APT ABLEPRINT

Void Free & Cost Saving Solution Provider

How Voids Vanish by Pneumatic Pressure Applied

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Coupled visco-mechanical and diffusion void growth modelling during composite curing,

Y. Ledru et. al., *Composites Science and Technology*, 2010, 2139-2145

- In the past over 20 years, Pneumatic Pressure Devoid has been applied in industries among traditional PCB , TFT-LCD, and the up-to-date Semiconductor field. The researchers integrates Fluid Mechanics and Gas Molecular Diffusion Theory to demonstrate the real devoid mechanism model.
- The three dominant parameters determined void size during curing
  - 1. onset of pressure application
  - 2. initial moisture concentration
  - 3. material diffusion coefficient
- In the De-void progress
  - 1. initially voids are shrunken by pneumatic pressure.
  - 2. gas and moisture concentration increase , then spontaneously diffusion externally
  - 3. small mobile molecules such gas and water can diffuse into polymer resin.
  - 4. Diffuse out totally while curing progress.

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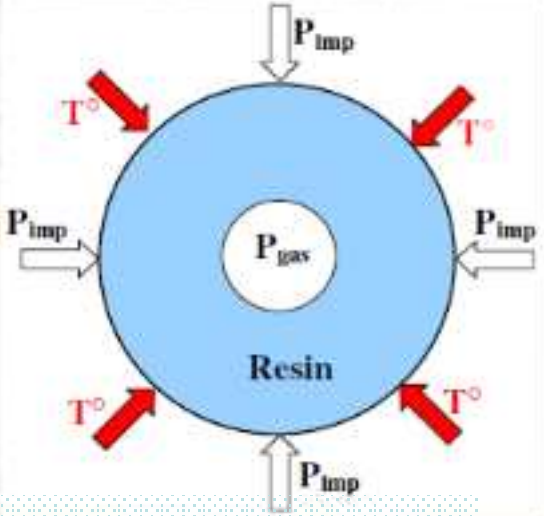
$$\frac{dm}{dt} = 4\pi D(C_\infty - C_{sat})R_p\left(1 + \frac{R_p}{\sqrt{\pi D\, t}}\right)$$



- The **dominant parameters** determined void size during curing
  - m : weight of void (include gas and moisture)
  - D : Diffusion coefficient
  - C_∞ : uniform dissolved gas concentration
  - C_{sat} : concentration near the void wall when temp. and pressure vary
  - Rp : void radius

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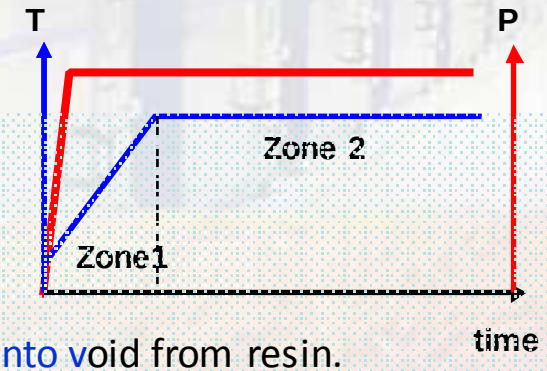

- In the Zone 2: T and P are constant
  - if dm/dt > 0，mass of void is increasing
    → gas or moisture go into void from resin.
  - if dm/dt < 0，mass of void is decreasing → air or moisture go into void from resin.
  - Assume C_∞=0 eventually, then dm/dt will be always <0 unless C_{sat} = 0.
  - If keeping low viscosity (low degree of curing in time interval): $C_\infty = C_{sat}$, dm/dt = 0
    - a. No existence of voids; or
    - b. resin is cured fully to make voids unable diffusing outwards between voids to materials.

- **In the Zone 1: Temp. and Pressure are not constant**

$$\frac{d}{dt}\left(\frac{M_{gas}}{T}\left(p_{imp}R_p^3 + 2\gamma_{LV}R_p^2\right)\right) = 3R_b D(C_\infty - C_{sat})R_p\left(1 + \frac{R_p}{\sqrt{\pi D\, t}}\right)$$

γ_{LV} : **Void surface tension**

α : **crosslink ratio**

η : **Viscosity**

  - 1. The theory is more complicate. Initial void size is leveraged by the ramp-up speed of temperature and pressure.
  - 2. Higher T make resin lower viscosity and void expansion but higher P make void shrinkage.

How Void Vanish by Pneumatic Pressure Applied

- There are some void vanish processes by diffusion method in conventional assembly process. Pneumatic pressure just make void vanish more efficiency. Those conventional assembly process can prove the void is not just shrunken but vanish eventually.

- Some conventional example processes are illustrated below

  - 1. Die Attach Process
    - Generally speaking, conventional chip packaging is to attach chip onto carrier, said substrate, lead-frame, chip, which adhesive layer between. In order to control void free inside/interface of adhesive layer, packaging houses usually finely tune the recipes of die attach bonder, such as die bonder temperature, force, and time to make adhesive layer with more wettability for void elimination.
    - Simply speaking, reaching adhesive wettability with heat first -> gas and moisture dissolve into adhesive resin easily. Die bonding cure make gas and moisture diffuse out of resin finally.
    - Pressure curing process is very powerful, more wider process widow to enormously boots up the diffusion to achieve Void Free.

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- 2. Cure Die Attach with FOW (Film over Wire) Material
  - For conventional FOW materials, it is easy for void generation while die attaching over wires. More, it is hard to eliminate voids by setting die bonder recipes.
  - Thus, usually material suppliers recommend two-step curing. First step with lower temperature(normally, over 100C but below recommended curing temperature) is to devoid by moving void outwards spontaneously to chip edges after heat energy absorption and then conversion of kinetic energy.
  - The compromise of such two-step curing is seriously tact time while curing.
  - Pressure curing process expedites de-voiding performance in terms of both temperature and pressure driving.

Pressure De-voiding Process : Reliable and Robust Solution

- Over 600 sets are installed all around the world
  - Widespread applications for materials such as liquid compound, DAP, DAF, FOW, CUF, NCF, NCP, Solder Paste, Copper Paste, Photo Transparent Paste…etc.
  - Moreover, applications among Semiconductors, PCB, LCD, MEMS, LED, SMT.
  - APT Pressure Oven with devoid process support is guaranteed by more than five years to be the outstandingly reliable and robust equipment and process.

VFS-60A

VTS-60A

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Thank you for your attention !

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