ACETAL COPOLYMER

KEPITAL®

POLYAMIDE

KEPAMID®

POLYESTER

KEPEX®

KPAC

Engineering Plastics

ACETAL COPOLYMER

KEPITAL®

KPAC

Engineering Plastics

1. General Information

KEPITAL® is the trade name for the polyacetal copolymer and homopolymer products of Korea Polyacetal Co., Ltd. (KPAC).
KEPITAL® offers well-balanced physical and mechanical properties with a powerful combination of highly crystalline and thermally stable structures. KEPITAL® provides excellent resistance to various chemicals and a wide processing window.

The characteristics of KEPITAL® are as follows:

- High mechanical properties
- High fatigue resistance
- Long-term dimensional stability
- Excellent fuel resistance
- Excellent creep resistance
- Superior friction resistance and wear resistance characteristics
- Superior chemical resistance and alkali resistance

KEPITAL®'s products range, from standard unfilled grades to high performance specialties, is well-balanced with inherent properties in order to meet both general purpose applications and specific engineering requirements.

KEPITAL® is easily processed to manufacture the finished product through the typical processes of both injection molding and extrusion. Therefore, KEPITAL® has been widely used in products such as automotive, electronics, consumer goods, etc.

This brochure provides insight into the physical and chemical properties of KEPITAL®, processing information and the diverse applications to help select the correct KEPITAL® grade for your application.

1-1. KEPITAL Nomenclature

F x x - ○○

1. Grade 2. Flowability 3.Characteristic

1-1-1. Grade

(1) Standard unfilled grades : F

(2) Reinforced & filled grades

- FG : Glass fiber reinforced
- MF : Milled glass fiber filled
- FB : Glass bead filled
- FT : Whisker filled
- TC : Talcum filled

(3) Impact modified grades : TE(FU)

(4) Low friction and wear grades

- FL : PTFE modified
- TS : Silicone modified
- FM : MoS2 filled
- NX, TX : Special lubricant package formulated

1-1-2. Flowability

x x	Melt Flow Rate (g/10 min)
10	3
15	6
20	9
25	13
30	27
40	48

1-1-3. Characteristics

○○	Characteristic
03/33	Mold released / moderate toughness
03H	Higher stiffness and strength than standard unfilled grade
51	UV-stabilized, Black color, outdoor
52	UV-stabilized, Natural color, indoor

1-2. Characteristic of KEPITAL

Description	Classification	Name	Characteristics
General	High viscosity	F10-01 F10-02	- Toughness - Rod, Sheet, Tube, Plate, Pipe - Reduced porosity and white marks
	Medium viscosity	F15-33	- Medium melt flow rate between F10 and F20 - High toughness - Proper for thick parts
		F20-03	- Standard type - Standard and balanced property - General injection molded parts
		F25-03	- Medium melt flow rate between F20 and F30 - General injection molded parts
	Low viscosity	F30-03 F30-34	- High melt flow rate - Multi-cavities parts - Proper for thin and small shape parts
	Extra low viscosity	F40-03 F40-34	- Short cycle time - Ultra high melt flow rate - Proper for thin and small shape parts
High rigidity	High viscosity	F10-03H	- Toughness and stiffness - Thick part
	Medium viscosity	F25-03H	- Medium melt flow rate between F20 and F30 - High stiffness
		F25-03HT	- Medium melt flow rate between F20 and F30 - Improved Toughness and friction property
Low VOC	High viscosity, rigidity	F10-03H LOF	- High viscosity - Low formaldehyde(HCHO) emission
	Medium viscosity	F20-03 LOF	- Medium viscosity - Low formaldehyde(HCHO) emission
	UV & Weather resistance	F20-52 LOF	- Medium viscosity - Low formaldehyde(HCHO) emission - UV/Light resistance *
	Low viscosity	F30-03LOF	- Low viscosity - Low formaldehyde(HCHO) emission
Reinforced & filled	Glass Fiber	FG2025K	- Low content of glass fiber - High rigidity and hardness
		FG2015	- Medium content of glass fiber - High stiffness and hardness
		FG2025	- High content of glass fiber - Maximum (Highest) stiffness, hardness and HDT - Reduced thermal expansion and shrinkage
	Glass Bead	FB2030	- Dimensional stability - Low warpage
	Talcum filled	TC3020	- Dimensional stability
	Whisker filled	FT2020	- Improved stiffness - Dimensional stability

Description	Classification	Name	Characteristics
Friction & Wear resistance	Silicone modified	TS-22H	- Low contents - High friction & wear resistance - High PV limit
		TS-25H	- High contents - Highest friction & wear resistance - Highest PV limit value
		TS-25A	- High contents - Highest friction & wear resistance - Delamination reduction
	PTFE modified	FL2020	- High friction & wear resistance - Low specific wear rate
	MoS_2 filled	FM2020 FM2520S	- Medium viscosity - Low specific wear rate in condition of high load, low speed and against metal - For bearing, bush parts
	Special lubricant package	TX-11H TX-21 TX-31	- High friction and wear resistance - Reduced noise
		NX-20	- High friction and wear resistance - Reduced noise - Silicone free
Impact modified	High toughness	TE-21 TE-22 TE-23	- Low contents of impact modifier - Impact modified grade for General purpose - Noise reduction
		TE-23S	- Low contents of impact modifier - High impact modified grade - Improved weld characteristics
		TE-24	- Medium contents of impact modifier - High impact modified grade
		TE-24S	- High contents of impact modifier - Super-toughened grade (Ultra high)
		TE-25	- Medium contents of impact modifier - High impact modified grade
		ST-50	- High contents of impact modifier - Improved impact-resistance and flexibility
UV & Weather resistance grade	General	F20-52	- Medium viscosity - UV/Light resistance * - For interior parts
		F30-52	- Low viscosity - UV/Light resistance * - For interior parts
	Low gloss	F20-52G	- Medium viscosity - UV/Light resistance * - For low gloss interior parts
		F30-52G	- Low viscosity - UV/Light resistance * - For low gloss interior parts

Description	Classification	Name	Characteristics
UV & Weather resistance grade	Black	F20-51	- Medium viscosity - Weather and UV/Light resistance - For interior and exterior parts
		F30-51	- Low viscosity - Weather and UV/Light resistance - For interior and exterior parts
	Impact resistance	F20-51U	- Medium viscosity - Weather and UV/Light resistance (Black colored) - For interior and exterior parts with improved impact strength
Medical	Medium viscosity	MX20BT01 MX25BT01	- Healthcare and medical application - Compliance to USP class6, ISO 10993-5 - Filed on DMF(Drug Master File)
	Low viscosity	MX30BT01	
Conductive	General	ET-20S	- Conductive carbon black filled - Conductivity - General purpose Type
		ET-20A	- Conductive carbon black filled - Conductivity - Improved fuel resistance
	High stiffness	FA-20	- Carbon black and carbon fiber reinforced - Conductive - High stiffness and high creep strength
		FC2010	- Carbon fiber reinforced - High stiffness
Anti-static	Specialty	ED-12	- Rod, Sheet, Plate - Static dissipation

* Can be matched with various colors

1-3. Typical properties of KEPITAL®

Description				General									High rigidity			Low VOC
				High viscosity		Medium viscosity			Low viscosity		Extra low viscosity		High viscosity	Medium viscosity		High viscosity, rigidity
Property		Test method	Unit	F10-01	F10-02	F15-33	F20-03	F25-03	F30-03	F30-34	F40-03	F40-34	F10-03H	F25-03H	F25-03HT	F10-03H LOF
Physical properties	Density	ISO 1183	g/cm^3	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41	1.41
	Water absorption	ISO 62	%	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Mechanical properties	Tensile modulus	ISO 527	MPa	2,500	2,600	2,600	2,750	2,750	2,850	2,850	2,900	2,900	2,800	2,850	2,700	2,800
	Tensile strength		MPa	63	63	64	65	65	65	65	65	65	67	68	64	67
	Elongation at yield	ISO 527	%	10	10	10	10	9	8	8	7	-	12	10	9	12
	Nominal strain at break		%	32	32	34	32	31	25	23	20	13	35	31	30	35
	Flexural strength	ISO 178	MPa	83	84	85	87	90	90	93	93	93	90	94	90	90
	Flexural modulus		MPa	2,350	2,400	2,450	2,550	2,650	2,700	2,700	2,750	2,700	2,600	2,800	2,600	2,600
	Charpy impact strength 23℃	ISO 179/1eA	kJ/m^2	8.0	8.0	7.0	6.5	6.0	5.5	5.5	5.0	3.5	8.5	6.5	6.0	8.5
	Charpy impact strength -30℃		kJ/m^2	6.5	6.5	6.0	5.5	5.5	5.0	4.5	4.0	2.2	6.5	6.0	5.0	6.5
Thermal properties	Melt index	ISO 1133	g/10min	3	3	6	9	13	27	36	45	75	3	13	13	3
	Melting point	ISO 11357	℃	165	165	165	165	165	165	165	165	165	170	170	170	170
	Heat deflection temperature(1.8MPa)	ISO 75	℃	96	96	96	100	100	101	101	101	101	100	101	100	100
	Coefficient of linear thermal expansion	ISO 11359	$x10^{-5}$/℃	12	12	12	12	12	12	12	12	12	12	12	12	12
Electrucal properties	Surface resistivity	IEC 60093	Ω	$1x10^{16}$	$1x10^{16}$	$1x10^{16}$	$1x10^{16}$	$1x10^{16}$	$1x10^{16}$	$1x10^{16}$	$1x10^{16}$	$1x10^{16}$	$1x10^{16}$	$1x10^{16}$	$1x10^{16}$	$1x10^{16}$
	Volume resistivity	IEC 60093	Ω · cm	$1x10^{14}$	$1x10^{14}$	$1x10^{14}$	$1x10^{14}$	$1x10^{14}$	$1x10^{14}$	$1x10^{14}$	$1x10^{14}$	$1x10^{14}$	$1x10^{14}$	$1x10^{14}$	$1x10^{14}$	$1x10^{14}$
	Dielectric strength	IEC 60243	kV/mm	19	19	19	19	19	19	19	19	19	19	19	19	19
Other	Mold shrinkage (Flow direction)	ISO 294-4	%	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0

Caution

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Low VOC			Reinforced & filled						Friction & Wear resistance					
Medium viscosity	UV& Weather resistance	Low viscosity	Glass Fiber			Glass Bead	Talcum filled	Whisker filled	Silicone modified			PTFE modified	MoS_2 filled	
F20-03 LOF	F20-52 LOF	F30-03LOF	FG2025K	FG2015	FG2025	FB2030	TC3020	FT2020	TS-22H	TS-25H	TS-25A	FL2020	FM2020	FM2520S
1.41	1.41	1.41	1.47	1.50	1.59	1.64	1.56	1.59	1.40	1.39	1.39	1.51	1.43	1.38
0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.23	0.2	0.2	0.2	0.18	0.2	0.2
2,750	2,600	2,850	4,900	5,400	9,000	4,000	4,850	7,300	2,600	2,650	2,450	2,250	2,600	2,300
65	62	63	100	105	150	53	58	84	62	59	57	45	65	58
10	10	8	-	-	-	-	-	-	10	9	12	10	9.5	10
32	34	25	3.4	2.7	2.4	2.9	5.0	2.7	22	23	30	14.5	20	33
87	83	90	160	175	220	97	112	146	85	83	80	70	90	80
2,550	2,350	2,600	4,750	5,200	8,250	4,050	5,290	6,800	2,500	2,550	2,500	2,150	2,690	2,400
6.5	6.0	5.5	6.5	7.0	8.0	2.5	3.8	3.6	7.0	5.5	7.0	3.0	5.5	5.5
5.5	5.5	4.5	6.5	7.0	8.0	2.0	2.5	2.5	6.0	4.5	6.0	2.5	4.0	4.0
9	10	27	13	11.5	7	19	5	15	13	24	15	5	11	10.5
165	165	165	165	165	165	165	165	165	168	168	165	165	165	165
100	92	101	160	161	162	117	122	152	90	98	90	87	105	89
12	13	12	6	5	3	8	8	10	11	11	11	10	11	11
$1x10^{16}$	$1x10^{16}$	$1x10^{16}$	$1x10^{16}$	$1x10^{16}$	$1x10^{16}$	$1x10^{16}$	$1x10^{16}$	$1x10^{16}$	$1x10^{16}$	$1x10^{16}$	$1x10^{16}$	$1x10^{16}$	$1x10^{16}$	$1x10^{16}$
$1x10^{14}$	$1x10^{14}$	$1x10^{14}$	$1x10^{14}$	$1x10^{14}$	$1x10^{14}$	$1x10^{14}$	$1x10^{14}$	$1x10^{14}$	$1x10^{14}$	$1x10^{14}$	$1x10^{14}$	$1x10^{14}$	$1x10^{14}$	$1x10^{14}$
19	19	19	-	-	23	20	21	-	-	-	-	16	-	-
2.0	2.0	2.0	1.0	0.9	0.7	1.4	1.4	0.9	2.1	2.1	2.1	2.0	2.1	2.1

Caution

※ Tensile properties except for modulus of reinforced and filled products and conductive high stiffness products were measured at 5 mm/min speed, and other products were measured at 50 mm/min.

※ Electrical properties of conductive and anti-static products are measured with KPAC standard specimens.

※ Electrical properties, such as surface resistivity or volumetric resistivity, are variable depending on injection molding machine, extruder structure, die design, pressure and speed. Before use, sufficient verification are needed. In addition, color shade will change with product thickness, residence time in barrel, and annealing conditions.

Description				Friction & Wear resistance				Impact modified							
				Special lubricant package				High toughness							
Property		Test method	Unit	TX-11H	TX-21	TX-31	NX-20	TE-21	TE-22	TE-23	TE-23S	TE-24	TE-24S	TE-25	ST-50
Physical properties	Density	ISO 1183	g/cm^3	1.40	1.39	1.39	1.38	1.39	1.37	1.36	1.36	1.35	1.32	1.34	1.28
	Water absorption	ISO 62	%	0.2	0.2	0.2	0.2	0.22	0.23	0.24	0.24	0.24	0.25	-	-
Mechanical properties	Tensile modulus	ISO 527	MPa	2,600	2,500	2,550	2,400	2,300	2,100	1,800	1,750	1,700	1,400	1,500	800
	Tensile strength	ISO 527	MPa	64	57	56	53	57	51	45	45	41	38	39	25
	Elongation at yield		%	10	10	8	10	9	11	12	12	13	23	14	22
	Nominal strain at break		%	40	33	32	25	40	>50	>50	65	>60	>100	>60	300
	Flexural strength	ISO 178	MPa	86	79	81	75	76	68	60	60	53	46	46	26
	Flexural modulus		MPa	2,550	2,350	2,450	2,100	2,150	1,900	1,650	1,750	1,450	1,300	1,250	800
	Charpy impact strength 23℃	ISO 179/1eA	kJ/m^2	9.5	7.5	6.5	4.5	8.0	11	13	18	18	28	21	N.B
	Charpy impact strength -30℃		kJ/m^2	7.0	5.0	4.5	3.5	6.0	6.5	6.5	7.0	7.0	9.0	7.0	7.0
Thermal properties	Melt index	ISO 1133	g/10min	5.0	16	30	12	11	8.5	8	3	6	2	6	4
	Melting point	ISO 11357	℃	170	165	165	165	165	165	165	165	165	168	165	165
	Heat deflection temperature(1.8MPa)	ISO 75	℃	97	90	89	90	84	76	76	75	71	61	65	58
	Coefficient of linear thermal expansion	ISO 11359	x10^{-5}/℃	13	13	13	8	13	13	13	13	13	13	13	12
Electrucal properties	Surface resistivity	IEC 60093	Ω	1x10^{16}	1x10^{16}	1x10^{16}	1x10^{16}	1x10^{16}	1x10^{16}	1x10^{16}	1x10^{16}	1x10^{16}	1x10^{16}	1x10^{16}	1x10^{16}
	Volume resistivity	IEC 60093	Ω · cm	1x10^{14}	1x10^{14}	1x10^{14}	1x10^{14}	1x10^{14}	1x10^{14}	1x10^{14}	1x10^{14}	1x10^{14}	1x10^{14}	1x10^{14}	1x10^{14}
	Dielectric strength	IEC 60243	kV/mm	19	19	19	-	-	-	-	-	21	-	21	-
Other	Mold shrinkage (Flow direction)	ISO 294-4	%	2.0	2.0	2.0	2.1	1.7	1.7	1.7	1.7	1.7	1.7	1.7	-

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UV & Weather resistance grade							Medical			Conductive				Anti-static
General		Low gloss		Black		Impact resistance	Medium viscosity		Low viscosity	General		High stiffness		Specialty
F20-52	F30-52	F20-52G	F30-52G	F20-51	F30-51	F20-51U	MX20 BT01	MX25 BT01	MX30 BT01	ET-20S	ET-20A	FA-20	FC2010	ED-12
1.41	1.41	1.39	1.39	1.41	1.41	1.39	1.41	1.41	1.41	1.38	1.39	1.43	1.43	1.32
0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	-	-	-	0.2	-
2,600	2,650	2,400	2,200	2,600	2,450	2,300	2,700	2,750	2,850	2,650	2,450	7,500	10,000	1,500
62	62	57	57	62	59	55	64	65	63	40	52	95	125	43
10	9	11	9	9	8	10	10	9	8	4	8	-	-	18
34	30	30	25	25	35	40	32	30	25	12	8	1.5	1.2	90
83	83	77	79	86	88	75	87	90	90	67	76	135	200	50
2,350	2,450	2,350	2,450	2,550	2,650	2,250	2,550	2,600	2,600	2,650	2,450	7,150	8,500	1,350
6.0	5.0	6.0	4.0	7.0	7.0	8.5	6.5	6.0	5.0	4.0	5.5	4.0	4.0	16
5.5	4.5	4.0	3.5	5.0	4.0	5.5	5.5	5.0	4.0	2.0	4.0	4.0	4.0	8.0
10	27	10	23	10	25	10.5	9	13	27	11.5	〈 1	3	9.5	〈1
165	165	165	165	165	165	165	165	165	165	165	165	165	165	165
92	90	88	88	92	92	89	100	100	98	88	92	160	160	70
13	13	11	11	11	11	11	12	12	12	12	11	4	2	12
$1x10^{16}$	$1x10^{16}$	$1x10^{16}$	$1x10^{16}$	$1x10^{16}$	$1x10^{16}$	$1x10^{16}$	$1x10^{16}$	$1x10^{16}$	$1x10^{16}$	$1x10^{3}$	$1x10^{3}$	$1x10^{3}$	$1x10^{5}$	$1x10^{8}$
$1x10^{14}$	$1x10^{14}$	$1x10^{14}$	$1x10^{14}$	$1x10^{14}$	$1x10^{14}$	$1x10^{14}$	$1x10^{14}$	$1x10^{14}$	$1x10^{14}$	-	-	-	-	-
19	19	-	-	19	19	19	19	19	19	-	-	-	-	-
2.0	2.0	2.1	2.1	2.1	2.1	2.0	2.0	2.0	2.0	1.9	2.0	0.9	0.7	1.6

Caution

※ Tensile properties except for modulus of reinforced and filled products and conductive high stiffness products were measured at 5 mm/min speed, and other products were measured at 50 mm/min.

※ Electrical properties of conductive and anti-static products are measured with KPAC standard specimens.

※ Electrical properties, such as surface resistivity or volumetric resistivity, are variable depending on injection molding machine, extruder structure, die design, pressure and speed. Before use, sufficient verification are needed. In addition, color shade will change with product thickness, residence time in barrel, and annealing conditions.

2. Processing of KEPITAL®

2-1. Equipment

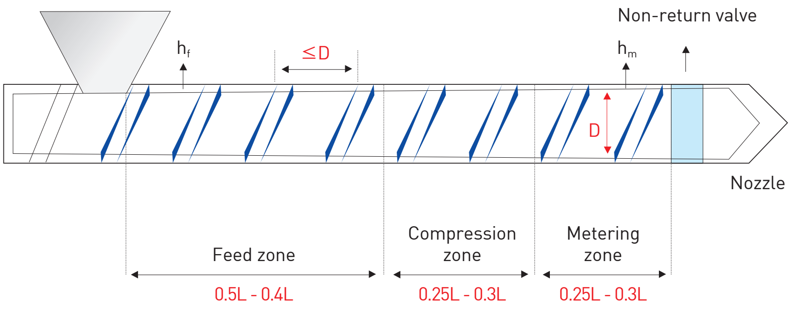
Injection molding is one of the common manufacturing methods for thermoplastics including KEPITAL® as it allows for designs of high complexity and cost-effective manufacturing methods. Therefore, understanding the process of injection molding for KEPITAL® is very important.
In order to obtain a high-quality product out of KEPITAL®, the recommendations or check-points on the injection molding machine are as following:

1) Open nozzle is recommended with a individual band heater on the nozzle itself. This type of nozzle has advantages over other nozzles when it comes to dealing with gaseous products that result from thermal decomposition without pressure building-up when the molding cycle is stopped or interrupted with melt left in the cylinder for over residence time.

2) The non-return valve (check ring) must be inspected to achieve holding pressure and cushion so as not to cause processed parts to experience sink marks, wide variations of weight or dimensions.

3) The compression zone of the screw is recommended at 25 to 30 % of screw length. Improper compression zone length may not only over-heat material but also cause a lack of pressure build-up in the plasticizing.

Fig 2-1. Typical injection molding screw for KEPITAL



[Recommendations on injection molding machine]

1) The one shot weight for KEPITAL® is 20-50 % of machine capacity

2) L/D: 20~23

3) Compression ratio: 2:1~3:1

4) When processing glass-fiber reinforced KEPITAL®, using a wear resistant plasticizing unit (screw and barrel) is advisable and regular inspection of screw for wear is recommended.

2-2. Injection molding

When designing injection molding tooling it is essential to review the dimensional requirements of the molded components (tolerances, capability), flow characteristics of the raw material, and cost-effectiveness to ensure operational goals can be accomplished.

2-2-1. Pre-drying

Being a non-hydroscopic material, KEPITAL® in its original packages can be processed without pre-drying unless it is exposed to a humid atmosphere for a prolonged periods of time. However, sometimes moisture that exists on the surface of pellet caused by improper handling or storage may result in a silver streak or nozzle drooling, so drying prior to molding may be necessary to prevent KEPITAL® from having these problems. In addition, in some cases, pre-drying is effective in reducing odor, mold deposits and in achieving improved surface appearance quality. Drying conditions are recommended at 80-90 °C for 3-4 hours.

2-2-2. Melt temperature

The melt temperature of KEPITAL® in general is from 180 to 210 °C, preferably 190~200°C. It is common for the melt temperature rises above the temperature at metering zone by 10-20°C, this results from mechanical shear heating during plasticizing. Barrel temperature set points do not equate to melt temperature as would be taken with a melt temperature pyrometer.

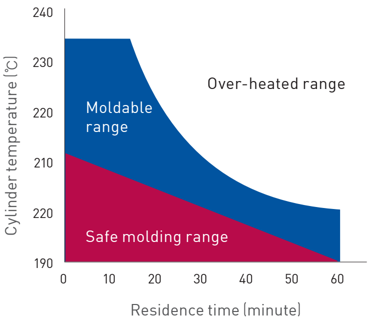
Table 2-1. Typical cylinder temperature for KEPITAL

Grade	Nozzle	Metering zone	Compression zone	Feed zone
General / UV & Weather resistance grade / Impact modified	180 ~ 210 ℃	190 ℃	180 ℃	170 ℃
Reinforced & filled		200 ℃	190 ℃	170 ℃
Low VOC	180 ~ 190 ℃	170 ℃	170 ℃	170 ℃

※ The above temperature is based on standard conditions and can be changed according to the size of injection molding machine and mold.
※ Refer to the separate materials for recommended injection molding conditions for low VOC product

When the melted improperly or exposed to long residence time in the plasticizing unit, over-heating causes thermal degradation, which results in discoloration, impairing mechanical properties, etc. The processing window; temperature versus melt residence time in the cylinder for standard unfilled grade is shown in Figure 2-2.

Fig 2-2. Cylinder temperature versus melt residence time in cylinder



2-2-3. Injection pressure

The injection pressure should be set high enough to achieve the set injection speed. The injection speed should not be reduced due to the low injection pressure. Typical injection pressures generally ranges 600 to 1200 bar.

2-2-4. Mold temperature

The mold temperature is a key parameters for injection molding of crystalline polymers. Mold temperature may widely be set up at 60-120 ˚C, and a general recommendation is 70-90 ˚C for general purpose of KEPITAL® molding grades. If the surface finish is important or the service temperature of finished part is expected to be high, higher mold temperature would be recommended.
To obtain a good quality product, the mold temperature must be consistently maintained so that the temperature distribution in the mold may be achieved uniformly. A mold temperature controller is recommended so that temperature, water flow rate and water pressure can be maintained.

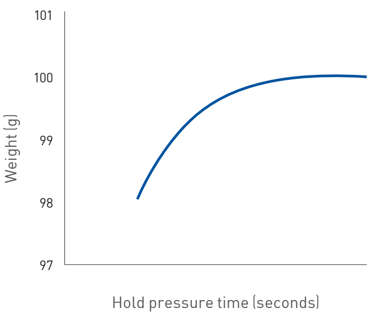
2-2-5. Injection speed

The injection speed should be determined by part geometry, such as gate size, gate location, flowability and mold temperature etc. In order to obtain better appearance, it is desirable to increase the injection speed. On the other hand, it is common to reduce the injection speed to reduce the flash, burn marks or the shear stress during injection.

2-2-6. Hold pressure

Hold pressure plays a key role in making KEPITAL® parts optimized not only in dimension but also in mechanical & physical properties. Because in the hold stage (hold/pack), remaining melt for about 1~5 % of a cavity is forced to fill in the cavity to compensate for the volume contraction during cooling. The hold (pack) time must be set to slightly exceed the gate seal time (normally ½ to 1 sec) at which a gate is completely solidified so a consistent product may be obtained.
As shown in Figure 2-3, the weight of a molded part increases upon the hold pressure time and then stops at a certain point. At this time the gate of the part is solidified entirely and no more material can be incorporated. Finally part weight shows consistency after the gate seal time. This study is commonly referred to as a Gate Freeze Study.
It is recommended that the hold pressure time be maintained until the gate seal is completed. Because the gate seal time changes mostly upon the shape of cross section and mold temperature, a proper hold pressure time must be determined such that the weight and dimension of a molded product are within a certain range.
By setting optimum hold pressure, molded parts product with consistent dimensions can be produced. As a rule of thumb, the hold time can be simply calculated by wall thickness (mm) times 8 seconds.

Fig 2-3. Hold pressure time and product weight



The hold pressure must be set in consideration of dimensional requirements. As a rule, hold pressure amounts to between 60-90 % of the injection pressure.

2-2-7. Plasticizing

Because plasticizing by an excessively fast rotating speed can make KEPITAL® decompose by high shear force, the reciprocating speed is preferably set as low as possible unless it does affect cycle time. Since screw RPM is dependent on diameter of the screw, screw line speed by screw can be utilized. As a result, screw line speed is recommended in the range of 150 mm/s to 200 mm/s, and with respect to the diameter of the screws following can be chosen.

Table 2-2. Screw rotational speed versus screw diameters

Screw Φ	25 mm	40 mm	55 mm
Screw rotational speed (rpm)	120	100	70

A back pressure of 10-20 bar is generally appropriate. However, to increase the efficiency of the dispersion of a color master batch (color concentrates) or pigment, higher mixing by increasing back pressure may be required. In addition high back pressure may be used to eliminate un-melted particles. In the case of glass fiber reinforced grades, high back pressure, proportional to rotational speed leads to breakage of the glass fiber, resulting in deterioration of mechanical strength. More importantly, excessive back pressure gives rise to lower output along with longer cycle time. Therefore, it should be taken into consideration in optimizing the back pressure.

2-2-8. Cooling

Total cooling time is determined as the sum of "hold pressure time + plasticizing time". Once KEPITAL® is solidified entirely, no additional cooling time is needed. Most of the time affecting the cooling time is the hold time. Therefore, assuming the hold pressure time is set appropriately, only screw retraction time needs to be taken into account.
In the case of a high crystalline resin like KEPITAL®, sometimes a prolonged cooling time at high mold temperature may be applied to minimize the residual stress.

2-2-9. Flowability

Figure 2-5 shows the results of the spiral flow test in which the flow properties of standard unfilled grades were evaluated. Influence on flowability is found to depend greatly on molecular weight. In addition, Figure 2-6 shows the spiral flow test results of F20-03 at different injection pressures, indicating that flow characteristics tend to increase with higher injection pressures.

Fig 2-4. Cooling time versus mold temperature

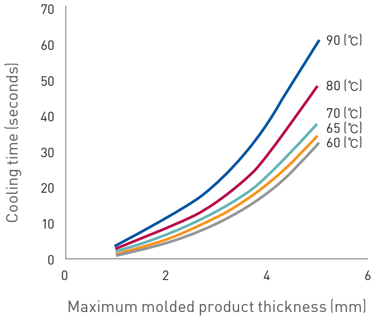


Fig 2-5. Flow path length of unfilled standard grades (melt temperature 200 °C, injection pressure 600 bar, thickness 3 mm spiral flow test)

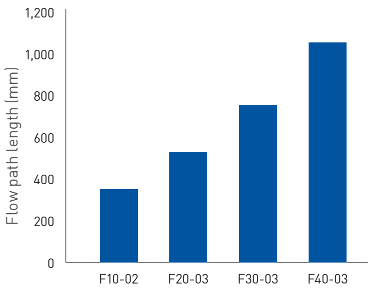


Fig 2-6. Flow path length of KEPITAL F20-03 as a function of injection pressures (melt temperature 200 °C, thickness 3 mm spiral flow test)

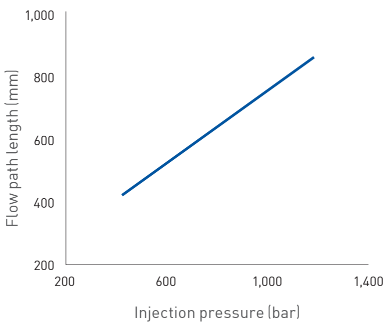


Fig 2-7. Flow characteristics of KEPITAL and other plastics during injection molding

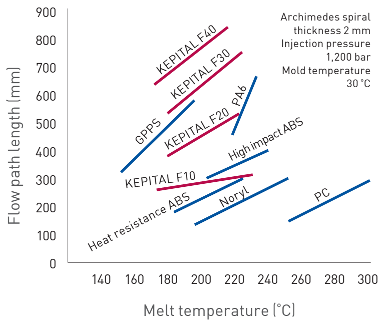


Fig 2-8. Shrinkage rate changes with mold temperature and specimen's thickness

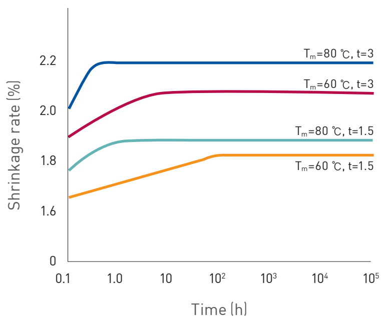


Fig 2-9. Shrinkage rate changes with injection pressures (F20-03, Melt temp. 200 °C, Specimen dia. 100 mm, t 2)

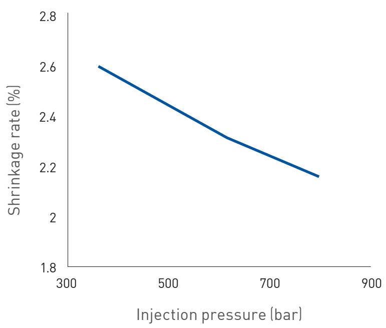
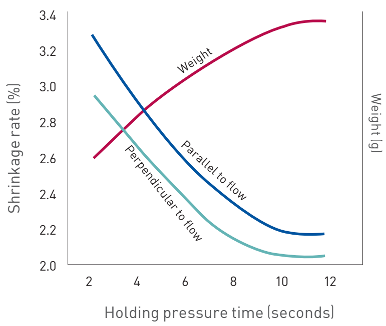


Fig 2-10. Shrinkage rate changes with holding pressures



Calculation of theoretical cooling time

$$S = \frac{t^2}{\pi^2 \alpha} \ln \left[\frac{8}{\pi^2} \frac{(T_c - T_m)}{(T_x - T_m)} \right] \qquad \alpha = \frac{R}{C_p \rho}$$

S = Theoretical cooling time
t = Maximum part wall-thickness
α = Thermal diffusivity of material
R = Thermal conductivity
C_p = Specific heat
T_x = Ejection temperature of molding
T_m = Mold temperature
T_c = Cylinder temperature

2-2-10. Cycle time

Cycle time varies with injection time, hold pressure time, cooling time, mold open time and safety margin at each cycle. Injection molding cycle time is closely related to part thickness. From a molder's stand point, a shorter cycle time is preferable; however, optimizing all time dependent parameters such as fill rate, hold pressure time and cooling time are very important to get quality parts out of KEPITAL®.

2-2-11. Shrinkage

The shrinkage rate is the most important factor determining a product's dimensions and is obtained from the sum of mold shrinkage and post-mold shrinkage. The shrinkage value, provided by KEP can be utilized in designing a part in the prototype phase. However most of the shrinkage behavior is affected by not only the plastics' characteristics but also the processing conditions and part geometry. Therefore, the shrinkage rate must be taken into account in consideration of all possible factors.

When mold temperature increases, the mold shrinkage rate increases, and post-mold shrinkage rate decreases.

In general, when the injection pressure increases, the shrinkage rate decreases. Experimentation can help to evaluate dimensions of a molded product. Key process input variables that can be adjusted by changing injection pressure and hold pressure and time can be evaluated vs key product dimensions.

Figure 2-10 demonstrates that shrinkage rate is high if hold pressure time is shorter than gate seal time.

2-3. Safety recommendation

2-3-1. Changing material in processing - Purging

In general, the cylinder (injection molding barrel) has to be cleaned/purged with a polyolefin or a purging compound before and after KEPITAL® processing.

2-3-2. The interruption of molding cycle

Molding cycles can be stopped and interrupted by technical malfunctions in the operating machine or for other reasons. In this case, some special actions should be considered to prevent unnecessary problems. The barrel temperature should be lowered to 150 ˚C but the nozzle temperature may be maintained to prevent material from over-heating. If long-period interruption is expected close the feed throat of pellets and purge the barrel of all resin. Once completed then lower cylinder (barrel) and nozzle temperatures.
Whereas increase the nozzle temperature to 200 ˚C and then raise the cylinder temperature gradually when restarting machine with KEPITAL® to prevent the nozzle being blocked by frozen material.

2-3-3. Recycling of KEPITAL® - Use of regrind

While recycled material mixing with virgin material does not particularly interfere with color difference, mechanical properties, and moldability, the high dosing rate of recycle is likely to cause contamination, and an increase in the melt index is accompanied by recycled frequencies.

2-4. Safety Precautions during processing

In processing of KEPITAL®, a ventilation extraction hood should be equipped over the barrel unit and measures should be implemented to ensure the ventilation of the work place.
KEPITAL® decomposes when subjected to excessive heating over 230 ˚C or the residence time in the injection barrel at 200 ˚C or higher. The decomposition of KEPITAL® generates formaldehyde gas which has a pungent smell and irritates the mucous membrane. Therefore, when thermal degradation is noticeable, the cylinder should be flushed by purging out melt and the cylinder temperature must be reduced at the same time. In order to prevent odor nuisance, thermally damaged material can be cooled down in a water bath. In addition, if material stays in a cylinder under the condition of a blocked nozzle, formaldehyde gas can rapidly build up a high gaseous pressure in the cylinder. When the pressure is elevated to a certain extent, the resin and gas in a cylinder are explosively discharged through the filling hopper, which could cause serious injury to operators and damage to the injection molding machine. It is therefore important to ensure the nozzle is never frozen or obstructed during processing.
KEPITAL® is immiscible with almost all other plastics. If other materials are introduced and mixed, caution is required because problems including contamination, lamination, and deterioration of physical properties arise. In the case of a master batch that requires implementation of colors, a

product based on KEPITAL® is recommended. Special attention should be considered to limit PVC exposure to KEPITAL®, because if even a small amount of PVC resin is introduced and mixed, it causes serious degradation to the KEPITAL® resin, it is a good practice to prevent introduction and mixing of materials and also to use individual injection molding machines for PVC and KEPITAL® only.

2-5. Troubleshooting guide for KEPITAL®

Processing problem	Causes	Remedies
Sticking in cavity	- Higher resistance to eject force - Insufficient cooling time	- Decrease injection pressure and check for undercut or insufficient draft - Clean mold surface - Increase the number of ejecting pins - Lower the mold temperature and increase mold close time
Short shot	- Insufficient flowability by low melt or mold temperature - Improper design with small gate or narrow flow channel - Unbalanced filling - Insufficient metering stroke	- Increase the cylinder temperature and mold temperature. - Increase injection pressure and speed - Enlarge the gate - Adjust runner balance - Increase metering stroke
Pit mark	- Low injection speed - Low holding pressure - Low melt or mold temperature	- Increase injection speed - Increase injection and holding pressure - Increase melt or mold temperature
Flow mark	- Slow injection speed - Low mold temperature	- Increase injection speed - Change the gate location or enlarge gate size - Increase mold temperature
Silver streak	- High moisture in granule - Decomposition by over-heating - Insufficient gas vent - Air entrap into cylinder - Contamination	- Drying at 80-90 ℃ for 3-4 hours - Lower the cylinder temperature or shorten residence time in cylinder - Check for gas vent - Increase back pressure - Check for contamination with PVC
Discoloration or burn mark	- Over-heating or too long residence time in cylinder - Insufficient gas vent - Fast injection speed	- Lower the cylinder temperature - Check for gas vent - Decrease injection speed
Contamination	- Contamination with other material - Black specks	- Take precautions on handling - Clean the cylinder
Flash	- Low clamping force - Too high injection pressure or holding pressure - Too fast injection speed - Mold wear	- Increase clamping force - Lower injection pressure or holding pressure - Lower injection speed - Repair mold
Sink and void	- Too low holding pressure - Wear of non-return valve - Improper cushion	- Increase holding pressure and time - Increase mold temperature - Gating at thick wall - Check for non-return valve

3. UL Standards

Each grade of KEPITAL has acquired the plastics materials standard (UL standard) from Underwriters Laboratories Inc.

Accredited UL standards of KEPITAL®

File No. : E120354

Descrip-tion	Material Designation	Color	Minimum Thickness (mm)	UL94 Flame Class	Relative Temperature Index (℃)			HWI	HAI	HVTR	D495	CTI
					Electric	Mechanical						
						Impact	Strength					
Polyacetal homo polymer	H100(+)	ALL	0.75	HB	50	50	50	4	0	0	3	0
			1.5	HB	50	50	50	4	0			
			3	HB	50	50	50	3	0		N.A.	
			6	HB	50	50	50	3	0			
General	F10-(xx)(+)	ALL	0.75	HB	110	95	100	-	-	0	5	1
			1.5	HB	110	95	100	4	0			
			3	HB	110	95	100	3	0		N.A.	
			6	HB	110	95	100	3	0			
	F15-(xx)(+)	NC	0.9	HB	50	50	50	-	-	-	-	-
			3	HB	50	50	50	-	-		N.A.	
	F20-(xx)(+)(r1)	ALL	0.75	HB	110	95	100	-	-	0	5	1
			1.5	HB	110	95	100	4	0			
			3	HB	110	95	100	3	0		N.A.	
			6	HB	110	95	100	3	0			
	F25-(xx)(+)	ALL	0.75	HB	110	95	100	-	-	0	5	1
			1.5	HB	110	95	100	4	0			
			3	HB	110	95	100	3	0		N.A.	
			6	HB	110	95	100	3	0			
	F30-(xx)(+)	ALL	0.75	HB	110	95	100	-	-	0	5	1
			1.5	HB	110	95	100	4	0			
			3	HB	110	95	100	3	0		N.A.	
			6	HB	110	95	100	3	0			

Description	Material Designation	Color	Minimum Thickness (mm)	UL94 Flame Class	Relative Temperature Index (℃)			HWI	HAI	HVTR	D495	CTI
					Electric	Mechanical Impact	Mechanical Strength					
General	F40-(xx)(+)	ALL	0.75	HB	110	95	100	-	-	0	5	1
			1.5	HB	110	95	100	4	0		N.A.	
			3	HB	110	95	100	3	0			
			6	HB	110	95	100	3	0			
UV & Weather resistance	F20-51U(f1)	BK	0.95	HB	50	50	50	-	-	-	-	-
	F20-52(+)	ALL	0.75	HB	110	95	100	-	-	-	-	-
Reinforced & Filled	FG2025(+)	ALL	0.75	HB	105	90	95	3	0	0	6	1
			1.5	HB	105	90	95	3	0		N.A.	
			3	HB	105	90	95	2	0			
	FG20-(c)(+)	ALL	0.75	HB	50	50	50	-	-	-	-	-
			3	HB	50	50	50	-	-		N.A.	
	FB-20#	ALL	0.75	HB	50	50	50	-	-	-	-	-
	TC3020(+)	ALL	0.75	HB	50	50	50	-	-	-	-	-
	FT-20(xx)(+)	ALL	0.75	HB	50	50	50	-	-	-	-	-
Friction & Wear resistance	FL-20(xx)(+)	ALL	0.75	HB	50	50	50	-	-	-	-	-
	TS-2(&)(+)	ALL	0.9-1.0	HB	50	50	50	-	-	-	-	-
	FS-20(xx)(+)	ALL	0.75	HB	50	50	50	-	-	-	-	-
	FM2020(+)	BK	0.75	HB	50	50	50	-	-	-	-	-
	FM25(xx)(+)	BK	0.94	HB	50	50	50	-	-	-	-	-
			3	HB	50	50	50	-	-		N.A.	
	TX-(Y)1(+)	ALL	1.5	HB	50	50	50	-	-	-	-	-
			3	HB	50	50	50	-	-		N.A.	
	NX-(XX)(+)	NC	0.8	HB	50	50	50	-	-	-	-	-
			3	HB	50	50	50	-	-		N.A.	
	CX-(XX)(+)	NC	0.8	HB	50	50	50	-	-	-	-	-
			3	HB	50	50	50	-	-		N.A.	

Descrip-tion	Material Designation	Color	Minimum Thickness (mm)	UL94 Flame Class	Relative Temperature Index (℃)			HWI	HAI	HVTR	D495	CTI
					Electric	Mechanical						
						Impact	Strength					
Friction & Wear resistance	WX-(XX)(+)	NC	1.5	HB	50	50	50	-	-	-	-	-
			3	HB	50	50	50	-	-	N.A.		
	LO-2(&)(+)	ALL	0.75	HB	50	50	50	-	-	-	-	-
Impact modified	TE-2(Z)(+)	ALL	1.5-1.7	HB	50	50	50	-	-	-	-	-
	FU20-(e)(+)	ALL	1.5	HB	50	50	50	-	-	-	-	-
			3	HB	50	50	50	-	-	N.A.		
Conductive	ET-20(+)	BK	0.75	HB	50	50	50	-	-	-	-	-
	FA-20(xx)(+)	BK	0.75	HB	50	50	50	-	-	-	-	-
	FC-20(xx)(+)	BK	0.75	HB	50	50	50	-	-	-	-	-

: May be replaced with two digits.
(&) : May be replaced by a digit indicating oil content.
(c) : Denotes glass fiber content 10-30% except 25%.
(e) : Denotes polyurethane content 5~50%.
(f1) : Suitable for outdoor use with respect to exposure to Ultraviolet Light, Water Exposure and Immersion in accordance with UL 746C.
(r1) : Virgin and regrind up to 100% by weight inclusive have the same basic characteristics.
(xx) : May be replaced by one or two digits except F20-52(+), F20-61(+) and F20-51U.
(Y) : May be replaced by one digit 1-9 according to indicating to viscosity of Base Resin without any changes in the composition.
(Z) : May be replaced by one digit 1-9 indicating filler content
+ : May be replaced by one, two, three, four, or five letters and/or one, two, or three digit numbers

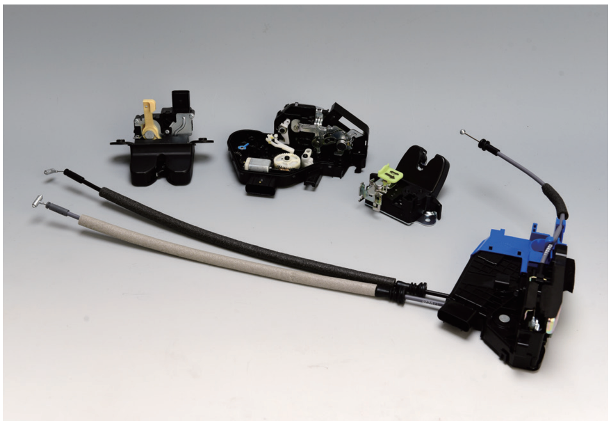
HWI : Hot Wire Ignition
HAI : High Ampare Arc Ignition
HVTR : High Voltage Arc Tracking Rate
D495 : Arc Resistance
CTI : Comparative Tracking Index

4. Applications

Automotive

Fuel pump module

Window regulator module



Door latch module

Bumper bracket parts

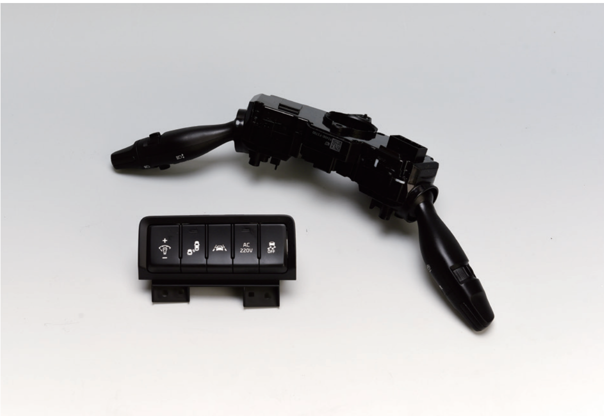
Gear parts

Side mirror parts

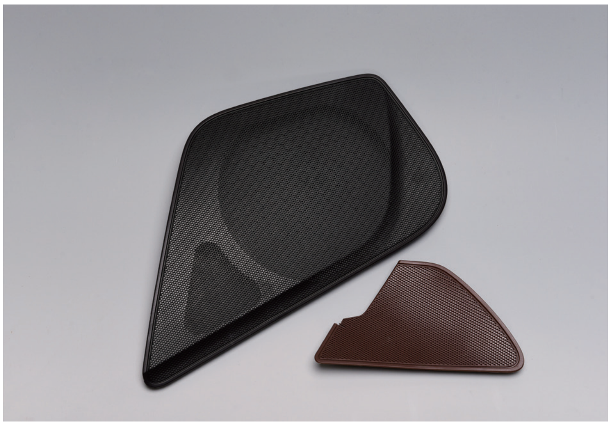
Through continuous innovation and new value creation, KPAC will be the premier chemical company providing humanity with solutions for a better future.

Seat belt module

Seat parts



Combination switch module

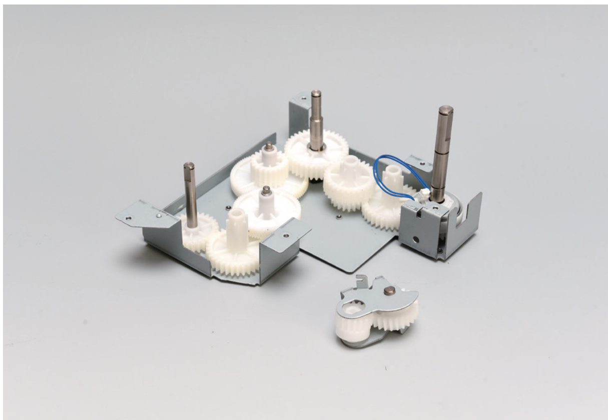


Speaker grille parts

HVAC parts

Clips (Fasteners)

Electric · Electronic · Construction & Consumer goods



Printer parts

Water purifier pitting

Cosmetic applications

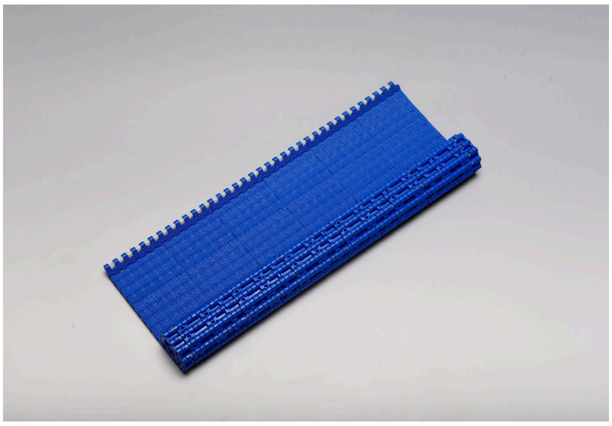
Massage chair parts

Zippers

Buckles

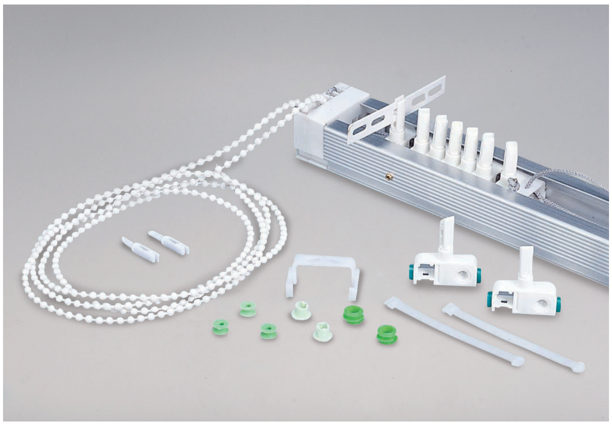
Sanitary parts

Rod and Plate



Conveyor belts

Rollers



Blind parts

Chair parts

5. Quality and standard accreditation

Korea Polyacetal Co., Ltd. is committed to creating profitable future for customers and has met the requirements of international quality accreditation systems such as IATF 16949 and ISO 14001, starting with ISO 9001.

Furthermore, we have obtained standard accreditations from UL, CSA, NSF and BS6920, compliance to FDA, and have established global excellence in terms of quality and stability.

Classification	Accreditation standard
System standard	- IATF 16949 - ISO 9001 - ISO 14001 - ISO 45001

- IATF 16949 : Integrated quality management system in automotive
- ISO 9001 : Quality management system
- ISO 14001 : Environment management system
- ISO 45001 : Safety and health management system

Standard accreditation certificate

ISO 9001

ISO 14001

IATF 16949

ISO 45001

Properties are subject to change upon new knowledge and development

※ Although the information and recommendations set forth herein are presented in good faith and believed to be correct, we recommend that persons receiving information must make their own determination as to its suitability to their purposes prior to use. The information is based on natural colored products only through relevant test methods and conditions. It is the obligation of the customer to determine whether a particular material and part design is suitable for a particular application. The customer is responsible for evaluating the performance of all parts containing plastics prior to their commercialization.

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POLYAMIDE

KEPAMID®

POLYESTER

KEPEX®

KPAC

Engineering Plastics

CONTENTS

1. Introduction

KEPAMID® is the trade name for the polyamide products of KOREA POLYACETAL Co., Ltd. There are two types of products which are KEPAMID®-PA6 and KEPAMID®-PA66. Because polyamide has amide functional group, –CONH-, in the molecular chain and intermolecular hydrogen bond, it has superior toughness, stiffness, fatigue, and chemical resistance properties.

The major characteristics of KEPAMID® are as follows :

- High heat resistance
- High stiffness by reinforcing glass fiber
- Excellent processing
- Excellent chemical resistance
- Excellent flammability with flame retardant
- Excellent wear property
- High water absorption rate

These various characteristics are supported by a wide product range such as unfilled, glass fiber reinforced, mineral filler reinforced, impact modified and specialty grades. KEPAMID® can be easily processed by injection molding, extrusion, gas assistant injection molding, and other well-known processing methods.
As such, KEPAMID® has been widely used in products such as automotives, electronics, consumer goods, etc.

This brochure provides the properties of KEPAMID® and an injection molding guide, trouble-shooting guides, and applications to help choose the right KEPAMID®. grade.

KEPEX® is the trade name for the polybutylene terephthalate, PBT, products of KOREA POLYACETAL Co., Ltd. KEPEX® has two types of products Which are divided into PBT and PET. Because PBT and PET have ester functional group in the molecular chain, they are classified into crystal-line polyester.

The major characteristics of KEPEX® are as follows :

- High mechanical strength
- Excellent chemical resistance
- Excellent surface gloss
- Long-term dimensional stability with low water absorption
- Excellent wear property
- Excellent electrical property
- Excellent creep and fatigue properties
- Long-term high heat stability
- Excellent flammability by adding flame retardants

These various characteristics are supported by a wide product range such as unfilled, glass fiber reinforced, flame retardant, impact modified, and specialty grades.

KEPEX® can be easily processed by injection molding, extrusion, gas assistant injection molding, and other well-known processing methods.
As such, KEPEX® has been widely used in products such as automotive, electronics, consumer goods, etc.

2. Characteristics of KEPAMID® and KEPEX®

2-1. KEPAMID®-PA6

Grade: Classification		Grade: Name	Application
Mold release	Fast cycle	1300CRH	General purpose injection molding grades for fast processing: Seat levers, Fasteners, Clips, Connectors, Brackets, Cable-ties
Impact modified	Standard	1500SA	Parts in which improved toughness or impact resistance is required: Head rests, Seat belt parts, Chairs, Helmets, Casters
	High impact	1500SF 1500SFU	
	Super tough	1500ST	
Glass fiber reinforced	GF	1315GF 1320GF 1330GF 1335GF 1345GF 1350GF 1520GF 1530GF 1533GFU	Parts in which high mechanical strength or heat resistance is required: Fuel injectors, Door garnish moldings, Out door handle bases, Timing belt covers, Reservoir tanks, Airbag housing, Power tool housing
	GF, heat stabilized	1315GFH 1350GFH	
	GF, impact	1310GSU 1315GSU 1340GFS	
Mineral filler filled	Low warpage	1320M7 1325M7 1330M7 1340GM8	Parts in which dimensional stability, low warpage or heat re-sistance is required: Wheel covers, Outdoor handles, Fuel filler doors, Ring cases
	Low warpage, impact	1515SM7 1525SM3	
Flame retardant	Unfilled, V-2	1500VT	Parts in which flame resistance is required: Coil bobbins, Connectors, MCCBs, Ash trays
	GF, V-0	1325GVS	
Extrusion	Extrusion	1825GF	Extrusion parts in which high stiffness is required: Window profiles

2-2. KEPAMID®-PA66

Grade			Application
Classification		Name	
Mold release	Fast cycle	2300MR	General purpose injection molding grade for fast processing: Seat levers, Fasteners, Clips, Gears, Connectors, Cable-ties, Canisters, Reservoir tanks, Fuse boxes, Coil bobbins
Impact modified	Standard	2300SE	Parts in which improved toughness or impact resistance is required: Fuse boxes, Fuel filler necks, Seat belt parts
	High impact	2300SF	
	Super tough	2300ST 2300SKT	
Glass fiber reinforced	GF	2315GF 2320GF 2330GF 2333GF 2345GF	Parts in which high mechanical strength or heat resistance is required: Reservoir tanks, Switches, Connectors, Bearing retainers, Air-bag mounting plates, Tension pulleys, Boiler parts
	GF, heat stabilized	2325GFH 2330GFH 2335GFH 2350GFH	
	GF, impact	2325GFS 2340GFS	
Glass bead / Bubble	Glass bead	2350GB	Parts in which high dimensional stability or low density is required: Clutch pistons, Fuel valve floats
	Glass bubble	2333GB	
Mineral filler filled	GF + MF	2340GM3 2440GM7 2330GM8 2340GM8	Parts in which high stiffness, heat resistance and dimensional stability are required: Fan & Shrouds, Intercooler ducts, Engine covers, Door valves, Timing belt covers, Boiler parts
	Low warpage	2340M7 2340M8	
CF	Carbon fiber	2320CF	Parts in which high strength, wear resistance and conductivity are required
Wear	GF + PTFE	2330GFA	Parts in which strength and wear resistance are required: Inner bush
Flame retardant	Unfilled, V-0	2300VT	Parts in which flame resistance is required: Bobbins, Connectors, MCCBs, Ash trays, Insulating discs
	GF, V-0	2315GVS 2325GVS 2325GVF	
Extrusion	Extrusion	2325GFS	Extrusion parts in which high stiffness is required: Window profiles

2-3. KEPEX®-PBT, PET

<table>
<tr><th colspan="3">Grade</th><th rowspan="2">Application</th></tr>
<tr><th colspan="2">Classification</th><th>Name</th></tr>
<tr><td>Unfilled</td><td>Fast cycle</td><td>3300M</td><td>Parts in which good surface and dimensional stability are required:
Contact lens frames</td></tr>
<tr><td>Toughened</td><td>Medium viscosity</td><td>3500SA</td><td>Parts in which improved toughness is required
Connectors, Bobbins, Boxes, Housings, Covers</td></tr>
<tr><td rowspan="4">Glass fiber reinforced</td><td>GF</td><td>3315GF
3320GF
3330GF
4345GF</td><td rowspan="2">Parts in which high mechanical strength or heat resistance is required:
Switches, Impellers, Connectors, Levers, Fans, Lamp sockets, Spoilers, Wiper arm blades, Sensor bases</td></tr>
<tr><td>GF, impact</td><td>3315GFS
3330GFS</td></tr>
<tr><td>GF, high gloss</td><td>3715GF
3730GF
3750GF</td><td>Parts in which high mechanical strength, heat resistance and good esthetic surface property are required:
Wiper parts, Air vent wings, Motor brackets</td></tr>
<tr><td>GF,
low warpage</td><td>3930GFU</td><td>Parts in which high mechanical strength, heat resistance and low warpage are required:
Sunroof frames, Motor housing</td></tr>
<tr><td>Glass bead</td><td>Low warpage</td><td>3330GB</td><td>Parts in which dimensional stability or low warpage is required:
Handle sensor dust covers</td></tr>
<tr><td rowspan="2">Mineral filler filled</td><td>GF + MF</td><td>3730GM5</td><td rowspan="2">Parts in which high stiffness, heat resistance, good esthetic surface property and Al vacuum metalizing or painting are required:
Bezels, Air flow meters, Power cable housing</td></tr>
<tr><td>Low warpage</td><td>3718M7
3725M7</td></tr>
<tr><td rowspan="2">Flame retardant</td><td>Unfilled</td><td>3300VS
3700V
4500V</td><td rowspan="2">Parts in which flame resistance is required:
Bobbins, Connectors, Sockets, Timer cases, Door latches, Wigs</td></tr>
<tr><td>GF, V-0</td><td>3305GVS
3315GVS
3315GVU
3330GVS
3330GVT</td></tr>
</table>

3. Typical properties of KEPAMID® and KEPEX®

3-1. KEPAMID®-PA6

Grade					Mold release	Impact modified					
Item			Test method	Unit	1300CRH	1500SA	1500SF	1500SFU	1500ST	1900SE	1900SF
					Fast Cycle	Standard	High	High, UV	Super tough	PA+PP	PA+PP
Physical	Filler Contents		ISO 1172	%	-	-	-	-	-	-	-
	Specific Gravity		ISO 1183	-	1.14	1.11	1.10	1.11	1.08	1.06	1.08
	Water Absorption		ISO 62	%	1.70	1.60	1.50	1.50	1.40	1.40	1.40
	Mold Shrinkage	(Flow)	ISO 294	%	1.0	1.2	1.7	1.7	1.8	1.6	0.7
		(Trans-verse)		%	0.9	1.0	1.6	1.6	1.7	2.1	1.0
Mechanical	Tensile Strength		ISO 527	MPa	83	69	61	63	55	57	55
	Elongation at break		ISO 527	%	20	25	60	60	70	20	18
	Flexural Strength		ISO 178	MPa	110	94	81	83	72	81	77
	Flexural Modulus		ISO 178	MPa	2,960	2,560	2,150	2,200	1,840	2,190	2,150
	Charpy notched Impact Strength		ISO 179	kJ/㎡	5.5	10	17	14	50	14	16
	Rockwell Hardness		ISO 2039	R-scale	120	117	112	112	110	111	115
Thermal	Melt Flow Index (235℃, 2.16kg)		ISO 1133	g/10min	46	15	13	13	14[(a)]	9	8
	Melting Point		ISO 11357	℃	220	220	220	220	220	220	220
	Heat Deflection Temperature	0.45MPa	ISO 75	℃	195	180	165	165	120	160	160
		1.8MPa		℃	65	55	55	55	50	60	60
	Flammability		UL94	–	HB	HB	HB	HB	HB	HB	HB

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KEPAMID®-PA6

Grade					Mineral filler filled					
Item			Test method	Unit	1320M7	1325M7	1330M7	1515SM7	1525SM3	1340GM8
					MF20	MF25	MF30	MF15	MF25	GF/MF40
Physical	Filler Contents		ISO 1172	%	20	25	30	17	25	40
	Specific Gravity		ISO 1183	–	1.29	1.34	1.39	1.24	1.29	1.47
	Water Absorption		ISO 62	%	1.40	1.30	1.25	1.40	1.30	1.40
	Mold Shrinkage	(Flow)	ISO 294	%	0.7	0.6	0.6	0.7	0.6	0.6
		(Transverse)		%	0.6	0.5	0.5	0.8	0.5	0.6
Mechanical	Tensile Strength		ISO 527	MPa	77	74	80	64	56	135
	Elongation at break		ISO 527	%	5.0	3.5	3.0	8.0	20	2.0
	Flexural Strength		ISO 178	MPa	127	127	137	98	91	205
	Flexural Modulus		ISO 178	MPa	5,000	5,880	6,620	4,110	2,900	9,400
	Charpy notched Impact Strength		ISO 179	kJ/㎡	3.3	3.1	3.4	4	10	5.7
	Rockwell Hardness		ISO 2039	R-scale	117	117	117	117	117	120
Thermal	"Melt Flow Index (235℃, 2.16kg)"		ISO 1133	g/10min	21	20	17	8	7	25
	Melting Point		ISO 11357	℃	220	220	220	220	220	220
	"Heat Deflection Temperature"	0.45MPa	ISO 75	℃	205	205	205	190	185	220
		1.8MPa		℃	135	150	160	110	115	210
	Flammability		UL94	–	HB	HB	HB	HB	HB	HB

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(a) : Melt flow index condition 275℃, 2.16kg

Glass fiber reinforced								GF, UV	GF, Heat stabilized		GF, Impact		Flame retardant	
1320GF	1330GF	1335GF	1345GF	1350GF	1520GF	1530GF	1825GF	1533GFU	1315GFH	1330GFH	1310GSU	1315GSU	1500VT	1325GVS
GF20	GF30	GF35	GF45	GF50	GF20	GF30	Extrusion	GF33	GF15+H	GF30+H	GF+Imp	GF+Imp	Unfilled	GF+FR
20	30	35	45	50	20	30	25	33	15	30	8	15	–	25
1.27	1.37	1.41	1.51	1.56	1.27	1.36	1.31	1.38	1.25	1.36	1.16	1.21	1.11	1.58
1.40	1.25	1.25	1.00	1.00	1.40	1.25	1.25	1.25	1.45	1.25	1.45	1.45	–	–
0.4	0.3	0.3	0.2	0.2	0.4	0.3	0.3	0.3	0.5	0.3	0.6	0.5	1.3	–
0.6	0.5	0.5	0.3	0.3	0.6	0.5	0.5	0.5	0.6	0.5	0.7	0.6	1.1	–
142	172	191	210	212	135	155	105	180	132	163	83	105	60	127
4.5	3.0	3.0	2.5	2.0	3.0	2.5	2.5	3.0	3.0	3.0	3.0	3.0	110	2.8
210	245	277	312	310	200	225	155	260	187	230	118	150	81	215
6,450	8,700	9,900	12,800	14,500	6,000	8,500	6,700	8,800	5,200	8,150	3,450	4,600	2,100	8,900
7.5	11	14	16	16	6.5	70	7.5	12	6.5	10	7.3	10	20	10
120	120	120	120	120	120	122	119	120	121	121	112	117	117	120
14	6	3	2	1	10	6	2[(a)]	6	14	5	14	12	13	3
220	220	220	220	220	220	220	220	220	220	220	220	220	220	220
220	220	220	220	220	220	220	220	220	220	220	205	215	–	215
205	210	210	210	210	205	210	210	210	205	210	190	200	–	205
HB	HB	HB	HB	HB	HB	HB	HB	HB	HB	HB	HB	HB	V-2	V-0

3-2. KEPAMID®-PA66

Grade					Mold release	Impact modified			Glass fiber reinforced				
Item			Test method	Unit	2300MR	2300SE	2300SF	2300ST	2315GF	2320GF	2330GF	2333GF	2345GF
					Fast cycle	Standard	High	Super tough	GF15	GF20	GF30	GF33	GF45
Physical	Filler Contents		ISO 1172	%	–	–	–	–	15	20	30	33	45
Physical	Specific Gravity		ISO 1183	–	1.14	1.11	1.11	1.08	1.24	1.27	1.37	1.38	1.50
Physical	Water Absorption		ISO 62	%	1.30	1.20	1.20	1.10	1.00	0.90	0.70	0.70	0.50
Physical	Mold Shrinkage	(Flow)	ISO 294	%	2.3	2.0	2.0	2.6	0.7	0.6	0.5	0.5	0.3
Physical	Mold Shrinkage	(Trans-verse)	ISO 294	%	2.3	2.2	2.2	2.8	1.1	1.0	0.8	0.8	0.5
Mechanical	Tensile Strength		ISO 527	MPa	79	69	65	49	121	147	188	190	236
Mechanical	Elongation at break		ISO 527	%	30	60	30	32	2.0	4.0	3.0	3.0	3.0
Mechanical	Flexural Strength		ISO 178	MPa	116	93	93	67	194	225	271	275	355
Mechanical	Flexural Modulus		ISO 178	MPa	2,970	2,450	2,400	1,860	5,640	6,460	8,340	9,200	13,750
Mechanical	Charpy notched Impact Strength		ISO 179	kJ/㎡	4.1	14	15	76	5.5	7.0	11	11	15
Mechanical	Rockwell Hardness		ISO 2039	R-scale	120	115	115	110	122	121	121	121	121
Thermal	Melt Flow Index (275℃, 2.16kg)		ISO 1133	g/10min	55	35	30	5	23	20	12	8	5
Thermal	Melting Point		–	℃	260	260	260	260	260	260	260	260	260
Thermal	Heat Deflection Temperature	0.45MPa	ISO 75	℃	230	220	220	215	260	260	260	260	260
Thermal	Heat Deflection Temperature	1.8MPa	ISO 75	℃	75	65	65	60	245	250	255	255	255
Thermal	Flammability		UL94	–	V-2	HB	HB	HB	HB	HB	HB	HB	HB

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(a) : Melt flow index condition 275℃, 5kg

Heat stabilized & Glass fiber reinforced					GF, Impact modified		GF + MF reinforced		
2325GFH	2330GFH	2333GFH	2335GFH	2350GFH	2325GFS	2340GFS	2340GM3	2440GM7	2340GM8
GF25+H	GF30+H	GF33+H	GF35+H	GF50+H	GF25+Imp	GF40+Imp	GF/MF40	GF/MF40	GF/MF40
25	30	33	35	50	25	40	40	38	40
1.33	1.37	1.39	1.42	1.57	1.31	1.40	1.44	1.47	1.48
0.70	0.70	0.70	0.70	0.50	0.70	0.70	0.60	0.60	0.60
0.6	0.5	0.5	0.5	0.3	0.5	0.5	0.6	0.4	0.4
0.9	0.8	0.8	0.8	0.5	0.8	0.8	0.9	0.4	0.6
177	189	186	213	235	142	155	118	113	147
2.5	3.0	3.0	3.0	2.5	2.0	2.5	4.0	2.0	3.0
257	275	274	306	337	189	230	186	161	214
7,610	8,810	9,800	10,240	14,100	6,580	9,240	6,860	9,200	8,960
10	11	10	13	16	8.0	22	3.5	4.0	5.8
121	121	121	121	121	119	111	121	113	120
16	13	7	6	12[(a)]	3	0.2	12	10	12
260	260	260	260	260	260	260	260	260	260
260	260	260	260	260	260	260	255	255	255
255	255	255	255	255	250	255	235	220	235
HB	HB	HB	HB	HB	HB	HB	HB	HB	HB

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KEPAMID®-PA66

Grade					Mineral filler filled				Carbon fiber	Wear resistant	Flame retardant			
Item			Test method	Unit	2340M7	2340M8	2350GB	2333GB	2320CF	2330GFA	2300VT	2315GVS	2325GVF	2325GVS
					MF40	MF40	GB50	GB33	CF20	GF30+PTFE	FR	GF15+FR	GF25+FR+Imp	GF25+FR
Physical	Filler Contents		ISO 1172	%	40	40	50	33	20	30	–	15	25	25
	Specific Gravity		ISO 1183	–	1.50	1.51	1.56	0.97	1.22	1.46	1.16	1.51	1.55	1.56
	Water Absorption		ISO 62	%	0.60	0.60	0.50	0.70	–	–	1.30	0.70	0.60	0.60
	Mold Shrinkage	(Flow)	ISO 294	%	0.6	0.7	0.6	1.2	–	–	1.5	–	0.2	0.4
		(Transverse)		%	0.7	1.0	0.4	1.0	–	–	1.3	–	0.4	0.7
Mechanical	Tensile Strength		ISO 527	MPa	76	98	80	81	215	150	85	122	142	150
	Elongation at break		ISO 527	%	2.0	3.0	3.5	4.0	2.0	2.0	6.0	2.0	2.0	2.0
	Flexural Strength		ISO 178	MPa	125	165	134	142	290	205	123	166	209	213
	Flexural Modulus		ISO 178	MPa	8,350	8,520	5,895	4,020	13,000	7,250	3,420	6,300	8,200	8,660
	Charpy notched Impact Strength		ISO 179	kJ/㎡	2.5	3.0	2.5	1.8	6.0	10	4.1	4.6	10	7.5
	Rockwell Hardness		ISO 2039	R-scale	113	119	117	120	120	110	119	121	118	121
Thermal	Melt Flow Index (275℃, 2.16kg)		ISO 1133	g/10 min	30	30	24	30	7	3	65	6	7	11
	Melting Point		–	℃	260	260	260	260	260	260	260	260	260	260
	Heat Deflection Temperature	0.45MPa	ISO 75	℃	245	250	–	–	–	–	230	255	255	255
		1.8MPa		℃	220	225	–	–	–	–	85	235	235	235
	Flammability		UL94	–	HB	HB	HB	HB	HB	HB	V-0	V-0	V-0	V-0

3-3. KEPEX®-PBT

Grade					Unfilled	Toughened	Flame retardant	Glass fiber reinforced				
Item			Test method	Unit	3300M	3500SA	3700V	3315GF	3315GFS	3330GF	3730GF	3750GF
					Fast cycle	Toughened	Unfilled	GF15	GF15+ Imp	GF30	PBT+ PET GF30	PBT+ PET GF50
Physical	Filler Contents		ISO 1172	%	–	–	–	15	15	30	30	50
	Specific Gravity		ISO 1183	–	1.33	1.31	1.46	1.40	1.39	1.53	1.57	1.75
	Water Absorption		ISO 62	%	0.07	0.07	0.07	0.06	0.06	0.05	0.05	0.05
	Mold Shrinkage	(Flow)	ISO 294	%	2.1	2.2	2.5	0.7	0.8	0.4	0.4	0.4
		(Trans-verse)		%	2.1	2.2	2.5	1.1	1.0	0.8	0.8	0.8
Mechanical	Tensile Strength		ISO 527	MPa	63	55	69	99	88	138	149	152
	Elongation at break		ISO 527	%	11	16	4.0	3.0	4.0	3.0	2.0	1.0
	Flexural Strength		ISO 178	MPa	96	83	103	152	140	205	214	211
	Flexural Modulus		ISO 178	MPa	2,800	2,500	3,100	5,200	4,900	8,800	9,800	16,560
	Charpy notched Impact Strength		ISO 179	kJ/㎡	3.4	4.3	2.1	5.8	9.5	8.8	8.3	8.7
	Rockwell Hardness		ISO 2039	R-scale	118	117	119	118	117	119	119	119
Thermal	Melt Flow Index (250℃, 2.16kg)		ISO 1133	g/10min	68	32	46 [a]	33	25	21	20[a]	6[a]
	Melting Point		ISO 11357	℃	220	220	220/250	220	220	220	220/250	220/250
	Heat Deflection Temperature	0.45MPa	ISO 75	℃	–	155	150	220	220	220	220	220
		1.8MPa		℃	68	55	50	205	205	210	210	210
	Flammability		UL94	–	HB	HB	V-2	HB	HB	HB	HB	HB
Electrical	Dielectric Constant		ASTM D150	–	3.0	3.0	3.3	3.1	3.2	3.4	3.4	3.4
	Dissipation Factor		ASTM D150	–	0.002	0.002	0.007	0.002	0.002	0.002	0.002	0.002
	Volume Resistivity		ASTM D257	Ω · cm	10^{16}	10^{16}	10^{16}	10^{16}	10^{16}	10^{16}	10^{16}	10^{16}
	Dielectric Strength		ASTM D149	KV/mm	18	18	20	21	21	22	22	22

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3-3. KEPEX®-PBT

Grade					Glass fiber reinforced		Flame retardant & Glass fiber reinforced				Mineral filler filled		
Item			Test method	Unit	4345GF	3930GFU	3315GVS	3315GVU	3330GVS	3330GVT	3725M7	3730GM5	3330GB
					PET GF45	GF30+ low warpage	GF15 + FR	GF15+ FR +UV	GF30+ FR	GF30+ FR toughened	MF25	GF/MF30	GB30
Physical	Filler Contents		ISO 1172	%	45	30	15	15	30	30	25	30	30
Physical	Specific Gravity		ISO 1183	–	1.70	1.48	1.54	1.55	1.67	1.63	1.54	1.56	1.53
Physical	Water Absorption		ISO 62	%	0.05	0.05	0.06	0.06	0.05	0.05	0.06	0.05	0.05
Physical	Mold Shrinkage	(Flow)	ISO 294	%	0.4	0.3	0.7	0.7	0.4	0.4	1.5	0.4	0.4
Physical	Mold Shrinkage	(Trans-verse)	ISO 294	%	0.8	0.5	1.2	1.2	0.7	0.7	1.5	0.8	0.8
Mechanical	Tensile Strength		ISO 527	MPa	172	120	96	88	130	128	51	119	56
Mechanical	Elongation at break		ISO 527	%	1.5	2.0	3.5	3.0	3.0	2.0	1.5	2.0	3.0
Mechanical	Flexural Strength		ISO 178	MPa	255	168	147	132	201	188	89	174	102
Mechanical	Flexural Modulus		ISO 178	MPa	14,250	8,080	5,390	5,880	9,790	9,190	5,680	9,330	4,160
Mechanical	Charpy notched Impact Strength		ISO 179	kJ/㎡	9.8	7.3	4.0	3.5	6.5	8.6	2.0	5.6	2.1
Mechanical	Rockwell Hardness		ISO 2039	R-scale	118	115	120	120	120	116	112	119	117
Thermal	Melt Flow Index (250℃, 2.16kg)		ISO 1133	g/10min	21[(b)]	14	28	35	19	15	53[(a)]	25[(a)]	21[(c)]
Thermal	Melting Point		ISO 11357	℃	250	220	220	220	220	220	220/250	220/250	220
Thermal	Heat Deflection Temperature	0.45MPa	ISO 75	℃	250	210	218	215	220	220	195	220	220
Thermal	Heat Deflection Temperature	1.8MPa	ISO 75	℃	225	200	200	200	210	210	100	210	210
Thermal	Flammability		UL 94	–	HB	HB	V-0	V-0	V-0	V-0	HB	HB	HB
Electrical	Dielectric Constant		ASTM D150	–	3.4	–	3.2	3.2	3.5	3.7	3.2	3.4	3.4
Electrical	Dissipation Factor		ASTM D150	–	0.002	–	0.002	0.001	0.002	0.002	0.002	0.002	0.002
Electrical	Volume Resistivity		ASTM D257	Ω · ㎝	10^{16}	–	10^{16}	10^{16}	10^{16}	10^{16}	10^{16}	10^{16}	10^{16}
Electrical	Dielectric Strength		ASTM D149	KV/mm	22	–	17	17	18	19	18	22	22

*It is the sole responsibility of the users to investigate whether any existing patents are infringed by the use of this product. This product is not intended for use in medical and dental implants and users should meet all safety and health standards. KPAC makes no warranty and assumes no liability in connection with any use of this information.

(a) : Melt flow index condition 265℃, 2.16kg (b) : 290℃, 2.16kg (c) : 250℃, 5kg

4. Injection molding guide

4-1. Equipment

Injection molding is a manufacturing process for producing parts from both thermoplastic and thermosetting plastic materials. It is important to understand the process of injection molding in order to obtain high quality products.

One cycle of the injection molding process is simple. Material is first dried at the recommended drying condition, and then it is fed into a heated barrel, mixed, and forced into a mold cavity where it cools and hardens to the configuration of the mold cavity.

More specific guidelines are :

1) The non-return valve or check ring should be regularly checked to achieve holding pressure and a proper amount of cushion, otherwise some issues such as sink marks, or variations of weight and dimension of the molded parts can occur.

2) An open nozzle is recommended for individual band heaters on the cylinder in order for separate heat control. It should be noted that it is very dangerous if the nozzle cools and the melted material hardens because the solid material will block the nozzle, which will cause a pressure increase inside the cylinder.

3) The compression zone in the screw is recommended to be in the range of 25~30 %. If the compression zone is too small, the melted material can be decomposed due to excessive shear heating.

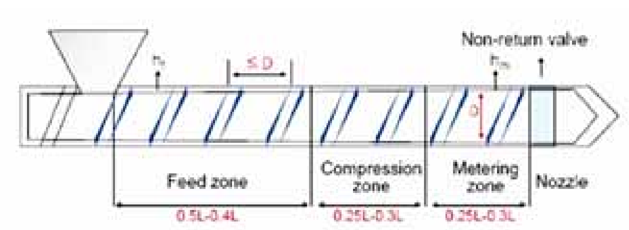


Figure 1. Typical injection molding screw for PA, PBT

<Recommendation for injection molding machine>

1) The one shot weight: 20 ~ 50 % of machine capacity
2) Screw diameter: Small or medium
3) Compression ratio: 3/1 ~ 4/1
4) L/D: More than 20

4-2. Injection molding

In mold fabrication, it is essential to previously review the dimensional precision, flow characteristics of the raw material, consistency of the product, cost-effectiveness, etc.

4-2-1. Pre-drying

Pre-drying of PA6 and PA66 is very important because they are hydrophilic materials, which can easily absorb water and cause a surface problem on the molded article. Sometimes, the injection molding process for these materials is difficult due to an excessive drooling problem. In addition, even though PBT and PET belonging to polyester groups rarely absorb water, they can become degraded while processing due to hydrolysis reaction. When hydrolysis reaction occurs, it can cause deterioration of the material's tensile and impact strength and surface issues such as flashes or silver streaks on the molded articles.To minimize the problem caused by water absorption, the water content of the material's pellets should be maintained below 0.02 %. Especially, because PET can absorb water faster than PBT, it should be dried thoroughly for good quality of the molded articles.

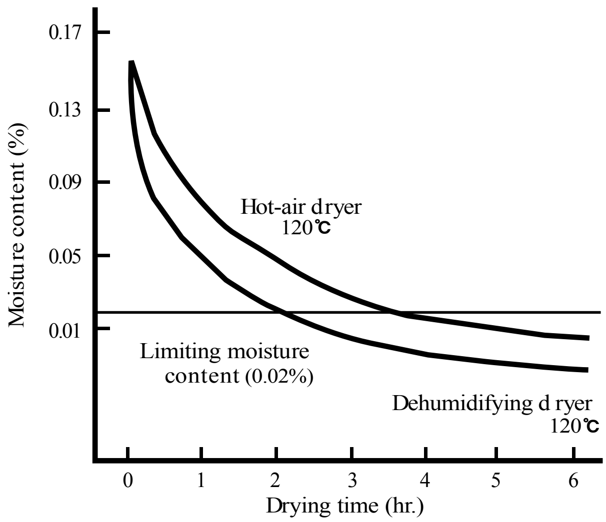


Fig 2. Water content of PET with drying time

Pre-drying conditions of PA6, PA66, PBT and PET are as follows.

Polymer	Dryer type	Tempera-ture	Time	Water Content
PA6 PA66	Dehumidifying Hopper	80℃ 90℃	4~6h 6~8h	0.05%
PBT PET	Hopper	120~130℃	3~5h	0.02%

As KEPAMID® is packed after its water content is thoroughly controlled the material is ready to use without pre-drying after opening the bag. However, if the bag is opened and exposed to air for a long time, pre-drying is necessary.

As KEPEX® is also packed after its water content is thoroughly controlled, the material is also ready to use without pre-drying after opening the bag. However, after the bag is opened and exposed to air for a long time, pre-drying is necessary. It should be dried at 120~130℃, for 3~5 hours. If the temperature is below 100℃, the drying effect will not be significant. In addition, if the temperature is above 150℃, the material can experience unfavorable effects such as oxidation and discoloration. When the material is dried at a proper temperature around 120℃, it can fully achieve the pre-drying effect.

4-2-2. Melt temperature

The melt temperature is generally higher than the set cylinder temperature due to shear heating of the screw rotation. The recommended cylinder temperatures are as follows:

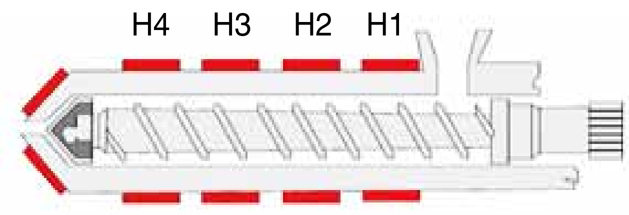


Fig 3. Cylinder temperature set

Polymer	Grade	H4	H3	H2	H1
PA6	Unfilled	240	240	240	230
	Impact	250	250	250	240
	Glass fiber	260	250	250	250
	Mineral filler	250	240	245	230
PA66	Unfilled	275	275	275	270
	Impact	285	280	280	270
	Glass fiber	290	285	285	280
	Mineral filler	290	285	285	280
	Unfilled FR*	275	265	270	260
	GF, FR*	300	290	285	280
PBT	Unfilled	250	240	240	230
	Unfilled FR*	245	235	245	230
	Glass fiber	250	250	240	230
	GF, FR*	250	240	245	230
PET	Glass fiber	290	280	270	260
	GF, FR*	280	275	270	260

* FR : Flame etardant

4-2-3. Injection pressure

Injection pressure should be set high enough to achieve a high injection speed that may not be lowered by a low injection pressure. The appropriate injection pressure range is between 800 ~ 2000 bar.

4-2-4. Mold temperature

The mold temperature is one of the most important parameters for injection molding of crystalline polymer in particular. The mold temperature may be widely set at 60 ~ 120°C, and a general recommendation is 70 ~ 90°C for general purpose use of KEPAMID® and KEPEX®.

If surface finish is important or the service temperature of a finished part is expected to be high, a higher mold temperature is recommended.

To obtain a good quality product, the mold temperature must be consistently maintained so that the temperature distribution in the mold may be achieved uniformly.

4-2-5. Injection speed

The injection speed should be determined by part geometry, gate size and location, surface features, flow characteristics, mold temperature, etc. In general, injection speed is set to high when there are flow marks, record marks, and sink marks; on the other hand, a low injection rate is good to prevent jetting, flush, burn marks, or gate

smears, which are generated by high shear force against the cavity wall.

4-2-6. Hold pressure

Hold pressure plays a key role in optimizing parts in not only dimension, but also in mechanical and physical properties. Because in the hold stage (hold/pack), remaining melted for about 1~5 % of a cavity is forced to fill into the cavity to compensate for the volume contraction during cooling. The hold (pack) time must be set to slightly exceed the gate seal time (normally ½ to 1 sec) at which a gate is completely solidified so that a constant product may be obtained. As shown in Figure 4, the weight of a molded part increases upon the hold pressure time and then stops at a certain point.

At this time, the gate of the part is solidified entirely and no more material can be incorporated. Finally, the part weight becomes constant after the gate seal time.
It is recommended that the hold pressure time be maintained until the gate seal is completed. Because the gate sealing time changes mostly upon the shape of cross-section and mold temperature, a proper hold pressure time must be determined such that the weight and dimension of a molded product are within a certain range.
By setting optimum hold pressure, molded parts products with consistent dimensions can be produced. As a rule of thumb, the hold time can be simply calculated by multiplying wall thickness (mm) times 8.
The hold pressure must be set in consideration of dimensional requirements. As a rule, hold pressure amounts to between 60-90 % of the injection pressure.

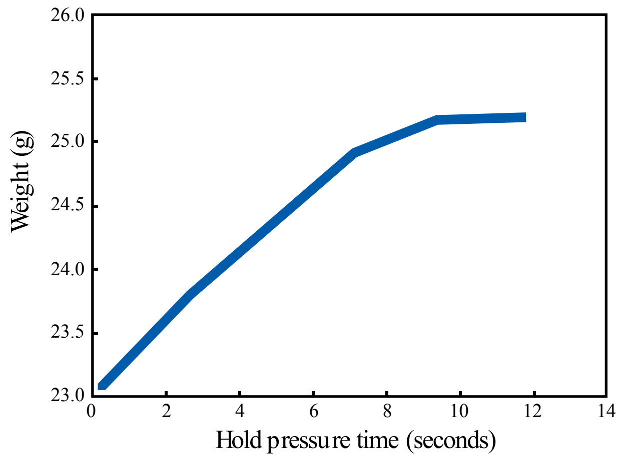


Fig 4. Hold pressure time and product weight

4-2-7. Plasticizing

Because a fast screw speed can cause material to decompose by high shear force, the reciprocating speed is preferably set as low as possible unless it affect cycle time. Generally, 80 ~ 120 screw RPM is recommended. But because screw speed is dependent on the screw diameter, the screw speed should be decreased with larger screw diameters.
A back pressure of 50 ~ 100 bar (hydraulic pressure usually 5 ~10 bar) is generally appropriate. However, to increase the efficiency of the dispersion of a color master-batch (color concentrates) or pigment, higher mixing by increasing back pressure may be required.
In addition, high back pressure may be used to eliminate un-melted particles. In the case of glass fiber reinforced grades, high back pressure, proportional to rotational speed leads to breakage of the glass fiber, resulting in deterioration of mechanical strength. More importantly, excessive back pressure gives rise to lower output along with longer cycle times. Therefore, it should be taken into consideration when optimizing the back pressure.

4-2-8. Cooling

The total cooling time is determined as the sum of “hold pressure time + screw retraction time + a shot safety margin”.
Once material is entirely solidified, no additional cooling time is needed. Most of the time affecting the cooling time is the hold time. Therefore, if hold pressure time is set appropriately, only screw retraction time needs to be taken into account.

| Calculation of theoretical cooling time |

$$S = \frac{t^2}{\pi^2 \alpha} \ln \left[\frac{8}{\pi^2} \frac{(T_c - T_m)}{(T_x - T_m)} \right] \qquad \alpha = \frac{R}{C_p \rho}$$

- S = Theoretical cooling time
- t = Maximum part wall-thickness
- α = Thermal diffusivity of material
- R = Thermal conductivity
- Cp = Specific heat
- T_x = Ejection temperature of molding
- T_m = Mold temperature
- T_c = Cylinder temperature

4-3. Change material / Interruption

4-3-1. Changing material

In general, the cylinder has to be cleaned with a polyethylene or polypropylene before and after processing. To prevent foreign material contamination and establish quality control, materials should be changed as little as possible.

4-3-2. Cleaning

If the molding cycle is stopped for a long time, the material in the cylinder can be decomposed and finally carbonized. This carbonized material is not easily separated from the screw. However, when the temperature is cooled down to room temperature, it can be contracted and separated from the screw, but imparts bad effects on the next molding. Therefore it is necessary, sometimes, to disassemble the screw and clean the carbonized material thoroughly.

5. Troubleshooting guide

Problem	Causes	Remedies
Sticking in cavity	· Higher resistance to eject force · Insufficient cooling time	· Decrease injection pressure and check for undercut or insufficient draft · Clean mold surface · Increase the number of ejecting pins · Lower the mold temperature and increase mold close time
Short shot	· Insufficient flowability by low melt or mold temperature · Improper design with small gate or narrow flow channel · Unbalanced filling · Insufficient metering stroke	· Increase the cylinder temperature and mold temperature. · Increase injection pressure and speed · Enlarge the gate · Adjust runner balance · Increase metering stroke
Pit mark	· Low injection speed · Low hold pressure · Low melt or mold temperature	· Increase injection speed · Increase injection and hold pressure · Increase melt or mold temperature
Flow mark	· Slow injection speed · Low mold temperature	· Increase injection speed · Change the gate location or enlarge gate size · Increase mold temperature
Silver streak	· High moisture in granule · Decomposition by over-heating · Insufficient gas vent · Air trapped in the cylinder · Contamination	· Dry at proper conditions · Lower the cylinder temperature or shorten residence time in cylinder · Check for gas vents · Increase back pressure · Check for contamination
Discoloration or burn mark	· Over-heating or too long residence time in cylinder · Insufficient gas vents · Fast injection speed	· Lower the cylinder temperature · Check for gas vents · Decrease injection speed
Contamination	· Contamination with other material · Black specks	· Take precautions on handling · Clean the cylinder
Flash	· Low clamping force · Too high injection pressure or holding pressure · Too fast injection speed · Mold wear	· Increase clamping force · Lower injection pressure or holding pressure · Lower injection speed · Repair mold
Sink and void	· Insufficient holding pressure · Wear of non-return valve · Improper cushion	· Increase holding pressure and time · Increase mold temperature · Gating at thick wall · Inspect for non-return valve

6. UL approval

Accredited UL standards of KEPAMID®, KEPEX® File No. : E120354

Grade	Color	Min. Thk (mm)	UL94 Flame Class	Relative temperature index(℃)			HWI	HAI	HVTR	D495	CTI
				Elec	Imp	Str					
1(@)00CR(+)	All	0.8 3.2	HB	65	65	65	3	0	0	5	0
1(@)25GV(+)	All	0.8 3.2	V-0	65	65	65	2 0	0	2	7	2
1@(b)GF+	All	0.8 3.0	HB	65	65	65	3 2	0	0	6	0
2300VT	All	0.8 3.2	V-0	65	65	65	4 3	0	1	5	0
2325GV+	All	0.8 3.2	V-0	130 130	115 115	130 130	0	0	3	7	1
2@(b)GF+	All	0.8 3.2	HB	65	65	65	3 1	0	1	5	0
3300V(+)	All	0.8 3.2	V-0	75	75	75	4 2	0	2	7	0
3330GV+	NC, BK	0.8 3.2	V-0	75	75	75	4 0	0	3	6	3
3@(b)GF+	All	0.8 3.2	HB	75	75	75	4 1	0	2	6	1

@ : one digit denoting viscosity number,

(b) : denotes glass fiber contents 10 ~ 45%

+ : Suffix optional A ~ Z

7. Applications

KEPAMID®-PA6

1


2


3


4


5


6


1. Outside door handles
2. Timing belt cover
3. Oil reservoir tanks
4. Door garnish moldings
5. Seat parts
6. Wind direction adjusters

KEPAMID®-PA6

7. Clips
8. Power tool housing
9. Electric cooker parts
10. Refrigerator hinge and roller
11. Fencing guard

KEPAMID®-PA66

1

2

3

4

5

6

1. Ashtray
2. Fuse box
3. Insulating discs
4. Alternator cover, spool
5. Seat lever
6. TGS Bracket

KEPAMID®-PA66

7

8

9

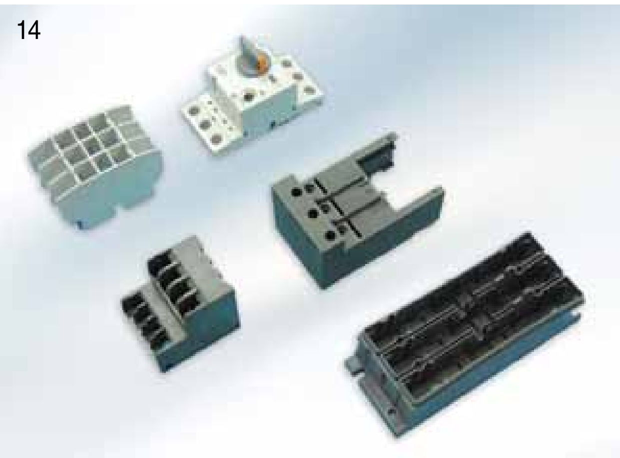
10

11

12

7. Brush holder
8. Tension pulley
9. Fuel valve floats
10. Accelerator pedal
11. Fan
12. Lid filler door

13


14


15

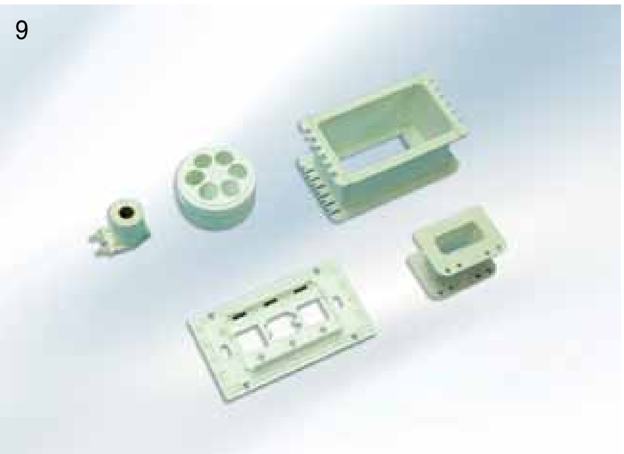

16

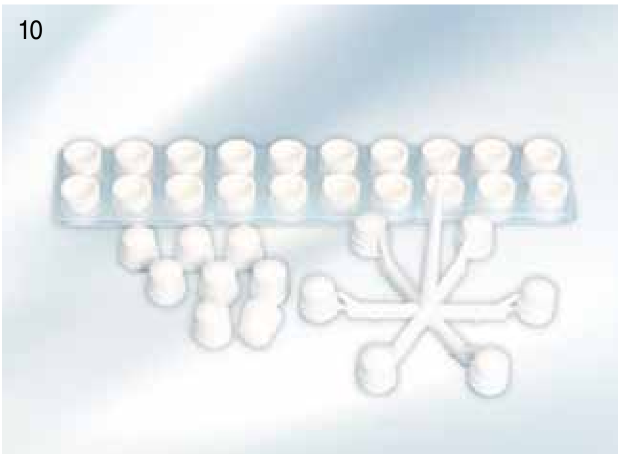

13. Shroud
14. MCCB
15. Boiler Caps
16. Guard of policemen

KEPEX®-PBT

1. Air vent wing
2. Door latch housing
3. Wiper arm and blade
4. Air flow meter
5. Motor bracket
6. Lamp bezel

KEPEX®-PBT





7. Handle sensor base/Dust cover
8. Wiper nozzle
9. Electric parts
10. Contact lens frame
11. Wig

8. Quality and standard accreditation

Korea Polyacetal Co., Ltd. is committed to creating profitable future for customers and has met the requirements of international quality accreditation systems such as IATF 16949 and ISO 14001, starting with ISO 9001.

Furthermore, we have obtained standard accreditations from UL, CSA, NSF and BS6920, compliance to FDA, and have established global excellence in terms of quality and stability.

Classification	Accreditation standard
System standard	- IATF 16949 - ISO 9001 - ISO 14001 - ISO 45001

- IATF 16949 : Integrated quality management system in automotive
- ISO 9001 : Quality management system
- ISO 14001 : Environment management system
- ISO 45001 : Safety and health management system

Standard accreditation certificate

ISO 9001

ISO 14001

IATF 16949

ISO 45001

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