ICCES, 2026, vol.36, no.1

Tech Science Press

DOI: 10.32604/icces.2026.014076

PROCEEDINGS

Programming Nonlinear Mechanics of Soft Composite Materials via Shear-Jamming Transition

Qin Xu[1,*]

[1]Department of Physics, Hong Kong University of Science and Technology, Hong Kong SAR, 999077, China

[*]Corresponding Author: Qin Xu. Email: qinxu@ust.hk

ABSTRACT

Soft composites are widely used in the modern materials industry and play a significant role in emerging engineering fields such as soft robotics, wearable medical devices, and intelligent responsive materials. Due to the multiscale complexity and structural heterogeneity of soft composites, classical theories struggle to describe the coupling between particle interaction networks and the elastic matrix in the dense limit. To address this issue, this study systematically investigates the role of shear jamming in the nonlinear mechanics of soft composites. First, a phenomenological model based on critical scaling laws was established to capture the nonlinear mechanics of soft composites [1]; Second, by controlling the coupling between shear-jamming structures and matrix elasticity, we achieve both programmable non-reciprocal responses [2] and tissue-like strain-stiffening [3]. These studies provide new insights for addressing key challenges in dense soft composites and open new pathways for the development of mechanically intelligent materials.

KEYWORDS

Soft composites; jamming; non-reciprocity; strain-stiffening

Acknowledgement: We appreciate important insights from Wenqi Hu (HKUST) and Yuliang Jin (ITP/CAS).

Funding Statement: We thank the Hong Kong Research Grants Council for the funding support (no. C6004-22Y, no. C6042-24G, and GRF no. 16307422).

Conflicts of Interest: The author declares no conflicts of interest to report regarding the present study.

References

1. Zhao, Y., Hu, H., Huang, Y., Liu, H., Yan, C., Xu, C., Zhang, R., Wang, Y., Xu, Q. (2024). Elasticity-controlled jamming criticality in soft composite solids. *Nature Communications, 15(1),* 1691.
2. Xu, C., Wang, S., Wang, H., Liu, X., Liu, Z., Zhao, Y., Hu, W., Xu, Q. (2026). Mechanical non-reciprocity programmed by shear jamming in soft composites. *Nature Materials, 25(1),* 117–123.
3. Zhao, Y., Pan, D., Pang, Y., Bares, J., Xu, C., Hu, H., Jin, Y., Xu, Q. (2026). Programming strain-stiffening in soft composites via structural memory near jamming. Under Review.

Copyright © 2026 The Author(s). Published by Tech Science Press.
This work is licensed under a Creative Commons Attribution 4.0 International License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.