



## Friction and syneresis in agar plates

Bosi MAO (毛博思)

*Centre de Recherche Paul Pascal,  
115 av. Dr. Schweitzer 33600 Pessac*

## ❖ Agar plate...

Mainly composed of water (>95%)  
 + 1 to 4 % agarose & agaropectin (polysaccharides)  
 + small amount of amino-acid, surfactants, etc.

## ❖ ... are subject to Syneresis

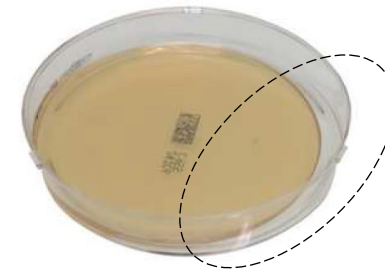
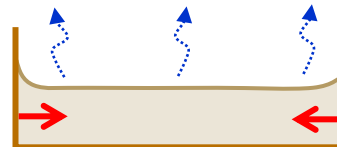
“spontaneous or stress-induced shrinkage of the gel matrix and expulsion of solvent”  
 → **delayed detachment of the gel**



t=0 h

Commercial Plate

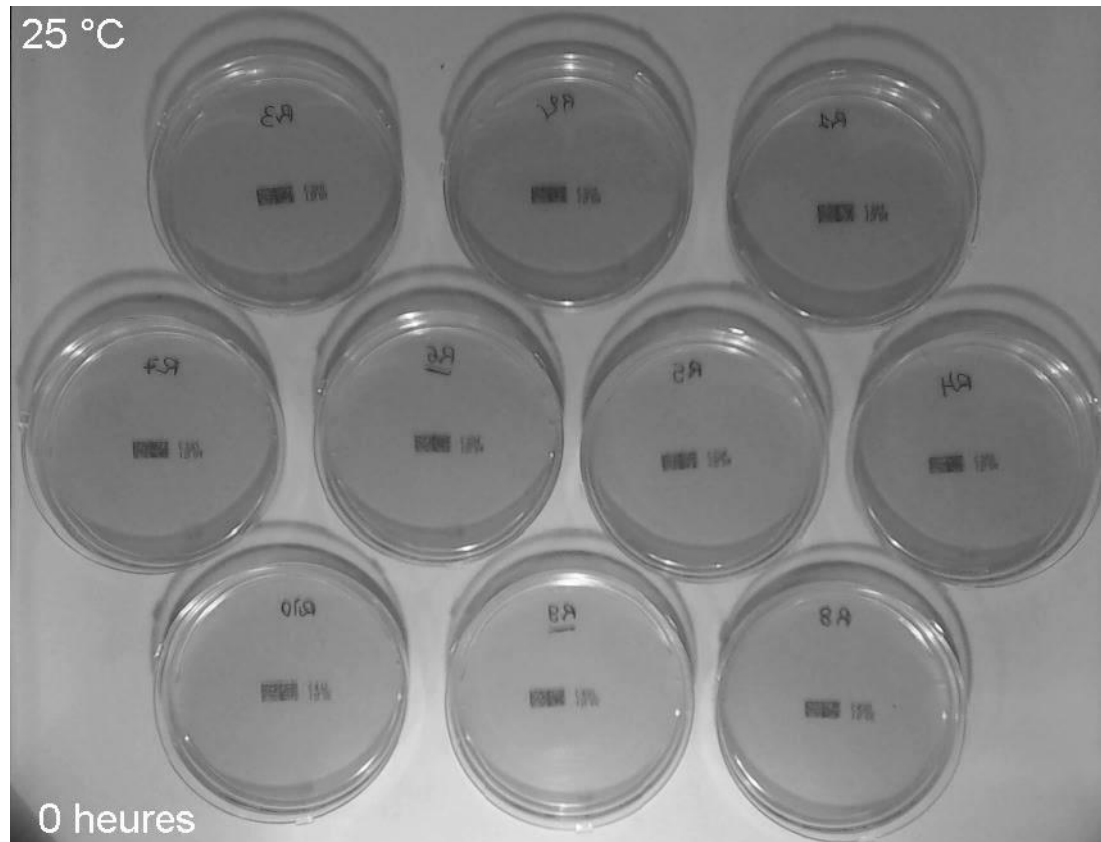
Water evaporation



t=15 h

Gel shrinkage

# “Delayed detachment” of the gel from the Petri dish



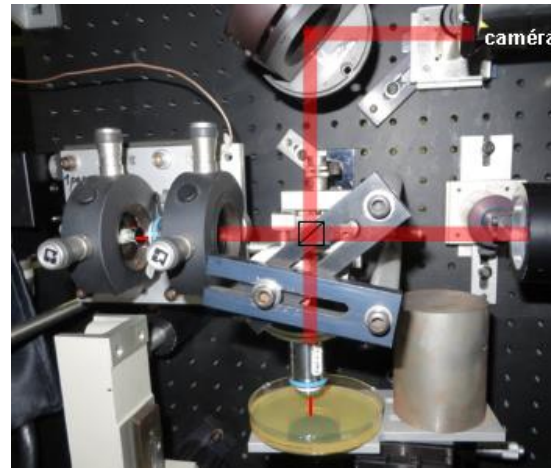
## Main goals of the project:

- rationalize the delayed detachment
- monitor the shrinkage dynamics for different boundary conditions
- impact of the gel’s microstructure on the dynamics

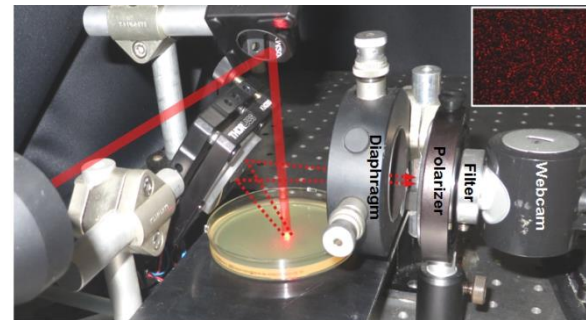
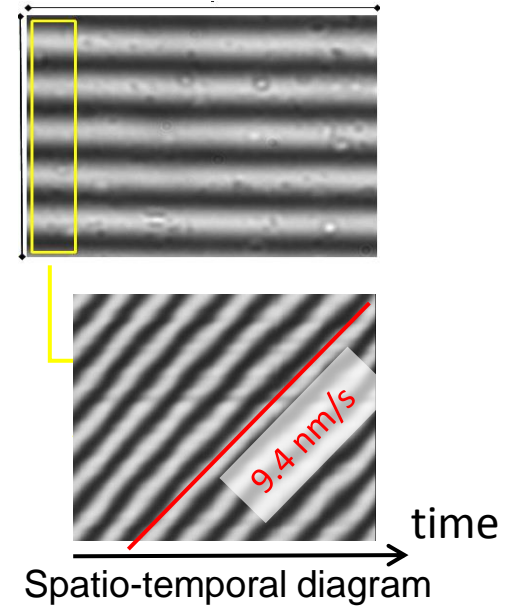


**1. Rheology**

Adhesion related issue



**2. Interferometry**



**3. Diffusing-Wave Spectroscopy (DWS)**

# How to monitor the gel formation?

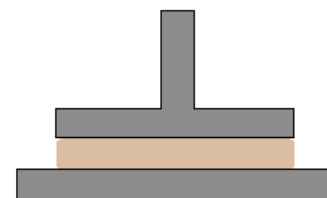
## ❖ Gel preparation



**Agar** (Sigma Aldrich® or BioMérieux®)



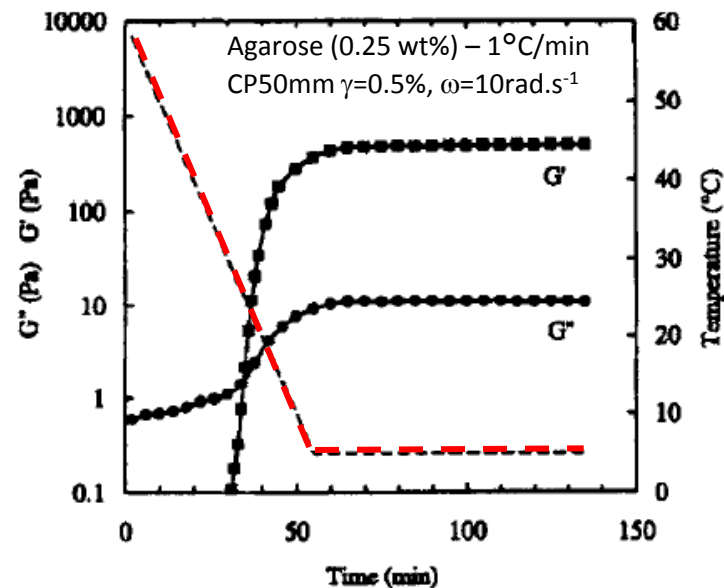
**Agar solution** (1.5% wt)  
100°C → 80°C



**Plate-Plate geometry** (Ø 40mm)  
Gap 500µm



Formation of an interconnected network made of double helices

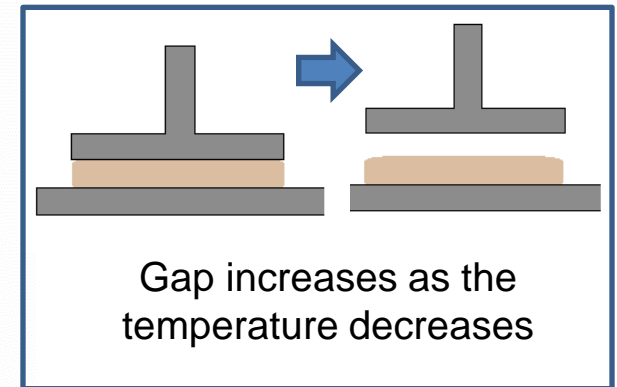
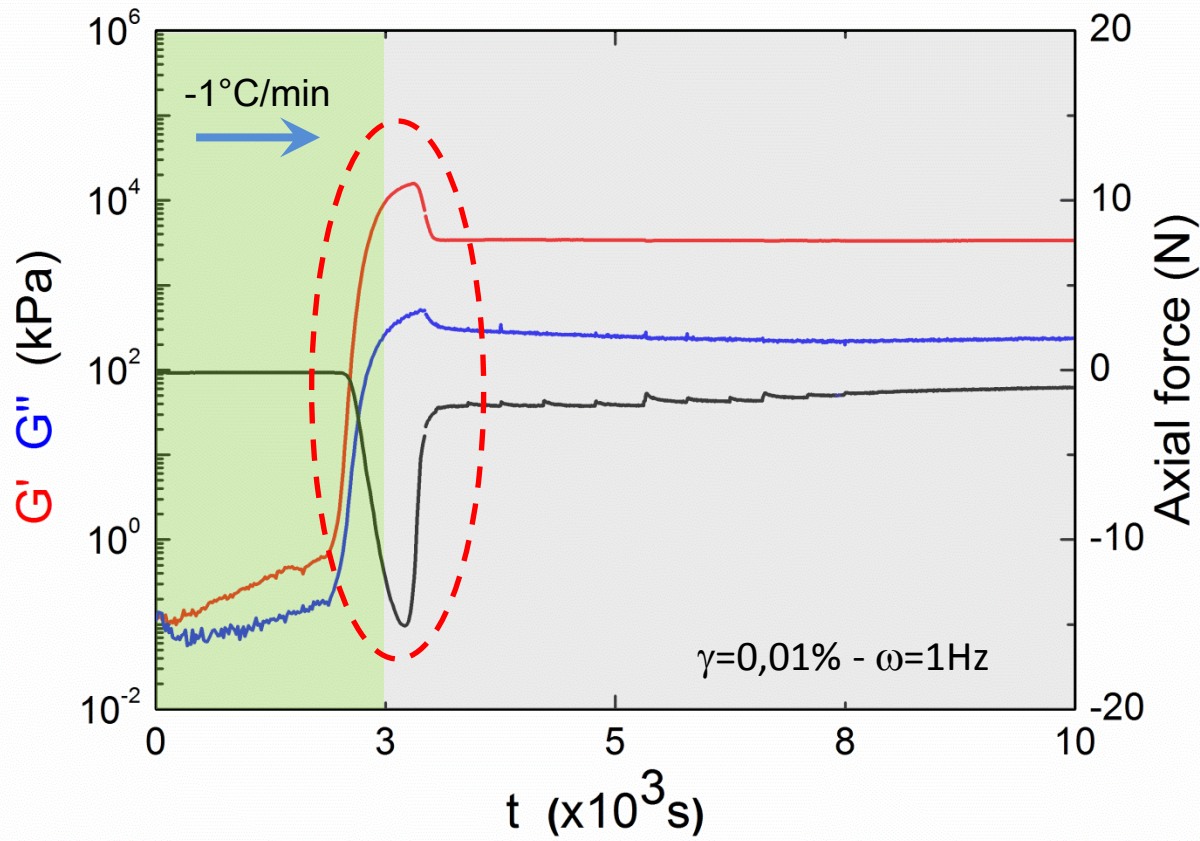


❖ Protocol :

Temperature ramp 70°C->20°C

+

Isothermal regime



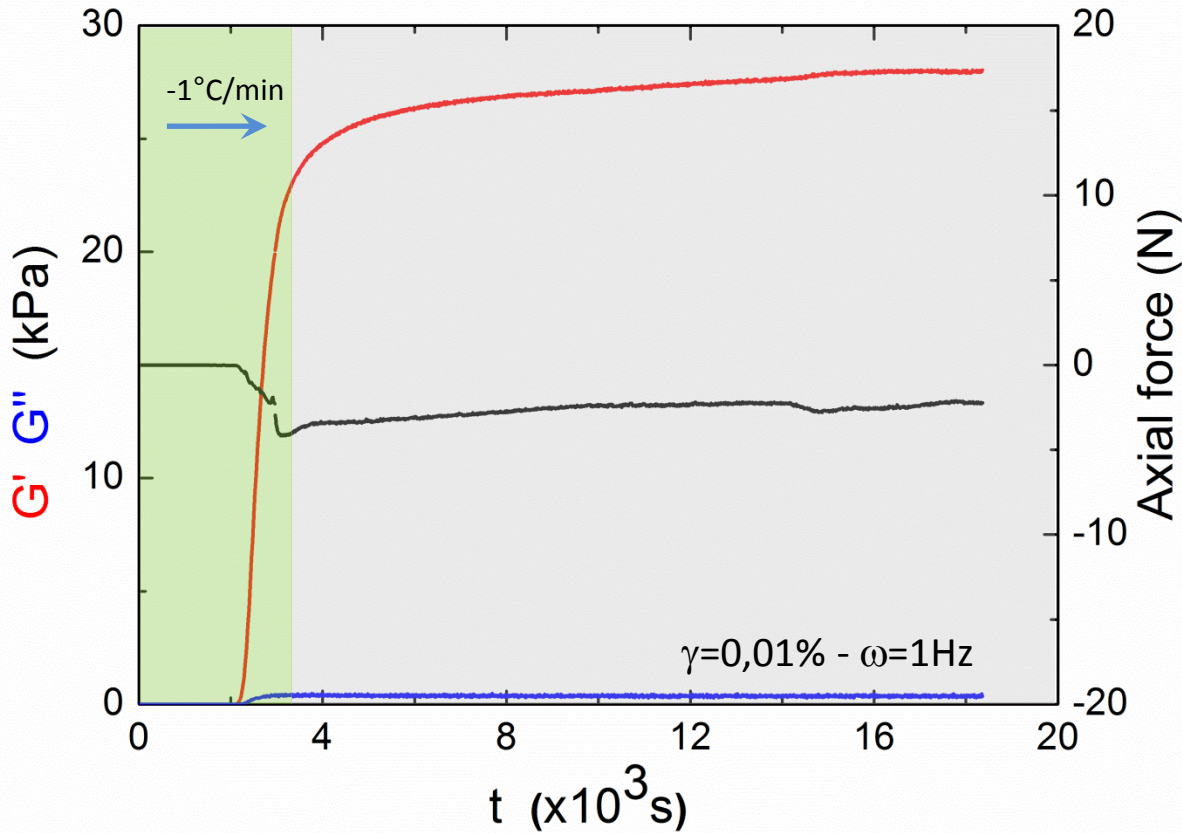
The gel is losing contact with the plate during its formation

❖ Protocol :

Temperature ramp 70°C->20°C

+ Isothermal regime

+ Temperature compensation



Temperature compensation is not enough – no steady state regime

# A proper protocol to monitor the gel formation

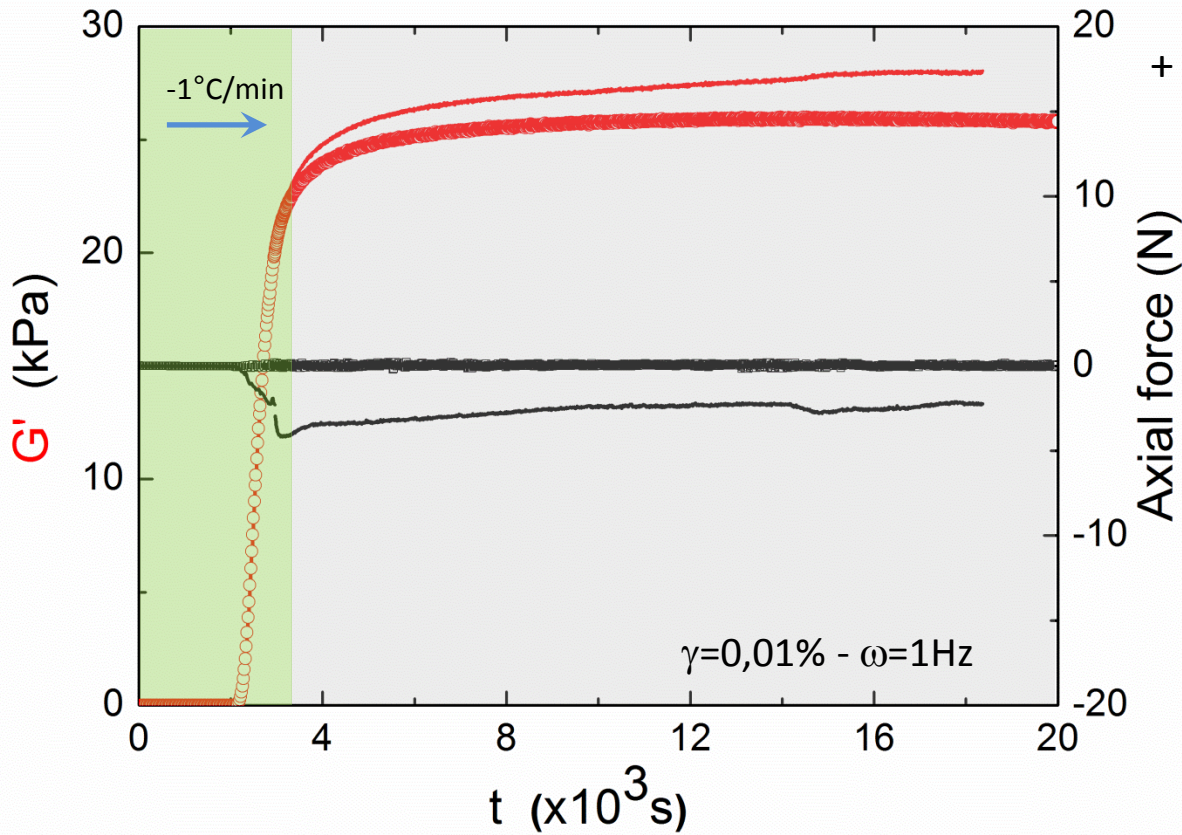
❖ Protocol :

Temperature ramp 70°C->20°C

+ Isothermal regime

+ Temperature compensation

+ Constant axial force



**Outlooks:** study the influence of several other parameters:

➤ Temperature drop, cooling rate, agar concentration, etc.



# The protocol needs to be adapted to the gel...

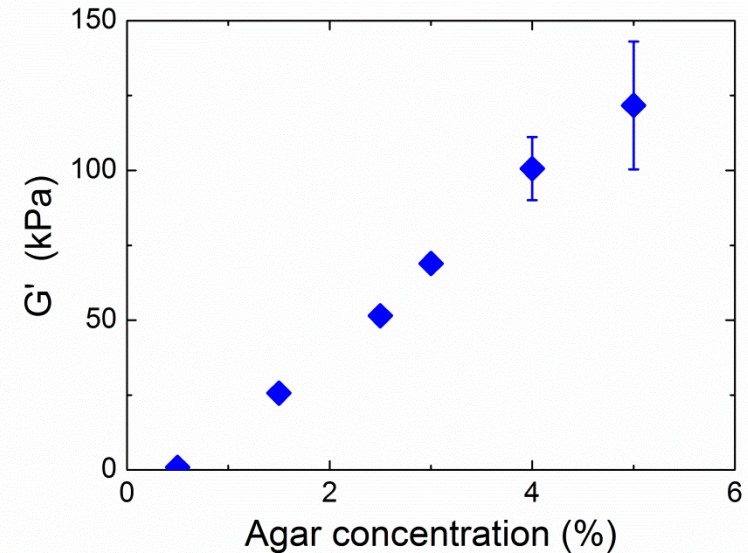
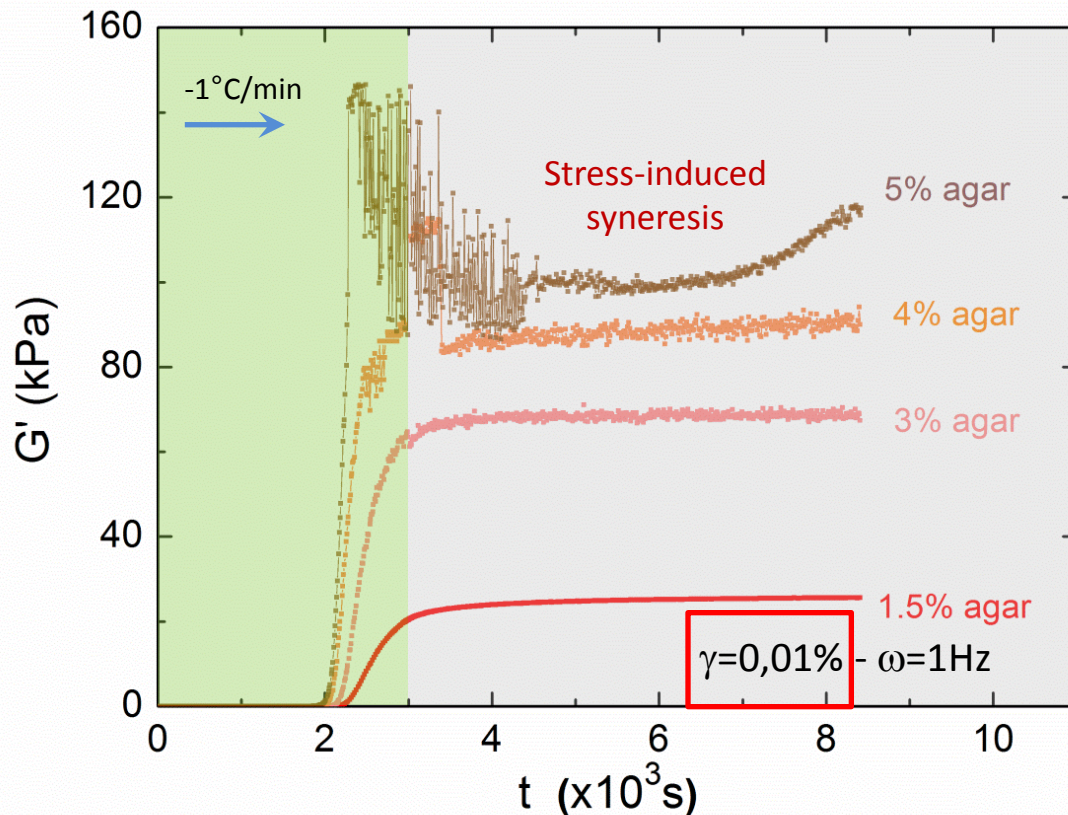
❖ Protocol :

Temperature ramp 70°C->20°C

+ Isothermal regime

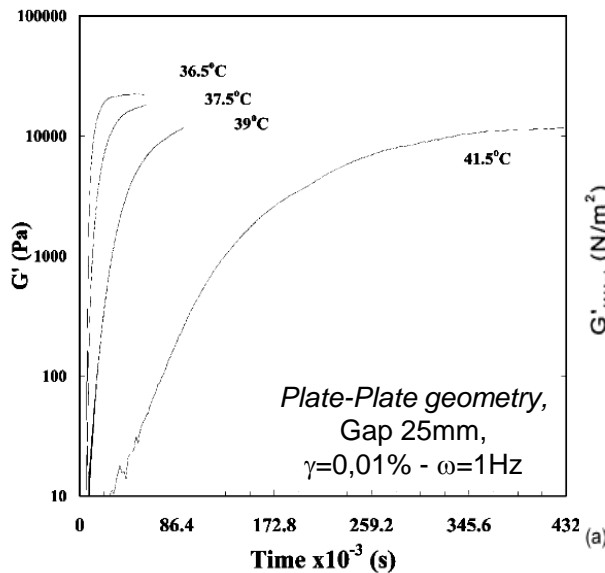
+ Temperature compensation

+ Constant axial force

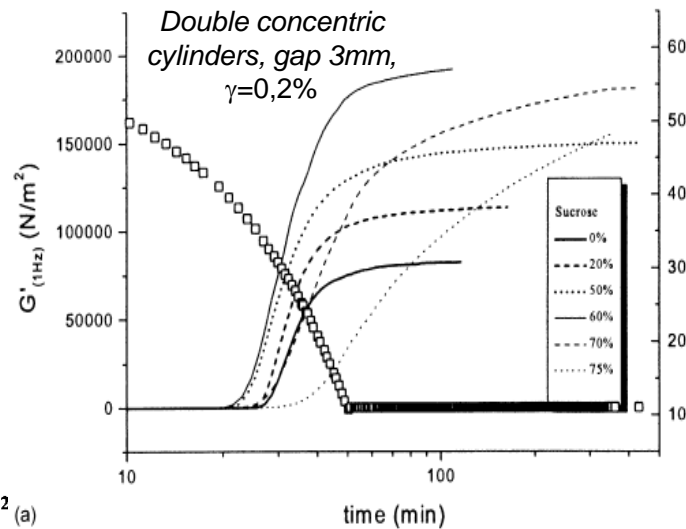


The strain amplitude should be adapted to the agar concentration!

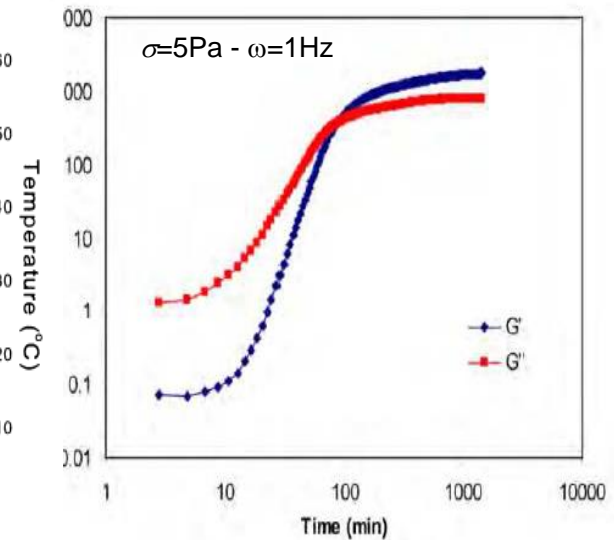
- ✓ The adhesion between the gel and the plate is a serious issue
- ✓ Measuring  $G'$  &  $G''$  requires temperature compensation & normal force control



Labropoulos *et al.*,  
Carbohydrate Polymers **50**, 407 (2002)

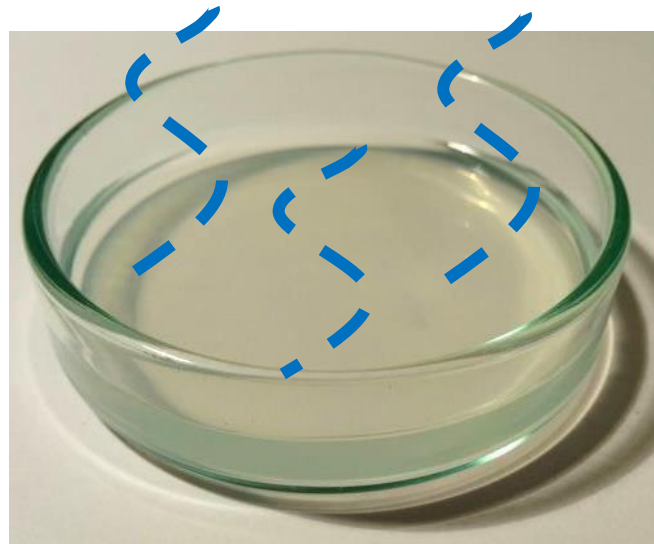


Norman *et al.*,  
Carbohydrate Polymers **54**, 83 (2003)



Grillet *et al.*, Rheology, Vicente(Ed.),  
**59** (2012)

Our work urges to revisit some results from the literature...



Thank you !