Viscoelastic Response Of Double Dynamics Polymer Networks Under Large Shear Deformation

Christina Pyromali

WP2, WP3: Structure & Dynamics

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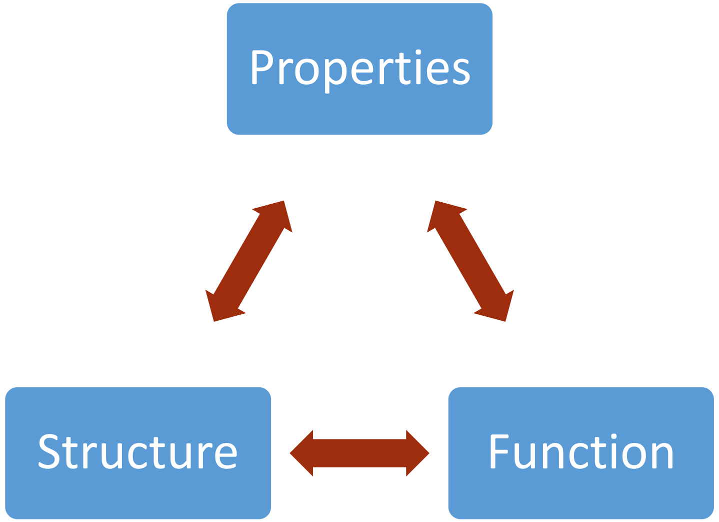
About me

- DoB: 10-10-1991
- MEng Chemical Engineering, NTUA, Greece, 2015
- MSc Advanced Chemical Engineering, UoB, UK, 2018
- ESR#5, 01-04-2018, UoC, Greece
- Advisors: Dimitris Vlassopoulos, George Petekidi

INITIAL TRAINING NETWORK

Motivation



- Understanding the multi-scale dynamics of reversible bonds, entanglements and overall architecture of DDNs can facilitate the **combination** and **control** of distinct features within the same material

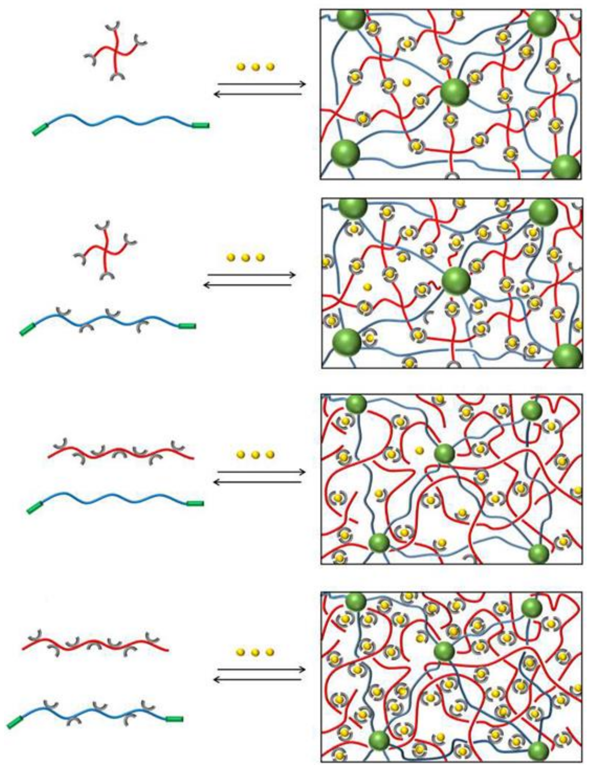
Objectives

- Non linear shear behavior investigation & correlation with:
  1. Model systems structure, composition and possible inhomogeneities
  2. LVE behavior
  3. Transient elongation properties
- Linear and non linear Creep testing for understanding the relationship with adhesive properties, the role of entanglements and the loss of macroscopic cohesion
- Understanding the origin and influence of shear thickening behavior

Materials

Investigation of the solid-state morphology development with fiber-like crystals

Metal-ligand, Phase Separation, Entanglements



("DoDyNet-ETN," 2017)

Double Dynamics Thermoplastic Elastomers

Linear segmented co-polymers with amide-based hard blocks

- Tunable elasticity
- Extensibility

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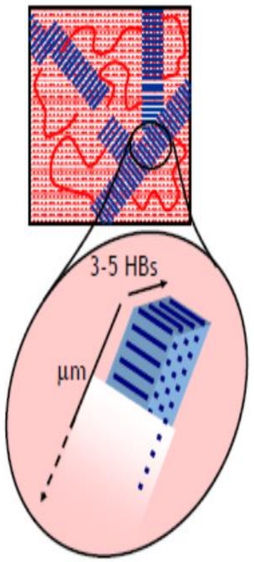
Short triblock copolymers

- Toughness
- Self-healing

TPEs of same chemistry but different density or length of hard blocks

- Tailor bonds lifetime

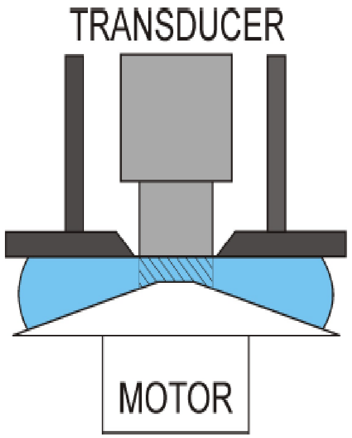


("DoDyNet-ETN," 2017)

Methods

Non-Linear Shear Behavior

- Cone And Partitioned Plate



(Constanzo, 2017)

Instabilities

- Edge fracture
- Wall slip
- Shear banding

- Composition, structure, ligand exchange mechanism, yielding, instabilities, cohesive strength, shear thinning, shear hardening, temperature effect

Creep

- Linear: terminal flow, network structure, long-time dynamics extension
- Recovery: Self healing
- Non linear: Crack propagation, yielding

Multi-Speckle Dynamic Light Scattering

- Slow modes

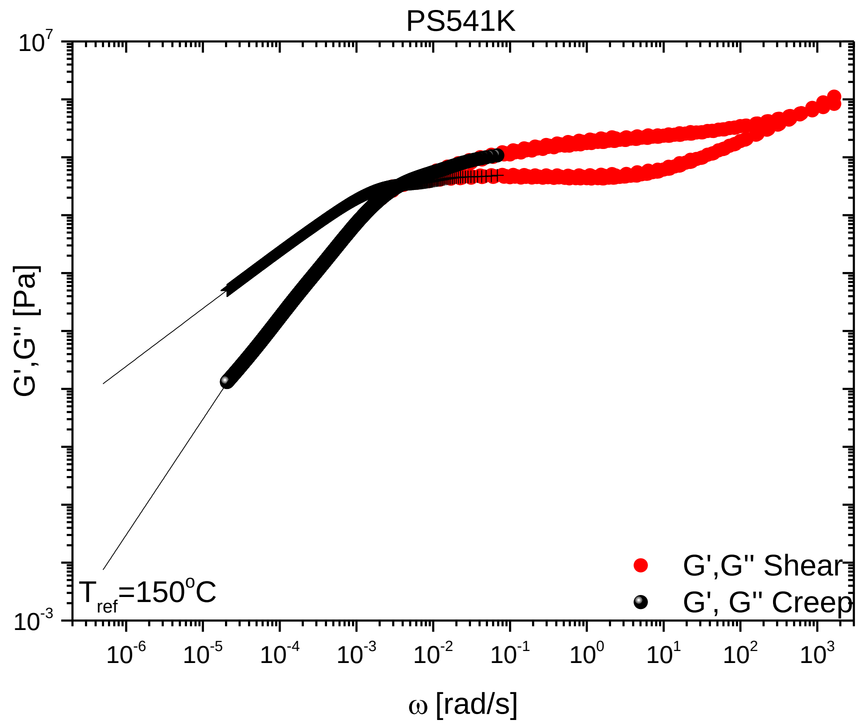
Small-Angle Neutron Scattering

- Inhomogeneity of the crosslinking density of the network
- Crystallite distance

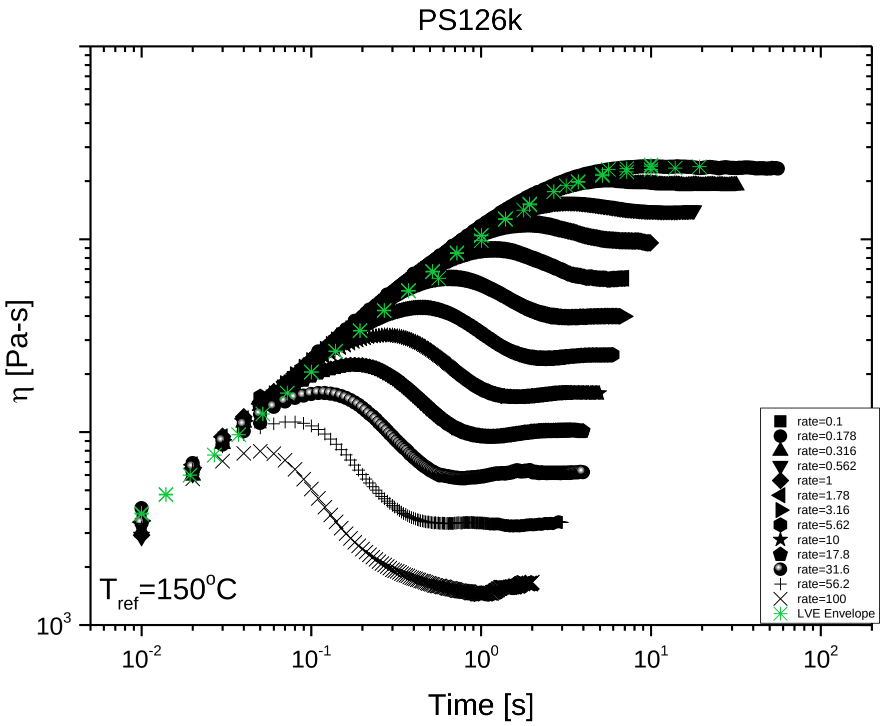
Dielectric Spectroscopy

- Metal-ligand lifetime

Results



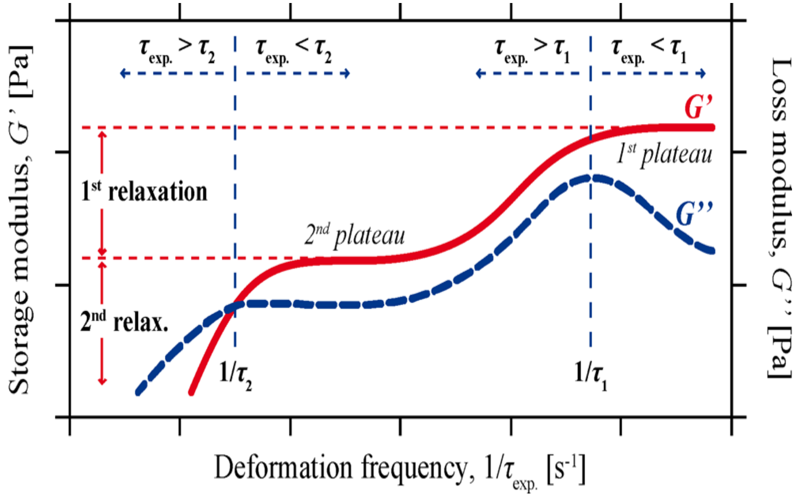
PS541K
G',G'' [Pa]
ω [rad/s]
T_{ref}=150°C
G',G'' Shear
G', G'' Creep



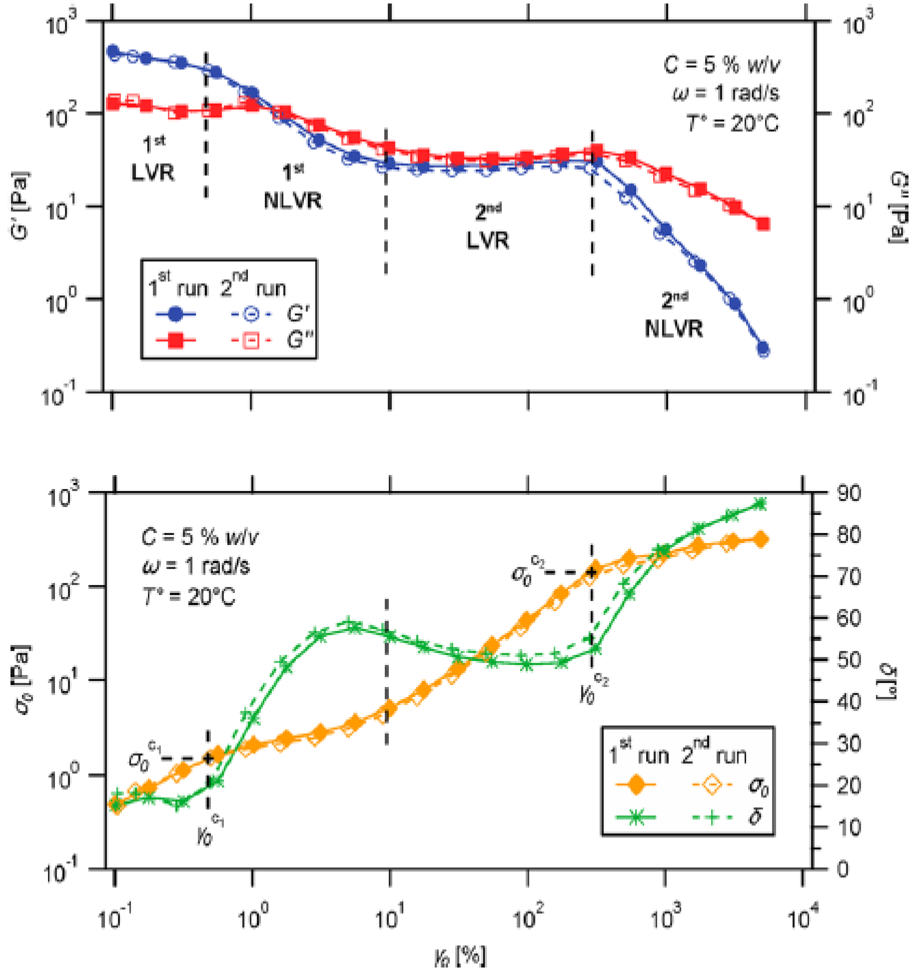
PS126k
η [Pa-s]
Time [s]
T_{ref}=150°C
rate=0.1
rate=0.178
rate=0.316
rate=0.562
rate=1
rate=1.78
rate=3.16
rate=5.62
rate=10
rate=17.8
rate=31.6
rate=56.2
rate=100
LVE Envelope

Discussion

- DDNs are expected to display a multiscale viscoelastic response showing more than one
  - transitions between linear and nonlinear regions
  - plateau regimes
  - multiple yielding
- TTS failure
  - Different bonding interactions

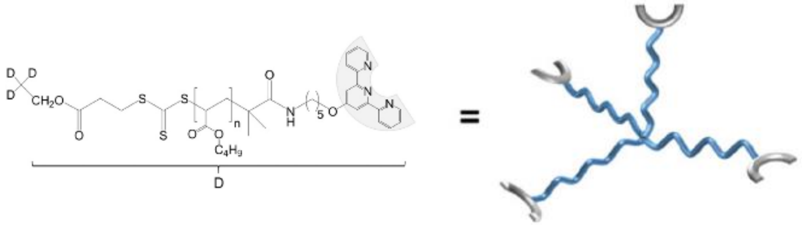


(Brassinne et al., 2013)



(Brassinne et al., 2016)

Starting project



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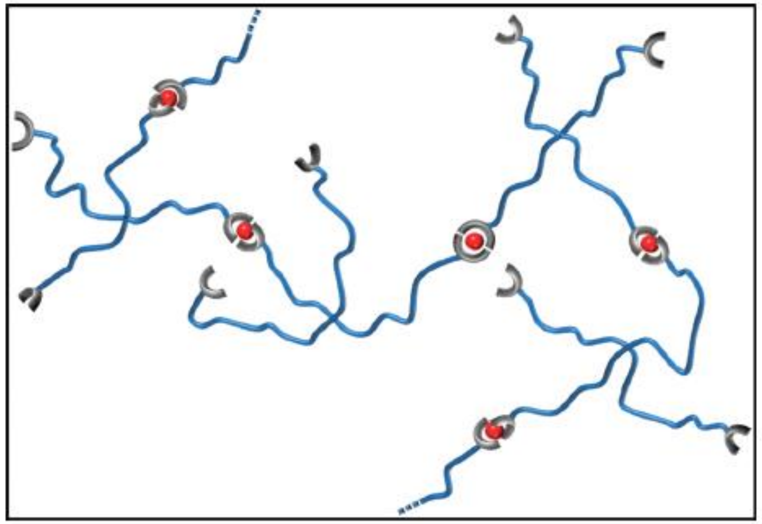
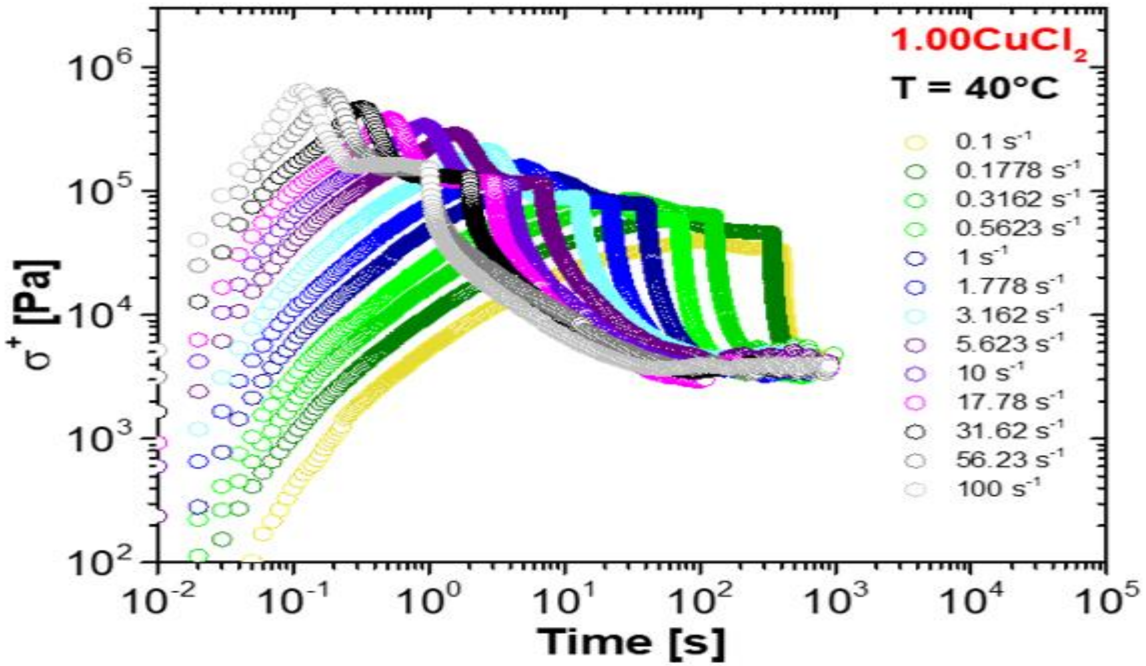
Metal Ions: $ZnCl_2$ $CuCl_2$ $CoCl_2$



(Zhuge et al., 2017)



(Zhuge, 2018)

- What's the structural evolution under non linear deformation?
- Is the residual stress at different deformation rates the same?
- Could the modified TMA model characterize the experimental data?

Thank you for your attention!

Questions?

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