

# Package Laminate for Green Applications-An Overview

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(LG화학)





# Package Laminate For Green Applications – An Overview

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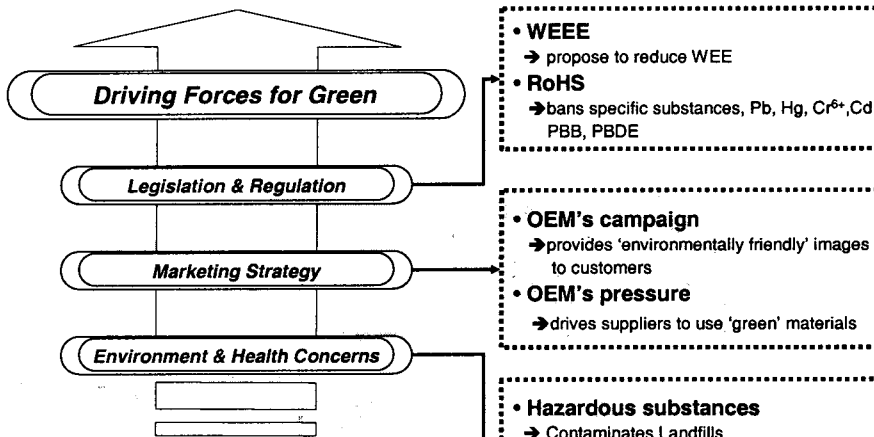
**LG CHEM, LTD / RESEARCH PARK**



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## DRIVING FORCES FOR GREEN MATERIAL



- WEEE : Waste Electrical and Electronic Equipment
- RoHS : Restrictions of Hazardous Substances
- PBB : PolyBrominated Biphenyls
- PBDE : PolyBrominated Diphenyl Ethers
- OEM : Original Equipment Manufacturer

## ISSUES OF ENVIRONMENT & HEALTH CONCERNS

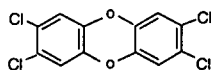
### • Lead (Pb)

- Known as a neurotoxic metallic element
- absorbed by human body, primarily through the lungs and stomach
- accumulated in bone and tissues and damages internal organs, nervous system and brain

- ◆ **Comparatively, adult adsorb 10% of lead ingestion and children adsorb 50%**
- ◆ **Special care needs for infants and children under the age of 7 years**

### • Brominated and Chlorinated Compounds

- produce the most toxic compounds, such as **dioxins**, during the incineration
- The IARC, the part of WHO, announced dioxins as the carcinogens



2,3,7,8-Tetrachlorodibenzo-*p*-dioxin (TCDD).

- is associated with ozone depletion

- IARC : The International Agency of Research on Cancer
- WHO : The World Health Organization

## DEFINITION OF GREEN MATERIAL

### Halogen Free

#### LITERALLY NO HALOGEN ELEMENT

- No Regulation for F & I & At

#### JPCA ES-01

- A maximum concentration value of 900 ppm by weight of Bromine or Chlorine

#### IEC 61249-2-21

- A maximum 900 ppm by weight of Br or Cl
- A Maximum total amount of 1500 ppm by weight of Bromine & Chlorine

### Lead Free

#### EU End-of-Life Vehicle Directive

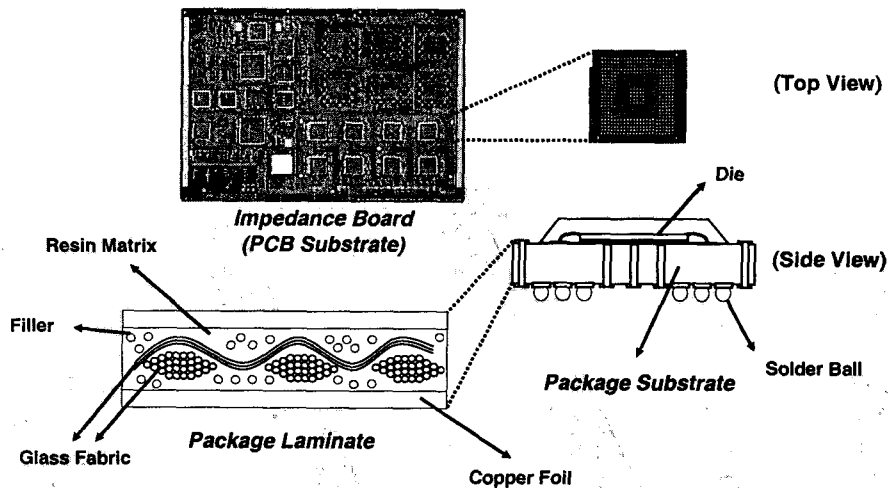
- A maximum 1000 ppm of Pb, Hg, Cr<sup>6+</sup> by weight in Homogenous Material (For Cd, 100 ppm is a maximum)

#### RoHS Directive

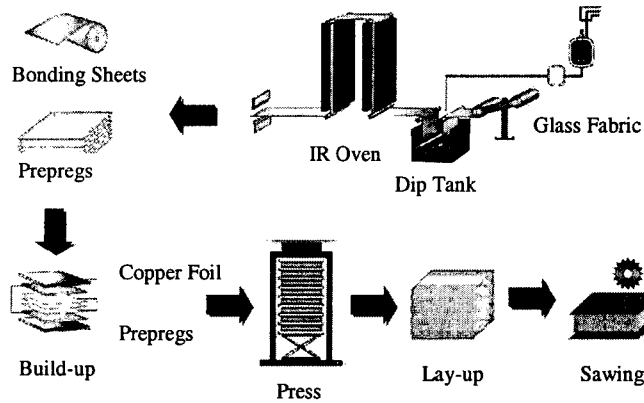
- A maximum 1000 ppm of Pb, Hg, Cr<sup>6+</sup>, PBB and PBDE by weight in Homogenous Material (For Cd, 100 ppm is a maximum)

**'GREEN' COVERS BOTH HALOGEN & LEAD FREES**

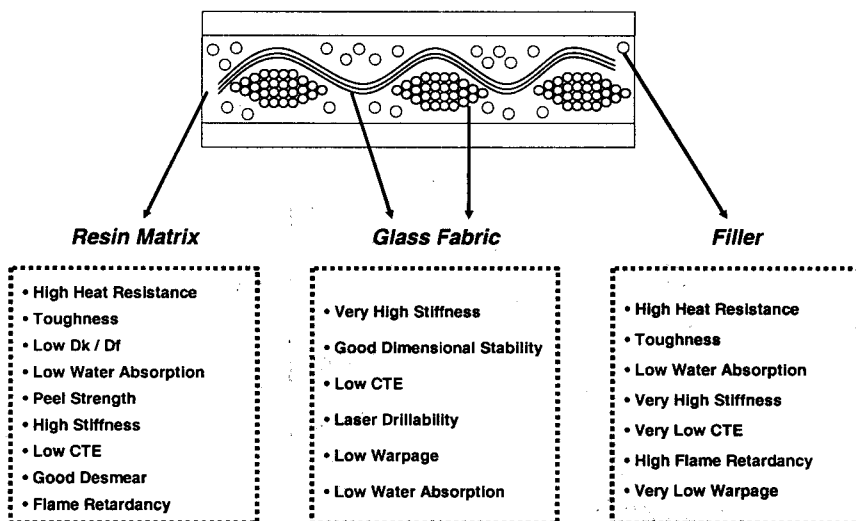
## STRUCTURE OF PACKAGE LAMINATE

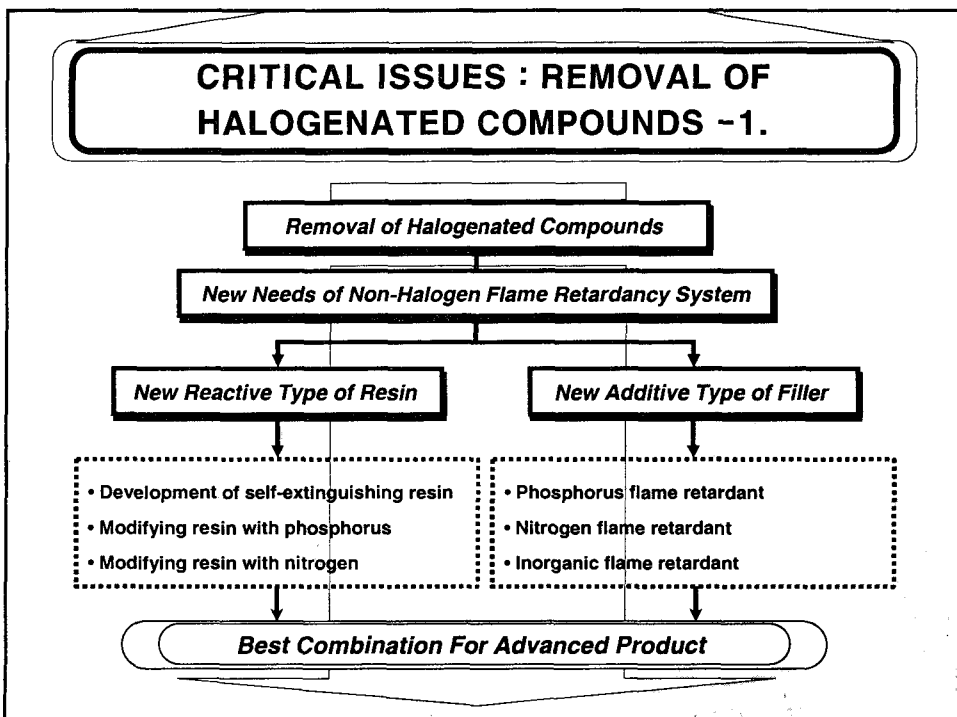
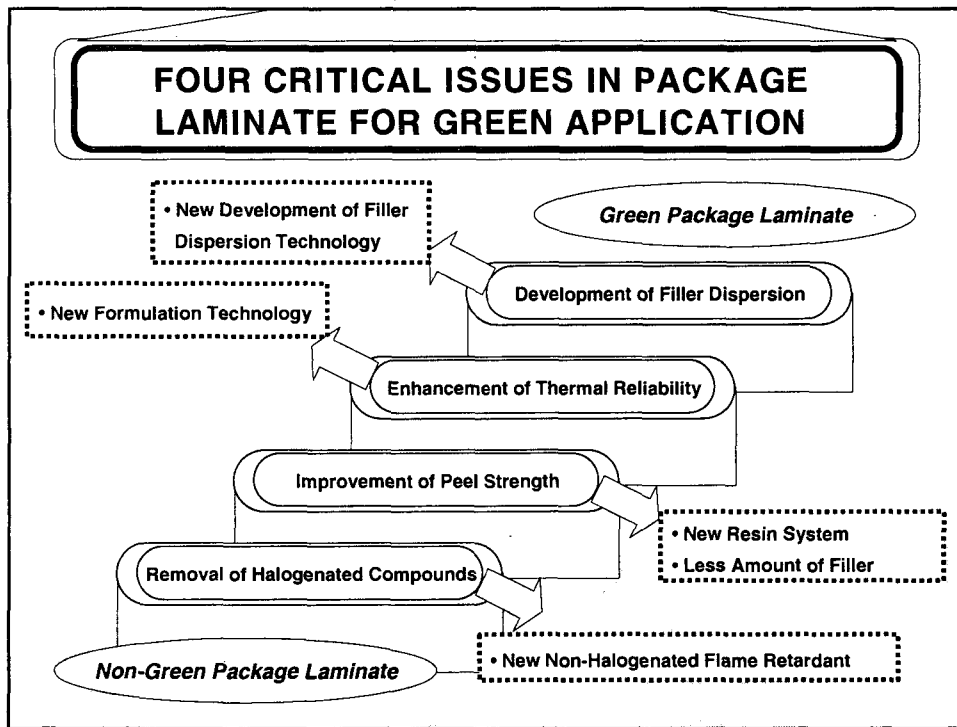


## MANUFACTURING PROCESS OF PACKAGE LAMINATE



## MAJOR ROLES OF EACH COMPONENT IN PACKAGE LAMINATE

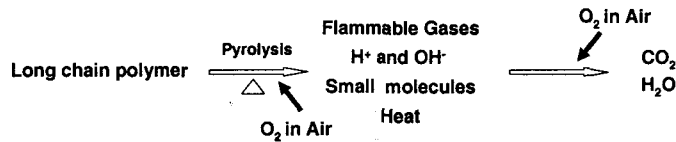




## FLAME RETARDANCY MECHANISM "HALOGENATED COMPOUND"

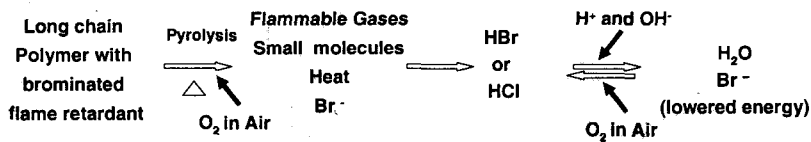
### Burning Mechanism

- H<sup>•</sup> and OH<sup>•</sup> radical break small molecules down
- Extinguished after no more break down of long chain polymer



### Halogenated Compound

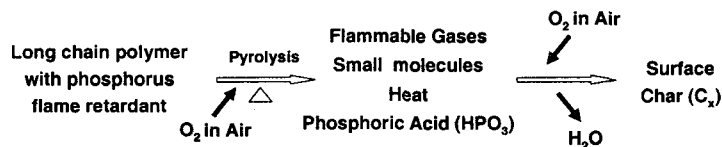
- Br reacts with H<sup>•</sup> and OH<sup>•</sup> forming HBr
- HBr reacts again with H<sup>•</sup> and OH<sup>•</sup>, producing H<sub>2</sub>O and Br<sup>-</sup> radical with lowered energy



## FLAME RETARDANCY MECHANISM "PHOSPHORUS FLAME RETARDANT"

### Phosphorus Flame Retardant

- H<sup>•</sup> and OH<sup>•</sup> radical break small molecules down
- Extinguished after no more break down of long chain polymer

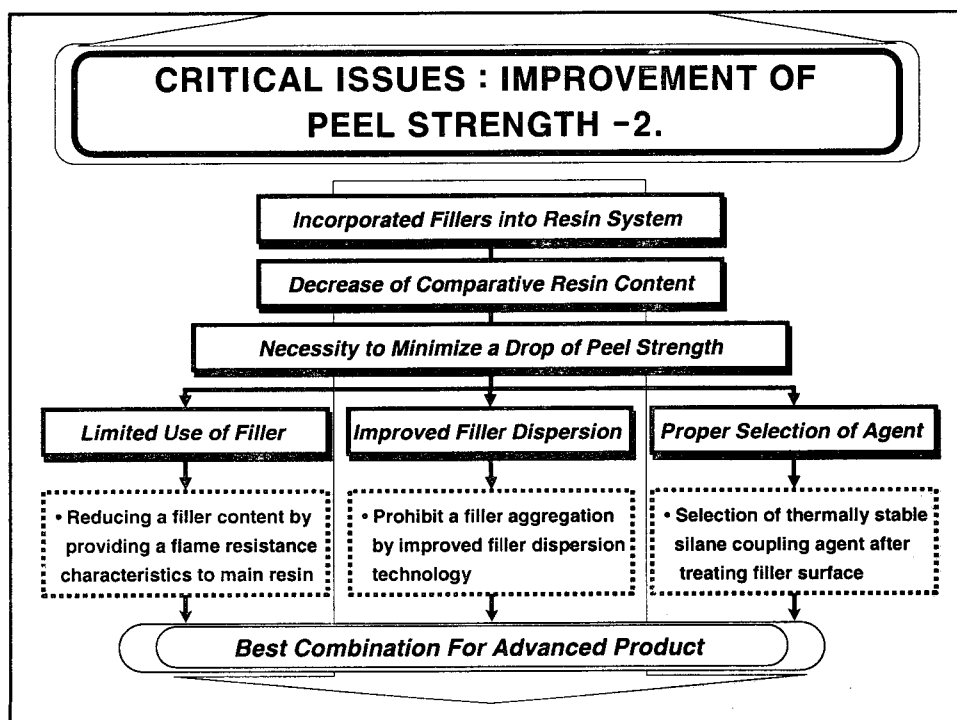
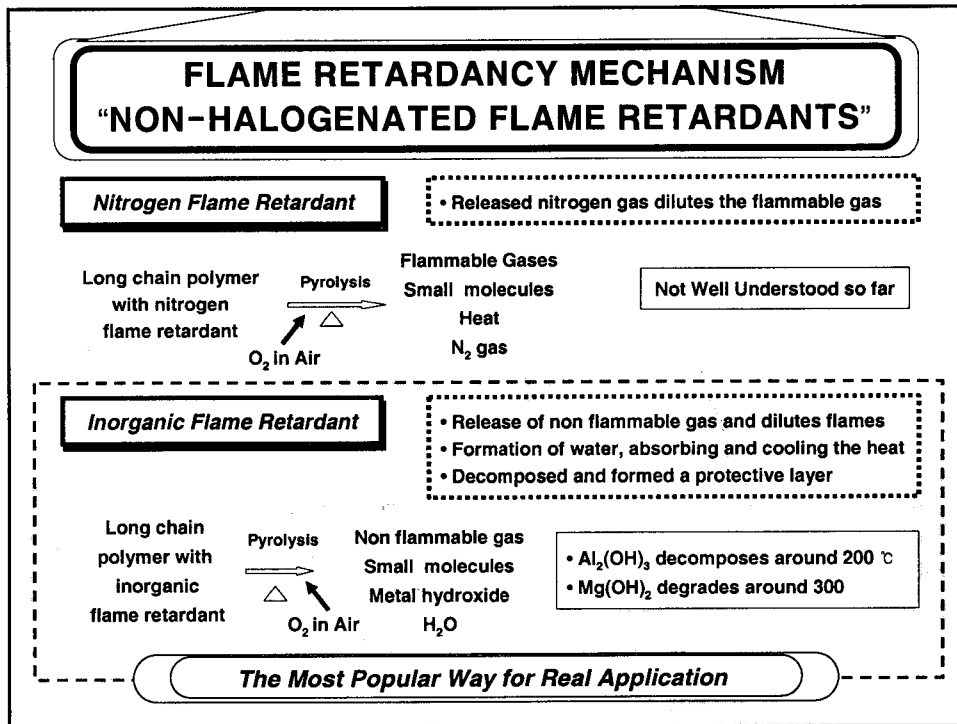


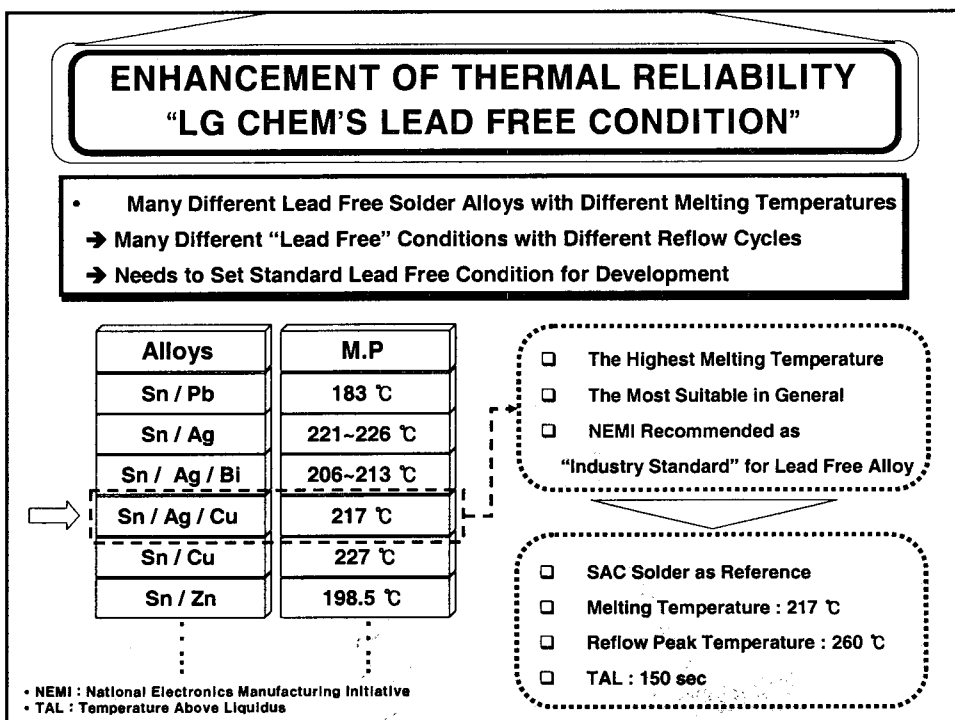
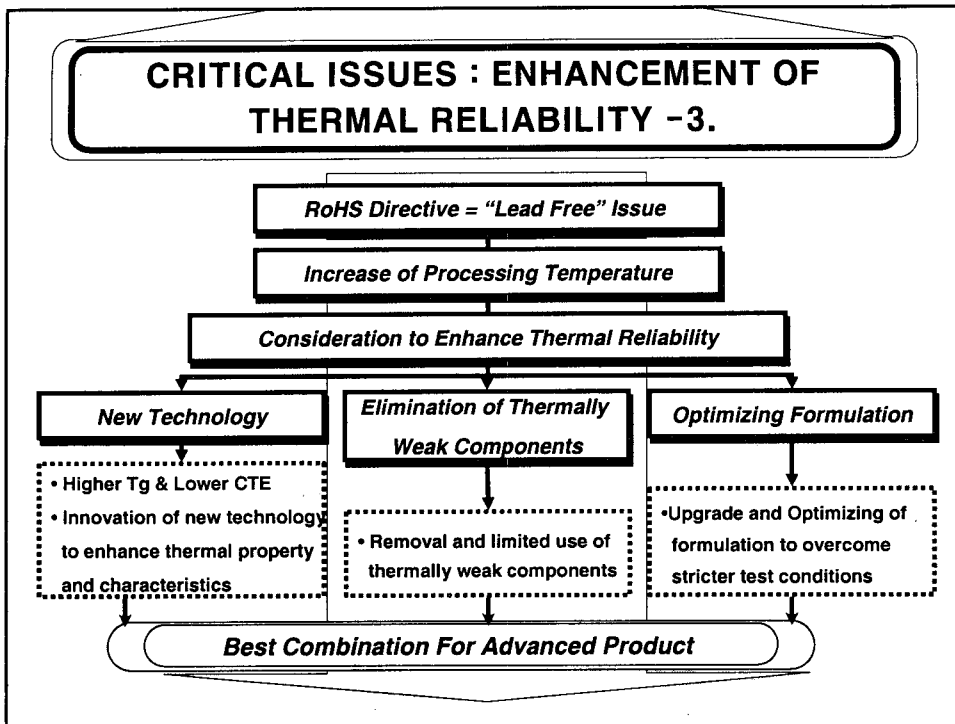
#### **NOTICE** : Summary of Failure History for Phosphorus Flame Retardant (July, 2002)

- Fujitsu recalled HDD (Model MPG3409AT-EF) with Sumitomo U series molding compound
- The molding compound included red phosphorus particles with dielectric thin film
- Instability & agglomerated phosphorus formed phosphoric acid
- The phosphoric acid attacked copper and silver and ionized them
- Under electrical filed, they moved and formed dendrites between adjacent pins
- Dendrite bridged two adjacent pins and electrical shorts or failure happened.

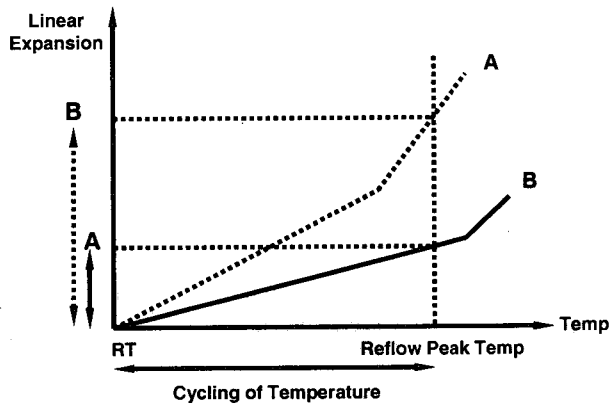
→ **Phosphorus compounds have not recommended for package applications**







## ENHANCEMENT OF THERMAL RELIABILITY "T<sub>g</sub> & CTE VS POTENTIAL FAILURE"



**More Potential Failure of A with Smaller T<sub>g</sub> & Higher CTE**

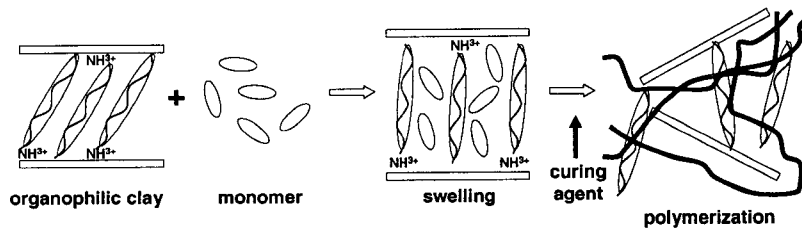
**Fatigue**

The larger volume expansion is, the higher residual stress is

**Fracture**

The higher possibility of material failure

## ENHANCEMENT OF THERMAL RELIABILITY "NANO-PARTICLE DISPERSION TECHNOLOGY"



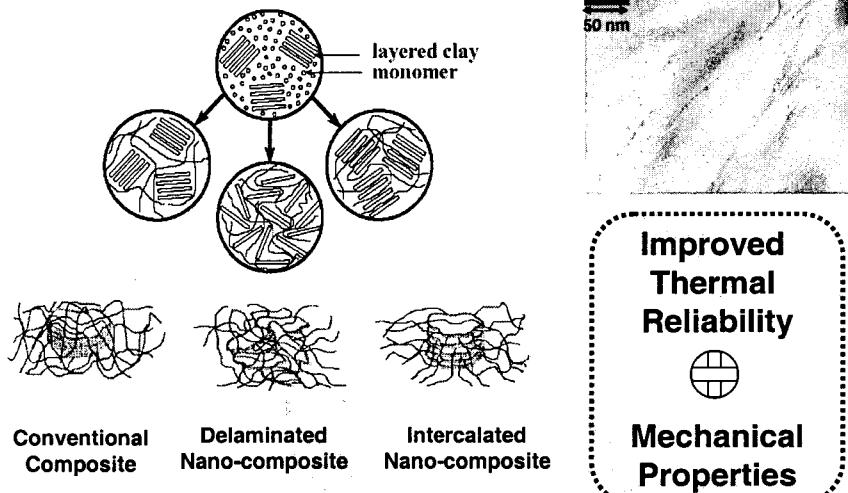
*Exfoliated nano-structures depend on a curing rate*

*A control of the Intergallery self-polymerization is important*

*Delaying extragallery matrix gelation is needed*

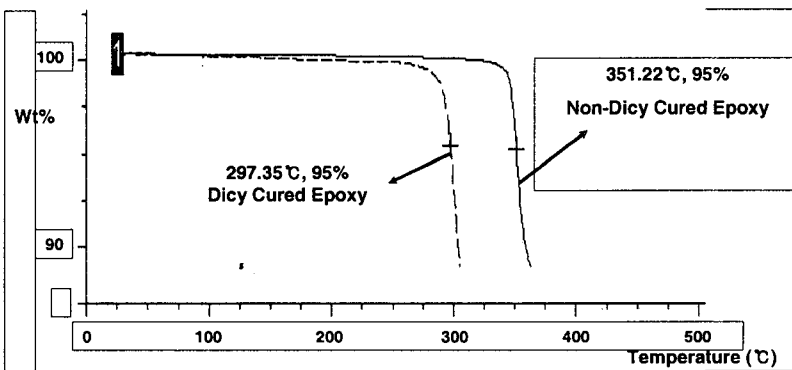
**No Delamination**

## NANO PARTICLE DISPERSION TECHNOLOGY "LG-P-500PN NANO COMPOSITE"



## REMOVAL AND LIMITED USE OF THERMALLY WEAK COMPONENTS

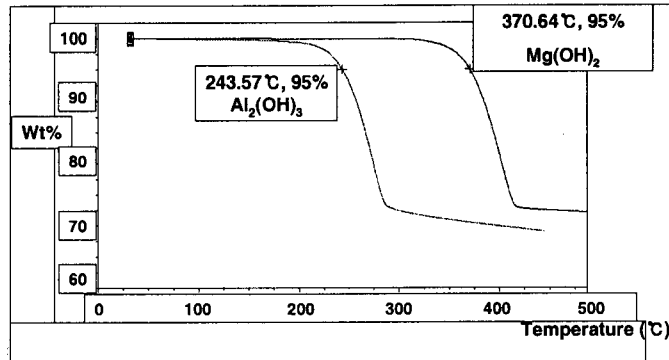
*Excluding Dicy Cured System*



Generally, Dicy-Cured Resin System Has Lower Degradation Temperature ( $T_d$ )

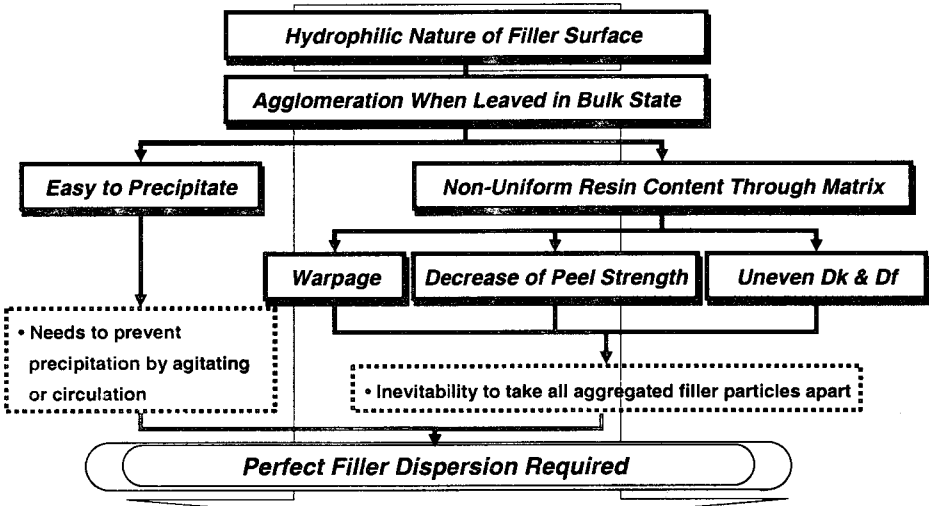
## REMOVAL AND LIMITED USE OF THERMALLY WEAK COMPONENTS

*Degradation Temperature of  $Al_2(OH)_3$  vs  $Mg(OH)_2$*

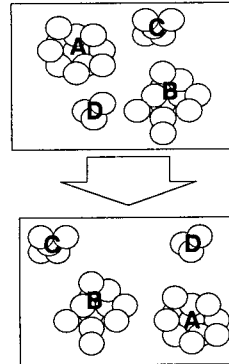
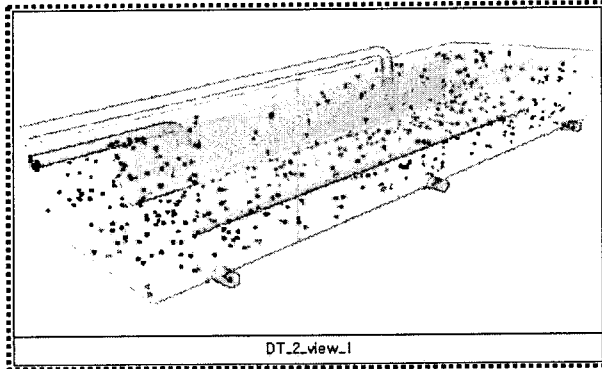


➔  **$Mg(OH)_2$  is More Thermally Stable, But More Amount is Needed**  
**Due to Lower Degradation Temperature, Limited Use of  $Al_2(OH)_3$  is Needed**

## CRITICAL ISSUES : DEVELOPMENT OF FILLER DISPERSION -4.



## DEVELOPMENT OF FILLER DISPERSION "PREVENTION OF FILLER PRECIPITATION"



- Simple agitation or circulation only changes of agglomerated filler locations
- Aggregated fillers cause the difference of resin content on locations
- "Warpage", "Uneven Electrical Properties", and "Decrease of Peel Strength"

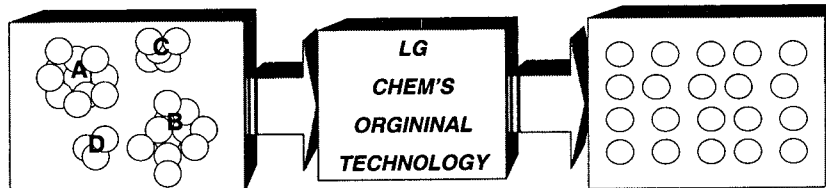
## DEVELOPMENT OF FILLER DISPERSION "PERFECT FILLER DISPERSION TECHNOLOGY (PFDT)"

v = terminal velocity

Particle Density	$D_p$ g/cm <sup>3</sup>
Fluid Density	$D_f$ g/cm <sup>3</sup>
Fluid Viscosity	$\mu$ cp

$$v = \frac{gD_p^2(D_p - D_f)}{18\mu}$$

Particle Size	Time to precipitate 10cm
0.1 $\mu$ m	380,000 hr
1 $\mu$ m	3,800 hr
10 $\mu$ m	38 hr



Agglomerated Fillers

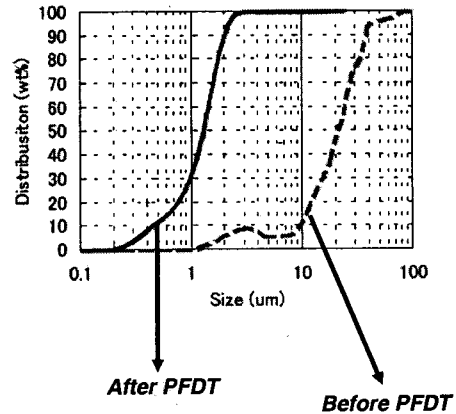
Perfectly Dispersed Fillers

## PERFECT FILLER DISPERSION TECHNOLOGY "BEFORE AND AFTER PTFT"

- Average Particle Size : 0.8 $\mu$ m
- Top Particle Size : 2.25 $\mu$ m
- Agglomerated Filler Distribution
  - above 10 $\mu$ m : 90%
  - above 20 $\mu$ m : 50%
  - above 100 $\mu$ m : 3-5%

PFDT

- No Agglomerated Fillers
  - above 10 $\mu$ m : 0%
  - above 3 $\mu$ m : 0%
  - above 1 $\mu$ m : 30%
  - above 0.45 $\mu$ m : 10%



\* No filler with size of more than 2.5 $\mu$ m → All Fillers are Taken Apart  
→ Perfect Filler Dispersion is Accomplished

## SUMMARY

1. Based on driving forces toward 'green' applications, general background, including legislation and definition, was reviewed.
2. Structure, manufacturing process, and major roles of each components of 'package laminate' were briefly presented.
3. Four critical issues of package laminate for green applications were suggested and detail strategy on each issue for development was stated.
  - a. removal of halogenated compounds
  - b. improvement of peel strength
  - c. enhancement of thermal reliability
  - d. development of filler dispersion
4. Starting from burning mechanism, mechanisms of major flame retardants were described and brief failure history of phosphorus flame retardant was shown.
5. LG CHEM's lead free condition was clarified and several factors to increase thermal reliability was summarized.
6. LG CHEM's technologies of both 'nano particle dispersion' and 'perfect filler dispersion' were explained and their effects were mentioned



**SUPERB QUALITIES OF YOUR PRODUCTS**

**WITH**

**ADVANCED PACKAGE LAMINATES**

**OF LG CHEM**

**THANK YOU !!!**

