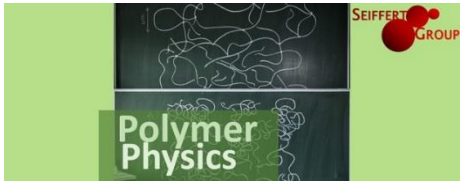
Paola Nicolella (ESR 10)

"Structure and diffusion in DDNs at the nano- to micro- scale"

Marie Sklodowska Curie ITN-DoDyNet
Double dynamics for design of new responsive polymer networks and gels

Prof. Dr. Sebastian Seiffert

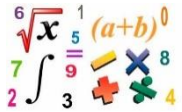
Institute of Physical Chemistry
Johannes Gutenberg
University Mainz
Germany



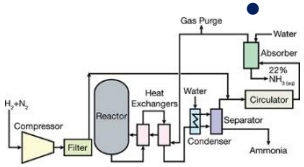
Introduction

Education

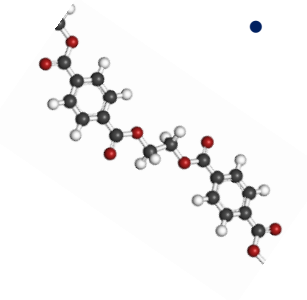
- 1996-2001 **German Primary School**
  Geilenkirchen – Germany / Rome - Italy



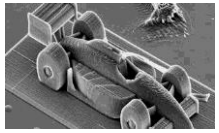
- 2009, **Scientific High School Graduation**
  Naples – Italy



- 2015, **Bachelor Degree in Chemical Engineering**
  Università degli Studi di Napoli Federico II – Italy
  - Chemical plants, Chemical reaction engineering, Industrial chemistry



- 2018, **Master of Science in Chemical Engineering (Molecules & Materials Engineering)**
  University of Twente – The Netherlands
  - Organic/Inorganic Materials Science, Elastomers Science & Engineering
  - Laboratory experience



- 2018, **Master of Science in Nanotechnology**
  University of Twente – The Netherlands
  - Characterization and Fabrication of Nanostructures, Cleanroom

Experience

- **Internship – Apollo Tyres R&D**
  Enschede – The Netherlands
  - Broadening of the tan δ curve with new polymers enhancing the wet grip without affecting rolling resistance (2 patents filed)

- **Master Thesis – University of Twente**
  Enschede – The Netherlands
  - Adsorption of macromolecules on designer substrates by Atomic Force Microscopy based Single Molecule Force Spectroscopy: The role of the surrounding medium

INITIAL TRAINING NETWORK

DDDynet

“Structure and diffusion in DDNs at the nano- to micro- scale”

JG|U

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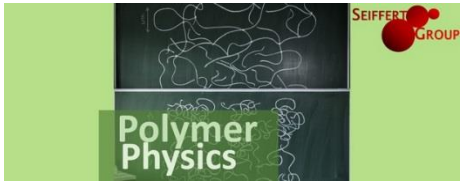
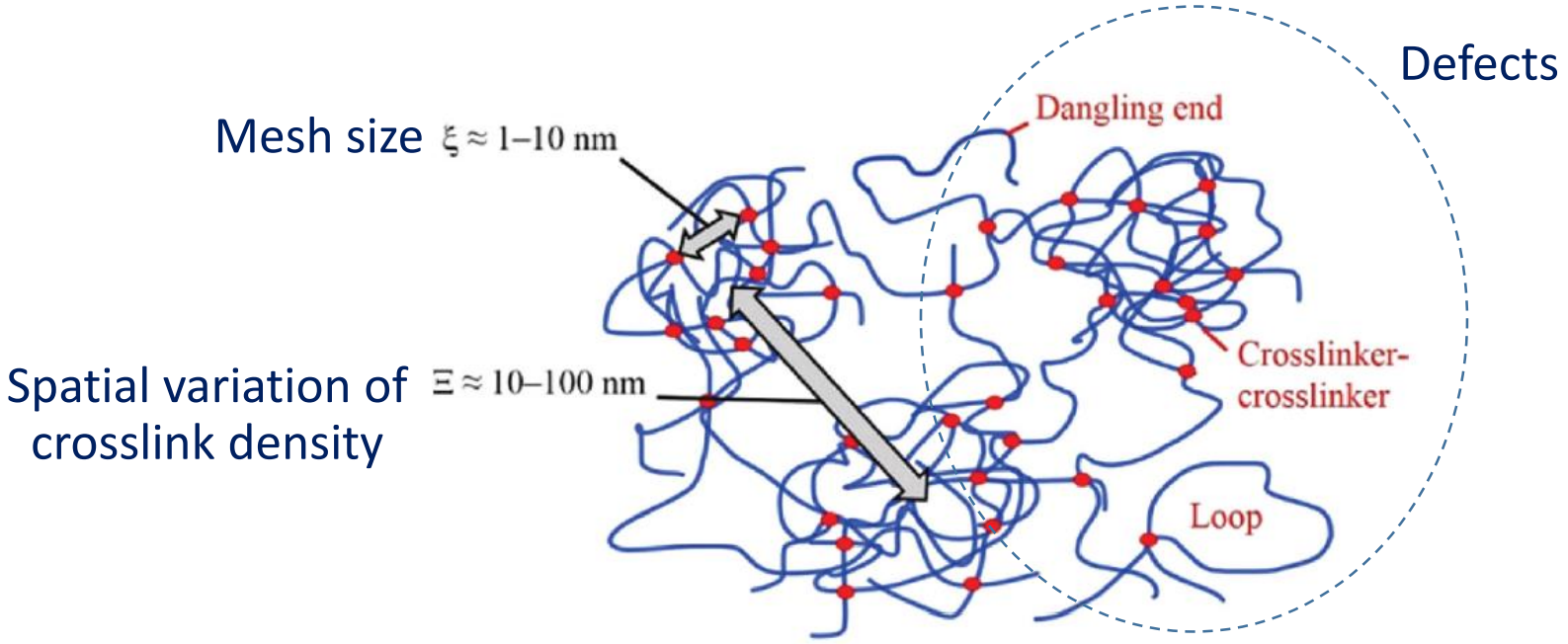


Research plan

- Mesh size, phase-separated domains and homogeneity
- Time evolution and equilibrium state of phase-separated domains. Their influence on the diffusion coefficient
  (collaboration with FORTH)
- Influence of synthesis protocol on the structure
  (collaboration with UCL)
- Role of heterogeneities on application properties
  (collaboration with ESPCI)
- Structure and diffusion in coating applications
  (collaboration with Allnex)

Heterogeneity in polymer networks

Nano-structural heterogeneity → inhomogeneous spatial distribution of crosslinks → distribution of mesh sizes

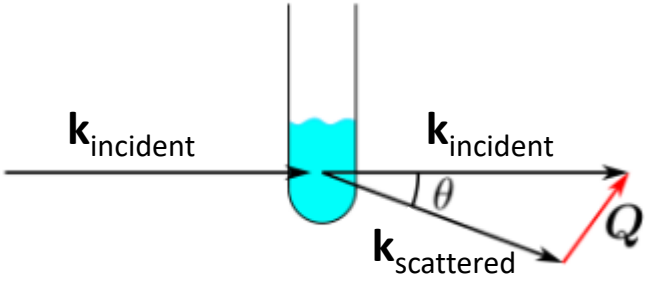


Nanostructural heterogeneity in polymer networks and gels.
F. Di Lorenzo and S. Seiffert, *Polymer Chem.* **2015**, *6*, 5515–5528.

Characterization techniques

- Dynamic light scattering (DLS)
- Static light scattering (SLS)
- Fluorescence recovery after photobleaching (FRAP)
- Rheology

Dynamic light scattering (DLS) & Static light scattering (SLS)



- Size distribution
- Homogeneity
- Diffusion coefficient $D = \frac{kT}{6\pi\eta\xi}$
- Mesh size ξ

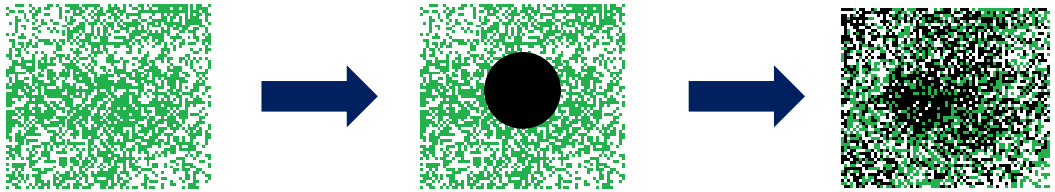
Q=$\mathbf{k}_{incident}$-$\mathbf{k}_{scattered}$=scattering vector

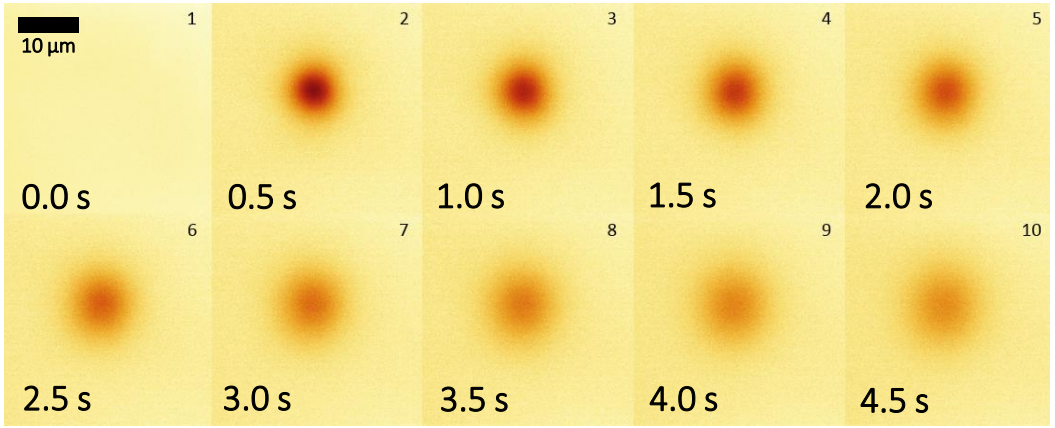
$$Q = \frac{4\pi n}{\lambda}\sin(\frac{\theta}{2})$$

SLS	DLS
Angular dependent measurement	Fixed angle
Average over time	Time dependent measurement

http://www.soft-matter.uni-tuebingen.de/index.html?dls.html

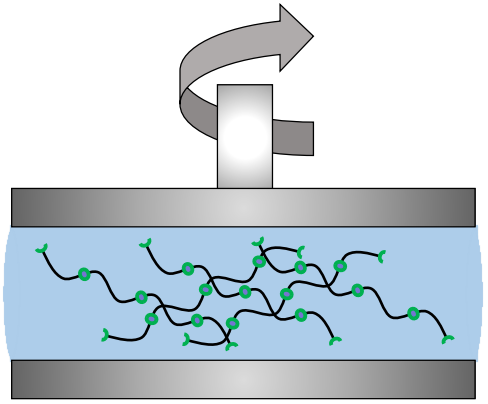
Fluorescence recovery after photobleaching (FRAP)

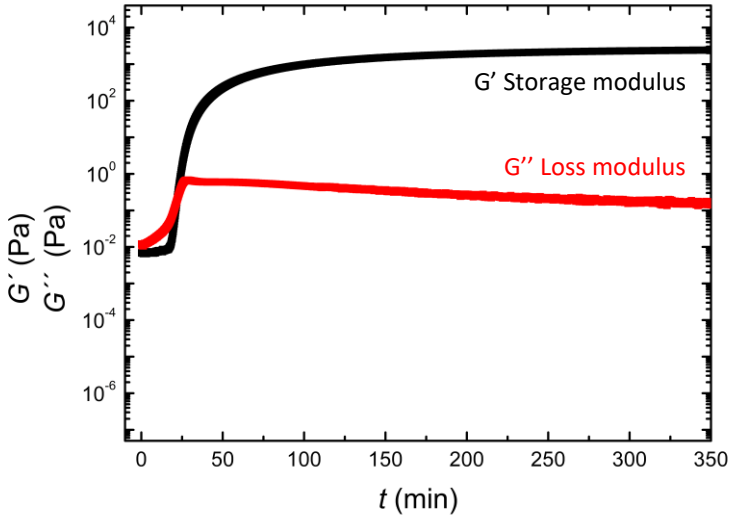




- Polydispersity
- Inhomogeneity

Rheology





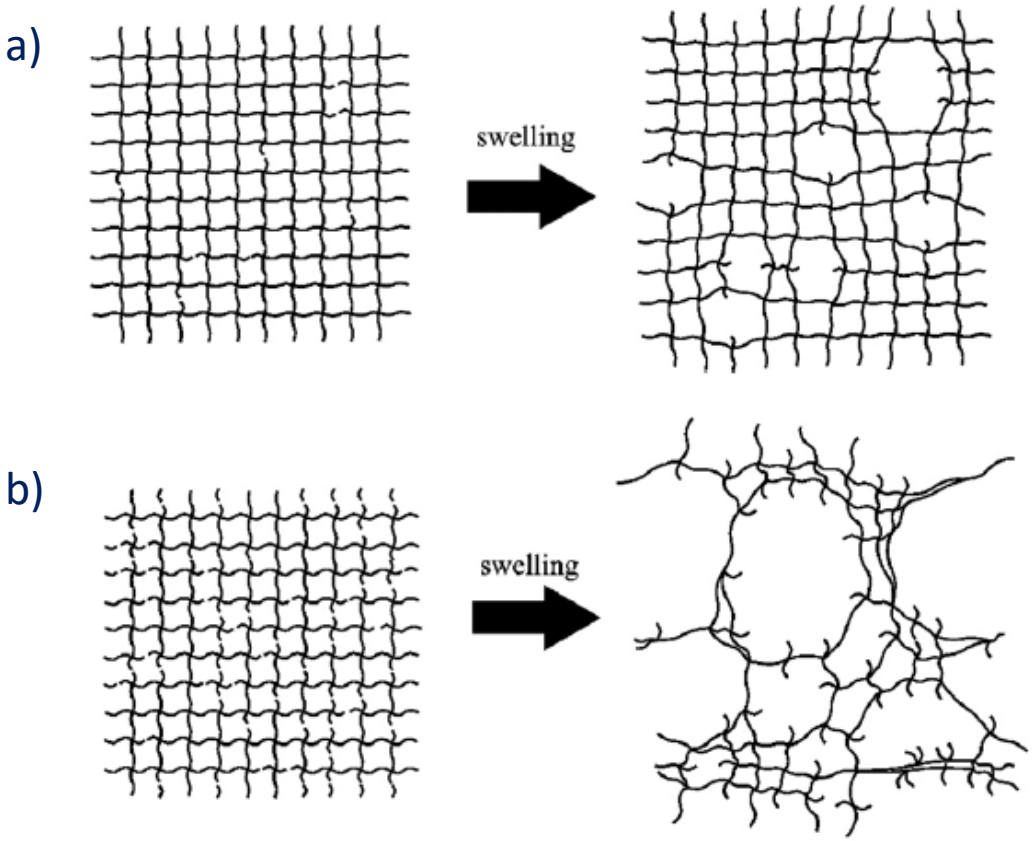
$$G = \nu R T$$

Crosslink density ➡ $\frac{1}{\nu}$ Occupied Volume ➡ $\sqrt[3]{\frac{1}{\nu}} = \xi$ Theoretical mesh size

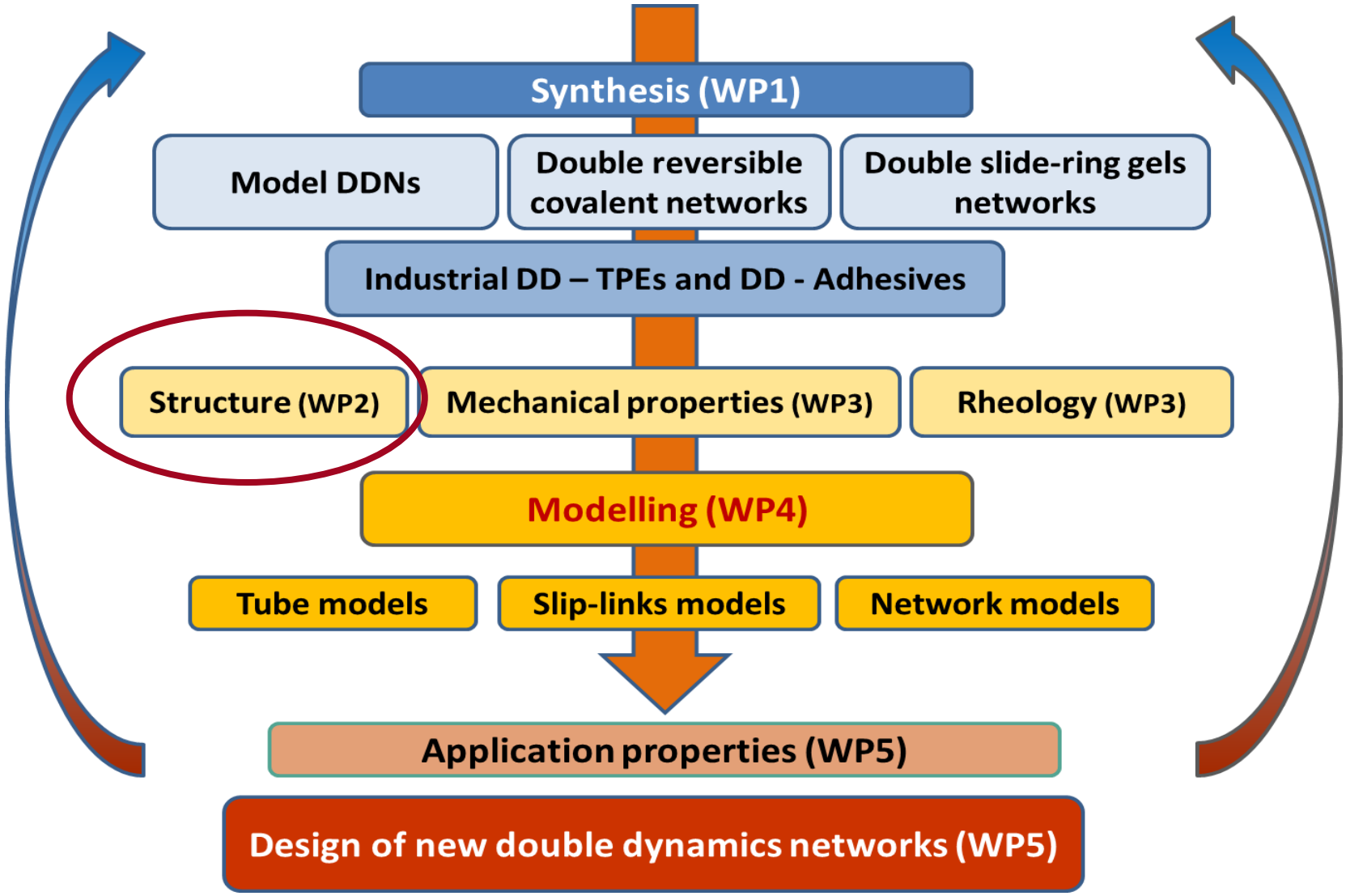
Interplay of Supra- and Macromolecular Dynamics in Metallo-Telechelic Polymers. Willi Schmolke-EPF Lyon 2017

Structure-Property Relations of Model-Network Gels. Not published - Sascha Schmitt

From structure to mechanical properties



Origin of Nanostructural Inhomogeneity in Polymer-Network Gels.
S. Seiffert, *Polymer Chem.* **2017**, *8*, 4472–4487.


Synthesis (WP1)
Model DDNs
Double reversible covalent networks
Double slide-ring gels networks
Industrial DD – TPEs and DD - Adhesives
Structure (WP2)
Mechanical properties (WP3)
Rheology (WP3)
Modelling (WP4)
Tube models
Slip-links models
Network models
Application properties (WP5)
Design of new double dynamics networks (WP5)

Thank you for your attention

Questions?

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SEIFFERT GROUP
Polymer Physics