

Polyacetal Copolymer

Iupital™

Iupital™

High-performance polyacetal copolymer developed by proprietary technology

Lupital™ is a high-performance copolymer-type acetal resin manufactured through a completely new process developed by our proprietary technology.

In-house integrated production from raw material to finished product delivering stable high quality

Lupital™, through its integrated production system from raw methanol to pellets, ensures constant supply of high-quality products.

A wide range of high-functionality grades for all applications

Lupital™ is offered in a wide range of highly functional grades to meet the diverse performance requirements of the latest electronics, OA, automobiles, precision machinery, and other applications.

Research and development of trust and a reliable technical service system that cover from raw materials to finished products

We provide comprehensive support, ranging from grade development, applied techniques, and processing technology development to meticulous technical services, ensuring a thorough response to all your needs.

Lupital™ is a crystalline resin having the molecular structure $-\text{[CH}_2\text{-O]}_n\text{-[CH}_2\text{-CH}_2\text{-O]}_m\text{-}$. The C-C bond gives the characteristics of a copolymer.

- **Highly-balanced, excellent mechanical properties**

Lupital™ features rigidity and toughness (impact resistance) as well as excellent mechanical properties.

- **Long-term durability under stress loading**

Excellent long-term durability under stress (fatigue resistance, spring characteristics, creep resistance, etc.).

- **Self-lubrication provides sliding properties**

Self-lubricating properties of this crystalline resin provide excellent anti-friction and anti-wear performance.

- **Outstanding chemical resistance**

Lupital™ has excellent chemical resistance against most organic and inorganic chemicals except strong acids.

- **Adaptable to wide range of environmental conditions.**

From low to high temperatures, Lupital™ has stable physical properties under a wide range of operating temperatures.

- **Long-term dimensional stability**

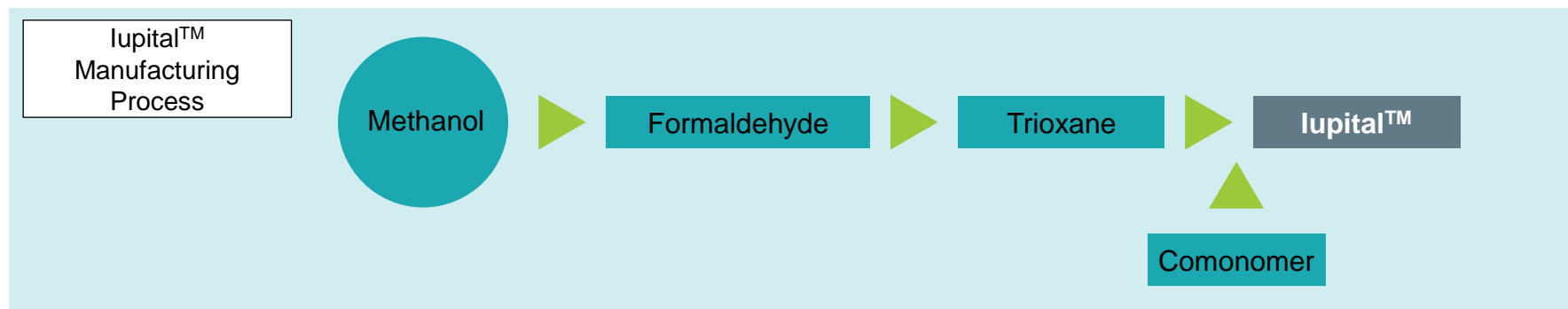
Lupital™ has excellent dimensional stability over a long period and can be used safely in precision parts.

- **Excellent molding workability**

Lupital™ has excellent flow properties over a wide range of molding temperatures which make it easily formable.

- **High thermal stability in molding**

Lupital™ has excellent thermal stability and is resistant to discoloration during molding, produces little mold deposit, and has excellent recyclability.



Grades and functions/features of Lupital™

Lupital™ is available in a wide range of highly-functional grades to meet your various performance requirements.

Lupital™ can be delivered in pellet form, available in many colors, depending on your application needs. We can also provide color concentrates (masterbatch) for each color upon request.



■ Standard/Non-Reinforced Grades [see [Here](#) for physical properties]

Grade		Function	Features
Classification	Name		
Standard	F10-01	High viscosity/Suitable for extrusion molding	Suitable for extrusion molding of round bars, pipes, etc.
	F10-02	High viscosity/Suitable for injection molding	Effective in reducing voids and sinks in molding of thick structure.
	F20-05	Medium viscosity (Standard)	Standard type.
	F25-05	Medium viscosity	Intermediate fluidity between F20 and F30.
	F30-05	High flow	Suitable for parts requiring high flow. Surface appearance and flow marks are improved from F20.
	F40-05	High flow	Has higher fluidity than F30 and is suitable for thin-walled molded parts.
Weather resistant	F20-54	Excellent weatherability	Suitable for use outdoors or in environments exposed to ultraviolet rays.
Antistatic	F20-61	Antistatic	Prevents dust adhesion and electrical noise by suppressing static buildup.
	FV-30	High flow/Antistatic	Antistatic performance equivalent to F20-61, with higher fluidity.
High rigidity	A25-05	High rigidity/Medium viscosity	More rigid than ordinary copolymers and has characteristics similar to homopolymers.
	A10-05	High rigidity/High viscosity	Higher viscosity than A25-05 with better long-term durability.



■ Reinforced/Filled Grades [see [Here](#) for physical properties]

Grade		Function	Features
Classification	Name		
Glass-filled	FG2025	High rigidity	The mechanical strength is greatly improved by filling glass fiber. The properties can be adjusted by the amount of filled glass fiber.
	MF3020	High rigidity and dimensional accuracy	Orientation of glass fiber less likely occurs, reducing warpage, sinks, and deformation.
	FB2025	Prevention of warpage and sink	Orientation of glass fiber does not occur, leading to further reduction of warpage, sinks, and deformation.
Carbon fiber-filled	FC2020D	Electrical conductivity	Exhibits high conductivity with extremely high rigidity, fatigue resistance, wear resistance, and heat resistance.
	FC2020H	Electrical conductivity/High rigidity	Higher rigidity, fatigue resistance, and wear resistance than FC2020D.
Whisker-filled	FT2010	High rigidity, dimensional accuracy, and better friction and wear characteristics into reinforced grades	Reinforced grade with potassium titanate whiskers, featuring high rigidity but small anisotropy of shrinkage and less warpage. In addition, it does not damage screws and mating materials.
	FT2020		

■ Inorganic Filler Grades [see [Here](#) for physical properties]

Grade		Function	Features
Classification	Name		
Electrical conductivity	ET-20	Electrical conductivity	Has excellent conductivity.
	ET-35	Improved conductivity and toughness	Better toughness than ET-20.
Inorganic filler	TC3015	Resistance to deformation under stress and dimensional accuracy	Significantly small deformation (distortion) under stress. Dimensional accuracy can also be achieved easily.

Grades and functions/features of Lupital™

■ Lubricated Grades [see [Here](#) for physical properties]

Grade		Function	Features
Classification	Name		
Lubricant type	LO-21A	Highly Lubricated for use with metal/dissimilar resin	Features high sliding property; sliding property especially against metal or dissimilar resins is good.
	LO-21AL	High viscosity/Highly Lubricated for use with metal/dissimilar resin	Higher viscosity than LO-21A and is suitable for round bar extrusion and profile extrusion.
Lubricant type	FX-11	Highly Lubricated/Universal	Features high sliding property, and in particular, it exerts a remarkable effect on sliding when both mating parts are Lupital.
	FX-11J	Highly Lubricated/High flow/Universal	Higher fluidity and improved surface appearance compared to FX-11. Also suitable for thin-walled molded parts.
	WA-11H	Highly Lubricated/High rigidity/Universal	Better mechanical properties than FX-11.
Fluororesin filler	FL2010	Highly Lubricated	Has high lubrication property and is especially suitable for use under high speed and high load.

■ Impact-Resistant/Flexible Grades [see [Here](#) for physical properties]

Grade		Function	Features
Classification	Name		
TPU-filled	FU2025	Flexible/Resistant to impact	Excellent flexibility (toughness) and impact resistance. Physical properties can be adjusted by the amount of TPU content.
Special elastomer-filled	ST1600	Flexible, resistant to impact, and high weld adhesion	High levels of flexibility (toughness), impact resistance, and weld adhesion are achieved at the same time. Physical properties can be adjusted by the amount of special elastomer content.

Grades and functions/features of Lupital™

■ Standards-Compliant Grades [see [Here](#) for physical properties]

Grade		Function	Features
Classification	Name		
Compliant to drinking water standards	F10-EW	High viscosity	Suitable for extrusion molding of round bars, pipes, etc.
	F20-EW	Medium viscosity	Standard type.
	FG2025MZ	Glass-filled (25%)	The mechanical strength is greatly improved by filling glass fiber.
Compliant to medical standards	MAS20	Medium viscosity	Standard type.
	MAS30	High flow	Suitable for articles requiring high flow, such as thin-walled articles.
	MAH25	High rigidity/Medium viscosity	More rigid than ordinary copolymers and has characteristics similar to homopolymers.
	MAL20	High sliding/Medium viscosity	Features high sliding property, and in particular, it exerts a remarkable effect on sliding when both mating parts are Lupital.
	MAL40	High sliding/High flow	Higher fluidity and improved surface appearance compared to MAL20. Also suitable for thin-walled molded parts.

■ Low VOC Grades [see [Here](#) for physical properties]

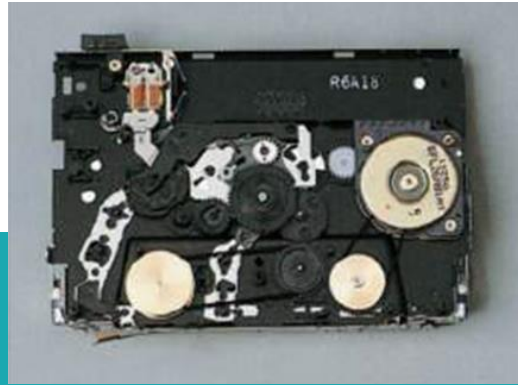
Grade		Function	Features
Classification	Name		
Standard	F20-73R1	Low VOC	The amount of volatile organic compounds (VOCs) generated is small and is suitable for parts used in automotive interior applications.
	F30-73R1	Low VOC/High flow	Features higher fluidity than F20-73R1 and is suitable for thin-walled parts and parts requiring high flow.
	F20-73R2	Low VOC	- Reduced mold deposit over R1 type.
Weatherproof	F20-55R2	Low VOC/Excellent weatherability	VOC emissions generated are low, with excellent weatherability.
High sliding	FX-11R1	Low VOC/High sliding	VOC emissions generated are low, with excellent lubricant property.
	FX-11JR1	Low VOC/High flow/High sliding	Higher flow than FX-11R1 and better surface appearance than FX-11. Also suitable for thin-walled molded parts.
TPU-filled	FU2020R2	Low VOC/Flexible/Resistant to impact	VOC emissions generated are low, with excellent flexibility (toughness) and impact resistance. Physical properties can be adjusted by the amount of TPU content.
Special elastomer-filled	ST1800R2	Low VOC/Special elastomer-filled/Flexible/Resistant to impact/High weld adhesion	VOC emissions generated are low. Furthermore, high levels of flexibility (toughness), impact resistance, and weld adhesion are achieved at the same time. Physical properties can be adjusted by the amount of special elastomer content.

Iupital™ has highly-balanced, advanced mechanical properties (both in rigidity and toughness) in a wide range of temperature environments.

Iupital™ also has outstanding rigidity compared to other engineering plastics, making it ideal as a resin alternative for metal mechanical components.



Pump components



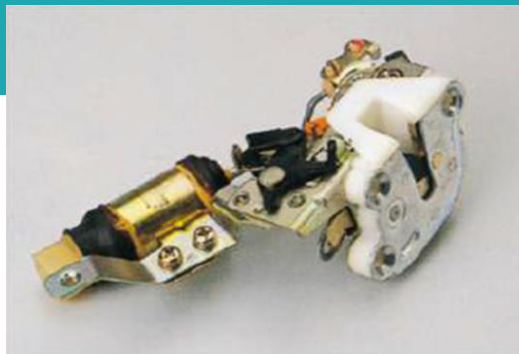
Personal cassette player mechanism



Bicycle bells



Water supply pipe joint



Door lock mechanism

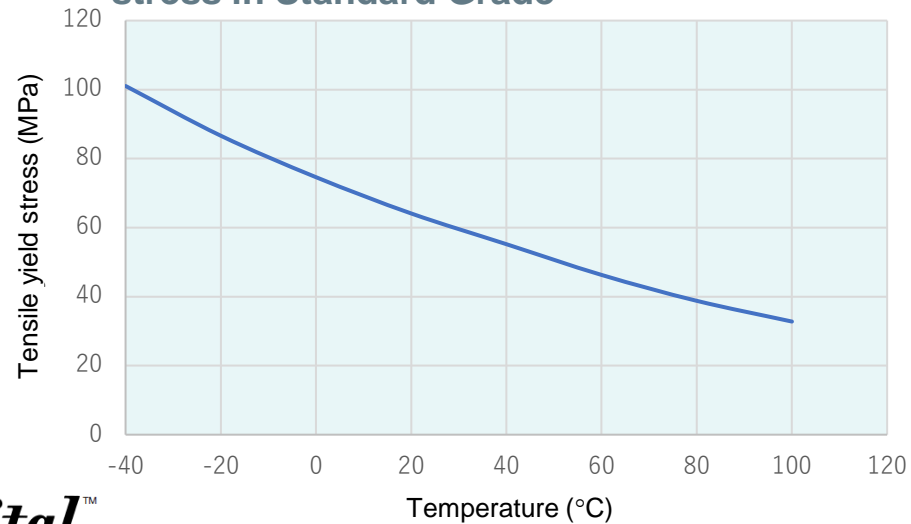


Mechanical properties

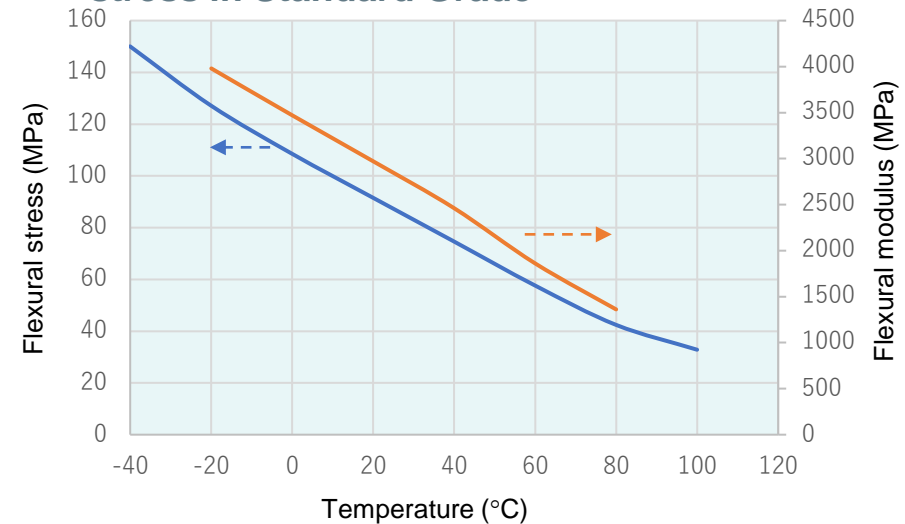
■ Typical mechanical properties of lupital™

Property	Test Method	Unit	Standard Grades				Reinforced/Filled Grades				Impact-Resistant Grades	
			F10	F20	F30	F40	FG2025	FB2025	FC2020H	FT2020	FU2025	FU2050
Density	ISO 1183	g/cm ³	1.41	1.41	1.41	1.41	1.59	1.59	1.46	1.59	1.35	1.29
Tensile yield stress	ISO 527-1, 527-2	MPa	63	64	64	64	-	-	-	-	39	24
Nominal tensile strain at break		%	33	30	25	20	-	-	-	-	>100	>200
Tensile stress at break		MPa	-	-	-	-	140	60	170	87	-	-
Tensile strain at break		%	-	-	-	-	3	6	2	4.5	-	-
Flexural strength		ISO 178	MPa	89	90	91	91	210	100	270	160	48
Flexural modulus		MPa	2500	2600	2700	2700	9100	3700	16000	7600	1400	750
Charpy notched impact strength	ISO 179-1, 179-2	kJ/m ²	8	7	6	5	9	4	-	4	19	65

■ Temperature dependency of tensile yield stress in Standard Grade



■ Temperature dependency of flexural stress in Standard Grade



Fatigue resistance, spring characteristics

lupital™ shows excellent fatigue resistance and spring characteristics under long-term cyclic stress. lupital™ is especially effective in mechanical components such as gears, springs, and snap-fit parts.



Chain



Curtain hooks



Belt buckles

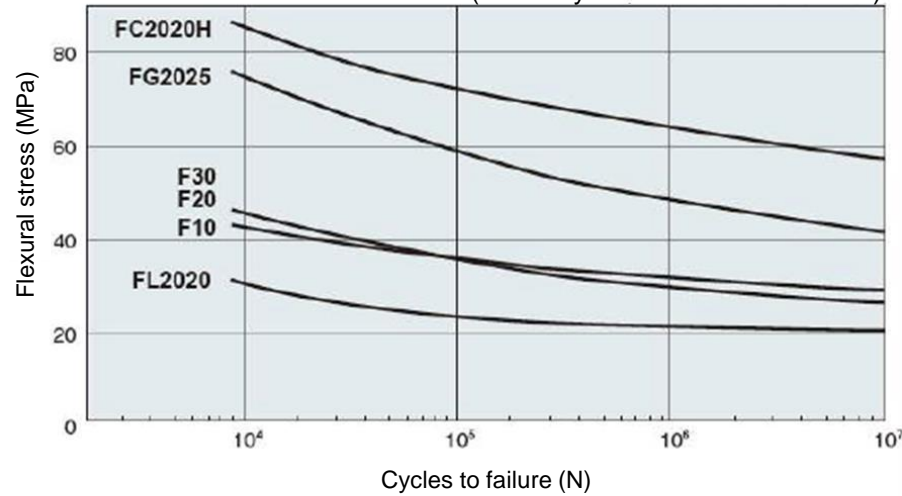
Electric fishing reel mechanism



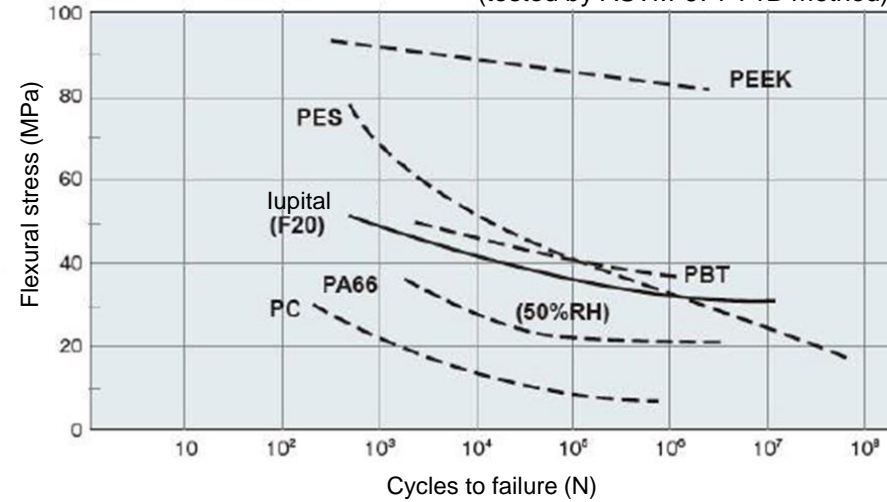
Toilet paper holder



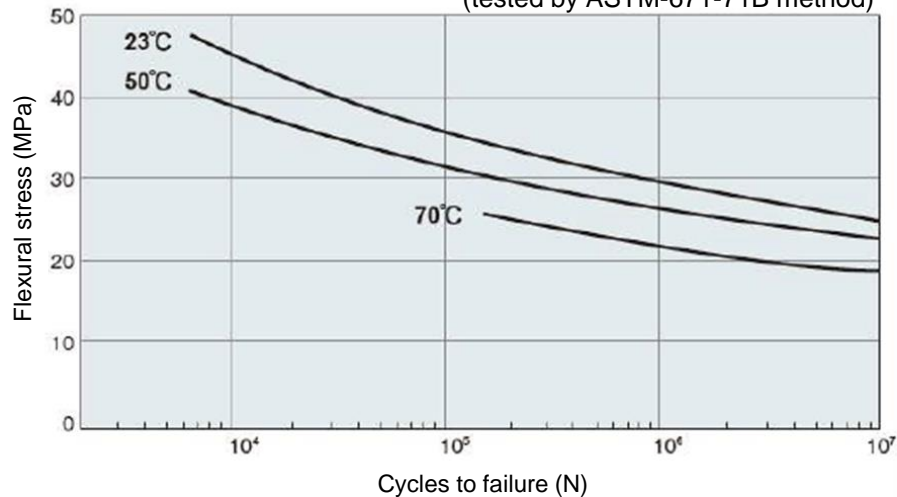
■ Relationship between flexural fatigue strength and number of cycles for each grade of lupital™ (23°C)
(tested by ASTM-671-71B method)



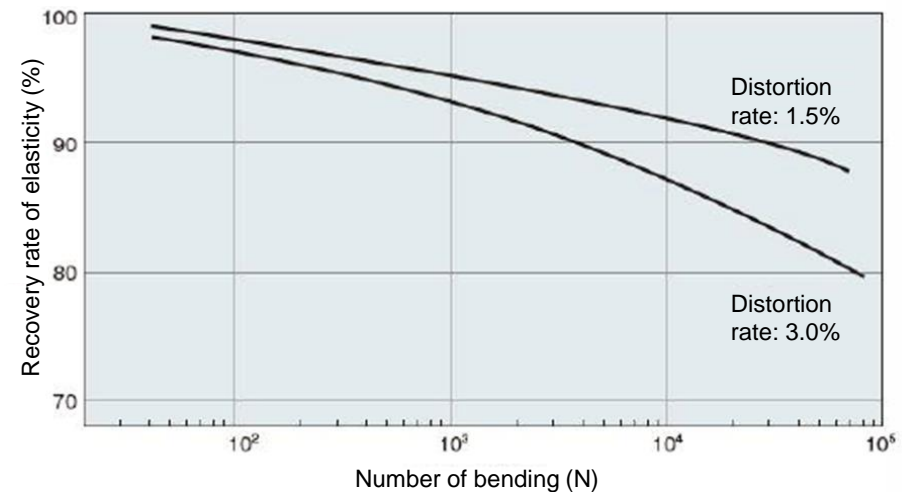
■ Fatigue resistance of various engineering plastics (23°C)
(tested by ASTM-671-71B method)



■ Temperature dependency of flexural fatigue characteristics of lupital™ (Standard Grade: F20)
(tested by ASTM-671-71B method)



■ Spring characteristics of lupital™ under repeated bending
(Elastic recovery characteristics, Standard Grade, 23°C)
(Thickness: 3.2 mm, Span: 40 mm, cantilevered testing method for molded part, pushed by piston at 60 cycles/min)



Creep resistance, stress relaxation

lupital™ has excellent durability (creep resistance and stress relaxation) under long-term loading. lupital™ allows product designing that makes full use of various mechanical processes such as insert molding, press fitting, self-tapping, and screw fastening.



Door rollers



Casters



Toy mechanism



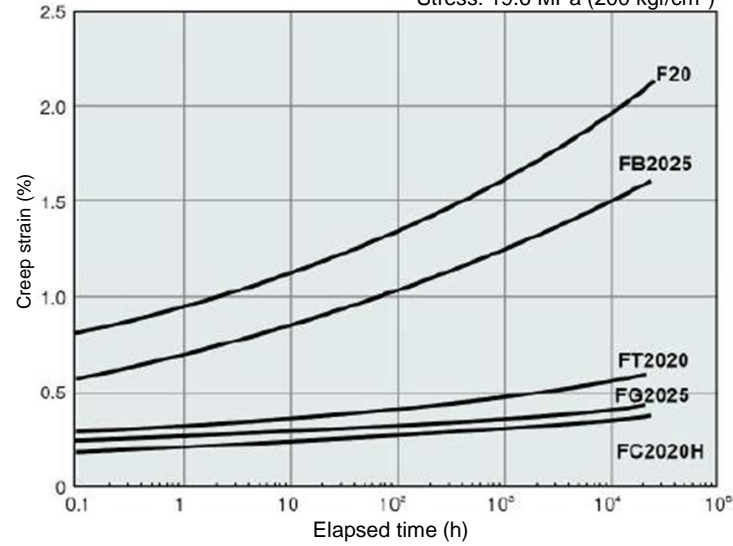
Window regulators



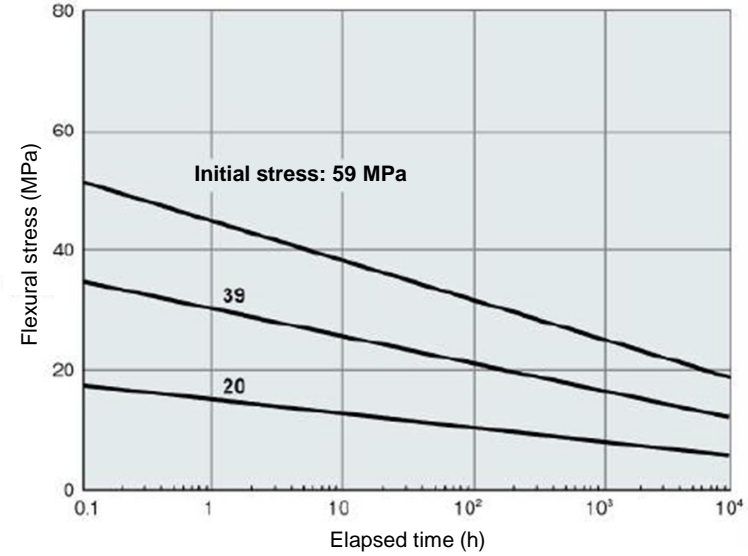
Rearview mirror stay

Creep resistance, stress relaxation

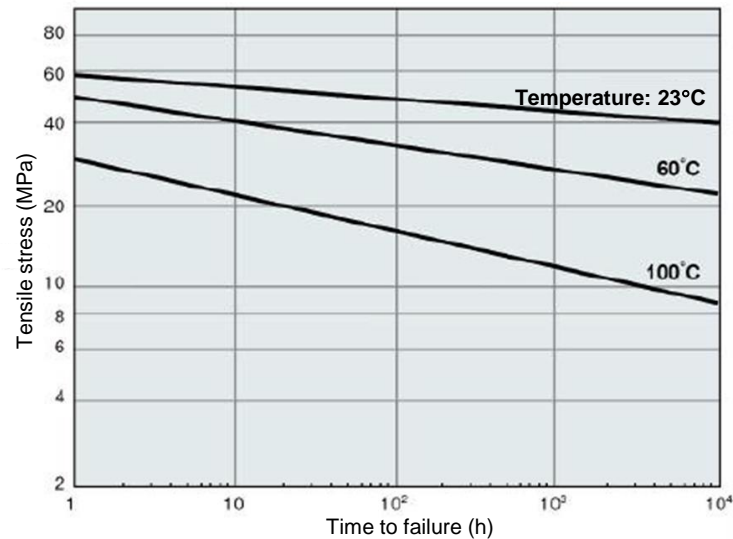
■ Flexural creep property of lupital™ (23°C)
Stress: 19.6 MPa (200 kgf/cm²)



■ Flexural stress relaxation characteristics of lupital™ (Standard Grade: F20, 23°C)



■ Tensile creep failure curve of lupital™ (Standard Grade: F20)



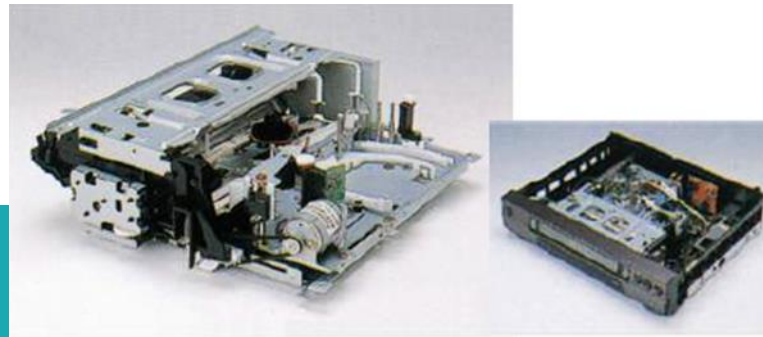
Anti-friction and anti-wear properties

Friction and wear resistance is one of the main features of Lupital™, together with fatigue and creep resistance. Lupital™ is ideal for use in gears, bearings, and other sliding mechanism components that require friction and wear resistance. Lupital™ exhibits excellent durability under severe conditions. For applications that require higher levels of friction and wear resistance, various “Lubricated Grades” are available depending on the performance requirements.

The FX-11 (J) grade is effective for improving the sliding performance and reducing noise when both matching parts (e.g., gears) are Lupital™.



Copier gears



VTR front loading system



Door check shoes

Color inkjet printer

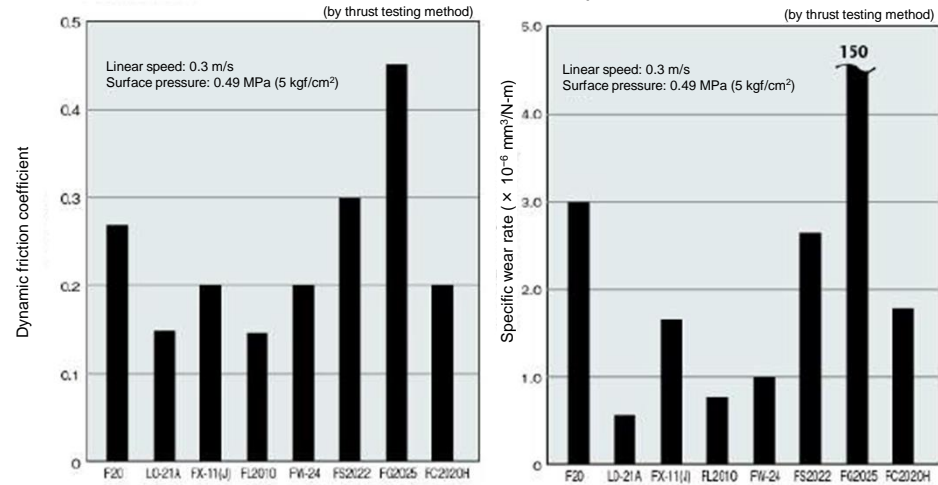


Gear shift clip



Anti-friction and anti-wear properties

Anti-friction and anti-wear properties of each grade of lupital™ [against steel (S45C)]

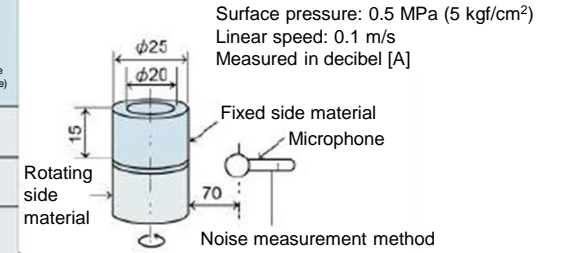


Friction and wear properties of lupital™ FX-11(J) grade (when both mating parts are lupital™)

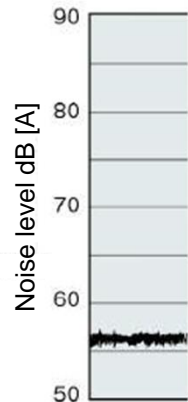
1. Dynamic friction coefficient and specific wear rate

Item	Test Conditions		FX-11(J) vs. FX-11(J)	F20 vs. F20 (both parts are Standard Grade)
	Surface pressure MPa (kgf/cm ²)	Linear speed m/s (cm/sec)		
Dynamic friction coefficient	0.25 (2.5)	0.1 (10)	0.13	0.42
	0.74 (7.5)		0.10	Melted
	1.23 (12.5)		0.12	—
	1.72 (17.5)		0.08	—
Specific wear rate X 10 ⁻⁶ mm ³ /N·m (X 10 ⁻² mm ³ /kgf·km)	0.05 (0.5)	0.3 (30)	<1 (<1)	120 (120)
	0.15 (1.5)		2 (2)	130 (130)

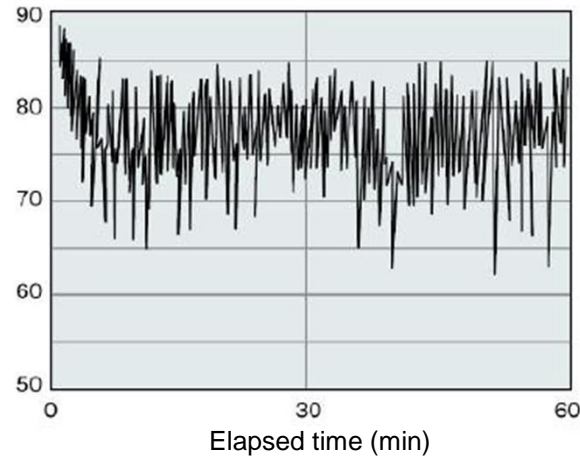
2. Sliding noise



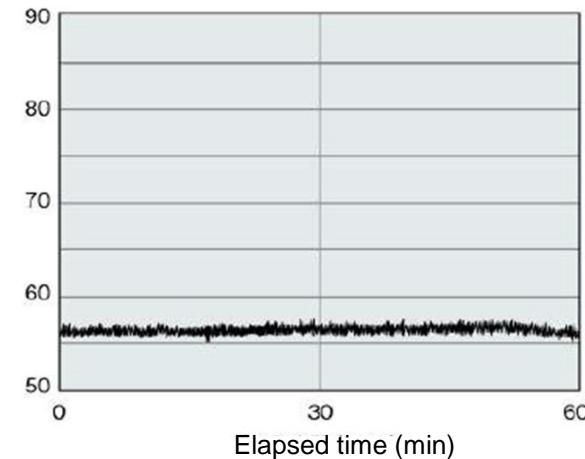
Background noise



F20 vs. F20



FX-11 (J) vs. FX-11 (J)



Molded lupital™ parts have excellent dimensional stability over long period.

After the post-shrinkage immediately after molding (depends on the mold temperature, etc. but usually completed within 2 to 3 days at longest), there is little change in dimensions even after one year if used at room temperature. Additionally, lupital™ has a low water absorption rate, and the dimensional change is negligible even under humid environment.

lupital™ can be used safely for ultra-precision parts such as high-precision gears.

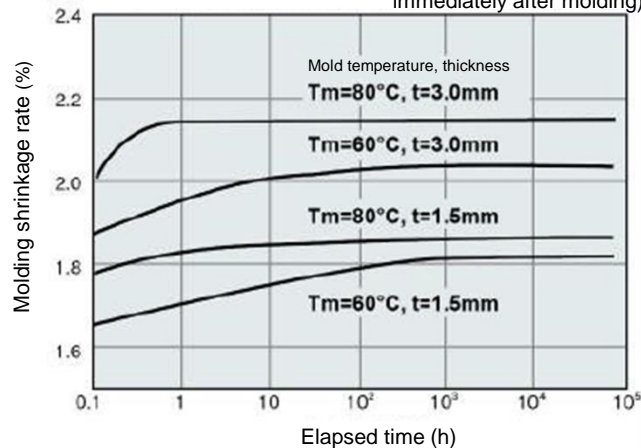
Clock mechanism



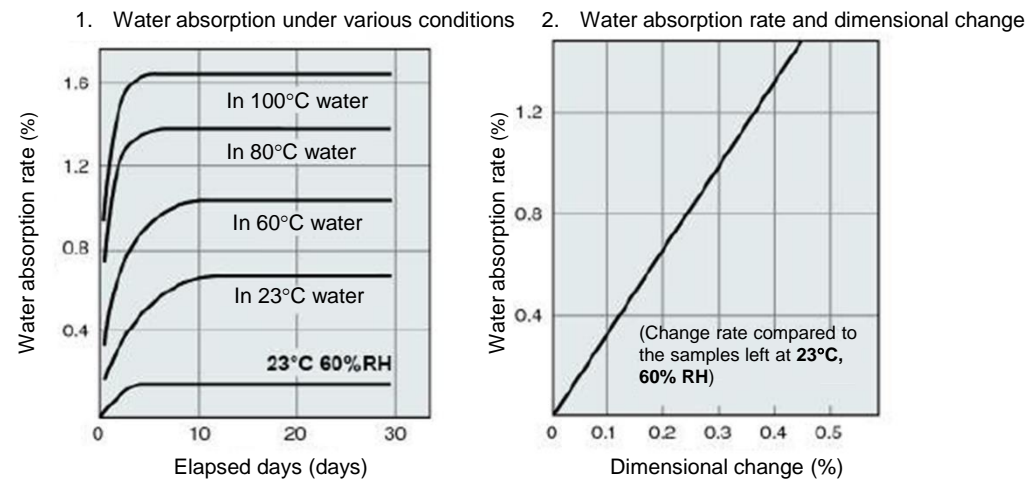
Watch mechanism



■ Long-term dimensional change of lupital™ (Standard Grade: 23°C)
(Long-term change in φ 30-mm disk due to shrinkage from immediately after molding)



■ Water absorption rate and dimensional change of lupital™ (Standard Grade)



lupital™ has high heat resistance including Temperature of Deflection Under Load (DTUL) and maintains its original mechanical strength for a long time even at high temperatures.
lupital™ is also suitable for high-temperature applications such as parts around automobile engines and heater fans.

Heater control unit mechanism



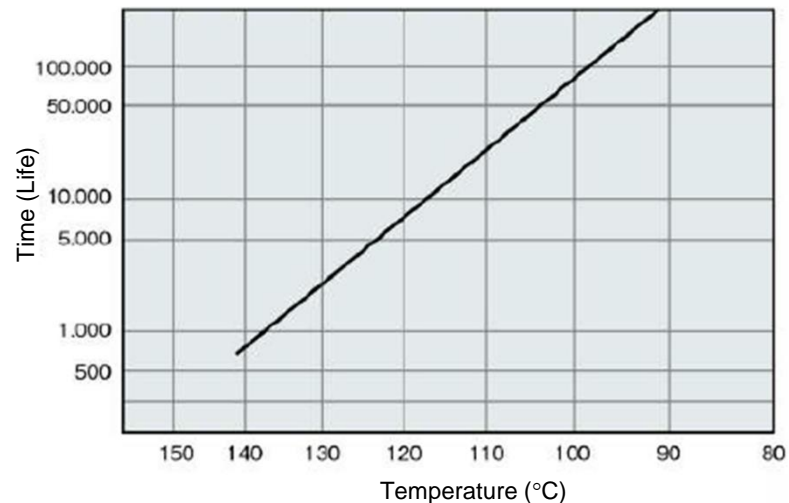
Brake booster piston relay



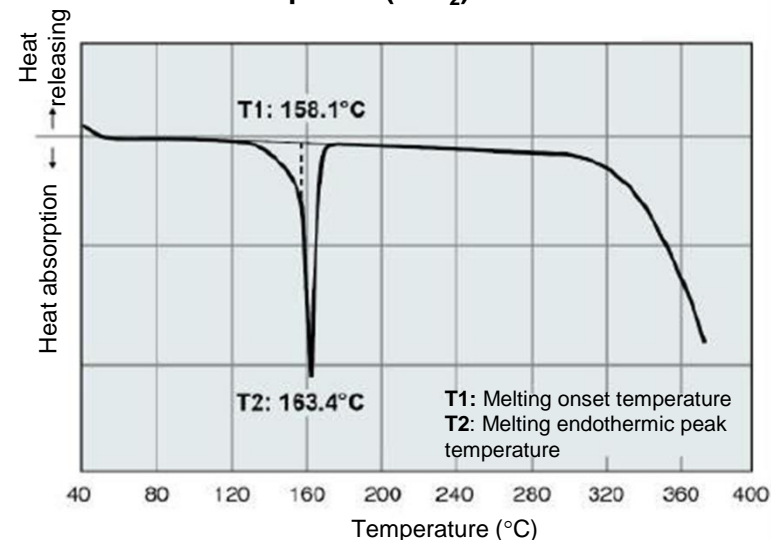
Heater fan



■ Temperature and time (life) of retaining 90% tensile strength in lupital™ (Standard Grade)



■ DSC curve of lupital™ (in N₂)



Chemical resistance

lupital™ exhibits outstanding strength against various chemicals.

lupital™ is particularly resistant to organic solvents, gasoline, oil, grease, and synthetic detergents while having strong resistance to hydrochloric and sulfuric acids (except for strong acids), and can be used safely for an extended period.

lupital™ is suitable for applications where contact with a wide range of chemicals and oils is assumed, such as automotive parts, fuel pumps, and oil/grease lubricated gears.



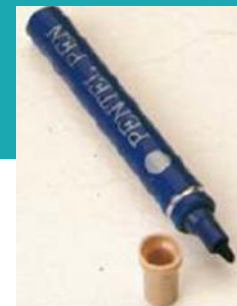
Fuel pump unit



Gasoline fuel cap



Water distribution port



Marker pen caps



One-touch pipe joints

Physical property change of lupital™ in chemicals (Standard Grade)

(Physical property change: The retention rate from the initial value as 100% is used for tensile strength and elongation at break; the change rate from the initial value is used for weight and dimensions.)

Compatibility classification... ⊕ Can be used without any problem, ○ Can be used under non-severe conditions, △ Can be used only for short period under normal temperature and no stress, × Not usable

Chemical name	Temperature (°C)	Immersion time	Change in physical properties				Compatibility
			Retention rate (%)		Change rate (%)		
			Tensile strength	Elongation at break	Weight	Dimension	
1. Organic solvent							
Methanol	50	365	88	130	1.75	0.96	⊕
Ethanol	50	365	89	128	1.65	0.92	⊕
Acetone	23	365	83	175	3.75	1.90	⊕ Slightly swollen
Toluene	50	365	90	119	2.90	1.50	⊕
Methyl ethyl ketone	23	365	85	161	3.46	1.72	⊕ Slightly swollen
Trichloroethylene	23	39	86	155	5.20	1.30	⊕ Slightly swollen
Carbon tetrachloride	23	365	98	139	1.54	0.29	⊕
Ethylene glycol	120	20	89	96	-	-	⊕
Acetic acid, 1% aqueous solution	23	365	101	93	0.22	0.20	⊕
2. Inorganic chemical							
Sulfuric acid, 1% aqueous solution	23	180	100	68	0.34	0.13	○
Hydrochloric acid, 10% aqueous solution	40	20	100	48	-0.79	0.14	△ Long-term: ×
Sodium hydroxide, 10% aqueous solution	23	365	102	88	-0.02	0.00	○ High temperature: △
Sodium hypochlorite (effective chlorine: 3 ppm)	23	180	100	66	-0.43	-	○
3. Gasoline							
Regular gasoline	50	365	92	100	1.31	0.68	⊕
Diesel oil	50	40	103	104	0.09	-0.04	⊕
Gasohol (CM20)	50	365	85	142	2.77	1.49	⊕ Slightly swollen
Gasohol (CE20)	50	365	86	138	2.57	1.35	⊕ Slightly swollen

Physical property change of lupital™ in chemicals (Standard Grade)

(Physical property change: The retention rate from the initial value as 100% is used for tensile strength and elongation at break; the change rate from the initial value is used for weight and dimensions.)

Compatibility classification... ⊙ Can be used without any problem, ○ Can be used under non-severe conditions, △ Can be used only for short period under normal temperature and no stress, × Not usable

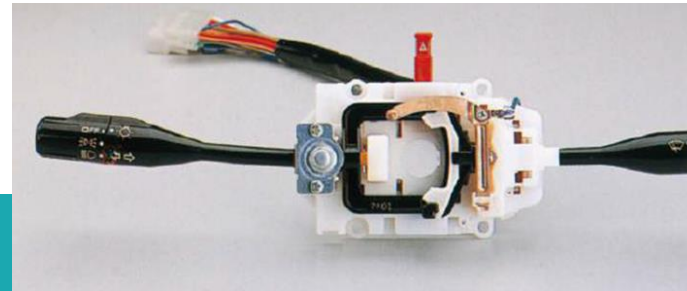
Chemical name	Temperature (°C)	Immersion time	Change in physical properties				Compatibility
			Retention rate (%)		Change rate (%)		
			Tensile strength	Elongation at break	Weight	Dimension	
4. Oil							
Nissan Brake Fluid 2500NR3	120	12	89	102	6.2	1.6	⊙
Toyota Brake Fluid DOT-3	120	12	89	112	5.9	1.4	⊙
Toyota ATF Special	120	12	100	98	0.3	-0.4	⊙
FUSO Engine Oil S3	120	12	103	113	-0.61	-0.42	⊙
Nissan Diesel Oil SAE30	120	12	104	83	-0.26	-0.56	⊙
5. Grease							
One Luber No. 2	100	40	105	95	-0.32	-0.27	⊙
Dow Corning FS-44MA	100	40	106	80	-0.41	-0.36	⊙
Cosmo LIMAX No. 2	120	12	101	110	0.52	0.59	⊙
6. Cutting fluid, etc.							
Yushiro cutting fluid EE56	23	180	100	124	0.12	0.1	⊙
Silicon oil	130	12	106	71	-0.43	-0.67	⊙
Vegetable oil	80	7	104	104	-	-	⊙
7. Other chemicals							
Diazo copier developer SD	23	60	96	100	-	-	⊙
Photo developer	50	40	95	112	2.12	0.75	⊙
Photo fixing solution	40	40	101	102	0.39	0.07	○ High temperature: △
Lion Mama Lemon	80	180	100	98	-0.05	-0.29	⊙
Kao Cuticle Care Shampoo	80	180	100	82	-1.23	-0.53	⊙
Kao Cuticle Care Conditioner	80	180	98	96	0.5	0.12	⊙
KINCHO U insecticide	23	7	100	100	-	-	⊙

The Standard Grade lupital™ can be used with no problem except when used outdoors or under harsh conditions such as constant exposure to direct sunlight.

We recommend the use of the Weather Resistant Grade for applications that require high weather (light) resistance, for example, parts that are constantly used outdoors or interior and exterior parts of automobiles.



Inner door handle



Combination switch casing

Window shade parts

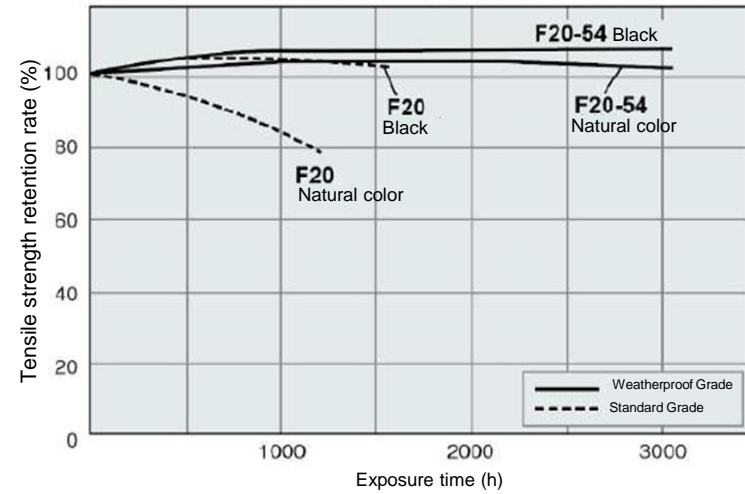


Seat adjustment lever



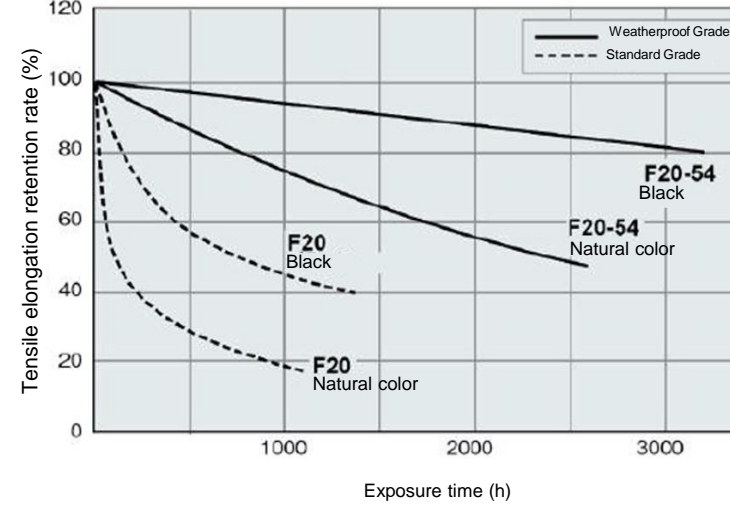
■ **Change in tensile strength of lupital™ by sunshine weather-ometer test**

(Black panel temperature: 83°C, No rain)



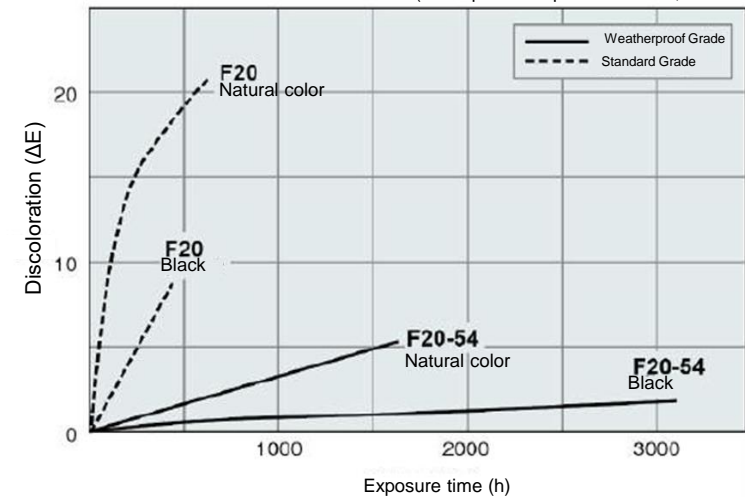
■ **Change in tensile elongation of lupital™ by sunshine weather-ometer test**

(Black panel temperature: 83°C, No rain)



■ **Color change of lupital™ in sunshine weather-ometer test**

(Black panel temperature: 83°C, No rain)



Iupital™ is also highly balanced in its electrical properties.

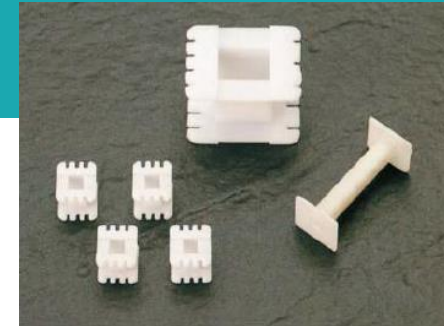
(For general electrical properties, refer to the chart “Main Properties of Each Grade”)

If static buildup is unfavorable or electric conductivity is required for your applications, please select the Antistatic Grade or the Electrically Conductive Grade.

Copier toner stirring



Coil bobbin



■ **Resistivity of Antistatic and Conductive Grades of Iupital™**

Property	Test Method	Unit	F20	F20-61	FC2020D	ET-35
	(ASTM)		(Standard Grade)			
Surface resistivity	D257	Ω	1.0x10 ¹⁶	1.5x10 ¹¹	2.0x10 ²	1.0x10 ²
Volume resistivity	D257	Ω·cm	1.0x10 ¹⁴	1.0x10 ¹⁴	2.0x10 ²	1.0x10 ²

lupital™ is readily molded by injection molding or other processing methods used for general thermoplastics. Particularly, lupital™ is one of the best among all engineering plastics in terms of “moldability” in injection molding. lupital™ can be molded at resin temperatures of around 200°C, the lowest for engineering plastics, while having high fluidity.

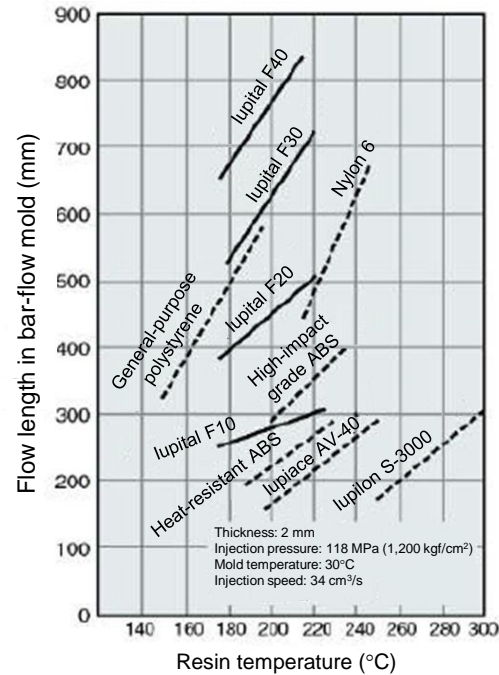


Hair dryer net

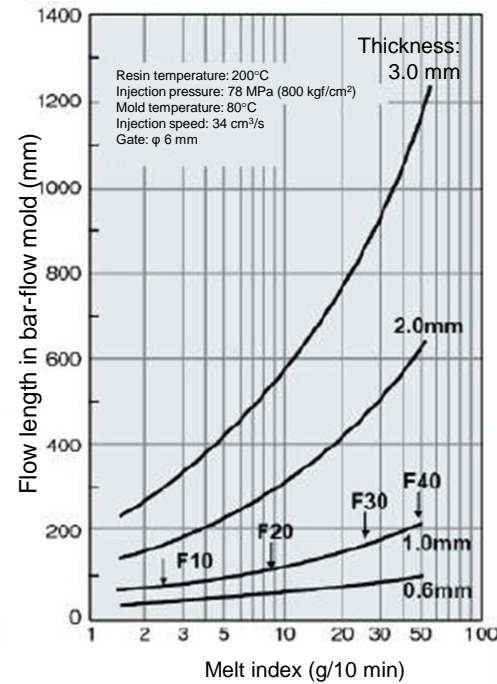


Speaker grills

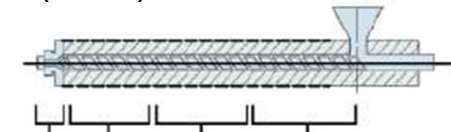
■ Flow characteristics of lupital™ and other resins in injection molding



■ Relationship between melt index and ■ Standard molding temperature conditions for each grade of lupital™ (Unit: °C)



Standard molding temperature conditions for each grade of lupital™ (Unit: °C)



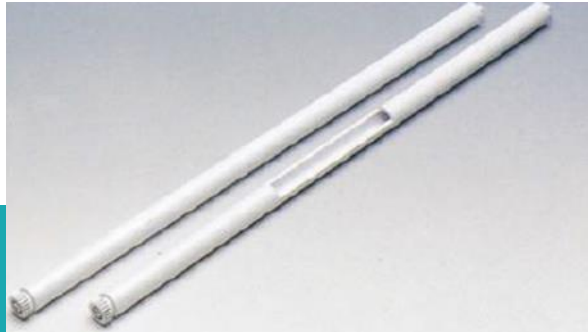
Grade	Nozzle	Cylinder front	Cylinder middle	Cylinder rear
Standard Grade		190	180	170
Weatherpro of Grade		190	180	170
FG,FB		200	190	170
FC	180 210	200	190	170
FT		190	180	170
FL,FW		190	180	170
LO,FX		190	180	170
FU		190	180	170
ET		190	180	170
TC		190	180	170

FU = Pre-drying at 80°C for 3 hours or more, Mold temperature 40°C or less
ET = Low injection speed

lupital™ has excellent thermal stability during molding.

This gives the following advantages unique to lupital™:

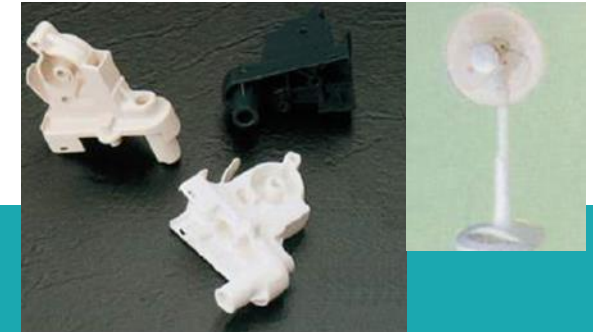
- Extremely little discoloration and deterioration even if it stays inside the molding machine.
- In recycling of materials in injection molding, the change in physical properties is very small even at a high recycling rate.
- The occurrence of mold deposits is reduced, enabling stable molding for a long period.



Gear rollers for fax machines



Camera mechanism components



Electric fan neck parts

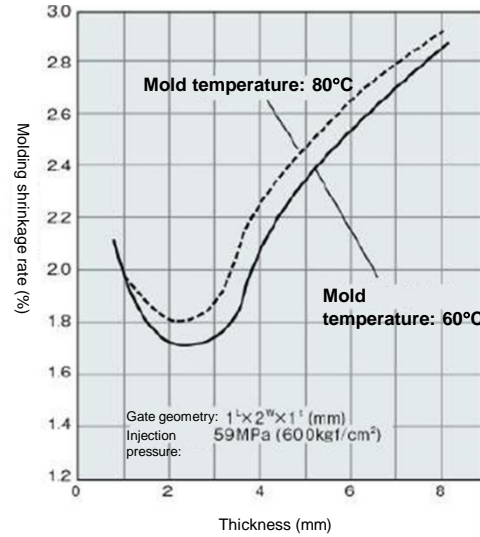
Hoist switch buttons



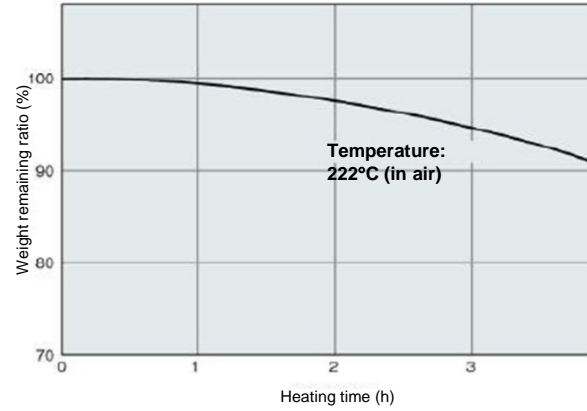
Cash register and PC keys



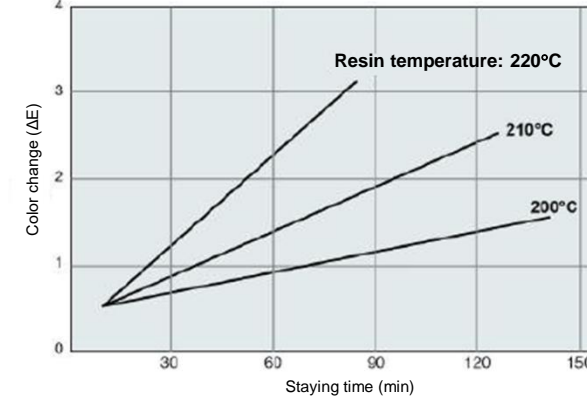
■ Relationship between part thickness and molding shrinkage rate of lupital™ Standard Grade (F20)



■ Weight loss characteristics of lupital™ by TGA (thermobalance)

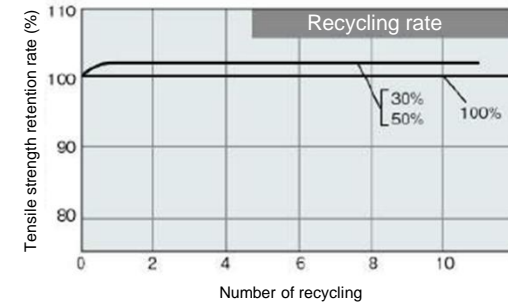


■ Color change of lupital™ due to staying inside molding machine (Standard Grade)

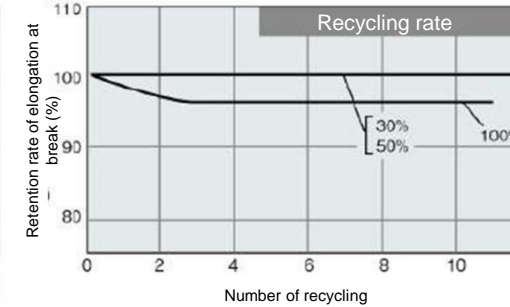


■ Number of recycling and physical property change of lupital™ (Standard Grade)

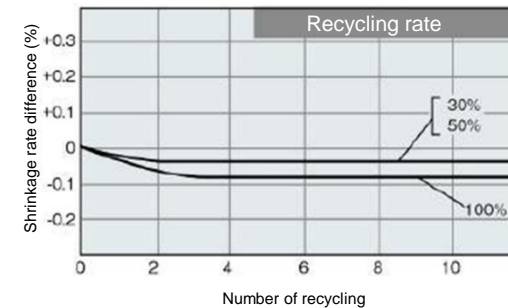
■ Change in tensile strength



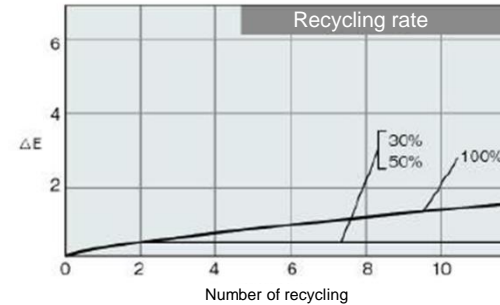
■ Change in tensile strength



■ Change in molding shrinkage rate



■ Color change



Iupital™ can be used with a wide range of secondary processing such as surface decoration and bonding.

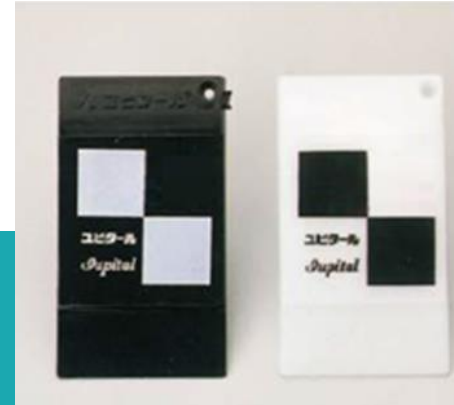
- Surface decoration: Printing, hot stamping, dyeing, sputtering, etc.
- Bonding: Press-fitting, self-tapping, ultrasonic bonding, heat sealing, adhesive bonding, etc.
- Machining: Cutting, die-cutting, etc.

These secondary processing may require unique prescriptions and processes depending on the type of processing. Please inquire with us for more information.



Floppy disk shutter
(Printing)

Counter wheels
(Hot stamping)



Print sample

Screw unit
(Cutting)



■ Lupital™ certified values according to UL

	Material designation	Color	Minimum thickness	UL94 flame class	Relative temperature index(°C)			Hot wire ignition	High ampere arc ignition	High voltage arc tracking rate	Arc resistance (D495)	Comparative tracking index
					Electric	Mechanical						
						with impact	without impact					
Standard / Non-Reinforced Grades	F10-(x2)+(d)	All	0.79	94HB	110	95	100	-	-	0	5	1
		All	1.57	94HB	115	95	100	4	0	0	5	1
		All	3.17	94HB	115	95	100	3	0	0	5	1
		All	6.35	94HB	115	95	100	3	0	0	5	1
	F20-(x2)+(d)	All	0.79	94HB	110	95	100	-	-	0	5	1
		All	1.57	94HB	120	95	100	4	0	0	5	1
		All	3.17	94HB	120	95	100	3	0	0	5	1
		All	6.35	94HB	120	95	100	3	0	0	5	1
	F25-(x2)+(d)	All	0.79	94HB	110	95	100	-	-	0	5	1
		All	1.57	94HB	115	95	100	4	0	0	5	1
		All	3.17	94HB	115	95	100	3	0	0	5	1
		All	6.35	94HB	110	95	100	3	0	0	5	1
	F30-(x2)+(d)	All	0.79	94HB	110	95	100	-	-	0	5	1
		All	1.57	94HB	115	95	100	4	0	0	5	1
		All	3.17	94HB	115	95	100	3	0	0	5	1
		All	6.35	94HB	115	95	100	3	0	0	5	1
	F40-(x2)+(d)	All	0.79	94HB	110	95	100	-	-	0	5	1
		All	1.57	94HB	115	95	100	4	0	0	5	1
		All	3.17	94HB	115	95	100	3	0	0	5	1
		All	6.35	94HB	115	95	100	3	0	0	5	1
	A25-(x1)+	All	0.79	94HB	50	50	50	-	-	-	-	-
	FV-30+	All	0.79	94HB	110	95	100	-	-	0	5	1
		All	1.57	94HB	115	95	100	4	0	0	5	1
		All	3.17	94HB	115	95	100	3	0	0	5	1
All		6.35	94HB	115	95	100	3	0	0	5	1	
F20-54+	All	0.79	94HB	50	50	50	-	-	-	-	-	
F20-61+	All	0.79	94HB	110	95	100	-	-	0	5	1	
	All	1.57	94HB	115	95	100	4	0	0	5	1	
	All	3.17	94HB	115	95	100	3	0	0	5	1	
	All	6.35	94HB	115	95	100	3	0	0	5	1	

■ Lupital™ certified values according to UL


	Material designation	Color	Minimum thickness	UL94 flame class	Relative temperature index(°C)			Hot wire ignition	High ampere arc ignition	High voltage arc tracking rate	Arc resistance (D495)	Comparative tracking index
					Electric	Mechanical with impact	Mechanical without impact					
Reinforced / Filled Grades	FG20(ee)+	All	0.79	94HB	105	95	100	-	-	0	6	1
		All	1.57	94HB	105	95	100	4	0	0	6	1
		All	3.17	94HB	105	95	100	3	0	0	6	1
	FG2025+	All	0.79	94HB	105	95	100	3	0	0	6	1
		All	1.57	94HB	105	95	100	3	0	0	6	1
		All	3.17	94HB	105	95	100	2	0	0	6	1
	FB20(cc)+	All	0.79	94HB	50	50	50	-	-	-	-	-
	FC20(cc)+	BK	0.79	94HB	50	50	50	-	-	-	-	-
FT20(uu)+	All	0.79	94HB	50	50	50	-	-	-	-	-	
Lubricated Grades	LO-2(#)+	All	0.79	94HB	50	50	50	-	-	-	-	-
	FX-1(y)+(d)+	All	0.79	94HB	50	50	50	-	-	-	-	-
		All	1.57	94HB	50	50	50	5	0	-	-	-
		All	3.17	94HB	50	50	50	5	0	0	4	0
	FL20(xx)+	All	0.79	94HB	50	50	50	-	-	-	-	-
	FW-2+	All	0.79	94HB	50	50	50	-	-	-	-	-
	WA-1Y+	All	0.79	94HB	50	50	50	-	-	-	-	-
Other modified grades	FU20(hh)(z)+	All	0.79	94HB	50	50	50	-	-	-	-	-
	TC30(ii)+	All	0.79	94HB	50	50	50	-	-	-	-	-

- (d) - Recognized for use up to 100% regrind.
- (x2) - May be replaced with two digits 00 - 49.
- + - Suffix optional, exceptions: The following cannot be used as optional suffixes: "T" for grade 2030, "A" for 1501, 1502, 1511, 1521 & 2502, "N" for NXG5050, NXG5030, NXG5501, & CGF-(v)(u), "S1" for F20-54.
- (x1) - May be replaced with two digits 00 - 10.
- (ee) - May be replaced by two digits to indicate glass content from 00 to 25%.
- (xx) - May be replaced with two digits.
- (cc) - May be replaced by two digits to indicate carbon content from 10 to 30%.
- (uu) - May be replaced by two digits to indicate filler content from 00 to 30%.
- (#) - May be replaced with one digit.
- (hh) - May be replaced by two digits to indicate polyurethane content from 00 to 50%.
- (z) - The material is recognized for flammability only. Consistent performance of all other critical properties cannot be assured, including but not limited to impact, strength, ignition, electrical and deformation.
- (y) - Replaced by one digit from 1 to 9.
- (ii) - May be replaced by two digits to indicate talc content from 00 to 30%.

- The data presented in this document are representative examples of the values measured by the test methods specified by our company according to the test methods cited in this document.
 - The application examples in this document do not guarantee the results of applying our company products to the applications described.
 - The industrial property rights and conditions of use related to the uses and applications described in this document shall be reviewed at the discretion of your company.
 - When handling our products (transportation, storing, molding, disposal, etc.), refer to technical documents and Safety Data Sheet (SDS) for the materials and grades to be used. Particularly, for use in food containers and packaging, medical parts, safety devices, children's toys, or the like, please consult us separately.
 - In Japan, the colored products of each of our grades may contain chemical substances subject to notify their names, etc. as per Appended Table 9 of Article 18-2 of the Order for Enforcement of Industrial Safety and Health Act based on the Article 57-2 of Industrial Safety and Health Act, which is the applicable law.
Please contact us for details.
 - When exporting our products and the products containing our products, we ask that you comply with relevant orders such as Foreign Exchange and Foreign Trade Act
 - The chemical substances used in our products are regulated by the chemical substance control system of each country, and a separate application may be required or import and export may not be possible. If you are an exporter or importer of our company products, please inquire about the regulatory compliance in the countries concerned.
- * Please note that the contents of this document are subject to change without notice due to revision.

Property Tables

* The data in the physical property table are representative of the measured values based on the test method.

				Standard/Non-Reinforced Grades									High Rigidity/Non-Reinforced Grade				
				Test Method	Test Conditions	Unit	F10-01 F10-02	F20-03 F20-05	F25-03 F25-05	F30-03 F30-05	F40-03 F40-05	F20-54	F20-61	FV-30	FRC-20	A10-03 A10-05	A25-03 A25-05
							High viscosity	Medium viscosity	Medium viscosity	Low viscosity	Low viscosity	Improved weather resistance	Antistatic	High flowAntistatic	Resistance to chlorine water	High rigidityHigh viscosity	High rigidityMedium viscosity
				-01: Extrusion Grade -02: Injection General Grade	General -	General -	General -	General -	General -	General -	General -	General -	General -	General -			
Physical properties																	
Density	ISO 1183	-	g/cm ³	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.39	1.41	1.41			
Water absorption rate	-	23°C, 60%RH	%	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.29	0.22	0.22			
Rheological properties																	
Melt mass flow rate	ISO 1133	Measurement temperature	g/10 min	2.5	9.0	16	27	52	9.0	9.0	31	-	2.5	14			
Melt volume rate			cm ³ /10 min	2.2	7.7	14	23	45	7.7	7.7	27	8.3	2.2	12			
			°C	190	190	190	190	190	190	190	190	190	190	190	190		
			Measurement load	kg	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16		
Molding shrinkage rate (3 mm)	-	MD TD	%	2.2 -	2.0 -	2.0 -	2.0 -	2.0 -	2.0 -	2.0 -	2.0 -	2.0 -	2.2 -	2.1 -			
Mechanical properties																	
Tensile modulus	ISO 527-1, 527-2	-	MPa	2800	2900	2900	2900	2900	2800	2800	2800	-	2900	3050			
Yield stress			63	64	64	64	64	62	63	63	63	57	67	69			
Yield strain			10	8.5	8.0	7.5	7.0	8.5	8.5	8.5	8.5	-	9.0	11.0			
Nominal strain at break			33	30	27	25	20	30	30	30	30	42	35	35			
Stress at break			MPa	-	-	-	-	-	-	-	-	-	-	-			
Strain at break	%	-	-	-	-	-	-	-	-	-	-	-					
Flexural strength	ISO 178	-	MPa	89	90	90	91	91	88	88	88	77	94	98			
Flexural modulus				2500	2600	2600	2700	2700	2500	2500	2500	2500	2300	2750	2950		
Charpy impact strength	ISO 179-1, 179-2	23°C	kJ/m ²	280	250	200	150	100	240	230	150	-	280	250			
Charpy impact strength, Un-notched				8.0	7.0	6.5	6.0	5.0	6.5	6.0	6.0	6.0	8.0	8.0	8.0		
Charpy impact strength, Notched		23°C	kJ/m ²														
Thermal properties																	
Melting temperature	ISO 11357-3		°C	166	166	166	166	166	166	166	166	165	168	170			
Load deflection temperature	ISO 75-1, 75-2	1.80 MPa	°C	100	100	100	100	100	100	100	100	94	104	105			
		0.45 MPa	156	156	156	156	156	156	156	156	156	-	158	160			
Linear expansion coefficient	ISO 11359-2	MD	1/°C	1.1E-04	1.1E-04	1.1E-04	1.1E-04	1.1E-04	1.1E-04	1.1E-04	1.1E-04	-	1.1E-04	1.1E-04			
		TD	1.1E-04	1.1E-04	1.1E-04	1.1E-04	1.1E-04	1.1E-04	1.1E-04	1.1E-04	1.1E-04	-	1.1E-04	1.1E-04			
Flammability	UL94	0.8 mmt	-	HB	HB	HB	HB	HB	HB	HB	HB	-	HB	HB			
Electrical properties																	
Relative permittivity	IEC 60250	100Hz	-	3.9	3.9	3.9	3.9	3.9	-	-	-	-	-	-			
		1 MHz	3.9	3.9	3.9	3.9	3.9	3.9	-	-	-	-	-	-			
Dielectric dissipation factor	IEC 60250	100Hz	-	0.002	0.002	0.002	0.002	0.002	-	-	-	-	-	-			
		1 MHz	0.007	0.007	0.007	0.007	0.007	0.007	-	-	-	-	-	-			
Volume resistivity	IEC 60093	-	Ω·m	1.E + 12	1.E + 12	1.E + 12	1.E + 12	1.E + 12	1.E + 12	1.E + 11	1.E + 11	-	1.E + 12	1.E + 12			
Surface resistivity	IEC 60093	-	Ω	1.E + 16	1.E + 16	1.E + 16	1.E + 16	1.E + 16	1.E + 16	1.E + 13	1.E + 13	-	1.E + 16	1.E + 16			
Withstand voltage	IEC 60243-1	1 mmt	MV/m	32	32	32	32	32	-	-	-	-	-	-			
		3 mmt	19	19	19	19	19	19	-	-	-	-	-	-			
Tracking resistance	IEC 60112	-	-	600	600	600	600	600	-	-	-	-	-	-			

Return				Reinforced/Filled Grades										
				FG2010	FG2020	FG2025	FG2030	MF3020	FB2025	FC2020D	FC2020H	FT2010	FT2020	
				Glass-filled	Glass-filled	Glass-filled	Glass-filled	Glass-filled	Glass-filled	Electrical conductivity	High rigidity	Whisker-filled	Whisker-filled	
				Glass fiber	Glass fiber	Glass fiber	Glass fiber	Milled fiber	Glass bead	Carbon fiber	Carbon fiber	Whisker	Whisker	
Item	Test Method	Test Conditions	Unit	10%	20%	25%	30%	20%	25%	20%	20%	10%	20%	
Physical properties														
Density	ISO 1183	-	g/cm ³	1.48	1.55	1.59	1.64	1.55	1.59	1.46	1.46	1.49	1.59	
Water absorption rate	-	23°C, 60%RH	%	0.20	0.20	0.20	0.20	0.20	0.20	0.36	0.28	0.23	.23	
Rheological properties														
Melt mass flow rate	ISO 1133	Measurement temperature Measurement load	g/10 min	-	-	9.0	-	20	5.0	3.5	6.0	7.5	5.5	
Melt volume rate			cm ³ /10 min	10.0	7.0	6.3	4.0	15	3.8	3.2	5.4	5.9	4.0	
			°C	190	190	190	190	190	190	190	190	190	190	190
			kg	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	
Molding shrinkage rate (3 mmt)	-	MD TD	%	1.4 -	0.8 -	0.6 -	0.3 -	1.7 -	1.6 -	0.4 -	0.4 -	1.7 -	0.9 -	
Mechanical properties														
Tensile modulus	ISO 527-1, 527-2	-	MPa	-	-	10000	-	4500	4000	17000	17000	5200	7800	
Yield stress				-	-	-	-	-	-	-	-	-	-	-
Yield strain				%	-	-	-	-	-	-	-	-	-	-
Nominal strain at break					-	-	-	-	-	-	-	-	-	-
Stress at break				MPa	90	120	140	150	60	60	130	170	73	87
Strain at break		%	4.0	3.0	3.0	2.0	4.0	6.0	1.5	2.0	5.5	4.5		
Flexural strength	ISO 178	-	MPa	140	190	210	220	100	100	200	270	120	160	
Flexural modulus				4600	7500	9100	11000	3900	3700	16000	16000	4800	7600	
Charpy impact strength Charpy impact strength, Un-notched	ISO 179-1, 179-2	23°C	kJ/m ²	-	-	60	55	40	60	-	-	90	50	
Charpy impact strength Charpy impact strength, Notched		23°C	kJ/m ²	7.0	9.0	9.0	9.0	4.0	4.0	-	-	5.0	4.0	
Thermal properties														
Melting temperature	ISO 11357-3		°C	166	166	166	166	166	166	166	166	166	166	
Load deflection temperature	ISO 75-1, 75-2	1.80 MPa	°C	160	161	162	163	118	115	162	162	140	154	
		0.45 MPa		-	164	164	164	164	160	158	164	164	160	163
Linear expansion coefficient	ISO 11359-2	MD	1/°C	-	-	3.0E-05	2.0E-05	-	-	-	1.5E-05	-	-	
		TD		-	-	1.1E-04	9.6E-05	-	-	-	1.1E-04	-	-	
Flammability	UL94	0.8 mmt	-	HB	HB	HB	HB	HB	HB	HB	HB	HB	HB	
Electrical properties														
Relative permittivity	IEC 60250	100Hz	-	-	-	4.1	-	-	-	-	-	-	-	
		1 MHz		-	-	-	4.1	-	-	-	-	-	-	
Dielectric dissipation factor	IEC 60250	100Hz	-	-	-	0.003	-	-	-	-	-	-	-	
		1 MHz		-	-	-	0.008	-	-	-	-	-	-	
Volume resistivity	IEC 60093	-	Ω·m	-	-	1.E + 12	1.E + 12	-	-	2.E + 00	2.E + 03	-	-	
Surface resistivity	IEC 60093	-	Ω	-	-	1.E + 16	1.E + 16	-	-	2.E + 02	5.E + 05	-	-	
Withstand voltage	IEC 60243-1	1 mmt	MV/m	-	-	25	-	-	-	-	-	-	-	
		3 mmt		-	-	16	-	-	-	-	-	-	-	
Tracking resistance	IEC 60112	-	-	-	-	600	-	-	-	-	-	-	-	

Return Item	Test Method	Test Conditions	Unit	Inorganic filler Grades				
				ET-20	ET-35	TC3015	TC3030	
				Electrical conductivity	Electrical conductivity	Inorganic filler	Inorganic filler	
				Conductive carbon	Conductive carbon	Inorganic	Inorganic	
				-	-	15%	30%	
Physical properties								
Density	ISO 1183	-	g/cm ³	1.41	1.41	1.52	1.63	
Water absorption rate	-	23°C, 60%RH	%	0.22	0.35	0.21	0.20	
Rheological properties								
Melt mass flow rate	ISO 1133	Measurement temperature	g/10 min	11	-	11	9.5	
Melt volume rate			cm ³ /10 min	9.5	1.4	8.3	6.9	
			°C	190	190	190	190	
			Measurement load	kg	2.16	2.16	2.16	2.16
Molding shrinkage rate (3 mmt)	-	MD TD	%	1.6 -	2.2 2.3	1.9 -	1.5 -	
Mechanical properties								
Tensile modulus	ISO 527-1,527-2	-	MPa	2700	2700	4900	6900	
Yield stress				-	-	51	-	-
Yield strain				%	-	-	-	-
Nominal strain at break					-	7.5	-	-
Stress at break				MPa	45	-	54	62
Strain at break				%	4.0	-	4.0	3.0
Flexural strength	ISO 178	-	MPa	70	86	103	111	
Flexural modulus				2400	2700	4600	7000	
Charpy impact strength Charpy impact strength, Un-notched	ISO 179-1,179-2	23°C	kJ/m ²	100	100	50	30	
Charpy impact strength Charpy impact strength, Notched		23°C	kJ/m ²	4.0	5.0	4.0	4.0	
Thermal properties								
Melting temperature	ISO 11357-3		°C	166	160	166	166	
Load deflection temperature	ISO 75-1, 75-2	1.80 MPa	°C	97	92	135	144	
		0.45 MPa		-	150	-	-	
Linear expansion coefficient	ISO 11359-2	MD	1/°C	1.1E-04	1.1E-04	7.0E-05	-	
		TD		1.1E-04	1.1E-04	7.0E-05	-	
Flammability	UL94	0.8 mmt	-	HB	HB	HB	HB	
Electrical properties								
Relative permittivity	IEC 60250	100Hz	-	-	-	-	-	
		1 MHz	-	-	-	-	-	
Dielectric dissipation factor	IEC 60250	100Hz	-	-	-	-	-	
		1 MHz	-	-	-	-	-	
Volume resistivity	IEC 60093	-	Ω·m	-	3.E-01	-	-	
Surface resistivity	IEC 60093	-	Ω	6.E + 01	8.E-01	-	-	
Withstand voltage	EC 60243-1	1 mmt	MV/m	-	-	31	-	
		3 mmt		-	-	-	-	
Tracking resistance	IEC 60112	-	-	-	-	600	-	

Return Item	Test Method	Test Conditions	Unit	High Sliding Grades					
				LO-21A	FX-11	FX-11J	WA-11H	FL2010	FL2020
				High slidingSpecialized for use with metal/dissimilar resin	High slidingMedium viscosity	High slidingLow viscosity	High slidingHigh rigidityLow viscosity	High sliding	High sliding
				Lubricant type	Lubricant type	Lubricant type	Lubricant type	Fluororesin	Fluororesin
				-	-	-	-	10%	20%
Physical properties									
Density	ISO 1183	-	g/cm ³	1.39	1.39	1.39	1.39	1.46	1.51
Water absorption rate	-	23°C, 60%RH	%	0.22	0.22	0.22	0.22	0.19	0.18
Rheological properties									
Melt mass flow rate	ISO 1133	Measurement temperature Measurement load	g/10 min	10	10	53	29	7.5	6.0
Melt volume rate			cm ³ /10 min	8.6	8.6	46	25	6.1	4.7
			°C	190	190	190	190	190	190
			kg	2.16	2.16	2.16	2.16	2.16	2.16
Molding shrinkage rate (3 mm)	-	MD TD	%	2.0 -	2.1 -	2.1 -	2.1 -	2.0 -	2.1 -
Mechanical properties									
Tensile modulus	ISO 527-1, 527-2	-	MPa	2700	2700	2700	2900	2650	2400
Yield stress				56	55	55	58	52	44
Yield strain			%	9.0	9.0	7.5	8.0	8.0	8.0
Nominal strain at break				40	35	25	21	18	15
Stress at break			MPa	-	-	-	-	-	-
Strain at break			%	-	-	-	-	-	-
Flexural strength	ISO 178	-	MPa	80	81	81	89	77	67
Flexural modulus				2500	2500	2500	2800	2400	2200
Charpy impact strength	ISO 179-1, 179-2	23°C	kJ/m ²	150	200	100	150	60	50
Charpy impact strength, Un-notched									
Charpy impact strength	ISO 179-1, 179-2	23°C	kJ/m ²	7.0	7.0	5.0	5.0	5.0	5.0
Charpy impact strength, Notched									
Thermal properties									
Melting temperature	ISO 11357-3		°C	166	166	166	170	166	166
Load deflection temperature	ISO 75-1, 75-2	1.80 MPa	°C	100	95	95	100	97	96
		0.45 MPa		156	156	156	-	154	151
Linear expansion coefficient	ISO 11359-2	MD	1/°C	1.1E-04	1.1E-04	1.1E-04	1.1E-04	1.1E-04	-
		TD		1.1E-04	1.1E-04	1.1E-04	1.1E-04	1.1E-04	-
Flammability	UL94	0.8 mmt	-	HB	HB	HB	-	HB	HB
Electrical properties									
Relative permittivity	IEC 60250	100Hz	-	-	-	-	-	-	-
		1 MHz		-	-	-	-	-	-
Dielectric dissipation factor	IEC 60250	100Hz	-	-	-	-	-	-	-
		1 MHz		-	-	-	-	-	-
Volume resistivity	IEC 60093	-	Ω·m	1.E + 12	1.E + 12	1.E + 12	1.E + 12	1.E + 12	1.E + 12
Surface resistivity	IEC 60093	-	Ω	1.E + 16	1.E + 16	1.E + 16	1.E + 16	1.E + 16	1.E + 16
Withstand voltage	IEC 60243-1	1 mmt	MV/m	30	36	36	-	25	-
		3 mmt		18	19	19	-	16	-
Tracking resistance	IEC 60112	-	-	600	600	600	-	600	-

Return				Impact-Resistant/Flexible Grades										
				FU2005	FU2015	FU2020	FU2025	FU2050	ST2000	ST1800	ST1700	ST1600		
Item	Test Method	Test Conditions	Unit	FlexibleImpact-resistant	FlexibleImpact-resistant	FlexibleImpact-resistant	FlexibleImpact-resistant	FlexibleImpact-resistant	FlexibleImpact-resistant	FlexibleImpact-resistant	FlexibleImpact-resistant	FlexibleImpact-resistant	FlexibleImpact-resistant	
				TPU	TPU	TPU	TPU	TPU	Elastomer	Elastomer	Elastomer	Elastomer		
				5%	15%	20%	25%	50%	-	-	-	-		
Physical properties														
Density	ISO 1183	-	g/cm ³	1.40	1.37	1.36	1.35	1.29	1.35	1.32	1.31	1.29		
Water absorption rate	-	23°C, 60%RH	%	-	-	-	-	-	-	-	-	-	-	
Rheological properties														
Melt mass flow rate	ISO 1133	Measurement temperature	g/10 min	8.6	6.7	6.2	6.0	4.5	5.6	5.0	4.3	3.2		
Melt volume rate			cm ³ /10 min	7.0	5.5	5.4	5.2	3.9	4.2	3.8	3.3	2.5		
			°C	190	190	190	190	190	190	190	190	190	190	
			Measurement load	kg	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16
Molding shrinkage rate (3 mmt)	-	MD	%	-	-	-	1.7	1.2	1.7	1.6	1.6	1.6	1.6	
		TD	%	-	-	-	-	-	1.8	1.8	1.8	1.8	1.7	
Mechanical properties														
Tensile modulus	ISO 527-1, 527-2	-	MPa	2422	1840	1670	1600	800	2200	2000	1900	1800		
Yield stress					57	44	41	39	24	47	44	41	37	
Yield strain					%	8.2	9.4	11	12	20	10	14	16	37
Nominal strain at break						35	45	> 100	> 100	> 200	60	50	60	100
Stress at break					MPa	-	-	-	-	-	-	-	-	-
Strain at break			%	-	-	-	-	-	-	-	-	-		
Flexural strength	ISO 178	-	MPa	78	60	54	48	24	66	60	57	52		
Flexural modulus				2215	1680	1490	1400	750	2000	1800	1700	1600		
Charpy impact strength	ISO 179-1, 179-2	23°C	kJ/m ²	270	NB	NB	NB	NB	NB	NB	NB	NB		
Charpy impact strength, Un-notched		23°C	kJ/m ²	7.5	8.5	11	19	65	14	14	16	21		
Charpy impact strength, Notched														
Thermal properties														
Melting temperature	ISO 11357-3		°C	166	166	166	166	166	166	166	166	166	166	
Load deflection temperature	ISO 75-1, 75-2	1.80 MPa	°C	87	74	69	76	64	80	76	74	71		
		0.45 MPa			150	143	132	-	-	148	142	138	133	
Linear expansion coefficient	ISO 11359-2	MD	1/°C	-	-	-	1.2E-04	-	1.2E-04	1.3E-04	1.3E-04	1.3E-04	1.3E-04	
		TD			-	-	-	1.2E-04	-	1.1E-04	1.3E-04	1.3E-04	1.4E-04	
Flammability	UL94	0.8 mmt	-	-	-	-	HB	HB	HB	HB	HB	HB	HB	
Electrical properties														
Relative permittivity	IEC 60250	100Hz	-	-	-	-	-	-	-	-	-	-	-	
		1 MHz			-	-	-	-	-	-	-	-	-	
Dielectric dissipation factor	IEC 60250	100Hz	-	-	-	-	-	-	-	-	-	-	-	
		1 MHz			-	-	-	-	-	-	-	-	-	
Volume resistivity	IEC 60093	-	Ω·m	-	-	-	-	-	-	-	-	-	-	
Surface resistivity	IEC 60093	-	Ω	-	-	-	-	-	-	-	-	-	-	
Withstand voltage	IEC 60243-1	1 mmt	MV/m	-	-	-	-	-	-	-	-	-	-	
		3 mmt			-	-	-	-	-	-	-	-	-	
Tracking resistance	IEC 60112	-	-	-	-	-	-	-	-	-	-	-	-	

Return	Item	Test Method	Test Conditions	Unit	Standards-Compliant Grades							
					F10-EW	F20-EW	FG2025 MZ	MAS20	MAS30	MAH25	MAL20	MAL40
					High viscosityCompliant to drinking water standards	Medium viscosityCompliant to drinking water standards	Glass-filledCompliant to drinking water standards	Medium viscosityCompliant to medical standards	Low viscosityCompliant to medical standards	Medium viscosityHigh rigidityCompliant to medical standards	Medium viscosityHigh slidingCompliant to medical standards	Low viscosityHigh slidingCompliant to medical standards
					General	General	Glass fiber	General	General	General	Lubricant type	Lubricant type
					-	-	25%	-	-	-	-	-
Physical properties												
Density	ISO 1183	-	g/cm ³	1.41	1.41	1.59	1.41	1.41	1.41	1.39	1.39	
Water absorption rate	-	23°C, 60%RH	%	0.22	0.22	0.20	0.22	0.22	0.22	0.22	0.22	
Rheological properties												
Melt mass flow rate	ISO 1133	Measurement temperature	g/10 min	-	-	-	9.0	27	14	10	53	
Melt volume rate			cm ³ /10 min	2.5	7.7	6.3	7.7	23	12	8.6	46	
			°C	190	190	190	190	190	190	190	190	
			kg	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	
Molding shrinkage rate (3 mmt)	-	MD	%	-	2.0	0.6	2.0	2.0	2.1	2.1	2.1	
		TD		-	-	-	-	-	-	-	-	
Mechanical properties												
Tensile modulus	ISO 527-1, 527-2	-	MPa	2750	2900	9800	2900	2900	3050	2700	2700	
Yield stress			62	64	-	64	64	69	55	55		
Yield strain			%	10.0	8.5	-	8.5	7.5	11.0	9.0	7.5	
Nominal strain at break			35	30	-	30	25	35	35	25		
Stress at break			MPa	-	-	135	-	-	-	-		
Strain at break			%	-	-	3.0	-	-	-	-		
Flexural strengthFlexural modulus	ISO 178	-	MPa	88	90	200	90	91	98	81	81	
				2450	2600	8800	2600	2700	2950	2500	2500	
Charpy impact strength	ISO 179-1, 179-2	23°C	kJ/m ²	-	250	60	250	150	250	200	100	
Charpy impact strength, Un-notched												
Charpy impact strength, Notched		23°C	kJ/m ²	8.0	7.0	9.0	7.0	6.0	8.0	7.0	5.0	
Thermal properties												
Melting temperature	ISO 11357-3		°C	165	166	166	166	166	170	166	166	
Load deflection temperature	ISO 75-1, 75-2	1.80 MPa	°C	100	100	162	100	100	105	95	95	
		0.45 MPa	°C	-	-	164	156	156	160	156	156	
Linear expansion coefficient	ISO 11359-2	MD	1/°C	1.1E-04	1.1E-04	3.0E-05	1.1E-04	1.1E-04	1.1E-04	1.1E-04	1.1E-04	
		TD		1.1E-04	1.1E-04	1.1E-04	1.1E-04	1.1E-04	1.1E-04	1.1E-04	1.1E-04	
Flammability	UL94	0.8 mmt	-	HB	HB	HB	HB	HB	HB	HB	HB	
Electrical properties												
Relative permittivity	IEC 60250	100Hz	-	-	-	-	3.9	3.9	-	-	-	
		1 MHz	-	-	-	-	3.9	3.9	-	-	-	
Dielectric dissipation factor	IEC 60250	100Hz	-	-	-	-	0.002	0.002	-	-	-	
		1 MHz	-	-	-	-	0.007	0.007	-	-	-	
Volume resistivity	IEC 60093	-	Ω·m	-	-	-	1.E + 12	1.E + 12	1.E + 12	1.E + 12	1.E + 12	
Surface resistivity	IEC 60093	-	Ω	-	-	-	1.E + 16	1.E + 16	1.E + 16	1.E + 16	1.E + 16	
Withstand voltage	IEC 60243-1	1 mmt 3 mmt	MV/m	-	-	-	32	32	-	36	36	
				-	-	-	19	19	-	19	19	
Tracking resistance	IEC 60112	-	-	-	-	-	600	600	-	600	600	

				Low VOC Grades										
Return	Item	Test Method	Test Conditions	Unit	F20-73R1	F20-73R2	F30-73R1	F20-55R2	FX-11R1	FX-11JR1	FU2010R2	FU2020R2	ST1800R2	ST1700R2
					Medium viscosity	Medium viscosity	Low viscosity	Improved weather resistance	High sliding	High slidingLow viscosity	FlexibleImpact-resistant	FlexibleImpact-resistant	FlexibleImpact-resistant High weld adhesion	FlexibleImpact-resistant High weld adhesion
					Standard	Standard	Standard	Standard	Lubricant type	Lubricant type	TPU	TPU	Elastomer	Elastomer
					-	-	-	-	-	-	10%	20%	-	-
Physical properties														
Density	ISO 1183	-	g/cm ³	1.41	1.41	1.41	1.41	1.39	1.39	1.38	1.37	1.32	1.31	
Water absorption rate	-	23°C, 60%RH	%	0.22	0.22	0.22	-	-	-	-	-	-	-	
Rheological properties														
Melt mass flow rate	ISO 1133	Measurement temperature	g/10 min	9.1	-	27	-	-	-	-	-	6.8	5.0	4.3
Melt volume rate			cm ³ /10 min	7.9	7.9	23	7.7	9.0	45.0	6.0	5.8	3.8	3.3	
			°C	190	190	190	190	190	190	190	190	190	190	190
			Measurement load	kg	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16	2.16
Molding shrinkage rate (3 mmt)	-	MD	%	2.0	2.0	2.0	2.0	2.0	2.0	-	-	1.6	1.6	
		TD	%	2.0	-	-	-	-	-	-	-	1.8	1.8	
Mechanical properties														
Tensile modulus	ISO 527-1, 527-2	-	MPa	2900	2900	2900	-	2700	2700	-	-	2000	1900	
Yield stress			65	63	64	62	55	55	51	45	44	41		
Yield strain			%	8.5	9.0	7.5	8.5	9.0	7.5	10	11	14	16	
Nominal strain at break			30	30	26	30	35	26	50	65	50	60		
Stress at break			MPa	-	-	-	-	-	-	-	-	-		
Strain at break	%	-	-	-	-	-	-	-	-	-				
Flexural strength	ISO 178	-	MPa	91	89	91	90	82	81	70	61	60	57	
Flexural modulus			2610	2600	2700	2700	2500	2500	2000	1700	1800	1700		
Charpy impact strength	ISO 179-1, 179-2	23°C	kJ/m ²	250	-	150	-	-	-	NB	NB	NB	NB	
Charpy impact strength		23°C	kJ/m ²	7.0	7.0	6.0	6.5	7.0	5.0	9.0	12.0	14.0	16.0	
Charpy impact strength														
Charpy impact strength														
Charpy impact strength														
Thermal properties														
Melting temperature	ISO 11357-3		°C	166	166	166	166	166	166	166	166	166	166	
Load deflection temperature	ISO 75-1, 75-2	1.80 MPa	°C	100	100	100	100	95	95	87	82	76	74	
		0.45 MPa	156	156	156	-	156	156	-	-	142	138		
Linear expansion coefficient	ISO 11359-2	MD	1/°C	1.1E-04	1.1E-04	-	-	-	-	-	-	1.3E-04	1.3E-04	
		TD	1.1E-04	1.1E-04	-	-	-	-	-	-	-	1.3E-04	1.3E-04	
Flammability	UL94	0.8 mmt	-	HB	HB	HB	HB	HB	HB	HB	HB	HB	HB	
Electrical properties														
Relative permittivity	IEC 60250	100Hz	-	3.9	3.9	-	-	-	-	-	-	-	-	
		1 MHz	-	3.9	3.9	-	-	-	-	-	-	-	-	
Dielectric dissipation factor	IEC 60250	100Hz	-	0.0020	0.0020	-	-	-	-	-	-	-	-	
		1 MHz	-	0.0070	0.0070	-	-	-	-	-	-	-	-	
Volume resistivity	IEC 60093	-	Ω·m	1.E + 12	1.E + 12	-	-	-	-	-	-	-	-	
Surface resistivity	IEC 60093	-	Ω	1.E + 16	1.E + 16	-	-	-	-	-	-	-	-	
Withstand voltage	IEC 60243-1	1 mmt	MV/m	32	32	-	-	-	-	-	-	-	-	
		3 mmt	19	19	-	-	-	-	-	-	-	-	-	
Tracking resistance	IEC 60112	-	-	600	600	-	-	-	-	-	-	-	-	