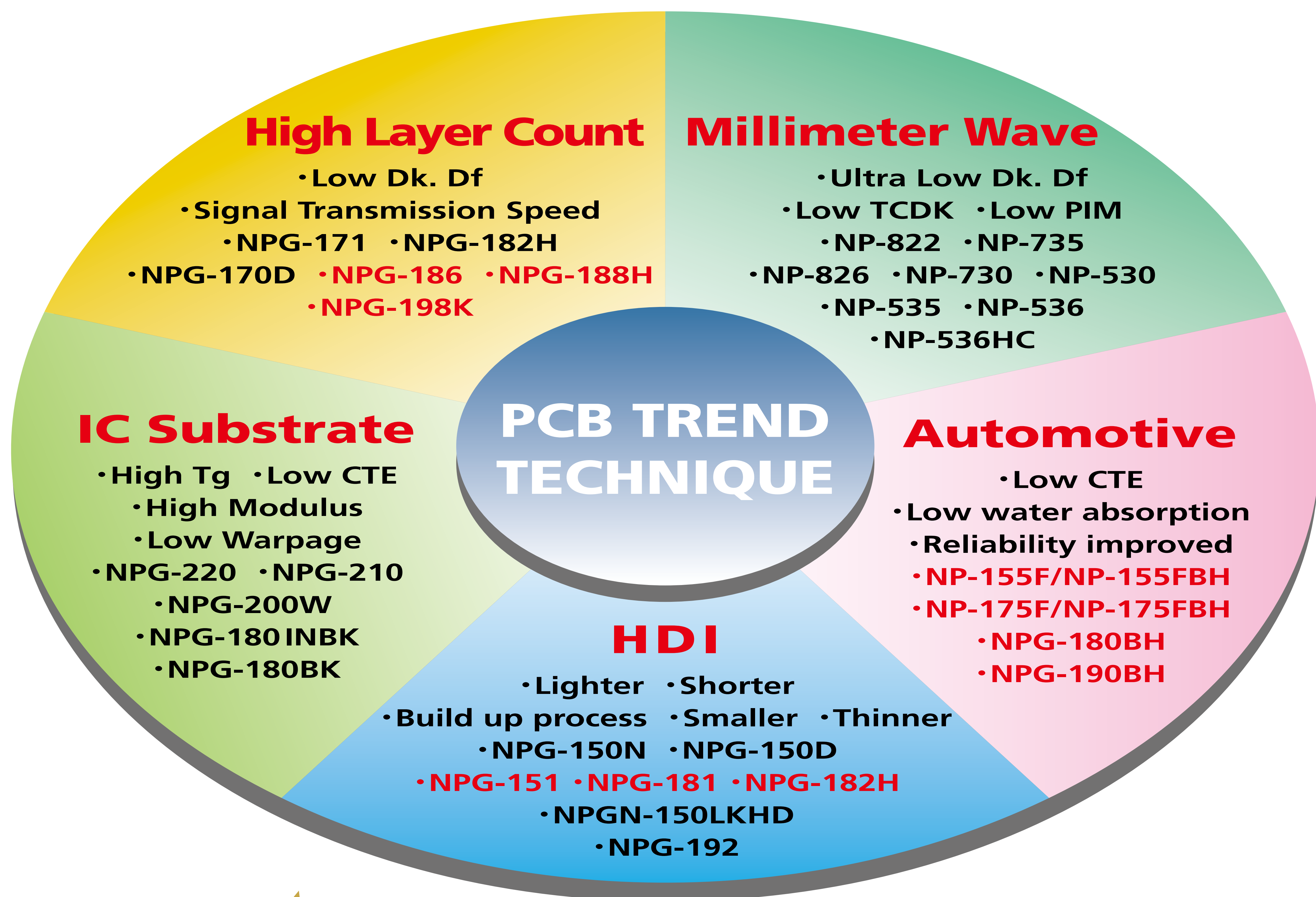


The CCL Material Trend

System Products of Nan Ya CCL



Millimeter Wave

- NP-735 NP-730 NP-826 NP-822 PTFE
- NP-530 NP-535 NP-536 NP-536HC

Automotive

- NPG-181PY High Tg CIT600(Under development)
- NPG-180BH/NPG-190BH
- NPG-151
- NP-175FBH
- NP-155F/NP-155FBH

HDI

- High Tg Low Dk NPG-181
- High Tg Low Dk/Df NPG-182H, NPG-192
- NPG-150N, NPG-151, NPG-150D
- Low Dk NPGN-150LKHD

Low Dk/Df : High Layer Count

- NPG-198K Super Ultra low loss(Under UL approval)
- NPG-186K/NPG-186 Ultra Low Loss
- NPG-188H Ultra Low Loss
- NPG-182H Low Loss
- NPG-170D Low Loss
- NPG-171 Middle Loss

IC Substrate

- BT/Epoxy NPG-200W, NPG-210, NPG-220
- NPG-180INBK, NPG-180BK

Traditional Product

- FR4 NP-140 Tg 140°C
- FR4 11PY(CTI600)
- CEM-3-09HT, CEM-3-10(CTI600), CEM-3-01 HC(CTI600)
- CEM-1-97PM, CEM-1-97(CTI600)



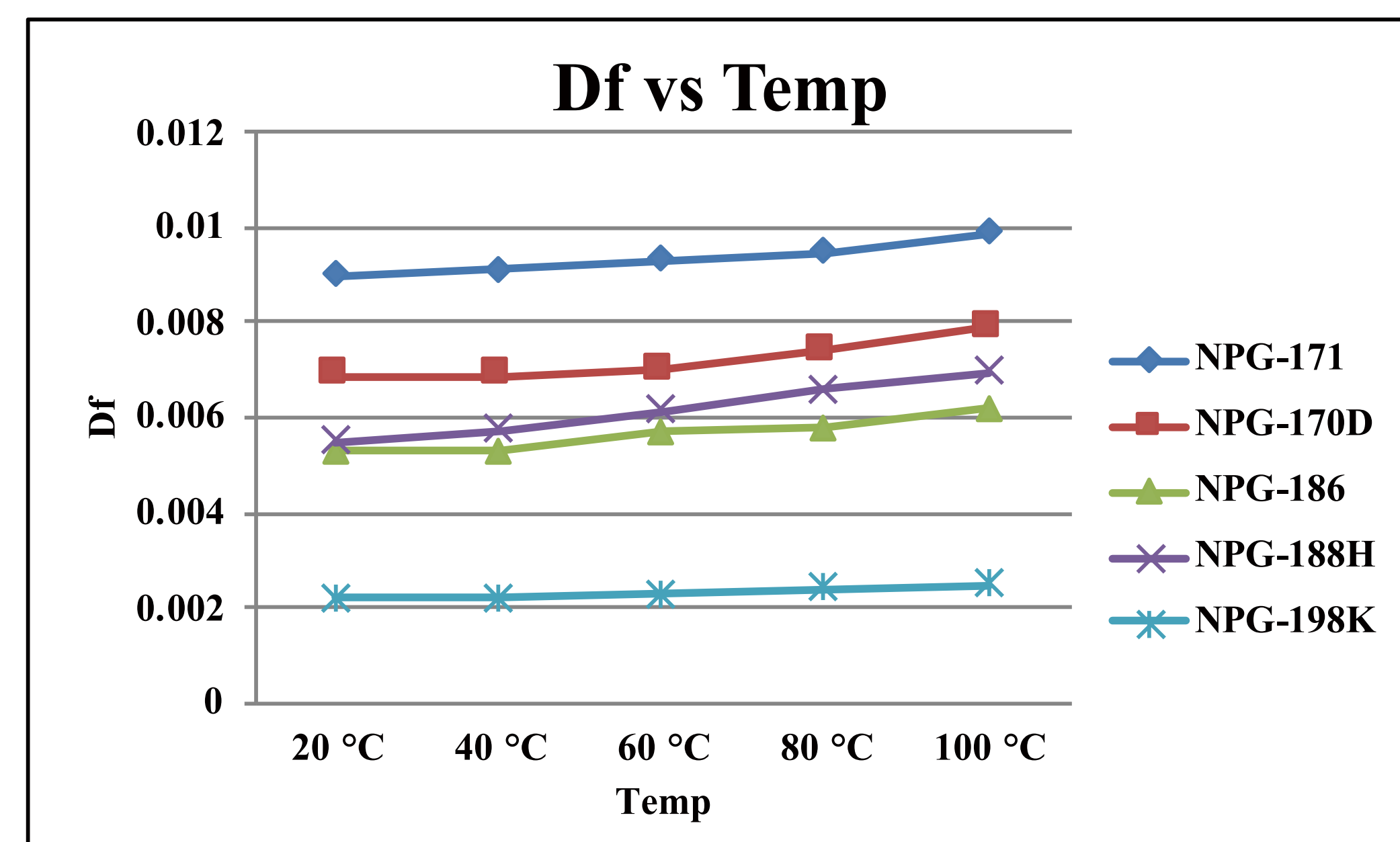
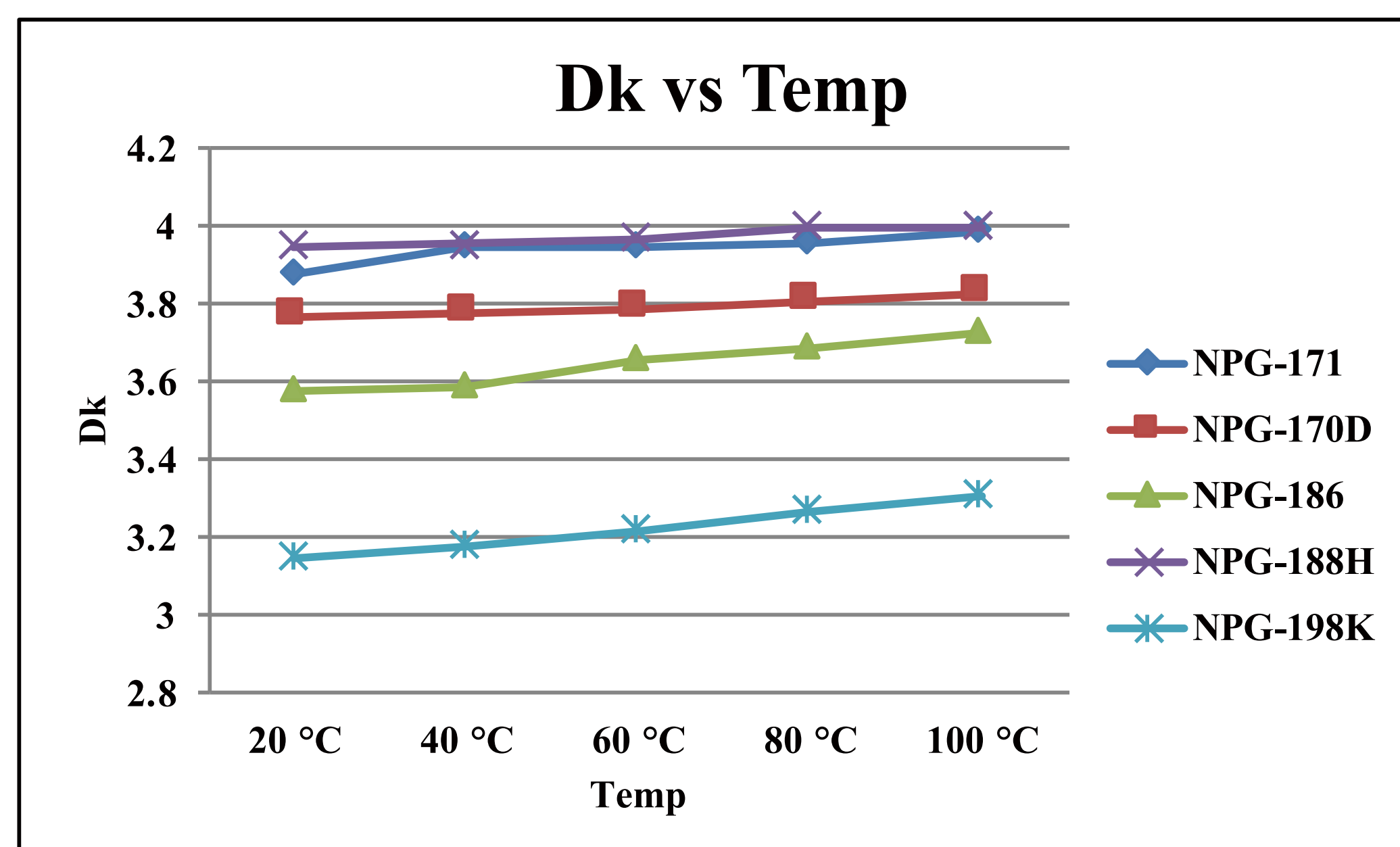
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High Layer Count Material Laminates Suited for High-Speed Applications

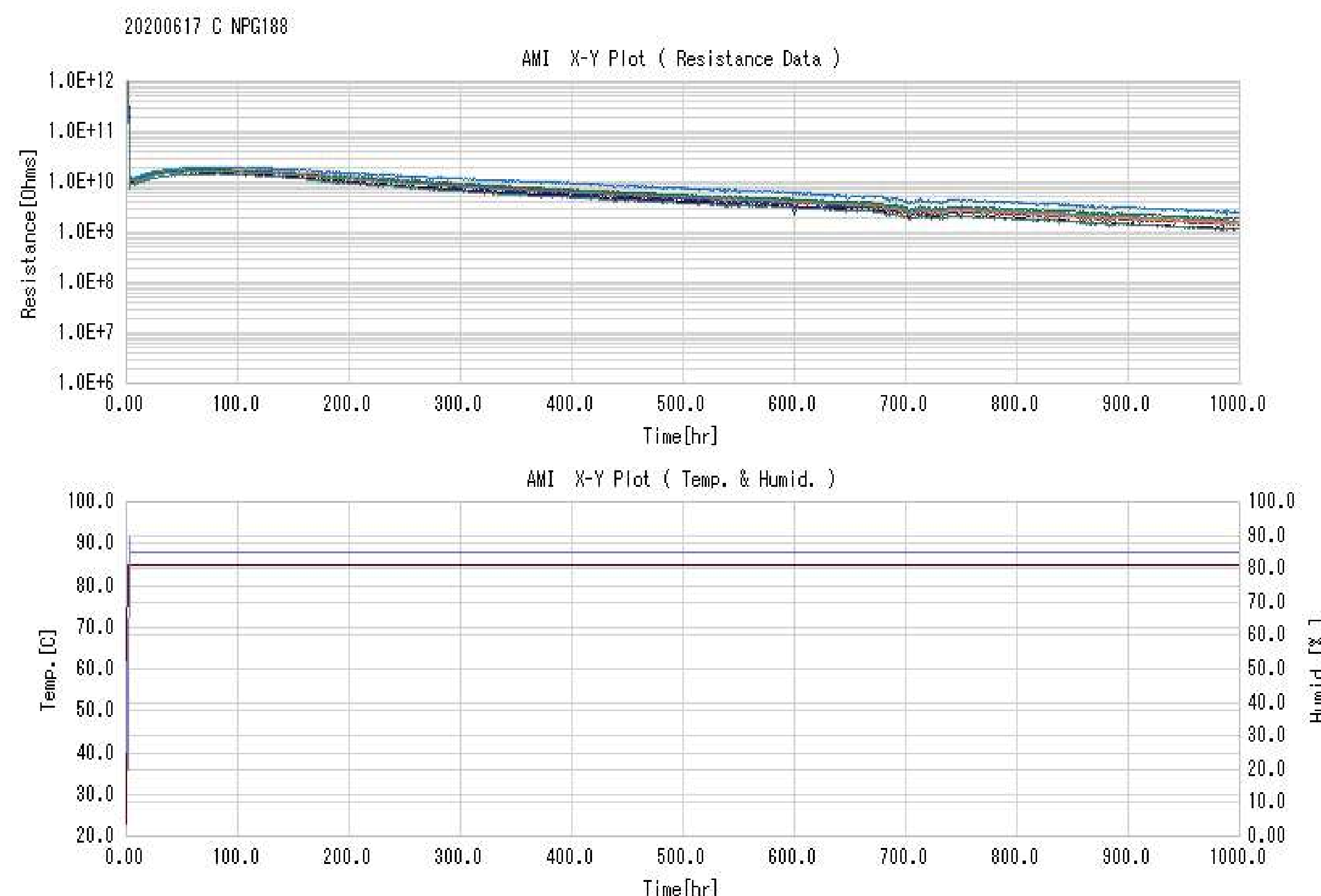
General Properties

Item	Unit	NPG-171	NPG-170D	NPG-182H	NPG-188H	NPG-186	NPG-186K	NPG-198K
Tg	°C	170	170	230 (TMA)	210 (TMA)	226 (DMA)	226 (DMA)	220 (DMA)
Z-axis CTE	$\alpha 1$ (ppm/°C)	40	35	30	30	33	33	35
	$\alpha 2$ (ppm/°C)	220	220	120	130	213	213	215
PCT 2 hr	Water Absorption %	0.2	0.18	0.10	0.15	0.12	0.12	0.1
	288°C solder dipping	10'	10'	10'	10'	10'	10'	10'
T260	Min	>60'	>60'	>60'	>60'	>60'	>60'	>60'
Td 5%	°C	365	390	430	420	400	400	410
Dk(3GHz)	-	4.14	4.03	4.0	3.9	3.9 (10GHz)	3.5 (10GHz)	3.23 (10GHz)
Df(3GHz)	-	0.008	0.006	0.005	0.0043	0.005 (10GHz)	0.0035 (10GHz)	0.002 (10GHz)
Delta-L	dB/inch @8GHz	0.99	0.75	0.71	0.58	0.54	0.48	0.44
	dB/inch @16GHz	1.72	1.35	1.25	0.96	0.93	0.82	0.74

Stable Electrical Properties



CAF Resistance



- Material : NPG-188H 30LB
- Board thickness : 4.0 mm
- Hole size : 0.3mm, Pitch 0.6 /0.7/0.8 mm
- Precondition : IR Reflow 260°C x 5 times
- Test Condition : 1000 hours, 85°C /85%RH, DC 1000V
- Pass Criteria : Insulation resistance $\geq 108 \Omega$
- Result : PASS

Heat Resistance

NPG-188H 30LB



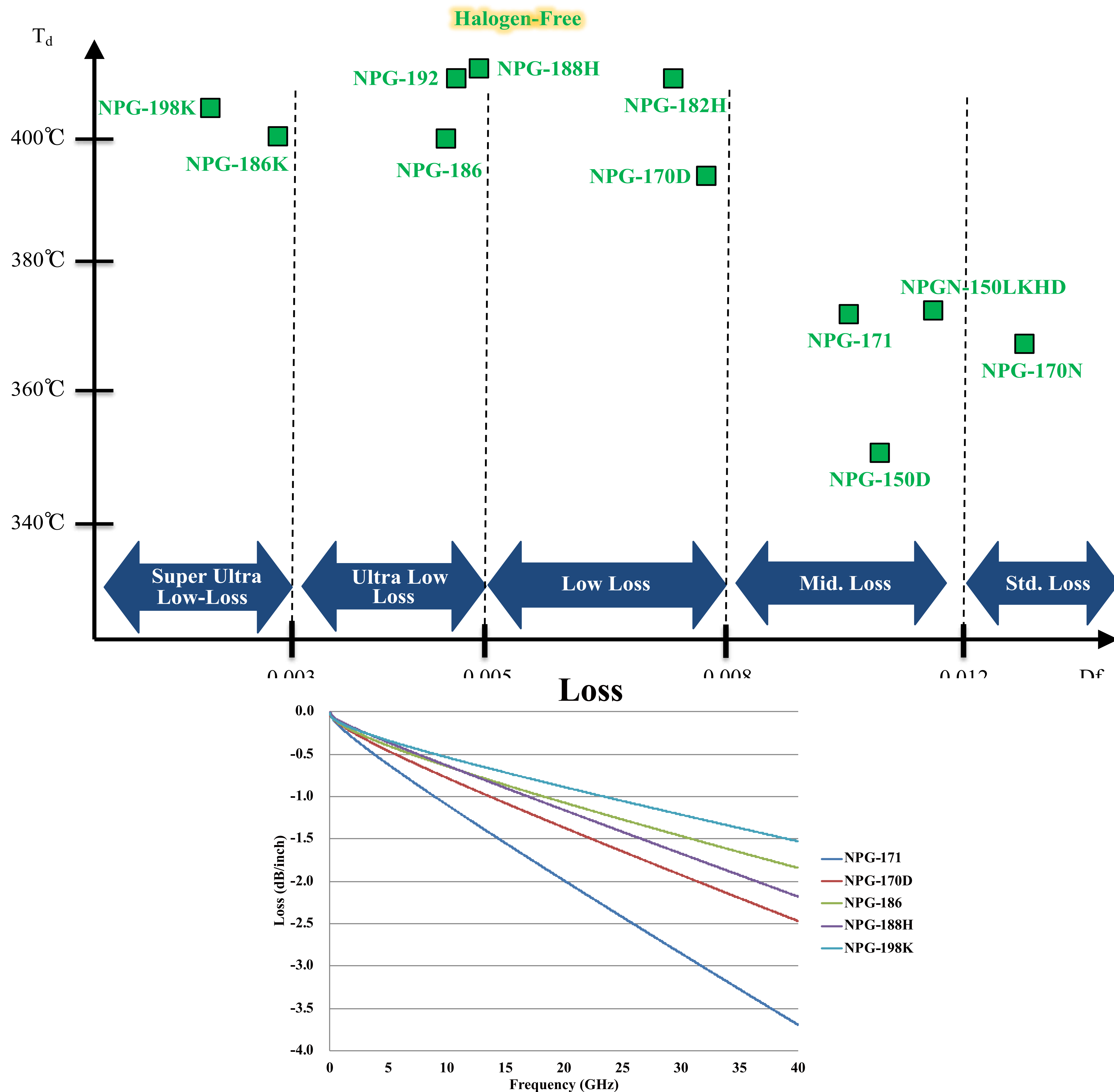
TH size : 0.25mm
TH pitch : 0.8mm
288°C floating : 10sec x 6times



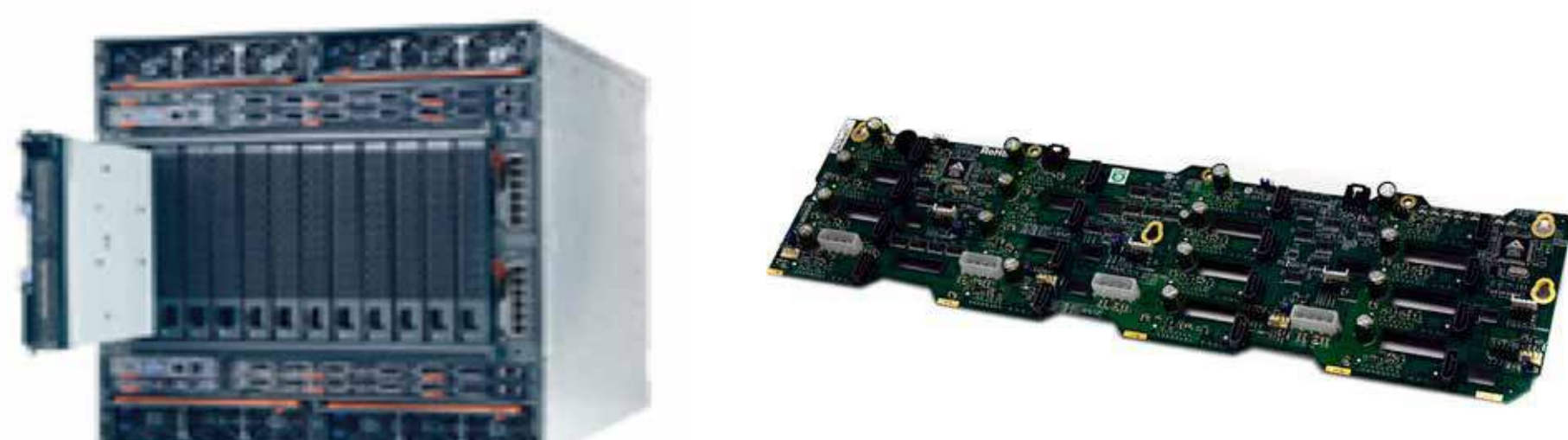
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High Layer Count Material Laminates Suited for High-Speed Applications

Decomposition Temp. (T_d) and Df @ 10GHz



Nan Ya Materials Application

Nan Ya Products	Applications
NPGN-150LKHD NPG-150D Series	Server Workstation 
NPG-170N NPG-171 Series	Networks Blade Server Backplanes 
NPG-170D NPG-186 NPG-188H NPG-198K	Server Storage Telecom 



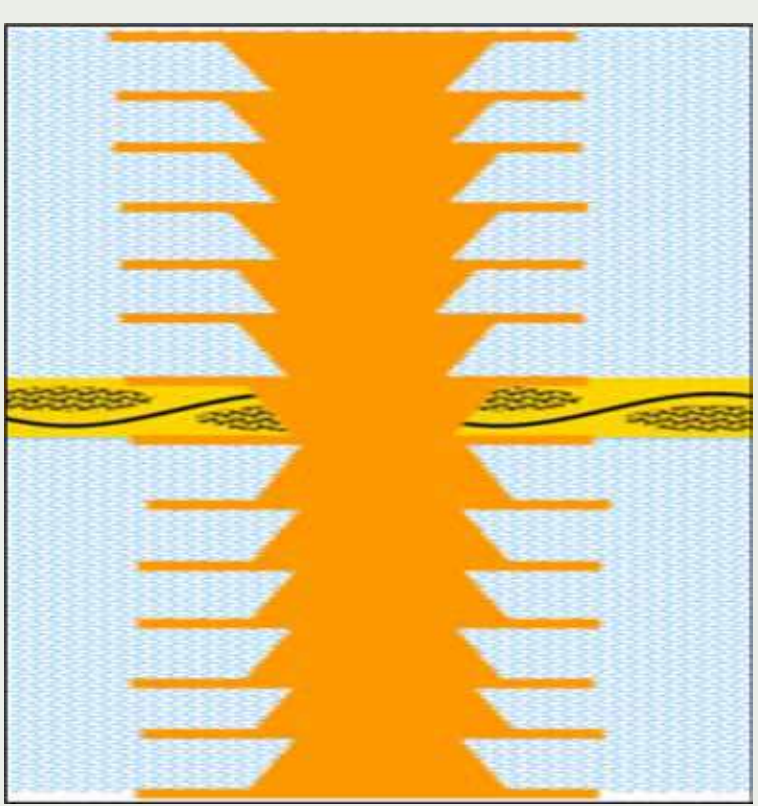
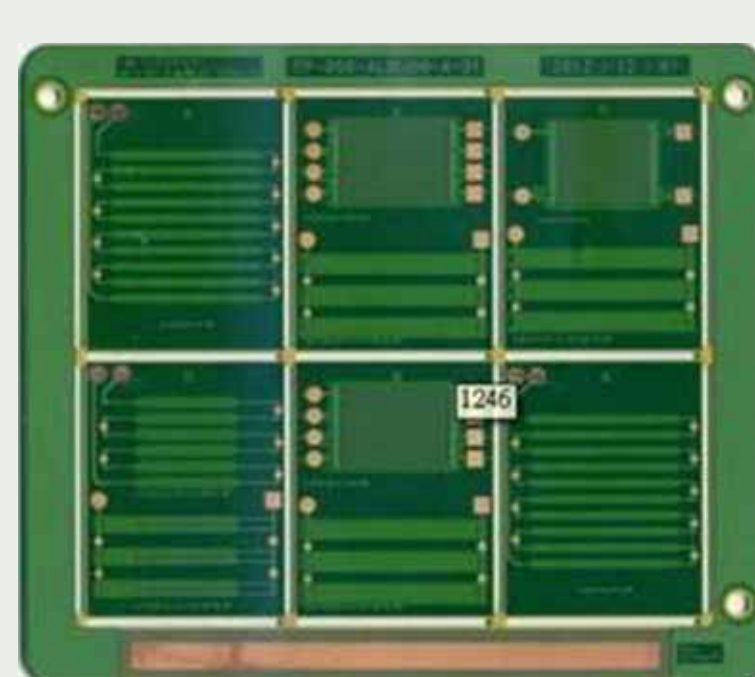
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High Density Interconnect Material

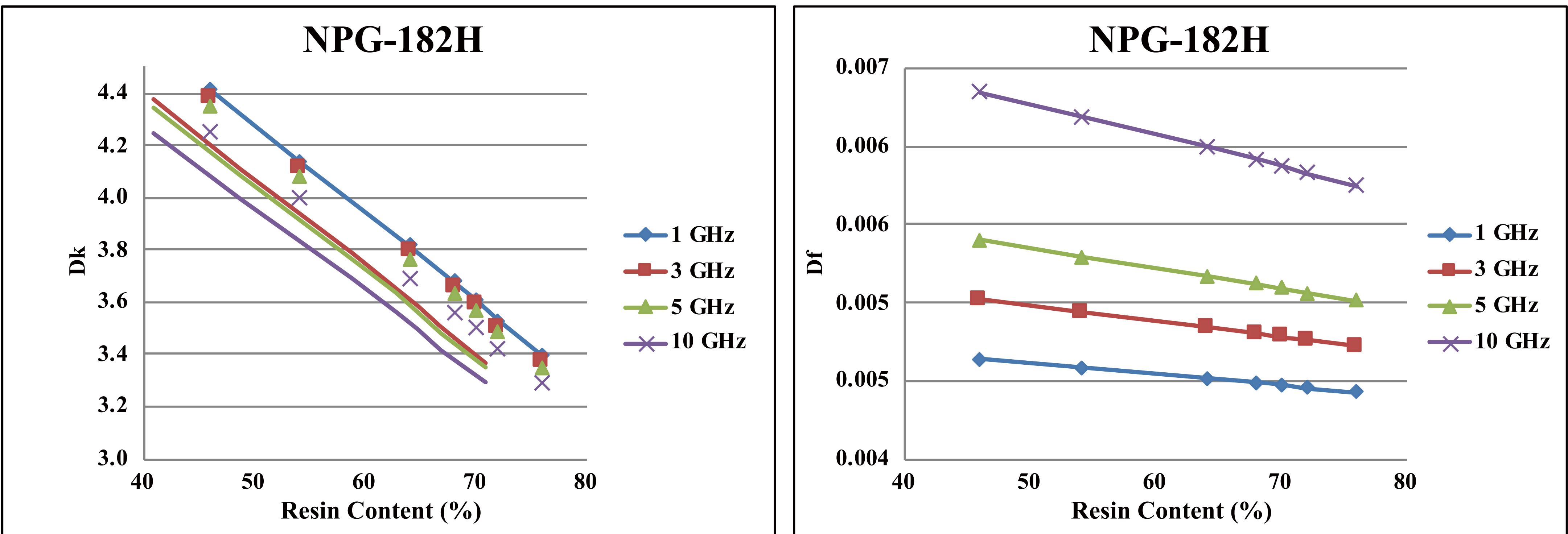
General Properties

Item	Test Condition	NP-155F	NPGN-150 LKHD	NPG-150D	NPG-151	NPG-181	NPG-182H	NPG-192
Tg	°C	150	150	155(TMA)	155(TMA)	180	230(TMA)	230(TMA)
Z-axis CTE	α -1(ppm/°C)	40	30	30	30	30	30	30
	α -2(ppm/°C)	240	224	220	210	210	120	130
PCT 2 hr	Water Absorption %	0.19	0.17	0.15	0.16	0.15	0.15	0.10
	288°C solder dipping	10'	10'	10'	10'	10'	10'	10'
T260	Min	>60'	>60'	>60'	>60'	>60'	>60'	>60'
Td 5%	°C	350	370	350	380	390	425	430
Dk(1GHz)	RC 74%	3.9	3.4	4.1	3.9	3.4	3.5	3.3 (RC70%@10GHz)
Df(1GHz)	RC 74%	0.013	0.012	0.009	0.013	0.008	0.005	0.004 (RC70%@10GHz)

Thermal Reliability

Materials	Construction (7+2+7)	Test Pattern	Test Item	Condition	Results
NPG-182H			Reflow	Peak temp @260°C	> 15 cycles
Core thickness 60 μm (1078x1ply)			Thermal Stability	Solder dipping 274°C	> 15 cycles
Built-up prepreg 1078(RC70%)			Hot Oil Test	25 °C x20"/260 °C x20"	> 20 cycles
			TCT	-55x15min/ 10" /125°C x15min	> 300 cycles

Dielectric Properties/Material: NPGN-182H



Nan Ya Materials Application

Nanya Products	Applications
NP-155F & NPG-150D Series	1+N+1, 2+N+2, 3+N+3 HDI-process compatible Desktop Laptop Tablet Mobile Phone Hard Disk Game Console LCD TV 
NPG-151 & NPG-150D Series	ELIC & any-layer HDI-process compatible Laptop Tablet Mobile Phone 
NPG-181 / NPGN-150LKHD Series (Low Dk Material) NPG-182H / NPG-192	ELIC & any-layer HDI-process compatible Tablet Mobile Phone 



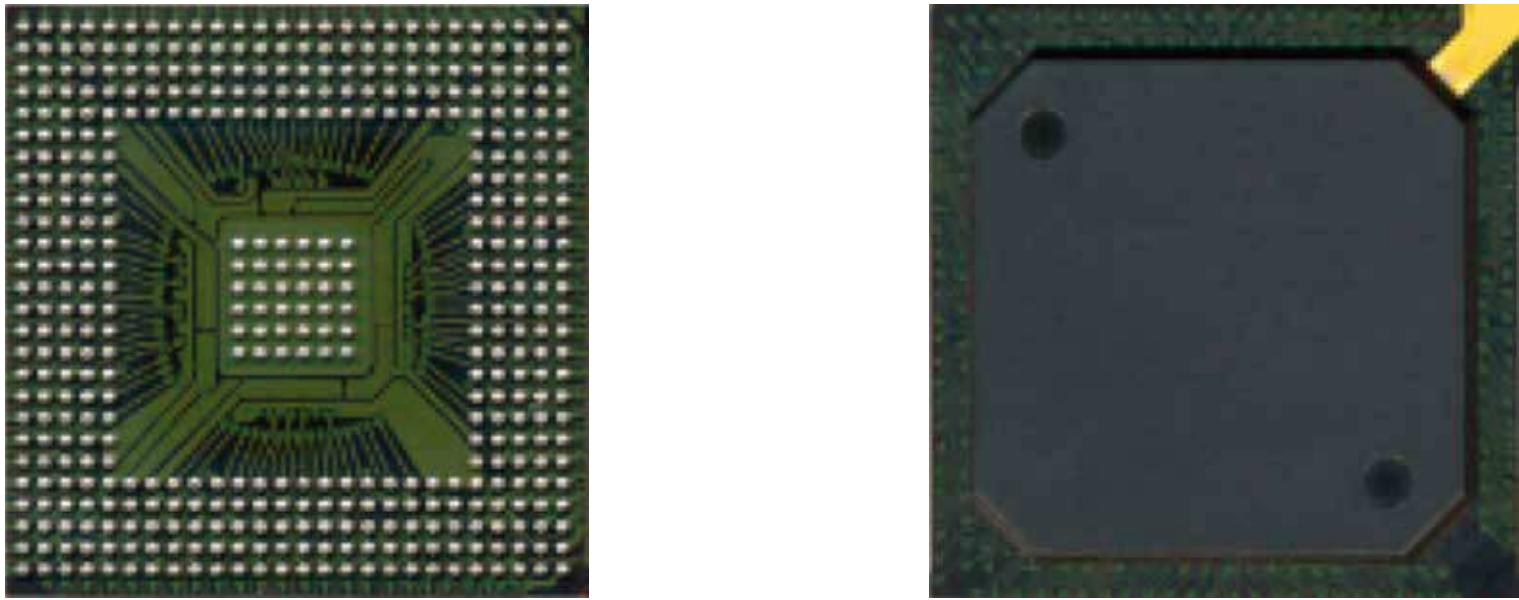
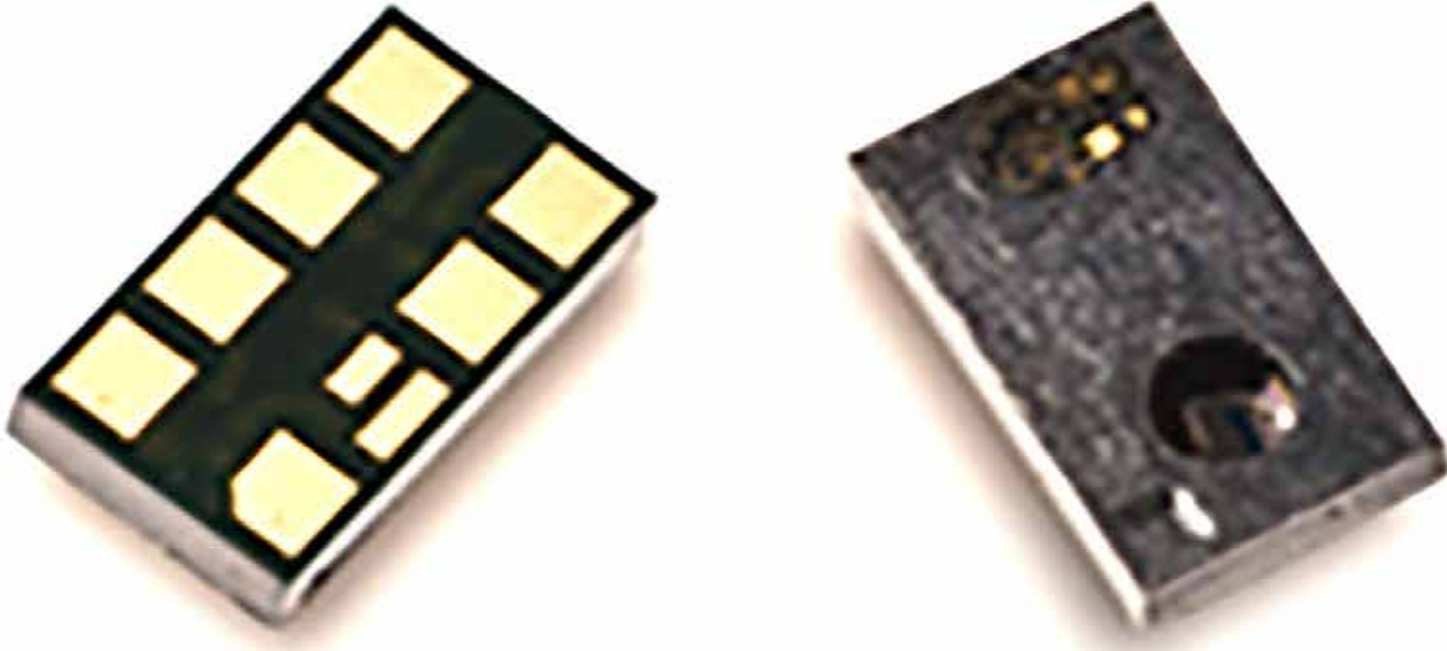
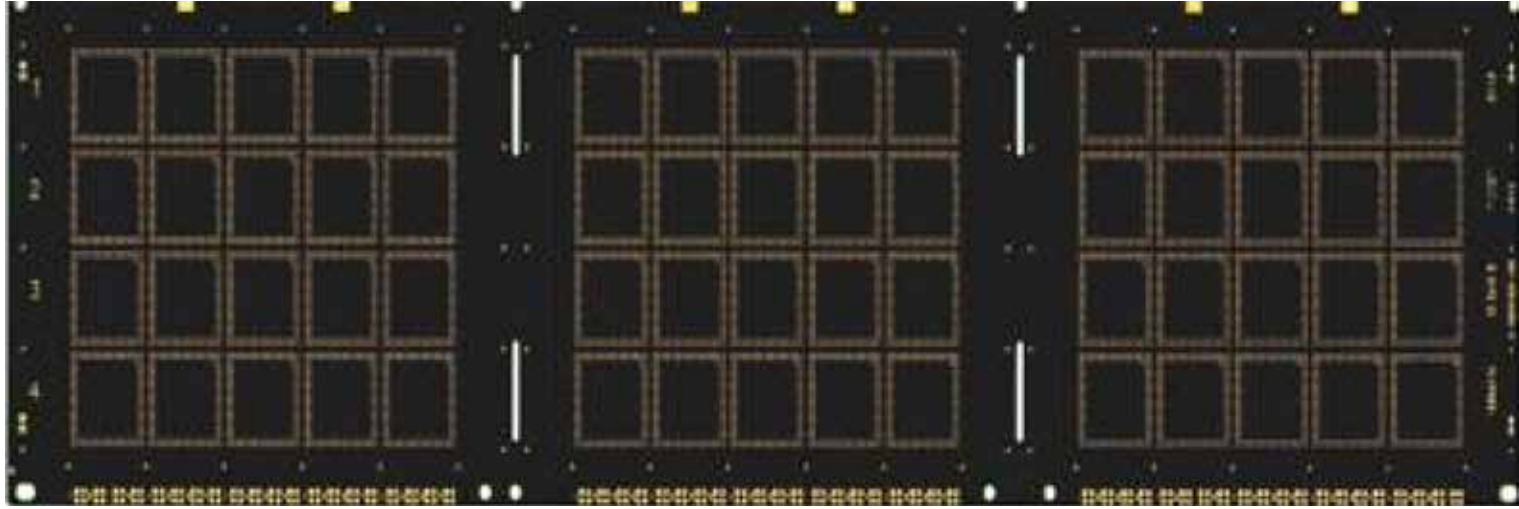
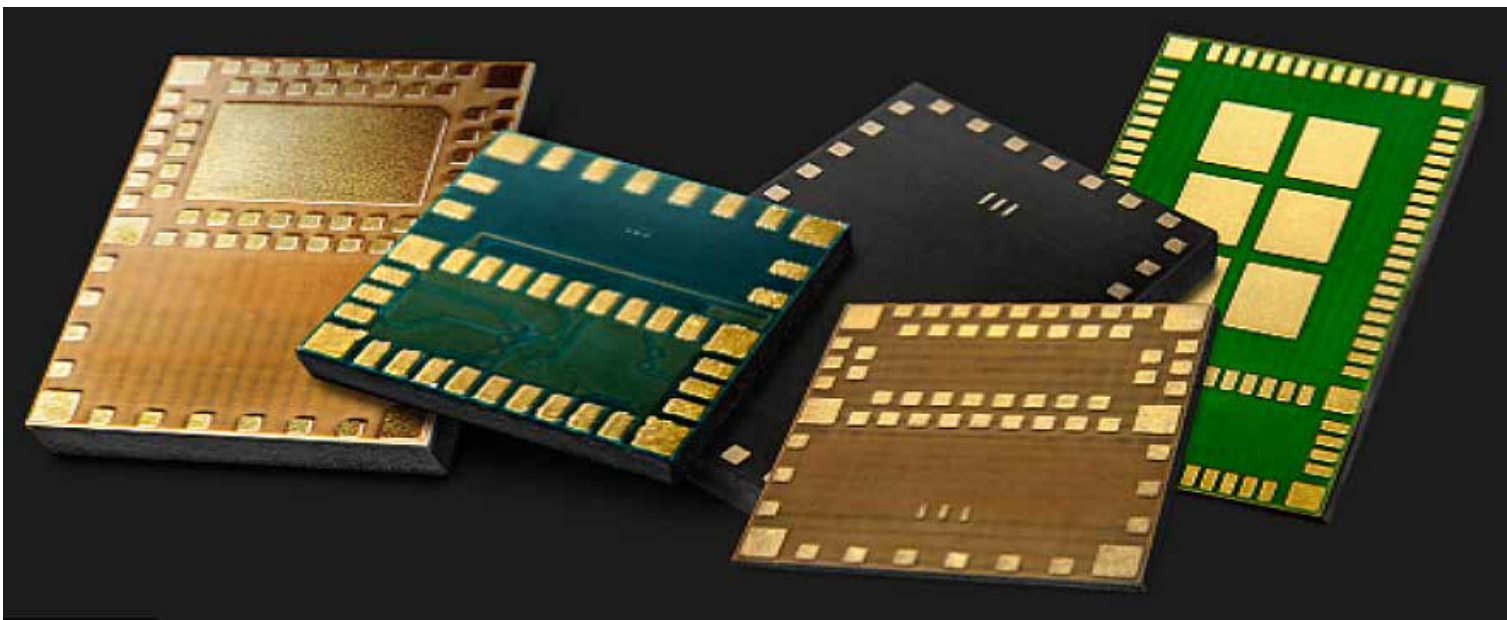
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Halogen Free IC Substrate Materials

General Properties

Test Item	Unit	NPG-180INBK	NPG-180BK	NPG-210	NPG-220
Color		Black	Black	Black	Black
Copper	oz	T	T	T	T
Peel strength	lb/in	4.9	4.9	4.0	4.5
Permittivity (1G Hz)	-	4.48	4.72	4.2	3.75(10G Hz)
Loss tangent (1G Hz)	-	0.010	0.013	0.006	0.004(10G Hz)
Tg by DMA	°C	240	240	310	270
Tg by TMA	°C	180	180	270	200
Storage Modulus at 50°C	GPa	22	22	25	23
Storage Modulus at 240°C	GPa	12	12	15	13
CTE-Z(α 1)	ppm/°C	30	30	20	28
CTE-Z(α 2)	ppm/°C	90	90	55	120
CTE-X,Y(α 1)	ppm/°C	12	12	6±1 (E glass) 4±1 (S glass)	10
W.A(D-23/24)	%	0.25	0.25	0.14	0.20
T288 Delamination with copper	min	>20'	>20'	>60'	>60'

Nan Ya Substrate Materials Applications

Nan Ya Products	Applications
NPG-180IN/NPG-180INBK	Memory card CSP DDR III , DDR IV PBGA 
NPG-180BK	Mini LED RGB Optical sensor 
NPG-210/ NPG-210 Type S	Ultra Low CTE FCCSP POP MCP 
NPG-220	Antenna in package 

Nan Ya IC Substrate Materials Features

1. Excellent dimensional stability and through-hole reliability
2. Excellent thermal stability and long term reliability
3. Excellent insulation properties for CAF
4. Raw materials integration to ensure consistent and stable supply



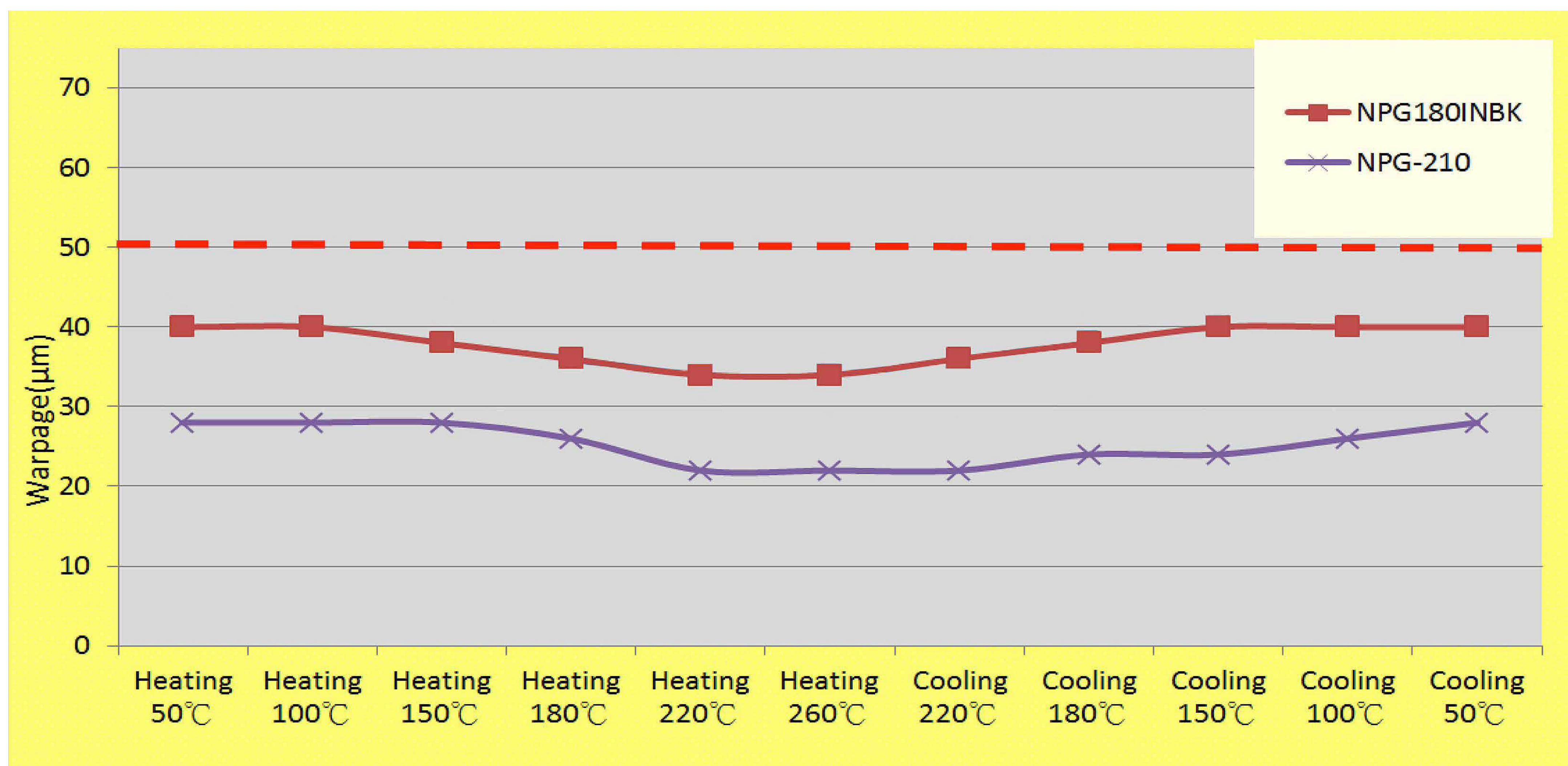
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Halogen Free IC Substrate Materials

Warpage Test of Nan Ya Substrate Cores

• Features :

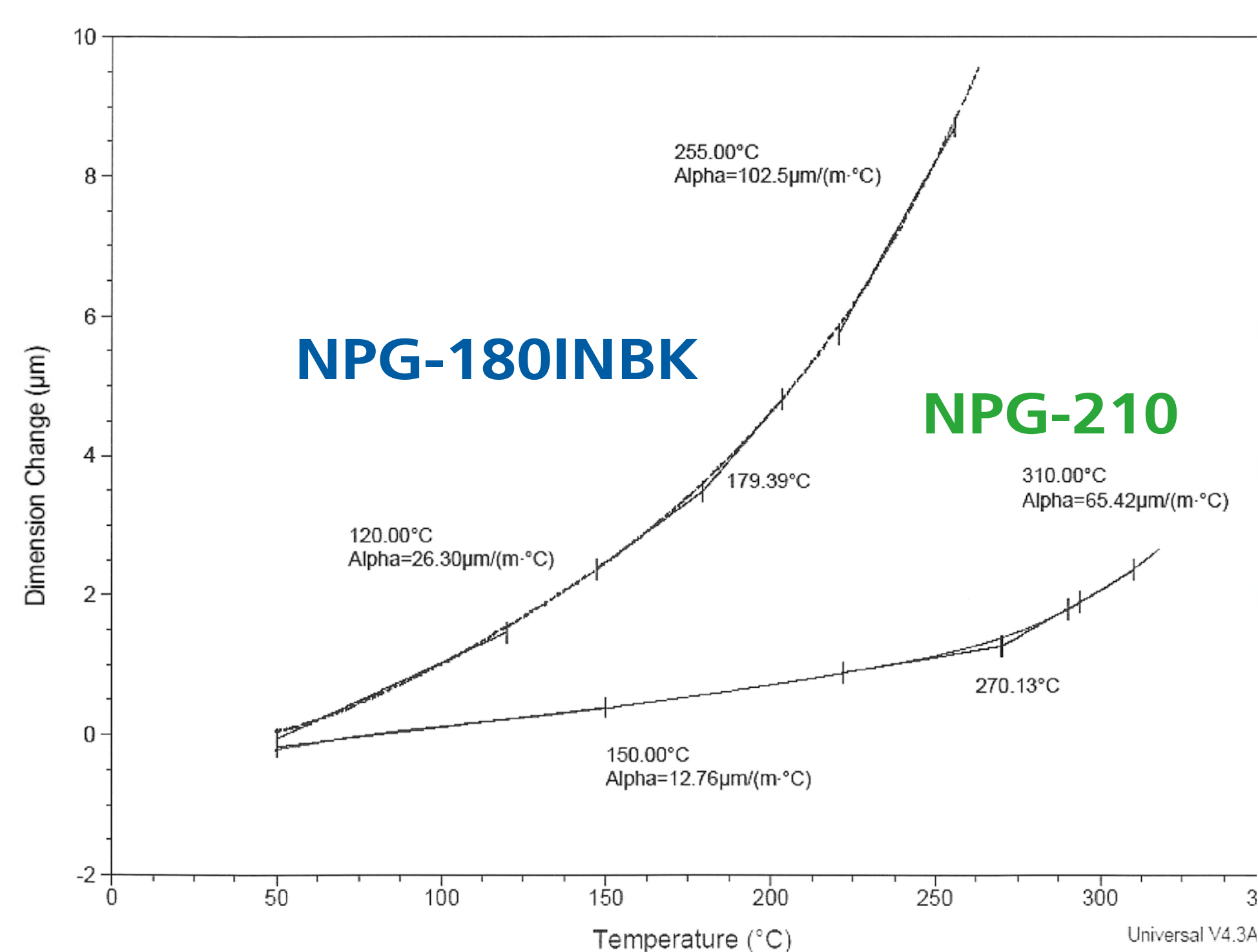
- Halogen and antimony free.
- Flammability meets UL 94 V-0.
- Excellent long term reliability.
- UV blocking type.
- Superior CAF-Resistance (Anti-migration).
- Reactive type flame retardants.
- High Tg (DMA> 300°C and ultra low C.T.E will provide excellent dimensional stability and through-hole reliability.



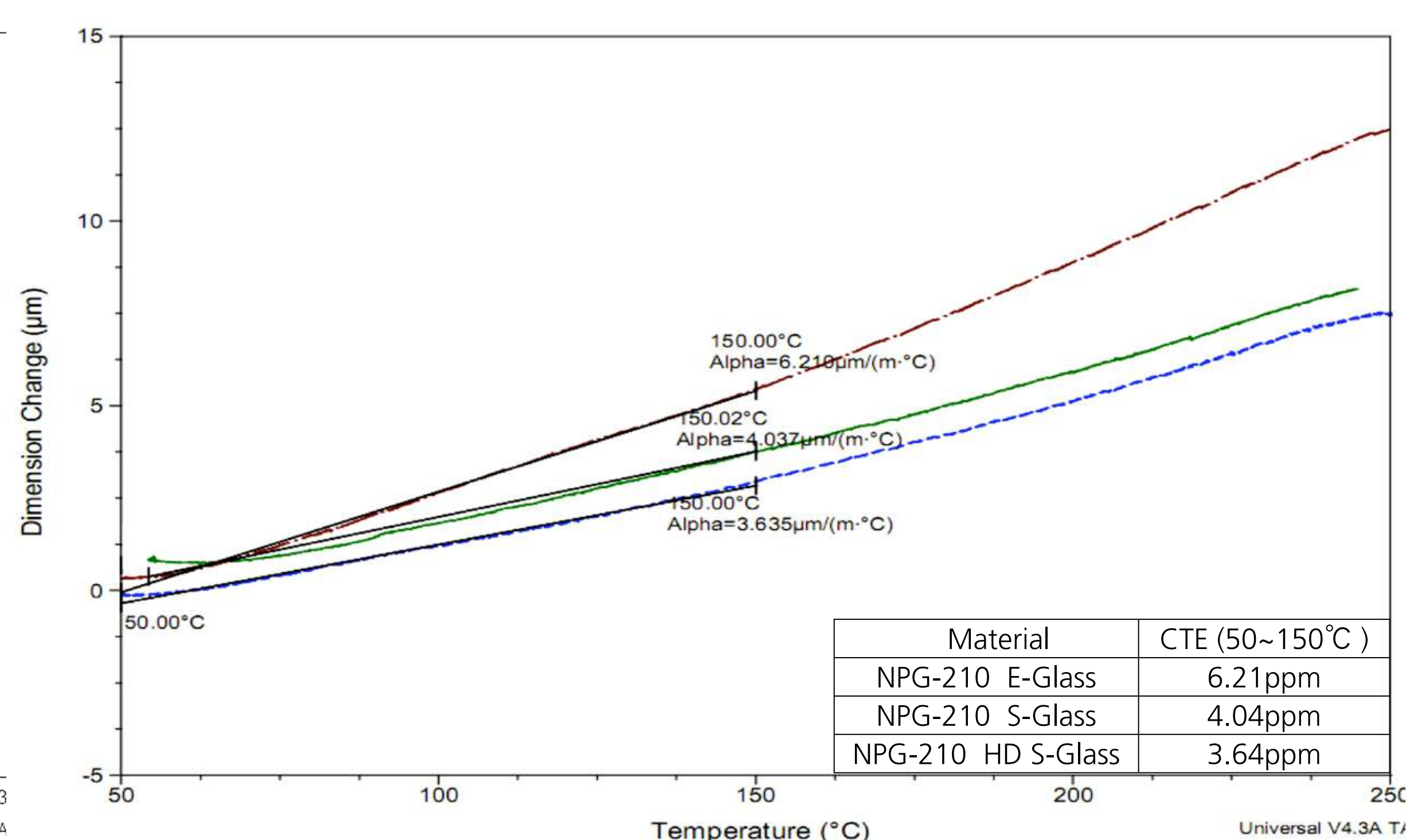
Nan Ya substrate cores with low warpage trend.

Nan Ya Low CTE Substrate Cores Comparison

Z AXIS CTE



X AXIS CTE



NPG-180IN and NPG-210 are designed with high Tg, low C.T.E and high stiffness to provide excellent thermal reliability and dimensional stability.



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Substrate Materials for Mini-LED Application

NPG-200W

• Applications



• Features

1. Excellent optical properties

- * In the visible range (400nm ~ 450nm), having high reflectivity
- * Excellent resistance to high temperature yellowing (antioxidant)
- * Excellent resistance to UV yellowing

2. High Tg and high thermal reliability

- * DSC Tg> 170 °C
- * High thermal stability
- * Low coefficient of expansion

• Property Comparison

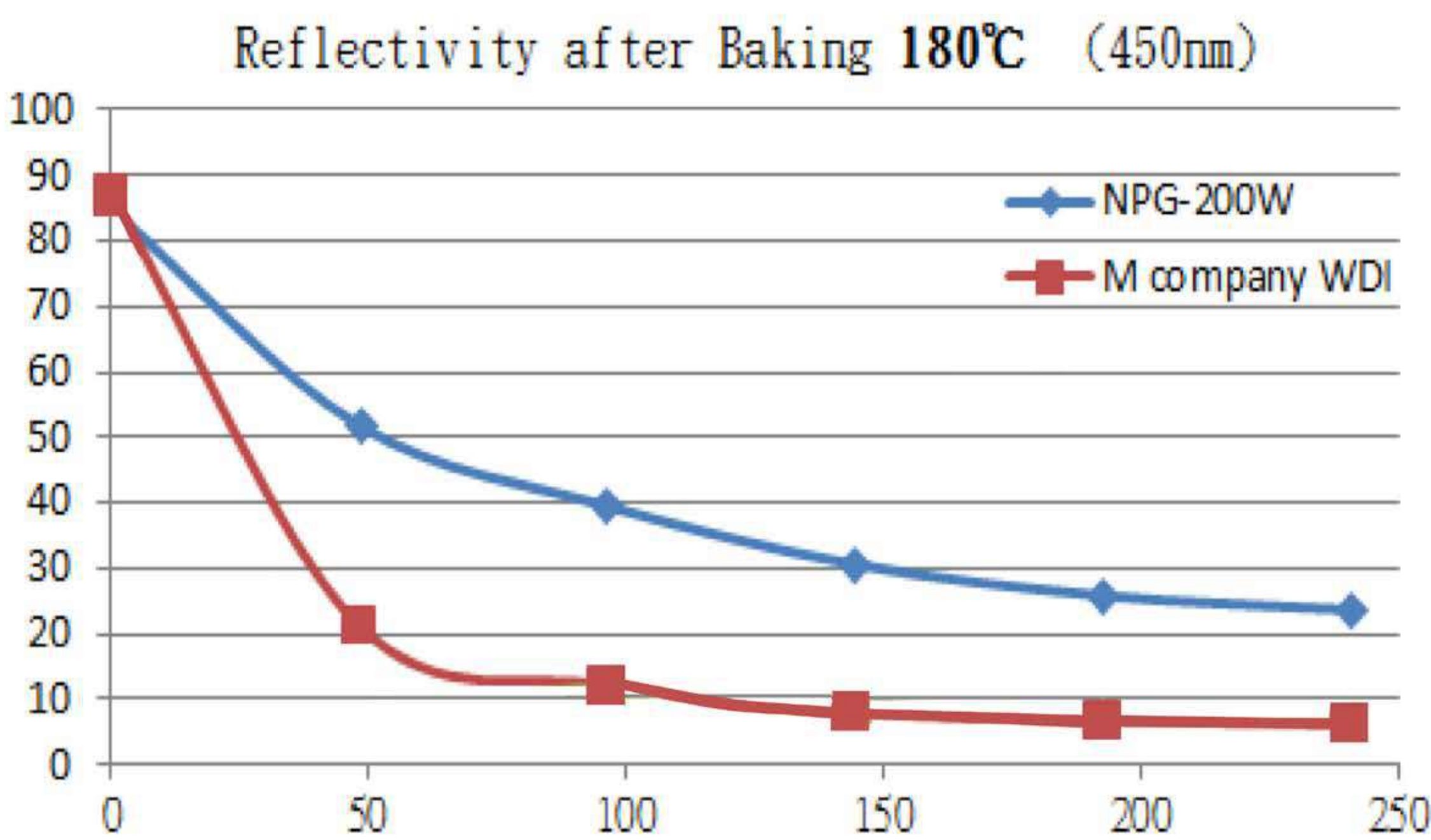
Test Item	Unit		Nan Ya NPG-200W	M company
Color	-		White	White
Halogen-free compliance	-		Yes	N/A
DK(1GHz)	-		5.2	5.7
Df(1GHz)	-		0.018	0.020
Insulation resistance	C-96/20/65		6*10 ¹⁴⁻¹⁵ Ω	5*10 ¹³⁻¹⁵ Ω
Suface resistance	C-96/20/65		6*10 ¹⁴⁻¹⁵ Ω	5*10 ¹³⁻¹⁵ Ω
CTE(X,Y,Z)	X	<Tg (ppm/°C)	15	15
	Y		15	15
	Z		35	33
	Z	>Tg (ppm)	170	171
Tg(by DMA)	-		205°C	200°C
1/2hr PCT TEST	Water absorption		0.27%	0.29%
	288°C dipping		>10'	>10'
Flame resistance	E-168/70		HB	HB

Reflectivity comparison after 180°C baking

Test Condition :

Temperature : 180°C *240hrs

Reflectivity Wave length : 450nm



Substrate color comparison after 180°C baking



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Automotive Application

FEATURES :

Excellent Thermal and Mechanical Properties

- Lead free compatible.
- Stable long time thermal storage.
- Low Z-CTE, high PTH reliability.

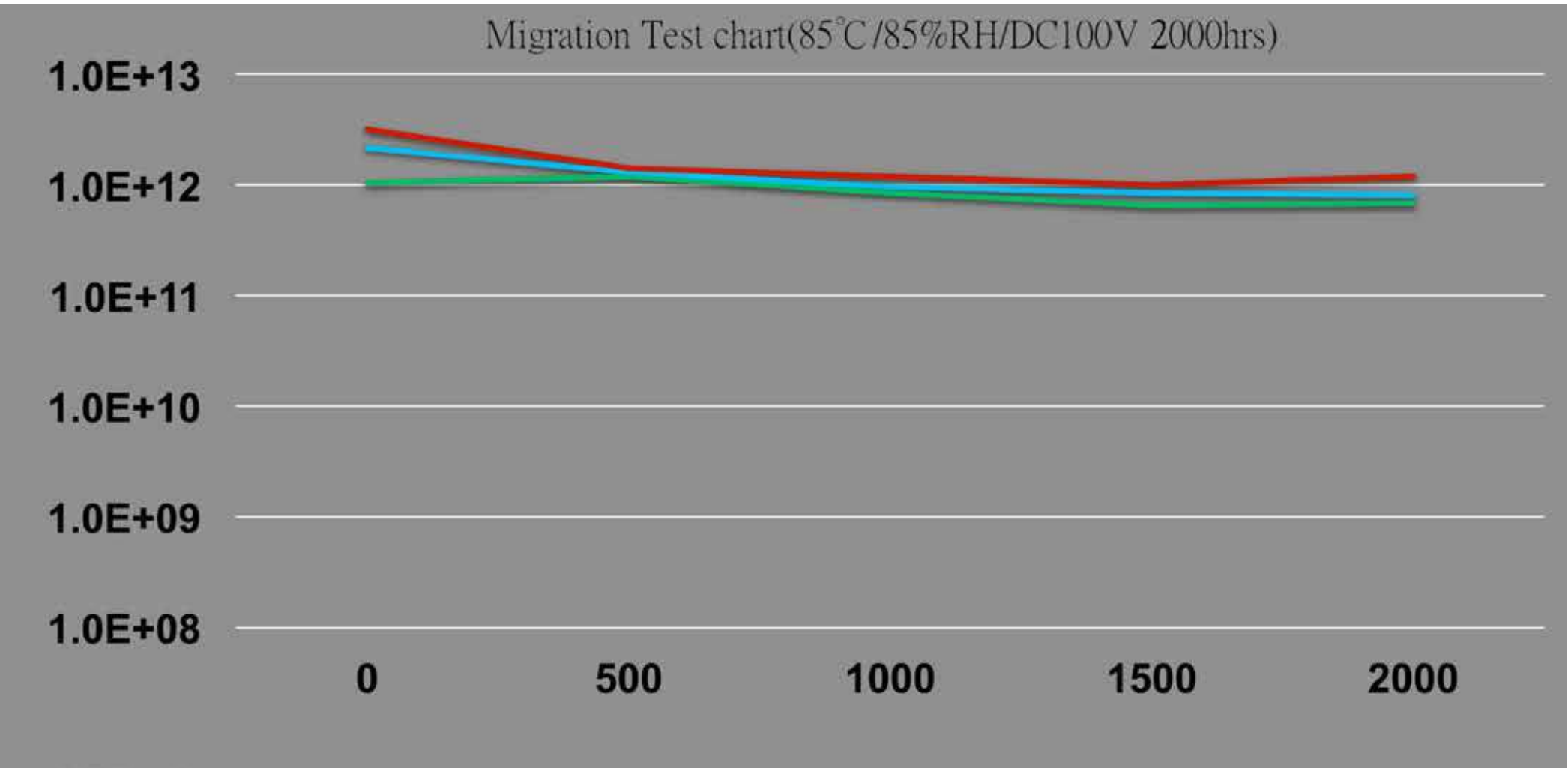
Excellent Insulation and CAF properties

Low Moisture Absorption

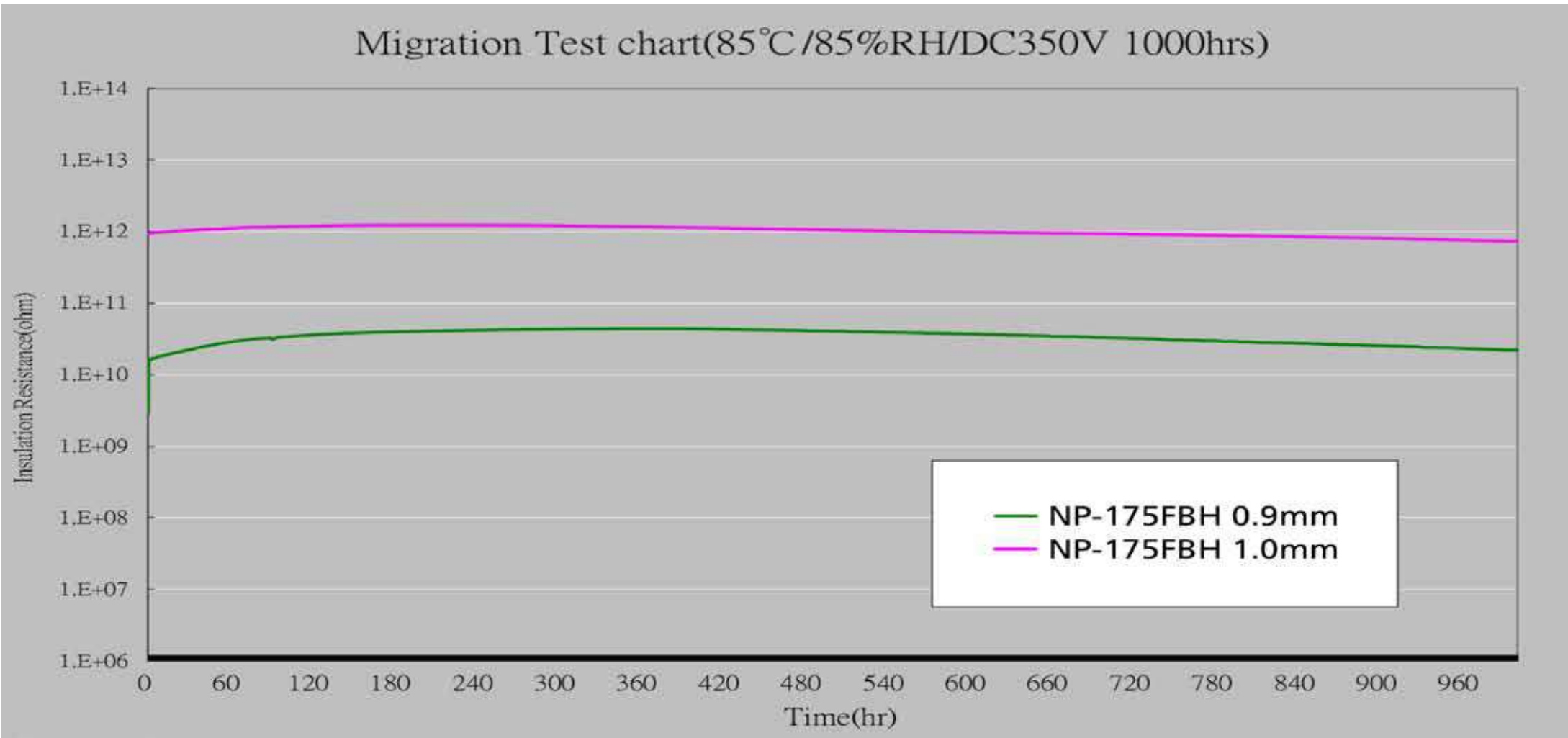
General Properties

Product Name	NP-155F	NP-155FBH	NP-175FBH	NPG-151	NPG-180BH	NPG-190BH
Properties	PN Mid TG	PN Mid TG	PN Hi TG	H/F	H/F, Hi TG Ultra Low CTE	H/F, Hi TG Low CTE
Tg (°C , By DSC)	150	150	170	155(TMA)	185	230(TMA)
Td (°C)	350	350	350	380	395	430
Fillers	Yes	Yes	Yes	Yes	Yes	Yes
Flammability (UL 94)	V-0	V-0	V-0	V-0	V-0	V-0
Z-Axis alpha 1 max (ppm/°C)	40-50	35-45	30-40	30-40	25-40	20-25
Z-Axis alpha 2 max(ppm/°C)	230-250	220-240	210-230	210-230	125-145	120-130
Z-Axis % (50~260°C)	3.0	2.6	2.2	2.4	1.6	1.4
T-260 (min)	>60'	>60'	>60'	>60'	>60'	>60'
T-288 (min)	>20'	>20'	>30'	>30'	>30'	>30'
Anti CAF	Yes	Yes	Yes	Yes	Yes	Yes

CAF Resistance



Material : NP-175FBH 8LB
Board thickness : 1.6 mm
Hole size : 0.3mm , Pitch 0.8 /0.9/1.0mm
Precondition : IR Reflow 260°C x 3 times
Test Condition : 2000 hours, 85°C/85% DC 100V
Pass Criteria : Insulation resistance $\geq 10^8 \Omega$
Result : PASS

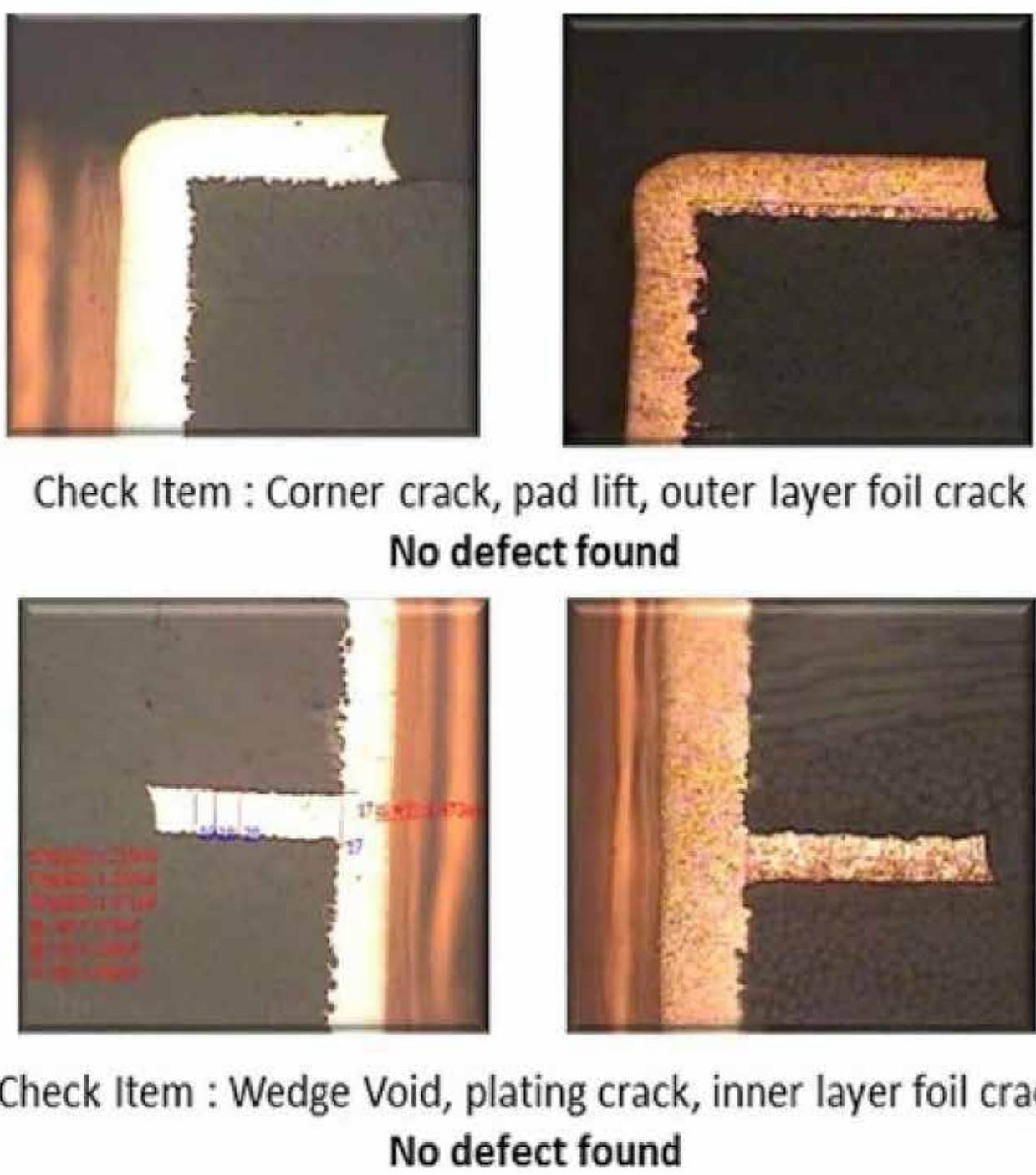
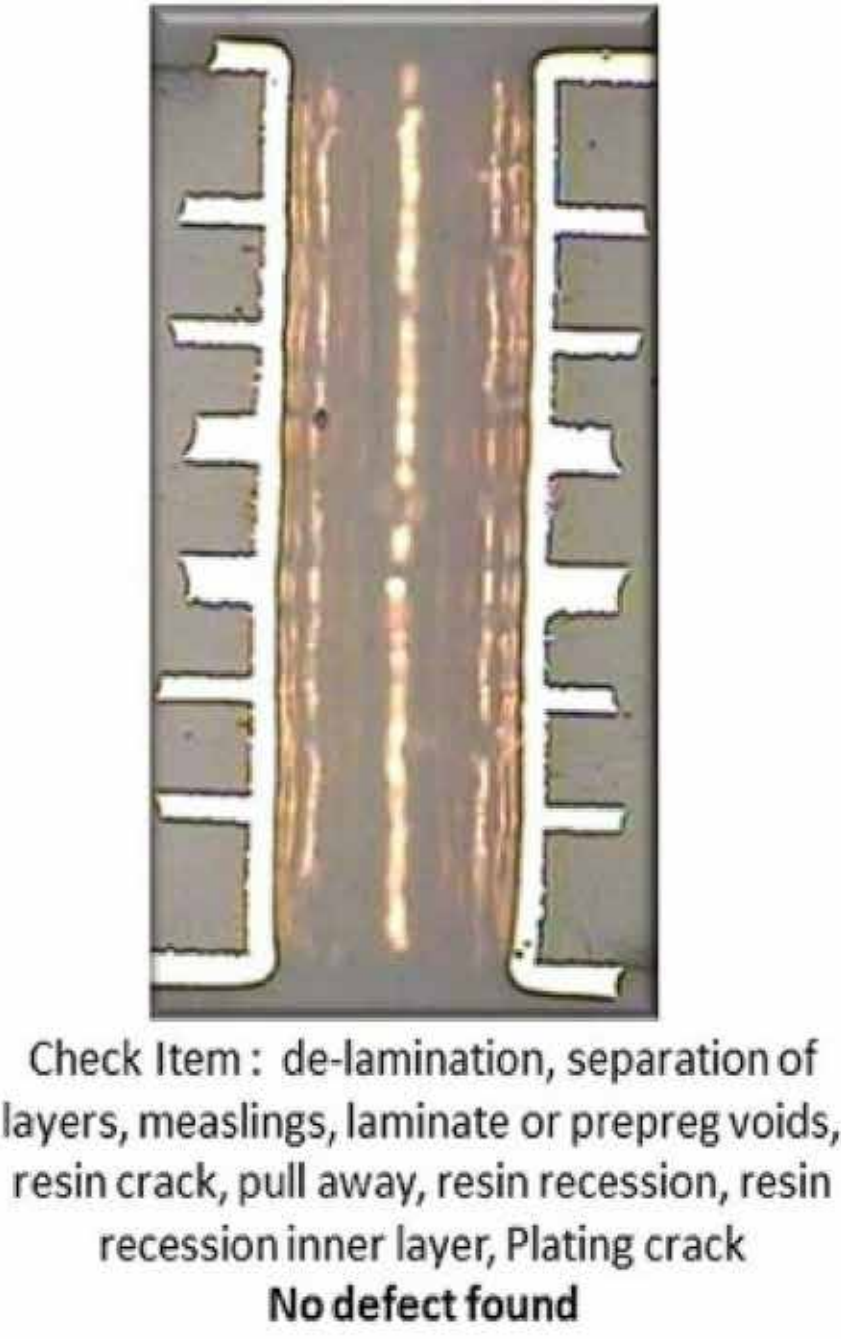
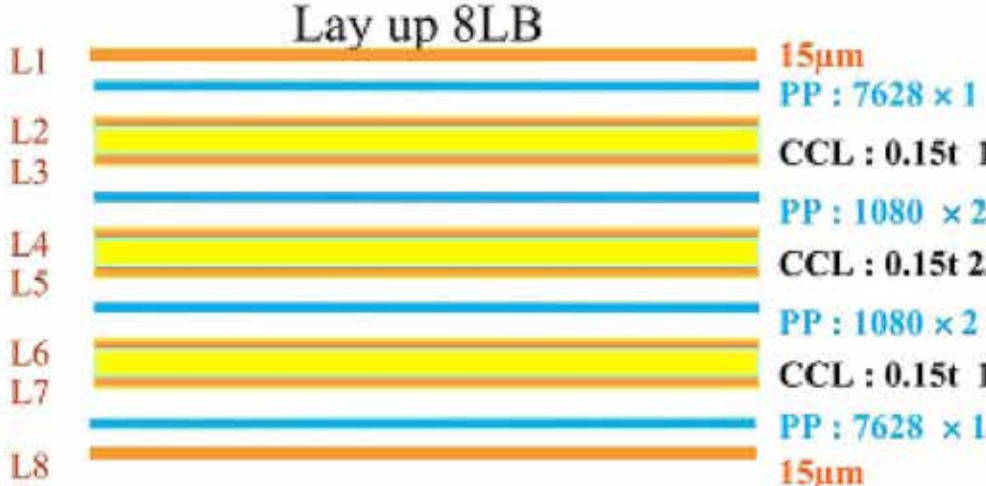


Material : NP-175FBH 8LB
Board thickness : 1.6 mm
Hole size : 0.3mm , Pitch 0.9/1.0mm
Precondition : IR Reflow 260°C x 3 times
Test Condition : 1000 hours, 85°C/85% DC 350V
Pass Criteria : Insulation resistance $\geq 10^8 \Omega$
Result : PASS

TCT Evaluated (Air to Air)

- Material : NP-175F 8LB
- Board thickness : 1.6mm
- Precondition: 3X reflow @ 260°C
- Pass Criteria :Resistance change < 10%
- Test Condition:-40°C/+145°C 30min / 10s / 30min 1000 cycle
- Result: PASS

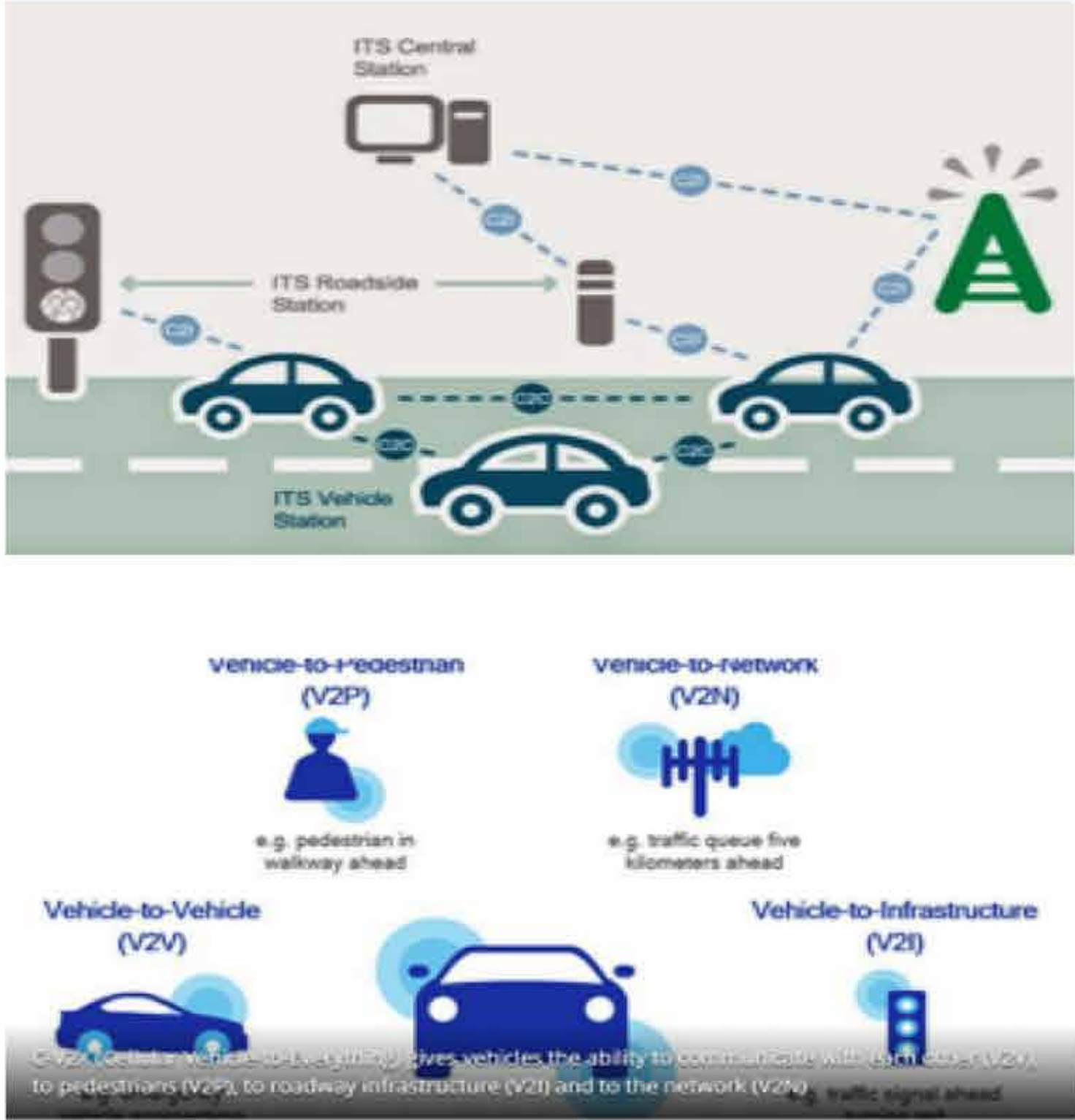
Hours	0	300	500	750	1000	Change Rate
1	0.8019	0.7928	0.81	0.8143	0.8238	2.73%
2	0.7187	0.7087	0.706	0.7059	0.7254	2.81%
3	0.7053	0.6985	0.693	0.6991	0.6855	-2.81%
4	0.4966	0.4917	0.485	0.4259	0.5037	1.43%
5	0.3929	0.387	0.418	0.4177	0.3942	0.33%
1	0.7938	0.7889	0.755	0.7552	0.7701	-2.99%
2	0.7145	0.7066	0.701	0.8004	0.7401	3.58%
3	0.7264	0.7119	0.717	0.7036	0.6956	-4.24%
4	0.4957	0.4985	0.49	0.4888	0.4809	-2.99%
5	0.3935	0.3871	0.41	0.4224	0.3963	0.71%
1	0.8511	0.8405	0.791	0.7991	0.832	-2.24%
2	0.7544	0.7516	0.735	0.7354	0.747	-0.98%
3	0.7585	0.7526	0.791	0.7916	0.748	-1.38%
4	0.5393	0.533	0.537	0.5388	0.526	-2.47%
5	0.4063	0.3991	0.421	0.4219	0.424	4.36%
1	0.7979	0.7909	0.7825	0.7898	0.7970	-0.11%
2	0.7156	0.7067	0.7035	0.7537	0.7378	3.10%
3	0.7159	0.7052	0.7050	0.7014	0.6906	-3.53%
4	0.4962	0.4961	0.4875	0.4574	0.4823	-0.70%
5	0.3932	0.3871	0.4140	0.4201	0.3953	0.52%
1	0.8225	0.8149	0.7730	0.7822	0.8011	-2.60%
2	0.7345	0.7291	0.7180	0.7679	0.7436	1.24%
3	0.7425	0.7323	0.7540	0.7476	0.7219	-2.70%
4	0.5175	0.5158	0.5135	0.5138	0.5035	-2.71%
5	0.3999	0.3931	0.4155	0.4222	0.4102	2.56%



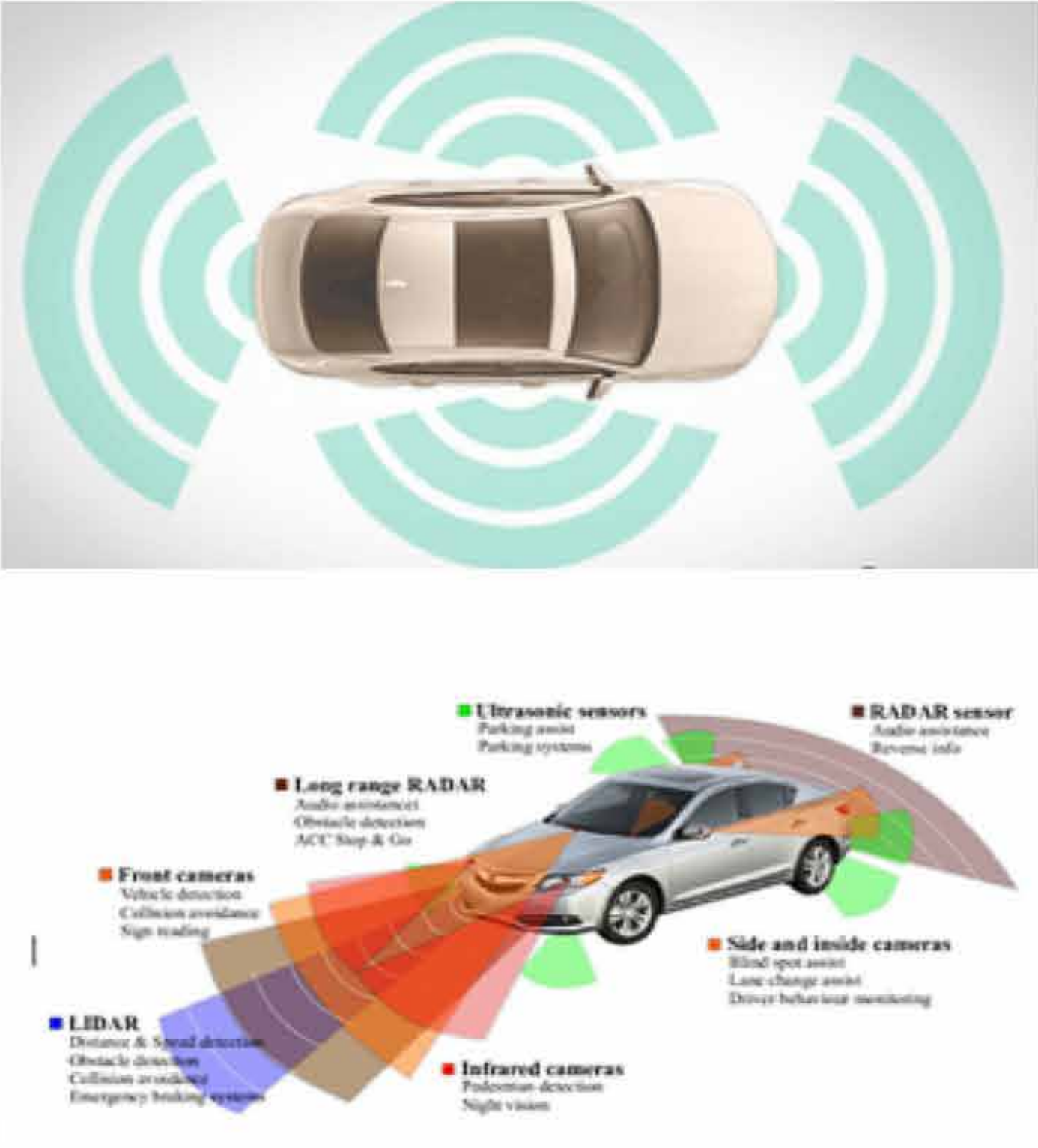
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Automotive Electronic Material Trend

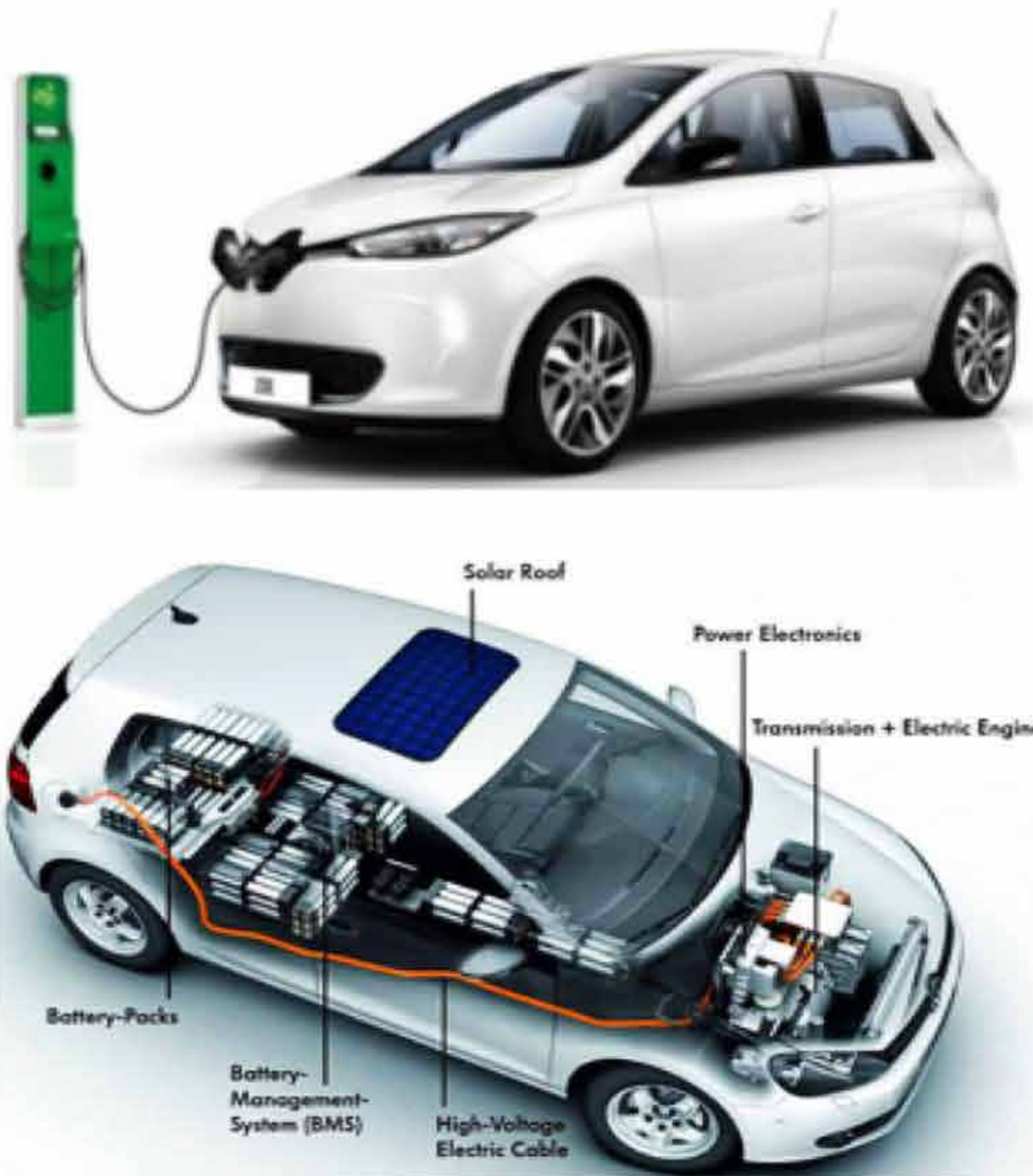
Internet of Vehicle



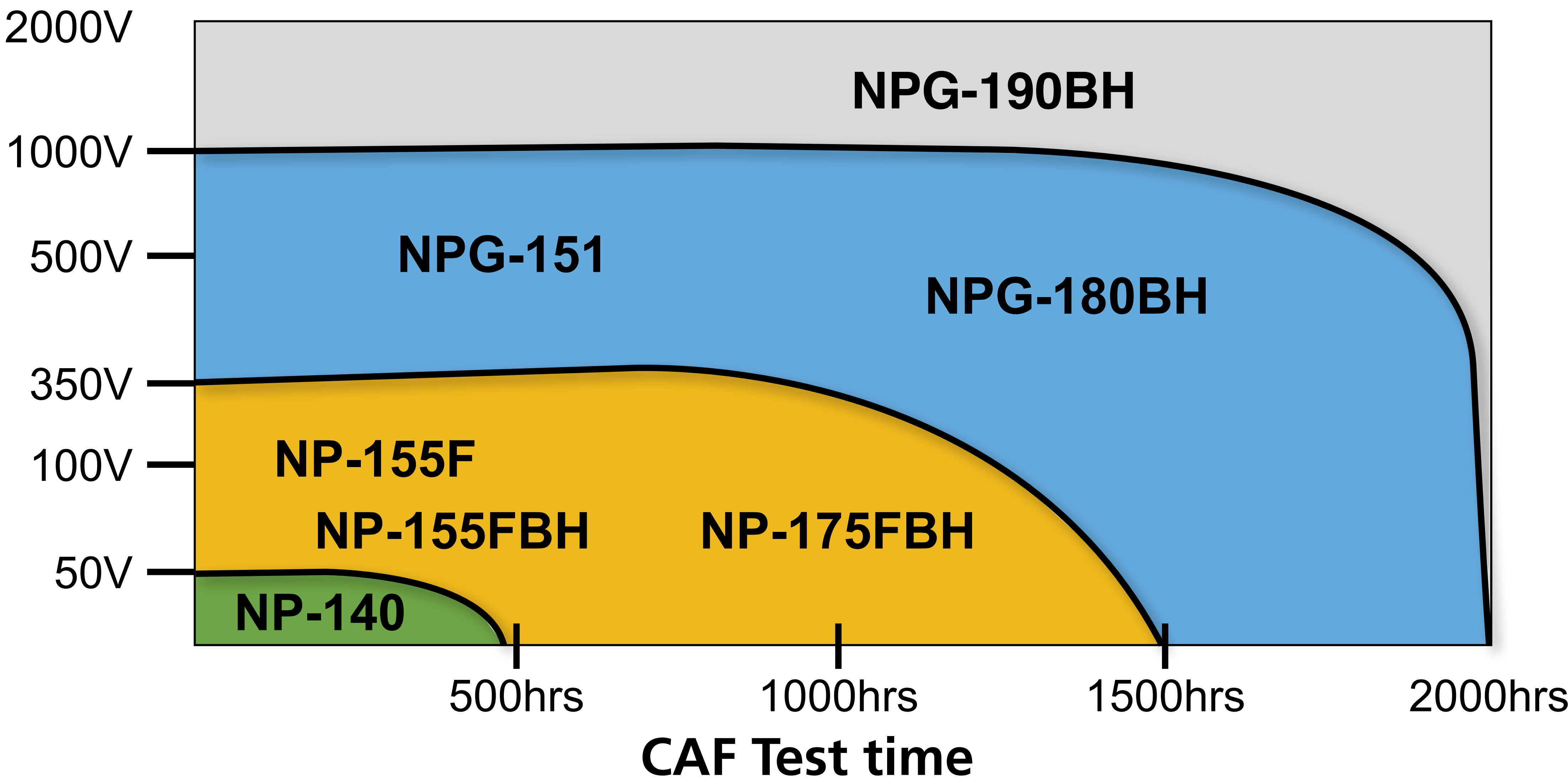
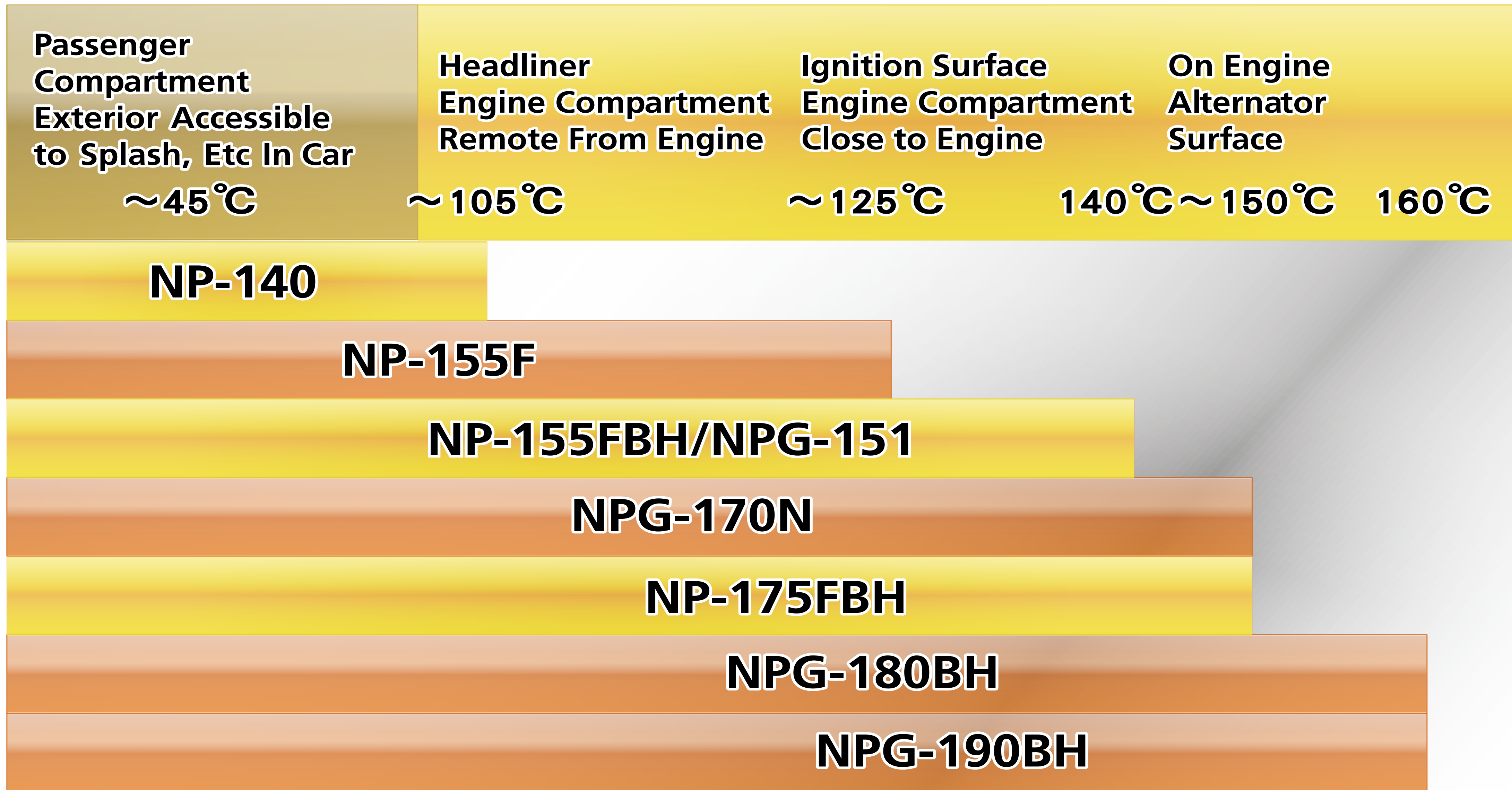
ADAS



New Energy



Automotive Product Update

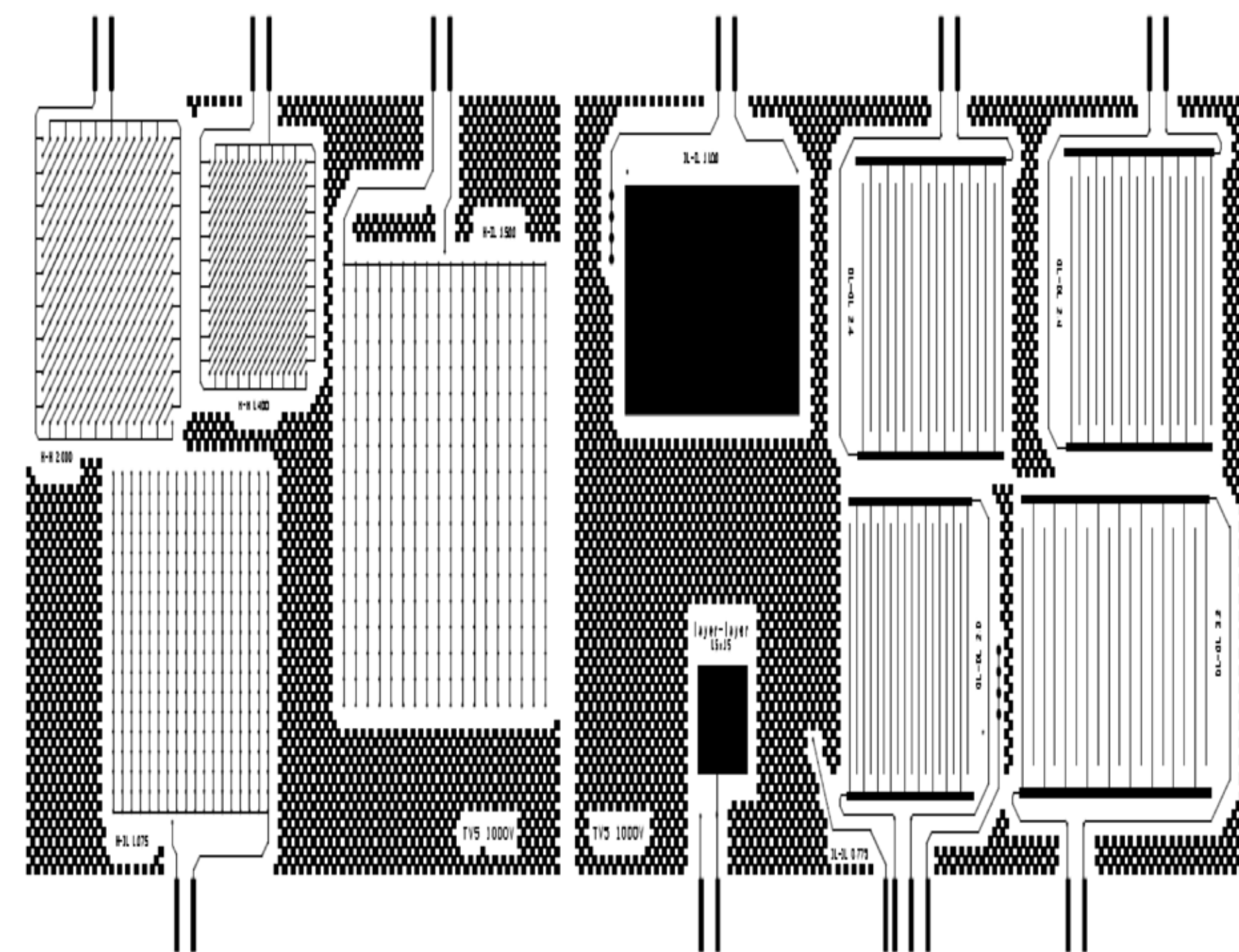
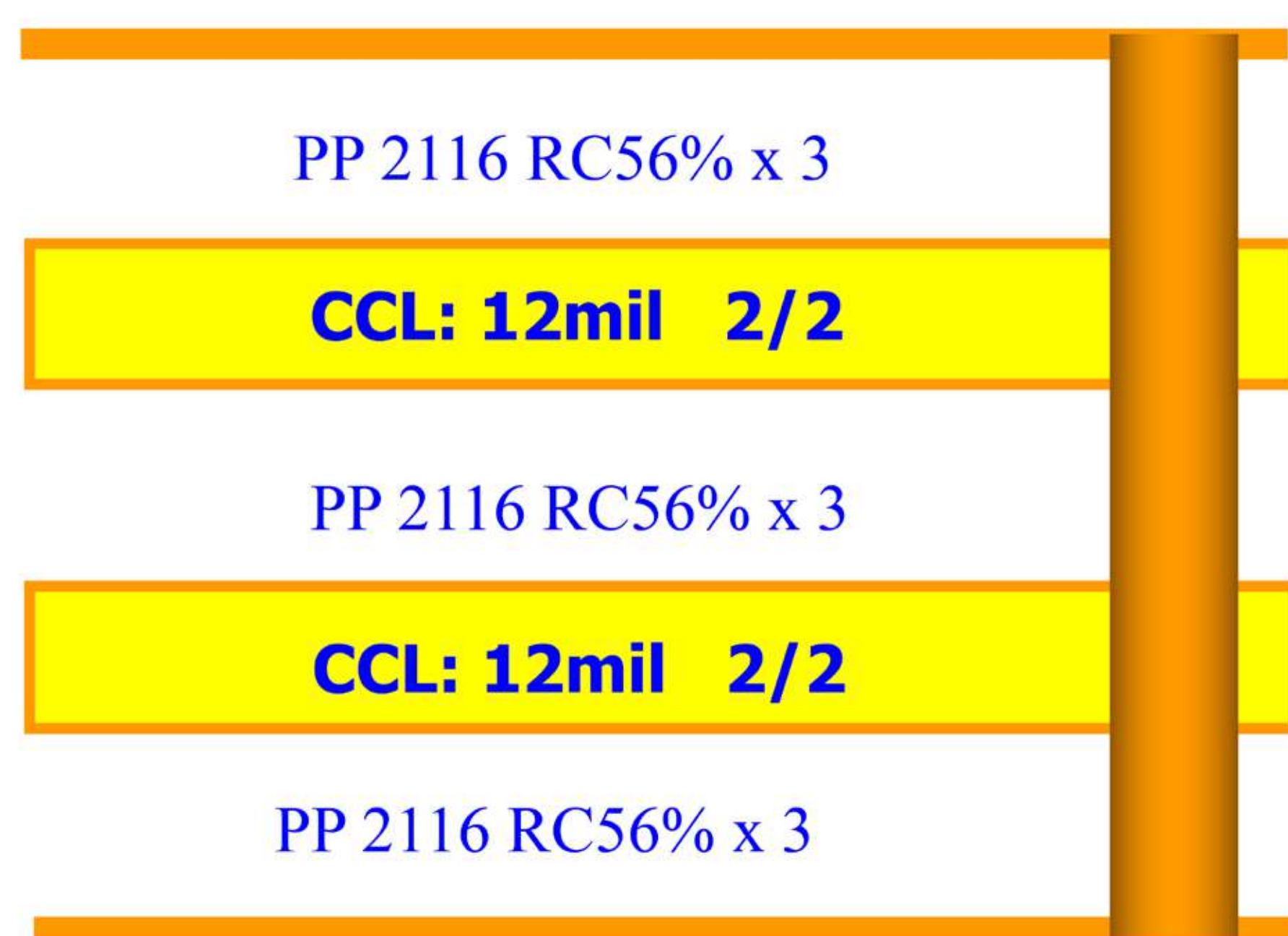


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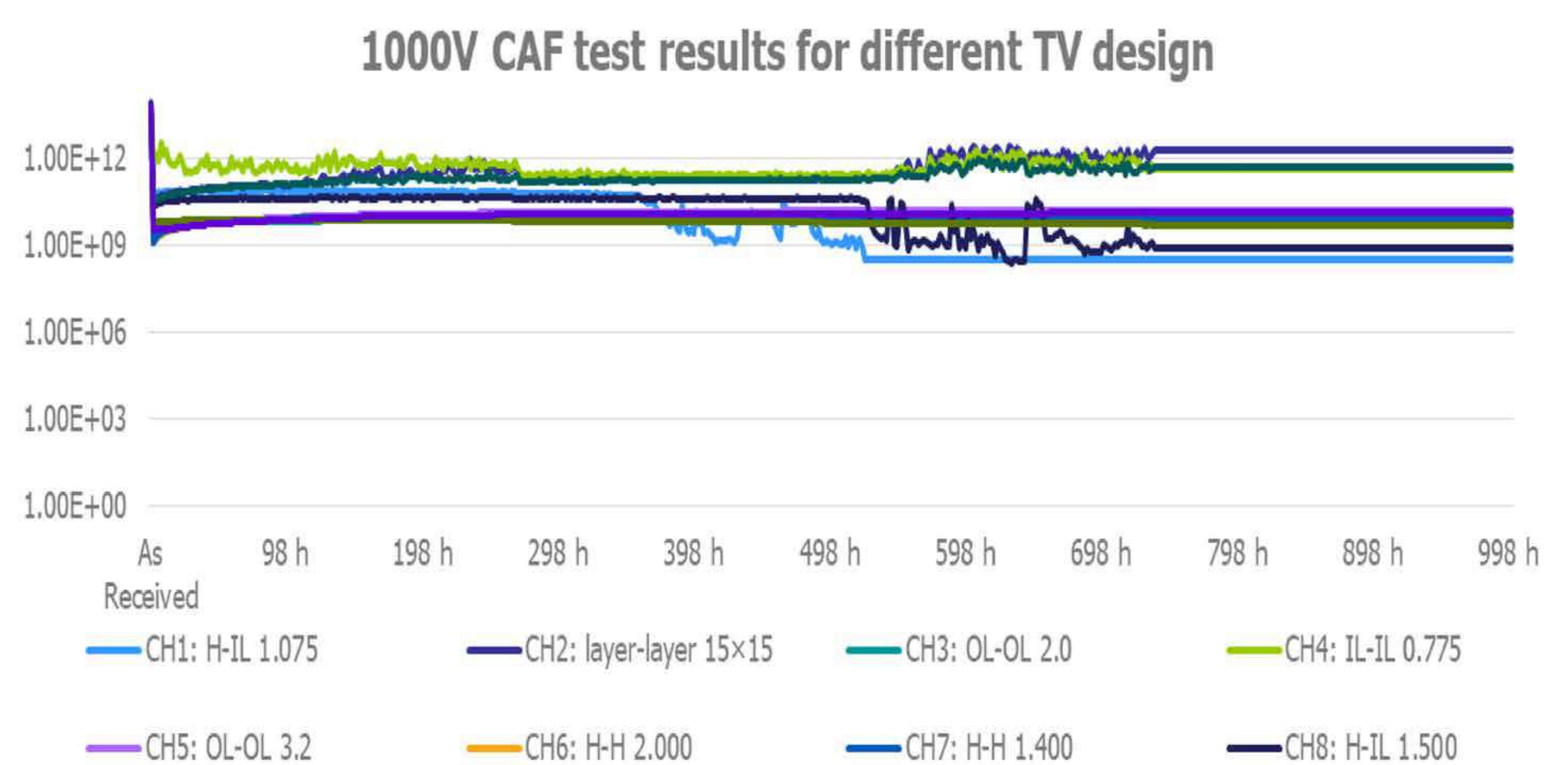
High Voltage & Heavy Copper CAF test

Test information

- Precondition: 3X lead free reflow at 260°C
- Test and bias voltage: 1000 V, 85 °C, 85% relative humidity, 1000hrs
- Test material: NP-175FBH
- Pass criteria: All insulation resistance are higher than 1.0E+08 ohms
- Test Patterns :

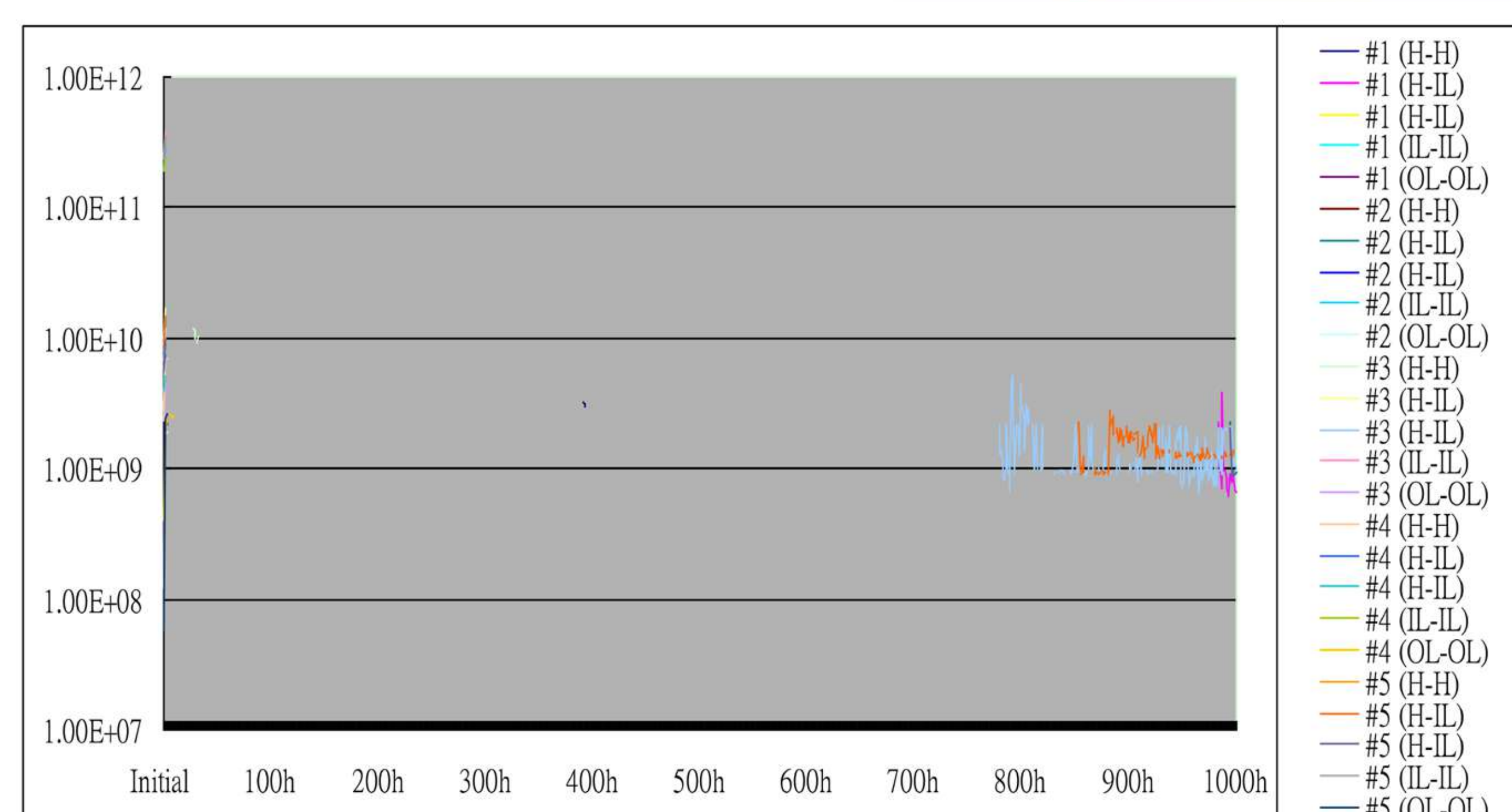
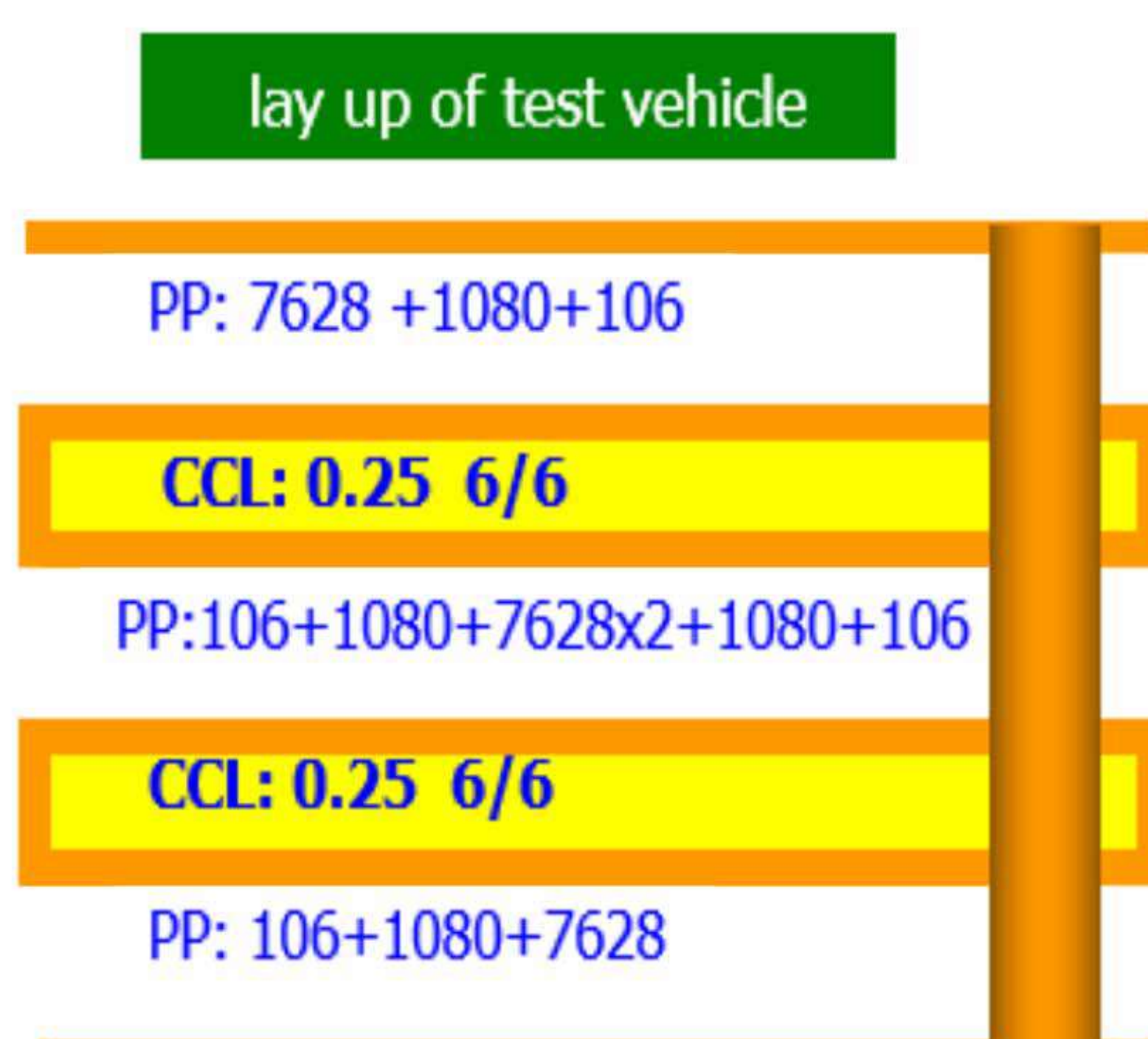
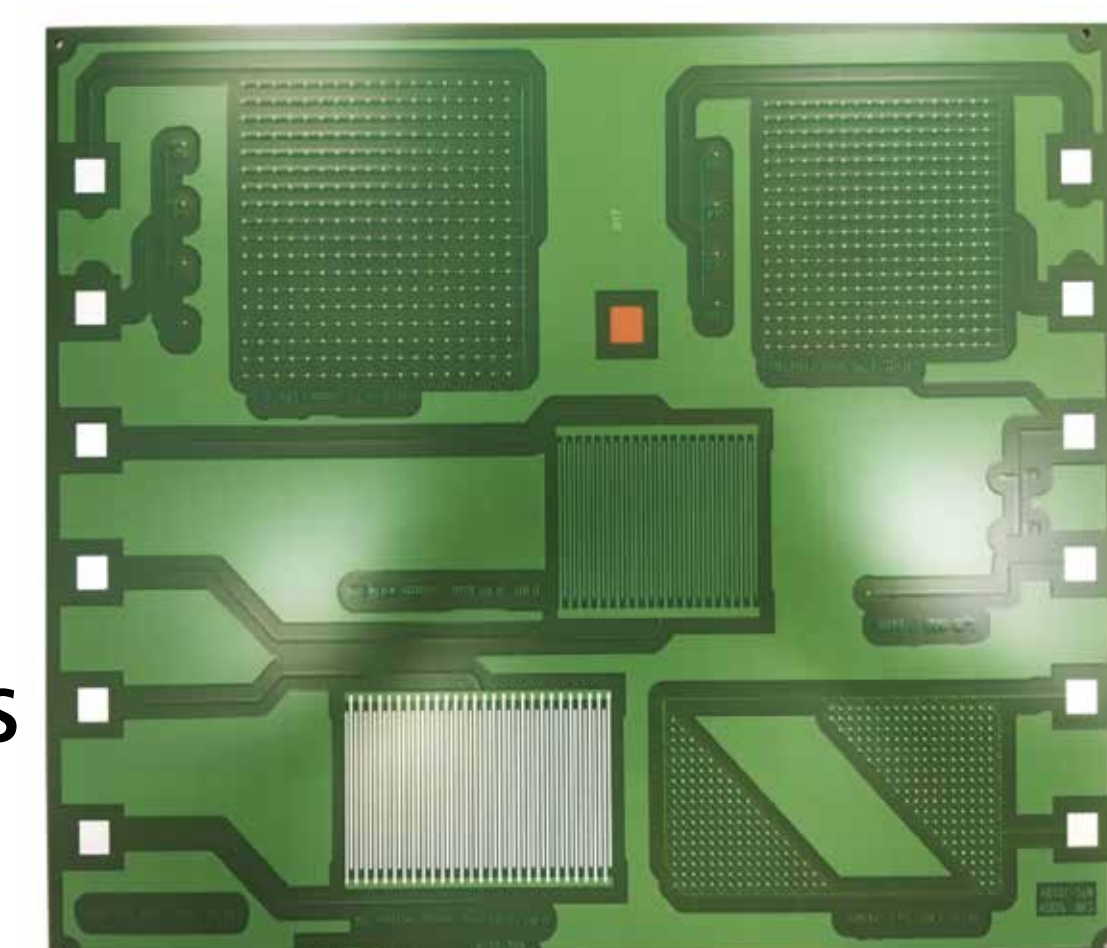


Test Sample	Test Pattern (mm)	Test Quantity (PC)	Test Result
NP-175FBH 6LB 2oz	H-H 1.400	10	Pass
	H-H 2.000	10	Pass
	H-IL 1.075	10	Pass
	H-IL 1.500	10	Pass
	IL-IL 0.775	10	Pass
	IL-IL 1.100	10	Pass
	OL-OL 2.0	10	Pass
	OL-OL 2.4	10	Pass
	OL-OL 3.2	10	Pass
	OL-OL 2.4 (Soldermask)	10	Pass
	layer-layer 15×15	10	Pass



NPG-180BH 6LB with 6oz inner layer

- Precondition: 3X lead free reflow at 260C
- Test and bias voltage: 500 V
85 +/- 2°C, 85 +3/-2% relative humidity, CAF 1000 hours
- Test Patterns : HW-HW 2.6mm, H-IL: 1.75mm; L/S:1.4mm
- Pass criteria: All insulation resistance are higher than 2.0E+07 ohms
- Result: Pass (All resistance high than 2.0E+07 ohms)



5G Network Application Materials

FEATURES :

- High speed and high frequency application.
- Low Dk/Df, high Tg, high heat resistance and high reliability.
- Suitable for communication and network (Router, server, switch) equipment.
- Hydrocarbon bondply NP-535B have Low Dk/Df and good resin flow, suitable for multilayer application.

5G Network application



Small cell



Mobile phone



5G Home router



5G Base station

General Properties

Item	Unit	NP-730	NP-826	NP-822	NP-530	NP-535	NP-536	NP-536HC	NP-535B Bondply	NPG-186	NPG-198K
Resin System	-	PTFE			Hydrocarbon					PPE	
Flame retardant	-	Halogen Free	Halogen Free	Halogen Free	Halogen	Halogen	Halogen	Halogen	Halogen	Halogen Free	Halogen Free
Dk (10GHz)	-	3.0	2.6	2.2	2.98	3.45	3.55	3.66	3.50	3.9	3.23
Df (10GHz)	-	0.0028	0.0025	0.0014	0.0036	0.0033	0.0036	0.0033	0.0037	0.0050	0.0020
Peel Strength (1oz)	lb/in	10	10	10	6.0-7.0	6.0-7.0	6.0-7.0	6.0-7.0	6.0-7.0	6.0-6.5	5.0-6.0
T288	Min	>60'	>60'	>60'	>60'	>60'	>60'	>60'	>60'	>60'	>60'
Td 5%	°C	540	541	539	365	360	360	412	400	395	404
Flammability	UL-94	V-0	V-0	V-0	V-0	V-0	V-0	V-0	V-0	V-0	V-0
PIM	dBc	≤ -158	≤ -158	≤ -158	≤ -158	≤ -158	≤ -158	≤ -158	-	-	-
outgassing	-	pass	pass	pass	-	-	-	-	-	-	-



南亞塑膠工業股份有限公司
NAN YA PLASTICS CORPORATION

High Frequency Millimeter Wave Materials

FEATURES :

- Low dielectric constant and low dissipation factor at high frequency range.
- Tightly controlled Dk tolerance enables more consistent performance.
- By choosing low roughness copper foil to reduce skin effect and signal loss.
- Excellent dimensional stability.
- Suit for Automotive Radar, 5G Infrastructure and Aerospace application.

Products	Electrical Properties (at 10GHz)	Composites	Applications
NP-536HC	Dk=3.66 Df=0.0033	Hydrocarbon Ceramic-filled Glass Fabric	Automotive Radar (24GHz)
NP-730	Dk=3.0 Df=0.0028	PTFE Ceramic-filled Glass Fabric	5G Infrastructure Base Station Antenna Power Amplifier Low Noise Block RF Components Aerospace
NP-735	Dk=3.5 Df=0.0030 TC=0.75 W/m · k	PTFE Ceramic-filled Glass Fabric	
NP-826	Dk=2.6 Df=0.0025	PTFE Glass Fabric	
NP-822	Dk=2.2 Df=0.0014	PTFE Glass Fabric	
NP-536HC	Dk=3.66 Df=0.0033	Hydrocarbon Ceramic-filled Glass Fabric	
NP-536	Dk=3.55 Df=0.0036		
NP-535	Dk=3.45 Df=0.0033		
NP-530	Dk=2.98 Df=0.0036		
NP-535B (Bonding Material)	Dk=3.5 Df=0.0037		
NPG-186	Dk=3.9 Df=0.0050	Low Dk Resin Ceramic-filled Glass Fabric	
NPG-186B (Bonding Material)			
NPG-198K	Dk=3.23 Df=0.0020		
NPG-198K (Bonding Material)			

