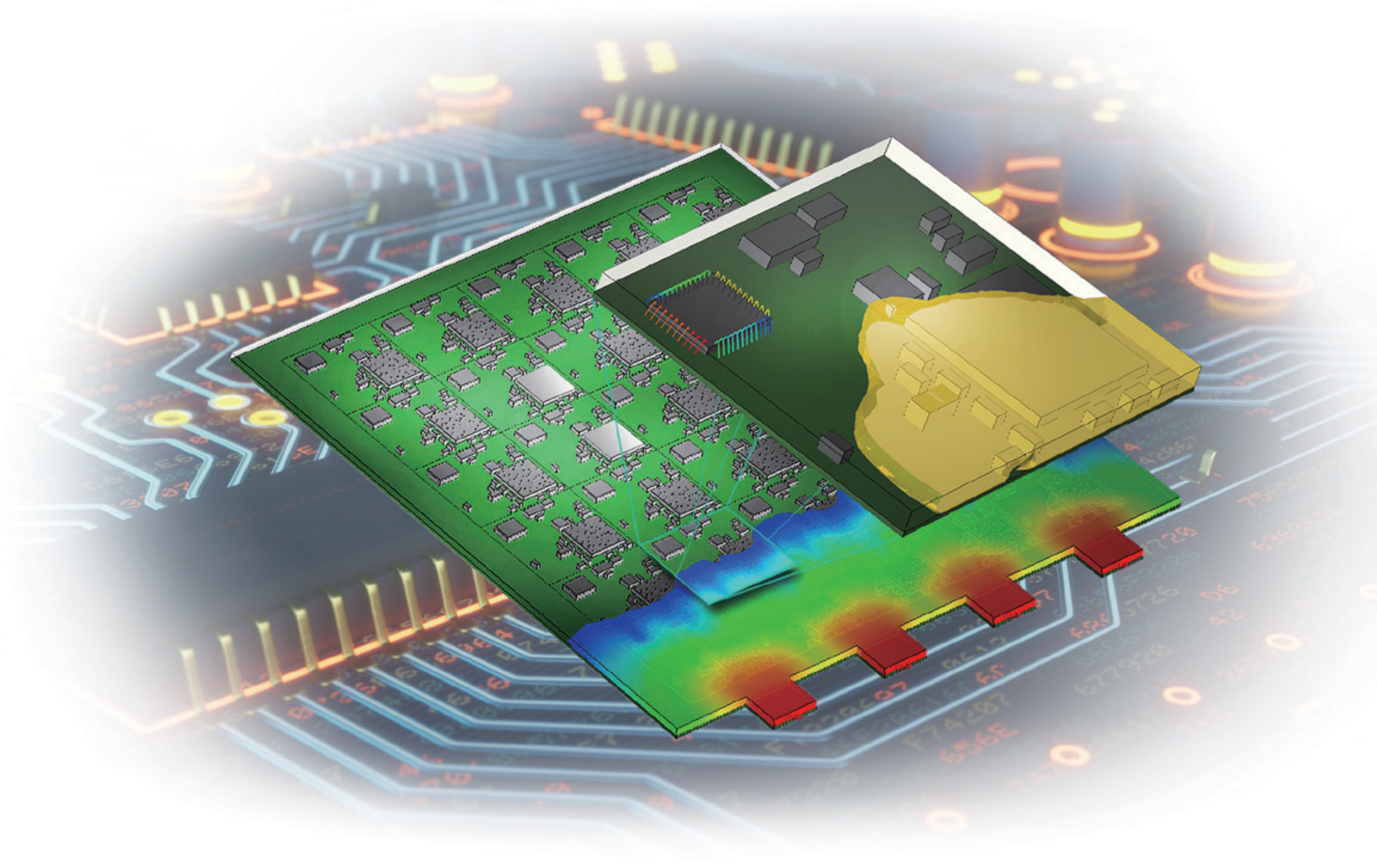
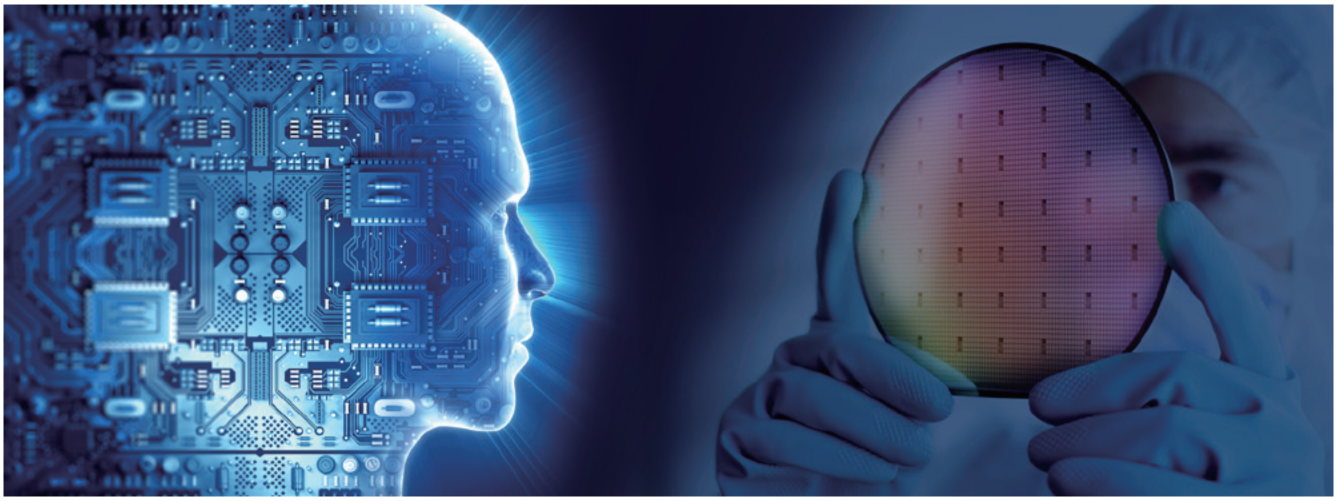
MOLDING INNOVATION

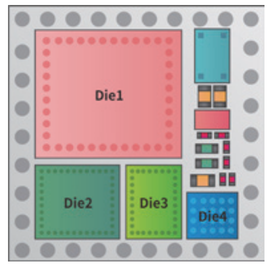
Moldex3D IC Packaging

Encapsulation Innovation



www.moldex3d.com

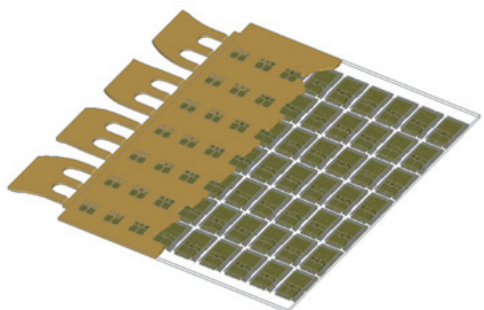


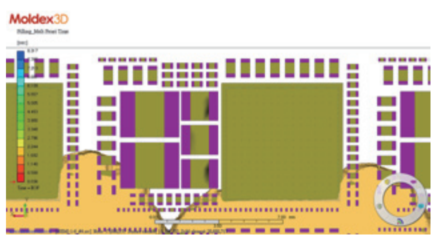


Moldex3D provides a variety of solutions for IC packaging, such as transfer molding, compression molding and the UnderFill process simulations for both 2.5D and 3D IC stacking. The UnderFill process includes Capillary UnderFill (CUF), No-flow UnderFill (NUF), Molded UnderFill (MUF), Non-conductive Paste (NCP), Embedded Wafer Level Package (EMWLP), etc., for the growing application of 3D IC stacking.

Evaluate and optimize epoxy flow pattern

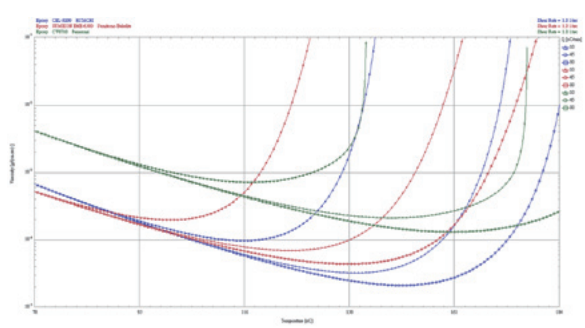
- Evaluate gate and runner designs through parametric modeling functions
- Visualize dynamic melt flow advancement for flow balance optimization
- Optimize geometry and component layout to avoid trapped air

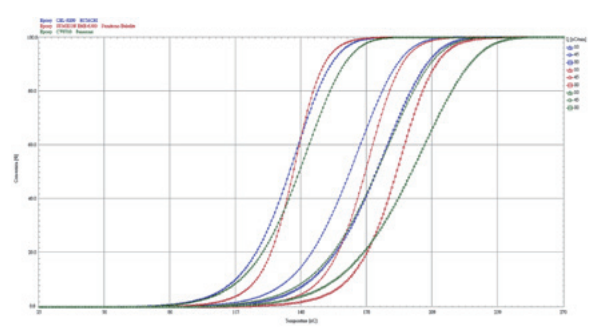


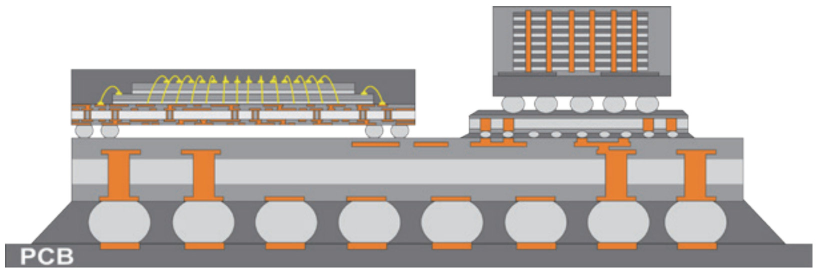


Evaluate the chemical rheology and viscoelastic properties for reactive molding compound

- Evaluate the variation of temperature and curing kinetics for reactive material
- Evaluate viscoelastic properties, chemical shrinkage and thermal expansion effect for different components

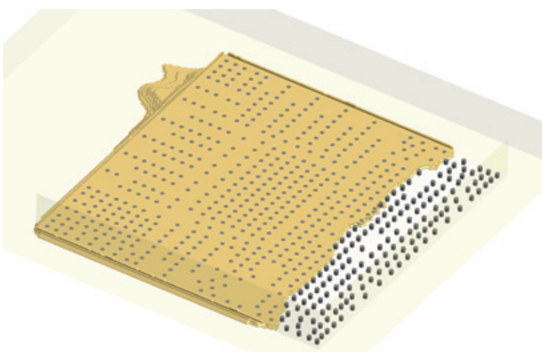


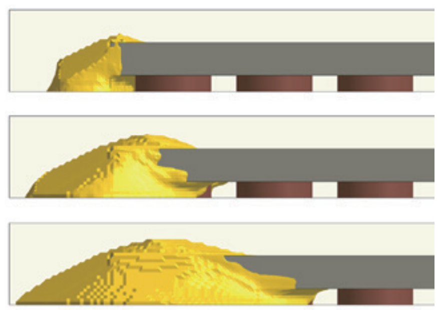




Capillary underfill simulation

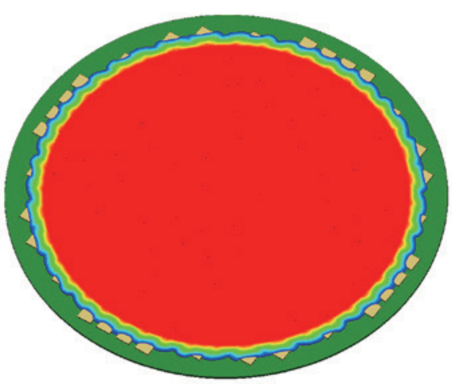
- Visualize capillary driven filling behavior with different surface tension and contact angle
- Evaluate the effects of bump pitch and bump pattern
- Optimize the dispensing setting for capillary underfill process

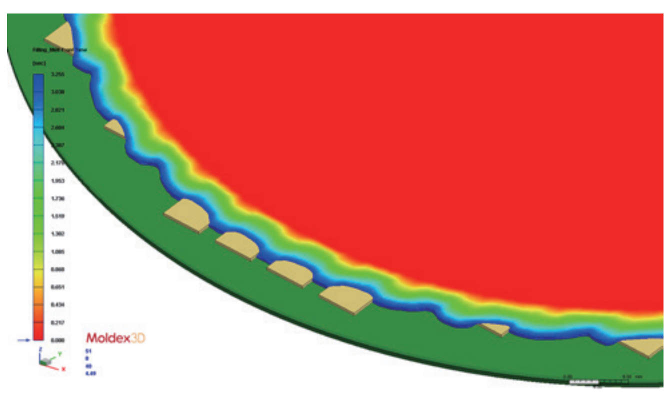


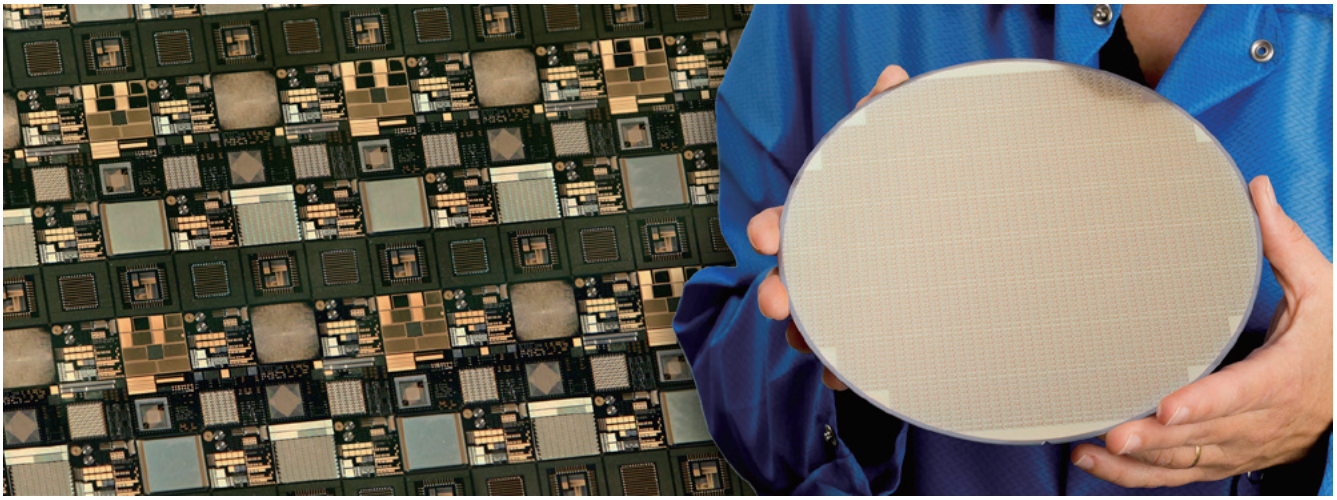


Compression molding simulation

- Visualize dynamic melt flow advancement during compression molding process
- Evaluate shear stress distribution and die shift for Fan-out package

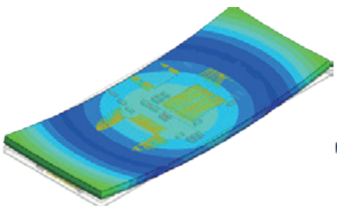




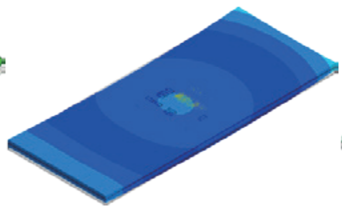


Post Mold Cure warpage simulation

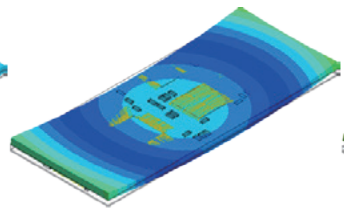
- Visualize stress relaxation and chemical shrinkage through post mold cure
- Predict temperature, conversion and stress distributions to optimize process control



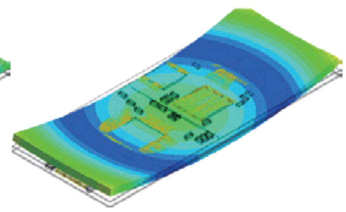
After curing



Post curing 120 sec



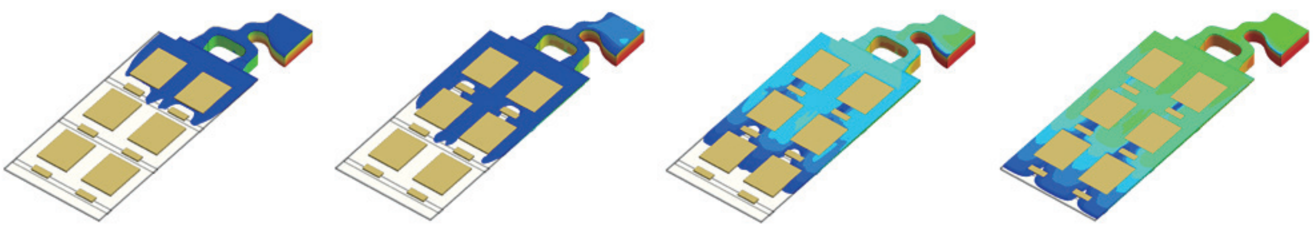
Post curing 360 sec



Post curing 600 sec

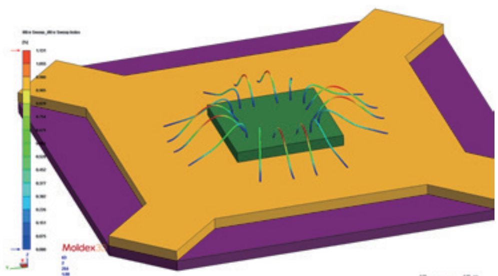
Visualize the effects of process design variation

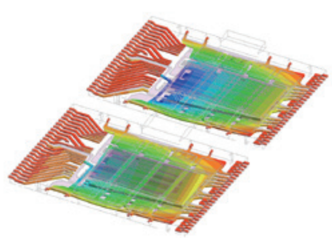
- Predict temperature, conversion and stress distribution due to process change
- Simulate real-world production with the diverse molding process
- Predict trapped air formation with venting effect

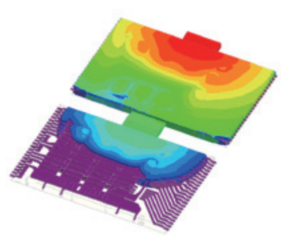


Validate design with co-simulation solution interface

- Evaluate wire sweep, chip deformation and paddle/die shift behaviors due to fluid-structure interaction
- Co-simulate to analyze structural performance with ANSYS and Abaqus







Molded Underfill Technology Leveraged on Moldex3D and won Best Paper of Session in IMAPS

Challenges

- Flow front evolution
- Void entrapment in chip

Solutions

- Utilizing Moldex3D Professional Package to obtain the optimum process settings in order to successfully improve the product' s molding problems

Benefits

- Reduced 2 or 3 mold revision times
- Saved NTD$200,000 ~ NTD$300,000 worth of mold revision costs
- Reduced 40,000pcs of the product capacity lost
- Improved the waterproof yield rate by 15%

Case Study

The objective of this case is to determine the UTAC has employed Moldex3D to setup a virtual molding trial laboratory since 2009. The team has applied it to numerous packaging projects successfully. "We aim to leverage Moldex3D simulation capabilities to solve key problems faced in production." said Ore Siew Hoon, the team leader. "Experiments involving a large DOE matrix are typically used to solve the molding issues, and is very time consuming and difficult because of the complex interactions between fluid flow, heat transfer and polymerization of encapsulant. Numerical simulation is an effective tool for analyzing the complicated physical phenomena", added Ore Siew Hoon. Recently, the Group' s technical paper was proudly awarded the Best Paper of Session in the 44th IMAPS International Symposium on Microelectronics. The comparisons between simulation and experiment is demostrated as Fig. 1.

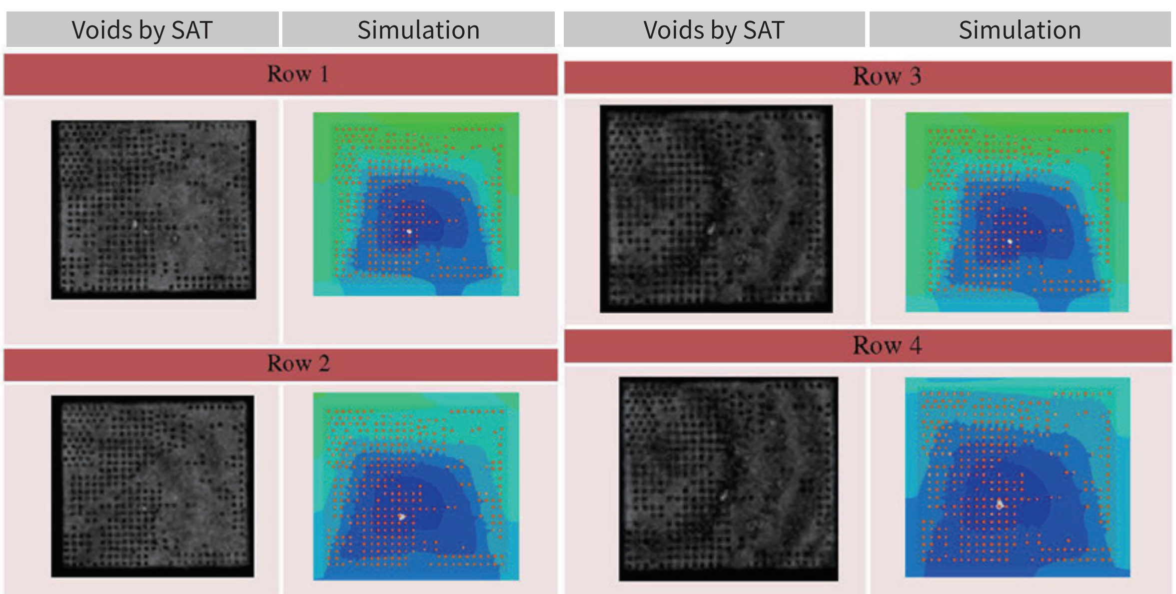


Fig. 1 Voids location and size captured by scanning acoustic microscope

Reference: Tamil, Jonathan, et al. "Molding flow modeling and experimental study on void control for flip chip package panel molding with molded underfill technology." Journal of Microelectronics and Electronic Packaging 9.1 (2012): 19-30.

Using Novel CAE Tools on Package Warpage prediction with Chemical shrinkage and Viscoelasticity Properties

Challenges

- Quality issues for dynamic warpage behavior of the package
- How to use Moldex3D to model the post mold cure process
- How to leverage the mold material properties for the cure kinetics, PVTC (Pressure Volume Temperature Cure) and viscoelasticity

Benefits

- Improve understanding of the quality control of post mold cure process
- Visualize and obtain the value of warpage changes with consideration of chemical shrinkage and viscoelasticity

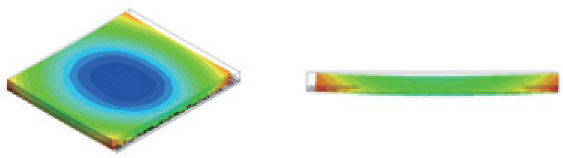
Solutions

- Moldex3D provides post mold cure analysis on package process , accurate simulated parameters. It provides true 3D results with consideration of filling, curing , and dynamic warpage

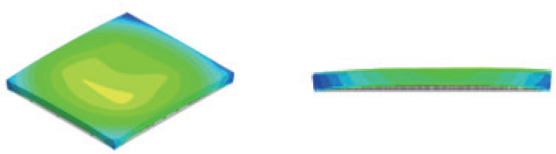
Case Study

The sensitivity model studied here only covered the molding process by capturing the mold flow and structural analysis based on fluid dynamics, PVTC, viscoelasticity with corresponding analytical equations and non-linear properties.
A higher cure shrinkage can yield a higher package warpage. The impact of mold cure conversion rate on Tg and PVTC can change the characteristic of package warpage from uncured to fully cured mold.

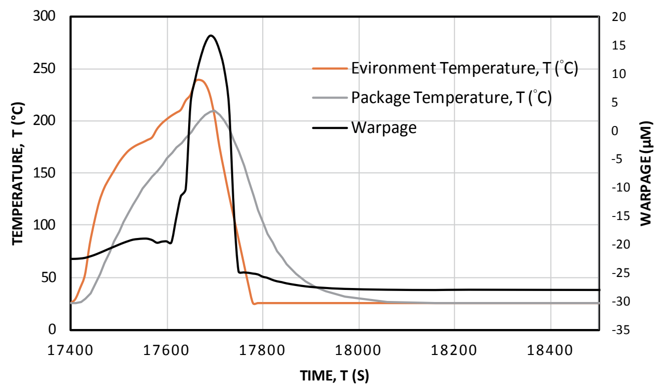
The modeling demonstrated that material with higher Tg gives rise to a lower package warpage.
The additional reflow cycles included in the model increases the package warpage as the result of changes in the viscoelasticity and stress relaxation.



(a) After Post mold cure stage



(b) At the 1st reflow cycle at 225°C



The predicted results with chemical shrinkage and viscoelasticity after the process reflow cycle

Reference : W. K. Loh, R. W. Kulterman, C. C. Hsu and H. Fu, "Modeling of Molded Electronic Package Warpage Characteristic with Cure Induced Shrinkage and Viscoelasticity Properties," 2018 IEEE 38th International Electronics Manufacturing Technology Conference (IEMT), Melaka, 2018, pp. 1-9.

iNEMI

Product Portfolio and Features

● Essential features contained | ○ Optional features

Standard Package

Molding Process		Transfer Molding
Mesh Technology	Mesh	●
	Designer	●
	Cadence Interface	○
Simulation Capabilities	Flow, Cure, Warp	●
	Thermal Analysis	●
	Stress	●
	Wire Sweep	●
	Paddle Shift	●
	FEA Interface	●
Solver Capabilities	Project	●
	Parallel Processing	8
Material Test	Viscosity (Rheometer)	●
	Curing Kinetics (DSC)	●

Solution Add-on

Molding Process	Material Test		
	Specific Volume (PVTC)	Visco-elastics Modulus (DMA)	Contact Angle
Compression Molding –Compression Molding –No Flow Underfill (NUF) –Embedded Wafer Level Package (EWLP)	●	○	○
Underfill –Capillary Underfill (CUF) –Molded Underfill (MUF)	○	○	●
Post Mold Cure –Chemical shrinkage of material –Viscoelasticity stress relaxation	●	●	

System Requirements

Platform	
Windows	Windows 10, 8, 7, Server 2016, Server 2012 R2
Hardware	
Minimum	Intel® Core i7 processor, 16 GB RAM, and at least 1 TB free space
Recommended	Intel Xeon Platinum 8000 series processor, at least 64 GB RAM & 4 TB free space HDD, NVIDIA Quadro & AMD Radeon series graphic card and 1920 x 1080 screen resolution

Moldex3D

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