

Drug-eluting melt-spun liquid-core fibers for hernia meshes



Empa

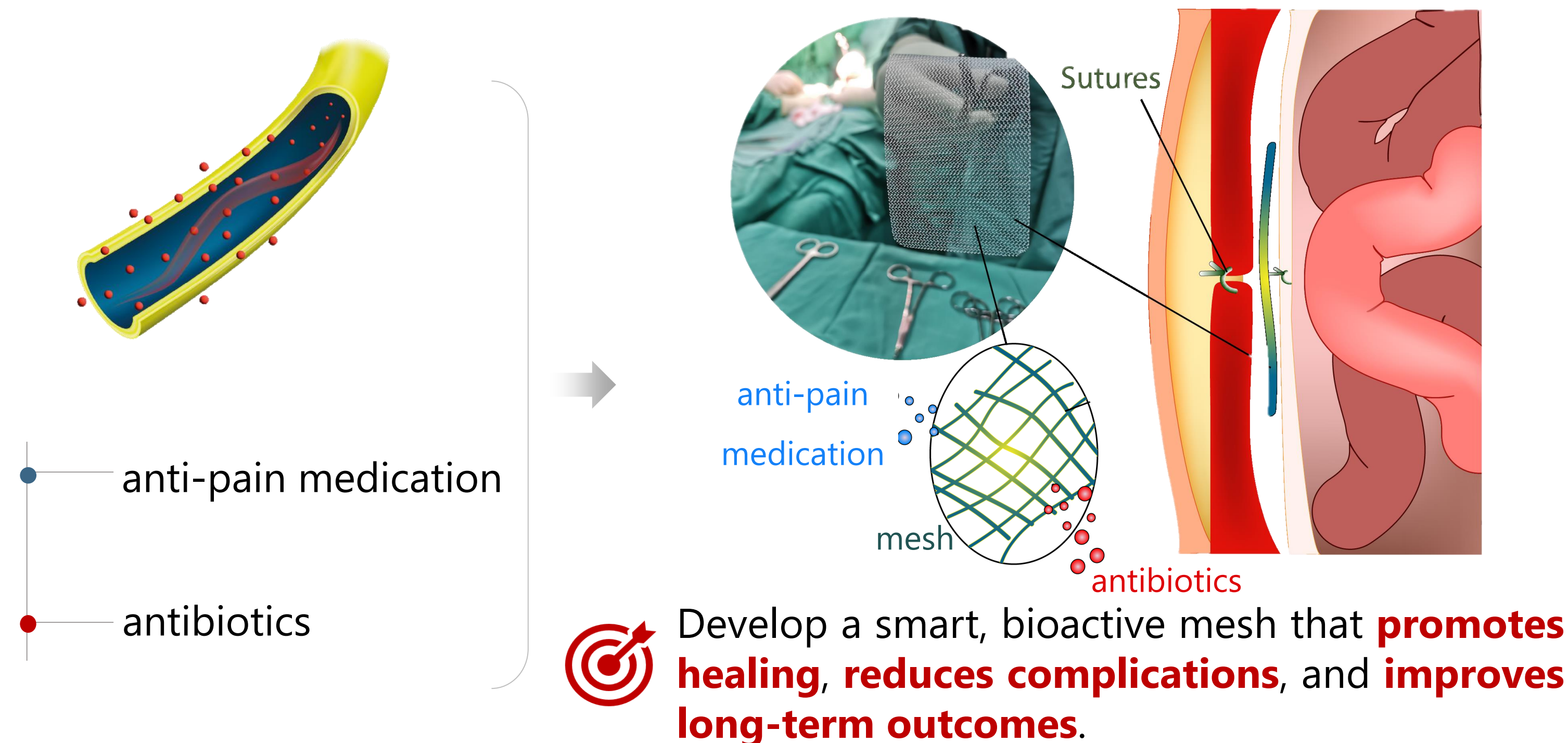
Materials Science and Technology

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Aim - Motivation



Melt-spinning

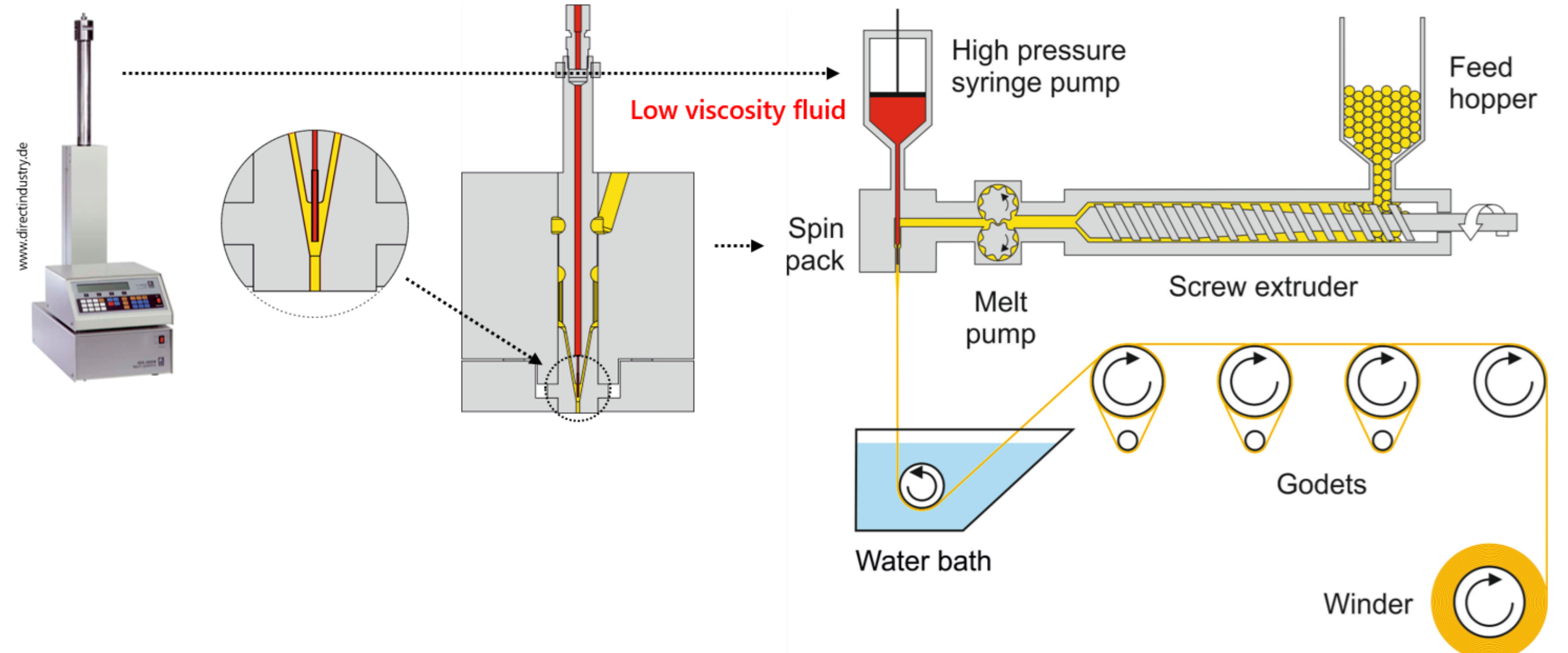


Figure 1: Continuous medical liquid-core fiber (MedLiCoF) co-extrusion line.

MedLiCoFs

The produced fibers differ in:

- the sheath material
- the draw ratio
- the sheath thickness
- drug molecule

Table 1: Characteristics of the produced MedLiCoFs.

Material of the fiber's sheath	Material of the fiber's core	Draw Ratio (DR)	liquid/polymer (vol %)
 Polycaprolactone (PCL)	PCL / PP / PLA	Undrawn or Drawn	Thick or Thin sheath
	PEG 400		
10mM Ibuprofen in PEG 400			
100mM Ibuprofen in PEG 400			
 Polypropylene (PP)	10mM Diclofenac in PEG 400		
 Poly(lactic acid) (PLA)	100mM Diclofenac in PEG 400		
	10mM Celecoxib in PEG 400		

Confocal Raman spectroscopy

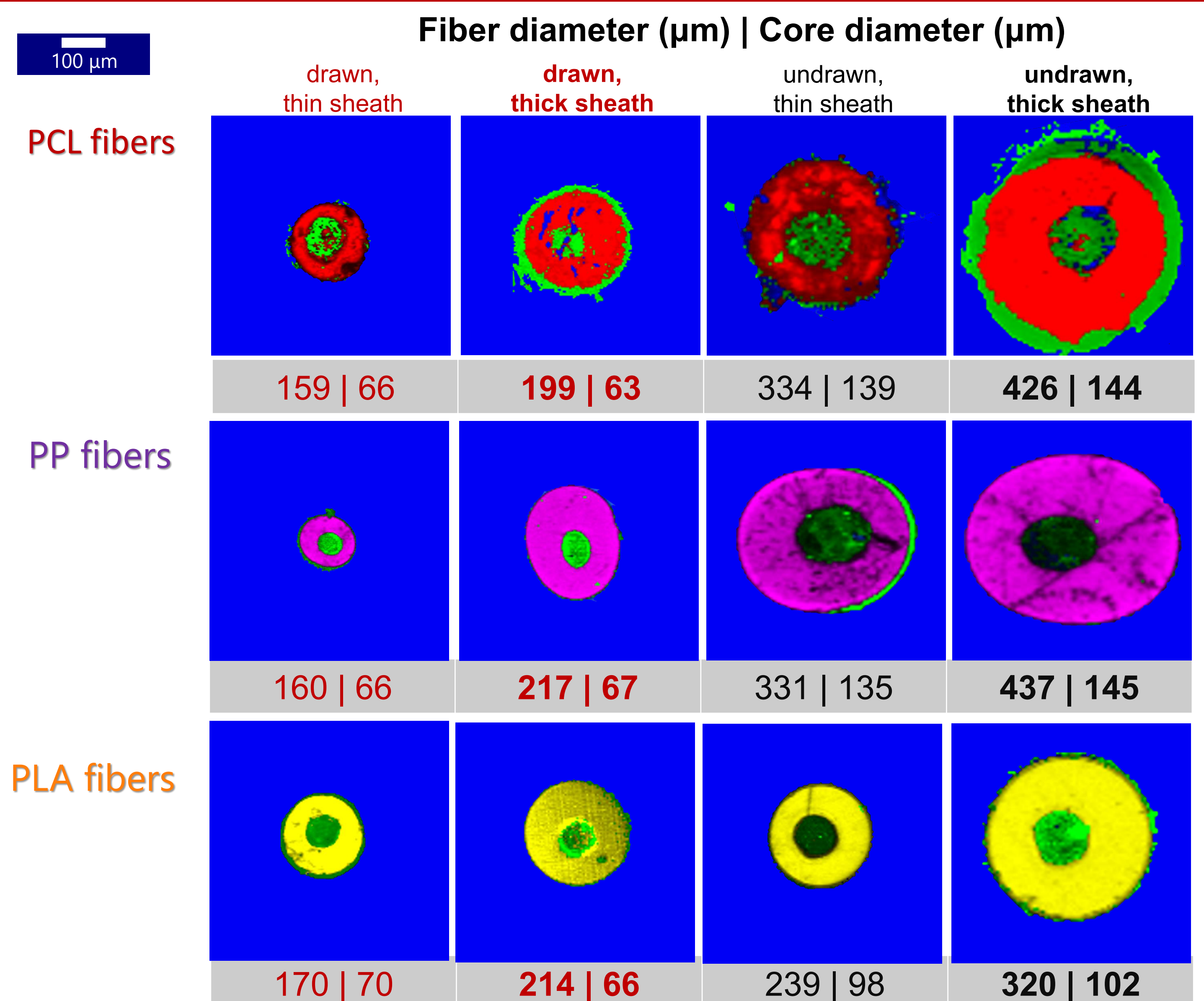


Figure 2: High-resolution Raman maps of the cross-sections of embedded PCL, PP, and PLA MedLiCoFs.

Tensile tests

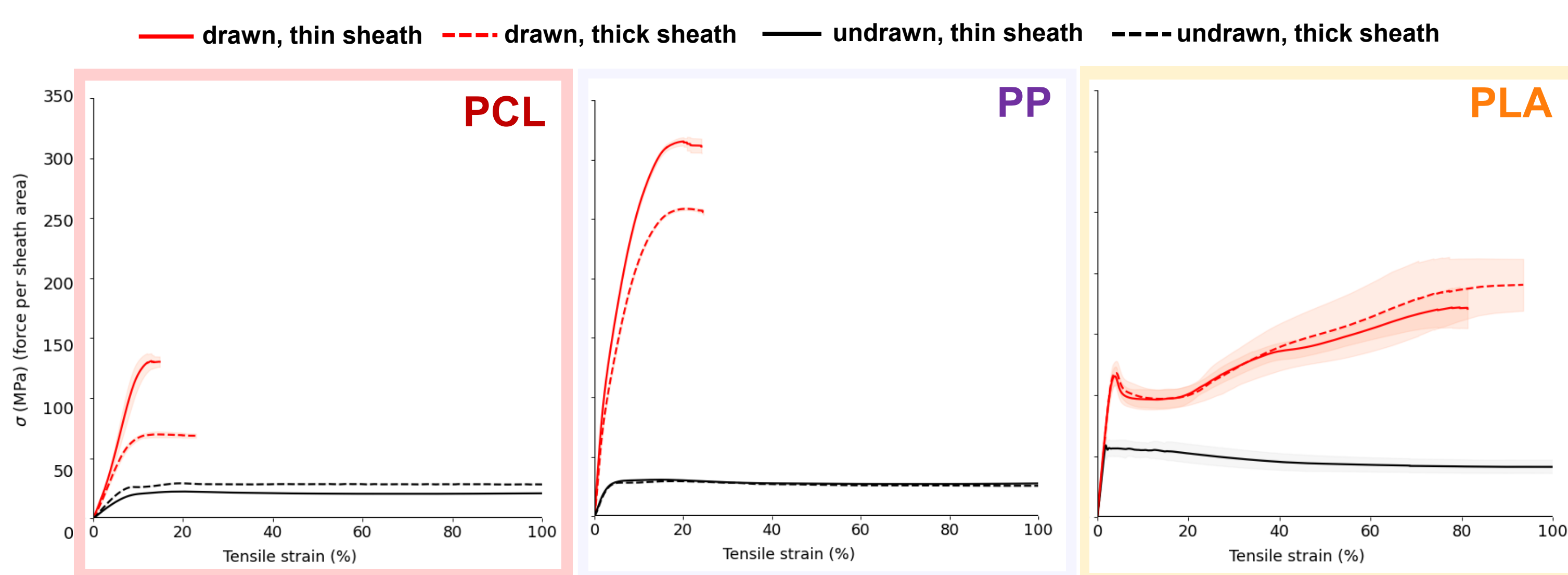


Figure 3: Mechanical properties of the PCL, PP and PLA fibers.

- Thin sheath fibers show higher tensile strength than thick sheath fibers, most-likely due to stress-induced crystallization.
- Drawn PP fibers achieve the highest tensile strength.

Time-dependent drug-release

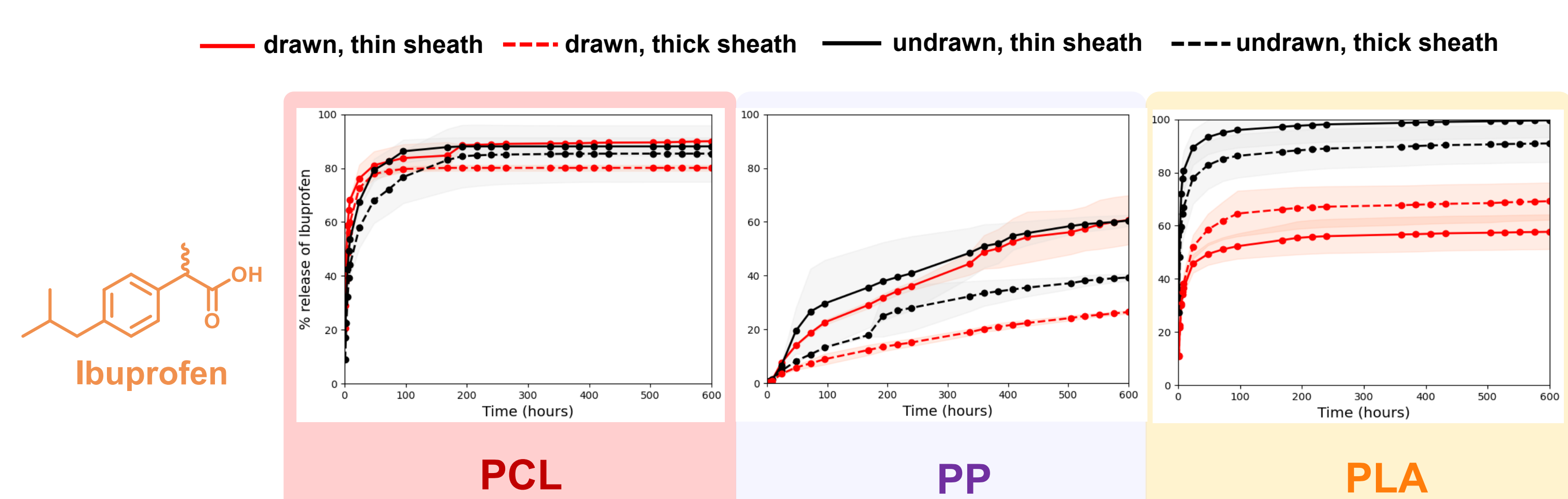


Figure 4: Drug release studies from liquid-core fibers with 100 mM Ibuprofen in PEG400.

- Fibers with a thin sheath show faster release kinetics
- The polymer sheath material affects the release kinetics

Conclusions / Outlook

Overall, the spinning of MedLiCoFs was successful resulting in a collection of drug-loaded liquid-core fibers. By employing different polymer sheath materials, as well as drug molecules differing release kinetics were obtained. Time-dependent drug release studies were conducted for all fiber types over a period of four weeks. Especially, PP fibers showed a great potential to achieve sustained drug delivery. Future work will focus on the biological evaluation of the fibers, including cyclooxygenase (COX) trials, to verify their anti-inflammatory efficacy. MedLiCoFs may also find applications in other medical applications involving melt-spun fibers.

References:

- E. Perret, *et al.*, Journal of Drug Delivery Science and Technology (112), 107229, 2025
- M. Röthlisberger, *et al.*, Polymer (298), 126885, 2024

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