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FibreNet

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Influence of the Displacement Rate on Longitudinal Modulus of Single Cellulosic Fibres

FibreNet seminar

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September 9th, 2021

Motivation

- Paper => fibre network.
- Lately focus on modelling and simulations.
- Accurate data is needed.
- Common assumption:
  - Plastic-elastic type of behaviour.
- Reality:
  - Fibres are **viscoelastic material**.
    - Slightly different behaviour than other materials (metals) => there is high relevance of the loading rate in tensile testing.
  - Nobody is looking into it => neglected.

Motivation

In this presentation I will try to explain the significance of the loading rate on the elastic modulus *E* of single fibres during the tensile testing.

Materials

Sample

- CTMP
- CP
- UKP
- VIS
- VIS no SH

Sample Holder

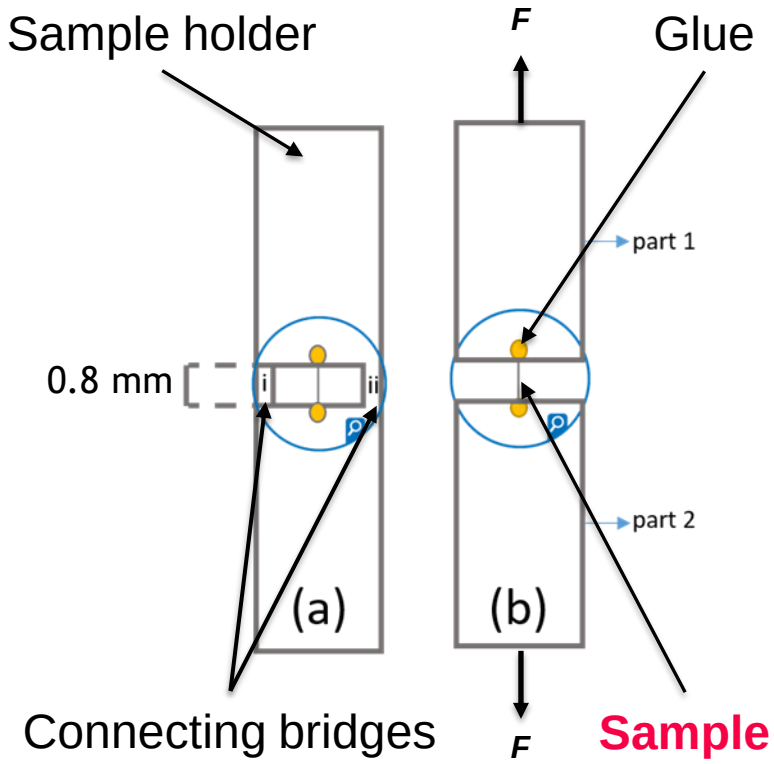
- Acrylic Glass
- 0.3 mm thick
- 0.8 mm gap

Glue

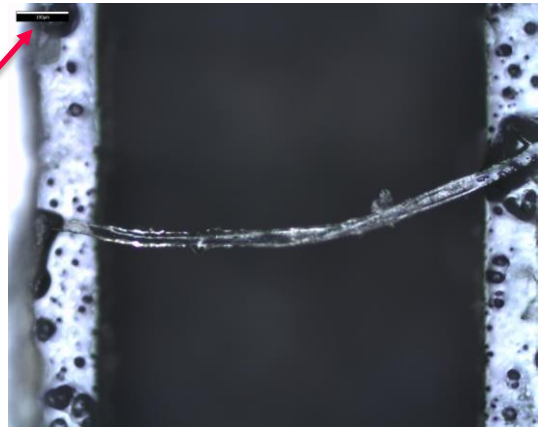
- Uhu Plus Endfest
- 2 Component Epoxy Glue

Sample preparation

- Preparation of single fibres
  - Swelling (24 h)
  - Dilution
  - Pressure drying
- Gluing on the SH
  - Uhu Plus Endfest
- Conditioning for 5 days
  - Curing of the glue
  - Elimination of *T* effect on SH

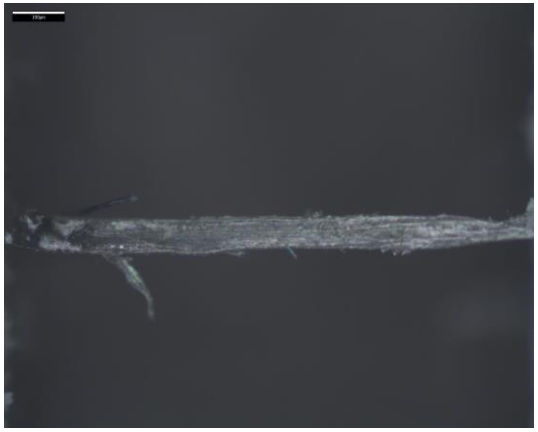


Infinite Focus Microscopy IFM

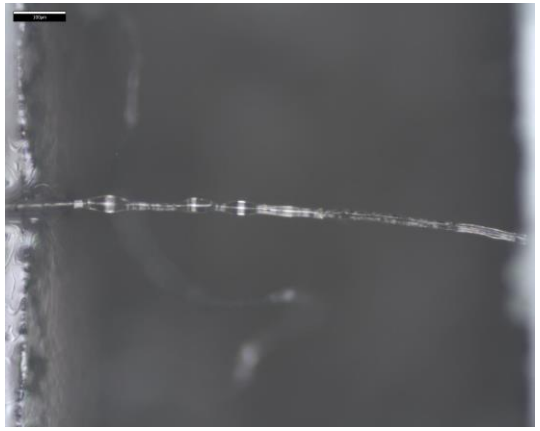


CTMP

CP



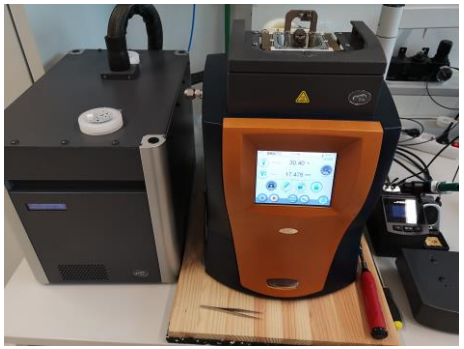
UKP

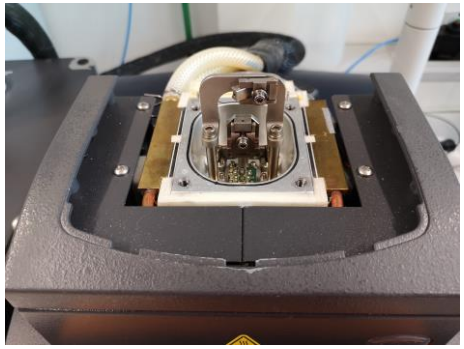


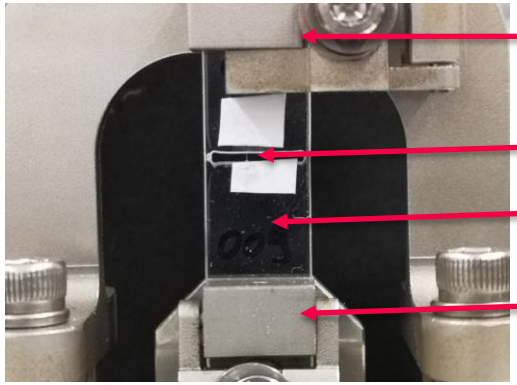
VIS

Dynamic Mechanical Analysis DMA

- Constant L_{max}:
  - L_{max} = 15 µm
- Displacement rates:
  - r_{min} = 0.113 %/s
  - r_{max} = 800 %/s
  - 2 min conditioning between cycles
- Measuring *F*

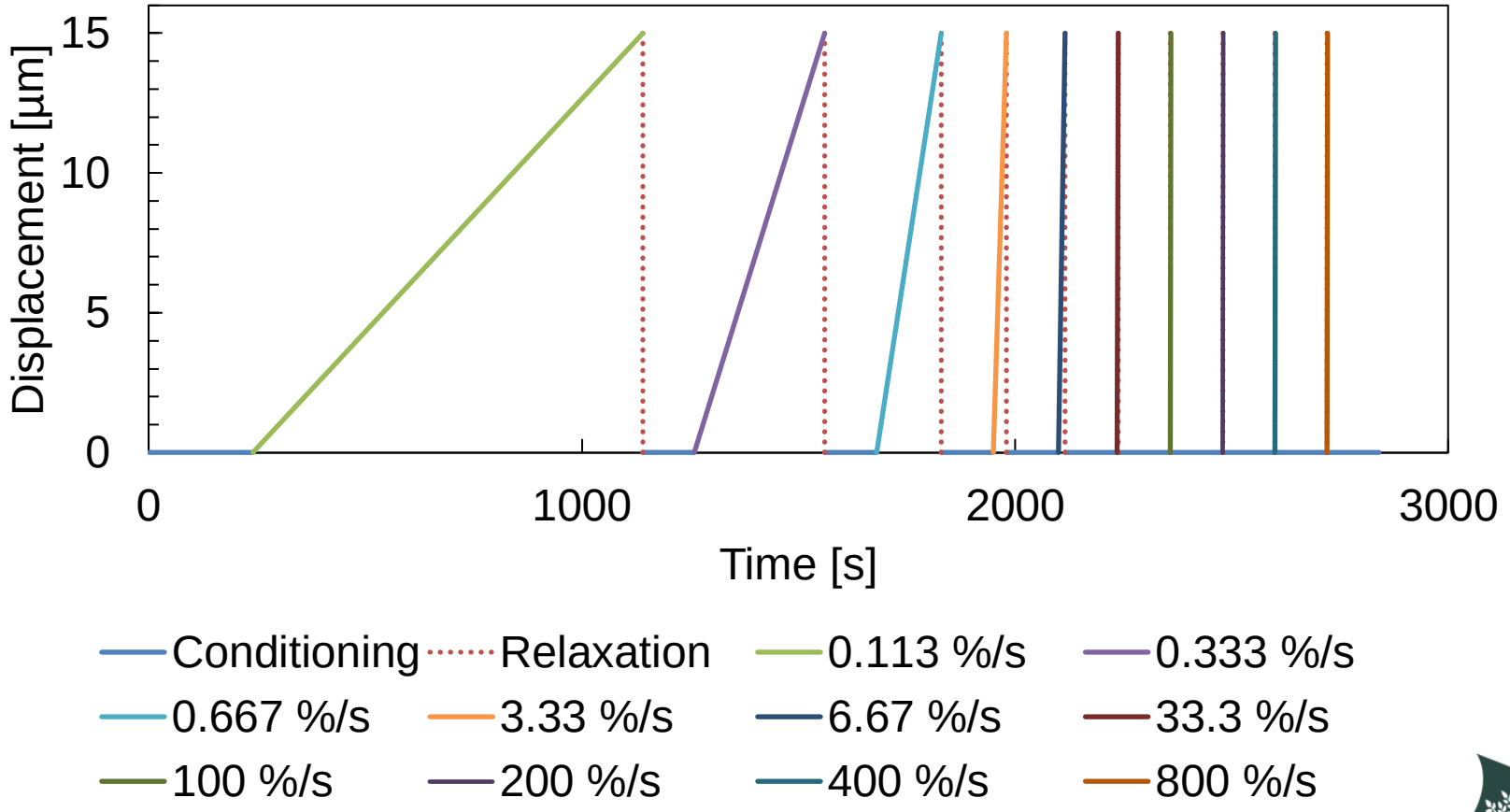




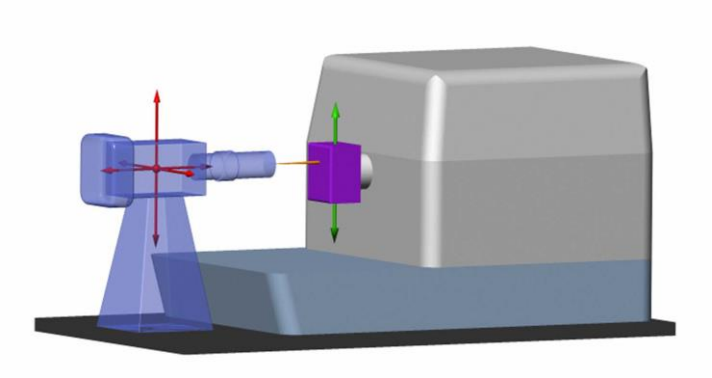


- Upper clamp (fixed)
- Sample
- Sample holder
- Lower clamp (moving)

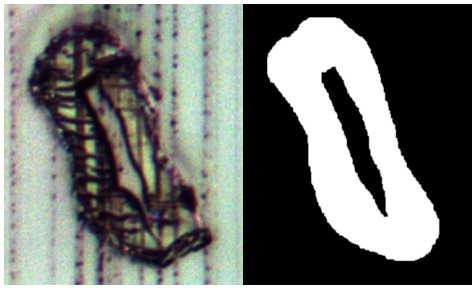
Dynamic Mechanical Analysis DMA



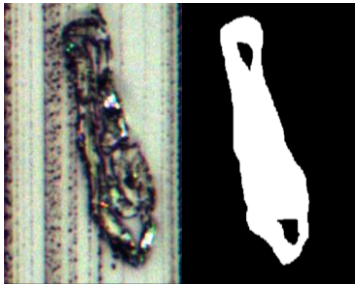
Microtomy



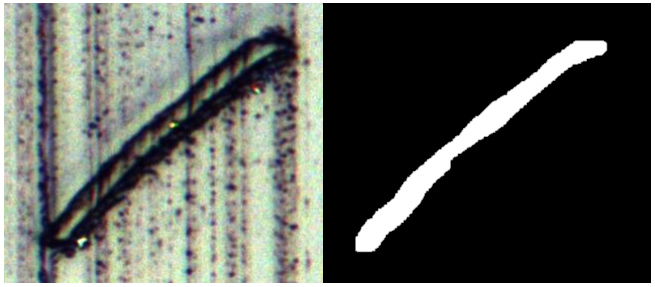
CP



CTMP

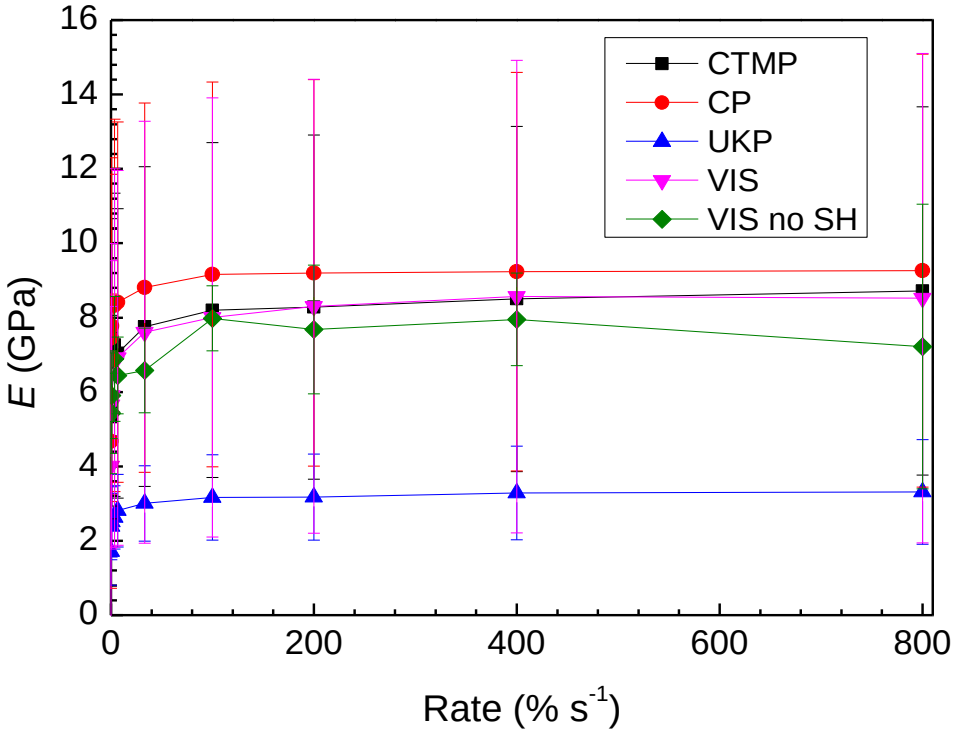


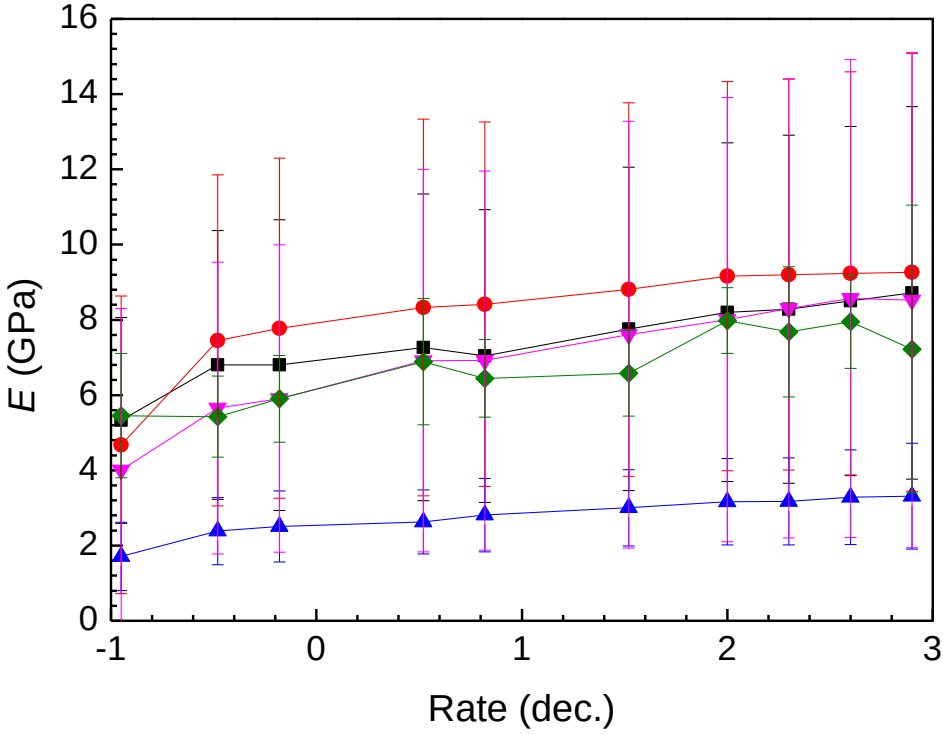
UKP



VIS

Results

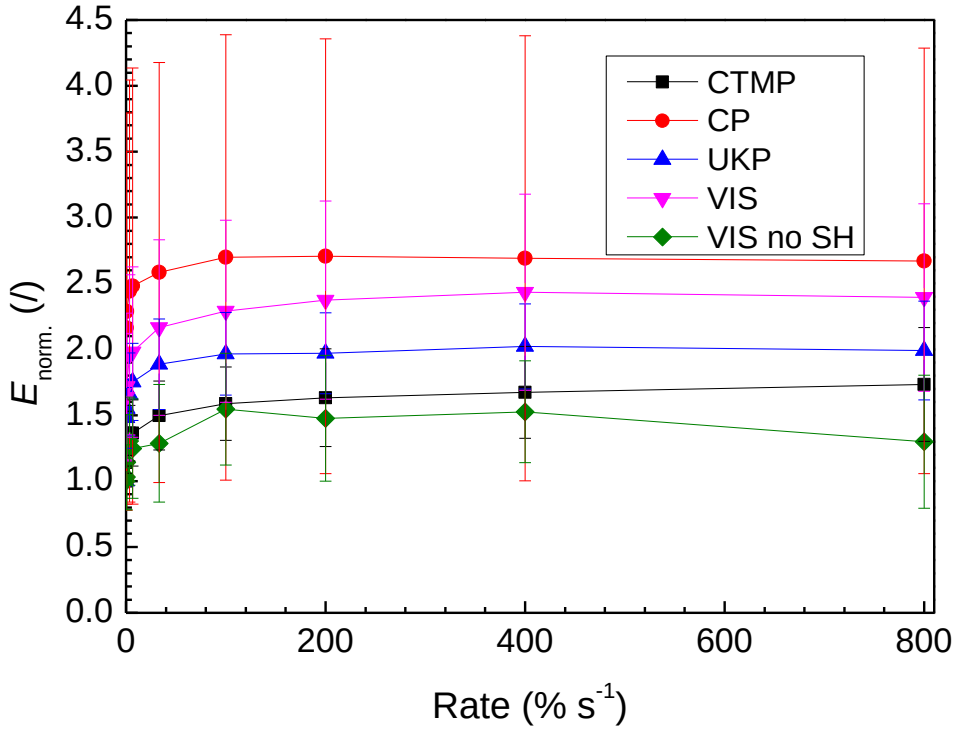

CTMP
CP
UKP
VIS
VIS no SH
E (GPa)
Rate (% s-1)
0
2
4
6
8
10
12
14
16
0
200
400
600
800

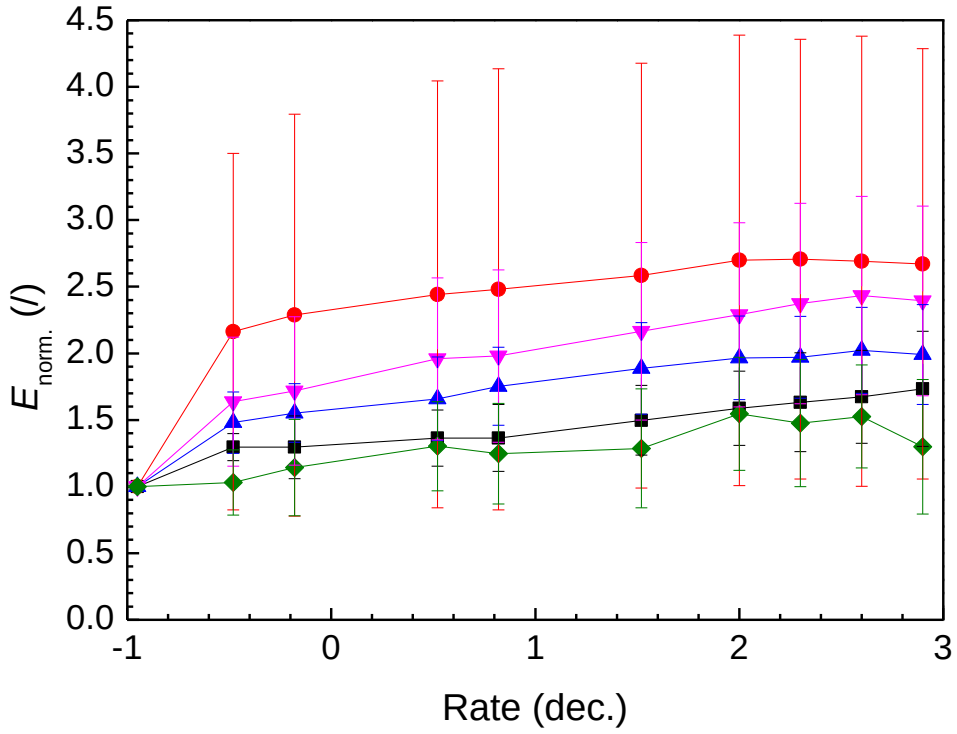

E (GPa)
Rate (dec.)
0
2
4
6
8
10
12
14
16
-1
0
1
2
3

Results

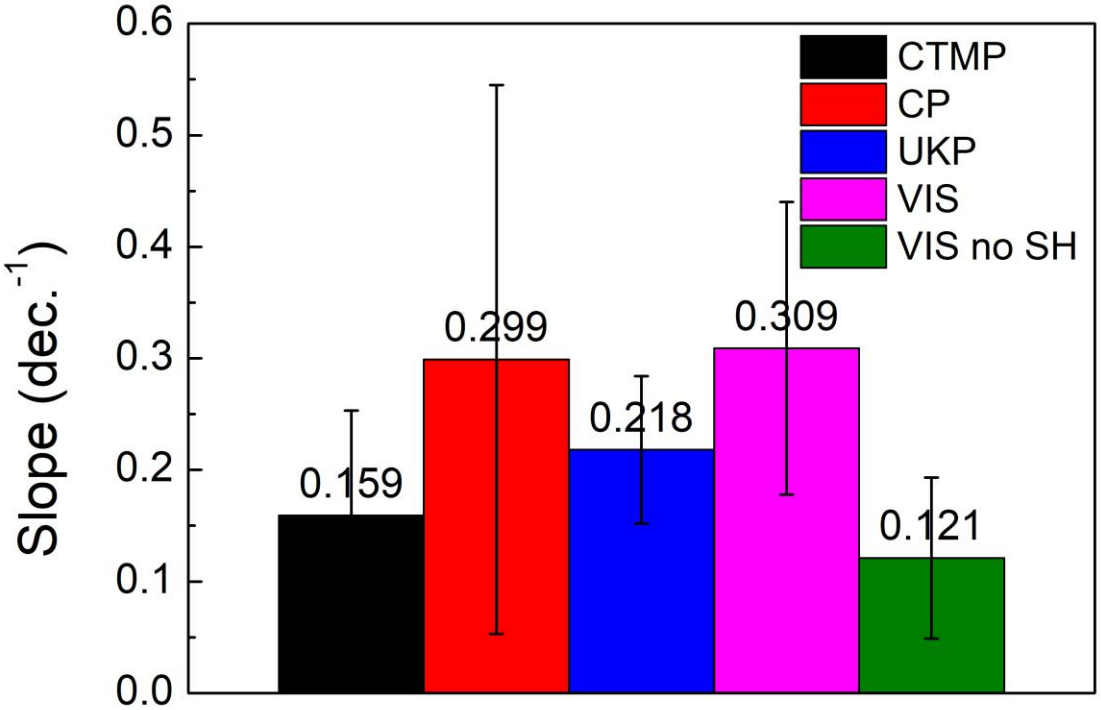
Sample	$E(r_{min})$ [GPa]	$E(r_{max})$ [GPa]	ΔE [GPa]	ΔE [%]
CTMP	5.32	8.73	3.39	64
CP	4.68	9.26	4.59	98
UKP	1.71	3.32	1.60	94
VIS	4.01	8.52	4.51	113
VIS no SH	6.89	7.22	1.77	32

Normalised results





Normalised results



When the loading rate increases by factor 10, the *E* will be increased by factor of the slope [dec^{-1}].

Conclusions

- *E* is significantly increasing with the increase of displacement rate for all fibre materials.
- The highest displacement rate dependency is shown by CP and VIS and the lowest by VIS no SH.

- Displacement rate **should not be neglected** in fibre tensile testing.

Thank you for your attention

Questions?

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 764713.