A global supplier of High Performance Resins
Multifunctional Resins

Nippon Kayaku Co., Ltd. Functional Chemicals Group, incorporates Epoxy and Acrylate resins designed to serve high performance and high quality demanding markets such as Composites and Electronics. We differentiate ourselves by offering sustainable solutions and developing complex products that incorporate proprietary technologies.

Our global network supports and serves with a common goal, providing the best products with the highest standards to all our customers. As one we deliver global “sukima” ideas.

NC-3000 series

- Excellent Flame Retardance
- Good Toughness
- Low Water Absorbance
- Biphenyl Aralkyl Type

XD-1000 series

- DCPD Type
- Low Water Absorption
- High Heat Durability (Tg)
- Mechanical Strength

EPPN-500 series

- Trisphenol Methane
- Excellent Heat Durability (Tg)
- High Modulus at High Temperatures

NC-7000 series

- Naphthol Cresol Novolac
- Low Water Absorption
- High Heat Durability (Tg)
- High Modulus

MIR-3000 series

- Maleimide Resin
- Heat Durability
- Low Water Absorption
- Toughness
**Phenol Aralkyl Type Epoxy Resin**

NC-3000 series & NC-2000-L flame retardance epoxy resin with high toughness.

The resin structure is a poly aromatic skeletal with a longer distance between functional groups. As a result, this resin can provide enhanced toughness whilst maintaining heat durability.

### NC-3000 series

<table>
<thead>
<tr>
<th></th>
<th>NC-3000</th>
<th>NC-3000-L</th>
<th>NC-3000-H</th>
<th>NC-3000-FH</th>
<th>CER-3000-L</th>
</tr>
</thead>
<tbody>
<tr>
<td>EEW g/eq.</td>
<td>258</td>
<td>272</td>
<td>276</td>
<td>288</td>
<td>328*</td>
</tr>
<tr>
<td>Softening Point °C</td>
<td>96</td>
<td>52</td>
<td>57</td>
<td>70</td>
<td>80*</td>
</tr>
<tr>
<td>ICI Melt viscosity (150°C) Pa*s</td>
<td>0.03</td>
<td>0.03</td>
<td>0.08</td>
<td>0.32</td>
<td>0.93*</td>
</tr>
<tr>
<td>Appearance</td>
<td>Semi-crystalline</td>
<td>Amorphous resin with yellow color</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Data post solvent evaporation from varnish.

### NC-2000-L

<table>
<thead>
<tr>
<th></th>
<th>NC-2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>EEW g/eq.</td>
<td>236</td>
</tr>
<tr>
<td>Softening Point °C</td>
<td>52</td>
</tr>
<tr>
<td>ICI Melt viscosity (150°C) Pa*s</td>
<td>0.09</td>
</tr>
<tr>
<td>Appearance</td>
<td>Amorphous resin with yellow color</td>
</tr>
</tbody>
</table>

Flaming test using **Epoxy – Phenol Resin** curing systems

<table>
<thead>
<tr>
<th>Resin formulation</th>
<th>Filler Content</th>
<th>Total Flaming Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>NC-3000/GPH-65</td>
<td>73vol%</td>
<td>33 / 43</td>
</tr>
<tr>
<td>NC-3000/PN</td>
<td>35vol%</td>
<td>55 / 48</td>
</tr>
<tr>
<td>EPPN-502H/PN</td>
<td>35vol%</td>
<td>Burn out / Burn out</td>
</tr>
</tbody>
</table>

**<Formulation>**

- GPH-65 : KAYAHARD GPH-65
- PN : Phenol novolac
- Filler : Spherical silica
- Catalyst : Triphenyl phosphine

**<Curing Condition>**

- 175°C Transfer Molding
- 180°C Final Cure

Flaming test using **Epoxy – Amine (DDS)** curing systems

<table>
<thead>
<tr>
<th>Resin formulation</th>
<th>Filler Content</th>
<th>Total Flaming Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>NC-3000/44DDS</td>
<td>73vol%</td>
<td>107 / 107</td>
</tr>
<tr>
<td>TGDDM/44DDS</td>
<td>73vol%</td>
<td>Burn Out / Burn Out</td>
</tr>
</tbody>
</table>

**<Formulation>**

- Hardener : 44DDS
- Filler : Spherical Silica 73vol% content
- Catalyst : Salicylic acid

**<Curing Condition>**

- 175°C Transfer Molding
- 180°C Final Cure

Typical Values for Reference Purposes Only
**Results of 3-Point Bending Tests / Toughness**

**Epoxy Resin cured with Diamine**

![Graph showing mechanical strength vs. elongation for NC-3000](image)

- **Formulation**
  - Catalyst: Salicylic acid (1-5 phr)
  - Hardener: Methylene bis(diethyl Aniline) (Same Equivalent to Epoxy)

- **Curing Condition**
  - 175°C Transfer Molding
  - 180°C Final Cure

**Epoxy Resin cured with Carboxylic Anhydride**

- **BPA type Epoxy resin**
  - NC-3000 50%
- **Hardener**
  - KAYAHARD MCD
- **Catalyst**
  - 2-Ethyl-4-methyl imidazole
- **Curing process**
  - 160°C Final curing

**Crystalized Epoxy Resin [ CER series ]**

### General Epoxy Resins
- Cold Flow Resistance = High Softening Point
- Fluidity = Low Viscosity
  - (Trade-off) High Softening Point = High Viscosity

**CER series**
- ★ High Softening Point & Low Viscosity ★

**NC-3000**
- Transparent / Amorphous resin

**CER-3000-L**
- White opaque resin
  - Semi-crystalline form (partial crystallization)

**BPA epoxy**
- NC-3000 50%
- NC-3000H 50%

<table>
<thead>
<tr>
<th>Property</th>
<th>NC-3000</th>
<th>CER-3000-L</th>
</tr>
</thead>
<tbody>
<tr>
<td>Softening Point (°C)</td>
<td>57</td>
<td>93</td>
</tr>
<tr>
<td>ICIMelt Viscosity @150°C (Pa.s)</td>
<td>0.07</td>
<td>&lt;0.03</td>
</tr>
</tbody>
</table>

**CER-1020**

<table>
<thead>
<tr>
<th>Property</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heat Durability DMA Tg</td>
<td>161</td>
</tr>
<tr>
<td>Flexural Strength MPa</td>
<td>133</td>
</tr>
<tr>
<td>Flexural Modulus GPa</td>
<td>2.9</td>
</tr>
<tr>
<td>Water Absorption 100°C 24h %</td>
<td>1.1</td>
</tr>
</tbody>
</table>

**BPA Epoxy resin**: Bisphenol A type epoxy resin

**Typical Values for Reference Purposes Only**
High Heat Durability (Tg)

Multi-Functional Epoxy Resins
High cured resin crosslinking density with excellent heat resistance.
High modulus demonstrated at high temperatures with low curing shrinkage.

### EPPN-500 series

<table>
<thead>
<tr>
<th></th>
<th>EPPN-501H</th>
<th>EPPN-501HY</th>
<th>EPPN-502H</th>
<th>EPPN-503</th>
</tr>
</thead>
<tbody>
<tr>
<td>EEW g/eq</td>
<td>166</td>
<td>167</td>
<td>169</td>
<td>183</td>
</tr>
<tr>
<td>Softening Point °C</td>
<td>53</td>
<td>61</td>
<td>67</td>
<td>88</td>
</tr>
<tr>
<td>ICI Melt viscosity (150°C) Pa·s</td>
<td>0.07</td>
<td>0.11</td>
<td>0.22</td>
<td>1.85</td>
</tr>
<tr>
<td>Appearance</td>
<td>Amorphous resin with pale yellow color</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**EEW**

**FAE-2500**

<table>
<thead>
<tr>
<th></th>
<th>FAE-2500</th>
</tr>
</thead>
<tbody>
<tr>
<td>EEW g/eq</td>
<td>216</td>
</tr>
<tr>
<td>Melting Point °C</td>
<td>86</td>
</tr>
<tr>
<td>ICI Melt viscosity (150°C) Pa·s</td>
<td>0.3</td>
</tr>
<tr>
<td>Appearance</td>
<td>Amorphous resin with pale yellow color</td>
</tr>
</tbody>
</table>

**GTR-1800**

<table>
<thead>
<tr>
<th></th>
<th>GTR-1800</th>
</tr>
</thead>
<tbody>
<tr>
<td>EEW g/eq</td>
<td>166</td>
</tr>
<tr>
<td>Melting Point °C</td>
<td>180</td>
</tr>
<tr>
<td>ICI Melt viscosity (150°C) Pa·s</td>
<td>-</td>
</tr>
<tr>
<td>Appearance</td>
<td>White powder</td>
</tr>
</tbody>
</table>

Typical Values for Reference Purposes Only

Cured Data with Phenol Novolac

**Tg Ranking**

**Cure Shrinkage Rank**

**Comparison (DMA)**

<Curing Condition>
- **PN**: Phenol Novolac
- **KTG**: KAYAHARD KTG-105 (Triphenol Methane)
- **Catalyst**: Triphenyl Phosphine
- **Transfer Molding** 175°C
- **Final Cure** 180°C
**High Tg and Flame Retardance**

**NC-3500**
NC-3500 is a multifunctional epoxy resin having a bi-phenylene structure. The cured resin shows high heat durability, thermal stability and good flame retardance.

**WHR-991S**
WHR-991S is a bisphenol type epoxy resin having a rigid imide structure. Not only can this structure reduce the curing shrinkage, it also improves the thermal stability and flame retardancy of the cured formulation.

**Cured Resin Properties (Cured with Phenol Novolac)**

<table>
<thead>
<tr>
<th>Sample Name</th>
<th>Heat Durability</th>
<th>Curing shrinkage</th>
<th>Thermal Stability</th>
<th>Dielectric Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DMA tanδMAX / °C</td>
<td>%</td>
<td>TD5 / %</td>
<td>DK GHz</td>
</tr>
<tr>
<td>NC-3000</td>
<td>167</td>
<td>1.8</td>
<td>343</td>
<td>3.22</td>
</tr>
<tr>
<td>NC-3500</td>
<td>209</td>
<td>1.7</td>
<td>333</td>
<td>3.29</td>
</tr>
<tr>
<td>WHR-991S</td>
<td>221</td>
<td>1.1</td>
<td>330</td>
<td>3.15</td>
</tr>
<tr>
<td>EPPN-501H</td>
<td>219</td>
<td>1.8</td>
<td>316</td>
<td>3.38</td>
</tr>
</tbody>
</table>

**Typical Values for Reference Purposes Only**

- Pale yellow solid
- EEW: 200 ~ 220g/eq
- Softening Point: 65 ~ 80°C
- ICI Melt Viscosity @150°C: 0.3 ~ 0.6 Pa•s

**Heat Durability & Flame Retardance**

**Heat Durability & Thermal Stability**

**Heat Durability (DMA tanδMAX)**

**Thermal Stability (TG-DTA 5% weight loss temp.)**

**Relationship to Heat Durability & Thermal Stability**

**Heat Durability & Flame Retardance**

**Heat Durability & Flame Retardance**

**Typical Values for Reference Purposes Only**

- Pale yellow solid
- EEW: 250 ~ 280g/eq
- Softening Point: 80 ~ 100°C
- ICI Melt Viscosity @150°C: 0.8 ~ 1.2 Pa•s

<Formulation and Curing Conditions>
- Hardener: Phenol Novolac
- Catalyst: TPP (Triphenyl Phosphine)
- Final Cure: 180°C

<Formulation and Curing Conditions>
- Hardener: Phenol Novolac
- Catalyst: TPP (Triphenyl Phosphine)
- Filler: Silica / Filler content 83wt%
- Sample thickness: 0.8mm
- Final Cure: 180°C

Typical Values for Reference Purposes Only

**NC-3500**: Biphenyl Aralkyl type epoxy resin
**EPPN-501H**: Trisphenolmethane type epoxy resin
High Tg and High Modulus

Naphthalene – Cresol Novolac Epoxy Resin
NC-7000 series has a naphthalene-cresol repeating group. As a result, this resin demonstrates high Tg and high modulus, whilst maintaining low moisture uptake. The Naphthalene group is a rigid structure and avoids water intercalations. Another strong benefit of this resin for composites is the high performance under Hot-Wet test conditions.

NC-7000 series

<table>
<thead>
<tr>
<th></th>
<th>NC-7300-L</th>
<th>NC-7000-L</th>
<th>NC-7000-H</th>
</tr>
</thead>
<tbody>
<tr>
<td>EEW (g/eq)</td>
<td>214</td>
<td>232</td>
<td>230</td>
</tr>
<tr>
<td>Softening Point (°C)</td>
<td>62</td>
<td>90</td>
<td>94</td>
</tr>
<tr>
<td>ICI Melt viscosity (150°C) (Pa*s)</td>
<td>0.04</td>
<td>0.78</td>
<td>1.33</td>
</tr>
<tr>
<td>Appearance</td>
<td>Amorphous resin with brown color</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Relationship of Tg & Water Uptake
NC-7000 series low water uptake, high Tg and Good HW properties

Modulus Ranking
NC-7000 series, high cured resin modulus

Typical Values for Reference Purposes Only
Tricyclodecane Phenol Type Epoxy Resin (DCPD Type)

XD-1000 series has a Tricyclodecane structure based on DCPD. This structure has a big and rigid aliphatic group, the cured resin exhibits high $T_g$ and lower water uptake. As a result, this resin can maintain higher Hot-Wet properties compared to other resins.

The epoxy density is small which contributes to good mechanical properties (toughness).

<table>
<thead>
<tr>
<th>XD-1000 series</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>XD-1000-2L</td>
<td>XD-1000-2L</td>
</tr>
<tr>
<td>XD-1000</td>
<td>XD-1000</td>
</tr>
<tr>
<td>XD-1000-H</td>
<td>XD-1000-H</td>
</tr>
<tr>
<td>EEW (g/equ)</td>
<td>239</td>
</tr>
<tr>
<td>Softening Point(ºC)</td>
<td>56</td>
</tr>
<tr>
<td>ICI Mel viscosity (150ºC) (Pa.s)</td>
<td>0.05</td>
</tr>
<tr>
<td>Appearance</td>
<td>Amorphous resin with brown color</td>
</tr>
</tbody>
</table>

**Cured Resin Properties: High $T_g$ & Low Water Uptake**

- **Hardener**: MDEA
- **Epoxy Resins**: XD-1000-2L, XD-1000, XD-1000-H
- **ICI Melt viscosity** at 150ºC/Pa.s
- **DMA tanδMAX** (ºC)
- **TMA Tg** (ºC)
- **Flexural modulus** (GPa)
- **Water Absorption** (100ºC, 24hr)

<table>
<thead>
<tr>
<th>Cured with MDEA</th>
<th>Cured with 44DDS</th>
</tr>
</thead>
<tbody>
<tr>
<td>XD-1000-2L</td>
<td>XD-1000</td>
</tr>
<tr>
<td>XD-1000</td>
<td>XD-1000-H</td>
</tr>
<tr>
<td>XD-1000-H</td>
<td>XD-1000</td>
</tr>
<tr>
<td>XD-1000-H</td>
<td>XD-1000</td>
</tr>
</tbody>
</table>

**Typical Values for Reference Purposes Only**

*EEW: Epoxy Equivalent Weight / Based on ISO3001*
*SP: Softening Point / Based on JIS K 7234*
*ICI melt viscosity: Based on ISO 3219 (ICI cone and plate viscometer)*
### BPA, BPF and PN Type Epoxy Resins

<table>
<thead>
<tr>
<th>Type</th>
<th>Viscosity (25°C)</th>
<th>T-Cl</th>
</tr>
</thead>
<tbody>
<tr>
<td>RE-310S</td>
<td>14500 mPa.s</td>
<td>400-550ppm</td>
</tr>
<tr>
<td>RE-303S-L</td>
<td>5050 mPa.s</td>
<td>250-400ppm</td>
</tr>
<tr>
<td>RE-304S</td>
<td>4650 mPa.s</td>
<td>600-700ppm</td>
</tr>
<tr>
<td>General BPA type Epoxy</td>
<td>12000-15000 mPa.s</td>
<td>&lt;2000ppm</td>
</tr>
</tbody>
</table>

- **Type**: Phenol Resin
- **MHHPA**: Methylhexahydrophthalic Anhydride
- **Carboxylic Anhydride cont.**: 0.9eq/Epoxy Equivalent
- **Catalyst**: 2-ethyl-4-methylimidazole
- **Catalyst cont.**: 1g/100g of Epoxy Resin
- **Curing Condition**: 160°C x 2hrs + 180°C x 8hrs

### KAYAHARD MCD & A-A

- **KAYAHARD MCD**: High Tg Carboxylic anhydride
- **KAYAHARD A-A**: Liquid type Amine hardener & Higher modulus

<table>
<thead>
<tr>
<th>Property</th>
<th>RE-304S</th>
<th>RE-305S</th>
<th>RE-310S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tg (°C)</td>
<td>190</td>
<td>212</td>
<td>197</td>
</tr>
<tr>
<td>DMA tanδMAX/°C</td>
<td>130</td>
<td>130</td>
<td>120</td>
</tr>
<tr>
<td>Flexural Strength (°C)</td>
<td>30</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>Flexural Modulus (GPa)</td>
<td>2.9</td>
<td>3.3</td>
<td>2.7</td>
</tr>
<tr>
<td>Water Absorption (100°C 24h)</td>
<td>1.0</td>
<td>1.1</td>
<td>1.0</td>
</tr>
</tbody>
</table>

### KAYABOND C-200S

- **Purity**: >99%
- **Melting Point**: >116°C
- **Appearance**: Slightly Brownish Powder

## Biphenyl aralkyl Type Phenol Resin

KAYAHARD KTG-105: Excellent High Tg

- **OH equiv. (g/eq.):** 198 (KAYAHARD GPH-65) / 231 (KAYAHARD GPH-103)
- **Softening Point (°C):** 65 (KAYAHARD KTG-105) / 102
- **ICI Melt viscosity (150°C) (Pa s):** 0.04 (KAYAHARD GPH-65) / 3.17 (KAYAHARD GPH-103)

## Trisphenol methane Type Phenol Resin

KAYABOND C-200S

- **Purity**: >99%
- **Melting Point**: >116°C
- **Appearance**: Slightly Brownish Powder

### KAYABOND C-200S

- **Purity**: >99%
- **Melting Point**: >116°C
- **Appearance**: Slightly Brownish Powder

**Typical Values for Reference Purposes Only**
Diluents

Di Functional Glycidyl Amine

GAN

GOT

Viscosity (25°C)

Epoxy Equivalent Weight

Appearance

100-160mPa • s

115-135g/eq.

Pale Yellowish Liquid

30-80mPa • s

125-145g/eq.

Pale Yellowish Liquid

GAN & GOT

Excellent low viscosity epoxy diluents.

These diluents reduce viscosity of the formulation whilst maintaining heat durability. Cured resins exhibit higher modulus compared to TGDDM.

Viscosity & Flexural Modulus DATA

GAN & GOT Viscosity Mixed with BPA-EP

GAN & GOT (%)

to BPA type Epoxy resin

GAN & GOT (%)

to TGDDM

Formulation and Curing Conditions

Hardener

Catalyst

Final Cure

KAYAHARD A-A

TGDDM (TetraglycidylDDM)

120°C 2hrs, 160°C 4hrs

KAYAHARD MCD

2-Ethyl-4-methyl imidazole 1phr/Epoxy

160°C

GAN & GOT (wt%)

Epoxy Resin

GAN

GOT

tanδMAX

30°C

30°C

RE-310S (ref)

100

0

-198

118

2.7

RE-310S

Mixed with GAN

75

10

-198

105

2.8

RE-310S

Mixed with GOT

75

-25

191

112

2.9

Viscosity & Flexural Modulus (25°C MPA)

GAN

GOT

BPA Epoxy

BPA Epoxy

TGDDM

Viscosity

(25°C mPa • s)

140

149

6,000

14,600

141,200

Cured Resin Flexural Modulus

(30°C MPA)

4.3

3.9

3.0

2.9

3.7

Tg (DMA tanδMAX) Regarding Contents of GAN & GOT

<Formulation and Curing Conditions>

Hardener : KAYAHARD MCD

Catalyst : 2-Ethyl-4-methyl imidazole 1phr/Epoxy

Final Cure : 160°C

Typical Values for Reference Purposes Only
<table>
<thead>
<tr>
<th>Name</th>
<th>Structure</th>
<th>Comments</th>
<th>Name</th>
<th>Structure</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Epoxy Resins</td>
<td></td>
<td></td>
<td>Epoxy Resins</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NC-3100, NC-3000-L</td>
<td></td>
<td>Biphenylnovolac type / Biphenylnovolac type</td>
<td>EPPN-501H</td>
<td></td>
<td>Triphenylmethane type / Triphenolmethane type</td>
</tr>
<tr>
<td>NC-3000</td>
<td></td>
<td>Biphenylnovolac type / Biphenylnovolac type Vanish Grade (Resin conc. 75% MEK 25%)</td>
<td>FAE-2500</td>
<td></td>
<td>Triphenylmethane type / Triphenolmethane type</td>
</tr>
<tr>
<td>NC-2000-L</td>
<td></td>
<td>Phenol aralkyl type</td>
<td>GTR-1800</td>
<td></td>
<td>Tetrakisphenol ethane type</td>
</tr>
<tr>
<td>XD-1000-2L, XD-1000, XD-1000-H</td>
<td></td>
<td>Triacycledecane Phenol novolac. / Dicyclopentadiene Phenol / DCPD</td>
<td>EOCN-102S, EOCN-103S, EOCN-104S</td>
<td></td>
<td>o-Crezol novolac type</td>
</tr>
<tr>
<td>NC-7000-L, NC-7300-L</td>
<td></td>
<td>Naphotol-Crezol novolac type</td>
<td>EOCN-1020 series</td>
<td></td>
<td>o-Crezol novolac type / Lower organic chlorine grade</td>
</tr>
<tr>
<td>Liquid Type Epoxy Resins</td>
<td></td>
<td></td>
<td>Phenol Resin / Epoxy Hardener</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RE-305, RE-306</td>
<td></td>
<td>Phenol novolac type</td>
<td>KAYAHARD GPH-65, KAYAHARD GPH-103</td>
<td></td>
<td>Biphenylnovolac type / Biphenylnovolac type</td>
</tr>
<tr>
<td>RE-305S</td>
<td></td>
<td>Phenol novolac type / Lower organic chlorine grade</td>
<td>KAYAHARD KTG-105</td>
<td></td>
<td>Triphenylmethane type / Tri phenolmethane type</td>
</tr>
<tr>
<td>Epoxy Diluent</td>
<td></td>
<td></td>
<td>Liquid Type Hardener</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GAN, GOT</td>
<td></td>
<td>Glycidyl Amines</td>
<td>KAYAHARD A-A</td>
<td></td>
<td>o-Ethyl Aniline novolac</td>
</tr>
<tr>
<td>BROC series, BR-250H</td>
<td></td>
<td>Brominated type Epoxy monomer</td>
<td>KAYAHARD MCD</td>
<td></td>
<td>MethylNadic anhydride</td>
</tr>
</tbody>
</table>
Maleimide Resins

**MIR-3000 series**

- **Maleimide Resin**

![Maleimide Resin Structure](image)

**Excellent Tg and Toughness**

- DMA Chart
- Storage Modulus (MPa) vs. Temperature (°C)
- tanδ vs. Temperature (°C)

**Cured Resin with Epoxy / Low Water Uptake & Good Strength**

- Water absorption test (100°C, 24hr)
- 3-point flexural test (r.t.)

![Water Absorption Test](image)

- **Formulation**
  - Maleimide resin & DCP (1.5phr)
  - (DCP: Dicumyl peroxide)

![3-point flexural test](image)

- **Curing Condition**
  - Final Cure Temp: 250°C

**Cured resin properties comparison of epoxy resin formulations**

<table>
<thead>
<tr>
<th>Composition</th>
<th>MIR-3000</th>
<th>Reference Epoxy Formulations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maleimide resin</td>
<td>Sample name</td>
<td>MIR-3000</td>
</tr>
<tr>
<td>Content</td>
<td>MIR-3000</td>
<td>56wt%</td>
</tr>
<tr>
<td>Epoxy resin</td>
<td>NC-3000-L</td>
<td>NC-3000-L</td>
</tr>
<tr>
<td>Phenol resin</td>
<td>GPH-65</td>
<td>GPH-65</td>
</tr>
<tr>
<td>Catalyst</td>
<td>2E4MZ</td>
<td>2E4MZ</td>
</tr>
<tr>
<td>Heat durability</td>
<td>DMA Tg</td>
<td>265</td>
</tr>
<tr>
<td>Thermal stability</td>
<td>tanδMAX / °C</td>
<td>372</td>
</tr>
<tr>
<td>Water uptake</td>
<td>%</td>
<td>1.3</td>
</tr>
</tbody>
</table>

**Curing Condition**

- 175°C transfer molding
- 200°C × 2h post cure

**Cured resin properties / Cured with Amines**

<table>
<thead>
<tr>
<th>Composition</th>
<th>MIR-3000</th>
<th>Ref</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maleimide resin</td>
<td>Sample name</td>
<td>MIR-3000</td>
</tr>
<tr>
<td>Content</td>
<td>MIR-3000</td>
<td>56wt%</td>
</tr>
<tr>
<td>Epoxy resin</td>
<td>NC-3000-L</td>
<td>NC-3000-L</td>
</tr>
<tr>
<td>Phenol resin</td>
<td>GPH-65</td>
<td>GPH-65</td>
</tr>
<tr>
<td>Amines</td>
<td>DDM(1.0eq.)</td>
<td>DDM(0.75eq.)</td>
</tr>
<tr>
<td>Catalyst</td>
<td>2E4MZ</td>
<td>2E4MZ</td>
</tr>
<tr>
<td>Heat durability</td>
<td>DMA Tg</td>
<td>265</td>
</tr>
<tr>
<td>Thermal stability</td>
<td>tanδMAX / °C</td>
<td>372</td>
</tr>
<tr>
<td>Water uptake</td>
<td>%</td>
<td>1.3</td>
</tr>
</tbody>
</table>

**Typical Values for Reference Purposes Only**

- DDM-MI: DDM type Bismaleimide
- DMM: Diamino diphenyl methane
**Brominated Phenol Novolac Type Epoxy Resin**

BREN series is a brominated phenol novolac type epoxy resin. This product demonstrates increased Thermal Stability, Heat Durability and Modulus compared with conventional items.

### BREN series

<table>
<thead>
<tr>
<th>Property</th>
<th>BREN-S</th>
<th>BREN-105</th>
</tr>
</thead>
<tbody>
<tr>
<td>EEW (g/eq.)</td>
<td>283</td>
<td>274</td>
</tr>
<tr>
<td>Softening Point (°C)</td>
<td>84</td>
<td>68</td>
</tr>
<tr>
<td>ICI Melt viscosity (190°C) (Pa•s)</td>
<td>1.20</td>
<td>0.16</td>
</tr>
<tr>
<td>Br content (%)</td>
<td>35</td>
<td>35</td>
</tr>
</tbody>
</table>

### Formulation and Curing Conditions

- **Epoxy Resin**: BREN or ETBA / EOCN-1020 = 25 / 75 (ETBA : Epoxy tetra Bromo bisphenol A)
- **Hardener**: 2E4MZ (1phr / epoxy)
- **Catalyst**: PN
- **Final Cure**: 180°C

---

**TGA Analysis (raw resin) at N₂ flow**

- **BREN-S**
- **ETBA**

**TGA Analysis (cured resin) at N₂ flow**

- **BREN-S**
- **ETBA**

---

**Brominated Epoxy Diluents**

- **BR-250H**
  - Br content ≒ 50%
  - Vis. 90-130mPa•s at 25°C

- **BROC, BROC—C**
  - Br content ≒ 50%
  - Vis. 120-230mPa•s at 25°C