



**Moldex3D**  
MOLDING INNOVATION

**2015 Molding Innovation Day**

# **Caratterizzazione dei Materiali**

**Tober Sun – CoreTech**

**10 Luglio 2015**  
**POINT Polo per Innovazione Tecnologica**  
**Dalmine Bergamo**

**Moldex3D Italia srl**  
**Corso Promessi Sposi 23/D -**  
**23900 Lecco (LC)**  
**[www.moldex3d.com](http://www.moldex3d.com)**

# Major Laboratory equipments line-up



**Rheograph RG25**  
Capillary viscosity and thermal conductivity with counter pressure equipped



**CR-6000**  
Capillary viscosity at different temperature and shear rates

**pvT-6000**  
pvT change at different temperature and pressure



**MCR 502**  
Rotation and oscillation tests for viscoelastic properties

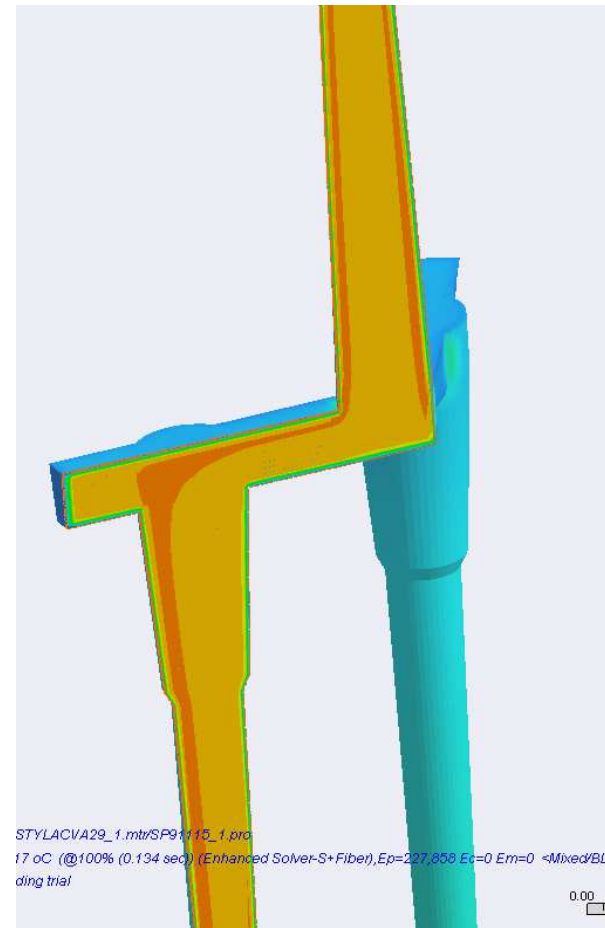
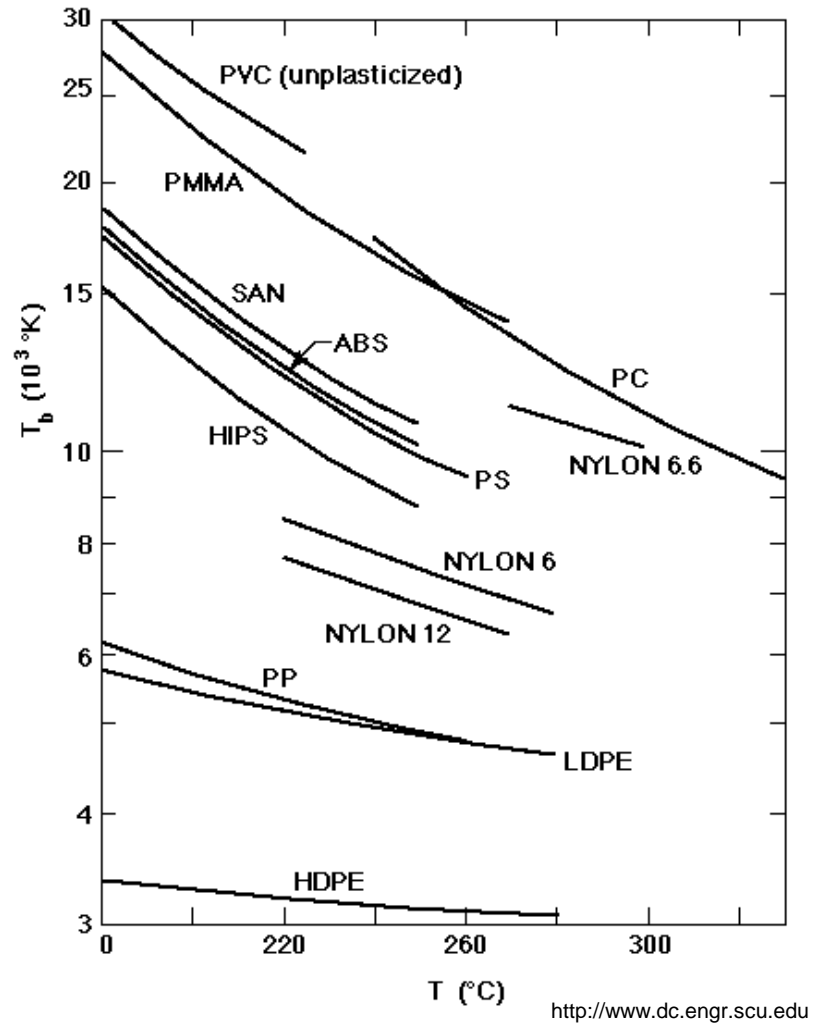


**DSC 8500**  
Transition temperatures and crystallization kinetics

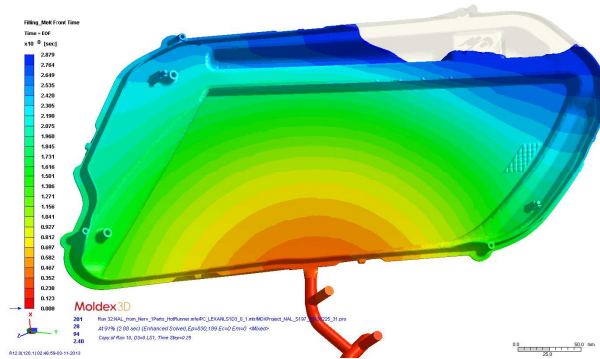


**Instron-8966**  
Mechanical properties

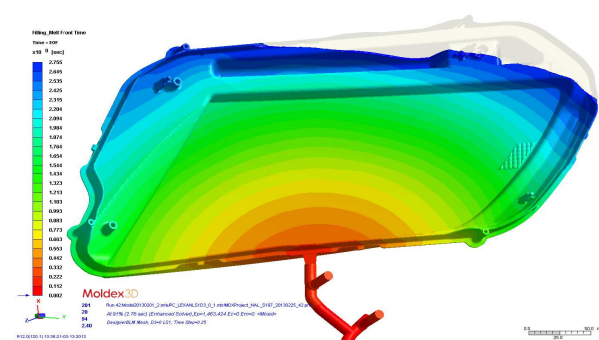
# Viscosity – temperature sensitivity



# Lighting prouct

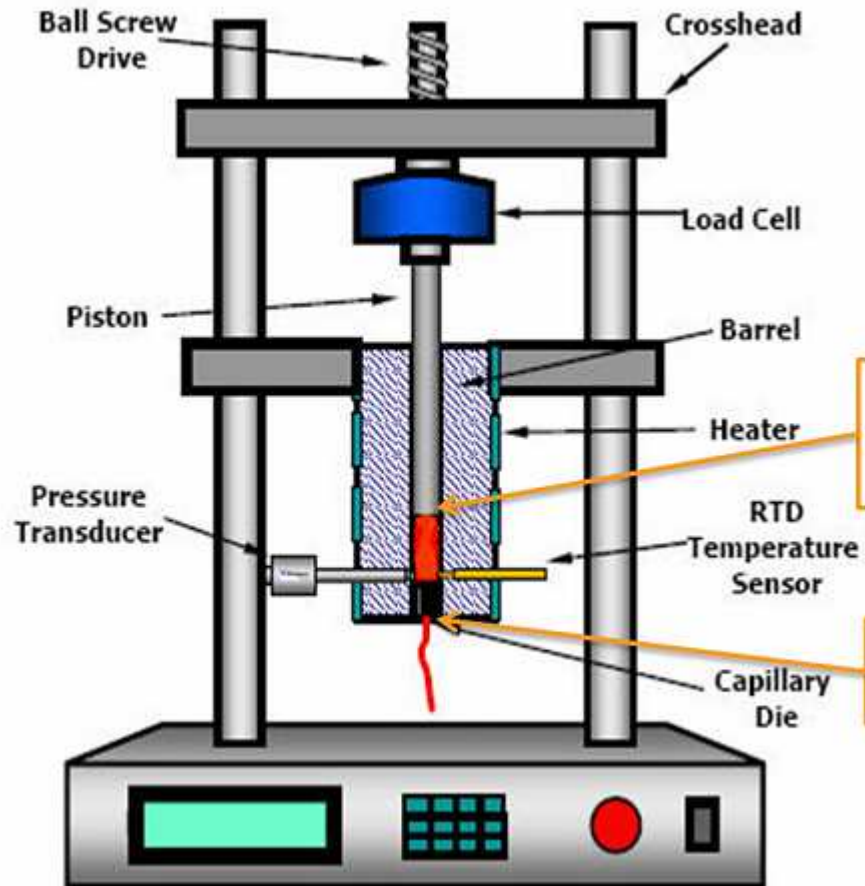


Consider temp imbalance



Not Consider temp imbalance

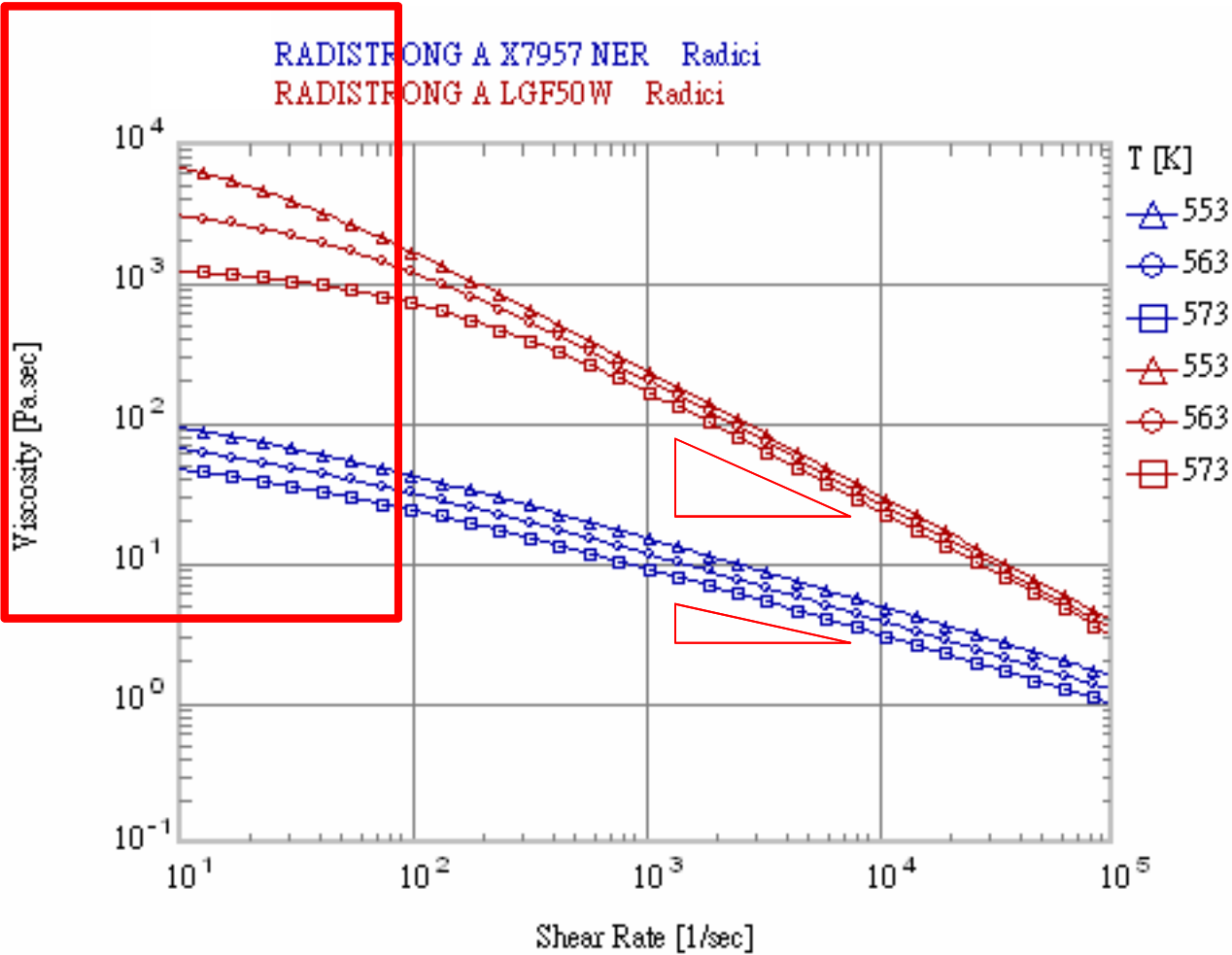
# Challenges for testing long (high) fiber



Friction between piston and barrel leads to instability for high loading long fiber materials (>50%) at high shear rate (>5000 1/s)

Wider capillary (2mm) for less coagulation near the die

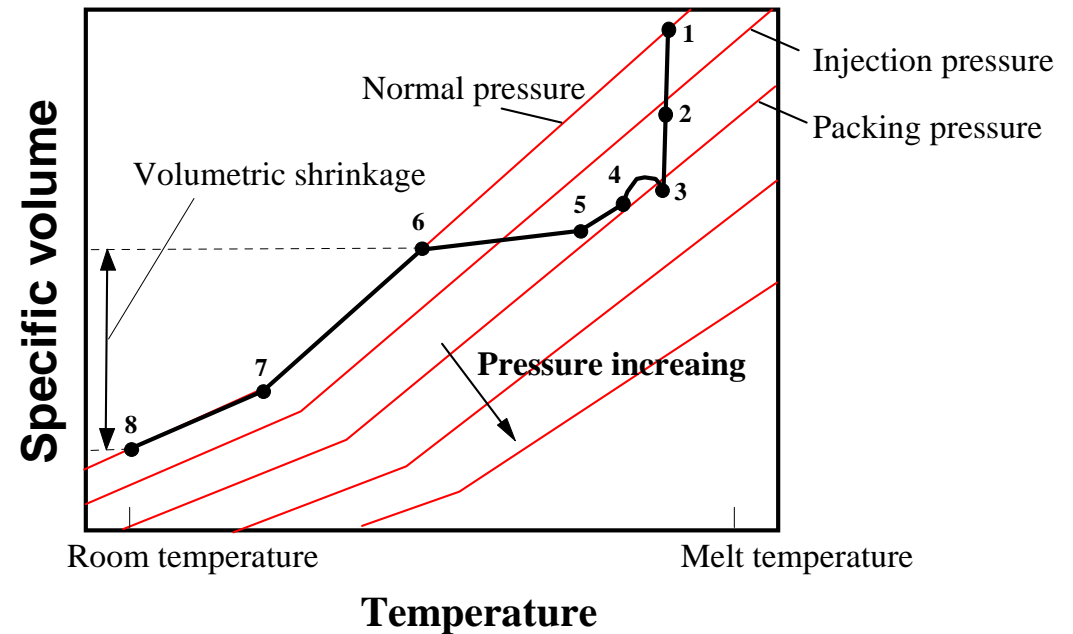
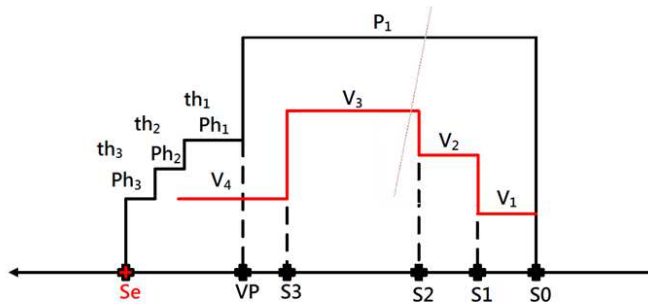
# e.g. Radici long fiber materials



# pvT effect during cooling

- > In injection molding processes, polymers is cooled from high temperature to normal temperature and solidified inside the cavity.
  - higher packing pressure and a longer packing time could lessen the shrinkage of the molded product.

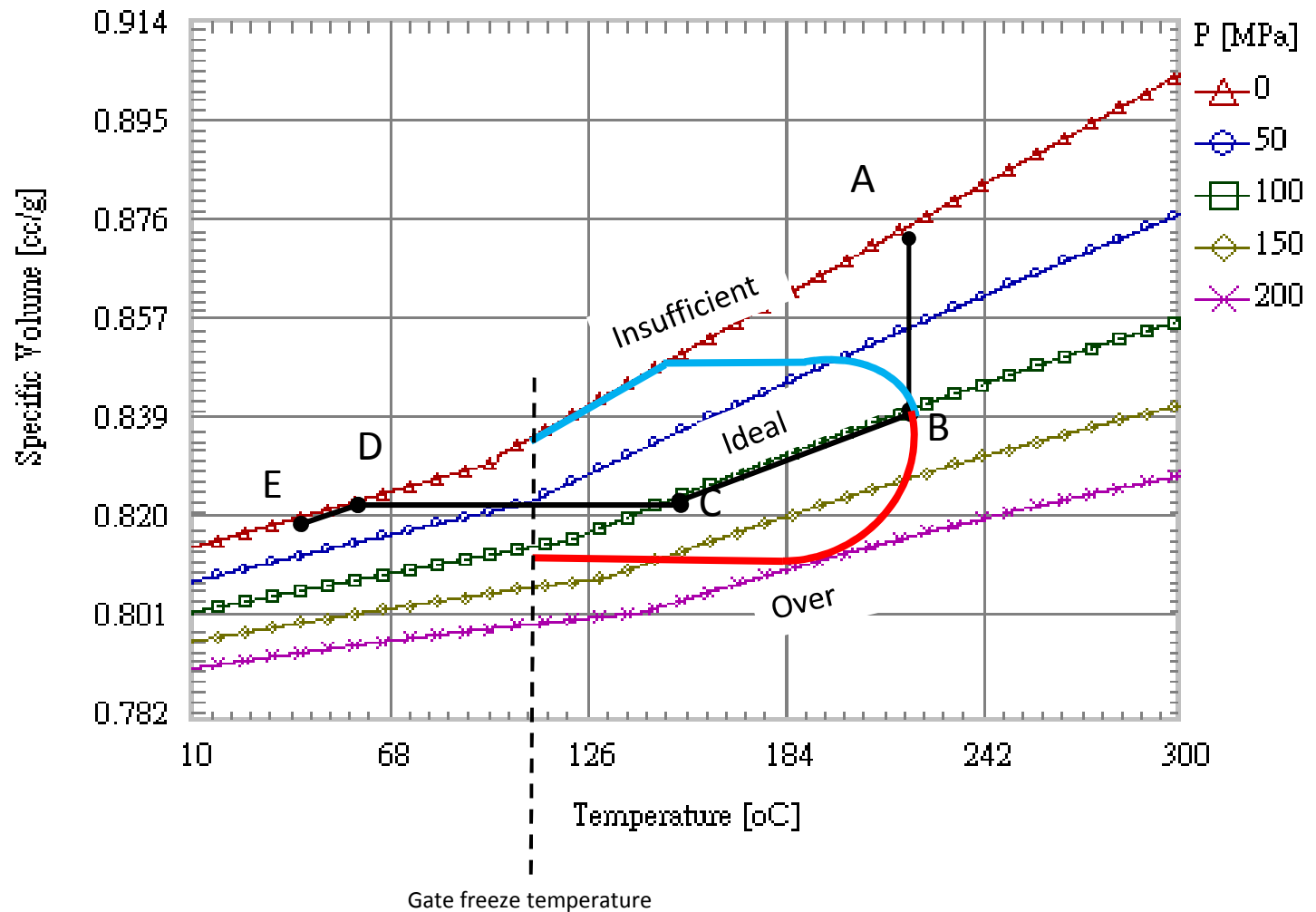
- 1: Start to fill
- 2: Completion of cavity filling
- 3: Cavity pressure arrives at maximum
- 4: Packing / holding stage begin.
- 5: Completion of packing/holding stage.
- 6: Cavity pressure drops to normal
- 7: Mold tooling and plastic parts demolding.
- 8: Plastic parts achieve thermal equilibrium.



# PVT and Packing profile optimization

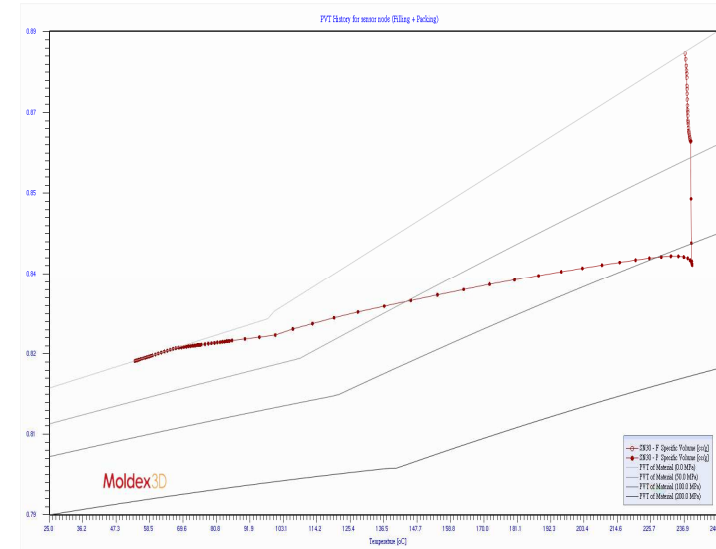
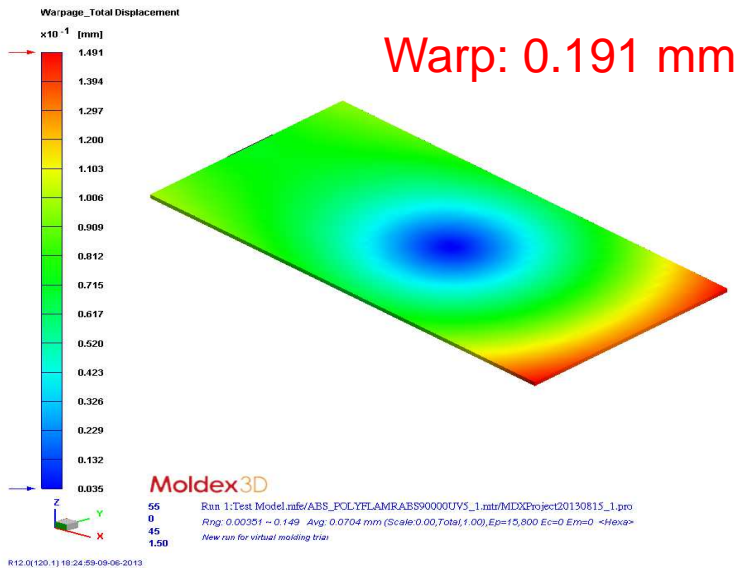
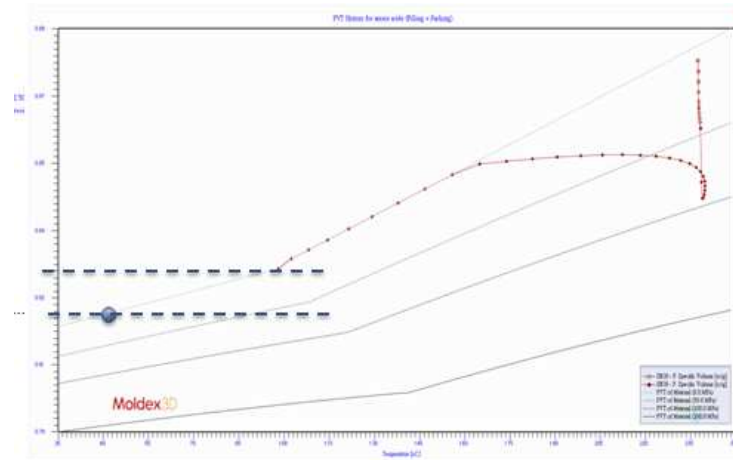
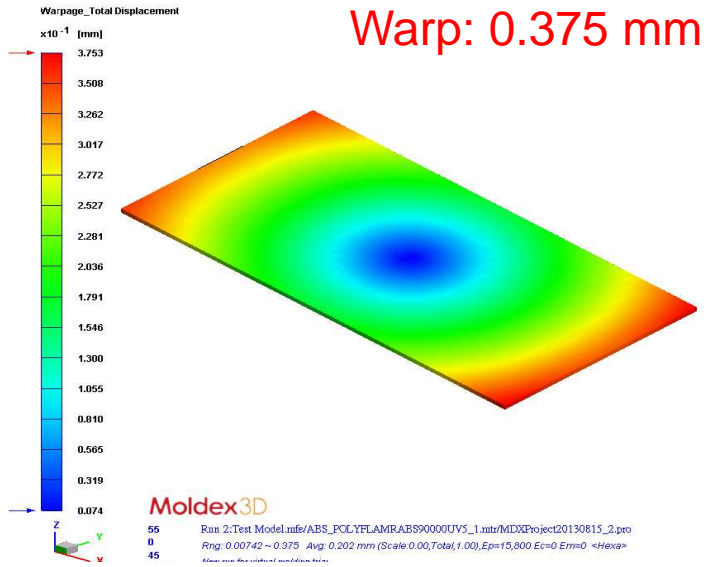


Gotech, pvT6000





# Optimize packing profile



# Solid viscoelasticity applications

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Annealing  
(Short term)

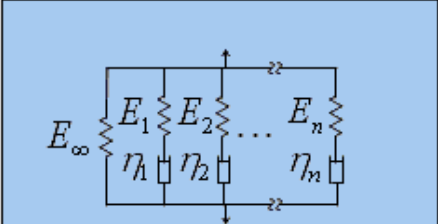


Under-the-hood  
(Long term)

# Modulus – time curve

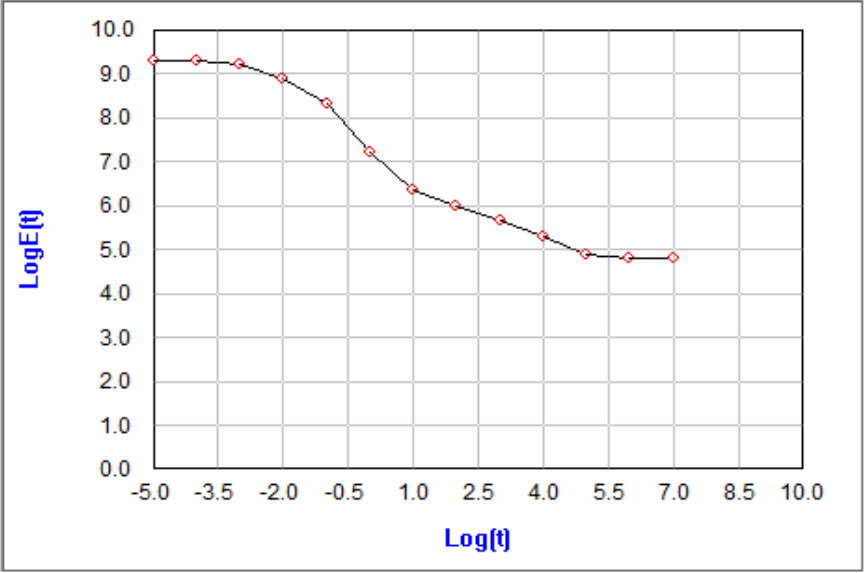
Material property setting

Generalized Maxwell model



$$E(t) = E_{\infty} + \sum_{i=1}^n E_i \exp\left(-\frac{t}{\lambda_i}\right)$$

Where :

$$\lambda_i \equiv \frac{\eta_i}{E_i}$$


Parameter setting

Maxwell element : 8

E Infinity : 70300

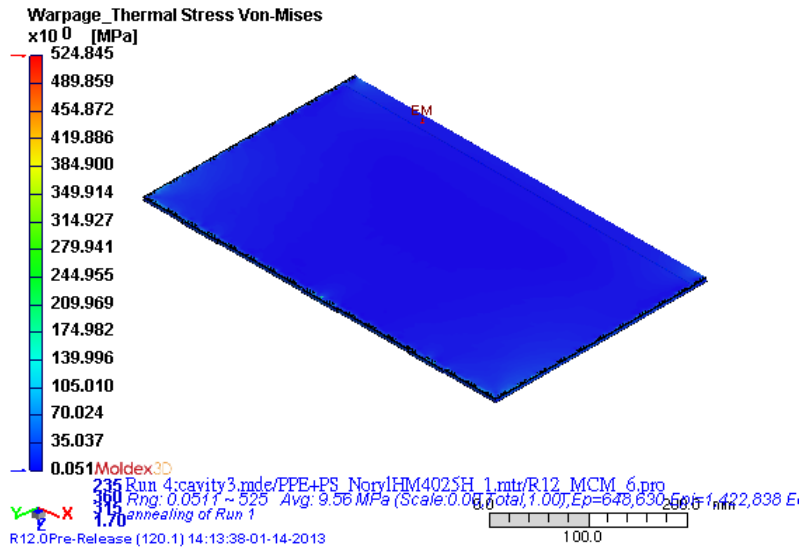
Element	Element-1	Element-2	Element-3	Element-4	Element-5	Element-6	Element-7	Element-8
Ei	1.16e+009	8.68e+008	1.16e+008	1.45e+007	2.89e+006	868000	361000	170000
lambda_i	0.002	0.05	0.35	1.5	10	150	3000	40000

Default OK Cancel

# Residual stress decreases

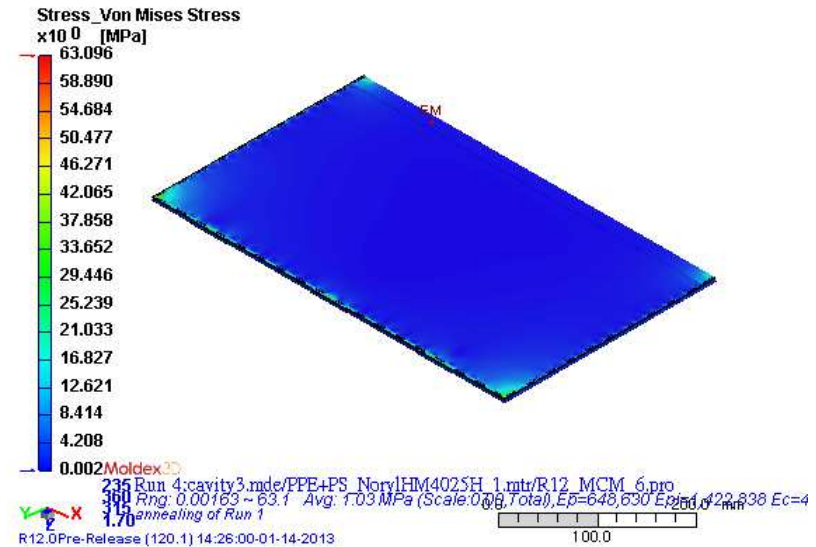
**Before usage**

Von-Mises stress: 0.38~524.8MPa



**After usage**

Von-Mises stress: 0.025~63.1MPa



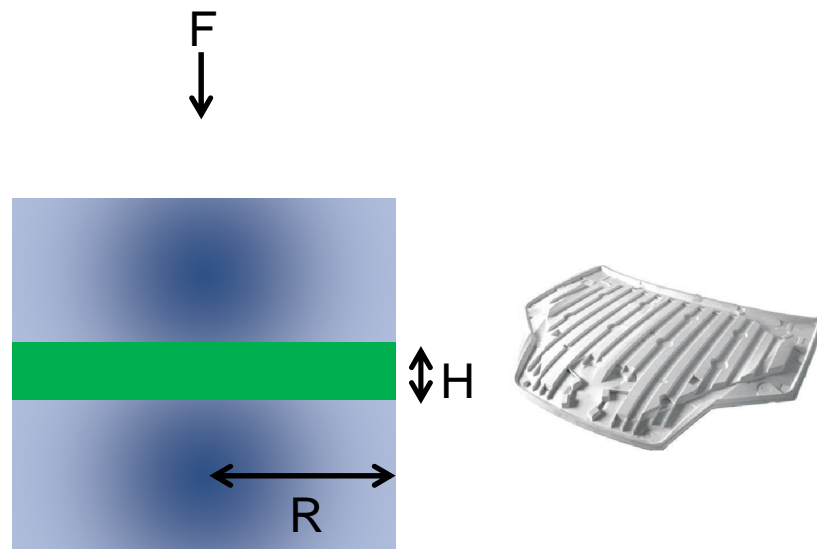
Highly CONFIDENTIAL

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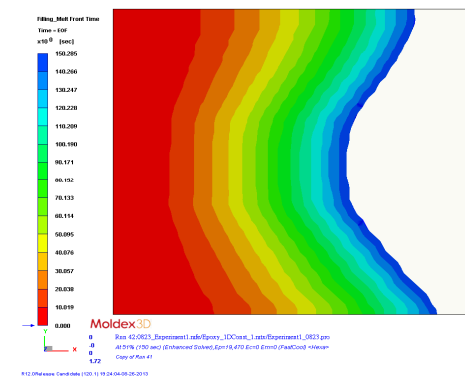
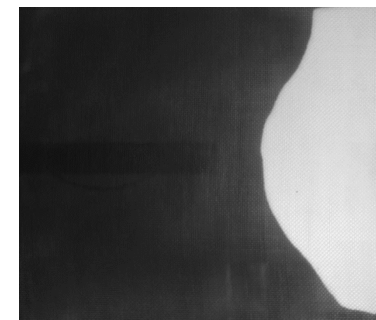
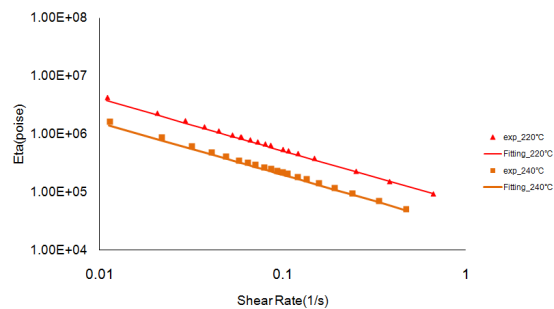
# Unique composite material support

## Glass mat thermoplastics compression

## RTM resin viscosity / fabric permeability



GMT\_Viscosity



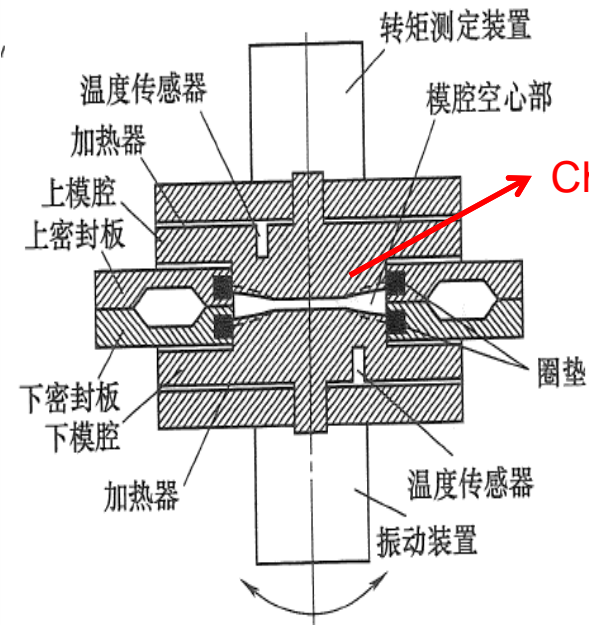
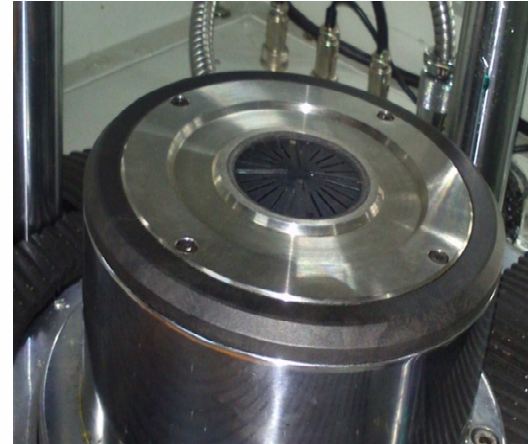
0 20 40 mm

# Rubber / foam rheometer

## > Oscillatory Shear

- Pressure curve
  - Degree of foaming
- Torque curve
  - Degree of vulcanization

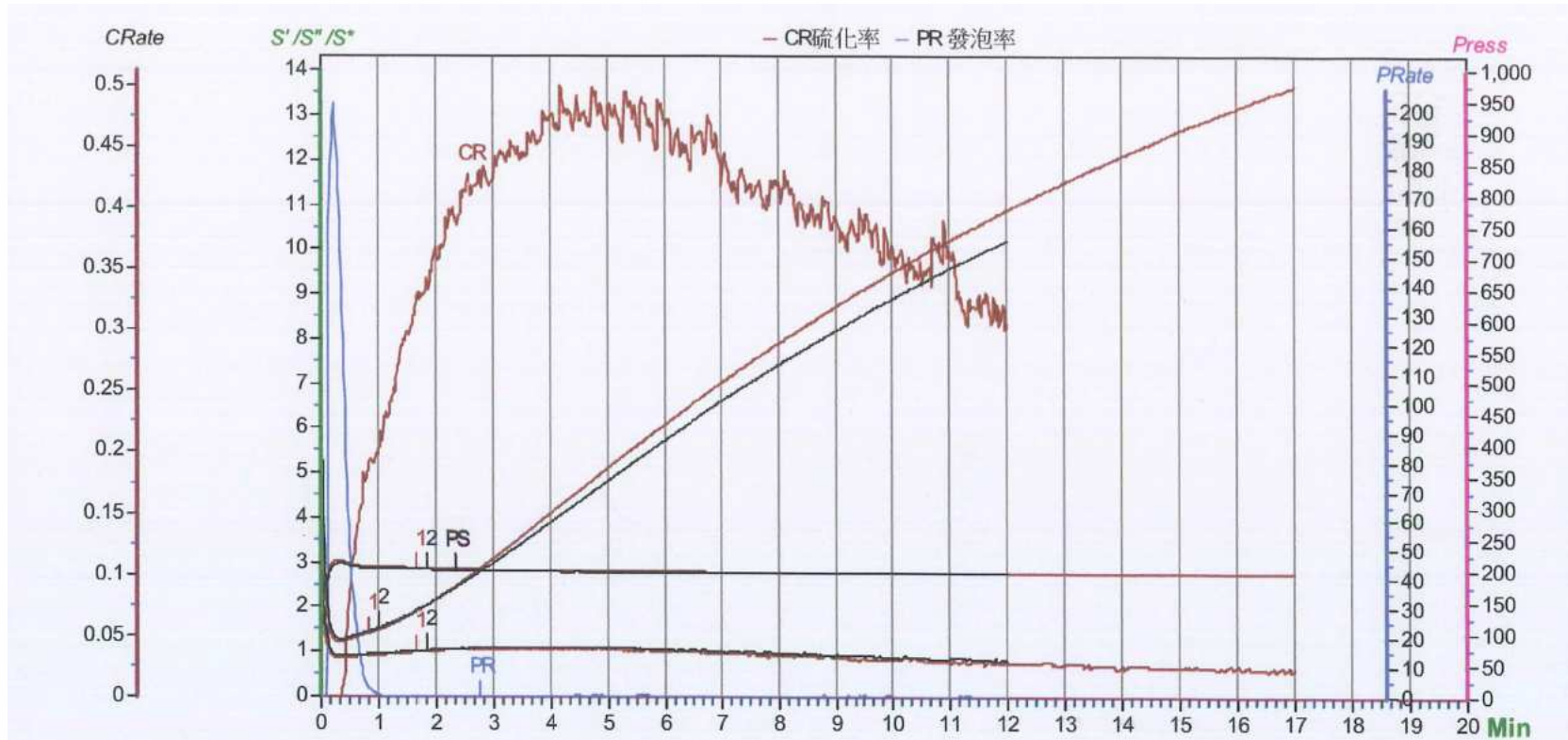
## Oscillatory Shear



Chamber are sealed

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# Results



日期/時間	S/N	膠料名稱	TS1	TS2	TC10	TC50	TC90	ML	MH	PC60	PC90	PL	PH	CRI	CHK
xbar Value			:	:	:										
Deviation +/-															
201505281633	19		2:03	3:08	2:20	7:30	14:33	1.22	13.66	0:10	0:13	189.18	216.78	8.76	O
201505281645	20		2:09	3:19	2:00	6:01	10:36	1.28	10.20	0:10	0:13	185.58	212.26	13.75	O

# Fitting by model

## > Cross Macosko model

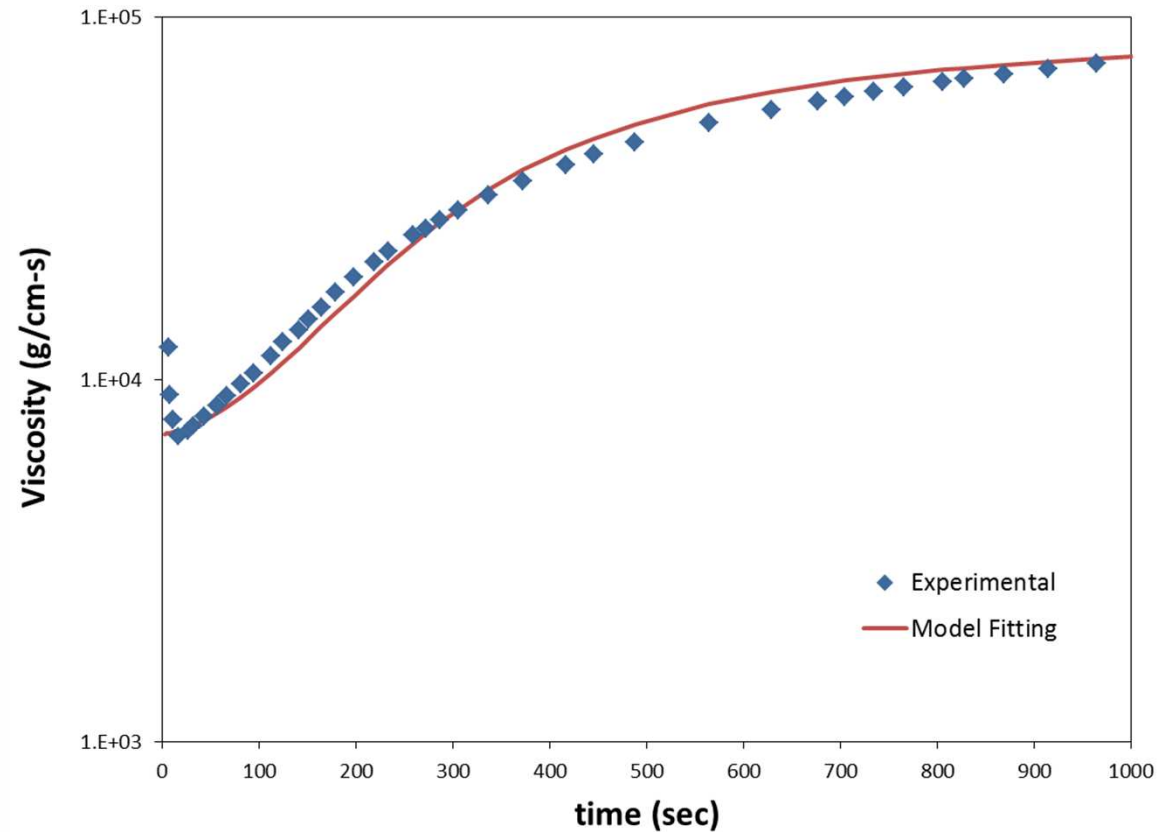
Cross Castro Macosko Model

$$\eta = \frac{\eta_0 \cdot \left( \frac{\alpha_g}{\alpha_g - \alpha} \right)^{c1+c2\alpha}}{1 + \left( \frac{\eta_0 \cdot \dot{\gamma}}{\tau} \right)^{1-n}}$$

$$\eta_0 = A \cdot \exp\left(\frac{Tb}{T}\right)$$

$$Tb = \frac{E_n}{R}$$

Cg	5.0000E+00	-
C1	1.5800E+01	-
C2	-4.2000E+00	-
A	5.6300E+06	g/(cm.sec)
Tb	8.7900E+03	K
n	2.7600E-01	-
Taus	1.0000E+01	dyne/cm^2





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**Una corretta  
caratterizzazione del materiale  
è la base  
per una corretta analisi e simulazione**



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