四川大学 SICHUAN UNIVERSITY

可展开结构与力学超材料

安宁

四川大学空天科学与工程学院

2026. 07. 11

个人简介

安宁 四川大学副研究员、研究生导师

- 2010.9-2020.6，西安交大，本科/博士，航空宇航科学与技术
- 2017.9-2019.9，哈佛大学，联合培养博士，力学
- 2021.9-至今，四川大学，副研究员、硕士生导师，航空航天力学与工程
- 2025.8-2026.2，意大利特伦托大学，力学与航空航天，访问学者，校外博导

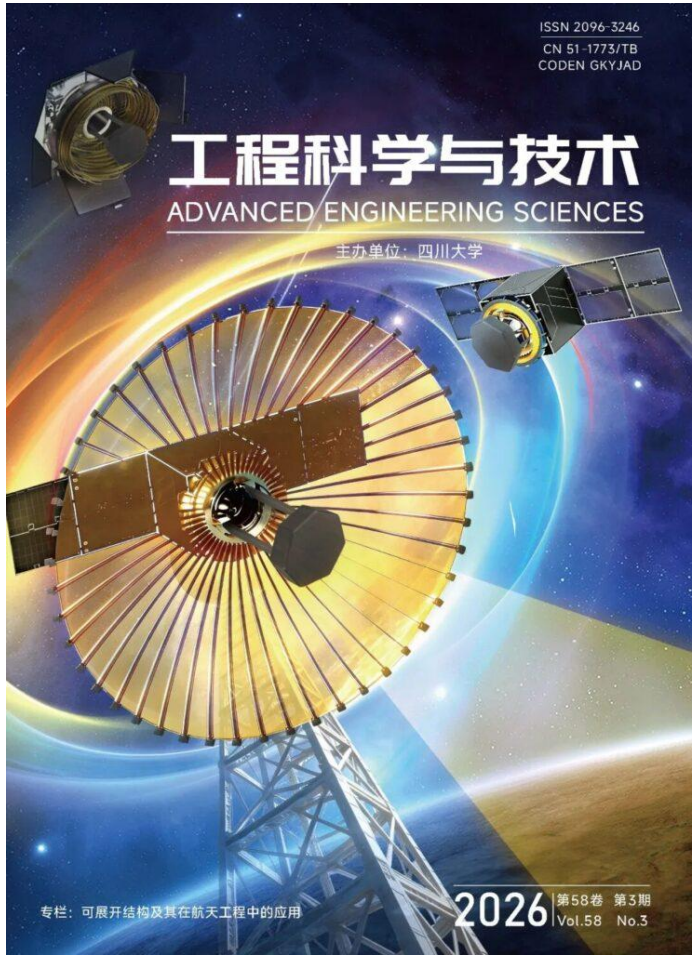
- 负责国自然基金2项，省部级及企业横向课题10余项；发表论文40余篇，包括2篇ESI高被引，5篇期刊封面或亮点论文。被引1800余次，H指数20。

➢ 2022年西安交通大学优秀博士学位论文，2024年NSFC-ERC“中欧人才项目”，2017/2025年两次国家留学基金委访问学者项目；5本中英文SCI/EI期刊青年编委，10余本行业期刊审稿人。

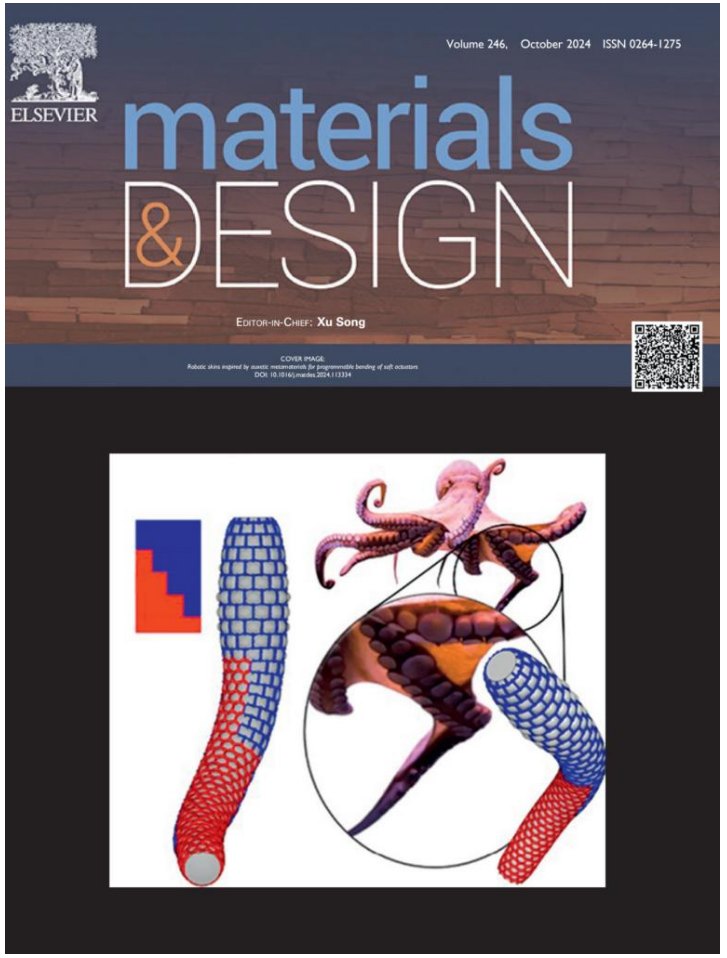
研究方向速览

四川大学 SICHUAN UNIVERSITY

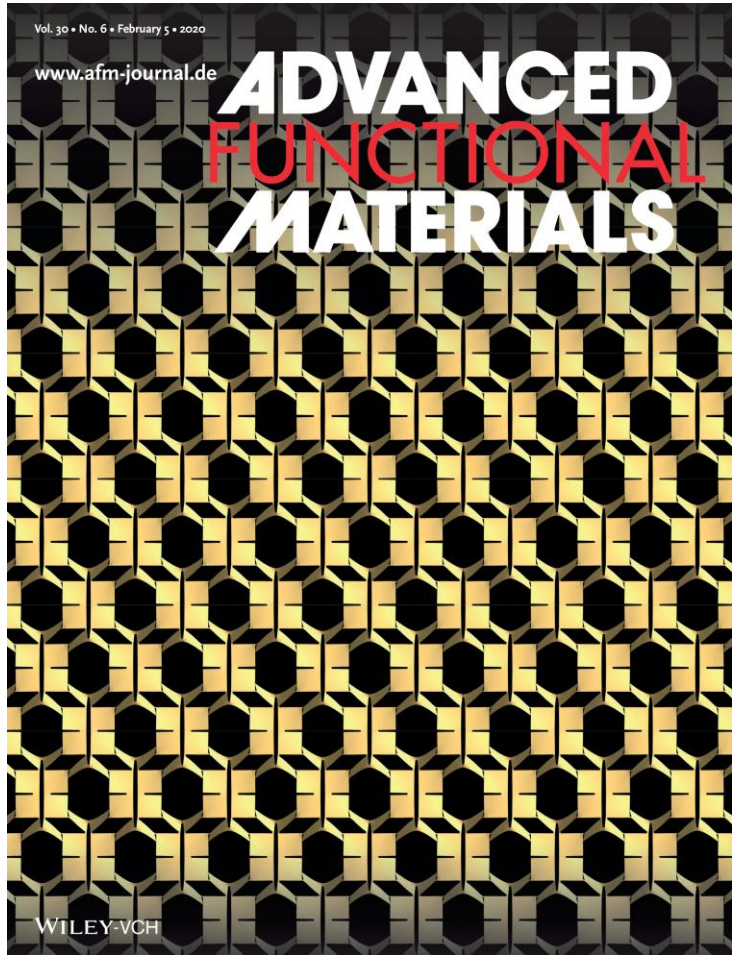
➢可展开结构



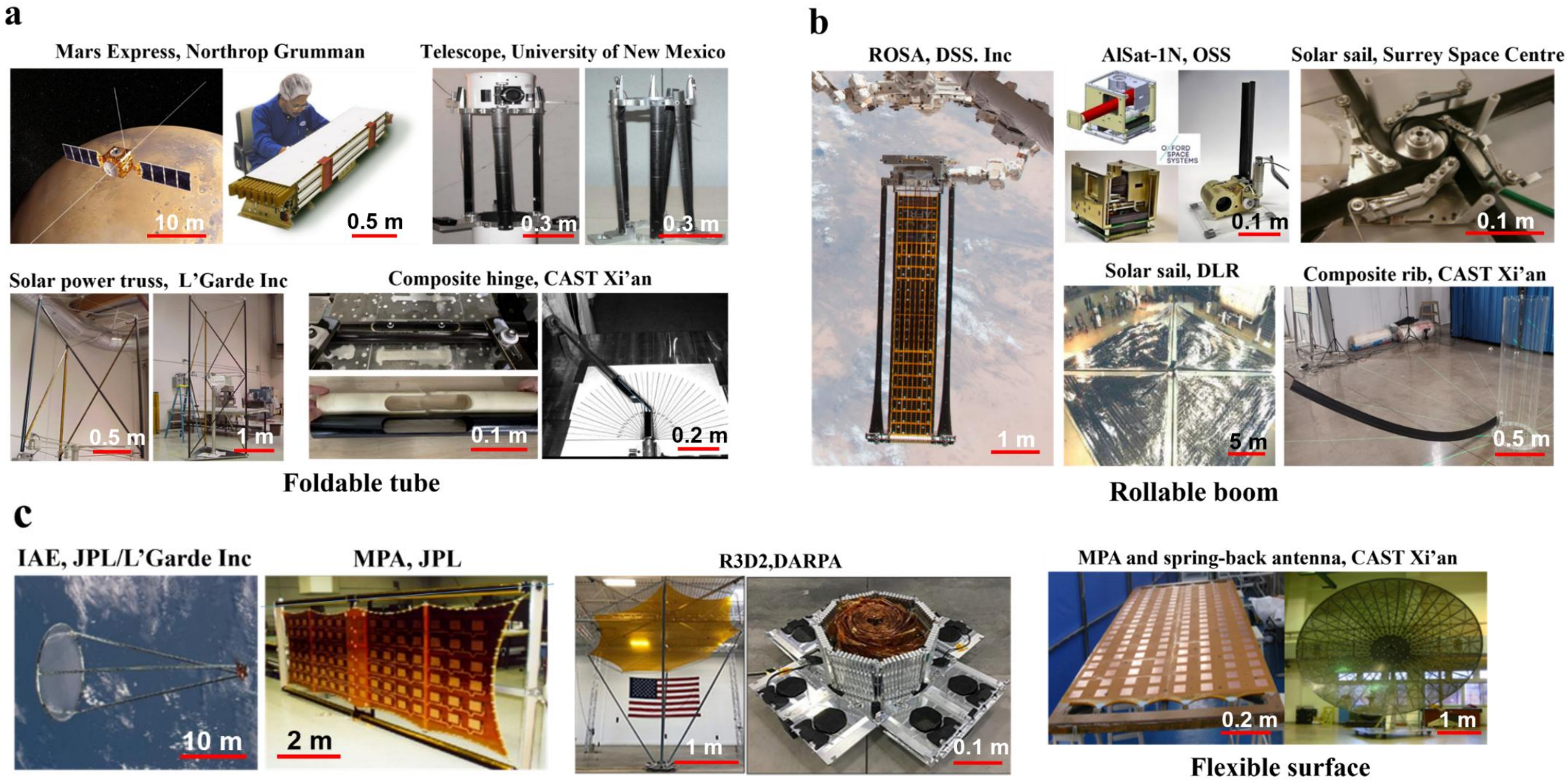
➢软体机器人



➢力学超材料



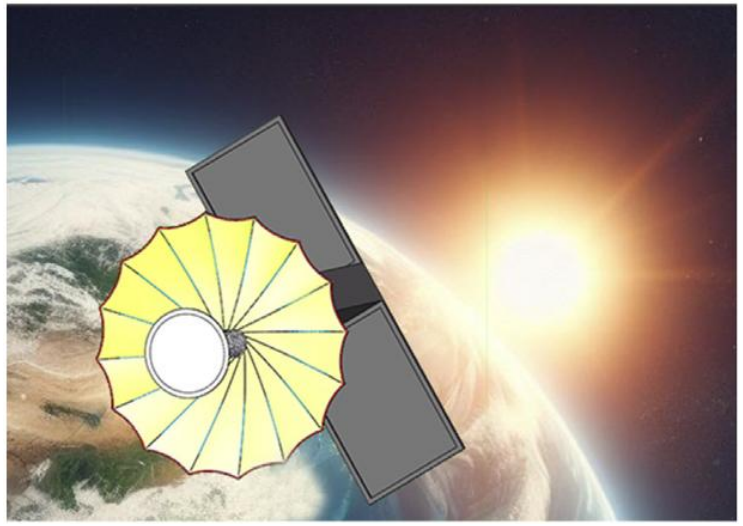
可展开空间结构

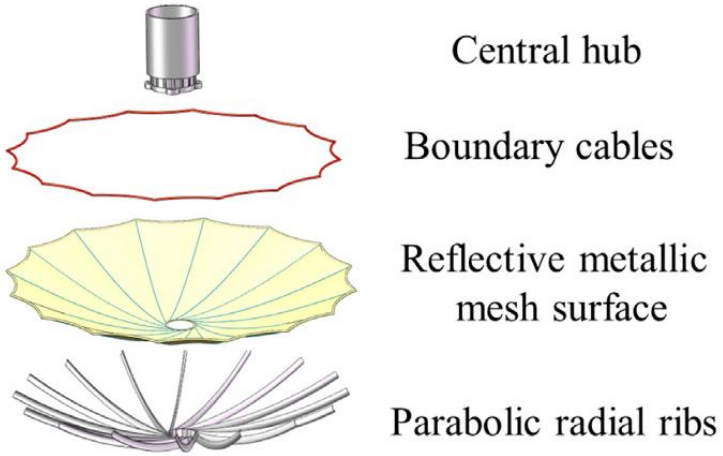


Ma, X.*, **An, N.,** et al. (2024) Design, modeling, and manufacturing of high strain composites for space deployable structures. *Communications Engineering*, 3(1), 78. **Top 25 downloaded papers of 2024**

缠绕肋天线

➢ 缠绕肋天线设计、制造、收展试验

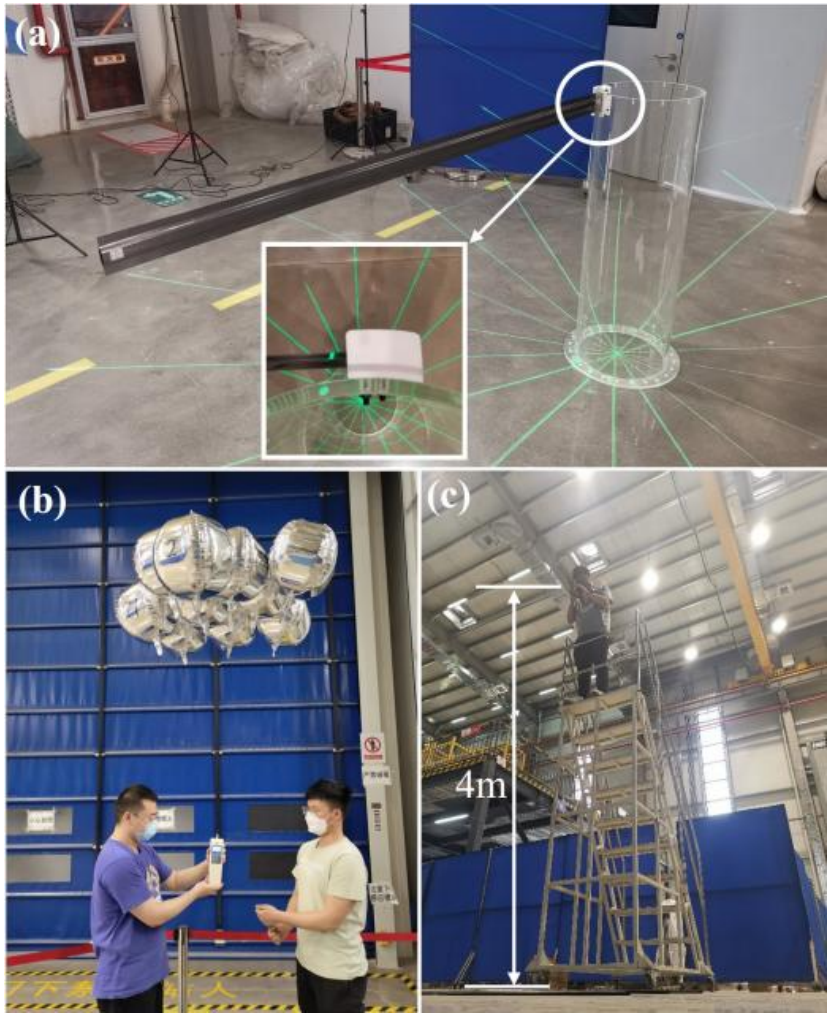


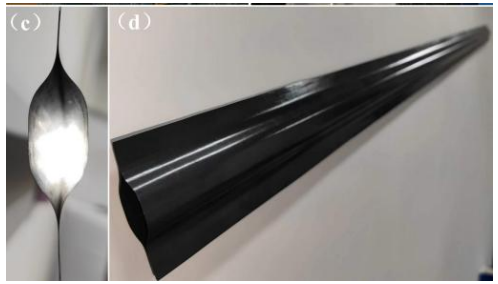


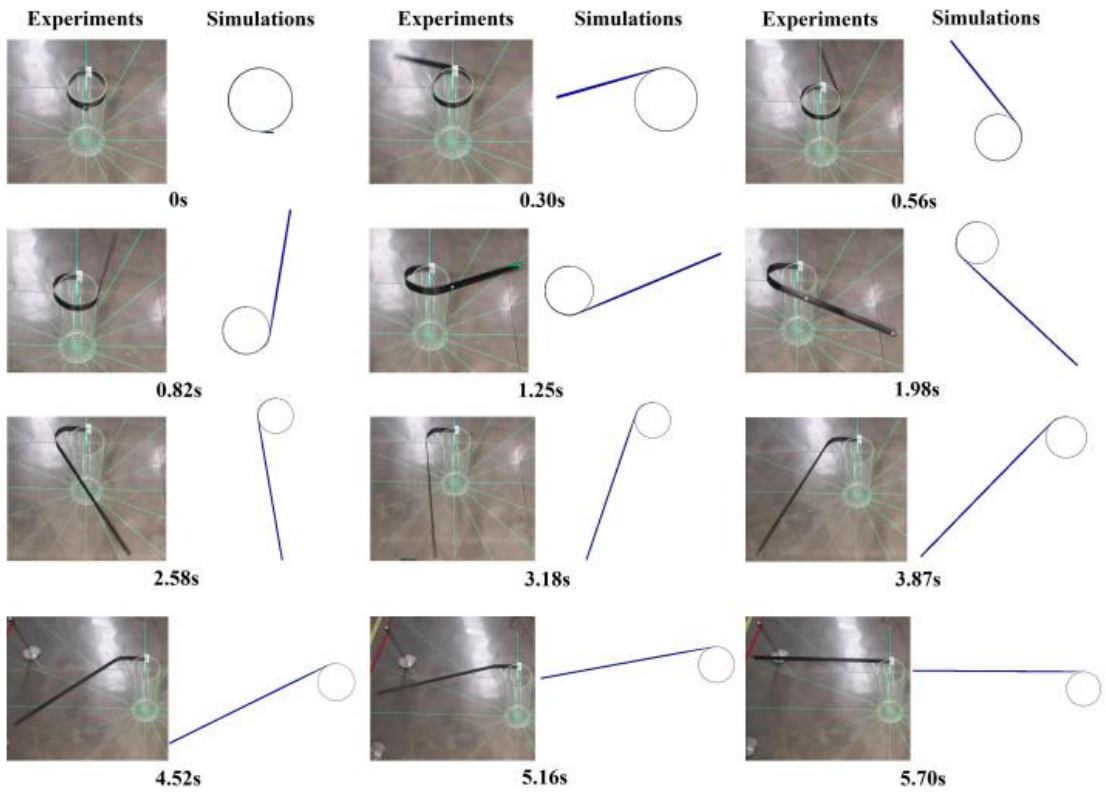
Zhu, S.#, Guo, R.#, Liu, H., Jin, X., Ma, X., Zhou, J., & **An, N.*** (2026) *Acta Astronautica*, 246, 422-443.

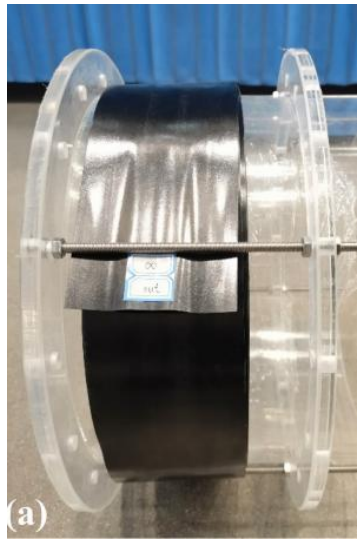
复合材料豆荚杆收拢展开分析

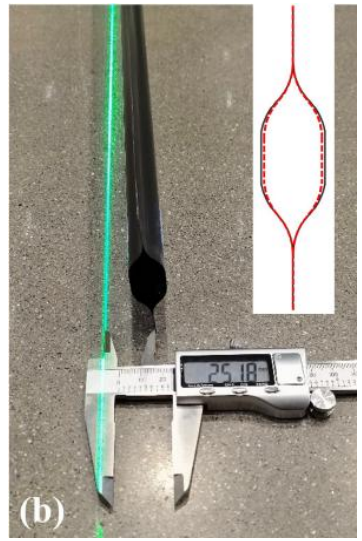
➢ 单根肋展开动力学试验









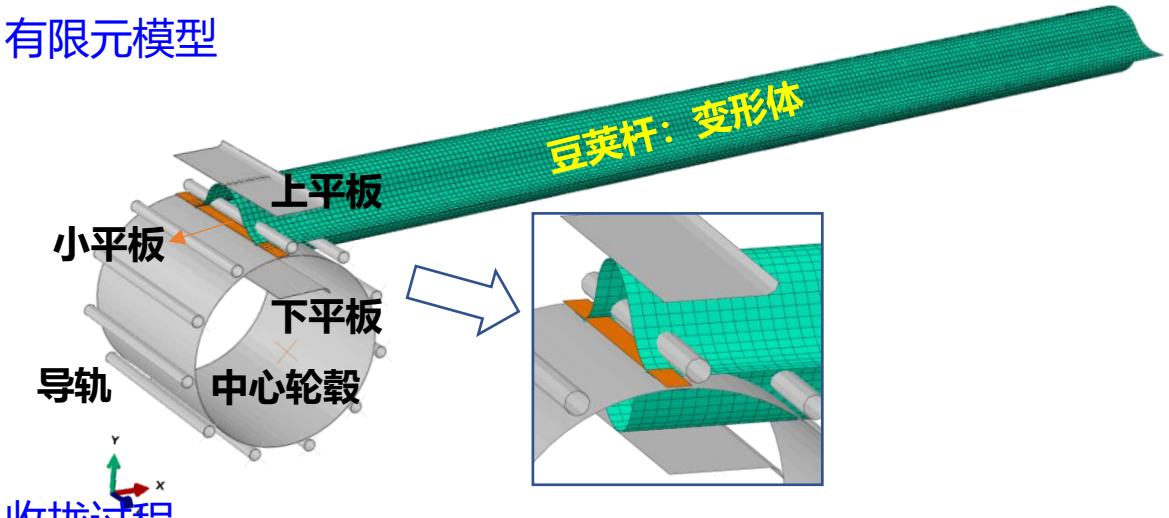


Guo, R.#, Jin, X.#, Jia, Q., Ma, X., **An, N.*** and Zhou, J., 2023. Acta Astronautica, 213, pp.567-577.

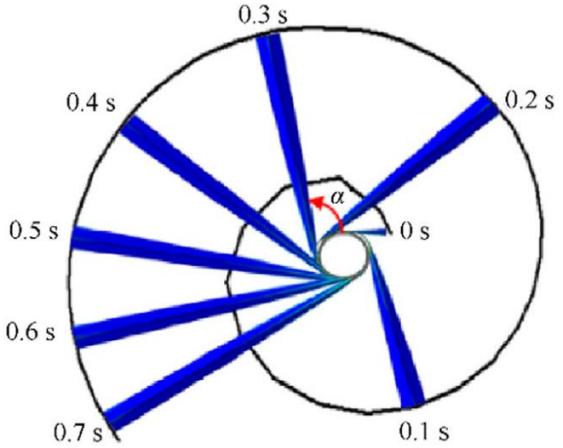
复合材料豆荚杆收拢展开分析

➢ 单根肋收拢展开分析

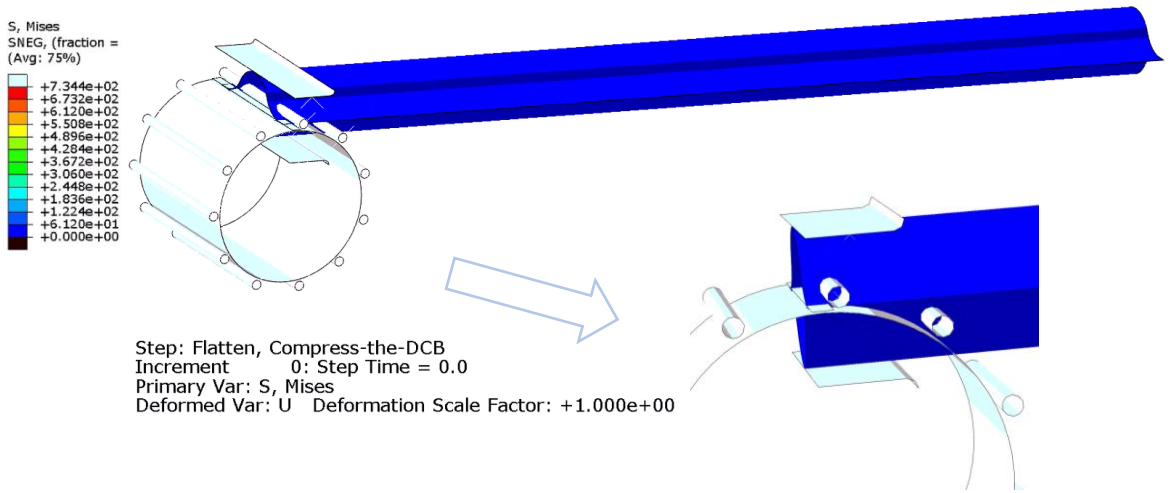
有限元模型



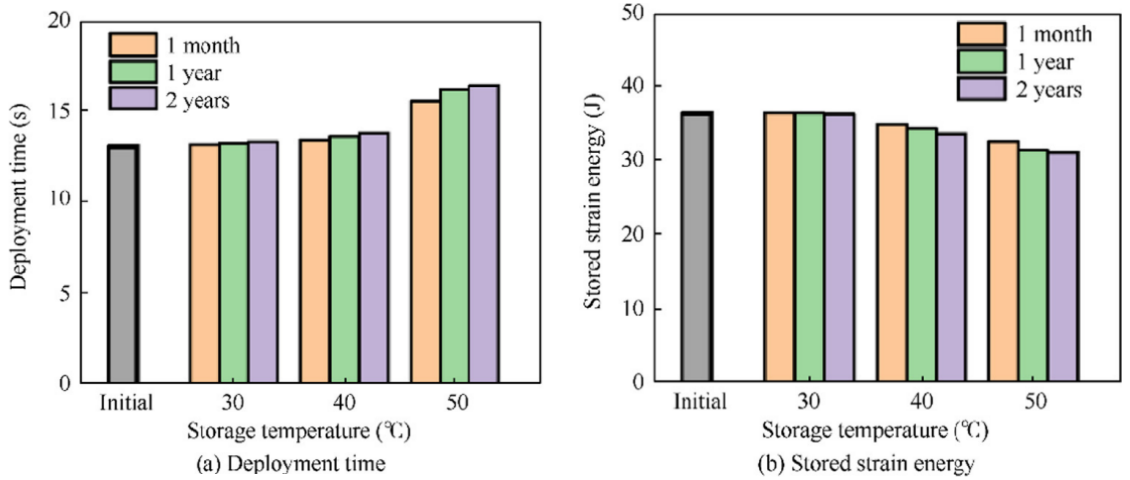
展开过程



收拢过程

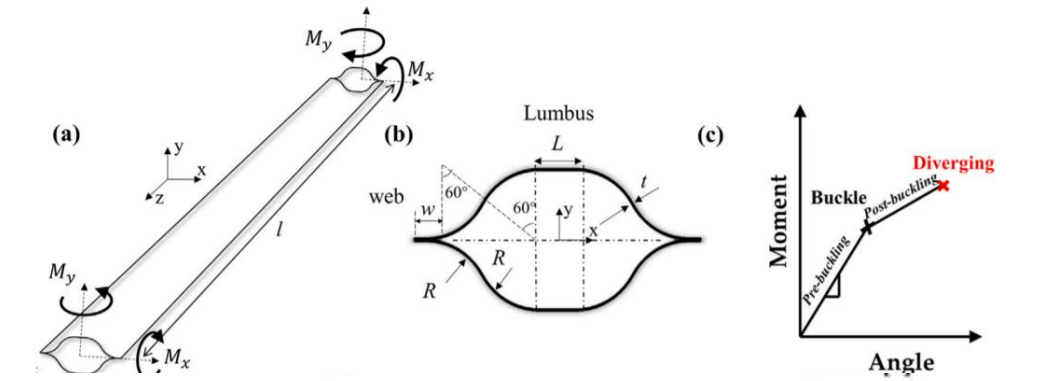


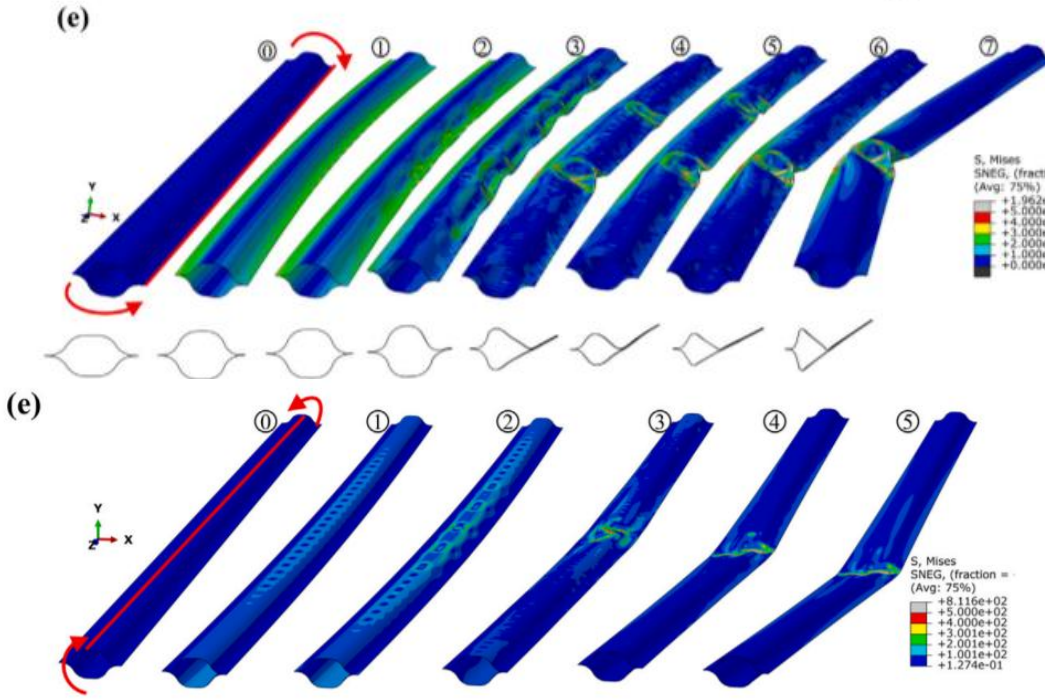
长期收拢的影响

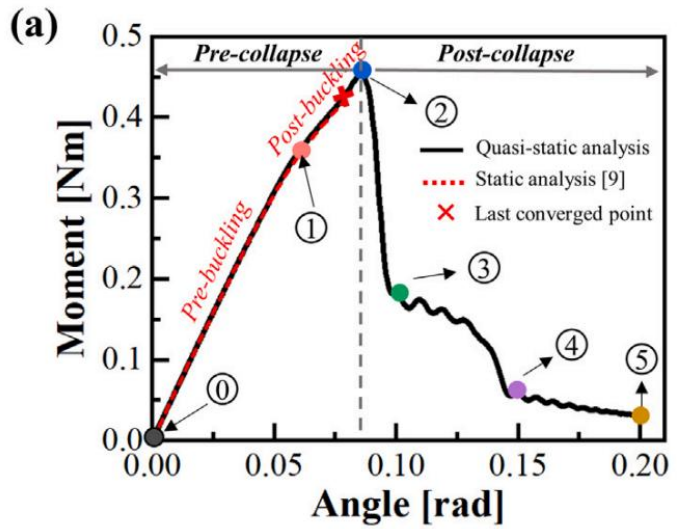


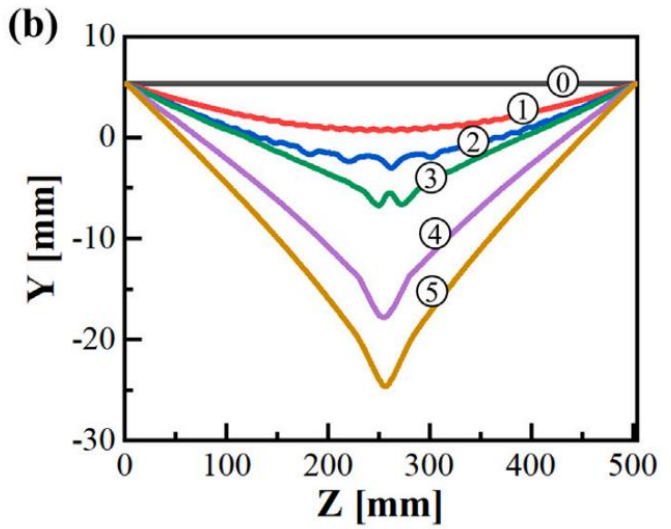
Deng, J., **An, N.***, Jia, Q., Ma, X., 2024. *Chinese Journal of Aeronautics*, 37(1), pp.162-172.

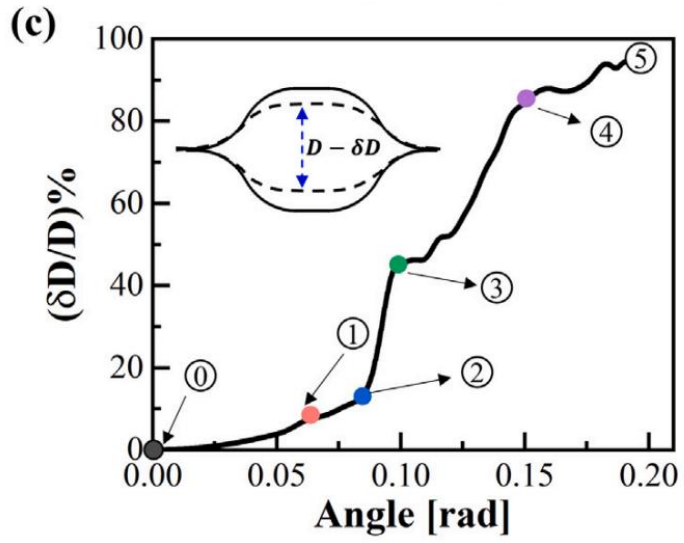
复合材料豆荚杆力学稳定性分析

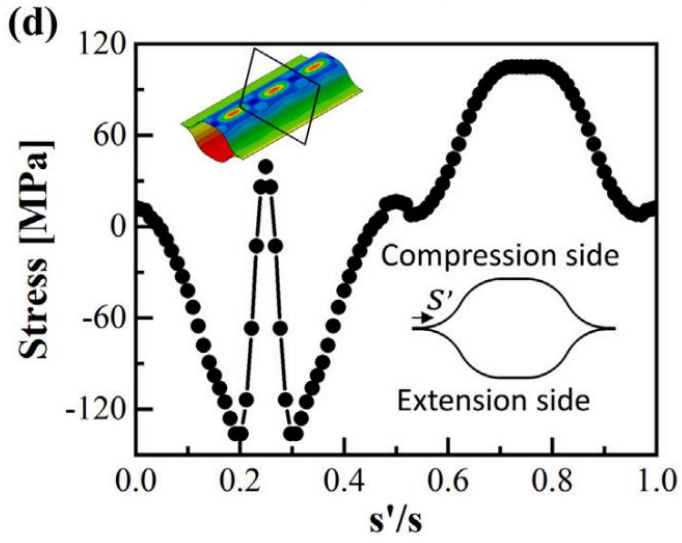








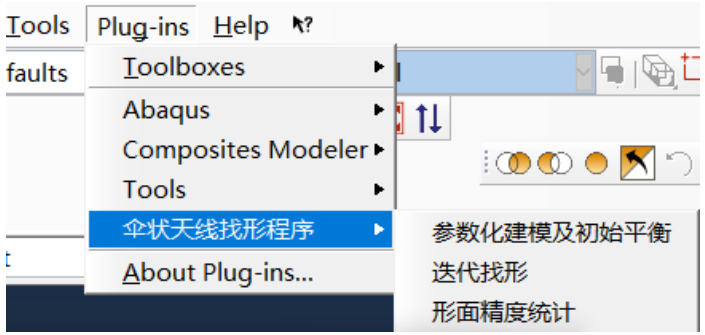


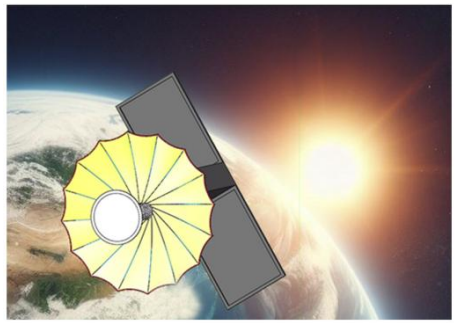


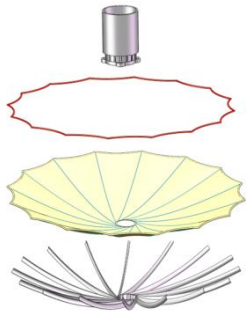
Jia, Q., **An, N.***, et al., 2022. *Composite Structures*, 287, p.115364.

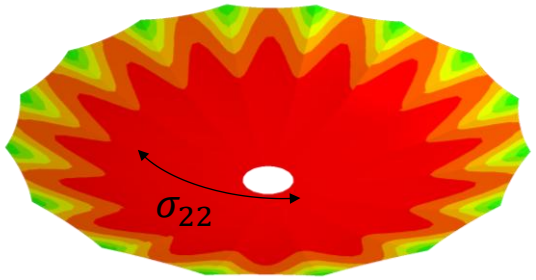
Jia, Q., **An, N.***, et al., 2021. *International Journal of Mechanical Sciences*, *207*, p.106661.

伞天线找形分析方法与软件定制

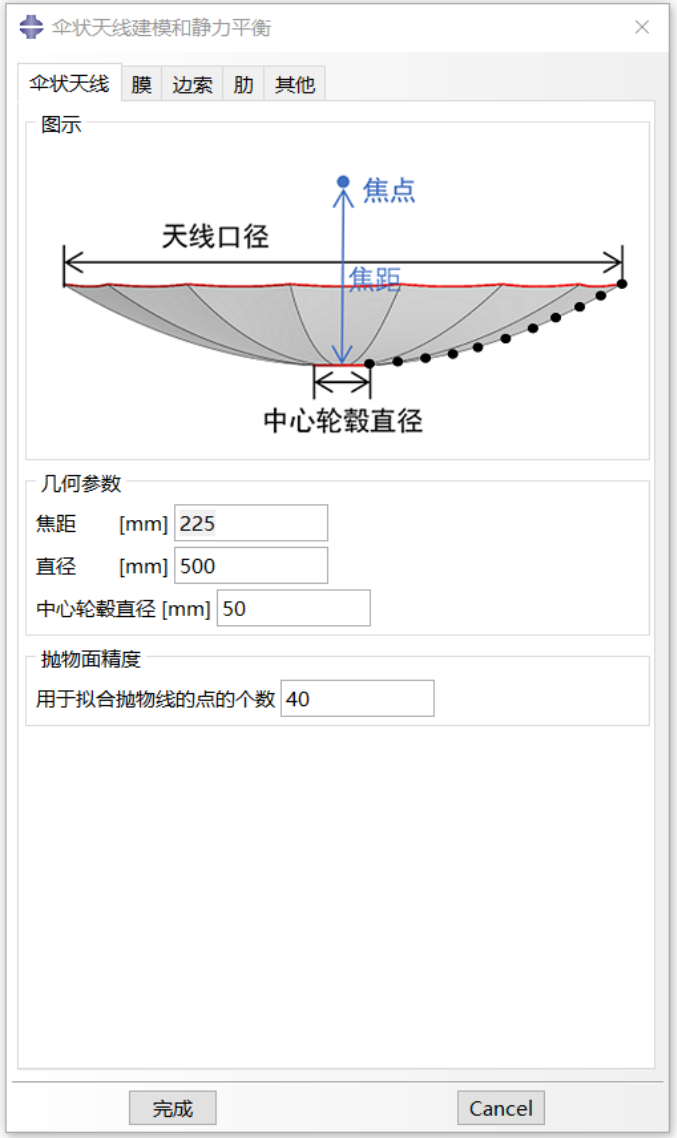


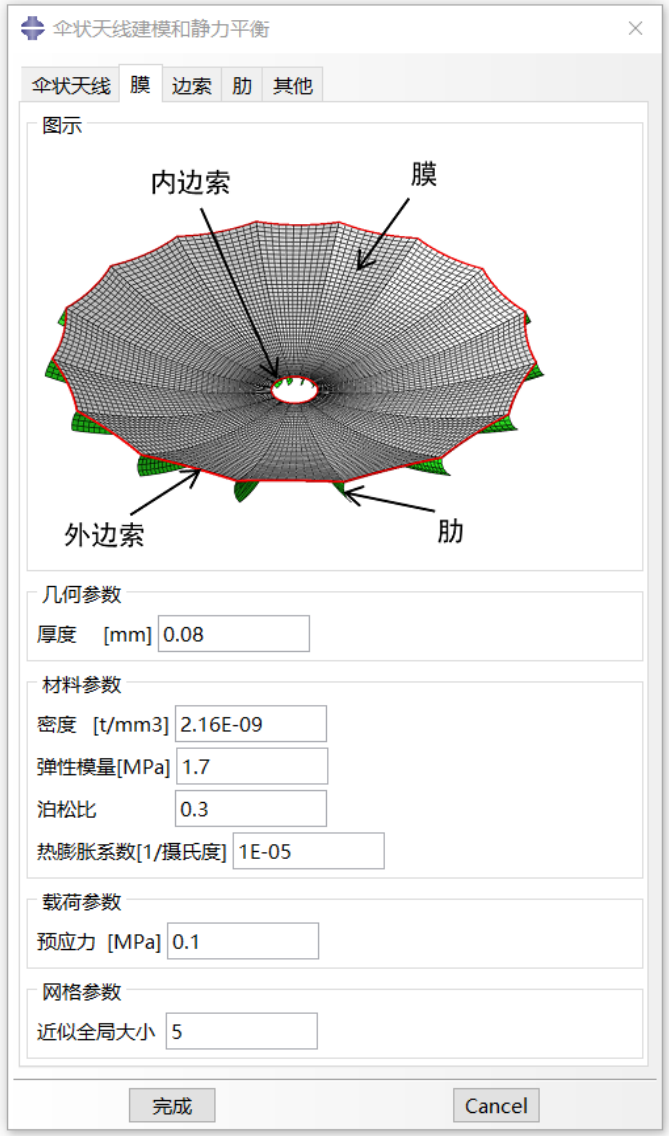






RMSE = 1.77 mm

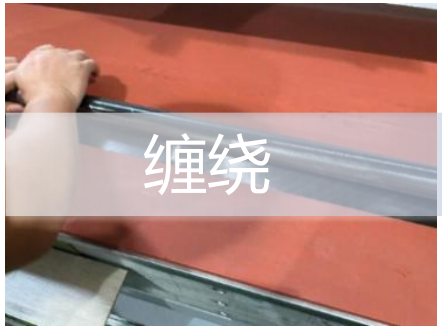




Zhu, S., ..., and **An, N.* (2024)**. *Advances in Engineering Software*, 198, 103789.

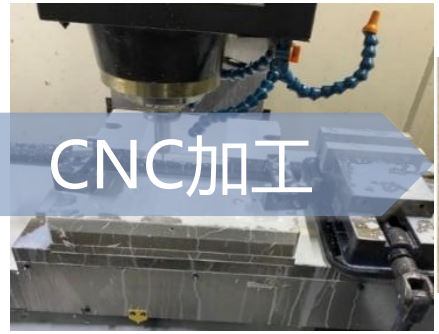
复合材料铰链折叠展开分析

➢ 复合材料圆管铰链加工及试验

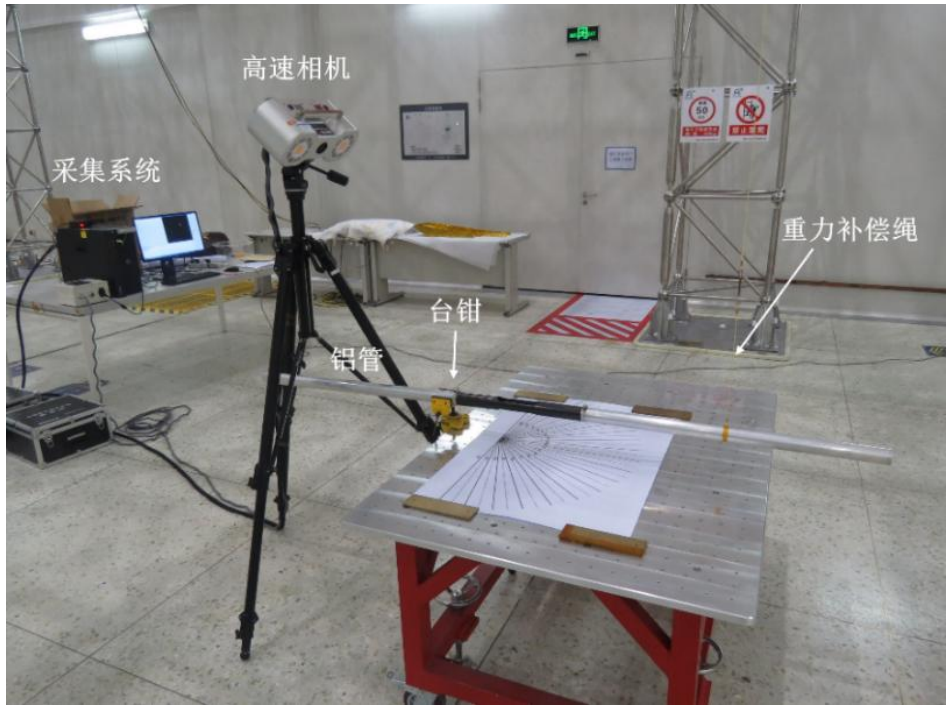

缠绕


紧固

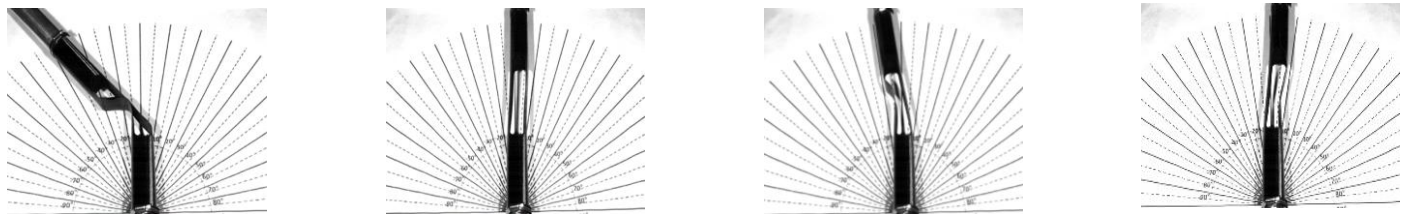

固化


CNC加工

铰链成品



仿真模型

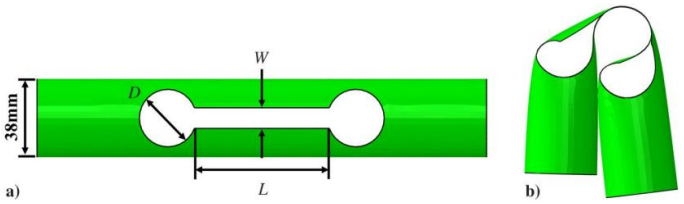


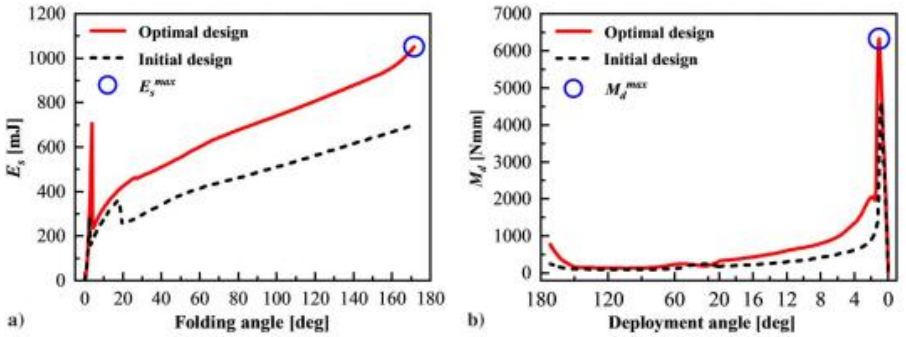
试验结果

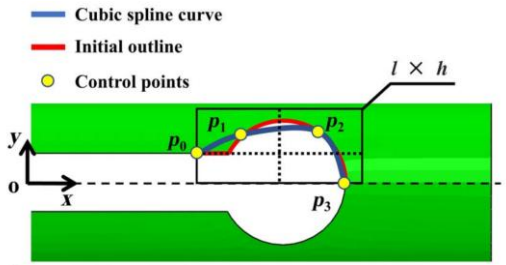
Jin, H., **An, N.***, Jia, Q., Guo, R., Ma, X., & Zhou, J., 2024. *Thin-Walled Structures*, *198*, p.111738.

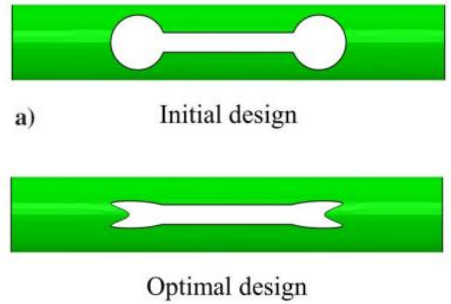
复合材料铰链切口形状优化

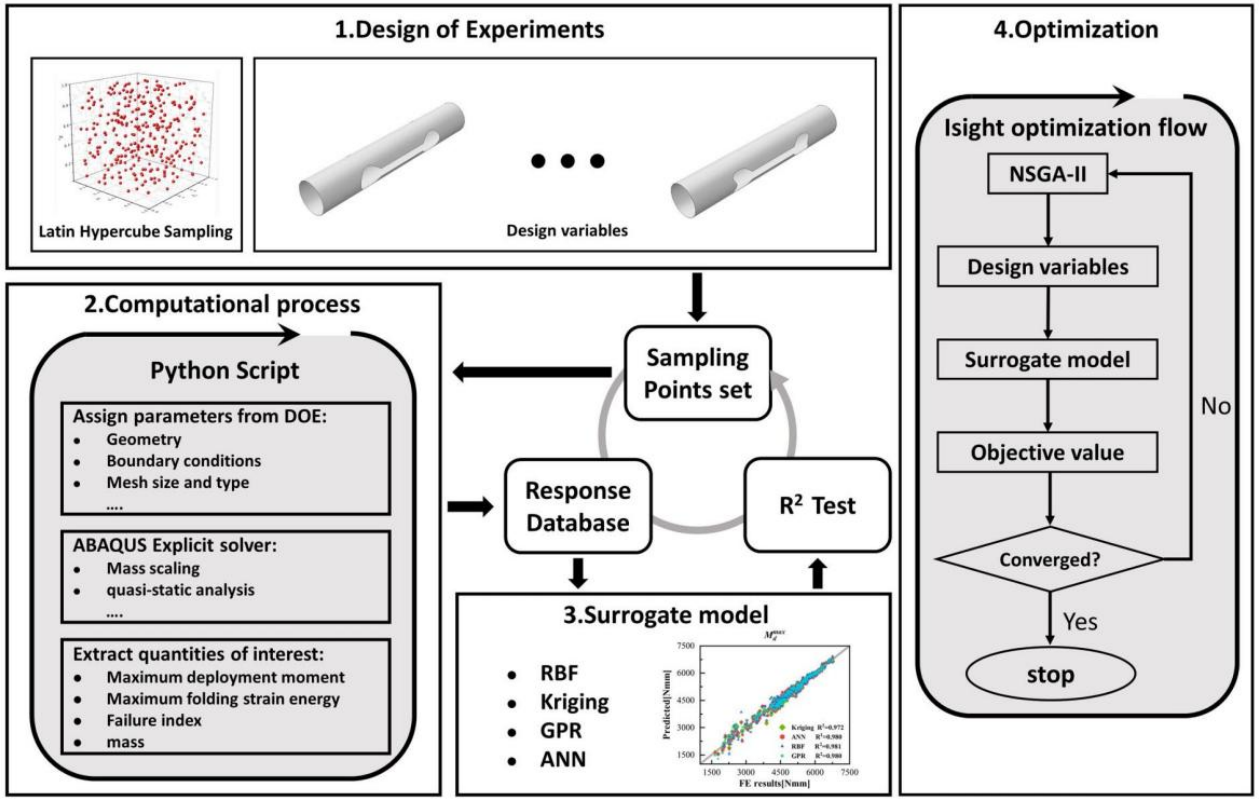
- **机器学习+有限元+优化算法**







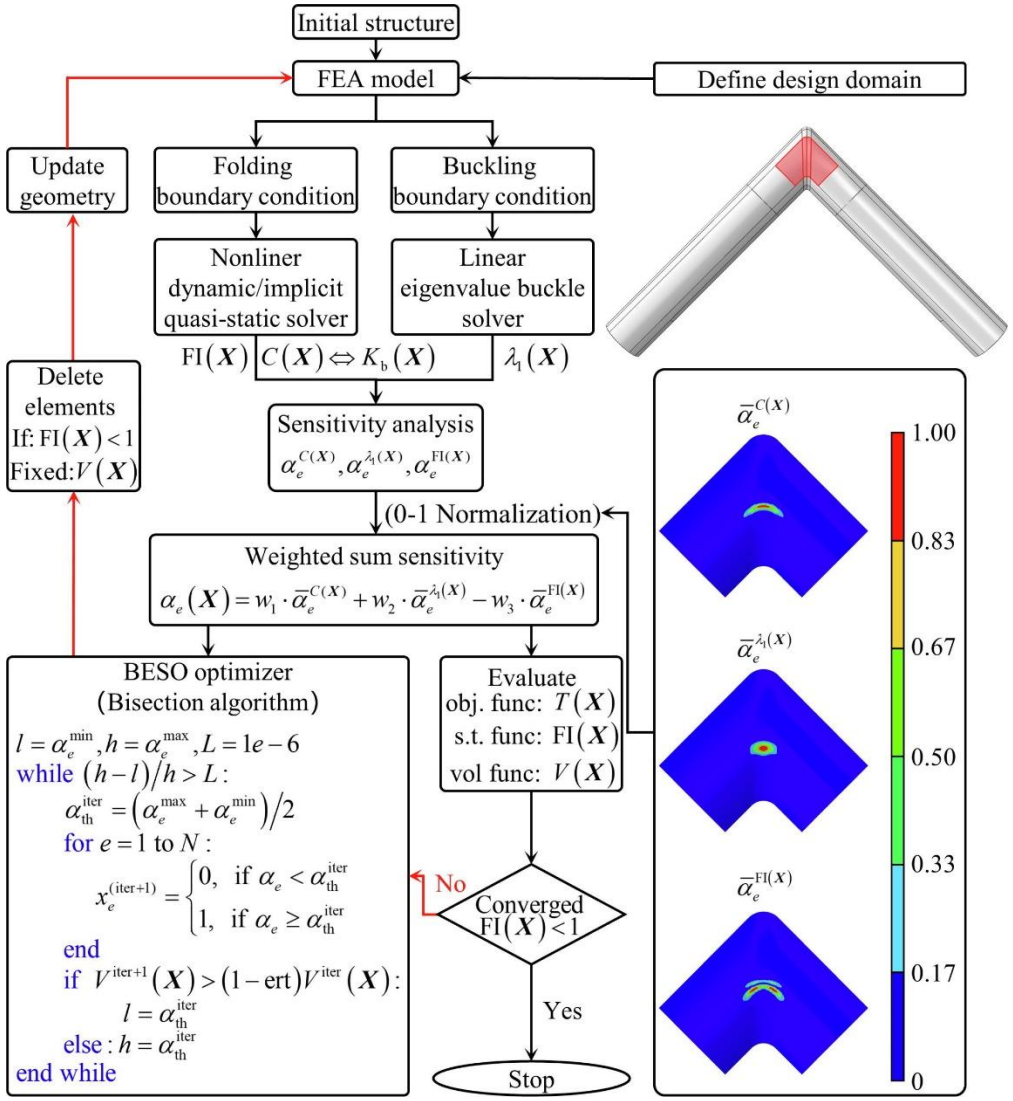


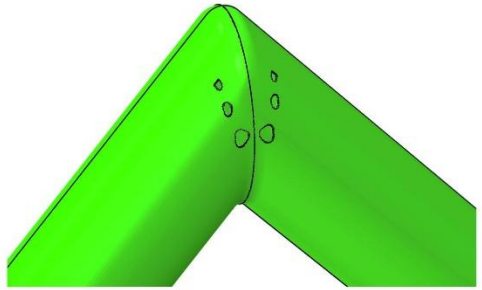


Jin, H., Jia, Q., **An, N.***, Zhao, G., Ma, X. and Zhou, J.*, 2022. AIAA Journal, 60(10), pp.5942-5953.

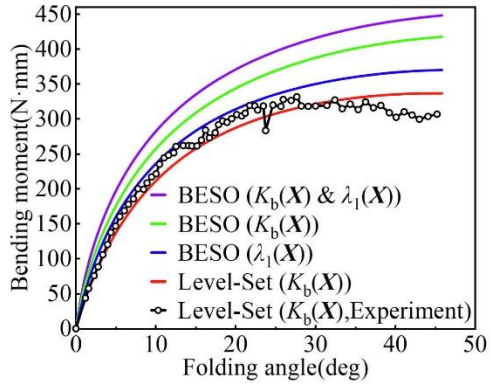
复合材料铰链拓扑优化

➢ 90°直角圆管铰链拓扑优化

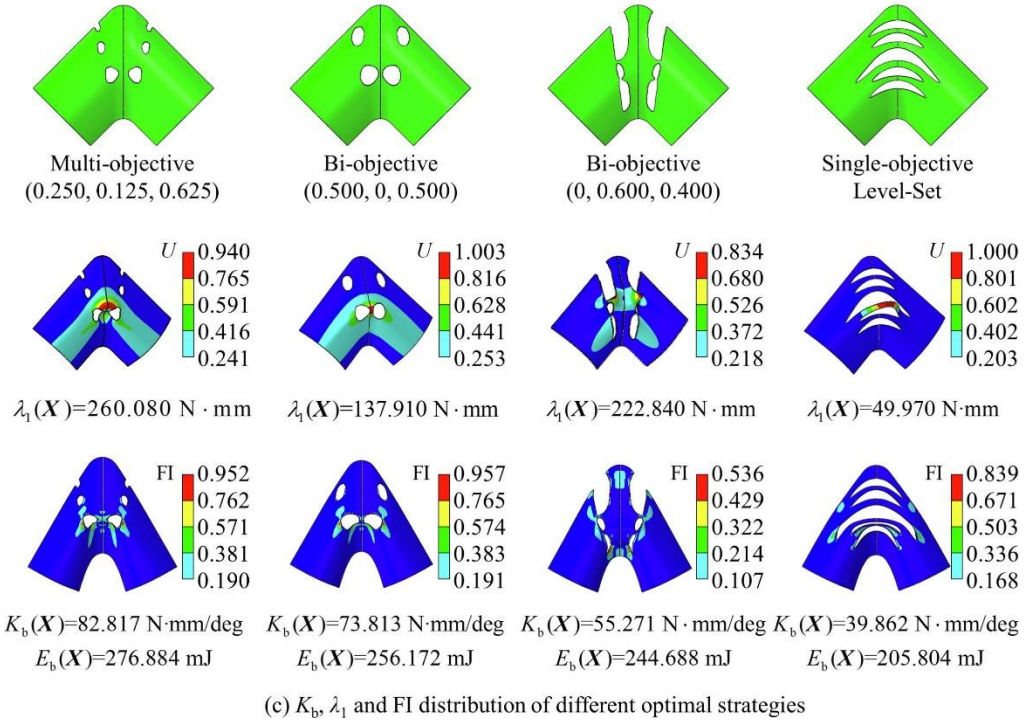




(a) Optimal design from multi-objective



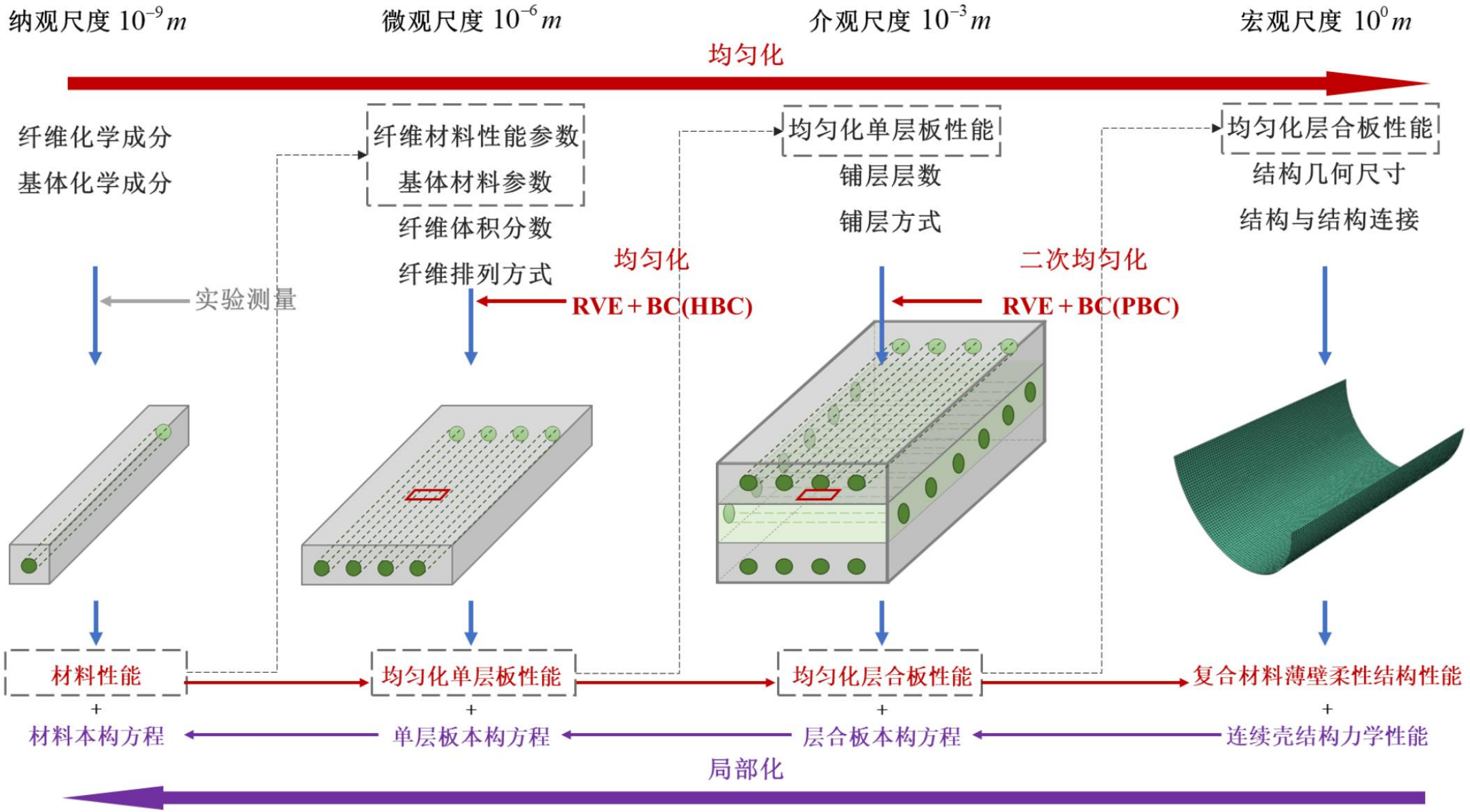
(b) Folding angle-moment curves



(c) K_b, λ_1 and FI distribution of different optimal strategies

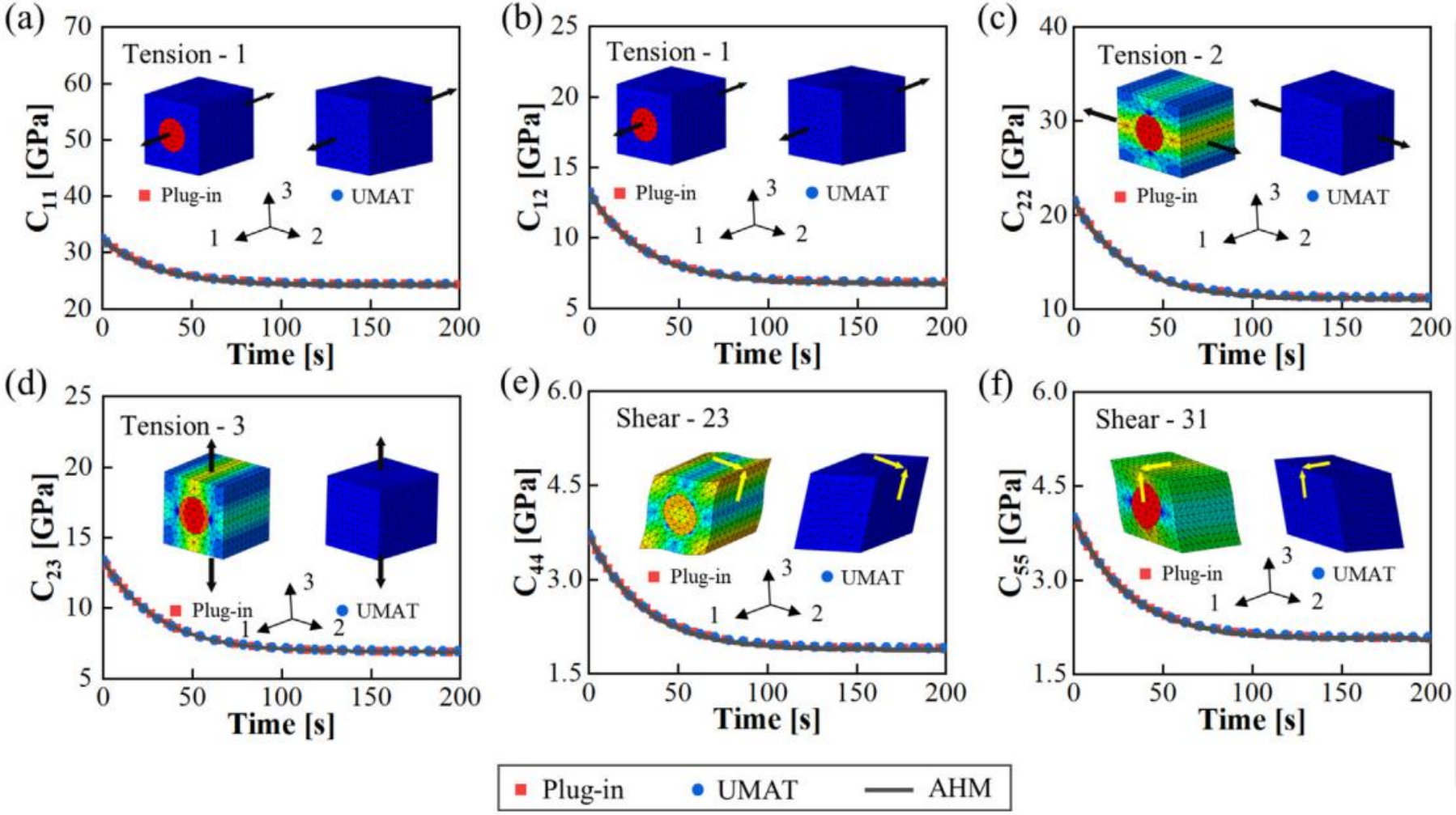
Jin, H., **An, N.***, Jia, Q., Shao, C., Ma, X., & Zhou, J.* (2025). *Chinese Journal of Aeronautics*, 103530.

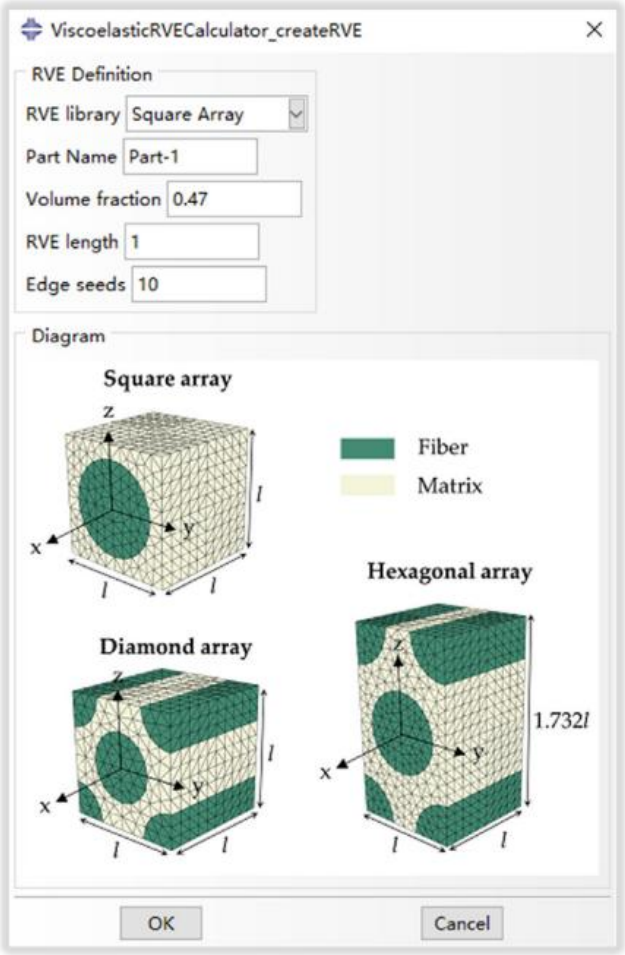
薄壁复合材料结构力学


纳观尺度 $10^{-9}m$
微观尺度 $10^{-6}m$
介观尺度 $10^{-3}m$
宏观尺度 $10^{0}m$
均匀化
纤维化学成分
基体化学成分
纤维材料性能参数
基体材料参数
纤维体积分数
纤维排列方式
均匀化单层板性能
铺层层数
铺层方式
均匀化层合板性能
结构几何尺寸
结构与结构连接
实验测量
均匀化
RVE+BC(HBC)
二次均匀化
RVE+BC(PBC)
材料性能
均匀化单层板性能
均匀化层合板性能
复合材料薄壁柔性结构性能
+
材料本构方程
单层板本构方程
层合板本构方程
连续壳结构力学性能
局部化

复合材料多尺度力学分析

➢ 复合材料微观力学模型（计算力学软件开发）

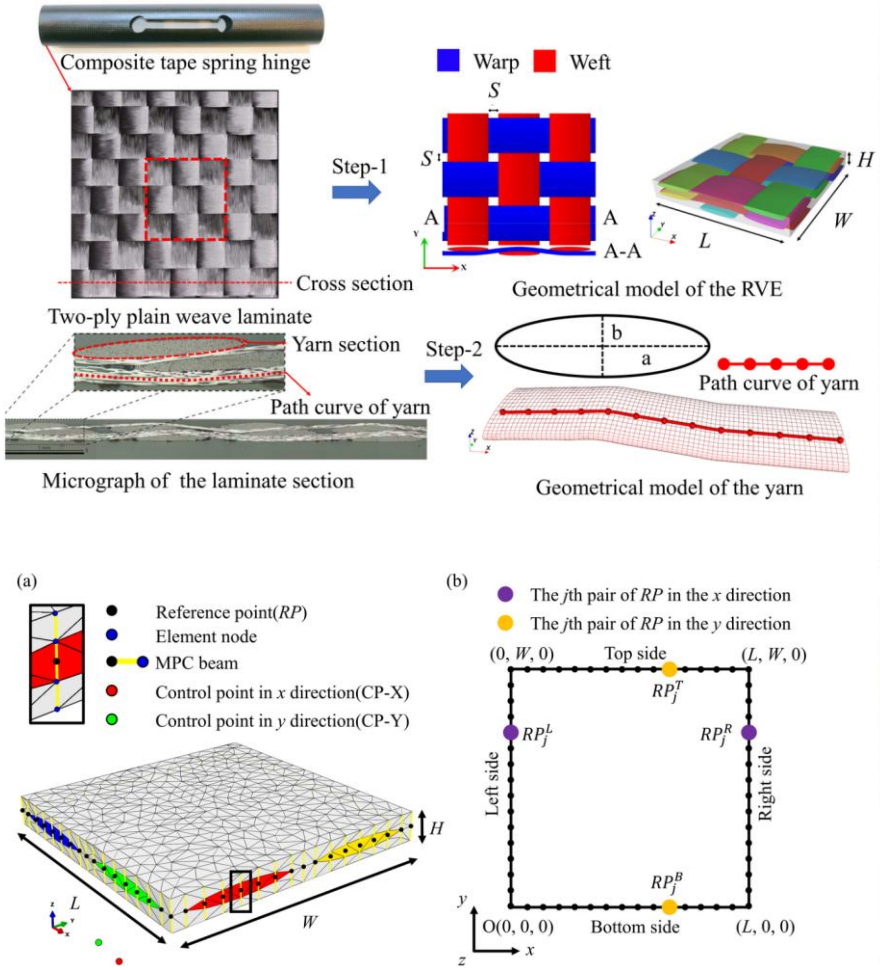


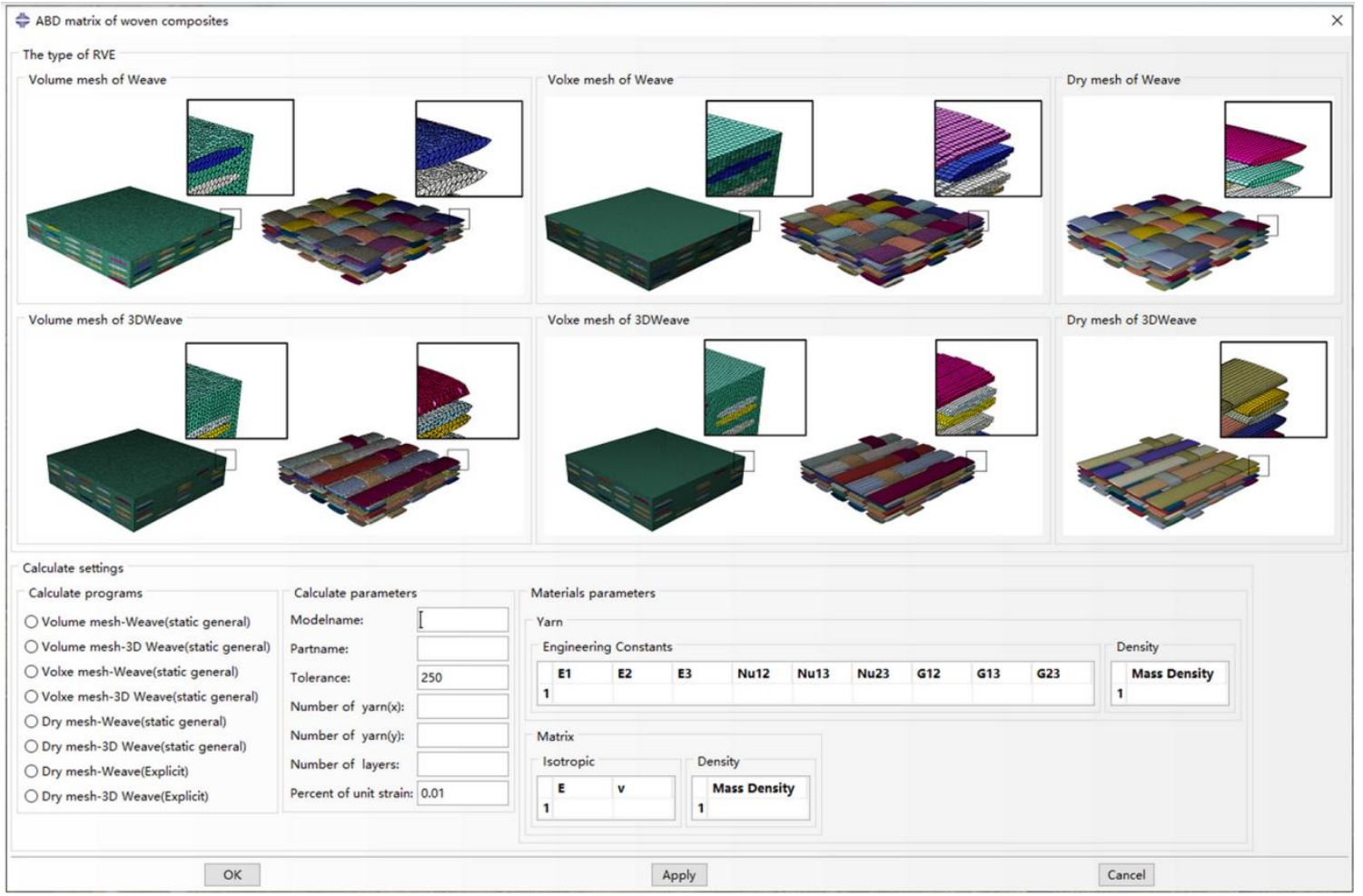


An, N.*, Jia, Q., Jin, H., Ma, X., & Zhou, J. 2022. *Materials & Design*, *219*, p.110754.

复合材料多尺度力学分析

➢ 编织复合材料力学性能分析（计算力学软件开发）

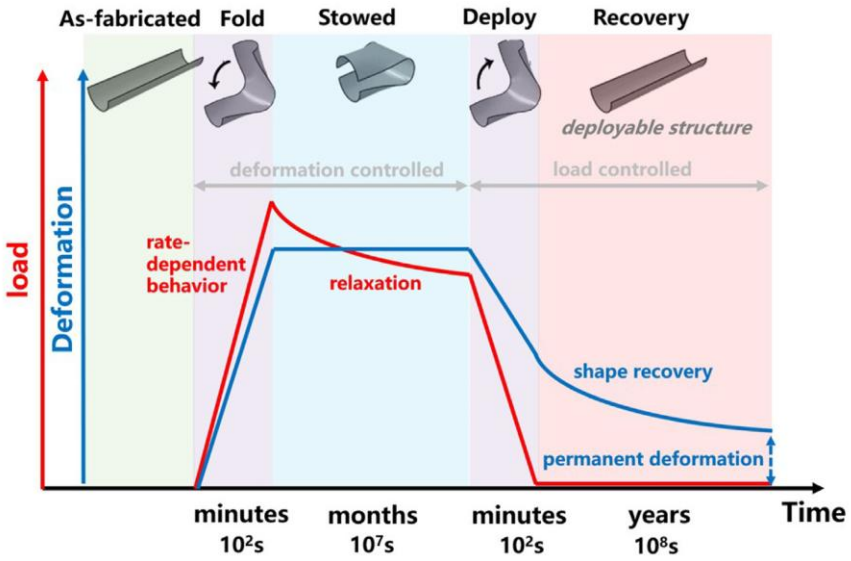


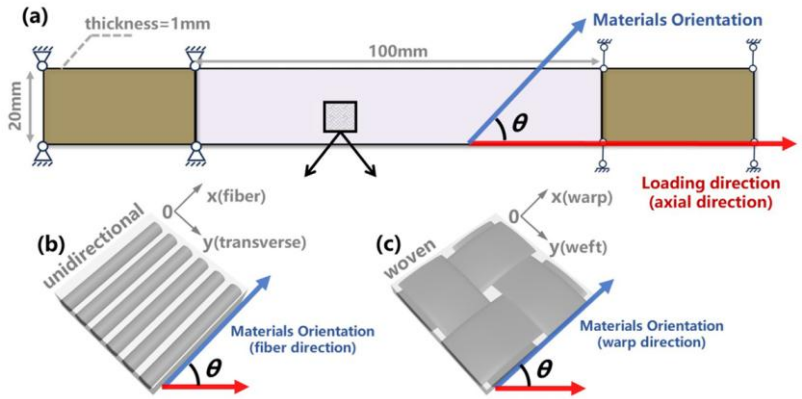


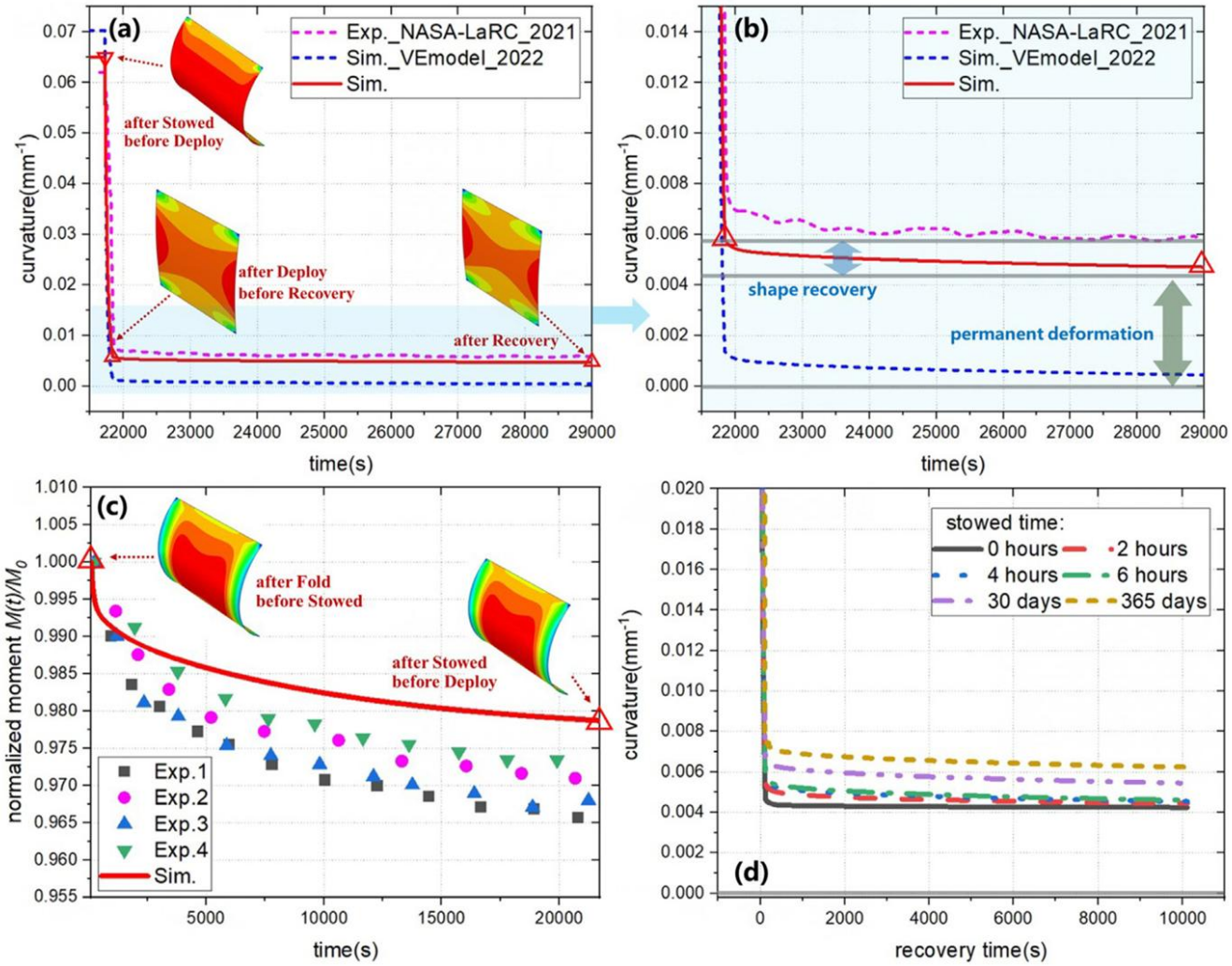
Jin, H., **An, N.***, Jia, Q., Ma, X., & Zhou, J.* (2024). *Composite Structures*, 337, p.118031.

复合材料多尺度力学分析

➢ 各向异性粘弹-粘塑性力学



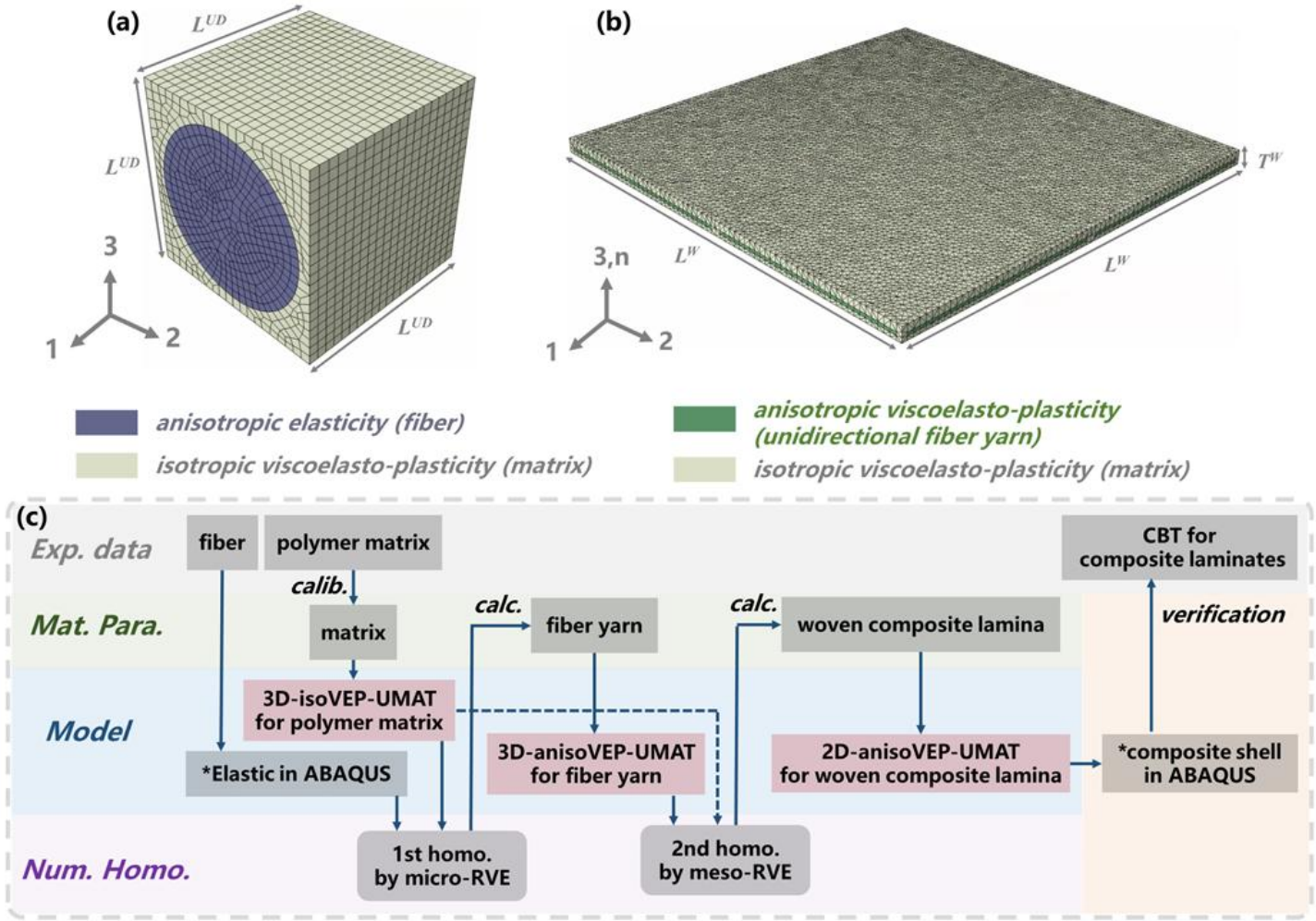


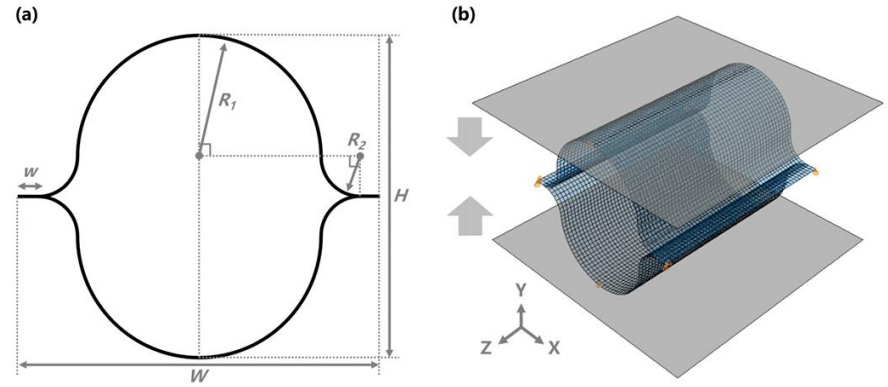


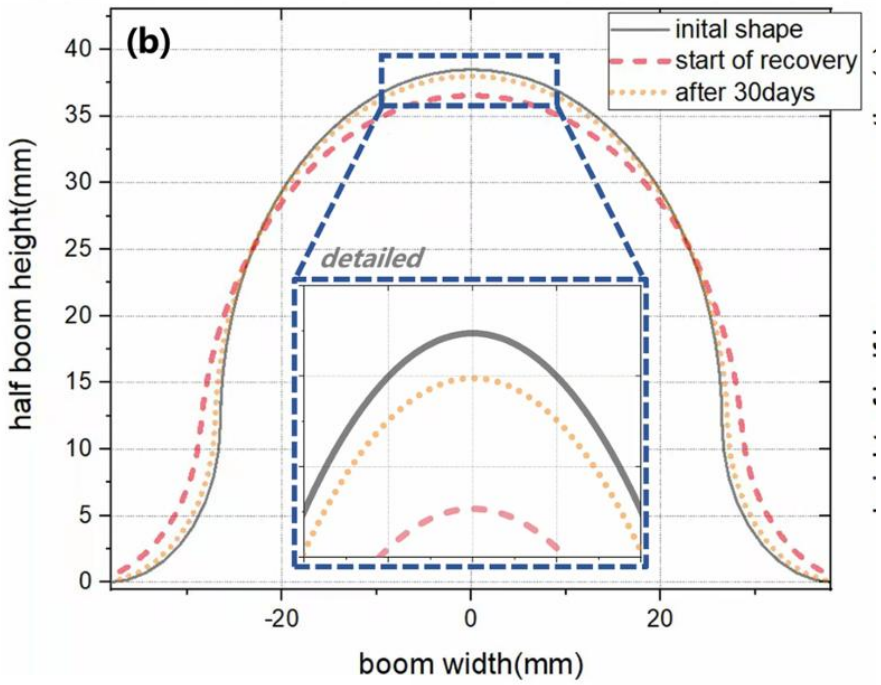
Yue, X., Guo, R., **An, N.***, & Zhou, J.* (2025). *International Journal of Solids and Structures*, 308, 113154.

复合材料多尺度力学分析

➢ 各向异性粘弹-粘塑性力学

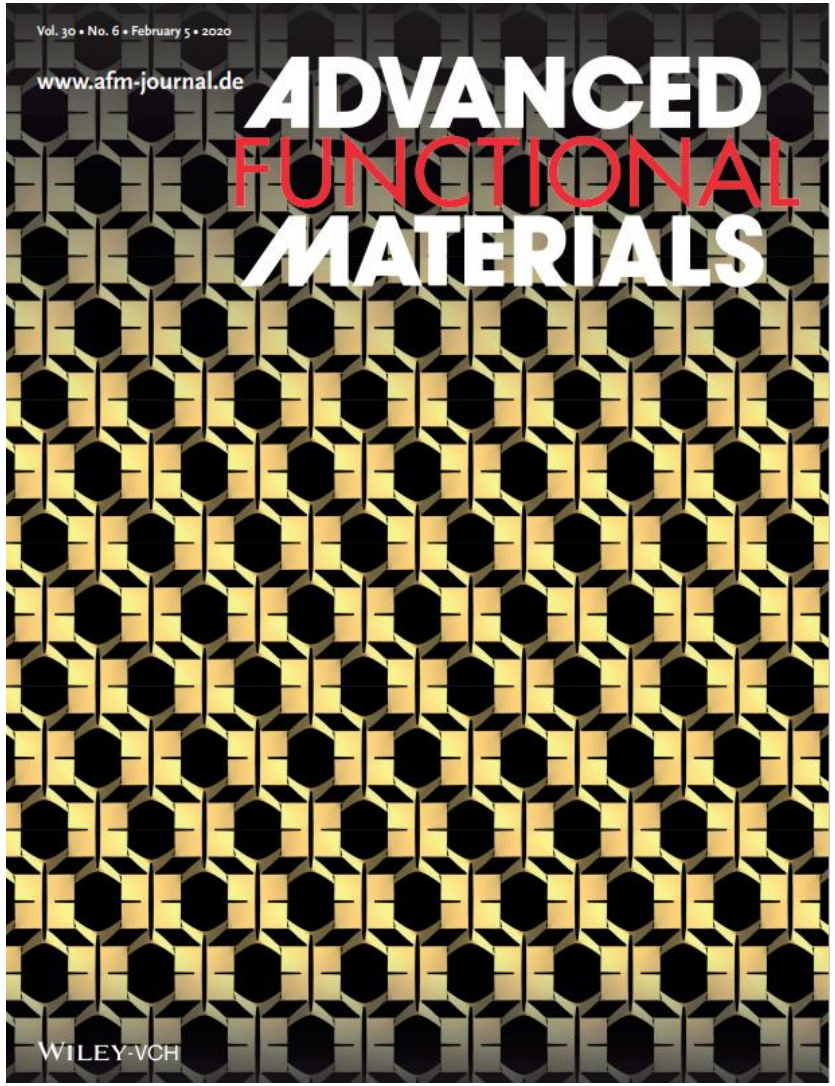


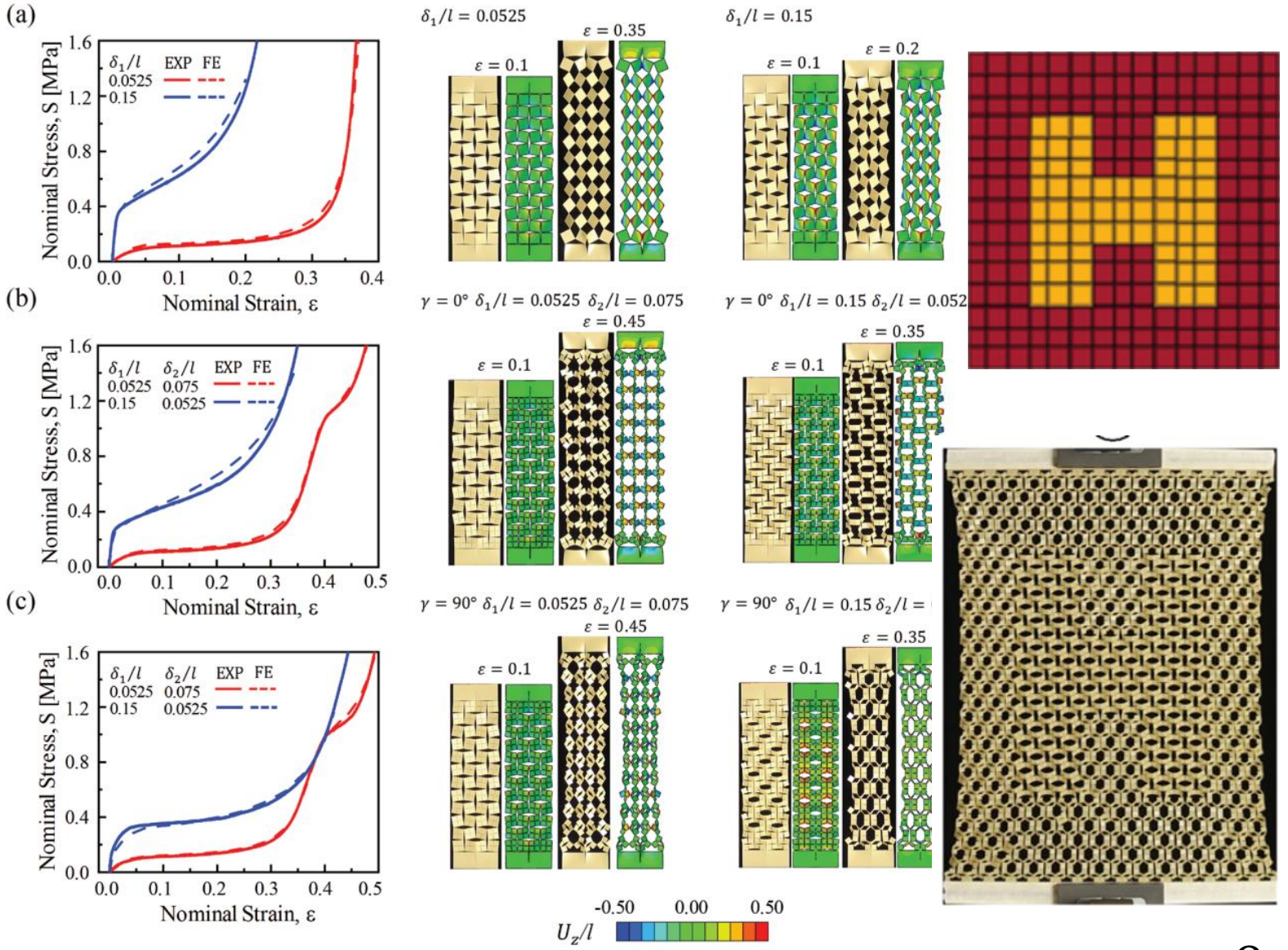




Yue, X., Guo, R., **An, N.***, Jin, H. & Zhou, J.* (2025). *Composite Structures, 383, 120185.*

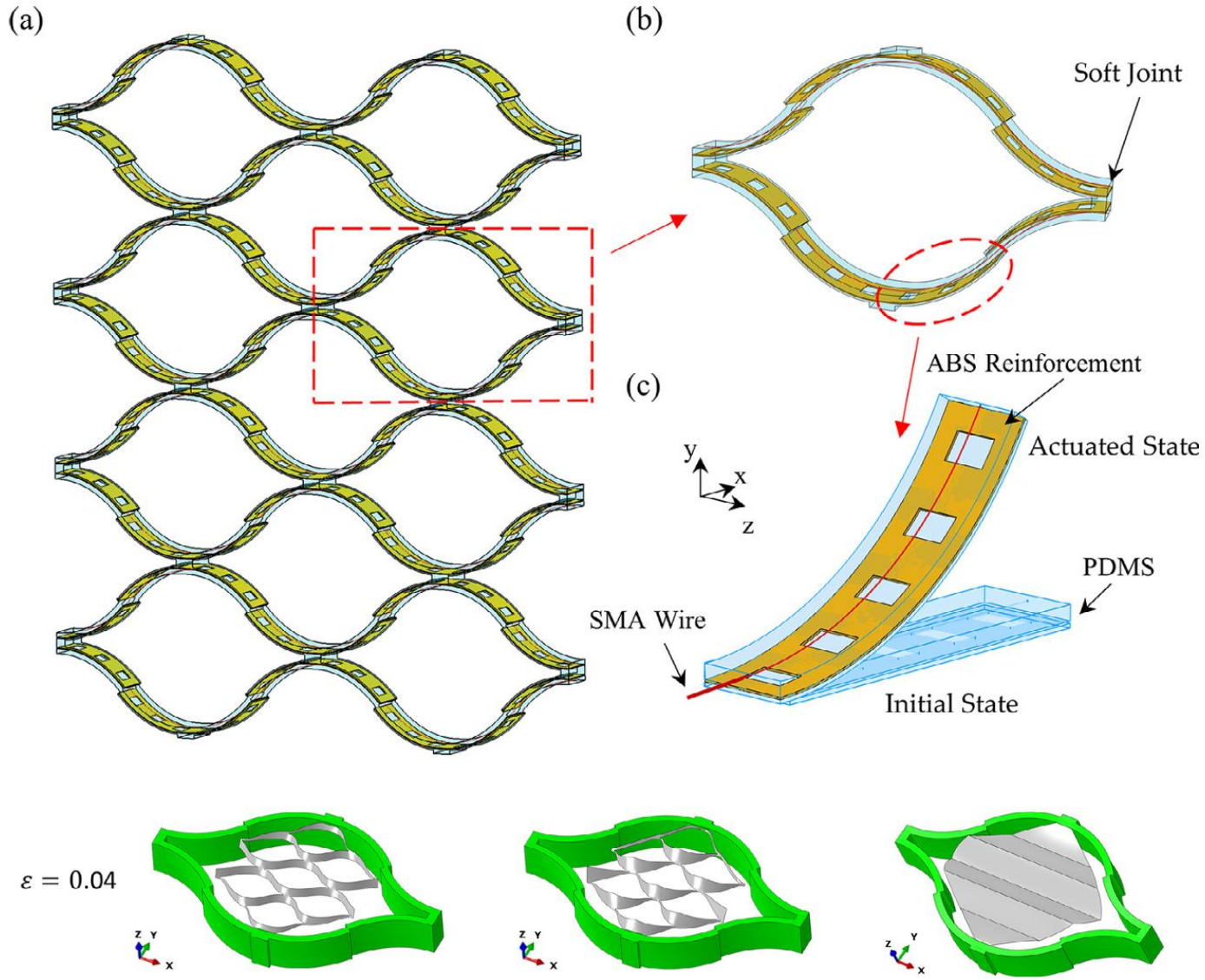
剪纸力学超材料

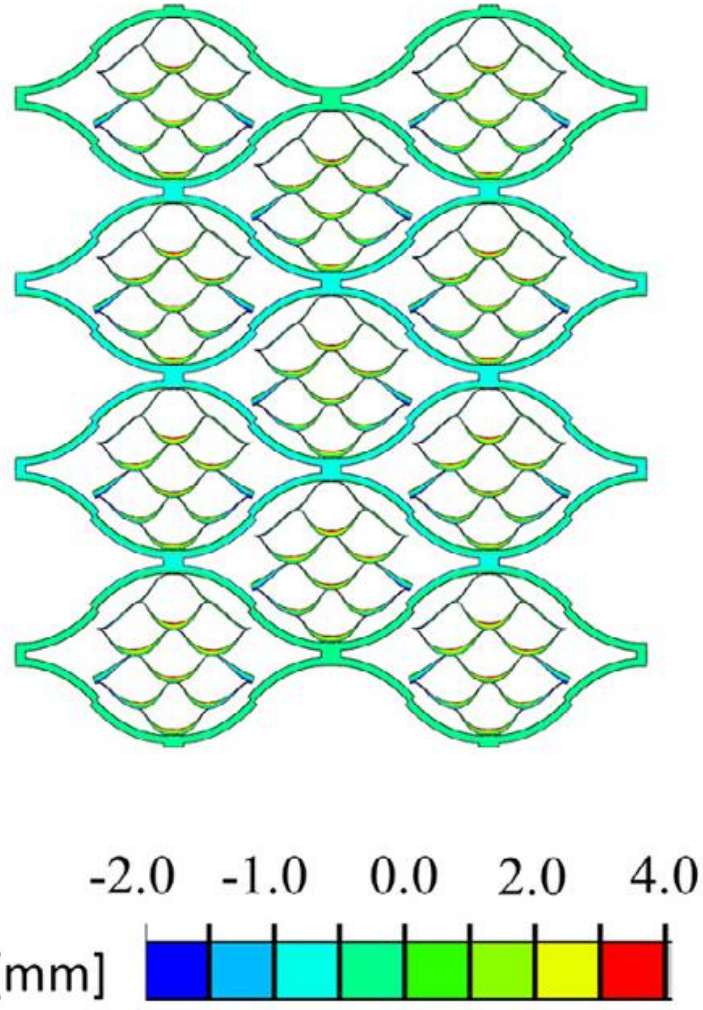




An, N., ..., Rafsanjani, A.* and Bertoldi, K.*, 2020. *Advanced Functional Materials*, *30*(6), p.1906711.

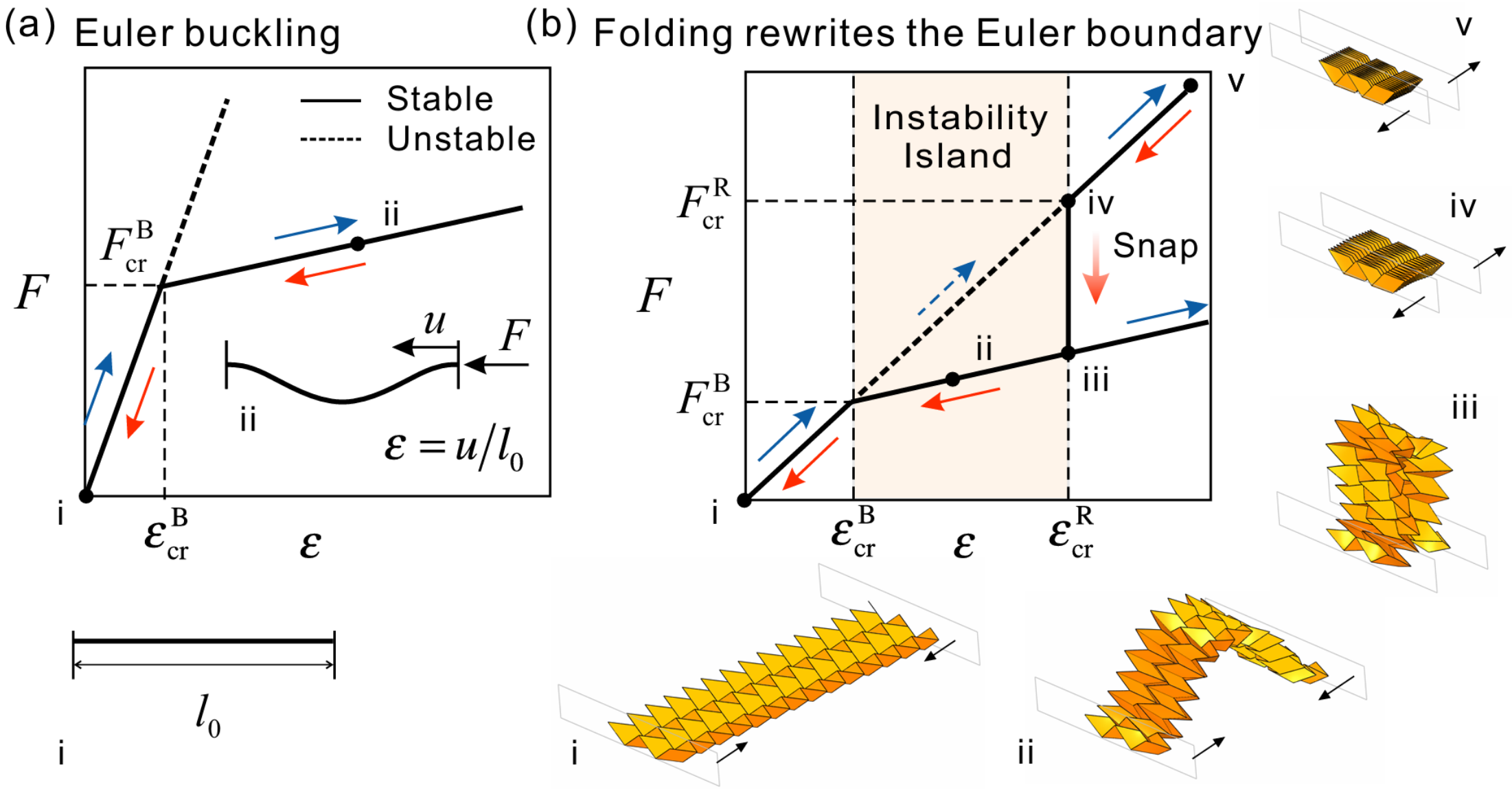
剪纸/折纸力学超材料





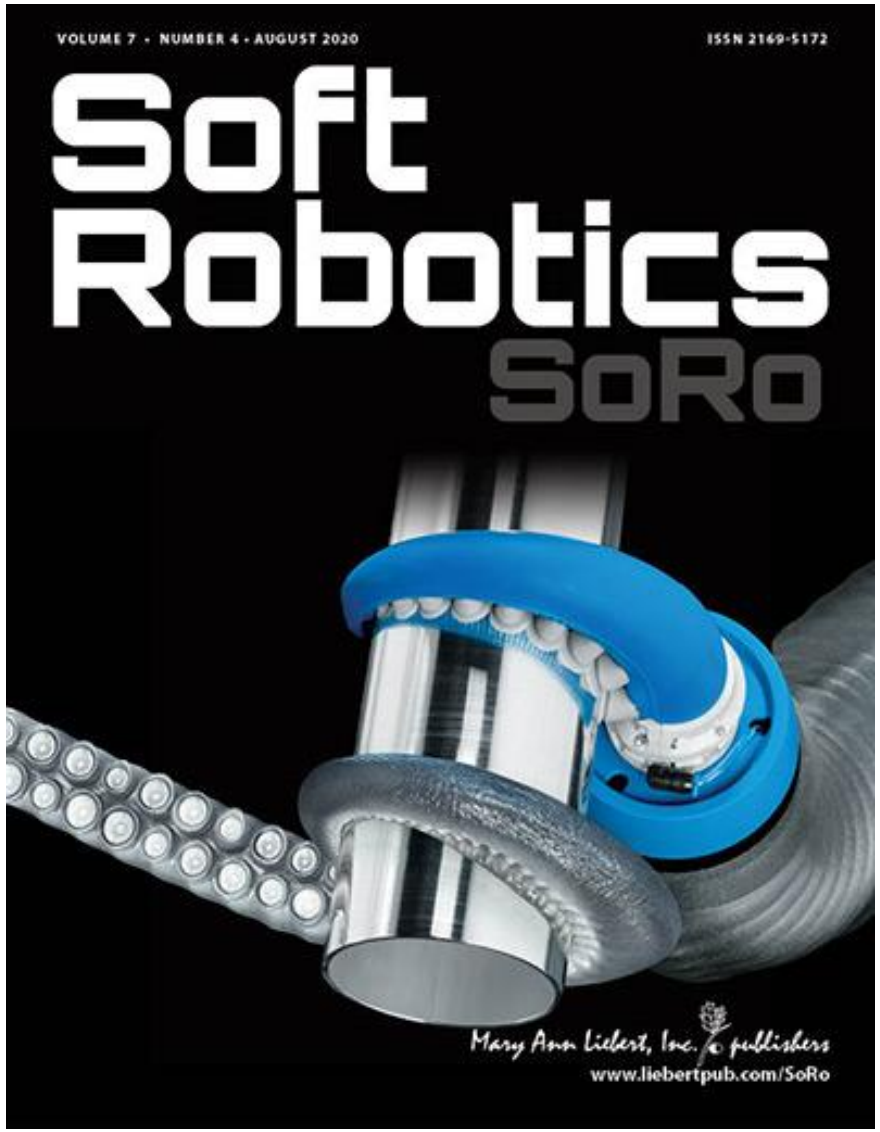
An, N., Li, M.*, & Zhou, J. (2020). *International Journal of Mechanical Sciences*, 180, 105753.

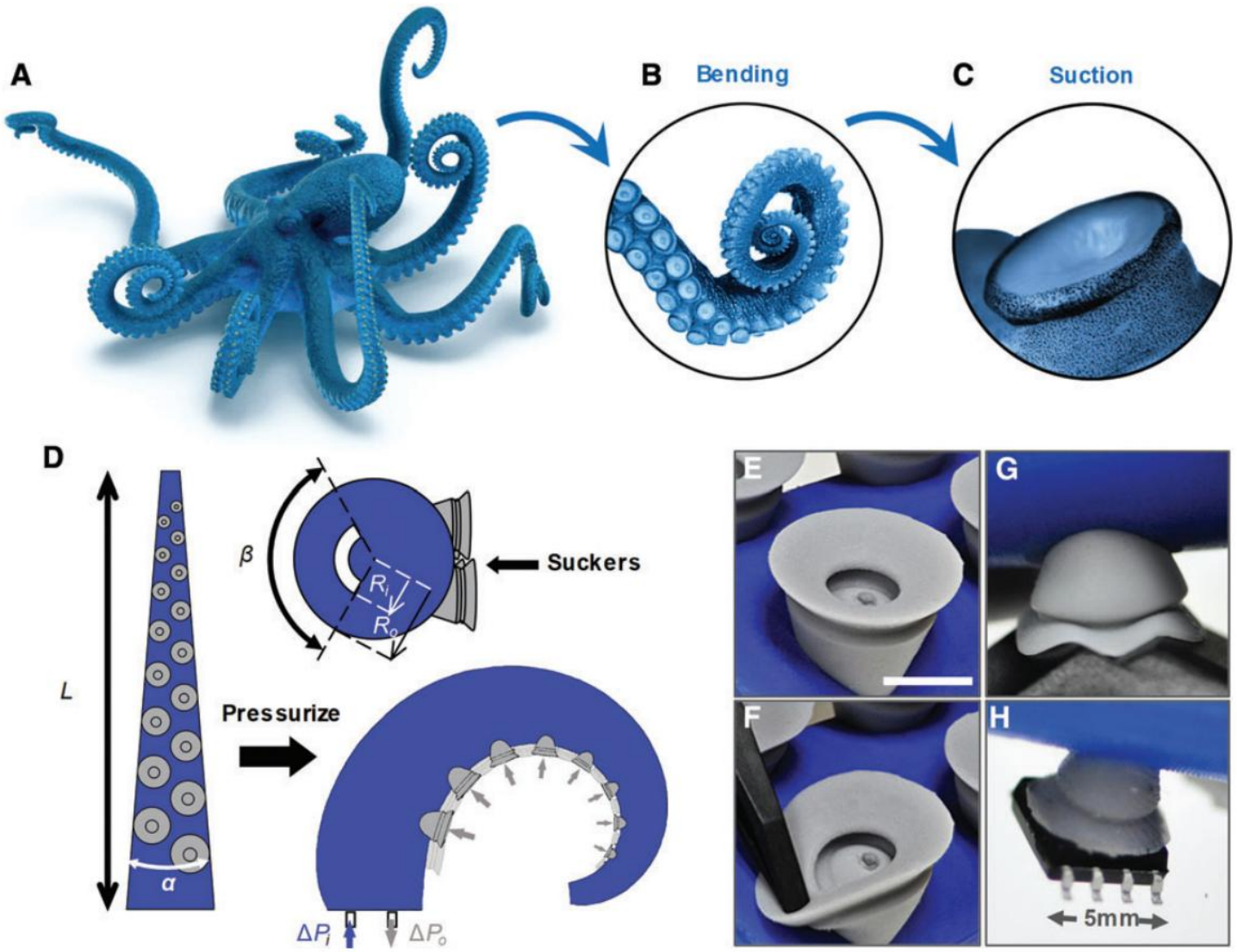
剪纸/折纸力学超材料



An, N., Dal Corso, F., Misseroni, D. (2026). Under Preparation

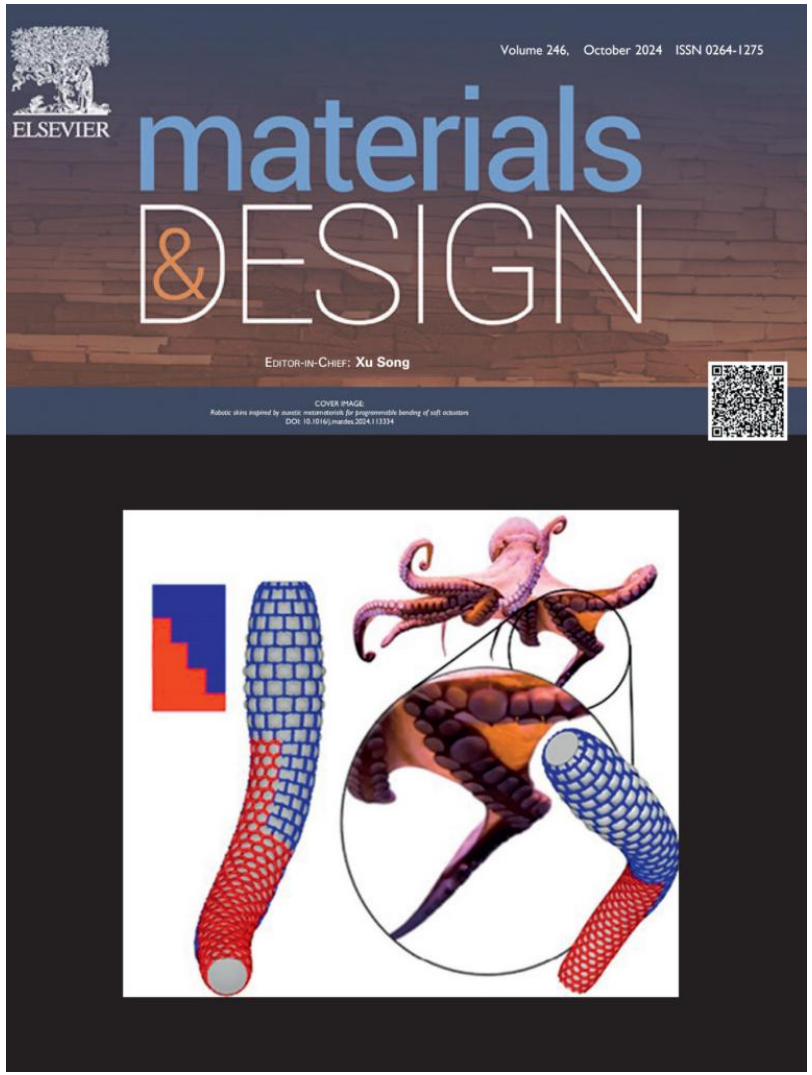
软体机器人

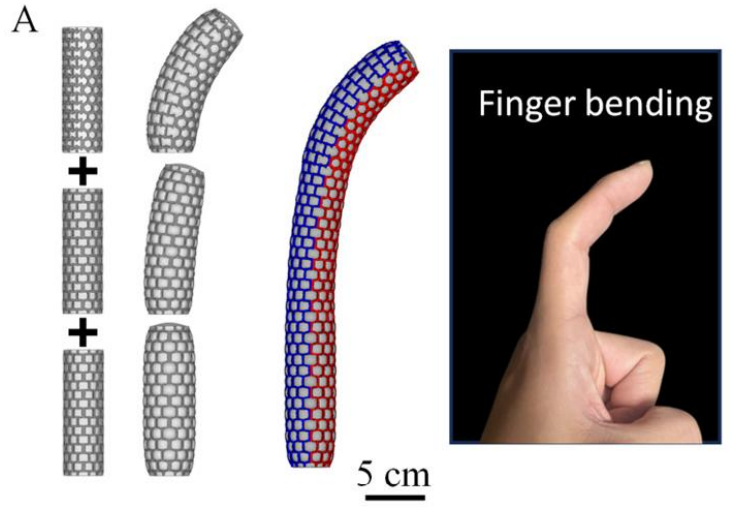


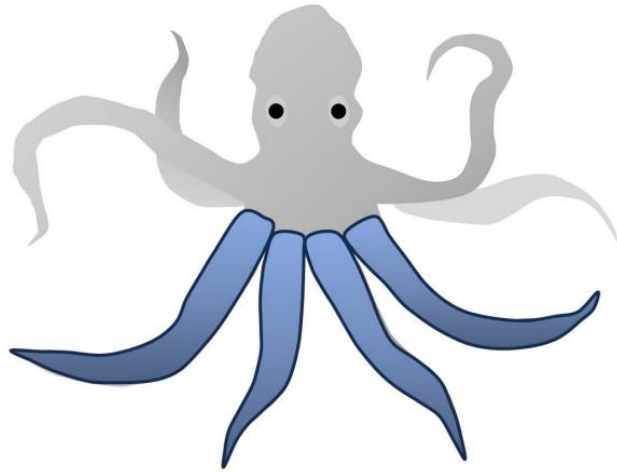


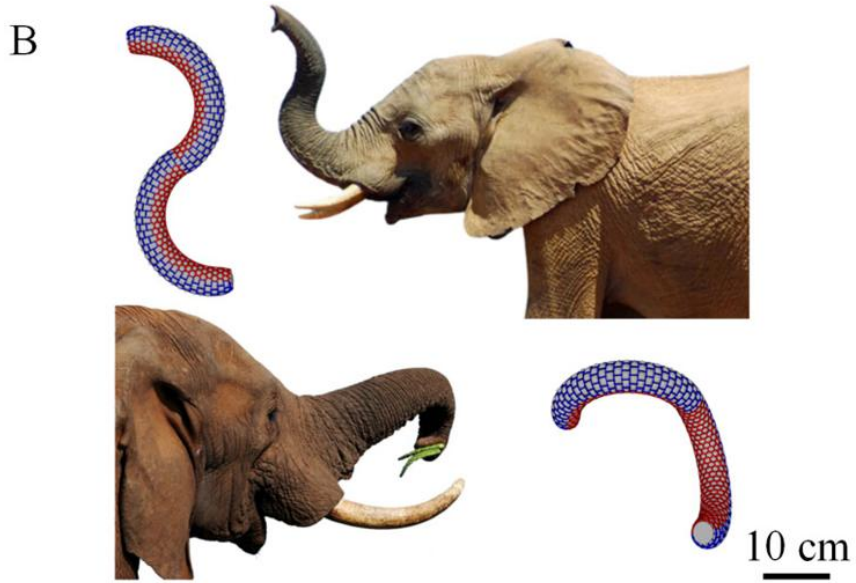
Xie, Z.#, Domel, A.G.#, **An, N.,** ..., Bertoldi, K.* and Wen, L.*, 2020. *Soft robotics*, 7(5), pp.639-648.

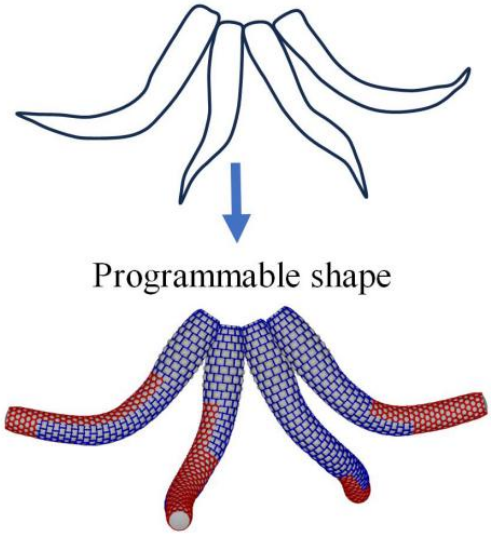
软体机器人





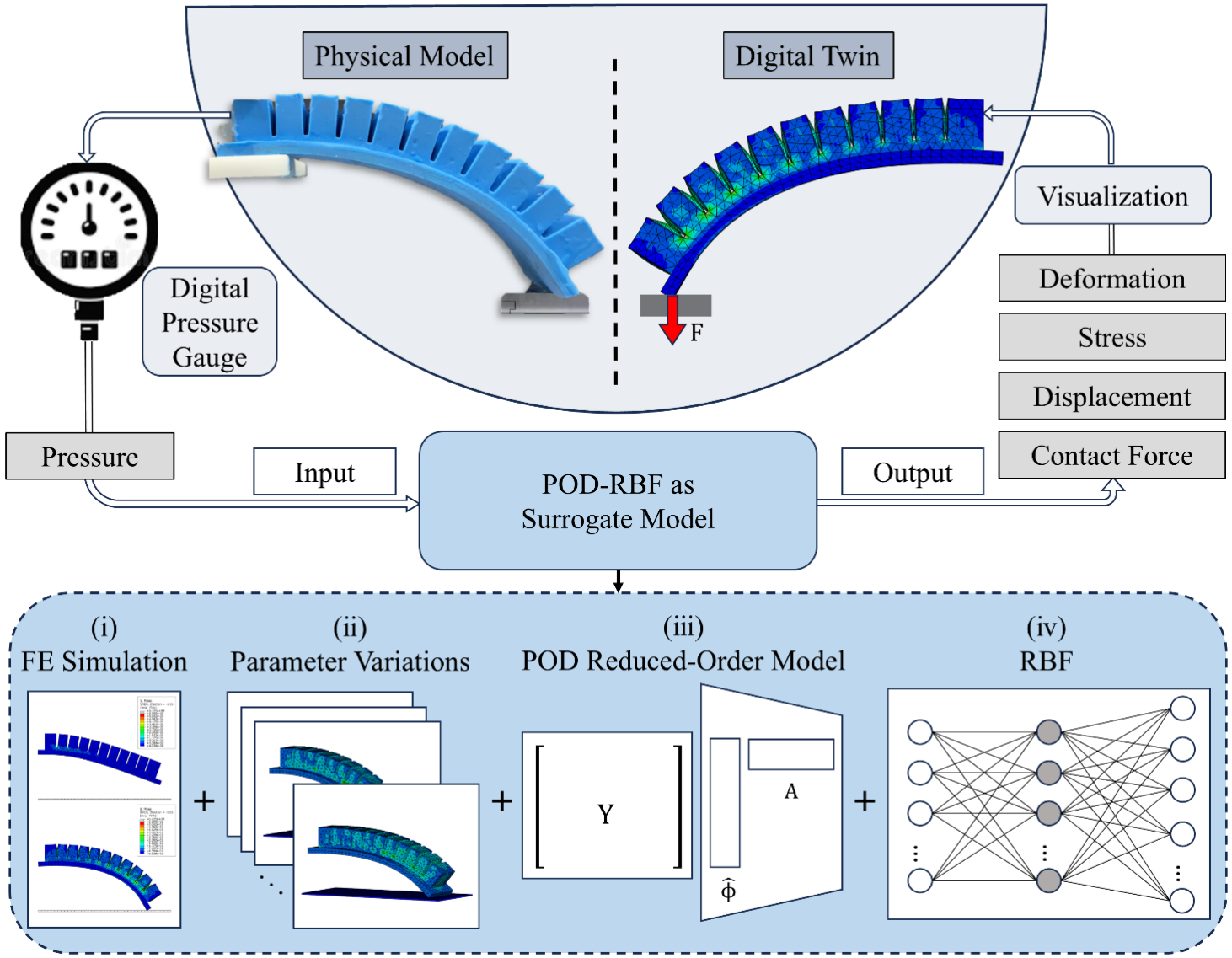


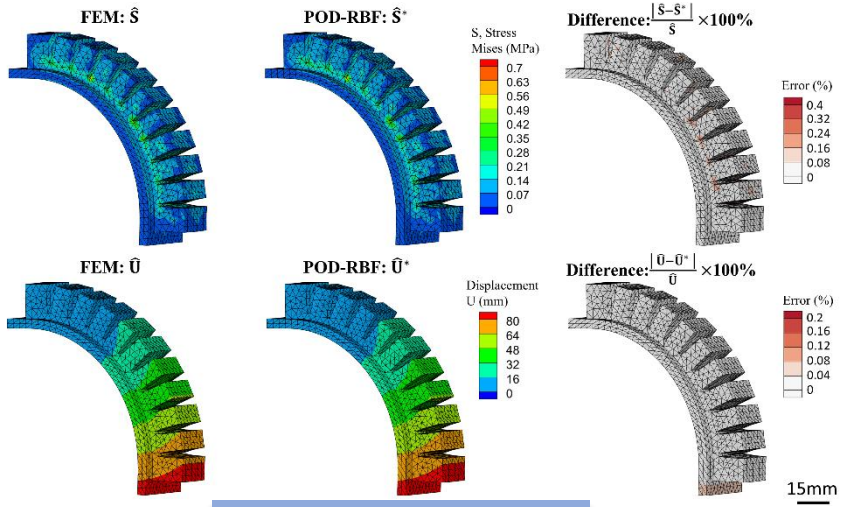


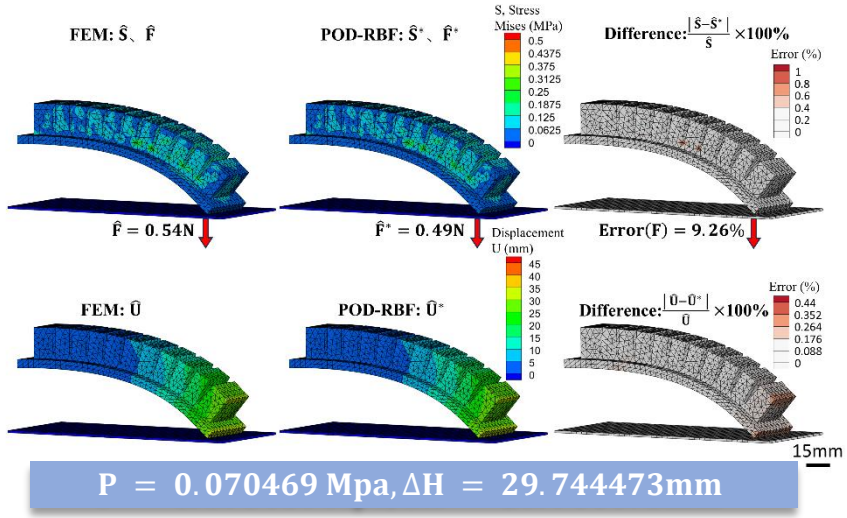


Pu, Y., Zheng, S., Hu, X., Tang, S., and **An, N.* 2024**. *Materials & Design*, 246, 113334.

软体机器人数字孪生

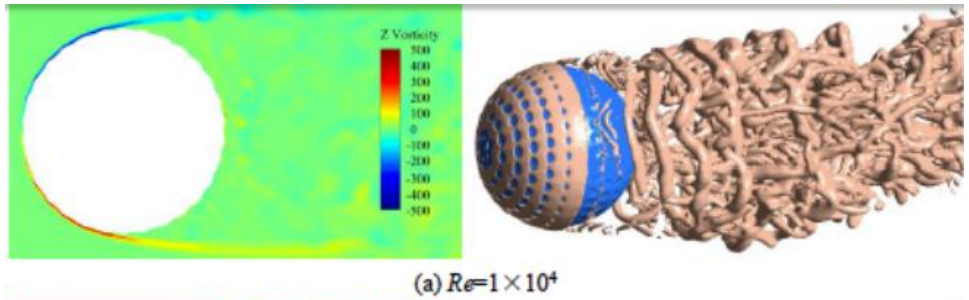




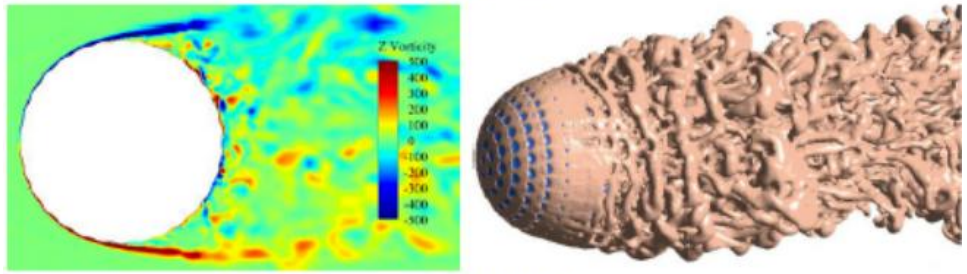


Pu, Y., Hu, X., Liu, X., Niu, S., and **An, N.* 2026**. *International Journal of Solids and Structures. 339, 114190.*

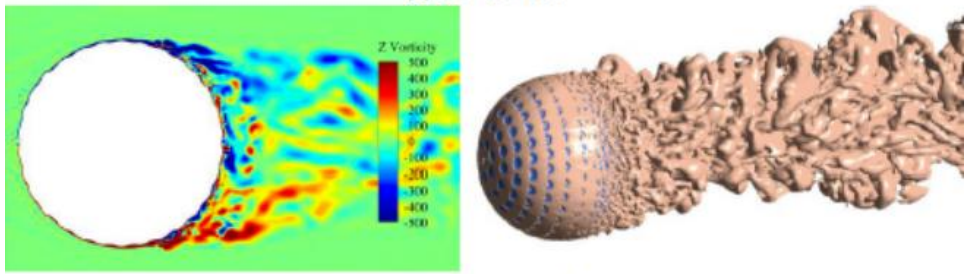
流动控制与减阻设计



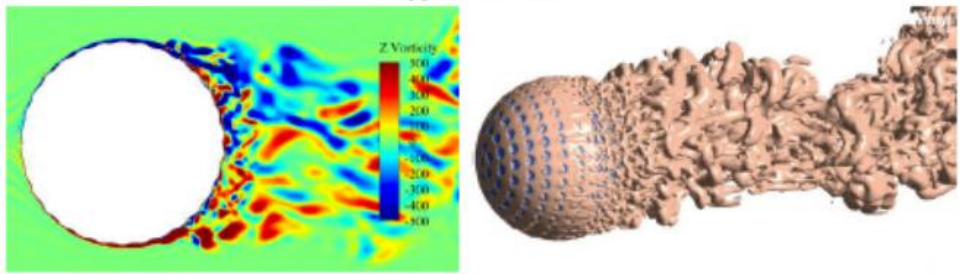
(a) Re=1×10⁴



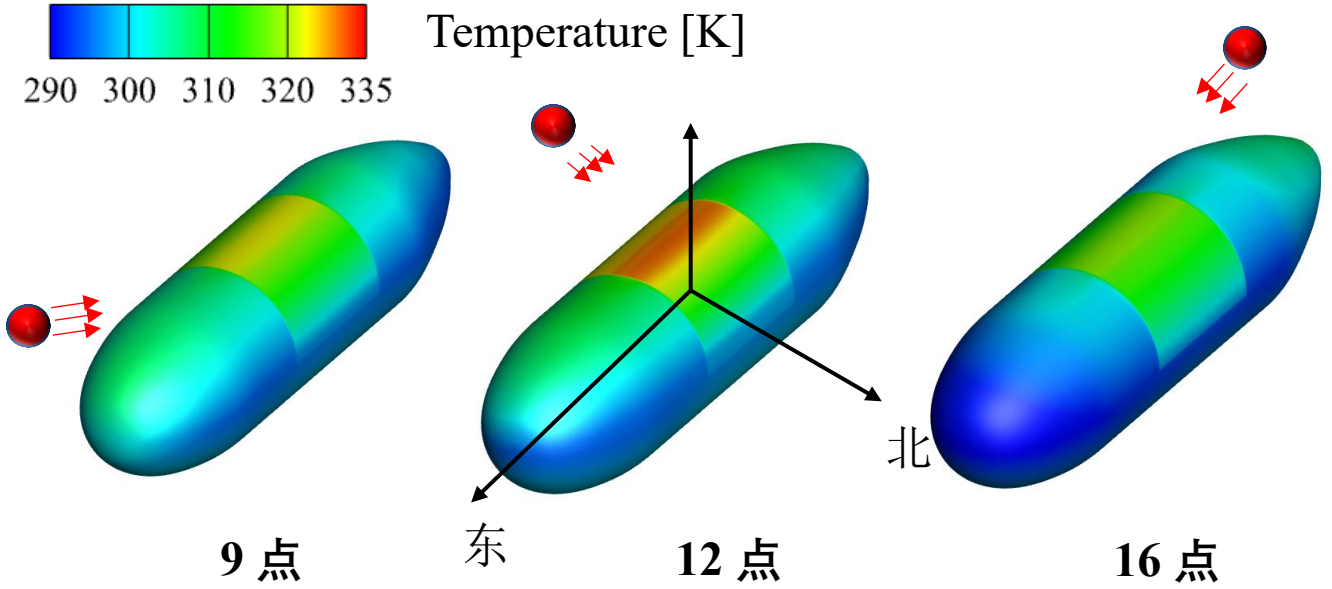
(b) Re=4.3×10⁴



(c) Re=7.5×10⁴



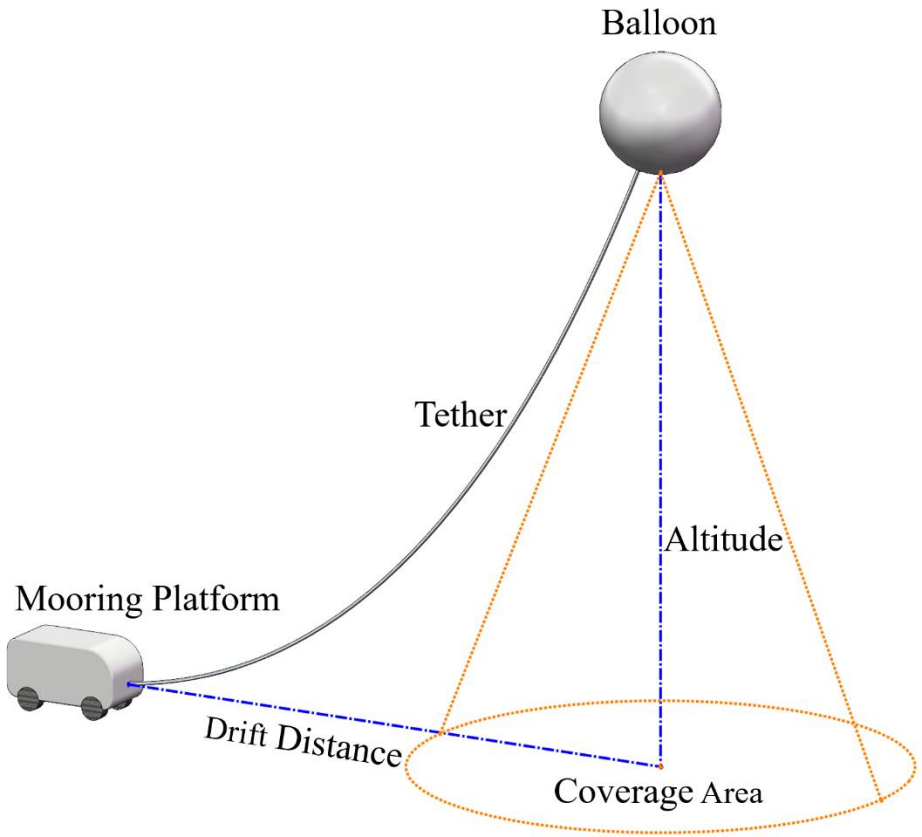
(d) Re=1.1×10⁵

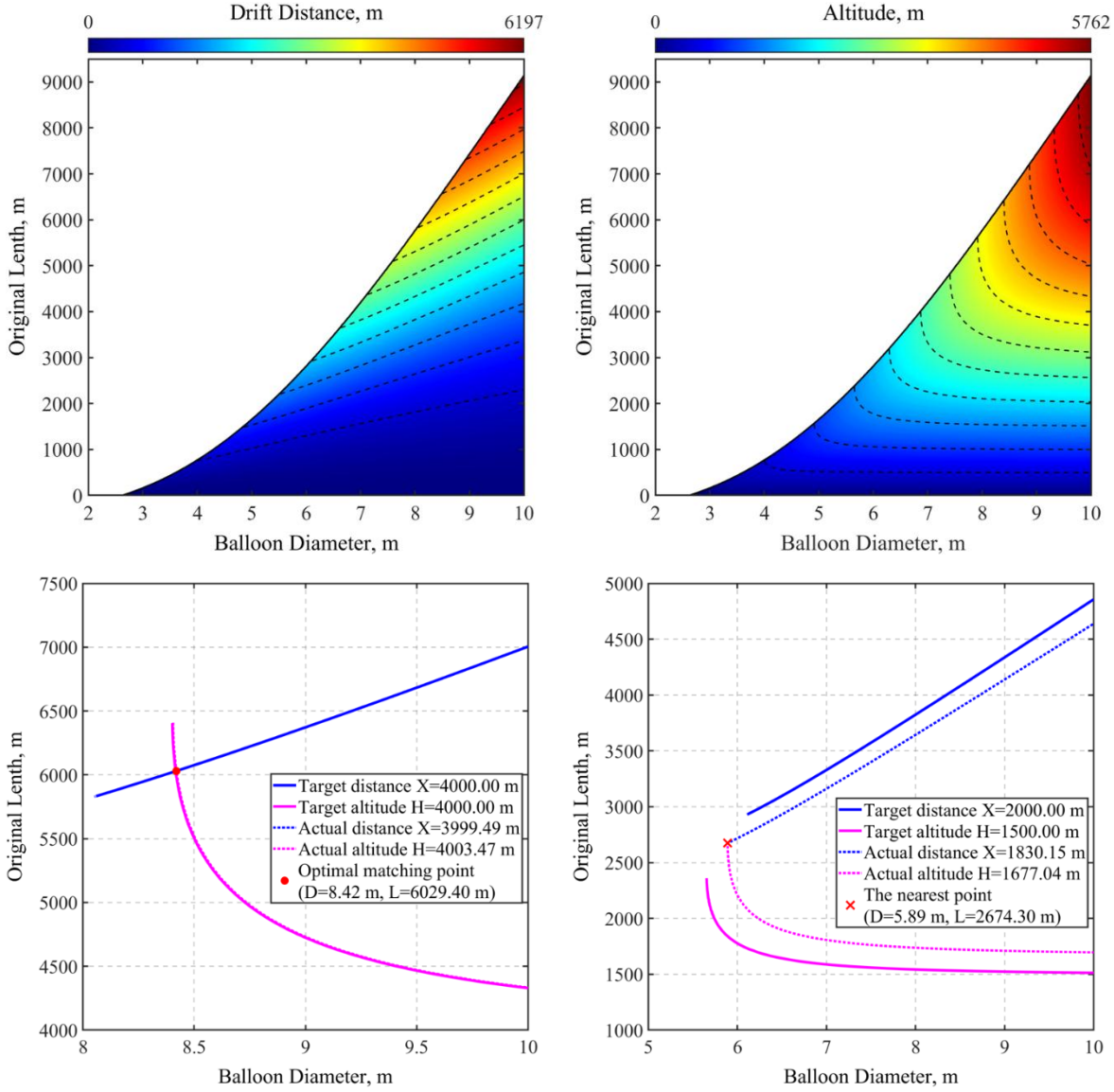


9 点　　12 点　　16 点

Fig.6 35m airship

系留气球升空过程模拟





Ni, Z., Zhu, S., Song, J., Dou, S., & **An, N.*** (2026) *Aerospace Science and Technology, 168, 111087.*

资源与研究特色

- 超算资源：国家超算，课题组工作站;
- CAE软件：ABAQUS，ANSYS Fluent
- 编程语言：Python，MATLAB，Fortran，C++;
- 开发与集成平台：TensorFlow，Keras，Isight，自研优化平台;
- 致力于发展和应用最先进的分析计算和仿真技术解决工程中的实际科学问题。

Join us

为什么选择我们团队?

- 充分的导师关注，个性化的指导和支持；
- 紧密的团队氛围，频繁的合作和交流机会；
- 创新的想法，面向工程应用和科学前沿开展研究。

- 个人主页：https://www.anning.me
- 电子邮箱：anning@scu.edu.cn

- 资源公开：https://github.com/Dr-Ning-An
- 资源公开：https://github.com/SCU-An-Group