Flow-assisted assembly of lignocellulose nanofibrils (LCNF) into microfibers

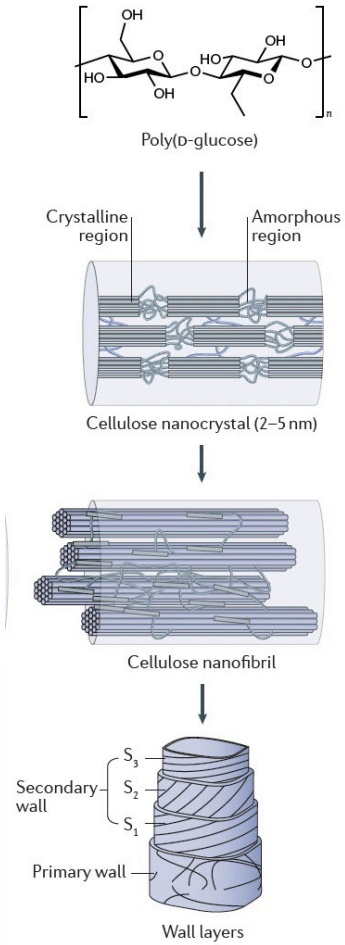
Saeed Davoodi

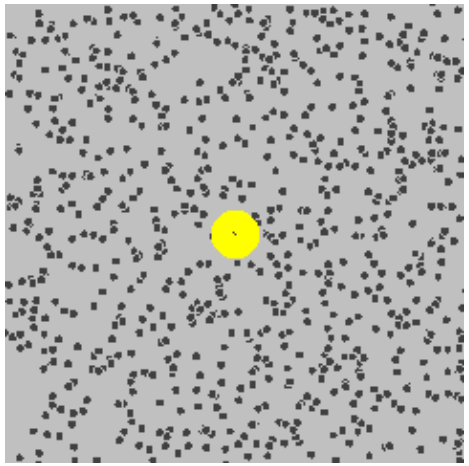
KTH Royal Institute of Technology, Stockholm, Sweden

Supervisors: Daniel Söderberg and Fredrik Lundell

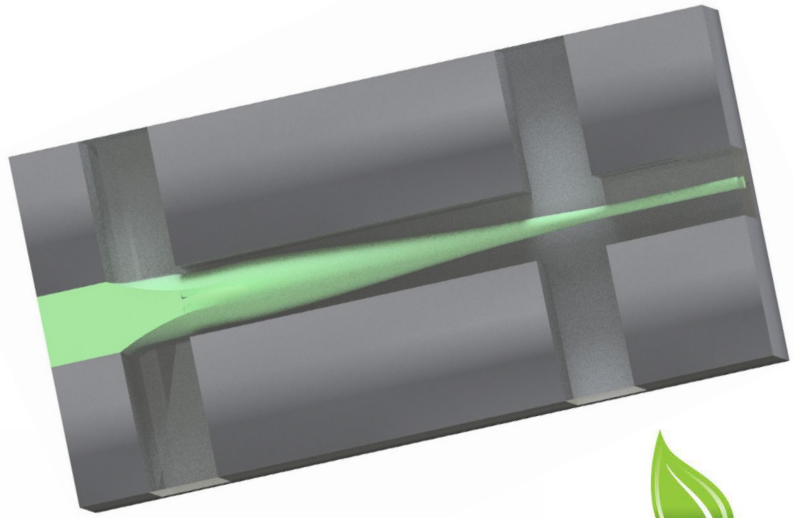
Alignment, inspired by nature!

Micro → Nano



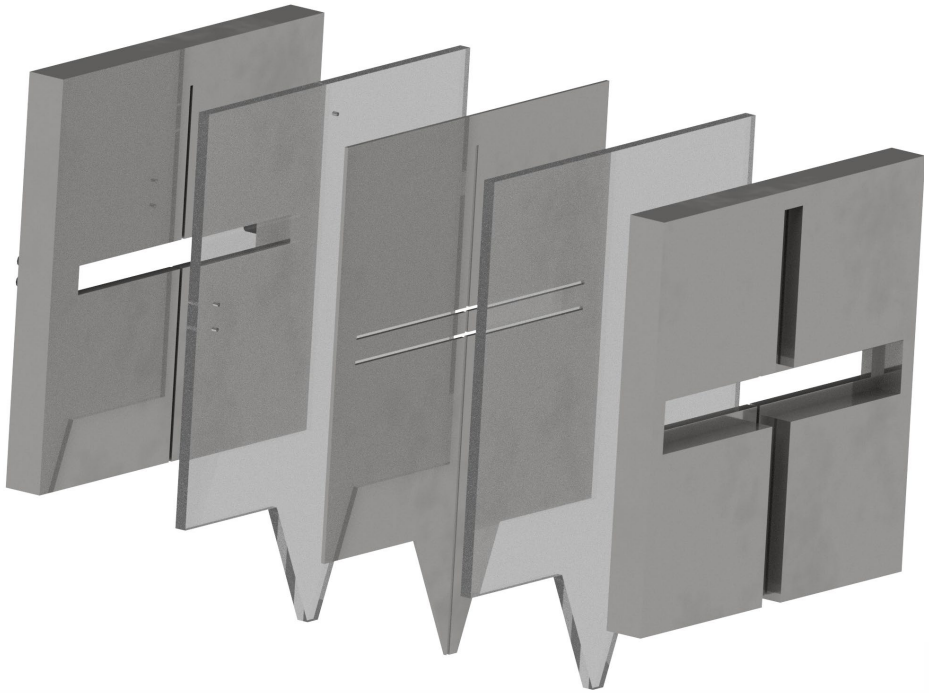


Brownian motion



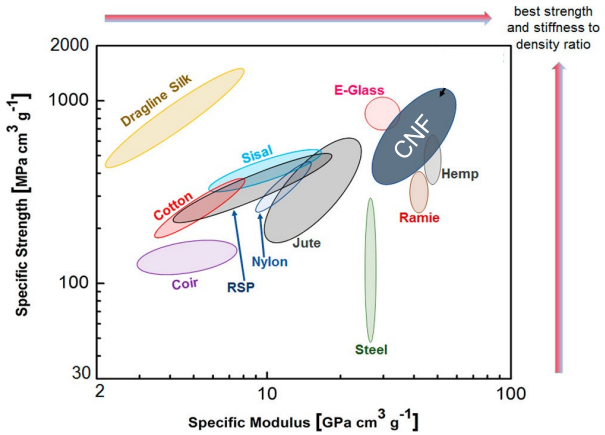
Ling, Shengjie, et al. Nature Reviews Materials 3.4 (2018): 1-15.

Flow Focusing



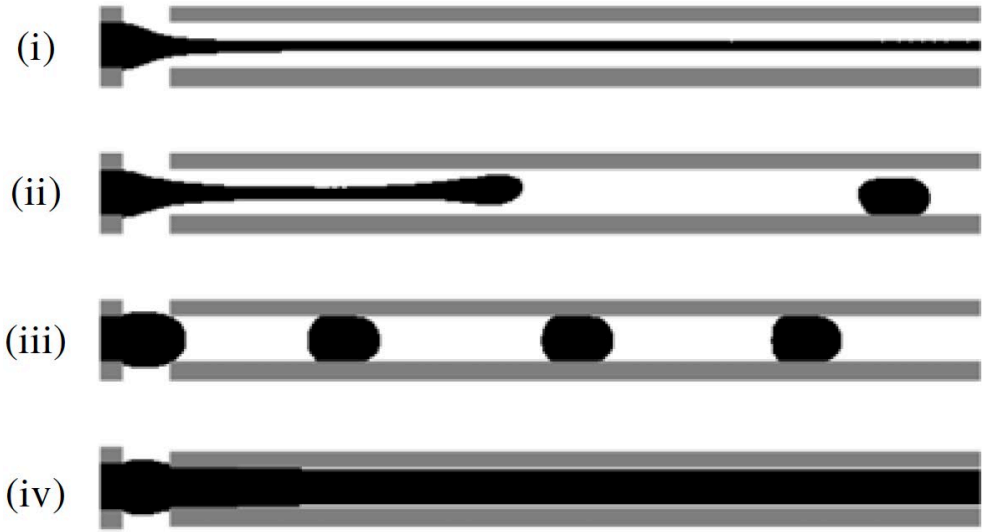
Effective Parameters

- Concentration, Aspect ratio, pH, Surface charge
- Colloidal Stability, Rheology, Flowability
- Brownian motion, Rotational diffusion Order Parameter
- Spinnability, Mechanical Properties Repeatability

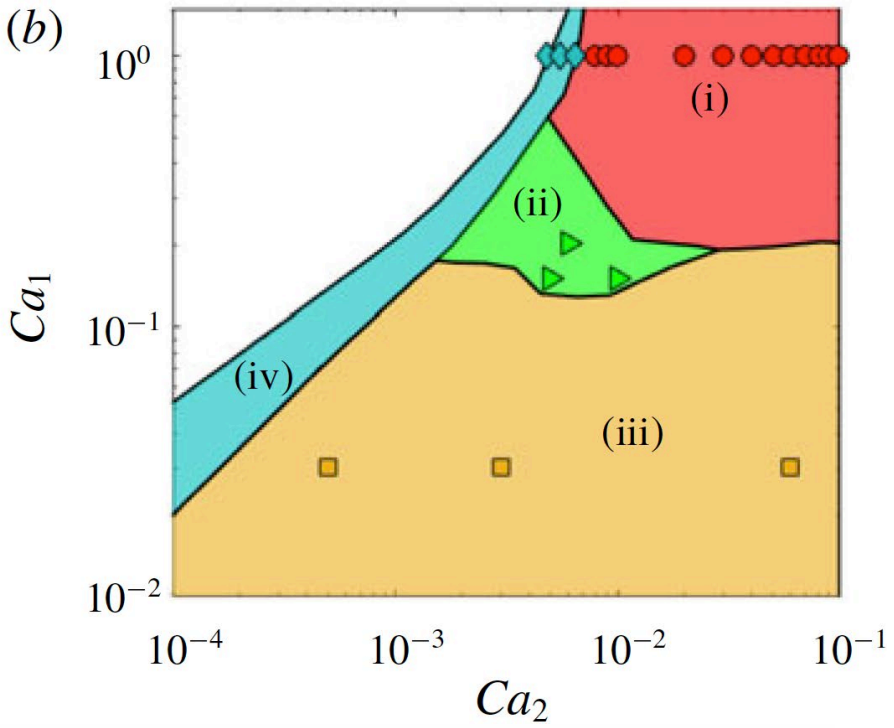


Mittal, Nitesh, et al. ACS nano 12.7 (2018): 6378-6388.

Dynamics in microfluidics

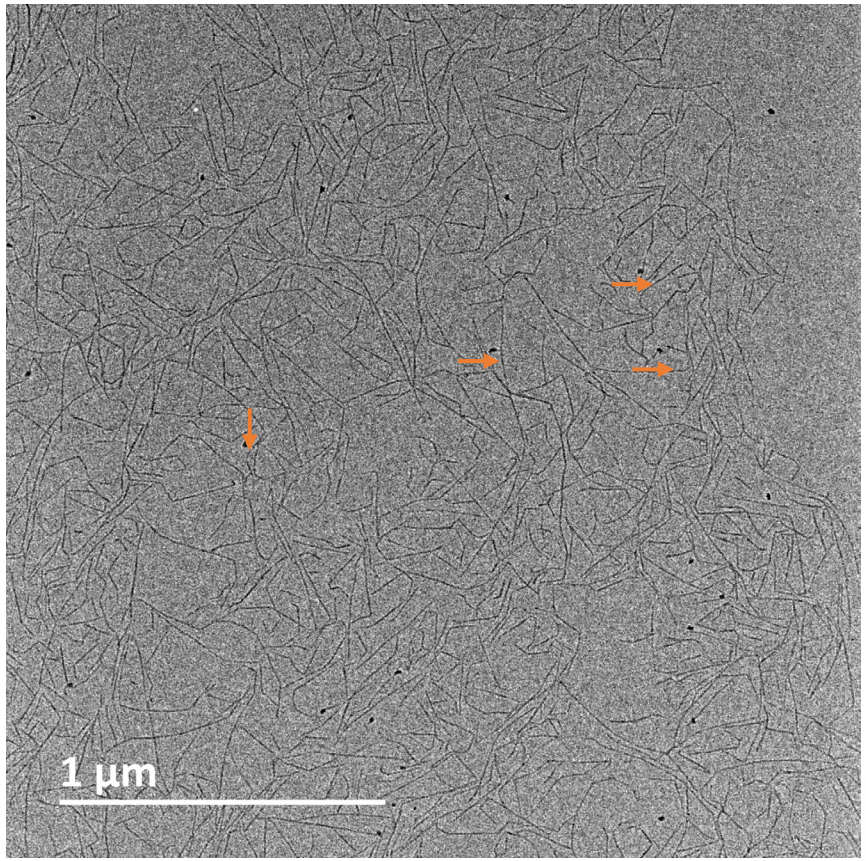


Gowda. V, Krishne, et al. Journal of Fluid Mechanics 876 (2019): 1052-1076.

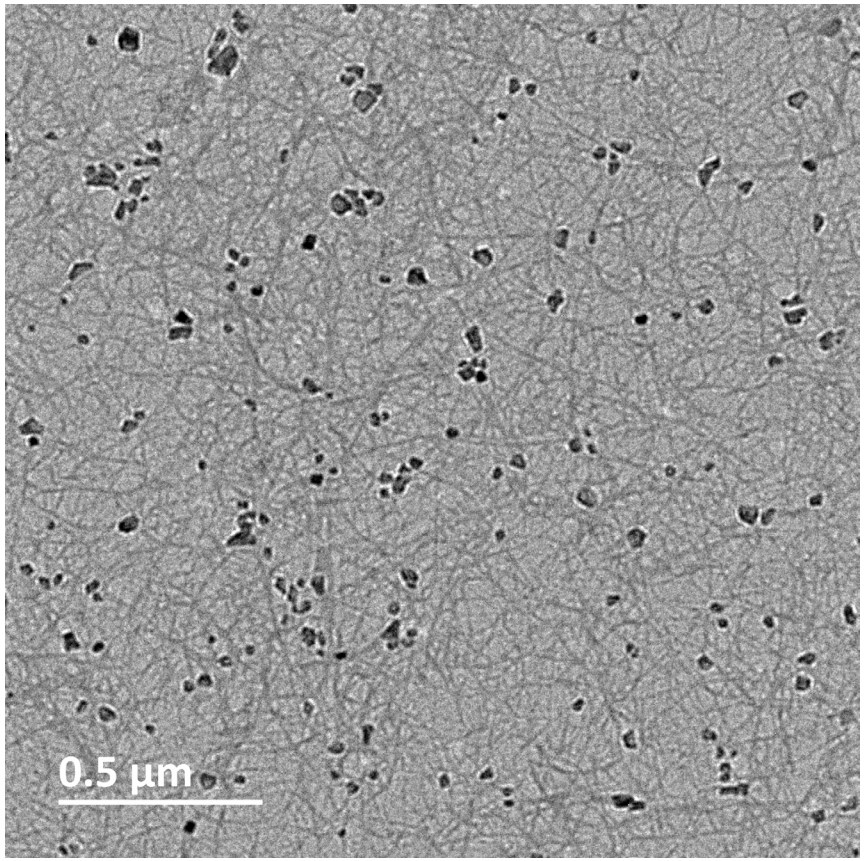


$$Ca = \frac{\eta U}{\gamma}$$

TEM

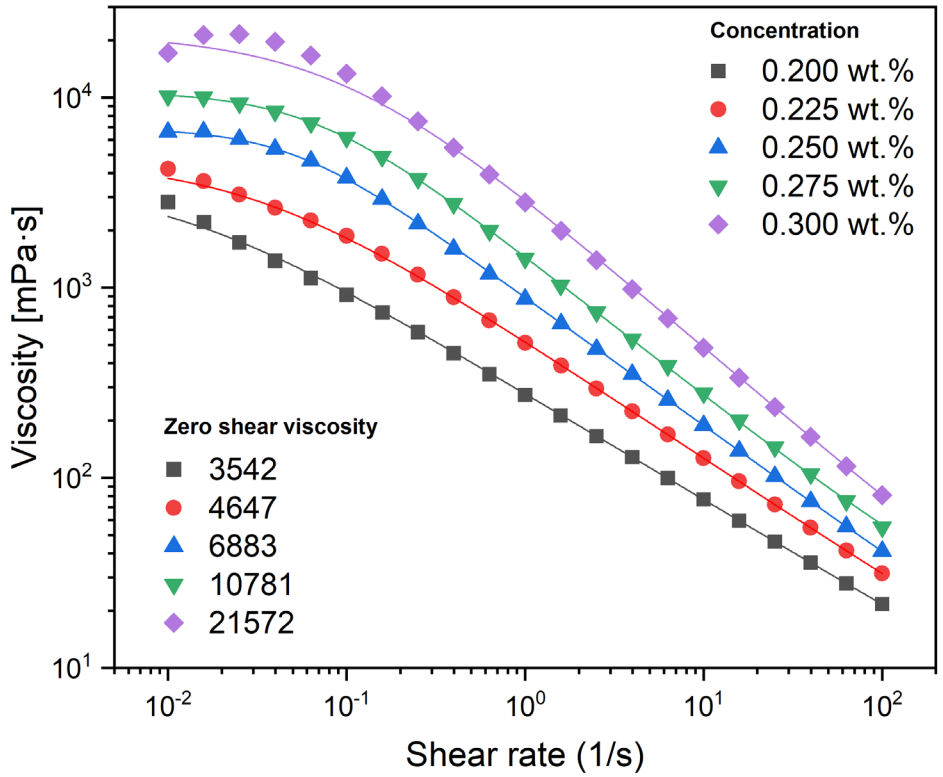


K2

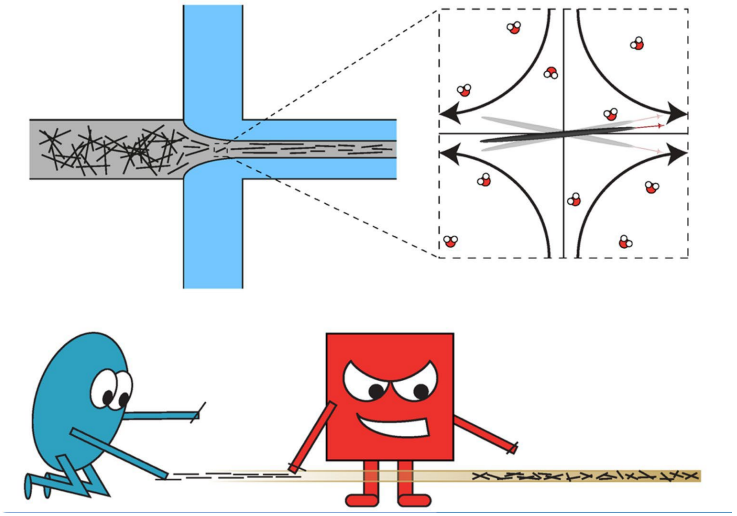


K90

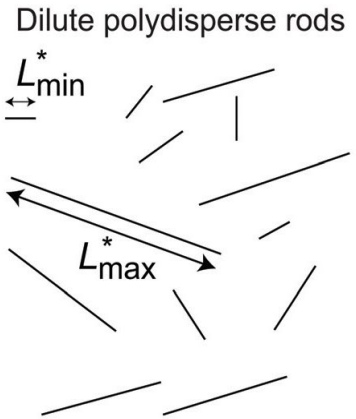
Rheology

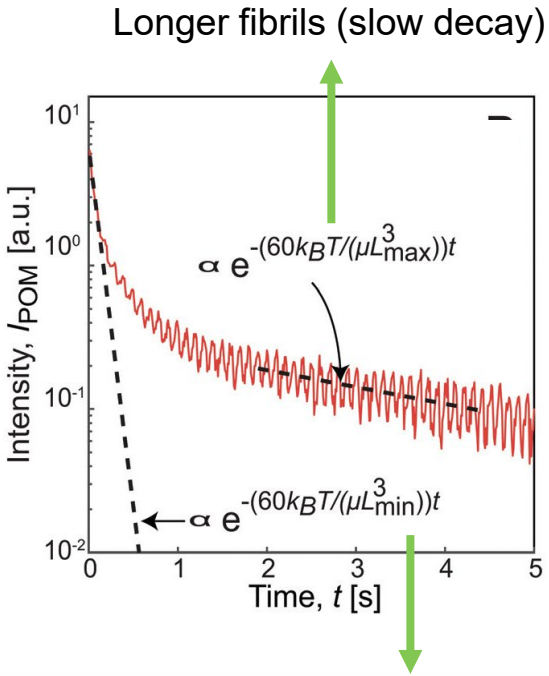

Concentration
0.200 wt.%
0.225 wt.%
0.250 wt.%
0.275 wt.%
0.300 wt.%
Zero shear viscosity
3542
4647
6883
10781
21572
Viscosity [mPa·s]
Shear rate (1/s)
10^4
10^3
10^2
10^1
10^-2
10^-1
10^0
10^1
10^2

Flow Stop - Polarized Optical Microscopy



$$D_r \approx \frac{5k_BT}{\mu L^3}$$

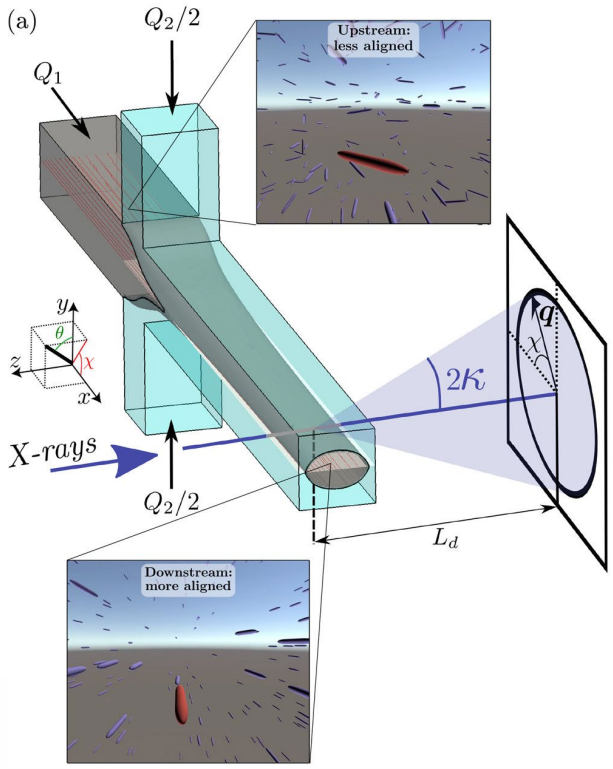


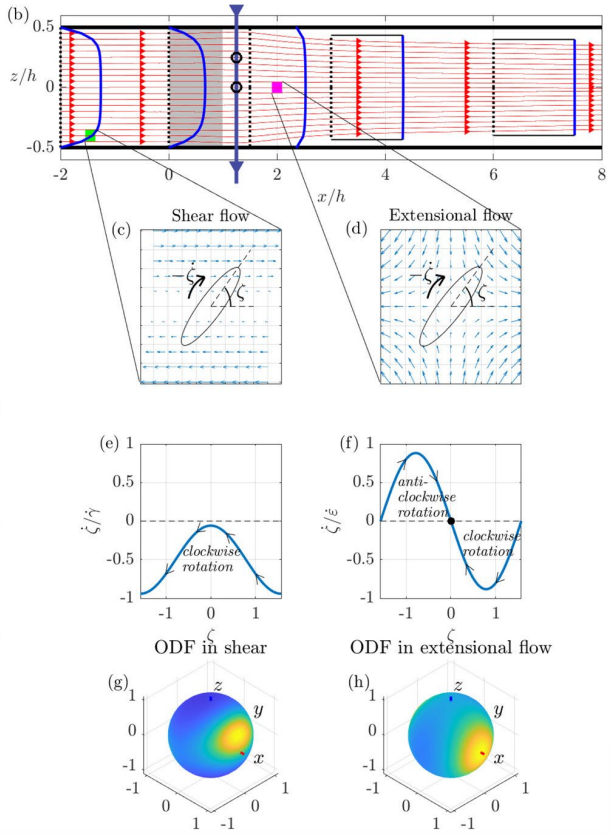


Flow Stop - Polarized Optical Microscopy

Results

Small Angle X-ray Scattering

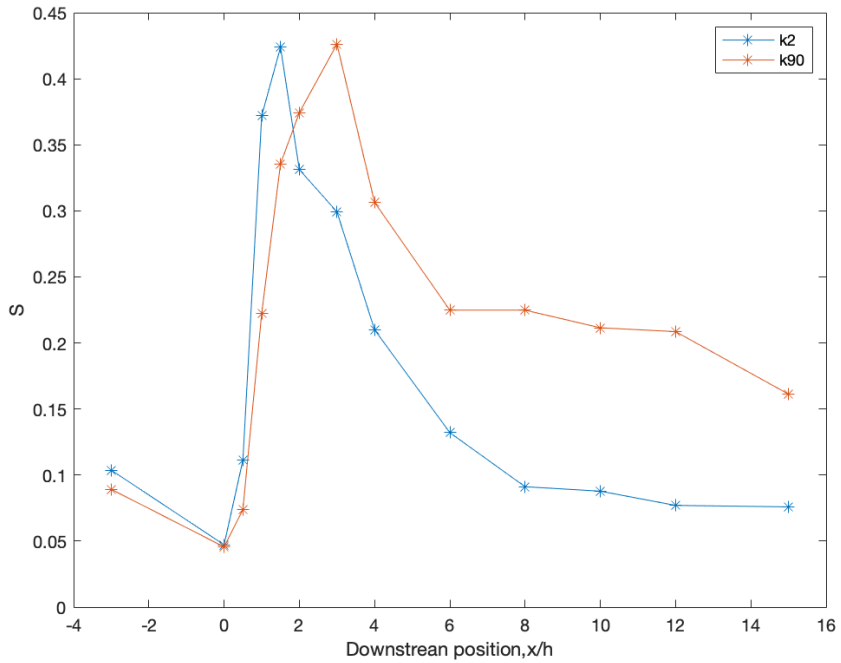


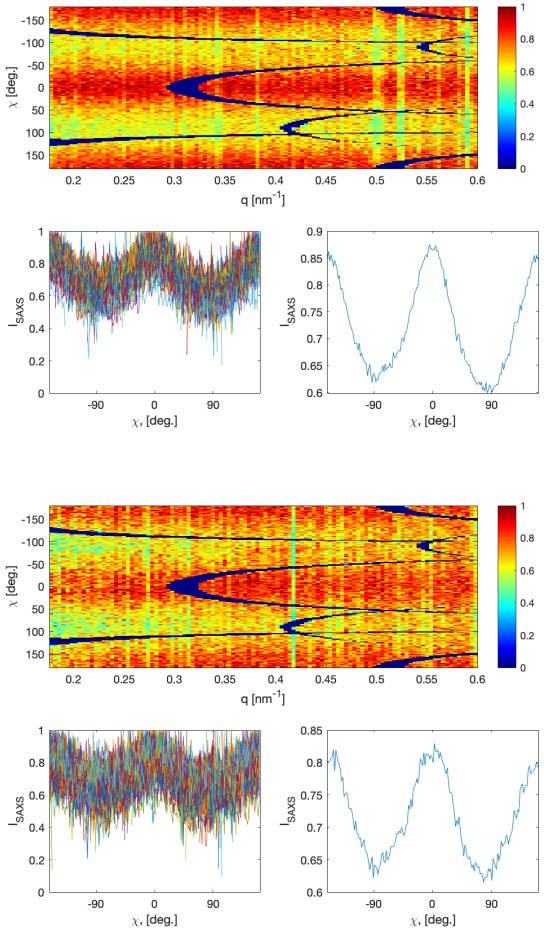


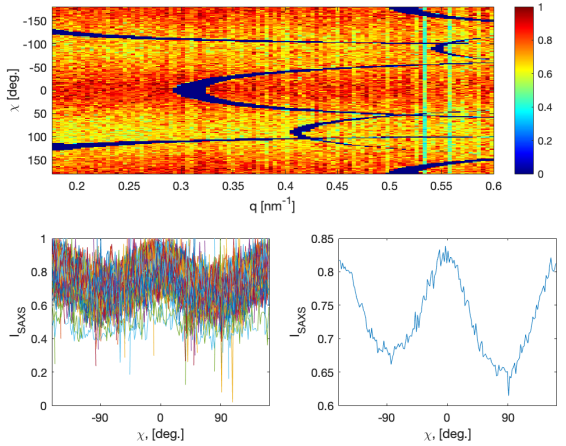
Gowda, V. Krishne, et al. ACS nano 16.2 (2022): 2120-2132.

Results

Small Angle X-ray Scattering

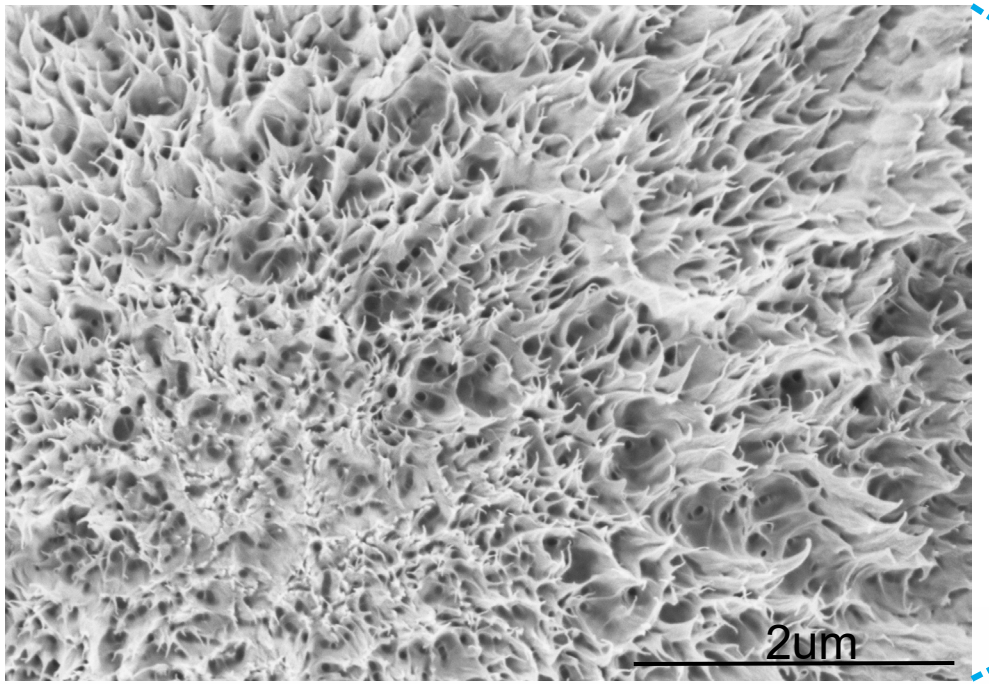


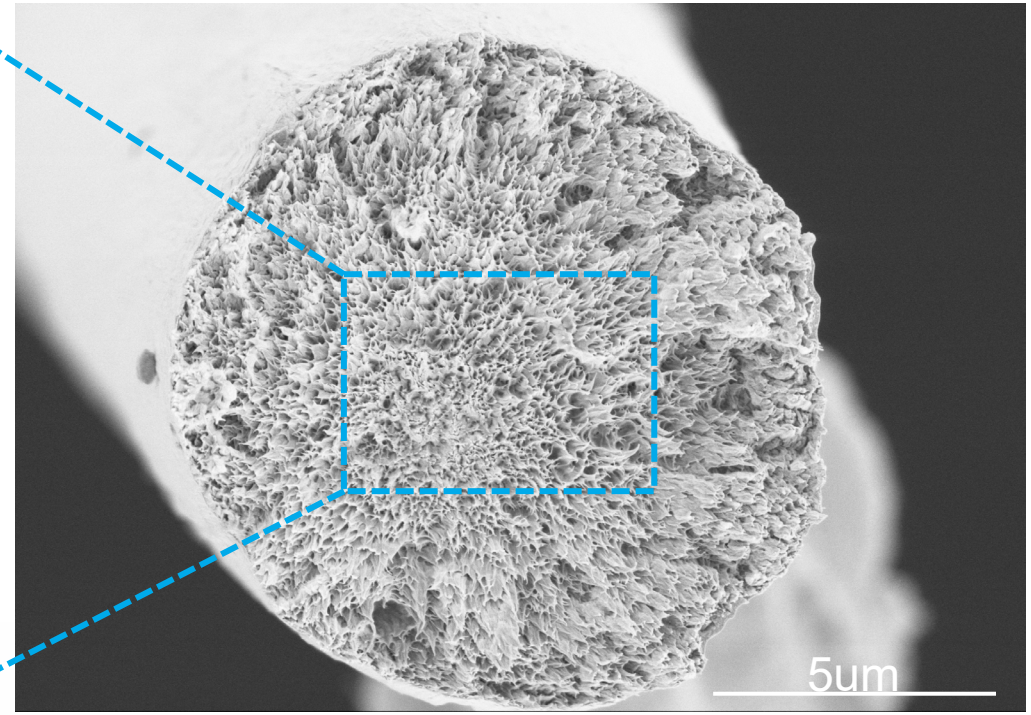




Mechanical Properties

Cross Section Morphology





Thank you!

Saeed Davoodi

sdavoodi@kth.se

Prof. Fredrik Lundell

Prof. Daniel Söderberg

Dr. Erfan Oliaei