



Technical Bulletin of Hiroxy for 2014

HiROXY[®]

High Performance Resin of Epoxy



**Newly Developed and
Developing Products**



How to Co-operate ?

Detail Needs, Effective F/up

High Performance Resin of Phenol HiRENOL[®]

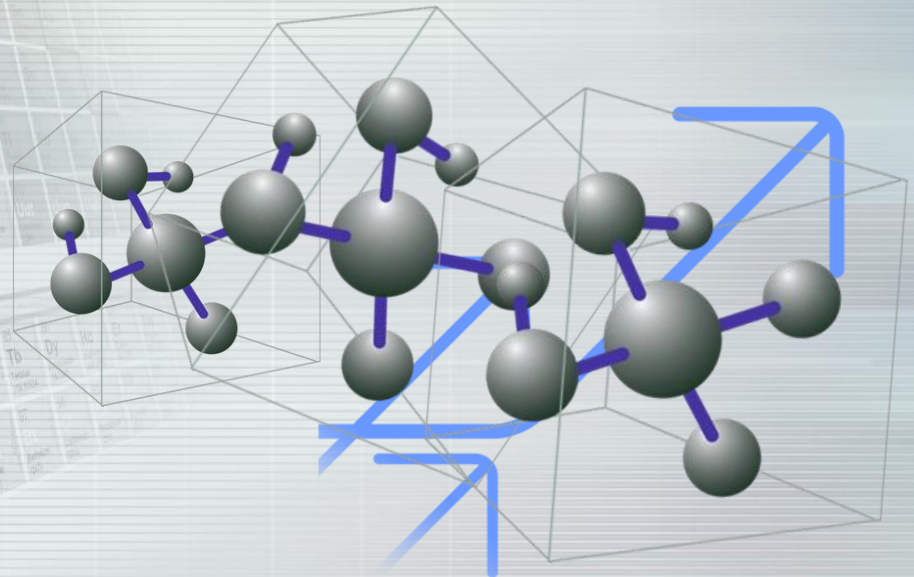
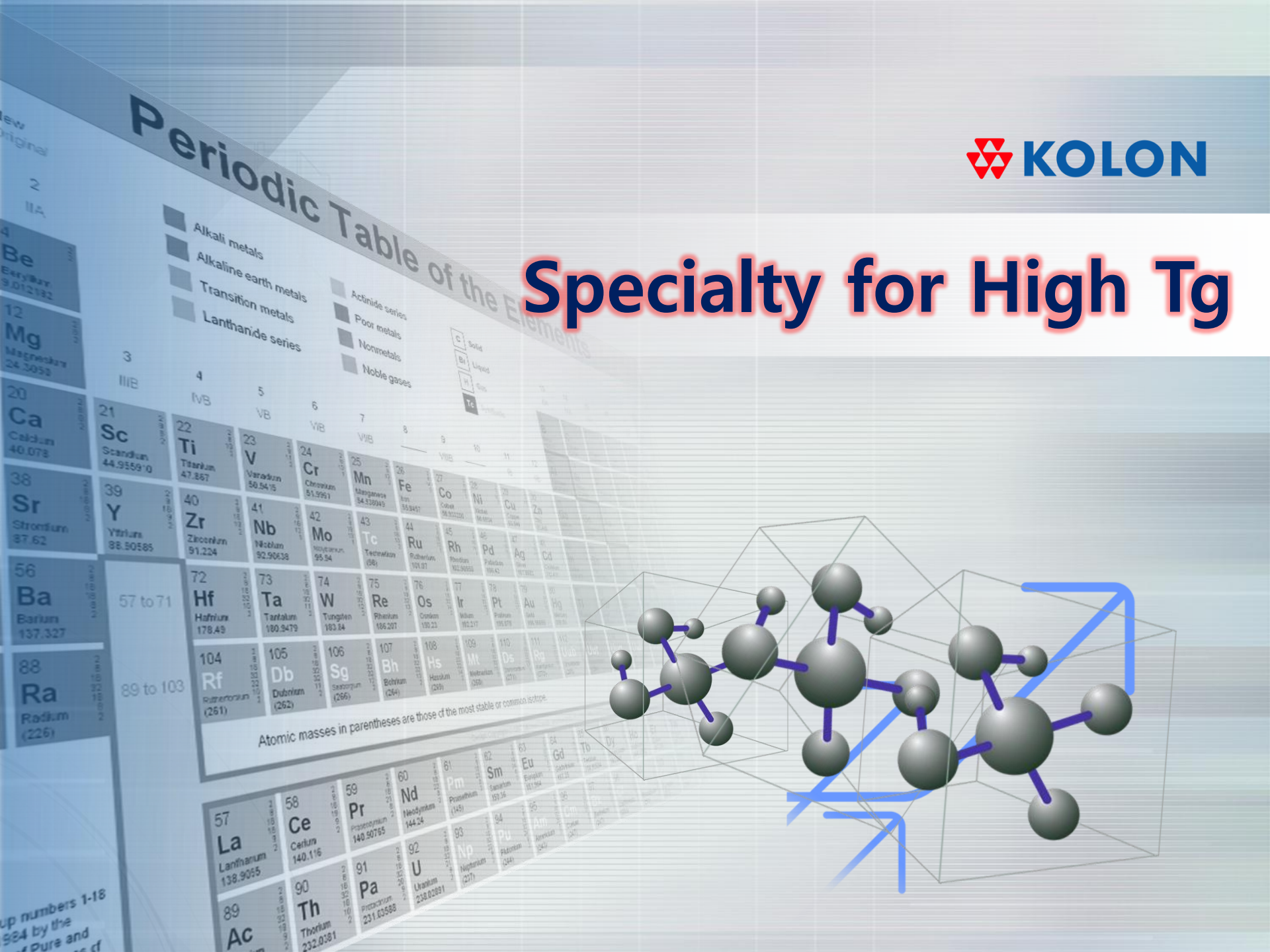
Newly Developed/Developing Items ...

- 1 Specialty for High Tg
- 2 Specialty for Halogen-Free
- 3 Narrow Dispersity Products
- 4 Specialty for Low Dk / Df
- 5 Special Benzoxazines
- 6 Several Special Resins

- ✓ **With** Product Name : Newly Developed or Newly Commercialized
- ✓ **Without** Product Name : Currently Under Developing or Under Evaluation

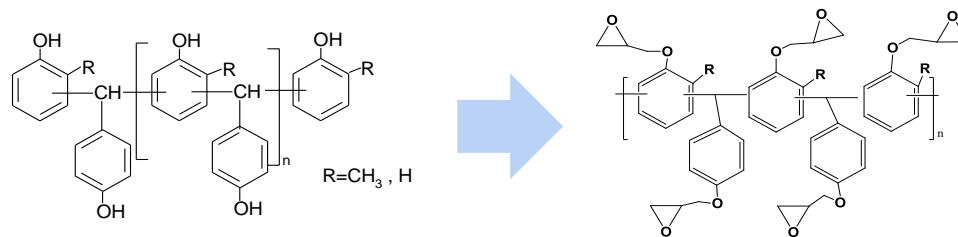
Periodic Table of the Elements

Specialty for High Tg

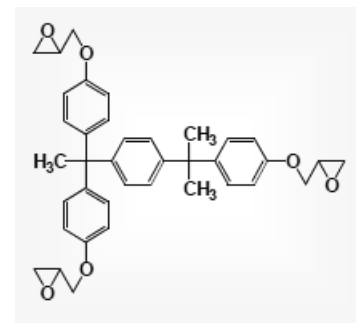
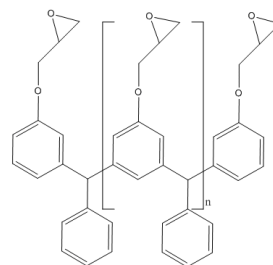


Atomic masses in parentheses are those of the most stable or common isotope.

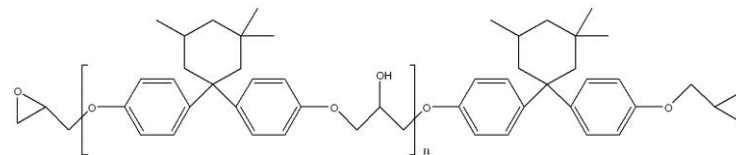
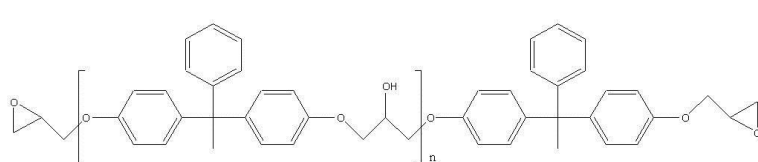
1 Multi-Functional Novolac & its Epoxy : KES-7255, KES-7270



2 Multi Functional Epoxy : KES-7255, KES-7264



3 New Bisphenol Epoxy : KES-7430, KES-7450



Product Name		Multi-Functional Novolac Resin	
		KPH-F3100	KPH-F3140
Chemical Structure		<p style="text-align: right;">R=CH₃, H</p>	
Properties	Appearance	Reddish Solid	Reddish Solid
	S.P. (°C, Mettler 2°C/min)	108~114	138~148
	Free Phenol (%)	0.1 max	1.5 max
	Water content (%)	0.2 max	0.3 max
Characteristics		<ul style="list-style-type: none"> ➤ Epoxy Resin Intermediate & Hardener(BGA) ➤ Multi-Functional, High Tg ➤ Improved Heat Resistance 	
Applications		<ul style="list-style-type: none"> ➤ Electrical printed circuit board. ➤ Electric Molding Compounds. ➤ High temp.adhesives & composites 	

Properties & Test Results				Note	
Classification		High Tg		High Tg (Ref.)	
Type		Multi-Functional Novolac		Phenol Novolac	
Structure					
Grade		KPH-F3100	KPH-F3140	KPH-F2003	
Resin Properties	S.P. (°C)	110	143	108	Mettler, 2°C/min
	M.W. (g/mol)	688	1032	2509	GPC
Curing Condition		KE-8128, Cat.=2E4MZ (0.07phr)			
Varnish G.T.	sec	360	275	267	@171°C
Tg	°C	138.7	152.3	140.7	DSC, CCL

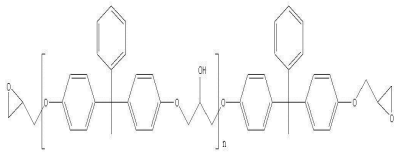
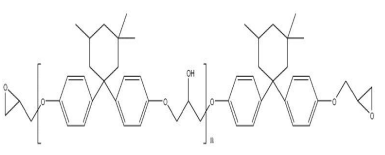
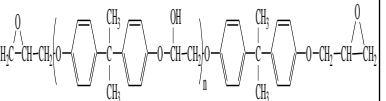
Product Name		Multi-Functional Novolac Epoxy Resin	
		KES-7260	KES-7270
Chemical Structure			
Properties	Appearance	Reddish Yellow Solid	Reddish Yellow Solid
	EEW (g/eq)	145~175	160~180
	S.P. (°C, B&R)	55~65	65~75
	Hy-Cl (ppm)	500 max	500 max
Characteristics		<ul style="list-style-type: none"> ➤ Multi Functional resins for Higher Cross-Linking Density ➤ Excellent Heat Resistance ➤ Epoxy resin for high temp. applications ➤ Improved mechanical properties 	
Applications		<ul style="list-style-type: none"> ➤ Electrical printed circuit board. ➤ Electric Molding Compounds. ➤ High temp.adhesives & composites 	

Properties & Test Results				Note	
Classification	High Tg	High Tg (Ref.)	High Tg (Ref.)		
Type	Multi-Functional Novolac Epoxy	Phenol Novolac Epoxy	Bisphenol A Novolac Epoxy		
Structure					
Grade	KES-7270	KEP-1142	KEB-3180		
Resin Properties	EEW (g/eq)	160 ~ 180	170 ~ 190		
	S.P. (°C)	65 ~ 75	70 ~ 75	B&R, 5°C/min	
	Hy-Cl (ppm)	500 Max.	500 Max.		
Curing Condition	PN (KPH-F2003), Cat.=2E4MZ (0.02 phr)				
Varnish G.T.	sec	190	192	219	@171°C
Tg	°C	187.3	192.1	203.1	DSC, CCL

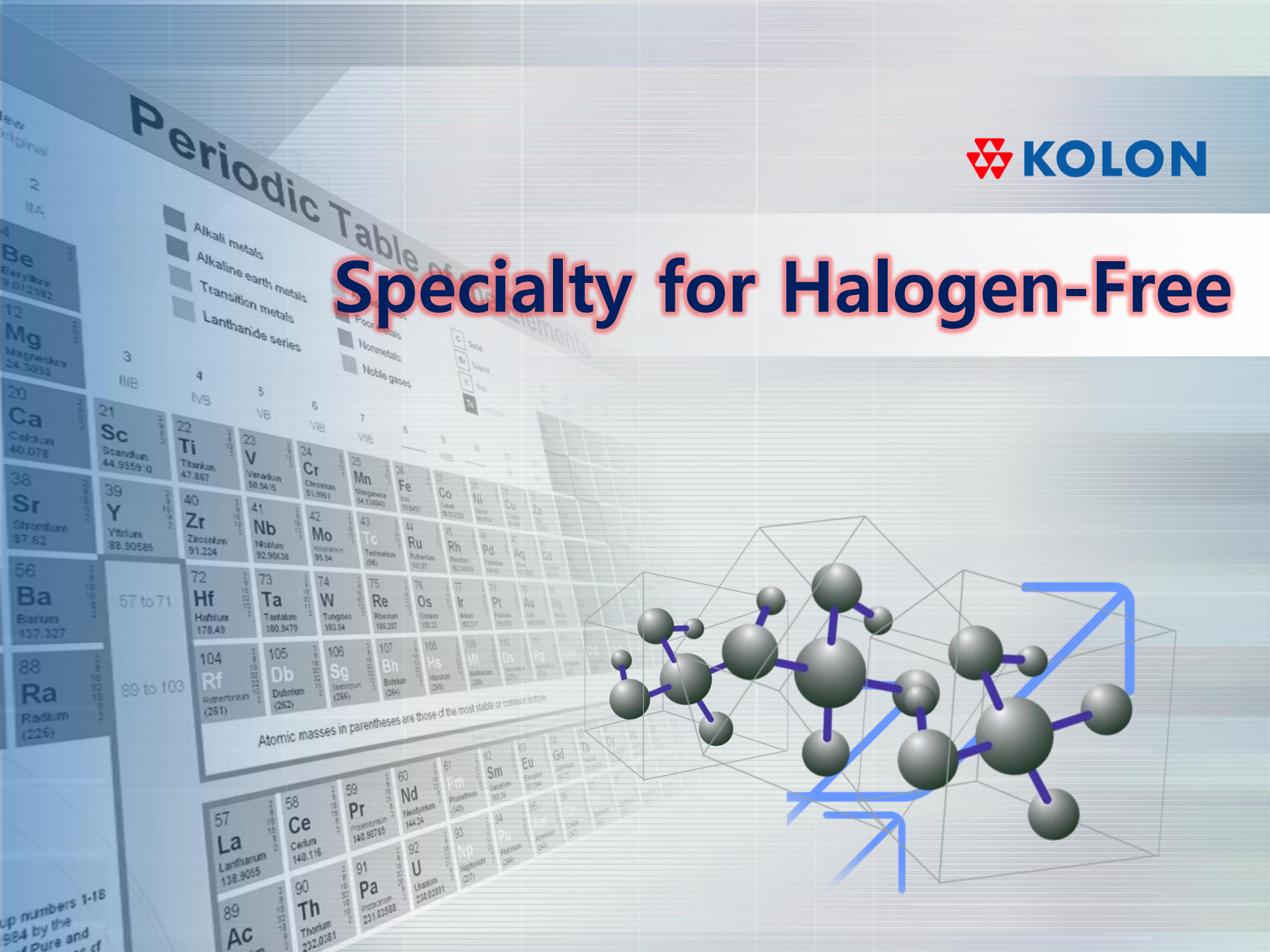
Product Name		Benz-Novolac Epoxy Resin			
		KES-7264	KES-7230	KES-7255	KES-7290
Chemical Structure					
Properties	Appearance	Yellow Solid	Yellow Semisolid	Yellow Solid	Yellow Solid
	EEW (g/eq)	200 ~ 220	185 ~ 225	200 ~ 240	220 ~ 260
	S.P. (°C)	59 ~ 65	-	50~60	85~95
	Hy-Cl (ppm)	500 max.	500 max.	500 max.	500 max.
	Color (Gardner)	5 max.	6 max.	6 max.	6 max.
Characteristics		<ul style="list-style-type: none"> ➤ Epoxy Resin for High Temp. Applications ➤ Multi-Functional, High Tg ➤ Improved Mechanical Properties 			
Applications		<ul style="list-style-type: none"> ➤ Electrical printed circuit board. ➤ Electric Molding Compounds. ➤ High temp.adhesives & composites 			

Properties & Test Results						Note
Classification		High Tg, Low Dk/Df			Low Dk/Df (Ref.)	
Type		Multi-Functional Epoxy			DCPD-Phenol Epoxy	
Structure						
Grade		KES-7235	KES-7255	KES-7290	Competitor's (D社)	
Resin Properties	EEW (g/eq)	208.0	219.7	239.84	273.1	
	S.P. (°C)	35.4	57.2	90.8	79.1	
	Hy-Cl (ppm)	302	286	427	54.6	
Curing condition		Dicy curing, Cat.=2MI				
Varnish G.T.	Sec	242	317	311	141	
Thickness	mm	0.59	0.60	0.64	0.82	
RC	%, Prepreg	23.6	24.8	25.0	43.09	
Tg	°C	164.8	193.8	194.0	206	DSC
					238.7	DMA
					201.3	TMA
Dk	1GHz	3.2	3.12	3.17	3.08	Mold Specimen
Df	1GHz	0.0133	0.0127	0.0165	0.0167	Mold Specimen
W.A.(%)	PCT 2hr	0.35	0.42	0.45	0.31	
Inter Ply	N/mm	1.02	0.94	0.6	1.24	
Peel	N/mm	1.41	1.19	1.03	1.5	
Delamination	Sec, PCT 2hr				360	
TMA	a1(ppm/°C)				86.46	
	a2(ppm/°C)				403.6	
	CTE(%)				3.319	

Product Name		New Bisphenol Epoxy Resin	
		KES-7430	KES-7450
Chemical Structure			
Properties	Appearance	Yellow Semisolid	Yellow Solid
	EEW (g/eq)	200 ~ 240	210 ~ 250
	S.P. (°C, B&R)	-	51 ~ 55
	Hy-Cl (ppm)	500 max.	500 max.
	Color (Gardner)	3 max.	3 max.
Characteristics		<ul style="list-style-type: none"> ➤ Epoxy Resin for Low Dk/Df ➤ Good Flammability – Especially KES-7430 ➤ High Tg & Improved Mechanical Properties ➤ High Tg & Improved Thixotropy – Especially KES-7450 	
Applications		<ul style="list-style-type: none"> ➤ Electrical printed circuit board. ➤ Electric Molding Compounds. ➤ High temp.adhesives & composites 	

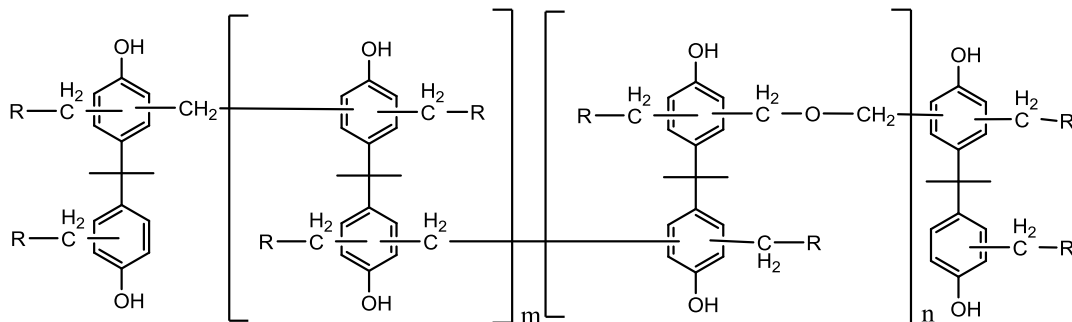
Properties & Test Results				Note
Classification		High Tg		General (Ref.)
Type		New Bisphenol Epoxy		Bisphenol A Epoxy
Structure				
Grade		KES-7430	KES-7450	KE-8128
Resin Properties	EEW (g/eq)	219.6	240	187
	S.P. (°C)	-	52	-
	Hy-Cl (ppm)	457.7	111	254.6
Curing condition		Dicy (4 phr), Cat.=2MI		
Thickness	mm	0.56	0.56	0.54
Tg	°C	172.8	195.4	141.1
Dk	1GHz	4.08	3.83	4.24
Df	1GHz	0.0107	0.0069	0.0064
W.A.(%)	PCT 2hr	0.79	0.62	0.67
Inter Ply	N/mm	1.07	1.02	1.06
Peel	N/mm	1.84	1.45	1.29
Delamination	Sec, PCT 2hr	>280	>300	>255

Specialty for Halogen-Free



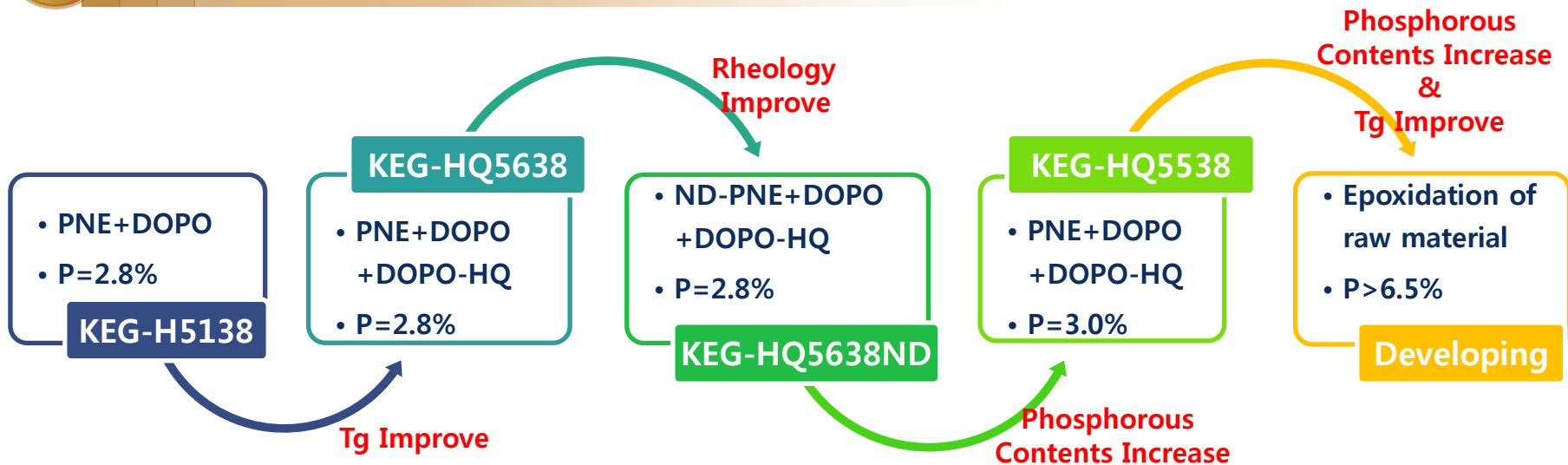
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DOPO-ATN : Flame Retardant Hardner

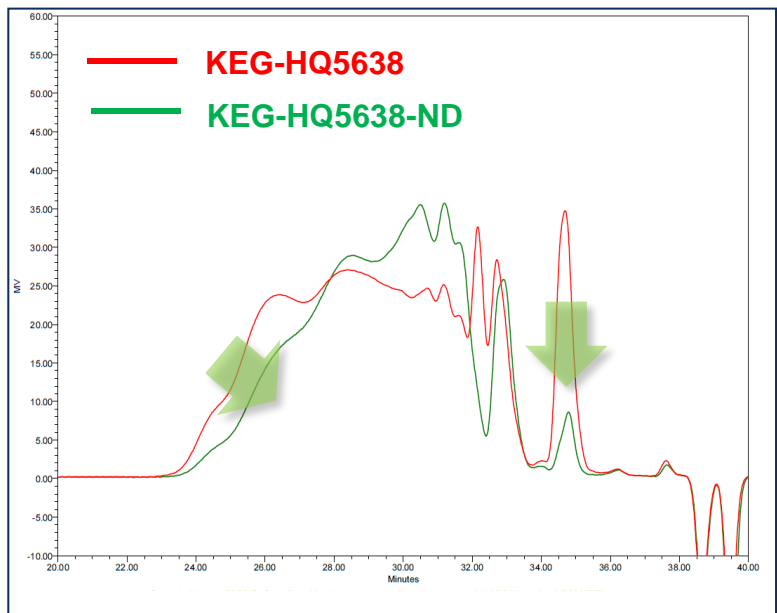


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Development of Phosphorous Modified Epoxy



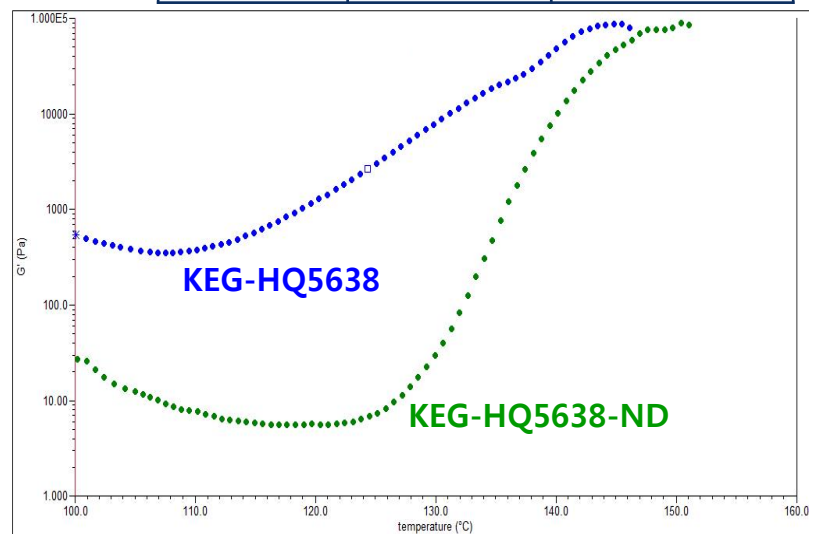
3 ND (Narrow Dispersity) Effect of DOPO-PNE



KEG-HQ5638-ND

	KEG-HQ5638	KEG-HQ5638-ND
Varnish GT (sec@171°C)	194	215 (111% ↑)
Prepreg G/T (sec@171°C)	19	58 (305% ↑)

KEG-HQ5638



Product Name		Halogen Free Hardner	
		KGH-L3200	KGH-L3201
Chemical Structure			
Properties	Appearance	Reddish Yellow Solid	Reddish Yellow Solid
	Viscosity (cps@25°C)	500~2500	500~2500
	M.W. (g/mol)	900~1000	900~1000
	P content (%)	8.5 ~ 8.8	8.9 ~ 9.2
Characteristics		<ul style="list-style-type: none"> ➤ Various P contents (Normally Higher then 8%) ➤ Excellent Adhesion, Flammability & Toughness 	
Applications		<ul style="list-style-type: none"> ➤ Electrical printed circuit board. ➤ Electric Molding Compounds. 	

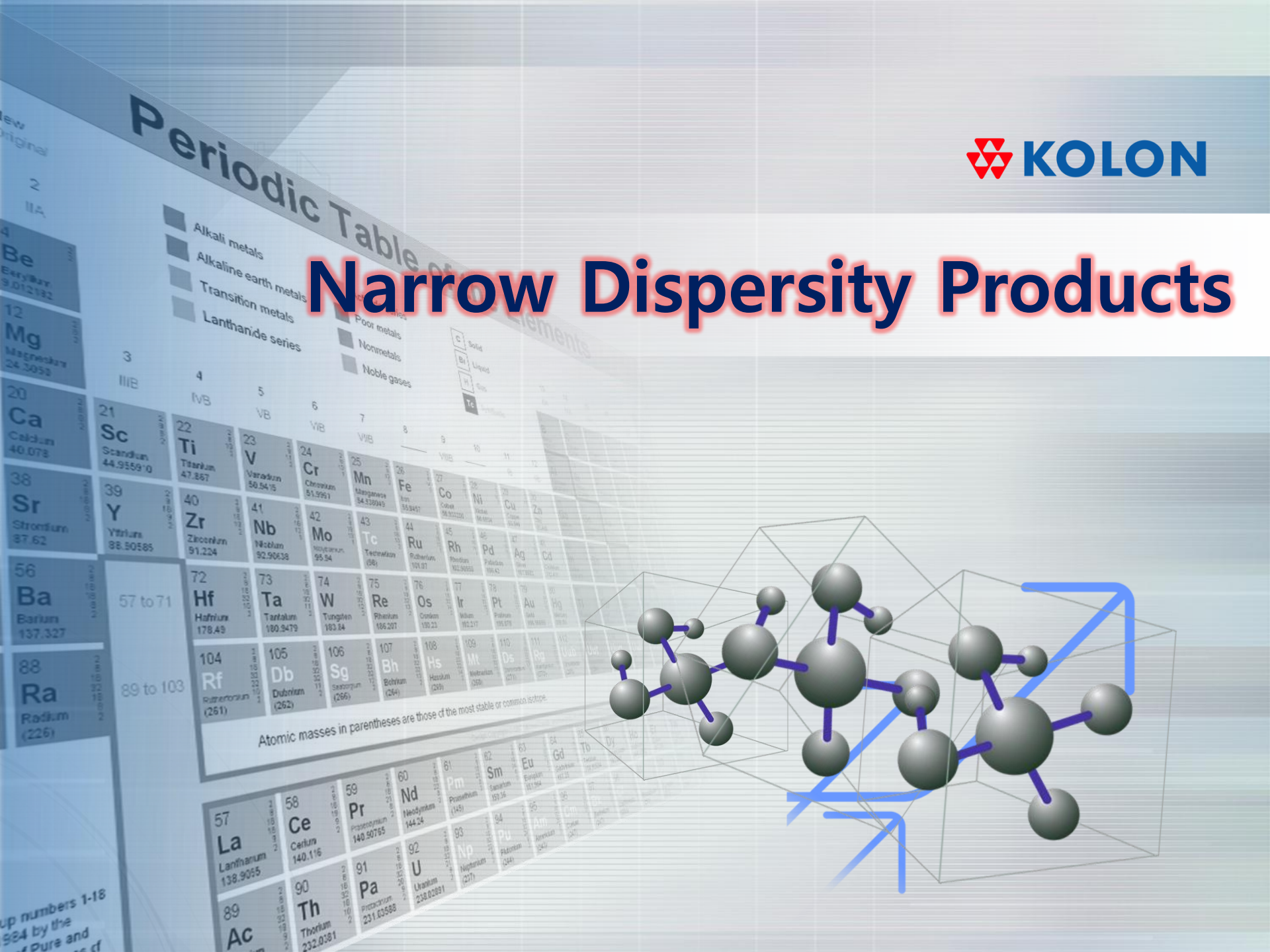
Properties & Test Results			Note	
Classification		Halogen Free Hardner		
Type		DOPO-ATN Hardner	DOPO Hardner (Ref.)	
Structure				
Grade		KGH-L3200	Competitor's	
Resin Properties	P content (%)	8.38	7.92	ICP Analysis
	N content (%)	0.48	0	ICP Analysis
	N.V. (%)	58.8	58.5	
	Vis. (cps@25°C)	2690	2182	
	M.W. (g/mol)	998	985	GPC
Curing condition		Epoxy (KEP-1138M85), Cat.=2MI (0.28phr), PN (S.P.=120°C) : DOPO-ATN=1:1 by wt.% Total content of P in the varnish=2.1%		
G.T.	sec	126	129	@171°C, Varnish
Tg	°C	171.4	171.1	DSC
		155.6	155.4	TMA
CTE	ppm/°C	α1 : 81.62, α2 : 280.3	α1 : 85.47, α2 : 248.6	CCL
W.A.	Wt.%	0.43	0.48	PCT 2hr
Inter Ply	N/mm	0.87~1.05	0.79~0.97	
Peel	N/mm	1.69~1.84	1.64~1.73	
T-288	min	>60	>60	
Flame Retardant	UL-94	V-0	V-0	

Product Name	Halogen Free Epoxy				
	KEG-H5138	KEG-HQ5638	KEG-HQ5638ND	KEG-HQ5538	
Chemical Structure	<p>X=</p> <p>or</p>	<p>X=</p> <p>or</p>	<p>X=</p> <p>or</p>	<p>X=</p> <p>or</p>	
Properties	Appearance	Yellow Solid			
	EEW (g/eq)	280 ~ 320	290 ~ 340	290 ~ 340	305 ~ 345
	Hy-Cl (ppm)	1000 max.	1000 max.	500 max.	500 max.
	P content (%)	2.8	2.8	2.8	3.0
Characteristics	<ul style="list-style-type: none"> ➤ Enhanced flame-retardant property ➤ Halogen-Free epoxy resin for an environment regulation ➤ Various phosphorus content for user's needs ➤ Excellent dimensional stability & enhanced mechanical performance ➤ Available in solid and solution type 				
Applications	<ul style="list-style-type: none"> ➤ Electrical printed circuit board. ➤ Electric Molding Compounds. ➤ Additive for flame retardant material 				

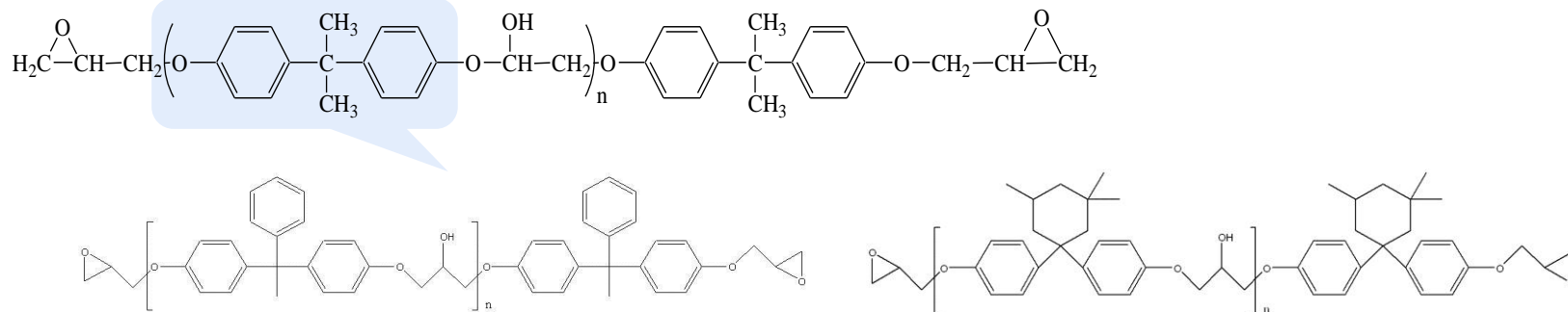
Properties & Test Results				Note	
Classification		Halogen Free Epoxy			
Type		DOPO-PNE	DOPO-HQ PNE		
Structure		<p>X= A or B</p> <p>X= or </p>	<p>X= or or </p>		
Grade		KEG-5138TMP75	KEG-HQ5638TM75	KEG-HQ5638TM75ND	
Resin Properties	EEW (g/eq)	294.7	300.1	314.5	
	Vis. (cps@25°C)	1225	2537		
	N.V. (wt.%)	74.8	75.8	75.4	
Curing condition		PN (KPH-F2004), Cat.=2E4MZ (0.07 phr)			
Varnish G.T.	Sec	220	194	215	
Thickness	mm	1.8053	1.7236	1.7546	
RC	%, Prepreg	49.2	48.2	48.3	
Tg	°C	134	141.8	143.1	DSC
Inter Ply	N/mm	0.87	0.92	1.33	
Peel	N/mm	0.92	1.00	1.06	
T288	min	>60	>60	>60	
TMA	a1(ppm/°C)	77.12	75.32	61.8	
	a2(ppm/°C)	299.7	293.8	288.9	
Flame Retardant	UL-94	V-0	V-0	V-0	

Product Name	Halogen Free Epoxy				
	Exp. #16	Exp. #19	Exp. #20	KEG-HQ5538MP75 (Ref.)	
Chemical Structure				<p>X= A or B</p>	
Properties	Appearance	Yellow liquid (PM Solution, NV=60)			Yellow liquid
	P content (%)	6.59	7.67	7.7	3.0
	EEW (g/eq)	370.5	381.7	401.9	315.5
	M.W. (g/mol)	1019	634	634	2155
	Varnish G.T. (Cured by Dicy)	459	451	469	325
	Prepreg Tg (Cured by Dicy)	165.5	170.7	171.5	149.7
Characteristics	<ul style="list-style-type: none"> ➤ Enhanced flame-retardant & heat resistance property ➤ Halogen-Free epoxy resin for an environment regulation ➤ Ultra high phosphorous content for user's needs ➤ PM Solution (N.V.=60) 				
Applications	<ul style="list-style-type: none"> ➤ Electrical printed circuit board. ➤ Additive for flame retardant material 				

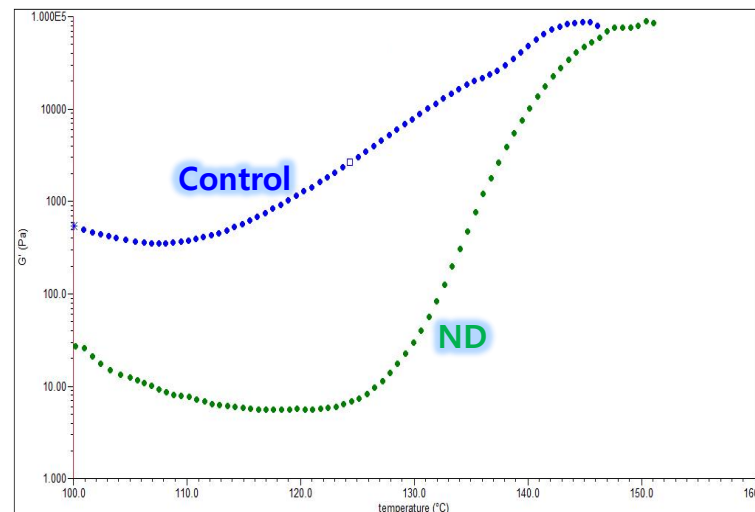
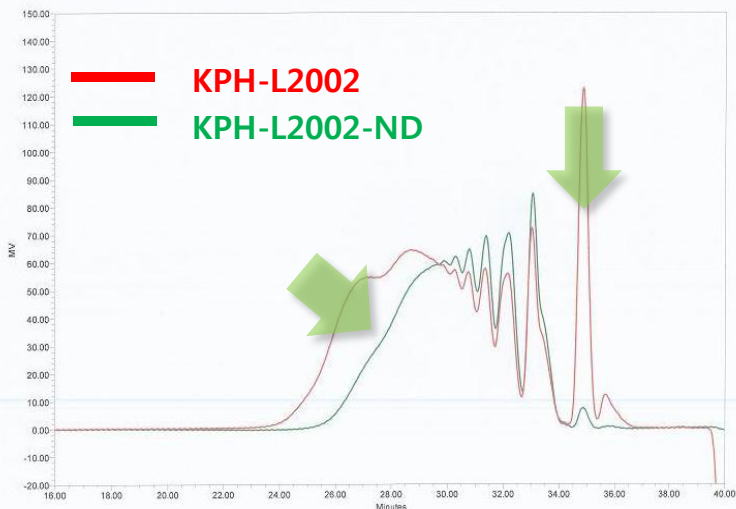
Narrow Dispersivity Products

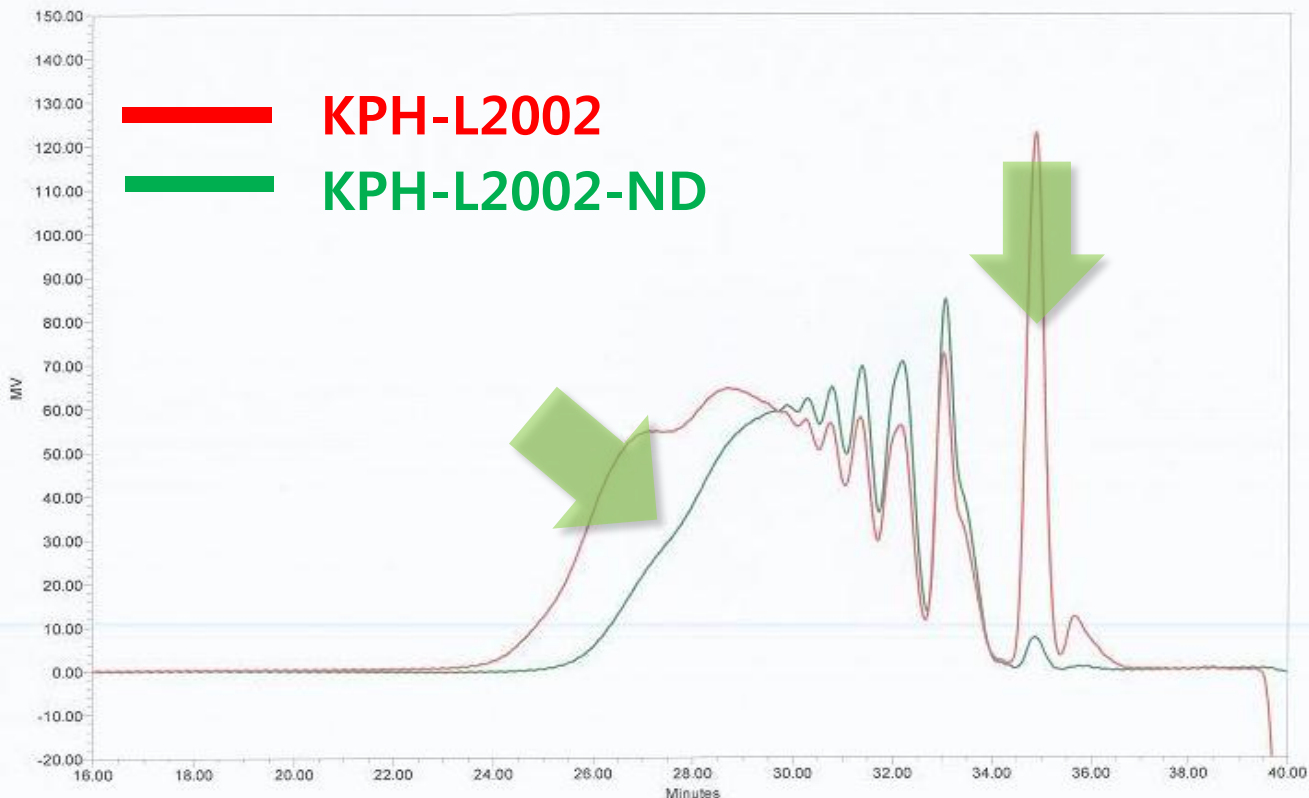


1 New Bisphenol Epoxy : Bis-Z Epoxy, Bis-AP Epoxy, Bis-TMC Epoxy



2 ND Phenol Novolac : KPH-F2002-ND





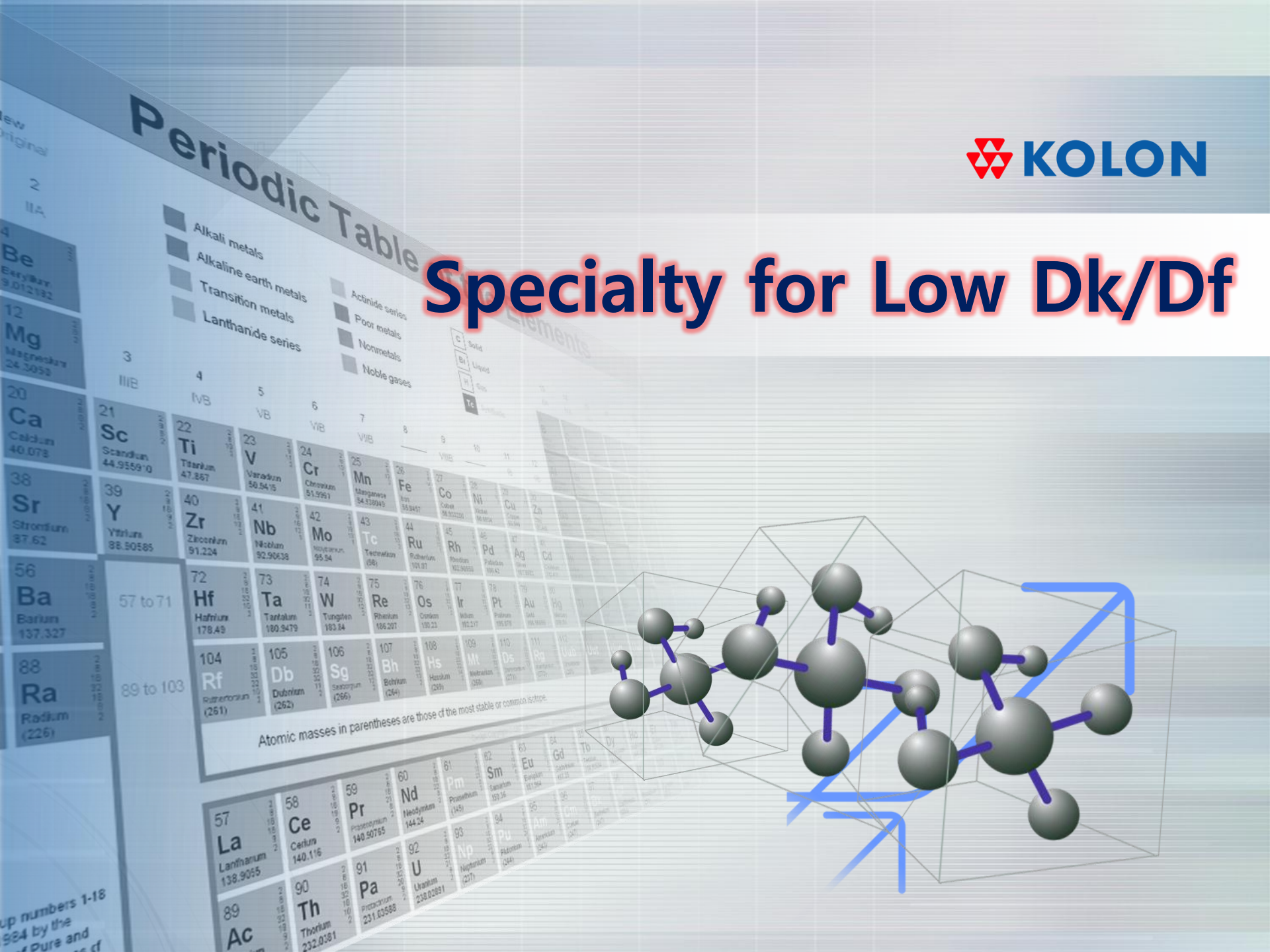
	Mw	Mn	PDI	-OH EW	SP (°C)	Melt Vis. (cps, 190°C)
KPH-F2002	1,924	974	1.97	106.5	101.0	100.8
KPH-F2002-ND	1,167	923	1.26	106.3	100.5	62.4 (38% ↓)

CCLS Properties	KPH-F2002	KPH-F2002-ND
Tg (DSC, °C)	153.4	164.6 (11.2°C ↑)
CTE (ppm/°C)	α1: 75.1 α2: 320.3	α1: 58.95 α2: 284.4
Inter-ply adhesion (N/mm)	1.53	1.62
Delamination (30~360°C,TMA)	356°C	358°C
T-288 (40°C~288°C, Iso 288°C)	> 20 min.	> 20 min.
Peel Strength (N/mm)	1.01	1.00
Water Absorption (wt%)	0.38%	0.37%
Solder Dip (After PCT, 288°C, min.)	> 5'	> 5'
Flammability (UL94-Rating)	V-0	V-0

* Formulation of KEF-6087 : PN Hardener = 1 : 1 equimolar ratio with 0.04 wt% of 2E4MZ

Periodic Table

Specialty for Low Dk/Df



- Alkali metals
- Alkaline earth metals
- Transition metals
- Lanthanide series
- Actinide series
- Poor metals
- Nonmetals
- Noble gases

Atomic masses in parentheses are those of the most stable or common isotope.

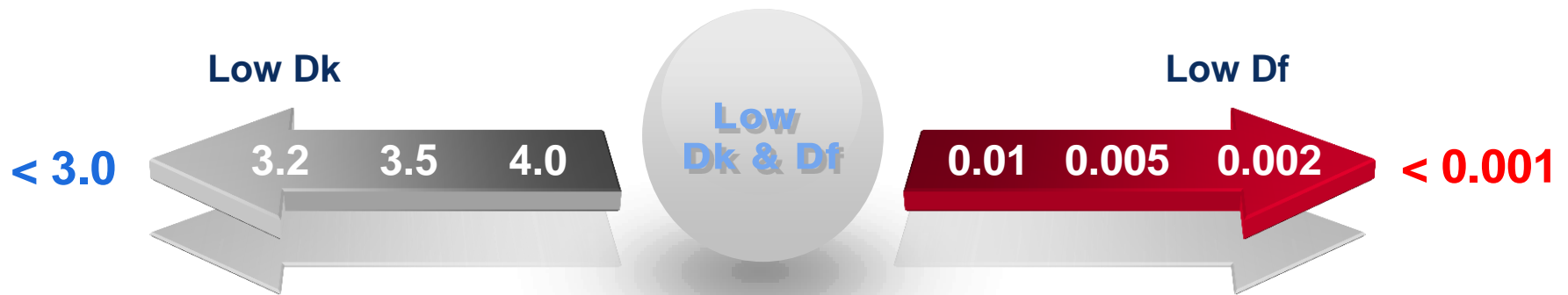
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✓ Resins for Low Dk/Df

The main factor of low Dk / Df system is...

- (1) Specific chemical structure (small dipoles : -CH₂-, -CF- etc.)
- (2) Low low water absorption
- (3) Free volume density after curing
- (4) Hydrophobic character

>> Currently, DCPD, Biphenyl, PPO, Poly BZX etc. are used for low Dk / Df resin.
 However, most of the resin's properties are not enough and can't achieve all properties in one epoxy system





Our new products for low Dk/Df

1. DCPD Modified...

- DCPD-Phenol Epoxy
- DCPD-BPA, DCPD-BPAN Epoxy
- DCPD-POP Epoxy

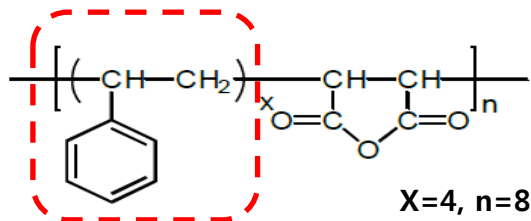
2. Aliphatic Group Modified...

- Hydrocarbon Resin Modified Hardner
- Alkyl Phenol Novolac Epoxy
- Terpene Modified Novolac Epoxy

3. Anhydride Type Hardner...

- Alpha Methyl Styrene – Maleic Anhydride Copolymer

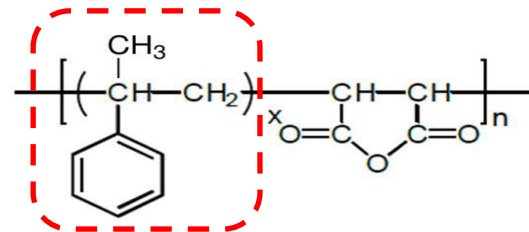
☑ New Anhydride type Hardener



SMA (Styrene - Maleic Anhydride)
Copolymer

- ▶ Feature of conventional SMA Resin
 - Relatively effective for lowering Dk and Df in CCL field
 - Styrene group provided low Dk/Df
 - MA group provided compatible with epoxy system and cured with epoxy
- However, there is patent dispute in case using SMA system**

Patent Free



Alpha Methyl Styrene - Maleic anhydride
Copolymer

- ▶ Substitute of Styrene part
 - Use **Alpha methyl styrene**
 - Can be achieved more higher properties than SMA Resin
- “ There is no patent dispute ”**

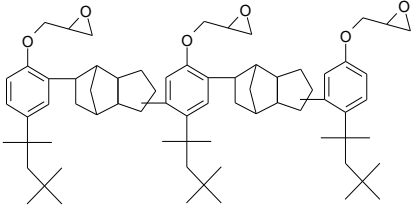
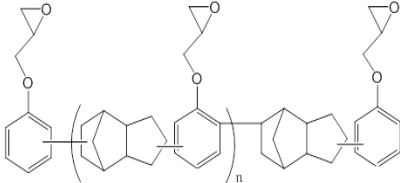
Product Name	DCPD Modified Phenol Epoxy			
	KES-7670	KES-7680	KES-7695	
Chemical Structure				
Properties	Appearance	Brown Solid	Brown Solid	Brown Solid
	EEW (g/eq)	250 ~ 270	260 ~ 280	260 ~ 280
	S.P. (°C)	65~ 75	75 ~ 85	95 ~ 105
	Hy-Cl (ppm)	500 Max.	500 Max.	500 Max.
	Color (Gardner)	Max.	Max.	Max.
Characteristics	<ul style="list-style-type: none"> ➤ Epoxy Resin for Low Dk/Df Applications ➤ Excellent Heat Resistance & Electrical Properties 			
Applications	<ul style="list-style-type: none"> ➤ CCL laminate for high speed PCB ➤ Electronic encapsulation and transfer molding ➤ Electrical heat resistance molding compound 			

Properties & Test Results						Note
Classification		Low Dk/Df			Low Dk/Df (Ref.)	
Type		DCPD-Phenol Epoxy				
Structure						
Grade		KES-7670	KES-7680	KES-7695	Competitor's (D社)	
Resin Properties	EEW (g/eq)	255.6	261.97	271.2	273.1	
	S.P. (°C)	72.8	81.8	98.9	79.1	
	Hy-Cl (ppm)	44.1	70.2	63.4	54.6	
Curing condition		Dicy curing, Cat.=2MI				
Varnish G.T.	Sec	164	145		141	
Thickness	mm		0.67		0.82	
RC	%, Prepreg		42.84		43.09	
Tg	°C	200.3	209.7		206	DSC
			247.1		238.7	DMA
			210.7		201.3	TMA
Dk	1GHz	3.00/2.98	3.08		3.08	Mold Specimen
Df	1GHz	0.136/0.0140	0.0178		0.0167	Mold Specimen
W.A.(%)	PCT 2hr		0.25		0.31	
Inter Ply	N/mm		1.03		1.24	
Peel	N/mm		1.43		1.5	
Delamination	Sec, PCT 2hr				360	
TMA	a1(ppm/°C)		38		86.46	
	a2(ppm/°C)		69.74		403.6	
	CTE(%)		1.695		3.319	

Product Name		DCPD Modified BPA, BPAN Epoxy Resin	
		KES-7760	KES-7770
Chemical Structure			
Properties	Appearance	Dark Brown Solid	Dark Brown Solid
	EEW (g/eq)	270 ~ 290	270 ~ 290
	S.P. (°C, B&R)	56 ~ 62	68 ~ 74
	Hy-Cl (ppm)	500 max.	500 max.
	Color (Gardner)	max.	max.
Characteristics		<ul style="list-style-type: none"> ➤ Epoxy Resin for Low Dk/Df Applications ➤ Excellent Heat Resistance & Electrical Properties 	
Applications		<ul style="list-style-type: none"> ➤ CCL laminate for high speed PCB ➤ Electronic encapsulation and transfer molding ➤ Electrical heat resistance molding compound 	

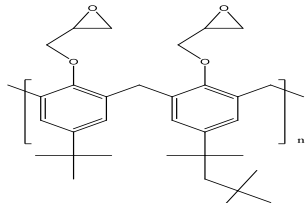
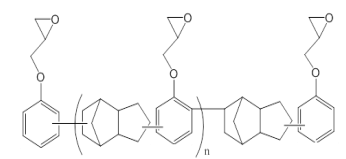
Properties & Test Results			Note		
Classification		Low Dk/Df	Low Dk/Df (Ref.)		
Type		DCPD-Phenol Epoxy			
Structure					
Grade		KES-7760	KES-7770	Competitor's (D社)	
Resin Properties	EEW (g/eq)	283	281.4	273.1	
	S.P. (°C)	59.2	70.1	79.1	
	Hy-Cl (ppm)	90	92	54.6	
Curing condition		Dicy curing, Cat.=2MI			
Varnish G.T.	Sec	225	196	141	
Thickness	mm	0.65	0.81	0.82	
RC	%, Laminate	32.4	41.2	43.09	
Tg	°C			206	DSC
			210.87	238.7	DMA
		154.65	168.85	201.3	TMA
Dk	1GHz	2.84	3.08	3.08	Mold Specimen
Df	1GHz	0.0118	0.0173	0.0167	Mold Specimen
W.A.(%)	PCT 2hr	0.29	0.31	0.31	
Inter Ply	N/mm	0.99	0.89	1.24	
Peel	N/mm	0.91	0.98	1.5	
Delamination	Sec, PCT 2hr			360	
TMA	a1(ppm/°C)	87.4	144.8	86.46	
	a2(ppm/°C)	351.5	463.5	403.6	
	CTE(%)	4.079	5.079	3.319	

Product Name	DCPD POP Modified Epoxy	
	KES-7790	
Chemical Structure		
Properties	Appearance	Dark Brown solid
	EEW (g/eq)	380~440
	S.P. (°C, B&R)	90~100
	Hy-Cl (ppm)	500 max.
	Color (Gardner)	-
Characteristics	<ul style="list-style-type: none"> ➤ Epoxy Resin for Low Dk/Df Applications ➤ Excellent Heat Resistance & Electrical Properties 	
Applications	<ul style="list-style-type: none"> ➤ CCL laminate for high speed PCB ➤ Electronic encapsulation and transfer molding ➤ Electrical heat resistance molding compound 	

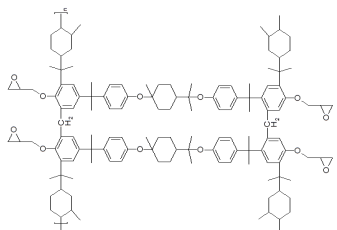
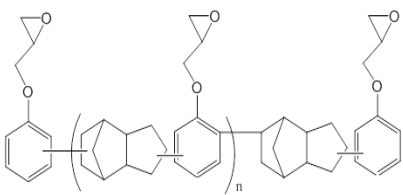
Properties & Test Results			Note	
Classification		Low Dk/Df	Low Dk/Df (Ref.)	
Type		DCPD-POP Epoxy	DCPD-Phenol Epoxy (HP-7200H)	
Structure				
Grade		DCPD-POP Epoxy	Competitor's (D社)	
Resin Properties	EEW (g/eq)	414.5	273.1	
	S.P. (°C)	91.6	79.1	
	Hy-Cl (ppm)	660	54.6	
Curing condition		Dicy curing, Cat.=2MI		
Varnish G.T.	Sec	270	141	
Thickness	mm	0.95	0.82	
RC	%, Prepreg	42.05	43.09	
Tg	°C	174.47	206	DSC
		197.38	238.7	DMA
		163.9	201.3	TMA
Dk	1GHz	2.71	3.08	Mold Specimen
Df	1GHz	0.0086	0.0167	Mold Specimen
W.A.(%)	PCT 2hr	0.28	0.31	
Inter Ply	N/mm	1.05	1.24	
Peel	N/mm	0.44	1.5	
Delamination	Sec, PCT 2hr	-	360	
TMA	a1(ppm/°C)	75.90	86.46	
	a2(ppm/°C)	390.3	403.6	
	CTE(%)	4.499	3.319	

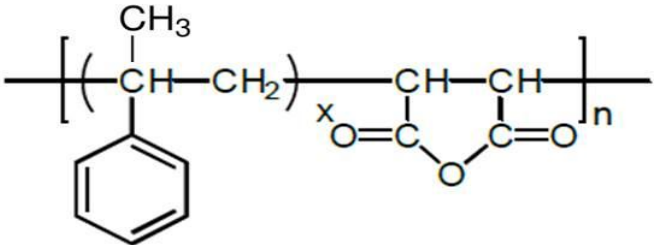
Product Name		Hydrocarbon Resin Modified Hardener	
		Si-DCPD-BPA	TCPD-BPA
Chemical Structure			
Properties	Appearance	Brown Solid	Dark Brown Solid
	Ph-OH equivalent (g/eq)	378	340
	S.P. (°C, B&R)	90~100	105~115
	Water content (%)	0.2 max.	0.2 max.
	Dk (@1GHz, Mold) Cured by Dicy	3.05	2.94
	Df (@1GHz, Mold) Cured by Dicy	0.017	0.013
Characteristics		<ul style="list-style-type: none"> ➤ Hardner for Low Dk/Df Applications ➤ Excellent Heat Resistance & Electrical Properties 	
Applications		<ul style="list-style-type: none"> ➤ CCL laminate for high speed PCB ➤ Electronic encapsulation and transfer molding ➤ Electrical heat resistance molding compound 	

Product Name		Alkylphenol Novolac Epoxy
		KES-7595
Chemical Structure		
Properties	Appearance	Yellow Solid
	EEW (g/eq)	345 ~ 385
	S.P. (°C, B&R)	94 ~ 98
	Hy-Cl (ppm)	500 max.
	Color (Gardner)	6 max.
Characteristics		<ul style="list-style-type: none"> ➤ Epoxy Resin for Low Dk/Df Applications ➤ Excellent Heat Resistance & Electrical Properties
Applications		<ul style="list-style-type: none"> ➤ CCL laminate for high speed PCB ➤ Electronic encapsulation and transfer molding ➤ Electrical heat resistance molding compound

Properties & Test Results						Note
Classification		Low Dk/Df			Low Dk/Df (Ref.)	
Type					DCPD-Phenol Epoxy	
Structure						
Grade		KES-7595			Competitor's (D社)	
Resin Properties	EEW (g/eq)	369.9			273.1	
	S.P. (°C)	95.1			79.1	
	Hy-Cl (ppm)	246			54.6	
Curing condition		PN Curing (KPH-F2004)	MFN Curing (KPH-3140)	Dicy curing, Cat.=2MI	Dicy curing, Cat.=2MI	
Varnish G.T.	Sec	270	270	220	141	
Thickness	mm	0.98	1.01	0.58	0.82	
RC	%, Prepreg				43.09	
Tg	°C	166.2	173.5	172.7	206	DSC
					238.7	DMA
		163.6	171	-	201.3	TMA
Dk	1GHz	3.72	3.67	3.95	3.91	CCL
Df	1GHz	0.012	0.014	0.0086	0.0126	CCL
W.A.(%)	PCT 2hr	0.36	0.40	-	0.31	
Inter Ply	N/mm	0.80	0.78	-	1.24	
Peel	N/mm	0.57	0.55	-	1.5	
Delamination	Sec, PCT 2hr	<10	<10	-	360	
TMA	a1(ppm/°C)	117.1	106.2	-	86.46	
	a2(ppm/°C)	347.2	380.3	-	403.6	
	CTE(%)				3.319	

Product Name		Terpene Modified Epoxy
		KES-7380
Chemical Structure		
Properties	Appearance	Yellow Solid
	EEW (g/eq)	360 ~ 400
	S.P. (°C, B&R)	80 ~ 86
	Hy-Cl (ppm)	500 max.
	Color (Gardner)	1500 max.
Characteristics		<ul style="list-style-type: none"> ➤ Epoxy Resin for Low Dk/Df Applications ➤ Excellent Heat Resistance & Electrical Properties
Applications		<ul style="list-style-type: none"> ➤ CCL laminate for high speed PCB ➤ Electronic encapsulation and transfer molding ➤ Electrical heat resistance molding compound

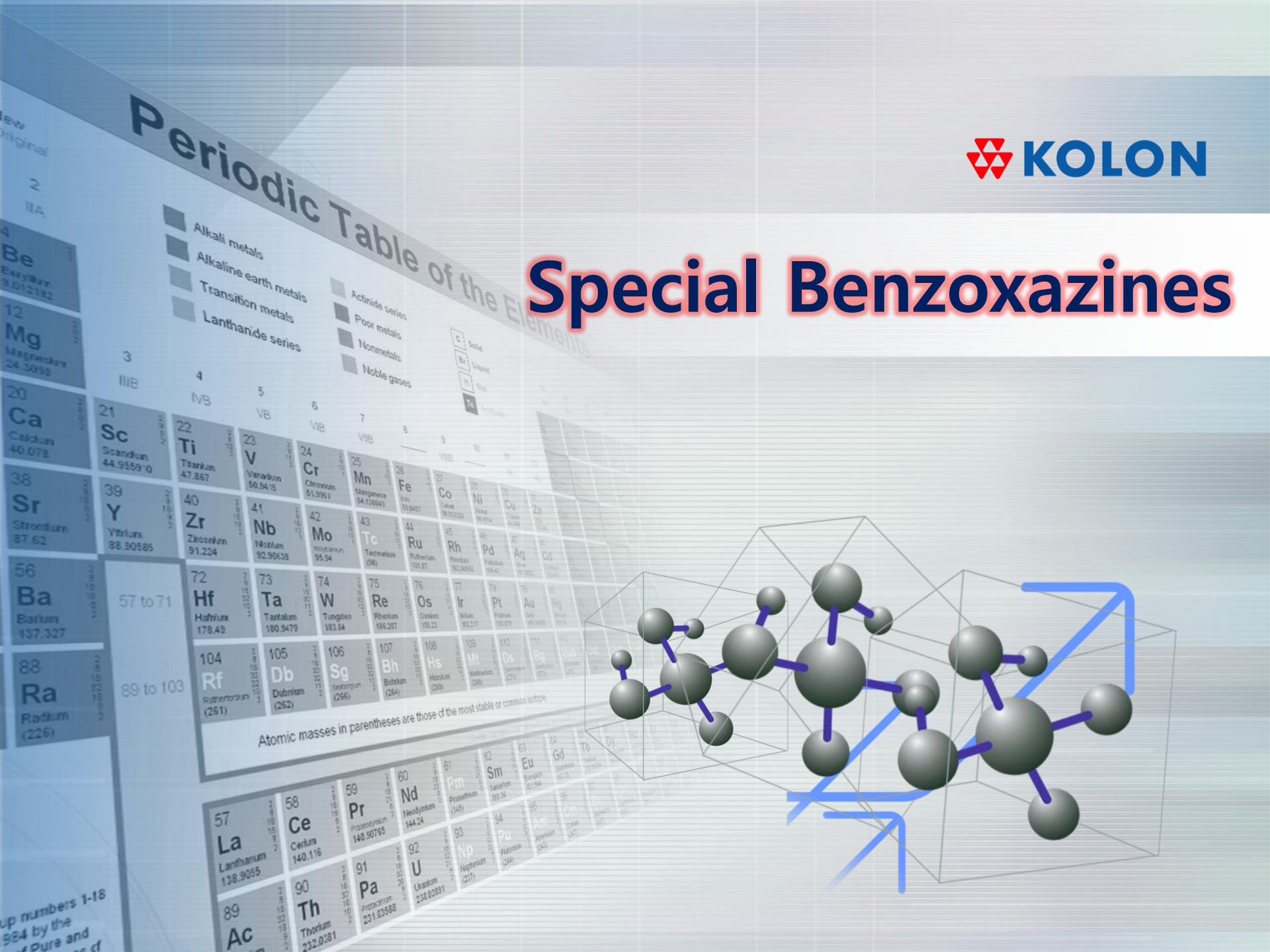
Properties & Test Results			Note	
Classification		Low Dk/Df	Low Dk/Df (Ref.)	
Type		Terpene Modified Epoxy	DCPD-Phenol Epoxy	
Structure				
Grade		KES-7380	Competitor's (D社)	
Resin Properties	EEW (g/eq)	343.8	273.1	
	S.P. (°C)	81.4	79.1	
	Hy-Cl (ppm)	358.4	54.6	
Curing condition		Dicy curing, Cat.=2MI		
Varnish G.T.	Sec	275	141	
Thickness	mm	0.74	0.82	
RC	%, Prepreg	41.35	43.09	
Tg	°C	-	206	DSC
		182.4	238.7	DMA
		165.4	201.3	TMA
Dk	1GHz	2.92	3.08	Mold Specimen
Df	1GHz	0.018	0.0167	Mold Specimen
W.A.(%)	PCT 2hr	0.01	0.31	
Inter Ply	N/mm	0.73	1.24	
Peel	N/mm	0.95	1.5	
Delamination	Sec, PCT 2hr	360	360	
TMA	a1(ppm/°C)	58.69	86.46	
	a2(ppm/°C)	163.9	403.6	
	CTE(%)	0.89	3.319	

Product Name	Alpha Methyl Styrene – Maleic Anhydride Copolymer	
	KSH-5100M60	
Chemical Structure		
Properties	Appearance	Orangish liquid
	Acid number (mgKOH/g)	140 ~ 160
	Free monomer (%)	0.1 >
	N.V. (wt.%)	58 ~ 62
Characteristics	<ul style="list-style-type: none"> ➤ Hardener for Low Dk/Df Applications ➤ Excellent Heat Resistance & Electrical Properties 	
Applications	<ul style="list-style-type: none"> ➤ CCL laminate for high speed PCB ➤ Electronic encapsulation and transfer molding ➤ Electrical heat resistance molding compound 	

Properties & Test Results			Note	
Classification		Low Dk/Df	Low Dk/Df (Ref.)	
Type		Alpha Methyl Styrene-Maleic Anhydride	Styrene-Maleic Anhydride	
Structure				
Grade		KSH-5100M60	Competitor's (C社)	
Resin Properties	Acid # (mgKOH/g)	214.5	145.6	
	Free monomer	811.5ppm (α Methyl Styrene)	0.1 % > (Styrene)	
	N.V. (%)	60.58	60.37	
Curing condition		KE-8128 cure, Cat.= 2MI (10% in MeOH)		
Varnish G.T.	Sec	237	203	
Thickness	mm	0.92	0.73	
RC	%, Prepreg	41.69	37.48	
Tg	°C	No Data	No Data	DSC
		232.41	182.43	DMA
		175.18	151.19	TMA
Dk	1GHz	2.92	2.91	Mold Specimen
Df	1GHz	0.0155	0.0150	Mold Specimen
Dk	1GHz	3.6583	4.3424	CCLS
Df	1GHz	0.0152	0.0111	CCLS
W.A.(%)	PCT 2hr	0.32	0.04	
Inter Ply	N/mm	0.812	0.530	
Peel	N/mm	1.010	0.832	
TMA	a1(ppm/°C)	130.8	159.5	
	a2(ppm/°C)	252.9	394.3	
	CTE(%)	3.222	4.465	

Periodic Table of the Elements

Special Benzoxazines

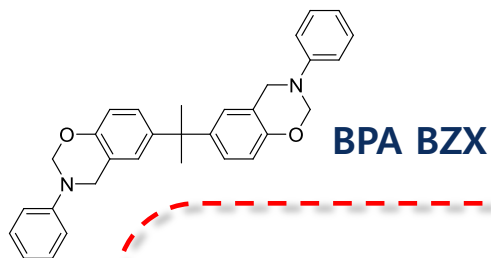


- Alkali metals
- Alkaline earth metals
- Transition metals
- Lanthanide series
- Actinide series
- Poor metals
- Nonmetals
- Noble gases

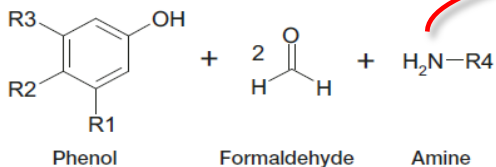
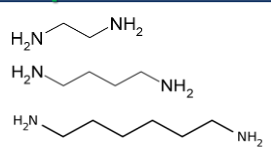
Atomic masses in parentheses are those of the most stable or common isotope.

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☑ Benzoxazine for High-speed PCB Application

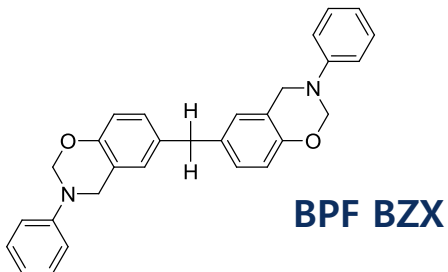


Aliphatic Amines

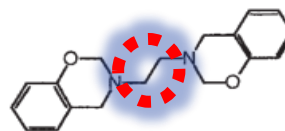


Combination of 3 Raw Materials

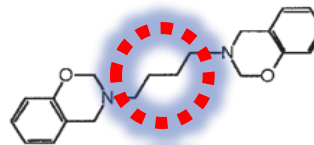
New Bisphenol



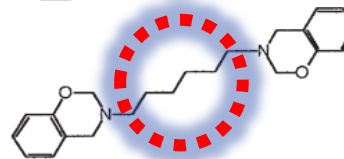
Aliphatic BZX



C2 BZX

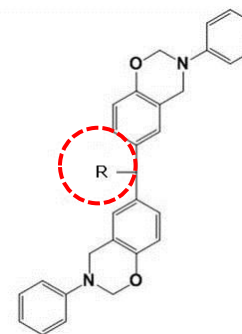


C4 BZX



C6 BZX

New Bisphenol BZX



New Bisphenol based BZX

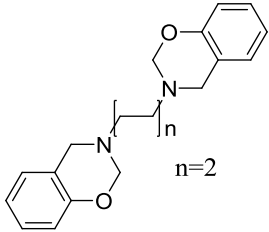
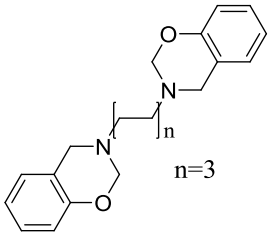
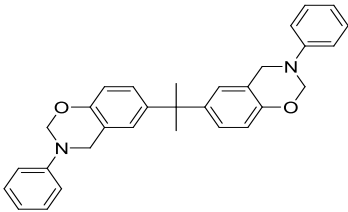
Product Name	Bisphenol A Benzoxazine		
	KAH-F5085	Competitor's	
Chemical Structure			
Properties	Appearance	Yellow Solid	Yellow Solid
	S.P. (°C, B&R)	~	~
	G.T. (sec@190°C), Self Curing	394	697
	Tg (°C, DSC), Self Curing	172.2	170.48
	Dk (@1GHz, Mold), Self Curing	2.98	3.37
	Df (@1GHz, Mold), Self Curing	0.009	0.0078
Characteristics	<ul style="list-style-type: none"> ➤ Hardner for Low Dk/Df Applications ➤ Excellent Heat Resistance & Electrical Properties 		
Applications	<ul style="list-style-type: none"> ➤ CCL laminate for high speed PCB ➤ Electronic encapsulation and transfer molding ➤ Electrical heat resistance molding compound 		

Properties & Test Results			Note
Classification	BZX	BZX (Ref.)	
Type	Bisphenol A Benzoxazine		
Structure			
Grade	KAH-F5085	Competitor's	
Resin Properties	S.P. (°C)		
	G.T. (sec@190°C)	394	697 Self Curing
	Tg (°C)	172.2	170.48 Self Curing
	Dk (@1GHz)	2.98	3.37 Self Curing, Mold
	Df (@1GHz)	0.009	0.0078 Self Curing, Mold
Curing condition	Self curing, Cat.=		
Varnish G.T.	Sec		
Thickness	mm	0.62	
RC	%, Prepreg		
Tg	°C	198.76	DMA
Dk	1GHz	3.89	CCL
Df	1GHz	0.0069	CCL
W.A.(%)	PCT 2hr		
Inter Ply	N/mm	0.88	
Peel	N/mm	1.19	
Delamination	Sec, PCT 2hr		
TMA	ppm/°C	$\alpha_1 =$, $\alpha_2 =$	$\alpha_1 =$, $\alpha_2 =$
	CTE(%)		
Flame Retardant	UL-94	Burns	

Product Name		Bisphenol F Benzoxazine	
		KAH-F5075	Competitor's
Chemical Structure			
Properties	Appearance	Yellow Solid	Yellow Solid
	S.P. (°C, B&R)	~	~
	G.T. (sec@190°C), Self Curing	307	235
	Tg (°C, DSC), Self Curing	183.14	173.7
	Dk (@1GHz, Mold), Self Curing	3.36	3.72
	Df (@1GHz, Mold), Self Curing	0.017	0.014
Characteristics		<ul style="list-style-type: none"> ➤ Hardner for Low Dk/Df Applications ➤ Excellent Heat Resistance & Electrical Properties 	
Applications		<ul style="list-style-type: none"> ➤ CCL laminate for high speed PCB ➤ Electronic encapsulation and transfer molding ➤ Electrical heat resistance molding compound 	

Properties & Test Results			Note
Classification	BZX	BZX (Ref.)	
Type	Bisphenol F Benzoxazine		
Structure			
Grade	KAH-F5075	Competitor's	
Resin Properties	S.P. (°C)		
	G.T. (sec@191°C)	307	235
	Tg (°C)	183.14	173.7
	Dk (@1GHz)	3.36	3.72
	Df (@1GHz)	0.017	0.014
Curing condition		Self curing, Cat.=	
Varnish G.T.	Sec		
Thickness	mm	0.63	
RC	%, Prepreg		
Tg	°C	195.96	DMA
Dk	1GHz	4.02	CCL
Df	1GHz	0.011	CCL
W.A.(%)	PCT 2hr		
Inter Ply	N/mm	0.88	
Peel	N/mm	1.32	
Delamination	Sec, PCT 2hr		
TMA	ppm/°C	$\alpha_1 =$, $\alpha_2 =$	$\alpha_1 =$, $\alpha_2 =$
	CTE(%)		
Flame Retardant	UL-94	V-1	

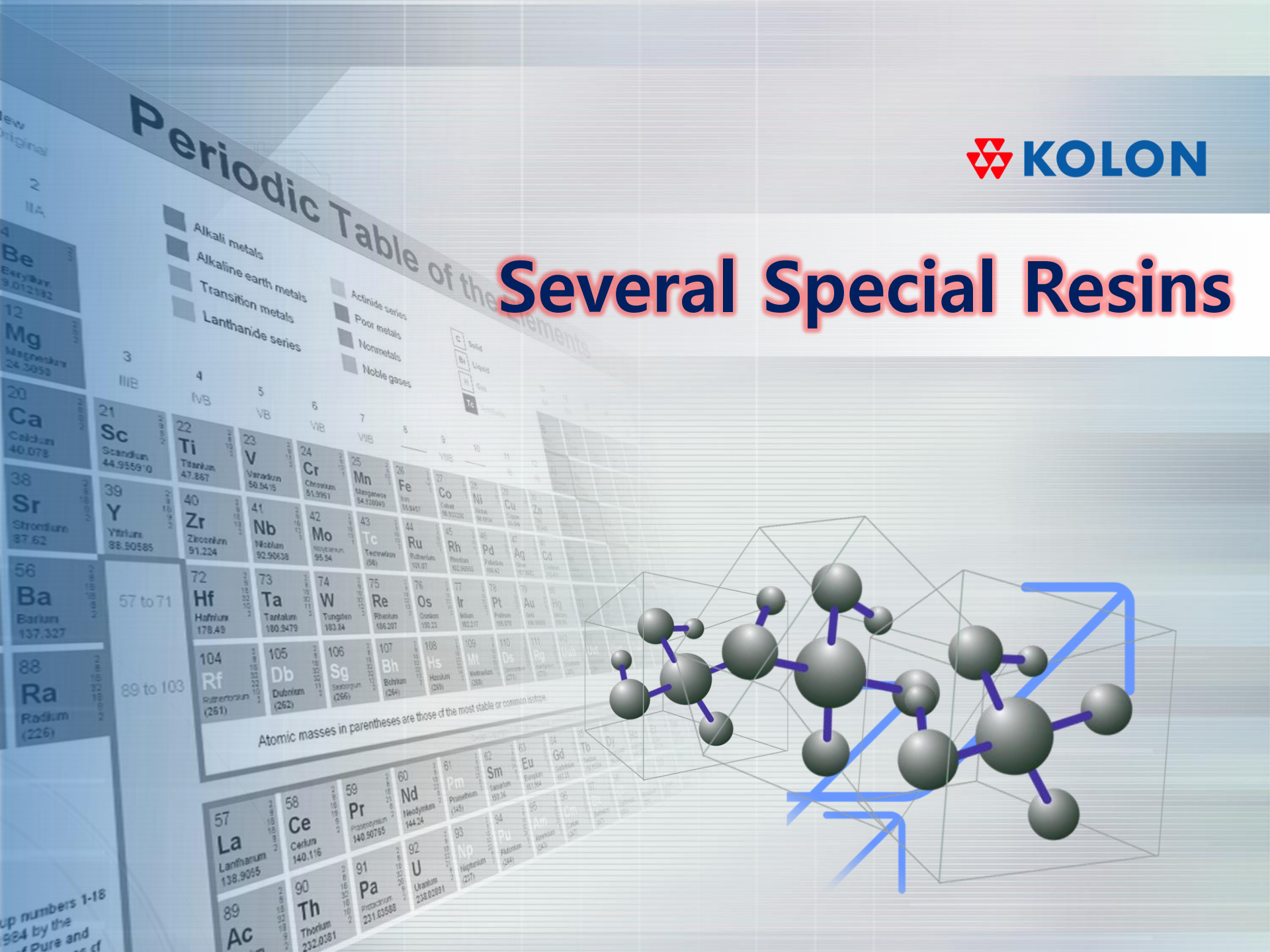
Product Name		Bisphenol F Benzoxazine	
		KAH-F5404	KAH-F5406
Chemical Structure			
Properties	Appearance	Yellow Solid	Yellow Solid
	S.P. (°C, B&R)	~	~
	G.T. (sec@190°C), Self Curing	120	396
	Tg (°C, DSC), Self Curing	222.5	200.59
	Dk (@1GHz, Mold), Self Curing	2.83	3.00
	Df (@1GHz, Mold), Self Curing	0.0044	0.0058
Characteristics		<ul style="list-style-type: none"> ➤ Hardner for Low Dk/Df Applications ➤ Low Temperature Curable & High Tg 	
Applications		<ul style="list-style-type: none"> ➤ CCL laminate for high speed PCB ➤ Electronic encapsulation and transfer molding ➤ Electrical heat resistance molding compound 	

Properties & Test Results				Note	
Classification		BZX		BZX (Ref.)	
Type		C4 BZX	C6 BZX	Bisphenol A BZX	
Structure					
Grade		KAH-F5404	KAH-F5406	KAH-F5085	
Resin Properties	S.P. (°C)				
	G.T. (sec@190°C)	120	396	394	Self Curing
	Tg (°C)	222.5	200.59	172.2	Self Curing
	Dk (@1GHz)	2.83	3.00	2.98	Self Curing, Mold
	Df (@1GHz)	0.0044	0.0058	0.009	Self Curing, Mold
Curing condition		Self curing, Cat.=			
Varnish G.T.	Sec				
Thickness	mm	0.65	0.52	0.62	
RC	% Prepreg				
Tg	°C	234.72		198.76	DMA
Dk	1GHz	4.00	3.98	3.89	CCL
Df	1GHz	0.0062	0.0092	0.0069	CCL
W.A.(%)	PCT 2hr				
Inter Ply	N/mm	1.76	0.72	0.88	
Peel	N/mm	1.5	0.65	1.19	
Delamination	Sec, PCT 2hr				
TMA	ppm/°C	$\alpha1=$, $\alpha2=$	$\alpha1=$, $\alpha2=$	$\alpha1=$, $\alpha2=$	
	CTE(%)				
Flame Retardant	UL-94	Burns	Burns	Burns	

Product Name		New Bisphenol-based BZX	
		New BZX	KAH-F5075 (Ref.)
Chemical Structure			
Properties	Appearance	Yellow Solid	Yellow Solid
	S.P. (°C, B&R)	~	~
	G.T. (sec@210°C), Self Curing	264	115
	Tg (°C, DSC), Self Curing	203.3	173.7
	Dk (@1GHz, Mold), Self Curing	3.23~3.34	3.41~3.55
	Df (@1GHz, Mold), Self Curing	0.01~0.011	0.016
Characteristics		<ul style="list-style-type: none"> ➤ Hardner for Low Dk/Df Applications ➤ Low Temperature Curable & High Tg 	
Applications		<ul style="list-style-type: none"> ➤ CCL laminate for high speed PCB ➤ Electronic encapsulation and transfer molding ➤ Electrical heat resistance molding compound 	

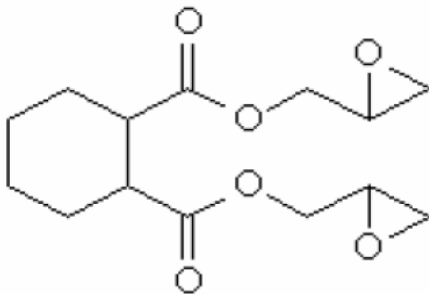
Properties & Test Results			Note	
Classification		BZX		
Type		New Bisphenol BZX	Bisphenol F BZX (Ref.)	
Structure				
Grade		New Bisphenol BZX	KAH-F5075	
Resin Properties	S.P. (°C)	96.2	90.3	
	G.T. (sec@210°C)	264	115	Self Curing
	Tg (°C)	203.3	173.7	Self Curing
	Dk (@1GHz)	3.23~3.34	3.41~3.55	Self Curing, Mold
	Df (@1GHz)	0.01~0.011	0.016	Self Curing, Mold
Curing condition		Self Curing, Cat.=		
Varnish G.T.	Sec			
Thickness	mm	0.52	0.62	
RC	%, Prepreg			
Tg	°C	248.16	198.76	DMA
Dk	1GHz	3.97~4.02	3.89	CCL
Df	1GHz	0.007~0.011	0.0069	CCL
W.A.(%)	PCT 2hr			
Inter Ply	N/mm		0.88	
Peel	N/mm		1.19	
Delamination	Sec, PCT 2hr			
TMA	ppm/°C	$\alpha 1 =$, $\alpha 2 =$	$\alpha 1 =$, $\alpha 2 =$	
	CTE(%)			
Flame Retardant	UL-94	V-0	Burns	

Several Special Resins



Product Name	Methyl Substituted Epoxy Resin	
	SE-8000	
Chemical Structure		
Properties	Appearance	Clear White
	EEW (g/eq)	400 ~ 520
	S.P. (°C, B&R)	52 ~ 62
	Hy-Cl (ppm)	500 max
Characteristics	<ul style="list-style-type: none"> ➤ Substitution of Hydroxyl Group ➤ Used for EMC & CCLS (IC Substrate) ➤ Low Viscosity and ease of Processing ➤ High Adhesion and Low Water Absorption ➤ Excellent Thermal Stability 	
Applications	<ul style="list-style-type: none"> ➤ Electrical printed circuit board. ➤ Electric Molding Compounds. ➤ High temp.adhesives & composites 	

Product Name	Allyl Novolac	
	KAH-L4020	
Chemical Structure	<p style="text-align: right;">n, m=0~3</p>	
Properties	Appearance	Yellow Liquid
	Ph-OH Equivalent (g/eq)	139 ~ 143
	Water Content (%)	Max. 0.2
	M.W. (g/mol)	700 ~ 800
Characteristics	<ul style="list-style-type: none"> ➤ Phenolic Resin Hardner of the solventless type ➤ Liquid, Solventless, ➤ Excellent Heat Resistance & Low Water Absorption 	
Applications	<ul style="list-style-type: none"> ➤ Electrical printed circuit board. ➤ Electric Molding Compounds. ➤ High temp.adhesives & composites 	

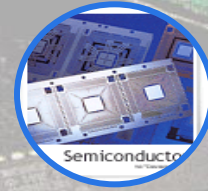
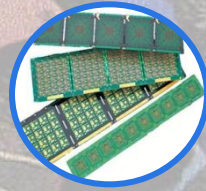
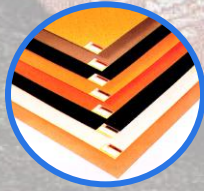
Product Name	Anhydride-based Epoxy	
	KES-7540	
Chemical Structure		
Properties	Appearance	Clear White
	EEW (g/eq)	150 ~ 175
	Vis. (cps@25°C%)	300 ~ 600
	Color (Gardner)	2 Max.
Characteristics	<ul style="list-style-type: none"> ➤ Low Viscosity and higher reactivity ➤ Transparent material to prevent cracking due to thermal stress relaxation ➤ Suitable for LED application, cast molding and adhesive 	
Applications	<ul style="list-style-type: none"> ➤ Electrical printed circuit board. ➤ Electric Molding Compounds. ➤ High temp.adhesives & composites 	

Product Type		Fluorinated Epoxy
Chemical Structure	KES-7600	
	KES-7615	
Properties	Appearance	White Semisolid
	EEW (g/eq)	KES-7600 : 220 ~ 260 / KES-7615 : 250 ~ 290
	Hy-Cl (ppm)	500 >
Characteristics		<ul style="list-style-type: none"> ➤ Hardener which has excellent properties of adhesion and Low Dk/Df ➤ significant effect on the adhesion such as inter-ply and peel strength
Applications		<ul style="list-style-type: none"> ➤ CCL laminate for high speed PCB ➤ Electronic encapsulation and transfer molding ➤ Electrical heat resistance molding compound

Properties & Test Results				Note	
Classification		Fluorinated Epoxy		Low Dk/Df (Ref.)	
Grade		KES-7600	KES-7615	DCPD-Phenol Epoxy (Competitor's, D社)	
Structure					
Resin Properties	EEW (g/eq)	243.5	268.9	273.1	
	Hy-Cl (ppm)	319	283	54.6	
Curing condition		DiCY cure, Cat.= 2MI (10% in MeOH)			
Varnish G.T.	Sec	234	231	141	
Thickness	mm	0.64	0.83	0.82	
RC	%, Prepreg	38.25	47.69	43.09	
Tg	°C	167.6	139.3	206	DSC
		198.8	168.3	238.7	DMA
		162.6	140.4	201.3	TMA
Dk	1GHz	4.06	4.02	3.91	CCLS
Df	1GHz	0.0093	0.0153	0.0126	CCLS
W.A.(%)	PCT 2hr	0.51	0.74	0.31	
Inter Ply	N/mm	1.37	2.44	1.24	
Peel	N/mm	1.34	1.99	1.5	
TMA	a1(ppm/°C)	22.1	74.0	86.46	
	a2(ppm/°C)	170.1	252.0	403.6	
	CTE(%)	1.876	3.464	3.319	

We are always ready to Serve You

Best of Best CCLS



Phenolic Hardener

- Phenol Novolac
- Cresol Novolac
- BPA Novolac
- Narrow Dispersity
- Alkyl Phenol Novolac
- BZX, MFN, ATN

Novolac Epoxy

- PNE
- CNE
- BNE
- High MW PNE
- Tetra Epoxy
- BPF Epoxy

Halogen Free

- DOPO-Resole
- DOPO-PN
- DOPO-PNE
- DOPO-HQ-PNE
- MDI-LER
- TDI/HDI/IPDI

Lead-Free


- HBr-MDI
- TDI/HDI/IPDI
- N=0 Epoxy
- BPF Epoxy

Other Specialty

- DCPD Modified
- Fluorine Modified
- Terpene Modified
- Benzoxazine

As a Strategic Raw Materials Supplying Partner for you

HOW TO COOPERATE ?

- 
- Tg, CTE, P/S ... ?
 - Due Date ... ?
 - Price Limit ... ?
 - How Low Df ... ?
 - How Low Dk ... ?