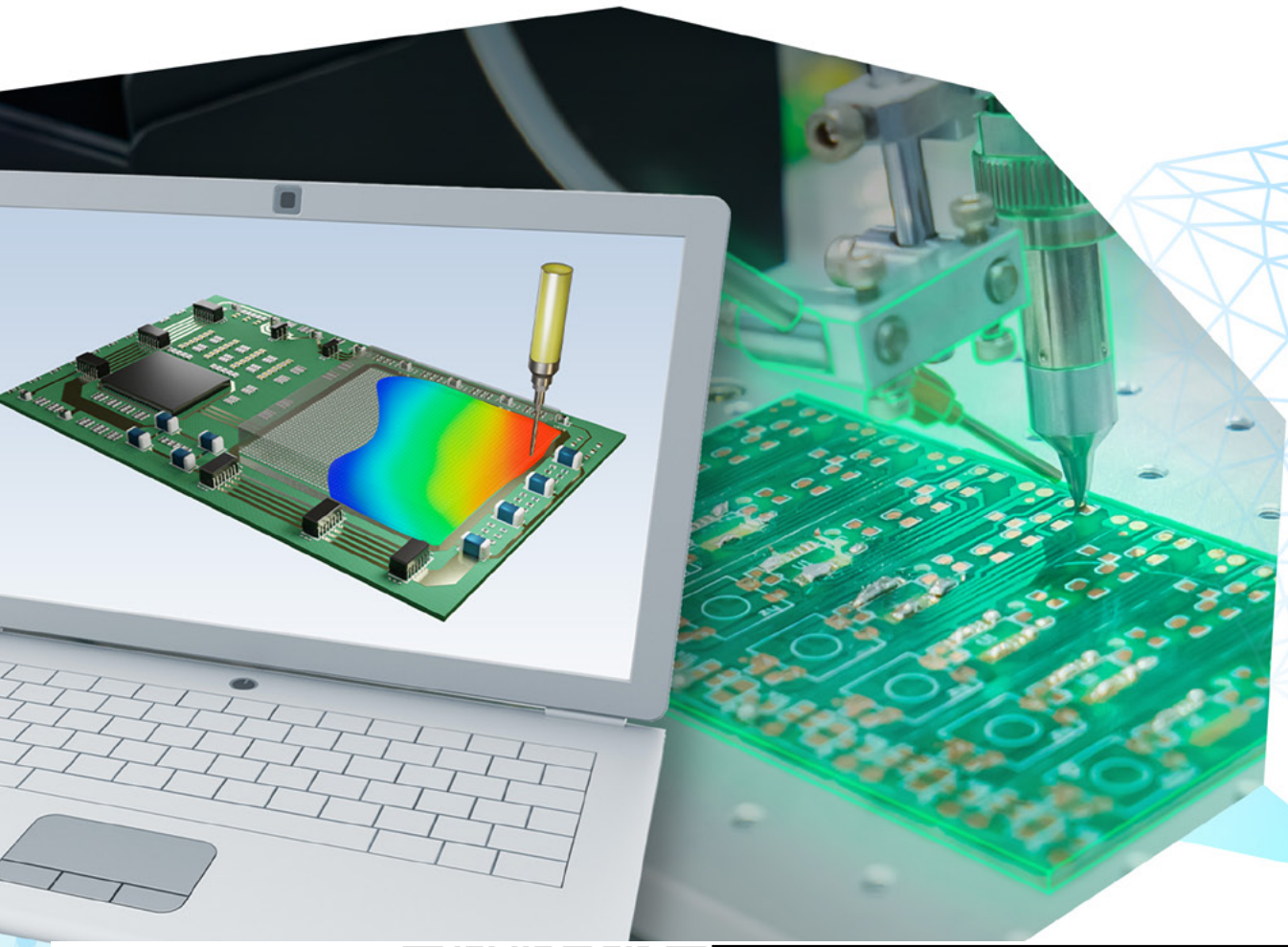
Moldex3D

IC Packaging

Encapsulation Innovation



PLM EGYPT
Industrial solutions for
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Application

PLM EGYPT
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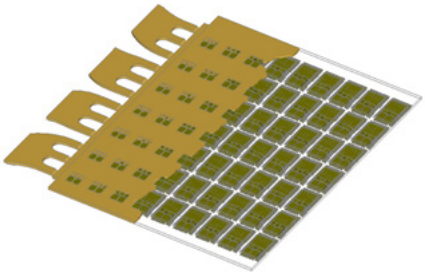
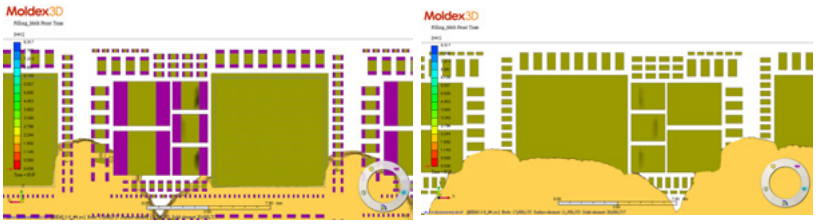
Evaluate Chip Layout and Epoxy Flow Pattern

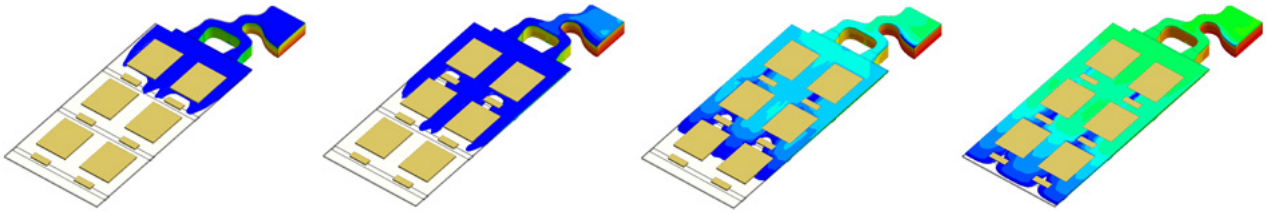
- Evaluate gate and runner designs through parametric modeling functions
- Visualize dynamic melt flow for flow balance optimization
- Optimize chip layout to avoid air-trap defect





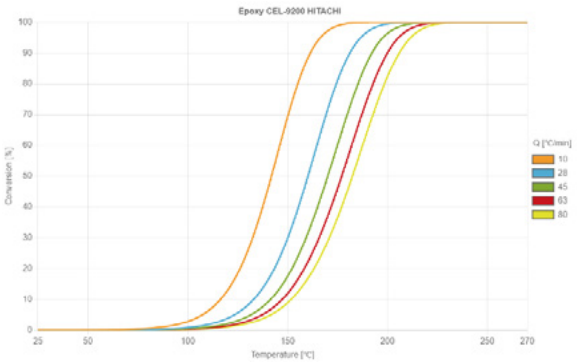
Predict the Effects of Process Variation

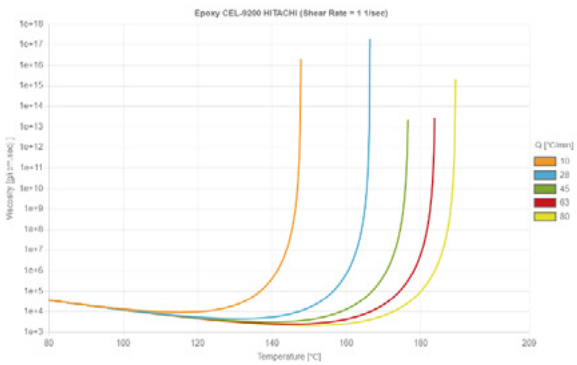
- Simulate real-world production process with the diverse molding condition
- Calculate temperature, conversion and stress distribution due to process change
- Predict bubble (air trap) formation with venting effect, and warpage



Advanced Material Property Measurement for Accurate Simulation

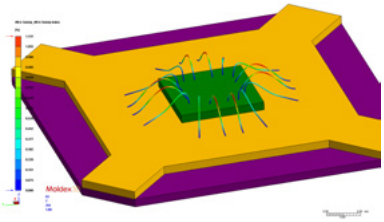
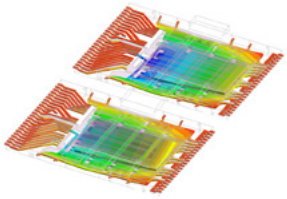
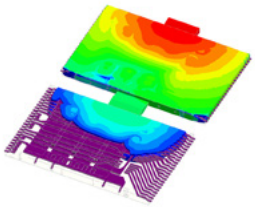
- Measure curing kinetics, viscosity, viscoelastic properties for flow simulation
- Determine viscoelasticity stress relaxation, chemical shrinkage and thermal expansion effect for warpage prediction





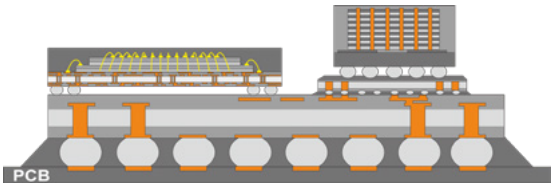
Validate Design with Co-Simulation Solution Interface

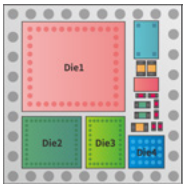
- Predict wire sweep, chip deformation and paddle/die shift behaviors via fluid-structure interaction
- Co-simulate to analyze structural performance with ANSYS and Abaqus

IC Packaging Solutions to Manufacturing Processes

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 encapsulation 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.



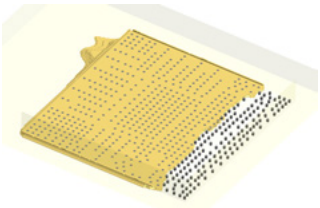
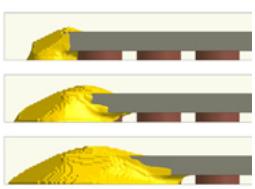


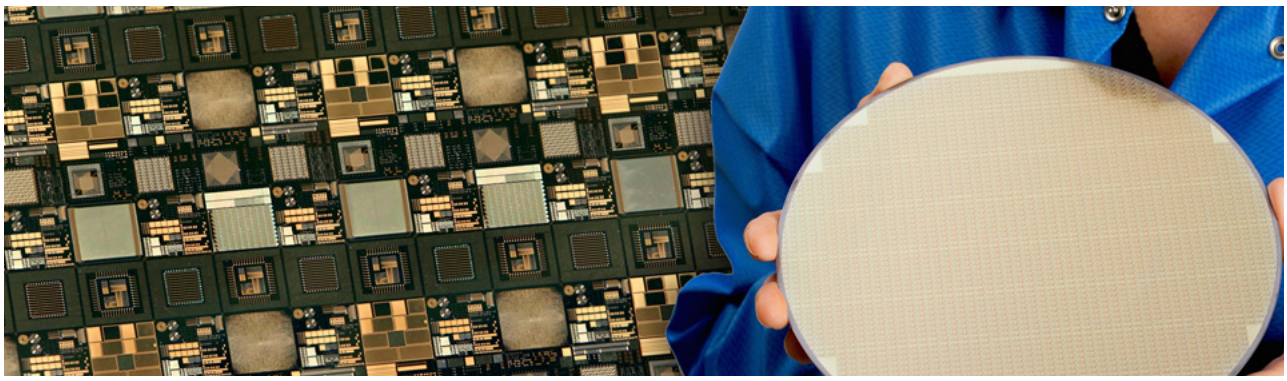
Transfer Molding and Molded Underfill Simulation

- Visualize filling and curing processes and predict potential molding defects
- Simulate the void location and optimize the gate and runner designs
- Calculate the pressure drop inside the air zone to optimize the air vent design
- Evaluate the process conditions and material properties to reduce cycle time

Capillary Underfill Simulation

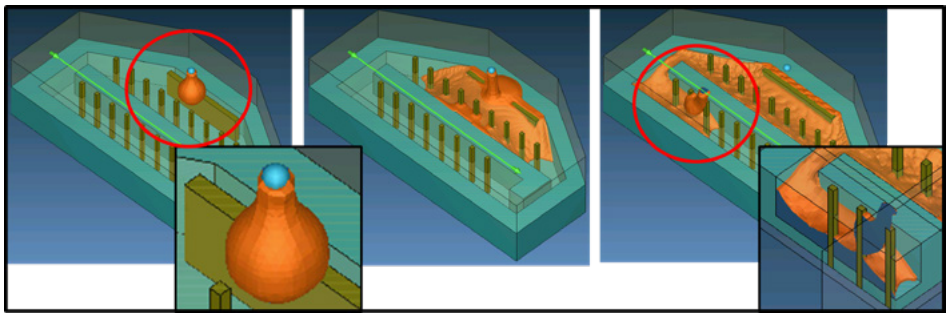
- Visualize capillary-force-induced filling behavior with different surface tension and contact angle
- Evaluate the flow effects due to bump pitch and bump pattern
- Optimize the dispensing setting for capillary Underfill process



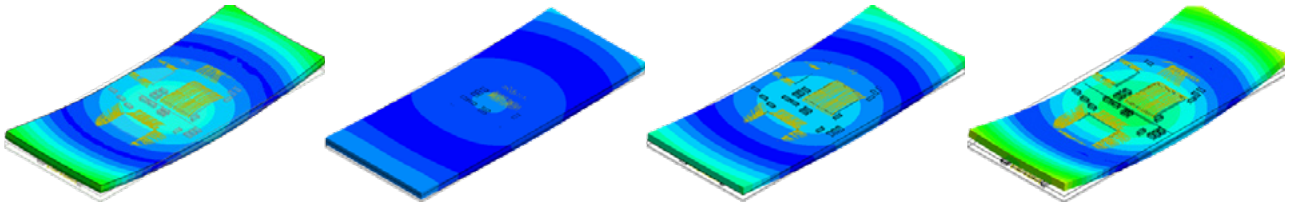
Potting

- More realistic and detailed visualization of dispenserpass and feeding
- Full physical model applied to simulate surface tension induced behaviors such as creeping
- User-friendly modeling tools and setting UI for a variety of process designs



Post Mold Cure Warpage Simulation

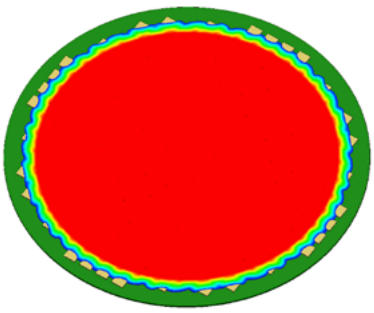
- Visualize stress relaxation and chemical shrinkage through post mold cure
- Calculate temperature, conversion and stress distributions and Predict deformation

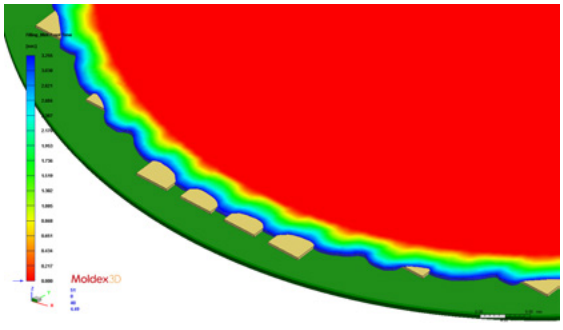


After curing | Post curing 120 sec | Post curing 360 sec | Post curing 600 sec

Compression Molding Simulation

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





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

Challenges

- Flow front evolution
- Void entrapment in chip

Benefits

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

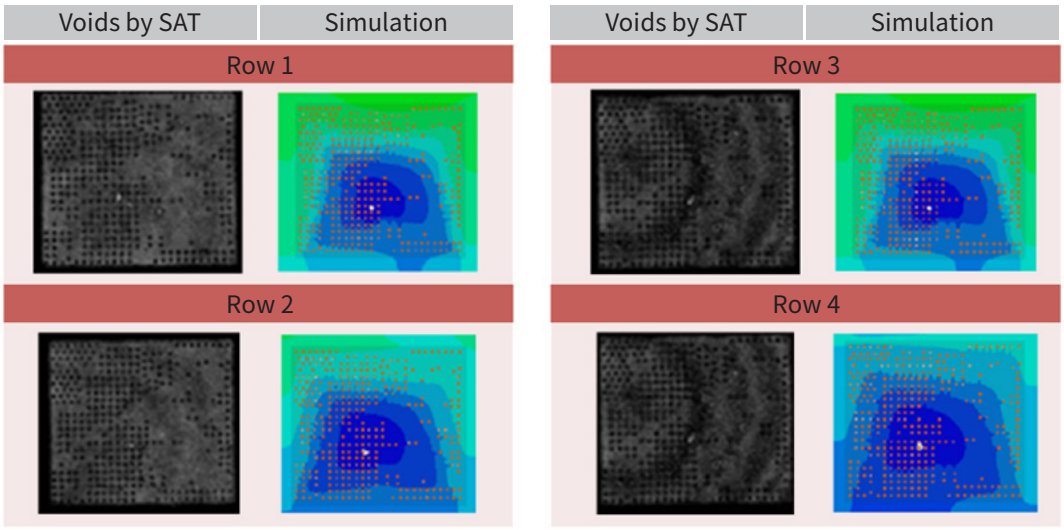
Solutions

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

Case Study

UTAC Group is a leading independent provider of semiconductor assembly and testing services for a broad range of integrated circuits. The Group offers a full range of package and test development, engineering and manufacturing services and solutions to a worldwide customer.

The objective of this case is to determine the UTAC has employed Moldex3D to set up 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, hear transfer and polymerization of encapsulant. Numerical simulation is an effective tool for analyzing the complicated physical phenomena,” added Ore Siew Hoon. 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 demonstrated as the image below.



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

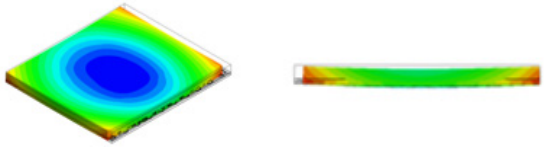
- Improve understanding of the quality control of post mold cure process
- Visualize and obtain the value of warpage changes with consideration of chemical shrinkage and viscoelasticity

Solutions

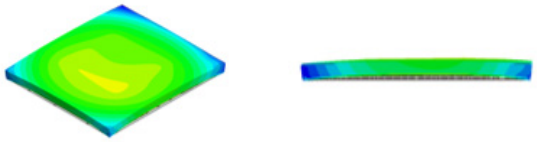
Moldex3D provides post mold cure analysis on package process, accurate simulated parameters. It provides true 3D results with consideration of filling, curing, and dynamic warpage

Case Study

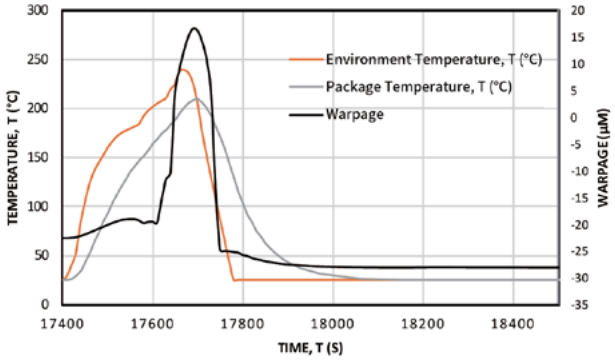
The sensitivity model studied here only covered the molding process by capturing the mold flow and structural analysis based on fluid dynamics, PVTC, viscoelasticity with corresponding analytical equations and non-linear properties. A higher cure shrinkage can yield a higher package warpage. The impact 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.

Product Portfolio and Features

● Essential features contained | ○ Optional features

	Professional Suite	Compression Suite	Dispensing Suite	Premium Suite
Solver Capabilities				
Parallel Processing	16	16	16	16
Material Database	●	●	●	●
Mesh Technology (Hybrid, Auto Hybrid, BLM, eDesign)	●	●	●	●
Simulation Capabilities				
Flow	●	●	●	●
Cure	●	●	●	●
Warp	●	●	●	●
Thermal	●	●	●	●
Stress	●	●	●	●
Wire Sweep	●	●	●	●
Paddle Shift	●	●	●	●
Pre/Post Processers				
Studio	●	●	●	●
Mesh	●	●	●	●
Auto-hybrid	●	●	●	●
Cadence Interface	●	●	●	●
FEA Interface	●	●	●	●
Optimization				
Expert (DOE)	●	●	●	●
Post Mold Cure (PMC)				
Chemical Shrinkage of Material	●	●	●	●
Viscoelasticity Stress Relaxation	●	●	●	●

Molding Process

● Essential features contained | ○ Optional features

	Professional Suite	Compression Suite	Dispensing Suite	Premium Suite
Transfer Molding				
Transfer Molding	●	●	●	●
Compression Molding (CM)				
Compression Molding	○	●	○	●
No Flow Underfill (NUF)	○	●	○	●
Embedded Wafer Level Package (EWLP)	○	●	○	●
Underfill				
Capillary Underfill (CUF)	○	○	●	●
Molded Underfill (MUF)	○	○	●	●
Potting				
Potting	○	○	●	●
Moldiverse				
Material Hub Cloud (MHC)	●	●	●	●
University - Moldex3D Software Training	●	●	●	●

Material Test Requirements

Analysis Type	
Filling/Curing Analysis	Viscosity (Rheometer) and Curing Kinetics (DCS) are required for measurement. For compression molding process, it is recommended to supplement the measured specific volume (PVTC). For underfill/potting process, it is recommended to supplement the measured surface tension and contact angle.
Post Mold Cure Analysis	Specific Volume (PVTC) and Viscoelasticity (DMA) are required for measurement.

System Requirements

Platform	Windows	Windows 10, Windows11, Windows Server 2019
	Linux	CentOS 7 series, CentOS 8 series, RHEL 7 series, RHEL 8 series
Hardware	Minimum	
	CPU	AMD Ryzen ™ 7 series, Intel® Core ™ i7 series
	RAM	16 GB RAM
	HDD	20 GB free space (For Program Installation)
	Recommended	
	CPU	AMD EPYC ™ Milan / Milan-X series, Intel® XEON® Gold / Platinum / Bronze series
	RAM	16GB x 8 With ECC / 3200Mhz
	HDD	4 TB SSD (For Project Management)
	Graphic Card	NVIDIA Quadro series, AMD Radeon series
	Screen Resolution	1920 x 1080

Note
1. Linux platform is used for calculation resource only. Moldex3D Pre/Post-processor does not support Linux platform.
2. To increase calculation efficiency and stability, it is recommended to switch off Hyper-Threading under RC/DMP structure. For memory population rules, please refer to your CPU processor type for optimized performance.