Introduction to SKYPURA

SK Chemicals Engineering Polymer Team

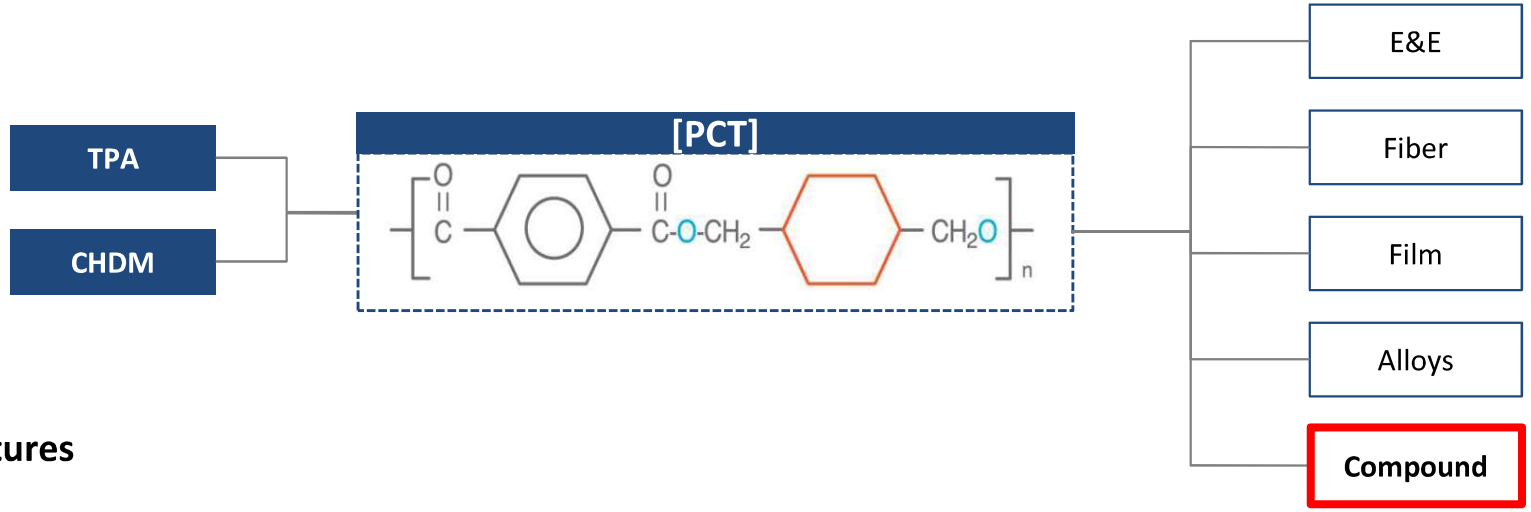
SKYPURA Overview

SKYPURA (PCT) is produced by reacting TPA and CHDM (1,4-cyclohexane dimethanol)

PCT

PCT (Poly Cyclohexylene dimethylene Terephthalate) is a high-performance engineering polyester plastic.

Due to its excellent thermal, hydrolysis stability and electrical properties, PCT can provide various mechanical and electrical advantages.

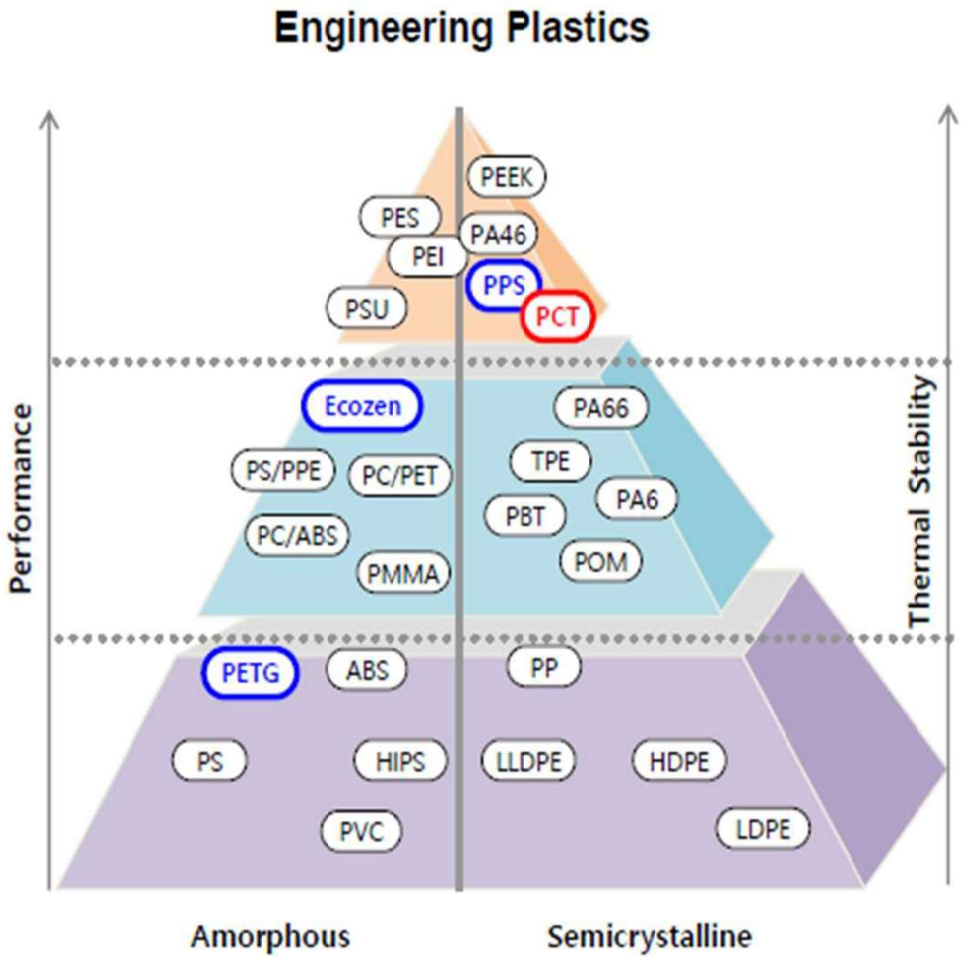


Main Key Features

- ✓ High heat resistance & Stability
- ✓ Good chemical resistance against alkaline agent and solvents
- ✓ Low moisture absorption & Excellent hydrolysis resistance
- ✓ Excellent Electrical Properties (CTI, GWT) & Excellent Metal adhesion
- ✓ Low oligomer
- ✓ Light weight
- ✓ Suitable for SMT connector

SKYPURA Overview

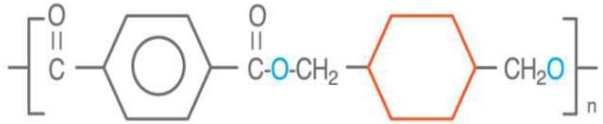
SKYPURA (PCT) is high performance polyester. It has excellent thermal, hydrolysis stability and electrical properties.



*EP: Engineering Plastic

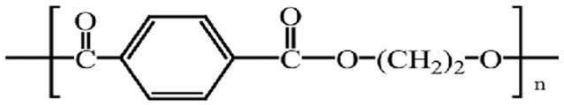
Comparison of PCT molecular structure with other EP

PCT — Tm 290 °C, Tg 90 °C

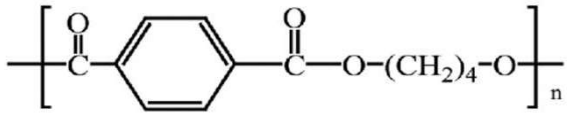


vs

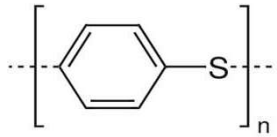
PET — Tm 250 °C, Tg 90 °C



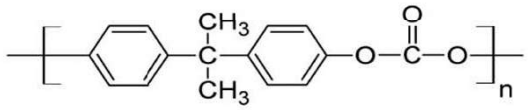
PBT — Tm 220 °C, Tg 44.5 °C



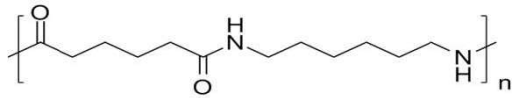
PPS — Tm 290 °C, Tg 90 °C



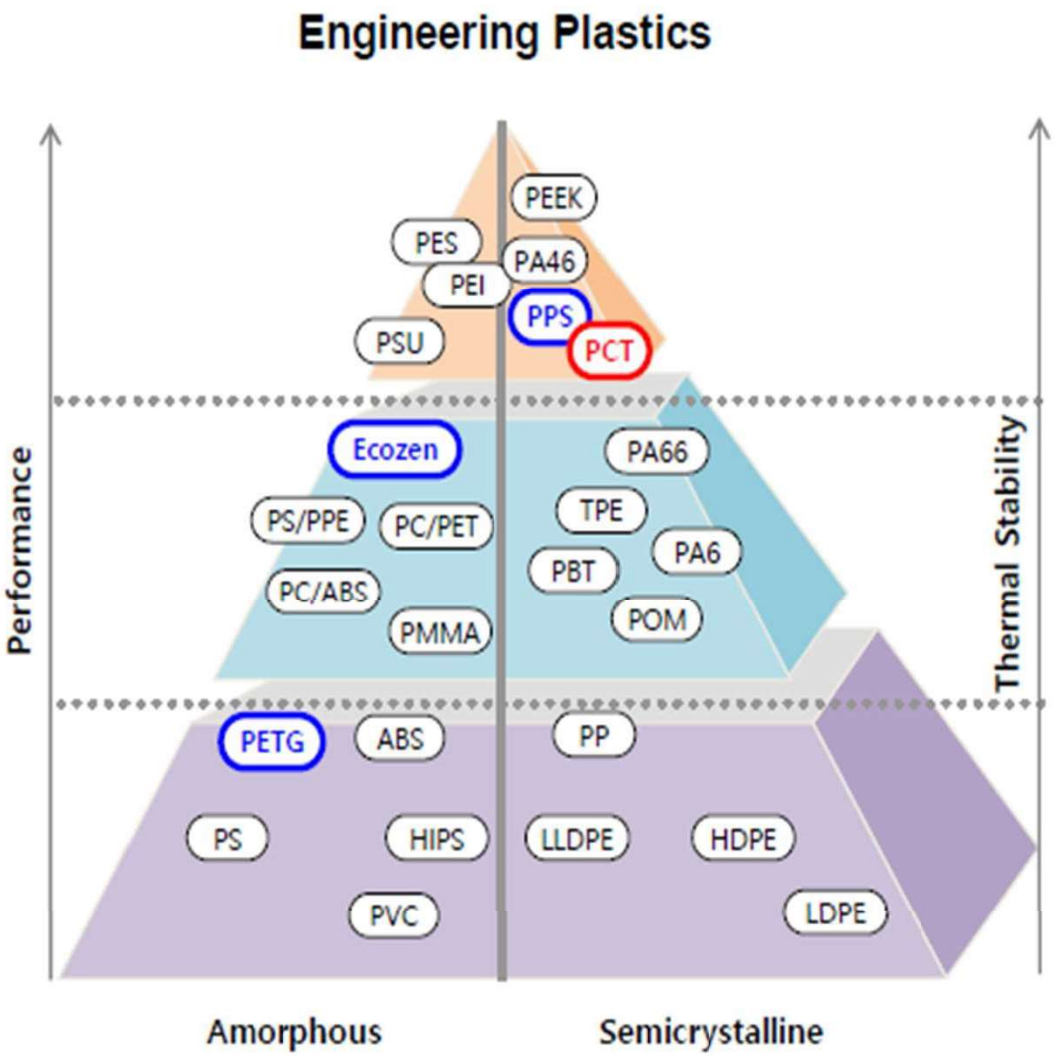
PC — Tg 147 °C



PA66 — Tm 260 °C, Tg 60°C



SKYPURA Overview



Typical Application Areas of PCT

E&E :
- LED Reflector
- Automotive Engine parts
- Electronic parts

Compounds :
- Connectors
- Food Containers
- Automotive Engine part
- Industrial / Electronic parts

Film :
- Optical film (for high temp. treatment)
- Coating film for electronics
- Back sheet for Photovoltaic

Fiber :
- Iron back pad
- Paint roll brush
- Industrial bag filter (PMC)

Application

SKY PURA

LED Reflector

- High Reflectance and Color stability
- Hydrostability

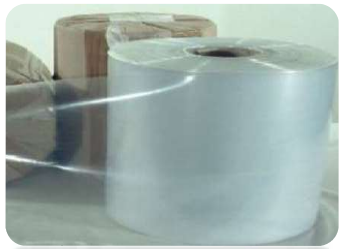
Connector

- Long-term Heat Stability
- Low Moisture Absorption
  (= Dimensional Stability)
- High HDT
- High CTI grade

Oven Tray

- FDA Approvals
- High HDT
- Food Detachment after cooking

Film



- Chemical Resistance
- Low Out-gassing
- Hydrostability

Fiber

- Chemical Resistance
- Anti-Hydrolysis

Introduction of SKYPURA for Connector Application

SKYPURA

Advantages of SKYPURA for Connector Application

▣ Why SKYPURA?

1. High Heat resistance & Stability

Due to **Lead free soldering** and **SMT production process**, high thermal properties are required
SKYPURA (PCT) has substantial thermal stability (Max 270°C to -40°C)

2. Excellent Electrical properties and Flame-retardant

SKYPURA(PCT) has high level of electrical properties in CTI (PLC1), HAI (PLC0) and Flame retardant properties (UL94: V-0)

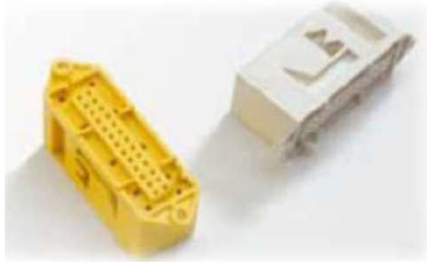
3. Chemical resistance

SKYPURA (PCT) has excellent chemical resistance against gasoline, break oil, including cleansing chemicals on PCB

4. Excellent hydrolysis resistance and weatherability

Due to chemical structure of PCT, SKYPURA shows superior hydrolysis resistance and weatherability

5. Good Color stability



Product Line up (Compounds)

◆ Technical Data of PCT Compounding Grades for Connector Applications

ISO	Test Method	Unit	Grade			
			7111F	7121F	7122T	7122TA
Flame Retardant			Y	Y	N	N
Glass Fiber %			15%	30%	30%	30%
Color			BK, NC	BK, NC	BK, NC	BK, NC
Classification	**Test Method**	**Unit**	**Technical Data Sheet**			
Mechanical Properties						
Tensile Strength	ISO 527	MPa	100	115	121	110
Tensile Strain	ISO 527	%	1.8	1.5	2.6	2.0
Tensile Modulus	ISO 527	MPa	5,000	10,800	7000	7000
Flexural Strength	ISO 178	MPa	145.0	175.0	180	160
Flexural Modulus	ISO 178	MPa	7,300	10,800	8000	6800
Impact Charpy Notched	ISO 179	kJ/m^2	6	6	11	10
Impact Charpy Unnotched	ISO 179	kJ/m^2	30	30	55	50
Thermal Properties						
Melting Temperature	ISO 11357-1/-3	℃	280	287	287	287
HDT @ 0.45 Mpa	ISO 75	℃	-	270	270	260
HDT @ 1.82 Mpa	ISO 75	℃	235	250	260	240
Flammability @ 0.8 mm	UL94	-	V-0	V-0	-	-
Flammability @ 1.5 mm	UL94	-	V-0	V-0	HB	HB
Flammability @ 3.0 mm	UL94	-	V-0	V-0	HB	HB
RTI Elec @ 0.8mm	UL 746B	℃	50.0	150	-	-
RTI Elec @ 1.5mm	UL 746B	℃	50.0	150	50.0	50.0
RTI Elec @ 3.0mm	UL 746B	℃	50.0	150	50.0	50.0

* (HDT = Heat Distortion Temperature) / (C.T.I = Comparative Tracking Index)

1) Information inserted in this document such as data, statements, representative values, etc. are provided solely for customer convenience.
2) It does not expressly or impliedly guarantee anything

Product Line up (Compound)

ISO	Test Method	Unit	Grade			
			7111F	7121F	7122T	7122TA
Flame Retardant			Y	Y	N	N
Glass Fiber %			15%	30%	30%	30%
Color			BK, NC	BK, NC	BK, NC	BK, NC
Classification	**Test Method**	**Unit**	**Technical Data Sheet**			
RTI Imp @ 0.8mm	UL 746B	℃	50.0	140	-	-
RTI Imp @ 1.5mm	UL 746B	℃	50.0	140	50.0	50.0
RTI Imp @ 3.0mm	UL 746B	℃	50.0	140	50.0	50.0
RTI Str @ 0.8mm	UL 746B	℃	50.0	140	-	-
RTI Str @ 1.5mm	UL 746B	℃	50.0	140	50.0	50.0
RTI Str @ 3.0mm	UL 746B	℃	50.0	140	50.0	50.0
Physical Properties						
Specific Gravity (Density)	ISO 1183	g/cm3	1.6	1.62	1.45	1.44±0.03
Mold Shrinkage MD	ISO 294-4	%	0.4	0.3	0.2	0.2
Mold Shrinkage TD	ISO 294-4	%	0.9	0.9	0.8	0.8
Electrical Properties						
C.T.I	IEC 60112	PLC	-	PLC 1	PLC 0	PLC 0
Dielectric Strength	IEC 243	kV/mm	-	20	16	16
Dielectric Constant @ 1 GHz	IEC 60250	-	-	3.0	3.0	3.0
Dielectric Constant @ 100 Hz	IEC 60250	-	-	3.1	3.1	3.1
Dielectric Constant @ 10 Hz	IEC 60250	-	-	3.2	3.2	3.2
Dissipation Factor @ 1 GHz	IEC 60250	-	-	0.009	0.01	0.01
HWI @ 0.7mm	UL 746A	PLC	-	PLC 0	-	-
HWI @ 1.5mm	UL 746A	PLC	-	PLC 0	-	-
HWI @ 3.0mm	UL 746A	PLC	-	PLC 0	-	-
HAI @ 0.7mm	UL 746A	PLC	-	PLC 0	-	-
HAI @ 1.5mm	UL 746A	PLC	-	PLC 0	-	-
HAI @ 3.0mm	UL 746A	PLC	-	PLC 0	-	-
HVTR	UL 746A	PLC	-	PLC 1	-	-
IPT	ASTM D2303	kV	-	1.5kV	-	-
Volume Resistivity	ASTM D257/ IEC 60093	Ohms.cm	-	1.0E+14	-	-

II. Characteristics of PCT

SKYPURA

PCT (Polycyclohexylenedimethylene Terephthalate)

High Heat Resistance & Stability

SKYPURA (PCT) shows high HDT ℃ compared to other materials

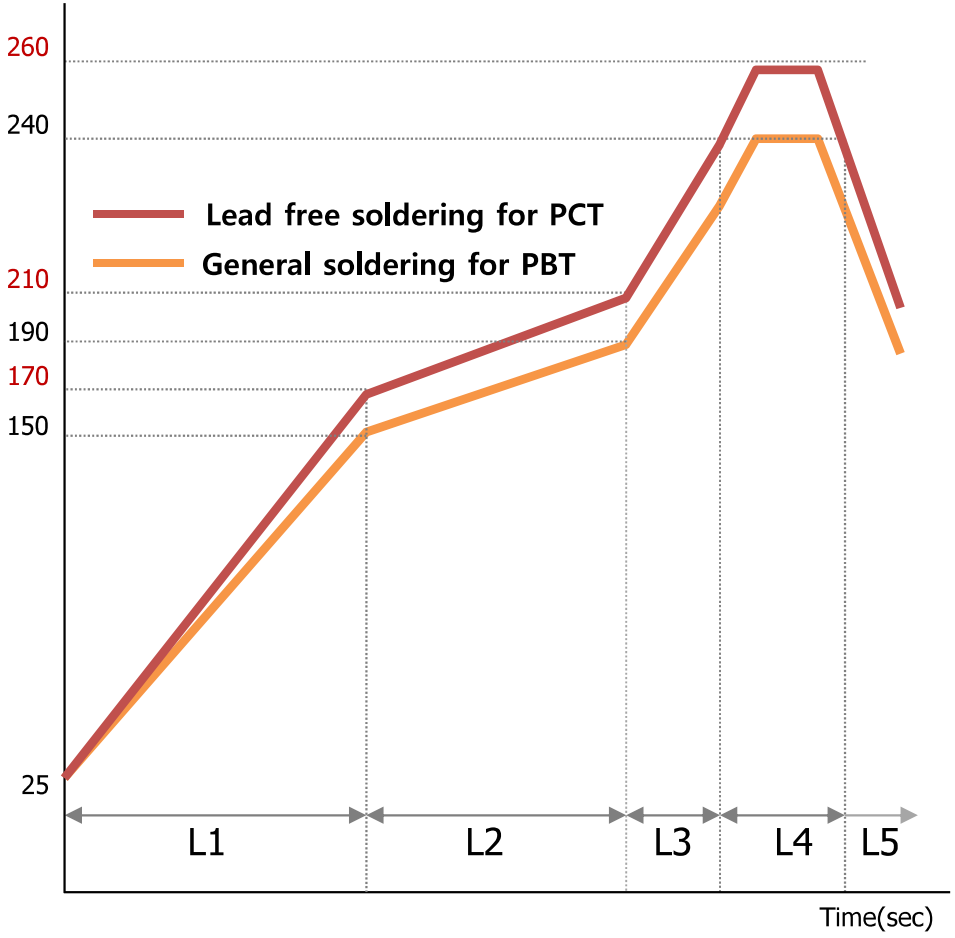
classification		Method	Unit	PCT		PBT	PA66, PA6T		PA46		PA9T		LCP
				7121F	7122T	BASF, B4300G6	70G33L	FR52G30NH	TS256F6	TS250F6	GN2330	G1300H	Celanese E130i
Density		ISO 1183	g/cm^3	1.62	1.45	1.53	1.39	1.44	1.56	1.68	1.62	1.37	1.61
Moisture		ISO 62	%			0.40%	1.20%	-	1.45%	1.50%	1.00%	1.60%	0.03%
Mold Shrinkage	MD	ISO 294-4	%	0.3	0.3	0.34	0.3	0.3	0.3	0.4	0.1	0.2	0.1
	TD		%	0.9	0.9	1.07	1.1	1	1	1.1	0.6	0.8	0.5
Tensile Properties	Strength	ISO 527	Mpa	111	121	135	140	130	170	125	185	160	150
	Strain		%	1.4	2.6	2.5	5	2	2	3.5	4	4	1.6
	Modulus		Mpa	10,800	7,000	10,000	8,000	10,500	12,000	8,000	-	-	15,000
Flexural Properties	Strength	ISO 178	Mpa	155	180	260	200	200	-	2	240	205	225
	Modulus		Mpa	10,800	7,000	10,000	6,000	10,000	10,000	7,300	11,000	8,500	15,000
Impact Charpy	Notched	ISO 179	kJ/m^2	6	11	11	17	7	8	11	10	11	22
	Unnotched		kJ/m^2	30	55	67	100	-	-	-	-	-	43
HDT	@0.45Mpa	ISO 75	℃	270	270	220	261	-	290	290	-	-	-
	@1.82Mpa		℃	250	260	215	252	283	290	290	285	290	275

High Heat Resistance & Stability

SKYPURA **(PCT)** has good thermal properties which is crucial for SMT production process.

Since the HDT of PCT is higher than that of PBT, high temperature SMT process is possible for PCT

< SMT setting profile for PCT >



Zone	L1	L2	L3	L4	L5
function	Start to increase	Warm up	heating	Soldering	cooling
For PBT	25~150	150~190	190~217	217~217	-
For PCT	25~170	170~210	210~237	237~237	
Time (sec.)	70	60~120	90~120		

Peak Temp. - MAX 245 ℃ → 265 ℃, 10sec Min.

Excellent Electrical properties and Flame-retardant

SKYPURA **(PCT)** has high level of electrical properties in CTI (PLC1), HAI (PLC0) and Flame retardant properties (UL94: V-0)

Component - Plastics
File Number: E215991

SK CHEMICALS CO LTD
310 Pangyo-ro Bundang-gu
Seongnam-si, Gyeonggi-do 13494 Republic of Korea

SKYPURA 7121F($)

Polycyclohexylene Dimethylene Terephthalate (PCT), pellets
($) - Should be replaced by three numbers and/or letters

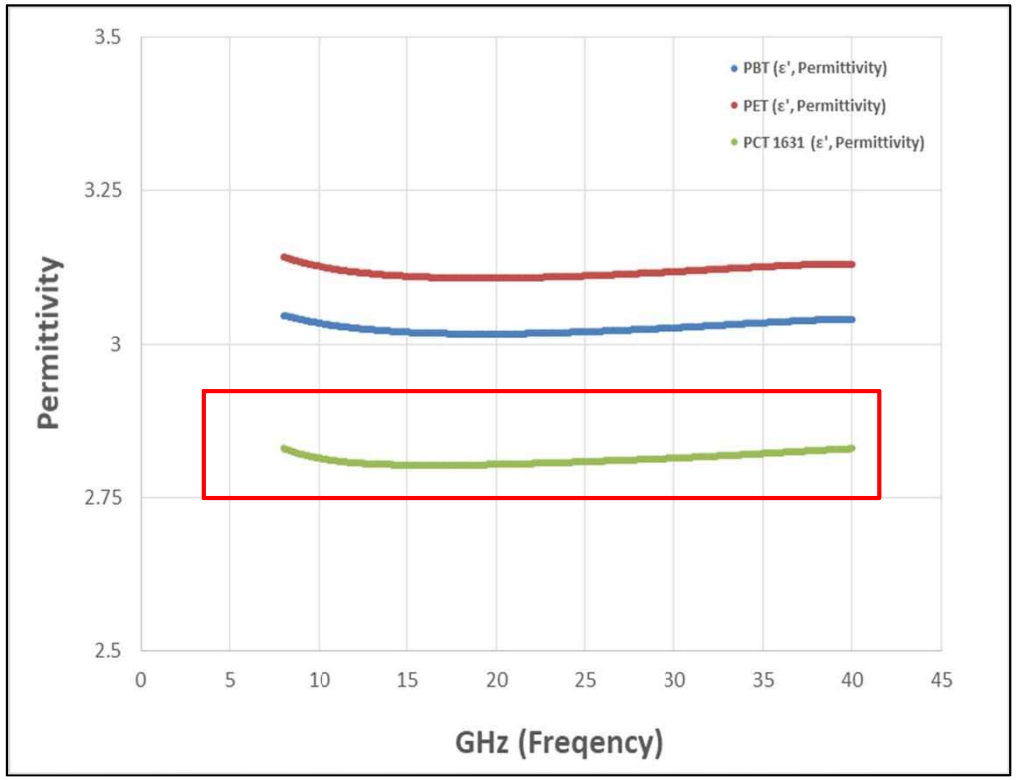
Flammability	Value	Test Method
Flame Rating		UL 94 IEC 60695-11-10, -20
0.8 mm, NC, BK	V-0	
1.5 mm, NC, BK	V-0	
3.0 mm, NC, BK	V-0	
Electrical	**Value**	**Test Method**
Hot-wire Ignition (HWI)		UL 746A
0.8 mm	PLC 3	
1.5 mm	PLC 3	
3.0 mm	PLC 0	
High Amp Arc Ignition (HAI)		UL 746A
0.8 mm	PLC 0	
1.5 mm	PLC 0	
3.0 mm	PLC 0	
Comparative Tracking Index (CTI)	PLC 1	UL 746A
Dielectric Strength	25 kV/mm	ASTM D149
High Voltage Arc Tracking Rate (HVTR)	PLC 3	UL 746A
Volume Resistivity	1.0E+15 ohms·cm	ASTM D257 IEC 60093

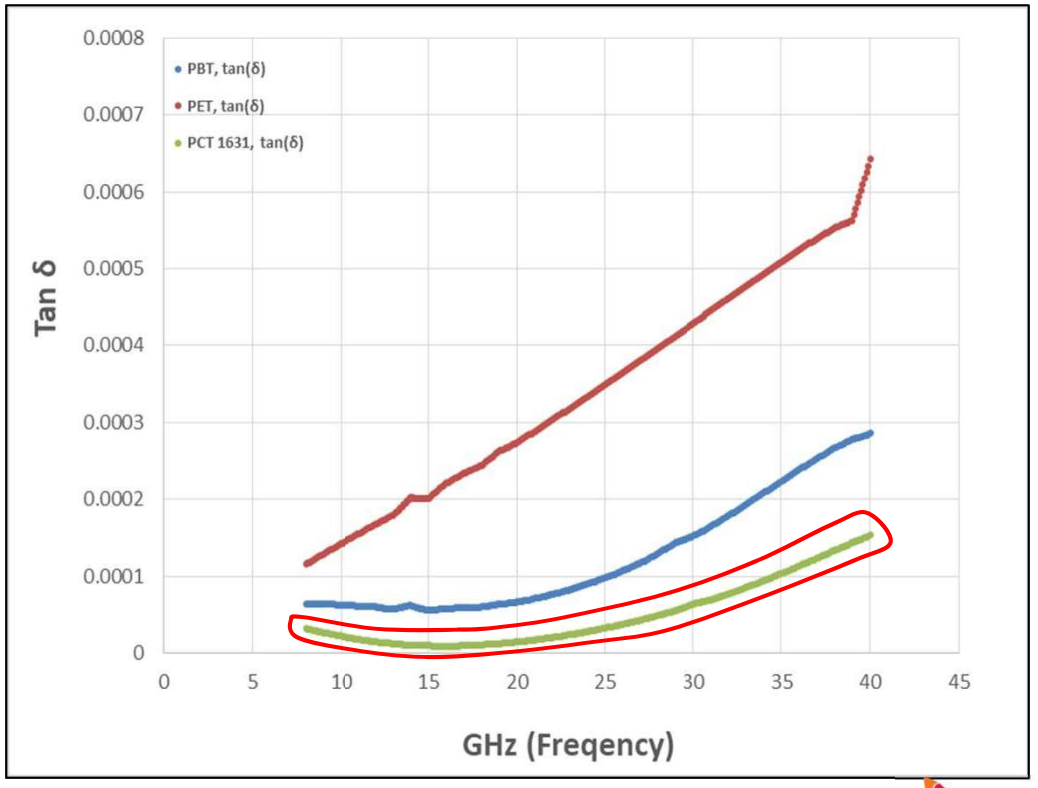
Excellent Electrical Properties

SKYPURA **(PCT)** has a low permittivity. Low permittivity is a key factor for electrical application (5G networks or 5th Generation Mobile Telecommunication.) Low permittivity reduce an electrical interference.

Classification	PCT 0502 (Homo-PCT)	PCT 1631 (Co-PCT)	PBT (IV 0.83)	PET (IV 0.80)
1GHz (Low Hz)	2.76	2.74	2.89	2.98
28GHz (High Hz)	2.87	2.81	3.02	3.12

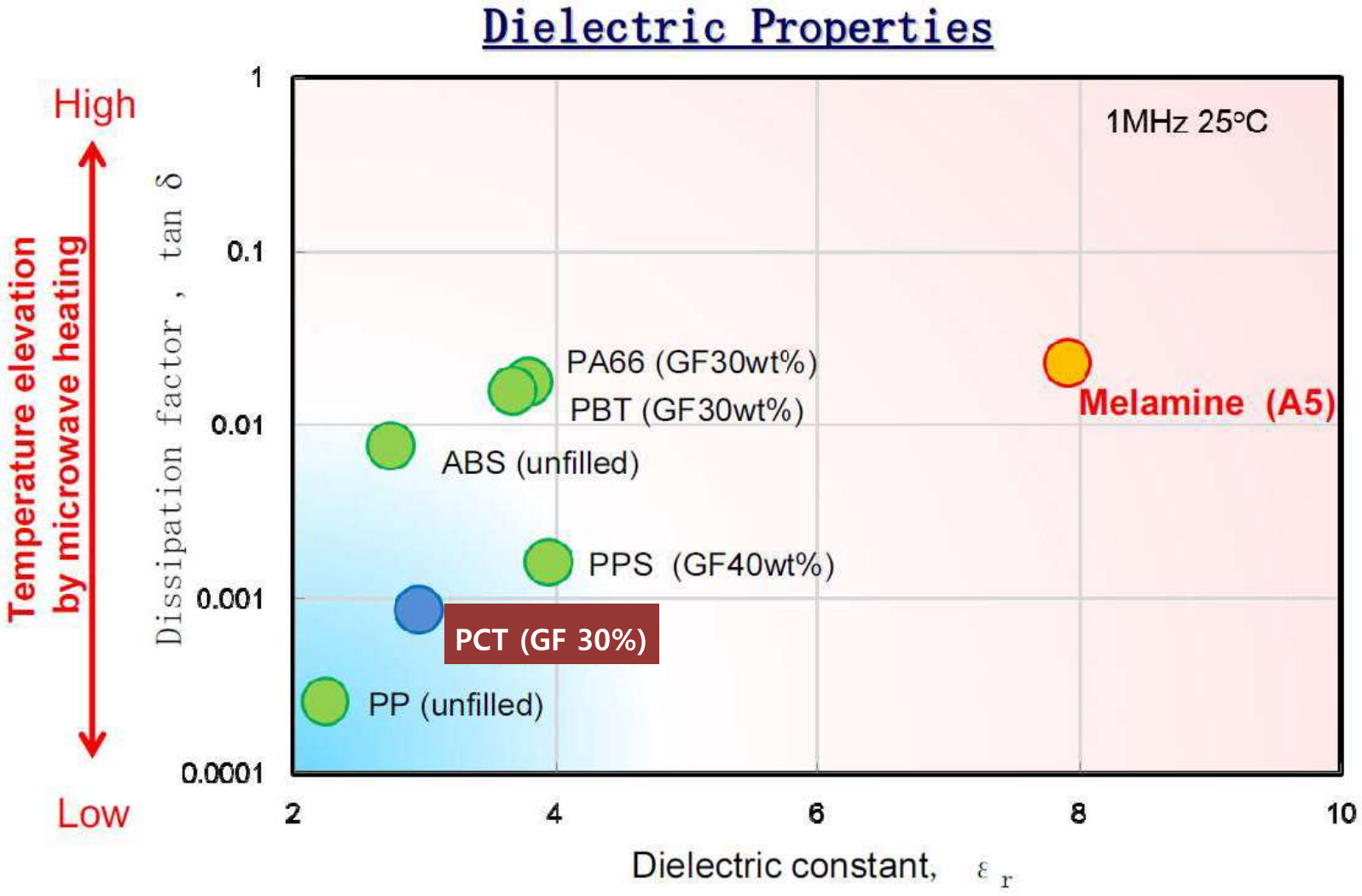
PCT 0502 Grade is captive material for PCT compounding grade





Excellent Electrical Properties

SKYPURA **(PCT)** has strong points of dielectric properties.



Comparisons of material properties

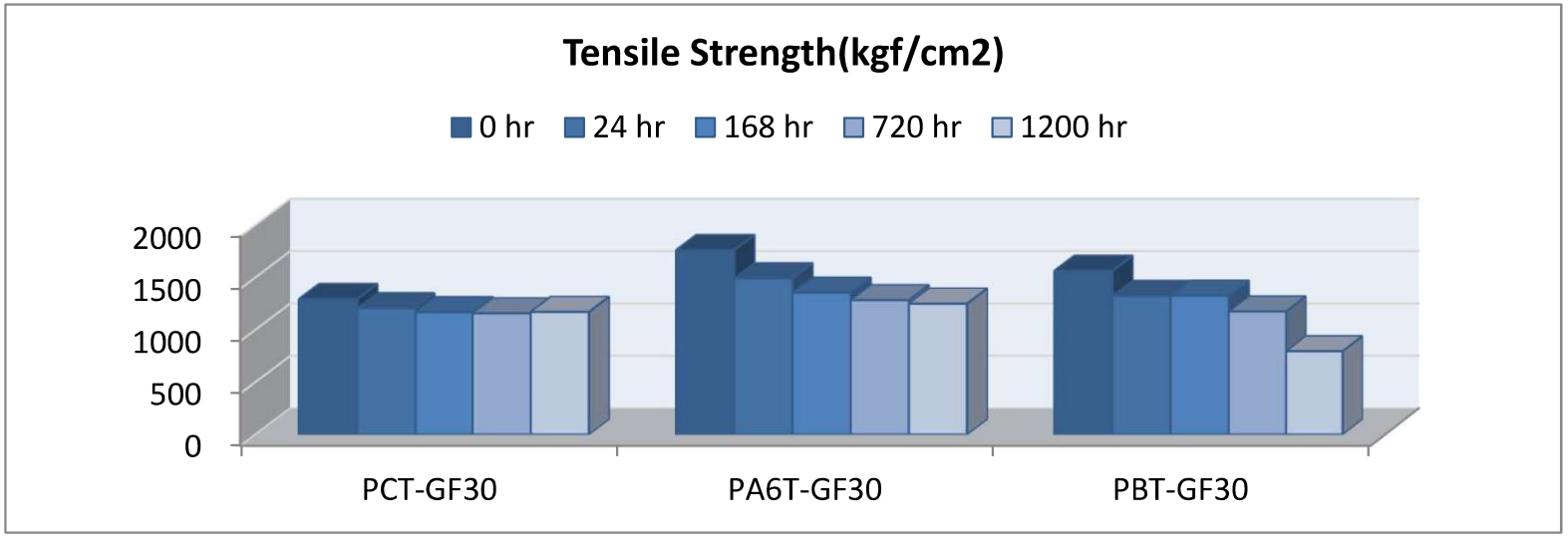
SKYPURA

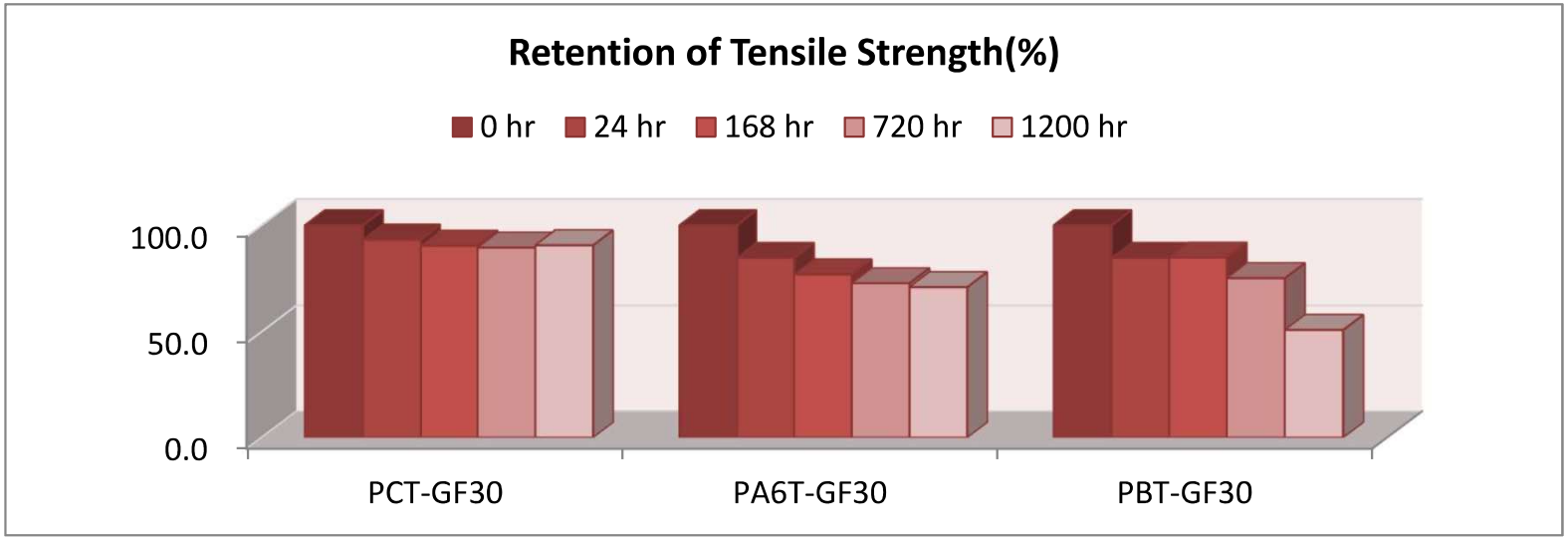
Properties

		Method	Unit	PCT		PBT	HTN (PA66, PA6T)		PA46		PA9T		LCP
				7122T	7121F	BASF, B4300G 6	DuPont 70G33	DuPontF R52G30 NH	DSM, TS256F6	DSM, TS250F6	GN2330	G1300H	E130i
Flammability	@ 0.4 mm	UL94	-	HB		-	-	V-0	-	-	-	-	-
	@ 0.8 mm		-	HB	V-2	HB	HB	V-0	V-0	V-0	V-0	HB	-
	@ 1.6 mm		-	HB	V-0	HB	HB	V-0	V-0	-	V-0	HB	V-0
Melting		ISO 11357	℃	280	280	225	262	310	295	295	306	306	335
C.T.I. (Comparative Tracking Index)		IEC 60112	PLC	0 (> 600V)	1 (> 400V)	2 (>250V)	0	0	-	1	1	0	3 (>175V)
Dielectric Constant	@ 1GHz	IEC 60250	-	3.0	3.0	3.8	4.0	3.7	-	-	-	-	3.3
	@ 100 Hz		-	3.1	3.1	4.0	4.2	-	-	-	-	-	4.0
	@ 10 Hz			3.2	3.2	-	-	-	-	3.4	3.4	3.3	4.2
Dielectric Strength		IEC 243	kV/mm	16	20	100	23	36	30	30	30	30	32
Dissipation Factor	@ 1GHz	IEC 60250	-	0.010	0.009	0.017	0.015	0.012	-	-	-	-	0.025
	@ 100 Hz			-	-	0.003	0.010	0.007	-	-	-	-	0.010
Processing properties	Injection Pressure	SK method	bar	55.0	56.0					66.0			
	Spiral	SK method	cm	15.0	15.5					15.2			

Hydrolytic Stability

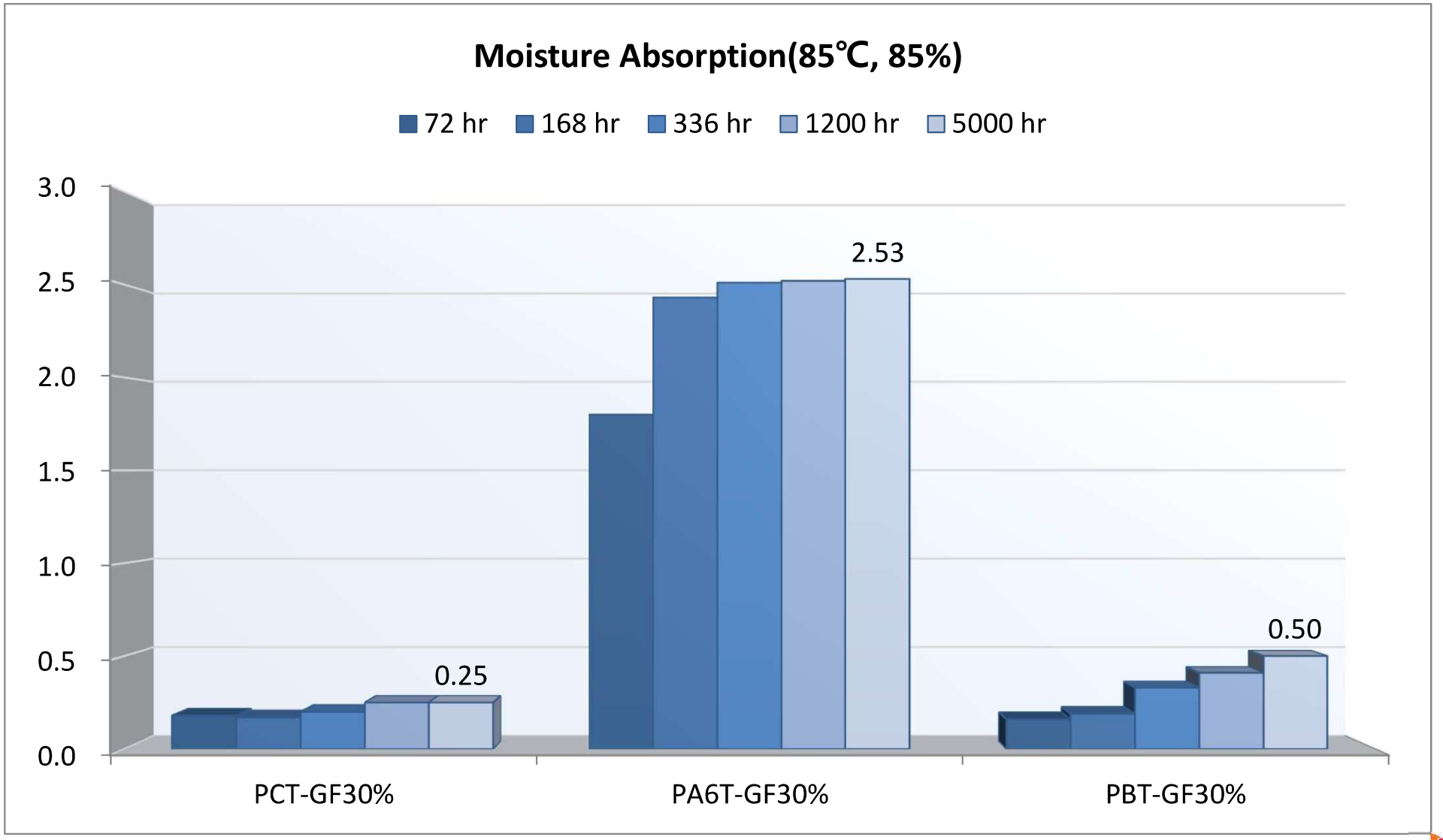
(PCT) has a better hydrolytic stability than PA6T and PBT (85℃, 85% humidity).
It retains 90% of its original tensile strength to 1,200hrs, while other plastics show drastic degradation of their properties.





Moisture absorption

SKYPURA **(PCT)** shows a lower moisture absorption than PA6T and PBT, which is important for dimensional stability and hydrolytic stability.



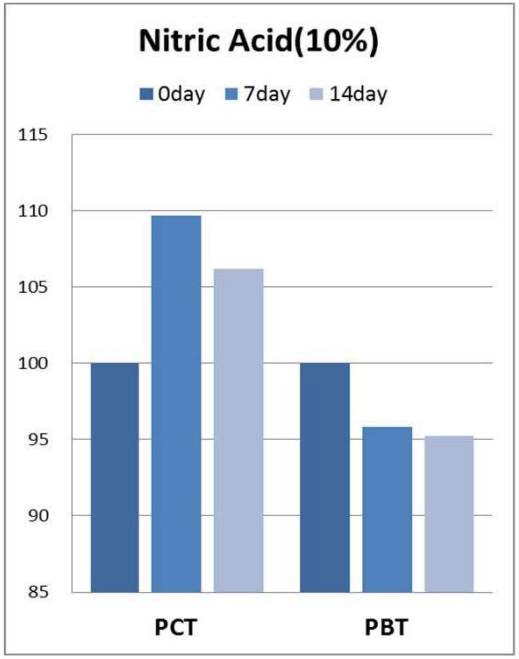
Chemical Resistance

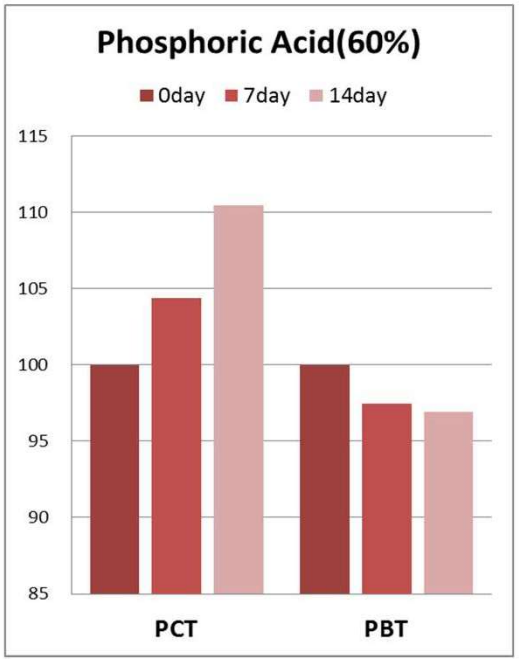
SKYPURA (PCT) shows a better chemical resistance than PBT. It shows a chemical resistance against strong solvents such as nitric acid, phosphoric acid, sulfuric acid and sodium hydroxide solution.

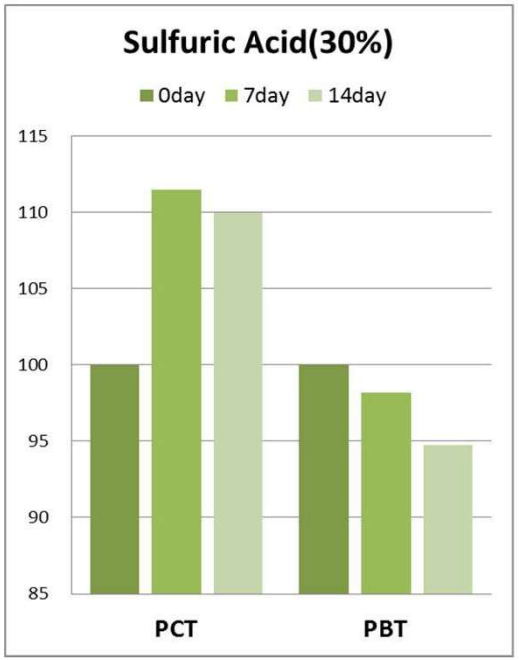
Tensile Strength Maintenance Rate (after 14 days)

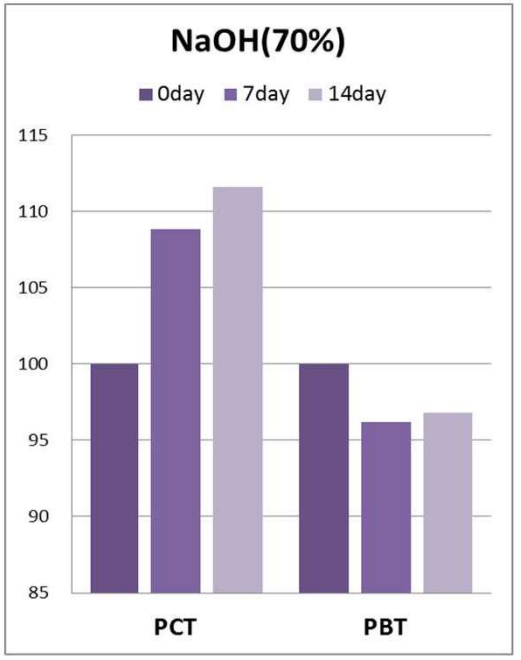
	Nitric Acid	Phosphoric Acid	Sulfuric Acid	NaOH
PCT	106	110	110	112
PBT	95	97	95	97

Strength Maintenance Rate (%) according to exposure time (@ Room Temp)



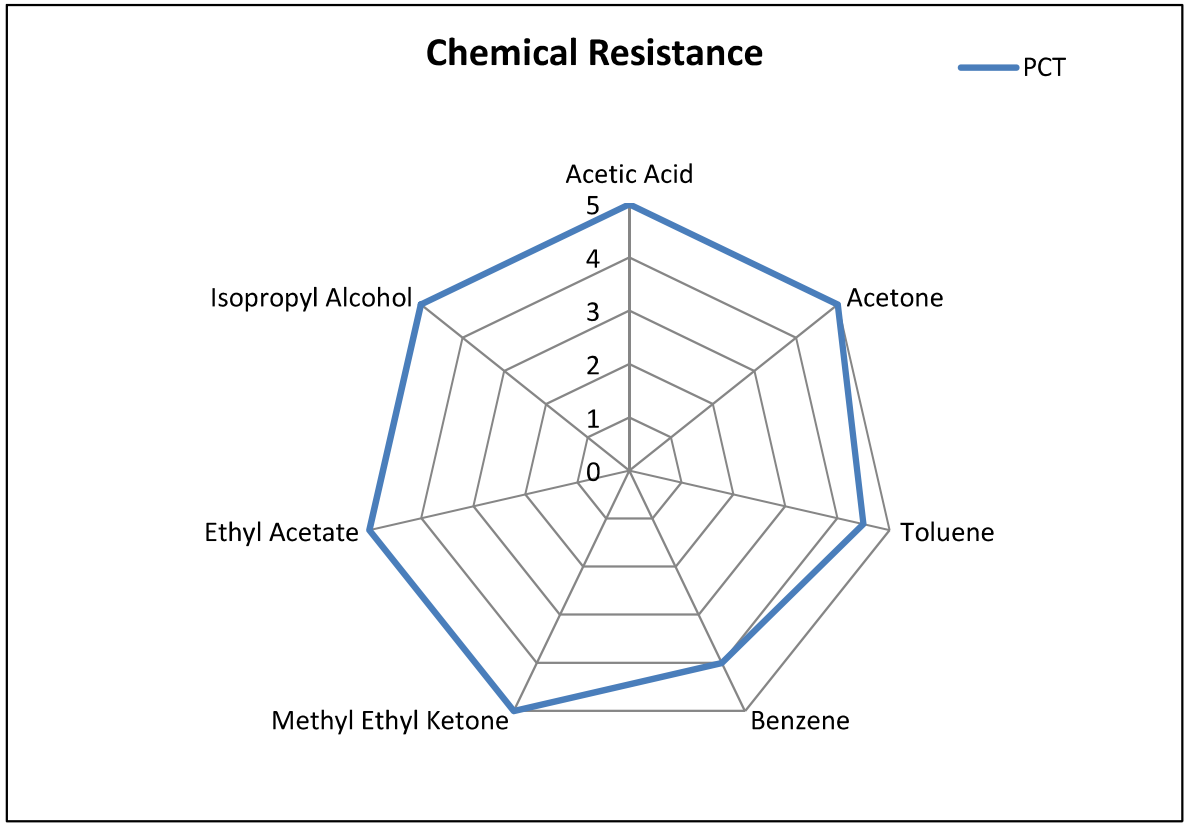






Chemical Resistance

SKYPURA **(PCT)** has an excellent resistance to organic chemicals because it's semi-crystallized material.



[Acetic Acid]

[Acetone]

[Toluene]

[MEK]

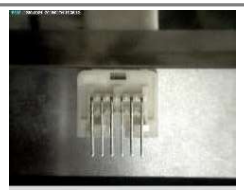
[Ethyl Acetate]

[Benzene]

Oil & chemical resistance

SKY PURA

	A. ENG Oil	B. Gasoline	C. Break Oil	D. Wind Shield Washer 100%	E. LLC 50%
Ref.					

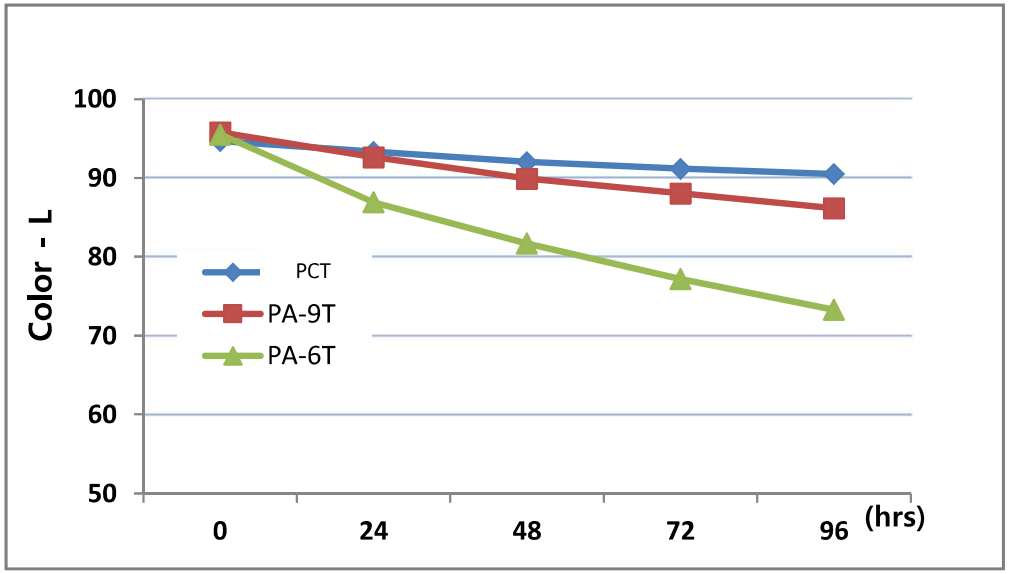
Remark	SK PCT 1st case				
	A	B	C	D	E
Appearance					
Voltage dip/sag(mΩ)	9.9	10.1	9.8	9.7	10.5
Results	☞ no problem				

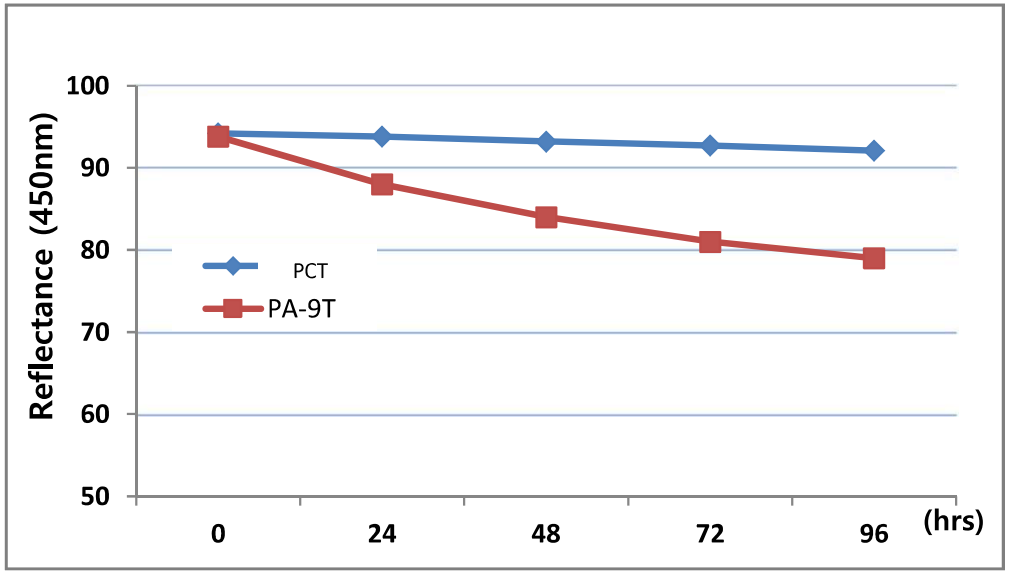
Remark	SK PCT 2nd case				
	A	B	C	D	E
Appearance					
Voltage dip/sag(mΩ)	10.6	10.8	10.7	10.9	11.2
results	☞ no problem				

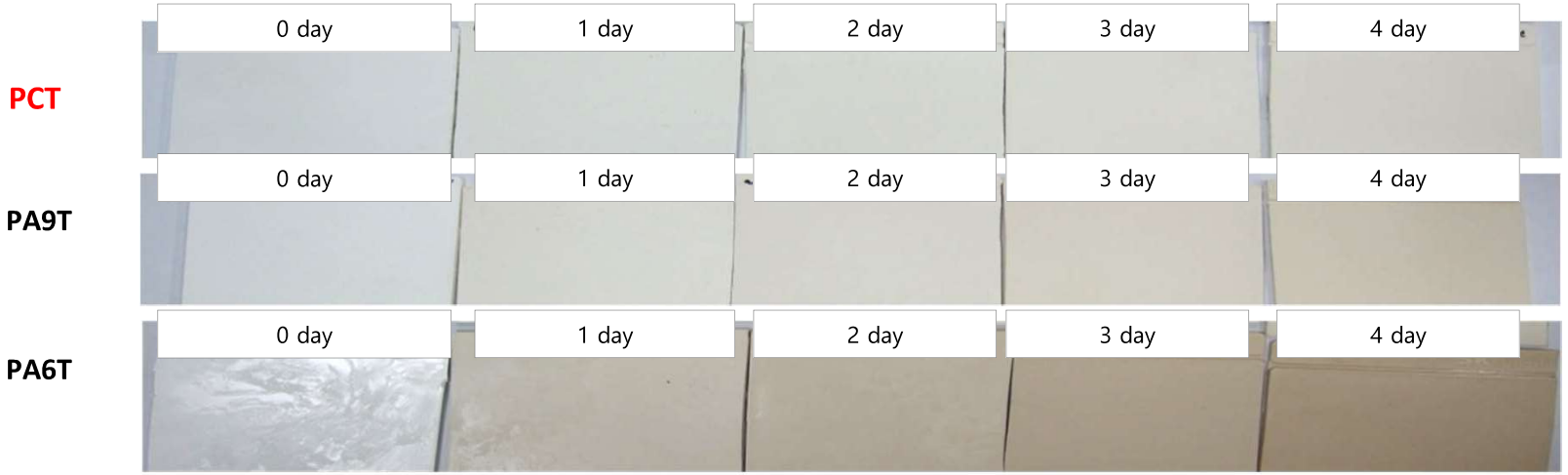
Color stability

SKY PURA (PCT) has a strong color stability. It shows a better color stability performance than high heat PA.

Color & Reflectance Change of PCT/GF (170℃ * 96 hours)

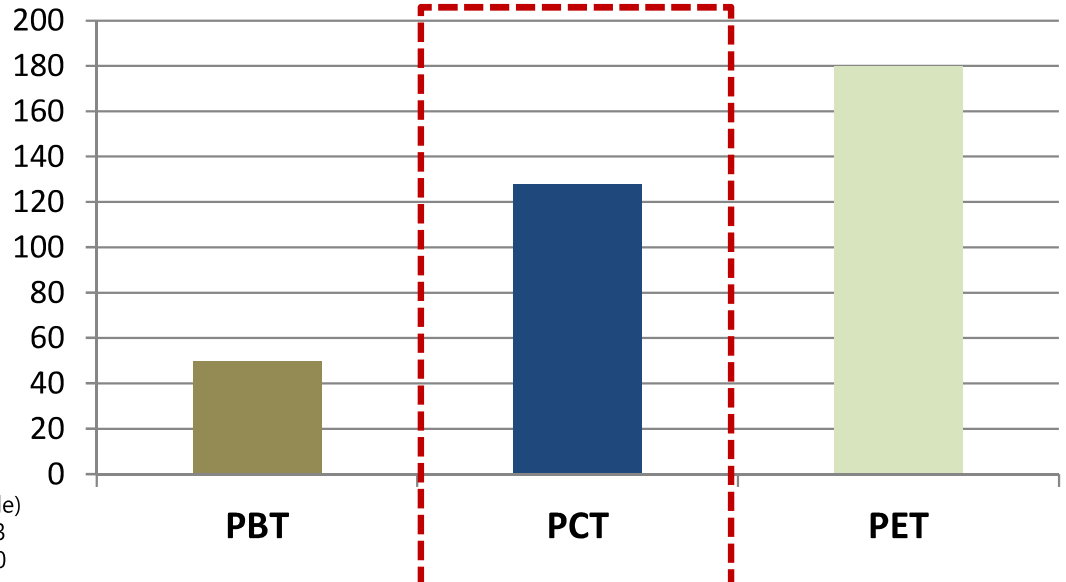






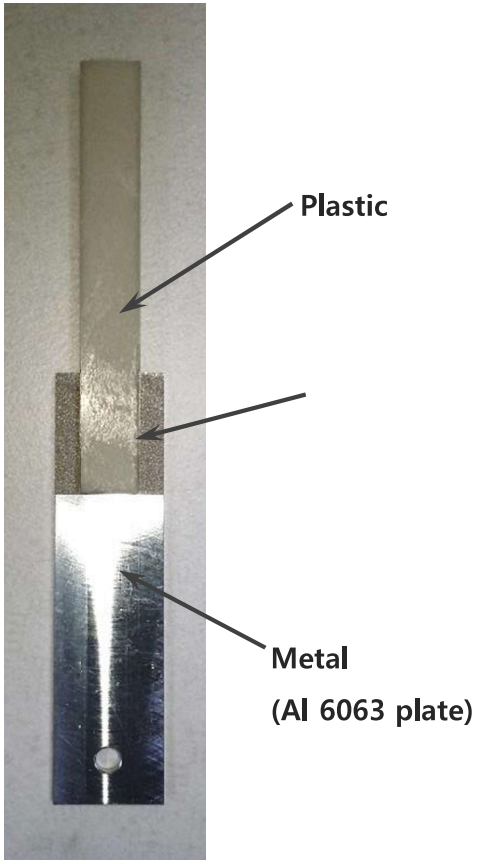
Excellent Metal Adhesion

SKYPURA **(PCT)** has an excellent Metal Adhesion properties. It can be applied in Mobile applications.



* **PCT** : SkyPura 3502 (Compounding Grade)
* **PBT** : C Company Ⅳ 0.83
* **PET** : H Company Ⅳ 0.80

	PBT	PCT	PET
Adhesion Property	△	○	◎
HDT (at 1.8MPa)	210	**250**	220
Permittivity (1GHz, Base resin)	2.89	**2.76**	2.98
Productibility (Cycle Time)	◎	○	△
Remarks	High Productibility	**Color Stability (after anodizing), High HDT**	High Adhesion



* **Measurement speed = 3mm/min**

* **Contact Area : 10 * 20 mm**

SKYPURA

Processing Guidelines

Classification	Units	Condition	Remarks
Mold Temperature	℃	< 50	▷ Using water cooling system - Temperature range : 60 ~ 150 ℃
Melt Temperature			
Nozzle (Hot Runner)	℃	280 ~ 300	▷ Nozzle tip : 300 ~ 310 ℃
Front (cylinder H1)	℃	270 ~ 300	▷ General Set Guide : (Nozzle) 290 – 285 -285 – 280 – 40 (Hopper)
Middle (cylinder H2)	℃	270 ~ 300	
Rear (cylinder H3)	℃	270 ~ 290	
Screw Speed	rpm	50 ~ 150	
Back Pressure	bar	2 ~ 7	
Injection Pressure	kgf/cm^2	1,000 ± 300	
Drying Temperature & Time	℃, hr	120℃, 5 ~ 6hr 120℃, Overnight	▷ Proper drying process is required before injection

*** Effects of Moisture (insufficient drying)**

- Degradation of Base Resin & any additives
- Adverse effect of the color of the final product
- Difficult control of the processing parameters such as melt pressure, rheology, and power consumption
- Bubble and silver streaks

*** It is better to reduce injection speed just at the gate (It would be helpful to decrease gate blush issue.)**

SK chemicals

Comparison of Properties : SK vs Celanese (ISO Ver.)

ISO	Test Method	Unit	Grade							
			SKYPURA 7111F	Thermx CG923	SKYPURA 7121F	Thermx CG933	SKYPURA 7122T	Thermx CGT33	SKYPURA 7122TA	Thermx CGT33
Flame Retardant			Y	Y	Y	Y	N	N	N	N
Glass Fiber %			15%	20%	30%	30%	30%	30%	30%	30%
Color			BK, NC	NC	BK, NC	NC	BK, NC	NC	BK, NC	NC
Classification	**Test Method**	**Unit**	**Tchenical Data Sheet**							
Mechanical Properties										
Tensile Strength	ISO 527	MPa	100	100	115	114	121	110	110	110
Tensile Strain	ISO 527	%	1.8	1.8	1.5	1.5	2.6	2.8	2.0	2.8
Tensile Modulus	ISO 527	MPa	5,000	8,000	10,800	10,800	7000	8400	7000	8400
Flexural Strength	ISO 178	MPa	145.0	145.0	175.0	172.0	180	180	160	180
Flexural Modulus	ISO 178	MPa	7,300	7,200	10,800	10,000	8000	7600	6800	7600
Impact Charpy Notched	ISO 179	kJ/m^2	6	5	6	6	11	10	10	10
Impact Charpy Unnotched	ISO 179	kJ/m^2	30	30	30	30	55	-	50	-
Thermal Properties										
Melting Temperature	ISO 11357-1/-3	℃	280	285	287	285	287	285	287	285
HDT @ 0.45 Mpa	ISO 75	℃	-	-	270	270	270	-	260	-
HDT @ 1.82 Mpa	ISO 75	℃	235	235	250	250	260	250	240	250
Flammability @ 0.8 mm	UL94	-	V-0	-	V-0	V-2	-	-	-	-
Flammability @ 1.5 mm	UL94	-	V-0	V-0	V-0	V-0	HB	HB	HB	HB
Flammability @ 3.0 mm	UL94	-	V-0	-	V-0	-	HB	HB	HB	HB
RTI Elec @0.35mm	UL 746B	℃	50.0	-	150	-	-	-	-	-
RTI Elec @0.7mm	UL 746B	℃	50.0	-	150	-	50.0	-	50.0	-
RTI Elec @1.5mm	UL 746B	℃	50.0	-	150	-	50.0	-	50.0	-
RTI Imp @0.7mm	UL 746B	℃	50.0	-	140	-	-	-	-	-
RTI Imp @1.5mm	UL 746B	℃	50.0	-	140	-	50.0	-	50.0	-
RTI Imp @3.0mm	UL 746B	℃	50.0	-	140	-	50.0	-	50.0	-
RTI Str @0.7mm	UL 746B	℃	50.0	-	140	-	-	-	-	-
RTI Str @1.5mm	UL 746B	℃	50.0	-	140	-	50.0	-	50.0	-
RTI Str @3.0mm	UL 746B	℃	50.0	-	140	-	50.0	-	50.0	-

Comparison of Properties : SK vs Celanese (ISO Ver.)

ISO	Test Method	Unit	Grade							
			SKYPURA 7111F	Thermx CG923	SKYPURA 7121F	Thermx CG933	SKYPURA 7122T	Thermx CGT33	SKYPURA 7122TA	Thermx CGT33
Flame Retardant			Y	Y	Y	Y	N	N	N	N
Glass Fiber %			15%	20%	30%	30%	30%	30%	30%	30%
Color			BK, NC	NC	BK, NC	NC	BK, NC	NC	BK, NC	NC
Classification	**Test Method**	**Unit**	**Tchenical Data Sheet**							
Physical Properties										
Specific Gravity (Density)	ISO 1183	g/cm3	1.57	1.57	1.62	1.63	1.45	1.44	1.44±0.03	1.44
Mold Shrinkage MD	ISO 294-4	%	0.4	0.4	0.3	0.3	0.2	0.3	0.2	0.3
Mold Shrinkage TD	ISO 294-4	%	0.9	0.9	0.9	0.8	0.8	0.8	0.8	0.8
Electrical Properties										
C.T.I	IEC 60112	PLC	-	PLC 2	PLC 1	PLC 1	PLC 0	PLC 0	PLC 0	PLC 0
Dielectric Strength	IEC 243	kV/mm	-	-	20	-	16	-	16	-
Dielectric Constant @ 1 GHz	IEC 60250	-	-	-	3.0	-	3.0	-	3.0	-
Dielectric Constant @ 100 Hz	IEC 60250	-	-	-	3.1	-	3.1	-	3.1	-
Dielectric Constant @ 10 Hz	IEC 60250	-	-	-	3.2	-	3.2	-	3.2	-
Dissipation Factor @ 1 GHz	IEC 60250	-	-	-	0.009	-	0.01	-	0.01	-
HWI @ 0.7mm	UL 746A	PLC	-	-	PLC 0	-	-	-	-	-
HWI @ 1.5mm	UL 746A	PLC	-	-	PLC 0	-	-	-	-	-
HWI @ 3.0mm	UL 746A	PLC	-	-	PLC 0	-	-	-	-	-
HAI @ 0.7mm	UL 746A	PLC	-	-	PLC 0	-	-	-	-	-
HAI @ 1.5mm	UL 746A	PLC	-	-	PLC 0	-	-	-	-	-
HAI @ 3.0mm	UL 746A	PLC	-	-	PLC 0	-	-	-	-	-
HVTR	UL 746A	PLC	-	-	PLC 1	-	-	-	-	-
IPT	ASTM D2303	kV	-	-	1.5kV	-	-	-	-	-
Volume Resistivity	ASTM D257/ IEC 60093	-	-	-	1.0E+14ohms ·cm	-	-	-	-	-

We care for the future

Healthcare, Earthcare

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