Tailored Mechanical Property of Liquid Crystal Elastomer Fiber Actuator

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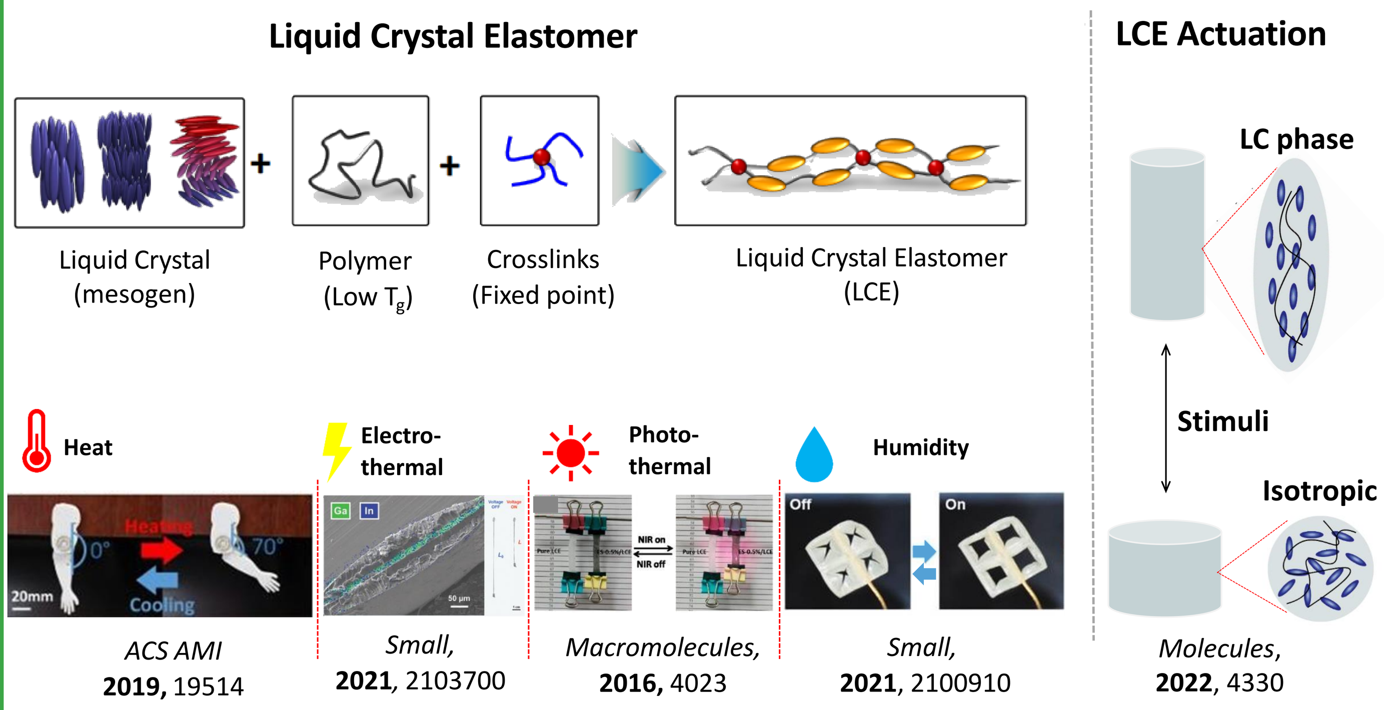
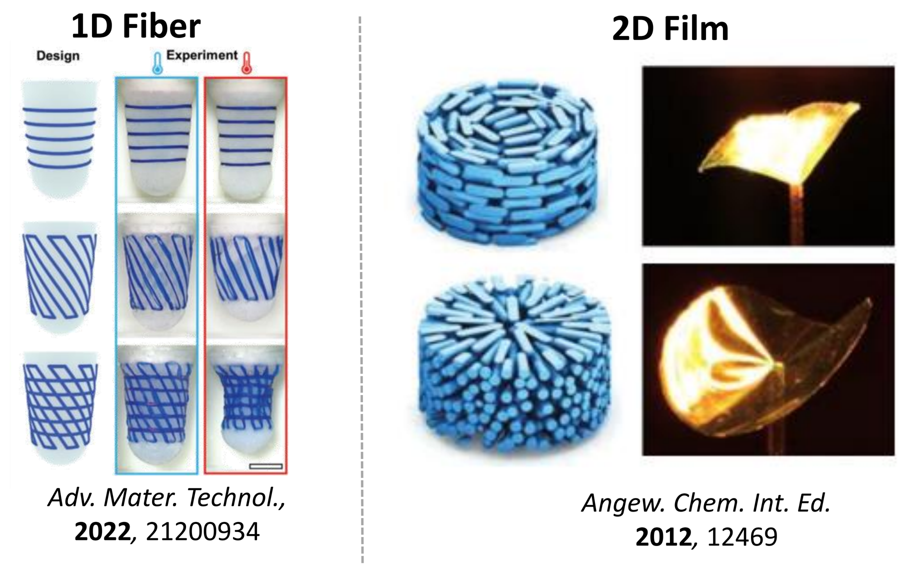
INTRODUCTION & OBJECTIVE

What are Liquid Crystal Elastomers (LCEs)?



Programmable & reversible actuation in response to various stimuli

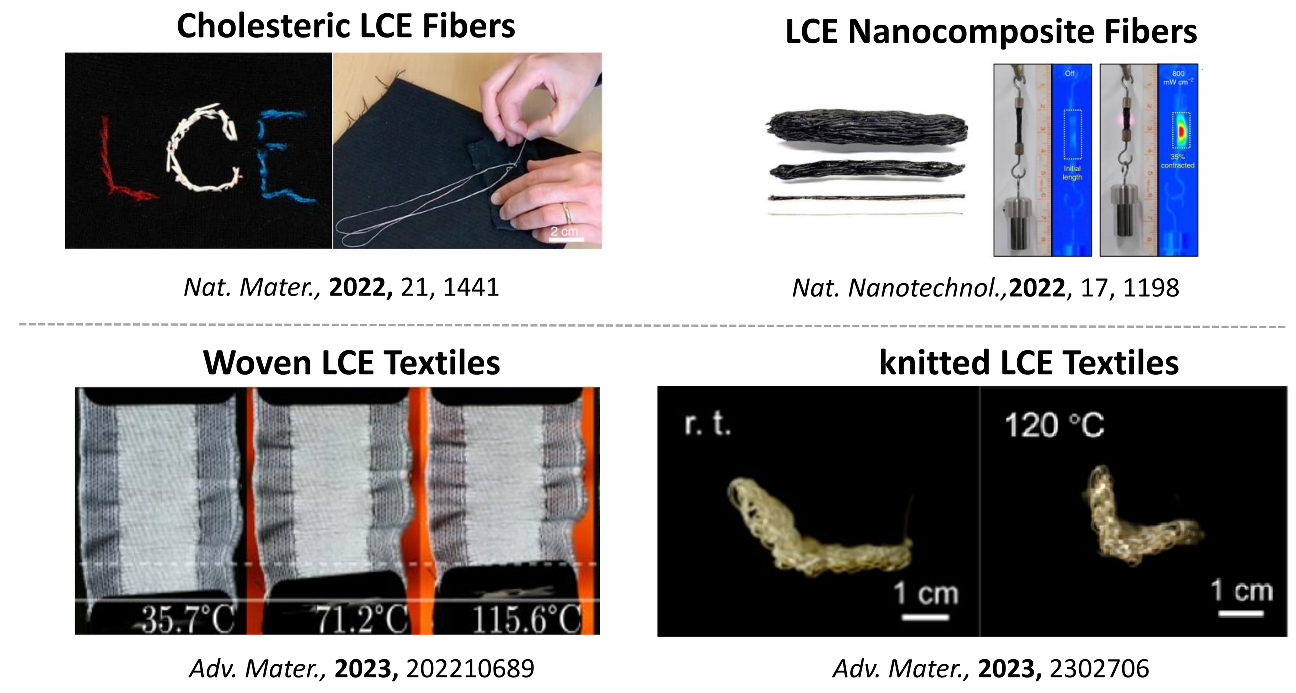
Why LCE Fibers? (1D vs 2D)



(+) No need for complex alignment process (vs film)

(+) Faster deformation rate due to large surface area (vs film)

Recent Research on LCE Fibers



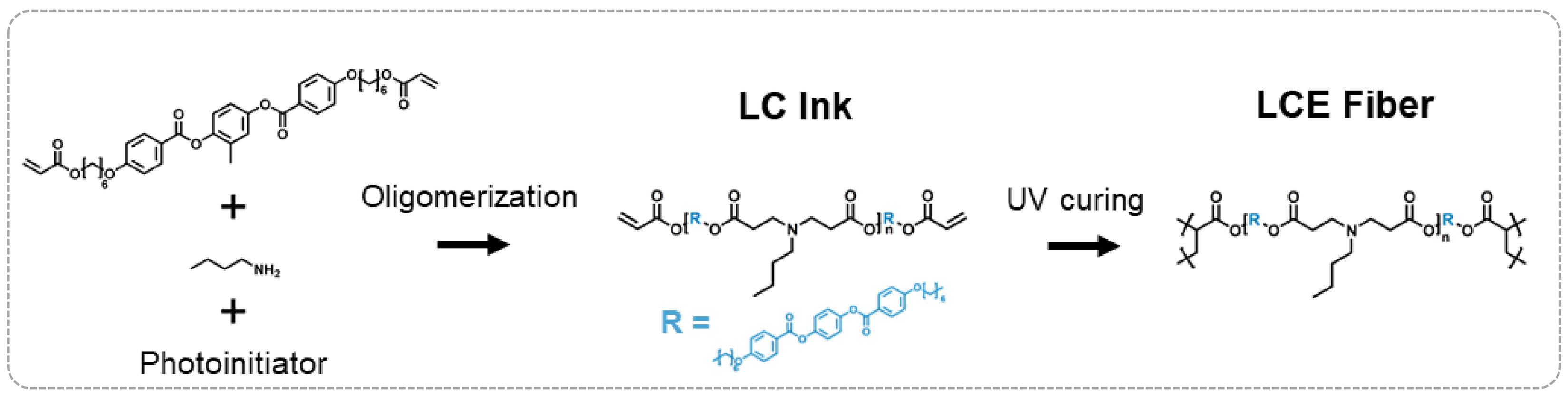
Useful for **artificial muscles** and **smart fabrics**

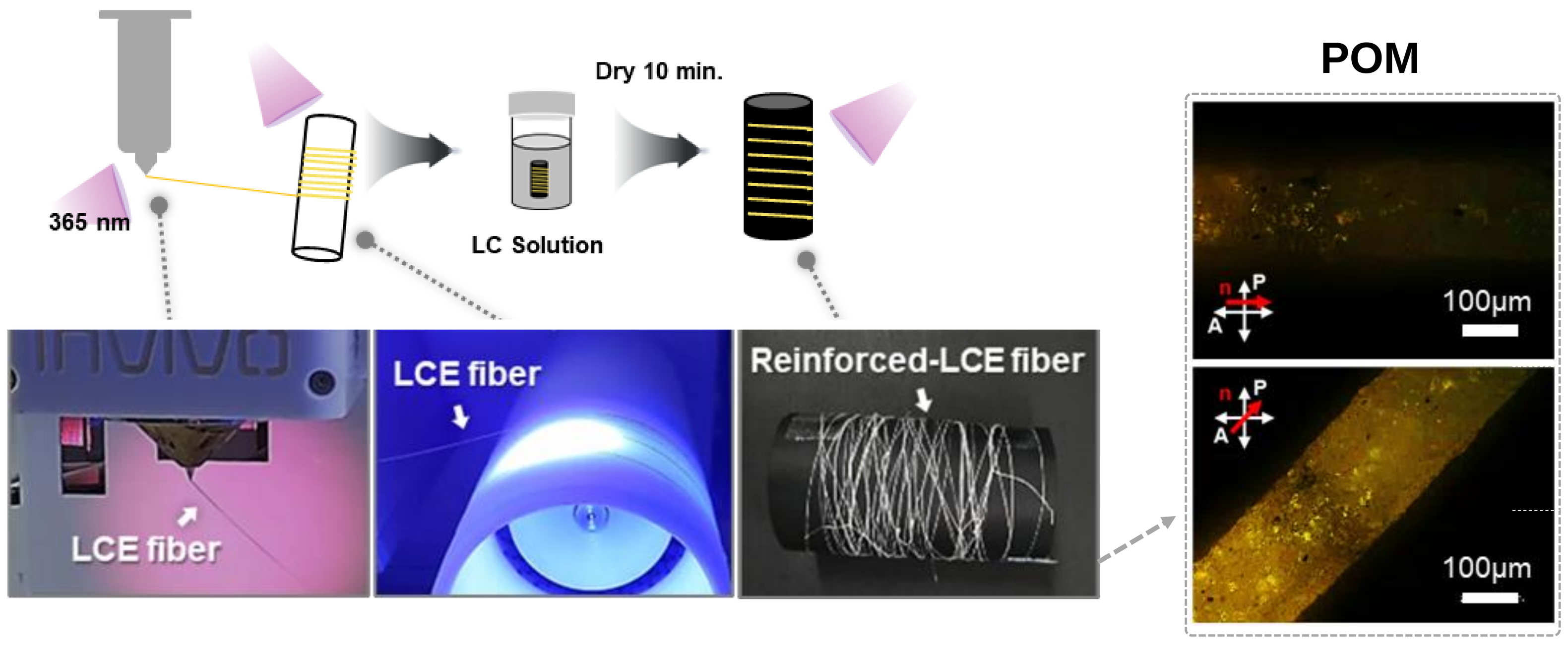
Research Objective

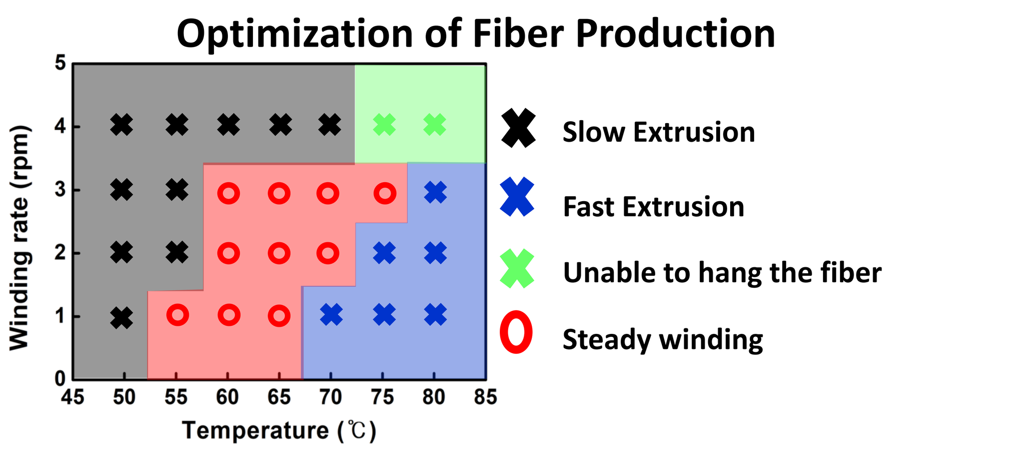
Can we develop a method to produce scalable LCE fibers with tunable mechanical properties and adhesion?

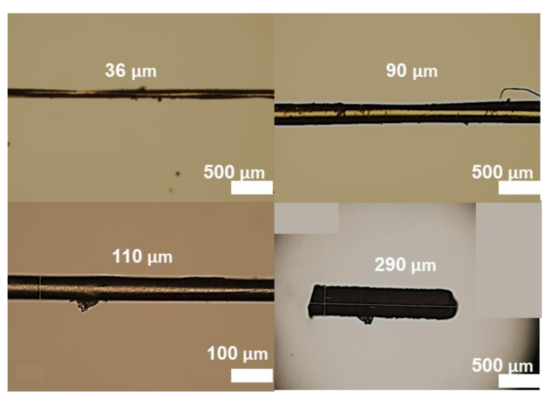
RESULTS & DISCUSSION

(1) Synthesis & Production of LCE Fibers



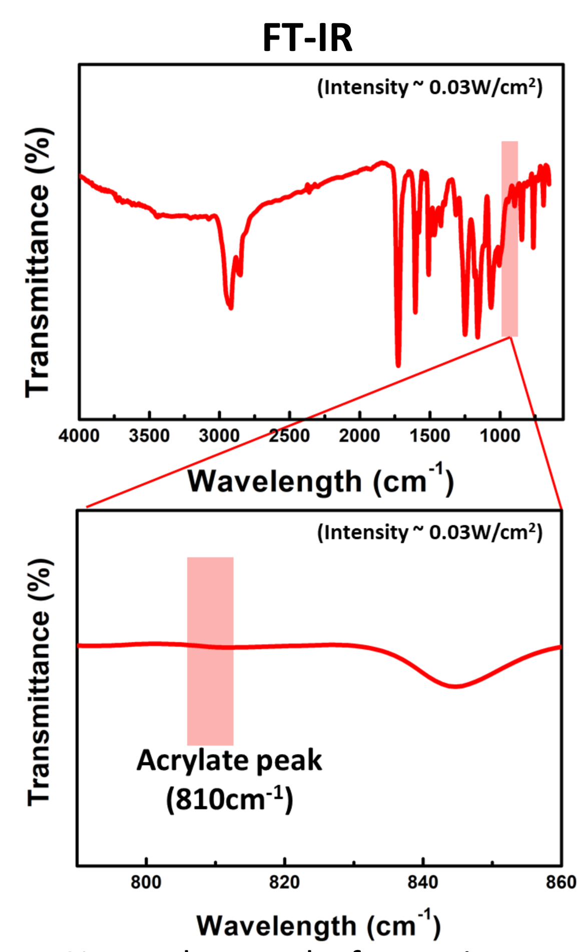




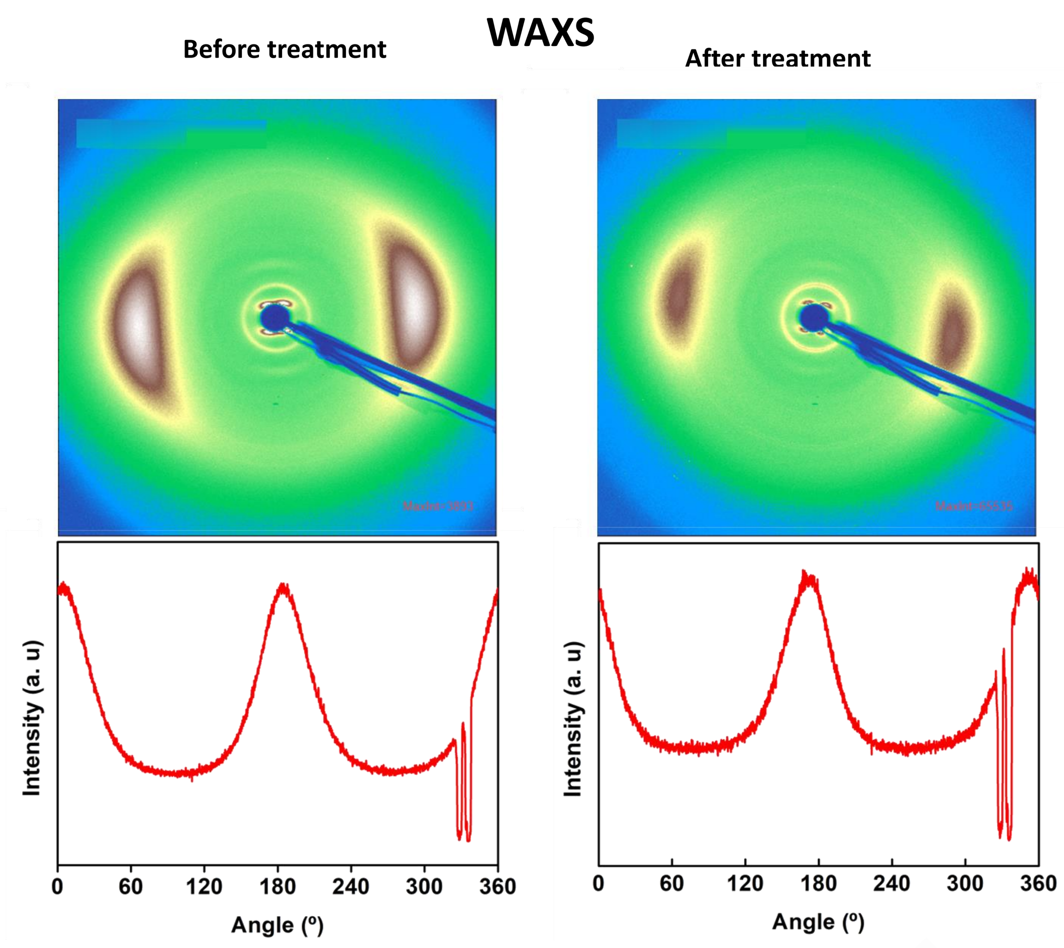


- A continuous, single strand of LCE fiber can be produced (> 10 m)
- Diameter (20-250 μm) can be tuned by nozzle size, temperature, etc.
- Orientation was verified by polarized optical microscopy (POM).

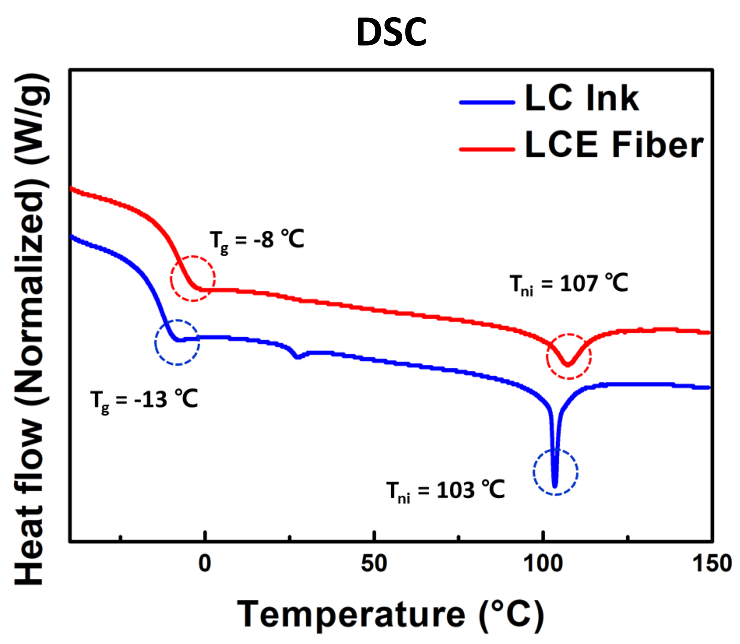
(2) Characterization

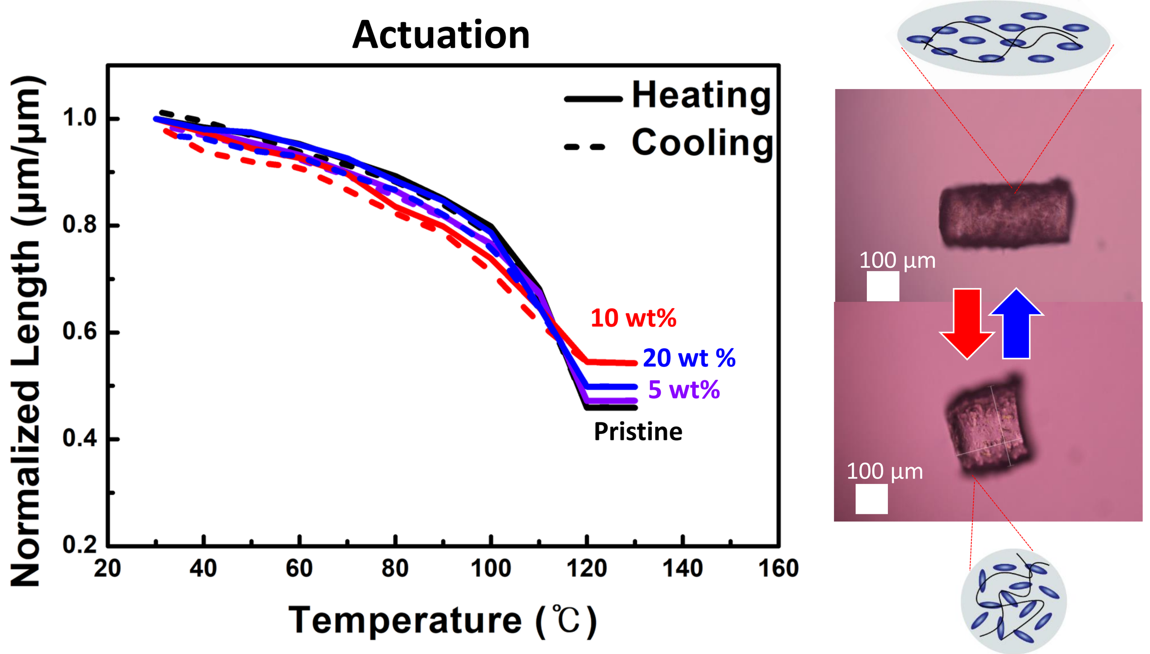


- No acrylate peak after curing



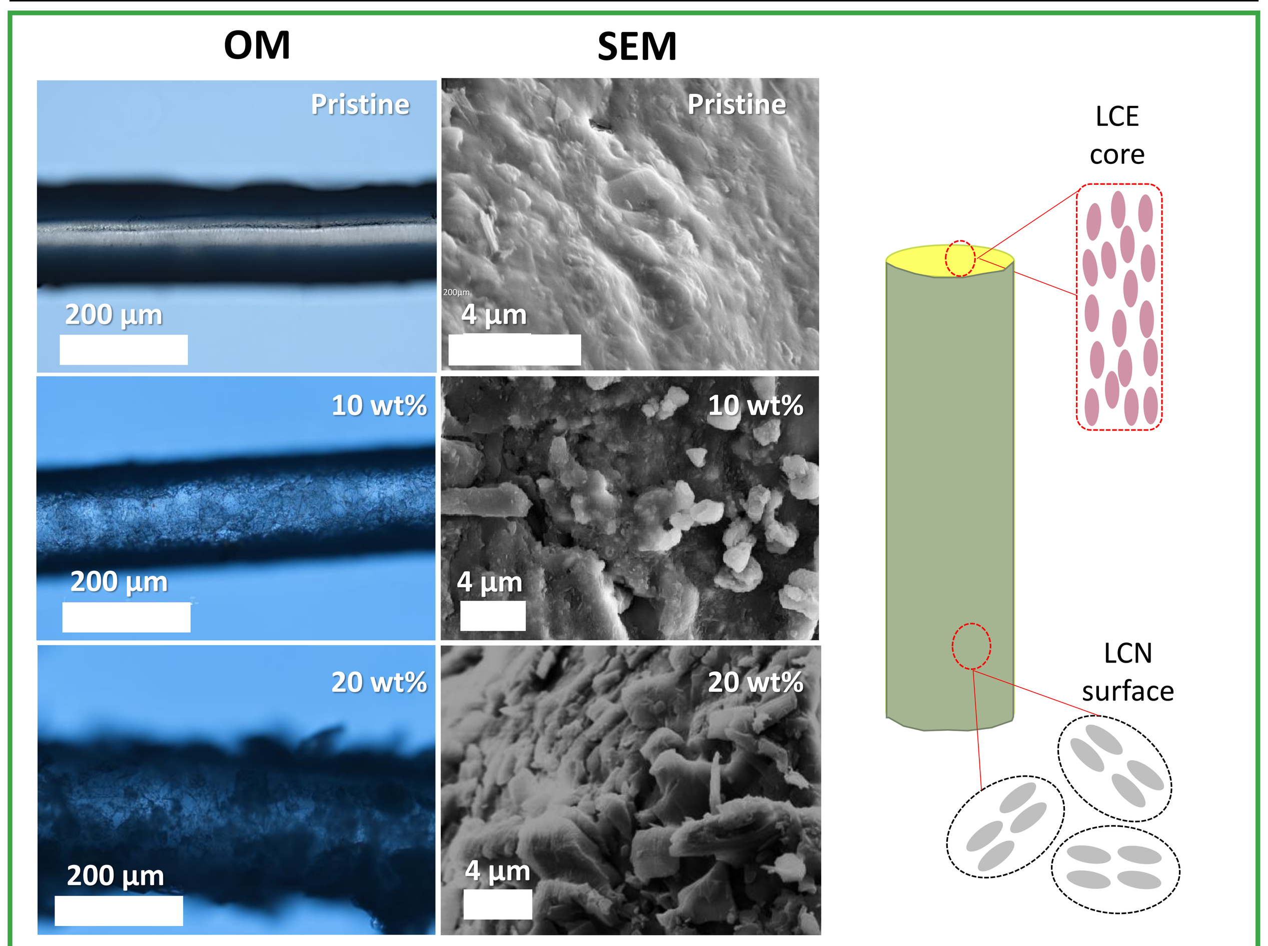
- No significant disruption in orientation after the LC solution treatment



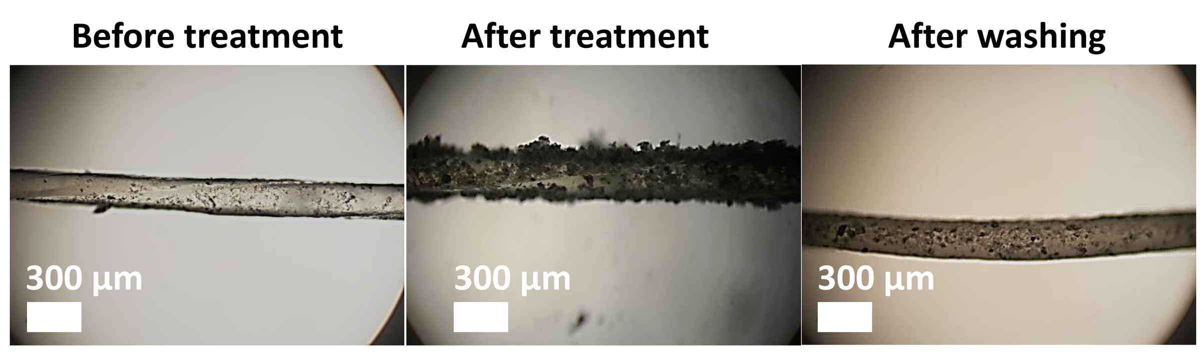


- Reversibly actuation (~50%) even after LCN coating

(3) Morphology

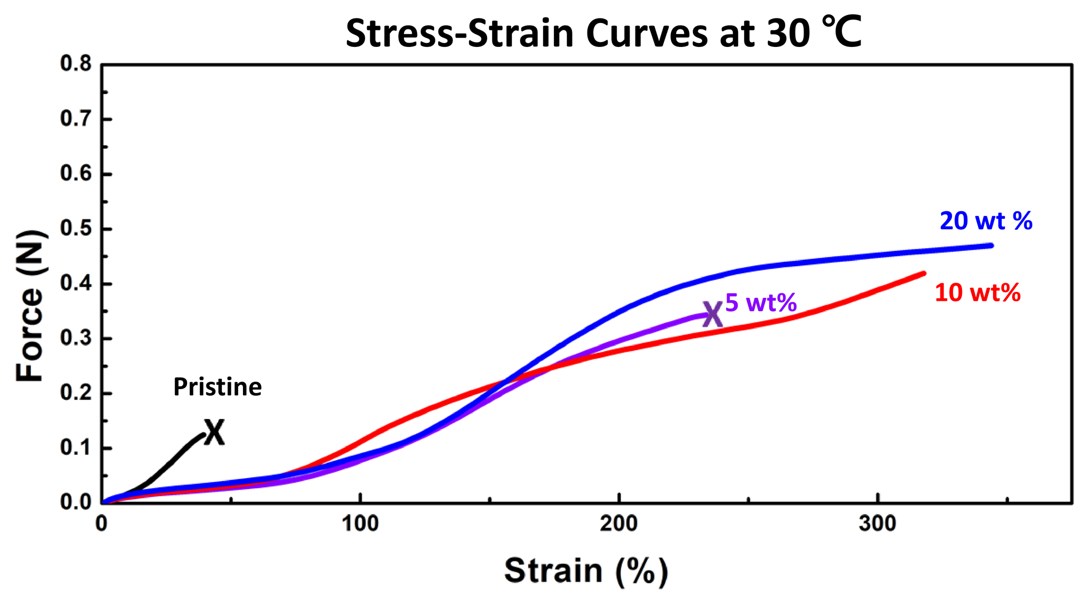


- Increasing EtOH solution concentration increases the surface roughness

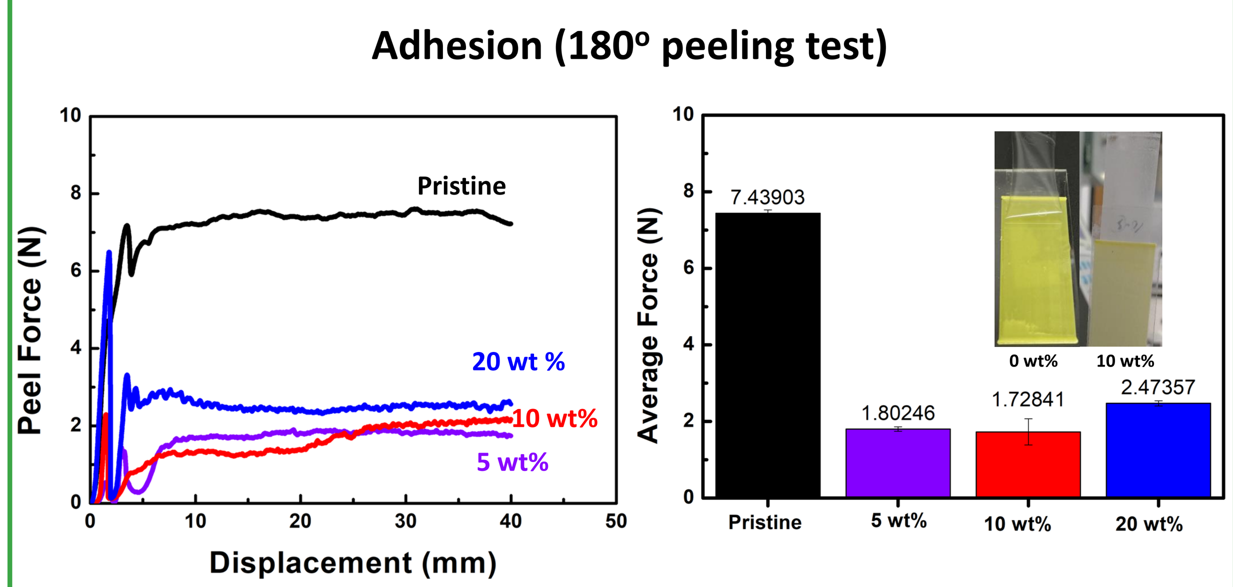


- After washing with EtOH, the fiber surface became smooth again

(4) Mechanical & Adhesive Property

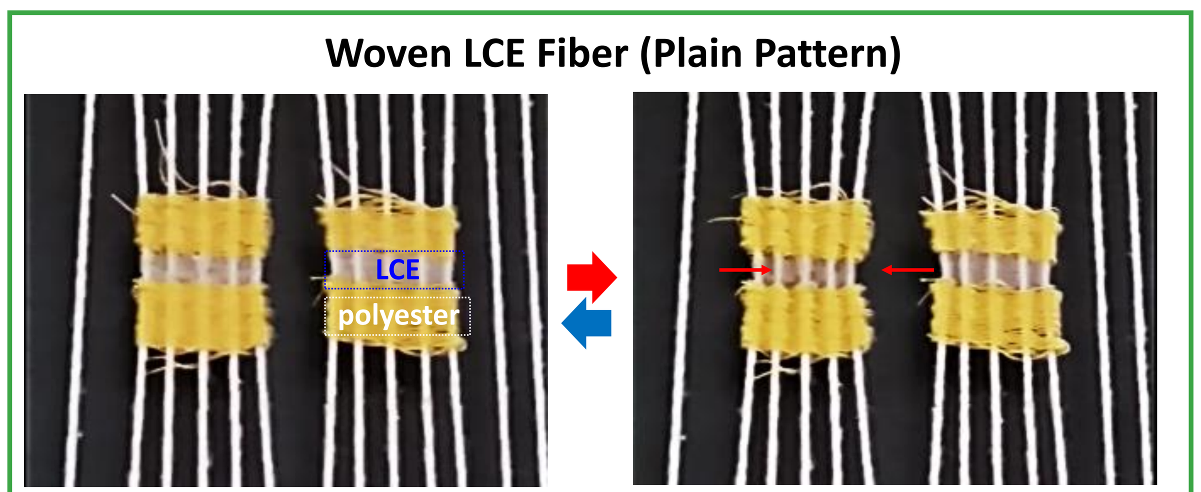


- Considerable increase in mechanical properties after the LCN treatment



- The peel strength considerably decreases by four times

(5) Weaving LCE Fibers



- Reversible contraction/expansion (RT ↔ 130 ℃, actuation strain ~18%)

CONCLUSION

- The method for mass production of LCE fibers (> 10 m) is developed via 3D printing coupled with a winding apparatus.
- Both mechanical property and adhesion of LCE fiber can be effectively modulated while preserving actuation

ACKNOWLEDGEMENTS

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