Application properties of DDNs

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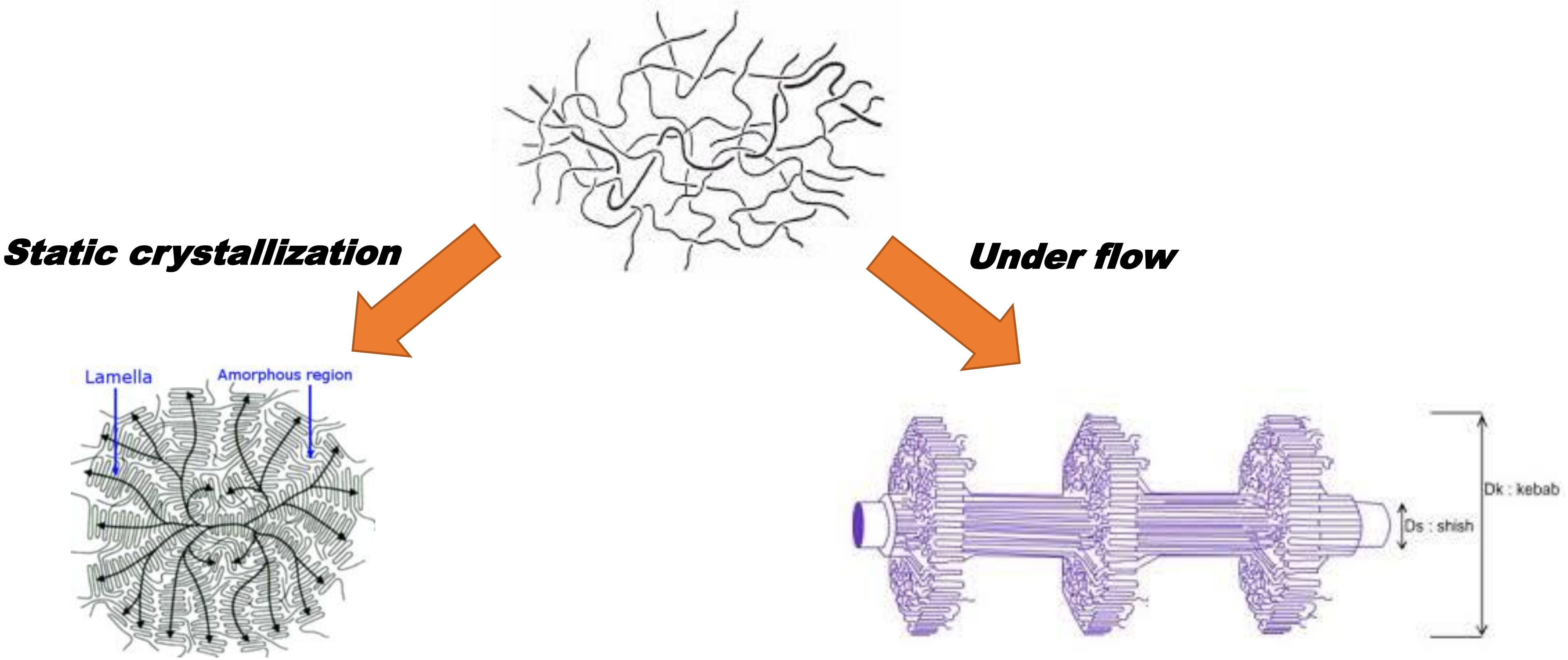
Brief Resume

2014, Bachelor of Engineering, Mechanical Engineering and Instrumentation
Dalian University of Technology, Dalian, China

2017, Master of Engineering, Polymer physics and Synchrotron Radiation Technology
University of Science and Technology of China, Hefei, China

Research Programs：Flow induced crystallization in iPP

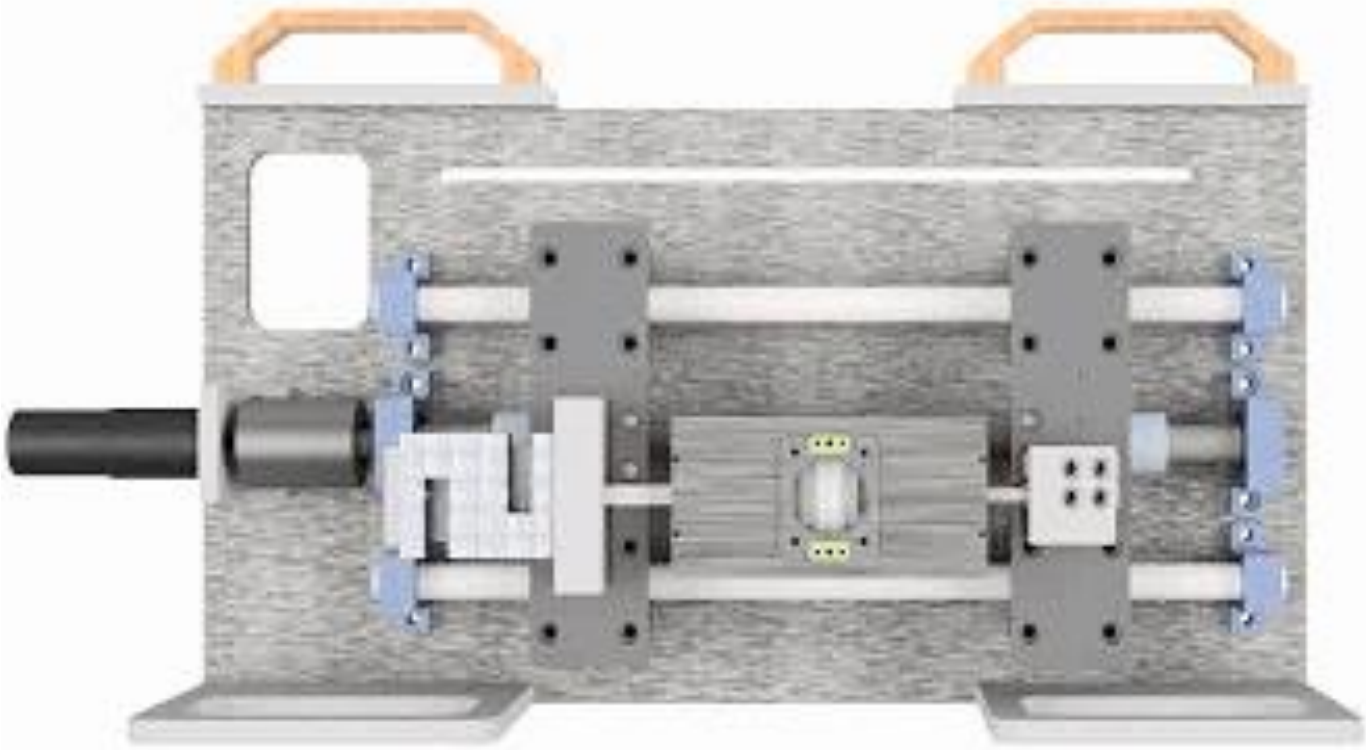
- **Structural Dynamic and Rheology during Flow Induced Crystallization of Polymer Melt**
- **Design and Fabrication of Home-made Rheometer**
- **Synchrotron Radiation Technology**

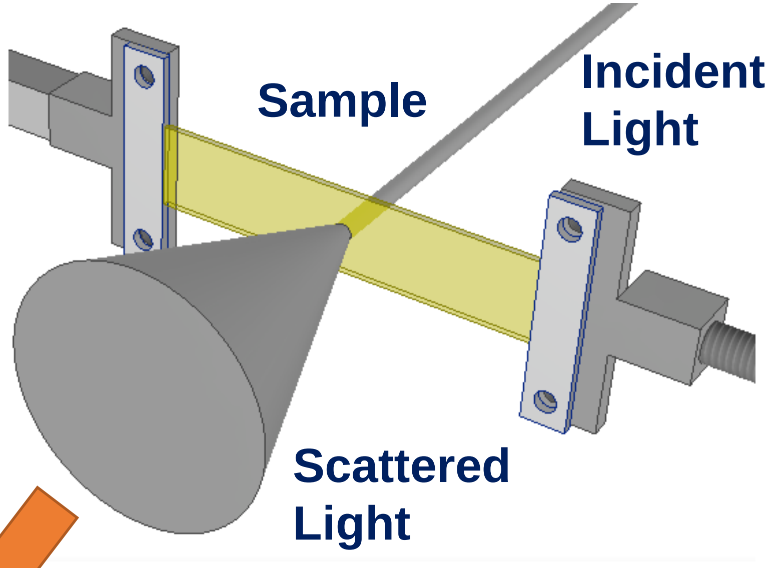


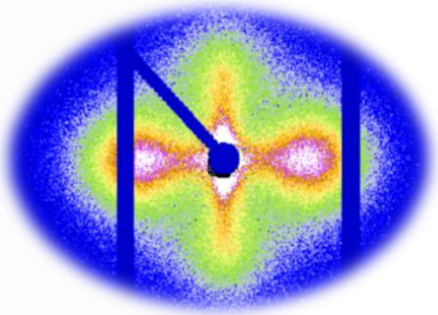
Spherulites

Shish-Kebab crystal

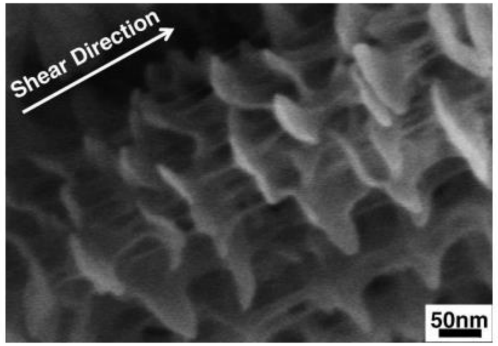
Extension rheometer and Synchrotron Radiation characterization



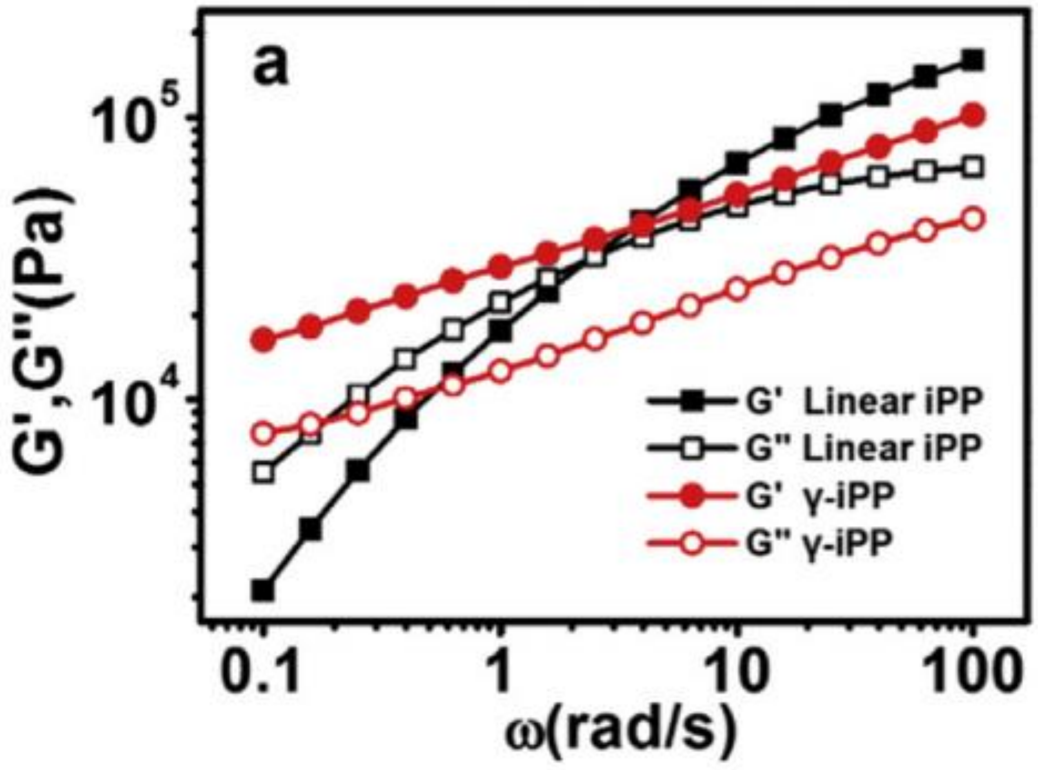


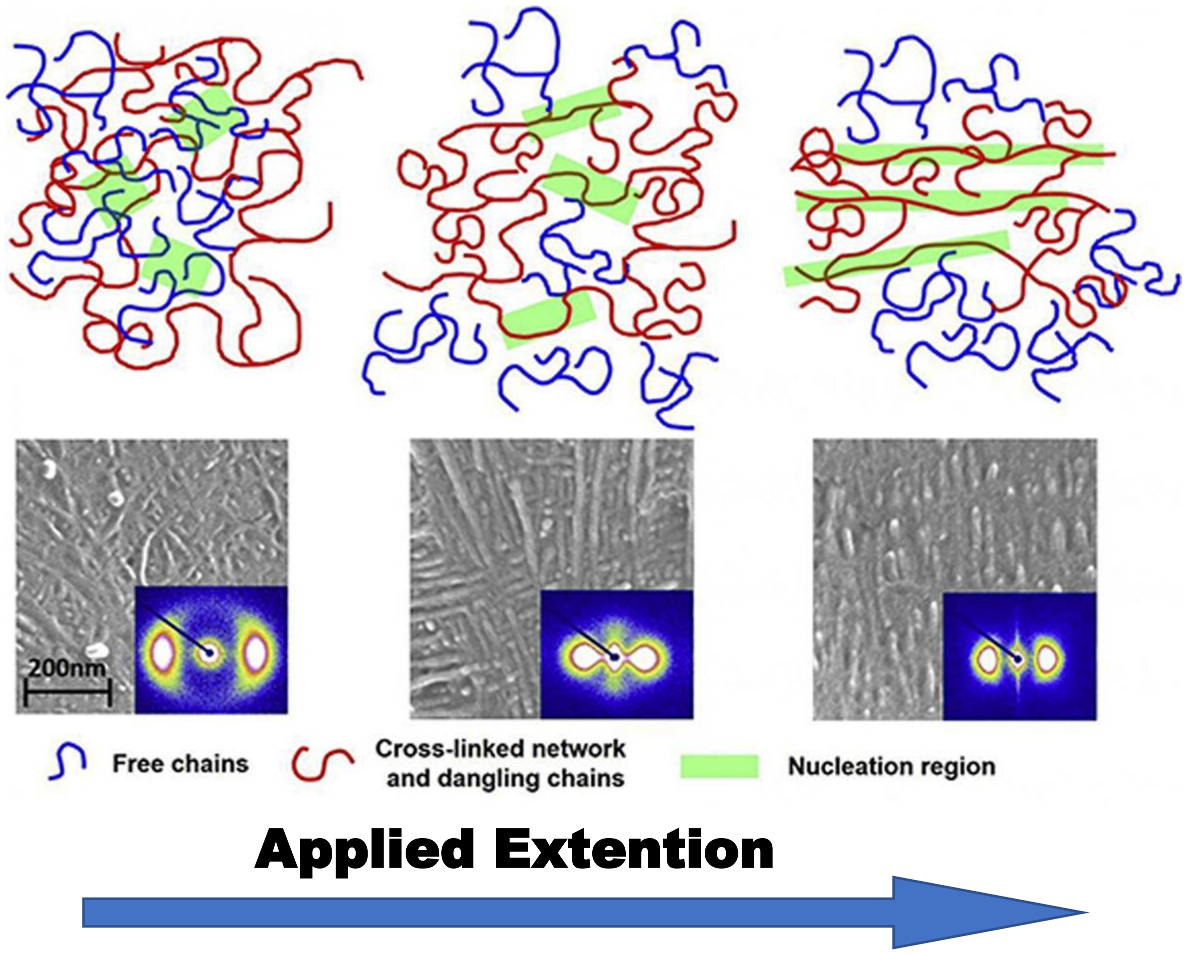


SAXS



Flow induced crystallization in Cross-linked iPP





iPP cross-linked with γ-radiation
Gel concentration: 62%

Ju, Jianzhu, et al. 2017

Application property: Fracture and Adhesion

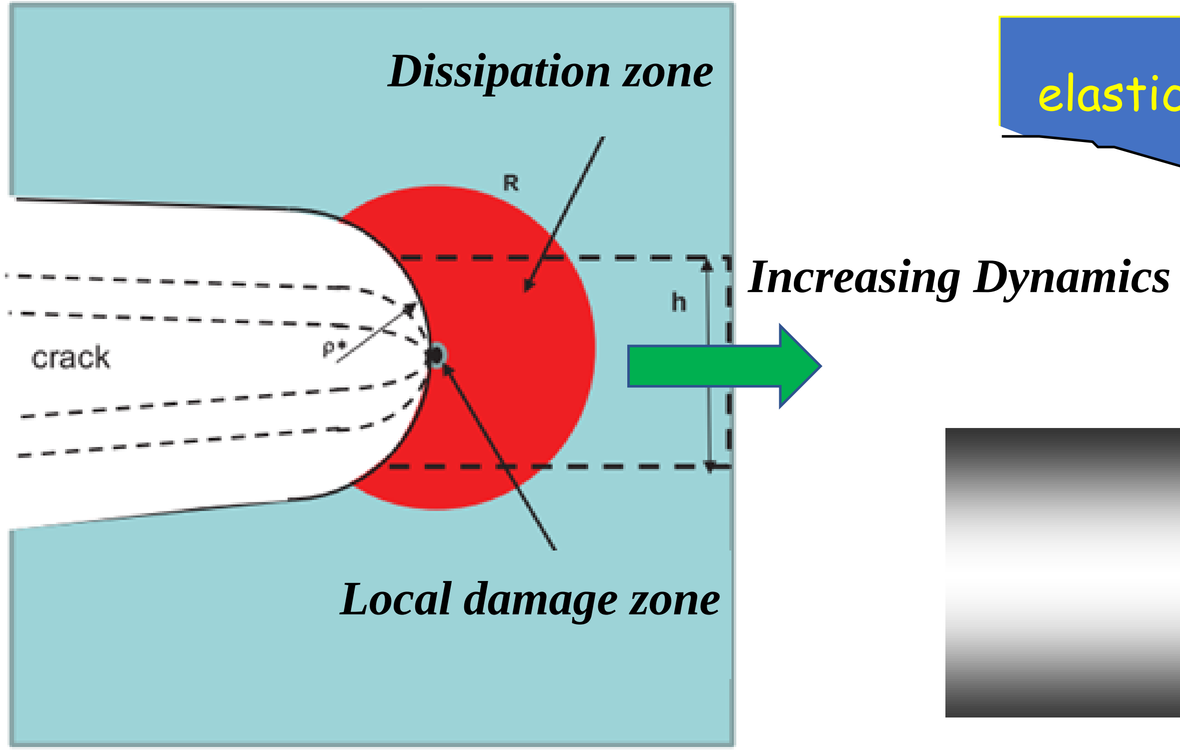
- **Fracture properties of DDNs**
  - **Materials**
    - **DDNs synthesized in WP3**
    - **Our model materials**
  - **Set-up**
    - **Uniaxial tensile machine with camera**
- **Adhesive properties of DDNs**
  - **Materials**
    - **DDNs synthesized in WP3**
    - **Our model materials**
  - **Set-up**
    - **Laboratory-made micro-tack machine**

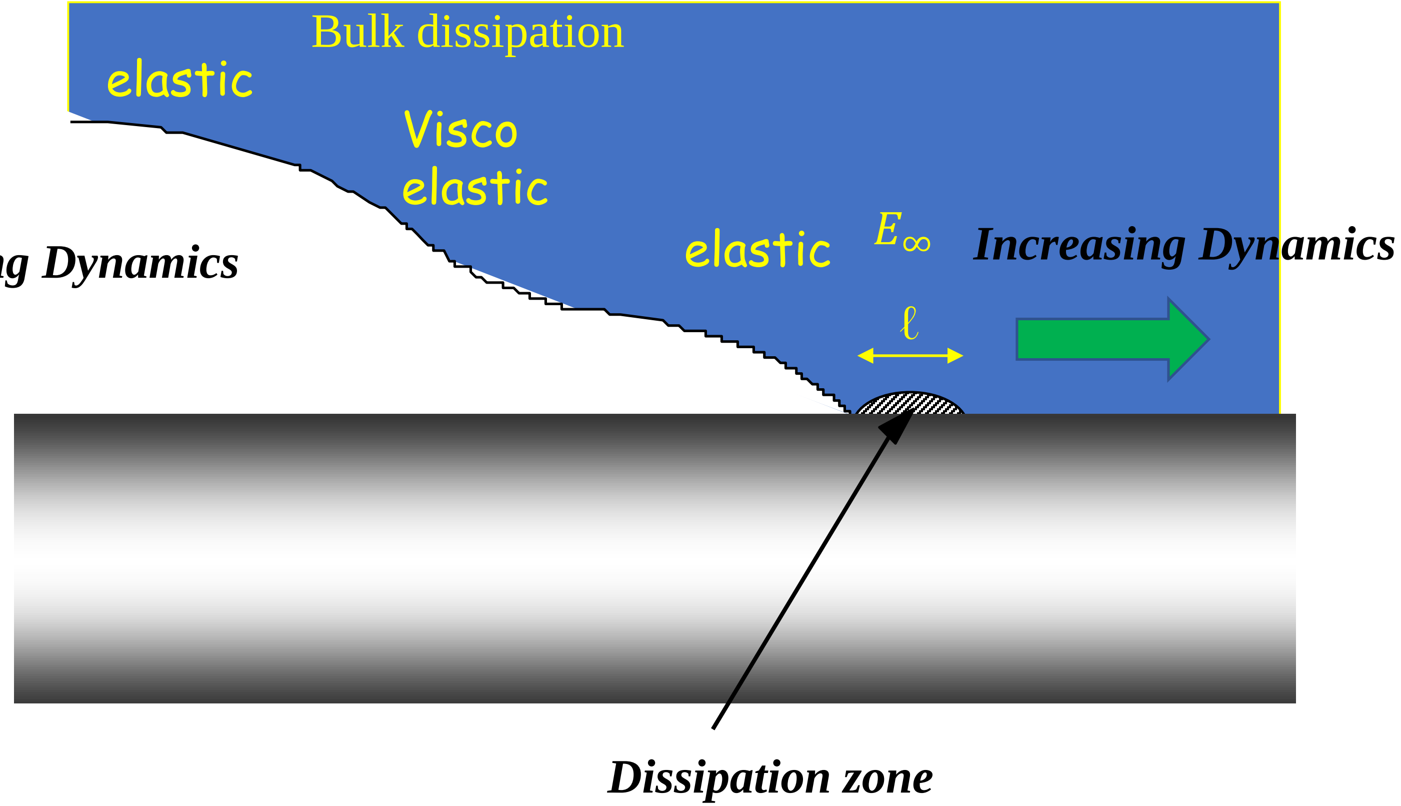
Mesoscopic characterization of dynamics by diffusing-wave spectroscopy in facture and adhesion

Research Proposal

In collaboration with Luca Cipelletti (Montpellier, CNRS)

Characterization of the dissipative zone





Fracture

Adhesive Debonding

Fracture at different length scale

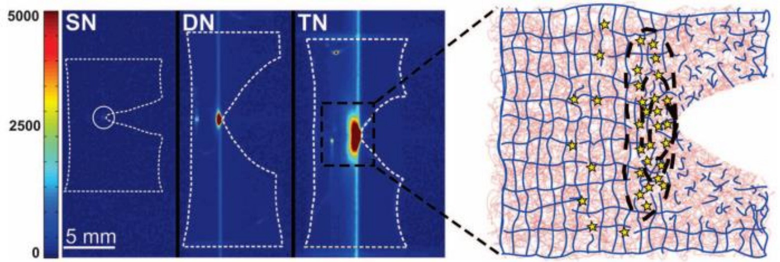
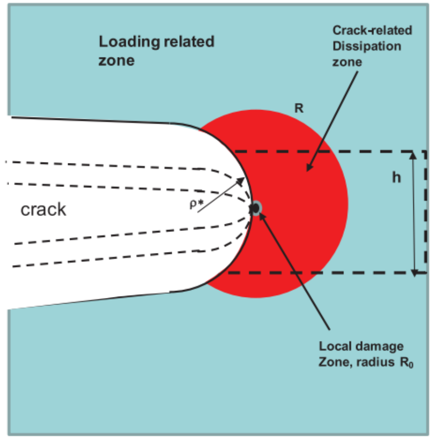
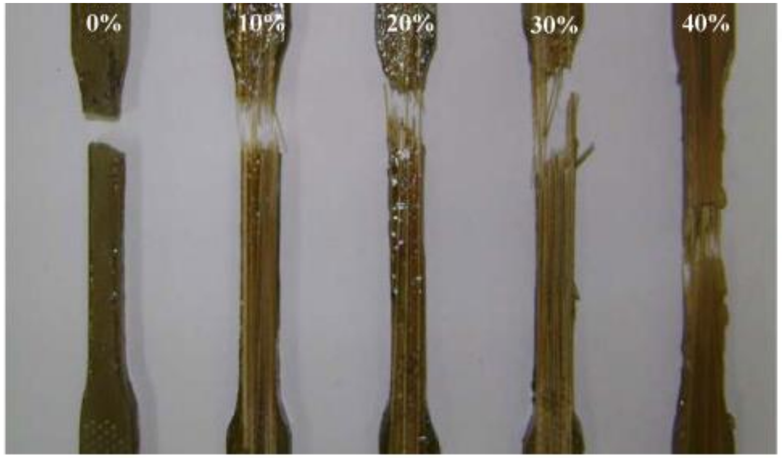


Fig. 5. Mapping of where bonds break during crack propagation. Intensity-colorized images of propagating cracks on notched samples containing dioxetane cross-linker in the first network, showing the light emission due to the breakage of bonds in SN, DN, and TN samples. The size and geometry of the sample are shown with a white dashed line. Vertical lines in the DN and TN image are due to detector artifacts; in DN and TN, spots far from the crack tip are due to reflection of the light on surface inhomogeneities and do not correspond to a local light emission. (Right) Schematic of the sacrificial bond-breaking mechanism in front of the crack tip for the DN and TN; the first network is represented in blue, and the second and third networks are in red.





Molecular scale (~10nm)

Ducrot, Etienne, et al.2014

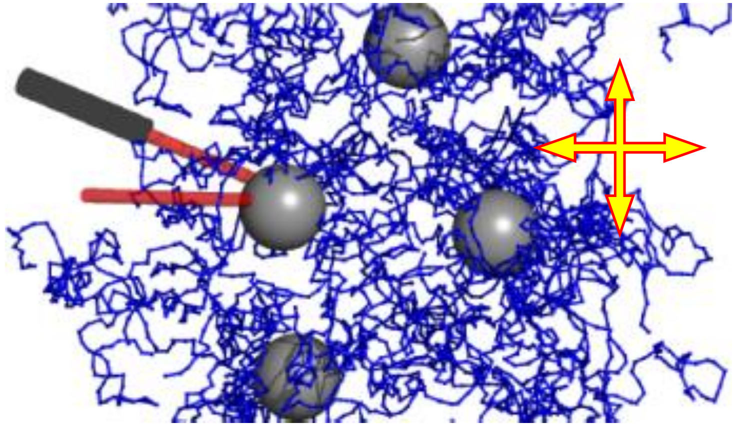
Mesoscopic scale (0,1 ~10 μm)

Creton, Costantino, and Matteo Ciccotti.2016

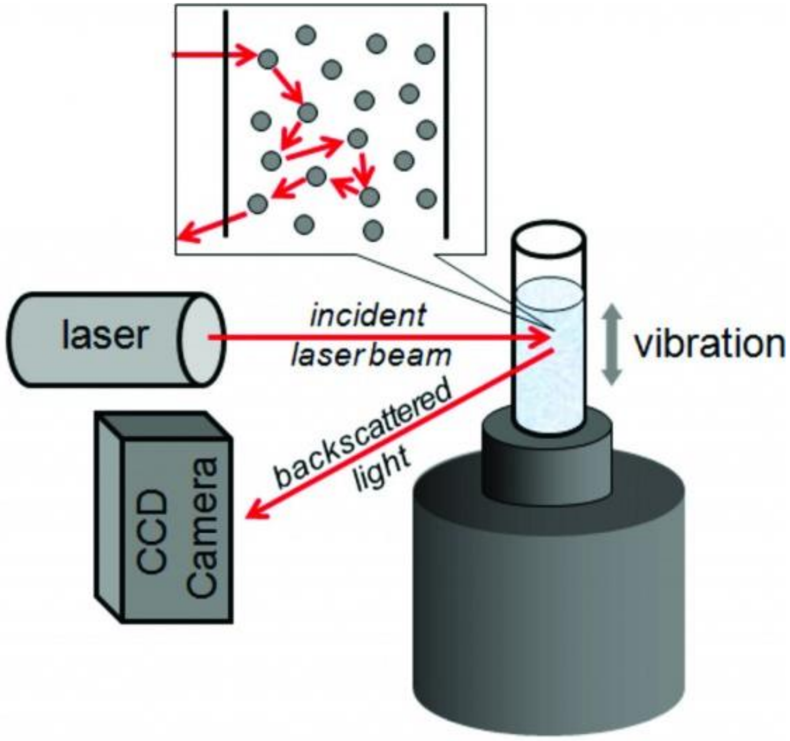
Macroscopic scale

Martínez, A. B., et al. 2017

Dynamic Light Scattering & Diffusing-Wave Spectroscopy



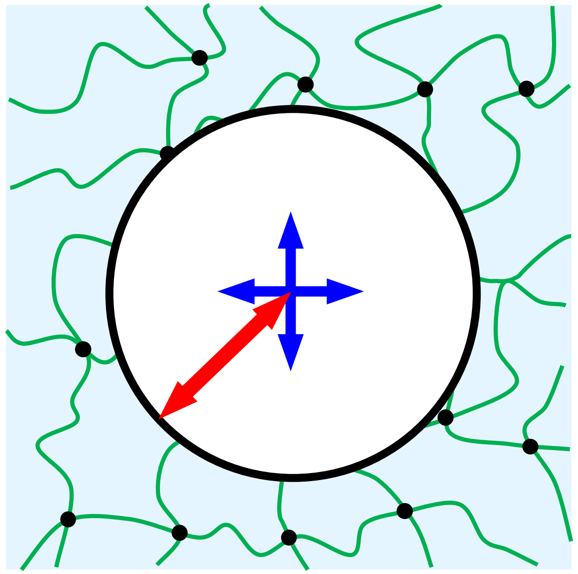
Polymer network + Probe particles

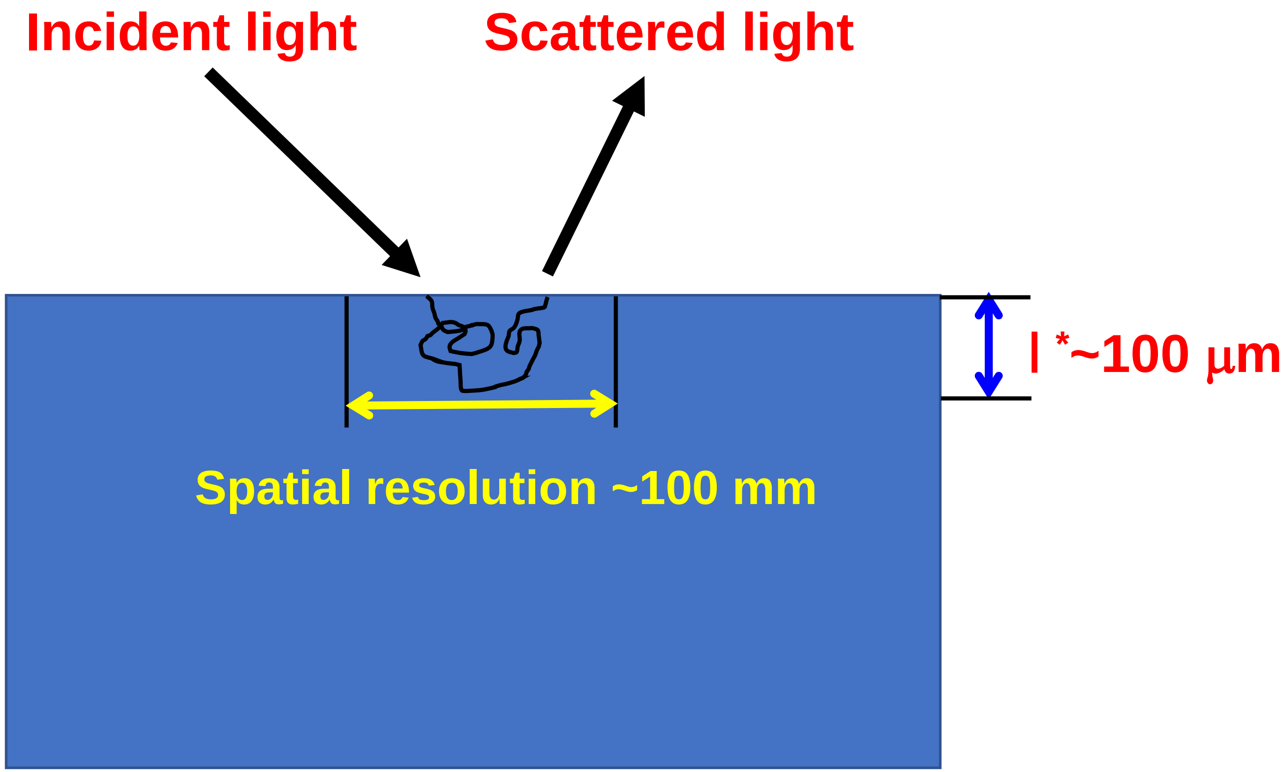


DWS: Multiple scattering

Krajina, Brad A., et al. 2017

Mean square displacement $\langle \Delta r^2(t) \rangle$ from DWS



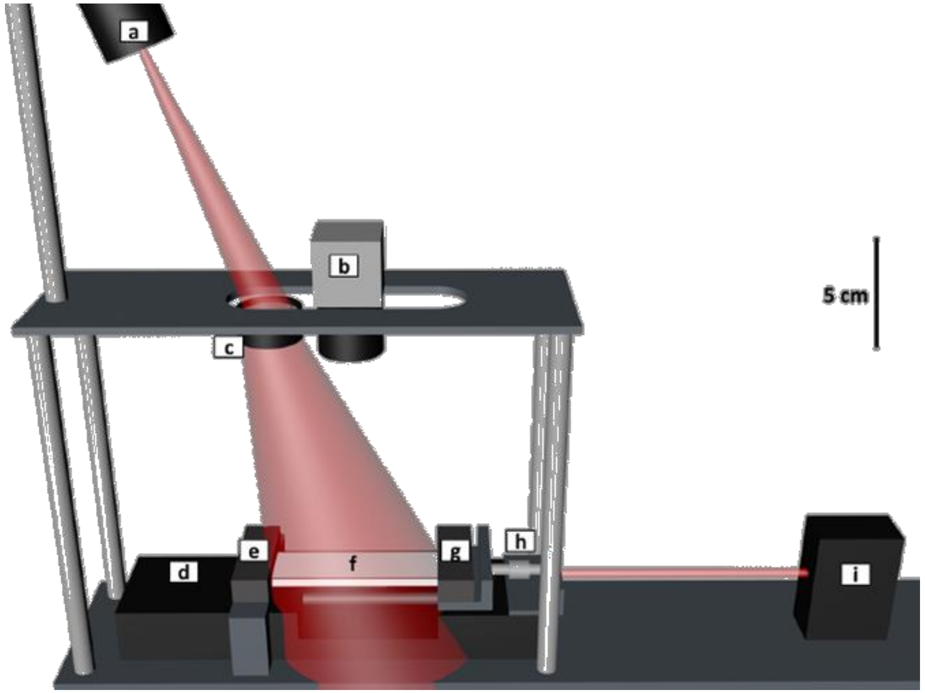


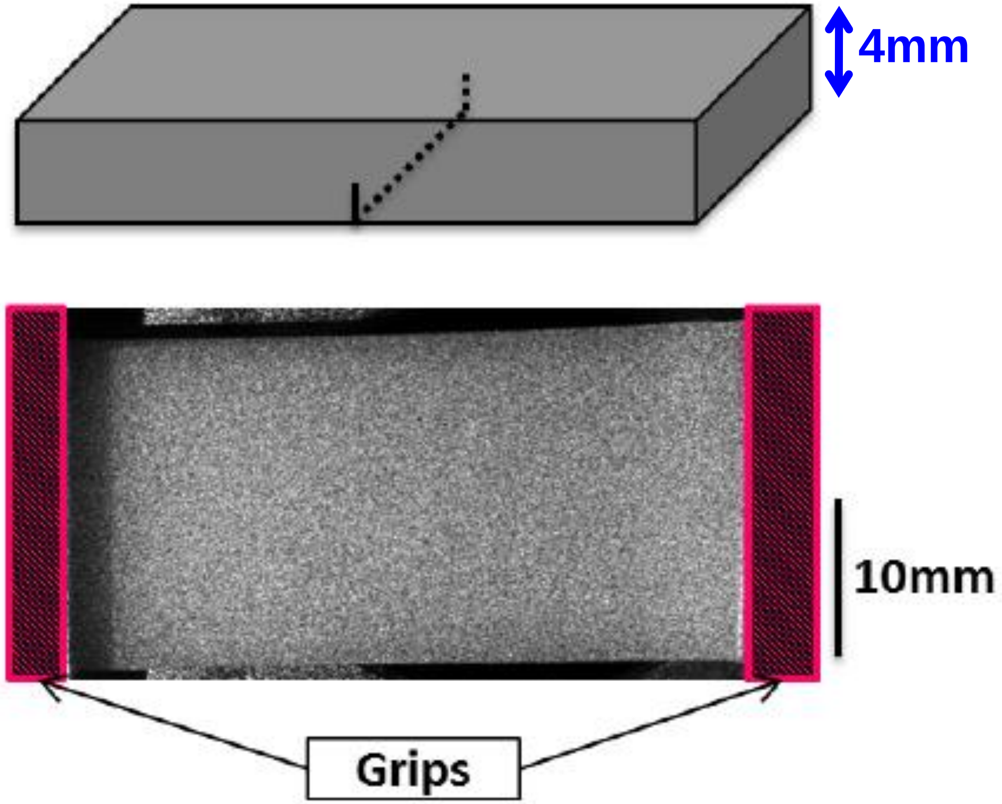
Particle Size : ~ μm

$\sqrt{\text{MSD}}$: 1 ~ 100 nm

DWS Set-up coupled with macroscopic fraction

PDMS rubber+
TiO_2 (d=300 nm, ϕ=0.0005)
Elastic modulus: 1.22 MPa



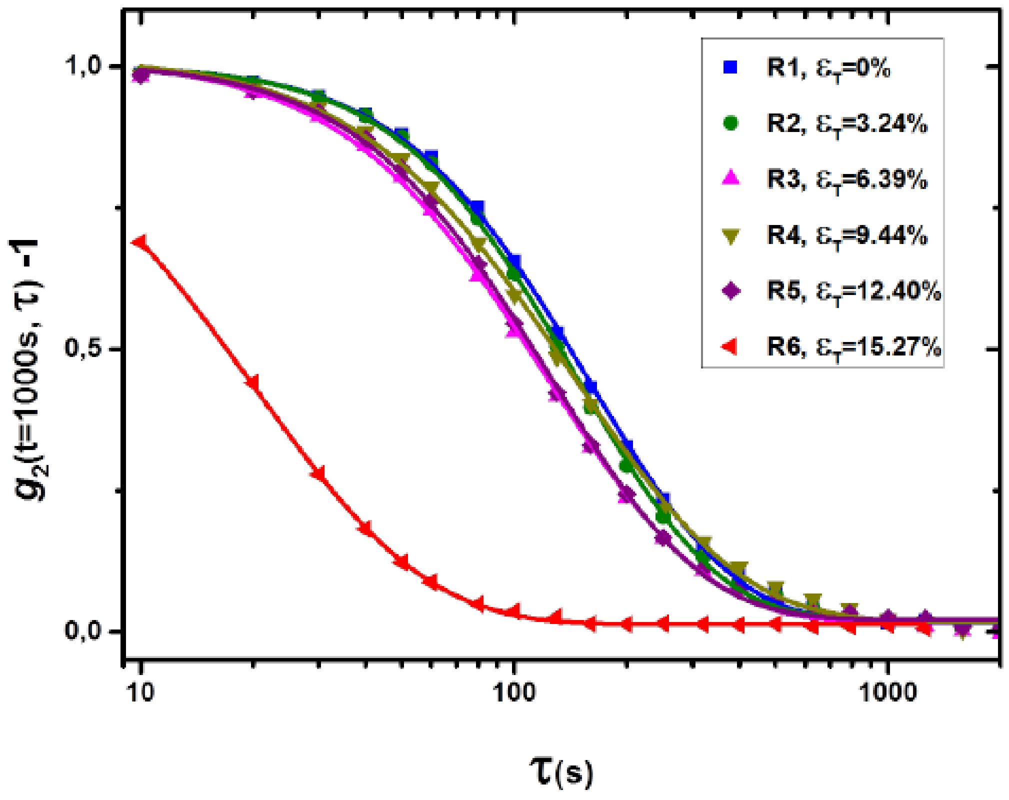


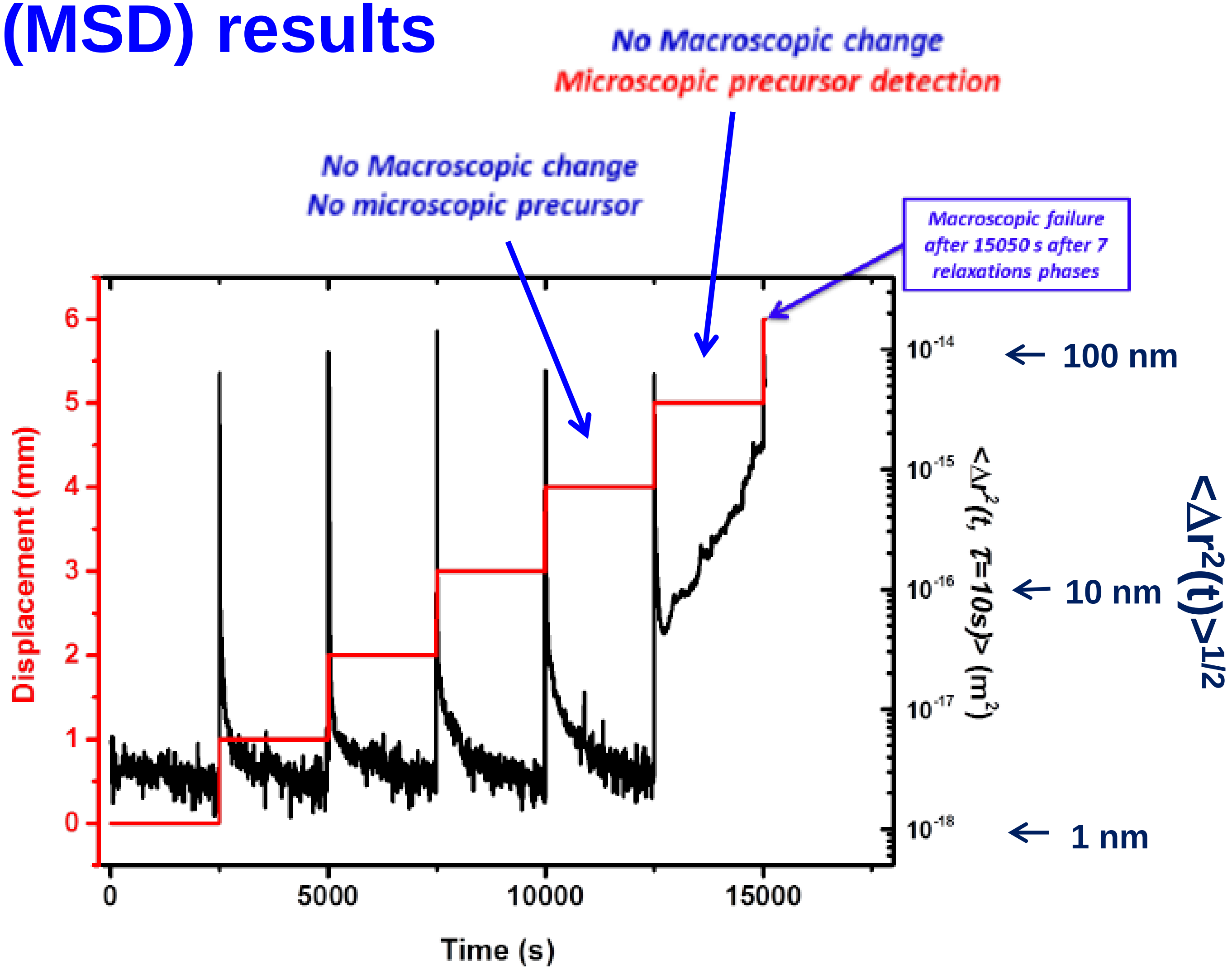
a: Laser
b: Camera
c: Lens
d: Motor
e: Fixed clamp

f: Sample
g: Moving clamp
h: Tensile sensor
i: Displacement sensor

Thesis of Mohamed-Yassine Nagazi, 2017

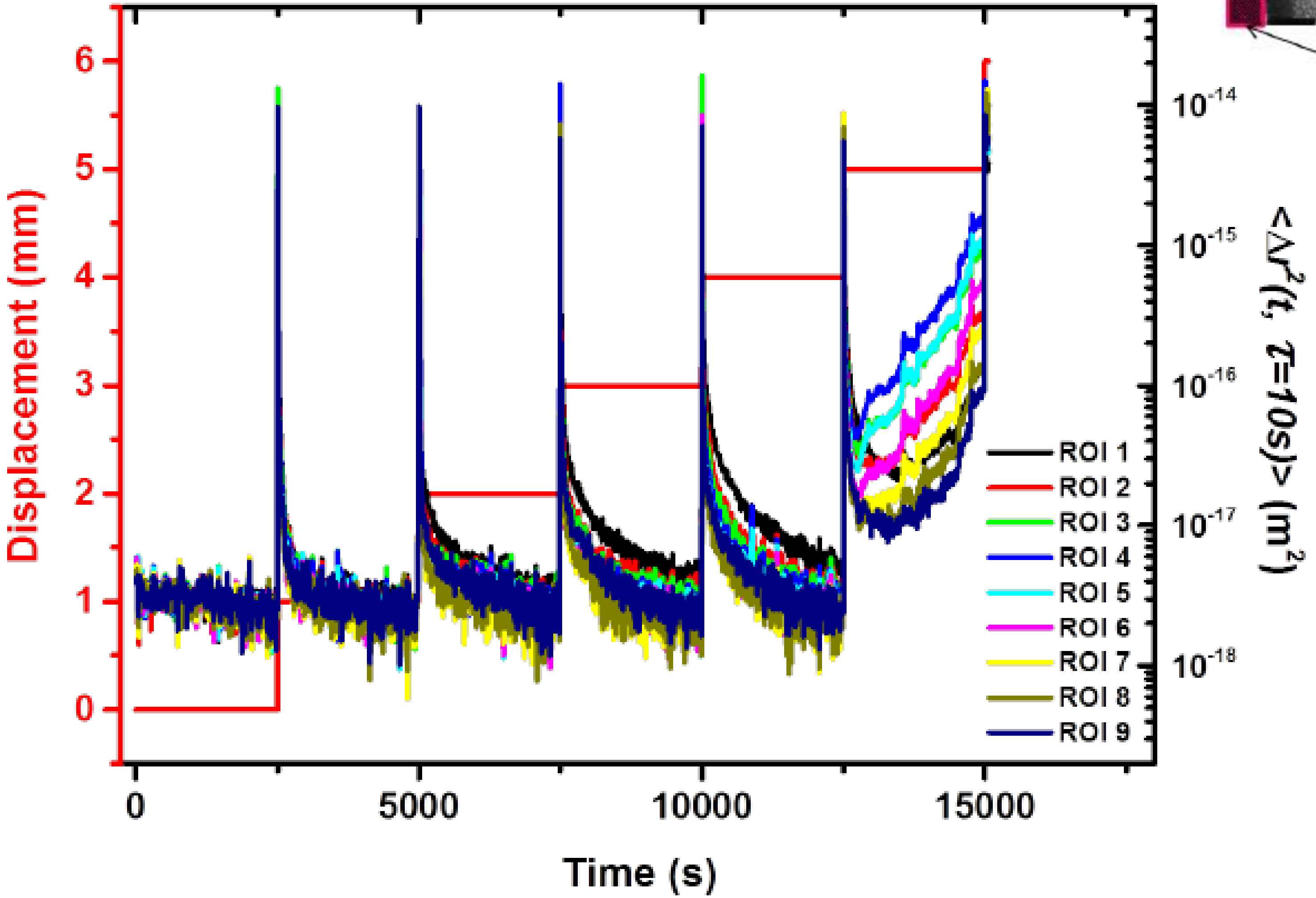
Mean square displacement (MSD) results

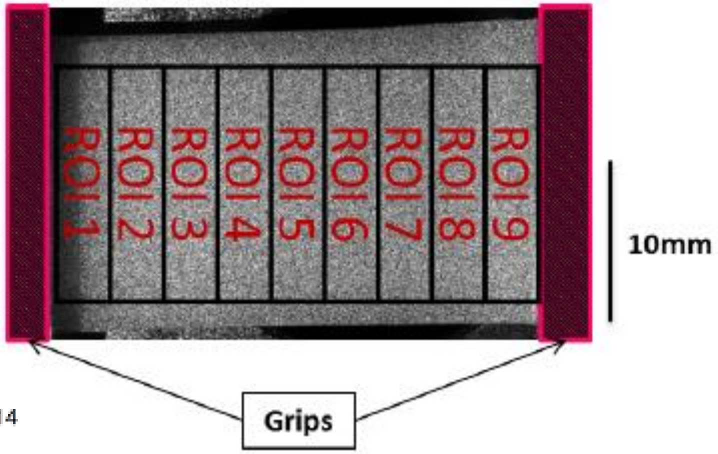




Fracture precursor before macroscopic change

MSD at different ROI





Local dynamics of Probe particles measured by DWS

- Quantitative measurement of mesoscopic (0,1~ 10 μm) dynamics
- High resolution of MSD ~ 1 nm
- Low spatial resolution (ensemble averaging) ~ 100 μm
- Small amount of probe particles required (ϕ < 0.01)
- Combination with different mechanical devices
  - Macroscopic mechanical tests
  - Fluorescence imaging with mechanophore molecules

Thanks for your attention!