



Cashew Benzoxazine Resin

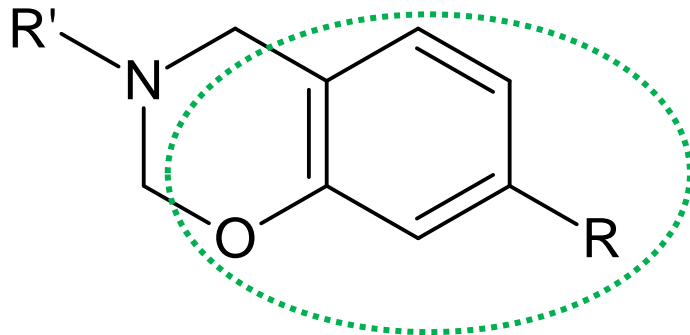
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Tohoku Chemical Industries, Ltd.
Development and Sales Department

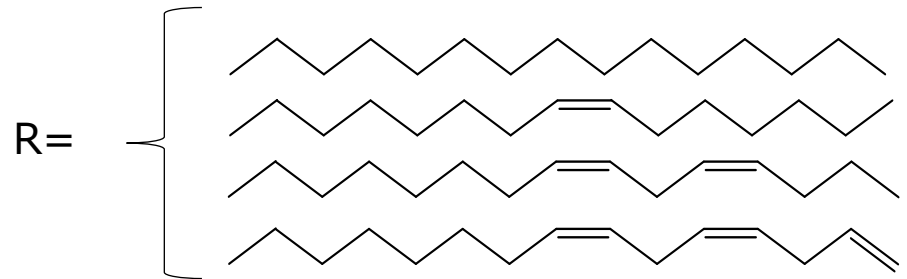
Cashew Benzoxazine Resin

- high **Heat Resistant** thermosetting resin
- high **Biomass** resin made from cashew nut shell liquid (CNSL)
- **Liquid** at room temperature
- high **Dimensional Stability**
- high **Dielectric** properties
- great **Flexibility**

the structure of *cashew benzoxazine*



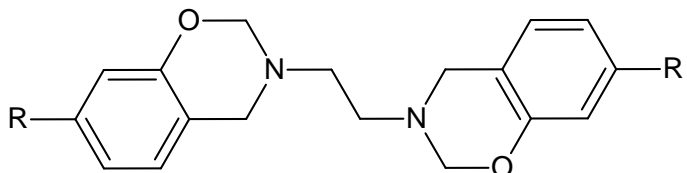
derived from cashew



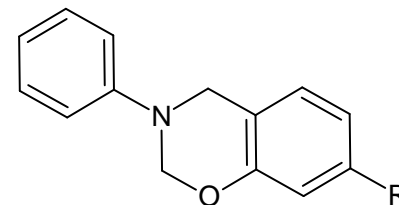
- ☑ They have long unsaturated alkyl chains.
- ☑ Various performances can be imparted by changing the structure of the amine moiety.



Properties of Cashew Benzoxazine Resin

CR-276 ● High Biomass Content



CR-507 ● Low Viscosity
● Good Solubility



red 	color	red 
17	gardner color scale	16
75	biomass content (%)	65
13010	viscosity (mPas@25°C)	186
0.998	specific gravity	1.004
99.8	non-volatile content at 125°C × 2hr (%)	99.4
n-Hexane, MEK, Ethyl acetate	solubility	n-Hexane, MEK, Ethyl acetate, EtOH (slightly) , BuOH, acetone
2225, 8668	average molecular weight Mn, Mw	589, 704

Properties of Cured Resin

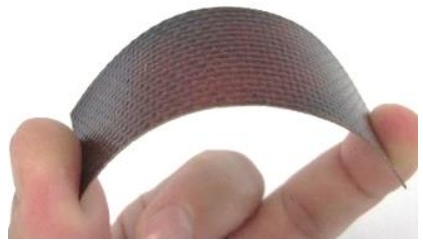


CR-276 ● low curing temperature

CR-507 ● high heat resistance

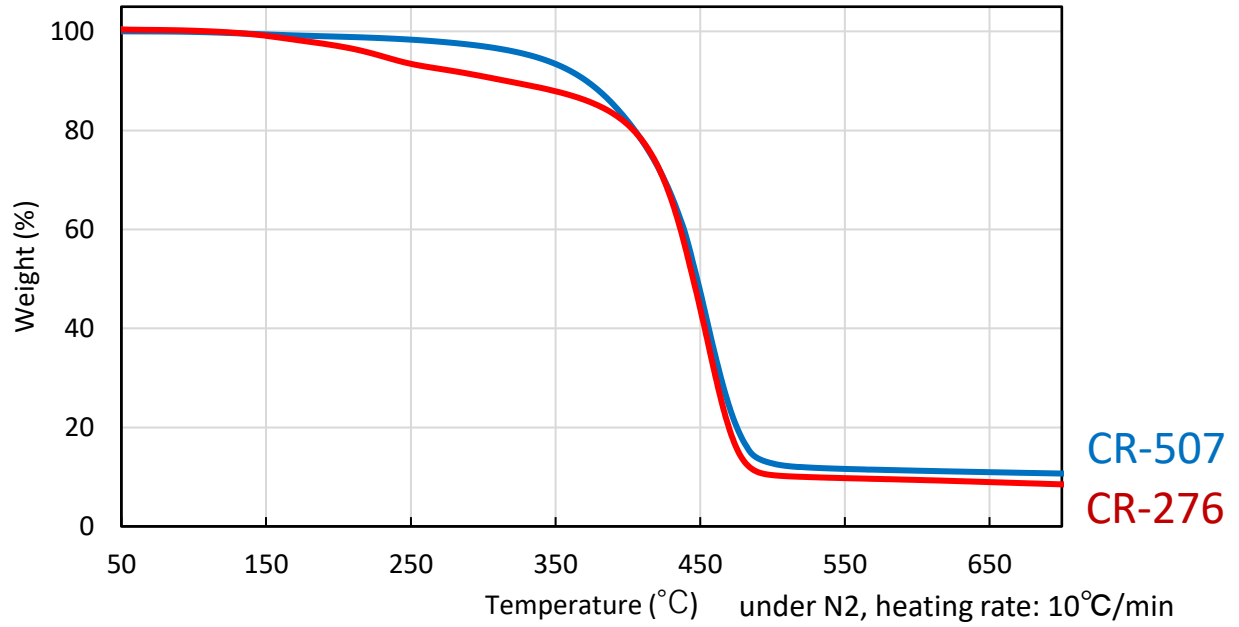
170°C × 5hr	curing condition	170°C × 2hr + 200°C × 9hr
46	shore D hardness at room temperature	42
230	5% pyrolysis temperature (°C) <small>*by thermogravimetric analysis</small>	334

CR-276 + glass cloth



☑ Both cured products are highly flexible.

Thermogravimetric Analysis



Examples of Use as Epoxy Resin Curing Agents

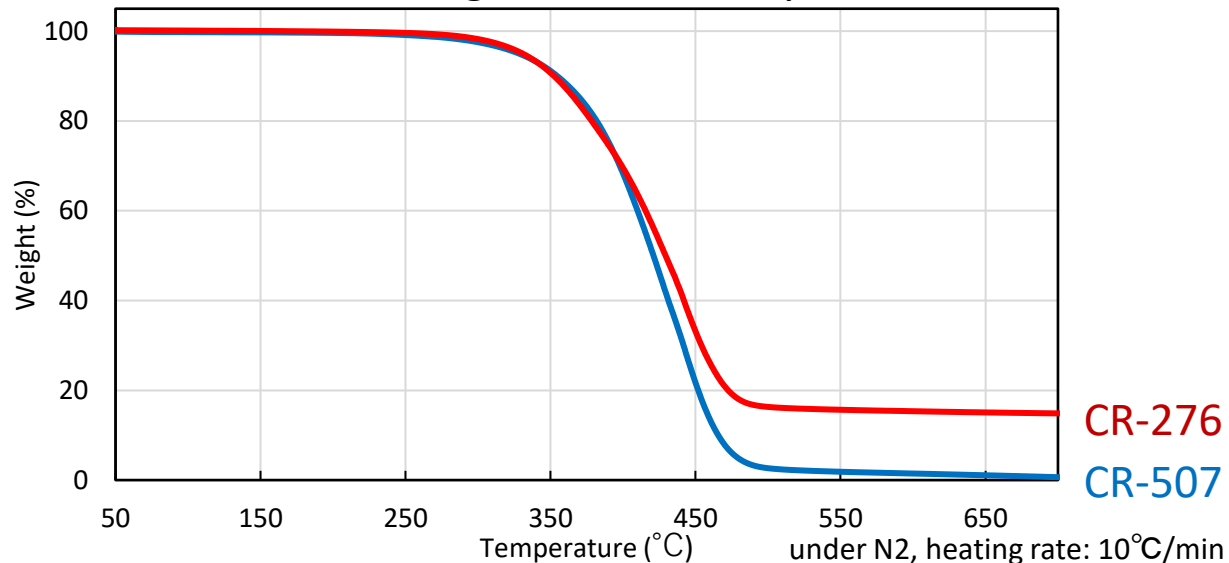


CR-276 ● Hard
● High heat resistance

CR-507 ● Soft
● High heat resistance

CR-276 50wt% + DGEBA 50wt%	composition	CR-507 50wt% + DGEBA 50wt%
200°C × 4hr	curing condition	200°C × 9hr
76	shore D hardness at room temperature	45
331	5% pyrolysis temperature(°C) <small>*by thermogravimetric analysis</small>	328

Thermogravimetric Analysis



CR-276 shows good heat resistance when copolymerized with DGEBA.

Mechanical and Electrical Properties of Cured Resin



composition	CR-276	CR-276 +DGEBA	
curing condition	180°C × 4hr	200°C × 4hr	
glass-transition temperature T_g (°C)	127	86	DMA (tan δ) (2°C/min, 1Hz)
heat deflection temperature (°C)	44	58	ASTM D648
coefficient of linear expansion ($\times 10^{-5} / ^\circ\text{C}$)	18	13	TMA (JIS K7197) (50-60°C)
bending strength (MPa)	9.8	52.7	JIS K6911
flexural modulus (GPa)	0.22	1.54	JIS K6911
maximum strain (%)	5.1	5.6	JIS K7171
fracture toughness value (MPa · m ^{1/2})	0.32	0.81	ASTM D5045
volume resistivity ($\Omega \cdot \text{cm}$)	3.5×10^{14}	6.2×10^{15}	JIS K6911
permittivity (1GHz)	2.61	2.84	Keysight Technologies RF4991A
loss tangent (1GHz)	0.0079	0.0089	
water absorption (wt%, at r.t., 24hr)	0.29	0.13	JIS K6911

Cashew benzoxazine resins exhibit good dielectric properties.



E N D
