IOWA STATE UNIVERSITY

Gelatin Fibers: Ribbon and Squared Shape

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Abstract

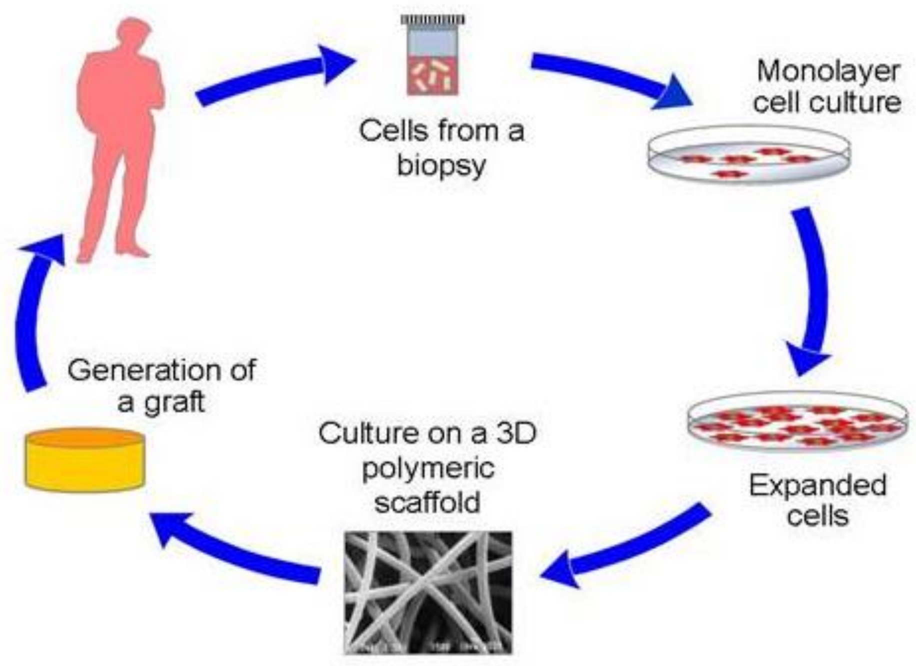
In the present work, the gelatin fibers with controlled size and shape are fabricated by microfluidic device using gelatin dissolved DMSO solution as core solution and ethanol as sheath solution. The viscosity of core solution increases from 446 to 5140 cP by the increase of gelatin concentration from 8 % to 12 %, which significantly changes the fiber morphology from smooth to rough and cross section from round to square. On the other hand, with the decrease of flow-rate ratio between sheath and core from 150:1 to 30:1, the ribbon-shaped gelatin fibers can be obtained, and the fiber dimensions (height × width) remarkably increase from 35 μm × 60 μm to 47 μm × 282 μm.

Introduction

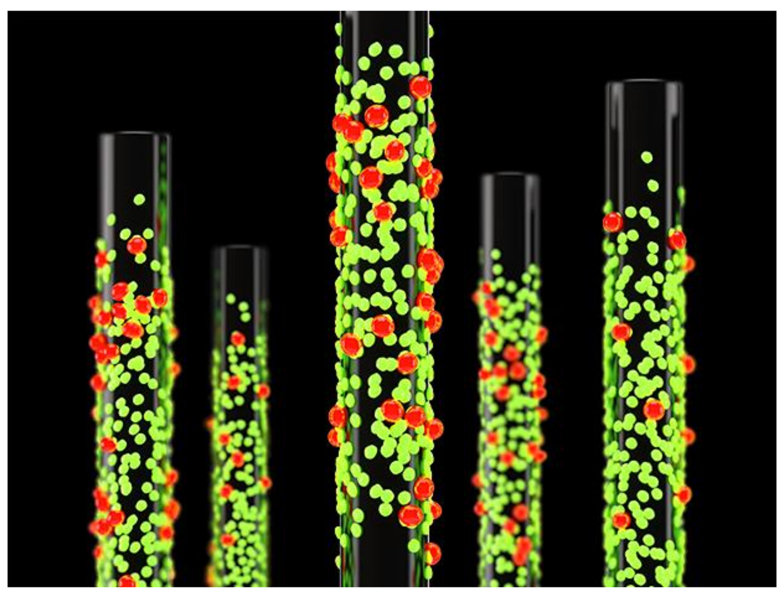
- Advantages of gelatin fibers

✓Inexpensive
✓Neutral
✓Water-soluble
✓Non-toxic
✓FDA-approved biopolymer
✓Cell adhesiveness

Tissue engineering



Drug delivery



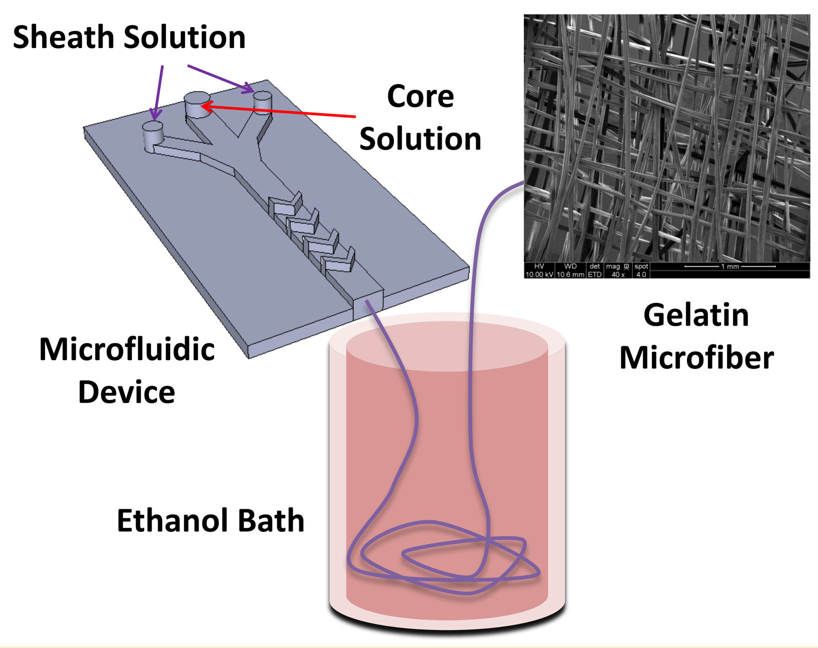
Would dressing

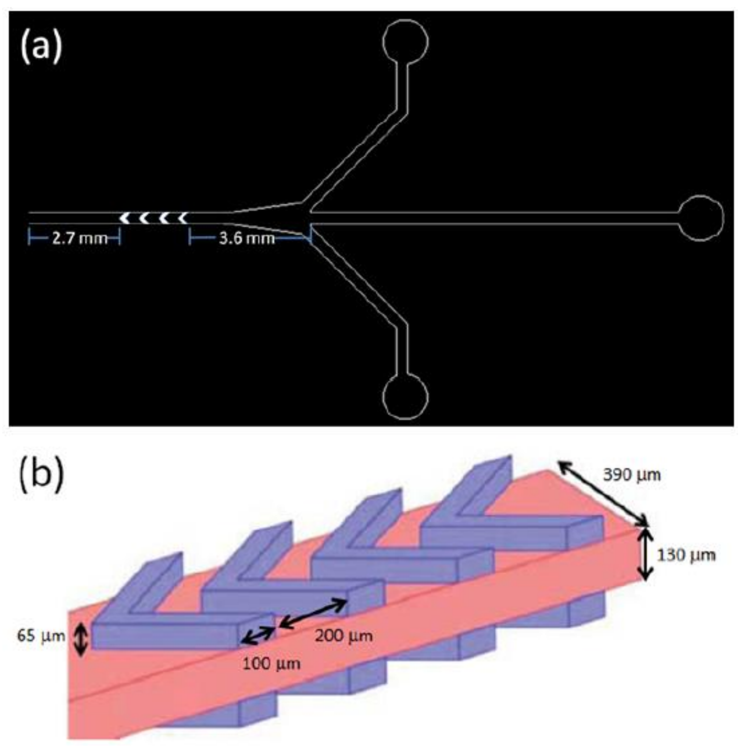
Problem

The cross-sectional shape of previously obtained gelatin fibers is almost exclusively limited to round shapes, and there is no report on microfibers with controllable size and shape.

Experimental

- Microfluidic method





✓Core solution:

8~12 wt% of gelatin powders were dissolved in the DMSO solution under vigorous stirring for 12 hours at 50 ℃

✓Sheath solution:

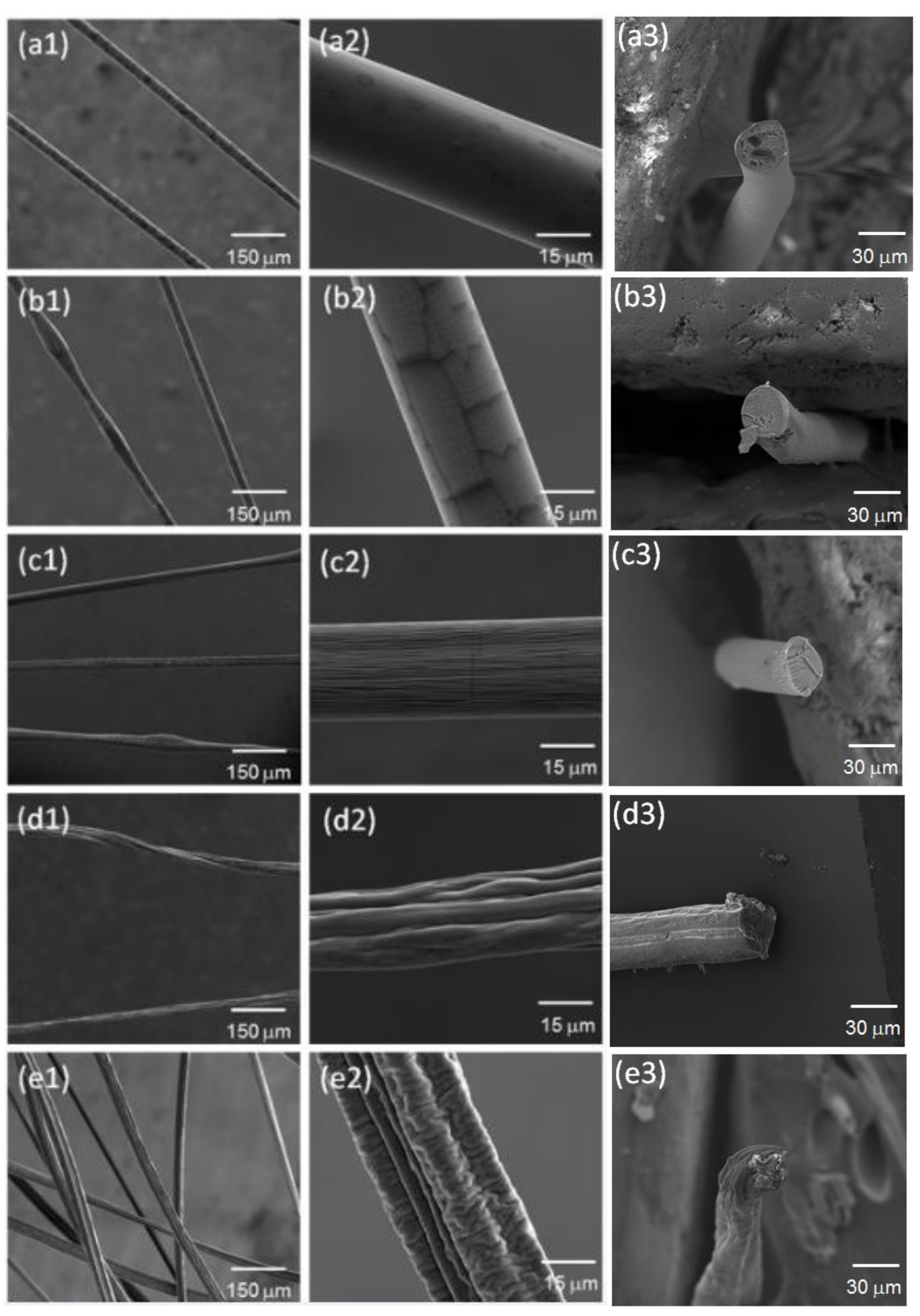
Absolute ethanol

✓The sheath-to-core flow rate ratio:

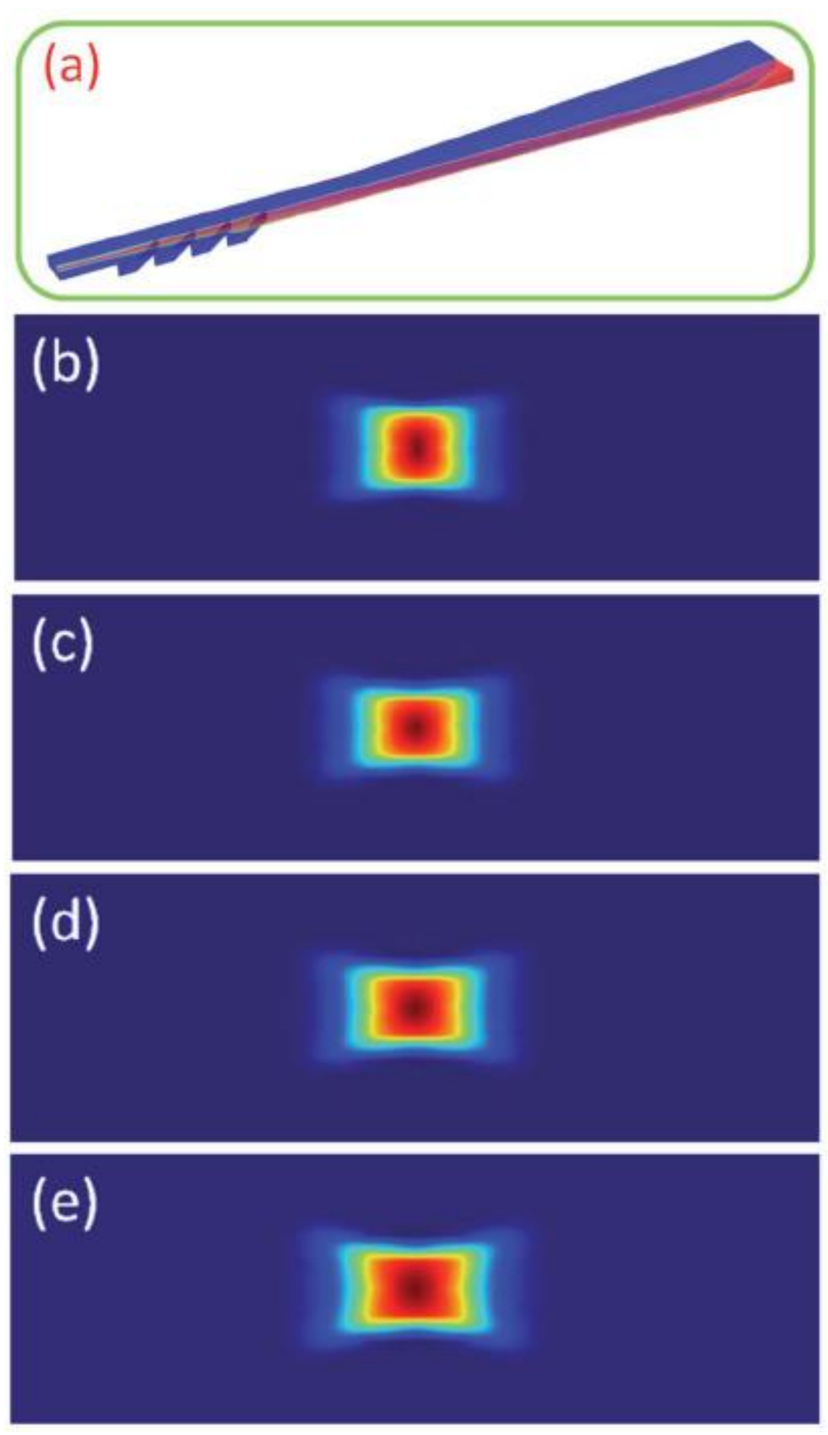
1500:5 μL/min (300:1), 1500:10 μL/min (150:1), 1500:20 μL/min (75:1), and 1500:50 μL/min (30:1).

Results and Discussion

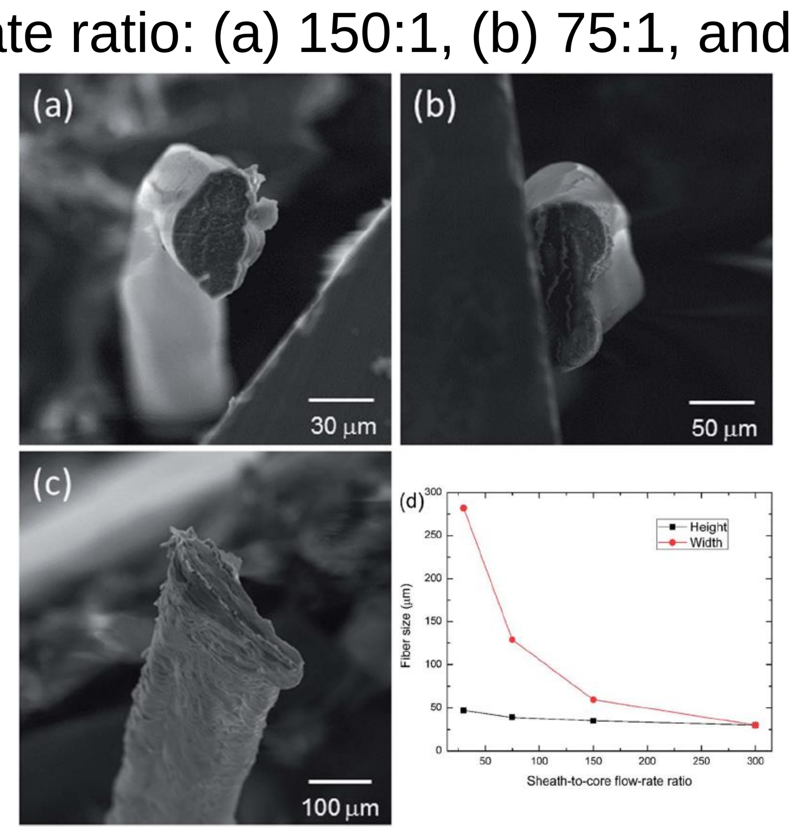
- SEM images of gelatin fibers (8～12 %)



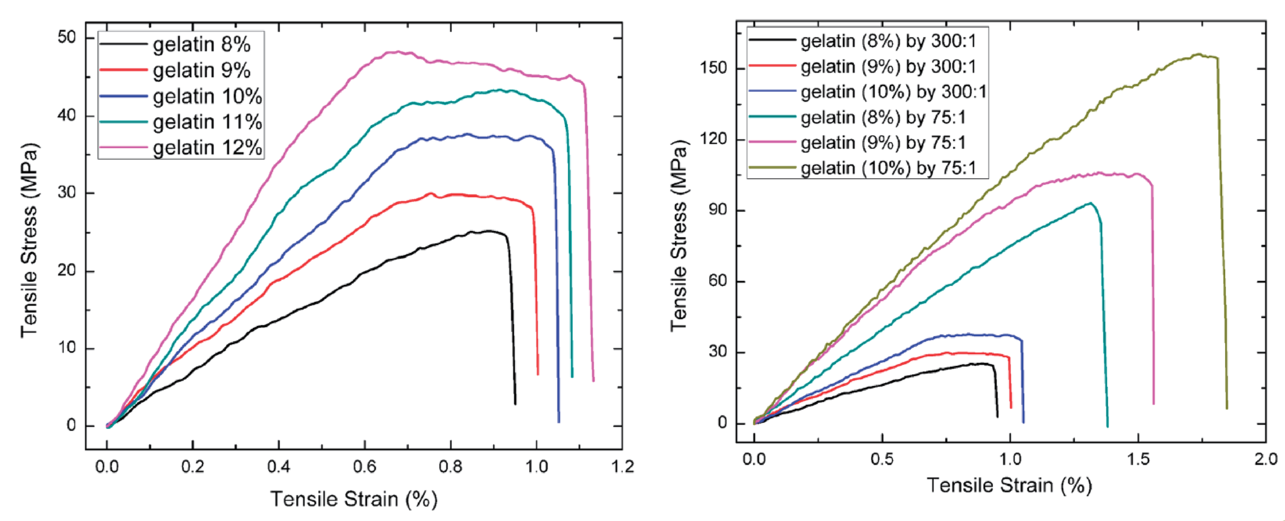
- COMSOL simulation results



- Gelatin fibers fabricated by various sheath-to-core flow rate ratio: (a) 150:1, (b) 75:1, and (c) 30:1



- Tensile stress-tensile strain curves



Conclusion

- The gelatin fibers with controlled size and shape are fabricated by microfluidic device for the first time.
- The experiment results fit well with the simulation results in terms of shape evolution.
- The novel cross sections of gelatin fiber are beneficial to enhance to Young’s modulus, tensile stress at break, and tensile strain at break.

References

Z. Bai, JMM. Reyes, R. Montazami, N. Hashemi, Journal of Materials Chemistry A, 2, 4878 (2014).