Decoding the viscoelasticity of complex macromolecules and transient networks from associating polymers based on tube model

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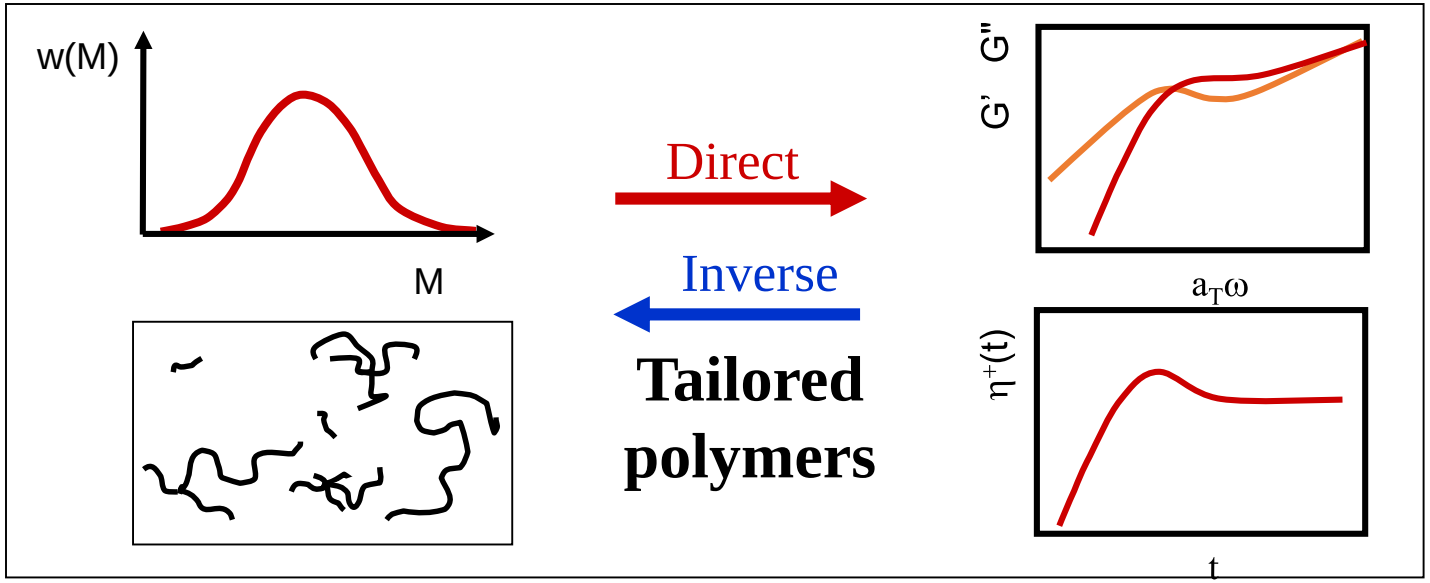
Structure-LVE relationship for complex polymers



Molecular structure of the polymer melt, Nature of the polymer

Linear viscoelastic properties (storage and loss moduli, viscosity)

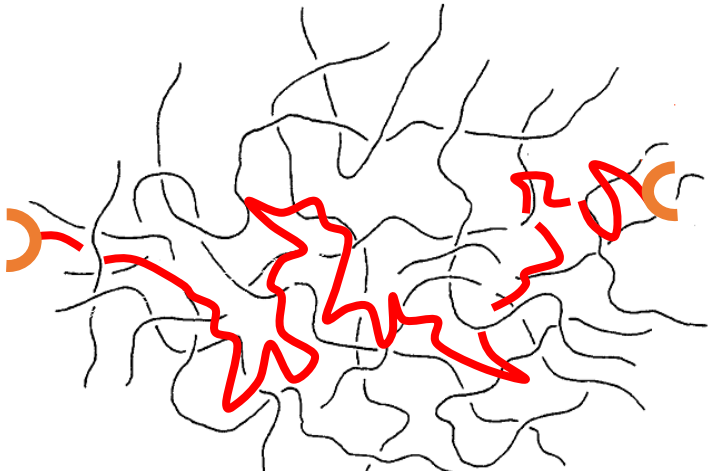
Modeling: Working on model polymers

Industrial polymers, associative systems

Sample characterization

Structure-LVE relationship for complex polymers

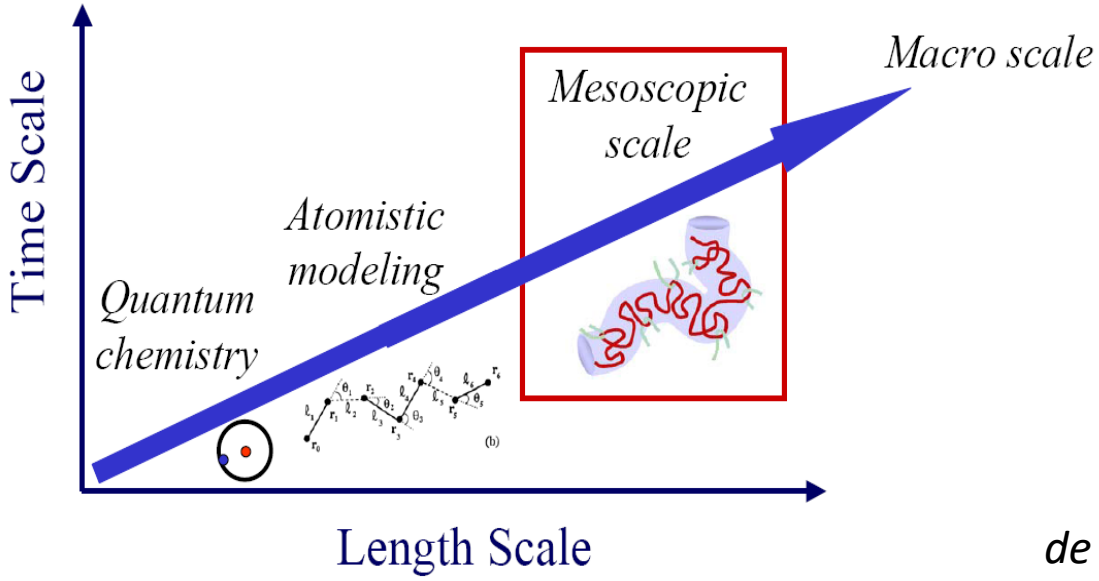
Modelling the viscoelastic behavior of telechelic polymer



Modulus governed by the entanglements

⬇

Tube-based model



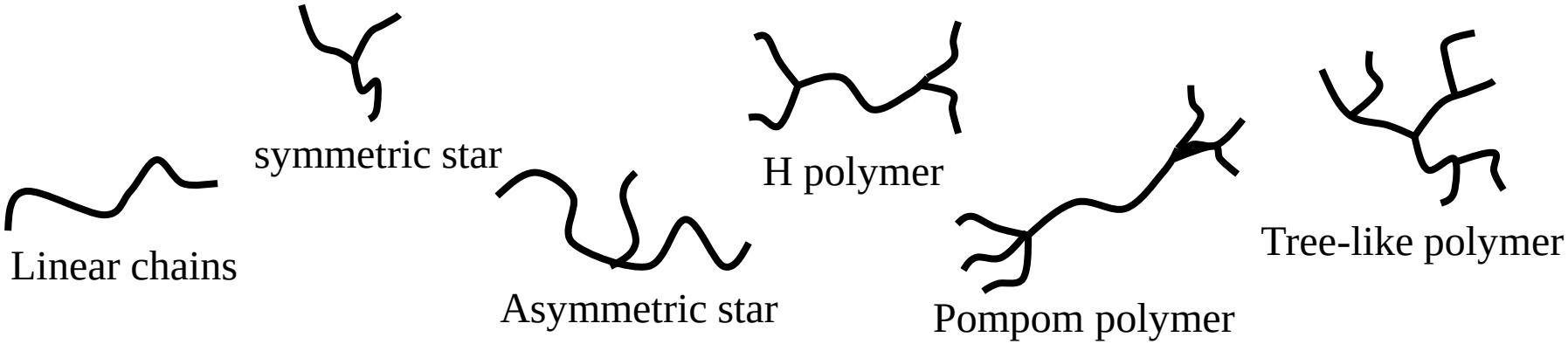
Material parameters:

$$M_e, \tau_e, G_0^N = \frac{4}{5}\frac{\rho RT}{M_e}$$

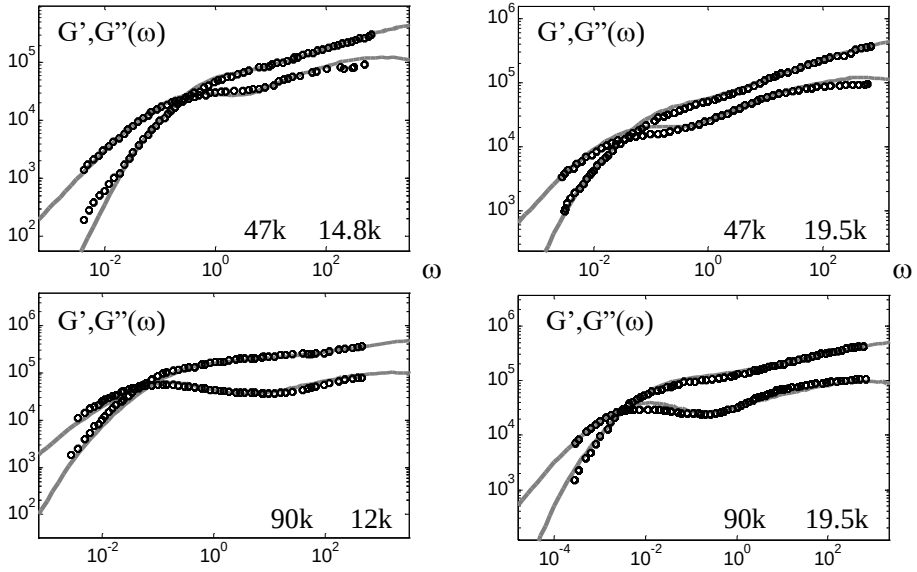
de Gennes 1971, Doi & Edwards, 1969

Structure-LVE relationship for complex polymers

Models branched polymers:



Developing a new model capable to predict the linear viscoelasticity of polydisperse complex samples



In collaboration with D. Vlassopoulos, 2005-2008

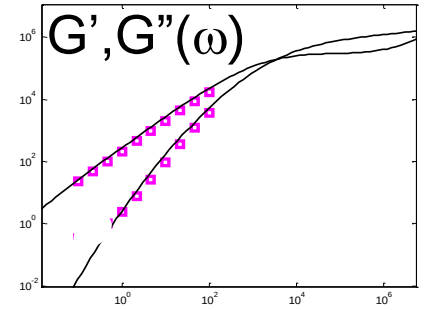
Branched PA6: from synthesis to rheology

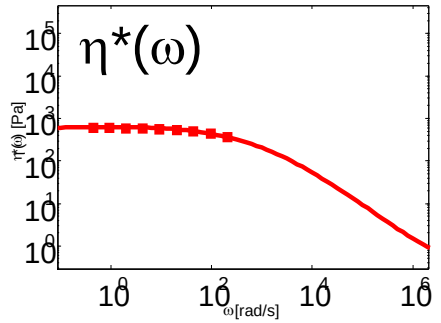
A_3 AB
AB
A_2 AB
B_2
AB
B_3
AB
Recipe (known)

Solid post-condensation

Melt

Chain architecture



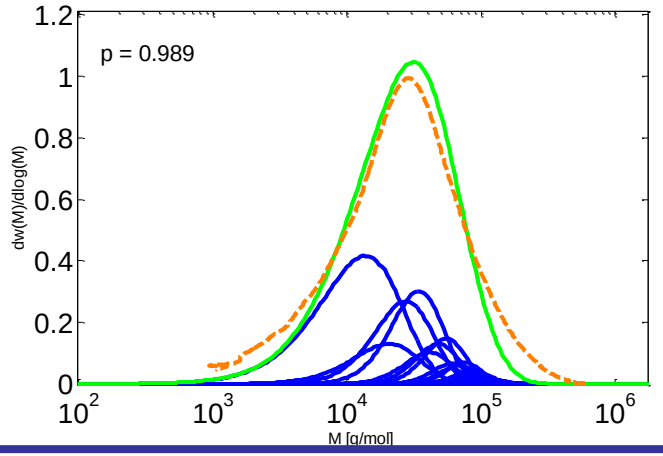


Oscillatory shear measurements

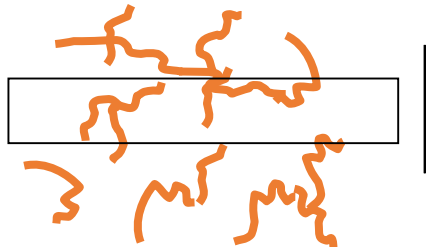
Conversion p

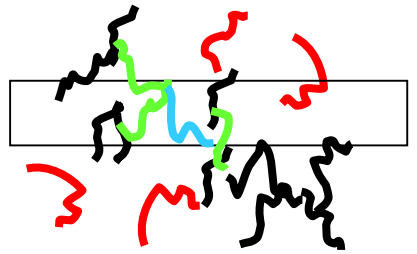
Exp. MWD (GPC – MALLS)

Monte Carlo simulations



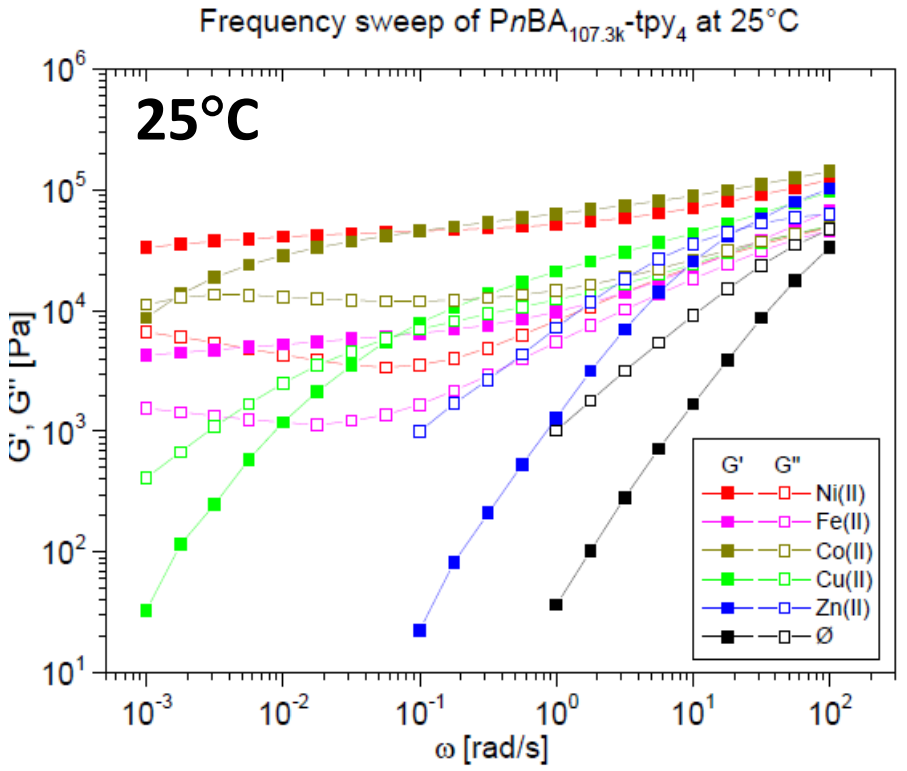
tube model

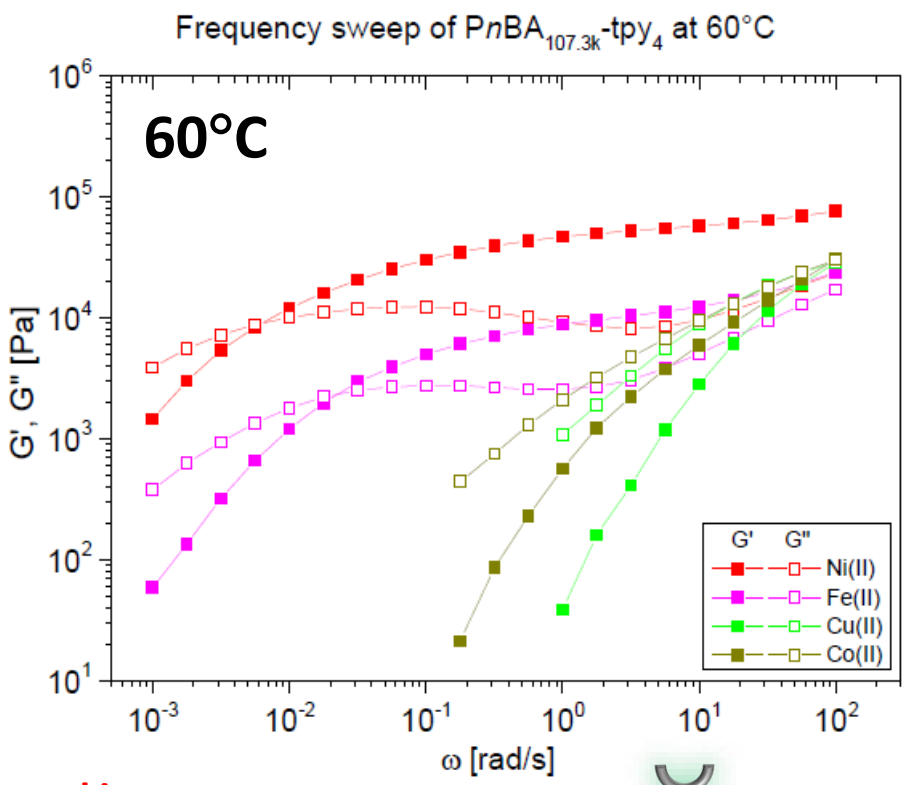




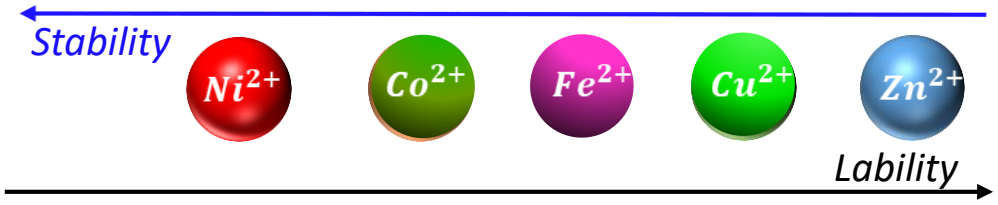
Metallo-supramolecular PnBA polymers

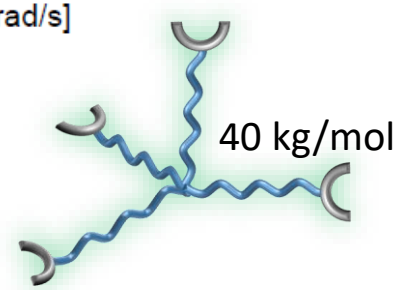
Influence of the ions nature and Temperature



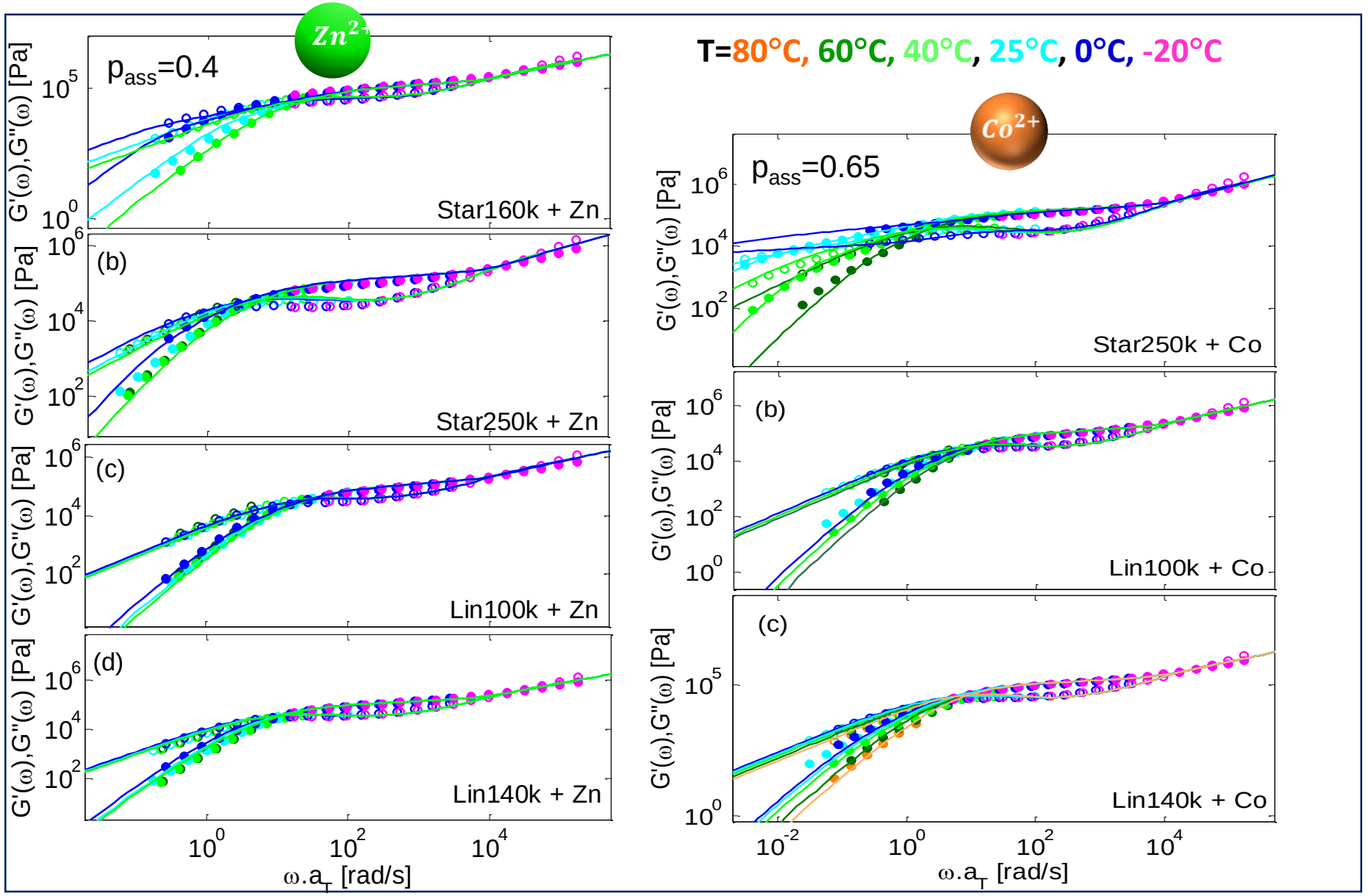


Transition metal ions



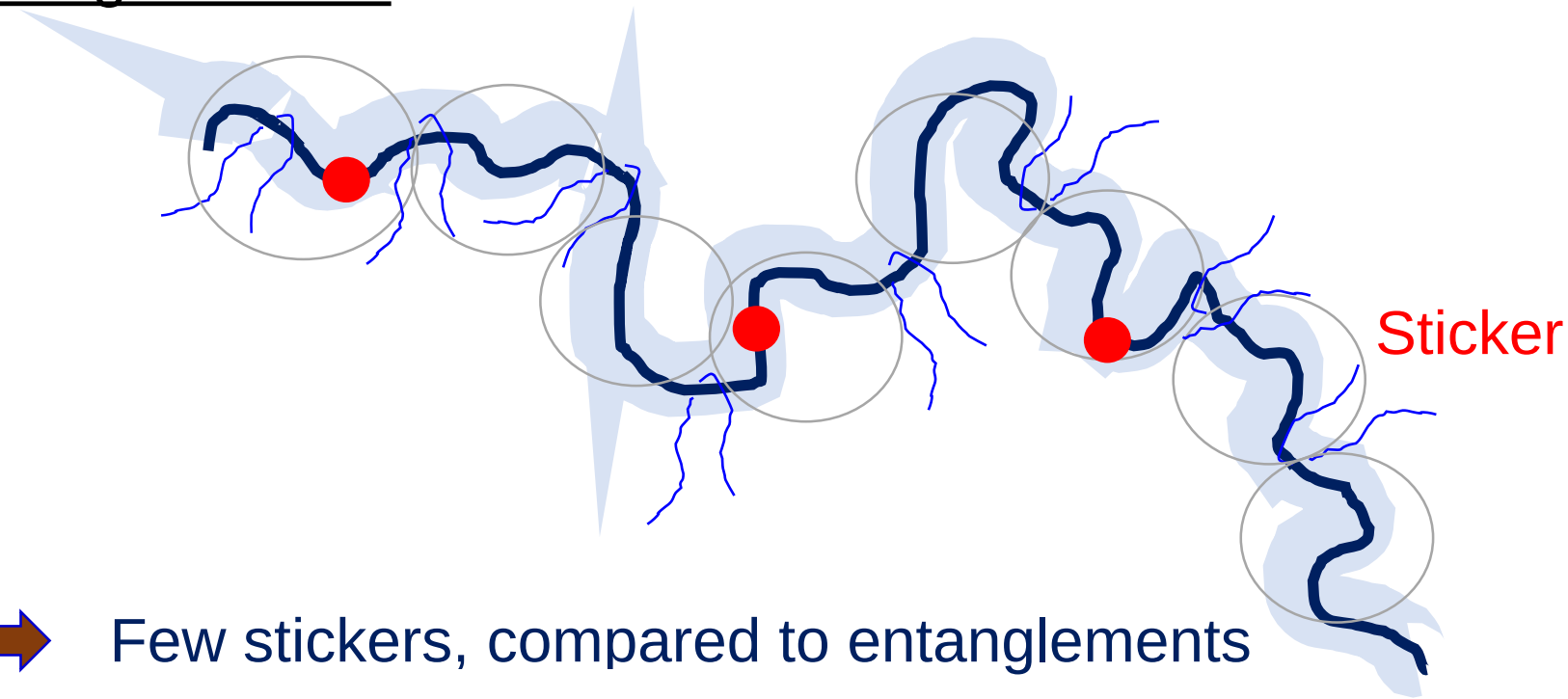


Telechelic PnBA Polymers



LVE of entangled sticky chains

Entangled chain:



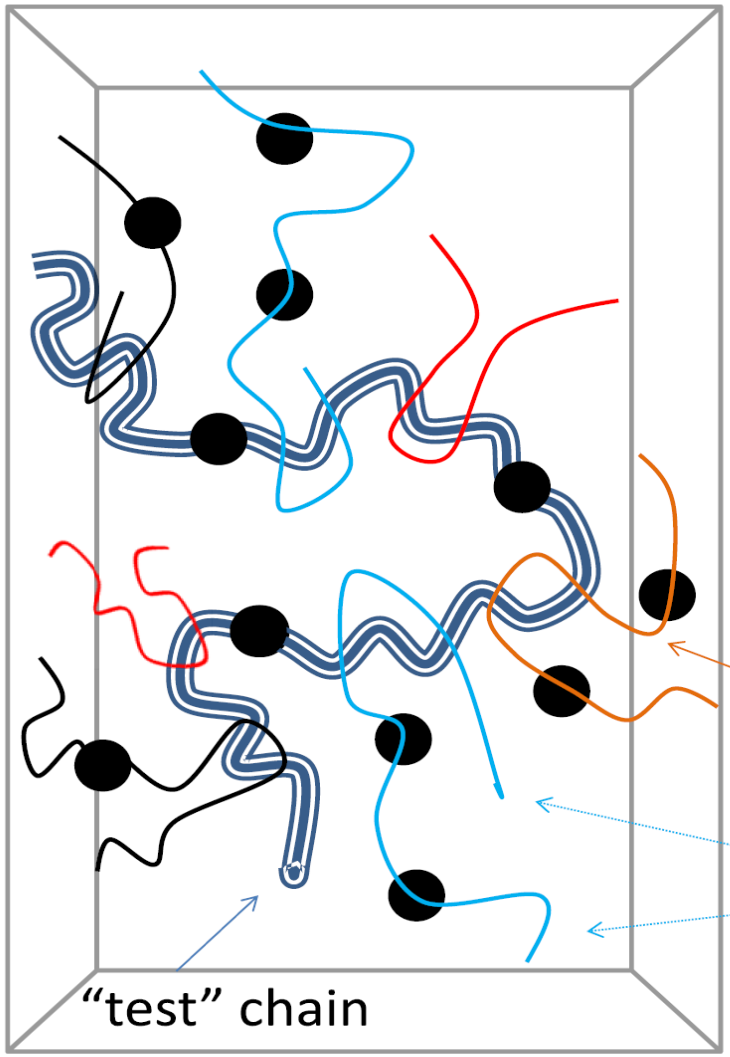
➡ Few stickers, compared to entanglements

$$M_{e,total}^{-1} = M_{e,ent}^{-1} + M_{e,XX}^{-1}$$

➡ Stickers with long lifetime

➡ Starting from TMA tube model

LVE of entangled sticky chains



AA aggregates

Star-like molecules

Trapped chains

Free linear chains

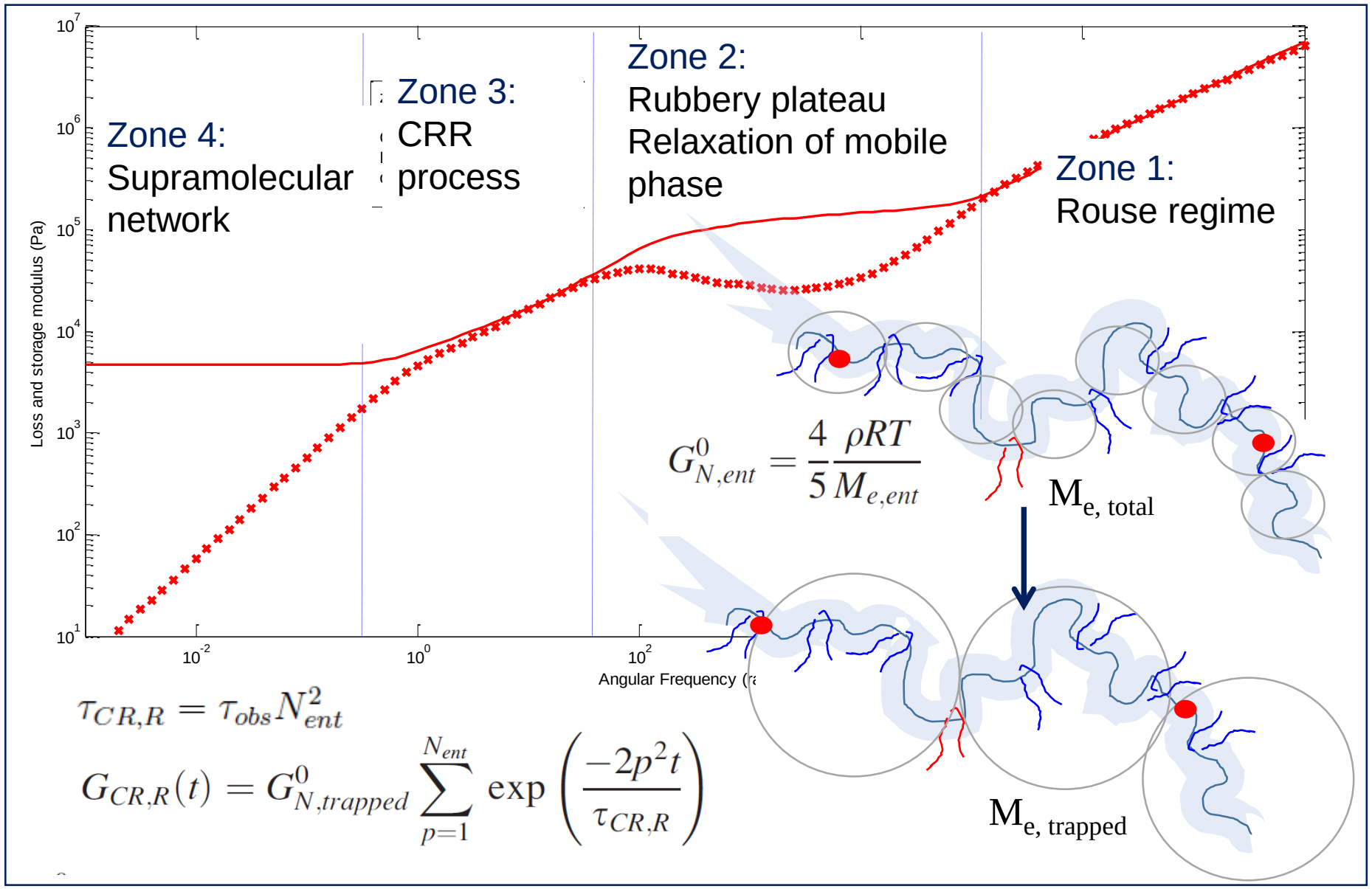
Trapped entanglements

Dangling ends of trapped chains

At low frequency: only the trapped chains cannot relax

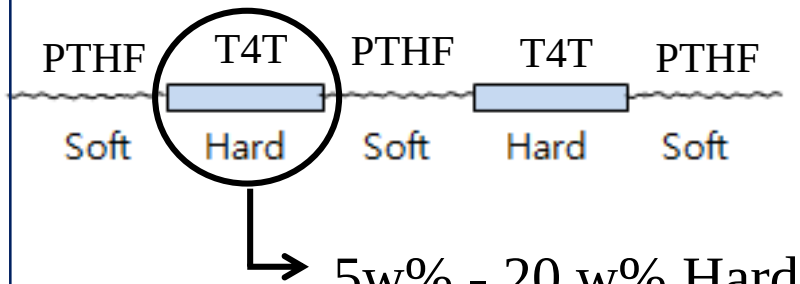
L. Hawke, M. Ahmadi, H. Goldansaz, E. van Ruymbeke, J. Rheol. 2016

LVE of entangled sticky chains

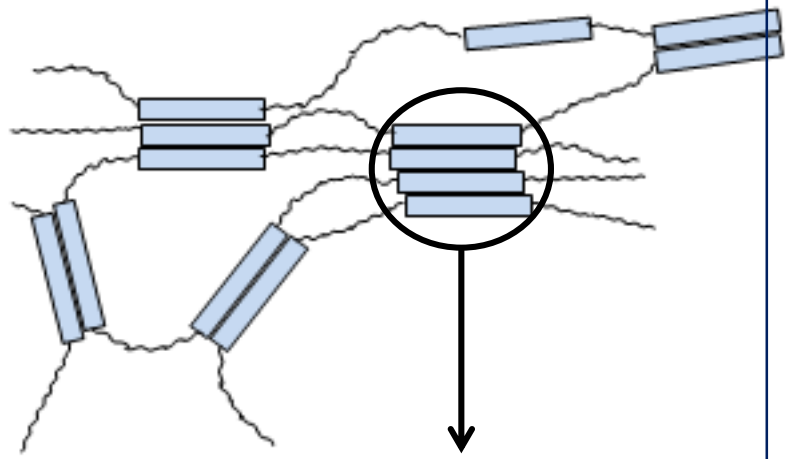


L. Hawke, M. Ahmadi, H. Goldansaz, E. van Ruymbeke, J. Rheol. 2016

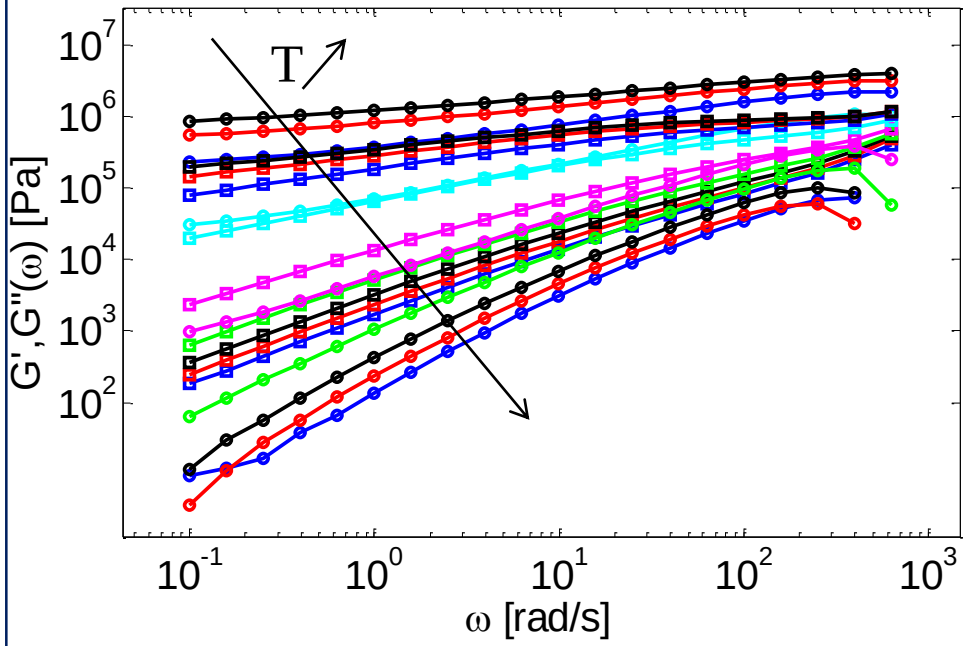
Thermoplastic elastomers

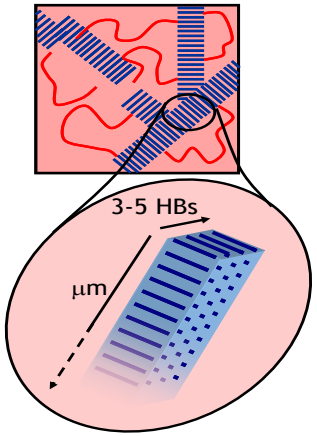


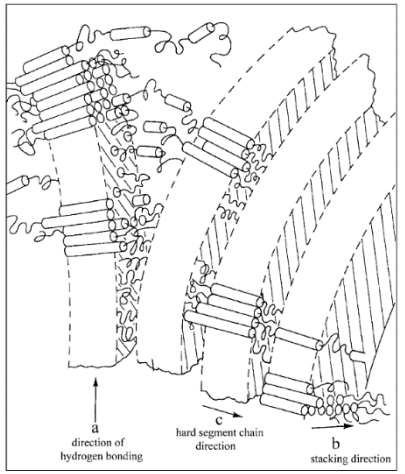
5w% - 20 w% Hard segments



H bonding and crystallization



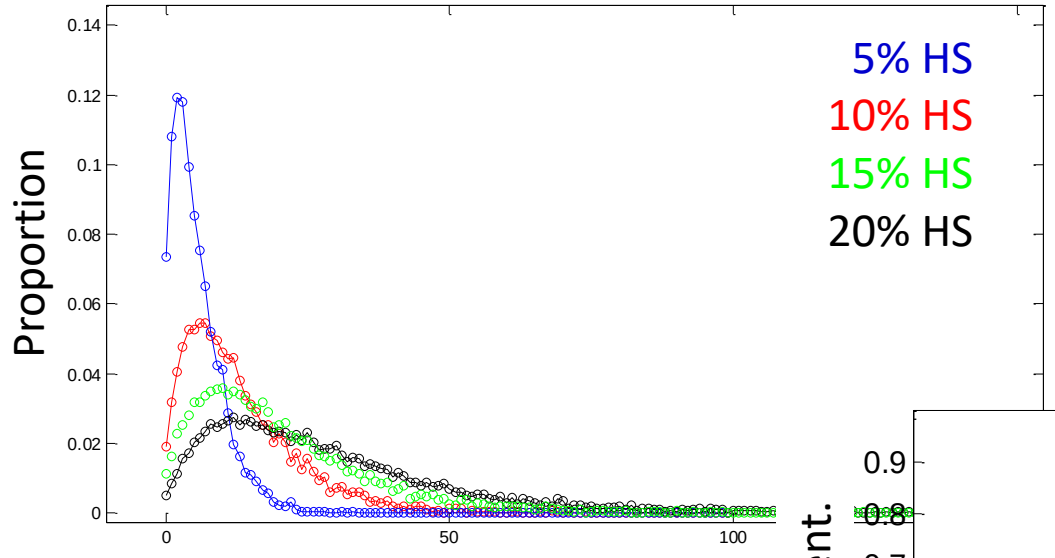


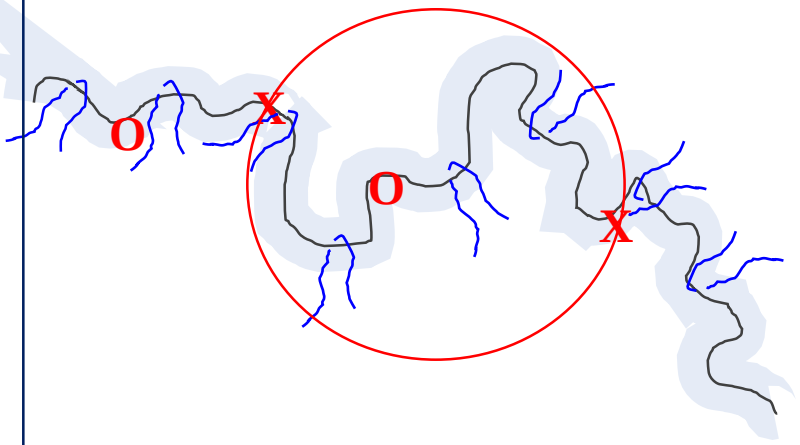


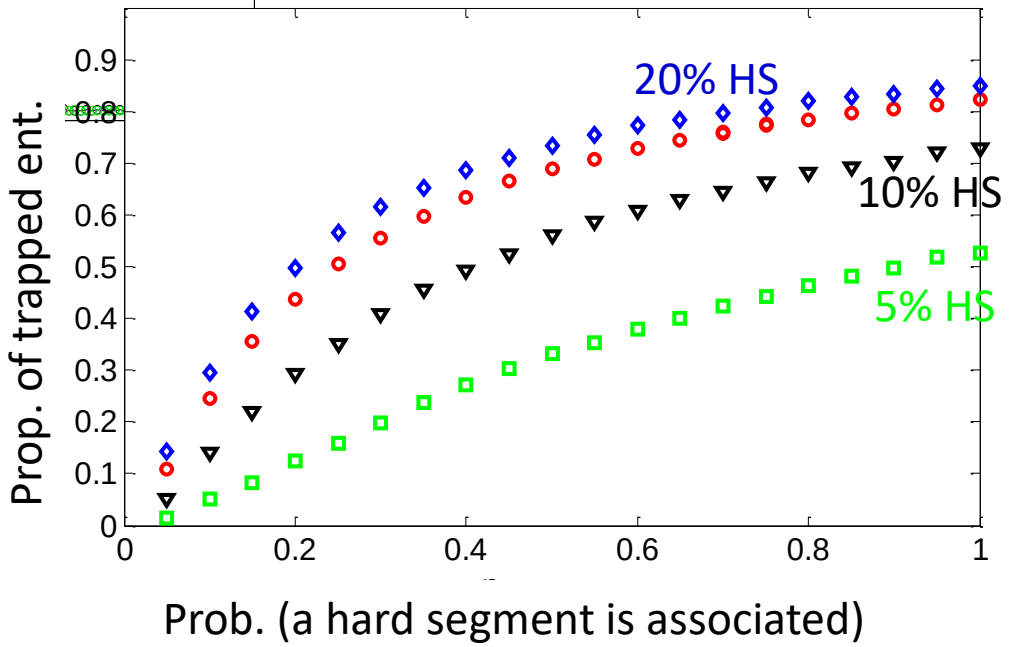
Large Mn (20 kg/mol) → Chains are entangled

G.J.E. Biemond, J. Feijen, R.J. Gaymans, J. Applied Polym. Sci. , 2007; R.J. Gaymans, Progress in Polym. Sci., 2011

Thermoplastic elastomers







*Low frequency data: governed by the **trapped entanglements***

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