



**MATRIX**  
CIRCUIT BOARD MATERIALS

# Introduction to **KB CCL** for the Automotive Industry

**KB**  
KINGBOARD

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# Automotive Materials Trend



# Automotive Materials Requirements

## RF/Microwave Communications

### New Safety Systems

- Advanced Driver Assist Systems (ADAS)

### RF/Microwave Communications

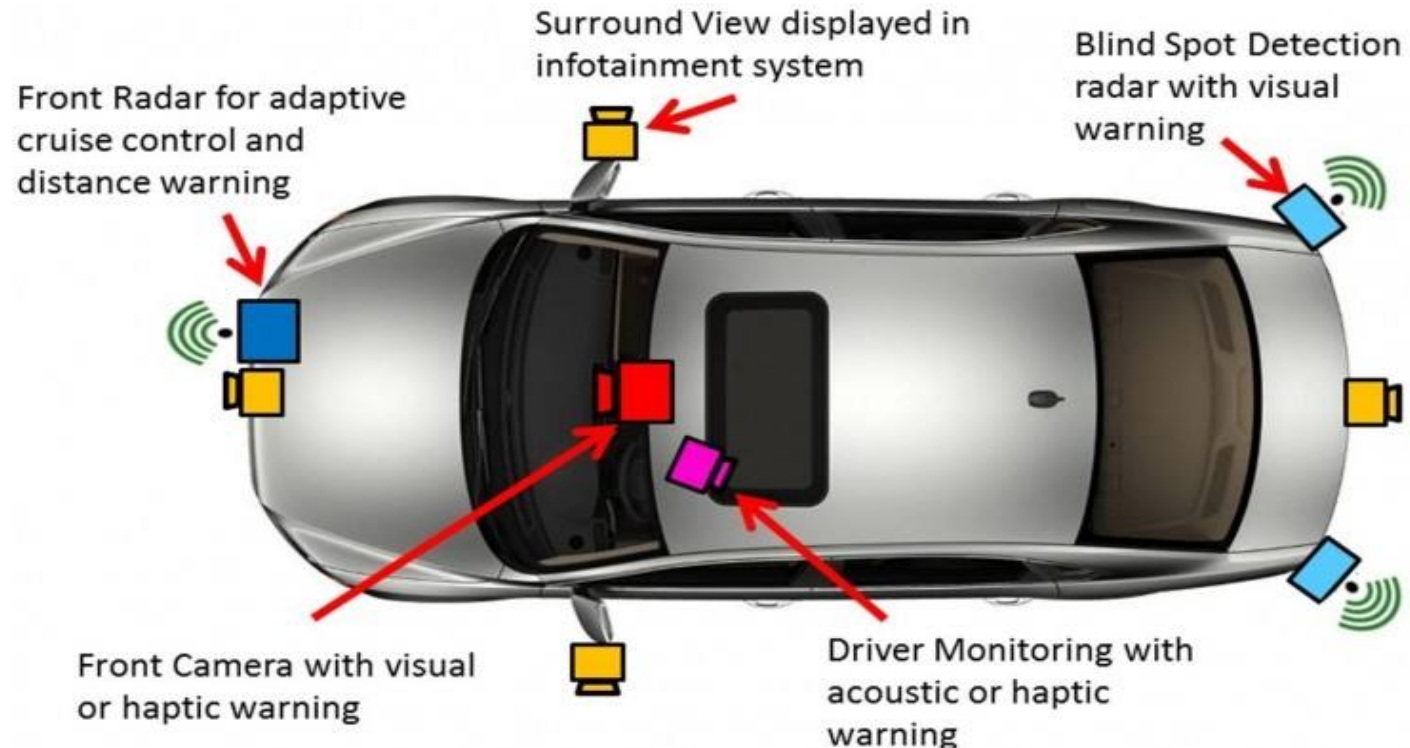
- High Frequency
- 24 GHz Radar
- 77 GHz Radar

### New PCB Requirements

- Higher Layer Counts
- HDI
- Thinner Dielectrics

### New Materials Requirements

- Ultra-low Dk/Df
- Low Z-CTE
- Anti-CAF





# Automotive Materials Requirements

## Heavy Copper for Hybrid/Electric Vehicles

### Hybrid/Electric Vehicles

- High Power Start

### High Voltage and Current

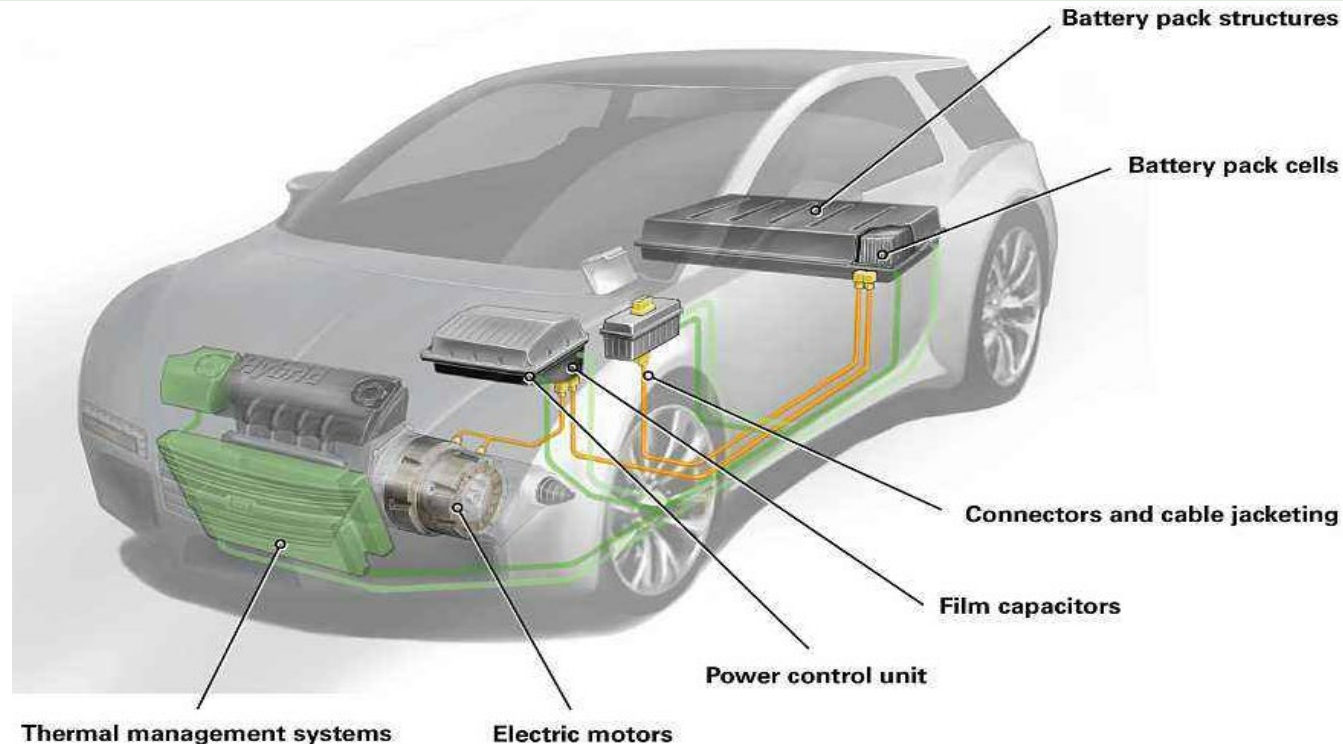
- High voltage CAF  
- 100/350/500v

### Heavy Copper

- 6 oz (210um)  
- 12 oz (400um)

### New Materials Requirements

- High Thermal Reliability  
- Ultra Low CTE



# Automotive Market Trend

## Wider Operating Temperatures

### Normal Test Standard

- (-25°C -125/140°C)
- 500/1000 Cycles

### Latest Test Standard

- (-25°C -125/140°C)
- 2000/3000 Cycles

### Wider Tempe. Range

- (-40°C -150/160°C)
- 1000/2000 Cycles

### New Materials Requirements

- High Thermal Reliability
- Ultra Low CTE

### 5 grades: Thermal Cycle

Position	Grade	Low Temperature	High Temperature
Within Cockpit	A	-40°C	85°C
Base Shield Below	B	-40°C	125°C
Motor	C	-40°C	145°C
Driving Medium	D	-40°C	155°C
Inner Motor	C	-40°C	165°C

# PCB Types and Uses

Vehicle Devices	PCB Types
Dashboard, Speedometer, Air-Con	Single/Double –layer PCB
Car stereo, Audio, Monitor	Double-layer PCB Multi-layer PCB
Automotive communication devices, Wireless location applications, Security control system	Multi-layer PCB HDI PCB
Engine system, power transmission control system	Rigid-flex PCB Metal-core PCB
Vehicle power controller, navigation devices	Embedded PCB

# CCL Application Requirement

	Safety System	Engine / EV System	Lighting	Infotainment	Inner Decoration
Scenario					
Application	RF/Microwave Communication	ECU, Transmission, Battery System	LED Lighting	Infotainment, Wifi Module, Car Video	Functional control panel
Requirement	High speed/ Low loss	High current/ High voltage	High thermal reliability	Miniaturization	Miniaturization
CCL Material	Low Dk/DF	Heavy Copper	Metal Clad/ Normal FR-4	Normal FR-4	Normal FR-4
Potential	★ ★ ★	★ ★	★ ★	★	★



# KB-(F) Series CCL on Automotive



# Customers



C customer



V customer



D customer



H customer



D customer

S customer



R customer

Y customer

Automotive OEM	KB CCL (Approved / Being processed)
C customer	<ul style="list-style-type: none"> <li>•KB 6165F (Approved)</li> <li>•KB 6167F (Being processed)</li> </ul>
V customer	<ul style="list-style-type: none"> <li>•KB 6165F (Approved)</li> <li>•KB 6167F (Being processed)</li> </ul>
D customer	<ul style="list-style-type: none"> <li>•KB 6165F (Approved)</li> <li>•KB 6167F (Approved)</li> </ul>
H customer	<ul style="list-style-type: none"> <li>•KB 6165F (Approved)</li> <li>•KB 6167F (Being processed)</li> </ul>
D customer	<ul style="list-style-type: none"> <li>•KB 6164F (Approved)</li> <li>•KB 6165F (Approved)</li> </ul>
S customer	<ul style="list-style-type: none"> <li>•KB 6160 (Approved)</li> <li>•KB 6165F (Approved)</li> </ul>
R customer	<ul style="list-style-type: none"> <li>•KB 6160 (Approved)</li> <li>•KB 6165F (Being processed)</li> </ul>
Y customer	<ul style="list-style-type: none"> <li>•KB 6160 (Approved)</li> <li>•KB 6165F (Approved)</li> </ul>

## Approval:

Continental Automotive Systems	
TECHNOLOGY QUALIFICATION RELEASE FOR PCB PA SOM M	
Technology / Reason for approval: New base Material : Class C Tg 150 °C 4/6/8 Layer Classes: C CAF (h): na Reflow profile : lead free	Supplier
Qualification details: Specifications: Az Testing Lab: filco Layout : 400644 Qualification rep: ip	Supplier manufacturing plants included in this release.
DEFINED MATERIALS:	PIC: PIC-FL150 Kaiping China Tg 150 °C
Min. Finished Hole Size	Basematerial supplier location
Innerylayer Cu thickness	Surface finish/ chemical
Outerylayer Cu thickness	Soldermask/ Hardener
HDI	Closed Hole (plug) / filler/ Hardener

SQ CERTIFICATE OF SUPPLIER QUALITY	
SQ 인증서	
회 사 명 : 박승연(주)	[안전부품]
대표 자 명 : 강성학	인증 품 목 : PCB
사업자번호 : 1078130805	인증 등급 : A
업 용 코드 : #4621	시험 항목 코드 : #462101
회사 주소 : 인천광역시 남구 도화동 718	
<p>협력사 품질평가 규정에 의해 상기안 같이 SQ(협력사 품질분류) 요구사항에 적합함을 인증합니다.</p>	
인증일자 : 2006년 01월 25일	
유효일자 : 2020년 12월 31일 까지	
최종평가일자 : 2017.06.29 [SQ사후평가(합격)]	
• 주 관 : 주식회사 경신	
• 추 형 : 현대-기아자동차	

# Automotive Customers



# KB-(F) Series CCL for Automotive

	Normal Tg		Mid Tg		High Tg	
Product name	<b>KB-6163F</b> <i>(new product)</i>	<b>KB-6164F</b>	<b>KB-6165F</b>	<b>KB-6165GC</b>	<b>KB-6167F</b>	<b>KB-6168</b>
Properties ★	Phenolic Fr-4	Phenolic Fr-4	Phenolic Fr-4	HF Fr-4 (CTI600)	Phenolic Fr-4	Phenolic Fr-4
TG(°C, DSC)	>135	140	155	150	175	185
TD(°C)	>340	>340	>345	>370	>350	>360
Peeling strength 1oz (N/mm)	1.5	1.57	1.4	1.55	1.39	1.4
Z-Axis alpha 1 max (ppm/°C)	42	45	49	33	49	30
Z-Axis alpha 2 max (ppm/°C)	250	260	238	220	208	192
Z-Axis % (50-260°C) ★	3.5	3.6	2.9	3.0	2.5	2.1
T-260 (min)	>50	>60	>60	>50	>60	>60
T-288 (min)	>15	>20	>20	>50	>20	>20
Anti-caf ★	YES	YES	YES	YES	YES	YES
Suggested Layers	2-8	2-14	2-20	2-30	2-30	2-32





# KB-6165F Introduction

## Material Features

- DSC TG>150 °C
- High Td: -350 °C
- Low Z-CTE
- Excellent CAF resistance

## Application

- HDI
- Automotive (Valeo & Denso Ten)
- Low end server device
- Multi-layer

## PCB specification

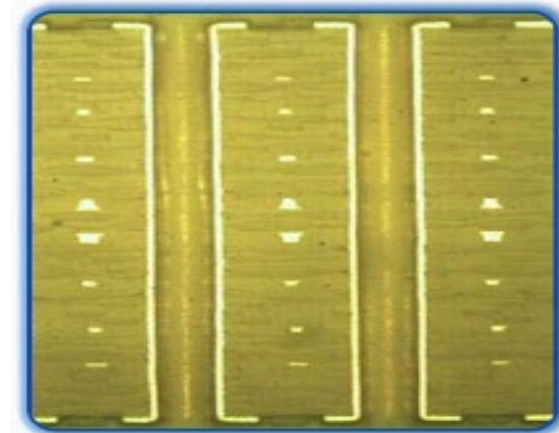
- Thickness of 20 layers PCB: 100mil
- Minimum hole diameter: 8mil
- Distance between holes: pitch 0.7mm
- Reflow condition: IR260\*5 Cycle

L1	H OZ
L2	106+1080
L3	0.5 OZ
L4	3.0mil core(1*1080)
L5	0.5 OZ
L6	2*106
L7	0.5 OZ
L8	3.5mil core(1*3313)
L9	0.5 OZ
L10	2*106
L11	1 OZ
L12	4.5mil core(1*2116)
L13	1 OZ
L14	106+3313
L15	1 OZ
L16	4.5mil core(1*2116)
L17	1 OZ
L18	106+3313
L19	2 OZ
L20	5mil core(2*1080)

L11	2 OZ
L12	3313+106
L13	1 OZ
L14	4.5mil core(1*2116)
L15	1 OZ
L16	3313+106
L17	1 OZ
L18	4.5mil core(1*2116)
L19	1 OZ
L20	2*106
L21	0.5 OZ
L22	3.5mil core(1*3313)
L23	0.5 OZ
L24	2*106
L25	0.5 OZ
L26	3.0mil core(1*1080)
L27	0.5 OZ
L28	106+1080
L29	H OZ



8 mil via, 0.8mm pitch



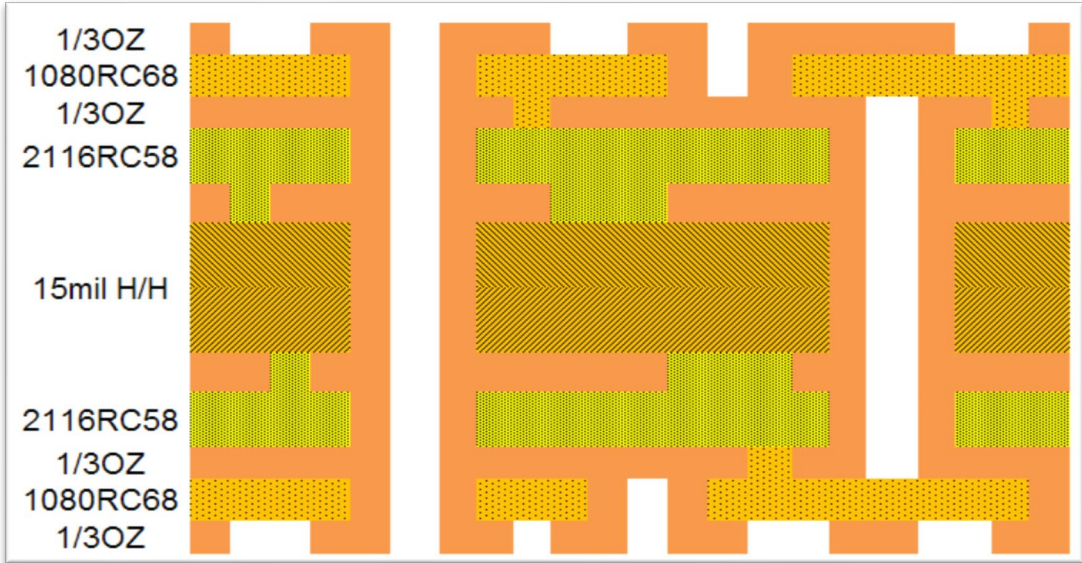
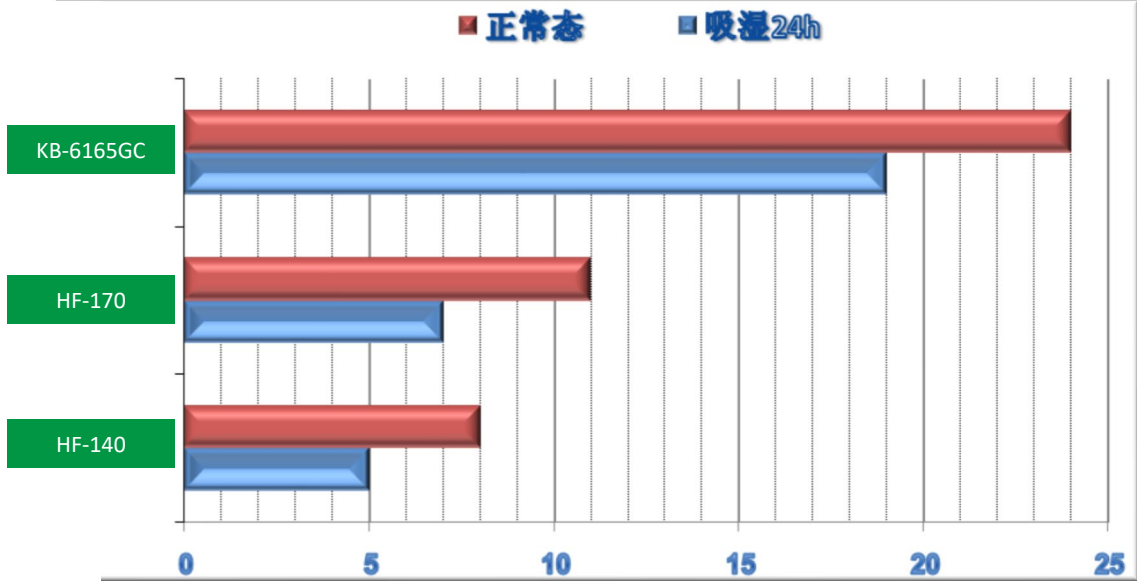
8 mil via, 0.7mm pitch



# KB-6165GC Introduction

- PCB Type: 4L
- Heat Resistance Test:
  1. Reflow with normal treatment
  2. Reflow with 85°C/85RH treatment for 24 hours

The heat resistance of KB-6165GC is obviously better than HF-140 and HF-170. KB-6165GC can reach 24 times reflow with normal treatment.



# KB-6167F Introduction

## Material Features

- DSC TG>170 °C
- High Td: -350 °C
- Low Z-CTE
- Excellent CAF resistance

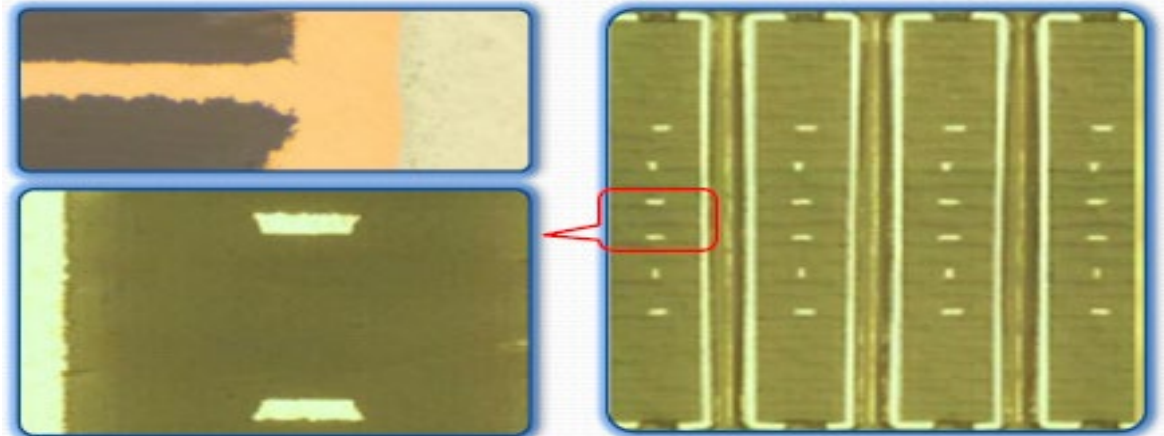
## Application

- HDI
- Automotive
- High end server device
- Multi-layer

## PCB specification

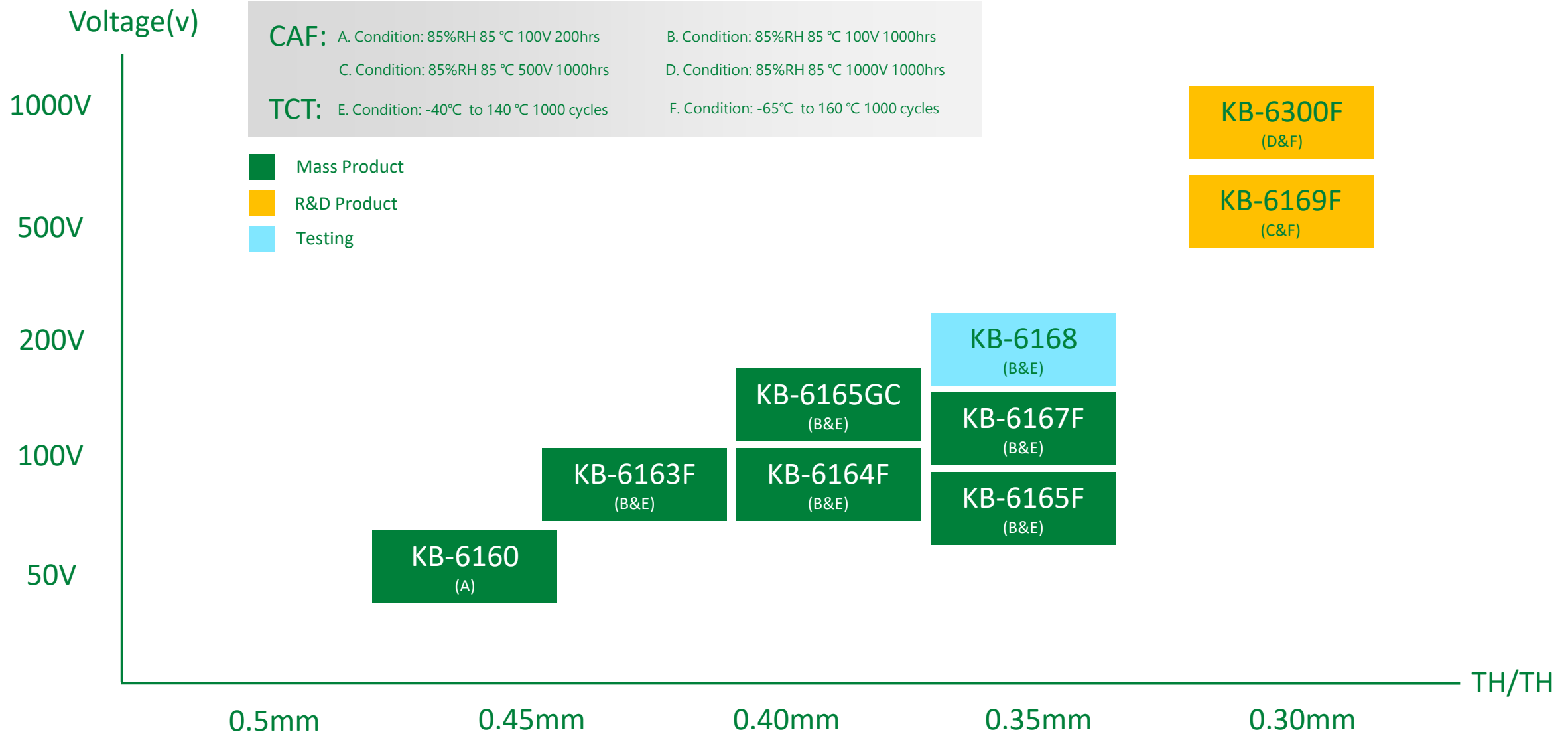
- Thickness of 26 layers PCB: 130 mil
- Minimum hole diameter: 8mil
- Distance between holes: pitch 0.7mm
- Reflow condition: IR260\*5 Cycle
- Thermal stress test: 108\*6 cycle 288 °C floating

L1	1/2 oz foil + plating	L14	1 oz Cu
L2	1080 RC:65%	L15	4.5 mil core 2116
L3	1/2 oz Cu	L16	1 oz Cu
L4	3 mil core 1080csl	L17	106+1080 RC:70%
L5	1080 RC:65%	L18	2 oz Cu
L6	1/2 oz Cu	L19	4.5 mil core 2116
L7	3 mil core 1080csl	L20	1 oz Cu
L8	106x2 RC:75%	L21	1080+106 RC:70%
L9	1/2 oz Cu	L22	1 oz Cu
L10	106+1080 RC:70%	L23	3 mil core 1080csl
L11	1 oz Cu	L24	1/2 oz Cu
L12	4.5 mil core 2116	L25	1080 RC:65%
L13	2 oz Cu	L26	1/2 oz Cu
	1080+106 RC:70%		1080 RC:65%
	1 oz Cu		1/2 oz foil + plating
	4.5 mil core 2116		
	1 oz Cu		
	2116x2 RC:58%		



8 mil via, 0.7mm pitch

# Material(s) Layout\* Anti-CAF



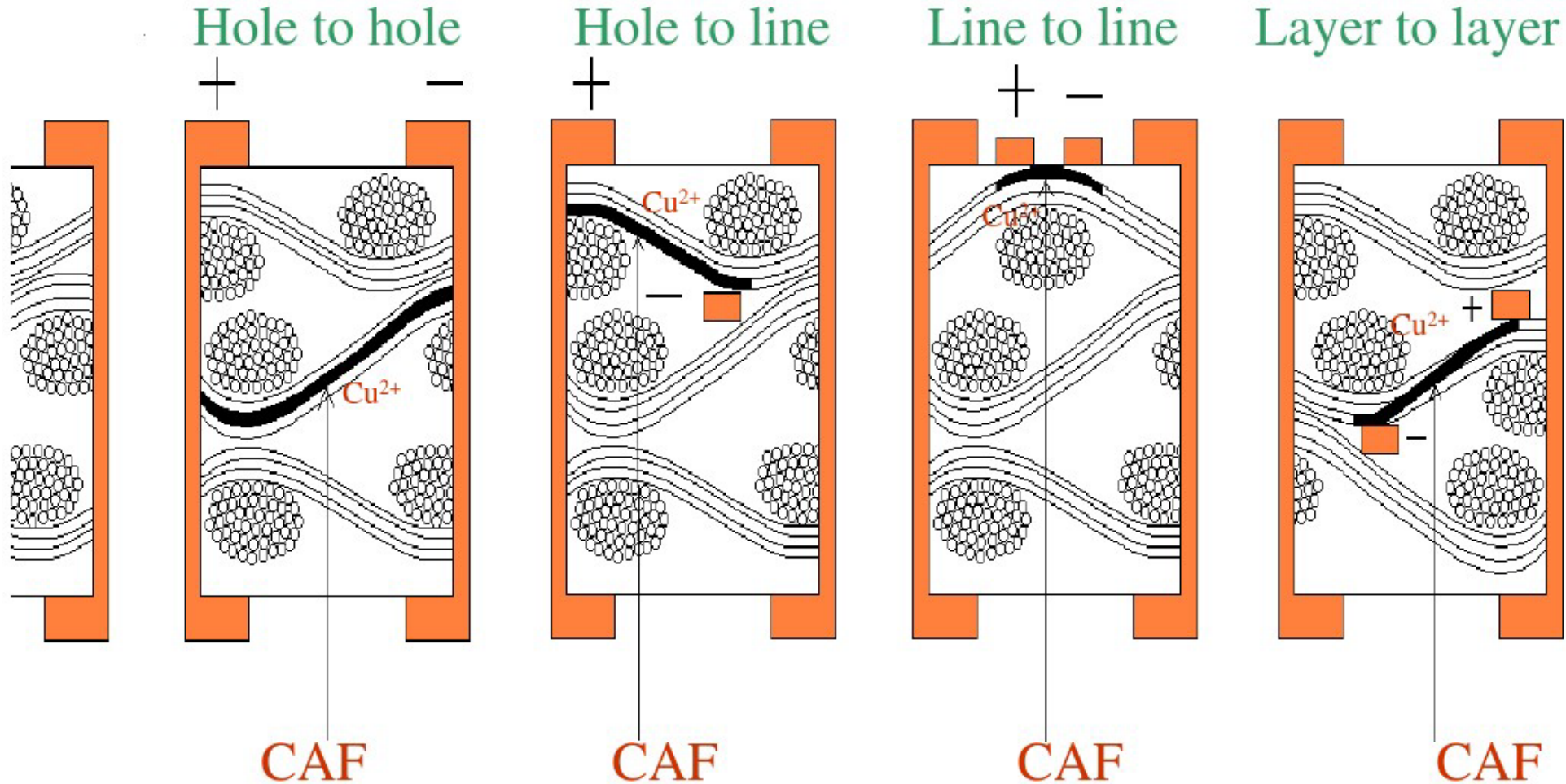


# Anti-CAF, Thermal Shock, PCT



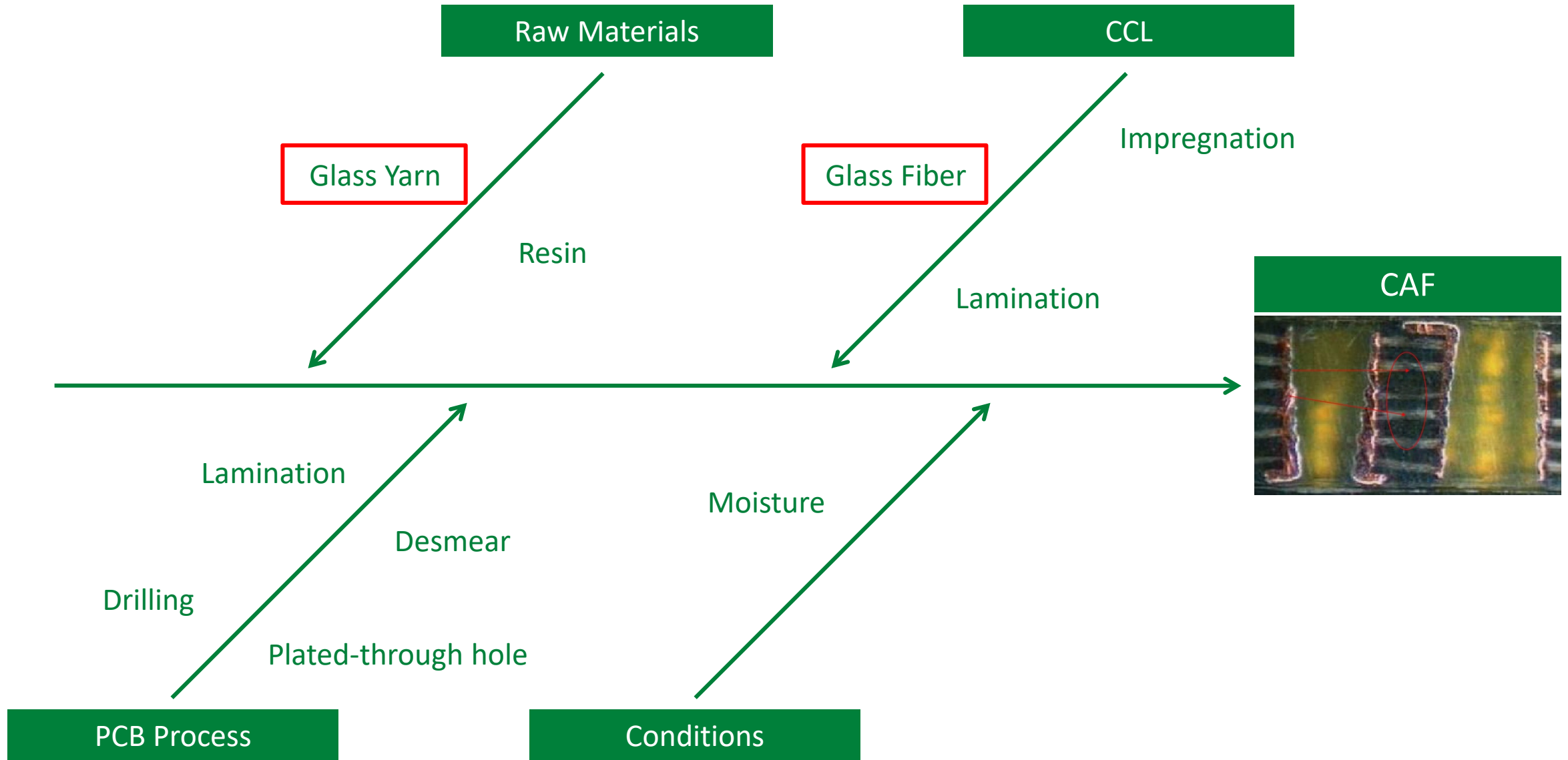
# What is CAF?

## CAF= Conductive Anodic Filament





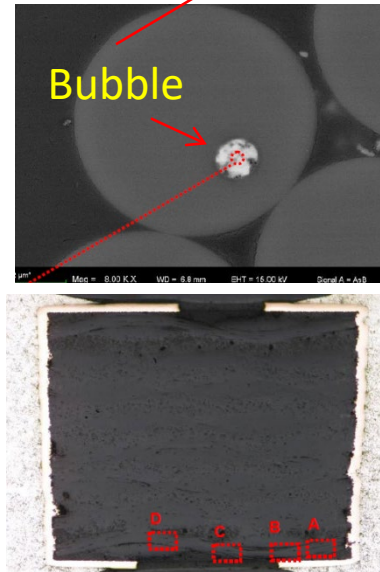
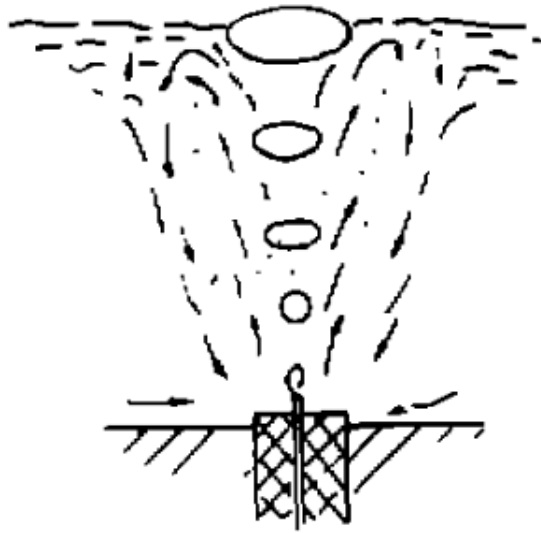
# CAF Influence Factors-CCL



# CAF Influence Factors - CCL

Glass Yarn

Hollow Fiber



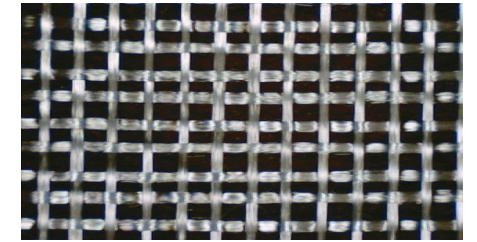
## Improvement:

1. Increase the 'Glass Fluid' temperature in furnace, this helps to decrease the viscosity of 'Glass Fluid', which is effective to eject the bubbles.
2. Using 'Bubbling technology', increase the convection flow, this also helps to eject the bubbles.

Glass Fiber



2116 Glass Fiber



1080 Glass Fiber



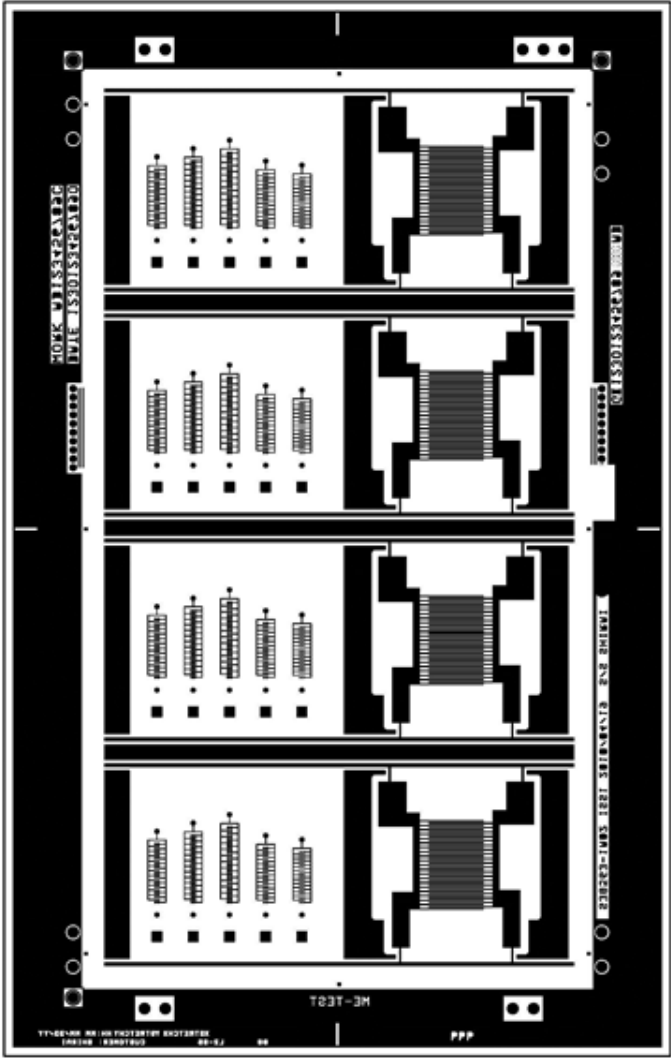
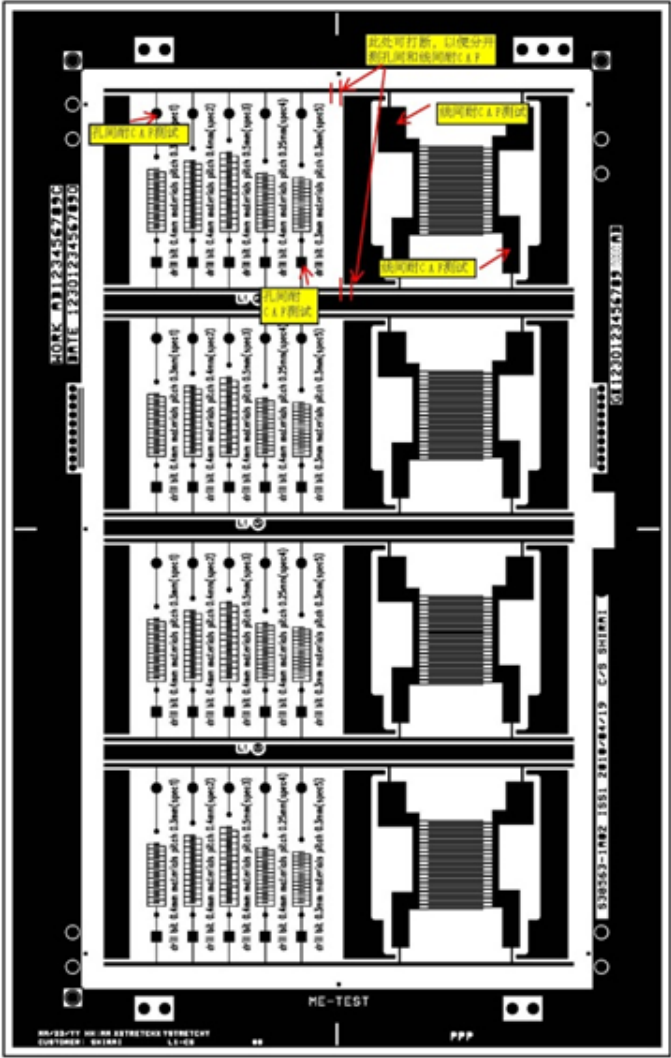
2116  
Open-filament Glass Fiber



1080  
Open-filament Glass Fiber

A better Impregnation with resin.

# Design Pattern



# Test Judgement

Test Item	Test method	Test Conditions	Judgment
Anti-CAF	High temperature & high humidity	T:85°C, RH:85%, 100VDC	TH/TH Insulation Resistance $\geq 10^8 \Omega$ L/L $\geq 5 \times 10^8 \Omega$
	Micro-sections	Vertical and level section of hole observation after the experiment	No delamination shall be observed, no ions migration
	Visual inspection	No measlings, delamination and copper peeling	
Rapid Temperature Change	Thermal shock, thermal cycling	T:60°C-125°C Dwell time: 30min/30min	After the holes feed through
	Micro-sections	Micro-sections of copper hole after the experiment	No delamination shall be observed, no wickings
	Visual inspection	No measlings, delamination and copper peeling	

**Anti-CAF test follows:**

**JIS 5012-9.4&9.5**

**Rapid Temperature Change:**

**JIS 5012-9.2**

# Anti-CAF Test Result

Time (hours)	Mode	TH/TH	TH/TH	TH/TH	TH/TH	TH/TH	PA/PA
	Pitch	0.3mm	0.4mm	0.5mm	0.25mm	0.3mm	/
	Diameter	0.4mm	0.4mm	0.4mm	0.4mm	0.3mm	/
100		PASS	PASS	PASS	PASS	PASS	PASS
240		PASS	PASS	PASS	PASS	PASS	PASS
336		PASS	PASS	PASS	PASS	PASS	PASS
445		PASS	PASS	PASS	PASS	PASS	PASS
557		PASS	PASS	PASS	PASS	PASS	PASS
789		PASS	PASS	PASS	PASS	PASS	PASS
953		PASS	PASS	PASS	PASS	PASS	PASS
1057		PASS	PASS	PASS	PASS	PASS	PASS

**Materials including: KB-6164F, KB-6165F, KB-6167F**



# KB-6164F Anti-CAF Test Result

Serial No.		1 Req: $>0.1E9\Omega$ (L/L $>0.5E9\Omega$ )						2 Req: $>0.1E9\Omega$ (L/L $>0.5E9\Omega$ )						3 Req: $>0.1E9\Omega$ (L/L $>0.5E9\Omega$ )						Judge	
Mat.	Period	TH/TH	TH/TH	TH/TH	TH/TH	TH/TH	L/L	TH/TH	TH/TH	TH/TH	TH/TH	TH/TH	L/L	TH/TH	TH/TH	TH/TH	TH/TH	TH/TH	L/L		
	Pitch	0.3	0.4	0.5	0.25	0.3	/	0.3	0.4	0.5	0.25	0.3	/	0.3	0.4	0.5	0.25	0.3	/		
	Diameter	0.4	0.4	0.4	0.4	0.3	/	0.4	0.4	0.4	0.4	0.3	/	0.4	0.4	0.4	0.4	0.3	/		
KB-6164F	1	Initial	99.73	90.88	88.65	18.65	135.6	135	90.73	97.83	84.75	18.77	120.8	120.4	98.93	87.78	97.4	74.38	84.82	109.5	Pass
		100	44.05	51.74	231.4	28.35	70.46	185.4	56.47	54.25	43.75	21.74	143.2	194.6	33.72	65.47	54.27	39.25	205.2	195.4	Pass
		240	30.15	37.88	73.87	18.95	64.16	58.37	40.27	105.7	105.7	27.76	72.74	67.15	43.94	70.38	138.4	57.74	102.4	91.99	Pass
		336	40.29	54.82	982.52	21.62	77.46	64.97	37.81	75.81	64.72	17.73	52.44	70.64	42.25	60.25	64.59	25.54	51.52	72.87	Pass
		445	82.68	147.7	40.57	16.54	64.92	99.12	87.29	133.4	162.7	12.59	106.2	112.2	30.82	60.45	93.97	22.59	89.95	60.79	Pass
		557	63.02	92.41	112.6	14.27	42.26	60.74	64.68	62.19	105.4	11.48	124.6	56.74	83.12	72.13	57.77	38.71	80.25	59.62	Pass
		789	60.12	92.42	102.24	22.47	93.87	58.91	123.7	47.13	46.43	16.93	106.7	69.12	77.63	151.6	101.7	64.15	34.47	54.49	Pass
		953	36.81	115.2	117.2	24.62	88.21	68.78	108.2	116.7	98.67	25.32	77.25	77.86	68.43	115.1	107.7	39.46	61.01	68.35	Pass
		1057	34.87	84.59	94.62	18.79	75.46	83.19	99.43	91.18	51.46	27.3	55.92	54.83	52.73	73.52	61.87	28.79	46.43	79.81	Pass

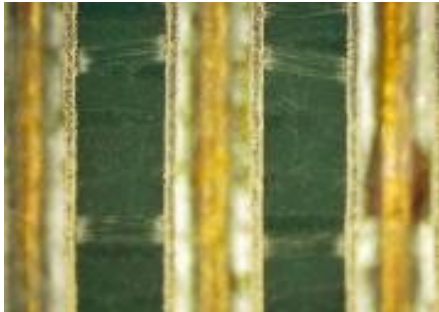



# KB-6165F Anti-CAF Test Result

Serial No.		1 Req: $>0.1E9\Omega$ (L/L $>0.5E9\Omega$ )						2 Req: $>0.1E9\Omega$ (L/L $>0.5E9\Omega$ )						3 Req: $>0.1E9\Omega$ (L/L $>0.5E9\Omega$ )						Judge	
Mat.	Period	TH/TH	TH/TH	TH/TH	TH/TH	TH/TH	L/L	TH/TH	TH/TH	TH/TH	TH/TH	TH/TH	L/L	TH/TH	TH/TH	TH/TH	TH/TH	TH/TH	L/L		
	Pitch	0.3	0.4	0.5	0.25	0.3	/	0.3	0.4	0.5	0.25	0.3	/	0.3	0.4	0.5	0.25	0.3	/		
	Diameter	0.4	0.4	0.4	0.4	0.3	/	0.4	0.4	0.4	0.4	0.3	/	0.4	0.4	0.4	0.4	0.3	/		
KB-6165F	2	Initial	128.1	114.2	118.2	123.3	116.3	112.6	141.2	82.27	106.5	98.33	98.52	11.91	92.92	87.62	50.64	41.09	56.53	126.7	Pass
		100	115.6	107.7	131.7	102.1	102.4	35.76	110.4	102.3	121.4	106.7	127.6	39.74	83.94	139.7	133.6	43.09	31.56	34.04	Pass
		240	124.3	124.2	92.56	20.26	59.97	169.6	33.76	72.86	102.4	144.8	232.6	108.6	92.56	73.76	136.7	53.71	102.5	63.6	合格
		336	61.27	72.34	99.28	31.34	34.82	98.42	49.82	114.1	107.7	64.4	70.04	159.9	74.99	67.73	84.11	29.96	65.77	142.1	合格
		445	92.5	162.6	109.6	132.7	18.57	94.88	132.7	149.4	82.88	179.6	106.6	99.65	74.41	132.3	109.4	44.3	79.66	130.8	合格
		557	17.86	174.6	30.84	17.62	75.46	113.4	110.8	96.47	102.4	93.02	105.6	34.26	30.53	165.7	103.1	29.11	29.66	94.45	合格
		789	75.52	97.92	25.23	46.62	94.47	92.01	77.67	41.59	131.1	116.2	165.7	77.56	98.65	123.4	135.7	63.23	57.23	77.67	合格
		953	33.89	65.12	58.12	58.13	35.75	87.78	32.15	36.18	103.7	99.16	118.1	116.1	27.76	65.61	75.48	31.57	28.86	115.4	合格
		1057	31.94	57.91	51.43	30.71	40.19	90.46	27.19	41.28	87.85	41.54	80.47	94.76	41.53	55.41	58.14	29.76	21.83	101.8	合格

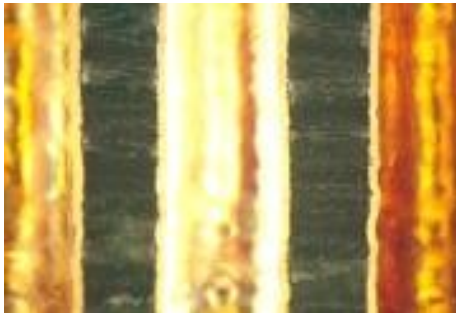

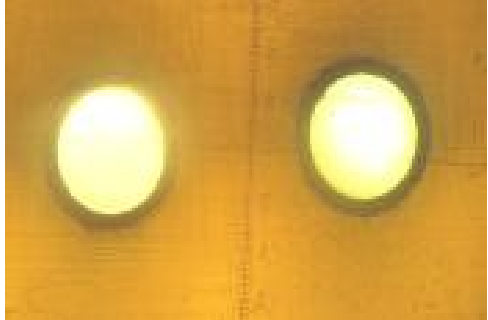

# KB-6167F Anti-CAF Test Result

Serial No.		1 Req: $>0.1E9\Omega$ (L/L $>0.5E9\Omega$ )						2 Req: $>0.1E9\Omega$ (L/L $>0.5E9\Omega$ )						3 Req: $>0.1E9\Omega$ (L/L $>0.5E9\Omega$ )							
Mat.	Period	TH/TH	TH/TH	TH/TH	TH/TH	TH/TH	L/L	TH/TH	TH/TH	TH/TH	TH/TH	TH/TH	L/L	TH/TH	TH/TH	TH/TH	TH/TH	TH/TH	L/L	Judge	
	Pitch	0.3	0.4	0.5	0.25	0.3	/	0.3	0.4	0.5	0.25	0.3	/	0.3	0.4	0.5	0.25	0.3	/		
	Diameter	0.4	0.4	0.4	0.4	0.3	/	0.4	0.4	0.4	0.4	0.3	/	0.4	0.4	0.4	0.4	0.3	/		
KB-6165F	3	Initial	98.42	47.43	118.2	101.7	92.86	87.68	95.57	85.72	107.5	88.82	73.86	96.86	72.75	66.45	88.45	87.10	73.82	115.3	Pass
		100	16.94	74.71	85.82	6.872	10.87	68.74	22.74	51.74	85.71	24.54	21.52	22.3	28.74	94.75	168.4	14.62	20.87	121.7	Pass
		240	36.23	30.75	56.74	7.892	12.55	58.86	28.39	65.75	30.92	13.52	11.85	68.21	17.86	17.82	19.27	8.905	13.21	78.92	Pass
		336	69.16	135.2	97.87	9.618	13.58	92.25	32.13	74.71	84.97	13.78	16.18	59.48	20.91	79.85	90.58	10.88	14.6	163.4	Pass
		445	76.68	127.8	194.7	10.87	14.54	64.77	41.3	106.3	109.6	16.27	14.25	64.21	21.72	110.7	134.2	9.534	10.31	135.1	Pass
		557	17.25	111.1	90.26	7.835	13.48	81.25	53.08	37.11	84.71	13.41	13.48	88.34	23.28	67.72	69.35	8.911	8.694	60.29	Pass
		789	29.83	120.2	112.1	13.83	21.39	70.18	41.16	140.3	163.2	23.91	20.86	72.04	92.48	131.2	142.3	15.51	20.94	86.64	Pass
		953	26.87	30.98	75.95	17.15	24.16	57.74	70.94	118.2	139.2	26.99	21.61	55.47	16.02	32.59	92.42	4.357	21.57	43.74	Pass
		1057	18.76	24.73	57.82	16.79	17.51	64.35	61.04	29.48	54.79	20.71	23.48	61.42	24.09	37.81	53.29	6.713	17.49	53.84	Pass

# KB-6164F Anti-CAF Test Result

Model	Vertical Micro-sections		Level Micro-sections	
	100 × (0.25mm)	100 × (0.40mm)	100 × (0.25mm)	100 × (0.40mm)
KB-6164F	<p>Glass fiber with slight wickings</p> 	<p>Glass fiber no obvious wickings</p> 	<p>Glass fiber no obvious wickings</p> 	<p>Glass fiber no obvious wickings</p> 

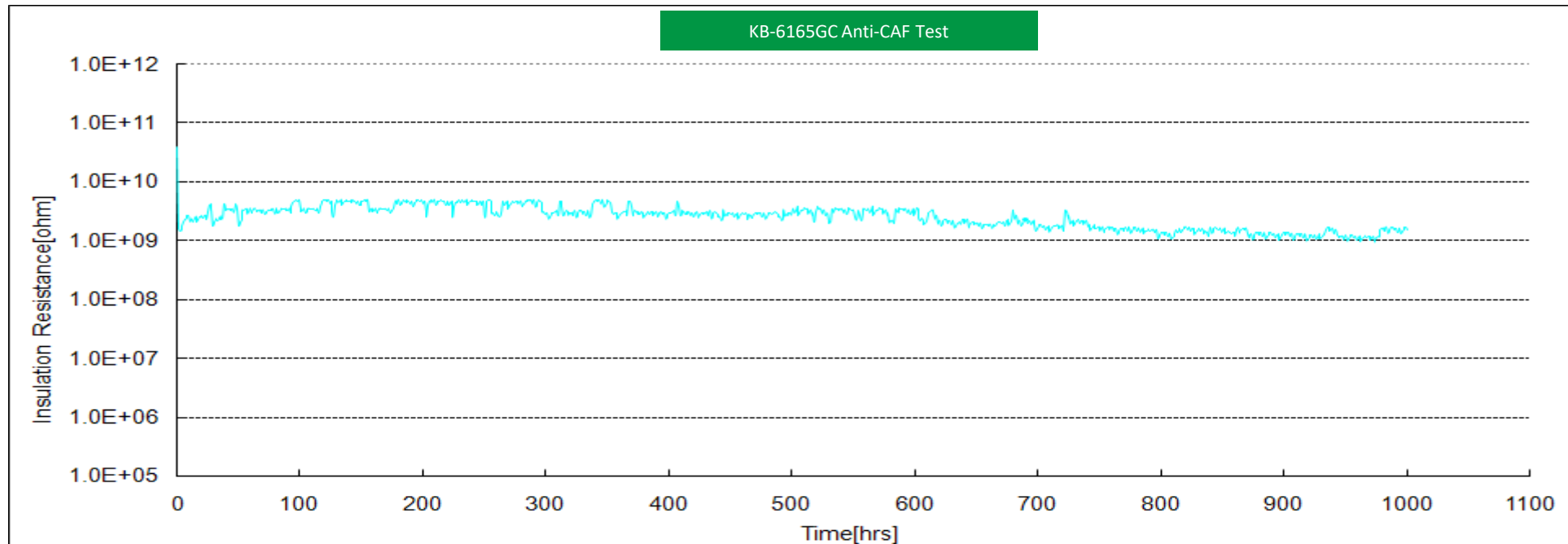
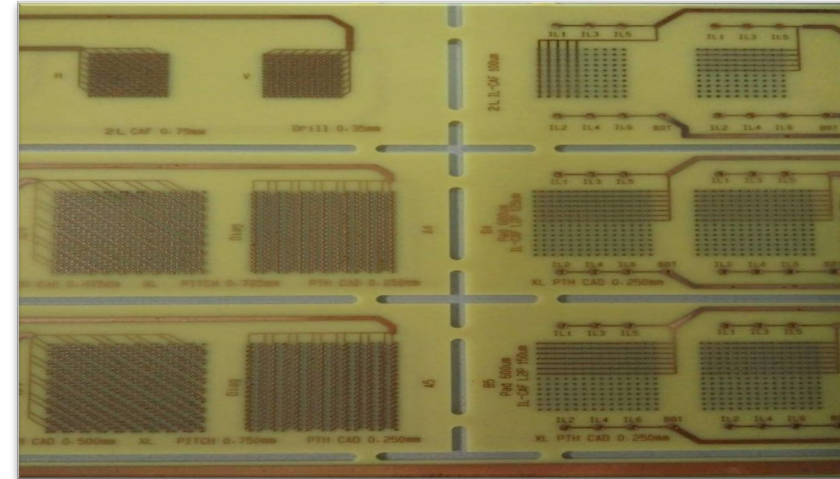
# KB-6165F Anti-CAF Test Result

Model	Vertical Micro-sections		Level Micro-sections	
	100 × (0.25mm)	100 × (0.40mm)	100 × (0.25mm)	100 × (0.40mm)
KB-6165F	<p>Glass fiber with slight wickings</p> 	<p>Glass fiber no obvious wickings</p> 	<p>Glass fiber no obvious wickings</p> 	<p>Glass fiber no obvious wickings</p> 

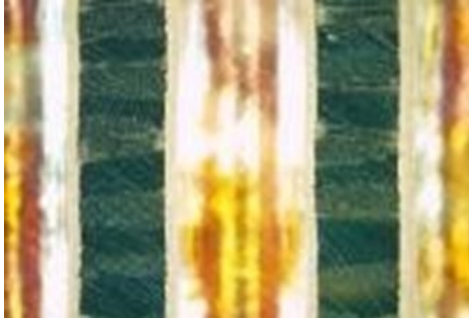
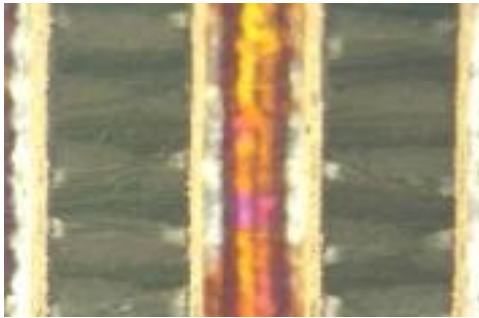




# KB-6165GC Anti-CAF Test Result

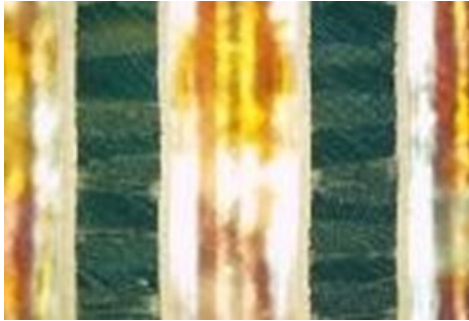
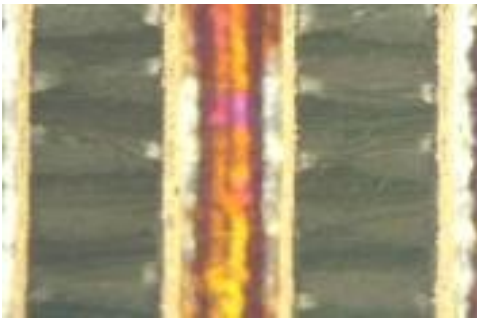


**Thickness: 1.5mm, 1/1. 7628x8**  
**Hole diameter : 0.35mm**  
**Distance (W-W) mm: 0.4mm**  
**Condition: 85 ±2°C, 85%RH, 100VDC**  
**Requirement: ≥100 Mohm**  
**Method: IPC-TM-650, 2.6.25**



# KB-6165GC Anti-CAF Test Result

Model	Vertical Micro-sections		Level Micro-sections	
	100 × (0.25mm)	100 × (0.40mm)	100 × (0.25mm)	100 × (0.40mm)
KB-6165GC	<p>Glass fiber with slight wickings</p> 	<p>Glass fiber no obvious wickings</p> 	<p>Glass fiber no obvious wickings</p> 	<p>Glass fiber no obvious wickings</p> 

# KB-6167F Anti-CAF Test Result

Model	Vertical Micro-sections		Level Micro-sections	
	100 × (0.25mm)	100 × (0.40mm)	100 × (0.25mm)	100 × (0.40mm)
KB-6167F	Glass fiber with slight wickings 	Glass fiber no obvious wickings 	Glass fiber no obvious wickings 	Glass fiber no obvious wickings 

# Third Party Anti-CAF Test Result

**SGS**

Material: KB-6165F

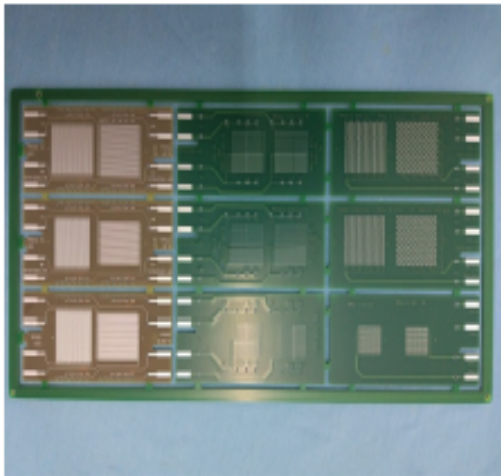
Layers: 6L

Quantity: 5 PCS

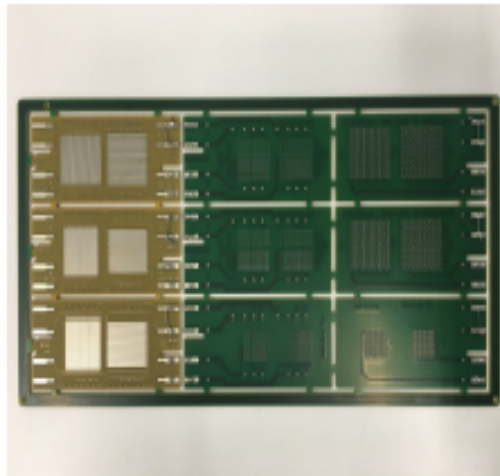
Method: IPC-TM-650, 2.6.25

## Test Conflation

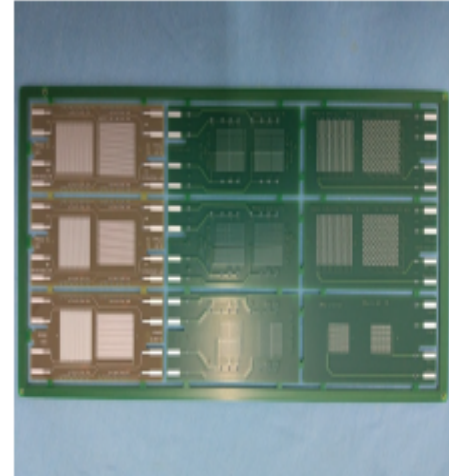
Temperature/Humidity:	85°C±2°C, RH85%+3%/-2%
Test Time:	96h without Bias, 1000h with Bias
Bias Voltage:	100±2VDC
Measurement Voltage:	100VDC
Measurement Time:	60s
Measurement Interval:	1h



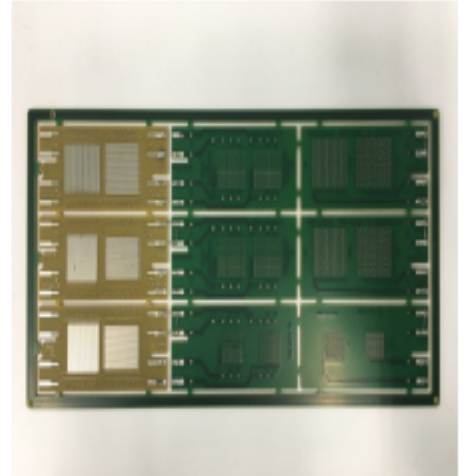
Appearance of sample before test-1#



Appearance of sample after test-1#



Appearance of sample before test-2#



Appearance of sample after test-2#



# Third Party Anti-CAF Test Result

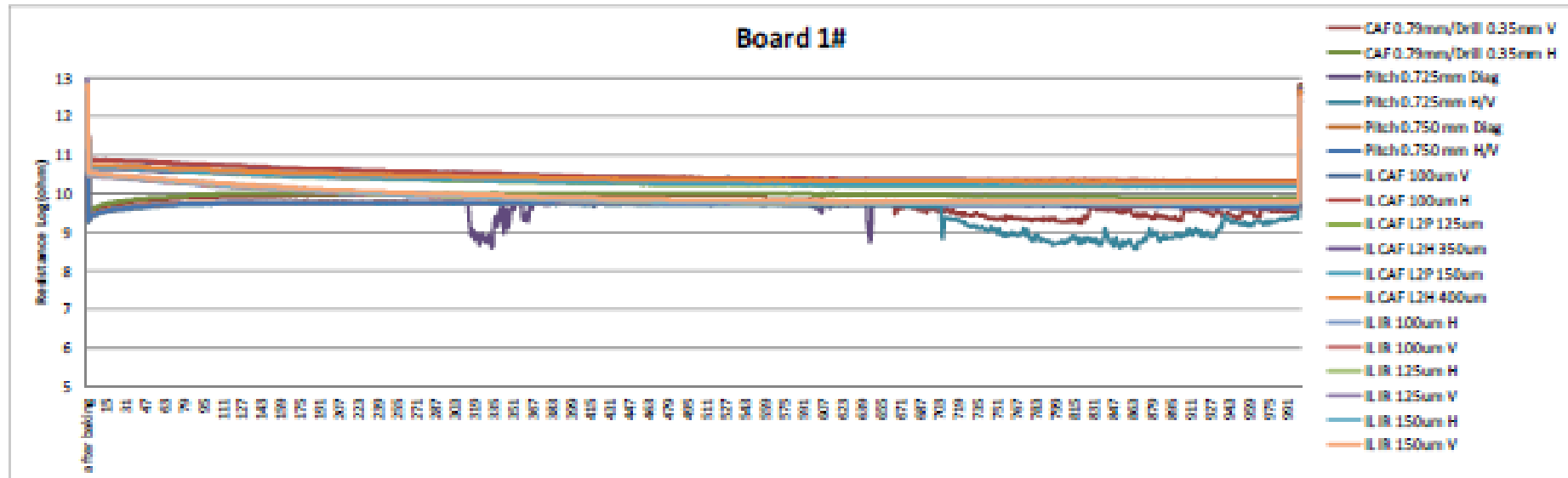


## Test Result:

Summarize result:

Sample No.	Test Item	Test Result	Criteria	Conclusion
1# /2# /3# /4# /5#	IR after precondition of baking	IR > 100MΩ	IR > 100MΩ and 1/100 of IR_initial	Pass
	IR_initial (96h THB/0h bias)	IR > 100MΩ		
	IR interval(every 1h during 1h-1000h bias)	IR > 100MΩ and 1/100 of IR_initial		
	Recovery IR (23°C/50%RH/24hrs)	IR > 100MΩ and 1/100 of IR_initial		
	IR after baking(105°C/6h)	IR > 500MΩ	IR > 500MΩ	

## IR Trend Graph:



# Third Party Anti-CAF Test Result

**SGS**

Material: KB-6165F

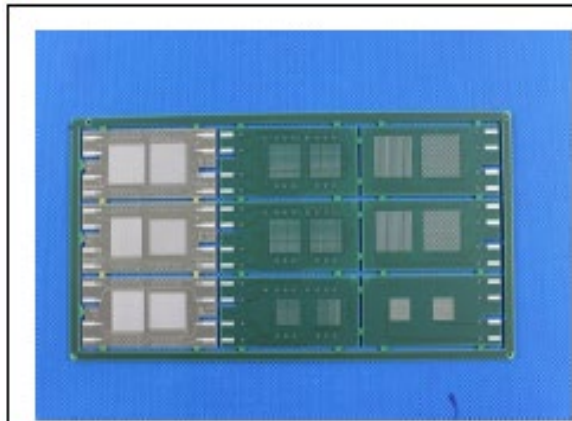
Layers: 8L

Quantity: 5 PCS

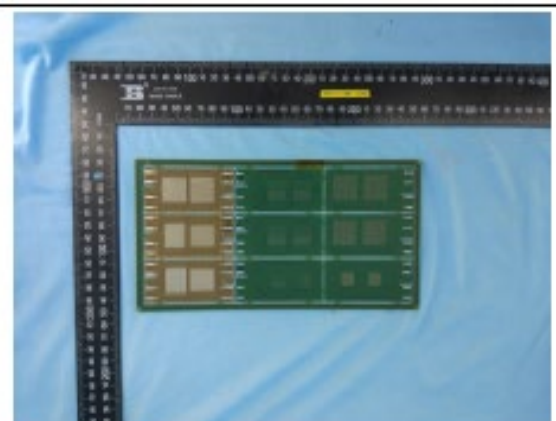
Method: IPC-TM-650, 2.6.25

## Test Conflation

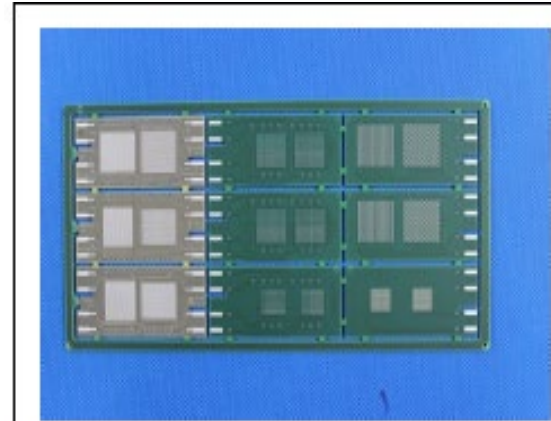
Temperature/Humidity:	85°C±2°C, RH85%+3%/-2%
Test Time:	96h without Bias, 1000h with Bias
Bias Voltage:	100±2VDC
Measurement Voltage:	100VDC
Measurement Time:	60s
Measurement Interval:	1h



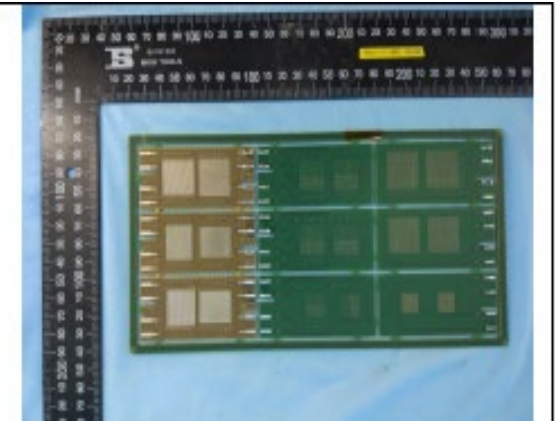
Before Test-1#



After Test-1#



Before Test-2#



After Test-2#

# Third Party Anti-CAF Test Result

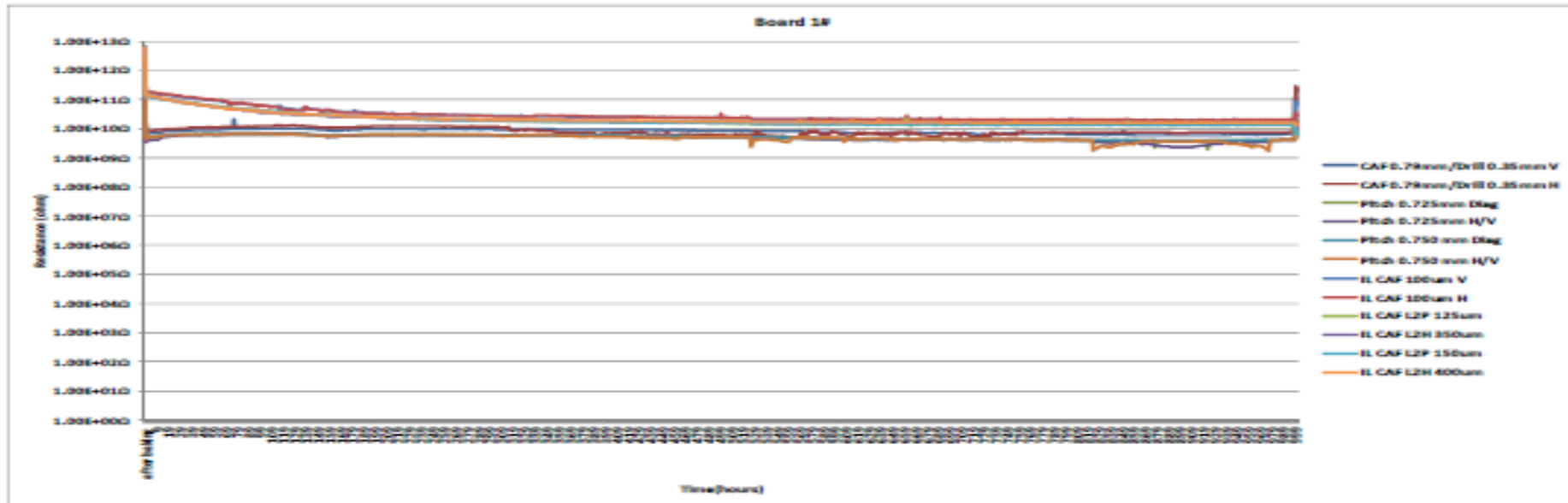


## Test Result:

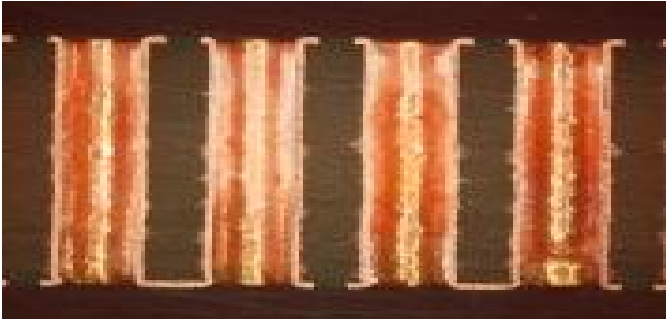
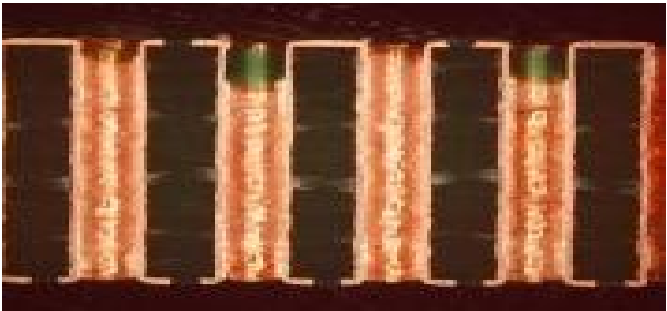
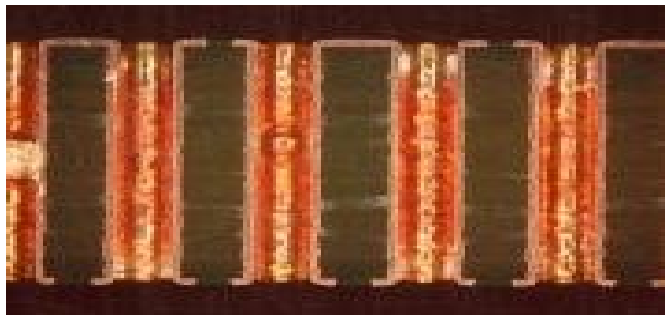
Summarize result:

Sample No.	Test Item	Test Result	Criteria	Conclusion
1# /2# /3# /4# /5#	IR after precondition of baking	IR > 100MΩ	IR > 100MΩ and 1/100 of IR_initial	Pass
	IR_initial (96h THB/0h bias)	IR > 100MΩ		
	IR interval(every 1h during 1h-1000h bias)	IR > 100MΩ and 1/100 of IR_initial		
	Recovery IR (23°C/50%RH/24hrs)	IR > 100MΩ and 1/100 of IR_initial		
	IR after baking(105°C/6h)	IR > 500MΩ	IR > 500MΩ	

## IR Trend Graph:



# TCT Micro-section

Item	Model	50 ×	Result
1	KB-6164F		No delamination, no copper peeling, no crack
2	KB-6165F		
3	KB-6167F		



# Pressure Cooker Test (PCT)

Producer	Normal TG		Mid TG	High TG
KB	KB-6160	KB-6164F	KB-6165F	KB-6167F

**Test method:** IPC-TM-650 2.6.16

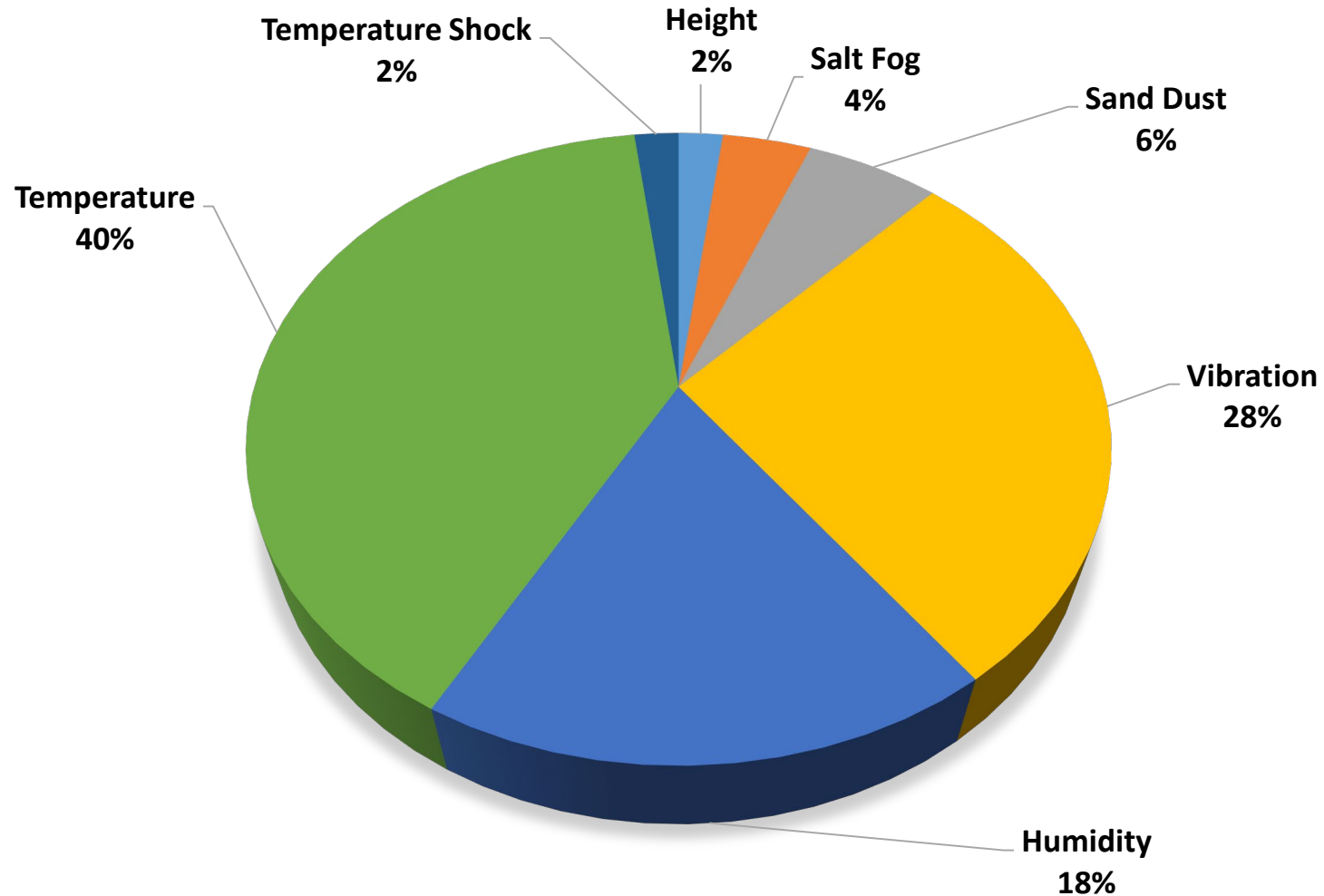
**Test condition:** 100% humidity & high pressure

**Test process:** PCT different time period (1H、 2H、 3H、 4H、 5H、 6H)

- Volume/surface resistivity
- Insulation resistance ;
- Water Absorption ;
- Tg/TD/CTE/T260/T288 ;

# Why PCT Test?

## Environmental Stress and Product Loss Efficacy



# PCT Test-Normal TG

Test item	Standard		Test Method	KB KB-6160	KB KB-6164F
Peel Strength (N/mm)	A	≥1.05	2.4.8	1.196/1.235	1.101/1.129
	F	≥1.05		1.203/1.196	1.156/1.164
Thermal Stress (Sec)	Float288°C≥60		2.4.13.1	>180	>180
Tg (°C)	/		2.4.25	139.0/139.3	144.5/142.9
TD (°C)	/		2.4.24.6	311.6	356.9
CTE (ppm/°C)	/		2.4.24	52.5/307.8	31.3/266.2
PTE(%)	/		2.4.24	4.21	3.61
T260(min)	/		2.4.24.1	10.61	>60
T288(min)	/		2.4.24.1	1.04	32.98
Water Absorption (%)	/		2.6.2.1	0.06	0.04
Tensile Strength (N/mm)	Fill	≥345	2.4.4	410.5	405.4
	Warp	≥415		513.3	536.3
CTI(V)	/		IEC60112	≥175	≥175
Flammability	94 V-0		UL94	V-0	V-0
Resistivity (MΩ)	A	≥1*10 <sup>5</sup>	JIS C 6481	2.39*10 <sup>9</sup>	1.16*10 <sup>9</sup>
	D-100°C	≥1*10 <sup>3</sup>		3.46*10 <sup>6</sup>	6.40*10 <sup>6</sup>

# PCT Test-Mid TG

Test item	Standard		KB-6165F
Peel Strength (N/mm)	A	≥1.05	1.144/1.202
	Float288°C	≥1.05	1.195/1.203
Thermal Stress (Sec)	Float288°C≥60		>180
Tg (°C)	≥150°C		153.5/154.9
TD (°C)	≥325°C		350.4
CTE (ppm/°C)	α1≤60/α2≤300		47.4/257.1
PTE(%)	≤3.5		3.13
T260(min)	≥30		>60
T288(min)	≥5		18.38
Water Absorption (%)	≤0.5		0.05
Tensile Strength (N/mm)	Fill	≥345	482.2
	Warp	≥415	574.8
CTI(V)	/		≥175
Flammability	94 V-0		V-0
Resistivity (MΩ)	A	≥1*10 <sup>5</sup>	1.14*10 <sup>9</sup>
	D-100°C	≥1*10 <sup>3</sup>	4.59*10 <sup>6</sup>



# PCT Test-High TG

Test item	Standard		KB-6167F
Peel Strength (N/mm)	A	≥1.05	1.275/1.118
	F	≥1.05	1.125/1.233
Thermal Strength (Sec)	Float288°C≥60		>180
Tg (°C)	≥170		176.5/177.2
Td (°C)	≥340		353.2
CTE (ppm/°C)	α1≤60/α2≤300		48.2/218.3
PTE (%)	≤3.0		2.43
T260(min)	≥30		>60
T288(min)	≥15		25.12
Water Absorption (%)	≤0.5		0.07
Tensile Strength (N/mm)	Fill	≥345	417.7
	Warp	≥415	507.5
CTI(V)	/		≥175
Flammability	94 V-0		V-0
Resistivity (MΩ)	A	≥1*10 <sup>5</sup>	7.58*10 <sup>8</sup>
	D-100°C	≥1*10 <sup>3</sup>	4.47*10 <sup>6</sup>

# KB CCL in Automotive

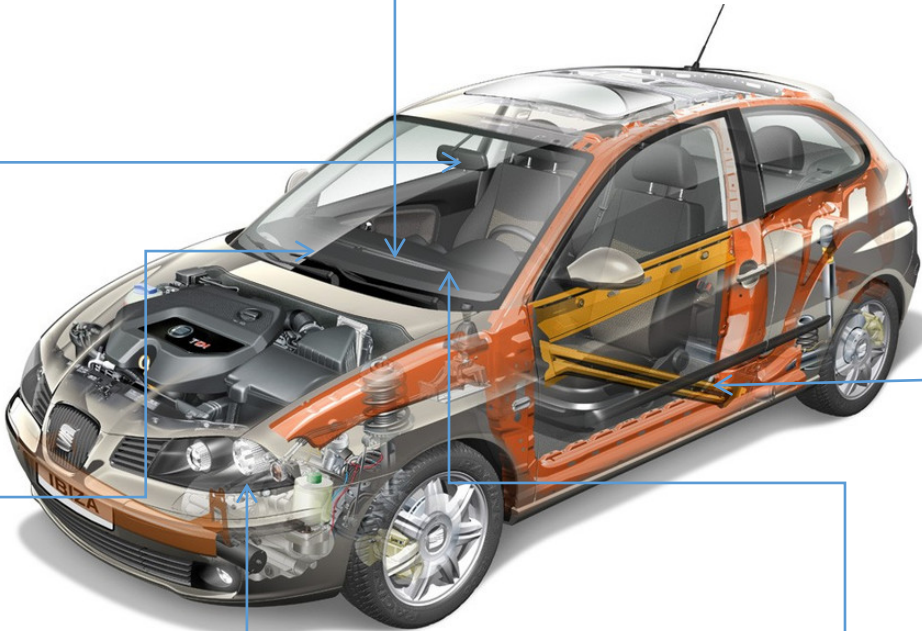


**Automotive camera, Multi purpose camera, Night view camera**  
KB Material Type: FR-4  
Product Code: KB-6160, KB-6165F

**Dashboard, Sun roof, Wiper, Car Media**  
KB Material Type: FR-4  
Product Code: KB-6160, KB-6165F, KB-6167F



**Engine ECU, Air bag, DC-DC Invertors, Hybrid Power Module, TCU, ABS**  
KB Material Type: FR-4  
Product Code: FR-6165F, KB-6167F



**Battery Management System**  
KB Material Type: FR-4  
Product Code: KB-6165F, KB-6167F, KB-6168



**Automotive Lighting, LED Light**  
KB Material Type: FR-4  
Product Code: KB-6160

**Infotainment, Wifi Module, Car Video, Communication Module**  
KB Material Type: FR-4  
Product Code: KB-6160, KB-6165F



# Safety Systems in Automotive



- Engine ECU
- High Reliability
  - High Voltage

**KB Material Type: FR-4**  
**Product Code: KB-616XF**



- DC-DC Converter
- High Reliability
  - High Power
  - High Voltage

**KB Material Type: FR-4**  
**Product Code: KB-616XF**



- HEV DC-DC Converter
- High Reliability
  - High Voltage (350V)

**KB Material Type: FR-4**  
**Product Code: KB-616XF**



- Hybrid Power Module
- High Current (800A)
  - High Power Dissipation
  - High Voltage (650V)

**KB Material Type: FR-4**  
**Product Code: KB-616XF**

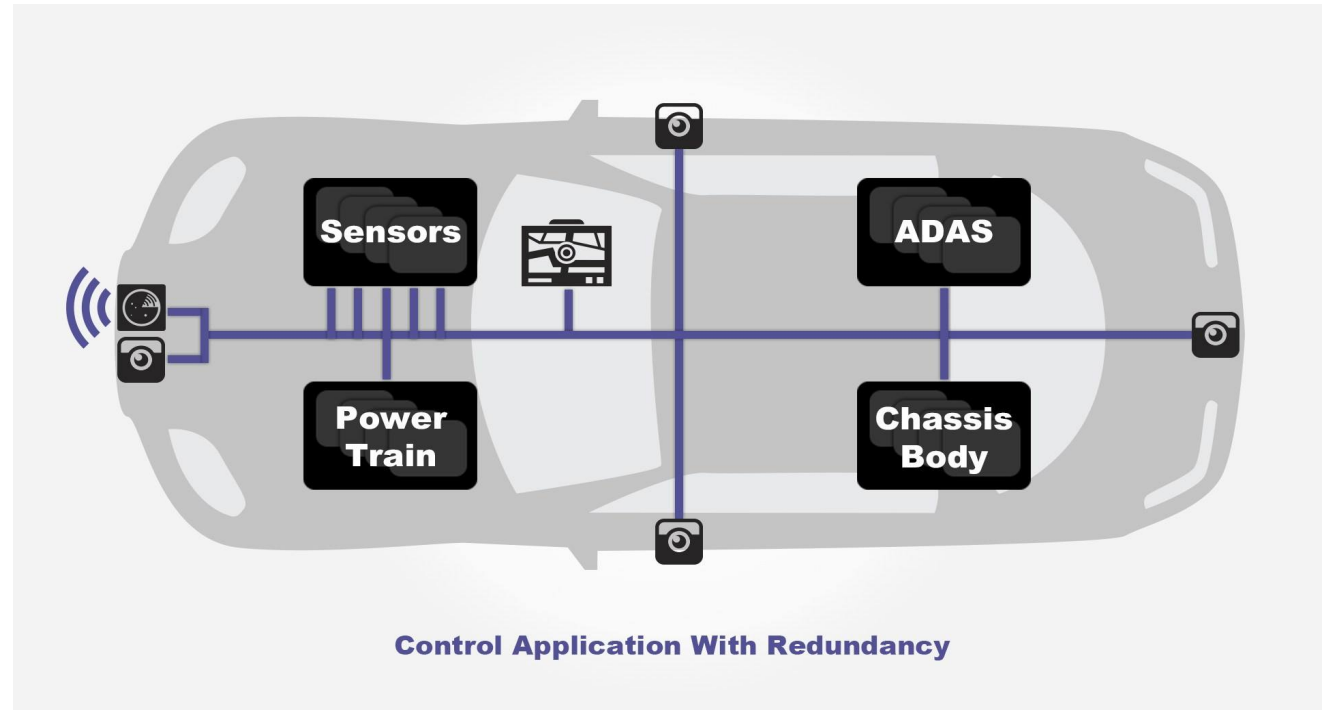


# Cameras and Sensors



## Components

- Ultrasonic sensor
- Mid-range camera
- Near-range camera
- Long range radar sensor



**KB Material Type: FR-4**  
**Product Code: KB-616XF**

Demand for miniaturization and HDI will grow to meet performance and cost reduction requirements.

# Automotive Lighting



## Lighting

- High Thermal Conductivity
- High Reliability
- Cost effective

**KB Material Type: CEM-1, CEM-3**

**Product Code: KB-6160,KB-5150H, KB-7150**



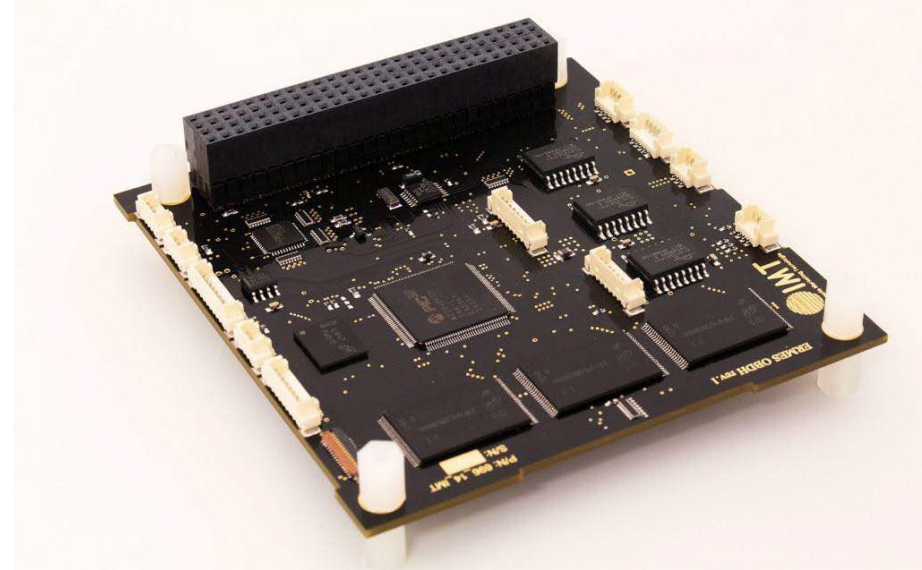


# Charging Systems



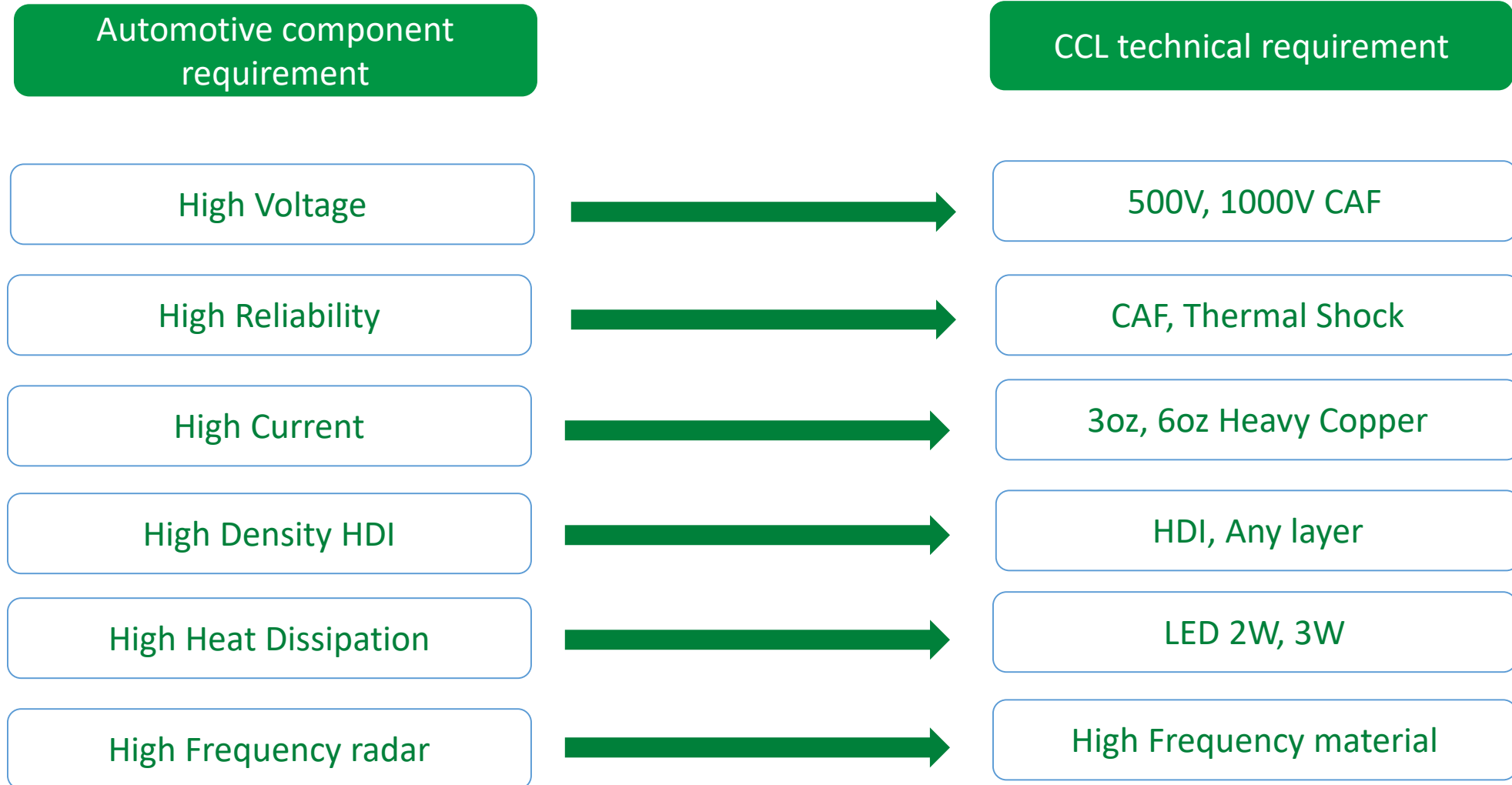
- Onboard Charger (OBC)
- High effective battery charging
  - Heavy copper design

**KB Material Type: FR-4**  
**Product Code: KB-616XF, KB-6168**  
**KB 6oz 6165F got UL certified.**



- Electronic filter for OBC
- For reliable fast charging on all power Grids
  - Heavy copper design

# Materials Requirements

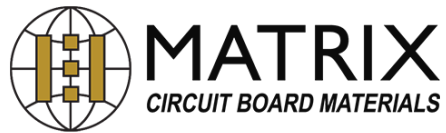


# Development Timetable

Categories		2016				2017				2018				2019				2020				Application	
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4		
Heavy Copper	6oz					A	A	B	B	B	C	C	D	D	D	D	D	D	D	D	D	D	High Current, Hybrid Power Module, Convertor
	12oz									A	A	A	B	B	C	C	C	D	D	D	D	D	
High Speed/Low Loss	Low-Dk glass KB-(GLD) Series					A	A	B	B	B	B	C	C	D	D	D	D	D	D	D	D	D	Low DK/DF (3.8-4.1)
	FR-4+PPO						A	A	A	A	B	B	B	B	C	C	D	D	D	D	D	D	PPO resin system (3.6-3.8)
	BT								A	A	A	A	B	B	B	C	C	D	D	D	D	D	BT resin system (3.0-3.4)
High TG	Tg-180 KB-6168					A	A	B	B	C	C	C	C	D	D	D	D	D	D	D	D	D	Wider Operating Temperatures
	Tg-200 KB-6200							A	A	B	B	B	C	C	C	C	D	D	D	D	D	D	
Halogen-free	Tg-150 (HF) KB-6165GC						A	A	B	B	C	C	D	D	D	D	D	D	D	D	D	D	Halogen Free Demand, Environmental Requirement
	Tg-170 (HF) PIC-5157G								A	A	B	B	C	C	C	D	D	D	D	D	D	D	
	Tg-180 (HF) PIC-5158G								A	A	B	B	B	B	C	C	C	D	D	D	D	D	
Anti-CAF KB-(F) series	50V (0.3/0.4/0.5mm)	C	C	C	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	Critical Anti-CAF Requirement
	100V (0.35/0.4/0.5mm)	C	C	C	C	C	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	
Metal-clad	Aluminum Base Laminates					A	A	A	B	B	B	C	C	C	C	C	D	D	D	D	D	D	Good Thermal Conductivity
	Copper Clad Laminates																						

# Thank You

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