drying temperature is around 130°C.

Figure 4-1-1 Drying Curve of SUMIKASUPER LCP



Measuring device : MS-70 Heating dry type moisture meter
(Manufactured by A&D Company, Limited)

Molding Temperature Setting

(1) Temperature of front part of cylinder and nozzle part

This is true for all resins, but it is necessary to properly control the resin temperature. Set the temperature at the front of the SUMIKASUPER LCP cylinder to 390 to 410°C for the E5000 series, 370 to 390°C for the E4000 series, 340 to 370°C for the E6000, SV6000, and SR1000 series, and to 330 to 360°C for the E6000HF, SV6000HF, SZ6000HF, and SR2000 series. When forming a complicated shape requiring high flowability, or a large item with a great difference between the long and short axes, set the front of the cylinder to a higher temperature. It is not recommended to set the temperature to more than 10°C above the applicable range because backflow to the hopper side tends to occur with the resin during injection.

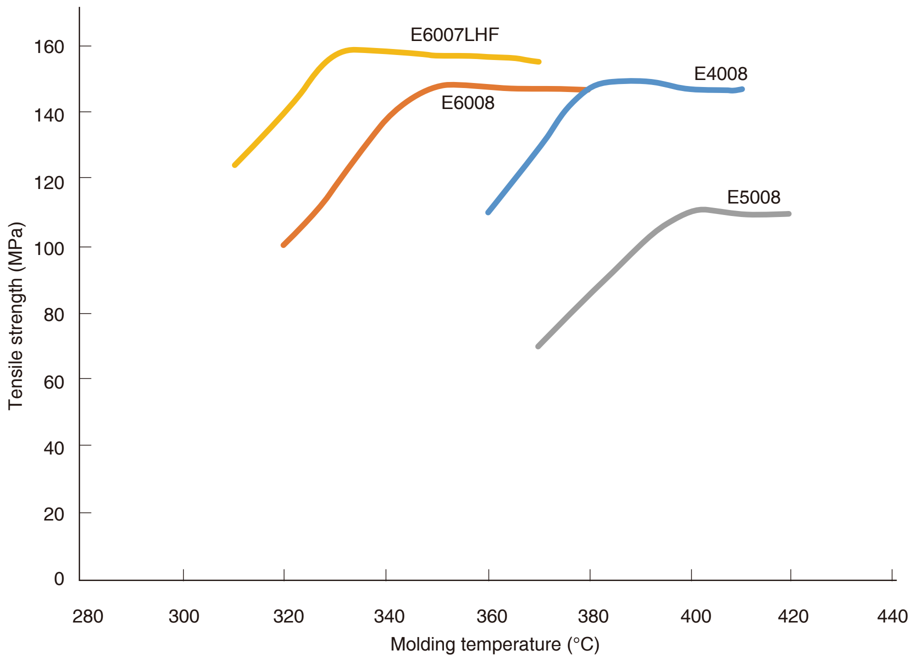
Regarding the cylinder temperature, stable physical properties can be obtained at a molding temperature of 400°C or higher with the E5000 series, 380°C or higher with the E4000 series, 340°C or higher with the E6000, SV6000, and SR1000 series, and 330°C or higher with the E6000HF, SV6000HF, and SR2000 series. For some applications, it is possible to obtain non-problematic physical properties even when molding is performed at lower temperatures, but if the temperature is too low, physical properties may deteriorate.

It is very important to control the temperature of the nozzle since it can easily affect the resin temperature. Therefore, be sure to consider the position of the temperature control sensor and heat retention. If there is a difference between the set nozzle temperature and the actual resin temperature, it is necessary to control it using the actual resin temperature. If the nozzle temperature is too high, drawing and stringing can occur, and if it is too low, cold slag can occur.

(2) Cylinder rear temperature

The temperature at the rear of the cylinder for SUMIKASUPER LCP should be lower than that at the front of the cylinder. Set it to 330 to 360°C for the E5000 series, 310 to 340°C for the E4000 series, and 280 to 320°C for the E6000, SV6000, SR1000, E6000HF, SV6000HF, SZ6000HF, and SR2000 series. When the cylinder rear temperature is high, the resin tends to backflow to the hopper side, which makes it difficult to get a stable metering.

Figure 4-1-2 Dependence of Tensile Strength on Molding Temperature



Injection Pressure and Injection Speed

(1) Injection pressure

SUMIKASUPER LCP has low melt viscosity and excellent flowability, so it does not require an extremely high injection pressure. For example, with the E6000 series, by raising the molding temperature to at least 350°C, sufficient flowability is achieved even at a low pressure of about 40MPa. Since the resin quickly solidifies, there is almost no impact on tensile strength even if the holding pressure changes in the range of 65 to 160MPa.

(2) Injection speed

For thin-walled complicated shapes, it is better to perform moldings at medium to high injection speeds. When molding ultra-thin products (0.2mm or less), the resin may solidify at thin portions, and thus may not be possible to achieve a sufficient flow length. Therefore, it is recommended to use high performance injection molding machines that enable high speed and high response (refer to “High-speed molding”(p.46)).

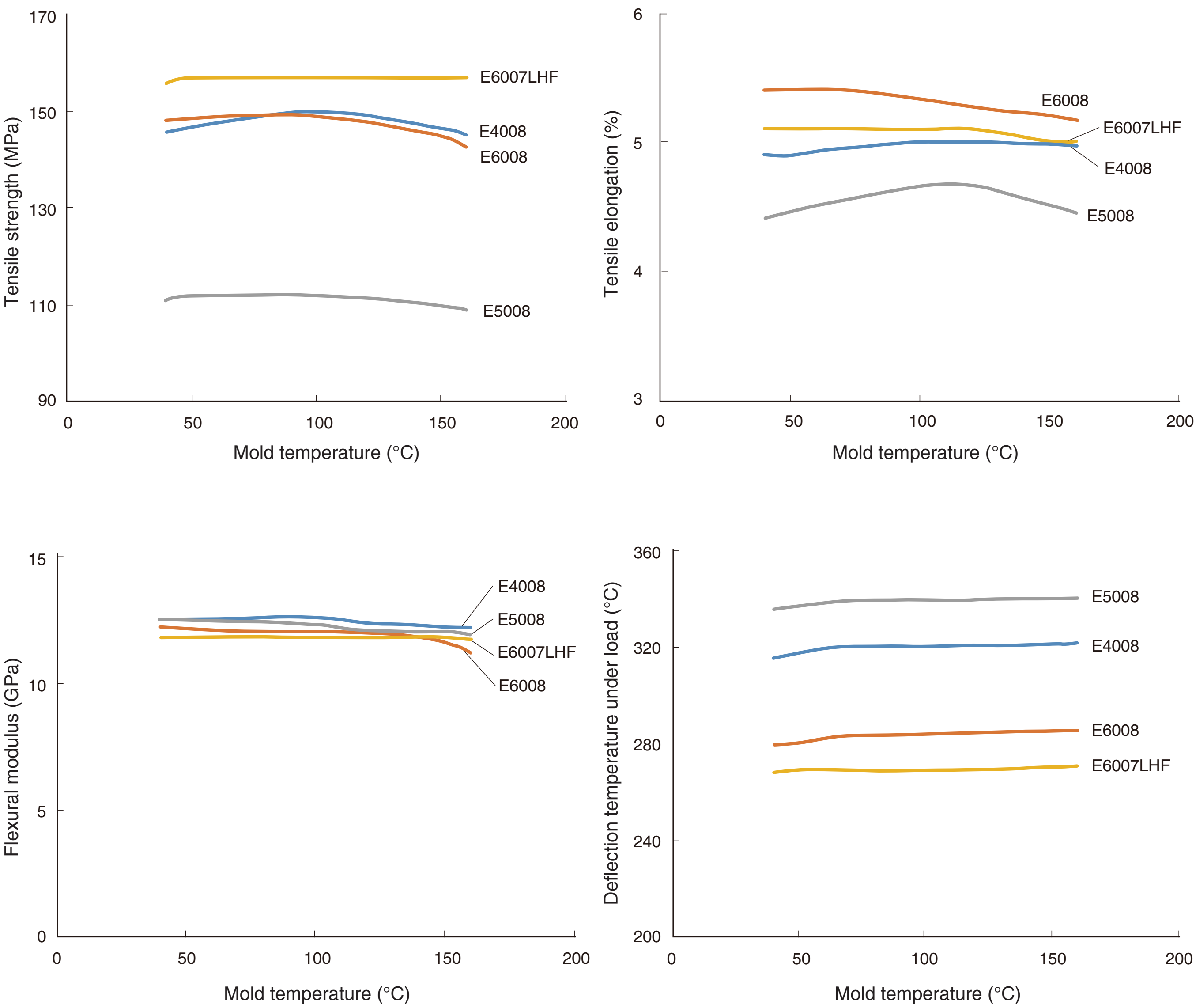
SUMIKASUPER LCP can be molded even at a constant injection speed. However, in order to avoid jetting from the nozzle and the gate, it would be better to lower the injection speed while the resin passes through the sprue or runner, raise the injection speed after passing through the gate. Lowering the injection speed just before filling is completed can also be effective to ensure stable molding.

If there are problems related to the weldlines on relatively thick products, a medium/low injection speed of 20 to 60mm/sec with the appropriate air vent design in the mold would improve them.

Mold temperature

The molecular structure of SUMIKASUPER LCP is rigid rod-like even in the molten state, and its molecules are easily oriented in the flow direction by the shear flow during injection molding. When the molten LCP is cooled in the mold, it can solidify rapidly while maintaining its molecular orientation. Since the solidification rate of SUMIKASUPER LCP is very high, the mold temperature has almost no impact on its properties. Therefore, injection molding can be performed at a very wide range of mold temperatures.
When molding thin-walled products, it is recommended to set the mold temperature to 60 to 100°C if the priority is placed on the molding cycle, 100 to 150°C if the flowability and the weld strength for the thin wall are important, and set it to 160°C or higher if the smoothness of the molded product surface is important. When the product shape is complicated and there are issues with mold release, it is recommended to set the mold temperature to a lower temperature. The surface temperature of the mold is affected by various factors other than the cooling water, so be sure to measure and check it when starting up the injection molding machine or when making major setting changes.

Figure 4-1-3 Dependence of typical properties on mold temperature



Metering (Plasticization) Setting

In order to ensure stable metering (plasticization) of SUMIKASUPER LCP, the temperature at the rear of the cylinder should be lower than that at the front of the cylinder. The recommended temperature range at the rear of the cylinder is 330 to 360°C for the E5000 series, 310 to 340°C for the E4000 series, and 280 to 320°C for the E6000, SV6000, SR1000, E6000HF, SV6000HF, SZ6000HF, and SR2000 series.
It is possible to shorten the metering time by setting a high screw rotation speed. However, if the screw rotation speed is too high, fillers such as glass fiber may be damaged. For small-diameter screws, the metering capacity is determined by the flight depth of the feed zone , and so refer to "Selection of Injection Molding Machine" (p.44) and select the suitable screw.
Since the metering tends to be more stable when the back pressure is low, set this value as low as possible.

Suck-back

Suck-back (screw decompression) should be set to the minimum value when necessary. If the suck- back is too large, air can easily get caught in the nozzle, resulting in molding defects such as blisters. Drooling from the nozzle can be controlled by adjusting the drying temperature of the resin and the nozzle temperature, or, if necessary, using a dedicated nozzle for LCP.

Purging Method

Since SUMIKASUPER LCP has extremely low melt viscosity compared to other resins including purging materials, it is necessary to make sure there is no residual resins or purging materials in the cylinder or nozzle when replacing them by purging. To make it easier to replace the SUMIKASUPER LCP during purging, it is recommended to lower the cylinder temperature by about 20 to 30°C compared to normal molding condition in order to increase the melt viscosity of SUMIKASUPER LCP. When performing purging, especially for the E4000 series and E5000 series, please keep in mind that due to the high processing temperature, there may smoke or blow out of gas or resin from the nozzle.

■Recommended Purging Material

Commercially available purging materials can be used for the purging of SUMIKASUPER LCP, and the following purging materials have been proven in use. Please note that purging material may decompose if it remains in a high temperature cylinder for a long time.

- ASACLEAN PX2 [Asahi Kasei Corporation]
- Z CLEAN S29 [Nissho Corporation]
- CELPURGE NX-HG [Daicel Miraizu Ltd.]

■When the same grade is used after molding is suspended

If molding needs to be suspended for 15 minutes or more, discharge the resin from the cylinder and lower the cylinder temperature to about 250°C. When resuming molding, perform purging according to the following procedure. If the injection molding process is restarted using the same grade after the machine has been shut down for several hours, the following purging procedure can also be applicable.

Table 4-1-3 Purging procedure when injection molding is suspended or shutdown

1 End of molding	Discharge the prior resin completely from the hopper and inside the cylinder.
2 Purging material input	Purge with a purging material at molding temperature.
3 Purge continuation	Set the cylinder temperature to 20 to 30°C lower than molding temperature.
4 Resin replacement	Supply SUMIKASUPER LCP immediately after discharging the purging material. Replace the inside of the cylinder with SUMIKASUPER LCP.
5 Operation suspended	Set the cylinder temperature to 250°C, or Shutdown the injection molding machine.
6 Resume operation	Set the cylinder temperature to 20 to 30°C lower than molding temperature.
7 Pre-purging	Purge with SUMIKASUPER LCP (at least 5 shots) while maintaining the temperature 20 to 30°C lower than the molding temperature.
8 Start of production	Purge the cylinder with at least 5 shots of SUMIKASUPER LCP after the cylinder temperature has been raised to the molding temperature and start production. (Note) When only changing the color of the same grade, skip steps 5, 6, and 7 above.

■When switching to SUMIKASUPER LCP from other resins

When molding of the prior resin is completed and changeing it to SUMIKASUPER LCP, perform the following procedure.

Table 4-1-4 Purging procedure when switching materials to SUMIKASUPER LCP

1 End of molding	Discharge the prior resin completely from the hopper and cylinder.
2 Cylinder temperature set	Set the cylinder temperature to 20 to 30°C lower than molding temperature.
3 Purging material input	Purge with a purging material immediately after the temperature reaches to the above set point.
4 Resin replacement	Supply SUMIKASUPER LCP immediately after discharging the purging material. Replace the inside of the cylinder with SUMIKASUPER LCP.
5 Resume operation	Set the cylinder temperature to the molding temperature of SUMIKASUPER LCP.
6 Start of production	Purge the cylinder with at least 5 shots of SUMIKASUPER LCP after the cylinder temperature has been raised to the molding temperature, and start production.

Flash Characteristics

SUMIKASUPER LCP solidifies quickly and has high thermal conductivity, so it causes little flash although it has high fluidity. This flash characteristic make SUMIKASUPER LCP suitable for molding thin-wall and small electronic components.
Figure 4-1-5 shows the results of SUMIKASUPER LCP flash characteristic evaluation. This figure shows the range of molding conditions that can produce good molded products (no flash) and the range of molding conditions that cannot (flash or short shots). SUMIKASUPER LCP has a relatively wide range of molding conditions that can produce good molded products, however, PPS and PBT can easily cause flash and short shots, making it difficult to secure good molding conditions for thin-wall molded products.

Figure 4-1-4 Mold for Evaluating Flash Characteristics

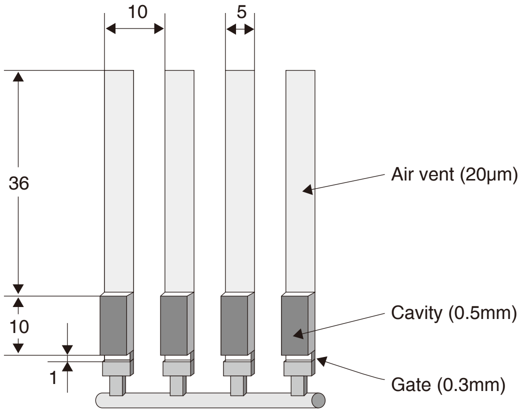
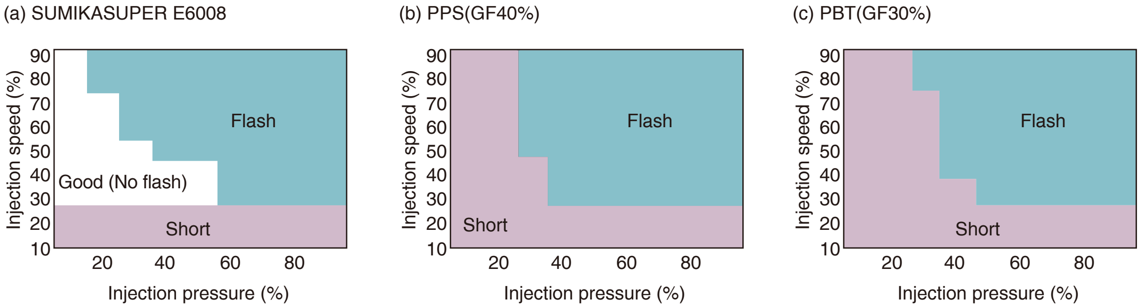


Figure 4-1-5 Comparison of the range of molding conditions that do not cause flash for LCP, PPS, and PBT



Molding machine : PS10E1ASE (Nissei Plastic Industrial Co., Ltd.)
Injection speed : 32cm³/sec
Injection pressure : 100% = 200MPa

4-2 Moldability

Apparent Melt Viscosity

Figure 4-2-1 and 4-2-2 show the shear rate dependence and temperature dependence of the apparent melt viscosity of SUMIKASUPER LCP, respectively. Compared to other engineering plastics, the apparent melt viscosity of SUMIKASUPER LCP is greatly affected by both the shear rate and temperature. Therefore, moldability depends greatly on the injection speed, cylinder temperature, and shear heat generated during injection molding. The low viscosity and high shear rate dependence of SUMIKASUPER LCP make high-speed injection molding possible since the pressure does not easily increase even at high injection speed. Its viscosity becomes extremely low under proper injection molding conditions, making it easy to fill thin-walled or complicated-shaped products. On the other hand, for stable production, it is necessary to properly manage the injection speed and cylinder temperature, and to monitor changes in shear force caused by wear or other factors.

Figure 4-2-1 Shear Rate Dependence of Apparent Melt Viscosity

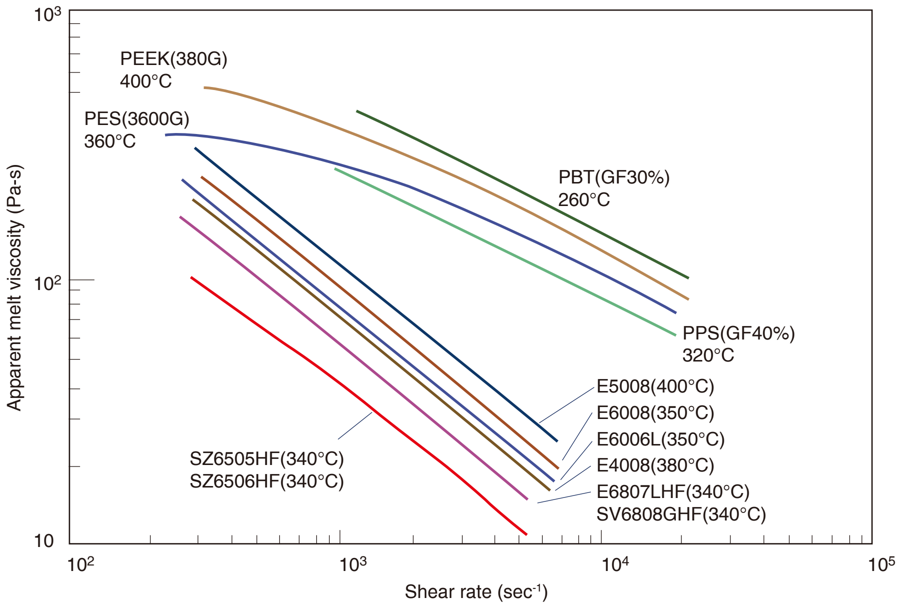
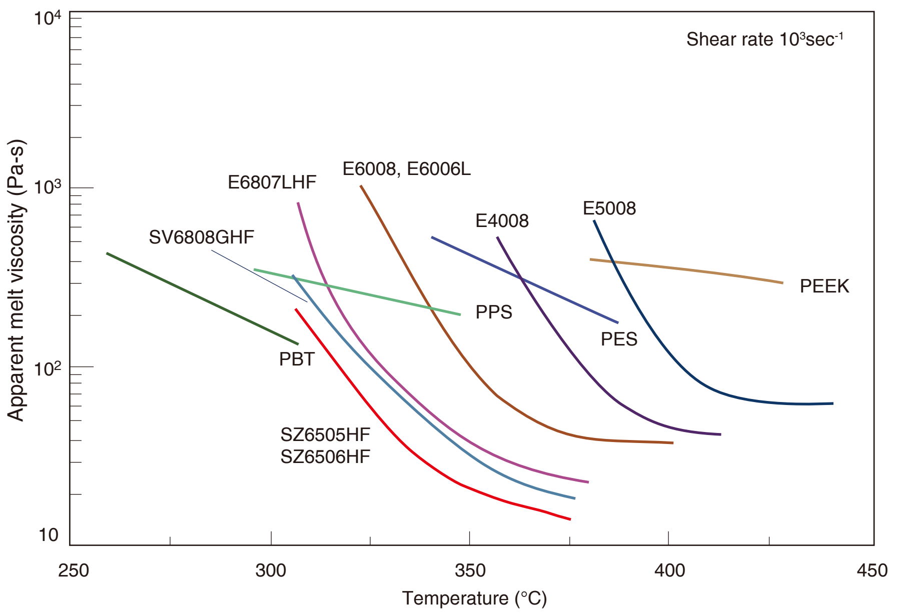


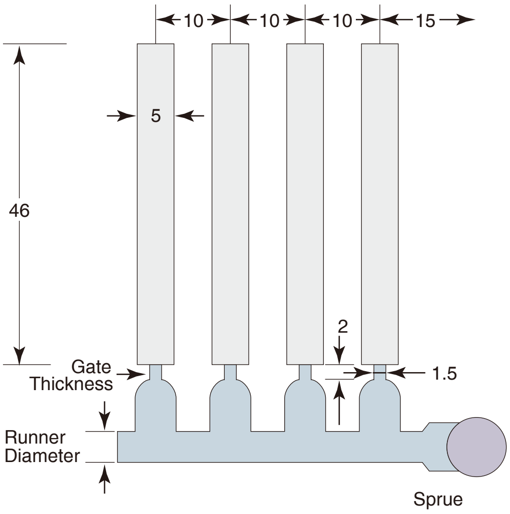
Figure 4-2-2 Temperature Dependence of Apparent Melt Viscosity



Thin-Wall Flowability

SUMIKASUPER LCP has excellent thin-wall flowability compared to other engineering plastics. Figure 4-2-4 shows the thin-wall flowability (thickness : 0.2, 0.3mm) of each grade, where flowability is measured using the tool shown in Figure 4-2-3, and Figure 4-2-5 shows the bar flow length with a thickness of 1mm.

Figure 4-2-3 Mold for Thin-Wall Flow Length Measurement (Unit : mm)



Product thickness : 0.3mm
Runner : 4.0mmφ
Gate : 0.3t×1.5w×2.0L
Flow length is 4 cavities average

Product thickness : 0.2mm
Runner : 3.0mmφ
Gate : 0.2t×1.5w×2.0L
Flow length is 4 cavities average

Molding machine : PS10E1ASE (Nissei Plastic Industrial Co., Ltd.)
Injection pressure : 0.2mm thickness : 90MPa
0.3mm thickness : 60MPa
Injection speed : 0.2mm thickness : 95%
0.3mm thickness : 60%
Mold temperature : 130°C

Figure 4-2-4 Thin-Wall Flowability

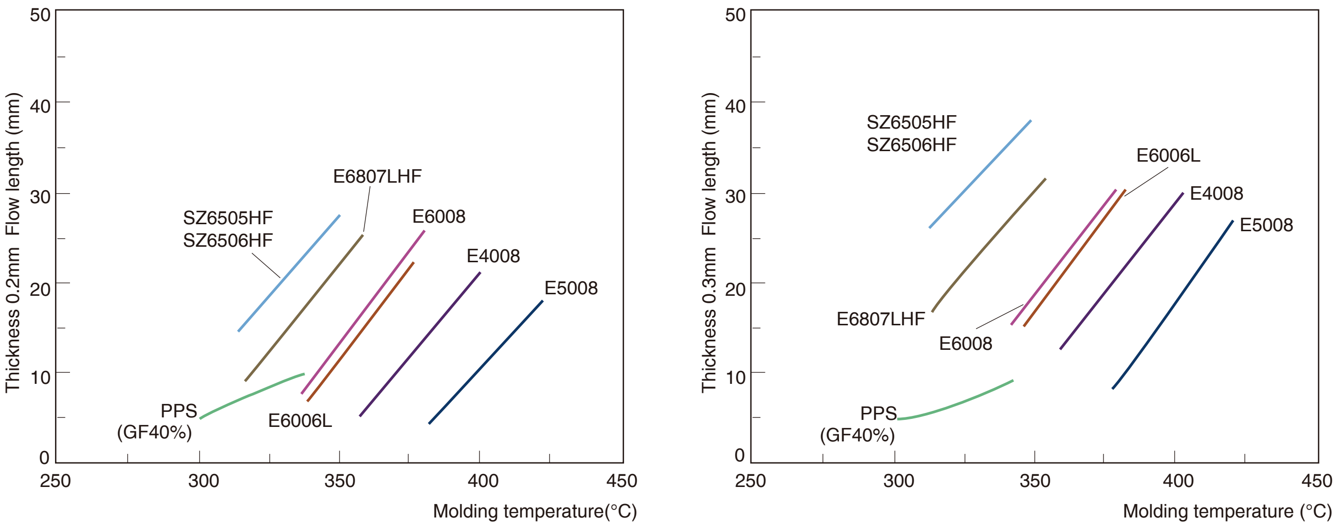
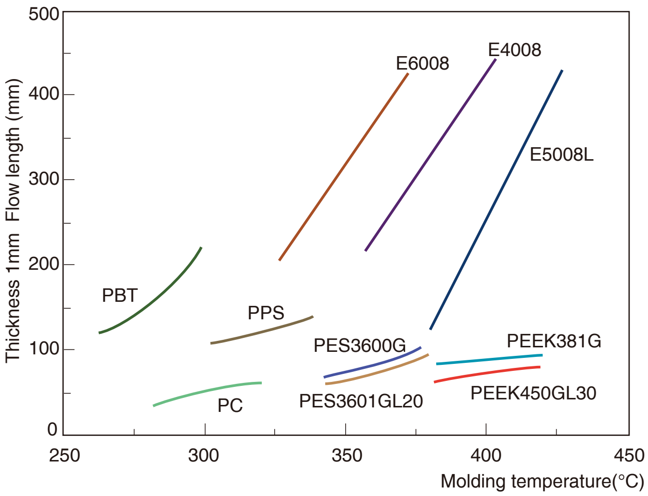


Figure 4-2-5 Flowability of Various Engineering Plastics at 1mm Thickness



Thin-Wall Flowability

The thin-wall flow length of SUMIKASUPER LCP depends on the molding conditions and mold shape. Figure 4-2-7 shows the results of thin-wall flow length evaluation for various grades molded at the same injection speed and pressure using the same mold as shown in Figure 4-2-6. SUMIKASUPER LCP has high flowability even a product thickness of 0.1mm, and a wide range of molding conditions can be applied, allowing it to be utilized in products of various shapes.

Thin wall flowability measurement conditions (0.10mm, 0.12mm, 0.15mm, 0.20mm, 0.30mm)

- Injection molding machine : ROBOSHOT S-2000i30B (FANUC Corporation)
- Resin temperature : Standard molding temperature
- Mold temperature : 120˚C
- Injection speed : 200mm/sec

Figure 4-2-6 Mold for Thin-Wall Flow Length Measurement

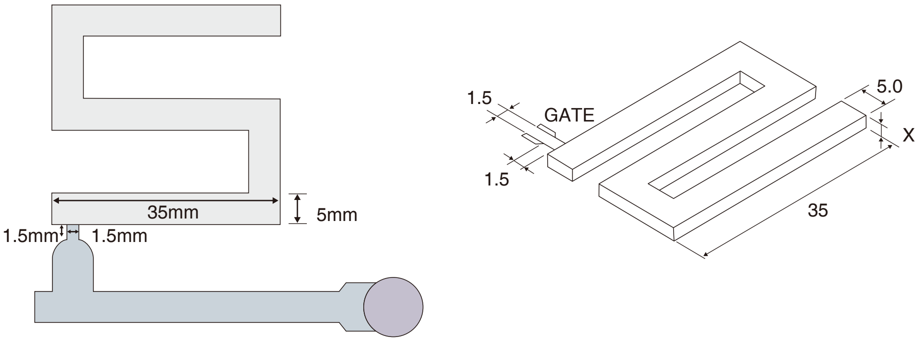


Figure 4-2-7 Thin-Wall Flow Length

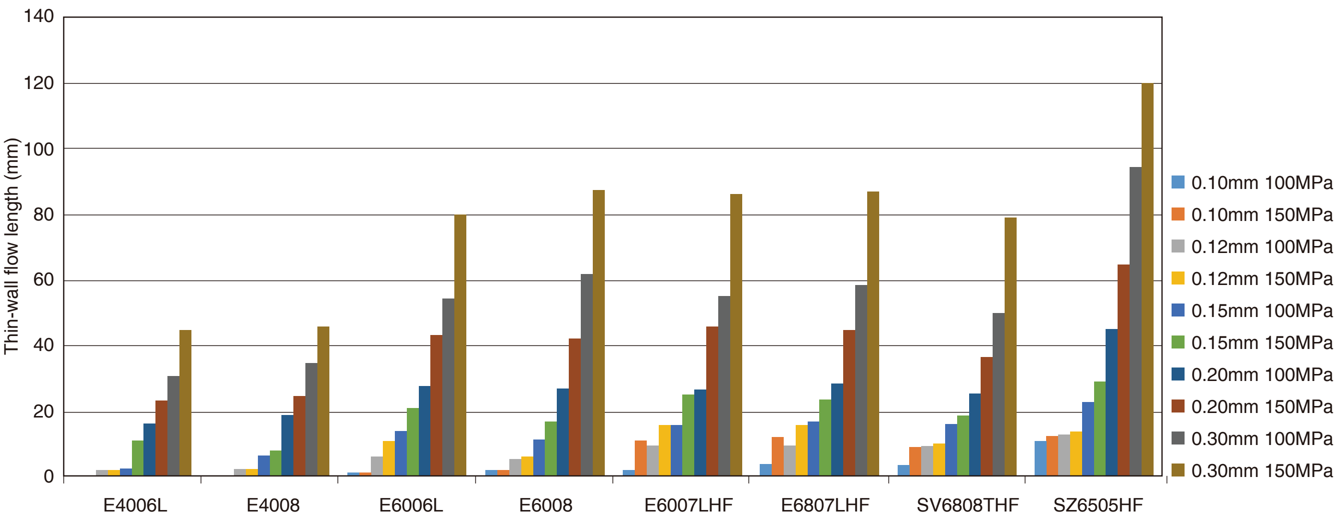


Figure 4-2-8 Thickness Dependence of Thin-Wall Flow Length 1

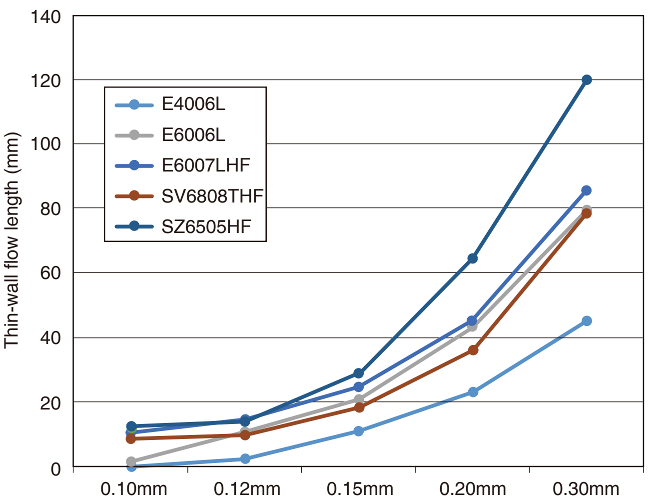
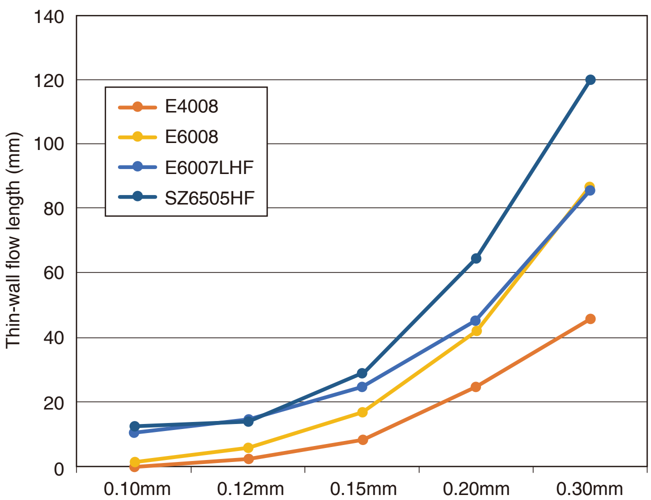


Figure 4-2-9 Thickness Dependence of Thin-Wall Flow Length 2



4-3 Injection Molding Machine and Mold Design

Selection of Injection Molding Machine

SUMIKASUPER LCP can be molded using both the standard inline type and plunger (preplasticating) type of injection molding machines. However, for E5000 series, it requires a higher molding temperature (up to 420°C), and thus the injection molding machine with high temperature specifications (450°C) is required.

Screw and Cylinder

- Since glass fiber is filled for most grades of SUMIKASUPER LCP, it is recommended that the wear-resistant materials be used for screws and cylinders.
- A standard full flight type screw is good for SUMIKASUPER LCP. Sub-flight screws and high mixing screws are not recommended because metering time will be extended.
- A typical screw design suitable for SUMIKASUPER LCP is as follows.
  - L/D (screw length [L]/screw diameter [D]) : approx. 18 to 22
  - Compression ratio : around 2.0 to 2.2
  - Ratio of each zone:
    - Feed zone : around 55%
    - Compression zone : around 25%
    - Metering zone : around 20%
- Screw heads for inline type injection molding machines are recommended to be equipped with backflow prevention mechanism.
- As the flow characteristics of SUMIKASUPER LCP are sensitive to temperature, it is necessary to use a PID controller to keep the cylinder temperature properly.
- Screws and cylinders require proper maintenance. Regularly monitor the check ring and the clearance between the cylinder and the screw to ensure that they meet the molding machine manufacturer's specifications.

Nozzle

- For the material of the nozzle, the same as those in "Screw and Cylinder" can be used.
- Open nozzles should always be used. Shut-off nozzles should not be used, as they have excessive dead space that can trap and retain resin.
- The nozzle heater must have a temperature controller (PID controller) that is independent of the cylinder.
- If their is a nozzle specifically designed for LCP, it is recommended to use it. It can be helpful in improving drooling and stringing problems.
- It is not recommended to use an extension nozzle. When using it, be sure to select one that enables uniform temperature distribution.

Injection Unit and Its Control System

- It is possible to use a general open-loop control type or closed-loop control type molding machine.
- Since the melt viscosity of SUMIKASUPER LCP depends greatly on the shear rate and it solidifies rapidly when cooled, it is recommended to use a high performance injection molding machine that enables high speed and high response when molding thin-walled products.

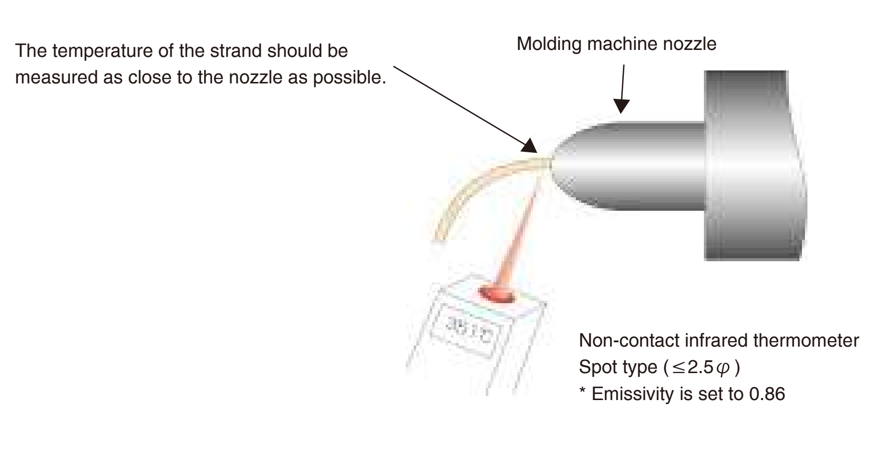
Injection Capacity

- It is recommended to select a molding machine whose shot size is about 1/3 to 3/4 of its maximum injection capacity. If the shot size is too small, the residence time of resin in the high temperature cylinder will be longer, and various molding defects are more likely to occur.
- When performing high cycle (short cycle time) molding, the shot size would need to be less than 1/2 of the maximum injection capacity to shorten the metering time.

Resin Temperature Control

Since the properties of SUMIKASUPER LCP molded products are highly dependent on the resin temperature during molding (cf. Figure 4-1-2), it is necessary to mold SUMIKASUPER LCP at an appropriate resin temperature. On the other hand, as the standard molding temperature for SUMIKASUPER LCP is extremely high (320 to 400°C), there may be a discrepancy between the setting temperature of the molding machine and the actual resin temperature. In this case, the potential of SUMIKASUPER LCP can not be fully utilized.
In order to prevent such problems, it is recommended that the resin temperature in the cylinder be monitored. The actual resin temperature can be measured, for example, by using an infrared radiation thermometer that can measure the temperature of a small area.

Figure 4-3-1 Measuring Method of Resin Temperature



High-Speed Injection Molding

As SUMIKASUPER LCP has a rapid solidification nature when cooled, it does not easily cause flashes during injection molding although its melt viscosity is very low.
However, when molding ultra-thin-walled products (<0.2mm), there are cases where the resin solidifies in the thin-walled part and sufficient flow length cannot be obtained. As a countermeasure in such cases, the injection molding machines with high speed and excellent injection response characteristics, such as electric injection molding machines or hydraulic injection molding machines with accumulators, are effective.

Figure 4-3-2 Maximum Flow Length without Flash Generation

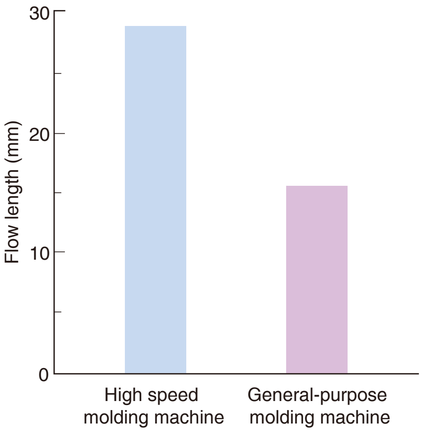
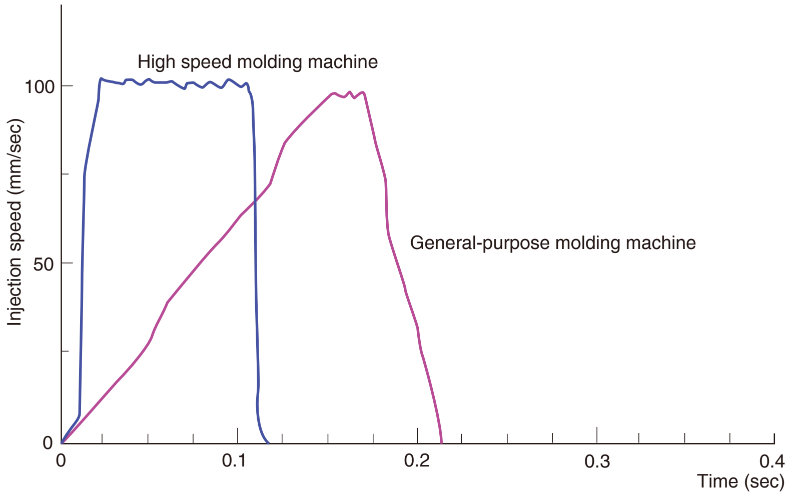


Figure 4-3-3 Comparison of Injection Response Characteristics



Hydraulic injection molding machine : UH-1000 (Nissei Plastic Industrial Co., Ltd.)
Electric injection molding machine : SE/SV series (Sumitomo Heavy Industries, Ltd.)
Electric injection molding machine : FANUC ROBOSHOT α-Si series (FANUC Corporation)
Electric injection molding machine : LP/TR series (Sodick Co., Ltd.)

(As shown above, when compared to general-purpose molding machine, the high speed molding machine provides the high injection speed in the initial period and thereafter molding is performed at the specified injection speed.)

Flow Length Measurement Mold : Use the one shown in Figure 4-3-5
Molding temperature : 360°C Grade : E6008
Injection speed 100mm/sec
V-P switching pressure 60MPa
General-purpose molding machine : PS-40E5 ASE (Nissei Plastic Industrial Co., Ltd.)
Injection speed 90% Injection pressure 90MPa

Mold Design

When SUMIKASUPER LCP is molded by injection molding, its molecules can be easily oriented in the flow direction due to shear flow. As a result, a molded product with high strength and modulus can be obtained, but at the same time, it must also possess anisotropy.
It is important to pay close attention to how the flow pattern in the cavity will be when designing the mold.

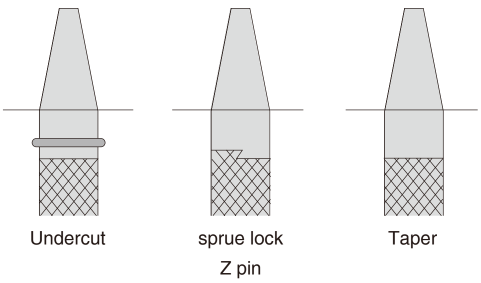
Mold materials

- For prototyping and small lot molding, carbon steels such as S55C can be used, but quenching is recommended when sliding parts are present.
- Since glass fiber is filled for most standard grades of SUMIKASUPER LCP, for the molds that require high dimensional accuracy or for mass production, it is recommended to use steel materials with a hardness of HRC55 to 62, SKD11 or its equivalent materials (HPM31, PD613, RIGOR, etc.), or higher.
- Since almost no corrosive gas is generated by SUMIKASUPER LCP, it does not cause mold corrosion and general mold materials can be used. However, when using a material with a mold hardness of less than HRC55, be sure to carefully consider any potential problems in advance.

Sprue

- The appropriate taper angle for sprues is 1° to 2° (one side).
- In order to remove the cold slag, it is recommended to provide a cold slag well at the sprue end. (4 to 5mmφ × 5mm or more)
- It is recommended to install a sprue lock to improve sprue release.

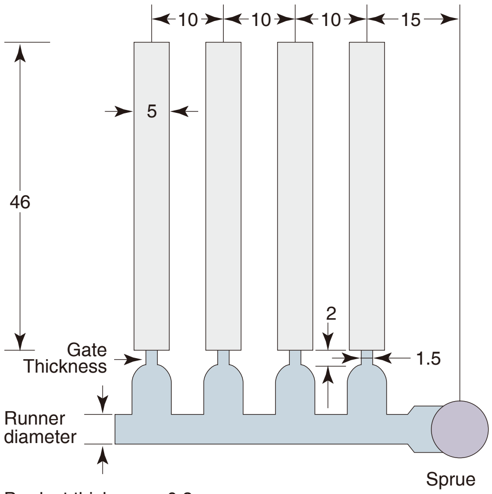
Figure 4-3-4 Sprue Diagram



Runner

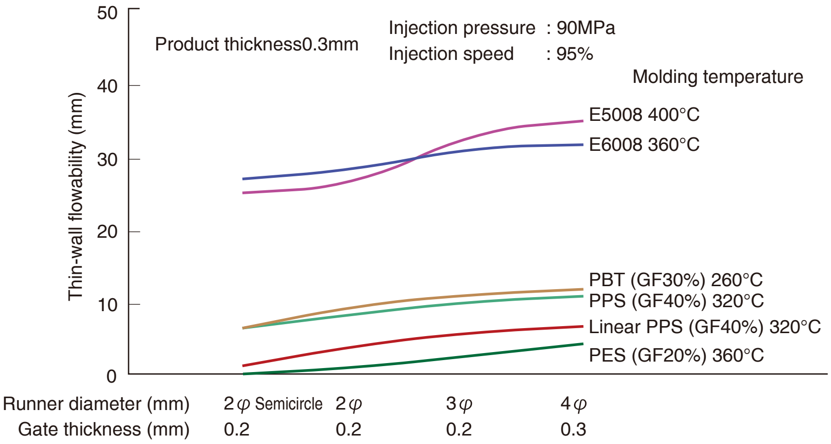
- Standard runners having either a circular, semicircular or trapezoidal cross-sectional shape can be utilized. However, it is recommended that runners having a circular or trapezoidal cross-sectional shape be used, as they are most efficient in terms of pressure loss and processability. As SUMIKASUPER LCP possesses excellent flowability, runner diameters can be decreased. Standard runner diameter is 2 to 5mm φ and guideline for runner diameters is 2/3 to 1/2 of that used for PPS and PBT (smallest: 1.5mmφ).
- When using multi-cavity molds, it is recommended that runners be correctly balanced so that individual cavities will be filled simultaneously with resin. Cold slug wells should also be installed at the ends of runners.

Figure 4-3-5 Mold for Thin-Wall Flow Length Measurement (Unit : mm)



Product thickness : 0.3mm
Flow length is 4 cavities average

Figure 4-3-6 Thin-Wall Flow Length

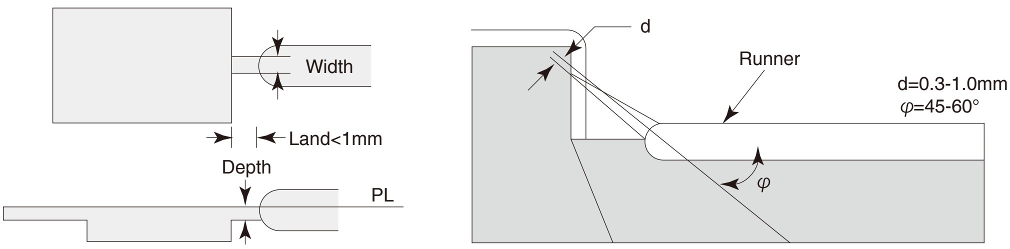


Gate

As the weld strength of SUMIKASUPER LCP is lower than that of other engineering plastics, it is necessary to limit the number of gates to only 1 to 2 places and give careful consideration to where to locate the gate, in order to avoid the formation of welds.

- Side gate
  The appropriate land length is 1mm or less, with a width of no more than 5mm. The land depth should be 70% of the wall thickness of the molded products, with a minimum depth of 0.2mm.
- Pinpoint gate
  The appropriate gate diameter range is from 0.3 to 1.5mm, with a land length of up to 1mm.
  If the gate diameter is increased, stringing and gate warpage may occur.
- Submarine (tunnel) gate
  The appropriate gate diameter is 0.3 to 1.0mm.
- Although the utilization of film gates and ring gates is possible, they are not commonly used in LCP molding.

Figure 4-3-7 Gate Diagram



Draft Angle

- The ideal draft angle is : 0.5° (1/90) to 1° (1/60) for thin-walled moldings; and 1° (1/60) to 2° (1/30) for thick-walled moldings.
- Using MR grades, moldings can be released from tool easier than general grades. The releasing force with MR grades is nearly the half of that with general grades. However, draft angle must be enlarged when moldings have greater depths.

Air Venting (Gas Drainage)

- As SUMIKASUPER LCP is often molded under high-speed injection molding conditions, the installation of mold air venting is recommended, in order that the air remaining in the mold can be discharged effectively.
- When welds occur in thin-walled products or at the ends of the flow, short shots defect tend to occur and weld strength will be insufficient. Therefore, it is recommended that air venting be installed to remedy this problem.
- SUMIKASUPER LCP has low melt viscosity and excellent flowability. However, as solidification occurs extremely rapidly, flash defect will not occur easily, even with the installation of air venting.
- The recommended depth for air vents ranges from 0.005 to 0.02mm.

Applying Hot Runner

During long-term continuous molding, resin can remain in dead spaces inside the molding machine, and the remaining resin may deteriorate or become colored. LCP can easily remain in such dead spaces since it has an extremely low melt viscosity. Therefore, when applying hot runners, it is necessary to pay sufficient attention to prevent black spots and cold slag caused by resin retention.

Points to be noted When Applying Hot Runners to SUMIKASUPER LCP

When selecting a hot runner for SUMIKASUPER LCP, please take note of the following points.

- The system must be capable of producing high levels of heating with a uniform temperature distribution.
  Heater integrated type is preferable. The manifold and nozzle temperatures should not be maintained too high.
  The areas coming into contact with the mold (gate areas) must be maintained at high temperatures.

Table 4-3-1 Temperature Specifications of Hot Runner

	Temperature specification of hot runner (MAX)
E6000HF series	up to 370°C
E6000 series	up to 380°C
E4000 series	up to 400°C
E5000 series	up to 420°C

- The hot runner design must be as free as possible from dead space within the flow channels.
  (To avoid the generation of black spots due to the long time retention of resin in the dead space.)
  External heating should be used, rather than internal heating, and the use of narrower flow channels will help to reduce the creation of dead space.
- The hot runner should be designed such that cold slag cannot easily contaminate into the hot resin.
  (To avoid the contamination of cold slags into the molded products.)
  When using open gates, it is recommended that the installation of sub-runners be considered (sprue-less molding).

Application of Hot Runners to SUMIKASUPER LCP

Table 4-3-2 Application of Hot Runners to SUMIKASUPER LCP

		Runner part		Gate seal			Application to SUMIKASUPER LCP		Remarks
		Internal heating	External heating	Open	Valve Gate	Thermal seal	Full hot runner (runner-less)	Sprueless molding	
JU-OH INC. 614 System		-	✓	-	-	✓	-	G	φ4 Electromagnetic induction heating
DMK JAPAN Inc. Mini Runner		-	✓	✓	-	-	B	A-E	*1
SEIKI Corp. Spear System	Type B (conventional)	✓	-	-	-	✓	B	B	
	EH Type	-	✓	-	-	✓	B	G	*2
Mold-Masters Corp Ltd. Master shot		-	✓	✓	✓	-	B	A-G	
FISA Corp. Plagate System		-	✓	-	-	✓	B	A	

E = Excellent : Application examples to SUMIKASUPER LCP are available.
G = Good : Applicable to SUMIKASUPER LCP.
A = Average : There are no examples of application to SUMIKASUPER LCP.
B = Bad : Not applicable to SUMIKASUPER LCP
*1 : When using multiple gates and extension nozzles for a sub-runner,it is better to control the temperature of each extension nozzle individually. It is also good to control the temperature of each nozzle individually for the molding of E5000 series which require high molding temperature.
*2 : Internal heating system for chip part

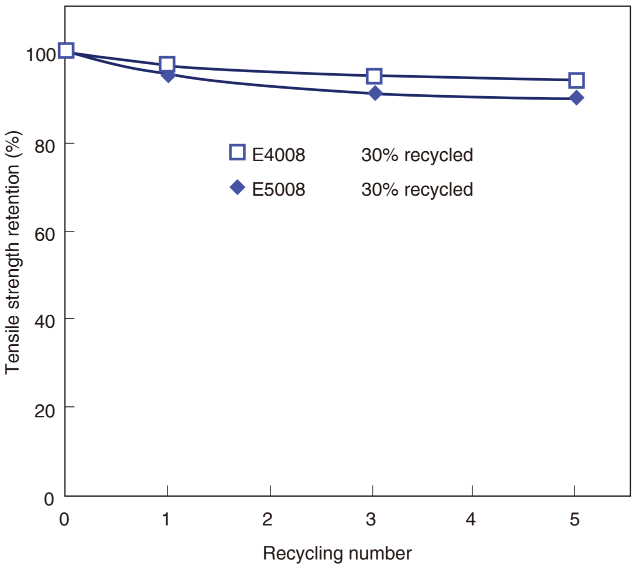
4-4 Use of Recycled LCP

SUMIKASUPER LCP shows excellent thermal stability when molding is performed under proper molding conditions, and it is able to retain its physical properties even after repeated recycling.

Changes in Properties When Recycled Materials are Mixed

For representative grades of SUMIKASUPER LCP, changes in properties were evaluated when the use ratio of recycled materials and their recycling number were varied. (see Figure 4-4-1 ,4-4-2 and Table 4-4-1) The use of recycled materials slightly degrades the properties of SUMIKASUPER LCP, but they are not degraded significantly even when the recycling number of recycled materials is increased.
When using recycled materials, it is necessary to carefully manage the quality of the recycled materials. In addition, the ratio of recycled materials to be used and the limit on the recycling number should be determined based on the required characteristics and quality of the molded products.

Figure 4-4-1 Relationship between the Number of Recycling and Tensile Strength Retention



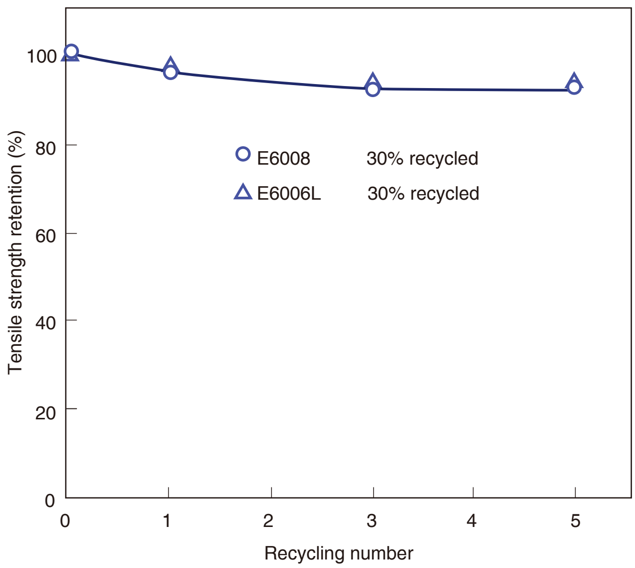
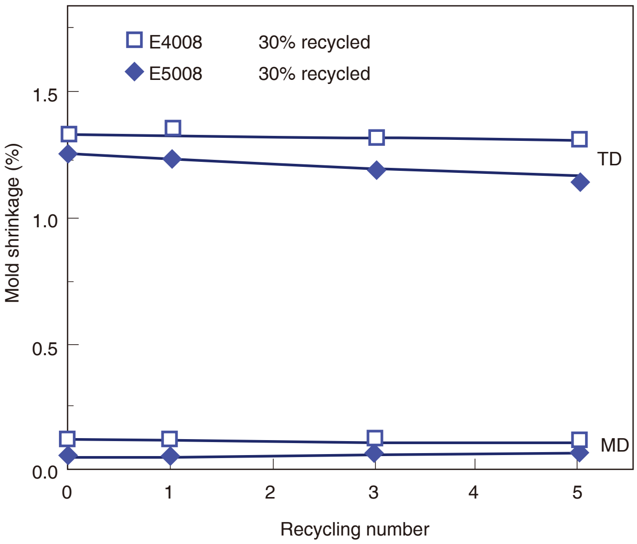


Figure 4-4-2 Relationship between the Number of Recycling and Mold Shrinkage



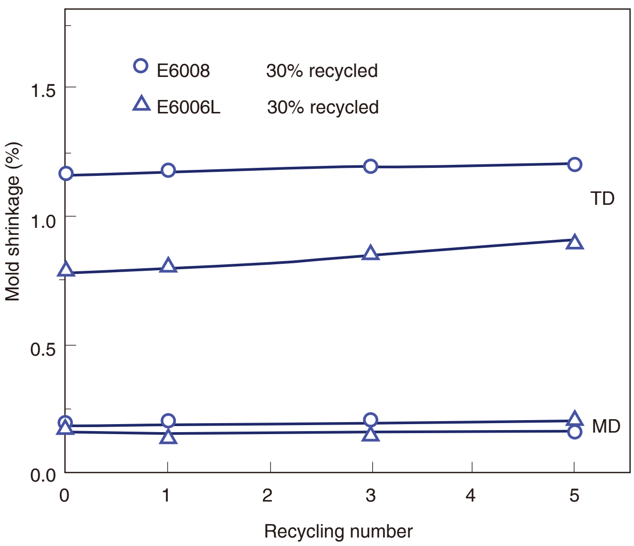


Table 4-4-1 Property retention rate of SUMIKASUPER LCP relative to virgin materials when the use ratio of recycled materials is 50%.

Unit : Retention (%)

		Test method	E6007LHF		E6807LHF		E6808UHF		SZ6505HF	
			50% 3 times recycled	50% 7 times recycled	50% 3 times recycled	50% 7 times recycled	50% 3 times recycled	50% 7 times recycled	50% 3 times recycled	50% 7 times recycled
Tensile strength		ASTM D638	99	99	94	96	100	98	91	95
Tensile elongation		ASTM D638	97	97	97	99	100	94	88	92
Flexural strength		ASTM D790	99	98	98	99	97	99	99	99
Flexural modulus		ASTM D790	99	99	100	99	98	99	99	99
Izod impact strength	Unnotched	ASTM D256	99	99	100	96	96	89	100	100
DTUL	1.82MPa	ASTM D648	98	98	99	99	98	99	99	100

Property Retention of SUMIKASUPER SV6808THF When Recycled Material Ratio Is Changed

Test Method

- Injection molding conditions : Resin temperature 350°C, Mold temperature 130°C
- Recycling method : The molded product is crushed in a pulverizer to produce recycled material.
- Use ratio of recycled material : 25, 50, 70, 80, and 100% (Uniformly mixed with virgin material)
- Number of times materials are recycled (Recycling number) : 1 to 3 times

Table 4-4-2 Property retention rate of SUMIKASUPER SV6808THF
when the use ratio of recycled materials and the recycling number are varied.

Unit : Retention (%)

		Test method	Virgin	25% 1time	25% 3times	50% 1time	50% 3times	70% 1time	70% 3times	80% 1time	80% 3times	100% 1time	100% 3times
Specific gravity		ASTM D792	100	100	100	100	100	100	100	100	100	100	100
Mold shrinkage rate(*)	MD	Internal	0.22	0.22	0.22	0.22	0.21	0.22	0.21	0.22	0.21	0.21	0.21
	TD	Internal	0.56	0.56	0.56	0.58	0.57	0.58	0.58	0.58	0.58	0.59	0.59
Tensile	Strength	ASTM D638	100	98	100	96	96	96	95	93	88	92	85
	Elongation	ASTM D638	100	102	103	99	96	97	96	94	94	96	82
Flexural	Strength	ASTM D790	100	100	102	99	99	100	96	96	91	96	88
	Modulus	ASTM D790	100	101	101	102	101	100	101	101	101	101	100
Izod impact strength	Unnotched	ASTM D256	100	101	98	96	94	95	81	90	77	95	63
DTUL	1.82MPa	ASTM D648	100	99	99	98	99	97	98	98	97	97	96
	0.45MPa	ASTM D648	100	99	100	99	99	99	98	99	97	98	96
Blistering temperature		Internal	100	100	104	104	104	104	100	100	100	100	100
Thin-wall flow length 100MPa	0.1mm	Internal	100	100	104	104	104	105	113	102	111	109	118
	0.2mm	Internal	100	99	101	104	106	104	111	105	114	109	122
	0.3mm	Internal	100	100	105	108	110	108	117	108	124	111	133
Thin-wall flow length 150MPa	0.1mm	Internal	100	103	102	106	102	108	111	107	107	109	113
	0.2mm	Internal	100	100	102	103	106	102	107	104	111	106	120
	0.3mm	Internal	100	102	103	105	106	104	110	106	112	108	118
Thin-wall flexural strength	0.1mm	Internal	100	96	95	99	101	99	95	98	99	94	97
	0.2mm	Internal	100	101	99	98	96	97	93	98	93	95	89
	0.3mm	Internal	100	98	101	107	104	103	100	102	95	100	82

*Mold shrinkage is measured on a 64mm x 64mm x 3mm flat test piece.

5. Secondary Operations

5-1 Welding

From the perspective of durability and weld strength, joining by welding is often used, and the hot plate welding method, vibration welding method, and ultrasonic welding method are typically used for SUMIKASUPER LCP. Laser welding methods that use laser light have also become common.
Resin temperature and shear (vibration) when welding are very important conditions for SUMIKASUPER LCP welding. Ultrasonic welding and CVT (IR + vibration welding) shown in the following table are preferable for SUMIKASUPER LCP welding.

Table 5-1-1 Typical Welding Methods for SUMIKASUPER LCP

Welding method		Hot plate welding	Ultrasonic welding	Vibration welding	Laser welding	IR welding	CVT (IR+ Vibration welding)
Application to SUMIKASUPER LCP		N Does not melt due to high melting point	G	N Does not melt due to high melting point	P-N If the product is thick, the laser will not penetrate	P	G
weldability	Weld strength	Have limited applicability	G (Small things are E)	E	E	G	E
	Appearance of welded part	P	G	G	E	E	E
	Weldable resin	Thermoplastic resin	Thermoplastic resin	Thermoplastic resin	Clear resin Absorbent resin	Thermoplastic resin	Thermoplastic resin
	Weld time	-	0.1-5sec	2-10sec	2-15sec	10-30sec	5-30sec
	Weldable size	Heater size-dependent	Business card size	Pallet size	Tail lens or similar size	Instrument panel size	Instrument panel size
Design	Product shape restrictions	Limitation on heater shape	Basically flat	3D shape	Highly flexible	Superior to vibration welding	Highly flexible
	Welded part design	Exclusive design	Exclusive design	Exclusive design	Exclusive design	Exclusive design	Exclusive design

E = Excellent, G = Good, P = Possible, N = No

5-2 Welding by Ultrasonic Wave

Ultrasonic welding is a method of bonding by melting the bonding surface through frictional heat generation using ultrasonic waves (20 to 40kHz). All SUMIKASUPER LCP grades can be welded using ultrasonic vibration. The strength of the bonded surface remains virtually unchanged even after thermal aging for 1 hour at 250°C.

Welding Strength Measurement Method

The test conditions are as follows.

- Test piece
  12.7 x 78 x 1.6mm 2 test pieces
  (One test piece has the protrusion shown below.)
- Welding method
  After setting the test pieces as shown in the figure on the right, the test pieces were shaken for 0.6 to 0.8 seconds at a frequency of 19.5kHz, an amplitude of 34μm, and a load of 176.4N.
- Measurement of welding strength
  Measure the shear strength at a tensile speed of 1.67 x 10^{-4}m/s.

Figure 5-2-1 Test Method for Ultrasonic Welding

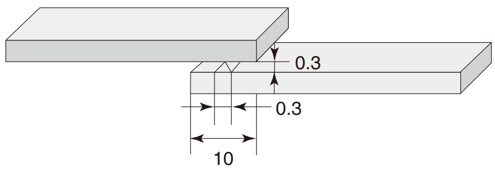


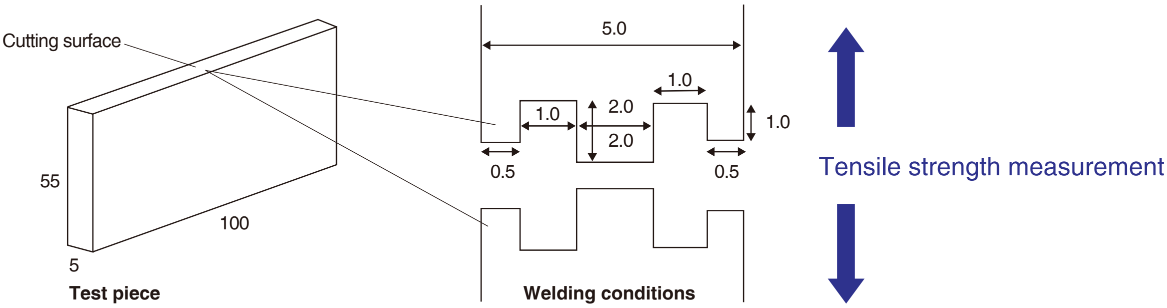
Table 5-2-1 Weldability by Ultrasonic Welder (Unit : N)

	Weld strength(N)	
	After welding	250°C,1hr thermal aging
E5008L	650	570
E5008	510	400
E4008	460	460
E6008	740	740
E6006L	710	650

5-3 Infrared (IR) Welding

IInfrared (IR) welding is a new technology for non-contact heating and joining of plastic parts. Since only the joint is radiated with infrared-rays, other parts are not affected by heat, allowing for a beautiful finish. Ultrasonic welding using vibration or vibration welding can cause scratches, but infrared welding does not cause scratches since it uses non-contact heating. SUMIKASUPER LCP is compatible with infrared welding.

Figure 5-3-1 Testing Method for IR Welding



Test piece
Grade : E6006L
Test piece size : 100 x 55 x 5mm
Welded rib width : 2mm

Welding conditions
Emitter width : 2mm
Emitter distance : 3mm
Emitter setting : 7.5A
Pressurization time : 10sec
Weld strength(MPa) = Max. test force/welding area

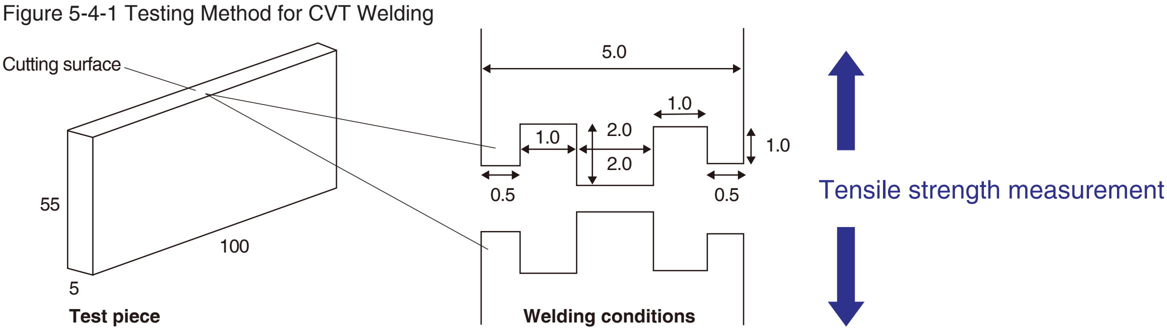
Table 5-3-1 IR Adhesive Strength of SUMIKASUPER LCP

IR irradiation time (s)	Pressurization (MPa)	Melt-in amount (mm)	Welding strength (MPa)
40	1.5	1.2	13.2
50	1.5	1.5	12.8
50	3	1.8	13.1

5-4 CVT (IR + Vibration) Welding

SUMIKASUPER LCP cannot be welded using vibration welding because it does not generate enough heat. However, vibration welding can be used if heating is performed in advance using IR. Compared to ultrasonic welding, large molded products are possible. CVT (IR + vibration) welding is recommended when greater welding strength is needed.

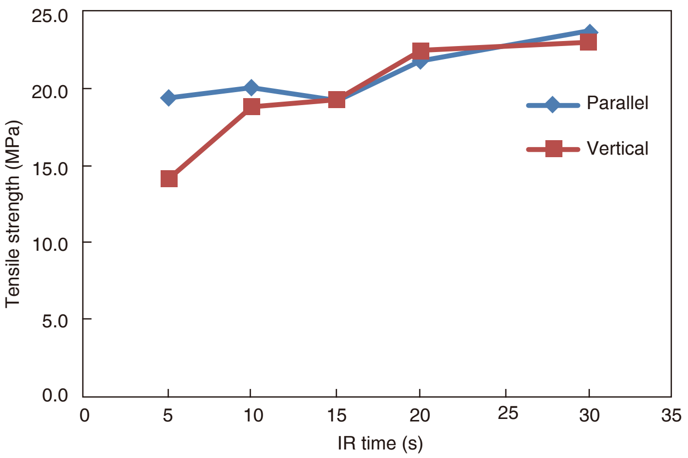
Figure 5-4-1 Testing Method for CVT Welding



Test piece
Grade : E6006L
Test piece size : 100×55×5mm
Welded rib width : 2mm

Welding conditions
Emitter width : 2mm
Emitter distance : 3mm
Emitter setting : 7.5A
Pressurization time : 10sec
Weld strength(MPa) = Max. test force/welding area

Figure 5-4-2 CVT Adhesive Strength of SUMIKASUPER LCP



Amplitude : 1.1mm
Vibration time : 1sec

5-5 Laser Welding

Laser welding is a method where laser light is used to generate heat at the interface with the welding target. When laser welding is used for resin, “light transmitting resins” and “light absorbing resins” are combined. SUMIKASUPER LCP is compatible with laser welding, but be sure to keep the following points in mind.

<Transmission Side Material>
Since SUMIKASUPER LCP has a filler, laser transmittance (infrared) is low, so it is necessary to reduce the thickness of moldings. Laser welding can be used for moldings with a thickness of up to 0.3mm (please contact us about thicknesses over 0.3mm). Since infrared transmittance is as low as 10 to 30%, there is a narrow application range. As for LCPs compatible with laser welding, grades with a low filler content and grades where only glass fiber is used are best. Grades with inorganic fillers added are not recommended since they have lower transmittance.

<Absorbing Side Material>
Use the same black grade as the transmission side material.

Figure 5-5-1 Testing Method for Laser Welding

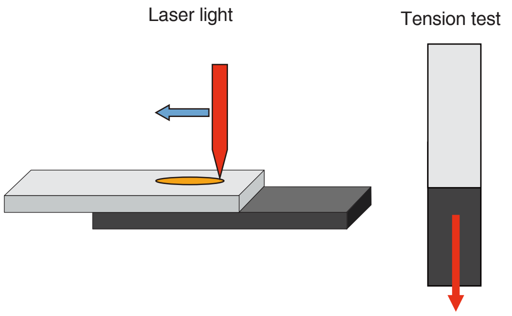


Table 5-5-1 Laser Weld Strength of SUMIKASUPER LCP

Transmitting side		Absorbing side		Glass plate	Weld strength (MPa)
Grade	Test piece thickness	Grade	Test piece thickness		
E6008	0.3mm	E6008 B	0.5mm	disuse	8.6
E6008	0.3mm	E6008 B	0.5mm	use	10.2
E4008	0.3mm	E4008 B	0.5mm	disuse	10.1
E6007LHF	0.3mm	E4008 B	0.5mm	use	15.6

5-6 Adhesion

With SUMIKASUPER LCP, adhesion using commercially available adhesives (Table 5-6-1) is possible without any special surface treatment. The bonded surface retains practical adhesive strength even after thermal aging at 250°C. Crystalline resins such as PPS may warp when the curing temperature is raised. However, warping does not occur with SUMIKASUPER LCP even when cured at a high temperature of 120 to 150°C, allowing for short processing times. For recommendations on how to use a particular adhesive, contact the adhesive manufacturer.

Adhesive Strength Measurement Method

The test conditions are as follows.

- Test piece
  ASTM No.1 test piece (thickness 3.2mm)
- Test method
  After applying the adhesive to the test pieces, they are overlapped by 10mm and cured in a hot air circulation oven.
- Measurement of strength
  Measure the shear strength at a tensile speed of 1.67 x 10^{-4}m/s.

Figure 5-6-1 Measurement Method of Adhesion Test

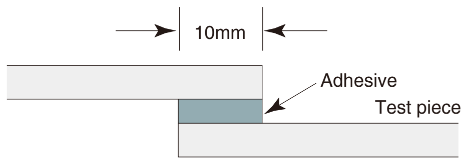


Table 5-6-1 Adhesive Strength of SUMIKASUPER LCP with Commercial Adhesives Unit: MPa

	Adhesive				
	TB2234D (ThreeBond)			Sumimac ECR-9173K (Sumitomo Bakelite)	
	After curing	250°C,1hr thermal aging	230°C, 1min IR Reflow	After curing	250°C,1hr thermal aging
E5008	9.2	3.0	9.2	9.1	3.8
E6008	7.7	2.8	7.8	8.8	3.5

	Adhesive					
	Technodyne AH 7052T (Taoka Chemical)		Technodyne AH 6072K (Taoka Chemical)		Technodyne AH 062K (Taoka Chemical)	
	After curing	250°C,1hr thermal aging	After curing	250°C,1hr thermal aging	After curing	250°C,1hr thermal aging
E5008	6.2	4.6	6.7	4.3	6.6	3.8
E6008	7.0	4.4	6.1	4.2	5.6	5.0

6. Applications of LCP

6-1 Grade Selection Guide for SUMIKASUPER LCP for Electrical and Electronic Applications

Grade Lineup

The following shows the features of the major grades of SUMIKASUPER LCP. When selecting a grade, first select the series based on the heat resistance required for the application.

(1) E5000 series
The E5000 series has the highest level of heat resistance among super engineering plastics. Use this when ultra-high heat resistance is especially needed with lead-free solder (dipping) at up to 400°C. However, it has super heat resistance, so the molding processing temperature is also high. Therefore, molding machines with high temperature specifications are needed along with regular maintenance.

(2) E4000 series
The E4000 series is a grade with excellent moldability and good heat resistance. Use this when heat resistance is needed up to 380°C with lead-free solder (dipping) such as for bobbins and relay cases. Since the standard molding temperature is 380°C, molding is possible using standard molding machines.

(3) E6000 series, E6000HF series, SV6000 series, and SV6000HF series
Our standard grades are the E6000 series, E6000HF series, SV6000 series, and SV6000HF series. These are well-balanced grades that have good mechanical properties and dimensional stability comparable to general-purpose engineering plastics, as well as high moldability, in addition to heat resistance capable of withstanding surface mounting (SMT) of electronic components. These can be used for a wide range of purposes. For applications requiring high dimensional stability and high moldability, select the E6000HF or SV6000HF series, which have excellent flowability.

(4) SZ series, SR series
The SZ series and SR series are special high-performance compound series with special functionality over existing grades. These are developed from LCP resin for specific applications such as connectors and LEDs. For applications requiring high flowability such as ultra-small parts where the flowability with E6000HF and SV6000HF is insufficient, select SZ6505HF or SR2506, which have the highest level of flowability among LCPs.

How to Select Each Grade

(1) Glass fiber reinforced grade
This grade of LCP reinforced with glass fiber has excellent mechanical strength and heat resistance. Characteristics such as mechanical strength, heat resistance, dimensional stability, and moldability change according to the length and amount of glass fiber filler.

- When mechanical strength and dimensional stability are needed, select the grades indicated with “L” such as E5008L, E4006L, E6006L, and E6007LHF that use chopped glass fiber (long glass fiber). When high strength is needed, consider SR1009 and SR1009L from the SR series with the highest level of mechanical strength among LCPs.
- When high heat resistance and high moldability are needed, consider E5008, E4008, E6008, etc., that use milled GF (crushed glass fiber).

Table 6-1-1 Glass Fiber Reinforced Grades of SUMIKASUPER LCP

	E5000 series	E4000 series	E6000 series SV6000 series	E6000HF series SV6000HF series	SZ·SR series
Heat resistance requirement level	Special ultra-high heat resistance	Ultra-high heat resistance	High heat resistance	High flow	High performance
Features	Dip-proof solder High temperature resistant reflow Thermal rigidity over 200°C	High temperature resistant reflow Thermal rigidity over 200°C	Reflow resistance Standard	Reflow resistance High flow Low warpage	Reflow resistance High performance functional specialization
Standard molding temperature (°C)	400	380	360	350	340-380
Milled GF Thin wall, small size	E5008 E52008	E4008 E4009	E6006 E6008	-	SR1009
Chopped GF High strength	E5006L E5008L	E4006L	E6006L	E6007LHF E6007LHF-MR	SR1009L

(2) Glass fiber / inorganic reinforced grade

Grades where LCP is reinforced with glass fiber and inorganic filler have a combination of inorganic filler and glass fiber characteristics, and show high dimensional stability, low warpage, and high flowability while maintaining mechanical strength and heat resistance.

Table 6-1-2 Glass Fiber / Inorganic Reinforced Grades of SUMIKASUPER LCP

	E5000 series	E4000 series	E6000 series SV6000 series	E6000 series SV6000 series	SZ·SR series
Heat resistance requirement level	Special ultra-high heat resistance	Ultra-high heat resistance	High heat resistance	High flow	High performance
Features	Dip-proof solder High temperature resistant reflow Thermal rigidity over 200°C	High temperature resistant reflow Thermal rigidity over 200°C	Reflow resistance Standard	Reflow resistance High flow Low warpage	Reflow resistance High performance functional specialization
Standard molding temperature(°C)	400	380	360	350	340-380
Glass fiber / inorganic reinforced	E5204L	E4205R	E6205L	-	SR1205L SZ6709L
Glass fiber / inorganic reinforced High flow and low warpage	-	-	E6809U SV6808L	E6807LHF E6808LHF E6808UHF E6808GHF SV6808THF SV6808GHF E6810LHF E6810KHF	SR2506

(3) Inorganic reinforced grade

The inorganic reinforced grade generally has better surface properties, higher tensile elongation, and better impact strength compared to the glass fiber reinforced grade. It also has high flowability.

Table 6-1-3 Inorganic Reinforced Grades of SUMIKASUPER LCP

	E5000 series	E4000 series	E6000 series SV6000 series	E6000HF series SV6000HF series	SZ·SR series
Heat resistance requirement level	Special ultra-high heat resistance	Ultra-high heat resistance	High heat resistance	High flow	High performance
Features	Dip-proof solder High temperature resistant reflow Thermal rigidity over 200°C	High temperature resistant reflow Thermal rigidity over 200°C	Reflow resistance Standard	Reflow resistance High flow Low warpage	Reflow resistance High performance functional specialization
Standard molding temperature(°C)	400	380	360	350	340-380
Inorganic	-	-	E6807T E6809T	-	SZ4506 SZ6505HF SZ6506HF SR2507

6-2 Grade Selection Guide for SUMIKASUPER LCP for Connector Applications

Characteristics Required of the Material

Surface mounting technology (SMT) where electronic components are mounted on boards at high temperatures of 250 to 270°C has become common in recent years. Therefore, LCP is widely used for SMT-compatible connectors due to its excellent heat resistance, dimensional stability, and precision molding.
As the performance and miniaturization of electronic devices has progressed, the connectors that connect boards and FPC (flexible printed circuits) boards to cables and boards have become more dense, smaller and thinner, and have higher transmission speeds. Therefore the characteristics needed from LCPs have also becoming more sophisticated. There are many types of connectors depending on the purpose of the connection, and the characteristics required for LCPs also differ. We develop grades with high performance and high functionality based on the needs of our customers, and provide a diverse lineup.

Grade Lineup for Connector Applications

The following is the lineup of SUMIKASUPER LCP grades for connectors. All grades have thin-wall flowability, thin-wall strength, and low warpage according to the required characteristics of the connector.

Table 6-2-1 Grade Lineup for Connector

Filler	Features		E series Standard	E / SV series General-purpose and functionality	SZ / SR series High performance
Glass fiber	Standard		E6007LHF	E6007LHF-MR	SR1009 SR1009L
Glass fiber / inorganic or inorganic alone	Low warpage	Standard	E6807LHF E6808LHF	SV6808THF SV6808L	SZ6505HF SZ6506HF
		High flow	E6808UHF E6808GHF	SV6808GHF	SR2506
		Low anisotropy	E6810LHF E6810KHF	E6809U	SR2507 SZ4506
Dielectric constant control	Low dielectric constant and low dielectric dissipation factor		E4205R	E6205L	SR1205L

Characteristics of Grades for Connector Applications

(1) Thin-wall flowability

The thin wall flowability of 0.10mm, 0.12mm, 0.15mm, 0.20mm, and 0.30mm of SUMIKASUPER LCP is shown below. SUMIKASUPER LCP exhibits the highest level of flowability among the many types of LCP.

Figure 6-2-1 Mold for Thin-Wall Flow Length Measurement

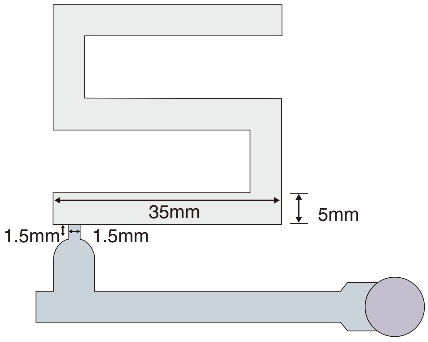


Figure 6-2-2 Thin-Wall Flowability of SUMIKASUPER LCP 1

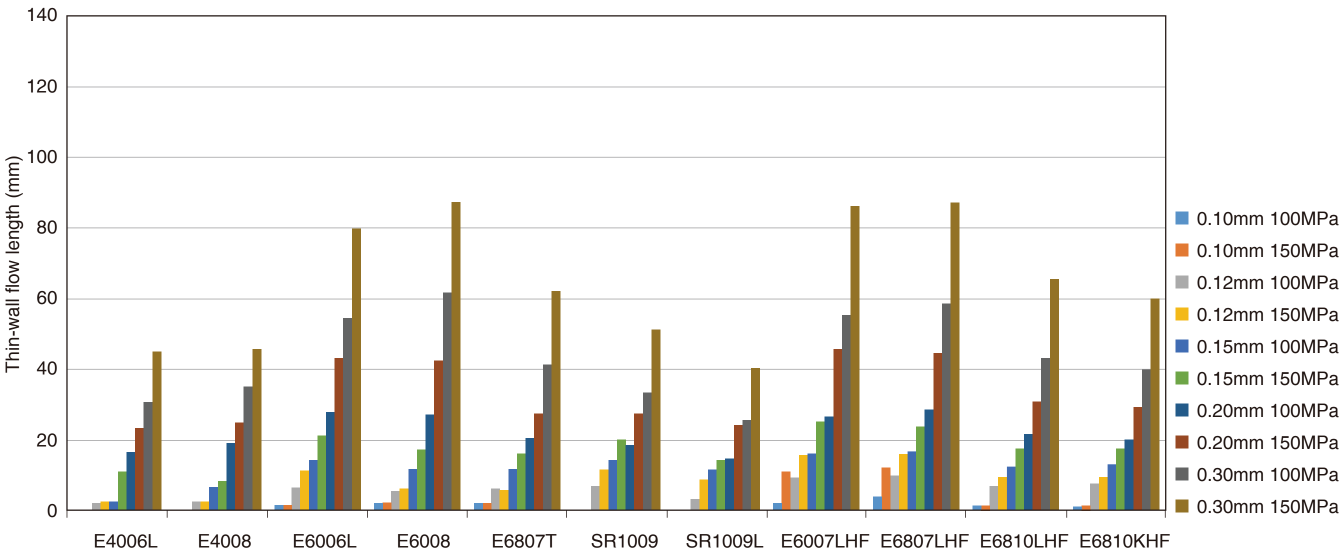
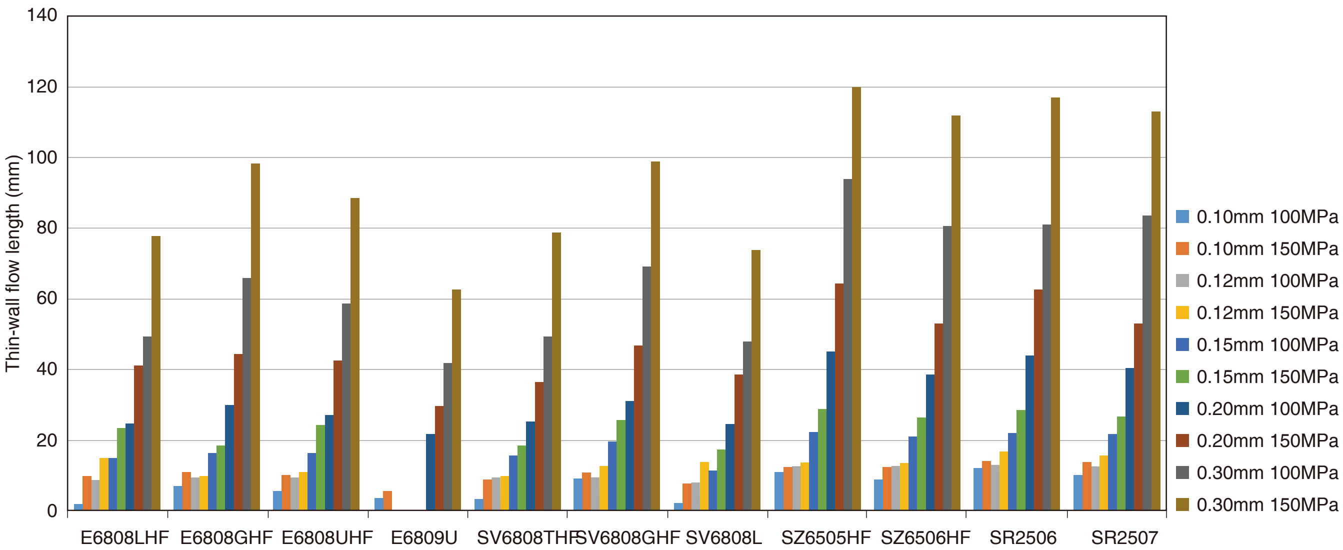


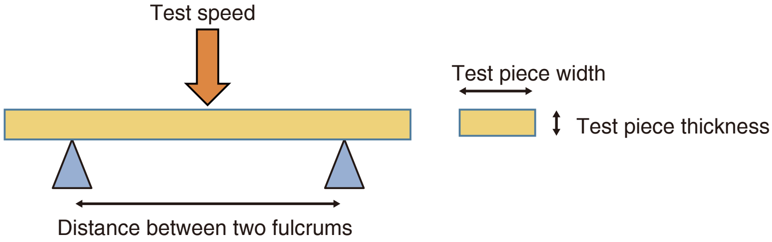
Figure 6-2-3 Thin-Wall Flowability of SUMIKASUPER LCP 2



(2) Thin-wall strength

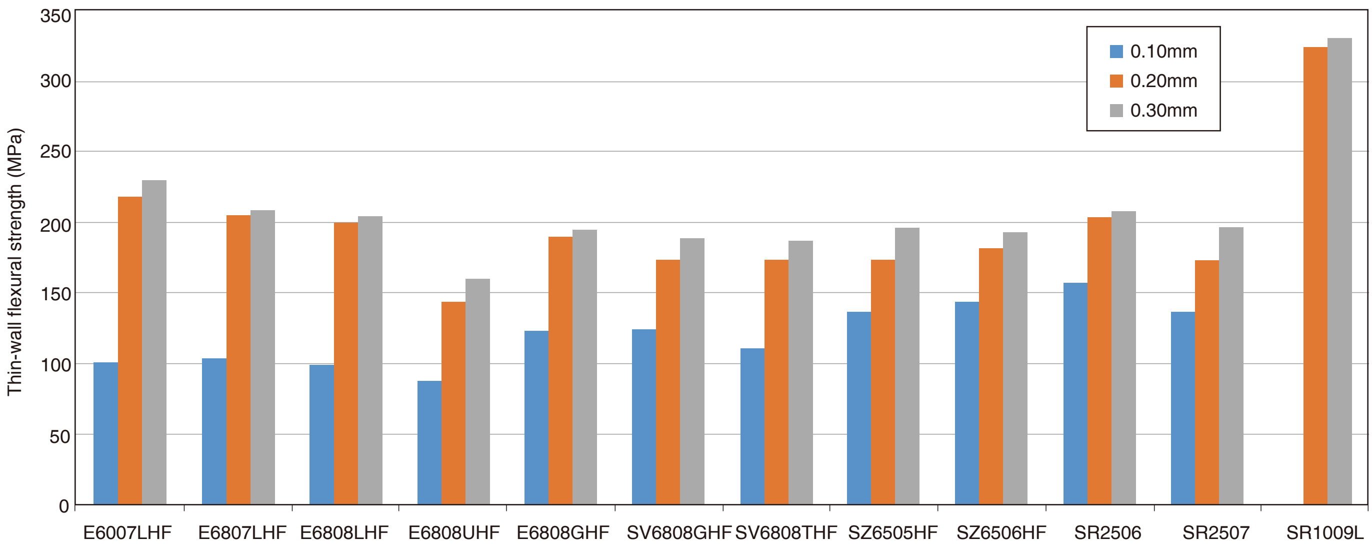
The following shows the thin-wall strengths for 0.10mm, 0.20mm, and 0.30mm grades of SUMIKASUPER LCP for connectors. SUMIKASUPER LCP has high mechanical strength even with a thin wall of 0.30mm or less.

Figure 6-2-4 Thin-Wall Strength Test Method



Test piece shape : Plate-shaped test piece
Test piece width : 5mm
Test piece thickness : 0.1, 0.20, 0.30mm
Distance between two fulcrums : 3mm(0.10mm), 5mm(0.20, 0.30mm)
Test speed : 2mm

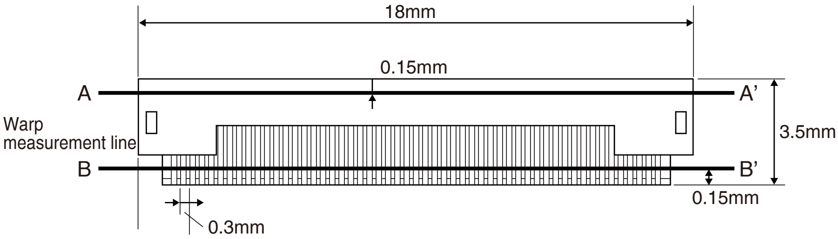
Figure 6-2-5 Thin-Wall Strength of SUMIKASUPER LCP



(3) Low warpage

For SMT connectors, poor soldering may result when the connector warps and deforms due to expansion/contraction of the LCP resin from heating during the reflow process and release of resin residual stress. The SUMIKASUPER LCP grades for connectors have excellent low warpage even before and after heating in the reflow process.

Figure 6-2-6 FPC Model Connector and Reflow Test Conditions



Warp Measurement Method

Measuring equipment : Core9030C (manufactured by CORES Corporation)

Reflow conditions : as shown below

Measurement method : The amount of warpage of the FPC model connector before and after reflow was calculated.

Warpage calculation method : The height of the lines A-A' and B-B' connecting both ends in the longitudinal direction are measured, the least square plane of the connector is calculated using the least squares method, and the distance between the lowest and highest points are then calculated as warpage.

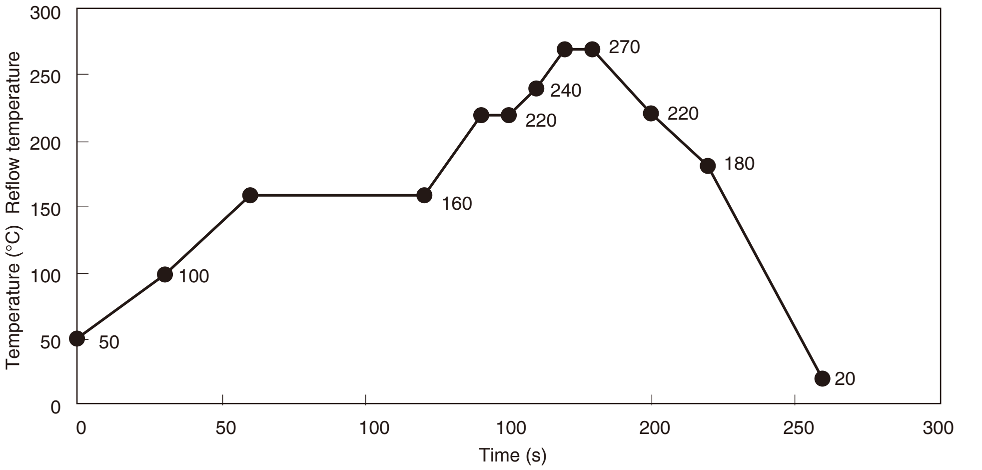
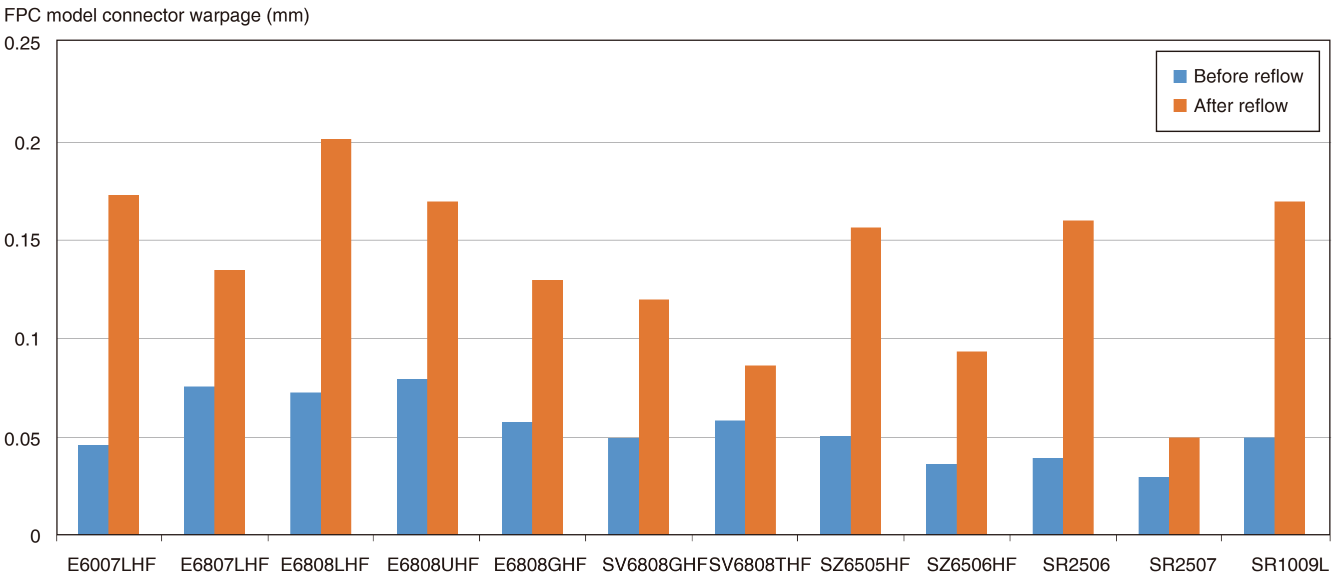


Figure 6-2-7 FPC Model Connector Warpage of SUMIKASUPER LCP



Grade Selection Guide for Connector Applications

There are many types of connectors depending on the purpose of the connection, and the characteristics required for materials also differ. When selecting a grade, it is necessary to consider the required characteristics and shape of the connector (especially the wall thickness of the molding). The following is a list of typical connector types and recommended grades. Some of the newest grades are not listed in the catalog, so please contact us about grade selection and other technical questions.

Table 6-2-2 Recommended Grades of SUMIKASUPER LCP by Connector

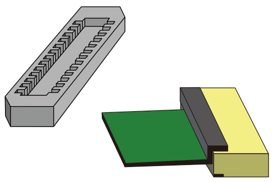
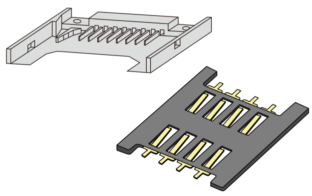
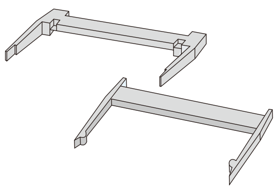
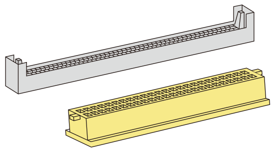
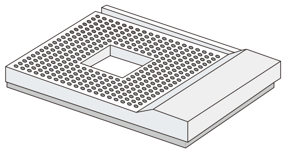
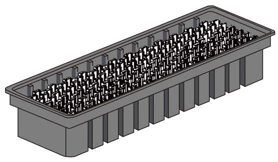
Connector type	Connector shape	Recommended grade	Features
□ Micro connector (0.3 to 0.4mm pitch) ・Board to board connector housing ・Board to FPC connector housing ・FPC connector housing	Ultra-compact/Fine pitch/Low profile 	E6808UHF E6808GHF SV6808THF SV6808GHF SZ6505HF SR2506 SR2507	High flow / Low warpage / Blister resistant High flow / Low warpage / High strength High flow / Ultra-low warpage High flow / Low warpage / High thin-wall strength Super high flow / Low warpage Super high flow / Low warpage / High weld Super high flow / Ultra-low warpage / Low linear thermal expansion
□ Card connector ・SIM card connector housing ・SD Card connector housing ・2 in 1 and 3 in 2 card connector housings	Flat plate shape/Ultra-thin wall/Insert 	E6808UHF SV6808THF SV6808GHF SZ6505HF SZ6506HF SR2506 SR2507	High flow / Low warpage / Blister resistant High flow / Ultra-low warpage High flow / Low warpage / High thin-wall strength Super high flow / Low warpage Super high flow / Ultra-low warpage Super high flow / Low warpage / High weld Super high flow / Ultra-low warpage / Low linear thermal expansion
□ Card edge (DDR, M2, S-ATA) connector ・DDR connector housing ・M2(NGFF) connector housing ・S-ATA connector housing	Uniaxial long shape/High strength 	E6808UHF SV6808THF E6808LHF E6809U E6810KHF E6810LHF	High flow / Low warpage / Blister resistant High flow / Ultra-low warpage High flow / Low warpage / High strength Low warpage / Low anisotropy / Blister resistant Low warpage / Low anisotropy Low warpage / Low anisotropy
□ I/O connectors ・USB connector housing ・HDMI connector housing ・I/O connector related housing	Small size/High density/ Robust/High speed transmission 	E6807LHF E6808LHF E6808UHF SV6808THF SV6808GHF E6809U E6810KHF	High flow / Low warpage / High strength High flow / Low warpage / High strength High flow / Low warpage / Blister resistant High flow / Ultra-low warpage High flow / Low warpage / High thin-wall strength Low warpage / Low anisotropy / Blister resistant Low warpage / Low anisotropy

Table 6-2-2 Recommended Grades of SUMIKASUPER LCP by Connector

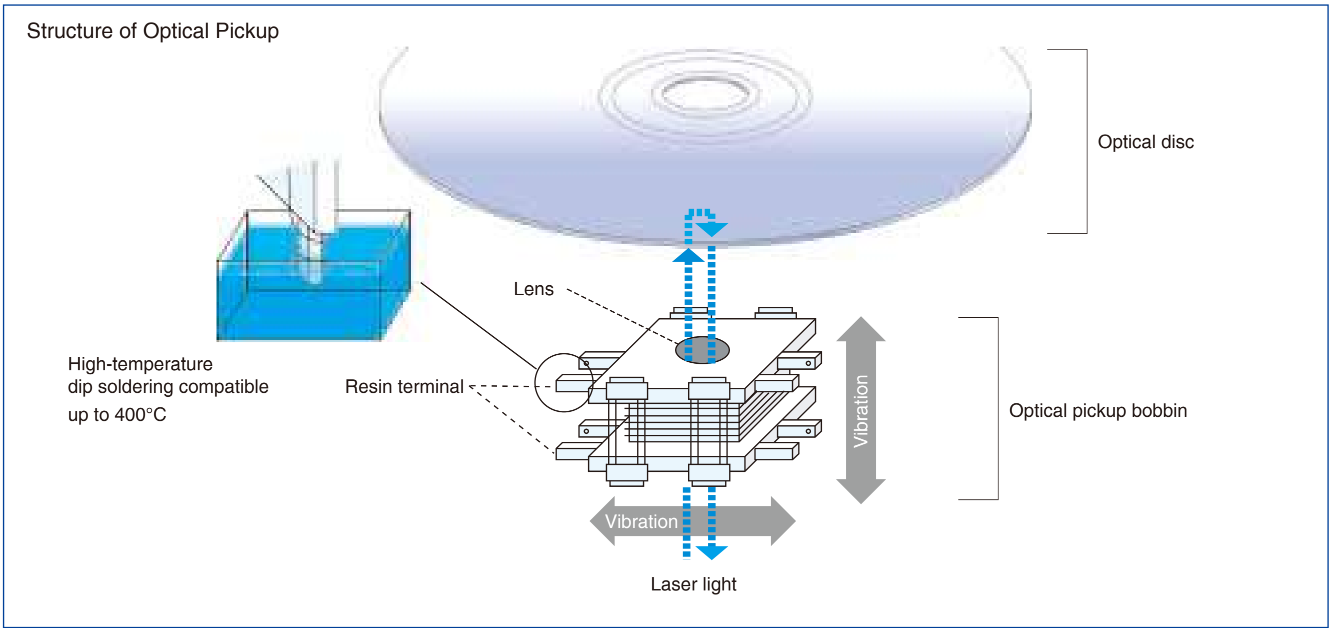
Connector type	Connector shape	Recommended grade	Features
□ Board to board connector, floating connector ・Board to board connector housing ・Floating connector housing ・Board to cable connector housing ・Automotive connector housings	Rectangular/Robust/Heat resistant/ High speed transmission 	E6006L E6008 E6007LHF E6007LHF-MR E6807LHF SV6808THF	Standard / High strength Standard / High flow High flow / High strength High flow / High strength / Mold release High flow / Low warpage / High strength High flow / Ultra-low warpage
□ CPU socket connector ・CPU socket connector housing	Flat plate shape/Grid type/ Heat resistant 	E6007LHF E6807LHF E6808UHF SV6808L	High flow / High strength High flow / Low warpage / High strength High flow / Low warpage / Blister resistant High heat resistance / High strength
□ Connector for high-speed transmission, coaxial connector ・Coaxial connector housing ・FPC connector for high speed transmission ・Backplane connector for high speed transmission ・Mezzanine connector	Rectangle/High density/Robust/ High speed transmission 	E6808UHF SV6808THF SZ6506HF SR2506 SR2507 E6205L SR1205L	High flow / Low warpage / Blister resistant High flow / Ultra-low warpage Super high flow / Ultra-low warpage Super high flow / Low warpage / High weld Super high flow / Ultra-low warpage / Low linear thermal expansion Low dielectric Low dielectric / Low dielectric dissipation factor

6-3 Grade Selection Guide for SUMIKASUPER LCP for Pick-up Bobbin Applications

What Is an Optical Pickup Bobbin?

Optical pickup bobbins are critical components used in the following devices: optical disc reading units for music CD and CD-ROM and DVD-ROM for PCs, and optical disc reading/writing units for music CD-R/RW discs and DVD discs (i.e., optical disc drives and optical disc recorders).
Optical disc drives are able to perform data reading and writing operations by applying laser beam onto minute pits on the disc, with dimensions in the μm (1/1000 mm), that have been engraved into optical discs. When reading and writing data, the focusing lens itself must be moved at extremely high speeds, using magnetic forces, in order to be able to focus the laser beam onto the correct sections of the disc, as it rotates at high speed. Coils are utilized to provide the magnetic force to move the lens. The lens is mounted on top of the optical pickup bobbin, as shown in the figure below, thus the bobbin can also be referred to as the "lens holder."

Figure 6-3-1 Structure of Optical Pickup Bobbin



Characteristics Required of the Material

The characteristics required for optical pickup bobbins are as follows. SUMIKASUPER LCP, which satisfies these characteristics, is widely used in optical pickup bobbins.

Table 6-3-1 Required Characteristics of Optical Pickup Bobbins and Characteristics of SUMIKASUPER LCP

Requirement	Reasons of the requirements	Characteristics of SUMIKASUPER LCP
Small size and light weight	For power saving and high sensitivity	Low specific gravity
		Formability that enables precision molding
Reading signals accurately	If resonation occurs at less than the operating frequency (up to 20kHz), the signal can not be read. The resonant frequency of low specific gravity and high rigidity material is high.	High rigidity (Flexural modulus at 0.5mm thickness = approx. 30GPa)
		Low specific gravity
Low cost	Can be mass-produced through injection molding. As dip soldering can be performed during the assembly process (350 to 400°C x several seconds), the process of inserting metal terminals is no longer required as cost.	Formability that enables precision molding
		Low specific gravity

Grades of SUMIKASUPER LCP for Optical Pickup Bobbins

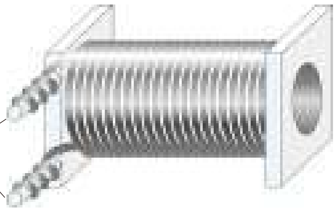
Of SUMIKASUPER LCP grades, the E5006L and E5008L grades are suitable for optical pickup bobbin applications.
The standard grade E5006L is the most suitable grade for pickup bobbins.
The E5008L is recommended for CD-DA (for audio) and low-speed CD-ROMs.

6-4 Grade Selection Guide for SUMIKASUPER LCP for Bobbin Applications

What Is a Bobbin?

A bobbin is a circular or polygonal cylinder made by winding an electric wire to make a coil. It is mainly made from electrically insulating resin, but since terminals are generally made from metal, the high cost of using both resin and metal parts are an issue. Therefore, resin terminal bobbins that are integrally molded with resin are currently under development.

Figure 6-4-1 Structure of the Bobbin



Characteristics Required of the Material

To pass a current through the wire, it is necessary to remove the coating (urethane, etc.) at the end of the wire that is wrapped with the terminal. One way to peel off the coating is to dip it in a high temperature (300 to 400°C) solder bath.

For metal terminals, heat is not transferred to the bobbin even when dipped in a solder bath, so it is possible to use resin with relatively low heat resistance. For resin terminals, highly heat-resistant resin is needed so that the terminals do not melt or deform. However, with the recent miniaturization of home appliances, bobbins are also becoming smaller, and even if the terminal is metal, heat from short terminals is transferred to the resin portion. Therefore, heat resistant resin is needed. Because of this, high heat resistance (300°C to 400°C x several seconds) and precision molding are needed to achieve miniaturization, which are required characteristics of resin materials for bobbins. In addition, thermoplastic resins have been attracting attention because of environmental concerns, so LCP is often selected as a good material for bobbins.

Grade Selection Guide for Bobbin Applications

The super heat resistant grade E5000 series is best for resin terminal bobbins. The E5000 series can also be used for metal terminals, but the heat resistance may be excessively high. The E5000 series has high short-term heat resistance, but the molding temperature is also very high at 400°C and issues related to retention degradation in the injection molding machine can easily occur. The high-heat-resistant grade E4008 is our typical grade recommended for bobbins and coils. It has a heat resistance of 300°C or higher and has good moldability. It meets many standards such as UL746B in addition to UL94 V-0.
For metal terminal bobbins, it is recommended to select a grade from the E4000 series or E6000 series after considering the required heat resistance temperature and moldability for the bobbin.
E52008 is a high-flow grade of the ultra-heat-resistant grade E5008. It is good for bobbins with a wall thickness of 0.2mm or less such as ultra-small bobbins for stepping motors.

Table 6-4-1 Grades of SUMIKASUPER LCP for Bobbin Applications

Types of bobbins	Recommended grade
Plastic terminal bobbin	E5000 series (E5008L, E5008 etc.)
Metal terminal bobbin (small size)	E5000 series (E5008L, E5008 etc.) E4000 series (E4006L, E4008 etc.)
Metal terminal bobbin (medium and large)	E5000 series (E5008L, E5008 etc.) E4000 series (E4006L, E4008 etc.) E6000 series (E6006L, E6008 etc.)

6-5 Grade Selection Guide for SUMIKASUPER LCP for OA Applications

What Are Fusing Parts for OA Equipment?

For fusing sections of multifunction printers (MFP) and laser beam printers (LBP), the general method is fusing (fixing) powdered toner transferred to paper at high temperature and pressure. Resin parts are sorted into two types: “Fusing section parts” and “Parts around the fusing section.”
“Fusing section parts” are parts that support high-temperature heat sources of 200 to 350°C, and parts that are used close to the heat source. “Parts around the fusing section” are parts that transport paper before and after fusing, and covers that cover all fusing part.

Characteristics Required of the Material

Since the required heat-resistant temperature for “Fusing section parts” differs according to the fusing method, a grade with sufficient heat resistance is needed for the material. For parts that support the fusing section heat source, thermal storage is needed for thermal efficiency. Sliding characteristics are needed for parts that come into direct contact with high-speed rotating films.
However, “Parts around the fusing section” such as guides for transporting paper and covers covering the whole fusing section are designed to prevent paper jams and maintain the pressure in the entire longitudinal direction during fusion, which requires low warpage. To achieve thin-walled products, thin-wall flowability during molding is also needed.

Grade Selection Guide for Fusing Parts of OA Equipment (Printer MFP, LBP)

For “Fusing section parts,” a wide selection is available according to the fusing method from the ultra-heat-resistant grade E5000 series to the E6000HF and SV6000HF series with other characteristics. When thermal storage and sliding characteristics are required, E5204L, E4205R, and E6205L are recommended with low thermal conductivity and good surface smoothness.
For “Parts around the fusing section,” the E6000HF and SV6000HF series are recommended for thin-wall flowability. Among these, E6808LHF and SV6808THF are recommended as grades with low warpage and good thin-wall flowability.

Table 6-5-1 Grades of SUMIKASUPER LCP for OA Applications

Type of parts for fusing section	Required characteristics	Recommended grade
Parts of fusing section	Standard	E6808LHF, E6007LHF-MR, E6006L, E4006L, E5006L etc.*
	Thermal storage, Sliding Characteristics	E6205L, E4205R, E5204L
Parts around the fusing section	Low warpage,High flowability	E6000HF, SV6000HF series (E6808LHF, SV6808THF etc.)

*Deflection temperature under load ; E6808LHF : 274°C,E6007LHF-MR : 269°C,E6006L : 284°C,E4006L : 310°C,E5006L : 355°C

6-6 Grade Selection Guide for SUMIKASUPER LCP for Relay Applications

What Is a Relay?

As the name indicates, a relay is a mechanism for relaying electric power. They can roughly be sorted into contact relays (mechanical relays) and non-contact relays (MOS FET relays, solid state relays). SUMIKASUPER LCP is mainly used for mechanical relays. A mechanical relay is comprised of a coil (electromagnet) and a switch (contact). When an electric current is applied to the coil, a magnetic force (electromagnet) is generated, and the switch is turned ON/OFF via that force. Relays are used for a wide range of applications from large machines such as automobiles and industrial robots to small devices such as OA equipment and home appliances that we use everyday.

Characteristics Required of the Material

Relays generally require high heat resistance (rigidity and strength at high temperatures and reflow resistance), low gas emission, low dust generation, and high dielectric strength. SUMIKASUPER LCP meets these characteristics. The best grade can be selected according to the heat resistance required for the relay and the thin-wall flowability needed for molding.

Grade Selection Guide for Relay Applications

The following are suitable grades of SUMIKASUPER LCP for relays that have these required characteristics. The high heat resistant grade E6008 and ultra-high heat resistant grade E4008 are best for relays. E5008 is recommended when more heat resistance is required. E6807LHF is recommended for thin relays requiring high flowability.

Table 6-6-1 Grades of SUMIKASUPER LCP for Relay Applications

Relay type		Required resistance	Recommended grade
For cover	Encapsulation type	Special high heat resistance	E5008, E5008L etc.
		Ultra-high heat resistance	E4008 etc.
	Open type	Ultra-high heat resistance	E4008 etc.
		High heat resistance	E6008 etc.
		High flow	E6807LHF etc.
For base		Ultra-high heat resistance	E4008 etc.
		High heat resistance	E6008 etc.
		High flow	E6807LHF etc.
For coil encapsulation		High heat resistance	E6008, E6807T etc.

6-7 Grade Selection Guide for SUMIKASUPER LCP for Automotive Parts Applications

What Are Automotive Parts Applications?

SUMIKASUPER LCP has many excellent features and is a material that can help to resolve problems related to automobile development such as (1) vehicle weight reduction, (2) reduction of harmful gases and CO2 emissions, (3) better fuel efficiency, and (4) introduction of new parts through electrification.

Specific Benefits of Using SUMIKASUPER LCP for Automotive Parts

- Thanks to its high flowability and excellent mechanical properties, it is possible to reduce the number of parts by integrating multiple parts, make parts more compact, and reducing the weight through thinning.
- It has good heat resistance (300°C or higher), allowing it to replace metal parts exposed to high temperature environments such as engine peripheral parts and lamp peripheral parts.
- It also has good dimensional stability (low expansion and shrinkage) in the extremely low to high temperature range required for automobiles, so it is possible to minimize product deformation caused by temperature changes. There is almost no loss of physical properties due to heat shock or the wetting and drying cycle.
- Since it has extremely low water absorption and minimal dimensional changes due to humidity, it is easy to design parts.
- It has excellent chemical resistance and can be used even in environments where it comes in contact with gasoline, engine oil, ATF, and LLC.
- It has excellent vibration damping properties, making it ideal for parts around engines, motors, and transmissions where resonance is an issue, housing components that require sound insulation such as gearboxes, and exterior panel components that insulate against rain and outside sound.
- It has been widely used with connectors and coil bobbins for electrical and electronic equipment, and can also be applied to in-vehicle electronic equipment components such as EV motor parts and PCUs.

Grade Selection Guide for Automotive Parts Applications

The following shows typical grades that are ideal for automotive parts. Select the grade that has the required characteristics.

Table 6-7-1 Grades of SUMIKASUPER LCP for Automotive Parts Applications

Grade	Features	Example of application
E6008	High heat resistance	Lamp peripheral parts (Parts example : lamp socket)
E6006L	High heat resistance,High strength	Mechanical parts, housing parts (Parts example : oil pan, oil pipe)
E6007LHF SZ6506HF	High flow	Thin-walled parts, large parts (Parts example : motor insulator)
E6807T E6808LHF	Surface property improvement	Design parts (Parts example : lamp bezel)
E4006L E4008	Ultra-high heat resistance	Engine peripheral parts (Parts example : heat insulation board)

6-8 SUMIKASUPER LCP for LED Applications

What Is a High Reflectance Grade?

These are molding materials that allow for high reflectance and high mechanical strength by combining our proprietary LCP with compound technologies.

Features of high reflectance grades

- Excellent heat resistance
  The LED grade has excellent heat resistance because LCP is used as the base polymer. It is ideal as a package material for high-brightness, high-output LEDs since there is almost no loss of reflectance from heat.
- High self-extinguishing properties
  Due to the high limiting oxygen index of the base polymer LCP, it exhibits UL94 V-0 flammability without adding flame retardants.
- Stable moldability
  As with the general grade of LCP, it shows stable moldability in injection molding of thin-walled shapes.
- Low water absorbency
  Because the base polymer, LCP, has the highest level of low water absorption among resin materials, it exhibits excellent moisture absorption reflow characteristics.

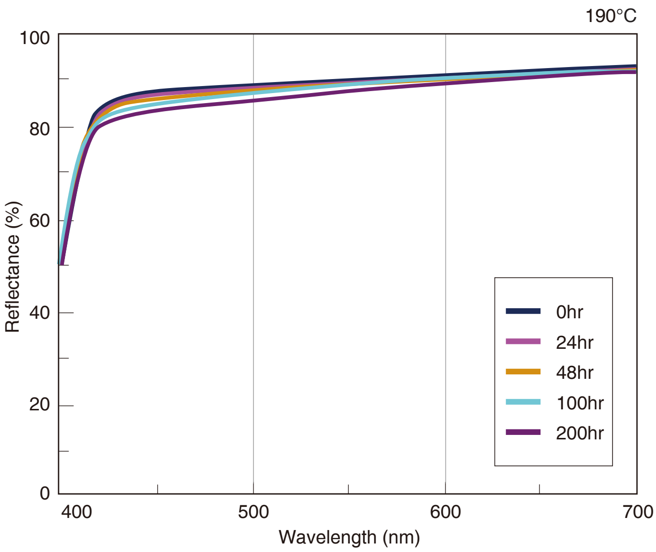
SZ6709L Characteristics Table

Table 6-8-1 Characteristics Table of SZ6709L

Item		Test method	Unit	SZ6709L
Molding color tone	L	-	-	91.0
	a			-0.3
	b			5.5
Reflectance	640nm	JIS K7105-1981	%	92
	520nm			90
	460nm			88
Water absorption rate		ISO 62	%	0.02
Specific gravity		ASTM D792	-	1.89
Mold shrinkage	MD	Internal	%	0.17
	TD			0.80
Tensile strength		ASTM D638	MPa	115
Tensile elongation		ASTM D638	%	5.0
Flexural strength		ASTM D790	MPa	140
Flexural modulus		ASTM D790	MPa	11,000
Izod impact strength		ASTM D256	J/m	310
Deflection temperature under load (1.82MPa)		ASTM D648	°C	275
Soldering Heat Resistance		Internal	°C	300

Reflectance and heat resistance of SZ6709L

Figure 6-8-1 Heat Resistance of SZ6709L Reflectance



6-9 SUMIKASUPER LCP for Food Contact Applications

SUMIKASUPER LCP has excellent heat resistance and chemical resistance, and is also used for application that contact food due to its excellent heat transmission. It weighs less than ceramic, has excellent thermal shock resistance, and has high heat resistance. Therefore, it can be used in a wide range of temperatures from freezing to direct heating in ovens.
Some grades of SUMIKASUPER LCP comply with food packaging material regulations in the US, Europe, and Japan. For details, refer to Chapter 7.Approvals. Some usage restrictions apply according to the application and usage conditions, so please contact us.

7. Approvals

SUMIKASUPER LCP conforms to many industrial standards and specifications, and has received certifications. The following is a list of the certifications that have been obtained.

Flammability

SUMIKASUPER LCP conforms to UL94 V-0. UL is a product safety standard established by Underwriters Laboratories Inc. Standard grades have received UL746B.

Electrical Appliances and Materials Safety Act

Some grades of SUMIKASUPER LCP have been registered for ball pressure temperature, horizontal combustion tests, and upper limit temperature under the CMJ (Certification Management Council for Electrical & Electronic Components & Materials of Japan) registration system based on the Electrical Appliances and Materials Safety Act. You can also view the registration status on the Japan Electrical Safety & Environment Technology Laboratories website (JET).

Food Contact Field

U.S.A.

Confirmed that some grades of SUMIKASUPER LCP meet the requirements of the Federal Food, Drugs, and Cosmetics Act and applicable food additive regulations of the United States.

Europe

Confirmed that some grades of SUMIKASUPER LCP meet the requirements determined in the “Commission Regulation (EU) No. 10/2011” for food packaging material regulations in Europe.

Japan

Some grades of SUMIKASUPER LCP contain ingredients on the positive list under Article 18, Paragraph 3 of the Revised Food Sanitation Act and Notification No. 370. Obtained a confirmation certificate issued by the Japan Hygienic Olefin and Styrene Plastics Association. Contact us for the latest details on acquisition status. The Japan Hygienic Olefin and Styrene Plastics Association was dissolved in March 2021. Their work was taken over by the Food Contact Materials Safety Center. The confirmation certificate remains valid.

Medical Field

Some grades of SUMIKASUPER have been tested for ISO 10993 and USP CLASS VI. For more information, please contact us.

TECHNICAL NOTE

Ultra-High Heat Resistant Engineering Plastics

SUMIKASUPER™ LCP

SUMITOMO CHEMICAL

Advanced Polymers Division

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