Study Record

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02-04/06/2025, Last modification:2025 年 6 月 5 日

目次

1 Outline

- Shot & submitted Prac video
- Elaborate read of [1], [2], [3], [4]
- Roughly read §2, 4 of [6]
- Prepped lab meeting slides
- BIOS1167 w12-1 review

Woke up:
Total Working Hours:
Fiddled Out for

2 Ling et al., 2018 [1]

(Review article)

2.1 Purpose and Scope

Comparing the natural and artificial nanofibrils, wrapping up the understanding on their difference in mechanical properties, on-going ways to improve artificial nanofibrils, and rational material designs. and efficient way to

2.2 Main Topics

Since my topic is about silk, I most elaborately read and comtemplate the following topics;

- Hierarchical structure of silk; Multidimentionality (the smallest unit→ β-sheet of 2-4 nm→ amorphous silk nanofibril of 50(±30) nm → silk fiber) of natural silk plays a crutial role Confinement to 2-4 nm allows ”stick-slip” motion under sheer, where H-bond will reform and thus the energy will be dissipilated. Plus, inplane mechanical anisotropy will increase the fracture resistance
- Fabrication strategies;(1D) artificial Spinning and (2D) chemical modification are mainly ongoing way. Though all the used way confirms nanofibrils ordered orientation, wet(a dope is extreded into a non-solvent just after the extrusion), dry (silk dope is dried on volatile solvant) artificial spinning can't realize the strength of their counterpart in nature; The interaction between the fibers is weaker. Both have pros and cons. The wet spinning can be undertaken with lower concentration while the dry spinning enables polymorphic arrangement. One of the merging way is ”microfluidic spinning,” which enables better controllability , which can realize better mechanical properties (stiffness, strength and toughness) than wet/dry spinnings, but its elastic moduli is still inferior to natural nanofibrils. 3D prining is also viable but can be done with thick, non-newtonian dope.

2.3 Key Figures/Models

2.4 Notable Points and Future Directions

- Scale-up Production
- To realize highly ordered structure

2.5 My Comments and Keywords

1. How can we explain the occurance of ”stick-slip” motion with nanoconfinement?

2.6 References of Interest

- Keten, S., Xu, Z. P., Ihle, B. & Buehler, M. J. Nanoconfinement controls stiffness, strength and mechanical toughness of β sheet crystals in silk. Nat. Mater. 9, 359-367 (2010). **This paper introduces the nanoconfinement of silk nanocrystals.**
- Omenetto, F. G. & Kaplan, D. L. New opportunities for an ancient material. Science 329, 528-531 (2010).
- Nova, A., Keten, S., Pugno, N. M., Redaelli, A. & Buehler, M. J. Molecular and nanostructural mechanisms of deformation, strength and toughness of spider silk fibrils. Nano Lett. 10, 2626-2634 (2010).

3 Mohammadi et al.,(2018),[2]

3.1 1. Background/Purpose

To demonstrate effect of weak dimerization of terminul sequences in the LLPS of silk spindroin.

3.2 2. Methods

3.3 3. Main Results

3.4 4. Novelty & Discussion

3.5 5. My Comments

4 Tersteegen et al.,(2024),[4]

4.1 1. Background/Purpose

To demonstrate effect of background on LLPS process and mechanical properties of coacervates.

4.2 2. Methods

POI is CBM-AQ12-CBM (CBM:cellulose binding module, AQ12:he main component of spindroin, IDRs). Compared HT(heat treatment), IMAC(l His-tag immobilized metal affinity chromatography) purified, BG, BG+IMAC.

4.3 3. Main Results

1. SEM
2. AIEs (Aggregation Induced Emitters):TPE4PH
3. micropippette aspiration and ICV analysis

4.4 4. Novelty & Discussion

4.5 5. My Comments

5 Shen et al.,(2020),[3]

5.1 1. Background/Purpose

To demonstrate fibre formation from coacervates under sheer considerable in nervous system almost regradless of AA seq

5.2 2. Methods

5.3 3. Main Results

1. SEM
2. AIEs (Aggregation Induced Emitters):TPE4PH
3. micropippette aspiration and ICV analysis

5.4 4. Novelty & Discussion

5.5 5. My Comments

1. In the first place, is it possible for composition change of surrounding to occur? How likely are they?

6 To-dos

- [6],[7],[8],[9],[10]
- §$2-3$ of Relativity Theory by Y. Sudo.
- BIOS1167, check quiz and review
- PMGT1860 individual assignment

参考文献

[1] Ling, S., Kaplan, D. L., & Buehler, M. J. (2018). Nanofibrils in nature and materials engineering. Nature Reviews Materials, 3(4), 18016. https://doi.org/10.1038/natrevmats.2018.16

[2] Mohammadi, P., Aranko, A. S., Lemetti, L., Cenev, Z., Zhou, Q., Virtanen, S., Landowski, C. P., Penttilä, M., Fischer, W. J., Wagermaier, W., & Linder, M. B. (2018). Phase transitions as intermediate steps in the formation of molecularly engineered protein fibers. Communications Biology, 1(1), 86. https://doi.org/10.1038/s42003-018-0090-y

[3] Shen, Y., Ruggeri, F. S., Vigolo, D., Kamada, A., Qamar, S., Levin, A., Iserman, C., Alberti, S., George-Hyslop, P. S., & Knowles, T. P. J. (2020). Biomolecular condensates un-

dergo a generic shear-mediated liquid-to-solid transition. Nature Nanotechnology, 15(10), 841 – 847. https://doi.org/10.1038/s41565-020-0731-4

[4] Tersteegen, J., Tunn, I., Sand, M., Välisalmi, T., Malkamäki, M., Gandier, J.-A., Beaune, G., Sanz-Velasco, A., Anaya-Plaza, E., & Linder, M. B. (2024). Recombinant silk protein condensates show widely different properties depending on the sample background. Journal of Materials Chemistry B, 12(46), 11953 – 11967. https://doi.org/10.1039/D4TB01422G

[5] Miserez, A., Yu, J., & Mohammadi, P. (2023). Protein-Based Biological Materials: Molecular Design and Artificial Production. Chemical Reviews, 123(5), 2049 – 2111. https://doi.org/10.1021/acs.chemrev.2c00621

[6] Guevorkian, K., Colbert, M.-J., Durth, M., Dufour, S., & Brochard-Wyart, F. (2010). Aspiration of Biological Viscoelastic Drops. Physical Review Letters, 104(21), 218101. https://doi.org/10.1103/PhysRevLett.104.218101

[7] Sequence grammar and dynamics of subcellular translation revealed by APEX-Ribo-Seq

[8] Keten, S., Xu, Z. P., Ihle, B. & Buehler, M. J. Nanoconfinement controls stiffness, strength and mechanical toughness of β sheet crystals in silk. Nat. Mater. 9, 359-367 (2010). **This paper introduces the nanoconfinement of silk nanocrystals.**

[9] Omenetto, F. G. & Kaplan, D. L. New opportunities for an ancient material. Science 329, 528-531 (2010).

[10] Nova, A., Keten, S., Pugno, N. M., Redaelli, A. & Buehler, M. J. Molecular and nanostructural mechanisms of deformation, strength and toughness of spider silk fibrils. Nano Lett. 10, 2626-2634 (2010).

7 New Words

- gradescope answer sheet: マークシート
- You have no right to say that
- つわり: morning sickness, emesis gravidarum【略】EG
- cervix: 子宮頸部
- blood clot: 血栓
- complication: 病気の併発
- hedonic[hiːdɒ́nɪk]: characterized by pleasure; 快楽的な
- adipocyte: 脂肪細胞
- satiety[sətʌíɪti]: 満腹感
- morbid 病的な
- 没事 [méishì]: 大丈夫

8 Diary

TIPA を導入したので LaTeX でも IPA 記号が使えるようになった。指導教官に"Keep reading!"と言われたのと、ちゃんと研究室が決まったっぽい。1 人が master でそれ以外はみんな PhD 課程以上だった。私が面白いと思ってる領域は明らかにブルーオーシャンではなくて渋い。生物的な妥当性も考えながら物理が使える人になりたいとは常々思ってる。「もうあの感情を抱くことはないんだなの気持ち」とメモに書いていたので何か思い出したんだけど、最早それすら忘れてしまった。